(1)

INSTALLATION RESTORATION PROGRAM

PHASE II - CONFIRMATION/QUANTIFICATION

STAGE 1

KALISPELL AIR FORCE STATION
MONTANA

BATTELLE COLUMBUS DIVISION
Denver Operations
Denver West Office Park
Building 52, Suite 250
14062 Denver West Parkway
Golden, Colorado 80401

MAY 1, 1989

FINAL REPORT

Approved for Public Release:
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PREPARED FOR:

HEADQUARTERS STRATEGIC AIR COMMAND
COMMAND SURGEON'S OFFICE (HQ SAC/SGPB)
BIOENVIRONMENTAL ENGINEERING DIVISION
OFFUTT AIR FORCE BASE, NEBRASKA 68113

UNITED STATES AIR FORCE
OCCUPATIONAL & ENVIRONMENTAL HEALTH LABORATORY (USAFOEHL)
BROOKS AIR FORCE BASE, TEXAS 78235-5501

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USAF OCCUPATIONAL & ENVIRONMENTAL HEALTH LABORATORY (USAFOEHL)
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19. ABSTRACT (Continue on reverse if necessary and identify by block number)

Battelle conducted a literature search and field investigation into the environmental effects of a 1981 diesel fuel spill at Kalispell Air Force Station. Site selection was based on IRP Phase I recommendations, the Phase II presurvey, and discussions with OEHL and the Base POC. Shallow soil samples, groundwater samples, and surface water samples were collected and analyzed. Chemical analyses of all samples included tests for aromatic organic chemicals and petroleum hydrocarbons.

The contamination detected in Phase II, Stage 1 does not appear to constitute any serious risk to human health or the environment. The site is rated as Category I; no further action needed.

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Preface

As part of the U.S. Air Force Installation Restoration Program (IRP), an investigation was undertaken at Kalispell Air Force Station, Montana, to determine if there are environmental or health concerns from the effects of a diesel fuel spill in 1981. This report, prepared by Battelle-Denver Operations, under Contract No. F33615-85-D-4507, Task 15, presents the results of the Phase II, Stage 1, IRP investigation.

Captain Patrick N. Johnson and Captain Logan VanLeigh, Technical Services Division, USAF Occupational and Health Laboratory (USAFOEHL), were the technical program monitors for this project. The investigation was directed by Dr. William McNeill and was undertaken under the technical management of Mr. Richard M. Winar. Field and investigative work was done by Ms. Mary F. Bergstrom. Mr. Martin Doornbos assisted with background geologic material.

Battelle wishes to acknowledge the help of Mr. John Frandcen of Kalispell AFS and Captain Burl Olson, Malmstrom AFB Bioenvironmental Engineer, for assistance in arranging and performing the field work.

APPROVED:

Robert K. Kennedy
Program Manager

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EXECUTIVE SUMMARY

INTRODUCTION

The United States Air Force (USAF) Installation Restoration Program (IRP) provides for the investigation and evaluation of past and present waste management which may pose a potential threat for environmental contamination at Air Force facilities.

Battelle was contracted by the USAF Occupational and Environmental Health Laboratory (OEHL) to conduct an IRP Phase II Stage 1, confirmation/quantification investigation at Kalispell Air Force Station (AFS), near Kalispell, Montana. Kalispell AFS is considered an off-Base site of Malmstrom Air Force Base (AFB) near Great Falls, Montana. This report covers only the work at Kalispell AFS which was part of the Malmstrom AFB Statement of Work. The Phase II Stage 1 investigation of Malmstrom AFB and two off-Base sites at Shelby and Brady, Montana are described in a separate report.

The purpose of the Phase II, Stage 1 investigation of this site is to provide a compilation of available information on the February, 1981 fuel-oil spill and its cleanup history and to evaluate the present and possible future impacts of the spill on the environment and/or human health.

INSTALLATION DESCRIPTION

Kalispell AFS is located approximately 13 miles south of the city of Kalispell, in Flathead County, Montana (Figure ES-1). It was built in the late 1950s to support the USAF/Federal Aviation Administration (FAA) long-range radar facilities on nearby Blacktail Mountain (Figure ES-1). The 215-acre station is located near the mouth of the Stoner Creek Valley. The watershed of Stoner Creek is used for logging, cattle grazing and gravel mining. The elevation of the station is about 3000 feet above mean sea level (msl), and topography at the station slopes gently down to Stoner Creek.

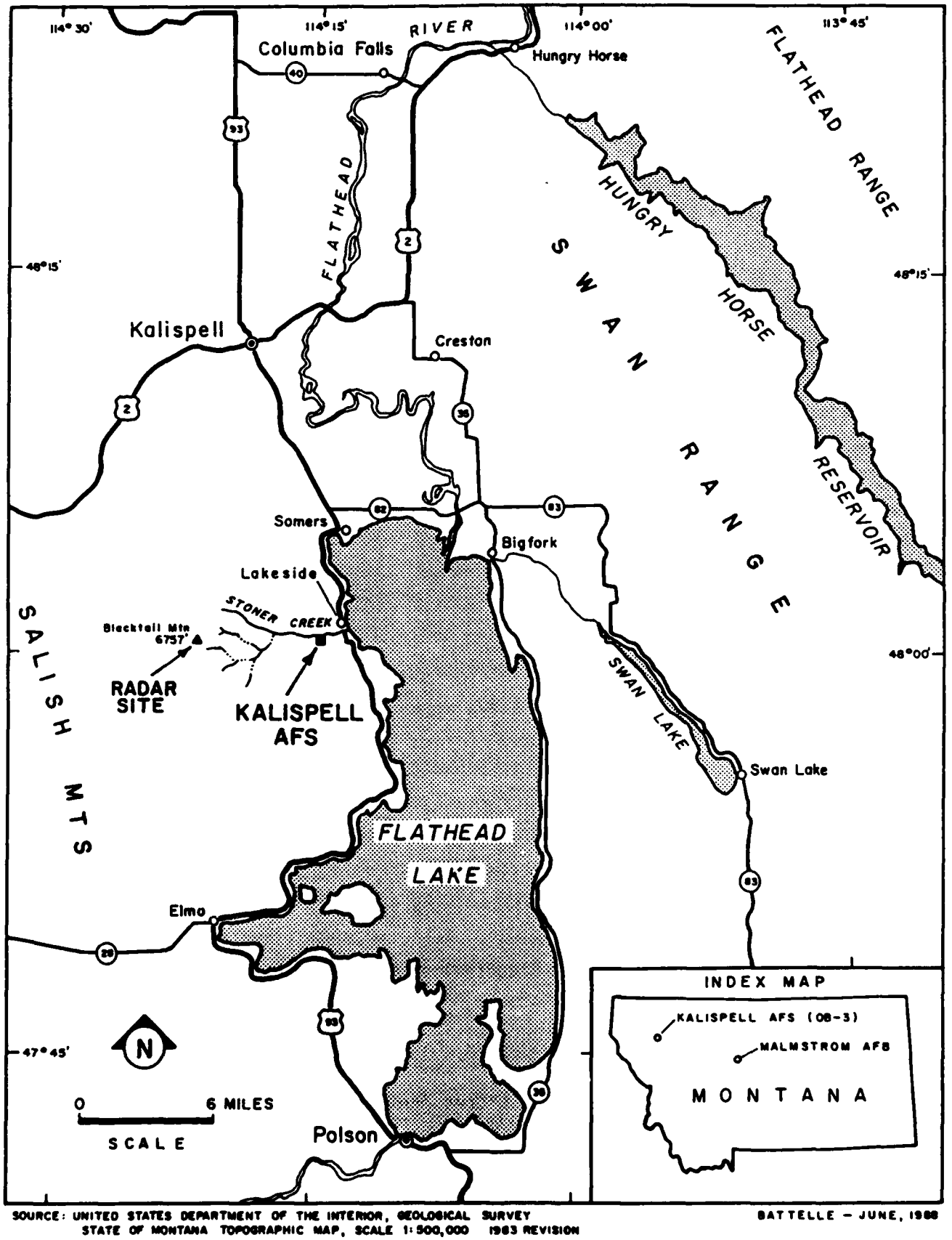


Figure ES-1
Index Map of Kalispell AFS, Montana

From 1977 to March, 1981, the U.S. Forest Service operated the Lakeside Young Adult Conservation Corps (YACC) Camp on the premises as a tenant of the USAF. In March, 1981, tenancy was not renewed and the USAF put the property up for sale. In 1985, the cantonment area and part of the housing area were sold to "Yom Partnership", which has provided facilities to a non-denominational Christian missionary training organization. In 1987, the remaining property was leased to Yom Partnership until the property transfer can be finalized.

The specific area under investigation at Kalispell AFS lies in the floodplain of Stoner Creek. Soils there are alluvial silts, sands, and gravels, presumably overlying glacial outwash, glacial drift and glacio-lacustrine deposits. Precambrian sedimentary bedrock of the Belt Series underlies the station at about 250 to 300 feet and is the source of groundwater for the onsite wells.

Stoner Creek is a fourth-order tributary that drains into Flathead Lake about one mile east of Kalispell AFS. It is a source of drinking water for some residents downstream from the station.

INCIDENT HISTORY

On February 27, 1981, an 8,000-gallon diesel-fuel spill occurred at Kalispell AFS. The tank valve from the 127,000-gallon, bulk heating-oil storage tank was allegedly vandalized and left partially open. Fuel escaped from the retaining wall surrounding the storage tank through a partially open gate valve, and flowed across approximately 200 feet of an open, grassy field to within 100 feet of Stoner Creek. Under the initial cleanup conducted by the U.S. Forest Service, 2000 gallons of fuel were reclaimed by the excavation of 175 yds^3 of soil, and 800 gallons of fuel were pumped out of the retaining structure.

In mid-April, 1981, fuel was observed seeping from springs along the banks of Stoner Creek, and two downstream residents reported fuel in their

drinking water. This seepage lasted at least four months. In an effort to contain this fuel oil, the U.S. Forest Service put sorbent material into the creek. Trenches were dug parallel to the creek to intercept groundwater flow. Culverts were emplaced and oil/water separators installed to pump out oil from the water table. Twenty-four 2-inch PVC-cased holes were bored to a depth of 20 feet in the spill area and monitored for fuel several times a week from April to November 1981. Monitoring was discontinued when no oil could be visually detected in the samples. The U.S. Forest Service installed new drinking water sources for two downstream residents as the result of litigation. During a visit to the site by the Phase I IRP Team in September, 1984 (JRB and Associates, 1985), no visible evidence of contamination was present in the stream. No other action had taken place at the site since 1984.

METHODOLOGIES

A records search of the files of the U.S. Forest Service, the Montana Bureau of Water Quality, and the Flathead County Disaster Services office were made to get information about the February 1981 spill and subsequent cleanup actions. An interview was held with William Pedersen of the U.S. Forest Service at the spill site. This helped Battelle personnel to choose representative sampling sites.

Types of samples collected included: six shallow (less than one foot deep) composite soil samples in the area where the fuel flowed to Stoner Creek, three surface water samples from Stoner Creek, and one water sample from each of the two onsite production wells. All water samples were analyzed in the field for pH, temperature, and specific electrical conductivity. All water and soil samples were analyzed for petroleum hydrocarbons and aromatic volatile organic chemicals.

Tools used for soil sampling included hand-operated soil augers, a shovel, stainless-steel spoons, and compositing buckets. To obtain a sufficient quantity of sample, several shallow (<1 foot deep) cores were taken

with the augers within a 1-square-foot area and combined. When the shovel was used, soil to a depth of 1 foot was overturned, the surface was scraped to remove contamination by the shovel, and a sample was collected from inside the clod. Disposable equipment such as spoons and trays were discarded after each sample was collected. Reusable equipment was decontaminated after each use.

One 8 oz. and one 4 oz. glass jar were filled at each sampling location. One sample out of the 6 was selected by USAF personnel to be split, and was collected as directed. The description, depth, and location of the soil sample were recorded in the field log-book.

Surface water samples from Stoner Creek were collected upstream from the spill, at the site of a seep where fuel was once found entering Stoner Creek, and at the downstream property boundary of Kalispell AFS. Two 40 ml glass septum vials were submerged in the stream flow to collect samples for aromatic volatile organics. One 0.5 gallon glass bottle was also submerged into the stream flow and filled to obtain a sample for petroleum hydrocarbon determination. Sulfuric acid was then added to the 0.5 gallon bottle until the water had a pH <2 for sample preservation. Temperature and pH of the water at each sample site was measured with a field pH meter by immersing the probe into a small beaker of sample. Equipment was decontaminated between each sample site. A small glass jar of water was collected at each sampling site for subsequent analyses by the specific conductivity meter.

Prior to collecting the water samples from the two onsite production wells, the closest tap to the well head was located, and the wells were pumped for 15 minutes to obtain representative samples. Samples were collected and preserved in the same manner and for the same parameters as previously described for surface water samples. Air Force personnel selected one groundwater sample to be split.

Samples were assigned identification numbers in accordance with the Air Force sample numbering scheme. Samples were given a Sample Site Identifier and a Base Sample Number.

After collecting a sample, the outer surface of the sample jar was wiped clean and a label was affixed. The lid was secured with tape, and the jar was carefully packed in coolers with ice to maintain a temperature of 4°C. The filled coolers were taped shut and sealed. Chain-of-custody forms accompanied all samples. The coolers were shipped via Federal Express to the analytical laboratory.

SUMMARY OF RESULTS

A summary of field activities and analytical results is presented in Table ES-1. Neither aromatic volatile organic chemicals nor petroleum hydrocarbons were found in the three surface water samples or in samples from the two onsite wells. No aromatic volatile organics were found in the soil samples, and only 829 mg/kg petroleum hydrocarbons (less than one tenth of one percent by weight) was found in one soil sample. This soil sample was taken from obviously stained soil in the moat between the tank and the retaining wall, where contamination is to be expected.

EVALUATION OF CONTAMINATION

The results of this investigation at Kalispell AFS indicate that there is no discernible impact upon the environment from the February, 1981 diesel spill. It appears that the surface soils, which would act as a source of continuing contamination to the groundwater and hence to Stoner Creek, hold very little, if any, residual fuel in the top few inches. The trenches dug to intercept contaminated groundwater before it reached Stoner Creek seem to have provided a safeguard against further contamination. Every year in the spring, precipitation increases, and the water flushes soluble and transportable materials from the soil. Five such spring flushes occurred between the time of the fuel spill and the sampling activities. The small amount of residual contamination indicates that these flushes have lessened the concentration of residual fuel contamination in the soil.

Table ES-1. Summary of Field Activities and Analytical Results

Site	Sample Number and Media	Analytical Results	Remarks
Kalispell AFS 1981 diesel fuel spill site	Six composite soil samples, 0-12"	Aromatic Volatile Organics: None detected	Not applicable
		Petroleum Hydrocarbons detected from stained soil within tank retaining was structure; 859 mg/kg.	Non-regulated substance; No standards for soil. Repair present leak.
	Three surface water samples from Stoner Creek	Aromatic Volatile Organics: None detected.	Not applicable
		Petroleum Hydrocarbons: None detected.	Not applicable
	Two groundwater samples from two onsite production wells	Aromatic Volatile Organics: None detected.	Not applicable
		Petroleum Hydrocarbons: None detected.	Not applicable

The pathways of potential migration (the shallow groundwater which seeps into the surface drainage) and the potential exposure targets downstream (those who use Stoner Creek for a drinking source) still exist. However, the source of contamination has been attenuated over the years, and it is concluded that the spill presently has no discernible impact on the environment or the people downstream. The positive indications of petroleum hydrocarbons in soils inside the tank retaining wall are of concern only because the moat is unlined.

RECOMMENDATIONS

The spill site at Kalispell AFS was evaluated for inclusion into one of three categories defined by the USAF: Category I--no further action, Category 2--additional Phase II investigation required, and Category 3--remedial action necessary. It has been placed in Category I - no further action required to alleviate pollution problems, as indicated in Table ES-2.

Even though no further environmental monitoring is deemed necessary at Kalispell AFS under provisions of the IRP, we suggest that the existing leak in the piping associated with the tank be repaired. In order to provide a degree of safety from possible future spills, it is recommended that consideration be given to the installation of a liner in the moat area. Also, the twenty-four holes drilled by the U.S. Forest Service to monitor the spill site are presently open. These should be located and properly plugged to prevent them from conducting contamination from the land surface directly into the shallow groundwater.

Table ES-2. Site Categorization and Recommendations for Kalispell AFS.

Site	Category	Recommended Action	Rationale
Kalispell AFS	I	No action required.	No fuel residues found in groundwater or surface water; No significant fuel residues found in soil.

1.0 INTRODUCTION

1.1 INSTALLATION RESTORATION PROGRAM

The Department of Defense (DOD) began the Installation Restoration Program (IRP) in 1976 to investigate and mitigate environmental contamination which may be present at DOD facilities as the result of past hazardous waste disposal and handling practices. In June 1980, DOD issued a Defense Environmental Quality Program Policy Memorandum (DEQPPM80-6) requiring identification of past hazardous waste disposal sites on DOD agency installations. The U.S. Air Force (USAF) implemented DEQPPM80-6 by message in December 1980. The IRP was revised in 1981 and reissued as DEQPPM81-5; the USAF implemented this memorandum by message on January 21, 1982.

The IRP as conducted under this contract was a four-phase program:

Phase I - Problem Identification/Records Search
Phase II - Problem Confirmation and Quantification
  a. Presurvey
  b. Field Evaluation - several stages as necessary
Phase III - Technology Base Development
Phase IV - Corrective Action

The IRP has now been converted to a Remedial Investigation/Feasibility Study (RI/FS) format, which is conducted with activities in a parallel format rather than in discrete phases.

Phase I was completed by JRB & Associates (1985). The Phase II Presurvey was completed by Battelle Memorial Institute (1985), and Battelle was retained by the USAF to undertake and complete the Phase II investigation at Kalispell Air Force Station (AFS) under contract Number F33615-85-D-4507, Task 15, IRP Phase II, Stage 1, "Field Evaluation at Malmstrom Air Force Base and Related Sites, Montana".

In the Phase I and the Phase II Pre-survey, Kalispell AFS was included as an "off-base" facility of Malmstrom Air Force Base (AFB). This document presents the results of the Kalispell Phase II field and laboratory investigation undertaken by Battelle. The results of the Malmstrom AFB Phase II Field Evaluation are available as a separate report.

Definitions of the acronyms, nomenclature, and units of measurement used in the Kalispell report are included in Appendix A.

1.2 PURPOSE AND SCOPE

The purpose of the Phase II, Stage 1 investigation of this site is to provide a compilation and evaluation of available information on the February 1981 diesel fuel oil spill and its cleanup history, and to evaluate the present and possible future impacts of the spill on the environment and/or human health.

To meet the above objectives Battelle undertook the following activities:

(1) Searched records to compile available information on the fuel spill, cleanup activities, and past and continuing impacts on the local environment.

(2) Performed an on-site environmental sampling program to evaluate the present state of contamination at the site. This program included collecting the following:

a) Six shallow composite soil samples in the top one foot of soil in the area where the fuel flowed to Stoner Creek.

b) Three surface water samples, one upstream and two downstream of where the spill entered the stream.

c) One water sample from each of the two on-site water wells.

Water and soil samples were analyzed for petroleum hydrocarbons and aromatic volatile organics.

Battelle's approach was to conduct the field work necessary to determine whether Kalispell AFS can be dropped from further consideration for investigative or remedial actions (Category I), whether further Phase II investigation is required (Category II) or whether remedial action is required (Category III). Existing data from previous investigations are integrated into the recommendations. Appendix B presents the complete Statement of Work.

1.3 HISTORY AND DESCRIPTION OF KALISPELL AFS

Kalispell AFS is located approximately thirteen miles south of the city of Kalispell, in Flathead County, Montana (Figure 1-1). The 215-acre station is located in the Salish Mountains off U.S. Highway 93 in Flathead National Forest and one mile west of the town of Lakeside. The facility is about a mile from the shore of Flathead Lake, roughly 235 miles northwest of Malmstrom AFB. The long-range radar facility which the station supports is located on Blacktail Mountain about 6 miles west of the Air Force Station and cantonment area (Figure 1-1).

Kalispell AFS was activated in the late 1950s as a support facility for joint USAF/FAA radar surveillance activities. In 1977 the Air Force Station was transferred temporarily to the U.S. Forest Service (USFS) for their use as a Young Adult Conservation Corps (YACC) camp. Records of various agencies kept during this time may refer to the site as the "Lakeside YACC Camp". In March 1981, the USFS relinquished its tenancy at Kalispell and the property reverted back to Air Force jurisdiction. In 1985, the cantonment area and all but 8 of the 27 houses and a vehicle storage facility in the residential area were sold to "YOM Partnership" (Mr. Ronald Gibe and Mr. Warren Drew), Polson, Montana. The partnership has provided the property and associated facilities to "Youth With a Mission", a non-denominational Christian missionary organization. This organization uses the facilities for missionary training. After the last of the military residents assigned to Kalispell AFS in August

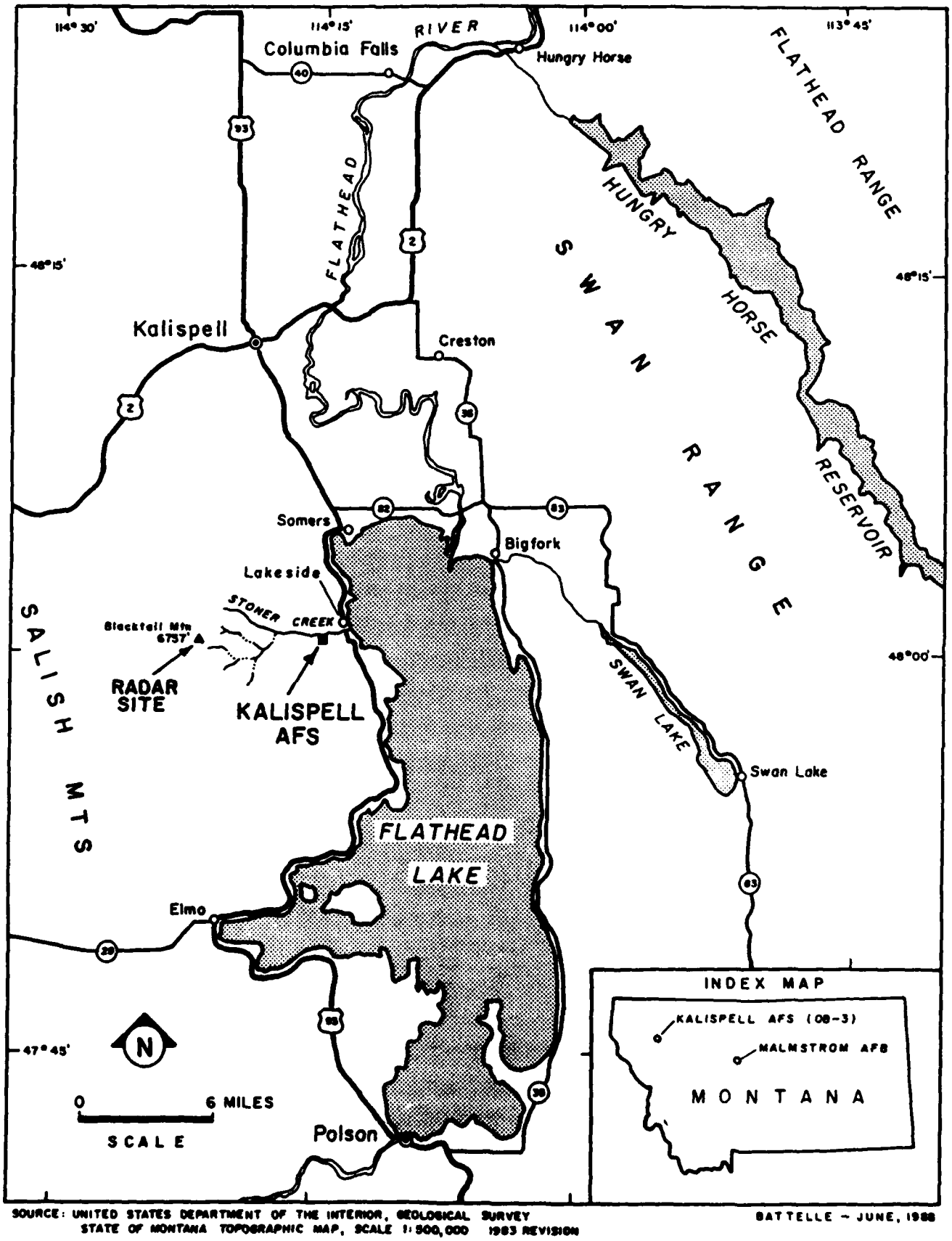


Figure 1-1 Index Map of Kalispell AFS, Montana

1987, the remaining property was leased to Yom Partnership until the property transfer can be finalized. "Youth With a Mission" granted written permission to Battelle-Columbus Division to bore test holes and conduct soil sampling (see Appendix H-1).

Within this report, we will refer to the facility as the Air Force Station (AFS) although it is recognized that most of the property has recently been sold.

According to the Phase I report (JRB and Associates, 1985), the AFS facility includes offices, a small power plant, sewage treatment lagoons, an Imhoff treatment tank, a warehouse and maintenance shop, two water wells and a water supply shop. There are 27 heating-oil tanks (275 gallons each) distributed throughout the cantonment; a 55-barrel MOGAS tank and a 48-barrel diesel storage tank are located in the shop area. There is also a 127,000 gallon bulk heating oil storage tank, which is the focus of this investigation, located just north of the shop area.

1.4 HISTORY OF FEBRUARY, 1981 FUEL SPILL INCIDENT

On February 27, 1981, an 8,000-gallon diesel fuel spill occurred at Kalispell AFS. The tank valve from the bulk storage tank was allegedly vandalized and left partially open. Fuel escaped from the retaining wall surrounding the storage tank as well, because the gate valve on the retaining wall had been left open. This spill occurred when the site was managed by the USFS and the initial containment and cleanup was undertaken by them. Two thousand gallons of fuel were reclaimed during soil excavation; another 800 gallons were contained in the retaining structure, and the remainder (approximately 5200 gallons) reportedly seeped into the ground about 100 to 300 feet from the fuel storage tanks. No other cleanup action was reported.

In mid-April of the same year (and one month after the station was returned to Air Force jurisdiction), fuel was observed seeping from springs along the south bank of Stoner Creek. This seepage continued for at least

four months. Two residents downstream who obtained their water supply from Stoner Creek reported fuel contamination in their private reservoirs. No other drinking water contamination was reported.

More cleanup activities were subsequently performed by the USFS, including using sorbents and trenching to contain the waste stream. Drinking water was supplied by Kalispell AFS to residents affected by the spill, and their water reservoirs were cleaned. Subsequently, as part of a court settlement, dug water wells were installed for the residents. During the September, 1984 site visit by the Phase I IRP team, there was no visible evidence of oil or grease contamination. Since 1984, no other action has taken place at this site.

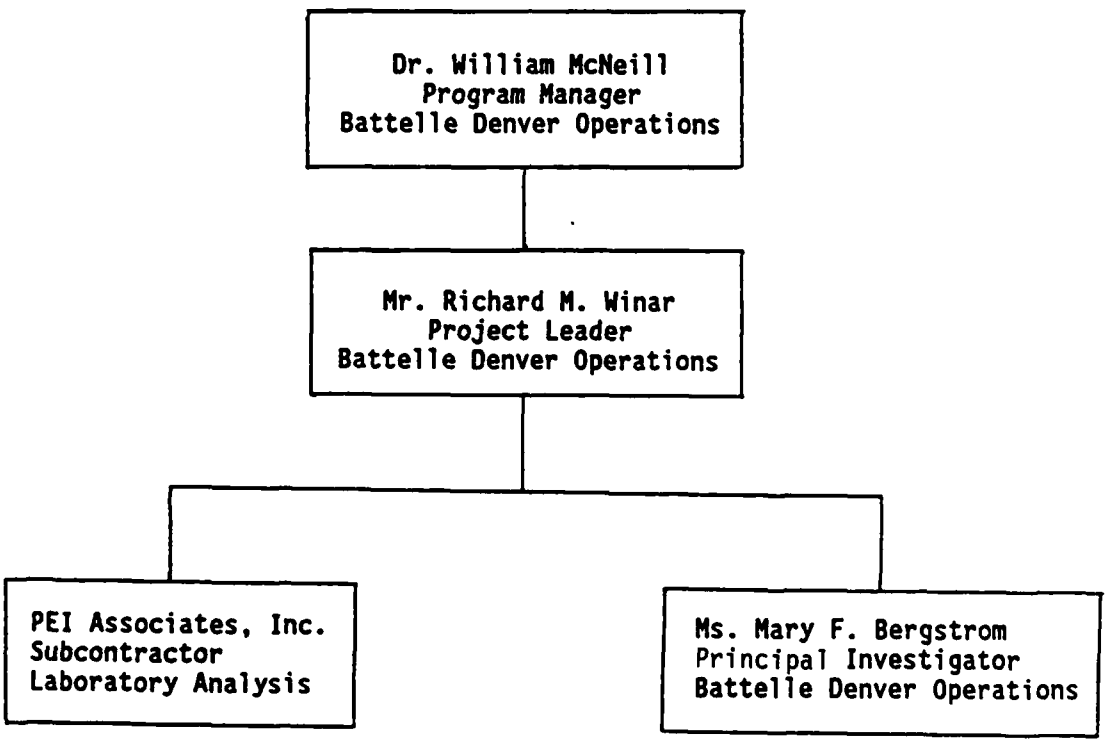
The area of the spill site is now a northeast-sloping, grassy playing field for the children at the camp. Slight differences in the vegetation communities can be seen in the playing field. The contaminated surface soil was scraped off as part of the cleanup effort in 1981, and this removal, rather than residual contamination, is probably responsible for those differences.

1.5 KNOWN AND SUSPECTED CONTAMINANTS

The focus of this investigation is on the diesel fuel spill from the 127,000-gallon storage tank on February 27, 1981. In an effort to detect the signature of residual heating fuel, all soil and water samples were analyzed for petroleum hydrocarbons and aromatic volatile organic compounds. These compounds include: benzene, toluene, ethylbenzene, chlorobenzene, p-xylene, m-xylene, o-xylene, 1,4-dichlorobenzene, 1,3-dichlorobenzene, and 1,2-dichlorobenzene. Water samples were also analyzed in the field for pH, temperature, and specific conductance.

Figure 1-2

Battelle Team Organization for IRP, Phase II, Stage 1
Investigation of Kalispell AFS, Montana



1.6 BATTELLE TEAM ORGANIZATION

The personnel who conducted the Phase II, Stage 1 investigation at Kalispell AFS are from the Battelle-Denver Operations office (Figure 1-2). The Program Manager was Dr. William McNeill and the Project Leader was Mr. Richard M. Winar, Senior Hydrogeologist. The Principal Investigator was Ms. Mary Bergstrom, Environmental Scientist, who conducted the field work. Mr. Martin Doornbos assisted with compiling background geologic literature. Appendix J contains the qualifications of each team member.

2.0 ENVIRONMENTAL SETTING

2.1 GEOGRAPHIC SETTING AND LAND USE

The Kalispell Air Force Station (AFS) is located on the eastern flank of the deeply glaciated Salish mountain range, approximately one mile west of Flathead Lake (Figure 2-1). This north-south trending range is bounded to the east and south by Flathead Lake and to the north by the Kalispell Valley. Elevations range from over 6,700 feet at Blacktail Mountain, located five miles toward the west to 2,883 feet at the shores of Flathead Lake. The AFS is approximately 3,000 feet above mean sea level (msl).

Kalispell AFS lies in the flood plain of Stoner Creek. The topography at the spill site slopes about 4° to the creek bank. Stoner Creek is a fourth-order tributary to Flathead Lake, and drains a 16,000 acre watershed (Delk, 1974). At the Kalispell AFS location, only one mile from the mouth of Stoner Creek, the valley is about 0.5 mile wide and U-shaped.

Land use in the Stoner Creek Watershed includes logging, range grazing by cattle, and gravel mining. Stoner Creek is used for recreational fishing and for drinking water.

2.2 CLIMATE

The climate in this area is governed by the maritime weather systems which move eastward from the Pacific Ocean and are then modified by continental air masses. This modification occurs especially during the winter months when cold Arctic fronts move south into this area and produce below-zero conditions.

The climatological records for the Kalispell area are compiled by the National Oceanic and Atmospheric Administration (NOAA) from information obtained from the Kalispell station located at the Flathead County Airport approximately twenty miles north of Kalispell AFS. The average annual

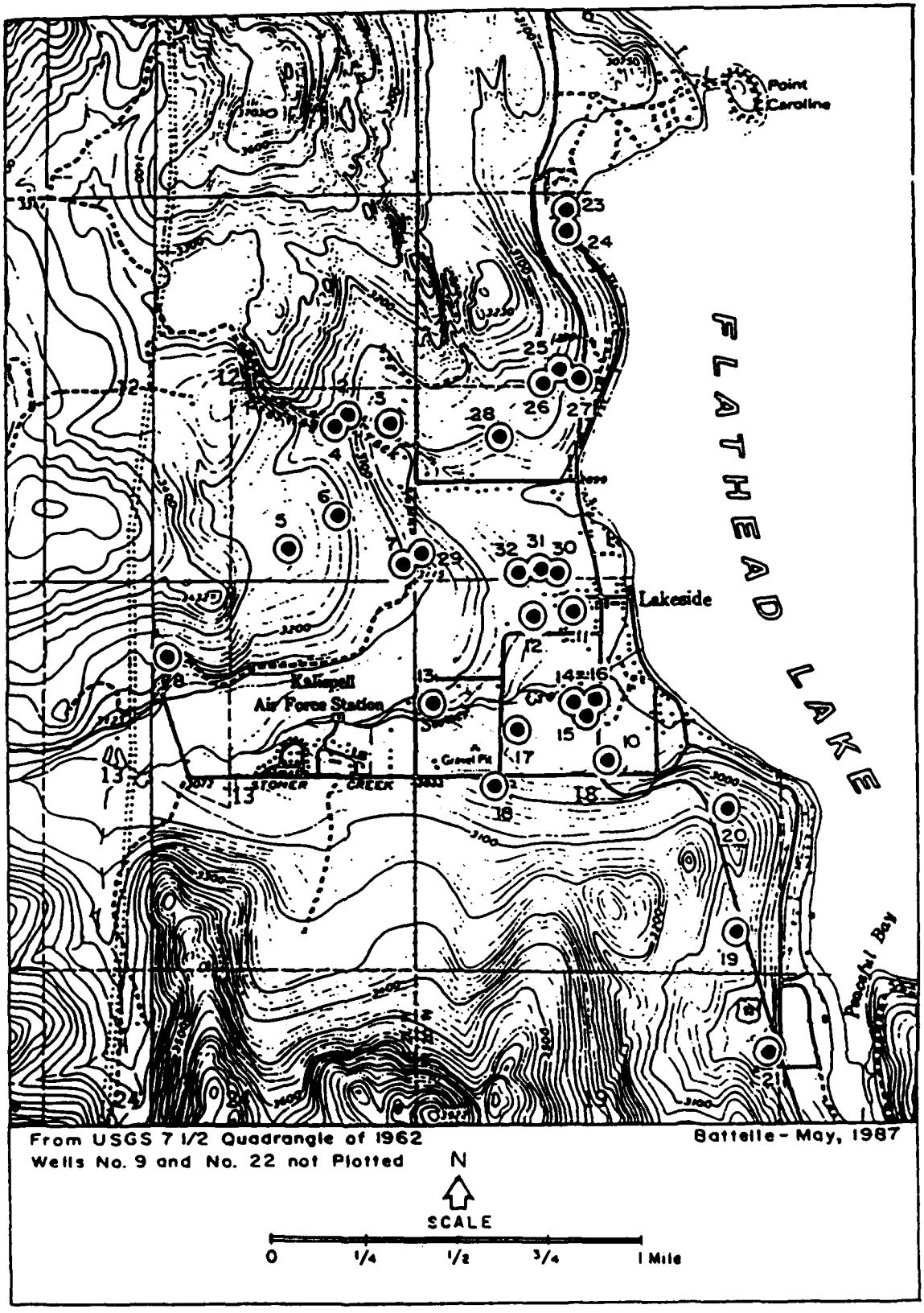


Figure 2-1: Location of Kalispell AFS and all Water Wells within Two Miles. Well numbers correspond to Table 2.2 which describes each well.

temperature at the Airport station is 42.5 °F (Table 2-1). The warmest month is July, which exhibits an average temperature of 65°F, and the coldest month is January, which averages 19.3°F. The growing season averages 150 days at Kalispell (Konizeski et al, 1968).

The average annual precipitation in this area is 15.93 inches, with about 25% of this precipitation occurring in May and June. The balance of the total precipitation is evenly distributed among the remaining months. Cumulative snowfall averages 68.3 inches, but as much as 12 feet may accumulate in the mountain areas (Johns, 1962).

2.3 REGIONAL GEOLOGY AND HYDROLOGY

The Salish Mountains are comprised of folded and faulted Precambrian "basement" rocks, which are meta-sedimentary rocks of the Belt Series (Konizeski et al, 1968). The lower part of the Belt Series, the Ravalli Group, crops out in the upper part of the Stoner Creek watershed and is comprised of gray to greenish-gray argillites and light gray quartzites. The Piegan Group, considered the middle part of the Belt Series, outcrops in the lower half of the watershed and is comprised of gray, silty, stromatolite-bearing dolomite. Delk (1974) indicates that the Siyeh Formation, outcropping in the lower part of the watershed, is limestone and dolomite with minor argillite lenses.

The Precambrian Belt series also underlies the glacial and glacio-lacustrine valley fill of the Kalispell Valley to the east of the Salish Mountains.

Initial uplift of this area occurred during the Laramide Orogeny of late Cretaceous through early Tertiary time. After a period of erosion during the middle Tertiary, an episode of compression triggered the faulting that produced the Rocky Mountain Trench and the Kalispell Valley to the north, which are major regional structural features.

Table 2-1. Climatological Data from the Flathead County Airport Weather Station, near Kalispell, 1950-1980 (NOAA, 1984)
(Latitude 48° 18'; Longitude 114° 16W')

MONTH	AVERAGE PRECIPITATION INCHES (1950 - 1980)	AVERAGE TEMPERATURE °F (1950 - 1980)
January	1.62	19.3
February	1.06	26.3
March	0.84	31.9
April	1.06	42.6
May	1.76	51.5
June	2.24	58.3
July	0.94	65.0
August	1.44	63.5
September	1.11	53.9
October	0.98	42.5
November	1.29	30.9
December	1.59	24.2
ANNUAL	15.93	42.5

During the Pleistocene, pre-Wisconsin glaciers are hypothesized to have over-ridden the region and deposited poorly sorted glacial drift. A lobe of the Cordilleran ice sheet entered the Kalispell Valley from the north during mid-Wisconsin time, and advanced southward past what is now Flathead Lake. This also covered the uplands with ice. Thousands of feet of glacial drift, comprised of undifferentiated gravels, sands, and silts, were deposited in the Kalispell Valley, and also on the adjacent uplands. When the glacial lobe receded, the Flathead arm of glacial Lake Missoula inundated the area to an elevation of 3,400 feet above sea level. The lake deposited several hundred feet of glacio-lacustrine silts and clays on top of the glacial drift. About 12,000 years ago, the water level receded to 2,883 feet above sea level, where it has remained to the present (Konizeski et al, 1968).

In the Kalispell Valley, the Pleistocene deposits contain the most abundant and reliable sources of groundwater. However, the Precambrian basement rocks are also water bearing, and they are the primary source of groundwater in the lower part of Stoner Creek Valley. The Precambrian formations are all treated as one aquifer because water-bearing zones in them are not distinctly separated. Water recharge is from leakage from overlying units and from direct infiltration of precipitation into joints and fractures. Yields from these wells are generally low (between 33 and 100 gpm) but are generally sufficient for domestic use (Konizeski et al, 1968). The potentiometric surface is often artesian because of overlying confining beds of lacustrine sediments or glacial drift.

2.4 SITE GEOLOGY AND HYDROLOGY

The spill site at Kalispell AFS is situated on the floodplain of Stoner Creek. Soil scientists contracted by the USFS at the time of the February, 1981 spill cleanup described the soil at the site as "gravelly silt loam over a layer of sands and gravel...slack water silts" (USFS files, March, 1981). The observations are in accord with U.S. Army Corps of Engineers (COE) descriptions (COE, 1959) made during drilling of the two on-site water production wells located near the spill site (Figure 2-2 and 2-3). From

production wells located near the spill site (Figure 2-2 and 2-3). From their descriptions, unconsolidated sands, gravels and silts overlie the Precambrian "limestones" and vary in thickness from 235 to 280 feet. These unconsolidated deposits originated from the several episodes of glacial activity during and preceding the Wisconsin era, from glacio-lacustrine deposits from the glacial Lake Missoula, and from modern alluvial sediments.

Two different aquifers and consequently, two different water levels exist at this site. The shallow "perched" aquifer exists in the near-surface unconsolidated sediments. According to Konizeski et al (1968), the water in the Precambrian bedrock is stored in fractures. Artesian conditions in wells that tap the Precambrian aquifer are common. Static water level measurements of the on-site wells (COE, 1959; JRB and Associates, 1985), vary between 30 and 50 feet below land surface. Water levels may be due to the perched aquifer and/or artesian conditions in the Precambrian aquifers.

The shallow aquifer is unconfined near the ground surface in the unconsolidated sediments. During cleanup actions taken after the February, 1981 spill, the water table was found to be at 8 feet below land surface (bls). The groundwater at this level discharges directly into Stoner Creek via springs and seeps along the bank. Groundwater flow at this level is quite rapid. The spill occurred on February 25, and oil contamination was reported in drinking water captured downstream in mid-April. Evidence of springs near the athletic field at the spill site was apparent in October, 1986, during the "dry" season. Therefore, during the spring, with more recharge from snowmelt and increased rainfall, the water table is nearer to the land surface, and more springs would be expected.

Stoner Creek has a mean annual runoff of 9,400 acre-feet (Farnes, 1971). The peak runoff occurs from April to June, when snowmelt and increased precipitation combine to provide more water to the watershed. Delk (1974)

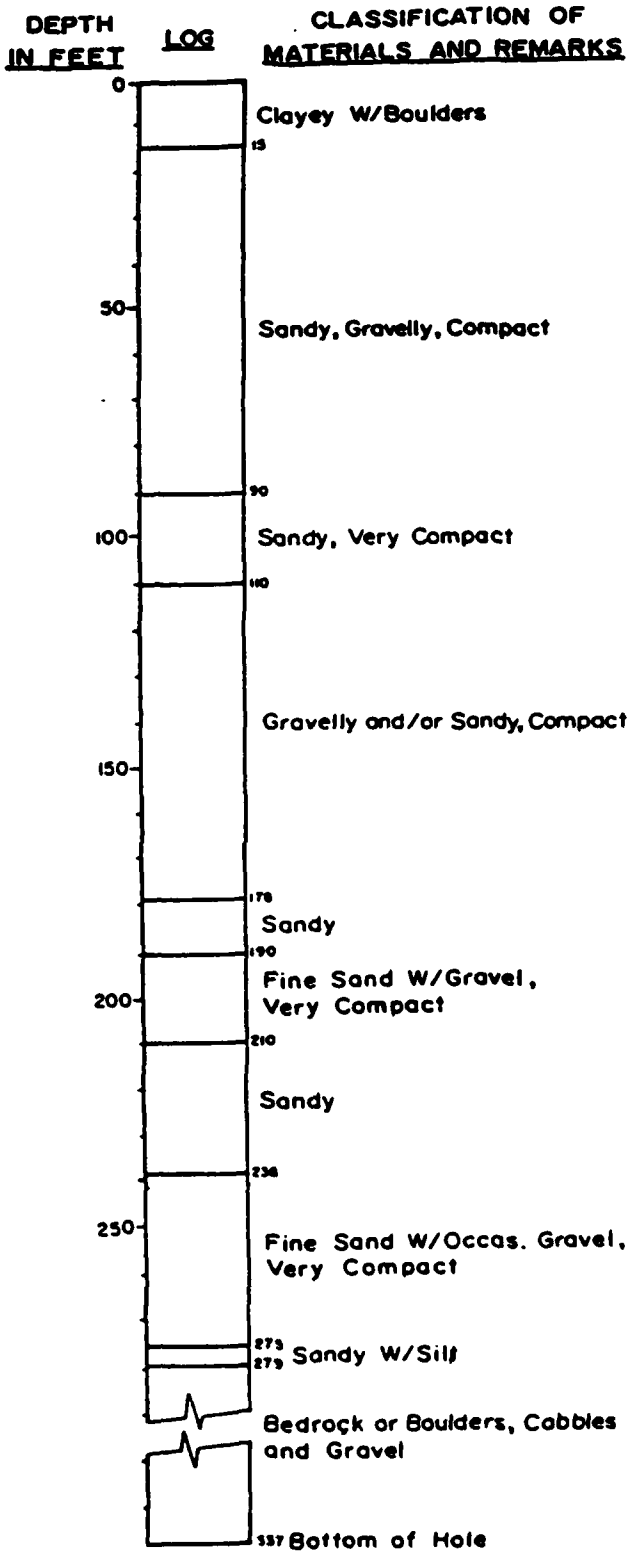


Figure 2-2
Well Log of Well #1, Building 141
Kalispell Air Force Station
(after COE, 1959)

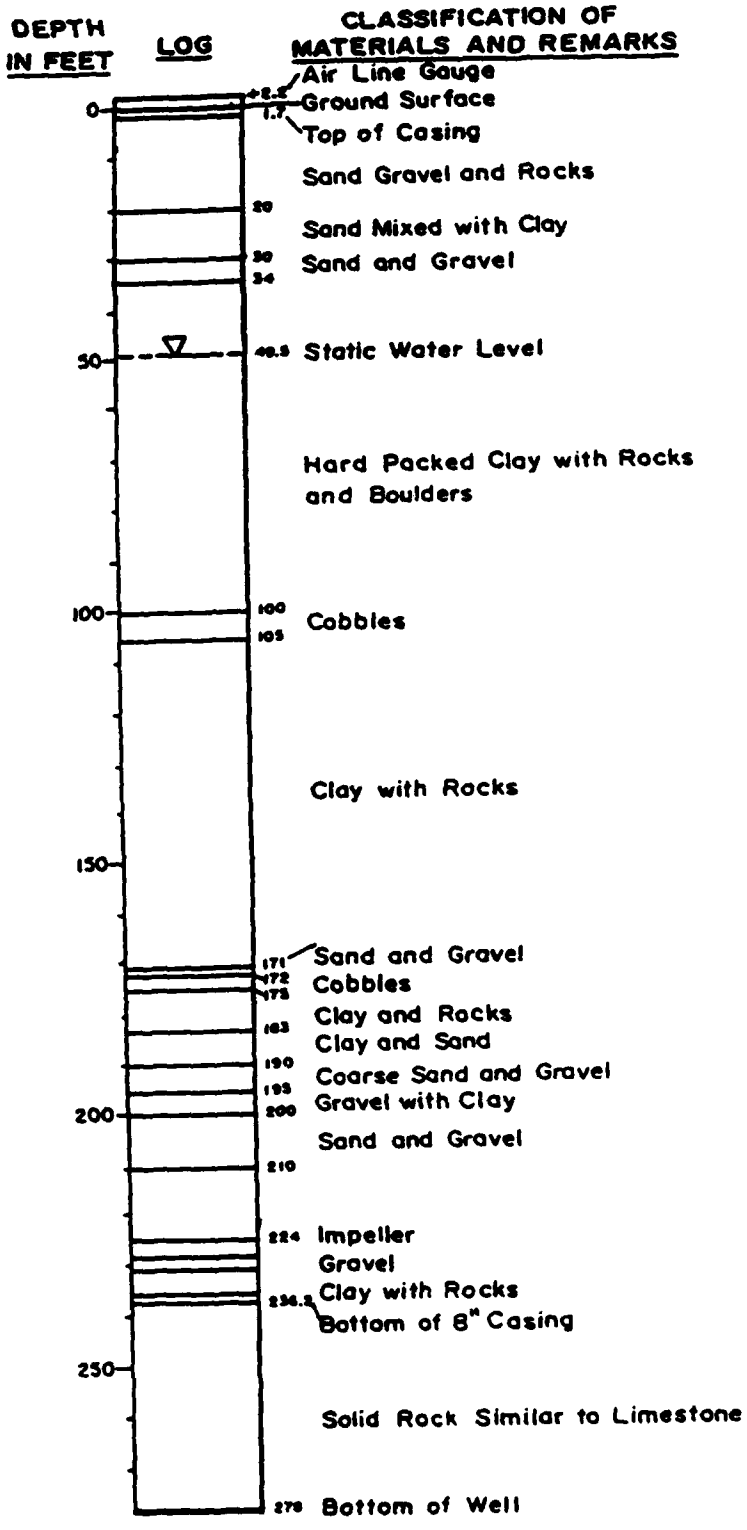


Figure 2-3
Well Log of Well #2, Building 180
Kalispell Air Force Station
(after COE, 1959)

conducted a reconnaissance water quality study on Stoner Creek. One sampling point was at the road crossing Stoner Creek (T26N, R20W, S13, elevation 3072 feet msl), approximately 0.5 miles upstream from the Kalispell AFS spill site. Stream discharge measured three times in June, 1973, averaged 7.62 cubic feet per second (cfs). No continuous discharge records have been gathered from the creek.

The water quality of Stoner Creek is classified as acceptable for drinking water use by Montana standards (USFS files; Delk, 1974), and is so used by residents downstream of Kalispell AFS. Although deep wells have been drilled for domestic use (see Section 2.5), several shallow dug wells and surface water intakes are recharged by Stoner Creek. Delk (1974) measured a variety of water quality parameters, including dissolved solids and bacteria, and did not find any violations of standards. During the spill cleanup of 1981, the creek was monitored briefly for oil and grease (no samples yielded levels above the detection limit of 5 mg/L) and for fecal coliform, which did not exceed drinking water standards. No analyses for toxic contaminants or for fuel residues had been performed previous to the present investigation.

2.5 WELLS IN THE VICINITY OF KALISPELL AFS

Figure 2-1 shows all water wells within a two-mile radius of Kalispell AFS. Table 2-2 lists these 32 wells and the major information about them; corresponding well logs are included in Appendix C. As shown in this table, and as discussed in Section 2.3, most of the wells are deep (160 to 640 feet) and are completed in the Precambrian basement rock. Well yields are generally less than 100 gpm, and many yield less than 30 gpm. Most wells are used for domestic purposes only and water quality data are not available.

Table 2-2.
Description of Water Wells Located within Two Miles of Kalispell AFS, Montana.

Well #	Location	Year Completed	Depth (feet)	Elevation (feet)	Static Water Level (feet, below land surface)	Date of SWL Measurement	Aquifer	Well Yield (gpm)	Use
1	26N21W11AA	1978	325	N/A	186	9/2/78	Precambrian	20	Domestic
2	26N21W12DA	1969	382	2995	132	4/29/69	Precambrian	25	Domestic
3	26N21W12DAA	1981	240	N/A	185	6/23/81	Precambrian	40	N/A
4	26N21W12DAB	1977	638	N/A	269	12/29/77	Precambrian?	26	Domestic
5	26N21W12DCD	1974	612	N/A	314	5/3/74	Precambrian	75	N/A
6	26N21W12DDB	1969	160	2965	109	5/2/69	Precambrian	22	Domestic
7	26N21W12DDD	1964	234	2980	90	9/18/64	Qal	10	Domestic
8	21N21W13BC	1976	247	N/A	62	12/30/76	Precambrian	12	Domestic
9	26N20W18	1977	245	N/A	55	5/31/77	Precambrian	10	Domestic
10	26N20W18ACC	1965	235	2980?	26	2/26/65	Precambrian	20	Domestic
11	26N20W18BA	1963	315	N/A	30	3/22/63	Precambrian	20	Domestic
12	26N20W18BAB	1968	265	3050	75	11/13/68	Precambrian	60	Domestic/Irrigation
13	26N20W18BCB	1982	360	N/A	100	1/15/82	Precambrian	12	N/A
14	26N20W18BDA	1969	297	N/A	89.5	8/29/69	Precambrian	25	Domestic/Irrigation
15	26N20W18BDA	1958	200	N/A	N/A	--	Qal	30	Domestic/Irrigation
16	26N20W18BDA	1973	390	N/A	16	8/6/73	Precambrian	30	Domestic/Irrigation

N/A = Information Not Available

Table 2-2 (Continued)
Description of Water Wells Located within Two Miles of Kalispell AFS, Montana.

