ROZAK ENGINEERING Civil, Construction & Environmental Consulting
P.O. Box 350 Kenai, Alaska 99611 (907) 283-5640 Fax (907) 283-0747

December 30, 2002

Alaska Dept. of Environmental Conservation
Division of Spill Prevention and Response
Storage Tank Program
43335 Kalifornsky Beach Rd, Suite 11
Soldotna, Alaska 99669

RECEIVED
DEC 30 2002
ADEC
Kenai Area Office

RE: Kenai Airport Fuel Service, Spill #90230026801
UST Facility ID #2187
Submittal of Remedial Action Schedule

Attention: Monica T. English, Environmental Specialist

The following schedule was prepared on behalf of Dean Eichholz and Dan Pitts, to fulfill the conditions of the department's letter of October 24, 2002. This schedule implements Phase I and II of the remedial action work plan transmitted to the department on December 23, 2002. The schedule for Phase III remediation, and groundwater sampling beyond May 2003, will be determined by ADEC and client during a meeting in June 2003.

Date (2003)	**Activity**
Apr 21	Install & develop new point of compliance (POC) monitor well (MW)
Apr 21-23	Conduct soil gas sampling (before water table rises)
Apr 23-24	Survey & sample 9 existing + 1 new POC MW
Apr 28-May 9	Model soil vapor migration into buildings & prepare site vapor map
May 19-24	Prepare report for soil vapor modeling & groundwater sampling
May 19-31	Develop fate & transport model, evaluate contamination plume, prepare report
Jun 2-14	Determine alternative cleanup levels (MCLs) using method 3
Jun 2	Start investigating aquifer as non-drinking water source (allow 60 days)
Jun 16	Meet with ADEC KAO about remedial action & long-term monitoring
Jul 7	Implement Phase III—remediation/monitoring per ADEC & client agreement

Prepared by,

Ronald T. Rozak

Ronald T. Rozak, PE
Principal Investigator

cc: Dan Pitts & Dean Eicholtz
Dennis Harwood, FAP Project Manager

ROZAK ENGINEERING Civil, Construction & Environmental Consulting
P.O. Box 350 Kenai, Alaska 99611 (907) 283-5640 Fax (907) 283-0747

December 23, 2002

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Division of Spill Prevention and Response
Storage Tank Program
43335 Kalifornsky Beach Rd, Suite 11
Soldotna, Alaska 99669

RECEIVED
DEC 24 2002
ADEC
Kenai Area Office

RE: Kenai Airport Fuel Service—Spill #90-23-00-268-01
UST Facility ID #2187
Submittal of Remedial Action Work Plan

Attention: Monica T. English, Environmental Specialist

The enclosed work plan was prepared on behalf of Dean Eichholz and Dan Pitts, to fulfill the conditions of the department's letter of October 24, 2002. As requested, this plan provides for assessment in the airport parking lot area, a comprehensive soil and groundwater cleanup plan, and a plan for determining the risks associated with contaminant vapors at the terminal building. The department also required that monitoring well MW1, MW6, MW9, MW10 and MW11 be re-sampled prior to November 15, 2002. Rozak Engineering sampled all those wells, plus MW8, on October 30, 2002. The groundwater monitoring report was completed on December 12, 2002 and delivered to the Kenai Area Office on December 18, 2002.

This work plan was drafted by Mark Prieksat, Ph.D, Soil Physicist, with oversight, input and review by Ron Rozak. Mr. Prieksat worked with Rozak Engineering during the subsurface investigation, sampling, and report completed in September 1999. This work plan also fulfills the requirement from the Grants & Contracts Section, refer to letter of July 29, 2002, for submittal of a work plan that conceptually addresses the tasks necessary to take this site to full closure. A work schedule, and a more detailed cost estimate for the Grants & Contracts Section, will be submitted by December 31, 2002.

Sincerely,

Ronald T. Rozak

Ronald T. Rozak, PE
Principal Investigator

cc: Mark Prieksat, Ph.D. (with report)
Dan Pitts & Dean Eichholz (with report)
Dennis Harwood, FAP Project Manager (cover letter only)

Remedial Action Work Plan
Kenai Airport Fuel Service
Kenai, Alaska

UST Facility ID #2187
Reckey #90230026801

December 2002

For:

Dan Pitts
P.O. Box 1916
Soldotna, AK 99669

Dean Eichholz
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By: Mark Prieksat, PhD and Ron Rozak, PE
Rozak Engineering
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CONTENTS

LIST OF ACRONYMS AND ABBREVIATIONS

μg/L	Microgram per liter
AAC	Alaska Administrative Code
ADEC	Alaska Department of Environmental Conservation
AS	Air sparging
AS/SVE	Air sparging/soil vapor extraction
ASTM	American Society for Testing and Materials
bgs	Below ground surface
BTEX	Benzene, toluene, ethylbenzene, and total xylenes
DRO	Diesel range organics
EDB	Ethylene Dibromide
GRO	Gasoline range organics
mg/kg	Milligram per kilogram
msl	mean sea level
MW	Monitoring well
OVA	Organic vapor analyzer
OVM	Organic vapor meter
PAH	Polycyclic aromatic hydrocarbons
POC	Point of compliance
PLC	Programmable logic controller
ppm	Parts per million
RAO	Remedial Action Objective
RME	Remote manifold enclosure
RRO	Residual range organics
scfm	Standard cubic feet per minute
SVE	Soil vapor extraction
UST	Underground storage tank
VOC	Volatile organic compound

1. INTRODUCTION

This document presents the Remedial Action Work Plan for the Kenai Airport Fuel Service UST facility (KAFS), located in Kenai, Alaska. The objectives of the corrective action at KAFS are to ensure protection of human health and the environment, and to establish current levels of soil and groundwater contamination prior to implementation of remedial action. Part of the investigation will involve determination of risk using ADEC's risk calculator.

