The conclusions and recommendations contained in this report are solely those of Law Environmental Incorporated and do not necessarily reflect the position of the United States Government or any of its departments or agencies.

FINAL REPORT

CONFIRMATION STUDY OF FORMER ATLAS MISSILE SITES FOR POTENTIAL TOXIC AND HAZARDOUS WASTE CONTAMINATION

FORMER ATLAS SITE S-11
ELLENBURG, NEW YORK

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LEGS Job No. 11-7006-05

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GLOSSARY OF ABBREVIATIONS

AWQC - Ambient Water Quality Criteria
CERCLA - Comprehensive Environmental Response Compensation and Liability Act
CONUS - Continental United States
DAA - Defense Appropriations Act
DERA - Defense Environmental Restoration Account
DERP - Defense Environmental Restoration Program
DOD - Department of Defense
EPA - Environmental Protection Agency
GSA - General Services Administration
HRS - Hazardous Ranking System
ICBM - Intercontinental Ballistic Missile
IRP - Installation and Restoration Program
MCL - Maximum Contaminant Level
MCLG - Maximum Contaminant Level Goal
NPL - National Priority List
PA - Preliminary Assessment
PAH - Polynuclear Aromatic Hydrocarbon
POL - Petroleum, Oils, and Lubricants
RCRA - Resource Conservation and Recovery Act
RI - Remedial Investigation
RI/FS - Remedial Investigation Feasibility Study
SI - Site Inspection
USACE - United States Army Corps of Engineers
USEPA - United States Environmental Protection Agency
USGS - United States Geological Survey

EXECUTIVE SUMMARY

The Department of Defense (DOD) is investigating former ATLAS missile sites throughout the United States for potential toxic and hazardous waste contamination. This report documents the confirmation study performed at ATLAS Missile Site S-11, located in Ellenburg, New York. The field investigation consisted of installing and sampling three ground-water monitoring wells, sampling surface soils, and sampling water from the missile silo at the installation. The samples were analyzed for purgeable aromatics, purgeable halocarbons, base/neutral extractables and metals. The analytical data for this inventory study are summarized in Section 4.0 of the report and are fully presented in the Appendices.

Evaluation of the data gathered during the site investigation at ATLAS Site S-11 indicate the following conclusions:

- Barium was present at low concentrations in the ground water and barium and lead were present in low concentrations in the silo water samples collected at the site. The concentrations of these two metals were below Maximum Contaminant Levels (MCLs). The low concentrations of barium and lead detected in the water samples does not indicate contamination.

- The chlorinated compound trans-1,2-dichloroethylene was present below the detection limit of 0.005 mg/l in the ground-water samples from MW-1102 and MW-1103 and in the silo water samples. Operations at the ATLAS facility may have used solvents or degreasers which contained trans-1,2-dichloroethylene. The concentrations of trans-1,2-dichloroethylene in the water samples is below the Maximum Contaminant Level Goal (MCLG) of 0.07 mg/l. The presence of this chlorinated compound in the ground and silo water samples may be a result of DOD activities, but the

concentrations detected are not indicative of significant contamination.

- The chlorinated compound trichloroethylene was detected at a concentration below the measurable detection limit of 0.005 mg/l in water samples from MW-1102 and the missile silo. The concentration of trichloroethylene in well MW-1103, 0.006 mg/l, slightly exceeded the MCL of 0.005 mg/l. Maintenance operations at the ATLAS facility may have used chlorinated solvents such as trichloroethylene. Therefore, the trichloroethylene detected in the water samples may be a result of DOD activities and the concentration in MW-1103 may represent significant contamination. This conclusion is mitigated by two factors: the trichloroethylene in MW-1103 was the only constituent which exceeded, although slightly, the regulatory standards, and levels of trichloroethylene less than 0.010 mg/l in shallow aquifers has been associated with nonpoint sources such as air pollution (Trouwborst, 1981).

- The volatile organic compound toluene was present in groundwater sample MW-1101 at a concentration below regulatory standards. The presence of toluene, a constituent of fuel, may be a result of DOD activity. However, the low concentration of toluene detected at the site is not indicative of significant contamination.

- The concentrations of metals in the soil samples collected at the site were near those of the background sample and within average levels established by Bowen (1966). The metals detected in the soil samples at Site S-11 most likely reflect natural soil concentrations.

- The pyrene which was found below the measurable detection limit in soil sample S-5 may be a result of ATLAS facility operations. Pyrene is a constituent of many common materials such as diesel fuel, asphalt, and coal tar.

Additionally, pyrene adheres readily to soil particles and tends to be relatively immobile in soil. The presence of pyrene at the low concentrations detected in the soil is not indicative of significant contamination.

The following preliminary conclusions and recommendations have been made based on the results of this investigation.

(1) Metals concentrations in the silo and ground water are below regulatory criteria and metals in the soil are within natural background levels.

(2) Trans-1,2-dichloroethylene was detected in the silo and ground water and toluene was detected in a single ground-water sample. However, the concentrations of these compounds are below drinking water standards.

(3) Trichloroethylene was detected in the silo and ground water. The concentration of trichloroethylene in MW-1103 slightly exceeded the drinking water standard and therefore may warrant further investigation.

The concentration of trichloroethylene indicates further study is necessary at Atlas Site S-11. Monitoring well MW-1103 should be resampled to determine if the concentration of trichloroethylene actually exceeds the MCL. If resampling confirms the finding that the concentration of trichloroethylene exceeds the MCL, a Public Health Assessment (PHA) should be performed on the site. ATLAS Site S-11 in Ellenburg, New York, should be referred to the Missouri River Division (MRD) for further study.

1.0 PROGRAM BACKGROUND

The U.S. Army Corps of Engineers (USACE) contracted with Law Environmental, Inc., Government Services Division (Contract No. DACW 41-86-D-0115) to perform a confirmation study at former ATLAS Site S-11 in Ellenburg, New York. This report documents the investigation that was performed at that site. The report is divided into six sections that discuss background information, existing site conditions, field investigation program, analytical results, data interpretation and preliminary determinations. The following material in this section of the report presents an overview of the ATLAS missile program and a comparison of this investigation program with other Federal investigation programs.

1.1 OVERVIEW OF THE ATLAS MISSILE SYSTEM

1.1.1 Background

The ATLAS Missile System was the foundation for the United States Intercontinental Ballistic Missile (ICBM) and space launch vehicle programs during the late 1950's and early 1960's. The ATLAS Missile Program began in 1946 under the code name Project MX774. The program evolved through several phases of improved engines, modified fuels, strategic missile deployment, varied launch configurations, and a space launch vehicle. The phase which influences the Defense Environmental Restoration Program involves the deployment of ATLAS Missiles at operational sites within the continental United States.

The Research and Development (R&D) phase of the ATLAS Missile Program was conducted at Cape Canaveral, Florida. The most memorable event associated with ATLAS during the R&D phase was the December 18, 1958, launch into orbit. During this mission, a recorded Christmas message was radioed back to earth from President Eisenhower. At that time ATLAS was on a high priority track to become an operational part of the ICBM Program. The

first two versions of the missile ATLAS A and ATLAS B were produced during this R&D phase.

ATLAS D was the first operational version of the missile; it was deployed at Vandenberg AFB, California; Warren AFB, Wyoming, and Offutt AFB, Nebraska. The subsequent E&F versions were also deployed at operational units in the U.S.

During the evolution of ATLAS versions D, E, and F, the launch mode for the missile was also evolving. The R&D versions of ATLAS had stationary launch facilities at Cape Canaveral and Vandenberg. However, the operational missile had to be deployed at remote sites, where it was not feasible to provide the stationary launch facilities. Therefore, ATLAS D was designed to be moved to the launch pad by a transporter, which subsequently erected the missile to its vertical launch position and then arched away from the missile at launch. The installations which deployed ATLAS D's were above ground facilities and provided no protection from attack.

The next improvement for ATLAS was the E version which was designed to survive a nearby nuclear explosion, which would produce up to 25 PSI overpressure to the launch facility. This criteria resulted in enclosing the missiles in "coffin like" vaults and redesigning the lifting truss to position the missile for launch. The missile vaults were partially buried, with protective doors that retracted from above the missile for launching. The launch operations were conducted from a buried control structure. ATLAS E sites were considered "semi-hard" sites.

The final improvement to the ATLAS Missiles System was to harden the facilities to provide protection for 100 PSI overpressure which would be produced by a nearby nuclear explosion. This resulted in emplacing the missile vertically in underground silos and isolating the missile from the silo within a spring mounted crib. The silo top was enclosed by heavy doors which were opened

for missile launch. The ATLAS F version was deployed at the hard sites. The launch mode was to elevate the missile above the silo door (top). Figure 1-1 shows a typical hardened ATLAS site with the missile in the launch position. Facilities at the surface of the hardened ATLAS sites included one or two quonset huts used for maintenance, and the launch control center entrance. Integrated ATLAS F facilities such as control rooms, crew quarters, and propellant storage were buried below ground. Figure 1-2 is an artist's sketch of a hardened ATLAS site showing the underground and surface facilities.

The ATLAS D, E and F versions were deployed at 13 squadrons located near 11 Air Force bases. The ATLAS deployments are summarized below:

Air Force Base	Location	Number of Missiles D Model	E Model	F Model
Vandenberg	Lompoc, CA	6		
Warren	Cheyenne, WY	6	9	9
Offutt	Omaha, NE	9		
Fairchild	Spokane, WA		9	
Forbes	Topeka, KS		9	
Schilling	Silina, KS			12
Lincoln	Lincoln, NE			12
Altus	Altus, OK			12
Dyess	Abilene, TX			12
Walker	Roswell, NM			12
Plattsburgh	Plattsburgh, NY (Includes ATLAS Site S-11 at Ellenburg, New York)			12

FIGURE 1-1

TYPICAL ATLAS SITE

ATLAS SITE S-11 - ELLENBURG, NEW YORK

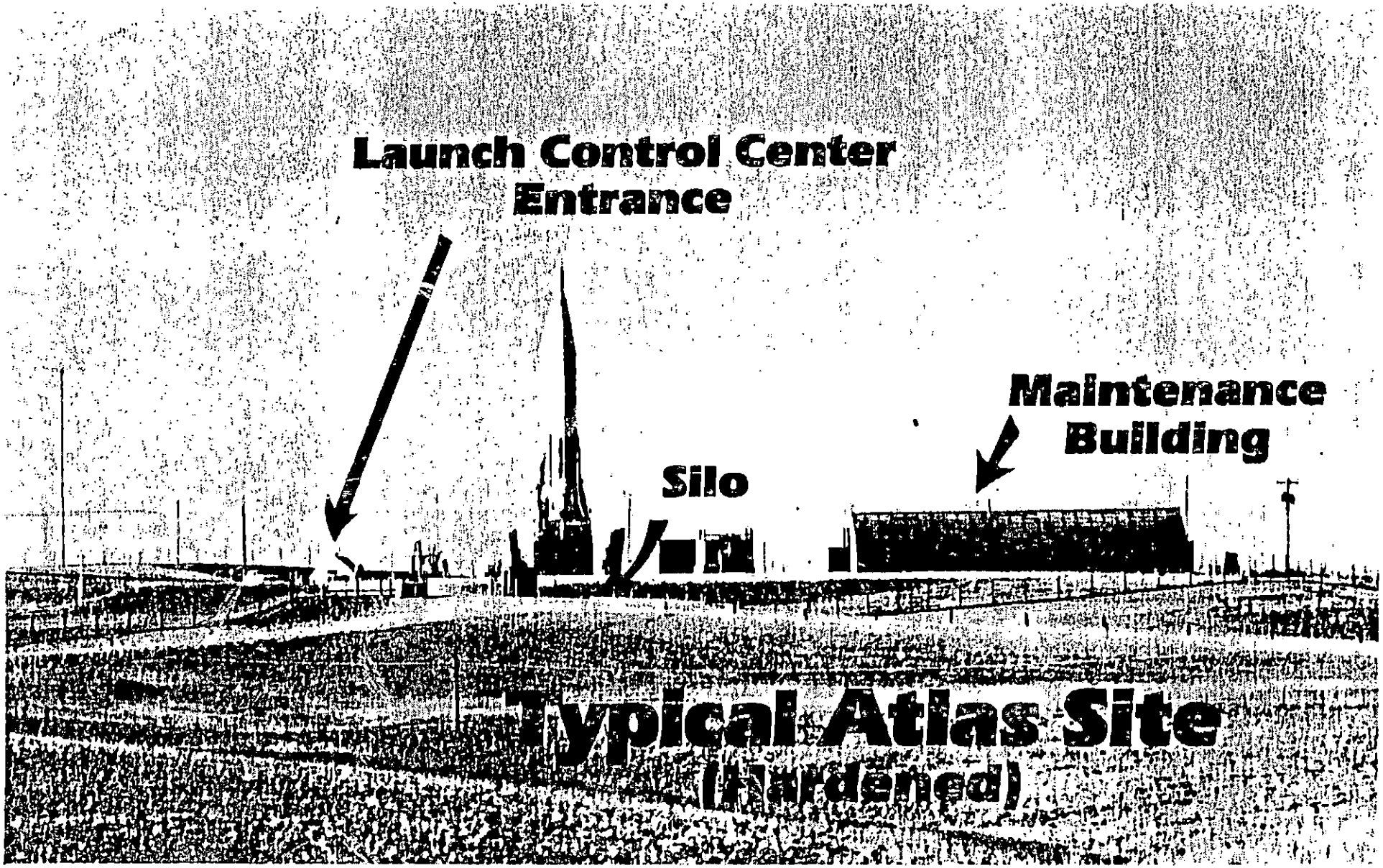
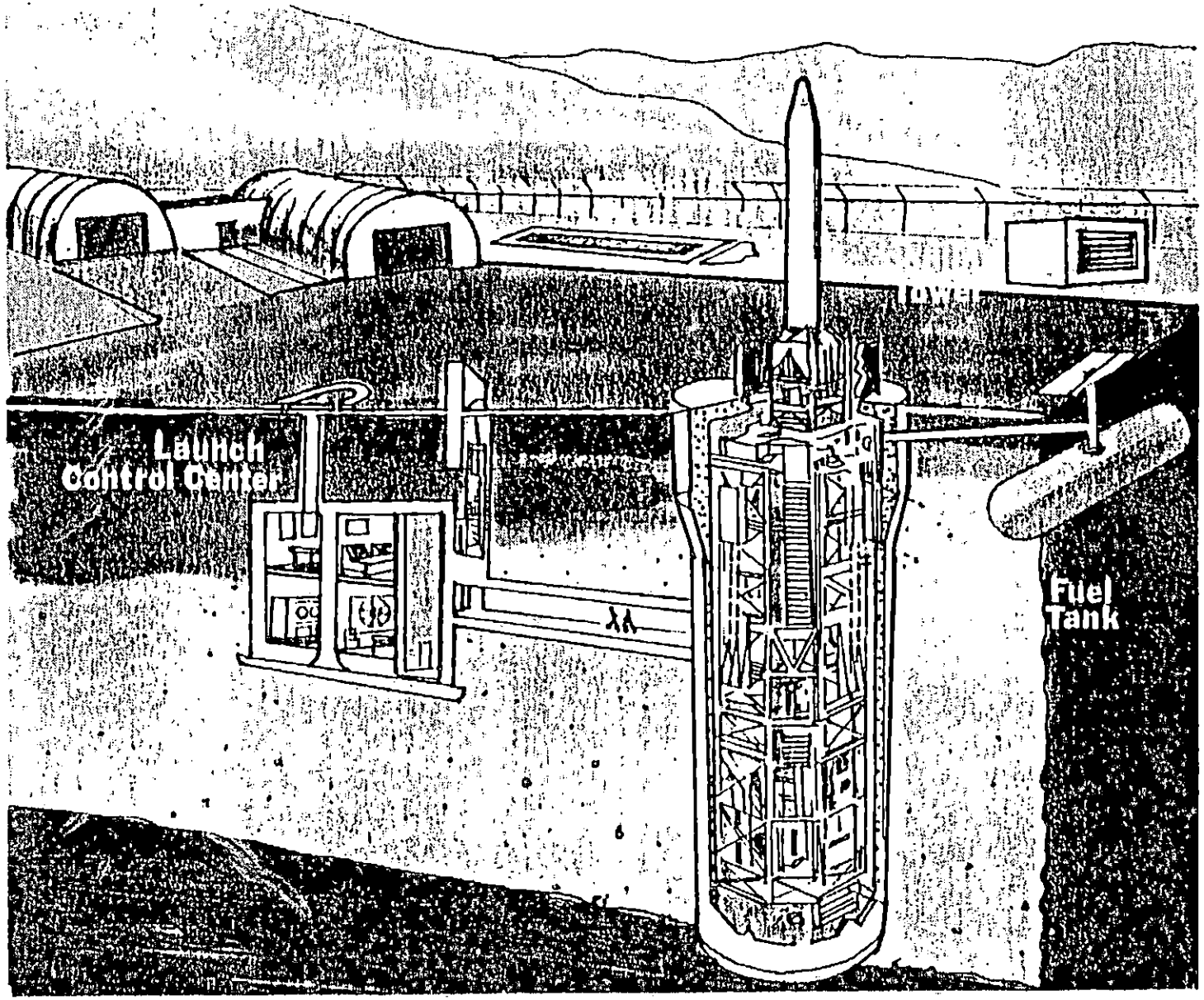


