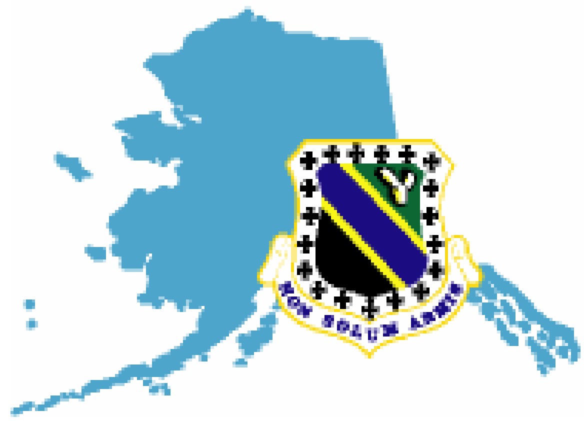

UNITED STATES AIR FORCE

OU 5 WETLANDS MONITORING AND SYSTEM OPTIMIZATION ELMENDORF AIR FORCE BASE, ALASKA

FINAL 2003 ANNUAL REPORT

May 2004

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OU 5 WETLANDS MONITORING AND SYSTEM OPTIMIZATION

Elmendorf Air Force Base, Alaska

Prepared for
3 Civil Engineering Office, Environmental Restoration

and

Air Force Center for Environmental Excellence

May 2004

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LIST OF ACRONYMS

ADEC	Alaska Department of Environmental Conservation
AFB	Air Force Base
AFCEE	Air Force Center for Environmental Excellence
ARRC	Alaska Railroad Corporation
BTEX	Benzene, Toluene, Ethylbenzenes, and Xylenes
COC	Contaminant of Concern
FS	Feasibility Study
FSP	Field Sampling Plan
MCL	Maximum Contaminant Level
MDL	Method Detection Limit
O&M	Operations and Maintenance
OU	Operable Unit
PAH	Polynuclear Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PVC	Polyvinyl Chloride
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
RI	Remedial Investigation
RL	Reporting Limit
ROD	Record of Decision
RPO	Remedial Process Optimization
SVOC	Semi-Volatile Organic Compound
TAH	Total Aromatic Hydrocarbons
TAqH	Total Aqueous Hydrocarbons

LIST OF ACRONYMS *(continued)*

TCE	Trichloroethene
TFH	Total Fuel Hydrocarbons
USACE	United States Army Corps of Engineers
USAF	United States Air Force
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound
WESTON	Weston Solutions, Inc.
WRS	Wetland Remediation System\
µg/L	Micrograms per Liter

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1.0 INTRODUCTION AND SITE OVERVIEW

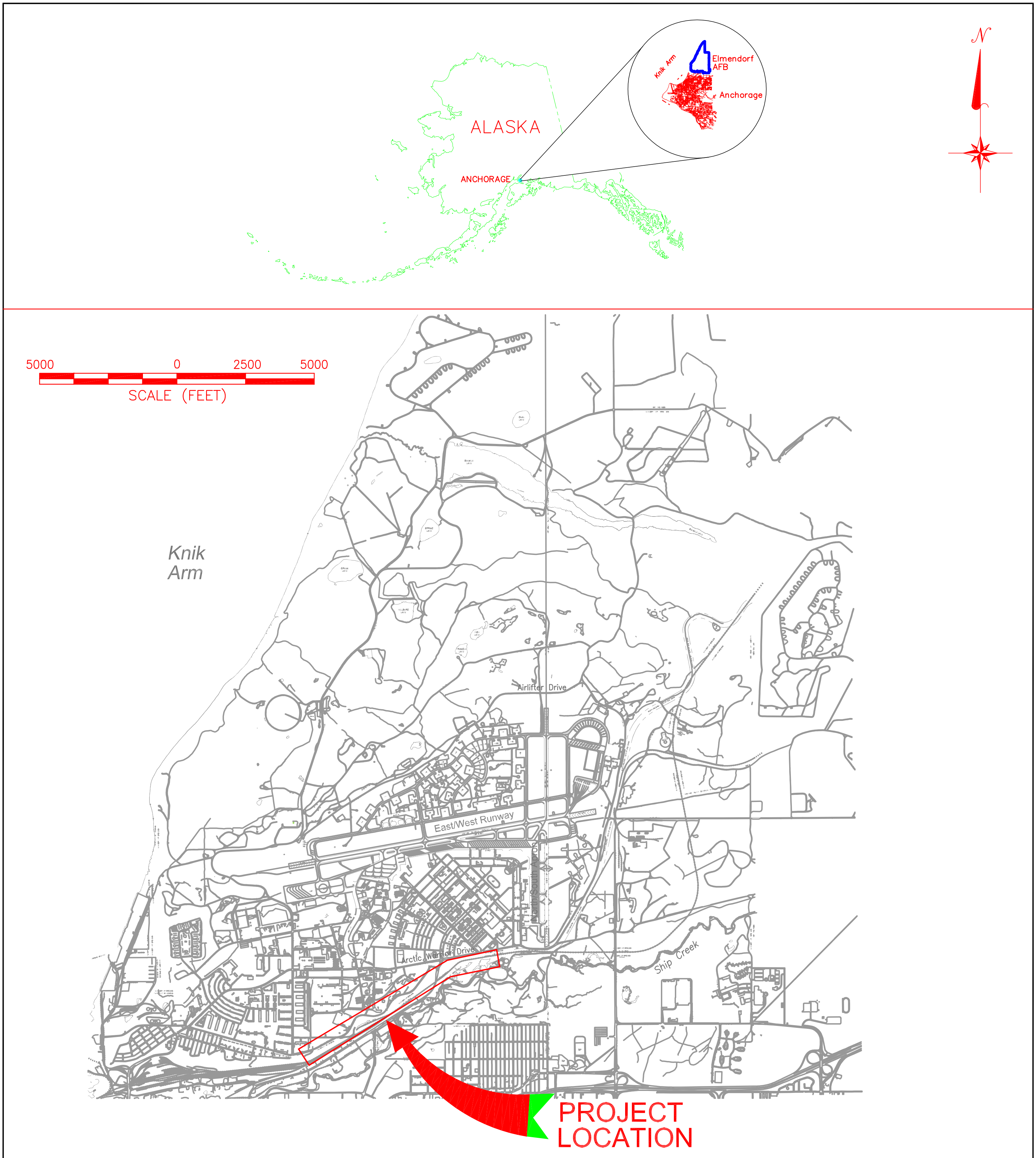
1.1 Introduction

Under contract agreement (Contract No. F41624-03-D-8622-0001) with the United States Air Force Center for Environmental Excellence (AFCEE), Weston Solutions, Inc. (WESTON) has prepared this report to evaluate the performance and protectiveness of the Operable Unit (OU) 5 Wetland Remediation System (WRS) and Beaver Pond Wetland for management of contaminated groundwater seeps which daylight at the base of the OU 5 bluff. These two wetland systems comprise the OU 5 Wetland Program. OU 5 is located at the southern end of Elmendorf Air Force Base (AFB), Alaska (see Figure 1-1).

Activities conducted during 2003 along the southern portion of OU 5 were outlined in the *Monitoring and Optimization Work Plan, Operable Unit 5, Engineered Wetland Remediation System* (United States Air Force [USAF], 2003b). In 2003, brief quarterly technical memorandums were also prepared for the OU 5 Wetland Program to present analytical data and provide an update of operation and maintenance (O&M) activities performed each period.

This annual report is intended as a comprehensive review of the monitoring results including a protectiveness evaluation, a historical data trend analysis, a review of O&M activities and overall system performance, and system and cost programming recommendations. Findings of monitoring and O&M activities conducted from 1 June 2003 through 31 March 2004 at OU 5 are presented. Historical data collected before this period is also presented in the evaluation of trends, as it was made available (i.e., May 2003 analytical data). This annual report is organized as follows:

- **Section 1:** Provides introduction and background information including status of Remedial Process Optimization (RPO), remedial action objectives and cleanup levels, a description of the WRS, and a discussion regarding changes in remediation goals and analytical methods.
- **Section 2:** Provides a protectiveness evaluation including a discussion of the selected remedy components, their status for meeting remediation goals, potential problem areas, a summary of sampling locations, and the status of regulatory compliance at each area of the remediation system (i.e., WRS, Beaver Pond, and new seeps).
- **Section 3:** Provides a system performance evaluation presenting 2003 and 2004 analytical results for the primary contaminants of concern (COCs), benzene and trichloroethene (TCE), and includes a discussion regarding natural attenuation of benzene and TCE at both the WRS and the Beaver Pond wetland areas. This section develops data trends for benzene, TCE, total aromatic hydrocarbons (TAH), and total aqueous hydrocarbon (TAqH). A brief summary of analytical results and trend analyses is presented for key upgradient groundwater monitoring wells, sampled as part of the Basewide Environmental Monitoring Program (administered under separate contract). Additionally, review of the overall system performance including a discussion of system shutdowns and major maintenance activities, is included.



UNITED STATES AIR FORCE

OU5 WETLAND REMEDIATION SYSTEM
SITE LOCATION MAP

ELMENDORF AIR FORCE BASE
ANCHORAGE, ALASKA

WESTON SOLUTIONS

JOB NO: 20077.043.001

DATE: 5 MARCH 2004

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FIGURE 1-1

- **Section 4:** Provides a cost evaluation including a comparison between annual O&M expenditures (base cost) from previous two years and the predicted expenditures for the upcoming year, along with a discussion of any base cost increases/decreases. Recommended additional expenditures for the upcoming year and outyears (to 2010), based on recommendations presented in Section 5, are included. A total proposed cost summary for each year is also included.
- **Section 5:** Provides recommendations for future system operation and monitoring and optimization including cost avoidance opportunities as well as additional recommendations to ensure protectiveness or increase system performance. Additionally, status of system recommendations initially provided in the 2001 annual report (USAF, 2002a) is presented.
- **Section 6:** A comprehensive list of references cited in this report.

Appendix A provides a Quality Assurance/Quality Control (QA/QC) Summary Report. Appendix B provides a complete set of laboratory analytical data, Chain-of-Custody forms, and cooler receipt forms. Appendix C provides WRS Performance Data including flow rate and retention time calculations. Appendix D provides a status summary of the 2001 O&M modification recommendations.

1.2 Site Overview

OU 5 is located in the southwest area of Elmendorf AFB and captures the shallow groundwater aquifer and surface water flow from a large portion of Elmendorf AFB. OU 5 is separated from the Ship Creek floodplain by a steep bluff. Numerous groundwater seeps located at the base of the bluff drain into pond and marsh areas located within the floodplain. Fuel constituents from past pipeline leaks have migrated into the shallow groundwater aquifer and subsequently through the seeps. This is the primary cause of the water and soil contamination at OU 5 (USAF, 1995a). A Record of Decision (ROD) was issued in 1995 by USAF (1995a) that presented:

- COCs to be addressed by the WRS;
- Natural attenuation;
- Institutional controls;
- Soil treatment in select areas;
- Treatment of the seeps along the bluff at the edge of the Ship Creek floodplain; and
- Required cleanup levels.

1.1.1 Remedial Process Optimization

AFCEE developed the RPO in 2001 as a systematic process for evaluating and improving site remediation so that maximum risk reduction is achieved for each dollar spent (AFCEE/ERT, 2001a). The goals of the RPO are to:

- Ensure the protectiveness of human health and the environment;

- Establish appropriate cleanup goals and facilitate re-evaluation of those goals;
- Collect appropriate data to evaluate the remediation process and progress;
- Reduce O&M costs; and
- Accelerate site closure and property transfers.

Table 1-1 describes the benefits of RPO implementation in the OU 5 Wetland Program.

Table 1-1 Implementation of RPO Goals in the OU 5 Wetland Program

RPO Goal	Implementation in OU 5 Wetland Program
Ensure protectiveness of human health and environment	A management decision was made to sample all seeps at the base of the bluff annually starting in 2001 (seeps with contaminant concentrations above cleanup levels are sampled quarterly). Annual sampling for seeps would be performed based on the decision guide presented in Figure 4-2 (i.e., if COCs are not above cleanup levels, sampling may not be performed). A specific section was included in the annual report to evaluate protectiveness of the remedy (Section 2). Efforts were introduced to increase coordination with the Basewide Groundwater Monitoring Program, specifically for implementation of the early warning monitoring well network.
Establish appropriate cleanup goals and facilitate re-evaluation of those goals	At other installations, less stringent site-specific cleanup levels are being applied at sites where engineering or institutional controls can be used to separate receptors from contaminated groundwater. However, this aspect of RPO is not considered an option for the shallow aquifer at Elmendorf AFB because future residential land use is a possibility. Cleanup goals were re-evaluated during the 2003 five-year review.
Collect appropriate data to evaluate remediation process and progress	Data collection was focused on influent seep locations to the WRS, effluent locations at the WRS Wetland Cell, and the Beaver Pond wetland.
Reduce O&M costs	Decision guides were developed for discontinuing monitoring at specific locations, when appropriate, based on previous monitoring results. O&M costs were reduced by focusing the monitoring on appropriate locations (i.e., influent and effluent only; interim locations at the pump stations no longer sampled as of 2002, based on previously documented consistent analytical results), eliminating unnecessary analyses from the analytical suite, eliminating sediment sampling based on consistent previous results, eliminating lengthy quarterly reports in favor of brief technical memorandums, and increasing pump maintenance to reduce expensive repair costs.
Accelerate site closure	Monitoring and evaluation of progress and associated decisions are based on the requirements of the OU 5 ROD. Communication of OU 5 natural attenuation processes, progress, and limitations to agencies facilitates implementation of this goal. Decision guides were developed for shutdown of pump stations, when appropriate.

AFB – Air Force Base
O&M – Operation and Maintenance
OU – Operable Unit
ROD – Record of Decision
RPO – Remedial Process Optimization
WRS – Wetland Remediation System

1.1.1.1 Optimization of Seep Monitoring and Collection

Two decision guides have been established to support optimization of seep monitoring efforts and flow collection (USAF, 2002a/2003a). The Decision Guide for Reduced Remedial Activity is a flow chart established to determine proper timing for removing seeps from the present monitoring program and shutting down pump stations. The Decision Guide for Increased Remedial Activity is a flow chart established to provide a decision process for restarting existing system collection areas or adding seeps to collection areas to ensure treatment; a modification to this decision guide has been proposed in this report to allow a pathway for removing seeps from the monitoring program. These decision guides are presented in Section 5 of this report (Figures 5-1, 5-2, and 5-3).

1.1.1.2 Early Warning Monitoring Well Network

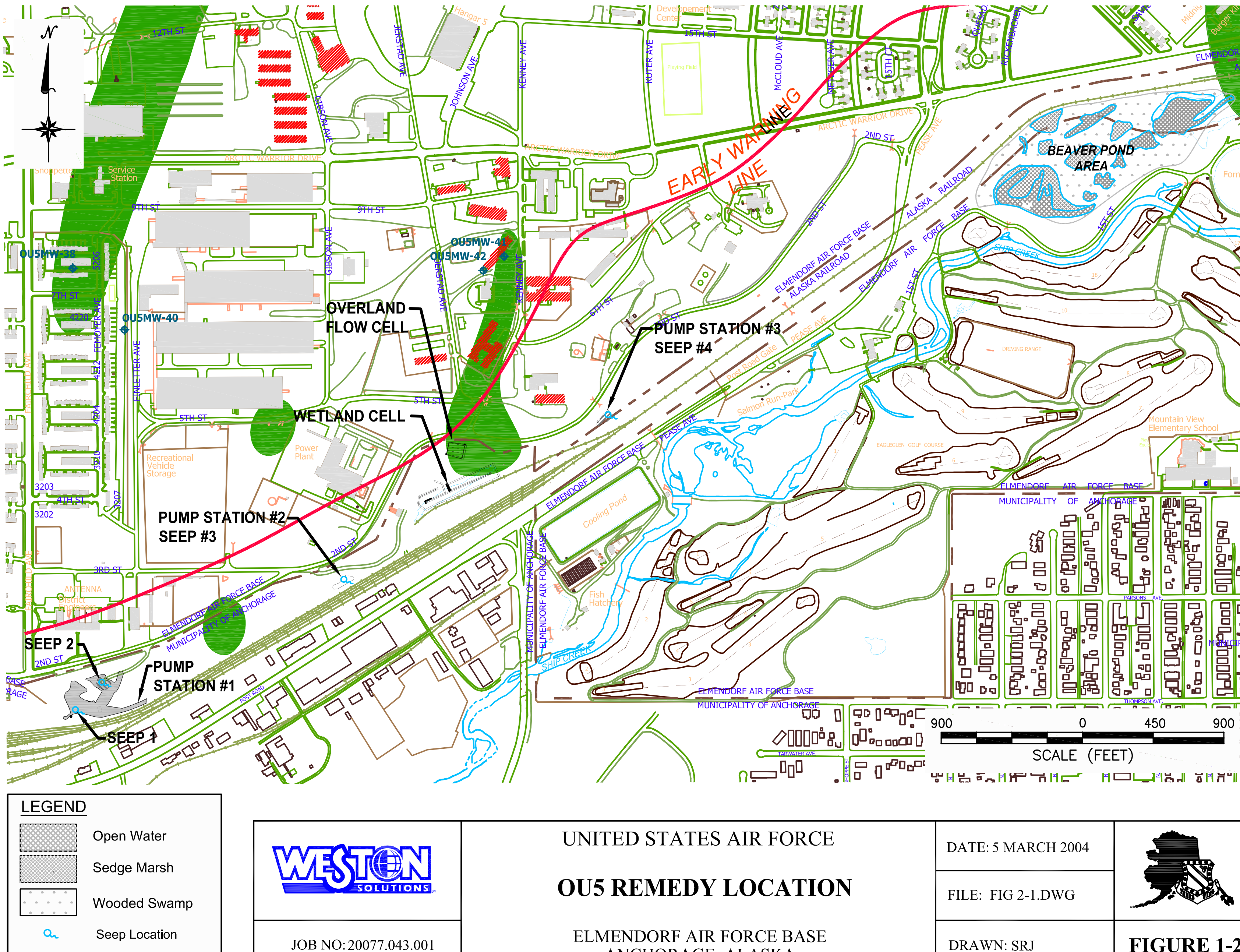
Groundwater monitor wells upgradient of an ideal early warning line have been identified in order to predict and program funding for any potential and necessary system modifications to intercept identified contaminant migration from upgradient sources. Groundwater velocities, estimated via groundwater surface measurements, were used to develop this early warning line located upgradient of the seep monitoring locations (see Figure 1-2). This early warning line represents the estimated distance that groundwater would theoretically flow in a two-year period. The groundwater velocity was calculated, conservatively, assuming only advection using Darcy's Law. Actual contaminant migration is expected to be slower than this due to retardation processes (USAF, 2002a). Use of this early warning line focuses monitoring resources where they are most needed, to ensure protection of Ship Creek.

1.1.2 Remedial Action Objectives

The 1995 OU5 ROD presented remedial corrective actions for OU5 including the construction and operation of the engineered WRS, and natural attenuation monitoring and institutional controls for the Beaver Pond wetland area (see Figure 1-2). Specific remedial action objectives were developed for OU 5 and include the following (USAF, 1995a):

- Protect human health and the environment by preventing ingestion and contact with contaminated groundwater by people and preventing animal contact with contaminated seep water;
- Use treatment techniques whenever practicable;
- Implement a solution that is capable of managing impacts from upgradient sources as the contaminants reach OU 5; and
- Implement a cost-effective solution that can achieve cleanup levels for the final COCs.

The ROD specified evaluation parameters including potential COCs to be addressed by the remedy, required cleanup levels, institutional controls, contaminant containment, and treatment of the seeps along the bluff at the edge of the Ship Creek floodplain. A risk assessment was conducted and final COCs were developed from the results of the risk assessment and existing regulatory standards (USAF, 1995a). The final COCs specified for groundwater originally consisted of benzene, TCE, total fuel hydrocarbons (TFH)-diesel, and TFH-gas. Since inception of the ROD, monitoring and evaluating of the TFH analytes have been modified for end



WESTON SOLUTIONS	UNITED STATES AIR FORCE **OU5 REMEDY LOCATION**	DATE: 5 MARCH 2004	
		FILE: FIG 2-1.DWG	
JOB NO: 20077.043.001	ELMENDORF AIR FORCE BASE ANCHORAGE, ALASKA	DRAWN: SRJ	**FIGURE 1-2**

J:\Fig 2-1.DWG

evaluation by TAH and TAqH concentrations. A detailed discussion of this change is included in Section 1.3.

Because the above remedial action objectives provide only a general guideline for evaluation of system performance, more specific remediation goals are recommended to support evaluation of system performance. These more specific recommended remediation goals are based on the ROD-specified cleanup goals for the final COCs and the anticipated timeline of achieving all cleanup goals by the year 2026. Remedy specific remediation goals for groundwater and surface water include the following (in order of preferred achievement):

- Meet the maximum contaminant level (MCL) cleanup level of 5 micrograms per liter (μg/L) for benzene at the effluent of both the WRS and Beaver Pond wetland area, and at Ship Creek.
- Meet the MCL cleanup level of 5 μg/L for TCE at the effluent of both the WRS and Beaver Pond wetland area, and at Ship Creek.
- Achieve decreasing trends for all OU 5 remedy applicable COCs (i.e., benzene, TCE, TAH, and TAqH) at upgradient monitoring well locations.
- Achieve decreasing trends for the influent locations of the WRS and Beaver Pond wetland area for remedy applicable COCs (i.e., benzene, TCE, TAH, and TAqH).
- Meet the MCL of 5 μg/L for benzene throughout OU 5, including the influent seep areas of the WRS and Beaver Pond wetland area.
- Meet the MCL of 5 μg/L for TCE throughout OU 5, including the influent seep areas of the WRS and Beaver Pond wetland area.
- Meet the TAH requirement of 10 μg/L throughout OU 5, including the influent seep areas of the WRS and Beaver Pond wetland area.
- Meet the TAqH requirement of 15 μg/L throughout OU 5, including the influent seep areas of the WRS and Beaver Pond wetland area.

These remediation goals provide a baseline for system performance evaluations presented in Section 3; status of these specific goals is addressed in Section 3.3. Decreasing contaminant trends are considered indicative that natural attenuation is occurring within OU 5. If increasing trends are encountered at upgradient OU 5 monitoring well locations, these trends may indicate that sources outside of the OU 5 area or previously unidentified sources may be affecting the area.

1.1.3 Remedial System Description

Components of the remedial action included the passive extraction of seep water (WRS), natural attenuation for the upper aquifer and surface water, institutional controls for the upper aquifer, and monitoring by sampling water and sediment. A feasibility study (FS) was conducted in 1993 of the capacity of the Beaver Pond wetland area to naturally attenuate contaminated water. This study, conducted as part of the *Remedial Investigation/Feasibility Study (RI/FS)* (USAF, 1994), provided the basis for the design of the WRS.

1.1.3.1 WRS

Each component of the WRS was designed for a specific remedial purpose. The WRS consists of seep collection systems, pump stations, an Overland Flow Cell, and a Wetland Cell. The seeps exit the OU 5 area at the bottom of the bluff. Currently four seeps (Seep 1, 2, 3, and 4) are collected and routed to the WRS. Water from each seep flows (via gravity) through gravel beds, into buried perforated collection pipes, and into a pump station. Seeps 1 and 2 flow to Pump Station 1, Seep 3 to Pump Station 2, and Seep 4 to Pump Station 3, all located at the base of the bluff. Figure 1-2 shows the location of the pump stations and associated seeps.

The water is pumped from the pump stations along the base of the bluff to the centrally located Overland Flow Cell and Wetland Cell. The collected water is pumped to Valve Box 3 (Manhole #3) located at the influent to the Overland Flow Cell, above the bluff. The water then flows through the Overland Flow Cell (an inclined bed of gravel). The objectives of the Overland Flow Cell are to remove volatile organic compounds (VOCs) via air stripping, increase dissolved oxygen concentration of the water to enhance biodegradation of organic compounds in the Wetland Cell, and to provide supplemental removal of fuel-range hydrocarbons in the treated water through biodegradation actions (USAF, 1995b).

From the Overland Flow Cell, the oxygenated water flows by gravity to the Wetland Cell located below the bluff. The water then flows through the engineered Wetland Cell, where naturally occurring biologic processes remove remaining contaminants, before the water is discharged and eventually flows into Ship Creek. The objectives of the Wetland Cell are to degrade fuel-range hydrocarbons in the water flowing through the Wetland Cell and to contain polychlorinated biphenyls (PCBs) within the existing sediment. Although microorganisms present in the wetland can degrade the other contaminants in the seep water, the majority of these other contaminants (e.g., TCE) are volatile compounds and are expected to be removed in the Overland Flow Cell via air stripping.

A total of 13 additional seeps (Seeps 5 through 15, 17, and 18) have been identified since the WRS began operating in 1997. The existence of these seeps prior to 2001 is uncertain. These new seeps are not currently routed to the WRS and were not evaluated prior to 2001 (this statement is presumed based on information for the area provided in the 1994 RI/FS [USAF, 1994]). In previous reports these seeps were presented as "newly identified seeps"; as several years of previous data now exists for these seeps, these seeps are merely represented by seep number in this report. These seeps will be further discussed throughout this report; a brief summary of plans to incorporate Seeps 9, 10, and 11 into the WRS is presented in Section 4.

1.1.3.2 Beaver Pond

The Beaver Pond wetland area (also referred to as the "Beaver Pond") is a natural wetland (Figure 1-2). The Beaver Pond is comprised of integrated marsh and small ponds. Design phase studies and more recent analytical data have demonstrated that the Beaver Pond wetland area can effectively remediate the contaminants entering into it by natural processes without a significant degradation of the wetland.

1.3 Analytical Methods and Regulatory Criteria

The final COCs identified in the ROD for groundwater at OU 5 consisted of TCE, benzene, TFH-diesel, and TFH-gas. The seeps exiting the bluff at the southern portion of OU 5 are considered discharges from groundwater and therefore the groundwater COCs must meet compliance with regulatory cleanup levels at the effluent of OU 5. Additionally, as the groundwater emerges as surface water, applicable surface water cleanup levels are also considered. Benzene and TCE are considered the primary risk drivers at OU 5 (USAF, 1995a). Table 1-2 presents the current cleanup goals for groundwater, surface water, and soil at OU 5.

Table 1-2 Applicable Cleanup Levels

Contaminant	Cleanup Level	Established By/Source
Surface Water		
TAH	10 μg/L	Alaska Water Quality Standards [a]
TAqH	15 μg/L	Alaska Water Quality Standards [a]
Hydrocarbon Sheen	No sheen	Alaska Water Quality Standards [a]
Groundwater		
TCE	5 μg/L	Maximum Contaminant Level [b]
Benzene	5 μg/L	Maximum Contaminant Level [b]
Soil		
TFH-Diesel	10 mg/kg	Alaska Cleanup Matrix Level C [c]

[a] The ROD-specified cleanup levels for TFH-diesel and TFH-gas were conceptually modified in 1998 to include TAH and TAqH. Because there was no standard for these COCs in groundwater, and because the groundwater emerges as surface water at the seeps that eventually flow into Ship Creek (an aquaculture resource), the aquaculture water standards for TAH and TAqH were used (18 AAC 70.020, based on ecological risk).
[b] Maximum Contaminant Level, 40 CFR Part 131, and 18 AAC 70.010a and d, 18 AAC 70.015 through 70.110, and 18 AAC 80.070.
[c] 18 AAC 75.341
μg/L – micrograms per liter
mg/kg – milligrams per kilogram
TAH – total aromatic hydrocarbon (sum of benzene, toluene, ethylbenzene, and xylenes)
TAqH – total aqueous hydrocarbon (sum of TAHs and detected polynuclear aromatic hydrocarbons [PAHs])
TCE – trichloroethene
TFH – total fuel hydrocarbons

The analytical methods specified in the 1996 *Remedial Design Title II Services Workplan* (USAF, 1996) to meet the presented groundwater cleanup goals included TFHs by United States Environmental Protection Agency (USEPA) Methods SW8015 MP (purgeable) and SW8015 ME (extractable) for TFH-gas and -diesel, respectively. Analytical methods specified in the 1996 Workplan for measuring the required COCs were determined to be inappropriate for evaluation of OU 5 final COCs because cleanup levels were well below the method detection limits (MDLs) approved in the 1996 Workplan. The detection limits for the USEPA Method SW8015M for purgeable and extractable petroleum hydrocarbons in water are normally 50 to 100 μg/L based on standard laboratory procedure without modification. These detection limits were 5 to 10 times the ROD-specified cleanup levels for TFH-gas and -diesel.

Based on discussions in May 1998 between the Alaska Department of Environmental Conservation (ADEC), USAF, and USEPA, it was agreed that since there was no standard for these COCs in groundwater, and because the groundwater emerges as surface water at the seeps that eventually end up in Ship Creek (an aquaculture resource), the aquaculture surface water standards for TAH and TAqH would be used (USAF, 1998a). Therefore, it was jointly agreed that the analytical methods for TFH analysis be changed from USEPA Method SW8015M to USEPA Methods 602 for benzene, toluene, ethylbenzene, and xylenes (BTEX) and SW8310 for polynuclear aromatic hydrocarbons (PAHs). Both of the revised methods have detection limits below 10 μg/L and allow for analysis of fuel hydrocarbon components.

