Section 3.0
DATA REPORTING AND EVALUTAION

Analytical data from groundwater sampling activities are summarized in this section for each of the nine program areas in the Basewide Program. A summary of the analytical methods for each source area is presented in Appendix A. Appendix B contains all of the tabulated 2002 analytical results for all program areas. Natural attenuation analysis results are included in Appendix C, along with a description of the process of natural attenuation of fuel compounds and chlorinated solvents.

Four data reporting categories (Occurrence of Free Product, Status of Groundwater Remediation which includes analytical results and plume delineation, Overall Performance of Natural Attenuation within Source Area, and Source Area Specific Recommendations) were selected in order to address program objectives. A summary of how each reporting category will address these objectives was presented in Section 2.

The following sections (3.1 through 3.9) provide data summaries and conclusions for the four reporting categories associated with each of the nine program areas. The conclusion subsections summarize significant trends and anomalous data. Section 4 addresses the comparison made between 2002 data and previous fate/transport groundwater model predictions, and summarizes groundwater quality base-wide.

3.1 Operable Unit 1

Four monitoring wells were sampled once at OU 1 in 2002. Table 1-5 lists the wells sampled in 2002 and Plate 1 shows the locations of the wells.

The major components of the selected remedy at OU 1 involve long-term groundwater monitoring, periodic reviews to assess protectiveness, and maintenance of institutional controls restricting access to shallow groundwater (USAF, 1994a). Analysis performed in 2002 included the OU 1 ROD-specified COCs, TCE and manganese, along with several natural attenuation parameters.

3.1.1 Occurrence of Free Product

No free product was detected at any OU 1 well in 2002.

3.1.2 Status of Groundwater Remediation

The following subsections compare results to regulatory cleanup levels and provide a comprehensive analysis of the performance of natural attenuation.

3.1.2.1 Comparison of Results to OU 1 Cleanup Levels

Four COCs were identified for OU 1 in the *OU 1 ROD* (USAF, 1994a), including 1,2- EDB, TCE, vinyl chloride, and manganese. Two of these COCs, EDB and vinyl chloride, were not detected above MCLs in 1996 and were dropped as COCs from OU 1 at that time. Table 3-1 provides a summary of COC concentrations exceeding cleanup levels over the last five years for OU 1. The data tables depict all historical data for wells that were above the cleanup levels during 2001 or 2002. Figure 3-1 shows historical concentrations for the target analytes manganese and TCE for the OU 1 wells sampled in 2002. All other data are presented in Appendix B of this report.

OU 1 groundwater COCs that exceeded cleanup levels during the 2002 sampling event are bold in Table 3-1. TCE was the only COC detected at concentrations above cleanup levels in 2002. TCE concentrations at LF59-MW-03 were at 9.9 micrograms per liter (µg/L) in 2002. This is slightly higher than the concentration in 2001; however, as shown on Figures 3-1 and 3-2, the overall trend for TCE is not discernibly increasing or decreasing at this sampling location. A detailed analysis of the natural attenuation at this plume is provided in the following subsections. Concentrations of manganese were below the ARAR level at all OU 1 wells for the second consecutive sampling event. At Wells LF05-MW-03 and LF05-MW-04 concentrations continue to decline as shown in the graphical representation (Figure 3-2). It is recommended to discontinue sampling for manganese at OU 1.

Table 3-1

Comparison of 2002 Analytical Results to Cleanup Levels at OU 1
Elmendorf AFB, Alaska

Well ID/Site	Analyte (units)	Analytical Results (a)															Record of Decision Cleanup Level (b)
		1992	1995		1996		1997		1998 Results		1999 Results		2000 Results		2001 Results	2002 Results	
		Summer	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Summer	Fall	Summer	Summer	
LF05-MW-03 (LF07)	Manganese (mg/L)	17.2	7.02	11.2	7.26	5.64	5.5	7.1	6.0	12.0	5.86	6.46	6.01	9.12	5.98	5.24	9.1
LF05-MW-04 (OT56)	Manganese (mg/L)	33.3	12.2	20.9	14.0	9.94	7.9	10.0	7.74	17.5	8.09	9.08	8.42	14	7.47	6.98	9.1
LF59-MW-03 (LF59-MW-03 Plume)	TCE (µg/L)	6.2	8.02	7.38	8.48	9.74	9.8	7.6	9.88	10.1	11.0	8.4	9.0	9.9	9.0	**9.9**	5.0

(a) - Data in **bold** exceeded ROD action level in 2002.
(b) - Record of Decision cleanup level as stated in the OU 1 ROD (USAF, 1994a).
ID - identification
µg/L - microgram per liter
mg/L - milligram per liter

(11X17)

Figure 3-1. Historical Manganese and TCE Concentrations, OU 1 Monitoring Wells.

[This page intentionally left blank.]

Figure 3-2. Manganese and TCE Trends, OU 1 Monitoring Wells.

3.1.2.2 LF59-MW-03 Plume Evaluation

Only one plume is associated with the OU 1 source area. This is a TCE plume that is associated with Wells LF59-MW-03 and LF59-MW-06R and is located at the intersection of Arctic Warrior Drive and 1st Avenue. The extent of the plume is thought to be concentrated within the small area surrounding Well LF59-MW-03. The upgradient and cross-gradient extent of this plume, however, have not yet been defined. The downgradient location for this plume, LF59-MW-06R, shows a slight concentration of daughter products but no sign of contaminant migration. Vertically, the plume occupies the shallow unconfined aquifer, which is underlain by the Bootlegger Cove Formation aquitard.

The source for this plume is thought to originate from the LF59 source area. The source area received general refuse and construction debris from 1965 until 1983 (USAF, 1994a) and may have housed an asphalt batch plant in the 1950s and 1960s (USAF, 1994f). The presence of surface and subsurface landfill debris, as well as tar seeps, were verified during the 1992 RI field activities (USAF, 1994f). Although the surface and subsurface debris and tar have since been investigated under the jurisdiction of Alaska's solid waste regulations, groundwater contamination remains within the OU 1 Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) program.

Currently, Well LF59-MW-03 is monitored as the in-source location and LF59-MW-06R is monitored as a downgradient location. The actual source location, however, has not been identified. These wells are shown on Plate 1 and were sampled once in 2002 as a part of the Basewide Program. In addition, historical TCE concentrations for this plume are shown on Plate 3.

In 2002, there were three parent products present within this plume, 1,1,2,2-tetrachloroethane (PCA), 1,1,1-trichloroethane (TCA) and TCE. The TCE concentration was at 9.9 µg/L and the 1,1,2,2-PCA concentration was at 18 µg/L. Only a trace of 1,1,1-TCA was detected.

An evaluation of natural attenuation data from Well LF59-MW-03 shows adequate evidence for anaerobic biodegredation of chlorinated solvents. The protocol score for this well is 15. Using this protocol, the higher the score, the stronger the evidence for anaerobic biodegradation. Electron acceptors at this location are low, indicating that that microbes are actively metabolizing a carbon source and using electron acceptors. Natural and anthropogenic carbon are not detected in the in-source well; however, they are present only at very low concentrations in the downgradient well. This may indicate a carbon source upgradient of the chlorinated solvent source, or a carbon source that is not present in the dissolved phase, but sorbed to aquifer materials. Daughter products were present in both the in-source and downgradient locations, which is additional evidence of anaerobic biodegradation of chlorinated solvents. Appendix C summarizes the data used in the study of this plume and the justification for the scores received.

Evidence for anaerobic biodegradation of chlorinated solvents in this plume is adequate. It appears that this plume is quite small and attenuating very quickly along the downgradient margin. Contaminant concentrations in the downgradient well remain very low and suggest that this plume is stable and poses little threat of migrating downgradient.

It is unclear when TCE will reach cleanup standards. Data from Well LF59-MW-03 for 1995 through 2001 indicate an increasing trend at greater than 95% confidence level. However, TCE concentrations in the downgradient well remain very low. In addition, natural attenuation data indicate adequate microbial activity, especially in the downgradient portion of the plume. The TCE concentrations observed in Well LF59-MW-03 likely indicate a continuing source, possibly in vadose zone soil or within the saturated zone. Modeling could be used to predict a cleanup date. Further delineation of the plume boundaries and source area conditions would likely be required to support such modeling.

3.1.3 Overall Performance of Selected Remedies as Compared to OU 1 ROD

The selected remedies for OU 1 call for groundwater monitoring and maintenance of institutional controls (ICs) until sampling determines that the remediation goals have been reached and risks are acceptable. As previously stated, there are remediation goals for several analytes: EDB, manganese, TCE, and vinyl chloride. Of these, only manganese and TCE remained above cleanup concentrations. In 2001, manganese fell below the ARAR level in the final two wells, LF05-MW-03 and LF05-MW-04. Concentrations remained below remediation goals in 2002. TCE, however, remains above its respective cleanup level. Although the rate is not rapid and concentrations fluctuate, evidence suggests that TCE concentrations will continue to decrease and that the cleanup levels should be met in the timeframe specified by the OU 1 ROD.

3.1.4 OU 1 Conclusions and Recommendations

The following are conclusions and recommendations derived from hydrogeologic and natural attenuation analysis of 2002 groundwater data for OU 1:

- No free product was detected at wells within the OU 1 program area during the 2002 field season.
- As indicated on Table 3-1, LF59-MW-03 was again the only OU 1 well sampled in 2002 that exceeded the TCE cleanup level of 5 µg/L. This sample concentration is slightly higher than last year; however, overall TCE levels at this well remain relatively consistent.
- An evaluation of natural attenuation of chlorinated solvents for the plume in OU 1 indicate an elevated presence of three parent products, 1,1,2,2-PCA, 1,1,1-TCA, and TCE. Evidence is considered adequate that natural attenuation will continue to remediate chlorinated solvents, and it is expected that the cleanup goals will be met.
- As a result of the 2002 Decision Guide analysis and a natural attenuation assessment of the OU 1 program area, it is recommended to discontinue monitoring for manganese at all locations. Wells LF59-MW-03 and LF59-MW-06R will continue to be monitored annually for TCE. Natural attenuation parameters will be removed from the analytical sampling scheme for 2003 but will be added to the sampling scheme prior to the next Five-Year Review in 2007.

3.2 Operable Unit 2

Five groundwater monitoring wells and one seep location were sampled once at OU 2 in 2002. The wells were sampled using PDBs as described in the *2002 Basewide Environmental Monitoring Plan* (USAF, 2002d). As a result of the 2001 Well Decision Guide, six wells were removed from the OU 2 sampling program in 2002. In addition, analysis was performed for only the ROD-specified COCs. Table 1-5 lists the wells sampled and Plate 1 shows the well and seep locations.

Well 46-WL-01 is located downgradient of "Four Million Gallon Hill" (the ST41 source area) and has been sampled as part of the OU 2 program area since 1996. The well was originally installed as an in-source well for Site ST69 in the SERA IA program area. In 2002, this well was sampled as part of the SERA Miscellaneous program area. This well is not considered necessary for downgradient monitoring for the ST41 source area, but will be used to continue monitoring at Site ST69.

The OU 2 ROD-specified selected remedies include the operation of an IRA system, source control through cleaning and removal, ICs, and monitoring for natural attenuation. The IRA was operated from 1992 to 1998 and groundwater is monitored at OU 2 through the Basewide Program.

3.2.1 Occurrence of Free Product

A measurable free product layer was detected at three wells during the 2002 field season (EW-2, ST41-16, and ST41-28). Based on historical records from the former tanks, the free product is likely jet fuel or avgas. Table 3-2 presents the OU 2 historical and 2002 product presence data for wells that contain product.

Table 3-2

Product Presence Detected in OU 2 Groundwater from Field Operations, 1995-2002
Elmendorf AFB, Alaska

Well ID	Description of Historical and 2002 Product Presence (Product thickness is provided in feet)							
	1995	1996	1997	1998	1999	2000	2001	2002
EW-2	NM	NM	NM	NM	NM	0.06	0.08	0.16
ST41-10R	NM	ND	Sheen	ND	ND	Sheen, odor	Odor	NM
ST41-16	NM	0.45	0.02	Sheen, odor	Sheen, odor	0.01	0.06	0.04
ST41-25	NM	ND	ND	Sheen, odor	ND	Sheen, odor	Odor	NM
ST41-28	NM	Free product[1]	0.02	Sheen, odor	0.34	0.06	0.01	0.18
T40001	NM	Sheen, odor	ND	ND	ND	Sheen, odor	Odor	NM

[1] Free product was detected, but the product thickness was not measured.
ID - identification
ND - Floating product was not detected during field events during the year indicated.
NM - The well indicated was not measured for free product during the given period.

3.2.2 Status of Groundwater Remediation

The following subsections compare results to OU 2 cleanup levels as well as provide a comprehensive analysis of the hydrocarbon plumes and groundwater models associated with this program area.

3.2.2.1 Comparison of Results to OU 2 Cleanup Levels

Four COCs were originally identified in the *OU 2 ROD* (USAF, 1995a) for ST41: benzene, toluene, ethylbenzene, and xylenes (BTEX). A comparison of concentrations over the last five years for those wells exceeding cleanup levels at OU 2 is provided in Table 3-3. The data tables depict all historical data for wells that were above the cleanup levels during 2001 or 2002. Figure 3-3 shows historical benzene data for all OU 2 wells sampled in 2002. All other data are presented in Appendix B of this report.

Three organic COCs (benzene, ethylbenzene, and toluene) exceeded cleanup levels. Ethylbenzene exceeded at two locations (ST41-16 and ST41-28). Toluene exceeded cleanup levels at one location (ST41-16). Benzene exceeded cleanup levels at four well locations (ST41-10R, ST41-16, ST41-25, and ST41-28) and at the head of the seep (ST41-SP01). This seep location, however, is not the point of compliance. The point of compliance is located at the center of the surface water body located downgradient of the seep. In 2002, benzene concentrations at ST41-07, were below cleanup levels for the first time. A decline in benzene concentrations was also seen in Wells ST41-10R and ST41-25. Benzene concentrations are graphically displayed on Figure 3-4 to illustrate trends. Plate 2 contains a drawing of the plumes with concentrations exceeding cleanup levels for benzene (>5 µg/L) throughout Elmendorf AFB.

3.2.2.2 OU 2 Plume Evaluation

The following subsections compare current contaminant trends to the selected remedy outlined in the OU 2 ROD and modeling reports. Natural attenuation parameters were not collected in 2002; therefore, a natural attenuation assessment is not included.

Table 3-3 (landscape)

[This page intentionally left blank.]

(11X17)

Figure 3-3. Historical Benzene Concentrations, OU 2 Monitoring Wells.

[This page intentionally left blank.]

Figure 3-4. Benzene Trends, OU 2 Monitoring Wells.

ST41 Plumes

The ST41 Plumes are located approximately one-half mile east of the Knik Arm on the west end of the Elmendorf Moraine as shown on Plate 1. Also known as "Four Million Gallon Hill", ST41 was the former location of four 1,000,000-gallon aviation gasoline USTs and associated piping. The USAF actively remediated this site from 1976 to 1999 to remove and treat dissolved phase fuel constituents and free product floating on the groundwater. The IRA, which operated from 1992 to 1998, functioned to intercept contaminated water at seep locations on both the north and south sides of ST41. The four USTs were demolished and the piping was removed from this site in 1996.

Two hydrocarbon plumes are associated with the ST41 source area (Plate 1). One plume, the ST41 North plume, is associated with Wells ST41-10R, ST41-28, EW-2 (in the product measurement program), and ST41-SP01 (new seep installed in 2002). This plume is upgradient of a natural wetlands area. The second plume, ST41 South, is associated with Wells ST41-07, ST41-16, and ST41-25.

These plumes were studied and modeled under several investigations. The most important of these were the *Operable Unit 2 Remedial Investigation Report* (USAF, 1994e), performed from 1990 to 1993, the *ST41 Treatability Study* (USAF, 1995g), and the *2000 ST41 Groundwater Modeling Report* (USAF, 2001b).

As described in Section 1 of this report, these plumes are located on the crest of the western end of the Elmendorf Moraine. The topography of the moraine causes groundwater in the shallow aquifer to flow off the moraine to the north and south, creating a groundwater divide. The plumes are located in this shallow aquifer, which is found at approximately 15 feet bgs and averages about 13 feet thick. The aquifer is underlain by the Bootlegger Cove Formation from 15 to 60 feet bgs. As with other sites on moraine deposits on base, soil stratigraphy and hydraulic conductivity are highly variable, which causes preferential groundwater pathways and the potential for perched and semi-confined aquifers.

During the 2002 Basewide Program, ST41 was sampled for volatile organic compounds (VOCs) only using PDBs. Many of the natural attenuation parameters; therefore, were not collected. This discussion focuses mainly on trends in data.

For all OU 2 wells sampled, data trends indicate a strong decrease in COC concentrations. Figure 3-4 graphically displays the concentrations over time. Well ST41-07, which contained benzene at a concentration as high as 2,100 µg/L in 1997, contained undetectable concentrations in 2002. Downgradient wells (ST41-25 and ST41-10R) for both plumes showed decreasing concentrations at a greater than 95% confidence level. This indicates that the plume is shrinking. As the case has historically been at this site, ST41-16 contained the highest concentration of all VOCs in 2002, with benzene at 13,000 µg/L. Ethylbenzene and toluene were also detected above cleanup levels in 2002. In addition, Wells EW-2, ST41-16, and ST41-28 all had measurable free product during 2002. One seep, ST41-SP01, was sampled as part of the Basewide Program for the first time in 2002. Although the seep contained benzene above the cleanup level at 22 µg/L, the point of compliance, as established in the *Evaluation of the ST41 Treatment System* (USAF, 1997c) is the center of the wetland to the north of the seep. This surface water location at the point of compliance was not sampled in 2002, but will become part of the Basewide Program beginning in 2003.

Groundwater transport modeling of the site was performed in 1995 and again in 2000. A comparison of current data suggests that both models may require recalibration for predicted concentrations in the south plume. Comparison of 2002 data to the concentrations predicted in the 2000 model show significant differences for the ST41 South Plume. For instance, Well ST41-16 in the south plume was predicted to contain total BTEX concentrations between 1,000 and 5,000 µg/L in 2002. In reality, concentrations in the well were measured at 38,200 µg/L. It appears, however, that concentrations in the upgradient margin of the southern plume, in the vicinity of Well ST41-07, is attenuating more rapidly than predicted. The 2000 model predicted that ST41-07 would contain a concentration of approximately 500 µg/L of total BTEX in 2002. The well actually contained no detectable quantities of BTEX in 2002.

A review of the parameters used in the models for the south plume indicates that the source removal efforts were likely overestimated. It is possible that more contaminated soil remains than was assumed by the models. This would account for free product and much higher concentrations than originally predicted.

Concentrations in wells in the north plume are somewhat close to model predictions. The 2000 model predicted that total BTEX in Well ST41-10R would be between 100 and 500 µg/L in 2005. In 2002, the concentration of total BTEX was measured at 1,301 µg/L in this well. This is down from 1,920 µg/L measured in 2000. The 2000 model also predicted that total BTEX would be between 1,000 and 5,000 µg/L in 2005 in Well ST41-28. In 2002, the concentration in this well was measured at 3,826 µg/L, which is approximately the same as measured in 2000. These data seem to validate the 1995 and 2000 models of the ST41 North Plume.

The OU 2 ROD estimated that groundwater would meet ROD requirements by 2016. Current BTEX concentrations in the ST41 South Plume indicate that cleanup levels may not be met by that date. BTEX concentrations in the wells in the ST41 North Plume appear to be on track, or close, to meeting that goal.

Recommendations for future work at these plumes include the following:

1. Begin sampling surface water at the point of compliance in the wetland to the north of ST41. Sample the head of the seep once every five years.
2. Determine feasibility of installing passive free product recovery systems in both plumes in order to accelerate cleanup times.
3. Revise and/or recalibrate the ST41 model to generate estimates for natural attenuation that match groundwater concentrations at the site.
4. Collect natural attenuation parameters every five years.

3.2.2.3 Overall Performance of Natural Attenuation as Compared to OU 2 Record of Decision and Current Modeling

Although natural attenuation parameters were not collected in 2002, trends for groundwater COCs within OU 2 are generally consistent with assumptions made in the *OU 2 ROD* (USAF, 1995a). The ROD states that contaminants will not migrate significantly from the site due to the fine-grained (clay and silt) nature of the soils, low groundwater velocity, and low hydraulic conductivity. Monitoring downgradient of ST41 confirms this. However, contaminant concentrations in the ST41 South Plume are not attenuating as quickly as predicted in the current groundwater models.

