

REMEDIAL INVESTIGATION ADDENDUM for SITE 1 - PRIVET ROAD COMPOUND

NAVAL AIR STATION
JOINT RESERVE BASE
WILLOW GROVE, PENNSYLVANIA



Engineering Field Activity Northeast
Naval Facilities Engineering Command

Contract No. N62472-03-D-0057
Contract Task Order 003

SEPTEMBER 2005



TETRA TECH NUS, INC.

REMEDIAL INVESTIGATION ADDENDUM
for
SITE 1 – PRIVET ROAD COMPOUND

NAVAL AIR STATION JOINT RESERVE BASE
WILLOW GROVE, PENNSYLVANIA

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

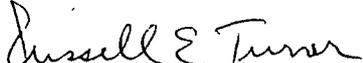
Submitted to:
Engineering Field Activity Northeast
Environmental Branch, Code EV2
Naval Facilities Engineering Command
10 Industrial Highway, Mall Stop #82
Lester, Pennsylvania 19113-2090

Prepared and submitted by:
Tetra Tech NUS
600 Clark Avenue, Suite 3
King of Prussia, Pennsylvania 19406-1433

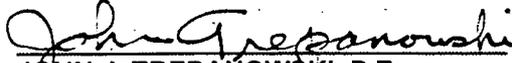
Contract No. N62472-03-D-0057
Contract Task Order 003

September 2005

PREPARED UNDER DIRECTION OF:


RUSSELL E. TURNER
PROJECT MANAGER
TETRA TECH NUS
KING OF PRUSSIA, PENNSYLVANIA

APPROVED FOR SUBMISSION BY:


JOHN J. TREPANOWSKI, P.E.
PROGRAM MANAGER
TETRA TECH NUS
KING OF PRUSSIA, PENNSYLVANIA

RI ADDENDUM FOR SITE 1 - PRIVET ROAD COMPOUND NAS JRB WILLOW GROVE, PENNSYLVANIA

INTRODUCTION

The purpose of this report is to present and review the additional groundwater quality data collected in the vicinity of Site 1 (the Privet Road Compound). The new data was obtained from new monitoring wells installed subsequent to the submission of the Site 1 RI report (TiNUS, July 2002). This report discusses how these data affect the site's conceptual model regarding the identification of potential chlorinated solvent volatile organic compound (VOC) source areas in the vicinity of Site 1.

GENERAL CONCLUSION

Groundwater quality and flow characteristics collected from more than a decade of remedial investigation (RI) activities focusing on the Privet Road Compound area indicate that there are several potential minor chlorinated solvent contaminant sources in the vicinity on Navy property. If there actually were minor chlorinated solvent sources on Navy property in the area (e.g., undocumented historical spill), they appear to be depleted of any sort of concentrated source that could continue to spread or be amenable to active remediation schemes.

The only potential major source of the chlorinated solvent found in the local groundwater (and Navy potable water production wells) appears to be an off-Base location southeast of the Privet Road Compound area across Pennsylvania Route 611 in the vicinity of the former Kellet Aircraft manufacturing facility.

DISCUSSION

The RI for Site 1 delineated coalescing groundwater plumes that are either migrating through the site under natural (ambient) flow conditions or are drawn to the site by the pumping of the two deep high-yielding Navy potable water wells. The RI concluded that the Privet Road Compound is not the major source of the VOCs detected in the Site 1 area groundwater, but noted that the difficulty and uncertainty in delineating the individual extents of the multiple plumes and their sources was compounded by the complex hydrogeology, which is characterized by the presence of multiple (unconfined and semi-confined to confined) aquifers that respond differently to the daily pumping of the Navy supply wells. The RI concluded that an off-site source (possibly in the vicinity of the former Kellet Aircraft Facility) appears to be the most significant source of VOCs, but the investigation also delineated three potential on-Base, lesser sources of VOCs, including:

- A potential source of PCE and TCE in the vicinity of Supply Well No. 1 or the Public Works Building.
- A possible minor source of TCE at the Privet Road Compound.
- A potential minor source of TCE southwest of the compound, in the vicinity or upgradient of the Navy Fuel Farm.

The delineation or identification of the potential sources in the vicinity of the Navy Fuel Farm, Supply Well No. 1, and the Public Works Building were constrained to varying degrees by the absence of monitoring wells at some locations, or, if wells were present, the absence of well cluster to simultaneously monitor the unconfined and confined portions of the aquifer. Subsequent to the completion of the RI, the Navy installed additional monitoring wells to address these data gaps. The analytical results from these wells, and their impact on the delineation of the potential source areas (and their impact to the site conceptual model) form the basis of this report.