In the 2001 *Monitoring and Optimization Work Plan* (USAF, 2001d), the analytical methods were again revised. For PAH evaluation, Method SW8270C SIM was specified. The use of Method SW8270C SIM allows for lower analyte detection limits while achieving regulatory cleanup levels. The other advantage of Method SW8270C SIM is that the method is not impacted by fuel constituents, which reduces the occurrence of elevated reporting limits. For VOC evaluation, Method SW8260B was specified. The use of Method SW8260B is an acceptable method per the AFCEE Version 3.0 (March 1998) and 3.1 (August 2001b) Quality Assurance Project Plan (QAPP). Method SW8260B uses mass spectrometry to specify detectable analytes. Method SW8260B typically produces fewer false positive results than Method 602. Method 602 is not a confirmatory method as retention time analysis is used to identify analytes, and therefore the potential for false positives is greater. Therefore, Method SW8260B provides more reliable data for evaluation of analyte concentrations. The lower analyte detection limits have allowed for improved monitoring of contaminant concentrations that may exit the WRS and Beaver Pond wetland area in the effluent waters.

In 2001, the lower detection limits allowed by Method SW8270C SIM showed that areas where non-detectable levels were found using SW8310 in previous years were generally still not detected using the more sensitive and more expensive method. Therefore, in 2002, as specified in the 2002 *Monitoring and Optimization Work Plan* (USAF, 2002b), Methods SW8310 and SW8260B were used.

In the 2003 *Monitoring and Optimization Work Plan* (USAF, 2003b), Methods SW8310 and SW8260B were specified. However, upon initiation of the field effort, there was concern regarding turn-around time required by SW8310. Some of the semi-volatile organic compounds (SVOCs) were listed as possibly requiring 24-hour turn-around time for analysis. This was not possible with SW8310. Furthermore, any detects for SW8310 would require confirmation by another method (SW8270), and in soils, SW8310 typically requires extract dilution that raised the method detection limit/reporting limit (MDL/RL). The instrument used for SW8270 analysis provides its own confirmation (retention time and mass differentiation). As the AFCEE QAPP provides for both Methods SW8270 and SW8310, Method SW8270 was used along with SW8260B for sample analysis, excluding the use of SW8310.

In addition, the fuel analyses TAH and TAqH are utilized for comparison purposes in the compliance evaluation presented in Section 2 and data trend discussions presented in Section 3. TAH and TAqH concentrations were determined from Methods SW8270 and SW8260B analytical results. TAH concentrations were determined by summing the concentrations of all detected BTEX. TAqH concentrations were determined by summing the concentrations of all detected PAHs and TAH compounds. Analytical data for the results of laboratory analysis are presented in Appendix B.

2.0 PROTECTIVENESS EVALUATION

The purpose of this protectiveness evaluation is to assess whether the remedial action implemented at OU 5 is protective of human health and the environment. The evaluation will focus on the ability of the remedy to satisfy the remedial action objectives specified in the ROD. The applicable health-related remedial action objectives are:

- Protect human health and the environment by preventing ingestion and contact with contaminated groundwater by people and preventing animal contact with contaminated seep water; and
- Implement a cost-effective solution to achieve the cleanup levels for the final COCs.

The overall point of compliance for evaluation of cleanup levels for OU 5 is Ship Creek. The monitoring point for evaluating WRS remedial effectiveness is the Wetland Cell effluent, located upstream of Ship Creek to ensure compliance. The monitoring point for evaluating Beaver Pond effectiveness is the Beaver Pond effluent, also located upstream of Ship Creek.

2.1 Current Protectiveness of Remedy

The status of the selected remedy at OU 5 is summarized in Table 2-1.

Table 2-1 Status of OU 5 Selected Remedy Components

No.	Remedy Component	Status
1	Collection and treatment of contaminated seeps in the western (i.e., Seeps 1, 2, and 3) and central (Seep 4) portion of the OU via an engineered WRS.	Ongoing
2	Containment of low-level PCBs in sediment within the Wetland Cell.	Complete
3	Excavation and treatment of approximately 3,000 cubic yards of fuel-contaminated soil.	Complete
4	Natural attenuation of groundwater in the contaminated upper aquifer, and surface water other than seep water, including the Beaver Pond wetland area.	Ongoing
5	Institutional controls that prohibit use of upper aquifer until cleanup goals are achieved.	Ongoing
6	Monitoring of groundwater, seeps, and surface water for identified COCs.	Ongoing
7	Monitoring of sediments for identified COCs.	Complete [a]

[a] *Environmental Restoration Program, Five-Year Review, Final Report* (USAF, 2003c)
COC – Contaminant of concern
OU – Operable Unit
PCB –polychlorinated biphenyls
WRS – Wetland Remediation System

In general, the OU 5 Wetland Program continues to protect human health and the environment via a combination of exposure reduction and contaminant treatment. Institutional controls remain in place to prevent use of contaminated water in the upper aquifer. The gravel that has been placed over the seep collection areas continues to prevent exposure to contaminated surface water, and these seep areas are monitored to ensure adequate gravel remains in place. The WRS and Beaver Pond continue to be successful at reducing contaminant concentrations to below cleanup levels. Documentation of achievement of cleanup levels and contaminant trend analyses for seeps, upgradient monitoring wells, and the Beaver Pond are presented in Section 3 of this report.

There are, however, several conditions identified that could ultimately lead to the OU5 Wetland program remedy not being protective. These include Seeps 9, 10, 11, and 17, which have shown elevated concentrations of TCE. These issues are presented along with proposed solutions in Table 2-2. Additionally, the proposed Alaska Railroad Corporation (ARRC) rail realignment project may create uncertain conditions. As the extent of potential impacts from the ARRC project is unknown, recommendations for addressing this project are presented in Section 4.4.

Table 2-2 Conditions Potentially Non-Protective of Human Health and the Environment

Condition	Problem and Proposed Solution
Groundwater at Seeps 9, 10, and 11	Seeps 9, 10, and 11 are not currently collected by the WRS. These seeps have been sampled regularly since 2001 to evaluate water quality. Results show that TCE exceeds cleanup levels at the seeps, but TCE is present at concentrations below cleanup levels immediately downgradient of the seeps, still upgradient of Ship Creek. The potential exists for infrequent human visitors and animal contact and for exceedance of cleanup levels at the point of compliance (Ship Creek) if there were a dramatic increase in TCE from upgradient sources. USAF has programmed funds in 2004 to incorporate the seeps into the WRS; plans for incorporation are discussed in Section 5. Following implementation of the proposed solution, this potentially non-protective condition would no longer be an issue to remedy protectiveness.
Wetland Cell Seeps 17 and 18	In 2001 and 2002, concentrations of TCE below cleanup levels were identified in the effluent of the Wetland Cell, but not in the influent to the Wetland Cell. Wetland Cell influent and effluent results for TCE and benzene were non-detect during 2003, with a low concentration of TCE (1 µg/l) identified at the Wetland Cell effluent in January 2004. Sample results from Seeps 17 and 18 (sampled for the first time in 2002) confirm that TCE from these seeps is entering the Wetland Cell at a location close to the effluent. This indicates that the potential exists for exceedance of cleanup levels if there is an increase in TCE concentration from upgradient sources. Recommendations for quarterly monitoring of these seeps are included in Section 5. If TCE concentrations in the seeps continue to increase, additional funding may need to be programmed for seep capture and routing of flows to the entrance of the Wetland Cell.

TAH – total aromatic hydrocarbon
TCE – trichloroethene
USAF – United States Air Force
WRS – Wetland Remediation System

2.2 Current Regulatory Compliance

Monitoring data shows that samples collected upgradient of Ship Creek (the OU 5 point of compliance) at the Wetland Cell effluent and Beaver Pond effluent are below the applicable regulatory levels for all ROD-identified COCs. However, analytical results from Seeps 9, 10, and 11 indicate that TCE concentrations continue to exceed the ROD-specified cleanup levels at the base of the bluff east of the Wetland Cell.

Figure 2-1 shows approximate locations for all 2003–2004 O&M period sample locations and presents a data summary for locations where benzene and TCE concentrations exceeded MCLs. Sampling was conducted for Round 1 in May 2003 by another Contractor. This data has been included in this report with no additional validation to that provided by the previous Contractor. Sampling was conducted by WESTON for Round 2 in August 2003, Round 3 in November 2003, and Round 4 in January and February 2004. The February 2004 sampling was conducted as several of the program seeps were frozen during January due to colder than typical temperatures. Additionally, available data for monitoring wells and Seeps 9, 10, and 11, sampled as part of the Basewide Program has been presented; Basewide Program sampling was performed in June 2003 and October 2003. Results for benzene and TCE analysis are presented and evaluated in Section 3.

2.2.1 WRS

As specified in the ROD, effluent water near the outflow of the Wetland Cell is sampled on a quarterly basis to ensure the WRS is effectively reducing concentrations of identified contaminants to below the cleanup levels. The overall point of compliance at OU 5 is Ship Creek. All sampling data indicate that water continues to meet cleanup levels at the outflow of the Wetland Cell, considerably upgradient of Ship Creek. Figure 2-2 shows the Wetland Cell sampling locations for both surface water and sediment. Benzene was not detected in the Wetland Cell effluent during sample rounds 1, 2, 3, or 4. TCE was not detected in the Wetland Cell effluent during sample rounds 1, 2, or 3; however a low level concentration (1.1 μg/L) was detected during round 4, well below the cleanup level of 5 μg/L. TAH and TAqH were not detected in the Wetland Cell effluent.

The 2003 analytical results for the primary COCs are presented in Section 3.1 and historical data/trends are presented in Section 3.2. These data indicate that the WRS continues to be effective and the current regulatory compliance goals are being met at the WRS effluent sampling point, located upgradient of the compliance point at Ship Creek.

2.2.2 Status of Seeps Identified Outside of the WRS

Although surface water exiting the WRS meets the applicable regulatory criteria, concern does exist over the presence of seeps identified outside of the WRS that are not currently treated by either the WRS or Beaver Pond wetland area.

In July 2001, five additional seeps (Seeps 5 through 9) were identified along the base of the bluff near the WRS. During an effort to define the horizontal extent of contamination along the base of the bluff east of Seep 9, five additional seep sampling locations (Seeps 10 through 14) were identified (the prior existence of these seeps is presumed, but uncertain) and sampled in October 2001, along with a second round of sampling for Seeps 5 through 9. Based on concentrations identified, Seeps 9, 10, and 11 were scheduled for quarterly sampling, and Seep 7 was scheduled for annual sampling.

During 2002, another three additional seeps were identified (Seeps 15, 17, and 18). No seep of number 16 has been identified. Seep 15 was first sampled in January 2002 and all three of these seeps were sampled in July and September 2002 to evaluate water quality. Based on concentrations identified, Seeps 15, 17, and 18 were scheduled for annual sampling. However, since Seeps 17 and 18 flow directly into the Wetland Cell, these seeps have been recommended for quarterly sampling, to provide data for potential mass balance calculations (see Section 5).

The sampling points at these other identified seep locations have been constructed similar to previously established seep sampling locations (i.e., Seeps 1 through 4). Short sections of slotted polyvinyl chloride (PVC) well casing were advanced approximately 2 feet below ground surface at each new seep, and water samples were collected directly from the casings.

Seeps that were sampled during the 2003-2004 O&M period, in addition to Seeps 1 – 4, included Seeps 7, 9, 10, 11, 15, 17, and 18. Seep sampling locations for the 2003-2004 O&M period are presented in Figure 2-3.

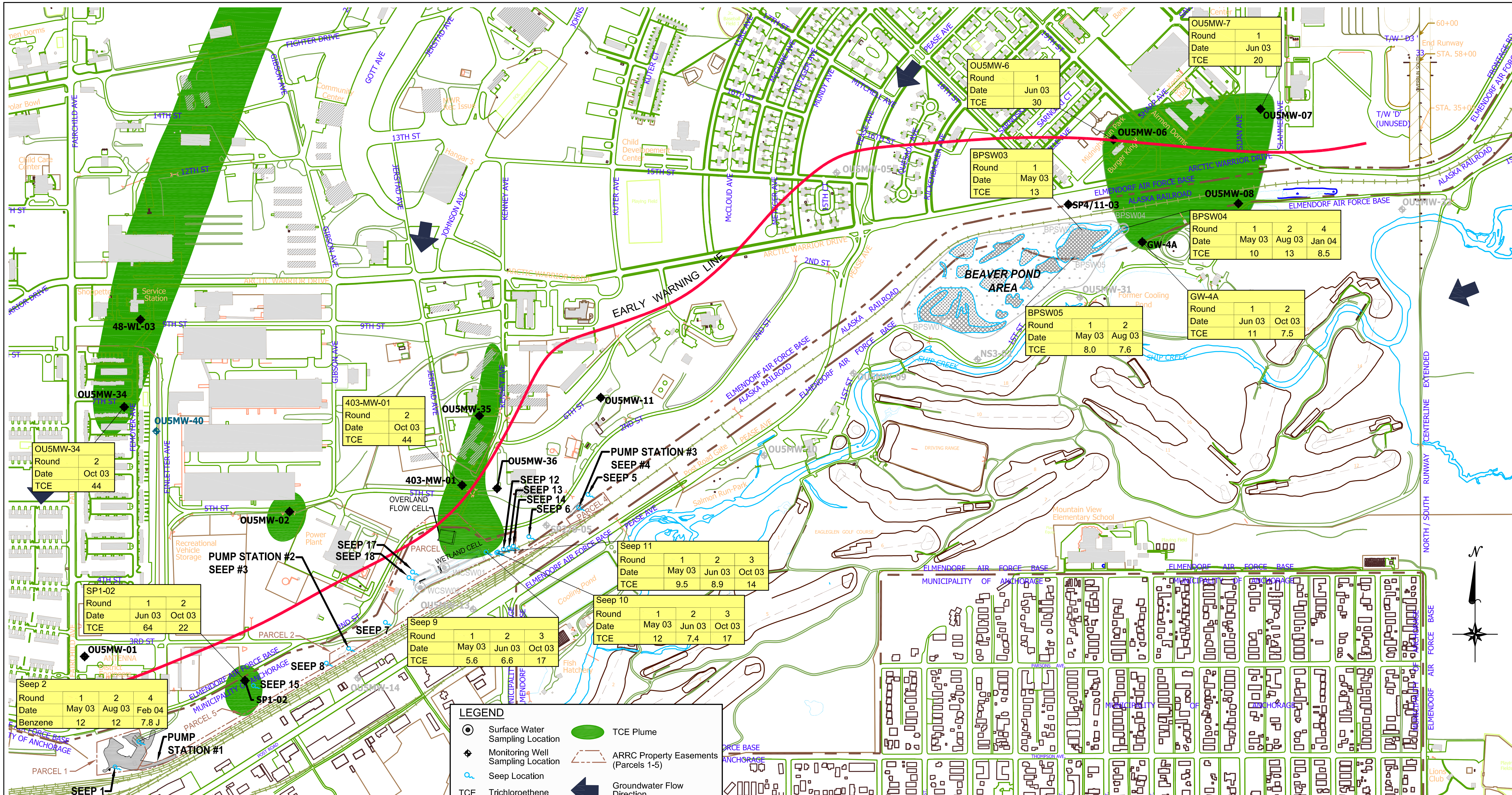
TCE was detected above the cleanup level of 5 μg/L at Seeps 9, 10, and 11 during the 2003-2004 sample rounds. These three seeps were also identified during previous sample rounds as exceeding regulatory levels for TCE. No other COCs were detected above the remediation goals/cleanup levels at any other identified seep sampling locations during 2003-2004. The 2003-2004 O&M period analytical results for the primary COCs are presented in Section 3.1 and historical data/trends are presented in Section 3.2.

Recommendations are provided in Section 5 for proposed quarterly seep monitoring of the seeps that have concentrations above the cleanup levels for the primary COCs and incorporating the seeps with consistently elevated TCE levels into the WRS for treatment.

2.2.3 Beaver Pond

Surface water near the effluent of the Beaver Pond (BPSW01) was sampled in May 2003, August 2003, and January 2004 to ensure that natural attenuation is effectively reducing levels of identified contaminants to below the applicable cleanup levels. The Beaver Pond sampling locations are shown on Figure 2-4. The analytical results for the primary COCs are presented in Section 3.1 and historical data/trends are presented in Section 3.2.

Benzene and TCE were not detected in the effluent surface water samples collected from the Beaver Pond effluent during any of the three sample rounds. TAH and TAqH were not detected in the Beaver Pond effluent. No COCs were detected above the regulatory levels at the effluent/outflow of the Beaver Pond; it appears that the Beaver Pond is actively remediating groundwater that discharges into the pond.



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UNITED STATES AIR FORCE

BENZENE AND TCE CONCENTRATIONS EXCEEDING MCLs, OU5, 2003-2004 O&M PERIOD

ELMENDORF AIR FORCE BASE
ANCHORAGE, ALASKA

JOB NO: 20077.043.001

DATE: 5 MARCH 2004

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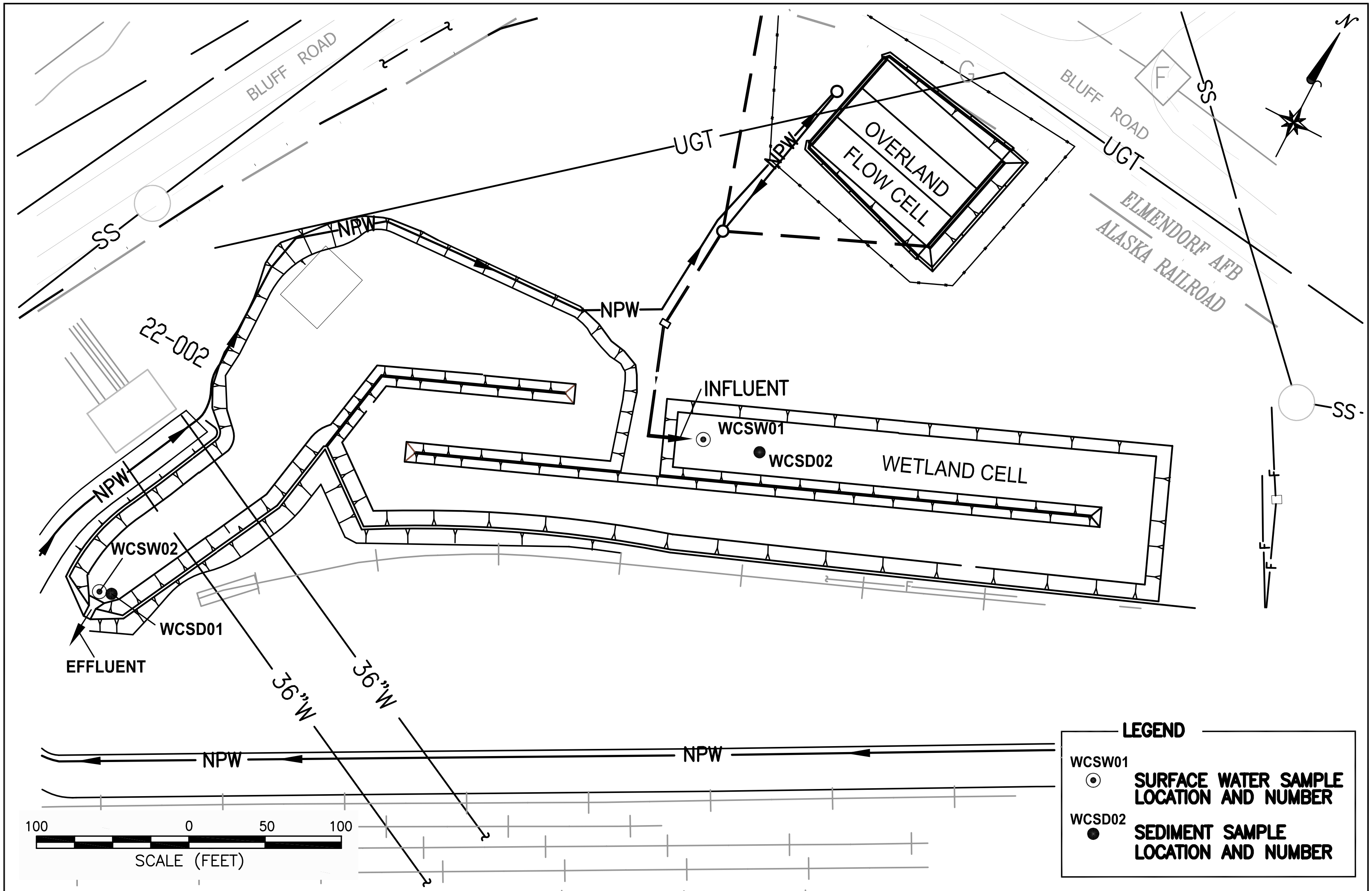
FIGURE 2-1



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UNITED STATES AIR FORCE

WETLAND CELL SAMPLING LOCATIONS
2003-2004 O & M PERIOD

ELMENDORF AIR FORCE BASE
ANCHORAGE, ALASKA

DATE: 5 MARCH 2004

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JOB NO: 20077.043.001

FIGURE 2-2

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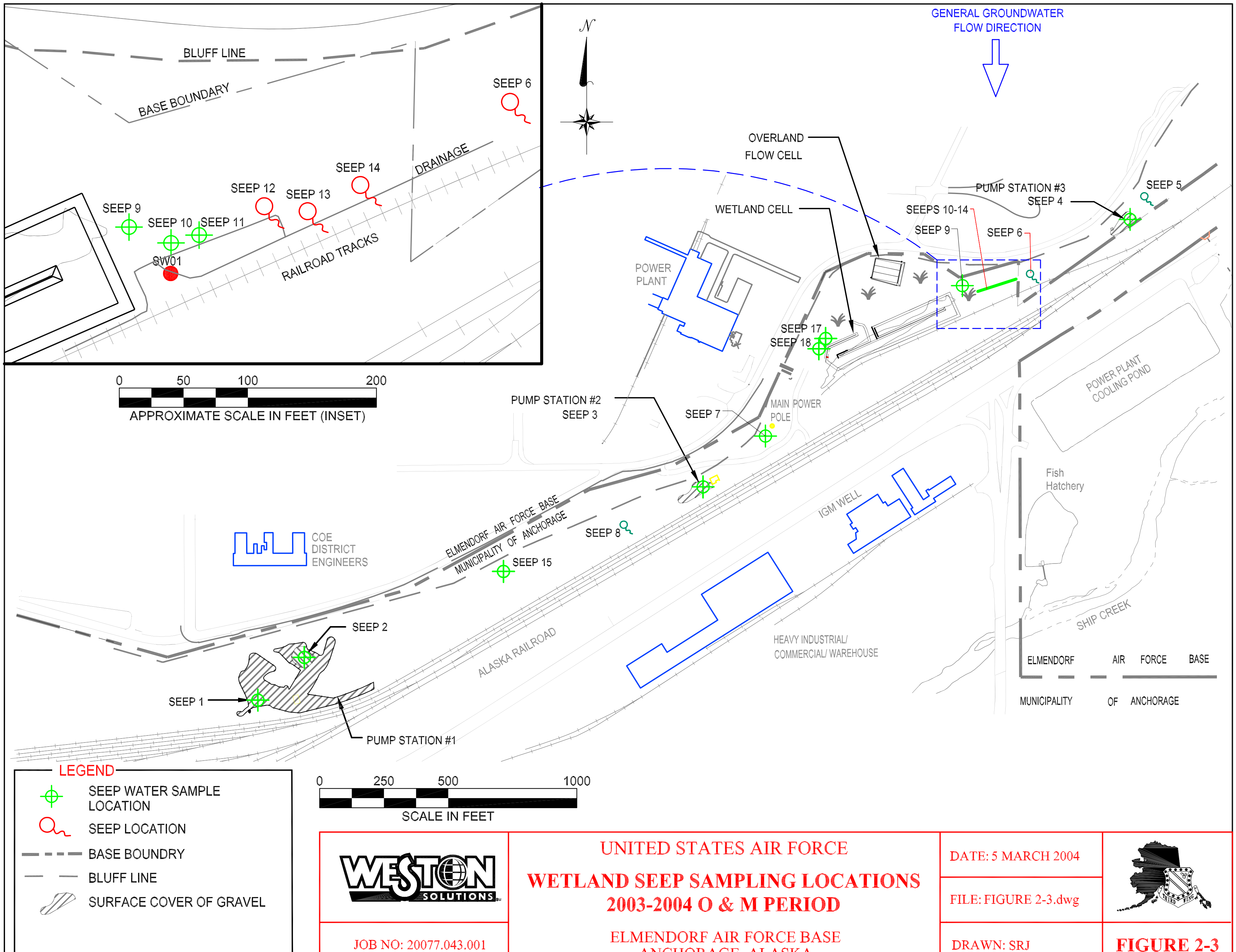

WESTON SOLUTIONS

UNITED STATES AIR FORCE

WETLAND SEEP SAMPLING LOCATIONS 2003-2004 O & M PERIOD

ELMENDORF AIR FORCE BASE
ANCHORAGE, ALASKA

DATE: 5 MARCH 2004

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JOB NO: 20077.043.001

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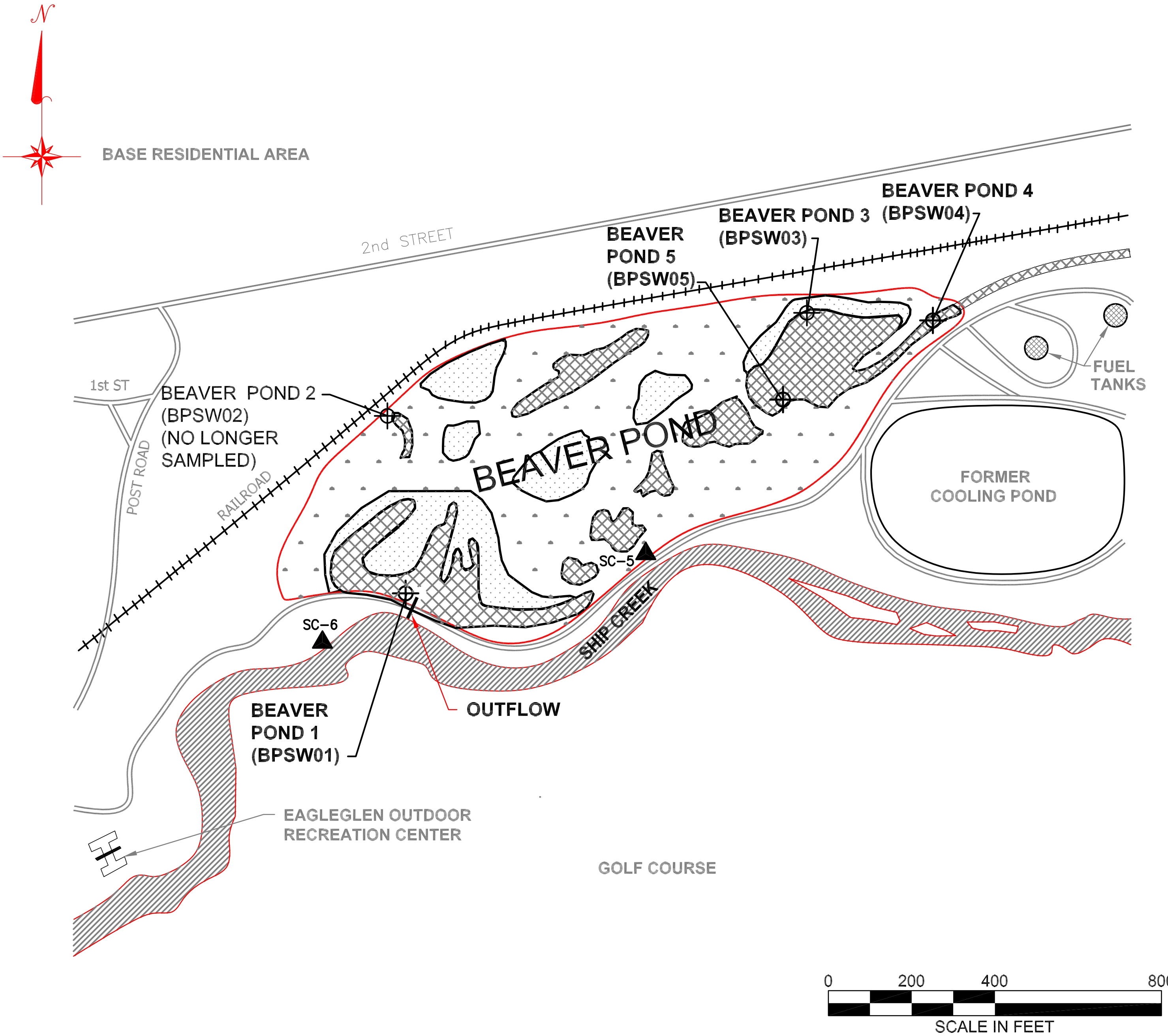
FIGURE 2-3



LEGEND

- SURFACE WATER AND SEDIMENT SAMPLE LOCATION, OU5 WETLAND MONITORING PROGRAM
- OPEN WATER
- SEDGE MARSH
- WOODED SWAMP
- SC-6 SURFACE WATER SAMPLE LOCATION, BASEWIDE ENVIRONMENTAL MONITORING PROGRAM

NOTES:

BEAVER POND 2 (BPSW02) - THIS SAMPLING LOCATION HAS BEEN REMOVED FROM THE SAMPLING PROGRAM BECAUSE SAMPLING CONDUCTED FROM 1999 - 2001 DID NOT INDICATED ANY SIGNIFICANT CONTAMINATION AT THIS LOCATION.