1.1 KAFS Background

KAFS is located inside the airport security fencing at the Kenai Muni
terminal building and the air traffic control tower located north of the
KAFS occupies two lots leased from the City of Kenai: Lot 4, Bloc
3A1, Block 1, FBO Subdivision South Addition No. 2. The lo
Fuel/Yutana Barge when they purchased the fueling facility from D
1999. Lot 1A, located down gradient of the KAFS UST facility, i
includes a frame office building occupied by the Alaska Flying Net
Everts Air Fuel.

Any intent to improve/ maintain evaporation pond?

The property was developed in the 1970s and was initially used as a staging area for general air cargo and fuel hauling. Woods Air Service, Northern Air Cargo, Everts Air Service, Stratolift, Arctic Aviation, Alaska Oil Sales, Weaver Brothers, Kenai Air Service, Andy's Flying Service, and Doyle's Fuel Service used trucks to fuel aircraft at the site. Several fish hauling businesses used the area for refueling a variety of aircraft: DC-3, DC-4, DC-6, and C-130. KAFS installed the first UST system at the site in 1984 and worked with the other fuel delivery businesses. Everts Air Service continues to haul fuel from the site. ERA Aviation fills their fuel truck and aircraft from the KAFS UST facility.

The initial UST system included three 10,000-gallon, single-wall steel tanks that stored Jet A, aviation gasoline, and 100 low-lead gasoline, two dispensers, and associated underground piping. Also, a 1000-gallon, single-wall, steel, underground tank stored 80/87 aviation-gasoline. The 1000-gallon tank was converted to regular unleaded gasoline several years later. This UST system was removed in October 1993 and replaced with a new UST system in 1994. The new system is comprised of two 12,000-gallon double wall tanks and a reel dispenser, located about 75 feet north of the old system.

1/16/09

Figure 1-1. KAFS/Kenai Topographic Map.

From: USGS 7.5' Quadrangle KENAI (C-4) SE, ALASKA
Provisional Edition 1986, Contour Interval 5 Meters

SCALE 1:25 000

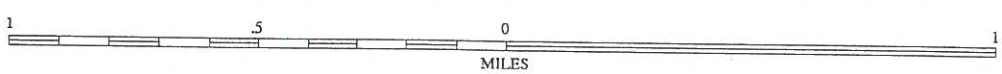
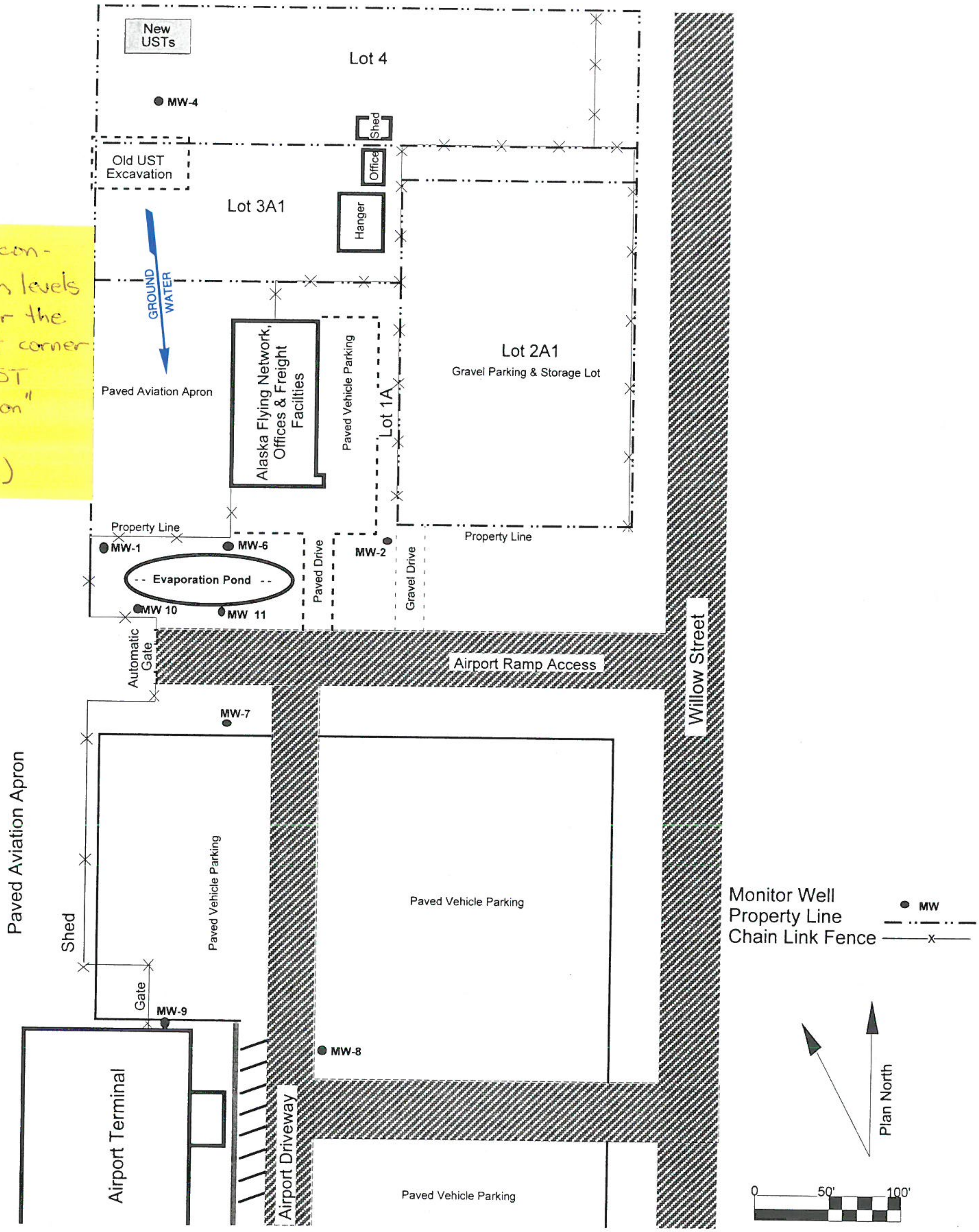