Well #	Location	Year Completed	Depth (feet)	Elevation (feet)	Static Water Level (feet, below land surface)	Date of SWL Measurement	Aquifer	Well Yield (gpm)	Use
17	26N20W18BDC	1975	196	N/A	47	12/9/75	Precambrian	45	Irrigation
18	26N20W18CBA	1982	264	N/A	144.5	7/6/82	Precambrian	15	Domestic
19	26N20W18D	1978	340	N/A	220	4/15/78	Precambrian	30	Domestic
20	26N20W18DA	1969	409	3090	255	5/15/69	Precambrian	42	Domestic/Irrigation
21	26N20W19AAD	1969	355	2910	70	4/25/69	Precambrian	150	Domestic/Irrigation
22	26N20W7	1979	320	N/A	40	4/9/79	Precambrian	15	N/A
23	26N20W7BAA	1982	200	2920	20	4/22/82	Precambrian	80	N/A
24	26N20W07BAA	1971	126	2899	21	11/9/71	Precambrian	75	Domestic
25	26N20W07BD	1970	254	3025	163	6/16/70	Precambrian	60	Domestic/Irrigation
26	26N20W07BDC	1958	192	N/A	156	6/7/58	N/A	15	Domestic
27	26N20W07BDDD	1964	85	2980	45	9/28/64	Qal	10	N/A
28	26N20W07CBA	1972	367	2975	149	10/12/72	Precambrian	40	Domestic
29	26N20W07CCC	1977	267	N/A	28	2/8/77	Precambrian	20	Domestic
30	26N20W07CDD	1957	175	N/A	21	7/29/57	Qal	350	Municipal
31	26N20W07CDC	1977	200	N/A	3	10/15/73	N/A	36	Domestic
32	26N20W07CDCC	1957	175	N/A	N/A	---	N/A	50	Domestic/Irrigation

N/A = Information Not Available

3.0 FIELD PROGRAM

3.1 DEVELOPMENT

The investigative program for Kalispell AFS Phase II, Stage 1 study was based on information presented in the Phase I report (JRB and Associates, 1985) and the Phase II Pre-survey report (Battelle, 1985) for Malmstrom AFB. In October 1985, a senior planning team visited Malmstrom AFB and established initial coordination with Base personnel concerning Kalispell AFS. Water samples from 3 wells on the station were collected on October 30, 1985 by Air Force personnel and analyzed for several chemical parameters of concern. The results were published in the Phase II Pre-survey report (Battelle, 1985). These data have provided background data for comparison with the analyses gathered in the Stage 1 investigation.

The site-specific field investigation plan for Kalispell AFS is outlined in the Technical Operations Plan (TOP) for Malmstrom AFB (included in the Phase II Stage 1 Malmstrom AFB Final Report, Appendix H).

3.2 IMPLEMENTATION

3.2.1 Field Schedule

Record searches and interviews with key people and the field sampling program were conducted on October 6, 7, and 8, 1986.

3.2.2 Record Searches and Interviews

A review was conducted of the U.S. Forest Service files on the "Lakeside YACC Oil Spill of February 27, 1981", at the Flathead National Forest Headquarters in Kalispell and the Big Fork Ranger Station in Big Fork. Because there has been litigation involved with this case, the files were orderly, up-to-date and complete. A report on the spill and photographs of cleanup operations obtained from Flathead County Disaster Services were also

reviewed. Telephone contact with personnel at the State of Montana Bureau of Water Quality and the file on the spill was reviewed by phone.

An interview at the spill site was held with Mr. William Pedersen, U.S. Forest Service Ranger for the Big Fork District. He personally took part in the spill containment, cleanup, and subsequent environmental monitoring. He provided invaluable assistance in selecting sample sites.

Records of the above contacts and copies of correspondence are included in Appendix H.

3.2.3 Sample Collection

Three surface water samples, two groundwater samples, and six soil samples were gathered at Kalispell AFS. All were collected in accordance with U.S. Environmental Protection Agency (USEPA) protocol (Table 3-1) and were analyzed for aromatic volatile organic chemicals and petroleum hydrocarbons. Water samples collected for petroleum hydrocarbon analyses were preserved with sulfuric acid.

Surface water samples were collected by immersing sample jars six inches below the stream surface. Water from the sample site was immediately measured for pH and temperature with a pH meter and a digital thermometer. Because of operational problems encountered with the specific electrical conductivity meter in the field, an additional water sample was collected from each site, and an electrical conductivity measurement was made of each sample approximately 48 hours after sampling. All field raw data is presented in Appendix D.

The pH meter and the specific conductivity meter were calibrated with a standard buffer solution prior to sampling (SOPs for the operation of these instruments are included in Appendix E). To prevent cross-contamination, each instrument was decontaminated by washing the probes with methanol and rinsing with distilled water (Appendix E).

Table 3-1. Parameters and Methods for Water and Soil Analyses, Kalispell AFS.

Matrix	Parameter	Analytical Method[a]	Sample Volume	Sample Container	Preservative	Maximum Holding Time[b]
Water	Aromatic Volatile Organics	EPA 602	40 ml	glass	none, 4°C	14 days
	Petroleum Hydrocarbons	EPA 418.1	0.5 gal	glass	H_2SO_4 to pH<2	none
Soil	Aromatic Volatile Organics	SW 5030/8020	250 ml	glass	none, 4°C	14 days
	Petroleum Hydrocarbons	SW 3550/EPA 418.1	500 ml	glass	none, 4°C	none

(a) From Standard Methods for Examination of Water and Wastewater, 16th Ed (1985); Methods for Organic Chemical Analysis of Municipal and Industrial Wastes (1982); Test Methods for Evaluating Solid Wastes (1982);

(b) These standards are for the comparable water methods; none have been established expressly for soils.

Groundwater samples were collected from two production wells that once provided the water supply for the AFS. They had not been used for a year prior to sampling. After purging the wells by pumping for 15 minutes, samples were collected at the first tap in the distribution system (before entering cisterns or chlorinators). Temperature, pH, and specific conductivity measurements were made as described above for the surface water samples.

The shallow soil samples were collected with a hand auger where feasible, and by shovel where the soil was too hard for the hand auger to penetrate. Samples were collected from the top one foot of soil. Where the auger was used, it was necessary to make several holes within a one-foot square area to obtain enough sample for analyses. When the shovel was used, care was taken to collect the sample from within the clump of soil to avoid possible contamination from the shovel's surface. The shovel and auger were decontaminated before each sample was collected by washing in detergent and rinsing with clean water, methanol, and distilled water. Metal spoons were used to collect the sample itself. These were washed and rinsed as above, used for sampling, and then discarded.

3.2.4 Field QA/QC and Sample Splits

No duplicate samples or field blanks for field QA/QC purposes were collected since the quota of duplicate samples was being submitted from Malmstrom AFB for the same project.

Sample splitting is required by the Air Force's Statement of Work (SOW). The first set of samples were sent directly to Pedco Environmental, Inc. (PEI). The Air Force representative selected one water and one soil sample (10 percent) and these samples were shipped to USAFOEHL, Brooks AFB, Texas. These procedures are detailed in Appendix E.

3.2.5 Sample Labeling and Numbering System

Samples were assigned identification numbers in accordance with the USAF sample numbering scheme.

Samples were give a Sample Site Identifier as follows:

- o installation code,
- o sample type,
- o sample location, and
- o sequence number.

Samples were assigned a Base sample number as follows:

- o sample method,
- o sample type,
- o date,
- o sample location, and
- o sequence number.

A detailed description of the sample numbering system is presented in Appendix G. If there was a need to define a sampling site or sample location in greater detail, the measurement data was included in the field log. AF Form 2752A was prepared for each sample, and a copy was furnished with each sample.

3.2.6 Sample Handling and Packaging

After collecting a sample, the outer surfaces of the sample jars and bottles were cleaned with paper towels, labeled, and lids secured with strapping tape. The bottles were then placed in a cooler with styrofoam packing so they would not be in contact each other during shipment. Ice placed in a plastic bag was laid on top of the sample jars to keep the samples cold during shipment. Sample submittal sheets sealed in plastic bags were

strapped with masking tape to the inside lid of the cooler, and the cooler drain was taped shut. Finally the cooler was wrapped with strapping tape, addressed, and secured with a signed and dated seal. The chain-of-custody form was placed in the Federal Express pouch on the outside of the cooler. Sample handling and packaging procedures are further detailed in Appendix E.

3.2.7 Chain-of-Custody Record

All samples were accompanied by a chain-of-custody record. When samples were transferred, both of the individuals relinquishing and receiving the samples signed, dated, and noted the time on the record. Completed chain-of-custody records are provided in Appendix F.

4.0 DISCUSSION OF RESULTS AND SIGNIFICANCE OF FINDINGS

This section is presented in two subsections. The first, "Results" lists the data and the findings and, as appropriate, discusses the quality of the data from both an analytical procedures standpoint and a field protocol view. It also addresses any allowable comparisons to regulatory standards · normal background levels. In the second subsection, "Significance", the extent of contamination in the soils and waters at the site is estimated from the analyses done and discussed in terms of the information available. The overall hazard is then evaluated in terms of availability of migration pathways and proximity to exposure targets.

4.1 RESULTS

The two groundwater sample sites, the three surface water sample sites, and the six soil sample sites at Kalispell AFS are shown on the site map (Figure 4-1). Well No. 1 (GW-1) is located at Building 141, and Well No. 2 (GW-2), is in Building 180 (Table 4-1). These wells are drilled into the Precambrian bedrock or boulders, cobbles, and gravel (see Section 2.4).

The water samples were analyzed in the field for temperature, pH, and specific electrical conductivity, and analyzed in the laboratory for petroleum hydrocarbons and aromatic volatile organic chemicals.

Field parameter values measured in October, 1986 were comparable to those measured in October, 1985 for the same wells (Table 4-2 and 4-3). Specific electrical conductivity of the two wells in 1986 were measured at 462 umhos and 488 umhos respectively (Table 4-2). These measurements are very comparable to the 453 umhos measured in the wells in 1985 (Table 4-3). The pH was also comparable between the two measurements.

The results of the laboratory analyses for the present investigation, (Table 4-2) show that no petroleum hydrocarbons were detected in concentra-

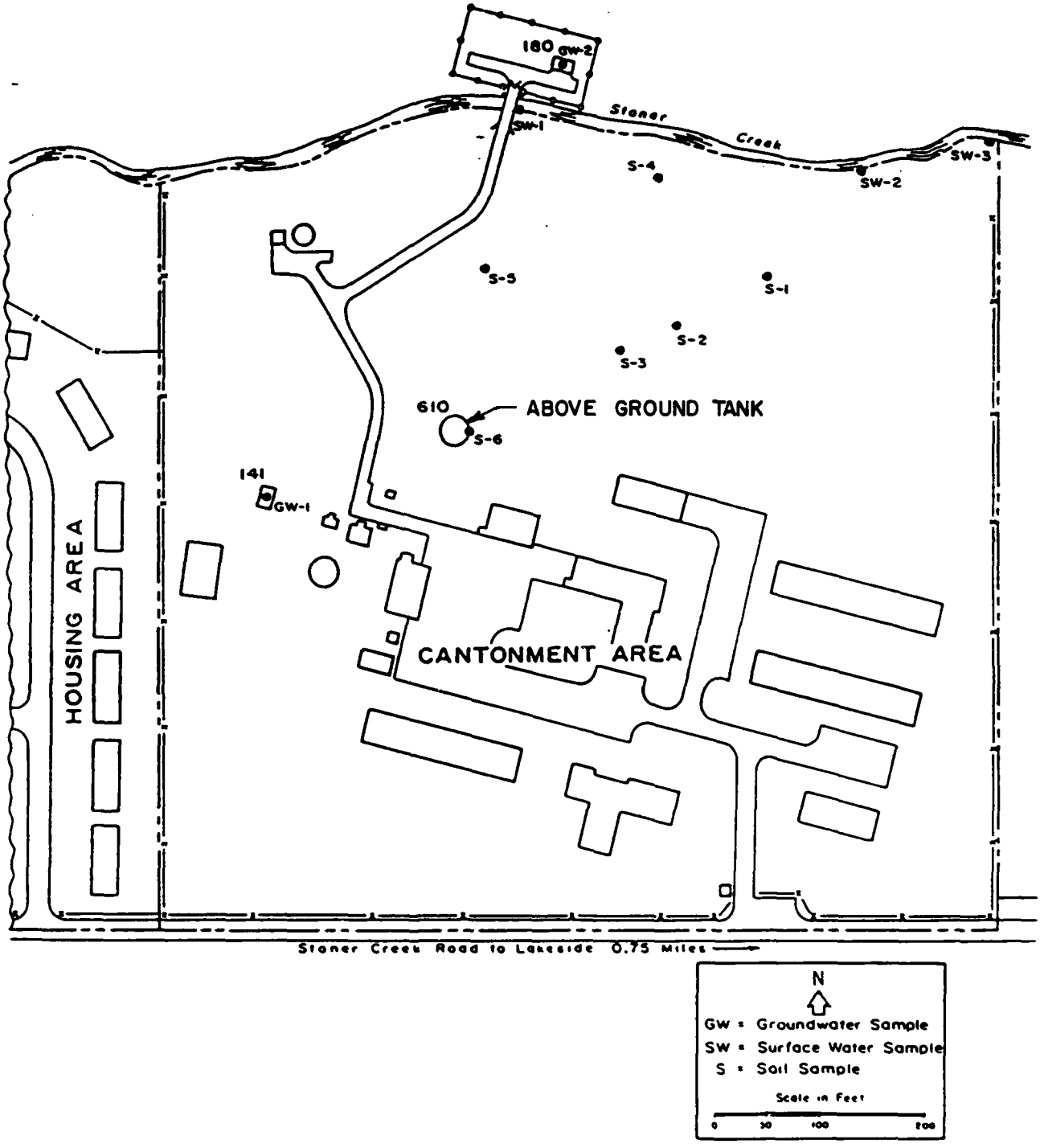


Figure 4-1: Site Map of Kalispell AFS
Showing Sample Site Locations

Table 4-1. Description of Groundwater and Surface Water Samples Collected at Kalispell AFS.

Field Site Number	Sample Number	Location Collected	Well Depth	Depth of Sample Collection
GW-1	GP-86-1006	Production well, Building 141	337'	----
GW-2	GP-86-1007	Production well, Building 180	278'	----
SW-1	GP-86-1008	Bridge crossing Stoner Creek (upstream from spill site).	----	0-6"
SW-2	GP-86-1009	Seep at which fuel oil entered Stoner Creek in 1981.	----	0-6"
SW-3	GP-86-1010	Kalispell AFS property boundary (downstream from spill site).	----	0-6"

Table 4-2. Results of Groundwater and Surface Water Samples Collected at Kalispell AFS

Field Site Number	Sample Number	Collection Date	Temperature °C	pH	Specific Electrical Conductivity umhos (25°C)	Petroleum* Hydrocarbons mg/L (EPA 418.1)	Aromatic* Volatiles ug/L (EPA 602)	Aromatic Volatile Analyses Dates	Holding Time Deadline
GW-1	GP-86-1006	10/6/87	10.4	7.30	462	ND (<1)	ND (<1.0)	10/17/86	10/20/86
GW-2	GP-86-1007	10/6/87	9.8	7.46	488	ND (<1)	ND (<1.0)	10/17/86	10/20/86
SW-1	GP-86-1008	10/6/87	9.2	8.38	309	ND (<1)	ND (<1.0)	10/17/86	10/20/86
SW-2	GP-86-1009	10/6/87	10.5	7.90	484	ND (<1)	ND (<1.0)	10/17/86	10/20/86
SW-3	GP-86-1010	10/6/87	9.2	8.33	318	ND (<1)	ND (<1.0)	10/17/86	10/20/86
	Blank**	-------	NA	NA	NA	ND (<1)	NA	---------	---------

*ND = Not Detected--Numbers in ( ) Represent Method Detection Limit (MDL);
NA = Not Analyzed
** Laboratory Blank

Table 4-3. Field and Laboratory Analyses from Kalispell AFS Production Wells, October, 1985. (From Battelle, 1985).

Field Site	Sample Number	Collection Date	Temperature °C	pH	Specific Electrical Conductivity (25°C)[c]	Oil and grease (EPA 413.2) mg/L	TOX[d] (EPA 9020) ug/L	TOC[e] (EPA 415.1) ug/L
Well #1 (GW-1)[a]	GP-85-0525	10/30/85	9.5	7.3	453	2	<10	0.6
Well #2 (GW-2)[a]	GP-85-0528	10/30/85	8.0	7.2	453	<1	16.7	0.3
	GP-85-0529[b]	10/30/85	8.0	7.2	453	1	<10	0.2

(a) 1986 field designation

(b) Field Duplicate of GW-2

(c) measured in laboratory

(d) TOX = Total organic halogens, a gross indicator of solvents.

(e) TOC = Total organic carbon, a gross indicator of fuel or organic chemicals.

tions greater than the reporting limit for water analyses (1 mg/L). Results of analyses of samples collected from the wells in October, 1985 (Battelle, 1985; Table 4-3) showed that oil and grease were present in GW-1 in concentrations of 2 mg/L, and not detected or present at the detection limit (1 mg/L) in GW-2. GW-1 contains a submersible pump which may have leaked small amounts of lubricating oils, and contributed to the low level of oil and grease in the October, 1985 sample, but the concentration is still very low and total organic carbon (TOC) analyses from the same well also are very low.

The oil and grease method (EPA 413.2) used for the 1985 sampling measures both biodegradable animal greases and vegetable oils, along with relatively non-biodegradable mineral oils. In contrast, the petroleum hydrocarbon method (EPA 418.1) used for the 1986 sampling only measures the mineral oils. The two methods are only roughly comparable, which may explain the difference in results between the two year's analyses.

No aromatic volatile organic chemicals were detected in samples from either well (Table 4-2). The lack of significant concentrations of the fuel indicators, coupled with the lack of petroleum hydrocarbons, suggest that fuel contamination in the groundwater tapped by these wells is nonexistent.

The three surface water samples were collected at the sites located on Figure 4-1 (see also Table 4-2). One sample was collected beneath the bridge crossing Stoner Creek near Building 180. The second was collected at a seep where fuel was discovered seeping out of the bank in 1981. It was collected from a stagnant pool, and iron bacteria scum was present on the surface of the water. There was no visual evidence of fuel contamination at the seep during the time of sampling. The third sample was collected at the downstream property line between the Kalispell AFS and the Stevens property. The water was clear and running freely. No evidence of fuel contamination was noted.

Table 4-2 gives the results of the surface water sample analyses. Neither petroleum hydrocarbons nor aromatic volatile organic chemicals were found. Specific conductivity measurements ranged from 309 to 484 umhos, which

compares favorably with the 300 to 400 umhos values recorded in the summer of 1973 at a sampling site approximately 0.5 miles upstream from the spill site (Delk, 1974). The pH and temperature values obtained are also reasonable.

The location of the soil samples are shown on Figure 4-1, and sample descriptions are included in Table 4-4. Sites S-1, S-2, and S-3 were located where the spill had contaminated the soil. Sites S-4 and S-5 were upgradient from the spill site itself and provided background samples. Both sites show evidence of surface seepage of water.

Site S-6 is the floor of the moat between the tank and the retaining wall. A sample was collected from this site because it was obviously fuel stained. The moat is also unlined (personal communication with Mr. William Pedersen, USFS, 10/6/87); so it was advisable to learn how much of a potential "source" these contaminated soils may be to the contamination of the underlying shallow groundwater.

The results are shown in Table 4-5. No aromatic volatile organic chemicals were found in concentrations above the detection limits. Three field samples were analyzed for aromatic volatile organics one day past the maximum holding time. A laboratory "duplicate" (CS-86-1002), was analyzed at this later date as well. The analyses are deemed valid in this report for sites S-3, S-4, and S-5 because (1) there was no obvious staining of the soil samples that would indicate fuel contamination and (2) CS-86-1002 analyzed before the maximum holding time limit showed no detectable contamination, and neither did the duplicate analyzed after the holding time limit.

The contaminated soil collected from inside the moat did not yield detectable aromatics. It was analyzed one day after the holding time, but this is probably not the primary reason it yielded no aromatics. The soil had been observed to be very dry, and the staining was old. It is likely that if volatiles were once present, they had escaped from the soil by the time of sample collection. Also, heating fuel in its original state, unlike gasoline,

Table 4-4. Description of Soil Samples Collected at Kalispell AFS.

Field Site Number	Sample Number	Description	Method of Collection	Depths
S-1	CS-86-1000	Dry sandy silt (disturbed). No visible staining or odor.	hand auger	0-12" (3 cores)
S-2	CS-86-1001	Dry sand with silt and gravel (disturbed). No visible staining or odor.	hand auger	0-8" (6 cores)
S-3	CS-86-1002	Dry sand with silt and gravel (disturbed). No visible staining or odor.	hand auger shovel	0-6" (2 cores) 0-8"
S-4	CS-86-1003	Wet clay (undisturbed). No visible staining or odor.	shovel	0-12"
S-5	CS-86-1004	Wet clay with some gravel (undisturbed). No visible staining or odor.	shovel	0-8"
S-6	CS-86-1005	Gravel and sand (disturbed). Visible staining and odor present.	shovel	0-10"

Table 4-5. Results of Soil Analyses from Samples Collected at Kalispell AFS.

Field Site Number	Sample Number	Collection Date	Percent Moisture (ASTM D2216)	Petroleum* Hydrocarbons mg/kg (SW 3550/EPA 418.1)	Aromatic* Volatiles mg/kg (SW 5030/8020)	Aromatic Volatile Analyses Dates	Holding Time Deadline
S-1	CS-86-1000	10/6/86	23.7	ND (<131)	ND (<1.3)	10/18/86	10/20/86
S-2	CS-86-1001	10/6/86	17.9	ND (<122)	ND (<1.2)	10/18/86	10/20/86
S-3	CS-86-1002	10/6/86	23.7	ND (<131)	ND (<1.3)	10/18/86	10/20/86
	CS-86-1002**	10/6/86	23.7	NA	ND (<1.3)	10/20/86	10/20/86
S-4	CS-86-1003	10/6/86	31.9	ND (<147)	ND (<1.5)	10/20/86	10/20/86
S-5	CS-86-1004	10/6/86	24.4	ND (<132)	ND (<1.3)	10/20/86	10/20/86
S-6	CS-86-1005	10/6/86	12.3	829 (ND=114)	ND (<1.1)	10/20/86	10/20/86
	CS-86-1005**	10/6/86	12.3	699 (ND=114)	NA	N/A	N/A
	Blank***	N/A	0.0	ND (<100)	NA	N/A	N/A

* ND = Not Detected Numbers in ( ) Represent Method Detection Limit (MDL);
NA = Not Analyzed
** Laboratory Replicate
*** Laboratory Blank
N/A = Not Applicable

contains only small concentrations of aromatic volatile organics. There may not have been enough concentration of hydrocarbons to be detected by the test.

No petroleum hydrocarbons were found in any of the soil samples collected outside of the retaining wall. The sample collected at S-6, inside the moat, yielded a petroleum hydrocarbon concentration of 829 mg/kg (Table 4-5). This value is very low (less than one tenth of 1% by weight), and there are no regulatory standards defining acceptable limits of petroleum hydrocarbons in soils. In fact, the State of Montana allows oil to be put on dirt roads for dust control.

Fuel contamination of the soil at S-6 is certainly confirmed by the petroleum hydrocarbon positive, but its low value indicates that the threat of this fuel polluting groundwater in any substantial way is negligible.

4.2 SIGNIFICANCE

Based on the field observations and analytical results of this investigation, it is known that the extent of present fuel contamination to the on-site wells, Stoner Creek, and the site's soils is negligible to non-existent. The on-site wells are several hundred feet deep and tap the Precambrian bedrock aquifer. The likelihood of oil seepage from the surface into this aquifer in any substantial concentration is low because of the relatively impermeable silt and clay layers in the unconsolidated deposits overlying the bedrock. The two wells are also slightly upgradient from the spill site, so contamination of them by the spill is again rather unlikely. The wells were never sampled during the time of the actual spill and have not been regularly monitored since; therefore no historical data is available.

There are regulatory guidelines established for many of the chemicals tested for in this study (Table 4-6), but the well water does not violate any of these standards.

Table 4-6. Safe Drinking Water Act (SDWA) Regulatory Guidelines for Maximum Concentrations of Selected Chemicals in Drinking Water.

Parameter	Method	Concentration	Status
Petroleum Hydrocarbons	EPA 418.1	none established	
Aromatic Volatile Organics	EPA 602		
Benzene		5 ug/L	Proposed MCL*
Toluene		2000 ug/L	Proposed RMCL**
Ethylbenzene		680 ug/L	Proposed RMCL
Chlorobenzene		none established	
Total Xylene		440 ug/L	Proposed RMCL
1,4 - Dichlorobenzene		740 ug/L	Proposed RMCL
1,3 - Dichlorobenzene		none established	
1,2 - Dichlorobenzene		620 ug/L	Proposed MCL

* MCL = Maximum Contaminant Level = Enforceable Standards.
** RMCL = Recommended Maximum Contaminant Level = Non-enforceable Health Goals.

The surface water of Stoner Creek also seems unaffected (neither petroleum hydrocarbons nor aromatic volatile organic chemicals were detected in the samples). This is not surprising because trenches paralleling the stream were dug during the spill cleanup in 1981 to intercept and remove any oil moving to the stream on the water table. Samples collected at water supply intakes directly downstream from the spill at the time of the peak discharge yielded oil and grease concentrations of less than 5 mg/L (USFS files). Therefore, there is even less likelihood now of detecting concentrations of petroleum hydrocarbons from the spill after five years of spring "flushes" of the groundwater table.

The extent of top soil contamination appears negligible. Most of the heavily contaminated soil and sod was removed during the spill cleanup operations in 1981. Even though oil did enter the water table at that time, by removing the contaminated soil promptly, the source for further groundwater contamination was removed. If residual fuel has moved deeper than sampled during this investigation, the effect of its presence has likely been attenuated by the action of the spring flushes that have occurred since the spill.

The fuel contamination is localized inside the retaining wall at the tank. The pipe leading from the tank to the distribution system is leaking on the unlined floor of the moat. It is possible that oil from this source is washing down through the soil and entering the water table, but it is impossible to judge the magnitude or extent of this contamination from the present investigation because no sampling of the water table was performed. Unless the bottom of the tank itself is leaking, the magnitude of contamination entering the water table (based on the low concentration of petroleum hydrocarbons in the soil sample from S-6) is judged to be low.

As a result of this investigation, it appears that the February, 1981 diesel fuel spill has been adequately remediated and that no significant threat to the environment or to human health from after-affects of the spill

exist today. Neither the groundwater on-site, nor Stoner Creek water violate drinking water guidelines or standards for the parameters tested.

The contaminated soil that would act as the major source of continued contamination of the groundwater and surface water pathways, and hence, impact humans through ingestion of drinking water, has been removed. Although the potential pathways of contaminant migration and exposure targets exist, it appears that the impact of the spill on the surrounding environment is today imperceptible.

5.0 ALTERNATIVE MEASURES

The results of this field investigation, coupled with interviews of key persons and evaluations of the records, suggest that the on-site wells (if they were ever affected by the fuel spill) are not affected by fuel contamination at the present time. Fuel was not detected in surface water resulting from the seep on the bank of Stoner Creek, nor was it evidenced in the surface water downstream from it. No visible fuel scum or affected vegetation was observed. These observations suggest that fuel is not now entering the stream from this seep, or if any is, it is negligible and has little or no environmental impact.

No soils sampled in the path of the spill itself were found to be contaminated with fuel. This suggests that the surface soils are not acting as a source of fuel contamination to the underlying groundwater. The one slightly-contaminated sample from the floor of the unlined moat between the tank and the retaining wall indicates that the contaminated soil here may be potentially acting as a source of contamination to the water table. However, no data regarding groundwater contamination exists to verify whether or not this is true.

Possible recommendations for future actions at Kalispell AFS include the following:

(1) During the spring flush (April to June), the optimum time, sample the seep in the Stoner Creek bank to see if fuel is seeping into the creek by this pathway.

(2) Sample the groundwater at the water table between the tank and Stoner Creek. The twenty four holes drilled in the area during the spill assessment in 1981 have never been grouted. Water level measurements could be made, and samples could be collected from selected boreholes to see if petroleum hydrocarbon contamination is present. Alternatively, one or

new holes could be drilled and the water sampled. (The old holes that are now open should be grouted or plugged in accordance with acceptable practices.)

The following suggestions are outside the scope of the IRP, but should be considered as alternatives for this site:

(1) The leak in the pipe leading from the tank to the distribution system should be repaired.

(2) Remove the fuel-contaminated gravel from the bottom of the moat between the tank and the retaining wall. A liner on the moat floor could be installed to prevent leaking oil from contaminating the soil and to prevent infiltrating rainwater from flushing contaminants downward to the water table. It might also be advisable to install an oil separator.

(3) Monitor the tank fuel inventory carefully to make sure leaks are detected and promptly remedied.

6.0 RECOMMENDATIONS

Based on the data and information available from this and previous investigations, Kalispell AFS is classified as a "Category I" site (no further action required). Fuel contamination was not found in either of the two onsite wells, in surface water samples from Stoner Creek, nor in soil samples from the path of the fuel spill. Negligible amounts of petroleum hydrocarbons found in the moat between the tank and its retaining wall is probably the result of many years of spillage, including current leaks, and not just from the spill of February 1981.

The cleanup actions conducted in 1981, which included removal of grossly contaminated soil, and the digging of trenches and installation of oil/water separators to collect and remove oil from the water table, seem to have effectively reduced the likelihood of contaminated groundwater entering Stoner Creek. Two residents immediately downstream from the spill site have had new water supplies provided them by the U.S. Forest Service, and no other residents downstream have complained within the last five years of fuel-contaminated water supplies. Therefore, due to the limited extent and low concentrations of contaminants, further investigative actions are not necessary.

The following suggestions are outside the scope of the IRP, but are, nonetheless, recommended for consideration. A lining for the floor of the moat between the tank and retaining wall should be considered. This is needed to prevent fuel from contaminating groundwater beneath the tank, and eventually entering Stoner Creek. It is also recommended that the boreholes in the athletic field be grouted or properly capped.

APPENDIX A

Definitions, Nomenclature, Units of Measurement

APPENDIX A
DEFINITIONS, ACRONYMS, AND UNITS OF MEASUREMENT

AF	-	Air Force
AFB	-	Air Force Base
AFS	-	Air Force Station
bls	-	Below Land Surface
DOD	-	Department of Defense
IRP	-	Installation Restoration Program
JRB and Associates	-	Firm that Accomplished Phase I of IRP
MCL	-	Maximum contaminant level in drinking water. Enforceable Standards.
OEHL	-	Occupational and Environmental Health Laboratory.
PEI	-	Pedco Environmental Inc., Analytical Laboratory
POC	-	Point of Contact
RMCL	-	Recommended maximum contaminant levels in drinking water. Non-enforceable health goals.
SOPs	-	Standard Operation Procedure
SDWA	-	Safe Drinking Water Act
USAFOEHL	-	United States Air Force Occupational and Environmental Health Laboratories
gpm	-	Gallons per minute.

APPENDIX A
GLOSSARY OF TERMS

Alluvium	-	General term for clay, slit, sand, gravel, or other similar detrital material deposited by a body of running water.
Aquifer	-	Geologic formation, group of formations, or part of a formation that is capable of yielding water to a well or spring.
Argillite	-	A very fine-grained, well indurated rock.
Artesian	-	Water levels which rise above the water bearing formation.
Cordillera	-	A group of mountains ranges having one common trend.
Cretaceous	-	The 3rd and last period in the Mesozoic Era.
Formation	-	A primary geologic rock unit.
Geologic	-	Study of the earth its formation and the changes its undergone or is undergoing.
Glacial Drift	-	Sediments transported and deposited by glaciers.
Glacial Till	-	Glacial soil deposits composed mainly of clay with sand, silt, and boulders.
Glaciolacustrine	-	Pertains to, produced by, or formed in a glacial lake or lakes.
Hydrologic	-	Relating to the water of the earth's surface.
Hydrogeology	-	Relating to the science of ground water and its geological relationships.
Lacustrine	-	Pertains to, produced by, or formed in a lake or lakes.
Laramide Orogeny	-	The diastrophic movement of the earth's crust during Jurassic until Lower Eocene.
Migration	-	Movement of oil, gas, or water through porous and permeable medium.
Moat	-	Area between tank and retaining well.

Perched	-	Pertains to ground water accumulation which is restricted and different from the normal water table of the area.
Pleistocene Age	-	The earlier of the two epochs comprising the Quaternary the age of glaciers.
Potentiometric	-	Refers to the relief or elevation of the water surface.
Quartzite	-	A metamorphic rock consisting primarily of quartz.
Recharge	-	The addition of water to the groundwater system by natural or artificial processes.
Remediation Measures	-	Actions necessary to clean up, remove or treat a substance or location so hazardous effects are eliminated or reduced.
Stromatolite	-	Laminated, but otherwise structureless calcareous objects. Algae fossils.
Surficial Geology	-	Formed on, situated at, or occurring on the earth's surface.
Volatile	-	A substance which tends to evaporate or vaporize into the air.

APPENDIX B

Statement of Work

INSTALLATION RESTORATION PROGRAM
PHASE II - CONFIRMATION/QUANTIFICATION (STAGE 1)
Malmstrom AFB MT

I. DESCRIPTION OF WORK

The overall objective of the Installation Restoration Program (IRP) Phase II investigation is assess potential contamination at past hazardous waste disposal and spill sites on Air Force installations. A series of staged field investigations may be required to meet this objective.

The purpose of this task is to undertake a field investigation at Malmstrom AFB MT (1) to confirm the presence or absence of contamination within the specified areas of investigation; (2) if possible, to determine the extent and degree of contamination and the potential for migration of those contaminants in the various environmental media; (3) to identify public health and environmental hazards of migrating pollutants based on State or Federal standards for those contaminants; and (4) to delineate additional investigations required beyond this stage to reach the Phase II objectives.

The Phase I IRP Report (mailed under separate cover) incorporates the background and description of the sites/zones for this task. To accomplish this survey effort, the contractor shall take the following actions:

A. General Requirements - The general requirements are applicable to all sites unless modified by the site specific work in Section I.B.

1. Monitor ambient air during all soil borings with a photoionization meter or equivalent organic vapor detector to identify the generation of potentially hazardous and/or toxic vapors or gases. Include air monitoring results in the boring logs. If soil encountered during borehole drilling is suspected to be hazardous because of discoloration, odor or air monitoring levels, containerize the soil cuttings in new, unused drums. Enter into the boring logs the depth(s) from which suspected contaminated soil cuttings were collected for containerization. Take a composite sample from the contents of each drum. Collect a maximum of 10 composite samples and test them for EP Toxicity (metals). Use RCRA criteria to determine if soil cuttings must be classified as hazardous waste (40 CFR 261.24).

2. Determine the exact location of all soil borings during the planning/mobilization phase of the field investigation. Consult with base personnel to minimize disruption of base activities, and to avoid underground utilities. Direct the drilling and sampling and maintain a detailed log of the conditions and materials penetrated during the course of the work. Do not drill boreholes into actual landfill areas.

3. Determine the areal extent of the sites by reviewing historical and current panchromatic and infrared aerial photography.

4. Soil Borings

a. Conduct soil borings not to exceed a maximum of 800 linear feet. Accomplish the borings using hollow-stem auger techniques. Obtain split-spoon samples at five foot intervals using ASTM Method D-1586. Refer to the site specific details, Section I.B., for the soil sample collection depths.

b. During the boring operations, describe lithologies encountered, and prepare stratigraphic logs. Place special emphasis on field identification of contaminated soils encountered.

c. Scan all split-spoon soil cores with a photoionization meter or equivalent organic vapor detector. Include monitoring results in the boring logs.

d. Whenever possible, measure water levels in all boreholes after the water level has stabilized. Examine the water surface for the presence of hydrocarbons. Include this information in the boring logs.

e. Tremie-grout all boreholes to the surface with a bentonite/ cement grout. It is especially important to insure that they be adequately resealed to preclude future migration of contaminants.

f. Permanently mark each location where soil borings are drilled. Record the location on a project map for each specific site or zone, whichever is applicable.

5. Borehole Cleanup

Remove all borehole cuttings and clean the general area following the completion of each borehole. Containerize and store cuttings according to paragraph IA1 of this task order. Each barrel shall have appropriate material labels and be numbered. The laboratory analyses of drum contents shall reflect the applicable drum identification numbers and shall be provided to the base POC when complete. Transport the drums containing suspected contaminated soils to a location on Malmstrom AFB designated by the POC. The base is responsible for ultimate disposal of contaminated soils using base resources.

6. Field Sampling

a. Strictly comply with the sampling techniques, maximum holding times, and preservation of samples as specified in the following references: Standard Methods for the Examination of Water and Wastewater, 16th Edition (1985), pages 37-44; ASTM, Section 11, Water and Environmental Technology; Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, 2nd Edition (USEPA, 1984); Methods for Chemical Analysis of Waters and Wastes, EPA Manual 600/4-79-020, pages xiii to xix (1983) and the Handbook for Sampling and Sample Preservation of Water and Wastewater, EPA Document 600/ 4-82-029 (1982).

b. Surface water or sediment samples are specified at several sites. Collect the surface water sample or sediment sample at each sample

location specified. Collect samples so as not to cause cross-contamination; obtain downstream samples first and obtain the water samples before sediment samples. Measure on site the pH, temperature, and specific conductance for all water samples.

c. Split all water and soil samples. Analyze one set and immediately deliver the other set (the same collection day) to the field government point of contact (POC). The field POC will select 10% of the split samples, package the selections with appropriate forms, and deliver them to the contractor within 24 hours of receipt. Supply all packing and shipping materials to the field POC's for packaging the split samples. Immediately ship (within 24 hours) the POC selected samples through overnight delivery to:

USAFOEHL/SA
Bldg 140
Brooks AFB TX 78235-5501

For all split samples sent to the USAFOEHL, complete an AF Form 2752A "Environmental Sampling Data" and/or an AF Form 2752B "Environmental Sampling Data - Trace Organics", (working copies have been provided under separate cover) with the following information:

(1) Date and time collected

(2) Purpose of sample (analyte and sample group)

(3) Installation name (base)

(4) Sample number (on containers)

(5) Source/location and depth of sample

(6) Contract Task Numbers and Title of Project

(7) Special Conditions (use of surrogate standard, special nonstandard preservations, etc.)

(8) Preservatives used

(9) Collector's name or initials

In addition, label each sample container with a permanent ink pen (laundry marker) to reflect the data in (1), (2), (3), (4), (8) and (9) above.

d. For every 10 field samples collected, take one additional sample (a field duplicate) for quality control purposes. Attachment 1 provides a 10% allowance for these additional analyses. Include all quality control data in the draft and final reports. Duplicates shall be indistinguishable from other analytical samples such that personnel performing the analyses should not be able to determine which samples are duplicates.

e. For every 20 field water samples collected, prepare and submit for analysis one field blank for all parameters analyzed in water. A minimum of one field blank for each parameter is required. Allowance for these additional analyses are included in Attachment 1.

f. Maintain chain-of-custody records for all samples, field blanks, and quality control samples.

7. Chemical Analyses

a. Analyze water and soil samples collected as specified in Section B below, Specific Site Work. The analytical parameters are summarized in Attachment 1 along with the required methods.

b. Archive all raw data, including QA/QC and standards data for not less than five years after project completion. Upon request, supply this data to the USAFOEHL/TS.

c. All analyses shall meet the required limits of detection for the applicable EPA method identified in Attachment 1.

d. For those methods which employ gas chromatography (GC) as the analytical technique (i.e., E601, E602, E608, E617, SW8010, SW8020, etc.) positive confirmation of identity is required for all analytes having concentrations higher than the Method Detection Limit (MDL). Conduct positive confirmation by second-column GC; however, gas chromatography/mass spectroscopy (GC/MS) can be used for positive confirmation if the quantity of each analyte to be confirmed is above the detection level of the GC/MS instrument. Analytes which cannot be confirmed will be reported as "Not Detected" in the body of the report, but results of all second-column GC or GC/MS confirmational analyses are to be included in the report appendix along with other raw analytical data. Base the quantification of confirmed analytes on the first column analysis. The maximum number of second-column confirmational analyses shall not exceed fifty percent (50%) of the actual number of field samples (to include duplicates). The total number of samples for each GC method listed in Attachment 1 includes this allowance. 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.

e. All chemical/physical analyses shall conform to state and other applicable federal and local regulatory agencies' legal requirements. If a regulatory agency specifies that a type of analysis be performed in a certified laboratory, assure compliance with the requirement and furnish documentation showing laboratory certification with the first analytical data supplied to the USAFOEHL/TS.

8. Decontamination Procedures:

a. Decontaminate all sampling equipment, including internal components, prior to use and between samples to avoid cross contamination. Wash equipment with a laboratory-grade detergent followed by drinking quality

water, solvent (methanol), and distilled water rinses. Allow sufficient time for the solvent to evaporate and the equipment to dry completely.

b. Thoroughly clean and decontaminate the drilling rig and tools before initial use and after each borehole completion. As a minimum, steam clean drill bits after each borehole is installed. Drill from the "least" to the "most" contaminated areas, if possible.

9. Plot and map all field data collected for each site according to surveyed positions.

10. Conduct a literature search of local hydrogeologic conditions to complement the Phase I Report (mailed under separate cover). Use this data to determine optimum borehole locations. Include the pertinent literature search information in an appendix of the Final Report. Develop the literature search data using the following guideline:

a. Topographic data

b. Geologic data

(1) Structure

(2) Stratigraphy

(3) Lithology

c. Hydrogeologic data

(1) Location of all existing and abandoned wells, including observation wells, springs natural ponds and seepages, that occur on or off the installation within a one-mile radius of sites to be investigated

(2) Groundwater table and piezometric contours

(3) Depth to groundwater

(4) Surface and groundwater quality

(5) Recharge, discharge and contributing areas

(6) Geologic setting, yield and hydrographs of springs and natural seepage.

d. Data on all existing and abandoned wells, to include observation holes, on or off the installation and within a one-mile radius of sites to be investigated.

(1) Location, depth, diameter, types of wells, and logs

(2) Static and pumping wat levels, hydrographs, yield, and specific capacity

(3) Present and projected groundwater development and use

(4) Corrosion, incrustation, well interference, and similar operation and maintenance problems

(5) Observation well networks

(6) Existing water sampling sites

e. Aquifer data

(1) Type, such as unconfined, artesian, or perched

(2) Thickness, depths, and formational designation

(3) Boundaries

(4) Transmissivity, storativity, and permeability

(5) Specific retention

(6) Discharge and recharge

(7) Ground and surface water relationships

(8) Aquifer models

f. Climatic data

(1) Precipitation (total and net)

(2) Evapotranspiration

B. Specific Site Work

In addition to items delineated in I.A. above, conduct the following specific actions at the sites listed below:

1. Kalispell Air Force Station (OB-3). (Kalispell AFS is approximately 225 miles northwest of Malmstrom AFB.)

a. Conduct a records search to compile information on the 1981 fuel oil spill, clean-up, and past and continuing impacts on the local environment. The record search should include U.S. Forest Service, Flathead National Forest Headquarters and Big Fork Ranger Station and Montana Department of Health and Environmental Sciences, Water Quality Bureau records on the Lakeside YACC oil spillage 2/27/81.

b. Collect six shallow composite soil samples in the top two feet of soil in the area where the fuel flowed to Stoner Creek.

c. Collect three surface water samples, one upstream and two downstream of where the spill entered the stream.

d. Collect a water sample from each of the two site water wells downgradient of the area of the fuel spill flow.

e. Analyze water and soil samples for petroleum hydrocarbons and aromatic volatile organics.

2. Landfill Northeast of WSA (SW-3).

a. Locate and review site aerial photographs and information not located during previous IRP efforts to better define site boundaries, contents of the landfill, and geology.

b. To determine lithology and integrity of soils around the landfill, perform four equally spaced soil borings to a depth of approximately 40 feet around the perimeter of the landfill.

c. Collect two soil or sediment samples in the bottom of the coulee which provides drainage for the landfill. Take samples in the top two feet of soil. Take one sample at a point selected in the field, somewhere between the landfill and the base boundary; take the other sample just inside the base boundary fence.

d. Collect four water samples; two from the coulee which drains the landfill (one upstream of the landfill and one downstream at the base boundary) and two near the downstream edge of the landfill trenches where any flowing or standing water is noted.

e. Analyze soil samples for petroleum hydrocarbons, aromatic volatile organics, halogenated volatile organics, 13 priority pollutant metals, and extractable priority pollutants (GC/MS).

f. Analyze water samples for petroleum hydrocarbons, aromatic volatile organics, non-halogenated volatile organics, halogenated volatile organics, 13 priority pollutant metals, extractable priority pollutants (GC/MS), total dissolved solids (TDS), and common anions.

3. Military Gas Station (PS-2)

a. Conduct a records search to determine the locations and configuration of the underground tanks and the extent of known leakage/ spillage at the site.

b. Perform four soil borings near the buried tanks. Drill the borings a minimum of five feet below the bottom of the tanks (approximately 20 feet deep). Collect a maximum of 12 soil samples from these borings at points of suspected contamination.

c. Analyze soil samples for petroleum hydrocarbons, aromatic volatile organics and lead.

4. Pole Storage Yard (IS-3)

Collect three soil samples within the top 2-feet of soil in the areas where PCB transformers were stored. Analyze the samples for PCBs.

5. Fire Training Area (FT-1)

a. Perform four 20-foot soil borings to determine vertical migration of contaminants. Position one boring within the fire training pit; another just outside of the pit; another in the oil separator area; and the last downgradient from the separator where pooling is likely to occur. Collect a maximum of twelve soil samples from the borings at points of suspected contamination or as required to define the extent of vertical migration of contaminants.

b. Analyze soil samples for petroleum hydrocarbons, aromatic volatile organics, halogenated volatile organics and lead.

6. ARRS Hangar (PS-5)

a. Collect four shallow (in the top 18 inches of soil) soil samples. Two samples shall be taken at the north edge of the apron where wash water is likely to flow off the apron. Two samples shall be taken in the ditch north of the apron.

b. Analyze soil samples for petroleum hydrocarbons, aromatic volatile organics, and halogenated volatile organics.

7. Bulk POL Storage Area (PS-4)

a. Perform four 20-foot soil borings outside the berms surrounding the fuel tanks. One boring shall be installed topographically upgradient of each of the two largest fuel tanks (two borings); and two borings shall be installed topographically downgradient of the tanks. Collect a total of 12 soil samples from the borings at points of suspected contamination or as required to characterize the vertical extent of contamination.

b. Analyze soil samples for petroleum hydrocarbons and aromatic volatile organics.

8. Flightline Landfill (SW-2)

a. Locate and review aerial photographs and information not identified during previous IRP efforts to better define site boundaries, contents of the landfill, and site geology.

b. Perform an electromagnetic survey of the site to better define its boundaries.

c. To determine lithology and integrity of the soils around the landfill, perform four equally spaced 40 foot soil borings around the perimeter of the landfill. Collect a maximum of 12 soil samples from these borings at points of suspected contamination.

d. Analyze soil sample for petroleum hydrocarbons, aromatic volatile organics, halogenated volatile organics, 13 priority pollutant metals and extractable priority pollutants (GC/MS).

9. Pumphouse No. 1 (PS-3)

a. Conduct a records search of Civil Engineering records to locate piping in the area, determine the condition of the piping, and identify likely areas of leakage.

b. Conduct a metal detector survey to locate underground piping and obstacles to sampling.

c. Collect eight shallow soil samples (to a maximum of four feet or to the depth of piping). Collect the samples in the vicinity of Pumphouse No. 1 and along 1st Street at points of suspected pipeline leakage.

d. Collect a water sample from each of the two storm sewer manholes to the east of Pumphouse No. 1 on 1st Street and an upgradient water sample from the nearest upgradient manhole (three total samples).

e. Analyze soil samples for petroleum hydrocarbons and aromatic volatile organics, and lead.

f. Analyze water samples for petroleum hydrocarbons and aromatic volatile organics.

10. Waste Disposal Site South of WSA (SW-5)

a. Collect four shallow soil samples (to a maximum depth of three feet) at locations where surface contamination is evident or where base personnel indicate abandoned drums were found.

b. Install one 20-foot boring topographically downgradient of the drum storage area to characterize vertical contamination. Collect a maximum of three samples for chemical analysis from the boring at points of suspected contamination as indicated by OVA or HNU meter readings, discoloration, odor or other contamination indicators.

c. Analyze the soil samples for petroleum hydrocarbons, aromatic volatile organics, halogenated volatile organics, nonhalogenated volatile organics, and extractable priority pollutants (GC/MS).

11. Drum Disposal East of DPDO (SW-1) (Note: DPDO is now DRMO (Defense Reutilization and Marketing Office.))

a. Identify the most probable areas on site where hazardous materials were stored or spills occurred through interviews with knowledgeable base personnel and inspection of the site.

b. Collect a maximum of 12 shallow soil samples (to one foot depth) in areas where hazardous materials were stored or spills occurred.

c. Analyze the soil samples for petroleum hydrocarbons, aromatic volatile organics, halogenated volatile organics, nonhalogenated volatile organics, and extractable priority pollutants.

12. Open Storm Ditch Southeast of POL Tank 41101 (WW-1)

a. Collect five sediment samples from the bottom of the coulee. Sample only the top six inches of sediment in the following locations:

(1) One sample just below the POL storage tanks.

(2) One sample just before the stream goes into the culvert below N street.

(3) One sample from the oil/water separator.

(4) One sample from downstream of the separator where the ditch from below the ARRS hangar enters the main coulee.

(5) One sample at the base perimeter.

b. Perform four soil borings each to a depth of 20 feet, in the main coulee which drains WW-1. Collect a maximum of 12 soil samples from the borings. Borings shall be located as follows:

(1) One boring near where the coulee exits the base.

(2) One boring where the road crosses the coulee.

(3) Two borings on the sides of the coulee one each to the northwest and southeast of the stream, and about half-way between the last road crossing the coulee and the base fence.

Locate these borings where contaminants would be likely to collect and infiltrate the soil.

c. Analyze the soil and sediment samples for petroleum hydrocarbons, aromatic volatile organics, halogenated volatile organics, nonhalogenated volatile organics, and extractable priority pollutants (GC/MS).

13. Launch Facility P-10 (OB-1) (LF P-10 is approximately 90 miles north of Malmstrom AFB near Shelby, Montana.)

a. Review clean-up records for the 1982 fuel spills and determine the extent of clean-up and ultimate fate of the spilled fuel.

b. Review geological and hydrogeological information for the site. Include review of boring and excavation logs from the construction of the launch facility. This information shall be used to estimate environmental impact of the past spill.

c. Perform two 20-foot soil borings at the spill site to determine vertical migration of the fuel. Collect a maximum of six soil samples from the borings.

d. Analyze the soil samples for petroleum hydrocarbons and volatile aromatic chemicals.

14. Launch Control Facility S-O (OB-2) (LCF S-O is approximately 55 miles north of Malmstrom AFB near Brady, Montana.)

a. Review clean-up records for the 1979 MOGAS spill and determine extent of clean-up and ultimate fate of the spilled fuel.

b. Review local sources of geological and hydrogeological information for the site. Include review of boring and excavation records from facility construction. Use the information to estimate environmental impact from the spill.

c. Collect one sample from the water well at the site.

d. Perform one 20-foot soil boring at the spill site to determine the extent of vertical migration of fuel. Collect a maximum of three soil samples from the boring.

e. Analyze the water sample for petroleum hydrocarbons, aromatic volatile organics, and lead.

f. Analyze the soil samples for petroleum hydrocarbons aromatic volatile organics and lead.

C. Health and Safety

Comply with USAF, OSHA, EPA, state and local health and safety regulations regarding the proposed work effort. Use EPA guidelines for designating the appropriate levels of protection at study sites. Prepare a written Health and Safety Plan for the proposed work effort and coordinate it directly with applicable regulatory agencies prior to commencing field operations. Provide an information copy of the Health and Safety Plan to the USAFOEHL after coordination with regulatory agencies. The Health and Safety Plan is specified in Sequence No. 7, Item VI below.

D. Technical Operations Plan

Immediately after the Notice To Proceed (NT?) for the delivery order, develop a Technical Operations Plan (TOP) based on the technical requirements specified in this task description. (See Sequence No. 20, Item VI, below). Follow the TOP format (mailed under separate cover). Provide the TOP to the USAFOEHL within two weeks of the NTP.

E. Data Review

1. Tabulate field and analytical laboratory results, including field and laboratory parameters and QA/QC data, as they become available and

incorporate them into the next monthly R&D Status Reports (Sequence No. 1, Item VI below) forwarded to the USAFOEHL. In addition to the results, report the following:

a. the time and dates for sample collection, extraction (if applicable) and analysis;

b. the method used and Method Detection Limits;

c. the Chain-of-Custody forms;

d. a cross-reference of laboratory sample numbers and field sample numbers; and

e. a cross-reference of field sample numbers to wells, boreholes, sites, etc.

2. Upon completion of all analyses, tabulate and incorporate all results into an Informal Technical Information Report (Sequence No. 3, Item VI, below) and forward the report to USAFOEHL for review a minimum of two weeks prior to submission of the draft report. Provide as a minimum the information specified in I.E.1. above.

3. Immediately report to the USAFOEHL Program Manager or his supervisor via telephone, data/results generated during this investigation which indicate a potential health risk (for example, a contaminated drinking water aquifer). Follow the telephone notification with a written notice within three days; attach a copy of the laboratory raw data (i.e., chromatogram).

F. *Reporting*

1. Prepare a draft report delineating all findings of this field investigation and forward it to the USAFOEHL (as specified in Sequence No. 4, Item VI, below) for Air Force review and comment. Strictly adhere to the USAFOEHL report format (mailed under separate cover). The format is an integral part of this delivery order. Draft reports are considered "drafts" only in the sense that they have not been reviewed and approved by Air Force officials. In all other respects, "drafts" must be complete, in the proper format, and free of grammatical and typographical errors. Include a discussion of the regional/site specific hydrogeology, well and boring logs, data from water level surveys, ground water surface and gradient maps, water quality and soil analysis results, available geohydrologic cross sections, and laboratory and field QA/QC information. For State's requiring the field work or technical effort be supervised by a State registered geologist, engineering geologist or professional engineer, insert this information in the report to include registration numbers, certificate and seals (as appropriate). Provide a complete separately bound report for Kalispell AFS (Site OB-3).

2. Review the results, conclusions and recommendations concerning the sites listed in this task which were investigated during previous IRP work. Use this information and data from previous efforts to establish trends and develop conclusions and recommendations. Integrate all investigative work

done at each site to date so the report reflects the total cumulative information for each site studied in this effort.

