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WELDON SPRING SITE REMEDIAL ACTION PROJECT CHEMICAL SOIL INVESTIGATION SAMPLING PLAN FOR THE WELDON SPRING CHEMICAL PLANT / RAFFINATE PITS

REV. 1

MAY, 1988

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CHEMICAL SOIL INVESTIGATION SAMPLING PLAN FOR THE WELDON SPRING CHEMICAL PLANT/RAFFINATE PITS

PREPARED FOR:

U.S. DEPARTMENT OF ENERGY
OAK RIDGE OPERATIONS OFFICE
UNDER CONTRACT NO. DE-AC05-86OR21548

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1.0 INTRODUCTION

1.1 Purpose

The purpose of this Chemical Soil Investigation Sampling Plan is to provide a systematic approach for chemically characterizing soils at the Weldon Spring Chemical Plant/Raffinate Pits (WSCP/WSRP) areas in support of the overall Site Characterization Plan. The Chemical Soil Investigation Sampling Plan is designed to determine the extent and magnitude of chemically contaminated soil, evaluate contaminant migration pathways, document uncontaminated areas, and identify soil contaminant concentrations in qualitative and quantitative terms.

1.2 Scope

This sampling plan reviews historical information, identifies data needs and uses, and outlines sampling and analytical procedures, quality assurance methods, and data documentation and reporting requirements for soil investigations at the Weldon Spring Site (WSS).

The scope of this sampling plan is limited to the chemical characterization of soil contaminants in the 220-acre area of the WSCP/WSRP. The Weldon Spring Quarry (WSQ) and vicinity properties will be addressed as Interim Response Actions (IRAs) and are not included under this plan. This plan is not intended

to provide a vadose zone characterization or geotechnical information. Radiological soils characterization was completed in 1987, the conclusions of which are summarized in this sampling plan.

The area in and under the raffinate pits is not addressed in this sampling plan. The raffinate pit wastes will be characterized under the Waste Sampling Plan - Raffinate Pits. Any characterization of soil underlying the raffinate pits will be performed following waste removal to avoid risk of leakage from the WSRP. All waste material will be excavated to meet applicable guidelines and standards determined in the Baseline Risk Assessment. The need for chemical characterization of soils underlying the pits will be evaluated upon completion of soils data interpretation.

The need for chemical characterization of soils underlying existing buildings and along process sewer lines will be evaluated based on the results of this investigation. Any required characterization will be performed following removal of buildings and process sewers.

2.0 BACKGROUND

2.1 Site Description

The WSCP/WSRP is located in St. Charles County, Missouri, approximately 30 miles west of St. Louis and 14 miles southwest of St. Charles as shown in Figure 2-1. The site is situated on Missouri State Highway 94, about two miles southwest of the junction of Highway 94 and U.S. Routes 40 and 61. The WSCP/WSRP is surrounded by state and federally owned lands. It is adjoined on the west by the Weldon Spring Training Area (WSTA) and on the east, north and south by Missouri Department of Conservation (DOC) lands.

The communities of Weldon Spring and Weldon Spring Heights are located approximately two miles from WSCP/WSRP with a combined population of 200. A significantly larger population within close proximity of WSCP/WSRP includes the St. Louis metropolitan area with a population exceeding 2.5 million, and St. Charles with a population of over 36,000.

The geology of the area is predominantly clayey and silty soils overlying weathered limestone bedrock. The limestone bedrock contains solution-enlarged joints and fractures. In general, groundwater movement in the area is toward the north.

The best aquifer for potable water is the St. Peter Sandstone,

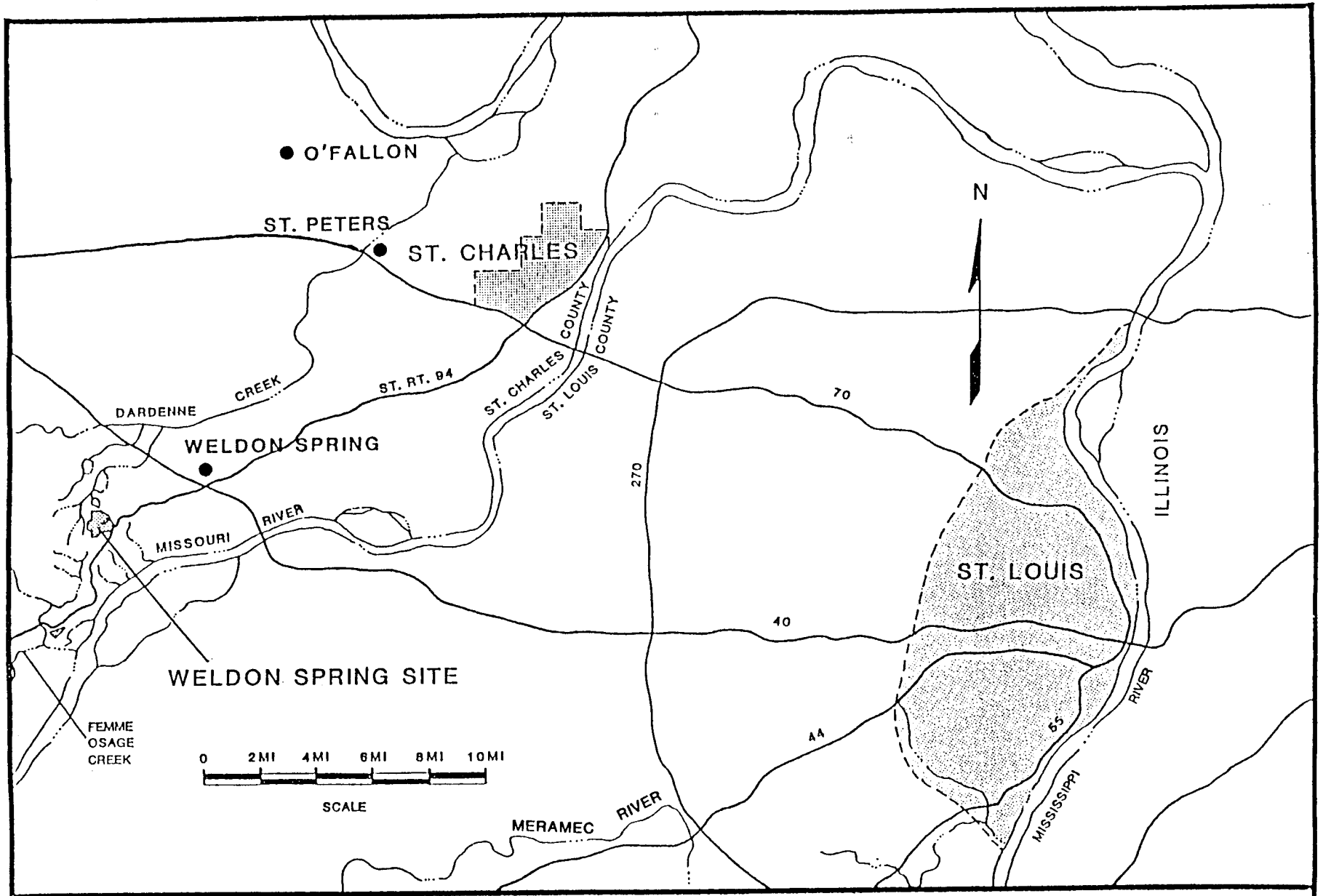

FIGURE 2-1

LOCATION OF THE WELDON SPRING SITE

approximately 600 feet below the surface at WSCP/WSRP. Two other aquifers of significance are the Burlington-Keokuk, about 200 feet thick and 60 feet below the surface, and the Sulfur Springs (Bushberg Sandstone), about 50 feet thick and 400 feet below the surface.

2.2 Site History

The site history, including previous decontamination efforts from 1941 to 1987 is summarized below. A more detailed history of WSS operations is included in Sections 2.2.1 - 2.2.4.

In April of 1941, the Department of the Army (DA) acquired 17,232 acres of land, and from November 1941 through January 1944, Atlas Powder Company operated a trinitrotoluene (TNT) and dinitrotoluene (DNT) explosives production facility known as the Weldon Spring Ordnance Works (WSOW). The 17,232-acre WSOW was closed and declared surplus to Army needs in April 1946. By 1949, all but approximately 2,000 acres had been transferred to the State of Missouri (August A. Busch Memorial Wildlife Area) and the University of Missouri (agricultural land). Except for several small parcels transferred to St. Charles County, the remaining property became the Weldon Spring U.S. Army Reserve and National Guard Training Area (WSTA).

Through a Memorandum of Understanding between the Secretary of the Army and the General Manager for the Atomic Energy Commission

(AEC) in May 1955, 205 acres of the former WSOW were transferred to the AEC for construction and operation of the Weldon Spring Uranium Feed Materials Plant (WSUFMP) to process uranium and thorium ore concentrates. Considerable explosives decontamination was performed by Atlas Powder and the DA prior to WSUFMP construction (DA, 1976).

The WSUFMP processed uranium and thorium ore concentrates from 1957 to 1966 with Mallinckrodt Chemical Works - Uranium Division as the AEC Operating Contractor. This facility consisted of 13 major process buildings and approximately 30 support structures as shown in Figure 2-2. The AEC closed the WSUFMP in December of 1966 when the facility was determined to be in excess of their needs.

On August 7, 1967, the AEC facility was selected as the site for a herbicide production facility, later known as the Weldon Spring Chemical Plant (WSCP). The Army was granted a license from the Nuclear Regulatory Commission (NRC) for the source material that was present as contamination throughout the site. On December 31, 1967, 169 acres of property and improvements were transferred to the Kansas City District-U.S. Corps of Engineers, which was responsible for the design and construction of the herbicide facility. The 52-acre WSRP and the WSQ remained under AEC control.

Decontamination and dismantling operations were initiated in

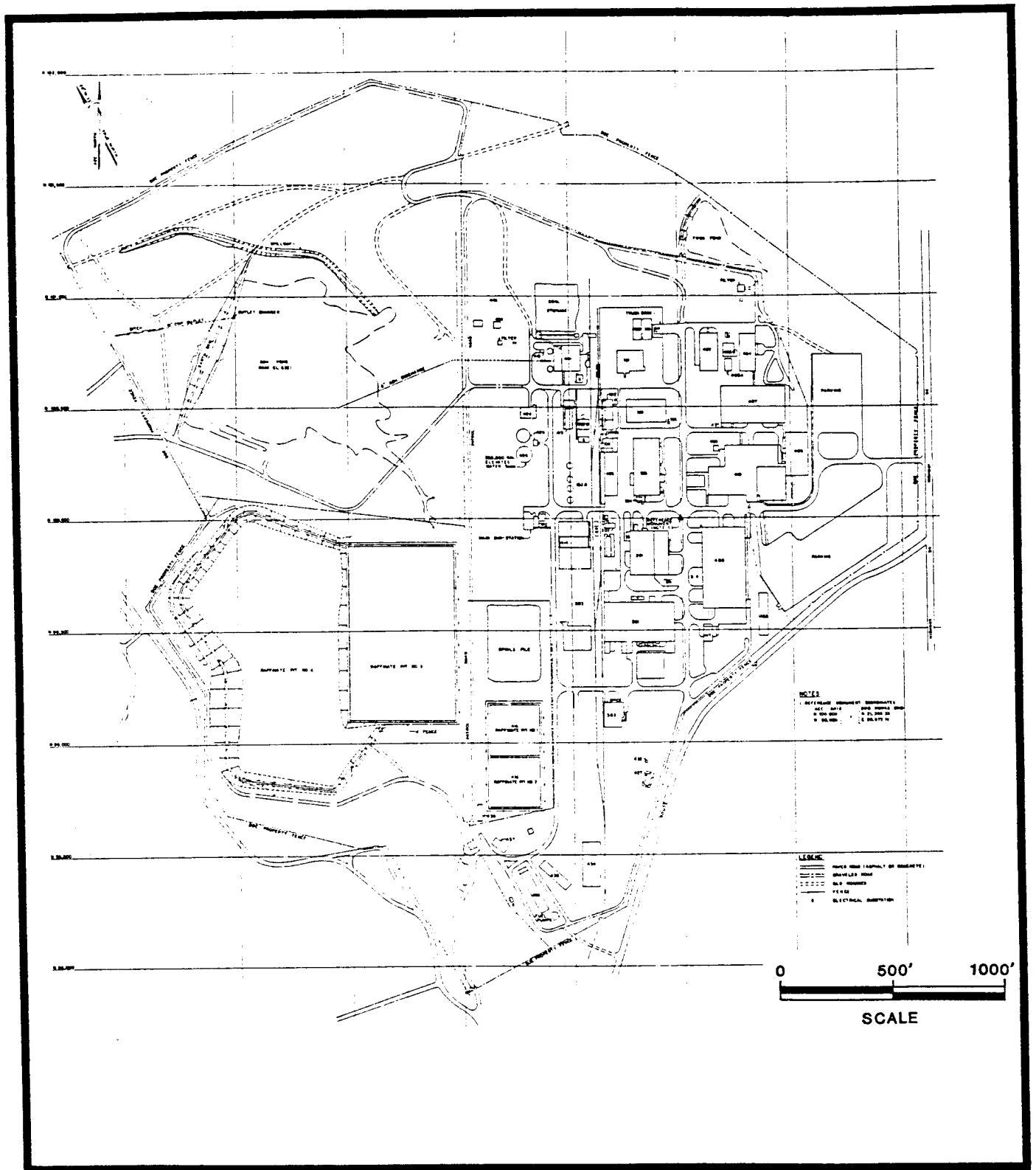

FIGURE 2-2

WSCP / WSRP

January 1968, by Thompson-Stearns-Roger Corporation (TSR), the Army's prime contractor for design and construction of the herbicide facility. Although some progress was made in decontaminating areas required for herbicide production equipment, the project was cancelled in February 1969 due to costs required to meet radiological contamination limits imposed on the facility and to the reduction of the military's requirements for herbicide.

The herbicide project was cancelled before any process equipment was installed for production. The DA retained the responsibility for the land and facilities at the WSCP.

The AEC contracted with National Lead Company of Ohio (NLO) to periodically visit the WSRP to perform environmental monitoring, maintain the pit embankments, and perform maintenance and surveillance tasks as necessary. In October 1981, Bechtel National, Incorporated (BNI), under contract to DOE (successor to AEC), assumed management responsibility for the WSRP and WSQ from NLO.

In November 1984, the DOE was directed by the Office of Management and Budget to assume custody and accountability for the WSCP from the DA. This transfer occurred on October 1, 1985.

In February 1985, DOE proposed designating the control and decontamination of the WSRP, WSCP, and WSQ as a major project.

Designation was effected by DOE Order 4240.1E dated May 14, 1985. A Project Management Contractor (PMC) for the Weldon Spring Site Remedial Action Project (WSSRAP) was selected in February 1986. In July 1986, a DOE Project Office was established on site. The PMC, MK-Ferguson Company, assumed control of the WSS on October 1, 1986.

2.2.1 Weldon Spring Ordnance Works: 1941-1949

The Atlas Powder Company operated the WSOW from November 1941 through January 1944. The complex consisted of 18 TNT and two DNT explosives manufacturing plants which were built within the borders of what is now the WSCP and WSTA. Figures 2-3 and 2-4 display the original WSOW layout and the current ownership, respectively. The first three TNT plants, and a portion of a fourth were built on what is now the WSCP/WSRP. Plate 1, bound at the back of this report, shows the locations of the TNT plants, roads, and process lines relative to the current WSCP/WSRP location.

At peak operation, the WSOW required 48 to 50 million gallons of water per day. In addition to the great quantities of water used for washing and mixing the chemicals, the process of manufacturing TNT and DNT also requires large quantities of nitric and sulfuric acids, and a chemical solution called sellite (sodium sulfite). The huge volume of wastewater generated at the WSOW caused the surface waters to become

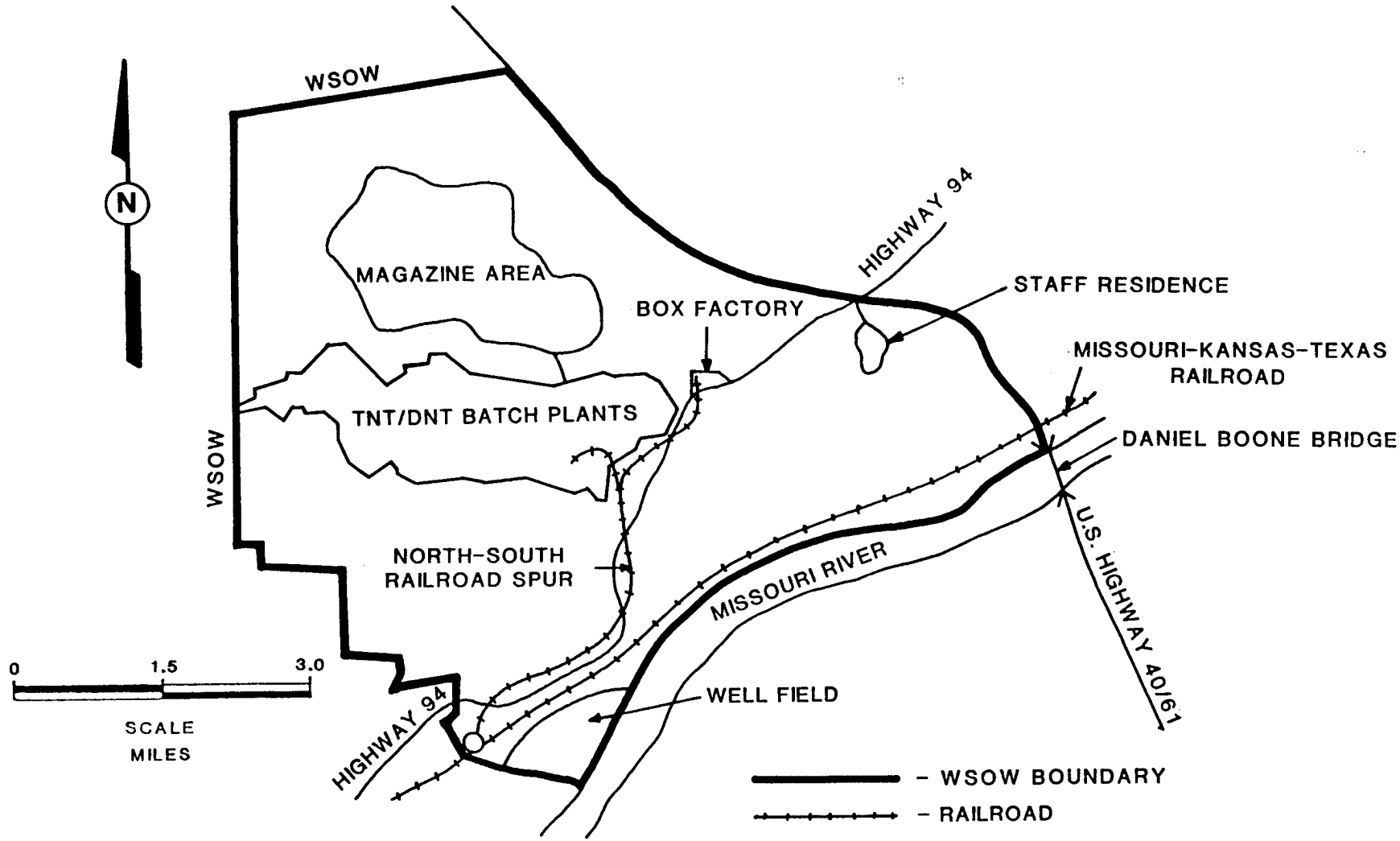

FIGURE 2-3

ORIGINAL WSOW LAYOUT

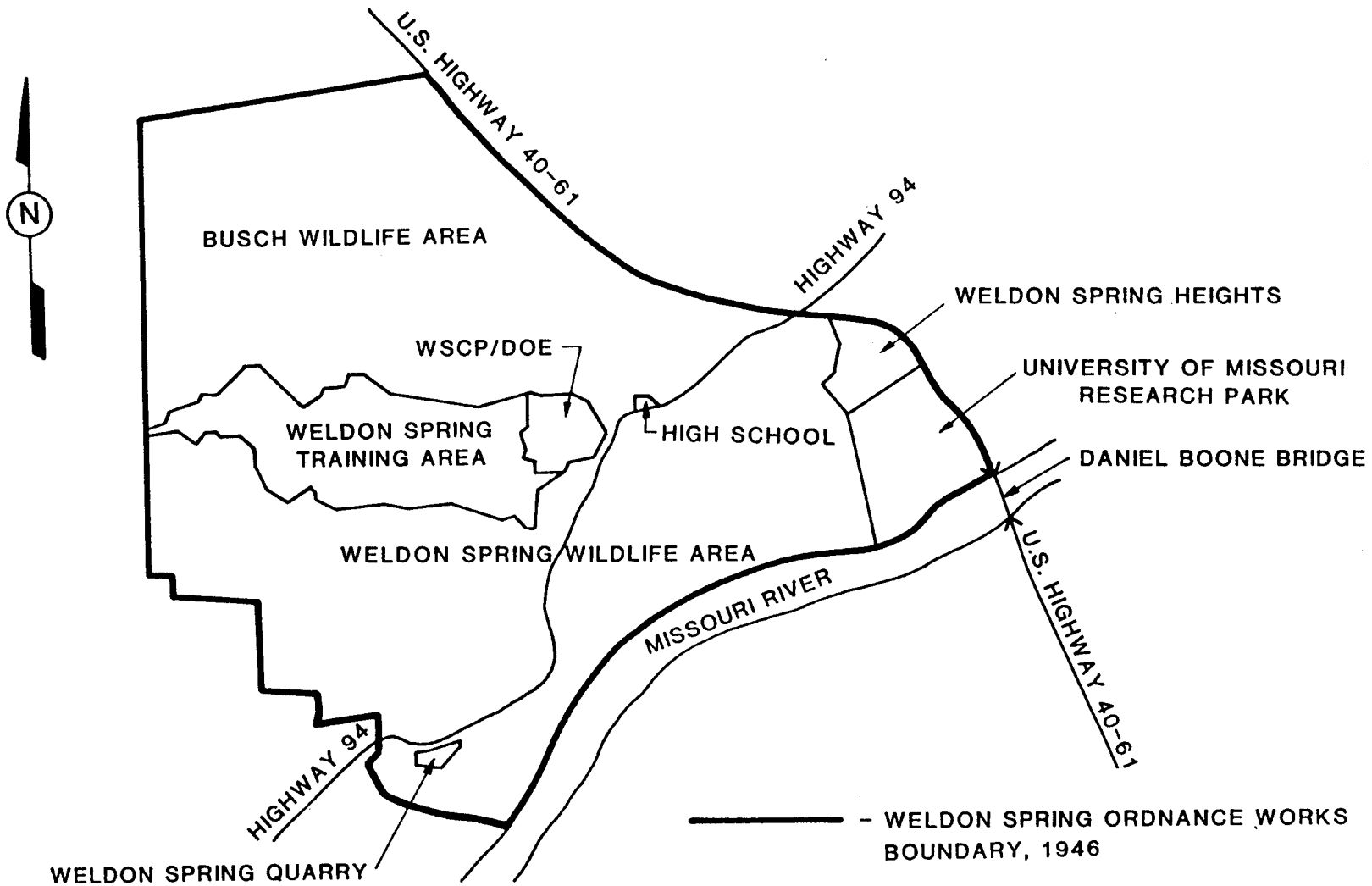

FIGURE 2-4

CURRENT DISPOSITION OF WSOW PROPERTY

polluted with TNT and DNT. Prior to construction of wastewater treatment plants in 1943, wastewater was discharged into seven lagoons for temporary storage. In December 1943, the Army drained and earth-filled four lagoons. The remaining three were drained but not filled at this time (USGS, 1944).

Water and wastewater lines served each batch plant. Separate wastewater lines were used for chemical waste and for sewage. The chemical wastewater lines carried red and yellow wastewater from each batch plant to various locations where the lines terminated. An estimated 66,000 linear feet of wooden wastewater lines were laid at the WSOW. The pipelines were generally made of cypress wood constructed similar to barrels with metal bands for support and were 10 feet or less in length. The lines discharged into wastewater treatment plants used to collect wastes for land disposal.

At the request of the War Department, the USGS conducted an investigation of groundwater and surface water contamination from TNT and DNT waste products. The contamination source was originally believed to be waste lagoons constructed to store wastewater. Subsequent field observations by the USGS revealed that wastewater was also discharged into ditches and streams, and that wastewater lines and catchment tanks frequently overflowed. A 1944 report by Fishel & Williams titled "The Contamination of Ground and Surface Waters by Liquid Wastes from the Weldon Spring Ordnance Works, Missouri," indicates a potential for soil

contamination along wastewater lines, in surface drainages, near production areas, at waste lagoons and wastewater catchment tanks.

The wastewater treatment plants were used to evaporate the wastewater into a sludge. The sludge was then hauled to open burning grounds for incineration. Eight burning grounds were used at WSOW. Seven of these areas are located off of the WSCP. One area, number five of the original eight, is thought to be located within the WSCP area and is shown in Figure 2-5. The WSOW temporarily ceased operations in January 1944, for approximately six months; then the DA reactivated it and operated it until the end of World War II.

Under the reactivation program at the WSOW, equipment in line No. 18 was cannibalized for use in other lines. Lines No. 2 and No. 3 were reassembled, but were never placed in operation. In addition, the WSOW produced a new type of TNT under the reactivation program. In January 1946, an Ordnance Review Board (ORB) was created to determine the disposition of contaminated buildings and equipment at various ordnance plants. In April 1946, the ORB declared the WSOW surplus property and transferred it to the War Assets Administration (WAA) on September 1, 1946. The WAA was organized to dispose of surplus U.S. government property.

