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WORK PLAN FOR CONDUCTING THE SITEWIDE REMEDIAL INVESTIGATION AND FEASIBILITY STUDY OF THE FEED MATERIALS PRODUCTION CENTER, FERNALD, OHIO JANUARY 1988

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Prepared For:

U.S. DEPARTMENT OF ENERGY
OAK RIDGE OPERATIONS

~~December 1986~~
January 1988

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SECTION 1.0

INTRODUCTION

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1.1 FEED MATERIALS PRODUCTION CENTER (FMPC) PROJECT SETTING

The FMPC is located on a 1050-acre site in a rural agricultural area about 20 miles northwest of downtown Cincinnati, Ohio in portions of Hamilton County and southern Butler County (Figure 1.1). The villages of Fernald, Ross, and Shandon are within a few miles of the site. The production facilities are oriented in a north/south direction and occupy about 136 acres in roughly the center of the site. Topographically,the facilities rest on a relatively level plain at about 580 feet above sea level. The main drainage channel for the western portion of the site is Paddy's Run, a tributary of the Great Miami River. Paddy's Run originates just north of the FMPC and flows south, and for a part of the year it is a dry stream bed with occasional flows. Drainage from the eastern portion of the site is to the Greater Miami River which is about three-quarters of a mile to the east. Vegetative cover of the site area includes deciduous forests, grasslands and cropland. Surrounding land use includes several residence and small industries, however, the major economic activities in the area are farming and dairy operations. Major farm crops include sweet corn, field corn, soybeans, wheat, and garden produce sold at local and nearby urban markets.

1.2 FMPC OPERATIONS

The Feed Materials Production Center (FMPC) is a government-owned, contract-operated federal facility for the production of pure uranium metals for the United States Department of Energy (DOE). The principal current operations consist of metal fabrication and the processing of accumulated plant residues and miscellaneous feed materials obtained from other DOE sites. A small amount of thorium processing has also been conducted in the past.

As a result of the activities conducted at the facility, both radioactive and non-radioactive wastes are generated. Up to 1984 disposal of solids and slurried wastes at the FMPC occurred in on-site pits and silos. Currently, wastes are drummed and stored for offsite disposal. In addition, thorium is stored on site.

Liquid effluent and airborne discharges are generated as a result of plant operations. Slightly radioactive particulates generated by manufacturing processes at the FMPC are ventilated through highly efficient bag-type dust collectors. General operations, however, including collector failures, have resulted in releases of uranium to the atmosphere since 1952. Liquid effluent from the production process is sent to a general plant sump for

treatment prior to release to the Great Miami River. Untreated stormwater run-off from the process areas is also routinely discharged to the Great Miami River and excess storm flows are periodically discharged to Paddy's Run Creek. Due to the porous nature of the underlying sand and gravel aquifer, there is a potential for uranium to migrate into the groundwater. The above-background levels of uranium detected in three off-site wells may be attributed to this.

1.3 FEDERAL FACILITY COMPLIANCE AGREEMENT (FFCA) AND RI/FS

On March 9, 1985, EPA issued a Notice of Noncompliance letter to DOE identifying the Agency's major concerns over potential environmental impacts associated with the FMPC's past and present operations. Between April, 1985, and July, 1986, conferences were held between the DOE and EPA representatives to discuss the issues and what steps DOE proposed to take to achieve and maintain compliance.

On July 18, 1986, a Federal Facility Compliance Agreement (FFCA) was jointly signed by DOE and EPA pertaining to environmental impacts associated with the FMPC. The FFCA was entered into pursuant to Executive Order 12088 (42CFR 47707) to ensure compliance with existing environmental statutes and implementing regulations. In particular, the FFCA is intended to ensure that environmental impacts associated with past and present activities at the FMPC is thoroughly and adequately investigated so that appropriate remedial response actions can be formulated, assessed, and implemented. Therefore, a sitewide RI/FS will be conducted pursuant to Section 106 of CERCLA and in conformance with the EPA "Guidance on Remedial Investigations Under CERCLA" and the EPA "Guidance on Feasibility Studies Under CERCLA". The RI/FS also will be consistent with the guidelines and criteria and considerations set forth in the National Contingency Plan (40 CFR 300), and the Superfund Amendment Reauthorization Act of 1986 (SARA).

Within the CERCLA framework, the purpose of the RI is to determine the nature and extent of any release, or threat thereof, of hazardous or radioactive substances, pollutants, or contaminants, and to gather all necessary data to support the FS. The work plan for the RI at the FMPC has been prepared to satisfy the following specific objectives:

- Identify and characterize the sources of radiological and chemical contamination;

- Determine the nature and extent of radiological and chemical contaminants or pollutants ~~compounds~~ in air, soils, sediments, surface water, and groundwater media, and characterize their occurrence in aquatic and

terrestrial organisms both on and off site;

- Identify the pathways and mechanisms for radiological and chemical constituent migration, and conduct public health risk assessments and environmental impact studies;

- Develop, validate, and apply various site models in order to augment the current understanding of the site environment, and to predict future impacts with and without remedial actions in lieu of future observations; and

- Provide necessary information for the identification, evaluation, and selection of the most environmentally and economically acceptable alternatives in the FS.

1.4 RI/FS WORK PLAN

In preparing the RI/FS work plan, existing information has been utilized in a preinvestigation analysis to focus the anticipated remedial action alternatives, outstanding information needs and the RI requirements. A preliminary analysis has been conducted and is reflected herein. Care was also taken to avoid redundancy with both the existing data base and investigations planned as part of other ongoing projects at the FMPC. Some modifications to the workplan will likely be required, however, as the evaluation of the existing data proceeds and new data are collected.

The purpose of the FS is to develop, evaluate ~~the EPA in order to~~ and recommend remedial action alternative(s), to the EPA in order to protect public health and welfare, and the environment from releases or threatened releases of hazardous or radioactive substances, pollutants, or contaminants at or from the FMPC if the public or the environment is at risk. In accordance with the FFCA, a more detailed workplan for the conduct of the FS at the FMPC will be developed based on the progressive findings of the RI. The FS workplan submitted herein is limited, therefore, to a description of the general approach that will be utilized to satisfy the nine-task FS described in the FFCA.

The work plan for the sitewide RI/FS at the FMPC will be comprised of separate work plans for the RI and the FS. This is necessary because only the RI work plan can be developed in sufficient detail at this time to serve as a guidance document of work to be performed among involved agencies and support contractors. A similar FS workplan is premature since the progressive findings of the RI are critical to the development of a detailed FS approach.
The Volume I work plan is comprised of five principal elements in addition to the introductory material of Section 1.0. In Section

2.0 (Problem Definition), the problems of the FMPC that are important to the sitewide RI/FS are defined. The various components of the FMPC and their relationship to both the FFCA requirements and CERCLA guidelines are given a common basis that carries through subsequent sections of the work plan. Section 3.0 (Preliminary Evaluation) is also a background section, and has been prepared to establish an investigative framework for the RI/FS. This section relates the proposed RI activities to information needs identified through a consideration of potential remedial actions.

The proposed scope of work for the RI is the subject of Section 4.0, "Technical Approach: Remedial Investigation". The format of Section 4.0 has been developed to coincide with the eight tasks specified in the Scope of Work for a Remedial Investigation: Feed Materials Production Center, which was included as Attachment A to the FFCA. These tasks include:

- Task 1 Description of Current Situation
- Task 2 Work Plan Requirements
- Task 3 Site Investigation
- Task 4 Site Investigation Analysis
- Task 5 Laboratory and Bench-Scale Studies
- Task 6 Reports
- Task 7 Additional Requirements
- Task 8 Community Relations Support

The information presented in Section 4.0 is an initial effort at characterizing the full scope of field and analytical investigations to be performed. Additional details on specific methods and controls will be provided in the Detailed Work Plan for the Remedial Investigation of the FMPC.

A similar approach is followed for the FS in Section 5.0 (Technical Approach: Feasibility Study). In this case, the scope of work is developed in accordance with the nine tasks specified in the Scope of Work for a Feasibility Study: Feed Materials Production Center, as attached to the FFCA. These tasks include:

- Task 9 Description of Current Situation
- Task 10 Work Plan
- Task 11 Development of Alternatives
- Task 12 Initial Screening of Alternatives
- Task 13 Detailed Analysis of Alternatives
- Task 14 Evaluation and Selection of Preferred Alternatives
- Task 15 Draft Feasibility Study Report
- Task 16 Final Feasibility Study Report
- Task 17 Additional Requirements

The Management Plan to be utilized in the performance of the RI/FS is described in Section 6.0. Included in Section 6.0 are

the project organization, project controls, schedules and deliverables.

SECTION 2.0

PROBLEM DEFINITION

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2.0 PROBLEM DEFINITION

2.1 SITE BACKGROUND

The FMPC began operations at the Fernald Site in the early 1950's, when the United States Atomic Energy Commission (AEC) completed a long-term plan to establish an in-house integrated production complex for processing uranium and its compounds from natural uranium ore concentrates. Uranium ore concentrates and recycle materials are converted to either uranium oxides or uranium ingots and billets for machining or extrusion into tubular form for production reactor fuel cores and target fuel element fabrication. The entire site was operational by the end of 1954.

In 1951, NLO, Inc. (formerly National Lead Company of Ohio), a subsidiary of NL Industries (formerly the National Lead Company), New York, entered into contract with the Department of Energy (formerly the Atomic Energy Commission) as operator of the FMPC. NLO, Inc. continued as the FMPC contract operator until January 1, 1986, when the Westinghouse Materials Company of Ohio (WMCO), a wholly owned subsidiary of the Westinghouse Electric Corporation, began contract responsibilities for management of the site operations and facilities for the next five years.

2.1.1 Description of the FMPC

The principle product from FMPC operations is uranium metal in various physical forms having several standard isotopic assays and purity controlled at a high level. The isotopic values range up to 1.25% Uranium-235 by weight percent of the total uranium content of the material. Most of the production stream metal is cast into ingots for extrusion into tubes at the DOE extrusion press facilities located at Reactive Metals, Incorporated (RMI), Ashtabula, Ohio. Some of the extrusions are returned to the FMPC where tube blanks undergo heat treating and fabrication into target element cores for DOE reactors. Other extruded material is further processed into fuel billets via an upset forge operation at RMI and is not returned to the FMPC. Both fuel cores and target elements are used in government reactors for the generation of electricity and the production of plutonium.

A wide variety of chemical and metallurgical processes are utilized at the FMPC to produce uranium metals. Large-scale chemical operations consist of processing enriched uranium scrap residues to produce a uranyl nitrate (UNH) feed solution. Purified UNH solution is concentrated and then denitrated to uranium trioxide (UO3). UO3 is converted to uranium tetrafluoride (UF4) for reduction to metal. Scrap materials generated in FMPC operations and those received from offsite are recycled for reentry into the production process.

In 1961, the FMPC began receipt of recycle feed materials from other DOE facilities. Being recycle materials, these feed streams to the FMPC processes contained minute quantities transuranic and fission products. Acceptance criteria for transuranics and fission products for receipt and shipment of feed materials and product have been estabished by DOE for the FMPC.

The acceptance criteria is as follows:

1. The total transuranic alpha activity shall not exceed 0.1% of the uranium alpha activity. It is further specified that alpha activity for plutonium shall not exceed 1360 dpm per gram uranium (10 ppb Pu as Pu-239).

2. Total measured beta activity for fission products per gram uranium shall not exceed twice the maximum beta activity of aged natural uranium.

3. Total measured gamma activity for radiological impurities (transuranic and fission products) per gram uranium shall not exceed twice the measured gamma activity of aged natural uranium.

The FMPC has been the DOE repository for thorium since 1975. Thorium was received from 1954 to 1975 for reprocessing into various forms. Since 1975 the FMPC has received, assayed, and stored/maintained quantities of thorium bearing materials for potential use in future DOE programs.

Materials exceeding these levels have been handled on a limited basis at the FMPC. Special processing, handling and health and safety requirements are invoked at the FMPC for the processing materials exceeding the maximum target

levels. A program was recently completed at the FMPC involving the processing plutonium out of specification (POOS) feed materials.

Plutonium Out of Specification (POOS)

A concentration of approximately 20 parts per billion (ppb) for plutonium and neptunium per gram of uranium has been considered as a target for maximum transuranic (TRU) content in materials handled at the FMPC. A plutonium concentration of 10 ppb has been set as the level at or below which the FMPC takes no additional precautions regarding worker protection beyond that required for virgin uranium.

Of the recycled feed materials which have been received at the FMPC, more than half of the plutonium was contained in approximately four percent of the received recycled materials. Since plutonium is the controlling radionuclide in the material, a program for sampling and analysis of feed materials for plutonium was instituted in order to identify and quantify POOS at the FMPC.

Materials classified are having POOS were repackaged and stored in special areas in order to provide sufficient radiation protection for workers and the environment. Special precautions were taken to control worker exposures during sampling and repackaging. In addition, plutonium-free uranium was mixed with the POOS in order to reduce the plutonium concentration to allow for more efficient implementation of operational radiation protection activities.

A site map showing FMPC buildings and process areas has been provided for reference purposes in Figure 2.1. Six production units are involved in chemical operations. Chemical processing begins at the Sampling Plant (Plant 1) where depleted, normal and enriched uranium materials are received, sampled, stored and shipped. The Sampling Plant is responsible for accountability and control of fissionable materials processed at the FMPC. The Refinery (Plants 2 and 3) digests enriched uranium residues, concentrates pure uranium solution and recovers uranium from waste solutions. The Green Salt Plant's (Plant 4) primary function is processing uranium trioxide to uranium tetrafluoride (green salt). The principle capabilities of the Pilot Plant are the reduction of uranium hexafluoride to uranium tetraflouride and

FIGURE 2.1

the purification and conversion of thorium nitrate solution to various thorium compounds. The Scrap Recovery Plant (Plant 8) process primarily involves upgrading enriched uranium recycle materials to produce feed materials for processing in the Refinery Plant.

Metal production and fabrication is carried out in three plants: the Metal Production Plant (Plant 5), the Special Products Plant (Plant 9) and the Metals Fabrication Plant (Plant 6). Metal processing steps begin with the production of uranium derby metal (Plant 5). The Special Products Plant casts recycle metal into large diameter ingots and the Metal Fabrication Plant treats the ingots for extrusion. Core Blanks from extruded tubes undergo heat treating and final machining operations to produce target element cores. Extruded billets are coextruded to produce nuclear reactor fuel cores. During the period 1954 through 1975, thorium operations were performed in the Metals Fabrication Plant, Recovery Plant, Special Products Plant and the Pilot Plant at the FMPC. The FMPC serves as the thorium repository for the DOE, maintaining long-term storage facilities for a variety of thorium materials.

2.1.2 Environmental Setting

The FMPC is located on a relatively level terrace approximately 580 feet above sea level. The regional climate is continental with temperatures ranging from an average 29.0 in January to 75.5 in July. Average annual precipitation is about 38 inches per year. Prevailing winds are from the south-southwest and the southwest. The FMPC lies within the New Madrid Seismic Zone. This seismic zone has been the site of some of the largest historical earthquakes in the continental United States (U.S. Geological Survey, 1985). The FMPC falls within zone 2 of the seismic risk area of the U.S. which corresponds to an area which could receive moderate damage from earth- quake activities (U.S. Bureau of Reclamation, 1973).

2.1.2.1 Soils

Soils in the region were formed in parent materials that were deposited by the action of glaciers, and consisting primarily of glacial till. Soils are generally deep and well drained loams and silt loams making them highly productive for agricultural activities.

U.S. Soil Conversation Service soil surveys are available for both Butler and Hamilton counties. These documents contain the most complete descriptions of local soils and will be used for the RI/FS as required. See Figure 2.4 Soils Associations Occurring on the FMPC (Current Situation volume).

2.1.2.2 Surface and Ground Water Hydrology

Natural drainage the FMPC is to Paddy's Run, a tributary of The Great Miami River. Paddy's Run originates just north of the FMPC and flows south to the river on the west side of the FMPC. The major aquifer in the region is a permeable glacial outwash deposit which occupies the New Haven Trough. This aquifer yields large quantities of water for domestic, municipal, and industrial uses throughout the region.

Bedrock underlying the FMPC consists of a flat lying shale with interbedded limestone layers. The bedrocks surface slopes generally to the northwest and forms the floors and walls of the New Haven Trough. Water levels in sand and gravel aquifers are approximately 60 to 90 feet below the land surface.

2.1.2.3 Ecology

The FMPC is in the transition zone between the beech forests to the north and the mixed broadleaf forests of the southern Appalachians. Vegetation outside the fenced, production area includes mowed pastures, brushy fields, and transition zones to second growth deciduous forests. Within the waste storage area, vegetation is primarily introduced grasses on the covered waste pits and scattered shrubs along small drainages.

2.1.2.4 Land Use and Population

The FMPC is located in Hamilton and Butler Counties. This area is characterized by residential, commercial, and light industrial development along the Great Miami River and highway corridors. Areas immediately surrounding the FMPC are primarily rural in nature, characterized by a predominance of agriculture, with some light industry and scattered residences.

2.1.3 Identified Substance Release Problems

2.1.3.1 Uranium Emission

On December 7, 1984, NLO, Inc., the contract manager for the FMPC, reported to the Department Energy's Oak Ridge Operation Office (DOE/ORO) that there had been an excessive and unanticipated amount of uranium emissions to the air. The loss occurred from Plant 9 operations from approximately mid-September to December 6, 1984. The loss totaled 123.9 kilograms (kg) of slightly enriched uranium. The excessive emissions caused no discernible impacts off-site; an intensive in-vivo whole body count of Plant 9 workers indicated no significant incorporation of uranium in the lungs. The DOE/ORO made reports to the National Response Center and several State of Ohio health and environmental protection agencies, pursuant to the provisions of CERCLA.

From analysis of available release data and air monitoring data, airborne uranium concentrations appear to have been less than the maximum permitted in DOE standards and guidelines for release to unrestricted areas. However, airborne uranium emissions to the environment since 1952 total 96,036 kg. Of this amount, 96 percent was released prior to 1970, when more efficient control measures were initiated.

2.1.3.2 Above Background Concentrations Uranium in Off-site Wells

Laboratory analysis of FMPC samples (collected since 1981) have demonstrated that the maximum uranium concentration in the water of three offsite wells is above background but below DOE guidelines for water released to unrestricted areas (6×10^{7} uCi/ml or 600 pCi/l from DOE 5480.1 chg. 2, Attachment XI-1, Table II, Column 2, 4-29-81). Although the measured concentrations are above background concentrations, they occur in non-drinking water wells. None of these wells are currently used as potable water supplies. Two of the wells are used in industrial processes only, and the ~~two~~ third, discontinued for potable use in 1985, is used for sampling purposes only.

Historical use of these wells for drinking water purposes have been examined. One well was used to supply drinking water. It is unclear as to the use of the remaining two wells prior to 1984. For additional information, please see the IT report provided to USEPA and OEPA and discussed on August 4, 1987. This matter continues under investigation.

2.1.3.3 Current Environmental Concerns

Sources of current environmental concerns include continued uranium particulate releases and effluent discharges. Storm water runoff flowing into the storm sewer ditch from the production area, and water runoff flowing into Paddy's Run from the waste pit storage area may be continuing sources of uranium contamination to surface and groundwaters.

The six waste pits and other types of waste storage areas remain as possible continuous sources of radiological and chemical contaminants to ground water. This results from the potential for leachate production and leakaage. Section 2.2 provides a more detailed account of the potential sources contaminant release.

2.1.3.4 Measured Radionuclides in Soils

Various studies of radioactive materials in surface soils surrounding the FMPC have indicated localized areas of above normal uranium concentrations in soils. The data collected in site studies suggests that contamination by uranium off-site appears to be through air pathways. Past data shows ranges in soil concentrations ranging from naturally occuring levels off-site, up to 65 pCi/g in FMPC production areas.

2.1.4 Sources, Pathways, and Receptors

Each element of the FMPC and surrounding environs requiring investigation in the RI/FS has been designated as either a potential source of environmental contamination, an environmental pathway of contaminant migration, or a potential contaminant receptor. This source-pathway-receptor framework brings all study elements into the context of a CERCLA investigation and the risk assessment phase of the work as summarized in Figures 2.2 and 2.3.

FIGURE 2.2

FIGURE 2.3

The relationship between sources and on-site and off-site pathways is illustrated in Figure 2.2. The blackened dots shown on the left-hand side of the figure indicate which sources may contribute radioactive or chemical constituents to the environmental media or production facility units identified in the middle column. The latter elements which represent the initial on-site contaminant receptors, also serve as the physical pathways by which contaminants can potentially be released to off-site environments. The entries on the right indicate the specific pathways that potentially link on-site contamination to off-site environmental receptors.

The off-site environmental receptors can serve as pathways to the point of exposure for human receptors. The specific pathways that are related to each of the public exposure pathways are illustrated in Figure 2.3. For example, contaminants entering Paddy's Run or the Great Miami River could reach a human receptor via direct contact or digestion contaminated surface water or sediments.

In the following sections, each entry in Figures 2.2 and 2.3 is described in terms terms its importance to the proposed RI/FS. This exercise will serve to define the FMPC data needs in direct relation to the preliminary evaluation described in Section 3.0, and hence to the technical basis for the proposed scope of the RI/FS presented in Sections 4.0 and 5.0.

2.2 POTENTIAL SOURCES OF ENVIRONMENTAL CONTAMINATION: WASTE STORAGE AND ADJACENT AREAS

2.2.1 Waste Pits

The six waste pits located in a controlled, fenced area west of the production facility represent the principal waste storage units at the FMPC (Figure 2.4). Waste Pit 1, constructed in 1952, was excavated into an existing clay lens and lined with clay/ , and used as a clearwell for liquid waste after Pit 2 was constructed. The effluent from Pit 1 was later pumped and discharged into the Great Miami River. Pit 1 was closed, backfilled, and covered with clean dirt in 1959. *It was closed in 1959/ backfilled/ and covered with clean fill dirt/* Waste Pit 2 was operated from 1957 through 1964, and was constructed with a compacted clay liner. The closed pit has been covered with

clean fill. Waste Pit 3, constructed into a clay lens with clay-lined walls, operated as a settling basin for liquid wastes between 1959 and 1968. The pit also received dry wastes between 1975 and 1977, at which time it was closed with a clean fill cover. Waste Pit 4, constructed in a manner similar to Waste Pit 3, operated from 1960 through May, 1986. Pit 4 was recently covered with clean fill and will be closed in compliance with RCRA. Waste Pit 5 received a variety liquid waste slurries from 1968 to 1983. It is presently being used for pH wastewater treatment. Pit 5 is lined with a 60-mil thick membrane liner. Waste Pit 6 was constructed in 1979 using a synthetic liner similar to Pit 5, and operated until 1985. The capacity of Pit 6 has not been reached; however, the pit is inactive.

Pit No. 5, which was placed in service in 1968, was designed and operated until 1983 as a surface impoundment receiving high solids bearing (slurried) waste streams and supernatant from the general sump wastewater treatment system. The high solids bearing waste directed to Pit No. 5 were primarily waste materials generated from FMPC refinery operations (neutralized raffinates). Settleable solids were removed from these waste streams in ~~Plant~~ Pit 5 by clarification. In 1983, when the solids holding capacity of Pit 5 was nearly exhausted, all high solids bearing waste streams were redirected to alternate on-site treatment systems. From 1983 until 1987, Pit No. 5 received only low solids bearing wastewater from the general sump treatment operation. The practice of transferring clarified general sump wastewater to Pit 5 was continued until 1987 to take advantage of Pit 5's remaining solids removal capabilities.

Runon water (stormwater) collected in Pit No. 4 is transferred to Pit No. 6 for sampling, chemical precipitation (as necessary) and pH adjustment. Collected stormwater in Pit No. 6 was transferred to Pit No. 5 for further settling and discharge via the clearwell and manhole 175. The practice of conveying collected stormwater from Pit 6 to Pit 5 was discontinued in February, 1987. Currently, collected stormwater from Pit 6 are transferred to the biodenitrification surge lagoon for treatment and discharge.

FIGURE 2.4

The volumes of the pits are 40,000 cubic yards (cy), 13,000 cy, 227,000 cy, 53,000 cy, 102,500 cy, and 9,000 cy, respectively. With the exception of Waste Pits 3 and 5, all pits received only dry wastes. Typical wastes disposed in the pits included some thorium and low level radioactive wastes associated with uranium metals production as well as some other materials such as asbestos, barium chloride salt, scraps, and trash.

The waste pits are a principal concern to the RI/FS due to the large volumes wastes stored and the potential environmental impact resulting from potential releases of radiological or chemical contaminants from the pits. The pits were not closed in a manner that would satisfy current regulatory design standards, and environmental contamination associated with leakage through the clay and membrane liners or ponding surface waters could be a continuing problem. With the exception of the stormwater outfall ditch, a portion of the potential contamination releases impacting all pathways and receptors can be potentially tied back to the waste pits. A principal objective the RI/FS is to further characterize the pits; the associated environmental releases and their relationship to pathways and receptors, and to develop and recommend the most cost-effective source control measures to satisfy applicable compliance standards.

2.2.2 Burn Pit

The burn pit was constructed in 1957 as a site to excavate clay to line Waste Pits 1 and 2. The burn pit was subsequently used to dispose of laboratory chemicals and to burn combustible materials, including pyrophoric and reactive chemicals, non-PCB oils, and other low-level combustible materials (Figure 2.5). The actual inventory of materials or chemicals that was disposed in the burn pit is unknown. The boundaries of the burn pit are no longer discernible from Pit 4. Operations at the burn pit were terminated in the summer of 1960.

The burn pit remains a potentially important source of contaminants to the underlying aquifers. Contaminated soils and atmospheric releases may also be associated with the burn pit, depending on the adequacy and integrity of the backfilled cover.

FIGURE 2.5

potential contamination of underlying groundwater by toxic metals leached from the fly ash and radionuclides, similar releases via surface water runoff to the stormwater outfall ditch, and potential releases of contaminated particulates to the atmosphere. Composite samples taken from each of the two existing fly ash piles at the FMPC were transferred to an off-site laboratory for complete radiological analysis. Small quantities of waste oils generated from FMPC operations were spread over portions of the retired fly ash pile for dust control control purposes. No other areas at the FMPC are recorded or other/ visse known to have received waste oils for dust control purposes/

2.2.5 K-65 Silos

Two eighty-foot diameter concrete silos located in the Waste Storage Area contain approximately 7,200 cy of waste raffinate. In excess of 11,200 kg of uranium and 1,600 curies of radium have been estimated to be present in the waste materials. Significant quantities of other metals are also known to be present in the silos.

A concern with the two K-65 silos (silos 1 and 2) is the release of radon gas to the atmosphere. Several programs to address this problem, including the implementation of engineered improvements to the covers and walls, have been completed over the years. A second issue is the potential for leachate formation from the large inventory of wastes contained in the silos, and the consequent potential for releases to the underlying soils and aquifers. Direct exposure to radiation released from the tanks is a third issue to be addressed in the RI.

2.2.6 Metal Oxide Tank

Metal Oxide Tank 3 contains dry powder-like waste raffinate. This calcined waste was pneumatically conveyed to the tank. From 1952 through 1959, more than 5,100 cy of calcined residues were disposed in the silo. These residues stored in the silo contain approximately 18,000 kg of uranium, some metal oxides, heavy metals, and trace amounts of radium. The silo contains less than 15 curies of radium-226. Impacts associated with gaseous emanations will be assessed as part of the risk assessment process of the RI/FS.

2.2.7 Sanitary Landfill

The FMPC sanitary landfill is located on a three-acre tract in the northwest corner of the production area. The facility is organized into 17 individual cells, five of which are full and out of service. The 12 remaining cells are awaiting issuance of an Ohio EPA Permit To Install. The sanitary landfill was used for the disposal of noncombustible, non-radioactive sanitary wastes generated onsite, non-radioactive construction rubble, water treatment lime sludge, and small quantities of asbestos. No hazardous wastes are handled at this facility, and there is no indication of prior or current releases of hazardous wastes or constituents from this facility.

Although no significant environmental problems are expected to be associated with the landfill, a potential for leakage to groundwater exists and will be a target for confirmatory investigations.

2.2.8 Clear Well

The clear well receives surface runoff from the waste pits as well as some flow-through process wastewater. It is used as a final settling basin prior to discharge to the Great Miami River via the FMPC National Pollutant Discharge Elimination System (NPDES) discharge point. It is anticipated that a significant amount of uranium-bearing settled solids is contained in the basin.

Since the reduction of waste in fluents to the clear well will be addressed as part of other study elements, any RI activities at the clear well will be for the purpose of establishing the condition of the facility and the nature of the bottom sludge. The resulting information will be used in the FS to evaluate the cost-effectiveness of any improvements at the clear well.

2.2.9 Deactivated Facilities

The deactivated Solid Waste Incinerator is located on the east side of the plant adjacent to the Sewage Treatment Plant and Manhole 175. The incinerator was originally used to burn combustible materials suspected of containing elevated levels of radionuclides. The incinerator was deactivated in 1979 when an upgraded combustible process waste material incinerator was constructed. Non-PCB waste oils were burned at this facility. Soil sampling

in this area has indicated concentrations of uranium up to 90 pCi/g.

The oil burner located north of the Boiler Plant was used from plant startup until approximately 1982 for burning spent machining oils generated from the FMPC production facility. The oil burner was deactivated in 1982 when an upgraded oil burner became operational.

The graphite burner located north of the Boiler Plant was used for volume reduction of unusable and broken graphite casting molds and crucibles. Operations at the graphite burner were phased out during 1984 at which time bulk graphite was transferred to Pit 4. Following the retirement of Pit 4, graphite was (and currently is) drummed for oxidation in Plant 8 at the FMPC for shipment to the Nevada Test Site (NTS) for disposal.

2.3 POTENTIAL SOURCES OF ENVIRONMENTAL CONTAMINATION: PRODUCTION AREA

2.3.1 Air Emissions

Emissions of particulate and gaseous material from the FMPC can be categorized as follows: (1) releases from the production area facilities from point sources (stacks); (2) fugitive releases; and (3) resuspension of material deposited on buildings or soil surfaces by previous releases. Ventilation systems within the production area collect gases and airborne particulates from over 400 individual operations or pieces of equipment. These ventilation systems are vented to the atmosphere through dust collectors to control total emissions from the plant. Emission sources with a potential for releasing radionuclides are provided with stack samplers to determine the magnitude of releases. Uranium, thorium, and associated daughter products are the primary radioactive emissions from these stacks. The principal non-radioactive emissions are particulates, nitrogen oxides, and sulfur oxides.

Transuranics are present as an impurity in incoming feed materials streams and do not appear to constitute a primary radioactive emission from the FMPC. Trace emissions of transuranics do, however, occur from process stacks. Full radiological analyses will be conducted as part of RI sampling plans. The associated impacts from the handling of trace amounts of transuranics will be

evaluated as part of the risk assessment.