3. In the results section, include water and soil analytical results and field quality control sample data. Report all internal laboratory quality control data (lab blanks, lab spikes, QL samples and lab duplicates), and laboratory quality assurance information in an appendix to the report. Also provide second-column confirmation results and quantities, and include which columns were used, instrument operating conditions and retention times. Summarize in the appendix the specific collection technique, analytical method, holding time, and limit of detection for each analyte (Standard Methods, EPA, etc.) in the Appendix.

4. Make estimates of the magnitude, extent and direction which detected contaminants are moving. Identify potential environmental consequences of the discovered contamination based upon State or Federal standards.

5. In the recommendation section, address each site and list them by category:

a. Category I consists of sites where no further action (including remedial action) is required. Data for these sites are considered sufficient to rule out unacceptable public health or environmental hazards.

b. Category II sites are those requiring an additional Phase II effort to determine the direction, magnitude, rate of movement and extent of detected contaminants. Identify potential environmental consequences of discovered contamination.

c. Category III sites are those that will require remedial action (ready for IRP Phase IV). In the recommendations for Category III sites, include any possible influence on sites in Categories I and/or II due to their connection with the same hydrological system. Clearly state any dependency betweens sites in different categories. Include a list of candidate remedial action alternatives, including Long Term Monitoring (LTM) as remedial action, and the corresponding rationale that should be considered in selecting the remedial action for a given site. List all alternatives that could potentially bring the site into compliance with environmental standards. For contaminants that do not have standards, EPA recommended safe levels for non-carcinogens (Health Advisory or Suggested-No-Adverse-Response Levels) and target levels for carcinogens (1×10^{-6} cancer risk level) may be used. Unless specifically requested, do not perform any cost analyses, or cost/benefit review for remedial action alternatives. However, in those situations where field survey data indicate immediate corrective action is necessary, present specific, detailed recommendations.

For each category above, summarize the results of field data, environmental or regulatory criteria, or other pertinent information supporting conclusions and recommendations. Reduce this summary information into a table (or tables) and insert it (or them) into the text and the Executive Summary.

6. Provide cost estimates by line item for future efforts recommended for Category II sites and LTM Category III sites. Submit these estimates

concurrently with the approved final technical report in a separate document. Only the cost requirements outlined in Sequence No. 2, Item VI, need be submitted.

a. For Category II sites, develop detailed site-specific estimates using prioritized costing format (i.e., cost of conducting the required work on: the highest priority site only; the first two highest priority sites only; the first three highest priority sites only; etc., until all required work is discretely costed) for the proposed work effort. The Air Force determines the priority of sites from contractor recommendations. Consider the type of contaminants, their magnitude, the direction and rate of their migration, and their subsequent potential for environmental and health consequences when developing recommendations for site prioritization.

b. For Category III sites slated for long-term monitoring, develop site-specific estimates which detail the costs associated with: (1) permanent installation of monitoring wells; (2) ground water sampling interface equipment, including permanent installations of pumps and sampling lines; and (3) four quarterly (1 year period) sample collections and laboratory chemical analyses of ground water, etc.

7. Provide an inventory of all on-base wells, to include production, irrigation, monitoring, etc. If the well has been abandoned, then give the reason.

8. Reference in an appendix any local, State and/or federal regulations which require specific well drilling techniques, materials, well development, purging, and sampling methods as specified in this work effort.

G. Meetings

The contractor's project leader shall attend 3 meetings to take place at a time to be specified by the USAFOEHL. Each meeting shall take place at Malmstrom AFB MT for a duration of one eight-hour day.

II. SITE LOCATION AND DATES:

Malmstrom AFB MT
Date to be established

III. BASE SUPPORT:

A. Prior to any contractor digging or drilling, the Base Civil Engineer will locate underground utilities and issue digging permits.

B. The Base Civil Engineer will assign accumulation points within the installation for the contractor to use to deliver any hazardous drill cuttings or hazardous well installation/development fluids generated from the required work.

C. The Base Civil Engineer will take custody of any hazardous drill cuttings or hazardous well installation/development fluids and properly dispose of the material according to applicable state/Federal regulations. The Contractor must provide laboratory analysis for the drill cuttings or hazardous well installation/development fluids contained in each barrel.

D. The base will provide the contractor with existing engineering plans, drawings, diagrams, aerial photographs, etc., to evaluate sites under investigation.

E. The base POC will select 10% of the split samples provided by the contractor, package them, and ensure they are picked up by the contractor within 24 hours of sample receipt by the POC. See paragraph I.A.6.c.

F. The Base will 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 conducting the survey:

1. Personnel identification badges and vehicle passes and/or entry permits.

2. A secure staging area for storage of equipment and supplies.

3. A supply (i.e., fire hydrant) for large quantities (up to a maximum of 1,000 gallons) of potable water to be used in borehole flushing, equipment cleaning, etc.

4. A temporary office area, not to exceed 100 square feet and equipped with a Class A telephone for local and long distance phone calls. The contractor shall pay for any long distance telephone calls made by his personnel from this phone.

5. A household-type refrigerator having approximately 2 cubic feet of freezer space for storage of blue ice.

G. The base shall ensure rights of easement and access to all private property so the contractor can perform any required tasks in this investigation.

IV. GOVERNMENT FURNISHED PROPERTY: None

V. GOVERNMENT POINTS OF CONTACT:

1. USAFOEHL Technical Program Manager

Captain Patrick N. Johnson
USAFOEHL/TSS
Brooks AFB TX 78235-5501
(512) 536-2158
AUTOVON 240-2158/2159
1-800-821-4528

2. Base Point of Contact (POC)

1Lt Burl Olson
USAF Hospital Malmstrom/SGPB
Malmstrom AFB MT 59402-5300
(406) 731-2469
AUTOVON 632-2469

3. MAJCOM Monitor
Lt Col John Pontier
HQ SAC/SGPB
Offutt AFB NE 68113-5001
(402) 294-4651
AUTOVON 271-4651

4. Base Civil Engineer POC
1Lt Ray Bruun
341st CSG/DEEV
Malmstrom AFB MT 59402-5300
(406) 731-3174
AUTOVON 632-3174

VI. In addition to sequence numbers 1, 5 and 11 listed in Attachment 1 to the contract, and which apply to all orders, the sequence numbers listed below are applicable to this order. Also shown are dates applicable to this order.

Sequence No.	Para No.	Block 10	Block 11	Block 12	Block 13	Block 14
20 (TOP)*	I.D.	OTIME	86 Aug 25	86 Aug 29		15
7 (Health & Safety)	I.C.	OTIME	86 Aug 29	86 Sep 05		3
3 (Prelim Data)	I.E.2	OTIME	***	***		3
4 (Tech. Rpt)	I.F.	ONE/R	87 JAN 30	87 APR 01	87 OCT 09	**
14		MONTHLY	86 Sep 12	86 Sep 15	****	3
15		MONTHLY	86 Sep 12	86 Sep 15	****	3
2 (Cost Data)	I.F.6.	OTIME	87 APR 01	87 OCT 09	*****	

*The Technical Operations Plans (TOP) required for this stage is due within two (2) weeks of the Notice to Proceed (NTP).

**Two draft reports (25 copies of each) and one final report (50 copies plus the original camera ready copy) are required. Incorporate Air Force comments into the second draft and final reports as specified by the USAFOEHL. Supply the USAFOEHL with an advance copy of the first draft, second draft, and final reports for acceptance prior to distribution. Distribute remaining 24 copies of each draft report and 49 copies of the final report as specified by the USAFOEHL.

***Upon completion of the total analytical effort before submission of the first draft report.

****Submit monthly hereafter.

*****Submit cost estimates (five copies) in a separately bound document with the Final Report only. Provide estimates for only those sites recommended for additional Phase II work (Category II) and Phase IV, Long Term Monitoring, (Category III).

Attachment 1

Analytical Methods, Detection Limits, and Number of Samples

PARAMETER	METHOD	DETECTION LIMIT	NO. OF SAMPLES	QA	TOTAL SAMPLES
Halogenated Volatile Organics	SW5030/SW8010	a	66 soil	7 soil	109 soil[d]
	EPA 601	a	4 water	2 water	9 water[e]
Aromatic Volatile Organics	SW5030/8020	a	113 soil	12 soil	188 soil[f]
	SW5030/8020	a	13 water	3 water	24 water[g]
Nonhalogenated Volatile Organics	SW5030/8015	a	36 soil	4 soil	60 soil[h]
			4 water	2 water	9 water[i]
Extractable Priority Pollutants (GC/MS)	SW3550/SW8270	a	50 soil	5 soil	55 soil
	EPA 625	a	4 water	2 water	6 water
Petroleum Hydrocarbons	SW3550/ EPA 418.1	1 mg/Kg	113 soil	12 soil	125 soil
	EPA 418.1	1 mg/L, water	13 water	3 water	16 water
Total Dissolved Solids (TDS)	EPA 160.1	10 mg/L. water	4 water	2 water	6 water
Priority Pollutant Metals (13 ea.)	EPA 200.7	c	4 water	2 water	6 water
	SW3050/6010	c	14 soil	2 soil	16 soil
	EPA 245.1 (Hg)	c	4 water	2 water	6 water
	SW7471 (Hg)	c	14 soil	2 soil	16 soil
	EPA 206.2 (As)	c	4 water	2 water	6 water
	SW3050/7060 (As)	c	14 soil	2 soil	16 soil
	EPA 270.2 (Se)	c	4 water	2 water	6 water
	SW3050/7740 (Se)	c	14 soil	2 soil	16 soil
Lead	SW3050/7420	10 mg/Kg	35 soil	4 soil	39 soil
	EPA 239.2	a	1 water	2 water	3 water
PCB	SW3550/SW8080	1.0 mg/Kg	3 soil	2 soil	8 soil[j]
Common Anions	A429	0.1 mg/L	4 water	2 water	6 water
pH (Field Test)	--	--	13 water	--	13 water
Temperature (Field Test)	--	--	13 water	--	13 water

Conductance (Field Test)	--	--	13 water	--	13 water
Ep Toxicity (Metals)	SW Manual	b	10 soil	3 soil	13 soil

a. Detection limits as specified by the applicable EPA or Standard Method.

b.

Metal	mg/L leaching solution
As	0.002
Ba	0.1
Cd	0.005
Cr	0.05
Pb	0.1
Hg	0.0002
Se	0.002
Ag	0.01

c

Element	Water Sample (mg/L)	Soil Samples (mg/Kg)
Sb	0.032	3.2
As	0.001	0.1
Be	0.0003	0.03
Cd	0.004	0.4
Cr	0.007	0.7
Cu	0.006	0.6
Pb	0.042	4.2
Hg	0.0002	0.1
Ni	0.015	1.5
Se	0.002	0.2
Ag	0.007	0.7
Tl	0.040	4.0
Zn	0.002	0.2

d. Total of 109 includes second column confirmation for 50% of the samples (36).

e. Total of 9 includes second column confirmation for 50% of the samples (3).

f. Total of 188 includes second column confirmation of 50% of the samples (63).

g. Total of 24 includes second column confirmation of 50% of the samples (8).

h. Total of 60 includes second column confirmation of 50% of the samples (20).

i. Total of 9 includes second column confirmation of 50% of the samples (3).

j. Total of 8 includes second column confirmation of 50% of the samples (3).

k. For soil samples, report results as mg/Kg of dry soil weight. Report percent moisture content for each soil sample.

Attachment 2

Sampling and Analytical Requirements
Malmstrom AFB MT
Soil

SITE	Halogenated Volatile Organics	Aromatic Volatile Organics	Nonhalogenated Volatile Organics	Extractable Priority Pollutants (GC/MS)	Petroleum Hydrocarbons	Priority Pollutant Metals (13 ea)	Lead	PCB
OB-3		6			6			
SW-3	2	2		2	2	2		
PS-2		12			12		12	
IS-3								3
FT-1	12	12			12		12	
PS-5	4	4			4			
PS-4		12			12			
SW-2	12	12		12	12	12		
PS-3		8			8		8	
SW-5	7	7	7	7	7			
SW-1	12	12	12	12	12			
WW-1	17	17	17	17	17			
OB-1		6			6			
OB-2		3			3		3	
Total	66	113	36	50	113	14	35	3

Attachment 2

Sampling and Analytical Requirements
Malmstrom AFB MT
Water

SITE	Halogenated Volatile Organics	Aromatic Volatile Organics	Nonhalogenated Volatile Organics	Extractable Priority Pollutants (GC/MS)	Petroleum Hydrocarbons	Total Dissolved Solids	Priority Pollutant Metals (13 ea)	Lead	Common Anions	pH	Temperature	Conductance
OB-3		5			5					5	5	5
SW-3	4	4	4	4	4	4	4		4	4	4	4
PS-3		3			3					3	3	3
OB-2		1			1			1		1	1	1
	4	13	4	4	13	4	4	1	4	13	13	13

APPENDIX C

On-Site Well Logs,
Off-Site Well Logs

APPENDIX C
Qualification of Data

The quality of many of the well logs included is poor due to their inability to be reproduced or because of the poor condition of the original log on file at the Montana Bureau of Mines and Geology (MBMG). Two separate attempts were made to obtain good reproductions of the original well logs, one by Battelle personnel sent to the MBMG office and one by the MBMG personnel. The more legible copy of the two is included in this report. If further clarity is desired, please contact the MBMG directly:

Tom Patton, Hydrogeologist
Montana Bureau of Mines and Geology
West Park Street
Butte, MT 59701
(406) 496-4167

029 26N 21W 11 AA FLATHEAD C-1

1

Form No. 603 (Rev. 7/76)

STATE OF MONTANA

File No. _____

Department of Natural Resources and Conservation

WELL LOG REPORT

White-Department
Yellow-Department
Pink-Well Owner
Gold-Driller

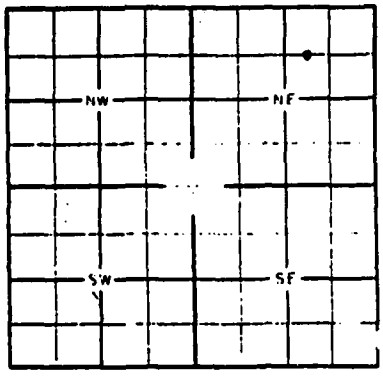
State law requires that this form be filed by the water well driller within 60 days after completion of the well, and Form 602, Notice of Completion of Groundwater Development, be filed by the well owner within 60 days after the water has been put to beneficial use.

1. WELL OWNER
Name William
54 Norwood - Superior, Wis.

2. CURRENT MAILING ADDRESS
Lakeside, Montana

3. PROPOSED USE X domestic (includes lawn and garden); _____ stock; _____ municipal; _____ industrial; _____ irrigation; _____ other (specify) _____

4. WELL LOCATION



W½ ¼ NW ¼ NE ¼ ¼ Section 11
T. 26 north N or S R. 21 west E or W
OR, Lot _____ Block _____
Subdivision _____
City Lakeside County Flathead
Elevation _____ Accuracy: __ ±10'; __ ±50'; __ ±100';

5. DRILLING METHOD _____ cable, _____ bored, / forward rotary, _____ reverse rotary, _____ jetted, / other (specify) _____

6. WELL CONSTRUCTION AND COMPLETION

Size of drilled hole	Size and weight of casing	From (feet)	To (feet)	Perforations _____ and/or Screen — Kind Size	From (feet)	To (feet)
b 11	#17	0'	148'			

Was casing left open end? X Yes, ___ No
Was a packer or seal used? ___ Yes, X No
If so, what material _____
Was the well gravel packed? ___ Yes, X No
Was the well grouted? ___ Yes, X No
To what depth? _____
Material used in grouting _____
Well head completion: Pitless adapter _____
12 in. above grade _____, other _____
(If other, specify) _____
Pump horsepower _____, pump type _____
Pump intake level _____ feet below land surface
Power (electric, diesel, etc.) _____

7. WATER LEVEL
Static water level 186' feet below land surface
If flowing, closed-in pressure _____ psi
_____ gpm flow through _____ inch pipe
Controlled by: ___ valve, ___ reducers, ___ other
(If other, specify) _____

8. WELL TEST DATA ___ pump ___ bailer ___ other
(If other, specify) Air
Pumping level below land surface:
270 ft. after ___ hrs. pumping 20+ gpm
___ ft. after ___ hrs. pumping ___ gpm

9. WAS WELL PLUGGED OR ABANDONED? ___ Yes X No
If yes, how? _____

10. DATE STARTED Aug. 30, 1978
DATE COMPLETED Sept. 2, 1978

11. WELL LOG
Depth (ft.)

From	To	Formation
0	25	Clay to few rocks
25	100	soft brown rock
100	165	Brown rock
165	200	Black rock
200	205	Brown rock
205	270	Black rock
270	275	Brown rock
275	325	Black rock

(use separate sheet if necessary)

12. DRILLER'S CERTIFICATION
This well was drilled under my jurisdiction and this report is true to the best of my knowledge.
10-4-78
Date

Firm Name

Address

Signature License No.

BC

C-2

029 26N 21W 12 DA FLATHEAD

GW 2 Revised 1969
STATE PUBLISHING COMPANY

County FLATHEAD

CODED

STATE OF MONTANA
ADMINISTRATOR OF GROUNDWATER CODE
MONTANA WATER RESOURCES BOARD

NOTICE OF COMPLETION OF GROUNDWATER APPROPRIATION BY MEANS OF WELL

Developed after January 1, 1962

(Under Chapter 237 Montana Session Laws, 1961, as amended)

This form to be prepared by driller, and three copies to be filed by the owner with the County Clerk and Recorder in the county in which the well is located, last copy to be retained by driller.

Please answer all questions. If not applicable, so state, otherwise the form may be returned.

Owner Asa E & Leah F. Clothier

Address Box 53
Lakeside, MT 59922

Date well started 4-26-69

completed 4-29-69

For Administrator's Use
File
GW 1

Type of well Drilled
(Dug, driven, bored or drilled)

Equipment used
(Churn drill, rotary or other)

Water Use: Domestic ☒ Municipal ☐ Stock ☐ Irrigation ☐

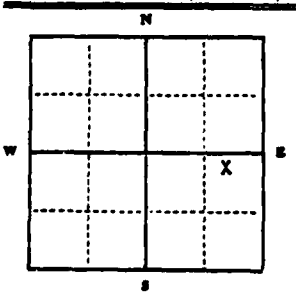
Industrial ☐ Drainage ☐ Other ☐* Garden/Lawn ☒

*Describe

USE: If used for irrigation, industrial, drainage or other. Explain, state number of acres and location or other data (i.e. Lot, Block and Addition).

ESTIMATED ANNUAL WITHDRAWAL 6,952,000 gallons

Size of Drilled Hole	Size and Weight of Casing	From (Feet)	To (Feet)	PERFORATIONS Kind Size	From (Feet)	To (Feet)
6"	6 5/8" O.D. x 1/4"	+1½'	27'	N O N E		



NE SE ¼ Sec. 12
T. 26 ¼ N R. 21 E
S W

Static water level 132 ft.*
Pumping water level 229 ft.*
at 270 gallons per minute,
measured minutes after pumping began.
*Measured from ground level
Well developed by air lift pump
for 4½ hours.
Power Diesel Pump 1 HP
Remarks: (Gravel packing, cementing, packers, type of shutoff)

INDICATE LOCATION OF WELL AND PLACE OF USE, IF POSSIBLE. EACH SMALL SQUARE REPRESENTS 40 ACRES.

Driller's Signature William F. Osborne

Driller's Address William F. Osborne
Rt. 6, Hwy. 93 South
Kalispell, MT 59901

LICENSE NO. 52

DRILLER'S LOG

Indicate the character, color, thickness of strata such as soil, clay, sand, gravel, shale, sandstone, etc. Show depth at which water is found and height to which water rises in well.

Top of Ground Approx. (Elev. above sea level) 2995'

From (Feet)	To (Feet)	
0	27	Unknown, reported to be clay & boulders
27	62	Unknown, reported to be brown & gray rock
62	131	Gray rock with few thin seams of brown rock
131	325½	Gray rock. Some water in fractures & seams below 220', 2 gpm @ 248', 3 gpm @ 268', 6 gpm @ 332½'
325½	328	Fractured tan to brown rock. Water. 20 gpm total
328	359	Dark gray rock
359	366	Fractured tan rock. Water 25 gpm total.
366	382	Dark gray rock

382' Show exact depth of bottom

MINES COPY

(3)

Form No. 603 R10/79 029 26N 21W 12 DAA FLATHEAD File No. 50007

CODED WELL LOG REPORT

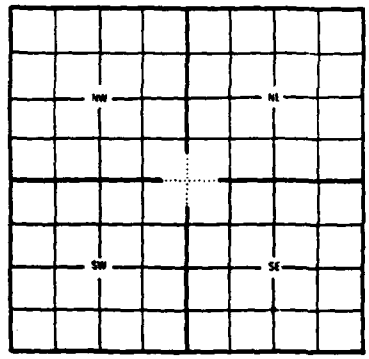
005685

State law requires that this form be filed by the water well driller within 60 days after compl

1. WELL OWNER
Name Jim Lind

2. CURRENT MAILING ADDRESS
Box 1246
Jackson, Wyoming 83001

3. WELL LOCATION



NE ¼ NE ¼ SE ¼ Section 12
Township 26 N/S Range 21 E/W
County Flathead
Lot _____ Block _____
Subdivision _____
Well Elevation _____
Accuracy: _____ ± 10'; _____ ± 50'; _____ ± 100';

4. DRILLING METHOD _____ cable, _____ bored,
X forward rotary, _____ reverse rotary, _____ jetted,
_____ other (specify) _____

5. WELL CONSTRUCTION AND COMPLETION

Size of drilled hole	Size and weight of casing	From (feet)	To (feet)	Perforations _____ and/or Screen _____ Kind Size	From (feet)	To (feet)
6"	6" 17#'	12" agl.	160' Bgl.			
	4½ pvc	120' BGL.	240' BGL	Slotn	120'	240'

Was casing left open end? X Yes ___ No
Was a packer or seal used? ___ Yes X No
If so, what material _____
Was the well gravel packed? ___ Yes X No
Was the well grouted? ___ Yes X No
To what depth? _____
Material used in grouting _____
Well head completion: Pitless adapter _____
12 in. above grade Yes, other _____
(If other, specify) _____
Pump horsepower _____, pump type _____
Pump intake level _____ feet below land surface
Power (electric, diesel, etc.) _____

6. WATER LEVEL
Static water level 195 feet below land surface
If flowing, closed-in pressure _____ psi
_____ gpm flow through _____ inch pipe
Controlled by: _____ valve, _____ reducers, _____ other
(if other, specify) _____

7. WELL TEST DATA _____ pump _____ bailer _____ other
(if other, specify) Air
Pumping level below land surface:
230 ft. after 3 hrs. pumping 40 gpm
_____ ft. after _____ hrs. pumping _____ gpm

8. WAS WELL PLUGGED OR ABANDONED? ___ Yes X No
If yes, how? _____

9. DATE STARTED 6-22-1981
DATE COMPLETED 6-23-1981

10. WELL LOG

Depth (ft.) From	To	Formation
0'	62'	Clay & Boulders
62'	91'	Clay & gravel
91'	143'	Clay
143'	225'	Blue Rock
225'	240'	Brown Rock water

RECEIVED
AUG 19 1981
MONTANA D.N.R.C.
KALISPELL FIELD OFFICE

(use separate sheet if necessary)

11. DRILLER'S CERTIFICATION
This well was drilled under my jurisdiction and this report is true to the best of my knowledge.

8-3-1981
Date

Chambers Drilling Co.
Firm Name

Box 1756 Columbia Falls Montana 59912
Address

[signature]
Signature

321
License No.

MONTANA DEPARTMENT OF NATURAL RESOURCES & CONSERVATION DNRC
32 SOUTH EWING HELENA, MONTANA 59601 449-3634

DEPARTMENT COPY

WL. 6'92 →

C-4

029-26N 21W 12 DAB FLATHEAD

FORM 1 (New 7)

RECEIVED

JAN 3 0 1978

MONT. DEPT. OF NATURAL RESOURCES & CONSERVATION

STATE OF MONTANA
Department of Natural Resources and Conservation

WELL LOG REPORT

WHITE — DEPARTMENT
PINK — BUREAU
CANARY — WELL OWNER
GOLDENROD — DRILLER

State law requires that this form be filed by the water well driller on any water well co pleted by him on and after July 1, 1973 within sixty (60) days after completion of the we

1. WELL OWNER: Name ASA and Leah Clothier Address Box 53, Lakeside, Montana 59922

2. WELL LOCATION: County Flathead ; NW ¼ NE ¼ SE ¼, Sec. 12, Twp. 26 N-S, Rg. 21

3. PROPOSED USE: X Domestic ___ Stock ___ Municipal ___ Industrial X Lawn and Garden ___ Irrigation ___ Other (*if other, specify*)

4. METHOD DRILLED: ___ Cable ___ Bored ___ Forward Rotary ___ Reverse Rotary ___ Jetted X Other (*if other, specify*) Air ary

5. WELL CONSTRUCTION: Diameter of hole 8" To 57 ft. 6" inches. Depth 638 ft.
Casing: X Steel X Plastic ___ Concrete ___ Threaded X Welded ___ Other (*if other, specify*)

Pipe Weight:	Dia.:	From:	To:
17½ lb/ft.	6 inches	+1½ feet	feet
1½ lb/ft.	4 inches	+1½ feet	366' 8" feet
lb/ft.	inches	feet	feet

Was perforated pipe used? ___ Yes X No
Length of pipe perforated ___ feet
Was casing left open end? X Yes ___ No
Was a well screen installed? ___ Yes X No
Material ___ Dia. ___ inches (*stainless steel, bronze, etc.*)
Perforation type: ___ slots ___ holes
Size ___ set from ___ feet to ___ feet
Size ___ set from ___ feet to ___ feet
Size ___ set from ___ feet to ___ feet
Was a packer or seal used? ___ Yes X No
If so, what material ___
Well type: ___ Straight screen ___ Graveled
Was the well grouted? X Yes ___ No
To what depth? 57 feet
Material used in grouting Puddled Clay
Well head completion: Pitless adapter ___
12" above grade X Other ___
(*If other, specify*) ___
Was the well disinfected? X Yes ___ No

6. WATER LEVEL:
Static water level 269 ft. below land surface
If flowing: closed-in pressure ___ psi
GPM flow ___ through ___ inch pipe
Controlled by: ___ Valve ___ Reducers ___ Other, *specify* ___

7. WELL TEST DATA: ___ Pump ___ Bailer ___ Other (*If other, specify*) Air Lift Pump
Pumping level below land surface:
Est. 420 ft. after 5 hrs. pumping ___ gpm
___ ft. after ___ hrs. pumping ___ gpm

8. WELL LOG:

Depth (ft.) From	Depth (ft.) To	Formation
0	2	Topsoil.
2	33	Sand, Gravel, Cobblestones a
		Boulders mixed in Tan Silt.
33	42	Tan Silt Sand mixed in Tan
		Silt with some Gravel.
42	47	Gray Silty Sand and Gravels.
47	72	Hard Blue Rock.
72	74	Soft Tan Rock.
74	93	Blue-Gray Rock.
93	94	Soft Tan Rock.
94	126	Blue-Gray Rock.
126	128	Soft Tan Rock.
128	143	Blue Rock.
143	144	Soft Tan Rock.
144	223	Blue-Gray Rock.
223	226	Tan Rock.
226	242	Blue-Gray Rock.
242	243	Tan Rock.
243	271	Blue and Tan Rock in Thin
		Alternate Layers.
271	273	Tan Rock.
273	280	Blue-Gray Rock
		(Continued) Page 1 of 2

(*Use separate sheet if necessary*)

9. DATE STARTED: December 15, 1977

10. DATE COMPLETED: December 29, 1977

11. WAS WELL PLUGGED OR ABANDONED? ___ Yes X
If so, how ___

12. DRILLER'S CERTIFICATION:
This well was drilled under my jurisdicti and this report is true to the best of m knowledge.

Liberty Drilling & Pump Company #52
Driller's or Firm Name *License N*

3050 Highway 93 South, Kalispell, MT 59
Address

Wm F. Osborne 1/28/
Signed by *Date*

William F. Osborne

ASA AND LEAH CLOTHIER
STATE WELL LOG REPORT
PAGE 2 OF 2

CON'T -	280 - 284	SOFT TAN ROCK
	284 - 299	BLUE-GRAY ROCK
	299 - 318	SOFT TAN ROCK
	318 - 341	TAN AND BLUE ROCK IN THIN ALTERNATE LAYERS
	341 - 344	SOFT TAN ROCK
	344 - 349	BLUE ROCK
	349 - 351	SOFT TAN ROCK
	351 - 356	TAN AND BLUE ROCK IN ALTERNATE LAYERS
	356 - 358	SOFT TAN ROCK
	358 - 485	TAN AND BLUE ROCK IN THIN ALTERNATE LAYERS. FRACTURES AT 434 FEET. SOME WATER, SEVEN GALLONS PER MINUTE TOTAL.
	486 - 526	TAN AND BLUE ROCK IN THIN ALTERNATE LAYERS
	526 - 528	TAN ROCK
	528 - 531	TAN AND BLUE ROCK IN THIN ALTERNATE LAYERS
	531 - 534	SOFT TAN ROCK
	534 - 524	TAN AND BLUE ROCK IN THIN ALTERNATE LAYERS
	624 - 626	TAN AND BLUE ROCK WITH FRACTURES. TWENTY SIX GALLONS PER MINUTE TOTAL.
	626 - 630	SOFT TAN ROCK
	630 - 638	TAN AND BLUE ROCK IN THIN ALTERNATE LAYERS

(5)

029 26N 21W 12 DCD

FORM No. 603 New 7-73

File No.

STATE OF MONTANA
Department of Natural Resources and Conservation

WHITE — DEPARTMENT
PINK — BUREAU
CANARY — WELL OWNER
GOLDENROD — DRILLER

(1)

WELL LOG REPORT

State law requires that this form be filed by the water well driller on any water well completed by him on and after July 1, 1973 within sixty (60) days after completion of the well.

1. WELL OWNER: Name LUCAS, Gerald Address Box 128, Lakeside, Montana 59922

2. WELL LOCATION: County Flathead; SE¼, SW¼, SE¼, Sec 12, Twp. 26 N-S, Rg. 21 E-W

3. PROPOSED USE: ___Domestic ___Stock ___Municipal X Industrial ___Lawn and Garden ___Irrigation ___Other (*if other, specify*)

4. METHOD DRILLED: ___Cable ___Bored ___Forward Rotary ___Reverse Rotary ___Jetted X Other (*if other, specify*) Air Rotary

5. WELL CONSTRUCTION:
Diameter of hole 8 inches. Depth 612 ft.
Casing: X Steel ___Plastic ___Concrete ___Threaded X Welded ___Other (*if other, specify*)
Pipe Weight: Dia.: From: To:
22.36 lb/ft. 8 5/8 inches +2 feet 9'7" feet
17.02 lb/ft. 6 5/8 inches +2 feet 145'5" feet
10.79 lb/ft. 5 inches 144'5" feet 609 feet
Was perforated pipe used? X Yes ___No
Length of pipe perforated 60 feet
Was casing left open end? X Yes ___No
Was a well screen installed? ___Yes X No
Material ___ Dia. ___ inches (*stainless steel, bronze, etc.*)
Perforation type: ___slots ___holes
12 Size ¼ x4" set from 509 feet to 529 feet
12 Size ¼ x 4" set from 549 feet to 569 feet
22 Size ¼ x 4" set from 589 feet to 609 feet
Was a packer or seal used? ___Yes X No
If so, what material ___
Well type: ___Straight screen ___Graveled
Was the well grouted? X Yes ___No
To what depth? Ten Feet feet
Material used in grouting Puddled Clay
Well head completion: Pitless adapter ___ 12" above grad X Other ___ (*If other, specify*) ___
Was the well disinfected? X Yes ___No

6. WATER LEVEL:
Static water level 314 ft. below land surface
If flowing: closed-in pressure ___ psi
GPM flow ___ through ___ inch pipe
Controlled by: ___Valve ___Reducers ___Other, *specify* ___

7. WELL TEST DATA: ___Pump ___Bailer X Other (*If other, specify*) Air Lift Pump
Pumping level below land surface:
Est. 439 ft. after 8 hrs. pumping 75 gpm
___ ft. after ___ hrs. pumping ___ gpm

8. WELL LOG:

Depth (Ft.) From	To	Formation
0	1	Black dirt
1	8	Brown rock & gravel mixed in tan silty clay
8	15	Light tan soft rock
15	47	Green-gray rock
47	107	Blue-gray rock
107	122	Soft broken brown rock
122	133	Hard blue rock
133	147	Hard blue & soft brown rock in alternate layers
147	203	Hard blue rock
203	218	Hard blue & soft brown rock in alternate layers
218	283	Blue-gray rock
283	309	Hard gray rock
309	332	Soft tan & white rock
332	351	Broken blue-gray rock
351	359	Soft brown rock
359	375	Hard blue-gray rock
375	379	Soft brown rock. Seeps of water
379	452	Hard blue-gray rock. Water, 7½ gpm total.
		CONTINUED ON BACK

(*Use separate sheet if necessary*)

9. DATE STARTED: April 22, 1974

10. DATE COMPLETED: May 3, 1974

11. WAS WELL PLUGGED OR ABANDONED? ___Yes X No
If so, how ___

12. DRILLER'S CERTIFICATION:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge.

LIBERTY DRILLING CO. 52
Driller's or Firm Name *License No.*

5950 Hwy. 93 South, Kalispell, MT 59901
Address

Signed by William F. Osborne, Owner *Date* 5/7/74

(Continued from Front)

452 - 544	Blue-gray and tan rock in thin alternate layers. Water in cracks and seams. Total 45 gpm.
544 - 552	Soft tan rock
552 - 569	Hard blue-gray rock
569 - 583	Blue-gray and tan rock in thin alternate layers. Water, total, 60 gpm.
583 - 612	Fractured gray rock. Water, total 75 gpm.

029 26N 21W 12 DCB -FLATHEAD C-8

(6)

GW 2 — Approved Stock Form—State Publishing Co., Helena, Montana 129

File No.....

DUPLICATE

T.....26N.....R.21W -12

County...Flathead.....

LOG

STATE OF MONTANA
ADMINISTRATOR OF GROUNDWATER CODE
OFFICE OF STATE ENGINEER

Notice of Completion of Groundwater Appropriation by Means of Well

DEVELOPED AFTER JANUARY 1, 1962

(Under Chapter 237, Montana Session Laws, 1961)

Top of Ground

(Elev. above sea level Approx. 2965')

Formations Log:

0 -	1½	Fine sand.
1½ -	14	Tan clay & gravels.
14 -	15½	Blue boulder.
15½ -	48	Red clay.
48 -	57	Gray to green rock.
57 -	59	Tan rock.
59 -	77½	Gray to green rock.
77½ -	78	Tan & brown rock.
78 -	114	Gray to green rock.
114 -	117	Tan & brown rock.
117 -	126	Gray rock.
126 -	127	Tan & brown rock. 7 GPM
127 -	146	Gray rock.
146 -	151	Tan rock. 22 GPM
151 -	160	Gray rock.

Water rises in the well 109 feet from surface.

Show exact depth of bottom.

Bottom of well 160'

Owner...Jim C. & Wynona M. Burdick.....Address...Lakeside, Montana.....

Driller...Liberty Drilling Co.....Address...Missoula, Montana.....

Date of Notice of appropriation of groundwater...None filed.....

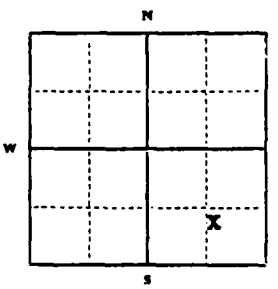
Date well started...4/29/69.....Date completed...5/2/69.....

Type of well...Drilled.....Equipment used...Air Rotary Rig.....
(Dug, Driven, bored or drilled) (Churn drill, rotary or other)

Water use: Domestic ☒ Municipal ☐ Stock ☐ Irrigation ☒
Industrial ☐ Drainage ☐ Other ☐

Indicate on the diagram the character and thickness of the different strat met with in drilling, such as soil, clay, shale, gravel, rock or sand, etc. Sho depth at which water is encountered, thickness and character of water-bearin strata and height to which the water rises in the well.

Size of Drilled Hole	Size and Weight of Casing	From (Feet)	To (Feet)	PERFORATIONS Kind Size	From (Feet)	To (Feet)
6"	6 5/8" OD x ¼"	+2	49'4"	NONE		



Indicate location of well and place of use, if possible. Each small square represents 40 acres.

Static Water Level for non-flowing wel ...109.....feet

Shut-in Pressure for Flowing Well Non-f

Pumping Water Level.....151.....fee at.....22..... .....gal. per minute.

Discharge in gal. per min. of flowing wel Non-flowing

How Tested...Air Lift Pump.....

Length of Test...Two hours.....

Remarks: (Gravel packing, cementing, pack ers, type of shutoff)...All water enter ing well from cracks and sea in the rock below 127 feet. Wells in this area can be de pended upon to produce clear sand free water year after year as long as they are not overpumped, i.e., th should be pumped at rates not in excess of 75 to 80 percent of the tested capacity of the aquifer.

SE ¼ Sec. 12 T. 26 R. 21

Use—If used for irrigation, industrial, drainage or other. Explain, stat number of acres and location or other data (i.e.: Lot, Block and Addi tion).

.....

.....

.....

This form to be prepared by driller, and three copies to be filed by the owner with the County Clerk and Recorder in the county in which the well is located, tissue copy to be retained by driller.

Please answer all questions. If not applicable, so state, otherwise the form will be returned.

.....22.....
Driller's License Number

William B. Cahoon
Driller's Signature

029 26N 21W 12 DDD FLATHEAD (7)

File No. [redacted] GW C-9 T. 26 R. 21 12

County Flathead

STATE OF MONTANA
ADMINISTRATOR OF GROUNDWATER CODE
OFFICE OF STATE ENGINEER

Notice of Completion of Groundwater Appropriation by Means of Well

(Under Chapter 237, Montana Session Laws, 1961)

Owner L. G. Hamilton Address Lakeside

Driller Homer McClarty Address 945 8th Ave N Kalispell

Date of Notice of Appropriation of Groundwater .....

Date well started Sept 9/64 Date Completed Sept 18/64

Type of well Drilled (Dug, driven, bored or drilled) Equipment Used 3-1 W Buccyrus Erie (Churn, drill, rotary or other)

Water Use: Domestic ☒ Municipal ☐ Other ☐ Irrigation ☐ Industrial ☐ Drainage ☐ Stock ☐

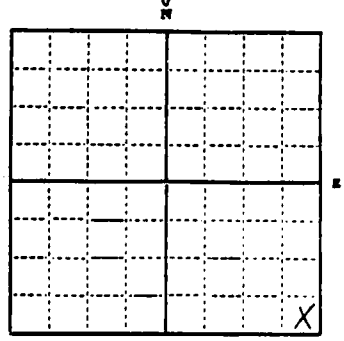
Top of Ground (Elev. above sea level 2980)

1 ft top soil
20' Cobblers & gravel
to
215' red clay & fine gravel
to
224' clay, fine gray gravel
to
Water bearing fine gravel
234 ft

Show exact depth of bottom.

☜ Indicate on the diagram the character and thickness of the different strata met with in drilling, such as soil, clay, shale, gravel, rock or sand, etc. Show depth at which water is encountered, thickness and character of water-bearing strata and height to which water rises in the well.

Size of Drilled Hole	Size and Weight of Casing	From (Feet)	To (Feet)	PERFORATIONS Kind Size	From (Feet)	To (Feet)
7" OD	23 #		224'4"			



T. 26 N. SE¼ SW¼ Sec. 12 T. 26 R. 21

Indicate location of well and place of use, if possible. Each small square represents 10 acres.

Static Water Level for non-flowing Well 90 feet.

Shut-in Pressure for Flowing Well .....

Pumping Water Level bottom feet at 10 gal. per minute.

Discharge in gal. per min. of flowing well .....

How Tested Bailer Length of Test 4 hrs

Remarks: (Gravel packing, cementing, packers, type of shutoff, location of place of use of groundwater if not at well, and any other similar pertinent information, including number of acres irrigated, if used for irrigation) .....

18
Driller's License Number

Homer McClarty
Driller's Signature

This form to be prepared by driller, and three copies to be filed by the owner with the County Clerk and Recorder in the county in which the well is located.

Please answer all questions. If not applicable, so state, otherwise the form will be returned.

Original to the County Clerk and Recorder; duplicate to the State Engineer; Triplicate to the Montana Bureau of Mines and Geology and Quadruplicate for the Appropriator.

C-10

029 26N 21W 13 BC Flathead

Form No. 603-(Rev. 7/76) STATE OF MONTANA File No. _____

RECEIVED JUL. 17 1978 MONT. DEPT. of NATURAL RESOURCES & CONSERVATION

Coded

Department of Natural Resources and Conservation

WELL LOG REPORT

White-Department
Yellow-Department
Pink-Well Owner
Gold-Driller

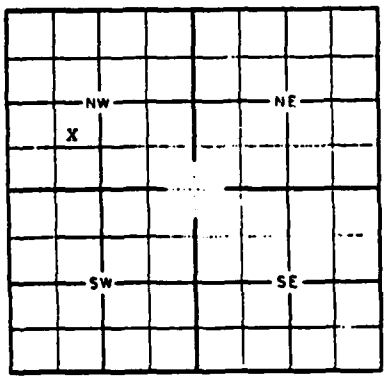
State law requires that this form be filed by the water well driller within 60 days after completion of the well, and Form 602, Notice of Completion of Groundwater Development, be filed by the well owner within 60 days after the water has been put to beneficial use.

1. WELL OWNER
Name Scott Ramsey

2. CURRENT MAILING ADDRESS
Box 395
Lakeside, Montana 59922

3. PROPOSED USE X domestic (includes lawn and garden); _____ stock; _____ municipal; _____ industrial; _____ irrigation; _____ other (specify) _____

4. WELL LOCATION



_____ ¼ _____ ¼ SE ¼ NW ¼ Section 13
T. 26 N R. 21 W
OR, Lot _____ Block _____
Subdivision _____
City Lakeside County Flathead
Elevation _____ Accuracy: __ ±10'; __ ±50'; __ ±100';

5. DRILLING METHOD _____ cable, _____ bored, X forward rotary, _____ reverse rotary, _____ jetted, X other (specify) Air Rotary

6. WELL CONSTRUCTION AND COMPLETION

Size of drilled hole	Size and weight of casing	From (feet)	To (feet)	Perforations _____ and/or Screen _____ Kind Size	From (feet)	To (feet)
12"	22.36 lbs per ft. X 8 5/8"	+2'	27'			
8"	Sch. 160 6" PVC	15'	247'	slots 3/16" 4"	187'	227'

Was casing left open end? X Yes, _____ No
Was a packer or seal used? _____ Yes, _____ No
If so, what material _____
Was the well gravel packed? _____ Yes, _____ No
Was the well grouted? X Yes, _____ No
To what depth? 27'
Material used in grouting Cement Grout
Well head completion: Pitless adapter _____
12 in. above grade X, other _____
(if other, specify) _____
Pump horsepower _____, pump type _____
Pump intake level _____ feet below land surface
Power (electric, diesel, etc.) _____

7. WATER LEVEL
Static water level 62 feet below land surface
If flowing, closed-in pressure _____ psi
_____ gpm flow through _____ inch pipe
Controlled by: _____ valve, _____ reducers, _____ other
(if other, specify) _____

8. WELL TEST DATA _____ pump _____ bailer X other
(if other, specify) Air Lift Pump
Pumping level below land surface:
est. 174 ft. after 5 hrs. pumping 12 gpm
_____ ft. after _____ hrs. pumping _____ gpm

9. WAS WELL PLUGGED OR ABANDONED? ___ Yes X No
If yes, how? _____

10. DATE STARTED 12-27-76
DATE COMPLETED 12-30-76

11. WELL LOG

Depth (ft.) From	To	Formation
0	1	Topsoil
1	7	Gravelly cobblestones & boulders embedded in tan silty clay
7	9	Boulder
9	32	Silty clay with embedded gravels & boulders
32	45	Blue rock
45	104	Brown & blue rock in alternate layers
104	120	Soft brown rock with thin seams of blue rock
120	156	Blue rock with thin seams of brown rock, seep of water
156	159	Soft brown rock with thin seams of blue rock, seep of water
159	184	Brown & blue rock, 4 Gallons Per Minute Water
184	203	Tan rock with some very soft zones few red clay seams between 198' & 203', 6 Gallons Per Minute Total
203	209	Blue rock
209	245	Tan & blue rock in alternate layers 10 Gallons Per Minute Total Water
245	247	Soft tan rock, 12 Gallons Per Minute Total Water
NO"		The incomplete description shown on item 4 is all that was furnished by our customer. We are unable to properly locate the well on the map with this description. Our customer has requested that this "well log report" be furnished with the available information.

(use separate sheet if necessary)

12. DRILLER'S CERTIFICATION
This well was drilled under my jurisdiction and this report is true to the best of my knowledge.
July 15, 1978
Date

Liberty Drilling Company
Firm Name
3850 Highway 93 South
Kalispell, MT. 59901
Address

Wm F Osborne 52
Signature License No.

029 26N 20W 18 FLATHEAD C-11

Form No. 603 (Rev. 7/76)

STATE OF MONTANA

File No. _____

Gold

Department of Natural Resources and Conservation

WELL LOG REPORT

White-Department
Yellow-Department
Pink-Well Owner
Gold-Driller

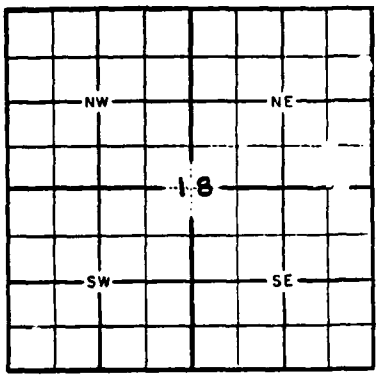
State law requires that this form be filed by the water well driller within 60 days after completion of the well, and Form 602, Notice of Completion of Groundwater Development, be filed by the well owner within 60 days after the water has been put to beneficial use.

1. WELL OWNER
Name Paul H. or Margaret H. [illegible]

2. CURRENT MAILING ADDRESS
Lakeside, MT 59922

3. PROPOSED USE ___ domestic (includes lawn and garden); ___ stock; ___ municipal; ___ industrial; ___ irrigation; ___ other (specify) _____

4. WELL LOCATION



___ ¼ ___ ¼ ___ ¼ ___ ¼ Section 18
T. ~~[illegible]~~ 24 N (N or S) R. 20 E or W
OR, Lot 13 Block _____
Subdivision Bigmac - Lakeside Plus
City _____ County Flathead
Elevation _____ Accuracy: __ ±10'; __ ±50'; __ ±100';

5. DRILLING METHOD ___ cable, ___ bored, X forward rotary, ___ reverse rotary, ___ jetted, ___ other (specify) _____

6. WELL CONSTRUCTION AND COMPLETION

Size of drilled hole	Size and weight of casing	From (feet)	To (feet)	Perforations ___ and/or Screen ___ Kind Size	From (feet)	To (feet)
6"	6-5/8" 17#	0	100			
	5-1/2" 15#	84	219	[illegible]		

Was casing left open end? ___ Yes, ___ No
Was a packer or seal used? ___ Yes, ___ No
If so, what material _____
Was the well gravel packed? ___ Yes, ___ No
Was the well grouted? X Yes, ___ No
To what depth? 20
Material used in grouting [illegible]
Well head completion: Pitless adaptor _____
12 in. above grade _____, other _____
(If other, specify) _____
Pump horsepower _____, pump type _____
Pump intake level _____ feet below land surface
Power (electric, diesel, etc.) _____

7. WATER LEVEL
Static water level 55 feet below land surface
If flowing, closed-in pressure _____ psi
_____ gpm flow through _____ inch pipe
Controlled by: ___ valve, ___ reducers, ___ other
(If other, specify) _____

8. WELL TEST DATA ___ pump ___ bailer X other (if other, specify) AIR
Pumping level below land surface:
160 ft. after 4 hrs. pumping 10 gpm
___ ft. after ___ hrs. pumping ___ gpm

9. WAS WELL PLUGGED OR ABANDONED? ___ Yes X No
If yes, how? _____

10. DATE STARTED 30 Nov 1977
DATE COMPLETED 30 Nov 1977

11. WELL LOG

Depth (ft.) From	To	Formation
0	2	Gravel & Clay
2	4	Boulder
4	75	Gravel, Clay, Boulders
75	85	Clay
85	90	Black Sand, Gravel, Water (2 GPM)
90	190	Orange & Yellow Clay
190	200	Brown Clay & Sand
200	230	Rock
230	245	Rock Fractures & Water
		No drive shoe.

(use separate sheet if necessary)

12. DRILLER'S CERTIFICATION
This well was drilled under my jurisdiction and this report is true to the best of my knowledge.

Date 5
Signature [illegible] License No.

BILLMAYER'S, INC.
Firm name
2197 Third Avenue East
Kalispell, MT 59901
Address

029 26N 20W 18 ACC C-12 \THEAD

GW 2 N H NEWS

Fi.: No.

TRIPLICATE

RECEIVED
JAN 10 1967
Montana Bureau of

T 26N R 20W 18

County Flathead

STATE OF MONTANA
ADMINISTRATOR OF GROUNDWATER CODE
OFFICE OF STATE ENGINEER

Notice of Completion of Groundwater Appropriation by Means of Well

(Under Chapter 237, Montana Session Laws, 1961)

Top of Ground

(Elev. above sea level [illegible])

Top Soil
Clay
1'-12'
Gravel
Sand
Cobbles
73 ft
Brown
Sandstone
219 ft
Solid
Rock

Water

Owner [illegible] Address Kalispell

Driller [illegible] Address [illegible]

Date of Notice of Appropriation of Groundwater

Date well started Dec 3, 1965 Date Completed Dec 26/65

Type of well Drilled (dug, driven, bored or drilled) Equipment Used [illegible] (Churn, drill, rotary or other)

Water Use: Domestic ☒ Municipal ☐ Stock ☐ Irrigation ☐
Industrial ☐ Drainage ☐ Other ☐

Indicate on the diagram the character and thickness of the differen strata met with in drilling, such as soil, clay, shale, gravel, rock or sand etc. Show depth at which water is encountered, thickness and character o water-bearing strata and height to which the water rises in the well.

Size of Drilled Hole	Size and Weight of Casing	From (Feet)	To (Feet)	PERFORATIONS Kind Size	From (Feet)	To (Feet)
7" OD	23 #		214			

N
W E
S

[illegible] Sec. 18 T 26 R 20

Indicate location of well and place of use, if possible. Each small square represents 10 acres.

235 ft.

Show exact depth of bottom.

Static Water Level for non-flowing Well 26 feet

Shut-in Pressure for Flowing Well

Pumping Water Level 120 feet at 20 gal. per minute

Discharge in gal. per min. of flowing well

How Tested Bailer Length of Test 3 hrs.

Remarks: (Gravel packing, cementing, packers, type of shutoff, location of place of use of groundwater if not at well, and any other similar pertinent information, including number of acres irrigated, if used for irrigation)

18
Driller's License Number

Howard McClary
Driller's Signature

This form to be prepared by driller, and three copies to be filed by the owner with the County Clerk and Recorder in the county in which the well is located.

Please answer all questions. If not applicable, so state, otherwise the form will be returned.

Original to the County Clerk and Recorder; duplicate to the State Engineer; Triplicate to the School of Mines and Quadruplicate for the Appropriator.

029 26N 20W 18 BA FL HEAD

C-13

File No. ..... GW 2 T. ..... R. ..... 18 W

County Flathead

RECEIVED
OCT 17 1963
Montana Bureau of Mines and Geology

STATE OF MONTANA
ADMINISTRATOR OF GROUNDWATER CODE
OFFICE OF STATE ENGINEER

Notice of Completion of Groundwater Appropriation by Means of Well

(Under Chapter 237, Montana Session Laws, 1961)

Owner D.J.E. Hunter Address Kalispell Mont

Driller Albert Justice Address Columbia Falls, Mont

Date of Notice of Appropriation of Groundwater None filed

Date well started Aug. 27-1962 Date Completed Oct 22-1963

Type of well Drilled (dug, driven, bored or drilled) Equipment Used Churn drill (Churn, drill, rotary or other)

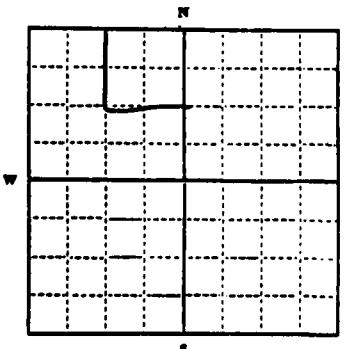
Water Use: Domestic ☒ Municipal ☐ Other ☐ Irrigation ☐
Industrial ☐ Drainage ☐ Stock ☐

(Top of Ground ... Miles above sea level)

0 to 32 ft silt with some gravel
32 to 65 ft dark hard formation
65 to 194 ft multi colored clay with some gravel
194 to 262 ft light colored clay
264 to 274 ft decomposed bed rock
274 to 314 ft very firm limestone bed rock
314 to 315 ft shattered bed rock with water
Total depth 315 ft 7"

Indicate on the diagram the character and thickness of the different strata met with in drilling, such as soil, clay, shale, gravel, rock or sand, etc. Show depth at which water is encountered, thickness and character of water-bearing strata and height to which water rises in the well.

Size of Drilled Hole	Size and Weight of Casing	From (Feet)	To (Feet)	PERFORATIONS Kind Size	From (Feet)	To (Feet)
	7" OD 23 lbs per ft.	0	274	None		



NE¼NW¼ Sec. 18 T. 26 R. 20

Indicate location of well and place of use, if possible. Each small square represents 10 acres.