FIGURE 1-2

ATLAS GENERIC SITE

ATLAS SITE S-11 - ELLENBURG, NEW YORK



In addition to locating the ATLAS missile squadrons at selected Air Force bases, each squadron dispersed its missiles to improve system survivability; except for early "soft" operational units at Vandenberg AFB, and Warren AFB which were not dispersed. The non-dispersed sites allowed up to three missiles to be controlled by a single control room. Subsequent semi-dispersed sites also allowed multiple missile control from a single control room. Extensive communications systems were involved with the semi-dispersed sites. The Fairchild AFB communications system for ATLAS incorporated a microwave system that was hardened to withstand 25 PSI overpressure and linked nine sites dispersed over 8,000 square miles. The preponderance of ATLAS sites were ATLAS F's which were hardened and dispersed. These "hard" sites each had individual control functions.

The ATLAS used liquid propellant - kerosene and oxygen. These were generally stored in separate below ground tanks remote from the launcher or silo. The ATLAS F version utilized a unitary concept of deployment; that is the missile was equipped with on-board tanks and the propellant could be stored in its onboard tanks or transferred from adjacent storage in minimal time. The missile also required that a positive pressure be maintained interior of the missile to enhance structural rigidity both in prelaunch and during flight. This positive pressure was provided by helium which was stored in the ATLAS F silo and on-board the missile.

The ATLAS Missile Program provided an important element of the U.S. defense system during a period of rapid evolution in ICBM systems. However, this evolutionary period was short lived. The first operational ATLAS system was at Vandenberg in September 1959. The last operational squadron was at Plattsburgh in December 1962. By 1965, the Plattsburgh squadron was dismantling their silos and the records indicate the silo equipment was sold for salvage. By 1966, the ATLAS F's were obsolete and were returned to the USAF for use in the military space program.

Therefore, the missile system was in place for only 3 to 5 years. During operational status, the ATLAS sites could have contributed to environmental contamination from fuel storage on site maintenance activities.

1.1.2 ATLAS Missile System Operations

A typical ATLAS F site (Figure 1-3) generally consisted of about 10 acres within a security fence. The major facility at the site was the underground silo which was 174 feet deep x 69 feet diameter. The silo was constructed of thick reinforced concrete walls. Two hydraulically-operated doors sealed the top of the silo. These doors were made of steel reinforced concrete, designed to withstand a nearby nuclear blast. The silo doors remained closed (Figure 1-4) during normal operation but were opened (Figure 1-5) to raise the ATLAS missile into firing position.

The ATLAS missile was supported in a spring-mounted crib which was suspended in the silo. The missile was 82 1/2 feet long and 10 feet in diameter. The silo space below the missile was used for propellant storage, missile support and fuel loading equipment. The silo also contained seven operations levels adjacent to the missile: lifting system, hydraulic power and air handling, launch control electronics, HVAC, diesel generator/fuel day tank, diesel generator, propellant loading. The silo configured in this manner comprised a unitary concept where all critical elements were contained within the silo.

About 150 feet away from the silo, an ATLAS F site contained a below grade Launch Control Center (LCC). The LCC was a two story structure approximately 40 feet in diameter. It provided personnel quarters and communications to the missile and to command and control centers. A reinforced concrete enclosed stairway (Figure 1-6) led down to the LCC.

FIGURE 1-3

TYPICAL ATLAS SITE PLAN

ATLAS SITE S-11 - ELLENBURG, NEW YORK

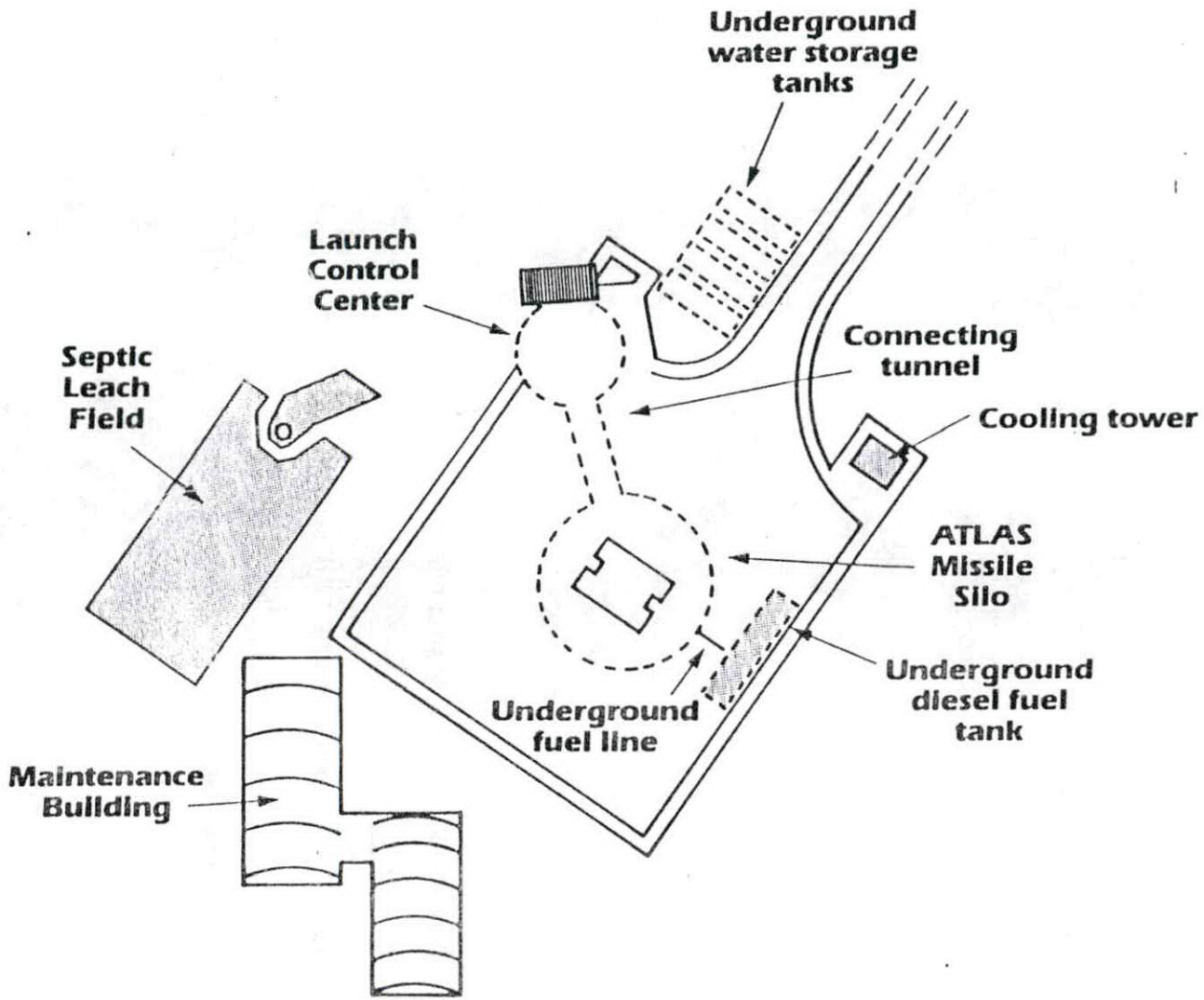


FIGURE 1-4

SILO DOORS (CLOSED)

ATLAS SITE S-11 - ELLENBURG, NEW YORK

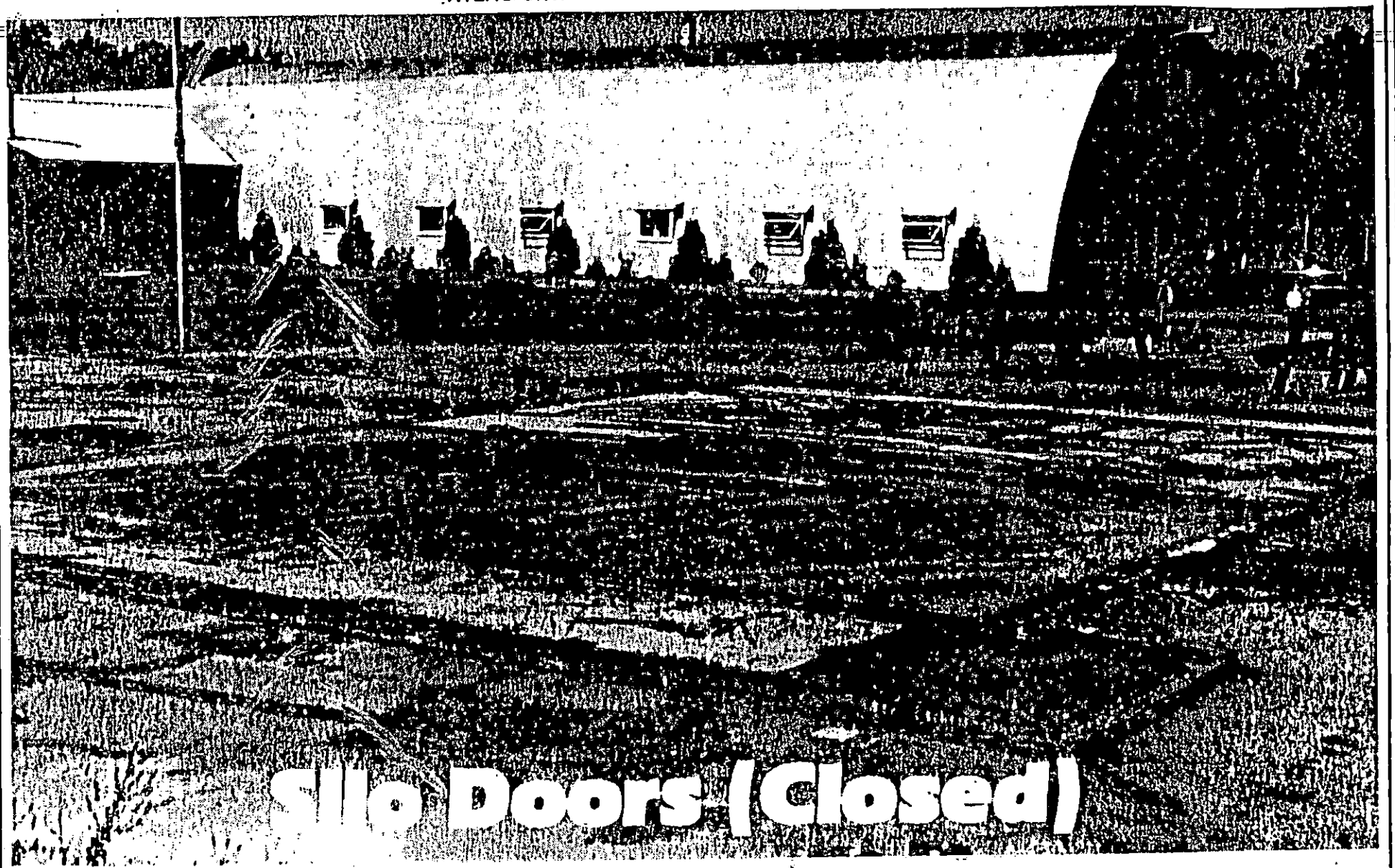


FIGURE 1-5

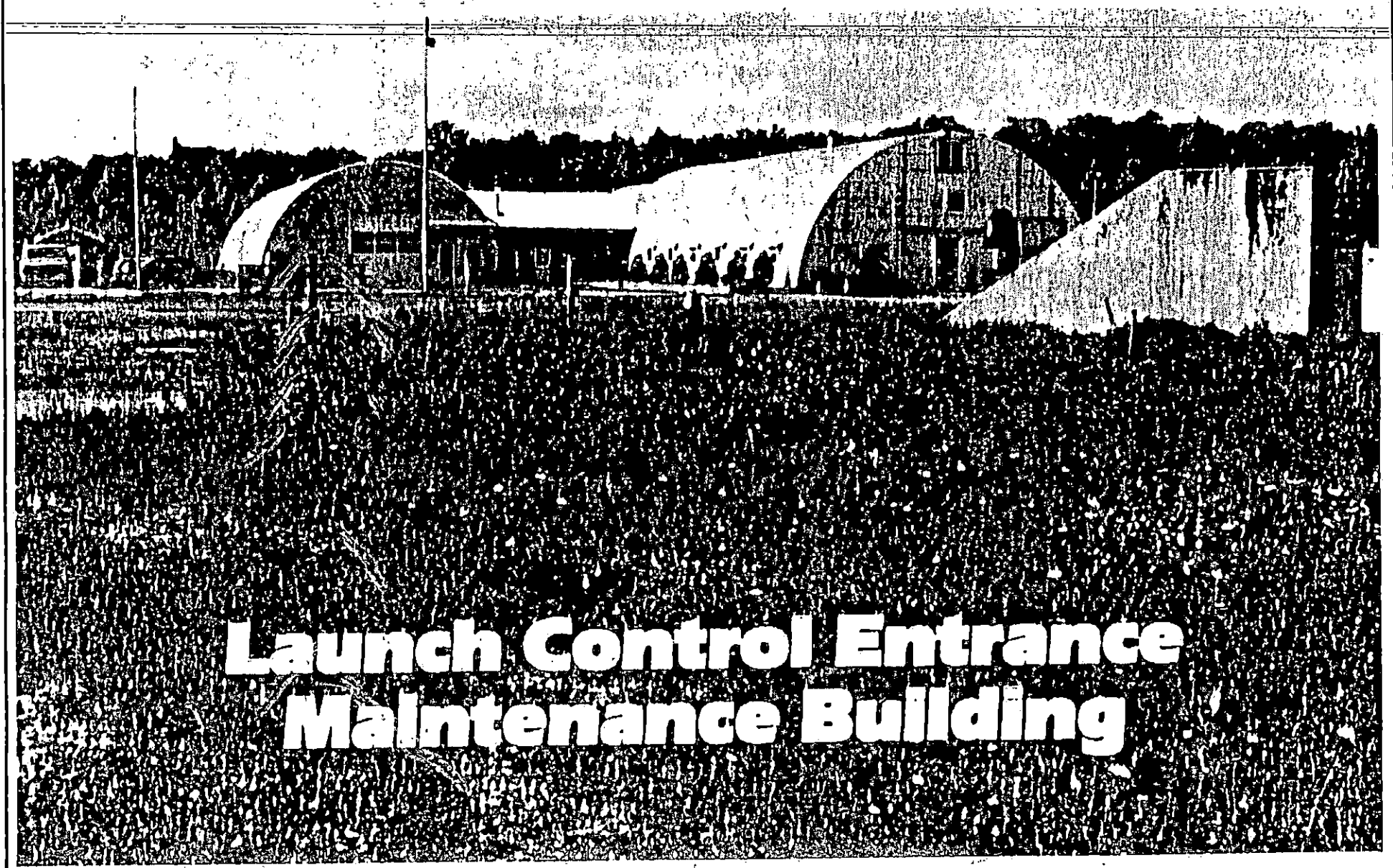
SILO DOORS (OPEN) WITH BLAST SHIELD

ATLAS SITE S-11 - ELLENBURG, NEW YORK

FIGURE 1-6

LAUNCH CONTROL ENTERANCE MAINTENANCE BUILDING

ATLAS SITE S-11 – ELLENBURG, NEW YORK



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The ATLAS F sites included facilities and equipment to maintain the missiles. The maintenance facility was a steel structure located at grade, near the silo (Figure 1-6). During site operations missile components could be removed from the silo and maintained within this facility. The maintenance building, security systems, and waste treatment facilities were the only above-grade facilities at a site.