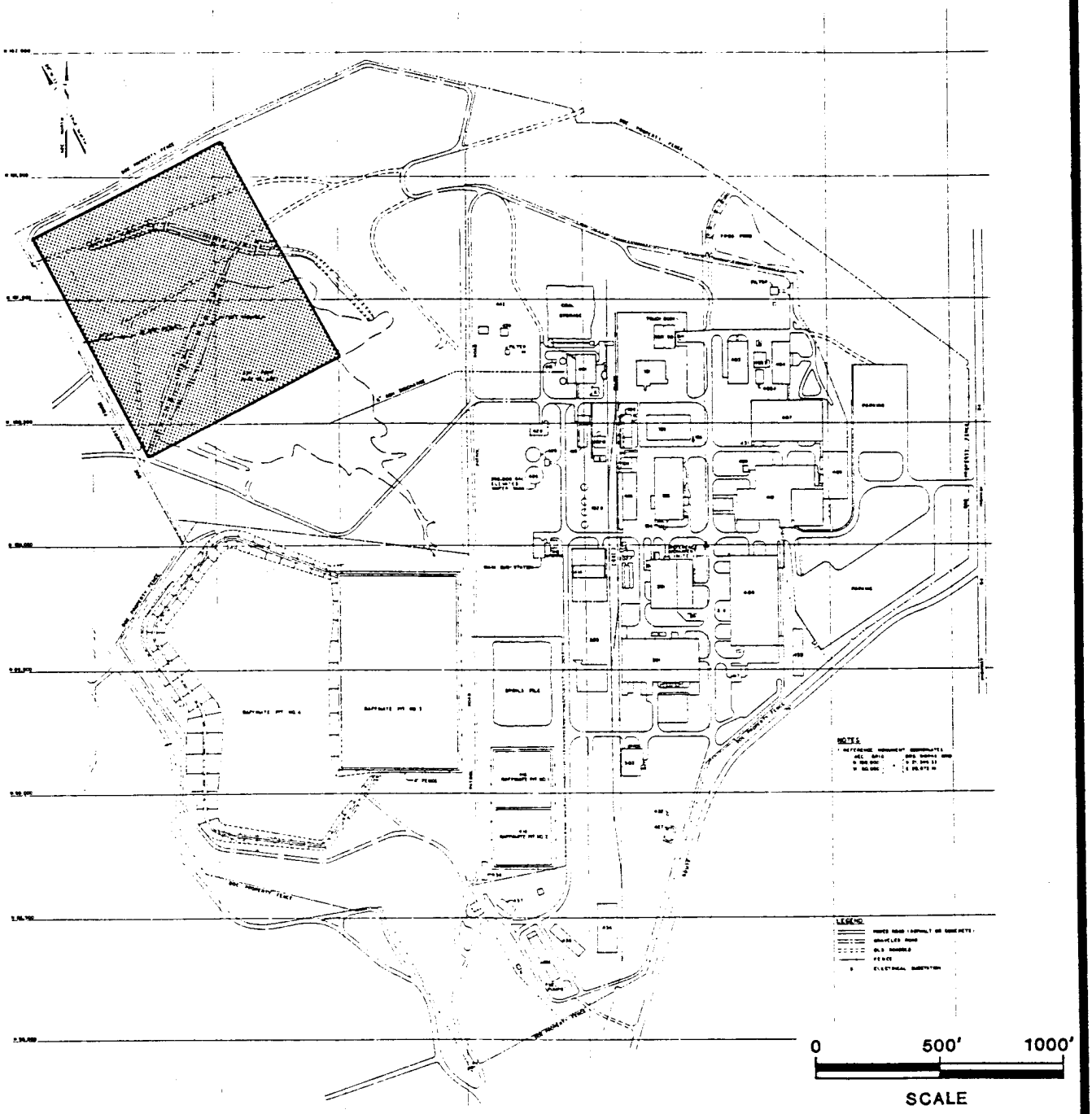

FIGURE 2-5

BURNING GROUND AREA

The first effort to decontaminate the WSOW was made by Atlas Powder Company in 1946. Atlas presumably decontaminated all equipment in accordance with accepted standards for stand-by service. In the fall of 1946, however, several fatalities occurred as a result of using improperly decontaminated equipment. Therefore, the ORB recommended that any processing equipment in direct contact with TNT, DNT or their intermediates be considered hazardously contaminated. In addition, the Board recommended removal of all earth known to be contaminated around processing buildings, catch tanks and similar areas. In 1946, following these recommendations, the Kansas City District of the Army Corps of Engineers removed 3,512 cubic yards of earth, burned 113,005 pounds of hand-picked TNT and 40 tons of TNT and other residues in place. It is not known if the Corps deposited this earth in the magazine area, the quarry, the burning grounds or somewhere else. In addition, many buildings were burned or otherwise destroyed. At the conclusion of this decontamination effort, the Corps published a report entitled: "Survey Covering Salvageable Equipment and Buildings in TNT Area at Weldon Spring Ordnance Works," Kansas City District Corps of Engineers, December 7, 1946 (USATHAMA, 1977). Of the more than 800 buildings comprising the WSOW, the Corps burned or demolished approximately 200 buildings. These 200 buildings were considered contaminated with explosives. It has been discovered much later that many of the 800 buildings at the WSOW contained asbestos insulation. This suggests the possibility of asbestos contamination in the remains of destroyed buildings.

2.2.2 Land Transfers: 1949-1954

In 1949, much of the original WSOW was sold to the public. The University of Missouri received approximately 8,000 acres for agricultural use (southern half of the WSOW). Subsequently, this land was purchased by the Missouri Department of Conservation (DOC)--the present owners. The DOC received about 7,000 acres and created the August A. Busch Memorial Wildlife Area (Busch Area- northern half of WSOW). St. Charles County Public Schools received about 40 acres, where Francis Howell High School now stands. The WAA was the grantor in all these transactions. In 1950, the General Services Administration (GSA), as successors of the WAA, took custodial control of the remaining 2,000 acres at Weldon Spring. The GSA conducted a renovation project to restore some buildings and equipment.

The GSA transferred the remaining 2,000 acres of WSOW land to the DA in July 1954, as part of the National Industrial Plant Reserve.

2.2.3 Uranium Feed Materials Plant: 1954-1966

In 1954, the Atomic Energy Commission (AEC) expressed an interest in using the area for the Weldon Spring Uranium Feed Materials Plant (WSUFMP). The Army agreed to transfer 205 acres to the AEC in 1955. Prior to transfer, decontamination operations were performed. These operations were limited to decontaminating only the 205-acre area transferred to the AEC. As a result of this

decontamination operation, it was assumed that all underground wastewater lines were removed from the WSCP/WSRP to the perimeter of the WSTA fence (USATHMA, 1977).

To ensure complete decontamination of underground process lines, trenches were dug 360 degrees around each foundation to locate any remaining underground lines that might be contaminated. Additional trenching was performed in adjacent areas where there was a potential for underground lines or contaminated residue collection points. Contaminated lines and materials located were removed and destroyed by flashing (burning with a flamethrower). It was discovered that as many as four underground lines remained around certain buildings because broken lines were neither repaired nor removed when bypass lines were installed. The new replacement lines were probably never mapped since production of explosives was top priority while the installation of waste lines was occurring. Large deposits of explosive materials were found in the pipelines that were located and removed in 1955. It was also reported that chunks of TNT, measuring approximately 36 inches in diameter and 18 inches thick, were removed from catch basins. (Campbell, 1986)

Contaminated materials were burned (presumably in the burning grounds area) and conveyed to designated storage areas as noncombustibles. Uncontaminated useful materials such as wood, utility poles and fire hydrants were salvaged for future use. Excess materials were accumulated and later sold as scrap. The

following list indicates the major work items performed (USATHAMA, 1977):

o Structures burned	59
o Structures removed by wrecking	8
o Structures remaining (uncontaminated)	2
o Underground piping removed, linear feet (estimated)	21,500
o Poles and supports removed (estimated)	1,600
o Poles salvaged	815
o Process equipment delivered to U.S. Army, items	33
o Contaminated earth removed, cubic yards (estimated)	28,250
o Concrete foundations removed, cubic yards (estimated)	1,400

The decontamination work above is described in very general terms in an AEC document on site preparation for construction of the WSUFMP (DA, 1976). After decontamination was completed, the DA transferred 205 acres to the AEC in August 1956. This land was to revert back to the DA whenever the AEC operations ceased.

To prepare the site for construction after the decontamination process, extensive cut and fill grading was performed across the site. Plate 2 shows the location of cut and/or fill grading relative to the current WSCP locations and topography.

The AEC contracted with Mallinckrodt Chemical Works to operate the WSUFMP. Operations which produced uranium metal from processed uranium ore began in June 1957, and ceased on December 31, 1966. The plant consisted of numerous buildings and four waste pits, called "raffinate" pits. The AEC also acquired the WSQ located four miles south of the WSCP/WSRP which was used to dispose of radiologically contaminated waste materials.

The WSUFMP, as first constructed, contained only two raffinate pits. The third and fourth pits were constructed in 1958 and 1964, respectively. The pits were used to deposit radioactive process waste from the WSUFMP. The Army transferred another 15 acres to the AEC for construction of the fourth pit. The land was carefully chosen to avoid taking any land contaminated with explosives, avoiding another decontamination operation. All waste pits were elevated to prevent surface drainage from entering the pits. Although the pits are located on the north side of the drainage divide between the Mississippi and Missouri rivers, indicating drainage into the Mississippi River watershed, the pits were designed in such a manner that allowed discharge into the Missouri River watershed, south of the divide. Decant from the pits (supernatant liquid after deposition of raffinate sludge) originally flowed into plant effluent and then to the southeast drainage easement. (When the AEC acquired the land for the WSUFMP in 1956, they obtained a drainage easement for the plant sewer outfall. This easement begins at the southeast corner of the plant and continues to the Missouri River. The DOC

owns the intervening land comprising this sewer outfall, however, the Army has retained control of the easement.)

The WSCP was transferred back to the Army in 1967 after the WSUFMP closed.

2.2.4 Weldon Spring Chemical Plant: 1967-1969

In August 1967, WSCP was selected for a herbicide orange (also known as "Agent Orange") facility because of the immediate need for herbicide in Southeast Asia. The Kansas City District-U.S. Corps of Engineers was responsible for design and construction of the facility and contracted with TSR Corp. for design and construction. The Army received a license to possess the radioactive material present as contamination on the site, but the WSQ and the WSRP remained under AEC control. However, the Army received permission from the AEC to dispose of radiologically contaminated equipment in the quarry and to pump plant waste into Raffinate Pit No. 4 with prior clearance from the AEC (DA, 1976).

In an amendment to the license, the Army specified that levels of radioactivity after decontamination were to be below the approved standards at the time. Due to these limits, the project was delayed and costs increased.

In January 1968, TSR Corporation took occupancy of the WSCP, and by February, decontamination and equipment removal had begun in Buildings 103 and 105 (Figure 2-2). Although progress was made, by January 1969, the estimated costs for completing the project had risen to 293% of the original bid, from approximately $10 million to over $30 million. At the same time, military demands for the herbicide were reduced. As a result, the project was cancelled in February 1969.

During decontamination operations, 20 railcars of stainless piping were shipped to National Lead Company of Ohio and about 900 truckloads containing 6,000 cubic yards of uranium-contaminated material were buried at the quarry. Furthermore, an unknown quantity (something less than 80 railcars) of radioactive material was shipped to Tennessee for reclamation.

2.2.5 Current Status: 1969-1988

Following the cancellation of the herbicide project in 1969, the WSCP remained under DA control and the WSRP was administered by the AEC. Only general maintenance activities such as mowing were performed from 1969 to 1987. Various characterization activities were performed by both the DA and AEC during this time. No decontamination or decommissioning efforts were performed during this period.

2.3 Physical Properties of Soil

Two previous studies at the WSCP/WSRP have established the current understanding of area soils and their physical properties. These studies, performed by Bechtel National in 1983-84 and 1986-87, defined on-site geology at the WSRP and WSCP respectively. The 1983-84 study focused on the 52-acre WSRP area. Soil samples were analyzed for grain size, laboratory hydraulic conductivity and several strength tests. The 1986-87 study evaluated the 169-acre WSCP and incorporated data from the previous report. Additional soil samples were collected and analyzed for liquid and plastic limit, grain size, unit weight, specific gravity, moisture content, centrifuge moisture equivalent, effective cation exchange capacity (CEC) and distribution ratio. Additional soil parameters were calculated including: void ratio, porosity, specific retention, specific yield, saturation and activity.

These studies defined WSCP/WSRP soils and their physical properties. Soils at the WSCP/WSRP area consist of six distinct units:

- Topsoil/Fill
- Loess
- Ferrelview Formation
- Clay Till
- Basal Till
- Residuum

The topsoil/fill unit is the first soil unit encountered on-site. Topsoil ranges in thickness from a few inches up to one foot. Topsoil is typically a dark, organic-rich silty clay to clayey silt. Fill at the WSCP/WSRP is highly variable in nature, ranging from silts and clays to gravel and debris. Up to 26 feet of fill is present in some locations at the WSCP/WSRP. Related to the fill are cut areas. Up to fourteen feet of material was cut from various areas and used as fill for low areas. Cut and fill relationships are displayed in Plate 2.

Loess deposits are present over portions of the site. Their areal distribution is highly variable due to predepositional topography and postdepositional erosion. Loess thickness ranges from 0 to 10 feet.

Underlying the topsoil and/or loess units is the Ferrelview Formation, which consists of orange-yellow to brown silty clay. The Ferrelview Formation developed as a weathering product of the underlying clay till and its lateral extent is controlled by the presence of the till. Figure 2-6 presents an isopach map of the Ferrelview Formation (BNI, 1987). Thickness ranges from 0 to more than 15 feet.

The clay till unit is a glacial till deposited during Kansan glaciation composed of a yellow-brown silty clay with minor

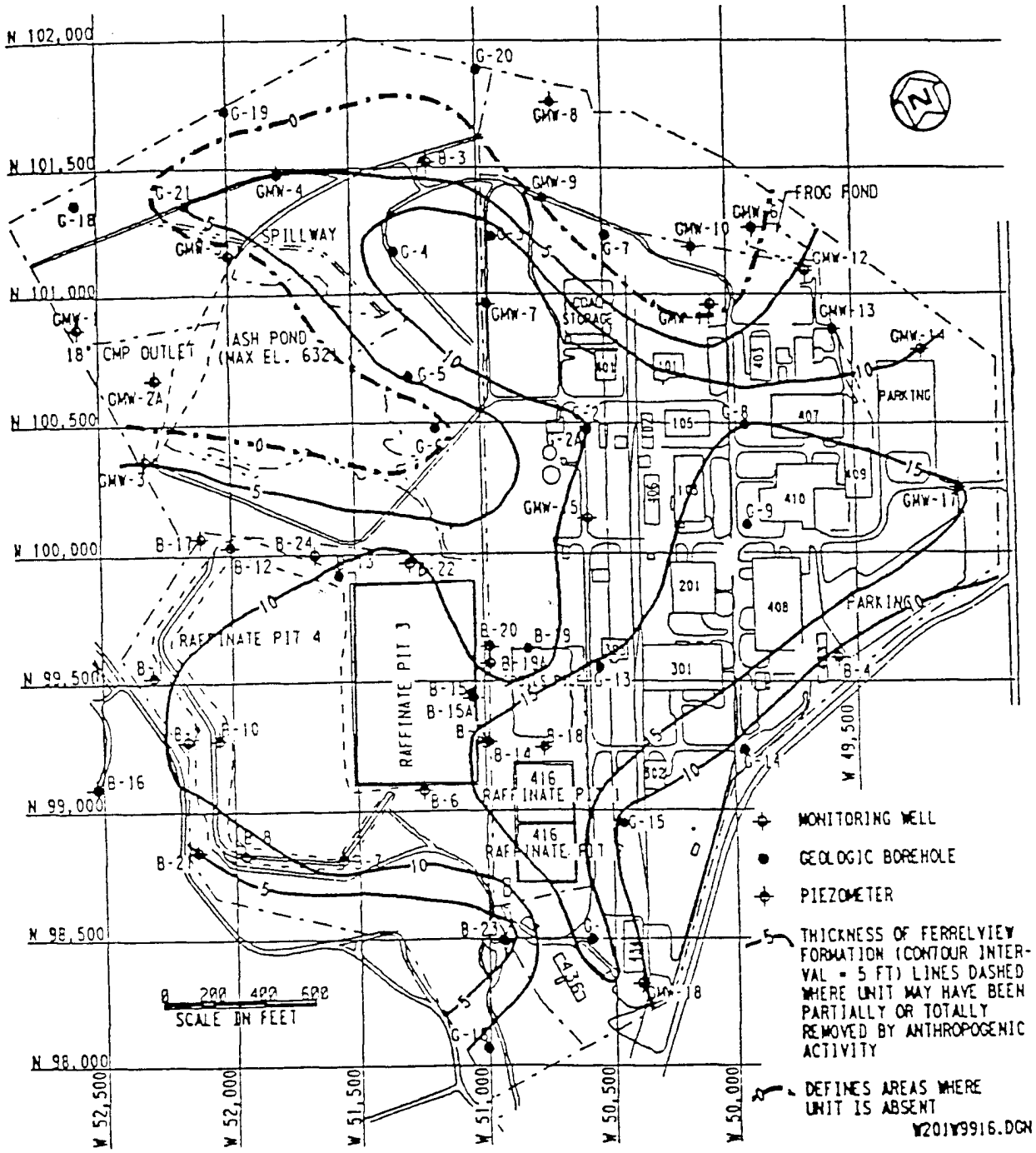

FIGURE 2-6

FERRELVIEW ISOPACH

amounts of sand and gravel. Up to 35 feet of clay till is present beneath the site, with the thickest deposits in the northern portion of the WSCP. Figure 2-7 presents an isopach map of the clay till unit (BNI, 1987).

Underlying the clay till is the basal till unit which contains greater amounts of gravel and angular chert in a clayey silt matrix. The basal till is thinnest (or absent) in areas with higher bedrock elevations. Figure 2-8 displays a basal till isopach map (BNI, 1987).

Residuum is present immediately overlying bedrock and consists of red and yellow clays with substantial quantities of chert. Thickness ranges from 0 to 23 feet for the residuum layer with the thickest deposits present in the Ash Pond area.

The average grain size distributions and Unified Soil Classification System (USCS) description for the soil units above the residium is presented in Table 2-1. Average moisture content (BNI, 1987) is also presented in this table.

Cation exchange capacity (CEC) was measured for both till units and the Ferrelview Formation. CEC values averaged 60.3 meq/100g for the Ferrelview Formation, 69.0 meq/100g for the clay till unit and 29.0 meq/100g for the basal till. The CEC is a measure of the propensity of the soil to exchange cations and retain contaminants. CEC tests indicate that the Ferrelview Formation

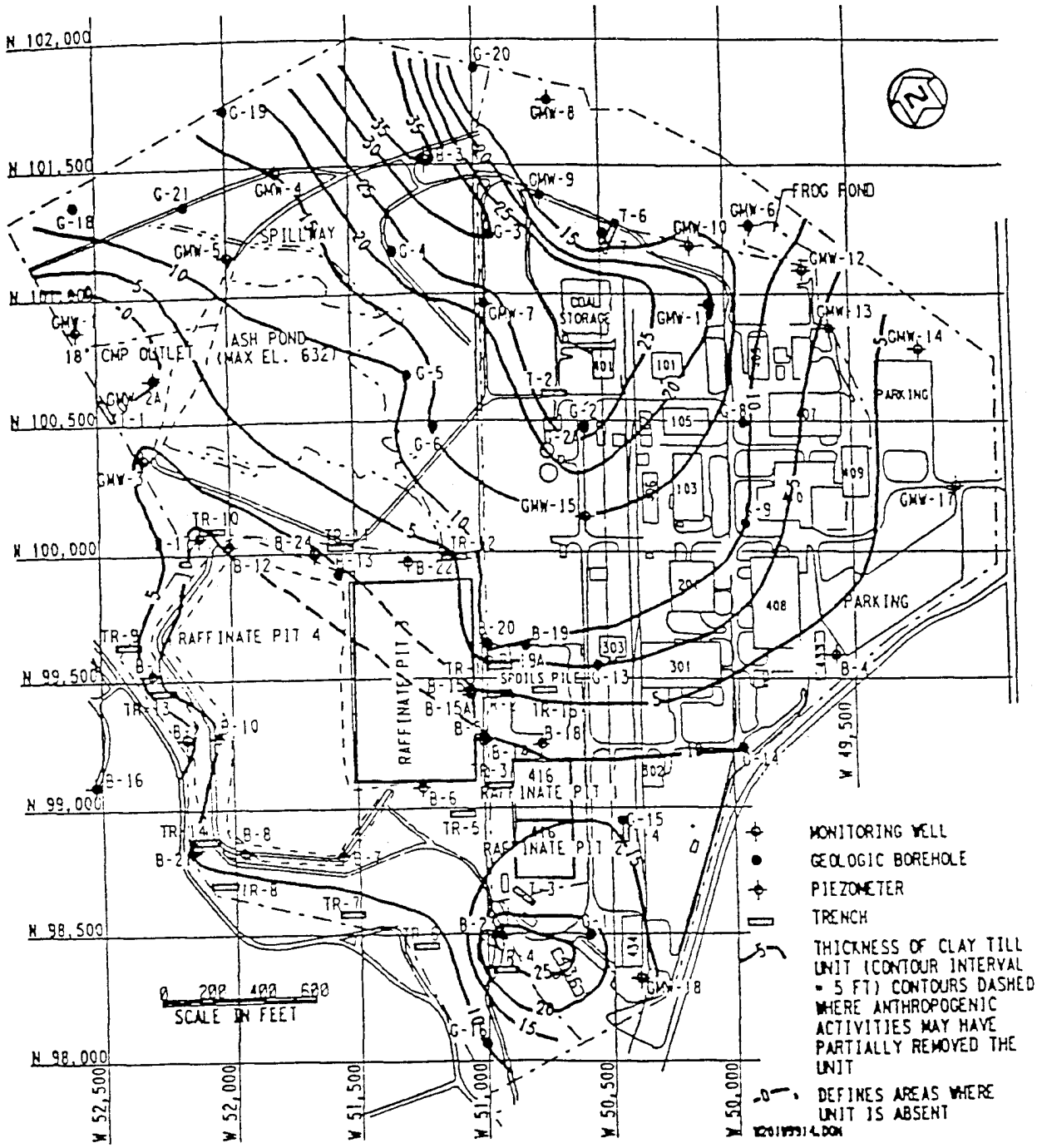

FIGURE 2-7

CLAY TILL ISOPACH

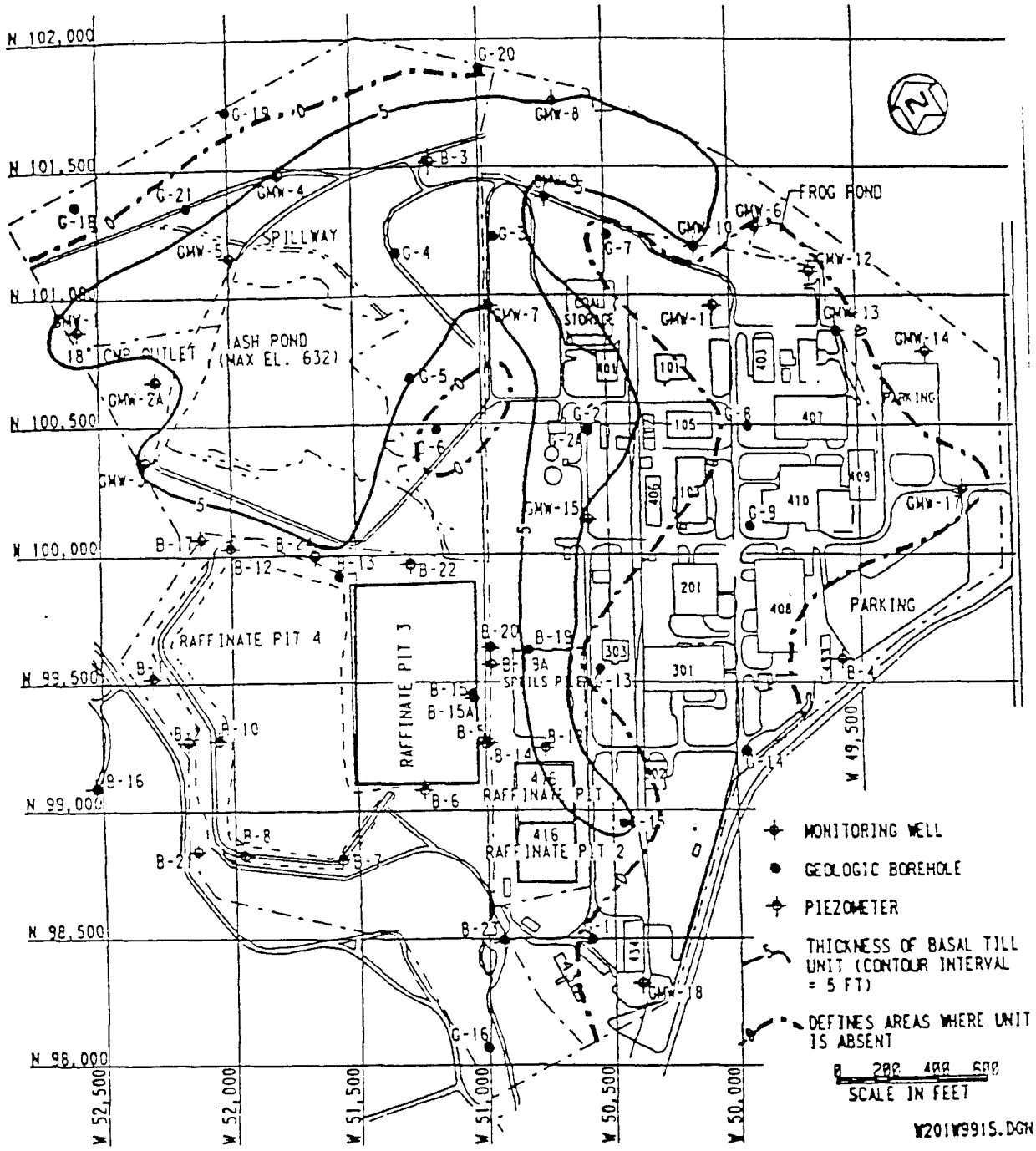

FIGURE 2-8

BASAL TILL ISOPACH

TABLE 2-1

GRAIN SIZE DISTRIBUTION FOR

SOIL UNITS

UNIT	USCS Classification	PERCENTAGE OF GRAIN SIZES GRAVEL	SAND	SILT	CLAY	MOISTURE CONTENT
Loess	CL	0	4.4	64	31.6	N.M.
Ferrelview Formation	CL-CH	2.8	9.8	49.6	39.6	24.7
Clay Till	CL	0.4	22.4	31.7	45.6	19.3
Basal Till	GC-CL	10.7	18.7	39.8	30.8	20.9
Residuum	**					

N.M. - not measured

Compiled from "Hydrogeological Characterization Report For Weldon Spring Chemical Plant," BNI 1987.

** Residuum information not available.

and the clay till are the primary soil units that can retain significant amounts of contaminants.

During the geological characterization of the WSRP performed by Bechtel National in 1983-84, soil samples were collected and analyzed for physical properties such as strength, grain size, and permeability. Since soil strength is of very limited usefulness in assessing contaminant migration, it will not be discussed in this work plan. Geotechnical properties of the soil will be addressed in detail under the Disposal Facility Siting Work Plan.

Laboratory testing indicated soil permeabilities ranging from 10-6cm/sec to 10-9cm/sec. These values are within the expected range for clay soils and clay tills. These values should be viewed as "ideal" conditions. The permeability of a clay soil unit can be increased by a number of factors including desiccation cracks, root penetration, soil jointing and chemical alteration. Individual samples may or may not be indicative of the whole unit.

Overall, natural soils above the residium at the WSCP/WSRP are low plasticity silty clays with a high CEC. They are generally "tight" and do not transmit significant amounts of water to the underlying bedrock. More permeable, preferred migration pathways may exist in the form of desiccation cracks, old borings, etc., and could potentially transmit contamination from source areas

into the groundwater. The residuum unit may also be extremely permeable.

3.0 DATA NEEDS AND USES

Soil investigations at the WSS will be performed to satisfy defined data needs. The data obtained from these investigations, applied in concert with existing data, will be used to identify contamination source areas, determine the extent and magnitude of contamination, evaluate migration pathways and document uncontaminated areas.

Section 3.1 provides information on the possible chemical contamination sources from both the WSOW and the WSUFMP. An assessment of existing chemical soil data is given relative to both operations and is followed by a discussion of data validity and the need for further data collection. Section 3.2 discusses the data needed to further define the extent and magnitude of contamination. Section 3.3 discusses potential migration pathways and the known environmental fate of specific contaminants. Section 3.4 discusses the data needed for documentation of uncontaminated areas.

3.1 Contamination Sources

The WSOW and WSUFMP operations are the two primary sources for soil contamination at the WSCP/WSRP. Since the processes at each of these plants are known, and no other materials are known to have been disposed of on-site, a detailed list of suspected contaminants can be prepared.

3.1.1 Weldon Spring Ordnance Works

WSOW TNT and DNT production consisted of treating liquid toluene with mixed nitric and sulfuric acid.

Three complete TNT production lines, and a portion of a fourth, were originally constructed in the 220-acre portion of the WSOW that later became the WSCP/WSRP. The primary suspected contaminants from WSOW are nitroaromatic residues, nitrate, sulfate, and metals. Table 3-1 lists the chemicals used in TNT and DNT production. Potential source areas include WSOW building locations, old wooden wastewater lines, spill areas, and surface drainages from process buildings.

Plate 1 presents WSOW features superimposed on existing site features.

3.1.1.1 Data Assessment of WSOW Sources

Twenty surface soil samples were taken in 1975 by the U.S. Army Chemical Demilitarization and Installation Restoration (DACDIR) team to provide a general assessment of the residual explosives present on site from previous WSOW operations. The majority of the surface and subsurface sampling points were located in areas suspected of containing the highest level of nitroaromatic contamination on-site, from building foundations, wastewater

TABLE 3-1

CHEMICALS USED IN TNT AND DNT PRODUCTION AT THE WSOW

CHEMICALS	USE(S)
Ammonia	Nitric acid production
Caustic Soda	Neutralize acidic wastewater
Chlorine*	Water treatment
Coal*	Burned for power generation
Fuel Oil	Sulfuric acid concentrating and wastewater treatment
Oleum	Used in TNT lines
Salt*	Power generation
Soda Ash*	Sellite production
Sulphur*	Sellite production
Toluene	TNT lines

*Process located outside of WSCP/WSRP

Source: WSSRAP 1987

lines, or in and around the burning ground area. Sampling locations are provided in Figure 3-1.