Show exact depth of bottom.

Static Water Level for non-flowing Well 30 feet.

Shut-in Pressure for Flowing Well Non flowing

Pumping Water Level 95 feet at 20 gal. per minute.

Discharge in gal. per min. of flowing well Non flowing

How Tested Bailer Length of Test 3 hrs.

Remarks: (Gravel packing, cementing, packers, type of shutoff, location of place of use of groundwater if not at well, and any other similar pertinent information, including number of acres irrigated, if used for irrigation)

All measurements from existing ground surface

No 55
Driller's License Number

Albert Justice
Driller's Signature

This form to be prepared by driller, and three copies to be filed by the owner with the County Clerk and Recorder in the county in which the well is located.

Please answer all questions. If not applicable, so state, otherwise the form will be returned.

Original to the County Clerk and Recorder; duplicate to the State Engineer; Triplicate to the Montana Bureau of Mines and Geology and Quadruplicate for the Appropriator.

C-14

029 26N 20W 18 BAB Flathead

12

GW 2 H H NEWS

T. 26N R. 20W 18 (15)

File No.....

County. Flathead

DUPLICATE

STATE OF MONTANA
ADMINISTRATOR OF GROUNDWATER CODE
OFFICE OF STATE ENGINEER

Notice of Completion of Groundwater Appropriation by Means of Well

(Under Chapter 237, Montana Session Laws, 1961)

Top of Ground Approx.
(Elev. above sea level 3050' ...)

Formations Log:

0 - 235	Glacial till.
235-258	Dirty gray rock.
258-260	Tan and brown rock. Water.
260-265	Dirty gray rock.

Owner William R. and Paloma Day; William and Muriel Day; Don McCarty; Guy McCarty; and George R. Mendoza Address Lakeside, Montana

Driller Liberty Drilling Co. Address Missoula, Montana

Date of Notice of Appropriation of Groundwater None filed

Date well started 11/12/68 Date Completed 11/13/68

Type of well Drilled (dug, driven, bored or drilled) Equipment Used Air Rotary Rig (Churn, drill, rotary or other)

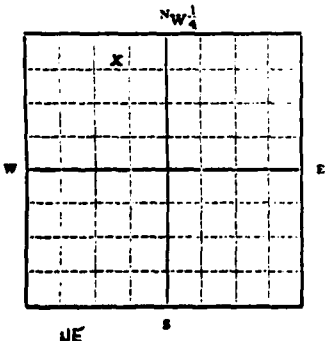
Water Use: Domestic ☒ Municipal ☐ Stock ☐ Irrigation ☐
Industrial ☐ Drainage ☐ Other ☐

Indicate on the diagram the character and thickness of the differe strata met with in drilling, such as soil, clay, shale, gravel, rock or san etc. Show depth at which water is encountered, thickness and character water-bearing strata and height to which the water rises in the well.

Size of Drilled Hole 6"

Water rises in the well 75 feet from suface.

Size and Weight of Casing	From (Feet)	To (Feet)	PERFORATIONS Kind Size	From (Feet)	To (Feet)
8 5/8 OD x 3/16	+1	227			
6 5/8 OD x 1/4	+1	237		NONE	



NW¼NW Sec. 18 T. 26N R. 20W

Indicate location of well and place of use, if possible. Each small square represents 10 acres.

Show exact depth of bottom.

Bottom of hole 265'

Static Water Level for non-flowing Well 75 fee

Shut-in Pressure for Flowing Well Non-f

Pumping Water Level 190 feet at 60 gal. per minut

Discharge in gal. per min. of flowing well Non-flowing

How Tested Air Lift Pump Length of Test 2½ hours

Remarks: (Gravel packing, cementing, packers, type of shutoff, loc tion of place of use of groundwater if not at well, and ar other similar pertinent information, including number acres irrigated, if used for irrigation) All water enteri well from cracks and seams in the rock below 2 feet. Wells in this area can be depended upon t produce clear sand free waterryear after year as lon as they are not overpumped, i.e., they should be pumped at rates not in excess of 50 to 75 per cent. of the tested capacity of the aquifer.

Driller's License Number No. 52

William R. Calvin
Driller's Signature

This form to be prepared by driller, and three copies to be filed by the owner with the County Clerk and Recorder in the county in which the well is located.

Please answer all questions. If not applicable, so state, otherwise the form will be returned.

Original to the County Clerk and Recorder; duplicate to the State Engineer; Triplicate to the Scho l of Mines and Quadruplicate for the Appropriator.

Form No. 603 R10/75

Coded 029

C-15

WELL LOG REPORT

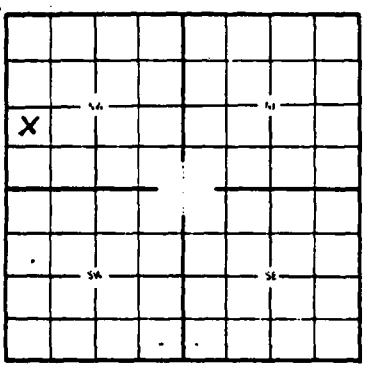
FLATHEAD

State law requires that this form be filed by the water well driller within 60 days after completion of the well.

1. WELL OWNER
Name Clyde Fauley

2. CURRENT MAILING ADDRESS
Box 156
West Glacier, Mont. 59936

3. WELL LOCATION



NW ¼ SW ¼ NW ¼ Section 18
Township 26 N N/S Range 20 W E/W
County [redacted]
Lot 61TRIG Block
Subdivision
Well Elevation
Accuracy: ____ ± 10'; ____ ± 50'; ____ ± 100';

4. DRILLING METHOD ____ cable, ____ bored,
X forward rotary, ____ reverse rotary, ____ jetted,
____ other (specify)

5. WELL CONSTRUCTION AND COMPLETION

Size of drilled hole	Size and weight of casing	From (feet)	To (feet)	Perforations ____ and/or Screen		
				Kind Size	From (feet)	To (feet)
6"	6" 17.02 lb	0	343			

Was casing left open end? X Yes ____ No
Was a packer or seal used? ____ Yes ____ No
If so, what material
Was the well gravel packed? ____ Yes ____ No
Was the well grouted? X Yes ____ No
To what depth? 25
Material used in grouting clay slurry
Well head completion: Pitless adapter
12 in. above grade X, other
(if other, specify)
Pump horsepower 1 1/4, pump type
Pump intake level feet below land surface
Power (electric, diesel, etc.) Electric

6. WATER LEVEL
Static water level 100 feet below land surface
If flowing, closed-in pressure ____ psi
____ gpm flow through ____ inch pipe
Controlled by: ____ valve, ____ reducers, ____ other
(if other, specify)

7. WELL TEST DATA ____ pump ____ bailer ____ other
(if other, specify) air
Pumping level below land surface:
340 ft. after 3 hrs. pumping 12 gpm
____ ft. after ____ hrs. pumping ____ gpm

8. WAS WELL PLUGGED OR ABANDONED? ____ Yes X No
If yes, how?

9. DATE STARTED 12/26/81
DATE COMPLETED 1/15/82

10. WELL LOG

Depth (ft.) From	To	Formation
0	2	top soil
2	80	clay & gravel
80	150	clay & boulders
150	250	brown clay & gravel
250	343	brown clay
343	360	fractured rock & water

(use separate sheet if necessary)

11. DRILLER'S CERTIFICATION
This well was drilled under my jurisdiction and this report is true to the best of my knowledge.

2/9/82
Date

Stinger Drilling
Firm Name

184 Sunsight Lp. Rd. Kalispell, Mont.
Address

[signature] 325
Signature License No.

MONTANA DEPARTMENT OF NATURAL RESOURCES & CONSERVATION
32 SOUTH EWING HELENA, MONTANA 59601 449-3634 DNRC

DEPARTMENT COPY
Well owner must complete Form 602 on reverse side.

WL · 8257

C-16
029 26N 20W 18 BDA FLATHEAD

14

GW 2

Approved Stock Form—State Publishing Co., Helena, Montana—56321

File No.....

T. 26N R. 20W

TRIPLICATE

County Flathead

LOG

STATE OF MONTANA
ADMINISTRATOR OF GROUNDWATER CODE
STATE WATER CONSERVATION BOARD

Notice of Completion of Groundwater Appropriation by Means of Well

DEVELOPED AFTER JANUARY 1, 1962

(Under Chapter 237 Montana Session Laws, 1961, as amended)

Top of Ground (Elev. above sea level Approx. 3050 ft.)

Formations in:

0	- 22	Clay.
22	- 40	Small stone and clay.
40	- 54	Gravel and clay. Some water.
54	- 56	Hard pan.
56	- 58	Clay and small stone.
58	- 59	Hard pan.
59	- 61	Quarts
61	- 72	Limestone.
72	- 105	Red lime-stone. (soft)
105	- 120	Red limestone hard layers.
120	- 130	Hard packed gravel and clay and water.
130	- 150	Limestone and clay.
150	- 205	Gravel and water.

Casing is perforated 48 to 54 ft., 120 to 130 ft., 150 to 165 ft.

Note: 0 - 205 ft. drilled by unknown driller.

205	- 240	Yellow clay with gravel mixed in.
240	- 263	Gravel im-bedded in yellow clay.
265	- 265	Brown sand and gravel with some yellow clay mixed in. Silty water.
265	- 276	Brown and yellow clay with gravel mixed in.
276	- 289	Blue and yellow rock. Seeps of water.
289	- 293	Hard blue rock.
293	- 297	Broken blue rock.

Show exact depth of bottom.

Bottom of well 299'

Owner Dorothy Rodfield Address Lakeside, Montana

Driller Liberty Drilling Co. Address Missoula, Montana

Date of Notice of appropriation of groundwater None filed.

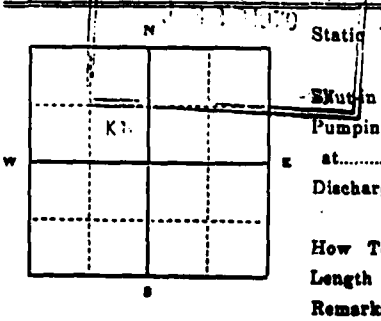
Date well started 8/22/69 Date completed 8/29/69

Type of well Drilled (Dug, driven, bored or drilled) Equipment used Cable tools (Churn drill, rotary or other)

Water use: Domestic ☒ Municipal ☐ Stock ☐ Irrigation ☒ Industrial ☐ Drainage ☐ Other ☐

Indicate on the diagram the character and thickness of the different strata met with in drilling, such as soil, clay, shale, gravel, rock or sand, etc. Show depth at which water is encountered, thickness and character of water-bearing strata and height to which the water rises in the well.

Size of Drilled Hole	Size and Weight of Casing	From (Feet)	To (Feet)	PERFORATIONS Kind Size	From (Feet)	To (Feet)
6"	6 5/8" OB x 1¼"	-5	278	N O N E		



Static Water Level for non-flowing wel 29'6" feet

Suction Pressure for Flowing Well Non-f...

Pumping Water Level 140 fee

at 25 gal. per minute.

Discharge in gal. per min. of flowing wel Non-flowing

How Tested Air Lift Pump

Length of Test 2 hrs.

Remarks: (Gravel packing, cementing, packers, type of shutoff) All water entering well is coming through cracks and seams in the rock below 295 feet. Wells in the area can be depended upon to reduce clear sand free water year after year as

(Continue on reverse side)

SE ¼ NW Sec. 18, T. 26N R. 20W

Indicate location of well and place of use, if possible. Each small square represents 40 acres.

USE—If used for irrigation, industrial, drainage or other. Explain, state number of acres and location or other data (i.e.: Lot, Block and Addition).

Approximately 1 1/3 acres.

Household, garden & lawn (3 families)

This form to be prepared by driller, and three copies to be filed by the owner with the County Clerk and Recorder in the county in which the well is located, tissue copy to be retained by driller.

Please answer all questions. If not applicable, so state, otherwise the form will be returned.

52
Driller's License Number

William S. Ahrens
Driller's Signature.

STATE OF MONTANA
COUNTY OF FLATHEAD } SS
Filed on the 17 day of Dec
A D 19 69 at 9:30 o'Clock AM
County Clerk and Recorder
By Deputy

	and yellow rock. Water.
297 - 299	Hard gray rock.

Water rises in well 29'6" from surface.

long as they are not overpumped, i.e., they should be pumped at rates not in excess of 70 to 80 percent of the tested capacity of the aquifer

15

029 26N 20W 18 AD

File No. ..... GW # C-18 T 26 R 20 18

County Flathead

RECEIVED
JAN 23 19[illegible]
Montana Bureau of Mines & Geology

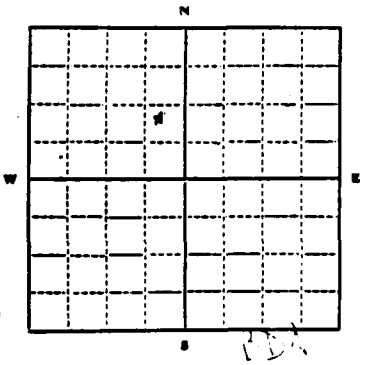
STATE OF MONTANA
ADMINISTRATOR OF GROUNDWATER CODE
OFFICE OF STATE ENGINEER

Declaration of Vested Groundwater Rights

(Under Chapter 237, Montana Session Laws, 1961)

1. Dorothy Redfield (Name of Appropriator), of Box 56 (Address) Lakeside (Town)

County of Flathead State of Montana have appropriated groundwater according to the Montana laws in effect prior to January 1, 1962, as follows:



NW¼ Sec. 18 T 26 R 20

Indicate point of appropriation and place of use, if possible. Each small square represents 10 acres.

2. The beneficial use on which the claim is based House hold, garden, & lawn

3. Date or approximate date of earliest beneficial use; and how continuous the use has been Dec. 1, 1958

4. The amount of groundwater claimed (in miner's inches or gallons per minute) 30 gal

5. If used for irrigation, give the acreage and description of the lands to which water has been applied and name of the owner thereof Vera Ashbridge irrigates garden & lawn ½ A. Mary Wolfe garden & lawn ½ Acre & Redfield ½ A. garden & lawn

6. The means of withdrawing such water from the ground and the location of each well or other means of withdrawal deepwell pump - (submersible)

7. The date of commencement and completion of the construction of the well, wells, or other works for withdrawal of groundwater drilling started June 1958, completed Nov. 6, 1958

8. The depth of water table 200 ft.

9. So far as it may be available, the type, size and depth of each well or the general specifications of any other works for the withdrawal of groundwater drilled well 8" casing 200 ft deep. Casing perforated at 48 to 54 ft 120 to 130 ft & 150 to 165 ft.

10. The estimated amount of groundwater withdrawn each year 600,000 gal

11. The log of formations encountered in the drilling of each well if available 0-22' clay, 22-40' small stone & clay, 40-54' gravel & clay & water, 54' hard pan, 61' gravel, 72' limestone, 105' red limestone (hard layers) 121' hard packed gravel, clay & water, 150' limestone & clay - 200' gravel & water

12. Such other information of a similar nature as may be useful in carrying out the policy of this act, including reference to book and page of any county record

Signature of Owner Dorothy Redfield

Date June 8, 1963

Three copies to be filed by the owner with the County Clerk and Recorder of the county in which the well is located.

Please answer all questions. If not applicable, so state, otherwise the form will be returned.

Original to the County Clerk and Recorder; duplicate to the State Engineer; Triplicate to the Montana Bureau of Mines and Geology, and Quadruplicate for the Appropriator.

029 26N 20W 18 BDA FLATHEAD 26N-R20W-18

C-19

FORM No. 603 New 7-

RECEIVED

JUN 21 1974

STATE OF MONTANA
Department of Natural Resources and Conservation

WELL LOG REPORT

File No. 16

WHITE — DEPARTMENT
PINK — BUREAU
CANARY — WELL OWNER
GOLDENROD — DRILLER

State law requires that this report be filed by the water well driller on any water well com pleted by him on and after July 1, 1973 within sixty (60) days after completion of the wel

1. WELL OWNER: Name Mabel M. Address 411 - 2nd Ave. E. Kalispell, Mont.

2. WELL LOCATION: County Flathead ; NE¼ SE¼ NW¼, Sec. 18, Twp. 26 N-S, Rg. 20 E

3. PROPOSED USE: X Domestic X Stock ___Municipal ___Industrial X Lawn and Garden
X Irrigation ___Other (*if other, specify*)

4. METHOD DRILLED: ___Cable ___Bored
___Forward Rotary ___Reverse Rotary
___Jetted X Other (*if other, specify*) Air Rotary

5. WELL CONSTRUCTION:
Diameter of hole 8 5/8 inches. Depth ___ ft.
Casing: X Steel ___Plastic ___Concrete
___Threaded X Welded ___Other (*if other, specify*)
Pipe Weight: Dia.: 8 5/8 From: 2'1" To: 298
22.36 lb/ft. 8 5/8 inches 2'1" feet 298 feet
___lb/ft. ___inches ___feet ___feet
___lb/ft. ___inches ___feet ___feet
Was perforated pipe used? ___Yes X No
Length of pipe perforated ___ feet
Was casing left open end? X Yes ___No
Was a well screen installed? ___Yes X No
Material ___ Dia. ___ inches
(*stainless steel, bronze, etc.*)
Perforation type: ___slots ___holes
Size ___ set from ___ feet to ___ feet
Size ___ set from ___ feet to ___ feet
Size ___ set from ___ feet to ___ feet
Was a packer or seal used? ___Yes X No
If so, what material ___
Well type: ___Straight screen ___Graveled
Was the well grouted? ___Yes X No
To what depth? ___ feet
Material used in grouting ___
Well head completion: Pitless adapter ___
12" above grade XX Other ___
(*If other, specify*) ___
Was the well disinfected? XX Yes ___No

6. WATER LEVEL:
Static water level 16 ft. below land surface
If flowing: closed-in pressure ___ psi
GPM flow ___ through ___ inch pipe
Controlled by: ___Valve ___Reducers
___Other, *specify* ___

7. WELL TEST DATA: ___Pump ___Bailer XX Other
(*If other, specify*) Air Lift Pump
Pumping level below land surface: Est.
164 ft. after 5 hrs. pumping 30 gpm
___ft. after ___hrs. pumping ___gpm

8. WELL LOG:

Depth (ft.) From	To	Formation
0	1	Topsoil.
1	5	Tan fine sand dirt.
5	16	Tan silty clay.
16	84	Cobblestones, boulders and gravel embedded in tan clay.
84	297	Red clay stone.
297	326	Gray and yellow rock in alternate layers.
326	390	Dark gray rock. Water 30 gpm

(*Use separate sheet if necessary*)

9. DATE STARTED: 8/1/73

10. DATE COMPLETED: 8/6/73

11. WAS WELL PLUGGED OR ABANDONED? ___Yes X N
If so, how ___

12. DRILLER'S CERTIFICATION:
This well was drilled under my jurisdictio and this report is true to the best of my knowledge.

LIBERTY DRILLING & PUMP CO. 52
Driller's or Firm Name *License No.*

Route #6, Hwy 93 South, Kalispell, MT 5990
Address

Signed by William F. Osborne, Owner *Date*

C-20

M Mk 605 New 7-75 26N 20W 1E BDC FLATHEAD File No. 17

Cadastral

RECEIVED

DEC 23 1975

STATE OF MONTANA

Department of Natural Resources and Conservation

WELL LOG REPORT

WHITE — DEPARTMENT
PINK — BUREAU
CANARY — WELL OWNER
GOLDENROD — DRILLER

State law requires that this form be filed by the water well driller on any water well completed by him on and after July 1, 1975 within sixty (60) days after completion of the well.

WELL OWNER: Name Flathead County Park Board Address PO Box 1000 Kalispell, MT. 59901

WELL LOCATION: County Flathead ; SW ¼ SE ¼ NW ¼, Sec. 18, Twp. 26 N-S, Rg. 20 W-E

PROPOSED USE: ___ Domestic ___ Stock ___ Municipal ___ Industrial ___ Lawn and Garden
X Irrigation X Other (*if other, specify*) Supply water for 5 acre Public Park known as Ben Williams Park

METHOD DRILLED: ___ Cable ___ Bored
___ Forward Rotary ___ Reverse Rotary
___ Jetted X Other (*if other, specify*)
Air Rotary

WELL CONSTRUCTION:
Diameter of hole 8 inches. Depth 196 ft.
Casing: X Steel ___ Plastic ___ Concrete
___ Threaded X Welded ___ Other (*if other, specify*)

Pipe Weight:	Dia.:	From:	To:
24 #lb/ft.	8 inches	1½ + feet	119'9" feet
17.5 lb/ft.	6 inches	105 feet	196 feet
___ lb/ft.	___ inches	___ feet	___ feet

Was perforated pipe used? X Yes ___ No
Length of pipe perforated Eleven feet
Was casing left open end? X Yes ___ No
Was a well screen installed? ___ Yes X No
Material ___ Dia. ___ inches
(*stainless steel, bronze, etc.*)
Perforation type: ___ slots ___ holes
Size ¼ x 3 set from 185 feet to 196 feet
Size ___ set from ___ feet to ___ feet
Size ___ set from ___ feet to ___ feet
Was a packer or seal used? ___ Yes X No
If so, what material ___
Well type: ___ Straight screen ___ Gravel packed
Was the well grouted? X Yes ___ No
To what depth? 117 feet
Material used in grouting Puddled Clay
Well head completion: Pitless adapter ___
12" above grade X Other ___
(*If other, specify*) ___
Was the well disinfected? X Yes ___ No

WATER LEVEL:
Static water level 47 ft. below land surface
If flowing: closed-in pressure ___ psi
GPM flow ___ through ___ inch pipe
Controlled by: ___ Valve ___ Reducers
___ Other, *specify* ___

WELL TEST DATA: ___ Pump ___ Bailer X Other
(*If other, specify*) Air lift pump
Pumping level below land surface:
122 ft. after 5 hrs. pumping 45 gpm
___ ft. after ___ hrs. pumping ___ gpm

8. WELL LOG:

Depth (ft.) From	To	Formation
0	6	Topsoil
6	41	Gravel, cobblestones & boulders embedded in tan silty clay.
41	69	Gravel & cobblestones embedded in gray clay.
69	86	Gravel mixed in tan silty clay.
86	98	Tan silty clay.
98	117	Gravel mixed in tan silty clay.
117	138	Tan & blue rock in alternate layers.
138	141	Red clay.
141	144	Tan rock.
144	153	Blue rock.
153	162	Green rock. Some water.
162	168	Broken tan rock. Water. Thirtee gallons per minute total.
168	181	Tan & blue rock in alternate layers. Water. Twenty gallons per minute total.
181	182	Red clay.
182	196	Fractured tan, blue & green ro Water. Forty five gallons per minute total.

(Use reverse side if necessary)

9. DATE STARTED: 12/04/75

10. DATE COMPLETED: 12/09/75

11. WAS WELL PLUGGED OR ABANDONED? ___ Yes X No
If so, how ___

12. DRILLER'S CERTIFICATION:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge.

Liberty Drilling & Pump Company 52
Driller's or Firm Name License No.

3850 Highway 93 South, Kalispell, MT 59901
Address

Signed by 12/22/75
Date

C-21 SENT TO HELENA W/L OF 8/30/82. 18

Form No. 603 R2/81 RECEIVED 029 26N 20W 18 CBA Flathead File No. C 50006

CODED AUG 18 1982 WELL LOG REPORT 76 LJ

State law requires that this form be filed by the water well driller within 60 days after completion of the well.

MONTANA D N R C

KALISPELL FIELD OFFICE

1. WELL OWNER
Name M. W. Landes Family Trust

2. CURRENT MAILING ADDRESS
P.O. Box 545
Lakeside, MT 59922

3. WELL LOCATION
County Flathead
Township 26 N/S Range 20 E/W
NE ¼ NW ¼ SW ¼ Section 18
Lot _____ Block _____
Subdivision _____

4. PROPOSED USE Domestic ☒ Stock ☐ Irrigation ☐
Other ☐ specify _____

5. DRILLING METHOD _____ cable, _____ bored, _____ forward rotary, _____ reverse rotary, _____ jetted, X other (specify) Air Rotary

6. WELL CONSTRUCTION AND COMPLETION

Size of drilled hole	Size and weight of casing	From (feet)	To (feet)	Perforations Slots and/or Screen Kind Size	From (feet)	To (feet)
6"	6 5/8" x .250	+1'6"	76'7"			
6"	4½" ID Class 160 PVC	56'	240'	slots ¼"x6"	200'	240'
6"		240'	264'			

Was casing left open end? X Yes ___ No
Was a packer or seal used? ___ Yes X No
If so, what material _____
Was the well gravel packed? ___ Yes X No
Was the well grouted? ___ Yes X No
To what depth? _____
Material used in grouting _____
Well head completion: Pitless adapter ___ Yes X No
Top of casing 12 in. or greater above grade X Yes ___ No

7. WHAT IS THE TEMPERATURE OF THE WATER?
46 Degrees Fahrenheit ☒ Measured ☐ Estimated

8. WATER LEVEL
Static water level 144'6" feet below land surface
If flowing; closed-in pressure _____ psi
_____ gpm
Controlled by: _____ valve, _____ reducers, _____ other, (specify) _____

9. WELL TEST DATA _____ pump _____ bailer X other, (specify) Air Lift
Pumping level below land surface:
Est. 180 ft. after 5 hrs. pumping 15 gpm
_____ ft. after _____ hrs. pumping _____ gpm

10. WAS WELL PLUGGED OR ABANDONED? ___ Yes X No
If yes, how? _____

11. DATE COMPLETED 7/06/82

12. WELL LOG (Page 1 of 2)

Depth (ft.) From	To	Formation
0	11	Gravel, cobblestones & boulders in light brown silty clay.
11	19½	Gravel & cobblestones in dark brown silty clay.
19½	20½	Boulder.
20½	40	Gravel, cobblestones & boulders in brown silty clay.
40	48	Gray & brown rock in alternate layers.
48	57	Light & dark brown rock with fractures infilled with orange clay.
57	82	Hard dark gray & gray-green rock with brown seams.
82	87	Gray-green, dark gray & brown rock in alternating layers.
		(CONTINUED ON PAGE 2)

(use separate sheet if necessary)

13. DRILLER'S CERTIFICATION
This well was drilled under my jurisdiction and this report is true to the best of my knowledge.

July 7, 1982
Date

Liberty Drilling & Pump Company
Firm Name
3850 Highway 93 South
Kalispell, MT 59901
Address

William F. Osborne 52
Signature License No.

MONTANA DEPARTMENT OF NATURAL RESOURCES & CONSERVATION
32 SOUTH EWING HELENA, MONTANA 59620 449-3962 DNRC

printed on recycled paper of minimum

WELL DRILLER COPY

Marvin Landes Family Trust
Well Log Report
July 7, 1982
Page 2 of 2

From	To	Formation
87	120½	Gray & brown rock with fractures infilled with orange clay.
120½	147	Light to dark gray rock with thin layers of orange-brown rock & calcite, in fractures.
147	155	Light to dark gray and gray-green rock with thin layers of brown rock.
155	166	Light to dark gray and gray-green rock with orange clay in fractures.
166	179	Light to dark gray and gray-green rock.
179	187	Light to dark gray and gray-green rock with orange clay in fractures.
187	195	Light to dark gray and gray-green rock.
195	207	Light to dark gray and gray-green rock with orange and white clay in fractures.
207	224	Light to dark gray rock with seams of brown rock. Water 2 G.P.M.
224	239	Light to dark gray and light to medium brown rock in alternating layers.
239	249	Fractured light to dark gray rock, light green rock and medium brown rock, in alternating layers with soft orange rock in fractures. Water 10 G.P.M. -total.
249	264	Fractured light to dark gray, light green and brown rock in alternating layers. Water 15 G.P.M. - total.

Note:

Wells of this type in this area can be depended upon year after year to produce clear, sand-free water as long as they are not overpumped, i.e., they should be pumped at rates not in excess of 70 - 80 percent of the tested capacity of the aquifer.

029 26N 20W 18 D FLATHEAD

Form No. 603 (Rev. 7/76) CODED

STATE OF MONTANA

File No. 18670-y762-

Department of Natural Resources and Conservation

White-Department
Yellow-Department
Pink-Well Owner
Gold-Driller

WELL LOG REPORT

029-26N-20W-18

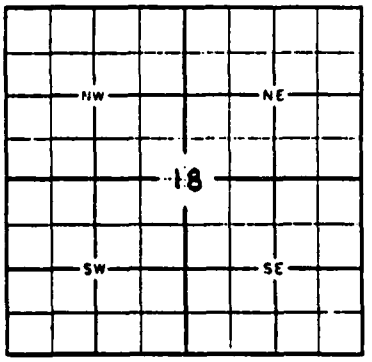
State law requires that this form be filed by the water well driller within 60 days after completion of the well, and Form 602, Notice of Completion of Groundwater Development, be filed by the well owner within 60 days after the water has been put to beneficial use.

1. WELL OWNER
Name Mike Felt

2. CURRENT MAILING ADDRESS
Big Fork, Montana 59901

3. PROPOSED USE X domestic (includes lawn and garden); ____ stock; ____ municipal; ____ industrial; ____ irrigation; ____ other (specify)

4. WELL LOCATION



____ ¼ ____ ¼ SE ¼ ____ ¼ Section ____
T. 26 (N) or S R. 20 E or (W)
OR, Lot ____ Block ____
Subdivision ____
City Lakeside County Flathead
Elevation ____ Accuracy: __ ±10'; __ ±50'; __ ±100';

5. DRILLING METHOD ____ cable, ____ bored, ____ forward rotary, ____ reverse rotary, ____ jetted, ____ other (specify)

6. WELL CONSTRUCTION AND COMPLETION

Size of drilled hole	Size and weight of casing	From (feet)	To (feet)	Perforations ____ and/or Screen ____ Kind Size	From (feet)	To (feet)
6"	6 5/8" 17#	0	81	None		

Was casing left open end? X Yes, ____ No
Was a packer or seal used? ____ Yes, X No
If so, what material ____
Was the well gravel packed? ____ Yes, ____ No
Was the well grouted? ____ Yes, ____ No
To what depth? 70 ft.
Material used in grouting Bentonite
Well head completion: Pitless adapter ____
12 in. above grade ____, other ____
(if other, specify) ____
Pump horsepower ____, pump type ____
Pump intake level ____ feet below land surface
Power (electric, diesel, etc.) ____

7. WATER LEVEL
Static water level 220 feet below land surface
If flowing, closed-in pressure ____ psi
____ gpm flow through ____ inch pipe
Controlled by: ____ valve, ____ reducers, ____ other
(if other, specify) ____

8. WELL TEST DATA ____ pump ____ bailer X other
(if other, specify) ____
Pumping level below land surface:
280 ft. after 4 hrs. pumping 20 gpm
340 ft. after 4 hrs. pumping 40 gpm

9. WAS WELL PLUGGED OR ABANDONED? ____ Yes X No
If yes, how? ____

10. DATE STARTED March 27, 1978
DATE COMPLETED April 15, 1978

11. WELL LOG

Depth (ft.) From	To	Formation
0	3	Top Soil.
3	19	Clay and Boulders.
19	70	Soft Rock.
70	80	Rock.
80	180	Fractured Rock.
180	250	Rock
250	260	Fractured rock and Water (6 GPM)
260	315	Rock.
315	330	Fractured rock and water. (30 GPM)
330	340	Rock.

(use separate sheet if necessary)

12. DRILLER'S CERTIFICATION
This well was drilled under my jurisdiction and this report is true to the best of my knowledge.
4/15/78
Date
Firm Name: Billmayer's Water Supply Co.
Address: 115 Kelly Road, Kalispell, Montana 59901
Signature ____ License No. 3

20

C-24 029 26N 20W 18DA FLATHEAD

(21)

GW 2 Approved Stock Form—State Publishing Co., Helena, Montana—48557

File No.....

DUPLICATE

(1)

T 26N R 20W - 18

County Flathead

LOG

STATE OF MONTANA
ADMINISTRATOR OF GROUNDWATER CODE
STATE WATER CONSERVATION BOARD

Notice of Completion of Groundwater Appropriation by Means of Well

DEVELOPED AFTER JANUARY 1, 1962

(Under Chapter 237 Montana Session Laws, 1961, as amended)

Top of Ground (Elev. above sea level Approx. 3090 ft.)

Formations Log:

0 -	1½	Top soil.
1½ -	5	Tan clay and cobblestones.
5 -	5½	Blue boulder.
5½ -	14	Tan clay and cobblestones.
14 -	45	Hard gray rock.
45 -	53	Tan and brown rock.
53 -	122	Gray rock.
122 -	136	Tan and brown rock.
136 -	165	Dark gray rock.
165 -	168	Tan and brown rock.
168 -	265	Gray rock.
265 -	267	Tan rock.
267 -	288	Gray rock.
288 -	295	Tan and light gray rock in alternate layers.
295 -	342	Light gray rock.
342 -	348	Tan rock.
348 -	405	Gray rock. 30 GPM
405 -	409	Light gray rock. 42 GPM Total.

Water rises in well 255 feet from surface.

Show exact depth of bottom.
Bottom of well 409 '

Owner Harold G. Taylor Address Lakeside, Montana
Patricia W. Taylor

Driller Liberty Drilling Co. Address Lincoln, Montana

Date of Notice of appropriation of groundwater None filed.

Date well started 5/9/69 Date completed 5/15/69

Type of well Drilled (Dug, driven, bored or drilled) Equipment used Air Rotary (Churn drill, rotary or other)

Water use: Domestic ☐ Municipal ☐ Stock ☐ Irrigation ☒
Industrial ☐ Drainage ☐ Other ☐

Indicate on the diagram the character and thickness of the different strata met with in drilling, such as soil, clay, shale, gravel, rock or sand, etc. Show depth at which water is encountered, thickness and character of water-bearing strata and height to which the water rises in the well.

Size of Drilled Hole	Size and Weight of Casing	From (Feet)	To (Feet)	PERFORATIONS Kind Size	From (Feet)	To (Feet)
6"	7" OD x [illegible]"	+1'6"	32'			

N / W / E / S — X

NW¼ Sec. 18 T. 26N R. 20W
Indicate location of well and place of use, if possible. Each small square represents 40 acres.

Static Water Level for non-flowing well 255 feet.

Shut-in Pressure for Flowing Well Non-f

Pumping Water Level 315 feet at 42 gal. per minute.

Discharge in gal. per min. of flowing well Non-flowing

How Tested Air Lift Pump

Length of Test 1½ hrs.

Remarks: (Gravel packing, cementing, packers, type of shutoff) All water entering well is coming from cracks and seams in the rock below 340 feet. Annular space around casing is grouted from 32 feet back toward surface with four sacks (Continue on reverse side)

USE—If used for irrigation, industrial, drainage or other. Explain, state number of acres and location or other data (i.e.: Lot, Block and Addition).

Approximately 35 - 40 acres.

This form to be prepared by driller, and three copies to be filed by the owner with the County Clerk and Recorder in the county in which the well is located, tissue copy to be retained by driller.

Please answer all questions. If not applicable, so state, otherwise the form will be returned.

32
Driller's License Number

William S. Oakes
Driller's Signature.

of cement.

Note: Wells in this area can be depended upon to produce clear sand free water year after year as long as they are not overpumped, i.e., they should be pumped at rates not in excess of 40 to 50 percent of the tested capacity of the aquifer.

14106

STATE OF MONTANA } ss
COUNTY OF FLATHEAD }
Filed on the 3 day of Feb
A D 19 70 at 4:15 o'Clock P M
Jem
County Clerk and Recorder
By [signature] Deputy

C-26

.029 26N 20W 19 AAD FLATHEAD

21

Approved Stock Form—State Publishing Co., Helena, Montana—50551

File No.

DUPLICATE

RECEIVED
JAN 27 1971
Montana Bureau of Mines & Geology

T 26N R 20W - 19

County Flathead

STATE OF MONTANA
ADMINISTRATOR OF GROUNDWATER CODE
STATE WATER CONSERVATION BOARD

Notice of Completion of Groundwater Appropriation by Means of Well

DEVELOPED AFTER JANUARY 1, 1962

(Under Chapter 237 Montana Session Laws, 1961, as amended)

Owner Neil J. and Christine Hanson Address Lakeside, Montana

Driller Liberty Drilling Co. Address Missoula, Montana

Date of Notice of appropriation of groundwater None filed.

Date well started 4/14/69 Date completed 4/25/69

Type of well Drilled (Dug, driven, bored or drilled) Equipment used Air Rotary (Churn drill, rotary or other)

Water use: Domestic ☒ Municipal ☐ Stock ☒ Irrigation ☒ Industrial ☐ Drainage ☐ Other ☒

Top of Ground Approx. (Elev. above sea level 2910 ft.)

Formations Log:

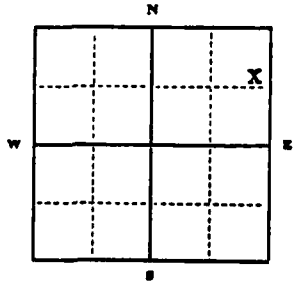
0 -	2	Tan clay.
2 -	51	Dark gray rock.
51 -	52	Tan rock.
52 -	82½	Dark gray rock.
82½ -	85	Tan and brown rock.
85 -	100	Dark gray rock.
100 -	101	Tan and brown rock.
101 -	115	Dark gray rock.
115 -	116	Tan and brown rock. 2 GPM
116 -	153	Dark gray rock.
153 -	154	Tan and brown rock.
154 -	157½	Dark gray rock.
157½ -	159	Tan and brown rock.
159 -	162	Dark gray rock.
162 -	163½	Tan and brown rock.
163½ -	180	Dark gray rock.
180 -	181½	Tan and brown rock.
181½ -	185	Dark gray rock.
185 -	186	Tan rock.
186 -	255	Dark gray rock.
255 -	257	Tan and brown rock.
257 -	319	Dark gray rock.
319 -	349	Tan and brown rock.
349 -	355	Dark gray rock.

Water rises in well 70 feet to surface.

Show exact depth of bottom. Bottom of well 355 ft.

Indicate on the diagram the character and thickness of the different strata met with in drilling, such as soil, clay, shale, gravel, rock or sand, etc. Show depth at which water is encountered, thickness and character of water-bearing strata and height to which the water rises in the well.

Size of Drilled Hole	Size and Weight of Casing	From (Feet)	To (Feet)	PERFORATIONS Kind Size	From (Feet)	To (Feet)
7"	7" OD x [illegible]"	+2'6"	355	N	O N	E



NE¼NW¼ Sec. 19 T. 26N R. 20W

Indicate location of well and place of use, if possible. Each small square represents 40 acres.

Static Water Level for non-flowing well 70 feet

Shut-in Pressure for Flowing Well Non-

Pumping Water Level 230 feet at 150 gal. per minute.

Discharge in gal. per min. of flowing well Non-flowing

How Tested Air Lift Pump

Length of Test 6 hours

Remarks: (Gravel packing, cementing, packers, type of shutoff) All water entering well is coming from cracks and seams in the rock between 115 and 349 feet. Casing is grouted in place from 32'6" back towards surface with two sacks of cement. (Continue on reverse side)

USE—If used for irrigation, industrial, drainage or other. Explain, state number of acres and location or other data (i.e.: Lot, Block and Addition).

Approximately 40 acres.

52
Driller's License Number

William E. Coburn
Driller's Signature.

This form to be prepared by driller, and three copies to be filed by the owner with the County Clerk and Recorder in the county in which the well is located, tissue copy to be retained by driller.

Please answer all questions. If not applicable, so state, otherwise the form will be returned.

Wells in this area can be depended upon to produce clear sand free water year after year as long as they are not overpumped, i.e., they should be pumped at rates not in excess of 30 to 40 percent of the tested capacity of the aquifer.

22

029 26 N 20 W 07 Flat Head

Form No. 603 (Rev. 7/76)

STATE OF MONTANA

File No. _____ (2

Coded

Department of Natural Resources and Conservation

WELL LOG REPORT

White-Department
Yellow-Department
Pink-Well Owner
Gold-Driller

NO
Loc

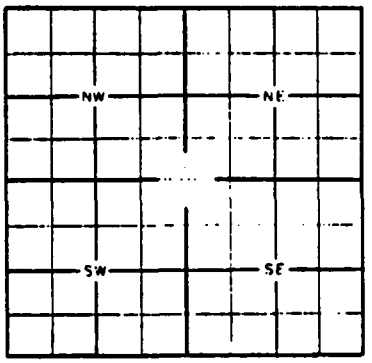
State law requires that this form be filed by the water well driller within 60 days after completion of the well, and Form 602, Notice of Completion of Groundwater Development, be filed by the well owner within 60 days after the water has been put to beneficial use.

1. WELL OWNER
Name Lorance Anderson

2. CURRENT MAILING ADDRESS
Box 118
Lakeside, MT.

3. PROPOSED USE _____ domestic (includes lawn and garden); _____ stock; _____ municipal; _____ industrial; _____ irrigation; _____ other (specify) _____

4. WELL LOCATION



_____¼ _____¼ _____¼ _____¼ Section 1
T. 26 N or S R. 20 E or W
OR, Lot 31 Block _____
Subdivision Savage Sub
City Lakeside County Flathead
Elevation _____ Accuracy: __ ±10'; __ ±50'; __ ±100';

5. DRILLING METHOD _____ cable, _____ bored, _____ forward rotary, _____ reverse rotary, ___ jetted, _____ other (specify) _____

6. WELL CONSTRUCTION AND COMPLETION

Size of drilled hole	Size and weight of casing	From (feet)	To (feet)	Perforations _____ and/or Screen _____ Kind Size	From (feet)	To (feet)
6"	5 5/8" 17	0	240			

Was casing left open end? X Yes, ___ No
Was a packer or seal used? ___ Yes, X No
If so, what material _____
Was the well gravel packed? ___ Yes, X No
Was the well grouted? X Yes, ___ No
To what depth? 20 Feet
Material used in grouting Drill cutting
Well head completion: Pitless adapter _____
12 in. above grade _____, other _____
(if other, specify) _____
Pump horsepower _____, pump type _____
Pump intake level _____ feet below land surface
Power (electric, diesel, etc.) _____

7. WATER LEVEL
Static water level 40' feet below land surface
If flowing, closed-in pressure _____ psi
_____ gpm flow through _____ inch pipe
Controlled by: ___ valve, ___ reducers, ___ other
(if other, specify) _____

8. WELL TEST DATA ___ pump ___ bailer X other
(if other, specify) Air
Pumping level below land surface:
_____ ft. after _____ hrs. pumping 15 gpm
_____ ft. after _____ hrs. pumping _____ gpm

9. WAS WELL PLUGGED OR ABANDONED? ___ Yes ___ No
If yes, how? _____

10. DATE STARTED April 2, 1979
DATE COMPLETED April 9, 1979

11. WELL LOG
Depth (ft.)

From	To	Formation
0	240	Old Well
240	270	Brown Hard Rock
270	280	Hard Grey Rock
280	320	Brown Fractured Rock
		Drive Shoe

(use separate sheet if necessary)

12. DRILLER'S CERTIFICATION
This well was drilled under my jurisdiction and this report is true to the best of my knowledge.
4/5/79
Date

Billmayer's Water Supply
Firm Name
115 Kelly Road
Kalispell, Montana 59901
Address

Signature _____ License No. _____

Form No. 603 R10/79 029 26N 20W 07 BAA Flathead 76226

CODED

WELL LOG REPORT

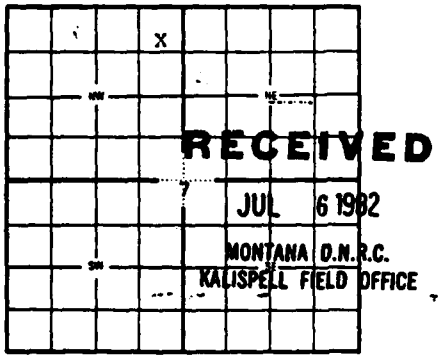
76LJ

State law requires that this form be filed by the water well driller within 60 days after completion of the well.

1. WELL OWNER
Name ~~Robert L. & Alyce L. Duvall~~

2. CURRENT MAILING ADDRESS
P.O. Box 7925
Boise, ID 83707

3. WELL LOCATION



RECEIVED
JUL 6 1982
MONTANA D.N.R.C.
KALISPELL FIELD OFFICE

NE ¼ NE ¼ NW ¼ Section 7
Township 26 N/S Range 20 E/W
County Flathead
Lot 1 Block
Subdivision Tract 7BA and 7BB
Well Elevation
Accuracy: 2920 ± 10'; ± 50'; ± 100';

4. DRILLING METHOD ____ cable, ____ bored, ____ forward rotary, ____ reverse rotary, ____ jetted, X other (specify) Air rotary

5. WELL CONSTRUCTION AND COMPLETION

Size of drilled hole	Size and weight of casing	From (feet)	To (feet)	Perforations slots and/or Screens Kind Size	From (feet)	To (feet)
6"	6 5/8"x .250	+1'5"	54'			
6"	4 9/16" x .250	49'3"	199'1"	slots 3/16"x3"	179'1"	199'1"
6"		199'1"	200'			

Was casing left open end? X Yes ____ No
Was a packer or seal used? X Yes ____ No
If so, what material Neoprene on steel @ 178'
Was the well gravel packed? ____ Yes X No
Was the well grouted? ____ Yes X No
To what depth?
Material used in grouting
Well head completion: Pitless adapter ____ No
12 in. above grade Yes, other
(If other, specify)
Pump horsepower ____, pump type
Pump intake level ____ feet below land surface
Power (electric, diesel, etc.)

6. WATER LEVEL
Static water level 20 feet below land surface
If flowing, closed-in pressure ____ psi
____ gpm flow through ____ inch pipe
Controlled by: ____ valve, ____ reducers, ____ other
(if other, specify)

7. WELL TEST DATA ____ pump ____ bailer ____ other
(if other, specify) Air Lift
Pumping level below land surface:
Lst. 175 ft. after 5 hrs. pumping 80 gpm
____ ft. after ____ hrs. pumping ____ gpm

8. WAS WELL PLUGGED OR ABANDONED? ____ Yes X No
If yes, how?

9. DATE STARTED 1/31/82
DATE COMPLETED 4/22/82

10. WELL LOG

Depth (ft.) From	To	Formation
0	2	Topsoil
2	17	Gravel, cobblestones & boulders mixed with brown sand
17	26	Tan clay
26	27	Broken rock imbedded in tan clay
27	33	Broken gray, green & brown rock with scattered gravel
33	42	Brown & green fractured rock
42	49	Grey & brown fractured rock
49	51	Soft yellow rock
51	68	Grey & brown fractured rock
68	78	Grey & green fractured rock
78	81	Soft yellow rock
81	97	Grey, green & brown fractured rock
97	161	Grey rock with fractures
161	165	Soft yellow rock with tan silt - 6 GPM of silty water
165	186	Grey, green & brown fractured rock- 20 GPM of water
186	196	Grey, green & brown fractured rock- 27 GPM of water - total
196	200	Grey, green & brown fractured rock- 80 GPM of water - total
		Note: Wells of this type in this area can be depended upon year after year to produce clear sandfree water as long as not overpumped i.e. should be pumped at rates not in excess of 60-70% of the tested capacity of the aquifer.

(use separate sheet if necessary)

11. DRILLER'S CERTIFICATION
This well was drilled under my jurisdiction and this report is true to the best of my knowledge.

June 2, 1982
Date

Liberty Drilling & Pump Company
Firm Name
3850 Highway 93 South
Kalispell, MT 59901
Address

William F. Osborne 52
Signature License No.

MONTANA DEPARTMENT OF NATURAL RESOURCES & CONSERVATION DNRC
32 SOUTH ewing HELENA, MONTANA 59601 449-2634

DEPARTMENT COPY WI . 9405

C-30

029 26N 20W 07 BAA FLATHEAD T24NR20W-7

24

3 GW 2 Revised 1969
STATE PUBLISHING COMPANY

County Flathead

STATE OF MONTANA
ADMINISTRATOR OF GROUNDWATER CODE
MONTANA WATER RESOURCES BOARD

NOTICE OF COMPLETION OF GROUNDWATER APPROPRIATION BY MEANS OF WELL

Developed after January 1, 1962

(Under Chapter 237 Montana Session Laws, 1961, as amended)

This form to be prepared by driller, and three copies to be filed by the owner with the County Clerk and Recorder in the county in which the well is located, last copy to be retained by driller.

Please answer all questions. If not applicable, so state, otherwise the form may be returned.

Edgar W. Lister

Owner Matilda S. Lister

Address

Lakeside, Montana 59922

Date well started 11/8/71

completed 11/9/71

For Administrator's Use
File
GW I

Type of well Drilled (Dug, driven, bored or drilled)

Equipment used Air Rotary (Churn drill, rotary or other)

Water Use: Domestic ☒ Municipal ☐ Stock ☐ Irrigation ☐

Industrial ☐ Drainage ☐ Other ☐* Garden/Lawn ☐

*Describe

USE: If used for irrigation, industrial, drainage or other. Explain, state number of acres and location or other data (i.e. Lot, Block and Addition).

ESTIMATED ANNUAL WITHDRAWAL 30,420,000

Size of Drilled Hole	Size and Weight of Casing	From (Feet)	To (Feet)	PERFORATIONS Kind Size	From (Feet)	To (Feet)
8"	8 5/8" OD by ¼"	+2'	43'7"	NONE		

N / W / E / S

X

SE ¼ NW ¼ Sec. 7

T. 26 N R. 20 E W

Static water level 21 ft.*

Pumping water level 63 ft.* at 75 gallons per minute, measured 120 minutes after pumping began.

*Measured from ground level.

Well developed by Air Lift Pump for 2 hours.

Power diesel Pump 150 HP

Remarks: (Gravel packing, cementing, packers, type of shutoff) annulus between eight inch casing and ten inch hole is backfilled with puddled clay and cuttings. All water (con't)

INDICATE LOCATION OF WELL AND PLACE OF USE, IF POSSIBLE. EACH SMALL SQUARE REPRESENTS 40 ACRES.

LISE TY DRILLING COMPANY

Driller's Signature

Driller's Address 2500 Reserve

Missoula, Montana 59801 LICENSE NO. 52

DRILLER'S LOG

Indicate the character, color, thickness of strata such as soil, clay, sand, gravel, shale, sandstone, etc. Show depth at which water is found and height to which water rises in well.

Top of Ground Approx. (Elev. above sea level) 2894

From (Feet)	To (Feet)	
0	27	tan clay with boulders and gravel mixed in
27	33	ed clay with gravel mixed in
33	42	Gravel imbedded in gr: clay
42	64	Gray rock
64	102	Dark gray rock
102	104	Fractured tan, brown and gray rock in alternate layers.
104	109	Dark gray rock
109	111	Fractured tan, brown and gray rock
111	115	Dark gray rock
115	117	Fractured tan, brown and gray rock
117	126	Dark gray rock

126' Show exact depth of bottom

Water rises in well 21' from surface.

(Con't) entering well through cracks and seams in the rock below 102 feet.

Note: Wells in this area can be depended upon to produce clear sand free water year after year as long as they are not overpumped, i.e., they should be pumped at rates not in excess of 50 to 60 percent of the tested capacity of the aquifer.

14,397

STATE OF MONTANA } SS
COUNTY OF [illegible] }

Filed on the [illegible] day of [illegible]
A.D. 19[illegible] at [illegible] o'clock [illegible] M.

[illegible]
County Clerk

By [illegible]

C-32

029 26N 20W 07 BD FLATHEAD

25

BD

Approved Stock Form—State Publishing Co., Helena, Montana—30551

GW 2

File No.

TRIPLICATE

T 26N R 20W — 7

County Flathead

LOG

STATE OF MONTANA
ADMINISTRATOR OF GROUNDWATER CODE
STATE WATER CONSERVATION BOARD

Notice of Completion of Groundwater Appropriation by Means of Well

DEVELOPED AFTER JANUARY 1, 1962

(Under Chapter 237 Montana Session Laws, 1961, as amended)

Top of Ground Approx. (Elev. above sea level 3025')

Formations Log:

0 -	1	Topsoil.
1 -	22	Tan clay & gravel.
22 -	24	Blue boulder.
24 -	28	Tan clay with gravel mixed in.
28 -	69	Gray rock.
69 -	80	Brown & gray rock.
80 -	111	Light gray & dark gray rock.
111 -	137	Light gray & tan rock.
137 -	198	Brown & light gray rock.
198 -	228	Dark gray rock. 5 GPM.
228 -	242	Light gray rock. 60 GPM. Total.
242 -	254	Dark gray rock.

Water rises in the well 163 feet to surface.

Show exact depth of bottom.
Bottom of well 254'

Owner Paul L. and Nona L. Ellsworth Address Lakeside, Montana

Driller Liberty Drilling Co Address Missoula, Montana

Date of Notice of appropriation of groundwater None filed

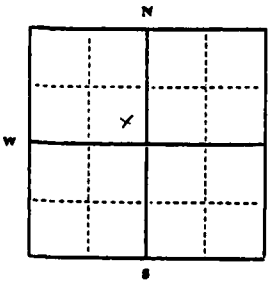
Date well started 6/15/70 Date completed 6/16/70

Type of well Drilled (Dug, driven, bored or drilled) Equipment used Air Rotary (Churn drill, rotary or other)

Water use: Domestic ☒ Municipal ☐ Stock ☐ Irrigation ☐
Industrial ☐ Drainage ☐ Other ☐

Indicate on the diagram the character and thickness of the different strata met with in drilling, such as soil, clay, shale, gravel, rock or sand, etc. Show depth at which water is encountered, thickness and character of water-bearing strata and height to which the water rises in the well.

Size of Drilled Hole	Size and Weight of Casing	From (Feet)	To (Feet)	PERFORATIONS Kind Size	From (Feet)	To (Feet)
10"	8 5/8	0	32			
	16"	32	38'6"	N O N E		



SE 1/4 Sec. 7 T26N R20W

Indicate location of well and place of use, if possible. Each small square represents 40 acres.