2.3.2 Thorium Inventory

Thorium is not regarded as a stored waste material and thus, is not addressed in Section 2.2. Thorium is addressed in Section 2.3.2.

Since about 1972, the FMPC has served as the DOE storage site for thorium. The current FMPC inventory of thorium materials consists of approximately 1100 metric tons (metric tons thorium) of bulk thorium oxide materials plus other inert materials like diatomaceous earth. Other than the small quantity (9 metric tons as thorium) of thorium nitrate solution in storage in the Pilot Plant Tank #2, the reaminder of the thorium inventory is in drum and container storage in the warehouse buildings. A small quantity of drums (212 drums) are in outside storage. In summary, Building 64 contains 181 drums; Building 65 contains 5599 drums; Building 67 contains 5992 drums; and, Building 68 contains 1317 drums. There are 240 containers within 212 drums in outside storage west of Building 65. The form of these materials includes thorium oxides, thorium, oxalate cake, thorium nitrate crystals, impure thorice gel, and various thorium solutions, metals and waste residues.

2.3.3 Stored Waste Inventory

Solid waste materials associated with uranium metals production are presently stored on the Plant 1 pad in steel drums awaiting further processing or off-site disposal at approved facilities. These waste streams include oils, sludges, contaminated burnables, filter cake, off spec UF4 or ThF4, reject U03, etc. The drums sit on an uncontrolled pad and are inspected on a weekly basis. Contents of deteriorated drums are repackaged. Other waste materials stored in drums on controlled surfaces include spent degreasing solvents (pilot plant warehouse); and PCB contaminated material (KC-2 warehouse).

2.3.4 Underground Storage Tanks

Eleven fuel and waste oil underground storage tanks are located on the FMPC. Two fiberglass tanks with a total capacity of 3,000 gallons were installed in 1980 and remain in use for the storage of non-hazardous substances. The remaining nine tanks are steel and were installed during plant construction. Five of these tanks remain in use. One active and one inactive tank were used

for the storage of hazardous substances. Sumps and subfloor reservoirs will also be inventoried and inspected.

Thirteen fuel and waste oil underground storage tanks are located on the FMPC. Two fiberglass tanks with a total capacity of 3,000 gallons were installed in 1980 and remain in use for the storage of non-hazardous substances. The remaining eleven tanks are steel and were installed during plant construction. Five of these tanks remain in use. Location, inventories, and status of these tanks are shown in Table 4.4. Out of service tanks will be examined for previous leaks and marked for removal or closing. One inactive tank was used for the storage of hazardous substances. The piping, lines, sumps, and subfloor reservoirs will be inventoried and inspected and the latter two will be used to determine the status of the floor drains.

2.3.5 Metal Waste Storage Areas

An estimated 10,000 tons of metallic scrap containing above-background levels of uranium are currently stored on controlled, curbed pads within the production area. One scrap pile consists primarily of ferrous material with a mixture of aluminum, stainless steel, copper, brass, and nickel. The remaining scrap is mica-coated copper scrap. No hazardous materials are known to have been received at these pads, with the exception of asbestos materials removed from various plant facilities.

2.3.6 In-process Materials

Numerous hazardous and radioactive materials are used in the production of feed materials. In-process materials include the following: input materials required to begin a particular process; recycle materials which are generated during a production process and are not considered waste or are required for any subsequent process; and feed materials which are final products of a production process. These classes of in-process materials are currently handled or generated by plants one through six, plants eight and nine, and the pilot plant. The tank farm stores in process materials in above grade storage

tanks. Both process input materials and recycle materials are routinely transferred between buildings in above-grade piping and manually in bulk form using drums and hoppers.

Process input materials are required to initiate and complete individual production processes. These materials are composed of raw materials received from off site and process input materials produced at the FMPC for use in subsequent processes. Process input materials include: depleted, normal and enriched uranium, uranyl nitrate, unirradiated enriched uranium dioxide fuel pellets and powder, uranium trioxide, uranium tetrafluoride, uranium hexafluoride, graphite, nitric acid, tributyl phosphate, kerosene, sodium carbonate, anhydrous hydrogen fluoride, ammonium hydroxide, anhydrous ammonia, sodium chloride, potassium chloride, and miscellaneous acids, bases, solvents, cutting oils, and degreasers.

Recycle materials are produced in various plants at FMPC or are received from other DOE sites and reprocessed to extract any usable quantities of process input materials. Recycle materials are carefully segregated at the point of generation and either drummed and stored until sufficient quantities are accumulated or reused immediately at one of the plants. Materials are received in drums from other DOE facilities and either stored or used immediately in one of the plants. Recycle materials include: enriched uranium slag, magnesium fluoride slag, scrap uranium metal, and nitric acid. Transuranics are present as an impurity in incoming feed materials streams. See section 2.3.1 for additional information on transuranics.

Feed materials produced at the FMPC represent final end products which are shipped off site to other DOE facilities. Feed materials include: depleted uranium metal, derbies, ingots, and billets, and enriched uranium fuel billets.

2.3.7 Currently Generated Wastes

Currently generated wastes are those materials which result from day to day FMPC operation and depleted in-process source materials which are not recyclable. Table 2.1 contains a list of wastes currently generated at the FMPC, of which some are packaged for offsite shipment and disposal.

TABLE 2.1

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H1

2.4 ON-SITE RECEPTORS AND PATHWAYS

2.4.1 Stormwater System

The storm sewer outfall ditch is a narrow and shallow ravine which receives overflow surface water runoff from portions of the production area and surrounding terrain. Radionuclides and other materials originating from the production area have entered the storm sewer system through accidental spills and through surface runoff. Under normal conditions, the storm sewer water is combined with the general sump effluent and other plant liquid effluents and is discharged to the Great Miami River. During periods of heavy runoff, excess storm sewer water was historically discharged directly into the storm sewer outfall ditch which discharges into Paddy's Run. This overflow condition is now controlled by a stormwater retention basin.

The stormwater retention basin at the FMPC as constructed will retain a 2 year 24 hour storm event. Excess flows exceeding this capacity are discharged (via an overflow) to Paddy's Run Creek. In accordance with the State of Ohio's Director's Findings and Orders, a new stormwater basin is currently planned to be constructed at the FMPC to increase available storage capacity to handle a 10 year 24 hour storm event.

Contaminated stormwater in this ditch could infiltrate the till and possibly recharge the underlying sand and gravel aquifer. This could represent, therefore, a short-circuited pathway for contaminants originating in the production area to enter a southern flowing groundwater system. The resolution of this issue could be important to any remedial action program to control sources of offsite groundwater contamination to the south.

2.4.2 Surface Drainageways

Several drainageways that exist within and adjacent to the waste pit area, and drain the production area, serve as a transport system for surface water runoff from the waste pit areas to Paddy's Run and off site. Such a drainage system is a potential source of groundwater contamination. Runoff that is collected and discharged directly to the soil may contain radioactive or other hazardous contaminants that can infiltrate into the underlying aquifer.

2.4.3 Main Effluent Line

The main effluent line of the FMPC traverses the entire site in an easterly direction. The line originates at the clear well near the western border of the site below Waste Pit 3, and conveys clarified process waste stream effluent eastward to a point of discharge at the Great Miami River. As it traverses the production area, stormwater enters through a tie-in with the stormwater collection system. The effluent line exits the FMPC near the sewage treatment plant, at which point treated effluent from the sewage treatment plant also enters the discharge line.

This line carries all of the wastewater leaving the FMPC; a leak any place in the line could become a local source of groundwater contamination. Leakage at the clear well could also contribute contaminants to Paddy's Run, and in turn to southern groundwater zones as a consequence of recharge from Paddy's Run. An important issue associated with the effluent line is the possibility that it could carry contaminants across a potential groundwater divide near the production area. Additionally, the potential exists for a zone of influence to the Southwest Ohio Water District well (see Section 2.5.5).

2.4.4 Groundwater Below The FMPC

The central importance of onsite groundwater is its role as both a receptor of contaminants from a variety of sources and a pathway for contaminant migration to offsite areas. The use of groundwater at the FMPC is for production water and onsite drinking water. This water, which is pumped from the sand and gravel aquifer below the blue-clay stratum, has not exhibited contamination.

The focus of any related data collection efforts in the RI will, therefore, include an improved characterization of the sources and a better understanding of the rate and direction of groundwater flow in the regional aquifer beneath the FMPC. By so doing, the source-pathway-receptor evaluation can be refined, and a prioritization of remediation needs can be accomplished in support of the FS. One important data deficiency that will be addressed is groundwater flow conditions in the sand and gravel aquifer in the eastern portion of the facility. A protective pumping program was implemented to control containment migration in the upper sand and gravel aquifer in the waste pit area.

2.4.5 Surface Soils

Most of the radiological contamination of surface soils at the FMPC is the result of deposition of airborne emissions over the life of the plant. Exceptions would include areas where accidental spills occurred, zones contiguous to waste storage units, or production units. As a result, the contamination of soils is expected to be dispersed and variable.

The soil sampling program proposed for the RI will be concentrated in the waste pit areas and any other locations considered to be particularly susceptible to soil contamination. Field screening techniques will be utilized as much as possible to identify areas with elevated concentrations of radionuclides. Off-site areas near the incinerator on the east side of the Fernald site, which have previously indicated uranium concentrations in soils up to 65 pCi/g, will be sampled for surface soils in addition to the existing data base from the Litigation Support Study.

Likely contamination of subsurface soils is a result of deposition of airborne emissions, accidental spills or line leaks, or surface water transport along drainageways to low spots within the production area. Subsurface soil contaminated would be expected to be dispersed and variable but associated with drainageways and low elevation surfaces. Field screening techniques will be utilized as appropriate to identify areas with elevated concentrations of radionuclides.

2.4.6 Subsurface Soils

Likely contamination of subsurface soils is a result of deposition of airborne emissions, spills or line leaks, or surface water transport along drainageways to low spots within the production area. Subsurface soil contaminated would be expected to be dispersed and variable but associated with drainageways and low elevation surfaces. Field screening techniques will be utilized as appropriate to identify hot spot areas.

2.5 OFF-SITE PATHWAYS (ENVIRONMENTAL RECEPTORS)

See Section 2.1.4 Sources, Pathways, and Figure 2.3 Potential Exposure Pathways to the Public, for additional information.

2.5.1 Atmosphere

The ambient air can potentially receive contaminated particulate and gaseous emissions from numerous sources throughout the FMPC. Atmospheric transport of contaminants is not constrained by physical boundaries, and thus a 360-degree impact area can potentially result. In addition, the uptake of airborne contaminants via inhalation is a passive occurrence to which the entire receptor population is potentially exposed. An offshoot of such an exposure pattern to radiological contaminants is the importance of cumulative doses.

One focus of the RI activities will be the quantification of cumulative doses to offsite populations due to 35 years of emissions from the facility. The computed doses can then be compared on a relative scale to doses computed for other exposure modes. Also, computed doses will be compared to applicable regulatory limits for the general populations. The effort described above is being conducted in support of an epidemiological study (see Section 4.4.3).

2.5.2 Paddy's Run

Natural drainage from large portions of the FMPC is to Paddy's Run. This waterway represents an important investigative element of the RI/FS because of its dual position as both a principal environmental pathway and an important environmental receptor. The contaminants enter Paddy's Run via surface water drainageways, surface infiltration and groundwater discharge. The Great Miami River is the most evident receptor of contaminants transported via Paddy's Run. Impacts on aquatic environments and the potential for human contact with contaminated organisms, water and sediments in Paddy's Run represent secondary pathway-receptor scenarios.

Paddy's Run is also a potential pathway for contaminant transport to the regional aquifer if radionuclides and/or hazardous chemicals enter the stream and then ifiltrate through the streambed. The scenario of groundwater - surface water - groundwater transport could be important to the explanation of southern groundwater contamination, particularly if a groundwater divide exists on the FMPC site.

2.5.3 Great Miami River

The Great Miami River represents the ultimate receptor of surface water

drainage and localized groundwater discharges from the site, and is both an important pathway and receptor of environmental releases from the FMPC. The three principal pathways of contaminant transport to the Great Miami River are Paddy's Run, the main effluent line from the plant through Manhole 175 and groundwater discharge.

The aquatic ecosystem of the river is a potentially impacted receptor of contaminants in the river. In addition, the river represents a mechanism for downstream transport of dissolved and suspended contaminants. This increases the possible exposure to humans either by direct contact or by ingestion of contaminated fish flesh.

Two related issues associated with the river as an environmental pathway require further resolution in the RI. The first is a quantification of background concentrations of radiological and chemical constituents in the river to allow a relative comparison of the contaminant mass flux from upstream sources with the corresponding flux from Paddy's Run and the main effluent line. Second, the degree to which the river recharges nearby pumping wells in relation to flow contributions from site areas, and the corresponding concentrations in target species in the two flow systems, must be determined to ascertain the relative impacts of site discharges on such wells.

2.5.4 Flora and Fauna

The flora and fauna of the FMPC have not been extensively studied, although surveys are underway with data currently being evaluated. A report is anticipated in the spring of 1987. Some species are of importance to the RI/FS for two principal reasons. The first is the potential impacts of radionuclide and chemical releases on the viability and vitality of both the organisms and their ecological environments. A second concern is the potential for contaminant biomagnification via the food chain, with fish and some game species representing upper levels of the food chain and direct food sources to the public.

2.5.5 Regional Aquifer

The role of the regional groundwater aquifer is as a receptor and a pathway to downgradient receptors. As a receptor, the principal issue associated with

the regional aquifer is the potential degradation of the groundwater as a natural resource and its relationship to established groundwater quality standards. Numerous potable and industrial water supply wells are located in the immediate vicinity and downgradient of the FMPC.

The largest withdrawal of the regional aquifer is associated with the Southwest Ohio Water District wells located along the western shoreline of the Great Miami River immediately to the east of the FMPC. The water withdrawn from these wells is piped for use as industrial process water. Two important issues associated with these wells require further investigation in the RI:

- The well pumpage represents the most significant artificial stress on the regional aquifer in the vicinity of the FMPC. This stress is thought to be a dominant factor in the establishment of local groundwater divides that may influence contaminant migration pathways from the FMPC via groundwater.
- Low levels of uranium have been observed in water produced from these wells.

From a public health standpoint, the private potable water supply wells to the south and possibly to the east of the FMPC represent a concern. Three private wells to the south of the FMPC have been observed to have above background levels of uranium. ~~None of these wells are currently used as a potable water supply. Preliminary evaluations of offsite data and assocated doses and risks have been performed as part of previous investigations.~~ <u>The use of these wells was discontinued in 1974, 1982, and 1985 as potable water sources. However, wells OS-2 and OS-3 are still used for porcess water. Well OS-1 is not accessable. The above background concentrations of radionuclides in the wells were discovered in December 1981 and the Department of Health was notified in the same month. The well users were notified in February 1982 and the public in general in August 1984 through the Environmental Monitoring report.</u> The related objective of the RI will be to collect a more extensive data base from offsite wells in order to refine these evaluations. Comparisons with applicable drinking water standards will be presented.

A critical technical issue to relate the two types of actions will be the aquifer flushing rate and the corresponding time required to realize the effects of source controls at receptor locations.

2.6 POTENTIAL EXPOSURE PATHWAYS TO THE PUBLIC

2.6.1 Direct Contact

The direct contact exposure scenario is associated primarily with potential contact with contaminated soils, sediments, and surface waters at offsite locations.

2.6.2 Inhalation

The inhalation exposure mode is directly related to atmospheric emissions and pathway transport that have been addressed in detail in previous sections. The evaluation of the effects of resuspension of contaminated soil for environmental transport will also be included. The quantification of cumulative doses and anticipated future doses to offsite populations will be a principal objective of the RI. Much of this determination may be based on existing data and the results of other completed and ongoing studies, as appropriate. Source controls will be the primary response action to be evaluated.

2.6.3 Ingestion

Potential health impacts associated with an ingestion exposure mode have ~~three~~ six principal components:

- The ingestion of agricultural crops grown or honey produced on the FMPC or adjacent areas;
- The ingestion of milk products or meat from livestock grazing on FMPC property or neighboring environs;
- The ingestion of fish collected from Paddy's Run or the Great Miami River; and
- The ingestion of sediment from Paddy's Run or the Great Miami River; and
- The ingestion of groundwater from new and existing wells; and
- The ingestion of game animals.

Many previous investigations have addressed these issues. The scope of the RI

will be sufficient to collect any data necessary for the eventual determination of dose and risk in the risk assessment task of the RI.

2.6.4 Direct Radiation Exposure

Direct radiation exposure to off-site populations is a concern due to the potential for both episodic releases (particularly from the K-65 silos) and the continuous, low-level releases of radon from the waste storage facilities. This exposure is being quantitatively evaluated as part of both the CDC epidemiological study and ongoing assessments of the K-65 silos. The results of these studies will be reviewed and incorporated into the comprehensive Endangerment Assessment to be conducted as part of the RI.

SECTION 3.0

PRELIMINARY EVALUATION

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SECTION 3.0

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3.0 PRELIMINARY EVALUATION

Section 2.0 presented a summary of the current understanding of environmental problems associated with the FMPC. The summary is based on available information from both site-specific investigations and pertinent regional references. In this section it is necessary to establish the investigative framework within which the technical approach was formulated including information needs and their relationship to the investigative tasks and the subsequent FS. In Section 4.0, a program of field investigation and supporting data analyses will be presented that will supplement the existing data base to satisfy the RI objectives.

3.1 INVESTIGATIVE FRAMEWORK

An investigative framework begins with an identification of the most plausible remedial action alternatives. Once the potential actions are identified, the types of technical, environmental, and health risk information to be addressed in determining the relative cost-effectiveness of the actions in the FS can be developed. In turn, the field and analytical tasks necessary to establish the data base can be structured. The latter formulation of investigative tasks essentially represents the scope of the RI.

Figure 3.1 presents a general framework to be used in this section to integrate the potential remedial actions, related information needs to perform an assessment of the actions, and proposed investigative tasks to satisfy the information needs for each of the potential sources, pathways, and receptors identified in Section 2.0. The use of this framework is best explained by considering Figure 3.1 as two matrices, with the middle column (Assessment Informational Needs) common to both matrices and serving to tie the feasibility study needs and the RI activities together.

The completion of the left-hand matrix for each source, pathway, or receptor begins with an identification of the general types of remedial actions that would be appropriate, effective, and responsive to the site problems associated with the specific source, pathway, or receptor under study. This determination was based on the current understanding of conditions at the FMPC, and is intended only for purposes of identifying data needs and focusing

RI activities. The FS will include a comprehensive screening of technologies, introduced and additional remedial action alternatives may be introduced and evaluated once the results of the RI and associated endangerment assessment are available.

This is then followed by a listing of the general types of information that must be available in the FS to perform a cost-effective analysis of the remedial action alternatives. Blackened dots are then entered into the matrix to indicate the specific data needs that are associated with each remedial action.

The column headings of the right-hand matrix are the types of field and analytical tasks that must be carried out in the RI to fulfill the data requirements (i.e., the row headings). In the case of the right-hand matrix, the blackened dots serve to identify which specific tasks will contribute information to satisfy a certain need.

The completed matrices represent an integrated framework that both summarizes the results of a preinvestigation evaluation (since a preliminary screening of remedial actions and informational needs is reflected), and justifies the scope of the RI that will be described in detail in Section 4.0. In this section, a summary description of each remedial action is provided, and a brief statement is made as to the importance of each type of information need. Due to the excessively large number of potential combinations to be addressed, the descriptions of the types of remedial actions and information needs will be provided only with the initial reference to each action or information need. Subsequent references will simply be cross-referenced without a corresponding narrative description. A description of the investigative tasks is included in the proposed technical approach to the RI in Section 4.0.

For ease of presentation in this and subsequent sections, only the information needs are presented specific to an individual source, pathway, or receptor. The potential remedial actions are comprehensive for the group of sources, pathways, or receptors represented in the figure. The individual blackened dots can be utilized to identify the subset of actions associated with each

specific source. The investigative tasks listed in each figure represent the full range of major investigative activities being proposed for the RI. This listing of tasks will be common to all figures presented in this and subsequent sections. Again, however, the individual blackened dots can be used to easily recognize the specific tasks that will be conducted at each source, pathway, or receptor.

Three important points of clarification that will apply to all subsequent sections are the following:

- The blackened dots entered into each figure are considered to represent only the most important relationships among remedial actions, informational needs, and investigative tasks. Secondary relationships are not shown, as for example, when a certain sampling program that is designed to satisfy a critical informational need will also contribute to understanding another issue;

- Investigative tasks that will generally augment the current understanding of the site problems, as for example, the review of available information and the analysis and management of newly collected data, are not included in the figure. Support tasks, such as community relations support, are likewise not shown; and

- *The "no action" alternative is not included on the figures. The reasons are that the no-action alternative will be evaluated in all cases to provide a comparative baseline for assessing other remedial action alternatives. It should be noted that the no action alternative is to be evaluated from the protection of human health and the environmental standpoint.*
  <u>The "no action" alternative is not included on the figures. The reasons are that the no-action alternative will be evaluated in all cases to provide a comparative baseline for assessing other remedial action alternatives. It should be noted that the no action alternative is to be evaluated from the protection of human health and the environmental standpoint.</u>

3.2 POTENTIAL SOURCES OF ENVIRONMENTAL CONTAMINATION: WASTE STORAGE AND ADJACENT AREAS

3.2.1 Potential Remedial Actions

The following descriptions of potential remedial actions for waste area sources of possible environmental contamination will highlight the principal

advantages and limitations of each action. The particular sources that could be potentially controlled or eliminated by the remedial actions are also identified.

3.2.1.1 Non-Removal with In-Place Stabilization

The alternative of non-removal with in-place stabilization would involve the injection of solidification or stabilizing agents (e.g., portland cement) into the waste storage unit to achieve an in-situ elimination of environmental releases. In-situ stabilization is the subject of considerable research, and would be most appropriate if removal alternatives are constrained by physical site conditions, the nature of the wastes, disposal restrictions, or unacceptable risks during implementation. This option would have a higher potential cost than other non-removal options, and would likely be incorporated in conjunction with other infiltration and flow control options. Therefore, it would be cost-effective only if other types of waste isolation techniques are determined to be inadequate by themselves. The compatibility of the wide variety of wastes with the stabilizing agent is a critical feasibility issue, as is the physical capacity to access the waste materials and inject the agent with an assurance that an adequate distribution of the agent has occurred.

Candidate Waste Sources:

- Waste Pit;
- Burn Pit;
- Lime Sludge Ponds;
- K-65 Silos;
- Metal Oxide Tank No. 3

3.2.1.2 Non-Removal With Infiltration Control

With the exception of a no-action scenario, the alternative of non-removal with infiltration control would represent a minimum remediation effort. This option would be most cost-effective when site conditions dictate that infiltration control through capping and stormwater diversion would adequately isolate the waste materials from groundwater, surface water, and airborne pathways. The eventual selection of this alternative would be most likely if all other types of waste isolation and removal alternatives are constrained by site conditions, the nature of the waste material, disposal restrictions, or

unacceptably high risks during implementation.

Candidate Waste Sources:

- Waste Pits;
- Burn Pit;
- Fly Ash
- Piles;
- Sanitary Landfill;
- Lime Sludge Ponds;
- K-65

3.2.1.3 Non-Removal With Subsurface Flow Control

The alternative of non-renewal with subsurface flow control could encompass several technologies such as groundwater cutoff structures (e.g., slurry walls) and subsurface leachate collection systems. Such an action would likely be incorporated in conjunction with infiltration control measures to achieve full effectiveness, and would thus represent an additional action rather than an alternate action. Only in the case of a continued potential for significant groundwater contamination and high residual risk (in relation to infiltration control alone) would subsurface flow control be warranted as a cost-effective action. The depth of waste burial and the local geologic and hydrogeologic settings are critical determinants of the feasibility of subsurface flow control. In the case of the FMPC waste areas, the localized variability of the till and the thickness of the underlying sand and gravel aquifer represent adverse conditions to the effectiveness of subsurface cutoff structures.

Candidate Waste Sources:

- Waste Pits;
- Burn Pit;
- Lime Sludge Ponds;
- K-65
- Silos;
- Metal Oxide Tank No. 3

3.2.1.4 Non-Removal with Surface Water Diversion

The option of non-removal with surface water diversion is an abridged version of the infiltration control option. It would be appropriate only for those cases where groundwater contamination potential either is not a critical issue

or could be adequately controlled through surface water diversion alone. The extent and relative cost of more positive infiltration control measures (e.g., an impermeable cover) would have to be a decision element when a lesser option is being considered. In the case of the FMPC areas, only the fly ash piles and the sanitary landfill would appear to be possible candidates for surface water control only.

Candidate Waste Sources:

- Fly Ash Piles;
- Sanitary Landfill

3.2.1.5 Removal with Onsite Compliance Disposal

One removal option involves the temporary removal and eventual replacement of the waste materials in the same or alternate onsite locations following the implementation of containment measures more advanced than the state-of practice at the time of waste generation and in compliance with current regulatory programs. This alternative would require that the wastes be in a physical condition suitable for handling, and could be limited by an imbalance between the degree of long-term risk reduction that would be achieved versus the short-term risk involved in waste removal, containment, and disposal. Overburden and other site conditions would be important assessment factors. A critical constraint would exist if the stored wastes are not consistent with the types of wastes that are currently approved (or could be approved) for disposal at the FMPC.

Candidate Waste Sources:

- All

3.2.1.6 Removal With Onsite Treatment (and Disposal)

A related option would provide for treatment prior to onsite disposal of the waste materials. Regulatory compliance, agency preferences, and a reduced potential for future environmental releases would be better served by this option, but at a considerably higher commitment of time, funds and personnel. Time-consuming treatability studies and related permitting would likely be necessary due to the highly variable nature of the wastes. In addition, the same engineering and public health constraints on waste recovery

and handling would apply, as would the potential restrictions on onsite disposal.

Candidate Waste Sources:

- All

3.2.1.7 Removal With Offsite Disposal

The option of removal with offsite disposal is similar to the previous options, with the primary difference being the final disposition of the recovered wastes. The same constraints and limitations on waste removal would apply, with the possibility that some types of wastes would be accepted only at distant facilities. Transportation requirements would also be very restrictive and costly, and onsite pretreatment prior to shipping may be required.

Candidate Waste Sources:

- All

3.2.1.8 Non-Removal With Radon Emission Controls

This option is only pertinent to the K-65 silos and the continued problems associated with radon emission. Specific technologies for emission control have not yet been identified, but would likely center on improvements to the covers and walls of the silos. Improved emissions monitoring and warning systems would also require evaluation. Regulatory requirements could override any of the non-removal options for the K-65 silos.

Candidate Waste Sources:

- K-65 Silos

3.2.2 Informational Needs

3.2.2.1 Nature of Wastes Stored

A characterization of the radiological, chemical, and physical properties of the stored wastes is important for three principal reasons. First, the risk to remediation personnel is directly affected by the physical and chemical characteristics of the wastes (e.g., radioactivity, toxicity, ignitability,

corrosiveness, etc.). Second, the risk posed by the wastes in place is a function of the radioactivity, toxicity, and migration potential of the waste material. Finally, the types of wastes would be important to the eventual selection of treatment and disposal alternatives under a removal scenario. These issues can be summarized as the relationship of the nature of the wastes to the current risk posed, the risk during implementation of any remedial action, and the residual risk after a remedial action is completed.

Affected Waste Sources:

- All

3.2.2.2 Volume, Depth, and Areal Extent of Wastes

The volume, depth, and areal extent of waste burial is of direct significance to the engineering feasibility and cost of waste removal and disposal options. The alternative of non-removal with in-place stabilization or subsurface flow control would be similarly influenced, since any such controls would have to extend to at least the depth of burial. Indirect effects of burial depth could include, for example, the occurrence of more or less favorable hydrogeologic conditions at depth. Knowledge of the areal extent of the waste source would be of importance to ensure that all wastes had been removed, covered, or otherwise remediated.

Affected Waste Sources:

- All

3.2.2.3 Leakage Potential

The potential for leakage of contaminants to underlying aquifers is concerned primarily with the presence, integrity, and adequacy of any natural or constructed leakage barriers, and the potential for infiltration into the wastes to an extent that would produce leachate. The determination of leakage potential is important to assess non-removal options and the probability that

releases to groundwater would occur if the wastes are not removed. Also inherent in this issue is whether migration away from the point of leakage would occur.

Affected Waste Sources:

- All

3.2.2.4 Local Hydrogeologic Setting

The local hydrogeologic setting is important to the technical feasibility and effectiveness of nonremoval with subsurface isolation action, as well as any removal option that involves on-site disposition of the recovered wastes. In addition, since the hydrogeologic setting is a principal factor in the potential for contaminant migration, it becomes a critical element in the evaluation of the no-action alternative.

Affected Waste Sources:

- All

3.2.2.5 Potential for Flooding

The potential for flooding is of importance to any non-removal option that would be affected by a flood event (e.g., an impermeable cover), or that would potentially result in a significant environmental release of contaminants during a flood (e.g., a subsurface flow control barrier). Since flooding is not expected at the waste management units, this issue may eventually be discarded upon the completion of the confirmation studies.

Affected Waste Sources:

- Waste Pits;
- Burn Pit

3.2.2.6 Surface Water Runoff Patterns

An understanding of existing surface water runoff patterns is required for any waste source that is not bermed and for which surface water diversions or infiltration and controls are being considered as potential remedial actions. Related information is necessary to check the adequacy of the

existing hydraulic capacity, and to conceptualize realignments, additions, or enlargements to an existing system.

Affected Waste Sources:

- Waste Pits;
- Burn Pit;
- Lime Sludge Ponds;
- Fly Ash Piles;
- Sanitary Landfill

3.2.2.7 Current Versus Residual Risk

A determination of the public health and environmental risks posed by the wastes (both now and in the future) is a principal component in the evaluation of the need for remedial action. The degree of risk currently posed by the wastes also provides a baseline for comparison of the risks to remediation personnel and off-site populations during implementation of any action, and of the residual risks after implementation. The effectiveness of any remedial action must be evaluated against the degree of risk reduction that would be achieved. Residual risks would be realized under any action short of complete destruction of the wastes. Public health and environmental risks (doses) posed by the wastes will be placed in perspective by comparing them to other risks (doses), to natural background (risks, doses), and to regulatory limits (doses).

Affected Waste Sources:

- All

3.2.2.8 Risk During Implementation

The risk posed to on-site workers and off-site populations during the implementation of any remedial action is considered to be one of the most important factors in assessing the cost-effectiveness of the actions. The degree of such risk is principally dependent on both the physical condition and the radiological and chemical nature of the waste materials.

Affected Waste Sources:

- All

3.2.2.9 Regulatory Constraints

The presence of a wide variety of radioactive, and chemical wastes at the FMPC will likely introduce considerable uncertainty into the interpretation of whether a given remedial action will comply with all pertinent regulations. It is possible that some technically feasible alternatives will eventually be eliminated due to a noncompliance determination. At a minimum, the regulatory and permitting requirements can be expected to cause uncertainties and possibly delays in the decisions and implementation phases of the remedial program at the FMPC.