The waste-water treatment and disposal practices were different at each site. Spray fields and percolation basins were used in areas where soil and climate was appropriate for sanitary waste treatment.

The unitary silo provided a means for fuel storage within the silo. However, there are indications that fuel may have also been stored in underground tanks remote from the silo at some sites. Another below grade tank was the diesel fuel storage for the diesel generators. Generally, steel tanks were provided within about 100 feet of the silo for this purpose.

1.1.3 Waste Generation

The ATLAS operational site activities which produced wastes or potential contaminants included:

propellant storage
diesel fuel storage
hydraulic systems
maintenance: petroleum, oil, lubricants, solvents, equipment operations, personnel, sanitary systems

The propellant storage included below grade tanks for kerosene and liquid oxygen. The duration of the ATLAS as an operational system was limited to three to five years. Therefore, underground tank leakage due to deterioration was unlikely. The most likely source of contamination from storage was spillage

during tank filling and possibly faulty connections in conveyance lines. The liquid oxygen was stored under cryogenic conditions and spillage or leakage was very improbable. Furthermore, loss of oxygen would not have produced a toxic condition. Propellants were also stored on board the ATLAS F's and in their silos. As such, spillage of kerosene inside the silo would have been discharged to the silo exterior through the silo discharge system.

Diesel fuel was stored in below grade tanks for all of the deployed ATLAS F sites. Diesel fuel was used in the on-site generator to supply power for control room and launch activities. At remote ATLAS F sites, where public electric power was not available, on-site generators supplied normal operating power as well as emergency power. Leakage from underground tanks, spillage during tank filling and escape of fuel during maintenance or repairs of generators could have produced contamination at the diesel storage tank location or adjacent to the silo.

Each ATLAS silo contained an enormous hydraulic lift system to move the missile from its cold storage position in the bottom of the silo, to the hot launch configuration at the surface. When the ATLAS system was decommissioned, some of the hydraulic fluid may have remained in the storage tanks, pressure lines, pumps and rams. Subsequent deterioration of the system may allow remnant hydraulic fluid to leak into the silo, and ultimately into the environment.

Maintenance of the missile and equipment at the launch sites was the most probable source for contamination. The sites contained hydraulic systems, pumps, generators, electronics, heating, ventilating, air conditioning, refrigeration, and other systems that required continuous maintenance to maintain operational reliability. Maintenance activities included the use of solvents, petroleum, oil, and lubricants (POL). The release of these potential contaminants could have resulted from the

discharge of these materials when the floors were cleaned or from the silo sump discharge line. It is also possible that some POL accumulations which were retained for routine proper disposal were accidentally or intentionally spilled within the site boundaries.

The support crew for the remote sites involved about 20 people, producing sanitary waste that was treated on site. The ATLAS sites commonly had a spray field or aeration basin to treat and discharge sanitary sewage. Typically, sanitary sewage disposal fields do not result in hazardous or toxic materials that persist in the shallow subsurface zones. Therefore, it is unlikely that this waste stream produced contamination.

The lowest level in the ATLAS F silo was the "Sump Level." Two automatically actuated 100 GPM capacity sump pumps located at this location remove liquids from the silo. The liquids were pumped through pipes that were routed up the silo wall and exited through the silo wall at level 2. The ultimate disposition of the silo effluent appears to have been to a drainage ditch, which was located far enough away from the silo to avoid interaction with the silo backfill and the launch control center. The USAF Operational Readiness Training Manual designates the ATLAS F complex into four quadrants, quadrant I contains the cooling tower and water plant, quadrant II contains the launch control center, quadrant III contains the electrical and communication stub-ups and quadrant IV contains the sump discharge areas. Quadrants II and IV are diagonally opposite each other. Therefore, it appears that the sump discharge usually occurs on the silo quadrant opposite the launch control center. This discharge may have been integrated with the area storm water management system and carried off-site by surface channels.

1.2 PROGRAM COMPARISON

The Department of Defense (DOD) conducts a number of industrial processes and manufacturing operations that are similar to those of private industry. In the late 1970's, DOD became aware of the negative impacts of what were previously considered acceptable disposal practices of waste materials associated with these processes and operations. In response to that knowledge, programs were developed between 1975 and 1978 by each service component to identify and assess potential contamination on active military installations. Authority to address problems of other than active installations was lacking because funds could not be spent on sites not owned by DOD.

The passage of the 1984 Defense Appropriations Act changed this situation. Specific language in the Act directed DOD to extend its efforts to include sites formerly used by DOD. The Act also broadened the definition of "hazard" to include structures and debris which were to be abandoned or had been abandoned upon termination of the site's military use.

The Act directed that the Secretary of Defense to assume overall management of the program to assure consistent approach and adequate resource allocation. A Defense Environmental Restoration Account (DERA) was established which provides the resources for the evaluation and characterization of potential chemical contamination at former DOD Sites.

Sites located on active DOD installations are being investigated under the Installation and Restoration Program (IRP). Sites either previously or presently owned by DOD not located on active DOD installations are handled separately from the IRP effort. In order to present a perspective of the formerly used (non-IRP) site investigation program, it is necessary to compare such efforts to the EPA's Superfund program and the DOD's IRP.

Figure 1-7 presents a block diagram illustration of the following investigative programs presently being conducted by various Federal agencies.

- EPA Superfund
- DOD/IRP
- DOD Non-IRP

Under Superfund, a Preliminary Assessment (PA) is conducted; it consists of a desk-top study and site visit which leads to a Site Inspection (SI). The SI usually includes limited sampling activities. After completion of the SI, a Hazard Ranking is performed and if the site scores above a certain number, it becomes a candidate for the National Priority List (NPL). Additional site investigations are conducted during the Remedial Investigation (RI), which is a comprehensive study to determine the extent of contaminants and their rate of movement.

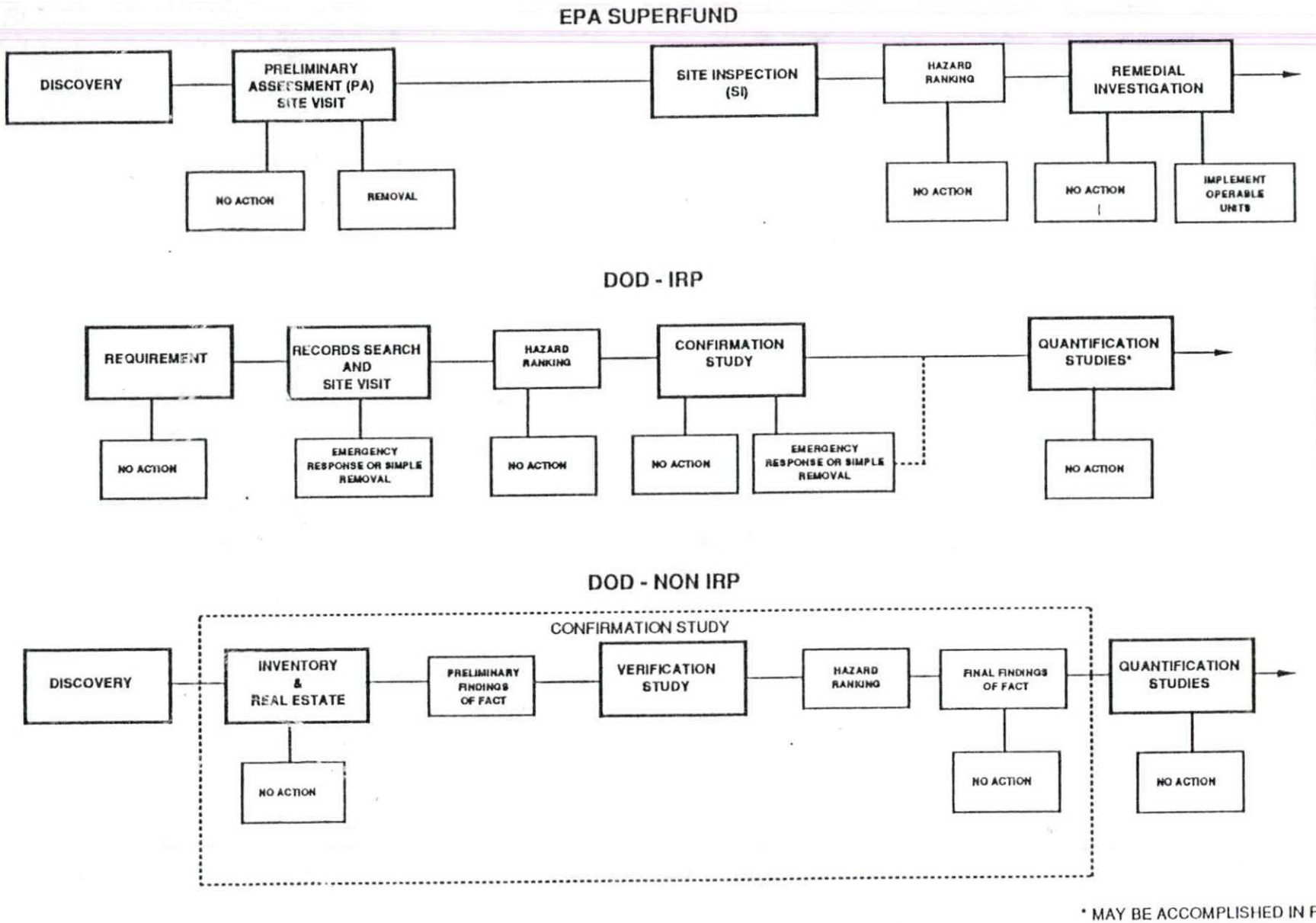
The DOD's IRP study consists of a records search and site visit to establish a potential list of sites possibly contaminated at an active installation. A Hazard Ranking System (HRS) is utilized to determine which sites will be investigated in order of environmental and/or public health importance.

The Non-IRP effort, under which the NIKE Sites are categorized, also has an Inventory Study. Unlike the IRP and Superfund programs, it is a real estate oriented effort to determine ownership of the site. In addition, certain studies are performed dealing with demolition of structures previously used by the DOD.

A similar task is evident for each phase of the three programs; that is, the Site Inspection (EPA); the Confirmation Study (IRP) and the Confirmation Study (NON-IRP). Each of these studies are similar in terms of investigative depth. Some soil and water sampling is accomplished and a few monitoring wells may be installed. The principle purposes for each study, however, may

GOVERNMENT ENVIRONMENTAL PROGRAMS

ATLAS SITE S-11 - ELLENBURG, NEW YORK



* MAY BE ACCOMPLISHED IN PHASES

be somewhat different from the others. For example, the purpose of a Non-IRP Confirmation Study is to make a preliminary determination of whether contamination exists and if it was caused by DOD operations.

The Remedial Investigation (RI) under the Superfund Program is the most complex field investigation effort. It correlates with the Quantification Studies under IRP and Non-IRP efforts.

In summary, the scope of effort for a Confirmation Study of a Non-IRP Site is shown on Figure 1-7 surrounded by the dotted lines. It can easily be seen that this type of study is very preliminary and cannot be compared with the project requirements for an RI, especially one with an NPL rating.

*****

2.0 SITE CONDITIONS

2.1 PROJECT OBJECTIVES

The text of the Scope of Work (SOW) for this confirmation study, dated May 20, 1987, is contained in Appendix L of this report. Item 2.0 of the SOW describes the purpose of this evaluation as follows: "to provide a preliminary determination of the presence or absence of chemical contamination which may have resulted from Department of Defense activities at the site." To fulfill this purpose, Law Environmental, Inc., performed these work elements:

- conducted site visit to collect background information;
- prepared work plan and safety plan;
- installed ground-water monitoring wells;
- collected and analyzed ground-water, silo water and soil samples;
- evaluated physical and chemical data;
- prepared an engineering report including a hazard ranking system (HRS) report.

Details of the work performed in each of these elements are described in the following sections of this report. Work Plans with detailed descriptions of field and laboratory procedures are presented in in Appendix H and Appendix I, respectively. This section of the report describes pertinent background information including details of the site visit, site location information, site physiography, land use, and current and past ownership and use of the site.

2.2 SITE VISIT SUMMARY

A site visit in accordance with Task 2 of the ATLAS contamination evaluation SOW was performed by Mr. Louis S. Karably of Law Environmental, Inc. in June, 1987. The site visit involved a meeting with USACE personnel from the Kansas City District and a

visual inspection of the ATLAS site. The following information was collected during the site visit.

- The site is located north of U.S. Highway 11 in the Town of Ellenburg, in northwest Clinton County (Figure 2-1). Access to the site from Plattsburgh is north on State Route 22, west on State Route 191, and west on Highway 11. Total mileage from Plattsburgh is approximately 30 miles.

- The surficial geology at the site apparently consists of glacial deposits over Cambrian-age Potsdam Formation basement rock (based on Isachsen and Fisher, 1970, Geologic Map of New York, Adirondack Sheet,") . Fill material may also be present around the site and specifically near the missile silo.