3.2.3 OU 2 Conclusions and Recommendations

The following are conclusions and recommendations derived from analysis of OU 2 data:

- For wells in the OU 2 program area, a measurable free product layer was detected at three well locations during the 2002 field season (EW-2, ST41-16, and ST41-28).
- Three organic COCs (benzene, ethylbenzene, and toluene) exceeded ARAR levels in 2002. Benzene exceeded the ARAR level at four well locations (ST41-10R, ST41-16, ST41-25, and ST41-28), and at the seep location (ST41-SP-01). Benzene levels at ST41-07, previously above cleanup levels, were not detected for the first time in 2002. Ethylbenzene exceeded the ROD-specified action level at two locations (ST41-16 and ST41-28), and toluene exceeded at one location (ST41-16).
- Data imply that natural attenuation is removing organic contaminants within OU 2. It appears that remediation is close to model predictions for the ST41 North Plume and is behind predictions for the ST41 South Plume.
- As a result of the 2002 Monitoring Frequency Decision Guide analysis of the OU 2 program area, it is recommended that Wells ST41-07 and ST41-25 and the head of the seep ST41-SP01 be sampled once every five years in conjunction with the Basewide Five-Year Review. One well, ST41-10R, and one surface water location at the point of compliance will be sampled during

the 2003 program year. It is also recommended to continue sampling for only the ROD specified COCs, benzene, ethylbenze, toluene, and total xylenes for the 2003 program year. Surface water samples will also be sampled for polynuclear aromatic hydrocarbons (PAHs) so that total aromatic hydrocarbon (TAH) and total aqueous hydrocarbon (TAqH) can be calculated. Natural attenuation parameters will be added to the sampling scheme for each of the aforementioned wells every fifth year.

- It is recommended that Wells EW-2, ST41-16, and ST41-28 remain in the Basewide Product Measurement and Recovery Program in 2003, but not be sampled regularly until free product is absent. However, USAF management may decide to sample these wells to support, calibrate, or confirm any new groundwater modeling at ST41.
- Data from the Basewide Program suggest that hand bailing is not effectively removing free product from the subsurface. Free product thicknesses have not significantly decreased since the beginning of the Basewide Program. Several types of free product removal systems are available that might be more effective than the OU 2 IRA at decreasing the free product layer at ST41 as well as at other areas on base. Research should be done to identify an appropriate modern and inexpensive system. Removal of free product will decrease the time to meet remediation goals and significant long-term cost savings could be made through use of the proper system.
- Revise and/or recalibrate the ST41 model to generate estimates for natural attenuation that match groundwater concentrations at the site.

3.3 Operable Unit 4

Four monitoring wells were sampled twice and two monitoring wells were sampled once within the OU 4 program area in 2002. Table 1-5 lists the wells sampled during each of the two rounds and Plate 1 shows the locations of the wells.

The selected remedial action for groundwater from the OU 4 ROD (USAF, 1995d) involves IC of land and water use, and preventing access to contaminated groundwater throughout OU 4 until cleanup levels have been achieved. In addition, groundwater monitoring is specified in the OU 4 ROD to assess contaminant migration. In 2002, OU4-E3 and IS6-01 were added into the OU 4 Basewide Program to meet ROD requirements for OU 4 East (Hangar 15) groundwater monitoring. One well, 48-WL-01, met the 2002 Decision Guide for removal and was not sampled in 2002. Wells 49-WL-01 and OU3MW-11 were moved from the OU 4 Program Area and are reported under the OU 5 Program Area as part of the Fairchild Plume.

3.3.1 Occurrence of Free Product

For wells in the OU 4 program area, a measurable free product layer was not detected in 2002. However, a fuel odor and/or hydrocarbon sheen was noted at two well locations (OU4W-08 and OU4W-11). Table 3-4 presents the OU 4 historical and 2002 product presence data for wells that contain product.

3.3.2 Status of Groundwater Remediation

The following subsections compare results to cleanup levels and provide a comprehensive analysis of the performance of natural attenuation as a selected remedy for groundwater contamination as outlined in the OU 4 ROD.

Table 3-4

Product Presence Detected in OU 4 Groundwater from Field Operations, 1995-2002

Well ID	Description of Historical and 2002 Product Presence (Product thickness is provided in feet)							
	1995	1996	1997	1998	1999	2000	2001	2002
OU4W-08	ND	0.02	0.225	Trace	Strong fuel odor	Strong fuel odor	Fuel odor	Fuel odor
FP-56	NM	NM	NM	NM	NM	Fuel odor	Fuel odor	ND
OU4W-11	Sheen	ND	0.025	Oily matter; tar odor	ND	Slight sheen, tar-like odor	Fuel odor	Fuel odor

ID - identification
ND - Floating product and/or fuel odor was not detected during field events during the year indicated.
NM - The well indicated was not measured for free product during the given period.

3.3.2.1 Comparison of Results to OU 4 Cleanup Levels

Nine COCs were originally identified for OU 4 in the *OU 4 ROD* (USAF, 1995d), and are listed in Table 2-1. Of these, benzene, PCE, and TCE are the only remaining chemical-specific COCs for OU 4. A comparison of concentrations over the last five years for OU 4 is provided in Table 3-5. Additionally, 2002 data was screened for any new detections that may have occurred at wells not previously depicted on this table. No new occurrences of benzene, PCE, or TCE were detected. The data tables depict all historical data for wells that were above the cleanup levels during 2001 or 2002. All data having qualifiers are included unless the data was flagged "R". Historical concentrations of target analytes benzene and TCE for all OU 4 wells sampled in 2002 are shown on Figure 3-5. All other data are presented in Appendix B of this report.

Current OU 4 groundwater contaminants exceeding cleanup levels during the 2002 sampling events are bold on Table 3-5. As indicated, three organic COCs (benzene, PCE, and TCE) exceeded ROD cleanup levels. Benzene exceeded the cleanup levels at two well locations (OU4W-04 and OU4W-08). Benzene concentrations at FP-56, fell below cleanup levels for the first time in 2002. The graphical representation, as shown on Figure 3-6 depicts a steady decline in benzene concentrations. PCE exceeded the cleanup level at two well locations (OU4W-11 and IS6-01). TCE exceeded the cleanup levels at three well locations (FP-56, IS6-01, and OU4W-11). The TCE concentration at these wells is also depicted on Figure 3-7. Plates 2 and 3 show historical cleanup level exceedances for both benzene and TCE, respectively.

3.3.2.2 OU 4 Plume Evaluation

The following subsections assess the evidence for natural attenuation and compare current contaminant trends to the selected remedy outlined in the OU 4 ROD.

3.3.2.2.1 OU 4 West Plumes

Three plumes are present in the OU 4 West area, the Hanger 10 Plume, the Hanger 11 Plume, and the FTA Plume. The first two plumes assessed contain fuel hydrocarbons, while the third plume contains both chlorinated solvents and fuel hydrocarbons.

3.3.2.2.1.1 Hangar 10 Plume

The Hangar 10 Plume is located just north of the East/West Runway in the central portion of the base as shown on Plate 1. The plume is found in the shallow unconfined aquifer in the Outwash Plain south of the Elmendorf Moraine and is underlain by the Bootlegger Cove Formation aquitard. The shallow unconfined aquifer is approximately 25 to 50 feet thick in this region of the base.

Table 3-5 (landscape)

(11X17)

Figure 3-5. Historical Benzene and TCE Concentrations, OU 4 Monitoring Wells.

[This page intentionally left blank.]

Figure 3-6. Benzene Trends, OU 4 Monitoring Wells.

Figure 3-7. TCE Trends, OU 4 Monitoring Wells.

The source for this plume was identified during an RI in 1993 (USAF, 1994d). At this time, it was determined that the plume likely originated from multiple sources in the vicinity of Hangar 10. These sources included several USTs to the southwest of Hangar 10, and several POL valve pits and a POL pump house, both southwest of the hangar. During the investigation, the plume was found to be approximately 1,800 feet long by 600 feet wide trending northeast to southwest. Well OU4W-04 was installed in the downgradient portion and is the only well currently monitored in the Hangar 10 Plume.

Well OU4W-04 was sampled once during the 2002 Basewide Program. Analytical results are shown in Appendix B with natural attenuation parameters reiterated in Appendix C of this report. An evaluation of natural attenuation parameters from this well shows strong evidence for biodegradation of fuel compounds found in this plume. It appears that microbes are rapidly utilizing all available electron acceptors at this location. This indicates that several types of organisms are present and breaking down fuels in the plume. The limiting factor for biodegradation of fuels in this plume is the finite amounts of electron acceptors available. Fortunately, electron acceptor concentrations are recharged daily through infiltration and the migration of uncontaminated groundwater from upgradient sources.

The only chemical-specific COC for this plume is benzene. Although benzene is found above the cleanup level in Well OU4W-04, the concentration has been declining since the well was first sampled in 1993. The concentration found in 2002 is one-seventh the highest concentration found during the 1993 RI. These results are displayed graphically on Figure 3-6. Benzene results for all sampling events at OU4W-04 are also shown on Plate 2.

It is apparent that biodegradation is acting to reduce contaminant concentrations within the Hangar 10 Plume. The OU 4 ROD (USAF, 1995d) predicted that groundwater would likely be remediated by 2010. This prediction appears to be plausible based on past and current contaminant concentrations and on current rates of natural attenuation.

3.3.2.2.1.2 Hangar 11 Plume

The Hangar 11 Plume is located just north of the Hangar 10 Plume in the central region of the base. This plume is also found in the shallow unconfined aquifer in the Outwash Plain south of the Elmendorf Moraine and is underlain by the Bootlegger Cove Formation aquitard. The shallow unconfined aquifer is approximately 25 to 50 feet thick in this region of the base.

The source for this plume was identified during a 1993 RI (USAF, 1994d). At this time, it was determined that the plume likely originated from two sources to the west and southwest of Hangar 11. These sources included USTs to the southwest of Hangar 11 and several POL valve pits to the west of the hangar. During the investigation, the plume was found to be approximately 750 feet long by 450 feet wide trending northeast to southwest. Well OU4W-08 was installed in the upgradient portion and is the only well currently monitored in this plume.

Well OU4W-08 was sampled once during the 2002 Basewide Program. Analytical results are shown in Appendix B with natural attenuation parameters reiterated in Appendix C of this report. Much like the assessment at OU4W-04, an evaluation of natural attenuation parameters from this well shows strong evidence for biodegradation of fuel compounds found in this plume. It appears that microbes are rapidly utilizing all available electron acceptors at this location. This indicates that several types of organisms are present and breaking down fuels in the plume. The limiting factor for biodegradation of fuels in this plume is the finite amounts of electron acceptors available. Fortunately, electron acceptor concentrations are recharged daily through migration of uncontaminated groundwater from upgradient sources and through infiltration.

Chemical-specific COCs for this plume are benzene, ethylbenzene, and toluene. Although benzene and toluene are found above the action level in Well OU4W-08, the concentrations have been declining since the well was first sampled in 1993. These results are displayed graphically on Figure 3-6. Benzene results for all sampling events at OU4W-08 are also shown on Plate 2.

It is apparent that biodegradation is acting to reduce contaminant concentrations within the Hangar 11 Plume. The OU 4 ROD (USAF, 1995d) predicted that groundwater would likely be remediated by 2010. This prediction appears to be plausible based on past and current contaminant concentrations and on current rates of natural attenuation.

3.3.2.2.1.3 Fire Training Area Plume

The FTA Plume is centrally located on Elmendorf AFB at the northwest corner of the North/South Runway. There are two plumes associated with this area, a chlorinated solvent plume and a benzene plume. Both of these plumes extend horizontally between Wells FP-56 and OU4W-11. Vertically this plume occupies groundwater in the shallow aquifer with a depth ranging from 25 to 50 feet. The source for these plumes is incomplete combustion of fire training materials in the FTA. Contaminants include chlorinated solvent products and hydrocarbons, mainly benzene. The FTA Plume boundaries were defined in the 1993 RI (USAF, 1994d) based on a soil gas survey, soil borings, groundwater grab samples and screening samples using hydropunch equipment, groundwater samples from permanent monitoring wells, and groundwater gradients using water level surveys (USAF, 1994d).

Wells FP-56 and OU4W-11 were monitored twice in the 2002 Basewide Program. Analytical results are shown in Appendix B, with natural attenuation parameters reiterated in Appendix C of this report. A natural attenuation analysis performed on this plume showed limited evidence for degradation of chlorinated solvents. The screening process for this plume yielded a score of 14. Appendix C presents the data used in the test and the justification for the score received.

Dechlorination, at least to the stage of DCE and DCA, seems to be taking place under sulfate-reducing conditions. This may be due to the presence of fuel hydrocarbons in the plume. It appears that three solvents, PCE, 1,1,1-TCA, and TCE, are present in the plume. The daughter products DCA and DCE are both found at high levels and appear to be accumulating. Almost all of the DCE found is cis-1,2-DCE, which indicates that it is a daughter product. The absence of vinyl chloride and chloroethane may indicate that DCE and DCA are not degrading. It is also possible that vinyl chloride is oxidized rapidly and is therefore not detected.

It is unclear whether natural attenuation of chlorinated solvents in this plume will be limited by the amount of carbon available. Natural and anthropogenic carbon concentrations are currently moderate but decreasing, which suggests the process may slow in the future. This is an indication that, although fuels in this plume will likely meet cleanup goals by 2008 as predicted in the OU 4 ROD, chlorinated solvents may not.

3.3.2.2.2 OU 4 East Plume (Hangar 15)

The OU 4 East Plume is oriented east-west in the eastern portion of the OU 4 program area, as shown on Plate 1. The eastern boundary is just west of Hanger 15 off Talley Ave. The western boundary is approximately 400 feet west of Well IS6-01. Vertically, the plume occupies the shallow unconfined aquifer averaging approximately 20 feet thick in this region.

A definite source for this plume was not determined during the OU 4 RI; however, two probable sources were given. The first is a dry well located to the east of Hangar 15. The second probable source for chlorinated solvent groundwater contamination in this area is leach fields, located just east of the facility, which receive wastewater from Hanger 15. The OU 4 East Plume boundaries were defined in the 1993 RI (USAF, 1994d) based on a soil gas survey, soil borings, groundwater grab samples and screening samples using hydropunch equipment, groundwater samples from permanent monitoring wells, and groundwater gradients using water level surveys.

The plume is currently monitored by in-source Well IS6-01 and downgradient Well OU4-E3. These are shown on Plate 1. Both wells were sampled twice in 2002 as a part of the Basewide Program. Analytical results are shown in Appendix B, with natural attenuation parameters reiterated in Appendix C of this report. According to the evaluation of natural attenuation, this plume shows limited evidence of anaerobic biodegradation of chlorinated solvents.

Dechlorination, at least to the stage of DCE, seems to be taking place under nitrate-reducing conditions. It appears that two solvents, PCE and TCE, are present in the plume. The concentration of these solvents is half of the amount present at the time of the RI, which also indicates natural attenuation. Although natural attenuation is occurring, the rates are not rapid. This is due to a lack of carbon in the system, which allows for the high levels of dissolved oxygen (DO) present in the plume. Microbes will continue to consume the DO, and other electron acceptors, prior to utilizing chlorinated solvents.

Although natural attenuation appears to be working at this plume, the rate is slow. This is due to both a lack of a carbon source and the presence of electron acceptors that are preferred over chlorinated solvents. Complete breakdown to concentrations below cleanup levels will occur, but not likely by the ROD-specified date. However, this is an isolated plume and there is no evidence of migration (downgradient Well OU4E-3 is non-detect) and no environmental receptors are threatened. As a result, it is recommended that the downgradient location be monitored every other year to track any migration, and that the in-source location be monitored once every five years to reassess natural attenuation.

3.3.3 Overall Performance of Natural Attenuation as Compared to the OU 4 Record of Decision

Natural attenuation, the main selected remedy for groundwater remediation at Source Area OU 4 does appear to be degrading both fuel and chlorinated solvents. There are several diverse plumes located in OU 4 and degradation rates vary accordingly. Generally, hydrocarbons are well on the way to meet cleanup goals set forth in the ROD. Their breakdown is occurring at a rate parallel with predictions. Chlorinated solvents appear to be degrading at a slower rate and are likely to take longer than predicted to meet cleanup levels set forth in the ROD.

3.3.4 OU 4 Conclusions and Recommendations

The following are conclusions and recommendations derived from hydrogeologic and statistical analysis of 2002 groundwater data for OU 4:

- For wells in the OU 4 program area, a measurable free product layer was not detected in 2002. However, a fuel odor and /or hydrocarbon sheen was noted at two well locations (OU4W-08 and OU4W-11).
- OU 4 groundwater COCs exceeding cleanup levels during the 2002 sampling events include benzene, PCE, and TCE. Benzene exceeded the action level at two well locations (OU4W-04 and OU4W-08). Benzene concentration levels at FP-56 were previously above cleanup levels, but fell below cleanup levels for the first time in 2002. PCE exceeded the actions levels at two well locations (OU4W-11 and IS6-01). TCE exceeded the cleanup level at three well locations (FP-56, IS6-01, and OU4W-11).
- Data imply that natural attenuation is removing organic contaminants within OU 4. Generally, remediation is occurring at a more rapid rate for hydrocarbons than for chlorinated solvents. Fuels are predicted to meet cleanup levels by the timeframe specified in the OU 4 ROD. Although biodegradation of chlorinated solvents is occurring, it will likely take longer than predicted to drop below cleanup levels.
- As a result of the 2002 Sampling Frequency Decision Guide and natural attenuation analysis of the OU 4 program area, it is recommended to adjust sampling frequency. Wells FP-56 and OU4W-11 will be monitored annually; Well OU4E-3 will be monitored once every two years; and Wells IS6-01, OU4W-04, and OU4W-08 will be monitored every five years. Monitoring for only ROD-specified COCs will occur with each event, and sampling for natural attenuation will occur in conjunction with the next Five-Year Review.
- In an effort to more effectively monitor on a plume-by-plume basis, Wells 49-WL-01 (previously of SERA I) and OU3MW-11 (previously of OU 3) were moved to the OU 5 program area. These wells are associated with the Fairchild Plume as are Wells 48-WL-03 and OU4MW-34. Movement of these wells will ensure continuity of data collection and reporting for the plume.

3.4 Operable Unit 5

Thirty monitoring wells were sampled twice within the OU 5 program area in 2002. Three additional OU 5 monitoring wells were installed and sampled once in 2002. Table 1-5 lists the wells sampled during each of the two rounds, with well locations shown on Plate 1. In addition, seven surface water sites at Ship Creek were sampled twice in 2002.

The selected remedial action for OU 5 groundwater involves long-term monitoring, the use of a constructed wetland remediation system, and IC of land and water use until cleanup levels have been achieved (USAF, 1995e). The first sampling as part of the Basewide Program began in 1996. The OU 5 constructed wetland system, built to reduce contaminant levels in groundwater before entering Ship Creek, began operation in 1997.

3.4.1 Occurrence of Free Product

Free product was not detected at any well location during the 2002 field season. Although no measurable quantity was noted, a hydrocarbon odor was detected at Well GW-4A.

3.4.2 Status of Groundwater Remediation

The following subsections compare results to regulatory cleanup levels as well as provide a comprehensive analysis of the performance of natural attenuation as a remedy for groundwater contamination as outlined in the OU 5 ROD.

3.4.2.1 Comparison of Results to OU 5 Cleanup Levels

Four COCs were originally identified in the OU 5 ROD (USAF, 1995e), including benzene and TCE (Table 2-1). A comparison of concentrations exceeding cleanup levels over the last five years for OU 5 is provided in Table 3-6. Additionally, 2002 data was screened for any new detections that may have occurred at wells not previously depicted on this table. No new occurrences were noted. The data tables depict all current and historical data for wells that were above the cleanup levels during 2001 or 2002. All data having qualifiers are included unless the data was flagged "R". Figures 3-8a and 3-8b show historical concentrations of the target analytes benzene and TCE for all wells sampled in OU 5 in 2002. All other data are presented in Appendix B of this report.