Affected Waste Sources:

- All

3.2.3 Summary

Figure 3.2 summarizes the investigative framework for the principal sources of environmental contamination associated with the waste storage areas at the FMPC. The "check marks" on the left-hand side of the figure are used to identify the appropriate remedial actions and related informational needs for each source, thereby summarizing the information presented in the preceding discussions.

The right hand side of the Figure relates the informational needs to the corresponding RI tasks, and provides a lead into the overall scope of the RI. Further details on the investigative tasks and their application to the specific informational needs will be presented in Section 4.0.

3.3 POTENTIAL SOURCES OF ENVIRONMENTAL CONTAMINATION: PRODUCTION AREA

3.3.1 Potential Remedial Actions

The large number of varied sources within the production area require an extensive list of potential remedial actions. For purposes of this

preinvestigation evaluation, the full range of actions has been condensed into nine categories, as described below.

3.3.1.1 Particulate Emission Controls

Any response to problems associated with airborne emissions will likely take the form of emission controls. Particulate emission controls, as defined for purposes of this evaluation, are limited to filtration or similar devices. The basic premise is that a significant portion of the radiological air releases are the result of radioactively contaminated particulates. A major emissions control project is currently underway at the production area, and it is possible that an assessment of such alternatives at some emission sources may become superfluous by the time the FS is initiated.

Candidate Sources:

- Air Emissions

3.3.1.2 Emissions Collection and Treatment

Options to collect and treat air emissions at the source are entirely analogous to particulate emission controls for purposes of this preliminary analysis. The only difference is that this category of actions would include technologies other than simple particulate filtration. The separation of the two could become important in the FS if the results of the dose and risk assessment indicate that technologies more advanced than those currently being implemented at the FMPC require consideration.

Candidate Sources:

- Air Emissions

3.3.1.3 Replace/Modify Existing Units

This category of action would be appropriate for any source of environmental contamination resulting from structural deficiencies in an existing operational unit or for which source modifications or controls are insufficient to adequately minimize associated impacts. Obvious examples are leaks in process pipelines. Such actions would be straightforward and thus

would appear to be easily justified if a direct tie to an environmental contamination problem is established in the RI.

Candidate Sources:

- Underground Storage Tanks;
- In-Process Materials;
- Thorium;
- Inventory;
- Air Emissions

3.3.1.4 Flow Diversion and Controls

Flow diversion and controls involve the construction of berms, flow equalization units, or similar devices to prohibit stormwater runoff from contacting highly contaminated areas within the production facility. As with the previous category of remedial action, the need to implement flow diversion and controls would be easily justified if one can establish that such an action would significantly reduce the contaminant load carried by stormwater runoff.

Candidate Sources:

- Stored Waste Inventory;
- Metal Storage Areas;
- In-Process Materials;
- Deactivated Facilities

3.3.1.5 Source Removal and Onsite Treatment (and Disposal)

The option of source removal and onsite treatment and disposal is analogous to the waste removal option previously discussed in Section 3.2.1.6. The primary difference is that the radiological or chemical materials stored in the production area are presently contained in drums, tanks, silos, or other types of containers, and/or are better segregated and characterized than the wastes in the pits.

Candidate Sources:

- Thorium Inventory;
- Stored Waste Inventory;
- Underground Storage Tanks;
- Metal Waste Storage Areas;
- Currently Generated Wastes;

- Deactivated Facilities;
- K-65 Silos

3.3.1.6 Source Removal and Offsite Disposal

The important points of discussion regarding source removal and offsite disposal have been adequately addressed in Sections 3.2.1.7 and 3.3.1.5, and need not be repeated here.

Candidate Sources:

- Thorium Inventory;
- Stored Waste Inventory;
- Underground Storage Tanks;
- Metal Waste Storage Piles;
- Currently Generated Wastes;
- Deactivated Facilities;
- K-65 Silos

3.3.1.7 Non-Removal With Improved Containment

The alternative of non-removal with improved containment can be compared to the option of removal with onsite compliance disposal described in Section 3.2.1.5. In the case of the production area wastes, however, the material is directly accessible and can be overpacked or moved to more environmentally controlled areas or improved holding facilities (e.g. aboveground tanks). The eventual implementability of these options will be highly dependent on regulatory constraints.

Candidate Sources:

- Thorium Inventory;
- Stored Waste Inventory;
- Underground Storage Tanks;
- Metal Waste Storage Piles;
- In-Process Materials;
- Currently Generated Wastes

3.3.1.8 Waste Minimization

Waste minimization as a remedial action category would include any production or process modification that reduces the ultimate volume of waste produced. Pretreatment of waste streams would also be considered as a waste minimization action. It is expected that the development and analysis of such options for

purposes of the FS will be well-coordinated with plant personnel. This is necessary due to the expertise involved and the need to maintain consistency with current and planned plant operations.

Candidate Sources:

- Currently Generated Wastes

3.3.1.9 Waste Stream Segregation

The proper segregation of low level radioactive, clean and hazardous wastes is a cost effective practice to minimize environmental impacts. Current waste segregation practices will be evaluated.

Candidate Sources:

- Currently Generated Wastes

3.3.2 Informational Needs

Several of the informational needs associated with production area sources are analogous to those previously described for waste area sources. These include the following:

- Characterization of Past and Current Releases
  - Counterpart: Nature of Wastes Stored (Section 3.2.2.1)
  - Affected Sources: Air Emissions
- Nature of Materials Stored and Waste Streams
  - Counterpart: Nature of Wastes Stored (Section 3.2.2.1)
  - Affected Sources:
    - -Stored Waste Inventory;
    - -Underground Storage Tanks;
    - -Metal Storage Area;
    - -In-Process Materials;
    - -Currently Generated Wastes;
    - -Thorium Inventory
- Regulatory Constraints
  - Counterpart: Regulatory Constraints (Section 3.2.2.9)
  - Affected Sources:
    - -All

- Potential for Leachate Formation and Migration

  - Counterpart: Leakage Potential (Section 3.2.2.3)
  - Affected Sources:

    -Thorium Inventory;
    -Stored Waste Inventory;
    -Metal Waste Storage Areas;
    -Underground Storage Tanks;
    -In-Process Materials

3.3.2.1 Depositional Patterns

An understanding of the depositional patterns associated with particulate emissions is important for three reasons. First, the degree of risk resulting from such emissions, and hence the need for and extent of remedial action, is dependent on the depositional patterns and the corresponding doses reaching offsite receptors. Second, the types of depositional patterns could indicate the types of source modifications that could alter these patterns. Finally, such information on environmental fate and transport can be used for a calibration of the atmospheric transport model.

Affected Source:

- Air Emissions

3.3.2.2 Potential for Contaminant Resuspension and Transport

Any problems with the stormwater system would be non-existent if the runoff was not slightly contaminated with radionuclides and possibly hazardous chemicals. A basic issue, therefore, is the likelihood of stormwater runoff to resuspend and transport contaminated soil particles in the immediate vicinity of historic contamination sources. A better understanding of this mechanism could influence the assessment of flow diversion and control options in the FS.

Affected Sources:

- Deactivated Facilities

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3.3.2.3 Potential for Leakage

The potential for leakage is used in this case to account for any structural deficiencies in pipes, drums, tanks, channels, etc. that would result in an unplanned point discharge of contaminants to the adjacent environment. Not only is the identification and characterization of such discharges important to a full understanding of the site problems, but responsive remedial actions are typically straightforward. The potential for leakage must also consider any deterioration of the various transport and storage units so that preventative measures can be used to avoid future releases.

Affected Sources:

- Stored Waste Inventories;
- Thorium Inventory;
- Underground Storage Tanks;
- Metal Waste Storage Piles;
- In-Process Materials;
- Currently Generated Wastes

3.3.2.4 Potential for Environmental Migration

The potential for environmental migration is primarily associated with the movement of contaminants from those waste sources where an episodic release of liquid wastes could occur. The stored drums and the underground storage tanks typify such sources. The eventual resolution of this issue in the RI will depend primarily on an assessment of any positive containment measures and the characteristics of the underlying soils and hydrogeologic setting.

Affected Sources:

- Thorium Inventory;
- Stored Waste Inventories;
- Underground Storage Tanks

3.3.2.5 Ultimate Source of Waste Streams

The analysis of waste minimization options and waste stream segregation requires an understanding of the source and modifications of the waste stream throughout the corresponding processes. It is expected that much of the necessary information to address this issue will be available from plant personnel and process diagrams, although some process line sampling may be necessary to fill information gaps or for confirmatory purposes.

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Affected Source:

- In-Process Materials;
- Currently Generated Wastes

3.3.3 Summary

Figure 3.3 has been prepared to summarily relate the potential remedial actions, informational needs, and investigative tasks associated with the production area sources. The entries are varied due to the dissimilar nature of the sources, as evidenced in the previous discussions. Whereas many of the entries in Figure 3.3 are different than those in Figure 3.2, many of the investigative tasks necessary to gain the information are of the same type. The technical activities common to these tasks are presented within the framework of an RI work plan in Section 4.0.

3.4 ON-SITE RECEPTORS AND PATHWAYS

The potential remedial actions and information needs for the onsite receptors and pathways are generally comprised of a combination of those associated with contaminant sources at the waste areas and production area. An effort will be made, therefore, to make use of the information presented in Sections 3.2 and 3.3, while highlighting any important differences.

3.4.1 Potential Remedial Actions

Two of the six remedial actions identified in Figure 3.3 have been treated in a previous section. These include:

- Surface Runoff Diversion and Control
  - Counterpart: Flow Diversion and Controls (Section 3.3.1.4)
  - Candidate Receptors/Pathways:
    - Stormwater System;
    - Surface Drainageways;
    - Effluent Line;
    - Clear Well
- Repair/Replace Unit
  - Counterpart: Repair/Replace Existing Units (Section 3.3.1.3)

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- Candidate Receptors/Pathways: Main Effluent Line; Clear Well; Stormwater System

The remaining potential remedial actions are described below.

3.4.1.1 Channel Lining

The alternative of channel lining is applicable only to well- defined drainageways that are currently underlain by either natural soils or deposited sediments. The purpose of channel lining is two fold: to eliminate the leakage of potentially contaminated surface water runoff to the underlying unsaturated zone, and to prohibit direct contact with previously contaminated bottom matrials. A variation to this alternative would be to remove the contaminated soils and sediments prior to lining. The implementation of other types of potential remedial actions, such as flow equalization and surface water diversion and controls, may greatly reduce the need for and cost-effectiveness of channel lining.

Candidate Receptors/Pathways:

- Stormwater System;
- Surface Drainageways

3.4.1.2 Soil/Sediment Removal

The removal and disposal of contaminated soils or sediments would represent an immediate severance of an environmental pathway of contaminants to groundwater, surface waters, biotic, and possibly public health receptors. The permanency of the solution would, however, require a concurrent elimination of the contaminant sources. Two important decision issues would accompany any soil or sediment removal option. These are the disposal issue, which would be dependent on both the volume and character of the materials to be removed, and the target level of residual contamination that would be acceptable from public health and envioronmental standpoints.

Candidate Receptors/Pathways:

- Stormwater System;

- Surface Drainageways;
- Main Effluent Line;
- Clear Well;
- Surface Soils;
- Subsurface Soils

3.4.1.3 Groundwater Pumping and Treatment

Groundwater pumping and treatment represents a commonly utilized approach for ground water remediation in those cases where chemicals released from waste materials have already migrated away from the source. Any such actions would have to meet clean-up standards as provided in Section 121 of SARA, including state applicably or relevant and appropriate requirements (ARAR's).

Conditions most favorable for this alternative are a well-defined, undirectional plume of limited extent and an aquifer in which pumping can be reasonably controlled. The feasibility of this alternative may be severely restricted in a highly permeable aquifer of great depth and lateral extent, or if recharge from surface water bodies represents a high percentage of flow contribution due to the concomitant dilution of the chemicals and the lack of effectiveness in treating the resultant low-concentration waste stream. Regional sources of ground water pollutants that could be drawn into the pumping well would also reduce the effectiveness of this alternative.

In terms of these general criteria for feasibility and effectiveness, conditions at the FMPC will be evaluated in the FS based on information and data gained in the RI. For example, other sources of off-site ground water contamination have not yet been substantiated and may not be a factor.

One variation of this option would be to strategically locate pumping wells so as to offset other pumping stresses, and thus to modify local groundwater flow patterns. The success of such an action would be very difficult to establish by predictive models, however, and consideration would have to be given to both the effects on existing production wells and any temporal changes that would occur if other wells are temporarily or permanently shut down. A possible need to treat the pumped water would considerably affect the cost of this option.

Candidate Receptors/Pathways:

- Groundwater Below the FMPC

3.4.1.4 Clean Soil Cover

The implementation of a clean soil cover over highly contaminated soils would eliminate any problems associated with direct human contact and stormwater runoff contact. However, the potential contamination of underlying groundwater would remain unless an impermeable cover material is used, and effects on flora would not be totally eliminated if the root zone extends to the underlying contaminated soils. Only a very localized implementation of this option can, therefore, be expected:

Candidate Receptors/Pathways:

- Surface Soils;
- Subsurface Soils

3.4.2 Informational Needs

Many of the informational needs associated with the initial receptors and pathways have been treated in previous sections. These include:

- Potential for Contamination of Groundwater
  - Counterpart: Leakage Potential (Section 3.2.2.3)
  - Affected Receptors/Pathways:
    - Stormwater System;
    - Surface Drainageways;
    - Surface Soils
- Hydrogeologic Setting
  - Counterpart: Local Hydrogeologic Setting (Section 3.2.2.4)
  - Affected Receptors/Pathways:
    - Stormwater Outfall Ditch;
    - Drainages at Waste Areas;
    - Main Effluent Line;
    - Clear Well
- Condition of Unit/Potential for Leakage
  - Counterpart: Potential for Leakage (Section 3.3.2.3)
  - Affected Receptors/Pathways:

-Main Effluent Line;
-Clear Well

- Effects on Surface Runoff

  - Counterpart: Potential for Contaminant Resuspention/Transport (Section 3.3.2.2)

  - Affected Receptors/Pathways: Surface Soils; Subsurface Drainageways

Other informational needs not accounted for above will be described in the following sections.

3.4.2.1 Nature and Extent of Soil/Sediment Contamination

For the FS, the need for and extent of any remedial action must be evaluated with respect to a baseline understanding of the problem. The nature and extent of soil and sediment contamination represent important aspects of the problem definition. Not only do these issues define the volume of soil or sediment to be removed or otherwise remediated, but they also are a consideration in disposal or treatment requirements. Most problems originating in soils and sediments, including the public health risks and environmental impacts, are also directly related to the nature and extent of the contamination.

Affected Receptor/Pathways:

- All (with the exception of Groundwater Below the FMPC: see below)

3.4.2.2 Nature and Extent of Groundwater Contamination

This informational need represents a baseline issue since it defines the bounds of the groundwater effects that must be addressed in the risk assessment and feasibility study. The nature and extent of any groundwater impacts associated with FMPC operations are of particular relevancy to the assessment of the no-action alternative and the groundwater pumping and treatment alternative. The characterization of onsite groundwater conditions is also important since any problems at offsite groundwater receptors are directly related to onsite conditions and what "crosses the fence line". The potential application of groundwater quality standards as a clean-up criterion would also dictate that a quantification of the nature and extent of onsite

groundwater contamination be achieved.

Affected Receptors/Pathways:

- Groundwater Below the FMPC

3.4.2.3 Relative Source Contributions

The feasibility and effectiveness of several remedial action alternatives are dependent on a knowledge of the various source terms for two principal reasons. First, the long-term effectiveness of the actions would be better served if controls of the major source terms are concurrently implemented. Second, the prioritization or location of some actions would likely be a function of the type and magnitude of the sources. Some options could also be impacted if upstream or upgradient sources of contamination exist. The observed presence of radionuclides in the Great Miami River at the Ross-Venice Bridge is an example of the latter issue.

Affected Receptors/Pathways:

- All (to varying degrees)

3.4.2.4 Mass Flow Rate to Receiving Streams

Although various concentrations of surface water contamination have been observed in the receptor and pathway elements, a more critical parameter is the rate at which contaminant mass is entering receiving waters. Not only do the risk and impacts at receptor locations depend on mass flux, but the relative contributions from a number of sources should also be compared in terms of relative mass flux for purposes of prioritizing response actions. An example is the main effluent line, the mass flux from which is an extremely small percentage of the background mass flux in the Great Miami River due to the large disparity in flow rates.

Affected Receptors/Pathways:

- All

3.4.2.5 Impacts on Flora and Fauna

Surface soils represent at pathway/receptor element for which a viable plant

and/or animal community is important for either environmental or use purposes. Livestock grazing is a critical element related to grasses growing on potentially contaminated soils. Therefore, an assessment of the overall impacts of environmental releases to soils must consider the degree of uptake by the flora and fauna. Similar concerns exist to a lesser degree for other receptor/pathway elements, and will be addressed as necessary in the RI.

Affected Receptors/Pathways:

- Surface Soils

3.4.2.6 Effects of Other Pumping Stresses

The assessment of groundwater pumping and treatment alternatives must consider the effects of existing pumping stresses on the performance of the proposed system. In turn, any negative effects of new pumping wells on the existing systems must also be understood. The potential use of pumping wells to offset the effects of other pumping operations, and hence to control groundwater flow patterns near the FMPC, has been discussed previously.

Affected Receptors/Pathways:

- Groundwater Below the FMPC

3.4.2.7 Rate and Dispersion of Groundwater Flow

A complete understanding of local groundwater flow patterns is a basic requirement for other investigative tasks (e.g., the modeling study and risk assessment) and the feasibility study. The net flushing rate of the aquifer is an important, technical issue in the assessment of plume migration and potential remedial actions (e.g., the groundwater pumping/treatment alternative). The importance of this issue centers on the time required to observe the benefits of source controls at receptor locations, which if short enough would reduce the need for response actions at the receptors. The vertical and horizontal dispersion of groundwater flow in porous media tends to "spread" the contaminants and effectively reduce concentrations with distance from the source. This process will be incorporated into the groundwater model.

Affected Receptor/Pathways:

- Groundwater Below the FMPC

3.4.2.8 Contaminant Attenuation and Transformation

Radiological and hazardous chemical constituents in a soil-groundwater matrix are subject to numerous types of physiochemical processes that result in either an actual reduction in contaminant mass (e.g., first order decay), or an entrapment of contaminants within the soil matrix (e.g., chemical adsorption). The net result of each type of process is an attenuation of the contaminant plume with distance from the source, and a retardation in the rate of movement of the contaminants. Such attenuation mechanisms are of obvious importance due to the concomitant reduction in contaminant dose reaching receptor locations via groundwater pathways. The same mechanisms also occur in the unsaturated zone, thereby reducing the contaminant concentrations reaching the aquifers as a result of environmental releases from waste areas, drainageways, contaminated soils, etc. Various modeling techniques are available to incorporate the effects of attenuation mechanisms into the analysis of contaminant migration in the RI. Groundwater monitoring data will be used for calibration purposes.

Affected Receptors/Pathways:

- Groundwater Below the FMPC;
- Surface Soils; Subsurface Soils

3.4.2.9 Surcharge/Flooding Potential

The surcharge of the stormwater system can result in contaminated surface water runoff bypassing the appropriate discharge point and entering more critical environments such as unlined drainageways. In addition, the potential for the runoff to contact contaminated soils increases if surcharging of the system causes localized ponding. This issue will be minimized upon completion of the FMPC equalization basin, and may not be a critical determinant in the FS.

Affected Sources:

- Stormwater System;
- Surface Drainageways

3.4.3 Summary

Figure 3.4 is a summary of the potential remedial action alternatives for onsite receptors and pathways and the associated informational needs. The investigative tasks being proposed to satisfy the informational needs are also presented in the figure. The latter relationship is further developed in Section 4.0.

3.5 OFF-SITE RECEPTORS AND PATHWAYS

3.5.1 Potential Remedial Actions

For purposes of this preliminary evaluation to focus RI/FS activities, the most feasible response actions for the five environmental receptors would appear to be oriented toward the reduction or elimination of the sources or pathways of contaminants to these receptors. The corresponding remedial actions have been addressed in detail in relation to the specific sources and receptors in previous sections, and need not be repeated in this section. The inclusion of only source and pathway remedial actions in this planning exercise does not eliminate other alternatives (e.g., off-site soil and ground water clean-up) from being evaluated in the FS. The results of the RI and risk assessment will determine whether other actions will have to be considered.

Offsite control of particulate emissions results only from source control onsite. The pumping and treatment of contaminated groundwater at offsite locations is entirely analogous to the option described in Section 3.4.1.3 for onsite groundwater. The hydrogeologic setting and general site conditions described in Section 3.4.1.3 could prove to be more pronounced at offsite locations, and the eventual implementation of an offsite pumping and treatment system may not prove to be a viable remedial action. The proposed modeling study and risk assessment will be used in assessing the effectiveness of this option.

The alternative of contaminated sediment removal has also been generally addressed in previous sections. Two points specific to Paddy's Run and the Great Miami River are:

- The general sand and gravel nature of the sediments in Paddy's Run and the Great Miami River would not be conducive to contaminant adsorption and entrapment. Therefore, any removal operations will likely be focused on depositional areas near bends and zones of ponding. Sampling during the RI will be used to confirm this hypothesis.

- Due to the relatively high flow velocities in the Great Miami River, the assessment of any sediment removal operation will have to consider the potential for contaminant release and transport during removal. The net environmental effect may be worse than the current, no-action condition. Periods of no flow would eliminate this concern in the case of Paddy's Run.

Another alternative that has been addressed in previous sections, but which has elements peculiar to Paddy's Run, is channel lining. The purpose of channel lining would be to eliminate the potential for leakage of contaminants to underlying soils and groundwater. On the other hand, channel lining would have significant impacts on stream ecology in general. In addition, groundwater discharge to or from Paddy's Run would be correspondingly eliminated, which could adversely modify migration patterns. An evaluation of channel lining in the FS will have to balance these conflicting effects.

Since the harvesting of any contaminated plants and aquatic organisms would necessarily destroy the same receptors that are to be "protected" by the response actions, this option would only be considered in terms of eliminating an environmental pathway of which the contaminated plants or organisms are a critical element. The ecological sampling to be conducted as part of the RI will help to clarify this issue.

3.5.2 Informational Needs

A review of the informational needs associated with the environmental receptors indicates a high degree of duplication with the informational needs described in previous sections. For consistency of presentation, a cross-referencing with the appropriate sections will be provided below. One exception to the general format is the regional aquifer receptor, which duplicates exactly the onsite groundwater issue in both the types of potential remedial actions and the associated informational needs. For this reason, a general reference is made to the contents of Section 3.4 rather than an element-by-element reference.

The following summaries provide a general cross-referencing to other sections:

- Nature and Extent of Contamination

  - Counterpart: Nature and Extent of Soil/Sediment Contamination (Section 3.4.2.1)

  - Affected Receptors:

    -Paddy's Run;
    -Great Miami River;
    -Flora and Fauna;
    -Regional Aquifer

- Potential for Contamination of Groundwater

  - Counterpart: Leakage Potential (Section 3.2.2.3)

  - Affected Receptors:

    -Paddy's Run;
    -Great Miami River

- Local Hydrogeologic Setting

  - Counterpart: Local Hydrogeologic Setting (Section 3.2.2.4)

  - Affected Receptors:

    -Paddy's Run;
    -Great Miami River

- Relative Source Contributions

  - Counterpart: Relative Source Contributions (Section 3.4.2.3)

  - Affected Receptors:

    -All

- Mass Flow Rate

  - Counterpart: Mass Flow Rate to Receiving Streams (Section 3.4.2.4)

  - Affected Receptors:

    -Paddy's Run;
    -Great Miami River

- Impacts on Indigenous Flora and Fauna

- Counterpart: Impacts on Flora and Fauna (Section 3.4.2.5)
- Affected Receptors:

  -All

- Sediment Resuspension Potential
  - Counterpart: Potential for Contaminant Resuspension/Transport (Section 3.3.2.2)
  - Affected Receptors:

    -Great Miami River
    -(Paddy's Run to a lesser extent)

3.5.3 Summary

Figure 3.5 presents, in summary form, the relationship among potential remedial actions, informational needs, and the proposed investigative tasks for the offsite pathways and environmental receptors of concern to this RI/FS.

3.6 POTENTIAL EXPOSURE PATHWAYS TO THE PUBLIC

3.6.1 Potential Remedial Actions

Most remedial actions to respond to human exposure to contaminants are associated with the reduction or elimination of the sources and pathways of contaminants to these receptors. These actions, which have been addressed in detail in the respective sections on waste sources and pathways, do not physically involve the receptors themselves. Thus, the informational needs related to source and pathway options are simply referenced back to previous sections. Two exceptions are the nature of contamination at each receptor and the associated risks. Although not of critical importance to the engineering feasibility of source and pathway controls, these issues could be critical to a determination of the need for and extent of the actions.

The remaining remedial actions address the receptors themselves, and in turn are dependent solely on the conditions (and associated risks) at the receptor locations. These are described in the following sections.

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3.6.1.1 Alternate Water Supply

If the final recommendation of the proposed RI/FS is that no aquifer remedial action is necessary as long as the groundwater in the immediate vicinity of the site is not used as a potable water supply, it may be cost-effective to develop an alternate water supply for the affected populations. The use of an alternate water supply would also be a possible interim measure during a period of flushing if source controls are shown to represent an effective, long-term response action to groundwater clean-up. The alternate supply could take the form of a new well in a non-impacted aquifer, or the use of storage facilities and imported water at each user location. The use of a regional distribution system is limited by the low-density development and the large distances between users.

Candidate Receptor:

- Ingestion

3.6.1.2 Treatment at the Tap

The treatment of potable water supplies at the user locations represents both an alternative to an alternate water supply and a variation on the groundwater pumping and treatment alternative. The reasons for groundwater treatment at the tap would be similar to those just described for an alternate water supply. The feasibility of this alternative would be directly related to the availability of appropriate treatment technologies, which will be identified and evaluated in the FS. The Ohio Department of Health will be consulted as to the acceptability of such systems for private use before any related remedial action scenarios are developed and evaluated in detail.

Affected Receptors:

- Ingestion

3.6.1.3 Access or Use Restrictions

One passive alternative to reduce the risks associated with direct contact and ingestion exposure modes is to restrict access to and the use of affected environments. Whereas this is already the case within FMPC boundaries, access to and use of offsite areas such as the Great Miami River are not

restricted. The imposition of such restrictions would have wide-ranging community impacts. Restrictions could also be extended to restraints on the use of FMPC areas for crop production and livestock grazing. Access and use restrictions do not appear to be warranted outside the FMPC areas. The RI risk assessment will address this issue.

Affected Receptors:

- Direct Contact;
- Ingestion

3.6.2 Informational Needs

The nature of contamination at each receptor is obviously important to a determination of the need for and extent of remedial actions, since it establishes the past and potential exposure doses. The need to quantify both the current and residual risks to exposed populations has been previously addressed, and is not repeated in this section.

3.6.3 Summary

The relationship among potential remedial actions, informational needs, and the proposed RI activities for the potential exposure pathways to the public is presented in Figure 3.6.

SECTION 4.0

TECHNICAL APPROACH: REMEDIAL INVESTIGATION

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SECTION 4.0

TECHNICAL APPROACH: REMEDIAL INVESTIGATION

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SECTION 4.0

TECHNICAL APPROACH - REMEDIAL INVESTIGATION

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4.0 TECHNICAL APPROACH: REMEDIAL INVESTIGATION

The scope of work for the remedial investigation phase of the site-wide RI/FS has been formulated in accordance with the model statement of work in the FFCA. As such, the scope of work is of the following eight tasks:

- Task 1 - Description of Current Situation
- Task 2 - Work Plan Requirements
- Task 3 - Site Investigation
- Task 4 - Site Investigation Analysis
- Task 5 - Laboratory and Bench-Scale Studies
- Task 6 - Reports
- Task 7 - Additional Requirements
- Task 8 - Community Relations Support

With the exception of Task 3 (Site Investigation), the technical approach to accomplish these eight tasks is fully described in the following sections. The description of the site investigation phase of the work is limited to a concise statement of the objectives, scope, and justification for frequency, and the various types of field activities to be conducted. Additional details on each type of activity are in a detailed sampling plan, the sections of which directly coincide with the breakdown of activities in Section 4.2 of this work plan.

The scope of work included in this work plan is based on the current understanding of site conditions and anticipated RI findings. Revisions may be necessary to ensure that the objectives are satisfied as a more complete information base is developed during the progress of the RI.

4.1 TASK 1: DESCRIPTION OF CURRENT SITUATION

A compilation and review of documents and analytical data pertinent to the FMPC was undertaken concurrent with the preparation of this work plan to compile an informational base for determination of data gaps. In addition, an initial site reconnaissance was conducted in order to field verify the conditions assumed in the preparation of this work plan. Observations of the surface conditions of the site were made to ascertain any health concerns related to direct contact with exposed waste material or potentially

contaminated soils. The site conditions were also evaluated to determine ground water, surface water, sediment, soil, waste, and other types of sampling locations.

The review and critical evaluation of the existing informational base is a continuing activity. The understanding of the current situation gained as a result of the review of the existing information is reported as Task 1 - Description of Current Situation. This task deliverable summarizes the setting, location, pertinent area boundary features, general site physiography and hydrogeology, and the historical use of the FMPC for the treatment, storage, and disposal of both hazardous and radioactive materials. A history of response actions, permit requirements, and a definition of boundary conditions for the RI/FS will be addressed. The nature and extent of the environmental problems associated with the FMPC are summarized in terms of the actual and potential off-facility and on-facility health and environmental effects.

Sections 2.0 and 3.0 of this work plan present the preliminary understanding of the problem and the preliminary evaluation completed as part of Task 1. These sections were prepared to better focus the understanding of the current situation to the sitewide RI/FS.

4.2 TASK 2: WORK PLAN REQUIREMENTS

In addition to the work plan presented herein, the activities completed under Task 2 included the preparation and review of six supporting documents that direct and control the technical activities to be conducted during the RI. These include:

- Sampling Plan - The primary purpose of the Sampling Plan is to provide justification and specific methodological and control guidance for all field work to be conducted during the RI. The sampling plan includes procedures for the collection, preservation, and handling of samples from environmental media. The following types of field investigations are addressed in the Sampling Plan: radiation measurements; surface soils; subsurface soils; ground water; sediment; surface water; biological resources; and facility testing. Section 4.2.1 discusses the Sampling Plan in more detail.

- Health and Safety Plan - The Health and Safety Plan is a site-specific document that identifies and assess physical and chemical

hazards to which field crews may be exposed. It identifies the potential exposure in relation to permissible exposure levels, and defines appropriate protection levels prior to the activation of field work. The levels of protection reviewed and modified as new data are acquired in the course of the site investigation. The Health and Safety Plan has been prepared in accordance with both EPA guidance documents and the specific requirements of DOE and its contractors.