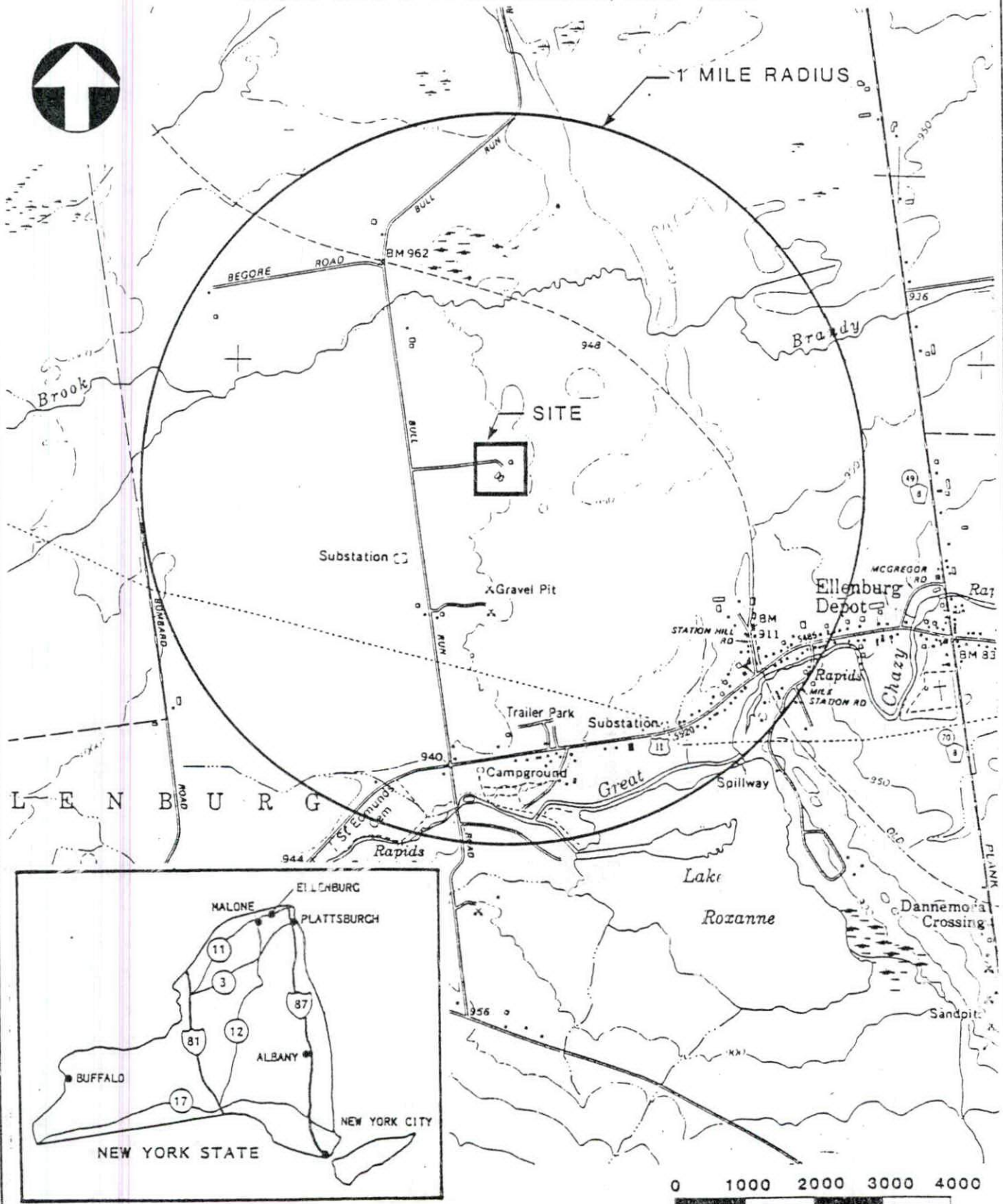
- The site is situated in a flat interstream area with Brandy Brook, a small stream, to the north and the North Branch of the Great Chazy River to the south. Surface water drainage from most of the site is to the southeast toward the North Branch of the Great Chazy River.

- Structures and buildings still present (1987) at the site include the missile silo, fuel tanks, two pump houses, two quonset huts, a liquid nitrogen fill stand, and a buried concrete launch control center. The current owner, the Town of Ellenburg, is using the site for storage and has modified the pump houses for use as a picnic area and has constructed a number of horseshoe pits in the southern portion of the site. Figure 2-2 contains a plan of the major site features. The silo doors and concrete pad are shown are Figure 2-3. The two quonset huts west of the silo are shown in Figure 2-4. The entrance to the launch control center is shown in Figure 2-5. The two metal pump houses are shown in Figure 2-6. These photographs indicate that the structures present are in good condition and the site is free of surface debris.