Figure 1-2. KAFS Site Map.



"Highest contamination levels were near the northwest corner of the UST excavation"
page 1-4 (1.2.3)

Previous Investigations

Several investigations have been conducted at the site, including the initial site assessment, subsequent release investigations, and monitoring.

1.2.1 Site Assessment

An initial site assessment was conducted in December 1991 by Northern Test Lab following two reported releases of fuel to the ground at the site in September of 1990. Everts Air Fuel experienced a release of jet fuel estimated to be less than 50 gallons. The other spill, estimated at about 200 gallons of unleaded gas, was released from a Doyle's Fuel Service truck while transferring fuel to an Everts Air Fuel aircraft. The assessment consisted of digging three test pits to groundwater, collecting field screen samples between the surface and the water table, and samples at groundwater for analytical testing. Evidence of fuel was present on the surface in the area of the western pump island. Elevated contamination levels were detected from the surface to the groundwater in the test pit dug near the pump island. Relatively low levels of contamination were detected at groundwater in the test pit to the north and east of the UST site. No contamination was detected above the water table at these test pits. The assessment did not identify the extent of contamination.

1.2.2 UST Removal Site Assessment

BC Excavating removed the UST system on October 18 and 19, 1993. Northern Test Lab conducted a site assessment at the time of removal and submitted the report to KAFS on February 3, 1994. Fuel contaminated soil and free product were encountered during the removal. During October 20-23, approximately 600 cubic yards of contaminated soil was excavated and stockpiled at the site. About 625 gallons for free product and water were removed from the tank pit. The excavation remained open for about a year, then the tank pit was backfilled and the area was paved with asphalt. A new UST system was installed 70 feet north of the old UST excavation

1.2.3 Interim Release Investigation

Rozak Engineering conducted an interim release investigation from October 29 through November 2, 1993. Soil samples were collected at groundwater around the sides of the UST excavation to help determine the source of the release at the UST site. The highest contamination levels were near the northwest corner of the UST excavation. Five test pits were dug between the UST site and the south property boundary to determine if the contamination had migrated off the property. Analytical testing of soil samples collected at groundwater indicated the contamination had not reached the south boundary of Lot 1A. No samples were collected below the water table. Piezometers, converted to monitor wells, installed at three of the test pits were surveyed and the groundwater flow was determined to be from north to south. The report, dated June 8, 1994, included a proposed soil-boring plan to determine the extent of the contamination plume. On July

26, 1994, five test holes were drilled and samples were collected continuously from five feet to about 15 feet. Monitor well MW4 was installed at the soil boring located between the old and new UST sites. The release investigation was terminated after the fifth boring due to lack of funds. Field screening and analytical testing of soil samples from the five borings, and water samples from the four monitor wells, indicated the contamination plume had migrated south of Lot 1A. The proposed release investigation was not completed and a report was not submitted.

(check file)

no report submitted?

1.2.4 Corrective Action Plan – Contaminated Soil Pile

The contaminated soil pile that was generated during excavation of the UST system was partially treated on-site using a modified air stripping system. On June 19, and 21, 1999, the entire soil pile and the material under the stockpile liner was field screened and segregated into two piles; one designated "contaminated" and the other "clean". Analytical testing showed the clean pile, 420 cu yd, met the cleanup levels for this site. After receiving ADEC approval, one-third of the clean soil was spread near the stockpile site and the remainder was left piled at the site. On July 8, 1999, the other pile, 240 cu yd, was hauled to the Soil Processing Inc. treatment plant at the UAA site on Kalifornsky Beach Road. The soil was thermally treated, sampled, approved by ADEC, hauled back to KAFS and spread at the former stockpile site. Monitoring wells MW1, MW2 and MW4 were sampled at this time and analysis results showed groundwater contamination migrating southward towards the airport terminal building.