The samples were transported to the Battelle-Columbus Laboratories, Columbus, Ohio, for analyses (gas chromatography-electron capture). A known positive sample was also provided to verify analytical detection.

Eight subsurface soil samples (Figure 3-1) were also collected at this time by the St. Louis District - U.S. Corps of Engineers. Seven of these samples were consolidated soil taken from the top three feet of earth. The eighth sample was taken from the interface where the Ash Pond dam construction material meets the original soil surface at a depth of approximately 25 feet below the top of the dam. Ash Pond was constructed for WSUFMP use. These samples were treated identically to previously collected soil samples and were also transported to and analyzed by Battelle-Columbus Laboratories.

Sample analyses were performed by the Battelle-Columbus Laboratories. The analyses were directed toward quantitative determination of 2,6-DNT, 2,4-DNT, and TNT. The analytical results indicated low-level (low ug/kg) contamination of the soil by all three nitroaromatic compounds.

Of the 20 surface soil samples submitted, seven samples (and the known positive sample which was also submitted) were not

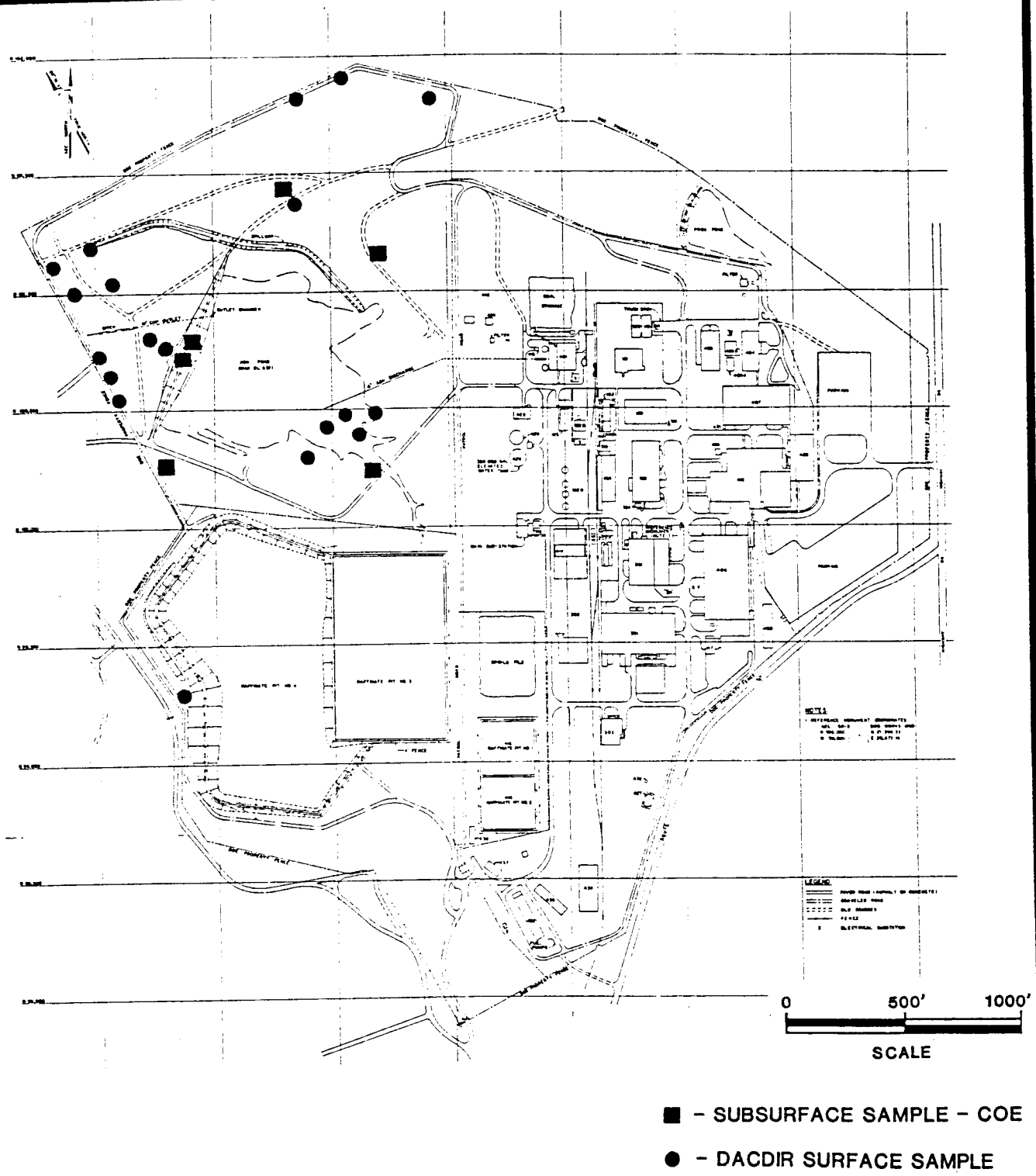

FIGURE 3-1

DACDIR SAMPLING LOCATIONS

analyzed "due to presence of some major interfering material(s) appearing in extracts of these samples." The 13 remaining samples were analyzed for 2,4 DNT, 2,6 DNT and TNT.

For the 2,6 DNT, six samples had non-detectable concentrations, and four samples had tentative identification, but less than the method detection limit of 1.0 ug/kg. The highest level detected in surface soil was 2.9 ug/kg.

For 2,4 DNT, only one sample had non-detectable concentrations, and 2 samples showed tentative identifications, but less than the method detections limit of 2.0 ug/kg. The highest level detected in surface soil was 38.3 ug/kg which was collected in the vicinity of TNT Production Line No. 4, located west of Raffinate Pit No. 4.

For TNT compounds, seven samples had non-detectable levels, and one sample had tentative identification, but was less than the method detection limit of 3.0 ug/kg. The highest TNT level detected was 32.4 ug/kg.

In the eight subsurface soil sampling locations, no interferences were found in the analytical matrixes. Seven of the eight subsurface soil samples were consolidated from the upper 1-3 feet of soil. The remaining subsurface sample was taken from 25 feet below the top of Ash Pond dam at the original WSOW topographic level.

The 2,6 DNT sample results ranged from <1.0 ug/kg to 12.9 ug/kg. For TNT, the sample results ranged from non-detectable to 292 ug/kg. Overall, the highest concentrations of nitroaromatics were identified in the Ash Pond dam (the area of the WSOW burning grounds).

This investigation established the presence of nitrated toluene compounds in WSCP/WSRP soils at concentrations in the lower microgram per kilogram range. Cross trenching operations failed to expose any remaining underground wastewater lines. Comparison of photographs taken during WSUFMP construction to WSOW wastewater lines indicate that WSUFMP construction would have encountered any unexcavated lines. While the analytical results presented do not meet current standards (see data validation discussion), significant deposits of nitroaromatics were not detected. This sampling effort did not incorporate cut and fill relationships between WSOW and WSUFMP topographies (Plate 2). This study concluded that a more extensive effort was required to assure total decontamination and removal of hazardous explosives material.

3.1.1.2 Data Validity and Assessment

Complete Quality Assurance/Quality Control (QA/QC) information is unavailable for the soil sampling efforts performed by the DACDIR in 1975. Limited analytical information is available in the 1976 Assessment of Weldon Spring Chemical Plant (DA, 1976).

The procedures utilized by the Battelle-Columbus Laboratories in 1975 are not consistent with the current semi-volatile analyses for 2,4 DNT and 2,6 DNT identified in SW-846 - Method 8090 for nitroaromatics (9/86) or USEPA Contract Laboratory Program methodology for the determination of extractable semi-volatiles (based on EPA Method 625). The analytical procedures employed also differ from the current USATHAMA High Pressure Liquid Chromotography (HPLC) method.

Furthermore, documentation of sample collection, handling, preservation, storage and transport by the DACDIR and QA procedures performed by Battelle-Columbus laboratories, including precision, accuracy, etc. was not included with the reported data.

The data presented in this report are useful in establishing areas of contamination and contaminant levels. However, the data presented cannot be validated according to the Quality Assurance Project Plan (QAPP) and will not be used in Risk Assessment analyses and/or final soil contamination interpretations. The data will be used to guide WSOW biased sampling.

3.1.2 Weldon Spring Uranium Feed Materials Plant

Uranium processing at the WSUFMP consisted of converting uranium ore concentrates to uranium metal with several intermediate

metallurgical steps. Figures 3-2, 3-3 and 3-4 depict the processing sequence and chemicals used in each stage.

The primary potential contaminants associated with uranium processing include: nitric acid, tributyl phosphate in hexane, ammonia, hydrogen fluoride, magnesium, uranium, radium, thorium and other trace metals. Table 3-2 lists the chemicals used for uranium processing and support operations.

To date, no soils investigation has been conducted specifically for chemicals associated with uranium production. However, in 1987, the DOE conducted a preliminary chemical soil contamination assessment and site investigation (PA/SI).

The preliminary assessment was based on the Phase I Water Quality Assessment. The Water Quality Assessment established baseline groundwater and surface water conditions at the WSS. All existing monitoring wells were sampled for the complete Hazardous Substance List, nitroaromatics, inorganic anions and radionuclides. The Phase I Water Quality Assessment detected the presence of nitrate, sulfate and nitroaromatics in the groundwater. No other organic or inorganic contaminants were observed in the groundwater, implying the lack of significant soil contamination by these compounds. The Phase I Water Quality Assessment was used in developing the Phase I Soil

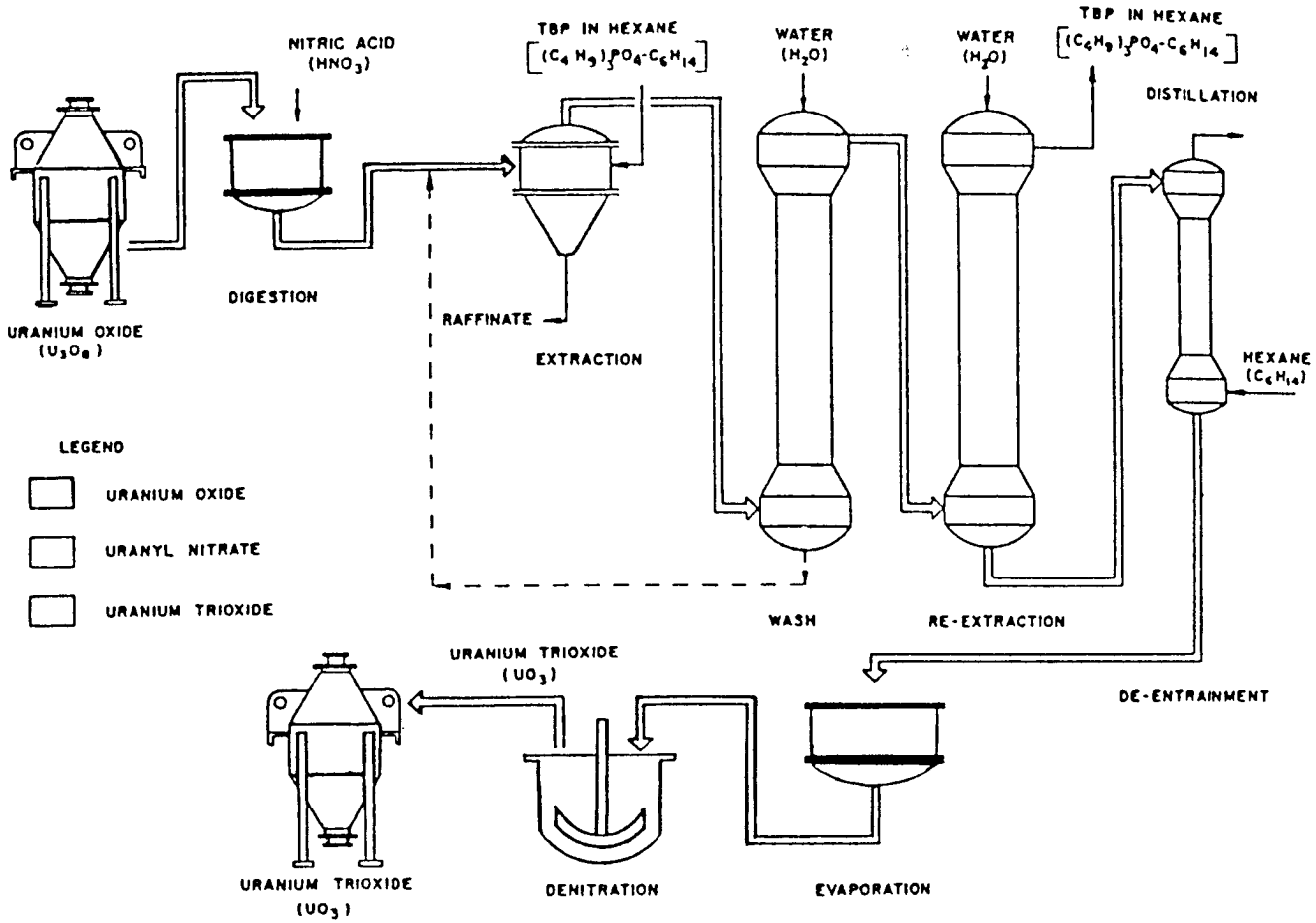

FIGURE 3-2

URANIUM PROCESSING SEQUENCE & CHEMICALS

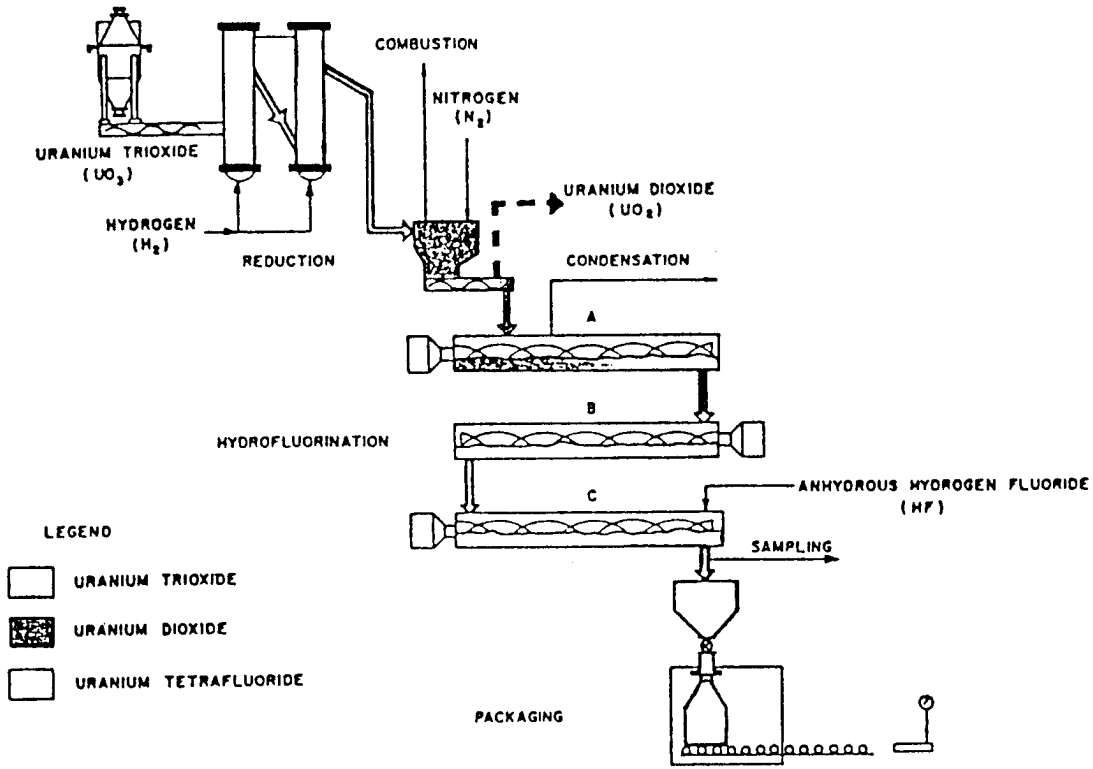

FIGURE 3-3

URANIUM PROCESSING SEQUENCE & CHEMICALS

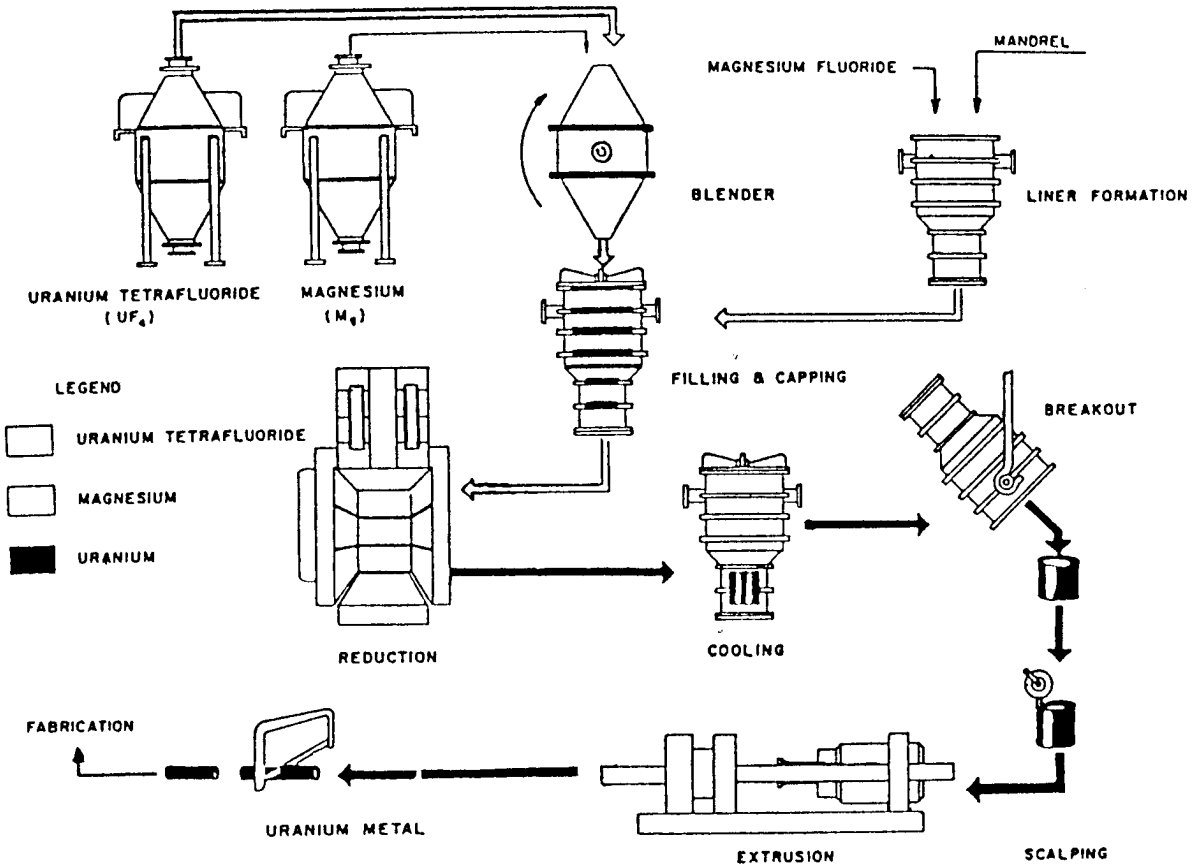

FIGURE 3-4

URANIUM PROCESSING SEQUENCE & CHEMICALS

TABLE 3-2

Chemicals Used for Uranium Processing at the Weldon Spring Uranium Feed Materials Plant

Building	Chemical Name
102	Hexane
102	Nitric Acid
102	Nitrogen
102	Sodium Hydroxide
102	Sulphuric Acid
103 and 403	Sodium Carbonate
103 and 403	Sodium Hydroxide
103 and 403	U_3O_3
103 and 403	UNH^3
103 and 403	UO_3
103 and 403	Uranium Ore Concentrates
104	Lime
105 and 403	Ether
105 and 403	Ethylene Glycol
105 and 403	Hexane
105 and 403	Nitric Acid
105 and 403	Sodium Carbonate
105 and 403	Sodium Hydroxide
105 and 403	Tributyl Phosphate
108	Ferric Nitrate
108	Nitric Acid
109 and 110	Compressed Gas Cylinders
201	Anhydrous Hydrogen
201	Fluoride
201	Ammonia
201	Green Salt
201	Hydrofluoric Acid
201	Hydrogen Gas
201	Nitrogen Gas
201	Orange Oxide
201	Propane
202	Anhydrous Hydrogen
202	Fluoride

TABLE 3-2(cont.)

Chemicals Used for Uranium Processing at the Weldon Spring Uranium Feed Materials Plant

Building	Chemical Name
202	Ammonia
202	Hydrofluoric Acid
301	Caustic Liquid
301	Green Salt
301	Magnesium
301	Uranium Metal
302	Magnesium
302	Graphite Sheets
401	Acid
401	Diesel Fuel
401	Fuel Oil
401	Gasoline
401	Hydrogen Zeolite--Water Softener
401	Phosphate
401	Refrigeration Brine
401	Salt
401	Sodium Zeolite--Water Softener
401	Sulfite
404	Green Salt
404	Helium
404	Hydraulic Oil
404	Hydrogen
404	Uranium Metal
407	Ether
407	Hydrofluoric Acid
407	Laboratory Chemicals
407	Perchloric Acid
408	Gasoline
408	Grease
408	Hydraulic Oil
408	Nitric Acid
410	Perchloric Acid

TABLE 3-2(cont.)

Chemicals Used for Uranium Processing at the Weldon Spring Uranium Feed Materials Plant

Building	Chemical Name
413	Chlorine
413	Chromate Phosphate
413	Sulphuric Acid
417	Acids (misc.)
417	Benzene
417	Corrosive Resistant Coating
417	Epoxy Paint and Catalysts
417	Flammable Materials
417	Gasoline
417	Hot Die Lube
417	Linseed Oil (Boiled)
417	Lubriplate
417	Melcolene
417	Metalube
417	Methylene Glycol
417	Methylisobutyl Ketone
417	Motor Oil
417	Paint
417	Paint Solvents
417	Phenoline Thinner
417	Polyclad
417	Polyurethane Paint
417	Rustbond Primer
417	Tar
428	Propane

Investigation. This site investigation was designed to provide baseline data of areal coverage across the site in areas absent of any chemical soils data.

This initial effort consisted of the collection of 135 samples from 32 locations within the 220 acres of the WSCP/WSRP. Five other boreholes were drilled immediately adjacent to the WSCP, four of which were drilled into the WSOW waste lagoon no. 1, which is located just northeast of Frog Pond, and one borehole was located between the WSCP property and WSOW waste lagoon no. 1. Borehole locations are shown in Figure 3-5.

Phase I soil samples were analyzed for nitroaromatics, metals, nitrate, sulfate, fluoride, chloride and percent moisture.

Analytical results indicated elevated levels of lead, zinc, barium, nitrate and sulfate in WSCP/WSRP soils. Nitroaromatics were not detected on-site. However, percent levels of nitroaromatics were observed in WSOW waste lagoon no. 1.

On-site background metal concentrations were statistically determined during the Phase I soil investigation. Table 3-3 presents the statistical information. This statistical background determination indicated potential contamination consisting of: aluminum, antimony, barium, iron, lead, magnesium, manganese, nickel, vanadium and zinc. This statistical determination was performed to evaluate the

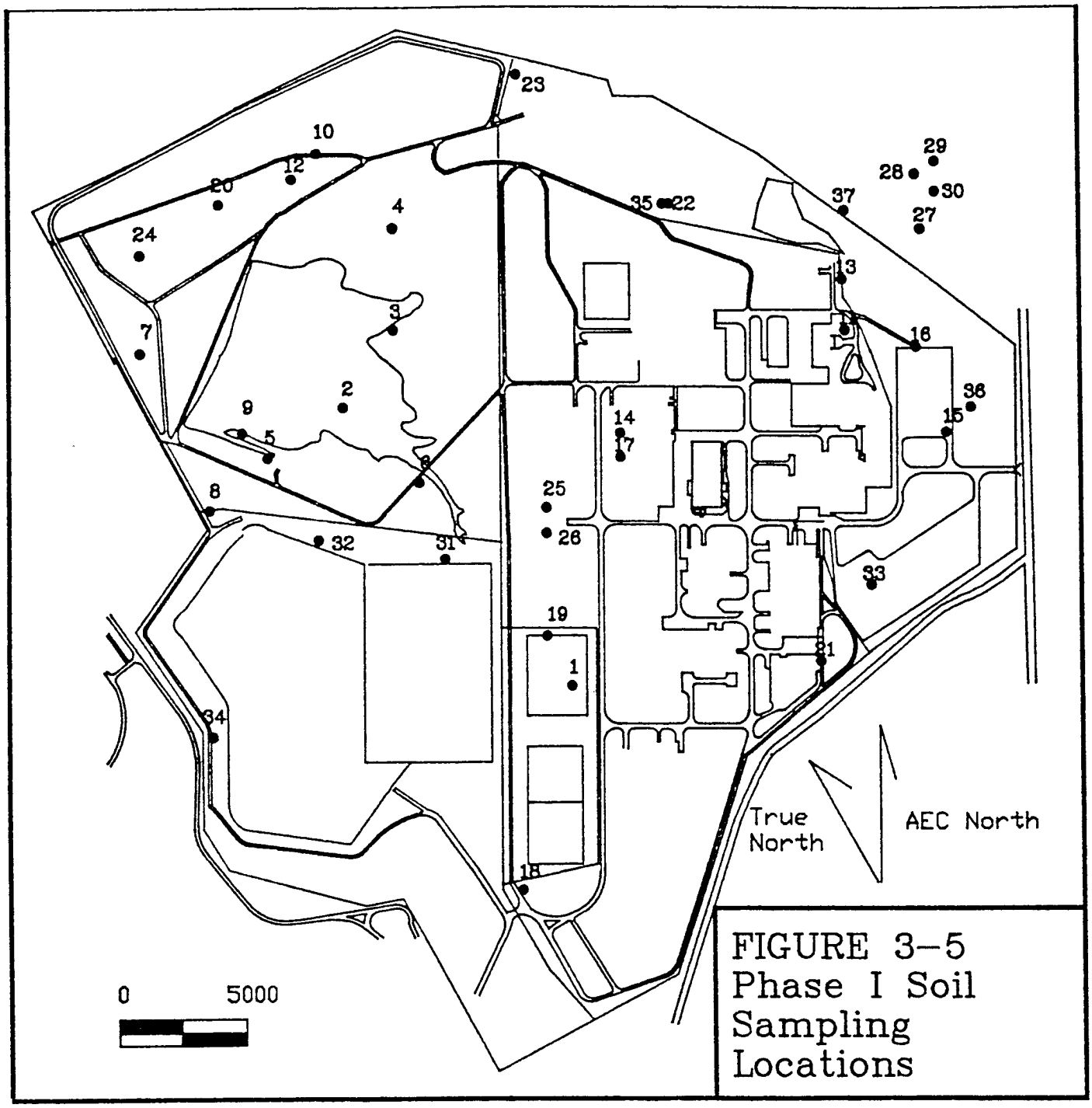

FIGURE 3-5
Phase I Soil Sampling Locations

TABLE 3-3

Statistical Data for Background Metals Concentrations in Soils at the WSCP/WSRP

Compound	Sample Size	Arithmetic Mean mg/Kg	Geometric Mean mg/Kg	Arithmetic Standard Deviation mg/Kg	On-site Background Ranges Low mg/Kg	On-site Background Ranges High mg/Kg
Al	142	12,536	11,350	4,902	1250	27,700
Sb	98	29	25	8	2	40
As	114	6	6	4	2	15
Ba	140	161	145	70	25	390
Be	129	1	1	1	< DL	6
Cd	125	3	3	1	< DL	7
Ca	114	3,495	3,044	1,839	190	9,300
Cr	144	24	23	6	2	42
Co	144	16	14	7	6	40
Cu	143	15	14	6	3	34
Fe	139	18,636	17,914	5,306	8,500	35,400
Pb	127	29	25	16	7	84
Li	92	10	9	3	< DL	17
Mg	133	2,437	2,256	956	417	5,900
Mn	127	495	370	334	49	1,400
Hg	Background less than the detection limit of 0.1 mg/Kg					
Ni	138	19	18	7	7	43
K	145	757	698	311	255	1,701
Se	Background less than the detection limit of 0.5 mg/Kg					
Ag	96	3	2	2	1	13
Na	136	486	437	202	49	982
Tl	Background less than the detection limit of 1.0 mg/Kg					
V	141	35	34	7	6	54
Zn	141	45	39	29	6	220

< DL - Less than detection limit

Source: WSSRAP, 1987

concentration distributions for each metal. Metals with normal distribution may not be contaminants in on-site soils. These on-site background values will be compared with off-site background samples to determine true background conditions as detailed in Section 4.5.2.