- Community Relations Plan - A Community Relations Plan was developed to provide the community with accurate, understandable, and timely information on RI progress; to give community members the opportunity to review data and analyses so as to contribute informed viewpoints during planning efforts; and to develop good working relationships with community members to promote continued progress of the RI/FS. The plan is based on guidelines developed by the U.S. EPA, and may be subject to change as the level and nature of community awareness and involvement require.

- Data Management Plan - The general purpose of the Data Management Plan is to provide a formatted, controlled clearinghouse for pertinent historical and newly collected data. The plan defines the capabilities of the data base management system, the upload and download format requirements, the associated security and administrative functions, and the integrated graphic features.

- Quality Assurance Project Plan - A Quality Assurance Project Plan was prepared in accordance with EPA guidance documents and DOE orders. The plan was developed to serve as a detailed guide for all sampling and analytical activities so as to ensure that the procedures used do not detract from the quality of the results, and to ensure that all activities, findings, and results follow an approved plan and are properly documented.

4.2.1 Sampling Plan

In Section 3.0 an investigative framework that related potential remedial actions, informational needs, and investigative tasks was utilized to present the types of RI activities that will be conducted at each source, pathway, and receptor. The Sampling Plan is the document that extends this general scope of activities into a specific series of monitoring, sampling, laboratory analyses, and related field tasks to be completed at the FMPC.

In accordance with the results of the preliminary evaluation (as illustrated in Section 3, Figures 3.2 through 3.6), 17 investigative tasks were considered necessary to satisfy the informational needs of the RI/FS. The next phase of the planning process was to translate the generic informational needs identified in Figures 3.2 through 3.6 into meaningful field data collection

efforts that would be consistent with both the currently available data base (so as to achieve cost-effectivness while avoiding redundancy) and site-specific conditions. Only the subset of the investigative tasks that corresponds to site investigation activities (i.e., field data collection efforts) under Task 3 of the RI/FS are of importance to this section. Ten such tasks were identified, corresponding to seven sampling plans (Table 4.1).

Also indicated in Table 4.1 are five investigative tasks that are being provided by ongoing or completed programs. The first, termed the Characterization Investigation Study (CIS), involves sampling of the wastes presently stored in Pits 1 through 6, the burn pit, lime sludge ponds, sanitary landfill, fly ash piles, and silos 1, 2, and 3 (i.e., K-65 silos and metal oxide tank). Each waste storage pit was cored to its full depth at several locations. Samples for physical and chemical analysis were composited from the cores.

In the same study, surface geophysical surveys were used to provide information regarding relatively shallow subsurface conditions throughout the central and southwest portions of the FMPC. The three techniques used were:

- Magnetometry - to locate areas in which buried metals occur;
- Ground Penetrating Radar (GPR) - to define the boundaries of the covered waste pits (i.e., Pits 1, 2, and 3) and to verify indications of buried metals (e.g., drums) from the magnetometer survey; and
- Electromagnetic Conductivity (EM) - to detect anomalously high conductivity in ground water and thus to show where contaminated ground water may be present.

A continuing comprehensive air monitoring program is conducted by WMCO as part of routine operations at the FMPC. This monitoring network was audited in April 1985 (DOE, 1985). Deficiencies noted in the audit report have been corrected and three off-site monitoring stations have been added to the network. At the present time, the monitoring of ambient concentrations of uranium and radon being performed by WMCO is adequate and satisfies DOE requirements for ambient monitoring of these constituents. The results of the ongoing monitoring program, when combined with the historic information, will provide an adequate data base for both the air modeling study and the risk

Table 4.1 Identification of Potential Field Activities

Investigative Task	Corresponding RI/FS Activity
Radiation Measurement	Task 3: Site Investigation (Radiation Measurement Plan)
Waste Sampling	(Provided by Characterization Information Study)
Surface Soil Sampling	Task 3: Site Investigation (Surface Soils Sampling Plan)
Sediment Sampling	Task 3: Site Investigation (Surface Water and Sediment Sampling Plan)
Surface Water Sampling	Task 3: Site Investigation (Surface Water and Sediment Sampling Plan)
Air Sampling	(Provided by ongoing WMCO program)
Ground Water Wells/Monitoring	Task 3: Site Investigation (Ground Water Sampling Plan)
Geophysics	(Provided by Characterization Information Study)
Deep Boreholes	Task 3: Site Investigation (Subsurface Soils Sampling Plan)
Vegetation Sampling	Task 3: Site Investigation (Biological Resources Sampling Plan)
Wildlife/Aquatic Resource Sampling	Task 3: Site Investigation (Biological Resources Sampling Plan)
Drum Sampling	(Provided by WMCO)
Waste Stream Sampling	(Provided by WMCO)
Facilities Testing	Task 3: Site Investigation (Facilities Testing Plan)
Ground Water Model	Task 4: Site Investigation Analysis

Table 4.1 (Continued)

Investigative Task	Corresponding RI/FS Activity
Air Model	Task 4: Site Investigation Analysis
Risk Assessment	Task 4: Site Investigation Analysis

assessment tasks of the RI/FS. A recent air modeling study conducted by IT Corporation and an ongoing modeling study by IT for purposes of supporting the Center for Disease Control's dose-effects willindicate if the data are adequate.

The remaining studies, a composite sample of each lot of the stored drums and a program of waste stream sampling, are being performed by WMCO. Data from these sampling activities will be evaluated and incorporated into the RI/FS data base in accordance with the QAPP. The completeness of the data collected from these programs will be reviewed in terms of the RI/FS data needs before additional work is performed.

The seven sampling plans combined represent a responsive scope of field investigations reflective of the current understanding of the FMPC and associated environmental concerns. Additional data collection and evaluation efforts now underway may contribute to refinements in the sampling plans. The progressive findings of the field activities proposed in the plans may reveal a need to increase the scope of the data collection efforts.

4.2.1.1 Radiation Measurement Plan

Objectives and Justification

Direct radiation measurements were performed in 1976 and 1985 at the FMPC site and its immediate environs by EG&G Energy Measurements, Inc., using the Aerial Measuring System (AMS). The results of these studies indicate that external radiation exposure rates at the site boundary, and for much of the site, do not exceed two times background levels for the area. Direct radiation measurements made at the site boundary by WMCO, using thermoluminescent dosimeters, confirm that external radiation exposure rates are at or near background levels for the area.

Although these survey results indicate that there may be no direct radiation hazard at the site boundary, valuable information can be obtained by performing direct radiation measurements on the FMPC site. Such direct radiation measurements are an essential part of an on-site assessment of radioactive contamination of surface soils.

The radiation measurement program will focus on characterizing the surface radiation fields within the FMPC. Direct radiation measurements indicate the magnitude of the radiation field at the location of the detector. Since the field strength is determined, in part, by the location and magnitude of radiation sources near the detector, measurements made with portable radiation survey instruments are used to locate and quantify radioactive materials in the field. Radiation measurements obtained in this investigation will be used in five principal ways:

- To collect sufficient data to quantify surface radiation fields;
- To develop exposure rate contours for selected areas of the FMPC site;
- To develop uranium concentration contour estimates for selected area of the FMPC site;
- To locate anomalies in both exposure rate contours and uranium concentration contours for further investigations; and
- To indicate the locations for biased surface soil sampling.

Scope

In order to assess the levels of radioactive contamination, radiation detection/measurement instruments must be chosen which can detect the type and energy of the radiations of concern. To assess radiation levels in the Production Area and other FMPC environs, radiation measurements will be performed using photon detectors coupled to survey meters. These will detect and quantify radiations emitted by uranium, thorium, and their daughter radionuclides. The principal goals of performing the radiation measurements in these areas is to provide a graphic identification of the areal extent of above-background surface radiation levels. From this information, the need for further sampling and analysis to determine radioactive contamination levels for surface soil can be identified.

Previous radiation measurements have been performed along Paddy's Run, in the storm sewer outfall ditch, and in the waste storage areas. Measurements from these areas and any other areas for which radiation measurement data are available will be evaluated for quality and completeness following the guidance presented in EPA's draft Data Quality Objectives, 1986. Areas which

have sufficient radiation measurement data will not undergo additional radiation measurements as a part of this phase of the remedial investigation. It is anticipated that the areas which will be surveyed are:

- The production area;
- The sewage treatment;
- The incineration areas; and
- The perimeter of the waste storage areas (including the area west of the production area and the southfield areas).

Prior to beginning radiation measurements, these areas will have a 100-foot grid pattern established and marked. The grid will extend beyond these areas by at least 300 feet. Should subsequent radiation measurements indicate soil concentrations of uranium in excess of the reference level, then the grid will be extended beyond such areas by 300 feet. This grid will include properties off the FMPC property to the east of the sewage treatment and incinerator areas, and possibly other off-site areas. A 1,000-foot grid pattern will be established and marked for the remainder of the FMPC site. Figure 4-1 shows the areal extent of radiation measurements to be performed for the FMPC site.

Reference Level

A reference level of 35.0 pCi/g for uranium-238 in soil, as indicated by radiation measurements, will be used to determine biased soil sampling locations. This reference level is not chosen as the remediation requirement for soil concentrations of uranium, since such a level will be determined after the environmental dose pathways analysis has been completed as part of the RI/FS. In addition, this concentration corresponds to the lower limit of detection of the most sensitive portable radiation survey instruments which can be used to detect uranium-238 daughters. These instruments are described below.

Based on a review of the operating history and radionuclide emission inventories for the FMPC, it has been determined that uranium isotopes (uranium-238 and uranium-234) were the principle radionuclides released from the FMPC which would be present in surface soils in the vicinity of the

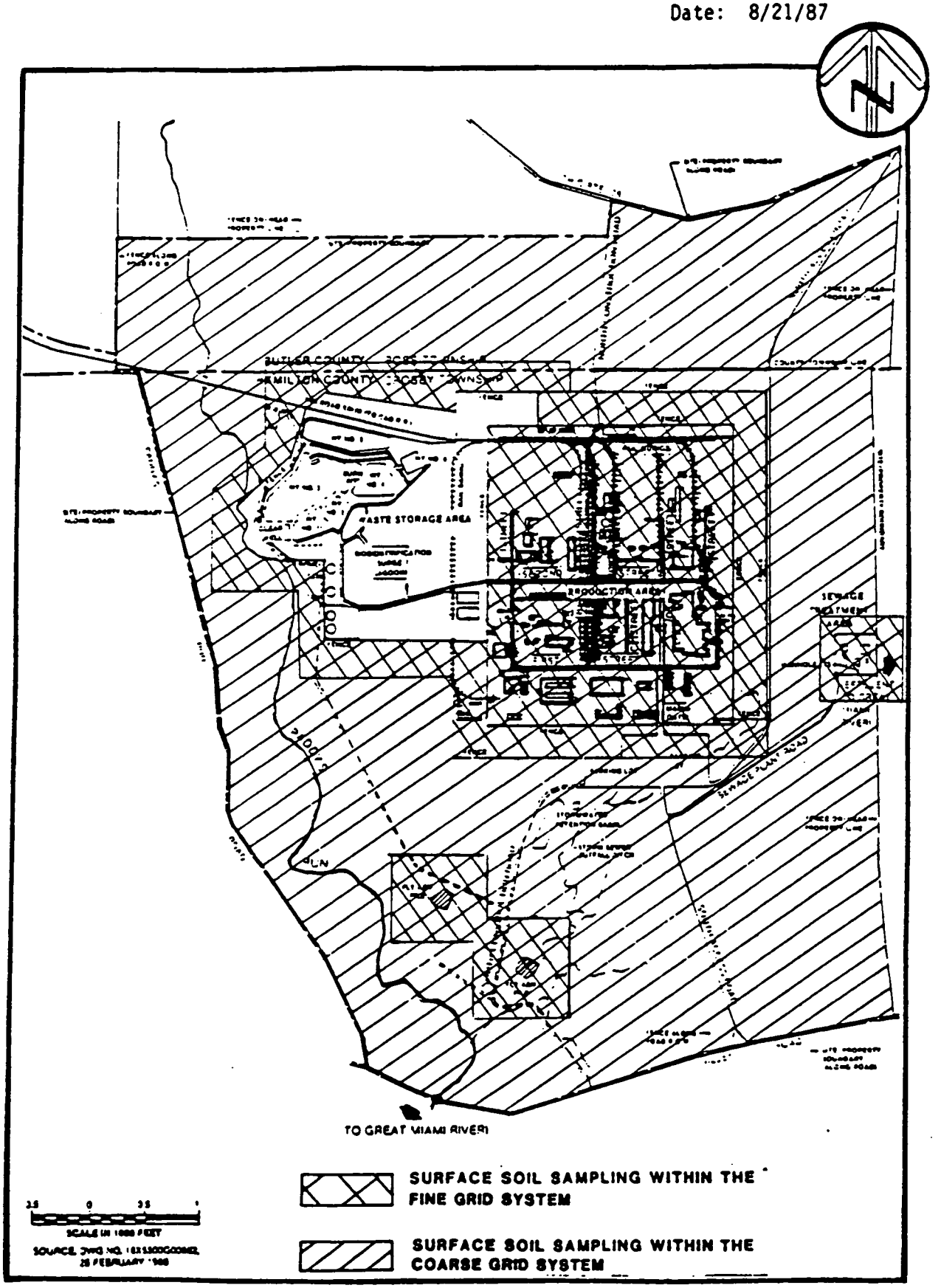

FIGURE 4.1

AREAL COVERAGE: SURFACE SOIL SAMPLING LOCATIONS

FMPC. In situ detection of these radionuclides in soil requires the use of portable radiation survey instruments which can detect gamma rays emitted by uranium-238 daughter radionuclides (thorium-234 and protactinium-234m). Both low-energy photon detectors and large-volume scintillation detectors (for high-energy gamma ray detection) will be used in the survey. Although these instruments have been chosen because of their high sensitivity for detection of uranium-238 daughter radionuclides, they will also detect other gamma-ray emitting radionuclides which may be present.

Low-energy photons, such as the 63 keV gamma rays emitted by thorium-234, are best detected with a Field Instrument for Detecting Low-Energy Radiations (FIDLER). The estimated lower limit of detection (LLD) of the FIDLER is approximately 35 pCi/g for uranium-238 in soil. This value of the LLD for the FIDLER is a key factor upon which the reference level is based.

Although the reference level of 35.0 pCi/g will be used to guide the collection of biased soil samples, the choice of this level will not preclude collection of soil samples with concentrations of uranium-238 less than 35.0 pCi/g. Radiation measurements and random soil sampling will be performed throughout the site, including areas previously determined to have soil concentrations of uranium-238 less than 10 pCi/g.

There will be a walkover of each 100-foot grid using portable scintillation survey instruments to detect and measure both the gamma-ray field and the X-ray field. Prior to the walkover survey, each 100-foot grid will be subdivided into sixteen 25-foot grids. This will allow adequate coverage of the grid during the walkover. Both large volume and FIDLER probes will be used. Continuous measurements will be performed over each grid area with an integrated reading. Locations within each grid which yield an instrument reading corresponding to a soil concentration in excess of the reference level will be marked by dropping a weighted flag at that location. Grid areas and grid points that occur on buildings or paved areas will not be surveyed. Instead, measurements will be made at the surface of the ground adjacent to the buildings or paved areas which are affected.

Measurements with a Pressurized Ionization Chamber (PIC) will be made at selected locations to determine the magnitude of the gamma-ray field (exposure rate) and to calibrate the hand-held, large-volume scintillation survey instruments. At least fifty (50) locations will be selected to provide PIC measurements which are representative of each area to be surveyed. The locations for PIC measurements will be dispersed throughout the radiation measurement locations shown in Figure 4.1 and will be selected to cover the entire range of exposure rates encountered at the site.

Grids for which instrument surveys indicate uranium concentrations exceeding the reference level (as flagged on the walkover survey sheets) will be further characterized by additional radiation survey instrument measurements to better define the areal extent of the contamination of that grid and adjacent grids. This will be done by performing a walkover survey of the area centered on the flagged location. The determination of the necessity and number of soil samples to be collected in any grid with an indicated uranium concentration greater than the reference level will be made according to Section 4.2.1.2, Surface Soil Sampling Plan.

The radiation field (exposure rate) will be measured at each grid point of the 1,000-foot grid at a height of one meter from the surface of the ground. Measurements will be performed using large-volume scintillation detectors. Field calibrations will be performed at no fewer than 20 locations using the PIC. The PIC will have a calibration traceable to the National Bureau of Standards prior to performing on-site measurements.

4.2.1.2 Surface Soils Sampling Plan

Objectives and Justification

The data on surface soil contamination at the FMPC has been collected primarily near the site boundary and off site. With the exception of 12 samples collected in 1984, uranium was the sole parameter of analysis. The data collected in these studies suggest that contamination by uranium in surface soils off site appears to be through the air pathway. Current data are adequate to describe off-site surface soil uranium concentrations, but not adequate to characterize on-site contamination of soils by radionuclides or hazardous ~~chemicals.~~ substances The following problems and data gaps are indicated:

- The extent of on-site soil contamination by radionuclides and hazardous chemicals is not known; and
- The areal and vertical extent of on-site soil contamination has not been defined.

The surface soil sampling program will focus on determining the effect that operations and waste disposal at the FMPC have had on the near surface soils and the degree that contaminated soils contribute to off-site migration of contaminants. Specifically, the objectives for surface soil sampling are to:

- Collect sufficient data to determine the extent of contamination by radioactive and hazardous chemicals on site;
- Confirm areas of surface radiological contamination identified in the radiation measurements survey and quantify the types and concentrations of radionuclides found;
- Provide data to characterize the source term for all radionuclides which have the potential to contribute to off-site environmental dose;
- Identify the types and determine the concentrations and areal extent of hazardous chemical contamination in surface soils on site; and
- Provide data that will determine where future subsurface soil sampling may be necessary.

The collected data will be used, along with previously collected data to:

- Develop a graphic representation of radiological contamination in surface soils on and near the FMPC;
- Evaluate the potential pathways for surface migration of radiological and chemical constituents away from the FMPC;
- Evaluate the actual and potential risk to public health and the environment resulting from surface soil contamination; and
- Identify the need for and evaluate remedial action alternatives for contaminated surface soils.

It is assumed that the surface soils sampling program recently conducted in the waste storage area as part of the CIS will provide data of the quality required for the RI/FS. As it becomes available, appropriate data resulting from the study will be included in the RI/FS.

Scope

Surface soil samples will be taken primarily in two general areas within the FMPC, as shown on Figure 4.2. The two areas are: (1) Production Area, sewage treatment area, and perimeter of the Waste Storage Area; and (2) remaining areas within the FMPC site boundary. In addition, surface soil samples will be taken off site at locations where vegetation samples will be collected and on site where required to provide data for field calibration of radiation measurement instruments.

Samples will be collected at the following locations:

1. Production Area, Sewage Treatment Area, and Perimeter of the Waste Storage Area

   Sample locations for radiological analyses will be determined upon completion of the radiation measurement survey. Localized areas indicated by instrument response as having elevated radiation levels as flagged in the walkover survey, will be sampled. For large areas with elevated radiation readings the radiation isopleths will be used to define and specify areas where surface samples will be taken. The criteria for selecting areas for surface soil sampling will be those areas that exhibit radioactive contamination which exceeds the reference levels defined in the Radiation Measurement Plan.

   Such areas identified for collecting surface soil samples are biased areas. Within large areas identified for biased sampling, a grid will be established with the same orientation as the 100-foot grid established for the radiation measurements survey. Soil sample locations on the grid will be selected using a random approach that assures all areas of the grid have the same probability of being selected and assures that a statistical representation of the area will be obtained. In addition, biased samples will be taken within each identified area which exhibit the highest surface radiation measurements of radionuclides in that area. It is estimated that approximately 200 soil sample locations will be required to adequately characterize the radiological contamination in this area.

   Biased samples for chemical analysis will be collected at any known accidental spill sites, areas adjacent to storage tanks, areas adjacent to railroad tracks, and areas adjacent to transformer pads. Samples will be analyzed for chemical constituents to determine the presence of soil contamination. It is estimated that 10 soil samples will be collected for chemical analysis.

2. Remaining Areas Within the FMPC Site Boundary:

   Samples in this area will be collected for radiological analyses. Sample locations will be the 1,000-foot grid points.

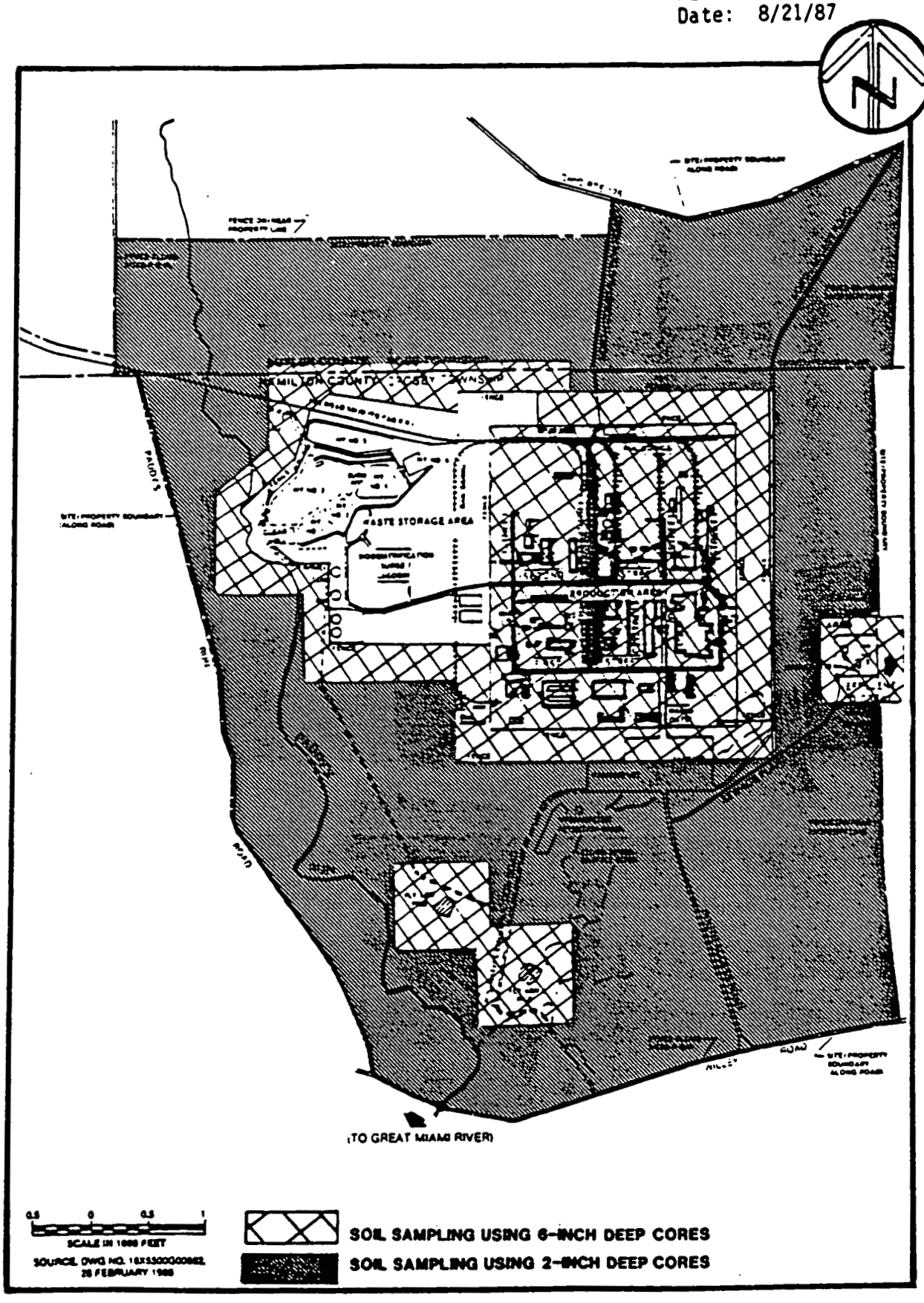

FIGURE 4.2
SURFACE SOIL SAMPLING METHODS

Samples for radiological analyses will be taken at three specified depth intervals at each identified sampling point. Samples will be taken at six-inch depth increments within the Production Area and sewage treatment area, and at two-inch depth increments outside the fenced areas and within the FMPC site boundary. The uppermost soil sample will be analyzed prior to the two lower samples. The two lower samples will be analyzed if concentrations exceeding the reference levels of radiological parameters are detected in the upper sample. Should contaminants be detected in all three samples, the location will be noted as a potential location for subsurface soil sampling.

Previous soil sampling work in the area of the FMPC has demonstrated that multiple depth samples from a single boring at each soil sampling location is adequate to support the mapping of soil contamination in the site environs (IT Corporation, 1986). In order to obtain an estimate of the variability of the measurement system, duplicate samples will be collected at 10 percent of the identified sample locations. The locations to be sampled in duplicate will be chosen at random.

Sample Density

A key objective of the surface soils sampling program is to investigate the spread of radionuclides over a geographical region by mapping the concentrations of the radionuclides and determining possible trends from an potential source. Concurrently, the mapping will identify the geographic boundaries of migration.

Many standard mapping techniques, however, do not account for the patterns of spatial continuity specific to each plume and do not yield any measure of reliability. The geostatistical technique of linear krieging, a method by which data are weighted according to their spatial continuity to predict the level of concentration, provides a commonly utilized solution. The krieging technique makes use of the variogram, a structural function characterizing spatial continuity (similarity among points as a function of the distance between them), and provides an estimate of reliability. However, practice has shown that linear krieging does not perform well in the presence of highly positively skewed frequency distributions such as those exhibited by the uranium concentration in soils at the FMPC. Variograms of concentration

levels tend to be ill-defined and overinfluenced by extremes. More importantly, the reliability measures do not provide any confidence levels, i.e., no degree of certainty, and the assumption of a normal distribution of errors is unjustified.

In cases of highly positively skewed frequency distributions, the use of the geostatistical technique known as "probability krieging" has been preferred (Flatman, et. al, 1985). This technique involves the application of linear krieging to estimate the conditional probability distribution of concentrations rather than the concentrations themselves. This conditional distribution method has several positive features for application to investigations such as the spread of radionuclides in the vicinity of FMPC:

- It is distribution free and resistant to extremes; hence, it can be applied to skewed data sets
- It yields confidence intervals which are not only data configuration-dependent but also data values-dependent
- It is reasonablly simple in application and has been shown to perform well

One application of the probability krieging technique is to identify data gaps and to provide information on the requisite distance spacing between locations for the collection of additional samples. As indicated on Figure 4.3, the dissimilarity between observations increases as the distance of separation between samples increases. That is, the amount of information to be gained on the concentration at a point by sampling at a second point decreases as the distance between the points increases. A trade-off therefore exists between maximizing the amount of information to be gained and minimizing the density (and cast) of a sampling program. An accepted rule of thumb is that the sampling distance should be equal to two-thirds of the range, which is the distance beyond which no information on one point will be gained by sampling at the second point (Jaurnel, 1986).

This technique was previously used in support of IT's soils sampling program at the FMPC. Using data on uranium in soils collected in 1984, an analysis

was performed to identify information gaps which had to be filled to map soil concentrations within an approximate five-mile radius of the FMPC. This distance was identified as approximately 2,400 feet.

This analysis was extended following IT's soil sampling program of the FMPC. Using only data from samples that exceeded 15 pCi/g, which would be pertinent when planning activities that are directed toward the identification of areas of elevated concentration, an application of probability krieging yielded a sampling distance of approximately 1,000 feet. This distance was well within the range of the resultant variogram.

The decrease in the distance from the 1984 value of 2,400 feet was due primarily to the inclusion of newly collected and higher concentration data from near the incinerator area. Since these conditions would lead to higher localized variability and a wider range of values, a smaller distance spacing between sampling points would be required to achieve the same statistical reliability.

For purposes of the RI/FS surface soils program, a 1,000-foot sampling grid was selected for those areas outside of the waste storage areas, Production Area, incinerator area, and the respective 300-foot extension zones (for which a 100-foot grid will be used). The selected spacing distance is considered to be conservative since the optimum value would be expected to lie between the 1,000-foot and 2,400-foot values previously computed. The reason is that concentration patterns in surface soils in the proposed 1,000-foot grid areas (e.g., pastures and woodlots on the FMPC) would be expected to lie between patterns in off-site areas (2,400 feet), where a more uniform distribution of concentrations approaching background is found, and those patterns highly influenced by data from the incinerator area (1,000 feet), where a more biased distribution toward elevated levels is found.

It is also important to note that the data from the radiological analysis of collected soil samples will be augmented by the results of the walkover radiation survey. The walkover survey will detect localized areas of surface soil contamination between grid points. Probability krieging is uniquely

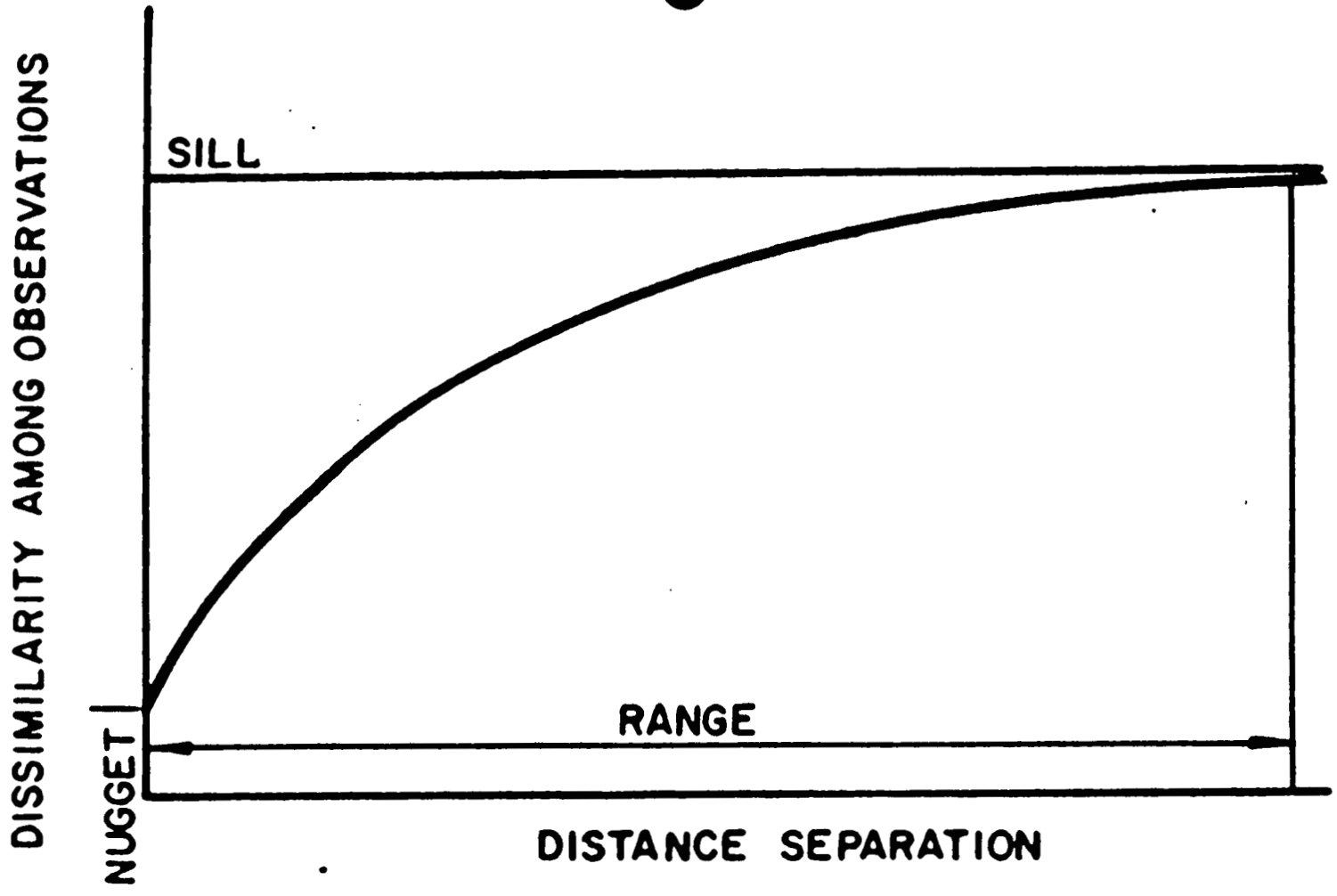

FIGURE 4.3
IDEALIZED VARIOGRAM

suited to the use of such combined data for spatial investigations (Jurnel, 1986).

