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CAPE ROMANZOF LRRS
ALASKA

ADMINISTRATIVE RECORD
COVER SHEET

AR File Number 08

Installation Restoration Program (IRP) Remedial Investigation/Feasibility Study

Stage 1

Cape Romanzof LRRS, Alaska

Prepared by

Woodward-Clyde Consultants

500 12th Street, Suite 100, Oakland, CA 94607-4014

June 1990

Second Draft Report (July 1989 – May 1990)

Prepared for

Alaskan Air Command
(HQ AAC/DEPV)

Elmendorf Air Force Base, Alaska 99506

United States Air Force
Human Systems Division (AFSC)
IRP Program Office (HSD/YAQ)

Brooks Air Force Base, Texas 78235-5501

DRAFT
INSTALLATION RESTORATION PROGRAM
REMEDIAL INVESTIGATION/FEASIBILITY STUDY

STAGE 1

SECOND DRAFT REPORT

FOR

CAPE ROMANZOF LRRS (ROM), ALASKA

June 1990

Prepared by

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A remedial investigation/feasibility study was conducted for nine sites at the Cape Romanzof LRRS, Alaska. The field investigation included well installation, soil sampling, a soil gas survey at two sites, and mapping. Chemical analyses were made on the samples.

As a result of the remedial investigation and qualitative risk assessment, three sites (ROM-1D 5099th Disposal Pit, ROM-4 Road Oiling, and ROM-5 New Landfill) were classified as Category 1, having no significant risks. One site (ROM-1S Aquifer) was classified as Category 2, referred to further study. Six sites (ROM-1D Waste Accumulation Area, ROM-1S Soil, ROM-3 Former Shop Area, ROM-8 Landfill, ROM-10 Former Truck Fill Stand, and ROM-12 Former Drum Storage Area) were classified as Category 3, for which feasibility studies were completed and remedial alternatives selected.

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PREFACE

This Technical Report describes the investigative and evaluative techniques and results adopted for the USAF under contract F33615-85D-4544 delivery order number 0005 to conduct an IRP Remedial Investigation/Feasibility Study (RI/FS) for the Cape Romanzof Long Range Radar Site (LRRS), one of the Alaskan Long Range Radar (LRRS) locations.

This assignment includes reviewing site history and defining the framework for this RI/FS; establishing the environmental setting through existing reports; conducting the field investigation program in conformance with the Stage 1 Final Work Plan; discussing results and significant findings, including providing a qualitative risk screening of identified contaminated sites; identification, screening, and analysis of remedial measures; and recommending which site requires no further IRP action, requires additional IRP effort, or requires recommended remedial actions. Field work took place in summer 1989.

Captain Walter Migdal, Human Systems Division, IRP Program Office (HSD/YAQ), was the Technical Project Manager.

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Executive Summary

EXECUTIVE SUMMARY

From July 25 to August 14 and from September 28 to 29, 1989, Woodward-Clyde Consultants (WCC) conducted a remedial investigation of soil, surface water and groundwater contamination at nine sites at the United States Air Force (USAF) Long Range Radar Site (LRRS) at Cape Romanzof, Alaska. The nine sites investigated included locations where diesel fuel, hazardous materials, waste oils, and ethylene glycol had been stored; locations where fuel or waste oils had been reportedly spilled; locations where landfills were filled with debris and hazardous materials; locations where waste oils had been applied to road surfaces for dust control; and surface water and groundwater at and near these locations (Engineering Sciences 1985). A brief description of each investigated site follows:

<u>ROM-1 Waste Accumulation Area</u>: location where drummed new products and liquid wastes had been stored until 1982. Several major spills and leaks of diesel fuel and MOGAS from storage tanks and pump fill nozzles have occurred nearby. The site is located between the Composite Facility and the Lower Camp POL tanks on the north side of the access road. Surface soils are fill material composed of sandy silt with boulders.

<u>ROM-1D 5099th Disposal Pit</u>: location where debris and other wastes were deposited when the Lower Camp facilities were razed. The site is a backfilled pit immediately south of the present fueling station. Surface soils are fill material composed of sandy silt with boulders and trace clay.

ROM-1S Large Fuel Spill: location where a large fuel spill (14,000 gallons) occurred. The site is south of the present fueling station and southwest of the demolished Lower Camp. The soils are native tundra. Two abandoned wells are within the boundary of distressed vegetation attributable to the spill.

ROM-3 Former Shop Area: location where oils, hydraulic fluids, solvents, toluene, paints, and ethylene glycol had been stored, leaked, and spilled. The site is the former shop area at Lower Camp, east of ROM-1D. The site also includes the groundwater of the installation water supply well and the surface water of the lake behind Huson Dam. Soils are fill material composed of sandy silt with boulders.

ROM-4 Road Oiling: location where liquid industrial wastes were applied to the road surface and the adjacent drainage ditches for dust control. The site includes the Upper Camp and Lower Camp roads. Soils are fill materials composed of sandy silt.

ROM-5 New Landfill: location where various wastes, debris, and garbage have been deposited. The site is behind (uphill of) the Composite Facility and drains down past the Industrial Dome to the main drainage ditch along the road. Soils in the drainage are fill material composed of sandy silt with boulders.

ROM-8 Landfill: location where various wastes, debris, and garbage have been deposited. The site is south of the access road, about ½ mile west of the Composite Facility. The landfill is covered by fill material (sandy silt with boulders) and is surrounded by native tundra. The tundra was excavated in many areas for landfill cover material. The surface water and groundwater in the vicinity are part of this site.

ROM-10 Former Truck Fill Stand: location where small POL spills associated with tank filling and transfers occurred. The site is above the beach at Kokechik Bay. Surface soils are native sandy silt with boulders.

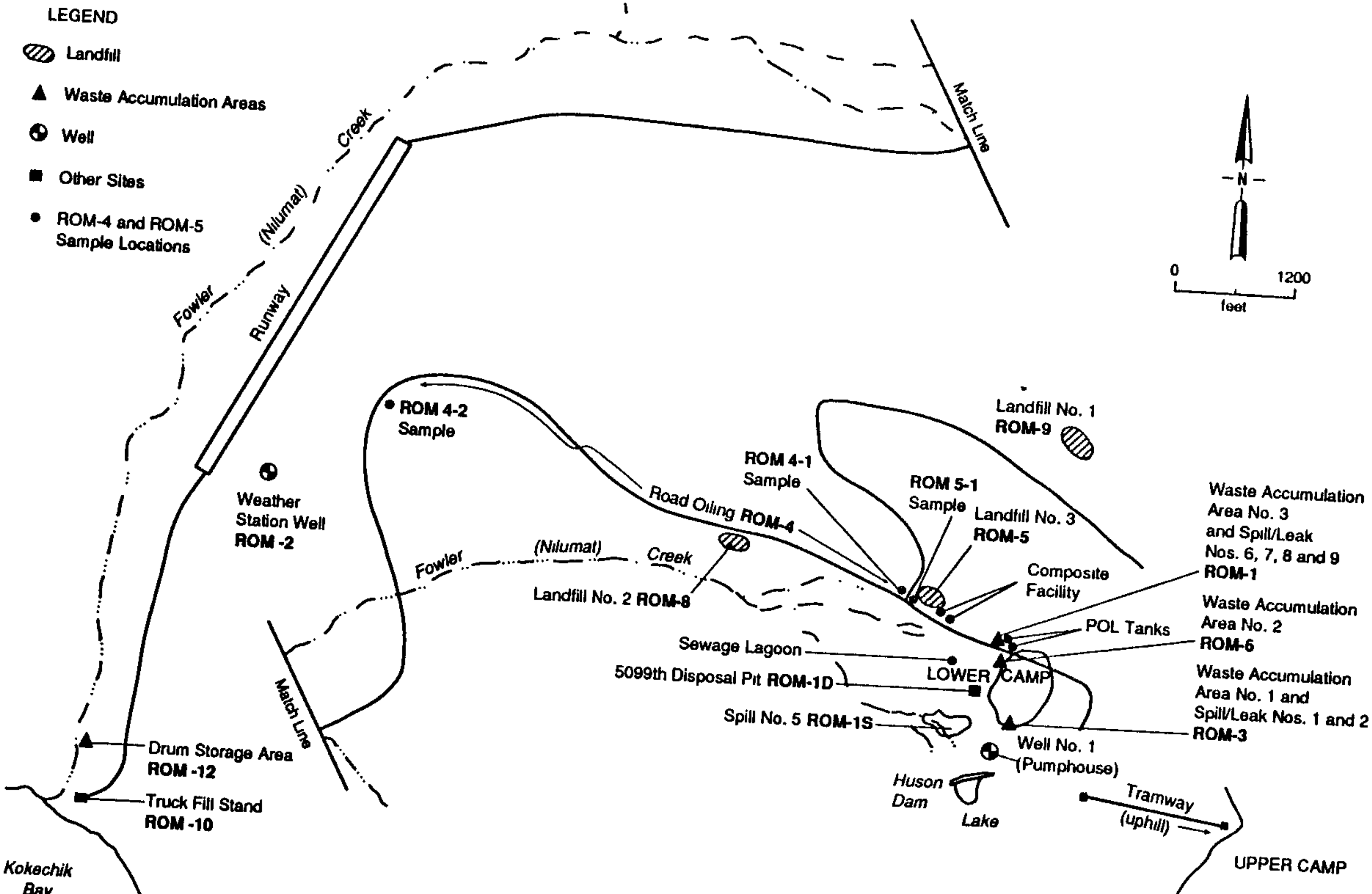
ROM-12 Former Drum Storage Area: location where drummed liquid wastes had been staged for shipment. The site is east of the beaver ponds near the mouth of Fowler Creek, and south of Fowler Creek. This site was identified by the WCC field crew in Summer 1989. The surface soils are native sandy silt with boulders, blackened from many spills or leaks.

These sites are shown on Figure ES-1. Other sites shown on the same figure (ROM-2, -6, -7, -9, and -11) were inspected and withdrawn from the investigation program either because they could not be located, the area appeared clean, or access to the site was too difficult to attain.

The field program included a soil gas survey at ROM-1D and ROM-3; soil/sediment sampling at all sites; surface water sampling at ROM-3 lake, ROM-8 streams, and ROM-12 beaver pond; groundwater sampling at ROM-1S, ROM-3, and ROM-8; monitoring well installation at ROM-8; surficial mapping of ROM-1S and ROM-8; and a hydrologic and geologic reconnaissance. A summary of field activities and quantities is presented in Table ES-1.

Analytical laboratory results of soil samples indicate that the only soil contamination problem at Cape Romanzof LRRS is total petroleum hydrocarbons (TPHs). Surface water sample results indicate that at ROM-8 only, the water is contaminated in certain areas with TPHs and PCBs. Groundwater results at ROM-1S abandoned wells and ROM-3 installation water supply well indicate the presence of TPHs and alpha BHC, a pesticide. A summary of maximum and geometric mean concentrations of chemicals in soil, surface water, and groundwater is shown in Tables ES-2 and ES-3.

The State of Alaska Department of Environmental Conservation (ADEC) interim standard for TPHs in soil of 100 mg/kg has been adopted as the cleanup standard at Cape Romanzof. A state ambient water quality criterion (AWQC) for surface water of 15 μg/L for TPHs is applied here. The federal and state AWQC of 92 ng/L for alpha BHC in surface water is applied to the groundwater because alpha BHC is a known carcinogen.



Note. The installation boundary is several thousand feet beyond the facilities shown
Source: Installation Documents and 1989 Field Investigation

Project No. 90275L	Cape Romanzof LRRS	SITE LOCATION MAP	Figure ES-1
Woodward-Clyd Consultants			

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Table ES-1. SUMMARY OF FIELD WORK BY SITE AT CAPE ROMANZOF LRRS

	ROM-1	ROM-1S	ROM-1D	ROM-3	ROM-4	ROM-5	ROM-8	ROM-10	ROM-12	Total
No. of Wells	--	--	--	--	--	--	4	--	--	4
Total Depth (feet)	--	--	--	--	--	--	56	--	--	56
Days of Soil Gas	--	--	3	4	--	--	--	--	--	7
Days of Mapping	--	3	--	--	--	--	4	--	--	7
Surface Water Samples	--	--	--	1	--	--	10	--	1	12
Groundwater Samples	--	2	--	1	--	--	4	--	--	7
Soil and Sediment Samples	3	4	2	5	2	1	10	1	3	31

Table ES-2. GEOMETRIC MEANS AND HIGHEST MEASURED CONCENTRATIONS OF CHEMICALS IDENTIFIED IN SOIL SAMPLES FOR EACH SITE AT CAPE ROMANZOF LRRS

Chemical Name	ROM-1		ROM-1S		ROM-1D		ROM-3		ROM-4	
	Max	Geom mean	Max	Geom mean	Max	Geom mean	Max	Geom mean	Max	Geom mean
Aluminum	8540.00	7668.86	NA	NA	11200.00	9103.85	9500.00	6893.77	7900.00	7900.00
Barium	54.00	51.27	NA	NA	51.00	50.50	89.00	66.53	68.00	68.00
Beryllium	ND	ND	NA	NA	0.20	0.14	ND	ND	0.20	0.20
Cadmium	ND	ND	NA	NA	ND	ND	ND	ND	ND	ND
Chromium	16.00	13.56	NA	NA	20.00	17.89	18.00	15.80	27.00	27.00
Cobalt	4.00	4.00	NA	NA	5.00	5.00	6.00	2.40	5.00	5.00
Copper	9.00	6.60	NA	NA	12.00	10.95	88.00	20.01	14.00	14.00
Lead	24.00	13.39	NA	NA	ND	ND	160.00	46.53	89.00	89.00
Manganese	170.00	160.72	NA	NA	290.00	228.47	200.00	133.91	163.00	163.00
Nickel	12.00	10.63	NA	NA	11.00	11.00	30.00	11.78	11.00	11.00
Vanadium	26.00	23.58	NA	NA	35.00	28.98	30.00	23.22	27.00	27.00
Zinc	89.00	47.31	NA	NA	33.00	30.40	120.00	52.35	81.00	81.00
Acetone	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bis(2-ethylhexyl)phthalate	ND	ND	ND	ND	ND	ND	ND	ND	2.40	2.40
BHC,alpha	ND	ND	NA	NA	ND	ND	ND	ND	ND	ND
Dichloroethane, 1,1-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dichlorobenzene, 1,4-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dichlorodifluoromethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dioctylphthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methylene chloride	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methylnaphthalene	16.00	1.00	ND	ND	ND	ND	ND	ND	ND	ND
Methylphenol, 2,4-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCBs	ND	ND	NA	NA	ND	ND	0.39	0.13	ND	ND
Trichloroethane, 1,1,1-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Toluene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Xylene	33.00	0.44	ND	ND	ND	ND	ND	ND	ND	ND
TPHs	3500.00	609.21	17000.00	5836.30	30.00	21.21	35000.00	13539.28	380.00	194.94

*Concentrations are in mg/kg.
NA = No analysis performed
ND = Not detected

Table ES-2. GEOMETRIC MEANS AND HIGHEST MEASURED CONCENTRATIONS OF CHEMICALS IDENTIFIED IN SOIL SAMPLES FOR EACH SITE AT CAPE ROMANZOF LRRS (concluded)

Chemical Name	ROM-5 Max	ROM-5 Geom mean	ROM-8 Max	ROM-8 Geom mean	ROM-10 Max	ROM-10 Geom mean	ROM-12 Max	ROM-12 Geom mean
Aluminum	5900.00	5900.00	7100.00	3403.00	NA	NA	7600.00	2598.49
Barium	61.00	61.00	58.00	39.27	NA	NA	45.00	25.30
Beryllium	ND	ND	ND	ND	NA	NA	ND	ND
Cadmium	ND	ND	7.00	1.64	NA	NA	ND	ND
Chromium	15.00	15.00	19.00	8.78	NA	NA	14.00	7.14
Cobalt	ND	ND	ND	ND	NA	NA	ND	ND
Copper	5.00	5.00	24.00	7.75	NA	NA	7.00	3.48
Lead	ND	ND	430.00	32.33	ND	ND	38.00	15.60
Manganese	130.00	130.00	250.00	130.20	NA	NA	81.00	33.59
Nickel	10.00	10.00	14.00	6.56	NA	NA	6.00	4.22
Vanadium	21.00	21.00	24.00	12.39	NA	NA	25.00	10.77
Zinc	23.00	23.00	370.00	56.89	NA	NA	35.00	12.95
Acetone	ND	ND	0.12	0.06	NA	NA	0.16	0.07
Bis(2-ethylhexyl)phthalate	ND	ND	ND	ND	NA	NA	ND	ND
BHC,alpha	ND	ND	ND	ND	NA	NA	ND	ND
Dichloroethane, 1,1-	ND	ND	ND	ND	NA	NA	ND	ND
Dichlorobenzene, 1,4-	ND	ND	ND	ND	NA	NA	ND	ND
Dichlorodifluoromethane	ND	ND	ND	ND	NA	NA	ND	ND
Dioctylphthalate	ND	ND	ND	ND	NA	NA	ND	ND
Methylene chloride	ND	ND	ND	ND	NA	NA	0.59	0.11
Methylnaphthalene	ND	ND	ND	ND	NA	NA	ND	ND
Methylphenol, 2,4-	ND	ND	ND	ND	NA	NA	ND	ND
PCBs	ND	ND	ND	ND	NA	NA	0.21	0.13
Trichloroethane, 1,1,1-	ND	ND	ND	ND	NA	NA	ND	ND
Toluene	ND	ND	ND	ND	NA	NA	ND	ND
Xylene	ND	ND	ND	ND	NA	NA	ND	ND
TPHs	100.00	100.00	100000.00	297.50	4900.00	4900.00	200000.00	100000.00

Table ES-3. GEOMETRIC MEANS AND HIGHEST MEASURED CONCENTRATIONS OF CHEMICALS IDENTIFIED IN WATER SAMPLES (RECOVERABLE FRACTION) FROM FOUR SITES AT CAPE ROMANZOF LRRS

Contaminant	Surface Water						Groundwater					
	ROM-3		ROM-8		ROM-12		ROM-1S		ROM-3		ROM-8	
	Highest	Geom Mean	Highest	Geom Mean	Highest	Geom Mean	Highest	Geom Mean	Highest	Geom Mean	Highest	Geom Mean
Aluminum	ND	ND	0.900	0.135	ND	ND	347.000	3.149	ND	ND	102.000	15.110
Barium	ND	ND	0.100	0.015	0.010	0.010	6.600	0.181	ND	ND	0.680	0.234
Beryllium	ND	ND	ND	ND	ND	ND	0.009	0.002	ND	ND	0.003	0.001
Cadmium	ND	ND	0.009	0.003	ND	ND	0.003	0.003	ND	ND	0.006	0.003
Chromium	ND	ND	ND	ND	ND	ND	0.092	0.027	ND	ND	0.150	0.038
Cobalt	ND	ND	ND	ND	ND	ND	0.200	0.043	ND	ND	0.040	0.024
Copper	ND	ND	ND	ND	ND	ND	0.360	0.043	ND	ND	0.080	0.035
Lead	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Manganese	ND	ND	1.100	0.042	ND	ND	10.000	1.018	ND	ND	2.700	1.614
Nickel	ND	ND	ND	ND	ND	ND	0.540	0.024	ND	ND	0.100	0.025
Vanadium	ND	ND	ND	ND	ND	ND	0.980	0.073	ND	ND	0.230	0.050
Zinc	0.060	0.060	0.070	0.026	0.050	0.050	4.200	0.324	0.030	0.030	0.290	0.122
Acetone	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bis(2-ethylhexyl)phthalate	ND	ND	11.000	5.372	ND	ND	37.000	9.743	14.000	14.000	32.000	7.953
BHC,alpha	ND	ND	ND	ND	ND	ND	0.093	0.039	ND	ND	ND	ND
Dichloroethane, 1,1-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.450	0.245
Dichlorobenzene, 1,4-	ND	ND	4.700	0.326	ND	ND	ND	ND	ND	ND	3.800	0.494
Dichlorodifluoromethane	ND	ND	11.000	4.881	ND	ND	4.500	4.500	ND	ND	ND	ND
Dioctylphthalate	ND	ND	ND	ND	17.000	17.000	20.000	7.937	ND	ND	23.000	7.323
Methylene chloride	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methylphenol, 2,4-	ND	ND	220.000	7.053	ND	ND	ND	ND	ND	ND	ND	ND
PCBs	ND	ND	2.700	0.583	ND	ND	ND	ND	ND	ND	ND	ND
Trichloroethane, 1,1,1-	ND	ND	1.100	0.151	ND	ND	ND	ND	ND	ND	ND	ND
Toluene	ND	ND	5.200	0.719	ND	ND	ND	ND	ND	ND	6.000	0.278
Xylene	ND	ND	4.000	1.134	ND	ND	ND	ND	ND	ND	7.100	0.971
TPHs	ND	ND	4.000	0.730	ND	ND	4.000	2.000	2.000	2.000	6.700	1.609
											2.000	0.707

NA = No analysis performed
ND = N[redacted]etected in any of the samples from the site.
Me[redacted]onc[redacted]tio[redacted]own [redacted]g/L, [redacted]rs a[redacted]n µ[redacted]

Evaluation of the significance of contaminant concentrations with respect to the cleanup levels and other site conditions by a qualitative risk assessment indicates that three sites require no further action (Category 1 sites): ROM-1D 5099th Disposal Pit, ROM-4 Road Oiling, and ROM-5 New Landfill. Six sites have contaminant concentrations requiring consideration of remedial action (Category 3 sites): ROM-1 Waste Accumulation Area, ROM-1S Large Fuel Spill, ROM-3 Former Shop Area, ROM-8 Landfill, ROM-10 Former Truck Fill Stand, and ROM-12 Former Drum Storage Area.

Within the aquifer beneath ROM-1S, which aquifer likely extends southeastward toward Huson Dam (see Figures ES-1 and 4-2), there may be a health risk; groundwater from this aquifer is the current installation water supply. A water sample from the water supply well (near Huson Dam) contained TPHs concentrations exceeding state ambient water quality standards. However, toxic or carcinogenic TPHs constituents were not detected, and insufficient data are available to evaluate the risk. Additional investigation is recommended for the site. This site was classified a Category 2 site.

A feasibility study was performed for the six sites requiring consideration of remedial action. A variety of remedial technologies were developed and screened for each general response action (Tables ES-4 and ES-5), and four operable units were defined (Table ES-6). The four operable units are TPHs in disturbed native soils or fill (ROM-1, ROM-10, and ROM-12), TPHs in undisturbed native soils (ROM-1S), TPHs (soil) and PCBs (surface water) at the ROM-8 Landfill, and TPHs at the ROM-3 Former Shop Area.

Remedial alternatives were developed for each operable unit, as shown in Table ES-6, using the associated technologies for the general response actions identified in Tables ES-4 and ES-5 and a detailed evaluation of the alternatives was performed. The alternatives were then rated and ranked and a recommended alternative selected. A summary of the recommendations for each site is presented in Table ES-7.

Table ES-4. LISTING OF GENERAL RESPONSE ACTIONS AND ASSOCIATED TECHNOLOGIES FOR CONTAMINATED SOIL AT CAPE ROMANZOF LRRS

General Response Action	Associated Technology for Soil
No Action/Institutional Controls	• Long-Term Monitoring • Fencing/Long-Term Monitoring
Containment	• Surface Caps • Surface Covers
Extraction	• Excavation
Onsite Treatment or Disposal	Physical • Soil Washing • Fixation • Thermal Technologies • Landfill Chemical • Reagent Oxidation Biological • Landfarming
Offsite Treatment or Disposal	• Landfill • Incineration
In Situ Treatment	Physical • Vapor Extraction • Steam Extraction • Attenuation • Fixation • Soil Washing Chemical • Photolysis Biological • Enhanced Biodegradation

Table ES-5. LISTING OF GENERAL RESPONSE ACTIONS AND ASSOCIATED TECHNOLOGIES FOR CONTAMINATED SURFACE WATER AT CAPE ROMANZOF LRRS

General Response Action	Associated Technology for Surface Water
No Action	• Long-Term Monitoring
Containment	• Hydraulic Barriers • Surface Water Diversion Ditches
Extraction	• Surface Water Collection
Onsite Treatment or Disposal	Physical • Air/steam stripping • Reverse Osmosis • GAC Chemical • Reagent Oxidation • Wet Air Oxidation Biological • Disposal at Cape Romanzof Sewer Plant

Table ES-6. REMEDIAL ALTERNATIVES BY OPERABLE UNIT AT CAPE ROMANZOF LRRS

OPERABLE UNIT A - DISTURBED NATIVE SOILS OR FILL

ROM-1 Waste Accumulation Area, ROM-10 Former Truck Fill Stand, and ROM-12 Former Drum Storage Area

1A - No Action/Institutional Controls
2A - Capping
3A - Excavation/On-Site Thermal Treatment
4A - Excavation/On-Site Landfarming

OPERABLE UNIT B - UNDISTURBED NATIVE SOILS

ROM-1S Large Fuel Spill

1B - No Action/Institutional Controls
2B - In Situ Enhanced Biodegradation

OPERABLE UNIT C - LANDFILL

ROM-8 Landfill

1C - No Action/Institutional Controls
2C - Capping with Hydraulic Controls
3C - Capping with Collection and On-site Treatment of Surface Water

OPERABLE UNIT D - FORMER SHOP AREA

ROM-3 Former Shop Area

1D - No Action/Institutional Controls
2D - Capping

Note: Numbers distinguish between alternatives only. No priority ranking is intended or implied.

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Table ES-7. RECOMMENDED FUTURE IRP EFFORTS FOR EACH SITE AT CAPE ROMANZOF LRRS

Site	Recommended IRP Effort	Category[a]
ROM-1	Excavation with landfarming	3
ROM-1D	No further action	1
ROM-1S Soil	No action	1
ROM-1S Aquifer	Investigate groundwater characteristics at the site	2
ROM-3	Capping	3
ROM-4	No further action	1
ROM-5	No further action	1
ROM-8	Capping with hydraulic controls	3
ROM-10	Excavation with landfarming	3
ROM-12	Excavation with landfarming	3

[a] Categories are:

1 No further IRP action
2 Further IRP study required
3 FS completed and remedial alternative selected

TAB

Section 1

1.0 INTRODUCTION

The U.S. Air Force (USAF) contracted Woodward-Clyde Consultants (WCC) to assess past hazardous material disposal and spill sites at the Cape Romanzof Long Range Radar Site (LRRS), Alaska, and to develop remedial actions for those sites which pose a threat to human health and welfare or to the environment. The project was authorized under the USAF Installation Restoration Program (IRP), which is similar to the U.S. Environmental Protection Agency (EPA) Remedial Investigation/Feasibility Study (RI/FS) Program. The USAF IRP was developed to provide response actions on USAF installations under provisions of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980. Cape Romanzof LRRS is not classified as a National Priority List (NPL) site under the EPA CERCLA program. For this reason, all the requirements of the "USAF Occupational and Environmental Health Laboratory Technical Service Division (AFOEHL/TS) Handbook to Support the Installation and Restoration Program Statements of Work for Remedial Investigation Feasibility Studies," Version 2.0, April 1988, which was developed to provide guidance to contractors in performing RI/FS at USAF sites meeting NPL criteria, were not necessarily satisfied. The RI/FS described in this report is Stage 1 of the RI/FS process for the Cape Romanzof LRRS sites.

This Technical Report discusses:

- Site history, site descriptions, and the framework for the RI/FS - Section 1.0

- Environmental setting of the Cape Romanzof area - Section 2.0

- Field investigation program to investigate the presence of on-site contamination in conformance with the Stage 1 Final Work Plan - Section 3.0

- Results and significant geologic, hydrogeologic, analytical, and contaminant findings, including qualitative risk screening of identified contaminated sites - Section 4.0

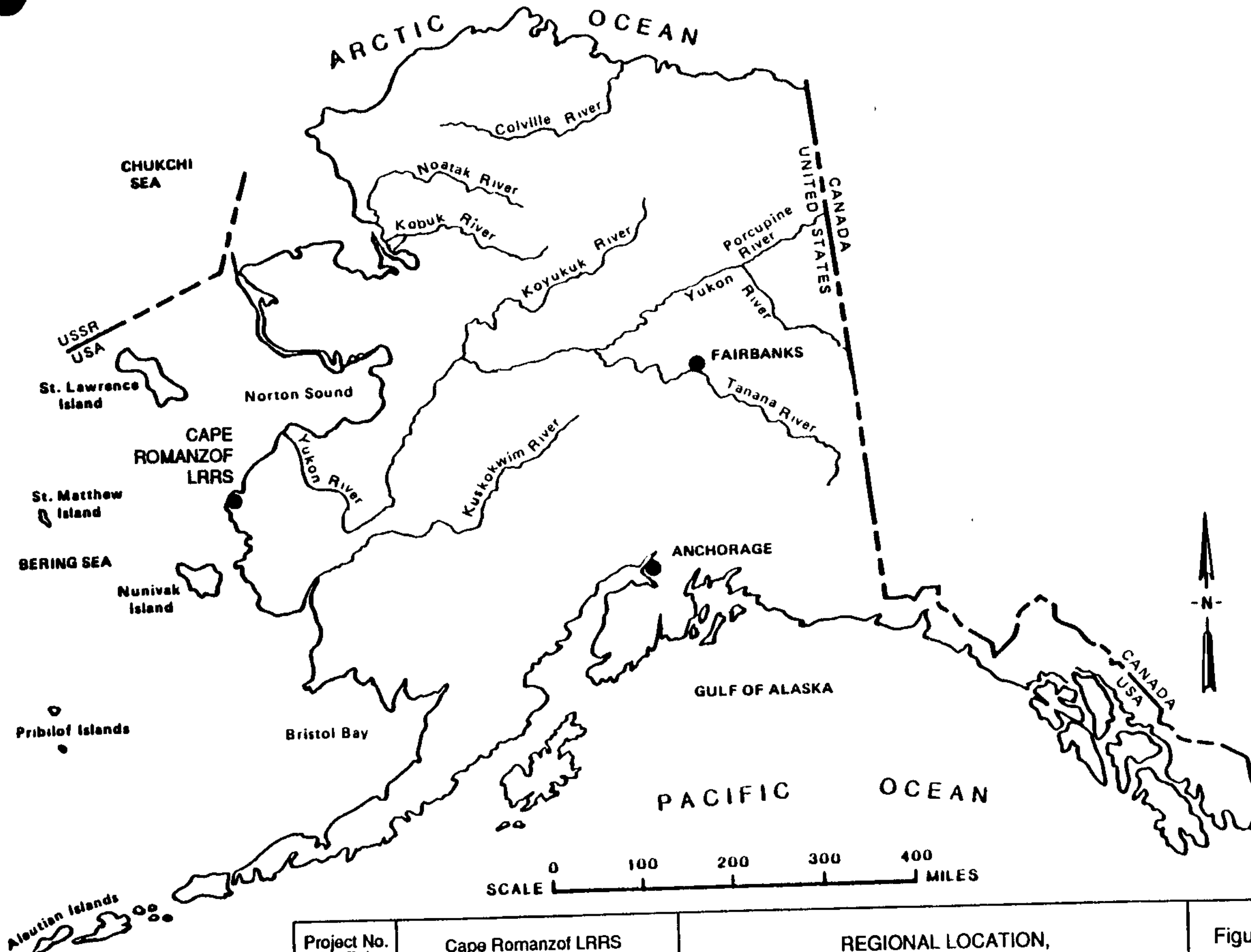
- Identification, screening, and analysis of alternative remedial measures to mitigate contaminated sites and detailed analysis of remedial alternatives - Section 5.0

- Recommendation of which sites require no further IRP action, require additional IRP investigation or evaluation effort, or require remedial actions - Section 6.0

1.1 SITE HISTORY

1.1.1 Description of Installation

Cape Romanzof LRRS consists of 4900 acres of land within the Yukon Delta National Wildlife Refuge. The installation is located 540 miles west of Anchorage on a small peninsula that extends into the Bering Sea (Figure 1-1). Two camps are connected by a road and a tramway. The Upper Camp contains radar equipment and the Lower Camp provides the necessary support facilities including housing, power plant, and bulk fuel storage. A runway serving the installation is located approximately 4 miles away from the Lower Camp (Figure 1-2). The nearest towns are Scammon Bay (population approximately 326) and Hooper Bay (population approximately 776) which are located 15 miles east and south, respectively. These communities are not accessible to Cape Romanzof LRRS by road. A new composite facility providing industrial and living facilities for station personnel was installed in 1984 and has replaced the previous Lower Camp structures.



Project No. 90275L	Cape Romanzof LRRS	REGIONAL LOCATION, CAPE ROMANZOF LRRS, ALASKA	Figure 1-1
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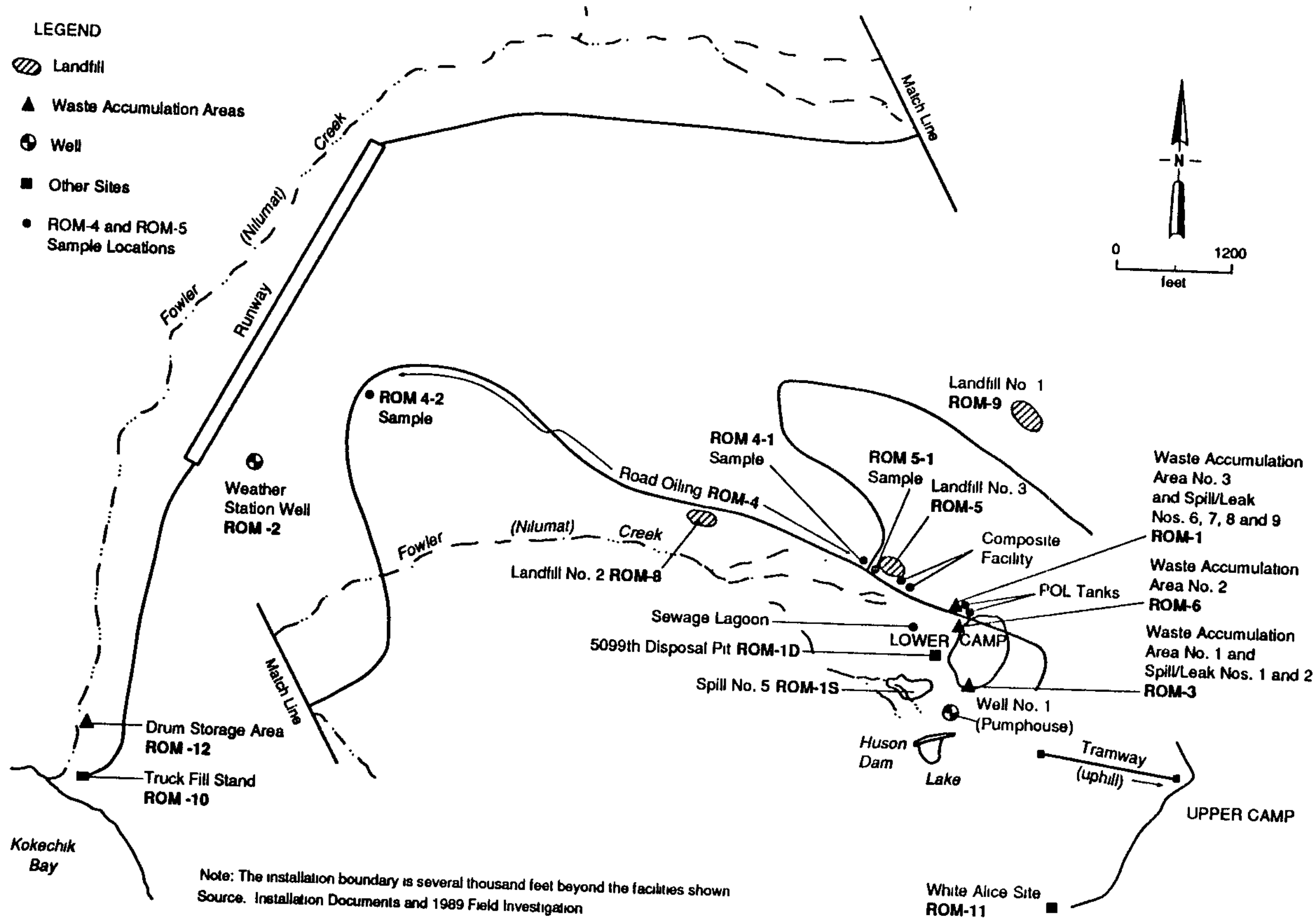
Source: Installation documents



Note: The installation boundary is several thousand feet beyond the facilities shown
Source. Installation Documents and 1989 Field Investigation

Project No. 90275L	Cape Romanzof LRRS	SITE LOCATION MAP	Figure 1-2
W odward-Clyde Consultants			

Cape Romanzof LRRS was one of the ten original aircraft control and warning (AC&W) sites in the Alaska air defense system. Installation construction was finished in 1952 and operations began in 1953.

Communications for the site were initially provided by high frequency radio. This was replaced in 1958 by a White Alice Communications System (WACS). In 1979 a commercially owned-and-operated communications system (Alascom) using a satellite earth terminal replaced the White Alice operations.

Cape Romanzof LRRS has been operated by a government contractor since 1977. GE Government Services currently operates the facility. Contractor operations enabled the elimination of 81 military positions, leaving 14 personnel in operations. A Joint Surveillance System (JSS), which allows transmitting radar and beacon data to the Elmendorf Region Operations Control Center (ROCC) by satellite, eliminated the remaining military positions in 1983. Completion of the Minimally Attended Radar (MAR) unit in the mid-1980s further reduced staff levels at the base.

1.1.2 Past Waste Management Practices

Various methods of waste management have been used at Cape Romanzof. Industrial liquid wastes were applied to roads until 1978. Since then, these wastes have been accumulated and then usually airlifted to off-base disposal locations. In some cases the liquid wastes have been transported by barge. Other wastes have been disposed of in landfills 1(areas receiving solid or semi-solid materials), dumps, hardfill (areas receiving construction debris, wood, used heavy equipment, and other miscellaneous spoil material), and incinerators. Much of the hazardous waste at Cape Romanzof is due to spills and leaks of diesel fuel and motor gasoline (MOGAS), either from drums in landfills or from petroleum, oil, and lubricant (POL) tanks or pipes.

1.1.3 Previous Installation Restoration Program (IRP) Activities

Engineering Science (ES) performed the Phase I records search in 1985. This study consisted of identifying sites possibly contaminated by past disposal practices, spills, and routine operations. Sites were identified from a review of base records and interviews with current and former employees. Hazards and potential hazards were assessed based on the probable chemical constituents present at each site and a review of regional geological and hydrological factors. Eleven sites assigned the highest hazard potential were recommended for further IRP action (ES 1985). These sites were inspected and confirmed during a WCC field reconnaissance in 1987. A work plan for remedial investigation was prepared in Spring 1988. The work plan was revised in Spring 1989 for summer work after funding was approved. In June 1989, another WCC field reconnaissance inspected the site in preparation for the summer's fieldwork.

1.2 SITE DESCRIPTION

Nine sites at Cape Romanzof were investigated in Summer 1989 for petroleum hydrocarbons, polychlorinated biphenyls (PCBs), volatile and semi-volatile organics, and metals contamination. The nine sites were ROM-1, ROM-1S, ROM-1D, ROM-3, ROM-4, ROM-5, ROM-8, ROM-10, and ROM-12 (see Figure 1-2). Two of these sites (ROM-1S and ROM-1D) were split from ROM-1 due to geographic location and waste management history. One site (ROM-12) was identified and added in the field.

The nine Cape Romanzof LRRS sites investigated in Summer 1989 are described as follows. Blueline drawing No. 1 (included as an attachment) presents the sites.

- ROM-1. Waste Accumulation Area No. 3 and Spill/Leak Nos. 6, 7, 8, and 9 - The Phase 1 Records Search (ES 1985) reports that this site is a waste accumulation area located between the new Composite Facility and the Lower Camp POL tanks on the north side of the access road, directly across from Site ROM-6. The spills/leaks are distributed west of the POL tanks. The waste accumulation area at this site was used from the 1950s to 1982 for storing drummed new products and liquid wastes. This area has also received PCBs, and leakage and spillage from drums stored on the ground. In addition, transformers marked "PCB" and large electrical switch units have been found at this area. Several major spills and leaks of diesel fuel and MOGAS from storage tanks and pump fill nozzles have occurred near the waste area. This site is less than 100 feet from surface water.

- ROM-1S. Spill/Leak No. 5 - This site is south of the present fueling station and southwest of the demolished Lower Camp (ROM-3). The Phase 1 Records Search (ES 1985) reports that spills from Waste Accumulation Area No. 3 and the other Spill/Leaks of ROM-1 and the demolished Lower Camp have contributed to the waste concentration here. Approximately 14,000 gallons of diesel fuel were lost in one of these spills. The area contains surface water, and could be hydraulically connected with the Lower Camp's drinking water supply.

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- ROM-1D. 5099th Disposal Pit - This site is immediately south of the present fueling station and north of ROM-1S. During 1987-88, the USAF 5099th Division razed the Lower Camp facilities and buried debris and other wastes in a large pit at this site. All asbestos and visible hazardous/toxic waste was reportedly removed prior to building disposal. During the Summer 1989 field investigation, this site was assigned to ROM-1S. For the purposes of this report, it has been broken out as a separate unit. This area is less than 500 feet from surface water, but is downgradient of Lower Camp's drinking water supply.

- ROM-3. Waste Accumulation Area No. 1 and Spill/Leak Nos. 1 and 2 - This is a waste accumulation area located at the former shop area adjacent to the site of the former power plant at Lower Camp (now razed). The Phase 1 Records Search (ES 1985) reported that wastes including oils, hydraulic fluids, solvents, toluene, paints, and ethylene glycol have been stored at this site; considerable spillage and leakage of wastes has occurred. It is reported that plows used for snow removal near the site often punctured or damaged stored drums, causing leakage. A major diesel fuel spill also occurred here. This waste accumulation area is a potential contamination area located upgradient of the station's drinking water supply (Well No. 1), about 100 yards southwest of the waste accumulation area.

- ROM-4. Road Oiling - This site is the Lower Camp and Upper Camp roads. The Lower Camp road is near a stream at several points. The Phase 1 Records Search (ES 1985) reported that from 1953 to 1978, liquid industrial wastes generated at Cape Romanzof were applied to roads for dust control and waste disposal purposes. This method is known as road oiling and has resulted in potentially hazardous types and amounts of material on the access roads. Wastes include lubricating oil, hydraulic fluids, ethylene glycol, and some solvents.

- ROM-5. Landfill No. 3 (Current landfill) - This site is the landfill presently being used by the base and is located adjacent to the new Composite Facility. A portion of the landfill was excavated during construction of the Composite Facility. The Phase 1 Records Search (ES 1985) reported that this landfill has received garbage, rubbish, wood, metal, plastic, construction and demolition debris, shop wastes, and incinerator ash. This landfill is adjacent to a stream and is near surface water.

- ROM-8. Landfill No. 2 (Old landfill) - This is a landfill on the south side of the access road between Lower Camp and the runway, about ½ mile downhill from the Composite Facility. The landfill occupies an area of about 1 to 1.5 acres, and operated until the mid-1970s. Similar to the landfill at Site ROM-5, this landfill has also received garbage, rubbish, wood, metal, plastic, construction and demolition debris, shop wastes, and incinerator ash (ES 1985). Water constantly flows through or underneath the landfill. Effluent streams have deposited a sediment that is reddish in color, and some vegetation around the streams has been affected.

- ROM-10. Spill/Leak No. 3 - This site was a truck fill stand located next to the former beach warehouse (now removed). The Phase 1 Records Search (ES 1985) reported that a number of small POL spills associated with tank filling and transfers occurred at this site. This site is above the beach at Kokechik Bay. The area is upgradient of Fowler Creek and Kokechik Bay.

- ROM-12. Former Drum Storage Area - This site is a blackened patch of soil east of the beaver ponds, south of Fowler Creek. Part of the site includes the east end of the easternmost beaver pond. Interviews with former station supervisors indicate that this black patch was a drummed waste storage area dating back to the beginning of the Air Force Station. Drummed waste was staged at this site for shipment out on the annual barge. Empty drums were stored nearby. The blackened area is upgradient of streams entering the beaver pond, which drains into Fowler Creek.

Five sites previously recommended for further IRP investigation were deleted in the Summer 1989 investigation for the reasons described below.

- ROM-2. The well was inaccessible for sampling because the pumping system was inoperable, and the pump and piping were abandoned in place. This would have required disassembly, which was beyond the scope of work. Reconnaissance of the area around the well failed to produce evidence of contamination. Fuel storage tanks are located approximately 200 feet away and downgradient from the well. Thus it is improbable that these fuel storage tanks could have been the source of contamination at this well. See further discussion in Section 3.2.4.

- ROM-6. After reconnaissance, no evidence was found that this site was ever a drum storage area. No evidence of contamination and no odors were observed.

- ROM-7. This site was previously identified as a landfill. It could not be located after the reconnaissance. A former Station Manager, Tom Hull, who worked at Cape Romanzof periodically since 1977, was not aware of a landfill existing here (T. Hull, personal communication, 1989). No evidence of contamination (e.g., no odors or stains) was observed.

- ROM-9. This site was previously identified as a landfill. It could not be located after the reconnaissance. Former Station Manager Hull was not aware of a landfill existing here (T. Hull, personal communication, 1989). No evidence of contamination (e.g., no odors or stains) was observed.

- ROM-11. The Former White Alice site has been demolished. All structures have been removed and debris buried in unknown, unrecognizable landfills. The area has been graded effectively, removing any evidence of past building locations and any visible signs of contamination.

1.3 PROGRAM DOCUMENTS

Documents specified in Section 1.0 of the AFOEHL/TS Handbook (Version 2.0, April 1988) were utilized as appropriate for this investigation. In addition, the Interim Final "Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA" by the EPA (October 1988) was utilized as a guide to the 1986 Superfund amendments (SARA) in regard to the RI/FS process.

1.4 OBJECTIVES

The objectives of the RI/FS were to investigate the presence of contaminants reported at each site, install monitoring wells, assess the extent of contamination, describe the environmental setting, evaluate environmental and health risk through qualitative risk screening, analyze alternative remedial measures to mitigate contaminated sites, and recommend which sites require no further IRP action, additional investigation, evaluation, or remedial actions.

TAB

Section 2

2.0 ENVIRONMENTAL SETTING

The environmental setting of Cape Romanzof LRRS is described in this section. The primary emphasis of this discussion is the identification of features or conditions that may facilitate the migration of contaminants. A literature review was conducted and is discussed in Section 2.1. The remaining sections discuss the environmental setting in more detail.

2.1 LITERATURE REVIEW

The general environmental setting of the Cape Romanzof area is not directly discussed in any of the references cited below. However, information is available concerning the regional environmental, geologic and hydrogeologic setting. The reader is referred to the report sections that follow for additional site-specific information.

Cape Romanzof LRRS is located on an isolated linear mountain mass that rises abruptly out of the Yukon-Kuskokwim Delta to a maximum elevation of 2342 feet above sea level. The surrounding lowlands are part of the Yukon-Kuskokwim Coastal Lowland subprovince of the Bering Shelf Physiographic Province. The lowland, named and described by Wahrhaftig (1965), is a lake-dotted marshy plain that rises from sea level eastward to a maximum elevation of 300 feet. The lowland is crossed by meandering streams of extremely low gradient which flow west into the Bering Sea; the lowland is also underlain by a discontinuous layer of permafrost.

Coonrad (1957) describes the mountainous areas within this province as being underlain by either Cretaceous sedimentary rocks or unknown age crystalline rocks. The surrounding lowlands are comprised of sand and silt floodplain deposits to an unknown depth.

Beikman (1980) shows the linear mountain mass containing the Cape Romanzof station as being composed dominantly of Cretaceous-age intrusive rocks of felsic composition (granitoid rocks). Péwé (1975) further describes the region as having been weathered and eroded by ice wedging, underlain by partial permafrost, and to show downslope mass wasting solifluction features. Ferrians Jr. (1965) also describes the permafrost in the region as being moderately thick to thin--ranging from 601 to 31 feet thick in the Bering Shelf Physiographic Province.

Groundwater occurrence in the region is also only generally described. Both Zenone and Anderson (1978) and Williams (1970) discuss the occurrence of groundwater in permafrost regions in Alaska, and, briefly, in the Yukon-Kuskokwim province. Feulner et al. (1971) also describe the general occurrence of groundwater in the area. Their report, which also describes the climate of the region, indicates that surface water in the Yukon River drainage is acceptable for public supply, and is of the calcium bicarbonate type. Groundwater at Cape Romanzof was found to contain about 22 mg/L total dissolved solids.

2.2 GEOGRAPHIC SETTING

2.2.1 Physiography

Cape Romanzof LRRS is located in the Yukon Kuskokwim Coastal Lowland section of the Bering Shelf, an Alaskan physiographic province. This physiographic section is a marshy, lake-dotted deltaic plain, surrounded by low rounded hills with locally steep slopes. The area has alpine tundra and barren ground, and elevations range from 10 to 2340 feet above sea level.

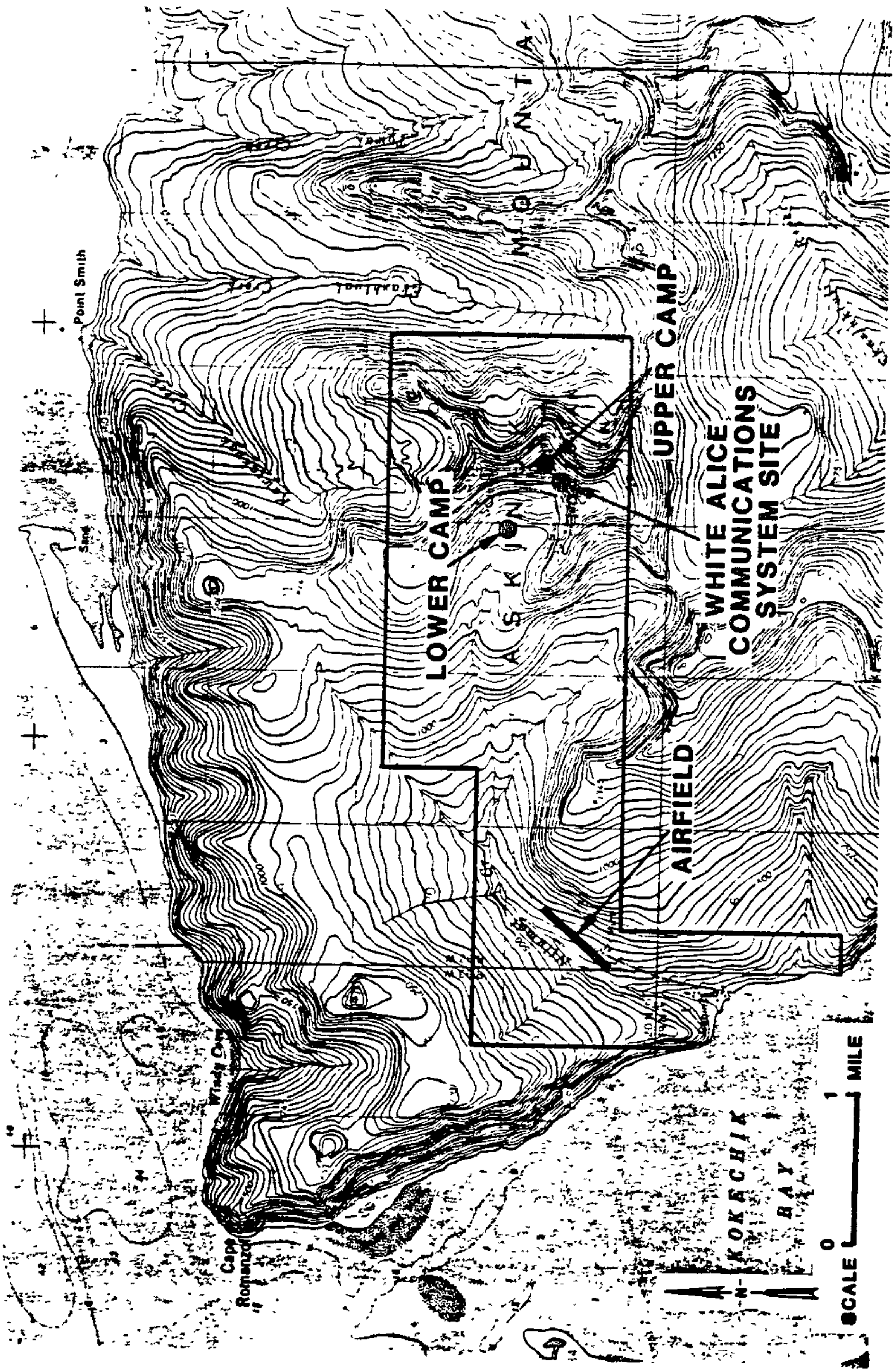
2.2.2 Topography

At Cape Romanzof LRRS, the elevation difference from high point to low point is about 2000 feet (see Figure 2-1). The Upper Camp is situated at the top of a ridge which overlooks a steep-sided valley, probably carved in part by a glacier. The longitudinal profile of this valley (containing Fowler Creek) is irregular and stepped, with steep segments followed by flat segments (as at the Lower Camp).

2.2.2.1 Drainage. Surface water drainage is accomplished chiefly by overland flow to Fowler Creek (identified as Nilumat Creek on USGS topographic maps) (see Figure 2-1). Some Upper Camp drainage may be directed eastward to Ekashluak Creek. The surface waters of the Cape Romanzof study area generally occur as ephemeral streams which drain to Kokechik Bay, a major surface water feature of the Yukon Delta National Wildlife Refuge.

2.3 GEOLOGY

Geologic units of all the principal time-stratigraphic systems from Precambrian to Quaternary are represented in Alaska. The major interior mountain chains have cores of Precambrian rocks; the core of the Coast Range is generally Mesozoic, bordered by younger sedimentary and volcanic materials. The lower mountains and hills are formed of like materials or of Mesozoic sedimentary rocks (Feulner et al. 1971). The coastal plains are formed by sedimentary materials of Mesozoic to Cenozoic age. Intense structural deformation has continued throughout Alaska's geologic history and has periodically modified the major geologic units by faulting, warping and folding. The deformational activity is pronounced along the state's Pacific Coast. Active volcanoes are located in the Wrangell Mountains of interior Alaska, in the Alaska Peninsula, and in the Aleutian Islands. The predominant structural trend parallels the Pacific Coast.



Project No. 90275L	Cape Romanzof LRRS	TOPOGRAPHY IN THE AREA OF CAPE ROMANZOF LRRS	Figure 2-1
Woodward-Clyde Consultants			

For the last two or three million years, frost climates have prevailed in Alaska and the geomorphic processes have been either glacial or periglacial (Wahrhaftig 1965). During Quaternary time, Alaska's landscapes have been reworked by the advance and retreat of the extensive continental glaciers. Changing firn lines delineate the glacial movement. Remnants of the glaciers are present today in the higher elevations of the Coast and Alaska Ranges. Although glacial activity was extensive, it was by no means all encompassing. Glaciation is evident in many parts of the state including the Pacific Mountain System, the Arctic Mountains, the Ahklun Mountains, and southern Seward Peninsula. However, some great expanses had no glacial activity. The principal areas not glaciated include the Intermountaine Plateaus, the Arctic Foothills, and the Arctic Coastal Plain. Figure 2-2 depicts the extent of Alaska's glaciated areas. The glacial activity is significant in that its advance eroded the uplands into block-like groups of mountains with rounded crests separated by U-shaped valleys and low passes. The ridges and peaks that rose above the upper ice sheet elevations remained angular and sharp in appearance (Wahrhaftig 1965). The mountain ranges crowned by such peaks exhibit dramatic relief and their valleys head in near vertical glacier-covered cirques. Glaciated lowlands tend to be inconsistent and include such features as moraines, drumlins, kames, eskers, and glacial lake plains. Rock basin and glacial deposit dammed lakes of great size and depth are common features of the glaciated lowland margins. The retreat and melting of the large glaciers produced great quantities of outwash sediment, which has resulted in the filling of many basins and lowlands. Each spring, large quantities of sediment continue to clog many of Alaska's major rivers and streams. The sediments are transported downstream with the flow and are eventually deposited many miles from their points of origin.

One of the most widely distributed Quaternary sediments is loess, a wind-blown silt. Loess occurs in most areas of Alaska below elevations of 1500 feet, ranging in thickness from fractions of an inch to 200 feet. The thickest loess deposits occur in central and western Alaska (Péwé 1975).

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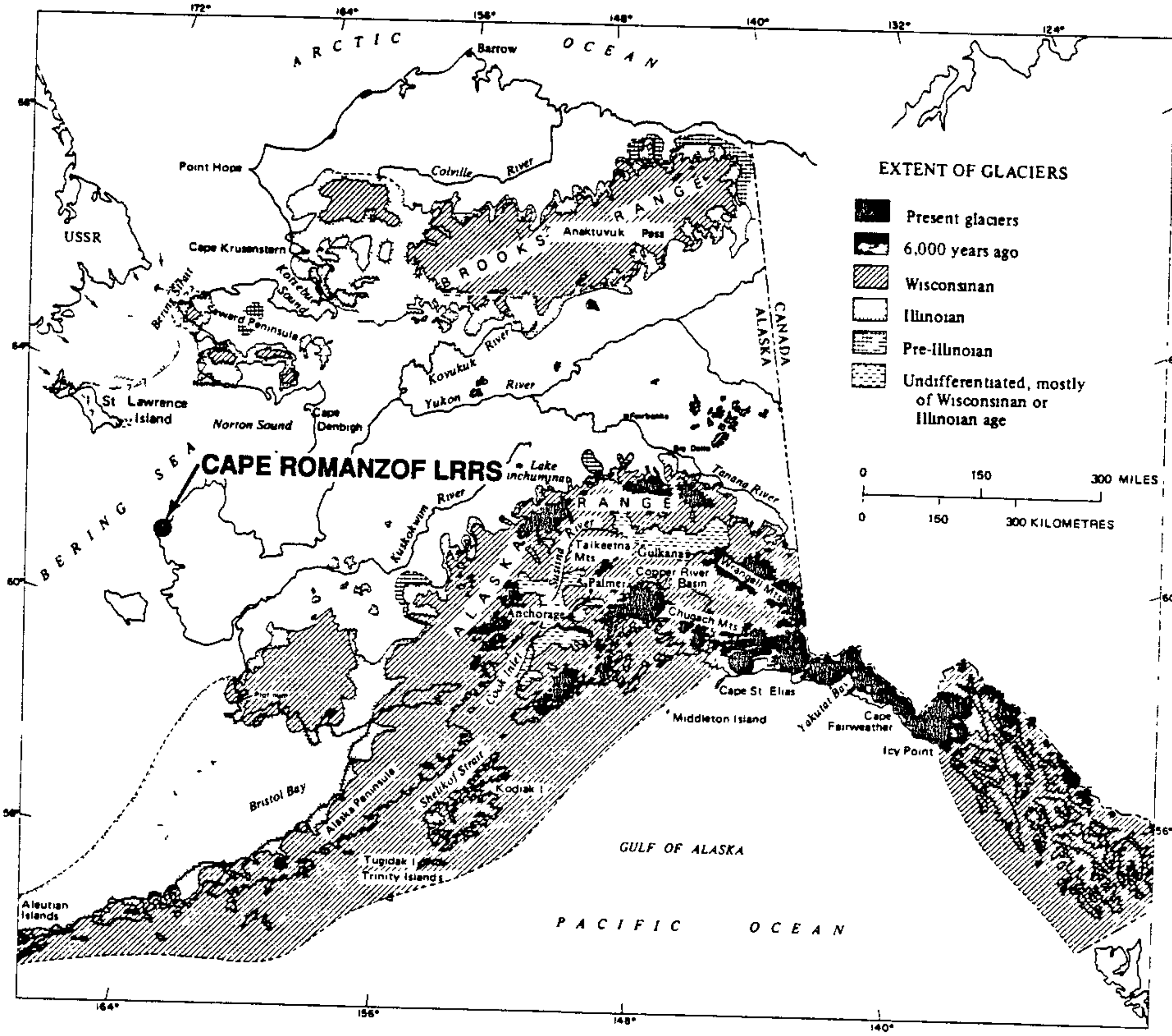


Source. Modified from Péwé, 1975

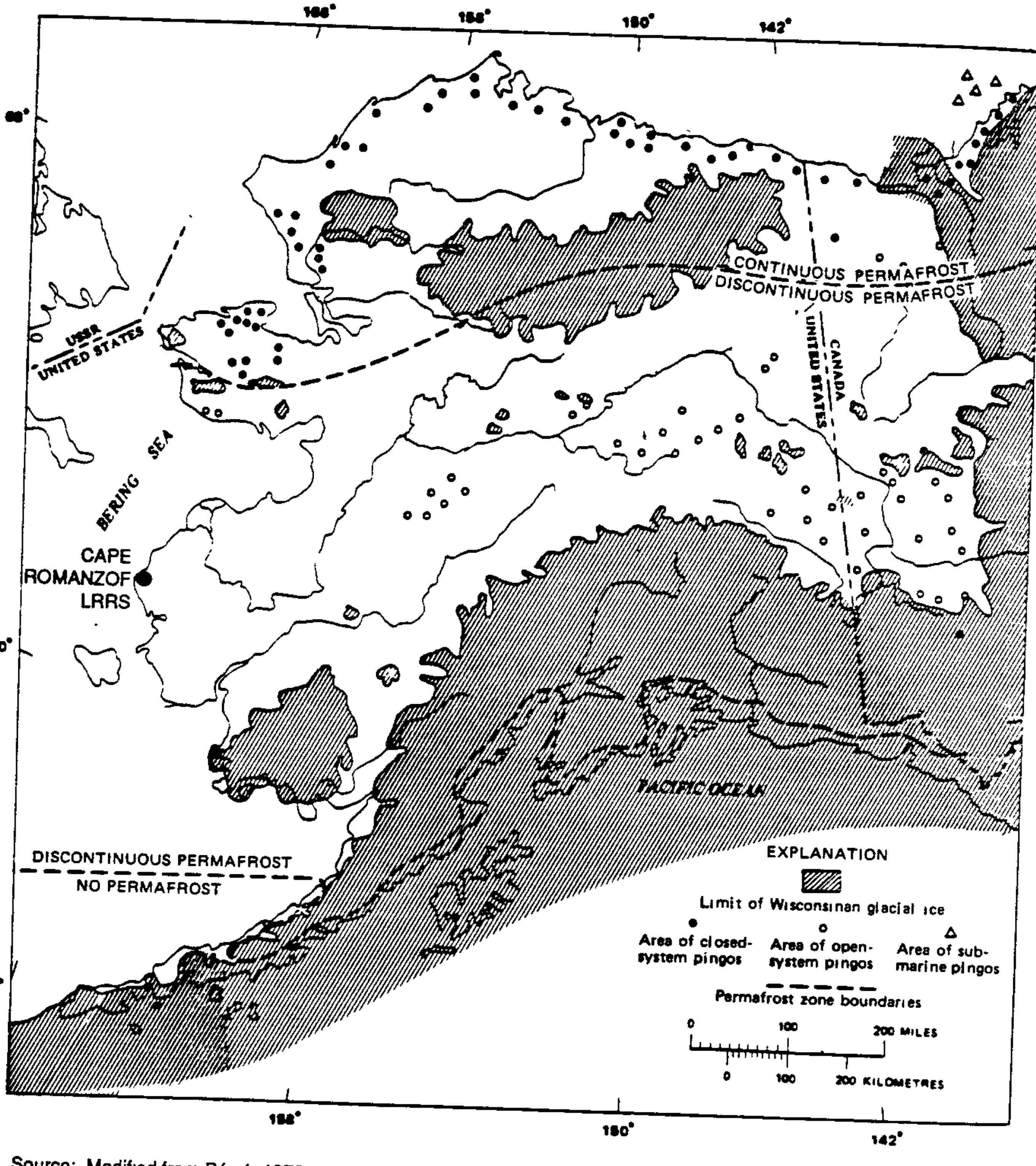
Project No. 90275L	Cape Romanzof LRRS	QUATERNARY GLACIATION IN ALASKA	Figure 2-2
Woodward-Clyde Consultants			

Alaska's generally cold climatic regime has produced a condition termed permafrost, a combination of geologic, hydrologic, and meteorologic characteristics which produces permanently frozen ground. Permafrost occurs in both unconsolidated sediments and bedrock, and its distribution includes most of the state with the notable exception of the Pacific Coastal area. The occurrence of permafrost varies from thin, scattered zones in the central Alaskan lowlands to sections more than 2132 feet thick near Prudhoe Bay (Selkregg 1975). Permafrost has a significant impact on the flow of groundwater. The distribution of Alaska's permafrost areas is shown on Figure 2-3. Permafrost is mapped in Alaska as continuous, discontinuous, or absent.

The very strong geologic processes at work today in Alaska have produced a unique environmental setting reflected in the Quaternary Geologic Map of the state (Figure 2-4). For example, Qg (Quaternary glacial deposits) represents the extent of materials common to Alaska's glaciated alpine mountains, and Qa (Quaternary alluvium) illustrates the distribution of the floodplain alluvium of major stream valleys. Cape Romanzof is located within coastal deposits of interbedded marine and terrestrial sediments (Qc).