Static Water Level for non-flowing wel 163 feet

Shut-in Pressure for Flowing Wel Non-f

Pumping Water Level 231 fee

at 60 gal. per minute.

Discharge in gal. per min. of flowing wel Non-flowing

How Tested Air Lift Pump

Length of Test Two hours

Remarks: (Gravel packing, cementing, packers, type of shutoff) Annular space between eight inch OD casing and ten inch hole filled with puddled clay to seal out contaminates. All water entering well from cracks and seams in the rock below 228 feet. Wells in this area can be depended upon to produce (Continue on reverse side)

USE—If used for irrigation, industrial, drainage or other. Explain, state number of acres and location or other data (i.e.: Lot, Block and Addition).

30F T-6DAC in N½ Sec 7, Twp 26, Rng 20
30F Larchwood Summer Homes 9
30F " " 10
30F T-6DA in Govt Lot 2 7 26 20

This form to be prepared by driller, and three copies to be filed by the owner with the County Clerk and Recorder in the county in which the well is located, tissue copy to be retained by driller.

Please answer all questions. If not applicable, so state, otherwise the form will be returned.

32
Driller's License Number

William S. Calvin
Driller's Signature.

029 26N 20W 07 BDC FLATHEAD

C-33
ow

File No.

T. 26 N R. 20 W 7

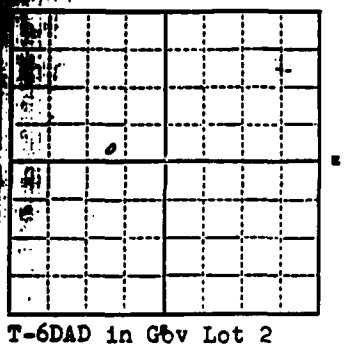
County Flathead

STATE OF MONTANA
ADMINISTRATOR OF GROUNDWATER CODE
OFFICE OF STATE ENGINEER

Declaration of Vested Groundwater Rights

(Under Chapter 237, Montana Session Laws, 1961)

1. Bruce H Walker, of Somers,
(Name of Appropriator) (Address) (Town)
County of Flathead State of Montana
have appropriated groundwater according to the Montana laws in effect prior to January 1, 1962, as follows:



T-6DAD in Gov Lot 2

¼ Sec. 7 T. 26 R20

Indicate point of appropriation and place of use, if possible. Each small square represents 10 acres.

2. The beneficial use on which the claim is based Household

3. Date or approximate date of earliest beneficial use; and how continuous the use has been June 7, 1958

4. The amount of groundwater claimed (in miner's inches or gallons per minute) 900 Gal per hour

5. If used for irrigation, give the acreage and description of the lands to which water has been applied and name of the owner thereof
no irrigation
Owner Bruce H Walker

6. The means of withdrawing such water from the ground and the location of each well or other means of withdrawal
Electric pump

7. The date of commencement and completion of the construction of the well, wells, or other works for withdrawal of groundwater
Started drilling Mar. 3, 1968 finished June 7, 1958

8. The depth of water table The well is 192 feet deep, water rised 36 feet from bottom

9. So far as it may be available, the type, size and depth of each well or the general specifications of any other works for the withdrawal of groundwater Drilled, cased with 7 inch pipe casing to 78 feet, solid rock, (no casing from 79 feet to bottom 192 feet)

10. The estimated amount of groundwater withdrawn each year None since June 1960

11. The log of formations encountered in the drilling of each well if available Boulders, clay and cement gravel to 79 feet, solid rock to 192 feet.

12. Such other information of a similar nature as may be useful in carrying out the policy of this act, including reference to book and page of any county record Drillers registration NO. 165

Signature of Owner Bruce H. Walker

Date Dec 29 1968

Three copies to be filed by the owner with the County Clerk and Recorder of the county in which the well is located.

Please answer all questions. If not applicable, so state, otherwise the form will be returned.

Original to the County Clerk and Recorder; duplicate to the State Engineer; Triplicate to the Montana Bureau of Mines and Geology and Quadruplicate for the Appropriator.

029 26N 20W 07 BDDD FLATHEAD

C-34
GW 2

File No. [illegible]

T 26 N R 20 W 7 (28)

County Flathead

STATE OF MONTANA
ADMINISTRATOR OF GROUNDWATER CODE
OFFICE OF STATE ENGINEER

Notice of Completion of Groundwater Appropriation by Means of Well

(Under Chapter 237, Montana Session Laws, 1961)

Owner Fred H. Spencer Address Lakeside

Driller Homer McCarty Address 945-8th E. Kalispell, Mont.

Date of Notice of Appropriation of Groundwater .....

Date well started Sept 22/64 Date Completed Sept 25/64

Type of well Drilled (dug, driven, bored or drilled) Equipment Used 24 W Bucyrus Erie (Churn, drill, rotary or other)

Water Use: Domestic ☐ Municipal ☐ Other ☐ Irrigation ☐
Industrial ☐ Drainage ☐ Stock ☐

Elev. above sea level 2950

1ft Top soil

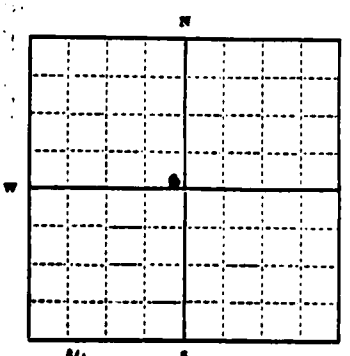
30ft boulders cobbles & gravel

75ft red clay gravel

85ft little seepage water Clay & gravel

☜ Indicate on the diagram the character and thickness of the different strata met with in drilling, such as soil, clay, shale, gravel, rock or sand, etc. Show depth at which water is encountered, thickness and character of water-bearing strata and height to which water rises in the well.

Size of Drilled Hole	Size and Weight of Casing	From (Feet)	To (Feet)	PERFORATIONS Kind Size	From (Feet)	To (Feet)
7" OD	23#		101ft			



SE¼ NW¼ Sec. 7 T 26 N R 20 W

Indicate location of well and place of use, if possible. Each small square represents 10 acres.

105 ft water bearing sand

Show exact depth of bottom.

Static Water Level for non-flowing Well ..... 45 feet.

Shut-in Pressure for Flowing Well .....

Pumping Water Level ..... feet at 10 gal. per minute.

Discharge in gal. per min. of flowing well .....

How Tested Bailer Length of Test 4 hrs

Remarks: (Gravel packing, cementing, packers, type of shutoff, location of place of use of groundwater if not at well, and any other similar pertinent information, including number of acres irrigated, if used for irrigation) .....

18
Driller's License Number

Homer McCarty
Driller's Signature

This form to be prepared by driller, and three copies to be filed by the owner with the County Clerk and Recorder in the county in which the well is located.

Please answer all questions. If not applicable, so state, otherwise the form will be returned.

Original to the County Clerk and Recorder; duplicate to the State Engineer; Triplicate to the Montana Bureau of Mines and Geology and Quadruplicate for the Appropriator.

029 26N 20W 07 CBA FLATHEAD T26N R20W-7

C-35

2E

GW 2 Revised 1969
STATE PUBLISHING COMPANY

County Flathead

STATE OF MONTANA
ADMINISTRATOR OF GROUNDWATER CODE
MONTANA WATER RESOURCES BOARD

NOTICE OF COMPLETION OF GROUNDWATER APPROPRIATION BY MEANS OF WELL

Developed after January 1, 1962

(Under Chapter 237 Montana Session Laws, 1961, as amended)

This form to be prepared by driller, and three copies to be filed by the owner with the County Clerk and Recorder in the county in which the well is located, last copy to be retained by driller.

Please answer all questions. If not applicable, so state, otherwise the form may be returned.

Owner James K. DeWitt

Address Lakeside, Montana 59922

Date well started 10/9/72

completed 10/12/72

For Administrator's Use
File
GW 1

Type of well Drilled
(Dug, driven, bored or drilled)

Equipment used Air Rotary
(Churn drill, rotary or other)

Water Use: Domestic ☒ Municipal ☐ Stock ☒ Irrigation ☐

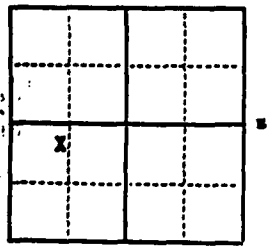
Industrial ☐ Drainage ☐ Other ☐* Garden/Lawn ☒

*Describe

USE: If used for irrigation, industrial, drainage or other. Explain, state number of acres and location or other data (i.e. Lot, Block and Addition).

ESTIMATED ANNUAL WITHDRAWAL 36,527,000 gallons

Size of Drilled Hole	Size and Weight of Casing	From (Feet)	To (Feet)	PERFORATIONS Kind Size	From (Feet)	To (Feet)
8"	8 5/8"OD x ¼" Wall	+1	58'	N O N E		



NW ¼ SW ¼ Sec. 7
T. 26 N R. 20 ☒ E ☐ W

Static water level 149 ft.*
Pumping water level 205 ft.*
at 40 gallons per minute,
measured 90 minutes after pumping began.
*Measured from ground level.
Well developed by air surge
for 2 hours.
Power Diesel Pump 150 HP
Remarks: (Gravel packing, cementing, packers, type of shutoff) All water entering well through cracks & seams in the rock below 329 feet. Walls in this area can be depended upon (CONT.).

INDICATE LOCATION OF WELL AND PLACE OF USE, IF POSSIBLE. EACH SMALL SQUARE REPRESENTS 40 ACRES.

Driller's Signature

Driller's Address LIBERTY DRILLING CO.

KALISPELL, MONTANA 59901 LICENSE NO. 52

DRILLER'S LOG

Indicate the character, color, thickness of strata such as soil, clay, sand, gravel, shale, sandstone, etc. Show depth at which water is found and height to which water rises in well.

Top of Ground Approx. Elev. above sea level 2975

From (Feet)	To (Feet)	
0	49	Gravel embedded in tan si
49	57	Tan silty sand & some gra
57	68	Hard gray rock
68	84	Gray & yellow rock in thi alternate layers.
84	159	Gray rock
159	161	Gray & yellow rock in thi alternate layers
161	209	gray rock
209	236	Gray & brown rock in thin alternate layers.
236	245	Gray & yellow rock in thi alternate layers.
245	261	Gray rock
261	268	Gray & yellow rock
268	284	Gray rock
284	290	Gray & yellow rock
290	329	Gray rock
329	352	Yellow & blue rock in thi alternate layers. Water
352	367	Gray & brown rock. Water.

367' Show exact depth of bottom

to produce clear sand free water year after year as long as they are not overpumped, i.e., they should be pumped at rates not in excess of 50-60 percent of the tested capacity of the aquifer.

C-37

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FORM No. 603 New 7-73

File No. 1

STATE OF MONTANA
Department of Natural Resources and Conservation
029 26N 20W07 CCC
WELL LOG REPORT
FLATHEAD

WHITE — DEPARTMENT
PINK — BUREAU
CANARY — WELL OWNER
GOLDENROD — DRILLER

State law requires that this form be filed by the water well driller on any water well com pleted by him on and after July 1, 1973 within sixty (60) days after completion of the wel

1. WELL OWNER: Name William Joseph Fine Address Box 111, Lakeside, Mt. 59922

2. WELL LOCATION: County Flathead ; SW ¼ SW ¼ SW ¼, Sec. 7, Twp. 26 N-S, Rg. 20 E

3. PROPOSED USE: X Domestic ___ Stock ___ Municipal ___ Industrial ___ Lawn and Garden ___ Irrigation ___ Other (*if other, specify*)

4. METHOD DRILLED: ___ Cable ___ Bored ___ Forward Rotary ___ Reverse Rotary ___ Jetted X Other (*if other, specify*) Air Rotary

5. WELL CONSTRUCTION:
Diameter of hole 8 inches. Depth 267 ft.
Casing: X Steel X Plastic ___ Concrete ___ Threaded X Welded ___ Other (*if other, specify*)

Pipe Weight:	Dia.:	From:	To:
22.3 lb/ft	8 5/8 inches	+1½ feet	173' feet
pvc lb/ft	6 5/8 inches	168' feet	267 feet
___ lb/ft.	___ inches	___ feet	___ feet

Was perforated pipe used? X Yes ___ No
Length of pipe perforated 30 feet
Was casing left open end? X Yes ___ No
Was a well screen installed? ___ Yes X No
Material ___ Dia. ___ inches (*stainless steel, bronze, etc.*)
Perforation type: X slots ___ holes
Size ¼" x 6" set from 231 feet to 261 feet
Size ___ set from ___ feet to ___ feet
Size ___ set from ___ feet to ___ feet
Was a packer or seal used? ___ Yes X No
If so, what material ___
Well type: ___ Straight screen ___ Graveled
Was the well grouted? X Yes ___ No
To what depth? 173 feet
Material used in grouting Cement Grout
Well head completion: Pitless adapter ___ 12" above grade X Other ___
(*If other, specify*) ___
Was the well disinfected? X Yes ___ No

6. WATER LEVEL:
Static water level 28 ft. below land surface
If flowing: closed-in pressure ___ psi
GPM flow ___ through ___ inch pipe
Controlled by: ___ Valve ___ Reducers ___ Other, *specify* ___

7. WELL TEST DATA: ___ Pump ___ Bailer X Other (*If other, specify*) Air Lift Pump
Pumping level below land surface:
147 ft. after 5 hrs. pumping 20 gpm
___ ft. after ___ hrs. pumping ___ gpm

8. WELL LOG:

Depth (ft.) From	To	Formation
0	20	Gravel & cobblestones in brow silty clay.
20	21	Boulder.
21	39	Gravel & cobblestones in brow silty clay.
39	59	Gray clay.
59	80	Multi-colored gravel in brown clay.
80	81	Red clay.
81	171	Multi-colored gravel in brown clay.
171	178	Broken gray rock.
178	200	Solid gray rock.
200	230	Gray & brown rock in alternate layers.
230	234	Soft brown rock.
234	260	Gray & brown rock in alternate layers. Water bel 247 feet.
260	267	Gray rock.

(*Use separate sheet if necessary*)

9. DATE STARTED: 2-1-77

10. DATE COMPLETED: 2-8-77

11. WAS WELL PLUGGED OR ABANDONED? ___ Yes X
If so, how ___

12. DRILLER'S CERTIFICATION:
This well was drilled under my jurisdicti and this report is true to the best of my knowledge.

Liberty Drilling Company 52
Driller's or Firm Name *License No*
3850 Highway 93 South
Kalispell, Montana 59901
Address

[signature] 7/25/
Signed by *Date*
William F. Osborne

C-38

029 24N 20W 07 CDD FLATHEAD

T2CNR-20W-7

3C

GW 2 Revised 1969
STATE PUBLISHING COMPANY

County FLATHEAD

STATE OF MONTANA
ADMINISTRATOR OF GROUNDWATER CODE
MONTANA WATER RESOURCES BOARD

NOTICE OF COMPLETION OF GROUNDWATER APPROPRIATION BY MEANS OF WELL

Developed after January 1, 1962

(Under Chapter 237 Montana Session Laws, 1961, as amended)

This form to be prepared by driller, and three copies to be filed by the owner with the County Clerk and Recorder in the county in which the well is located, last copy to be retained by driller.

Please answer all questions. If not applicable, so state, otherwise the form may be returned.

Owner William H. Brass and Maxine E. Brass, h/w as T

Address Lakeside, Montana

P. O. Box 36

Date well started 7/9/57

completed 7/29/57

For Administrator's Use
File
GW 1

Type of well DRILLED (Dug, driven, bored or drilled)

Equipment used CHURN (CABLE) DRILL (Churn drill, rotary or other)

Water Use: Domestic ☒ Municipal ☐ Stock ☐ Irrigation ☐

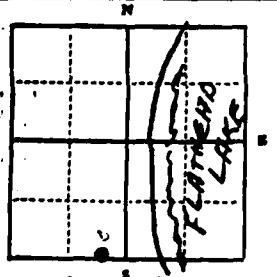
Industrial ☐ Drainage ☐ Other ☐* Garden/Lawn ☐

*Describe

USE: If used for irrigation, industrial, drainage or other. Explain, state number of acres and location or other data (i.e. Lot, Block and Addition).

ESTIMATED ANNUAL WITHDRAWAL 12,000,000 gallons

Size of Drilled Hole	Size and Weight of Casing	From (Feet)	To (Feet)	PERFORATIONS Kind Size	From (Feet)	To (Feet)
	8" 25lb	top	164			



Gov't. Lot 4 in SW¼ SW¼ Sec. 7
T. 26 N R. 20 EX W

Static water level 21 ft.*
Pumping water level 105 ft.*
at 350 gallons per minute,
measured minutes after pumping began.
*Measured from ground level.
Well developed by McClarty
for hours.
Power Elec. Pump 5 HP
Remarks: (Gravel packing, cementing, packers, type of shutoff)

INDICATE LOCATION OF WELL AND PLACE OF USE, IF POSSIBLE. EACH SMALL SQUARE REPRESENTS 40 ACRES.

Driller's Signature This is an amendment to an appropriation
Driller's Address Pumping figures are actual as in use, and operation.
LICENSE NO.

Amended to #9070. Filed Jan 3, 1962

JAN 2 1962

DRILLER'S LOG

Indicate the character, color, thickness of strata such as soil, clay, sand, gravel, shale, sandstone, etc. Show depth at which water is found and height to which water rises in well.

Top of Ground (Elev. above sea level)

From (Feet)	To (Feet)	
TOP	72	GRAVEL, BOULDERS AND CEMENT GRAVEL
72	140	SOLID ROCK, SHALE WITH BOULDERS
140	146	SOLID ROCK
146	151	GRAVEL AND CEMENT GRAVEL
151	177	WATER BEARING GRAVEL

175 Show exact depth of bottom

C-39

FORM No. 505 Rev 7-73

RECEIVED
OCT 23 1973
MONT. DEPT. of NATURAL RESOURCES & CONSERVATION

757160

STATE OF MONTANA
Department of Natural Resources and Conservation
029 26N 20W 07 CDC
WELL LOG REPORT

File No. Flathead 31

WHITE — D[illegible]
PINK — BU
CANARY — 005673
GOLDENROD — [illegible]

State law requires that this form be filed by the water well driller on any water well completed by him on and after July 1, 1973 within sixty (60) days after completion of the well.

1. WELL OWNER: Name Gary Sager Address Lakeside, MT 59922

2. WELL LOCATION: County Flathead; SW¼ SE¼ SW¼, Sec. 7, Twp. 26 N, Rg. 20 E W
Savage Lakeside Lot 13

3. PROPOSED USE: x Domestic ___ Stock ___ Municipal ___ Industrial ___ Lawn and Garden
___ Irrigation ___ Other (*if other, specify*) D 7/26/77

4. METHOD DRILLED: ___ Cable ___ Bored
x Forward Rotary ___ Reverse Rotary
___ Jetted ___ Other (*if other, specify*)

5. WELL CONSTRUCTION:
Diameter of hole 6 inches. Depth 200 ft.
Casing: x Steel ___ Plastic ___ Concrete
___ Threaded x Welded ___ Other (*if other, specify*)

Pipe Weight	Dia.:	From:	To:
17 lb/ft.	6-5/8 inches	0 feet	162 feet
14 lb/ft.	5-1/2 inches	150 feet	200 feet
___ lb/ft.	___ inches	___ feet	___ feet

Was perforated pipe used? x Yes ___ No
Length of pipe perforated 1 feet
Was casing left open end? x Yes ___ No
Was a well screen installed? ___ Yes x No
Material ___ Dia. ___ inches
(*stainless steel, bronze, etc.*)
Perforation type: x slots ___ holes
Size C.T. set from 198 feet to 199 feet
Size ___ set from ___ feet to ___ feet
Size ___ set from ___ feet to ___ feet
Was a packer or seal used? ___ Yes x No
If so, what material ___
Well type: ___ Straight screen ___ Graveled
Was the well grouted? x Yes ___ No
To what depth? 20 feet
Material used in grouting Drill Cuttings
Well head completion: Pitless adapter x
12" above grade x Other ___
(*If other, specify*) ___
Was the well disinfected? x Yes ___ No

6. WATER LEVEL:
Static water level 3 ft. below land surface
If flowing: closed-in pressure ___ psi
GPM flow ___ through ___ inch pipe
Controlled by: ___ Valve ___ Reducers
___ Other, *specify* ___

7. WELL TEST DATA: ___ Pump ___ Bailer x Other
(*If other, specify*) Air
Pumping level below land surface:
100 ft. after 4 hrs. pumping 36 gpm
___ ft. after ___ hrs. pumping ___ gpm

8. WELL LOG:

Depth (ft.) From	To	Formation
0	20	Boulders & Clay
20	40	Clay & Boulders
40	185	Clay & Gravel
185	200	Rock (Water)

(*Use separate sheet if necessary*)

9. DATE STARTED: October 7, 1973

10. DATE COMPLETED: October 15, 1973

11. WAS WELL PLUGGED OR ABANDONED? ___ Yes x No
If so, how ___

12. DRILLER'S CERTIFICATION:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge.

BILLMAYER'S, INC. 5
Driller's or Firm Name *License No.*

Bigfork, MT 59911
Address

J R Billmayer 10/15/73
Signed by *Date*

029 26N 20W 07 CDCC FLATHEAD

GW4

File No.....

TRIPLICATE

C-40

T. 26 N R. 20 W

County.....Flathead.....

STATE OF MONTANA
ADMINISTRATOR OF GROUNDWATER CODE
OFFICE OF STATE ENGINEER

RECEIVED
JAN 8 - 1962

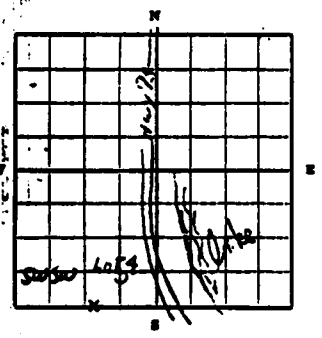
Declaration of Vested Groundwater Rights

(Under Chapter 237, Montana Session Laws, 1961)

1. F. Donald Hacker, of P. O. Box 1 Lakeside
(Name of Appropriator) (Address) (Town)

County of Flathead State of Montana

have appropriated groundwater according to the Montana laws in effect prior to January 1, 1962, as follows:



Lot 4 Sec. 7 T26N R 20 W

Indicate point of appropriation and place of use, if possible. Each small square represents 10 acres.

2. The beneficial use on which the claim is based Domestic and Irrigation

3. Date or approximate date of earliest beneficial use; and how continuous the use has been July 31, 1957; continuous.

4. The amount of groundwater claimed (in miner's inches or gallons per minute) 50 gallons per minute

5. If used for irrigation, give the acreage and description of the lands to which water has been applied and name of the owner thereof Sl Govt Lot 4 7-26-20
F. Donald Hacker

6. The means of withdrawing such water from the ground and the location of each well or other means of withdrawal Pump in Southwest corner of Lot 4.

7. The date of commencement and completion of the construction of the well, wells, or other works for withdrawal of groundwater Commenced on 7/9/1957 completed 7/27/1957.

8. The depth of water table 175 feet.

9. So far as it may be available, the type, size and depth of each well or the general specifications of any other works for the withdrawal of groundwater 8" casing, to depth of 134 feet, 25lb 8" casing, 5 horse pump- will produce 50 gallons per hour.

10. The estimated amount of groundwater withdrawn each year 100,000 gallons

11. The log of formations encountered in the drilling of each well if available Top to 72ft. gravel boulders and cement gravel; 72 ft to 140 ft solid rock, shale with boulders; 140 feet to 146 feet solid rock; 146 to 151 feet, gravel & cement gravel; 151 feet to 172, water bearing gravel.

12. Such other information of a similar nature as may be useful in carrying out the policy of this act, including reference to book and page of any county record

Signature of Owner F. Donald Hacker

Date January 3, 1962

Three copies to be filed by the owner with the County Clerk and Recorder of the county in which the well is located.

Please answer all questions. If not applicable, so state, otherwise the form will be returned.

Original to the County Clerk and Recorder; duplicate to the State Engineer; Triplicate to the School of Mines and Quadruplicate for the Appropriator.

PUMPING TEST WELL NO 2

APRIL 26, 1958

34 G.P.M. FIRST 30 MIN: DRAWDOWN 16 FT. WATER CLOUDY
34 TO 45 G.P.M. FOLLOWING HOUR DRAWDOWN 23.5 TO 30 FT. WATER CLEARING
45 G.P.M. FOLLOWING 11 1/2 HOURS DRAWDOWN 30 TO 35.5 FT. WATER CLEAR

APRIL 27, 1958

71 TO 64 G.P.M. FIRST HOUR: DRAWDOWN 35 TO 45.5 FT. WATER CLOUDY
97 TO 74 G.P.M. FOLLOWING 45 MIN. DRAWDOWN 71 TO 86 FT. WATER MUDDY TO CLEAR
72 TO 83 G.P.M. FOLLOWING 9 1/2 HOURS DRAWDOWN 86 TO 109.5 FT WATER CLEAR TO CLOUDY
69 TO 80 G.P.M. FOLLOWING 3 1/2 HOURS DRAWDOWN 59.5 TO 91 FT. WATER CLEAR

APRIL 28, 1958

76 TO 102 G.P.M. FIRST 3 HOURS DRAWDOWN 59 TO 164 FT. WATER CLOUDY
98 TO 95 G.P.M. FOLLOWING 9 HOURS DRAWDOWN 164 TO 162 FT. WATER CLEARING TO CLEAR

(after Coe, 1958)

APPENDIX D

Field Raw Data

Specific Conductance Data From Water
Samples Collected at Kalispell AFS, 10/6/86.

Sample Site	Sample No.	Specific Conductance Uncorrected (umhos)	Temperature at Time of Specific Conductance Reading (^{o}C)	Corrected Values for Specific Conductance (to $25^{o}C$)
GW-1	GP-86-1006	420	20.0	462
GW-2	GP-86-1007	443	20.0	488
S-1	GP-86-1008	281	20.0	309
S-2	GP-86-1009	291	20.0	484
S-3	GP-86-1010	294	20.0	318

APPENDIX E

Sampling and Analytical Procedures

Appendix E

Qualification of Data

The following reproductions within this appendix are the best quality that can be obtained from the documents furnished to us.

APPENDIX E

Sampling and Analytical Procedures

1.0 CALIBRATION OF FIELD EQUIPMENT

The following analytical equipment will be necessary to use for the onsite remedial investigation:

pH Meter. For in-field analysis of water samples. Initial factory calibration is provided and periodic field calibration with standard buffer solution is required.

Electrical Conductivity Meter. For measurement during well sampling. Factory calibration of instrument and conductivity cell provided. Periodic field calibration with standard buffer solution is required.

Mercury Thermometer. For measurement of water temperatures during sampling. Calibration: factory calibrated once.

Other equipment that might become necessary during the field investigation will be calibrated according to the manufacturer's recommendations and/or generally accepted practice. Calibration procedures will be documented for the project file, and copies of the procedures will be available in the Field Team Manager's office.

2.0 PREVENTIVE MAINTENANCE OF FIELD EQUIPMENT

All equipment used by Battelle and its subcontractors for work in the remedial investigation will be maintained under a preventive maintenance program. The onsite team leader will prepare a maintenance schedule for equipment that will list the maintenance tasks for each piece of Battelle-owned or operated equipment. Maintenance will follow manufacturers' instructions and will be performed as indicated in the field log book applicable to the given piece of equipment:

- pH Meter
- Electrical conductivity meter
- Mercury Thermometer

Battelle will subcontract the following activity during the study:

- Chemical analyses of soil and water samples

Battelle has specified or will specify to subcontractor firms providing these services that any and all equipment used at the Malmstrom Air Force Base be maintained in a proper and safe working order. Any equipment or device determined not to be in such order by Battelle field personnel will be replaced, repaired, or corrected.

3.0 FIELD ANALYTICAL PROCEDURES AND DATA REPORTING

3.1 Chemical Data

3.1.1 Procedures for Field Measurement of pH

Field pH measurements for all water samples will be made in accordance with a selected procedure from Standard Methods for the Examination of Water and Wastewater (16th Edition); ASTM, Section 11, Water and Environmental Technology; Methods for Chemical Analysis of Water and Wastes (EPA Manual 600/4-79-020); or Handbook for Sampling and Sample Preservation of Water and Wastewater, EPA Document 600/4-82-029, as well as the tech-technical manual for the field pH meter. Field pH measurements will be made as soon as possible after the collection of the sample. Since pH is temperature dependent, the temperature of the sample at the time of the pH measurement will be recorded. The electrode will be cleaned after each sample. (See Section 6.0 on decontamination). The meter will be calibrated daily before use with a reference buffer solution.

3.1.2 Procedures for Field Measurement of Specific Electrical Conductivity

Field EC measurements for all water samples will be made in accordance with the references listed above for pH measurements and the technical manual for the EC meter. If the temperature of the sample is other than 25 degrees C, a temperature correction will be made and the result reported at 25 degrees C. The probe will be cleaned after each sample. (See Section 6.0). The instrument will be standardized with KCL solution daily before use.

3.2 Soil Boring Data

3.2.1 Procedures for Shallow Surface Soil Sampling

Specific steps to be followed in the collection of soil samples are outlined below:

1. Clear surface vegetation, rocks, leaves, and debris from the sample point.

2. Using a solid-stem hand auger or other necessary equipment, collect necessary volume of soil for sample analysis. Prepare and preserve samples.

3. Record depth of sample or sample interval in bound notebook.

4. Record time of sampling and observations of sample conditions.

3.3 Surface Water Sampling Data

3.3.1 Procedures for Surface Water Sampling

Samples will be collected using a pond sampler or by submersing the correct sample container. Sampling equipment will be thoroughly cleaned between samples (see Section 6.0) and rinsed with water from the sample location prior to sampling.

Specific steps to be followed in the collection of surface water samples are outlined below:

1. Check calibration of pH and specific conductance meters and temperature probe and record in bound notebook.

2. Collect samples of surface water beginning downstream and measure pH, specific conductance, and temperature; record in bound notebook.

3. Collect necessary volume of water for sample analysis. Prepare and preserve samples according to methods described in Section 7.2. Split sample and use the special procedures to exclude air or light from the sample, if required.

4. Record time of sampling and observations of sample conditions in bound notebook.

3.4 Surveying Data

3.4.1 Surveying Procedures

All sampling sites will be surveyed and located on aerial photographs or USGS quadrangle maps using a Chain and Brunton Compass. Locations will be surveyed to the nearest foot.

4.0 SAMPLING NUMBERING SYSTEM

4.1 Sample Identification

Sample identification will be accomplished in accordance with the instructions recommended by the Air Force covering the use of the AF Form 2752, as well as the instructions for the development of a specific identifier for the site location and sample type with an installation code, together with the instructions for the assignment of a base sample number to identify individual units in a sample.

The use of the sampling codes will require coordination of the Field Team Leader with base personnel to ensure that the installation code is correct and that the sample location is consistent with the identifiers used by the base.

In the use of the AF Form 2752, one form will be prepared for each sample, and a copy will be furnished with each sample. It will indicate the type of analysis to be performed. The information includes the sample preservation methods that will be used and a listing of environmental sampling methods. This listing will be of value to onsite personnel to indicate special container requirements for additional analyses that may be specified.

Onsite personnel will obtain assistance in defining any special sampling requirements from the Battelle Project Manager's office.

4.2 Additional Site Information

In applications where there is a need to define a sampling site in greater detail, such as a sample location from a surface impoundment, the location a measurement data will be indicated in the field logs. A brief indicator will be included in the comments section of the AF Form 2752. This information will include the sampling depths, if appropriate.

4.3 Identification of Sample Sites

Sample splitting procedures are given in Section 7.1. The split samples will be delivered to base personnel with appropriate packaging material as required by the contract. Since all groundwater samples will be split, the sample identifier will differentiate between the two portions by the addition of the parenthetical "B" following the sample identifier on the portion that Battelle retains.

4.4 Use of Control Samples

Blank samples, spiked samples, and duplicate samples represent an essential part of the Quality Assurance Program of Battelle and PEI Laboratories to provide estimates of the adequacy of sampling and laboratory procedures. Sample splitting is required by the Air Force to independently assess the laboratory results obtained by Battelle and PEI. In addition to the split samples analyzed by the Air Force, laboratory samples will also be split by PEI to assess the accuracy and precision of their laboratory procedures. Furthermore, blank samples, spiked samples, and duplicate samples will be furnished regularly to the laboratory for analysis. A minimum of 1 in 10 samples will be furnished on a random basis and they will be designated on the same basis as the normal samples so the laboratory personnel will not be aware of which samples are for quality control and/or quality assurance. The field notebook will indicate which samples are duplicates or blanks.

The split samples and duplicate samples are used as quality control samples to assess the accuracy and precision of laboratory methods. Analyses of these samples may indicate the need for corrective actions and/or the need for additional data. The blank or spiked samples are used to assure the precision of sampling results and can also indicate problems in sampling collection techniques. (See Section 7.0, Sample Handling and Packing.)

5.0 GROUNDWATER MONITORING AND SAMPLING

Two existing wells will be sampled in this project. One sample will be collected from each well and analyzed for the onsite and offsite parameters. Onsite parameters include pH, specific conductance, and temperature (see Section 3.0).

All measuring, purging, and sampling equipment will be decontaminated as described in Section 11.0 prior to data collection.

5.1 Groundwater Level Measurement

Groundwater level will be measured in each well prior to sampling (see Section 3.0 for procedural details).

5.2 Surveying of Wells

The locations of the existing wells will have been determined by previous investigations. No surveying is needed.

5.3 Sampling for Onsite Analysis

Before performing any sample analysis, whether onsite or offsite, the integrity of the samples must be assured by using proper collection procedures. The sample must be representative of the aquifer of concern.

Each well will be properly prepared prior to sample withdrawal. Stagnant water in the casing will be removed so that the sample can be taken from water that has recently entered the well from the aquifer.

This will be accomplished by removing three times the volume of water standing in the well. If a well is encountered which is easily pumped dry, the volume to be removed will be reduced and the well will be sampled upon recovery. Water evacuated from the well will be disposed at some distance from it so that there is no likelihood of immediate recharge by the stagnant water. If the water is determined to be hazardous it will be drummed and turned over the Malmstrom AFB for disposal (see Section 9.0).

Samples will be collected from the purged wells by pumping or bailing. The first water withdrawn after purging will be used to rinse the sample container, then water will be poured directly into the sample jars.

The sample jars will be glass and will be pre-labeled. The labels will conform to the specifications in Sections 12 and 13 and the QA Plan in the Presurvey Report and the chain-of- custody requirements described therein will be followed.

Onsite analyses will include testing for pH, specific conductance, and temperature (see Section 6.0 for procedures).

5.4 Sampling for Offsite Analysis

Purging, water level measurements, and onsite analyses will be performed prior to collecting samples for offsite analyses (see Sections 5.1, 5.2, and 5.3). Water samples will be collected and split in accordance with procedures outlined in Section 7.0. The sample containers and preservation methods required are as follows:

Parameter	Container	Preservative
Halogenated Volatile Organics	2-40 ml septum Vial, glass	4°C
Aromatic Volatile Organics	2-40 ml septum vial, glass	4°C
Non-halogenated Volatile Organics	2-40 ml septum vial, glass	4°C
Extractable Priority Pollutants	1-1,000 ml, glass	4°C
Petroleum Hydrocarbons	1-5,000 ml, glass	4°C
Total Dissolved Solids	1-500 ml, glass	4°C
Priority Pollutant Metals (13)	1-1,000 ml, glass	Filter in field, 4°C; H_2SO_4 to pH < 2
Lead	1-1,000 ml, glass	Filter in field, 4°C; H_2SO_4 to pH < 2
Common Anions	1-500 ml, glass	4°C

All samples will be handled, packed, and shipped in accordance with procedures outlined in Sections 7.0 and 8.0.

6.0 DECONTAMINATION PROCEDURES

Decontamination consists of physically removing contaminants and/or changing their chemical nature to innocuous substances. The extent of the decontamination procedures is dependent on a number of factors, the most important being the type of contaminants involved: the more harmful the contaminant, the more extensive and thorough the decontamination must be.

All equipment will be cleaned prior to and after each use on this project. Decontamination will consist of combinations of steam cleaning and/or detergent (trisodium phosphate) wash, drinking-quality water rinse, methanol rinse, and distilled water rinse.

6.1 Soil Sampling

Tools to be used for soil sampling include: split-spoon sampler, scoops, sample-cutting knives, and compositing buckets. Decontamination will include wiping off visible particulate matter, washing with a laboratory-grade detergent in clean water and solvent (methanol) rinsing, and final rinsing with distilled water.

When necessary, the OVA will be decontaminated prior to continuing work, but not less than once per day. Decontamination of the injection port, column, and detector will consist of a purge of the equipment with carrier gas accompanied by a marked temperature elevation of the heating zone. Syringes will be decontaminated by rinsing with methanol, water, and finally with methanol again.

6.2 Well Development and Pump Test

All equipment used for well purging will be decontaminated prior to and after use at each well. This includes all pumps and downhole equipment not

permanently installed. The decontamination procedures will be similar to those described for soil sampling Section 6.1.

6.3 Water Level Measurement

The water level indicator is a probe-and-cable assembly which will be employed to detect water levels in the wells. It will be decontaminated before use in each well. The probe and cable will be cleaned with a disposable, soap-impregnated cloth and rinsed with water, then methanol, then distilled water and wiped dry.

6.4 Water Sampling

Groundwater will be sampled from pumped drinking water wells. At least three well casing volumes will be evacuated prior to sampling.

Equipment used for sampling surface water will also be decontaminated prior to and between samples.

6.5 Personnel Decontamination

The personnel decontamination procedures to be used at Malmstrom AFB will be performed as needed at each drilling location or other sampling site prior to entering vehicles or leaving the study area. Battelle and each subcontractor will provide all protective clothing for its own personnel and the equipment necessary to comply with decontamination procedures specified in the Health and Safety Plan.

7.0 SAMPLE HANDLING AND PACKING

7.1 Split Sample Procedures

All samples are to be split. Battelle will analyze one split of each sample and provide the other split to the base point of contact (POC) on the same collection day along with packaging materials sufficient to package 10% of these samples for overnight shipment. Within 24 hours of sample collection, the base POC will return these samples to the contractor for subsequent overnight delivery to:

USAFOEHL/SA
Bldg. 140
Brooks AFB, Texas 78235-5501

The sample sent to the USAFOEHL/SA will be accompanied by the following information:

- Purpose of sample (analyte)*
- Installation name (base)*
- Sample number (on containers)*
- Source/location and depth of sample
- Contract Task Number and Title of Project
- Method of collection (bailer, suction pump, air-lift pump, etc.)
- Volumes removed before sample taken
- Special conditions (use of surrogate standard, special nonstandard preservatives, etc.)
- Preservatives used*
- Date and time of sampling*
- Sampler's name*

(*This data will be labeled on each sample container.)

For every 10 field samples collected, Battelle will take one additional sample (a field duplicate) for quality control purposes. Table 2-4 provides a 10% allowance for these additional analyses. All quality control data will be included in the draft and final reports. Duplicates will be indistinguishable from other analytical samples so that personnel performing the analyses will not be able to determine which samples are duplicates.

For every 20 field water samples collected, Battelle will prepare and submit for analysis one field blank for all parameters analyzed in water. A minimum additional analyses are included in Table 2-4.

This information will be forwarded with each sample by properly completing an AF 2752. In addition, copies of field logs documenting sample collection will accompany the samples.

Chain-of-custody records for all samples, field blanks, and quality control samples will be maintained.

7.1.1 Groundwater Sampling and Splitting Procedures

All water samples collected will be analyzed onsite for pH, temperature, and specific conductance.

All wells will be purged prior to sampling to ensure that fresh formation water is collected. Purging will proceed until at least three well volumes of water have been displaced or until pH, temperature, and specific conductance stabilize. If water flow to the well is too low or recharge too slow to meet above conditions, the number of volumes purged will be documented and the well will be sampled in the most practical manner to get a representative sample.

Samples may be obtained by bailing or pumping. If a bailer is used and samples are to be tested for volatile organic compounds (VOA), the VOA vials will be filled from the bailer to a positive meniscus and capped. For other

parameters, one-half of the water in the bailer will be poured into one container and the other half into the other container. Additional bails will be obtained and split in similar manner until a sufficient volume of sample is obtained.

If the sample is obtained by pumping, a container large enough to accommodate the total volume of all samples will first be rinsed with water from the well being sampled and then filled with sample water. The VOA vials will be filled and the sample remaining in the large container will be split using the above procedures.

All sampling equipment will be decontaminated prior to use, between samples, and between sampling locations to avoid cross contamination (see Section 6.0).

7.1.2 Soil Sampling and Splitting Procedures

Split spoons or other sampling tubes will be decontaminated between samples (see Section 6.0). The contents of each split spoon will be carved from the center of the spoon and placed in the sample bottles. If the recovery of the spoon is sufficient, a portion will be placed in VOA vials, and the rest in a wide-mouth sample bottle. All bottles will be labeled for future identification and placed on ice.

7.2 Sample Containers

Glass jars for soil samples will be provided by the laboratory contractor.

7.3 Sample Handling and Decontamination

The collected sample and its container represents one of the major avenues of personnel and environmental exposure. Precautions will be taken to ensure that all the samples removed from the site are within the sample container and that no residue remains on the outside of the container.

The procedure for collecting soil and sediment samples will be as follows:

- Identify and document sample collection point or points, depth increment of samples collected, and sampling devices used (see Section 8.0, Sample Custody and Documentation).

- Complete log book entries, sample tags, and field record sheets with the sample identification point, date, time and names or initials of all persons handling the sample in the field.

- Clean the outer surface of sample jars containing soil samples with paper towels and clean water.

- Place sample tags on sample containers.

- Seal sample containers.

- Remove sample container to packaging are.

The procedures for collecting water samples are generally the same as for soil and sediment, except that the water is discharged directly from the bailer or pump to the large sample container(s), and appropriate preservatives are added to the containers prior to capping.

7.4 Procedures for Packing Low-Concentration (Environmental) Samples

Most (if not all) samples collected during this investigation are expected to contain low concentrations (less than 10 ppm) of organic and inorganic chemical compounds and will, therefore, be considered environmental samples. Procedures for packing low-concentration soil and water samples for shipment will be as follows:

- Determine maximum weight allowed per package from the shipper (140 pounds for Federal Express shipment).

- Secure sample bottle lids or plastic caps on brass tubes with strapping tape or evidence tape.

- Mark volume level on bottles with grease pencil.

- Place about three inches of inert cushioning material, such as vermiculite or zonolite, in bottom of cooler.

- Labels/Sample Tags: numbered sample tags will be used on all samples. The organic/inorganic traffic report number labels will appear on the bottles to be sent to the analytical laboratories. Cover the labels with clear plastic tape.

- Place containers in cooler in such a way that they do not touch.

- Put VOA vials in Ziploc plastic bags and place them in the center of the cooler.

- Pack bottles, especially VOA vials, in inert cushioning material.

- Fill cooler with inert cushioning material and blue ice if sample refrigeration is required.

- Put paperwork (chain-of-custody and traffic report copies) in plastic bags and tape with masking tape to inside lid of cooler.

- Tape cooler drain shut.

- After acceptance by Federal Express or other shipper, wrap cooler completely with strapping tape at two locations. Secure lid by taping and do not cover any labels.

- Place lab address on top of cooler.

- Put "THIS SIDE UP" labels on all four sides and "FRAGILE" labels on at least two sides.

- Affix numbered custody seals on front-right and back-left of cooler. Cover seals with wide, clear tape.

7.5 Procedures for Packing Medium-Concentration Samples

If medium-concentration samples (10 ppm - 15 percent) are collected (as indicated by in-field OVA screening), they will probably fall within the Flammable Liquids or ORM-A hazard class per DOT shipping regulations. The following packing and labeling procedures will be followed:

- Secure sample jar lids or plastic caps on brass tubes with strapping tape or evidence tape.

- Position jars and tags in Ziploc plastic bag so that the tag may be read.

- Place about 1/2 inch of cushioning material (such as vermiculate or zonolite) in the bottom of a metal can (such as a paint can).

- Place jar in can and fill remaining volume of can with cushioning material.

- Close the can using three clips to secure the lid.

- Write traffic number on can lid. Indicate "THIS SIDE UP" by drawing an arrow and place the correct DOT hazard class label on the can. Do not overlap labels.

- Place about one inch of packing material in bottom of cooler.

- Place cans or brass tubes in cooler and fill remaining volume of cooler with packing material.

- Put paperwork in plastic bags and tape with masking tape to inside lid of cooler.

- Tape cooler drain shut.

- After acceptance by Federal Express or other shipper, tape cooler completely around with strapping tape at two locations. Secure lid by taping and do not cover <u>any</u> labels.

- Place lab address on top of cooler.

- Put "THIS SIDE UP" labels on all four sides and DOT hazard class label on at least two sides.

  Note: Write DOT hazard class on wide tape and place on side of cooler if this is not marked on the margin of your DOT label.

- "Danger-Peligro" (Cargo Aircraft Only) labels should be placed on at least two sides of the cooler.

- Affix numbered custody seals on front-right and back-left of cooler. Cover seals with wide, clear tape.

8.0 SAMPLE CUSTODY AND DOCUMENTATION

8.1 Sample Identification Documents

The Field Team Leader will retain a copy of all Sample Identification Documentation (AF 2752). A weekly cumulative listing of the sampling will be furnished to the laboratory performing the analysis of samples, and to Battelle's Project Management office. This document will be used in tracking the sample results. The accumulative listing of field sampling will indicate the purpose of each sample.

8.2 Field Log Books

Field log books will be dedicated to specific operations and/or to specific sites where long-term tasks are being performed. The log books will allow the entry of any operational data that the personnel responsible for data collection desire to note in the record of events.

Field log books will indicate on the initial page the specific purpose to which they are dedicated. They will also indicate general information on location and Standard Operating Procedures that are applicable to the purpose indicated.

The individual entries in the log book will cover a finite time period no greater than one operating shift. Each entry will be completed by a line being drawn across the page at the entry completion; a signature, date and the time will be noted at the end of the entry.

Individual entries will begin with an indication of the time and dates of the entry and the data, which may have any format, but may generally provide the following information that is of interest in data retrieval:

- Operation description: i.e., type of sampling and testing, witnessing, packaging, drilling, monitoring equipment maintenance, etc.

- Personnel involved

- Special safety requirements

- Special equipment involved (note if within calibration)

- Weather conditions

- Field work sequential log; i.e., sampling location sample identification, test results, times of performance of testing or sampling, sample preparation, sample packaging or delivery, disposal tasks or any unusual occurrences, including breakdowns, special instructions, or any accident or incident information.

Field log books will be maintained for all soil boring operations and any monitoring well drilling and development operations. The field logs will be the primary repository for the geological data developed in these operations. The log books will be used to note soil classification data, indications of soil discoloration, organic vapor test data, sample makeup data, driller's log reference, any indications of drilling anomalies, water table indicators, and refer once to appropriate logging information developed for each drilling site.

A field log book will be maintained for each geophysical test site to provide a reference to all testing and sampling performed at each site, together with appropriate test results. The log will describe the test operation, equipment, personnel, special equipment, safety equipment, SOPs, and weather conditions, and will indicate test results or a reference to them.

A field log book will be maintained for each set of monitoring or sampling tasks not covered by the above. This will include a groundwater monitoring field log and a sediment or surface water sampling log. These logs will indicate date and time and the sample location, type, and other data.

A field log book will be maintained for very specialized pieces of field equipment, such as a four-wheel-drive vehicle or an organic vapor analyzer. These will be mainly to log use, calibration and maintenance. The entry will normally indicate the date, data, and the individual making the data entry.

8.3 Data Accumulation

Field data collected in other than the field data books will be furnished to the Battelle Project Management office where it will be used in analysis and evaluation, the preparation of reports, and the development of conclusions and recommendations. These data will become part of the central data file.

8.4 Chain-of-Custody Record

A Battelle chain-of-custody form will be filled out for, and included with, each cooler to be shipped. When properly completed, the form will provide all needed information on where and how the sample originated, why it was collected, and who had it at any time. The collector/shipper will retain a copy of the form.

8.5 Corrections to Documentations

Any corrections to field logs, notes, custody forms, labels, etc. will be accomplished by drawing a line through the incorrect notation, initialing the deletion, and then writing in the correction.

8.6 Traffic Reports and Sample labels

The traffic reports used will be OEHL form AF 2752. Each label will have enough information to completely identify the source, date of collection, collector, and any preservatives used.

PEI ASSOCIATES, INC.
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PEI ASSOCIATES, INC. LABORATORY

QUALITY ASSURANCE PLAN

AMERICAN INDUSTRIAL HYGIENE ASSOCIATION
ACCREDITATION NO. 49

Approved by: _____ Corporate Quality Assurance Coordinator

_____ Division Director

_____ Division Quality Assurance Coordinator

Revised January 1982

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FIGURES

1.0 INTRODUCTION

Figure 1-1 presents the corporate quality assurance organization and illustrates the relationship of the Laboratory Group's quality assurance activities to the total corporate quality assurance effort. Mr. Charles Zimmer, Corporate Quality Assurance Coordinator, is trained in statistics and has over 20 years of experience in the environmental field.

The principal function of the PEDCo Environmental Laboratory is to provide data that are:

- representative
- accurate
- precise
- complete
- comparable
- defensible
- on time

The management of PEDCo Environmental is committed to these objectives and has a policy of producing data of documented high quality.

Quality assurance is the sum of all those activities in which the laboratory is engaged that will ensure the validity of the information generated.

Quality assurance is not restricted to the development and retention of quality control (QC) charts for precision and accuracy, but rather includes all laboratory activities that affect the results produced. These activities include, but are not restricted to, the choice of methods, education of personnel, handling of specimens, and reporting of results.

The purpose of this manual is to outline the quality assurance activities of the PEDCo Environmental Laboratory.

LIST OF INDIVIDUALS RECEIVNG THE
LABORATORY QUALITY ASSURANCE PLAN

Charles E. Zimmer
Lawrence A. Elfers
Eugene W. Koesters
Thomas J. Wagner
Craig H. Caldwell
Harry W. Jess
Ida J. Bennett
Dwight R. Hayes

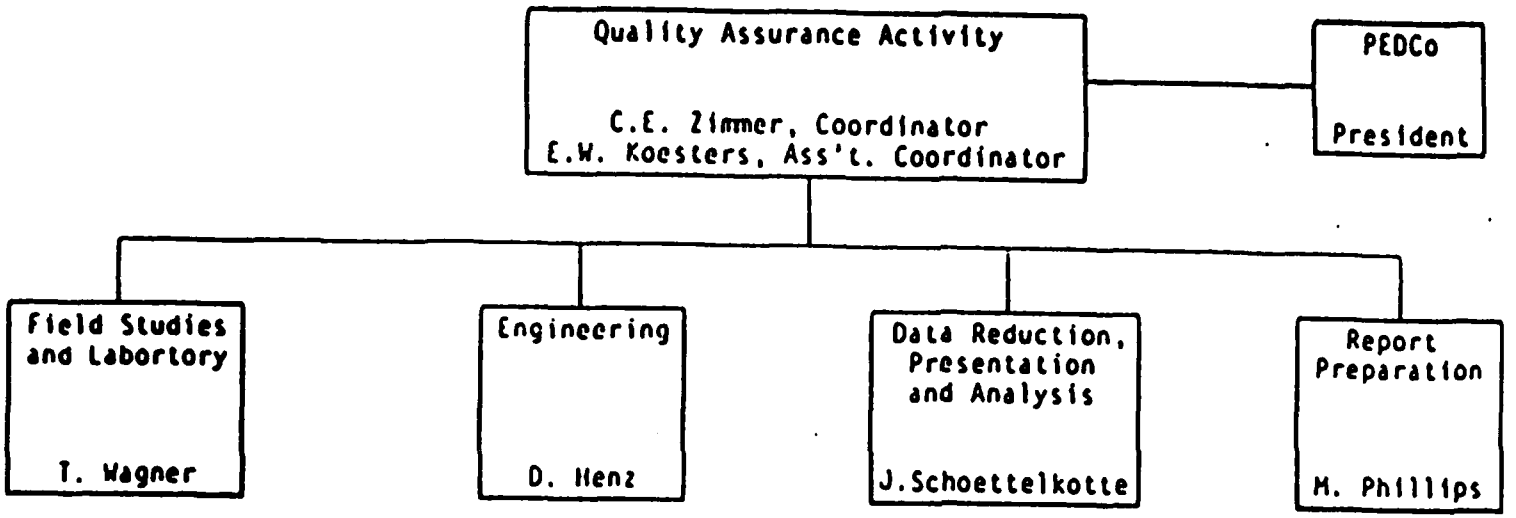


Figure 1-1. Organization of corporate quality assurance.

2.0 LABORATORY ORGANIZATION AND RESPONSIBILITIES

The organization of the PEDCo Environmental Laboratory is designed to provide an efficient flow of administrative, technical, quality assurance, and advisory activities throughout its operation.

The organizational chart is presented as Figure 2-1, and the responsibilities of the staff are outlined below.

2.1 DIRECTOR

The responsibilities of the Director are as follows:

- Set objectives for the Field Studies/Laboratory Division.
- Plan the Division's course and policies.
- Organize the personnel, facilities, equipment, and materials into a coherent organization that can fulfill the Division's plans.
- Integrate the various parts of the organization.
- Measure the success in achieving the objectives.
- Resolve problems.

2.2 ASSOCIATE DIRECTOR

The responsibilities of the Associate Director are as follows:

- Coordinate the activities of the Field Studies/Laboratory Division.
- Primary administrative contact with regulatory and accreditation agencies.
- Assist the Director in the implementation and supervision of administrative operations.
- Provide liaison with clients.