Sample Analysis

Because soil samples collected for radiological analyses are taken where radiation levels exceed the reference level, samples designated for radiological analysis will be analyzed for the following parameters that are representative of the materials found at FMPC:

- Gamma Spectral Analysis
- Isotopic uranium
- Isotopic thorium
- Sr-90
- Tc-99
- Np-237
- Ra-226

Soil samples designated for chemical analysis will be analyzed for the following parameters:

- HSL Inorganics
- HSL Volatiles
- HSL Semivolatiles
- HSL Pesticides/PCBs

4.2.1.3 Ground Water Sampling Plan

Objectives and Justification

The hydrogeological field program will focus on determining the effect that the operations and waste disposal practices at the FMPC have had on ground water. The overall objective of the Ground Water Sampling Plan is to satisfy identified data gaps in order to:

- Determine if subsurface water-bearing zones below the FMPC have been contaminated both on site and off site
- Determine the concentrations and sources of contaminants on site and indicate any migration of hazardous substances off-site
- Characterize the rate and direction of ground water flow within each separate hydrologic unit

- Determine the effects pumping ground water and resulting recharge/discharge relationships have on ground water flow and contaminant transport, and
- Define areas of subsurface migration and ground water discharge for contaminants.

The study will focus on identifying sources of ground water contamination, pathways for contaminant transport, and receptors or potential receptors of the contaminants. The reason this study will focus on these issues is that one of the most critical decisions to be made in relation to the FMPC site outside of the waste storage area is the need for, and extent of, ground water remediation. Only by defining the ground water system and the sources and pathways of contamination can remedial actions be considered and their impacts assessed with respect to public health issues.

In order to achieve these objectives, a phased approach to field activities is planned. The first major phase of work, which is the subject of the Ground Water Sampling Plan, will concentrate on satisfying the principal data gaps in the current understanding of ground water flow patterns and ground water quality from a regional perspective and in relation to specific potential sources, pathways, and receptors. The Ground Water Sampling Plan represents a responsive plan reflective of the current understanding of the FMPC and associated ground water conditions. Additional data collection and evaluation efforts now underway may contribute to refinements in the final plan. This will ensure that field investigation activities will satisfy the overall study objectives without a redundancy of effort. Other or proposed ground water studies may reveal the need to change the number of proposed monitoring wells based on new interpretations of ground water flow patterns and contaminant plumes.

Scope

A total of 92 monitoring wells are proposed for installation during Phase I of the RI/FS. Three different water-bearing zones will be intercepted by the proposed monitoring wells. Figures 4.4 through 4.8 show the locations of the existing and proposed monitoring wells. Proposed well locations were selected based on data gaps identified from previous ground water studies and sampling results from the existing wells. The existing well locations were used to the

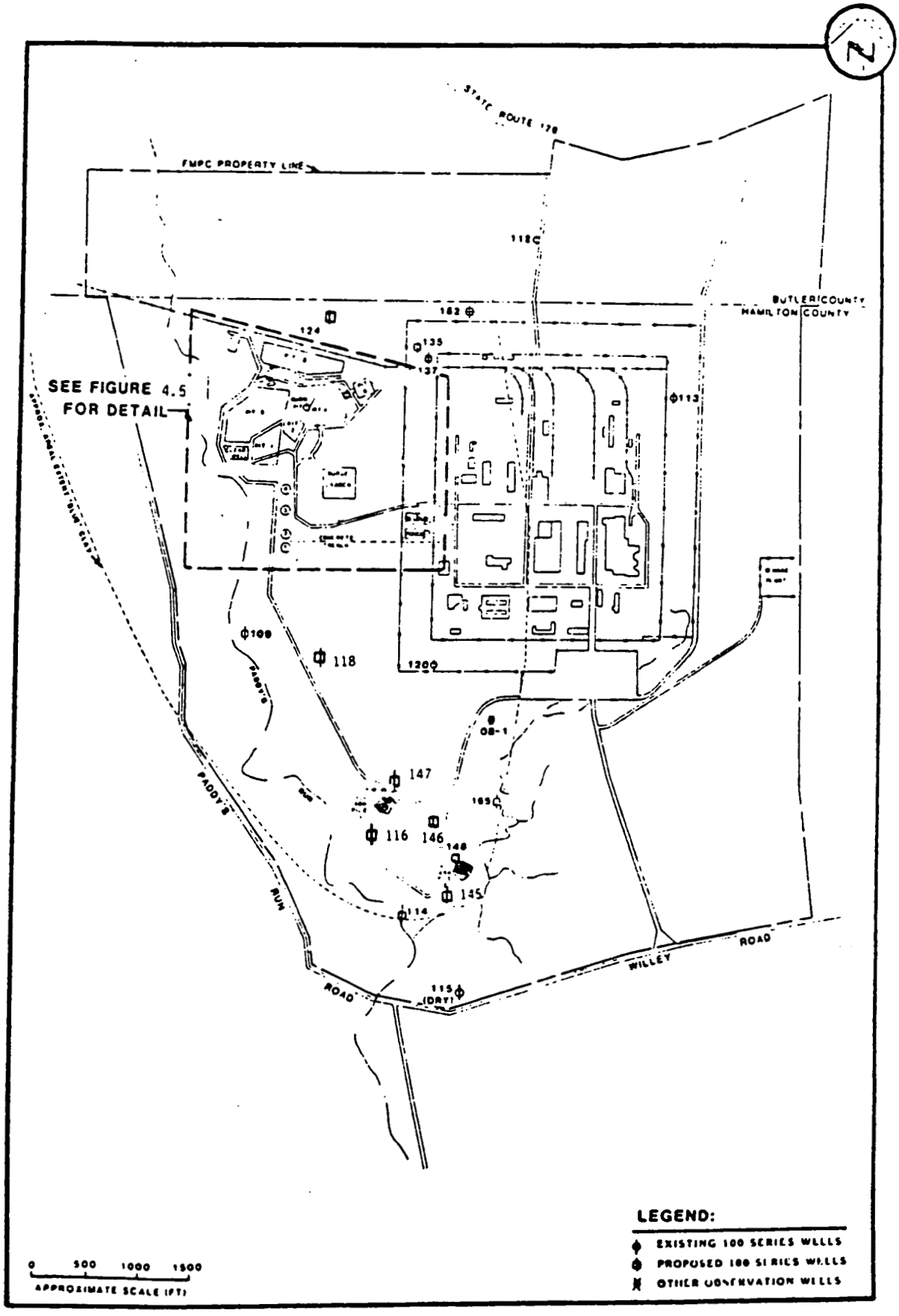

FIGURE 4.4

100 SERIES WELLS- GLACIAL TILL FMPC FACILITY

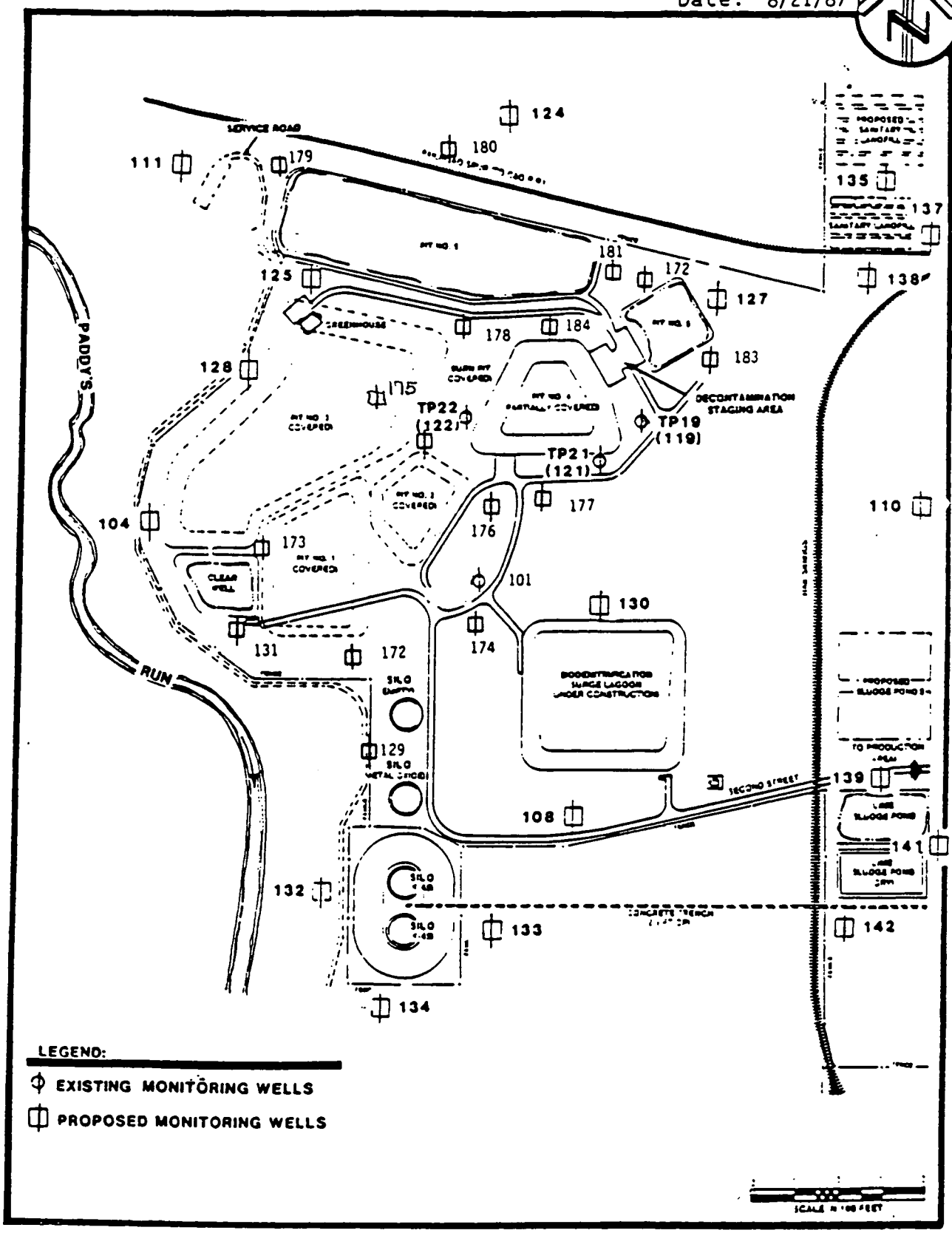

FIGURE 4.5
100 SERIES WELLS- WASTE MANAGEMENT AREA

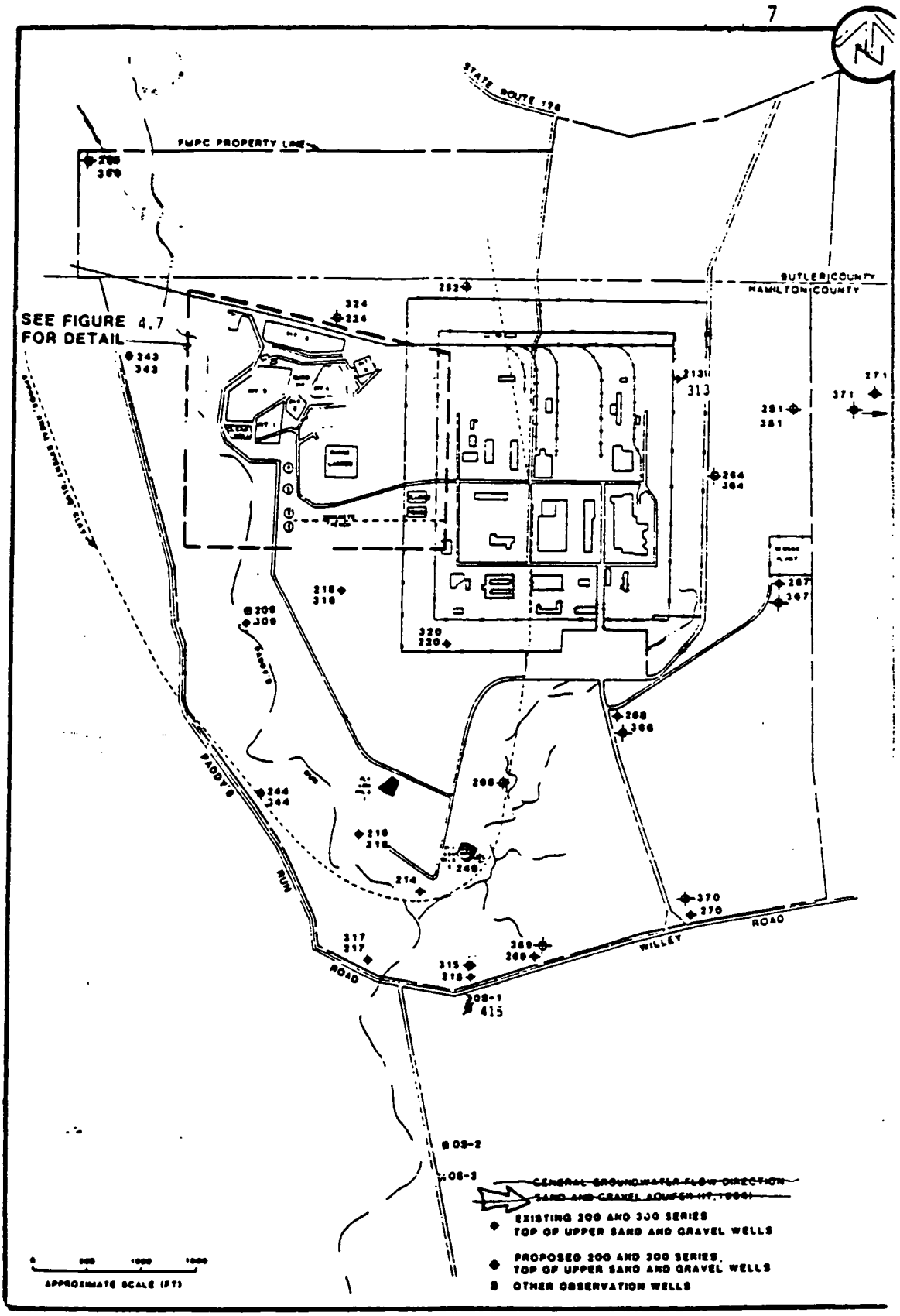

FIGURE 4.6

200 SERIES AND 300 SERIES WELLS - SAND AND GRAVEL AQUIFER FMPC FACILITY

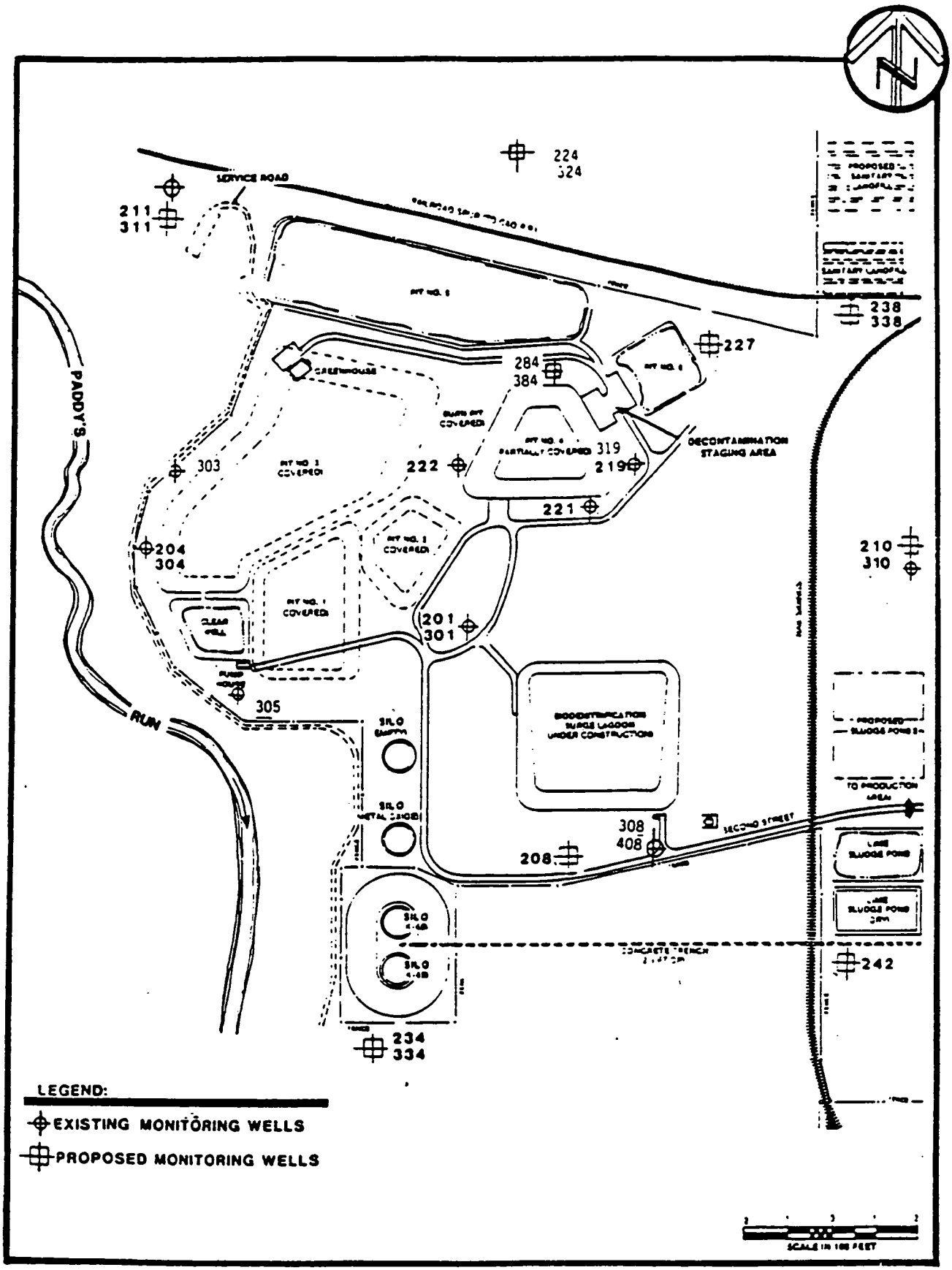

FIGURE 4.7

200 AND 300 SERIES WELLS- WASTE MANAGEMENT AREA

Figure 4.8

maximum extent possible in establishing the monitoring network for this investigation. Well depths at each location were selected to provide necessary information on the three aquifers of concern.

The number and specific locations of the new wells have been formulated around 17 unresolved technical issues and related data needs identified from the data quality objectives process. Table 4.2 has been prepared to relate each new well (as identified by its well number) to the issue or issues that its specific placement will address. Most wells address multiple issues, while each issue is addressed by at least one well. Also indicated in Table 4.2 are the existing wells at each location to highlight the two or three-well clusters being formed by the new wells.

The shallowest wells (100-series) will be completed primarily in the till and will screen either the water table or isolated perched water. Based on stratigraphic logs from existing borings on site, it is estimated that the wells in the till will be up to 35 feet deep. A total of 42 new shallow wells are proposed. The till material is the unit most likely to be contaminated by direct contact with wastes and by surface water infiltrating through waste areas and adjacent contaminated soils. In order to examine the extent of potential impact in the soils overlying the regional aquifer, it will be necessary to place a grouping of shallow wells immediately around the waste storage units and other potentially contaminated areas. This approach is necessary because stratigraphy within the till and near surface soils is variable and subsurface interpretations cannot be extended accurately across large areas. Only local interpretations of the flow system within this near surface unit are justifiable.

Most of these wells will be completed in till; however, the till may be very thin or absent in some proposed locations for shallow wells. Such a condition will not necessarily reduce the value of the shallow well, however, and a 100-series well will be installed in the upper 35 feet of the unit.

The sand and gravel outwash deposits which underlie the glacial till are hydrologically less complex than the till. These deposits are also more extensive and represent a regional-scale buried channel aquifer which is being

EXISTING WELLS				MONITOR GROUND WATER IN TILL NEAR WASTE AREAS	PROVIDE RING OF WELLS AROUND POTENTIAL SOURCE	EXAMINE FLOW AND QUALITY IN UPPER SAND AND GRAVEL	EXAMINE FLOW AND QUALITY IN LOWER SAND AND GRAVEL	EXAMINE VERTICAL FLOW COMPONENT IN SAND AND GRAVEL	CHARACTERIZE GROUND WATER EAST OF THE PRODUCTION AREA	EXAMINE POTENTIAL FLOW DIVIDE AND EASTWARD FLOW COMPONENT	PROVIDE ADDITIONAL DATA ON SOUTHERN FLOW COMPONENT	EXAMINE REGIONAL FLOW PATTERNS	PROVIDE BACKGROUND (UPGRADIENT) CONTROL POINTS	EXAMINE EFFECTS OF MAIN EFFLUENT LINE	EXAMINE EFFECTS OF FLY ASH PILES	EXAMINE EFFECTS OF STORM WATER OUTFALL DITCH	EXAMINE GROUND WATER QUALITY NEAR PADDY'S RUN	EXAMINE FLOW PATTERNS NEAR PADDY'S RUN	EXAMINE PRODUCTION AREA AS POTENTIAL SOURCE	EXAMINE GROUND WATER QUALITY AT FRPC BOUNDARY
100 SERIES	200 SERIES	300 SERIES	400 SERIES																		
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		303																			
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268							368	368	368	368	368		367						367	367	
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			184	184	284	284 384															

TABLE 4.2

PLACEMENT RATIONALE FOR PLANNED ON-SITE MONITOR WELL LOCATIONS

used for water supply purposes. Results of analysis of previous samples collected from the existing wells indicates contamination in this aquifer in the area immediately downgradient of the waste pit area. Analysis of samples from off-site wells to the south of the FMPC have also exhibited elevated levels of uranium. The nature and extent (vertical and/or horizontal) of this contamination cannot be adequately defined using the existing monitoring well network.

Therefore, a series of intermediate depth wells (200-series) will be installed to a depth of approximately 70 feet to screen the upper portion of the upper sand and gravel aquifer. Twenty-two 200-series wells will be installed in this aquifer.

Very little information is currently available on the potential downward transport of contaminants from the upper portion of the sand and gravel aquifer into deeper zones. Because this aspect of contaminant transport is important to an assessment of the current and future effects of the ground water pathway, the proposed well locations for the sand and gravel aquifer were developed to maximize the number of well couplets in the upper and lower zones of the sand and gravel aquifer. Nineteen new well couplets will be created as a result of this program.

Three deep wells (400-series) will be installed on site below the "blue-clay" reported to underlie the upper sand and gravel aquifer at some as yet undetermined locations. Data from existing wells completed in this zone do not indicate elevated levels of any radiological or chemical constituents. In fact, the existing data do not indicate that any contaminants have reached the lower sand and gravel unit that directly overlies the blue clay. Because the blue clay may impede the downward migration of contaminants to the underlying aquifer, and no contamination is known to be present, the penetration of this layer with borings and wells should be avoided, if possible. This investigative approach will be, therefore, to install the 300-series wells as part of this sampling plan to determine the quality of ground water in the sand and gravel unit which overlies the blue clay. ~~--If contamination--is--detected,--then--deeper--wells--that--penetrate through-the-blue-clay-(400-series)-will-be-proposed.~~

The 300 series wells are to determine if the "Blue Clay" is present under the FMPC site and if its presence is influencing the migration of contaminants or ground water flow. The current drilling program is designed to drill the 300 series wells to the target elevation of the blue clay. If the blue clay is not encountered at the target elevation the boring is extended and additional 15 feet to be sure that the blue clay is not present. The Well is then completed with the screen at the blue clay target depth. If the blue clay is encountered, the well is to be completed at the top of the blue clay. Whether the blue clay is present or not theses wells will provide water samples and hydrologic data at a consistent elevation. The evaluation of the boring logs, chemical analyses and hydrologic data will determine if additional wells are required to further define the presence of the blue clay. This data analysis will also determine if the 400-series wells are necessary.

Three 400-series wells are proposed for installation off site. Two wells are proposed to evaluate ground water quality and hydraulic gradients vertically throughout the aquifer east of the site where large pumping stresses might induce downward migration of contaminants into the deeper aquifer zones. The third well is in an area outside the influence of the pumping wells and upgradient of the facility.

Very little is known about the quality of ground water directly beneath the Production Area. To pinpoint the Production Area as a distinct source of ground water contamination (thereby focusing subsequent studies and potential remedial actions) and to assess its impact on the water-bearing zones, monitoring wells will be placed in the till and the upper sand and gravel aquifer in upgradient and down gradient directions. ~~No wells are currently proposed within the active Production Area. However, wells may be proposed after the soils and radiological surveys are completed for the area, and once the detailed evaluation of existing data and the modeling study resolve local ground water patterns.~~ The location of wells in the Production Area will be determined after completion of the soil and radiological surveys, ground water flow patterns, and other environmental conditions in the surrounding area have been determined.

Current evidence suggests that ground water in the till is not directly connected to ground water in the underlying sand and gravel unit (Dames and Moore, 1985). Water levels in the two units are different, and the top of the sand and gravel unit is not saturated. ~~Therefore, until the distribution of constituents in the till is more clearly defined, the approach will be to drill each shallow well in the till before advancing the corresponding deeper holes into the sand and gravel aquifer below. This will avoid the inadvertent spread of contaminants by drilling through potentially high concentrations of compounds.~~ All borings are to be drilled with cable tool equipment The cable tool technique advances steel casing as the boring is deepened. This casing maintains and open boring without the use

of drilling muds and provides a barrier against the downward migration of contaminants form shallower aquifers. Cable tool drilling will be used though out the drilling program, therefore the deeper well in each cluster will be drilled first to determine the target depths of the other wells in the cluster.

All boreholes for wells will be advanced using cable tool drilling methods and will follow the general procedures presented in the QAPP. A temporary steel casing will be drilled, driven, or pushed as the borehole is advanced to the bottom of the hole. The temporary casing will be nominal eight inch diameter to allow for construction of the monitoring well. Cuttings will be removed from the borehole using a sand pump or dart valve bailer, whichever proves more effective. During the process of drilling monitoring wells, relatively undisturbed soil samples will be collected with a split-spoon sampler. The sampling and logging of subsurface materials is incorporated into the Subsurface Soils Sampling Plan, as discussed in Section 4.2.1.4.

Shallow wells (100-series) will be screened in the water table or in localized perched water zones in the till which overlies the upper portion of the regional sand and gravel aquifer over most of the site. The intermediate wells (200-series) will be screened at the top of the sand and gravel aquifer so that the top of screen is below the till base and at least ten feet below the water table. The deep wells (300-series) will be screened at the top of a clay layer referred to as the "blue clay." In the event that blue clay is not encountered, the well is screened at a depth approximately equal to the elevation of the top of the blue clay beneath the production area. The 400-series deep wells are screened so that the bottom of the screen is ten feet from the top of the bedrock.

The monitoring wells will be constructed in accordance with the well design and installation procedures detailed in the QAPP. Four-inch inside diameter (I.D.) 316 stainless-steel pipe will be used for well construction. Ten-foot sections of 316 stainless steel, 0.01-inch-slot screens will be used (minimum three square inches open area per lineal foot of screen) for 300- and 400-series wells. Fifteen feet of screen will be used for 200 series wells so that five feet of screen can be left above the water table.

Upon completion, the monitoring wells will be developed by pumping and flushing with water to remove fines from the area around the sending zone and the monitoring well. All the new monitoring wells will be surveyed to establish the horizontal location of each well according to the UTM or State Planar coordinate system. The elevation at the top of the measuring point on the well casing will also be surveyed to provide vertical control for ground water level measurements. Horizontal coordinates will be accurate to 0.5 feet (0.15 meters); elevation will be accurate to 0.01 foot (0.003 meters). The existing wells which are to be included in the monitoring network will also be surveyed if necessary to ensure elevation and location accuracy. Much of this effort was recently completed in support of another DOE investigation, however.

After all new monitoring wells have been installed and have fully recovered from any new well development or aquifer testing programs, static water levels will be measured in all wells, including those from the previous surveys included in the network. The purpose of these measurements is to map the water table and potentiometric levels in the aquifer at a single point in time. Water level measurements will be made in all wells in the network on a monthly basis for one year to evaluate the effects of seasonal variations on water levels.

In addition, the electronic data logger with two transducers will be installed at Well Locations 9 and 14. One recorder will be installed on each of two wells, 109 and 209. Wells 114 and 214, which are located along Paddy's Run, will each be fitted with a transducer. Data from these recorders will be used to detect patterns in water level changes. Water levels will be measured continuously during both a dry season and a wet season to determine the stream stage/ground water level relationships. A specific measurement period will be determined once the project is initiated and a final schedule is developed.

Aquifer Testing

Two types of aquifer tests may be performed at the FMPC. These include long-term pumping tests and short-term slug tests. Pumping tests are specifically suited to determining transmissivity and storativity in water table, leaky, or confined aquifers. These tests provide measurements over a relatively large volume of the aquifer and are useful in identifying recharge/discharge zones and/or barrier boundaries. Slug tests are suited to measurements of hydraulic conductivity in the material immediately adjacent to the well screen.

As part of the characterization program for the till, short-term slug tests will be performed at upgradient wells; at wells in the area of the waste pits; at a well in the vicinity of the surge lagoon; at a well in the vicinity of the K-65 Silo No. 1; at a well in the vicinity of the sludge ponds; and at wells in the fly ash pile areas.