FIGURE 2-1

SITE LOCATION MAP

ATLAS SITE S-11 ELLENBURG, NEW YORK



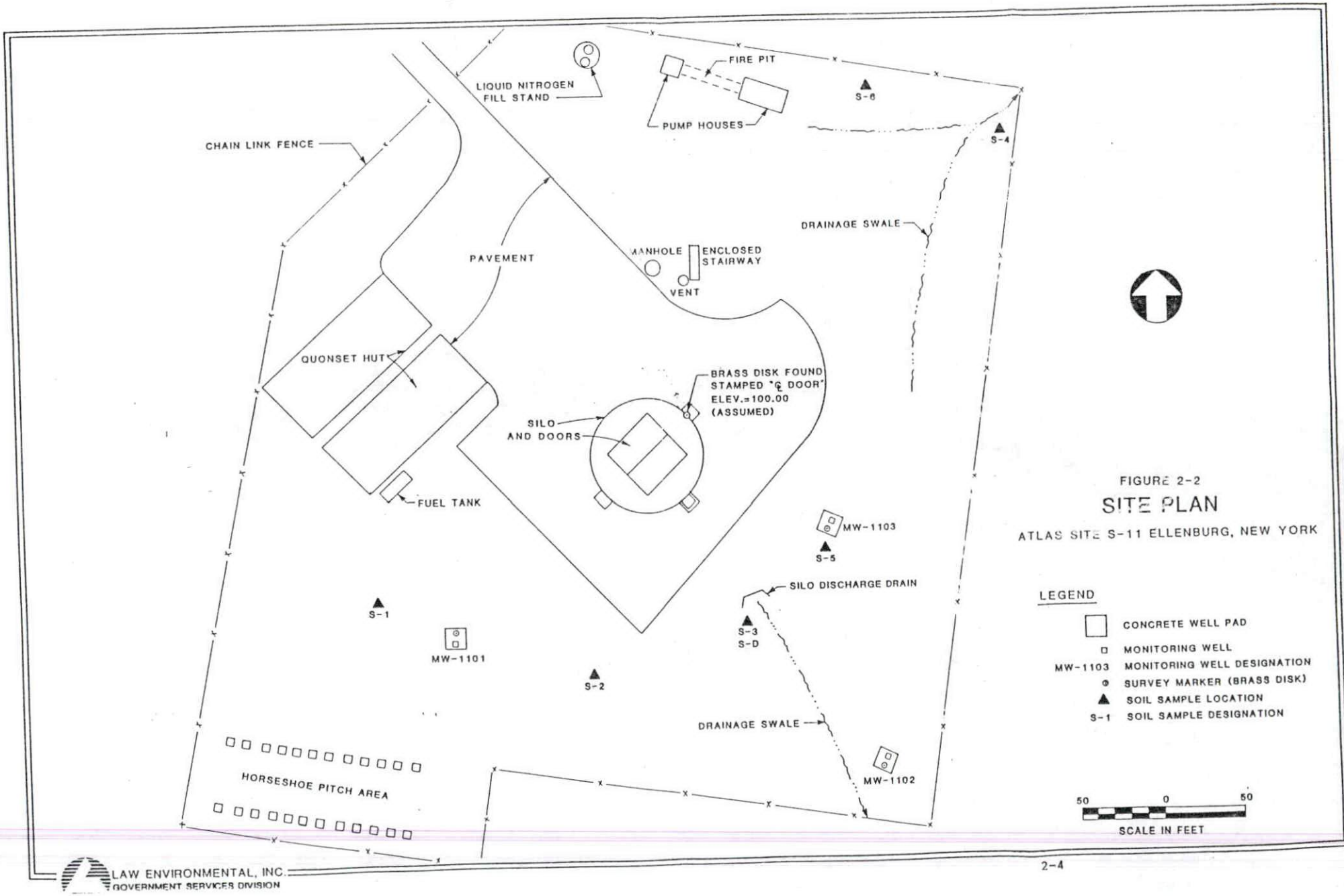


FIGURE 2-2

SITE PLAN

ATLAS SITE S-11 ELLENBURG, NEW YORK

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FIGURE 2-3

SILO DOORS AND CONCRETE PAVEMENT

ATLAS SITE S-11 - ELLENBURG, NEW YORK

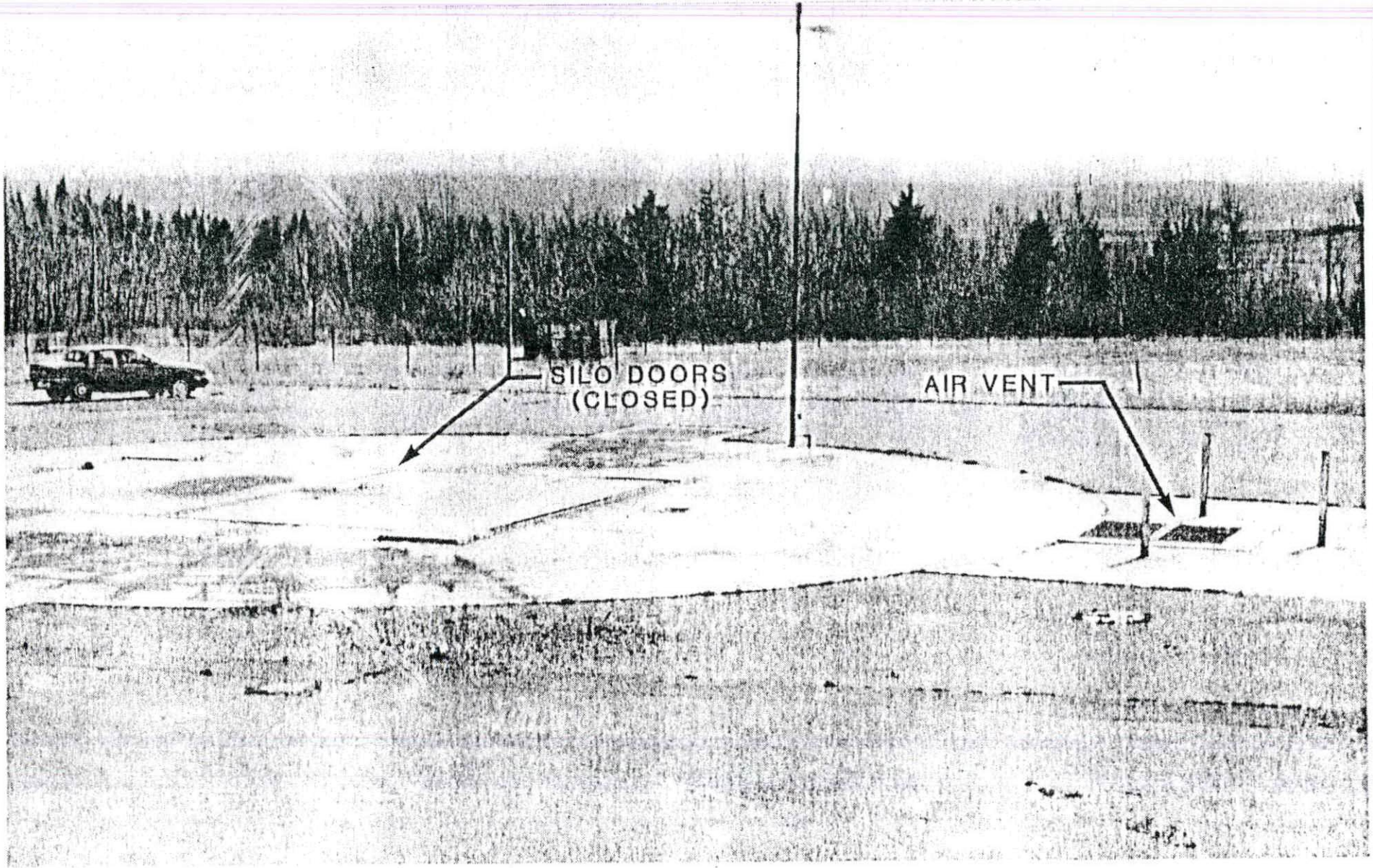

FIGURE 2-4

QUONSET HUTS

ATLAS SITE S-11 - ELLENBURG, NEW YORK

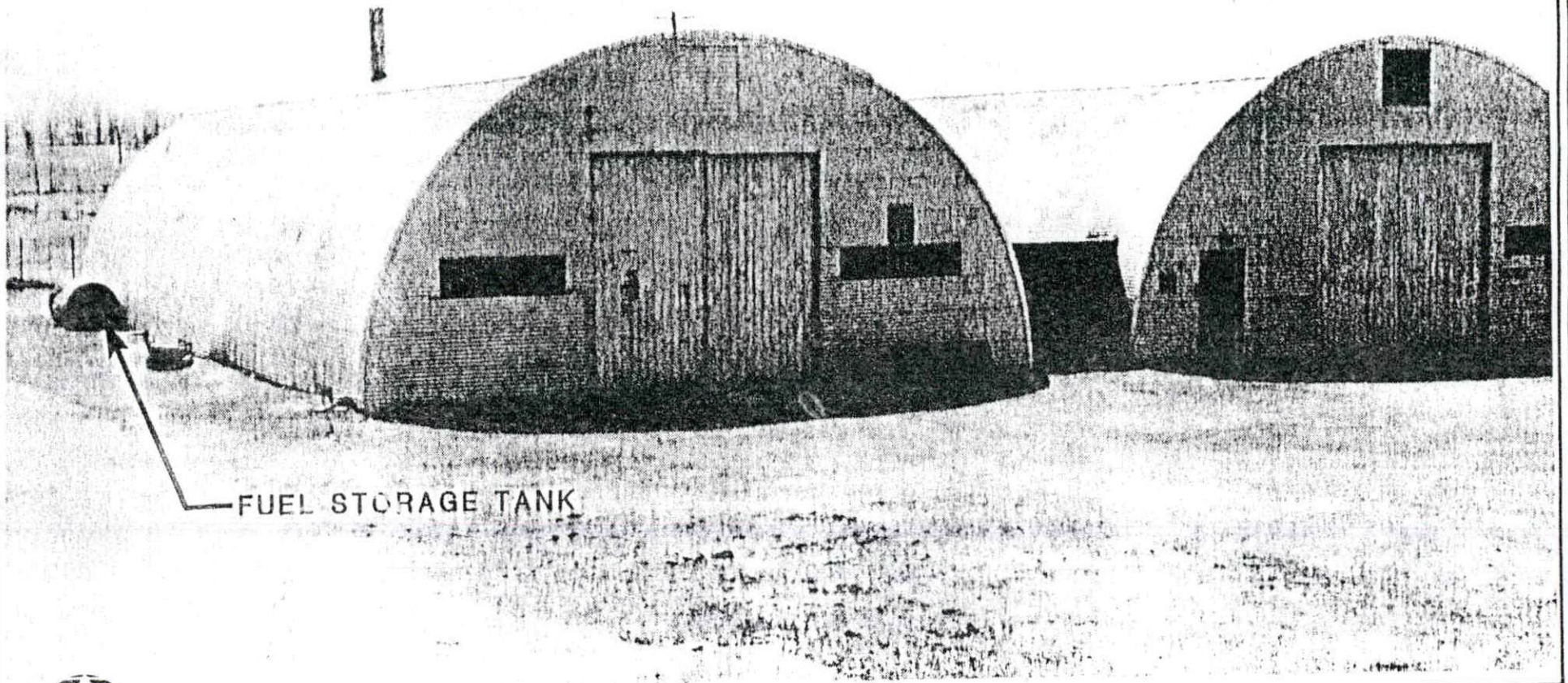

FIGURE 2-5

ENTRANCE TO LAUNCH CONTROL CENTER

ATLAS SITE S-11 - ELLENBURG, NEW YORK

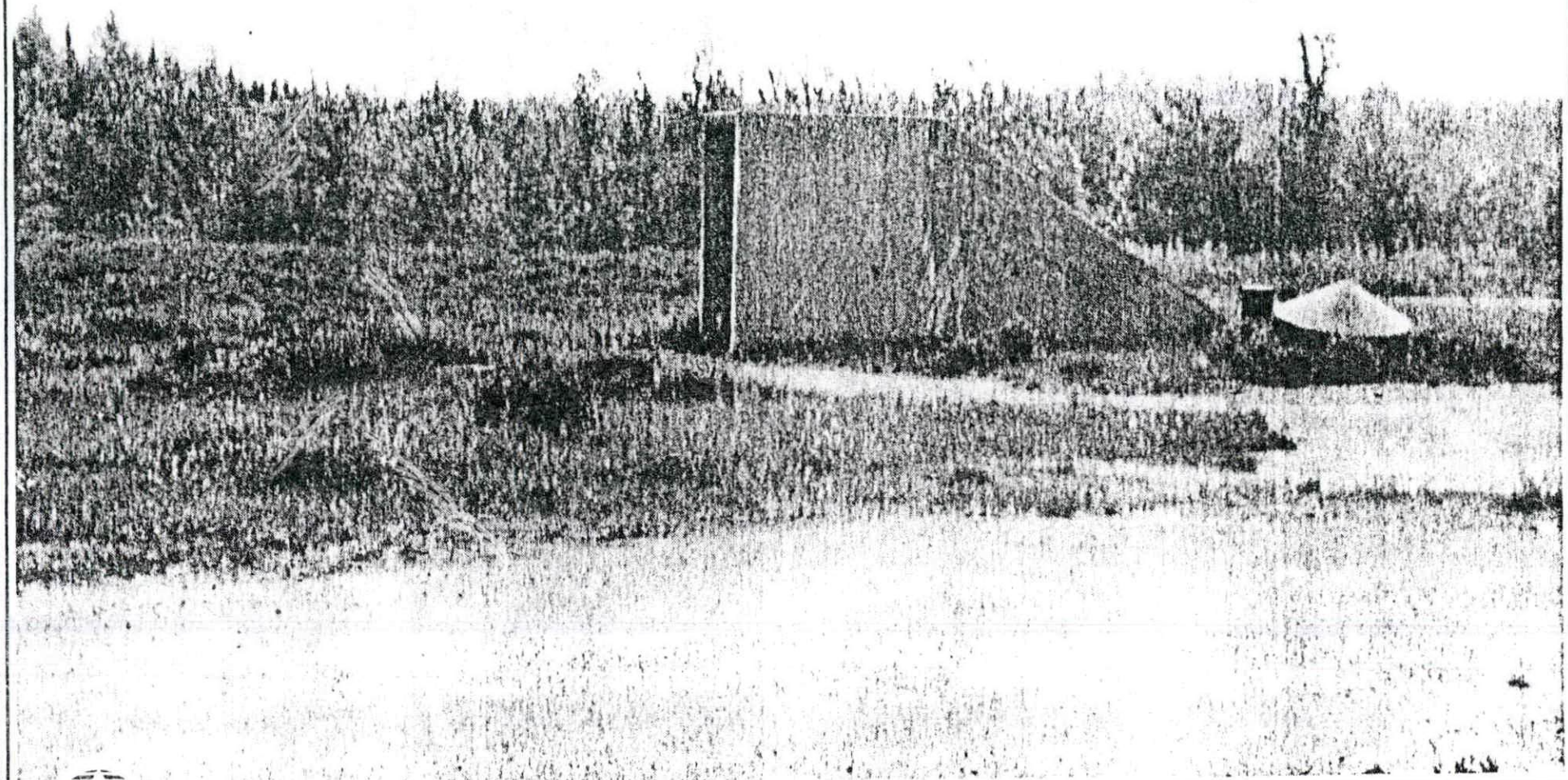

FIGURE 2-6

PUMP HOUSES

ATLAS SITE S-11 - ELLENBURG, NEW YORK

- One concrete and steel subsurface missile silo is located in the center of the facility. The silo is approximately 70 feet in diameter and 187 feet deep with 12 foot thick reinforced concrete walls. The silo doors are in the closed position. Paving covers a 150 square foot area around the concrete missile silo pad.

- The silo sump discharge line is located east of the silo. Discharge from the silo sump system appears to be directed to a swale which leads southeast off of the site.

2.3 SITE LOCATION AND ENVIRONMENTAL FEATURES

Atlas Site S-11 is located near Ellenburg, New York, approximately seven miles south of the Canadian - United States border. The site is contained in the St. Lawrence Valley physiographic province adjacent to the Adirondack province. In this region the Pre-Cambrian crystalline mountains of the Adirondack range are bordered by foothills of Paleozoic sedimentary rock that descend northward to the St. Lawrence Lowlands (Denny, 1974). The site lies on the northern flank of the Adirondack Mountains in a region characterized by rolling lowlands with isolated rocky hills.

Borings drilled at the site indicate that the facility is underlain by a highly indurated sandstone. The Geologic Map of New York, Adirondack Sheet (1970) confirms that this materials is the Cambrian-Age Potsdam Formation. This formation is composed primarily of hard quartz sandstone, but also contains some arkose and shale beds. The Potsdam sandstone underlies the rugged foothills between the Adirondack mountains and the St. Lawrence Valley.

Above the bedrock is a relatively thin mantle of dense glacially-derived sands and silty sands. The topography of the entire Adirondack region has been molded by a number of glacial

episodes; the last of which, the Wisconsin, occurred as recently as 12,000 years ago. The glacial deposits underlying the site appear to be ground moraine. Ground moraine, formed as the moving glaciers scoured the underlying bedrock, is areally the most prevalent glacial deposit in the region.

Ground water in the study area occurs in both the unconsolidated glacial deposits and the consolidated sandstone. The yield of wells drilled in glacial material is highly variable and depends predominantly on lithology. Wells drilled in poorly sorted till tend to have low yield, but may still provide adequate domestic supplies. Wells set in sandy glacial drift material tend to be more productive. Ground water in the highly indurated sandstone is present only in secondary joints and fractures. The yield of wells set in the sandstone depends primarily on the number of joints which the well intercepts. Ground-water quality in the study area is generally good. Water from the glacial deposits tends to be mineralized and may contain significant concentrations of dissolved iron. The bedrock produces water of potable quality (Giese and Hobba, 1970).

As part of the site investigation, three ground-water monitoring wells were installed at the site. Potsdam Formation sandstone was encountered in all the borings at depths ranging from three to six feet. The surficial material consisted of a firm to dense brown sand with traces of silt and some boulders. Site stratigraphy and shallow ground-water conditions encountered are discussed in Section 5.1 of this report.

Topography of the site is relatively uniform. Maximum relief is less than 10 feet. Average elevation at the site is approximately 955 feet above mean sea level (msl). The low relief makes an accurate determination of surface water flow difficult. Water from the northern portion of the facility appears to drain northeasterly towards Brandy Brook. Brandy Brook flows into the Great Chazy River approximately three miles east of the site. Surface water originating in the southern portion of

the site appears to be directed southeast to the North Branch of the Great Chazy River. Discharge from the silo sump system is also directed to the southeast.

The climate of the Adirondack region is characterized by cold, harsh winters and relatively mild summers. According to climatological data from a station approximately 15 miles south of the site, the mean annual temperature for the region is 44° F. Annual precipitation is approximately 33 inches with an additional 81 inches of snowfall per year. The rainfall is evenly distributed throughout the year but most occurs between June and October.

2.4 LAND USE

Land use in the immediate vicinity of the site is a mixture of agriculture, woodland, and rural residential. A number of single family residences are located on Bull Run Road adjacent to the site, but woods and fields border the facility. The unincorporated Town of Ellenburg is located approximately 1.5 miles southwest of the site. The population within a one-mile radius of the site is approximately 360. This estimate is based on a house count (assuming 2.3 people per house) from the New York Department of Transportation 7.5-minute Ellenburg Depot Quadrangle.

2.5 OWNERSHIP AND PRIOR USE

Atlas Site S-11 was originally acquired in 1960 by the DOD for the purpose of constructing a missile launching facility. Site S-11 was one of 12 sites scattered throughout the region and collectively known as the Plattsburgh Atlas Missile Complex. By September 1965, all Atlas ICBM sites in the Plattsburgh Complex were deactivated.

Atlas Site S-11 was conveyed by the General Services Administration (GSA) to the Town of Ellenburg in 1967. Currently(1988), the town uses the site for recreational purposes and for storage. Vehicles are being stored in the quonset huts. A horseshoe pitch area has been constructed in the southern portion of the site. A fire pit for picnics and cookouts has been constructed between the two pump houses. The underground missile silo and launch control center are not being used by the owners.

*****

SECTION 3.0 - SITE INVESTIGATION

3.1 INTRODUCTION

Prior to initiating any field activities, a site visit was performed by personnel from Law Environmental, Inc. Monitoring well and other sampling locations were selected during the site visit. The locations of the monitoring wells, shown in Figure 2-1, are slightly different from those shown in the Monitoring Well Installation Plan (MWIP). Site conditions necessitated changing slightly the monitoring well locations in the field. The new locations were selected to optimize the monitoring of the ground water at the site. These locations were selected with the concurrence of the Kansas City District Corps of Engineers whose representative was present at the site during the field work.

3.2 WORK PLANS

After the site visit and selection of proposed sampling stations, work plans were developed to describe planned site investigation procedures. Specific work plans developed for ATLAS Site S-11 were:

- Monitoring Well Installation Plan, (Appendix H)
- Sampling and Analytical - QA/QC Plan (Appendix I)
- Safety, Health and Emergency Response Plan (Appendix J).

These plans constitute the working documents that provided guidance for the field investigation procedures. The Work Plans were sent to the Kansas City District Corps of Engineers (COE) for review and approval. Following COE approval, the notice to proceed with field work was received in October, 1987 and the field investigation program began October 19, 1987.

For convenience, a brief outline of field techniques are presented in the following paragraphs along with field data gathered during the monitoring well installation activities, and the sampling program.

3.3 MONITORING WELL INSTALLATION

Three shallow ground-water monitoring wells were installed to investigate specific subsurface areas at ATLAS Site S-11. Soil samples for geotechnical analysis were taken during the installation of each monitoring well. The wells were installed and completed according to the approved Monitoring Well Installation Plan (contained in Appendix H). The following sections briefly discuss monitoring well drilling, construction, development and hydraulic conductivity testing.

3.3.1 Monitoring Well Locations

The location of monitoring wells installed at Site S-11 are shown in Figure 2-2. Each location is discussed below:

- Monitoring Well MW-1101

  Monitoring Well MW-1101 is located south of the underground missile silo and southeast of the quonset huts. The well was positioned to monitor the ground water in the vicinity of the missile silo, quonset huts, and the nearby fuel storage tanks.

- Monitoring Well MW-1102

  Monitoring Well MW-1102 is located southeast of most of the site in an area apparently downgradient from all the facilities. The well was installed in a swale that carried

the the silo sump discharge. This location was chosen to monitor the ground water migrating off the site.

- Monitoring Well MW-1103

Monitoring Well MW-1103 is located east of the silo in the northern portion of the site. The well was positioned to monitor ground water in the vicinity of the missile silo, the launch control center, and adjacent underground fuel storage tanks.

3.3.2 Monitoring Well Construction

The Monitoring Well Installation Plan for ATLAS Site S-11 states that the soil test boring should be terminated after penetrating about 10 feet into the water table or at auger refusal. Each well was constructed after drilling the borehole to the specified depth. The monitoring well was constructed of: 2-inch inner diameter (ID) Polyvinyl Chloride (PVC) (threaded, flush-joint) casing, No. 10 slot (0.010 inch) pre-manufactured PVC screen; riser pipe; non-carbonate silica sand; bentonite pellets; grout mixture (cement, bentonite, and water); steel security cap with lock; and protective steel posts. A concrete pad (4 inches x 3 feet x 3 feet) was constructed around each well.

An Acker "Soil Max" rig was used to install the monitoring wells at Site S-11. The rig was equipped with 6 1/4-inch ID, 12-inch outer diameter (OD) hollow stem augers. Rock was cored with a 2 5/8-inch OD core barrel. Cored borings were subsequently reamed with 3-inch and 6-inch OD tricone roller bits. Generally, no changes were made to the basic program described in the Monitoring Well Installation Plan (see Appendix H). However, the boring for MW-1103 had to be offset three times due to auger refusal and once when the core barrel became wedged in the boring. The well in boring MW-1103 was eventually constructed according to specifications.

The monitoring wells were installed between November 5 and November 20, 1987. Each well was installed as follows: begin the boring with hollow stem augers, sampling with a split-spoon sampler until auger refusal; rock core until the termination depth; assemble the 2-inch PVC screen and risers inside the boring; add the sand pack and bentonite seal through the annular space between the boring wall and the PVC casing; wet the bentonite pellets and allow swelling for 30 minutes; mix and add cement-bentonite grout; and construct surface protection system (pad, steel casing, protective posts, etc.). Table 3-1 shows pertinent information concerning well construction.

A copy of the daily log of activities is contained in Appendix A along with the final test boring records, field boring logs, and geotechnical analytical data. The daily logs contain information regarding quantities and types of material used at the site; the test boring records show relevant stratigraphic data on each well and well construction information; the field boring logs are copies of the actual log completed by the field geologist; and the geotechnical analytical results contain grain size analyses, moisture content and Atterberg limits (where applicable) for samples from each boring.

3.4 MONITORING WELL DEVELOPMENT

Well development was accomplished between November 25 and December 8, 1987. The purpose of well development is two-fold: to remove fine particles (silt and clay) that were introduced into the well during the drilling process and to improve the hydraulic connection between the aquifer and the well. After allowing the grout seal and pad to cure for approximately 24 hours, each well at ATLAS Site S-11 was developed manually using a PVC bailer and by surging periodically with a surge block. Well development data are summarized in Tables 3-2 and 3-3.

TABLE 3-1

WELL CONSTRUCTION DATA
ATLAS SITE S-11
ELLENBURG, NEW YORK

Well Number	Depth[1]	Screened Interval[1]	Thickness (ft)			Date Installed
			Sand Pack	Bentonite Layer	Grout Layer	
MW-1101	15.0	4.2 - 14.2	12.0	2.2	0.8	11/23/87
MW-1102	22.0	11.9 - 21.9	12.1	2.1	7.8	11/17/87
MW-1103	29.0	18.5 - 28.5	13.0	3.0	13.0	11/20/87

NOTES:

(1) Approximate depth below ground surface

All measurements in feet

TABLE 3-2

WELL DEVELOPMENT DATA
ATLAS SITE S-11
ELLENBURG, NEW YORK

Well No.	Development Process	Quantity of Water in Well[1] (gal)	Quantity of Water Removed (gal)	Date[2]
MW-1101	Surging, bailing, pumping	1.8	5	11/25 to 12/08/87
MW-1102	Surging, bailing, pumping	6.9	6.9	11/19/87
MW-1103	Surging, bailing, pumping	5.6	36	11/25 to 12/08/87

Notes:

(1) Quantity of water in well casing and annulus.
(2) Wells MW-1101 and MW-1102 were developed between November 25 and December 8, 1987. All wells were bailed dry a minimum of five times during development.

TABLE 3-3

GROUND-WATER QUALITY MEASUREMENTS
ATLAS SITE S-11
ELLENBURG, NEW YORK

Well Number	pH	Specific Conductance umhos/cm	Temperature (^{o}C)	Date
MW-1101	6.1	170	7.0	11/25/87
MW-1102	6.3	210	8.0	11/19/87
MW-1103	6.3	430	9.5	11/25/87

NOTE:

All measurements reflect readings during well development.