1.2.5 Interim Remedial Action Reports

A series of remedial action reports and plans were developed during the period between 1995 and 1999. In 1999, seven temporary sampling wells were installed and two soil borings were drilled immediately down-gradient of the former UST location. Results indicated that soil contamination exceeding cleanup standards still remained in the area near the former UST location. Groundwater samples indicated that the contaminated groundwater plume extended further south than the location of the existing monitoring wells. (no sentinel well) P.O.C. well

In November 1999, three additional down-gradient monitoring wells were installed at the site. The data indicated that the contaminant plume extended about 500 feet south of the former UST site. However, a dramatic decrease was noted in the contaminant levels in an area where the surface was not covered with asphalt. This observation prompted the design and construction of an evaporation pond in an unpaved area south of the KAFS site (see Rozak, 1999).

In May 2002, the pond was excavated and a sump pump and sprinkler were installed at the west end of the pond (Rozak, 2002a). The purpose of the pump and sprinkler were to aerate the water enhancing volatilization of the contaminants in the groundwater. Additionally at this time, three more groundwater-monitoring wells were installed at the site. Sampling and analysis of groundwater from these wells indicated the presence of groundwater contamination that potentially extended underneath the airport terminal building. Groundwater collected from MW-9, installed immediately north of the terminal building was found to contain benzene at 5.48 ppm and GRO at

29.1 ppm (Rozak 2002a). However, data suggested the possibility that contamination in MW-9 could have resulted from another source near the terminal building. The analytical data also showed that the evaporation pond was effective at reducing contaminant levels in groundwater at the site.

1.3 Current Conditions

At the current time, the leading edge of the plume has not been delineated. Elevated soil and groundwater contaminant levels still exist in the area south of the former UST.

1.4 Groundwater Modeling

A preliminary groundwater model was developed in November 2002 for the KAFS site. Modeling results indicate that the contaminant plume has migrated down gradient of the site. However, contamination in MW-9 appears to be somewhat of an anomaly and may have several explanations, none of which can be proven at the current time. The high readings at MW-9 could be the result of 1) significant disturbance due to recent installation of the monitoring well, 2) indication of another source area near the north end of the terminal building, or 3) the movement of the center of mass of the plume as a pulse.

1.5 Remedial Action Objectives

The proposed objectives of the potential remedial actions at KAFS are to:

- Establish current contaminant levels and extent
- Determine health risk associated with the site
- Minimize leaching of contaminants from soil to groundwater; and
- Minimize migration of contaminants in groundwater from the site.

1.6 Work Plan Summary

This work plan addresses remedial actions proposed for the KAFS site and is presented in the following sections:

- Section 1.0 presents the introduction to the work plan, including a site description, historical information, sampling results, and remedial action objectives.
- Section 2.0 presents the nature and extent of contamination at the site.
- Section 3.0 presents the three phases of the proposed remedial action.
- Section 4.0 presents an overview for the design of the proposed remediation system.
- Section 5.0 lists references cited in this report.

2. NATURE AND EXTENT OF CONTAMINATION

This section describes the results of groundwater sampling and analyses activities at the KAFS site conducted in May 2002 (Rozak, 2002a). The analysis results are summarized in Table 2-1.

2.1 Groundwater Contaminant Levels

Analytical results from the May 30, 2002 groundwater-monitoring event conducted by Rozak Engineering are presented in this section. These results are compared to the applicable ADEC groundwater cleanup levels (18 AAC 75).

- **GRO** was detected in all five monitoring wells at the site in concentrations ranging from 0.3 mg/L to 29.1 mg/L. Samples from MW-9 (29.1 ppm) and MW-7 (2.65 ppm) exceeded the GRO drinking water cleanup level of 1.3 mg/L.
- **Benzene** was detected in all five samples in concentrations ranging from 0.022 mg/L to 5.48 mg/L. Benzene levels exceeded the ADEC cleanup level of 0.005 mg/L in all five wells. Ethylbenzene, toluene, and total xylenes levels from MW-9 exceeded cleanup levels.
- **EDB** was detected in groundwater samples from three of the groundwater wells (MW-8, MW-9, and MW-11). Concentrations of EDB ranged from 0.000034 mg/L to 0.000069 mg/L. EDB concentrations were only slightly above the cleanup level in MW-8 and MW-9