3.2 Extent and Magnitude of Contamination

Previous studies have not adequately defined the extent and magnitude of chemical contamination at the Weldon Spring Site. As discussed in the Site History (Section 2.2), the normal operations of the WSOW produced large quantities of "red water" as well as acid waste, bad batches of TNT, and other miscellaneous waste streams. Waste disposal practices during the operation of the WSOW appear to have been driven mainly by expediency. As a result, the potential exists for soil contamination from normal operations, as well as from the leaks and spills that may have occurred during operations.

Existing site sampling locations, when compared with the site history, indicate unsampled areas that could be potential areas of contamination. A statistically developed random sampling program and biased sampling program are required to define the extent and magnitude of contamination.

Elevated nitrate and sulfate levels were observed in locations near potential WSOW source areas. No elevated inorganic anion levels were detected near potential WSUFMP sources.

A more detailed discussion of this effort is presented in "Phase I Chemical Soil Investigation at the WSCP/WSRP" (MK-Ferguson, 1988).

The data presented in this report were collected using acceptable techniques and methods. Chain of custody was maintained according to approved WSSRAP procedures. Sample analyses were performed according to U.S. EPA approved methods or USATHAMA methods (for nitroaromatics). The data presented in this report will be validated according to procedures described in the QAPP and will be used in final data interpretation.

The Phase I data will be used to guide and focus this larger sampling event. Particularly useful is the nitroaromatic data collected from WSOW waste lagoon no. 1. These data demonstrated the nitroaromatic binding to soil particles as concentrations decreased from percent levels to below detection limits in eight feet. This information will be used to focus WSOW biased sampling and random area sampling.

Overall, this baseline effort supplied essential information to guide and focus the Chemical Soil Investigation Sampling Plan.

3.3 Soil Migration Pathways

There are three potential mechanisms for migration of contaminants at the WSCP: groundwater transport, volatilization, and wind or surface water erosion of contaminated soil particles. Groundwater transport is likely to be the most important, especially for the nitroaromatics and inorganics.

Contaminants considered in this section are: inorganics (primarily nitrates and sulfates), metals (principally lead), nitroaromatics, and PCBs. Their migration pathways and mobility are discussed below.

3.3.1 Nitrate

The significant migration pathway for nitrate is movement with groundwater. Nitrate is very mobile in groundwater due to its anionic negative charge and high water solubility (ESE, 1986). It is likely that nitrate will move with the groundwater, without significant soil attenuation (ESE, 1986). Concentrations at the WSCP/WSRP can be lowered mainly by hydrodynamic dispersion.

3.3.2 Sulfate

Like nitrate, the primary significant migration pathway for sulfate is movement with groundwater. Also like nitrate, sulfate is an anion and very mobile (ESE, 1986). Unlike nitrate, sulfate is less subject to biological transformation. Sulfate is susceptible to reduction only at extremely low anaerobic Eh which is unlikely to occur in groundwater beneath the WSCP. Sulfate may also be removed from groundwater by precipitation as a mineral such as gypsum. Sulfate would be expected to be slightly less mobile than nitrate, but is still considered to be a very mobile anionic species. (ESE, 1986)

3.3.3 Lead

Lead is the principal nonradioactive metal contaminating soils at the WSCP/WSRP site. Lead was used extensively in WSOW production facilities because it is resistant to corrosion and sparking. Phase I soil sampling has detected isolated areas of elevated lead concentrations. It is expected that lead contamination will remain in discrete pockets of elevated concentration in the soil. This is due to the usage of lead only in particular areas of production and its hydrogeochemical behavior in the soil.

Lead is strongly adsorbed to soils with a pH above 5. Lead adsorption increases with pH, cation exchange capacity, organic carbon content, and phosphorus levels (ESE, 1985). Movement of lead in the groundwater is unlikely to be the dominant mode of transport, although some lead may be found in groundwater near localized areas of high concentration. The primary migration pathway for lead is expected to be wind or surface water erosion of soil particles containing adsorbed lead. The vegetative cover on the WSOW site should greatly abate this migration pathway by reducing soil erosion.

3.3.4 Nitroaromatics

3.3.4.1 2,4,6 - Trinitrotoluene (TNT)

Migration pathways for TNT are controlled by adsorption (ESE, 1986). However, TNT is not as tightly bound to the soil as lead, so the migration pathways include transport by groundwater as well as direct transport of TNT or TNT-contaminated soil particles.

TNT's reported water solubility is 117-200 mg/l (ESE, 1985). It is unlikely that TNT transport in groundwater will be limited by solubility. Retardation factors (Rd) are a function of the organic carbon content of the soil with higher organic carbon content causing more adsorption resulting in a higher Rd. Horizontal and vertical migration rates in contaminated soil of

as little as one inch per year have been estimated for TNT (ESE, 1985) in clay soils and climatic conditions similar to the WSCP/WSRP.

TNT has a relatively low vapor pressure and a low Henry's Law constant; therefore, volatilization is not expected to be a significant migration pathway.

Biodegradation could be an important mechanism for the attenuation of nitroaromatics and nitrates. Important factors controlling biodegradation rates are: pH, Eh, nutrient availability, and temperature. As a nitroaromatic such as TNT moves through the groundwater regime, it could be transformed microbially and eventually mineralized to ammonia. The ammonia could then be rapidly nitrified to nitrate. Finally, as the groundwater declines in redox potential, nitrate can be reduced to N_2 by denitrification. Unfortunately, data is not available to make a quantitative assessment of the importance of biological degradation processes at the WSCP/WSRP and WSOW.

Photolysis (chemical decomposition due to exposure to light) is a dominant degradation process in surface waters (Spanggord et al, 1980) and is a likely process that may suppress TNT concentrations to undetectable levels in ponds receiving ground water discharge with measureable TNT. Photolytic decomposition products include 1,3,5-TNB.

3.3.4.2 1,3,5 - Trinitrobenzene (TNB)

TNB may be more resistant to degradation than TNT. Sufficient evidence is not available to estimate degradation rates in environmental systems, but the limited data that are available indicate that TNB is resistant to hydrolysis and is neither photolytically nor biochemically degraded as readily as TNT. The environmental behavior of TNB is expected to be very similar to that of TNT. Adsorption to soil particles should be a major factor in controlling TNB migration pathways. Migration pathways will be by groundwater transport and movement of contaminated soil.

The Henry's Law constant for TNB is approximately an order of magnitude greater than for TNT (ESE, 1985). Thus, volatilization could be more of a factor in TNB transport than for TNT.

TNB movement with groundwater is likely to be the most significant migration pathway for TNB at the WSOW.

3.3.4.3 Dinitrotoluenes (DNT)

The DNT isomers (DNTs) are relatively more mobile, volatile and degradable than TNT (ESE, 1985). Retardation factors are estimated as low as 1.2 for DNTs. This implies that DNT isomers would move through the soil with essentially the same velocity

as groundwater. Thus, this is expected to be the primary migration pathway for DNT.

DNT isomers are also quite volatile, with a Henry's Law constant nearly three times that of TNB. Volatilization, especially from surface soils, may be a significant means of DNT migration. Volatilization and degradation by photolysis would be important factors in reducing DNT concentrations in surface soils or water (ESE, 1985).

Photolysis is an important process affecting DNTs in surface waters, with reported half-lives of a few hours to approximately 1 week (Spanggord et al, 1980). Photolytic decomposition and volatilization may account for failure to observe DNTs in surface waters that receive groundwater discharge from the TNT manufacturing area.

3.3.4.4 Dinitrobenzenes (DNB)

DNB isomers should behave very similarly to DNT with respect to volatility and absorption (Spanggord et al, 1980). Transport with groundwater should be the primary migration pathway, with volatilization an important factor in surface soil or water.

3.3.5 Polychlorinated Biphenols (PCB)

PCB migration will be through direct contact with PCB oil and/or through erosion of contaminated soil because PCBs bind tightly to soil particles and are not transported with groundwater (CRC, 1982). PCBs are very stable and do not transform or biodegrade easily in soil (CRC, 1982).

3.3.6 Asbestos

Asbestos fibers are mobile only by wind, surface water, and direct soil mixing. The vegetative cover present at the WSCP/WSRP should control and minimize asbestos migration. The degree and nature of this control is not known and would be extremely difficult to quantify.

3.4 Documentation of Uncontaminated Areas

Knowledge of site history, previous studies, Phase I sampling results, and knowledge of the likely routes of migration for chemical contaminants on-site all indicate potentially contaminated areas. The areas of the site with no implicating factors pointing to chemical contamination must be sampled in a systematic way so they can be shown to be free of contamination. In addition, areas known to be free of contamination, but similar geologically to the contaminated

areas on-site, must be sampled to establish background levels for metals and inorganics to allow a true and valid assessment of on-site contamination.

Sampling locations in these areas have been selected on a random basis. Proper statistical methods have been applied to insure that the number of samples will be adequate to provide a statistically valid coverage of the area and establish the mean and standard deviation of background concentrations of naturally occurring constituents. A detailed description of the statistical approach selected to characterize areas not suspected of being contaminated is presented in Section 4.5.

4.0 SAMPLING PROGRAM

4.1 Sampling Objectives

Soil sampling for chemical characterization will be conducted to meet several objectives. The objectives are to:

1) Determine the extent and magnitude of chemical contamination.

2) Locate potential chemical contamination sources.

3) Document uncontaminated areas.

4) Provide a data base sufficient for consideration of remedial action options.

5) Provide data base sufficient for preparation of risk assessment.

6) Establish background concentrations in native soils.

4.2 Sampling Rationale

The focus of this soils investigation is to quantify the nature and extent of chemical contamination in terms of the specific objectives stated in Section 4.1. Because of the size of the

site and the diversity of activities that have occurred over the last 45 years, two sampling approaches--biased and unbiased sampling--are proposed to provide a comprehensive soil contamination characterization. The biased sampling locations are based on historical documentation and recent site investigation results presented in previous sections. Specific sampling locations were selected based on association with either the WSUFMP operations or the WSOW operations. Areas of known radiological contamination are defined in Section 4.3.1. Specific sampling locations are discussed and identified by site coordinates, along with sampling depths, analytical parameters, and a brief rationale. All soil sampling locations are presented in Plate 3.

Unbiased sampling will be conducted over the entire site in order to provide a statistically valid data base for soils characterization and to document uncontaminated areas. The statistical approach to unbiased sampling is presented in Section 4.5.

4.3 WSUFMP Biased Sampling

Sampling locations discussed in the following sections were selected based on site history, plant operations, and previous data. Soil samples will be collected from 71 locations. Analytical parameters were selected based on contaminant source characteristics and previous data. A total of 191 samples will be collected. The locations, depths, analytical parameters and

rationale are presented in Table 4-5. Collected samples will be analyzed for chemical parameters only and not for radiological constituents since radiological characterization is complete. However, the areas of radiological contamination are of concern for both safety and handling procedures. Section 4.3.1 discusses areas known or suspected to be radiologically contaminated. These areas will be chemically characterized. Section 4.3.2 discusses plant operations in relation to chemical source areas, provides rationale for sample locations, details borehole depths and describes analytical parameters.

4.3.1 Radiological Investigations

RADCON Survey - 1975

A radiological survey was conducted in September 1975, by the U.S. Army Radiation Control team (RADCON), to determine outdoor areas of contamination, identify contaminants and assess the potential radiological hazard to the properties surrounding the site. Natural uranium and its decay products were anticipated to be the major source of contamination. The RADCON team surveyed the perimeter of the site at the fence and 10 meters inside the fence. Measurements were taken on the ground surface at 250-foot intervals.

The survey conducted around the Weldon Spring Chemical Plant buildings indicated that the areas around buildings 428, 429, 437, 439, and 443 were free of detectable contamination. The

areas surrounding the remainder of the buildings were contaminated to varying levels from background to more than 500 times background. Three pieces of uranium metal were found alongside major support buildings. Although the most heavily contaminated areas are characteristically located near major process buildings and the pilot plants, some support buildings were found to be surrounded by significant contamination. For example, visible uranium oxide and uranium fluoride deposits were found alongside the Paint Shop (Bldg. 417). The area in front of the Administration Building (Bldg. 409) was found to be contaminated to approximately eight times the background in portions of the parking lot. Apparently automobile lubricants collected on the parking lot and trapped low-level airborne contaminants during plant operations. All expansion joints between surface materials on-site which contain tar have likewise collected and concentrated contamination.

WSSRAP Survey - 1987

In February, 1985, the DOE established the Weldon Spring Site Remedial Action Program (WSSRAP) to effect remedial action at the site. Because additional radiological information and data were needed to complete the Environmental Impact Statement (EIS), DOE developed a radiological characterization plan for the WSCP/WSRP.

This field work was performed from April through July 1987. The intent of this program was to determine the horizontal and

vertical extent of radioactive contamination within the WSCP/WSRP area that exceeds guidelines for remedial action.

A combination of surface and subsurface radiometric measurements, and surface and subsurface soil samples were collected. Exact sampling and measurement locations were determined by an on-site survey utilizing the AEC coordinate system to positively locate sampling location.

Boreholes were drilled at 317 locations. Samples were collected from each borehole in one-foot increments to a minimum depth of five feet. Boreholes were then logged with a gamma-ray spectrometer. Elevated spectrometer readings triggered subsequent radium and thorium-232 analyses. Selected samples were archived for possible future uranium and/or thorium-230 analysis if the spectrometer log indicated no elevated gamma activities. The following paragraphs briefly discuss the radiological contamination findings at specific locations. Each area is shown in Figure 4-1. Residual soil guidelines are presented in Table 4-1.

A complete description of the radiological characterization can be found in the final report entitled "Radiological Characterization Report of the WSS."

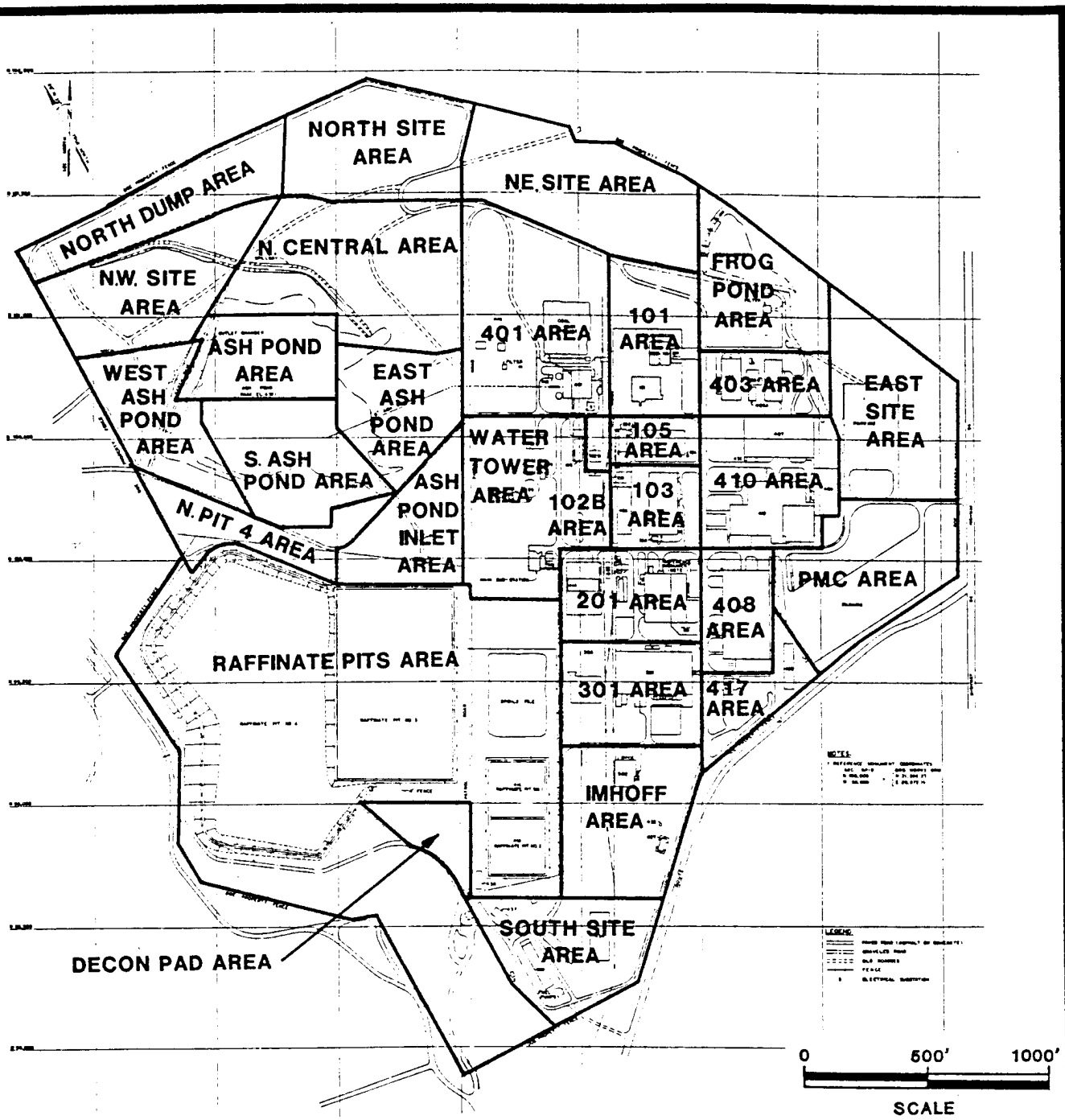

FIGURE 4-1

AREA BREAKDOWN OF WSCP/WSRP FOR RADIOLOGICAL CHARACTERIZATION

TABLE 4-1

RESIDUAL SOIL GUIDELINES FOR RADIONUCLIDES

	Radionuclide	Guideline
*	Uranium, natural	60 pCi/g
	Ra-226 and -228; Thorium-230 and -232	5 pCi/g in upper 15 cm of soil
		15 pCi/g in subsequent 15 cm layers

* Uranium guideline has not been formally established for WSSRAP. This value is currently being used on an interim basis.

pCi/g - picocuries per gram

Source: WSSRAP, 1987

North Dump Area

A borehole drilled near the western boundary of the dump indicates that the contamination extends deeper than five feet. The eastern half of the dump is contaminated to a 36-inch depth. Results indicated Ra-226 contamination slightly below surface soil guidelines in a small region east of the dump area.

North, Northwest, Northeast, and North Central Areas

All in-situ measurements and soil sample results indicate that these areas are below soil guidelines.

Frog Pond Area

In-situ measurements and soil sample results indicate that a large portion of this area is above soil guidelines. The inlet to Frog Pond is contaminated to a depth of 36 inches. A drainage area located NNE of Frog Pond is contaminated to a depth of 12 inches.

The grounds south of Frog Pond contain a mixture of radionuclides exceeding guidelines.

Building 403 Area

Boreholes and surface soil sample results indicate that the grounds surrounding the buildings are contaminated to a depth of

12 inches with the exception of a small area east of building 404 where the contamination extends to 24 inches.

Building 101 Area

Several areas on the concrete dock have elevated gamma radiation readings.

Building 401 Area

A large portion of the grounds in this area are below guidelines. Historical information has indicated feed material spills occurred along the railroad tracks. The contamination within this area is surficial and is predominantly uranium. The area below the coal pile is known to have radionuclides above residual soil guidelines. Drainage from the coal pile area leads into the northeast site area and the outfall from Frog Pond extends across the northern portion of this area.

East Site and PMC Area

All in-situ measurements and soil sample results indicate that these areas are below the residual soil guidelines.

Building 410, 103, and 105 Areas

A borehole drilled in Building 103 area indicates contamination to a depth of 24 inches beneath the building. A borehole drilled in Building 105 showed no contamination above the guidelines. A borehole drilled to the southeast of Building 105 showed considerable contamination. The surface soil in the Building 410 area showed detectable contamination.

102B Area

Boreholes and surface soil samples have indicated contamination in this area above soil guidelines.

Water Tower Area

A major portion of this area is below residual soil guidelines. However, an isolated area around the tank farm and water tower has elevated uranium concentrations.

Ash Pond Inlet Area

This area contains isolated areas of contamination.

East Ash Pond and Ash Pond Areas

No radiological contamination is present in these areas.

South Ash Pond Area

This area is radiologically contaminated to a depth of eight feet.

West Ash Pond Area

The Ash Pond outfall is contaminated at a depth of 60 inches (15 pCi/g U-238) and at 36 inches (60 pCi/g U-238). An area of Th-230 contamination is present at one borehole location.

Building 408 Area

The grounds in this area show contamination to a depth of 12 inches. All sample results for this area are above the residual soil guidelines.

Building 417 Area

Portions of this area are above the residual soil guidelines.

Building 201 and 301 Areas

A borehole drilled in Building 201 is contaminated to a depth of 12 inches. The grounds surrounding the buildings show contamination exceeding guidelines.

Imhoff Tank Area

A large portion of the grounds is below residual contamination guidelines. Isolated areas of contamination exist including one area of Th-230 contamination.

4.3.2 WSUFMP Biased Sampling Approach

This section discusses the use of chemicals associated with the production of uranium trioxide, uranium tetraflouride and uranium metal. Specifically it discusses the site locations where certain chemicals were used, disposed of or spilled during operations and relates the information to the selection of potential contaminant source areas. By combining potential source information with historical soils data, Phase I Water Quality Assessment data, and the containerized chemical inventory conducted in the buildings by PMC personnel in 1987, site-specific soil sampling will be conducted. This sampling will verify the contaminant sources, characterize the extent of these sources, determine the extent of any contaminant migration and provide an assessment of the rate of contaminant migration. All sampling locations, rationale, depths and analytical parameters are presented in Table 4-5 following the discussion of WSCP facilities.

Discussion of the chemical plant is divided into three general areas: Major Building Structures, Yard and Yard Structures, and Surrounding Land Areas.

Major Building Structures. The contents of the buildings are quite variable. Certain buildings have been emptied and partially decontaminated. Most of the buildings contain original process equipment and several have been used to store material removed from other buildings. Major building structures are listed in Table 4-2.

Yard and Yard Structures. These include smaller process buildings and utility structures as well as loose equipment, drums, piping, vehicles, vessels, etc., scattered randomly throughout the yard area. Table 4-3 lists items situated in the yard areas. The major structures consist of small buildings or structures used intimately with the process. However, many of the structures involve utilities which traverse most of the yard. The major fixed yard structures include overhead piping and underground piping. The overhead piping is concentrated near the process buildings and the steam plant, although steam piping connects most buildings in the plant area. Substantial amounts of the insulation used on these overhead pipes contain asbestos and have deteriorated to the point of falling off the pipe to the ground. The underground piping system includes sanitary sewers, process sewers, storm drains, potable and fire water lines, etc. The sanitary system originally fed two septic tanks with filters and an Imhoff tank which discharged effluent by outfall to a

TABLE 4-2

MAJOR BUILDINGS at the WSCP

FEED PREPARATION AND SAMPLING PLANT - BUILDING 101

DIGESTION AND DENITRATION - BUILDING 103

TBP AND ETHER EXTRACTION - BUILDING 105

GREEN SALT PLANT - BUILDING 201

METALS PLANT - BUILDING 301

MAGNESIUM BUILDING - BUILDING 302

STEAM PLANT - BUILDING 401

WET AND DRY CHEMICAL PILOT PLANT - BUILDING 403

METALS PILOT PLANT - BUILDING 404

LABORATORY BUILDING - BUILDING 407

AUXILIARY TO THE PILOT PLANTS - AREA 405

WAREHOUSE - BUILDING 406

MAINTENANCE AND STORES BUILDING - BUILDING 408

ADMINISTRATION BUILDING - BUILDING 409

SCRAP CLASSIFICATION AND EQUIPMENT STORAGE FACILITY - AREA 414

PAINT SHOP - BUILDING 417

STORAGE BUILDINGS - BUILDINGS 433, 434, 435, 436, 437, 438

Source: WSSRAP, 1987

TABLE 4-3

YARD AND YARD STRUCTURES

REFINERY TANK FARM - AREA 102

NITRIC ACID RECOVERY FACILITY - AREA 108

GREEN SALT TANK FARM - AREA 202

PRIMARY ELECTRIC POWER - 412

COOLING TOWER - AREA 413

PROCESS INCINERATOR - AREA 415

ELEVATED WATER TANK - AREA 426

PRIMARY SEWAGE TREATMENT PLANT - AREA 427

PROPANE GAS PLANT - AREA 428

RESERVE WATER FACILITIES - AREA 429

FIRE TRAINING - AREA 439 & 443

RAILROADS

OVERHEAD PIPING SYSTEM

SITE IMPROVEMENTS

WATER DISTRIBUTION

SANITARY SEWER SYSTEM

PROCESS SEWER SYSTEM

OUTFALL SEWER SYSTEM

STORM SEWER SYSTEM

Source: WSSRAP, 1987

drainage easement leading to the Missouri River. The process sewer system also discharges to this easement through the same outfall pipe. Surface drainage that collects on the site is discharged through pipes and open ditches to several outfall ditches leading to off-site areas. Surface water enters the site from small watersheds to the south and northeast.

Surrounding Land Areas. These lie outside the building and yard areas and include: the Frog Pond area to the northeast, the northern boundary area, the Ash Pond area to the northwest, the raffinate pit area to the southwest, and the southern boundary area. Table 4-4 lists the areas comprising the Surrounding Land Areas. Figure 4-2 gives a general delineation of the areas as well as an indication of where surface water moves to and from the site.

The Frog Pond area includes its watershed area and discharge stream exiting the site. This area, specifically the pond and outfall stream, were used by the WSUFMP for stormwater discharge and process wastes from buildings 403 and 404. The area still contains features of the WSOW including a tram line and process wastewater surface conveyance.