BEAVER POND 4 (BPSW04) - SAMPLING INITIATED AT THIS SAMPLING LOCATION IN 2002 TO REPLACE FORMER SAMPLING LOCATION BPSW02. SAMPLE IS LOCATED IN THE OPEN-WATER DITCH EAST OF BPSW03.

BEAVER POND 5 (BPSW05) - SAMPLING INITIATED AT THIS SAMPLING LOCATION IN 2002 IN PROXIMITY OF FORMER BASEWIDE ENVIRONMENTAL MONITORING PROGRAM SAMPLING LOCATION SC-3.

WESTON SOLUTIONS	UNITED STATES AIR FORCE **BEAVER POND SURFACE WATER AND SOIL/SEDIMENT SAMPLE LOCATIONS**	DATE: 5 MARCH 2004 FILE: OU5_FIGS2.dwg	
JOB NO: 20077.043.001	ELMENDORF AIR FORCE BASE ANCHORAGE, ALASKA	DRAWN: SRJ	**FIGURE 2-4**

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3.0 SYSTEM PERFORMANCE EVALUATION

A system performance evaluation is presented to assess the effectiveness of the OU 5 remedy and to evaluate progress towards achieving cleanup goals. This section presents analytical results for the primary COCs, benzene and TCE, a discussion of the natural attenuation of benzene and TCE at both the WRS and Beaver Pond wetland area, and evaluates contaminant data trends for benzene, TCE, TAH, and TAqH concentrations in seeps and upgradient monitoring wells.

Samples were collected as specified in the Field Sampling Plan (FSP) and QAPP referenced in the *2003 Monitoring and Optimization Work Plan* (USAF, 2003b), unless noted here. All water samples were submitted for laboratory analysis of the following: PAHs by Method SW8270, and VOCs by Method SW8260B to include BTEX and TCE. Sediment samples were analyzed for VOCs and PAHs. The 2003 Work Plan referenced sample analysis by SW8310 for PAHs; however, this was changed to SW8270 for SVOCs to create conformance between the Basewide and the OU5 Wetland Program. Furthermore, any detects for SW8310 require confirmation by another method (SW8270), and SW8310 in soils typically requires extract dilution that raises the MDL/RL.

A complete set of the analytical results for water and sediment samples collected during this reporting period is provided on disk in Appendix B.

3.1 Natural Attenuation of Benzene and TCE

Sampling rounds were conducted in May 2003 (Round 1), August 2003 (Round 2), November 2003 (Round 3), and January/February 2004 (Round 4) to assess the natural attenuation of benzene and TCE at the WRS. Round 4 follow-up sampling was performed in February 2004 for Seeps 1, 2, and 4 to provide a complete set of influent data, as Seep 1 and 2 were frozen in November 2003 and January 2004, and Seep 4 was also frozen in January 2004. Sampling rounds were conducted in May 2003 (Round 1), August 2003 (Round 2), and January 2004 (Round 4) to assess the natural attenuation of benzene and TCE at the Beaver Pond.

Analytical data shows that natural attenuation is effectively reducing benzene and TCE concentrations to below current ROD cleanup levels at the outflows of the WRS and Beaver Pond. Some elevated levels of TCE were found at upgradient locations in the Beaver Pond (Section 3.1.2) and in seeps outside of the WRS (Sections 2.2.2 and 3.2.1.4). In addition, influent TAH and TAqH concentrations have consistently exceeded regulatory levels at Seep 2 (Section 3.2.3). The following subsections summarize these analytical results from the two of the four sampling rounds.

3.1.1 WRS

As part of the WRS design, water from four seep areas is directed through a gravel collection area, into pump stations that pump the water up to the Overland Flow Cell (Figure 3-1). As the water flows through the gravel, oxygen is introduced into the water, allowing biodegradation of hydrocarbon contaminants as well as volatilization of contaminants to occur. The *2001 Annual Technical Report* (USAF, 2002a) provides data, analyses, and discussion that shows natural attenuation/biodegradation occurs between the seeps and the pump stations. Additional biodegradation and volatilization occur as water passes through the Overland Flow Cell before it discharges to the Wetland Cell (Figure 3-1).

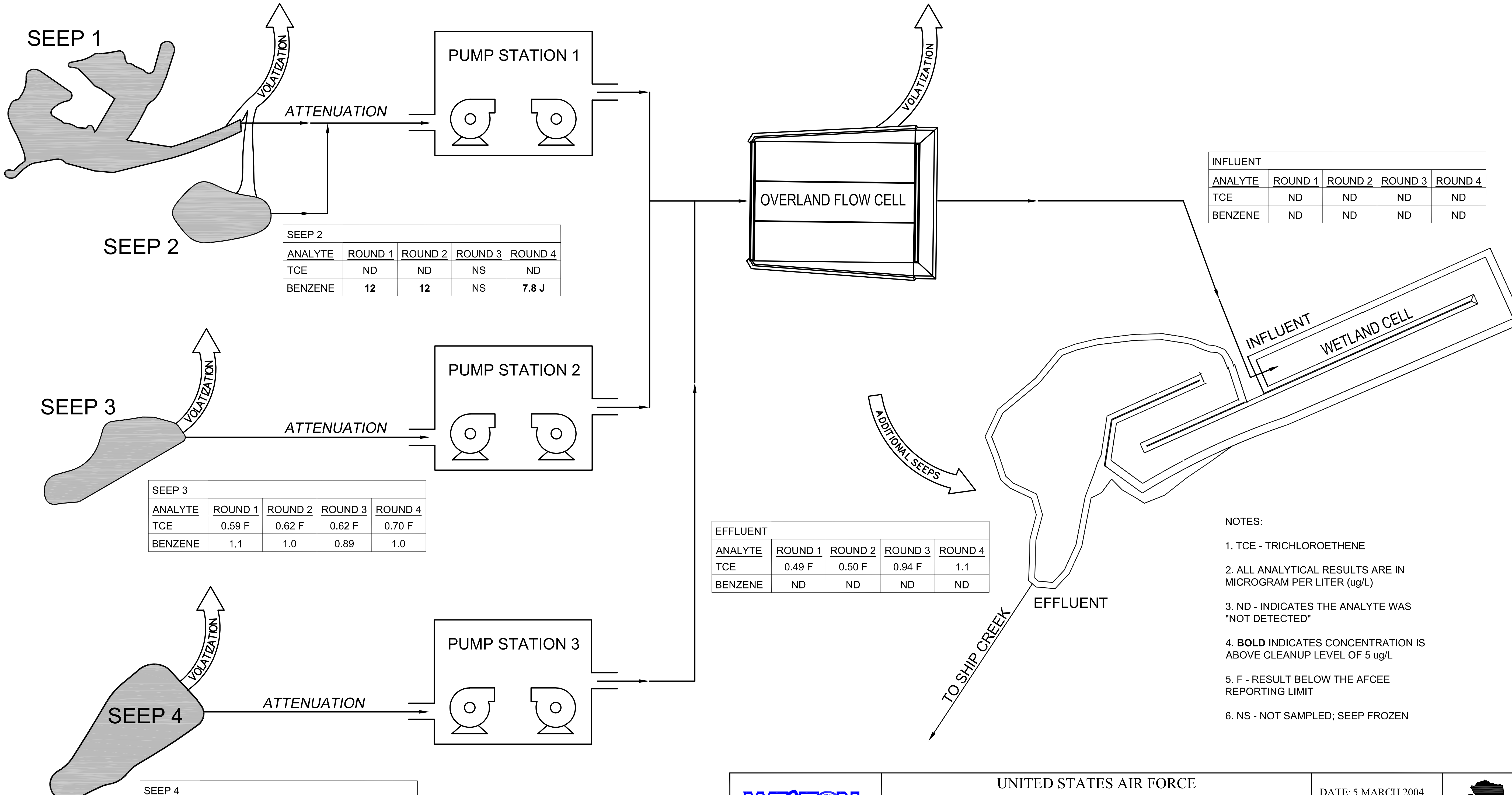
During each sample round, water samples were collected at Seeps 1 through 4 and near the influent and effluent locations of the Wetland Cell. During August, sediment samples were also taken from the influent and effluent areas of the Wetland Cell. Analytical results for benzene and TCE in the water samples collected from Seeps 1 through 4 and the Wetland Cell are summarized in the following two subsections.

3.1.1.1 Seep Collection Areas (Seeps 1 - 4)

Seeps 1 through 4 are sampled quarterly as part of the monitoring program (refer to Figures 2-1 and 2-3). Benzene was detected at a concentration above the applicable cleanup level of 5 μg/L at Seep 2 during Round 2 (August) at 12 μg/L; neither Seep 1 nor 2 was sampled during November due to frozen seep conditions. A low concentration of benzene was detected at Seep 3 during Round 2 (August) at 1 μg/L. Benzene was not detected at either Seep 1 or 4 during Round 2 (August), nor detected at Seep 4 during Round 3 (November). TCE was not detected at any of the seeps above the AFCEE reporting limit for the rounds sampled; concentrations are significantly below cleanup levels.

Monitoring data show that fuel contamination continues to exist at Seep 2, while sources associated with Seeps 1, 3, and 4 do not appear at levels that contribute to contamination in OU 5, for the primary risk constituents of benzene and TCE. Analytical results are shown on Table 3-1, seep sample locations are shown on Figure 2-3, and locations where results were found to exceed the established cleanup criteria for benzene and TCE are shown on Figures 2-1 and 3-1.

SEEP 1				
ANALYTE	ROUND 1	ROUND 2	ROUND 3	ROUND 4
TCE	ND	ND	NS	ND
BENZENE	0.63	ND	NS	0.42



SEEP 2				
ANALYTE	ROUND 1	ROUND 2	ROUND 3	ROUND 4
TCE	ND	ND	NS	ND
BENZENE	**12**	**12**	NS	**7.8 J**

SEEP 3				
ANALYTE	ROUND 1	ROUND 2	ROUND 3	ROUND 4
TCE	0.59 F	0.62 F	0.62 F	0.70 F
BENZENE	1.1	1.0	0.89	1.0

SEEP 4				
ANALYTE	ROUND 1	ROUND 2	ROUND 3	ROUND 4
TCE	ND	ND	ND	ND
BENZENE	ND	ND	ND	ND

INFLUENT				
ANALYTE	ROUND 1	ROUND 2	ROUND 3	ROUND 4
TCE	ND	ND	ND	ND
BENZENE	ND	ND	ND	ND

EFFLUENT				
ANALYTE	ROUND 1	ROUND 2	ROUND 3	ROUND 4
TCE	0.49 F	0.50 F	0.94 F	1.1
BENZENE	ND	ND	ND	ND

NOTES:

1. TCE - TRICHLOROETHENE
2. ALL ANALYTICAL RESULTS ARE IN MICROGRAM PER LITER (ug/L)
3. ND - INDICATES THE ANALYTE WAS "NOT DETECTED"
4. **BOLD** INDICATES CONCENTRATION IS ABOVE CLEANUP LEVEL OF 5 ug/L
5. F - RESULT BELOW THE AFCEE REPORTING LIMIT
6. NS - NOT SAMPLED; SEEP FROZEN

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JOB NO: 20077.043.001

UNITED STATES AIR FORCE
WRS NATURAL ATTENUATION
BENZENE AND TCE RESULTS
2003-2004 O&M PERIOD
ELMENDORF AIR FORCE BASE
ANCHORAGE, ALASKA

DATE: 5 MARCH 2004

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FIGURE 3-1

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Table 3-1 Benzene and TCE Analytical Results for Seeps 1 through 4

Sampling Event	Seep 1		Seep 2		Seep 3		Seep 4	
	Benzene (µg/L)	TCE (µg/L)	Benzene (µg/L)	TCE (µg/L)	Benzene (µg/L)	TCE (µg/L)	Benzene (µg/L)	TCE (µg/L)
Round 1 May-03	0.63	ND (0.12)	**12**	ND (0.12)	1.1	0.59 F	ND (0.11)	ND (0.12)
Round 2 Aug-03	ND (0.072)	ND (0.18)	**12**	ND (0.18)	1	0.62 F	ND (0.072)	ND (0.18)
Round 3 Nov-03	NS	NS	NS	NS	0.89	0.62 F	ND (0.072)	ND (0.18)
Round 4 Jan-04	NS	NS	NS	NS	1	0.7 F	NS	NS
Round 4 Feb-04	0.42	ND (0.18)	**7.8 J**	ND (0.18)	--	--	ND (0.4)	ND (0.18)

Bold – indicates result above cleanup level of 5 µg/L
µg/L – microgram per liter
-- Not sampled
F – The analyte was positively identified, but the associated numerical value is below the AFCEE reporting limit.
J – The analyte was positively identified, the quantitation is an estimation.
ND – not detected, method detection limit shown in parentheses
NS – Not sampled, seeps frozen at time of sample round.
TCE – trichloroethene

3.1.1.2 Wetland Cell

Surface water samples were collected near the influent and effluent of the Wetland Cell during each sampling event (see Figure 2-2 and 3-1). Analytical results for benzene and TCE in water collected from the Wetland Cell are presented in Table 3-2.

Benzene was not detected in any samples collected from the Wetland Cell. TCE was not detected at the influent; however, it was detected in low concentrations at the effluent of the Wetland Cell. Residual TCE concentrations are being introduced via contaminated seeps that flow directly into the Wetland Cell, which include Seeps 17 and 18.

Sediment samples were collected at the influent and effluent of the Wetland Cell (see Figure 2-2) during August 2003. PAH or VOC compounds were not detected in either of the samples above the AFCEE reporting limit.

Table 3-2 Benzene and TCE Analytical Results for Wetland Cell Influent and Effluent

Sampling Event	Wetland Cell (Influent)		Wetland Cell (Effluent)	
	Benzene (µg/L)	TCE (µg/L)	Benzene (µg/L)	TCE (µg/L)
Round 1 May-03	ND (0.11)	ND (0.12)	ND (0.11)	0.49 F
Round 2 Aug-03	ND (0.072)	ND (0.18)	ND (0.072)	0.50 F
Round 3 Nov-03	ND (0.072)	ND (0.18)	ND (0.072)	0.94 F
Round 4 Jan-04	ND (0.072)	ND (0.18)	ND (0.072)	1.1

µg/L – microgram per liter
F – The analyte was positively identified, but the associated numerical value is below the AFCEE reporting limit.
ND – not detected, method detection limit shown in parentheses
NS – Not sampled, seeps frozen at time of sample round.
TCE – trichloroethene

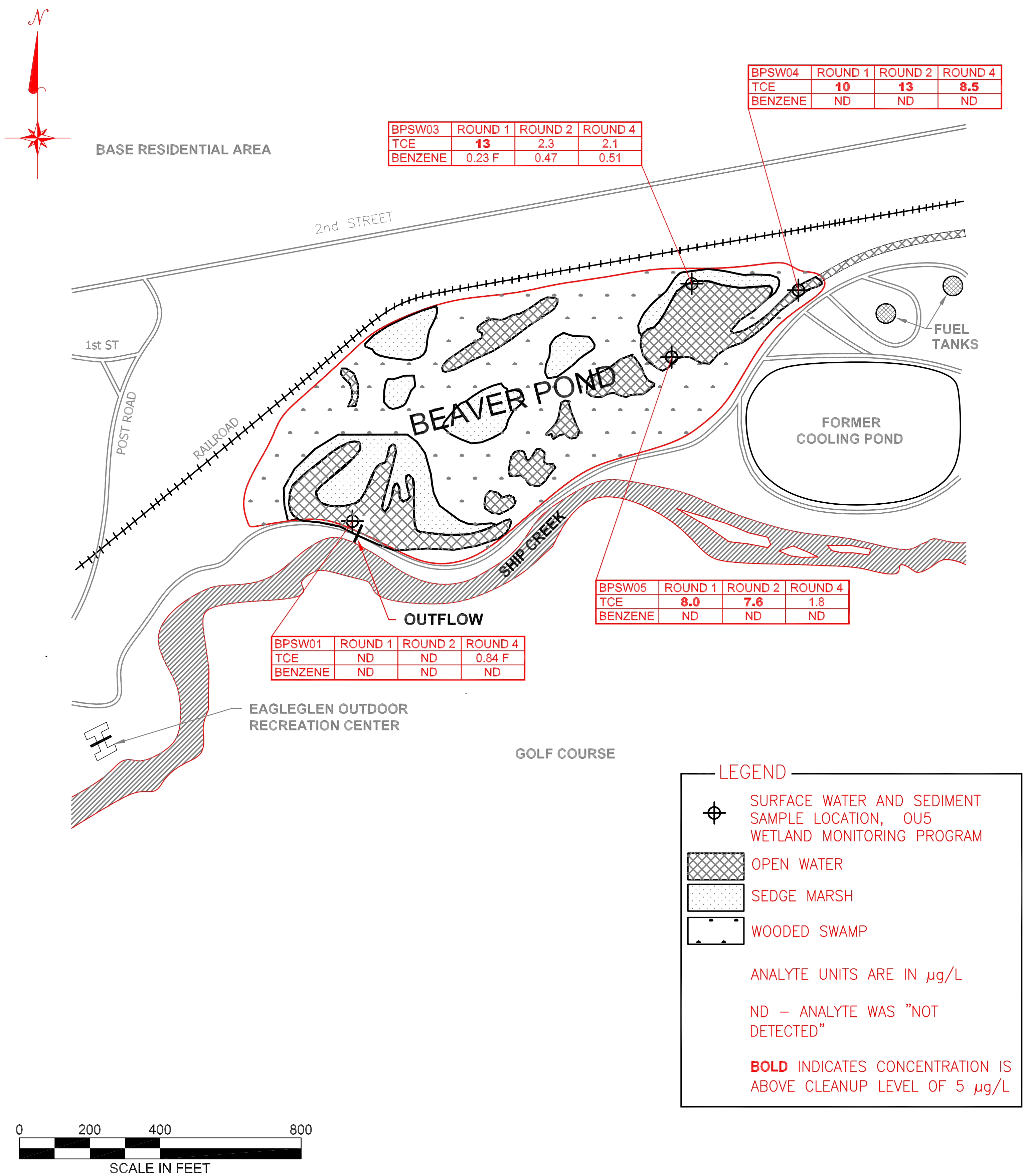
3.1.2 Beaver Pond

Surface water samples were collected from the Beaver Pond (see Figure 2-4) during three sampling rounds (May 2003, August 2003, January 2004) at four (4) locations as listed below:

- BPSW01 is near the outflow as part of the OU 5 wetlands monitoring.
- BPSW03 is upgradient in the vicinity of the groundwater seeps near the north perimeter.
- BPSW04 is located in the open water ditch east of BPSW03 and replaces the former sampling location BPSW02. Former sampling location, BPSW02 was removed from the sampling program in 2002 because previous sampling results had not identified any significant contamination at that location.
- BPSW05 is a sampling location in proximity of the former Basewide Environmental Monitoring Program Sampling Location SC-3.

Sediment samples were collected in August at approximately the same locations as surface water samples BPSW01, BPSW03, and BPSW05 (see Figure 2-4).

TCE was detected in the three upgradient water sample locations (BPSW03, BPSW04, and BPSW05) during both sample rounds. TCE concentrations in two of these sample locations were above the regulatory cleanup level of 5 µg/L during the May and August 2003 rounds, and above the regulatory cleanup level at one location in January 2004. At the effluent surface water sample location (BPSW01), TCE was not detected in August. Low levels of benzene were detected at the Beaver Pond influent location BPSW03 in August; however was not detected in any other Beaver Pond surface water samples, including the effluent. Analytical results for benzene and TCE at the Beaver Pond are presented in Figure 3-2 and Table 3-3.



BPSW04	ROUND 1	ROUND 2	ROUND 4
TCE	**10**	**13**	**8.5**
BENZENE	ND	ND	ND

BPSW03	ROUND 1	ROUND 2	ROUND 4
TCE	**13**	2.3	2.1
BENZENE	0.23 F	0.47	0.51

BPSW05	ROUND 1	ROUND 2	ROUND 4
TCE	**8.0**	**7.6**	1.8
BENZENE	ND	ND	ND

BPSW01	ROUND 1	ROUND 2	ROUND 4
TCE	ND	ND	0.84 F
BENZENE	ND	ND	ND

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BEAVER POND NATURAL ATTENUATION
BENZENE AND TCE RESULTS
2003 - 2004 O & M PERIOD

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ANCHORAGE, ALASKA

DATE: 5 MARCH 2004

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FIGURE 3-2

Sediment samples were collected at influent and effluent of the Beaver Pond during August 2003. PAHs or VOCs were not detected in either of the samples above the AFCEE reporting limit. Consistently low concentrations of contaminants in sediment samples at the Beaver Pond indicate contaminants are being attenuated in the water rather than being adsorbed into the sediments. A complete set of analytical data is provided in Appendix B.

Table 3-3 Benzene and TCE Analytical Results for Water in the Beaver Pond

Sampling Event	BPSW03 (Influent)		BPSW04 (Influent)		BPSW05 (SC-3) (Influent)		BPSW01 (Effluent)	
	Benzene (μg/L)	TCE (μg/L)	Benzene (μg/L)	TCE (μg/L)	Benzene (μg/L)	TCE (μg/L)	Benzene (μg/L)	TCE (μg/L)
Round 1 May-03	0.23 F	**13**	ND (0.11)	**10**	ND (0.11)	**8.0**	ND (0.11)	ND (0.12)
Round 2 Aug-03	0.47	2.3	ND (0.072)	**13**	ND (0.072)	**7.6**	ND (0.072)	ND (0.18)
Round 4 Jan-04	0.51	2.1	ND (0.072)	**8.5**	ND (0.072)	1.8	ND (0.072)	0.84 F

Note: Locations were not sampled for Round 3.
Bold – indicates result above cleanup level of 5 μg/L
μg/L – microgram per liter
F – The analyte was positively identified, but the associated numerical value is below the AFCEE reporting limit.
ND – not detected, method detection limit shown in parentheses
TCE – trichloroethene

3.2 Data Trends

Historical and current data from Seeps 1 through 4 and upgradient monitoring wells were reviewed to develop contaminant data trends for benzene, TCE, TAH, and TAqH. Data is presented from the 1994 through February 2004 sampling events. The seeps were not sampled during 1997 (USAF, 1998b). Additionally, data for the influent to the Beaver Pond wetland area is presented for 1993 and 1997 though November 2003.

3.2.1 WRS

Data trend analysis for the WRS includes Seeps 1 through 4 (which are collected and pumped to the WRS), and the Wetland Cell influent and effluent areas. Additionally, trend analysis is presented for the other identified seeps for which monitoring was initiated in 2001-2002 (i.e., Seeps 7, 9-11, 15, 17, and 18).

3.2.1.1 Benzene Trends at Seeps 1 through 4

Monitoring data from 1994 through February 2004 show elevated benzene concentrations at Seep 2, with concentrations varying between 1 and 15 μg/L. Prior to the January 2003 sampling event, benzene was consistently detected at low concentrations (1.1 to 3.25 μg/L) at Seep 3. Benzene has been detected at very low concentrations (<1.0 μg/L) occasionally at Seeps 1 and 4. Benzene concentrations in both Seeps 2 and 3 appear elevated from 1998 through 2000, then decreased in 2001. Maximum benzene levels were detected for Seep 2 in May and July 2002, then concentrations decreased again, however varied. Due to frozen conditions, Seep 2 could not be sampled in November 2003 or January 2004. Benzene concentrations at the other seeps appear to be consistent with previous years' data and safely below the cleanup level of 5 µg/L.

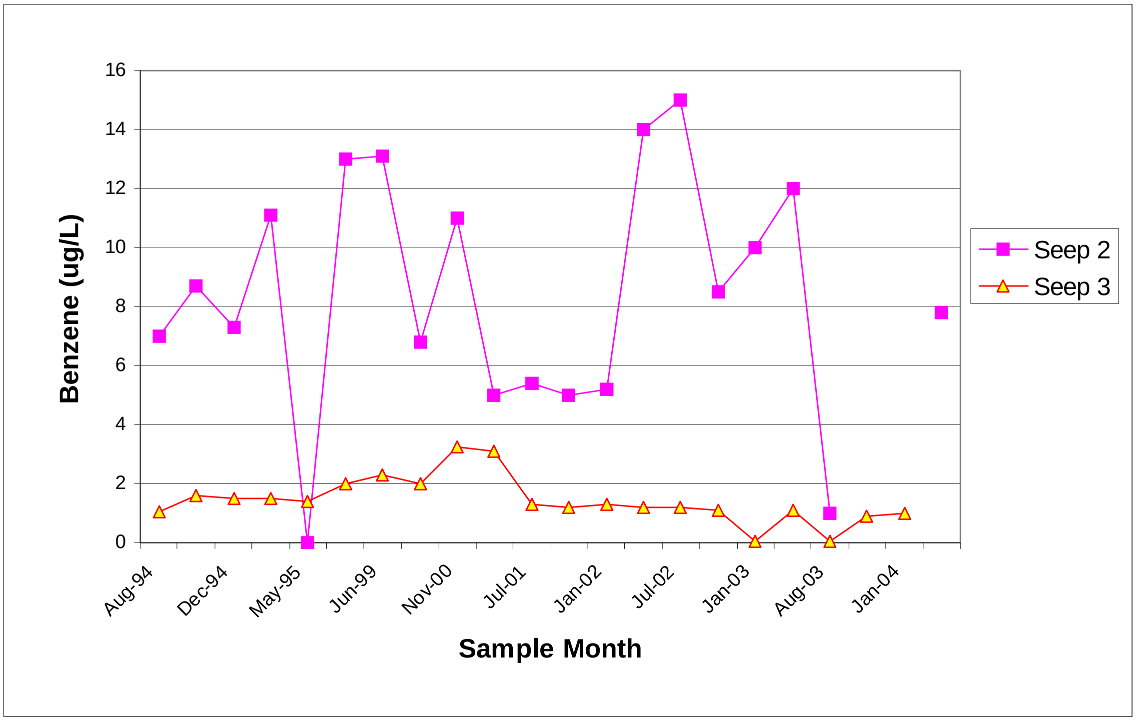
Table 3-4 presents benzene data trends in Seeps 1 through 4. Trends for Seeps 2 and 3 are presented graphically in Figure 3-3.

Table 3-4 Benzene Trends in Seeps 1 through 4, Wetland Remediation System

Sampling Event		Seep 1 (µg/L)	Seep 2 (µg/L)	Seep 3 (µg/L)	Seep 4 (µg/L)
1994[a]	Aug	ND	**7**	1.07	ND
	Oct	0.06	**8.7**	1.58	--
	Dec	ND	**7.31**	1.52	--
1995[a]	Mar	ND	**11.1**	1.48	--
	May	ND	ND	1.39	0.2[b]
	May	--	--	--	ND
	May	--	--	--	ND
1998[a]	Oct	0.3	**13**	2	0.4
1999[a]	Jun	ND	**13.1**	2.3	ND
	Oct	ND	**6.8**	2	ND
2000[a]	Nov	0.58	**11**	3.25	ND
2001[a]	Apr	ND	**5**	3.1	ND
	Jul	0.2	**5.4**	1.3	ND
	Oct	ND	**5**	1.2	ND
2002	Jan	0.18	**5.2**	1.3	ND
	May	0.81	**14**	1.2	ND
	Jul	ND	**15**	1.2	ND
	Sep	ND	**8.5**	1.1	ND
2003	Jan	0.6	**10**	ND	ND
	May	0.63	**12**	1.1	ND (0.11)
	Aug	ND (0.072)	**12**	1.0	ND (0.072)
	Nov	NS[a]	NS[a]	0.89	ND (0.072)
2004	Jan	NS[a]	NS[a]	1	NS[a]
	Feb	0.42	**7.8 J**	--	ND (0.4)

[a] Source: USAF, March 2002a. 2001 *Annual Technical Report for Operable Unit 5 Wetland Remediation System*
[b] In May 1995, Seep 4 was sampled three times at three different locations. Benzene was detected at 0.2 µg/L in May at one of the seep sampling locations.
Bold – indicates result above cleanup level of 5 µg/L
µg/L – microgram per liter
-- Not sampled.
F – The analyte was positively identified, but the associated numerical value is below the AFCEE reporting limit.
J – The analyte was positively identified, the quantitation is an estimation.
ND – not detected, method detection limit shown in parentheses
NS [a] –Not sampled, seeps frozen at time of sample round, seeps sampled in February when conditions temporarily thawed.