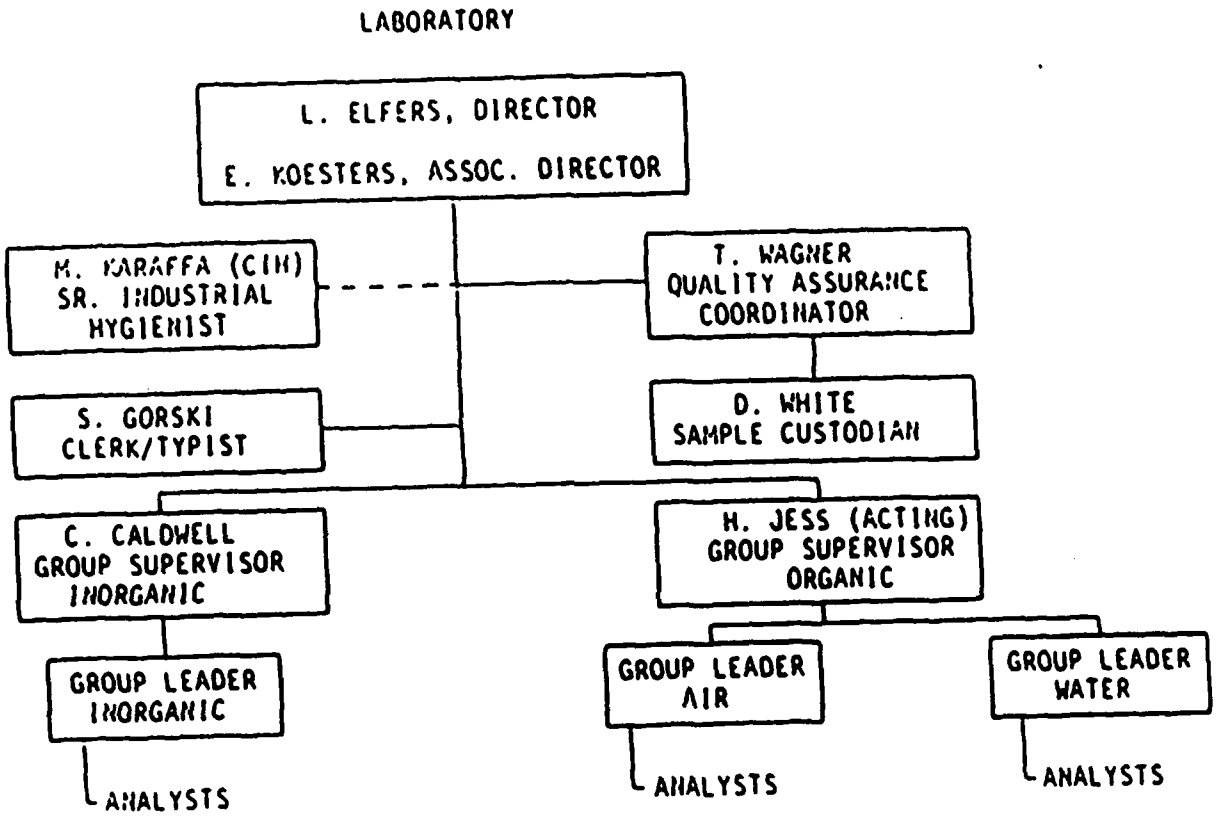


Figure 2-1. Organizational chart.

2.3 QUALITY ASSURANCE COORDINATOR

The responsibilities of the Quality Assurance Coordinator are as follows:

- Develop, coordinate, and evaluate the quality assurance program.
- Conduct routine checks on quality assurance items (Figure 2-2).
- Review performance evaluation results.
- Evaluate methods and procedures.
- Act as technical advisor to Group Supervisors.
- Issue, prepare, and evaluate audit samples.
- Develop quality assurance plans for special projects.

2.4 SENIOR INDUSTRIAL HYGIENIST (CIH)

The responsibilities of the Senior Industrial Hygienist are as follows:

- Interpret AIHA accreditation requirements and establish appropriate company policy.
- Advise Group Supervisors on all industrial hygiene activities of the laboratory.
- Assist the Quality Assurance Coordinator in the design of the entire Laboratory Quality Assurance Plan.

2.5 GROUP SUPERVISOR

The responsibilities of the Group Supervisors are as follows:

- Set objectives for the laboratory.
- Plan the laboratory's course and policy.
- Organize the laboratory personnel and facilities.
- Evaluate the success of the laboratory.
- Serve as project director.

QUALITY ASSURANCE CHECKLIST

ITEM	FREQUENCY	DATE
SAMPLE LOG	MONTHLY	
ANALYSIS REQUISITION BOOK	MONTHLY	
PROCUREMENT LOG	MONTHLY	
DATA FILES	MONTHLY	
Q.C. CHARTS	MONTHLY	
REAGENTS:		
A) NEW ITEMS DATED	MONTHLY	
B) OUTDATED ITEMS REMOVED	MONTHLY	
MAINTENANCE & CALIBRATION RECORDS		
A) AA SPECTROPHOTOMETERS	MONTHLY	
B) BALANCES	MONTHLY	
C) HYDROTHERMOGRAPH	MONTHLY	
D) BOMB CALORIMETER	MONTHLY	
E) SPECTROPHOTOMETERS	MONTHLY	
F) GC, GC/MS	MONTHLY	
METHODS MANUALS	YEARLY	
Q.A. MANUAL UPDATE	YEARLY	
TRAINING RECORDS	YEARLY	
GENERAL PROCEDURES	RANDOM	
CLEANLINESS	RANDOM	
SAFETY	RANDOM	
PERFORMANCE EVALUATION RESULTS (PAT, WP, SO_2, NO_x, DGM, COAL, METHOD 3)	AS RECEIVED	

Figure 2-2. Quality assurance checklist.

2.6 GROUP LEADERS

The responsibilities of the Group Leaders are as follows:

- Determine the technical methods to be used.
- Direct the day-to-day work.
- Handle personnel matters.
- Anticipate problems.
- Troubleshoot.
- Review reports for technical accuracy.
- Manage projects as assigned.
- Train the analysts.

2.7 SAMPLE CUSTODIAN/QUALITY CONTROL CLERK

The responsibilities of the Sample Custodian/Quality Control Clerk are as follows:

- Receive and log samples entering the laboratory.
- Maintain custody records.
- Proper storage of samples.
- Document custody changes in the laboratory.
- Receive and log reagents entering the laboratory (Figure 2-3).
- Maintain Quality Control Charts.
- Alert Quality Assurance Coordinator to any unusual trends on Quality Control Charts.

2.8 ANALYSTS

The responsibilities of the Analysts are as follows:

- Perform sampling and analyses according to approved PEDCo methods.

PEDCo ENVIRONMENTAL LABORATORY

Reagent Procurement Record

Item Description	Qty.	P.O. No.	Date		Lot No.	Vendor	Expiration Date	Comments
			Ord.	Rec.				

Figure 2-3. Example of reagent procurement record.

- Alert the Group Leader to any analytical problems and document the problems on the data sheet.
- Perform routine maintenance and calibration of instruments.
- Prepare reagents.

2.9 LABORATORY CLERK

The responsibilities of the Laboratory Clerk are as follows:

- Maintain records.
- Maintain the Project Status Board.
- Perform general clerical duties.

3.0 METHODS

The PEDCo Environmental Laboratory normally uses published methods, e.g., Federal Register methods for Environmental Protection Agency (EPA) Compliance analyses, NIOSH publications for industrial hygiene samples, and various other regularly accepted analytical references such as those of the ASTM. If a different method, or a change to an existing method is needed, the alteration is documented in the PEDCo Laboratory Method Series Manual. Each procedure accepted for use in the PEDCo Environmental Laboratory is entered in the manual along with the following legend:

PEDCo ENVIRONMENTAL METHOD CONTROL

Parameter _____ Method _____
Use approved by _____ Date _____
Termination approved by _____ Date _____

The most often used methods are reviewed and changed as necessary. These accepted methods have been collected in two identical sets: one as the master laboratory control document, the other as the working copy in the laboratory. As new individual methods attain more frequent use, they are reviewed, changed as necessary, and included as PEDCo approved methods. All PEDCo approved methods are reviewed at least annually and reapproved for use. The front page of each approved method tracks the dates at which changes to the method have been introduced and dates on which the method has been reviewed.

The methods which PEDCo Environmental, Inc. routinely uses for analysis are selected from these publications:

1. Methods for Chemical Analysis of Water and Wastes. U.S. EPA, Cincinnati, Ohio, 1979, Publication No. EPA-600/4-79-020.

2. Test Methods for Evaluating Solid Waste, Physical/Chemical Methods. U.S. EPA SW-846, 1980.

3. Quality Assurance Handbook for Air Pollution Measurement Systems, Volumes I, II, III. EPA-600/9-76-005, EPA-600/4-77-027a, and EPA-600/4-77-027b.

4. Guidelines Establishing Test Procedures for the Analysis of Pollutants. Federal Register, December 3, 1979, Vol. 44, No. 233, Part 3, pp. 69464-69575.

5. NIOSH Manual of Analytical Methods. U.S. Department of Health, Education and Welfare; Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, Cincinnati, Ohio. Second Edition. Vols. 1, 2, 3; April 1977. Vol. 4, August 1978. Vol. 5, August 1979. Vol. 6, August 1980.

6. Annual Book of ASTM Standards, Part 26, Gaseous Fuels; Coal and Coke; Atmospheric Analysis. American Society for Testing and Materials. Philadelphia, Pennsylvania, 1980.

7. Annual Book of ASTM Standards, Part 31, Water. American Society for Testing and Materials. Philadelphia, Pennsylvania, 1979.

8. Methods of Air Sampling and Analysis. 2nd ed., APHA Intersociety Committee, 1977.

9. Standard Methods for the Examination of Water and Wastewater. 15th ed., 1980, American Public Health Assn., Washington, D.C. 20005.

10. Handbook for Analytical Quality Control in Water and Wastewater Laboratories. EPA-600/4-79-019, 1979.

4.0 CHAIN OF CUSTODY

This section contains custody procedures used in the laboratory. Custody procedures used during sampling are contained in the quality assurance plans for the field groups and the complete procedure is compiled in a separate document.

4.1 SAMPLE RECEIVING

Every sample entering the lab for analysis is assigned a unique alphanumeric identity on the Sample Receipt and Record Sheet (Log). In the sample log-in book, the number is correlated with the client's identification and with the number of the analysis requisition form. A copy of the sample receipt and record sheet is shown in Figure 4-1.

The analysis requisition is a triplicate form that lists the client, project number, type and number of samples submitted, and analyses required. It also assigns analysts to specific tasks and shows the number of hours estimated for those tasks.

The white (top) sheet of the requisition form is placed in the requisition binder; the pink sheet is placed with the samples and later with the raw data. The yellow sheet is given to the person requesting the analyses. In some cases, the yellow copy may accompany some of the samples if a batch includes both inorganic and organic analyses. A copy of the sample analysis requisition and record sheet is shown as Figure 4-2.

The samples remain in the locked sample storage room until removed for analysis. This transfer is documented on a Sample Control Record (Figure 4-3) which is maintained by the sample custodian. The Sample Control Record documents all custody changes which occur in the laboratory and each procedure performed on the sample.

4.2 SAMPLE ANALYSES

Prior to the analyst receiving the sample from the sample custodian, a laboratory data sheet is prepared by the analyst.

PEDCO ENVIRONMENTAL LABORATORY

SAMPLE RECEIPT AND RECORD SHEET

Sample Number	Requisition Number	Client Name	Client's Sample Identification & Type	Project Number	Date Received	Container Number	Date Reported	Month Billed	Date Discarded

Revised 1/19/81

Figure 4-1. Example of Sample Receipt and Record Sheet.

PEDCo ENVIRONMENTAL LABORATORY

SAMPLE ANALYSIS REQUISITION AND RECORD SHEET No. 1252

Client: _____ Date: _____

Project no.: _____ Requested by: _____

Date results needed: _____

Type and number of samples: _____

Analyses Required	Ref. Method

Special Instructions: _____

Retain samples until: _____ Budget: _____ Cost: _____

RESOURCES

Personnel	Man-hours Est.	Man-hours Act.	Date done	Activity

Figure 4-2. Example of Sample Analysis Requisition and Record Sheet.

SAMPLE CONTROL RECORD

LABORATORY SAMPLE NO.	REMOVED BY	DATE & TIME REMOVED	REASON	DATE & TIME RETURNED

Figure 4-3. Example of Sample Control Record.

The laboratory data sheet (Figure 4-4) includes the following information:

- Sample numbers
- Date sample received by the analyst
- Analysis and method number
- Portion required for analysis
- Signature of analyst
- Signature of chemist checking calculations

Release of samples requires annotation of the Sample Control Record and verification of information and sample container condition. If the sample is to be transferred between two persons (i.e., two analysts), the transfer must take place through the sample custodian. In other words, the sample must be returned to the sample custodian and it is then reissued.

After obtaining the sample from the laboratory sample custodian, the analyst verifies the data and makes appropriate annotation of the records. If a question arises, it is first discussed with the sample custodian. If this does not resolve the problem, it is brought to the attention of the person submitting the sample for analysis. If the problem cannot be resolved, the sample is voided. The analyst keeps the samples in view or under limited-access locked storage. The analyst visually inspects the sample to determine that the physical condition is suitable for analysis. For any sample for which the condition is questionable or the method of collection was inappropriate, such as the presence of an inappropriate interference, the samples are not analyzed, and the data sheet is annotated. The analyst must maintain proper custodial procedures while analyzing a sample. Samples or intermediate solutions must be in the analyst's physical possession, in view, or in limited-access locked storage. The laboratories are locked so that only authorized personnel have access.

Analyses should be conducted in accordance with the procedures specified in the contract statement of work and referenced by number to the standard method in the laboratory procedures manual. Any deviation from these procedures must be annotated, and the analyst must be prepared to justify deviations under oath. All data are recorded on the data sheet. All measurements associated with the sample must be traceable in accordance with good quality assurance record-keeping procedures. Thus, associated calibrations must be recorded either directly on or attached to the data sheet or indirectly by reference to the standard solution number or instrument number.

All of the columns used on a data sheet must be labeled. Extra columns may be used for intermediate results of calculations if that will make for clearer understanding.

LABORATORY DATA

Client ______________________ Analysis ______________________

PN ____________ Date ____________ Method Number ______________________

Analyst ______________________ Checker ______________________

	SAMPLE NUMBERS						

Figure 4-4. Example of Laboratory Data Record.

The axes of all graphs are labeled as follows: micrograms and ppm are the x, or horizontal axes; O.D. and scale divisions are the y, or vertical axes. If the least squares fit is calculated, indicate this on the data sheet and record the slope, y-intercept, and the correlation coefficient.

Sample calculations should be included so a reviewer at a later date can ascertain immediately what was done.

4.3 SAMPLE RECORD KEEPING

The PEDCo alphanumeric identification is used on all data sheets, containers, beakers, etc. The client's sample number or name can be used for extra information, if desired. Exceptions are instances in which a set of numbered containers, such as Kjeldahl flasks or ashing crucibles, is used; here the container number must be matched on the data sheet with the PEDCo alphanumeric identification.

All raw data for analyses in progress are kept in project folders in a rack when not actually being used. When all the tests on a set of samples are completed, all of the raw data sheets with the pink requisition form attached are placed in the appropriate Group Leader's "In" basket.

Associated calibration curves and charts should be signed and dated; a system of positive identification and controlled storage is used. The exact method of analysis must be readily ascertainable. This is most easily done by making reference to the standard analytical procedure used when a method allows for a choice of procedures. If any portion of the sample remains after analysis is completed and if storage is required, the analyst must reseal the sample, and return it to the laboratory sample custodian. Appropriate annotations are made in the transfer records and the sample is stored in accordance with specified procedures.

The analyst's calculations are checked as required by internal audit. The person checking the calculations signs and dates the data sheet. The data sheet is returned to the file. All records must be in ink. Errors are corrected by drawing a straight line through the error and initialing. Completed records are maintained by the laboratory sample custodian. Use of records other than official records is prohibited.

When all analyses are completed, the report is prepared and delivered. A copy of the report, the raw data, and other documents are placed in the laboratory files which are kept in a locked, limited access area. The filing system utilizes a client

5.0 QUALITY CONTROL

Reliability in analytical determinations is maintained through strict adherence to quality control procedures. PEDCo's procedures are designed to control both the accuracy and precision of analytical results.

5.1 ACCURACY

When the analytical procedure is appropriate, a known reference standard is routinely analyzed to ensure the accuracy of results. This standard may be spiked into a separate aliquot of a sample or analyzed as a separate sample itself. The procedure is to run this standard with each lot of samples sent to the laboratory. In addition, if more than 10 individual analyses are made, additional standards will be analyzed at the rate of 1 standard per 10 analyses.

Control charts are prepared using an estimate of the method variability (i.e., standard deviation) obtained from the literature, or determined by repeated duplicate analyses run in the laboratory. A control chart for accuracy is shown as Figure 5-1. Each time the analyst runs a reference standard, the result is entered on the control chart. If the analytical procedure is in control, the estimate of the standard should lie within the $\pm 2\sigma$ control limits. The results should be random, and tend to fall above and below the true value for the standard. If an individual analysis of the reference standard falls outside the 2σ limits, the analyst is required to repeat the analysis of the standard. Should this second result also fall outside the 2σ limits, the group leader determines the cause of the discrepancy and makes the necessary corrections in procedure or technique.

The control chart also provides a means of detecting bias in results. Evidence of bias is obvious when the individual analyses of the reference standard tend to be all above (or below) the true value, or begin to show a definite trend in the amount of departure from the true value. When this situation occurs, the sample custodian notifies the group leader and the quality assurance coordinator even before the 2σ limit is exceeded. Again, routine sample analysis is not continued until the source of bias has been identified and corrected.

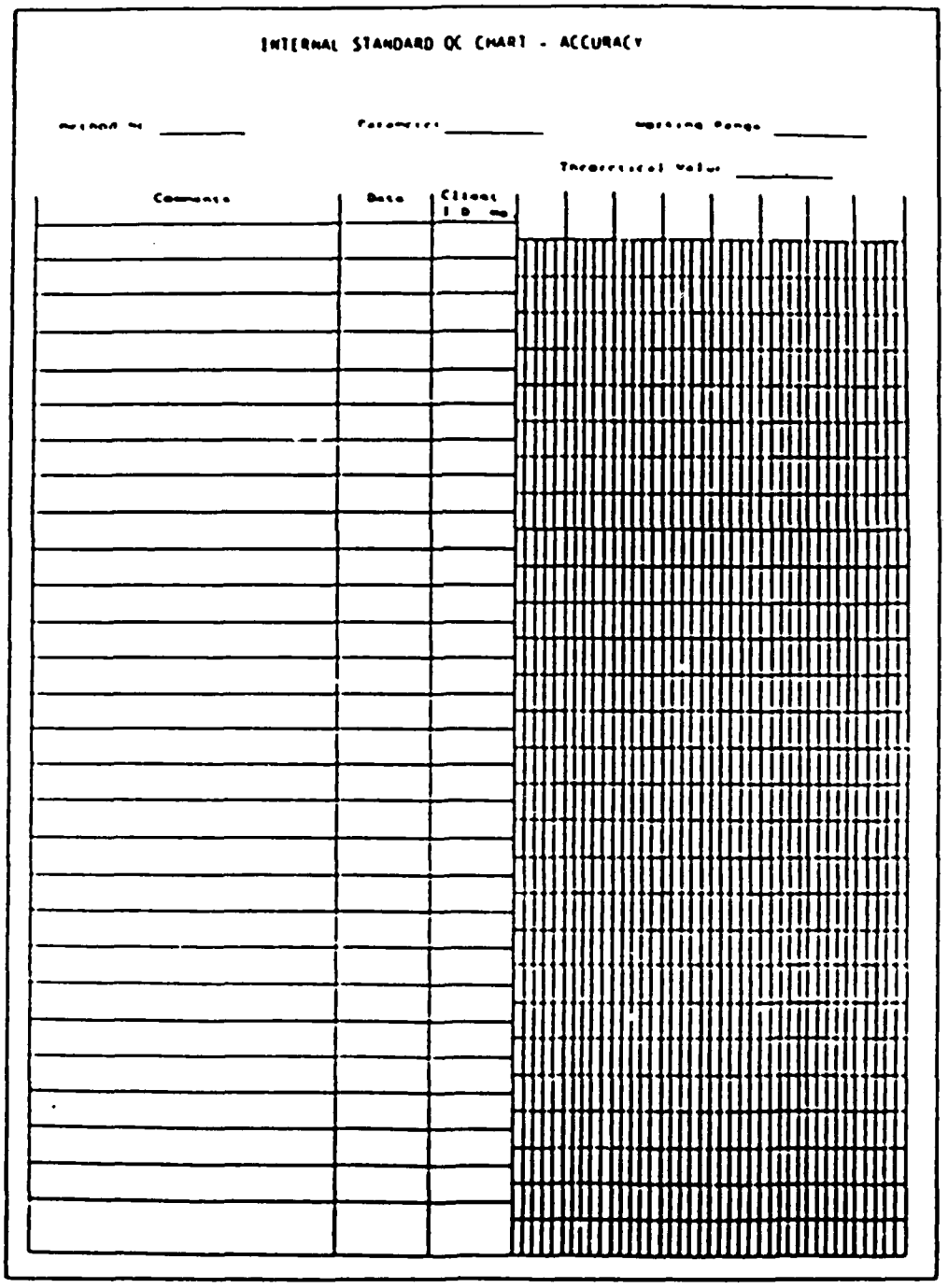


Figure 5-1. Accuracy control chart.

5.2 PRECISION

Replicate analyses are performed on at least 10% of the samples processed by the laboratory. A record of the precision of most analyses is kept by calculating and plotting the coefficient of variation (CV) of the pairs. The coefficient of variation is defined by the equation:

$$CV = \frac{s}{\bar{X}} = \frac{\left[\frac{(X_1 - X_2)^2}{2}\right]^{1/2}}{\left|\frac{(X_1 + X_2)}{2}\right|}$$

where X_1 and X_2 = values of the given parameter for the replicates,
s = the standard deviation of the replicates, and
$\bar{X}$ = the mean of the replicates

The mean CV for an appropriate number of sample pairs (usually 20) is determined, and the upper control limit (UCL) at the 99.5 percentile is calculated (UCL = 2.8 $\overline{CV}$ for duplicate values). The mean and control limit values are plotted on the chart shown as Figure 5-2.

The analysts report the results of replicate analyses each day to the sample custodian on forms provided. The sample custodian calculates and plots CV along with the date and client code.

Quality Control data sheets for the organic group are shown as Figures 5-3, 5-4, and 5-5, and for the inorganic group as Figures 5-6 and 5-7.

5.3 CORRECTIVE MEASURES

When the sample custodian records a value that is out of specification (for either accuracy or precision), the group leader is immediately notified. A series of steps are then taken to correct the deficiency:

- The data are examined for calculation error.
- The group leader discusses the test with the analyst to see if a procedural error was made.
- The reagents used are examined to see if any were out of date or used in error.
- The instrument, if one was used, is examined for defects or improper calibration.

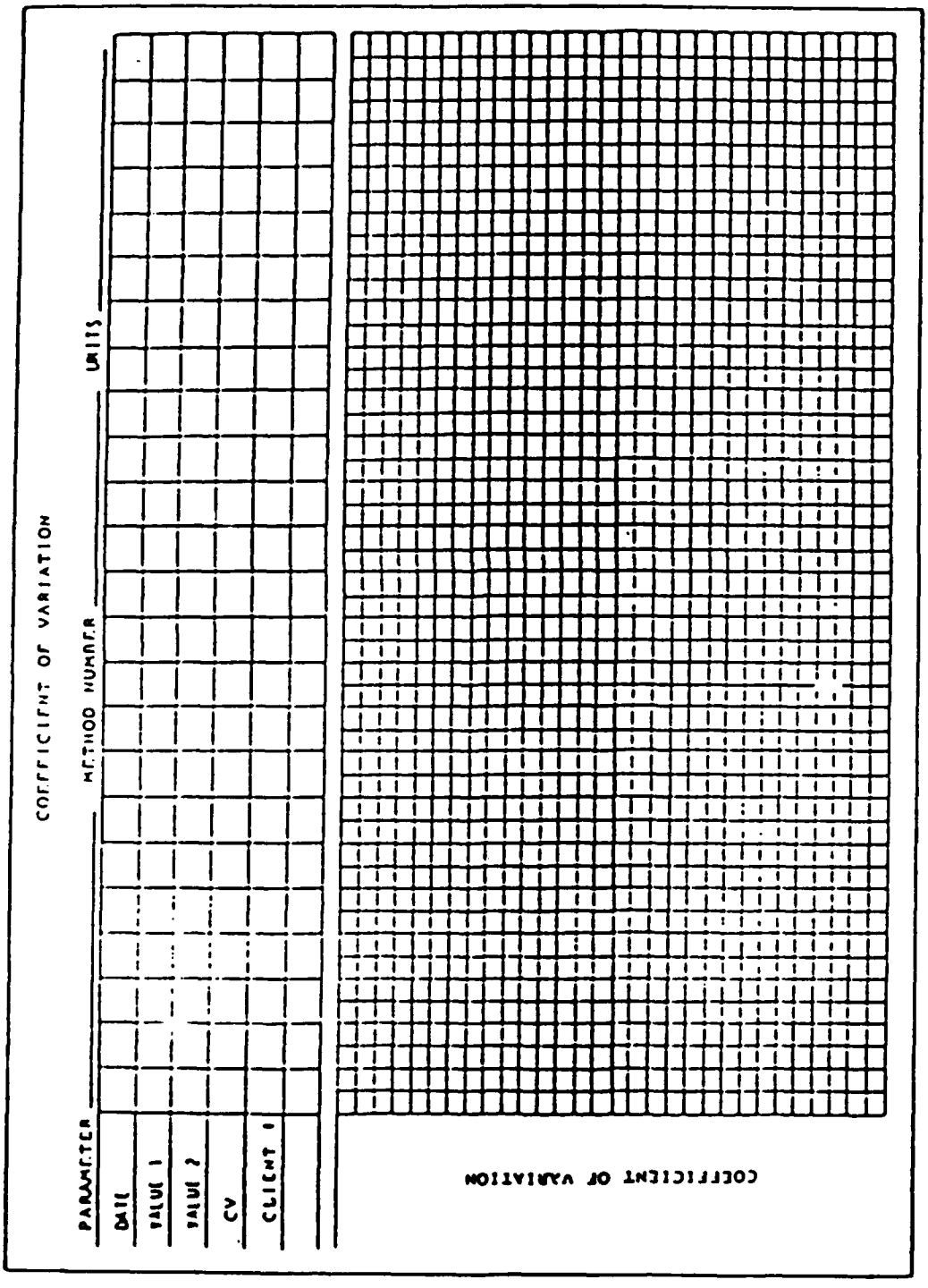


Figure 5-2. Precision control chart.

Sample No: _____

Lab Standard ID: _____

QUALITY CONTROL REPORT

A. MATRIX SPIKE ANALYSIS

COMPOUND (including surrogates)						CONCENTRATION (ug/l)			
P.	P.	P.	P.	P.	COMPOUND NAME	Sample Result (SR)	Spiked Sample Result (SSR)	Spike Added (SA)	% Recovery*

This QC Report also covers the following sample numbers:

*% Recovery = $\frac{(SSR - SR)}{(SA)} \times 100$

Figure 5-3. Quality control report - matrix spike.

Sample No: _____

Lab Standard ID: _____

QUALITY CONTROL REPORT

B. DUPLICATE ANALYSIS

COMPOUND (including surrogates)					CONCENTRATION (ug/l)		
P.	P.	#		COMPOUND NAME	Aliquot 1 (D_1)	Aliquot 2 (D_2)	Coefficient of variation

This QC Report also covers the following sample numbers:

Figure 5-4. Quality control report - duplicate analysis - organic.

Additional Sample Calculations:

Quality Control Calculations

PRECISION

Parameter	Sample No.	Values Obtained

ACCURACY

Date	Theor. Vol.	Exp. Vol.	% of Theor.

Figure 5-5. Quality control report - charcoal tubes.

STANDARD REFERENCE MATERIAL REPORTING FORM
(INTERNAL STANDARD FOR ACCURACY)

Method No. _____ Parameter _____

Working Range _____ Units _____

Client _____ PM _____ Date _____

Values determined _____

_____

_____

_____

Figure 5-6. Quality control report of accuracy - inorganic.

REPLICATE ANALYSIS REPORTING FORM

Method No. _____ Parameter _____

Working Range _____ Units _____

Client _____ PM _____ Date _____

Values determined	A	B	Difference
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____

Figure 5-7. Quality control report of precision - inorganic.

If the error is corrected by recalculation, no further steps are taken. If the error was due to one of the other causes, the test is rerun to obtain answers within specifications. Should the results again be out of specifications, the above procedures are followed in greater detail and the test rerun by another analyst and/or with freshly prepared reagents.

5.4 PERFORMANCE EVALUATION (Audits)

The PEDCo Environmental Laboratory participates in the Proficiency Analytical Testing Program administered by NIOSH; the Water Pollution Performance Evaluation Program administered by the U.S. EPA; and the U.S. EPA Stationary Source Quality Assurance Program for SO_2, NO_x, DGM, coal, and Method 3. The audit results are reviewed by the Division Directors and the Quality Assurance Coordinator and discussed with the Group Supervisors and the analysts.

The PEDCo Laboratory also has been approved by the U.S. EPA Environmental Monitoring and Support Laboratory in Las Vegas, Nevada for the analysis of priority pollutants from hazardous waste sites. PEDCo has participated successfully in various preaward performance surveys and ongoing performance audits under existing contracts.

5.5 DATA VALIDATION

All data generated by the laboratory is checked for technical accuracy by the Group Leaders. This involves verifying that the appropriate analytical method was used, the detection limit is appropriate, the proper number of significant figures are reported, and the data were calculated properly (This is done by repeating the calculations for at least one sample). The data is then given to the Data Clerk who redoes all hand calculations and verifies all data entries into computer programs. The data is then reviewed by the Quality Assurance Coordinator before the report is issued.

5.6 REPORTS

Analytical reports are typed by the Laboratory Clerk and checked by the Data Clerk before being signed by the appropriate supervisor. Major reports include summaries of all quality control data.

Twice weekly status reports of all laboratory projects (by Analysis Requisition number) are prepared and submitted to the Division Director. These reports include:

- date samples received
- date analysis started
- date report due
- percent completed
- appropriate remarks (problems and corrective actions)

These reports also include the status of all major instrumentation.

6.0 TRAINING

It is corporate policy that each year each professional employee is encouraged to attend one short course or its equivalent specific to the employee's professional responsibilities.

Each new employee undergoes an orientation and on-the-job training period before being assigned independent duties. When reproducible results are routinely obtained by the analyst, he or she is considered fully trained.

Additionally, institution of new techniques, modification of procedures, or the acquisition of new equipment is accompanied by appropriate in-house, or if necessary, extramural training.

Selected personnel are also trained in tasks different from their regular assignments.

7.0 INSTRUMENT MAINTENANCE AND CALIBRATION

PEDCo Environmental, Inc. maintains Preventive Maintenance and Service Contracts with the manufacturers of all major instruments in use in the laboratory (Finnigan Corporation, Hewlett-Packard Company, Perkin-Elmer Corporation). Maintenance logs are compiled for each major instrument.

7.1 INORGANIC SECTION

The following calibration procedures are followed:

- Analytical balances are checked with class S weights each day that they are used. If a trend in inaccuracy is found, and cannot be corrected by PEDCo personnel, professional service is obtained. The balances are serviced and checked by an NBS certified service agent each year.

- Atomic absorption spectrophotometers are calibrated for each metal analyzed and a record kept of instrument response. Should a lack of sensitivity or other malfunction be detected that cannot be corrected in-house, professional service is obtained.

- Ultraviolet/visible spectrophotometers are checked with standard color cuvettes each day they are used, and checked for mirror and grating alignment monthly. Service criteria are as described for the other instruments.

- The bomb calorimeter is calibrated monthly as recommended by the manufacturer.

7.2 ORGANIC SECTION

Gas chromatographs and the gas-chromatograph-mass spectrometers are calibrated when used, for sensitivity, accuracy and accurate mass assignment. If the required sensitivity cannot be obtained, prescribed maintenance procedures are initiated. If these do not enhance the instrument response to the level desired, professional service is obtained.

8.0 GLASSWARE CLEANING PROCEDURES

8.1 INORGANIC SECTION

Glassware is routinely cleaned with an alkaline detergent, rinsed with hot tap water, and oven dried. Before use, each item is rinsed with deionized water and/or the solution to be used. Glassware to be used for trace metal analyses is cleaned in either alcoholic sodium hydroxide or chromic acid, followed by a soak in 1:1 nitric acid and a rinse with deionized water (ASTM TYPE I).

8.2 ORGANIC SECTION

In the organic laboratory involved in the analysis of samples containing residues in the parts per billion range, the preparation of scrupulously clean glassware is mandatory. Particular care must be taken with glassware such as Kuderna-Danish flasks, evaporative concentrator tubes, or any other glassware coming in contact with an extract that will be evaporated to a lesser volume.

Basic cleaning steps are as follows:

- Remove surface residuals immediately after use.
- Hot soapy soak to loosen and flotate most of residue.
- Hot water rinse to flush away flotated residue.
- Soak with deep penetrant or oxidizing agent to destroy traces of organic residue.
- Hot water rinse to flush away materials loosened by deep penetrant soak.
- Rinse with distilled water to remove metallic deposits from the tap water.
- Rinse with high purity acetone followed by high purity methylene chloride.
- Bake in a muffle furnace at 400°C for 30 minutes.
- Flush the glassware just before using with the same solvent to be used in the analysis.

9.0 SAFETY PROCEDURES

9.1 LABORATORY CONDUCT

- Follow instructions exactly.
- Perform only authorized experiments.
- Protect eyes, face, hands and body.
- Practice good housekeeping.
- Learn basic first aid.
- Know where to get help quickly.
- Know location of first aid and fire fighting equipment.
- Report all accidents and unusual occurrences immediately.
- Be professional.

9.2 FIRE PREVENTION

- Store all flammable liquids in the fireproof cabinets.
- Whenever possible, and always when large quantities are involved, use flammable liquids in a fume hood. When it is necessary to use flammables on an open bench, be certain that there are no open flames nearby.
- Place waste flammable liquids in the appropriate safety cans for disposal.
- Dispose of solid and liquid oxidants, such as peroxides, perchlorates, and nitrates, by flushing down the sink with water. Keep these materials away from flammable items such as wood and paper.
- Be certain not to overload electrical circuits. Do not use equipment with worn or bare wiring.

- Be aware of the two types of fire extinguishers in the laboratories. The dry chemical (ABC) type is for use on paper, liquid, or electrical fires. The CO_2 (BC) type is for use on liquid or electrical fires.

- Know the location of the fire alarms on the hall wall near the northeast exit stairwell and in the elevator area.

9.3 PREVENTION OF POISONING

- Use toxic materials such as chlorine gas, cyanides, and bromine in a hood only. These are inhalation hazards, and some are toxic by skin absorption. Use gloves when handling bromine.

- Some compounds in use in the lab are slow-acting poisons when ingested or absorbed in small amounts. Among these are arsenic, mercury, lead, and hexavalent chromium compounds. Wear gloves when handling these compounds in high concentrations and wash hands thoroughly after use.

- Clean up all chemical spills, even of seemingly harmless materials. One spill may react with another. Neutralize concentrated acids with sodium carbonate (Na_2CO_3), and bases with boric acid (H_3BO_4) before cleaning up.

- Always use a rubber bulb to pipet.

- Exercise care in handling of all samples. Their contents are unknown.

- Do not eat, drink, or smoke in the lab work areas.

- If you have any questions about handling a particular compound or reaction, consult your supervisor, the wall chart, or the CRC Handbook of Laboratory Safety.

9.4 PERSONAL SAFETY

- Clean up all water spills on the floor.

- Use only equipment and tools suited to the job at hand.

- Dispose of broken glass only in the marked container.

- Do not wear loose clothing or open-top shoes. Wear a laboratory coat at all times and a rubber apron, goggles, or gloves when indicated.

9.5 SAFETY EQUIPMENT

- Know how to use the following items in the laboratory: fire extinguishers, fire blankets, safety showers, eye wash stations, first aid kits and the rescue air pack.

9.6 GENERAL

- Protective Clothing - Each employee will be provided a sufficient number of laboratory garments (i.e., lab coats, smocks, etc.) to be worn at all times while in the laboratory. Care of these garments by the laundry service company is the responsibility of the employee. Each employee should have one clean garment available at all times.

- Eye Protection - Safety glasses are required under Federal law and must be utilized. Custom-fit safety glasses or corrective lenses are furnished by PEDCo.

- Foot Protection - Conventional street-type footwear is sufficient. Sandals, canvas, or similar footwear should not be worn in the laboratory.

- Miscellaneous - Rubber, cloth, or leather gloves are available for hand protection and must be worn whenever the occasion warrants.

- Exits - Be conscious at all times of the nearest laboratory exit and nearest building exit.

INSTRUCTIONS FOR COMPLETING AF FORM 2752, ENVIRONMENTAL SAMPLING DATA

The purpose of this form is to record environmental and drinking water sampling information. The form will be used for submitting environmental and drinking water samples (except radiological samples) to the USAF Occupational and Environmental Health Laboratory (USAF OEHL). Use AF Form 2753 for radiological sampling data.

1. Identification Data. Plastic embossed cards for recording identification data may be used in lieu of the following handwritten entries:

a. Sampling Site Identifier. Enter code for Sampling Site Identifier (see page 3).

b. Base. Enter name of base where sample is collected.

c. Sampling Site Description. Enter name of sampling site.

2. Date Collection Began. Enter date sample collection began (e.g., if Jan 14, 1981, enter 81/01/14).

3. Time Collection Began. Enter time (24-hour clock) sample collection began.

4. Collection Method. Check whether sample was a grab sample or a composite sample. If a composite sample, enter number of hours from beginning to the completion of compositing.

5. Mail Reports To. Enter four-digit base code in small boxes (same code as first four digits of environmental identifier if same base). Enter mailing addresses where analysis results will be sent. Include unit designation, office symbol, base, state, and ZIP code.

6. Sample Collected By. Enter name (last name only), grade and AFSC of individual collecting sample.

7. Signature. Enter signature of individual collecting sample.

8. AUTOVON. Enter AUTOVON number of responsible individual who can answer questions from the laboratory concerning the sample.

9. Reasons for Submission. Enter code (in the box to the right of shaded "E") indicating reason for submitting sample.

10. Base Sample Number. Enter eight-digit coded base sample number for each sample. See pages 4-5.

11. OEHL PID. Leave blank.

12. Analysis Requested. Check the block to the left of the analyses desired. For parameters not listed, enter parameter name and number in the blank spaces provided under the appropriate preservation group. Continue in the Comments Section if required.

13. On-Site Analyses. Enter results of any on-site analyses. For parameters not listed, enter parameter name, number, value and unit in the blank spaces provided.

14. Preserve a one liter (one quart) sample as shown in page 7 for each group in which an analysis is requested.

15. Submit one copy of the completed form in a waterproof envelope with the sample to USAF OEHL/SA, Building 140, Brooks AFB TX 78235.

THE SAMPLING SITE IDENTIFIER

1. All environmental monitoring and drinking water sampling sites must be identified in a standardized manner. The sampling site identifier will be used for local identification purposes and will be the primary identifier for environmental data stored in a central Automatic Data Processing (ADP) repository.

2. The sampling site identifier is nine alphanumeric characters made up of the installation code, followed by the sampling site type code and the sampling location number.

a. Installation Code. The four-digit number now used for the film dosimetry program with a zero prefix (available from project monitor or base bioenvironmental engineer).

b. Sampling Site Type. A two-letter code to identify the source of the sample (see para 5 of this attachment for the complete list).

c. Sample Location Number. A three-digit number assigned locally.

3. The code formed when the three elements are combined is unique for a particular sampling point. If the sampling location is taken out of service, destroyed or no longer used, the code will not be reassigned to another sampling site nor used again.

4. The new code will look like this:

Installation Code	Sample Type	Sample Location
0 1 2 3	AB	4 5 6

5. Sample Type Codes:

Sampling Site Type	Code
Air	AO
Nonpotable water, source (effluent)	NS
Nonpotable water, process	NP
Nonpotable water, ambient	NA
Potable water, distribution system	PD
Potable water, ground water (untreated)	PG
Potable water, surface water (untreated)	PS
Potable water, other	PO
Solid	SO

CODED BASE SAMPLE NUMBER

This section contains accepted environmental sampling methods recommended by the USAF OEHL. The basis for any monitoring program rests upon information obtained from sampling. Improper sampling can negate even the most careful and accurate work performed by the remainder of the monitoring team. Therefore, the proper selection, collection, identification and shipment of environmental samples are paramount for a successful monitoring program. (General instructions for packaging and shipping samples are contained in Section V). Additional information can be obtained from:

USAF OEHL/ECA AUTOVON 240-2891 or (512) 536-2891
USAF OEHL/ECW AUTOVON 240-3305 or (512) 536-3305
USAF OEHL/ECE AUTOVON 240-3667 or (512) 536-3667

ASSIGNMENT OF BASE SAMPLE NUMBERS

Environmental samples that are collected at base level must be assigned a sample number, regardless of whether they are analyzed locally or at a central laboratory such as the USAF OEHL. This coded sample number will enable the analysis results to be ultimately stored in and retrieved from a central data repository. A sample number code consists of eight digits. The first two digits classify the sample as to the method and type of sample. The next two digits identify the calendar year that the sample was taken and the last four digits identify the locally assigned sample number, progressing in numerical sequence from sample number 0001 to sample number 9999. Sample number codes follow:

a. First 2 digits

(1) Digit #1 -

Sample Method	Code
Grab Sample	G
Composite Sample	C

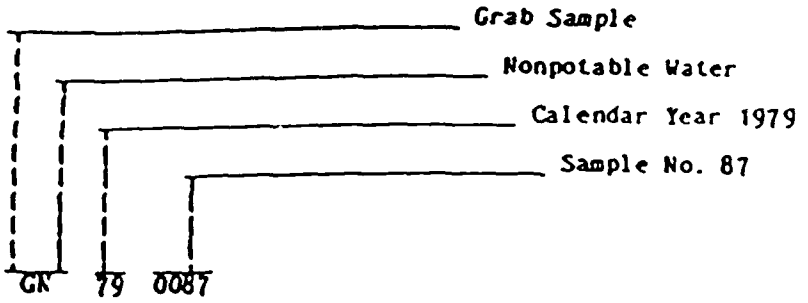
(2) Digit #2 -

Sample Type	Code
Nonpotable	N
Potable Water	P
Residue (Incinerator Ash)	D
Sludge (Wet or Dry)	L
Soil	S
Unclassified	C
Vegetation	V

b. Next 2 digits - Code for sample year using last two numbers of calendar year in which sample was taken. Example: Code for CY 1981 is 81.

c. Last 4 digits - Code for locally assigned, numerically sequenced sample number. Example: Code for thirteenth sample taken during a calendar year is 0013.

Completed Base Sample Number. To illustrate a completed code, consider an environmental water sample taken to characterize storm water runoff. The sample was a grab sample taken from a storm drain. Eighty-six other samples had already been taken at the base that year (CY 1979). The sample would be:



USAF OEHL WORK CENTER CODES

	Analysis of Industrial Hygiene Samples
1XX	Liquid Media or Eluent for Tube Analysis
2XX	Liquid Media or Eluent for Pesticide Type Analysis
3XX	Eluent or Solvent for Metals Analysis
4XX	Collection Media Colorimetric Analysis
5XX	Media for Gravimetric/Physical Observations
6XX	Media for Volumetric/Electrometric AN
7XX	Media for Liquid Chromatography
9XX	Special Modification
1XXX	Special Analysis (Bulk Industrial Products)
9XXX	Analysis of Biological Materials
1XXXX	Analysis of Water or Soil (Environmental) Samples
	10100-10199 A Preservation Group
	10300-10399 D Preservation Group (Cyanides)
	10400-10499 E Preservation Group (Phenols)
	10500-10599 F Preservation Group (Metals)
	10600-10699 G Preservation Group (Unpreserved)
	10600 J Preservation Group (Sulfides)
	10700-10799 H Preservation Group (Pesticides)
	10800-10899 I Preservation Group (Trace Organics)
2XXXX	Radioassay of Materials

PRESERVATION METHODS

NOTE: A preservative must be added immediately after collection unless the sample is to be analyzed for dissolved materials. For dissolved materials analysis, filter as soon as possible, and then add the preservative.

GROUP		DESCRIPTION
A	(A1XX)	Cool to 4°C; add sulfuric acid to pH <2; submit 1 liter in a polyethylene or glass container.
	(A2XX)	Same as Group A1XX except that a separate 1 liter individual sample must be submitted in a glass container.
D	(D1XX)	Cool to 4°C; add sodium hydroxide to pH >12; add sodium thiosulfate if residual chlorine exists in the sample. Submit 1 liter in a polyethylene or glass container.
E	(E1XX)	Cool to 4°C; add sulfuric acid to pH <2; submit 1 liter in a polyethylene or glass container.
F	(F1XX)	Add nitric acid to pH <2; submit 1 liter in a polyethylene or glass container.
	(F2XX)	This group is for boron. Do not add nitric acid to this group--no preservative is necessary. Do not, under any circumstances, submit sample in a glass container.
G	(G1XX)	Cool to 4°C; add no other preservative; submit 1 liter in a glass or polyethylene container.
	(G3XX)	This group is for asbestos. No other preservative is necessary.
H	(H1XX)	Cool to 4°C; add sodium thiosulfate if residual chlorine exists in sample; submit 1 liter in glass container with Teflon® lined cap.
	(H2XX)	These analytes degrade rapidly and it is generally not feasible to submit samples for this analyte. If it is necesary call USAF OEHL/SAN [AUTOVON 240-3626 or (512) 536-3626/Mr Nishioka].
J	(J1XX)	This sample is for sulfides. Cool to 4°C; add 2 ml of a 22% zinc acetate solution per liter of sample. Submit 1 liter in a glass or polyethylene container.
T	(T1XX)	Submit only in special containers obtained from USAF OEHL/SAN [AUTOVON 240-3626 or (512) 536-3626/Mr Rodriguez].
	(T4XX)	Cool to 4°C; add sodium thiosulfate if residual chlorine exists in sample; submit 1 liter in glass container with Teflon lined cap.

These instructions supersede all previously issued preservation instructions.