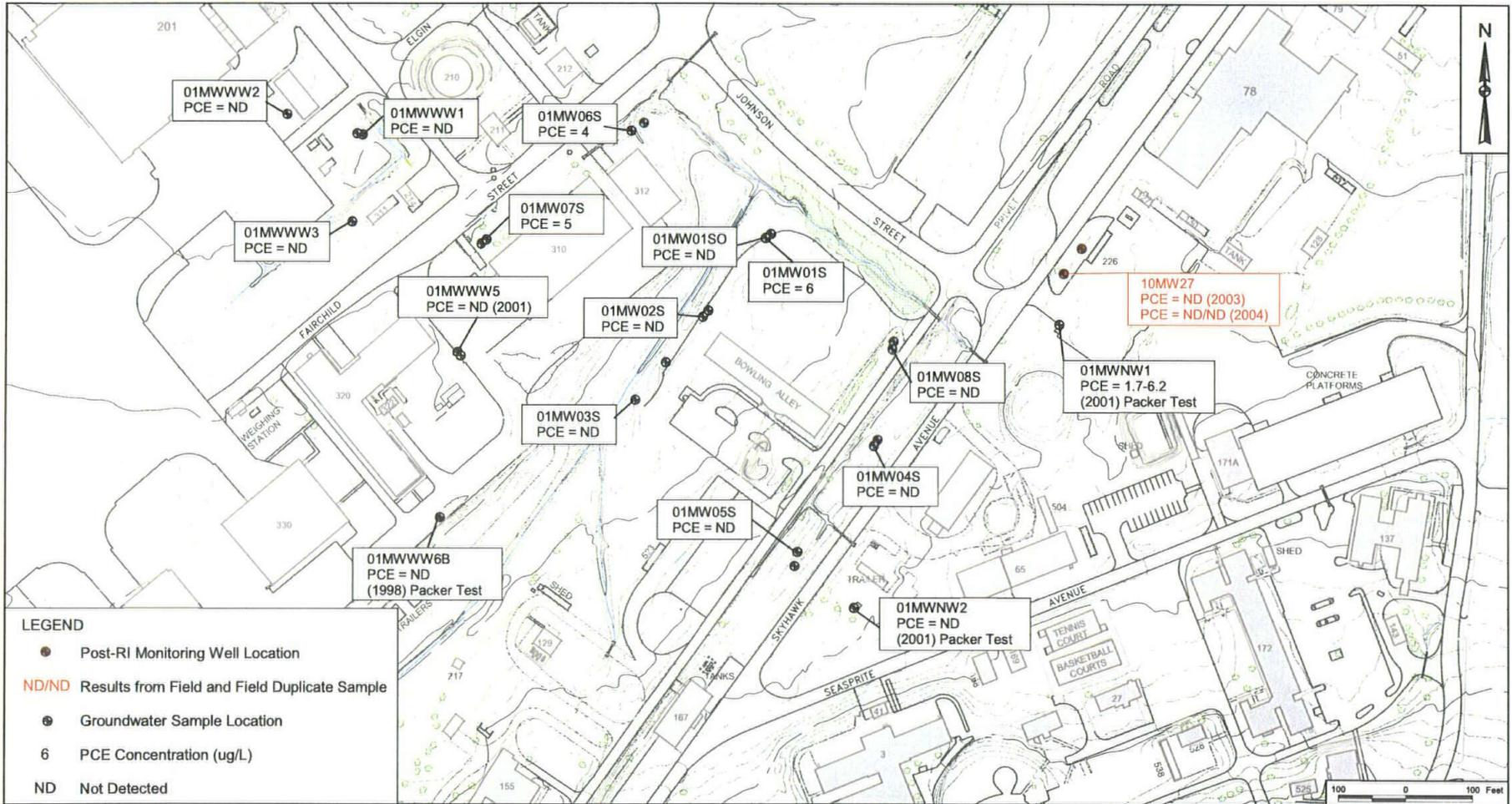
1. Supply Well No. 1, the Public Works Building and Possible Minor Source at the Privet Road Compound

New monitoring wells 10MW27 and 10MW28 were installed northeast of the Privet Road Compound and in the immediate vicinity of Supply Well No. 1. The purpose of the new wells was to address the RI data gap concerning the groundwater quality in the area northeast of Supply Well No. 1 near the Navy Public Works Building (Building No. 78), and to determine if one of the apparent sources of VOCs cited in the RI occurs in this vicinity. Both wells were constructed to monitor the bedrock.

- Monitoring well 10MW27 was constructed as an open hole between the depths of 16 - 42 feet, and monitors multiple fractures within that open interval.
- Monitoring well 10MW28 was constructed with a well screen extending from the subsurface interval of 98 - 108 feet, and monitors a fractured interval extending from a subsurface depth of about 100 - 105 feet.

Relative to the existing site conceptual model, monitoring well 10MW27 is interpreted to monitor the shallow, unconfined aquifer. Monitoring well 10MW28 is interpreted to monitor the uppermost portion of the confined aquifer, although this interpretation is based solely on the depth of the well.

The groundwater analytical results for 10MW27 and 10MW28 for two sampling rounds (June 2003 and February 2004) are illustrated for selected VOCs in Figure 1 - Figure 4. The interpretation of these data and their integration into the site conceptual model result in the following conclusions:

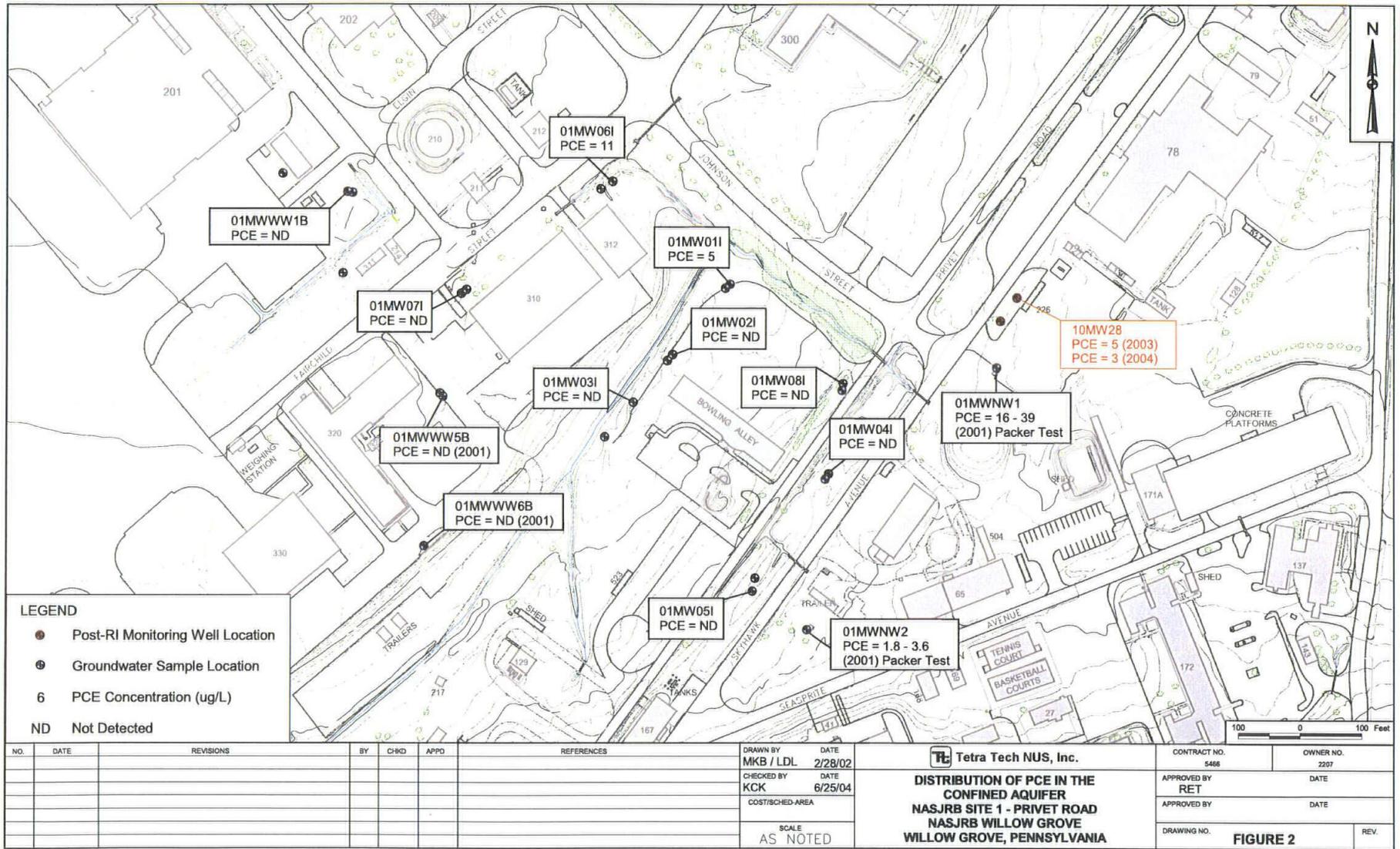


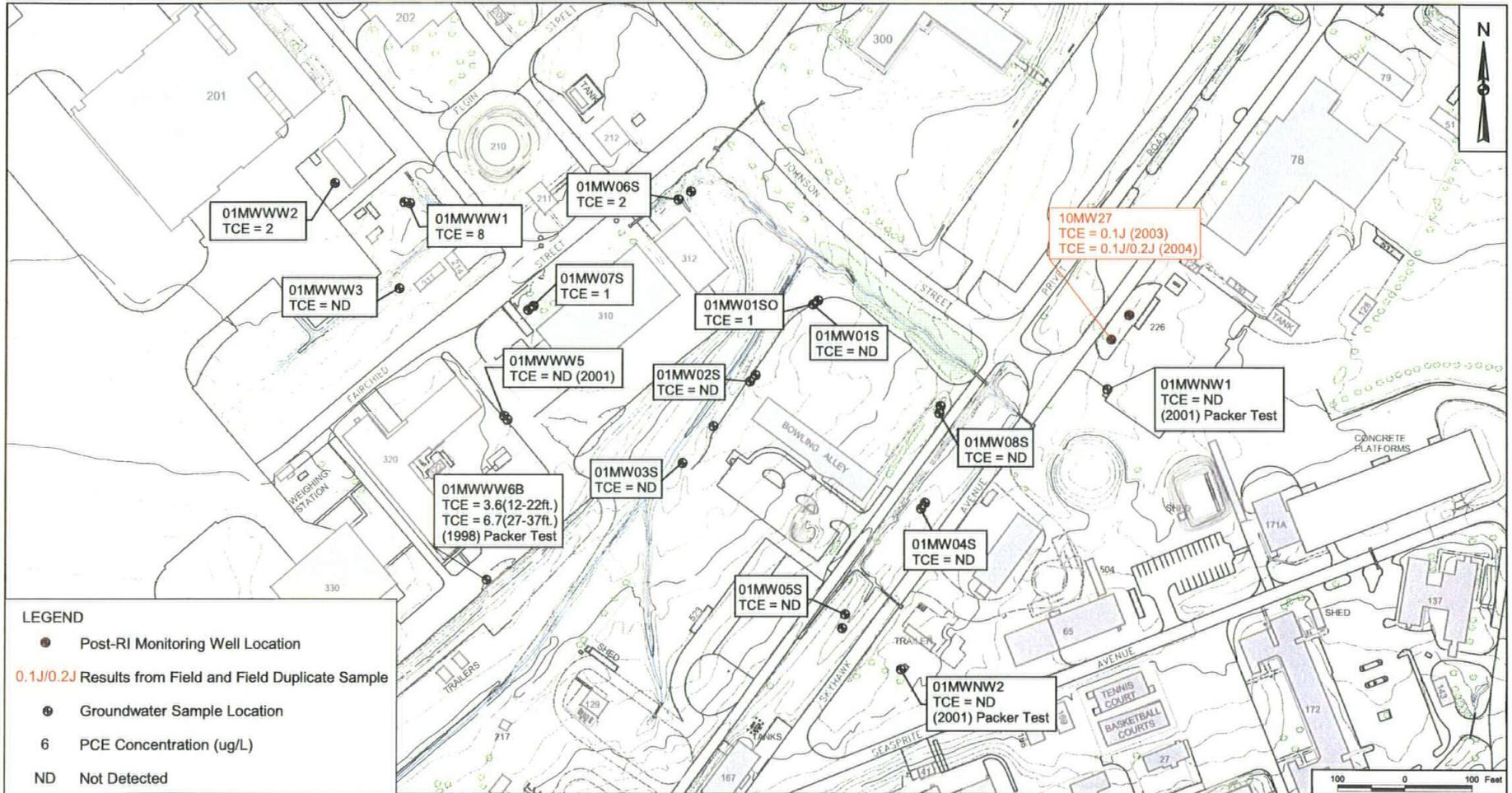
LEGEND

- Post-RI Monitoring Well Location
- Groundwater Sample Location
- 6 PCE Concentration (ug/L)
- ND Not Detected
- ND/ND Results from Field and Field Duplicate Sample

NO.	DATE	REVISIONS	BY	CHKD	APPO	REFERENCES	SCALE	Tetra Tech NUS, Inc. DISTRIBUTION OF PCE IN THE UNCONFINED AQUIFER NASJRB SITE 1 - PRIVET ROAD NASJRB WILLOW GROVE WILLOW GROVE, PENNSYLVANIA	CONTRACT NO.	OWNER NO.
							AS NOTED		5466	2207
									APPROVED BY	DATE
									APPROVED BY	DATE
								DRAWING NO.	FIGURE 1	REV.