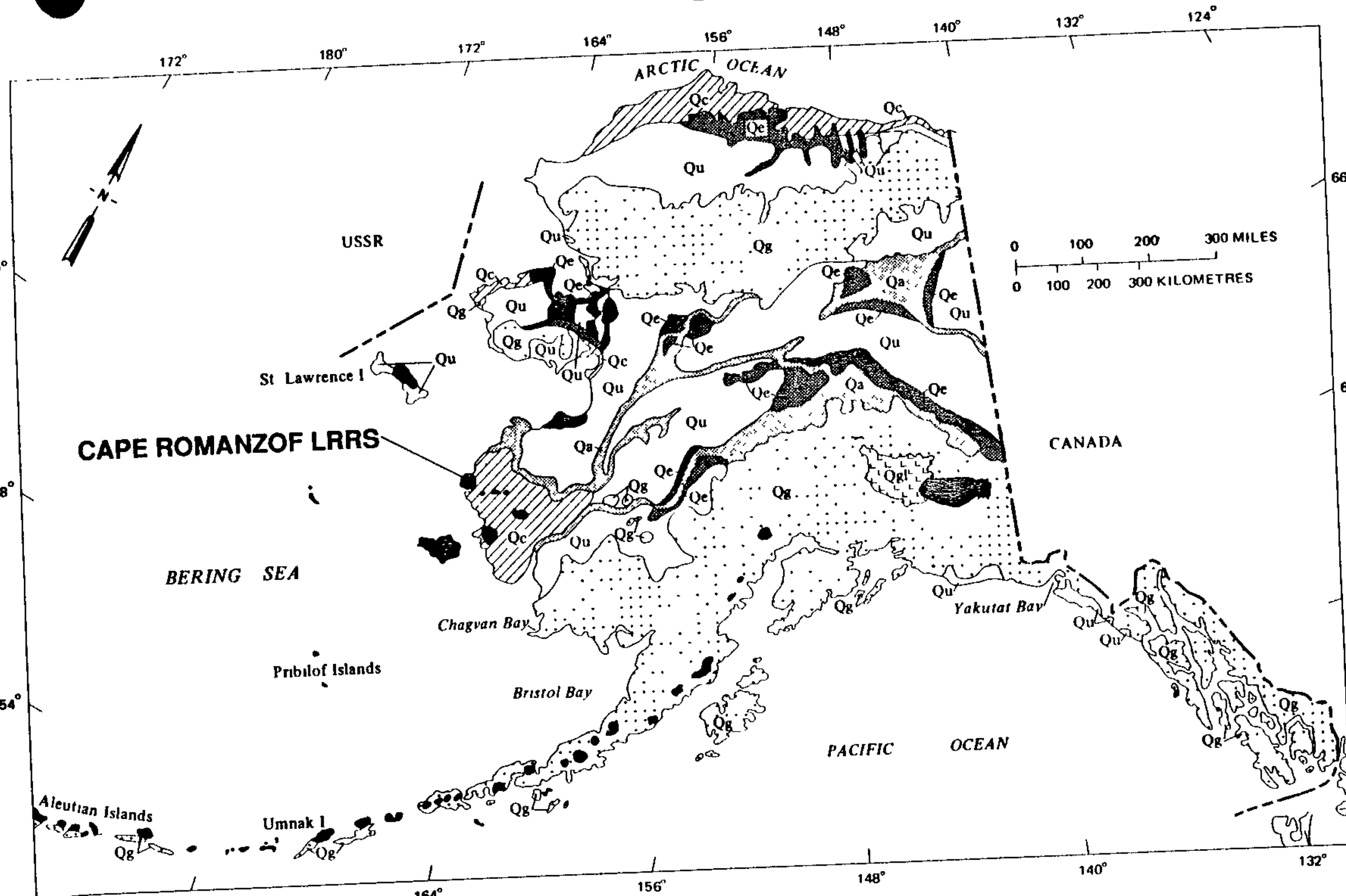
The Cape Romanzof LRRS is located within the valley of Fowler (Nilumat) Creek; the upper part of this valley has very steep sides and a relatively shallow-sloped valley floor. This U-shaped valley cross section and the stepped longitudinal profile of Fowler Creek are typical of glaciated valleys.

The geology of the Upper Camp facilities (located on the narrow ridge above the valley) is characterized by a thin accumulation of angular sand and block residues overlying granitoid bedrock of Towak Mountain. The granitoid rocks appear to have a composition of quartz-monzonite to granodiorite, although no systemic sampling or analysis for detailed



Source: Modified from Péwé, 1975

Project No. 90275L	Cape Romanzof LRRS	PERMAFROST ZONES OF ALASKA	Figure 2-3
Woodward-Clyde Consultants			



Sketch map of major regional groups of surficial deposits in Alaska Qg, glacial and other deposits associated with heavily glaciated alpine mountains, Qgl, glaciolacustrine deposits of larger Pleistocene proglacial lakes, Qu, undifferentiated deposits associated with generally unglaciated uplands and lowlands of the Interior and North Slope, Qa, fluvial deposits, Qe, eolian deposits, Qc, coastal deposits of interbedded marine and terrestial sediments Solid black areas are deposits associated with volcanic peaks and flows.

Source: Modified from Péwé, 1975

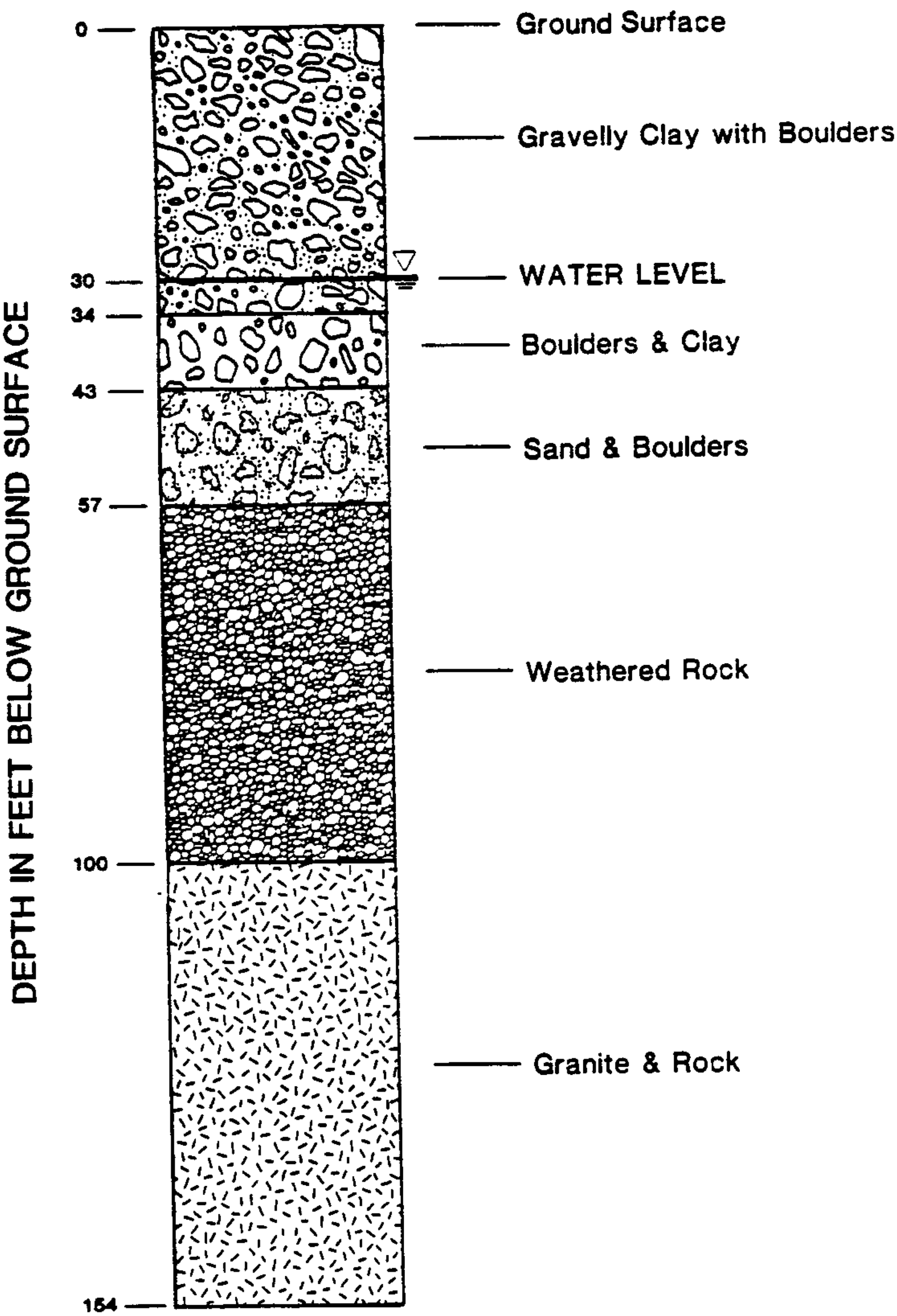
Project No. 90275L	Cape Romanzof LRRS	QUATERNARY GEOLOGIC MAP OF ALASKA	Figure 2-4
Woodward-Clyde Consultants			

chemical composition was conducted. Two major joint sets are apparent in the granitoid bedrock. The dominant set shows a general strike orientation of ranges from N55E to N85W with an average dip of about 80 degrees south. The less dominant set is oriented about N18E, and dips about 80 degrees to the northwest.

The Lower Camp and adjacent facilities are underlain by deposits of talus and other colluvial materials that have moved down the steep valley side slopes toward Fowler Creek largely under the influence of gravity. This colluvium consists of granitoid material of a wide range of material sizes, from large granite blocks (1 to 2 feet, minimum dimension) to fine-coarse grained sand, silt, and minor clay. At the base of the steep slope, colluvium forms an apron that extends across part of the low-angle slope on the valley floor adjacent to Fowler Creek. The Lower Camp, the ROM-8 Landfill, and the main access road are located at the uphill margin of this apron, near the base of the northern steep slope (Figure 1-2). Groundwater Monitoring Wells MW-1 through MW-4 at the landfill installed during summer 1989 penetrated up to 19.5 feet of this colluvial apron.

The central, low-slope angle part of the U-shaped valley is underlain by alluvial and possibly glacial deposits. Well No. 1, located near the valley axis, shows a sequence of gravelly clay with boulders (0 to 43 foot depth) overlying sand and boulders (34 to 57 foot depth). This sequence, in turn, overlies weathered bedrock and then fresh granitoid bedrock at a depth of 100 feet (Figure 2-5). The alluvial/glacial material underlying the valley floor probably interfingers in the subsurface with the colluvial apron along a zone downslope and towards Fowler Creek from the Lower Camp and the ROM-8 Landfill.

No permafrost conditions were observed during 1989 field investigations at Cape Romanzof LRRS. According to Williams (1970), permafrost may be generally absent from wells drilled in glacial cirques and protected hollows at locations such as Cape Romanzof.



SOURCE: MODIFIED FROM GEOLOGICAL SURVEY
WATER RESOURCES DIVISION FILE DATA, UNDATED

Project No. 90275L	Cape Romanzof LRRS	WELL NO. 1 LOG CAPE ROMANZOF LRRS	Figure 2-5
Woodward-Clyde Consultants			

2.4 HYDROLOGY

2.4.1 Surface Water

The surface waters of the State of Alaska have been classified in accordance with their present or potential utilization in order to maintain the highest quality standards possible. The classification system makes distinctions between inland and marine waters and further subdivides these broad categories. The classification system is detailed in Water Quality Standards (Alaska Department of Environmental Conservation 1979). The classification of waters receiving discharge of runoff or effluent is as follows:

1. Fresh Waters
   - 1A Water supply
   - 1B Water recreation
   - 1C Aquatic life and wildlife propagation

2. Marine waters
   - 2A Water supply (aquaculture, seafood processing, etc.)
   - 2B Water recreation
   - 2C Aquatic life and wildlife propagation
   - 2D Consumptive harvesting of raw aquatic life

At Cape Romanzof, the receiving stream, Fowler (Nilumat) Creek, drains into Kokechik Bay. All of the freshwater streams on the base are classified for high quality as shown above in 1A. Kokechik Bay is assigned the high quality use classification in 2A, above.

During the field activities in July and August 1989, two types of surface water drainage were observed: 1) established drainages with continuous flow and well defined drainage courses, and 2) stream drainages having intermittent flow in time and space, and poorly defined courses;

some of these streams disappeared into the tundra just short of a downgradient junction with an established stream. Both drainage types were present in the vicinity of ROM-8 Landfill (see Figure 3-5). Intermittent streamflow was present mostly in areas disturbed by excavations or road embankments; such stream flow was often fed by springs in the deeper parts of the excavations.

At ROM-8 Landfill, the engineered drainage along the north side of the main access road (see Figure 3-5 and blueline drawing No. 2) contained a constantly flowing surface stream (during the July/August field work) except for the stream reach opposite and upgradient from the landfill and associated excavations. This reach had flowing surface water on July 29, 30, and 31, 1989, followed by a period of no surface flow on August 1, 2, 3, and 4, and then a resumption of surface flow on August 5, 6, and 7. This cyclic flow pattern suggests that some of the surface and subsurface flow north of the main access road was being diverted downgradient southwestward through or under the road embankment and through the landfill. This migration could have locally lowered the potentiometric surface to a level below stream bottom during periods of decreased precipitation/runoff, causing this stream reach to be temporarily dry at ground surface. The presence of several active seeps on the landfill surface to the southwest (see Figure 3-5) supports this suggestion.

Between ROM-8 Landfill and Fowler Creek, excellent examples of the two types of drainage described above were observed. Both streams encountered there are tributaries to Fowler Creek, but otherwise they were very different. The eastern drainage originated to the east of the landfill area (Figure 3-5), flowed continuously in a well defined channel, and descended to Fowler Creek through a well-defined small canyon cut through the steep slope adjacent to Fowler Creek. By contrast, the western drainage originated from springs located in the excavations east of the landfill, flowed in a circuitous path along the eastern and southern margins of the landfill, became locally ponded and broken into several distributive courses in the disturbed area south of the landfill, then became reintegrated into a main floor that passed over the tundra surface without a defined channel, and finally disappeared into the tundra at the top of the steep slope adjacent to Fowler Creek. Directly below this last point, a spring issued water from the base of the steep slope directly into Fowler Creek.

The data presented above indicate that groundwater occurs at shallow depths beneath the tundra surface in some areas; and depending on local conditions, this water can intermittently appear as surface flow. Shallow groundwater is also present in some of the granitoid block fields, as is documented west of ROM-8 Landfill (see Figure 3-5). Here, near-surface flowing water was seen at some points between granitoid blocks about 2 to 3 feet below the surface, and subsurface flow was heard at many other points. Where these conditions occur, it is evident that subsurface flow can be converted to surface flow by excavations a few (less than 10) feet deep.

2.4.2 Groundwater

Alaska's groundwater resources are reported to be highly variable. The most productive groundwater sources are the unconsolidated alluvial aquifers of the state's major river valleys and the glacial outwash aquifers underlying coastal basins and some lowland areas. No major aquifers have been identified in glacial and glaciolacustrine formations of the interior valleys or in deltaic deposits (Zenone and Anderson 1978). Major bedrock aquifers are restricted to the carbonate rocks of the Brooks Range of Arctic Alaska and along the north side of the Alaska Range. Most bedrock aquifers in Alaska exhibit poor hydraulic qualities and produce only small yields locally.

Four generalized geohydrologic environments of Alaska have been described by Williams (1970). They include alluvium of floodplains, terraces, and fans in major valleys and in upland and mountain areas; coastal lowland deposits; glacial and glaciolacustrine deposits of the interior valleys; and bedrock aquifers of the uplands and mountain ranges. The distribution of these four major geohydrologic units throughout Alaska is shown on Figure 2-6. This figure is an attempt to illustrate Alaska's overall groundwater resources; however, local variations likely occur.

At Cape Romanzof LRRS, the most significant groundwater resources are present in the unconsolidated alluvial and glacial deposits that underlie the valley floor of the upper part of Fowler Creek. Minor amounts of groundwater are available on the valley slopes as local perched water. Permafrost, which controls the occurrence and movement of groundwater in much of Alaska, was not found to be present during the 1989 field investigations at Cape Romanzof (see Section 2.2).

2.4.2.1 Hydrogeology at Cape Romanzof LRRS. Data pertaining to hydrogeologic conditions were derived from three sources, namely: 1) observations of geomorphic and surficial geologic features; 2) well data from ROM-8 Landfill (for colluvial groundwater occurrences); and 3) well data from Water Supply Well No. 1 (for alluvial/glacial groundwater occurrence). The following paragraphs discuss hydrogeology in the Fowler Creek Valley in terms of available data from the above sources pertaining to stratigraphy, structure, geomorphology, groundwater occurrence, piezometric surface/levels, and permeability/well yield.

The water-bearing geologic units at Cape Romanzof LRRS include: 1) granitoid-rich colluvium on the steep valley sides and adjacent parts of the valley floor, 2) alluvium/glacial(?) deposits underlying the central part of the valley floor, and 3) weathered granitoid bedrock which underlies the surficial deposits of colluvium and alluvial/glacial(?) deposits.

2.4.2.2 Hydrogeology of Granitoid Colluvium. The granitoid colluvium is present as a surficial mantle covering the steep valley slopes of Fowler

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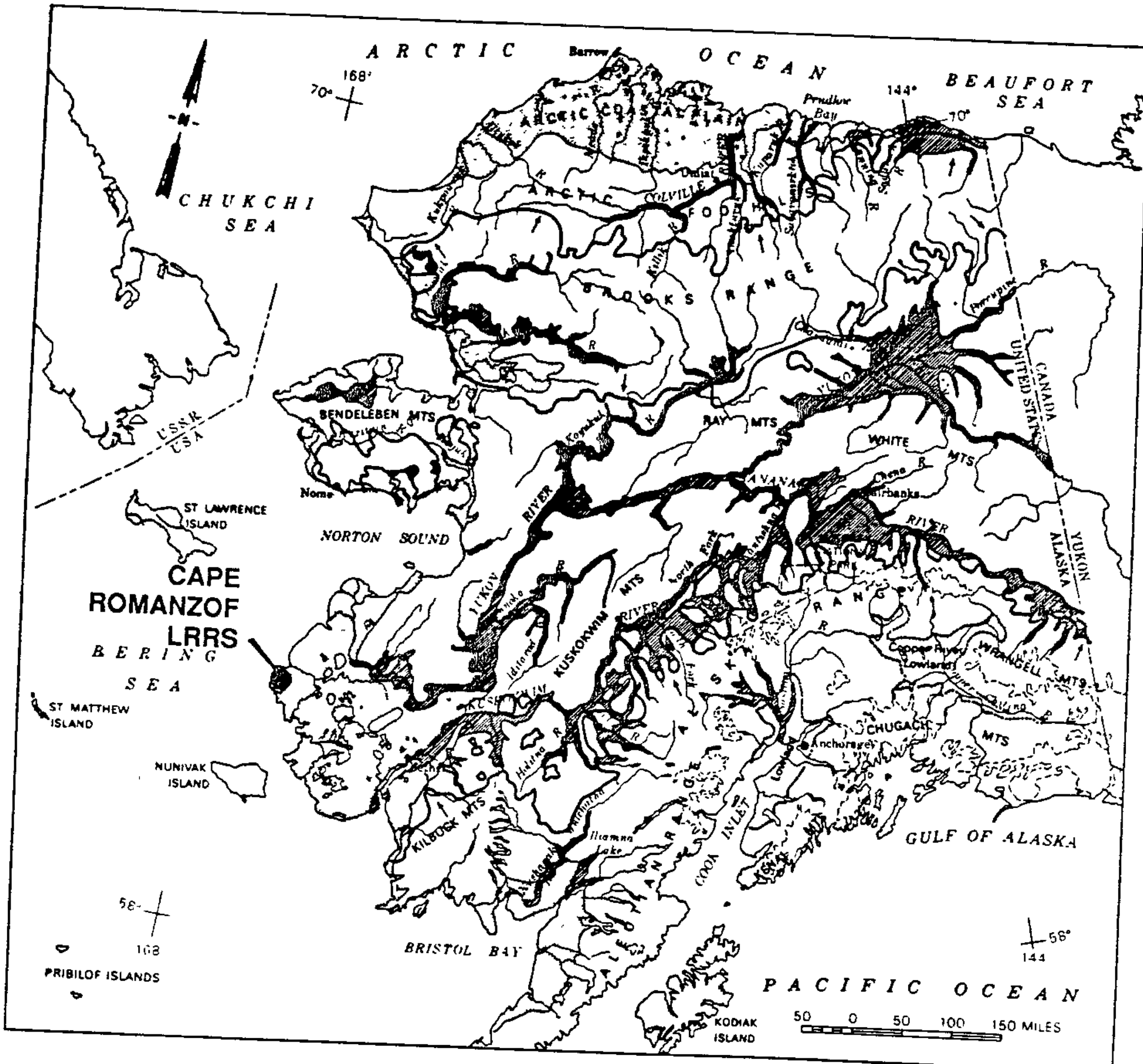

EXPLANATION

Alluvium of major valleys
Sand, gravel, and silt of flood plains, low terraces, and alluvial fans

Coastal-lowland deposits
Chiefly silt and sand, and subordinate amounts of gravel, includes sand and gravel of bars, beaches and spits, and sand, silt and gravel of deltas. Within limits of Pleistocene glaciation, include till, glaciomarine, and glacioestuarine deposits

Bedrock of mountains and uplands
Chiefly bedrock mantled locally by weathered bedrock rubble reworked by frost action, alluvium, and eolian deposits, and within limit of Pleistocene glaciation, by glacial deposits

Limit of Pleistocene glaciation
Unconsolidated deposits within this limit may include till sand and gravel and silt and clay of glacial, glaciolacustrine, glaciomarine, or glacioestuarine origin (Coulter and others, 1965)

Cook Inlet and Copper River Lowlands
Approximate upper limit of lacustrine silt, clay, sand, gravel and stony silt and clay of extensive glacial lakes in Copper River Lowland and of glaciolacustrine, glacioestuarine, and glaciomarine deposits in the Cook Inlet lowland

Major glaciers and ice fields

Contact

Source: Modified from Williams, 1970

Project No. 90275L	Cape Romanzof LRRS	GEOHYDROLOGIC UNITS OF ALASKA	Figure 2-6
Woodward-Clyde Consultants			

Creek and the adjacent parts of the low-slope valley floor. This mantle is a prism-shaped mass, being thin near the ridge tops and thickening to perhaps several tens of feet at the base of the steep valley slopes. The maximum thickness is unknown; wells at ROM-8 Landfill penetrate up to 19.5 feet of this colluvium.

The stratigraphy of the granitoid colluvium consists of alternating areas and layers of large singular granitoid blocks (1 to 2 feet minimum dimension), and decomposed granitic debris (coarse to fine sand, silt, and minor clay). At ground surface, distinct areas of each lithologic type (up to several acres or more in extent) are visible; fields of angular granitic blocks, devoid of any regulation, alternate with fields of tundra, which is rooted in the finer grained colluvial material. Downslope solifluction processes are clearly active on the valley slopes of Fowler Creek; in some cases this results in movement of the finer grained colluvium and tundra downslope over the top of granitoid block fields (see Figure 2-7, photo A). More commonly, solifluction lobes are seen on broad steeply-sloping tundra surfaces as a series of linear welts, reminiscent of ocean waves moving toward a low-sloping beach (see Figure 2-7, photo B). In the subsurface, colluvium stratigraphy (based on the four groundwater monitoring wells at ROM-8 Landfill) consists of alternating layers of finer grained colluvium (coarse to fine sand, silt, minor clay) and large granitoid blocks. Two of the wells at ROM-8 Landfill (MW-1 and MW-2) encountered two separate layers of granite blocks between finer grained colluvium, within a total depth less than 20 feet.

Structurally, the granitoid colluvium layers are oriented subparallel to the valley slopes and floor on which they are deposited. Thus, these layers are steep on the steep valley slopes of Fowler Creek and gradually flatten to low dips where colluvium extends out over the margins of the low-sloping valley floor. As described in Section 2.2, these colluvial materials probably terminate in the subsurface by interfingering with alluvial/glacial(?) deposits underlying the central part of Fowler Creek Valley.

Geomorphic conditions in Fowler Creek Valley constitute one of the main forces determining the formation and distribution of widespread granitoid colluvium. The steep-sided U-shaped valley (likely related to the former presence of glaciers) provides the topographic relief conducive to the development of an extensive colluvial mantle. The subarctic climate also provides conditions for a predominance of physical over chemical weathering processes (mostly freeze-thaw conditions) which promotes: 1) physical disintegration of granitoid rocks into sand-size material, and 2) active downslope gravity-driven processes, such as solifluction.

Groundwater occurs within granitoid colluvium at all locations where wells penetrate this material. This colluvial mantle provides the main pathway for transport of precipitation from the ridge tops and valley sides to the alluvial/glacial(?) deposits located in the central part of the flat valley floor. At ROM-8 Landfill, groundwater was found in four wells in colluvium under water table (unconfined) conditions. Groundwater occurred in wells at shallow depths beneath the ground surface, and beneath the landfill material. A map of ROM-8 Landfill showing well locations is shown on Figure 3-5. It was also noted that at excavations adjacent to the landfill, springs (representing the water table) appeared at various locations where these excavations exceeded 5 or 6 feet in depth (see Figure 3-5). A contoured groundwater elevation map based on the four monitoring wells (see Figure 2-8) and a cross-section oriented downslope and through the landfill (see Figure 2-9), show that the top of groundwater (water table) slopes uniformly to the southwest parallel to the topographic slope. Thus, the direction of groundwater flow is towards the southwest. Also, the water table (top of saturated zone) occurs below the landfill material (about 5 feet below at MW-3 and about 3 feet below at MW-4). Permeability is irregular within the granitoid colluvium, as shown by the variation in recharge times noted during well development and purging (see Section 4.1). This effect is likely related to the highly variable distribution of fine and coarse materials within the granitoid colluvium.

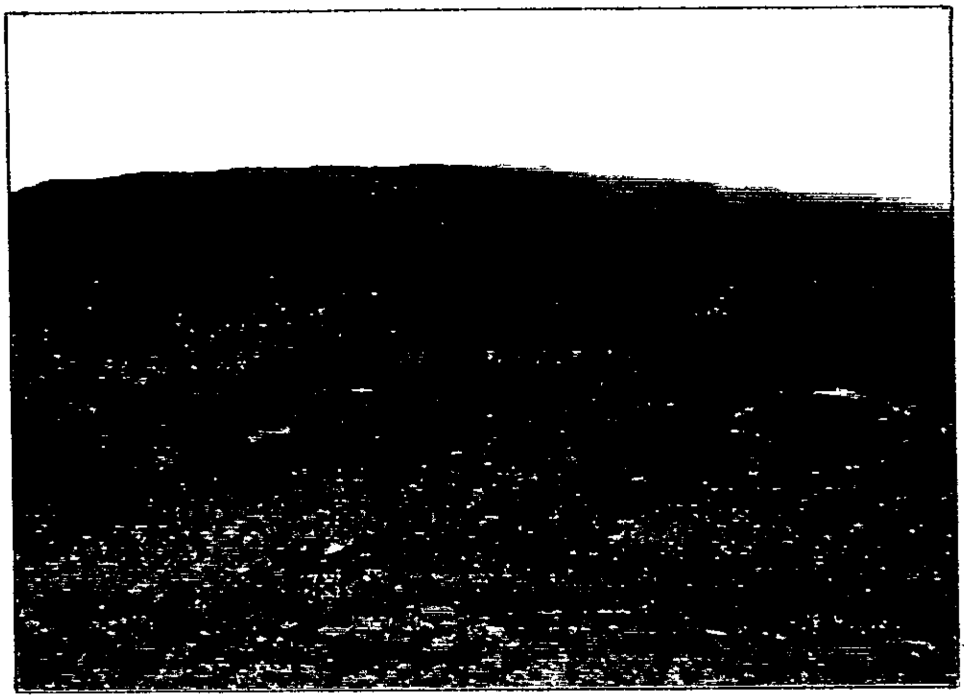

Figure 2-7A. COLLUVIUM-COVERED SLOPE NORTH OF COMPOSITE FACILITY, SHOWING LOBES OF SOIL AND FINE-GRAINED COLLUVIUM FLOWING DOWNSLOPE (by solifluction) OVER AREAS OF ANGULAR GRANITOID BLOCKS

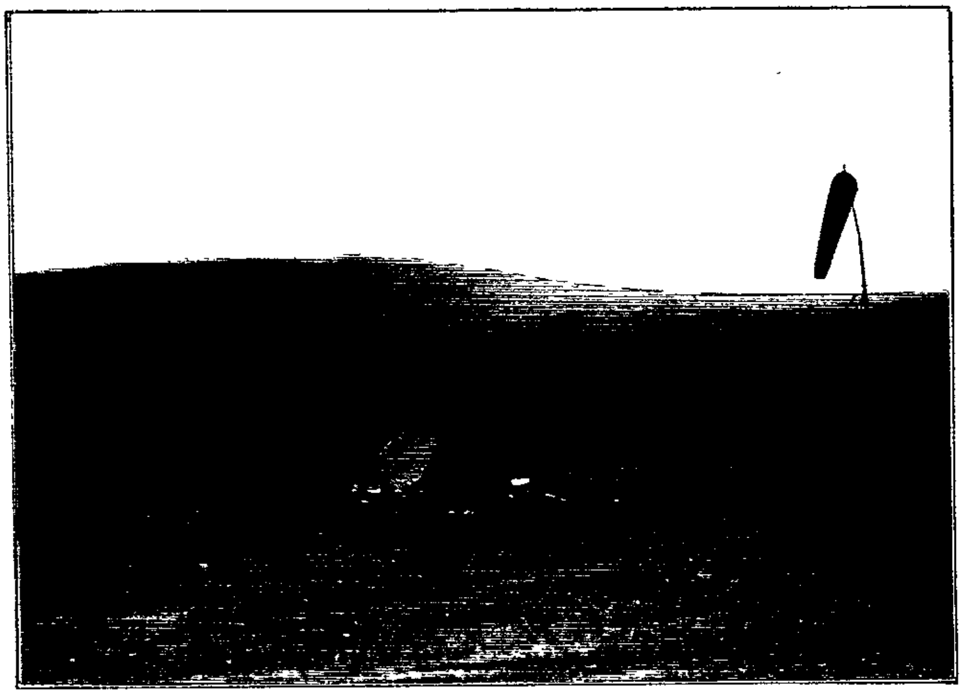

Figure 2-7B. COLLUVIUM-COVERED SLOPE NORTHWEST OF AIRSTRIP RUNWAY AND FOWLER CREEK, SHOWING LINEAR WELTS OF SOLIFLUCTION MASSES MOVING DOWNSLOPE (upper right to lower left)

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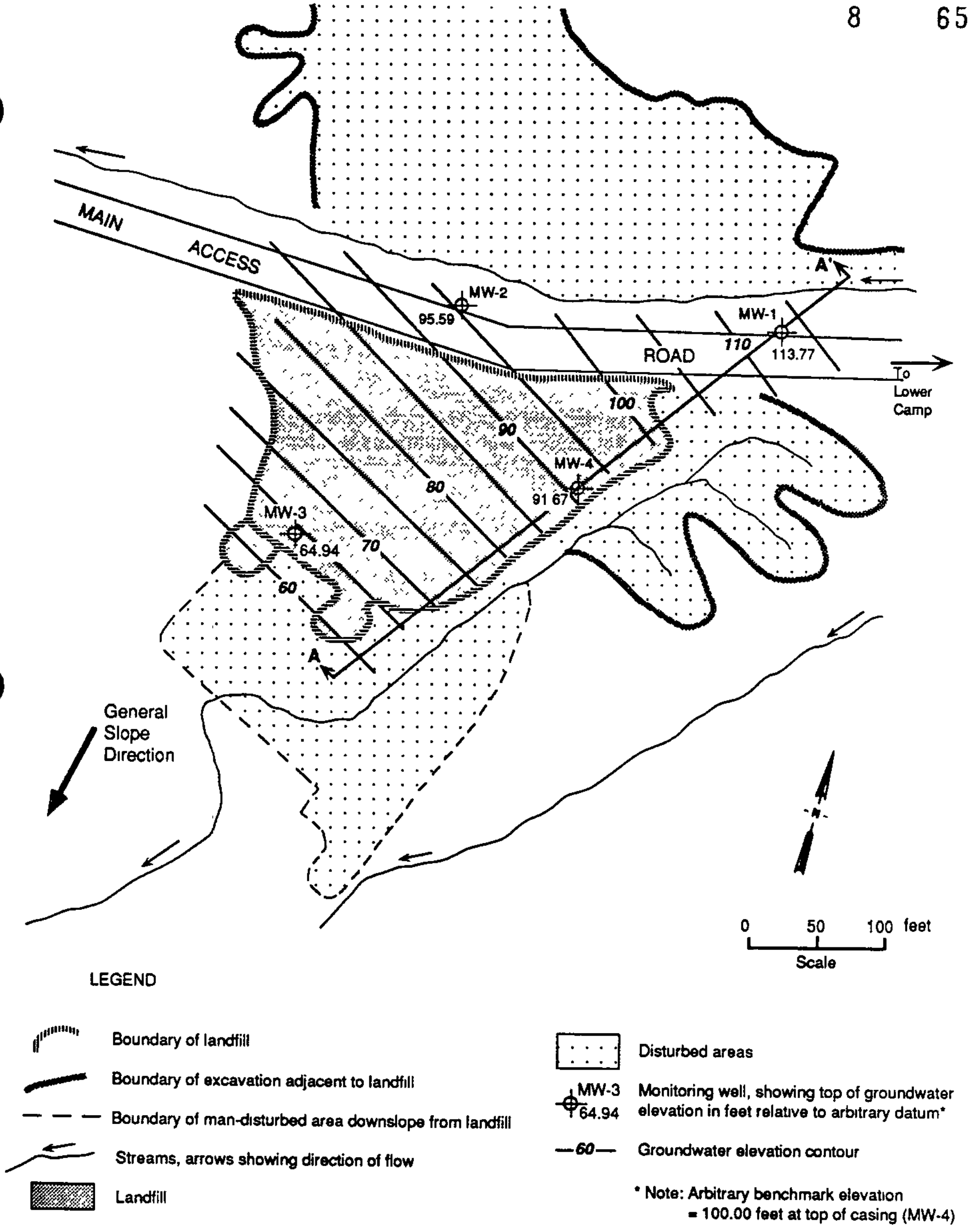

Project No. 90275L	Cape Romanzof LRRS	CONTOURED GROUNDWATER ELEVATIONS ROM-8 LANDFILL AUGUST 13 AND 14, 1989	Figure 2-8
Woodward-Clyde Consultants			

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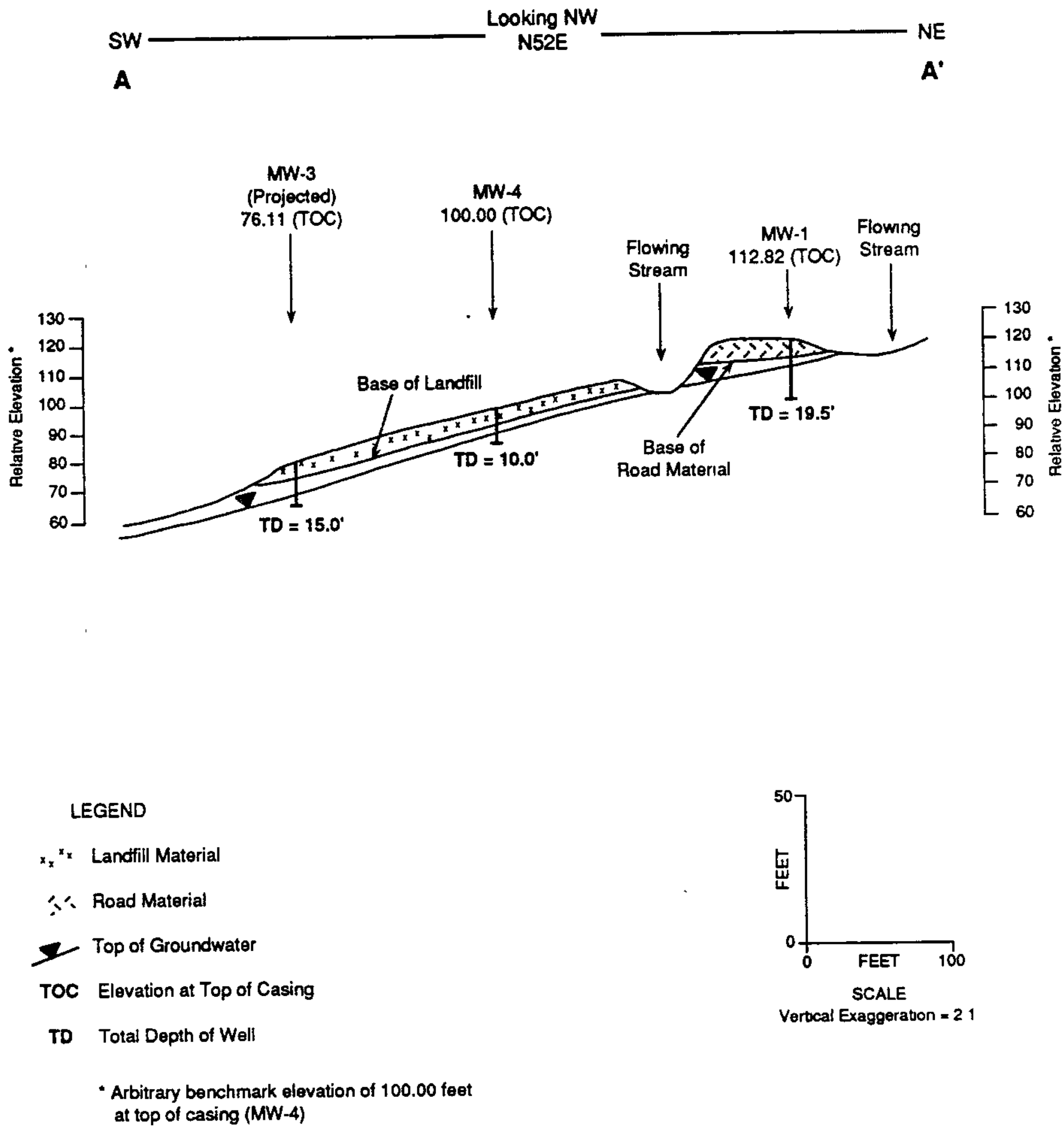


Project No. 90275L	Cape Romanzof LRRS	CROSS-SECTION A-A' ROM-8 LANDFILL	Figure 2-9
Woodward-Clyde Consultants			

This variability makes the estimation of well yield from wells screened in these materials highly uncertain.

2.4.2.3 Hydrogeology of Alluvial/Glacial(?) Deposits. These deposits are located within and underlying the central part of Fowler Creek Valley. Their presence is known mostly on the basis of the geologic log of Water Supply Well No. 1 (see Figure 2-5). This well is located near the head of Fowler Creek Valley and upstream from Lower Camp (see Figure 1-2). In addition, the geomorphic features in the central part of Fowler Creek Valley (i.e., local broad, nearly flat surfaces devoid of granite blocks, plus stepped geometry of longitudinal stream profile) infer the presence of underlying alluvial and possibly glacial deposits. Also, the yield of Well No. 1 (capable of 60 gallons per minute according to Feulner 1966) indicates that the aquifer consists of a more uniform and better sorted material than observed in the granitoid colluvium.

The stratigraphy of the alluvial/glacial(?) deposits (based only on Well No. 1 log) consists of at least 57 feet of "gravelly clay with boulders" plus "boulders and clay," overlying a lower unit of "sand and boulders" (see Figure 2-5). The upper clay-rich and boulder-rich unit may be glacial till; in non-glacial deposits these two size range end members (clay and boulders) are normally found in separate units. The lower unit described as "sand and boulders" is possibly alluvium or glacial outwash deposits, possibly related to an advancing glacier that later overrode the outwash and deposited a glacial till.

Since only one subsurface point is known for these deposits, the structural configuration of the deposits cannot be demonstrated. However, it is likely that these deposits are confined to the central part of Fowler Creek Valley, dip generally downstream, and interfinger with the granitoid colluvium toward the valley margins.

Groundwater is present within these deposits at Well No. 1; the probable aquifer is the sand/boulder lower unit (at 43- to 57-foot depths) plus underlying weathered granite bedrock. The upper clay-rich unit (0- to 43-foot depths) probably constitutes an aquitard. It was noted that static water level at Well No. 1 was at 29-foot depth, or within the aquitard and 14 feet above the top of the probable aquifer. This static water level represents a piezometric level, and thus groundwater exists in the sand/boulder aquifer under confined conditions.

Two other open, unsealed wells (previously undocumented) were found during the 1989 investigation in the central part of Fowler Creek Valley. These wells are located at the ROM-1S site, about 400 feet downstream from Well No. 1 (see Figure 1-2). It is likely that these wells also penetrated part of the alluvial/glacial(?) deposits; however, no information on lithologies penetrated or well histories is presently available.

2.4.2.4 Hydrology of Weathered Granitoid Bedrock. Weathered bedrock occurs in a zone of variable thickness stratigraphically above fresh unweathered bedrock and stratigraphically below the surficial materials consisting of granitoid colluvium and alluvium/glacial(?) deposits. Weathered bedrock is thin on the narrow ridgetop above Fowler Creek Valley (at Upper Camp and White Alice site); here abundant outcrops of granitoid bedrock containing distinctive joint sets are present (see discussion in Section 2.2). The weathered bedrock zone increases in thickness downslope (as does the overlying granitoid colluvium) and seems to attain maximum thickness under the surficial deposits on the valley floor. At Well No. 1, weathered bedrock is reported to be 43 feet thick (57 to 100 foot depth).

Well No. 1 was cased to a depth of 98 feet. Presumably, the screened interval in this casing extended to 98 foot depth; if so, this screened interval included most of the 43-foot thickness of the weathered bedrocks noted in the geologic log (57 to 100 foot-depth; see Figure 2-5). It is likely that some of the potential 60 gallon per minute yield from this well comes from the weathered bedrock zone. Groundwater present in this zone probably migrated through weathered bedrock downslope from the ridges above Fowler Creek Valley, percolating through the increasingly thicker weathered bedrock zone which was covered by surficial granitoid colluvium and alluvium/glacial(?) deposits. Also, some groundwater probably migrated downward from the overlying surficial deposits into the weathered bedrock zone.

2.4.3 Water Use

Cape Romanzof LRRS obtains its water supply from groundwater, which is present in bedrock and overlying alluvial sediments along Fowler Creek. The installation obtained its drinking water supply from two wells drilled into bedrock. Only Water Supply Well No. 1 is now being used. This well was drilled to a depth of 154 feet and cased with 8-inch-diameter pipe to a depth of 98 feet and is reportedly capable of pumping 60 gallons per minute. The static water level in this well was measured at 29 feet below grade (Feulner 1966), which suggests that local groundwater occurs under artesian (confined) pressure.

In 1962, a second well (Well No. 2) was installed. The Phase I Records Search (ES 1985) reported the well to be 96 feet deep and is equipped with 6-inch-diameter casing. This second well, which is now inactive, served only the Weather Station Building and reportedly became contaminated with POL products in 1964. Attempts were made to purify the water for continued use, utilizing a charcoal filtration device. During the 1989 field investigation, attempts to sample Well No. 2 were unsuccessful because the well was inaccessible to sampling. It is not known if the source of the POL contamination in local groundwater was ever identified or if the situation was ever corrected. During the spring-summer months, groundwater is pumped from the Lower Camp (Well No. 1) to local storage facilities for later use.

2.5 CLIMATOLOGY/AIR

Due to its size and geographic complexity, the state of Alaska encompasses four major climatic zones which have been established on the basis of similar temperature and precipitation values. Figure 2-10 depicts the distribution of the Alaskan climatic zones. Rainfall is highly variable across Alaska, ranging from 5 inches annually in the arctic climatic zone to some 300 inches annually along the southeast coast in the maritime zone (NOAA 1983; Zenone and Anderson 1978). The dramatic variation in rainfall is caused by orographic effects related to topography and exposure. Coastal mountain ranges receive the most rainfall while interior lowlands receive the least.

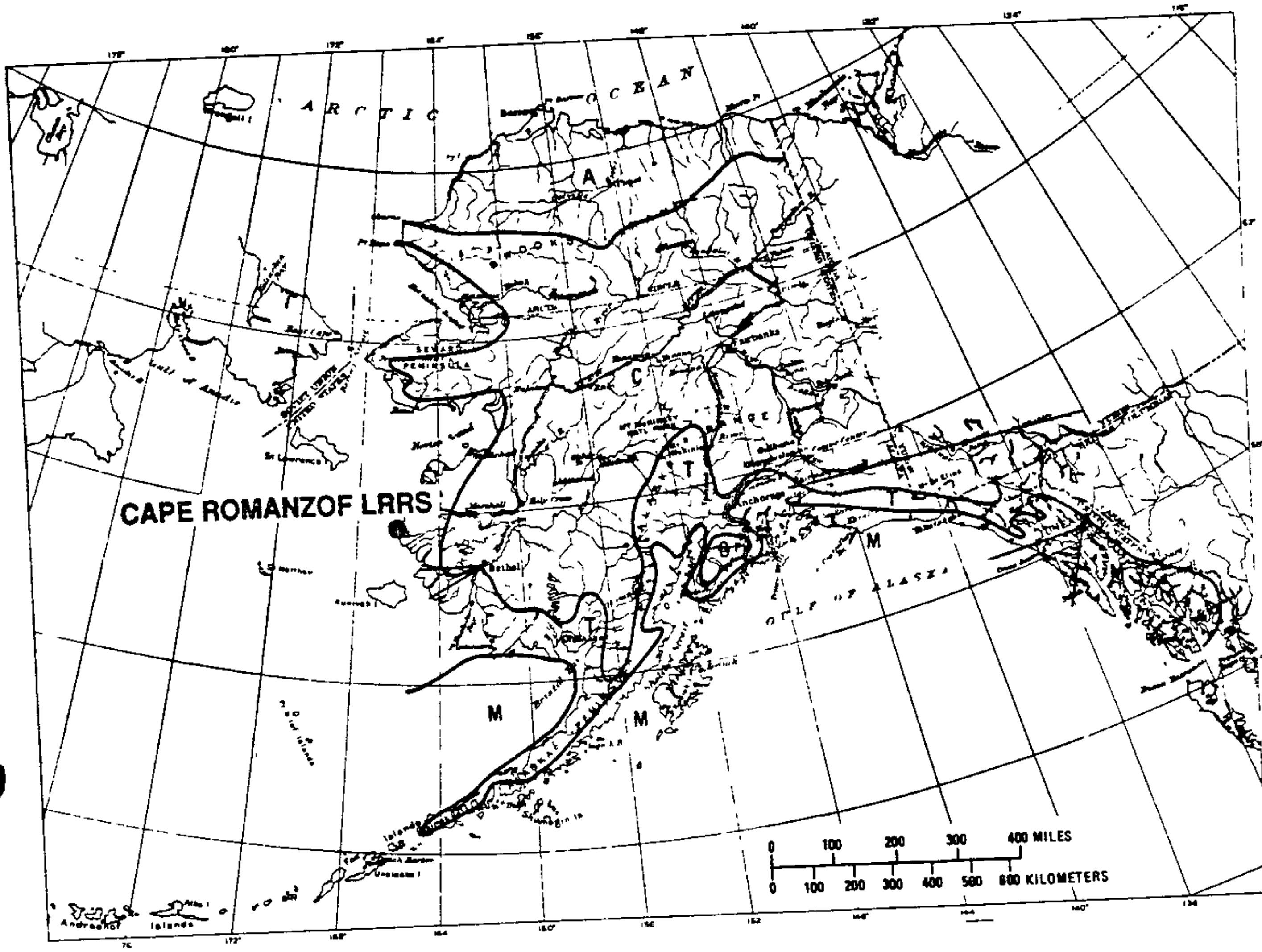
Cape Romanzof LRRS lies in the "maritime" climatic zone. Table 2-1 shows temperature, precipitation, snowfall, and wind data for the site.

According to Patric and Black (1968), potential evapotranspiration per year at Cape Romanzof is 14.80 inches; the total precipitation (see Table 2-1) is 26.80 inches. The net precipitation (total precipitation minus potential evapotranspiration) at Cape Romanzof is therefore 12.00 inches. This amount of precipitation is potentially available for infiltration into the subsurface to recharge local aquifers.

2.6 HUMAN ENVIRONMENT

2.6.1 Population

Contractor operations beginning in 1977 greatly reduced the number of personnel on the base. Further reductions in staff level have occurred since the MAR unit was completed. Approximately six contract personnel are presently based at Cape Romanzof LRRS.



Source: Modified from Zenone and Anderson, 1978

Project No. 90275L	Cape Romanzof LRRS	ALASKA CLIMATIC ZONES	Figure 2-10
Woodward-Clyde Consultants			

Table 2-1. CAPE ROMANZOF LRRS CLIMATOLOGICAL DATA

Month	Temperature (°F) Mean Daily Max	Mean Daily Min	Mean Monthly	Extreme Max	Extreme Min	Precipitation (in.) Monthly Mean	Monthly Max	Monthly Min	Max 24 Hrs	Snowfall (in.) Monthly Mean	Monthly Max	Max 24 Hrs	Surface Winds Pvlg. Drctn.	Speed
Jan	19	9	24	49	-23	1.3	4.2	0	1.0	10	34	7	NNE	15
Feb	14	4	9	48	-26	1.1	4.3	0	1.2	8	32	13	NNE	16
Mar	19	8	14	46	-26	1.3	6.8	0	1.2	11	69	11	NNE	14
Apr	26	16	21	46	-12	1.0	3.4	.1	.9	8	26	7	NNE	13
May	40	31	36	71	3	1.4	3.1	.0	.9	4	19	8	NNE	10
Jun	47	38	43	72	25	2.6	6.0	.1	1.9	1	4	2	S	9
Jul	53	45	49	78	31	2.9	6.5	.3	2.0	0	0	0	S	8
Aug	53	46	50	78	33	5.0	8.8	1.2	2.8	0	3	2	S	8
Sep	47	40	44	63	23	4.6	8.9	1.3	1.7	1	6	3	NNE	11
Oct	34	28	31	60	4	2.4	6.1	.8	1.4	10	40	19	NNE	12
Nov	26	18	22	45	-7	1.6	5.5	0	2.0	11	23	9	NNE	15
Dec	17	8	13	48	-23	1.6	4.2	0	1.3	14	47	7	NNE	16
ANN	33	24	29	78	-26	26.8	8.9	.0	2.8	78	69	19	NNE	12
EYR	22	22	22	22	22	24	24	24	24	24	24	24	?????	9

Period of Record: 1953 - 1981
Source: 11th Weather Squadron, Elmendorf AFB, AK

2.6.2 Demographics

Cape Romanzof LRRS consists of 4900 acres of land within the Yukon Delta National Wildlife Refuge. The installation is located 540 miles west of Anchorage on a small peninsula which extends into the Bering Sea. The nearest towns are Scammon Bay (population 326) and Hooper Bay (population 776) which are located 15 miles to the east and south, respectively. These communities are not accessible to Cape Romanzof by road.

The populations of Scammon Bay and Hooper Bay are nearly 100 percent Native Alaskan. Employment is seasonal, with peak economic activity in the summer months. Major sources of employment are the Bureau of Land Management firefighting programs, commercial fishing, and the associated canneries. Income from these enterprises is supplemented by public assistance payments and subsistence activities such as hunting, fishing, trapping, and gathering. Residents also earn money from the sale of grass baskets and ivory handicrafts.

2.6.3 Land Use

Cape Romanzof LRRS is located within the limits of the Yukon Delta National Wildlife Refuge, a federally protected, pristine natural environment. Salmon spawn in Fowler (Nilumat) Creek and beaver have constructed several ponds. Arctic fox have been sighted around the Composite Facility. The peregrine falcon, sighted at the Cape Romanzof installation, may be a transient at any time at the installation.

TAB

Section 3

3.0
FIELD INVESTIGATION PROGRAM

This section discusses field activities conducted at the sites investigated at Cape Romanzof LRRS during the 1989 field program. Also described are methods used in the investigation, data quality objectives of the investigation, and the quality assurance/quality control (QA/QC) program.

3.1 ORGANIZATION AND DEVELOPMENT OF THE FIELD PROGRAM

The field program consisted of soil gas surveys; monitoring well installation; soil, sediment, surface water and groundwater sampling; surface and geologic mapping; and horizontal and vertical survey of sampling points and other features.

3.2 SUMMARY OF FIELD ACTIVITIES AT EACH SITE

The following field activities were performed during summer 1989 at the Cape Romanzof (ROM) sites. These activities are summarized in Tables 3-1 to 3-6. A chronology of events is provided in Table 3-1. A summary of field tasks by site is shown in Table 3-2. Information on water and soil analyses by site and in summary is given in Tables 3-3 through 3-6.

3.2.1 ROM-1 Waste Accumulation Area

The site is located in the Lower Camp area, as shown on Figure 3-1. There are no longer any visibly stained soils or odors associated with this former waste accumulation area. Stained soils and odors noted by the 1987 reconnaissance team have apparently been removed, diluted and/or covered with soil in the last 2 years.

Table 3-1. CHRONOLOGY OF FIELD INVESTIGATION, SUMMER 1989, CAPE ROMANZOF LRRS

Date	Event
6/23	Receive Notice to Proceed
6/28	S. James, D. Graham, and G. Busse arrive for a 1-day site inspection prior to field work
7/17-26	Field equipment mobilized, but bad weather and air charter scheduling conflicts prohibit transport of equipment from Anchorage to Cape Romanzof
7/25-27	Geological Survey (M. Bonkowski)
7/27	Drill rig and other equipment arrive at Cape Romanzof on a Mark Air L-100 (Hercules)
7/28	Well Installation Crew (G. Busse, T. Rogers, K. Brown, and G. Erickson) arrives at Cape Romanzof
7/29	Inventory Supplies Complete Well MW-1 (ROM-8)
7/30	Complete Well MW-2 (ROM-8)
7/31	Complete Wells MW-3 and MW-4 (ROM-8) Set up Gas Chromatograph and Tent
8/1	Start drilling MW-5 (ROM-1D); Drilling rig down for repairs Hydrologic survey at ROM-8 Landfill F. Gomez arrives and sets up soil gas instruments
8/2	Start surficial mapping at ROM-8 landfill Commence soil gas survey at ROM-1D 5099th Disposal Pit
8/3	Continue soil gas survey at ROM-1D 5099th Disposal Pit Continue surficial mapping at ROM-8 landfill
8/4	Commence soil gas survey at ROM-3 former shop area Complete soil gas survey at ROM-1D 5099th Disposal Pit Complete surficial mapping at ROM-8 landfill; start surficial mapping at ROM-1S Large Fuel Spill
8/5	Continue soil gas survey at ROM-3 Former Shop Area Continue surficial mapping at ROM-1S Large Fuel Spill USAF TPM Lt. W. Migdal and WCC RI/FS Manager M. Adu arrive for site inspection

Table 3-1. CHRONOLOGY OF FIELD INVESTIGATION, SUMMER 1989, CAPE ROMANZOF LRRS (concluded)

Date	Event
8/6	Installation inspection and inventory of sites Continue soil gas survey at ROM-3 Former Shop Area Migdal, Adu, Brown, and Erickson depart site Complete surficial mapping at ROM-1S Large Fuel Spill Decision to abandon borehole at MW-5 (ROM-1D)
8/7	Develop monitoring wells at ROM-8 landfill Conduct vertical control survey at ROM-8 landfill Complete soil gas survey at ROM-3 Former Shop Area
8/8	Develop monitoring wells R. Spencer arrives, Gomez and Rogers depart site Packed up soil gas equipment
8/9	Develop monitoring wells Investigation of Well 2 at Weather Station, and beach area S. Brown arrives
8/10	Sampling at ROM-3, ROM-1D, ROM-1S, and ROM-8
8/11	Sampling at ROM-3 and ROM-1S, ROM-8, ROM-1
8/12	Sample Well A and Well B at ROM-1S Mark Air L-100 (Hercules) departs with drill rig and other equipment
8/13	Map sample locations at ROM-8 and ROM-1 Sampling at ROM-8; commence sampling at ROM-12, ROM-4, and ROM-5 Commence purging monitoring wells
8/14	Sampling at ROM-4, ROM-10, ROM-8, and ROM-12 Demob gear All WCC personnel (Busse, Spencer, and Brown) depart site
8/15	Pickup truck and last equipment leave site
9/28	R. Spencer and D. Evans arrive for resampling Purge monitoring wells
9/29	Purge monitoring wells Sample ROM-8 WCC crew departs

Table 3-2. SUMMARY OF FIELD WORK BY SITE AT CAPE ROMANZOF LRRS

	ROM-1	ROM-1S	ROM-1D	ROM-3	ROM-4	ROM-5	ROM-8	ROM-10	ROM-12	Total
No. of Wells	--	--	--	--	--	--	4	--	--	4
Total Depth (feet)	--	--	--	--	--	--	56	--	--	56
Days of Soil Gas	--	--	3	4	--	--	--	--	--	7
Days of Mapping	--	3	--	--	--	--	4	--	--	7
Surface Water Samples	--	--	--	1	--	--	10	--	1	12
Groundwater Samples	--	2	--	1	--	--	4	--	--	7
Soil and Sediment Samples	3	4	2	5	2	1	10	1	3	31

Table 3-3. ANALYTICAL METHODS AND NUMBER OF WATER ANALYSES BY SITE AT CAPE ROMANZOF LRRS

Parameter	Analytical Method	ROM-1	ROM-1S	ROM1D	ROM-3	ROM-8	ROM-10	ROM-12	Total
Specific Conductance (Field Test)	E120.1	--	2	--	2	14	--	1	19
pH (Field Test)	E150.1	--	2	--	2	14	--	1	19
Temperature (Field Test)	E170.1	--	2	--	2	14	--	1	19
Petroleum Hydrocarbons	E418.1	--	2	--	2	14	--	1	19
ICP Screen (23 metals, exclude Boron and Silica)	SW3005/ SW6010								
Total Recoverable		--	2	--	2	14	--	1	19
Dissolved		--	2	--	2	14	--	1	19
Purgeable Halocarbons	SW5030/ SW8010	--	2	--	2	14	--	1	19
Purgeable Aromatics	SW5030/ SW8020	--	2	--	2	14	--	1	19
Organochlorine Pesticides and PCBs	SW3510/ SW8080	--	2	--	2	14	--	1	19
Semivolatile Organic Compounds	SW3510/ SW8270	--	2	--	2	14	--	1	19

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Table 3-4. ANALYTICAL METHODS AND NUMBER OF SOIL ANALYSES BY SITE AT CAPE ROMANZOF LRRS

Parameter	Analytical Method	ROM-1	ROM-1S	ROM-1D	ROM-3	ROM-4	ROM-5	ROM-8	ROM-10	ROM-12	Total
Petroleum Hydrocarbons	SW3550/ E418.1	3	4	2	5	2	1	10	1	3	31
ICP Screen (23 metals, exclude Boron and Silica)	SW3050/ SW6010	3	--	2	5	1	1	10	--	3	25
Organochlorine Pesticides and PCBs	SW3550/ SW8080	3	--	2	5	2	1	10	--	3	26
Volatile Organic Compounds	SW8240	3	4	2	5	1	1	10	--	3	25
Semivolatile Organic Compounds	SW3550/ SW8270	3	4	2	5	1	1	10	--	3	25
Soil Moisture	ASTM D2216	3	4	2	5	2	1	10	1	3	31

Table 3-5. SUMMARY OF WATER ANALYSES AT CAPE ROMANZOF LRRS

Parameter	Analytical Method	Reporting Units	Number of Analyses	Trip Blanks	AMB Cond Blanks	Equip. Blanks	Dup/Rep	Second Column	Total Analyses
Specific Conductance (Field Test)	E120.1	µmhos/cm	19	--	--	--	--		19
pH (Field Test)	E150.1	pH Units	19	--	--	--	--		19
Temperature (Field Test)	E170.1	°C	19	--	--	--	--		19
Petroleum Hydrocarbons	E418.1	mg/L	19	--	--	1	2		22
ICP Screen (23 metals, exclude Boron and Silica)	SW3005/ SW6010	mg/L							
Total Recoverable			19	--	--	1	2		22
Dissolved			19	--	--	--	2		21
Purgeable Halocarbons	SW5030/ SW8010	µg/L	19	6	1	1	2	--	29
Purgeable Aromatics	SW5030/ SW8020	µg/L	19	6	1	1	2	--	29
Organochlorine Pesticides and PCBs	SW3510/ SW8080	µg/L	19	--	--	1	2	--	22
Semivolatile Organic Compounds	SW3510/ SW8270	µg/L	19	--	--	1	2		22

Table 3-6. SUMMARY OF SOIL ANALYSES AT CAPE ROMANZOF LRRS

Parameter	Analytical Method	Reporting Units	Number of Analyses	Rep	Second Column	Total Analyses
Petroleum Hydrocarbons	SW3550/ E418.1	mg/kg	31	3		34
ICP Screen (23 metals, exclude Boron and Silica)	SW3050/ SW6010	mg/kg	25	3		28
Organochlorine Pesticides and PCBs	SW3550/ SW8080	mg/kg	26	3		29
Volatile Organic Compounds*	SW8240	mg/kg	25	3		28
Semivolatile Organic Compounds	SW3550/ SW8270	mg/kg	25	3		28
Soil Moisture	ASTM D2216	percent (%)	31	--		31

* Soil samples for volatile organic compounds analysis were shipped with water samples, and trip blanks were analyzed by methods 8010 and 8020.

In lieu of collecting samples from visibly contaminated areas, three near-surface soil samples were collected from three very small drainage channels that flow only during a rainfall. These locations would serve as accumulation points for mobile contaminants in the surrounding soils. Sample locations were marked and mapped as shown on Figure 3-2.

3.2.2 ROM-1S Large Fuel Spill

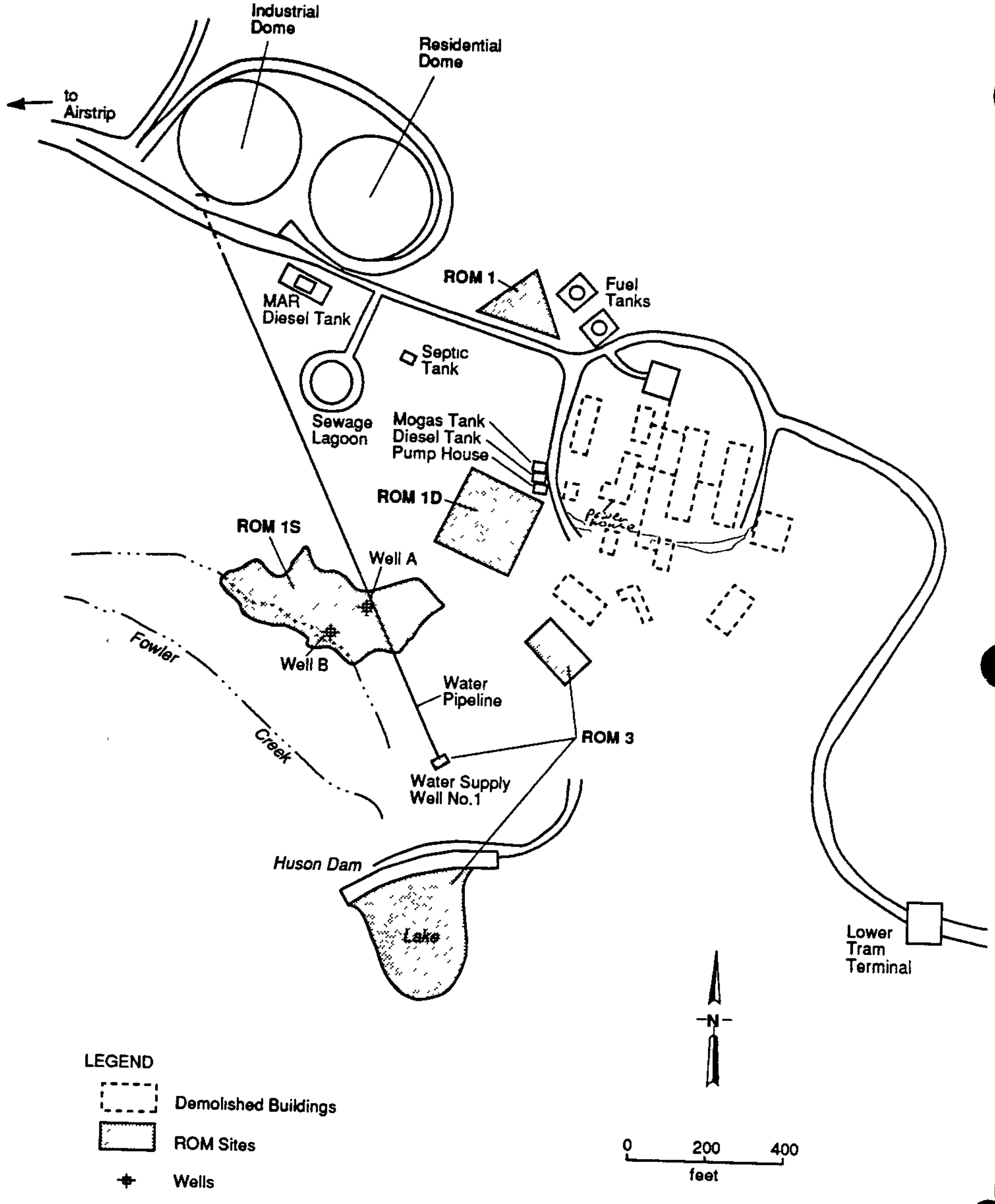
The site is located southwest of the Lower Camp area, as shown on Figure 3-1. The area still affected by the large fuel spill is apparent from the visible swath of darkened, distressed tundra. This area was traversed and mapped. Four near-surface soil samples were collected within the affected area: one near the head, two in the middle, and one near the terminus of the spill. Sample locations were marked and mapped as shown on Figure 3-2.