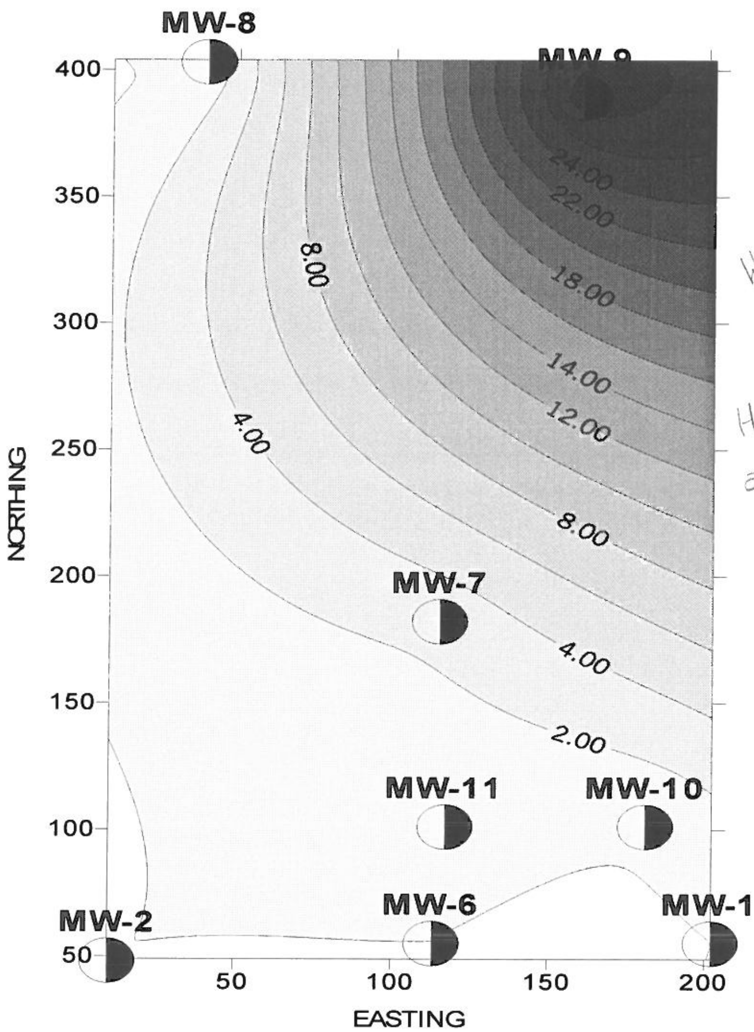
Table 2-1. Summary of Maximum Chemical of Concern Concentrations in Groundwater, mg/L

Analyte	May 2002 Result	ADEC Cleanup Level 1
GRO	29.1	1.5
Benzene	5.48	0.005
Toluene	6.92	1.0
Ethylbenzene	0.38	0.7
Xylenes	0.8	10
EDB	0.000069	0.00005
Notes: 1 Cleanup levels based on State of Alaska regulation 18 AAC 75.345.		

2.2 Groundwater Contaminant Plume Status

Modeling results indicate that the contaminant plume has migrated down gradient of the site and may have migrated beneath the airport terminal building. The airport terminal building is located immediately south of MW-9. However, contamination in MW-9 appears to be somewhat of an anomaly and may have several explanations, none of which can be proven at the current time. Figure 2-1 shows the May 2002 GRO contaminant plume at the site.

Figure 2-1. May 2002 GRO Plume Map.



Surfer

- Modeling of Oct sample results?

Which program generated this plume map?

Have you looked @ a benzene plume map?

2.3 Soil Contamination

The most recent soil sampling conducted in the area near the former UST site was conducted in 1999. The BTEX levels measured during that sampling event showed that the soil near the south end of the former tank pit were still contaminated, but at levels significantly less than detected during the initial site assessment in 1991. Benzene was detected at 51.5 mg/kg and GRO was detected at 160 mg/kg (Rozak, 1999). It is likely that due to the asphalt covering the site, very little volatilization occurs and the contaminants remain trapped within the soil at the site.

3. REMEDIAL ACTION

This work plan outlines several phases of remedial action to be undertaken at the KAFS site. Phase I is a data-gathering event to collect pertinent soil and groundwater data necessary to fully characterize the site. Phase II consists of an assessment of vapor migration and determination of risk, and Phase III outlines the design, construction, and operation of a remediation system.

3.1 Phase I

3.1.1 Point of Compliance Well

The information collected to date has not adequately characterized the site. In general, the down gradient or leading edge of the plume has not been detected and the groundwater plume remains undefined. A point of compliance (POC) well will be installed down gradient of the site in an area near the southeast end of the Kenai Airport terminal. The POC well will be used to define the down gradient extent of the plume and allow development of a comprehensive groundwater contamination map for the site. POC may be difficult, if not impossible, to establish due to other known and unknown contamination sites in the area. This data is also necessary to determine risk associated with the site as outlined in Phase II. Costs for Phase I activities are shown in Table 3-1.

3.1.2 Soil Gas Sampling

Soil gas contamination will be measured and evaluated for the potential for subsurface contamination in soil or ground water to adversely impact air quality in buildings at the site. Up to sixteen soil gas sample points will be identified. A probe sampler will be driven at each point. The probe will be connected to a PID or FID and volatile organic concentrations in the soil gas will be measured at depths of 1, 3, 5, 7, and 9 feet below ground surface (bgs).

all soil gas results to be reported.

- Four sampling points will be located along the north and west sides of the airport terminal building. Data from these sampling points will be used to assess the potential for migration of contaminated vapors into the airport terminal building.

- Up to four sampling points will be located along the north and west sides of the Alaska Flying Network building. Data from these sampling points will be used to assess the potential for migration of contaminated vapors into the AFN building.

- Up to four sampling points will be located in an area northwest of the north end of airport terminal building. These sampling points will be used to assess the pot existence of an additional source area contributing to contamination at MW-9.

parking area?