OU 5 groundwater COCs that exceeded cleanup levels during the 2002 sampling events are bold in Table 3-6. TCE was the only COC detected at concentrations above cleanup levels in 2002. The TCE concentration at Well OU5MW-08, above the cleanup level (5 µg/L) for the first time in 2001, was found below the action level in 2002. TCE concentrations exceeded the ROD cleanup level at ten monitoring well locations (1836-WL-01, 48-WL-03, 49-WL-01, 403-MW-01, GW-4A, OU3MW-11, OU5MW-02, OU5MW-06, OU5MW-07, and SP1-02). Figure 3-9 graphically displays TCE trends over time for seven of these wells.

(11X17)

Figure 3-8a. Historical TCE Concentrations, OU 5 Monitoring Wells.

[This page intentionally left blank.]

(11X17)

Figure 3-8b. Historical TCE Concentrations, OU 5 Monitoring Wells (Continued).

[This page intentionally left blank.]

Table 3-6 (landscape)

Figure 3-9. TCE Trends, OU 5 Monitoring Wells.

3.4.2.2 OU 5 Plume Evaluation

The following subsections assess the evidence for natural attenuation and compare current contaminant trends to the selected remedy outlined in the OU 5 ROD.

3.4.2.2.1 Fairchild Plume

The Fairchild Plume is oriented north-south in the western portion of the OU 5 program area, as shown on Plate 1. The northern end of the plume is located just south of 23rd street. The southern margin of the plume is undefined. The eastern margin is defined by Well OU3MW-06 and the western margin defined by Well OU3MW-16. Vertically, the plume occupies the shallow unconfined aquifer, which is underlain by the Bootlegger Cove Formation aquitard. The aquifer averages approximately 25 feet thick in this region of OU 5. The total length of this plume (as currently defined) is approximately 4,000 feet.

The source area for this plume was SD16, which was originally an OU 3 program area source. SD16 was a ditch or series of ditches used in the 1950s and 1960s to dispose of wastes, including solvents, paints, and other liquid wastes (USAF, 1995f). This source area was re-graded and vegetated and a status of NFA was established in the OU 3 ROD (USAF, 1997a). In addition, the northern portion of SD16 was historically, and is currently, used as a snow accumulation area for snow from the east-west runway and taxiway.

The plume is currently monitored by wells in the OU 4 and OU 5 program areas. Seven wells associated with this plume were sampled in 2002. These are shown on Plate 1. They include two wells in OU 4 (49-WL-01 and OU3MW-11) and five wells in OU 5 (48-WL-03, OU3MW-06, OU3MW-16, OU5MW-01, and OU5MW-34).

An evaluation of natural attenuation data from wells within this plume shows complex plume behavior. Varying rates of natural attenuation within the plume were noted. These differences appear to be driven by differing amounts and sources of carbon in the system throughout the plume. Appendix C summarizes the data used in the study of this plume and the justification for the scores received.

Well OU3MW-11

Three locations within this plume show elevated evidence of biodegredation. At the most upgradient well in the plume, OU3MW-11, the protocol score is 11, which is classified as limited evidence for anaerobic biodegredation of chlorinated solvents. Electron acceptor concentrations at this location are low, likely due to low concentrations of natural or anthropogenic carbon migrating into the plume from farther upgradient. BTEX compounds and total organic carbon (TOC) were detected only at low concentrations at this location. Their presence has led to microbial breakdown of TCE, which in turn has led to the presence of the daughter product cis-1,2-DCE. Another parent product, PCE, is also found at this location at low concentrations. Historical concentrations of TCE for this well are shown on Plate 3. These concentrations are displayed graphically on Figure 3-9. This figure shows fluctuating concentrations over time. Statistical analysis of these concentrations proved to be inconclusive. Although values are decreasing, it is at less than an 80% confidence level.

Well 49-WL-01

Near the center of the plume, Well 49-WL-01 shows stronger evidence for natural biodegredation of TCE. The protocol score for this location is 19, which is considered adequate evidence for anaerobic biodegredation of chlorinated solvents. This is due to the presence of a source of fuel hydrocarbons contributing carbon to the system. This location, Site ST71 (originally in the SERA I program area), was the site of a UST leak that occurred before 1992. No estimate was made on the amount of fuel released, but it was clear that the leak occurred for several years prior to removal of the tank (USAF, 1994c). Contaminated soil was removed to the excavation depth of the backhoe (18 feet bgs) and clean soil was used as backfill. Low concentrations of fuel compounds (below cleanup levels) are still found at this location in groundwater, which is leading to an elevated rate of microbial activity and biological breakdown of TCE. Both TCE and the daughter product DCE are found at this location. The parent product PCE is also found at low concentrations in this well. Historical concentrations of TCE for this well are shown on Plate 3. The time-series plot on Figure 3-9 shows steadily decreasing concentrations

since 1998. It appears that concentrations increased slightly from 1996 to 1998, which may represent a slug of TCE that migrated through the plume. Statistical analysis of TCE concentrations in this well from 1995 through 2002 shows decreasing concentrations at a greater than 95% confidence level.

Well 48-WL-03

Farther downgradient of 49-WL-01 is Well 48-WL-03. Evidence for anaerobic biodegredation within this well is slightly decreased from Well 49-WL-01. The protocol score for this location is 13, which is considered limited evidence for anaerobic biodegredation of chlorinated solvents. This is also elevated due to a local source of fuel hydrocarbons. This well is located just downgradient of the Service Station, formerly Site SS62 in the SERA I program area. The site formerly had two waste oil tanks, four gasoline tanks, and one diesel fuel tank. All of the tanks were removed in 1990, at which time several areas of fuel contamination were discovered. Contaminated soil was removed to the excavation depth of the backhoe (18 feet bgs) and clean soil was used as backfill. As with Well 49-WL-01, low concentrations of fuel compounds are still found at this location in groundwater, which has led to an elevated rate of microbial activity and biological breakdown of TCE. Natural attenuation in this well is at reduced rates from the location of Well 49-WL-01. The difference stems from much lower quantities of fuels in the system at this location. It is likely that more of the source was removed at this location than at ST71, reducing the carbon source. The daughter product cis-1,2-DCE appears to accumulate in this location and is found at higher concentrations than at any other location in the plume. PCE is not present in this well. Historical concentrations of TCE for this well are shown on Plate 3. These concentrations are displayed on a time-series plot on Figure 3-9. This figure shows somewhat fluctuating concentrations in this well over time and a spike in concentrations in 1997. This spike is also seen in the upgradient Well 49-WL-01. This may represent a slug of TCE that migrated through the plume. Statistical analysis of TCE concentrations in 48-WL-03 from 1995 through 2002 proved to be inconclusive. Although values are decreasing, it is at less than an 80% confidence level.

Well OU5MW-34

In an attempt to locate the downgradient margin of the Fairchild Plume, Well OU5MW-34 was installed approximately 600 feet south of Well 48-WL-03. The boring log for this well is presented in Appendix F, with soil analytical data presented in Appendix B of this report. Soil screening data from the vadose zone at this location showed no evidence of contamination. The groundwater sample collected at this location contained 42 µg/L of TCE. The protocol score for this location is 1, which is considered inadequate evidence for anaerobic biodegredation of chlorinated solvents. This is due to a lack of anthropogenic and natural carbon in the system. No significant concentrations of anthropogenic carbon were found and only low concentrations of natural carbon were detected. The daughter product cis-1,2-DCE was detected at very low concentrations as well, which is likely due to migration from the upgradient location rather than from biodegredation of TCE at this location. This suggest that although DCE may be increasing at 48-WL-03, it is apparently disappearing as it moves downgradient. This is likely due to the reoccurrence of an aerobic environment in the downgradient margin of the plume, causing oxidation or aerobic microbial breakdown of DCE. As included in the discussion above, a mass of TCE appears to have migrated past Well 48-WL-03 in 1997. The high concentrations of TCE in Well OU5MW-34 could be reflective of a mass concentration at this location. The high TCE concentrations may also be due to preferential pathways present in the outwash plain soils found in this region of the base.

Well OU3MW-16

Located approximately 1,100 feet to the southwest of Well OU5MW-34 is Well OU3MW-16. Analytes measured in this well in 2002 were limited to VOCs and, therefore, most natural attenuation parameters were not collected. Only a trace of TCE and moderate concentrations of DCE were found in this well. PCE was not found at this location. Based on this information, this well appears to be either located on the western margin of the plume or located downgradient of the plume.

Well OU5MW-01

The final well sampled in 2002 associated with this plume is Well OU5MW-01. This well appears to be located directly downgradient of the plume near the southern boundary of Elmendorf AFB.

No TCE, DCE, or PCE were found in this well. The parent product 1,1,1-TCA and its daughter product 1,1-DCA were found at very low concentrations in this well.

Fairchild Plume Summary

Natural biodegradation of TCE in this plume, as with other chlorinated solvent plumes on base, is limited by the amount of carbon in the aquifer. High rates of microbial activity correspond directly with areas of fuel leaks in the central portion of the plume. It appears that the area of influence of an introduced carbon source is limited. The carbon is used up rapidly and not allowed to migrate far from the source.

A mass of TCE appears to have migrated through the location of Wells 49-WL-01 and 48-WL-03 in 1997 and may now be in the proximity of Well OU5MW-34. In addition, the downgradient margin of this plume is not yet defined, but is likely located between Wells OU5MW-34 and OU5MW-01. The downgradient margin of the plume should be defined in future field efforts through soil borings and groundwater sampling. Monitoring of a downgradient well near the margin of the plume should then take place. The use of a water level survey in wells within and around this plume prior to future drilling events is recommended to improve placement of wells.

It does not appear that chlorinated solvents are degrading at high rates throughout this plume. It is also unclear if TCE concentrations will decrease to below the cleanup level by the year 2010 as predicted in the OU 5 model. The OU 5 ROD states that monitoring may continue until the year 2025 if cleanup goals are not met. It is possible that TCE in this plume will be below 5 µg/L by that date. Additional modeling of this plume is recommended once plume margins are better defined.

3.4.2.2.2 OU3MW-25 Plume

The OU3MW-25 Plume is located approximately 1,600 feet to the east of the upgradient end of the Fairchild Plume at the corner of Jerstad Ave. and Fighter Drive as shown on Plate 1. As with the Fairchild Plume, the OU3MW-25 Plume trends north-south and is underlain by the Bootlegger Cove Formation aquitard. Only one well, OU3MW-25, is currently monitored within this plume and plume boundaries, therefore, are not well defined. The TCE level in this well is currently between 5 and 6 µg/L, slightly above the cleanup level of 5 µg/L outlined in the OU 5 ROD.

This area was originally studied as part of the OU 3 Program area, but OU3MW-25 is now monitored as part of the Taxiway "N" program area as a downgradient sentry well for fuel hydrocarbon migration. This discussion focuses on the presence of TCE contamination and evidence for natural attenuation in this well.

During the OU 3 RI/FS, groundwater screening and sampling were performed upgradient and downgradient of this well in order to define the extent of groundwater contamination associated with this area. The data showed low concentrations of TCE slightly upgradient of OU3MW-25 as well as at several downgradient locations. Based on the OU 3 RI/FS results, it is likely that TCE found in this well and at Wells OU5MW-02 and SP1-02, also in OU 5, is from Source Area SD16. This is also the source area for the Fairchild Plume as described in Section 3.4.2.2.1. The source areas for the downgradient wells were not confirmed during the OU 3 RI/FS or during subsequent investigations. Although all contaminants found in this region of base may have originated at the same large source area, historical and current data indicate that that there is not one continuous plume. For instance, Well OU3MW-06, on the eastern side of the Fairchild Plume, is below cleanup levels. Due to preferential pathways, varying amounts of groundwater infiltration (due to precipitation and use of the source area as a snow dump), and varying events and amounts of contaminant dumping, it is likely that more than one distinct plume could originate from this single large source area. It is possible that all of these wells are points within plumes that originated at the same source. This theory is based on data collected during OU 3, OU 5, and SERA characterization. Sampling points included soil gas sampling, soil geoprobe grab samples, soil borings, and groundwater samples. Data from these phases of investigation indicated widespread contamination, likely related to historical activities at SD16 (originally studied under OU 3). The definition of a plume is a continuous body of groundwater that contains contaminants at concentrations above ROD-specified

cleanup levels. This definition is important because it governs which wells are monitored and where new wells are drilled. The discussion of TCE contamination in groundwater in these wells remains separate for 2002; however, as data are not available to confirm that it is all from one source.

Evidence for anaerobic biodegradation of TCE at this location is limited. The protocol score for this well is 11. Electron acceptor concentrations at this location are low, which indicates a source of carbon in the system. TOC was found only at low concentrations with BTEX not detected. Both TCE and 1,1,1-TCA were detected as well as daughter products of both compounds.

Although data provided some evidence for anaerobic biodegradation of the chlorinated solvents present at this location, these parameters likely reflect breakdown occurring slightly upgradient of this well. As with other plumes in the area, a lack of carbon is apparently limiting the rate of breakdown of chlorinated compounds at this area.

The well was first sampled in 1993 during the RI/FS. It was sampled again in 1999 and has been sampled twice per year since. Results show concentrations generally hovering between 5 and 6 µg/L since 1999. Second round data appear slightly higher than first round data for most years. Statistics were not run for this well since concentrations are low and remaining stable.

Although it does not appear that chlorinated solvents are breaking down at high rates at this location, concentrations are low and stable. TCE found at this location is not likely to affect any receptors. It is unclear if TCE will decrease to below the cleanup level by 2010 as predicted in the OU 5 model. The OU 5 ROD states that monitoring may continue until the year 2025 if cleanup goals are not met. It is possible that TCE at this location will be below 5 µg/L by that date.

3.4.2.2.3 OU5MW-02 Plume

The OU5MW-02 Plume is located south of the OU3MW-25 Plume and southeast of the Fairchild Plume near the corner of 5th Street and Gibson Ave. The location of the plume is shown on Plate 1. Like other plumes in this region of the base, it is located in an unconfined aquifer in outwash plain soils and is underlain by the Bootlegger Cove Formation. The source for this plume is undetermined, but data collected during the OU 3 RI/FS (USAF, 1995f) indicate that the source may be SD16. As described above, this is the source for the Fairchild and OU3MW-25 plumes as well. Only one well, OU5MW-02, is monitored in this plume. The lateral extent of this plume is, therefore, undefined.

Evidence for anaerobic biodegradation of chlorinated solvents at this location is inadequate. The protocol score for this well is 3. This is due to very low natural and anthropogenic carbon concentrations, which is inhibiting microbial activity. The parent products 1,1,1-TCA and TCE are found in this well along with daughter products of both compounds. Anaerobic biodegradation is occurring, but at very low rates.

A graph of TCE in this well, shown on Figure 3-9, displays slightly fluctuating concentrations. TCE concentrations overall appear to be relatively stable with minute increases and decreases at this location. Statistical analysis for this well completed in 2001 showed no statistically valid trend for TCE. Statistical analysis was not repeated in 2002.

As with other plumes in this region of the base, chlorinated solvents are not breaking down at high rates at this location. Though this is the case, contaminant concentrations are low and do not appear to be increasing. Current and historical data do not indicate the presence of any large mass of TCE moving downgradient from this location. It is unclear if TCE will decrease to below the cleanup level by 2010 as predicted in the OU 5 model. The OU 5 ROD states that monitoring may continue until the year 2025 if cleanup goals are not met. It is possible that TCE at this location will be below 5 µg/L by that date.

3.4.2.2.4 SP1-02 Plume

This plume is located approximately 1,300 feet downgradient of the OU5MW-02 Plume as shown on Plate 1. Well SP1-02 is located just south of 2nd Street, at the edge of the bluff overlooking the Ship Creek flood plain. The well is located at the southern boundary of Elmendorf AFB and is in outwash plain soils. This plume is located in the same unconfined aquifer as other plumes in the region. The source for this plume has not been verified, but data collected during the OU 3 RI/FS (USAF, 1995f) and the OU 5 RI (USAF, 1993b) indicate that the source for this plume is upgradient. The most likely source is SD16, which is the source of the Fairchild Plume and the OU3MW-25 Plume. SP1-02 is the only well monitored in this plume. The lateral extent of this plume, therefore, is undefined but it is likely that the low level of TCE found in this well has migrated to this location from several thousand feet upgradient. It is possible that Wells OU3MW-25, OU5MW-02, and SP1-02 are locations within various plumes that originated at the same source.

Evidence is adequate for anaerobic biodegradation of chlorinated solvents at this location. The protocol score for this well is 5. As with other plumes in the area, natural and anthropogenic carbon in the system are very low, limiting the rate of microbial activity. Electron acceptors are not being heavily used. TCE and 1,1,1-TCA are found at this location along with daughter products of both compounds. Anaerobic biodegradation is occurring at very slow rates in this plume.

Graphical display of TCE in this well is shown on Figure 3-9. A decreasing trend is visually apparent from review of this figure. Statistical analysis of the data for this well from 1994 through 2002 shows a decreasing trend at a greater than 95% confidence level.

As with other plumes in this region of the base, chlorinated solvents are not breaking down at high rates at this location. Though this is the case, contaminant concentrations are low and are decreasing. Current and historical data do not indicate the presence of any large mass of TCE moving downgradient to this location from an upgradient source. It is unclear if TCE will decrease to below the cleanup level by 2010 as predicted in the OU 5 model, but appears likely at the current rate of contaminant loss in this well. The OU 5 ROD states that monitoring may continue until the year 2025 if cleanup goals are not met.

3.4.2.2.5 Kenney Ave. Plume

The Kenney Ave. Plume lies in the central portion of the OU 5 program area at the intersection of Kenney Ave. and 5th Street as shown on Plate 1. This plume is primarily associated with Well 403-MW-01. The northern boundary of the plume is not yet completely defined; however, upgradient monitoring well results have indicated it does not extend to Well OU5MW-35. Like the northern boundary, the southern boundary is also not clearly defined. Downgradient of the plume are OU 5 Wetland Seeps 9, 10, and 11, which have shown contamination above cleanup levels in both 2001 and 2002 (USAF, 2002c and Appendix B of this report). The eastern and western boundaries are defined and extend approximately 300 feet in either direction from 403-MW-01. Vertically, the plume occupies the shallow unconfined aquifer, which is underlain by the Bootlegger Cove Formation aquitard. The aquifer averages approximately 25 feet thick in this region of OU 5.

The source area for this plume is unknown. Previous data and historical documents cited a source area at Building 5332, the former Diesel Maintenance Shop. This possible source appears to be directly upgradient of Well 403-MW-01. In an effort to better define the possible source and plume boundaries, further investigation was performed during the 2002 field season. Well OU5MW-35, drilled directly between the known contamination and the former Diesel Maintenance Shop, did not show any chlorinated solvents or hydrocarbon compounds. This redirected the efforts downgradient and closer to Well 403-MW-01. Further investigations will be performed in 2003 to better define the source.

This plume is currently being monitored by the following OU 5 wells: 403-MW-01, OU5MW-35, and OU5MW-36. The following seeps are downgradient of the plume and are monitored under the OU 5 WRS: Seeps 9, 10, 11, 17, and 18. These locations are shown on Plate 1.

Well 403-MW-01

This well is the only in-plume well monitored for the Kenney Ave. Plume. The concentration is relatively high, in comparison to Seeps 9, 10, and 11, which are directly downgradient. There is little evidence of natural attenuation. The protocol score for this well is 6, which is classified as limited evidence for anaerobic biodegradation of chlorinated solvents. Daughter products are found at this location at low concentrations, but without BTEX and little TOC, only slight microbial breakdown of TCE will occur.

Seeps 9, 10, and 11

In 2001, the USAF sampled three seeps that are not being collected and treated in the WRS. These seeps are directly downgradient of the Kenney Ave. Plume but are monitored under the OU 5 WRS Program (USAF, 2003). Chemical data from the seeps indicated the presence of TCE contamination above cleanup levels. A study was performed in 2002 to evaluate methods to address these seeps. In 2003, the USAF will contract design of additional discharge structures to capture the three seeps and divert them to the WRS. Construction of the discharge structures will take place in 2004. It was determined that the existing wetland could be used to treat the TCE from the upgradient Kenney Ave. Plume. While natural attenuation appears to be very limited upgradient of these seeps, these seeps will be captured and treated in the Wetland Cell.