Two abandoned wells, located in the path of the spill, were discovered during the initial survey of the site. These are shown as Wells A and B on Figure 3-2. One well (Well B) may have served as a base water supply well at one time, as evidenced by a concrete building foundation surrounding the well head. The other well (Well A) appears to have never been developed and was probably abandoned at the time of its installation. The wells were purged, using an electric 4-inch submersible pump, and groundwater samples were collected.

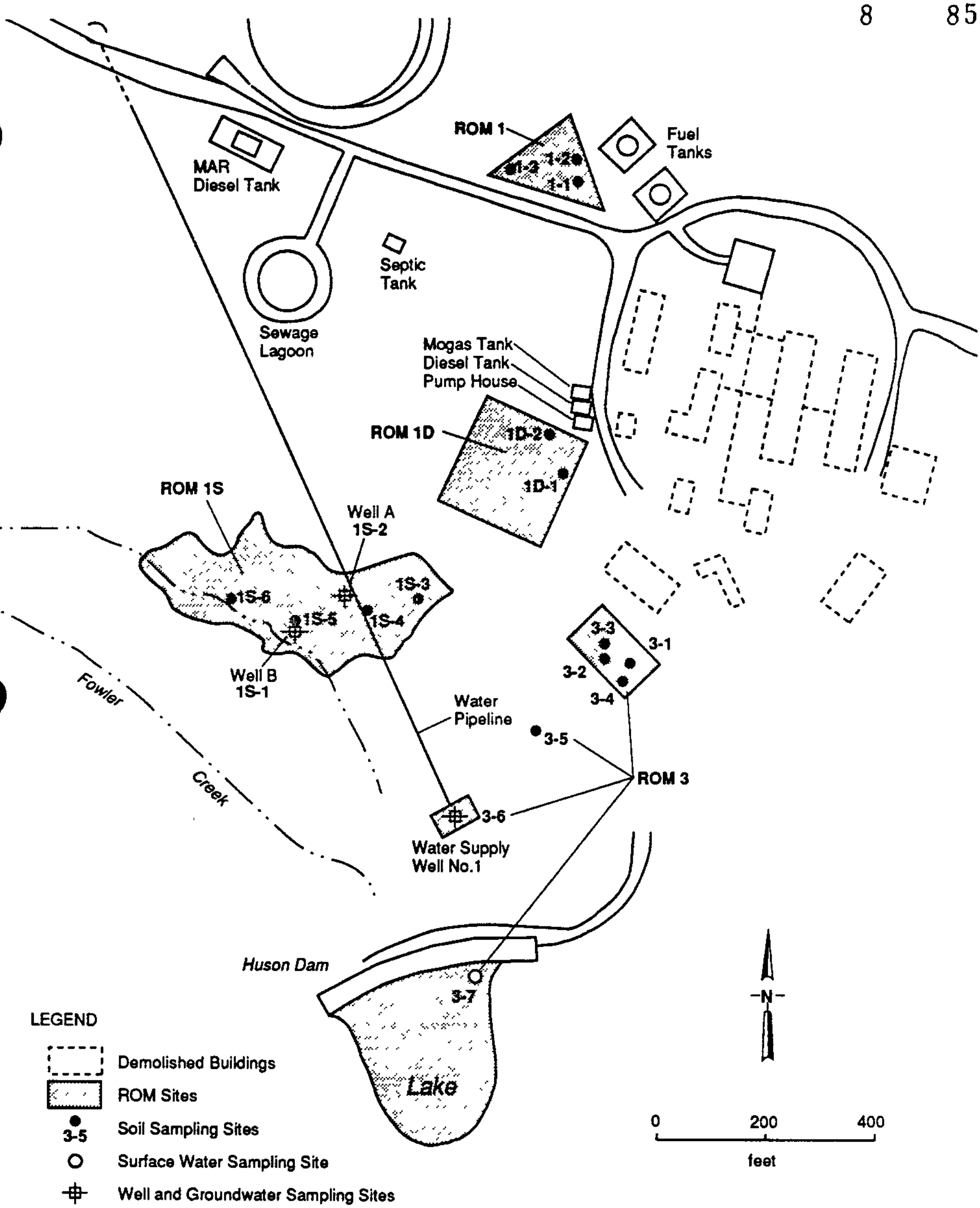
3.2.3 ROM-1D 5099th Disposal Pit

The site is located in the Lower Camp area, as shown on Figure 3-1. A soil gas survey, consisting of 21 sample probe locations, from depths ranging between 2.5 and 4.5 feet, was performed at this relatively recent landfill. This landfill was created by the 5099th CEOS the disposal of debris and wastes resulting from the demolition and cleanup of the former adjacent camp (shown as demolished buildings on Figure 3-1). The probe locations and the immediate area were mapped, as shown on Figure 3-3.

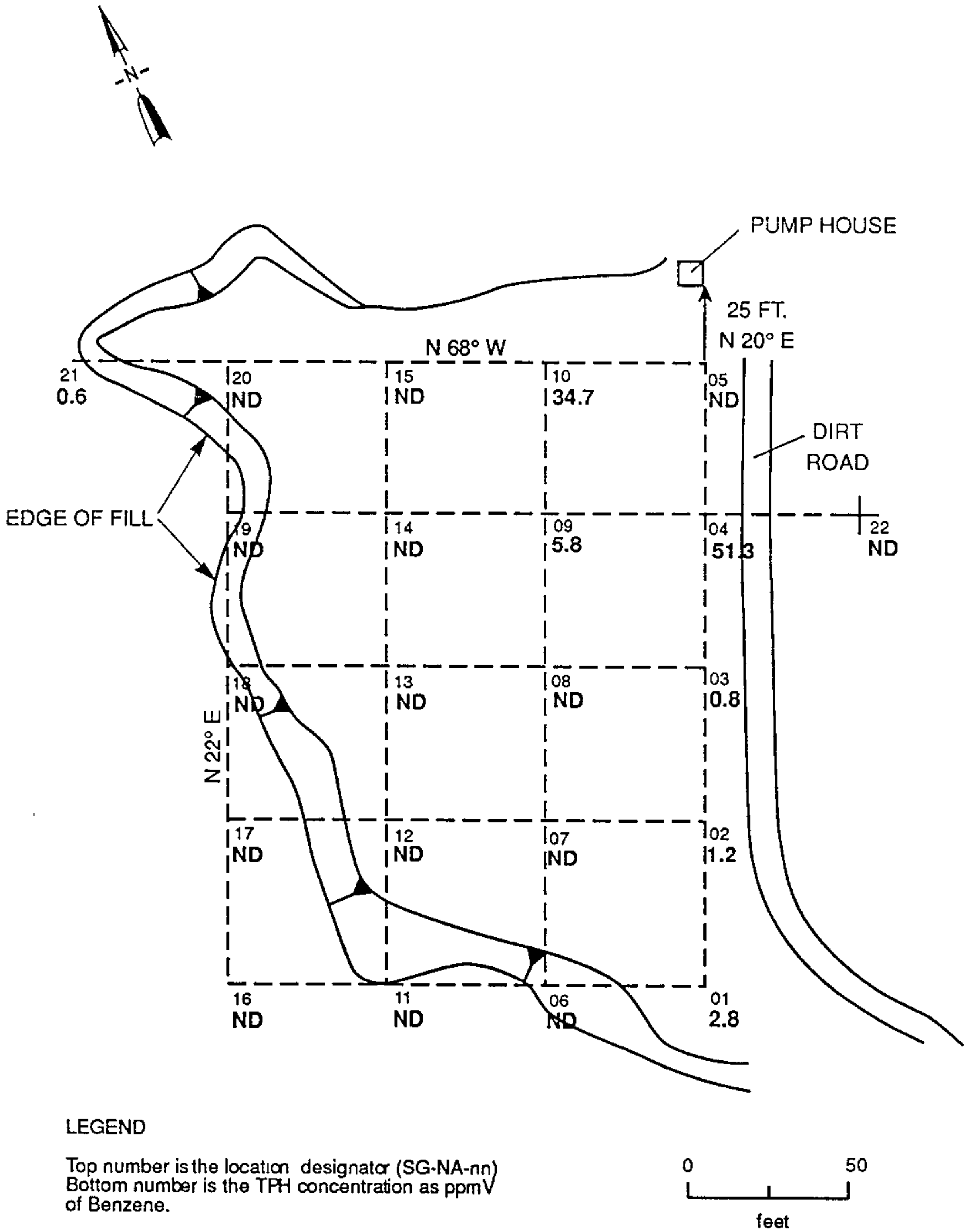
8 84



Project No. 90275L	Cape Romanzof LRRS	ROM 1, ROM 1S, ROM 1D, AND ROM 3 LOCATIONS	Figure 3-1
Woodward-Clyde Consultants			



Project No. 90275L	Cape Romanzof LRRS	ROM 1, ROM 1S, ROM 1D, AND ROM 3 SAMPLING LOCATIONS	Figure 3-2
Woodward-Clyde Consultants			



Project No. 90275L	Cape Romanzof LRSS	ROM-1D SOIL GAS SURVEY	Figure 3-3
Woodward-Clyde Consultants			

Based on the results obtained from the soil gas survey, two soil samples were collected from contaminated locations. Sample locations were marked and mapped as shown on Figure 3-2.

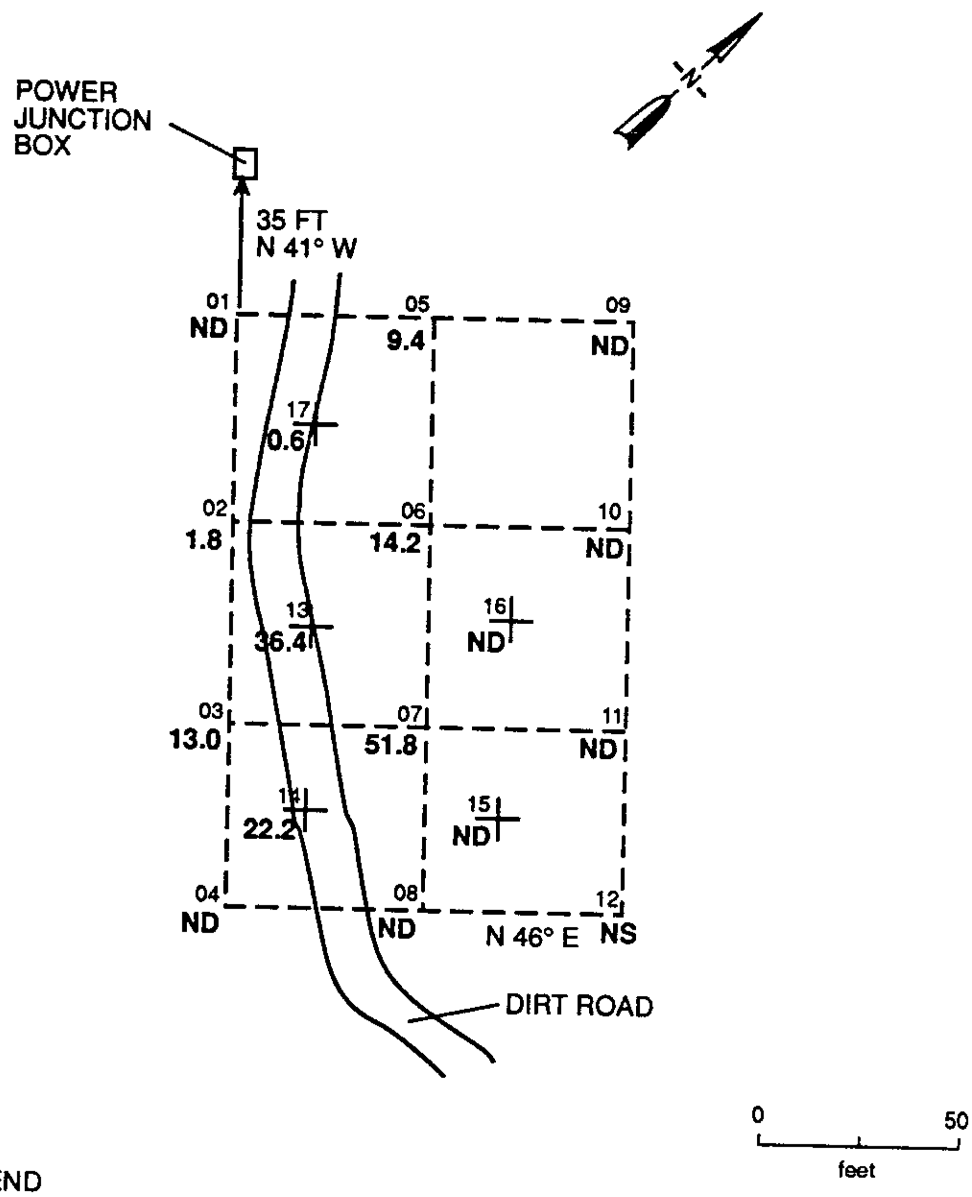
3.2.4 ROM-2 Weather Station Well

This well is located east of the airstrip runway, as shown on Figure 1-2. An attempt to obtain a groundwater sample from this long-abandoned water well was unsuccessful. The well has been out of service for many years, and to gain access to the groundwater inside the well would have required stripping all the insulation material from the well head area, lowering a person into the 48-inch CMP overcasing, then pulling and dismantling the pump and discharge piping. These conditions were not known prior to the sampling attempt; and could not have been accomplished with available equipment and personnel. Therefore, the groundwater sample scheduled to be taken here was not collected.

3.2.5 ROM-3 Former Shop Area

This site is located in the Lower Camp area, as shown on Figure 3-1. Partially filled containers of waste and stained soils noted by the 1987 reconnaissance team were no longer present at this site. Because the buildings had been demolished by the 5099th CEOS, there was no point of reference to indicate the exact location of the former shop.

A soil gas survey was performed here to better define locations to be investigated further by soil sampling. Seventeen soil gas probes were installed and sampled, from depths of 2.0 to 4.5 feet. Not all locations were possible for dual sampling due to subsurface conditions that inhibited the probe from penetrating to the greater depth. The probes were located as shown on Figure 3-4. At location number 12, a sample was not collected due to running mud that clogged the tee and the needle of the syringe (WCC 1989a). Based on soil gas results, four soil samples were collected from locations shown to be contaminated. These soil sample locations are shown on Figure 3-2.



LEGEND

Top number is the location designator (SG-NA-nn)
Bottom number is the TPH concentration as ppmV of Benzene.

ND = Not detected

NS = Not sampled due to equipment malfunction

Project No 90275L	Cape Romanzof LRRS	ROM-3 SOIL GAS SURVEY	Figure 3-4
Woodward-Clyde Consultants			

In addition, several samples of soil and water were collected from the area southwest of and mostly downgradient from the former shop area. For convenience, these samples were included in the ROM-3 study. One sediment sample (3-5) was collected from a small drainage downslope (in the tundra) from the area of the soil gas survey. One surface water sample (3-7) was collected from the small lake formed behind a small earth-filled dam. One groundwater sample (3-6) was collected from the LRRS water supply well. Sample locations were marked and mapped and are shown on Figure 3-2.

3.2.6 ROM-4 Road Oiling

Two soil samples were collected in drainage ditches adjacent to the main installation road. Sample locations were marked and mapped as shown on Figure 1-2. One sample was collected west of the Industrial Dome, and the other was collected about 2 miles downgradient, above the lower intersection of the main and winter access roads. The arrows on Figure 1-2, ROM-4 Road Oiling, point to the approximate sample locations.

3.2.7 ROM-5 New Landfill

The site is located near the Composite Facility, as shown on Figure 1-2. One near-surface soil sample was collected from a small drainage that had flow only during rain. This sample would show any contamination that may have been transported to this location by surface runoff from the New Landfill or from the existing shop area (Industrial Dome). The location was marked and mapped, as shown on Figure 1-2. This location is southwest of the ROM-5 landfill.

3.2.8 ROM-6 Waste Accumulation Area

This site (in the Lower Camp Area) had been reported as a former waste accumulation area that had been cleaned, regraded and filled over (see location on Figure 1-2). Due to the apparent effective cleanup effort performed here, the field team was unable to clearly locate this site or, after canvassing a broad area, uncover any visible contamination. With the concurrence of the Air Force Technical Program Manager (TPM), the one soil sample scheduled for this site was deleted.

3.2.9 ROM-7 Dump

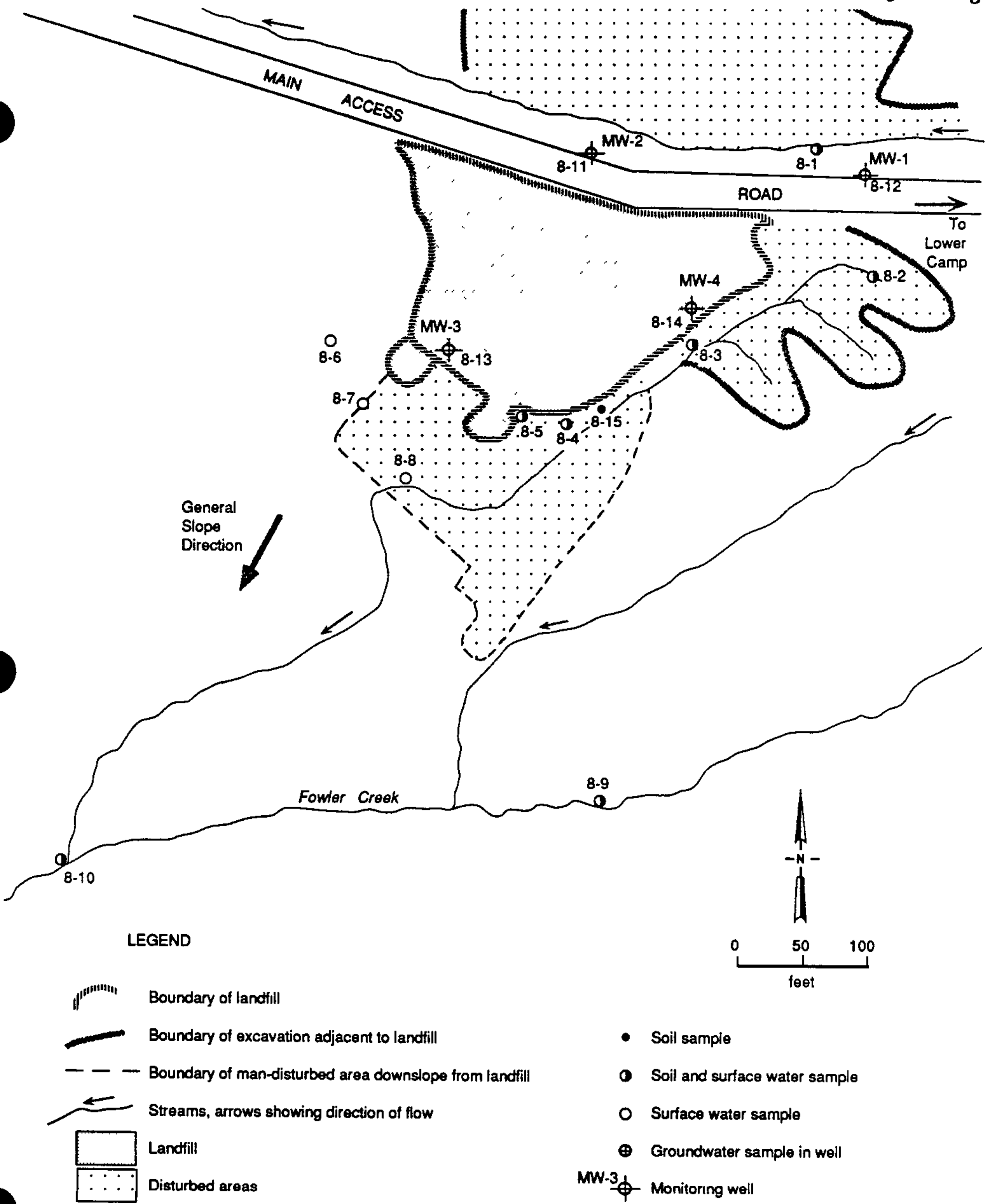
These reported dump areas on the east side of Upper Camp were surveyed by the field team and no evidence was found that they existed. With the concurrence of the Air Force TPM, the soil sample scheduled for this site was deleted.

3.2.10 ROM-8 Landfill

This site is located adjacent to the main access road, as shown on Figure 1-2. The landfill that makes up this site is unsightly, with a large amount of exposed metal, wood and plastic debris. There are several areas of stained soils, several points of effluent emanating from the downslope side of the landfill, and two drainages containing active surface flow just upslope and adjacent to the landfill.

The landfill was mapped, surface water courses and points of effluent were located, and the outline and the general topography of the landfill and adjacent area were shown.

Four 4-inch monitoring wells were installed: two on the north, upgradient side of the landfill and two in the landfill, at the extreme, downgradient side. Locations of these monitoring wells and sampling locations are shown on Figure 3-5. The downgradient wells were not located off the landfill because of either rough or mushy unstable tundra terrain below the face of the landfill, which prevented movement of the drill rig beyond the landfill. The wells were completed at total depths between 10 and 19.3 feet below ground surface. After development of the wells, a groundwater sample was collected from each well. Elevations of well casings and other landfill features were established by a level survey. Groundwater elevations were measured and recorded. Blueline drawing No. 2 (attached) shows the mapped landfill and survey results.



Project No. 90275L	Cape Romanzof LRRS	SAMPLING LOCATIONS AT ROM-8 LANDFILL	Figure 3-5
Woodward-Clyde Consultants			

Water and sediment samples were collected from two locations in the drainages upgradient from the landfill (see Figure 3-5). Three water and sediment sample sets were collected at points of effluent from the face of the landfill. One near-surface soil sample was collected from stained soil located adjacent to an electrical transformer. Three water samples were collected from drainages leading from the landfill located approximately 100 feet away. Two water and sediment sample sets were collected in Fowler Creek, one set upstream from surface runoff emanating from the landfill and one set downstream.

3.2.11 ROM-9 Landfill

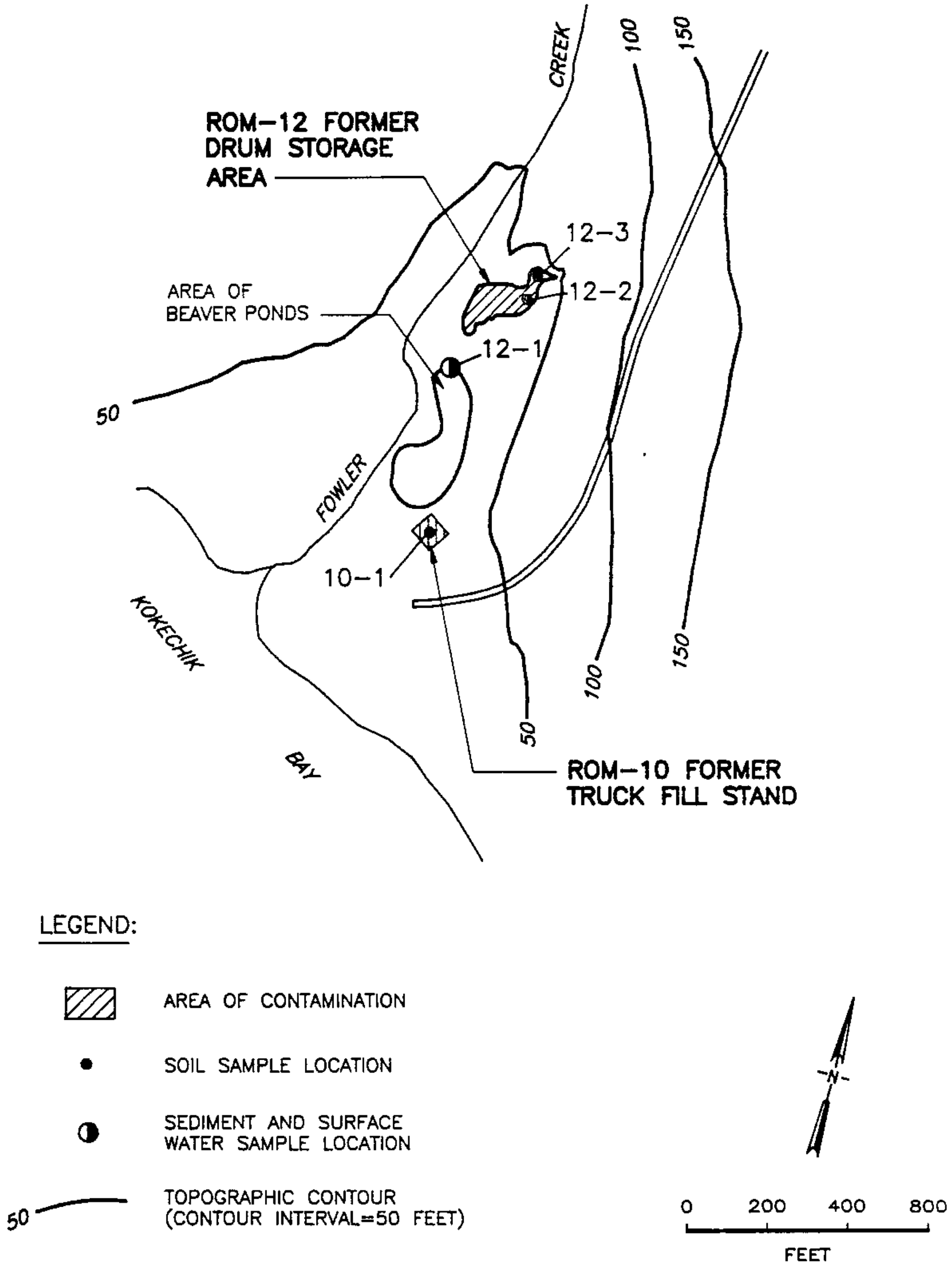
The location of this landfill could not be determined; thus the one soil sample scheduled here was deleted with the concurrence of the Air Force TPM.

3.2.12 ROM-10 Former Truck Fill Stand

This site is located near the mouth of Fowler Creek, as shown on Figure 1-2. The "truck fill stand" no longer exists and the area has been graded, so there was no accurate point of reference for the location of the soil sample scheduled to be collected at this site. Based on a map of the former area and an observed stained soil area, a soil sample was collected from what was thought to be the former location of the truck fill stand. The sample location was marked and mapped, as shown on Figure 3-6.

3.2.13 ROM-11 Former White Alice Station

The former White Alice Station (on the high ridge, southwest of Upper Camp) has been demolished, the debris buried, and all points of reference removed. Figure 1-2 shows the approximate site. The area has been regraded and there are no visible signs of contamination. With the concurrence of the Air Force TPM, the two soil samples scheduled to be collected here were deleted.



Project No. 90275L	CAPE ROMANZOF LRRS	ROM-10 AND ROM-12 SAMPLING LOCATIONS	Figure 3-6
Woodward-Clyde Consultants			

ROM3

3.2.14 ROM-12 Former Drum Storage Area

This site is located near the mouth of Fowler Creek, as shown on Figure 1-2. This site had not previously been documented and was discovered by the 1989 field team. Further investigation showed that the area was an old POL drum staging area up until the late 1970s. The site consists of a dark-stained area approximately ¼ acre in size. The stained area was mapped. Vegetation within the affected area is dead and there is an odor of old fuel.

Two soil samples were collected from the stained area; and one water and sediment sample set were collected from a beaver pond that lies downslope (southwest) of this area. The sample locations were marked and mapped as shown on Figure 3-6.

3.3 METHODS

3.3.1 Soil Gas Sampling

Sampling probes were constructed from 3/4-inch Schedule 80 steel pipe and driven into the ground to specified or practical depth using a jackhammer. Approximately 1 foot of the probe pipe was left above ground surface. The top end of the pipe (blunted by jackhammer driving) was cut off with a power saw, and the inside of the newly sawn end was threaded to receive the stainless steel sampling tee.

The sampling method used to collect the soil gas samples utilized a vacuum pump connected to one end of a stainless steel tee that had been attached to the upper end of the sampling probe. The other side of the tee was plugged with a sealing septum and a locking nut. When vacuum was applied to the connected system, it was allowed to purge for 2 minutes. Subsequently, the pump idled and two 5-ml glass syringes were sequentially inserted through the septum and filled with the flowing vapors. The syringes were immediately taken to the field laboratory, where they were analyzed by gas chromatography. All seven samples collected on the first day of sampling were analyzed in duplicate (both syringes from a single probe were analyzed separately) to verify instrument and sampling techniques. The duplicate samples were later gradually reduced to one for every ten collected samples. Since the samples were taken from the "negative" pressure side of the pump, and a separate probe was used at each location, the only sampling equipment that was in contact with the sample stream (before the sampling point) was the stainless steel tee, which was removed periodically and decontaminated to minimize the potential for cross contamination.

Decontamination consisted of flushing the tee successively with hexane, methanol and reagent grade water. Nitrogen gas was used to dry and purge the tee before installing it in the next probe. Because of the high moisture and rain at the site, the pump was brought to the living quarters for drying each evening. Despite this care for the pump, on the third day of sampling it was necessary to replace the pump with a new one. With this change it became apparent that the old pump had the vacuum gauge offset by 3 inches of mercury; the reported values were corrected by this factor.

Faulty vacuum readings would give indications of the soil type (high readings indicate clayey soils, lower readings pervious soils), but would not influence the measured contaminant concentrations.

To confirm the cleanliness of the equipment (syringes, glass bulb for standards and GC) several blank samples were injected every day to verify each of the possible sources of contamination. All blanks indicated that the system was operated free of interference and cross contamination between consecutive injections.

The analytical equipment used for the soil gas survey was a 3400 series Varian gas chromatograph (GC), with a Hewlett-Packard integrator model 3393 for plotting and integrating the signal from the Tracor photo-ionization detector installed on the GC. The analytical method was EPA Test Method

602 modified according to the following parameters: isothermal run at 100°C, analysis time 15 minutes, and column Supelcoport 80/100 SP2100 3/8 in. OD. The calibrating gas standard was prepared daily by injecting 1 μl of a stock liquid mixture (containing benzene, toluene, ethylbenzene and the three xylenes -BTEX-, 10 μg/μl each) into a 500-ml pre-cleaned glass bulb. Each peak was identified separately and the integrated areas were used to calculate the total BTEX content. The liquid mixture inside the bulb was allowed to volatilize, creating the gas standard that normalized as benzene equivalent to 31 ppmV. The reported values were normalized to "benezene equivalents" following AFOEHL RPJMS Handbook instructions, to report soil gas units in "parts per million, benzene" (PPMB). This technique was useful to account for compounds that did not exactly match the calibration standard, but were presented in the samples. By reporting benzene equivalents, the unidentified compounds were included in the calculation, providing a conservative result. The average site temperature (10°C), the atmospheric pressure (680 mm mercury), and the analyte's molecular weights were used to calculate the concentration of the standard. The instrument was calibrated daily by injecting three different volumes (1, 2 and 4 ml) of the bulb atmosphere into the GC to generate the reference response factors (for 31, 62, and 124 ppmV, respectively). The sample concentrations were computed based on these response factors, and were reported and normalized as ppmV benzene.

3.3.1.2 Sample Preparation-Collection Procedure. Two to five milliliters of soil gas sample were directly injected into the GC immediately after collection from the sampling probe, and the reported concentrations were volume corrected (equivalent to sample concentration/dilution technique) to compensate for the difference of volume between the samples and the standards.

3.3.1.3 Record Keeping. For record keeping of the soil gas semi-quantitative analysis, a book marked ROM-03 3000-01 was kept and updated daily with comments, notes, calculations and results of the findings and analysis of each sample. In addition, a sample sequence table and a draft gridmap were maintained to visually identify the affected areas. The information provided herein is the compilation of the field notes collected during the soil gas survey.

3.3.2 Surficial Mapping

Areas of visible contamination, sample locations, well locations, geologic and hydrologic features were surficially mapped in order to document conditions at the time of the investigation and the locations of sampling.

This task was accomplished by first making a reconnaissance of each area to be mapped to identify important features and possible reference points that could be used for mapping. Reference points included road intersections, corners of buildings, and other man-made features.

Areas of visible contamination, sample locations, and the soil gas survey sites were mapped by traversing the sites using a hand-held compass for bearings and pacing the distances. Site features such as surface water, drainages, visible contamination, and sampling locations were identified and located on a map or sketch made for each site. Individual sites were located on a base map to show overall orientation of the sites. Blueline drawings No. 1 and 2 show the site and the survey of the ROM-8 landfill.

At all locations where soil, sediment, and surface water samples were collected, a permanent marker was installed. The marker consisted of an 18-inch length of #3 rebar, driven fully into the ground, with a 1½-inch aluminum cap on top. The sample number identifying the location was stamped into the cap using impact lettering tools. Sample locations can be recovered by using the maps made, visually locating the markers, and/or by locating the markers using a metal detector.

3.3.3 Well Installation and Completion

Four groundwater wells were constructed at the ROM-8 Landfill. Two wells (MW-1 and MW-2) were located upgradient of the landfill, along the north edge of the main access road (see Figure 3-5). Two additional wells (MW-3 and MW-4) were located at the southern and eastern (i.e., lower) margins of the landfill and downgradient from MW-1 and MW-2. Total depths of these wells ranged from 10.0 to 19.3 feet. A summary of construction details for these wells is provided in Table 3-7.

The 10-inch-diameter boreholes, in which 4-inch-diameter monitoring wells were constructed, were advanced using a truck-mounted CME-75 mobile drill rig equipped with a string of 10-inch hollow-stem augers and air rotary percussion bits which fit inside the augers. An additional trailer-mounted air compressor was used for air rotary drilling operations.

Drilling conditions anticipated were a combination of loose colluvial materials and large, hard granitoid blocks. The drilling technique that proved most effective was to first advance the drill hole as far as possible with one open-ended 10-inch hollow-stem auger. When the drilling rate slowed enough to indicate the presence of a hard rock mass, the air rotary percussion bit and drill rods were lowered inside the hollow-stem auger. The drill hole was advanced by air rotary percussion drilling through the hard rock mass to create a pilot hole for subsequent reaming by the wider hollow-stem auger. After reaming had been accomplished, the drill hole was advanced by standard augering until the next hard rock mass was encountered; the above described pilot hole reaming process was then repeated.

The monitoring wells were designed to provide a short screen interval (10 feet or less) across the top of shallow groundwater. An annular-space filter pack material of #8-14 sand was placed to a level of 1.0 to 2.0 feet above the top of the screen. Directly above the filter pack, a seal of bentonite chips 2.0 to 3.0 feet thick was added. The top of the hole was

Table 3-7. SUMMARY OF CONSTRUCTION DETAILS FOR GROUNDWATER MONITORING WELLS AT ROM-8

Well Number	Diameter	Date Installed	Borehole Diameter	Drilling Method	Total Borehole Depth (ft)	Casing Depth (ft)	Screened Interval (ft) Depth	Screened Interval (ft) Length	Filter Pack Interval (ft) Depth	Filter Pack Interval (ft) Length	Seal Interval (ft) Depth	Seal Interval (ft) Length	Elevation (ft) Casing Notch	Elevation (ft) Groun…
MW-1	4"	7/29/89	10"	HSA*	19.5	19.3	8.8 - 18.8	10.0	6.0 - 19.3	13.3	3.0 - 6.0	3.0	122.82	121.5
MW-2	4"	7/30/89	10"	HSA	12.3	12.3	4.5 - 12.1	7.6	3.5 - 12.3	8.8	1.5 - 3.5	2.0	104.71	102.7
MW-3	4"	7/31/89	10"	HSA	14.4	14.4	5.4 - 14.2	8.8	3.4 - 14.4	11.0	1.4 - 3.4	2.0	76.11	73.6
MW-4	4"	7/31/89	10"	HSA	10.0	10.0	4.0 - 10.0	5.8	3.0 - 10.0	7.0	1.0 - 3.0	2.0	100.00**	97.5

* HSA = Hollow-Stem Auger
** Arbitrary benchmark elevation

Casing Material - PVC
Screen Slot Size - 0.020"
Filter Pack Material - #8-14 Sand
Seal Material - Bentonite Chips
Backfill Material - Cement Grout

8 99

backfilled to the ground surface with a cement grout. At ground surface, a concrete pad (2 feet on a side and 3-4 inches thick) was poured around the well casing. All well casings extended above ground level (1.3 to 2.5 feet), and were topped with PVC slip or screw caps. Boring logs are provided in Appendix A.

Well development was accomplished using a decontaminated 1.5-incn PVC positive displacement hand pump. Each well was pumped and surged until dry several times over a 3-day period. Well development extended over 3 days primarily because recharge was slow. Well MW-4 recharged the quickest, followed by MW-2, MW-3, and MW-1. Water quality measurements were taken over the course of development. Development ceased when the groundwater ran clear of sand and sediments, and when water quality parameters (specific conductance, pH, and temperature) stabilized. Details of well development are given in Table 3-8.

All above-ground well casings were enclosed in locking steel protective cylinders that were cemented into the surface pad. Padlocks (identically keyed) were placed on all steel cylinders to secure the wells. Wells MW-1 and MW-2 (located along the access road north margin) were also flanked with protective guard posts.

3.3.4 Soil Sampling

Prior to collection of soil samples, each site was inspected to identify visible surface contamination or areas which could be accumulation points for contaminants. The soil gas survey was successful in targeting "hot spots" of volatile organic compound contamination at two sites, and several of the soil samples were co-located with the soil gas sample locations. The sampling sites were staked out by the field engineer. The sampling team collected soil samples using two methods, by spoon directly into the sample container, or through an "excavation process" using jackhammer, pick, and shovel to break through the hard surface layer followed by spooning the soil into the sample container. The two methods are described below.

Table 3-8. MONITORING WELL DEVELOPMENT DATA, CAPE ROMANZOF LRSS

Well ID and Total Depth	Date	Time	Water Level (feet)	Total Volume Withdrawn: Cumulative Gallons	Total Volume Withdrawn: Cumulative Bore Volumes	pH	Specific Conductance (μmhos/cm)	Temperature (°C)	Comments
ROM-8 MW-1	7-Aug-89	1250	10.02	6.0	0.8	*	120	5.2	Pumped well dry
21.55'		1400	17.25			--	--	--	Well has not recharged yet
	8-Aug-89	1615	9.89	12.0	1.6	6.82	145	5.0	Pumped well dry
	9-Aug-89	1040	9.79	17.5	2.3	6.69	148	3.1	Pumped well dry
		1915	11.13	22.5	3.0	7.07	125	5.5	Pumped well dry
ROM-8 MW-2	7-Aug-89	1337	9.70	9.0	2.3	6.26	52	4.8	Pumped well dry
15.76'	8-Aug-89	1640	9.61	19.0	4.8	6.54	30	6.0	Pumped well dry
	9-Aug-89	1010	9.54	24.0	6.1	6.70	30	3.5	Pumped well dry
		1935	8.62	31.5	8.0	6.73	25	4.9	Pumped well dry
ROM-8 MW-3	7-Aug-89	1905	11.15	5.0	1.1	6.68	140	4.0	Pumped well dry
18.06'	8-Aug-89	1515	11.67	10.0	2.2	6.85	145	3.0	Pumped well dry
	9-Aug-89	1120	11.19	14.0	3.1	7.01	153	2.7	Pumped well dry
		1605	11.19	18.0	4.0	7.24	160	5.1	Pumped well dry, clear
ROM-8 MW-4	7-Aug-89	1945	8.20	4.5	1.3	6.59	100	4.2	Pumped well dry
13.44'	8-Aug-89	1450	8.36	12.5	3.7	7.73	100	4.2	Pumped well dry, good recharge
		1545	--	17.5	5.1	--	--	--	Pumped well dry, septic odor
	9-Aug-89	1140	8.45	22.5	6.6	6.96	85	3.8	Pumped well dry
		1625	8.69	27.5	8.1	7.20	82	5.0	Pumped well dry, slightly turbid

* Weather was cold, pH meter malfunctioned.
-- Parameter not collected.

Soil surfaces close to the Composite Facility were composed of graded fill materials, generally sandy silt. To collect a sample, the top 1-2 inches were scraped away by shovel. A decontaminated stainless steel spoon was used to scrape away the top surface and then the sample was collected from undisturbed soil into a laboratory-cleaned 16-oz glass jar. The jar was sealed, labeled, and placed in a cooler for storage until shipment.

The areas where the soil gas survey took place had recently been graded and as a result were highly compacted. The soil was graded fill, generally sandy silt with boulders. A generator-powered jackhammer was used to break up the compacted soil. Refusal was met at depths between 0.5 and 1.6 feet. A shovel and pick were used to extend the hole to about an 8-inch-diameter and to scrape away more soil. A decontaminated stainless steel spoon was used to collect the sample by scraping the soil into the laboratory-cleaned 16-oz glass jar. The jar was sealed, labeled, and placed in a cooler for storage until shipment.

3.3.5 Sediment Sampling

Before sediment samples were collected, the field engineer, during his reconnaissance of the installation and in consultation with the USAF TPM and WCC project manager, identified the best locations for sample collection. These locations were staked and sometimes marked with construction flagging. Sediment samples were collected in two ways. In intermittent waterways, the top 1 inch of soil was scraped away by shovel or stainless steel spoon. In some cases where surface water flow interfered with sample collection, a berm was constructed out of local materials to temporarily divert the flow. The sediment sample was then collected into the laboratory-cleaned glass jars with a decontaminated stainless steel spoon.

In streams or ponds, the sediment in the stream channel and immediately adjacent to the water was collected with a decontaminated stainless steel spoon into the laboratory-cleaned glass jars. After the appropriate number of jars were filled, the containers were dried, labeled, and placed into a cooler for storage until shipment.

3.3.6 <u>Surface Water Sampling</u>

Surface water sample locations were staked out at most of the sediment sample locations. All surface water samples had a corresponding sediment sample. Surface water samples were collected from streams, the pond, or the lake directly into the sample containers. In some cases, where streams had low flow (less than 1 inch deep), a decontaminated 1-liter glass beaker was filled and decanted into the sample bottles. In one case (ROM8-3), water flow fanned out just above the logical sampling point. The sampling team excavated a 3-inch-deep, 10-inch-diameter hole and fashioned a dam out of local materials below the sampling point to capture the inflow. Following a 2-hour break, the reservoir had filled enough to collect a sample. After the sample was collected into the bottles, each bottle was dried, labeled, and stored in a cooler for storage before shipment.

Water quality measurements were taken at each surface water sampling location. Measurements of specific conductance (measured in μmhos/cm), pH (measured in pH units), and temperature (measured in °C) were taken in water collected into a decontaminated 1-liter glass beaker. The instruments used for these measurements were rinsed with ASTM Type II reagent water between each measurement. Table 3-9 gives water quality measurements for the surface water samples.

3.3.7 <u>Groundwater Sampling</u>

Seven wells were sampled to assess groundwater quality. One well was the installation water supply source, two were abandoned wells, and four wells were installed by the WCC field team during Summer 1989. Water level measurements were obtained before purging wells for sampling. It was not

Table 3-9. WATER QUALITY MEASUREMENTS FOR SURFACE WATER SAMPLES COLLECTED AT CAPE ROMANZOF LRRS

Location I.D.	Date	Time	pH	Specific Conductance µmhos/cm	Temperature (°C)	Comments
ROM3-7	11-Aug-89	0943	7.78	22.0	7.2	Clear
ROM8-001	11-Aug-89	1125	8.10	20.0	7.2	Very clear water
ROM8-002	11-Aug-89	1140	8.02	21.0	5.0	Very clear water
ROM8-003	11-Aug-89	1410	7.20	64.0	6.9	Effluent over red zone at lower terrace
ROM8-004	11-Aug-89	1205	7.50	39.0	7.5	At confluence of effluent and stream; clear water
ROM8-005	11-Aug-89	1220	7.05	180.0	9.0	At pond at toe of lower terrace; water is light brown & turbid
ROM8-006	11-Aug-89	1245	7.72	48.0	7.0	Stream under talus; very clear water
ROM8-007	11-Aug-89	1245	7.33	108.0	10.5	Stream draining lower terrace to "delta"; clear water
ROM8-008	11-Aug-89	1340	8.00	25.0	8.1	Furthest effluent sampling point
ROM8-009	13-Aug-89	1340	7.60	22.0	10.0	Along Fowler Creek, upgradient of landfill
ROM8-010	13-Aug-89	1325	7.47	21.0	8.9	Along Fowler Creek, downgradient of landfill
ROM12-001	13-Aug-89	1430	5.92	48.0	14.5	East end of easternmost beaver pond

possible to obtain a water level measurement for the water supply well at ROM-3 because no port existed. Generally, three casing volumes of water were purged from a well to obtain a representative sample of formation water. Water quality measurements were taken at regular intervals during purging. Constant readings for specific conductance, temperature, and pH indicated that a stabilization of water type had been attained, and that formation groundwater was being pumped. Water level and water quality measurements are shown in Tables 3-10 and 3-11.

The base water supply well was pumped for 8 minutes (pump rate approximately 60 gpm). Pumped water was sampled from a bypass port outside of the pumphouse. The two abandoned wells were purged using a 4-inch-diameter submersible pump. The four new wells were purged by manual bailing. Because recharge was generally slow in the new wells, bailing extended over 2 days.

Once the requisite three casing volumes or more of water were extracted from the well and water quality stabilized, the water was allowed to recharge and a sample was taken. The required bottles were filled, dried, and stored in a cooler for storage before shipment.

3.4 DATA QUALITY OBJECTIVES

Data quality objectives for the Cape Romanzof LRRS RI/FS are discussed in the IRP Stage 1 Final Quality Assurance Project Plan (WCC 1989b). Enseco Rocky Mountain Analytical Laboratory (RMAL) in Arvada, Colorado, provided analytical laboratory services for the Cape Romanzof LRRS RI/FS.

The purpose of QA/QC procedures is to produce data of known quality that meet or exceed the requirements of standard analytical methods, and satisfy the program requirements. The objectives of the quality assurance efforts for this program were twofold. First, they provided the mechanism for ongoing control and evaluation of measurement data quality throughout

Table 3-10. WATER LEVEL DATA IN MONITORING WELLS AT CAPE ROMANZOF LRRS

Well I.D.	Date	Time	Water Level (ft from top of casing)
ROM-3 Well 1	unknown	unknown	29.00*
ROM-8 MW-1	14-Aug-89	1340	9.05
ROM-8 MW-2	13-Aug-89	1200	9.12
ROM-8 MW-3	13-Aug-89	1045	11.17
ROM-8 MW-4	13-Aug-89	1045	8.33
ROM-1S Well B	10-Aug-89	1620	14.71
	12-Aug-89	1945	14.50
ROM-1S Well A	12-Aug-89	1205	23.58
ROM-8 MW-1	28-Sep-89	1510	8.77
ROM-8 MW-2	28-Sep-89	1300	8.64
ROM-8 MW-3	28-Sep-89	1515	10.92
ROM-8 MW-4	28-Sep-89	1537	6.53

* Measured from ground surface.

Table 3-11. MONITORING WELL WATER QUALITY MEASUREMENTS AT CAPE ROMANZOF LRRS

Well I.D.	Date	Time	Total Volume Withdrawn (Cumulative) Gallons	Bore Volumes	pH	Specific Conductance (µmhos/cm)	Temperature (°C)	Comments
ROM3-6	11-Aug-89	0935	--	--	8.24	20	3.9	Pumped at approximately 60 gpm for 8 minutes, clear
ROM-8 MW-1	13-Aug-89	1000	0.0	0.00	--	--	--	
		1020	7.0	0.90	6.80	49	4.9	Turbid, no odor
	14-Aug-89	0935	12.0	1.50	7.30	95	4.9	Turbid, no odor
			17.0	2.10	7.40	72	5.0	Turbid, no odor
			18.5	2.30	7.60	72	5.5	Slightly turbid, very slow recharge
	28-Sep-89	1510	5.0	0.64	6.70	59	5.0	Slightly turbid, no odor
		1525	8.0	1.03	6.90	52	5.9	Slightly turbid, no odor
		1640	11.0	1.42	6.70	42	5.0	Clear, no odor
		2030	14.5	1.87	--	--	--	
	29-Sep-89	0930	22.0	2.83	6.80	47	4.5	Slightly turbid, no odor
			25.0	3.22	7.10	50	4.5	Slightly turbid, no odor
ROM-8 MW-2	13-Aug-89	0945	0.0	0.00	--	--	--	
			13.0	2.90	7.10	16	4.0	Turbid, no odor
			15.5	3.40	7.10	20	3.0	Turbid, no odor
		1200	18.0	3.90	6.50	20	2.5	Turbid, no odor
ROM-8 MW-3	13-Aug-89	1045	0.0	0.00	--	--	--	
			5.0	1.10	6.48	157	4.0	Turbid, no odor
		2100	10.5	2.30	6.93	155	4.9	Slightly turbid, no odor
	14-Aug-89	0940	13.5	2.97	6.58	155	4.0	Slightly turbid, no odor
			16.5	3.64	6.73	165	4.5	Slightly turbid
	28-Sep-89	1515	5.0	1.09	7.21	175	4.8	Rusty brown, slight odor
		1550	9.0	1.96	6.80	178	5.0	Slightly turbid
		1610	13.0	2.83	6.80	162	4.9	Slightly turbid
		1620	17.0	3.7	7.00	175	4.8	Slightly turbid

Table 3-11. MONITORING WELL WATER QUALITY MEASUREMENTS AT CAPE ROMANZOF LRRS (concluded)

Well I.D.	Date	Time	Total Volume Withdrawn (Cumulative) Gallons	Bore Volumes	pH	Specific Conductance (µmhos/cm)	Temperature (°C)	Comments
ROM-8 MW-4	13-Aug-89	1045	0.0	0.00	--	--	--	
			5.0	1.50	6.70	90	3.0	Turbid, septic odor
		2100	10.0	3.00	7.00	90	3.1	Brown turbid, septic odor
	14-Aug-89	0900	10.0	3.00	6.76	90	3.2	Clear, septic odor
			12.5	3.76	6.76	97	3.3	Slightly turbid, septic odor
	28-Sep-89	1537	5.0	1.09	6.84	54	4.5	Murky black, septic odor
		1555	8.0	1.74	7.15	59	5.0	Murky black, septic odor
		1615	12.0	2.61	7.14	59	5.0	Less murky, septic odor
	29-Sep-89	0920	15.0	3.26	6.49	72	5.5	Murky gray
ROM-1S Well A	12-Aug-89	1845	0.0	0.00	--	--	--	Well purging was continous
		1853	90.0	1.00	8.30	21	2.5	Slightly turbid, no odor
			130.0	1.45	7.50	27	2.5	Brown, thick, and high sediment
			180.0	2.00	7.50	27	2.5	Brown, thick, and high sediment
			230.0	2.55	7.10	22	1.8	Brown, thick, and high sediment
			280.0	3.10	*	22	1.8	Brown, thick, and high sediment
			310.0	3.40	*			Brown, thick, and high sediment
ROM-1S Well B	12-Aug-89	1130	0.0	0.00	--	--	--	
		1135	70.0	2.30	6.10	50	5.8	Slightly turbid, fuel odor
		1138	150.0	5.00	6.10	60	4.5	Fairly clear, fuel odor
		1148	180.0	6.00	6.00	60	4.3	Fairly clear, fuel odor
		1152	210.0	7.00	6.00	60	4.2	Fairly clear, fuel odor

* Weather was cold, pH meter malfunctioned

-- Parameter not collected

the course of the project. Second, quality control data were used to define data quality for the various measurement parameters in terms of precision and accuracy. Data quality objectives for the various measurement parameters associated with site characterization efforts are presented in Tables 3-12 and 3-13 and are discussed below.

3.4.1 Precision and Accuracy

Rocky Mountain Analytical Laboratory's quality control (QC) program is based upon the results of Laboratory Control Samples (LCS), which are well-characterized, laboratory-generated samples used to monitor the laboratory's day-to-day performance of routine analytical methods. Duplicate Control Samples (DCS) and Single Control Samples (SCS) are LCS which are used to monitor the precision and accuracy of the analytical process, independent of matrix effects. Method Blanks, which are also LCS, are used to identify any background interference or contamination of the analytical system which may lead to the reporting of elevated concentration levels or false positive data. The purpose of the LCS are to establish control limits. These limits are used to determine whether data generated by the laboratory on any given day are in control. The precision, accuracy, and the percent recovery for environmental samples were calculated using the formulas presented in the IRP RI/FS Stage 1 Final Quality Assurance Project Plan (WCC 1989b).

When RMAL prepares QC samples, these samples are labeled with a QC lot number. The QC lot number is associated with the date the sample was prepared. Samples analyzed concurrently by the same test are assigned the same QC lot number. Projects which contain numerous samples, analyzed over several days, may have multiple QC lot numbers associated with each test. The quality control information includes a listing of the QC lot numbers associated with each of the samples reported, DCS and SCS recoveries from the QC lots associated with the samples, and control limits for these lots. The QC data were reported by test code in the QA section.

Table 3-12. ANALYTICAL OBJECTIVES FOR PRECISION, ACCURACY, COMPLETENESS AND ESTIMATED DETECTION LIMITS, SOIL ANALYSIS AT CAPE ROMANZOF LRRS

Parameter	Reference Method	Detection Limit**	Precision Objective*+	Accuracy Objective+	Completeness Objective+
Volatiles	SW8240	0.1 mg/kg	± 24%	60-133% spike recovery	90%
Semi-Volatiles	SW3550/SW8270	1 mg/kg	± 20%	11-142% spike recovery	90%
Metals	SW3050/SW6010	1 to 9 mg/kg	± 20%	75-125% spike recovery	90%
Total Petroleum Hydrocarbons	SW3550/E418.1	50 mg/kg	± 100%	50-200% spike recovery	90%
Organochlorine Pesticides/PCBs	SW3550/SW8080	0.01 to 0.2 mg/kg	± 20%	20-160% spike recovery	90%

* As measured by relative percent difference of sample duplicates. Precision and accuracy objectives (limits) are not available for environmental samples. Rocky Mountain Analytical Laboratory does not maintain limits due to variability associated with these types of samples.

** Values provided for detection limits are based on actual data provided by the subcontract laboratory for routine sample types. These values are considered estimates, as actual detection limits achieved for specific samples will vary due to interferences or required dilutions. For methods containing multiple analytes, a range of values is given to account for different detection limits for individual analytes.

\+ Quality Control Acceptance Criteria established by Rocky Mountain Analytical Laboratory.

Table 3-13. ANALYTICAL OBJECTIVES FOR PRECISION, ACCURACY, COMPLETENESS AND ESTIMATED DETECTION LIMITS, WATER ANALYSIS AT CAPE ROMANZOF LRRS

Parameter	Detection Reference Method	Precision Limit**	Accuracy Objective*+	Completeness Objective+	Objective+
Volatiles	SW8010/SW8020	0.1 to 9 µg/L	± 24% recovery	60-130% spike	90%
Semi-Volatiles	SW3510/SW8270	5 to 50 µg/L	± 50% recovery	50-150% spike	90%
Metals	SW3005/SW6010	1 to 9 mg/L	± 20% recovery	75-125% spike	90%
Total Petroleum Hydrocarbons	E418.1	1 mg/L	± 100%	50-150% spike recovery	90%
Organochlorine Pesticides/PCBs	SW3510/SW8080	0.02 to 1 mg/L	± 20%	20-160% spike recovery	90%

* As measured by relative percent difference of sample duplicates. Precision and accuracy objectives (limits) are not available for environmental samples. Rocky Mountain Analytical Laboratory does not maintain limits due to variability associated with these types of samples.

** Values provided for detection limits are based on actual data provided by the subcontract laboratory for routine sample types. These values are considered estimates, as actual detection limits achieved for specific samples will vary due to interferences or required dilutions. For methods containing multiple analytes, a range of values is given to account for different detection limits for individual analytes.

\+ Quality Control Acceptance Criteria established by Rocky Mountain Analytical Laboratory.

Control limits for accuracy (percent recovery) were based on the average, historical percent recovery ±3 standard deviation units. These control limits were fairly narrow, based on the consistency of the matrix being monitored, and were updated on a quarterly basis.

For organic analyses, an additional control measure was taken in the form of an SCS. The SCS is a control sample spiked with surrogate standards which were analyzed with every analytical lot. The recovery of the SCS was charted in exactly the same manner as described for the LCS, and provides a daily check on the performance of the method.

The laboratory control sample and surrogate control sample reports were reviewed for all data reports obtained from laboratory analysis of samples collected at Cape Romanzof LRRS. The accuracy (percent recovery) of LCS samples, was within laboratory-established limits for 96 percent of QC lots analyzed for all data reports. The precision, which is measured by the relative percent difference (RPD) for the LCS samples, was within laboratory-established limits for 98 percent of QC lots analyzed for all data reports. Laboratory Control Samples were prepared and analyzed for halogenated volatile organics by gas chromatography (GC), volatile organics by gas chromatography/mass spectrometry (GC/MS), semi-volatile organics by GC and GC/MS, metals analysis, and wet chemistry analysis (total petroleum hydrocarbons). SCSs were prepared and analyzed for volatile organics by GC.

Matrix-specific QC was based on the use of an actual environmental sample for precision and accuracy determinations and commonly relies on the analysis of matrix spikes (MS) and matrix spike duplicates (MSD). This information, supplemented with field blank results, was used to assess the effect of the matrix and field conditions on analytical data. Matrix spike and MSD samples were prepared and analyzed for halogenated volatile organics by GC, volatile organics by GC/MS, aromatic volatile organics by GC, semivolatile organics by GC/MS, and for metals and TPHs analyses on soil and aqueous samples. Matrix spike and MSD recoveries were within laboratory-established limits for laboratory control samples (LCS) for 78 percent of matrix-specific QC samples analyzed for all data reports. The RPD values for the MS and MSD samples were also within laboratory-established limits for LCS samples for 89 percent of MS and MSD samples analyzed for all data reports.

3.4.2 Completeness

Completeness is defined as a measure of the amount of valid data obtained from a measurement system compared with the amount that is expected to be obtained under normal conditions. The completeness of the analysis was documented by providing information that allowed the analyst to assess the quality of the results. Included in the data reports were an overview of the report, sample description information, analytical results, quality control reports, and a description of analytical methodology. Also included in the reports, if applicable, were second column laboratory work sheets. The objective for completeness of data capture was reached for all measurement parameters.

3.4.3 Representativeness

The representativeness of the data is the degree to which data delineate a characteristic of a population, parameter variations at a sampling point, or an environmental condition. All analytical data represented the sample analyzed. Duplicate and replicate samples were analyzed and provided a representation of parameters of interest at each specific location. Analytical methods were selected to provide the best available measurements of parameter concentrations.

3.4.4 Comparability

Comparability was expressed by the confidence with which one data set can be compared to another data set measuring the same property. RMAL used approved analytical methods which originate predominantly from regulatory agencies. Generally, the methods used were those specified by the EPA and other federal agencies. The laboratory quality control program at RMAL was designed to establish consistency in the performance of these methods by monitoring data quality with internal QC checks. Internal QC checks included the use of surrogates in samples and matrix and method spikes. All are traceable to reference materials. In addition, the laboratory participates in two separate performance evaluation programs, Environmental Research Associates (ERA) samples and EPA Certified Laboratory Program (CLP), in accordance with specified methods.

3.5 FIELD QUALITY ASSURANCE/QUALITY CONTROL (QA/QC) PROGRAM

The field QA/QC program for the Cape Romanzof LRRS RI/FS, which included sampling procedures, sample custody, internal quality control checks, field calibration, and field preventive maintenance procedures, followed guidelines outlined in the IRP RI/FS Stage I Final Quality Assurance Project Plan (March 1989). A summary of all field activities for each site is given in Section 3.2 and summarized in Appendix C. A summary of the field QA/QC validation is given in Section 4.2.

3.6 LABORATORY QUALITY ASSURANCE/QUALITY CONTROL (QA/QC) PROGRAM

The laboratory QA/QC program for the Cape Romanzof LRRS RI/FS is discussed in the IRP RI/FS Stage 1 Final Quality Assurance Project Plan (March 1989).

Calibration of instruments was routinely done to ensure that the analytical system was operating correctly and functioning at the proper sensitivity to meet established detection limits. The complexity of modern instruments has created the demand for tighter control so that malfunctions may be quickly detected and the quality of analytical results continually maintained. Each instrument was calibrated with standard solutions appropriate for the type of instrument and the linear range established for the analytical method. The frequency of calibration and concentration of standards were determined by the manufacturer's guidelines and the analytical method.

RMAL was evaluated on laboratory performance after reviewing four data reports containing the analytical results for the soil and water samples collected at Cape Romanzof LRRS. Review of the analytical results revealed that RMAL had problems completing a portion of the analyses within contractually specified holding times. Holding times were exceeded for 4 of 49 (8 percent) organochlorine pesticides and polychlorinated biphenyls (PCBs) analyses (Method SW8080), and 4 of 55 (7 percent) semi-volatile organic compounds analysis (Method SW8270).

WCC investigated the technical quality of those data associated with contractually specified holding time exceedances and concluded that resampling of the samples (at RMAL expense) would offer the best data to support the results and conclusions of the Cape Romanzof LRRS RI/FS. Resampling was done in late September 1989.

RMAL was reevaluated on laboratory performance after reviewing the two data reports containing the analytical results for the resampling for soil and water samples collected during September 1989. Review of the analytical results has revealed that RMAL had problems completing a portion of the analyses within contractually specified holding times. Holding times were exceeded for 2 of 6 (33 percent) semivolatile organic compounds analyses (Method SW8270). The problem occurred because of an overload of soil samples requiring Method SW8270 analysis. The soil samples were extracted within holding time, but the extracts were analyzed 1 day after the analysis holding time had been exceeded. RMAL has implemented corrective measures to prevent a similar problem from happening in later analytical phases of the project.

WCC investigated the technical quality of those data associated with contractually specified holding times which were exceeded and is satisfied that the problem does not significantly affect the technical quality of the results and conclusions of the Cape Romanzof LRRS RI/FS.

To minimize downtime in the laboratory, preventive maintenance was routinely performed on each analytical instrument. Designated laboratory personnel were factory-trained in the routine maintenance procedures for every major instrumentation. When repairs were necessary, they were performed by either the in-house engineers or the instrument manufacturer under service contracts and warranties. Each laboratory maintained detailed logbooks of preventive maintenance and repairs for each analytical instrument. Instrument performance was typically checked by monitoring instrument performance criteria for known standards.

TAB

Section 4

4.0 RESULTS AND SIGNIFICANCE OF FINDINGS

This section contains the results and significant findings for the sites investigated at Cape Romanzof LRRS. Section 4.1 discusses the following for each site: site setting, geology and soils, hydrology, analytical results, soil gas results (at two sites), contaminant migration, and the significance of the results. Section 4.2 presents the quality assurance/quality control validation.

Section 4.3 develops cleanup standards from federal, state, and local standards applicable to the Cape Romanzof sites for contaminants found to be present. Section 4.4 provides a two-tiered health/environmental risk screening for each site to identify which sites require remedial action based on health and environmental considerations. Remedial action will be considered for sites where contaminant levels exceed regulatory standards or where the health/environmental risk screening indicates potential risk. Volumes of soil with contaminant concentrations above proposed cleanup levels are estimated for sites where these conditions apply.