TABLE 4-4

SURROUNDING LAND AREA

Frog Pond Area

Northern Boundary Area

Ash Pond Area

Raffinate Pit Area

Southern Boundary Area

Source: WSSRAP, 1988

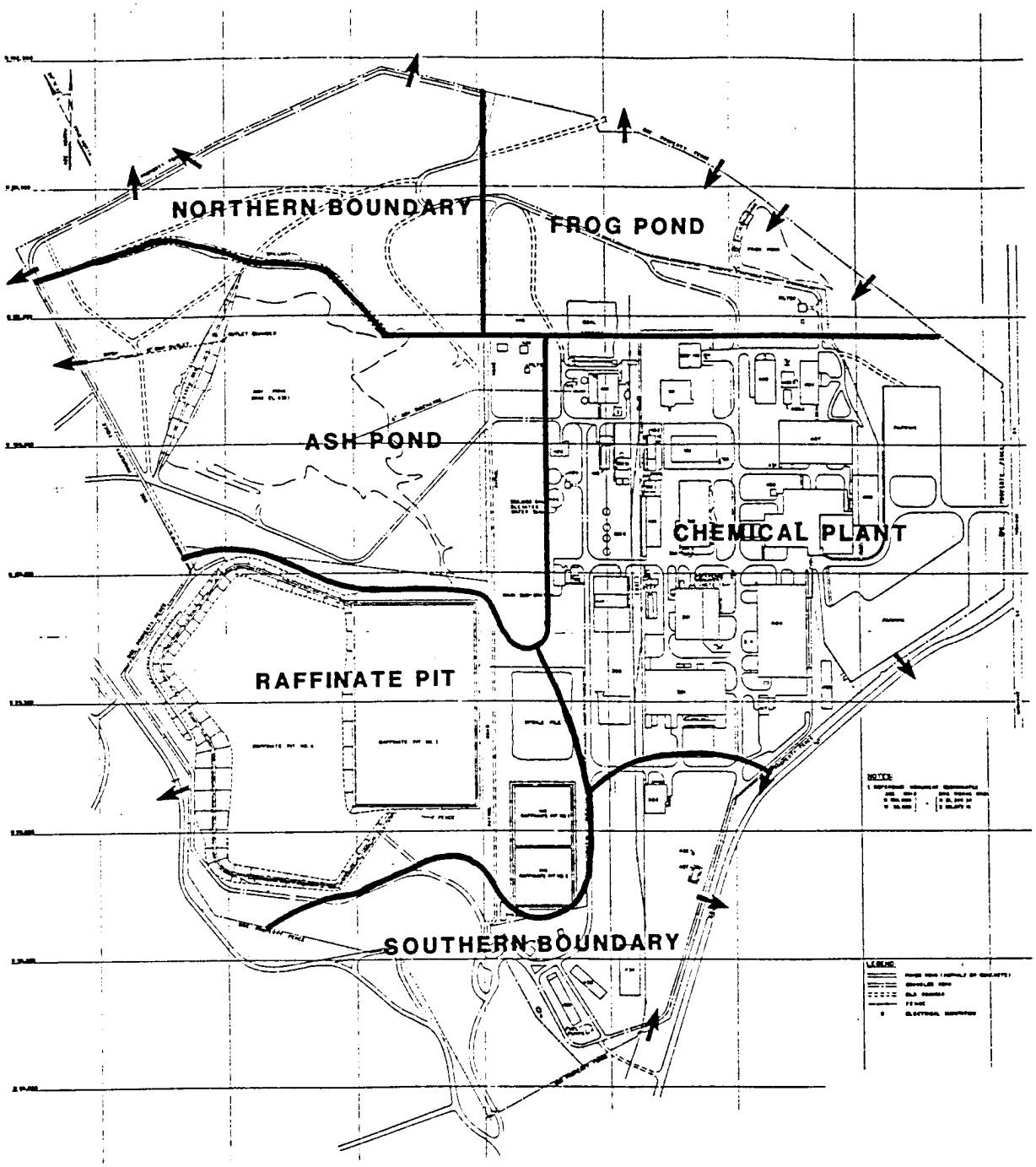

FIGURE 4-2

DELINEATION OF MAJOR AREAS OF THE SITE

The Ash Pond is another major area. Spent ash from the steam plant was slurried to this surface impoundment for settling prior to discharge of the water. The area below the dam contains rubble from the WSOW. Along the south upstream shore of the pond, radiologically contaminated material was dumped.

Areas along the northern boundary, just west of the Frog Pond area, also have been untouched since the WSOW operations except for surface storage of discarded equipment and rubble, (not waste products). Most of this stored material has been removed but remnants still exist. The area was also used by the WSOW as a burn area for TNT waste disposal.

The area south of the raffinate pits was partially modified when the WSUFMP was constructed and has been used for surface dumping of solid waste material. Most material has been removed except for debris close to the remaining buildings. The Imhoff tank for treatment of sanitary sewage and the buildings used during construction are also located in this area but are discussed with yard structures. The eastern part of this area is the watershed for surface drainage southeast to the Missouri River.

The following sections describe WSUFMP process facilities. The need for sampling is discussed along with analytical parameters and sampling locations. Three samples will be collected from each location unless noted. Sample intervals at each location are: 0 to 6 inches, 24 to 30 inches, and 54 to 60 inches, unless otherwise noted. A more detailed description of sample location,

sampling interval, analytical parameters and location selection rationale is presented in Table 4-5, located at the end of this section.

FEED PREPARATION AND SAMPLING PLANT - BUILDING 101, AREA 109, 110

The Feed Preparation and Sampling Plant was designed to process approximately 75 tons per day of the low assay feed material concentrates.

The plant consisted basically of equipment and facilities for drying, grinding, screening, blending and sampling of both wet and dry ore concentrates and process residues. The three major functions performed in the building were to:

- Prepare representative samples of feed material for accountability purposes;
- Eliminate tramp metal, wood and foreign material from feed material; and
- Eliminate ammonia and/or residual organics from feed materials by oxidation and heating.

In addition, a 68,800-square-foot storage pad (Areas 109 and 110) was provided for the storage of incoming drummed feed material. An unloading dock was provided in the storage area.

The storage pad is poured concrete construction with a hardened surface, sloped, and provided with a complete trench drainage system which collects the rain and wash-water drainage from both the pad and Building 101 in a common sump. Sampling will be performed in the wash-water drainage area based on the potential for residual organic contamination. These locations are:

#	Coordinates W	N	Analytical Parameters
1)	50,100	100,730	Metals (MTL), Volatiles (VOA), Semivolatiles (SV) Pesticides, PCB (PP), Total Organic Halides (TOX)
2)	50,100	100,650	MTL, VOA, SV, PP, TOX
3)	50,040	100,700	MTL, VOA, SV, PP, TOX
4)	50,240	100,030	MTL, SV, Inorganics (IO), TOX
5)	50,130	100,960	MTL, SV, IO, TOX
6)	50,120	101,600	MTL, SV, IO, TOX

DIGESTION AND DENITRATION - BUILDING 103

Building 103 is composed of two major sections: the Digestion Section and the Denitration Section. In the Digestion Section, sampled ore concentrates were digested and transferred as slurry to Refinery Building 105 where the solution was purified by solvent extraction. The second section of Refinery Building 105 then received the purified uranium nitrate trioxide. The content and function of the two sections is more fully outlined below.

Digestion Section. The digestion portion of the refinery was designed to dissolve uranium concentrates in nitric acid. The

concentrates were received either in the form of oxides of uranium or in the form of sodium, magnesium and calcium salts of uranium. They were normally free-flowing powders that were transported from the Feed Preparation and Sampling Plant (Building 101) to the refinery in transfer hoppers and were fed directly into the four digesters. The resulting slurry was then transferred and stored in holding tanks from which it was pumped to the extraction plant (Refinery Building 105).

Denitration Section. After purification, the uranyl nitrate solution from the extraction plant (Refinery Building 105) was pumped to the denitration section where it was further concentrated in steam-heated tanks and finally transferred to gas-fired denitration pots.

The resultant dry product, uranium trioxide powder, also known as orange oxide, was pneumatically conveyed from each pot to the penthouse section where it dropped by gravity through a pulverizer, vibrating screen, one-stage sampler, and finally into transfer hoppers for movement to the Green Salt Plant (Bldg. 201). The oxides of nitrogen generated during the denitration cycle were collected and returned to the nitric acid recovery facility.

Sampling will be performed in the vicinity of Building 103 based on the use of nitric acid and metal acids. The sampling locations are:

#	Coordinates W	N	Analytical Parameters
7)	50,220	100,325	MTL, VOA, SV, pH, IO
8)	50,125	100,080	MTL, VOA, SV, pH, IO

TBP AND ETHER EXTRACTION - BUILDING 105

The Refinery Building (Building 105) removed essentially all uranium from the digested slurry received from Building 103 and returned the uranium as purified uranyl nitrate solution to the Denitration Section of Building 103. The process consisted of a two-stage solvent extraction operation in which tributyl phosphate (TBP)-hexane was used as the first stage solvent and diethyl ether as the second stage solvent.

The impurities contained in the digest slurry were concentrated and removed as raffinate from the TBP-hexane extractors in the form of an acid slurry. This slurry was transferred to the raffinate neutralization system prior to disposal in the raffinate pits.

The aqueous re-extract liquor containing the bulk of the uranium present in the feed concentrates was washed with hexane in a spray column to remove entrained TBP. It was then heated to flash off all remaining hexane. The solvent-free re-extract liquor was finally concentrated in a triple effect evaporator

located in the boil-down section and pumped to the Denitration Section of Building 103 as pure uranyl nitrate solution.

Raffinate from the first stage extraction was washed with hexane in a spray-type wash column to remove TBP and then stripped of hexane by boiling off the solvent in a stripping tank. The solvent-free raffinate was pumped to the raffinate neutralization system in the Denitration Section of Building 103 and on to the raffinate pits. All sump liquors in this first-stage extraction section were collected and stripped of TBP and hexane in a similar manner. The solvent-free sump liquor was then pumped to the sump liquor concentration system located in the Digestion Section of Building 103. All TBP and hexane recovered from the extract, raffinate, and sump liquor was adjusted to the proper TBP concentration by boiling off excess hexane in a still. The evaporated hexane was condensed and re-used.

Sampling will be performed in the vicinity of Building 105 based on the use of TBP, hexane, nitric acid, and diethyl ether. Sampling locations are:

#	Coordinates W	N	Analytical Parameters
9)	50,240	100,475	VOA, SV, IO
10)	50,150	100,425	VOA, SV, IO

GREEN SALT PLANT - BUILDING 201

The Green Salt Plant (Building 201) was designed to convert uranium trioxide (UO_3 or orange oxide), the product of Building 103, to uranium tetrafluoride (UF4), known as green salt.

Orange oxide powder was received from the Refinery Building (Building 105) in portable hoppers. The oxide was fed to a reduction reactor where the uranium trioxide (UO_3) was continuously reduced at an elevated temperature to uranium dioxide (UO_2 or brown oxide) with hydrogen gas. The uranium dioxide was then converted to uranium tetrafluoride by contacting it countercurrently at high temperature with hydrogen fluoride (HF) gas in three hydrofluorination reactors operating in series.

Basically, this process contains six reactor banks, each with four horizontal reactors arranged one above the other, a re-run bank similar to the reactor banks, a green salt reverter, and a pilot bank, consisting of three smaller reactor tubes. Uranium trioxide was reduced continuously to uranium dioxide by the countercurrent flow of hydrogen in a tubular reactor.

The hydrogen for the reduction step was made by the catalytic dissociation of anhydrous ammonia in special package units. Hydrofluoric acid for the hydrofluorination step was received from the tank farm (Area 202) as a liquid and was vaporized in steam jacketed tanks. Auxiliary facilities included six dust

collection and four vacuum cleaning systems for handling dusts, a lime scrubbing system for removing the last traces of HF from gases being vented to the atmosphere, two Freon refrigeration systems and a nitrogen producer.

Sampling will be performed in the vicinity of Building 201 based on the use of hydrofluoric acid, a lime scrubbing system, Freon, and asbestos.

The sampling location is:

#	Coordinates W	N	Analytical Parameters
11)	50,225	99,850	MTL, VOA, SV, pH, IO

METALS PLANT - BUILDING 301

The Metals Plant (Building 301) was designed to convert uranium tetrafluoride (UF_4) received from Building 201 to metal. The conversion was accomplished by a batch process, involving a thermite-type reduction of the uranium tetrafluoride with magnesium.

The reduction was carried out in large refractory-lined containers, known as "bombs," which were heated in a furnace for several hours in order to bring the reactants to a temperature at which the reaction, once ignited, occurred spontaneously. After removal from the furnace, the bombs were cooled and disassembled. The metal, which settled to the bottom of the bomb

and solidified, was removed from the slag in a so-called "breakout" operation. The cylindrical metal shape produced in this process was fabricated without recasting and was therefore considered a direct ingot and given the designation of "dingot". The magnesium fluoride slag produced by the reaction was crushed, ground and a portion recycled for use as the refractory liner for the bombs. The chips of metal removed during the machining of the dingot were segregated and collected for reclamation.

Sampling will be performed in the vicinity of Building 301 based on the use of caustics, magnesium, and solvents. Sampling locations are:

#	Coordinates W	N	Analytical Parameters
12)	50,375	99,650	MTL, VOA, SV, pH, IO
13)	50,075	99,400	MTL, VOA, SV, pH, IO
14)	50,225	99,400	MTL, VOA, SV, pH, IO

MAGNESIUM BUILDING - BUILDING 302

The Magnesium Building (Building 302) served as an important auxiliary facility to the Metals Plant (Building 301). It provided facilities (1) for unloading the finely divided magnesium metal chips received either by rail or truck in returnable 22-gallon drums, (2) for pelletizing and storing an inventory of drums in carload lots, and (3) for processing the magnesium through a magnetic separator and repackaging it in weighed lots of 55-gallon drums for use as a single charge in the

metals plant. Because of the hazards involved in storing large quantities of finely divided magnesium, it was necessary to isolate the building from other operating areas. Sampling will be performed in the vicinity of Building 302 based on the use of magnesium and lead.

Sampling location:

#	Coordinates W	N	Analytical Parameters
15)	50,390	99,175	MTL, IO

STEAM PLANT - BUILDING 401

The Steam Plant and its auxiliary facilities furnished the WSUFMP with steam, refrigerated brine, soft water, compressed air, and emergency electric power. The yard structures include coal and ash handling facilities, salt storage, coal storage and ash disposal areas.

The boilers were located outside the building and were supported by individual structural steel frames. The induced draft fans were located to the east of the building and discharged into two ground-supported steel stacks. A stack was used also for a small incinerator installed to the west of the steam plant. Two plant air receivers, a diesel exhaust muffler, an acid storage tank, and a diesel oil storage tank were located outside the building walls. Sampling will be performed in the vicinity of Building

401 based on the use of asbestos, barium chloride, coal, chlorine, hydrofluoric acid, diesel oil, fuel oil, lube oil, gasoline, oxalic acid, phosphate, sulfite and salts.

Sampling locations are:

#	Coordinates W	N	Analytical Parameters
16)	50,575	100,725	MTL, VOA, SV, IO
17)	50,550	100,950	MTL, SV, TOX
18)	50,550	101,070	MTL, SV, TOX
19)	50,550	101,210	MTL, SV, TOX
20)	50,660	100,940	MTL, SV, TOX

WET AND DRY CHEMICAL PILOT PLANT - BUILDING 403

The Wet and Dry Chemical Pilot Plant (Building 403) was designed to house pilot plant equipment for performing operations similar to those carried out in the digestion, extraction, and denitration areas of the operating plant. Sampling performed in the vicinity of Building 403 will be based on the use of nitric acid, magnesium, lime, iron, aluminum, hexane, and TBP. Sampling location is:

#	Coordinates W	N	Analytical Parameters
21)	49,800	100,675	MTL, VOA, SV, IO

METALS PILOT PLANT - BUILDING 404

The Metals Pilot Plant (Building 404) houses the metallurgical pilot plant and includes such facilities as blenders, jolters, breakout equipment, reduction furnaces, vacuum casting equipment and a small ceramics laboratory. The building was designed for maximum flexibility of equipment installation. It is located immediately north of the laboratory (Building 407). Sampling in the vicinity of Building 404 will be based on the use of barium fluoride, lithium chloride, and lithium fluoride. Sampling location is:

#	Coordinates W	Coordinates N	Analytical Parameters
22)	49,725	100,675	MTL, VOA, SV, IO

WAREHOUSE - BUILDING 406

The Warehouse (Building 406) provides storage space for dry chemicals, recycled and special feed materials, intermediate products and miscellaneous materials. Both railroad car and truck unloading docks are provided. Since most dry chemicals were used in the refinery area, the warehouse is equipped with a ramp so that materials can be moved to other buildings by fork truck. No sampling is proposed in this area due to the presence of large areas of concrete.

SUPPORT FACILITIES

LABORATORY BUILDING - BUILDING 407

Building 407 provided the necessary laboratory facilities for the plant. Approximately two-thirds of the building housed analytical facilities with the remaining third housing development facilities.

Although many chemicals were used in Building 407, there is no historical information indicating routine transport of chemicals from Building 407 to other buildings, nor are there any documented spills in the area. Therefore sampling in the vicinity of Building 407 will not be performed.

MAINTENANCE AND STORES BUILDING - BUILDING 408

The Maintenance and Stores Building (Building 408) provided the on-site maintenance facilities. The building housed maintenance shops, maintenance stores, automotive maintenance, fire trucks and offices for shop and stores supervision. The shops were located side by side along the exterior wall of the building facing the plant. Each had access on the interior side of the building to a "multiple-use" work space which was serviced by a truck aisle running the length of the building. A fire wall divided the building longitudinally into two equal areas. The stores section was on the opposite side of the fire wall from the shops.

Automotive maintenance and repair facilities were located at the south end of the building adjacent to the motor pool. A shipping and receiving dock was provided at the southeast corner of the building which is nearest to the plant entrance. Adjacent to the dock was a decontamination, cleaning and degreasing station. Sampling in the vicinity of Building 408 will be based on the use of many chemicals associated with facility and automotive maintenance. Sampling locations are:

#	Coordinates W	N	Analytical Parameters
23)	49,700	99,550	VOA, SV, PP, IO
24)	49,910	99,830	VOA, SV, PP, IO
25)	49,775	99,975	MTL, VOA, SV, IO, PP

ADMINISTRATION BUILDING - BUILDING 409

The Administration Building (Building 409) was designed and arranged to serve as an administrative and technical headquarters.

Chemical contamination is not expected in the vicinity of building 409 and no sampling will be performed.

SERVICES BUILDING - BUILDING 410

The Services Building (Building 410) housed the following facilities: cafeteria, health department, guard house, gate house and change rooms.

Although Building 410 contained chemicals for first aid and health services, there is no record of routine transport of chemicals in and out of the building nor any record of chemical spills in the vicinity, and sampling will not be performed.

SCRAP CLASSIFICATION AND EQUIPMENT STORAGE FACILITY-AREA 414

The Scrap Classification and Equipment Storage Facility (Area 414) provided for the storage of large pieces of equipment and for the receipt, classification and salvage of usable parts.

The facility consists of a concrete pad and a prefabricated building. The building housed salvage and reclamation operations and provided storage for equipment that could not be stored outdoors. Fenced enclosures are installed for classified scrap. No sampling is planned for this area.

PAINT SHOP - BUILDING 417

The Paint Shop (Building 417) was housed in a separate one-story building divided into two equal sections by a fire wall. One section was used for general storage and the other as work space. Sampling in the vicinity of Building 417 will be based on the routine use of benzene, methylisobutyl ketone, phenoline thinner, various paint solvents, and metals.

Sampling locations are:

#	Coordinates W	N	Analytical Parameters
26)	49,800	99,340	MTL, VOA, SV, IO, TOX
27)	49,870	99,440	VOA, SV, IO
28)	49,830	99,470	MTL, VOA, SV, IO

STORAGE BUILDINGS-BUILDINGS 433, 434, 435, 436, 437 & 438

These buildings fulfilled several functions during the construction of the plant. They were constructed for temporary use as construction warehouses, personnel offices, shops, motor pool including fuel station, garages and general storage. Building 437 is constructed of brick and was previously part of the WSOW. The remaining buildings are Butler-type on concrete slab.

Sampling locations are:

#	Coordinates W	N	Analytical Parameters
29)	50,740	98,250	MTL, VOA, SV, IO
30)	50,710	98,350	MTL, VOA, SV, IO
31)	50,830	98,410	VOA, SV, IO
32)	50,680	98,410	MTL, VOA, SV, IO
33)	50,610	98,370	MTL, VOA, SV, PP, IO
34)	50,570	98,330	MTL, VOA, SV, PP, IO
35)	50,560	98,440	MTL, VOA, SV, PP, IO

36)	50,670	98,610	MTL, VOA, SV, PP, IO, TOX

REFINERY TANK FARM - AREA 102

The Refinery Tank Farm provided facilities for the unloading, storing, and transferring of liquid process materials required in the refinery operation which were supplied or handled in tank-car or tank-truck quantities. Storage tanks were furnished for hexane, ethyl ether, dilute nitric acid, sulfuric acid, and 50 percent caustic soda solution. Other facilities in this area include unloading docks, transfer pumps and drum filling equipment.

Tank Farm 102A handled all of the above materials except nitric acid, which was handled in Tank Farm 102B.

There are no buildings in the area. All equipment was located in open concrete saddle pedestals. Twelve tanks (19,000 to 26,000 gal) were located in the area but have been removed.

Sampling in the vicinity of the tank farm will be based on the use of hexane, nitric acid, sulfuric acid, ethyl ether and sodium hydroxide. Sampling locations are:

#	Coordinates W	N	Analytical Parameters
37)	50,500	100,140	MTL, VOA, SV, PP, IO, pH
38)	50,500	100,240	MTL, VOA, SV, PP, IO, pH
39)	50,440	100,170	MTL, VOA, SV, PP, IO, pH

40)	50,440	100,380	MTL, VOA, SV, PP, IO, pH
41)	50,440	100,450	MTL, VOA, SV, PP, IO, pH
42)	50,310	100,520	MTL, VOA, SV, PP, IO, pH
43)	50,360	100,540	MTL, VOA, SV, PP, IO, pH
44)	50,350	100,480	MTL, VOA, SV, PP, IO, pH
45)	50,340	100,420	MTL, VOA, SV, PP, IO, pH

NITRIC ACID RECOVERY FACILITY - AREA 108

The Nitric Acid Recovery Plant was designed to recover for re-use the bulk of the nitric acid required for digestion. Accordingly, the facility was equipped to:

- collect and absorb nitrogen oxides from the Digestion and Denitration Building in water or weak nitric acid; and
- reconcentrate the recovered weak nitric acid.

The recovery plant was essentially an outdoor installation. Housing was provided for compressors and instrument panels. Sampling in the vicinity of Area 108 will be based on the use of nitric and ferric acids. Sampling location is:

#	Coordinates W	N	Analytical Parameters
46)	50,350	100,350	MTL, TOX, pH, IO

GREEN SALT TANK FARM - AREA 202

The Green Salt Tank Farm (Area 202) provided for tank car unloading and storage of anhydrous hydrofluoric acid (AHF) and anhydrous ammonia, both utilized in the Green Salt Plant (Building 201). In addition, storage and tank car loading facilities were installed for the 70 percent hydrofluoric acid (70% HF) recovered in the green salt process.

The five AHF tanks were located within an insulated enclosure. Five additional tanks were not enclosed, but were located within a diked area. Unloading pumps for AHF and a loading pump for 70% HF acid were installed. A compressor house was provided for the ammonia unloading compressor. Sampling in the vicinity of the Green Salt Tank Farm will be based on the use of hydrofluoric acid, anhydrous ammonia and anhydrous hydrogen fluoride. Sampling locations are:

#	Coordinates W	N	Analytical Parameters
46)	50,370	99,830	MTL, TOX, pH, IO
47)	50,370	99,850	MTL, TOX, pH, IO
48)	50,370	99,110	MTL, TOX, pH, IO
49)	50,300	99,950	MTL, TOX, pH, IO
50)	50,350	99,980	MTL, TOX, pH, IO

ELECTRICAL TRANSFORMER AREAS

Substation No. 412, the main electrical substation on site, contains the electrical equipment (switches and transformers) necessary for the transformation of incoming power at 34.5 KV to plant distribution power of 13.8 KV. Numerous smaller electrical transformers are located in the WSCP and samples will be collected based on the use of PCB and PCB contaminated oil. Sampling locations are:

#	Coordinates W	Coordinates N	Analytical Parameters
51)	50,790	98,300	PCB
52)	49,940	99,740	PCB
53)	50,200	99,640	PCB, IO
54)	50,250	99,920	PCB, IO
55)	50,680	99,990	PCB
56)	50,440	100,340	PCB
57)	50,480	100,640	PCB, IO
58)	49,700	100,360	PCB
59)	49,780	100,800	PCB

COOLING TOWER - AREA 413

The Cooling Tower is constructed of redwood lumber. It was designed to handle 12,000 gpm and to cool the water from 110°F to 90°F at a wet bulb temperature of 78°F.

A reinforced concrete basin with flume was installed, having a capacity of 80,000 gallons--the minimum amount of water storage required for proper operation of the cooling tower.

A steel frame building with corrugated asbestos siding was constructed adjacent to the cooling tower to house the pumping facilities, the chemical treatment and the electrical equipment necessary for the operation. Sampling in the vicinity of Area 413 will be based on the use of chlorine, chromate phosphate, and sulphuric acid. Sampling location is:

#	Coordinates W	N	Analytical Parameters
60)	50,525	100,525	IO

PROCESS INCINERATOR - AREA 415

The Process Incinerator was a small combustion unit for (1) burning trash or wastes from which uranium was to be recovered from the ashes and (2) burning of classified documents. Chemical contamination is not suspected in this area and no sampling will be performed in this area.

ELEVATED WATER TANK - AREA 426

The Elevated Overhead Storage Tank has a capacity of 350,000 gallons and stands 186 feet above the foundation. It is supported by six tubular steel legs set on a concrete foundation

and is equipped with a steam-heated standpipe. The installation provided a positive means of preventing any possible backflow

from the process system to the potable water system. Chemical contamination is not suspected in this area and no sampling will be performed in this area.

PRIMARY SEWAGE TREATMENT PLANT - AREA 427

A Primary Sewage Treatment Plant was installed near the south site boundary. It was sized to handle sewage wastes for approximately 1,300 persons per day. An Imhoff tank design for sludge settling and digestion was used. Sampling will be based on the spectrum of chemicals used on-site. A single grab sample will be collected and analyzed for metals, semivolatiles, PCBs, pesticides, inorganic anions, and TOX.

PROPANE GAS PLANT - AREA 428

A Propane Gas Plant was installed near the west side of the building area to provide fuel gas to the various plants to satisfy process heating requirements. Two 30,000-gallon storage tanks were provided. No chemical contamination is expected in this area, and samples will not be collected.

RESERVE WATER FACILITIES - AREA 429

The Reserve Water Facilities consist of a large ground storage tank and an auxiliary pump house. No contamination is expected and samples will not be collected.

FIRE TRAINING - AREA 439 & 443

During operations of the plant, the fire protection department maintained fire training facilities on the site. The foundations of these facilities are all that remains. Sampling in this area will be based on the presence of drums of unknown chemicals located during the 1987 chemical inventory. Since oil possibly contaminated with PCB's may have been utilized in the fire training area, the samples will be analyzed for PCB's, PCDF's and dioxins in addition to other parameters. Two grab samples will be collected from the fire training area. Sampling locations are:

#	Coordinates W	N	Analytical Parameters
62)	50,910	100,860	Nitroaromatics, MTL, VOA, SV, PP, PCDP's, dioxins, TOX - Grab from pit
63)	50,810	100,770	MTL, SV, PP, PCDF's, dioxins, TOX - Grab from filter

RAILROADS

A railroad system was installed within the plant site for delivering raw materials to and removing product from the plant.