Seeps 17 and 18

Seeps 17 and 18 are newly identified seeps that discharge directly into the Wetland Cell, downgradient of Well 403-MW-01 and the Kenney Ave. Plume. These seeps were sampled for the first time in 2002 as part of the OU 5 WRS program and results and reported in the 2002 OU 5 WRS Annual Report (USAF, 2003). Sampling showed that these seeps contained TCE at levels below, but approaching, cleanup levels. The identification of TCE in these seeps appears to indicate that TCE from the vicinity of Well 403-MW-01 is discharging from the bluff in several different areas (i.e., at Seeps 17 and 18, and at Seeps 9, 10, and 11). The discharge of TCE into the Wetland Cell close to the effluent is a concern due to the limited residence time before discharge.

In summary, natural biodegradation of TCE in this plume is very limited. The limits appear to be due to a lack of carbon in the aquifer. Due to biodegradation rates and proximity to receptors, natural attenuation within the aquifer by itself is not a feasible remedy for the Kenney Ave. Plume. Contaminant migration off Elmendorf property is occurring. However, with the capture of Seeps 9, 10, and 11 by the OU 5 WRS that is planned for 2004, treatment will occur and discharge from the WRS will remain below cleanup levels. It is also recommended that a follow-on investigation be performed in 2003 to delineate this plume and pinpoint the source.

3.4.2.2.6 Slammer Ave. Plume

The Slammer Ave. Plume is located in the eastern portion of OU 5 near the corner of Slammer Ave. and Arctic Warrior Drive, as shown on Plate 1. The plume boundaries are defined in the north by Wells 61-WL-01 and 61-WL-02, on the west by Well SP4/11-03, and on the east by Well OU5MW-08. As groundwater migrates downgradient from this plume, the majority is captured by the Beaver Pond. Vertically, the plume occupies the shallow unconfined aquifer and is underlain by the Bootlegger Cove Formation. The saturated zone in this part of the outwash plain ranges from 10 feet thick near Ship Creek to 50 feet thick at the upgradient margin of the plume. The source for this plume is unknown. The majority of field investigations in this area of the base were performed in order to delineate fuel contamination and did not explore the source of this chlorinated solvent plume.

In previous years, contamination in this area was treated as three separate plumes. Data suggest that contamination found in the wells in this area could be from one source. This discussion treats the known contamination as one plume. In 2002, nine wells were monitored in association with this plume. Four of those, 61-WL-01, 61-WL-02, SP4/11-03, and 1836-WL-01, were added to the Basewide Program in 2002 to better define plume boundaries.

A discussion of evidence for natural attenuation of chlorinated solvents in this plume is provided below. Appendix C of this report summarizes the present data used in the study of this plume and the justification for the score received.

61-WL-01 and 61-WL-02

These wells were sampled in the Basewide Program in 2002 to better define the upgradient margin of the Slammer Ave. Plume. Low concentrations of TCE and 1,1,1-TCA were found in these wells. These wells are considered to be north of the upgradient end of the plume.

SP4/11-03

This well was sampled in 2002 as a downgradient well for contamination found in Well OU5MW-06. TCE was found just above the detection level. This well is considered to be outside the western boundary of the Slammer Ave. Plume.

OU5MW-06

This well is located within the upgradient western portion of the plume. The evidence for natural attenuation of chlorinated solvents in this well is negative. The protocol score for this well was negative one. Aerobic conditions with high concentrations of other electron acceptors are interfering with the natural attenuation of chlorinated solvents at this location. This is likely due to a lack of natural and anthropogenic carbon in the system. Three probable parent products are found in the plume at this location, indicating the release of three separate solvents. These are PCE, 1,1,1-TCA, and TCE. Low concentrations of DCE, the daughter product of TCE, are also present in the plume. The concentration is slightly above the detection level. Reductive dechlorination is most likely occurring only at very low rates at this location. Graphical representation of data for this well from 1994 through the present shows steadily decreasing concentrations (Figure 3-9). Statistical analysis of these data shows decreasing concentrations at greater than 95% confidence level.

In this portion of the Slammer Ave. Plume, chlorinated solvents are not breaking down at high rates. Though this is the case, contaminant concentrations are low and decreasing. Current and historical data do not indicate the presence of any large slugs of TCE moving downgradient to this location from an upgradient source. It is unclear if TCE will decrease to below the cleanup level by 2010 as predicted in the OU 5 model, but appears possible given the current rate of contaminant loss in this well. The OU 5 ROD states that monitoring may continue until the year 2025 if cleanup goals are not met.

OU5MW-07

This well is located at the upgradient end of the eastern side of the Slammer Ave. Plume as shown on Plate 1. The evidence for natural attenuation of chlorinated solvents in this well is limited with a protocol score of 7. High concentrations of electron acceptors are interfering with the natural attenuation of chlorinated solvents at this location. Native and anthropogenic carbon are at very low concentrations. The high concentrations of electron acceptors also indicate that carbon concentrations in this part of the system are low. Elevated concentrations of two parent products are found in the plume, indicating the release of two separate solvents. These are 1,1,2,2-PCA and TCE. Low concentrations of daughter products of both solvents are also present in the plume, with slightly more 1,1,2-TCA (daughter product of 1,1,2,2,-PCA) present than DCE (daughter of TCE). These concentrations are slightly above detection levels. The plume appears to be migrating downgradient with little loss of contaminant mass at this location. The limiting factor in this portion of the plume is likely the lack of available carbon.

Graphical representation of data for this well from 1994 through the present shows TCE concentrations hovering generally between 18 and 25 µg/L. Statistical analysis for concentrations in this plume from 1994 through 2002 shows increasing concentrations at greater than a 95% confidence level. Concentrations appear to be slightly increasing, with no masses of highly contaminated groundwater moving to or from this location.

1836-WL-01

This well is located to the southwest of Well OU5MW-07. The well was sampled to better define the plume associated in the area around OU5MW-07 and OU5MW-08. The location of Well 1836-WL-01 was thought to be on the western margin of the plume. TCE in this well was found

at 14 µg/L along with 1,1,2,2-PCA and the daughter product 1,2-DCA. In addition, low concentrations of several fuel compounds were found in this well. The concentration of TCE in the well indicates that this location is within the plume and that the plume boundary extends to include the area between OU5MW-06 and OU5MW-07, different than originally thought.

OU5MW-08

This well is located on the eastern margin of the Slammer Ave. Plume downgradient of Well OU5MW-07. Evidence for anaerobic biodegradation at this location is inadequate with a protocol score of 1. Behavior in this area of the plume is much like that in OU5MW-07. High concentrations of electron acceptors are interfering with microbial breakdown of chlorinated solvents at this location. Native and anthropogenic carbon are at very low concentrations. The high concentrations of electron acceptors also indicate that carbon concentrations in this part of the system are low. Elevated concentrations of 1,1,2,2-PCA and TCE are found in the plume, indicating the release of both solvents. A low concentration of the daughter product of 1,1,2-TCA is also present in the plume. Daughter products of TCE are not present. The limiting factor in this portion of the plume is again likely due to the lack of available carbon.

Graphical representation of data for this well from 1994 through the present shows TCE concentrations hovering generally between 2 and 5 µg/L (Figure 3-9). Statistical analysis for data from 1994 through 2002 determined that concentrations are increasing with a 95% confidence level. Although concentrations are slightly increasing, data suggest that no slugs of highly contaminated groundwater are moving to or from this location.

GW-4A

This well is centered in the downgradient end of the plume, just upgradient of the Beaver Pond as shown on Plate 1. Water appears to flow into the Beaver Pond after reaching this point. Evidence for anaerobic biodegradation of chlorinated solvents at this location is inadequate with a protocol score of 5. Electron concentrations in this well are low, but generally appear high enough to interfere with breakdown of chlorinated solvents. As with most other locations within this plume, carbon concentrations are very low. Like in upgradient wells, parent products 1,1,2,2-PCA and TCE are both detected. The daughter product of each solvent is also found at this location. The limiting factor for this location is again a lack of carbon.

As shown on the time-series plot on Figure 3-9, concentrations are generally hovering between 5 and 11 µg/L at this location, with a spike in concentrations in 2001. Statistical analysis of data from 1994 through 2002 determined that concentrations are increasing with a 90% confidence level. Based on upgradient data, it appears that no large masses of contaminant are moving from upgradient toward this portion of the plume.

OU5MW-31

This well is located just south of the eastern portion of the Beaver Pond. The evidence for natural attenuation of chlorinated solvents at this location is limited, but stronger than at the upgradient locations. The screening process for this well yielded a score of 12. Electron acceptor concentrations at this location are very low, with TCE the only solvent present. Daughter product cis-1,2-DCE is also present. Natural and anthropogenic carbon, however, were at very low concentrations.

Data from this well indicate that the water may have gone through remedial processes prior to reaching this location. Although electron acceptor concentrations are low, there is a lack of carbon at this location. This suggests that the system may have been driven to an anaerobic state upgradient of this location. Given that this well is located only about 200 feet south of the Beaver Pond and at a lower elevation, it is possible that the Beaver Pond environment itself created the anaerobic conditions found in this well. In addition, the solvent 1,1,2,2-PCE and its daughter product have disappeared from the water and the concentration of TCE has been greatly reduced. The data suggest the possibility that groundwater found in Well OU5MW-31 has first passed through the Beaver Pond. This may indicate that not all surface water found in the Beaver Pond leaves as surface water. A small amount may infiltrate back into

the ground and mix with groundwater. If correct, this also provides further evidence that the Beaver Pond is an excellent remediation system for chlorinated solvent-contaminated groundwater.

Slammer Ave. Plume Summary

Chlorinated solvent plumes in this portion of OU 5 seem to show more than one behavior, with slightly higher levels of natural attenuation in the downgradient portions, likely due to the influence of the carbon-rich wetlands. Dechlorination, at least to the level of DCA and DCE, seems to be taking place under nitrate-reducing conditions in the upgradient portions of the area, and ferric iron to sulfate-reducing conditions in the downgradient portions. It appears that up to four different parent products, PCE, 1,1,2,2-PCA, 1,1,1-TCA, and TCE, were released into the groundwater upgradient of the Beaver Pond. The daughter products 1,1,2-TCA, DCE, and DCA were all detected in the plume, indicating that some level of anaerobic biodegredation of these solvents is or has taken place in the groundwater upgradient of the wetlands. It appears that only very low concentrations of TCE are escaping through the Beaver Pond back into groundwater on the downgradient end.

Currently, evidence suggests that contaminated groundwater seeps from upgradient locations into the Beaver Pond area and is remediated through various processes within the wetlands. It appears that not all of the water entering the wetlands exits as surface water and there is possibly some communication between the Beaver Pond and downgradient groundwater. Some of the surface water in the wetlands may infiltrate and become groundwater. This may be the case with groundwater found in OU5MW-31. The contaminants and their daughter products have been stripped from the water in this well with only low concentrations remaining. The Beaver Pond appears to be an excellent remediation system for the full range of chlorinated hydrocarbons.

Although the Beaver Pond is capturing and treating the majority of this plume, it is possible that the eastern margin of this plume is migrating past the eastern end of the Beaver Pond and not being captured. Sampling in 2003 should include Wells OU5GW-42 and OU5GW-44 to the southeast of the Beaver Pond to determine if any TCE-contaminated groundwater is migrating toward Ship Creek in this area. In addition, a water level survey of all existing wells and surface water in the vicinity of Beaver Pond may help to determine if surface water in Beaver Pond is infiltrating and mixing with downgradient groundwater.

It does not appear that chlorinated solvents are breaking down at high rates throughout this plume, but it is clear that they are being remediated within Beaver Pond. It is unclear if TCE will decrease to below the cleanup level by the year 2010 as predicted in the OU 5 model. The OU 5 ROD states that monitoring may continue until the year 2025 if cleanup goals are not met. It is possible that TCE at this location will be below 5 µg/L by that date.

3.4.2.2.7 Early Warning Line Wells

The Early Warning Line (Plate 1) was established in 2001 to provide a early detection of contaminant plumes that may threaten Ship Creek. The distance between the Early Warning Line and Ship Creek represents the theoretical average distance groundwater would flow in two years. This distance was selected because it represents the minimum possible time that the USAF would require to obtain funding for an active seep capture or other remedial activity to prevent impact to Ship Creek. The actual distance in feet was calculated using boring logs and groundwater gradient data. Soil permeability was determined using published values for soil types encountered in soil borings. Conductivity values from an OU 5 pump test were also considered. Based on these data, a range of average linear velocity for groundwater was calculated. Velocities ranged from approximately 7 feet/year to approximately 1,000 feet/year. The Early Warning Line was drawn at the conservative end of this range and represents an average linear velocity of approximately 1,000 feet/year. Therefore, the Early Warning Line is located approximately 2,000 feet upgradient of Ship Creek.

In 2002, seven monitoring wells were sampled for VOCs using a semi-permeable membrane device called a PDB. Further information regarding the PDB is provided in the *Basewide Environmental Monitoring Plan* (USAF, 2002d). These wells are shown on Plate 1 and listed in Table 1-5. These wells

were sampled semi-annually in 2002, with the first event occurring on June 7, 2002, and the second on August 31, 2002.

Six of the seven wells sampled as part of this system were below cleanup levels for TCE for both rounds during 2002. One well had concentrations above cleanup levels for both rounds; Well 1836-WL-01 had 14 µg/L TCE in Round 1 and 17 µg/L TCE in Round 2 as seen in Table 3-6. Further discussion of this well is provided in Section 3.4.2.2.6 Slammer Ave. Plume.

In summary, sampling upgradient of the Early Warning Wells in 2002 did not identify any contaminant plumes that pose an imminent threat to Ship Creek. It is recommended that PDB sampling for VOCs continue on an annual basis at all wells in the 2002 OU 5 Early Warning System. This relatively inexpensive method of monitoring will help to provide warning of any unsuspected contaminant migration toward Ship Creek.

3.4.2.2.8 Sentry Wells

Sentry wells are wells located upgradient of environmental receptors (Table 1-5), but within (downgradient of) the Early Warning Line. These wells are critical for monitoring contaminant plumes that extend toward receptors like Ship Creek. These wells are also sampled using PDBs.

A total of eight sentry wells are monitored in OU 5. Year 2002 data showed no evidence of increasing groundwater contamination at any location within the sentry well network.

3.4.2.2.9 Ship Creek Surface Water

In the vicinity of Ship Creek, Elmendorf AFB is situated on late-Quaternary glacial outwash deposits consisting chiefly of sands with varying amounts of silts and gravels. The outwash overlies silt and clay units of the Bootlegger Cove Formation, which act as an aquitard for the shallow water table aquifer. The Bootlegger Cove Formation occurs at a depth of approximately 10 feet bgs. Hydrogeologically, the investigation area is underlain by both a shallow unconfined aquifer and a deep confined aquifer.

Ship Creek was not formally included in any Elmendorf OUs; therefore, there are no specific cleanup goals that directly apply to the creek. However, Ship Creek is hydraulically downgradient from most of the OUs on Elmendorf AFB. As such, it is a potential pathway for contaminated groundwater migrating from the OUs to downstream human and environmental receptors. Although it was not formally added into the Basewide Program until 1997, Ship Creek has been sampled consistently by the USAF since 1994. The primary purpose of long-term monitoring of Ship Creek is to evaluate target analytes (which correlate in part to the adjacent OU 5 groundwater target analytes) and to determine whether or not the target analytes (benzene and TCE) are migrating to the creek from upgradient ground and surface water source areas. To date, no contaminants have been detected above state or federal drinking water standards in Ship Creek downgradient of Elmendorf AFB.

Sampling of Ship Creek occurred semi-annually at seven sampling locations, SC-1B, SC-2, SC-4, SC-5, SC-6, SC-7, and SC-8 (Plate 1). The first sampling event occurred on May 30, 2002, and the second on August 15, 2002. Sampling location SC-3, Beaver Pond, was originally sampled as a part of the Basewide Program. In an effort to classify all wetland information, this location was added and sampled as a part of the OU 5 Wetland Remediation Program in 2002. All Beaver Pond data is reported in the *2002 Annual Report, Operable Unit 5 Engineered Wetland Remediation System (Draft) (USAF, 2002e).*

As mentioned above, the target analytes for Ship Creek are benzene and TCE. Analytical methods for SC-2, SC-4, SC-6, and SC-7 include volatile organics only (SW8260B). However, at SC-1B and SC-8, the influent and effluent locations of Elmendorf AFB, analytical Method SW8310, along with SW8260, are used to meet aquaculture water requirements (USAF, 2002c). These two analyses are used to calculate TAH and TAqH for surface water at OU 5. Methods E353.3 (Nitrate and Nitrite), 365.3(total phosphorus), and SW6010 and SW6020 were removed from surface water sampling in 2002. These

methods were used to assess natural attenuation only, which is irrelevant for surface water. Natural attenuation parameters remain in the OU 5 groundwater sampling suite.

For all locations during both rounds, no target analytes were reported above detection levels. For sampling locations SC-1B and SC-8, all TAH and TAqH results were below surface water criteria. All field and analytical data for Ship Creek is presented in Appendix B of this report.

In summary, Ship Creek, one of the two major environmental receptors of Elmendorf AFB groundwater, is protected from contaminant migration. As a result of the continuing RPO program, it is recommended to stop sampling at SC-2, SC-4, SC-5, SC-6, and SC-7 in 2003. Sampling of locations SC-1B and SC-8 on an annual basis will be sufficient to identify whether contamination is reaching Ship Creek.

3.4.3 Overall Performance of Natural Attenuation as Compared to OU 5 ROD

At the upgradient portions of OU 5, a lack of carbon in the substrate is limiting anaerobic biodegradation of chlorinated solvents. In areas where past fuel releases occurred, anaerobic biodegradation is working at accelerated rates. This shows that microbes responsible for the anaerobic breakdown of chlorinated solvents are present in the substrate, and need only a carbon source to increase biodegradation rates. There is no evidence for highly concentrated slugs of contaminant migrating from upgradient toward any receptors within the program area. At the downgradient portion of OU 5, at Seeps 9, 10, and 11, capture by the WRS will remediate off-site migration. Also, plumes that are captured by Beaver Pond are being remediated through processes of natural attenuation. It has been shown that the WRS and Beaver Pond are capable of treating the migrating contaminants at concentrations measured within OU 5. It is unlikely that all TCE at OU 5 will be below cleanup levels by the year 2010 as predicted in the OU 5 model. The OU 5 ROD states that monitoring may continue until the year 2025 if cleanup goals are not met. It is possible that TCE at OU 5 will be below 5 µg/L by that date.

3.4.4 OU 5 Conclusions and Recommendations

The following are conclusions and recommendations derived from hydrogeologic and natural attenuation analysis of 2002 groundwater data for OU 5:

- Wells 49-WL-01 and OU3MW-11 in the Fairchild Plume were moved from the OU 4 Program Area to the OU 5 Program Area in 2002.
- For wells in the OU 5 program area, free product was not detected at any well location during the 2002 field season. Although no measurable quantity was noted, a hydrocarbon odor was detected at Well GW-4A.
- TCE was the only COC detected at concentrations above OU 5 ROD cleanup levels in 2002. TCE concentrations exceeded the ROD cleanup level at ten monitoring well locations (1836-WL-01, 48-WL-03, 49-WL-01, 403-MW-01, GW-4A, OU3MW-11, OU5MW-02, OU5MW-06, OU5MW-07, and SP1-02).
- Evaluation of natural attenuation parameters and historical and current data trends indicates that natural attenuation of chlorinated solvents is occurring at slow rates for most of OU 5. In areas where a carbon source is present in the aquifer, natural attenuation is working at accelerated rates. It is unlikely that all TCE at OU 5 will be below cleanup levels by the year 2010 as predicted in the OU 5 model.
- Monitoring data indicate that natural attenuation by itself will not be sufficient to reduce chlorinated compounds at the Kenney Ave. Plume to below cleanup levels prior to discharging at the seeps. Groundwater from this plume, with TCE above the cleanup level, is exiting the bluff at OU 5 Wetland Seeps 9, 10, and 11. TCE is also exiting the bluff at concentrations close to cleanup levels at Seeps 17 and 18. Secondary remediation for this groundwater plume is or will occur in the Wetland Cell at OU 5.