4.1 DISCUSSION OF RESULTS AT SITES INVESTIGATED

Background data and summaries of analytical data pertinent to the investigated sites are provided in Tables 4-1 through 4-6. A general summary of individual site features and site history is shown in Table 4-1. Metal concentration data are provided in Tables 4-2, 4-3 and 4-4. Table 4-2 presents comparisons between measured site soil concentrations of metals and soil concentrations in the western United States. None of the metal concentrations in soil at Cape Romanzof LRRS exceeded the concen-

Table 4-1. SUMMARY OF SITE FEATURES AT CAPE ROMANZOF LRRS

Site	Location	Site History	Setting	Comments
ROM-1	East of Composite Facility	Stores drummed products and liquid waste	Fill material	Flat area
ROM-1D	South of fueling station	Disposal pit for former buildings	Fill material	Flat area
ROM-1S	Southwest of fueling station and road	14,000-gallon diesel fuel spill	Tundra	Steep gradients in tundra
ROM-3	South end of demolished Lower Camp	Waste accumulation at former shop area	Fill material	Flat area
ROM-4	Installation road system	Applied industrial wastes to roads between 1953 to 1978	Gravel road and adjacent tundra	Area is on and adjacent to installation roads
ROM-5	Current landfill behind Industrial Dome	Receives refuse from installation activities	Fill material/ landfill debris	Flat area, drains to stream
ROM-8	Former landfill 1/2 mile west of Composite Facility	Received refuse from installation activities in the 1970s	Fill material/ landfill debris	Area drains directly to Fowler Creek
ROM-10	Former truck fill stand above beach	Small POL spills occurred during tank filling and transfers	Native soil	Area drains directly to Fowler Creek
ROM-12	Former Drum Storage Area	Staging area for drummed waste	Native soil	Flat area drains to beaver ponds

Table 4-2. COMPARISON OF MEASURED HEAVY METALS CONCENTRATIONS IN SOIL AT CAPE ROMANZOF LRRS WITH CONCENTRATIONS IN SOILS IN WESTERN UNITED STATES*

Metal	Range of Measured Concentration	Concentration in Soil Western United States	
		Range	Average
Aluminum	0.3 - 11,200	5000 - >100000	54000
Arsenic	ND	<0.2 - 97	6.1
Barium	10 - 89	70 - 5000	560
Beryllium	0.2	<1 - 15	0.6
Cadmium	4 - 7	<1 - 10	<1
Chromium	7 - 27	3 - 2000	38
Cobalt	4 - 6	<3 - 50	8
Copper	4 - 88	2 - 300	21
Iron	3310 - 91,200	1500 - >100000	20000
Lead	24-430	<2 - 700	18
Manganese	9 - 250	30 - 5000	390
Molybdenum	ND	<3 - 7	<3
Nickel	2.5 - 30	<5 - 4500	16
Vanadium	5 - 35	7 - 500	66
Zinc	2 - 370	<10 - 2100	51

* Values in mg/kg
ND = Not detected
Source: Conner and Shacklette 1975; Shacklette and Boerngen 1985

Table 4-3. METAL CONCENTRATIONS IN UNPOLLUTED NATURAL WATERS OF NORTH AMERICA

Metal	Surface Waters (streams/rivers/lakes)	Public Water Supplies	Ground Water	Ocean Water
Aluminum	3500 (average)		100-28,000	
Barium	45 (median)	43 (median)		
Beryllium	0.3-0.75			
Cadmium	1-10 (4% more than 10) 0.01-0.10*			up to 0.125*
Chromium	<10; 1.4-5.8 1-2*	0.43 (median)		0.05-0.5*
Cobalt	0.2 (mean)			
Copper	10 (common) 0.5-1.0*	8.3 (median)		≤2*
Iron	10 (for typical river)	1000-10,000 (common)		
Lead	1->10 ≤3*			≤0.05*
Manganese	up to 360 or "a few hundred"			
Nickel	10 (median) 0.3 (median)	<2.7		1.8*
Vanadium	0.9 (average)	<43 (median)		
Zinc	5-45 0.5-15*			0.4-5*

* Values in μg/L

Sources: Hem 1985; Moore and Ramanoorthy 1984

Table 4-4. METAL CONCENTRATIONS (TOTAL RECOVERABLE - UNFILTERED) IN BACKGROUND SURFACE WATER AND GROUNDWATER SAMPLES* (in mg/L - from Appendix B)

Metal	Surface water		Groundwater	
	Sample 2	Sample 9	Sample 11	Sample 12
Aluminum	ND	ND	102	28
Barium	0.01	ND	0.68	0.26
Beryllium	ND	ND	0.003	ND
Cadmium	ND	ND	ND	ND
Chromium	ND	ND	0.15	0.06
Cobalt	ND	ND	0.04	ND
Copper	ND	ND	0.08	ND
Iron	0.13	ND	116	30
Lead	ND	ND	ND	ND
Manganese	ND	ND	2.1	1.9
Nickel	ND	ND	0.1	0.04
Vanadium	ND	ND	0.23	0.07
Zinc	ND	0.01	0.29	0.08

* All samples were from ROM-8 Landfill. See Figure 3-5 for location of water samples.

Table 4-5. GEOMETRIC MEANS AND HIGHEST MEASURED CONCENTRATIONS OF CHEMICALS IDENTIFIED IN SOIL SAMPLES FOR EACH SITE AT CAPE ROMANZOF LRRS

Chemical Name	ROM-1 Max	ROM-1 Geom mean	ROM-1S Max	ROM-1S Geom mean	ROM-1D Max	ROM-1D Geom mean	ROM-3 Max	ROM-3 Geom mean	ROM-4 Max	ROM-4 Geom mean
Aluminum	8540.00	7668.86	NA	NA	11200.00	9103.85	9500.00	6893.77	7900.00	7900.00
Barium	54.00	51.27	NA	NA	51.00	50.50	89.00	66.53	68.00	68.00
Beryllium	ND	ND	NA	NA	0.20	0.14	ND	ND	0.20	0.20
Cadmium	ND	ND	NA	NA	ND	ND	ND	ND	ND	ND
Chromium	16.00	13.56	NA	NA	20.00	17.89	18.00	15.80	27.00	27.00
Cobalt	4.00	4.00	NA	NA	5.00	5.00	6.00	2.40	5.00	5.00
Copper	9.00	6.60	NA	NA	12.00	10.95	88.00	20.01	14.00	14.00
Lead	24.00	13.39	NA	NA	ND	ND	160.00	46.53	89.00	89.00
Manganese	170.00	160.72	NA	NA	290.00	228.47	200.00	133.91	163.00	163.00
Nickel	12.00	10.63	NA	NA	11.00	11.00	30.00	11.78	11.00	11.00
Vanadium	26.00	23.58	NA	NA	35.00	28.98	30.00	23.22	27.00	27.00
Zinc	89.00	47.31	NA	NA	33.00	30.40	120.00	52.35	81.00	81.00
Acetone	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bis(2-ethylhexyl)phthalate	ND	ND	ND	ND	ND	ND	ND	ND	2.40	2.40
BHC,alpha	ND	ND	NA	NA	ND	ND	ND	ND	ND	ND
Dichloroethane, 1,1-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dichlorobenzene, 1,4-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dichlorodifluoromethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dioctylphthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methylene chloride	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methylnaphthalene	16.00	1.00	ND	ND	ND	ND	ND	ND	ND	ND
Methylphenol, 2,4-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCBs	ND	ND	NA	NA	ND	ND	0.39	0.13	ND	ND
Trichloroethane, 1,1,1-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Toluene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Xylene	33.00	0.44	ND	ND	ND	ND	ND	ND	ND	ND
TPHs	3500.00	609.21	17000.00	5836.30	30.00	21.21	35000.00	13539.28	380.00	194.94

Concentrations are in mg/kg
NA = No analysis performed
ND = Not detected

Table 4-5. GEOMETRIC MEANS AND HIGHEST MEASURED CONCENTRATIONS OF CHEMICALS IDENTIFIED IN SOIL SAMPLES FOR EACH SITE AT CAPE ROMANZOF LRRS (concluded)

Chemical Name	ROM-5		ROM-8		ROM-10		ROM-12	
	Max	Geom mean	Max	Geom mean	Max	Geom mean	Max	Geom mean
Aluminum	5900.00	5900.00	7100.00	3403.00	NA	NA	7600.00	2598.49
Barium	61.00	61.00	58.00	39.27	NA	NA	45.00	25.30
Beryllium	ND	ND	ND	ND	NA	NA	ND	ND
Cadmium	ND	ND	7.00	1.64	NA	NA	ND	ND
Chromium	15.00	15.00	19.00	8.78	NA	NA	14.00	7.14
Cobalt	ND	ND	ND	ND	NA	NA	ND	ND
Copper	5.00	5.00	24.00	7.75	NA	NA	7.00	3.48
Lead	ND	ND	430.00	32.33	NA	NA	38.00	15.60
Manganese	130.00	130.00	250.00	130.20	ND	ND	81.00	33.59
Nickel	10.00	10.00	14.00	6.56	NA	NA	6.00	4.22
Vanadium	21.00	21.00	24.00	12.39	NA	NA	25.00	10.77
Zinc	23.00	23.00	370.00	56.89	NA	NA	35.00	12.95
Acetone	ND	ND	0.12	0.06	NA	NA	0.16	0.07
Bis(2-ethylhexyl)phthalate	ND	ND	ND	ND	NA	NA	ND	ND
BHC,alpha	ND	ND	ND	ND	NA	NA	ND	ND
Dichloroethane, 1,1-	ND	ND	ND	ND	NA	NA	ND	ND
Dichlorobenzene, 1,4-	ND	ND	ND	ND	NA	NA	ND	ND
Dichlorodifluoromethane	ND	ND	ND	ND	NA	NA	ND	ND
Dioctylphthalate	ND	ND	ND	ND	NA	NA	ND	ND
Methylene chloride	ND	ND	ND	ND	NA	NA	ND	ND
Methylnaphthalene	ND	ND	ND	ND	NA	NA	0.59	0.11
Methylphenol, 2,4-	ND	ND	ND	ND	NA	NA	ND	ND
PCBs	ND	ND	ND	ND	NA	NA	0.21	0.13
Trichloroethane, 1,1,1-	ND	ND	ND	ND	NA	NA	ND	ND
Toluene	ND	ND	ND	ND	NA	NA	ND	ND
Xylene	ND	ND	ND	ND	NA	NA	ND	ND
TPHs	100.00	100.00	100000.00	297.50	4900.00	4900.00	200000.00	100000.00

Concentrations are in mg/kg
NA = No analysis performed
ND = Not detected

Table 4-6. GEOMETRIC MEANS AND HIGHEST MEASURED CONCENTRATIONS OF CHEMICALS IDENTIFIED IN WATER SAMPLES (RECOVERABLE FRACTION) FROM FOUR SITES AT CAPE ROMANZOF LRRS

	Surface Water						Groundwater					
	ROM-3		ROM-8		ROM-12		ROM-1S		ROM-3		ROM-8	
Contaminant	Highest	Geom Mean	Highest	Geom Mean	Highest	Geom Mean	Highest	Geom Mean	Highest	Geom Mean	Highest	Geom Mean
Aluminum	ND	ND	0.900	0.135	ND	ND	347.000	3.149	ND	ND	102.000	15.110
Barium	ND	ND	0.100	0.015	0.010	0.010	6.600	0.181	ND	ND	0.680	0.234
Beryllium	ND	ND	ND	ND	ND	ND	0.009	0.002	ND	ND	0.003	0.001
Cadmium	ND	ND	0.009	0.003	ND	ND	0.003	0.003	ND	ND	0.006	0.003
Chromium	ND	ND	ND	ND	ND	ND	0.092	0.027	ND	ND	0.150	0.038
Cobalt	ND	ND	ND	ND	ND	ND	0.200	0.043	ND	ND	0.040	0.024
Copper	ND	ND	ND	ND	ND	ND	0.360	0.043	ND	ND	0.080	0.035
Lead	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Manganese	ND	ND	1.100	0.042	ND	ND	10.000	1.018	ND	ND	2.700	1.614
Nickel	ND	ND	ND	ND	ND	ND	0.540	0.024	ND	ND	0.100	0.025
Vanadium	ND	ND	ND	ND	ND	ND	0.980	0.073	ND	ND	0.230	0.050
Zinc	0.060	0.060	0.070	0.026	0.050	0.050	4.200	0.324	0.030	0.030	0.290	0.122
Acetone	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bis(2-ethylhexyl)phthalate	ND	ND	11.000	5.372	ND	ND	37.000	9.743	14.000	14.000	32.000	7.953
BHC,alpha	ND	ND	ND	ND	ND	ND	0.093	0.039	ND	ND	ND	ND
Dichloroethane, 1,1-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.450	0.245
Dichlorobenzene, 1,4-	ND	ND	4.700	0.326	ND	ND	ND	ND	ND	ND	3.800	0.494
Dichlorodifluoromethane	ND	ND	11.000	4.881	ND	ND	4.500	4.500	ND	ND	ND	ND
Dioctylphthalate	ND	ND	ND	ND	17.000	17.000	20.000	7.937	ND	ND	23.000	7.323
Methylene chloride	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methylphenol, 2,4-	ND	ND	220.000	7.053	ND	ND	ND	ND	ND	ND	ND	ND
PCBs	ND	ND	2.700	0.583	ND	ND	ND	ND	ND	ND	ND	ND
Trichloroethane, 1,1,1-	ND	ND	1.100	0.151	ND	ND	ND	ND	ND	ND	6.000	0.278
Toluene	ND	ND	5.200	0.719	ND	ND	ND	ND	ND	ND	7.100	0.971
Xylene	ND	ND	4.000	1.134	ND	ND	ND	ND	ND	ND	6.700	1.609
TPHs	ND	ND	4.000	0.730	ND	ND	4.000	2.000	2.000	2.000	2.000	0.707

NA = No analysis performed
ND = Not detected in any of the samples from the site.
Metal and TPH concentrations shown in mg/L, others are in)g/L.

tration range for western United States soils. Table 4-3 presents metal concentrations in unpolluted surface water and groundwaters of the United States. Table 4-4 presents measured surface water/groundwater metal concentrations at that site at Cape Romanzof considered to most closely represent background conditions. Summaries of analytical data for the highest and mean concentrations of all analytes at all investigated sites are provided for soil samples in Table 4-5, and for water samples in Table 4-6.

4.1.1 ROM-1 Waste Accumulation Area

4.1.1.1 Site Geology and Soils. The surficial soil is fill material consisting of reworked granitoid colluvium (sandy silt and granitoid blocks).

4.1.1.2 Site Hydrology. Surface water runoff was observed while it was raining. Surface water flowed in the shallow drainages marked by soil samples ROM 1-1 and -2 westward towards another shallow drainage marked by soil sample ROM 1-3 (see sample locations on Figure 3-2). Surface water then dropped into the installation drainage ditch which parallels the main access road and flows to the northwest.

4.1.1.3 Analytical Results. Three soil samples were tested for the full suite of analytes, see Table 3-4. Analytical results, shown in Appendix B, indicated the presence of nine metals, all of which were within the range of metals normally found in the western U.S. (Shacklette and Boerngen 1985), see Table 4-2.

Concentrations of organic compounds above detection limit were reported for xylene and total petroleum hydrocarbons (TPHs). The highest value for xylene was 33 mg/kg. All three samples detected TPHs between 170 and 3500 mg/kg. Maximum and geometric mean concentration values for these analytes are shown in Table 4-5. Besides xylene, no other aromatic hydrocarbons such as benzene, toluene, or ethyl benzene were found.

4.1.1.4 Contaminant Migration. The contamination appears to be generally held within the soils. Minor migration may occur towards the west via surface runoff into the drainage along the road.

4.1.1.5 Evaluation/Significance of Findings. Based on the above results, the principal contaminant found was TPHs, along with lesser concentrations of xylene. This soil contamination is consistent with any spills associated with fuel tank and drum storage activities at this site and upgradient to the northeast (see Table 4-1 and Figure 3-1). Because no BTEX constituents other than xylenes were found to be present, the contamination is probably not recent; the BTEX constituents having mostly volatilized. The base of contamination is unknown because sampling was conducted only of the surficial soils (less than 6 inches deep).

Surface water runoff from this site flows in the installation drainage ditch to the northwest past the Composite Facility, ROM-5, ROM-4, and ROM-8. One surface water sample above the ROM-8 landfill showed a TPHs concentration of 2 mg/L. It is possible that part of the TPHs contamination above ROM-8 could be related to runoff from ROM-1; see later discussions in Section 4.1.7.

4.1.2 ROM-1D 5099th Disposal Pit

4.1.2.1 Site Geology and Soil. The surficial soil is fill material consisting of reworked granitoid colluvium. A layer of fine-grained material covers the fill. The colluvium contains large granitoid blocks (1-2 ft minimum dimension) intermixed with fine- to coarse-grained sand, silt, and a trace of clay.

4.1.2.2 Site Hydrology. No surface flow was observed at this site except while raining. During Summer 1989, a borehole was drilled to 13.5 feet in fill at this site without encountering groundwater. Based on the elevation difference (about 40 feet) between this site and the valley floor to the southwest, it is anticipated that the water table (top of saturated zone) is located considerably deeper than 14 feet at this site.

4.1.2.3 Soil Gas Survey. The results of the soil gas survey are presented in Table 4-7 and on Figure 4-1. Locations SG-NA-04 and SG-NA-10 at ROM-1D showed the highest content of volatile compounds at 51.1 and 22.0 ppmV (as benzene), with replicate results of 51.3 and 34.7 ppmV, respectively. Five other samples were reported positive between 0.6 and 5.8 ppmV. The remaining 15 samples were reported ND. All samples were collected from the probes installed at the practically reachable depth (between 2.0 and 4.5 feet). Soil samples were then collected at the two locations with the highest volatile compounds; these locations are shown on Figure 3-2.

4.1.2.4 Analytical Results. Two soil samples collected from areas which had high readings during the soil gas survey were tested for the analytes shown in Table 3-4 and are reported in Appendix B. For organic compounds, the only concentration found above detection limit was 30 mg/kg TPHs in one soil sample. Analyses for BTEX resulted in values of ND.

4.1.2.5 Contaminant Migration. The contamination appears to be buried below the surface. The soil surface was difficult to penetrate with the soil sampling collection tools. Soil samples were collected above the areas of highest contamination reported by the soil gas survey. Surface water runoff would probably not carry off significant quantities of contaminated soil. Contamination appears to be reasonably contained by the soil cap over the pit.

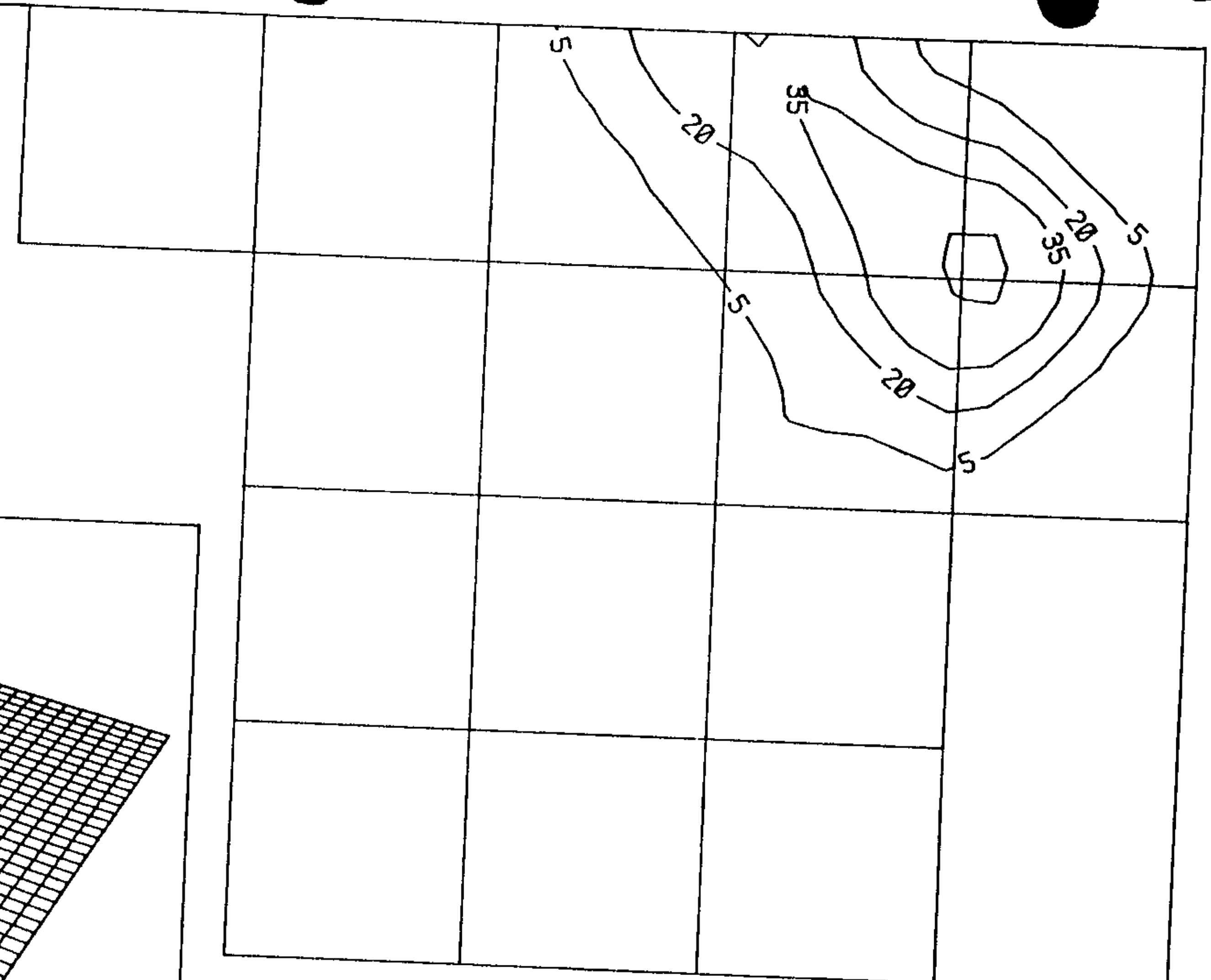
4.1.2.6 Evaluation/Significance of Findings. Based on the soil gas and analytical results, the near-surface soils do not appear to be contaminated except at soil sample location 1D-2. Thus, the materials disposed of into the former pit seem to be sufficiently buried and contained so that any surface water flow would likely transport only very small amounts of contaminated soil. The effect of groundwater leaching through the disposal

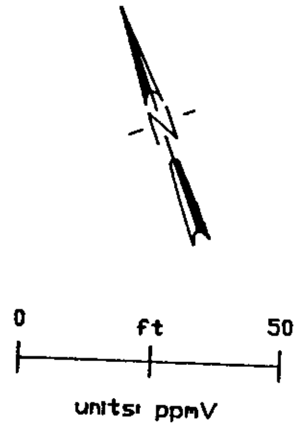
Table 4-7. SOIL GAS SAMPLING DATA AT ROM-1D, CAPE ROMANZOF LRRS

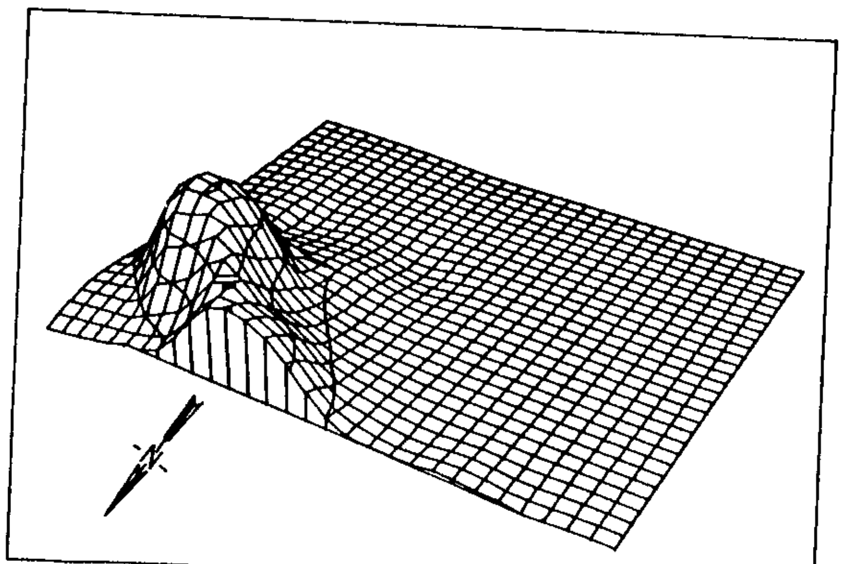
Sample ID	Sample Date	Depth (ft)	Vacuum in. Hg	Benzene eq.ppmV	Detection Limit
SG-NA-01	03-Aug-89	2.5	2	2.8	1.5
SG-NA-01QC	03-Aug-89	2.5	2	2.1	0.6
SG-NA-02	03-Aug-89	4.0	22	ND	1.5
SG-NA-02QC	03-Aug-89	4.0	22	1.2	0.6
SG-NA-03	03-Aug-89	3.0	2	ND	1.5
SG-NA-03QC	03-Aug-89	3.0	2	0.8	0.6
SG-NA-04	03-Aug-89	4.5	2	51.1	0.6
SG-NA-04QC	03-Aug-89	4.5	2	51.3	0.6
SG-NA-05	03-Aug-89	4.5	2	ND	0.6
SG-NA-05QC	03-Aug-89	4.5	2	ND	0.6
SG-NA-06	04-Aug-89	4.5	1	ND	0.6
SG-NA-06QC	04-Aug-89	4.5	1	ND	0.6
SG-NA-07	04-Aug-89	2.5	20	ND	0.6
SG-NA-08	04-Aug-89	4.5	1	ND	0.6
SG-NA-09	03-Aug-89	3.0	7	4.3	0.6
SG-NA-09QC	03-Aug-89	3.0	7	5.8	0.6
SG-NA-10	03-Aug-89	4.0	1	22.0	0.6
SG-NA-10QC	03-Aug-89	4.0	1	34.7	0.6
SG-NA-11	04-Aug-89	4.0	4	ND	0.6
SG-NA-12	04-Aug-89	2.0	23	ND	0.6
SG-NA-13	04-Aug-89	4.5	1	ND	0.6
SG-NA-14	03-Aug-89	4.5	2	ND	0.6
SG-NA-15	03-Aug-89	4.5	1	ND	0.6
SG-NA-15QC	03-Aug-89	4.5	1	ND	0.6
SG-NA-16	04-Aug-89	4.0	2	ND	0.6
SG-NA-17	04-Aug-89	3.0	1	ND	0.6
SG-NA-18	04-Aug-89	4.5	1	ND	0.6
SG-NA-18QC	04-Aug-89	4.5	1	ND	0.6
SG-NA-19	03-Aug-89	4.0	2	ND	0.6
SG-NA-20	03-Aug-89	4.0	2	ND	0.6
SG-NA-21	03-Aug-89	4.0	2	0.6	0.6
SG-NA-22	07-Aug-89	4.5	3	ND	0.6

NOTES:

"QC" after Sample ID indicates the sample is a replicate QC sample.
Depth is the measured depth from the surface.
ND: Not Detected
Total hydrocarbons expressed in parts per million (volume) as Benzene.







ROM-1D CONCENTRATION PERSPECTIVE

Project No. 90275L	Cape Romanzof LRRS	ROM-1D ISOCONCENTRATION CONTOURS WITH CONCENTRATION PERSPECTIVE	Figure 4-1
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pit is unknown; however, results of the boring indicate dry conditions to a depth of at least 13.5 feet.

4.1.3 ROM-1S Large Fuel Spill

4.1.3.1 Site Geology and Soils. This site is located on the nearly flat valley floor of Fowler Creek, and is covered by tundra vegetation. Adjacent to the site to the northeast is the large area of fill composed of reworked granitoid colluvium on which Sites ROM-1D and ROM-3 are located. Site ROM-1S is probably underlain by alluvial and glacial(?) deposits similar to those penetrated in Water Supply Well No. 1 located about 300 feet to the southeast. At that well, these deposits consist of an upper unit of "gravelly clay with boulders" (43 feet thick) overlying a lower unit of "sand and boulders" (14 feet thick) (refer to Figure 2-5).

4.1.3.2 Site Hydrology. Surface flow tends to follow incised paths in the nearly flat ground surface at this site. Flow direction is mostly to the south- west towards Fowler Creek and thence northwest along Fowler Creek. Groundwater is present at depth in the alluvial/glacial(?) deposits under confined conditions. At Well No. 1 the piezometric level of groundwater was measured at 29-foot depth when the well was first completed, which is 14 feet above the top of the sand-and-boulders aquifer and within the gravelly clay aquitard.

In addition, two abandoned and unsealed wells are present within this site (see Wells "A" and "B" on Figure 3-2). Total depths and water levels in these two wells are different. The shallower Well B has a 25.7-foot total depth and had a water level at 14.5-foot depth, whereas the deep Well A has a 55.3-foot total depth and had a water level at 20-foot depth. According to the Cape Romanzof LRRS Base Plan which shows topographic contours in this area, the ground surface elevations of Wells A, B, and Water Supply Well No. 1 are very similar.

4.1.3.3 Analytical Results. Four soil samples and two groundwater samples were analyzed for the parameters shown in Tables 3-3 and 3-4. Analytical results are reported in Appendix B. Locations of these samples are shown on Figure 3-2. The soil samples reported TPHs concentrations ranging from 5000 mg/kg at the highest elevation (near the fill to the east) to 9100 mg/kg near the water supply line to 1500 mg/kg found at abandoned Well B, to 17,000 mg/kg at the lowest elevation (along a tributary to Fowler Creek). No BTEX constituents were found in the soil samples.

Groundwater from both abandoned wells was tested for the full suite of analyses (see Table 3-3). Several samples were collected in duplicate to fulfill field QC requirements. In Well B, alpha-BHC was found in a concentration of 0.093 µg/L but was not found in the field duplicate sample. The difference may be explained by the following. The value of 0.093 µg/L is close to the detection limit of 0.05 µg/L. Values reported at concentrations less than three times the detection limit can have large associated error due to instrument variability and difficulty in quantitation at levels near the detection limit. TPHs were found in both the primary and duplicate samples at a concentration of 4 mg/L. TPHs were not found above detection limits in Well A. BTEX was not found above detection limits in either well. Four metals were found in Well B and ten metals were found in Well A; all were judged to be in the range of recoverable metals detected in background groundwater; see Table 4-4.

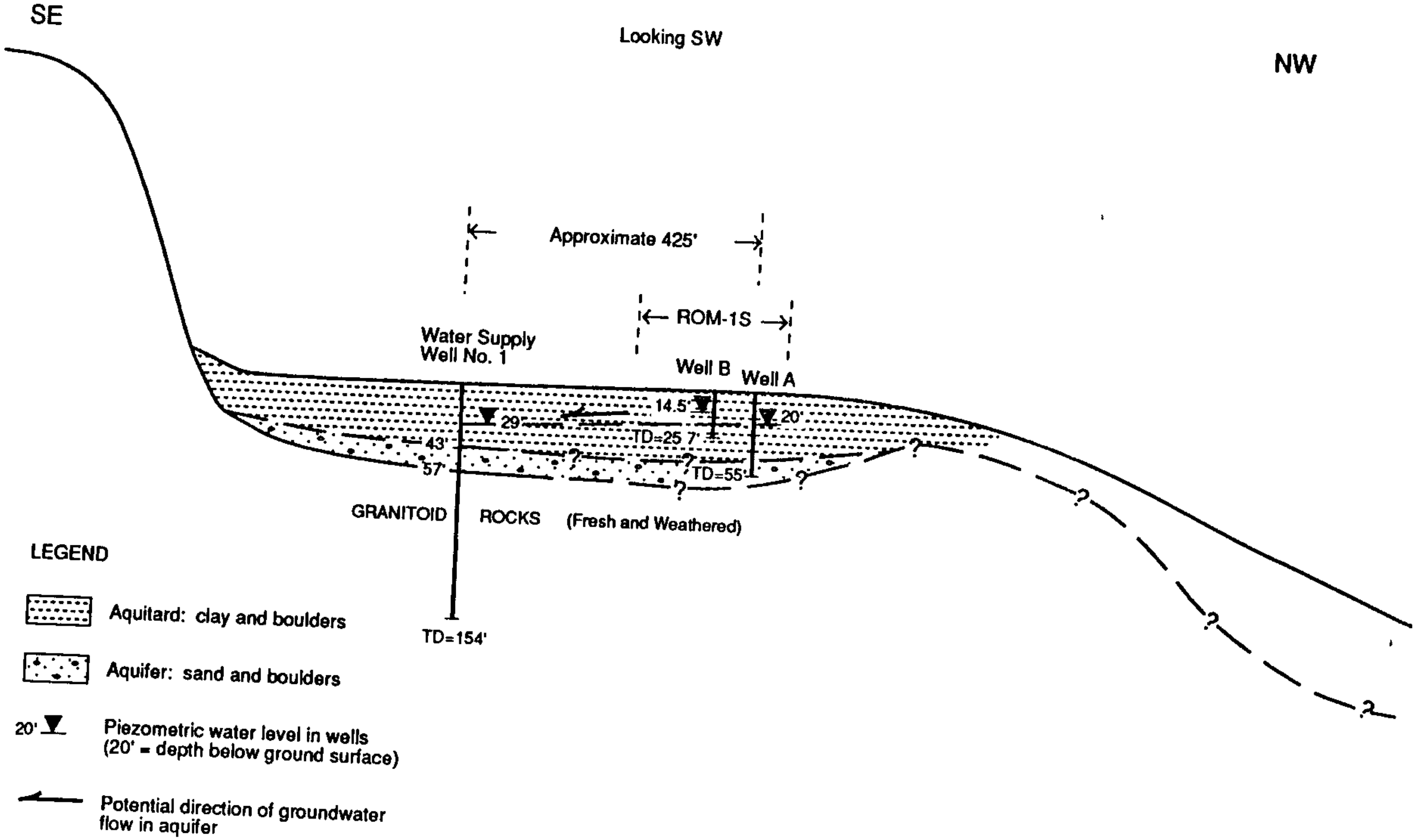
4.1.3.4 Contaminant Migration. Surface water flowing across this area downslope to the northwest provides a mechanism for potential contamination of surface water in Fowler Creek. A surface water sample from Fowler Creek (ROM 8-9) located about a 1/2 mile downstream from ROM-1S contained no TPHs concentrations above detection limit. Thus, most of the contamination from this spill has apparently been contained upstream near ROM-1S in the surface soil and the underlying alluvial units.

For groundwater, downward percolation of water through the fuel spill residue in the soil and the upper gravelly clay aquitard unit provides a mechanism for potential contamination of the lower sand-and-gravel aquifer unit. The presence of TPHs at a concentration of 4 mg/L in groundwater at shallow Well B (located within the Fuel Spill area) indicates that contamination has likely extended downward for an uncertain distance through the gravelly clay unit. The actual vertical extent of this contamination is unknown at present. Water Supply Well No. 1 (discussed under ROM-3) is located 300 feet southeast of the fuel spill. A groundwater sample from this well (see ROM-3 discussion below) contained a TPHs concentration of 2 mg/L. BTEX constituents were not present above detection limit in either of these groundwater samples.

4.1.3.5 Evaluation/Significance of Findings. Based on the above results, petroleum hydrocarbon contamination from the fuel spill at ROM-1S has apparently been contained mostly in the surface soil and the underlying gravelly clay aquitard unit. Contamination seems to have migrated downward at least 14 to 25 feet into the 43-foot-thick aquitard. The volatile BTEX constitutes may have mostly volatilized since the surface spill.

The base of this contamination is not known based on available data. The absence of TPHs concentrations above detection limit in deep Well A (T.D. 55 feet) suggests that the base of contamination is above this depth; but without data on well screen or well history, this situation cannot be fully assessed.

The direction of groundwater flow in this area is uncertain. The topographic gradient is very low and generally to the northwest along Fowler Creek. However, piezometric groundwater levels in Wells A and Water Supply Well No. 1 and their similar topographic elevation suggest that groundwater flow may be locally to the southeast from Well A toward Water Supply Well No. 1 (see Figure 4-2). This could provide a mechanism for transport of ROM-1S contamination to Well No. 1 and explain the 2 mg/L TPHs



Project No. 90275L	Cape Romanzof LRRS	DIAGRAMMATIC CROSS SECTION ALONG FOWLER CREEK SHOWING POTENTIAL SOUTHEASTWARD GROUNDWATER FLOW FROM WELL A (ROM-1S) TO WATER SUPPLY WELL NO. 1 (ROM-3)	Figure 4-2
Woodward-Clyde Consultants			

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occurrence in Well No. 1. This situation cannot be fully evaluated without more data on well history and screen interval for Wells A and B.

The unsealed conditions of Wells A and B provide an open conduit for transport of any additional contamination to the subsurface units and groundwater. Therefore, it is recommended that these wells be properly sealed and abandoned as soon as possible.

4.1.4 ROM-3 Former Shop Area

4.1.4.1 Site Geology and Soil. The surficial soil is fill material consisting of reworked granitoid colluvium. A layer of fine-grained material covers the fill. The colluvium contains large granitoid blocks (1-2 ft minimum dimension) intermixed with fine- to coarse-grained sand, silt, and trace of clay.

4.1.4.2 Site Hydrology. No surface flow was observed at this site except while raining. During Summer 1989, a borehole was drilled to 13.5 feet in fill at the nearby ROM-1D site without encountering groundwater. Based on the elevation difference (about 40 feet) between this site and the valley floor to the southwest, it is anticipated that the water table (top of saturated zone) is located considerably deeper than 14 feet at this site.

For convenience, water sampling from two locations southwest of ROM-3 was also included in ROM-3 studies, as shown on Figure 3-2. The lake behind Huson Dam (see Figure 3-2) is intended for recharging the drinking water aquifer, pumped at Water Supply Well No. 1 (C. Humphries, 1990, personal communication).

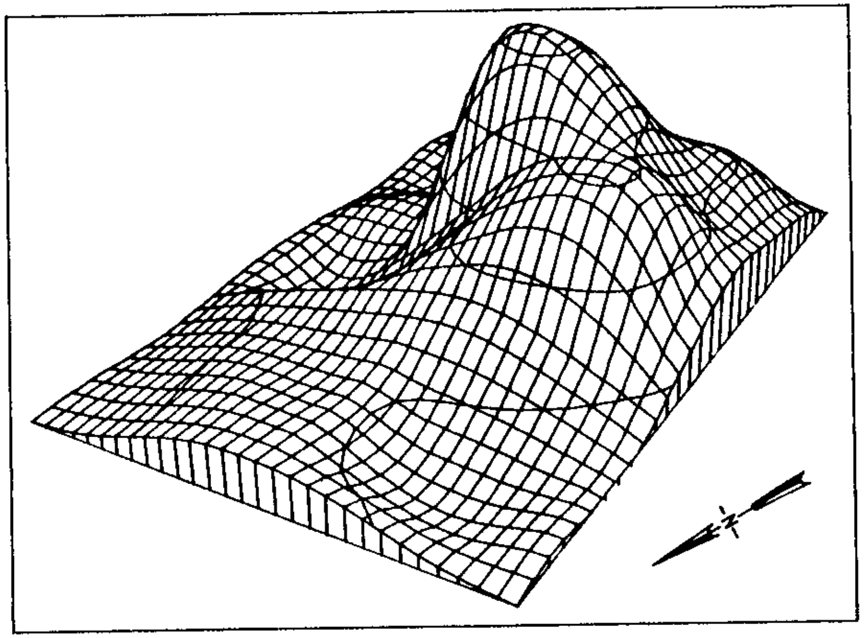
4.1.4.3 Soil Gas Survey. The results of the soil gas survey conducted at the Former Shop Area are presented in Table 4-8 and on Figure 4-3. Nine samples were reported positive, with SG-NA-07 (2.5 feet) being the highest value (51.8 ppmV with a replicate of 46.5 ppmV). The remaining thirteen samples were reported ND.

Table 4-8. SOIL GAS SAMPLING DATA AT ROM-3, CAPE ROMANZOF LRRS

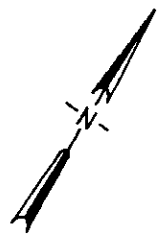
Sample ID	Sample Date	Depth (ft)	Vacuum in. Hg	Benzene eq.ppmV	Detection Limit
SG-NA-01	05-Aug-89	2.5	3	ND	0.6
SG-NA-01	05-Aug-89	4.5	22	ND	0.6
SG-NA-02	05-Aug-89	2.5	2	ND	0.6
SG-NA-02	07-Aug-89	4.5	21	1.8	0.6
SG-NA-03	06-Aug-89	3.0	2	13.0	0.6
SG-NA-03	06-Aug-89	4.5	10	ND	0.6
SG-NA-03QC	07-Aug-89	4.5	22	ND	0.6
SG-NA-04	06-Aug-89	2.0	1	ND	0.6
SG-NA-04QC	06-Aug-89	2.0	1	ND	0.6
SG-NA-04	07-Aug-89	4.5	22	ND	0.6
SG-NA-05	06-Aug-89	2.0	4	6.7	0.6
SG-NA-05QC	06-Aug-89	2.0	4	9.4	0.6
SG-NA-06	06-Aug-89	2.5	5	14.2	0.6
SG-NA-07	06-Aug-89	2.5	5	51.8	0.6
SG-NA-07QC	06-Aug-89	2.5	5	46.5	0.6
SG-NA-07	07-Aug-89	4.5	22	9.2	0.6
SG-NA-08	06-Aug-89	2.5	22	ND	0.6
SG-NA-08	07-Aug-89	4.5	22	ND	0.6
SG-NA-09	05-Aug-89	2.5	22	ND	0.6
SG-NA-09QC	06-Aug-89	2.5	25	ND	0.6
SG-NA-10	05-Aug-89	2.5	6	ND	0.6
SG-NA-10QC	05-Aug-89	2.5	6	ND	0.6
SG-NA-10QC	06-Aug-89	2.5	17	ND	0.6
SG-NA-11	05-Aug-89	4.5	2	ND	0.6
SG-NA-11QC	06-Aug-89	4.5	5	ND	0.6
SG-NA-12	Not Sampled due to mud clogging tee and needle of syringe				
SG-NA-13	07-Aug-89	2.5	5	36.4	0.6
SG-NA-14	07-Aug-89	2.5	6	22.2	0.6
SG-NA-15	07-Aug-89	2.5	11	ND	0.6
SG-NA-16	07-Aug-89	2.5	4	ND	0.6
SG-NA-17	07-Aug-89	2.5	10	0.6	0.6

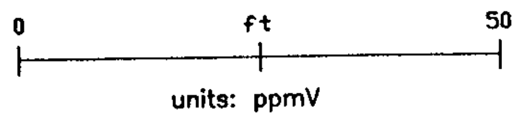
NOTES:

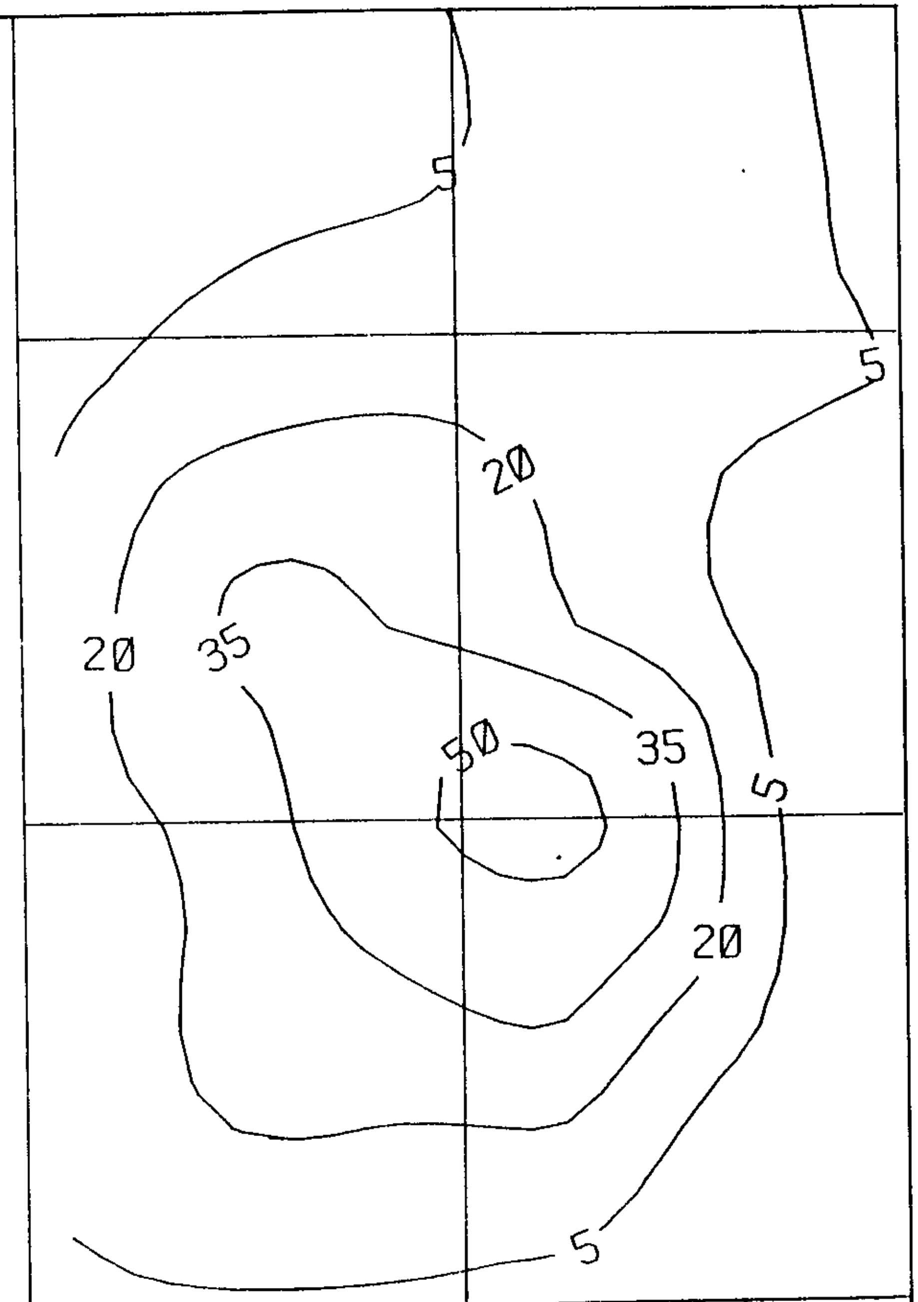
"QC" after Sample ID indicates the sample is a replicate QC sample.
Depth is the measured depth from the surface.
ND: Not Detected
Total hydrocarbons expressed in parts per million (volume) as Benzene.



ROM-3 CONCENTRATION PERSPECTIVE







Project No. 90275L	Cape Romanzof LRRS	ROM-3 ISOCONCENTRATION CONTOURS WITH CONCENTRATION PERSPECTIVE	Figure 4-3
Woodward-Clyde C nsultants			

4.1.4.4 Analytical Results. Four soil samples, one sediment sample, and two water samples were collected and analyzed for the full suite of analytes (Tables 3-3 and 3-4). Analytical results are reported in Appendix B. Locations of these samples are shown on Figure 3-2.

Four soil results indicated the presence of nine metals, one sample reported 10 metals. The metals found were within acceptable ranges (see Table 4-2). All soil samples detected TPHs in concentrations ranging from 2400 mg/kg to 35,000 mg/kg. PCBs were reported in the sediment sample (ROM 3-5) at a concentration of 0.39 μg/kg.

The water samples were taken at two locations southwest of ROM-3, namely a groundwater sample (ROM 3-6) from Water Supply Well No. 1 and a surface water sample (ROM 3-7) from the lake behind Huson Dam. Groundwater concentrations of 2 mg/L TPHs and 0.03 mg/L zinc were reported in the installation water supply well sample. BTEX constituents above the detection limits were ND. The surface water sample from the lake reported ND for all parameters.

4.1.4.5 Contaminant Migration. The high levels of TPHs contamination held in the surficial soils at ROM-3 are subject to transport via surface water flow. Runoff from this landfill is towards the southwest and Fowler Creek.

In groundwater, local migration of contaminants from Well A in the ROM-1S Large Fuel Spill to Water Supply Well No. 1 is possible (as discussed in Section 4.1.3). This potential contaminant migration is discussed further in the next paragraph.

4.1.4.6 Evaluation/Significance of Findings. As shown on Figure 3-2, sampling for this site was conducted in four separate subareas: 1) the former shop area, now a landfill; 2) a drainage from the landfill (sample 3-5); 3) Water Supply Well No. 1; and 4) the lake behind Huson Dam. The soil gas and soil sample analytical results indicate that the soils to 4.5 feet at the former shop area are contaminated with TPHs. The depth and lateral extent of contamination are unknown. This former shop area can be reasonably remediated separate from the other three subareas of ROM-3.

The tundra area should undergo remediation for TPHs in conjunction with remediation of the nearby ROM-1S Fuel Spill soil. The level of PCBs found in this sample was below the trigger cleanup level (see Section 4.3).

The groundwater from the water supply well aquifer contains TPHs in an amount that warrants additional investigation. The source of the contamination is presently unclear, it could be that ROM-3 soil contaminants have leached to the groundwater or it is conceivable that fuel absorbed into the tundra at the site of the ROM-1S Large Fuel Spill has reached the water table and been pulled towards the water supply well during normal pumping operations. Also, the piezometric water levels at Well A (ROM-1S) and the Water Supply Well No. 1 (ROM-3) suggest a potential local southeastward flow towards Water Supply Well No. 1 as discussed in Section 4.1.3. As discussed in Section 2.2, the Fowler Creek Valley is characterized by glacial erosion. As postulated on Figure 4-2, the scouring action of the glacier could have created a depression in the bedrock before advancing down valley. This bedrock depression and subsequent alluvial infilling could result in confined aquifer conditions which are observed in Water Supply Well No. 1. Further investigation would be needed to adequately define the geologic and hydrogeologic subsurface conditions in the ROM-3/ROM-1S areas, and the extent of contamination.

4.1.5 ROM-4 Road Oiling

4.1.5.1 Site Geology and Soils. The road surface soil is mostly sandy silt, derived from reworked granitoid colluvium.

4.1.5.2 Site Hydrology. Surface flow in the drainage ditch north of this road receives drainage from all areas north of the Lower Camp access road, and runoff from ROM-5 New Landfill. Flow in this ditch proceeds downhill in a westward direction.

4.1.5.3 Analytical Results. Two soil samples were collected, both in drainage ditches along the road. These samples were at either end of the road segment studied as shown on Figure 1-2. One sample was analyzed for TPHs and PCBs only, and the second was analyzed for the full suite of analytes (see Table 3-4). Analytical results are reported in Appendix B. Results indicated the presence of eleven metals, all of which were within acceptable ranges (see Tables 4-2 and 4-5). The samples reported TPHs concentrations of 100 mg/kg and 380 mg/kg. BTEX analyzed for in one sample was reported as ND.

4.1.5.4 Contaminant Migration. The migration potential of any contaminants from the road surface is high. Few of the installation roads are level. Runoff is captured in ditches paralleling the road; this runoff eventually reaches Fowler Creek.

4.1.5.5 Evaluation/Significance of Findings. The installation road system is upwards of 6 miles long. Two samples were taken in ditches along the main access road between the Composite Facility and the Alascom Station. The TPHs values are close to the Alaska standard for TPHs in soil. It appears that the road surface has been sprayed with waste oil as reported in the Phase I Records Search (Engineering Science 1985), and some of the oil has washed down to the sediments in the ditch. It would be impractical to suggest any remedial action for such a large area with such little contamination.

4.1.6 ROM-5 New Landfill

4.1.6.1 Site Geology and Soils. The surficial soil is a fill material consisting of reworked granitoid colluvium (sandy silt and granitoid blocks).

4.1.6.2 Site Hydrology. Surface water runoff was observed while it was raining. Surface water flowed in the small drainage path downgradient from the landfill and leading toward the access road.

4.1.6.3 Analytical Results. One soil sample was collected and analyzed for the full suite of analytes (see Table 3-4). This sample was located in a small drainage downgradient from the landfill as shown on Figure 1-2. Eight metals were reported, and all of these were within ranges normally found in the western U.S. (see Table 4-2). TPHs were reported at a concentration of 100 mg/kg. All other analytes, including BTEX, were reported as ND.

4.1.6.4 Contaminant Migration. The ROM-5 landfill (currently active) is situated upgradient from the soil sample location. Contaminants from the landfill would be carried via surface water flow through this drainage and into the drainage ditch leading to Fowler Creek.

4.1.6.5 Evaluation/Significance of Findings. The only analyte reported above detection limits was TPHs, at 100 mg/kg (the State of Alaska MCL). TPHs at this sampling site could have migrated from the upgradient landfill, and/or from road-oiling activities. Because the TPHs concentration does not exceed the State of Alaska MCL, remediation is not warranted.

4.1.7 ROM-8 Landfill

4.1.7.1 Site Geology and Soils. The native surficial materials underlying the landfill at this site consist of granitoid colluvium, which is at least 13 feet thick (maximum well penetration below landfill or road embankment). Weathered and fresh granitoid bedrock is probably present at unknown depths below the granitoid colluvium. A map showing the landfill, monitoring wells, and adjacent features is provided in Drawing 2.

In Monitoring Wells MW-1, MW-2, MW-3, and MW-4, the granitoid colluvium consisted of alternating layers of large granitoid blocks (1 to 2 feet vertical dimension) and zones of finer-grained well-graded granular material composed of sand and silt with a trace of clay. Large granitoid blocks were encountered at 8.5 and 14 feet in MW-1, at 5 and 13 feet in MW-2, at 6.3 and 7.5 feet in MW-3, and at 10 feet in MW-4.

4.1.7.2 Site Hydrology. Surface water was observed flowing westward within an engineered drainage along the north (uphill) side of the main access road, and also along a natural drainage which extended along the eastern and southern margins of the landfill. Flow in the natural drainage seems to have mostly originated from springs in several excavations up to 6 feet deep, located east of the landfill. In addition, several active seeps were present on the landfill surface (lower lift). Surface flow from these seeps across the landfill surface extended for up to 100 feet before terminating and reentering the landfill material.

Groundwater was present both within the landfill and the underlying granitoid colluvium. The water table (top of saturated zone) was encountered at 2 to 3 feet below the landfill in the granitoid colluvium, as shown on Figures 2-9 and 2-10. Direction of groundwater flow is southwestward, parallel to the topographic slope.

Part of the surface water flow and subjacent groundwater flow within the engineered drainage north and upgradient from the landfill apparently is being diverted to the southwest, downgradient and through the landfill. This is indicated by temporary periods of no surface flow in the drainage reach opposite the landfill, plus the presence of several prominent seeps on the lower landfill surface.

4.1.7.3 Analytical Results. Eight soil samples, 10 surface water samples and four groundwater samples were analyzed for the analytes listed in Tables 3-3 and 3-4. Analytical results are reported in Appendix B.

Location of these samples is shown on Figure 3-5. Maximum and geometric mean concentrations are shown in Tables 4-5 and 4-6.

The soil samples reported TPHs levels ranging from 40 to 100,000 mg/kg. Eight metals were reported in six soil samples, while nine metals were reported in the other two samples. All metals that were reported are within the range of metals normally found in the western U.S. (Shacklette and Boerngen 1985), see Table 4.2.

For surface water samples, between three and five metals were reported. All of these metals were within the normal background levels, shown in Table 4-4, except for cadmium, (0.009 mg/L) in Sample 8-5. Several organic compounds were reported in the surface water samples analyzed. The compounds are 2,4-methyl phenol (220 µg/L), 1,4 dichlorobenzene (4.7 µg/L), PCBs (2.7 µg/L), 1,1,1-trichloroethane (1.1 µg/L), and xylenes (4.0 µg/L). BTEX organics other than xylenes were not detected above detection limits. Also, three surface water samples located at ROM8-1, -5, and -6 reported TPHs levels between 1.0 mg/L and 4.0 mg/L, the remaining samples were ND.

For groundwater samples, between 6 and 10 metals were reported. The metals found were within the normal background levels shown in Table 4-4, except for cadmium. In the downgradient Well MW-4, reported concentrations of organic compounds were 1,4-dichlorobenzene (3.8 µg/L), 1,1-dichoroethane (0.45 µg/L), 1,1,1-trichloroethane (6.0 µg/L), xylenes (6.7 µg/L), and TPHs (2.0 mg/L). BTEX constituents other than xylenes were not found above detection limits.

4.1.7.4 Contaminant Migration. Surface water and groundwater flowing downslope to the west and southwest across this site provide a mechanism for potential contamination of Fowler Creek.

4.1.7.5 Evaluation/Significance of Findings. The analytical results presented above indicate that contamination associated with the landfill at this site is moderate, and consists principally of TPHs located in soil and PCBs and TPHs in surface water at the perimeter of the landfill, as follows:

Contaminant	Location	Sampling Medium/Concentration
TPHs	Samples 8-4, 8-5, 8-15 - at the south toe of the landfill and under a discarded transformer	Soil; 2500-100,000 mg/kg
	Samples 8-1, 8-5, 8-6 - around perimeter of landfill	Surface water; 1-4 mg/kg
PCBs	Sample 8-6 - west of the southwest corner of the landfill under granitoid blocks	Surface water; 2.7 μg/L
Cadmium	Sample 8-5 at the south toe of landfill	Surface water (probably in part leachate); 0.009 mg/L

Concentrations of other organic compounds were below any federal or state standards discussed in Sections 4.3 and 4.4. The cadmium concentration in groundwater from Well MW-3 (0.003 mg/L) is below the federal and state proposed maximum contaminants levels of 0.005 mg/L, discussed further in Sections 4.3 and 4.4.

These compounds are not present above detection limit downgradient at Fowler Creek, indicating that migration of these compounds has not yet reached Fowler Creek, or that these compounds are heavily diluted.

4.1.8 ROM-10 Former Truck Fill Stand

4.1.8.1 Site Geology and Soils. The surficial soils consist of sandy silt and boulders. These materials are part of the alluvial deposits of nearby Fowler Creek, which are laterally transitional into beach and shoreline deposits to the southwest along the margin of Kokechik Bay. With depth, these surficial soils are likely mixed and interbedded with granitoid colluvium (slope deposits) which are present on the moderately steep to steep slopes on either side of Fowler Creek. The thickness of these mixed alluvial and colluvial deposits at Well No. 2 (located about 3800 feet upstream and on the eastern slope of Fowler Creek) was found to be 74 feet (WCC 1989c).

4.1.8.2 Site Hydrology. This site is located less than 200 feet east of Fowler Creek, about 15 feet in elevation above the flowing creek level, and less than 500 feet from the shoreline of Kokechik Bay. The area north of this site (upstream) contains much riparian vegetation, and groundwater level is near ground surface. Locally, the flatter areas have been modified by the activities of beavers, which have produced several dammed areas containing standing water.

4.1.8.3 Analytical Results. One soil sample was analyzed for TPHs only; a concentration of 4900 mg/kg was reported. This sample was located at the presumed location of the former truck fill stand, as shown on Figure 3-6. No existing structures were found to indicate the exact location of this former stand.

4.1.8.4 Contaminant Migration. Surface water and subsurface groundwater flow toward nearby Fowler Creek provides a potential mechanism for transporting contamination to the creek from the source now present within the soil. The area around the truck fill stand is nearly flat, and runoff from this area could lead either to Fowler Creek or directly to Kokechik Bay.

4.1.8.5 Evaluation/Significance of Findings. The high reported TPHs value (4900 mg/kg) indicates that the sampling location is at or near the site of the former truck fill stand, as shown on installation drawings. Because of the close proximity of this contamination to the surface waters of Fowler Creek and the waters of Kokechik Bay (with aquatic organisms), this contamination represents a potentially significant environmental risk.

4.1.9 ROM-12 Former Drum Storage Area

4.1.9.1 Site Geology and Soils. The surficial soils consist of sandy silt and boulders. These materials are part of the alluvial deposits of nearby Fowler Creek, which are laterally transitional into beach and shoreline deposits to the southwest along the margin of Kokechik Bay. With depth, these surficial soils are likely mixed and interbedded with granitoid colluvium (slope deposits) which are present on the moderately steep to steep slopes on either side of Fowler Creek. The thickness of these mixed alluvial and colluvial deposits at Well No. 2 (located about 3200 feet upstream and on the eastern slope of Fowler Creek) was found to be 74 feet (WCC 1989c).

4.1.9.2 Site Hydrology. This site is located about 60 feet (minimum distance) east of Fowler Creek, about 15 feet in elevation above the flowing creek level, and less than 800 feet from the shoreline of Kokechik Bay. The area between this site and ROM-10 (to the south) contains much riparian vegetation; and groundwater level is near ground surface. Locally, the flatter areas have been modified by the activities of beavers, which have produced several dammed areas containing standing water.

4.1.9.3 Analytical Results. Two soil samples, one sediment sample and one surface water sample were collected and analyzed for the full suite of analytes, shown in Tables 3-3 and 3-4. Analytical results are reported in Appendix B. Locations of these samples are shown on Figure 3-6. Maximum and geometric mean concentrations are shown in Tables 4-5 and 4-6.

Eight metals were reported in the soil samples and four metals were reported in the sediment sample. All metals reported were within normal ranges, see Table 4-2. Three metals were detected in the surface water sample, all of which were within normal ranges as shown in Table 4-3.

One soil sample reported 0.21 mg/kg PCBs. The two soil samples had TPHs values of 100,000 and 200,000 mg/kg. The sediment sample reported a level of 50 mg/kg TPHs. No BTEX constituents were reported above the detection limit.

4.1.9.4 Contaminant Migration. The soil now appears to hold the TPHs and PCBs contaminants. The soil is dry, weathered, caked, and stained black and smells of petroleum hydrocarbons. The area is flat with a slight gradient to the south towards the northernmost and easternmost beaver pond. Surface water flow and groundwater flow toward the beaver pond and Fowler Creek from this site may transport contamination now held in the soil.

4.1.9.5 Evaluation/Significance of Findings. The two soil samples collected within the stained area had values representing 10 and 20 percent petroleum hydrocarbons. The sediment and surface water samples collected immediately downstream in one of the beaver ponds indicated little to no contamination. Thus, it seems that the spilled petroleum products were mostly absorbed and trapped in the native soil. Surface flow may transport some contamination southward to the beaver ponds and thence to Fowler Creek. The intensity of contamination at this site and proximity to Fowler Creek poses a potentially significant environmental risk from TPHs. The PCBs concentration (0.21 mg/kg) is below the EPA standard of 10 ppm for cleanup.

4.2 QUALITY ASSURANCE/QUALITY CONTROL (QA/QC) VALIDATION

The Enseco Rocky Mountain Analytical Laboratory (RMAL), of Arvada, Colorado, performed the chemical analyses for the Cape Romanzof LRRS project. The purpose of quality assurance/quality control procedures is to produce data of known quality that meet program requirements as specified in the Quality Assurance Project Plan, March 1989. The objectives of the quality assurance/quality control activities are twofold. First, they provide the mechanism for ongoing control and evaluation of measurement data quality throughout the course of operations. Second, quality control data define data quality for the various measurement parameters in terms of precision and accuracy. Table 4-9 summarizes QA/QC data for the Cape Romanzof LRRS project. Appendix F (2 volumes) contains all laboratory data for the project.

Duplicate (water) and replicate (soil) samples were collected periodically to estimate sample variability in laboratory results and for qualitative verification of a substance's presence or absence. Verification was confirmed if a substance was present or absent in both primary and duplicate samples. Two samples had high relative percent difference (RPD). Sample ROM8-G-WS-N-008 had a RPD value of 101%; this was an unfiltered water sample for metal analysis. It is possible that one or both replicate samples had sediment in them. Observed analytical results can be significantly affected when sediment is present in the sample. Soil Sample ROM8-G-SE-FR-004 had RPDs ranging from 31.1% to 90.9% for metal results. This may be attributed to the potential for stratification of contaminants within soil samples or to the variability inherent in replicate soil samples. These samples cannot be considered out of control since RMAL does maintain limits for matrix specific samples.

In two instances, organic compounds were detected in the primary sample and not in the replicate sample. Both samples were collected at ROM-8 Landfill (Samples 4 and 10). Acetone was reported in the first sample and

Table 4-9. SUMMARY OF QUALITY ASSURANCE/QUALITY CONTROL DATA FOR CAPE ROMANZOF LRRS

Sample Number	Total Petroleum Hydrocarbons Method E418.1	RPD	Organochlorine Pesticides & PCBs Method SW8080	RPD	Semi-volatile Organics Method E8270	RPD	Volatile Organics Method SW8240	RPD
CAPRM-ROM8-G-WS-N-008	ND		ND		ND			
CAPRM-ROM8-G-WS-FR-008***	ND	--	ND	--	ND	--		
CAPRM-ROM3-SC-SO-N-002	30000 mg/kg		ND		ND		ND	
CAPRM-ROM3-SC-SO-FR-002**	28000 mg/kg	6.9%	ND	--	ND	--	ND	--
CAPRM-ROM8-G-SE-N-004	2500 mg/kg		ND		ND		Acetone 0.12 mg/kg	
CAPRM-ROM8-G-SE-FR-004**	3000 mg/kg	18.2%	ND	--	ND	--	ND	--
CAPRM-ROM1S-B-WG-N-001	4 mg/L				# Di-n-octyl phthalate 20)g/L			
CAPRM-ROM1S-B-WG-FR-001***	4 mg/L	0%			ND	--		
CAPRM-ROM8-G-SE-N-010	40 mg/kg		ND		ND		ND	
CAPRM-ROM8-G-SE-N-010**	40 mg/kg	0%	ND	--	ND	--	ND	--

Samples collected by WCC during Summer 1989 and analyzed by RMAL.
RPD - Relative Percent Difference
ND - Not Detected
- Laboratory or field contaminate.
* - Concentration of recoverable and dissolved metals for these samples are similar, unless noted in column. Metal shown in column is the recoverable fraction.
** - Replicate soil sample.
*** - Duplicate water sample.