There is a definite possibility that the diameter and rate of discharge of any potential pumping wells will not be conducive to a long-term pumping test in

the relatively permeable and extensive sand and gravel aquifer. Therefore, the need for a long-term pumping test will be determined only after the preliminary modeling study can be used to predict the level of aquifer response that would be expected.

Ground water samples will be collected from new and selected existing wells. The new wells will include 42 100-series, 22 200-series, 22 300-series wells, three 400-series wells, and 3 off-site wells. Thirty-six additional monitoring wells that exist on site, along with selected off-site wells, will be included in the sampling network. Additionally, approximately six till wells, six top of upper sand and gravel aquifer wells, and six bottom of upper sand and gravel aquifer wells, will be selected at upgradient locations and sampled to establish background concentrations.

Sampling during this hydrogeologic investigation will be performed after all wells are installed and on three later occasions during different seasonal conditions. The initial ground water sampling event is expected to occur in March 1988. Additional well sampling will not be proposed until the resultant data base is evaluated. ~~Proper ground water sampling procedures will be used to assure that no contamination or bias is introduced into the sample.~~ Although it may be interesting to sample the wells as they are completed, there is no rational justification for such sampling. The data would be scattered over a relatively large time interval and thus not be easily comparable to the quarterly sampling proposed or useful to the ground water model. The drilling program is not dependent ~~of~~ on the results since cable tool drilling is being used, thus such progressive sampling is not required. Finally, the data analysis to determine if additional wells are necessary will be dependent on geologic evaluations as well as water gradient and water quality data form all the wells. Spot analyses from the wells will not improve this interpretation.

Sample Analysis

A total of 143 wells have been identified for sampling. During Phase I activities, samples will be collected from each of these wells on two occasions. All samples well be analyzed in the field for pH, temperature, conductivity, and dissolved oxygen.

Since the selection of each new well was specifically justified within the context of the monitoring well network, it is necessary to analyze all ground water samples for a full suite of

radiological parameters and a more focused set of general water quality indicators to achieve the overall study objectives. All ground water samples will be analyzed for a set of radiological parameters that include radionuclides or materials handled at the FMPC. These parameters, which are consistent with those being tested under the ongoing RCRA monitoring program include:

- Total Uranium
- Isotopic Uranium
- Isotopic Plutonium
- Radium-226
- Radium-228
- Neptunium-237
- Total Thorium
- Isotopic Thorium
- Technetium-99
- Cesium-137
- Strontium-90
- Ruthenium-106

All samples will also be analyzed for the following parameters that are being used as indicators of drinking water quality under the ongoing RCRA program:

- pH
- Specific Conductance
- Chloride
- Iron
- Manganese
- Phenols (total)
- Sodium
- Sulfate
- Gross alpha
- Gross beta
- Alkalinity as $CaCO_3$
- Carbonate/Bicarbonate
- Arsenic
- Barium
- Cadmium
- Chromium (hexavalent;-Total)
- Fluoride
- Lead
- Mercury
- Selenium
- Selenium
- Silver
- Ammonia
- Total Organic Nitrogen

As a result of the review of volume II of the CIS, the samples will be analyzed for Primary Drinking Water Organics, Organophosphorous Pesticides, 2,3,7,8-TCDD/TCDF and PCDD/PCDF, and tributyl phosphate. This is referred to as the HSL + list of analytical parameters. The analysis of ground water samples for the Hazardous Substance List Plus (HSL +) organics and other toxic metals will be performed on a limited basis. The reason for this reduced scope is twofold:

- The ongoing RCRA ground water monitoring program is already testing of organics and metals on a quarterly basis at 41 on-site and off-site wells, and will be continued on at least a semiannual basis in the future.

- The frequency and levels of detection of these species during the RCRA program indicate that a problem worthy of a comprehensive testing program is the RI/FS (in comparison to the radiological problem) does ont exist in the ground water underlying the FMPC and adjacent areas.

In order to confirm that these conditions are the case, ~~13~~ 16 selected ground water samples will be analyzed for HSL volatile

and semivolatile organics and HSL inorganics, including cyanide, plus Dioxins, Tributyl Phosphate, and Organophosphate ~~and~~ Pesticides. ~~No pesticides or herbicides have ever been detected in the RCRA program, and will not be analyzed under this program.~~ The wells to be sampled for HSL analysis have been selected to augment the quarterly RCRA monitoring program. These include ten new shallow wells within the waste storage area; a shallow well immediately to the east of the Production Area; and 200-series wells in the upper sand and gravel aquifer east of the Production Area and South of the Production Area along the storm sewer outfall ditch. Additionally, based upon a review of the findings of the CIS and the current HSL sampling program, the FMPC proposes to augment this program by the addition of 20 HSL water quality samples. Water quality samples will be drawn from 20 additional monitoring wells and analyzed for the HSL + parameters. The following additional 100-series wells will be sampled and analyzed for the HSL +; 104, 110, 119, 121, 125, 172, 173, 174, 175, 176, 178, 183, and 116. The following 200-series wells will be sampled and analyzed for the HSL + as well; 214, 215, 216, 219, 220, 221, and 222.

In addition, the analytical results of the recently completed CIS program of the wastes stored in the waste pits, ponds, and silos well be evaluated when available. CIS results will be used to guide selection of analytes for well samples. Lower limits of detection for contaminants of concern will aid in this decision making process. If organics and/or metals are found in significant concentration in these samples, ground water samples from any nearby downgradient wells will also be analyzed for the HSL parameters.

4.2.1.4 Subsurface Soils Sampling Plan

Objectives and Justification

The overall objective of the Subsurface Soils Sampling Plan is to provide additional detail on subsurface conditions within the FMPC that may define or influence contaminant migration pathways. The subsurface soils investigation will provide additional information on:

- The subsurface stratigraphy in the site area and its relationship to the distribution of ground water;
- The lateral and vertical extent of radionuclide and hazardous ~~chemical~~ substance contamination of subsurface soils to assess the nature and ial subsurface pathways to ground water

  change to "solubility"

  properties of the subsurface soils that may retard or int movement, or define potential pathways; and

  properties of the subsurface soils, for use in asibility of remediation alternatives.

The subsurface soils sampling program is an integral part of the ground water monitoring well installation program. However, it is addressed separately in the Subsurface Soils Sampling Plan due to the difference in underlying objectives and the specificity of methods and equipment. The locations of boreholes for sampling subsurface soils coincide with many of the proposed locations for the wells. Although these locations were primarily dictated by ground water issues (as summarized in Table 3.1), the general selection criterion of location near potential contamination sources, pathways, and receptors that are distributed across the FMPC also satisfy the informational needs of the subsurface soils program.

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Scope

Continuous sampling of subsurface soils will be performed during the drilling of the boreholes for all 100-series wells and through the till where 100-series wells will not be installed (Figures 4.7 and 4.8). At locations where more than one well is to be installed (i.e., couplets and three-well clusters), subsurface soil samples will be collected only once through the geologic column, so that a profile of the geologic material is obtained from ground surface to the bottom of the deepest boring.

In accordance with the results of the preliminary evaluation (as illustrated in Figures 3.2 through 3.6), 17 investigative tasks were considered necessary to satisfy the informational needs of the RI/FS. The next phase of the planning process was to translate the generic informational needs identified in Figures 3.2 through 3.6 into meaningful field data collection efforts that would be consistent with both the currently available data base (so as to achieve cost-effectiveness while avoiding redundancy) and site-specific conditions. Only the subset of the investigative tasks that corresponds to site investigation activities (i.e., field data collection efforts) under Task 3 of the RI/FS are of importance to this section. Ten such tasks were identified, corresponding to seven sampling plans (Table 4.1).

Also indicated in Table 4.1 are five investigative tasks that are being performed under separate contract. The first, termed the Characterization Investigation Study (CIS), involves sampling of the wastes presently stored in Pits 1 through 6, the Burn Pit, Lime Sludge Ponds, Sanitary Landfill, Fly Ash Piles, and Silos 1, 2, and 3 (i.e., K-65 silos and the metal oxide tank). Each waste storage area was cored to its full depth at several locations. Samples for physical and chemical analysis were composited. Samples analyzed for volatiles were collected separately in the field, and extracted separately in the lab and the extractions were composited for analyses.

Borings will be advanced using cable tool drilling methods. During the drilling program, standard penetration tests will be conducted and subsurface soil samples will be collected using an 18-inch drive split-spoon sampler in accordance with ASTM Method DF1586-84. Soils will be continuously sampled in the till. Split-spoon sampling beyond the base of the till will be conducted every five feet and at each change in lithology, as determined by the project

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site geologist. In addition, undisturbed samples will be collected at a rate of two per borehole if clay layers are found in the till. Undisturbed samples will also be collected of the uppermost portion of the blue clay layer at the location of the three 300-series wells in closest proximity to the FMPC production wells (Wells 311, 334, and 338). Conventional 30-inch Shelby tubes will be used if subsurface conditions permit.

All samples will be examined and described by the project site geologist. The geologist will describe and classify all samples based on their color (Munsell Soil Color Charts), texture (Unified Soil Classification System), estimated water content, and depth from land surface. All field observations will be recorded on the standard forms provided in the QAPP.

Field Screening of Subsurface Soil Samples

Immediately upon opening each split-spoon sample, the samples will be screened for volatile organics using OVA and HNu field instruments. If a volatile release is detected, a soil sample of the core will be transferred to a standard VOA vial. The field screening procedure for radionuclides will utilize each of the three detectors - a large-volume scintillation detector, a FIDLER detector, and an alpha-particle detector. Any sample for which the screening value exceeds background by three standard deviations for any of the three procedures will be a candidate for laboratory analysis.

Sample Analysis

Subsurface soil samples will be collected from 54 separate locations where new wells are to be installed. The laboratory analysis program associated with these samples will be comprised of four elements, as follows:

- Radiological analysis;
- Geochemical analysis;
- Geotechnical/enginering properties testing; and
- Organic/inorganic analysis.

It is estimated that over 1,500 split-spoon or Shelby tube samples will be collected during the subsurface program. An analysis of all samples is not feasible, nor is it necessary to achieve a satisfactory understanding of the overall site conditions. The final program will be dependent on field

results, as described below. All samples will be archived for additional testing, as deemed appropriate based on the initial testing results.

Subsurface soil samples will be selected for radiological analysis based on the results of the field screening. At least one sample per horizon (till, upper sand and gravel, and lower sand and gravel) per location will undergo radiological analysis, yielding a minimum of 94 analyses.

The sample selected for laboratory analysis will be that which exhibits the highest relative reading above the screening criterion for the given location and horizon.

All samples sent to the laboratory will be tested for a set of radionuclides historically used, stored, or produced at the FMPC. These parameters are the same as those being analyzed under RCRA compliance monitoring, and include:

- Total Uranium
- Uranium 234
- Uranium 235
- Uranium 236
- Uranium 238
- Radium 226
- Radium 228
- Technetium 99
- Thorium 228
- Thorium 232
- Cesium 137
- Strontium 90
- Ruthenium 106
- Neptunium 237
- Plutonium 238
- Plutonium 239
- Plutonium 240
- Thorium 230

The purpose of the geochemical analysis program is to gain quantitative information on parameters that can be used as indicators of the potential for contaminant migration through (or adsorption to) subsurface soils. The soil properties selected as indicators of contaminant migration and attenuation include: total cation exchange capacity, total organic carbon (TOC), grain-size, and leachable iron and manganese. Samples will be selected for analysis based on differences in visual properties (i.e., color, texture, etc.), with spatial distribution being a second criterion. Since the degree of variability is expected to decrease as one proceeds downward through the soil horizons, more samples for geochemical analysis will be taken in the till than in the sand and gravel aquifer. In particular, it is estimated that 20 samples will be obtained from the till, ten from the upper sand and gravel aquifer, and five from the lower sand and gravel aquifer.

Geotechnical (engineering) properties testing will be performed on a minimum of 20 undisturbed Shelby tube samples. Engineering properties to be tested include:

- Modified Proctor Compaction Test (ASTM D1557);
- Vertical Permeability;
- Unconfined Compression (ASTM D2166);
- Triaxial Shear Test (consolidated isotropically undrained, C.I.U., with pore pressure - ASTM D2850); and
- Vertical Consolidation (dial reading/time technique - ASTM D2166).

The presence of organic and toxic inorganic compounds in subsurface soils has not been documented to be a problem at the FMPC. Even if cases had been reported, it would be difficult to pinpoint locations of elevated levels through a borehole subsurface soils program if sample locations are randomly selected. The proposed approach is to subject a sample to a full HSL analysis if one of two observations is made: (1) the sample has unusual odor or visual evidence of organic or inorganic contamination; or (2) a relatively high reading occurred during the field screening for volatile organics. Any samples meeting either of these criteria (with a minimum of two samples per borehole where either one or both criteria are met) will be subjected to a full HSL analysis for volatile organics, semivolatile organics, and inorganic metals.

4.2.1.5 Surface Water and Sediment Sampling Plan

Objectives and Justification

The surface water and sediment sampling programs have been combined into a single Surface Water and Sediment Sampling Plan due to a similarity of objectives. These objectives are:

- Identify the distribution and extent of radiological constituents in sediments from Paddy's Run and site drainage systems leading into Paddy's Run.
- Characterize the radiological and hazardous ~~chemical constituents~~ substances and their spatial distributions at one point in time along drainage

pathways from the site towards Paddy's Run, discharge points into Paddy's Run, as well as Paddy's Run.

- Determine the presence of radiological constituents and their concentrations at a given point in time in the Great Miami River both upstream and downstream of the FMPC outfall, the confluence of Paddy's Run with the Great Miami River and upstream and downstream of the SOWC collector wells.

- Identify radiological constituents in the sediments of the Great Miami River at locations upstream and downstream of the SOWC collector wells, at the FMPC NPDES outfall, the confluence of Paddy's Run with the Great Miami River, and at depositional locations in the Great Miami River.

- Determine if the FMPC is a significant source of organics and selected inorganics to the Great Miami River and Paddy's Run.

In addition to the investigative scope described herein, a companion study being performed in response to Order 14 of the OEPA's June 26, 1987, Directors Findings and Orders will contribute valuable information and insight into those objectives dealing with the Great Miami River. The companion study has as its principal objective the determination of whether the main effluent line is a source of contamination to the nearby SOWC wells. A key component of the the investigation is the effects of the main effluent line on river water quality, and in turn the interactions between the water column, sediments, and underlying aquifer. The field work and hydrologic analysis associated with this study will provide considerable additional information on the reach of the river nearest to, and most likely affected by, the main effluent line.

Scope

Table 4.3 has been prepared as a summary of the Surface Water and Sediment Sampling Plan. The plan has two primary components. The first is associated with the four principal surface water courses (Great Miami River, Paddy's Run, storm water outfall ditch, and the main effluent line), and involves a multi-element sampling plan designed to make use of ongoing WMCO monitoring programs and previous study results. The second component involves a variety of surface water drainage paths, conveyance facilities, and ponding areas in the waste storage areas and Production Area. The sampling plan for these locations is designed to provide a characterization of surface water and sediments at one point in time. This limited effort could pinpoint any

TABLE 4.3
SUMMARY OF SURFACE WATER
AND SEDIMENT SAMPLING PLAN

LOCATION	SURFACE WATER SAMPLING PLAN*	SEDIMENT SAMPLING PLAN*
Great Miami River	Quarterly at seven locations: FR, O/WQ[1]	Quarterly at seven locations: FR; Quarterly at one location: GS
Paddy's Run	Quarterly at three locations: FR, O/WQ[2]	Quarterly at three locations: U, A/B, R; Quarterly at one location: FR, GS; One sample at four locations: HSL±
Storm Water Outfall Ditch	Four locations during a storm event: U, A/B, R; One location: FR, O/WQ[3]	One sample at three locations: FR, GS; One sample at two locations: HSL±
Main Effluent Line (Manhole 175)	Quarterly: FR, O/WQ[4] One sample: HSL±	Quarterly: FR, GS One sample: HSL±
Waste Storage Areas		
o Two drainage paths to Southwest	One sample from each U, A/B, R	One sample at one location: HSL±
o Abandoned drainage pipes along west	One sample at three locations (if flowing): U, A/B, R	None[6]
o Drainage north of Pit 5	One sample at three locations (if flowing): U, A/B, R	One sample at one location: HSL±
o Drainage north of railroad tracks	One sample at two locations: U, A/B, R	One sample at one location: HSL±
o Drainage south of Pit 1 and Clear Well	One sample at two locations: U, A/B, R	None[6]
o Drainage north of surge lagoon	One sample at two locations: U, A/B, R	None[6]

COM:Table4-3

TABLE 4.3
(Continued)

LOCATION	SURFACE WATER SAMPLING PLAN*	SEDIMENT SAMPLING PLAN*
o Drainage south of Pit 4 and 6	One sample at three locations: U, A/B, R	None[6]
o Seep near greenhouse (plus any other seeps: assume 5)	One sample: U, A/B, R, HSL + (one sample from other seeps: U, A/B, R) HSL+	~~None~~ HSL+ [6] One sample from other seeps: HSL +
o Drainages from upper fly ash pile	One sample at four locations: U, A/B, R O/WQ	One sample at four locations: U, A/B, R; One sample from one location: HSL+
Production Area		
o Two drainages southeast of substation	One sample at two locations in each: U, A/B, R	One sample at two locations in each: U, A/B, R
o Drainage near rail siding	One sample at two locations: U, A/B, R	One sample at two locations: U, A/B, R
o Six culverts	One sample from each U, A/B, R	One sample from each U, A/B, R
o Manholes and catch basin	One sample at 12 locations: U, A/B, R,	One sample at 12 locations: U, A/B, R

*U = Total Uranium
A/B = Gross Alpha and Beta
R = Ra-226 and Ra-228
O = TOC and TOX
WQ = General Water Quality Parameter
FR = Full Radiological Analysis
GS = Grain Size
HSL+ = HSL Organics and Inorganics Plus Dioxins, Tributyl Phosphate, Organophosphate, and Pesticides

[1]Ongoing WMCO Monitoring Program: Monthly (Composite) at three locations: U, R, A/B

[2]Ongoing WMCO Monitoring Program: Weekly at five locations: U, A/B; Bimonthly: R

[3]Ongoing WMCO Monitoring Program: Weekly at one location: U, A/B; Bimonthly: R (when flowing)

[4]Ongoing WMCO Monitoring Program: Daily: U, A/B; Monthly: R, Ru-106, Th-232

TABLE 4.3
(Continued)

[5]Represents work recently performed as part of the CIS

[6]Sampling and radiological testing of sediments in drainage ditches recently performed as part of the CIS.

significant contaminant sources or problems that would otherwise continue undetected. The results of either of these components of the sampling plan could indicate that additional sampling is required to fully evaluate the respective source or pathway of concern.

Surface water sampling locations on the Great Miami River will coincide with the sampling stations established by WMCO (Figure 4.49), and will include four additional sampling locations. As indicated on the figure, the additional locations are immediately opposite the SOWC well on the west bank, just downstream from the point of discharge of the main effluent line, within the depositional area at the bend in the river downstream from the previous point, and immediately downstream from the confluence with Paddy's Run. Currently, WMCO is collecting daily grab samples from sampling points W1 (upstream from the main effluent line) and W3 (downstream from the effluent discharge). In addition, weekly grab samples are collected at point W4, approximately 7.6 km downstream from the confluence of Paddy's Run with the Great Miami River. The daily and weekly samples are composited monthly for a determination of uranium, Ra-226 and Ra-228, and gross alpha and beta concentrations.

The surface water sampling plan will augment this ongoing program by collecting samples from the same three locations and four new locations on a quarterly basis for one year, and analyzing for the full set of radiological parameters, TOX, TOC, and general water quality parameters. This quarterly sampling plan will characterize seasonal flow and water quality variations for an extended list of indicator radiological parameters. If consistent with the overall project schedule, samples will be obtained in April, July, October, and January. Approximate flow rates will be obtained from an existing USGS Great Miami River gaging station at Hamilton, Ohio. Direct measurements of flow will also be made at the point of sampling.

Sediment samples will be collected on a quarterly basis from the same locations. Samples will be collected at the quarter points in the channel and from depositional and floodplain areas at each location. One sample from the most prominent depositional area at each location will undergo full radiological analysis, and grain-size testing will be performed at one location to assist in determining if sorption is an important process and

whether an important source is present. All other sediment samples from the Great Miami River will be archived within their original container in an environmentally controlled area at IT's Radiological Lab (RSL) in Oak Ridge, Tennessee. If the single sample analyzed from each location exhibits a concentration of any parameter exceeding twice background, all archived samples from that location and sampling event will also be subjected to a full radiological analysis. An exception to this strategy is that all sediment samples from the background location (W1) will be analyzed during the first round of sampling to better establish background conditions.

Surface water flow in Paddy's Run is monitored at WMCO stations W5, W9, W10, W11, and W8 (Figure 4.9). Station W5 provides an upstream control, Stations W9 and W10 represent upstream and downstream locations with respect to the waste storage area, Stations W11 and W7 provide a similar upstream/ downstream pair for the confluence of the storm water outfall ditch with Paddy's Run, and Station W8 is a downstream off-site location. Weekly samples are analyzed by WMCO for uranium content and gross alpha and beta activity. Bimonthly composites of weekly samples are analyzed for Ra-226 and Ra-228.

The spatial distribution provided by these six stations is considered adequate for monitoring surface water effects in Paddy's Run. The ongoing program will be supported in the RI/FS, however, by quarterly sampling at Stations W10, W11, and W7, with analysis for the full radiological program, TOC, TOX, and the general water quality parameters. The selected stations are the closest downstream locations from the two principal sources of contaminants to Paddy's Run (i.e., the waste storage area and storm water outfall ditch), and a control point upstream from the confluence with the outfall ditch. As with the Great Miami River surface water program, the extended list of parameters will yield confirmatory quantitative information on the presence or absence of additional parameters of concern, and will indicate relative contributions and seasonal variability of the sources.

Sediment samples will be collected at Stations W10, W11, and W7 on a quarterly basis. Station W5 will also be included in the sediment sampling program to provide a background comparison. Samples from Stations W5, W11, and W10 will be analyzed only for the base set of parameters (uranium, Ra-226, Ra-228,

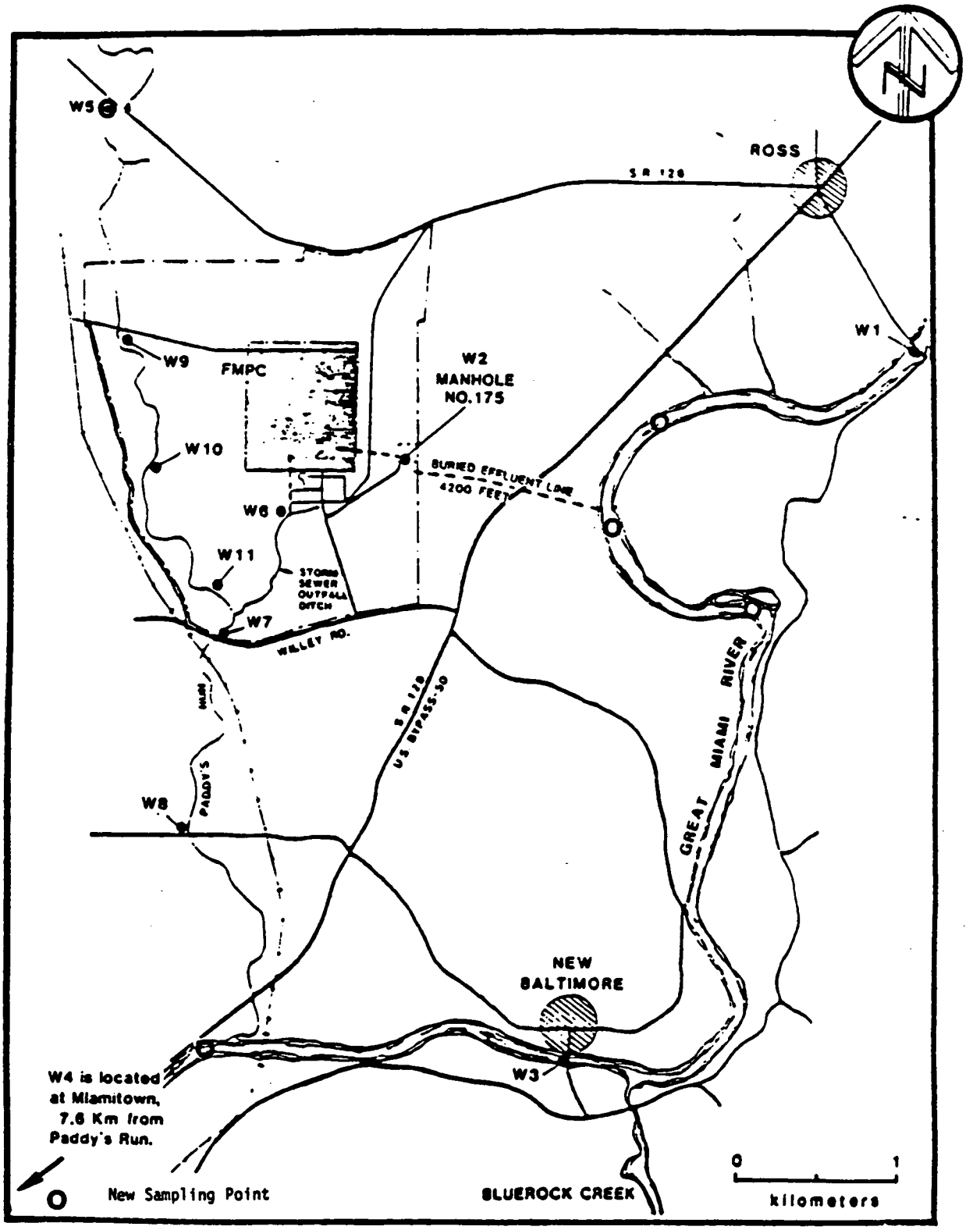

FIGURE 4.9
SURFACE WATER SAMPLING LOCATIONS

GREAT MIAMI RIVER AND PADDY'S RUN

gross alpha and beta), whereas a full complement of radiological parameters will be tested along with grain size for sediment samples from Station W7. In addition, sediment samples from the same four locations will be analyzed on one occasion for the full set of HSL parameters.

Station W6 is used by WMCO to monitor effluent associated with the storm water drainage ditch. Weekly samples are collected for uranium and gross alpha and beta analyses, while a bimonthly composite is analyzed for Ra-226, and Ra-228. The proposed program will involve a single sampling episode during a storm event at five locations along the ditch. Four samples will be analyzed only for the base set of radiological parameters, while the most downstream sample will be analyzed for the full radiological parameter list, TOC, TOX, and the general water quality parameters. The distribution of sampling points along the length of the ditch will document either significant gains or losses of radiological constituents as one proceeds downstream. The one extended set of analyses will be for confirmatory purposes.

Information provided in the background document indicates a noticeable change in sediment characteristics and contaminant concentrations along the ditch. For this reason, three sediment samples will be collected along the length of the ditch. A full set of radiological parameters and grain size will be tested to document these conditions and to establish any correlation with grain size. In addition, sediment samples will be collected for full HSL analysis at two locations. These include a point just upstream from the confluence with Paddy's Run (downstream from the fly ash piles), and a point of depression in the channel pathway near the midpoint of the ditch length (upstream from the fly ash piles).

Surface water discharges are also being monitored by WMCO at Station W2. Station W2 is the sampling point at Manhole 175 that is used to monitor effluent from the Production Area and is the specified compliance point for the NPDES permit. Continuous samples are currently being collected in proportion to the total flow. Samples (24-hour composites) are collected daily and analyzed for uranium content and alpha/beta radioactivity. Monthly composites of the daily samples are analyzed for Ra-226, Ra-228, Ru-106 and

Th-232. Two semiannual composites are analyzed for other radionuclides.

In support of the data base being generated by WMCO, quarterly surface water samples will be obtained from Station W2 for one year and analyzed for the extended set of constituents. This program will provide confirmatory data as to whether organics and selected inorganics are being discharged to the Great Miami River via the main effluent line.

Sediment samples will be collected from Manhole 175 concurrently with the quarterly surface water samples. The samples will be analyzed for the same full set of radiological parameters and grain size. One surface water and one sediment sample will also be analyzed for the full set of HSL parameters during the initial round of sampling.

Numerous surface runoff drainageways exist within or near the waste storage areas and in the Production Area. These drainages may have been in the past, or may currently remain, receptors of contaminants from spills, leaks, overtoppings, or other kinds of releases associated with the waste storage units. As part of the Surface Water and Sediment Sampling Plan, single surface water samples will be collected at various locations along the drainageways. Each sample will be analyzed for the base set of radiological parameters in order to flag any elevated concentrations or contamination patterns. These findings could result in source identification and focused remediation actions. The drainages and locations are identified Table 4.3.

Sediment samples were collected for radiological analysis at numerous locations along these same drainages as part of the CIS. The proposed effort is to collect a single sediment sample from four key drainages to Paddy's Run at a point downstream of any potential releases from waste storage areas, and to subject these samples to a full HSL analysis. These locations include the southwest drainage ditch near the K-65 silos, the drainage ditch north of Pit 5, the drainage ditch from near the sanitary landfill north of the railroad tracks, and a drainage from the upper fly ash pile.

Flow measurements will be taken at the time of sampling at each location. All

surface water and sediment sample locations in open channels (streams, drainages, ditches, etc.) will be located by placing stakes on opposite banks of the sampling location. The number of the sampling location will be marked on each stake and recorded for future surveying.

Sample Analysis

All surface water samples will be subject to the following field analyses.

- pH
- Temperature
- Conductivity
- Dissolved Oxygen
- Flow

The surface water and sediment sampling program summarized in Table 4.3 will yield the following number of samples for analysis:

- Total Uranium, Gross Alpha and Beta, Ra-226, Ra-228

  - 55 surface water samples
  - 40 sediment samples

- Full Radiological Program

  - 45 surface water samples
  - 39 sediment samples

- TOC, TOX, and General Water Quality Parameters

  - 49 surface water samples

- HSL + Parameters (Organic Volatiles and Semi-Volatiles, Inorganics, and Pesticides/PCBs)

  - 6 surface water samples
  - ~~11~~ 17 sediment samples

- Grain Size Analysis

  - 15 sediment samples

In addition, random field sample splits, random field blanks, and blind duplicates will be analyzed on a 10 to 15 percent frequency.