- The Slammer Ave. Plume is flowing into Beaver Pond where it is remediated. Some contaminated groundwater may be migrating past the eastern end of Beaver Pond.
- It is recommended that the downgradient margin of the Fairchild Plume be delineated in 2003. It is also recommended that further modeling be performed at this location to help evaluate whether the selected remedy (natural attenuation) will meet cleanup levels by 2010 as predicted in the OU 5 model.
- Seeps 9, 10, and 11 will be channeled into the OU 5 WRS where treatment will occur. It is recommended that the Kenney Ave. Plume source and boundaries, still unknown, be identified through soil boring and well installation in 2003. Future modeling efforts will be considered only when this is achieved.
- It is recommended that two additional sample locations, Wells OU5GW-42 and OU5GW-44 located southeast of Beaver Pond, be sampled with PDBs in 2003 to determine the downgradient extent of the eastern margin of the Slammer Ave. Plume.
- If Wells OU5GW-42 and OU5GW-44 contain TCE, this may indicate that the Slammer Ave. Plume is bypassing Beaver Pond. In this case, it is recommended that the eastern margin of the plume be delineated via subsurface investigation in 2004. Based on the monitoring well data, modeling of this plume should also be performed in 2004. The use of enhanced natural attenuation may be considered based on modeling results.
- It is recommended that a water level survey of all surface water bodies and wells in the vicinity of Beaver Pond be performed and groundwater origins and flow directions be reassessed.
- It is recommended that sampling of the OU 5 Early Warning Wells take place on an annual schedule with the sampling event occurring in the summer.
- It is recommended that sampling of OU 5 Sentry Wells take place on a semi-annual schedule with six months between rounds.
- It is recommended that Ship Creek surface water locations SC-1B and SC-8 be monitored annually. It is recommended that sampling at locations SC-2, SC-4, SC-5, SC-6, and SC-7 be discontinued in 2003.
- It is recommended that Wells 401-WL-03 and 401-WL-04 be added to the Basewide Program in support of investigation of ST401. In addition, it is recommended that Well SP2/6-05, located downgradient of Site ST401, be sampled in support of this investigation. These three wells should be sampled for gasoline range organic (GRO), diesel range organic (DRO), residual range organic (RRO) and VOCs.

3.5 Operable Unit 6

There were 14 monitoring wells sampled in 2002. In addition, seven seep locations were added in 2002 to the OU 6 sampling program to track day lighting groundwater at the WP14/LF04 and LF02 source areas. A total of nine seeps were samples. Table 1-5 lists the wells and seeps sampled, and Plate 1 show the locations of both the wells and seeps.

Currently groundwater is monitored semi-annually and seeps monitored annually as part of the Basewide Program. The purpose for monitoring at OU 6 is to assess contaminant migration and the timely reduction of contaminant concentrations by natural attenuation. Free product recovery during the summer months of June, July, August, and September is also currently ongoing at OU 6 Source Areas WP14 and LF04.

3.5.1 Occurrence of Free Product

For wells in the OU 6 program area, free product was detected at two wells during the 2002 field season (OU6MW-12 and OU6MW-77). A fuel odor and/or sheen was noted at four additional wells. Table 3-7 presents current and historical product presence data for wells in the OU 6 program area that contain product.

Table 3-7

Product Presence Detected in OU 6 Groundwater from Field Operations, 1996-2002
Elmendorf AFB, Alaska

Well ID	Description of Historical and 2002 Product Presence (Product thickness is provided in feet)						
	1996	1997	1998	1999	2000	2001	2002
OU6MW-12	NM	NM	NM	0.06	0.02	NM	0.01
OU6MW-13	ND	ND	ND	ND	0.01	ND	NM
OU6MW-18	0.9	IN	0.02[a]	0.07[b]	Odor	ND	IN
OU6MW-63	ND	0.12	0.08	0.01	Sheen, odor	Odor	Odor
OU6MW-67	ND	ND	ND	ND	ND	Sheen, odor	NM
OU6MW-77	Free product	0.33	Sheen, odor	0.45	0.19	0.10	0.26
OU6MW-91[c]	NM	NM	NM	NM	NM	Sheen, odor	Sheen, odor
OU6MW-92[c]	NM	NM	NM	NM	NM	Sheen, odor	ND
14-MW-120	NM	NM	NM	NM	NM	Sheen, odor	Odor
14-MW-121	NM	NM	NM	NM	NM	Sheen, odor	Odor
14-MW-133	NM	NM	NM	NM	NM	Odor	NM

[a] After one month of SD15 system in operation.
[b] After SD15 system was shut down for two months.
[c] These wells are part of the 2001 WP14 Limited Field Investigation.
ID - identification
IN - Insufficient water in well to measure product thickness.
ND - Floating product was not detected during field events during the year indicated.
NM - The well indicated was not measured for free product during the given period.

3.5.2 Status of Groundwater Remediation

The following subsections compare results to regulatory cleanup levels and provide a comprehensive analysis of the performance of natural attenuation as a remedy for groundwater contamination as outlined in the OU 6 ROD.

3.5.2.1 Comparison of Results to OU 6 Cleanup Levels

Between the four active source areas at OU 6 (LF02, LF04, SD15, and WP14), seven COCs were identified in the OU 6 ROD (USAF, 1997b): 1,1,2-TCA; 1,2-DCA; benzene; ethylbenzene; methylene chloride; toluene; and TCE. Table 3-8 depicts current and historical data for wells that were above the cleanup levels during 2001 or 2002. All data having qualifiers are included. Historical concentrations of the target analytes benzene and TCE for all OU 6 wells sampled in 2002 are shown on Figure 3-10. All other data are presented in Appendix B of this report.

Table 3-8 (Page 1 of 2)

Table 3-8 (Page 2 of 2)

[This page intentionally left blank.]

(11X17)

Figure 3-10. Historical Benzene and TCE Concentrations, OU 6 Monitoring Wells.

[This page intentionally left blank.]

OU 6 groundwater COCs that exceeded cleanup levels during the 2002 sampling events are bold on Table 3-8. As indicated, results for four COCs (benzene, ethylbenzene, toluene, and TCE) exceeded cleanup levels. Benzene exceeded the cleanup level at seven well locations (OU6MW-17, OU6MW-46, OU6MW-63, OU6MW-77, OU6MW-91, 14-MW-120, and 14-MW-121) and at three seep locations (LF04-SP02, LF04SP-03, and LF04-SP04). TCE exceeded the cleanup levels at two well locations (OU6MW-17 and OU6MW-90). Ethylbenzene exceeded the cleanup levels at three locations (OU6MW-46, OU6MW-77, and OU6MW-91). Toluene exceeded the cleanup level at one well location (OU6MW-77). Methylene chloride, previously above the cleanup level at OU6MW-91, fell below the action level in 2002.

COCs were plotted to graphically display observed trends over time. Figure 3-11 contains time series plots of benzene trends in groundwater at the five well locations that met the criteria specified in Section 2. Figure 3-12 contains time series plots of TCE trends in groundwater at three well locations that met the criteria outlined in Section 2. Plate 2 depicts historical and current benzene concentrations for hydrocarbon plumes on Elmendorf AFB and Plate 3 depicts historical and current TCE concentrations for chlorinated solvent plumes on Elmendorf AFB.

3.5.2.2 OU 6 Plume Evaluation

The following subsections assess the evidence for natural attenuation and compare current contamination trends to the selected remedy outlined in the OU 6 ROD.

3.5.2.2.1 PL81 North Plume

This plume is located on the western portion of Elmendorf AFB above the Knik Arm Bluff near the intersection of 26th Street and the Knik Bluff Trail. The PL81 North Plume trends northeast to southwest. The lateral extent of the plume has not been defined. The known extent is up to 800 feet in length, with a width of approximately 400 feet. This plume is shown on Plate 1.

Although several documented source areas exist in the vicinity of the PL81 North Plume, including WP14 and LF04, the source for the PL81 North Plume was determined to be Valve Pit 11. This valve pit is part of an abandoned pipeline designated PL81 under the SERA program. The dissolved contaminants released from this valve pit have been shown in previous investigations to have migrated westward to areas WP14 and LF04. The plume is shown on Plate 1. At depth, the plume occupies a shallow unconfined aquifer on the southern margin of the Elmendorf Moraine physiographic unit. The following subsections describe the physical characteristics and groundwater quality in this region of OU 6.

Subsurface Conditions

This portion of OU 6 lies within the Elmendorf End Moraine mapped by early workers in the Anchorage region (Miller & Dobrovolny, 1959 and Schmoll & Dobrovolny, 1972). The Elmendorf Moraine consists of clays, silts, sands, and gravels typical of glaciofluvial environments. The site lies on the transition between the glaciofluvial deposits and alluvial outwash plain deposits. The depth and extent of the geologically older Bootlegger Cove Formation at WP14 has not been fully investigated. Soil borings throughout OU 6 indicate that the Bootlegger Cove Formation occurs 100 to 110 feet above msl or approximately 80 to 90 feet bgs. The average depth to groundwater at WP14 is variable with an average of approximately 25 feet bgs.

At least three distinct aquifers exist beneath both Source Areas LF04 and WP14. Confined and unconfined aquifers, as well as small perched aquifers, have been identified in the LF04 and WP14 subsurface. Layers of low permeability soil of various thicknesses separating the aquifers consist of highly heterogeneous, often overcompacted, glacial till. Many discontinuous lenses of soil having higher porosity and permeability are also present (USAF, 1996c). Thin layers of silty clay appear to support a series of perched aquifers. The unconfined groundwater regime is underlain by a regional deep aquifer that occurs below the Bootlegger Cove Formation. Groundwater flow in the unconfined system is generally toward the west/southwest, with discharge into Knik Arm. Seeps LF04-SP03 and LF04-SP04 are locations speculated to be groundwater discharge points from these source areas. The depth to the

Figure 3-11. Benzene Trends, OU 6 Monitoring Wells.

Figure 3-12. TCE Trends, OU 6 Monitoring Wells.

hydrostratigraphic units vary considerably across the site. Thickness of the saturated interval of the shallowest hydrostratigraphic unit ranges between 10 and 30 feet. Communication among hydrostratigraphic units in the subsurface has not yet been investigated. However, chemical data from wells screened within the deeper aquifers suggests local communication among the groundwater regimes in not likely.

LF04 and WP14 were first investigated in 1994 under the OU 6 RI/FS (USAF, 1996a). At that time, the investigation was limited to Source Areas LF04 and WP14. The 1996 RI/FS presented the first subsurface data for the area and mapped shallow aquifer contamination. PL81 was evaluated as the potential source area for the contaminated groundwater in 2000 by Jacobs Engineering Group (JEG), Inc. and reported in the *Site Evaluation Report for Source Area WP14* (USAF, 2001a). Borings and monitoring wells were installed during the 2000 investigation in an effort to delineate the source of fuel-related contamination in groundwater. The investigation concluded that the likely source for the groundwater contamination at WP14 is the former Valve Pit 11 (PL81). The 2001 Site Evaluation Report concluded that fuel hydrocarbons were released at the valve pit and migrated downgradient via two preferential pathways. The main pathway leads past Wells 14-MW-121, OU6MW-77, and OU6MW-78 and discharges at a seep. During periods of high groundwater infiltration, a second pathway lead a northern route past Wells OU6MW-75 and OU6MW-67 and then combined with the first pathway to discharge at the same seep, LF04-SP04. This seep was monitored in 2002 under the Basewide Program along with Seep LF04-SP03. JEG estimated that approximately 400 cubic yards of vadose zone soil contamination remained beneath the former Valve Pit 11. In addition, some limited vadose soil contamination was detected at the former weathering pad location in WP14. This location is downgradient of the Valve Pit 11 and within the known PL81 North Plume boundaries.

URS investigated the PL81 North Plume in 2001 in order to determine the migration direction of free product associated with Wells OU6MW-77 and OU6MW-12. The study confirmed that two groundwater pathways exist, both migrating west from the site, but determined that they do not recombine and discharge at the same seep. The study concluded that two distinct pathways exist, with the northern pathway exiting the formation at the seep, and the southern pathway, containing free product, migrating further west/southwest.

In 2002, two soil borings were advanced and one was converted to a monitoring well as a follow-on investigation to the PL81 source area. These locations are shown on Plate 1. The purpose of the 2002 investigation was to help further delineate aquifer characteristics in the area. The first boring, OU6SB-94a, was installed approximately 135 feet north of OU6MW-13 and 100 feet west of OU6MW-91. The aquifer containing the PL81 North Plume was not encountered during the advancement of this boring. A second boring (OU6MW-94) was located approximately 50 feet northwest of OU6MW-91 and was converted to a monitoring well.

URS prepared two geologic cross-sections using information from soil borings installed from 1994 to 2002. The cross-section locations are shown in plan view on Figure 3-13 and depicted on Figures 3-14 and 3-15. The cross-sections present the pathway used by the shallow aquifer as it migrates to the west. Figure 3-13 shows the valve pit source area. As groundwater in the shallow aquifer migrates downgradient, it reaches a point just west of OU6MW-12 where it flows northward. The shallow aquifer is not present in Well OU6MW-13 or in the soil boring OU6SB-94a, which is approximately 135 feet north of OU6MW-13. The cross-section B-B' shows varying groundwater elevations within the aquifer. The differences seen may represent two distinct alluvial depositional environments. Areas of lower groundwater elevation may represent older channel deposits. Groundwater flow is dictated by the differences in these two deposits. These conclusions are not based on groundwater elevations taken during the same event and do not account for seasonal variability. Further, most of the borings were advanced only partially into the shallow aquifer and confining units were not investigated.

A review of analytical data shows that contamination is found predominantly in these areas. Contamination has not been found in borings or wells with higher groundwater elevations, such as SB105, SB106, 14-MW-111, and 14-MW-138. It appears that as groundwater flows through the Valve

Figure 3-13. PL81 North Cross-sections Plan View.

[This page intentionally left blank.]

Figure 3-14. PL81 Cross-section A to A'. (11x17)

[This page intentionally left blank.]

Figure 3-15. PL81 Cross-section B to B'. (11x17)

[This page intentionally left blank.]

Pit 11 area, it becomes contaminated and follows the preferential pathways. These findings seem to uphold conclusions made in 2000 and 2001.

Groundwater Quality

Five wells and two seeps were sampled in 2002 as part of the PL81 North Plume investigation. These locations are shown on Plates 1 and 2. All wells sampled as part of this investigation contained fuel hydrocarbon concentrations above OU 6 cleanup levels. In addition, both seep samples contained benzene, GRO, and DRO.

Seep LF04-SP04 appears to be the point where the PL81 North Plume discharges. The origin of the seep is at an elevation of 145.61 feet above msl, which correlates well with the westward end of the shallow aquifer. Contamination found in this seep is not unexpected based on upgradient groundwater conditions in this aquifer. However, Seep LF04-SP03, its origin found at an elevation of 106.66 feet above msl, is likely the daylighting point of a deeper aquifer. This elevation appears to correlate with deep groundwater encountered during drilling of Wells OU6MW-13 and OU6MW-77. Benzene was found at 9.1 µg/L in the sample from this seep. It is unclear whether the benzene detected in LF04-SP03 represents actual aquifer contamination or if the source is located on the bluff slope. It is possible that contaminants are migrating downward through slope deposits and impacting the downgradient portion of this aquifer. It is known that groundwater in Well OU6MW-13 is uncontaminated and has been so in all sampling events. Groundwater results from Well OU6MW-77 cannot be correlated to Seep LF04-SP03 because the well was completed and screened in the shallowest aquifer.

Due to the highly fluctuating concentrations of fuel compounds and a limited data set for many wells in this plume, statistical analysis was not performed for all locations. However, a time-series plot and statistical analysis were performed for the downgradient Well OU6MW-77. The time-series plot, shown on Figure 3-11, displays large fluctuations in benzene concentrations.

An assessment of natural attenuation parameters for the PL81 North Plume shows excellent evidence for biodegradation of fuels. Microbes are rapidly utilizing all available electron acceptors throughout the plume, indicating the presence of several species of microorganism. In addition, alkalinity appears to be at elevated concentrations in some downgradient portions of the plume, which is also an indication of strong microbial activity.

Although microbial degradation of fuel compounds is highly active in this plume, a review of historical and current data suggests the presence of a residual source. Based on previous investigations, however, this is not unexpected. Both the 1994 RI/FS and the 2000 site evaluation found evidence of smear zone contamination in as many as 23 soil borings. Evidence for smear zone contamination was also reported during the 2001 and 2002 investigations. Data for wells throughout the plume display fluctuating concentrations, as would be expected in wells affected by seasonal rise and fall of groundwater elevations in the presence of smear zone contamination. The historical and current presence of free product in wells within this plume is likely a residual source for much of the smear zone contamination found. In addition, vadose zone soil contamination was reported during the 2000 investigation in four borings (SB 122, SB 132, SB 133, and SB 134) installed next to the valve pit and one boring (SB 121) installed in the weathering pad area in WP14. The recommendation after the investigation was to remove up to 400 cubic yards of contaminated soil from the vadose zone.

Evidence for natural attenuation within this plume is very strong. Vadose zone and smear zone soil contamination continue to impact groundwater. It is expected that this residual soil contamination will remain as a source for groundwater contamination for many years. It is therefore recommended that contaminated vadose zone soil be excavated from the subsurface. In addition, it is recommended that free product be removed using a passive system if feasible. The use of free product removal systems may be limited due to overcompacted soils and a generally low yielding aquifer. An addition of one to two more wells downgradient of Wells OU6MW-91 and OU6MW-94 is recommended to characterize the westward extent of free product and the shape of the shallowest aquifer.

The OU 6 ROD established a cleanup goal of 14 years (2011) for groundwater. Given that contaminated vadose zone and smear zone soils are present at the site, along with free product on the water table, it is unlikely that this goal will be met.

3.5.2.2.2 OU6MW-46 Plume

This plume is located only a few hundred feet south of the PL81 North Plume. The plume was investigated as part of the WP14 source area during the 1994 RI/FS. At that time, the plume was determined to be separate from the PL81 North Plume. Additional soil borings installed in 2000 indicated that the OU6MW-46 Plume was distinct from the PL81 North Plume. Currently, the plume is only monitored by Well OU6MW-46, and dimensions are not defined. Groundwater at this location is found at a depth of approximately 5 feet bgs. For a description of subsurface conditions at this location, the reader is referred to discussion of the PL81 North Plume.

Natural attenuation parameters at this location show excellent evidence for biodegradation of fuels. As with the PL81 North Plume, microbes are rapidly utilizing all available electron acceptors. In addition, historical and current benzene concentrations, although fluctuating, are statistically decreasing. This suggests that the source for dissolved fuel contamination is limited.

It is recommended that this plume continue to be monitored annually for COCs only and for natural attenuation parameters every fifth year to support the Five-Year Review. It is possible that groundwater at this location will be below OU 6 cleanup levels by 2011, which is the cleanup goal established in the OU 6 ROD.

3.5.2.2.3 PL81 South Plume

This plume is found in the southern portion of LF04 in the west-central part of the base. The plume is located approximately 600 feet southwest of the PL81 and OU6MW-46 Plumes. The plume is approximately 250 feet long trending east-west and discharging the bluff at Seep LF04-SP02. The site is located in outwash plain soils with groundwater found at approximately 45 feet bgs.

This plume was studied during the 1994 RI/FS as part of LF04 South. The investigation determined that the source for this plume was a pump house, formerly located just to the west of Well OU6MW-63. During drilling of this well, extremely high levels of vadose zone soil contamination were encountered. Although few soil samples were submitted for laboratory analysis, photoionization detector (PID) readings beginning at about 7 feet bgs were greater than 2,000 parts per million by volume (ppmv), which was the upper reading limit of the instrument. The boring log for the hole describes the soil beginning at 5 feet bgs as having a strong total petroleum hydrocarbon (TPH) odor. At 10 feet bgs, the boring log describes the soil as "wet with hydrocarbon (not water)". This description continues to at least 32 feet, where the soil is only described as wet. Water, however, was not encountered until 41 feet bgs and PID readings remained greater than 2,000 ppmv. Notes indicate that the drilling crew began wearing respirators after the first 20 feet bgs. A soil sample collected at the top of the water column contained gasoline at a concentration of 5,880 milligrams per kilogram (mg/kg).

Although vadose zone soil appeared to contain very high concentrations of fuels, no free-product was observed on groundwater after installation of the well in 1994. Conditions in 2002 indicate a significant change. A sheen on the groundwater was present in Well OU6MW-63 and there was free-product exiting the bluff at Seep LF04-SP02.