Table 4-9. SUMMARY OF QUALITY ASSURANCE/QUALITY CONTROL DATA FOR CAPE ROMANZOF LRRS (concluded)

Sample Number	Recoverable and Dissolved Metals Method E6010	RPD	Halogenated Volatile Organics Method E8010	RPD	Aromatic Volatile Organics Method E8020	RPD	Total Solids Method D2216	RPD
CAPRM-ROM8-G-WS-N-008	Iron 0.59 mg/L *		ND		ND			
CAPRM-ROM8-G-WS-FR-008***	Iron 1.8 mg/L *	101%	ND	--	ND	--		
CAPRM-ROM3-SC-SO-N-002	*						94.3%	
CAPRM-ROM3-SC-SO-FR-002**	*	--					97.7%	3.5%
CAPRM-ROM8-G-SE-N-004	Aluminum 2600 mg/kg Calcium 800 mg/kg Copper 9 mg/kg Iron 22400 mg/kg Zinc 260 mg/kg *						59.9%	
CAPRM-ROM8-G-SE-FR-004**	Aluminum 4500 mg/kg Calcium 1100 mg/kg Copper 24 mg/kg Iron 14700 mg/kg Zinc 110 mg/kg *	53.5% 31.5% 90.9% 41.5% 81.1%					15.4%	118%
CAPRM-ROM1S-B-WG-N-001	*		ND		ND			
CAPRM-ROM1S-B-WG-FR-001***	*	--	ND	--	ND	--		
CAPRM-ROM8-G-SE-N-010	Iron 7200 mg/kg *						85.9%	
CAPRM-ROM8-G-SE-N-010**	Iron 8100 mg/kg *	11.8%					85.3%	0.7%

Samples collected by WCC during Summer 1989 and analyzed by RMAL.
RPD - Relative Percent Difference
ND - Not Detected
- Laboratory or field contaminate.
* - Concentration of recoverable and dissolved metals for these samples are similar, unless noted in column. Metal shown in column is the recoverable fraction.
** - Replicate soil sample.
*** - Duplicate water sample.

di-n-octyl phthalate in the second sample. Acetone is a common laboratory solvent and a typical source of laboratory contamination, di-n-octyl phthalate is a common field contaminant. Both compounds' presence was most likely due to the abovementioned types of contamination.

Several trip blanks as well as one ambient conditions blank, and two equipment blanks were analyzed. All samples were free of contamination from reported compounds except the equipment blanks. Bis(2-ethylhexyl) phthalate and methylene chloride were detected individually in the equipment blank samples. Methylene chloride is a common laboratory solvent, and laboratory contamination is considered the source of this compound. The use of latex gloves while collecting the samples or in the preparation of the sample at the laboratory is considered the source for the presence of bis(2-ethylhexyl) phthalate in the equipment blank. Incomplete cleaning of laboratory glassware used for sample preparation is another possible source of phthalate contamination.

4.3 REGULATORY CLEANUP STANDARDS AND HEALTH AND ENVIRONMENTAL CRITERIA

The contaminants of concern detected at Cape Romanzof are TPHs and PCBSs. This section presents regulatory cleanup levels and health and environmental criteria for these contaminants.

4.3.1 Applicable or Relevant and Appropriate Requirements

EPA has defined whether a given environmental regulation constitutes an applicable or relevant and appropriate requirement (ARAR) for CERCLA sites. Applicable requirements are those promulgated regulations that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site. Promulgated requirements are those laws and regulations that are of general applicability and are legally enforceable and enforced. EPA states in the guideline document that nonpromulgated advisories and guidance documents issued by federal or state governments do not have the status of potential

ARARs, but may be used to determine the level of cleanup necessary to protect human health and the environment. For a regulation to be applicable, the remedial action must satisfy all of the jurisdictional prerequisites of the requirement.

Even if it is not applicable as defined above, a regulation may be relevant and appropriate. According to EPA, relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements that address problems or situations sufficiently similar to those encountered at a CERCLA site that the use of these requirements is well-suited to the site in question.

EPA has classified ARARs into three groups:

- Ambient or chemical-specific requirements that set concentration limits for various environmental media (ambient water, drinking water, ambient air, soil or solid waste)
- Performance, design, or technical requirements, e.g., regulations for closure of hazardous waste landfills, RCRA incineration standards, RCRA land disposal prohibitions, and pretreatment standards for discharges to Publicly Owned Treatment Works (POTWs)
- Location requirements or siting restrictions.

Regulations in Groups 2 and 3 would only be applicable at Cape Romanzof if remedial action such as transport, treatment, or disposal of hazardous waste was considered. Since these actions are not so considered, only those ARARs or advisories or guidance that are ambient or chemical-specific requirements (Group 1), (as opposed to ARARs classified as action-specific or location-specific) are used in the qualitative risk screening. Group 1 requirements "set health or risk-based concentration limits or ranges in various environmental media for specific hazardous substances, pollutants, or contaminants" (EPA 1987).

4.3.1.1 Federal and State Regulations. Regulations that could serve as potential ARARs for Cape Romanzof are:

- Federal ambient water quality criteria (EPA 440/5-86-001)
- Water quality criteria established by the State of Alaska (18 AAC 70)
- Interim standard cleanup guidelines developed by the State of Alaska for total petroleum hydrocarbons (Alaska Department of Environmental Conservation)
- PCBs Spill Cleanup Policy developed by the EPA

These regulations are discussed in the following sections and evaluated by contaminant in Table 4-10.

Federal and State Ambient Water Quality Criteria. There are federal water quality criteria for health and aquatic life for various contaminants but not for TPHs. For toxic and other deleterious organic and inorganic substances and for petroleum hydrocarbons, the State of Alaska has established minimum health and aquatic life standards for ambient water used for aquaculture, seafood processing, industrial processes, and recreation; and for harvesting raw mollusks and other raw aquatic life for human consumption (18 AAC 70). The standards established for marine water uses are presented below. The standards are the same for similar fresh water uses.

Aquaculture. Toxic substances shall not individually or in combination exceed 0.01 times the lowest measured 96-hour LC50 for life stages of species identified by the State of Alaska as being the most sensitive, biologically important to the situation, or exceed criteria cited in

Table 4-10. STANDARDS AND CRITERIA FOR WATER CONTAMINANTS (All values in mg/L)

Contaminant	Federal MCL	Alaska MCL	Federal AWQC Health	Alaska AWQC Health	Federal AWQC Aquatic Life	Alaska AWQC Aquatic Life
Aluminium	NE	NE	NE	NE	NE	NE
Barium	1.0/5.0*	1.0/5.0*	NE	NE	NE	NE
Beryllium	NE	NE	0.0000068	0.0000068	0.0053	0.0053
Cadmium	0.01/0.005*	0.01/0.005*	0.01	0.01	0.0011	0.0011
Chromium (+3)	NE	NE	170	170	0.21	0.21
Chromium (+6)	0.05/0.1*	0.05/0.1*	0.05	0.05	0.011	0.011
Cobalt	NE	NE	NE	NE	NE	NE
Copper	1.3*	1.3*	NE	NE	0.00012#	0.00012#
Manganese	NE	NE	NE	NE	NE	NE
Nickel	NE	NE	0.134	0.134	0.096#	0.096#
Vanadium	NE	NE	NE	NE	NE	NE
Zinc	NE	NE	NE	NE	0.047	0.047
Dichlorobenzene, 1,4-	0.075	0.075	0.4	0.4	NE	NE
Dichloroethane, 1,1-	NE	NE	NE	NE	NE	NE
Dimethylphenol, 2,4-	NE	NE	NE	NE	NE	NE
Hexachlorocyclohexane, alpha-	NE	NE	0.0000092	0.0000092	NE	NE
Methylnaphthalene	NE	NE	NE	NE	NE	NE
PCBs	0.005*	0.005*	0.000000079	0.000000079	0.000014	0.000014
TPHs	NE	See (a) below	NE	NE	NE	0.015
Trichloroethane, 1,1,1-	0.2	0.2	18.4	18.4	NE	NE
Xylene	10*	10*	NE	NE	NE	NE

* Proposed Maximum Contaminant Level (MCL)
AWQC = Ambient Water Quality Criteria
NE = Not established
\# Hardness related. Value is for hardness of 100 mg/L calcium carbonate.
(a) Non-numerical standard. "Shall not cause a visible sheen upon the surface of the water. Shall not exceed concentration which individually or in combination impart odor or taste as determined by organoleptic tests".

EPA Quality Criteria for Water or Alaska Drinking Water Standards, whichever concentration is less. (LC50 is an experimentally derived estimate of the concentration of a chemical in water that will kill 50 percent of the exposed population of aquatic organisms.) Substances must not be present or exceed concentrations that individually or in combination impart undesirable odor or taste to fish or other aquatic organisms as determined by either bioassay or organoleptic tests.

Petroleum hydrocarbon levels shall not exceed 0.01 times the continuous-flow 96-hour LC50, or if not available, the static 96-hour LC50 for the species involved.

Propagation of Fish and Wildlife. Toxic substances shall not exceed standards for aquaculture.

Petroleum hydrocarbons in the water column shall not exceed 15 μg/L or 0.01 of the lowest measured continuous flow 96-hour LC50 for life stages of species identified by the State of Alaska as the most sensitive, biologically important species in a particular location, whichever concentration is less. Total aromatic hydrocarbons in the water column shall not exceed 10 μg/L or 0.01 of the lowest measured continuous flow 96-hour LC50 for life stages of species identified by the State of Alaska as the most sensitive and/or biologically important species in a particular location, whichever concentration is less. There shall be no concentrations of hydrocarbons, animal fats, or vegetable oils in the sediment that cause deleterious effects to aquatic life. Surface waters and adjoining shorelines shall be virtually free from floating oil, film, sheen, or discoloration.

One groundwater sample from ROM-1S had a concentration of alpha BHC and TPHs above the federal and state AWQC. Surface water samples from ROM-8 also had TPHs concentrations greater than the federal and state standards.

Seafood Processing. Toxic substances shall not exceed EPA ambient water quality criteria standards.

Petroleum hydrocarbons shall not cause a film, sheen, or discoloration on the surface or floor of the waterbody or adjoining shorelines. Surface waters shall be virtually free from floating oils and shall not exceed concentrations which individually or in combination impart odor or taste as determined by organoleptic tests.

Industrial Processing. Toxic substances that pose hazards to worker contact shall not be present.

Petroleum hydrocarbons shall not make the water unfit for the intended industrial use.

Water Recreation. Toxic substances shall not exceed EPA ambient water quality criteria standards.

Petroleum hydrocarbons shall not cause a film, sheen, or discoloration on the surface or floor of the water body or adjoining shorelines. Surface waters shall be virtually free from floating oils.

Raw Aquatic Life Harvesting. Toxic substances shall not exceed standards for aquaculture.

Petroleum hydrocarbons shall not exceed concentrations which individually or in combination impart undesirable odor or taste to organisms as determined by bioassay and/or organoleptic tests.

State TPHs Interim Cleanup Standards.

TPHs in Soil. ADEC has established an interim soil cleanup target level of 100 mg/kg for TPHs (ADEC 1989). Six sites, ROM-1, -1S, -3,

-8, -10, and -12, had TPHs concentrations in soil significantly greater than 100 mg/kg. Site ROM-4 had TPHs concentrations of 100 and 380 mg/kg. The one measurement at Site ROM-5 was 100 mg/kg.

PCBs Spill Cleanup Policy.

PCBs. The EPA promulgated a PCBs spill cleanup policy in the April 2, 1987, Federal Register. The policy is intended for spills occurring after the Federal Register notice, but may be applied to previous spill sites at the discretion of the EPA Regional Office having jurisdiction. EPA Region X, which has jurisdiction for PCBs spills in Alaska, adopted the policy for spills occurring before and after the Federal Register notice.

The PCBs spill policy requires that for high-concentration spills of PCBSs (above 500 ppm) in nonrestricted access areas, soil containing more than 10 ppm of PCBSs must be removed, and excavated to a depth of at least 10 inches. Specific requirements for confirmation sampling are described in the Federal Register notice. The PCBs cleanup policy also states that the excavation must be filled with clean soil, containing less than 1 ppm PCBSs. Two sites, ROM-3 and ROM-12, had PCBs values, but these were less than 10 mg/kg.

4.3.2 Health and Environmental Standards and Criteria

Health and environmental standards and criteria for TPHs at Cape Romanzof LRRS have not been established. Standards for ambient water quality based on beneficial uses and drinking water standards exist for some metals and organics and are presented on Table 4-10.

4.4 SITE RISK SCREENING

4.4.1 Introduction

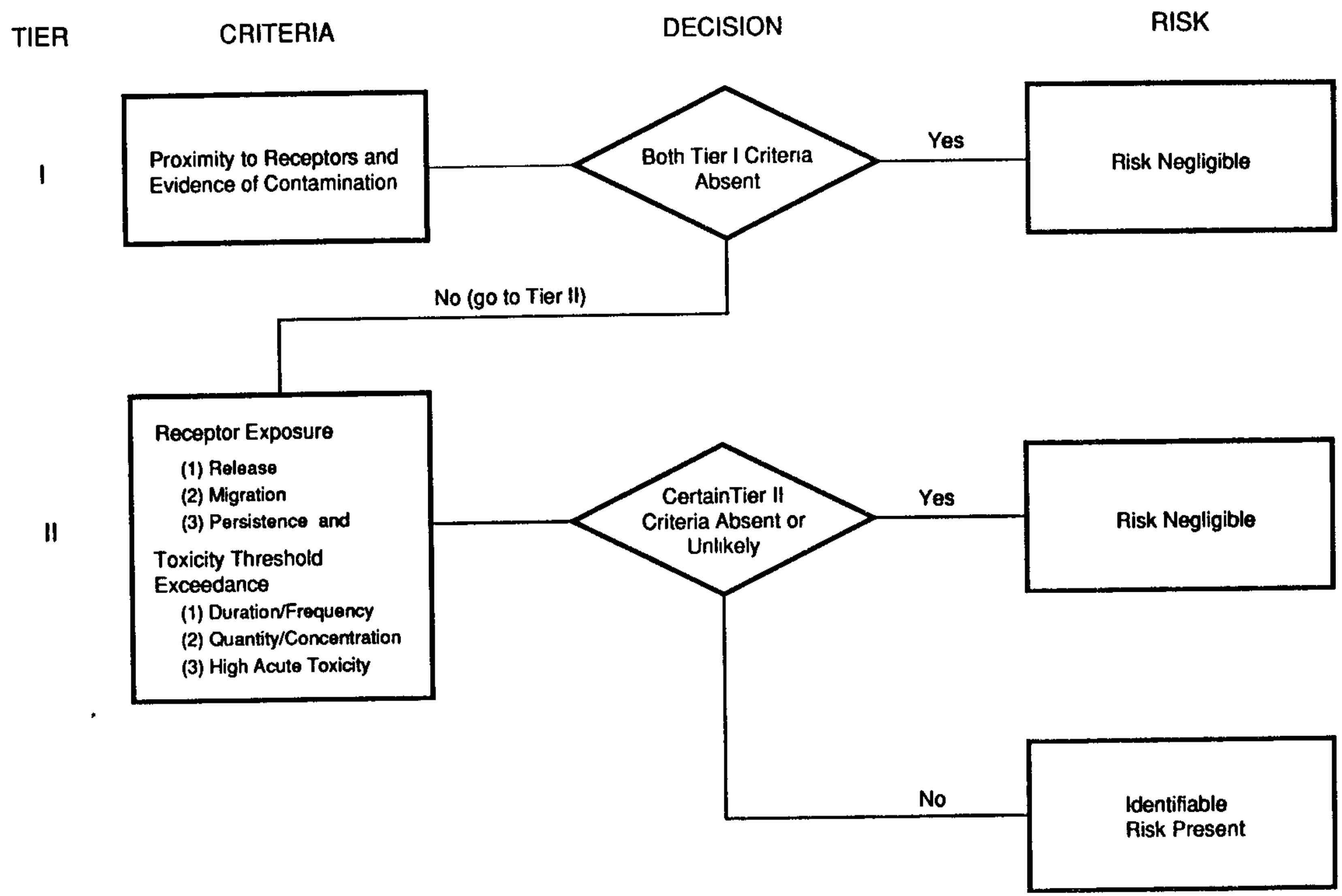
Sites that might require remediation at the Cape Romanzof LRRS were identified by applying a risk screening process developed by WCC to rapidly identify at U.S. Air Force facilities, chemically contaminated sites that could have a significant impact on human health and the environment. The process is less rigorous than risk assessments associated with CERCLA sites and differs from the Defense Priority Model in that it cannot be used to rank sites. CERCLA risk assessment guidelines are not strictly applicable to sites at the Cape Romanzof facility because none of the sites is on the National Priority List.

The risk screening process is composed of a two-tiered hierarchical decision scheme. The process is summarized in the flow diagram on Figure 4-4. In Tier I, two criteria are used: (1) proximity of the site to sensitive biological receptors and (2) evidence of environmental contamination. When either of these criteria is met, screening proceeds to Tier II. If neither criterion is met, the process stops and remediation is deemed unnecessary unless required by federal, state, or local government. The proximity criterion would be satisfied if a village, water body containing organisms of importance to humans in the area, or area inhabited or used by endangered species is within 1 mile of a site. Detection of a chemical in soil or water samples from a site was considered evidence of environmental contamination provided that the measured concentration of the chemical exceeded background or the chemical is not naturally occurring.

In Tier II, the screening process involves estimating whether or not exposure is likely to occur and if the toxicity threshold of any of the chemicals under evaluation is exceeded. Risk is significant only when exposure is determined to be likely to occur and the toxicity criterion is met.

Exposure is considered likely to occur when:

- Contaminant release from the site has occurred or is likely to occur,



Project No. 90275L	Cape Romanzof LRRS	FLOW DIAGRAM SHOWING TWO LEVELS OF RISK SCREENING AND CRITERIA FOR DECISION MAKING AT EACH LEVEL	Figure 4-4
Woodward-Clyde Consultants			

- Contaminant migration from the facility has occurred or is likely to occur, <u>or</u>

- At least one contaminant is environmentally persistent.

When there is no evidence that a chemical has been released from a site, release is considered likely when the chemical has a vapor pressure of at least 10 torr (10 mm of mercury) or an aqueous solubility of at least 100 mg/L.

OK

When there is no evidence that migration beyond the boundaries of a facility has occurred, the propensity of a chemical to migrate is considered significant when it was found in surface or groundwater, annual rainfall exceeds 20 inches, the site is located on a slope and soil erosion is evident, the soil is poorly vegetated, or the site is located on or close to the edge of a body of water.

The toxicity threshold criterion is satisfied when:

(1) The duration or frequency of exposure is judged sufficient to cause health or environmental effects, <u>and</u> either (2) or (3) applies

(2) The measured concentration of at least one contaminant exceeds the standard or criterion established by the federal or state government for the protection of human health and the environment, <u>or</u>

(3) One or more contaminants exhibits high acute toxicity to mammals or aquatic life.

The third criterion was applied to contaminants with no applicable standards or criteria. Standards and criteria against which measured contaminant concentrations were compared were limited to federal and state drinking water and ambient water quality criteria. Cleanup standards were not used.

A chemical was considered to exhibit high acute toxicity when its oral LD50, dermal LD50, or inhalation LC50 is equal to or less than 50 mg/kg, 43 mg/kg, or 100 ppm (1000 mg/m^3 for nonvolatile chemicals), respectively, or its 48- or 96-hour LC50 in aquatic organisms is equal to or less than 1 mg/L.

Exposure to a toxic concentration of a chemical does not automatically result in the occurrence of adverse effects; exposure time must be sufficiently long to allow toxic levels of the chemical to reach active sites in the body. For that reason, exposure duration and frequency were considered in the risk screening process.

4.4.2 Site Contaminants

Table 4-5 shows the geometric mean and highest measured concentration of most of the chemicals detected in soil samples from each site. Chemicals that were detected, but not listed in the table, are sodium, potassium, calcium, and iron, and magnesium, which are generally considered essentially non-toxic. Table 4-6 shows the geometric means and highest measured concentration of chemicals recovered from surface and groundwater samples. Because water quality criteria are based on recoverable quantities of chemicals, only the reported recoverable concentrations were considered in the screening process.

When a chemical was found in measurable quantities in some of the samples of the same kind from a site, the geometric mean was based on all reported values, including values below detection limits. It was assumed that the concentrations below detection limits were one-half the detection limit. When the concentration of a chemical was reported as being below detection limits in all of the samples of the same kind from a site, the concentration of the chemical was assumed to be zero and listed as not detected (ND).

Before the risk screening process was applied, the chemicals identified in soil and water samples were examined to identify those that may not be true environmental contaminants. In this project, an environmental contaminant is defined as a chemical that is not normally found in the environment or is present in abnormally high concentrations. Metals are elements and are thus found naturally in soil and water. To be classified as contaminant, a metal would have to be present at a concentration that is higher than would normally be found in the sample subjected to chemical analysis. In the absence of information on the normal concentrations of metals in soil in the Cape Romanzof area, the measured concentrations of metals in the soil samples were compared with concentrations reported by Conner and Shacklette (1975) and Shacklette and Boerngen (1985) in soil in the conterminous United States (Table 4-2). None of the metals in soil from the Cape Romanzof sites was found at abnormally high concentrations; hence, the metals in the soil were not classified as contaminants.

For assessment of the metals detected in Cape Romanzof water samples, information regarding the normal concentration range in unpolluted surface water, groundwater, and ocean water in North America was found in Hem (1985) and Moore and Ramamoorthy (1984). These data are compiled on Table 4-3. In order to provide a more local indication of background metal concentration in water, two surface water samples were obtained from areas not believed to be influenced by any of the Cape Romanzof sites. These samples were ROM-8-G-WS-N-002 and ROM-8-G-WS-N-009 (referred to as samples

2 and 9). Both samples were collected upgradient from the ROM-8 landfill. The former was from a spring and the latter was from Fowler Creek. Two groundwater samples were also obtained from points topographically above the ROM-8 landfill. They were ROM-8-B-WG-N-011 and 012 (referred to as samples 11 and 12). Metal concentrations found in these background surface water and groundwater samples are shown in Table 4-4.

A comparison of the regional and local metal background data (Tables 4-3 and 4-4) indicates that local surface water concentrations are consistent with or lower than regional concentrations. Groundwater concentrations for a given metal are consistently higher than surface water concentrations, in both tables. The relatively high concentrations of aluminum and iron in local background groundwater likely are the result of the presence of these elements largely in the colloidal (or particulate) state in the unfiltered samples shown on Table 4-4 (see Hem 1985). Separate analysis of filtered portions of these same samples (indicating dissolved concentrations of aluminum or iron) show ND of less than 0.5 mg/L concentrations for these metals (see Appendix B). Also, aluminum and iron are elements that are particularly abundant in waters draining igneous rock terrain (Hem 1985). Thus, relatively high concentrations are expected at Cape Romanzof which is dominated by igneous granitoid bedrock.

Regarding surface water at specific ROM sites, barium was the only metal found in the surface water sample from ROM-3, and barium and zinc were the only metals found in the surface water sample from ROM-12. The concentrations of barium in both samples as well as the surface water samples from ROM-8 were the same as or very close to the concentrations in the local background samples; hence, barium was not classified as a surface water contaminant at the three sites. The average concentrations of zinc in surface water samples from these three sites were 2.6 to 6 times the concentration in the local background samples, but mostly within the ranges of regional background samples. Zinc was not classified as a contaminant because the concentrations of that metal in the surface water samples were below 0.1 mg/L, which is the highest concentration reported by Duram et al. (1971) for 605 of 714 filtered surface water samples from around the conterminous United States (the remaining samples contained higher levels of zinc).

Of the metals remaining as potential contaminants of ROM-8 surface waters--aluminum, cadmium, and manganese--aluminum and manganese were present at maximum concentrations of about one-hundredth and one-half, respectively, of their concentrations in "background" groundwater samples, and are not classified as surface water contaminants. Therefore, only cadmium remains as a surface water contaminant at ROM-8.

Regarding groundwater, ten metals were detected in measurable quantities in the background groundwater samples (Table 4-4). The mean concentration of each of the ten metals in groundwater samples from ROM-1S, -3, and -8 was within the respective range found in the background groundwater samples. Therefore none of the metals in groundwater was classified as groundwater contaminants.

Several organic compounds detected in the soil and water samples were also eliminated as noncontaminants. They were acetone, bis(2-ethylhexyl)phthalate, dichlorodifluoromethane, di-octyl phthalate, methylene chloride, and toluene. All of these compounds are believed to have been introduced into the samples during laboratory processing. Acetone, dichlorodifluoramethane, methylene chloride, and toluene are used as solvents in laboratory preparation; phthalates are typically associated with plastic or latex products used in the laboratory.

Table 4-11 identifies the chemicals subjected to the risk screening process and the media in which they were detected at each site.

Table 4-11. CHEMICALS SUBJECTED TO THE RISK SCREENING PROCESS AND MEDIA IN WHICH THEY WERE DETECTED AT EACH SITE, CAPE ROMANZOF LRRS

Contaminant	ROM-1	ROM-1S	ROM-1D	ROM-3	ROM-4	ROM-5	ROM-8	ROM-10	ROM-12
Cadmium							SW/GW		
BHC,alpha		GW							
Dichloroethane, 1,1-							GW		
Dichlorobenzene, 1,4-							GW/SW		
Methylnaphthalene	S								
Methylphenol, 2,4-							SW		
PCBs				S			SW		S
Trichloroethane, 1,1,1-							GW/SW		
Xylene							GW/SW		
TPHs	S	S/GW	S	S/GW	S	S	S/GW	S	S

S = soil
GW= groundwater
SW= surface water

4.4.3 Biological Characteristics

The biological characteristics, including human presence, of Cape Romanzof and the surrounding area are described in Section 2.5.

4.4.4 Tier I Screening Results

4.4.4.1 Proximity to Biological Receptors. All of the sites addressed in this report are within 1 mile of Fowler Creek, which is visited by salmonids seasonally and is assumed to be inhabited by ecologically important species. ROM-1, -1S, -1D, -3, -4, -5 all are within 1 mile of the Cape Romanzof living quarters where technicians live.

4.4.4.2 Evidence of Contamination. Evidence of contamination was found at all of the sites. Petroleum hydrocarbons, measured as total petroleum hydrocarbons (TPHs) were found in soil samples from every site and in groundwater samples from ROM-1S, -3, and -8, which, with ROM-12, were the only sites from which water samples were collected. Metal contamination of surface water was evident at ROM-8 and ROM-12. Metal contamination of groundwater was evident at ROM-1S and ROM-8.

4.4.5 Tier II Screening Results

4.4.5.1 Exposure Potential.

Contaminant Release from Site Boundary. Site boundaries were not well defined, therefore, it was not possible to determine if any of the contaminants had been released from the site. Contaminants were found in surface and/or groundwater samples from ROM-1S, -3, and -8, which suggests that contaminant release from these sites is possible.

Contaminant Migration from Cape Romanzof LRRS. Cape Romanzof is located in a valley with steep slopes. Annual rainfall amounts to about 27 inches. Rainwater and snowmelt runoff appears heavy enough to result in movement of chemical contaminants from the sites to Fowler Creek and into Kokechik Bay. Because of these conditions, contaminant migration from all of the sites to points beyond the boundary of the Air Force Station was considered possible.

Environmental Persistence. Of the nine organic chemicals evaluated, two were classified as environmentally persistent. These chemicals are alpha-BHC and PCBSs. Alpha-BHC was detected in groundwater at ROM-1S. PCBSs were detected in soil at ROM-3 and ROM-12 and in surface water at ROM-8. All of the metals were classified as environmentally persistent. Metal contamination of surface water was evident at ROM-8.

4.4.5.2 Toxicity Threshold.

Exceedance of Standards or Criteria. Table 4-10 shows, for each chemical evaluated, the highest levels allowed by the federal government and the State of Alaska in drinking water and ambient water quality criteria developed by these governments for the protection of human health and aquatic organisms. No standards or criteria were found for aluminum, cobalt, manganese, vanadium, 1,1-dichloroethane, 2,4-dimethylphenol, and methylnaphthalene. Standards and criteria were compared only with contaminants whose measured concentrations were reported as recoverable because at present, federal ambient water quality criteria apply to recoverable rather than to dissolved levels.

Also, ambient water quality criteria for the protection of aquatic organisms were not applied to groundwater as the kinds of organisms the criteria were developed to protect do not live in groundwater.

One metal and three of the organic chemicals chosen for evaluation were present in surface water or groundwater at concentrations exceeding standards or criteria in at least one sample. The metal is cadmium. The organic chemicals are alpha-BHC, PCBSs, and TPHs. All other organics listed in Table 4-11 were encountered at concentrations below standards or criteria.

In surface water, the ambient water quality criterion for protecting aquatic life against cadmium was exceeded at ROM-8.

Alpha-BHC was found in groundwater only at ROM-1S; its concentration exceeded the federal ambient water quality health criterion of 9.2 ng/L. PCBSs (Aroclor 1260) were found in a surface water sample from ROM-8, at a measured concentration that exceeded the federal ambient water quality health criterion of 0.079 ng/L and the aquatic life criterion of 0.014 µg/L. The health criteria for both compounds correspond to a lifetime incremental cancer risk of 10^{-6}. The concentration of TPHs in surface water from ROM-8 exceeded Alaska's ambient water quality criterion of 0.015 mg/L for protection of aquatic life. PCBSs in soil were below the 10-ppm standard.

Finally, TPHs in soil met or exceeded the 100-mg/kg standard at seven sites: ROM-1, -1S, -3, -4, -8, -10, and -12.

Health Risk of TPHs. Petroleum-derived hydrocarbons (identified as TPHs in EPA Method 418.1) may contain a wide variety of compounds, including some which constitute a health risk common because of known or suspected carcinogenicity or toxicity. Such compounds are contained in two of the many chemical classes found in TPHs, namely the volatile organic compounds (e.g., BTEX-benzene, toluene, ethylbenzene, xylenes), and the PAHs (polynuclear aromatic hydrocarbons). Benzene and some of the PAHs (e.g., benzo-a-pyrene) are known or suspected carcinogens; while toluene and xylene have toxic properties (Lee et al. 1988; Stokman and Dime 1986).

Additional compound-specific analyses (beyond E418.1) were conducted at Cape Romanzof sites to identify the presence of BTEX (EPA Method 8020) and PAHs (EPA Method 8270). No BTEX or PAH compounds were found above detection limits at any of the ROM sites, indicating that the TPHs at Cape Romanzof are relatively nonhazardous.

Acute Toxicity. None of the chemicals evaluated is acutely toxic enough to be classified as highly toxic to humans. According to EPA (1986), several of them exhibit 48- or 96-hour LC50s of 1.0 mg/L or less in aquatic organisms, qualifying them as highly toxic to such organisms. They are beryllium, cadmium, hexavalent chromium, copper, nickel, zinc, and PCBSs. One or more of these chemicals were considered contaminants in ROM-1S, ROM-3, ROM-8, and ROM-12. Although PCBSs were detected in soil samples from ROM-3 and ROM-12, the acute toxicity criterion was not satisfied because fish are aquatic, not terrestrial organisms.

Duration and Frequency of Exposure. The well in which alpha-BHC was found at ROM-1S taps water from a shallow zone, which may be connected to the deep aquifer that is the source of drinking water for station personnel (refer to discussion in Section 4.1). Because the contaminants of the shallow aquifer could enter the aquifer used as a source of drinking water, the duration and frequency of exposure of station personnel to alpha-BHC and TPHs via water consumption were considered sufficient to cause adverse health effects if the concentrations were high.

The duration and/or frequency of exposure of aquatic life to cadmium and PCBSs, could be adequate to potentially cause adverse effects if cadmium and PCBSs in the surface water at ROM-8 entered Fowler Creek. The geometric mean concentration of cadmium was about 3 times the ambient water quality criterion developed to protect against chronic effects. The geometric mean concentration of PCBSs was about 40 times higher than the chronic criterion. Specific information needed to estimate the degree of dilution that would occur between ROM-8 and Fowler Creek is not available. However, due to 1) the small leachate volume compared to the flow volume in Fowler Creek, 2) the relatively low AWQC exceedance of cadmium (3), and 3) the difference between this exceedance and that for PCBSs (40), it was judged that the degree of dilution required to prevent exceedance would be achieved for cadmium, but would not be achieved with certainty for PCBSs. When the exceedance of the AWQC is considered for

TPHs at ROM-8, the exceedance is several times higher (up to 266). The degree of dilution necessary to prevent exceedance in Fowler Creek would not be achieved with certainty. The exposure frequency/duration of aquatic organisms to PCBSs and TPHs was thus scored adequate to potentially cause toxic effects.

Although the concentration of TPHs in several water samples exceeded the Alaskan ambient water quality criteria for protection of aquatic life, frequency and duration of exposure in groundwater at ROM-1S and ROM-3 were scored inadequate because the kinds of aquatic organisms that the criteria were developed to protect do not live in groundwater.

4.4.6 Summary and Discussion of Two-Tiered Health and Environmental Risk Screening

Tables 4-12 and 4-13, respectively, summarize the results of the Tier I and II risk screening processes. The results indicate that chemicals in soil and water at ROM -1S and ROM-8 may present a significant risk, but that risk presented by chemicals at other sites appears to be insignificant or of uncertain risk.

The risk screening process is qualitative and may underestimate actual risk in some cases and overestimate risk in others. The results should not be used alone to dictate whether or not cleanup is necessary. When the results indicate risk is significant, confirmation should be considered. When the results indicate that risk is insignificant, the risk screening process should be examined more closely to determine if some important process that might cause risk to be significant was overlooked.

4.4.7 Identification of Sites Requiring Remedial Action

ROM-1S and ROM-8 were the only sites identified by the qualitative risk screening as requiring consideration for remedial action. However, additional requirements for remediation are represented by significant exceedance of standards or criteria. These significant exceedances at

Table 4-12. SUMMARY OF TIER I SCREENING PROCESS, CAPE ROMANZOF LRRS*

Criterion	ROM-1	ROM-1S	ROM-1D	ROM-3	ROM-4	ROM-5	ROM-8	ROM-10	ROM-12
Proximity to Biological Receptors	X	X	X	X	X	X	X	X	X
Evidence of Contamination	X	X	X	X	X	X	X	X	X
DECISION	Go to Tier II	Go to Tier II	Go to Tier II	Go to Tier II	Go to Tier II	Go to Tier II	Go to Tier II	Go to Tier II	Go to Tier II

* "X" indicates that a criterion was met.

Table 4-13. SUMMARY OF TIER II SCREENING RESULTS, CAPE ROMANZOF LRRS*

Criterion	ROM-1	ROM-1S	ROM-1D	ROM-3	ROM-4	ROM-5	ROM-8	ROM-10	ROM-12
Exposure Potential									
Contaminant Release from Site		X		X			X		
Contaminant Migration from Station	X	X	X	X	X	X	X	X	X
Environmental Persistence		X		X			X		X
Toxicity Threshold									
Exposure Duration/ Frequency		X					X		
Standard or Criterion Exceeded	X	X		X			X	X	X
Acute Toxicity				X			X		X
Estimated Risk	Not Significant	Significant	Not Significant	Not Significant	Not Significant	Not Significant	Significant	Not Significant	Not Significant

*"X" indicates criterion is satisfied.

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various sites are presented in Table 4-14. Based on these results, further consideration for remedial actions related to excessive TPHs in soil is required at all of these sites, namely ROM-1, -3, -10, and -12. The feasibility study in Section 5.0 evaluates remedial alternatives for these six sites.

Site ROM-1S contains contamination in two separate media, soil and groundwater. The groundwater medium is not well-defined and requires additional investigation to provide data sufficient for remediation consideration (see discussion in Section 4.4.8). The soil medium parameters are estimated on the basis of available data in Section 4.4.10.2; and remediation of soil at ROM-1S is considered in Section 5.3.2 and 5.5.3 (Operable Unit B).

4.4.8 Identification of Sites Requiring Further Remedial Investigation

Based on the two-tiered screening evaluation conducted in this section, the groundwater within the aquifer at ROM-1S (which likely extends southeast to include the station water supply well at ROM-3) is insufficiently defined to permit a reasonable remedial action consideration for groundwater at these sites. As shown on Figure 4-2 and discussed in Sections 4.1.3.4, 4.1.3.5, and 4.1.4.6, it is possible that the documented groundwater contamination at ROM-1S (TPHs and alpha-BHC) could be migrating southeastward toward the station water supply well in ROM-3 and could be contributing to the TPHs concentrations detected in the water supply well.

TPHs was detected in the water supply well at a concentration of 2 mg/L which is more than 100 times the Alaska AWQC aquatic life standard of .015 mg/L. However, the compounds of health risk concern within the TPHs category (namely BTEX and PAHs) were not found above detection limit in this well or in the ROM-1S wells. Also, as has been pointed out in the site risk screening discussion (Section 4.4.5.2), ambient water quality standards for aquatic life (see Table 4-10) cannot strictly be applied to groundwater, because the organisms these standards were developed to protect do not live in groundwater.

Table 4-14. SITES REQUIRING REMEDIATION BASED ON MEDIA AND CONTAMINANT, CAPE ROMANZOF LRRS

	Soil	Groundwater	Surface Water
ROM-1	TPHs		
ROM-1S	TPHs	alpha BHC	
ROM-3	TPHs		
ROM-8	TPHs		Cd PCBs TPHs
ROM-10	TPHs		
ROM-12	TPH		

Nevertheless, the data (as summarized below) suggest that there is a low likelihood of a potential health risk to station personnel (via direct ingestion from the water supply well), and possibly also an impact on aquatic life (via some eventual pathway from groundwater to surface water to Kokechik Bay), depending on dilution factors.

- TPHs concentrations of 2 mg/L are present in water supply well (ROM-3), and 4 mg/L in Well B (ROM-1S)--about 130 and 260 times, respectively, the Alaska AWQC standard .

- Alpha-BHC (a systemic insecticide and an environmentally persistent compound) is present only in Well B (ROM-1S) at a concentration about 10 times higher than Federal and Alaska AWQC Health standards.

- Piezometric level in Well B is higher than at the water supply well, but insufficient stratigraphic data are available to identify whether enough hydraulic continuity exists between these wells to permit significant migration of contamination toward the water supply well.

Considering the above-described situation in groundwater at ROM-1S/ROM-3, it is judged prudent to recommend further investigation at these sites to more completely characterize the sites' geologic and hydrogeologic parameters, and thus the potential health hazard. Since compounds of immediate health risk concern have not been detected in the station water supply well, the implementation of any Interim Remedial Measures (IRM) does not appear warranted.

Therefore, it is recommended that additional site investigations, including groundwater resampling, should be conducted at the ROM-1S/ROM 3 aquifers as soon as possible.

4.4.9 Summary of Sites Requiring No Further Action

Based on the two-tiered screening evaluation conducted in this section (Tables 4-12 and 4-13), three sites are found to have insignificant risk and do not significantly exceed regulated cleanup levels. Sites recommended for no further remedial actions include:

- ROM-1D 5099th Pit
- ROM-4 Areas of Road Oiling
- ROM-5 Area below New Landfill

4.4.10 Physical Extent of Contamination at Sites Requiring Further Remedial Action

Based on the location of samples containing contamination above the cleanup level of 100 mg/kg TPHs and visual observations during the site investigation, estimates of the areas and volumes of soils requiring remedial action at each site were made. These estimates are described below for each site and summarized in Table 4-15. The extent of contamination is shown on the attached Drawing No. 1.

4.4.10.1 ROM-1 Waste Accumulation Area. The ROM-1 contamination area was estimated to equal the approximately triangular area formed by connecting the locations of the three soil samples collected. The two legs of the triangle have lengths of 45 feet and 150 feet, respectively, for an area of 3375 square feet. A depth of contamination of 3 feet was assumed to arrive at a total volume of contaminated soil of 375 cubic yards.

4.4.10.2 ROM-1S (Soil) Large Fuel Spill. The surface soil within the area of the ROM-1S site was estimated from visual observation of dead vegetation at the site. This was an irregularly shaped area of approximately 88,200 square feet. A depth of contamination of 3 feet was assumed to arrive at a total volume of contaminated soil of 9797 cubic yards.

Table 4-15. SUMMARY OF ESTIMATED CONTAMINATED SOIL AREA AND VOLUME AT CAPE ROMANZOF LRRS

Site	Estimated Area of Contamination (square feet)	Estimate of Soil Contamination (cubic yards)
ROM-1 Waste Accumulation Area	3,375	375
ROM-1S Large Fuel Spill	88,200	9,797
ROM-3 Former Shop Area	12,600	2,104
ROM-8 Old Landfill	49,900	11,526
ROM-10 Former Truck Fill Stand	170	19
ROM-12 Former Drum Storage Area	10,300	1,907

Compiled by WCC based on field observations during Summer 1989.

4.4.10.3 ROM-3 Former Shop Area. The area of the ROM-3 contamination was estimated as the mean of the area enclosed by the grid encompassing the former shop area part of the site and the area defined by the contour of the soil gas measurements of 5 ppmV or above. The estimated area of contamination was approximately 12,600 square feet. A depth of contamination of 4.5 feet was estimated from the soil gas measurements for a total volume of contaminated soil of 2104 cubic yards.

4.4.10.4 ROM-8 Landfill. The area of ROM-8 contamination was defined by the boundaries of the landfill. The area is divided into two sections: an upper section of approximately 12,400 square feet with an estimated depth of contamination of 10 feet and a lower section of approximately 37,500 square feet and an estimated depth of contamination of 5 feet. The total area is approximately 49,900 square feet and the total volume of contaminated soil is approximately 11,526 cubic yards.

Surface water downgradient (southwest) of ROM-8 was also found to be contaminated with levels of PCBSs. Surface flow during a 4-month summer is estimated to be approximately 50 gpm for purposes of the feasibility study.

4.4.10.5 ROM-10 Former Truck Fill Stand. The area of the ROM-10 site was estimated from site maps to be a rectangle of area approximately 170 square feet. A depth of contamination of 3 feet was assumed to give a total volume of contaminated soil of 19 cubic yards.

4.4.10.6 ROM-12 Former Drum Storage Area. The area of the ROM-12 site was estimated from visual observation of the extent of stained soil. This is an irregularly shaped area of approximately 10,300 square feet. Because of the high contamination and history of use a depth of contamination of 5 feet was assumed to give a total volume of contaminated soil of 1907 cubic yards.

TAB

Section 5

5.0 FEASIBILITY STUDY FOR CAPE ROMANZOF LRRS SITES

5.1 INTRODUCTION

Section 5.0 contains the feasibility study (FS), which consists of an evaluation of remedial technologies and alternatives for the six sites identified in Chapter 4.0. The technologies are screened in Section 5.2 for technical applicability, using data about contaminants and site characteristics collected in the remedial investigation (RI). In Section 5.3 sites are grouped into Operable Units based on the nature of contamination present and similar site conditions. In Section 5.4, remedial alternatives are assembled from the technologies found to be appropriate for remedial actions as a result of the screening process. Section 5.5 evaluates the remedial alternatives. Section 5.6 compares the remedial alternatives.

This FS generally follows the outline given in the AFOEHL/TS Handbook to Support the Installation and Restoration Program (IRP) Statement of Work for Remedial Investigation/Feasibility Studies (RI/FS)," Version 2.0, 1988. Due to the remote location of Cape Romanzof, the FS focuses on remedial actions that accommodate the severe climatic, logistical, and environmental conditions specific to this site.

Weather conditions limit potential out-of-doors remedial activities to within a 3-months-per-year working window. Seasonal weather conditions also limit transportation options. When the weather is favorable, normal transportation to and from the site is limited to air service as conditions permit. Barge transport is technically feasible but highly dependent on sea and landing conditions.

Economic factors play a significant role in evaluating potential remedial actions because of the remote location of Cape Romanzof. Transportation of equipment and materials to and from the site is costly. Labor rates are high and a premium is paid for imported labor. Since the site is not accessible to local communities, labor, equipment, and most materials needed to implement remedial actions will have to be imported. While barge transport is technically feasible, air transport of remedial equipment and crews is used for the cost estimates in this report. Air transport is clearly superior to barge transport in terms of schedule flexibility, and was found to be much more economical if lease costs of equipment during the long barge transport are considered.

The fragile tundra environment of Alaska is sensitive to many types of commonly employed remedial activities (such as excavation). Therefore, remedial actions which do not cause damage to tundra are favored in the evaluation of alternatives.

5.1.1 Background and Nature of Contamination

The contamination documented in the RI Sections 1.0 through 4.0, has resulted primarily from surface spills of petroleum fuels. PCBs-containing fluids or pesticides and leaks from aboveground storage tanks and pipes have leaked from unknown sources at the landfill and large fuel spill area. Table 5-1 summarizes the identified chemical contaminants by site and gives estimated volumes of contaminated soils. The method used to estimate the volumes is presented in Section 4.4.10 of the RI. The volumes of contaminated soil by site, based on the cleanup levels developed in Chapter 4.0, range from 19 to 11,526 cubic yards. The identified contaminants consist primarily of total petroleum hydrocarbons (TPHs) in soil and surface water, and polychlorinated biphenyls (PCBs) in surface water. The petroleum-product contaminants are primarily diesel fuels which are heavy-end, nonvolatile (carbon content greater than 9) petroleum hydrocarbons. The table also identifies whether the site's soil is native tundra,

Table 5-1. SITE IDENTIFICATIONS AND DESIGNATIONS, PRIMARY CHEMICAL CONTAMINANTS AND VOLUMES OF CONTAMINATED SOIL AT CAPE ROMANZOF LRRS

Site Designation	Site Identification	Soil Type	Chemical Contaminants Above Cleanup Levels	Volume of Contaminated Soil (cu. yd)
ROM-1	Waste Accumulation Area	Fill	TPHs	375
ROM-1S	Large Fuel Spill	Native	TPHs	9,797
ROM-3	Former Shop Area	Fill	TPHs	2,104
ROM-8	Old Landfill	Fill[a]	TPHs	11,526
ROM-10	Truck Fill Stand	Disturbed Native/Fill	TPHs	19
ROM-12	Drum Storage Area	Disturbed Native/Fill	TPHs	1,907

TPH = total petroleum hydrocarbon.

[a]Remedial actions for PCBs and TPHs in surface water also pertain to this site. A surface water runoff from ROM-8 of 50 gpm is estimated to require remediation during the summer season only.

previously disturbed native soils, or introduced fill material. This distinction becomes important when discussing operable units later in Section 5.3.

5.2 PRELIMINARY ALTERNATIVE REMEDIAL ACTIONS

The purpose of this section is to identify viable alternative remedial actions for the six Cape Romanzof LRRS sites that require consideration for remediation.

5.2.1 General Response Actions

Table 5-2 is a listing of general response actions to remediate contamination at the Cape Romanzof sites.

5.2.2 Applicable Remedial Technologies

For each of the general response actions listed in Table 5-2, a list of potential remedial technologies has been identified which accomplish the response action. These potential technologies are presented for soil in Table 5-3 and for surface water in Table 5-4.

5.2.3 Initial Screening of Possible Remedial Technologies

Technologies selected for screening represent the most appropriate candidate methods for containment or extraction and treatment of contaminated soil and surface water at the Cape Romanzof LRRS sites. The criteria used to initially screen the technologies listed in Tables 5-3 and 5-4 were site conditions, waste characteristics, technical feasibility and logistics, especially as they are affected by the environmental and economic factors discussed in Section 5.1.

5.2.3.1 Soils. Technologies for the remediation of contaminated soils at Cape Romanzof are discussed in groups based on types of general response action as listed in Table 5-3.

Table 5-2. LISTING OF GENERAL RESPONSE ACTIONS FOR CAPE ROMANZOF LRRS

General Response Actions
No Action/Institutional Controls
Containment
Extraction
Onsite Treatment
Offsite Treatment
In Situ Treatment

Table 5-3. LISTING OF GENERAL RESPONSE ACTIONS AND ASSOCIATED TECHNOLOGIES FOR CONTAMINATED SOIL AT CAPE ROMANZOF LRRS

General Response Action	Associated Technology for Soil
No Action/Institutional Controls	• Fencing
Containment	• Surface Caps • Surface Covers • Surface Water Diversion Ditches
Extraction	• Excavation
On-site Treatment or Disposal	Physical • Soil Washing • Fixation • Thermal Technologies • Landfill Chemical • Reagent Oxidation Biological • Landfarming
Off-site Treatment or Disposal	• Landfill • Incineration
In Situ Treatment	Physical • Vapor Extraction • Steam Extraction • Attenuation • Fixation • Soil Washing Chemical • Photolysis Biological • Enhanced Biodegradation

Table 5-4. LISTING OF GENERAL RESPONSE ACTIONS AND ASSOCIATED TECHNOLOGIES FOR CONTAMINATED SURFACE WATER AT CAPE ROMANZOF LRRS

General Response Action	Associated Technology for Surface Water
No Action/Institutional Controls	• Long-Term Monitoring
Containment	• Hydraulic Barriers • Surface Water Diversion Ditches • Capping
Extraction	• Surface Water Collection
On-site Treatment or Disposal	Physical • Air/steam stripping • Reverse Osmosis • GAC Chemical • Reagent Oxidation • Wet Air Oxidation Biological • Collection and Disposal at Cape Romanzof Sewer Plant

No Action/Institutional Controls. This alternative would include construction of fencing as an institutional control to prevent unauthorized site access. Some natural biological degradation and dispersion of TPHs can be expected during the summer months. The no action/institutional controls alternative is considered further in this FS as a baseline comparison for other potential remedial soil technologies.

Containment. Containment of contaminated soil or other solid media is defined to include: isolation of the waste mass surface from potential direct receptors trespassing the site (as opposed to barriers such as fences which keep potential receptors from trespassing altogether); minimizing the inherent surface erosion and transport potential of the waste mass; isolation of the waste mass from the agents of surface erosion and transport, such as wind and surface runoff; isolation of the waste mass from the agents of subsurface leachate production and transport, such as groundwater and infiltrating surface water; or any combination of the above. Containment options considered to be technically feasible include surface caps, surface covers, and surface water diversion ditches.

The primary purpose of a surface cap is to minimize the infiltration of leachate-producing water through the underlying waste mass which would otherwise generate leachate. A surface cap also reduces the inherent surface erodibility and transport potential of the waste mass and serves as a barrier to direct human and animal contact. In its most essential form, a surface cap consists of a layer of low permeability material. In general, this low permeability layer could consist of a variety of materials including compacted clay, a mixture of bentonite and native soils, or impermeable synthetic membranes covered by soil. The use of synthetic membranes is favored at this site over other imported materials such as bentonite due to its relatively high "area coverage-to-weight" ratio (recall that the Cape Romanzof site is accessible to large cargoes only by aircraft and perhaps by ocean-going landing barge). The use of native soil to form the low permeability layer is less feasible due to its typically shallow extent, relatively low clay content, and its value as an environmental resource.

Installation of the synthetic membrane is preceded by placing fill to form a bedding layer over the entire site surface. The fill material for this bedding material should be sufficiently fine-grained that it will not tear or puncture the membrane and the layer should be sufficiently thick as to prevent tearing of the membrane by angular or sharp materials at the surface of the waste mass. This bedding layer is then graded to promote efficient drainage from the surface of the membrane. The native soils at the site are typically so rocky and relatively rare that this bedding layer should be supplemented by a cushion of relatively thick synthetic geotextile between the bedding soil and the membrane. The 40-to 60-mil-thick impermeable membrane is then placed in sections thermally fused together in the field.

A 12-inch-thick armor layer of fill material is then placed over flat to relatively moderately sloping areas of the membrane layer to protect the membrane from surface exposure to ultraviolet light, agents of erosion, and to human or animal activity. Since this armor layer will consist of the same rocky borrow material used for the membrane bedding layer, it should likewise be supplemented by a cushion of relatively thick geotextile between the armor layer and the membrane. This geotextile should and can be placed over all areas, including relatively steep portions, of the membrane surface since it too provides a significant measure of exposure protection to the membrane.

Potential borrow sites for bedding material which have already been extensively disturbed by excavation include the existing borrow excavation adjacent to the ROM-8 landfill and the cut slope adjacent to the airstrip. Excavated material will require rough segregation at the borrow site to remove granitoid cobbles prior to use as bedding or armor material. Material excavation, hauling, placement of fill, and site grading will utilize standard earthworking equipment and trucks sufficiently small to be transportable by air yet large enough to be reasonably productive. Synthetic membranes and geotextiles will be installed by specialists supplied by the material vendor, supplemented by general labor.

Once constructed, a surface cap becomes a passive remedial system requiring periodic visual inspection of the surface condition of the system and as-needed repair. Isolated tears or punctures of the membrane can be repaired with patches. Significant repair or replacement is not expected within a 30-year project life.

The primary purpose of a surface cover is to act as a barrier to prevent human and animal contact. A surface cover also reduces the surface erodibility and transport potential of the waste mass, but any reduction of surface water infiltration is incidental. A surface cover consists of a layer of soil, rock, or other durable material placed directly over the waste mass with a minimum of site preparation. The cover must be relatively nonerodible and reasonably difficult to remove or otherwise breach by casual, incidental human trespass and by normal animal occupation. While a wide variety of materials can be used to form a surface cover, it is expected that the surface cover will consist of a 12-inch layer of unsegregated soil and rock excavated from the borrow areas identified earlier. Construction equipment and manpower are as described earlier for surface caps. A surface cover is a passive remedial system requiring periodic visual inspection. Significant maintenance or repair of a surface cover system is not expected within a 30-year project life.

The effectiveness of a surface cover constructed of native borrow material in preventing animal contact with underlying contaminated soil is uncertain. The soil comprising the cover may prove an attractive habitat to borrowing rodents which in turn will attract predatory species. Ingestion by these predators of rodents routinely residing in contaminated soils may lead to a bioaccumulation of soil contaminants in these predators. An earthen surface cover is also inherently less effective than a low permeability surface cap in isolating the waste mass from the agents of surface erosion and transport, particularly if disturbed by animal habitation. For these reasons, earthen surface covers are not considered further in this report as a potential remedial technology.

The purpose of a surface water diversion ditch is to minimize the encroachment of run off from areas upgradient across the contaminated mass which would otherwise result in hydraulic erosion and transport or leachate-producing infiltration. A surface water diversion ditch could be constructed with hand labor and backhoes. The useful life of the ditch and the protection it provides to a subject site is improved by lining the ditch with impermeable prefabricated plastic or metal channel sections or synthetic membranes. In some instances, existing drainageways and ditches could be upgraded to design performance standards by the simple addition of a channel lining.

Surface caps and surface water diversion are considered further in this report.

Extraction. Excavation is the common method of extracting contaminated soil at and below the ground surface using conventional earthmoving equipment. Depending on the amount of material and depth of excavation, different types of equipment can be used. Excavation methods are not affected by waste types or technical requirements at this site. However, a narrow outdoor operating window limits outdoor construction to 3 months per year. Excavation will impact undisturbed areas of native vegetation at some sites. The use of excavation will result in the removal of identified contaminants, resulting in protection of the environment. Excavated soils can be treated or disposed of on site or off site. This technology is considered further.

On-site Treatment or Disposal.

Physical Methods/Soil Washing. Soil washing involves flushing excavated contaminated soil with water containing surfactants which enhance removal of hydrophobic organics adsorbed onto soil particles. This technology relies heavily on materials handling and separation technology developed by the metals mining industry. The effectiveness of washing depends primarily on soil characteristics, contaminants, degree of mixing, and the surfactant effectiveness. Although soil washing has been used for soil contaminated with organics, it is a relatively sophisticated and novel technology. Soil washing is not evaluated further in this FS.

Physical Methods/Fixation. The use of fixation technology on contaminated soil usually involves the chemical fixation or cementing of contaminants to soil particles to reduce leaching potential. Fixation of metals has been applied commercially for several years, but the effectiveness of these processes on organic contaminants is less proven. For this reason, it will not be considered further in this FS.

Physical Methods/Thermal Technologies. Thermal technology may be applied to the Cape Romanzof site contaminants either as destructive incineration or thermal treatment/volatilization for diesel-contaminated soils. Incineration is a higher temperature version of thermal treatment that is generally used to oxidize all molecular species to their theoretical limits at the temperature of the combustion chamber. Because thermal treatment can accomplish the same level of cleanup with diesel fuel contamination as incineration, and is lower cost and simpler logistically, incineration will not be considered further in this FS. Low-temperature thermal treatment volatilizes the hydrocarbon contaminants from the soil matrix and captures them for disposal or reuse as fuel. Mobile thermal units are available. Use of on-site thermal treatment of contaminated soils is considered further in this FS.

Physical Methods/On-Site Landfill. An on-site secure landfill could be constructed to hold the contaminated materials. However, this alternative is complicated by technical and permitting issues. Siting a landfill in close proximity to the Bering Sea and where the water table is high may not be acceptable to permitting authorities. Siting studies and permitting are time consuming. Public acceptance might also be difficult to obtain. For these reasons, the on-site landfill is not evaluated further in this FS.

Chemical Methods/Reagent Oxidation. Oxidants, such as ozone and hydrogen peroxide, are capable of destroying organic contaminants in soil. However, these oxidizing agents are not selective and may react with other oxidizable material in the soil. Therefore, a large amount of the oxidant may be consumed by non-hazardous organic and inorganic materials. This effect could increase chemical consumption significantly. Oxidation could also change the chemical balance of the soil if the soil is to be redeposited. Chemical oxidation may also produce byproducts which are more soluble and toxic than their parent compounds. This alternative is not further addressed in this FS because of technical immaturity.

Biological Methods/Landfarming. Landfarming is a technology which was originally developed by the petroleum industry for oily wastes and soils. Landfarming involves the physical removal of contaminated soils, their aeration on an impermeable surface, and the addition of biologically important chemicals (e.g., nutrients, water) to enhance degradation. Surficially contaminated soils can be treated in situ by irrigation, nutrient addition, and rototilling. Deeper contaminated soils must be excavated and treated above ground in a similar fashion. Because of this technology's proven effectiveness, landfarming is evaluated further in this FS.

Off-site Treatment and Disposal.

Disposal in Landfill. Off-site treatment or disposal options are limited to disposal of the contaminated soils at a hazardous waste landfill. Off-site treatment is not considered further because existing on-site technologies are expected to achieve the same results more cost effectively. The nearest hazardous waste landfill is located in Oregon. Transportation options from the site to the nearest hazardous waste landfill include periodic air transport services and possibly a barge. Barge traffic is limited to the summer months before ice precludes the use of waterways. This technology will be considered further for contaminated soil that cannot be treated using on-site methods.

Incineration. Off-site incineration would involve on-site extraction of contaminated soil but treatment would be physically located in the conterminous United States. For reasons cited above, including logistics and availability of on-site solutions, off-site incineration is not considered further in this FS.

In Situ Treatment. The use of in situ treatment technologies offers many advantages considering the remote location of Cape Romanzof LRRS and possible damage to the tundra associated with using heavy excavation equipment. In situ technologies may either be physical, chemical, or biological processes. Physical processes include vapor or steam extraction, attenuation, fixation, and soil washing. The only identified chemical process is photolysis. The only biological process identified is enhanced biodegradation.

Physical Methods/Vapor Extraction. In vapor extraction, a vacuum is applied to a grid of perforated extraction wells to remove the contaminant. Vapor extraction is applicable to contaminants with high vapor pressure, such as gasoline, and is less applicable to diesel fuel. The low permeability of the native soils also suggests it is not technically feasible. This technology is not considered further in this FS.

Physical Methods/Steam Extraction. Steam extraction is used to remove contaminants less volatile than those removable with vapor extraction. Steam is applied through a hollow shaft, the bottom of which is connected to a drill bit. The bit is used to induce thorough mixing. Vapors are continually extracted, monitored, and scrubbed. Contaminants are captured using a condenser in combination with granular activated carbon. The high-temperature injection of steam for this technology is expected to adversely affect the tundra. This technology has also not been used extensively to date and is not considered mature enough for use at this location. For these reasons, it is not considered further in this FS.

Physical Methods/Attenuation. Attenuation involves the addition of adsorbing material to the contaminated soil to reduce the contaminant's mobility. However, this technology is not a long-term or permanent solution. Typical adsorbents commonly used include organic material (such as hay, nut shells, rice hulls) which degrades over time. This degradation allows the contaminants to leach as the adsorbent degrades, and therefore this technology is not addressed further in this FS.

Physical Methods/Fixation. Fixation technology for in situ treatment is similar to aboveground fixation discussed earlier, and involves the surface and subsurface introduction of a physical or chemical binder to the soil. Although use of this technology as developed for inorganic contaminants has been successful, it has not proven effective for organic contamination. Therefore, this alternative is not further evaluated in this FS.

Physical Methods/Soil Washing. In situ soil washing technology uses the same principle as excavated soil washing, already discussed, except that the washing solution is applied to the soil in place, and then collected for treatment. Contaminated soil is washed with water containing surfactants, which enhance removal of hydrophobic organics adsorbed onto soil particles. The effectiveness of washing depends primarily upon soil characteristics, contaminants, degree of mixing, and the surfactant effectiveness. In situ soil washing is technologically less proven than soil washing on excavated soil. The degree of mixing is harder to control, and the depth of mixing is limited. In addition, hydraulic control on subsurface waters must be demonstrated to prevent inadvertent spreading of contamination and the wash water requires treatment before discharge. No successful, practical application of soil washing has been demonstrated; it will not be evaluated further in this FS.

Chemical Methods/Photolysis. The only identified in situ chemical technology to address soil contamination is photolysis. In this technology, photodegradation occurs when the contaminated soil is exposed to air and direct sunlight. This process can be enhanced by the introduction of proton donors. The typical method of treatment involves application of the proton donor, followed by tillage to expose the contaminated soil to sunlight. Considering the northerly location of the sites and the limited winter sunlight, it is doubtful that this technology will attain the goals of the remedial activities in a timely fashion. Therefore, photolysis is not considered further in this FS.

Biological Methods/Enhanced Biodegradation. Biological techniques can be applied to restore diesel-fuel-contaminated soil at the Cape Romanzof site. This would involve adjusting physical and chemical factors of the contaminated medium to stimulate metabolic activities of naturally occurring microorganisms present in the medium. Since the organic contaminants are among the most abundant organic substrates ("food") in the medium, the microorganisms will metabolize the contaminants oftentimes at rates sufficient to effectively decontaminate the medium.

Biological methods have been used for many years to treat petroleum-related contamination. In a recent pilot study it has been shown that biodegradation can be effective in an Arctic climate (WCC 1990). Generally, effective stimulation of microbial activity can be accomplished by adding oxygen and nutrients. This technology is evaluated further in this FS.

5.2.3.2 Surface water. During the RI it was discovered that surface water at one point downgradient of the ROM-8 Landfill site was contaminated with TPHs and PCBs. Information such as exact contaminant concentrations, surface water flowrates, and horizontal extent of contamination are not known. It is presumed, but not a certainty, that leachate is generated in the landfill only during summer and that treatment would be, therefore, needed during the summer months only. Each treatment technology would be coupled with a surface water collection and removal step, except in the case of containment.

Despite the lack of information about the ROM-8 site, a list of technologies identified for possible remediation of surface water contamination is assembled in Table 5-4. The identified technologies are evaluated with respect to known site conditions, cost, logistics, and climatic constraints.

No Action/Institutional Controls. This alternative would include no remedial construction combined with a long-term monitoring program, since contamination would remain at the site. Periodic water sampling and chemical testing would be done until the level of contamination was reduced below remediation levels due to natural biodegradation and dispersion. The time period for sampling and analysis would be annually for 10 years. Some natural biological degradation and dispersion of TPHs and PCBs can be expected during the summer months. The no action/institutional controls alternative is considered further in this FS as a baseline comparison for other potential remedial surface water technologies. This alternative is passive and does not effectively contribute to the long-term protection of public health and welfare or environment.

Containment (Leachate Minimization). The generation of surface water runoff from the ROM-8 Landfill which is contaminated with TPHs and PCBs may be minimized by prevention of water infiltration into the landfill. This may be accomplished by installing an overlying cap to prevent infiltration of water through the top of the landfill and by instituting hydraulic controls such as diversion ditches to prevent the infiltration or flow of surface water originating upgradient into or across the landfill. Both of these technologies are described previously as possible remedial technologies for contaminated soils and will be considered further.

Extraction (Leachate Collection). Contaminated leachate escaping the landfill as surface water (i.e., seepage from the face of the landfill) may be collected by the installation in a collection ditch downgradient of the landfill. The ditch would be provided with a sump and water would be pumped from the sump to whatever subsequent treatment process is used to remediate the contamination in the water. The sump and collection ditch would be lined with prefabricated plastic sections or a synthetic liner to prevent infiltration of collected leachate into the soil. This technology is considered further.

On-site Treatment or Disposal. Potential on-site remedial technologies for the treatment of contaminated surface water include three physical methods, two chemical methods, and biological methods.

Physical Methods/Stripping. Air/steam stripping technology involves the physical removal of primarily volatile compounds. Since the diesel and PCBs contaminants are not volatile, these technologies are not further addressed in this FS.