Based on information available on the FMPC waste inventory, the following

parameters will be selected for the full radiological plan:

- Total Uranium
- Uranium 234
- Uranium 235
- Uranium 236
- Uranium 238
- Radium 226
- Radium 228
- Technetium 99
- Thorium 228
- Thorium 230
- Thorium 232
- Cesium 137
- Strontium 90
- Ruthenium 106
- Neptunium 237
- Plutonium 238
- Plutonium 239
- Plutonium 240

The general water quality parameters will include the following:

- pH
- Specific Conductance
- Chloride
- Iron
- Manganese
- Phenols (total)
- Sodium
- Sulfate
- Gross Alpha
- Gross Beta
- Copper
- Nickel
- Arsenic
- Barium
- Cadmium
- Chromium (hexavalent, total)
- Fluoride
- Lead
- Mercury
- Nitrate
- Selenium
- Silver
- Molybdenum

4.2.1.6 Biological Resources Sampling Plan

Objectives and Justification

There are four objectives to the biological resources sampling plan:

- To determine if contaminant substance release to the FMPC environs results in significant uptake, assimilation, and transfer through ecological habitats;
- To determine if ~~contaminant~~ hazardous substance release to the FMPC environs results in uptake and assimilation in agricultural products and crops;
- To determine if the above represent significant pathways to human receptors, and the potential risk to humans from those pathways; and
- To determine if federal or state threatened or endangered species exist within the FMPC environs, and the potential risk which is posed to their existence or welfare through contaminant release from the FMPC.

On-site sampling will be used to evaluate existing conditions at the FMPC, whereas the off-site sampling will be used to evaluate the extent of off-site conditions as well as to establish background levels for control areas. A determination of radiological substances in food chain species will be used to evaluate risk to human health relative to environmental fate and transport.

Scope

Discussions with Federal and State endangered species experts resulted in the identification of two species that could occur on the FMPC. These include one species of mammal, the Indiana bat (Myotis sodalis), and one amphibian, the cave salamander (Eurycea lucifuga) Surveys will be conducted within habitats that may potentially support these species to verify their presence or absence.

In addition to the above, two raptor species of state concern have been observed at the FMPC. These were the Coopers hawk (Accipiter cooperi), and the northern harrier (Circus cyaneus). Although these species have no legal status, their breeding habitat in Ohio may be endangered. Consequently, their presence on site will be monitored. Surveys will also be conducted for additional plant or animal species of Federal or State concern if they are discovered on the FMPC environs.

Samples of vegetation, agricultural products, garden produce, and terrestorial and aquatic organisms on and near the FMPC will be collected for analysis. The type, location, and frequency of each sample grouping will necessarily vary in order to reflect anticipated contaminant pathways and to satisfy the overall study objectives.

Sample locations for vegetation will be randomly selected at both on-site and off-site areas in both upwind and downwind directions. The WMCO off-site control area located in Indiana will be used as a control area to conduct sampling for background levels. Three samples of each vegetation species selected for analysis due to its importance to grazing livestock and game animals will be collected from each on-site and off-site location. A total of 21-28 vegetation samples will be collected for analysis. All remaining

samples will be archived.

If subsequent surface soil sampling results indicate areas of elevated concentration in important crop or livestock locations, additional vegetation samples will be collected from these areas if they differ from the original sampling locations.

One downwind site or immediately adjacent to the FMPC, along with the control area, will be used for the sampling of agricultural crops and garden produce. Four species will be sampled at each location to represent the full range of growth patterns. A preliminary determination based on field observations includes potatoes, corn, soybeans, and beets. Three composite samples of each species will be collected at each location, resulting in a total of 24 samples. Individual sample sites will be chosen on a random basis by pacing off randomly chosen coordinates within the agricultural field or plot being investigated.

Forbs, grasses, agricultural crops, and produce samples will be removed, with roots and above ground parts intact, from within a 0.5 m^2 circular quadrant at each sampling point. A soil sample will be taken from the center of each quadrant and archived. Roots and above ground parts from each sample location will be separated in the field and analyzed separately.

Milk and eggs represent additional agricultural products of interest to the biological sampling plan. However, due to the existing data base and the ongoing routine monitoring of such products by WMCO, no additional sampling is proposed for the RI/FS.

Wildlife species will be captured for analysis at two sites--within the controlled production or waste area of the FMPC and within the open space near the southwest corner of the FMPC property. The capture will be achieved using live traps, snap traps, or other appropriate techniques. Two samples each of two game species and one nongame species will be collected at each location, yielding a total of twelve samples. Game species could include, for example, the eastern cottontail, gray or red squirrels, or quails. Mice will likely be the nongame species.

Fish and benthic macroinvertebrates will be sampled, if present, at a total of seven stations on Paddy's Run and the Great Miami River. Three locations on Paddy's Run include the railroad crossing upstream from the FMPC, just upstream from the point of discharge from the stormwater outfall ditch, and near the confluence with the Great Miami River. The four river locations include points four river miles upstream and downstream from the FMPC, at the outfall from the main effluent line, and near the confluence with Paddy's Run.

Three fish samples and three macroinvertebrate samples will be collected for analysis at each location, resulting in 21 samples of each. Fish samples will be collected with an electroshocker or with nets. Larger game fish will represent a single sample; smaller fish samples will be composited. Samples of benthic macroinvertebrates will be composited by order following collection. Samples not sent for analysis will be archived. Biological resources sampling locations are shown in Figure 4.10.

Sample Analysis

All samples collected for analysis will be analyzed for isotopic uranium, strontium, and cesium. If any samples are found to contain elevated levels of these indicator parameters, an archived sample or a newly collected sample from the same location will be analyzed for the following extended list of radiological parameters:

- Sr-90
- Tc-99
- Cs-137
- Ru-106
- Np-237
- Ra-226
- Ra-228
- Isotopic Plutonium
- Isotopic Uranium
- Isotopic Thorium

Roots and above-ground plant tissue samples will be washed prior to tissue analysis. The resulting liquor from the washing processes will be stored and a sub-sample of the root and above ground liquors will be analyzed separately. The weight of plant material and volume of wash liquor collected will be recorded on the analysis form. This procedure will isolate potential

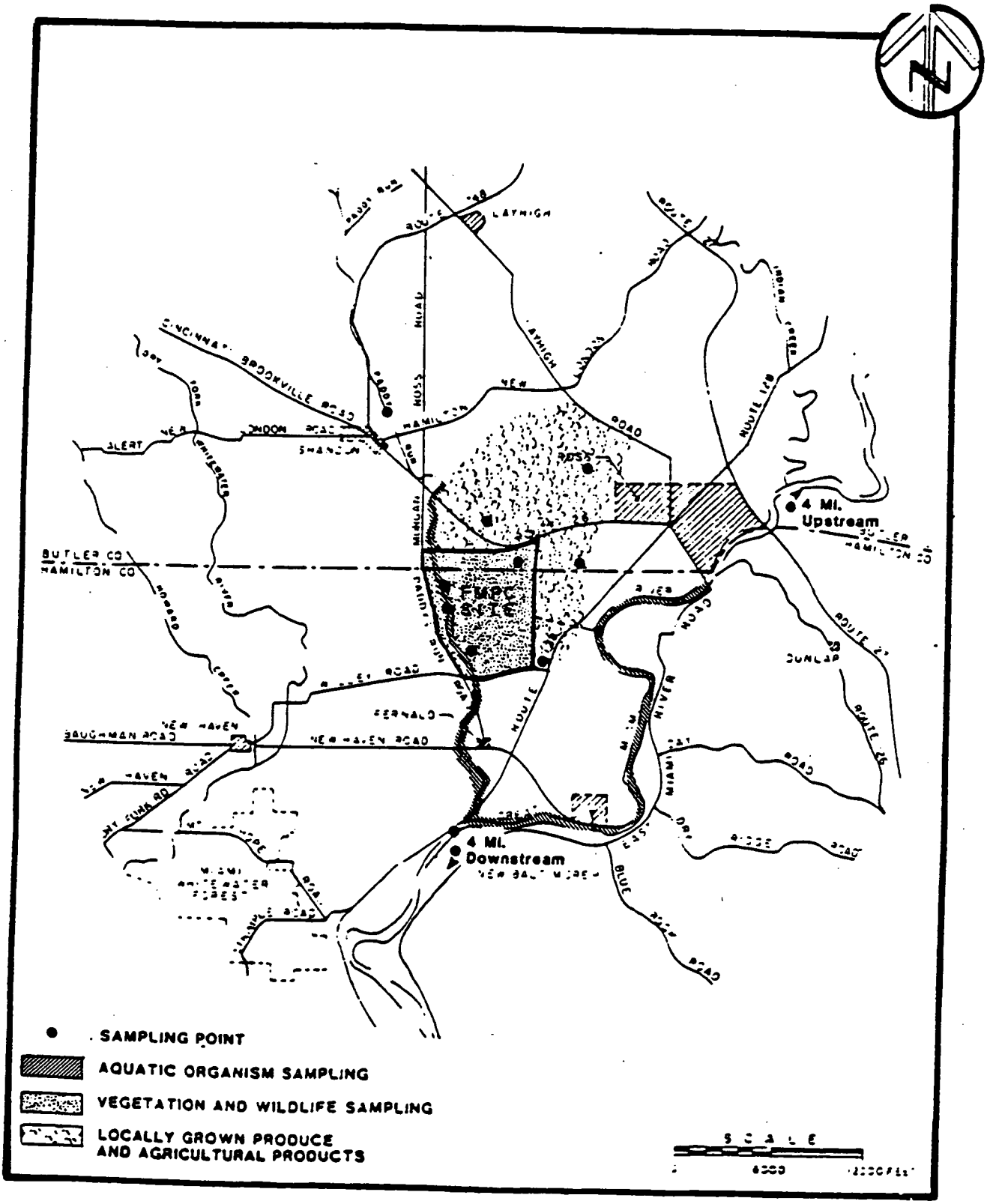

FIGURE 4.10
BIOLOGICAL RESOURCES SAMPLING LOCATIONS

contaminants which may have accumulated on above ground plant deposition, and contaminants in the soil clinging to the root surface. The time of collection from the last rainfall will be annotated on the collection label to correlate with wash deposition on above-ground plant parts.

4.2.1.7 Facilities Testing Plan

The objective of the Facilities Testing Plan is to determine if leakage of hazardous materials has occurred or has the potential of occurring from the underground storage tanks located in the Production Area, the line from the clearwell to Manhole 175, production storage pads, hazardous waste storage tanks, dikes, ancillary below-ground piping, and sumps. These facilities have been in use for up to 36 years. Consequently, they may be near the end of their design life, and have an increased probability of failure. Failure in an underground storage tank (or its related piping) for example, could result in either the gradual or sudden release of tank contents. Testing the integrity of these facilities by methods described herein will identify those areas requiring further investigation. Subsequent investigations will identify the extent of any contaminant release should testing indicate that an integrity failure has occurred.

A second facility involving related concerns is the main effluent line which conveys treated wastewater to the Great Miami River. The integrity of and potential leakage from this conveyance line is being evaluated by WMCO under a separate contract in response to Order 14 of the Director's Findings and Orders. The results of this work will be reviewed and incorporated into the RI/FS as appropriate.

Scope

Underground tank testing will be conducted once during the sampling program. The underground storage tanks which will be tested are located in the production area, and listed in Table 4.4. Their approximate locations are shown in Figure 4.11.

The testing program will be accomplished in the following steps:

1. Preliminary Data Collection for Tank Testing:

Table 4.4

TYPES AND LOCATION OF UNDERGROUND STORAGE TANKS

TANK NUMBER	AGE	LOCATION	TOTAL CAPACITY (GALLON)	CONSTRUCTION MATERIAL	TANK STATUS	SUBSTANCE
1	6	Garage	1,500	Fiberglass	In Use	Fuel
2	6	Garage	1,500	Fiberglass	In Use	Fuel
3	34	Engine House	12,250	Steel	In Use	Fuel
4	34	Truck Dock At Plant 1	3,000	Steel	In Use	Fuel
5	34	Tank Farm At Plant 4	13,525	Steel	In Use	Fuel
6	34	Garage	200	Steel	Not In Use	Waste Oil
7	34	Maintenance Shops Building Change	1,000	Steel	In Use	Fuel
8	34	Plant 9 (Northside)	500	Steel	In Use	Waste Oil
9	34	Garage	1,000	Steel	Not In Use	Fuel
10	34	Garage	1,000	Steel	Not In Use	Fuel
11	34	Garage	3,000	Steel	Not In Use	Fuel

151

96

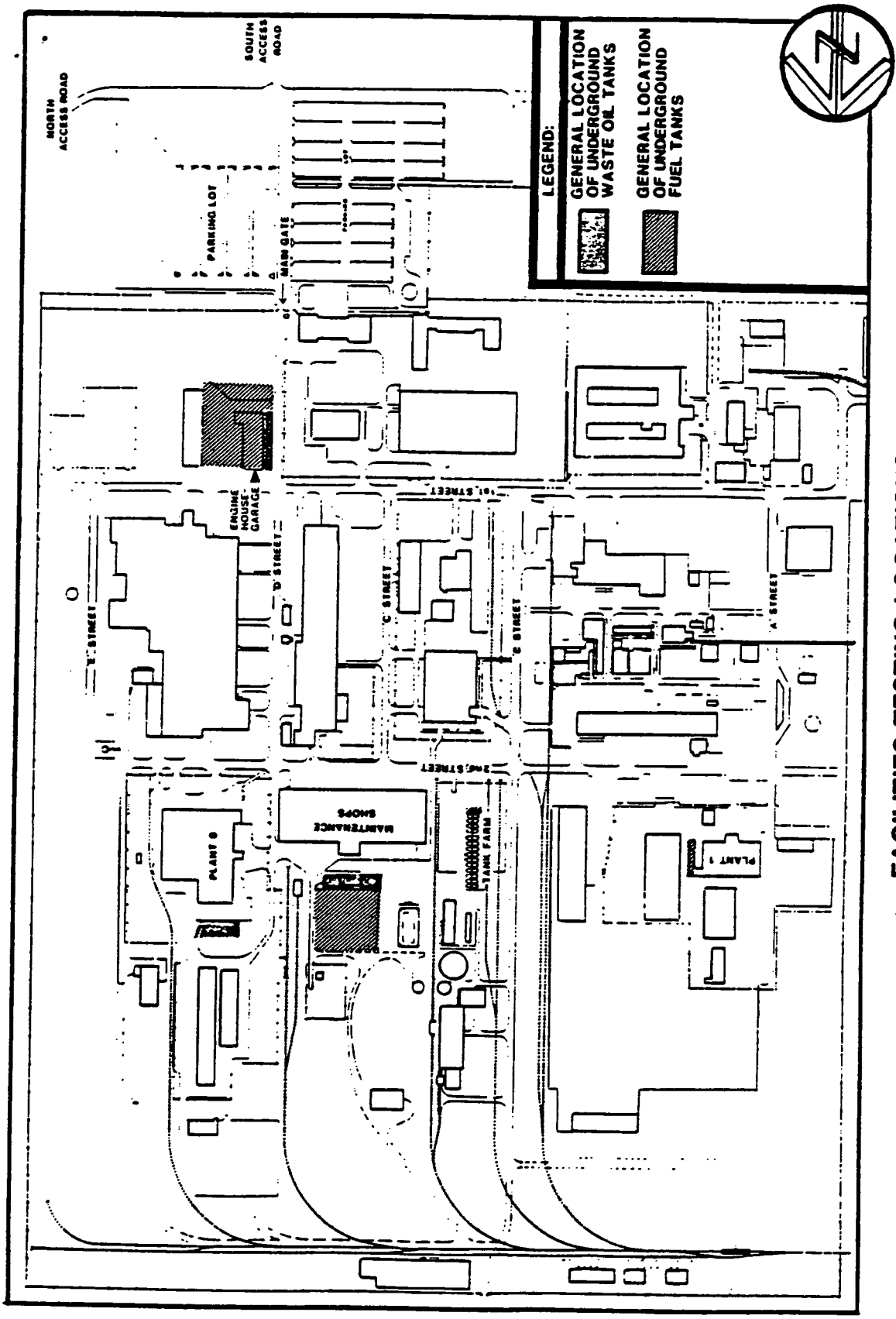

Figure 4.11 **FACILITIES TESTING LOCATIONS: UNDERGROUND STORAGE TANKS**

- Assemble existing drawings and reference material;
- Identify lines and tanks to be tested;
- Determine line operating characteristics, including flow rate and pressure, and
- Examine detailed engineering drawings of each tank and line showing existing joints, flanges, fittings, valves, branches, and construction features, with notation showing sectionalizing points, and proposed test sections.

2. Underground tanks and lines will be tested using the proprietary Petroleum Tank and Line Testing method (PetroTite). This method will comply with the requirements of Ohio Fire Code and NFPA 329, "Recommended Practice for Handling Underground Leakage of Flammable and Combustible Liquids" and as further specified by the manufacturer of the equipment selected for the test. This procedure was selected because product circulation during the PetroTite testing provides better temperature compensation than other tests. The following general procedures will be used:

   - The tank under test is completely filled with petroleum product, and all air pockets and bubbles are carefully located and bled. Lines connecting to the tank are valved off, or otherwise isolated;
   - A standpipe is set up to increase the static pressure in the tank by a measured amount, thus slightly displacing the ends of the tank;
   - A recirculating pump system is used to thoroughly mix the product in the tank, eliminating temperature gradations or stratification. The temperature of the tank contents is measured and recorded;
   - The product added to maintain a constant level of fuel for a specified time (i.e., replacing any leakage) is measured using a graduated beaker; and
   - The leakage rate of product per unit of time is computed.

A specific methodology will be submitted for approval after a subcontractor has been selected.

Test Results

An underground tank leakage rate of more than 0.05 gal./hr/tank is unacceptable (NFPA, Bulletin No. 329). Tanks which show a higher rate of loss should be excavated for visual inspection, and appropriate repair or replacement of the tank or its connecting lines will be considered. Tank features which do not comply with RCRA Subtitle I proposed regulations will be identified.

Scope

The line from the clean well to Manhole 175, production storage pads, hazardous waste storage tanks, dikes, ancillary below ground piping and sumps will be tested for integrity once during the sampling plan. These systems are plantwide and even extend outside the boundaries of the production area.

The integrity testing programs will be accomplished in the following steps:

1. Preliminary Data Collection

   - Assemble existing drawings and reference materials
   - Identify lines, pads, tanks, dikes, piping, and sumps to be tested
   - Determine all operational characteristics, including flow rates and pressure where applicable.

2. The integrity testing of the line frm the clear well to manhole 175, production storage pads, hazardous waste storage tanks, dikes, ancillary below ground piping and sumps will consist of the following procedures:

   - Visual examination whenever possible
   - Pressure testing of storage tanks and underground piping
   - TV camera inspection of underground piping where feasible
   - Volumetric level testing for sumps

Test Results

Any compromise in the integrity of the systems will necessitate the development of a sampling program for the analysis and content of any potential contamination.

4.3 TASK 3 - SITE INVESTIGATION

4.3.1 Problem Definition

In Section 2.0, ~~discussed,~~ the potential environmental problems associated with the FMPC facility were addressed. Relationships between sources of radiological and chemical contaminants potentially being released from waste and production areas, and pathways to both on-site and off-site receptors were established through an analysis of existing practices and conditions, potential remediation activities, data and information needs, and potential risks. The

report on Task 1 - Description of Current Situation, is being developed for submittal. This document will contain an in-depth review of the nature and extent of existing FMPC conditions and problems, and will include a description of previous response actions.

4.3.2 Data Needs

From the review of the current situation, and a preliminary evaluation of remedial technologies, technical data needs have been identified that are necessary for the preparation of the sitewide RI/FS. These data needs have been addressed in relation to proposed field activities in Section 4.2.1.

4.3.3 Procedures for Site Investigations

The site investigation tasks have as a general objective the collection of all data necessary to characterize conditions as to their actual or potential hazard to human health and the environment. Site investigation activities will follow detailed objectives and procedures being developed as Task 2, - Work Plan Requirements, which contain the Sampling Plans. A brief summary of the sampling plan objectives and procedures has been presented in Section 4.2.1.

4.3.4 Site Investigation Activities

During this task six major programs will be executed and completed:

- Hazardous Analyses Program;
- Hydrogeologic Investigation;
- Groundwater Quality Investigation;
- Soils and Sediments Investigation;
- Surface Water Investigation; and
- Off-Facility Water Supply Investigation

Each of these programs has specific data needs identified in Section 3.0 that are reflected in the sampling plans. To gather appropriate data for the above programs, technical field teams will be organized and mobilized as discussed below.

4.3.5 Investigative Field Teams

Each investigative field team will be organized under an experienced Task Leader to gather data in accordance with procedures specified in the

respective discipline sampling plans. Pertinent technical personnel will be assigned to prepare for and execute field sampling. This includes:

- Preparation of procurement needs;
- Obtaining required equipment, supplies, etc., and in the case of subsurface and geohydrology, obtaining drilling contractors;
- Making specific assignments and schedules for field sampling activities;
- Documenting and shipping samples to Contract Laboratory Program (CLP) laboratories for analysis, and scheduling laboratory analyses;
- Coordinating efforts with the project director; and
- Execution of the field investigation following sampling plan procedures.

Each field team will have a task leader with technical experience in field investigation situations, and in the management of sampling crews. Decisions on sampling problems, should they arise, will be made by the task leader after consultation with and approval from the Project Director, DOE, and WMCO. The discipline makeup of field crews necessary to provide investigative products as requested in Task 3 are the following:

- Hazardous Analyses Program
  - Organic and inorganic chemist
  - Health and radiation physicist
  - Process and chemical engineer
  - Geotechnical engineer
  - Air quality specialist
- Hydrogeologic Investigation
  - Hydrogeologist
  - Hydrologist
  - Geologist
  - Geotechnical engineer
- Ground Water Quality Investigation
  - Hydrogeologic modeler
  - Hydrogeologist
  - Hydrologist
  - Health and radiological physicist
  - Organic and inorganic chemist
- Soils and Sediments Investigation
  - Geotechnical engineer

- Soils engineer
- Organic and inorganic chemist
- Health and radiological physicist
- Ecologist

• Surface Water Investigation
  - Hydrologist
  - Ecologist
  - Hydrologic modeler
  - Health and radiological physicist
  - Organic and inorganic chemist

• Off-Facility Water Supply Investigation
  - Hydrologist
  - Organic and inorganic chemist
  - Health and radiological physicist

Each of the above programs may utilize disciplines from another program, as required. Technical assistance in investigative activities may alsobe provided at the technician level with personnel trained in the respective disciplines. All field activities will be coordinated through the RI/FS Site Manager, and will be subject to the approval of the Project Director and Technical Project Manager.

4.4 TASK 4: SITE INVESTIGATION ANALYSIS

4.4.1 Data Management and Evaluation

Data obtained during the investigation will be evaluated throughout the course of the RI to support other investigative tasks and to identify necessary changes to the scope of the study in a timely manner. The quality and completeness of the data base resulting from the RI will also be examined in this task in terms of its adequacy for the evaluation of potential remedial technologies and alternative actions in the Feasibility Study. Methods of data evaluation are very specific to individual investigative tasks, the desired use of the results, and the necessary degree of confidence in the conclusions. Therefore, specific data evaluation programs will be developed as the data are collected and reviewed.

Various statistical techiques can be used to evaluate data from the sampling programs. For example, geostatistical analysis will support different mappings of the magnitude and extent of site contamination. Basically, there are three types of mappings which may be produced. These are:

- Mapping of the statistically optimal estimate of contaminant concentration;

- Mapping of the probability that actual contamination exceeds a given threshold level; and

- Mapping of the contaminant level which will not be exceeded with a fixed probability (for example, the contaminant level for which there is a 95 percent probability that a measurement will be lower).

The types of mappings that will be used in the RI assessment will be determined as the project progresses. The first type can be used to determine spatial trends (for example, directional plumes or the spatial distribution of contamination), or to delimit candidate areas for remediation. The second type of mapping, isoprobability maps, can be used to determine the risks of declaring a clean area contminated or a contaminated area clean. The third type of mapping, isoquantile maps, can be used to evaluate the spatial distribution of contaminant concentrations known with a fixed level of certainty.

Other types of presentation formats typical of geolotic, hydrogeologic, and environmental studies will also be utilized for purposes of data summarization. Examples include:

- The location, thickness, and character of areas containing waste or waste-generated chemicals will be outlined on the site topographic map. Sampling locations and approximate concentrations for one or more indicator chemicals can also be depicted on the map;

- Site geology will be dipicted on a series of geologic cross sections that transect the most pertinent waste and/or environmentally affected areas of the site; the till, including the location and thickness of clay and sand and gravel aquifer, and the associated blue clay strata will be graphically characterized;

- Ground water flow gradients and directions will be depicted on ground water table (potentiometric) contour maps superimposed on a topographic map for both the till and the sand and gravel aquifers. The monitoring well locations will also be shown on the topographic map;

- The results of the hydrogeologic data analysis program will be presented on base maps. This information will include, for example, the location or locations of water-bearing strata and other

subsurface features, the degree of vertical connection between the till and sand and gravel aquifer, ground water/surface water interrelationships, and any local geologic or hydrogeologic migration. The results of the ground water modeling study will be used to support this effort, particularly with regard to predicted flow and contaminant transport behavior under various pumping scenarios;

- The regional site maps will be used to identify potential receptors of any chemicals released from the site, as well as any other sources of wastes in the regional area that could be contributing chemicals to the wells being monitored.

The entire data management and evaluation program will be formulated around the Data Base Management Plan. This data management program is intended to:

- Provide a relational data base management tool;
- Be capable of upload and download of completed or partial data;
- Possess integrated security and administrative functions;
- Accept chemical analysis data directly from a laboratory either through telecommunciations or on magnetic media; and
- Have integrated graphic and statistical analysis capabilities.

This data management system will allow for the storage, retrieval, analysis, and display of the historical and new data acquired during the RI.

4.4.2 Ground Water Modeling

4.4.2.1 Evaluation of Hydrogeologic Regime

An evaluation of the hydrogeologic regime will be performed based upon a review of project and historic data. This evaluation will provide an understanding of the ground water flow and chemical species and distribution observed at the FMPC, and will include a water balance for the site to establish recharge tothe aquifers, communication between aquifers, and direction and rate of ground communication between aquifers, and direction and rate of ground water flow. An investigation of the observed chemical species concentrations in the soils and ground water relative to dispersion analysis and the results of the water balance will be performed to establish the

potential source loadings and to permit evaluations of the mass transport parameters required for subsequent numerical modeling.

The water balance will be performed for the site to evaluate recharge rates through the till and stream channels and into the buried channel aquifer. The analysis will consist of evaluating information on site soils and local meteorology to establish rates of evapotranspiration, precipitation, surface runoff, and infiltration. Infiltration and percolation through the till and stream beds will be evaluated to assess recharge to the underlying aquifers. The significance of existing production wells in the vicinity of the site will also be evaluated during this investigation. Additionally, the potential leakage associated with the site sewer system will be addressed.

The distribution of chemical species in the ground water will be evaluated to investigate the species mass loadings associated with recharge of the aquifer, and to assist in understanding the existing conditions. Existing closed-form solutions for dispersion in uniform flow will be utilized to identify reasonable distribution patterns which are consistent with the observed results from site monitoring wells. By establishing estimates of mass loadings to the aquifer, geochemical parameters for the mass transport analysis can be developed. Irreconcilable differences between observed data and the results of the analysis may suggest areas for further data collection.

4.4.2.2 Planning Level Modeling Study

In 1985, GeoTrans, a ground water consultant, completed a modeling study of the buried channel aquifer near the FMPC. The results of this study indicated the potential presence of a ground watre divide in a location different from the north-south alignment previously conjectured. GeoTrans utilized the results of the study to recommend that additional wells be strategically placed to confirm the new findings, since such findings could have an effect on contaminant pathways and the interpretation of historical data.

The previous work by GeoTrans illustrates the value of a numerical model in planning field activities. In particular, the application of even a ground water flow model (rather that an more complex contaminant transport model) can provide considerable insight into the direction and rate of ground water flow

in lieu of field data. Examples of the types of information that can be derived from a model include:

- Identification of aberrant local ground water flow patterns that may be induced by a combination of stresses, but which would not be otherwise known when planning field efforts. The GeoTrans results are illustrative of this value;
- Determination of expected patterns of ground water flow away from waste sources, thereby aiding in any plume monitoring;
- Assessment of the degree of interaction between aquifers or between streams and aquifers, which would reduce the level of uncertainty in deciding on the need to monitor multiple aquifers in a given area;
- Approximation of travel times, which when used in combination with long-term monitoring results could provide insight into aquifer flushing times. This may be of particular value at the FMPC due to the possibility that many of the historical observations of contamination may be associated with singular discharge episodes;
- Estimation of dilution, which is important to the preevaluation of public health and environmental risks; and
- Evaluation of the limits of upgradient dispersion to ensure that planned background wells are indeed outside of any potential waste plumes.

The above information can be considered a planning tool to future monitoring programs and a "check" to increase confidence in existing field data and its interpretation.

Preliminary hydrogeologic simulations will be performed. This will aid in the evaluation and interpretation of the data and will allow predictions regarding contaminant migration pathways from potential source areas.

Only models capable of three-dimensional solute transport simulation will be considered. The reason is that any modeling efforts carried out as part of the data evaluation work will represent a first step in the applicaton of the same model code to subsequent asswssment tasks when solute transport becomes critical. The initial effort will be limited to ground water flow modeling since this alone will provide the necessary input to a ground water sampling plan at off-site locations. An attempt will first be made to access and build upon the earlier work of GeoTrans. If the SWIFT II code and GeoTrans' data

base are not available, the following codes will be evaluated for their suitability to the FMPC:

- GEOFLOW, a finite element simulation model capable of numerically simulating two- and three-dimensional fluid flow and solute mass transport;
- SUTRA, a finite element program for saturated-unsaturated ground water flow with chemically reactive single-species solute transport; and
- SWENT, a three-dimensional finite difference code for simulation of fluid and solute radionuclide transport.

The conceptualizaton of the model will involve the development and quality control "check" of the input data base as well as the establishment of meaningful boundary conditions and initial conditions.

Data that will require development and review include the geologic setting, initial potentiometric head distribution in each aquifer, fluid transmission and storage properties, and natural or man-made recharge and discharge terms (e.g., pumping). Any newly compiled data will be reviewed and appropriate changes to the input data base will be made.

An iterative process of model testing should result in calculated values of head (water elevation) similar to those observed withing the aquifer system. The criterion for what is a "close enough" match between model predictions and field observations is based on the complexity of the system, the level of detail of the available data base, and the eventual use of the model results. For this initial phase of modeling in support of data evaluation, the performance criteria will be relaxed since the model is only being used to identify significant patterns in ground water flow and to test the validity of assumptions for use in refining the field investigation plans. At the same time, if the schedule and budget permit, additional efforts will be spent in refining model results since this will prove beneficial in later tasks when the same model is extended to include contaminant transport.

4.4.2.3 Hydrogeologic Simulation

The objectives of the computer simulations of ground water flow and mass

transport are to:

- Determine ground water flow rates and directions;
- Further define and quantify recharge (i.e., surface water and ground water);
- Evaluate the observed water quality data relative to the identified potential chemical consittuent sources;
- Determine the relative importance of the identified sources in terms of chemical constituent loading rates to areas of the aquifer;
- Predict current and future contaminant transport patterns for use in the Endangerment Assessment; and
- Provide a framework for predicting and evaluating the effects of proposed remedial alternatives in the Feasibility Study. Possible remedial measures that could be evaluated include determining locations and spacing of intercepter wells with associated pumping rates and duration of pumping, and source controls by partial ground water cutoff (e.g., slurry walls).