Concentrations of benzene in Well OU6MW-63 are currently slightly above the cleanup level. This concentration is far lower than that measured in 1994. This behavior is expected as fuel weathers and ages. Heavier compounds, such as GRO and DRO, do not naturally attenuate as easily as benzene and remain in soil and groundwater for longer periods of time. A time-series plot of benzene from 1994 through 2002 is shown on Figure 3-11. Statistical analysis of the data from 1996 through 2002 determined no significant trend. Concentrations have remained stable for that period.

Seep LF04-SP02 was also sampled as part of the Basewide Program in 2002. As mentioned above, groundwater exiting the bluff at this location carries contaminants from the PL81 South Plume. The seep originates about 250 feet northwest of Well OU6MW-63 and travels down a small stream

through a narrow ravine. The stream exits the ravine approximately 35 feet above msl and then flows into a small wetland approximately 10 feet above msl. After migrating through a swampy tidal marsh, water from the seep flows into the Knik Arm. Through soil gas and groundwater screening during the 1994 RI/FS, the PL81 South Plume was demonstrated to follow this pathway. Sample results from 2002 at the origin of the seep contained benzene at a concentration of 37 µg/L, GRO at 5,300 µg/L, and DRO at 87,000 µg/L. A second round of sampling, which included a downgradient sample collected just above the Knik Arm beach, was performed in fall of 2002 to compare results at the origin of the seep to downgradient results. At the origin of the seep during this second round of sampling, benzene was found at 9.5 µg/L, GRO at 1,300 µg/L, and DRO at 89,000 µg/L. At the downgradient location, benzene and GRO were not detected and DRO was found at 200 µg/L. Figure 3-16 shows a conceptual site model for the plume with 2002 sample results.

Although the 2002 seep sample results demonstrate that contamination was being remediated before entering the Knik Arm, this may not always be the case. It is possible that under certain conditions, such as during times of high groundwater flow, contaminants could travel the distance (about 300 to 400 feet) from the origin of the seep down stream to the marine water before being remediated to acceptable concentrations. It is recommended that annual sampling of the downgradient surface water location begin starting in May 2003. Samples should be analyzed for VOCs, DRO, and GRO. Further action should be considered based on evaluation of results. In addition, a passive product removal system should be installed in this plume if feasible. Due to the position of existing wells on the site, at least one additional well should be installed as an extraction well between OU6MW-63 and the bluff.

The OU 6 ROD established a cleanup goal of 14 years (2011) for groundwater. Given that contaminated vadose zone and smear zone soils are present at the site, along with free product on the water table, it is unlikely that this goal will be met.

3.5.2.2.4 LF04 Bluff Seeps

Seven seeps were sampled along the LF04 Bluff as part of the 2002 Basewide Program. Two of the seeps (LF04-SP03 and LF04-SP04) are associated with the PL81 North Plume, and one seep (LF04-SP02) is associated with the PL81 South Plume. Discussion of these seeps is provided above in their relation to their associated plumes. The following subsections describe results of the remaining four seeps sampled. All seeps are shown on Plate maps and survey data are provided in Appendix E.

LF04-SP01

This seep is located only about 200 feet southwest of Seep LF04-SP02 and is found at an elevation of 80.19 feet above msl. GRO and 1,1,2,2-PCE were both found at concentrations just above the method detection limits. No other contaminants were detected. Data from this well help to further define the limits and migration direction of the PL81 South Plume.

LF04-SP05

This seep is located at an elevation of 114.26 feet above msl. DRO was found at this location at just above the method detection limit (65 µg/L). No other contaminants were found.

LF04-SP06

Seep LF04-SP06 is found at an elevation of 42.69 feet above msl. DRO was found at this location at just above the method detection limit (50 µg/L). No other contaminants were found.

LF04-SP07

This seep is located near the top of the bluff at an elevation of 171.37 feet above msl. Acetone, toluene, GRO, and DRO were all found at concentrations slightly above method detection limits. No other contaminants were detected.

[This page intentionally left blank.]

Figure 3-16. PL81 South Plume Conceptual Site Model with 2002 Analytical Results. (11x17)

[This page intentionally left blank.]

3.5.2.2.5 SD15 Plume

The SD15 Plume is located in the north eastern portion of the base just off of Talley Avenue. The location and wells associated with this plume are presented on Plate 1. The boundaries of this plume are associated with Wells OU6MW-17, OU6MW-18, and OU6MW-90. Two of these wells are currently used to monitor the plume (OU6MW-17 and OU6MW-90). In 2002, Well OU6MW-18 was dry, and as a result, was not sampled. The SD15 plume is isolated and is not in close proximity to an environmental receptor. Vertically, the plume occupies a perched aquifer. The aquifer is on average approximately 10-15 feet thick in this region of OU 6. The total area of this plume is approximately 1,600 feet.

The source of this plume is a former sludge disposal site located on the north side of Elmendorf AFB, just west of Talley Ave., on the Elmendorf Moraine. The primary sources of contamination at this site are identified as various spent petroleum products and solvents, which were stored in aboveground tanks, contained in filter elements, or otherwise released onto the concrete or open ground surface at SD15. The remedy selected for SD15, as documented in the OU 6 ROD, is an HVE system with ICs, long-term monitoring for perched aquifer groundwater and deep soils, and excavation, thermal treatment, and back-filling for shallow soils. An HVE system was installed at this site and began operating in 1997. To date, the system has treated over 365,000 gallons of contaminated groundwater from the perched aquifer. Because groundwater contamination in the deep aquifer has not exceeded regulatory or health levels, remediation of the deep aquifer has not been required.

This plume is unique in that the contaminants include hydrocarbons and chlorinated solvents. Both benzene and TCE are above cleanup levels at both OU6MW-17 and OU6MW-90. This environment is actually quite conducive to biodegradation of both fuels and solvents. Microbes under these conditions will use the fuel compounds as an electron donor and the chlorinated compounds as electron acceptors, thereby gaining energy while degrading both contaminants.

The two locations sampled within in this plume show evidence of biodegradation. The protocol summary score for OU6MW-17 and OU6MW-90 is 9, which is classified as limited evidence for anaerobic biodegradation of chlorinated solvents. There are several factors involved in this outcome. Electron acceptors such as nitrate and sulfate are low, which is due to the presence of the hydrocarbons and elevated rates of microbial activity. High levels of DO were measured during sampling of these wells. Levels of BTEX were slightly below the 0.1 milligram per liter (mg/L) protocol limit. Historically, fuel constituents have been present and would contribute to BTEX numbers well above the 0.1 mg/L which would contribute to natural attenuation. It is possible that microorganisms are using fuel constituents other than BTEX as the substrate in this plume, which is not taken into account in the protocol process. TOC was detected and available as an electron donor.

Dechlorination, at least to the stage of DCE and DCA, appears to be taking place. This may be due to co-metabolism of fuel and chlorinated solvent compounds, as previously explained. It appears that up to four different solvents, PCE, 1,1,2,2-PCA, 1,1,1-TCA, and TCE, are present in the plume. The daughter products 1,1,2-TCA, DCA, and DCE are all present. Almost all of the DCE found is cis-1,2-DCE, which indicates that it is a daughter product. The absence of vinyl chloride and chloroethane may indicate that DCE and DCA are not degrading. Vinyl chloride may also be oxidized rapidly, and therefore, not be detected in groundwater samples.

It is unclear whether natural attenuation in this plume will be limited by the amount of carbon available. Current levels of anthropogenic carbon seem to be high and it is likely that the remaining carbon will allow for continued natural attenuation. Although natural attenuation is occurring slowly, it appears likely that the site will meet cleanup levels by the predicted time in the ROD.

3.5.2.2.6 LF02 Plume

The LF02 Plume is located on the southeastern corner of the base just north of the Boniface Visitors' Center and west of Vandenburg Ave. The plume consists of low concentrations of TCE (3 to 4 µg/L) and moderate concentrations of 1,1,2,2-PCE (9 to 12 µg/L). A risk-based goal of 0.43 µg/L for 1,1,2,2-PCE was established in the OU 6 ROD. The plume is monitored by in-source Well

OU6MW-49R, downgradient Well 53-WL-05, and seep location LF02-SP01. The plume lies in a shallow unconfined aquifer in alluvial sediments. The source for this plume is a landfill that was used to dispose of construction debris and general refuse from the 1940s to the 1950s. The source area is situated partially on a bluff overlooking the Ship Creek floodplain, and partially on the floodplain. The depth to groundwater at the site ranges from 1 foot bgs in the topographically low portions of the site to up to 30 feet bgs in the higher portions of the site.

An assessment of natural attenuation parameters for this plume shows inadequate evidence for biodegradation of chlorinated solvents. A lack of natural and anthropogenic carbon and high levels of electron acceptors, other than chlorinated solvents, are severely limiting subsurface microbial activity. Some daughter product of TCE is present, indicating that biodegradation of chlorinated solvents is occurring at slow rates. In 1994, 1,1,2,2-PCE was found as high as 45 µg/L in the original Well OU6MW-49, with TCE found at 5.39 µg/L. Current concentrations of these chlorinated solvents are much lower, indicating that natural attenuation is working.

The seep sample from LF02-SP01, taken at the same location as the 1994 RI/FS Seep LF02-SP06, contained only one analyte, 1,1,2,2-PCE, at concentrations above the detection level. This analyte was detected at 0.44 µg/L.

No COCs were established for LF02 in the OU 6 ROD and no contaminants were found at high concentrations during the 2002 Basewide Program. The ROD established a 23 year time-frame (2020) for groundwater to be cleaned up. It is possible that groundwater at this location will meet this goal.

3.5.3 Overall Performance of Natural Attenuation as Compared to OU 6 ROD

Natural attenuation appears to be working at high rates for fuel-related plumes that are found in OU 6. It has been shown that some areas, particularly in the western portion of OU 6, contain contaminated vadose zone and smear zone soil, which is acting as a continuing source for groundwater contamination. These sources will make it difficult for groundwater to meet cleanup goals within the time-frames outlined in the ROD. The two chlorinated solvent plumes found in OU 6 display slow rates of natural attenuation. It is still possible that these plumes will meet the goals established in the ROD.

3.5.4 OU 6 Conclusions and Recommendations

The following are conclusions and recommendations derived from hydrogeologic and natural attenuation analysis of 2002 groundwater data for OU 6:

- For wells in the OU 6 program area, free product was detected at two wells during the 2002 field season (OU6MW-12 and OU6MW-77). A fuel odor and/or sheen was noted at four additional wells.
- Results for four COCs (benzene, ethylbenzene, toluene, and TCE) exceeded cleanup levels. Benzene exceeded the cleanup level at seven well locations (OU6MW-17, OU6MW-46, OU6MW-63, OU6MW-77, OU6MW-91, 14-MW-120, and 14-MW-121) and at three seep locations (LF04-SP02, LF04SP-03, and LF04-SP04). TCE exceeded the cleanup levels at two well locations (OU6MW-17 and OU6MW-90). Ethylbenzene exceeded the cleanup levels at three locations (OU6MW-46, OU6MW-77, and OU6MW-91). Toluene exceeded the cleanup levels at one well location (OU6MW-77). Methylene chloride, previously above the cleanup level at OU6MW-91, decreased below the cleanup level in 2002.
- Data strongly imply that natural attenuation is effectively removing organic contaminants within OU 6 groundwater. However, areas of contaminated vadose zone and smear zone soil remain, which will increase the time to meet groundwater cleanup goals.
- As a result of the 2002 Well Decision Guide analysis of the OU 6 program area, three wells will be removed in 2003 (OU6MW-67 because it is a redundant sample point in the PL81 North Plume and OU6MW-81 and OU6MW-82 because they are screened in a deeper aquifer). Well OU6MW-77 will not be sampled as a part of the Basewide Program but will remain in the

product recovery program. Annual monitoring will occur at the remaining OU 6 program area wells and will test for only ROD-specified COCs. It is recommended that natural attenuation parameters be sampled every five years in conjunction with the Five-Year Review.

- For the PL81 North Plume, the following are recommended:
  1. Implement the planned performance based contract for cleanup of contaminated soil from the vadose zone at Valve Pit 11 source and the WP14 weathering pad source as soon as practical.
  2. Install a passive free product removal system if feasible.
  3. Install further monitoring wells in the westward (downgradient) portion of the plume.
- For the PL81 South Plume, the following are recommended:
  1. Establish a point of compliance directly above the Knik Arm beach below LF04-SP02 and begin annual sampling of surface water for VOCs, DRO, and GRO.
  2. Base further action on 2003 results.
  3. If feasible, install a passive free product removal system as soon as practicable.

3.6 SERA Phase I

The SERA Phase I program was established to address the assessment and remediation of POL-contaminated sites at Elmendorf AFB. Several remedial action alternatives have been implemented to address contaminated media at SERA sites, including, but not limited to, bioventing and long-term monitoring. It is also assumed that natural attenuation (biodegradation) will occur over time.

As a result of the 2002 Decision Guide, 12 SERA Phase I monitoring wells were sampled once in 2002. Sampling was performed in accordance with the long-term groundwater monitoring effort to evaluate contaminant migration and to determine the extent of natural attenuation occurring at the sites. Table 1-5 lists the wells sampled and Plate 1 shows the location of the program areas and of the wells. Well W3 was not sampled in 2002 due to the presence of free product.

3.6.1 Occurrence of Free Product

For wells in the SERA Phase I program area, free product was detected at one well during the 2002 field season (43-WL-11). A fuel odor and/or sheen were noted at four additional wells (43-WL-07, 43-WL-09, 56-WL-04, and W4). Table 3-9 presents current and historical product presence data for wells in the SERA Phase I program area that contain product.

Table 3-9

Product Presence Detected in SERA Phase I Groundwater from Field Operations, 1995-2002
Elmendorf AFB, Alaska

Well ID	Description of Historical and 2002 Product Presence (Product thickness is provided in feet)							
	1995	1996	1997	1998	1999	2000	2001	2002
43-WL-07	Sheen, odor	Sheen, odor	Sheen, odor	ND	ND	0.1	Odor	Odor
43-WL-09	NM	NM	NM	NM	NM	NM	NM	Odor
43-WL-11	Free product[1]	Free product[1]	0.105	0.075	0.66	0.66	0.86	0.56
56-WL-01	ND	Sheen	ND	Sheen, odor	NM	Sheen	Odor	ND
56-WL-04	Sheen, odor	1.0	0.02	0.004	0.04	Sheen, odor	Sheen, odor	Sheen, odor
56-WL-05	ND	Sheen	ND	ND	ND	Odor	Odor	ND
SP7/10-04	Sheen, odor	Sheen	Sheen, odor	ND	<0.01	Odor	Odor	ND
W-3	NM	Free Product, NM	NM	NM	1.07	0.23	0.01	NM
W-4	ND	ND	ND	ND	0.01	Sheen, odor	Odor	Sheen, odor

[1] Free product was detected, but the product thickness was not measured.
ID - identification
ND - Floating product was not detected during field events during the year indicated.
NM - The well indicated was not measured for free product during the given period.

3.6.2 Status of Groundwater Remediation

The following subsections compare results to regulatory cleanup levels and provide a comprehensive analysis of the performance of natural attenuation as a remedy for groundwater contamination as outlined in the decision documents.

3.6.2.1 Comparison of Results to SERA Phase I Cleanup Levels

Six COCs were identified for SERA Phase I to characterize groundwater contamination relating to POL products, as addressed in Table 2-1. Table 2-1 illustrates fuel-related compounds consistent with SERA program goals for POL-contaminated sites. The six COCs identified in this report include benzene, DRO, ethylbenzene, GRO, toluene, and total xylene. A comparison of COC concentrations over the last five years for SERA Phase I is provided in Table 3-10. The data tables depict current and historical data for wells that were above the regulatory levels during 2001 or 2002. All data having qualifiers are included unless the data was flagged "R". Figure 3-17 shows historical concentrations for the target analyte benzene for all SERA Phase I wells sampled in 2002. All other data are presented in Appendix B of this report.

Current SERA Phase I groundwater COCs above cleanup levels during the 2002 sampling events are bold on Table 3-10. As indicated, five of the COCs were found above cleanup levels in 2002. Benzene exceeded the cleanup level at four well locations (43-WL-07, 43-WL-11, SP7/10-04, and W-4). Ethylbenzene exceeded the action level at two well locations (43-WL-07 and 43-WL-11). GRO exceeded the cleanup level at four locations (43-WL-07, 43-WL-11, SP7/10-04, and W-4). DRO exceeded the cleanup level at eight locations (43-WL-07, 43-WL-11, 56-WL-01, 56-WL-04, 56-WL-05, AP-3567, SP7/10-04, and W-4). Toluene exceeded the cleanup level at 43-WL-11.

The only target analyte for all SERA locations is benzene. DRO and GRO fuel compounds are also COCs. Benzene results for the SERA Phase I monitoring wells meeting the criteria in Section 2 are displayed along with well locations on Plate 2.

Table 3-10 Comparison of 2002 Analytical Results to Cleanup Levels, SERA Phase I Monitoring Wells.

[This page intentionally left blank.]

(11X17)

Figure 3-17. Historical Benzene Concentrations, SERA Phase I Monitoring Wells.

[This page intentionally left blank.]

Graphical representation of SERA Phase I benzene data that meets requirements outlined in Section 2 are presented on Figure 3-18. Historical and 2002 DRO and GRO concentration results meeting the criteria in Section 2 are displayed on Figure 3-19.

3.6.2.2 SERA I Plume Evaluation

The following subsections assess the evidence for natural attenuation and compare current contamination trends to the selected remedy outlined in the *Corrective Action Plan , SERA Phase I* (USAF, 1995b) and in the *Continued Investigation at SERA Phase II Sites (ST36/66, ST74, ST61) Report* (USAF 1999a).

3.6.2.2.1 ST36/66 Plume

ST36/66 is the northern most plume currently monitored under the Basewide Program. This plume is located in the northwest portion of the base approximately ¼ mile west of Spring Lake. A bioventing system has been in operation since 1996 and three wells are currently used to monitor its effectiveness. The plume was investigated under the SERA Phase I and Phase II work and is summarized in the CAP and *SERA Phase II Continued Investigation Report* (USAF, 1999a). Well 56-WL-01 was installed in the source, while Wells 56-WL-04 and 56-WL-05 were installed downgradient. At the time of installation, the plume was less than 60 feet in circumference while today contaminants are found in the downgradient wells. Total plume length currently is greater than 65 feet. The plume is located in a shallow unconfined aquifer at a depth of approximately 65 feet bgs on a kame deposit. Flow direction within this aquifer is unclear due to complex soil stratification and individual groundwater flow paths (USAF, 1999a).

The source for the ST36/66 Plume was identified as an UST. In 1988, the piping system from the tank failed and released heating oil. The tank was emptied and taken out of service following the release. Contaminated vadose zone soil was left in place. Two other USTs (ST66) on the site were investigated under SERA Phase II and appeared to not be contributing to groundwater contamination (USAF, 1999a).

Groundwater contaminants found in these wells in 2002 consisted mainly of DRO, with minor concentrations of BTEX and GRO detected. Natural attenuation parameters from this plume show excellent evidence for biodegradation of fuel. Virtually all of the electron acceptors, DO, nitrate, and ferric iron, are being used and the plume is currently under sulfate-reducing conditions. A review of historical and current contaminant concentrations indicates that the plume is degrading. A sheen and concentrations of DRO up to 40,000 µg/L were detected in 1994 and reported in the SERA Phase I CAP. Free product and a DRO concentration of 127,000 µg/L were found in Well 56-WL-04 in 1996. In 2002, a slight sheen was detected in Well 56-WL-04 and dissolved DRO concentrations were found up to 15,000 µg/L in Well 56-WL-05. Concentrations of DRO over the past five years have fluctuated in all three wells. Figure 3-19 shows historical and current results for these wells.

Natural attenuation appears to be working moderately well for remediation of the ST36/66 Plume. Parameters indicate that microbes are actively utilizing electron acceptors and breaking down hydrocarbons. Since groundwater is relatively deep at this location (65 feet bgs), it can be assumed that a relatively large amount of soil in the vadose zone was impacted by releases from the UST. In 2001, the USAF completed closure sampling for the bioventing system. Borehole sampling indicated that most soil contamination was limited to a zone just above groundwater. This is likely due to a smear zone effect, which can also cause fluctuations in groundwater contaminant concentrations. Vadose zone contamination above the smear zone is apparently not affecting groundwater quality at this location.