RECOMMENDED ENVIRONMENTAL SAMPLING METHODS

STORET #	NAME	PRESERVATIVE WORK CENTER	NOTES	REF
34205	ACENAPHTHENE	T4XX-10820	C	E610
34200	ACENAPHTHYLENE	T4XX-10820	C	E610
1001462AD	ACID EXTRACT. PRIORITY POLLUTANT	T4XX-10810	C	E625
00436	ACIDITY (MINERAL)	G1XX-10610	A	E305
70506	ACIDITY (TOTAL)	G1XX-10610	A	E305
34210	ACROLEIN	T4XX-10820	C	E603
34215	ACRYLONITRILE	T4XX-10820	C	E603
70312	AGGRESSIVE INDEX	G1XX-10000		
39330	ALDRIN	H1XX-10700	C	E608
00425	ALKALINITY (BICARBONATE)	G1XX-10610	A	A403
00430	ALKALINITY (CARBONATE)	G1XX-10610	A	A403
00420	ALKALINITY (HYDROXIDE)	G1XX-10610	A	A403
00415	ALKALINITY (PHENOLTHALEIN)	G1XX-10610	A	A403
00410	ALKALINITY (TOTAL)	G1XX-10610	A	A403
01106	ALUMINUM (DISSOLVED)	F1XX-10500	A	E202
01105	ALUMINUM (TOTAL)	F1XX-10500	A	E202
00610	AMMONIA (NITROGEN)	A1XX-10110	A	E350
34420	ANTHRACENE	T4XX-10820	C	E610
34556	DIBENZO(a,h)ANTHRACENE	T4XX-10820	C	E610
01095	ANTIMONY (DISSOLVED)	F1XX-10520	A	E204
01097	ANTIMONY (TOTAL)	F1XX-10510	A	E204
01000	ARSENIC (DISSOLVED)	F1XX-10520	A	E206

RECOMMENDED ENVIRONMENTAL SAMPLING METHODS

STORET #	NAME	PRESERVATIVE WORK CENTER	NOTES	REF.
01002	ARSENIC (TOTAL)	F1XX-10510	A	E206
34225	ASBESTOS	G3XX-10000	C	C
01005	BARIUM (DISSOLVED)	F1XX-10520	A	E208
01007	BARIUM (TOTAL)	F1XX-10510	A	E208
1001463BE	BASE/NEUTRAL EXTR. PRI. POLLUT.	T4XX-10820	C	E625
34030	BENZENE (OBTAIN SPECIAL CONTAINER FROM LAB)	T1XX-10850	F	E503
39120	BENZIDINE	T4XX-10820	C	E605
34526	BENZO(a)ANTHRACENE	T4XX-10820	C	E610
34230	BENZO(b)FLUORANTHENE	T4XX-10820	C	E610
34242	BENZO(k)FLUORANTHENE	T4XX-10820	C	E610
34247	BENZO(a)PYRENE	T4XX-10820	C	E610
34521	BENZO(ghi)PERYLENE	T4XX-10820	C	E610
01010	BERYLLIUM (DISSOLVED)	F1XX-10520	A	E210
01012	BERYLLIUM (TOTAL)	F1XX-10510	A	E210
39340	BHC ISOMERS	H1XX-10700	C	E608
39337	a-BHC	H1XX-10700	C	E608
39338	b-BHC	H1XX-10700	C	E608
34259	d-BHC	H1XX-10700	C	E608
00310	BOD (BIOCHEMICAL OXYGEN DEMAND)	G1XX-10000	AI	
01020	BORON (DISSOLVED)	F1XX-10500	B	A404B
01022	BORON (TOTAL)	F1XX-10500	B	A404B

RECOMMENDED ENVIRONMENTAL SAMPLING METHODS

STORET #	NAME	PRESERVATIVE WORK CENTER	NOTES	REF.
71870	BROMIDES	G1XX-10630	A	A405
32101	BROMODICHLOROMETHANE (OBTAIN SPECIAL CONTAINER FROM LAB)	T1XX-10860	D	E501
32104	BROMOFORM (OBTAIN SPECIAL CONTAINER FROM LAB)	T1XX-10860	D	E501
34413	BROMOMETHANE (OBTAIN SPECIAL CONTAINER FROM LAB)	T1XX-10860	D	E501
01025	CADMIUM (DISSOLVED)	F1XX-10520	A	E213
01027	CADMIUM (TOTAL)	F1XX-10510	A	E213
00915	CALCIUM (DISSOLVED)	F1XX-10520	A	E215
00916	CALCIUM (TOTAL)	F1XX-10510	A	E215
00405	CARBON DIOXIDE (CALCULATED)	G1XX-10610	A	A406
32102	CARBON TETRACHLORIDE (OBTAIN SPECIAL CONTAINER FROM LAB)	T1XX-10860	D	E601
00340	CHEMICAL OXYGEN DEMAND (COD)	A1XX-10130	A	A505A
39350	CHLORDANE	H1XX-10700	C	A509
00940	CHLORIDES	G1XX-10630	A	E325
50064	*CHLORINE (FREE AVAILABLE)	G1XX-10000	I	
50066	*CHLORINE (COMBINED AVAILABLE)	G1XX-10000	I	
50060	*CHLORINE (TOTAL RESIDUAL)	G1XX-10000	I	
34301	CHLOROBENZENE (OBTAIN SPECIAL CONTAINER FROM LAB)	T1XX-10850	F	E601
32106	CHLOROFORM (OBTAIN SPECIAL CONTAINER FROM LAB)	T1XX-10800	D	E601

RECOMMENDED ENVIRONMENTAL SAMPLING METHODS

STORET #	NAME	PRESERVATIVE WORK CENTER	NOTES	REF.
34311	CHLOROETHANE (OBTAIN SPECIAL CONTAINER FROM LAB)	T1XX-10860	D	E601
34273	BIS(2-CHLOROETHYL) ETHER	T4XX-10820	C	E611
34278	BIS(2-CHLOROETHOXY)METHANE	T4XX-10820	C	E611
34263	BIS(2-CHLOROISOPROPYL)ETHER	T4XX-10820	C	E611
34576	CHLOROETHYLVINYL ETHER (OBTAIN SPECIAL CONTAINER FROM LAB)	T1XX-10860	D	E602
34418	CHLOROMETHANE (OBTAIN SPECIAL CONTAINER FROM LAB)	T1XX-10860	D	E602
34518	2-CHLORONAPHTHALENE	T4XX-10820	C	E612
01030	CHROMIUM (DISSOLVED)	F1XX-10520	A	E218
01032	CHROMIUM (HEXAVALENT)	F1XX-10510	AX	A312B
01034	CHROMIUM (TOTAL)	F1XX-10510	A	E218
34320	CHRYSENE	T4XX-10820	C	E610
01035	COBALT (DISSOLVED)	F1XX-10500	A	E219
01037	COBALT (TOTAL)	F1XX-10500	A	E219
31501	*COLIFORM (TOTAL)	G1XX-10000	X	
00080	COLOR	G1XX-10620	A	E110
01040	COPPER (DISSOLVED)	F1XX-10520	A	E220
01042	COPPER (TOTAL)	F1XX-10510	A	E220
00720	CYANIDES (TOTAL)	D1XX-10300	A	A412D
00722	CYANIDES (AMENABLE TO CHLORINE)	D1XX-10300	A	A412D
39730	2,4-D	H1XX-10700	C	A509

RECOMMENDED ENVIRONMENTAL SAMPLING METHODS

STORET #	NAME	PRESERVATIVE WORK CENTER	NOTES	REF.
39310	4,4'-DDD	H1XX-10700	C	E608
39320	4,4'-DDE	H1XX-10700	C	E608
39300	4,4'-DDT	H1XX-10700	C	E608
39370	DDT ISOMERS	H1XX-10700	C	A509
39570	DIAZINON	H2XX-10700	C	A509
32105	DIBROMOCHLOROMETHANE (OBTAIN SPECIAL CONTAINER FROM LAB)	T1XX-10860	D	E501
34536	1,2-DICHLOROBENZENE (ORTHO) (OBTAIN SPECIAL CONTAINER FROM LAB)	T1XX-10850	F	E602
34566	1,3-DICHLOROBENZENE (META) (OBTAIN SPECIAL CONTAINER FROM LAB)	T1XX-10850	F	E602
34571	1,4-DICHLOROBENZENE (PARA) (OBTAIN SPECIAL CONTAINER FROM LAB)	T1XX-10850	F	E602
34631	3,3'-DICHLOROBENZIDENE	T4XX-10820	C	E605
34668	DICHLORODIFLUOROMETHANE (OBTAIN SPECIAL CONTAINER FROM LAB)	T1XX-10860	D	E601
34496	1,1-DICHLOROETHANE (OBTAIN SPECIAL CONTAINER FROM LAB)	T1XX-10860	D	E601
32103	1,2-DICHLOROETHANE (OBTAIN SPECIAL CONTAINER FROM LAB)	T1XX-10860	D	E601
34501	1,1-DICHLOROETHENE (OBTAIN SPECIAL CONTAINER FROM LAB)	T1XX-10860	D	E601
34546	1,2-DICHLOROETHYLENE (OBTAIN SPECIAL CONTAINER FROM LAB)	T1XX-10860	D	E601
34423	DICHLOROMETHANE (OBTAIN SPECIAL CONTAINER FROM LAB)	T1XX-10860	D	E601

RECOMMENDED ENVIRONMENTAL SAMPLING METHODS

STORET #	NAME	PRESERVATIVE WORK CENTER	NOTES	REF.
34451	1,2-DICHLOROPROPANE (OBTAIN SPECIAL CONTAINER FROM LAB)	T1XX-10860	D	E601
34704	CIS-1,3-DICHLOROPROPENE (OBTAIN SPECIAL CONTAINER FROM LAB)	T1XX-10860	D	E601
34699	TRANS-1,3-DICHLOROPROPENE (OBTAIN SPECIAL CONTAINER FROM LAB)	T1XX-10860	D	E601
39380	DIELDRIN	H1XX-10700	C	E608
34611	2,4-DINITROTOLUENE	T4XX-10820	C	E609
34626	2,6-DINITROTOLUENE	T4XX-10820	C	E609
00300	*DISSOLVED OXYGEN	G1XX-10000	CX	
34641	DURSBAN	H1XX-10700	C	E611
34361	ENDOSULFAN I	H1XX-10700	C	E608
34356	ENDOSULFAN II	H1XX-10700	C	E608
34351	ENDOSULFAN SULFATE	H1XX-10700	C	E608
39390	ENDRIN	H1XX-10700	C	E608
34366	ENDRIN ALDEHYDE	H1XX-10700	C	E608
34371	ETHYLBENZENE (OBTAIN SPECIAL CONTAINER FROM LAB)	T1XX-10850	F	E602
31613	*FECAL COLIFORM	G1XX-10000	I	
31673	*FECAL STREPTOCOCCI	G1XX-10000	I	
34376	FLUORANTHENE	T4XX-10820	C	E610
34381	FLUORENE	T4XX-10820	C	E610
00951	FLUORIDES	G1XX-10630	B	E340
38260	FOAMING AGENTS (SEE SURFACTANTS)	G1XX-10620	AX	E425

RECOMMENDED ENVIRONMENTAL SAMPLING METHODS

STORET #	NAME	PRESERVATIVE WORK CENTER	NOTES	REF.
00901	HARDNESS (CARBONATE)	G1XX-10600	A	A314A
00902	HARDNESS (NONCARBONATE)	G1XX-10600		
00900	HARDNESS (TOTAL)	F1XX-10510	A	A314A
39410	HEPTACHLOR	H1XX-10700	C	A509
39420	HEPTACHLOR EPOXIDE	H1XX-10700	C	E608
39700	HEXACHLOROBENZENE	T4XX-10820	C	E608
34391	HEXACHLOROBUTADIENE	T4XX-10820	C	E612
34386	HEXACHLOROCYCLOPENTADIENE	T4XX-10820	C	E612
34396	HEXACHLOROETHANE	T4XX-10820	C	E612
00400	*HYDROGEN ION (pH)	G1XX-10000	AX	E150
34403	INDENO(1,3-CD)PYRENE	T4XX-10820	C	E610
71865	IODIDES	G1XX-10630	AX	E345
01046	IRON (DISSOLVED)	F1XX-10520	A	E236
01045	IRON (TOTAL)	F1XX-10510	A	E236
34406	ISOPHORONE	T4XX-10820	C	E609
00625	KJELDAHL NITROGEN (TOTAL)	A1XX-10110	A	E351
70311	LANGLIER INDEX	G1XX-10000	A	A203
01049	LEAD (DISSOLVED)	F1XX-10520	A	E239
01051	LEAD (TOTAL)	F1XX-10510	A	E239
39782	LINDANE	H1XX-10700	C	E608
00925	MAGNESIUM (DISSOLVED)	F1XX-10520	A	E242
00927	MAGNESIUM (TOTAL)	F1XX-10510	A	E242

RECOMMENDED ENVIRONMENTAL SAMPLING METHODS

STORET #	NAME	PRESERVATIVE WORK CENTER	NOTES	REF.
01056	MANGANESE (DISSOLVED)	F1XX-10520	A	E243
01055	MANGANESE (TOTAL)	F1XX-10510	A	E243
1001465MT	MAXIMUM TRIHALOMETHANE POTENTIAL (OBTAIN SPECIAL CONTAINER FROM LAB)	T1XX-10830	E	E501
38260	MBAS (SEE SURFACTANTS)	G1XX-10620	AX	E425
71890	MERCURY (DISSOLVED)	F1XX-10520	A	E245
71900	MERCURY (TOTAL)	F1XX-10510	A	E245
39480	METHOXYCHLOR	P1XX-10700	C	E608
34423	METHYLENE CHLORIDE (OBTAIN SPECIAL CONTAINER FROM LAB)	T1XX-10600	D	E601
81595	METHYL ETHYL KETONE (OBTAIN SPECIAL CONTAINER FROM LAB)	T1XX-10850	D	E503
81596	METHYL ISOBUTYL KETONE (OBTAIN SPECIAL CONTAINER FROM LAB)	T1XX-10850	D	E503
01060	MOLYBDENUM (DISSOLVED)	F1XX-10500	A	E246
01062	MOLYBDENUM (TOTAL)	F1XX-10500	A	E246
34301	MONOCHLOROBENZENE (OBTAIN SPECIAL CONTAINER FROM LAB)	T1XX-10800	F	E602
34696	NAPHTHALENE	T1XX-10820	C	E610
01065	NICKEL (DISSOLVED)	F1XX-10520	A	E249
01067	NICKEL (TOTAL)	F1XX-10510	A	E249
00620	NITRATES (AS NITROGEN)	A1XX-10110	AI	E353
00630	NITRATES-NITRITES	A1XX-10100	AI	E353
00615	NITRITES (AS NITROGEN)	A1XX-10110	AI	E353

RECOMMENDED ENVIRONMENTAL SAMPLING METHODS

STORET #	NAME	PRESERVATIVE WORK CENTER	NOTES	REF.
34447	NITROBENZENE	T4XX-10820	C	E609
00625	NITROGEN (TOTAL KJELDAHL)	A1XX-10110	A	E351
34438	N-NITROSODIMETHYLAMINE	T4XX-10820	C	E607
34428	N-NITROSODI-N-PROPYLAMINE	T4XX-10820	C	E607
34433	N-NITROSODIPHENYLAMINE	T4XX-10820	C	E607
00086	*ODOR	G1XX-10620	X	
00560	OIL & GREASE	A2XX-10120	CJ	E413
00680	ORGANIC CARBON	A1XX-10130	A	E415
00671	ORTHO PHOSPHATE (DISSOLVED)	A1XX-10110	AX	E365
00300	*OXYGEN (DISSOLVED)	G1XX-10000	X	
39516	PCB (POLYCHLORINATED BIPHENYLS)	T4XX-10850	C	E608
00400	*pH (HYDROGEN ION)	G1XX-10000	X	
34461	PHENANTHRENE	T4XX-10820	C	E610
32730	PHENOLS	E1XX-10400	A	E420
34452	4-CHLORO-3-METHYLPHENOL	T4XX-10810	C	E604
34586	2-CHLOROPHENOL	T4XX-10810	C	E604
34601	2,4-DICHLOROPHENOL	T4XX-10810	C	E604
34606	2,4-DIMETHYLPHENOL	T4XX-10810	C	E604
34606	2,4-DINITROPHENOL	T4XX-10810	C	E604
34657	2-METHYL-4,6-DINITROPHENOL	T4XX-10810	C	E604
34591	2-NITROPHENOL	T4XX-10810	C	E604
34646	4-NITROPHENOL	T4XX-10810	C	E604

RECOMMENDED ENVIRONMENTAL SAMPLING METHODS

STORET #	NAME	PRESERVATIVE WORK CENTER	NOTES	REF.
34694	PENTACHLOROPHENOL	T4XX-10810	C	E604
34621	2,4,6-TRICHLOROPHENOL	T4XX-10810	C	E604
34636	4-BROMOPHENYL PHENYLETHER	T4XX-10820	C	E611
34641	4-CHLOROPHENYL PHENYLETHER	T4XX-10820	C	E611
00671	PHOSPHATES ORTHO (DISSOLVED)	A1XX-10110	AI	E365
70507	PHOSPHATES ORTHO (TOTAL)	A1XX-10100	A	E365
00665	PHOSPHORUS (TOTAL)	A1XX-10110	A	E365
1000069PH	PHTHALATE ESTER SCREEN	T4XX-10820	C	E606
39100	BIS(2-ETHYLHEXYL)PHTHALATE	T4XX-10820	C	E606
34292	BUTYLBENZYL PHTHALATE	T4XX-10820	C	E606
39110	DI-N-BUTYL PHTHALATE	T4XX-10820	C	E606
34336	DIETHYL PHTHALATE	T4XX-10820	C	E606
34341	DIMETHYL PHTHALATE	T4XX-10820	C	E606
34596	DI-N-OCTYL PHTHALATE	T4XX-10820	C	E606
31751	*PLATE COUNT, TOTAL	G1XX-10000	X	
00935	POTASSIUM (DISSOLVED)	F1XX-10520	A	E258
00937	POTASSIUM (TOTAL)	F1XX-10510	A	E258
1001462AE	PRIORITY POLLUTANT-ACID EXTR.	T4XX-10810	C	E625
1001463BE	PRIORITY POLLUTANT - BASE/NEUT. EXT	T4XX-10820	C	E625
1001465MT	PRIORITY POLLUTANT - MAX.TRIHALO.PO (OBTAIN SPECIAL CONTAINER FROM LAB)	T1XX-10830	F	E501
82080	PRIORITY POLLUTANT - TOT.TRIHALOMET (OBTAIN SPECIAL CONTAINER FROM LAB)	T1XX-10840	D	E501

RECOMMENDED ENVIRONMENTAL SAMPLING METHODS

STORET #	NAME	PRESERVATIVE WORK CENTER	NOTES	REF.
1001461PA	PRIORITY POLLUTANT - VOL. AROMATICS (OBTAIN SPECIAL CONTAINER FROM LAB)	T1XX-10850	F	E602
1001460PH	PRIORITY POLLUTANT-VOLATILE HALOCAR (OBTAIN SPECIAL CONTAINER FROM LAB)	T1XX-10860	D	E601
71220	*PSEUDOMONAS, AERUGINOSA	G1XX-10000	I	
34469	PYRENE	T4XX-10820	C	E610
00500	RESIDUE (TOTAL)	G1XX-10642	A	E160
70300	RESIDUE FILTERABLE (TDS)	G1XX-10640	AX	E160
00530	RESIDUE NON-FILTERABLE (SS)	G1XX-10640	AX	E160
50086	RESIDUE (SETTLEABLE)	G1XX-10600	A	E160
00520	RESIDUE (VOLATILE FILTERABLE)	G1XX-10600	AX	E160
00535	RESIDUE (VOLATILE NON-FILTERABLE)	G1XX-10600	AX	E160
00505	RESIDUE VOLATILE (TOTAL)	G1XX-10642	AX	E160
00480	SALINITY	G1XX-10600	A	A210A
01145	SELENIUM (DISSOLVED)	F1XX-10520	A	E270
01147	SELENIUM (TOTAL)	F1XX-10510	A	E270
39750	SEVIN	H2XX-10700	C	A509
00955	SILICA	G1XX-10600	B	E370
01075	SILVER (DISSOLVED)	F1XX-10520	A	E272
01077	SILVER (TOTAL)	F1XX-10510	A	E272
39760	SILVEX (2,4,5-TP)	H1XX-10700	C	A509
00930	SODIUM (DISSOLVED)	F1XX-10520	A	E273
00929	SODIUM (TOTAL)	F1XX-10510	A	E273

RECOMMENDED ENVIRONMENTAL SAMPLING METHODS

STORET #	NAME	PRESERVATIVE WORK CENTER	NOTES	REF.
00095	SPECIFIC CONDUCTANCE	G1XX-10620	A	E120
80110	SPECIFIC GRAVITY	G1XX-10600	A	A213
00945	SULFATES	G1XX-10630	A	E375
00745	SULFIDES	J1XX-10600	AX	E376
00740	SULFITES	G1XX-10600	AX	E377
38260	SURFACTANTS (MBAS AS LAS)	G1XX-10620	AX	E425
39740	2,4,5-T	H1XX-10700	C	A509
32240	TANNINS & LIGNINS	G1XX-10600	A	A513
00010	*TEMPERATURE (^{o}C)	G1XX-10000	X	
34516	TETRACHLOROETHANE (OBTAIN SPECIAL CONTAINER FROM LAB)	T1XX-10860	D	E601
34475	TETRACHLOROETHYLENE (OBTAIN SPECIAL CONTAINER FROM LAB)	T1XX-10860	D	E601
00730	THIOCYANATES	D1XX-10300	A	A412
01057	THALLIUM (DISSOLVED)	F1XX-10520	A	E279
01059	THALLIUM (TOTAL)	F1XX-10510	A	E279
01100	TIN (DISSOLVED)	F1XX-10500	A	E282
01102	TIN (TOTAL)	F1XX-10500	A	E282
01150	TITANIUM (DISSOLVED)	F1XX-10500	A	E283
34506	1,1,1-TRICHLOROETHANE (OBTAIN SPECIAL CONTAINER FROM LAB)	T1XX-10860	D	E601
34511	1,1,2-TRICHLOROETHANE (OBTAIN SPECIAL CONTAINER FROM LAB)	T1XX-10860	D	E601

RECOMMENDED ENVIRONMENTAL SAMPLING METHODS

STORET #	NAME	PRESERVATIVE WORK CENTER	NOTES	REF.
39180	TRICHLOROETHYLENE (OBTAIN SPECIAL CONTAINER FROM LAB)	T1XX-10860	D	E601
34488	TRICHLOROFLUOROMETHANE (OBTAIN SPECIAL CONTAINER FROM LAB)	T1XX-10860	D	E601
82080	TRIHALOMETHANES (TOTAL) (OBTAIN SPECIAL CONTAINER FROM LAB)	T1XX-10840	D	E501
00076	TURBIDITY	G1XX-10620	AX	E180
39175	VINYL CHLORIDE (OBTAIN SPECIAL CONTAINER FROM LAB)	T1XX-10860	D	E601
81710	M-XYLENE (OBTAIN SPECIAL CONTAINER FROM LAB)	T1XX-10850	F	E503
81711	O-XYLENE (OBTAIN SPECIAL CONTAINER FROM LAB)	T1XX-10850	F	E503
78132	P-XYLENE (OBTAIN SPECIAL CONTAINER FORM LAB)	T1XX-10850	F	E503
01090	ZINC (DISSOLVED)	F1XX-10500	A	E289
01092	ZINC (TOTAL)	F1XX-10510	A	E289

EEF D-06-1
June 25, 1984

STANDARD OPERATING PROCEDURE (SOP) FOR DETERMINING CONDUCTANCE

INTRODUCTION

This SOP describes the method for determining the conductivity of various waters, using a Barnstead PM-70CB Conductivity Bridge. A YSI 3403 conductivity cell (1.0 constant) is used in conjunction with the bridge. This bridge is capable of conductance measurements from 0.1 µmho to 0.12 µmho. Measurement is accurate to three significant figures.

Bridge Range Calibration

1. Rotate the MULTIPLIER knob to the KILOHMS X1 (CAL) position.
2. Set the Digital switch to 10.00.
3. Place the CHECK-OPER. switch to the CHECK position.
4. Place the OFF-ON switch to the ON position.
5. Rotate the SENSITIVITY knob to near the center position.
6. Rotate the OHMS screw as required until the meter needle is aligned with the 0 mark on the meter.
7. Rotate the MULTIPLIER knob to the MICROMHOS X10 (CAL) position.
8. Rotate the MHOS screw as required until the meter needle is aligned with the 0 mark on the meter.

Conductance Measurement

1. Connect the conductivity cell terminals to the binding posts.
2. Submerge the cell above its vent slots in the liquid.
3. Tilt the cell and lightly tap it to expel through the vent slots any air trapped in the cell. (Keep suspended in sample, do not touch glass surfaces.)
4. Allow sample to come to room temperature, if possible.
5. Place the OFF-ON switch to the ON position.
6. Place the CHECK-OPER. switch to the OPER. position.
7. Rotate the SENSITIVITY knob fully clockwise.

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8. Set the digital switch to 11.99.
9. Set the "MULTIPLIER" knob at the NANOMHOS x 100 position.
10. Starting with the left digit, decrease the setting on the digital switch until the meter is at null.
11. The measured conductivity is the setting on the digital switch times the setting on the MULTIPLIER scale x the cell constant.
12. Determine temperature of sample within 0.5°C. if the temperature of the samples is not 25°C, make temperature correction as follows:
    a. If the temperature is below 25°C ,add 2% of the reading per degree.
    b. If the temperature is above 25°C, subtract 2% of the reading per degree.
13. Report results as Specific Conductance, μmhos/cm at 25°C.

Bridge Zero Adjustment

1. Rotate the MULTIPLIER knob to the KILOHMS X1 (CAL) position.
2. Short circuit the binding posts.
3. Set the Digital switch to 0.00.
4. Place the CHECK-OPER. switch to the OPER. position.
5. Place the OFF-ON switch to the ON position.
6. Rotate the SENSITIVITY knob fully clockwise.
7. Rotate the ZERO ADJUST screw as required until the meter needle is aligned with the 0 mark on the meter.
8. Remove the short circuit from the binding posts.

EEF D-06-1
June 25, 1984

Cell Calibration

1. Check the accuracy of the cell constant and conductivity bridge monthly using standard potassium chloride solution as given in the following table:

Conductivity 0.01 m KCL (°C)	Micromhos/cm
21	1305
22	1332
23	1359
24	1386
25	1413
26	1441
27	1468
28	1496

Approved by:

Section 526 SOP representative

A. Barker

R. Mayer

APPROVED

EFF D-04-1
June 25, 1984

STANDARD OPERATING PROCEDURE (SOP) FOR DETERMINING pH (Orion Model 211 pH Meter)

INTRODUCTION

This SOP describes the method for determining the pH of a solution using the portable Orion Model 211 pH meter. This convenient, rugged instrument meets exacting standards and exceeds the requirements of ASTM Method E70, Type II. The full pH range is accurate to better than 0.05 pH units. A gel-filled unbreakable combination pH electrode is employed with the meter.

Setting Up

1. Connect electrode to meter.
2. Immerse electrode in pH 7.0 buffer.
3. Adjust temperature control to temperature of buffer.
4. Swirl liquid and with switch "ON", allow buffer reading to stabilize and adjust to "CALIB" dial so that the digital display indicates the pH of the buffer at the solution temperature. (See Table.)
5. Check calibration with a second buffer solution of different pH. Adjust the "SLOPE" screw on bottom of meter until pH at the solution temperature is displayed (See Table.)
6. Switch to "OFF" and rinse electrode (Instrument is ready for use).

Measurement of pH

1. Immerse electrode in sample.
2. Adjust temperature control to temperature of sample.
3. Swirl liquid and switch to "ON".
4. Read and record pH value.
5. Switch back to "OFF".
6. Rinse electrode thoroughly and blot.
7. Proceed similarly with any additional measurements.

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Approved by:

Section 526 SOP representative

A. Barker

R. Mayer

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TABLE 1

TEMP (°C)	pH 7.00 Buffer	pH 4.01 Buffer	pH 10.01 Buffer
5	7.08	4.00	10.25
10	7.06	4.00	10.18
15	7.03	4.00	10.12
20	7.01	4.00	10.06
25	7.00	4.01	10.01
30	6.98	4.02	9.97
35	6.98	4.02	9.93
40	6.97	4.03	9.89
50	6.97	4.06	9.83
60	6.98	4.09	--

7

MASTER LIST OF SOIL AND SEDIMENT SAMPLES
MALMSTROM AIR FORCE BASE

Site ID	Field Sample No.	Lab No.	Mat.	Q/C	Date Coll.	Ketones Est. Date	Ketones Anal. Date	Ketones Anal. Ddln.	Halogenated Vol. Est. Date	Halogenated Vol. Anal. Date	Halogenated Vol. Anal. Ddln.	Aromatic Vol. Est. Date	Aromatic Vol. Anal. Date	Aromatic Vol. Anal. Ddln.	PCBs Est. Date	PCBs Est. Ddln.	PCBs Anal. Date	PCBs Anal. Ddln.	Extractable Priority Pollutants Est. Date	Extractable Priority Pollutants Est. Ddln.	Extractable Priority Pollutants Anal. Date	Extractable Priority Pollutants Anal. Ddln.
FT1	GS-86-1083	GA489	S		10-18-86	-	-	-	10-31	10-31	11-01	10-30	10-30	11-01	-	-	-	-	-	-	-	-
FT1	GS-86-1084	GA490	S	D1083	10-18-86	-	-	-	10-31	10-31	11-01	10-30	10-30	11-01	-	-	-	-	-	-	-	-
FT1	GS-86-1085	GA491	S		10-18-86	-	-	-	10-31	10-31	11-01	10-30	10-30	11-01	-	-	-	-	-	-	-	-
FT1	GS-86-1086	GA492	S		10-18-86	-	-	-	10-31	10-31	11-01	10-30	10-30	11-01	-	-	-	-	-	-	-	-
FT1	GS-86-1087	GA493	S		10-18-86	-	-	-	10-31	10-31	11-01	10-30	10-30	11-01	-	-	-	-	-	-	-	-
FT1	GS-86-1088	GA494	S	A1088	10-18-86	-	-	-	10-31	11-01	11-01	10-30	11-01	11-01	-	-	-	-	-	-	-	-
FT1	GS-86-1089	GA496	S		10-18-86	-	-	-	10-31	11-01	11-01	10-30	10-30	11-01	-	-	-	-	-	-	-	-
FT1	GS-86-1090	GA496	S		10-18-86	-	-	-	10-31	11-01	11-01	10-30	10-30	11-01	-	-	-	-	-	-	-	-
FT1	GS-86-1091	GA497	S	A1091	10-18-86	-	-	-	10-31	11-01	11-01	10-30	10-30	11-01	-	-	-	-	-	-	-	-
FT1	GS-86-1092	GA498	S		10-18-86	-	-	-	10-31	11-01	11-01	10-30	10-30	11-01	-	-	-	-	-	-	-	-
FT1	GS-86-1093	GA499	S		10-18-86	-	-	-	10-31	11-01	11-01	10-30	10-30	11-01	-	-	-	-	-	-	-	-
FT1	GS-86-1094	GA500	S		10-18-86	-	-	-	10-31	11-01	11-01	10-30	10-30	11-01	-	-	-	-	-	-	-	-
FT1	GS-86-1095	GA501	S		10-18-86	-	-	-	10-31	11-01	11-01	10-30	10-31	11-01	-	-	-	-	-	-	-	-
FT1	GS-86-1096	GA502	S	D1094	10-18-86	-	-	-	10-31	11-01	11-01	10-30	10-31	11-01	-	-	-	-	-	-	-	-
IS3	GS-86-1074	GA187	S		10-16-86	-	-	-	-	-	-	-	-	-	10-20	10-23	11-07	11-15	-	-	-	-
IS3	GS-86-1075	GA188	S	A1075	10-16-86	-	-	-	-	-	-	-	-	-	10-20	10-23	11-07	11-15	-	-	-	-
IS3	GS-86-1076	GA189	S		10-16-86	-	-	-	-	-	-	-	-	-	10-20	10-23	11-07	11-15	-	-	-	-
SS1	GS-86-1097	GA503	S		10-20-86	-	-	-	-	-	-	10-31	11-02	11-03	-	-	-	-	-	-	-	-
SS1	GS-86-1098	GA504	S	A1098	10-20-86	-	-	-	-	-	-	10-31	10-31	11-03	-	-	-	-	-	-	-	-
SS1	GS-86-1099	GA505	S		10-20-86	-	-	-	-	-	-	10-31	10-31	11-03	-	-	-	-	-	-	-	-
SS1	GS-86-1100	GA506	S		10-20-86	-	-	-	-	-	-	10-31	10-31	11-03	-	-	-	-	-	-	-	-
SS1	GS-86-1101	GA507	S		10-20-86	-	-	-	-	-	-	10-31	10-31	11-03	-	-	-	-	-	-	-	-
SS1	GS-86-1102	GA508	S	D1101	10-20-86	-	-	-	-	-	-	10-31	11-01	11-03	-	-	-	-	-	-	-	-
SS1	GS-86-1103	GA509	S		10-20-86	-	-	-	-	-	-	10-31	11-02	11-03	-	-	-	-	-	-	-	-
															-	-	-	-	-	-	-	-
SS2	GS-86-1104	GA510	S		10-21-86	-	-	-	-	-	-	11-01	11-01	11-04	-	-	-	-	-	-	-	-
SS2	GS-86-1105	GA511	S	A1105	10-21-86	-	-	-	-	-	-	11-01	11-01	11-04	-	-	-	-	-	-	-	-
SS2	GS-86-1106	GA512	S		10-21-86	-	-	-	-	-	-	11-01	11-01	11-04	-	-	-	-	-	-	-	-
															-	-	-	-	-	-	-	-
PS2	GS-86-1020	FZ064	S		10-12-86	-	-	-	-	-	-	10-20	10-20	10-26	-	-	-	-	-	-	-	-
PS2	GS-86-1021	FZ065	S	A1021	10-12-86	-	-	-	-	-	-	10-20	10-20	10-26	-	-	-	-	-	-	-	-
PS2	GS-86-1022	FZ066	S		10-12-86	-	-	-	-	-	-	10-20	10-20	10-26	-	-	-	-	-	-	-	-
PS2	GS-86-1023	FZ067	S		10-12-86	-	-	-	-	-	-	10-20	10-20	10-26	-	-	-	-	-	-	-	-

MASTER LIST OF SOIL AND SEDIMENT SAMPLES
MALMSTROM AIR FORCE BASE

Site ID	Field Sample No.	Lab No.	Mat.	Q/C	Date Coll.	Ketones Est. Date	Ketones Anal. Date	Ketones Anal. Ddln.	Halogenated Vol. Est. Date	Halogenated Vol. Anal. Date	Halogenated Vol. Anal. Ddln.	Aromatic Vol. Est. Date	Aromatic Vol. Anal. Date	Aromatic Vol. Anal. Ddln.	PCBs Est. Date	PCBs Est. Ddln.	PCBs Anal. Date	PCBs Anal. Ddln.	Extractable Priority Pollutants Est. Date	Extractable Priority Pollutants Est. Ddln.	Extractable Priority Pollutants Anal. Date	Extractable Priority Pollutants Anal. Ddln.
PS2	GS-86-1024	FZ868	S		10-12-86	-	-	-	-	-	-	10-20	10-20	10-26	-	-	-	-	-	-	-	-
PS2	GS-86-1026	FZ869	S		10-12-86	-	-	-	-	-	-	10-20	10-20	10-26	-	-	-	-	-	-	-	-
PS2	GS-86-1026E	FZ870	S	D1025	10-12-86	-	-	-	-	-	-	10-20	10-20	10-26	-	-	-	-	-	-	-	-
PS2	GS-86-1026	FZ871	S		10-12-86	-	-	-	-	-	-	10-20	10-21	10-26	-	-	-	-	-	-	-	-
PS2	GS-86-1027	FZ872	S		10-12-86	-	-	-	-	-	-	10-20	10-21	10-26	-	-	-	-	-	-	-	-
PS2	GS-86-1028	FZ873	S		10-12-86	-	-	-	-	-	-	10-20	10-21	10-26	-	-	-	-	-	-	-	-
PS2	GS-86-1029	FZ874	S		10-12-86	-	-	-	-	-	-	10-20	10-21	10-26	-	-	-	-	-	-	-	-
PS2	GS-86-1030	FZ875	S		10-12-86	-	-	-	-	-	-	10-20	10-21	10-26	-	-	-	-	-	-	-	-
PS2	GS-86-1031	FZ876	S	A1031	10-12-86	-	-	-	-	-	-	10-20	10-21	10-26	-	-	-	-	-	-	-	-
PS3	GS-86-1123	GA770	S		10-24-86	-	-	-	-	-	-	11-06	11-06	11-07	-	-	-	-	-	-	-	-
PS3	GS-86-1124	GA771	S		10-24-86	-	-	-	-	-	-	11-06	11-06	11-07	-	-	-	-	-	-	-	-
PS3	GS-86-1125	GA772	S		10-24-86	-	-	-	-	-	-	11-06	11-07	11-07	-	-	-	-	-	-	-	-
PS3	GS-86-1126	GA773	S		10-24-86	-	-	-	-	-	-	11-06	11-06	11-07	-	-	-	-	-	-	-	-
PS3	GS-86-1127	GA774	S		10-24-86	-	-	-	-	-	-	11-06	11-07	11-07	-	-	-	-	-	-	-	-
PS3	GS-86-1128	GA775	S	A1128	10-24-86	-	-	-	-	-	-	11-06	11-07	11-07	-	-	-	-	-	-	-	-
PS3	GS-86-1129	GA776	S		10-24-86	-	-	-	-	-	-	11-06	11-06	11-07	-	-	-	-	-	-	-	-
PS3	GS-86-1130	GA777	S		10-24-86	-	-	-	-	-	-	11-06	11-06	11-07	-	-	-	-	-	-	-	-
PS4	GS-86-1039	FZ877	S	A1039	10-13-86	-	-	-	-	-	-	10-20	10-20	10-27	-	-	-	-	-	-	-	-
PS4	GS-86-1040	FZ878	S		10-13-86	-	-	-	-	-	-	10-20	10-20	10-27	-	-	-	-	-	-	-	-
PS4	GS-86-1041	FZ879	S		10-13-86	-	-	-	-	-	-	10-20	10-20	10-27	-	-	-	-	-	-	-	-
PS4	GS-86-1042	FZ880	S		10-13-86	-	-	-	-	-	-	10-20	10-22	10-27	-	-	-	-	-	-	-	-
PS4	GS-86-1043	FZ881	S		10-13-86	-	-	-	-	-	-	10-20	10-22	10-27	-	-	-	-	-	-	-	-
PS4	GS-86-1044	FZ882	S		10-13-86	-	-	-	-	-	-	10-20	10-21	10-27	-	-	-	-	-	-	-	-
PS4	GS-86-1045	FZ883	S	D1044	10-13-86	-	-	-	-	-	-	10-20	10-21	10-27	-	-	-	-	-	-	-	-
PS4	GS-86-1049	FZ884	S		10-13-86	-	-	-	-	-	-	10-20	10-21	10-27	-	-	-	-	-	-	-	-
PS4	GS-86-1050	FZ885	S		10-13-86	-	-	-	-	-	-	10-20	10-21	10-27	-	-	-	-	-	-	-	-
PS4	GS-86-1051	FZ886	S	A1051	10-13-86	-	-	-	-	-	-	10-20	10-21	10-27	-	-	-	-	-	-	-	-
PS4	GS-86-1052	FZ926	S		10-13-86	-	-	-	-	-	-	10-21	10-21	10-27	-	-	-	-	-	-	-	-
PS4	GS-86-1053	FZ927	S	D1052	10-13-86	-	-	-	-	-	-	10-21	10-21	10-27	-	-	-	-	-	-	-	-
PS4	GS-86-1054	FZ928	S		10-13-86	-	-	-	-	-	-	10-21	10-21	10-27	-	-	-	-	-	-	-	-
PS4	GS-86-1055	FZ929	S		10-13-86	-	-	-	-	-	-	10-21	10-21	10-27	-	-	-	-	-	-	-	-
PS6	GS-86-1032	FZ887	S		10-12-86	-	-	-	10-24	10-24	10-26	10-21	10-21	10-26	-	-	-	-	-	-	-	-

MASTER LIST OF WATER SAMPLES
MALMSTROM AIR FORCE BASE

Site ID	Field Sample No.	Lab No.	Mat.	Q/C	Date Coll.	Ext. Date	Ketones Anal. Date	Ketones Anal. Ddln.	Halogenated Vol. Ext. Date	Halogenated Vol. Anal. Date	Halogenated Vol. Anal. Ddln.	Aromatic Vol. Ext. Date	Aromatic Vol. Anal. Date	Aromatic Vol. Anal. Ddln.	Extractable Priority Pollutants Ext. Date	Extractable Priority Pollutants Ext. Ddln.	Extractable Priority Pollutants Anal. Date	Extractable Priority Pollutants Anal. Ddln.
SW3	GM-86-1187	GA596	W	A1187	10-22-86	10-30	10-30	11-05	11-04	11-04	11-05	11-03	11-03	11-05	10-24	10-29	11-11	12-03
SW3	GM-86-1188	GA597	W		10-22-86	10-30	10-30	11-05	11-04	11-04	11-05	11-04	11-04	11-05	10-24	10-29	11-11	12-03
SW3	GM-86-1189	GA598	W	D1188	10-22-86	10-30	10-30	11-05	11-04	11-04	11-05	11-04	11-04	11-05	10-24	10-29	11-11	12-03

Table 3

Parameters, Analytical Methods, and Reporting Limits
For Soil and Sediment Samples
Malmstrom AFB and Kalispell AFS

PARAMETER	ANALYTICAL METHOD	REPORTING LIMITS 0% MOISTURE	REPORTING LIMITS 35% MOISTURE
Moisture	ASTM D2216	-	-
Petroleum Hydrocarbons	3550/418.1	100 mg/kg	153.8 mg/kg
Lead	3050/6010	5.5 mg/kg	8.5 mg/kg
Ketones	5030/8015		
2-Butanone		15 mg/kg	23.1 mg/kg
4-Methyl-2-pentanone		15 mg/kg	23.1 mg/kg
PCB's	3550/8080		
Aroclor 1016		1 mg/kg	1.5 mg/kg
Aroclor 1221		1 mg/kg	1.5 mg/kg
Aroclor 1232		1 mg/kg	1.5 mg/kg
Aroclor 1242		1 mg/kg	1.5 mg/kg
Aroclor 1248		1 mg/kg	1.5 mg/kg
Aroclor 1254		1 mg/kg	1.5 mg/kg
Aroclor 1260		1 mg/kg	1.5 mg/kg
Halogenated Volatiles	5030/8010		
Chloromethane		0.2 mg/kg	0.3 mg/kg
Bromomethane		3.0 mg/kg	4.6 mg/kg
Dichlordifluoromethane		4.5 mg/kg	6.9 mg/kg
Vinyl Chloride		0.5 mg/kg	0.8 mg/kg
Chloroethane		1.3 mg/kg	2.0 mg/kg
Methylene Chloride		0.6 mg/kg	0.9 mg/kg
Trichlorofluoromethane		0.3 mg/kg	0.5 mg/kg
1,1-Dichloroethene		0.3 mg/kg	0.5 mg/kg
1,1-Dichloroethane		0.2 mg/kg	0.3 mg/kg
trans-1,2-Dichloroethene		0.3 mg/kg	0.5 mg/kg
Chloroform		0.1 mg/kg	0.2 mg/kg
1,2-Dichloroethane		0.1 mg/kg	0.2 mg/kg
1,1,1-Trichloroethane		0.1 mg/kg	0.2 mg/kg
Carbon tetrachloride		0.3 mg/kg	0.5 mg/kg
Bromodichloromethane		0.3 mg/kg	0.5 mg/kg
1,2 Dichloropropane		0.1 mg/kg	0.2 mg/kg
trans-1,3-Dichloropropene		0.9 mg/kg	1.4 mg/kg
Trichloroethene		0.3 mg/kg	0.5 mg/kg
Dibromochloromethane		0.2 mg/kg	0.3 mg/kg

MASTER LIST OF SOIL AND SEDIMENT SAMPLES
MALMSTROM AIR FORCE BASE

Site ID	Field Sample No.	Lab No.	Mat.	Q/C	Date Coll.	Ketones Est. Date	Ketones Anal. Date	Ketones Anal. Ddln.	Halogenated Vol. Est. Date	Halogenated Vol. Anal. Date	Halogenated Vol. Anal. Ddln.	Aromatic Vol. Est. Date	Aromatic Vol. Anal. Date	Aromatic Vol. Anal. Ddln.	PCBs Est. Date	PCBs Est. Ddln.	PCBs Anal. Date	PCBs Anal. Ddln.	Extractable Priority Pollutants Est. Date	Extractable Priority Pollutants Est. Ddln.	Extractable Priority Pollutants Anal. Date	Extractable Priority Pollutants Anal. Ddln.
P05	05-06-1033	FZ000	S		10-12-86	-	-	-	10-24	10-27	10-28	10-21	10-21	10-28	-	-	-	-	-	-	-	-
P05	05-06-1034	FZ000	S		10-12-86	-	-	-	10-24	10-27	10-28	10-21	10-21	10-28	-	-	-	-	-	-	-	-
P05	05-06-1035	FZ000	S	A1035	10-12-86	-	-	-	10-24	10-26	10-28	10-21	10-21	10-28	-	-	-	-	-	-	-	-
S01	05-06-1077	GA110	S		10-16-86	10-29	10-29	10-30	10-27	10-27	10-30	10-23	10-24	10-30	-	-	-	-	10-21	10-30	10-29	11-30
S01	05-06-1078	GA111	S		10-16-86	10-29	10-29	10-30	10-27	10-27	10-30	10-23	10-23	10-30	-	-	-	-	10-21	10-30	10-31	11-30
S01	05-06-1079	GA112	S		10-16-86	10-29	10-29	10-30	10-27	10-28	10-30	10-23	10-23	10-30	-	-	-	-	10-21	10-30	10-31	11-30
S01	05-06-1080	GA113	S		10-16-86	10-29	10-29	10-30	10-27	10-28	10-30	10-23	10-23	10-30	-	-	-	-	10-21	10-30	10-31	11-30
S01	05-06-1081	GA114	S		10-16-86	10-29	10-29	10-30	10-27	10-28	10-30	10-23	10-23	10-30	-	-	-	-	10-21	10-30	10-30	11-30
S01	05-06-1082	GA115	S	A1082	10-16-86	10-29	10-29	10-30	10-27	10-27	10-30	10-23	10-23	10-30	-	-	-	-	10-21	10-30	10-31	11-30
S01	05-06-1115	GA000	S	A1115	10-23-86	10-29	10-30	11-06	11-05	11-06	11-06	11-05	11-06	11-06	-	-	-	-	10-30	11-06	11-11	12-09
S01	05-06-1116	GA001	S		10-23-86	10-30	10-30	11-06	11-05	11-06	11-06	11-05	11-05	11-06	-	-	-	-	10-30	11-06	11-11	12-09
S01	05-06-1117	GA002	S		10-23-86	10-30	10-30	11-06	11-05	11-06	11-06	11-05	11-06	11-06	-	-	-	-	10-30	11-06	11-11	12-09
S01	05-06-1118	GA003	S		10-23-86	10-30	10-30	11-06	11-05	11-06	11-06	11-05	11-07	11-06	-	-	-	-	10-30	11-06	11-11	12-09
S01	05-06-1119	GA004	S		10-23-86	10-30	10-30	11-06	11-05	11-06	11-06	11-05	11-06	11-06	-	-	-	-	10-30	11-06	11-12	12-09
S01	05-06-1120	GA005	S		10-23-86	10-30	10-30	11-06	11-04	11-09	11-06	11-05	11-06	11-06	-	-	-	-	10-30	11-06	11-12	12-09
S02	05-06-1066	FZ030	S		10-14-86	-	-	-	10-25	10-25	10-28	10-21	10-21	10-28	-	-	-	-	10-21	10-28	10-31	11-30
S02	05-06-1067	FZ031	S	A1067	10-14-86	-	-	-	10-25	10-25	10-28	10-22	10-22	10-28	-	-	-	-	10-21	10-28	10-30	11-30
S02	05-06-1068	FZ032	S		10-14-86	-	-	-	10-25	10-25	10-28	10-21	10-22	10-28	-	-	-	-	10-21	10-28	10-29	11-30
S02	05-06-1069	FZ033	S		10-14-86	-	-	-	10-25	10-27	10-28	10-22	10-22	10-28	-	-	-	-	10-21	10-28	11-01	11-30
S02	05-06-1060	FZ034	S	A1060	10-14-86	-	-	-	10-25	10-27	10-28	10-21	10-22	10-28	-	-	-	-	10-21	10-28	10-31	11-30
S02	05-06-1061	FZ035	S		10-14-86	-	-	-	10-25	10-27	10-28	10-22	10-22	10-28	-	-	-	-	10-21	10-28	10-30	11-30
S02	05-06-1062	FZ000	S		10-15-86	-	-	-	10-25	10-25	10-29	10-22	10-22	10-29	-	-	-	-	10-21	10-29	11-01	11-30
S02	05-06-1063	FZ000	S	A1063	10-15-86	-	-	-	10-25	10-25	10-29	10-22	10-22	10-29	-	-	-	-	10-21	10-29	10-31	11-30
S02	05-06-1064	FZ000	S		10-15-86	-	-	-	10-25	10-25	10-29	10-22	10-22	10-29	-	-	-	-	10-21	10-29	10-30	11-30
S02	05-06-1065	FZ001	S		10-15-86	-	-	-	10-25	10-25	10-29	10-22	10-23	10-29	-	-	-	-	10-21	10-29	10-31	11-30
S02	05-06-1066	FZ002	S		10-15-86	-	-	-	10-25	10-27	10-29	10-22	10-23	10-29	-	-	-	-	10-21	10-29	10-30	11-30
S02	05-06-1067	FZ003	S	A1067	10-15-86	-	-	-	10-25	10-26	10-29	10-22	10-23	10-29	-	-	-	-	10-21	10-29	10-30	11-30
S03	05-06-1072	GA105	Sd		10-16-86	-	-	-	10-28	10-28	10-30	10-23	10-23	10-30	-	-	-	-	10-21	10-30	11-01	11-30
S03	05-06-1073	GA106	Sd		10-16-86	-	-	-	10-28	10-28	10-30	10-23	10-24	10-30	-	-	-	-	10-21	10-30	11-01	11-30
S05	05-06-1068	GA101	S		10-15-86	10-29	10-29	10-29	10-27	10-27	10-29	10-23	10-23	10-29	-	-	-	-	10-21	10-29	10-30	11-30
S05	05-06-1069	GA102	S		10-15-86	10-29	10-29	10-29	10-27	10-27	10-29	10-23	10-23	10-29	-	-	-	-	10-21	10-29	10-30	11-30

MASTER LIST OF SOIL AND SEDIMENT SAMPLES
MALMSTROM AIR FORCE BASE

Site ID	Field Sample No.	Lab No.	Mat.	Q/C	Date Coll.	Ketones Est. Date	Ketones Anal. Date	Ketones Anal. Ddln.	Halogenated Vol. Est. Date	Halogenated Vol. Anal. Date	Halogenated Vol. Anal. Ddln.	Aromatic Vol. Est. Date	Aromatic Vol. Anal. Date	Aromatic Vol. Anal. Ddln.	PCBs Est. Date	PCBs Est. Ddln.	PCBs Anal. Date	PCBs Anal. Ddln.	Extractable Priority Pollutants Est. Date	Extractable Priority Pollutants Est. Ddln.	Extractable Priority Pollutants Anal. Date	Extractable Priority Pollutants Anal. Ddln.
SW6	GS-06-1070	GA103	S	D1009	10-15-86	10-29	10-29	10-29	10-27	10-27	10-29	10-23	10-23	10-29	-	-	-	-	10-21	10-29	10-30	11-30
SW6	GS-06-1071	GA104	S		10-15-86	10-29	10-29	10-29	10-27	10-27	10-29	10-23	10-23	10-29	-	-	-	-	10-21	10-29	10-30	11-30
SW6	GS-06-1110	GA099	S		10-22-86	10-30	10-30	11-05	11-04	11-06	11-05	11-04	11-04	11-05	-	-	-	-	10-23	11-05	10-31	12-02
SW6	GS-06-1114	GA093	S	D1110	10-22-86	10-30	10-30	11-05	11-04	11-05	11-05	11-04	11-05	11-05	-	-	-	-	10-23	11-05	10-31	12-02
SW6	GS-06-1111	GA098	S		10-22-86	10-30	10-30	11-05	11-04	11-05	11-05	11-04	11-05	11-05	-	-	-	-	10-23	11-05	10-31	12-02
SW6	GS-06-1112	GA091	S		10-22-86	10-30	10-30	11-05	11-04	11-05	11-05	11-04	11-05	11-05	-	-	-	-	10-23	11-05	10-31	12-02
SW6	GS-06-1113	GA092	S		10-22-86	10-30	10-30	11-05	11-04	11-05	11-05	11-04	11-05	11-05	-	-	-	-	10-23	11-05	10-31	12-02
SW1	GS-06-1011	FZ701	S		10-11-86	10-23	10-23	10-25	10-23	10-23	10-25	10-20	10-20	10-25	-	-	-	-	10-21	10-25	10-30	11-30
SW1	GS-06-1012	FZ702	S		10-11-86	10-23	10-23	10-25	10-23	10-23	10-25	10-20	10-20	10-25	-	-	-	-	10-21	10-25	10-31	11-30
SW1	GS-06-1013	FZ703	S	A1013	10-11-86	10-23	10-23	10-25	10-23	10-23	10-25	10-20	10-20	10-25	-	-	-	-	10-21	10-25	10-30	11-30
SW1	GS-06-1014	FZ704	S		10-11-86	10-23	10-23	10-25	10-23	10-23	10-25	10-20	10-20	10-25	-	-	-	-	10-21	10-25	10-31	11-30
SW1	GS-06-1015	FZ705	S		10-11-86	10-23	10-23	10-25	10-23	10-24	10-25	10-20	10-20	10-25	-	-	-	-	10-21	10-25	10-30	11-30
SW1	GS-06-1016	FZ706	S		10-11-86	10-23	10-23	10-25	10-23	10-24	10-25	10-20	10-20	10-25	-	-	-	-	10-21	10-25	10-30	11-30
SW1	GS-06-1017	FZ863	S		10-11-86	10-21	10-23	10-25	10-23	10-24	10-25	10-20	10-20	10-25	-	-	-	-	10-21	10-25	11-01	11-30
SW1	GS-06-1018	FZ864	S		10-11-86	10-21	10-23	10-25	10-23	10-24	10-25	10-20	10-20	10-25	-	-	-	-	10-21	10-25	10-31	11-30
SW1	GS-06-10180	FZ865	S	D1018	10-11-86	10-21	10-23	10-25	10-24	10-24	10-25	10-20	10-20	10-25	-	-	-	-	10-21	10-25	10-30	11-30
SW1	GS-06-1019	FZ866	S		10-11-86	10-21	10-23	10-25	10-24	10-25	10-25	10-20	10-21	10-25	-	-	-	-	10-21	10-25	10-30	11-30
SW1	GS-06-1036	FZ867	S		10-12-86	10-21	10-24	10-26	10-24	10-24	10-26	10-20	10-20	10-26	-	-	-	-	10-21	10-26	10-29	11-30
SW1	GS-06-1037	FZ868	S		10-12-86	10-21	10-24	10-26	10-24	10-24	10-26	10-20	10-20	10-26	-	-	-	-	10-21	10-26	10-30	11-30
SW1	GS-06-10377	FZ869	S	D1037	10-12-86	10-21	10-24	10-26	10-24	10-24	10-26	10-20	10-20	10-26	-	-	-	-	10-21	10-26	10-30	11-30
SW1	GS-06-1038	FZ870	S		10-12-86	10-21	10-24	10-26	10-24	10-27	10-26	10-20	10-20	10-26	-	-	-	-	10-21	10-26	10-30	11-30
SW1	GS-06-1046	FZ704	Sd	A1046	10-13-86	10-21	10-24	10-27	10-24	10-27	10-27	10-20	10-21	10-27	-	-	-	-	10-21	10-27	11-01	11-30
SW1	GS-06-1047	FZ862	Sd	91046	10-13-86	10-21	10-24	10-27	10-24	10-25	10-27	10-20	10-21	10-27	-	-	-	-	10-21	10-27	11-01	11-30
SW1	GS-06-1048	FZ863	Sd		10-13-86	10-21	10-24	10-27	10-24	10-25	10-27	10-20	10-22	10-27	-	-	-	-	10-21	10-27	11-01	11-30
SW1	GS-06-1131	GA776	Sd		10-24-86	10-30	10-30	11-07	11-07	11-07	11-07	11-06	11-06	11-07	-	-	-	-	10-30	11-07	11-12	12-09
SW1	GS-06-1121	GA666	Sd		10-23-86	10-30	10-30	11-06	11-05	11-10	11-06	11-05	11-07	11-06	-	-	-	-	10-30	11-06	11-12	12-09
SW1	GS-06-1122	GA667	Sd		10-23-86	10-30	10-30	11-06	11-05	11-09	11-06	11-05	11-06	11-06	-	-	-	-	10-30	11-06	11-12	12-09

Table 3 (Continued)

PARAMETER	ANALYTICAL METHOD	REPORTING LIMITS 0% MOISTURE	REPORTING LIMITS 35% MOISTURE
Extractable Priority Pollutants (Continued)	3550/8270		
bis(2-chloroethoxy) methane		1 mg/kg	1.5 mg/kg
1,2,4-Trichlorobenzene		1 mg/kg	1.5 mg/kg
Napthalene		1 mg/kg	1.5 mg/kg
Hexachlorobutadiene		1 mg/kg	1.5 mg/kg
4-Chloro-3-methylphenol		1 mg/kg	1.5 mg/kg
Hexachlorocyclopentadiene		1 mg/kg	1.5 mg/kg
2,4,6-Trichlorophenol		1 mg/kg	1.5 mg/kg
2-Chloronaphthalene		1 mg/kg	1.5 mg/kg
Dimethyl Phthalate		1 mg/kg	1.5 mg/kg
Acenaphthylene		1 mg/kg	1.5 mg/kg
N-Nitrosodimethylamine		5 mg/kg	7.7 mg/kg
Benzidine		5 mg/kg	7.7 mg/kg
2,4-Diphenylhydrazine		5 mg/kg	7.7 mg/kg
Acenaphthene		1 mg/kg	1.5 mg/kg
2,4-Dinitrophenol		1 mg/kg	1.5 mg/kg
4-Nitrophenol		1 mg/kg	1.5 mg/kg
2,4-Dinitrotoluene		1 mg/kg	1.5 mg/kg
2,6-Dinitrotoluene		1 mg/kg	1.5 mg/kg
Diethyl Phthalate		1 mg/kg	1.5 mg/kg
4-Chlorophenylphenyl ether		1 mg/kg	1.5 mg/kg
Fluorene		1 mg/kg	1.5 mg/kg
4,6-Dinitro-2-methylphenol		1 mg/kg	1.5 mg/kg
N-Nitrosodiphenylamine		1 mg/kg	1.5 mg/kg
4-Bromophenylphenylether		1 mg/kg	1.5 mg/kg
Hexachlorobenzene		1 mg/kg	1.5 mg/kg
Pentachlorophenol		1 mg/kg	1.5 mg/kg
Phenanthrene		1 mg/kg	1.5 mg/kg
Anthracene		1 mg/kg	1.5 mg/kg
Di-n-butyl phthalate		1 mg/kg	1.5 mg/kg
Fluoranthene		1 mg/kg	1.5 mg/kg
Butylbenzylphthalate		1 mg/kg	1.5 mg/kg
3,3'-Dichlorobenzidine		2 mg/kg	3.1 mg/kg
Benzo(a)anthracene		1 mg/kg	1.5 mg/kg
bis-(2-ethylhexyl)phthalate		1 mg/kg	1.5 mg/kg
Chrysene		1 mg/kg	1.5 mg/kg
Di-n-octyl phthalate		1 mg/kg	1.5 mg/kg
Benzo(b)fluoranthene		1 mg/kg	1.5 mg/kg
Benzo(k)fluoranthene		1 mg/kg	1.5 mg/kg
Indeno(1,2,3-cd)pyrene		1 mg/kg	1.5 mg/kg
Dibenzo(a,h)anthracene		1 mg/kg	1.5 mg/kg
Benzo(g,h,i)perylene		1 mg/kg	1.5 mg/kg

Table 3 (Continued)

PARAMETER	ANALYTICAL METHOD	REPORTING LIMITS 0% MOISTURE	REPORTING LIMITS 35% MOISTURE
Halogenated Volatiles (Continued)	**5030/8010**		
1,1,2-Trichloroethane		0.1 mg/kg	0.2 mg/kg
cis-1,3-Dichloropropene		0.5 mg/kg	0.8 mg/kg
2-Chloroethyl vinyl ether		0.3 mg/kg	0.5 mg/kg
Bromoform		0.5 mg/kg	0.8 mg/kg
1,1,2,2,-Tetrachloroethane		0.1 mg/kg	0.2 mg/kg
Tetrachloroethene		0.1 mg/kg	0.2 mg/kg
Chlorobenzene		0.6 mg/kg	0.9 mg/kg
1,3-Dichlorobenzene		0.8 mg/kg	1.2 mg/kg
1,2-Dichlorobenzene		0.4 mg/kg	0.6 mg/kg
1,4-Dichlorobenzene		0.6 mg/kg	0.9 mg/kg
Aromatic Volatiles	**5030/8020**		
Benzene		1 mg/kg	1.5 mg/kg
Toluene		1 mg/kg	1.5 mg/kg
Ethylbenzene		1 mg/kg	1.5 mg/kg
Chlorobenzene		1 mg/kg	1.5 mg/kg
p-xylene		1 mg/kg	1.5 mg/kg
m-xylene		1 mg/kg	1.5 mg/kg
o-xylene		1 mg/kg	1.5 mg/kg
1,4-dichlorobenzene		1 mg/kg	1.5 mg/kg
1,3-Dichlorobenzene		1 mg/kg	1.5 mg/kg
1,2-Dichlorobenzene		1 mg/kg	1.5 mg/kg
Extractable Priority Pollutants	**3550/8270**		
Phenol		1 mg/kg	1.5 mg/kg
bis (2-chloroethyl) ether		1 mg/kg	1.5 mg/kg
2-Chlorophenol		1 mg/kg	1.5 mg/kg
1,3-Dichlorobenzene		1 mg/kg	1.5 mg/kg
1,4-Dichlorobenzene		1 mg/kg	1.5 mg/kg
1,2-Dichlorobenzene		1 mg/kg	1.5 mg/kg
bis(2-chloroisopropyl) ether		1 mg/kg	1.5 mg/kg
4-Methylphenol		1 mg/kg	1.5 mg/kg
N-nitroso-di-n-propylamine		1 mg/kg	1.5 mg/kg
Hexachloroethane		1 mg/kg	1.5 mg/kg
Nitrobenzene		1 mg/kg	1.5 mg/kg
Isophorone		1 mg/kg	1.5 mg/kg
2-Nitrophenol		1 mg/kg	1.5 mg/kg
2,4-Dimethylphenol		1 mg/kg	1.5 mg/kg

Table 3 (Continued)

PARAMETER	ANALYTICAL METHOD	REPORTING LIMITS 0% MOISTURE	REPORTING LIMITS 35% MOISTURE
Priority Pollutant Metals			
Antimony	3050/6010	7.6 mg/kg	11.7 mg/kg
Arsenic	3050/7060	0.5 mg/kg	0.8 mg/kg
Beryllium	3050/6010	0.1 mg/kg	0.2 mg/kg
Cadmium	3050/6010	0.1 mg/kg	0.2 mg/kg
Chromium	3050/6010	1.1 mg/kg	1.7 mg/kg
Copper	3050/6010	0.6 mg/kg	0.9 mg/kg
Lead	3050/6010	5.9 mg/kg	9.1 mg/kg
Mercury	7471	8.0 mg/kg	12.3 mg/kg
Nickel	3050/6010	1.1 mg/kg	1.7 mg/kg
Selenium	3050/7740	0.4 mg/kg	0.6 mg/kg
Silver	3050/6010	0.6 mg/kg	0.9 mg/kg
Thallium	3050/6010	10.8 mg/kg	16.6 mg/kg
Zinc	3050/6010	0.4 mg/kg	0.6 mg/kg

Note: All analytical results and reporting limits for soil and sediment samples in this report are given on a dry weight basis. This means that the reporting limits for each sample are dependent on the percent moisture content of that sample. The reporting limits shown in this table encompass the range of moisture contents in samples collected at Malmstrom AFB during this investigation.