The trackage is connected at the south boundary line to a railroad spur line that previously served the WSOW. The new railroad system within the plant area consists of double tracks that pass through the building area, and terminate at track bumpers located near the north boundary line. Track turnouts are strategically located to facilitate the movement of loaded or empty cars to and from the various buildings. Limestone ballast at a greater than normal depth was utilized on 190 feet of the track adjacent to the Green Salt Tank Farm, Area 202, in order to neutralize acid spills or drips from hydrofluoric acid tank car unloading. Decontamination of box cars was accomplished using a reinforced concrete basin installed under the east track adjacent to the feed storage pad, Areas 109 and 110. A track hopper is erected under the west track adjacent to the coal storage area for unloading coal from hopper cars to use in Building 401. Sampling will be performed in this area based on an uninvestigated tank area south of Areas 109 and 110. Sampling location is:

#	Coordinates W	N	Analytical Parameters
64)	50,360	100,660	MTL, VOA, SV, IO, PP

UNDERGROUND TANKS

Several underground tanks are present in various areas of the WSCP. These tanks were primarily used to store gasoline, fuel

oil, diesel fuel and other hydrocarbons. Sampling will be performed near each underground tank. Sampling locations are:

#	Coordinates W	N	Building	Analytical Parameters
65)	50,390	100,820	401	VOA
66)	50,750	100,770	439	MTL, SV, PP, TOX
67)	49,740	100,970	101	MTL, VOA, PP, TOX
68)	50,590	98,210	436	VOA
69)	49,870	99,590	408	VOA, PP

MISCELLANEOUS

Included in this category are several filters, isolated tanks and other areas suspected of being chemically contaminated. Analytical parameters were selected based on location, known process and/or suspected contaminants. Samples will be collected at 0 to 6 inch, 24 to 30 inch, and 54 to 60 inch intervals unless noted. Sampling locations are:

#	Coordinates W	N	Area	Analytical Parameters
70)	50,510	99,530	303	MTL, VOA, SV, PP
71)	50,460	99,600	303	MTL, VOA
72)	50,520	99,770	419	MTL, VOA, SV, IO, PP
73)	50,980	100,420	428	MTL, VOA, SV, PP
74)	49,880	100,240	410	MTL, VOA, SV, TOX

75)	49,800	100,620	407	MTL, VOA, SV, IO, PP, TOX, Asbestos
76)	49,730	100,040	404	MTL, SV, PP, TOX - Grab from filter
77)	49,890	100,840	403	MTL, SV, PP
78)	51,970	100,520	Ash Pond	Nitroaromatics, MTL, VOA, SV, IO, PP, TOX, pH

OVERHEAD PIPING SYSTEM

Steam, air, brine and fuel gas were carried in pipe-lines supported overhead on steel pipe racks and bridges. Steam was distributed through a network of asbestos-insulated pipes to the various buildings where it was used for process and heating purposes.

In order to accommodate all the various piping systems, a support system was erected which consisted of steel pipe poles and structural steel and pipe bents, along with several structural steel bridges. The supports were installed on concrete foundation piers.

Utility lines included in the overhead piping systems were as follows:

High pressure air

Instrument air

Ethylene glycol, supply and return

Fuel gas

High pressure steam

Piping for the transfer of the following chemicals was also part of the overhead distribution systems:

Concentrated nitric acid

Dilute nitric acid

Sulfuric acid

Lime slurry

Aluminum nitrate

Ferric nitrate

Caustic

Sodium carbonate

Diethyl ether

Hexane

Deionized water

Additional process lines include:

Digested slurry

"NG" liquor (recycled uranyl nitrate solution)

Aqueous uranyl nitrate

Raffinate

Sump liquor slurry

NO_2 fume headers

Since no documented leaks or spills occurred from overhead piping or railroad systems, samples will not be collected from these areas. However, sample locations selected randomly as discussed in Section 4.5 will provide coverage of affected areas.

SANITARY SEWER

A network of underground sewers was installed to collect and carry sanitary effluent from the various buildings to the primary sewage treatment plant, Area 427.

It was necessary due to the topography of the site to install septic tanks and drainage fields for the steam plant (Building 401) and the pilot plants (Building 403 and 404) since gravity flow to the sanitary sewer system was not possible.

The sanitary sewer system is from 4 to 12 feet deep and consists of 4,780 lineal feet of vitrified clay pipe, 6 in. to 10 in. diameter, and 245 lineal feet of 6 in. cast iron soil pipe.

PROCESS SEWER SYSTEM

A network of underground process sewers was installed to handle large quantities of manufacturing wastes containing chemicals and small amounts of low level radioactive materials. No reported leaks or failures of the process sewer system are known. Minor amounts of leakage would be extremely difficult to detect with borehole sampling. A more rational approach is to observe excavation operations, inspect the sewer lines and collect biased samples during excavation operations.

All WSUFMP Biased Sampling Locations are presented in Table 4-5.

TABLE 4-5

Weldon Spring Feed Materials Plant Biased Sampling Locations

POINT #	COORDINATES WEST	COORDINATES NORTH	COORDINATES DESCRIPTION	NUMBER OF SAMPLES	DEPTH OF SAMPLE	SAMPLE TYPE COMP./GRAB	TYPE OF SOIL CHEMICAL ANALYSIS*	RATIONALE
Building 101 Area								
1)	50,100	100,730	Uninvestigated area east of 101	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	D,F,G,H,M,N	Unknown area
2)	50,100	100,650	Uninvestigated area east of 101	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	D,F,G,H,M,N	Unknown area
3)	50,040	100,700	Uninvestigated area east of 101	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	D,F,G,H,M,N	Unknown area
4)	50,240	101,030	Drum storage, north of 109 & 110	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	D,G,H,L,N	Unknown contents; nitric acid, organics
5)	50,130	100,960	Drum storage, north of 109 & 110	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	D,G,H,L,N	Unknown contents
6)	50,120	101,600	Drum storage, north of 109 & 110	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	D,G,H,L,N	Unknown contents
Building 103 Area								
7)	50,220	100,325	Process Lines at 103	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	D,F,G,H,L,O	Process lines into-out of building
8)	50,125	100,080	Process lines at 103	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	D,F,G,H,L,O	Process lines into-out of building
Building 105 Area								
9)	50,240	100,475	Process Lines at 105	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	F,G,H,L	Process lines into-out of building
10)	50,150	100,425	Process Lines at 105	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	F,G,H,L	Process lines into-out of building
Building 201 Area								
11)	50,225	99,850	Chemical transfer at 201 area	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	D,F,G,H,L,O	Chemical transfer point
Building 301 Area								
12)	50,375	99,650	Chemical transfer at 301 area	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	D,F,G,H,L,O	Chemical transfer point
13)	50,075	99,400	Chemical transfer at 301 area	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	D,F,G,H,L,O	Chemical transfer point
14)	50,225	99,400	Chemical transfer at 301 area	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	D,F,G,H,L,O	Chemical transfer point

* See key code for analytical description, page 112.

TABLE 4-5 (cont.)

POINT #	COORDINATES WEST	COORDINATES NORTH	COORDINATES DESCRIPTION	NUMBER OF SAMPLES	DEPTH OF SAMPLE	SAMPLE TYPE COMP./GRAB	TYPE OF SOIL CHEMICAL ANALYSIS	RATIONALE
Building 302 Area								
15)	50,390	99,175	Grassy area north of building 302	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	D,L	Lead & Magnesium chips released in this area
Building 401 Area								
16)	50,575	100,725	Incineration 401	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	D,F,G,H,L	Stock/incinerator area
Building 401 Area								
17)	50,550	100,950	Coal storage area north of 401	3	0-6", 2-2.5", 4.5-5'	Composite at each interval	D,G,H,N	Uninvestigated area
18)	50,550	101,070	Coal storage area north of 401	3	0-6", 2-2.5", 4.5-5'	Composite at each interval	D,G,H,N	Uninvestigated area
19)	50,550	101,210	Coal storage area north of 401	3	0-6", 2-2.5", 4.5-5'	Composite at each interval	D,G,H,N	Uninvestigated area
20)	50,660	100,940	Coal storage area north of 401	3	0-6", 2-2.5", 4.5-5'	Composite at each interval	D,G,H,N	Uninvestigated area
Building 403 Area								
21)	94,800	100,675	Process line 403	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	D,F,G,H,L	Process line
Building 404 Area								
22)	49,725	100,675	Process line 404	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	D,F,G,H,L	Process line
Building 408 Area								
23)	49,700	99,550	One drum east of 408	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	F,H,L,M	Unknown contents of drums; cyanide, PCBs
24)	49,910	99,830	Drum storage west of 408	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	F,G,H,L,M	Unknown contents; sodium cyanide, PCBs
25)	49,775	99,975	Degreasing station 408	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	D,F,G,H,L,M	Use of solvents, degreasers, cleaning agents
Building 417 Area								
26)	49,860	99,340	Drum storage area south of 417	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	D,F,G,H,L,M	Unknown contents of drums; benzene, MBK, phenolene, solvents
27)	49,870	99,440	Drum storage area south of 417	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	F,G,H,L	Unknown contents of drums

TABLE 4-5 (cont.)

POINT #	COORDINATES WEST	COORDINATES NORTH	COORDINATES DESCRIPTION	NUMBER OF SAMPLES	DEPTH OF SAMPLE	SAMPLE TYPE COMP./GRAB	TYPE OF SOIL CHEMICAL ANALYSIS	RATIONALE
Building 417 Area (continued)								
28)	49,830	99,470	Drum storage area south of 417	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	D,F,G,H,L	Unknown contents of drums
Buildings 433, 434, 435, 436, 437, & 438								
29)	50,740	98,250	Drum storage area west of 436	2	0-6", 2-2.5', 4.5-5'	Composite at each interval	D,F,G,H,L	Unknown contents of drum
30)	50,710	98,350	Drum storage area, west and adjacent to 436	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	D,F,G,H,L	Unknown contents of drums
31)	50,830	98,410	Drum storage area, west of 436	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	F,G,H,L	Unknown contents of drums
32)	50,680	98,410	Drum storage area, east and adjacent to 436	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	D,G,H,F,L	Unknown contents of drums
33)	50,610	98,370	Drum storage area west of 435	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	D,F,G,H,L,M	Unknown contents of drums
34)	50,570	98,330	Drum storage area west of 436	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	D,F,G,H,L,M	Unknown contents of drums
35)	50,560	98,440	Drum storage area east side of 435	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	D,F,G,H,L,M	Unknown contents of drums; PCBs, sulfuric, nitric, sodium fluoride
36)	50,670	98,610	Concrete pad east of 437	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	D,F,G,H,L,M,N	Unknown concrete pad; PCBs, sulfuric, nitric, sodium fluoride
Area 102 A and B								
37)	50,500	100,140	Area 102B tank farm area	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	D,F,G,H,L,M	Unknown contents of tanks; hexane, sulfuric, ethyl ether, sodium hydroxide
38)	50,500	100,240	Area 102B tank farm area	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	D,F,G,H,L,M,O	Unknown contents of tanks, hexane, sulfuric, ethyl ether, sodium hydroxide
39)	50,440	100,170	Area 102B tank farm area	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	D,F,G,H,L,M,O	Unknown contents of tanks, hexane, sulfuric, ethyl ether, sodium hydroxide

TABLE 4-5 (cont.)

POINT #	COORDINATES WEST	COORDINATES NORTH	COORDINATES DESCRIPTION	NUMBER OF SAMPLES	DEPTH OF SAMPLE	SAMPLE TYPE COMP./GRAB	TYPE OF SOIL CHEMICAL ANALYSIS	RATIONALE
Area 102 A and B (continued)								
40)	50,440	100,380	Area 102B tank farm area	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	D,F,G,H,L,M,O	Unknown contents of tanks, hexane, sulfuric, ethyl ether, sodium hydroxide
41)	50,440	100,450	Area 102B tank farm area	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	D,F,G,H,L,M,O	Unknown contents of tanks; hexane, sulfuric, ethyl ether, sodium hydroxide
42)	50,310	100,520	Area 102A tank farm area	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	D,F,G,H,L,M,O	Unknown contents of tanks; hexane, sulfuric, ethyl ether, sodium hydroxide
43)	50,360	100,540	Area 102A tank farm area	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	D,F,G,H,L,M,O	Unknown contents of tanks; hexane, sulfuric, ethyl ether, sodium hydroxide
44)	50,350	100,480	Area 102A tank farm area	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	D,F,G,H,L,M,O	Unknown contents of tanks; hexane, sulfuric, ethyl ether, sodium hydroxide
45)	50,340	100,420	Area 102A tank farm area	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	D,F,G,H,L,M,O	Unknown contents of tanks; hexane, sulfuric, ethyl ether, sodium hydroxide
Area 108								
46)	50,350	100,350	108, west side near railroad tracks	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	D,L,N,O	Nitric acid area, nitric & ferric acids
Area 202								
47)	50,370	99,830	South end of 202 adjacent to HF tanks	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	D,L,N,O	Possible metals & acid; hydrofluoric acid, anhydrous ammonia, hydrogen fluoride
48)	50,370	99,850	South end of 202 adjacent to HF tanks	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	D,L,N,O	Possible metals & acid
49)	50,370	99,110	South end of 202 adjacent to HF tanks	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	D,L,N,O	Possible metals & acid
50)	50,300	99,950	South end of 202 adjacent to HF tanks	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	D,L,N,O	Possible metals & acid
51)	50,350	99,980	South end of 202 adjacent to HF tanks	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	D,L,N,O	Possible metals & acid

TABLE 4-5 (cont.)

POINT #	COORDINATES WEST	COORDINATES NORTH	COORDINATES DESCRIPTION	NUMBER OF SAMPLES	DEPTH OF SAMPLE	SAMPLE TYPE COMP./GRAB	TYPE OF SOIL CHEMICAL ANALYSIS	RATIONALE
Transformers								
52)	50,790	98,300	Transformer substation, west of 436	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	M	Possible PCBs
53)	99,940	99,740	Substation west of 408	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	M	Possible PCBs
54)	50,200	99,640	Substation north of 301	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	L,M	Possible PCBs; caustics, magnesium, asbestos
55)	50,250	99,920	Substation west of 201	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	L,M	Possible PCBs; hydrofluoric acid, lime, Freon, asbestos
56)	50,680	99,990	Substation west of 201	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	M	Possible PCBs
57)	50,440	100,340	Substation west of 108	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	M	Possible PCBs, nitric & ferric acids
58)	50,480	100,640	Substation south of 401	3	0-6", 2-3.5', 4.5-5'	Composite at each interval	L,M	Possible PCBs; barium chloride, chlorine, hydrofluoric, phosphate, sulfate,
59)	49,700	100,360	Substation north of 410	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	M	Possible PCBs
60)	49,780	100,800	Substation north of 405B	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	M	Possible PCBs
Building 413 Area								
61)	50,525	100,525	Chemical transfer area 413	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	L	Chemical transfer point
Area 427								
62)	50,180	98,830	Waste treatment facility Area 427	1	Sludge & sediment from bottom of pond	Grab from bottom of pond	D,G,H,L,M,N	Unknown contents pond
Areas 439 & 443								
63)	50,910	100,860	Fire training pit west of 439	1	Sludge & sediment from bottom of pit	Grab	A,D,F,G,H,M,N	Unknown contents

TABLE 4-5 (cont.)

POINT #	COORDINATES WEST	COORDINATES NORTH	COORDINATES DESCRIPTION	NUMBER OF SAMPLES	DEPTH OF SAMPLE	SAMPLE TYPE COMP./GRAB	TYPE OF SOIL CHEMICAL ANALYSIS	RATIONALE
Areas 439 & 443 (continued)								
64)	50,810	100,770	Filter south of 439	1	Sludge & sediment from bottom of filter	Grab	D,G,H,L,M,N	Unknown contents
Railroad Area								
65)	50,360	100,660	Tank area east of 101 on railroad tracks	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	D,F,G,H,L,M	Unknown contents
Tanks - Underground								
66)	50,390	100,820	Underground fuel tank, NE of 401	3	2' intervals to 10'	Composite at each interval	F,M	Unknown contents
Tanks - Underground								
67)	50,750	100,770	Underground tank south of 439	5	2' intervals to 10'	Composite at each interval	D,G,H,M,N	Unknown contents
68)	49,740	100,970	Underground treatment tank near 101	3	2' intervals to 10'	Composite at each interval	D,F,M,N	
69)	50,590	98,210	Fuel storage tank south of 436	5	Composite Samples at 2' intervals 40 10' (0-2, 2-4, 4-6, 6-8, 8-10)	Composite at each interval	F	Underground fuel tanks; PCBs, sulfuric acid, nitric acid, sodium fluoride
70)	49,870	99,590	Underground storage tank south of 408	5	Samples at 2' intervals to 10' (0-2, 2-4, 4-6, 6-8, 8-10)	Composite at each interval	F,M	Unknown contents
Miscellaneous								
71)	50,510	99,530	Area south of 303	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	D,F,G,H,M	Unknown area
72)	50,460	99,600	Area 313 "chips storage" around foundation	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	D,F,G,H,L	Unknown storage area
73)	50,520	99,770	Scrap storage yard south of 419	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	D,F,G,H,L,M	Unknown storage area
74)	50,980	100,420	Stainless steel tank, TBP outside fence west of 428	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	D,F,G,H,M	Unknown contents; propane

TABLE 4-5 (cont.)

POINT #	COORDINATES WEST	COORDINATES NORTH	COORDINATES DESCRIPTION	NUMBER OF SAMPLES	DEPTH OF SAMPLE	SAMPLE TYPE COMP./GRAB	TYPE OF SOIL CHEMICAL ANALYSIS	RATIONALE
75)	49,880	100,240	Radiologically contaminated area west of 410	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	D,G,H,M,N	Unknown area
76)	49,800	100,620	Concrete pad	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	D,F,G,H,L,M,N,K	Unknown area
77)	49,730	100,040	Filter, north of 404	1	Sludge & sediment from bottom of filter	Grab	D,G,H,M,N	Unknown contents; barium fluoride, lithium chloride, lithium fluoride
78)	51,970	100,520	Landfill (drum disposal area)	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	A,D,F,G,H,L,M,N,O	Unknown disposal area
79)	49,890	100,840	Tank north of 403	3	0-6", 2-2.5', 4.5-5'	Composite at each interval	D,G,H,M	Unknown contents

KEY FOR SOIL CHEMICAL ANALYSES

A = Nitroaromatics group (2,4-DNT; 2,6-DNT; 1,3-DNB; 1,3,5-TNB, and 2,4,6-TNT)

B = Nitrite

C = Sulfate

D = Metals

E = Mercury

F = GC/MS volatile fraction

G = GC/MS acid fraction

H = GC/MS BNA fraction

I = Hexavalent chromium

K = Asbestos

L = Inorganics, SO_4, SO_3, NO_3, NO_2, Fl

M = Pesticides/PCBs

N = TOX

O = Soil pH

P = Select metals - aluminum, antimony, barium, iron, lead, magnesium, manganese.

Note: See WSSRAP, RI/FS, QAPP for method description, detection limits, and holding times

4.4 WSOW Biased Sampling Program

4.4.1 Chemical Sources and Source Areas

The TNT and DNT production process that was carried out by Atlas Powder Company during the operation of the WSOW was similar to that used at other TNT and DNT plants.

TNT plants all use the same basic chemical process, i.e., the treatment of liquid toluene with mixed nitric and sulfuric acids followed by removal of undesired isomers and residual dinitrated toluene by conversion to soluble species. The undesired isomers plus residual dinitrated species were removed from the reaction mixture by treatment with aqueous sodium sulfite solution, called "sellite," which reacted with everything except the desired product. The spent sellite solution, containing the extracted sulfonate derivatives, was known as "red water," and constituted a major inherent waste stream.

Red water is a deep red, almost black, aqueous stream containing an extremely complex mixture of nitroaromatics and various inorganic salts. The organic portion is mostly accounted for by the various sulfonated derivatives of the three undesired TNT isomers.

Other organic constituents include smaller fragments, dissolved a-TNT, and complex, unidentified dye bodies formed from the photolysis of a-TNT by sunlight. The inorganic portion consists

mainly of unreacted sulfite plus nitrite and nitrate formed in the extraction reactions. Red water varies somewhat in composition from plant to plant and from run to run, but a typical composition is:

Water

Na_2SO_3-Na_2SO_4

$NaNO_2$-$NaNO_3$

Sulfonated or sellited nitro compounds

Solids

Ash

Figure 4-3 shows the schematic flow diagram of the batch process which was used by WSOW. Numerous buildings at the WSOW have been identified. Table 4-6 relates building number to process description where known. The nitration reactions are carried out in three consecutive batch units referred to as "Mono," "Bi," and "Tri" Houses. The feed chemicals to the Mono House (T-7) are toluene and waste acid from the Bi House (T-12), fortified with 60% HNO_3.

After reaction, the waste acid was transferred to a storage tank for recovery, and the partially nitrated toluene was pumped to the Bi House where further nitration was effected with waste acid from the Tri House (T-9), fortified with 60% HNO_3. The result was a mixture of all possible dinitrated isomers, "Bi Oil." After settling and separation, the Bi Oil was pumped to the Tri House where the feed acid was a mixture of 98% nitric acid and

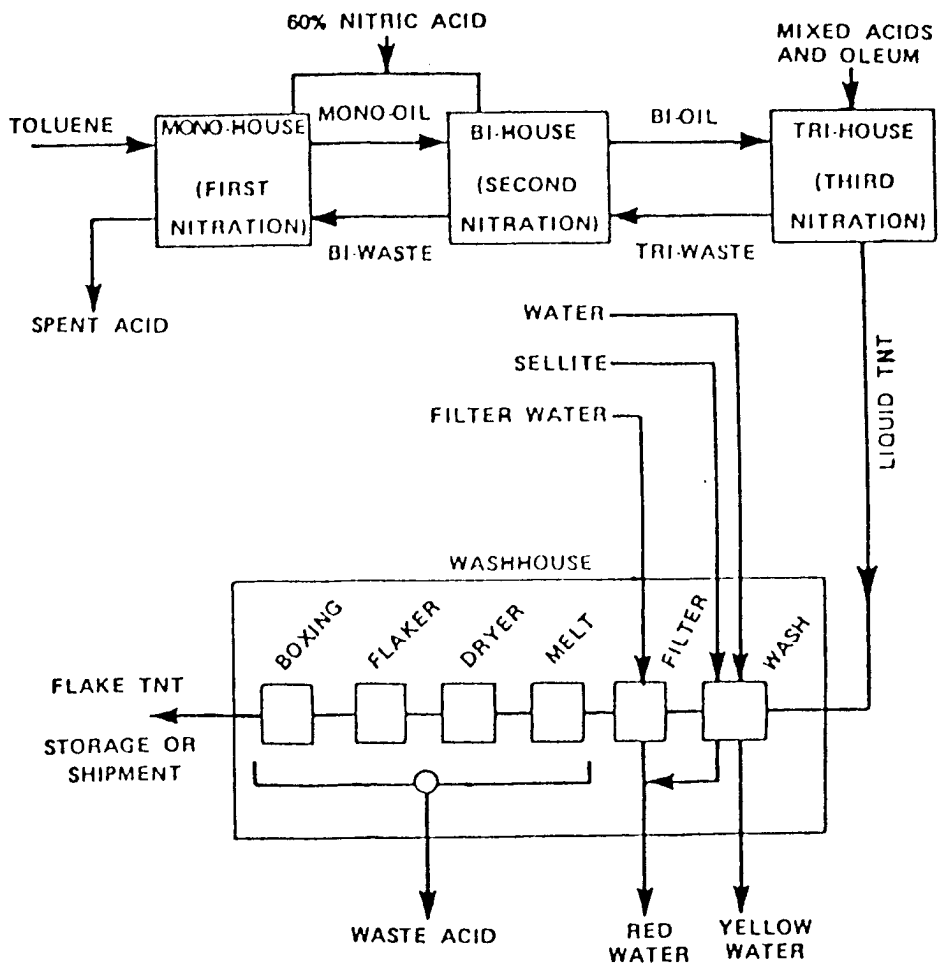

FIGURE 4-3

WSOW SCHEMATIC FLOW DIAGRAM WITH WASTE STREAMS

TABLE 4-6

WELDON SPRING ORDNANCE WORKS PROCESS BUILDING DESIGNATION

T-1	Toluene Storage
T-3	Acid Unloading
T-4	Acid Unloading
T-5	Acid Unloading
T-6	Acid Unloading
T-7	Mono Nitrating Houses
T-8	Acid Recovery Houses
T-9	Trinitrating Houses
T-10	Acid Storage
T-11	Valve House
T-12	Bi-Fortifier Houses
T-13	Wash Houses
T-16	Settling Houses
T-17	Sellite Storage
T-18	Wet Powder Holdovers
T-19	Grainer Houses
T-20	Motor House
T-22	Settling Tanks
T-23	Dry Holdover
T-24	Pack Houses
T-25	Motor House
T-26	Rubbish Sheds
T-32	Settling Tanks
T-33	Transfer House
T-35	Pelleting
T-36	Box Service
T-37	Box Conveyor
T-38	Strapping House

Source: WSSRAP, 1987

oleum. The nitrated product from this third nitration stage operation was crude TNT containing a-TNT (2,4,6-trinitrotoluene), which was the desired product, and unsymmetrical TNT isomers, which were the impurities. The crude TNT was fed to the Wash House (T-13) for purification.

The purification of crude TNT involves crystallization in water, free acid neutralization with soda ash and solutilization and removal of undesirable nitrated products by treatment with a solution of sodium sulfite (sellite). The wastewater from the sellite purification stage was transferred to the red water treatment plant for disposal by evaporation-concentration and concentrate incineration.

The TNT slurry was transferred to a filter tank where it was washed and filtered on a screen leaving layers of TNT crystals. The crystals were reslurried with water and pumped to a melt tank where TNT was melted and most of the water was removed by evaporation. The molten product was run into hot air dryers for the removal of residual water. The water-free product was solidified on a water-cooled flaker drum or stainless steel belt, and the resultant film was removed in the form of small flakes by scraping the drum or belt with a beryllium blade. The flaked TNT was boxed and sent to a packing house for transfer to a storage or loading area.

Four waste streams are shown in Figure 4-3: spent acid, waste acid, red water, and yellow water. The spent acid was not

discharged; the nitric acid was distilled off and reused and the residual sulfuric acid was sold for commercial use. The waste acid (mostly spillage, floor drainage and the like) was neutralized with lime or soda ash and discharged to the chemical sewer for treatment and discharge to wastewater lagoons or surface drainage. The yellow water, essentially a dilute nitrator, and the red water were destroyed as previously described.

Dinitrotoluene (DNT), a closely related explosive, can be made in a TNT plant and was produced at the WSOW. No DNT was produced in production lines 1, 2, 3, and 4. Plate 1 shows the location of the process and waste lines as they existed on what is now the WSCP/WSRP. Of the 18 production lines which existed during the peak production period, only lines 1-4 were located in the vicinity of the WSCP/WSRP.

At the time of the closing of the WSOW, all lines, equipment and facilities were reportedly decontaminated to a known condition.

In addition to equipment and building contamination, all earth known to be contaminated around process buildings, catch tanks, and drainage ditches was removed in 1946. The depth of the soil contamination varied from 4 inches to 3 feet, depending on the nature of the soil.

Since the WSOW facilities have been demolished and much process-specific information was destroyed in 1974, a

building-by-building description of the process is not possible. This biased sampling effort is guided by investigations at the WSTA and at other ordnance works facilities (West Virginia, Alabama Army Ammunition Plant).

4.4.2 WSOW Biased Sampling Approach

The biased sampling program for WSOW sources was developed based on WSOW building locations, WSOW topography, current knowledge of WSOW production and waste management practices, and investigations at other ordnance works. Biased sampling locations were targeted towards TNT production areas representing potential source areas. Sampling depths were established using a cut and fill map (Plate 2) to assure that original WSOW topography was sampled. The cut and fill map was prepared by comparing 1954 topography to 1964 topography and contouring the difference in elevation. Cut areas were topographically higher in the WSOW time frame. Fill areas were lower topographically in WSOW days. The accuracy of this map is plus or minus two feet. Sampling locations in fill areas will be sampled to greater depths than cut areas. Analytical parameters were selected based on chemicals used in TNT production which may be present after forty years.

Sampling locations, depths, analytical parameters, and selection rationale for the WSOW biased soil sampling are presented in Table 4-7. Sample locations are shown in Plate 3.