The CAP did not predict a date when cleanup goals would be met, but overall contaminant concentrations are decreasing. In order to assure that the plume is not migrating off site, it is recommended that Wells 56-WL-06, 56-WL-08, and 56-WL-09 be included in the next sampling round.

Figure 3-18. Benzene Trends, SERA Phase I Monitoring Wells.

Figure 3-19. Historical DRO and GRO, SERA Phase I Monitoring Wells. **(11X17)**

[This page intentionally left blank.]

In addition, a water level survey in all wells on site should be performed at the time of that sampling event to help determine groundwater flow direction. All wells on site should also be resurveyed in order to accurately plot groundwater surface contours.

3.6.2.2.2 SS43 Plumes

SS43 is located north of the East/West Runway between Taxiways "J" and "M". Three fuel hydrocarbon plumes are found at this site and all are discussed in this section. Several types of release events during different periods of time created the plumes found at this part of the base. The release events included leaking USTs and associated pipelines and fuel spills during aircraft refueling.

Airlifter Plume

The Airlifter plume is monitored by Wells 43-WL-09 and 43-WL-11. The plume is located south of Airlifter Drive and just west of Building 15380. The plume trends roughly north-south. Boundaries of this plume are somewhat unclear due to mingling with other plumes downgradient. The upgradient margin of the plume is defined by Well 43-WL-09.

The source for the plume was determined during an investigation of SERA Phase I in 1994, which is summarized in the SERA Phase I CAP (USAF, 1995b). Under this investigation, the site was labeled ST43. At this time, it was found that two USTs with associated piping and disperser island, located a few feet north of Well 43-WL-11, were responsible for soil and groundwater contamination. In addition, an abandoned fuel pipeline was located just south of 43-WL-11. It was uncertain if the pipeline was contributing to the contamination. One of the USTs was reconditioned and kept in use, while the other was removed and its piping abandoned in 1994.

The site was also studied during 1997 and is reported in the *SERA Phase V Summary Report* (USAF, 1999b). At this time, the site was labeled ST507. During this investigation, five soil borings were drilled in the vicinity of the USTs and disperser island. The report concluded that the horizontal extent of smear zone contamination at the site had not yet been defined. No evidence of vadose zone contamination was found.

Free-phase fuel product has been measured in Well 43-WL-11 since its installation in 1994. From 1996 to 2001, the Basewide Program measured and removed free product from this well on a monthly basis. In 2002, product in this well was measured and actively removed by bailer on a weekly basis. Approximately ½ gallon of product was removed each week. During the final measurement of product in late September of 2002, no measurable product was detected. The well, however, was still bailed and only a sheen was present on purge water.

SS43 Plume

The upgradient margin of the second plume in this area is located approximately 500 feet southwest of Well 43-WL-11. The boundaries of this plume are also somewhat unclear due to the presence of several sources that were active at various periods of time. In addition, the upgradient Airlifter Plume has likely affected groundwater quality at this location. Sources for the plume include a 50,000-gallon release of JP-4 in 1964 and a 36,000-gallon release in 1980. In addition, releases associated with a pump house and associated valve pits and piping are also suspected.

This plume is being actively remediated by the ST43/55 bioventing system and is currently monitored by in-source Wells 43-WL-07 and SP7/10-04, and by downgradient Well SP7/10-01. In addition, Well W-3 is used to measure and remove free product.

W4 Plume

The third plume in the area is located approximately 800 feet southwest of the SS43 Plume. The plume is located northwest of the junction of Taxiways "J" and "M". Only Well W-4 is monitored in this plume and boundaries are not clearly established. The source for this plume is also not clearly defined, but is likely associated with leaking fuel pipelines and/or surface spills during refueling activities.

Subsurface soil and groundwater sampled in 1994 indicated that Well W-4 was located at the upgradient end of the plume and that the plume was fairly small in size.

Natural attenuation parameters for these plumes show excellent evidence for biodegradation of fuel hydrocarbons. Microbes are rapidly utilizing all available electron acceptors, indicating that several species of microorganisms are present and are breaking down hydrocarbons. However, a review of contaminant concentrations through 2001, provided conflicting trends. While Wells 43-WL-07 and SP7/10-04 benzene trends were statistically decreasing, the trend for benzene in Well W-4 was increasing and no statistical trend could be determined for Well 43-WL-11 due to fluctuating concentrations. Statistics were not repeated for these wells in 2002. As mentioned above, free product has been present in Wells 43-WL-11 and W-3 since the early 1990s. Current quantities of free product are approximately the same as when first measured in 1994. This indicates that free product is acting as a continuous source for dissolved groundwater contamination.

In preparation of the CAP for SERA Phase I (USAF, 1995b), it was determined that removal of free product by a pumping system would not be effective given the type of product found and the aquifers' characteristics. It was recommended at that time that hand bailing be used, instead of pumping, to remove free product. However, because free product thicknesses have not decreased since the CAP was developed, it appears that hand bailing has not produced the desired results and the source for dissolved groundwater contamination remains.

New product removal systems have been developed since production of the CAP in 1995. Systems are less expensive and do not rely on pumping large quantities of groundwater as assumed in development of the CAP. Installation of a passive product recovery system should be considered in order to remove the source and reduce the time it takes to meet groundwater cleanup goals. Research should be done to identify a system appropriate for site conditions.

It is unclear when groundwater at this site will meet cleanup goals. If efforts to remove free product are successful, the time to remediation goals will be significantly reduced. The CAP did not outline a date by which groundwater cleanup goals would be met.

3.6.2.2.3 ST61 Plume

The ST61 Plume is located east of Fairchild Ave. approximately 1/3 of a mile south of Hillberg Lake in the northern portion of the base. The site is located north of the Elmendorf Moraine. Vertically, the plume occupies the shallow, unconfined aquifer and is underlain by the Bootlegger Cove Formation. The aquifer is approximately 15 to 20 feet thick at this location.

The source for this plume was identified during several investigations, as described in the SERA Phase I CAP (USAF, 1995b). The sources were determined to be a corroded and leaking UST and an unknown source located upgradient of the UST. Currently, the plume is approximately 150 feet long by 50 feet wide. Contaminants found in the plume include DRO, GRO, and trace concentrations of xylenes. Wells sampled in this plume are upgradient Well AP-3606, in-source Well AP-3567, and downgradient Well 45-WL-02. The plume is currently being treated by the ST61 bioventing system.

Evaluation of natural attenuation parameters shows strong evidence for biodegradation of fuel compounds in this plume. There is an ample electron acceptor supply, particularly of sulfate, which is being used rapidly by microbes. Virtually all of the BTEX components, which were found above cleanup levels in 1994, have been eliminated from the system. DRO is the only compound still found above ADEC cleanup levels at 11,000 µg/L in Well AP-3567. This concentration is above the original concentration detected in 1994. No contaminants are found in the downgradient Well 45-WL-02, and only very low levels of DRO are found in the upgradient well, AP-3606. The upgradient well was originally installed downgradient of the unknown source. Since this well is now clean, the upgradient source appears to have been remediated.

The CAP described a clay layer that was thought to be acting to inhibit downward migration of contaminants from the UST. Contaminants were forced to migrate laterally from the source until a vertical pathway down to groundwater was found. It is likely that some of the product released from the UST is still in the process of downward migration and contributing small amounts of DRO to the aquifer. In addition, seasonal changes in groundwater elevations are likely creating a smear zone effect, which can result in fluctuating contaminant concentrations in groundwater.

Bioventing and natural attenuation appear to be working well for remediation of the ST61 Plume. The CAP did not predict a date when cleanup goals would be met, but overall contaminant concentrations are decreasing, the plume is shrinking, and contaminants have not migrated downgradient.

3.6.3 Overall Performance of Natural Attenuation as Compared to SERA Phase I Corrective Action Plan

Data show that fuel hydrocarbon contamination in groundwater at SERA Phase I is being remediated effectively by natural attenuation. Several species of microorganisms are rapidly utilizing electron acceptor supplies within all plumes studied. It is evident that some plumes are shrinking and contaminant concentrations are decreasing. Although no target cleanup dates were outlined in the SERA Phase I CAP, it is expected that time to remediation at SERA Phase I will be similar to that of OU 2 and OU 6.

3.6.4 SERA Phase I Conclusions and Recommendations

The following are conclusions and recommendations derived from hydrogeologic and natural attenuation analysis of 2002 groundwater data for SERA Phase I:

- For wells in the SERA Phase I program area, free product was detected at two wells during the 2002 field season (43-WL-11 and W3). A fuel odor and/or sheen was noted at four additional wells (43-WL-07, 43-WL09, 56-WL-04, and W4). Product thickness data from 43-WL-11 and W-3 indicate that product removal should be continued at these locations.
- Five of the COCs were found above cleanup levels in 2002. Benzene exceeded the cleanup level at four well locations (43-WL-07, 43-WL-11, SP7/10-04, and W4). Ethylbenzene exceeded the cleanup level at two well locations (43-WL-07 and 43-WL-11). GRO exceeded the cleanup level at four locations (43-WL-07, 43-WL-11, SP7/10-04, and W4). DRO exceeded the cleanup level at eight locations (43-WL-07, 43-WL-11, 56-WL-01, 56-WL-04, 56-WL-05, AP-3567, SP7/10-04, and W4). Toluene exceeded the cleanup level at 43-WL-11.
- For all wells in SERA Phase I, a review of natural attenuation parameters indicates that the process is actively removing the contaminant mass. One well, W-4, exhibited an increasing trend for benzene, possibly indicating the effect of a smear zone as water levels change. Natural attenuation parameters in groundwater taken from this well indicate high levels of microbial activity.
- It is recommended that Wells 43-WL-11 and W-3, both of which contain free product, remain in the free product measurement and recovery program in 2003. Since the presence of free product can cause dissolved concentrations to fluctuate and cause contamination of sampling equipment, it is recommended that these wells not be sampled until free product is no longer present.
- It is recommended that the *Decision Guide for Monitoring Well Sampling Frequency* be revised to discuss monitoring wells that contain free product. A note should be added to the guide which states "Wells containing free product will not be sampled but will be included in the Basewide Product Measurement and Recovery Program. These wells may be sampled when free product is no longer present."
- Annual monitoring will continue at Wells SP7/10-04, W-4, 56-WL-04, and 56-WL-05. It is also recommended that monitoring occur once every two years for Wells SP7/10-01, 45-WL-02, and AP3567. Wells AP3606, 43-WL-09, and 56-WL-01 will be sampled every five years in conjunction with the Five-Year Review. Until the Five-Year Review all wells will be sampled for COCs only. At that time of the Review, wells will be sampled not only for COCs but also for natural attenuation parameters.

- It is recommended that Wells 56-WL-06, 56-WL-08, and 56-WL-09 be sampled once during the 2003 sampling event at ST36/66. In addition, a water level survey should be performed for all wells at the site. Also a resurveying of all well polyvinyl chloride (PVC) elevations should be completed in order to better understand groundwater flow at the site.
- It is recommended that a passive product recovery system be put in place at Wells 43-WL-11 and W-3 during the 2003 field season.

3.7 SERA Phase II

Ten SERA Phase II monitoring wells were sampled in 2002. Table 1-5 lists wells sampled and Plate 1 shows the locations of the program area and the wells.

As a result of the 2002 Decision Guide, SERA Phase II monitoring wells were sampled once in 2002. Sampling was performed in accordance with the long-term groundwater monitoring effort to evaluate contaminant migration and to determine the extent of natural attenuation occurring at the sites.

3.7.1 Occurrence of Free Product

For wells in the SERA Phase II program area, a measurable free product layer was detected for the first time at 56-WL-36 in 2002. This well is associated with a known DRO/benzene plume. A fuel odor was noted in 2002 at four wells: 59-WL-30, 62-WL-05, 64-WL-01, and for the first time at 59-WL-31. Table 3-11 presents current and historical product presence data for wells in the SERA Phase II program area that contain product.

Table 3-11

Product Presence Detected in SERA Phase II Groundwater from Field Operations, 1995-2002
Elmendorf AFB, Alaska

Well ID	Description of Historical Product Presence (Product thickness is provided in feet)							
	1995	1996	1997	1998	1999	2000	2001	2002
59-WL-30	ND	Sheen	ND	ND	0.01	ND	Odor	Odor
59-WL-31	ND	ND	ND	ND	ND	ND	ND	Odor
59-WL-36	ND	ND	ND	ND	ND	ND	ND	0.04
60-WL-04	ND	ND	ND	ND	ND	ND	Odor	ND
62-WL-02	ND	Sheen	Trace	ND	Sheen, odor	ND	Odor	ND
62-WL-05	ND	ND	ND	ND	ND	ND	Odor	Odor
64-WL-01	Sheen, odor	Sheen	Sheen	ND	Sheen, odor	ND	Odor	Odor

ID - identification
ND - Floating product or odor was not detected during field events during the year indicated.

3.7.2 Status of Groundwater Remediation

The following subsections compare results to regulatory cleanup levels and provide a comprehensive analysis of the performance of natural attenuation as a remedy for groundwater contamination as outlined in the decision documents for SERA Phase II.

3.7.2.1 Comparison of Results to SERA Phase II Regulatory Levels

Six COCs were identified for SERA Phase II to characterize groundwater contamination relating to POL products, as addressed in Table 2-1. Table 2-1 illustrates fuel-related compounds consistent with SERA program goals for POL-contaminated sites. The six COCs identified in this report include benzene, DRO, ethylbenzene, GRO, toluene, and total xylenes. A comparison of historical concentrations for those wells with analytes over the MCL concentration in 2001 or 2002 for SERA Phase II is provided in Table 3-12. The data tables depict current and historical data for wells that were above the cleanup levels during 2001 or 2002. Figure 3-20 shows historical concentrations for the target analyte benzene for all SERA Phase II wells sampled in 2002. All other data are presented in Appendix B of this report.

Table 3-12 Comparison of 2002 Analytical Results to Cleanup Levels at SERA Phase II Monitoring Wells.

[This page intentionally left blank.]

(11X17)

Figure 3-20. Historical Benzene Concentrations, SERA Phase II Monitoring Wells.

[This page intentionally left blank.]

SERA Phase II groundwater COCs exceeding cleanup levels during the 2002 sampling events are bold in Table 3-12. Four COCs (GRO, DRO, benzene, and toluene) exceed cleanup levels. Benzene exceeded the cleanup level at four well locations (59-WL-30, 59-WL-31, 64-WL-01, and 62-WL-05). DRO exceeded the cleanup level at one well location (59-WL-31). GRO exceeded the cleanup level at five locations (59-WL-30, 59-WL-31, 59-WL-36, 60-WL-04, and 62-WL-05). Toluene exceeded the cleanup level at one well location (59-WL-31).

Target analytes were graphically displayed to identify trends over time. Figure 3-21 contains time series plots of benzene trends in groundwater at the six well locations that met the criteria outlined in Section 2. The only target analyte for all SERA locations is benzene. DRO and GRO fuel compounds, however, are also COCs. Benzene results for the SERA Phase II monitoring wells meeting the criteria in Section 2 are displayed along with well locations on Plate 2. DRO and GRO results meeting the criteria in Section 2 are displayed on Figure 3-22.

3.7.2.2 SERA II Plume Evaluation

The following subsections assess the evidence for natural attenuation and compare current contaminant trends to the selected remedy outlined in the decision documents for SERA Phase II.

3.7.2.2.1 ST32 Plumes

The following plumes are associated with Source Area ST32. Site ST32, the 29 UST areas, is located along the Elmendorf Moraine north of the east-west runway. Twenty-nine 50,000-gallon USTs were buried over an 80-acre area along the face and crest of the moraine. The USTs were interconnected and delivered fuel to the flight line by gravity flow. At the time of the SERA Phase II Site Assessment (USAF, 1995c), the extent of soil and groundwater contamination was not defined. Today, however, it is believed that these plumes are relatively isolated. Vertically, they occupy the shallow aquifer, which is generally unconfined, but due to local stratigraphic conditions, can occur in the moraine as perched and semi-confined. The contaminants of concern at this area include DRO, GRO, BTEX, and lead related to the JP-4 and avgas stored in the tanks during their operational lifetime. The following plumes are associated with these 29 UST areas. A natural attenuation assessment for each plume is provided below.

59-WL-31 Plume

This plume is located just west of the intersection of Fairchild Ave. and Airlifter Drive. Well 59-WL-31 is downgradient of Tanks 1 and 2. However, a much closer potential source of contamination is the pipeline and associated valve box. Well 59-WL-31, a sentry location for ST32, was sampled once in 2002 as a part of the Basewide Program. This is the only well used to monitor the associated plume. An assessment of natural attenuation of this plume indicates that several of the electron acceptors, mainly nitrate and sulfate, may no longer be present but have been expended in degradation. An elevated level of ferrous iron also indicates natural attenuation has occurred. Along with ferrous iron, there is an elevated level of total iron in Well 59-WL-31. This indicates that there is likely an ample supply of ferric iron to be used as an electron acceptor to continue the degradation process.

Well 59-WL-31 appears to have high, fluctuating levels of benzene contamination, possibly due to pulses of contamination migrating past the well. However, levels in 2002 are half that of the level at the time of the site assessment. It is likely this decline will continue, but at a slower rate. DRO, GRO, and toluene will also begin to decline but at a reduced rate due to the complexity of the compounds. This slow rate in natural attenuation may be due to the fact that this plume could reside in a perched aquifer. With less fresh water filtrating through the system, there is less possibility for new electron acceptors.

This plume is not in close proximity of an environmental receptor thus possible contaminant migration before total biodegradation is not likely. Historically, a downgradient well, 59-WL-38, sampled in previous years but not in 2002 contained no benzene. It is recommended to sample Well 59-WL-31 once every five years to track natural attenuation rates and possible migration.

Figure 3-21. Benzene Trends, SERA Phase II Monitoring Wells.

Figure 3-22. Historical DRO and GRO, SERA Phase II Monitoring Wells. **(11X17)**

[This page intentionally left blank.]

59-WL-30 and 59-WL-36 Plume

The northern boundary for this plume is located just north of Airlifter Drive at 35th Street at Well 59-WL-30. The southern boundary is located midway between Airlifter Drive and Taxiway "M". The source for this plume, as with others at ST32, is a former leaking UST (Tank 5 removed in 1993). The complete extent of this plume has not been determined and it is possible that there are two plumes. However, historical information does not document a separate source for the contaminants present at 59-WL-36, but rather refers to this well as a downgradient location for various former ST32 USTs. Vertically, this plume occupies the shallow aquifer underlain by the Bootlegger Cove Formation. Remedial actions for this plume include a bioventing system with provisions for air injection and SVE operational modes, and groundwater monitoring. One in-source (59-WL-30) and one downgradient (59-WL-36) groundwater location were monitored once in the Basewide Program for 2002.

An assessment of natural attenuation reveals several things about this plume. First, the presence of ferric iron indicates natural attenuation is occurring. Several electron acceptors, however, are relatively low at the in-source location. For example, DO is found at concentrations above 1 mg/L. However, this may be a result of operation of the bioventing system. The occurrence of natural attenuation and the effectiveness of the bioventing system are also represented by the decline of benzene concentrations in-source. Based on current and historical data, it appears likely that natural attenuation will continue, especially at the downgradient location. Benzene levels downgradient at 59-WL-36 dropped below the detection limits in 2001 and remained below in 2002. Electron acceptors remain elevated at this location and indicate that further remediation of GRO, DRO, and migrating contaminants is possible.

It is recommended to continue monitoring at the current locations (59-WL-30 and 59-WL-36) once every five years. With natural attenuation in progress, monitoring once every five years will provide an update of contaminant levels and a current assessment of degradation.

3.7.2.2.2 Heritage Park Plumes

The Heritage Park Plumes are located in the area surrounding Heritage Park. Heritage Park is located at Slammer and Sijan Ave. near Heritage Circle Drive. Three plumes are associated with this area: one at Well 60-WL-04 (ST48), one at Well 64-WL-01 (ST68), and one at Well 62-WL-05 (ST68). These wells, along with downgradient locations (ST20-03, 62-WL-02, and 62-WL-06) were sampled once as a part of the Basewide Program in 2002. Each of these plumes is very isolated with the extent of contamination found only at the in-source location. Vertically, these plumes occupy the shallow unconfined aquifer, which is underlain by the Bootlegger Cove Formation aquitard. The aquifer averages about 25 feet thick.