Figure 3-3 Benzene Trends in Seeps 2 and 3



3.2.1.2 TCE Trends at Seeps 1 through 4

Seeps 1 through 4 were first analyzed for TCE from 1993 to 1995 as part of a field study to support the Remedial Design for OU 5 (USAF, 1995c). Until 2001, no other samples collected from these seeps were analyzed for TCE. As shown in Table 3-5, low concentrations of TCE were detected at Seep 3 in August 1994, and at levels less than 1 µg/L in more recent sampling. TCE has not been identified as a concern at Seep 1, 2, or 4.

Table 3-5 TCE Trends in Seeps 1 through 4, Wetland Remediation System

Sampling Event		Seep 1 (µg/L)	Seep 2 (µg/L)	Seep 3 (µg/L)	Seep 4 (µg/L)
1994[a]	Aug	ND	ND	0.073	--
	Oct	ND	ND	ND	--
	Dec	ND	ND	ND	ND
1995[a]	Mar	ND	ND	ND	--
	May	--	--	--	ND
	May	ND	ND	ND	ND
	May	--	--	--	0.46
2001[a]	Jul	ND	ND	0.50	ND
	Oct	ND	ND	0.48	ND
2002	Jan	ND	ND	0.54	ND
	May	ND	ND	0.56	ND
	Jul	ND	ND	0.64	ND
	Sep	ND	ND	0.64	ND
2003	Jan	ND	ND	ND	ND
	May	ND (0.12)	ND (0.12)	0.59 F	ND (0.12)
	Aug	ND (0.18)	ND (0.18)	0.62 F	ND (0.18)
	Nov	NS[a]	NS[a]	0.62 F	ND (0.18)
2004	Jan	NS[a]	NS[a]	0.70 F	NS[a]
	Feb	ND (0.18)	ND	--	ND (0.18)

[a] Source: USAF, March 2002a. 2001 *Annual Technical Report for Operable Unit 5 Wetland Remediation System*
[b] In May 1995, Seep 4 was sampled three times at three different locations. TCE was detected (at 0.46 µg/L) at one of the seep sampling locations.
Bold – indicates result above cleanup level of 5 µg/L
µg/L – microgram per liter
-- Not sampled
F – The analyte was positively identified, but the associated numerical value is below the AFCEE reporting limit.
ND – not detected, method detection limit shown in parentheses
NS[a] – Not sampled, seeps frozen at time of sample round, seeps sampled in February when conditions temporarily thawed.
TCE – trichloroethene

3.2.1.3 TAH and TAqH Trends at Seeps 1 through 4

Evaluation of data from 1998 through February 2004 shows that TAH and TAqH concentrations have consistently exceeded cleanup levels at Seep 2. Elevated TAH and TAqH concentrations were noted at Seep 3 in November 2000 and April 2001, but have remained low since July 2001. In general, TAH and TAqH concentrations have consistently remained low at Seep 1. A spike of toluene at 50 µg/L was detected at Seep 4 in August 2003, which resulted in elevated TAH and TAqH concentrations. In the 2002 Annual Report, the toluene spike at Seep 4 in October 1999 was indicated as questionable, due to a disputed toluene detection of 54.2 µg/L, whereas all other constituents were non-detect. Chemistry analytical data and chromatograms were reviewed for the August 2003 toluene detection, and the analyte has been positively identified as present. Analytical results for Seep 4 in February 2004 indicate no detectable level of toluene. Recommendations for Basewide monitoring of potential upgradient sources are presented in Section 4.

Table 3-6 presents TAH and TAqH data trends in Seeps 1 through 4. Trends are graphically presented in Figure 3-4, 3-5, 3-6, and 3-7.

Table 3-6 TAH and TAqH Trends in Seeps 1 through 4, Wetland Remediation System

Sampling Event		Seep 1		Seep 2		Seep 3		Seep 4	
		TAH (µg/L)	TAqH (µg/L)	TAH (µg/L)	TAqH (µg/L)	TAH (µg/L)	TAqH (µg/L)	TAH (µg/L)	TAqH (µg/L)
1998 [a]	Oct	0.8	0.8	**360**	**388.3**	5	5	0.4	0.4
1999 [a]	Jun	ND	0.1	**411.6**	**442.4**	5.3	5.3	ND	0.5
	Oct	ND	ND	**155**	**155.1**	4.6	4.6	**54.2** [b]	**54.2** [b]
2000 [a]	Nov	0.6	0.7	**311**	**378**	**14**	14	ND	ND
2001 [a]	Apr	ND	ND	**160**	**161**	**15**	**15**	ND	ND
	Jul	0.37	0.43	**164**	**182**	1.45	1.54	0.14	0.24
	Oct	0.46	0.59	**253**	**274**	1.5	1.6	0.53	0.75
2002	Jan	0.4	0.47	**258.3**	**285**	1.49	1.79	0.28	0.51
	May	1	1.87	**125.8**	**152.8**	1.2	1.2	ND	ND
	Jul	0.14	0.14	**133.5**	**134.2**	0.12	0.12	6.7	6.8
	Sep	ND	ND	**149.8**	**166.7**	1.1	1.1	1.1	1.1
2003	Jan	1.34	1.34	**176.8**	**202.9**	ND	ND	0.16	0.16
	May	1.23	2.74	**109.7**	**133.7**	1.54	2.56	ND (0.57)	ND (1.56)
	Aug	ND (0.60)	0.81	**133.9**	**150.6**	1.53	1.72	**50.5**	**50.7**
	Nov	NS [a]	NS [a]	NS [a]	NS [a]	1.42	1.60	ND (0.60)	ND (0.78)
2004	Jan	NS [a]	NS [a]	NS [a]	NS [a]	1.53	1.79	NS [a]	NS [a]
	Feb	2.18	5.20	**170.3**	**203.6**	--	--	ND (0.60)	ND (0.83)

Note- Chlorobenzene compounds required for TAH were not included in the report from the lab for the 2001 analyses. A review of the raw data indicated that these compounds were not present in these samples. Chlorobenzene has been excluded from 2003/2004 TAH data compilation.

[a] Source: USAF, March 2002a. 2001 *Annual Technical Report for Operable Unit 5 Wetland Remediation System*

[b] The elevated TAH and TAqH concentration at Seep 4 in October 1999 resulted from a questionable toluene detection of 54.2 µg/L.

Bold – indicates result above cleanup levels of 10 µg/L for TAH and 15 µg/L for TAqH.

µg/L – microgram per liter

-- Not sampled

ND – not detected, method detection limit shown in parentheses

NS [a] – Not sampled, seeps frozen at time of sample round, seeps sampled in February when conditions temporarily thawed.

TAH – total aromatic hydrocarbon (sum of detected BTEX compounds). The summation for non-detected analytes was done using method detection limits shown in parentheses.

TAqH – total aqueous hydrocarbon (sum of TAHs and detected PAHs). The summation for non-detected analytes was done using method detection limits shown in parentheses.

Figure 3-4 TAH Trends in Seeps 1, 3, and 4

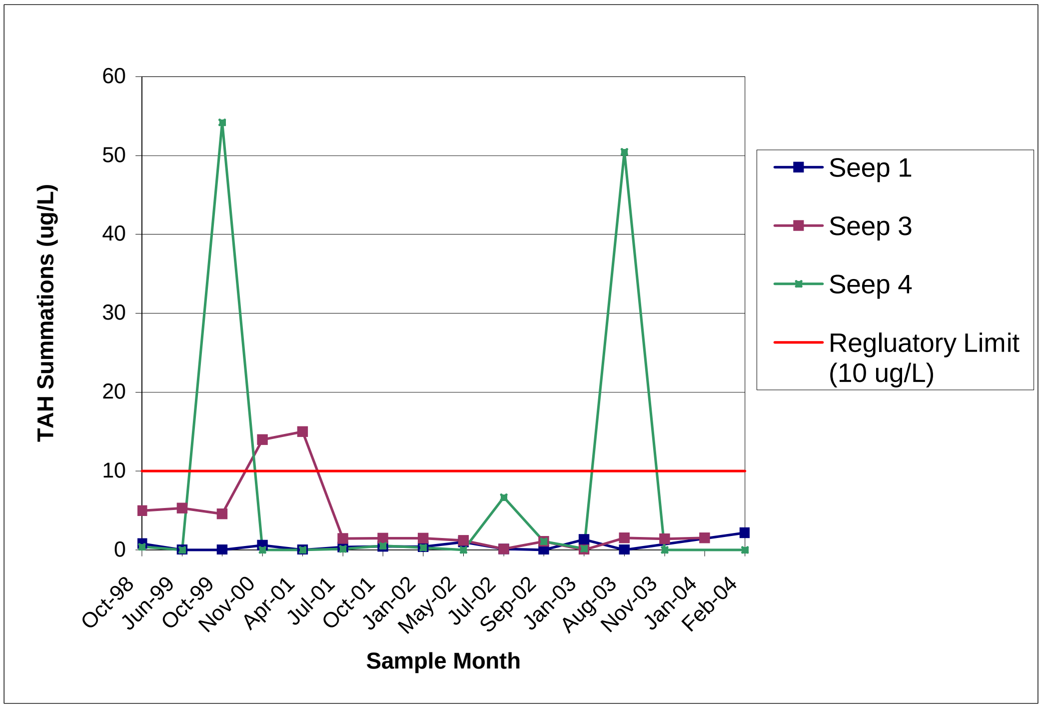


Figure 3-5 TAH Trends in Seep 2

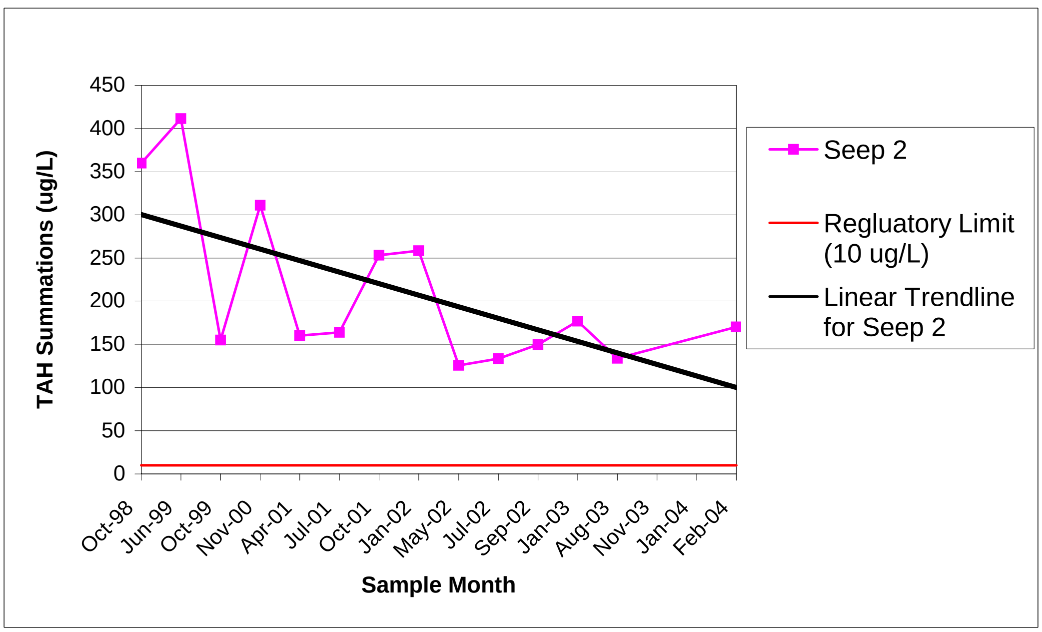


Figure 3-6 TAqH Trends in Seeps 1, 3 and 4

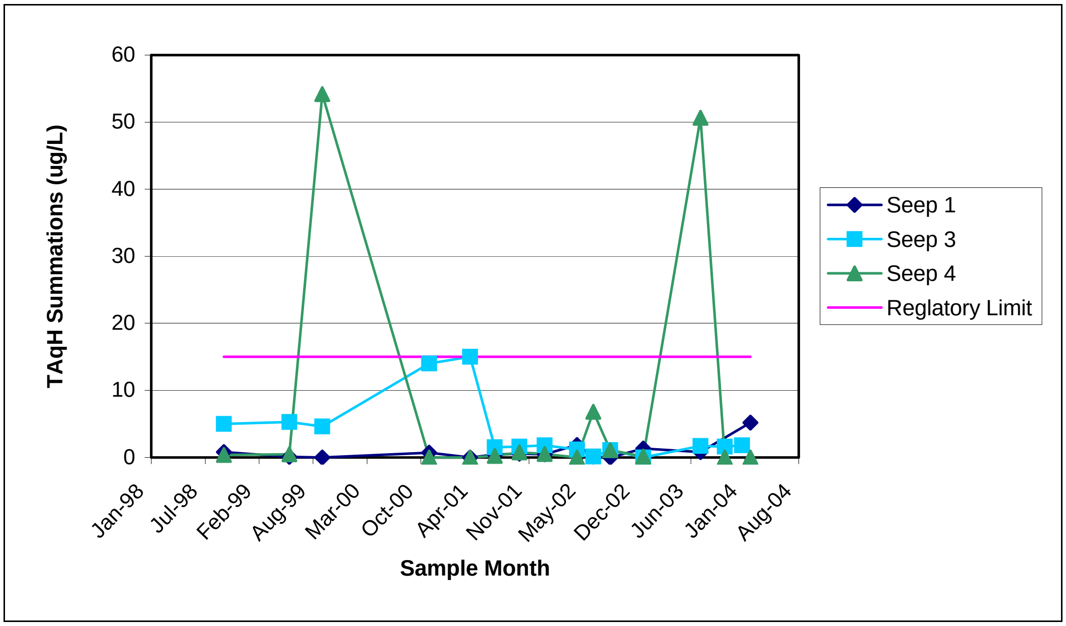
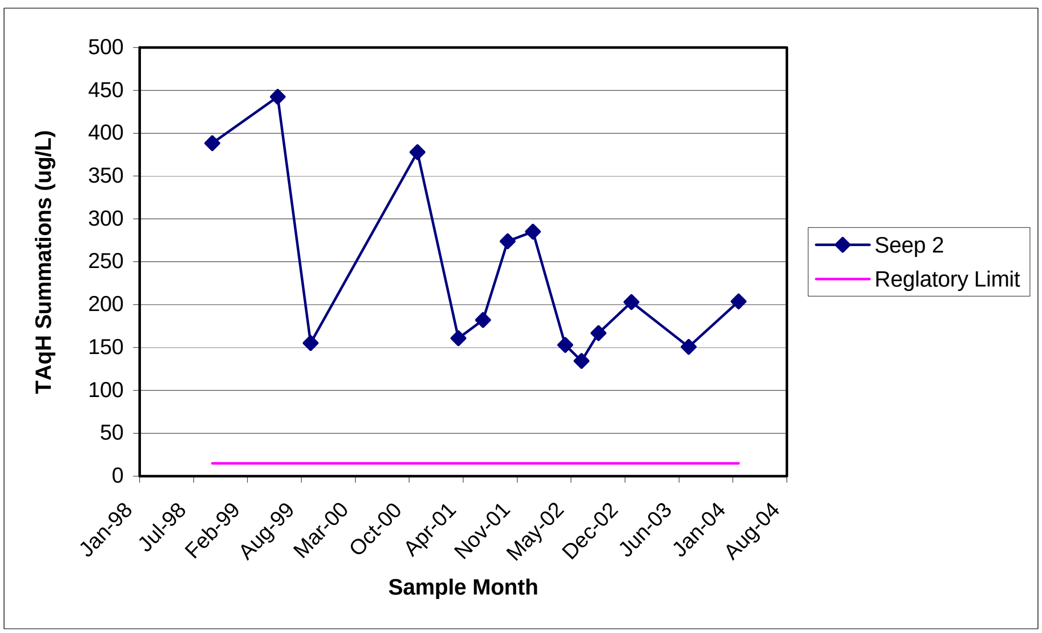


Figure 3-7 TAqH Trends in Seep 2



3.2.1.4 Benzene and TCE Trends at the Wetland Cell

Surface water samples from the Wetland Cell influent have consistently been non-detect for both benzene and TCE. In addition, benzene has not been detected in the effluent water. TCE has been detected at very low concentrations in the effluent water of the Wetland Cell, as shown in Table 3-7. In January 2004 a TCE concentration of 1.1 µg/L was detected at the effluent of the Wetland Cell. These data suggest that TCE contamination is being introduced to the Wetland Cell, downgradient of the influent area. As discussed in Section 3.2.2, Seeps 17 and 18 located near the effluent of the Wetland Cell are the likely source of this contamination.

Table 3-7 Benzene and TCE Trends at the Wetland Cell

Sampling Event		Influent		Effluent	
		Benzene (µg/L)	TCE (µg/L)	Benzene (µg/L)	TCE (µg/L)
2001 [a]	July	ND (0.11)	ND (0.12)	ND (0.11)	0.30 F
	October	ND (0.11)	ND (0.12)	ND (0.11)	1.3
2002 [b]	January	ND (0.11)	ND (0.12)	ND (0.11)	0.73 F
	May	ND (0.11)	ND (0.12)	ND (0.11)	0.60 F
	July	ND (0.11)	ND (0.12)	ND (0.11)	0.30 F
	September	ND (0.11)	ND (0.12)	ND (0.11)	0.62 F
2003 [b]	January	ND (0.11)	ND (0.12)	ND (0.11)	1.0
2003	May	ND (0.11)	ND (0.12)	ND (0.11)	0.49 F
	Aug	ND (0.072)	ND (0.18)	ND (0.072)	0.50 F
	Nov	ND (0.072)	ND (0.18)	ND (0.072)	0.94 F
2004	Jan	ND (0.072)	ND (0.18)	ND (0.072)	1.1

[a] Source: USAF, March 2002a. *2001 Annual Technical Report for Operable Unit 5 Wetland Remediation System*
[b] Source: USAF, March 2003a. *2002 Annual Technical Report for Operable Unit 5 Wetland Remediation System*
µg/L – microgram per liter
F – The analyte was positively identified, but the associated numerical value is below the AFCEE reporting limit.
ND – not detected, method detection limit shown in parentheses
TCE – trichloroethene

3.2.2 Benzene and TCE Trends at Other Identified Seeps

In 2001, water samples from identified Seeps 5 through 14 were analyzed (USAF, 2002a). In 2002 and 2003, seeps that were sampled included Seeps 7, 9, 10, 11, 15, 17, and 18. As discussed in Section 2, Seeps 9, 10, and 11 were found to exceed TCE cleanup levels during all sampling rounds to date, and Seep 15 exceeded the TAH cleanup level in September 2002. All other seeps were below cleanup levels; however, the presence of low level TCE concentrations was also identified in Seeps 7, 17, and 18. Seeps 17 and 18 are located on the northwest edge of the Wetland Cell (see Figure 2-3) and are contributing to low levels of TCE found in the Wetland Cell effluent water.

Evaluation of data trends are split into two groups: Seeps 9, 10, and 11 which are proposed for routing to the Wetland Cell and are sampled quarterly; Seeps 17 and 18, for which a portion of flows enter the wetland cell directly, are recommended for quarterly sampling; and Seeps 7 and

15, which are from outlying areas and are sampled annually. Data trends for benzene, TCE, TAH, and TAqH are presented in Table 3-8 through Table 3-11.

Although Seeps 5, 6, 8, 12, 13, and 14, were not sampled during 2003, annual monitoring is to be performed based on Figure 5-2, therefore historical data for these seeps will be presented following 2004 field activities as part of that annual report. Future sampling of these seeps are referenced in Section 5; however, 2001 sampling results indicated either non-detect concentrations for COCs or concentrations below 2 µg/L (USAF, 2002a).

Benzene was not detected in any of the results for Seeps 9, 10, and 11 (see Table 3-8). TCE was detected above the 5 µg/L cleanup level for all three locations. TAH and TAqH concentrations were non-detect or significantly below regulatory levels (see Table 3-9).

Table 3-8 Data Trends for Benzene and TCE for Seeps 9, 10, 11

Sampling Event		Seep 9		Seep 10		Seep 11	
		Benzene (µg/L)	TCE (µg/L)	Benzene (µg/L)	TCE (µg/L)	Benzene (µg/L)	TCE (µg/L)
2001 [a]	Jul [a]	ND	**6.5**	--	--	--	--
	Oct [a]	ND	**6.5**	ND	**8.6**	ND	**10**
2002 [b]	Jul [b]	ND (0.11)	**5.6**	ND (0.11)	**9.9**	ND (0.11)	**8.4**
	Sep [b]	ND (0.11)	**7.8**	ND (0.11)	**11**	ND (0.11)	**9.9**
2003	Jan [b]	ND (0.11)	**6.7**	ND (0.11)	**10**	ND (0.11)	**8.3**
	May	ND (0.11)	**5.6**	ND (0.11)	**12**	ND (0.11)	**9.5**
	Jun [c]	ND (0.14)	**6.6**	ND (0.14)	**7.4**	ND (0.14)	**8.9**
	Oct [c]	ND (0.072)	**17**	ND (0.072)	**17**	ND (0.072)	**14**

Note: No sampling preformed at seeps for November 2003 or January 2004 rounds.
[a] Source: USAF, March 2002a. *2001 Annual Technical Report for Operable Unit 5 Wetland Remediation System*
[b] Source: USAF, March 2003a. *2002 Annual Technical Report for Operable Unit 5 Wetland Remediation System*
[c] Source: USAF, March 2004 Draft. *Basewide Environmental Monitoring Program*
µg/L – microgram per liter
-- Not sampled
ND – not detected, method detection limit shown in parentheses
TCE – trichloroethene

Table 3-9 Data Trends for TAH and TAqH for Seeps 9, 10, 11

Sampling Event		Seep 9 TAH (µg/L)	Seep 9 TAqH (µg/L)	Seep 10 TAH (µg/L)	Seep 10 TAqH (µg/L)	Seep 11 TAH (µg/L)	Seep 11 TAqH (µg/L)
2001 [a]	Jul [a]	ND	0.05	--	--	--	--
	Oct [a]	0.19	0.19	--	--	--	--
2002 [b]	Jul [b]	ND	ND	0.11	0.11	ND	ND
	Sep [b]	ND	ND	ND	ND	ND	ND
2003	Jan [b]	ND	ND	0.10	0.10	ND	ND
	May	ND (0.57)	ND (1.56)	ND (0.57)	ND (1.56)	ND (0.57)	ND (1.56)
	Jun [c]	ND (0.96)	NC	ND (0.96)	NC	ND (0.96)	NC
	Oct [c]	ND (0.78)	NC	ND (0.60)	NC	ND (0.60)	NC

Note: No sampling preformed at seeps for November 2003 or January 2004 rounds
[a] Source: USAF, March 2002a. *2001 Annual Technical Report for Operable Unit 5 Wetland Remediation System.* TAH summation included chlorobenzene.
[b] Source: USAF, March 2003a. *2002 Annual Technical Report for Operable Unit 5 Wetland Remediation System*
[c] Source: USAF, March 2004 Draft. *Basewide Environmental Monitoring Program.*
µg/L – microgram per liter
-- Not sampled
NC – Not calculated, data not available for PAHs.
ND – not detected, method detection limit shown in parentheses
TAH – total aromatic hydrocarbon (sum of detected BTEX compounds). The summation for non-detected analytes was done using method detection limits shown in parentheses.
TAqH – total aqueous hydrocarbon (sum of TAHs and detected PAHs). The summation for non-detected analytes was done using method detection limits shown in parentheses.

Benzene was not detected in Seeps 7, 17, or 18; however, it was identified in low concentrations at Seep 15, but below cleanup levels (see Table 3-10). TCE concentrations were detected below cleanup levels at Seeps 7, 17, and 18, and not detected at Seep 15.

Table 3-10 Data Trends for Benzene and TCE for Seeps 7, 15, 17, 18

Sampling Event		Seep 7 Benzene (µg/L)	Seep 7 TCE (µg/L)	Seep 15 Benzene (µg/L)	Seep 15 TCE (µg/L)	Seep 17 Benzene (µg/L)	Seep 17 TCE (µg/L)	Seep 18 Benzene (µg/L)	Seep 18 TCE (µg/L)
2001	Jul [a]	ND (0.11)	3.0	--	--	--	--	--	--
	Oct [a]	ND (0.11)	4.1	--	--	--	--	--	--
2002 [a]	Jul [b]	ND (0.11)	4.3	2.7	ND (0.12)	ND (0.11)	3.1	ND (0.11)	2.2
	Sep [b]	ND (0.11)	4.3	2.5	ND (0.12)	ND (0.11)	3.5	ND (0.11)	2.3
2003	Jan [b]	ND (0.11)	2.9	1.7	ND (0.12)	ND (0.11)	**5.3**	ND (0.11)	2.6
	May	ND (0.11)	2.9	0.36 F	ND (0.12)	ND (0.11)	2.3	--	--
	Aug	ND (0.072)	3.6	1.9	ND (0.18)	ND (0.072)	3.4	ND (0.072)	2.1

Note: No sampling performed at seeps for November 2003 or January 2004 round.
[a] Source: USAF, March 2002a. *2001 Annual Technical Report for Operable Unit 5 Wetland Remediation System*
[b] Source: USAF, March 2003a. *2002 Annual Technical Report for Operable Unit 5 Wetland Remediation System*
Bold – indicates result above cleanup levels of 5 µg/L.
µg/L – microgram per liter
-- Not sampled
F – The analyte was positively identified, but the associated numerical value is below the AFCEE reporting limit.
ND – not detected, method detection limit shown in parentheses
TCE – trichloroethene

Varying trend results for benzene and TAH suggest the presence of fuel contamination and the need for further monitoring of Seep 15, which is discussed further in Section 4. For Seeps 7, 17, and 18 TCE concentrations are of concern. TAH and TAqH results are summarized in Table 3-11.

Table 3-11 Data Trends for TAH and TAqH for Seeps 7, 15, 17, 18

Sampling Event		Seep 7		Seep 15		Seep 17		Seep 18	
		TAH (µg/L)	TAqH (µg/L)	TAH (µg/L)	TAqH (µg/L)	TAH (µg/L)	TAqH (µg/L)	TAH (µg/L)	TAqH (µg/L)
2002 [a]	Jul [a]	ND	ND	6.18	6.35	ND	ND	ND	0.23
	Sep [a]	ND	ND	**11.35**	11.52	ND	ND	ND	0.26
2003	Jan [a]	0.10	0.10	2.30	2.30	ND	ND	ND	0.39
	May	ND (0.57)	ND (1.56)	0.83	1.82	ND (0.57)	ND (1.56)	--	--
	Aug	ND (0.60)	7.31	4.50	4.91	ND (0.60)	ND (0.84)	ND (0.60)	ND (1.26)

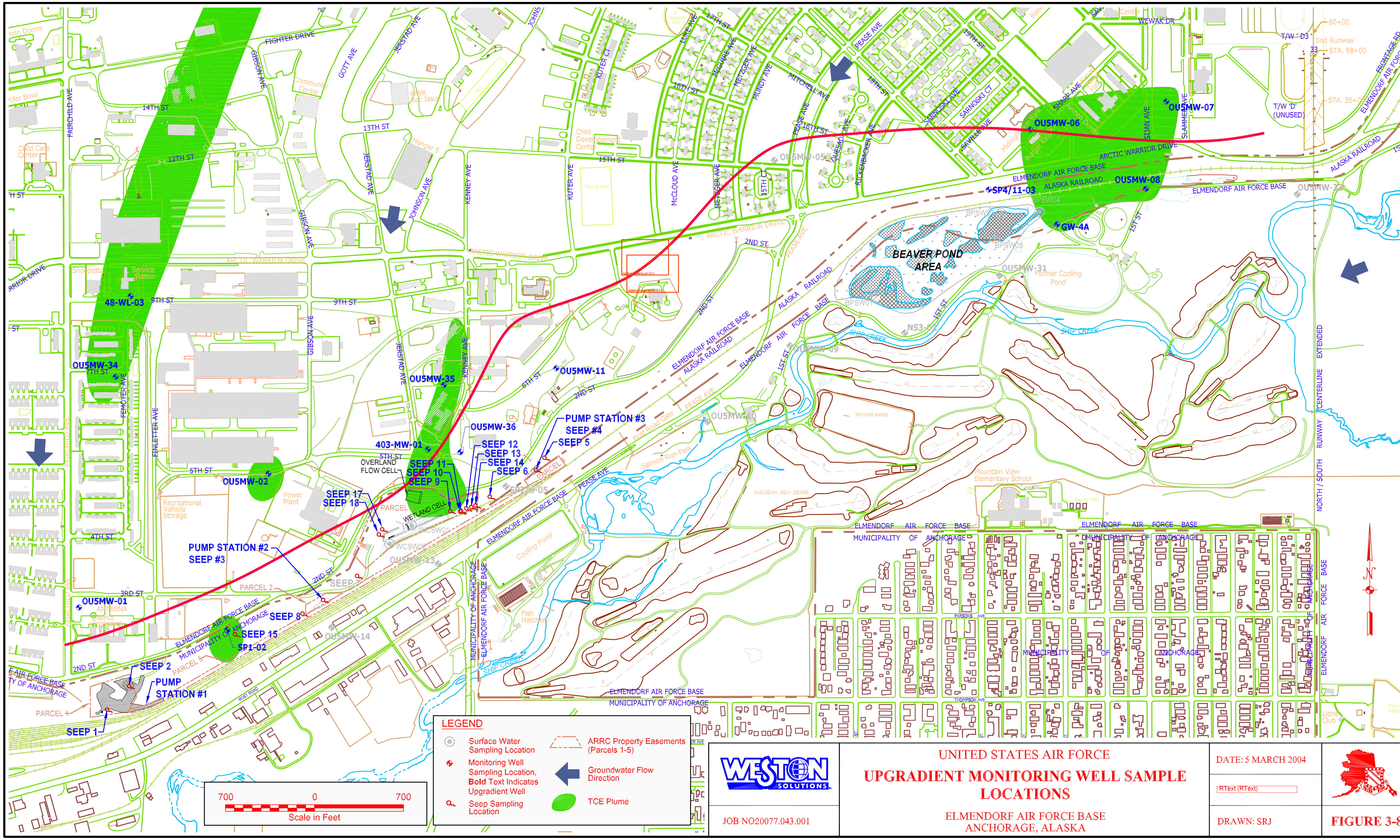
Note: No sampling performed at seeps for November 2003 or January 2004 round.
[a] Source: USAF, March 2003a. *2002 Annual Technical Report for Operable Unit 5 Wetland Remediation System*
Bold – indicates result above cleanup levels of 10 µg/L for TAH and 15 µg/L for TAqH.
µg/L – microgram per liter
-- Not sampled
ND – not detected, method detection limit shown in parentheses
TAH – total aromatic hydrocarbon (sum of detected BTEX compounds). The summation for non-detected analytes was done using method detection limits shown in parentheses.
TAqH – total aqueous hydrocarbon (sum of TAHs and detected PAHs). The summation for non-detected analytes was done using method detection limits shown in parentheses.