Forms completed in the field during well development are presented in Appendix C. Data recorded in the field included: date, static water level, quantity of water standing in the well (including the sand pack), water quality data details, physical characteristics of water, development equipment, surge techniques and water quantity removed. The wells were allowed to stabilize for at least 24 hours before collecting water quality samples. Table 3-3 shows measurements for specific parameters used to monitor the development water (pH, specific conductance, temperature) during different stages of well development. No major variations in these parameters were noted during well development.

3.4.1 Water Levels

Static water-level measurements were obtained during the permeability testing. These data, along with surveyed well-head elevations, are presented in Table 3-4. The water levels in the monitoring wells at the site are between 8.36 feet and 19.40 feet below the top of the PVC casings. These water level measurements represent site-relative elevations ranging from 81.61 feet mean sea level (msl) to 84.02 ft. msl. These data and ground-water flow are discussed in Section 5.1

3.4.2 Site Survey

Well-head elevations at ATLAS Site S-11 were surveyed during January, 1988, by Laberge Engineering and Consulting Group Ltd. The surveying firm is located in Plattsburgh, New York. State plane coordinates datum and vertical control datum were not available near the site. A disk which was found near the silo was used as an arbitrary benchmark with an assumed elevation of 100.00 ft. msl. Well elevations and coordinates are based on this arbitrary reference elevation. Field notes and the completed site survey are contained in Appendix K.

TABLE 3-4

GROUND-WATER ELEVATION SUMMARY
ATLAS SITE S-11
ELLENBURG, NEW YORK

Well No.	TOC (1) (feet)	Water Surface (feet below TOC)	Date	Water Elevation (feet)	Coordinates (2) X	Y
MW-1101	96.39	12.39	12/28/87	84.00	11,397.363	10,553.639
MW-1102	92.38	8.36	12/17/87	84.02	11,655.516	10,480.385
MW-1103	101.01	19.40	12/17/87	81.61	11,626.815	10,621.504

Notes:

(1) TOC - Top of well casing elevation based on arbitrary bench established on site and referenced on the site survey in Appendix K. Datum assumed to be 100 feet mean sea level (msl).

(2) Coordinates based on local grid system established on site and referenced in the site survey in Appendix K.

3.5 HYDRAULIC CONDUCTIVITY TESTING

A hydraulic conductivity test known as a slug test was performed on each well after well development and before sampling. The test consists of inserting a slug (solid PVC rod) into the water column in the well to raise the water level (slug-in test) or removing a slug of water from the water column to lower the water level (slug-out test). The recovery to static water level is recorded over time. Test results were measured using an Enviro-Labs EL-200 Data Logger hydrologic monitoring device. Data was evaluated using the Bouwer and Rice (1976) technique to calculate the hydraulic conductivity for each well. Data and hydraulic conductivity computations for each well test are presented in Appendix D.

Table 3-5 shows the range of permeabilities measured in monitoring wells at ATLAS Site S-11. Values range from 8.76 x 10^{-4} to 2.85 x 10^{-3} centimeters/second (cm/s). The measured hydraulic conductivities are are within a range typical for moderately fractured crystalline rock.

3.6 SAMPLING PROGRAM

Sampling at ATLAS Site S-11 was performed in three episodes. Geotechnical sampling was performed during the drilling program which occurred between November 5 and November 20, 1987. Soil samples for chemical analysis were collected on November 11, 1987. Ground-water and silo water samples were collected on December 10, 1987. Specific sampling protocol are contained in Appendix I - the Sampling and Analysis Plan. Information relative to field drilling and sampling activities is presented here.

TABLE 3-5

HYDRAULIC CONDUCTIVITY DATA SUMMARY
ATLAS SITE S-11
ELLENBURG, NEW YORK

Well No	SWL[1] (from TOC)	Type Test	Hydraulic Conductivity[2] (cm/s)	Date Test Performed
MW-1101	12.39	Slug in	1.36×10^{-3}	12/28/87
		Slug out	2.73×10^{-3}	
MW-1102	8.36	Slug in	2.85×10^{-3}	12/17/87
		Slug out	2.53×10^{-3}	
MW-1103	19.40	Slug in	1.24×10^{-3}	12/17/87
		Slug out	8.76×10^{-4}	

NOTES:

(1) SWL - Static Water Level from TOC (Top of Casing)
(2) From Bouwer and Rice (1976) calculation. Data and complete results are contained in Appendix D.

3.6.1 Geotechnical Data

Drilling at ATLAS Site S-11 was initiated on November 5, 1987. The wells were drilled with an Acker "Super Max" truck-mounted drilling rig. Overburden samples were obtained with a split-spoon sampler at various depths. Bedrock samples were obtained with a 2 5/8-inch core barrel. Samples from each boring were analyzed for grain size distribution, moisture content, and Atterberg limits. The laboratory results are presented in Table 3-6.

3.6.2 Ground-Water Samples

Prior to collecting samples, monitoring wells were purged with a 1.5-inch x 3-foot teflon bailer. Work plan specifications required that a minimum of five casing volumes of water be removed from each well. Table 3-7 shows purging data for the site.

Ground-water samplers were collected from each of the three monitoring wells. A Field Sampling Report, for each well is included in Appendix F. Ground-water samples that were collected from each of the monitoring wells included the following: field samples, a duplicate field sample from well MW-1102 (Quality Control), and a Quality Assurance sample for the USACE. In addition, a rinsate sample was collected to test field cleaning procedures. Table 3-8 lists the numbers and types of water samples taken at ATLAS Site S-11 and the parameters for analysis.

3.6.3 Silo Water Samples

To access the underground silo, a hole was drilled through the silo door. Water in the silo was sampled with a 1.5-inch x 3-foot teflon bailer. Samples collected from the silo included a field sample, a QC duplicate sample, a QA duplicate, and a sample equipment rinsate. Table 3-9 lists the silo samples collected at ATLAS Site S-11 and the parameters for analysis.

TABLE 3-6

SOIL LABORATORY DATA SUMMARY
ATLAS SITE S-11
ELLENBURG, NEW YORK

I.D. Number	Sample Interval(ft)	Percentage Sand/Gravel	Percentage Silt/Clay	Unified Soil Classification	Percentage Moisture	Atterberg Limits LL	PL	PI
MW-1101 #2	2.0 - 3.0	67.9	32.1	SM	12.2		NONPLASTIC	
MW-1102 #1	0.0 - 2.0	64.9	35.1	SM	16.5	19	16	3
MW-1103 #4	6.0 - 8.0	96.2	3.8	SP	5.5		NONPLASTIC	
MW-1103 #9	9.0 - 11.0	73.6	26.4	SM	21.3	27	21	6

NOTES:
LL - Liquid Limit
PL - Plastic Limit
PI - Plasticity Index

Classification	Percentage Silt/Clay
SP or SW	<5
SP-SM	5-12
SP-SC	5-12
SM	>12
SC	>12
ML or CL	>50
MH	>50

TABLE 3-7

WELL PURGING DATA SUMMARY
ATLAS SITE S-11
ELLENBURG, NEW YORK

Well No.	SWL[1] (feet)	Well Depth Below TOC (feet)	Quantity in Well[2] (gal)	Quantity Purged (gal)	Well Volumes Purged	Date
MW-1101	13.3	17.5	0.7	0.7[3]	1	12/10/87
MW-1102	10.3	23.9	2.2	11.0	5.0	12/10/87
MW-1103	17.8	30.8	2.1	10.4	5.0	12/10/87

NOTES:

(1) SWL - Depth in feet from Top of Casing (TOC) to Static Water Level (SWL) measured 12/8/87.
(2) Quantity in well casing. Once casing volume = (Total depth of well - SWL) x 0.16 gal/ft.
(3) Bailed dry.

TABLE 3-8

GROUND-WATER
SAMPLES AND PARAMETERS FOR ANALYSIS
ATLAS SITE S-11
ELLENBURG, NEW YORK

Sample Type	Number of Samples	Parameters		
		Purgeable Aromatics and Halocarbons	Base/Neutral Extractables	Total Metals
Field Sample	3	x	x	x
Quality Control (AE)				
Duplicate	1	x	x	x
Sampling blank	1	x	x	x
Trip blank	1	x	-	-
Quality Assurance (USACE)				
Duplicate	1	x	x	x
Sampling blank	1	x	x	x
Trip blank	1	x	-	-

NOTES:

AE - Law Environmental, Inc.
USACE - United States Army Corps of Engineers
x - Indicates sample was collected for chemical analysis.
- - Indicates no sample was collected.

TABLE 3-9

SILO WATER
SAMPLES AND PARAMETERS FOR ANALYSIS
ATLAS SITE S-11
ELLENBURG, NEW YORK

Sample Type	Number of Samples	Parameters: Purgeable Aromatics and Halocarbons	Parameters: Base/Neutral Extractables	Parameters: Total Metals
Field Sample	1	x	x	x
Quality Control (A-E)				
Duplicate	1	x	x	x
Sampling blank	1	x	x	x
Trip blank	1[(a)]	x	-	-
Quality Assurance (USACE)				
Duplicate	1	x	x	x
Sampling blank	1	x	x	x
Trip blank	1[(a)]	x	-	-

NOTES:

A-E	Law Environmental, Inc.
USACE	United States Army Corps of Engineers
x	Indicates sample was collected for chemical analysis.
-	Indicates no sample was collected.
(a)	One trip blank was analyzed for both ground and silo water samples.

3.6.4 Shallow Soil Sample Locations S-1 through S-6

Shallow soil samples were collected at six locations on the site using a stainless steel hand auger. The sample depths ranged between 0.5 to 2.0 feet for all soil samples. Analytical results for these samples are presented in Section 4.4. Figure 2-2 shows the sampling locations. Table 3-10 lists numbers and types of soil samples collected and the parameters for analysis. Below is a description of each sampling location and the purpose for each location.

- Soil sample S-1 was taken in a field on the southeast side of the quonset huts. This location was selected to monitor the soil around the quonset huts.

- Soil sample S-2 was collected north of the horseshoe pitch area in a small swale. This location was chosen to monitor soil contained in the swale.

- Soil sample S-3 was collected from silo discharge area. This location was intended to monitor the soils around the silo sump discharge. The duplicate sample was collected at this location.

- Soil sample S-4 was collected in the northeast corner of the site near the fence boundary. This area was selected to monitor the soils which may receive run-off from the northern portion of the site.

- Soil sample S-5 was collected south of monitoring well MW-1103. Sample S-5 was intended to monitor the soils in the vicinity of MW-1103.

- Soil sample S-6 is the background sample. Results from the background sample are the basis for comparison of soil

TABLE 3-10

SOIL SAMPLES AND
PARAMETERS FOR ANALYSIS
ATLAS SITE S-11
ELLENBURG, NEW YORK

		Parameters		
Sample Type	Number of Samples	Purgeable Aromatics and Halocarbons	Base/Neutral Extractables	Total Metals
Field Sample	6	x	x	x
Quality Control (AE)				
Duplicate	1	x	x	x
Sampling blank	1	x	x	x
Trip blank	1	x	-	-
Quality Assurance (USACE)				
Duplicate	1	x	x	x
Sampling blank	1	x	x	x
Trip blank	1	x	-	-

NOTES:

AE Law Environmental, Inc.
USACE United States Army Corps of Engineers
x Indicates sample was collected for chemical analysis.
- Indicates no sample was collected.

analytical results. The sample was in the northern portion of the site in an area apparently isolated from potential contamination sources.

3.6.4.1 Sampling Procedure

Soils for chemical analysis were collected with a stainless steel hand auger. The auger portion itself was about a foot long and three inches wide. At approximately 0.5 to 2.0 foot depth, the filled auger was put in a stainless steel bowl. Using a stainless steel spoon, the 40-ml vials for purgeable aromatics and purgeable halocarbon (volatile organics) were filled directly from the hand auger. There was no mixing of the soil at this point. After all samples for volatile organics were taken, the rest of the sample in the auger was emptied into the bowl. At sampling locations chosen for duplicate samples, a second auger-full of soil was acquired. This soil was mixed with the remains of the first auger in the stainless steel bowl using a stainless steel spoon. Samples for total metals and base neutral extractables at one location were taken from this mixed soil. Specific sampling procedures are outlined in the Sampling and Analysis Plan (Appendix I).

Soil sampling included collection of the following samples: six field samples, one duplicate field sample at S-3, a soil equipment rinsate, and a trip blank (filled in the laboratory before shipment to the site). Quality control samples were also collected for the USACE. The sampling equipment was cleaned prior to collecting each sample to aid in preventing cross-contamination between sampling locations.

*****

4.0 TEST RESULTS

Samples for chemical analysis were collected from the silo water, ground water, and soil at ATLAS Site S-11. The analytical program used and the results of the analyses performed on samples collected from the site are presented in the following section. Interpretation of the data is presented in Section 5.0.

4.1 GROUND WATER ANALYTICAL RESULTS

Three monitoring wells were sampled in accordance with the Work Plan specifications (Appendix I). Table 4-1 lists the analytical methods used for ground-water samples and the detection limits for these methods. Samples from the wells were analyzed for purgeable aromatics, purgeable halocarbons, base/neutral extractables, and metals. Table 4-2 lists the analytical results for ground-water samples, including the rinsate, the duplicate and the travel blanks. Appendix E contains the complete analytical laboratory results.

Test results contained in Table 4-2 show that five purgeable organic compounds were detected in the ground-water samples collected at Site S-11. Methylene chloride was present below the measurable detection limit of 0.005 mg/l in all the field samples, the duplicate, the rinsate, the trip blank, and the method blank. Trans-1,2-dichloroethylene and trichloroethylene were detected in monitoring wells MW-1102 and MW-1103. Except for the concentration of trichloroethylene in well MW-1103, which was 0.006 mg/l, the concentrations of the two chlorinated compounds were below the measurable detection limit of 0.005 mg/l. Chloroform and toluene were detected at concentrations below the measurable detection limit of 0.005 mg/l in the rinsate sample. Toluene was also detected below the measurable detection limit in MW-1101.

TABLE 4-1
ANALYTICAL METHODS FOR WATER SAMPLES
ATLAS SITE S-11
ELLENBURG, NEW YORK

Parameter	Method[1]	Detection Limit (mg/L)[2]
Purgeable Aromatics	8240 (GC/MS)	0.005
Purgeable Halocarbons	8240 (GC/MS)	0.005 - 0.01
Base/Neutral Extractables	8270 (GC/MS)	0.01 - 0.05
Metals:		
Arsenic (As)	7060 (Furnace AA)	0.005
Barium (Ba)	6010 (ICP)	0.010
Cadmium (Cd)	6010 (ICP)	0.005
Chromium (Cr)	6010 (ICP)	0.010
Lead (Pb)	6010 (ICP)	0.005
Mercury (Hg)	7470 (Cold Vapor)	0.0002
Selenium (Se)	7740 (Furnace AA)	0.010
Silver (Ag)	6010 (ICP)	0.010

NOTES:

(1) Source: EPA September, 1986

(2) For Ecology and Environment, Inc., laboratory equipment and analytical procedures.