Physical Methods/Reverse Osmosis. Reverse osmosis is a process for removal of dissolved solids (such as seawater desalinization), and is capable of producing high-purity water. This technology can have high energy requirements, and generates a brine stream which may require disposal as a hazardous waste. This technology is not suitable for removal of TPHs and PCBs contaminants expected from the ROM-8 surface water. This technology is not discussed further in this FS.

Physical Methods/Granular Activated Carbon (GAC). GAC works well for the removal of mixed organic compounds down to nondetectable levels in the liquid phase. This technology is well suited to the treatment of the low levels of PCBs and TPHs present in the surface water at this site. The technology is also operationally simple consisting of fixed beds of GAC. If dissolved organic content in the surface water is high, then carbon consumption will be high. This technology will be evaluated further.

Chemical Methods/Reagent Oxidation. Reagent oxidation involves the introduction of hydrogen peroxide or ozone to the contaminated water and contaminant removal by off-gasing. The ability to chemically oxidize low levels of PCBs to nontoxic products has not been well demonstrated. This is also a relatively complex technology considering the remote site location. This technology will not be considered further.

Chemical Methods/Wet Air Oxidation. Wet air oxidation is a process for destroying soluble liquid contaminants that are less amenable to biological or thermal destruction. The waste stream is mixed with air at temperatures from 350-750°C and pressures as high as 2000 psi. Organic compounds are oxidized to CO_2, H_2O, and some low-molecular-weight organics such as aldehydes, acetone, and acids. Use of this technology is appropriate when the organic contaminant concentrations are in the 1-10 percent range. This technology is not evaluated further in this FS because the organic contaminant concentrations at all but one site fall far below this range.

Biological Methods. The contaminated surface water could be collected and discharged to the Cape Romanzof LRRS sewer plant. Biological technologies rely on the utilization by biological organisms of the contaminants as a food source. Sufficient dissolved organic compounds must be present in the water to be treated to sustain biological growth. It is likely that additional nutrients would have to be added for treatment of the surface water at this site. In addition, the use of biological technologies to treat low levels of PCBs has not been well demonstrated. For the highly chlorinated PCBs (Aroclor 1260) it is likely that a very complex process consisting of both anaerobic and aerobic biological treatment would be required. The Cape Romanzof LRRS Sewer Plant is a small facility not designed for treatment of low levels of TPHs or PCBs or for the quantity of surface water which may require treatment. Therefore, extraction and disposal with biological methods at the installation sewer plant is not further addressed in this FS.

5.3 OPERABLE UNITS

The concept of operable units has been developed in this FS to provide a logical division of site contamination problems. An operable unit is defined as a distinct action or set of actions which can be taken within the overall remedial action program and which effectively moves toward, but does not necessary complete nor preclude, future site remediation activities.

For this FS, four distinct operable units have been defined to address soil contamination at disturbed native soil or fill sites, soil contamination at undisturbed native soil sites, combined soil contamination and surface water contamination at landfill sites, and soil contamination at landfill sites. The operable unit concept is applicable at this installation because of the nature of the contamination problem and, in general, the ability to separate remedial actions addressing each typical situation. A no action alternative and a number of distinct remedial actions are defined for each operable unit. The evaluation of each alternative for an operable unit generally assumes that there is no dependence upon the alternatives selected for other operable units. This approach provides for an even-handed analysis of each alternative and is, for the most part, representative of the actual approach that will be used for site remediation. It is recognized, however, that interrelationships between alternatives from different operable units may exist. These interrelationships must be considered in final selection of remedial technologies and detailed engineering of a remedial action plan for this installation.

The four operable units have been labeled with letters (A, B, C, and D). Alternatives within each operable unit are numbered with the appropriate letter following.

5.3.1 Operable Unit A - Disturbed Native Material/Fill

Sites in this operable unit have been selected based on the nature of the existing soils. Cape Romanzof LRRS consists of various buildings, roads, and pads to facilitate site operations. In these areas, the native tundra has been previously disturbed or overlaid with fill material, and excavation activities to remove contamination could proceed without further damage to the native tundra. Sites included in Operable Unit A include ROM-1 Waste Accumulation Area, ROM-10 Former Truck Fill Stand, and ROM-12 Former Drum Storage Area.

5.3.2 Operable Unit B - Undisturbed Native Soils

The site in this operable unit has an intact tundra ground cover. Alternatives developed for this operable unit are designed to minimize further disruptions to the tundra. The site contained in this operable unit is the ROM-1S Large Fuel Spill Area.

5.3.3 Operable Unit C - Landfill

This operable unit was developed to address technologies specific to soil and surface water contamination at the ROM-8 Landfill. Remedial alternatives developed for this operable unit must address both the soil contamination with TPHs and the surface water contamination with TPHs and PCBs. It is assumed that existing landfill volumes will be left undisturbed for this site.

For the surface water, it is assumed that if leachate collection and treatment is conducted that the treated surface water will be disposed of at the site. This discharge option is the most technologically simple, since it does not require additional piping off site. Construction activities for piping installation may disturb tundra growth. Reinjection or surface disposal would require approval from the Alaska Department of Environmental Conservation (ADEC).

5.3.4 Operable Unit D - Former Shop Area

The site in this operable unit consists of a site containing mixed soil and debris resulting from use of the area as a disposal site. In this area previous excavation has occurred and the area has been filled in with solid waste from site activities. It is assumed that the existing landfill volume would be left undisturbed for this site. The site included in this operable unit is ROM-3 Former Shop Area.

5.4 REMEDIAL ALTERNATIVES

Remedial alternatives were prepared for each of the Operable Units A, B, C, and D from the screened technologies found to be suitable for remediation at the Cape Romanzof site. A list of preliminary alternative remedial actions and an initial screening of these remedial alternatives are given in Table 5-5. This screening was used to develop the list of remedial alternatives for each Operable Unit given in Table 5-6. These

Table 5-5. PRELIMINARY SCREENING OF REMEDIAL ALTERNATIVES AT CAPE ROMANZOF LRRS

Remedial Alternative	Operable Unit A Disturbed Native Soils or Fill	Operable Unit B Undisturbed Native Soils	Operable Unit C Old Landfill	Operable Unit D Former Shop Area
No Action/Institutional Controls	Retained	Retained	Retained	Retained
Capping	Retained	Eliminated due to negative impact on tundra	Not Applicable	Retained
Capping and Hydraulic Controls	Not Applicable	Not Applicable	Retained	Not Applicable
Capping and Surface Water Collection/Treatment	Not Applicable	Not Applicable	Retained	Not Applicable
Excavation/On-site Thermal Treatment	Retained	Eliminated due to negative impact on tundra	Eliminated due to negative environmental/health impact of disturbing landfill	Eliminated due to negative environmental/health impact of disturbing landfill
Excavation/On-Site Landfarming	Retained	Eliminated due to negative impact on tundra	Eliminated due to negative environmental/health impact of disturbing landfill	Eliminated due to negative environmental/health impact of disturbing landfill
Excavation/Disposal at Off-site Landfill	Eliminated due to exorbitantly high costs relative to similarly effective on-site alternatives	Eliminated due to negative impact on tundra and high cost	Eliminated due to negative environmental/health impact of disturbing landfill	Eliminated due to negative environmental/health impact of disturbing landfill
In Situ Enhanced Biodegradation	Eliminated due to more effective landfarming alternative	Retained	Eliminated due to negative environmental/health impact of increased leachate production	Eliminated due to negative environmental/health impact of increased leachate production

Table 5-6. REMEDIAL ALTERNATIVES BY OPERABLE UNIT AT CAPE ROMANZOF LRRS

OPERABLE UNIT A - DISTURBED NATIVE SOILS OR FILL

ROM-1 Waste Accumulation Area, ROM-10 Former Truck Fill Stand, and ROM-12 Former Drum Storage Area

1A - No Action/Institutional Controls
2A - Capping
3A - Excavation/On-Site Thermal Treatment
4A - Excavation/On-Site Landfarming

OPERABLE UNIT B - UNDISTURBED NATIVE SOILS

ROM-1S Large Fuel Spill

1B - No Action/Institutional Controls
2B - In Situ Enhanced Biodegradation

OPERABLE UNIT C - LANDFILL

ROM-8 Landfill

1C - No Action/Institutional Controls
2C - Capping with Hydraulic Controls
3C - Capping with Collection and On-site Treatment of Surface Water

OPERABLE UNIT D - FORMER SHOP AREA

ROM-3 Former Shop Area

1D - No Action/Institutional Controls
2D - Capping

Note: Numbers distinguish between alternatives only. No priority ranking is intended or implied.

remedial alternatives will be evaluated in detail in the following section. Criteria used for screening of technologies to develop the remedial alternatives were those identified in the AFOEHL/TS Handbook (Version 2.0, 1988) for Phase II screening of alternatives.

5.5 DETAILED ANALYSIS OF REMEDIAL ALTERNATIVES

5.5.1 Introduction

This section evaluates the remedial alternatives developed in the previous section, using criteria listed in the AFOEHL/TS Handbook (Version 2.0, 1988). These criteria include:

- Compliance with cleanup standards
- Protection of human health and the environment
- Technical feasibility
- Implementation logistics
- Reduction of toxicity, mobility, and volume
- Long-term effectiveness
- Institutional requirements
- Cost-effectiveness

For each operable unit, this section presents a process description, cost estimate, and noncost evaluation for the remedial alternatives expected to be effective for contamination present at sites within the operable unit.

The process description describes the steps required to implement each alternative. The cost analysis is presented in tabular form using 1990 dollars as a basis. The noncost summary is also presented in tabular form, discussing the criteria listed above except cost. The last section compares the alternatives in terms of the evaluation criteria and cost.

A list of cost assumptions common to various alternatives is found in Appendix D. Cost assumptions pertaining to a particular remedial alternative are discussed in the section on that alternative.

5.5.2 Operable Unit A

This operable unit is for ROM-1 Waste Accumulation Area, ROM-10 Former Truck Fill Stand, and ROM-12 Former Drum Storage Area. The contaminated soil here is previously disturbed native soil material. The estimated volume of contaminated soil totals 2301 yd^3 for the three sites. The site surface areas for ROM-1, ROM-10, and ROM-12 are approximately 3400 ft^2, 200 ft^2, and 10,300 ft^2, respectively.

5.5.2.1 Alternative 1A - No Action/Institutional Controls. This alternative consists of fencing the contaminated sites as an institutional control to deter people and wildlife from entering. Natural degradation of hydrocarbons is expected to occur, although slowly, due to the short summer season when the average high temperature is approximately 50°F.

Fence material would be transported from Anchorage. The linear feet of fencing was estimated from the areal extent of contamination estimate presented in the RI discussion. The fence would be installed using imported labor.

A cost estimate is given in Table 5-7. Table 5-8 discusses this alternative in terms of the noncost evaluation criteria.

5.5.2.2 Alternative 2A - Capping. This alternative includes the installation of low-permeability surface caps and construction of surface water diversion ditches.

Once the sites have been cleared and rough graded, a 6-inch-thick bedding layer of soil will be placed and fine graded. The borrow site for bedding and armor material at ROM-1 will be the existing borrow excavation

Table 5-7. COST SUMMARY FOR ALTERNATIVE 1A - NO ACTION/INSTITUTIONAL CONTROLS. SITES: ROM-1 WASTE ACCUMULATION AREA, ROM-10 FORMER TRUCK FILL STAND, AND ROM-12 FORMER DRUM STORAGE AREA

Item	Quantity	Unit Rate ($)	Total $
Labor			
Fence installation, 2 people	228 hrs	$50/hr	$11,400
Transportation			
Air charter to transport equipment and materials to site	1	18,000	18,000
Air charter to remove equipment from site	1	9,000	9,000
Round trip labor from Anchorage	2	900	1,800
Material			
1021 linear feet of chainlink fence, posts, and concrete	1,021 LF	8/LF	8,170
Equipment			
Drill rig on crawler	2 weeks	2,450/wk	4,900
Air Compressor	2 weeks	300/wk	600
Concrete Mixer	2 weeks	140/wk	280
Pickup Truck	2 weeks	250/wk	500
SUBTOTAL			$54,650
20% CONTINGENCY			10,930
TOTAL			$65,580

Table 5-8. EVALUATION CRITERIA SUMMARY FOR ALTERNATIVE 1A - NO ACTION/INSTITUTIONAL CONTROLS

Compliance with Cleanup Standards	Does not meet the proposed cleanup standard for TPHs in soil.
Protection of Human Health and the Environment	Human access and access of large wildlife would be deterred by fencing, but no other mitigation of impact to the environment occurs.
Technical Feasibility	Feasible.
Implementability/Logistics	Implementable, material and equipment requirements are minor for this alternative.
Reduction of Toxicity, Mobility, and/or Volume	No reduction of toxicity, mobility, or volume of contaminants would occur as a result of this remedial alternative.
Long-term Effectiveness	The time required for natural degradation of TPHs contaminants cannot be predicted, but is expected to be several decades.
Institutional Requirements	None

adjacent to ROM-8, located approximately 3600 feet distant, and the borrow site for ROM-10 and ROM-12 will be the cut slope adjacent to the airstrip, located, on average, approximately 6800 feet distant. Upon completion of the bedding layer, heavy-duty geotextile (16-oz Polyfelt or equivalent) will be placed followed in turn by a 60-mil high density poly (HDPE) membrane, another layer of geotextile, and a 12-inch-thick armor layer of soil. Diversion ditches lined with HDPE membrane or similar low-permeability material will then be constructed to convey off-site runoff around the individual sites.

For cost-estimating purposes, it is estimated that the construction equipment used will include a wheel mounted backhoe/front end loader (Case 580 or equivalent) for excavation of borrow material and diversion ditches; a relatively small wheel-mounted front-end loader (Caterpillar 910 or equivalent) for site clearing, grading, and spreading of bedding and armor material; and a 12-cubic-yard end dump truck for hauling borrow material to the individual sites and for miscellaneous duties. These types of equipment have been selected to balance field productivity with air transportability. All equipment, materials, and personnel will be flown to the site from Anchorage. It is estimated that two flights each by L-100 Super Hercules air freighters will be required for transport in and out. It is estimated that earthworking will require a crew of five, later supplemented by two technicians supplied by the geofabric and membrane manufacturer for the installation of these materials. With these estimates it is expected that approximately 10 to 14 days will be required to construct the surface caps and drainage improvements.

A cost estimate for this alternative appears in Table 5-9. Table 5-10 discusses this alternative in terms of the noncost evaluation criteria.

5.5.2.3 <u>Alternative 3A - Excavation/On-Site Thermal Treatment</u>. This alternative consists of five major steps: shipment of the thermal treatment unit, equipment setup, excavation of the soil, treatment, and

Table 5-9. COST SUMMARY FOR ALTERNATIVE 2A - CAPPING SITES: ROM-1 WASTE ACCUMULATION AREA, ROM-10 FORMER TRUCK FILL STAND, AND ROM-12 FORMER DRUM STORAGE AREA

Item	Quantity	Unit Rate ($)	Total $
Heavy Equipment Rental Backhoe/front end loader (Case 580 or equivalent)	1 mo	$3,000	$3,000
Front end loader (Caterpillar 910 or equivalent)	1 mo	3,000	3,000
End dump truck, 12 cy capacity (Mack 400 CM or equivalent)	1 mo	3,000	3,000
Transportation Charges Four round trips by Super Hercules L-100 aircraft to transport equipment, materials and main construction crew to and from Anchorage - Cape Romanzof	4 round-trips	18,000	72,000
Charter flight to transport geotextile/membrane installation specialists Anchorage - Cape Romanzof	2 persons	900	1,800
Contractor labor costs for mobilization and demobilization	L.S.	10,000	10,000
Site Preparation (Includes clearing and rough grading) Labor costs	50 hr	50/hr	2,500
Equipment Operation costs	30 hr	10/hr	300
Placement of 6-in. Bedding Layer, includes borrow excavation, hauling, and backfilling. Labor costs	100 hr	50/hr	5,000
Equipment operation costs	60 hr	10/hr	600

Table 5-9. COST SUMMARY FOR ALTERNATIVE 2A - CAPPING SITES: ROM-1 WASTE ACCUMULATION AREA, ROM-10 FORMER TRUCK FILL STAND, AND ROM-12 FORMER DRUM STORAGE AREA (concluded)

Item	Quantity	Unit Rate ($)	Total $
Placement of 16-oz. Geotextile Layers			
Labor costs	75 hr	50/hr	3,750
Material costs (includes labor cost of specialist)	27,600 ft^2	0.40/ft^2	11,040
Placement of 60-mil HDPE Membrane			
Labor costs	70 hr	50/hr	3,500
Material costs (includes labor cost of specialist)	13,800 ft^2	1.10/ft^2	15,180
Placement of 12-inch Armor Layer			
Labor costs	200 hr	50/hr	10,000
Equipment Operation Costs	60 hr	10/hr	600
Construction of Lined Surface Water Diversion Ditches	L.S.	8,000	8,000
SUBTOTAL			$153,270
20% CONTINGENCY			30,650
CONSTRUCTION COST TOTAL			$183,920

Table 5-10. EVALUATION CRITERIA SUMMARY FOR ALTERNATIVE 2A - CAPPING

Compliance with Cleanup Standards	Does not meet the proposed cleanup standard for TPHs in soil.
Protection of Human Health and the Environment	Surface migration and hydraulic subsurface migration of contaminants will be significantly reduced by the addition of a low-permeability cap and surface water diversion. Human and wildlife intrusion will be deterred by the presence of the cap.
Technical Feasibility	Utilizes standard construction equipment and techniques. Site conditions are amenable.
Implementability/Logistics	All construction personnel, equipment, and liner materials must be transported to site by air. Little logistical support currently on site. Nearby potential borrow sources and access roads are available. No significant maintenance of remedial systems is expected to be required within 30 years.
Reduction of Toxicity, Mobility, and/or Volume	Since this alternative does not include treatment, reduction of contaminant toxicity and/or volume is not accomplished. Contaminant mobility is reduced by the cap.
Long-Term Effectiveness	Addition of geotextile layers is expected to be effective in preventing puncturing of liner. Little risk of liner puncturing due to human or animal intrusion. Liner ability to withstand cold and freeze/thaw cycles has had limited testing. Expected life of liner is not known but is estimated to be greater than 30 years. Surface water diversion is expected to be effective for the foreseeable future. The time required for natural degradation of TPHs is increased by reducing surface water and air infiltration/gas exfiltration. While the time for complete degradation cannot be predicted, it is expected to be at least many decades.
Institutional Requirements for Implementation of Remedial Alternative	None

demobilization of the treatment unit. The equipment comes partially disassembled on four separate trailers. The units would be transported by air from Anchorage. Approximately 1 week is required to assemble the unit. Operating personnel are supplied with the unit and would be responsible for assembly.

The contaminated soil would be excavated using equipment contracted from Anchorage, with operators. A gas chromatograph would be used on site to screen soil samples and guide the excavation work. Supervising personnel would be used to oversee the excavation work and operate the gas chromatograph.

The excavated material would be fed into the low-temperature thermal treatment unit at a rate of 7½ tons per hour. The unit would be operated 24 hours a day until all the soil is treated, approximately 530 hours. The unit requires supplementary propane gas fuel, 460 volt 3-phase power, and a 10-gpm water supply. The cost for treatment includes air pollution abatement equipment.

After treatment, the equipment would be disassembled in 1 week and readied for shipment back to Seattle.

The cost estimate for this alternative is presented in Table 5-11. A discussion of noncost evaluation criteria for this alternative is found in Table 5-12.

5.5.2.4 Alternative 4A - Excavation/On-Site Landfarming. This alternative would involve the following activities. The total volume of contaminated soil estimated to be present at the three sites (2301 yd^3) would be excavated and spread on site over a plastic-lined pad (approximate pad dimensions: 220 ft x 220 ft). A gas chromatograph would be used at the sites to screen soil samples and guide the excavation work. The excavated sites would be backfilled with clean fill obtained elsewhere on site.

Table 5-11. COST SUMMARY FOR ALTERNATIVE 3A - ON-SITE THERMAL TREATMENT SITES: ROM-1 WASTE ACCUMULATION AREA, ROM-10 FORMER TRUCK FILL STAND, AND ROM-12 FORMER DRUM STORAGE AREA

Item	Quantity	Unit Rate ($)	Total $
Labor			
Excavation confirmation sampling/Treatment oversight	480 hr	$95/hr	$45,600
Soil excavation contractor	756 hr	50/hr	37,800
Equipment			
Backhoe	2 mo	2,400/mo	4,800
Bulldozer	2 mo	3,000/mo	6,000
Loader	2 mo	4,000/mo	8,000
Dump Truck	2 mo	3,000/mo	6,000
LTTS stand by	1 wk	19,000/week	19,000
Propane tank car rental (7 tanks)	3 mo	9,500/mo	28,500
GC for excavation confirmation sampling	14 day	1,500/day	21,000
Treatment Costs LTTS operation (includes operating labor, per diem.)	4,350 ton	100/ton	435,000
Propane fuel	65,000 gal	0.65/gal	42,250
Transportation Costs			
LTTS and Excavation equipment Air charter	8 round trips	27,000	216,000
Labor transport from Anchorage round trip	5	900	4,500
Sample Shipment, Cape Romanzof to RMAL (Excavation confirmation sampling)	8 coolers	120/cooler	960
Per Diem			
Excavation confirmation sampling and treatment oversight	60 day	10/day	600
Lab Analysis TPHs	100 samples	75/sample	7,500
SUBTOTAL			$ 883,510
20% CONTINGENCY			176,700
TOTAL			$1,060,210

RMAL - Rocky Mountain Analytic Lab
LTTS - Low Temperature Thermal Treatment Unit
GC - Gas Chromatograph

Table 5-12. EVALUATION CRITERIA SUMMARY FOR ALTERNATIVE 3A - EXCAVATION/ON-SITE THERMAL TREATMENT

Compliance with Cleanup Standards	Meets the proposed cleanup standard for TPHs in soil.
Protection of Human Health and the Environment	TPHs contamination would be removed from the soil by volatilization, resulting in protection of human health and the environment.
Technical Feasibility	Low temperature thermal treatment units are not subject to stringent operating condition requirements since they only need to volatilize contaminants, not destroy them. Incinerators and thermal treatment units are proven technologies in the hazardous waste treatment field.
Implementability/Logistics	Thermal treatment unit not routinely available in Alaska. Special mobilization of unit to Alaska from mainland probable. All equipment, personnel, and supplies must be flown in and out of site.
Reduction of Toxicity, Mobility, and/or Volume	Reduces the toxicity, mobility and volume of the TPHs contaminants in the soil. Concentrations of TPHs below proposed cleanup levels would remain in the soil at the site.
Long-term Effectiveness	The contaminants above proposed cleanup criteria would be removed from the site permanently.
Institutional Requirements	Air emissions from the thermal treatment unit would be regulated.

The excavated soils would be spread over the pad to a depth of 18 inches. The soil would be irrigated to a moist level with a water solution containing a dilute mixture of inorganic nutrients and a biodegradable emulsifying agent. The soil would then be rototilled on a biweekly basis, and irrigated as needed to maintain soil moisture. These activities would continue through the summer.

The initial soil excavation and treatment would be done with equipment and labor imported from Anchorage. The ongoing soil treatment would be done using labor imported from Anchorage. Supervising personnel would oversee excavation and the initial soil treatment.

At the beginning and end of the summer treatment, the soils would be sampled statistically to evaluate the degree of contaminant reduction achieved during the first summer of treatment. If contaminant levels have not declined below the proposed cleanup level for TPHs in soils of 100 mg/kg, the soils would be covered with heavy-duty black plastic sheeting, and active treatment would be suspended until the next summer. The annual cycle would continue until the target level had been attained. At that time, the treated soil would be deposited and spread over a suitable location at the site.

Treatment effectiveness is anticipated to be high due to contaminant loss through enhanced volatilization and biodegradation. Aeration (through rototilling) would enhance both forms of contaminant loss, while nutrient supplements and emulsifier addition would enhance biodegradation in the contaminated soil. Treatment could be satisfactory in as little as one summer, although one or more additional seasons of treatment may be required.

Table 5-13 summarizes the anticipated costs for two summers' treatment associated with this alternative, and Table 5-14 discusses the noncost evaluation criteria.

Table 5-13. COST SUMMARY FOR ALTERNATIVE 4A - EXCAVATION/ON-SITE LANDFARMING. SITES: ROM-1 WASTE ACCUMULATION AREA, ROM-10 FORMER TRUCK FILL STAND, AND ROM-12 FORMER DRUM STORAGE AREA

Item	Quantity	Unit Rate ($)	Total $
First Year Costs			
Labor			
Soil treatment	240 hr	$50/hr	$12,000
Oversight	176 hr	95/hr	16,720
Excavation Contractor	756 hr	50/hr	37,800
Equipment Rental			
Backhoe for excavation	1 mo	2,400/mo	2,400
Dumptruck for hauling	1 mo	4,000/mo	4,000
Bulldozer for spreading	1 mo	3,000/mo	3,000
Loader	1 mo	3,000/mo	3,000
GC for confirmation sampling	14 day	1,500/day	21,000
Transportation			
Air charter for equipment transport	2 trips	18,000/trip	36,000
Labor transport from Anchorage, roundtrip	13	900	11,700
Sample shipment, Cape Romanzof to RMAL	10 coolers	120/cooler	1200
Per Diem Oversight Labor	30 day	10/day	300
Materials			
Treatment chemicals	2,301/yd^3	22/yd^3	50,620
Fuel for equipment			3,500
Chemical distribution system supplies			1,500
Plastic sheet for landfarm areas	53,843 ft^2	$0.0432/ft^2	2,330
Purchase Rototiller			3,000
Analysis (TPHs)			
End-of-year sampling	20 samples	75/sample	1,500
Excavation confirmation sampling	100 samples	75/sample	7,500
SUBTOTAL FIRST YEAR			$219,070

Table 5-13. COST SUMMARY FOR ALTERNATIVE 4A - EXCAVATION/ON-SITE LANDFARMING. SITES: ROM-1 WASTE ACCUMULATION AREA, ROM-10 FORMER TRUCK FILL STAND, AND ROM-12 FORMER DRUM STORAGE AREA (concluded)

Item	Quantity	Unit Rate ($)	Total $
Second Year Costs			
Labor			
Soil Treatment	240 hr	$50/hr	$12,000
Oversight/Sampling	96 hr	95/hr	9,120
Contractor labor	300 hr	50/hr	15,000
Equipment Rental			
Bulldozer	1 mo	3,000/mo	3,000
Loader	1 mo	3,000/mo	3,000
End dump	1 mo	3,000/mo	3,000
Transportation			
Air charter for equipment transport	2 trips	18,000/trip	36,000
Air charter transport treatment supplies	1 trip	9,000/trip	9,000
Labor transport round trip from Anchorage	12	900	10,800
Sample shipment, Cape Romanzof to RMAL	2 coolers	120/cooler	240
Per Diem Oversight Labor	14 day	10/day	140
Materials			
Treatment chemicals	2,301/yd^3	22/yd^3	50,620
Equipment fuel			1,500
Analysis (TPHs)			
Start-, End-of-year sampling	40 samples	75/sample	3,000
SUBTOTAL SECOND YEAR			$156,420
Discount Factor[a]			0.95
SUBTOTAL DISCOUNTED SECOND YEAR COSTS			$148,600
FIRST YEAR COSTS			219,070
SUBTOTAL PROJECT COSTS			$367,670
20% CONTINGENCY			73,530
TOTAL PROJECT COSTS 1990 BASIS			$441,200

[a] Discount rate of 5%

RMAL - Rocky Mountain Analytic Lab

GC - Gas Chromatograph

Table 5-14. EVALUATION CRITERIA SUMMARY FOR ALTERNATIVE 4A - EXCAVATION/ ON-SITE LANDFARMING

Compliance with Cleanup Standards	Complies with the cleanup standards for TPHs in soils.
Protection of Human Health and the Environment	Protection of human health and the environment is achieved when degradation below clean-up levels occurs.
Technical Feasibility	Petroleum products have been degraded successfully, even in cool climates. However, duration of remediation will be longer than in a temperate region.
Implementability/ Logistics	Major equipment and machinery required must be imported.
Reduction of Toxicity, Mobility, and/or Volume	Reduces toxicity and volume; mobility enhanced when TPHs volatilized and reduced when TPHs is biodegraded. Low levels of TPHs below cleanup levels may remain in back-filled soils.
Long-term Effectiveness	Effective, contaminants destroyed by microbial metabolism. Residual TPHs potentially less mobile, since organic material created by microbial action may bind the contaminants.
Institutional Requirements	Air permit may be required, since some contaminants will be volatilized during rototilling operation.

5.5.3 Operable Unit B

This operable unit is for ROM-1S Large Fuel Spill. The contaminated soil here is undisturbed native tundra. The estimated total volume of contaminated soil is 9797 yd^3.

5.5.3.1 Alternative 1B - No Action/Institutional Controls. This alternative consists of fencing the contaminated site as an institutional control to deter people and wildlife from entering. Natural degradation of hydrocarbons is expected to occur, although slowly, due to the short summer season when the average high temperature is approximately 50°F.

Fence materials would be transported from Anchorage. The linear feet of fencing was calculated from the areal extent of contamination presented in the RI discussion. The fence would be installed using imported labor.

A cost estimate is given in Table 5-15. Table 5-16 discusses this alternative in terms of the noncost evaluation criteria.

5.5.3.2 Alternative 2B - In Situ Enhanced Biodegradation. This alternative would involve the following activities. The contaminated tundra area would be sprayed on an annual basis during the start of summer season with a dilute solution of emulsifier and on a biweekly basis during the summer with a solution of inorganic nutrients. The soil treatment would be done using imported labor. Supervising personnel would oversee the first treatment application and collection of samples at the start and end of each summer. The nutrient/emulsifier solution would be sprayed from the high-elevation end of the spill area using a pump-and-hose system. Irrigation activities would only wet the affected soils, not saturate them. Emphasis would be placed on irrigating those areas within the site exhibiting indications of excessive contamination (i.e., dead vegetation), and the surface flow channels through which the spilled fuel originally passed. It is assumed that 4 months of treatment would be conducted each year.

Table 5-15. COST SUMMARY FOR ALTERNATIVE 1B - NO ACTION/INSTITUTIONAL CONTROLS. SITE: ROM-1S LARGE FUEL SPILL

Item	Quantity	Unit Rate ($)	Total $
Labor			
Fence installation	400 hr	$50/hr	$20,000
Equipment			
Drill rig on crawler	3 wk	2,450/wk	7,350
Air compressor	3 wk	300/wk	900
Concrete mixer	3 wk	140/wk	420
Pickup truck	3 wk	250/wk	750
Material			
1800 linear feet of chainlink fence, posts, and concrete	1,800 LF	8/LF	14,400
Transportation			
Air charter to transport equipment and materials to site	1	18,000	18,000
Air charter to remove equipment from site	1	9,000	9,000
Round trip labor from Anchorage	2	900	1,800
SUBTOTAL			$72,620
20% CONTINGENCY			14,520
TOTAL			$87,140

Table 5-16. EVALUATION CRITERIA SUMMARY FOR ALTERNATIVE 1B - NO ACTION/ INSTITUTIONAL CONTROLS

Compliance with Cleanup Standards	Does not meet the proposed cleanup standard for TPHs in soil.
Protection of Human Health and the Environment	Human access and access of large wildlife would be deterred by fencing, but no other mitigation of impact to the environment occurs.
Technical Feasibility	Feasible.
Implementability/Logistics	Implementable, materials and equipment requirements are minor for this alternative.
Reduction of Toxicity, Mobility, and/or Volume	No reduction of toxicity, mobility, or volume of contaminants would occur as a result of this remedial alternative.
Long-term Effectiveness	The time required for natural degradation of TPHs contaminants cannot be predicted, but is expected to be several decades.
Institutional Requirements for Implementation of Remedial Alternative	None

At the beginning and end of the summer treatment, the effectiveness of the first summer of treatment in this area would be assessed by performing a statistically designed sampling program where soil samples would be collected and analyzed for TPHs. Observations of revegetation would also be recorded. Treatment in the area would continue each summer until the concentration of TPHs declined below the proposed cleanup level of 100 mg/kg.

Treatment effectiveness is difficult to predict. Since the treatment is applied to the surface of the tundra, subsurface contamination may persist for extended periods because this treatment approach does very little with respect to enhancing subsurface microbial activities. In the cost analysis, it is assumed that 5 years of treatment would be necessary to restore this area.

A cost estimate for this alternative appears in Table 5-17. A discussion of the noncost evaluation for this alternative is found in Table 5-18.

5.5.4 Operable Unit C

This operable unit is ROM-8 Old Landfill. At this site, the soil is contaminated with TPHs and in addition the surface water runoff is contaminated with PCBs and TPHs. The estimated total volume of contaminated soil is 11,526 yd^3. The surface area of the site (horizontal projection) is approximately 50,000 ft^2. The quantity of surface water runoff is not well-defined, though an estimate of 50 gpm is used in this report. This run off is assumed to occur for 4 months during the summer period of each year.

5.5.4.1 Alternative 1C - No Action. This alternative consists of fencing the contaminated sites to deter people and animals from entering. Natural degradation of TPHs is expected to occur, although slowly due to the short summer season when the average high temperature is approximately 50°F.

Table 5-17. COST SUMMARY FOR ALTERNATIVE 2B - IN SITU ENHANCED BIODEGRADATION. SITE: ROM-1S LARGE FUEL SPILL

Item	Quantity	Unit Rate ($)	Total $
Recurring Yearly Costs For ROM-1S Large Spill Site			
Labor			
Soil treatment	240 hr	$50/hr	$12,000
Supervision/sampling	16 hr	95/hr	1,520
Transportation			
Sample shipment, Cape Romanzof to RMAL	2 coolers	120/cooler	240
Round trip labor from Anchorage	11	900	9,900
Air charter shipment of treatment chemicals	1	9,000	9,000
Materials			
Treatment chemicals	9,797 yd^3	22/yd^3	215,530
Lab Analysis (TPHs)	14 samples	75/sample	1,050
YEARLY TOTAL			$249,240
Present cost discount factor for 5-year program			4.42
1990 Present cost of 5-year program[a]			$1,101,640
One Time First Year Initial Costs			
Labor			
Supervision	16 hr	95/hr	1,520
Sampling	16 hr	50/hr	800
Transportation			
Round trip labor from Anchorage	2	900	1,800
Sample shipment, Cape Romanzof to RMAL	1 cooler	120/cooler	120

Table 5-17. COST SUMMARY FOR ALTERNATIVE 2B - IN SITU ENHANCED BIODEGRADATION. SITE: ROM-1S LARGE FUEL SPILL (concluded)

Item	Quantity	Unit Rate ($)	Total $
Lab Analysis (TPHs)	14 samples	75/sample	1,050
Initial Expenses for Equipment and Supplies			1,500
SUBTOTAL			$1,108,430
20% CONTINGENCY			221,690
TOTAL PROJECT COSTS 1990 BASIS			$1,330,120

[a] Present worth of annuity, continuous compounding equals $\frac{(e^{rn}-1)}{re^{rn}}$, where n = 5 years and r = 5%.

Table 5-18. EVALUATION CRITERIA SUMMARY FOR ALTERNATIVE 2B - IN SITU ENHANCED BIODEGRADATION

Compliance with Cleanup Standards	If effectively implemented, meets proposed cleanup standards for TPHs in soils.
Protection of Human Health and the Environment	Protective of human health, minimal impact to native tundra occurs during treatment. Protection of the environment is achieved when degradation below cleanup levels occurs.
Technical Feasibility	Petroleum products have been degraded successfully by in situ biodegradation, even in cool climates. However, duration of remediation will be longer than in a temperate region, and final effectiveness is not known.
Implementability/ Logistics	Minimal equipment and chemicals are required for this technology.
Reduction of Toxicity, Mobility, and/or Volume	Reduces toxicity and volume; mobility may be enhanced by irrigation. Low levels of TPHs below cleanup level may remain in soils.
Long-term Effectiveness	If effective, contaminants are destroyed by microbial metabolism. Residual TPHs potentially less mobile, since organic material created by microbial action may bind the contaminants.
Institutional Requirements	None required.

Fence material would be transported from Anchorage. The linear feet of fencing was estimated from information about areal extent of contamination presented in the RI report. The fence would be installed using imported labor.

In addition, periodic sampling and analysis of the surface water runoff would be conducted. The sampling would occur annually for 10 years.

A cost estimate appears in Table 5-19. Table 5-20 discusses this alternative in terms of the noncost evaluation criteria.

5.5.4.2 Alternative 2C - Capping with Hydraulic Controls. This alternative includes the installation of a low-permeability surface cap and improvements of the surface drainage of the site by lining with low permeability materials the existing roadside installation ditch and constructing additional lined diversion ditches around the landfill.

Considerable effort will be required to prepare the site for installation of the surface cap: the landfill will be consolidated by collecting ravelled material (soil and debris) from beyond the toe of the fill slopes and replacing it on the surface of the lower level of the landfill. Miscellaneous oversized rocks and debris such as drums and scrap metal that obstruct placement of the cap will be compacted or entirely removed. The surface of the landfill will be rough graded to flatten piles of material and backfill major depressions. Consolidation, clearing, and rough grading of the landfill will be followed by the backfilling of borrow material to form a bedding layer of a nominal thickness of 12 inches. This nominal thickness is expected to be required to compensate for loss of finer-grained borrow material through voids between the rocky surface material at the landfill, to completely cover its rough topography, and to achieve the proper fine grade across the landfill for efficient surface drainage. The borrow source for the bedding and armor material will be the

Table 5-19. COST SUMMARY FOR ALTERNATIVE 1C - NO ACTION/INSTITUTIONAL CONTROLS. SITE: ROM-8 OLD LANDFILL

Item	Quantity	Unit Rate ($)	Total $
Recurring Yearly Costs for Surface Watering Monitoring			
Labor			
Sample collection	16 hr	$95/hr	$1,520
Transportation			
Round trip labor from Anchorage	1 r.t.	900	900
Sample shipment Cape Romanzof to RMAL	1 cooler	120/cooler	120
Lab Analysis			
TPHs	2 samples	95	190
PCBs	2 samples	333	670
YEARLY TOTAL			$3,400
Present Cost Discount factor for 10-year program			7.87
1990 Present Cost of[a] 10-year program			$26,760
Labor			
Fence installation, 2 people	370 hrs	50/hr	18,500
Equipment			
Drill rig on crawler	3 weeks	2,450/wk	7,350
Air compressor	3 weeks	300/wk	900
Concrete mixer	3 weeks	140/wk	420
Pickup truck	3 weeks	250/wk	750
Material			
1650 linear feet of chainlink fence, posts, and concrete	1,650 LF	8/LF	13,200
Transportation			
Air charter to transport equipment and materials to site	1	18,000	18,000

Table 5-19. COST SUMMARY FOR ALTERNATIVE 1C - NO ACTION/INSTITUTIONAL CONTROLS. SITE: ROM-8 OLD LANDFILL (concluded)

Item	Quantity	Unit Rate ($)	Total $
Air charter to remove equipment from site	1	9,000	9,000
Round trip labor from Anchorage	2	900	1,800
SUBTOTAL			$96,680
20% CONTINGENCY			19,340
TOTAL			$116,020

[a]Present worth of annuity, continuous componding equals $\frac{(e^{rn}-1)}{re^{rn}}$, where n=10 years and r=%5

RMAL-Rocky Mountain Analytic Lab

Table 5-20. EVALUATION CRITERIA SUMMARY FOR ALTERNATIVE 1C - NO ACTION/ INSTITUTIONAL CONTROLS

Compliance with Cleanup Standards	Does not meet the proposed cleanup standard for TPHs in soil or for PCBs and TPHs in surface water.
Protection of Human Health and the Environment	Human access and access of large wildlife would be deterred by fencing, but no other mitigation of impact to the environment occurs.
Technical Feasibility	Feasible.
Implementability/ Logistics	Implementable, materials and equipment requirements are minor for this alternative.
Reduction of Toxicity, Mobility, and/or Volume	No reduction of toxicity, mobility, or volume of contaminants would occur as a result of this remedial alternative.
Long-term Effectiveness	The time required for natural degradation of TPHs contaminants cannot be predicted, but is expected to be several decades.
Institutional Requirements for Implementation of Remedial Alternative	None

nearby excavation exploited as the original source of the landfill cover material. Upon completion of this bedding layer, a cushion layer of heavy-duty geotextile (16-oz Polyfelt or equivalent) will be placed followed in turn by a 60-mil HDPE membrane, another layer of geotextile, and a 12-inch-thick armor layer.

The existing roadside installation ditch that has been identified as an apparent source of leachate-producing surface and relatively shallow groundwater to the landfill will be enlarged as necessary and lined with HDPE membrane or similar low-permeability material in the vicinity of the landfill. Additional lined ditches will be constructed as needed to divert surface flows around the landfill.

For cost-estimating purposes, it is expected that the construction equipment used will include a wheel-mounted backhoe/front end loader (Case 580 or equivalent) for excavation of borrow material and diversion ditches and miscellaneous site preparation; a relatively small wheel-mounted front-end loader (Caterpillar 910 or equivalent) for site preparation, grading, spreading of backfill and supplemental borrow excavation; and a 12-ton truck for miscellaneous hauling duties. This equipment is expected to balance field productivity with air transportability. All equipment, materials, and personnel will be flown to the site from Anchorage. It is estimated that two flights each way by Super Hercules air freighters will be required for equipment and material transport. It is expected that earthworking will require a crew of four, later supplemented by three technicians supplied by the manufacturer of the geofabric and membrane for installation of these materials. With these estimates it is expected that approximately 20 days will be required to complete construction of the surface cap and drainage improvements.

A cost estimate for this alternative appears in Table 5-21. Table 5-22 discusses this alternative in terms of the noncost evaluation criteria.

Table 5-21. COST SUMMARY FOR ALTERNATIVE 2C - CAPPING WITH HYDRAULIC CONTROL. SITE: ROM-8 LANDFILL

Item	Quantity	Unit Rate ($)	Total $
Heavy Equipment Rental			
Backhoe/front end loader (Case 580 or equivalent)	1 mo	$3,000	$3,000
Front end loader (Caterpillar 910 or equivalent)	1 mo	3,000	3,000
End dump truck, 6 cy capacity (Mack 300 CF or equivalent)	1 mo	2,500	2,500
Transportation Charges			
Four round trips by Super Hercules L-100 aircraft to transport equipment, materials, and main construction crew to and from Anchorage Cape Romanzof	4 round-trips	18,000	72,000
Charter flight to transport geotextile/membrane installation specialists to and from Anchorage - Cape Romanzof	3 persons	900	2,700
Contractor labor costs for mobilization and demobilization	L.S.	8,000	8,000
Site Preparation (Includes consolidation, clearing, rough grading)			
Labor costs	160 hr	50/hr	8,000
Equipment operation costs	96 hr	10/hr	960
Placement of 12-in. Bedding Layer (includes borrow excavation and backfilling, no haul required.).			
Labor costs	260 hr	50/hr	13,000
Equipment operation costs	130 hr	10/hr	1,300

Table 5-21. COST SUMMARY FOR ALTERNATIVE 2C - CAPPING WITH HYDRAULIC CONTROL. SITE: ROM-8 LANDFILL (concluded)

Item	Quantity	Unit Rate ($)	Total $
Placement of 16-oz. Geotextile Layers			
Labor costs	135 hr	50/hr	6,750
Material costs (includes labor cost of specialist)	100,000 ft^2	0.40/ft^2	40,000
Placement of 60-mil HDPE Membrane			
Labor costs	190 hr	50/hr	9,500
Material costs (includes labor cost of specialists)	50,000 ft^2	1.10/ft^2	55,000
Placement of 12-inch Armor Layer			
Labor costs	260 hr	50/hr	13,000
Equipment costs	130 hr	10/hr	1,300
Construction of Lined Surface Water Diversion Ditches	L.S.	15,000	15,000
SUBTOTAL			$255,010
20% CONTINGENCY			51,000
CONSTRUCTION COST TOTAL			$306,010

Table 5-22. EVALUATION CRITERIA SUMMARY FOR ALTERNATIVE 2C - CAPPING WITH HYDRAULIC CONTROLS

Compliance with Cleanup Standards	Does not meet the proposed cleanup standard for TPHs in soil. Will reduce generation of surface water leachate contaminated with TPHs and PCBs.
Protection of Human Health and the Environment	Surface migration and hydraulic subsurface migration of contaminants will be significantly reduced by the addition of a low-permeability cap and surface water diversion. Human and wildlife intrusion will be deterred by the presence of the cap.
Technical Feasibility	Utilitizes standard construction equipment and techniques. While technically feasible, the present condition of the landfill will require significant improvement prior to installing the surface cap.
Implementability/Logistics	All construction personnel, equipment, and liner materials must be transported to site by air. Little logistical support currently on site. Nearby potential borrow sources and access roads are available. No significant maintenance of remedial systems is expected to be required within 30 years.
Reduction of Toxicity, Mobility, and/or Volume	Since this alternative does not include treatment of soils, reduction of toxicity and/or volume is not accomplished. Volume of surface water leachate contaminated with TPHs and PCBs will be reduced.

5.5.4.3 Alternative 3C - Capping with Collection and Treatment of Surface Water Leachate. This alternative is the same as Alternative 2C with the additional feature of collection and treatment of surface water leachate from the landfill. The leachate collection system will consist of a network of lined drainage ditches located immediately adjacent and downgradient of the landfill. These ditches will drain to a central collection sump and collected leachate will then be pumped to an on-site treatment facility.

Utilizing the same equipment and personnel as described for Alternative 2C, approximately 25 days will be required to complete construction of the surface cap, drainage improvements, and leachate collection systems.

The treatment system will consist of fixed beds of granular activated carbon (GAC). Two cannisters each containing 2000 pounds of carbon will be used. A submersible pump located in the collection sump will pump the collected leachate through the series of two carbon units. The GAC will remove the organic compounds present, primarily TPHs in addition to the small amounts of PCBs, before discharge of the treated water by reinjection or surface disposal at the site. Approval from ADEC will be required.

The treatment system would only be operated for four months during the summer season of each year. It is assumed that contract personnel from Anchorage would service the system on a monthly basis during this period to perform any required maintenance and to collect samples for verification of treatment system performance. In addition, as the GAC becomes saturated with organic compounds it will require replacement. The spent GAC must be removed, placed in drums, and shipped to an approved facility for regeneration. Fresh GAC must be shipped to the site to replace the spent material. The estimates for rate of GAC use are based on an estimated leachate flow of 50 gpm for 4 months each year and concentrations of 2 mg/L TPHs and 3 μg/L PCBs.

It is not known for how long the leachate treatment would have to continue, until the hydraulic controls have largely eliminated the flow. It is assumed for the cost estimate that the treatment system would require operation for a 10-year period.

A cost estimate for this alternative appears in Table 5-23. Table 5-24 discusses this alternative in terms of the noncost evaluation criteria.

5.5.5 Operable Unit D

This operable unit is ROM-3 Former Shop Area. The soil at this site, which consists of fill and debris from disposal of site structures, is contaminated with TPHs. The estimated total volume of contaminated soil is 2104 yd^3. The surface area of the site is approximately 12,600 ft^2.

5.5.5.1 Alternative 1D - No Action. This alternative consists of fencing the contaminated sites to deter people and wildlife from entering. Natural degradation of hydrocarbons is expected to occur, although slowly, due to the short summer season when the average high temperature is approximately 50°F.

Fence material would be transported from Anchorage. The linear feet of fencing was estimated from the areal extent of contamination estimate presented in the RI discussion. The fence would be installed using imported labor.

A cost estimate is given in Table 5-25. Table 5-26 discusses this alternative in terms of the noncost evaluation criteria.

5.5.5.2 Alternative 2D - Capping. This alternative includes the construction of a low-permeability surface cap and surface water diversion ditches.

Table 5-23. COST SUMMARY FOR ALTERNATIVE 3C - CAPPING WITH COLLE[illegible] AND TREATMENT OF SURFACE WATER LEACHATE
SITE: ROM-8 LANDFILL

Item	Quantity	Unit Rate ($)	Total $
Construction of Cap and Collection System			
Heavy Equipment Rental			
Backhoe/front end loader (Case 580 or equivalent)	1 mo.	$3,000	$3,000
Front end loader (Caterpillar 910 or equivalent)	1 mo.	3,000	3,000
End dumptruck, 6 cy capacity (Mack 300 CF or equivalent)	1 mo.	2,500	2,500
Transportation Charges			
Four round trips by Super Hercules L-100 aircraft to transport equipment, materials, and main constructin crew to and from Anchorage-Cape Romanzof	4 r.t.	18,000	72,000
Charter flight to transport geotextile/membrane installation specialists to and from Anchorage-Cape Romanzof	3 r.t.	900	2,700
Contractor labor costs for mobilization and demobilization	L.S.	8,000	8,000
Site Preparation (Includes consolidation, clearing, and rough grading)			
Labor costs	160 hr	50/hr	8,000
Equipment operation costs	96 hr	10/hr	960

Table 5-23. COST SUMMARY FOR ALTERNATIVE 3C - CAPPING WITH COLLECTION AND TREATMENT OF SURFACE WATER LEACHATE
SITE: ROM-8 LANDFILL (continued)

Item	Quantity	Unit Rate ($)	Total $
Placement of 12-in Bedding Layer (Includes borrow excavation and backfilling, no haul required)			
Labor costs	260 hr	$50/hr	$13,000
Equipment operation costs	130 hr	10/hr	1,300
Placement of 16-oz. Geotextile Layers			
Labor costs	135 hr	50/hr	6.750
Material costs (includes labor cost of specialists)	100,000 ft^2	0.40/ft^2	40,000
Placement of 60-mil HDPE Membrane			
Labor costs	190/hr	50/hr	9,500
Material costs (includes labor cost of specialists)	50,000 ft^2	1.10/ft^2	55,000
Placement of 12-inch Armor Layer			
Labor costs	260 hr	50/hr	13,000
Equipment costs	130 hr	10/hr	1,300
Construction of Lined Surface Water Diversion Ditches	L.S.	15,000	15,000
Construction of Surface Water Leachate Collection Ditches and Sump (pump, piping and other utilities not included)	L.S.	10,000	10,000
Subtotal Cap and Collection System Installation			$265,010

Table 5-23. COST SUMMARY FOR ALTERNATIVE 3C - CAPPING WITH COLLECTION AND TREATMENT OF SURFACE WATER LEACHATE
SITE: ROM-8 LANDFILL (continued)

Item	Quantity	Unit Rate ($)	Total $
Construction of Treatment System			
Labor			
Construction Contractor	160 hr	$50/hr	$8,000
Oversight	80 hr	95/hr	7,600
Transportation (equipment and materials included in transportation costs for construction of cap)			
Round trip labor from Anchorage	4 r.t.	900	3,600
Materials (GAC units, pump, piping, instruments, electrical			15,000
Subtotal Treatment System Installation			$34,200
Recurring Yearly Costs for Treatment System Operation			
Labor			
Operation and Maintenance	80 hr	$50/hr	$4,000
Transportation			
Round trip labor from Anchorage	4 r.t	900	3,600
Sample Shipment Cape Romanzof to RMAL	4 coolers	120/cooler	480
Materials			
Replacement of GAC (including new carbon regeneration of spent carbon, freight, and labor for replacement)	350 lbs	8/lb	2,800

Table 5-23. COST SUMMARY FOR ALTERNATIVE 3C - CAPPING WITH COLLECTION AND TREATMENT OF SURFACE WATER LEACHATE
SITE: ROM-8 LANDFILL (concluded)

Item	Quantity	Unit Rate ($)	Total $
Utilities Electricity	1100 kw-h	$0.15	$165
Lab Analysis			
TPHs	12 samples	75	900
PCBs	12 samples	333	4,000
Yearly Total			$15,945
Present cost discount factor for 10-year program			7.87
Present cost of 30-year program[a]			$125,490
SUBTOTAL PROJECT COSTS			$424,700
20% Contingency			84,940
TOTAL 1990 COST FOR INSTALLATION AND 10-YEAR OPERATION			$509,640

[a] Present worth of annuity, continuous compounding equals $\frac{(e^{rn}-1)}{r\,e^{rn}}$ where n = 30 years and r = 5%.

RMAL - Rocky Mountain Analytical Laboratory
GC - Gas Chromatograph

Table 5-24. EVALUATION CRITERIA SUMMARY FOR ALTERNATIVE 3C - CAPPING WITH COLLECTION AND TREATMENT OF SURFACE WATER LEACHATE

Compliance with Cleanup Standards	Does not meet the proposed cleanup standard for TPHs in soil. Will achieve the proposed cleanup standard for PCBs and TPHs in water.
Protection of Human Health and the Environment	Surface migration and hydraulic subsurface migration of contaminants will be significantly reduced by the addition of a low-permeability cap and surface water diversion. Leachate produced will be collected and treated. Human and wildlife intrusion will be deterred by the presence of the cap.
Technical Feasibility	Utilizes standard construction equipment and techniques. While technically feasible, the present condition of the landfill will require significant improvement prior to installing the surface cap.
Implementability/Logistics	All construction personnel, equipment, and liner materials must be transported to site by air. Little logistical support currently on site. Nearby potential borrow sources and access roads are available. Maintenance of treatment system for 10 years at remote site will be problem.
Reduction of Toxicity, Mobility, and/or Volume	This alternative does not include treatment for TPHs contamination in soil so reduction of contaminant toxicity and/or volume is not accomplished. The hydraulic controls reduce the mobility of the contaminants. For surface water leachate, PCBs and TPHs contaminants will be completely removed from water by adsorption onto GAC. Subsequent thermal regeneration of GAC will lead to total destruction of these contaminants.

Table 5-24. EVALUATION CRITERIA SUMMARY FOR ALTERNATIVE 3C - CAPPING WITH COLLECTION AND TREATMENT OF SURFACE WATER LEACHATE (concluded)

Long-Term Effectiveness	Addition of geotextile layers is expected to be effective in preventing puncturing of liner. Little risk of liner puncturing due to human or animal intrusion. Liner ability to withstand cold and freeze/thaw cycles has had limited testing. Expected life of liner is not known but is estimated to be greater than 30 years. Surface water diversion systems is expected to be effective for the foreseeable future. The time required for degradation of TPHs is increased by reducing surface water and air infiltration/gas exfiltration. While the time for complete degradation cannot be predicted, it is expected to be at least many decades. Properly maintained, the leachate collection and treatment system will continue to meet cleanup standards for PCBs and TPHs in water until the leachate flow is minimized by the hydraulic control system.
Institutional Requirements for Implementation of Remedial Alternative	Reinjection or on-site disposal of treated leachate will require approval of Alaska Department of Environmental Conservation.

Table 5-25. COST SUMMARY FOR ALTERNATIVE 1D - NO ACTION/INSTITUTIONAL CONTROLS. SITE: ROM-3 FORMER SHOP AREA

Item	Quantity	Unit Rate ($)	Total $
Labor			
Fence installation, 2 people	100 hours	$50/hr	$5,000
Equipment			
Drill rig on crawler	1 week	2,450/wk	2,450
Air compressor	1 week	300/wk	300
Concrete mixer	1 week	140/wk	140
Pickup truck	1 week	250/wk	250
Material			
450 linear feet of chainlink fence, posts, and concrete	450 LF	8/LF	3,600
Transportation			
Air charter to transport equipment and materials to site	1	18,000	18,000
Air charter to remove equipment from site	1	9,000	9,000
Round trip labor from Anchorage	2	900	1,800
SUBTOTAL			$40,540
20% CONTINGENCY			8,110
TOTAL			$48,650

Table 5-26. EVALUATION CRITERIA SUMMARY FOR ALTERNATIVE 1D - NO ACTION/ INSTITUTIONAL CONTROLS

Compliance with Cleanup Standards	Does not meet the proposed cleanup standard for TPHs in soil.
Protection of Human Health and the Environment	Human access and access of large wildlife would be deterred by fencing, but no other mitigation of impact to the environment occurs.
Technical Feasibility	Feasible.
Implementability/ Logistics	Implementable, material and equipment requirements are minor for this alternative.
Reduction of Toxicity, Mobility, and/or Volume	No reduction of toxicity, mobility, or volume of contaminants would occur as a result of this remedial alternative.
Long-term Effectiveness	The time required for natural degradation of TPHs contaminants cannot be predicted, but is expected to be many decades.
Institutional Requirements	None

Once the site has been cleared and rough graded, a 6-inch-thick bedding layer of soil and rock will be placed and fine-graded. The borrow site for the bedding and armor material will be the existing borrow area near the ROM-8 landfill, approximately 4200 feet distant. Upon completion of the bedding layer, a cushion layer of heavy duty geotextile (16-oz. Polyfelt or equivalent) will be placed, followed in turn by a 60-mil HDPE membrane, another layer of geotextile, and a 12-inch-thick armor layer. Diversion ditches lined with HDPE membrane or similar low-permeability materials will then be constructed to convey runoff around the site.

For cost-estimating purposed, it is estimated that the same equipment and personnel as described for Alternative 2A will be used. With these estimates, it is expected that approximately 14 days will be required to complete construction of the surface cap and drainage improvements.

A cost estimate for this alternative appears in Table 5-27. Table 5-28 discusses this alternative in terms of the noncost evaluation criteria.

5.5.6 Comparison of Remedial Alternatives

In this section, the remedial alternatives for each operable unit are compared on the basis of technical, environmental, human health, institutional, and economic criteria outlined in the AFOEHL/TS manual. This section summarizes information presented individually for each alternative earlier in this chapter. A summary of costs for all remedial alternatives is given in Table 5-29.

5.5.6.1 Operable Unit A.

Technical Analysis. The order of technical feasibility and implementability for this operable unit, from most to least favorable, is 1A (No Action), 2A (Capping), 4A (Excavation/Landfarming), 3A (Excavation/Thermal Treatment). Implementation of Alternative 1A (No Action) is straightforward.

Table 5-27. COST SUMMARY FOR ALTERNATIVE 2D - CAPPING
SITE: ROM-3 FORMER SHOP AREA

Item	Quantity	Unit Rate ($)	Total $
Heavy Equipment Rental			
Backhoe/front end loader (Case 580 or equivalent)	1 mo	$3,000	$3,000
Front end loader (Caterpillar 910 or equivalent)	1 mo	3,000	3,000
End dumptruck, 12 cy capacity (Mack 400 CM or equivalent)	1 mo	3,000	3,000
Transportation Charges			
Four roundtrips by Super Hercules L-100 aircraft to transport equipment, materials, and main construction crew to and from Anchorage-Cape Romanzof	4 r.t.	18,000	72,000
Charter flight to transport geotextile/membrane installation specialists to and from Anchorage-Cape Romanzof	2 r.t.	900	1,800
Contractor labor costs for mobilization and demobilization	L.S.	10,000	10,000
Site Preparation (Includes clearing and rough grading)			
Labor costs	40 hr	50/hr	2,000
Equipment operation costs	16 hr	10/hr	160

Table 5-27. COST SUMMARY FOR ALTERNATIVE 2D - CAPPING
SITE: ROM-3 FORMER SHOP AREA (concluded)

Item	Quantity	Unit Rate ($)	Total $
Placement of 6-in Bedding Layer (Includes borrow excavation, hauling and backfilling)			
Labor costs	40 hr	50/hr	2,000
Equipment operation costs	24 hr	10/hr	240
Placement of 16-oz. Geotextile Layers			
Labor costs	70 hr	50/hr	3,500
Material costs (includes labor cost of specialists)	25,200 ft^2	0.40	10,080
Placement of 60-mil HDPE Membrane			
Labor costs	65 hr	50/hr	3,250
Material costs (includes labor cost of specialists)	12,600 ft^2	1.10/ft^2	13,860
Placement of 12-inch Armor Layer			
Labor	80 hr	50/hr	4,000
Equipment Cost	48 hr	10/hr	480
Construction of Lined Surface Water Diversion Ditches	L.S.	3,000	3,000
SUBTOTAL			$135,370
20% CONTINGENCY			27,070
CONSTRUCTION COST TOTAL			$162,440

Table 5-28. EVALUATION CRITERIA SUMMARY FOR ALTERNATIVE 2D - CAPPING

Compliance with Cleanup Standards	Does not meet the proposed cleanup standard for TPHs in soil.
Protection of Human Health and the Environment	Surface migration and hydraulic subsurface migration of contaminants will be significantly reduced by the addition of a low-permeability cap and surface water diversion. Human and wildlife intrusion will be deterred by the presence of the cap.
Technical Feasibility	Utilizes standard construction equipment and techniques. Surface conditions are amenable.
Implementability/Logistics	All construction personnel, equipment, and liner materials must be transported to site by air. Little logistical support currently on site. Nearby potential borrow sources and access roads are available. No significant maintenance of remedial systems is expected to be required within 30 years.
Reduction of Toxicity, Mobility, and/or Volume	Since this alternative does not include treatment, reduction of contaminant toxicity and/or volume is not accomplished. Contaminant mobility is reduced by the cap.
Long-Term Effectiveness	Addition of geotextile layers is expected to be effective in preventing puncturing of liner. Little risk of liner puncturing due to human or animal intrusion. Liner ability to withstand cold and freeze/thaw cycles has had limited testing. Expected life of liner is not known but is estimated to be greater than 30 years. Surface water diversion is expected to be effective for the foreseeable future. The time required for natural degradation of TPHs is increased by reducing surface water and air infiltration/gas exfiltration. While the time for complete degradation cannot be predicted, it is expected to be at least many decades.
Institutional Requirements for Implementation of Remedial Alternative	None

Table 5-29. SUMMARY OF REMEDIAL ALTERNATIVE COSTS

Alternative	Cost ($)
1A - No Action	$65,580
2A - Capping	183,920
3A - Excavation/On-site Thermal Treatment	1,060,210
4A - On-site Landfarming	441,200
1B - No Action	87,140
2B - In Situ Enhanced Biodegradation	1,330,120
1C - No Action	116,020
2C - Capping/Hydraulic Controls	306,010
3C - Capping/Collection and Treatment Surface Water	509,640
1D - No Action	48,650
2D - Capping	162,440

Note: Costs are rounded to hundreds of dollars. These costs are presented as January 1990 dollars.

Alternative 4A (Excavation/Landfarming) can be done with materials and equipment which are imported from Anchorage. Landfarming of TPHs-contaminated materials has been done for many years.

Alternative 2A (Capping) involves the logistics of moving the cap materials to the site. The long-term effectiveness of the cap is uncertain since there is limited experience with the effect of freeze/thaw cycles on synthetic cap integrity.

Alternative 3A (Excavation/Thermal Treatment) would involve shipment of the thermal treatment unit to the site. The basis of technology for volatilizing the hydrocarbons is proven, and is not significantly affected by site conditions. The logistics of transporting the required equipment and propane fuel to the site will be difficult.

Environmental and Human Health Analysis. Alternatives 3A (Excavation/Thermal Treatment) and 4A (Excavation/Landfarming) meet the proposed cleanup standard for TPHs in soil. For Alternative 3A (Excavation/Thermal Treatment), the TPHs would be removed from the soil immediately after excavation. Alternative 4A (Excavation/Landfarming) would probably reduce TPHs contaminants in the soil within 2 years or more. No adverse environmental effects are expected from these treatments as long as excavated areas are backfilled with soil immediately.

Alternatives 1A (No Action) and 2A (Capping) do not meet the proposed cleanup standards for TPHs in soil. Although some natural biodegradation of the TPHs contaminants would occur, Arctic studies of diesel fuel spills have shown that these spills have persisted for several decades. Alternative 1A (No Action) would deter entry to the contaminated sites with fencing. Alternative 2A (Capping) would prevent contact with the TPHs-contaminated soil and also slow the vertical migration of contaminants by preventing infiltration of surface waters as long as the cap remained intact.

Institutional Analysis. Alternative 3A (Excavation/Thermal Treatment) would require a permit for air discharges.

Economic Analysis. In this operable unit, the least costly treatment is estimated to be Alternative 1A (No Action) followed by Alternative 2A (Capping). The high cost of Alternative 3A (Excavation/Thermal Treatment) is primarily due to the remoteness of the site; the thermal treatment unit would have to be flown to the site together with the large volume of propane fuel required.

For Alternatives 2A (Capping) and 4A (Excavation/Landfarming), the accuracy of the cost estimate is linked to the accuracy of the contaminated soil estimate. If the contaminated area or volume is found to be larger than that used in this FS, the implementation cost of the alternative would also increase, and vice versa. The cost of Alternative 1A (No Action) is not greatly sensitive to changes in contaminated soil volume. For Alternative 3A (Excavation/Thermal Treatment), the cost of shipping and mobilizing the thermal treatment unit to the site is comparable to the treatment cost (which is affected by contaminated soil volume).

5.5.6.2 Operable Unit B.

Technical Analysis. The order of technical feasibility and implementability for this operable unit, from most to least favorable, is 1B (No Action) followed by 2B (In Situ Enhanced Biodegradation). Implementation of Alternative 1B (No Action) is straightforward.

Alternative 2B (In Situ Enhanced Biodegradation) would not be difficult to implement. The biological degradation of TPHs contaminants is well-documented in the continental U.S., and degradation of TPHs at the site is expected to be slower due to the colder weather of this area.