2192 WillowGravel/GIS/Apr's/L-SITE-1a apr LAYOUT: FIGURE 1 06/25/04 MKB

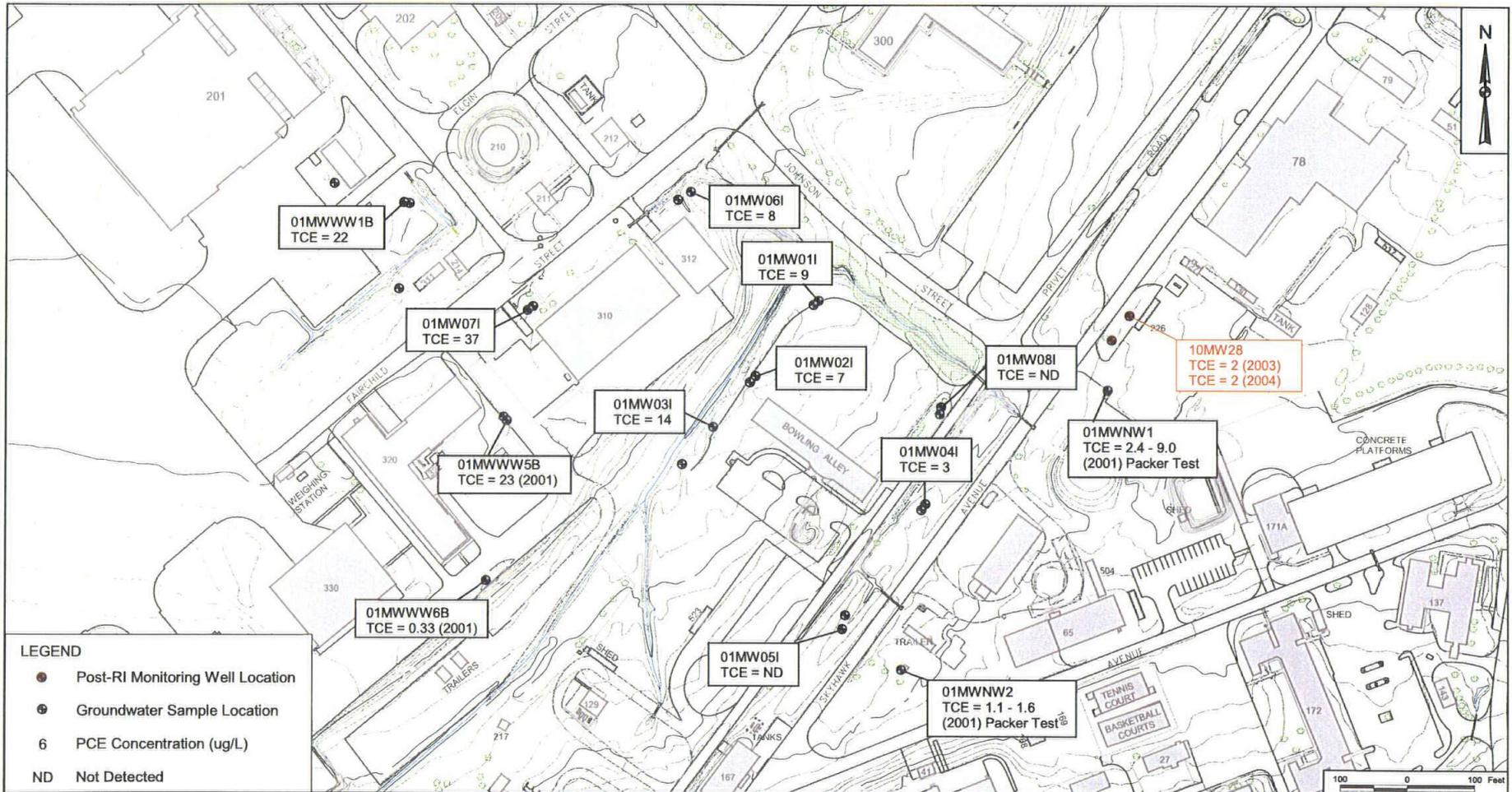




LEGEND

- Post-RI Monitoring Well Location
- 0.1J/0.2J Results from Field and Field Duplicate Sample
- ⊕ Groundwater Sample Location
- 6 PCE Concentration (ug/L)
- ND Not Detected

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES	DRAWN BY	DATE	Tetra Tech NUS, Inc. DISTRIBUTION OF TCE IN THE UNCONFINED AQUIFER NASJRB SITE 1 - PRIVET ROAD NASJRB WILLOW GROVE WILLOW GROVE, PENNSYLVANIA	CONTRACT NO.	OWNER NO.
							MKB / LDL	2/22/02		5466	2207
							CHECKED BY	DATE		APPROVED BY	DATE
							KCK	6/25/04		RET	
							COST/SCHED-AREA		APPROVED BY	DATE	
							SCALE		DRAWING NO.	FIGURE 3	REV.
							AS NOTED				



NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES	SCALE	AS NOTED	CONTRACT NO.	OWNER NO.	APPROVED BY	DATE	DRAWING NO.	REV.
									5466	2207			FIGURE 4	

Tetra Tech NUS, Inc.

**DISTRIBUTION OF TCE IN THE
CONFINED AQUIFER
NASJRB SITE 1 - PRIVET ROAD
NASJRB WILLOW GROVE
WILLOW GROVE, PENNSYLVANIA**

- The source of the PCE detected in the unconfined aquifer at Site 1 is not located in the immediate vicinity of Supply Well No. 1 or the Public Works building. The RI had concluded that a minor source of PCE could exist in this vicinity.
- The source of the TCE and PCE detected in the confined aquifer (and the potable supply wells) at Site 1 is not located at the Privet Road Compound, but must be located hydraulically upgradient from Site 1. This supports the interpretations presented in the RI, which had concluded that the TCE and PCE detected within the confined aquifer at Site 1 was migrating to the site from an off-site source located in the general vicinity of the former Kellet Aircraft facility (see Figure 5).
- A minor source of VOCs is located near new monitoring well 10MW27, or in the general vicinity of the Public Works building. VOCs detected in the unconfined aquifer at very low concentrations in this area include TCE; cis-1,2-DCE; 1,1,1-TCA; and 1,1-DCE.