- Up to four additional sampling points will be located in the area immediately south former tank locations. Data collected at these locations will be used to determi relative contaminant levels that currently exist at the former tank location. This d

field screening however will require soil analyses above historic smear zone also be used to determine locations for soil borings, if required as part of the site characterization.

3.1.3 Soil and Groundwater Sampling

A complete round of groundwater samples will be collected from the nine existing wells at the site and the newly installed POC well. Thus, ten wells will be sampled for GRO/BTEX. Six of the wells will be sampled for EDB. All wells will be surveyed and sampled to develop a comprehensive groundwater map for the site. This data is necessary to determine the risk associated with the site and to develop a fate and transport model for the site as described in Phase II.

defined as: ?

Additionally, if significant soil contamination is detected during the soil gas sampling work, soil samples will be collected and analyzed for GRO/BTEX. Soil samples will be collected in conjunction with the soil gas samples and will utilize the same equipment (driven sampler). For cost purposes only, assume that 10 soil samples will be collected and analyzed as part of the Phase I assessment. Analytical data from soil samples could potentially provide evidence of another source area not associated with the KAFS site, or could provide information concerning contaminant concentrations at the former tank pit site necessary to assess risk and determine the need for installation of a remedial system. High levels of contaminants in existing wells confirm need for remedial system.

collect soil samples @ GW interface or deepest point.

Soil samples will also be analyzed to determine the physical parameters necessary to develop alternate cleanup levels under method three. The parameters are bulk density, porosities, moisture content, and total organic carbon. Hydraulic conductivity and infiltration rate will also be estimated from soil physical characteristics.

3.1.4 Optional Soil Borings

In the event that soil samples cannot be collected using the driven probe sampler, up to four soil borings will be drilled in the area immediately down gradient from the former tank pit location. As referenced in section 3.1.3, this data may be necessary to develop a current understanding of contaminant levels at the site in order to assess the need for installation of a remedial system. For cost purposes only, assume that up to four soil borings will be drilled at the site.

Table 3-1. Phase I Cost Estimate.

Item	Unit Rate	Quantity	Total
Install POC Well	LS	1	$3,000
Soil Gas Sampling	LS	1	$12,000
Soil/Groundwater Sampling and Analytical Testing	LS	1	$6,000
Optional Soil Borings	LS	1	$4,000

Subtotal	$25,000
10% Contingency Factor	$2,500
Total Estimated Cost	$27,500

3.2 Phase II

Phase II of the work plan involves assessment of risk for subsurface migration of soil vapors into buildings at the KAFS site and at the airport terminal. This phase also involves determination of alternate cleanup levels (ACLs) using method three, and work to establish that the aquifer at the site be designated as a non-drinking water aquifer. Numerical modeling will also be performed to demonstrate contaminant plume dynamics and provide data input for the risk assessment. Phase II costs are shown in Table 3-2.

3.2.1 Subsurface Soil Vapor Assessment

Empirical soil vapor contaminant data will be input into a model for estimation of subsurface vapor migration into buildings. Since 1998, EPA has developed a series of models for estimating indoor air concentrations and associated health risks from subsurface vapor intrusion into buildings. One model, the Johnson and Ettinger Model, is specifically used to determine contaminant partitioning and subsurface vapor transport into buildings. The Johnson and Ettinger Model will be used to assess conditions at the KAFS, specifically the risk and potential for vapor migration into the AFN building and the airport terminal building. Lab numbers needed on vapor readings from soils. Chemical specific concentrations

Additionally, measured soil vapor contaminant data will be used to develop an empirical soil vapor map of the site. sample collection techniques.

3.2.2 Alternate Cleanup Levels

Method three allows flexibility in determining alternate cleanup levels for soil and groundwater at contaminated sites. Site-specific data collected as part of Phase I will be used to determine alternate cleanup levels for the KAFS site. Either the calculations will be done by hand, showing all necessary calculations, or the method three calculator will be used in evaluating the ACLs. If necessary, a complete method four risk assessment will be performed utilizing the data collected during Phase I and all previous sampling events.

In addition to assessing ACLs, information will be collected to pursue a determination that the aquifer is a non-drinking water source. This determination will be made in coordination with the City of Kenai and the surrounding community. public notice

3.2.3 Fate and Transport Modeling

Soil and groundwater data (physical, geologic, and contaminant data) will be used to develop a fate and transport model to assess long-term trends within the contaminated groundwater plume. The model used will likely be MODFLOW, Groundwater Vistas, or a similar model and will be capable of predicting plume movement based on the hydrology, geology, and contaminant initial conditions. Data collected during Phase I will be critical to development of the model and determining the initial conditions at the site. The model output will be used in the risk assessment at the site, and will also be used during development of a long-term monitoring plan, if necessary.

Table 3-2. Phase II Cost Estimate.