TABLE 4-2
SUMMARY OF POSITIVE ANALYTICAL RESULTS FOR GROUND WATER
ATLAS SITE S-11
ELLENBERG, NEW YORK
ALL RESULTS IN Mg/l
SAMPLED DECEMBER 12, 1987

Parameter	Sample Designation						
	MW-1101	MW-1102	MW-1100[1]	MW-1103	MWR Rinsate	Trip Blank	Method Blank
Purgeable Aromatics and Halocarbons							
Methylene chloride	<0.005[2]	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Trans-1,2-dichloroethylene	ND	<0.005	<0.005	<0.005	ND	ND	ND
Trichloroethylene	ND	<0.005	<0.005	0.006	ND	ND	ND
Toluene	<0.005	ND	ND	ND	<0.005	ND	ND
Chloroform	ND	ND	ND	ND	<0.005	ND	ND
Base/Neutral Extractables							
Dimethyl phthalate	ND	ND	ND	ND	<0.010	NT	ND
Di-n-butyl phthalate	ND	<0.010	<0.010	<0.010	<0.010	NT	<0.010
Di-n-octyl phthalate	<0.010	<0.010	ND	ND	<0.010	NT	ND
Bis (2-ethyl hexyl) phthalate	<0.010	<0.010	ND	ND	<0.010	NT	<0.010
Metals (Total							
Barium (Ba)	0.050	0.084	0.085	0.066	ND	NT	NT

NOTES:

(1) Ground water duplicate sample from MW-1102.

(2) < indicates compound present below listed measurable detection limit.

ND = Constituent not detected in sample.

NT = Sample not analyzed for constituent.

Four base neutral compounds, all phthalates, were detected at concentrations below the measurable detection limit of 0.010 mg/l in ground-water samples collected at the site. The rinsate sample contained all four phthalate compounds. The method blank contained di-n-butyl phthalate and bis (2-ethyl hexyl) phthalate. Wells MW-1101 and MW-1102 contained di-n-octyl phthalate and bis (2-ethyl hexyl) phthalate. Di-n-butyl phthalate was detected in wells MW-1102 and MW-1103. Dimethyl phthalate was only present in the rinsate and not in any of the field samples.

Barium was the only metal detected in the ground-water samples collected at the site. The concentration of barium in the samples ranged from 0.050 to 0.085 mg/l.

4.2 SILO WATER RESULTS

Water contained in the underground missile silo was sampled in accordance with the Work Plan specifications. Analytical methods used for the ground-water samples were also used for the silo water samples. Table 4-3 presents the analytical results for the silo samples. Appendix E contains the complete analytical laboratory results.

Table 4-3 shows that the same five purgeable organic compounds that were detected in the ground-water were also present in the silo water. All the purgeable organics were found below the measurable detection limit of 0.005 mg/l. Methylene chloride was present in all of the field samples, the rinsate, and the method blank. Toluene and chloroform were detected only in the rinsate sample. Trans-1,2-dichloroethylene and trichloroethylene were present in both the silo water sample and the duplicate.

TABLE 4-3
SUMMARY OF POSITIVE ANALYTICAL RESULTS FOR SILO WATER
ATLAS SITE S-11
ELLENBURG, NEW YORK
ALL RESULTS IN MG/L (PPM)
SAMPLED DECEMBER 12, 1987

Parameter	Sample Designation			
	SW	SWD[1]	SWR Rinsate	Method Blank
Purgeable Aromatics and Halocarbons				
Methylene chloride	<0.005[2]	<0.005	<0.005	<0.005
Trans-1,2-dichloroethylene	<0.005	<0.005	ND	ND
Trichloroethylene	<0.005	<0.005	ND	ND
Toluene	ND	ND	<0.005	ND
Chloroform	ND	ND	<0.005	ND
Base/Neutral Extractables				
Bis (2-ethyl hexyl) phthalate	<0.010	<0.010	<0.010	<0.010
Di-n-butyl phthalate	<0.010	<0.010	<0.010	<0.010
Di-n-octyl phthalate	ND	<0.010	<0.010	ND
Metals (Total)				
Barium (Ba)	0.040	0.040	ND	NT
Lead (Pb)	0.008	0.008	ND	NT

NOTES:

(1) Silo duplicate sample.
(2) < indicates compound detected but below the listed measurable detection limit.
ND = Constituent not detected in the sample.
NT = Sample not analyzed for constituent.

Three base/neutral extractables were present in the silo water at concentrations below the measurable detection limit of 0.010 mg/l. Di-n-octyl phthalate and bis (2-ethyl hexyl) phthalate were detected in the field sample, the duplicate, the rinsate, and the method blank. Di-n-octyl phthalate was present in the duplicate silo water sample and the rinsate.

Barium and lead were detected in the silo water samples collected at Site S-11. The barium concentration was 0.040 mg/l in the field sample and duplicate. The concentration of lead in the silo water samples was 0.008 mg/l.

4.3 SOIL ANALYTICAL RESULTS

Six shallow soil samples were collected at ATLAS Site S-11 and analyzed for purgeable aromatics, purgeable halocarbons, base neutral extractables, and metals. The analytical methods used are shown in Table 4-4.

The results of the soil analyses are shown in Table 4-5. Only one purgeable organic compound, methylene chloride, was detected in the soil samples collected at Site S-11. Methylene chloride was found in the six field samples, the duplicate, the rinsate, the trip blank, and the method blank. The highest methylene chloride concentration detected in the soil analyses, 2.7 mg/kg, was found in the method blank.

Four base/neutral extractable compounds were found in the soil samples. Di-n-butyl phthalate was present at a concentration below the measurable detection limit 0.33 mg/kg in all the field samples. Bis (2-ethyl hexyl) phthalate was present below the measurable detection limit in samples S-2, S-D (the duplicate of S-3), S-6, and the method blank. Pyrene, a Polynuclear Aromatic Hydrocarbon (PAH), was found below the measurable detection limit of 0.33 mg/kg in soil sample S-5.

TABLE 4-4
ANALYTICAL METHODS FOR SOIL
ATLAS SITE S-11
ELLENBURG, NEW YORK

Parameter	Method[1]	Detection Limit (mg/kg)[2]
Purgeable Aromatics	8240 (GC/MS)	0.5 - 1.0
Purgeable Halocarbons	8240 (GC/MS)	0.5 - 1.0
Base/Neutral Extractables	8270 (GC/MS)	0.33 - 4.0
Metals:		
Arsenic (As)	7060 (Furnace AA)	1.0
Barium (Ba)	6010 (ICP)	1.0
Cadmium (Cd)	6010 (ICP)	1.0
Chromium (Cr)	6010 (ICP)	1.0
Lead (Pb)	6010 (ICP)	0.5
Mercury (Hg)	7471 (Cold Vapor)	0.1
Selenium (Se)	7740 (Furnace AA)	1.0
Silver (Ag)	6010 (ICP)	2.0

NOTES:

(1) Source: EPA, September, 1986.
(2) For Ecology & Environment, Inc., laboratory equipment and analytical procedures.

TABLE 4-5
POSITIVE ANALYTICAL RESULTS FOR SOIL
ATLAS SITE S-11
ELLENBURG, NEW YORK
ALL RESULTS IN MG/KG
SAMPLED NOVEMBER 11, 1987

	Sample Designation									
Parameter	S-1	S-2	S-3	S-D[1]	S-4	S-5	S-6[2]	Rinsate[3]	Trip Blank[3]	Method Blank
Purgeable Aromatics and Halocarbons										
Methylene chloride	2.1	1.9	2.0	1.9	0.77	1.9	0.67	0.007	0.007	2.7
Base/Neutral Extractables										
Di-n-butyl phthalate	<0.33[4]	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	ND	NT	<0.33
Bis(2-ethyl hexyl) phthalate	ND	<0.33	ND	<0.33	ND	ND	<0.33	ND	NT	<0.33
Di-n-octyl phthalate	ND	ND	ND	ND	ND	ND	<0.33	0.26	NT	0.092
Pyrene	ND	ND	ND	ND	ND	<0.33	ND	ND	NT	ND
Metals										
Arsenic (As)	2.88	1.57	2.76	2.61	4.23	4.02	2.07	ND	NT	NT
Barium (Ba)	43.3	19.6	46.6	35.2	54.9	64.8	19.7	ND	NT	NT
Chromium (Cr)	9.24	3.53	7.04	6.64	9.15	10.8	5.35	ND	NT	NT
Lead (Pb)	10.3	4.08	14.2	5.0	17.3	14.6	13.5	ND	NT	NT

NOTES:

(1) Duplicate sample from S-3.
(2) Background soil sample.
(3) Rinsate and blank results given in mg/l.
(4) < indicates compound present below measurable detection limit.
ND - Constituent not detected in sample.
NT - Sample not analyzed for constituent.

The metals arsenic, barium, chromium, and lead were present in the soil samples collected at the site. The concentrations of these metals in the soil samples were within background levels established by Bowen (1966) and generally near the concentration of the background sample. These results will be discussed in Section 5.0 of this report.

4.4 QUALITY ASSURANCE/QUALITY CONTROL RESULTS

Quality Assurance/ Quality Control (QA/QC) criteria for this site was delineated in the Sampling and Analytical-QA/QC Plan contained in Appendix I of this report. QA/QC criteria are established for sampling methods and testing procedures as well as documentation of control and organizational responsibility.

Five types of QA/QC samples for ATLAS Site S-11 were analyzed by the laboratory. These samples consisted of duplicates, replicates, spikes, travel blanks and sampler rinsates. In addition to these samples, the laboratory has established internal QA samples which are used to analyze method controls, instrument calibration and internal QA procedures. Complete analytical results and QA/QC results are in Appendices E and F, respectively.

Duplicates of a ground-water sample, the silo water sample, and a soil sample were collected at the site. The ground-water sample duplicate was taken at Monitoring Well MW-1102. No purgeable aromatics, purgeable halocarbons or base/neutral extractables were present in the ground-water duplicate above the measurable detection limit. However, six organic compounds were detected below the measurable detection limit in sample MW-1102 and four were present below the measurable detection limit in the duplicate. Barium was the only metal present in the ground-water sample. Agreement between the original and duplicate barium analyses was high. Agreement between the original and duplicate

analyses of organic compounds was generally good with the exception of the phthalate compounds. The reason for the variation in the phthalate results will be addressed in Section 4.5. The results of the original and duplicate analyses for the constituents which were detected in the ground water are listed below.

Parameter	MW-1102		MW-110D (duplicate)	
Methylene Chloride	<0.005	mg/l	<0.005	mg/l
Trans-1,2-Dichloroethylene	<0.005	mg/l	<0.005	mg/l
Trichloroethylene	<0.005	mg/l	<0.005	mg/l
Bis (2-ethyl hexyl) Phthalate	<0.010	mg/l	ND	
Di-n-butyl Phthalate	<0.010	mg/l	<0.010	mg/l
Di-n-octyl Phthalate	<0.010	mg/l	ND	
Barium	0.084	mg/l	0.085	mg/l

The silo duplicate results for metals analyses were identical to the original field sample results. With the exception of di-n-octyl phthalate, all the organic compounds which were detected at concentrations below the measurable detection limit in the field sample were also present at the same level in the duplicate sample. The following shows the original and duplicate results for the compounds which were present in the silo water.

Parameter	SW		SW-D (duplicate)	
Methylene Chloride	<0.005	mg/l	<0.005	mg/l
Trans-1,2-Dichloroethylene	<0.005	mg/l	<0.005	mg/l
Trichloroethylene	<0.005	mg/l	<0.005	mg/l
Bis (2-ethyl hexyl) Phthalate	<0.010	mg/l	<0.010	mg/l
Di-n-butyl Phthalate	<0.010	mg/l	<0.010	mg/l
Di-n-octyl Phthalate	ND		<0.010	mg/l
Barium	0.040	mg/l	0.040	mg/l
Lead	0.008	mg/l	0.008	mg/l

The soil sample duplicate was collected from sample location S-3. The purgeable organic compound methylene chloride was found at 2.0 mg/kg in the soil sample and 1.9 mg/kg in the duplicate. Two base/neutral extractable compounds, di-n-butyl phthalate and bis (2-ethyl hexyl) phthalate, were present below the measurable detection limit in the duplicate. Di-n-butyl phthalate was also present below the measurable detection limit in sample S-3, but bis(2-ethyl hexyl) phthalate was not detected. Agreement between the sample and duplicate metals analyses was generally good. The concentration of lead in the duplicate was 35 percent of the concentration of lead in the original. The heterogeneous nature of soil typically causes a wide range of results. The results of the other duplicate metals analyses showed differences ranging from 5 to 31 percent. The following presents results for the constituents which were detected in the soil sample and duplicate.

Parameter	S-3	S-D (duplicate)
Methylene Chloride	2.0 mg/kg	1.9 mg/kg
Di-n-butyl Phthalate	<0.33 mg/kg	<0.33 mg/kg
Bis (2-ethyl hexyl) Phthalate	ND	<0.33 mg/kg
Arsenic	2.76 mg/kg	2.61 mg/kg
Barium	46.60 mg/kg	35.20 mg/kg
Chromium	7.04 mg/kg	6.64 mg/kg
Lead	14.20 mg/kg	5.00 mg/kg

Replicate samples are aliquots of a single sample that is split on arrival at the laboratory or when analyzed. Replicates are taken from the same sample bottle and extracted and analyzed as two separate samples. Results of the replicate analyses are compared to the original samples, yielding a relative percent difference. Two water samples, MW-1101 and SW-R, were replicated for metals analysis; the results showed a maximum of 4 percent relative percent difference. Sample SW-R was replicated for purgeable organics and the results showed a zero percent difference. One soil sample, S-1, was replicated for metals, and showed between zero and 16 percent relative difference. Sample S-5 was replicated for purgeable organics. The relative percent differences for these parameters ranged from 0 to 5 percent.

Sample and matrix spikes are known amounts of analyte that are added to a sample. Both the sample and the spiked sample are analyzed and the results compared. Percent recoveries are calculated to determine the amount of analyte added. If the spike analyses is accurate, the percent recovery should equal the amount of analyte actually added. The spike technique is routinely used in the laboratory to calibrate equipment. Table 4-6 shows the results of the sample spike analyses. For total

TABLE 4-6
QUALITY CONTROL: PERCENT RECOVERY
FOR SPIKE SAMPLES
ATLAS SITE S-11
ELLENBURG, NEW YORK

Parameter	Medium	Percent Recovery (range)	EPA QC Limits (1) (range)
SAMPLE SPIKE			
Total Metals	Water	92 - 120	80 - 125
Total Metals	Soil	82 - 106	24 - 127
MATRIX SPIKE			
Volatile Organics	Soil	76 - 110	59 - 172

NOTES:

(1) EPA advisory limits expressed as a percentage.
Source: Inorganics - EPA, Contract Laboratory Programs, January, 1984
Organics - EPA, Contract Laboratory Programs, November, 1986

metals in water, percent recovery for spiked samples ranged from 92 to 120 percent. Percent recovery for total metals in soil ranged from 82 to 106 percent. All sample spike analyses were within EPA QC advisory limits (EPA, January 20, 1984). Matrix spike analyses were performed for organic compounds in a soil matrix. The percent recovery for the matrix spike analyses ranged from 76 to 110 percent. These results are shown in Table 4-6. The results of the matrix spike analyses are within EPA advisory limits (EPA, November 24, 1986).

Surrogate spikes are compounds which are similar to the analyte in chemical composition, extraction and chromatography, but which are not normally found in the field sample (EPA, September 1986). A common tracer element used in surrogate spikes is deuterium. The surrogate spike sample is analyzed and the percent recovery of the added chemical is computed. Table 4-7 shows the results of the surrogate spike analyses. Surrogate spike recoveries for both purgeable organics and base/neutral extractables in soil and water were within advisory limits established by the EPA (EPA, November 24, 1986).