Further recommendations regarding these seeps not currently collected by the influent of the WRS are provided in Section 4.

3.2.3 Benzene and TCE Trends in Monitoring Wells Upgradient to the WRS

TCE and benzene data from 1997 through 2003 associated with upgradient groundwater wells monitored by the Basewide Environmental Monitoring Program were reviewed to gain a better understanding of upgradient contaminant sources potentially impacting OU 5. The following wells are located upgradient of the WRS including 48-WL-03, SP1-02, OU5MW-02, 403-MW-01, and, as of 2002, OU5MW-34, OU5MW-35, and OU5MW-36. Locations of the monitoring wells are shown on Figure 3-8. Well monitoring is performed either semi-annually, annually, bi-annually, or on a 5-year frequency, depending on Basewide Environmental Monitoring Program goals.

A summary of upgradient monitoring well data (upgradient to the WRS) and historical analytical results for the OU5 primary risk drivers (benzene and TCE) are presented in Table 3-12. Figure 2-1, in Section 2, shows results for well sample locations where results exceeded the 5-µg/L cleanup level for benzene or TCE.


SEEP 1
SEEP 2
PUMP STATION #1
SEEP 15
SP1-02
SEEP 8
PUMP STATION #2
SEEP #3
SEEP 17
SEEP 18
OVERLAND FLOW CELL
WETLAND CELL
SEEP 11
SEEP 10
SEEP 9
403-MW-01
SEEP 12
SEEP 13
SEEP 14
SEEP 6
PUMP STATION #3
SEEP #4
SEEP 5
OU5MW-01
OU5MW-02
OU5MW-34
OU5MW-35
OU5MW-36
OU5MW-11
48-WL-03
OU5MW-06
OU5MW-07
OU5MW-08
SP4/11-03
GW-4A
BEAVER POND AREA
FAIRCHILD AVE
FEMOYER AVE
FINLETTER AVE
GIBSON AVE
JERSTAD AVE
KENNEY AVE
KUTER AVE
McCLOUD AVE
ARCTIC WARRIOR DRIVE
ELMENDORF AIR FORCE BASE
MUNICIPALITY OF ANCHORAGE
ALASKA RAILROAD
NORTH / SOUTH RUNWAY CENTERLINE EXTENDED
LEGEND
Surface Water Sampling Location
Monitoring Well Sampling Location, Bold Text Indicates Upgradient Well
Seep Sampling Location
ARRC Property Easements (Parcels 1-5)
Groundwater Flow Direction
TCE Plume
700 0 700
Scale in Feet
N
WESTON SOLUTIONS
JOB NO20077.043.001
UNITED STATES AIR FORCE
UPGRADIENT MONITORING WELL SAMPLE LOCATIONS
ELMENDORF AIR FORCE BASE
ANCHORAGE, ALASKA
DATE: 5 MARCH 2004
DRAWN: SRJ
FIGURE 3-8

Wells OU5MW-35 and OU5MW-36 were non-detect for benzene and below cleanup levels for TCE (OU5MW-35 had 0.94 µg/L and OU5MW-36 had 3.6 µg/L in 2002 [USAF, 2003a]). The other five upgradient wells have shown elevated concentrations of TCE and historical analytical results for these wells are listed in Table 3-12. The elevated concentration of TCE (64 µg/L) at SP1-02 will be further evaluated under the Basewide Environmental Monitoring Program (USAF, 2004). Between 1997 and 2003, benzene was detected above the AFCEE reporting limit in only one of the five wells (48-WL-03) monitored upgradient of the WRS (USAF, 2001a).

TCE trends for four of the monitoring wells located upgradient of the WRS (48-WL-03, OU5MW-02, SP1-02, and 403-MW-01) fluctuate at concentrations above the regulatory MCL. Although TCE data is not available for Well 403-MW-01 prior to 2001, recent TCE concentrations are elevated above MCLs.

Elevated concentrations of TCE were identified in Well SP1-02, which is located just uphill from Seep 15; however, Seep 15 did not contain detectable concentrations of TCE. The elevated TCE concentrations identified in Seeps 9, 10, and 11 are likely associated with high TCE concentrations found in Well 403-MW-01. These data indicate the need for continued monitoring at the seeps and the upgradient monitoring wells. Discussion for continued monitoring of upgradient wells are summarized in Section 5.

3.2.4 Beaver Pond

Data trend analysis for the Beaver Pond includes TCE and benzene results from surface water (influent and effluent) and upgradient monitoring well samples collected between 1997 and summer 2003. These data depict consistently low to non-detectable concentrations of benzene. Upgradient TCE concentrations are elevated, although TCE at the effluent has consistently been low or non-detect.

3.2.4.1 Benzene and TCE Trends at the Beaver Pond

Surface water samples collected between 1997 and January 2004 at the influent and effluent areas of the Beaver Pond have indicated low to non-detectable concentrations of benzene. These consistent results, along with no active upgradient source identification, indicate benzene concentrations are likely to remain below MCLs at the Beaver Pond. Because benzene has not been detected in Beaver Pond effluent samples, benzene cleanup goals are being achieved.

Historically, BPSW05 (formerly SC-3) has had occurrences of TCE at concentrations above the detection limit. However, TCE has never been detected above the MCL in the Beaver Pond effluent water samples. It is apparent that the Beaver Pond wetland area is successfully decreasing benzene and TCE concentrations in the water to below the cleanup levels prior to its entry into Ship Creek. Historical influent and effluent analytical results for TCE and benzene at the Beaver Pond are shown in Table 3-13.

Table 3-12 Historical Analytical Results for Benzene and TCE in Groundwater Monitoring Wells Upgradient of WRS

Well ID:		**48-WL-03**		**OU5MW-34**		**SP1-02**		**OU5MW-02**		**403-MW-01**	
Downgradient Seeps:		1, 2, 3, 8, 15		1, 2, 3, 8, 15		15		3, 7, 8, 15		9 – 14, 17, 18	
		Benzene (µg/L)	**TCE (µg/L)**	**Benzene (µg/L)**	**TCE (µg/L)**	**Benzene (µg/L)**	**TCE (µg/L)**	**Benzene (µg/L)**	**TCE (µg/L)**	**Benzene (µg/L)**	**TCE (µg/L)**
1997 [c]	Spring	0.59	**67**	NS	NS	ND [0.3]	**30**	ND[a]	**11**	ND (0.05) [b]	NS
	Fall	0.4	**44**	NS	NS	ND [0.3]	**21**	ND[a]	**8.6**	NS	NS
1998 [c]	Spring	0.62	**18.8**	NS	NS	0.0798 F	**17**	ND[a]	**10.4**	NS	NS
	Fall	0.78	**33**	NS	NS	ND (0.06)	**21.9**	ND[a]	**11.1**	NS	NS
1999 [c]	Spring	0.69	**35 M**	NS	NS	ND (0.12)	**20 M**	ND[a]	**10 M**	NS	NS
	Fall	0.52	**26**	NS	NS	ND (0.12)	**18**	ND[a]	**9.1**	NS	NS
2000 [c]	Spring	0.90 F	**23**	NS	NS	ND (0.11)	**19**	ND[a]	**9**	NS	NS
	Summer	0.7	**25**	NS	NS	0.1 F	**30**	ND[a]	**8.1**	NS	NS
2001 [c]	Spring	0.8	**31**	NS	NS	0.1 F	**21**	ND[a]	**11**	NS	NS
	Summer	ND[a]	**14**	NS	NS	ND[a]	**16**	ND[a]	**11**	ND (0.11)	**66**
2002 [c]	Spring	0.30 F	**22**	NS	NS	ND (0.11)	**16**	ND (0.11)	**9.8**	ND (0.11)	**53**
	Summer	0.31 F	**28**	ND (0.11)	**42**	ND (0.11)	**12**	ND (0.11)	**12**	ND (0.11)	**49**
2003	Summer	NS[d]	NS[d]	NS[e]	NS[e]	0.4	**64**	NS[f]	NS[f]	NS[g]	NS[g]
	Fall	NS[d]	NS[d]	ND (0.072)	44	ND (0.072)	**22**	NS[f]	NS[f]	ND (0.072)	44

[a] The method detection limit is not known.
[b] Sampled November 1996 after initial well development, as part of underground storage tank (UST) Release Closure Investigation at Building 22-009.
[c] Source: USAF, March 2003a. *2002 Annual Technical Report for Operable Unit 5 Wetland Remediation System*
[d] Not sampled as well is no longer part of the Basewide Monitoring Program
[3] Not sampled as well is only sampled annually
[f] Not sampled as well is only sampled every 5 years
[g] Not sampled as well is only sampled biannually
Bold – indicates result above cleanup levels of 5 µg/L.
µg/L – microgram per liter
F – The analyte was positively identified, but the associated numerical value is below the AFCEE reporting limit.
M – A matrix effect was present.
ND – not detected, method detection limit shown in parentheses
NS – not sampled
TCE – trichloroethene

Table 3-13 Benzene and TCE Trends in Influent and Effluent Water at the Beaver Pond

Sample Location:		Benzene (µg/L)				TCE (µg/L)			
		Influent[a]			Effluent[b]	Influent[a]			Effluent[b]
		BPSW03	BPSW04	BPSW05 (SC-3)[c]	BPSW01	BPSW03	BPSW04	BPSW05 (SC-3)[c]	BPSW01
1993[d,e]	Sept	ND	NS	NS	NS	ND	ND	ND	ND
1997[e]	May	NS	NS	ND (0.3)	NS	NS	NS	NS	NS
	Sept	NS	NS	ND (0.3)	NS	NS	NS	NS	NS
1998[e]	Apr	NS	NS	0.117 F	NS	NS	NS	**6.54**	NS
	Aug	NS	NS	0.196 F	NS	NS	NS	**6.17**	NS
1999[e]	May	NS	NS	0.12 F	NS	NS	NS	**6.6**	NS
	Jun	ND (0.5)	NS	NS	ND (0.5)	NS	NS	NS	NS
	Jul	NS	NS	ND (0.012)	NS	NS	NS	4.8	NS
	Oct	0.9	NS	NS	ND (0.5)	NS	NS	NS	NS
2000[e]	May	NS	NS	0.13 F	NS	NS	NS	4.1	NS
	Jul	NS	NS	ND (0.11)	NS	NS	NS	4.2	NS
	Nov	ND (0.5)	NS	NS	ND (0.5)	NS	NS	NS	NS
2001[e]	Apr	ND (0.5)	NS	NS	ND (0.5)	NS	NS	NS	NS
	May	NS	NS	ND (0.11)	NS	NS	NS	**9.6**	NS
	Jul	0.2 F	NS	ND (0.11)	ND (0.11)	3.5	NS	**10**	*
	Oct	0.21 F	NS	NS	ND (0.11)	3.3	NS	NS	ND (0.12)
2002[f]	Jul	0.28 F	ND (0.11)	ND (0.11)	ND (0.11)	3.6	**8.7**	**7.1**	ND (0.12)
	Sept	0.26 F	ND (0.11)	ND (0.11)	ND (0.11)	**5.1**	**9.9**	**9**	0.14 F
2003	May	0.23 F	ND (0.11)	ND (0.11)	ND (0.11)	**13**	**10**	**8**	ND (0.12)
	Aug	0.47	ND (0.072)	ND (0.072)	ND (0.072)	2.3	**13.0**	**7.6**	ND (0.18)
2004	Jan	0.51	ND (0.072)	ND (0.072)	ND (0.072)	2.1	**8.5**	1.8	0.84 F

*The incorrect effluent sampling location was sampled in July 2001 and therefore is not reported.
[a] Former influent location BPSW02 is not shown—sample results from 1993 and 2001 have not detected any contamination at this location and the location has been removed from the sampling program.
[b] Prior to 2001, Ship Creek surface water (Basewide Sampling locations SC-5 and SC-6) was sampled and presented as effluent of the Beaver Pond. All results were non-detect.
[c] BPSW05 is the same location as Basewide Sampling location SC-3 (pre-2002 data).
[d] 1993 sample specified as seep 2 is at BPSW03 location/ seep 1 at BPSW02
[e] Source: USAF, March 2002a. 2001 *Annual Technical Report for Operable Unit 5 Wetland Remediation System*
[f] Source: USAF, March 2003a. *2002 Annual Technical Report for Operable Unit 5 Wetland Remediation System*
Bold – indicates result above cleanup levels of 5 µg/L.
µg/L – micrograms per liter
F – The analyte was positively identified, but the associated numerical value is below the AFCEE reporting limit.
ND – not detected, method detection limit shown in parentheses
NS – not sampled
TCE – trichloroethene

3.2.2.2 Benzene and TCE Trends in Monitoring Wells Upgradient of the Beaver Pond

Benzene and TCE data from 1997 through 2003 associated with upgradient groundwater wells monitored by the Basewide Environmental Monitoring Program have been reviewed to gain a better understanding of upgradient contaminant sources potentially impacting OU 5. Four of these wells are located upgradient of the Beaver Pond. In 2002, an additional well (SP4/11-03) was added to the sampling program as a part of the early warning system to help identify any unknown contaminant presence. Results indicated that benzene was not detected and TCE was present at a very low concentration (less than 1 µg/L). Locations of the monitoring wells are shown on Figure 3-8. Historical analytical results for the four wells with elevated concentrations of COCs are listed in Table 3-14. Figure 2-1 shows results for sample locations where results exceeded the 5 µg/L cleanup level for benzene or TCE.

Table 3-14 Historical Analytical Results for Benzene and TCE in Groundwater Monitoring Wells Upgradient of Beaver Pond

Well ID:		GW-4A		OU5MW-06		OU5MW-07		OU5MW-08	
		Benzene (µg/L)	TCE (µg/L)	Benzene (µg/L)	TCE (µg/L)	Benzene (µg/L)	TCE (µg/L)	Benzene (µg/L)	TCE (µg/L)
1997 [a]	Spring	0.5	**5.5**	ND [0.3]	**46**	ND [0.3]	**17**	ND [0.3]	2.3
	Fall	ND [0.3]	**8**	ND [0.3]	**39**	ND [0.3]	**19**	ND [0.3]	2.4
1998 [a]	Spring	0.56	**6.6**	0.0981 F	**36.2**	0.198 F	**23.1**	ND (0.04)	2.6
	Fall	0.84	**6.9**	0.127 F	**47**	0.244 F	**31.1**	ND (0.04)	3.5
1999 [a]	Spring	ND (0.12)	4.9 M	ND (0.12)	**34 M**	ND (0.12)	**20 M**	ND (0.12)	2.9 M
	Fall	0.78	4.2	ND (0.12)	**33**	0.16 F	**21**	ND (0.12)	3.3
2000 [a]	Spring	ND (0.11)	**5.1**	ND (0.11)	**28**	ND (0.11)	**22**	ND (0.11)	3.8
	Summer	0.2 F	**8.4**	ND (0.11)	**26**	0.2 F	**18**	ND (0.11)	4.3
2001 [a]	Spring	ND[c]	**11**	ND[c]	**25**	0.1 F	**19**	ND[c]	4.3
	Summer	ND[c]	**13**	ND[c]	**29**	ND[c]	**23**	ND[c]	**5.1**
2002 [b]	Spring	ND (0.11)	**11**	ND (0.11)	**30**	0.12 F	**20**	ND (0.11)	4.1
	Summer	ND (0.11)	**11**	ND (0.11)	**37**	ND (0.11)	**24**	ND (0.11)	4.8
2003	Summer	NS	**11**	NS	**30**	ND (0.14)	**20**	NS	4.9
	Fall	0.36	**7.5**	NS	NS	NS	NS	NS	NS

[a] Source: USAF, March 2001a. *Annual Report for Groundwater Sampling Activity*
[b] Source: USAF, March 2003a. *2002 Annual Technical Report for Operable Unit 5 Wetland Remediation System*
[c] The method detection limit is not known.
-- not sampled
Bold – indicates result above cleanup levels of 5 µg/L.
µg/L – micrograms per liter
F – The analyte was positively identified, but the associated numerical value is below the AFCEE reporting limit.
M – A matrix effect was present.
ND – not detected, method detection limit shown in parentheses
NS – not sampled
TCE – trichloroethene

Consistently non-detect or low concentrations of benzene in upgradient wells indicate that benzene concentrations are likely to remain below MCLs at the Beaver Pond.

Since 1997, TCE was detected in all four of the wells that were located upgradient of the Beaver Pond (i.e., GW4-A, OU5MW-06, OU5MW-07, and OU5MW-08). Three of these wells have consistently elevated TCE results with fluctuating concentrations (see Table 3-14 and Figure 2-1). Because TCE is present in upgradient sources, contaminant loading at the Beaver Pond may continue; however, concentrations are not increasing dramatically and the Beaver Pond continues to effectively remediate the remaining TCE concentrations. This is evidenced by consistent non-detectable concentrations of contaminants in Beaver Pond effluent samples (see Table 3-13). Recommendations for continued monitoring of upgradient wells are included in Section 4.

3.3 Cleanup Progress

Based on USEPA guidance during development of the ROD (USAF, 1995a), a 30-year planning horizon for the remedy was established, resulting in a target completion date of 2026. The remedy-specific goals provide the guidelines for the system performance evaluations and determination of whether the remedy is allowing progression towards the identified cleanup levels. The status of the remedy specific remediation goals for groundwater and surface water are included in Table 3-15.

The data for this reporting period indicates fluctuating TCE concentrations, which should be closely monitored to ensure early detection in the event of any additional contaminant loading. Based on the analytical data presented in Section 3.2, natural attenuation continues to be successful through the WRS and Beaver Pond systems. However, TCE concentrations in influent waters of the Beaver Pond, Seeps 9, 10, and 11, Seeps 17 and 18 (direct influent to Wetland Cell), and upgradient monitoring wells remain elevated and decreasing trends are not definitively apparent. In addition, Seep 17 has shown a recent elevated TCE result.

The influent seeps to the WRS (i.e., at Seeps 1 through 4) are trending towards achieving cleanup levels ahead of the completion date of 2026. The exception to this is elevated benzene, TAH, and TAqH concentrations at Seep 2, and an occasional spike of toluene at Seep 4. Cleanup levels have been met at Seeps 1, and 3 for benzene, TCE, TAH, and TAqH. At Seep 2, TCE concentrations are below the cleanup level; however, benzene, TAH and TAqH levels are still above the regulatory levels and fluctuating. Although an overall decreasing trend is evident for TAH and TAqH, highly fluctuating concentrations of TAH, TAqH, and benzene indicate that these trends need to be closely monitored to ensure that a clear decreasing trend is attained and cleanup levels will be achieved prior to 2026.

Table 3-15 Current Status of Remedy-Specific Remediation Goals for OU 5

Remediation Goal	On Track for 2026?	Status Description
Meet the benzene cleanup level of 5 µg/L at the effluent of both the WRS and Beaver Pond wetland area, and at Ship Creek.	Yes	The effluent the WRS and the Beaver Pond (both upgradient of Ship Creek) have consistently been below the benzene cleanup level.
Meet the TCE cleanup level of 5 µg/L at the effluent of both the WRS and Beaver Pond wetland area, and at Ship Creek.	Yes	The effluent the WRS and the Beaver Pond (both upgradient of Ship Creek) have consistently been below the TCE cleanup level.
Achieve decreasing trends for all OU 5 remedy applicable COCs (i.e., benzene, TCE, TAH, and TAqH) at upgradient monitoring well locations.	Questionable	Benzene, TAH, and TAqH appear to be consistently low or decreasing in the wells. However, TCE fluctuates at elevated concentrations, and a decreasing trend is not yet apparent.
Achieve decreasing trends for the influent locations of the WRS and Beaver Pond wetland area for remedy applicable COCs (i.e., benzene, TCE, TAH, and TAqH).	No	Consistently ND results for both TCE and benzene at influent to wetland cell; however, Seep 2 has evidence of fuel contamination. TAH and TAqH trends at Seep 2 appear to be decreasing. Benzene at Seep 2 continues to fluctuate at elevated concentrations. Additionally, a spike of toluene (50 µg/L) was detected at Seep 4 in August 2003. Slight increasing TCE trend evident at the influent of the Beaver Pond.
Meet the MCL of 5 µg/L for benzene throughout OU 5, including the influent seep areas of the WRS and Beaver Pond wetland area.	Questionable	Benzene levels throughout OU 5 are generally below the MCL, with the exception of Seep 2. Benzene at Seep 2 has a fluctuating trend at concentrations above the MCL.
Meet the MCL of 5 µg/L for TCE throughout OU 5, including the influent seep areas of the WRS and Beaver Pond wetland area.	No	Several upgradient wells, Seeps 9 through 11 and 17, and influent water at the Beaver Pond have had elevated TCE concentrations and a decreasing trend is not yet apparent.
Meet the TAH requirement of 10 µg/L throughout OU 5, including the influent seep areas of the WRS and Beaver Pond wetland area.	Questionable	TAH concentrations throughout OU 5 are generally below the MCL, with the exception of fluctuating elevated concentrations at Seep 2 and one hit at Seep 15. Additionally, a spike of toluene (50 µg/L) was detected at Seep 4 in August 2003. However, the overall trend for TAH appears to be decreasing.
Meet the TAqH requirement of 15 µg/L throughout OU 5, including the influent seep areas of the WRS and Beaver Pond wetland area.	Questionable	TAqH concentrations throughout OU 5, are generally below the MCL, with the exception of consistently elevated concentrations at Seep 2. Additionally, a spike of toluene (50 µg/L) was detected at Seep 4 in August 2003. However, the overall trend for TAqH appears to be decreasing.

COC – contaminant of concern
MCL – maximum contaminant level
µg/L – microgram per liter
ND – not detected
OU – operable unit
TAH – total aromatic hydrocarbon
TAqH – total aqueous hydrocarbon
TCE - trichloroethene
WRS – Wetland Remediation System

Other identified seeps (i.e., Seeps 7, 9-11, 15, 17, and 18) are trending toward achieving cleanup levels for benzene, TAH, and TAqH before the target date. However, consistently elevated TCE at Seeps 9, 10, and 11 and associated upgradient sources indicate that these areas need to be closely monitored for TCE. Potential contaminant levels at Seeps 9, 10, and 11 will be managed by incorporation into the WRS at point of entry into the Wetland Cell. Seep 17 had a recent (January 2003) elevated TCE result above the cleanup level and also should be closely monitored as this seep flows directly into the Wetland Cell. In addition, Seep 15 should be monitored for these COCs due to a historical TAH result above the MCL.

At Seep 4, cleanup levels have been met for benzene, TCE, TAH, and TAqH; however, toluene concentrations are occasionally a concern. In 1999 one exceedance was noted for TAH and TAqH; however, this exceedance may be associated with a questionable laboratory detection for toluene. Again in August 2003, high concentration of toluene resulted in an exceedance for TAH and TAqH. Based on upgradient monitoring well data, Pump Station 3, which collects influent water from Seep 4, may be considered for shut down and winterization. Seep 4 will be sampled quarterly in 2004. If the concentrations of contaminants are below regulatory requirements following the 2004 rounds of sampling, Pump Station 3 will be evaluated for mothballing using the decision guide presented in Section 5 (Figure 5-1).

Data collected from the effluent of the WRS and Beaver Pond indicates that the remedy selected for the OU 5 area is allowing attenuation and biodegradation of contaminants such that cleanup levels at the compliance point (Ship Creek) are being achieved. In addition, it appears that cleanup goals at Seeps 1 and 3 are being achieved. However, Seep 2 continues to show fuel contamination (i.e., benzene, TAH, and TAqH above MCLs) and upgradient sources (i.e., wells, Beaver Pond influent, and seeps) indicate that TCE sources continue to fluctuate at concentrations significantly above the ROD-specified cleanup level and it is not yet clear that these cleanup goals will be achieved by 2026.

Analytical results indicate that TCE exceeds cleanup levels at Seeps 9, 10, and 11 located east of the Wetland Cell. These data indicate the need for TCE monitoring at upgradient monitoring wells and incorporating the identified seep water into the WRS. Drawings and cost estimates for the incorporation of these three new seeps into the Wetland Cell were submitted in December 2003 and reviewed at a meeting with AFCEE and Elmendorf AFB representatives. Specifications were submitted in late December 2003.

Analytical results indicate lower concentrations of TCE were evident at Seeps 7, 17, and 18; additionally, Seep 17 has previously exceeded the 5 µg/L cleanup level. Partial flows from Seeps 17 and 18 are currently collected by the Wetland Cell. These data indicate the need for TCE monitoring at upgradient monitoring wells. In addition, monitoring should be continued at Seep 15 where sampling resulted in detectable levels of benzene. Recommendations are presented in Section 4.

3.4 System Operational Performance Review

A review of overall system performance indicates that the system is effectively treating contaminant loads and meets the average five-day retention time requirements for treatment. A summary of performance data including wetland cell volumes, flow rates, and retention times is included in Appendix C. As documented in previous reports, the majority of the contaminant reduction occurs between the seeps and their associated pump stations through processes of natural attenuation including biodegradation and volatilization.

Weekly system checks were performed to monitor the seep collection and pumping systems, the condition of the overland flow and wetland cells, and general site condition. Only limited data is available regarding the volume of water treated by the individual pump stations because flow meters at all three pump stations have not been operational. Therefore, only system flow data pertaining to the Wetland Cell is presented.

During the Round 3 and 4 of sampling (November 2003 and January 2004), sampling could not be performed at Seeps 1 and 2, as these sampling ports were frozen. The inability to sample is not believed to be a problem that had occurred during previous winters. Options to mitigate this problem are discussed in Section 4, Recommendations. Weekly inspections of these frozen seeps continued; the seeps temporarily thawed in February 2004 and sampling took place at that time.

Maintenance was performed based on conditions identified during weekly inspections and included both routine and non-routine (critical) maintenance. Table 3-16 presents a summary of maintenance tasks performed during the 2003-2004 O&M period. The following subsections present further details of tasks summarized in Table 3-16.