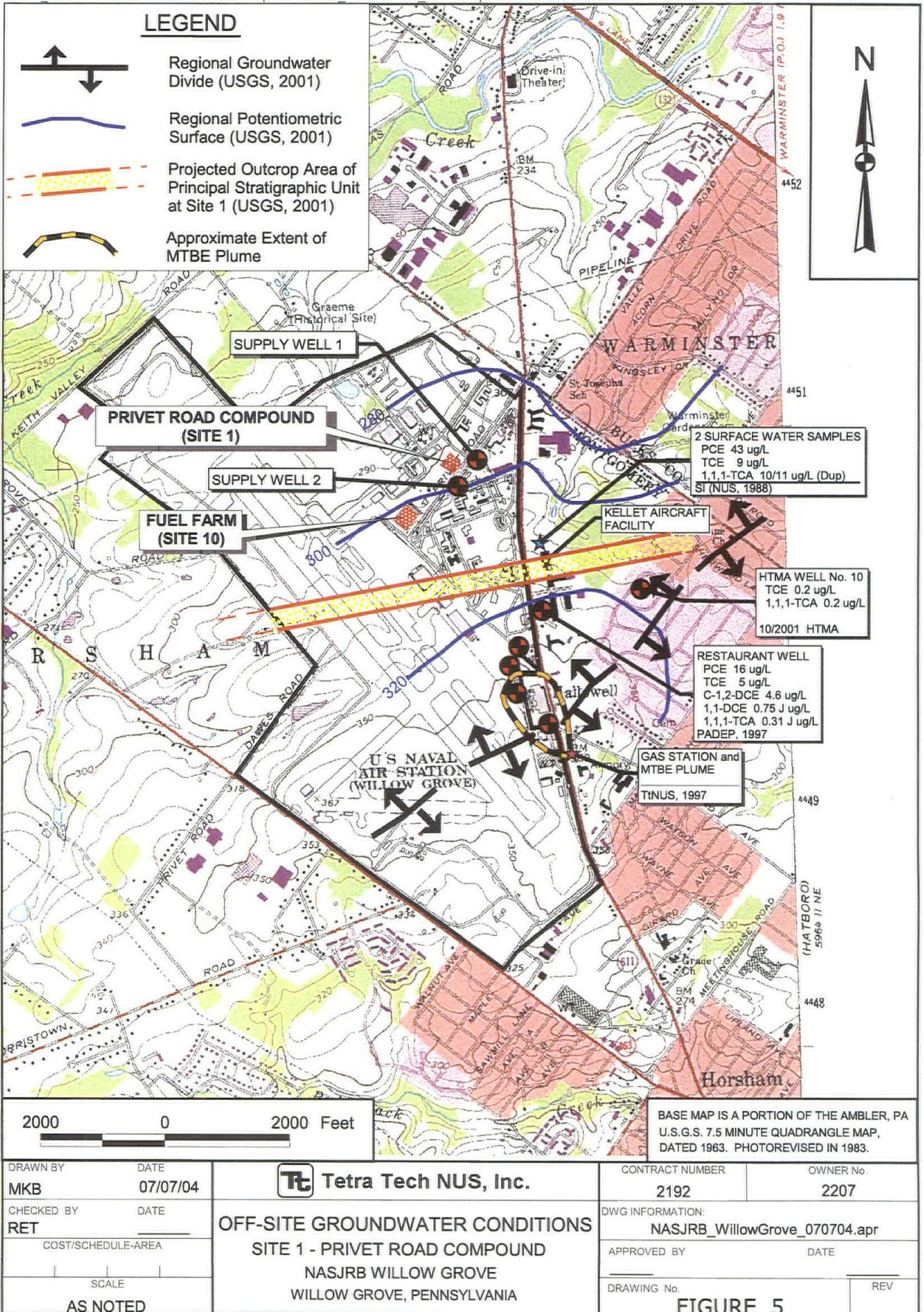
These conclusions are supported by the following observations:

- PCE is not detected in the shallow unconfined aquifer, and is detected in the semi-confined aquifer at concentrations ranging from 3 - 5 ug/L.

The RI concluded that the PCE in the vicinity of Site 1 represents coalescing PCE plumes (at least laterally, if not vertically) that originate at two different sources. The lower concentrations of PCE detected to the north and west of Site 1 in the unconfined aquifer (see Figure 1, wells 01MW01S, 01MW06S, and 01MW07S) were interpreted to originate at a local, less concentrated source of PCE, possibly in the general vicinity of Supply Well No. 1. The more highly concentrated PCE detected in the semi-confined aquifer (see Figure 2) was interpreted to have migrated to Site 1 from a more highly contaminated off-site source.

As illustrated in Figure 1, the PCE concentrations detected in 10MW28 (3 - 5 ug/L) are consistent with the PCE detections (ranging from 1.7J (J = estimated) - 6.2J ug/L) in the shallower packer test intervals (between the depths of 52 - 152 feet). The RI tentatively attributed these shallower PCE detections in Supply Well No. 1 to groundwater impacts within the unconfined zone, but also concluded that based on the depths of the packered intervals and the conceptual site model, most of these zones were potentially in the semi-confined portion of the aquifer. The new analytical data from 10MW28 (coupled with the non-detection of PCE in the unconfined zone at 10MW27) indicate that the shallower packered intervals from Supply Well No. 1 most likely are within the semi-confined portion of the aquifer.