TABLE 4-7

WSOW Biased Soil Sampling Locations

Borehole Number	Coordinates West	Coordinates North	Borehole Depth	Number of Samples	Chemical Analysis*
Wash House Area of TNT Production Line No. 1					
1	49,370	100,740	12	6	A, L, O, P
2	49,425	100,725	14	7	" "
3	49,410	100,758	14	7	" "
4	49,468	100,712	14	7	" "
5	49,475	100,770	14	7	" "
75	49,450	100,870	14	7	" "
Drainage From TNT Production Line No. 1					
6	49,450	100,450	16	8	A, L, O, P
7	49,583	100,650	20	10	" "
8	49,635	100,850	21	11	" "
9	49,625	101,000	12	6	" "
Final Production Area of TNT Line No. 1					
10	50,040	101,285	6	3	A, L, O, P
11	50,055	101,215	6	3	" "
12	50,100	101,240	6	3	" "
13	50,140	101,255	8	4	" "
TNT Production Line No. 2 Acid Recovery Building Drainage					
14	50,550	101,050	14	7	A, L, O, P
15	50,550	101,000	20	10	" "
16	50,550	100,950	22	11	" "
17	50,500	100,950	22	11	" "
18	50,600	100,950	22	11	" "
TNT Production Line No. 2 T-11 Building Area					
19	50,765	100,685	10	5	A, L, O, P
20	50,785	100,685	10	5	" "
Wash House Area of TNT Production Line No. 2					
21	50,760	100,150	12	6	A, L. O, P
22	50,785	100,120	12	6	" "
23	50,800	100,150	12	6	" "
24	50,900	99,985	10	5	" "
25	50,850	100,100	10	5	" "
26	50,850	100,185	12	6	" "
27	50,900	100,250	10	5	" "
TNT Production Line No. 3 T-11 Building Area					
28	51,285	99,990	8	4	A, L, O, P
29	51,400	100,400	10	5	" "
30	51,400	100,450	10	5	" "

* See key for chemical analyses description, page 112.

TABLE 4-7 (cont.)

WSOW Biased Soil Sampling Locations

Borehole Number	Coordinates West	Coordinates North	Borehole Depth	Number of Samples	Chemical Analysis	
Final Production Area of TNT Line No. 2						
31	51,185	100,845	10	5	A, L, O, P	
32	51,220	100,860	10	5	" "	
33	51,250	100,890	10	5	" "	
34	51,280	100,890	10	5	" "	
35	51,320	100,875	10	5	" "	
36	51,365	100,880	10	5	" "	
37	51,400	100,850	10	5	" "	
38	51,430	100,900	8	4	" "	
Final Settling Tank of TNT Production Line No. 3						
39	52,220	100,750	14	7	A, L, O, P	
40	52,200	100,725	14	7	" "	
Drainage From TNT Lines 2 and 3						
41	52,116	100,760	20	10	A, L, O, P	
42	52,123	100,732	20	10	" "	
43	52,135	100,710	20	10	" "	
Wash House Area of TNT Production Line No. 3						
44	51,815	100,360	8	4	A, L, O, P	
45	51,780	100,315	8	4	" "	
46	51,840	100,280	8	4	" "	
47	51,800	100,265	8	4	" "	
48	51,760	100,243	8	4	" "	
TNT Production Line No.4 T-9 Building Area						
49	51,225	98,775	10	5	A, L, O, P	
50	51,200	98,800	8	4	" "	
51	51,225	98,825	8	4	" "	
TNT Production Line No.4 T-10 Building Area						
52	51,642	98,925	8	4	A, L, O, P	
53	51,334	98,945	10	5	" "	
54	51,322	98,950	8	4	" "	
TNT Production Line No.1 T-24 Building Area						
55	51,200	101,500	8	4	A, L, O, P	
56	51,200	101,450	8	4	" "	
Wastewater Line Excavation						
57	51,565	100,850	10	5		*

TABLE 4-7 (cont.)

WSOW Biased Soil Sampling Locations

Borehole Number	Coordinates West	Coordinates North	Borehole Depth	Number of Samples	Chemical Analysis
Burning Grounds Area					
58	52,300	101,400	10	5	A, K, L, O, P *
59	52,350	101,400	10	5	" " *
60	52,400	101,400	10	5	" " *
61	52,250	101,400	10	5	" " *
WSOW Rubble Area					
62	52,900	100,400	10	5	A, K, L, O, P *
63	52,775	100,475	10	5	" " *
Cinder Pile					
64	51,400	100,690	0 to 18"	1	A, K, L, O, P
WSOW Dump Area					
65	51,300	100,850	0 to 12"	1	" "
66	51,275	100,845	0 to 12"	1	" "
67	51,250	100,855	0 to 12"	1	" "
68	51,320	100,850	0 to 12"	1	" "
WSOW Foundation					
69	51,550	100,850	0 to 12"	1	" "
WSOW Foundation					
70	51,700	100,850	0 to 12"	1	" "
WSOW Rubble Pile					
71	51,745	100,925	0 to 12"	1	" "
72	51,770	100,920	0 to 12"	1	" "
WSOW Rubble and Foundation					
73	52,400	100,700	0 to 12"	1	" "
74	52,350	100,700	0 to 12"	1	" "

All surface sampling locations are approximate.
Exact locations will be surveyed prior to sampling.

4.4.2.1 Selection and Number of Locations

Soil sampling locations were selected based on WSOW processes, building locations, and topography. For example, areas producing or transporting wastewater have the highest potential for nitroaromatic contamination. Surface drainageways from production areas carried wastewater (USGS, 1944) and should be sampled. Areas of acid usage increase the potential for metals contamination. The areas to be sampled are presented in Table 4-7. The rationale for sampling each area is detailed in the heading above each group of samples and is followed by specific sample locations, borehole depths, number of samples and chemical analyses. Seventy-five boreholes are proposed for the WSOW biased sampling. In addition, 11 surface soil samples will be collected from six areas.

4.4.2.2 Sampling Depths and Intervals

Borehole depths are presented in Table 4-7. Depths were determined by evaluating past and present topography and assuring that each borehole penetrated WSOW topography. Sampling intervals were selected based on the nature of the soils and the suspected contaminants mobility. The primary WSOW contaminants are nitroaromatics and metals, both of which bind to soil particles. Therefore, samples will be collected continuously and composited over two-foot intervals.

4.4.2.3 Analytical Parameters

Analytical parameters for WSOW biased samples include nitroaromatics, select metals, nitrate, nitrite, sulfate, and pH. The exact parameters are listed in Table 4-7. Exact analytical methods are explained in Section 5.0.

4.5 Unbiased Area Sampling

To date, an extremely limited data base has been developed for chemical characterization and contaminant distribution over the 220-acre WSCP/WSRP site. Therefore, in order to meet the sampling objectives to: (1) determine the extent and magnitude of contamination, (2) document uncontaminated areas and (3) provide representative data for risk assessment preparation, it will be necessary to conduct a statistically designed, unbiased sampling effort. The sample design will provide uniform coverage of the site, complementary to the biased sampling programs discussed in Sections 4.3 and 4.4.

The primary objective of the area sampling is to document areas believed to be uncontaminated. The recorded site history indicates probable areas of contamination, and these areas are addressed in the biased sampling program. However, there remains a significant area previously unaddressed as to its status of contamination. While a very large number of samples would be required to document the absence of contamination at specific

locations over the entire site, a statistically designed sampling approach will provide a method for determining areas free of contamination to a known confidence level.

Establishing background metals and inorganic anion concentrations in native soils are also addressed in this section.

4.5.1 Statistical Sampling Approach

The appropriate number of sample locations for achieving data sufficiency and representation is determined using a statistical approach outlined in "Preparation of Soil Sampling Protocol: Techniques and Strategies" (Mason, 1983).

The approach requires the collection of samples on a regular line transect pattern over the investigation area with randomly selected starting locations. The line transect pattern consists of equilateral triangles laid out to form a hexagon. The size of the hexagon and corresponding side lengths of the equilateral triangle are determined using the following formula where L equals the length of a side of a triangle.

$$A = 2.598(L^2)$$

The area is determined by fitting the site into a square area extending 50 feet beyond the site boundary. The total area of the site using this method is 20,250,000 square feet. This area,

when used in the above formula, results in a sample spacing of 558 feet and a hexagonal side length of 279 feet.

Based on a 95% confidence level and 20% acceptable error margin using the following formula:

$$n = (CR)^2 \ t^2/p^2$$

Where: n = number of samples

cr = coefficient of variation

t = two tailed t value

p = allowable margin of error

The total number of sample locations is determined to be 91. Figure 4-4 shows the example locations determined by the Line Transect A system. In order to plot at least 91 sample locations within the site boundary, two hexagonal grids are placed over the site with randomly selected starting locations for orientation. In some cases, the sample points fall in locations currently unaccessible. These sample locations will be moved off the grid in the direction of the shortest distance from the grid node. For example, sample locations which fall in the region of the raffinate pits have been moved out of the pit to the closest accessible area. In this manner, the number of sample locations will remain at 91 in order to achieve a 95% confidence level.

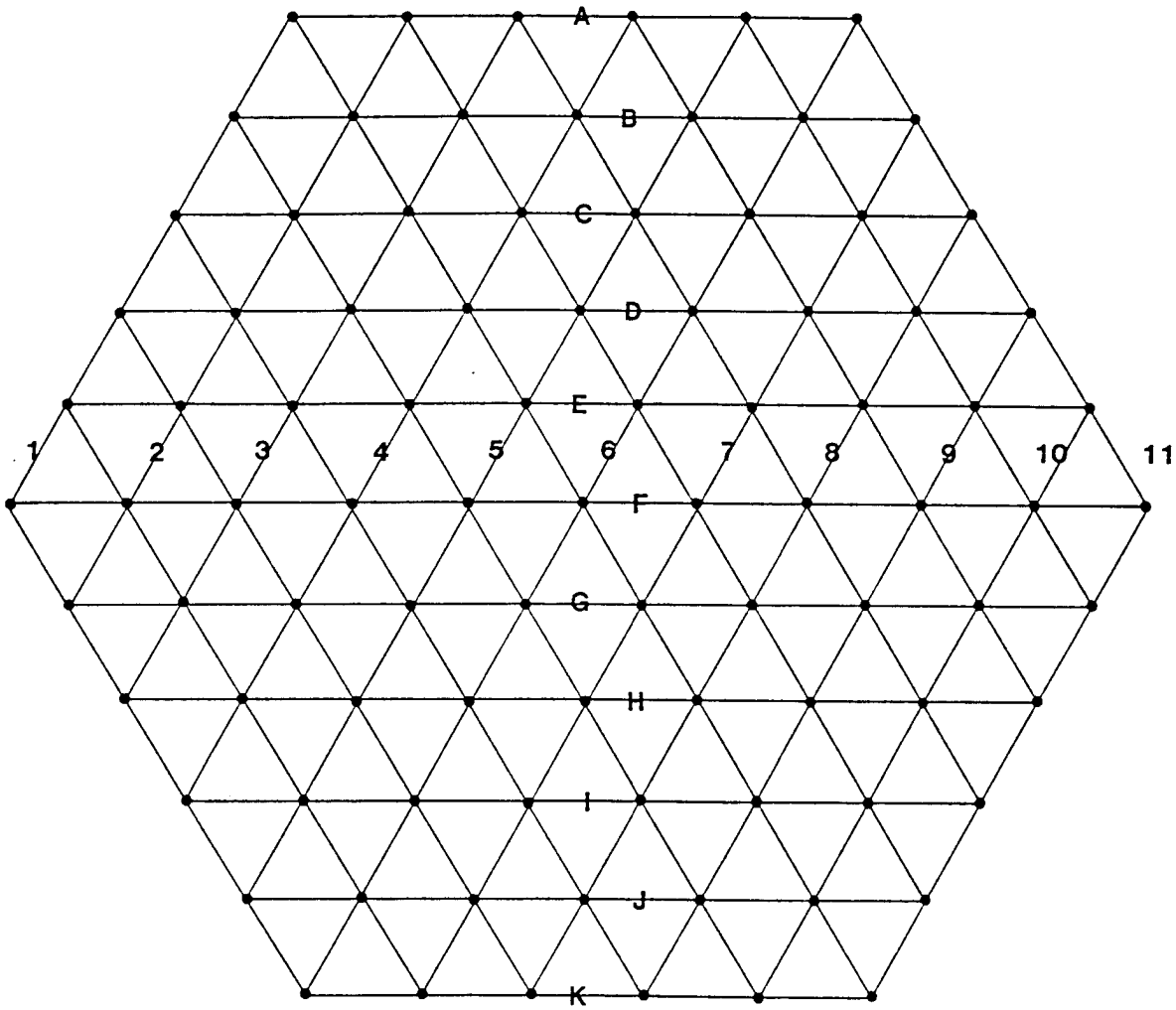

FIGURE 4-4

EXAMPLE LOCATIONS

Figure 4-5 presents an overlay of the two hexagonal grids on the site figure. Figure 4-6 presents the sample locations numbered 1-91.

The overall sampling program, both biased and unbiased, was used to determine the probability of detecting a hotspot of a given size. The formula for determining this probability is:

$$p = n A^1/A$$

n = # of sample locations

A^1 = Area of target

A = Area of study

p = Probability of detection

The total number of sample locations to be used in contamination assessment is 277. There are 245 samples from this work plan and 32 samples from the Phase I Soil Investigation.

The target was assumed to be elliptical in shape with a semimajor axis of 100 feet and a semiminor axis of 50 feet. This target shape was selected based on a point spill or discharge source with overland dispersion. The target size was selected based on the operational life of the WSOW and WSUFMP. Any spills or discharges are assumed to have occurred with enough frequency to

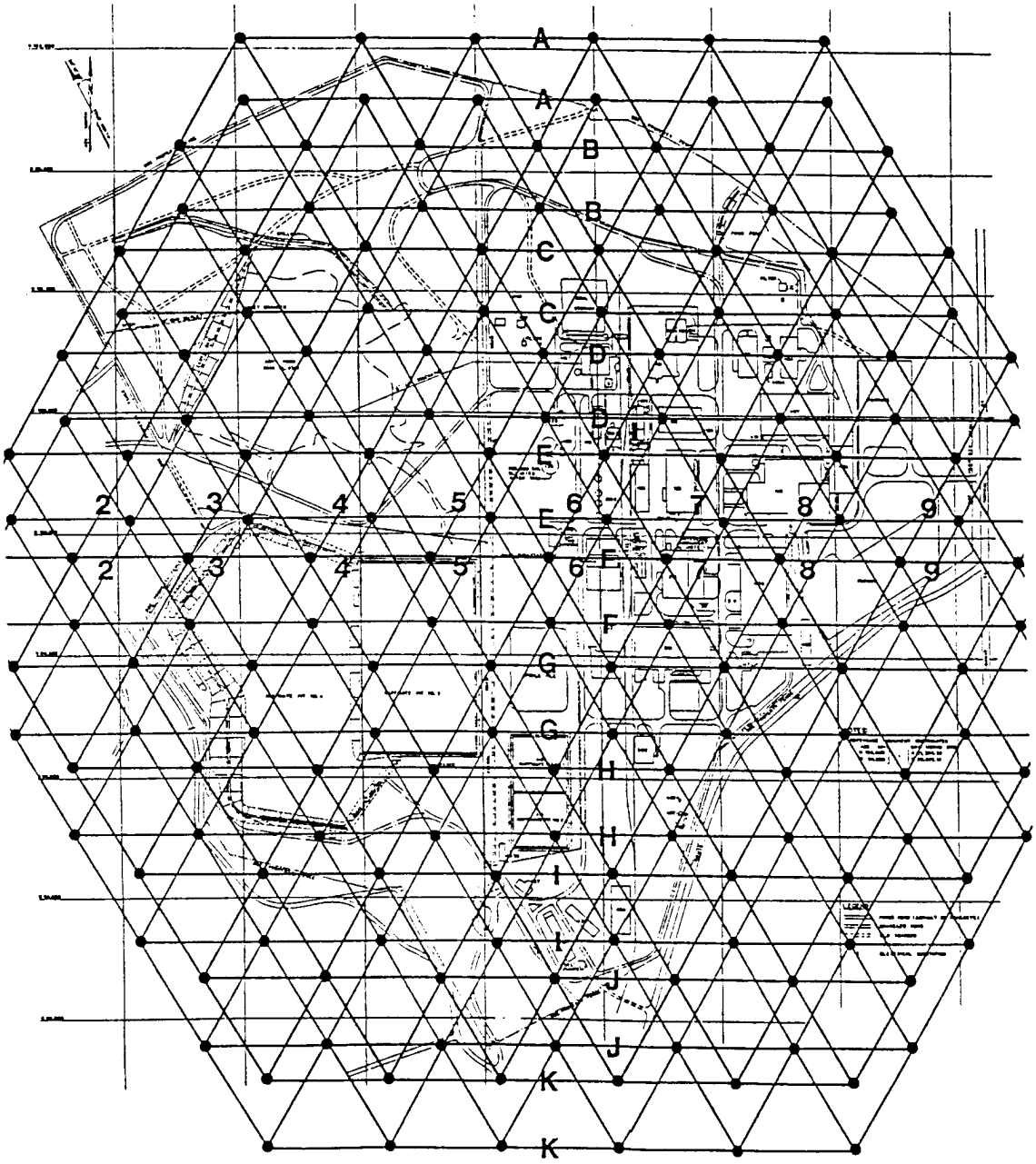

FIGURE 4-5

HEX GRID OVERLAY

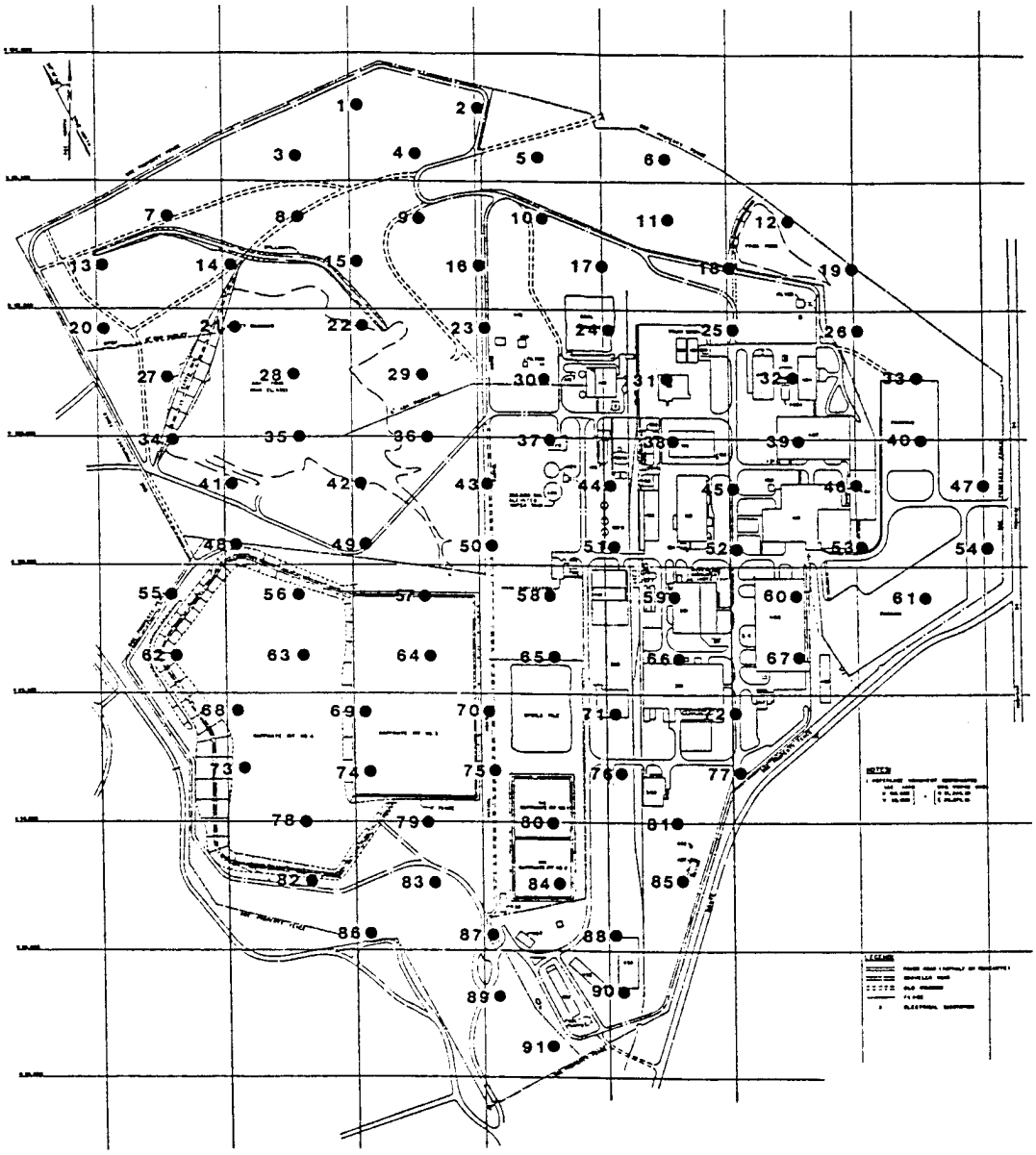

FIGURE 4-6

RANDOM GRID

create an area 200 feet long by 100 feet wide. Using the previously stated equation and assumptions, the probability of detecting elliptical hotspots 200 feet by 100 feet is 45 percent. Changes in target size or shape can affect this probability. However, this target shape and size are realistic, given the known processes and lack of uncontrolled dumping.

4.5.1.1 Sampling Depths and Intervals

Borehole depths were determined by evaluation of the cut and fill topography presented in Plate 2. In order to ensure coverage to the probable extent of vertical migration, borehole depths will be to fifteen feet in cut areas and undisturbed areas. Borehole depths in fill areas will equal the fill depth plus fifteen feet of undisturbed soil. Portions of alternating two-foot intervals will be composited for analyses. For example, the 0-1 interval will be composited with the 2-3, 4-5 and 6-7 foot intervals, and the 8-9 foot interval will be composited with the 10-11, 12-13 and 14-15 foot intervals, resulting in two samples for analysis from 15 feet of sample core. Therefore, a sample will represent 4 one-foot alternating intervals. No more than 4 one-foot intervals will be composited per sample. The composite intervals

were selected to detect large areas of contamination in areas not expected to be contaminated and to keep the number of samples to a manageable number. Detection of contamination under this program may require additional sampling to further define the actual extent. Table 4-8 presents borehole depths, cut and fill depths and sample intervals.

4.5.1.2 Number of Samples

The total number of composite samples is 227. These samples will provide a statistically valid site-wide data base for the contamination assessment.

4.5.1.3 Analytical Parameters

All random samples will be analyzed for a wide range of organic and inorganic constituents in order to provide documentation of previously unsampled areas. The analytical parameters were selected by analyzing and interpreting Phase I soil results (Section 3.1.2) and cut and fill relationships (Plate 2).

The Phase I Soil Investigation established the propensity of nitroaromatics to bind to WSCP/WSRP soil particles as percent

TABLE 4-8

Area Sampling Depth and Intervals

Sample Number	Sample West	Coordinates North	Cut or Fill Depth	Borehole Depth	Number of Samples	Composite Intervals	Soil Chemical Analysis
1	51,500	101,800	0'	15'	2	(0-1, 2-3, 4-5, 6-7) (8-9, 10-11, 12-13, 14-15)	A, B1
2	51,000	101,800	0'	15'	2	" "	A, B1
3	51,750	101,600	0'	15'	2	" "	A, B1
4	51,250	101,600	0'	15'	2	" "	A, B1
5	50,700	101,600	0'	15'	2	" "	A, B1
6	50,200	101,600	2'C	15'	2	" "	A, B1
7	52,300	101,320	6'C	15'	2	" "	A, B1
8	51,750	101,330	0'	15'	2	" "	A, B1
9	51,250	101,300	0'	15'	2	" "	A, B1
10	50,700	101,300	0'	15'	2	" "	A, B1
11	50,250	101,300	2'	15'	2	" "	A, B1
12	49,690	101,250	8'C	15'	2	" "	A, B1
13	52,500	101,150	2'F	17'	3	(0-1, 2-3, 4-5, 6-7) (8-9, 10-11, 12-13, 14-15) (16-17)	A, B2, C1
14	52,000	101,150	2'F	17'	3	" " "	A, B2, C1
15	51,500	101,150	2'F	17'	3	" " "	A, B2, C1
16	51,000	101,150	0'	15'	2	(0-1, 2-3, 4-5, 6-7) (8-9, 10-11, 12-13, 14-15)	A, B1

* Location moved off grid to accessible location

A = 0-1, 2-3, 4-5, 6-7 ANALYZED FOR A, D, F, G, H, L, N, O.

B = 8-9, 10-11, 12-13, 14-15 (-1 IF ANALYZED FOR L, O) (-2 IF ANALYZED FOR A, D, F, G, H, L, N, O)

C = 16-17, 18-19, 20-21, 22-23 DEPENDING ON TOTAL DEPTH (-1 IF ANALYZED FOR L, O) (-2 IF ANALYZED FOR A, D, F, G, H, L, N, O)

D = 24-25, 26-27, 28-29, DEPENDING ON TOTAL DEPTH (-1 IF ANALYZED FOR L, O) (-2 IF ANALYZED FOR A, D, F, G, H, L, N, O)

E = 30-31, 32-33, 34-35, DEPENDING ON TOTAL DEPTH (-1 IF ANALYZED FOR L, O) (-2 IF ANALYZED FOR A, D, F, G, H, L, N, O)

TABLE 4-8

Area Sampling Depth and Intervals

Sample Number	Sample Coordinates West	North	Cut or Fill Depth	Borehole Depth	Number of Samples	Composite Intervals		Soil Chemical Analysis
17	50,500	101,150	10'F	25'	4	+(16-17, 18-19, 20-21, 22-23)	(24-25)	A, B2, C2, D1
18	50,000	101,150	4'C	15'	2	"	"	A, B1
19	49,500	101,150	2'C	15'	2	"	"	A, B1
20	52,500	101,900	6'F	21'	3	"	"	A, B2, C1
21	52,000	100,900	4'F	19'	3	"	"	A, B2, C1
22	51,500	100,900	0'	15'	2	"	"	A, B1
23	51,000	100,900	0'	15'	2	"	"	A, B1
24	50,500	100,900	14'F	29'	4	+(26-27, 28-29)		A, B2, C2, D1
25	50,000	100,900	0'	15'	2	"	"	A, B1
26	49,500	100,900	4'F	19'	3	"	"	A, B2, C1
27	52,250	100,725	6'F	21'	3	"	"	A, B2, C1
28	51,780	100,750	2'F	17'	3	"	"	A, B2, C1
29	51,280	100,750	2'F	17'	3	"	"	A, B2, C1
30	50,750	100,700	2'C	15'	2	"	"	A, B1
31	50,280	100,750	2'F	17'	3	"	"	A, B2, C1

* Location moved off grid to accessible location

A = 0-1, 2-3, 4-5, 6-7 ANALYZED FOR A, D, F, G, H, L, N, O.

B = 8-9, 10-11, 12-13, 14-15 (-1 IF ANALYZED FOR L, O) (-2 IF ANALYZED FOR A, D, F, G, H, L, N, O)

C = 16-17, 18-19, 20-21, 22-23 DEPENDING ON TOTAL DEPTH (-1 IF ANALYZED FOR L, O) (-2 IF ANALYZED FOR A, D, F, G, H, L, N, O)

D = 24-25, 26-27, 28-29, DEPENDING ON TOTAL DEPTH (-1 IF ANALYZED FOR L, O) (-2 IF ANALYZED FOR A, D, F, G, H, L, N, O)

E = 30-31, 32-33, 34-35, DEPENDING ON TOTAL DEPTH (-1 IF ANALYZED FOR L, O) (-2 IF ANALYZED FOR A, D, F, G, H, L, N, O)

TABLE 4-8

Area Sampling Depth and Intervals

Sample Number	Sample West	Coordinates North	Cut or Fill Depth	Borehole Depth	Number of Samples	Composite Intervals		Soil Chemical Analysis
32	49,780	100,730	6'F	21'	3	"	"	A, B2, C1
33	49,310	100,740	4'F	19'	3	"	"	A, B2, C1
34	52,240	100,440	2'F	17'	3	"	"	A, B2, C1
35	51,770	100,430	2'F	17'	3	"	"	A, B2, C1
36	51,230	100,420	0'	15'	2	"	"	A, B1
37	51,730	100,420	2'C	15'	2	"	"	A, B1
38	50,220	100,420	2'C	15'	2	"	"	A, B1
39	49,740	100,420	8'F	23'	3	"	"	A, B2, C1
40	49,270	100,420	4'C	15'	2	"	"	A, B1
41	52,010	100,320	2'F	17'	3	"	"	A, B2, C1
42	51,500	100,340	2'C	15'	2	"	"	A, B1
43	50,970	100,330	2'C	15'	2	"	"	A, B1
44	50,500	100,330	4'C	15'	2	"	"	A, B1
45	50,000	100,330	2'F	17'	3	"	"	A, B2, C1
46	49,520	100,330	4'F	19'	3	"	"	A, B2, C1
47	49,000	100,330	6'C	15'	2	"	"	A, B1

* Location moved off grid to accessible location

A = 0-1, 2-3, 4-5, 6-7 ANALYZED FOR A, D, F, G, H, L, N, O.