The first of these plumes is associated with in-source Well 60-WL-04 and downgradient Well ST20-03. The source area for this plume, ST48, is associated with two diesel fuel line leaks occurring in 1968 and in 1991. Contaminated soils were removed but the groundwater assessment showed contaminants (DRO, GRO, and BTEX). Benzene concentrations in this plume have rapidly declined and, for the first time, in 2002, were not detected at 60-WL-04 (Figure 3-21) . The only remaining analyte above the action level at this plume is GRO (1,700 µg/L). A natural attenuation assessment of this plume shows that electron acceptors, especially sulfate, remain elevated in both the in-source and downgradient locations. It is likely that natural attenuation will continue. Although at a slower rate than benzene, it is probable that GRO concentrations will decline.

The second of these plumes is associated with in-source Well 64-WL-01 and downgradient Well 62-WL-02. The source area for this plume, ST68, is associated with a pipeline leak between an aboveground manifold and a valve pit. Minor soil and substantial groundwater contamination were identified. Contaminants consist of DRO, GRO, and BTEX. An assessment of natural attenuation at this location show that the breakdown of benzene has occurred and that the electron acceptors needed to continue degradation are present. Benzene levels have significantly decreased (Figure 3-21 and Plate 2) and are just above the action level of 5 µg/L for 2002. Nitrate and sulfate, both acceptors, are present in-

source and downgradient of the plume providing ideal conditions for continued biodegradation of benzene. No other contaminants remain above cleanup levels for this plume.

The final Heritage Park Plume is associated with Well 62-WL-05 (in-source) and 62-WL-06 (downgradient). This well is also associated with Source Area ST68. Elevated levels of benzene and GRO are associated with Well 62-WL-05. However, none of the analytes of concern are present downgradient of the known plume. A natural attenuation assessment of this plume indicates that while generally the electron acceptors are low in-source, there is an elevated level of total iron. Ferric iron, a portion of total iron, has previously been used as an electron acceptor and with elevated levels, will likely continue to be used as an acceptor. While sulfate and nitrate, also electron acceptors, are low at the in-source location, the downgradient location (62-WL-06) has both nitrate and sulfate. This indicates conditions are ideal for any migration downgradient to undergo natural attenuation.

In summary, natural attenuation of benzene is occurring at the Heritage Park Plumes and will continue until all levels are below remediation goals. Although GRO is degrading at a slower rate, it is likely that this contaminant will not migrate or reach a receptor before natural remediation is complete. It is recommended that downgradient wells (62-WL-02, 62-WL-06, and ST20-03) be sampled once every two years and in-source wells (64-WL-01, 62-WL-05, and 60-WL-04) be sampled once every five years.

3.7.3 Overall Performance of Natural Attenuation and Selected Remedies as Compared to SERA Phase II Decision Documents

The selected remedies for both the ST32 Plumes and the Heritage Park Plumes are functioning as predicted in the SERA Phase II Site Assessment. Natural attenuation is degrading contaminants and a steady decline in levels is reported at most in-source and all downgradient locations. Electron acceptors remain elevated indicating possibility for a continuation of natural attenuation. It appears that the bioventing system at Well 59-WL-30 is also functioning as predicted and will continue to aid in the remediation of hydrocarbons.

3.7.4 SERA Phase II Conclusions and Recommendations

The following are conclusions and recommendations derived from hydrogeologic and natural attenuation analysis of 2002 groundwater data analysis within SERA Phase II:

- For wells in the SERA Phase II program area, a measurable free product layer was detected for the first time at 56-WL-36 in 2002. A fuel odor was noted in 2002 at four wells: 59-WL-30, 62-WL-05, 64-WL-01, and for the first time at 59-WL-31.
- Four COCs (GRO, DRO, benzene, and toluene) exceeded cleanup levels. Benzene exceeded the cleanup level at four well locations (59-WL-30, 59-WL-31, 64-WL-01, and 62-WL-05). DRO exceeded the cleanup level at one well location (59-WL-31). GRO exceeded the cleanup level at five locations (59-WL-30, 59-WL-31, 59-WL-36, 60-WL-04, and 62-WL-05). Toluene exceeded the cleanup level at one well location (59-WL-31).
- For all wells in SERA Phase II, a review of natural attenuation parameters indicates that the process is actively removing the contaminant mass and will continue until cleanup levels are met.
- As a result of the 2002 Well Decision Guide analysis, it is recommended that monitoring occur once every two years for Wells 62-WL-02, 62-WL-06, and ST20-03. Wells 64-WL-01, 62-WL-05, 60-WL-04, 59-WL-31, 59-WL-30, and 59-WL-36 be sampled every five years in conjunction with the Five-Year Review. At that time all of the wells will be sampled not only for COCs but also for natural attenuation parameters.
- It is recommended that Well 59-WL-36 be added to the product measurement and recovery program.

3.8 SERA Miscellaneous

In 2000, the SERA Miscellaneous program area was added to the Basewide Program. In 2002, this program area contained three monitoring wells that were sampled twice in 2002. Table 1-5 lists the wells sampled and Plate 1 shows the location of these wells.

In 2002, Well 46-WL-02 was added to the sampling program as a downgradient location for Source Area ST69. Well 46-WL-01, previously an OU 2 well, is upgradient of this location.

3.8.1 Occurrence of Free Product

A measurable product layer was not detected at any well in the SERA Miscellaneous program area in 2002. A fuel odor was reported at Well 46-WL-01. Table 3-13 presents current and historical product presence data for wells in the SERA Miscellaneous program area that contain product.

Table 3-13

Product Presence Detected in SERA Miscellaneous Groundwater from Field Operations, 1995-2002
Elmendorf AFB, Alaska

Well ID	Description of Historical and 2002 Product Presence (Product thickness is provided in feet)							
	1995	1996	1997	1998	1999	2000	2001	2002
46-WL-01	ND	Sheen, odor	ND	Sheen, odor	Sheen, odor	ND	Sheen, odor	Odor
46-WL-02	NM	Sheen, odor	ND	ND	ND	Sheen, odor	Odor	ND

ID - identification
ND - Floating product was not detected during field events during the year indicated.
NM - The well indicated was not measured for free product during the given period.

3.8.2 Status of Groundwater Remediation

The following subsections compare results to regulatory cleanup levels and provide a comprehensive analysis of the performance of natural attenuation as a remedy for groundwater contamination as outlined in the decision documents for SERA Miscellaneous.

3.8.2.1 Comparison of Results to SERA Miscellaneous Cleanup Levels

Six COCs were identified for SERA Miscellaneous to characterize groundwater contamination relating to POL products, as addressed in Table 2-1. Table 2-1 illustrates fuel-related compounds consistent with SERA program goals for POL-contaminated sites. The six COC identified in this report include benzene, DRO, ethylbenzene, GRO, toluene, and total xylene. In 2002, the only COC reported above cleanup levels was benzene. Benzene concentrations at 46-WL-01 were reported at 8.5 µg/L (Table 3-14). The concentration in 2002 was lower than last year but is consistent with the other sampling events.

Table 3-14

Comparison of 2002 COCs to Cleanup Levels for SERA Miscellaneous
Elmendorf AFB, Alaska

Well ID	Analyte (mg/L)	Analytical Results									
		1998		1999		2000		2001		2002	Cleanup Level (MCL)
		Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Summer	
46-WL-01 (ST69 Plume)	Benzene	2.54	5.51	9.2	13.0 B	1	7.4	24.0	50.0	**8.5**	5

Data in **bold** exceeded the cleanup level in 2002.
B - The analyte was found in the associated blank, as well as in the sample.
ID - identification
µg/L - microgram per liter
MCL - Maximum contaminant level. Unless otherwise noted, Potential Regulatory Levels in this table are MCL values.

The groundwater target analyte for the SERA Miscellaneous program area is benzene. Plate 2 displays historical target analyte results for 46-WL-01 along with the well location. The data table depicts current and historical data for wells that were above the cleanup levels during 2001 or 2002. All data having qualifiers are included unless the data was flagged "R". Figure 3-23 shows historical concentrations for the target analyte benzene for all SERA Miscellaneous wells sampled in 2002 and shows historical concentrations of the target analytes benzene and TCE for both Taxiway "N" wells sampled in 2002. A graphical analysis for Well 46-WL-01 is presented on Figure 3-24.

3.8.2.2 Plume Delineation and Evaluation of Natural Attenuation at ST69

The ST69 Plume is located in the western portion of Elmendorf on Fairchild Ave. It is approximately 1,000 feet south west of the 26th Ave. and Fairchild intersection. This is an isolated plume found in the shallow unconfined aquifer which ranges from 5 to 15 feet thick in this region of the base. This aquifer is underlain by the Bootlegger Cove Formation.

The source for this plume was a 500-gallon diesel fuel spill which reportedly occurred between 1989 and 1990. During the site investigation benzene levels were reported at 240 µg/L at 46-WL-01. Benzene remains the contaminant of concern for this site.

Well 46-WL-01, the in-source location, and Well 46-WL-02, the downgradient location, were sampled twice during the 2002 Basewide Program. Analytical results are shown in Appendix B with natural attenuation parameters from these wells reiterated in Appendix C of this report. An evaluation of natural attenuation parameters from these wells shows strong evidence for natural attenuation. Concentrations have greatly decreased since the site investigation and the presence of ferrous iron indicated ferric iron has been used as an electron acceptor. Even with the process historically occurring, electron acceptors remain elevated and it is likely that microbes will continue to utilize the acceptors. Downgradient, Well 46-WL-02 shows no sign of contaminant migration. However, electron acceptors also are elevated at this well and, should migration occur, benzene should continue to degrade through natural attenuation processes.

A time series plot for benzene concentrations in Well 46-WL-01 is shown on Figure 3-24. This figure shows high concentrations of benzene in 1993 and generally decreasing concentrations thereafter. A spike in concentrations was detected in data from the second round of sampling in 2001, which may be the effect of smear zone soil contamination. Statistical analysis of benzene concentrations in this well from 1996 through 2002 is inconclusive. No statistical trend can be established for this data set.

The site assessment for ST69 recommends continued monitoring at 46-WL-01. With an acceptable rate of natural attenuation occurring, monitoring for this well will continue on a five-year basis. Downgradient Well 46-WL-02 will be monitored every two years to track any migration.

(11X17)

Figure 3-23. Historical Benzene and TCE Concentrations, SERA Miscellaneous and Taxiway "N" Monitoring Wells.

[This page intentionally left blank.]

Figure 3-24. Benzene and TCE Trends, SERA Miscellaneous and "TWN" Wells.

3.8.3 Overall Performance of Natural Attenuation as Compared to Guidance Documents

The selected remedies for ST69 call for groundwater monitoring until sampling determines that the remediation goals have been reached and risks are acceptable. As previously stated, there are remediation goals for several analytes: benzene, DRO, and GRO. Of these, only benzene remains above regulatory levels. The natural attenuation assessment for the benzene plume at ST69 indicated that remediation is occurring and conditions remain favorable for further breakdown. It is recommended to continue monitoring on a reduced frequency until benzene is below regulatory levels at this plume.

3.8.4 SERA Miscellaneous Conclusions and Recommendations

The following are conclusions and recommendations derived from the 2002 groundwater data analysis for the SERA Miscellaneous program area:

- A measurable product layer was not detected at any well in the SERA Miscellaneous program in 2002. A fuel odor was reported at Well 46-WL-01.
- The only COC reported above cleanup levels was benzene. Benzene concentrations at 46-WL-01 were reported at 8.5 µg/L. The concentration in 2002 was lower than last year but is consistent with the other sampling events.
- An assessment of natural attenuation at SERA Miscellaneous wells indicates that natural attenuation is occurring and conditions remain favorable for continued breakdown of benzene.
- In 2002, none of the SERA Miscellaneous wells met the criteria for removal. Two of the current wells will be monitored on a reduced frequency: 46-WL-01 once every five years and 46-WL-02 once every two years. Natural attenuation parameters will be taken at these wells every five years. Well WGN-01, the sentry well location at Hillberg Lake, will continue to be monitored annually for COCs.
- It is recommended to sample the ST69 downgradient location, 46-WL-02, every two years to ensure no contaminant migration is occurring and that concentrations continue to decline. It is also recommended to sample 46-WL-01 every five years to provide information for the Five-Year Review and to update the assessment of natural attenuation.

3.9 Taxiway "N"

In 2002, the two Taxiway "N" monitoring wells were sampled twice. Table 1-5 lists the wells sampled, and Plate 1 shows the locations of the wells. The Taxiway "N" program area was incorporated into the Basewide Program in 1998.

As a result of the 2002 Decision Guide analysis, neither of the wells met the criteria for removal from the Taxiway "N" program area. Both wells will be sampled at a reduced frequency beginning in 2003. Well TWN-MW-46 will be sampled once every five years for COCs and natural attenuation parameters. Well OU3MW-25 will also be sampled once every five years but analytes will include volatile organics only.

3.9.1 Occurrence of Free Product

A strong hydrocarbon odor was detected at TWN-MW-46 during Round 2 in 2002; however, a measurable product layer was not present at any of the Taxiway "N" program area wells.

3.9.2 Status of Groundwater Remediation

The following subsections compare results to regulatory cleanup levels as well as provide a comprehensive analysis of the performance of natural attenuation as a remedy for groundwater contamination as outlined in decision documents.

3.9.2.1 Comparison of Results to Taxiway "N" Cleanup Levels

Seven COCs were identified for Taxiway "N" as indicated on Table 2-1. To be consistent with program goals for POL-contaminated sites, the table only presents fuel-related compounds, with the exception of TCE. The seven COCs established in this report include benzene, DRO, ethylbenzene, GRO, toluene, total xylenes, and TCE. Table 3-15 contains 1998-2002 data meeting the Section 2 criteria.

Table 3-15

Comparison of 2002 Analytical Results to Cleanup Levels for Taxiway "N"
Elmendorf AFB, Alaska

Well ID	Analyte (mg/L)	Analytical Results										Cleanup Level (MCL)
		1998		1999		2000		2001		2002		
		Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	
TWN-MW-46	Diesel Range Organics	4,140	4,850	900 J	2,490	1,370	1,400	840	600	1,100	970	1,500 C
OU3MW-25	TCE	NM	NM	5.2	7.3 M	5.2 M	5.6	5.2	5.7	**5.1**	**5.6**	5.0

Data in **bold** exceeded the cleanup level in 2002.
C - Groundwater cleanup level from 18 AAC 75.345, Table C (ADEC, 2003).
J - The analyte was positively identified, but the quantitation is an estimate.
M - A matrix effect was present.
ID - identification
µg/L - microgram per liter
MCL - Maximum contaminant level. Unless otherwise noted, Potential Regulatory Levels in this table are MCL values.
NM - not measured
TCE – trichloroethene

Current Taxiway "N" COCs that exceeded cleanup levels during the 2002 sampling events are bold on Table 3-15. As indicated, TCE exceeded the cleanup limit at OU3MW-25. It should be noted that the TCE presence at OU3MW-25 is not a result of Taxiway "N" contaminant infiltration but is associated with a source yet to be determined (possibly SD16). TCE concentrations for OU3MW-25 are graphically displayed on Figure 3-23. DRO remained below the cleanup level for the third consecutive year at Well TWN-MW-46 in 2002.

The primary groundwater target analytes for Taxiway "N" are benzene and TCE. As indicated, TCE exceeded the cleanup level at OU3-MW-25. Benzene did not exceed the cleanup level during the 2002 field season. Results for Taxiway "N" monitoring wells are displayed along with well locations on Plate 3.

3.9.2.2 Plume Delineation and Evaluation of Natural Attenuation within Source Area

Although there is not an in-source well used for monitoring the fuel spill associated with Taxiway "N", the following subsections evaluate natural attenuation parameters present in a downgradient well. A natural attenuation assessment for the TCE plume associated with OU3MW-25 was also performed and reported in the following subsections.

3.9.2.2.1 Taxiway "N" Plume

Taxiway "N" is located on relatively flat terrain sloping gently to the southwest, and located directly south of OU 4. The Taxiway "N" site was incorporated into the Basewide Program in 1998 to track and characterize the extent of groundwater contamination resulting from a fuel spill, which occurred in 1997. Geologically, Taxiway "N" plume is found in the shallow unconfined aquifer and is underlain by the Bootlegger Cove Formation. The shallow aquifer at Taxiway "N" occurs at a depth ranging from approximately 18 to 30 feet bgs. The locations of the two monitoring wells within this program area are shown on Plate 1.

There are currently no benzene plumes associated with Taxiway "N". Well TWN-MW-46 reported benzene levels below the regulatory level for the first time in 1999. DRO, also previously above regulatory levels at TWN-MW-46, was reported below in 1999. Wells TWN-MW-46 and OU3MW-25 are currently monitored as a part of the Basewide Program and were sampled twice during 2002. The purpose of groundwater monitoring at Taxiway "N" is to track the lateral movement of the fuel-constituent plume, specifically as it migrates toward downgradient OUs and, ultimately, Ship Creek.

A natural attenuation assessment performed at Well TWN-MW-46 indicates that natural attenuation is occurring. As previously stated, benzene levels at this well have been reported as high as 15.3 µg/L in 1998. In 2002, benzene levels were reported at 0.97 µg/L. DRO, also a COC at this area,

was again reported below regulatory levels in 2002. Electron acceptors at the upgradient well are present, but at low levels. Electron acceptors, including TCE, are present in the downgradient Well OU3MW-25 in ample concentrations. This indicates that any hydrocarbons that migrate downgradient should be quickly utilized by microbes and the extent of migration would be limited.

Natural attenuation appears to be functioning as predicted at the time of the site assessment. It is recommended that monitoring occur at the downgradient location, TWN-MW-46, every five years to track natural attenuation and possible plume migration.

3.9.2.2.2 OU3MW-25 Plume

An evaluation of natural attenuation of this plume was done in conjunction with the OU 5 evaluation of the Fairchild Plume (Section 3.4.2.2.2). Chlorinated solvents are being broken down but at a slow rate. Concentrations are low and no receptors are threatened. It is recommended, however, to completely delineate the plume or plumes associated with the SD16 source area and OU 5.

3.9.3 Overall Performance of Natural Attenuation as Compared to Guidance Documents

Natural attenuation has functioned as planned for hydrocarbon contamination resulting from the Taxiway "N" spill. Both benzene and DRO concentrations remain below regulatory levels and electron acceptors, though at low levels, should reduce small amounts of contaminant migration, should any occur. The natural attenuation assessment performed at Well OU3MW-25 for chlorinated solvents, mainly TCE, showed limited evidence for anaerobic biodegradation. Biodegradation is likely occurring slightly upgradient of this well and, as with other TCE plumes in this area, a lack of carbon is limiting the rate of breakdown. Decision documents for the nearest OU, OU 5, state that monitoring may continue until the year 2025 if cleanup goals are not met. It is likely that this goal will be met at Well OU3MW-25.

3.9.4 Taxiway "N" Conclusions and Recommendations

The following are conclusions and recommendations derived from the 2002 groundwater data analysis within Taxiway "N":

- A strong hydrocarbon odor was detected at TWN-MW-46 during the second round of sampling in 2002; however, a measurable product layer was not present at either of the Taxiway "N" program area wells.
- TCE exceeded the cleanup level at OU3MW-25. It should be noted that the TCE presence at OU3MW-25 is not a result of Taxiway "N" contaminant infiltration but is associated with another source. DRO remained below the cleanup level at Well TWN-MW-46 for the third consecutive year in 2002; benzene concentrations have also remained below cleanup levels for the fourth consecutive year.
- An assessment of natural attenuation at both well locations indicates that biodegradation of hydrocarbons is occurring. There are no time-specific goals for complete remediation; however, it does appear that remediation goals should be met for the Taxiway "N" site.
- Based on the 2002 Decision Guide analysis, there are no wells or analytical methods that meet the Decision Guide criteria for removal from the Taxiway "N" program area. It is recommended, however, that both wells will be sampled at a reduced frequency beginning in 2003. Well TWN-MW-46 will be sampled once every five years for COCs and natural attenuation parameters. Well OU3MW-25 will also be sampled once every five years, but analytes will include volatile organics only.