The new groundwater analytical data from 10MW27 (the non-detections of PCE) indicate that the source of the PCE in the unconfined aquifer is not in the immediate vicinity of Supply Well No. 1. If the source was in



this area (or just upgradient of this area), then PCE would have been expected in the unconfined aquifer. The absence of PCE in the unconfined aquifer and the presence of PCE in the semi-confined aquifer (10MW28) indicates that the primary source of the PCE contamination at Site 1 must be hydraulically upgradient of the site and at a sufficient distance to allow the PCE to migrate to the depths where it is detected within the semi-confined aquifer at Site 1. The Privet Road Compound (the former waste disposal area) cannot be the source of this PCE, because the compound is located hydraulically downgradient from 10MW28 under non-pumping conditions, and the location of 10MW28 (it is not situated between the compound and Supply Well No. 1) precludes the possibility that the pumping of the supply well draws the PCE from the compound through 10MW28.

Relative to the site conceptual model, the new groundwater analytical data from 10MW27 and 10MW28 confirm that the source of the PCE that is detected within the more highly impacted semi-confined aquifer is not the Privet Road Compound, or any area in the immediate vicinity of Site 1 or Supply Well No. 1. These new data, however, do not confirm that the minor source of the PCE impacting the unconfined aquifer along the northern border of the site is located in the general vicinity of Supply Well No. 1. The source of this PCE is unknown.

- TCE is detected in both the unconfined and semi-confined aquifer, but the concentrations in the semi-confined portion of the aquifer are greater by approximately one order of magnitude. The TCE concentrations in 10MW27 range between 0.1J - 0.2J ug/L. TCE was detected in 10MW28 at 2 ug/L.

The RI concluded that the nature and three-dimensional extent of TCE in the vicinity of the Privet Road Compound is extremely complex and that possibly four separate TCE plumes coalesce (at least laterally, if not vertically) in the vicinity of the compound.

In the unconfined aquifer, the distribution of TCE (with detections limited to the northwestern portion of the site, see Figure 3) is generally similar to the distribution of PCE. Although the data overall were considered inconclusive and somewhat conflicting (particularly because the groundwater quality of the unconfined aquifer in the vicinity of the newly installed 10MW27 was not known), the RI concluded that a relatively minor source of TCE appeared to exist in the vicinity of the Public Works Building. The analytical results from 10MW27 confirm that a minor source of TCE exists in this general vicinity.

For the confined aquifer (see Figure 4), the packer test results of Supply Well No. 1 indicated that TCE was not detected within the four intervals tested between the depths of 52 - 152 feet, but that TCE was consistently detected (at concentrations ranging between 2.4J - 9.0J ug/L) within the four intervals tested between the depths of 182 - 354 feet. Similar to the earlier discussion for PCE, the RI presented multiple lines of evidence to conclude that the TCE within the confined aquifer of Supply Well No. 1 originated at an

upgradient, off-site source in the vicinity of the former Kellet Aircraft facility (the RI also concluded that other, on-site sources of TCE might account for the TCE detections within the confined aquifer at the locations downgradient of the Privet Road Compound, as will be discussed in Section 2).

The higher concentrations of TCE in the confined aquifer versus the unconfined aquifer at a location hydraulically upgradient from the Privet Road Compound confirm that Site 1 is not the source of the TCE, and that the source is not in this immediate vicinity, but must be at some hydraulically upgradient location. This supports the conclusion of the RI, and again suggests that the source of most of the TCE detected in this area may be in the vicinity of the former Kellet Aircraft facility.

Although the higher concentrations of TCE in the confined aquifer (10MW28) versus the unconfined aquifer (10MW27) overall are consistent with the site conceptual model, the presence of TCE in 10MW28 (screened from 98 - 108 feet) and its absence in Supply Well No. 1 within the packered intervals of similar depth (79 - 85 feet, 106 feet, and 124 - 152 feet) represents an apparent inconsistency in this compound's distribution. Former monitoring well MW-1 (a former monitoring well that was reportedly damaged by construction and apparently covered by a building foundation or asphalt paving) was located near (approximately 200 feet northeast) of 10MW28. This well was cased to a depth of 40 feet, and was an open borehole between the depths of 40 - 200 feet. An historical (1984) groundwater sample from MW-1 contained TCE at a concentration of 2.3 ug/L, which is similar to the concentrations detected in 10MW28 (2 ug/L) and in the fracture within Supply Well No. 1 located at a depth of 182 feet (2.4 ug/L). The RI concluded that under non-pumping conditions, the vertical hydraulic gradient at Site 1 is oriented upward, indicating the tendency for groundwater (in the absence of a confining layer) to flow upward from the confined interval to the unconfined interval and potentially redistribute the deeper contamination into the shallower horizons. The Navy has tried to locate the former well MW-1 using measurements of its reported location as well as magnetometer sensing with no success. If the former monitoring well MW-1 was in some way related with the low level TCE contamination encountered in the vicinity of Building 78, there is no way to confirm that relationship now.

- Cis-1,2-DCE is not detected in the unconfined aquifer (10MW27), and is detected in the semi-confined aquifer (10MW28) at a low concentration of 0.2J ug/L.

Cis-1,2-DCE generally occurs as a dechlorination (breakdown) product of TCE, and typically has a similar extent or occurrence pattern as the parent compound. The RI reported that for the packer tests for Supply Well No. 1 (USGS, 2001), 1,2-DCE was detected at concentrations ranging from 1.0J - 4.7J ug/L in the four zones ranging between the depths of 182 - 354 feet that also contained detections of TCE. Similarly, 1,2-DCE was not detected in the four shallower zones (ranging between the depths of 52 - 152 feet) where TCE was not detected. Within the other site monitoring wells, cis-1,2-DCE was only reported from 05MW071,

which is also the monitoring well that is most heavily impacted by TCE. At the monitoring well cluster, the absence of cis-1,2-DCE in the unconfined aquifer and its occurrence at a very low concentration in the confined aquifer are consistent and proportional to the concentrations of TCE reported from these wells.

- 1,1,1-TCA is detected in both the unconfined and semi-confined aquifer, but the concentrations in the unconfined aquifer are greater by approximately one order of magnitude. The 1,1,1-TCA concentrations in 10MW27 range between 3 - 6 ug/L, and in 10MW28 range between 0.5J - 0.9J ug/L.