Table 3-16 Operation Maintenance Summary

Date	Comments
Routine Maintenance	
Date	**Comments**
7/22/03	Iron oxide removed from inlet distribution trough of Overland Flow Cell.
9/3/03	Water diverted from lift stations to allow replacement of gravel in Wetland Cell.
9/5/03	Flow in Wetland Cell returned to normal.
10/30/03	Iron oxide removed from inlet distribution trough of Overland Flow Cell.
10/30/03 to 11/3/03	Winterization of Overland Flow Cell including application of a gate sealant.
2/2/04 to 2/9/04	Pumps from Pump Station 3 were pulled from sump and replaced with spare pump for storage shed. Pumps were delivered to Alaska Pump Supply for rebuilding, which included new bearings, mechanical seals, gaskets, oil, and painting. One rebuilt pump was reinstalled into Pump Station 3 and the other rebuilt was put into storage shed.
Non-routine Maintenance	
Date	**Comments**
Beavers in Wetland Cell	
6/13/03	Debris blocking discharge weir in Wetland Cell was removed.
6/14/03	Debris blocking discharge weir in Wetland Cell was removed, informed Elmendorf Base Wildlife of beavers presence.
6/20/03	Male beaver captured in Wetland Cell.
7/2/03	Lowest retention time due to blockage of discharge weir, wetland cell lowered to accommodate.
7/9/03	Debris blocking discharge weir in Wetland Cell was removed, informed Elmendorf Base Wildlife of beavers presence.
7/15/03	Female beaver captured in Wetland Cell.
9/29/03	Heavy rains caused slight blockage of discharge weir.
VFD	
7/2/03	VFD 2 at Pump Station 1 experienced failure and went offline.
7/3/03	VFD 2 at Pump Station 2 reprogrammed, returned system to online.
12/22/03	VFD system failure in Pump Station 2, system rebooted and returned online, temperature sensor not working correctly, new sensor was ordered.
1/23/04	New temperature sensor was installed in Pump Station 2. Sensor waivers up to +15°F when pump runs due to connection sensing electrical “noise” from motor.
Iron Oxide Flushing	
10/23/03	Force main from Pump Station 1 to Overland Flow Cell clogged.
10/24/03	Clogged line was jetted and Pump Station 1 returned online.
Temporary Check Dams	
9/29/03	Installation of temporary check dams at Seeps 9, 10, and 11 began.
10/3/03	Repairs were made to temporary check dams at Seeps 9, 10, and 11 due to heavy rains.
10/6/03	Installation of temporary check dams at Seeps 9, 10 and 11 completed.
10/20/03	Surveyed in the elevations and locations of Seeps 9, 10, and 11; the valve pit; and the nearby stream.
11/7/03	Disassembly of temporary check dams at Seeps 9, 10, and 11 completed.
Pump Maintenance	
11/11/03	Pump seal failure at Pump Station 1. Replaced broken pump with spare pump.
12/5/03	Pump repaired by Alaska Pump Supply with new mechanical seals, gaskets, and oil, was picked up and set aside as the spare pump in the storage shed.

3.4.1 Routine Maintenance

Routine system maintenance was performed as identified required during weekly system checks. Routine maintenance included removal of iron oxide precipitate from the inlet distribution of the Overland Flow Cell and winterization of the cell, and periodic pump maintenance.

As part of the normal system maintenance, the iron oxide precipitate was removed from the inlet distribution trough at the Overland Flow Cell on 22 July 2003.

The gravel in the body of the overland flow cell causes the water flowing through it to become oxygenated by splashing and bubbling through it. Over time, this gravel had become partly clogged with silt and iron oxide precipitate and plants were growing in the silt and iron oxide. On 3 September 2003, water was diverted from the Lift Stations to bypass the Overland Flow Cell and set to flow directly into the Wetland Cell. Gravel was removed from three aeration cells by a vacuum truck. This material was analyzed, found to be non-hazardous, and disposed of as fill at Landfill LF05. The non-woven filter fabric and impermeable liner located directly underneath this area were found to be in excellent shape and did not require any repairs. After replacing the gravel in these aeration cells the vacuum truck removed iron oxide precipitate from the inlet distribution trough and moss from the outlet trough. Water flow was returned to normal on 6 September 2003. The following week, ruts in the road created by the vacuum trucks were filled in and leveled and these areas were seeded with grass.

On October 30th the flow from the Lift Station to the Overland Flow Cells was short-circuited and the accumulated iron oxide was pumped out. At this time, the inlet trough into the Overland Flow Cells was winterized by lowering and sealing two gates that restrict the water flow to the center cell. The first attempt to install the gates was unsuccessful and on Friday, 31 October 2003, a sealant was applied and allowed to cure over the weekend. On the morning of November 3rd, inflow was restored and the gate seals held.

Both 7.5 HP pumps in Lift Station 3 were removed from service for scheduled maintenance and replaced with the single spare 7.5 HP pump the week of 2 February 2004. Both pumps were operational when they were turned in for major triennial maintenance. During this maintenance, both pumps received new bearings, mechanical seals, gaskets, and oil. One of the rebuilt pumps was reinstalled as the second pump in Lift Station 3 and the other was placed in storage as the spare pump.

3.4.2 Non-Routine Maintenance

Several maintenance issues arose during the 2003-2004 O&M period for the WRS system. These included addressing beaver intrusion into the Wetland Cell, variable frequency drive performance, line jetting, and pump station maintenance.

<u>Beavers in Wetland Cell</u>

The minimum design-required retention time is 5 days. The actual retention time was less than the goal of 5 days on July 2nd, due to issues associated with beaver occupancy of the Wetland Cell. During this period, beavers had dammed the outlet structure and water had backed up in the Wetland Cell. At this time the Wetland Cell was lowered to avoid a potential overflow of the berms.

Looking from the fence south of the overland flow cell on 13 June 2003, the water level in the wetland cell appeared to be high. The V-notch discharge weir from the Wetland Cell was almost completely blocked by naturally occurring debris from reeds and willows that had become packed with silt and decaying material from the bottom of the Wetland Cell (Figure 3-9). At that time, a small stream of clear water (no silt or sediment visible in it) was flowing over the soil and grass on the west side of the concrete outlet structure. The debris was removed from the V-notch weir, and the top of the opening of the weir was raised to the water surface level to give the maximum opening for the trapped water to flow through. The culvert under the railroad tracks which transports the discharge from the Wetland Cell was observed to ensure that the water from the Wetland Cell did not back up above the top of its headwall.

Figure 3-9 Beaver Dam at V-Notch Weir

The water surface was above the highest reading on the scale located on the east side of the concrete outlet structure. Measuring from the top of the water to the top of the scale on the east side of the outlet structure showed the water surface elevation to be approximately 94.98 feet. The outside berm of the Wetland Cell was inspected to determine if the high water in the Wetland Cell was flowing over the top of the outside berm. Only one additional water overflow area was discovered. This area was approximately 10 feet west of the west edge of the concrete outlet structure. The water flowing over the top of the berm and through the grass in this area was also clear and free of silt or sediment. Within one hour of the discovery, the water was below the surface of the berm in both locations that had been overtopped. No erosion or damage to the soil from the overflow was noted in either location. Both locations are within 10 feet of the outlet structure. Thus, the water flowing over the berm had been retained in the Wetland Cell, permitting treatment of dissolved contaminants and minimizing the risk that contaminated water was released.

On the afternoon of June 13th, personnel removed all of the reed debris and silt from the vicinity of the Wetland Cell to minimize the chances of this happening again. The water level continued to drop and the outflow was matched again to the inflow rate. When the Wetland Cell was checked on June 14th, the V-notch weir was again blocked with willow cuttings, reeds, and silts. Upon closer examination, the bottoms of the willow cuttings appeared to have been chewed through. The rapid recreation of the blockage and the teeth marks lead to the conclusion that a beaver had moved into the wetland cell, determined that the V-notch weir was allowing the water to escape, and was doing all it its power to block the release of water.

Elmendorf AFB Wildlife was notified and they coordinated with a licensed trapper to remove the beaver. The trapper noted that there were two beavers, apparently a mated pair, in the Wetland Cell. These two had built a lodge in the Wetland Cell. A male beaver was captured during the evening of June 20th. The blocking of the V-notch weir stopped after this beaver was caught and the problem has since abated.

However, on July 9th a beaver once again blocked the V-notch weir. Base wildlife was once again notified. During the night of July 15th this second beaver was captured. This beaver was a female and appeared to be the mate from the first beaver. The trapper theorized that the female left the Wetland Cell after the mate was captured, but then returned and went back to work. There have been no recurrences of blockage of the V-notch weir since July 15th.

After the removal of a female beaver on July 15th the reoccurrence of blockage of the V-notch weir has lessened. A period of heavy rains lasted for several days prior to September 29th. At that time, an inspection of the weir found six to eight chewed off willow saplings lodged in the V-notch by the outer weir. A closer examination showed that with such few saplings present and no signs of sticks being used to construct a dam to block the outer structure, it was unlikely the work of a beaver. A call was made to request that Elmendorf AFB Wildlife personnel check to see if a beaver, muskrat, or other animals was taking up residence in the area as this could potentially damage the surrounding berms. Following this blockage, no other detrimental animal activity has been observed.

Variable Frequency Drives

Two pumps are located at each pump station and, in general, the existing pumps are keeping up with present flows. Variable frequency drive number two (VFD 2) at Pump Station 1 became inoperable on July 2nd. An electrician from Control Kraft was called to the site and reprogrammed this VFD. VFD 2 was brought back online on July 3rd. Because there are two VFDs and two pumps in each lift station, no problems with pumping the water from Seeps 1 and 2 to the Overland Flow Cell were observed.

The variable frequency drive system in Lift Station 2 malfunctioned on December 22nd and after being rebooted the fault disappeared and the system began to operate normally. Also, a temperature sensor became problematic and was no longer sending signal to its programmable logic controller. It did not affect the ability of the lift station's heater to maintain temperature because an internal thermostat operates the heater. A new sensor was ordered and will be installed upon its arrival.

Iron Precipitate Flushing

Periodic flushing of iron precipitates from the lines has alleviated some of the problems associated with the reduced capacity of the piping system. Back pressure has been reduced overall; however, concern still exists over a section of piping, located between Pump Stations 1 and 2 where the length of line is greater than that which can be reached by jet flushing operations. The jet flushing activities that have been conducted are successful in removing buildup in the lines for a distance of about 400 feet. However, the line between the two pump stations is approximately 1,700 feet long. Installing cleanouts at regular intervals along the length of this pipeline would provide a means to clear the entire line and minimize flow backup. It is recommended that cleanouts be installed along the line at 200-foot intervals (i.e., eight cleanouts) to ensure the precipitate can be removed (see Section 4).

On 23 October 2003, the force main from Pump Station 1 to the Overland Flow Cell became clogged and the two pumps in the lift station at Seeps 1 and 2 were unable to keep up with the water flow. Water accumulated in the pump station and penetrated one pump's external seal. After shutting off the inlet valve into the pump station and pumping out the lift station into the seep collection area no visible obstruction could be seen. A jetting service was brought in on October24th and the first 400 feet of this force main was flushed out. A clog composted of iron oxide was released and water began to flow into the Overland Flow Cell. As one pump was damaged, a single pump was put into operation and within two days had removed all the stored water from the seep collection area and the water level was dropped to approximately three feet deep in the pump station. The single pump did not have any problems keeping up the inflow. After the water in the well was pumped down, approximately six inches of iron oxide was removed from the bottom of the lift station. The damaged pump was taken to Alaska Pump Supply and after being repaired was installed back into Lift Station 1 on November 10th. At this time the heaters and control station at each lift station and control stations by the Overland Flow Cell were checked and found operational.

Temporary Check Dams

During September 2003, temporary check-dams were installed at Seeps 9, 10, and 11 to better estimate flows from these seeps. After several days of heavy rain, check-dams at Seeps 10 and 11 required repair. In October 2003, the elevations and locations of these three seeps, the valve pit, and the nearby stream were surveyed to provide information required to design a system to convey the seep water to the Wetland Cell. Routine monitoring of these flows across the check-dams continued until mid-November when the check-dams were removed.

4.0 COST EVALUATION

4.1 Summary of Annual O&M Costs

The base annual O&M costs include planning and management, general system maintenance, monitoring, and reporting. Associated O&M costs for the remedy (including monitoring and maintenance of the WRS and monitoring of the Beaver Pond wetland area) are presented in Table 4-1. Costs are presented for O&M periods from 2001 through 2004 for comparison purposes, and for predicted expenditures for the 2004-2005 O&M period.

Table 4-1 Annual O&M Costs, OU 5 Wetlands

Task Number	Task	Description	Expenditures ($) 01-02 O&M[a]	Expenditures ($) 02-03 O&M[b,e]	Expenditures ($) 03-04 O&M[c]	Predicted Expenditures ($) 04-05 O&M[d]
1	Planning	Efforts associated with O&M work plan preparation	12,724	17,334	27,400	32,516
2	Fieldwork	Operation and maintenance of the WRS as outlined in the O&M Manual, and sampling labor	79,538	71,000	70,982	73,500
3	Periodic Maintenance	Remove and replace gravel in Overland Flow Cell	-	-	16,800	-
4	Environmental Modifications	Design and field modifications for incorporation of Seeps 9, 10, and 11 into the WRS	-	-	28,500	130,000
5	ARRC Evaluation	Review and coordination support to the Air Force for the proposed ARRC rail realignment project	-	-	33,276	64,008
6	Reporting	Report preparation, including evaluation of monitoring data, and report distribution	43,000	52,000[d]	36,920	57,958[f]
7	Chemistry/ Data	Laboratory analysis of environmental samples, coordination with laboratory, providing quality assurance and quality control for data collection and analysis, and data compilation	56,760	32,000	32,500	36,228
8	Management	Project management and general coordination/ oversight	16,963	30,745	40,152	42,954
Total:			**$208,985**	**$203,079**	**$286,530**	**$437,164**

[a] Presented expenditures are representative of the O&M, performed by URS Corporation for July 2001 through March 2002.
[b] Presented expenditures are representative of O&M, performed by URS Corporation beginning April 2002 and projected through March 2003; URS performed system O&M through May 2003.
[c] Presented expenditures are representative of O&M, performed by Weston Solutions, Inc. beginning June 2003 and projected through March 2004.
[d] Estimated/planned expenditures are representative of estimated future O&M, for April 2004 through March 2005.
[e] The O&M 2002-2003 cost estimate includes Annual Technical Report, Quarterly Summary Reports (electronic), and Five-Year Review report.
[f] In addition to the annual O&M report, costs include a Final System Modification, Record of Decision technical memorandum for the addition of Seeps 9, 10, and 11, and an O&M Manual update for adding Seeps 9, 10, and 11.
ARRC – Alaska Railroad Corporation
O&M – operation and maintenance

4.1.1 Explanation of Cost Increases/Decreases

Additional cost expenditures are due to the need to incorporate additional seeps into the WRS, based on the Decision Guide for Increased Remedial Activity (Section 5, Figure 5-2), and additional coordination required for the proposed ARRC rail realignment project.

Figure 5-1 contains a Decision Guide for Reduced Remedial Activity, which includes shutting down pump stations. As discussed in Section 3.3, Seep 4 will be evaluated during the 2004-2005 O&M period to determine if it can be shut down and winterized.

Costs increased for 2004-2005 O&M period are associated with system modification and program management (O&M Manual update/ROD).

Costs associated with routine system maintenance are currently being evaluated for optimization and cost reduction. However, the need for additional seep monitoring outside the WRS has created cost increases. Table 4-2 presents items for which cost increases and/or decreases are known for the upcoming year.

Table 4-2 O&M Cost Increases or Decreases, OU 5 Wetlands

Task Group	Item Description	Status (Approximate Cost)
Environmental Modifications	Seeps 9, 10, and 11 will be routed to the Wetland Cell. A final system modification report will be required.	Increase: 04-05 ($130,000)
ARRC Evaluation	Design review and coordination support to the Air Force for the proposed ARRC rail realignment project will be required to assess impacts to the OU5 Wetland Program.	Increase: 04-05 ($64,008)
Reporting	The OU5 O&M manual requires updating; as no functioning electronic version exists, additional effort will be required.	Increase: 04-05 ($15,000)
Reporting	A technical memorandum will be generated modifying the ROD.	Increase: 04-05 ($3,000)
Chemistry/Data	Water sampling at the Beaver Pond was conducted twice during 2002–2003 O&M Period. The frequency will increase to quarterly during the 2003–2004 O&M Period to comply with the ROD.	Increase ($4,000)
Chemistry/Data	Water sampling during the 2003–2004 O&M Period will include quarterly sampling of seeps that exceeded cleanup goals during the previous period (one additional round of sampling). This includes quarterly sampling for Seeps 9, 10, and 11.	Increase ($3,000)
Chemistry/Data	Water sampling during the 2003–2004 O&M Period will include sampling of all seeps exiting the bluff at least once. Seeps not already sampled during the quarterly sampling effort include Seeps 7, 15, 17, and 18.	Increase ($2,000)

Note: Cost increase/decreases are referenced per O&M period.

4.2 Summary of Predicted Annual Program Cost for 2003 through 2010

Cost increases associated with non-standard maintenance/system optimization work that may be required to ensure compliance and system protectiveness in the future are presented in Section 5. Table 4-3 presents a summary of estimated annual costs for O&M from 2004 through

2011 developed by adding the base 2004-2005 O&M costs presented in Section 4.1 to the non-standard recommendations presented in Section 5.

Table 4-3 Predicted Total Annual Costs (ROM) for 2004 through 2011
OU 5 Wetlands

Item	04-05	05-06	06-07	07-08	08-09	09-10	10-11
Annual O&M[a]	$228,156	$228,156	$228,156	$228,156	$228,156	$228,156	$228,156
Environmental Modifications	$130,000	--	--	--	--	--	--
ARRC Evaluation	$64,008	--	--	--	--	--	--
Install Cleanouts	--	$20,000	--	--	--	--	--
O&M Manual Update	$15,000	--	--	--	--	--	$7,500
Five-Year Review	--	--	--	$8,000	--	--	--
Wash/Replace Gravel at OFC	--	--	$16,800	--	--	$16,800	--
Place gravel at seeps	--	$8,000[b]	--	--	$8,000	--	--
Totals:							
Present value (2003 dollars):	$437,164	$256,156	$244,956	$236,156	$236,156	$244,956	$243,156
Future worth (5% interest):	**$437,164**	**$268,964**	**$270,064**	**$273,380**	**$287,049**	**$312,633**	**$315,801**

Note: Installation of potential monitoring wells required for upgradient monitoring covered under the Basewide Environmental Monitoring Program.
Predicted costs are per O&M period.

[a]Annual O&M is the base cost presented in Table 4-1 for 2004-2005 O&M expenditures.
[b]Obtain funding and/or gravel in 2005 and 2008 for future use at seep areas as needed.
OFC – Overland Flow Cell
ROM – Rough Order-of-Magnitude
WRS – Wetland Remediation System

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5.0 RECOMMENDATIONS

This section presents system operation, monitoring, and optimization recommendations based on the review presented in Section 3.

5.1 Recommendations and Cost Avoidance Opportunities

Potential cost avoidance opportunities, additional recommendations to further optimize operation and protectiveness, and upcoming high-cost maintenance tasks are presented and prioritized in Table 5-1. Also included are recommendations and cost avoidance opportunities pending from the initial 2001 recommendations, and modifications implemented during the 2003-2004 O&M period.

Several of the 2001 O&M modification recommendations were implemented during the 2002-2003 O&M period, and a status update of these recommendations were presented in the 2002 annual report (USAF, 2003a, Table 4-1). Appendix D provides a red-line/strike out version of this table indicating status of the proposed recommendations as of February 2004. Recommendations that are still pending implementation are further discussed in Section 5.2.

Based on the results of the optimization task evaluations, system O&M, and evaluation of chemical data, additional activities have been identified that may assist with remedy optimization, sustainability, and ultimately reduce system cost. The following recommendations for optimization of the WRS are based on recorded observations during the June 2003 through August 2003 period:

- **Piping between Pump Stations 1 and 2:** It is recommended that the piping within Pump Station 1 and pipe runs toward Pump Station 2 are jet-flushed three to four times annually to remove iron precipitate sludge within the transport piping. This will not only ensure optimal flow rates, but should also increase the lifespan of the pumps. In addition to the above, the installation of cleanouts along the pipe run from Pump Station 1 to Pump Station 2 to further optimize system performance should also be considered.
- **Flow Meters:** As of mid-February, none of the flow meters in the lift stations were functioning. The iron oxide precipitate that forms naturally when the anoxic seep water adsorbs oxygen and the dissolved ferrous oxide changes to insoluble ferric oxide has a debilitating effect on the flow meters. The contractor that jetted the lines from Lift Station 1 recommended replacing the 1½-inch lines that currently house the flow meters and replace them with 2-inch lines. This larger line size would match the minimum pipe size elsewhere in the system. A 2-inch line should be fitted with matching flow meters and installed at these locations. This should allow the iron oxide precipitate to pass through without fouling the pipes. One of the flow meters was replaced in March 2004 for evaluation.
- **Beaver Impacts:** Ongoing observation of the Wetland Cell should continue to minimize damage to the Wetland Cell should any more beavers take residence and

block the flow of water through the V-notch weir. The Wetland Cell will be monitored as part of the weekly WRS inspection process.

Based on the recommendations provided in this report, Table 5-2 summarizes the suggested monitoring frequency at the WRS sampling locations for the 2004-2005 O&M period.

Table 5-1 OU5 Wetland Program System Optimization Recommendations

Recommendation	Purpose and (or) Justification	Timeline	ROM Cost Increase	ROM Cost Decrease	Status
Cost Avoidance Opportunities					
Remove sediment sampling from monitoring program	Annual sediment sampling was originally intended to confirm contaminated sediment removal. Sediment sampling has consistently shown COCs are below cleanup levels.	2004-2005 O&M Period	-	$2,000 per year	Pending regulatory approval—currently a recommendation in the Five-Year Review
Shut down and winterize Seep 4/ Pump Station 3.	Based on analytical data trends, Seep 4/Pump Station 3 could be shut down and winterized in 1 to 2 years.	2003–2004 O&M Period	-	-	Revoked. This is no longer recommended due to identification of DRO contaminated groundwater and soils upgradient of Seep 4, and toluene spike in August 2003.
Shut down and winterize Seep 3/ Pump Station 2.	Based on analytical data trends and the draft decision tree developed with regulatory approval, Seep 3/Pump Station 2 could potentially be shut down and winterized in 2 to 4 years.	2005–2007 O&M Period	-	$6,000 (annual labor, analytical, & O&M)	Pending. At least one more year of favorable analytical seep data (i.e., below cleanup levels) is needed. Also need to evaluate potential impacts of ARRC rail re-alignment plans.
Additional Recommendations					
Sample Seep 4 during timeframe when analytical spike for toluene has been identified.	Two historical hits of toluene have been identified as Seep 4; one in October 1999 (noted as questionable) and one in August 2003.	2004-2005 O&M Period	$1,000 (analysis, labor)	-	Planned for 2004. Perform additional sampling during August, September, and October 2004 to determine if potential seasonal relationship exists.
Incorporate Seeps 9, 10, and 11 into the WRS system for treatment.	Samples from Seeps 9, 10, and 11 have consistently shown TCE levels above the cleanup goal. To ensure protectiveness, funding for construction of a collection system for these seeps has been programmed for 2004.	2004	$100,000	-	Scheduled for 2004.

Table 5-1 OU5 Wetland Program System Optimization Recommendations *(continued)*

Recommendation	Purpose and (or) Justification	Timeline	ROM Cost Increase	ROM Cost Decrease	Status
Additional Recommendations					
Determine the TCE degradation rate in Wetland Cell, and capabilities for additional contaminate loading. Specific recommendations to determine this rate are given in the three bulleted recommendations below.	The ARRC's expansion project may uncover new seeps contaminated with TCE which may be added to the system. Knowing the degradation rate for TCE in the wetland cell will allow a more accurate estimate of the amount of TCE from new areas that can be added to the treatment system and still meet the ROD's requirements.	see below	see below	see below	see below (next 3 lines)
Continue quarterly monitoring of other Seeps 9, 10, and 11 containing concentrations of COCs above the cleanup goal.	Quarterly monitoring should be conducted at seeps that have exceeded maximum contaminant limits to further evaluate if protectiveness of the remedy is being met.	2002 – 2005 O&M Period	$4,000	-	<u>Ongoing.</u> Sampling rounds between Oct 2001 and Jan 2004 have documented that TCE at Seeps 9, 10, and 11 is consistently at levels above the cleanup goal. These seeps are schedule to be routed to the WRS Wetland Cell during 2004. Quarterly monitoring is recommended to continue.
Install and monitor flow meter at proposed culvert transporting flows from Seeps 9, 10, and 11. Sample water discharging from culvert quarterly for TCE.	Seeps 9, 10, and 11 will be routed directly into the Wetland Cell. Concentrations of TCE entering the Wetland Cell together with their flow rates will be needed for a mass balance equation. Concentrations may vary between seeps and Wetland Cell due to blending of seep waters and induced aeration.	2004-2005 O&M Period	$4,000	-	<u>Scheduled for 2004.</u>

Table 5-1 OU5 Wetland Program System Optimization Recommendations *(continued)*

Recommendation	Purpose and (or) Justification	Timeline	ROM Cost Increase	ROM Cost Decrease	Status
Additional Recommendations					
Continue quarterly monitoring of Seeps 17, and 18 containing concentrations of TCE near or above the cleanup goal.	Seeps 17 and 18 flow directly into the wetland cell. They have low levels of TCE and these concentrations will be used as part of the mass balance equation to determine the degradation rate of TCE in the wetland cell.	2002–2005 O&M Period	$4,000	-	<u>Ongoing.</u> Seeps 17 and 18 drain directly into the Wetland Cell. Low levels of TCE were identified in both of these seeps and in January 2003, the sample from Seep 17 exceeded TCE cleanup levels. The Wetland Cell effluent continues to remain below cleanup levels.
Continue annual monitoring of additional identified seeps (including seeps 7 and 15)	Quarterly monitoring should be conducted at other seeps that have exceeded maximum contaminant limits to further evaluate if protectiveness of the remedy is being met.	2002–2005 O&M Period	$3,000	-	Seep 15 should continue to be monitored due to elevated TAH levels identified in 2002. All seeps not captured by the WRS will be sampled at least annually.
Continue semi-annual monitoring of Beaver Pond surface water sample locations containing concentrations of COCs above the cleanup goal.	Semi-Annual monitoring should continue to ensure protectiveness of outflows to Ship Creek.	Ongoing	-	-	<u>Ongoing.</u> TCE is present above cleanup criteria at beaver pond sample locations BPSW04 and BPSW05. BPSW04 in particular has shown increasing TCE concentrations and should be monitored further to evaluate this trend. However, the beaver pond effluent sample location, BPSW01, has consistently shown TCE contamination levels beneath regulatory criteria.

Table 5-1 OU5 Wetland Program System Optimization Recommendations *(continued)*

Recommendation	Purpose and (or) Justification	Timeline	ROM Cost Increase	ROM Cost Decrease	Status
Additional Recommendations					
Integrate the Basewide Environmental Monitoring Program into the OU 5 wetland monitoring program and utilize its results for prediction of contaminant loading at the OU 5 WRS and Beaver Pond. Specific recommendations are given in the three bulleted recommendations below.	Upgradient groundwater information obtained through the Basewide Environmental Monitoring Program can be used as an early warning system to predict contaminant loading at the OU 5 WRS and Beaver Pond.	see below	see below	see below	see below (next 3 rows)
Install wells to evaluate the Slammer Ave. TCE plume.	Increasing TCE concentrations in the influent to the Beaver Pond (BPSW04) may be indicating that the Slammer Ave. TCE plume is moving downgradient.	2004	Part of Basewide Environ. Monitoring Program		Planned for 2004.
Sample existing and install new groundwater wells located upgradient of seeps 9, 10, and 11 identified in 2001 that have concentrations of TCE above cleanup levels.	Groundwater monitoring data may identify upgradient source areas as well as predict future contaminant loading along base of bluff. Some of these groundwater wells are not monitored in the Basewide Environmental Monitoring Program.	2002–2010 O&M Period	Part of Basewide Environ. Monitoring Program	-	Ongoing. New wells were installed and several additional wells have been added to the Basewide program by Kenny Ave. which is upgradient of the Wetland Cell to evaluate the distribution of TCE. The Basewide Groundwater Monitoring program is modeling this TCE plume to predict its effect on Seeps 9, 10, and 11.

Table 5-1 OU5 Wetland Program System Optimization Recommendations *(continued)*

Recommendation	Purpose and (or) Justification	Timeline	ROM Cost Increase	ROM Cost Decrease	Status
Additional Recommendations					
Install additional wells to evaluate any areas upgradient from new seeps where COC concentration is increasing.	Installation of one to two additional wells may be necessary to define the extent of COC contamination and provide upgradient monitoring.	2003–2010 O&M Period	Part of Basewide Environ. Monitoring Program	-	Ongoing. Currently new wells planned upgradient of Beaver Pond. Well installations would be provided for under the Basewide Environmental Monitoring Program
Change valve at head of Overland Flow Cell to direct water from seeps directly to Wetland Cell. Mothball the Overland Flow Cell for possible reactivation if needed in future.	Most of the reduction in BTEX and POL contamination takes place in the seep areas prior to collection. With the addition of Seeps 9-11 directly into the Wetland Cell in 2004, TCE may become the main COC requiring treatment. The OFC oxygenates the seep water before it enters the wetland cell. Oxygenated or aerobic water favors treatment of POL constituents, however, TCE is better treated in an anaerobic environment. Taking the OFC out of the system would produce a more anaerobic environment.	2005	--	$5,600 per year	If new TCE contaminated seeps are added to the WRS as a result of the ARRC's expansion during 2004 the OFC may be left in the system because the OFC can remove some of the TCE by volatilization prior to it entering the wetland cell.
Maintenance Tasks					
Install cleanouts along the pipe run from Pump Station 1 to Pump Station 2.	Current pipe design limits the pipe maintenance options (i.e., full line jetting). System head calculation modifications indicate that fouling in the pipes may be decreasing the effective pipe operating diameter and increasing head loss.	2005–2006 O&M Period	$20,000	-	Installation of cleanouts is recommended to assist with long term maintenance.