A travel or trip blank consisting of de-ionized water was analyzed for purgeable organic compounds (purgeable aromatics and halocarbons) in ground water and soils. Tables 4-2 and 4-5 contain results of the trip blank analyses. Methylene chloride was found in the soil trip blank at 0.007 mg/l and the ground-water trip blank at <0.005 mg/l. Methylene chloride was found in the laboratory method blanks and throughout the samples. Analytical data for the travel blanks and method blanks is included in Appendix E of this report.

TABLE 4-7
QUALITY CONTROL: PERCENT RECOVERY
FOR SURROGATE SPIKE SAMPLES
ATLAS SITE S-11
ELLENBURG, NEW YORK

Parameter	Medium	Percent Recovery (range)	EPA QC Limits (1) (range)
PURGEABLE ORGANICS	Water	88 - 108	76 - 115
	Soil	88 - 120	28 - 142
BASE/NEUTRAL EXTRACTABLES	Water	44 - 121	24 - 127
	Soil	43 - 94	28 - 142

NOTES:

(1) EPA advisory limits expressed as a percentage.
Source: Organics - EPA, Contract Laboratory Programs, November, 1986

A rinsate was sample collected from the ground-water (Teflon bailer) and soil samplers (stainless steel hand auger) to monitor field cleaning techniques. Sampler rinsates consisted of de-ionized water which was collected after being passed through the sampler and subsequently analyzed for the same parameters as the field samples. Tables 4-2, 4-3, and 4-5 contain results of the rinsate sample analyses. The ground-water rinsate contained methylene chloride, toluene, chloroform, dimethyl phthalate, di-octyl phthalate, bis (2-ethyl hexyl) phthalate, and di-n-butyl phthalate at concentrations below the measurable detection limit. The silo water rinsate sample contained the same parameters, except for dimethyl phthalate, at identical levels. Methylene chloride was detected at 0.007 mg/l and di-n-octyl phthalate was detected at 0.26 mg/l in the soil rinsate. The rinsate analyses is used to monitor the effectiveness of sample apparatus cleaning and to document the potential cross-contamination. The phthalate compounds which occur in the rinsate samples were also found in the method blanks. Most likely, the presence of phthalates in the rinsate does not indicate field conditions. Chloroform was present in the rinsate sample, but not in any field samples. Based on the nature of the methylene chloride and phthalate contamination in the rinsate sample and method blank, the bailer cleaning appears to have been adequate. The source of the methylene chloride and phthalates will be discussed in Section 4.5.

Document control was used in this investigation to provide QA/QC for sampling protocol and sample Chain-Of-Custody. Documents were completed and signed in the field by the sampling personnel to adhere to QA/QC guidelines.

Field Sampling Reports were completed at each sampling location. These documents included sample identification, number and type of sample containers, and preservation method. The Field Sampling Reports also indicate the personnel, the sampling method, and specific sampling protocol. The Field Sampling

Reports for ATLAS Site S-11, contained in Appendix F, document the QA/QC data for sampling.

Chain-of-Custody Reports were maintained for each of the sample shipment containers used to transport samples to the laboratory. The reports were completed by field personnel and the technician who received the samples at the laboratory. These reports indicate that all the samples were received by the laboratory in satisfactory condition for the designated tests. Chain-of-Custody Reports are contained in Appendix F.

A sample tracking record is shown in Table 4-8. All samples were analyzed within the holding times specified by the Work Plans.

4.5 FACTORS INFLUENCING RESULTS

Low levels of methylene chloride, di-n-butyl phthalate, di-n-octyl phthalate, and bis (2-ethyl hexyl) phthalate were detected in many of the ground water, silo water, and soil samples collected at Site S-11. These constituents were also present in the rinsate samples, trip blanks, and method blanks for each media. Toluene and chloroform were detected in the rinsate samples for ground-water and silo water analyses. Chloroform was found in the ground water rinsate, but not in any field samples. The results of the Quality Control analyses and communication with the analytical laboratory indicate that the presence of methylene chloride, the phthalate compounds, toluene, and chloroform at ATLAS Site S-11 does not reflect contamination at the site but may indicate contamination arising in the laboratory. A letter from Ecology and Environment, Inc., outlining the potential sources of laboratory contamination is contained in Appendix F. These contaminants include methylene chloride, phthalate compounds, toluene, and chloroform.

TABLE 4-8
SAMPLE TRACKING RECORD
ATLAS SITE S-11
ELLENBURG, NEW YORK

ANALYSIS	MEDIA	DATE SAMPLED	LAB RECEIPT	DATE ANALYZED	MAXIMUM HOLDING TIMES SPECIFIED BY METHOD(1)	MAXIMUM HOLDING TIMES ACTUAL
METALS	Soil	11/11(2)	11/12	11/17 - 18	6 months	7 days
	Ground water	12/10	12/11	12/17 - 30	6 months	20 days
	Silo water	12/10	12/11	12/17 - 30	6 months	20 days
EXTRACTABLES	Soil	11/11	11/12	11/17 (ext),12/1-3(3)	7 days until extrac-	5 (ext), 16 days
	Ground water	12/10	12/11	12/17 (ext),1/5-7	tion & 40 days after	7 (ext), 20 days
	Silo water	12/10	12/11	12/17 (ext),12/21-22	extraction	7 (ext), 5 days
PURGEABLE ORGANICS	Soil	11/11	11/12	11/22 - 24	14 days	13 days
	Ground water	12/10	12/11	12/22	14 days	12 days
	Silo water	12/10	12/10	12/22	14 days	12 days

NOTES:

(1) Mercury specified maximum holding time 28 days.
(2) All samples collected in 1987.
(3) Date of extraction (ext) and date of analysis.

Methylene chloride is a solvent commonly used in analytical laboratories. Volatilized methylene chloride may be absorbed by the samples from the ambient laboratory atmosphere or may be present in trace quantities in methanol used during the extraction process. Methylene chloride was detected in the method blanks for soil and water samples. According to information provided by Ecology and Environment, compounds present in the method blank indicate a laboratory source.

Phthalate compounds occur in plastics, rubber, and PVC. Ecology and Environment, Inc., attributes the phthalate contamination detected in the samples to the use of plastic gloves during solvent rinsing in the extraction laboratory. Phthalates were detected in a majority of the samples collected at the site, including the method blanks.

Toluene was detected in the ground-water and silo water rinsates. Communication with the laboratory indicates that the toluene detected in these quality assurance samples is an artifact of the methanol used in the laboratory during sample preparation.

Chloroform was detected in concentrations below the measurable detection limit in the rinsate sample for ground water and silo water. No field samples, trip blanks or method blanks contained chloroform. It is likely that the presence of chloroform in the ground water and silo water rinsates is due to the use of de-ionized water contaminated with chloroform during collection of the rinsate sample. Thus the chloroform detected in these samples does not indicate contamination at the site.

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5.0 INTERPRETATION OF TEST RESULTS

5.1 EVALUATION OF SITE CHARACTERISTICS

ATLAS Site S-11 is located in the Adirondack region of northern New York State. The area is characterized by broad, rugged mountains and rounded hills with numerous rivers and small lakes. Glacial deposits cover most of the region. In the study area, a thin mantle of glacial till overlies the Potsdam Formation sandstone which forms the rolling Adirondack terrain.

The site is contained within the Adirondack Forest Preserve. Land use and development within the preserve are strictly controlled. Open space comprises the predominant land use around the site, although a number of residences are also located in the vicinity. The Town of Ellenburg is located 1.5 miles southwest of the site. The estimated population within a one mile radius of the site is 360 people. Except for a few resort areas, the rugged terrain and forest preserve status of the Adirondack region make the area relatively sparsely populated.

The ground surface at the site slopes generally east at a very gentle grade. Maximum topographic relief within the former ATLAS site is less than 10 feet. Surface run-off from the northern portion of the site follows a northeast trending swale. Surface run-off from the southern half of the site appears to be directed to a southeast trending swale which was constructed to facilitate drainage of the sump discharge system. Surface drainage originating on the site ultimately discharges into the Great Chazy River, located approximately one mile south of the facility.

Ground water at Site S-11 occurs between 8.36 and 19.40 feet below the ground surface. The ground water encountered at the site was contained in the sandstone of the Potsdam Formation.

The Potsdam sandstone is characteristically dense and contains little primary void space. Ground-water flow in the sandstone occurs in secondary openings such as joints or fractures. The relatively high hydraulic conductivity of the wells at the site, approximately 10^{-3} cm/sec, indicate that the sandstone underlying the site is moderately fractured. Ground-water flow in fractured rock can be highly irregular due to the lack of interconnection between fracture systems. The depth at which water was encountered beneath the site was highly variable. The well which had the highest ground elevation, MW-1103, showed the lowest water table elevation. Based on data from the three monitoring wells, ground water flow is directed to the northeast. This contradicts the flow indicated by the topography. The apparently anomalous water table elevations may be a result of an irregular fracture system in the bedrock.

5.2 EVALUATION OF ANALYTICAL DATA

The analytical results for this investigation are summarized in Tables 4-2, 4-3 and 4-5 of this report. Appendix E contains the complete laboratory results. Tables 5-1, 5-2 and 5-3 list the maximum silo water, ground water, and soil concentrations of the parameters detected at ATLAS Site S-11. For comparison, the table containing ground and silo water results also lists Federal regulatory criteria. The table containing the soil analytical results lists typical ranges for those parameters in soils in the continental United States.

5.2.1 Ground Water Results

The purgeable organic trans-1,2-dichloroethylene was detected at a concentration below the measurable detection limit of 0.005 mg/l in wells MW-1102 and MW-1103. Trichloroethylene was present below the measurable detection limit of 0.005 mg/l in MW-1102 and at 0.006 mg/l in MW-1103. The Maximum Contaminant Level Goal

TABLE 5-1

SUMMARY OF GROUND-WATER CONSTITUENT CONCENTRATIONS
COMPARED TO CURRENT STANDARDS AND CRITERIA
ATLAS SITE S-11
ELLENBURG, NEW YORK
All results in Mg/l

Parameter	Maximum Concentration Detected (mg/l)	Regulatory Criteria (mg/l)
Purgeable Halocarbons		
Trans-1,2-dichloroethylene	<0.005[1]	0.07[2]
Trichloroethylene	0.006	0.005[3]
Toluene	<0.005	2.0[2]
Metals (Totals)		
Barium (Ba)	0.085	1.00[4]

NOTES:

(1) "<" signifies that constituent was detected but at a concentration below the measurable detection limit.
(2) Proposed Maximum Contaminant Level Goal (MCLG), EPA, Federal Register, November 13, 1985.
(3) Maximum Contaminant Level (MCL), EPA, Federal Register, July 8, 1987.
(4) Maximum Contaminant Level (MCL) from EPA, National Primary Drinking Water Regulations, 1985.

TABLE 5-2

SUMMARY OF SILO WATER CONSTITUENT CONCENTRATIONS
COMPARED TO CURRENT STANDARDS AND CRITERIA
ATLAS SITE S-11
ELLENBERG, NEW YORK
All results in Mg/l

Parameter	Maximum Concentration Detected (mg/l)	Regulatory Criteria (mg/l)
Purgeable Halocarbons		
Trans-1,2-dichloroethylene	<0.005[1]	0.07[2]
Trichloroethylene	<0.005	0.005[3]
Metals (Totals)		
Barium (Ba)	0.040	1.00[4]
Lead (Pb)	0.008	0.05[4]

NOTES:

(1) "<" signifies that constituent was detected but at a concentration below the measurable detection limit.
(2) Proposed Maximum Contaminant Level Goal (MCLG), EPA, Federal Register, November 13, 1985.
(3) Maximum Contaminent Level (MCL), EPA, Federal Register, July 8, 1987.
(4) Maximum Contaminant Level (MCL) from EPA, National Primary Drinking Water Regulations, 1985.

TABLE 5-3

SUMMARY OF SOIL CONSTITUENT CONCENTRATIONS
COMPARED TO AVERAGE BACKGROUND CONCENTRATIONS
ATLAS SITE S-11
ELLENBURG, NEW YORK
All Results in Mg/Kg

Parameter	Maximum Soil Concentration (Mg/Kg)	Average Background Level[1] Avg. (Range) (Mg/Kg)
Base/Neutral Extractables		
Pyrene	<0.33[2]	NA[3]
Metals (Total)		
Arsenic	4.23	6 (0.1 - 40)
Barium	64.8	500 (100-3000)
Chromium	10.8	100 (5-3000)
Lead	17.3	10 (2-200)

NOTES:

(1) Source: Trace Elements in Biochemistry, H. Bowen, 1966.
(2) < indicates compound present below measurable detection limit.
(3) Background levels not determined for organic constituents.

(MCLG) for trans-1,2-dichloroethylene is 0.07 mg/l. The Maximum Contaminant Level (MCL) for trichloroethylene is 0.005 mg/l. The two compounds are chlorinated solvents which may have been used during operations at the ATLAS facility. Additionally, research has indicated that trans-1,2-dichloroethylene may be produced by the anaerobic decomposition of trichloroethylene (Cline and Viste, 1984). The chlorinated solvents detected at the site may be a result of DOD activities. However in all but a single water sample concentrations were below water quality standards.

The concentration of trichloroethylene in MW-1103 slightly exceeded the MCL of 0.005 mg/l. Although tricholoethylene may have been used during the operation of the ATLAS facility, the low concentrations detected may not be result of DOD activities. Trichloroethylene in shallow aquifers at concentrations less than 0.010 mg/l may be attributed to nonpoint sources such as air pollution (Trouwborst, 1981).

Toluene was found below the detection limit of 0.005 mg/l in the sample collected from MW-1101. Toluene is a constituent of fuel, and the presence of toluene in the ground-water sample may be a result of DOD activity at the site. The MCLG for toluene is 2.0 mg/l. Therefore, the traces of toluene detected in MW-1101 may be a result of DOD contamination, but the concentration present is significantly less than the regulatory criteria.

Barium was detected in the ground water at concentrations which ranged from 0.050 to 0.085 mg/l. These concentrations are well below the Maximum Contaminant Level (MCL) of 1.00 mg/l . The barium concentrations most likely does not represent ground-water contamination.

5.2 2 Silo Water Results

Trans-1,2-dichloroethylene and trichloroethylene were detected in the silo water sample and duplicate at concentrations below the measurable detection limit of 0.005 mg/l. The MCLG proposed by

the EPA for trans-1,2-dichloroethylene is 0.07 mg/l. The MCL for trichloroethylene is 0.005 mg/l. Therefore, concentrations of trichloroethylene and trans-1,2-dichloroethylene detected in the silo are below regulatory standards and are not indicative of significant contamination in the silo water.

Barium and lead were the only metals detected in the silo water. The concentrations of these metals were below the MCLs and most likely do not reflect contamination in the silo water.

5.2.3 Soil Results

The base/neutral extractable pyrene was present below the measurable detection limit of 0.33 mg/kg in soil sample S-5. This sample was collected directly east of the silo near monitoring well MW-1103. Pyrene is a constituent of diesel fuel, asphalt, and coal tar. Pyrene adheres readily to soil particles and tends to be highly immobile. The low concentration of pyrene detected in the soil sample may be a result of DOD activities, but does not indicate significant contamination.

Based on the samples collected at the ATLAS Site S-11, the soil contains concentrations of metals which are close to that of the background sample and within the average range of soils reported by Bowen (1966). Only low concentrations of the metals arsenic, barium, chromium, and lead were detected in the soil samples. Metals concentrations of soil at the site are most likely a reflection of natural soil composition and not indicative of contamination.

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