Table 4

Parameters, Analytical Methods, and Reporting Limits
For Water Samples
Malmstrom AFB and Kalispell AFS

PARAMETER	ANALYTICAL METHOD	REPORTING LIMITS
Petroleum Hydrocarbons	418.1	1 mg/L
Ketones	5030/8015	
2-Butanone		3 ug/L
4-Methyl-2-pentanone		3 ug/L
Halogenated Volatiles	601	
Chloromethane		0.08 ug/L
Bromomethane		1.18 ug/L
Dichlordifluoromethane		1.81 ug/L
Vinyl Chloride		0.18 ug/L
Chloroethane		0.52 ug/L
Methylene Chloride		0.25 ug/L
Trichlorofluoromethane		0.13 ug/L
1,1-Dichloroethene		0.13 ug/L
1,1-Dichloroethane		0.07 ug/L
trans-1,2-Dichloroethene		0.10 ug/L
Chloroform		0.05 ug/L
1,2-Dichloroethane		0.03 ug/L
1,1,1-Trichloroethane		0.03 ug/L
Carbon tetrachloride		0.12 ug/L
Bromodichloromethane		0.10 ug/L
1,2 Dichloropropane		0.04 ug/L
trans-1,3-Dichloropropene		0.34 ug/L
Trichloroethene		0.12 ug/L
Dibromochloromethane		0.09 ug/L
1,1,2-Trichloroethane		0.02 ug/L
cis-1,3-Dichloropropene		0.20 ug/L
2-Chloroethyl vinyl ether		0.13 ug/L
Bromoform		0.20 ug/L
1,1,2,2,-Tetrachloroethane		0.03 ug/L
Tetrachloroethene		0.03 ug/L
Chlorobenzene		0.25 ug/L
1,3-Dichlorobenzene		0.32 ug/L
1,2-Dichlorobenzene		0.15 ug/L
1,4-Dichlorobenzene		0.24 ug/L

Table 4 (Continued)

PARAMETER	ANALYTICAL METHOD	REPORTING LIMITS
Aromatic Volatiles	602	
Benzene		0.2 ug/L
Toluene		0.2 ug/L
Ethylbenzene		0.2 ug/L
Chlorobenzene		0.2 ug/L
p-xylene		0.3 ug/L
m-xylene		0.3 ug/L
o-xylene		0.3 ug/L
1,4-dichlorobenzene		0.3 ug/L
1,3-Dichlorobenzene		0.4 ug/L
1,2-Dichlorobenzene		0.4 ug/L
Extractable Priority Pollutants	625	
Phenol		10 ug/L
bis (2-chloroethyl) ether		10 ug/L
2-Chlorophenol		10 ug/L
1,3 Dichlorobenzene		10 ug/L
1,4-Dichlorobenzene		10 ug/L
1,2-Dichlorobenzene		10 ug/L
bis(2-chloroisopropyl) ether		10 ug/L
4-Methylphenol		10 ug/L
N-nitroso-di-n-propylamine		10 ug/L
Hexachloroethane		10 ug/L
Nitrobenzene		10 ug/L
Isophorone		10 ug/L
2-Nitrophenol		10 ug/L
2,4-Dimethylphenol		10 ug/L
bis(2-chloroethoxy) methane		10 ug/L
1,2,4-Trichlorobenzene		10 ug/L
Napthalene		10 ug/L
Hexachlorobutadiene		10 ug/L
4-Chloro-3-methylphenol		10 ug/L
Hexachlorocyclopentadiene		10 ug/L
2,4,6-Trichlorophenol		10 ug/L
2-Chloronaphthalene		10 ug/L
Dimethyl Phthalate		10 ug/L
Acenaphthylene		50 ug/L
N-Nitrosodimethylamine		50 ug/L
Benzidine		50 ug/L
2,4-Diphenylhydrazine		10 ug/L
Acenaphthene		10 ug/L
2,4-Dinitrophenol		10 ug/L
4-Nitrophenol		10 ug/L
2,4-Dinitrotoluene		10 ug/L
2,6-Dinitrotoluene		10 ug/L
Diethyl Phthalate		10 ug/L
4-Chlorophenylphenyl ether		10 ug/L

Table 4 (Continued)

PARAMETER	ANALYTICAL METHOD	REPORTING LIMITS
Extractable Priority Pollutants (Continued)	625	
Fluorene		10 ug/L
4,6-Dinitro-2-methylphenol		10 ug/L
N-Nitrosodiphenylamine		10 ug/L
4-Bromophenylphenylether		10 ug/L
Hexachlorobenzene		10 ug/L
Pentachlorophenol		10 ug/L
Phenanthrene		10 ug/L
Anthracene		10 ug/L
Di-n-butyl phthalate		10 ug/L
Fluoranthene		10 ug/L
Butylbenzylphthalate		10 ug/L
3,3'-Dichlorobenzidine		20 ug/L
Benzo(a)anthracene		10 ug/L
bis-(2-ethylhexyl)phthalate		10 ug/L
Chrysene		10 ug/L
Di-n-octyl phthalate		10 ug/L
Benzo(b)fluoranthene		10 ug/L
Benzo(k)fluoranthene		10 ug/L
Indeno(1,2,3-cd)pyrene		10 ug/L
Dibenzo(a,h)anthracene		10 ug/L
Benzo(g,h,i)perylene		10 ug/L
Priority Pollutant Metals		
Antimony	200.7	77.2 ug/L
Arsenic	206.2	4.8 ug/L
Beryllium	200.7	0.7 ug/L
Cadmium	200.7	1.4 ug/L
Chromium	200.7	11.3 ug/L
Copper	200.7	6.4 ug/L
Lead	200.7	60.3 ug/L
Mercury	245.1	0.6 ug/L
Nickel	200.7	11.5 ug/L
Selenium	270.2	4.4 ug/L
Silver	200.7	6.6 ug/L
Thallium	200.7	110 ug/L
Zinc	200.7	3.9 ug/L
Common Anions		
Bromide	300.0	0.2 mg/L
Chloride	300.0	0.2 mg/L

Table 4 (Continued)

PARAMETER	ANALYTICAL METHOD	REPORTING LIMITS
Common Anions (Continued)		
Fluoride	300.0	0.2 mg/L
Nitrate-N	300.0	0.2 mg/L
Nitrite-N	300.0	0.2 mg/L
Phosphate	300.0	0.2 mg/L
Sulfate	300.0	0.2 mg/L
Total Dissolved Solids	160.1	0.1 mg/L

APPENDIX F

Chain-of-Custody Forms

F-1

PEI ASSOCIATES, INC.
SAMPLE SHIPPING/RECEIVING RECORD

1. NAME OF ESTABLISHMENT _____ PN _____

2. SENDER	3. CARRIER	4. RECEIVER
Signature Mary F. Bergstrom	Company Federal Express	Courier from Depot
Date 7 October 86	Signature J. Mc Haigh	Signature _____
Sent From Kalispell, MT	Date Oct. 7, 1986	Date _____
	B/L No. 3794383 23	LAB CUSTODIAN
		Signature Jami Miller
		Date 10/8/86
		Condition upon Receipt No chain of custody seals

5. SHIPMENT DESCRIPTION

	Seal No.	Seal Intact?	Seal No.	Seal Intact?
Number of Packages				
Sealed (yes or no)				
Types of Containers				
Condition prior to Shipment				

6. CONTENTS

Sample I.D. No.	Type of Sample	Sealed (yes or no)	Seal No. if any	Condition (damaged, loss of liquid, etc.)
GP-86-1006B	Water			
GP-86-1007B	water			
GP-86-1008B	"			
GP-86-1009B	"			
GP-86-1010B	"			

PEI ASSOCIATES, INC.
SAMPLE SHIPPING/RECEIVING RECORD

1. NAME OF ESTABLISHMENT _____ PN _____

2. SENDER

Signature Mary F. Bingham
Date 7 October 86
Sent From Kalispell AFS, Montana

3. CARRIER

Company Federal Express
Signature [illegible]
Date Oct. 7, 1986
B/L No. 3794383 23

4. RECEIVER

Courier from Depot
Signature _____
Date _____
LAB CUSTODIAN
Signature Jami Miller
Date 10/8/86
Condition upon Receipt No chain of Custody seals

5. SHIPMENT DESCRIPTION

	Seal No.	Seal Intact?	Seal No.	Seal Intact?
Number of Packages				
Sealed (yes or no)				
Types of Containers				
Condition prior to Shipment				

6. CONTENTS

Sample I.D. No.	Type of Sample	Sealed (yes or no)	Seal No. if any	Condition (damaged, loss of liquid, etc.)
CS-86-1000B	Soil			
CS-86-1001B	Soil			
CS-86-1002B	Soil			
CS-86-1003B	Soil			
CS-86-1004B	Soil			
CS-861005B	Soil			

APPENDIX G

Analytical Data

PEI Associates, Inc.
11499 Chester Road
Cincinnati, OH 45246
(513) 782-4700

Cover Form 1
Report Date: 11/14/86

United States Air Force
Occupational and Environmental Health Laboratory
Brooks Air Force Base, TX 78235-5501
Contract No. F33615-85-D-4507
Task Order: 15
Base: Malmstrom AFB
Site: OB-3 (Kalispell AFS)

Reviewed Chain-of-Custody: Yes

Base Sample Number	Site Sampling Identifier	PEI Number	Matrix	Sample Date	Sample Time
CS-86-1000B	0124-SO-076	FZ541	Soil	10/06/86	1645
CS-86-1001B	0124-SO-076	FZ542	Soil	10/06/86	1700
CS-86-1002B	0124-SO-076	FZ543	Soil	10/06/86	1715
CS-86-1003B	0124-SO-076	FZ544	Soil	10/06/86	1745
CS-86-1004B	0124-SO-076	FZ545	Soil	10/06/86	1800
CS-86-1005B	0124-SO-076	FZ546	Soil	10/06/86	1815

NR = Not Recorded in field

Submitted by: Craig H Caldwell

PEI Associates, Inc.
11499 Chester Road
Cincinnati, OH 45246
(513) 782-4700

Cover Form 2
Report Date: 11/14/86

United States Air Force
Occupational and Environmental Health Laboratory
Brooks Air Force Base, TX 78235-5501
Contract No. F33615-85-D-4507
Task Order: 15
Base: Malmstrom AFB
Site: OB-3 (Kalispell AFS)

Analyses performed on samples from this site

Analysis	Method No.
Aromatic volatiles	5030/8020
Petroleum hydrocarbons	3550/418.1
Moisture	ASTM D2216

Submitted by: Greg H Caldwell

PEI Associates, Inc.
11499 Chester Road
Cincinnati, Ohio 45246
(513) 782-4700

Base: Malmstrom
Site: OB-3
Task Order: 15

United States Air Force / O.E.H.L.
Brooks Air Force Base, TX 78235
Contract No. F33615-85-D-4507

Report Date: 11-10-86

Analysis of solids for percent moisture by ASTM D2216:

Field I.D.	PEI I.D.	Sample Date	Analysis Date	Moisture Percent
CS-86-1000	FZ541	10-7-86	11-4-86	23.7
CS-86-1001	FZ542	10-7-86	11-4-86	17.9
CS-86-1002	FZ543	10-7-86	11-4-86	23.7
CS-86-1003	FZ544	10-7-86	11-4-86	31.9
CS-86-1004	FZ545	10-7-86	11-4-86	24.4
CS-86-1005	FZ546	10-7-86	11-4-86	12.3

Submitted by: T. Sanders

PEI Associates, Inc.
11499 Chester Road
Cincinnati, Ohio 45246
(513) 782-4700

Base: Malmstrom
Site: OB-3
Task Order: 15

United States Air Force / O.E.H.L.
Brooks Air Force Base, TX 78235
Contract No. F33615-85-D-4507

Report Date: 11-10-86

Analysis of solids for Petroleum Hydrocarbons by Method 3550/418.1

(Reporting limits and data are on a dry basis)

Field I.D.	PEI I.D.	Reporting Limit, mg/kg	Sample Date	Extract Date	Analysis Date	Moisture Percent	Result mg/kg
CS-86-1000	FZ541	131	10-7-86	10-14-86	1--20-86	23.7	ND
CS-86-1001	FZ542	122	10-7-86	10-14-86	1--20-86	17.9	ND
CS-86-1002	FZ543	131	10-7-86	10-14-86	1--20-86	23.7	ND
CS-86-1003	FZ544	147	10-7-86	10-14-86	1--20-86	31.9	ND
CS-86-1004	FZ545	132	10-7-86	10-14-86	1--20-86	24.4	ND
CS-86-1005	FZ546	114	10-7-86	10-14-86	1--20-86	12.3	829
CS-86-1005	FZ546 *	114	10-7-86	10-14-86	1--20-86	12.3	699
	Blank	100	10-7-86	10-14-86	1--20-86	0	ND

* = Replicate

alk 10/20/86
CHC 3/17/87

ND = Not detected

Submitted by: T. Sanders

PEI Associates, Inc.
11499 Chester Road
Cincinnati, Ohio 45246
(513) 782-4700

Base: Malmstrom
Site: OB-3
Task Order: 15
Base Sample No.: CS-86-1000B
PEI Number: FZ541

United States Air Force / O.E.H.L.
Brooks Air Force Base, TX 78235
Contract No. F33615-85-D-4507

Sampling Date: 10-6-86
Extraction Date: 10-18-86
Report Date: 12-3-86

==========

Analysis of solid samples for aromatic volatiles by Method 5030/8020

Moisture: 23.7 % (Reporting limits and data are on a dry basis)

Compound	Reporting Limit, mg/Kg	Col 1 Result
Benzene	1.3	ND
Toluene	1.3	ND
Ethylbenzene	1.3	ND
Chlorobenzene	1.3	ND
p-xylene	1.3	ND
m-Xylene	1.3	ND
o-Xylene	1.3	ND
1,4-dichlorobenzene	1.3	ND
1,3-Dichlorobenzene	1.3	ND
1,2-Dichlorobenzene	1.3	ND

Analysis Date(s): 10-18-86

ND = Not detected

Submitted by: T. Sander

PEI Associates, Inc.
11499 Chester Road
Cincinnati, Ohio 45246
(513) 782-4700

Base: Malmstrom
Site: OB-3
Task Order: 15
Base Sample No.: CS-86-1001B
PEI Number: FZ542

United States Air Force / O.E.H.L.
Brooks Air Force Base, TX 78235
Contract No. F33615-85-D-4507

Sampling Date: 10-6-86
Extraction Date: 10-18-86
Report Date: 12-3-86

==========

Analysis of solid samples for aromatic volatiles by Method 5030/8020

Moisture: 17.9 % (Reporting limits and data are on a dry basis)

Compound	Reporting Limit, mg/Kg	Col 1 Result
Benzene	1.2	ND
Toluene	1.2	ND
Ethylbenzene	1.2	ND
Chlorobenzene	1.2	ND
p-xylene	1.2	ND
m-Xylene	1.2	ND
o-Xylene	1.2	ND
1,4-dichlorobenzene	1.2	ND
1,3-Dichlorobenzene	1.2	ND
1,2-Dichlorobenzene	1.2	ND

Analysis Date(s): 10-18-86

ND = Not detected

Submitted by: T. Sanders

PEI Associates, Inc.
11499 Chester Road
Cincinnati, Ohio 45246
(513) 782-4700

Base: Malmstrom
Site: OB-3
Task Order: 15
Base Sample No.: CS-86-1002B
PEI Number: FZ543

United States Air Force / O.E.H.L.
Brooks Air Force Base, TX 78235
Contract No. F33615-85-D-4507

Sampling Date: 10-6-86
Extraction Date: 10-18-86
Report Date: 12-3-86

==========

Analysis of solid samples for aromatic volatiles by Method 5030/8020

Moisture: 23.7 % (Reporting limits and data are on a dry basis)

Compound	Reporting Limit, mg/Kg	Col 1 Result
Benzene	1.3	ND
Toluene	1.3	ND
Ethylbenzene	1.3	ND
Chlorobenzene	1.3	ND
p-xylene	1.3	ND
m-Xylene	1.3	ND
o-Xylene	1.3	ND
1,4-dichlorobenzene	1.3	ND
1,3-Dichlorobenzene	1.3	ND
1,2-Dichlorobenzene	1.3	ND

Analysis Date(s): 10-18-86

ND = Not detected

Submitted by: T. Sam

PEI Associates, Inc.
11499 Chester Road
Cincinnati, Ohio 45246
(513) 782-4700

Base: Malmstrom
Site: OB-3
Task Order: 15
Base Sample No.: CS-86-1002B
PEI Number: FZ543

United States Air Force / O.E.H.L.
Brooks Air Force Base, TX 78235
Contract No. F33615-85-D-4507

Sampling Date: 10-6-86
Extraction Date: 10-18-86
Report Date: 12-3-86

==========

Analysis of solid samples for aromatic volatiles by Method 5030/8020

Moisture: 23.7 % (Reporting limits and data are on a dry basis)

Compound	Reporting Limit, mg/Kg	Col 1 Result
Benzene	1.3	ND
Toluene	1.3	ND
Ethylbenzene	1.3	ND
Chlorobenzene	1.3	ND
p-xylene	1.3	ND
m-Xylene	1.3	ND
o-Xylene	1.3	ND
1,4-dichlorobenzene	1.3	ND
1,3-Dichlorobenzene	1.3	ND
1,2-Dichlorobenzene	1.3	ND

Analysis Date(s): 10-20-86

ND = Not detected

Submitted by: T. Sandlin

PEI Associates, Inc.
11499 Chester Road
Cincinnati, Ohio 45246
(513) 782-4700

Base: Malmstrom
Site: OB-3
Task Order: 15
Base Sample No.: CS-86-1003B
PEI Number: FZ544

United States Air Force / O.E.H.L.
Brooks Air Force Base, TX 78235
Contract No. F33615-85-D-4507

Sampling Date: 10-6-86
Extraction Date: 10-18-86
Report Date: 12-3-86

==========

Analysis of solid samples for aromatic volatiles by Method 5030/8020

Moisture: 31.9 % (Reporting limits and data are on a dry basis)

Compound	Reporting Limit, mg/Kg	Col 1 Result
Benzene	1.5	ND
Toluene	1.5	ND
Ethylbenzene	1.5	ND
Chlorobenzene	1.5	ND
p-xylene	1.5	ND
m-Xylene	1.5	ND
o-Xylene	1.5	ND
1,4-dichlorobenzene	1.5	ND
1,3-Dichlorobenzene	1.5	ND
1,2-Dichlorobenzene	1.5	ND

Analysis Date(s): 10-20-86

ND = Not detected

Submitted by: V. Sa

PEI Associates, Inc.
11499 Chester Road
Cincinnati, Ohio 45246
(513) 782-4700

Base: Malmstrom
Site: OB-3
Task Order: 15
Base Sample No.: CS-86-1004B
PEI Number: FZ545

United States Air Force / O.E.H.L.
Brooks Air Force Base, TX 78235
Contract No. F33615-85-D-4507

Sampling Date: 10-6-86
Extraction Date: 10-18-86
Report Date: 12-3-86

==========

Analysis of solid samples for aromatic volatiles by Method 5030/8020

Moisture: 24.4 % (Reporting limits and data are on a dry basis)

Compound	Reporting Limit, mg/Kg	Col 1 Result
Benzene	1.3	ND
Toluene	1.3	ND
Ethylbenzene	1.3	ND
Chlorobenzene	1.3	ND
p-xylene	1.3	ND
m-Xylene	1.3	ND
o-Xylene	1.3	ND
1,4-dichlorobenzene	1.3	ND
1,3-Dichlorobenzene	1.3	ND
1,2-Dichlorobenzene	1.3	ND

Analysis Date(s): 10-20-86

ND = Not detected

Submitted by: T. Sandlin

PEI Associates, Inc.
11499 Chester Road
Cincinnati, Ohio 45246
(513) 782-4700

Base: Malmstrom
Site: OB-3
Task Order: 15
Base Sample No.: CS-86-1005B
PEI Number: FZ546

United States Air Force / O.E.H.L.
Brooks Air Force Base, TX 78235
Contract No. F33615-85-D-4507

Sampling Date: 10-6-86
Extraction Date: 10-18-86
Report Date: 12-3-86

==========

Analysis of solid samples for aromatic volatiles by Method 5030/8020

Moisture: 12.3 % (Reporting limits and data are on a dry basis)

Compound	Reporting Limit, mg/Kg	Col 1 Result
Benzene	1.1	ND
Toluene	1.1	ND
Ethylbenzene	1.1	ND
Chlorobenzene	1.1	ND
p-xylene	1.1	ND
m-Xylene	1.1	ND
o-Xylene	1.1	ND
1,4-dichlorobenzene	1.1	ND
1,3-Dichlorobenzene	1.1	ND
1,2-Dichlorobenzene	1.1	ND

Analysis Date(s): 10-20-86

ND = Not detected

Submitted by: T. Sam

PEI Associates, Inc.
11499 Chester Road
Cincinnati, OH 45246
(513) 782-4700

Cover Form 1
Report Date: 11/14/86

United States Air Force
Occupational and Environmental Health Laboratory
Brooks Air Force Base, TX 78235-5501
Contract No. F33615-85-D-4507
Task Order: 15
Base: Malmstrom AFB
Site: OB-3 (Kalispell AFS)

Reviewed Chain-of-Custody: Yes

Base Sample Number	Site Sampling Identifier	PEI Number	Matrix	Sample Date	Sample Time
GP-86-1006B	0124-PS-076	FZ547	Water	10/06/86	1400
GP-86-1007B	0124-PS-076	FZ548	Water	10/06/86	1445
GP-86-1008B	0124-PS-076	FZ549	Water	10/06/86	1500
GP-86-1009B	0124-PS-076	FZ550	Water	10/06/86	1515
GP-86-1010B	0124-PS-076	FZ551	Water	10/06/86	1530

NR = Not Recorded in field

Submitted by: Gail Caldwell

PEI Associates, Inc.
11499 Chester Road
Cincinnati, OH 45246
(513) 782-4700

Cover Form 2
Report Date: 11/14/86

United States Air Force
Occupational and Environmental Health Laboratory
Brooks Air Force Base, TX 78235-5501
Contract No. F33615-85-D-4507
Task Order: 15
Base: Malmstrom AFB
Site: OB-3 (Kalispell AFS)

Analyses performed on samples from this site

Analysis	Method No.
Aromatic volatiles	602
Petroleum hydrocarbons	418.1

Submitted by: Craig H Caldwell

PEI Associates, Inc.
11499 Chester Road
Cincinnati, Ohio 45246
(513) 782-4700

Base: Malmstrom
Site: OB-3

Task Order: 15

United States Air Force / O.E.H.L.
Brooks Air Force Base, TX 78235
Contract No. F33615-85-D-4507

Report Date: 12-17-86

Analysis of waters for Petroleum Hydrocarbons by Method 418.1

Field I.D.	PEI I.D.	Reporting Limit, mg/liter	Sample Date	Extract Date	Analysis Date	Result mg/L
GP-86-1006	FZ547	1	10-7-86	10-14-86	10-20-86	ND
GP-86-1007	FZ548	1	10-7-86	10-14-86	10-20-86	ND
GP-86-1008	FZ549	1	10-7-86	10-14-86	10-20-86	ND
GP-86-1009	FZ550	1	10-7-86	10-14-86	10-20-86	ND
GP-86-1010	FZ551	1	10-7-86	10-14-86	10-20-86	ND
	Blank	1		10-14-86	10-20-86	ND

ND = Not detected

Submitted by: T. Sanders

PEI Associates, Inc.
11499 Chester Road
Cincinnati, Ohio 45246
(513) 782-4700

Base: Malmstrom
Site: OB-3
Task Order: 15
Base Sample No.: GP-86-1006B
PEI Number: FZ547

United States Air Force / O.E.H.L.
Brooks Air Force Base, TX 78235
Contract No. F33615-85-D-4507

Sampling Date: 10-6-86
Extraction Date: 10-17-86
Report Date: 12-3-86

==========

Analysis of water samples for aromatic volatiles by Method 602

Compound	Reporting Limit, ug/L	Col 1 Result
Benzene	1.0	ND
Toluene	1.0	ND
Ethylbenzene	1.0	ND
Chlorobenzene	1.0	ND
p-Xylene	1.0	ND
m-Xylene	1.0	ND
o-Xylene	1.0	ND
1,4-Dichlorobenzene	1.0	ND
1,3-Dichlorobenzene	1.0	ND
1,2-Dichlorobenzene	1.0	ND

Analysis Date(s): 10-17-86

ND = Not detected

Submitted by: T. Sanders

PEI Associates, Inc.
11499 Chester Road
Cincinnati, Ohio 45246
(513) 782-4700

Base: Malmstrom
Site: OB-3
Task Order: 15
Base Sample No.: GP-86-1007B
PEI Number: FZ548

United States Air Force / O.E.H.L.
Brooks Air Force Base, TX 78235
Contract No. F33615-85-D-4507

Sampling Date: 10-6-86
Extraction Date: 10-17-86
Report Date: 12-3-86

==========

Analysis of water samples for aromatic volatiles by Method 602

Compound	Reporting Limit, ug/L	Col 1 Result
Benzene	1.0	ND
Toluene	1.0	ND
Ethylbenzene	1.0	ND
Chlorobenzene	1.0	ND
p-Xylene	1.0	ND
m-Xylene	1.0	ND
o-Xylene	1.0	ND
1,4-Dichlorobenzene	1.0	ND
1,3-Dichlorobenzene	1.0	ND
1,2-Dichlorobenzene	1.0	ND

Analysis Date(s): 10-17-86

ND = Not detected

Submitted by: T. Sandlin

PEI Associates, Inc.
11499 Chester Road
Cincinnati, Ohio 45246
(513) 782-4700

Base: Malmstrom
Site: OB-3
Task Order: 15
Base Sample No.: GP-86-1008B
PEI Number: FZ549

United States Air Force / O.E.H.L.
Brooks Air Force Base, TX 78235
Contract No. F33615-85-D-4507

Sampling Date: 10-6-86
Extraction Date: 10-17-86
Report Date: 12-3-86

==========

Analysis of water samples for aromatic volatiles by Method 602

Compound	Reporting Limit, ug/L	Col 1 Result
Benzene	1.0	ND
Toluene	1.0	ND
Ethylbenzene	1.0	ND
Chlorobenzene	1.0	ND
p-Xylene	1.0	ND
m-Xylene	1.0	ND
o-Xylene	1.0	ND
1,4-Dichlorobenzene	1.0	ND
1,3-Dichlorobenzene	1.0	ND
1,2-Dichlorobenzene	1.0	ND
Analysis Date(s):		10-17-86

ND = Not detected

Submitted by: T. Sam

PEI Associates, Inc.
11499 Chester Road
Cincinnati, Ohio 45246
(513) 782-4700

Base: Malmstrom
Site: OB-3
Task Order: 15
Base Sample No.: GP-86-1009B
PEI Number: FZ550

United States Air Force / O.E.H.L.
Brooks Air Force Base, TX 78235
Contract No. F33615-85-D-4507

Sampling Date: 10-6-86
Extraction Date: 10-17-86
Report Date: 12-3-86

==========

Analysis of water samples for aromatic volatiles by Method 602

Compound	Reporting Limit, ug/L	Col 1 Result
Benzene	1.0	ND
Toluene	1.0	ND
Ethylbenzene	1.0	ND
Chlorobenzene	1.0	ND
p-Xylene	1.0	ND
m-Xylene	1.0	ND
o-Xylene	1.0	ND
1,4-Dichlorobenzene	1.0	ND
1,3-Dichlorobenzene	1.0	ND
1,2-Dichlorobenzene	1.0	ND
Analysis Date(s):		10-17-86

ND = Not detected

Submitted by: T. Sam

PEI Associates, Inc.
11499 Chester Road
Cincinnati, Ohio 45246
(513) 782-4700

Base: Malmstrom
Site: OB-3
Task Order: 15
Base Sample No.: GP-86-1010B
PEI Number: FZ551

United States Air Force / O.E.H.L.
Brooks Air Force Base, TX 78235
Contract No. F33615-85-D-4507

Sampling Date: 10-6-86
Extraction Date: 10-17-86
Report Date: 12-3-86

==========

Analysis of water samples for aromatic volatiles by Method 602

Compound	Reporting Limit, ug/L	Col 1 Result
Benzene	1.0	ND
Toluene	1.0	ND
Ethylbenzene	1.0	ND
Chlorobenzene	1.0	ND
p-Xylene	1.0	ND
m-Xylene	1.0	ND
o-Xylene	1.0	ND
1,4-Dichlorobenzene	1.0	ND
1,3-Dichlorobenzene	1.0	ND
1,2-Dichlorobenzene	1.0	ND
Analysis Date(s):		10-17-86

ND = Not detected

Submitted by: T. Sanders

APPENDIX H

Correspondence

October 3, 1986

Battelle Company
Denver, Colorado

Gentlemen:

Let this serve as permission to enter our land and do environmental testing. I understand that the date you will be here is October 6, or thereabouts.

Sincerely,

Rick Sorum

Rick Sorum
Administrator

RS/hp
cc: Captain Bill Holley

LINDA ARMBRUST
P.O. BOX 147
KALISPELL, MT 59903

1014

Mary Longstreet →

TELEPHONE CONVERSATION

☐ INCOMING ☒ OUTGOING

DATE OF CALL: 3/13/87 **CHARGE NUMBER**_____

FOR BATTELLE: Mary Bergstrom, Environmental Scientist **INTERNAL DISTRIBUTION**

OTHER PARTY: Mr. Kevin Keenan, Enforcement Officer

Company Affiliation: State of Montana
Water Quality Bureau

SUMMARY OF CALL:

Mr. Kevin Keenan had been asked by Mr. Steven Pilcher, Director of Montana Bureau of Water Quality, to find any files on "Lakeside YACC oil spill" the Bureau had. He located one file, and listed the contents of it over the phone to me. The fill consisted of a U.S. Forest Service analyses from Stoner Creek, an inspection report and some correspondence (the last of which was dated August 11, 1981). According to this file, the state did not take any samples of their own from Stoner Creek for analyses during 1981, nor have any been collected since the spill.

It appeared from our conversation that no information is contained in the Water Quality Bureau file which I do not already have from the U.S. Forest Service file from Big Fork.

TELEPHONE CONVERSATION

☐ INCOMING ☒ OUTGOING

DATE OF CALL: 3/12/87 **CHARGE NUMBER** _____

FOR BATTELLE: Mary Bergstrom, Environmental Scientist **INTERNAL DISTRIBUTION**

OTHER PARTY: Mr. Roger Thorvilson, Section Supervisor

Company Affiliation: Department of Health and Environmental Science
Solid and Hazardous Waste Bureau

SUMMARY OF CALL:

I asked him if Montana had any regulations or guidelines for acceptable limits of oil/petroleum in soil. He said that there were no guidelines or standards. Road oiling is legal in Montana, as long as no RCRA hazardous waste is mixed with it and it doesn't violate a fire prohibition code.

TELEPHONE CONVERSATION

☐ INCOMING ☐ OUTGOING

DATE OF CALL: 0820 Hrs 5/20/87

CHARGE NUMBER _____

FOR BATTELLE: Marty H. Doornbos

INTERNAL DISTRIBUTION

OTHER PARTY: Fred Shewman

Company Affiliation: Water Quality Bureau

SUMMARY OF CALL:

Discussed Montana rules and regulations for water observation well abandonment procedure. No formal written procedure exists for water well abandonment in Montana. Written rules do exist for abandonment of exploration drill holes.

Mr. Shewman suggested leaving these wells operational in case of further need. If this is the case, the casing should be equipped with a PVC pipe cap.

If these wells are to be abandoned, the casing should be pulled or cut off below land surface and the hole filled with bentonite pellets.

List of Contacts

Ms. Linda Brandvold, Engineering Geologist
Flathead National Forest Headquarters
P.O. Box 147
Kalispell, Montana 59901
(406) 755-5401

Mr. Kevin Keenan, Enforcement Officer
Water Quality Bureau
Cogswell Bldg.
Rm A-206
Helena, Montana 59620
(406) 444-2406

Mr. Wallace Page, Hydrologist
U.S. Forest Service
Flathead National Forest Headquarters
P.O. Box 147
Kalispell, Montana 59901
(406) 755-5401

Mr. William Pedersen, District Ranger
U.S. Forest Service
Big Fork Ranger Station
Big Fork, Montana 59911
(406) 837-5081

Mr. Kim S. Potter, Director
Disaster and Emergency Services
723 5th Ave. East
Kalispell, Montana 59901
(406) 752-5300

Mr. Fred Shewman, Supervisor of Permit Section
Water Quality Bureau
Cogswell Bldg.
Rm A-206
Helena, Montana 59620
(406) 444-2406

Mr. Roger Thorvilson, Section Supervisor
State of Montana
Department of Health and Environmental Sciences
Solid and Hazardous Waste Bureau
Rm B-201
Cogswell Bldg.
Helena, Montana 59620
(406) 444-2821

APPENDIX I

References

APPENDIX I

REFERENCES

Battelle Memorial Institute, 1985. Presurvey Report for Phase II Installation Restoration Program (IRP), Malmstrom Air Force Base, Montana, prepared for Department of the Air Force, Occupational and Environmental Health Laboratory, Brooks Air Force Base, Texas.

Boettcher, Arnold J., 1980. Ground-water Resources in the Central Part of the Flathead Indian Reservation, Northwestern Montana, U.S. Geological Survey Open-File Report 80-731, 41pp.

Brietkrietz, Alex, 1966. Basic Water Data Report No. 3 Kalispell Valley, Montana, Montana Bureau of Mines and Geology Bulletin 53, 25pp.

Clapp, C.H., 1932. Geology of A Portion of the Rocky Mountains of Northwestern Montana, Montana Bureau of Mines and Geology Memoir No. 4, 30pp.

Coe, 1959. Kalispell AFS, Additional Water Supplies, General Layout, US Army Corps of Engineers, Drawing No. AW71-05-03. 7 sheets.

Delk, Robert, 1974. Water Quality of Stoner Creek, Flathead National Forest Service, Swan Lake District, 21pp.

Farnes, P.E., 1971. Mountain Precipitation and Hydrology From Snow Surveys, Proc. West. Snow Conf., April 20-22, 1971, Billings, MT.

Johns, Willis M., 1962. Geologic Investigations in the Kootenai-Flathead Area, Northwest Montana, Southwestern Flathead County, Montana Bureau of Mines and Geology Bulletin 29, 38pp.

Johns, W.M., Smith, A.G., Barnes, W.C., Gilmour, E.H., and Page, W.D., 1963. Geologic Investigations in the Kootenai-Flathead Area, Northwest Montana, Montan Bureau of Mines and Geology Bulletin 36, 68pp.

Johns, Willis M., 1964. Progress Report on Geologic Investigations in the Kootenai-Flathead Area, Northwest Montana, Montana Bureau of Mines and Geology Bulletin 42, 66pp.

JRB Associates, 1985. Installation Restoration Program Phase I-Records Search, 341st Strategic Missile Wing, Malmstrom AFB, Montana, prepared for Strategic Air Command Offutt AFB, Nebraska.

Konizeski, R.L., Brietkrietz, Alex and McMurtrey, R.G., 1968. Geology and Ground Water Resources of the Kalispell Valley, Northwestern Montana, Montana Bureau of Mines and Geology Bulletin 68, 42pp.

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REFERENCES

Montan Bureau of Mines and Geology files, 1986.

NOAA, 1984. Climatological Data Annual Summary, Montana, National Oceanic and Atmospheric Administration, Volume 87, Number 13.

Ross, Clyde P., 1959. Geology of Glacier National Park and the Flathead Region Northwestern Montana, Geological Survey Professional Paper 296, 121pp.

APPENDIX J

Biographies of Key Personnel

WILLIAM MCNEILL

Manager,
Environmental Sciences and Engineering

Education

B.A., Chemistry, Colgate University
M.A., Inorganic Chemistry, Temple University
Ph.D., Physical Chemistry, Temple University

Qualifications

Dr. McNeill has had extensive experience in planning and managing technical operations on military-related environmental projects. He retired as Director of Technical Operations for the Rocky Mountain Arsenal before joining Battelle. His responsibilities have included environmental monitoring and compliance with environmental regulations, demilitarization of toxic chemical materials, development of environmental response programs, and operation of demilitarization and contamination control processes and plants. Dr. McNeill has participated in frequent briefings to senior officials including the Governor of Colorado, members of Congress, chiefs of staff of the U.S. Army, the administrator of the EPA, and military officers. He has also served on numerous environmental task groups and committees.

Relevant Experience at Battelle

Operations Manager, Battelle Denver Operations, Denver, Colorado. Responsible for program development, staff development, marketing, research in environmental and health sciences, hazardous waste management, water quality, and water resources. Program Manager, Air Force Installation Restoration Program for eight installations. Program Manager, USATHAMA Novel Processes for chemical agent decontamination in buildings.

Prior Professional Experience

Rocky Mountain Arsenal. Held positions of Chief Scientist, Director of Process and Environmental Assurance and Chief of Environmental Division. As Director of Technical Operations, an organization of 100 scientists, engineers, and technicians, responsible for all technical mission programs and briefings to senior officials and for participation in task group and committee activities.

Frankford Arsenal, Philadelphia Pennsylvania. As director of Applied Science, responsible for research and development in laser safety, laser countermeasures, and advanced concepts in support of commodity mission

WILLIAM MCNEILL (Continued)

development programs. Served as Chief of the Barrier Counterbarrier Office established to coordinate technical programs of 12 Army agencies in mine and barrier detection and countermeasures. Also, as Chief of Physical Chemical Branch, responsible for research programs in electrochemistry, thin films, and spectroscopy. Developed new laboratory capabilities and staff for research on the adsorption and scattering of laser radiation.

Professional Recognition and Affiliations

Member, American Chemical Society
Member, American Ordnance Association
Member, Association of Old Crows
Member, Sigma Xi

Served on the Governor's Task Force on Rocky Mountain Arsenal. Was Co-Chairman of the Technical Review Committee on the RMA Environmental Program and Ad Hoc Chairman of the Negotiation Team -- Memorandum of Agreement on RMA Remedial Action Program with Environmental Protection Agency, Colorado Department of Health, and Shell Oil Company. Directed investigation of the National Task Team to investigate leaking Weteye bombs.

Selected Publications

Dr. McNeill is the author of 24 technical papers, 11 U.S. Government Reports, and holds 10 U.S. patents. Selected publications include:

McNeill, W. M. et al. 1979. Investigation of leaking weteye bombs. Report of the Weteye Reassessment Inspection Task Group. Rocky Mountain Arsenal and the Army Materials and Mechanics Research Center, October.

McNeill, W. M. 1976. Chemical demilitarization capabilities at Rocky Mountain Arsenal. American Defense Preparedness Association Symposium on Demilitarization of Munitions, Hawthorne, Nevada. April.

McNeill, W. M. 1973. Laser hardened materials--Army overview. DoD High Energy Laser Effects Conference, Monterey, CA. October.

McNeill, W. M. 1969. Anodic spark synthesis of ceramic materials. Invited paper presented to The American Ceramic Society. Spring Meeting, Philadelphia, PA.

Jennings, T. and W. M. McNeill. 1968. Sputtering due to negative oxygen ions in oxygen discharges. Applied Physics Letters, January.

RICHARD M. WINAR

Senior Research Scientist
Environmental Sciences Division

Education

B.S. Geology, University of Illinois
M.S. Geology, University of Illinois

Qualifications

Mr. Winar's more than 25 years experience as a professional geologist coupled with his broad academic training have provided him with a versatile background that is successfully being applied to the solution of problems associated with hazardous waste, groundwater geology, environmental geology, waste disposal, and related fields.

In addition he has both directed and participated in numerous siting and multi-disciplinary studies which included ecology, meteorology, air quality, engineering, water quality, and socioeconomic studies. Being a project director and vice president and partner in Dames & Moore and also as chief geologist for Gustavson Associates has provided him with training in the management of project and personnel.

Relevant Experience at Battelle

Senior Research Scientist & Project Manager. Mr. Winar has headed hazardous waste investigations being carried out at Air Force Bases in Guam and Montana. This work entailed the technical and/or project management of numerous sites associated with landfills, oil and fuel spills, groundwater contamination, and monitoring wells, as well as associated studies. The completion of studies will require an environmental analyses of the hazardous waste areas and resultant contaminates and recommendations as to mitigation of these problems.

Prior Professional Experience

Gustavson Associates, Inc. Vice President and Chief Geologist, technical and personnel management of a staff of professional consulting geologist and petroleum engineers, and project director of selected programs. Accomplished natural resource assessments, environmental assessments of coal degasifications and shale gas wells, and filed water quality discharge permits for mine development, provided management direction and technical input to groundwater investigation reports and applications for groundwater discharge permits associated with 12 power plants in Florida, applied EM surveys to the determination of contaminant plumes adjacent to groundwater inputs. Directed hazardous waste assessment proposals for numerous clients.

RICHARD M. WINAR (Continued)

Dames & Moore. Firm partner and project director of environmental and earth sciences program. Directed water quality and groundwater monitoring; investigated fly ash and solid waste disposal location; performed siting studies for nuclear and fossil-fueled power plants, transmission lines, industrial plants, pipelines, etc.; project management of multi-discipline monitoring and impact studies including biological baseline studies, geology, air quality monitoring, socio-economic, land use, and meteorology; consulted on underground gas storage environmental concerns and geology; designed hazardous waste disposal studies; directed and geohydrological studies for radioactive waste disposal, and feasibility of industrial disposal wells; underwent hazardous waste safety training.

Environmental Planning Staff of Commonwealth Edison Company. Staff Geologist. Directed sampled programs that yielded QA/QC chain-of-custody samples. Selected solid waste disposal sites; investigated geohydrology and water supply problems; directed environmental, geological, biological, meteorological, and power plant siting studies. Headed Corps of Engineer's Discharge Permit Applications for numerous power plants, performed surface water hydrology studies. Trouble shooter for pollution problems at 17 power plants: directed studies on thermal and atmospheric problems at co ling lakes; interfaced with government environmental geology to power generation actions which caused pollution problems.

Earth Science Laboratories. Consulting Geologist and Manager of Underground Disposal Operation. Directed gas storage exploration and environmental assessment; completed groundwater surveys, deep well disposal feasibility studies, solid waste disposal site evaluations, and water pollution reports, undertook oil and gas prospect evaluations; offered expert testimony, and managed exploration drilling programs.

Consulting Geologist, self-employed. Grand Rapids, Michigan. Conducted water pollution control and groundwater studies; supervised well drilling and exploration programs; accomplished water well and salt water disposal well designs; completed a 6,000 foot industrial disposal well's feasibility, drilling, casing installation, permitting, etc.; provided testimony in state and court hearings; completed mineral evaluations.

Exxon Corporation. Exploration Geologist - Illinois, Indiana, Kentucky, and Michigan. Exploration geology and production geology, geological supervision of the drilling of over 400 wells, various stratigraphic studies.

Professional Recognition and Affiliations

Professional Geologist, Certification No. 190, State of Delaware, Board of Registration

Registered Geologist, Certification No. 3392, State of California, Board of Registration for Geologists and Geophysicists.

RICHARD M. WINAR (Continued)

Certified Professional Geologist No. 1951, American Institute of Petroleum Geologists

American Institute of Professional Geologists: elected 1983 as National Vice President, past Chairman of the Educational Affairs Committee, Chairman of National Ethics Committee, past Vice President and Treasurer of Colorado Section, past President of the Illinois Section

Water Pollution Control Federation: past member over ten years

American Association of Petroleum Geologists: past Area Representative for Michigan

Selected Publications

Winar, Richard M., Molas and Associated Formations in the San Juan Basin, Bull. of American Association of Petroleum Geology, Vol. 42, September 1958.

Winar, Richard M., et al, Mississippi-Pennsylvanian Boundary in Southwestern Colorado, Symposium on Lower and Middle Paleozoic Rocks of Colorado, 1 Rocky Mountain Association of Geologists, 1961. Edited by Berg. R.R. and Rold J.W.

Winar, Richard M., The Disposal of Wastewater Underground, Industrial Water Engineering, March 1967.

Winar, Richard M., Environmental Concerns of Underground Compressed Air Energy Storage, Proceedings of the Workshop on Compressed Air Energy Storage Systems, Arlie House, Virginia, December 18 & 19, 1975, Winar, Richard M., Possibilities for Increased Underground Gas Storage Along the Atlantic Seaboard, pp 222-226, American Gas Association, 1975 Section Operating Proceedings.

Winar, Richard M., Needed: More Underground Gas Storage Along Atlantic Seaboard, Pipeline and Gas Journal, November 1976, pp. 30-37.

Winar, Richard M., et al, Feasibility of Underground Storage/Disposal of Noble Gas Fission Products, August 1979, ANL 78-81, Argonne National Library.

Winar, Richard M., Crystalline Intrusives in the United States and Regional Geologic Characteristics Important for Storage of Radioactive Waste, Report NO. ONW 1-50, December 1979.

RICHARD M. WINAR (Continued)

Winar, Richard M., et al, Regional Site Selection Criteria for Nuclear Waste Disposal Repositories, Proceedings of ASCOPE 1981, the ASEAN Council on Petroleum, Second Conference, Manila, Philippines.

Winar, Richard M. and Chairman LaSala, A.M. Jr., et al, Radioactive Waste - Issues and Answers, information booklet published and distributed by the American Institute of Professional Geologists, Arvada, Colorado, September 1984.

MARY F. BERGSTROM

Environmental Scientist
Environment and Health Sciences
Battelle Denver Operations

Education

B.S., Geology, University of Washington
M.S., Environmental Biology, Ohio State University

Qualifications

Ms. Bergstrom's diverse technical background includes training in geology, ecology, limnology, and arctic soil and vegetation analysis. In the field of hazardous waste investigation and cleanup, she has planned, supervised, and conducted site investigations involving field sampling of contaminated environmental media. She has been responsible for researching and evaluating regulatory compliance requirements of Federal laws (CERCLA, RCRA, NEPA, CWA, etc.) and state laws for permitting purposes. She has researched and written worker protection plans that comply with EPA, U.S. Air Force, and OSHA regulations and is well versed in U.S. Army regulations for field investigation of chemical warfare agent-contaminated media. She has been responsible for the technical writing as well as the review of work plans and studies required under the National Contingency Plan (CERCLA) and for the comparable Investigation Restoration Program of the Air Force.

Relevant Experience at Battelle

Decontamination Technology Study. Subtask leader for a project investigating ways to decontaminate buildings that are contaminated with chemical warfare agents. Responsible for writing a work plan that complied with pertinent U.S. Army, federal and state environmental, safety, and surety regulations. Also responsible for securing the necessary permits and authorizations to proceed with the plan.

Hazardous Waste Site Investigations. Responsible for providing technical input into the planning and implementation of site investigations in the western U.S. and Guam; for writing site health and safety plans and technical reports; for performing field investigations; for providing a liaison between project leaders and laboratory subcontractors.

MARY F. BERGSTROM (Continued)

Prior Professional Experience

State of Ohio Environmental Projection Agency. As a hazardous waste investigator of unregulated sites, her responsibilities included identifying, field surveying, sampling, and evaluating potential hazardous waste sites, especially those involving groundwater contamination; arranging and overseeing responsible party cleanups in compliance with RCRA regulations; technical review of statements of work, work plans, remedial investigation/feasibility studies, and remedial action plans as set forth in the National Contingency Plan under CERCLA; serving as contact for the media, public, local and federal government for selected projects.

Institute for Polar Studies, Ohio State University. As a literature researcher, she organized and implemented a plan for a computer data base of arctic soil characteristics. As a laboratory researcher, she was responsible for the preparation and pollen analysis of fossil and modern lake sediments; x-radiography and visual stratigraphy of sediment cores; research report writing.

Professional Recognition and Affiliations

Member, National Water Well Association

MARTIN H. DOORNBOS

Environmental Geologist
Battelle Denver Operations

Education

B.S. Geological Engineering, Montana College of Mineral Science and Technology
M.S. Geological Engineering, Montana College of Mineral Science and Technology (Thesis pending)

Qualifications

Mr. Doornbos has had extensive experience in field geologic mapping, both reconnaissance and in detail, using a variety of maps and field instruments. His geologic exploration experience includes supervising drilling programs using a number of different methods such as reverse-circulation, core, and air hammer drilling. In the field of hydrogeology, he has been involved in the installation of observation wells, conducting tracer tests (both fluorescein dye and sodium bromide), involved in the interpretation of difference geophysical methods (both surface and borehole), installation of various types of ground and surface water monitoring equipment, and many other aspects of hydrogeology.

Relevant Experience at Battelle

Field Environmental Geologist. Investigator involved in the determination of possible soil and groundwater contamination at a U.S. Air Force Base. Conducted records research, determined borehole locations based upon the research, and was involved in all aspects of the drilling and sampling operation.

Prior Professional Experience

Montana College of Mineral Science and Technology. Responsible for teaching a groundwater hydrology lab including preparing and grading assignments along with lecturing during the lab period.

Cyprus Industrial Minerals Company. Responsible for field exploration of an industrial mineral including supervising field crews, supervising drilling operations, reconnaissance and detail mapping, and prospect evaluation.

MARTIN H. DOORNBOS (Continued)

Pegasus Gold Ltd. Responsible for the drilling operation, and field reconnaissance mapping and sampling during the exploration of precious metals. Also involved in a detailed prospect evaluation using various geological and geophysical methods.

Professional Recognition and Affiliations

Member, National Water Well Association
Engineer in Training (4/83)
Plan to become a registered Professional Engineer in 1988.

APPENDIX K

Technical Operations Plan
and
Health and Safety Plan

(See Malmstrom AFB Phase II,
Stage 1 Final Report)