B = 8-9, 10-11, 12-13, 14-15 (-1 IF ANALYZED FOR L, O) (-2 IF ANALYZED FOR A, D, F, G, H, L, N, O)

C = 16-17, 18-19, 20-21, 22-23 DEPENDING ON TOTAL DEPTH (-1 IF ANALYZED FOR L, O) (-2 IF ANALYZED FOR A, D, F, G, H, L, N, O)

D = 24-25, 26-27, 28-29, DEPENDING ON TOTAL DEPTH (-1 IF ANALYZED FOR L, O) (-2 IF ANALYZED FOR A, D, F, G, H, L, N, O)

E = 30-31, 32-33, 34-35, DEPENDING ON TOTAL DEPTH (-1 IF ANALYZED FOR L, O) (-2 IF ANALYZED FOR A, D, F, G, H, L, N, O)

TABLE 4-8

Area Sampling Depth and Intervals

Sample Number	Sample West	Coordinates North	Cut or Fill Depth	Borehole Depth	Number of Samples	Composite Intervals	Soil Chemical Analysis
48	51,970	100,080	2'F	17'	3	" "	A, B2, C1
49	51,500	100,020	2'F	17'	3	" "	A, B2, C1
50	51,000	100,020	2'F	17'	3	" "	A, B2, C1
51	50,500	100,020	0'	15'	2	" "	A, B1
52	50,000	100,020	2'F	17'	3	" "	A, B2, C1
53	49,500	100,020	0'	15'	2	" "	A, B1
54	49,000	100,010	6'C	15'	2	" "	A, B1
55	42,240	99,830	0'	15'	2	" "	A, B1
*56	51,700	100,000	0'	15'	2	" "	A, B1
*57	51,250	99,950	20'F	35'	5	+(30-31, 32-33, 34-35)	A, B2, C2, D2, E1
58	50,750	99,850	0'	15'	2	" "	A, B1
59	50,250	99,850	4'C	15'	2	" "	A, B1
60	49,750	99,900	4'C	15'	2	" "	A, B1

* Location moved off grid to accessible location

A = 0-1, 2-3, 4-5, 6-7 ANALYZED FOR A, D, F, G, H, L, N, O.

B = 8-9, 10-11, 12-13, 14-15 (-1 IF ANALYZED FOR L, O) (-2 IF ANALYZED FOR A, D, F, G, H, L, N, O)

C = 16-17, 18-19, 20-21, 22-23 DEPENDING ON TOTAL DEPTH (-1 IF ANALYZED FOR L, O) (-2 IF ANALYZED FOR A, D, F, G, H, L, N, O)

D = 24-25, 26-27, 28-29, DEPENDING ON TOTAL DEPTH (-1 IF ANALYZED FOR L, O) (-2 IF ANALYZED FOR A, D, F, G, H, L, N, O)

E = 30-31, 32-33, 34-35, DEPENDING ON TOTAL DEPTH (-1 IF ANALYZED FOR L, O) (-2 IF ANALYZED FOR A, D, F, G, H, L, N, O)

TABLE 4-8

Area Sampling Depth and Intervals

Sample Number	Sample West	Coordinates North	Cut or Fill Depth	Borehole Depth	Number of Samples	Composite Intervals		Soil Chemical Analysis
61	49,250	99,900	4'C	15'	2	"	"	A, B1
*62	52,350	99,660	0'	15'	2	"	"	A, B1
*63	51,800	100,000	0'	15'	2	"	"	A, B1
*64	51,000	99,650	18'F	33'	5	"	"	A, B2, C2, D2, E1
65	50,710	99,650	2'F	17'	3	"	"	A, B2, C1
66	50,240	99,650	4'C	15'	2	"	"	A, B1
67	49,720	99,650	0'	15'	2	"	"	A, B1
*68	52,200	99,410	0'	15'	2	"	"	A, B1
*69	51,000	99,000	2'F	17'	3	"	"	A, B2, C1
70	51,000	99,430	2'F	17'	3	"	"	A, B2, C1
71	50,510	99,430	4'F	19'	3	"	"	A, B2, C1
72	50,010	99,430	0'	15'	2	"	"	A, B1
*73	52,150	99,150	0'	15'	2	"	"	A, B1
*74	51,450	98,850	2'F	17'	3	"	"	A, B2, C1
75	50,980	99,180	2'F	17'	3	"	"	A, B2, C1
76	50,480	99,180	2'F	17'	3	"	"	A, B2, C1

* Location moved off grid to accessible location

A = 0-1, 2-3, 4-5, 6-7 ANALYZED FOR A, D, F, G, H, L, N, O.

B = 8-9, 10-11, 12-13, 14-15 (-1 IF ANALYZED FOR L, O) (-2 IF ANALYZED FOR A, D, F, G, H, L, N, O)

C = 16-17, 18-19, 20-21, 22-23 DEPENDING ON TOTAL DEPTH (-1 IF ANALYZED FOR L, O) (-2 IF ANALYZED FOR A, D, F, G, H, L, N, O)

D = 24-25, 26-27, 28-29, DEPENDING ON TOTAL DEPTH (-1 IF ANALYZED FOR L, O) (-2 IF ANALYZED FOR A, D, F, G, H, L, N, O)

E = 30-31, 32-33, 34-35, DEPENDING ON TOTAL DEPTH (-1 IF ANALYZED FOR L, O) (-2 IF ANALYZED FOR A, D, F, G, H, L, N, O)

TABLE 4-8

Area Sampling Depth and Intervals

Sample Number	Sample West	Coordinates North	Cut or Fill Depth	Borehole Depth	Number of Samples	Composite Intervals		Soil Chemical Analysis
77	50,000	99,200	2'C	15'	2	"	"	A, B1
*78	52,180	99,000	2'F	17'	3	"	"	A, B2, C1
79	51,350	99,000	2'F	17'	3	"	"	A, B2, C1
*80	50,550	99,000	2'F	17'	3	"	"	A, B2, C1
81	50,250	99,000	0'	15'	2	"	"	A, B1
82	51,720	98,780	2'F	17'	3	"	"	A, B2, C1
83	51,300	98,790	2'F	17'	3	"	"	A, B2, C1
*84	50,550	98,790	2'F	17'	3	"	"	A, B2, C1
85	50,250	98,750	0'	15'	2	"	"	A, B1
86	51,500	98,550	0'	15'	2	"	"	A, B1
87	51,040	98,550	0'	15'	2	"	"	A, B1
88	50,500	98,550	0'	15'	2	"	"	A, B1
89	50,950	98,300	0'	15'	2	"	"	A, B1
90	50,500	98,350	0'	15'	2	"	"	A, B1
91	50,800	98,150	0'	15'	2	"	"	A, B1

* Location moved off grid to accessible location

A = 0-1, 2-3, 4-5, 6-7 ANALYZED FOR A, D, F, G, H, L, N, O.

B = 8-9, 10-11, 12-13, 14-15 (-1 IF ANALYZED FOR L, O) (-2 IF ANALYZED FOR A, D, F, G, H, L, N, O)

C = 16-17, 18-19, 20-21, 22-23 DEPENDING ON TOTAL DEPTH (-1 IF ANALYZED FOR L, O) (-2 IF ANALYZED FOR A, D, F, G, H, L, N, O)

D = 24-25, 26-27, 28-29, DEPENDING ON TOTAL DEPTH (-1 IF ANALYZED FOR L, O) (-2 IF ANALYZED FOR A, D, F, G, H, L, N, O)

E = 30-31, 32-33, 34-35, DEPENDING ON TOTAL DEPTH (-1 IF ANALYZED FOR L, O) (-2 IF ANALYZED FOR A, D, F, G, H, L, N, O)

levels of nitroaromatics in the old waste lagoon decreased below detectable levels in approximately eight feet. This tendency may be viewed as "worst case" since the waste lagoon contained water acting as a driving hydraulic head for several years and still retains water. As a result of this analysis, the lowest composite sample from each random sample location will not be analyzed for nitroaromatics. Undisturbed and cut areas will have one composite sample analyzed for nitroaromatics, while fill areas will have at least two (depending on fill thickness) composite samples analyzed for nitroaromatics. Since the processes and potential contaminants from the WSOW and WSUFMP are known, it is not necessary for all random samples to be analyzed for the complete Hazardous Substances List (HSL). Very limited numbers of volatile and semivolatile organic compounds were used in TNT and uranium production. Any organic contamination outside of production areas should be minor in nature. Therefore, only the upper composite samples at each location will be analyzed for the complete HSL. Locations in cut or undisturbed areas will have one sample analyzed for the complete HSL, while fill areas will have at least two (depending on fill thickness) samples submitted for complete HSL analyses, so that one composite sample for HSL compounds will be representative of the original surface material. The Phase I Water Quality Assessment documented the absence of organic compounds in the groundwater, further indicating the lack of significant vertical migration of organic soil contaminants.

All random samples will be analyzed for WSSRAP indicator parameters which include nitrate, nitrite, sulfate, fluoride, soil pH, and percent moisture. These indicator parameters, coupled with the nitroaromatic and HSL analyses, will allow interpretation of all random sample data.

4.5.2 Background Samples

Background samples will be collected from an uncontaminated area within 5 miles of the site, and will be equal to 20% of the number of random samples. The area selected for background samples need not be upwind since significant wind transport is not expected from WSOW or WSUFMP processes. These samples will be analyzed for selected metals (aluminum, antimony, barium, iron, lead, magnesium, manganese, nickel, vanadium, and zinc) and inorganic anions and will be used to establish an environmental baseline data set for contamination assessment. These background samples will allow a valid assessment of calculated background values for on-site metal concentrations. Due to the widespread use of nitric and sulfuric acid in WSOW production, the potential exists for broad areas to be affected by these chemicals. Therefore, background samples for inorganic anions must be collected off-site in an area unaffected by WSOW or WSUFMP processes. Figure 4-7 shows the location of the background samples in relation to the WSCP. Two samples will be collected from each of 25 boreholes spaced according to the previously defined grid. Samples will be composited in the same manner as random samples. According to the St. Charles County Soil

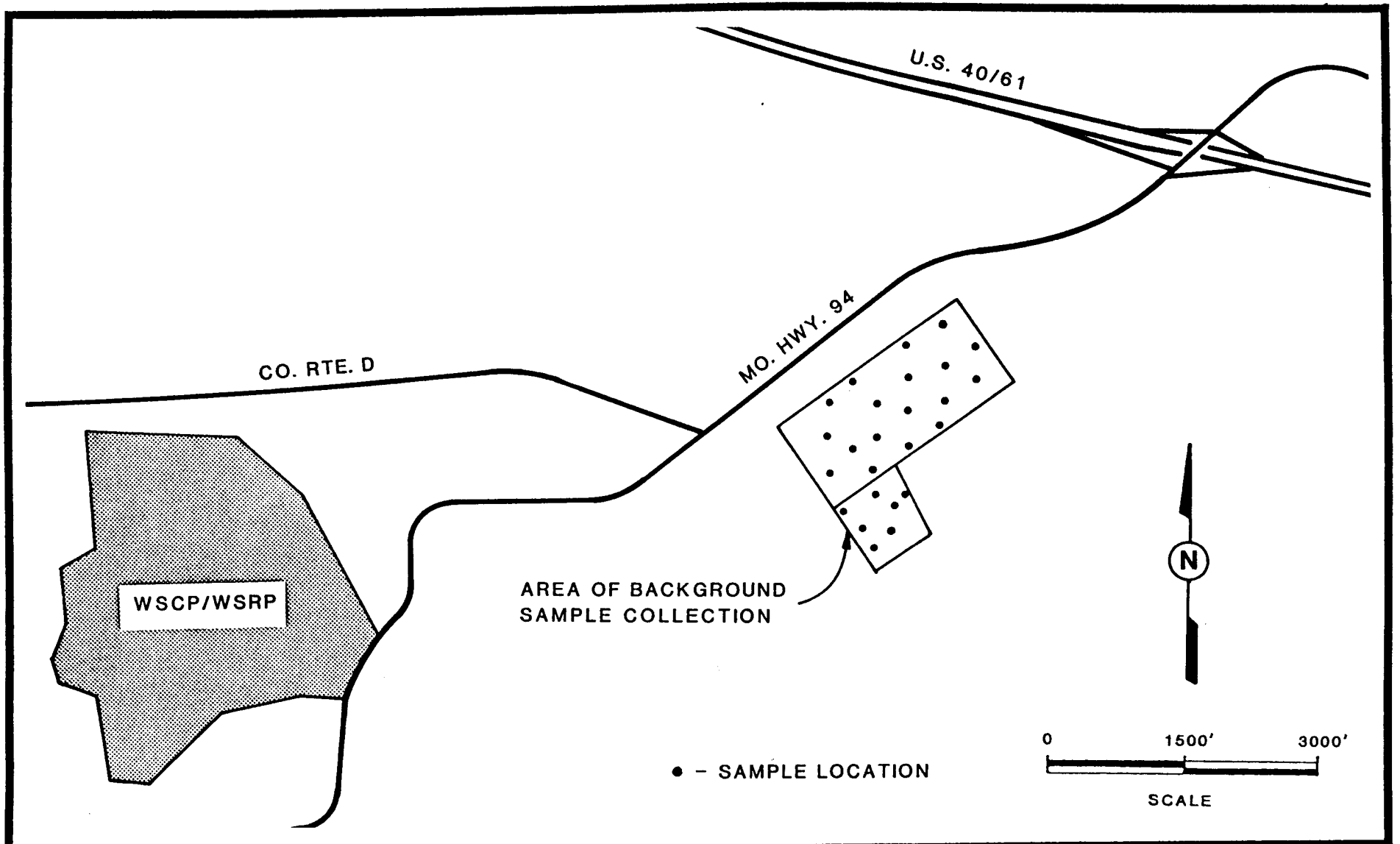

FIGURE 4-7

BACKGROUND SOIL SAMPLE LOCATIONS

Conservation Service Soil Survey, this area exhibits the same soil association (Armster-Mexico-Hatten Assoc.) and vegetative cover native to the WSCP/WSRP area. The area is also located near the Missouri-Mississippi River surface divide and is unaffected by surface drainage from the WSUFMP and WSOW areas.

4.6 Sampling Procedures

4.6.1 Sample Collection

Soil samples will be collected by continuous coring to the desired depth, using hollow stem augers and continuous sampling equipment capable of obtaining a 2 inch diameter by 60 inch long continuous sample. The sampling device will advance with the augers, and is divided longitidinally to facilitate sample removal. This type of sampling equipment has been sucessfully used on WSS soils in previous investigations, and provides sufficient sample for all required analyses and allows thorough geologic logging. Split spoons will be used if samples are not properly retained.

Actual sample collection will be performed using stainless steel spatulas to collect the samples from the desired intervals. Composites will be mixed in a stainless steel pan prior to filling sample containers. Compositing will be performed by mixing visually equal aliquots. All sample collection and compositing will be performed in areas protected from direct

sunlight. All drill cuttings will be collected and stored on-site in the Ash Pond Area.

4.6.2 Radiological Screening of Samples

Continuous monitoring for radiological contamination will be performed during all drilling and sampling activities conducted within areas known or suspected to be radiologically contaminated. A G-M probe will be placed immediately over exposed surface and subsurface samples. Samples which exceed a count rate of 700 cpm will be considered radiologically contaminated and will be handled according to WSSRAP Standard Operating Procedures 2.05.01, Radiation Soil Sampling.

4.6.3 Sample Preservation

Soil samples will be preserved by cooling to $4^{o}C$ as soon as possible after collection and compositing, and will be maintained at $4^{o}C$ during shipment to the laboratory. All samples will be collected in glass jars with polytetrafluorethylene (TFE) lined lids.

Chain-of-custody documentation will be maintained from the time of collection until the samples are delivered to the laboratory according to approved WSSRAP procedures.

4.6.4 Field Equipment Decontamination

The following decontamination efforts will be used to clean sampling equipment and prevent cross-contamination during sample collection and compositing.

All sampling tools will be decontaminated between samples according to the following decontamination procedure:

1. Steam clean
2. Deionized water rinse
3. Toluene Rinse
4. Double Hexane Rinse
5. Air dry

All rinse solvents will be collected and disposed of properly. In addition, where possible, sampling equipment will be stored in plastic containers or precleaned aluminum foil.

Auger flights, drill rigs, drill rods and samplers will be cleaned by steam cleaning on the decontamination pad. This pad allows the whole rig to be cleaned and the wash-water collected for proper management. All augers, samplers and drill rods will be steam cleaned between boreholes. Samplers will be steam cleaned between samples and subjected to the previous described solvent rinse procedure.

All wastewater, waste solvents, and soiled cleaning materials used for decontamination will be collected for proper treatment or disposal.

4.6.5 Borehole Grouting

After completing each borehole and removal of drilling equipment, the boreholes will be completely backfilled with a Bentonite-cement grout which will remain plastic and provide a flexible seal for each boring. This grouting program will maintain the integrity of WSCP/WSRP soils for potential long term disposal. Moisture content of the existing soils will prevent dessication of grout seals. Drill cuttings will be removed from the sampling location and placed in the Ash Pond area. Ultimate disposal must await completion of characterization activities.

5.0 ANALYTICAL PROCEDURES

Appendix B of the WSSRAP Quality Assurance Program Plan (QAPP) outlines all analytical methodologies and detection limits for the analytical parameters addressed in this work plan. A general discussion of the methodologies for organics, inorganics, and nitroaromatics is given in the following sections.

5.1 Organics

Selected soil samples will be analyzed for organic compounds as detailed in "Attachment A, USEPA Contract Laboratory Program Statement of Work for Organic Analysis," October 1986. These analyses include: volatiles, semi-volatiles (including acid and base neutral fractions), pesticides, and PCBs. These analyses will be performed in accordance with the analytical procedures described in the above referenced Scope of Work (SOW). Detection limits are also listed in the above referenced document. Analytical data will be validated as described in the QAPP. Nitroaromatics will be discussed separately.

5.2 Inorganics

Soil samples will be analyzed for several inorganic compounds including metals, nitrate, nitrite, sulfate, chloride, fluoride and pH. Those analyses included in the SOW for inorganic analysis under the USEPA Contract Laboratory Program (CLP) will

be analyzed according to the CLP-required procedures. CLP-required detection limits will also be met. Nitrate, nitrite, sulfate, chloride, and fluoride analyses will be performed according to EPA method 300.0. Soil pH will be determined according to EPA method 9045.

5.3 Nitroaromatics

All nitroaromatic analyses will be performed according to USATHAMA methodology. Analysis will be performed by High Pressure Liquid Chromatography (HPLC). USATHAMA-required standards of precision and accuracy will be met. Approximate detection limits are listed below.

Compound	Approximate Detection Limit
TNT	1 mg/Kg
2,4 -DNT	1 mg/Kg
2,6 -DNT	1 mg/Kg

In the event that high percent-levels of nitroaromatics are detected, soil samples will be submitted for the characteristic of reactivity testing as defined in 40 CFR 261, subpart C to determine explosive stability.

All analytical data will be validated as described in the QAPP.

All primary analyses will be performed by metaTRACE, Inc. of St. Louis, Missouri. Replicate samples will be submitted to JTC Associates of Rockville, Maryland. All sample containers and field blanks will be prepared by the laboratories.

5.4 Sample Containers

Soil samples will be placed in appropriate sample containers. All soil samples, with the exception of volatile organics, will be placed in amber glass jars with TFE-lined caps. Volatile organic samples will be placed in 40-milliliter glass jars with TFE-lined caps.

6.0 QUALITY ASSURANCE

The purpose of the soil sampling quality assurance (QA) procedures is to ensure that the data collected are of known and sufficient quality to assess contamination at the site both qualitatively and quantitatively. Soil sample quality and representativeness will be maintained by the quality assurance measures and samples described in this section. Further description of the overall site characterization quality assurance program is addressed in the QAPP.

QA samples will be collected to assess analytical and sampling variability, to determine the effects of compositing on samples, to demonstrate the effectiveness of decontamination procedures and to assure that samples are not contaminated during shipment to the laboratory. Laboratory data will be validated according to the procedures outlined in the QAPP. Precision, accuracy and representativeness will be determined as outlined in the QAPP.

QA samples will be collected throughout soil investigations at the WSS. Duplicate and replicate samples, field handling blanks and field blanks will be collected to assess sample quality and representativeness during each step of the sampling process. Each QA sample type will be discussed in detail in the following sections.

6.1 Duplicate Samples

Duplicate samples will be collected at the same time, in the same way, and contained, preserved, and transported in the same manner as the original sample. Duplicate samples will be used to verify the reproducibility and precision of the data. All duplicate samples will be submitted as blind duplicates.

All sample locations will require a 1 in 20 duplication for data validation.

6.2 Field Blanks

Field blanks of a known soil composition will be handled in the same manner as the sample and subsequently analyzed to identify possible sources of contamination during collection, preservation, handling and transport. One field blank per sampling team, per day will be prepared in advance of the sampling event. Field blanks will be used to determine analytical accuracy.

6.3 Triplicate Samples

Triplicate samples provide a measure of precision and representativeness of a single sample which tests the homogeneity of the sample. Five percent of all samples will be split into duplicate samples to provide blind duplicates for the analytical laboratory and a third replicate for the referee (JTC) laboratory to determine interlab precision. The use of a referee (JTC) laboratory aids in determining the reliability of the data by detecting bias in the analysis.

6.4 Matrix Spikes, Matrix Spike Duplicates, Spikes and Duplicates

The laboratory is required to perform quality assurance analyses to evaluate analytical method performance. Matrix spikes (MS) and matrix spike duplicates (MSD) are required for organic analyses at a 1 in 20 frequency. Spikes and duplicates are required for all inorganic and nitroaromatic analyses at the same 1 in 20 frequency. These samples will assess laboratory and method performance.

7.0 DATA DOCUMENTATION

This section discusses the documentation procedures to be followed during site sampling and include: log book entry, sample identification, and chain-of-custody procedures.

7.1 Log Books

All field measurements will be recorded in project log books. All data will be recorded directly and legibly in field log books with entries signed and dated. Any entries to be changed will be changed so as to not obscure the original entry. The reason for the change will be stated and the change and explanation will be signed and identified at the time the change is made.

Specific log book entries will be made during soil boring operations.

The log books will be of bound waterproof paper and will be completed using waterproof ink or marker. The book will contain a listing of all personnel at the sampling location and their affiliation, the time of arrival and departure from the site and each sampling location, personnel risiting and/or inspecting and/or auditing the sampling crews, accidents, unusual occurrences or observation, variations from specifications and the contractor's representative authorizing the variations, weather conditions, readings on evironmental monitoring and other

relevant equipment information necessary to allow a re-creation of events. The recorded information will serve as a permanant record of field activities and will serve as a reference resource for evaluating observed data anomalies which may be attributed to weather conditions or field procedures.

In addition to log book entries, specific technical information will be recorded on borehole logging form ENP 7-1. Information to be recorded on the borehole logging form includes:

- Date
- Location number
- Coordinates
- Description of location
- Elevation
- Depth
- Geologic description of soil

Soil descriptions will be done in accordance with the Unified Soil Classification System as described in ASTM D2487-69 (1975), test method for classification of soils for engineering purposes.

The borehole log entries will be made by a geologist with a minimum of a 4 year degree in Geology or Geological Engineering and recent relevant experience in preparing lithologic logs in unconsolidated materials.

7.2 Sample Identification

Field samples will be identified with appropriate sample labels which include: date, time, location number, preservation method, and requested analyses. Sample location numbers will be labeled according to the WSSRAP Standard Operating Procedure (SOP) 4.01.01 (Appendix A - QAPP).

7.3 Chain of Custody

Established Chain-of-Custody (COC) procedures will be followed to document sample possession and to verify that the samples are not tampered with or altered prior to analysis. The WSSRAP COC procedure provides an accurate written record of each sample from the time of collection through analysis and allows the results of the analysis to be used as evidence. COC will be maintained according to WSSRAP SOP Number 4.01.02 (Appendix A - QAPP).

The COC record form (4.01.02) will accompany a sample or group of samples as custody of the sample(s) is transferred from the original custodian to subsequent custodians. Copies of all COC forms will be maintained in project files at the weldon spring site.

7.4 Packaging and Shipping

Samples will be packaged for shipment to the laboratory as specified in WSSRAP SOP 4.01.04 (Appendix A - QAPP).

COC will be maintained throughout shipment to a laboratory or storage. Completed COC forms will be sealed inside transporting containers, a copy of which will be filed in the WSSRAP filing system. Copies of COC forms returned from laboratories will be included in this file. The lab copy will assure that the samples arrived intact.

Laboratories receiving samples will be notified prior to shipping and instructed to notify the shipper in the event that samples are damaged or missing.

All applicable Department of Transportation regulations will be followed during sample shipment.

7.5 Reporting

Completed COC records will be filed in the WSSRAP project filing system and the Environmental Safety and Health (ES&H) files. Copies of the COC forms returned from laboratories will also be filed in the ES&H file. Any problems or variances to the approved COC procedures will be recorded in the file and reported to the Quality Assurance Manager.

8.0 REPORTING REQUIREMENTS

Upon completion of the soil sampling and laboratory analysis program, a comprehensive data review will be performed in preparation of a chemical contaminant preliminary data report. The preliminary data report will present raw data only and will not include a contamination assessment. The data report will compare the data against the field blanks to detect contamination from sampling, compare field sampling replicates, review laboratory quality control, delineate unusable data and attach appropriate qualifiers to usable data. The data report will also explain the limitations of qualified data and summarize detection limits for non-detectable results.

Following the completion of the data report, a contamination assessment report will be prepared in support of the overall site characterization report. Specifically, the report will assess contamination by considering the quantities and types of contaminants at and around the site and transport mechanisms that are allowing or may allow migration of contaminants from the site. The contamination assessment report will include a summary of findings most relevant to the objectives of the site characterization and to the evaluation of remedial action alternatives.

9.0 REFERENCES

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200 0 200 400

SCALE FEET

MKE DOCUMENT NO. 5121-C:DW-D-01-0278-A

U. S. DEPARTMENT OF ENERGY

OAK RIDGE, TENNESSEE

DESIGNED	DRAWN
CHECKED	
INSPECTED	
RECOMMENDED	

CHEMICAL PLANT CONSTRUCTION DRAWINGS

PLATE 1

1943 WELDON SPRING ORDNANCE WORKS

APPROVED	DATE	CHIEF ENG./QA MGR.	DATE	PMC ENG'G. MGR.	DATE	DOE PROJ. ENG.	DATE

MORRISON-KNUDSEN ENGINEERS, INC.
A MORRISON-KNUDSEN COMPANY
WSSRA PROJECT
180 HOWARD ST. SAN FRANCISCO, CA 94105

PROJECT NO. DE-AC05-86OR21548

DRAWING NO. 5121E-CP-501

3-9-87

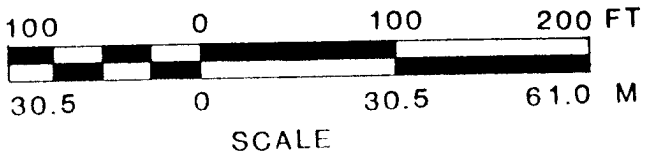
A E	ENG'G MGR.	QA MK-F	DOE APP.

106
● 0.0

Borehole location, number and depth of contamination (feet)

654
○ 0.0

Surface soil sample location, number and depth of contamination (feet)



98000

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PLATE 2

SITE SOIL ZONES WITH GREATER THAN

15 pCi/g U-238, 5 pCi/g RA-226, 5-pCi/g TH-230