The RI reported that for the packer tests for Supply Well No. 1 (USGS, 2001), 1,1,1-TCA was detected at concentrations ranging between 1.5J and 2.6J ug/L in four of the five zones tested between the subsurface depths of 52 - 182 feet, but was not detected in the three deeper zones tested between the subsurface depths of 241 - 354 feet. For the Supply Well No. 2 packer tests, 1,1,1-TCA was not detected in any of the five zones tested between the subsurface depths of 68 - 314 feet. Throughout the rest of the site, the only two historical detections of 1,1,1-TCA were at 01MW01S (1J ug/L in 1991 but not detected (ND) in 1997), and 01MW06I (3J ug/L in 1991 but ND in 1997).

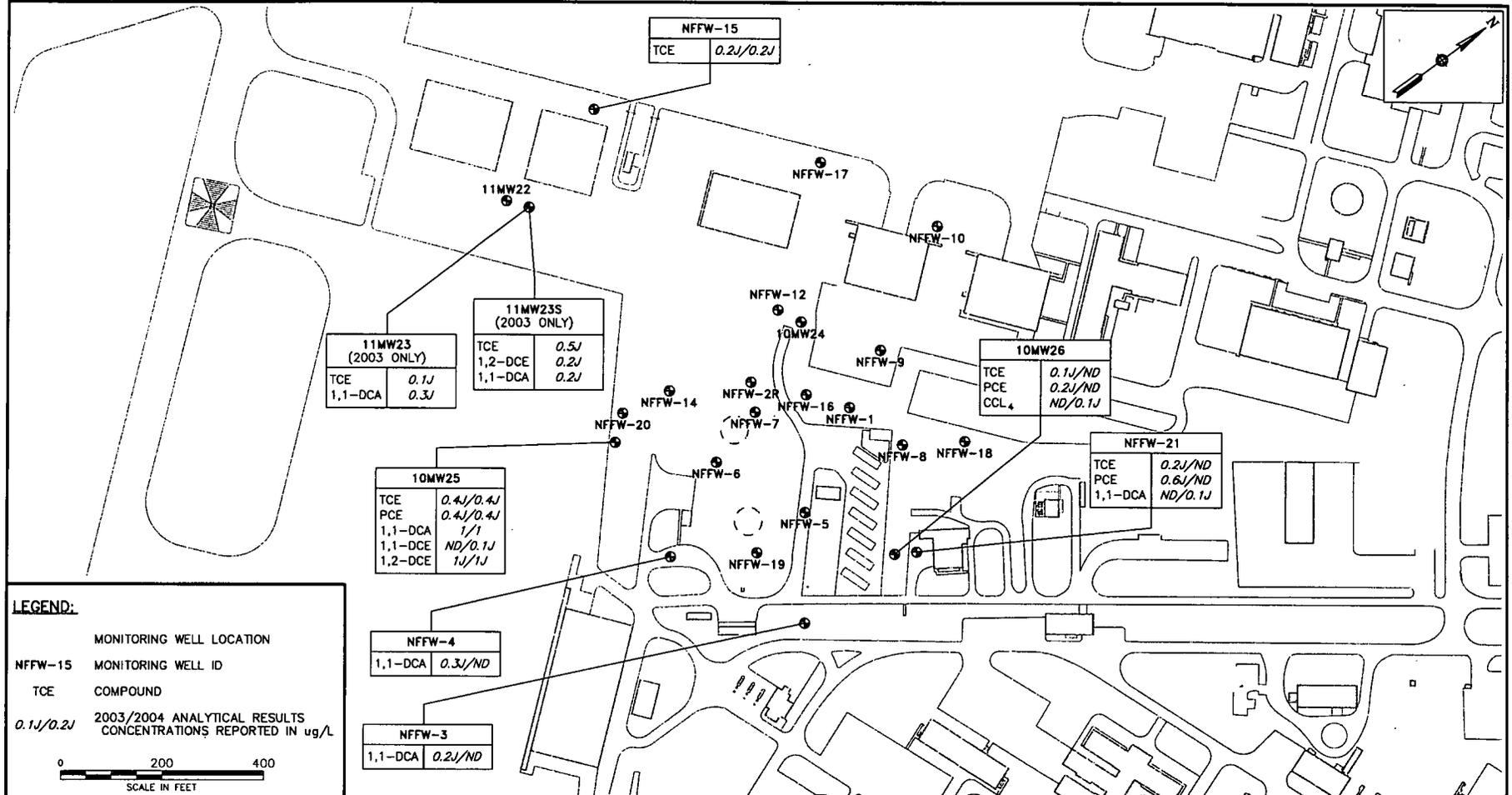
The observations that the highest concentrations of 1,1,1-TCA are detected in the shallower (unconfined) portions of the aquifer, and that the detections (except for the two low detections in 1991) are restricted to the immediate vicinity of Supply Well No. 1, are apparently indicative of a minor source of 1,1,1-TCA in the general vicinity (or just upgradient) of 10MW27.

- 1,1-DCE is detected in both the unconfined and semi-confined aquifer, but the concentrations in the unconfined aquifer are greater by approximately one order of magnitude. The 1,1-DCE concentrations in 10MW27 range between 2 - 4 ug/L, and in 10MW28 range between 0.1J - 0.4J ug/L.

1,1-DCE was not detected during the RI in either the supply wells or the monitoring wells. The limited areal extent of 1,1-DCE in the vicinity of the new monitoring well cluster, and the observation that the highest concentrations are detected in the shallower (unconfined) portion of the aquifer, are apparently indicative of a minor source of 1,1-DCE in the general vicinity (or just upgradient) of 10MW27.