Item	Unit Rate	Quantity	Total
Soil Vapor Assessment	LS	1	$5,000
ACLs and Risk Assessment	LS	1	$10,000
Fate and Transport Modeling	LS	1	$15,000
Subtotal			$30,000
5% Contingency Factor			$1,500
Total Estimated Cost			$31,500

3.3 Phase III

The existing remedial system (evaporation pond/trench) located at the KAFS site may be adequate to treat groundwater flowing down gradient from the former tank site. That system however, will not provide remediation of contaminated soil potentially located at the former UST site. If data collected during Phase I indicate that significant contamination still exists at the former tank site to warrant installation of a treatment system, then Phase III will be implemented. The selected remedial action for contaminated groundwater and soil at the KAFS site is treatment of the groundwater-soil interface or smear zone using air sparging/soil vapor extraction (AS/SVE). Periodic groundwater monitoring would be conducted to assess the effectiveness of the remediation process. Shallow groundwater, the asphalt capped parking area, relatively volatile contaminants, and the relatively homogeneous fine sands found at the site bode well for the effectiveness of the remedial technique. This section describes the selected remedial action.

3.3.1 Remedial Action Evaluation

AS/SVE is an effective method for removing the volatile component of petroleum hydrocarbons and provides an oxygenated zone that promotes biodegradation. An SVE well would be installed in the center of four radially-spaced AS wells to promote vapor movement through the contaminated soil and groundwater at the site. Combination of SVE and AS wells would prevent vapor migration away from the treatment area.

The following describes the effectiveness, implementability, and costs of the selected remedial action at the KAFS site:

- Effectiveness: AS/SVE are highly effective in removing volatile compounds from soil and groundwater and for promoting biodegradation of petroleum contaminants.
- Implementability: The potentially contaminated soil area is located within the middle of an existing paved airplane parking/taxi area and is immediately south of the existing underground fuel tanks. An AS/SVE system would be installed by drilling the wells through the asphalt, and then trenching through the asphalt to install supply lines from the wells to the blower/vacuum pumps and control. Installation of wells and associated piping will take four to seven days and will cause some disruption to the operations of businesses at the AFN building.
- Cost: Capital costs for AS/SVE systems are relatively high and construction efforts are moderate due to the well installation and trenching. Groundwater monitoring and evaluation would also be required over the near term. However, long-term operational costs are considered relatively low because an AS/SVE system would only need to operate for a short time period. Estimated costs are provided in Table 3-3. These costs are based on previous experience with similar systems and do not account for used equipment that may be acquired from another site. Second year O&M and third year groundwater monitoring costs are included in the contingency amount.

Table 3-3. Phase III Cost Estimate.

Item	Unit Rate	Quantity	Total
Capital Costs			
One AS/SVE System (design, reports equipment and installation)	LS	1	$175,000
Operation and Maintenance Costs			
Systems O & M	$12,000/yr	1-2 years	$12,000
Groundwater Monitoring	$12,000/yr	2-3 years	$24,000
Decommission MWs and AS/SVE system, restore site	LS	1	$15,000
Subtotal			$226,000
15% Contingency Factor			$33,900
Total Estimated Cost (nearest $5,000)			$260,000

3.4 Total Project Costs

The total projected costs of the project (Phases I, II, and III) are shown in Table 3-4. The costs of specific items are subject to change and not all phases of the project may be necessary based on the data collected at the site. The actual cost will be determined as the project develops.

Table 3-4. Total Project Cost Estimate.

Item	Unit Rate	Quantity	Total
Phase I	LS	1	$27,500
Phase II	LS	1	$31,500
Phase III	LS	1	$260,000
Total Estimated Cost			$319,000

4. REMEDIATION SYSTEM DESIGN

This section presents a conceptual remedial design plan or approach for the KAFS site. The selected remedy—AS/SVE—is expected to reduce contaminants below regulatory cleanup levels for contaminated soil and groundwater immediately down gradient of the former UST site. This section presents general details that would be included or taken into consideration in the preparation of a final remedial action design.

4.1 Treatment Process

AS is a technique used for removing hydrocarbons and VOCs from saturated and unsaturated (vadose) soil zones. Air is injected into a sparging well within the saturated zone. Air flows outward and upward from the sparging well into the saturated zone through a branched network of air channels. As air moves through the capillary fringe and contacts the vadose zone, the channeling effect diminishes, and air flows more uniformly through the soil.

SVE is a similar technology whereby soil vapors are extracted through wells placed in the vadose zone. During the SVE process, vacuum pressure created in the vadose zone causes air to flow toward the SVE well. SVE systems are often used in conjunction with AS systems to control the off-site migration of organic vapors displaced during the sparging process.

Contaminant removal from AS/SVE systems is accomplished by volatilization and biodegradation. The contributions from these mechanisms are largely factors of the airflow rate; contaminant volatility; and physical properties of the soil and groundwater such as soil type, porosity, and hydraulic conductivity. Within the saturated zone and the capillary fringe, these removal mechanisms readily occur along the flow channels. However, a great portion of the contaminant mass may be distributed in saturated pore spaces disconnected from the air channels. Removal of this "disconnected" contamination would be dependent upon the rates of mass transfer and contaminant volatilization between air channels and saturated voids.

The primary contaminant removal mechanism of the remedial system is volatilization. Volatilization is effective at treating all the chemicals of concern (COCs) at the site except DRO. Biodegradation will occur but is not a significant component in contaminant reduction in order to reach the remedial action objectives of the COCs except for DRO. Reductions in DRO will be achieved through long-term biodegradation.

4.2 Design Assumptions

The area to be treated includes the former location of the USTs and the immediately down gradient groundwater. The AS/SVE system would be housed in a conex or similar container that includes intrinsically safe equipment.