Environmental and Human Health Analysis. As was discussed earlier in this report, disruptive activities at sites where native tundra vegetation occurs would not be suitable remedial alternatives. Alternative 1B (No Action) would not meet the proposed cleanup levels. Although some natural biodegradation of the TPHs contaminants would occur, Arctic studies of diesel fuel spills have shown that these spills have persisted for several decades. Fencing at the site would discourage entry of people and wildlife, thus reducing the chance of contact with the contaminated material.

Alternative 2B (In Situ Enhanced Biodegradation) would act to reduce contaminant levels gradually without further disrupting the native vegetation which already appears to be recovering.

Institutional Analysis. No institutional issues affect implementation of the alternatives developed for this operable unit.

Economic Analysis. Of the two alternatives identified for treatment of Operable Unit B, Alternative 1B (No Action) was found to be much less costly than Alternative 2B (In Situ Enhanced Biodegradation). For Alternative 2B (In Situ Enhanced Biodegradation), the cost estimate is sensitive to the accuracy of the contaminated soil volume estimate. If the contaminated volume is found to be larger than that used in this FS, the implementation cost of the alternative would also increase, and vice versa. The cost of Alternative 1B (No Action) is not sensitive to moderate changes in soil volume.

5.5.6.3 Operable Unit C.

Technical Analysis. The order of technical feasibility and implementability for this operable unit, from most to least favorable, is 1C (No Action), 2C (Capping/Hydraulic Controls), 3C (Capping/Surface Water Collection and Treatment). Implementation of Alternative 1C (No Action) is straightforward.

Alternative 2C (Capping and Hydraulic Controls) involves the logistics of moving the cap materials to the site. The long-term effectiveness of the cap is uncertain since there is limited experience with the effect of freeze/thaw cycles on the synthetic.

Alternative 3C (Capping and Collection and Treatment of Runoff) involves the same considerations as Alternative 2C. In addition, operation of the collection and treatment system for surface water runoff will require long-term monitoring and maintenance. The duration of remediation cannot be accurately predicted in advance, but is assumed to involve 10 years.

None of the alternatives considered for this operable unit meet the proposed cleanup standards for TPHs in soil. Although some natural biodegradation of the TPHs contaminants would occur, Arctic studies of diesel fuel spills have shown that these spills have persisted for several decades. Alternative 1C (No Action) would deter entry to the contaminated sites with fencing. Alternatives 2C (Capping with Hydraulic Controls) and 3C (Capping with Collection and Treatment of Runoff) would prevent contact with the TPHs-contaminated soil and also minimize the generation of leachate by preventing infiltration of surface waters as long as the cap remained intact.

Alternative 1C (No Action) does not meet the cleanup standards for PCBs and TPHs in surface water runoff. Alternative 2C (Capping with Hydraulic Controls) would greatly reduce the quantity of surface water leachate contaminated with PCBs and TPHs from the ROM-8 site.

Alternative 3C (Capping with Collection and Treatment of Runoff) meets the proposed cleanup standard for PCBs and TPHs in surface water.

<u>Institutional Analysis</u>. For Alternative 3C (Capping with Collection and Treatment of Runoff), the spent GAC waste load must be manifested since

it is a hazardous waste under the EPA RCRA program. The spent GAC waste load must be regenerated or disposed of at a facility which is permitted to accept such waste. In addition, this alternative would require approval from ADEC for reinjection or disposal of treated water.

Economic Analysis. For this operable unit, the least costly alternative is Alternative 1C (No Action) followed by Alternative 2C (Capping with Hydraulic Controls). The cost estimate for Alternative 3C (Capping with Collection and Treatment of Runoff) was based on a 10-year treatment duration. The treatment duration is uncertain since it is not known for how long PCBs and TPHs contamination in the surface water leachate from ROM-8 will persist. The actual cost could, therefore, be higher or lower.

For Alternatives 2C (Capping with Hydraulic Controls) and 3C (Capping with Collection and Treatment of Runoff), the accuracy of the cost estimate is linked to the accuracy of the contaminated soil surface estimate, which is reasonably well-known. Similarly, the cost for Alternative 1C (No Action) depends on the periphery of the landfill, which is reasonably well known.

For Alternative 3C (Capping with Collection and Treatment of Runoff) the accuracy of the cost estimate is linked to the flowrate of surface water collected downgradient of ROM-8 and to the concentration of organic compounds in this water. If the flowrate or concentration were found to be higher than used in this FS, the implementation cost of the alternative would increase, and vice versa.

5.5.6.4 Operable Unit D.

Technical Analysis. The order of technical feasibility and implementability for this operable unit, from most to least favorable, is 1D (No Action), followed by 2D (Capping). Implementation of Alternative 1A (No Action) is straightforward.

Alternative 2D (Capping) involves the logistics of moving the cap materials to the site. The long-term effectiveness of the cap is uncertain since there is limited experience with the effect of freeze/thaw cycles on synthetic cap integrity.

Environmental and Human Health Analysis. Alternatives 1D (No Action) and 2D (Capping) do not meet the proposed cleanup standards for TPHs in soil. Although some natural biodegradation of the TPHs contaminants would occur, Arctic studies of diesel fuel spills have shown that these spills have persisted for several decades. Alternative 1A (No Action) would deter entry to the contaminated sites with fencing. Alternative 2A (Capping) would prevent contact with the TPHs-contaminated soil and also slow the vertical migration of contaminants by preventing infiltration of surface waters as long as the cap remained intact.

Institutional Analysis. No institutional issues affect implementation of the alternatives developed for this operable unit.

Economic Analysis. Of the two alternatives identified for treatment of Operable Unit D, Alternative 1D (No Action) was found to be less costly than Alternative 2D (Capping). For Alternative 2D (Capping), the cost estimate depends on the accuracy of the contaminated soil area estimate. The cost of Alternative 1D (No Action) is not very sensitive to moderate changes in soil area.

TAB

Section 6

6.0 RECOMMENDATIONS

This chapter addresses the nine Cape Romanzof sites individually, making recommendations for the direction that future IRP efforts, if any, should follow. The sites are identified as either Category 1, 2, or 3 sites.

Category 1 sites are those where no further action is required, since it was determined that no significant impact to human health or the environment has occurred or will occur at the site. A Technical Document to Support No Further Action will be developed for each Category 1 site.

Category 2 sites are those which require additional investigation to:

- Determine the mobility, toxicity, and volume (MTV) of detected contaminants,

- Evaluate human health and environmental risks associated with each contaminant, and

- Conduct the detailed evaluation of remedial alternatives

Recommendations for further site investigation are made to enable completion of the above three activities.

Category 3 sites are those where the FS process has been completed. A preferred remedial alternative for each operable unit is recommended here, based on the results of the detailed analysis of Section 5.0.

6.1 CATEGORY 1 SITES

Three sites requiring no further action were identified as a result of the two-tiered screening process of Section 4.0. These sites are:

ROM-1D 5099th Disposal Pit
ROM-4 Road Oiling
ROM-5 Area Below New Landfill

The above sites met the Tier One criteria requiring that Tier Two screening be done. In the Tier Two screening, at least one of the exposure criteria and one of the threshold exceedance criteria must be satisfied for further action at the site to be required. The requirements for further action at the above sites were not met, i.e., the risk is not considered significant.

For two other sites that were included in the feasibility study of Section 5.0 and the selection process of Section 6.3 below, the recommended alternative was No Action.

This was the case unequivocally for one site, ROM-1S Large Fuel Spill. For one other site, ROM-3 Former Shop Area, the recommended alternative is either No Action or, if implemented jointly with other sites, Capping. These two sites recommended for No Action, then, are classified as Category 1 sites. They remain included in Section 6.3 for the Category 3 sites discussion and evaluation.

A Technical Document to Support No Further Action (TDSNFA) will be prepared for the five sites mentioned above.

6.2 CATEGORY 2 SITES

The ROM-1S aquifer, which likely extends southeast to the water supply well at ROM-3 (see Figure 4-2), was identified as a Category 2 site requiring further data collection to better define geologic and hydrologic conditions, and the extent and nature of contamination in the groundwater within this drinking water source. Investigation should include resampling of groundwater in all wells, and geophysical surveys (surface-based and down-hole) to identify pertinent stratigraphic and boundary conditions of the aquifer.

Chemical analyses of groundwater should include an additional analytical method (e.g., E8015) designed to better differentiate and identify the various TPHs constituents (the currently used TPHs analysis, E418.1, uses an infrared method unable to identify specific TPHs compounds, or to distinguish between naturally occurring and refined petroleum compounds). Once contamination constituents are identified and geologic/ hydrogeologic parameters are better defined, a risk assessment can be conducted to determine if station personnel are at risk. If there is a risk, the next steps would involve either further investigation to determine a remediation, or provision of an alternate water supply.

A Work Plan and Data Quality Objectives (DQO) will be developed for this site.

6.3 CATEGORY 3 SITES

Six sites require consideration for further remedial action:

ROM-1 Waste Accumulation Area
ROM-1S Large Fuel Spill (Soil)
ROM-3 Former Shop Area
ROM-8 Landfill

ROM-10 Former Truck Fill Stand
ROM-12 Former Drum Storage Area

In the preceding sections of this report, technologies applicable for cleanup of contaminants present at these sites were screened, the sites were grouped into operable units, sets of remedial alternatives specific to each operable unit were developed, and the remedial alternatives for each operable unit were evaluated.

The sites grouped into Operable Unit A (Disturbed Soil/Fill) were ROM-1, ROM-10, and ROM-12. Operable Unit B (Native Tundra) consists of Site ROM-1S (Soil). The soil and surface water contamination at Site ROM-8 was grouped into Operable Unit C (Landfill). Operable Unit D (Former Shop Area) consists of Site ROM-3.

To identify the most cost-effective, technically feasible remedial alternative protective of human health and the environment, a weighted factor rating of alternatives was performed. The AFOEHL's Handbook (Version 2.0, 1988) states that the following criteria should be used to compare and select the best remedial alternative:

- Compliance with cleanup standards
- Protection of health and the environment
- Technical feasibility
- Implementability
- Present worth of costs
- Institutional aspects

For this rating, weighting factors from one to three were assigned to each criterion listed above. A weighted rating was used to emphasize criteria judged more important to selection of the preferred remedial alternative. The first two criteria above were assigned a weight of two, the next a weight of one, the following two a weight of three, and the last a weight of one.

Each criterion was scored on a scale of zero to three, with three being the most favorable. The score for each remedial alternative was totaled and the remedial alternative with clearly the highest score within the operable unit was recommended for implementation. If two or more alternatives were closely scored, an additional evaluation was performed prior to final selection. The score assignment was based on engineering experience and judgement of the WCC staff. The rationale for the scoring judgements is presented in Section 5.6.

Table 6-1 summarizes the scoring for Operable Unit A (Disturbed Soil/ Fill). Table 6-2 summarizes the scoring for Operable Unit B (Native Fill). Table 6-3 summarizes the scoring for Operable Unit C (Land-Tundra). Table 6-4 summarizes the scoring for Operable Unit D (Former Shop fill). Table 6-4 summarizes the scoring for Operable Unit D (Former Shop Area).

The difference in scoring for Operable Unit A (Disturbed Soil/Fill) was not pronounced. While the score for Alternative 3A (Thermal Treatment) was significantly lower, the scores for Alternatives 1A (No Action), 2A (Capping), and 4A (Excavation/Landfarming) differed by only one point. The tradeoffs between these three alternatives are cost versus protection of health and environment and compliance with cleanup levels. The estimated cost of Alternative 4A (Excavation/Landfarming) is about seven times higher than that of Alternative 1A (No Action) and more than twice that of Alternative 2A (Capping). A disadvantage of Alternative 4A is the lack of predictable treatment success under the less-than-ideal climatic conditions present at the site. It is the opinion of WCC that unfavorable climatic conditions should only lengthen treatment duration, not prevent its success. Initial results from the pilot-scale test conducted at the Kotzebue AFS in Summer 1989 under the IRP program indicate that landfarming is viable under Arctic conditions (WCC 1990). The major disadvantage of Alternatives 1A and 2A is the lack of cleanup; Alternative 2A (Capping) at least prevents contact and lessens the possibility of transport of the

Table 6-1. WEIGHTED RANKING SUMMARY FOR OPERABLE UNIT A (DISTURBED SOIL/FILL)

		Alternatives			
Criteria	Weighting Factor	1 (No Action)	2 (Capping)	3 (Thermal Treatment)	4 (Land Farming)
Protection of Health and the Environment	2	1	2	3	3
Comply with Cleanup Levels	2	0	0	3	3
Technical Feasibility	1	3	3	3	2
Implementability	3	3	3	0	2
Cost	3	3	2	0	1
Institutional Requirements	1	3	3	1	2
Total Score (Σ Weighting Factor x Score)		26	25	16	25

Scoring ranges from 0 to 3, with 3 being most favorable.

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Table 6-2. WEIGHTED RANKING SUMMARY FOR OPERABLE UNIT B (NATIVE TUNDRA)

Criteria	Weighting Factor	Alternatives: 1 (No Action)	Alternatives: 2 (In Situ Enhanced Biodegradation)
Protection of Health and the Environment	2	1	2
Comply with Cleanup Levels	2	0	3
Technical Feasibility	1	3	2
Implementability	3	3	2
Cost	3	3	0
Institutional Requirements	1	3	2
Total Score (Σ Weighting Factor x Score)		26	20

Scoring ranges from 0 to 3, with 3 being most favorable.

Table 6-3. WEIGHTED RANKING SUMMARY FOR OPERABLE UNIT C (LANDFILL)

		Alternatives		
Criteria	Weighting Factor	1 (No Action)	2 (Capping with Hydraulic Controls)	3 (Capping with Collection and Treatment of Runoff)
Protection of Health and the Environment	2	1	2	2
Comply with Cleanup Levels	2	0	1	2
Technical Feasibility	1	3	3	3
Implementability	3	3	2	0
Cost	3	3	2	1
Institutional Requirements	1	3	3	2
Total Score (S Weighting Factor x Score)		26	24	16

Scoring ranges from 0 to 3, with 3 being most favorable.

Table 6-4. WEIGHTED RANKING SUMMARY FOR OPERABLE UNIT D (FORMER SHOP AREA)

Criteria	Weighting Factor	Alternatives 1 (No Action)	Alternatives 2 (Capping)
Protection of Health and the Environment	2	1	2
Comply with Cleanup Levels	2	0	0
Technical Feasibility	1	3	3
Implementability	3	3	3
Cost	3	3	2
Institutional Requirements	1	3	3
Total Score (S Weighting Factor x Score)		26	25

Scoring ranges from 0 to 3, with 3 being most favorable.

contaminants, while Alternative 1A (No Action) just makes direct contact more difficult by fencing. Considering the regulatory "bias for treatment", especially for the heavily contaminated Site ROM-12, Alternative 4A (Excavation/Landfarming) is the remedial alternative recommended for Operable Unit A (Disturbed Soil/Fill).

For Operable Unit B (Native Tundra), Alternative 1B (No Action) scored six points higher than Alternative 2B (In Situ Enhanced Biodegradation). The tradeoffs between these two alternatives are primarily protection of health and the environment and compliance with proposed cleanup levels versus implementability and cost. The estimated cost for Alternative 2B (In Situ Enhanced Biodegradation) is about 15 times higher than that of Alternative 1B (No Action). Due to the significant difference in the scores, high cost difference and the uncertainty of predictable treatment success for Alternative 2B under the less-than-ideal climatic conditions at the site, Alternative 1B (No Action) is recommended for Operable Unit B. The difference in predictability of treatment success compared between Operable Units A and B lies in the method of biodegradation, excavation and landfarming with good expected success versus on-site biodegradation with somewhat uncertain success.

The scoring for Operable Unit C (Landfill) was close, with Alternative 1C (No Action) scoring two points higher than Alternative 2C (Capping with Hydraulic Controls). Alternative 3C (Capping with Collection and Treatment of Runoff) scored much lower due to its much higher cost and difficult implementability; it is not considered further. Alternative 2C (Capping with Hydraulic Controls) does more to protect health and the environment than does Alternative 1C (No Action), but is almost three times more costly and more difficult to implement. Because of the expected significant improvement in protectiveness and moderate cost, Alternative 2C (Capping with Hydraulic Controls) is recommended over Alternative 1C (No Action).

For Operable Unit D (Former Shop Area), the scores for Alternative 1D (No Action) and Alternative 2D (Capping) differed by one point only. Again it was a tradeoff between the higher level of protection of health and the environment produced by Alternative 2D versus the much lower cost and easier implementation for Alternative 1D. Considering the desirability of positive remediation, though without treatment, Alternative 2D (Capping) is recommended. This recommendation also considers that the cost of this alternative would be reduced by more than half if heavy equipment mobilized for other sites could be used.

Following evaluation and recommendations for individual operable units considered separately, the interaction between operable units--i.e., the effect of the selection of a given remediation at one site or group of sites on the selection at another site(s)--was considered. Physically there is no interaction, except that effective remediation at ROM-1D and ROM-3 might have a long-term beneficial effect on the ROM-1S (Aquifer) (which is recommended for further investigation). The principal interaction is in cost savings that can be achieved, especially in equipment and personnel mobilization, if several sites or groups of sites (operable units) are remediated jointly.

The particular question that was asked in this case is: If an alternative for an operable unit can be constructed largely with equipment mobilized for remediation of another operable unit, would deletion of mobilization logistics and costs change the rating of the first alternative significantly enough that the selection might be changed? Evaluation indicated that the recommendation for two operable units needed to be reconsidered. For Operable Unit D (Former Shop Area), elimination of mobilization costs was already implicitly considered in the selection of capping, and therefore no change is needed. For Operable Unit A (Disturbed Soil/Fill), elimination of mobilization costs would significantly reduce the cost of both capping and on-site landfarming, and would make them both more attractive vis-a-vis no action. Then, a direct comparison between capping and landfarming would remain about the same as before, with the same recommendation in favor of landfarming. Hence, the consideration of the interaction between operable units does not indicate the need for any changes in recommendations.

In conclusion, the following remedial alternatives are recommended for the Category 3 sites:

Operable Unit A: Alternative 4A, Excavation/Landfarming
Operable Unit B: Alternative 1B, No Action
Operable Unit C: Alternative 2C, Capping with Hydraulic Controls
Operable Unit D: Alternative 2D, Capping

6.4 SUMMARY OF RECOMMENDATIONS

The recommendations for action are as follows:

ROM-1 Waste Accumulation Area: Category 3

The recommended remedial alternative is excavation of TPHs-contaminated soils with landfarming.

ROM-1D 5099th Disposal Pit: Category 1

No further action is recommended. A TDSNFA will be prepared for this site.

ROM-1S (Soil) Large Fuel Spill: Category 1

The recommended remedial alternative for soil contamination is no action, which places this site into Category 1. A TDSNFA will be prepared for this site.

Aquifer Beneath ROM-1S and Part of ROM-3: Category 2

Further investigation is necessary here. A work plan will be prepared for this site.

ROM-3 Former Shop Area: Category 3

The recommended remedial alternative is capping.

ROM-4 Road Oiling: Category 1

No further action is recommended. A TDSNFA will be prepared for this site.

ROM-5 New Landfill: Category 1

No further action is recommended. A TDSNFA will be prepared for this site.

ROM-8 Landfill: Category 3

The recommended remedial alternative is capping with hydraulic controls.

ROM-10 Former Truck Fill Stand: Category 3

The recommended remedial alternative is excavation of TPHs-contaminated soil with landfarming.

ROM-12 Former Drum Storage Area: Category 3

The recommended remedial alternative is excavation of TPHs-contaminated soil with landfarming.

TAB

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TAB

Appendix A

APPENDIX A

BOREHOLE LOGS

BOREHOLE LOG (SOIL)

INSTALLATION ID: CAPRM
LOCATION ID: ROM - 8 - MW1
LOCATION TYPE: BH
LOCATION PROXIMITY: I
COORDINATES (FT): NORTH: NA
EAST: NA
SURFACE ELEVATION (FTMSL):
DRILLER CODE: Discovery Drilling-Kyle Brown
CONSTRUCTION METHOD: B
DATE STARTED: 7/29/89
DATE COMPLETED: 7/29/89
BOREHOLE DEPTH (FT.): 19.5
BOREHOLE DIAM. (IN.): 10

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (FT)
7/29/89	1305	10.0
7/29/89	1412	10.0
7/30/89	0827	8.3

LOCATION DESCRIPTION: On north side of access road, upgradient of ROM8 Landfill

MAP REFERENCE ID:
LOCATION CROSS REFERENCE:

LITHOLOGIC LOG

LOGGER CODE: T.R

DEPTH (FT)	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	SAMPLE METHOD	SAMPLE ID	BLOW COUNT (PER 6")	N VALUE	CLASS/CODE USC	VISUAL DESCRIPTION
0 - 11	—	—	—	—	—	—	N/A	OTHR	Road embankment material and granitic sediments
11 - 12.5	1.5'	0.8'	—	U	N/A	6/6/6	N/A	OTHR	Mixture of coarse grained biotite-rich granitic rock fragments, and angular fine to coarse grained granitic sand, some silt, little clay, wet
									Large granitic blocks encountered at 8.5' - 10.5' and 14' - 15.5' (drilled through blocks with air percussion rotary drill string inside hollow stem auger)

LOCATION PROXIMITY (LPRCODE)
I - WITHIN INSTALLATION
O - OUTSIDE INSTALLATION

CLASS/CODE - SEE SRTCODE LIST, THEN APPROPRIATE CODE LIST

CONSTRUCTION METHODS (CMCCODE)
- R - AIR ROTARY
- B - BORED OR AUGERED
- C - CABLE-TOOL
- D - DUG
- HS - HOLLOW STEM AUGER
- J - JETTED
- P - AIR-PERCUSSION
- RM - REVERSE ROTARY, MUD
- T - TRENCHING
- V - DRIVEN
- W - DRIVE AND WASH

SAMPLE METHODS (SSMCODE)
- A - AUGER CUTTINGS
- S - 2" O.D. 1.38" I.D. DRIVE SAMPLE
- U - 3" O.D. 2.42" I.D. TUBE SAMPLE
- T - 3" O.D. THIN-WALLED SHELBY TUBE
- O - OTHER, GRAB SAMPLE

BOREHOLE LOG (SOIL)

INSTALLATION ID: CAPRM
LOCATION ID: ROM - 8 - MW2
LOCATION TYPE: BH
LOCATION PROXIMITY: I
COORDINATES (FT): NORTH: NA
EAST: NA
SURFACE ELEVATION (FTMSL):
DRILLER CODE: Discovery Drilling-Kyle Brown
CONSTRUCTION METHOD: B
DATE STARTED: 7/30/89
DATE COMPLETED: 7/30/89
BOREHOLE DEPTH (FT.): 12.3
BOREHOLE DIAM. (IN.): 10

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (FT)
7/30/89	0915	10.0 (in auger)
7/30/89	1135	10.0 (in auger)
7/30/89	1245	7.3 (in well)

LOCATION DESCRIPTION: On north side of access road, upgradient of and immediately across from ROM8 Landfill

LOCATION CROSS REFERENCE:
MAP REFERENCE ID:
LOGGER CODE: T.R.

LITHOLOGIC LOG

DEPTH (FT)	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	SAMPLE METHOD	SAMPLE ID	BLOW COUNT (PER 6")	N VALUE	CLASS/ CODE USC	VISUAL DESCRIPTION
0 - 10	—	—	—	—	—	—	N/A	OTHR	Road embankment material and granitic sediments
10 - 11.5	1.5'	0.8'	—	U	N/A	8/8/3	N/A	OTHR	Mixture of coarse grained granitic rock fragments (coarse grained biotite-rich granitic rock) and fine to coarse grained granitic sand, angular fragments, some silt and clay
									Large granitic blocks at 5' - 7', and at 12.8' (T.D.) deepest penetration (drilled through blocks with air percussion rotary drill string inside hollow stem auger)

CLASS/CODE - SEE SRTCODE LIST, THEN APPROPRIATE CODE LIST

LOCATION PROXIMITY (LPRCODE)
I - WITHIN INSTALLATION
O - OUTSIDE INSTALLATION

CONSTRUCTION METHODS (CMCCODE)
AR - AIR ROTARY
B - BORED OR AUGERED
C - CABLE-TOOL
D - DUG
HS - HOLLOW STEM AUGER
J - JETTED
P - AIR-PERCUSSION
RM - REVERSE ROTARY, MUD
T - TRENCHING
V - DRIVEN
W - DRIVE AND WASH

SAMPLE METHODS (SSMCODE)
A - AUGER CUTTINGS
S - 2" O.D. 1.38" I.D. DRIVE SAMPLE
U - 3" O.D. 2.42" I.D. TUBE SAMPLE
T - 3" O.D. THIN-WALLED SHELBY TUBE
O - OTHER, GRAB SAMPLE

BOREHOLE LOG (SOIL)

INSTALLATION ID: CAPRM
LOCATION ID: ROM - 8 - MW3
LOCATION TYPE: BH
LOCATION PROXIMITY: I
COORDINATES (FT): NORTH: NA
EAST: NA
SURFACE ELEVATION (FTMSL):
DRILLER CODE: Discovery Drilling-Kyle Brown
CONSTRUCTION METHOD: B
DATE STARTED: 7/30/89
DATE COMPLETED: 7/31/89
BOREHOLE DEPTH (FT.): 14.4
BOREHOLE DIAM. (IN.): 10

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (FT)
7/30/89	1758	8.5
7/31/89	0900	8.25

LOCATION DESCRIPTION
On south end of lower lift of ROM8 Landfill.
Downgradient of Landfill

MAP REFERENCE ID:
LOCATION CROSS REFERENCE:

LITHOLOGIC LOG

LOGGER CODE: T.R.

DEPTH (FT)	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	SAMPLE METHOD	SAMPLE ID	BLOW COUNT (PER 6")	N VALUE	CLASS/ CODE USC	VISUAL DESCRIPTION
- 6.3	—	—	—	A	N/A	—	N/A	FILL	Landfill material - misc wood and
									plastic mixed with granitic sand
.3 - 14.4	—	—	—	A	N/A	—	N/A	OTHR	Mixed granitic sand/silt/clay and
									large 1.0' - 2.0' (vertical dimension)
									granitic blocks
									Blocks from 6.3' - 7.4' and
									7.5' to 8.5' (soft)

LOCATION PROXIMITY (LPRCODE)
I - WITHIN INSTALLATION
O - OUTSIDE INSTALLATION

CLASS/CODE - SEE SRTCODE LIST, THEN APPROPRIATE CODE LIST

NSTRUCTION METHODS (CMCCODE)
- AIR ROTARY
B - BORED OR AUGERED
C - CABLE-TOOL
D - DUG
HS - HOLLOW STEM AUGER
J - JETTED
P - AIR-PERCUSSION
RM - REVERSE ROTARY, MUD
T - TRENCHING
V - DRIVEN
W - DRIVE AND WASH

SAMPLE METHODS (SSMCODE)
A - AUGER CUTTINGS
S - 2" O.D. 1.38" I.D. DRIVE SAMPLE
U - 3" O.D. 2.42" I.D. TUBE SAMPLE
T - 3" O.D. THIN-WALLED SHELBY TUBE
O - OTHER, GRAB SAMPLE

BOREHOLE LOG (SOIL)

INSTALLATION ID CAPRM
LOCATION ID ROM - 8 - MW4
LOCATION TYPE BH
LOCATION PROXIMITY I
COORDINATES (FT): NORTH NA
EAST NA
SURFACE ELEVATION (FTMSL)
DRILLER CODE Discovery Drilling-Kyle Brown
CONSTRUCTION METHOD B
DATE STARTED 7/31/89
DATE COMPLETED 7/31/89
BOREHOLE DEPTH (FT.) 10.0
BOREHOLE DIAM. (IN.) 10

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (FT)
7/31/89	1405	8.3 (in auger)
7/31/89	1520	5.5 (in well casing)

LOCATION DESCRIPTION
On south east side of lower lift of ROM8 Landfill. Downgradient of Landfill

MAP REFERENCE ID
LOCATION CROSS REFERENCE
LOGGER CODE T.R.

LITHOLOGIC LOG

DEPTH (FT)	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	SAMPLE METHOD	SAMPLE ID	BLOW COUNT (PER 6")	N VALUE	CLASS/CODE USC	VISUAL DESCRIPTION
0 - 5.0	—	—	—	A	N/A	—	N/A	FILL	Landfill material - wood, metal cans, metal pipe, rubber tires, granitic rock fragments and sand
5 - 10.0	0.2'	0.2'	—	U	N/A	25 for 0.2'	N/A	OTHR	Granitic colluvium - mixed rock fragments and sand/silt/clay

LOCATION PROXIMITY (LPRCODE)
I - WITHIN INSTALLATION
O - OUTSIDE INSTALLATION

CLASS/CODE - SEE SRTCODE LIST, THEN APPROPRIATE CODE LIST

CONSTRUCTION METHODS (CMCCODE)
AR - AIR ROTARY
B - BORED OR AUGERED
C - CABLE-TOOL
D - DUG
HS - HOLLOW STEM AUGER
J - JETTED
P - AIR-PERCUSSION
RM - REVERSE ROTARY, MUD
T - TRENCHING
V - DRIVEN
W - DRIVE AND WASH

SAMPLE METHODS (SSMCODE)
A - AUGER CUTTINGS
S - 2" O.D. 1.38" I.D DRIVE SAMPLE
U - 3" O.D. 2.42" I.D. TUBE SAMPLE
T - 3" O.D. THIN-WALLED SHELBY TUBE
O - OTHER, GRAB SAMPLE

TAB

Appendix B

APPENDIX B
LABORATORY SOIL AND WATER SAMPLES
ANALYTICAL RESULTS

APPENDIX B
LABORATORY SOIL AND WATER SAMPLES
ANALYTICAL RESULTS

This appendix reports the results of analyses for all samples collected during August and September, 1989. Analytes excluded from the lists are those determined to be laboratory contaminants, those which had no values reported above the detection limit, or those water quality parameters not considered contaminants.

The laboratory contaminants are acetone, bis(2-ethyl-hexyl)phthalate, dichlorodifluoromethane, di-n-octyl phthalate, methylene chloride, and toluene.

In soil samples, analytes for which no values were reported above the detection limit were the organics in EPA method 8240 and method 8270 and the metals in EPA method 6010 antimony, molybdenum, silver, and thallium. The other inorganics (anions) in method 6010, calcium, magnesium, potassium, and sodium, had reported values over the detection limit yet they are not listed here because they are not considered contaminants. All organochlorine pesticides/PCBs in EPA method 8080 except for alpha-BHC and Aroclor 1260 were excluded as well, because no values above detection limits were reported.

In water samples, all halogenated volatile organics in EPA method 601 (8010) except for 1,1-dichloroethane and 1,4-dichlorobenzene, all aromatic volatile organics in EPA method 602(8020) except for xylenes, and all semivolatile organics in EPA method 625(8270) except for 4-methylphenol were excluded from this listing. All these compounds were excluded because no values above detection limits were reported. All organochlorine pesticides/PCBs in EPA method 608(8080) except for alpha-BHC and Aroclor 1260 were excluded because no values above the detection limits were reported. The metals in EPA method 6010 antimony, arsenic, molybdenum, silver, and thallium were excluded as well, also because no values above the detection limits were reported. The other inorganics (anions and cations) in method 6010, calcium, magnesium, potassium, selenium, and sodium had reported values over the detection limit yet they are not listed here because they are considered non-contaminants.

Table B-1

LABORATORY ANALYSIS SUMMARY FOR SOIL SAMPLES TAKEN AT CAPE ROMANZOF (results reported in mg/kg)

SAMPLE ID	DATE	ANALYSES	ANALYTICAL RESULTS						
			Aluminum	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper
ROM1-G-SE-N-1	8/12/89	418.1, 6010, 8240, 8270, 8080	8540	54	ND	ND	16	4	9
ROM1-G-SE-N-2	8/12/89	418.1, 6010, 8240, 8270, 8080	8330	48	ND	ND	13	4	8
ROM1-G-SE-N-3	8/12/89	418.1, 6010, 8240, 8270, 8080	6340	52	ND	ND	12	4	4
ROM1D-SC-SO-N-1	8/10/89	418.1, 6010, 8240, 8270, 8080	11200	50	0.20	ND	20	5	12
ROM1D-SC-SO-N-2	8/10/89	418.1, 6010, 8240, 8270, 8080	7400	51	ND	ND	16	5	10
ROM1S-SC-SO-N-3	8/10/89	418.1, 8270, 8240	NA	NA	NA	NA	NA	NA	NA
ROM1S-SC-SO-N-4	8/10/89	418.1, 8270, 8240	NA	NA	NA	NA	NA	NA	NA
ROM1S-SC-SO-N-5	8/10/89	418.1, 8270, 8240	NA	NA	NA	NA	NA	NA	NA
ROM1S-SC-SO-N-6	8/10/89	418.1, 8270, 8240	NA	NA	NA	NA	NA	NA	NA
ROM3-SC-SO-N-1	8/10/89	418.1, 6010, 8240, 8270, 8080	6300	49	ND	ND	16	6	88
ROM3-SC-SO-N-2	8/10/89	418.1, 6010, 8240, 8270, 8080	7000	73	ND	ND	15	ND	13
ROM3-SC-SO-FR-2	8/10/89	418.1, 6010, 8240, 8270, 8080	7500	83	ND	ND	18	ND	13
ROM3-SC-SO-N-3	8/10/89	418.1, 6010, 8240, 8270, 8080	5600	89	ND	ND	15	ND	16
ROM3-SC-SO-N-4	8/10/89	418.1, 6010, 8240, 8270, 8080	9500	49	ND	ND	15	ND	18
ROM3-SC-SE-N-5	8/10/89	418.1, 6010, 8240, 8270, 8080	6100	67	ND	ND	16	ND	15
ROM4-G-SO-N-1	8/13/89	418.1, 6010, 8240, 8270, 8080	7900	68	0.20	ND	27	5	14
ROM4-G-SO-N-2	8/14/89	418.1, 8080	NA	NA	NA	NA	NA	NA	NA
ROM5-G-SE-N-1	8/13/89	418.1, 6010, 8240, 8270, 8080	5900	61	ND	ND	15	ND	5
ROM8-G-SE-N-1	8/10/89	418.1, 6010, 8240, 8270, 8080	5700	41	ND	ND	12	ND	8
ROM8-G-SE-N-2	8/10/89	418.1, 6010, 8240, 8270, 8080	4000	36	ND	ND	10	ND	7
ROM8-G-SE-N-3	8/10/89	418.1, 6010, 8240, 8270, 8080	1500	44	ND	5	ND	ND	ND
ROM8-G-SE-N-4	8/10/89	418.1, 6010, 8240, 8270, 8080	1200	35	ND	7	19	ND	16
ROM8-G-SE-FR-4	8/10/89	418.1, 6010, 8240, 8270, 8080	2600	34	ND	4	7	ND	9
ROM8-G-SE-N-5	8/10/89	418.1, 6010, 8240, 8270, 8080	4500	42	ND	ND	9	ND	24
ROM8-G-SE-N-9	8/13/89	418.1, 6010, 8240, 8270, 8080	3560	29	ND	ND	7	ND	5
ROM8-G-SE-N-10	9/29/89	418.1, 6010, 8240, 8270, 8080	3900	38	ND	ND	9	ND	6
ROM8-G-SE-FR-10	9/29/89	418.1, 6010, 8240, 8270, 8080	4400	42	ND	ND	10	ND	9
ROM8-G-SO-N-15	8/14/89	418.1, 6010, 8240, 8270, 8080	7100	58	ND	ND	15	ND	10
ROM10-G-SO-N-1	8/14/89	418 1	NA	NA	NA	NA	NA	NA	NA
ROM12-G-SE-N-1	8/13/89	418.1, 6010, 8240, 8270, 8080	595	10	ND	ND	ND	ND	ND
ROM12-G-SO-N-2	8/13/89	418.1, 6010, 8240, 8270, 8080	3880	36	ND	ND	14	ND	4
ROM12-G-SO-N-3	8/14/89	418.1, 6010, 8240, 8270, 8080	7600	45	ND	ND	13	ND	7
DETECTION LIMIT			20	1	0 20	2	4	4	3

See last page for footnotes and abbreviations

Table B-1

LABORATORY ANALYSIS SUMMARY FOR SOIL SAMPLES TAKEN AT CAPE ROMANZOF (results reported in mg/kg) (continued)

SAMPLE ID	ANALYTICAL RESULTS									
	Iron	Lead	Manganese	Nickel	Vanadium	Zinc	BHC,alpha	PCB	Xylene	TPH
ROM1-G-SE-N-1	14000	24	170	12	26	35	ND	ND	ND	170
ROM1-G-SE-N-2	12100	ND	148	10	24	89	ND	ND	33.0	3500
ROM1-G-SE-N-3	11300	ND	165	10	21	34	ND	ND	ND	380
ROM1D-SC-SO-N-1	16900	ND	290	11	35	33	ND	ND	ND	ND
ROM1D-SC-SO-N-2	12200	ND	180	11	24	28	ND	ND	ND	30
ROM1S-SC-SO-N-3	NA	NA	NA	NA	NA	NA	NA	NA	ND	5000
ROM1S-SC-SO-N-4	NA	NA	NA	NA	NA	NA	NA	NA	ND	9100
ROM1S-SC-SO-N-5	NA	NA	NA	NA	NA	NA	NA	NA	ND	1500
ROM1S-SC-SO-N-6	NA	NA	NA	NA	NA	NA	NA	NA	ND	17000
ROM3-SC-SO-N-1	25600	26	200	30	25	120	ND	ND	ND	9700
ROM3-SC-SO-N-2	10100	79	110	10	22	50	ND	ND	ND	30000
ROM3-SC-SO-FR-2	10400	63	120	10	24	58	ND	ND	ND	28000
ROM3-SC-SO-N-3	8600	49	120	11	18	32	ND	ND	ND	35000
ROM3-SC-SO-N-4	13200	ND	140	9	30	33	ND	ND	ND	9000
ROM3-SC-SE-N-5	10700	160	130	9	22	56	ND	0.39	ND	2400
ROM4-G-SO-N-1	12900	89	163	11	27	81	ND	ND	ND	380
ROM4-G-SO-N-2	NA	NA	NA	NA	NA	NA	ND	ND	NA	100
ROM5-G-SE-N-1	10000	ND	130	10	21	23	ND	ND	ND	100
ROM8-G-SE-N-1	9900	ND	110	8	21	25	ND	ND	ND	54
ROM8-G-SE-N-2	7400	ND	130	6	15	16	ND	ND	ND	ND
ROM8-G-SE-N-3	91200	48	140	2.5 (d)	6	100	ND	ND	ND	97
ROM8-G-SE-N-4	78100	430	250	14	5	370	ND	ND	ND	2500
ROM8-G-SE-FR-4	22400	65	97	7	10	260	ND	ND	ND	3000
ROM8-G-SE-N-5	14700	62	120	6	14	110	ND	ND	ND	640
ROM8-G-SE-N-9	6150	ND	88	5	12	23	ND	ND	ND	90
ROM8-G-SE-N-10	7200	ND	130	6	14	28	ND	ND	ND	40
ROM8-G-SE-FR-10	8100	ND	150	7	16	31	ND	ND	ND	40
ROM8-G-SO-N-15	11200	150	140	10	24	42	ND	ND	ND	100000
ROM10-G-SO-N-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	4900
ROM12-G-SE-N-1	3310	ND	9	ND	ND	2	ND	ND	ND	50
ROM12-G-SO-N-2	8120	38	52	5	25	35	0.01	0.21	ND	200000
ROM12-G-SO-N-3	10600	ND	81	6	25	31	ND	ND	ND	100000
DETECTION LIMIT	5	20	1	5	4	1	0.01	0.20	0.1	30

See last page for footnotes and abbreviations

Table B-2

LABORATORY ANALYSIS SUMMARY (RECOVERABLE) FOR WATER SAMPLES AT CAPE ROMANZOF (micrograms/liter, except for metals and TPH in mg/L)

SAMPLE ID	DATE	ANALYSES	ANALYTICAL RESULTS				
			Aluminum	Barium	Beryllium	Cadmium	Chromium
ROM1S-B-WG-N-1	8/12/89	418.1, 8010, 8020, 8270, 8080, 6010	0.3	0.03	ND	ND	ND
ROM1S-B-WG-FR-1	8/12/89	418.1, 8010, 8020, 8270, 8080, 6010	0.3	0.03	ND	ND	ND
ROM1S-B-WG-N-2	8/12/89	418.1, 8010, 8020, 8270, 8080, 6010	347.0	6.60	0.009	ND	0.92
ROM3-WF-WP-N-6	8/11/89	418.1, 8010, 8020, 8270, 8080, 6010	ND	ND	ND	ND	ND
ROM3-G-WS-N-7	8/11/89	418.1, 8010, 8020, 8270, 8080, 6010	ND	ND	ND	ND	ND
ROM8-G-WS-N-1	8/11/89	418.1, 8010, 8020, 8270, 8080, 6010	ND	ND	ND	ND	ND
ROM8-G-WS-N-2	8/11/89	418.1, 8010, 8020, 8270, 8080, 6010	ND	0.01	ND	ND	ND
ROM8-G-WS-N-3	8/11/89	418.1, 8010, 8020, 8270, 8080, 6010	0.3	0.04	ND	ND	ND
ROM8-G-WS-N-3	9/29/89	8080	NA	NA	NA	NA	NA
ROM8-G-WS-N-4	8/11/89	418.1, 8010, 8020, 8270, 8080, 6010	ND	0.01	ND	ND	ND
ROM8-G-WS-N-5	8/11/89	418.1, 8010, 8020, 8270, 8080, 6010	ND	0.10	ND	0.009	ND
ROM8-G-WS-N-6	8/11/89	418.1, 8010, 8020, 8270, 8080, 6010	0.9	0.03	ND	ND	ND
ROM8-G-WS-N-7	8/11/89	418.1, 8010, 8020, 8270, 8080, 6010	ND	0.07	ND	ND	ND
ROM8-G-WS-N-8	8/11/89	418.1, 8010, 8020, 8270, 8080, 6010	ND	0.01	ND	ND	ND
ROM8-G-WS-FR-8	8/11/89	418.1, 8010, 8020, 8270, 8080, 6010	ND	0.01	ND	ND	ND
ROM8-G-WS-N-9	8/13/89	418.1, 8010, 8020, 8270, 8080, 6010	ND	ND	ND	ND	ND
ROM8-G-WS-N-10	8/13/89	418.1, 8010, 8020, 8270, 8080, 6010	ND	ND	ND	ND	ND
ROM8-B-WG-N-11	8/13/89	418.1, 8010, 8020, 8270, 8080, 6010	102.0	0 68	0.003	ND	0.15
ROM8-B-WG-N-12	8/14/89	418.1, 8010, 8020, 8270, 8080, 6010	28.0	0.26	ND	ND	0 06
ROM8-B-WG-N-12	9/29/89	8270, 8080	NA	NA	NA	NA	NA
ROM8-B-WG-N-13	8/14/89	418.1, 8010, 8020, 8270, 8080, 6010	2 5	0.13	ND	0.006	ND
ROM8-B-WG-N-13	9/29/89	8270, 8080	NA	NA	NA	NA	NA
ROM8-B-WG-N-14	8/14/89	418.1, 8010, 8020, 8270, 8080, 6010	7.3	0.13	ND	ND	ND
ROM8-B-WG-N-14	9/29/89	8270, 8080	NA	NA	NA	NA	NA
ROM12-G-WS-N-1	8/13/89	418.1, 8010, 8020, 8270, 8080, 6010	ND	0.01	ND	ND	ND
QUALITY ASSURANCE/QUALITY CONTROL:							
ROM1S-EB-1	8/12/89	8010, 8020	ND	0.01	ND	ND	ND
ROM1S-AB-1	8/12/89	8010, 8020	NA	NA	NA	NA	NA
ROM8-B-WS-EB-1	8/13/89	418.1, 6010, 8080, 8270	ND	ND	ND	ND	ND
ROM8-B-WG-EB-2	9/29/89	8270, 8080	NA	NA	NA	NA	NA
DETECTION LIMIT			0.2	0.01	0.002	0.005	0.03

See last page for footnotes and abbreviations

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Table B-2

LABORATORY ANALYSIS SUMMARY (RECOVERABLE) FOR WATER SAMPLES AT CAPE ROMANZOF (micrograms/liter, except for metals and TPH in mg/L)

SAMPLE ID	ANALYTICAL RESULTS								
	Cobalt	Copper	Iron	Lead	Manganese	Nickel	Vanadium	Zinc	BHC,alpha
ROM1S-B-WG-N-1	ND	ND	5.40	ND	0.44	ND	ND	0.09	0.093
ROM1S-B-WG-FR-1	ND	ND	3.80	ND	0.24	ND	ND	0.09	ND
ROM1S-B-WG-N-2	0.20	0.36	710.00	ND	10.00	0.54	0.98	4.20	ND
ROM3-WF-WP-N-6	ND	ND	0.09	ND	ND	ND	ND	0.03	ND
ROM3-G-WS-N-7	ND	ND	ND	ND	ND	ND	ND	ND	ND
ROM8-G-WS-N-1	ND	ND	ND	ND	ND	ND	ND	0.02	ND
ROM8-G-WS-N-2	ND	ND	0.13	ND	ND	ND	ND	ND	ND
ROM8-G-WS-N-3	ND	ND	24.00	ND	0.33	ND	ND	0.06	ND
ROM8-G-WS-N-3	NA	NA	NA	NA	NA	NA	NA	NA	ND
ROM8-G-WS-N-4	ND	ND	1.80	ND	0.04	ND	ND	0.02	ND
ROM8-G-WS-N-5	ND	ND	25.00	ND	1.10	ND	ND	0.07	ND
ROM8-G-WS-N-6	ND	ND	1.80	ND	0.20	ND	ND	0.07	ND
ROM8-G-WS-N-7	ND	ND	4.40	ND	0.48	ND	ND	0.06	ND
ROM8-G-WS-N-8	ND	ND	0.59	ND	0.02	ND	ND	0.01	ND
ROM8-G-WS-FR-8	ND	ND	1.80	ND	0.04	ND	ND	0.02	ND
ROM8-G-WS-N-9	ND	ND	ND	ND	ND	ND	ND	0.01	ND
ROM8-G-WS-N-10	ND	ND	0.08	ND	ND	ND	ND	0.05	ND
ROM8-B-WG-N-11	0.04	0.08	116.00	ND	2.10	0.10	0.23	0.29	ND
ROM8-B-WG-N-12	ND	ND	30.00	ND	1.90	0.04	0.07	0.08	ND
ROM8-B-WG-N-12	NA	NA	NA	NA	NA	NA	NA	NA	ND
ROM8-B-WG-N-13	ND	ND	8.70	ND	2.70	ND	ND	0.06	ND
ROM8-B-WG-N-13	NA	NA	NA	NA	NA	NA	NA	NA	ND
ROM8-B-WG-N-14	ND	0.08	41.00	ND	0.63	0.02	ND	0.16	ND
ROM8-B-WG-N-14	NA	NA	NA	NA	NA	NA	NA	NA	ND
ROM12-G-WS-N-1	ND	ND	3.10	ND	0.04	ND	ND	0.05	ND
ROM1S-EB-1	ND	ND	ND	ND	ND	ND	ND	ND	ND
ROM1S-AB-1	NA	NA	NA	NA	NA	NA	NA	NA	NA
ROM8-G-WS-EB-1	ND	ND	ND	ND	ND	ND	ND	ND	ND
ROM8-B-WG-EB-2	NA	NA	NA	NA	NA	NA	NA	NA	ND
DETECTION LIMIT	0.04	0.03	0.05	0.20	0.01	0.01	0.04	0.01	0.050

See last page for footnotes and abbreviations

Table B-2

LABORATORY ANALYSIS SUMMARY (RECOVERABLE) FOR WATER SAMPLES AT CAPE ROMANZOF (micrograms/liter, except for metals and TPH in mg/L)									
SAMPLE ID	ANALYTICAL RESULTS								
	DCA, 1,1-	DCB,1,4-	M-phenol-4	PCB	TCA, 1,1,1-	Xylene	TPH		
ROM1S-B-WG-N-1	ND	ND	ND	ND	ND	ND	4		
ROM1S-B-WG-FR-1	ND	ND	ND	ND	ND	ND	4		
ROM1S-B-WG-N-2	ND	ND	ND	ND	ND	ND	ND		
ROM3-WF-WP-N-6	ND	ND	ND	ND	ND	ND	2		
ROM3-G-WS-N-7	ND	ND	ND	ND	ND	ND	ND		
ROM8-G-WS-N-1	ND	ND	ND	ND	ND	ND	4		
ROM8-G-WS-N-2	ND	ND	ND	ND	0.84	ND	ND		
ROM8-G-WS-N-3	ND	4.70	ND	ND	1.10	4.0	ND		
ROM8-G-WS-N-3	NA	NA	NA	ND	NA	NA	NA		
ROM8-G-WS-N-4	ND	ND	ND	ND	ND	ND	ND		
ROM8-G-WS-N-5	ND	ND	220	ND	ND	ND	1		
ROM8-G-WS-N-6	ND	ND	ND	2.7	ND	ND	2		
ROM8-G-WS-N-7	ND	ND	ND	ND	ND	ND	ND		
ROM8-G-WS-N-8	ND	ND	ND	ND	ND	ND	ND		
ROM8-G-WS-FR-8	ND	ND	ND	ND	ND	ND	ND		
ROM8-G-WS-N-9	ND	ND	ND	ND	ND	ND	ND		
ROM8-G-WS-N-10	ND	ND	ND	ND	ND	ND	ND		
ROM8-B-WG-N-11	ND	ND	ND	ND	ND	ND	ND		
ROM8-B-WG-N-12	ND	ND	ND	ND	ND	ND	ND		
ROM8-B-WG-N-12	NA	ND (d)	ND	ND	NA	NA	NA		
ROM8-B-WG-N-13	ND	ND	ND	ND	ND	ND	ND		
ROM8-B-WG-N-13	NA	ND (d)	ND	ND	NA	NA	NA		
ROM8-B-WG-N-14	0.45	3.80	ND	ND	6.00	6 7	2		
ROM8-B-WG-N-14	NA	ND (d)	ND	ND	NA	NA	NA		
ROM12-G-WS-N-1	ND	ND	ND	ND	ND	ND	ND		
ROM1S-EB-1	ND	ND	ND	ND	ND	ND	ND		
ROM1S-AB-1	ND	ND	NA	NA	ND	ND	NA		
ROM8-G-WS-EB-1	NA	ND (d)	ND	ND	NA	NA	ND		
ROM8-B-WG-EB-2	NA	ND (d)	ND	ND	NA	NA	NA		
DETECTION LIMIT	0 40	0.50	10	1.0	0 20	2 0	1		

See last page for footnotes and abbreviations

Table B-3

LABORATORY ANALYSIS SUMMARY (DISSOLVED) FOR WATER SAMPLES AT CAPE ROMANZOF (results reported in mg/L)								
			ANALYTICAL RESULTS					
SAMPLE ID	DATE	ANALYSES	Aluminum	Barium	Beryllium	Cadmium	Chromium	Cobalt
ROM1S-B-WG-N-1	8/12/89	6010	ND	0.03	ND	ND	ND	ND
ROM1S-B-WG-FR-1	8/12/89	6010	ND	0.03	ND	0.006	ND	ND
ROM1S-B-WG-N-2	8/12/89	6010	ND	ND	ND	ND	ND	ND
ROM3-WF-WP-N-6	8/11/89	6010	ND	ND	ND	ND	ND	ND
ROM3-G-WS-N-7	8/11/89	6010	ND	ND	ND	ND	ND	ND
ROM8-G-WS-N-1	8/11/89	6010	ND	ND	ND	ND	ND	ND
ROM8-G-WS-N-2	8/11/89	6010	ND	ND	ND	ND	ND	ND
ROM8-G-WS-N-3	8/11/89	6010	ND	ND	ND	ND	ND	ND
ROM8-G-WS-N-4	8/11/89	6010	ND	ND	ND	ND	ND	ND
ROM8-G-WS-N-5	8/11/89	6010	ND	0.08	ND	ND	ND	ND
ROM8-G-WS-N-6	8/11/89	6010	ND	0.02	ND	ND	ND	ND
ROM8-G-WS-N-7	8/11/89	6010	ND	0.07	ND	ND	ND	ND
ROM8-G-WS-N-8	8/11/89	6010	ND	ND	ND	ND	ND	ND
ROM8-G-WS-FR-8	8/11/89	6010	ND	ND	ND	ND	ND	ND
ROM8-G-WS-N-9	8/13/89	6010	ND	ND	ND	ND	ND	ND
ROM8-G-WS-N-10	8/13/89	6010	ND	ND	ND	0.006	ND	ND
ROM8-B-WG-N-11	8/13/89	6010	ND	0.02	ND	ND	ND	ND
ROM8-B-WG-N-12	8/14/89	6010	ND	0.03	ND	ND	ND	ND
ROM8-B-WG-N-13	8/14/89	6010	ND	0 09	ND	ND	ND	ND
ROM8-B-WG-N-14	8/14/89	6010	ND	0.05	ND	ND	ND	ND
ROM12-G-WS-N-1	8/13/89	6010	1.1	0.03	ND	ND	ND	ND
DETECTION LIMIT			0.2	0.01	0.002	0 005	0.03	0 04

See last page for footnotes and abbreviations

Table B-3

LABORATORY ANALYSIS SUMMARY (DISSOLVED) FOR WATER SAMPLES AT CAPE ROMANZOF (results reported in mg/L) (continued)								
SAMPLE ID				ANALYTICAL RESULTS				
	Copper	Iron	Lead	Manganese	Nickel	Vanadium	Zinc	
ROM1S-B-WG-N-1	ND	2.90	ND	0 23	ND	ND	0.13	
ROM1S-B-WG-FR-1	ND	0.54	ND	0 22	ND	ND	0.19	
ROM1S-B-WG-N-2	ND	0.13	ND	0.09	ND	ND	0.04	
ROM3-WF-WP-N-6	ND	ND	ND	ND	ND	ND	0.10	
ROM3-G-WS-N-7	ND	ND	ND	ND	ND	ND	0 06	
ROM8-G-WS-N-1	ND	ND	ND	ND	ND	ND	0 02	
ROM8-G-WS-N-2	ND	ND	ND	ND	ND	ND	0.03	
ROM8-G-WS-N-3	ND	11.00	ND	0.31	ND	ND	0.06	
ROM8-G-WS-N-4	ND	0.83	ND	0.03	ND	ND	0.03	
ROM8-G-WS-N-5	ND	3.90	ND	1.10	ND	ND	0.06	
ROM8-G-WS-N-6	ND	ND	ND	0.01	ND	ND	0.07	
ROM8-G-WS-N-7	ND	0.39	ND	0.46	ND	ND	0.07	
ROM8-G-WS-N-8	ND	0.44	ND	0.02	ND	ND	0.02	
ROM8-G-WS-FR-8	ND	0.43	ND	0.02	ND	ND	0.02	
ROM8-G-WS-N-9	ND	ND	ND	ND	ND	ND	0.04	
ROM8-G-WS-N-10	ND	ND	ND	ND	ND	ND	0.03	
ROM8-B-WG-N-11	ND	0.22	ND	0.14	ND	ND	0.03	
ROM8-B-WG-N-12	ND	ND	ND	1.20	ND	ND	0.04	
ROM8-B-WG-N-13	ND	7.00	ND	2.30	ND	ND	0.09	
ROM8-B-WG-N-14	ND	21.00	ND	0.51	ND	ND	0.06	
ROM12-G-WS-N-1	ND	15.00	ND	0.06	ND	ND	ND	
DETECTION LIMIT	0.03	0.05	0.20	0.01	0.01	0.04	0.01	

See last page for footnotes and abbreviations

EXPLANATION OF ABBREVIATIONS USED IN TABLES B-1, B-2, AND B-3

NA - PARAMETER NOT ANALYZED
ND - NOT DETECTED
(d) - DETECTION LIMIT DIFFERS FROM OTHER ANALYSES

418.1 - TOTAL PETROLEUM HYDROCARBON ANALYSIS
6010 - METALS
8010 - HALOGENATED VOLATILE ORGANICS BY GC
8020 - AROMATIC VOLATILE ORGANICS BY GC
8080 - ORGANOCHLORINE PESTICIDES AND PCBs
8240 - VOLATILE ORGANICS BY GC/MS
8270 - SEMIVOLATILE ORGANICS BY GC/MS

DCA 1,1- = 1,1-DICHLOROETHANE
DCB,1,4- = 1,4-DICHLOROBENZENE
M-phenol-4 = 4-METHYLPHENOL
PCB = POLYCHLORINATED BIPHENYLS
TCA, 1,1,1- = 1,1,1-TRICHLOROETHANE
TPH = TOTAL PETROLEUM HYDROCARBONS

TAB

Appendix C

APPENDIX C

FIELD SAMPLING SUMMARY

Table C - 1
CAPE ROMANZOF LRRS FIELD SAMPLING SUMMARY

SAMPLE I D CAPRM-	DATE SAMPLED	SAMPLER	SAMPLE DEPTH (ft)	SAMPLE MATRIX	SAMPLE DESCRIPTION	SAMPLING METHOD	ANALYSES
ROM1-G-SE-N-001	12-Aug-89	RS	0 17	Sediment	Fill Material	Grab	418.1, 6010, 8240, 8270, 8080, D2216
ROM1-G-SE-N-002	12-Aug-89	RS	0 17	Sediment	Fill Material	Grab	418.1, 6010, 8240, 8270, 8080, D2216
ROM1-G-SE-N-003	12-Aug-89	RS	0 17	Sediment	Fill Material	Grab	418 1, 6010, 8240, 8270, 8080, D2216
ROM1D-SC-SO-N-001	10-Aug-89	RS	1 3	Soil	Fill Material	Grab	418 1, 6010, 8240, 8270, 8080, D2216
ROM1D-SC-SO-N-002	10-Aug-89	RS	1 4	Soil	Fill Material	Grab	418 1, 6010, 8240, 8270, 8080, D2216
ROM1S-B-WG-N-001 (WELL B)	12-Aug-89	RS		Water	Groundwater	Bailer	418 1, 8010, 8020, 8270, 8080, 6010(T & D)
ROM1S-B-WG-FR-001 (WELL B)	12-Aug-89	RS		Water	Groundwater	Bailer	418.1, 8010, 8020, 8270, 8080, 6010(T & D)
ROM1S-B-WG-N-002 (WELL A)	12-Aug-89	RS		Water	Groundwater	Bailer	418.1, 8010, 8020, 8270, 8080, 6010(T & D)
ROM1S-SC-SO-N-003	10-Aug-89	RS	0 42	Soil	Tundra	Grab	418 1, 8270, 8240, D2216
ROM1S-SC-SO-N-004	10-Aug-89	RS	0 5	Soil	Tundra	Grab	418 1, 8270, 8240, D2216
ROM1S-SC-SO-N-005	10-Aug-89	RS	0 5	Soil	Tundra	Grab	418.1, 8270, 8240, D2216
ROM1S-SC-SO-N-006	10-Aug-89	RS	0 5	Soil	Tundra	Grab	418 1, 8270, 8240, D2216
ROM1S-EB-001	12-Aug-89	RS		Water	Aqueous	Bailer	8010, 8020
ROM1S-AB-001	12-Aug-89	RS		Water	Aqueous	Grab	8010, 8020
ROM3-SC-SO-N-001	10-Aug-89	RS	1 35	Soil	Fill Material	Grab	418.1, 6010, 8240, 8270, 8080, D2216
ROM3-SC-SO-N-002	10-Aug-89	RS	1 5	Soil	Fill Material	Grab	418 1, 6010, 8240, 8270, 8080, D2216
ROM3-SC-SO-FR-002	10-Aug-89	RS	1 5	Soil	Fill Material	Grab	418 1, 6010, 8240, 8270, 8080, D2216
ROM3-SC-SO-N-003	10-Aug-89	RS	1 6	Soil	Fill Material	Grab	418 1, 6010, 8240, 8270, 8080, D2216
ROM3-SC-SO-N-004	10-Aug-89	RS	1 4	Soil	Fill Material	Grab	418 1, 6010, 8240, 8270, 8080, D2216
ROM3-SC-SE-N-005	10-Aug-89	RS	6	Sediment	Tundra	Grab	418 1, 6010, 8240, 8270, 8080, D2216

see last page for footnotes and description of analyses

Table C - 1
CAPE ROMANZOF LRRS FIELD SAMPLING SUMMARY (continued)

SAMPLE I D CAPRM-	DATE SAMPLED	SAMPLER	SAMPLE DEPTH (ft)	SAMPLE MATRIX	SAMPLE DESCRIPTION	SAMPLING METHOD	ANALYSES
ROM3-WF-WP-N-006 (WATER SUPPLY WELL)	11-Aug-89	RS		Water	Groundwater	Bailer	418.1, 8010, 8020, 8270, 8080, 6010(T & D)
ROM3-G-WS-N-007 (LAKE)	11-Aug-89	RS		Water	Surface Water	Grab	418.1, 8010, 8020, 8270, 8080, 6010(T & D)
ROM4-G-SO-N-001	13-Aug-89	RS		Soil	Fill Material	Grab	418 1, 6010, 8240, 8270, 8080, D2216
ROM4-G-SO-N-002	14-Aug-89	RS		Soil	Fill Material	Grab	418 1, 8080, D2216
ROM5-G-SE-N-001	13-Aug-89	RS		Sediment	Fill Material	Grab	418 1, 6010, 8240, 8270, 8080, D2216
ROM8-G-SE-N-001	10-Aug-89	RS		Sediment	Silty Sand	Grab	418.1, 6010, 8240, 8270, 8080, D2216
ROM8-G-WS-N-001	11-Aug-89	RS		Water	Surface water	Grab	418 1, 8010, 8020, 8270, 8080, 6010(T & D)
ROM8-G-SE-N-002	10-Aug-89	RS		Sediment	Silty Sand	Grab	418 1, 6010, 8240, 8270, 8080, D2216
ROM8-G-WS-N-002	11-Aug-89	RS		Water	Surface water	Grab	418 1, 8010, 8020, 8270, 8080, 6010(T & D)
ROM8-G-SE-N-003	10-Aug-89	RS		Sediment	Silty Sand	Grab	418.1, 6010, 8240, 8270, 8080, D2216
ROM8-G-WS-N-003	11-Aug-89	RS		Water	Surface water	Grab	418 1, 8010, 8020, 8270, 8080, 6010(T & D)
ROM8-G-WS-N-003*	29-Sep-89	RS		Water	Surface water	Grab	8080
ROM8-G-SE-N-004	10-Aug-89	RS		Sediment	Silt w/ organic matter	Grab	418.1, 6010, 8240, 8270, 8080, D2216
ROM8-G-SE-FR-004	10-Aug-89	RS		Sediment	Silt w/ organic matter	Grab	418 1, 6010, 8240, 8270, 8080, D2216
ROM8-G-WS-N-004	11-Aug-89	RS		Water	Surface water	Grab	418.1, 8010, 8020, 8270, 8080, 6010(T & D)
ROM8-G-SE-N-005	10-Aug-89	RS		Sediment	Silty Sand	Grab	418 1, 6010, 8240, 8270, 8080, D2216
ROM8-G-WS-N-005	11-Aug-89	RS		Water	Surface water	Grab	418 1, 8010, 8020, 8270, 8080, 6010(T & D)
ROM8-G-WS-N-006	11-Aug-89	RS		Water	Surface water	Grab	418 1, 8010, 8020, 8270, 8080, 6010(T & D)
ROM8-G-WS-N-007	11-Aug-89	RS		Water	Surface water	Grab	418 1, 8010, 8020, 8270, 8080, 6010(T & D)

see last page for footnotes and description of analyses

Table C - 1

CAPE ROMANZOF LRRS FIELD SAMPLING SUMMARY (continued)

SAMPLE I D CAPRM-	DATE SAMPLED	SAMPLER	SAMPLE DEPTH (ft)	SAMPLE MATRIX	SAMPLE DESCRIPTION	SAMPLING METHOD	ANALYSES
ROM8-G-WS-N-008	11-Aug-89	RS		Water	Surface water	Grab	418 1, 8010, 8020, 8270, 8080, 6010(T & D)
ROM8-G-WS-FR-008	11-Aug-89	RS		Water	Surface water	Grab	418 1, 8010, 8020, 8270, 8080, 6010(T & D)
ROM8-G-SE-N-009	13-Aug-89	RS		Sediment	Silty Sand	Grab	418 1, 6010, 8240, 8270, 8080, D2216
ROM8-G-WS-N-009	13-Aug-89	RS		Water	Surface water	Grab	418 1, 8010, 8020, 8270, 8080, 6010(T & D)
ROM8-G-SE-N-010	13-Aug-89	RS		Sediment	Silty Sand	Grab	418 1, 6010, 8240, 8270, 8080, D2216
ROM8-G-SE-N-010*	29-Sep-89	RS		Sediment	Silty Sand	Grab	418 1, 6010, 8240, 8270, 8080, D2216
ROM8-G-SE-FR-010	29-Sep-89	RS		Sediment	Silty Sand	Grab	418 1, 6010, 8240, 8270, 8080, D2216
ROM8-G-WS-N-010	13-Aug-89	RS		Water	Surface water	Grab	418 1, 8010, 8020, 8270, 8080, 6010(T & D)
ROM8-B-WG-N-011 (WELL MW2)	13-Aug-89	RS		Water	Groundwater	Bailer	418 1, 8010, 8020, 8270, 8080, 6010(T & D)
ROM8-B-WG-N-012 (WELL MW1)	14-Aug-89	RS	9 05	Water	Groundwater	Bailer	418 1, 8010, 8020, 8270, 8080, 6010(T & D)
ROM8-B-WG-N-012* (WELL MW1)	29-Sep-89	RS	8 77	Water	Groundwater	Bailer	8080, 8270
ROM8-B-WG-N-013 (WELL MW3)	14-Aug-89	RS	11 17	Water	Groundwater	Bailer	418.1, 8010, 8020, 8270, 8080, 6010(T & D)
ROM8-B-WG-N-013* (WELL MW3)	29-Sep-89	RS	10 92	Water	Groundwater	Bailer	8080, 8270
ROM8-B-WG-N-014 (WELL MW4)	14-Aug-89	RS	8 33	Water	Groundwater	Bailer	418 1, 8010, 8020, 8270, 8080, 6010(T & D)
ROM8-B-WG-N-014* (WELL MW4)	29-Sep-89	RS	6 53	Water	Groundwater	Bailer	8080, 8270
ROM8-G-SO-N-015	14-Aug-89	RS		Soil	Fill Material Sandy silt under transformer	Grab	418 1, 6010, 8240, 8270, 8080, D2216
ROM8-G-WS-EB-001	13-Aug-89	RS		Water	Surface Water	Grab	418.1, 8010, 8020, 8270, 8080, 6010(T & D)
ROM10-G-SO-N-001	14-Aug-89	RS		Soil	Sandy Silt	Grab	418 1, D2216
ROM12-G-SE-N-001	13-Aug-89	RS		Sediment	Silty Sand	Grab	418 1, 6010, 8240, 8270, 8080, D2216
ROM12-G-WS-N-001	13-Aug-89	RS		Water	Surface Water	Grab	418.1, 8010, 8020, 8270, 8080, 6010(T & D)

see last page for footnotes and description of analyses

Table C - 1
CAPE ROMANZOF LRRS FIELD SAMPLING SUMMARY (concluded)

SAMPLE I D CAPRM-	DATE SAMPLED	SAMPLER	SAMPLE DEPTH (ft)	SAMPLE MATRIX	SAMPLE DESCRIPTION	SAMPLING METHOD	ANALYSES
ROM12-G-SO-N-002	13-Aug-89	RS		Soil	Blackened Sandy Silt	Grab	418 1, 6010, 8240, 8270, 8080, D2216
ROM12-G-SO-N-003	14-Aug-89	RS		Soil	Blackened Sandy Silt	Grab	418 1, 6010, 8240, 8270, 8080, D2216

* - Resampled for these analytes because of laboratory holding time exceedences of the August 1989 samples
Sample I D Number
ROM-8 = Site Designation at Cape Romanzof LRRS
G, B, SC = Method of Collection Grab, Bailer, or Scraped side of Excavation
SO, SE, WS, WG = Matrix soil, sediment, surface water, or groundwater
N, FR, EB, AB = Type of sample Normal, field replicate, equipment blank, or ambient conditions blank
001 = Sample number at that location

D2216 - Soil Moisture Content
418 1 - Total Petroleum Hydrocarbons
6010 - Metals
6010(T&D) - Metals (Total & Dissolved)
8010 - Halogenated Volatile Organics by GC
8020 - Aromatic Volatile Organics by GC
8240 - Volatile Organics by GC/MS
8270 - Semivolatile Organics by GC/MS
8080 - Organochlorine Pesticides and PCBs

TAB

Appendix D

APPENDIX D
LIST OF COST ESTIMATING ASSUMPTIONS

APPENDIX D

LIST OF COST ESTIMATING ASSUMPTIONS

Contractor personnel for oversight of field remedial and sampling activities will travel from Anchorage, Alaska. Labor rates are estimated at $95 per hour. Airfare is estimated to be $900 round trip, and per diem at $10/day (based on cost of accommodations at Cape Romanzof LRSS).