2. The Navy Fuel Farm

- New monitoring wells 10MW24, 10MW25, and 10MW26 were installed in the vicinity of the Navy Fuel Farm (see Figure 6) to address the RI conclusion of a potential source of TCE in this vicinity. Although the data were considered incomplete and inconclusive, the quantitative distribution of TCE within the upper portion of the confined aquifer at, and downgradient of, the Privet Road Compound (see Figure 4)



12

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES	DRAWN BY	DATE	Tetra Tech NUS, Inc. IR SITES 10 AND 11 ANALYTICAL RESULTS FOR CHLORINATED SOLVENT COMPOUNDS NAS JRB WILLOW GROVE WILLOW GROVE, PENNSYLVANIA	CONTRACT NO.	OWNER NO.
							MKB	7/6/04		2192	
							CHECKED BY	DATE		APPROVED BY	DATE
							COST/SCHED-AREA			APPROVED BY	DATE
							SCALE	AS NOTED	DRAWING NO.	FIGURE 6	REV. 0

and the results of the packer tests within Air Force monitoring well 01MWWW6B (which detected TCE within the upper, unconfined aquifer) appeared to be indicative of possible TCE sources located either in the general vicinity, or upgradient, of the Navy Fuel Farm. Dual phase remediation for spilled fuel in this area occurred from January 1998 through December 2002. The groundwater treatment and air sparging operations underway in the shallow zone over those years may have altered the natural shallow (unconfined) groundwater regime, and reduced the amount of TCE near the extraction points (NFF2R, NFFW14 and NFFW16) of the groundwater remediation system.

The new wells are deeper wells that were paired with an existing, shallower monitoring well to create well clusters at each of three locations.

- Monitoring well 10MW24 is screened through the subsurface depths of 60 - 70 feet; this well is paired with NFFW-12, which is a shallow well screened from 6.5 - 26.5 feet.
- Monitoring well 10MW25 is screened through the subsurface depths of 102 - 112 feet; this well is paired with NFFW20, which is a shallow well screened from 14 - 34 feet.
- Monitoring well 10MW26 is screened through the subsurface depths of 110 - 120 feet; this well is paired with NFFW-21, which is a shallow well screened from 9 - 34 feet.

Relative to the existing site conceptual model, the existing shallow wells are interpreted to monitor the shallow, unconfined aquifer and each of the new monitoring wells is interpreted to monitor the uppermost portion of the confined aquifer, although this interpretation is based solely on the depth of the well.

The groundwater analytical results for two sampling rounds (June 2003 and February 2004) for all of the wells in the vicinity of the fuel farm are summarized for selected VOCs (chlorinated solvents) in Figure 6. Some of the Fuel Farm wells also contain BTEX compounds, but these are not included in the table or discussed in this report because their occurrence is not relevant to the issues being addressed by this investigation.

The analytical results indicate that overall, the VOCs of concern occur infrequently and at very low concentrations (typically less than 1.0 ug/L) in the general vicinity of the Fuel Farm. The interpretation of these data and their integration into the site conceptual model result in the following conclusions:

- The Fuel Farm is not a significant source of TCE. The RI had concluded that the source of some of the TCE detected within the unconfined aquifer at Site 1 could exist in the general vicinity of the Fuel Farm.

- The limited suite of VOCs detected at low concentrations within the confined aquifer tend to support the conclusion of the RI that the most significant source of the VOCs detected at Site 1 is located off site, in the general area of the former Kellet Aircraft facility.
- A minor source of 1,1-DCA exists in the general vicinity (but upgradient) of Site 10.
- A minor TCE source may have existed in the general vicinity of Site 10 and Site 11 (the aircraft fuel unloading site).

These conclusions are supported by the following observations:

- The Fuel Farm is not a significant source of TCE: TCE is detected in only a few wells at low concentrations (none exceeding 0.5J ug/L), which is not indicative of a significant source in this area, or a source large enough to account for the TCE concentrations detected within the upper portion of the confined aquifer at Site 1. However, the TCE detections that were reported at the Fuel Farm indicate that two sources of TCE may exist in this general area.
 - A minor TCE source may exist in the general vicinity west-southwest of Site 10, or between Sites 10 and 11. In 2003 and 2004, TCE was detected here at low concentrations within the unconfined aquifer from monitoring wells NFFW-15 (0.2J ug/L; well screened from 7.5 - 32.5 feet) and 11MW23S (0.5J ug/L; well screened from 22 - 32 feet). However, higher historical TCE detections have been recorded, including 1993 detections of 3J ug/L at NFFW-15 and 2J ug/L at NFFW-20 (screened from 14 - 34 feet). In 1991, TCE was detected at 10 ug/L from NFFW-13. This well, which is no longer available, was located southeast of NFFW-15, and adjacent to the southwest corner of Building No. 345. The construction details of NFFW-13 are not known, but it is assumed to have been a shallow well, similar in construction to the other Site 10 wells.
 - A minor TCE source may exist to the north, and just downgradient, of Site 10. Here, TCE was detected in the unconfined aquifer at 0.2J ug/L in 2003, but was not detected in 2004.
- The limited detections of VOCs at low concentrations within the confined aquifer are interpreted to represent the western lateral extent of the VOC plume that the RI identified as migrating onto NASJRB Willow Grove from an off-site source that is located in the general vicinity of the former Kellet Aircraft facility.
 - Based on the regional groundwater flow directions (see Figure 5), Site 1 is located nearly directly downgradient from the former Kellet facility, while Site 10 is located in a less downgradient (nearly side gradient) position.

- The nature of the VOC plume identified within the confined aquifer at Site 10 (see Figure 6) supports the interpretation of an upgradient source. VOCs detected within the confined aquifer at Site 10 include TCE, PCE, cis-1,2-DCE, and 1,1-DCE. These compounds have been detected at multiple, upgradient off-site locations (see Figure 6).
- A minor source of 1,1-DCA may exist in the general vicinity (but upgradient), of Site 10. Multiple wells monitoring both the unconfined and confined portions of the aquifer contain low concentrations (1 ug/L or less) of 1,1-DCA, including NFFW-3 and NFFW-4, which are located upgradient of the Fuel Farm. The presence of 1,1-DCA in the unconfined aquifer, and its absence in the probable off-site source area near the former Kellet facility (Figure 5) suggest that the source of this VOC may be on base.