Table 5-1 OU5 Wetland Program System Optimization Recommendations *(continued)*

Recommendation	Purpose and (or) Justification	Timeline	ROM Cost Increase	ROM Cost Decrease	Status
Maintenance Tasks					
Clean-out pump stations and conduct a jet-flush of the piping.	Due to the high concentrations of iron in the seep waters, iron precipitate in the pump stations will become a concern over the life-cycle of the WRS.	2002-2010 O&M Period	$4,400 per year	-	Currently 3 to 4 flushings per year at $1,100 per event is sufficient. This may decrease after cleanouts (above) are installed. Preventative jetting should be performed during Spring and Fall of each year.
Evaluate Seeps 1, 2, and 4 for potential freeze protection options.	Sample ports at Seeps 1, 2, and 4 frozen during part of the 2003-2004 winter season, making these seeps inaccessible for quarterly sampling. If conditions re-occur, consider installation of heat trace system.	2004-2005 O&M Period	$8,000	-	Monitor seeps for re-occurring freeze conditions that may impact ability to perform analytical monitoring. Make determinations based on conditions.
Observe Wetland Cell for potential beaver impacts, and evaluate for necessary interventions.	During the 2004 summer season, beavers infiltrated the wetland cell and blocked the flow of water through the v-notch weir.	2004-2005 O&M Period	$0	-	Monitor Wetland Cell frequently for beaver activity and notify Base wildlife if issue identified.
Replace sample location markers with new.	Existing survey lathe markers have become weathered. Replace with new, more permanent markers to ensure consistency of sample location.	2004	$0	-	Planned for 2004.
Jet flush accumulated iron oxide from force mains from lift stations in late winter.	Ensures maximum pipe flow over for water during spring breakup to increase pump life.	Each year	$0	--	Started in March 2004.
Place new gravel at seep collections areas.	Ensure protectiveness of remedy by mitigating potential receptor exposure to contaminated seep water. Monitor for need.	2002–2010 O&M Period	$8,000	-	Contingency for future-as needed at all seeps. Gravel placed at Seep 2 during March 2003. Area should be monitored annually for ponding and potential need for additional gravel.

Table 5-1 OU5 Wetland Program System Optimization Recommendations *(continued)*

Recommendation	Purpose and (or) Justification	Timeline	ROM Cost Increase	ROM Cost Decrease	Status
Maintenance Tasks					
Remove and wash or replace the drain rock located in the Overland Flow Cell.	Build up of organics and iron precipitate will necessitate cleanout every 3 years if the Overland Flow Cell is operated year-round.	2006–2007 O&M Period	$6,000	-	Performed cleanout and replacement of gravel in September 2003. Evaluate possibility of additional gravel placement in lieu of replacement by monitoring oxygen saturation of water at the Overland Flow Cell collection trough.
Evaluate vegetation conditions of Wetland Cell.	Ensure healthy system and stable conditions to continue treatment of influent TCE concentrations.	2004	$1,000	-	Proposed for 2004. Should be added for every third year in future.

ARRC – Alaska Railroad Corporation
COC – contaminant of concern
ROM – Rough Order-of-Magnitude
DRO – diesel range organic
O&M – Operation and Maintenance
OU – operable unit
TAH – total aromatic hydrocarbon
TCE – trichloroethene
WRS – Wetland Remediation System

Table 5-2 Recommended Sampling Locations and Frequency 2004–2005 O&M Period

Task Analysis	Locations	Events	Total No. Field Samples	Field Duplicate	Matrix Spike	Matrix Spike Duplicate	Trip Blank	Total
Seep Water Sampling (Seeps 1, 2, 3, 4, 9, 10, and 11)								
PAH by SW8310	7	4	28	4	2	2	0	36
VOC by SW8260B	7	4*	28*	4	2	2	4	40*
Dissolved Oxygen (field)	7	1	7	1	0	0	0	8
Temperature (field)	7	1	7	1	0	0	0	5
Seep Water Sampling (Seeps 5, 6, 7, 8, 12, 13, 14, and 15)								
PAH by SW8310	8	1	8	1	1	1	0	11
VOC by SW8260B	8	1	8	1	1	1	1	12
Dissolved Oxygen (field)	8	1	8	1	0	0	0	9
Temperature (field)	8	1	8	1	0	0	0	9
Seep Water Sampling (Seeps 17 and 18)								
PAH by SW8310	2	4	8	1	1	1	0	11
VOC by SW8260B	2	4	8	1	1	1	1	12
Dissolved Oxygen (field)	2	1	2	1	0	0	0	3
Temperature (field)	2	1	2	1	0	0	0	3
Surface Water Sampling at Wetland Cell (Influent and Effluent)								
PAH by SW8310	2	4	8	1	1	1	0	11
VOC by SW8260B	2	4	8	1	1	1	1	12
Dissolved Oxygen (field)	2	4	2	1	0	0	0	3
Temperature (field)	2	4	2	1	0	0	0	3
Surface Water Sampling at the Beaver Pond (BPSW01, BPSW03, BPSW04, and BPSW05)								
PAH by SW8310	4	4	16	2	2	2	0	22
VOC by SW8260B	4	4	16	2	2	2	4	26
Dissolved Oxygen (field)	4	4	4	1	0	0	0	5
Temperature (field)	4	4	4	1	0	0	0	5

*Note 1: Recommended sample months include May 2004, July 2004, October 2004, and January 2005; additional sampling planned at Seep 4 in August and September to evaluate for presence of toluene.
Note 2: VOC analysis will include benzene, toluene, ethylbenzene, and xylenes (BTEX), chlorobenzene, and trichloroethene (TCE).
Note 3: Additional samples may be required for equipment blanks if sampling equipment is not disposable (i.e., equipment is re-used). Also, the number of trip blanks will vary depending on the total number of days sampled and number of coolers that contain VOC samples.
PAH – polynuclear aromatic hydrocarbon
VOC – volatile organic compound

5.2 System Modification Decision Guides

Procedures were proposed in the 2001 annual report for removing seeps from the monitoring program and shutting down pump stations after sufficient data demonstrates that contaminant levels are below cleanup levels, attenuation has been successful, and remedial action objectives and protectiveness will continue. The diagram presented in Figure 5-1 represents the current version of the decision guide for removing seeps from the present monitoring program and shut down of pump stations.

In 2001, a recommendation was made to consider shutting down and winterizing Seep 4/Pump Station 3 as a result of consistent non-detect results for TCE and benzene sampling at that location (per Figure 5-1). Recently, a site investigation (USAF/USACE, 2002) was performed at ST401, located upgradient of Seep 4, and determined that DRO contamination is present. The report indicated that Pump Station 3 might currently collect potential DRO contaminated seep water from ST401 and treat it within the WRS. Additionally, random elevated toluene concentrations, as detected in 1999 and 2003, are a concern at Seep 4. To ensure protectiveness, the pump station should continue to operate and collect this water for treatment.

In addition, because seeps containing elevated TCE levels were identified in 2001 (i.e., identified Seeps 9, 10, and 11), it was recommended that procedures be established for adding seeps to collection areas and/or establishing other mitigation efforts to ensure protectiveness goals specified in the ROD are attained and specific remediation goals can be achieved. The diagram presented in Figure 5-2 represents the current version of this decision guide for increased remedial activity.

Proposed modification to Figure 5-2 is presented as Figure 5-3 to allow a pathway for removal of seeps from the sampling program, and/or to allow for further reduced sampling frequency.

5.3 Other System Impacts

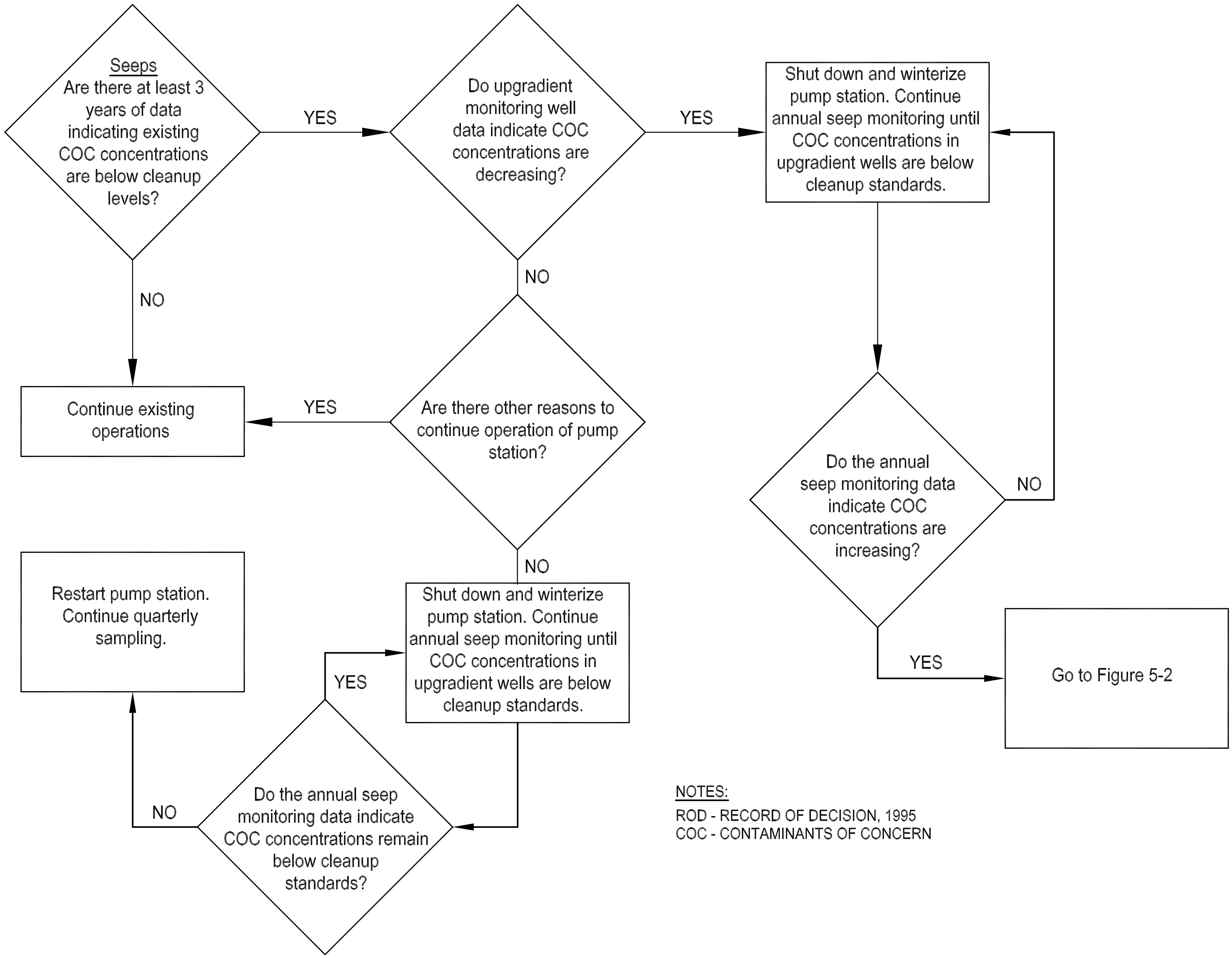
The ARRC proposed rail realignment project may significantly impact WRS. The potential impacts of the project may include, but are not limited to, the following:

- Moving seep collection area boundaries;
- Re-routing piping, electrical, and communication lines; and
- Installation of new seep collection areas.

The ARRC is proposing construction of a new rail line immediately north of the existing lines in their rail yard which is to the south of Pump Stations 1 and 2. This new rail line would be on land on which EAFB has a 30-year easement from the ARRC. This proposed new rail line would potentially impact Seeps 1 and 3 and the insulated and heat traced force main which runs from all three pump stations to the valve box located by the wetland cell.

The 50% design drawings for this proposed new rail line were reviewed and written comments on these drawings were submitted to Elmendorf AFB on 21 July 2003. A meeting was held at ARRC's office in Anchorage on 1 August 2003 to discuss the potential changes and the written comments on these drawings. Minutes from that meeting were submitted to Elmendorf AFB on 5 August 2003. As final design drawings have not yet been prepared, the implications are not fully known, and therefore this report does not include specific recommendations, timelines, or costs for this potential impact.

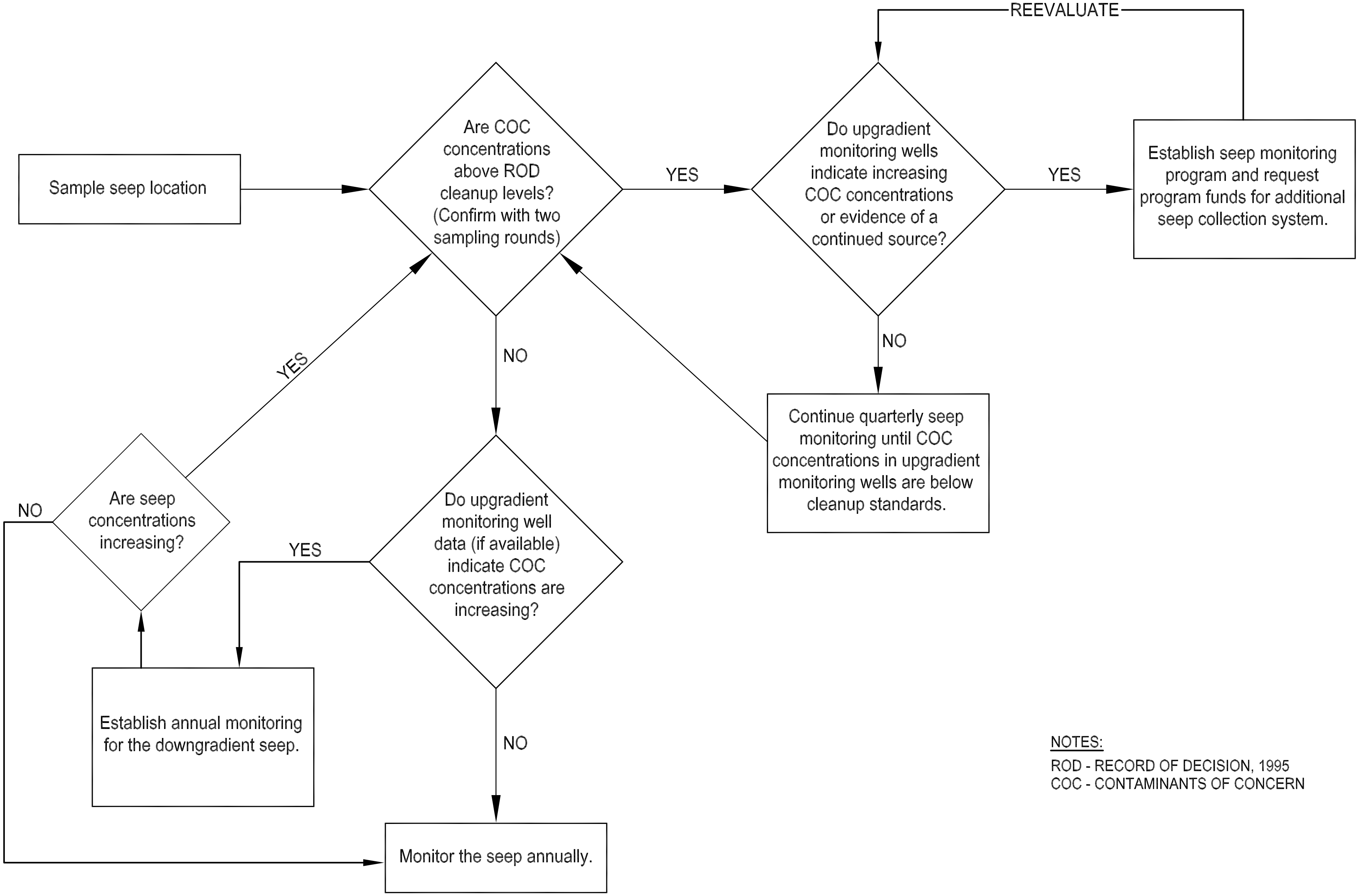
DECISION GUIDE FOR SHUTTING DOWN PUMP STATIONS



NOTES:
ROD - RECORD OF DECISION, 1995
COC - CONTAMINANTS OF CONCERN

WESTON SOLUTIONS	UNITED STATES AIR FORCE **DECISION GUIDE FOR REDUCED REMEDIAL ACTIVITY**	DATE: 13 MAY 2004	
		FILE: Fig 5-1, 5-2.dwg	
JOB NO: 20077.043.001	ELMENDORF AIR FORCE BASE ANCHORAGE, ALASKA	DRAWN: SRJ	**FIGURE 5-1**

DECISION GUIDE FOR RESTARTING AN EXISTING SEEP COLLECTION AREA OR ADDING A NEW SEEP COLLECTION AREA FOR TREATMENT



NOTES:
ROD - RECORD OF DECISION, 1995
COC - CONTAMINANTS OF CONCERN

WESTON SOLUTIONS

JOB NO: 20077.043.001

UNITED STATES AIR FORCE

DECISION GUIDE FOR INCREASED REMEDIAL ACTIVITY

ELMENDORF AIR FORCE BASE
ANCHORAGE, ALASKA

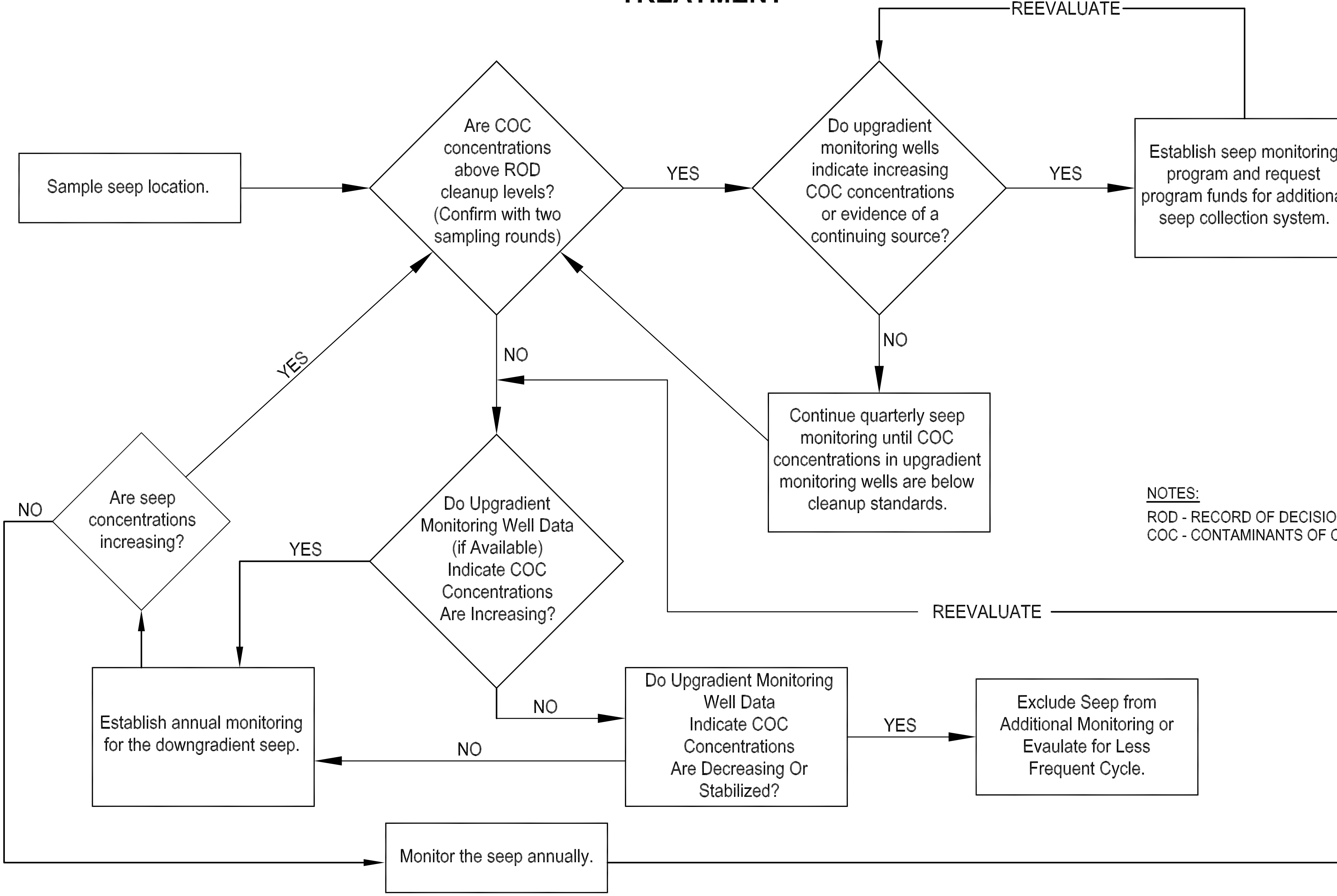
DATE: 13 MAY 2004

FILE: Fig 5-2.dwg

DRAWN: SRJ

FIGURE 5-2

PROPOSED REVISED DECISION GUIDE FOR RESTARTING AN EXISTING SEEP COLLECTION AREA OR ADDING A NEW SEEP COLLECTION AREA FOR TREATMENT



NOTES:
ROD - RECORD OF DECISION, 1995
COC - CONTAMINANTS OF CONCERN

WESTON SOLUTIONS	UNITED STATES AIR FORCE **PROPOSED DECISION GUIDE FOR INCREASED REMEDIAL ACTIVITY**	DATE: 13 MAY 2004	
		FILE: Fig 5-1,5-3.dwg	
JOB NO: 20077.043.001	ELMENDORF AIR FORCE BASE ANCHORAGE, ALASKA	DRAWN: SRJ	**FIGURE 5-3**

5.4 Future Direction of Remedial Process Optimization

Future RPO efforts will include the following:

- Continued integration and information sharing with the Basewide Groundwater Monitoring Program, particularly for development and implementation of the Early Warning System at OU 5. Specifically, monitoring may be modified in response to new information on contaminant plume distribution and migration. Such modifications would ensure further protection of Ship Creek.

- Continued refinement of the decision guides to ensure optimal seep monitoring and collection. Specifically, for the operation of the Wetland Cell, the RPO goals of accelerated site closure and reduction of O&M costs need to be reconciled with "intangible" benefits such as positive public relations both within the military and within surrounding communities.

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APPENDIX A – QA/QC REPORT

Appendix A
QA/QC SUMMARY REPORT

A1. INTRODUCTION

This Quality Assurance/Quality Control (QA/QC) Report summarizes the evaluation of analytical data associated with the collection of surface water, seep water and sediment samples. These data have been reviewed to assess ongoing monitoring and optimization activities of the Operating Unit (OU) 5 engineered wetlands groundwater remediation system located at Elmendorf Air Force Base (AFB), Alaska.

Acceptance criteria for this project are specified in the Air Force Center for Environmental Excellence (AFCEE) Quality Assurance Project Plan (QAPP) Version 3.1 (AFCEE, 2001), the project-specific Quality Assurance Plan, Appendix B Part 2 of the Sampling and Analysis Plan, and variances approved for the project. Overall, the data have met the quality control acceptance criteria specified for this project. Non-conformances of data are identified, discussed, and qualified in this report. Appendix B provides a complete set of laboratory analytical data, stored as digital files in portable document format (PDF), on compact disks.

A1.1 Objectives

This report summarizes the results of the QA/QC data associated with the analysis of surface water, groundwater and soil samples for organic constituents. Any potential bias resulting from the quality issue identified by the data flag is discussed in this QA/QC summary report.

Organic Parameters

- Volatile organic compounds (VOCs) by gas chromatography/mass spectrometry (GC/MS), United States Environmental Protection Agency (USEPA) Method SW8260B.
- VOCs by gas chromatograph/photoionization detection (GC/PID), USEPA Method SW8021B.
- Polynuclear aromatic hydrocarbons (PAHs) by gas chromatography/mass spectrometry (GC/MS), United States Environmental Protection Agency (USEPA) Method SW8270D.
- Gasoline-range organic compounds (GRO) by gas chromatography/flame ionization detection (GC/FID), Alaska Department of Environmental Conservation (ADEC) Method AK101.
- Diesel and Motor Oil range organic compounds (DRO/RRO) by gas chromatography/flame ionization detection (GC/FID), ADEC Method AK102/103.

Three rounds of sampling were conducted - two during 2003 and one during the first quarter of 2004. Samples were collected August 12 – 15, 2003; November 18, 2003; January 20, 2004; and February 12, 2004. Laucks Testing Laboratories, Inc. (LTL) in Seattle, Washington performed all analytical testing.

A summary of surface water samples submitted for analysis is provided in Table A-1. Samples were analyzed in accordance with USEPA *Test Methods for Evaluating Solid Waste,* SW-846, update III, (USEPA, 1996) and/or laboratory standard operating procedures.

Table A-1

Samples Submitted for Analysis 2003-2004

Sample Type	August 2003 *(Round 1)*	October / November 2003 *(Round 2)*	January 2004 *(Round 3a)*	February 2004 *Round (3b)*
Seeps/Surface Water	27	12	12	4
Sediments	9	0	0	0
Equipment Blank	0	0	0	0
Trip Blanks	2	2	3	1

The data qualification guidance in the AFCEE QAPP, Version 3.1 (AFCEE, 2001) was followed when determining data flags for the OU 5 Wetlands samples. Definitions of flags used in this report follow.

A2. DATA QUALIFIERS

The AFCEE QAPP Version 3.1 (2001) generally was followed when determining data qualifiers for the Basewide Program samples. Data qualifiers (flags) used to qualify data, listed in order of significance based on AFCEE guidelines, are as follows:

- **R -** The data are unusable due to deficiencies in the ability to analyze the sample and meet QC criteria.
- **M -** A matrix effect was present.
- **J -** The analyte was positively identified; the quantitation is an estimate.
- **F -** The analyte was positively identified; the associated numerical value is below the reporting limit.
- **B -** The analyte was found in the associated blank as well as the sample.

The “R” data qualifier is applied to analytical results that have failed to meet critical AFCEE quality control criteria. These results have a high degree of uncertainty and should not be used. Matrix spike/matrix spike duplicates (MS/MSDs) samples were analyzed at a frequency of one MS/MSD pair for every 18 field samples collected.

An “M” data qualifier is applied to sample results when spike recoveries exceed the specified limit. Exceptions are when the sample spike is less than 25 percent of the analyte found in the sample and where the spike recovery is above the specified limit and the sample result is not detected.

A “J” data qualifier is used to indicate the sample result is an estimate. The primary situation where this qualifier was used was when a laboratory control sample (LCS) or surrogate was measured above the specified limit and the associated result was above the reporting limit. The control failure indicated a possible either high or low bias, depending on whether the failure was above or below the specified limit.
The “F” data qualifier is used to indicate that the associated analyte was detected but below the project-specified reporting limit. This data qualifier does not indicate a data quality issue.

A “B” data qualifier was used to indicate contamination was present when a contaminant found in a sample above the reporting limit was also equal to or less than ten times the level found in the associated blank. This limited application of this flag to results where the potential contamination represented at least ten percent of the analyte found in the sample.

In some cases, professional judgment was applied by the reviewer in order to provide maximum utility of the data; all such cases are identified in this QA/QC summary. An example is if an analyte is non detected, the matrix spike recovery is slightly less than the acceptance criterion, but the internal standards, surrogate spikes, and laboratory control standard met yielded acceptable recoveries. Rather than rejecting the result, it might be flagged as non-detected at the reporting limit rather than at the method detection limit.

The review focuses on criteria for the following QA/QC parameters and their overall effect on the data:

- Sample handling chain of custody (COC);
- Holding-time compliance;
- Field QA/QC (trip blanks, equipment rinse blanks, and field duplicates);
- Initial and continuing calibration verification (ICV and CCV) check sample recoveries;
- Method Reporting Limits (RLs);
- Method blank (MB) sample recovery;
- Surrogates spike recoveries;
- Analytical methods;
- Precision and accuracy; and
- Completeness.

A2.1 Sample Handling (Chain-of-Custody) and Receiving

COC forms and laboratory case narratives were reviewed to determine if any sample handling procedures might affect the integrity of the samples and the quality of the resulting data. Copies of the COCs and cooler receipts are included in Appendix B.

Samples were packed with frozen gel packs and shipped to the laboratory by Federal Express air express service. Generally, samples were in route for 12 to 24 hours. COC forms and laboratory case narratives were reviewed to determine if any sample handling procedures might affect the integrity of the samples and the quality of the resulting data. These included handling issues such as sample temperature, holding time, and container integrity. All QAPP requirements were met.

A2.2 Holding-Time Compliance

All samples were extracted and/or analyzed within the recommended hold time for the analytical procedures utilized for this project.