Alternatives requiring excavation of contaminated soils will use an on-site gas chromatograph to identify the areal and vertical extent of excavation required to remove contaminated soil. Off-site laboratory analysis will confirm the on-site gas chromatographic results.

Air transportation rates are based on communications with Mark Air, Inc. of Anchorage, Alaska.

Heavy equipment rental and operation rates are based on communications with various suppliers in the Anchorage area.

Labor and equipment costs for earthwork construction are based on productivity guidelines established by R.S. Means, Inc. and on engineering judgement and experience.

Site construction labor rates are estimated at $50/hour and include pro-rated per diem expenses.

Laboratory analysis costs are estimated to be:

TPH .... $ 75/sample
PCB $333/sample
Sample shipment $120/cooler

Discount rate for present worth calculations is assumed to be 5 percent before taxes and after inflation.

TAB

Appendix E

APPENDIX E

STATEMENT OF WORK FOR CAPE ROMANZOF AFS. AK

F33615-85-D-4544, PROPOSED ORDER 10, IRP RI/FS STAGE 1,

CAPE ROMANZOF, AK

STATEMENT OF WORK (SOW)

THE INSTALLATION RESTORATION PROGRAM
REMEDIAL INVESTIGATION/FEASIBILITY STUDY (RI/FS)

STAGE 1 FOR

Cape Romanzof AFS, Alaska

I. DESCRIPTION OF WORK

1.1 **Scope.** The objective of the Air Force Installation Restoration Program (IRP) is to assess past hazardous waste disposal and spill sites on Air Force installations and develop remedial actions consistent with the National Contingency Plan (NCP) for those sites which pose a threat to human health and welfare or the environment. The intent is to conduct the remedial investigation and feasibility study in parallel instead of in serial fashion. The USAFOEHL/TS Handbook, Version 2.0, dated April, 1988 (mailed under separate cover), and the Cape Romanzof AFS, AK, Stage 1 Work Plan and Quality Assurance Project Plan (QAPP) are an integral part of this task. All references in this Statement Of Work to the "Handbook" refer to the above version of the USAFOEHL/TS Handbook and imply by reference that it is provided under separate cover. The contractor shall comply with all Handbook, Work Plan and QAPP requirements. Section 1 of the Handbook lists all documents that apply to this Statement of Work (SOW). The contractor shall accomplish the following actions for this stage of the IRP process at Cape Romanzof AFS, AK:

a. literature search,

b. determine public health and environmental requirements,

c. field investigation,

d. baseline risk assessment,

e. develop preliminary alternative remedial actions,

f. initial screening of alternatives,

g. detailed analysis of alternatives,

h. develop Data Quality Objectives (DQOs) for any follow-on effort,

i. prepare Reports, Plans and Decision Documents.

1.2 **Literature Search.** Conduct a literature search to determine the geological, hydrogeological, and environmental settings for this investigation. Requirements are supplied under separate cover (see "Environmental Setting", Section II of the Report Format, contained in Section 3, USAFOEHL/TS Handbook). When gathering information for the demographic setting and conducting the well inventory, consider only those populations and wells within a [redacted] of the installation. Sources include: IRP Phase I Report, Federal and State geological agency reports, academic theses and related university research, municipality and county reports, and historical and current aerial photographs. Cite all bibliographic references reviewed, including personal communications, in the appropriate part of the report. Identify gaps in data or analyses which may prevent an adequate determination of contaminant migration patterns or other factors critical to assessing the hazard potential associated with the individual sites.

1.3 **Public Health and Environmental Requirements.** Review the DQOs developed in the Stage 1 Work Plan and reevaluate the threat of contaminants to public health and welfare or the environment through a literature search of documents. This effort shall satisfy the requirements contained in the Superfund Amendments and Reauthorization Act (SARA) of 1986, to identify all Applicable or Relevant and Appropriate Requirements [redacted] Sources for ARARs are listed in the Handbook, Section 2.

1.4. **Field Investigation.** As used in this SOW, 'field investigation' refers to the collection of all data, environmental and biological samples, and subsequent laboratory analysis of samples. The purpose of data collection, sample collection and laboratory analysis is to determine whether any contaminants generated from installation activities are entering the environment. The field investigation is used to determine the source, extent and migration of any identified contaminants, and the magnitude of contamination relative to ARARs and any naturally occurring or background concentrations for specific compounds. All decisions concerning any aspect of the field investigation shall be made in coordination with the USAFOEHL/TS Technical Program Manager (TPM).

1.4.1 **Quality Assurance/Quality Control (QA/QC).** A quality assurance/quality control (QA/QC) program shall be conducted and documented for ALL work specified in this Delivery Order. The USAFOEHL approved QA/QC program is described in the IRP Stage 1 Quality Assurance Project Plan (QAPP).

1.4.1.1 Data generated under the QA/QC program shall be used to evaluate the analytical results assembled for each site and to formulate conclusions and recommendations pertaining to the need for additional site investigations or remediation.

1.4.1.2 QA/QC requirements for chemical analyses, field operations, laboratory operations, required detection limits, field sampling, sample preservation, sample holding times, equipment decontamination, and chain-of-custody are delineated in the Handbook, Section 12. Project specific QA/QC requirements, if applicable, are described in paragraph 1.4.13, Site-specific Requirements.

1.4.1.3 Annex A, Tables A-4 and A-5 specify the maximum number of field QA/QC samples allowed for each analytical parameter for the entire investigative effort. The distribution of field QA/QC samples by site, sampling round, etc., is specified in the IRP Stage 1 Work Plan.

1.4.2 **Drilling Supervision.** The field investigation (including all drilling and sampling operations) shall be supervised by a [redacted] geologist, engineering geologist, hydrogeologist or [redacted] Engineer [redacted] to install test wells. A detailed log of the conditions and materials penetrated during the course of the work shall be maintained by the geologist/hydrogeologist on site. Decisions on well and boring locations, well depths, screened intervals, and other well construction details shall be made [redacted] the USAFOEHL/TS TPM and the supervising geologist/hydrogeologist.

1.4.3 **Regulatory Requirements and Permits.** All well drilling, development, purging, sampling methods, and other activities pertaining to this effort must conform to State and other applicable regulatory agency requirements. [redacted] an appendix to the Final Report (paragraph I.1.11.1). Complete permits, applications, and other documents which may be required by local and/or State regulatory agencies for the installation of test wells. File these documents with appropriate agencies and pay all applicable permitting and filing fees.

1.4.4 **Borehole Installation.**

1.4.4.1 **Shallow Soil Borings.** Accomplish all borings using a hand [redacted] Conduct a maximum of thirty-two (32) soil borings, not to exceed a total of ninety-six (96) linear feet (see Annex A, Table A-1 for distribution by site). Collect a maximum of forty-one (41) boring samples for laboratory analysis.

1.4.4.2 **Lithologic Samples.** Describe lithology of materials encountered during borings and prepare borehole log descriptions. Correlate materials encountered with the local geology of the area as determined from the literature search. Include boring logs in the Final Report (paragraph I.1.11.1). Monitor all cuttings continuously with a photoionization meter or appropriate organic vapor analyzer ([redacted] and [redacted] the vapor levels detected.

1.4.4.3 **Air Monitoring During Drilling.** Monitor the ambient air during all well drilling and soil boring work with a photoionization meter or appropriate organic vapor analyzer to identify any generation of potentially hazardous and/or toxic vapors or gases. Include air monitoring results in the borehole logs. If soil encountered during borehole drilling or test pit work is suspected to be hazardous because of abnormal discoloration, odor or air monitoring levels, containerize the soil cuttings in new, unused drums. (Note: Contractor is responsible for providing all necessary containers, i.e., 55-gallon drums.) Enter into the boring logs the depth(s) from which suspected contaminated soil cuttings were collected.

1.4.4.4 **Soil Toxicity Sampling.** Collect a maximum of four [redacted] samples, one from the contents of each drum specified in paragraph I.1.4.4.3. Test each composite sample for metals (EP Toxicity, Method SW1310), for volatile organic compounds (Method SW8240), and for base/neutral and acid extractable organic compounds (Method SW3550/SW8270) to determine if the soil cuttings must be disposed of as hazardous waste.

1.4.4.5 **Marking Borehole Locations.** Permanently mark each soil boring location. Record the location on a project map for each specific site or zone, whichever is applicable.

1.4.5 **Well Installation.** Drill a maximum of four (4) wells (see Annex A, Table A-1 for distribution by site). Total footage for all wells in this task shall not exceed one-hundred ninety (190) linear feet. Total screening for all wells in this task shall not exceed forty (40) linear feet.

1.4.5.1 **Well Drilling.** Drill all wells using hollow-stem auger technique(s). Augers, temporary casings and/or boreholes shall be sufficiently large to provide a minimum of 2 inch annular space on all sides of the well casing and screen during well completion. Ensure wells are installed straight, plumb and centered in the borehole. Describe the lithology of materials encountered as described for borings in paragraph I.1.4.4.2. Containerize drill cuttings and test for toxicity as described in paragraphs I.1.4.4.3 and I.1.4.4.4. Avoid installing wells in depressions or areas subject to frequent flooding and/or standing water. If wells must be installed in such areas, design the wells such that standing water does not leak into the top of the casing or cascade down the annular space from a 25 year flood.

1.4.5.2 **Well Casing Requirements.** Construct each shallow well with 4-inch inside diameter (I.D.), Schedule 40, PVC casing. Use threaded screw-type joints only. Glued fittings are not permitted. Flush-thread all connections.

1.4.5.3 **Well Depth.** Install wells at a sufficient depth to collect representative samples of aquifer quality and to intercept contaminants that may be floating or stratified in the aquifer.

1.4.5.4 **Well Screening Requirements.**

a. Screen each shallow well using 4-inch I.D., PVC casing having up to 0.020-inch openings. Screen opening size may be smaller based upon borehole geology or sieve analysis of aquifer materials. Each well screen shall be a maximum of ten (10) feet in length. Cap the bottom of the screen.

b. Screen all wells so as to collect floating contaminants and to allow for all yearly fluctuations of the water table. Screen all wells a minimum of five (5) feet.

c. Once the casing is in place, install the sand/gravel pack. If the formation is compatible with the screen opening size, allow the formation to collapse around the well screen. Supplement with washed and bagged, rounded silica sand or gravel with a grain size distribution compatible with the screen and the formation. Place the pack from the bottom of the borehole to two (2) feet above the top of the screen. The sand/gravel pack should not extend into an overlying formation. Tremie a two (2) foot bentonite seal (granulated or pellets) above the sand/gravel pack. Ensure that the bentonite forms a complete seal. Grout the remainder of the annulus to the land surface with a Type I Portland cement/bentonite slurry. The slurry shall be prepared by adding 3-5 pounds of bentonite and 6.5 gallons of clean water for each 94 pound sack of Type I Portland cement. The bentonite used shall be free of additives that may affect water quality.

1.4.5.5 **Well Completion.** Complete all test wells using the following specifications:

a. Coordinate with the Base Point Of Contact (POC) to determine well completion (flush or projected above the ground surface) requirements.

(1) If well stick-up is of concern in an area, complete the well flush with the land surface. Cut the casing two to three inches below land surface, and install a protective locking lid consisting of a cast-iron valve box assembly. Center the lid assembly in a three (3) foot diameter concrete pad sloped away from the valve box. Ensure that free drainage is maintained within the valve box. Also, provide a screw-type casing cap to prevent infiltration of surface water. Maintain a minimum of one (1) foot clearance between the casing top and the bottom of the valve box. Clearly mark the well number on the valve box lid and well casing using an impact labeling method.

(2) If an above-ground-surface completion is used, extend the well casing two or three feet above land surface. Provide an end plug or casing cap for each well. Shield the extended casing with a steel guard pipe (sleeve) which is placed over the casing and cap and seated in a two-foot by two-foot by four-inch (2' X 2' X 4") concrete surface pad. Slope the pad away from the well sleeve. Install a lockable cap or lid on the guard pipe. Install three (3), three-inch diameter concrete-filled steel guard posts if the base POC determines the well is in an area which needs such protection. The guard posts shall be five (5) feet in total length and installed radially from each wellhead. Recess the guard posts approximately two (2) feet into the ground and set in concrete. Do not install the guard posts in the concrete pad placed at the well base. Fill each guard post with concrete. Clearly mark the well number on the well protective sleeve exterior using paint and/or impact lettering. The base POC will specify color to blend with the paint scheme of the base.

b. All wells shall be secured as soon as possible after drilling. Provide corrosion resistant locks for both flush and above-ground well assemblies. The locks must either have identical keys or be keyed for opening with one master key. Turn the lock keys over to the Base POC following completion of the field effort.

c. Include well completion summaries in the Final Report (paragraph I.1.11.1).

1.4.5.6 **Well Logs.** For each well, prepare a well completion log and schematic diagram showing well construction details. Lithologic descriptions and other information included in the well logs shall conform to the specifications of paragraph I.1.4.4.2.

1.4.5.7 **Well Development.** Develop each well as soon as practical after well completion and grout curing with a submersible pump, bailer, and/or airlift method. Continue well development until the discharge water is clear and free of sediment to the fullest extent possible (ie. turbidity less than 5 NTU). Measure the rate of water production, pH, specific conductance, and water temperature during well development and include this information in the Final Report (paragraph I.1.11.1).

1.4.5.8 **Water Level Measurements.** Measure water levels at all test wells as feet below the measuring point elevation (usually top of casing) to the nearest 0.01 foot. Report as feet above mean sea level (MSL). Measure static water levels in wells prior to well development and before all well purging preceeding sampling events.

1.4.5.9 **Well Abandonment.** Recommend well abandonment method(s) or technique(s) which are applicable to the type of test wells installed and the geological conditions. Consider that these wells will be abandoned at some future date after the study objectives have been met. The actual process of well abandonment is ~~not a part of~~ this task order. Insure that the recommended method(s) is consistent with State and local well abandonment guidelines or regulations.

1.4.6 **Measure Locations.** Determine by ~~tape measure~~, to the nearest foot, the location of all soil augerings and sampling points. Distance shall be measured from some permanent feature or object at the site. Record the positions on both project and site-specific maps.

1.4.7 **Surveying.** Determine by certified land surveyor the elev~~ations and locations of all~~ newly installed ~~test wells, soil~~ borings, and s~~ampling points~~. This shall be a third order survey. Notch the top of the riser casing where well elevations are established. Record the positions on both project and site-specific maps. Bench marks used must have previously been established from, and be traceable to, a US Coast and Geodetic Survey (USCGS) or US Geological Survey (USGS) survey marker. Clearly identify all bench mark locations on the base map.

1.4.8 **Well and Boring Precautions.** Mark the field locations of all test wells and soil borings during the planning/mobilization phase of the field investigation. Consult with the Cape Romanzof POC to minimize disruption of base activities, to properly position wells with respect to site locations, and to avoid underground utilities. Obtain written approval from the station POC prior to commencement of field operations.

1.4.9 **Well and Borehole Cleanup.** Uncontaminated cuttings may be spread over the general area in the vicinity of the well or borehole. Containerize and store cuttings suspected to be hazardous in accordance with paragraph I.1.4.4.3. Transport these drums to an accumulation point within the installation boundary designated by the station POC. Upon determining if any drum contains hazardous waste, the contractor shall label only those drums containing hazardous waste, prepare and sign the manifest documents as an agent for the Air Force. Labelling and packaging of the hazardous waste shall be in accordance with DOT regulations. The contractor is also responsible for ~~transporting [illegible] labelled drums~~ from Cape Romanzof AFS, AK to the Defense Reutilization and Marketing Office ~~(DRMO)~~ located at Elmendorf AFB AK. Air Force guidance for shipment of hazardous material/waste within AAC is provided in regulation AACR 19-7. The 11 TCW is responsible for ultimate disposal of contaminated soils.

1.4.10 **Test Pits.** Employ a [redacted] for a maximum of [redacted] day(s) to conduct test pit evaluations. Describe lithologies encountered during test pit digging and prepare stratigraphic logs. Place special emphasis on the visual identification of contamination. Monitor the test pit with a pho[redacted]n meter or appropriate organic vapor analyzer. Permanently mark each location where test pits are dug and record the location on the base map. Following test pit evaluations, fill in the test pit to the original land elevation. See the Handbook, Section 12 for procedures on test pit sampling.

1.4.11 **Geophysical Surveys**

1.4.11.1 **Soil Gas Surveys.** Establish appropriate grid systems and conduct a maximum of [redacted] days of soil gas survey. Prepare a posting map of soil gas values relative to their location on the grid used. Provide this map in an Informal Technical Information Report submitted after completion of the soil gas surveys. (Item VI, Sequence No. 3, paragraph 6.1).

1.4.11.2 **Simple Removals.** Perform simple removals in accordance to paragraph 5.3.1 of the Mar 1989 Cape Romanzof AFS, AK Work Plan. Removals shall be treated the same as suspected drill cuttings and disposed of as stated in paragraph I.1.4.9 of this SOW.

1.4.12 **Sample Collection.**

1.4.12.1 **Ground and Surface Water Samples.** Collect a maximum of six (6) groundwater and thirteen (13) surface water samples. The maximum number of analyses for each parameter and the required analytical method is given in Table A-4, Annex A.

1.4.12.2 **Soil and Sediment Samples.** Collect a maximum of forty-five (45) soil and sediment samples. The maximum number of analyses for each parameter and the required analytical method is given in Table A-5, Annex A.

1.4.13 **Site-specific Requirements.** Perform the site-specific requirements as listed in the following sub-paragraphs. The field tasks shall be performed as specified in Section 5 of the IRP Stage 1 Work Plan. Refer to Annex A of this SOW, Table A-1 for the number of wells, borings, soil gas ,and test pits by site. Table A-2 lists water analyses by site, and Table A-3 lists soil analyses by site.

1.4.13.1 **Site 1. Waste Accumulation Area No. 3, Including Spill/Leak Nos. 6,7,8, and 9 (ROM-1).**

a. Field tasks include: Hand augerings and collection of soil samples.

b. [redacted] waste accumulation area no. 3.

1.4.13.2 **Site 2. Large Fuel Spill (ROM-1s).**

a. Field tasks include: Soil gas survey , hand augerings and collection of soil samples.

1.4.13.3 **Site 3. Weather Station Well no. 2 (ROM-2).**

a. Field tasks include: Collection of one groundwater sample.

1.4.13.4 **Site 4. Waste Accumulation Area No. 1 (ROM-3), Well and Lake.**

a. Field tasks include: Hand augerings, collection of soil and sediment samples, collection of surface and groundwater samples.

b. [redacted] waste accumulation area no. 1.

1.4.13.5 **Site 5. Lower and Upper Camp Roads** (ROM-4).

a. Field tasks include: Hand augerings and collection of soil samples.

1.4.13.6 **Site 6. Landfill No. 3** (ROM-5).

a. Field tasks include: Hand augering and collection of one soil sample.

1.4.13.7 **Site 7. Waste Accumulation Area No. 2** (ROM-6).

a. Field tasks include: Hand augering and collection of one soil sample.

1.4.13.8 **Site 8. Dump Area** (ROM-7).

a. Field tasks include: Hand augering and collection of one soil sample.

1.4.13.9 **Site 9 Landfill No. 2** (ROM-8).

a. Field tasks include: Well installation, groundwater and surface water/effluent sample collection, soil and sediment sample collection.

b. [redacted]evaluations.

1.4.13.10 **Site 10. Landfill No. 1** (ROM-9).

a. Field tasks include: Hand augering and collection of one soil sample.

1.4.13.11 **Site 11. Spill/Leak No. 3** (ROM-10).

a. Field tasks include: Hand augering and collection of one soil sample.

1.4.13.12 **Site 12. White Alice Site** (ROM-11).

a. Field tasks include: Hand augerings and collection of soil samples.

1.5 Baseline Risk Assessment. After a thorough review of all data gathered during the field investigation and the determination of ARARs (paragraph I.1.3), determine the potential risk to human health and welfare or the environment from the contaminants identified at the various sites investigated. If a baseline risk assessment was performed during a previous IRP Stage, update and refine the assessment based on the newly collected data. The required elements of the baseline risk assessment are provided in the Handbook, Section 3 (Report Format Section IV). Include results of the baseline risk assessment in Section IV of the Final Report (paragraph I.1.11.1). Identify those sites posing no threat to human health, welfare or the environment and which no further action is appropriate. Prepare a decision document to support this finding (paragraph I.1.10.1).

1.6 Preliminary Alternative Remedial Actions (FS Phase I). For all past hazardous waste disposal and spill sites investigated at Cape Romanzof AFS, AK, except those where no further action is applicable, utilize the data and conclusions obtained from the hydrogeological survey, site characterization, and baseline risk assessment to develop preliminary alternative remedial actions. If preliminary remedial actions were developed during a previous IRP Stage, reevaluate the remedial actions selected based on the newly collected data. The required elements for the FS Phase I are provided in the Handbook, Section 3 (Report Format Section V). Alternatives developed shall include the following categories:

a. Alternatives for off-site treatment and/or disposal

b. Alternatives that attain ARARs

c. Alternatives that exceed ARARs

d. Alternatives that do not attain ARARs

e. No action

Further, alternatives outside of these categories may also be developed, such as non-cleanup alternatives (e.g., alternate water supply, relocation, etc). Documentation of the remedial alternative development process, including the decision rationale, shall be provided as an Informal Technical Information Report (Item VI, Sequence No. 3, paragraph 6.1) and shall be included in Section V of the Final Report (paragraph I.1.11.1).

1.7 Initial Screening of Alternatives (FS Phase II). The alternatives developed in paragraph I.1.6 shall be screened to eliminate those that are clearly infeasible or inappropriate, prior to undertaking detailed evaluation of the remaining alternatives. Screening criteria are as follow:

a. Public health/environmental impacts. Adverse effects on the environment or public health and welfare will preclude further consideration of a remedial alternative. Those alternatives that do not satisfy the objective of the Feasibility Study and substantially contribute to the protection of public health environment will be selected.

b. Technical feasibility. Technologies that may prove extremely difficult to implement, will not achieve the remedial objectives in a reasonable time period, or will rely upon unproven technology should be modified or eliminated.

c. Cost. The object of the cost screening is to eliminate alternatives that have costs on the order of magnitude greater than those of other equally effective alternatives. An alternative whose costs far exceeds that of other alternatives will usually be eliminated unless other significant benefits may also be realized. Cost data sources should be limited to standard cost indices, "Remedial Actions at Waste Disposal Sites" (EPA,1982), and other readily available information. The objective in calculating the costs is to achieve an accuracy within -50 to +100 percent. Perform cost screening only on alternatives remaining after the public health and environmental screening.

d. An Informal Technical Information Report (ITEM VI, Sequence 3, paragraph 6.1) shall be prepared detailing the screening process and identifying the alternatives remaining (paragraph I.1.11.2). This decision process shall be included in Section V of the Final Report (paragraph I.1.11.1).

1.8 Detailed Analysis of Remedial Alternatives. Perform a detailed analysis of the alternatives remaining after the initial screening. The analysis shall follow the procedures listed below. Additional guidance can be found in EPA/540/G-85/003, Guidance on Feasibility Studies Under CERCLA. Provide an Informal Technical Information Report describing the analysis procedures, results and conclusions to the USAFOEHL/TS (Item VI, Sequence No. 3, paragraph 6.1). The analysis procedures, decision process, results and conclusions of the detailed analysis shall be included in the Final Report (paragraph I.1.11.1).

1.8.1 **Technical analysis.** The technical analysis shall evaluate each remedial alternative for performance, reliability, implementability, and safety. The technical analysis will, as a minimum:

a. Evaluate alternatives in terms of their [redacted] the intended function, such as removal, destruction, treatment, etc.

b. Discuss how the alternative does (or does not) comply with [redacted] When an alternative does not comply, discuss how the alternative prevents or minimizes the migration of wastes and public health or environmental impacts and discuss special design needs that could be implemented to achieve compliance.

c. Consider any special site or waste conditions that may affect performance. Specifications shall be based on ASTM, AASHTO or other applicable engineering standards if appropriate. On-site alternatives shall include an analysis of locational factors that may impact effectiveness.

d. Evaluate operation, maintenance, and monitoring requirements of alternatives. Consider the demonstrated performance of alternatives at other sites and locations.

e. Identify and review potential off-site facilities to ensure compliance with applicable RCRA and other EPA environmental program requirements, both current and proposed. Potential disposal facilities should be evaluated to determine whether off-site management of site wastes could result in a potential for a future release from the disposal facility.

f. Identify temporary storage requirements, off-site disposal needs and transportation plans.

g. Describe whether the alternative results in permanent treatment, resource recovery, or destruction of the wastes, and, if not, the potential for furture release to the environment.

h. Outline the safety requirements for remedial implementation (including both on-site and off-site health and safety considerations).

i. Describe how the alternative could be phased into individual operable units. The description should include a discussion of how various operable units of the total remedy could be implemented individually or in groups, resulting in a significant improvement or savings in cost.

1.8.2 **Environmental Analysis.** Assess each alternative in terms of the extent to which it is expected to prevent damage and provide protection to public health, welfare, and the environment. Perform an Environmental Assessment (EA) for each alternative. The EA should focus on the site problems and pathways of contamination actually addressed by each alternative. The EA for each alternative will include, as a minimum, an evaluation of beneficial effects of the response, adverse effects of the response, and an analysis of measures to mitigate adverse effects. The no-action alternative will be fully evaluated to describe the current site situation and anticipated environmental conditions if no action is taken. The no-action alternative will serve as the baseline for the analysis.

1.8.3 **Public Health Analysis.** Each alternative will be assessed in terms of the extent to which it mitigates long-term exposure to any residual contamination and protects public health both during and after completion of the remedial action. The asssessment will describe the levels and characterization of contaminants on-site, potential exposure routes, and potentially affected population. The effect of the "no-action" should be described in terms of short-term effect, e.g., lagoon failure, long-term exposure to hazardous substances, and resulting public health impacts. Each remedial alternative will be evaluated to determine the level of exposure to contaminants and the reduction over time. The relative reduction in public health impacts for each alternative will be compared to the no-action level. For management of migration measures, the relative reduction in impact will be determined by comparing residual levels of each alternative with ARARs. For source control measures or with ARARs not available, the comparison should be based on the relative effectiveness of technologies. The no-action alternative will serve as the baseline for the analysis.

1.8.4 **Institutional Analysis.** Evaluate the effects of Federal, State and local standards and other institutional requiremnts on the design, operation and timing of each alternative. Specifically, assess regulatory requirements, permit requirements, community relations, and participating agency coordination. All applicable or relevant public health and environmental standards, interagency coordination needs and other institutional issues shall be identified.

1.8.5 **Cost Analysis.** Evaluate the cost of each remedial alternative (and for each phase or segment of each alternative). The cost for each alternative will be presented as a present worth cost and will include the total cost of implementing each alternative and the annual operation and maintenance costs. Both monetary costs and associated non-monetary costs, e.g., reduction of aesthetics or recreaton values, will be included. A distribution of the costs over time will be provided. At a minimum, perform the following steps:

a. Estimation of costs. Estimate capital and operation and maintenance costs for each alternative. The cost estimate should provide an accuracy of -30 to +50 percent and are prepared using data available from the remedial investigation. Estimates should be based on other similar projects or standard costing guides such as the "Means Guide" and the "Dodge Guide". Other sources include "Remedial Action Completion" and "Handbook: Remedial Action at Waste Disposal Sites".

b. Present worth analysis. Using the estimated costs, calculate annual costs and present worth for each alternative.

c. Sensitivity analysis. Evaluate the sensitivity of cost estimates to changes in key assumptions and parameters, such as discount rate.

1.8.6 **Evaluation of Cost-Effective Alternatives.** Alternatives will be compared using the results of the technical, environmental, public health, institutional and economic analysis. At a minimum, the following areas will be used to compare alternatives and select a recommended remedy:

a. Present worth of total costs. The net present value of capital and operating and maintenance costs must be presented.

b. Health information. For the no-action alternative, the USAFOEHL prefers a quantitative statement including a range estimate of maximum individual risk. Where quantification is not possible, a qualitative analysis may suffice. For source control options, a quantitaive risk assessment is not required. For management of migration measures, present a quantitative risk assessment including a range estimate of maximum individual risks.

c. Environmental effects. Only the most important effects or impacts should be summarized. Reference can be made to supplemental information arrayed in a separate table, if necessary.

d. Technical aspects of the remedial alternatives. The technical aspects of each remedial alternative relative to the others should be clearly delineated. Such information generally will be based on the professional opinion of the contractor regarding the site and the technologies comprising the remedial alternative.

e. Information on the extent to which remedial alternatives meet the technical requirements and environmental standard of applicable environmental regulations. This information should be arrayed so that differences in how remedial alternatives satisfy such standards (ARARs) are readily apparent. The general types of standards that may be applicable at the site include (1) RCRA design and operating standards, (2) drinking water standards, and (3) environmental discharge standards.

f. Information on community effects. The type of information that should be provided is the extent to which implementation of a remedial alternative disrupts the community (e.g., traffic, temporary health risks, and relocation), and the likely public reaction.

g. Other factors. This category of information would include such things as institutional factors that may inhibit implementing a remedial alternative and any other site-specific factors identified in the course of the detailed analysis that may influence which alternative is selected.

1.9 **Data Quality Objectives (DQOs).** For those sites where contamination is detected but the available data does not permit completing the detailed analysis of alternatives, identify and define the DQOs necessary to complete the feasibility study and risk assessment. These DQOs will define the scope of the Work Plan to be prepared for any follow-on IRP task order (I.1.12.1.1). Incorporate the DQOs into Section VI of the Final Report (paragraph I.1.11.1).

1.10 **Decision Documents.**

1.10.1 **Technical Document to Support No Further Action (TDSNFA).** Using the format provided in the Handbook, Section 11, prepare a decision document for each IRP site where the results of this investigation indicate that no significant threat to human health and welfare or the environment exists (Item VI, Sequence No. 4, paragraph 6.1).

1.10.2 **Technical Document to Support a Remedial Action Alternative.** For those IRP sites where the available data permits detailed screening of remedial alternative actions and selection of a recommended alternative, prepare a decision document to support the selection process (Item VI, Sequence No. 4, paragraph 6.1). Use the format provided in the Handbook, Section 11.

1.11 **Reports**

1.11.1 **Final Report.** Prepare a report delineating all findings from this investigative stage of the remedial investigation/feasibility study. This report must also include a detailed discussion of the recommended alternative remedial actions and a description of the work proposed, including the DQOs for any follow-on remedial investigation and feasibility study that may be required. Forward the report to USAFOEHL/TS for Air Force and regulatory agency review (Item VI, Sequence No. 4, paragraph 6.1).

1.11.1.1 **Tables and Figures.** The contractor shall provide as many tables and figures as required. Lists of required figures and tables are found as attachments to the Report Format (USAFOEHL/TS Handbook, Section 3). All figures and tables shall be clear and easy to interpret, shall be of publishable quality, and shall contain legends that identify the symbols used for the purposes of the illustration.

1.11.1.2 **Draft Reports.** Draft reports are considered "drafts" only in the sense that they have not been reviewed and approved by the Air Force. In all other respects, "drafts" must be complete, in the proper format, and free of grammatical and typographical errors. All draft reports shall be thoroughly screened through in-house peer technical review before being released to USAFOEHL/TS.

1.11.1.3 **Report Format.** Strictly adhere to the USAFOEHL/TS Report Format (USAFOEHL/TS Handbook, Section 3) for preparation of draft and Final Reports. This format is an integral part of this Delivery Order.

1.11.1.4 **Microfiche Copies of Final Report.** Provide three (3) microfiche copies of the approved Final Report (Item VI, Sequence No. 17, paragraph 6.1).

1.11.2 **Informal Technical Information Report.** Upon completion of all analyses, tabulate and incorporate all analytical data into an Informal Technical Information Report and forward the report to USAFOEHL/TS no later than three (3) weeks after all analyses have been completed (Item VI, Sequence No. 3, paragraph 6.1). Use the format provided in the USAFOEHL/TS Handbook, Section 8.

1.12 Plans.

1.12.1 [redacted] For those sites where no further action is not appropriate and the available data does not permit detailed analysis of alternatives, the contractor shall initiate preparation of plans for any follow-up effort only after the first draft report has been coordinated with the Technical Program Manager and Air Force comments have been incorporated into the first draft report. The follow-up plans shall be delivered at the same time as the second draft report (paragraph I.1.11.1).

1.12.1.1 **IRP Work Plan For Next Effort.** Use the [redacted] provided in the Handbook, Section 4. Distribute copies as directed by USAFOEHL/TS (Item VI, Sequence No. 4, paragraph 6.1).

1.12.1.2 [redacted] In a separate letter, submit a lump sum cost estimate for the effort required to perform the work detailed in the Work Plan for the next effort (Item VI, Sequence No. 2, paragraph 6.1).

1.13 Data Management. In addition to the hard copy of the field and laboratory test results submitted with the monthly R & D Status Report, data collected in this effort shall be archived with Air Force-compatible computer hardware and software and forwarded to USAFOEHL/TS per format and media instruction provided in the IRPIMS Data Loading Handbook (provided under separate cover). (Item VI, Atch 2, Sequence No. 1, paragraph 6.2).

1.14 Meetings. A maximum of three (3) contractor personnel shall attend three (3) meetings at [redacted] Each meeting shall be two 8-hour workdays in duration. All meetings shall be coordinated by USAFOEHL/TS.

1.15 Special Notifications. Immediately report to the USAFOEHL/TS TPM or his/her supervisor, via telephone, any data/results generated during this investigation which may indicate an imminent health risk. Follow the telephone notification with a written notice within three (3) days and attach a copy of the raw laboratory data (e.g., chromatograms, standards used for calibration, etc).

1.16 R & D Status Reports. Include all data as required by the USAFOEHL/TS Handbook, Section 6. Tabulated field and laboratory test results and QA/QC data shall be incorporated into the next monthly R & D Status Report as they become available and forwarded to the USAFOEHL/TS (Item VI, Sequence No. 1, paragraph 6.1).

1.17 Health and Safety Plan. Provide a written Health and Safety Plan within four (4) weeks after the Notice To Proceed (NTP) (Item VI, Sequence No. 4, paragraph 6.1). Comply with USAF, OSHA, EPA, State and local health and safety regulations regarding the Stage 1 RI/FS work effort. Use EPA guidelines for designating the appropriate levels of protection needed at the study sites. Coordinate the Health and Safety Plan directly with applicable regulatory agencies prior to submittal to USAFOEHL/TS.

1.18 [redacted] **Stage 1.** Provide a written QAPP within three (3) weeks after Notice To Proceed (Item VI, Sequence No. 4, paragraph 6.1). Use the QAPP format provided under separate cover (USAFOEHL/TS Handbook, Section 5).

1.19 The above technical efforts including the [redacted] for each category are estimates only. Should the technical efforts, including field work, require variations from these estimates, the contractor shall obtain written concurrence from the USAFOEHL/TS prior to proceeding with the variations. Under such circumstances, the ceiling of this order shall remain unchanged.

1.20 Due to the extreme remoteness of Cape Romanzof, the contractor shall be responsible for securing transportation of all equipment and contractor personnel to the the station. Provisions shall be made to include two (2) USAFOEHL/TS personnel on one site visit.

II. SITE LOCATION AND DATES:

Cape Romanzof AFS AK
Date to be established

III. **BASE SUPPORT**

The 11 Tactical Control Wing (11 TCW) will provide the following support to the contractor:

3.1 Locate underground utilities and issue digging or other appropriate permits to the IRP contractor prior to the commencement of digging or drilling operations.

3.2 Assign accumulation points within the installation to which the contractor can deliver any drill cuttings, removal items or well installation/development fluids generated from the required work which are suspected to be hazardous. The contractor is responsible for providing all necessary containers (55-gallon drums) and for transporting the containerized material to the accumulation point.

3.3 Take custody of any auger cuttings, drill cuttings or well installation/ development fluids suspected to be hazardous and properly dispose of the material according to applicable State and/or Federal regulations. Supply contractor with the Cape Romanzof AFS generator number to be used in preparing and signing of the manifest documents as an agent for the Air Force. Con[redacted] drums containing ha[redacted] from the Cape Romanzof AFS, AK to DRMO at Elmendorf AFB, AK.

3.4 Coordinate with the contractor and DRMO the transportation and acceptance of the hazardous waste to the DRMO facility at Elmendorf AFB, AK.

3.5 Provide the contractor with existing engineering plans, drawings, diagrams, aerial photographs, digitized map files, etc., to facilitate evaluation of IRP sites under investigation.

3.6 Arrange for, and have available prior to the start-up of field work, the following services, materials, work space, and items of equipment to support the contractor during the investigation:

a. Personnel identification badges, vehicle passes and/or entry permits.

b. A secure staging area (approximately 1000 square feet) for storing equipment and supplies.

c. A supply (e.g., fire hydrant, stand pipe, etc.) of large quantities of potable water for borehole flushing, equipment cleaning, etc.

d. A paved area where drilling equipment can be cleaned and decontaminated. A source of potable water (i.e., ordinary outdoor water faucet) and a 110/115 VAC electrical outlet must be available within 25 feet of the paved area for steam cleaner hookup. Drainage from this paved area should be through an oil/water separator to a sanitary sewer.

e. A temporary office area, not to exceed 100 square feet and equipped with a Class A telephone for local and long distance telephone calls. The contractor shall pay for any long distance telephone calls made by contractor personnel from this phone.

f. A set of keys to the locks on any existing test/monitoring wells at Cape Romanzof AFS, AK. The keys shall be returned to the station POC by the contractor when the survey has been completed.

g. Assist the contractor in obtaining billeting and meals for up to [redacted] during the field investigation. The technical program manager (TPM) and contractor will coordinate the date of arrival with the station POC at least one month prior to the visit.

h. Assist the contractor in obtaining landing authority at Cape Romanzof AFS, AK.

IV. GOVERNMENT FURNISHED PROPERTY: None

V. GOVERNMENT POINTS OF CONTACT:

5.1 USAFOEHL/TS
Technical Program Manager (TPM)
1 Lt Walter Migdal
USAFOEHL/TSS
Brooks AFB TX 78235-5501
(512) 536-9001
AV 240-9001
1-800-821-4528

5.2 11 TCW POC
Mr Carl Gysler
11 TCW/LGD
Elmendorf AFB AK 99506
(AC) (907) 552-3691
(AV) 317-552-3691

5.3 MAJCOM POC
Mr James W. Hostman
HQ AAC/DEPV
Elmendorf AFB,AK 99506
(AC) (907) 552-4151
(AV) 317-552-4151

VI. DELIVERABLES

6.1 Attachment 1 of the basic contract. In addition to Sequence Numbers 1 and 5 listed in Attachment 1 to the basic contract which apply to all orders, the Sequence Numbers and dates listed below are applicable to this order:

Sequence No.	Para No.	Block 10	Block 11	Block 12	Block 13	Block 14
3 (Health & Safety)	I.1.17	OTIME	16 JUN 89	4 AUG 89	-	10
3 (ITIR- Soil Gas Map)	I.1.4.11.1	OTIME	*	*	-	4
3 (ITIR- Analytical Data)	I.1.11.2	OTIME	*	*	-	4
3 (ITIR- Prelim. RA)	I.1.6	OTIME	4 SEP 89	6 NOV 89	-	4
3 (ITIR-Screen of RAs)	I.1.7	OTIME	5 OCT 89	27 NOV 89	-	4
3 (ITIR- " Detailed RA)	I.1.8	OTIME	12 OCT 89	15 DEC 89	-	4
4 (Decision Documents)	I.1.10	ONE/R	4 SEP 89	12 JAN 90	11 MAY 90	***
4 (Tech. Rpt)	I.1.11.1	ONE/R	4 SEP 89	15 DEC 89	14 JUN 90	**
4 (Work Plan)	I.1.12.1.1	ONE/R	11 DEC 89	21 MAR 90	16 MAY 90	****
4 (QAPP)	I.1.18	ONE/R	11 DEC 89	21 MAR 90	16 MAY 90	****
2 (Cost Ltr)	I.1.12.1.2	OTIME	11 DEC 89	11 MAY 90	-	3
17 (Microfiche)	I.1.11.1.4	OTIME	11 DEC 89	14 JUN 90	-	3

6.2 Attachment 2 of the basic contract.

Sequence No.	Para No.	Block 10	Block 11	Block 12	Block 13	Block 14
1 (Data Management)	I.1.13	OTIME	*	*	-	1

6.3 Notes:.

* For the soil gas map, provide the ITIR within three weeks of soil gas survey completion. For the analytical data, provide the ITIR upon completion of the total analytical effort and not later than three weeks after all analyses have been completed. Provide the Data Management disk

with the analytical data.

** One first draft report (10 copies), one second draft report (15 copies), and one Final Report (30 copies plus the original camera-ready copy) are required. Incorporate Air Force comments into the second draft and Final Reports as specified by USAFOEHL/TS. Supply USAFOEHL/TS with an advance copy of the first draft, second draft, and Final Reports for acceptance prior to distribution. Distribute the remaining 9 copies of the first draft report, 14 copies of the second draft report, and 29 copies of the Final Report as specified by USAFOEHL/TS.

*** One draft (10 copies) and one final (25 copies) of each decision document is required. Supply the USAFOEHL/TS with one advance copy of each draft and final decision document for acceptance prior to distribution. Incorporate Air Force comments into the final decision documents as specified by USAFOEHL/TS. Distribute the remaining 9 copies of the draft and 24 copies of the final decision documents as specified by USAFOEHL/TS.

**** One first draft Plan (10 copies), one second draft Plan (15 copies), and one Final Plan (25 copies) are required. Incorporate Air Force comments into the second draft and Final Plan as specified by USAFOEHL/TS. Supply USAFOEHL/TS with an advance copy of the first draft, second draft, and Final Plan for acceptance prior to distribution. Distribute the remaining 9 copies of the first draft Plan, 14 copies of the second draft plan, and 24 copies of the Final Plan as specified by USAFOEHL/TS.

ANNEX A, Table A-1
Summary of Field Work by Site

	ROM-1	ROM-1s	ROM-2	ROM-3	ROM-4	ROM-5	ROM-6	ROM-7	ROM-8	ROM-9	ROM-10	ROM-11[2]	Back-ground	Total
No. of Wells	-	-	-	-	-	-	-	-	4	-	-	-	-	4
No. of Borings	9	4	-	6	6	1	1	1	-	1	1	2	-	32
Days of Soil Gas	-	6	-	-	-	-	-	-	-	-	-	-	-	6
Days of Test Pits	-	-	-	-	-	-	-	-	3	-	-	-	-	3
Surface water samples	-	-	-	1	-	-	-	-	12	-	-	-	-	13
Groundwater samples	-	-	1	1	-	-	-	-	4	-	-	-	-	6
Soil and Sediment samples	9	4	-	7	6	1	1	1	8	1	1	2	-	41

ANNEX A, Table A-2
Approximate Number of Water Analyses by Site

PARAMETER	ANALYTICAL METHOD	ROM-1	ROM-1s	ROM-2	ROM-3	ROM-4	ROM-5	ROM-6	ROM-7	ROM-8	ROM-9	ROM-10	ROM-11	Total
Specific Conductance (Field Test)	E120.1	-	-	1	2	-	-	-	-	16	-	-	-	19
pH (Field Test)	E150.1	-	-	1	2	-	-	-	-	16	-	-	-	19
Temperature (Field Test)	E170.1	-	-	1	2	-	-	-	-	16	-	-	-	19
Petroleum Hydrocarbons	E418.1	-	-	1	2	-	-	-	-	16	-	-	-	19
ICP Screen (23 metals, exclude Boron and Silica)	SW3005/ SW6010													
Total Recoverable		-	-	-	2	-	-	-	-	16	-	-	-	18
Dissolved		-	-	-	2	-	-	-	-	16	-	-	-	18
Purgeable Halocarbons	SW5030/ SW8010	-	-	1	2	-	-	-	-	16	-	-	-	19
Purgeable Aromatics	SW5030/ SW8020	-	-	1	2	-	-	-	-	16	-	-	-	19
Organochlorine Pesticides and PCBs	SW3510/ SW8080	-	-	-	2	-	-	-	-	16	-	-	-	18
Semivolatile Organic Compounds	SW3510/ SW8270	-	-	1	2	-	-	-	-	16	-	-	-	19

ANNEX A, Table A-3
Approximate Number of Soil Analyses by Site

PARAMETER	ANALYTICAL METHOD	ROM-1	ROM-1s	ROM-2	ROM-3	ROM-4	ROM-5	ROM-6	ROM-7	ROM-8	ROM-9	ROM-10	ROM-11	Drill Cuttings	Total
Petroleum Hydrocarbons	SW3550/ E418 1	6	4	-	7	6	1	1	1	8	1	1	2	-	38
ICP Screen (23 metals, exclude Boron and Silica)	SW3050/ SW6010	6	-	-	7	-	1	-	1	8	1	-	-	-	24
Organochlorine Pesticides and PCBs	SW3550/ SW8080	9	-	-	7	6	1	1	-	8	1	-	2	-	35
Volatile Organic Compounds	SW8240	6	4	-	7	-	1	1	-	8	1	-	-	4	28
Semivolatile Organic Compounds	SW3550/ SW8270	6	4	-	7	-	1	1	-	8	1	-	-	4	30
Extraction Procedure Toxicity, Metals Only	SW1310	-	-	-	-	-	-	-	-	-	-	-	-	4	4
Toxic Characteristic Leaching Procedure	FED REG VOL 51, NO. 114, 13 JUN 86	-	-	-	-	-	-	-	-	-	-	-	-	4	4
Soil Moisture Content	ASTM D2216	9	4	-	7	6	1	1	1	8	1	1	2	4	45

ANNEX A, Table A-4
Analytical Methods and TOTAL Number of Water Analyses

PARAMETER	ANALYTICAL METHOD (a)	REPORTING UNITS	NUMBER OF ANALYSES	TRIP BLANKS	AMB COND BLANKS	EQUIP BLANKS	DUP/REP	SECOND COLUMN (e)	TOTAL ANALYSES
Specific Conductance (Field Test)	E120.1	umhos/cm	19	-	-	-	-	-	19
pH (Field Test)	E150.1	pH Units	19	-	-	-	-	-	19
Temperature (Field Test)	E170.1	deg C	19	-	-	-	-	-	19
Petroleum Hydrocarbons	E418.1	mg/L	19	-	-	2	2	-	23
ICP Screen (23 metals, exclude Boron and Silica)	SW3005/ SW6010	mg/L							
Total Recoverable			18	-	-	2	2	-	22
Dissolved (c)			18	-	-	2	2	-	22
Purgeable Halocarbons	SW5030/ SW8010	ug/L	19	2	2	2	2	14	41
Purgeable Aromatics	SW5030/ SW8020	ug/L	19	2	2	2	2	14	41
Organochlorine Pesticides and PCBs	SW3510/ SW8080	ug/L	18	-	-	-	2	10	30
Semivolatile Organic Compounds	SW3510/ SW8270	ug/L	19	-	-	2	2	-	23

ANNEX A, Table A-5
Analytical Methods and TOTAL Number of Soil Analyses (b)

PARAMETER	ANALYTICAL METHOD (a)	REPORTING UNITS	NUMBER OF ANALYSES	TRIP BLANKS	AMB COND BLANKS	EQUIP BLANKS	DUP/REP	SECOND COLUMN (e)	TOTAL ANALYSES
Petroleum Hydrocarbons	SW3550/ E418.1	mg/kg	38	-	-	-	3	-	41
ICP Screen (23 metals, exclude Boron and Silica)	SW3050/ SW6010	mg/kg	24	-	-	-	2	-	26
Organochlorine Pesticides and PCBs	SW3550/ SW8080	mg/kg	35	-	-	-	3	19	57
Volatile Organic Compounds	SW8240	mg/kg	32	3	-	-	3	-	38
Semivolatile Organic Compounds	SW3550/ SW8270	mg/kg	30	-	-	-	3	-	33
Extraction Procedure Toxicity, Metals Only	SW1310	mg/L	4	-	-	-	-	-	4
Toxic Characteristic Leaching Procedure (d)	FED REG VOL 51, NO. 114, 13 JUN 86	mg/L	4	-	-	-	-	-	4
Soil Moisture Content (b)	ASTM D2216	per cent (%)	45	-	-	-	-	-	45

NOTES

a Unless an abbreviated list of analytes is specified under "Parameter" above, the analytical protocol shall include all analytes listed in the referenced analytical method. The methods cited are from the following sources:

"A" Methods	Standard Methods for the Examination of Water and Wastewater, 16th Edition (1985)
"E" Methods	Methods for Chemical Analysis of Water and Wastes, EPA Manual, 600/4-79-020 (USEPA, 1983 - with additions)
"SW" Methods	Test Methods for Evaluating Solid Waste, Physical/ Chemical Methods, SW-846, 3rd Edition (USEPA, 1986)
"ASTM" Methods	American Society for Testing and Materials, 1919 Race Street, Philadelphia PA 19103

b For soil/sediment samples, report results as mg/kg of dry soil or sediment. Report moisture content for each sample. Contractor shall modify the equation for calculation of moisture content in ASTM D-2216 to read:

$$w = [(W1-W2)/(W1-WC)] \times 100$$

where w = moisture content, %

W1 = weight of container and moist soil, g

W2 = weight of container and oven-dried soil, g

WC = weight of container, g.

c The sample shall be filtered in the field through a 0.5 um filter at the time of sample collection and before sample preservation.

d Analyze for all 52 toxic characteristic contaminants listed in the Federal Register.

e The maximum number of second-column confirmational analyses shall not exceed fifty percent (50%) of the actual number of field samples (to include duplicates, replicates, ambient condition blanks, trip blanks and equipment blanks). If the number of samples requiring second-column confirmation exceeds this allowance, contact the USAFOEHL/TS Technical Program Manager. The total number of samples listed in Tables A-4 and A-5 includes the allowance applicable to each GC method. If GC/MS, or a combination of second-column GC and GC/MS, is used, the total cost of all such analyses for a particular parameter shall not exceed the funding allowed for positive confirmation using only second-column GC.

TAB

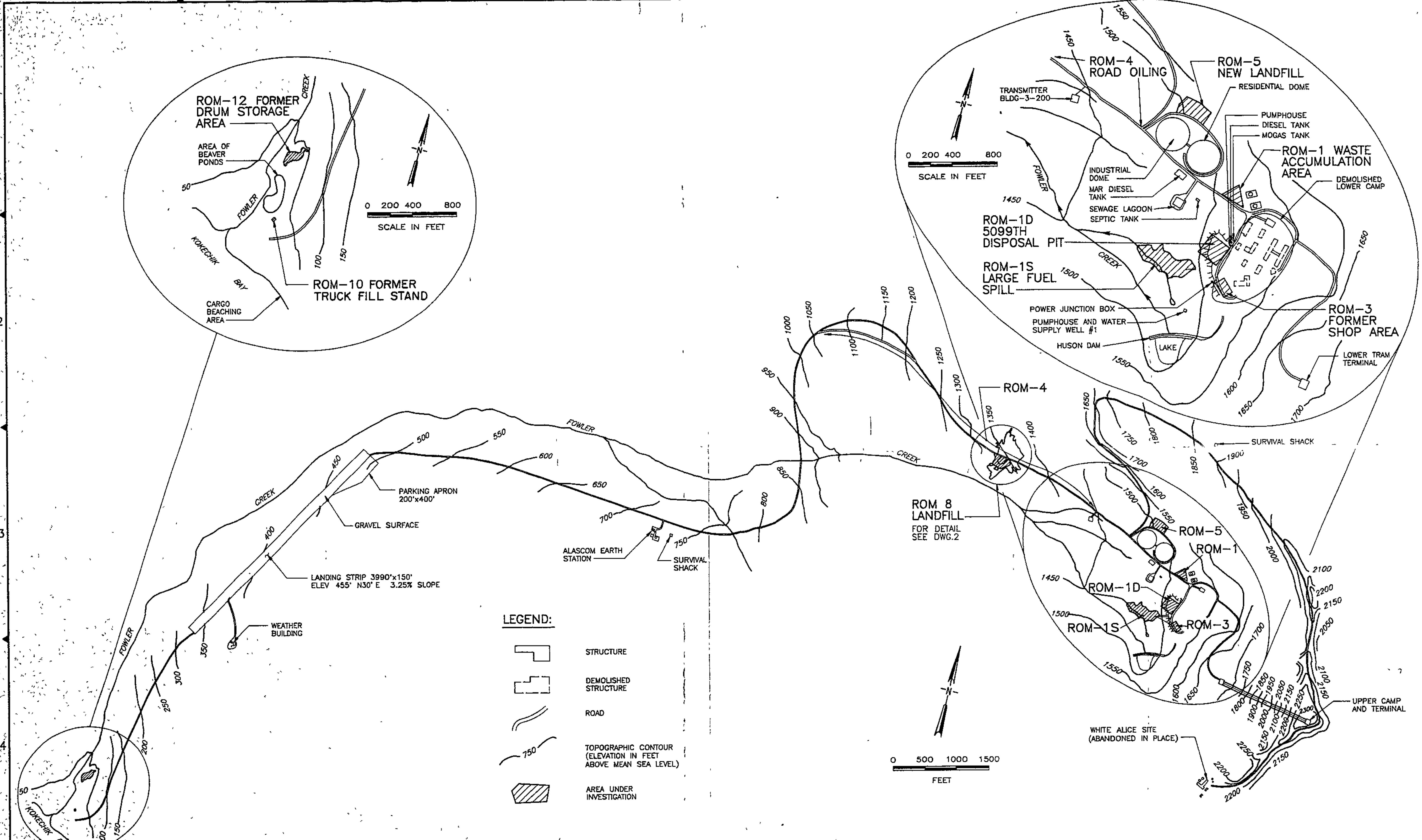
Appendix F

APPENDIX F

INFORMAL TECHNICAL INFORMATION REPORT

PRELIMINARY DATA (ANALYTICAL)

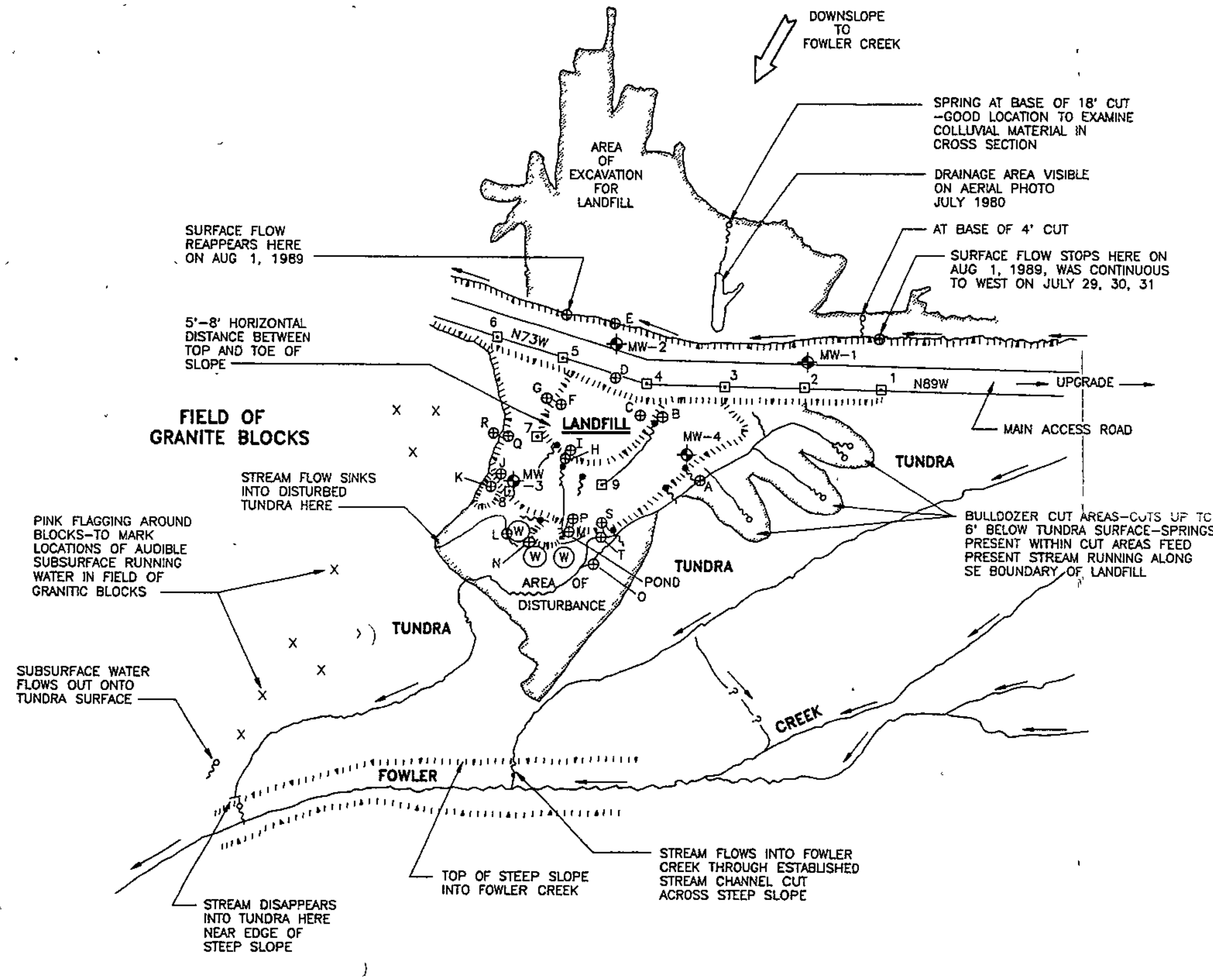
ATTACHED VOLUMES 1 AND 2

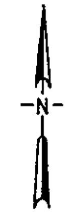


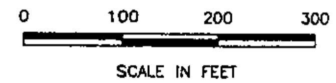
Woodward-Clyde Consultants	DESIGNED RS DRAWN JY CHECKED: UL	SUBMITTED Woodward-Clyde Consultants APPROVED Woodward-Clyde Consultants APPROVED	DATE
CAPE ROMANZOF LONG RANGE RADAR SITE ALASKA	INSTALLATION SITE PLAN	SCALE AS SHOWN DATE JUNE 1990 PROJECT NO 90275L	DRAWING NO 1 SHEET NO OF

ROM1

8 332







ELEVATION SURVEY – AUGUST 7, 1989

BASED ON ARBITRARY BENCHMARK ELEVATION OF 100.00 FEET ABOVE SEA LEVEL AT MONITORING WELL 4 (MW-4), TOP OF CASING

STATION	DESCRIPTION	ELEVATION
LANDFILL		
MW-1	TOC *	122 82
MW-1	GROUND	121 50
MW-2	TOC *	104 71
MW-2	GROUND	102 70
MW-3	TOC *	76 11
MW-3	GROUND	73 61
MW-4	TOC *	100.00 (BENCHMARK)
MW-4	GROUND	97.50
A	CREEK	93 1
B	TOE OF SLOPE	98 5
C	TOP OF SLOPE	103 1
D	EDGE OF ROAD	102 5
E	DITCH	98 5
F	TOP OF SLOPE	93 6
G	TOE OF SLOPE	89 1
H	TOE OF SLOPE	86.0
I	TOP OF SLOPE	92 2
J	TOP OF SLOPE	72 6
K	TOE OF SLOPE	64 7
L	STANDING WATER	64 3
M	POND	72 1
N	TOE OF SLOPE	66 8
[illegible]	CREEK	[illegible]
P	TOP OF SLOPE	78 8
Q	TOP OF SLOPE	81 9
R	TOE OF SLOPE	68 9
S	TOP OF SLOPE	90 8
T	TOE OF SLOPE	82 6

* TOC = TOP OF CASING

LEGEND:

- EDGE OF LANDFILL LIFTS AND OTHER SLOPES
- EDGE OF DISTURBED AREA BEYOND LANDFILL – BULLDOZER CUTS AND OTHER SURFACE DISRUPTION
- ⊡ 1 HORIZONTAL CONTROL SURVEY STATION
- ⊕ D VERTICAL CONTROL SURVEY STATION
- MW-2 GROUNDWATER MONITORING WELL
- (W) STANDING WATER
- SEEP ON LANDFILL
- SPRING

No.	DATE	BY	APPR.	REVISION DESCRIPTION

Woodward-Clyde Consultants

DESIGNED: TR	SUBMITTED: Woodward-Clyde Consultants		DATE
DRAWN: JY	APPROVED: Woodward-Clyde Consultants		
CHECKED: UL	APPROVED:		

CAPE ROMANZOF
LONG RANGE RADAR SITE
ALASKA

MAP OF ROM-8 LANDFILL AND VICINITY

SCALE AS SHOWN
DATE JUNE 1990
PROJECT NO 902751
DRAWING NO. 2
SHEET NO ___ OF ___

ROM2

FINAL PAGE

ADMINISTRATIVE RECORD

FINAL PAGE