The AS/SVE system would include the following components:

- One AS system that injects air below the water table would be used. A total of four or more AS wells would be installed.
- One SVE system would be used to remove soil vapors from above the water table. A total of one or more SVE wells would be installed.
- An underground piping system would be used to connect the blowers to the AS injection and SVE extraction wells. Trenching would be required to bury the distribution and service lines. The trenches would be partially grouted during backfilling to prevent short-circuiting of air-flow through the trench.

After installation, the system would be operated for about one to two years to effectively remediate the potentially contaminated soil area immediately south of the former UST location. Monitoring would be performed once each month to adjust air injection and extraction rates, measure air emissions, and perform system inspection and preventive maintenance.

The AS/SVE system would be designed and installed to operate under the following guidelines:

- Control vapor migration to minimize the movement of vapors into adjacent structures,
- Operate for a limited time necessary to effectively remediate the contaminated soil area,
- Minimize migration of dissolved groundwater concentrations, and
- Operate year-round.

4.3 Sparging Wells

AS wells are designed to provide the conduit by which air is delivered to the subsurface. Typical AS wells would be constructed of 1.25-inch (nominal size), Schedule 40, black iron riser pipe with a 4-foot section of 0.010-inch vertically cut stainless-steel screen and would be installed using direct-push technology.

Well Placement and Spacing

The AS injection wells would be placed within the groundwater zone of greatest contamination and at locations that would not interfere with existing utilities. Four or more AS wells would be installed at the site to a depth of about 18 feet below ground surface. This would be about 5 to 8 feet below the groundwater surface.

The wells would be typically spaced approximately 10 meters (30 feet) on center from the SVE well. This well spacing is based on an estimated 10-meter radius of influence of the AS treatment areas.

Wellhead Access

The wellheads would be accessible through a wellhead access chamber. A typical access chamber would be a 12-inch-diameter, flush-mount well box.

4.4 Soil Vapor Extraction System

The primary purposes of the SVE system are to volatilize contaminants in the vadose zone and to capture vapors that are produced during air sparging. Components of the SVE system include the extraction blower, extraction wells, associated piping and flow-control valves, and water knockout tank.

4.5 Air Extraction Requirements

Air would be extracted from the SVE wells by using a flow rate of approximately 40 to 60 scfm per well, depending upon the final number of wells. The total airflow rate from the SVE wells would equal or exceed the airflow rate of the air sparging system. The design radius of influence for the SVE wells is estimated to be approximately 60 feet.

Air would be extracted from the SVE wells with a blower to achieve the airflow and vacuum head requirements of the SVE system. Vacuum and pressure relief valves would be installed on the inlet and outlet sides of the blower to maintain airflow to the blower in case a line obstruction occurs.

4.6 Piping and Airflow Control

Extracted air would flow from the SVE wellheads through a piping system sized to minimize head loss. Service lines from the wells are typically constructed of 2-inch inside diameter, high-density polyethylene pipe or compressor hose that transitions to 2-inch inside diameter, braided polyvinyl chloride (PVC) hose at the flow meter connections. Airflow would be controlled by a valve on each individual SVE service line. Airflow from each well would converge into a remote manifold enclosure (RME). Airflow from the RME would then flow through a common pipe through an RME subgrade knockout drum to a manifold in the connex. Air would then move through a connex knockout drum and the extraction blower and would then discharge to the outside of the connex through a stack pipe. The stack pipe could be routed to an off-gas treatment system as needed. SVE piping inside the connex is typically Schedule 40, 2-inch black iron. The programmable logic controller would control flow between the RME and the off-gas treatment system.

4.7 Extraction Wells

The SVE well would induce airflow through the contaminated soil and collect air forced into the vadose zone by the sparging system. The well casing and screen are typically constructed of 4-inch ID, flush-threaded, Schedule 40 PVC. The well would extend to a depth of about 6 feet below ground surface. The well screen would have 0.020-inch double slots. The borehole annulus is usually backfilled with pea gravel from the bottom of the screened interval to approximately two feet above the screen. The remainder of the annulus would be backfilled with bentonite grout.

Well Placement and Spacing

The intent of the SVE system is to capture the air that is injected through the AS wells and volatile vapors that subsequently partition into the gas phase. Based on preliminary calculations using the hydraulic conductivity and moisture content of the Kenai sand typically found at the site, the radius of influence for a SVE well is about 60 feet. Thus, one SVE well should be capable of capturing air injected through the AS wells.

4.8 Trenching

All main lines and service lines leading to the SVE and sparging wells would be insulated and placed below ground surface in trenches. To minimize the number of trenches, SVE and sparging pipes would be consolidated in a common trench wherever possible. Pipe trenches would typically be excavated to approximately 12 inches below the existing ground surface and backfilled, with grout used to prevent short-circuiting.

4.9 Soil Gas Monitoring Wells

Soil gas monitoring wells would be installed at three locations within and external to the treatment system to assess efficiency and to ensure that vapors from the AS wells are not migrating away from the treatment area.

5. REFERENCES

Alaska Department of Environmental Conservation (ADEC) 2000a. Title 18 Alaska Administrative Code (AAC) Chapter 78, Underground Storage Tanks, as amended through August 27.

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