A2.3 Trip Blanks

Trip blanks were shipped with coolers containing samples for VOC (SW8260B, SW8021B, and AK101) analysis. In the event that a trip blank was not included in the cooler, all detected VOC results were flagged "B" to indicate that contamination may have occurred during transport.

A2.4 Initial and Continuing Calibration Verification

ICV and CCV standards are analyzed to monitor instrument performance prior to, during and concluding sample analysis. Frequency and acceptable ranges for each test performed for this project are outlined in the AFCEE QAPP, Version 3.1, or the cited procedure for those tests not specified in the AFCEE QAPP. ICV and CCV standards that did not meet control criteria are discussed in for each analytical method in Section A3.

A2.6 Method Reporting Limits

Method reporting limits are specified in the AFCEE QAPP, Version 3.1, and in the project-specific QAPP for soil and water samples. Methods were evaluated and specified based on the ability of each procedure to measure below regulatory levels and at or below historical data levels at each site. RLs achieved by the laboratory met the requirements for this project.

A2.7 Method Blanks

Method blanks are analyzed concurrent with a batch of 20 or fewer samples for each of the analytical procedures performed for this project. These samples are prepared in the laboratory in conjunction with project samples to monitor for contamination during the laboratory analytical procedure. A measured result above the required RL would indicate a laboratory method control problem that could affect data quality. For this project, method blanks were tested at the required frequency. All method blank results were less than the RL.

A2.8 Surrogates

Surrogates are specified for organic chromatographic analytical procedures. Surrogates are compounds similar to those tested and are specified for methods employed for this project. These compounds are added to each sample tested before the extraction step of the procedure; measured recovery indicates overall method performance for each sample. Surrogates that failed to meet recovery criteria are discussed in section A3.

A3. ANALYTICAL METHODS

A3.1 VOC - USEPA Method SW8260B and SW8021B

The percent difference values for dichlorodifluoromethane and tert-butylbenzene exceeded 20% for the following Round 1 water samples. All associated sample results were below the rejected for use and flagged "R".

EOU503-BLSP01-108	EOU503-BLSP02-108	EOU503-BLSP03-608
EOU503-BLSP01-108	EOU503-BLSP02-608	EOU503-BLSP03-808
EOU503-BLSP01-608	EOU503-BLSP03-108	EOU503-BLSP03-808
EOU503-BLSP02-108	EOU503-BLSP03-108	EOU503-BLSP07-108

EOU503-BLSP07-108	EOU503-BLSP15-108	EOU503-BLSP17-808
EOU503-BLSP09-108	EOU503-BLSP15-108	EOU503-BLSP17-808
EOU503-BLSP10-108	EOU503-BLSP17-108	EOU503-BLSP18-108
EOU503-BLSP11-108	EOU503-BLSP17-108	EOU503-BLSP18-108

The percent difference values for chloromethane and bromomethane for an ICV associated with Round 1 water samples analyzed on 08/19/03 exceeded the 25% acceptance criterion. The following associated sample results were below the RL and have been as rejected "R".

EOU503-BLSP04-108	EOU503-BPSW02-608	EOU503-WCSD01-608
EOU503-BPSD01-608	EOU503-BPSW03-108	EOU503-WCSW01-108
EOU503-BPSW01-108	EOU503-BPSW05-108	EOU503-WCSW01-608
EOU503-BPSW01-608	EOU503-BPSW05-808	EOU503-WCSW01-808

The percent difference or percent drift values for dichlorodifluoromethane, bromomethane, acetone, naphthalene, and 1,2,3-trichlorobenzene for a CCV associated with Round 1 soil samples analyzed on 08/20/03 exceeded the 25% acceptance criterion. All associated sample results were below the RL and have been flagged as rejected "R".

EOU503-BPSD03-108	EOU503-BPSD05-808	EOU503-WCSD02-108
EOU503-BPSD04-108	EOU503-WCSD01-108	
EOU503-BPSD05-108	EOU503-WCSD01-808	

The percent difference or percent drift values for chlorohexane, MTBE, n-butylbenzene, 1,2,4-trichlorobenzene, hexachlorobutadiene, naphthalene, and 1,2,3-trichlorobenzene for a CCV associated with Round 1 water samples analyzed on 08/22/03 exceeded the 25% acceptance criterion. All following associated sample results have been flagged as rejected "R".

EOU503-BPSD03-108	EOU503-BPSD05-808	EOU503-WCSD02-108
EOU503-BPSD04-108	EOU503-WCSD01-108	
EOU503-BPSD05-108	EOU503-WCSD01-808	

The recovery of methyl tert-butylether (MTBE), n-butylbenzene, 1,2-dichlorobenzene, and naphthalene from the laboratory control standard analyzed on 08/22/03 exceeded the upper control limit. The associated sample results were previously rejected based on other QC exceedances.

Recoveries of 1,2,4-trichlorobenzene, 1,2,4-trimethylbenzene, 1,2-dibromo-3-chloropropane, 1,2-dichlorobenzene, 1,3-dichlorobenzene, 1,3-dichloropropane, 1,4-dichlorobenzene, 4-isopropyltoluene, bromoform, chloroethane, chloromethane, cis-1,3-dichloropropene, dibromomethane, hexachlorobutadiene, isopropylbenzene, m,p-xylene, methyl tert-butyl ether, n-butylbenzene, o-xylene, sec-butylbenzene, and styrene exceeded the matrix spike, duplicate spike (MS/MSD) or relative percent difference (RPD) acceptance criteria due to matrix interference. These analytes were flagged "M" in the following Round 1 soil samples.

EOU503-BPSD03-108	EOU503-BPSD05-808	EOU503-WCSD02-108
EOU503-BPSD04-108	EOU503-WCSD01-108	
EOU503-BPSD05-108	EOU503-WCSD01-808	

Recoveries of 1,2,4-trimethylbenzene, 1,2-dibromo-3-chloropropane, 1,2-dichlorobenzene, 1,3-dichlorobenzene, 1,3-dichloropropane, 1,4-dichlorobenzene, 4-isopropyltoluene, bromoform, chloroethane, cis-1,3-dichloropropene, dibromomethane, isopropylbenzene, m,p-xylene, o-xylene, sec-butylbenzene, styrene, and tert-butylbenzene exceeded the matrix spike, duplicate spike (MS/MSD) or relative percent difference (RPD) acceptance criteria due to matrix interference. These analytes were flagged "M" in the following Round 1 water samples.

EOU503-BPSD01-608	EOU503-WCSD01-608

Recovery of 1-chlorohexane exceeded the matrix spike, duplicate spike (MS/MSD) or relative percent difference (RPD) acceptance criteria due to matrix interference. This analyte was flagged "M" in the following Round 2 water sample.

EOU503-WCSW02-108

The RPD value for hexachlorobutadiene in the initial calibration associated with Round 2 water samples exceeded the acceptance criteria of 15%. All sample results were below the RL and have been flagged as rejected "R".

The percent difference values for 1-chlorohexane for the ICV associated with Round 2 water samples was not available due to laboratory oversight, since this analyte was not spiked into the ICV sample. All sample results were below the RL and have been flagged as rejected "R".

The percent difference or percent drift value for acetone for the CCV associated with Round 2 water samples analyzed on 10/16/03 exceeded the 25% acceptance criterion. All following associated sample results have been flagged as rejected "R".

OU4-OU4MW08R-GW-121003	OU5-OU5MW39-GW-131003	OU5-OU5MW41-GW-131003
OU5-49WL01-GW-121003	OU5-OU5MW41B-GW-131003	OU5-OU5MW42-GW-131003

Due to limited sample volume, MS/MSD analysis was not performed for samples analyzed on 10/212/03. Instead, blank spike, blank spike duplicate (BS/BSD) analysis was performed. Recovery of 2,2-dichloropropane exceeded the BS/BSD acceptance criteria. Results for this analyte were flagged as rejected "R" in the following Round 2 water samples.

OU5-403MW01-GW-121003	OU5-OU5MW37-GW-121003	OU5-OU5SP11-SP-141003
OU5-GW4A-GW-121003	OU5-OU5MW40-GW-121003	OU5-SP102-GW-121003
OU5-OU5MW34-GW-131003	OU5-OU5SP09-SP-141003	
OU5-OU5MW36-GW-121003	OU5-OU5SP10-SP-141003	

The percent difference or percent drift value for acetone for the CCV associated with Round 3a water samples analyzed on 01/26/04 exceeded the 25% acceptance criterion. All sample results have been flagged as rejected "R".

A trip blank sample was not collected for the Round 3a sampling event associated with the following samples. A conservative approach was taken by the reviewer, and all detected 1,1-trichlorethane and trichloroethene results were flagged "B" to indicate that potential sample contamination may have occurred. Both analytes were detected in all samples in the sample delivery group.

OU5-OU5SP09-SP-200104 OU5-OU5SP10-SP-200104 OU5-OU5SP11-SP-200104
OU5-OU5SP10B-SP-200104

One trip blank sample shipped to the laboratory was determined to contain methylene chloride at 3.4 µg/L. The associated water sample results from Round 3a were flagged "B" to indicate potential blank contamination.

EOU504-BPSW01-101 EOU504-BPSW04-101 EOU504-BPSW05-101
EOU504-BPSW03-101

The percent difference or percent drift values for 4-methyl-2-pentanone for the CCVs associated with Round 3b water samples analyzed on 02/13/04 and 02/17/04 exceeded the 25% acceptance criterion. All associated sample results were below the RL and have been flagged as rejected "R".

EOU504-BLSP03-101 EOU504-BLSP03-801 EOU504-WCSW02-101

The percent difference or percent drift value for dichlorodifluoromethane for the CCV associated with Round 3b water samples analyzed on 02/17/04 exceeded the 25% acceptance criterion. All associated sample results were below the RL and have been flagged as rejected "R".

EOU504-BLSP01-102 EOU504-BLSP04-102 EOU504-BLSP04-802
EOU504-BLSP02-102

A3.2 PAH - USEPA Method SW8270D

Recovery of naphthalene exceeded the matrix spike, duplicate spike (MS/MSD) or relative percent difference (RPD) acceptance criteria due to matrix interference. Based on the judgment of the reviewer, this analyte were flagged "M" only in the Round 1 soil sample EOU503-BLSP01-108.

Recovery of the surrogate 1-fluoronaphthalene exceeded the upper control limit for two soil samples from the Round 1 sampling event. The results for acenaphthene in samples EOU503-BLSP02-108 and EOU503-BLSP03-108 were flagged as estimated "J", possible high bias.

Recovery of indeno(1,2,3-cd)pyrene from the matrix spike, duplicate spike (MS/MSD) or relative percent difference (RPD) was less than the lower control limit due to matrix interference for the water samples collected during the Round 1 sampling event. This analyte was flagged "M", possible low bias, in the following samples.

EOU503-WCSW01-108 EOU503-WCSW01-808 EOU503-WCSW02-108

Recovery of anthracene and benzo(a)pyrene from the matrix spike, duplicate spike (MS/MSD) or relative percent difference (RPD) was less than the lower control limit due to matrix interference for the water sample

EOU503-WCSW02-111collected during the Round 2 sampling event. These analytes were flagged "M", possible low bias, in this sample only.

Recovery of the surrogate pyrene-d10 was less than the lower control limit for water sample EOU504-BPSW01-101 from the Round 3a sampling event. The results for the following analytes were not-detected and therefore flagged as rejected "R".

benzo(a)anthracene	benzo(g,h,i)perylene	dibenzo(a,h)anthracene
benzo(a)pyrene	benzo(k)fluoranthene	indeno(1,2,3-cd)pyrene
benzo(b)fluoranthene	chrysene	pyrene

Recovery of the surrogate 1-fluoronaphthalene was greater than the upper control limit for water sample EOU504-BLSP01-102 from the Round 3b sampling event. The results for the following analytes were not-detected and therefore flagged as rejected "R".

acenaphthene	fluoranthene	naphthalene	phenanthrene
anthracene	fluorene		

Recovery of the internal standards chrysene-d12 and pyrelene-d12 was greater than the upper control limit for water sample EOU504-BLSP02-102 from the Round 3b sampling event. The results for the following analytes were flagged as "M" due to apparent matrix interference.

benzo(a)anthracene	chrysene	pyrene

All other control criteria for this procedure met the goals for this project.

A3.3 GRO – ADEC Method AK101

No data qualification was required for the gasoline-range organics analyses of water samples from Round 2.

A3.4 DRO/RRO – ADEC Method AK102/103

No data qualification was required for the diesel and motor oil-range organics analyses of water samples from Round 2.

A4. PRECISION AND ACCURACY

Precision criteria monitor analytical reproducibility (relative percent difference), and accuracy criteria monitor agreement of measured result with "true values" as determined by the analytical spike recovery. These data are generated by analyzing a MS/MSD at a frequency of two samples per batch of 18 field samples. QC acceptance criteria are specified in the AFCEE QAPP, Version 3.1, or laboratory standard operating procedures for both precision and accuracy. Precision and accuracy requirements apply when the concentration of analyte added to the MS/MSD sample, is equal to or greater than the analyte found in the original sample. MS/MSD recoveries outside the accepted range generally indicate matrix interference, and all project samples of a similar matrix associated with the failure are qualified with an "M" flag.

Method accuracy is also measured by the analysis of a LCS. One LCS sample per analytical batch of 20 or less project samples must be analyzed. Recovery of each analyte tested within the required range is a measure of method control. The laboratory is required to reanalyze samples if LCS failure occurs. For some tests, due to holding time considerations, this is not possible. If the LCS is outside control limits, affected data are qualified as estimates with a "J" flag. If LCS recoveries are low, non-detect data are rejected and qualified with an "R" flag.

Precision and accuracy measurements were measured at the required frequency for this project. Precision and accuracy measurements were measured within the required limits for this project, except as discussed in section A3.

A5. COMPLETENESS

The percentage of valid results is reported as completeness. Completeness is calculated after the QC data have been evaluated and the results applied to the measurement data. In addition to results identified as being outside of the QC limits established for the method, broken or spilled samples, or samples that could not be analyzed for any other reason, are included in the assessment of completeness. Only samples that are rejected are considered invalid for the calculation of completeness.

Completeness is calculated as follows:

$$\frac{T - (I + NC)}{T} \times 100\% = Completeness$$

where: T = Total number of expected measurements for a method and matrix;
I = Number of invalidated results for a method and matrix; and
NC = Number of results not collected (e.g., bottles broken, etc.) for a method and a matrix.

AFCEE completeness goals are 95% for water samples and 90% for soil samples collected for this project. All completeness goals were met for the project.

A.6 References

Air Force Center for Environmental Excellence (AFCEE). *Quality Assurance Project Plan, Version 3.1.* August 2001.

United States Environmental Protection Agency (USEPA). *Test Methods for Evaluating Solid Waste*, *SW-846*, *update III.* 1996.

APPENDIX B – LABORATORY ANALYTICAL DATA

APPENDIX C – WRS PERFORMANCE DATA

Appendix C
WRS Operational Data

Wetland Cell volumes and associated effluent flows and retention times have been calculated throughout the operating period of the WRS to monitor system operational performance. Volume calculations assume the wetland cell has a bottom width of 40 feet with a 1: 2 (Vertical: Horizontal) side slopes, a cell length of 1,500 feet, and a vegetative cover of about 5 percent. Wetland Cell performance data calculated from water level and weir gate height measurements collected during the FY 2003 operating period are presented in Table C-1.

Table C-1
WRS Performance Data, FY 2003

Date	Weir Measurements			Wetland Cell Volume (ft^3)	Flow Rate (gpm)	Retention Time (days)
	Water (feet)	V-Notch (feet)	Height (feet)			
19-Mar-03	93.90	93.50	0.40	135315	113.59	6.19
25-Mar-03	93.90	93.50	0.40	135315	113.59	6.19
04-Apr-03	93.85	93.50	0.35	131878	81.35	8.42
07-Apr-03	93.86	93.50	0.36	132451	87.29	7.89
15-Apr-03	93.86	93.50	0.36	132451	87.29	7.89
21-Apr-03	93.88	93.49	0.39	133594	106.62	6.51
08-May-03	93.87	93.50	0.37	133022	93.47	7.40
16-May-03	93.85	93.50	0.35	131878	81.35	8.42
20-May-03	93.85	93.50	0.35	131878	81.35	8.42
29-May-03	93.87	93.50	0.37	133022	93.47	7.40
5-Jun-03	Clogged					
13-Jun-03	Clogged					
16-Jun-03	Clogged					
23-Jun-03	93.78	93.42	0.36	125823	87.29	7.49
2-Jul-03	93.37	92.9	0.47	93480	169.99	2.86
7-Jul-03	94	93.7	0.30	144176	55.33	13.54
14-Jul-03	94.38	93.95	0.43	185500	136.10	7.08
16-Jul-03	94.38	94.03	0.35	185500	81.35	11.85
18-Jul-03	94.38	94.03	0.35	185500	81.35	11.85
25-Jul-03	93.78	93.48	0.30	125823	55.33	11.82
1-Aug-03	94.47	94.09	0.38	195000	99.92	10.14
8-Aug-03	94.37	94.04	0.33	185000	70.22	13.69
15-Aug-03	94.34	93.92	0.42	182500	128.32	7.39
22-Aug-03	94.45	94.07	0.38	193000	99.92	10.04
29-Aug-03	94.47	94.07	0.40	195000	113.59	8.92
5-Sep-03	94.27	93.90	0.37	173020	93.47	9.62
12-Sep-03	94.14	93.71	0.43	155663	136.10	5.94
19-Sep-03	93.91	93.60	0.31	136180	60.06	11.78
26-Sep-03	93.99	93.60	0.39	143300	106.62	6.98
3-Oct-03	93.82	93.45	0.37	129283	93.47	7.19

Date	Weir Measurements			Wetland Cell Volume (ft^3)	Flow Rate (gpm)	Retention Time (days)
	Water (feet)	V-Notch (feet)	Height (feet)			
10-Oct-03	93.92	93.60	0.32	137042	65.02	10.95
17-Oct-03	93.88	93.57	0.31	133594	60.06	11.56
24-Oct-03	93.84	93.46	0.38	131013	99.92	6.81
31-Oct-03	93.79	93.42	0.37	125823	93.47	7.00
7-Nov-03	93.68	93.35	0.33	117334	70.22	8.68
14-Nov-03	93.71	93.35	0.36	119844	87.29	7.14
21-Nov-03	93.73	93.35	0.38	121523	99.92	6.32
26-Nov-03	93.77	93.40	0.37	124958	93.47	6.95
5-Dec-03	93.70	93.32	0.38	119005	99.92	6.19
12-Dec-03	93.67	93.39	0.28	116779	46.57	13.03
19-Dec-03	93.62	93.30	0.32	113170	65.02	9.04
31-Dec-03	93.65	93.30	0.35	115668	81.35	7.39
9-Jan-04	93.54	93.30	0.24	106429	31.67	17.46
16-Jan-04	93.57	93.33	0.24	108986	31.67	17.88
23-Jan-04	93.50	93.30	0.20	103175	20.08	26.70
30-Jan-04	93.49	93.30	0.19	102365	17.66	30.12
6-Feb-04	93.52	93.32	0.20	104802	20.08	27.12
13-Feb-04	93.50	93.30	0.20	103175	20.08	26.70
20-Feb-04	93.53	93.32	0.21	105616	22.68	24.20
27-Feb-04	93.74	93.47	0.27	122363	42.52	14.96
5-Mar-04	93.78	93.45	0.33	125721	70.22	9.30
12-Mar-04	93.96	93.60	0.36	140510	87.29	8.37
19-Mar-04	93.84	93.50	0.34	131018	75.66	9.00
26-Mar-04	93.90	93.55	0.35	135315	81.35	8.64

ft – feet, elevation

gpm – gallons per minute

During the 1997 Startup Period, a minimum Wetland Cell retention time of 5 days was established as an operational guideline to ensure that regulatory cleanup levels are met. On July 2n[d], the maximum flow rate (170 gpm) occurred, which resulted in a retention time of 2.9 days, slightly less than the operational guideline. This was due to setting the V-notch gate intentionally low to release backup caused by the beaver problem and reestablish a reasonable amount of spare volume in the cell.

WRS performance data presented in the precious table indicates that over the course of this operating period (March 2003 through March 2004), the average wetland cell retention time was 10.9 days. However most of the reporting period, the retention times remained around 8.3 days. High retention times (25-30 days were recorded in January and February when ice buildup and low flows occurred.

APPENDIX D – CURRENT STATUS OF 2001 O&M MODIFICATION RECOMMENDATIONS

Table D-1

Status of Previous (2001) Recommendations

Recommendation	Purpose and (or) Justification	Timeline	ROM Cost Increase	ROM Cost Decrease	Status
Cost Avoidance Opportunities					
Eliminate sampling at interim treatment components of the WRS (i.e., pump stations and the Overland Flow Cell).	Contaminant reduction capabilities at interim treatment components of the WRS have been well documented in quarterly sampling events. Further documentation on a quarterly basis is unnecessary. Seep influent and Wetland Cell effluent sampling is sufficient to document treatment.	2002 – 2003 O&M Period	-	$8,000	Implemented.
Initiate a routine pump and pipe system maintenance schedule to reduce long-term cost associated with pumps at the WRS.	Routinely scheduled maintenance may increase the life-cycle of the pumps and reduce long-term maintenance costs. Maintenance tasks include: precipitate removal from pump stations, routine pump maintenance, and line jetting. Maintenance schedules may also be used to forecast long-term costs associated with the O&M of the WRS.	2002 – 2003 O&M Period	$4,000 (labor and jetting)	$6,000 (annual pump repair savings)	Implemented. Initiated 3-year pump maintenance and periodic pump station precipitate removal/line jetting.
Reduce reporting costs by eliminating the production of quarterly status reports.	Quarterly monitoring data is incorporated into and annual report. Additional interim reporting may be unnecessary. Quarterly monitoring data could be discussed at quarterly status meetings.	2002 – 2003 O&M Period	$1,000 per year (meetings)	$7,500 per year	Implemented. Lengthy quarterly status reports have been replaced by brief technical memos (~2 pg length).
Shut down and winterize Seep 4/ Pump Station 3.	Based on analytical data trends, Seep 4/Pump Station 3 could be shut down and winterized in 1 to 2 years.	2003 – 2004 O&M Period	-	~~$6,000 (annual labor, analytical, & O&M cost)~~	Revoked. This is no longer recommended due to identification of DRO contaminated groundwater and soils upgradient of Seep 4, and toluene spike in August 2003.

Table D-1 (Continued)

Recommendation	Purpose and (or) Justification	Timeline	ROM Cost Increase	ROM Cost Decrease	Status
Cost Avoidance Opportunities					
Shut down and winterize Seep 3/ Pump Station 2.	Based on analytical data trends and the draft decision tree developed with regulatory approval, Seep 3/Pump Station 2 could potentially be shut down and winterized in 2 to 4 years.	2005 – 2007 O&M Period	-	$6,000 (annual labor, analytical, & O&M)	Pending. At least ~~two~~ one more year~~s~~ of favorable analytical seep data (i.e., below cleanup levels) is needed. Also need to evaluate potential impacts of ARRC rail re-alignment plans.
Additional Recommendations					
Use screening methods (i.e., soil gas evaluations) to identify TCE sources immediately upgradient of 2001 newly identified contaminated seep areas.	Information will be used to identify contaminant source areas upgradient of the area of concern and predict future contaminant loading along the base of the bluff at OU 5.	2002 – 2003 O&M Period	-	-	Complete. Soil gas investigation did not provide significant new information. Additional monitoring wells are planned.
Sample visible seeps entering the Wetland Cell above ground surface from the bluff and not currently incorporated into the main WRS pipe system to determine if additional contaminant loading is occurring.	Additional contaminant loading may be occurring. At least two additional seeps entering the Wetland Cell have been identified. These seeps may be a risk to system protectiveness.	2002 – 2005 ~~2003~~ O&M Period	$3,000	-	Implemented. Seeps 17 and 18 drain directly into the Wetland Cell. Low levels of TCE were identified in both of these seeps and in January 2003, the sample from Seep 17 exceeded TCE cleanup levels. The Wetland Cell effluent continues to remain below cleanup levels. Seep 15 should continue to be monitored due to elevated TAH levels identified in 2002.

Table D-1 (Continued)

Recommendation	Purpose and (or) Justification	Timeline	ROM Cost Increase	ROM Cost Decrease	Status
Additional Recommendations					
Continue quarterly monitoring of ~~newly~~ other identified seeps containing concentrations of COCs above the cleanup goal.	Quarterly monitoring should be conducted at ~~new~~ other seeps that have exceeded maximum contaminant limits to further evaluate if protectiveness of the remedy is being met.	2002 – 2005 ~~2003~~ O&M Period	$4,000	-	Ongoing. ~~Four s~~Sampling rounds between Oct 2001 and Jan 2004 ~~(Oct 2001, July 2002, Sept 2002, Jan 2003)~~ have documented TCE at Seeps 9, 10, and 11 is consistently at levels above the cleanup goal. These seeps are schedule to be routed to the WRS Wetland Cell during 2004. Quarterly monitoring is recommended to continue. Seeps 17 and 18 were sampled three times and TCE was present in all samples (at levels below the cleanup goal except for one sample at Seep 17 that exceeded the cleanup goal in January 2003). All seeps not captured by the WRS will be sampled at least annually.

Table D-1 (Continued)

Recommendation	Purpose and (or) Justification	Timeline	ROM Cost Increase	ROM Cost Decrease	Status
Additional Recommendations					
Integrate the Basewide Environmental Monitoring Program into the OU 5 wetland monitoring program and utilize its results for prediction of contaminant loading at the OU 5 WRS and Beaver Pond.	Upgradient groundwater information obtained through the Basewide Environmental Monitoring Program can be used as an early warning system to predict contaminant loading at the OU 5 WRS and Beaver Pond.	2002 – 2003 2003 – 2004 O&M Period		-	~~Ongoing.~~ Completed. Several new monitoring wells ~~are planned~~ were installed upgradient from the Wetland Cell to evaluate the distribution of TCE (Fairchild and Kenny Avenue plume areas – See Basewide Environmental Monitoring Program).
Sample existing groundwater wells located upgradient of seeps identified in 2001 that have concentrations of TCE above cleanup levels.	Groundwater monitoring data may identify upgradient source areas as well as predict future contaminant loading along base of bluff. Some of these groundwater wells are not monitored in the Basewide Environmental Monitoring Program.	2002 – 2003 2003 – 2004 O&M Period	$6,000	-	Ongoing. Several additional wells have been added to the Basewide program and new monitoring wells ~~are planned~~were installed in 2003 (Kenny Avenue Plume) upgradient of the Wetland Cell to evaluate the distribution of TCE.
Install additional wells to evaluate any areas upgradient from seeps where COC concentration is increasing.	Installation of one to two additional wells may be necessary to define the extent of TCE contamination and provide upgradient monitoring.	2003 – 2010 O&M Period	$7,000 per year (one well per year)	-	Ongoing. ~~New wells are planned upgradient of the Wetland Cell to evaluate TCE distribution.~~New wells were installed upgradient of the seeps.
Maintenance Tasks					
Cover exposed water at Seep 2 with gravel to mitigate potential exposure to receptors.	Ensure protectiveness of remedy by mitigating potential receptor exposure to contaminated seep water. This task is anticipated over a two-year period to meet funding constraints.	2002 – 2003 O&M Period	$8,000	-	~~Partially completed.~~ Completed. Gravel placed in March 2002. ~~Additional gravel is required at Seep 2.~~

Table D-1 (Continued)

Recommendation	Purpose and (or) Justification	Timeline	ROM Cost Increase	ROM Cost Decrease	Status
Maintenance Tasks					
Install cleanouts along the pipe run from Pump Station 1 to Pump Station 2.	Current pipe design limits the pipe maintenance options (i.e., full line jetting). System head calculation modifications indicate that fouling in the pipes may be decreasing the effective pipe operating diameter and increasing head loss.	2004 – 2005 O&M Period	$20,000	-	Recent observations of possible line backup prompted installation of larger capacity pumps as an interim measure. ~~(see Table 4-2).~~ Installation of cleanouts is recommended to assist with long term maintenance.
Clean-out pump stations and conduct a jet-flush of the piping.	Due to the high concentrations of iron in the seep waters, iron precipitate in the pump stations will become a concern over the life-cycle of the WRS.	2002 - 2010 O&M Period	$4,400 per year	-	Ongoing. Currently 3 clean-outs / flushings per year at $1,100 per event is sufficient. This may decrease after cleanouts (above) are installed.
Remove and wash or replace the drain rock located in the Overland Flow Cell.	Build up of organics and iron precipitate will necessitate cleanout every 3 years if the Overland Flow Cell is operated year-round.	20034	$6,000	-	~~Planned for 2004.~~Completed. Performed cleanout and replacement of gravel in September 2004.

COC – contaminant of concern
DRO – diesel range organic
O&M – Operations and Maintenance
OU – operable unit

ROM - Rough Order-of-Magnitude
TAH – total aromatic hydrocarbon
TCE - trichloroethene
WRS – Wetland Remediation System