To achieve these objectives, the three-dimensional model developed for the planning level modeling study will be updated with the new project data and a contaminant transport code will be incorporated.

Simulation Methodology

The methodology will consist of developing a model which can accurately simulate the response of the hydrogeologic regime to various remedial action measures which influence the aquifer flow field and chemical constituent transport. The existing flow field results from site properties and external conditons. Because the model will present a finite protion fo the aquifers, conditions at the model boundaries in conjunction with the flow and transport properties must be selected to result in a reasonable simulation of the current ground water flow, potentiometric surface, and chemical species distribution at the site. Successful simulation of the existing site conditions will provide validation of the model and will provide confidence in the recharge and mass loading estimates established from previous analyses.

The simulation methodology for proposed alternatives will consist of the following analyses performed for various combinations for remedial action

alternatives:

- Validation of the models with respect to the existing flow field, potentiometric surfaces, and chemical constituent distribution in the aquifer;
- Simulation of selected remedial action alternatives using a three-dimensional model to identify the areal influence on the flow field, potentiometric surface, and average aquifer concentrations and mass flux; and
- Sensitivity analyses of significant simulation parameters on selected alternatives.

Validation studies will assess steady-state conditions of flow and transient mass transport. Simulation of various remedial action alternatives will consider both steady-state and transient flow and mass transport.

Model Development

To simulate the hydrogeologic regime at the FMPC, a horizontal planar and possibly vertical cross-sectional flow model will be utilized. Site-specific data will be input to the model and an iterative process will be used during the validation analysis to refine and quantify various parameters such as hydraulic conductivity and recharge.

Site-specific input to the flow model will include a finite element or finite difference grid system, boundary conditions (specified potentiometric heads and flow boundariew when appropriate), aquifer recharge and hydraulic conductivity zones, bottom of aquifer elevations, initial satkurated thickness, and locations of production wells with corresponding pumping rates.

Model Setup - Horizontal Plane

The specific objectives in setting up the horizontal (x-y) plane of the three-dimensional model are as follows:

- Develop a finite element grid system optimizing use of field data and incorporating element geometries conducive to accurate numerical results;
- Provide a valid representation of the horizontal distribution of site geologic and hydrogeologic characteristics; and

- Establish the regional extent of the model to be sufficient to evaluate the proposed remedial action alternatives without significant influence of boundary conditions.

The grid system will be refined in areas of primary interest to reflect the density of available data, variability of aquifer characteristics, and physical site features, and to enable simulation of potential remedial alternatives.

Model Setup - Vertical Plane

Vertical cross sections along the principal directions of ground water flow in the FMPC area may be developed to provide a representative base for mass transport simulations. Hydrogeologic units will be incorporated into the model according to their observed distribution.

Using methodology consistent with that described previously, the selection of boundaries for the vertical (z) plane will be developed according to the following rationale:

- The top horizontal grid boundary will represent the ground water table and inflow line for ground water recharge determined during model validation;
- The two side boundaries will be constant head or no-flow boundaries; and
- The bottom horizontal grid line will be a no-flow boundary representing the contact with the buried channel bottom (shale unit) of relatively low hydraulic conductivity.

Model Input Data

The input data for analysis of ground water flow (hydrologic parameters) and chemical constituent transport (geochemical mass transport parameters) at the FMPC site will be based upon results of field investigation programs and data available in the literature. Site-specific data used in the models will include geologic information such as the bedrock valley survey, boring log data, hydraulic conductivity test results, potentiometric head measurements, and chemical analyses of ground water. In addition, the simulations will incorporate the interpretation of site geology and geochemistry (e.g.,

geologic cross sections, potential chemical constituent sources) which will be based on parameters observed. The range for each parameter will be refined by model validation. For parameters and site area conditions where site-specific measurements are not available, data from the literature for sites with similar hydrologic properties will be evaluated. In addition, sensitivity analyses will be performed to examine the effect of parameter variation on the results of modeling.

Model Validation

An iternative procedure will be used to validate the models by comparing computer potentiometric surfaces and chemical constituent concentraiton profiles with observed data according to the following steps:

- Development of the grid system;
- Preparation of the input parameters and selection of validation parameters;
- Comparison of computed potentiometric levels with the observed data; and
- Variation of the validation parameters within ranges specified until the validation requirements are satisfied.

The following criteria for assessing the status of the validated models will be used:

- The computed potentiometric heads are similar to measured values with similar gradients;
- The computed chemical constituent concentrations and mass flux are consistent with measured values;
- Values for input parameters are within known ranges; and
- The principle of mass balance is satisfied.

Model validation will be performed based on average conditions observed at the site, such as the potentiometric surface which is subject to seasonal fluctuation. It is anticipated that validation of the model relative to the computed potentiometric surface can be performed to within three feet of observed values. Validation associated with mass transport is more

difficult. The results of the models should reflect the overall concentration distribution observed at the site with similar estimates of total mass flux. However, because of the limited data available on concentration distribution over the entire model domain, and the unknown history of the contaminants on the site, specific values to use in validation analyses are difficult to assign. It is anticipated that the mass flux of the ground water as computed from the available data can be simulated within an order of magnitude with the relative concentration distribution similar to observations interpreted from the monitoring well.

Sensitivity Analyses

The model input parameters will be subjected to sensitivity analyses to test model responses to the potential range of key parameters. These analyses will permit evaluation of the effects of key hydrological and mass transport parameters on model output.

It is anticipated that sensitivity analyses will be conducted for the following parameters:

- Hydraulic conductivity;
- Recharge;
- Communication between aquifers;
- Storage coefficient; and
- Dispersion coefficient.

4.4.3 Air Modeling

4.4.3.1 Objectives

One purpose of the air modeling study is to satisfy the FFCA by retrospectively predicting for each year of plant operation the inhalation dose and deposition of radioactive material released from the FMPC. In particular, the model predictions will include:

- The inhalation dose to the off-site population within a 2, 5, 10, and 50 mile radius of the FMPC and the dose to the maximally exposed individual; and

- The deposition and resulting whole body and organ doses of radioactive material in areas within 2 and 5 mile radii of the FMPC. Total deposition as predicted by the model will be compared to measurements of radioactive materials in soils and sediments.

A second purpose more divertly aligned with needs of the RI/FS is the use of the model to predict doses and exposure to off-site populations under current and projected future conditions for use in the endangerment assessment for the no-action alternative. Similarly, the model will be applied in the FS to predict the effects of various remedial actions on the off-site doses.

An air modeling study currently being performed by IT Corporation in support of an epidemiological study by the Center for Disease Control (CDC) for DOE will directly satisfy the first purpose of the modeling study. This work is being performed under strict quality control conditions, including review at each critical stage by an external peer review team made up of recognized experts in related fields. The US EPA is represented on the peer review team. It has been determined that the resultant model code will be directly transferable for use in satisfying the RI/FS air modeling needs described above.

IT has recently issued a "Dispension/Radiation Dose Assessment Modeling Protocol for the Feed Materials Production Center" for use in the CDC modeling work. This protocol calls for the use of the AIRDOS/EPA modeling code. The AIRDOS/EPA computer code is an environmental model which calculates radionuclide concentrations in air; rates of deposition on ground surfaces; and ground surface concentrations (i.e., buildup); however it does not take into consideration the effects of downwash and building wake. Radiation doses to man are calculated as a result of radionuclide inhalaiton and ingestion of meat, milk, and fresh vegetables exposed to particulate fallout. Direct exposure due to air submersion and groundslide are also computed. Up to twelve specific target organ doses can be calculated during a single run of the code. The AIRDOS code will compute both population and maximum individual doses on a flexible polar grid established for the FMPC.

4.4.3.2 Data Needs

The computation of the inhalation dose is dependent on the predicted ambient air concentration of radioactive materials. computation of the off-site concentration and deposition requires that the following data be available for use in the AIRDOS/EPA model:

- A year-by-year inventory of radionuclide emissions for the radionuclides contributing to at least 90 percent of the total dose (i.e., primarily U-238, U-235, Th-230, and Rn-222);
- Air monitoring data at sufficient locations to provide actual measurements for validating the reliability of the model predictions;
- Meteorological data representative of the FMPC area for each year of plant operation;
- Demographic data for each zone (i.e., sector and radius grid) for each year of plant operation;
- Specific radionuclide data describing deposition and gravitational settling velocities, and dose conversion factors for each target organ of interest;
- Specific FMPC stack data describing physical stack parameters, for use in assessing the effective height of release and for determining the location of the source center for dispersion modeling.

The previous work of IT in support of DOE's litigation efforts at the FMPC, its current work in support of the CDC study, and the data review and scoping efforts recently completed in the preparation of the RI/FS Work Plan have determined that the combination of the historic data base and the data generated from ongoing monitoring programs will satisfy each of the aforementioned data needs. Consequently, no additional air monitoring program is being proposed for purposes of the RI/FS. The validity of this decision will be tested through the peer review being conducted as part of the CDC study. if data deficiencies are indentified through the CDC work, new data collection efforts may be completed either as part of the RI/FS or under separate contract. The value of any additional data in improving model reliability will have to be weighed against the potential impacts on schedule, since long-term records are usually required to determine average conditions and trends for air-related parameters.

Emissions Inventory

Radionuclide emissions from the FMPC for the period 1951 through 1984 have been compiled by WMCO (Boback, 1987). This report includes annual emission of uranium for each stack for each year of operation, stack parameters (stack height and inside diameter, exhaust gas temperature and velocity), particule size distributions, and an inventory of radionuclides for several of the plants. The US EPA had reviewed early versions of this document, and responses to all US EPA comments were incorporated into the final document.

These data will be used as part of the CDC study to prepare a uranium emission inventory for each of the 34 years (1951-1984) of FMPC operations. This inventory as well as the supporting documentation (Bobach, 1987) will be reviewed and approved by the CDC prior to preparing the data for input to the AIRDOS-EPA model. The inventory will also be updated by including the 1985 and 1986 emission inventories.

A more limited emissions inventory is also available for other radionuclides, including isotopes of plutonium, neptunium, thorium, radon, cesium, nuthenium, technetium, strontium, and protactinium (Boback, 1987). According to the protocols for the CDC/IT air modeling study, the 75th percentile of the observed frequency distribution for each of these radionuclides will be used as a conservative estimate of the respective release rates for input as source terms to the AIRDOS/EPA model.

Air Monitoring Data

WMCO currently collects air monitoring data from 12 stations within and near the FMPC. Seven high volume samplers encircle the site at the fenceline to monitor emissions at the point of release to off-site locations. This program was augmented in 1986 by the addition of two continuously operating particulate samplers to form a swquential line of samplers outward from the Production Area in a downwind direction. The remaining three stations operate at critical receptor locations off site. These are located to the southwest, south, and northeast of the FMPC, and thus span the dominant upwind and downwind directions.

Weekly samples are collected from these stations and analyzed for uranium

content and beta activity. Yearly composite samples are analyzed for trace radionuclides such as isotopes of neptunium, plutonium, and thorium.

Concentrations of radon-222 are monitored at nine on-site and five off-site stations using commercially available instruments. Radon-222 is also measured at two private residences and at two elementary schools. Since 1986, concentrations of thoron (radon-220) have been included for measurement at the on-site and off-site stations.

Within limits, the resultant data base can be used to directly compute the dose and associated risk to off-site populations as a result of air born contaminant release. The model will be used to extend the predictive capability if the reliability of the model results can be established. The capacity of the existing monitoring data to satisfy the requirements of model calibration appears to be sufficient. The long-term uranium data at the plant boundary will allow testing of the model over a several year period and under varying operational and meteorologic conditions. The more recent data collected from the three stations aligned downwind between the Production Area and the fenceline (and even including the off-site location to the northeast) will provide a test of the model's capacity to reproduce depositional and dispersion patterns. Finally, the limited data base on other radionuclides can be used in conjunction with the average emission values to independently test the sensitivity and reliability of the model in terms of the nuclide-specific parameters.

The integrity of the ongoing air monitoring program depends on the accuracy of the sample collection techniques and the laboratory analysis of the samples collected. To ensure the integrity of environmental monitoring data, the FMPC maintains on comprehensive QA program. This program is consistent with DOE Order 5700.6A, "Quality Assurance;" ANSI/ASME NQA-q, "Quality Assurance Program Requirements for Nuclear Facilities;" and other applicable DOE Orders and federal and state regulations. A 1985 audit of the FMPC air monitoring program by Oak Ridge personnel determined the network to be sufficient and reliable, witha recommendation to install several additional monitoring stations. This recommendations has since been implemented. The FMPC utilized both commercial laboratories and in-house analytical facilities under strict

quality control procedures. Interlaboratory programs are also used to document the reliability of monitoring data.

Meteorological Data

An on-site meteorological station has been operational at the FMPC for only about one year. The length of this data base is not sufficient for modeling purposes. The closest National Weather Service station to the Fernald site collects data at the Greater Cincinnati Airport located near Covington, Kentucky. The airport is 16 miles south of the FMPC and is situated in gently rolling terrain about three miles south of the Ohio River. The topographic features of the surrounding area would not locally affect flow conditions at the airport. Similarly, there are no significant topographical features within five miles of the FMPC which would alter wind flow patterns at the plant. The orientation of the Ohio River in this area is west-northwest to east-southeast. A windrose for the Greater Cincinnati Airport does not indicate any predominance of wind direction along the axis of the river valley. The prevailing wind direction is from the south-southwest, which is quite typical for southwestern Ohio.

Based on these topographical considerations and the proximity of the Greater Cincinnati Airport, meteorological data recorded at the airport are expected to adequately reflect conditions at the Fernald site. An analysis performed by IT in support of DOE's litigation work documented a very high correlation between the airport data and the meteorological data collected at the FMPC station during the last year.

Meteorological data in the form of annual frequency distributions of wind speed and direction by Pasquill stability class were obtained for Cincinnati for each of the 34 years. These annual frequency distributions were prepared by the National Climatic Center, and will be used in the model.

Demographic Data

Population doses require population distribution data for each zone in which a dose is computed. A zone is the area within a given wind direction sector subtended by the radii of interest. For FMPC retrospective doses this amounts to 4 radii multiplied by the 16 wind direction sectors, or a total of 64

population values for each year of plant operation. These data will be supplied by local census records. Because the populations will be linearly interpolated between the closest years in which a census was taken.

Radionuclide Data

In computing air concentrations and resulting inhalation doses AIRDOS/EPA requires two kinds of data unique to each radionuclide of interest:

1. Deposition and gravitation settling velocities - The deposition velocity describes the rate at which radionuclides are deposited on vegetation and effectively removed from the air. The gravitational settling velocity is the rate at which radionuclide particulates are removed by falling out of the air and is dependent upon the size and density of specific particulates. These values will be obtained from published literature, and will be reviewed with the US EPA prior to use.

2. Dose coversion factors - These quantities relate the damage done to the body due to the inhalation of a given radionuclide. They are unique for each human organ and radionuclide. In this study, dose conversion factors will be taken from the International Commission on radiological Protection (IRCP) references, and will include additional effects resulting from the formation of daughter products from inhaled parent radionuclides.

Stack Data

Stack data describing the physical dimensions and other unique features are required for each stack of interest. These data are used in assessing the effective height of release including the plume rise. Stack specific data include the stack height, stack diameter, exhaust flow rate, exhaust temperature, and an indication as to the presence of a rain cap. These data are available as part of the emissions inventory report (Boback, 1987).

4.4.4 Endangerment Assessment

The purpose of the Endangerment Assessment is to address the potential human health and environmental effects posed by exposure to radioactive and chemical contaminants from the FMPC under the no-action alternative. The Endangerment Assessment to be conducted at the FMPC will follow and be consistent with U.S. EPA's "Superfund Public Health Evaluation Manual: (EPA/540/1/86/060, October 1986). ~~--EPA--guidance--in--relation--to--CERCLA/SARA investigations.~~ In particular, the assessment will be performed in accordance with "The Endangerment Assessment Handbook" (U.S. EPA; August, 1985) and the Toxicology Handbook -- Principles

Related to Hazardous Waste Site Investigations" (U.S. EPA; August, 1985). The Endangerment Assessment will consist of the following four elements:

- Identification of Contaminants of Concern
- Toxicity Assessment
- Exposure Assessment
- Risk Characterization

4.4.4.1 Identification of Contaminants of Concern

The purpose of this work element is to characterize any hazards associated with substances found in the various media in site-specific circumstances in order to focus the balance of the appraisal on the most meaningful contaminants in terms of the risks faced by the public and the environment. The identification of contaminants of concern is provided by the following elements:

- Description of the scope of the compiled and reduced radiological and chemical analytical data base;
- Determination of the extent of radiological and chemicals constituents in the relevant environmental media such as surface and subsurface soils, air, and surface water and sediments, and ground water;
- Selection of indicator parameters that adequately represent specific hazards posed by the site.

The identification of contaminants of concern will consider both radiological and toxic chemical contaminants since the toxicological properties and possibly the modes of exposure will vary and could be individually or collectively important. In addition, the non-radioactive hazards associated with radiolocial constituents will be evaluated due to their potential importance to a risk assessment. For example, the most abundant radionuclides released from the FMPC since it began operations have been Uranium-238 and Uranium-234. From a radiological standpoint, both Uranium-234 and Uranium-238 are long-lived alpha particle emitters and thereby present a hazard to body tissues after intake into the body. Following intake (inhalation or ingestion), a fraction of the radionuclides is taken up into the blood. On the other hand, the chemical toxicity of uranium compounds can also cause both acute and chronic effects. Inhalation of these compounds at sufficiently high

concentrations during exposures of short duration may have some health impact during an acute (minutes to hours) exposure. Chronic exposure to the soluble compounds at sufficiently high levels can result in kidney damage.

A hazardous analysis of uranium compounds has been completed as part of a previous litigation-support risk assessment. The information compiled will be reviewed and updated during the proposed Endangerment Assessment. Similar information will be developed for all the radiological and chemical constituents of interest.

4.4.4.2 Toxicity Assessment

The selected ~~indicator-parameters~~ contaminants of concern will be classified and evaluated int he context of their toxicological properties and related health effects. The toxicity assessment will be a two-step process consisting of a toxicological evaluation and a dose-response assessment. The toxicological evaluation will involve a qualitative evaluation of available information and data to determine the nature and severity of actual or potential health and environmental hazards associated with exposure to each ~~indicator-chemical~~ contaminant of concern and radiological substance. The evaluation will include a critical review and interpretation of toxicity data form epidemiological, clinical, animal, and in vitro studies resulting in a toxicity profile for each contaminant of concern in relation to site-specific circumstances.

With regard to toxicological effects of radiation exposure, a linear, no threshold dose-response relationship will be assumed. The effective dose equivalent (dose) will be calculated using the internationally accepted models of the International Commission on Radiological Protection (ICRP) which are endorsed by the National Council on Radiation Protection and Measurement (NCRP). With this approach, the dose to individuals is calculated for each radionuclide in each mode of intake. Because variations in duration of exposures, rates of intake, chemical form of radionuclides, and human metabolism, application of this method form chronic environmental exposure provides a best estimate of dose to individuals in specific areas.

In the context of toxicity due to chemical exposure, as differentiated from radiation, most chemicals of concern produce health effects that possess a threshold below which the impact will not occur. Another way of stating this

factor is that there will not be any health consequences (radiation is not included) from exposure to concentrations of such chemicals at levels below the threshold value. For carcinogenic chemicals, for which the toxic response is cancer, a no-threshold model will be used in accordance with current U.S. EPA guidance.

The dose-response assessment for noncarcinogenic chemicals will utilize appropriate quantitative indices of toxicity identified during the toxicological evaluation to determine "acceptable" exposure levels which are not expected to cause adverse health effects for the contaminants of concern. The "acceptable levels" will be expressed as acceptable daily intakes (ADI's), ambient air standards, water quality criteria, etc. For carcinogenic chemicals, the dose-response assessment will be used to estimate the probability that a specific adverse effect will occur.

4.4.4.3 Exposure Assessment

Once the target constituents are characterized with respect to their hazard potential, an assessment of potential exposure will be completed for each type of receptor. Of initial concern is the development of exposure pathways, which are the routes radiological and hazardous materials take to reach a susceptible human receptor. The following types of potential exposure pathways will be considered for contaminants released from the FMPC:

- Inhalation of airborne contaminants;
- Dermal contact via submersion in a contaminated atmoshpere;
- Direct contact with contaminated soils, sediments, water, and vegetation;
- Ingestion of contaminated ground water, fish, fowl, food crops, meat, and milk;
- Ingestion of contaminated soils and sediments; and
- Direct exposure to radiation.

A related component of the exposure assessment is the evaluation of the environmental fate and transport of chemicals between the environmental media. This component generally refers to the physical or chemical mechanisms

which release a contaminant to the environmental pathway. Although analytical methods to predict such releases are available (e.g., through geochemical models), common practice is to utilize actual field observations to define the contaminant releases for input to a fate and transport model.

The exposure levels at the receptor locations will be primarily developed through the application of the ground water and air transport models to calculate concentrations, with appropriate adjustment for the probability, extent, and duration of actual exposure based on generally accepted routines (e.g., inhalation and ingestion rates, transfer and trap efficiencies, etc.).

4.4.4.4 Risk Characterization

The characterization of risk will integrate all of the information that is developed in the toxicity and exposure assessments to characterize all types of potential or actual risks at the FMPC. These will include carcinogenic risks, noncarcinogenic risks, environmental risks, and risks to public welfare.

Risk to public health will be characterized by comparing any estimated exposure levels to relevant environmental criteria and standards based on the nature of the health impact. Cancer risk levels, if there are any animal or human carcinogens include in the ~~indicator chemical~~ contaminant of concern list, will be quantified. Chronic exposure to the threshold chemicals will also be quantified to the extent possible.

In this assessment, the following two accepted principles will be employed:

- A carcinogenic risk due to radiation exposure will be defined as the probability that a specified dose will cause fatal cancer in some fraction of the people exposed; and
- Dose response is considered to be independent of dose rate.

The absolute risk model as set forth by the Committee on the Biological Effects of Ionizing Radiation will be used with modifications derived from reports for the United Nations Scientific Committee on the Effects of Atomic

Radiation and the ICRP.

A qualitative environmental impact analysis will be utilized to identify and characterize any actual or potential environmental risks associated with the FMPC. The analysis will be performed in the context of site-specific circumstances to determine if any environmental impacts are occurring or could occur as a result of exposure to the radioactive and chemical contaminants present at or released from the site.

The risks to public welfare will also be qualitatively evaluated, and will include adverse effects on property values, future land used, recreational and commercial activities, public perception and opinion, and the quality of life. Any quantitative results generated through DOE's ongoing litigation support efforts will be appropriately incorporated into the analysis if the information is available for public release.

4.5 TASK 5: LABORATORY AND BENCH-SCALE STUDIES

After the investigative components of the RI have been completed and the potential remedial actions have been identified, it may be necessary to conduct laboratory or bench-scale studies to further evaluate some of the actions. This work would include any studies required to evaluate the effectiveness of remedial actions or to establish engineering criteria necessary for design and implementation.

Examples of studies that may be undertaken to support development of various remedial action alternatives include:

- Capping - Compaction and permeability studies;
- Containment Barrier - Chemical compatibility studies of leachate and slurry wall materials;
- Stabilization/Solidification - Chemical compatibility and leachying studies; and
- Ground Water Removal and Treatment - Determination of pore replacement volumes and treatability studies for flushing of wastes.

The specific studies needed under this task to supplement later feasibility

study efforts will be identified, outlined in detail, and proposed in the form of a work plan prior to execution. Since it is impossible to specifically identify such studies now, this must be considered a scope change when and if the studies are agreed upon by U.S. EPA.

4.6 TASK 6: REPORTS

The results of Tasks 1 through 5 will be documented in a detailed Remedial Investigation Report. A draft report will be prepared for U.S. EPA review, as will a final report that incorporates all appropriate comments.

The RI report will be formatted to directly correspond either to the components of Task 3 (Site Investigation) and Task 4 (Investigation Analysis) of the statement of work attached to the FFCA, or to the report contents identified in U.S. EPA's Guidance on Remedial Investigations Under CERCLA. The table of contents from the latter document has been reproduced as Figure 4.12.

4.7 TASK 7: ADDITIONAL REQUIREMENTS

4.7.1 Reporting Requirements

Section 6.7 of this work plan presents a detailed breakdown of all reporting requirements associated with the sitewide RI/FS contract. Included among the requirements are monthly Technical Progress Reports, which will contain the following elements:

- Identification of site and activity;
- Status of work at the site and progress toward achieving compliance with the FFCA;
- Percentage of completion;
- Difficulties encountered during the reporting period;
- Actions being taken to rectify problems;
- Changes in personnel;

FIGURE 4.1[illegible]

REMEDIAL INVESTIGATION REPORT FORMAT

EXECUTIVE SUMMARY

1.0 INTRODUCTION
- 1.1 SITE BACKGROUND INFORMATION
- 1.2 NATURE AND EXTENT OF PROBLEM(S)
- 1.3 REMEDIAL INVESTIGATION SUMMARY
- 1.4 OVERVIEW OF REPORT

2.0 SITE FEATURES INVESTIGATION
- 2.1 DEMOGRAPHY
- 2.2 LAND USE
- 2.3 NATURAL RESOURCES
- 2.4 CLIMATOLOGY

3.0 HAZARDOUS SUBSTANCES INVESTIGATION
- 3.1 WASTE TYPES
- 3.2 WASTE COMPONENT CHARACTERISTICS AND BEHAVIOR

4.0 HYDROGEOLOGIC INVESTIGATION
- 4.1 SOILS
- 4.2 GEOLOGY
- 4.3 GROUND WATER

5.0 SURFACE WATER INVESTIGATION
- 5.1 SURFACE WATER
- 5.2 SEDIMENTS
- 5.3 FLOOD POTENTIAL
- 5.4 DRAINAGE

6.0 AIR INVESTIGATION

7.0 BIOTA INVESTIGATION
- 7.1 FLORA
- 7.2 FAUNA

8.0 BENCH AND PILOT TESTS

9.0 PUBLIC HEALTH AND ENVIRONMENTAL CONCERNS
- 9.1 POTENTIAL RECEPTORS
- 9.2 PUBLIC HEALTH IMPACTS
- 9.3 ENVIRONMENTAL IMPACTS

REFERENCES

APPENDICES

- Results of sampling tests and all other data; and
- Summary of all plans and procedures completed during the past month as well as any activities scheduled for the next month.

The monthly progress report will list target and actual completion dates for each activity, including project completion, and will provide an explanation of any deviation from the milestones in the workplan schedule.

4.7.2 Laboratory Certification

Only CLP laboratories will be used in this RI/FS.

4.8 TASK 8: COMMUNITY RELATIONS SUPPORT

As indicated in Section 4.2, a Community Relations Plan has been developed for RI/FS activities at the FMPC. The DOE will be the lead agency for implementing the Community Relations Plan. Community relations activities to be performed by DOE will be consistent with Superfund community relations policies, as stated in Guidance for Implementing the Superfund Program and Community Relations in Superfund: A Handbook. The primary role of the site contractors will be to provide technical support to the DOE for the successful execution of the Community Relations Plan, particularly in relation to public meetings.

SECTION 5.0

TECHNICAL APPROACH: FEASIBILITY STUDY

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SECTION 5.0

TECHNICAL APPROACH: FEASIBILITY STUDY

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5.0 TECHNICAL APPROACH: FEASIBILITY STUDY

5.1 INTRODUCTION

This section of the Work Plan is intended to provide a more detailed structure for identifying, evaluating, and selecting remedial action alternatives under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), and the Superfund Amendments and Reauthorization Act (SARA) of 1986.

The Feasibility Study process begins with the development of specific alternatives based on general response actions identified in the remedial investigations to address site contamination problems. Technologies within response categories such as waste and effluent controls, excavation and waste removal, in-situ treatment, process modification, etc., will be screened for their technical applicability to the site. Technologies considered technically appropriate will then be combined to form alternatives that fulfill specific categories of remediation. The alternatives will be screened on the basis of public health and environmental concerns and order-of-magnitude costs.

Alternatives that pass the screening process will undergo detailed analyses to provide the decisionmaker with information for selecting the alternatives that is cost-effective. The detailed analyses encompass the engineering, institutional, public health, environmental, and cost analyses. The engineering analysis evaluates constructability and reliability to ensure the implementability of alternatives. The institutional analysis examines alternatives in terms of the Federal, State, and local requirements, advisories, or guidance that must be considered to protect the public health, welfare, and environment. The public health exposure evaluation includes baseline site evaluation, exposure assessment, standards analysis, short and long-term effects of each alternative, and endangerment assessment. The environmental analysis includes examines capital and operation costs, and involves present worth and sensitivity analyses.

Once the detailed analyses are conducted, the information will be organized to compare findings of the evaluations for each alternative. The objective of this summary is to ensure that important information is presented in a concise

format so that the decisionmaker can choose the remedy that provides the best balance of health and environmental protection, and engineering reliability with cost.

The format for the Feasibility Study Report is presented below. It describes the specific elements to be included, the rationale for their inclusions, the level of detail, and the documentation that will accompany the report. The following nine specific tasks will be included in the study:

Task 9 Description of Current Situation
Task 10 Feasibility Study Work Plan
Task 11 Development of Alternatives
Task 12 Initial Screening of Alternatives
Task 13 Detailed Analysis of Alternatives
Task 14 Evaluation and Selection of Preferred Alternatives
Task 15 Draft Feasibility Study Report
Task 16 Final Feasibility Study Report
Task 17 Additional Requirements

5.2 TASK 9: DESCRIPTION OF CURRENT SITUATION

Information of the site's background, the nature and extent of the problem, and the previous response activities presented in Task 1 of the Remedial Investigation will be incorporated into the Feasibility Study. Any changes to the original project scope described in the Task 1 characterization will be discussed and justified based on the results of the Remedial Investigation.

Following the summary of the current situation, a site-specific statement of the purposes for the response, based on the results of the Remedial Investigation, will be presented. The statement of purpose will identify the actual or potential exposure pathways that will be addressed by remedial alternatives. It has been preliminarily determined that groundwater, surface water and airborne pathways constitute important contaminant migration routes. These issues will be updated with RI data for this task.

5.3 TASK 10: FEASIBILITY STUDY WORK PLAN

A Work Plan that includes a technical approach, personnel requirements, and schedules will be submitted to the U.S. EPA for review and approval for the proposed Feasibility Study.

Based on the site-specific problems and statement of purpose identified in Task 9, a master list of feasible technologies will be developed. These technologies must include both on-site and off-site remedies, depending on site problems. The master list will be screened based on site conditions, waste characteristics, and technical requirements to eliminate or modify those technologies that may prove extremely difficult to implement, will require unreasonable time periods, or will rely on insufficiently developed technology. Each identified technology will be presented in the Work Plan with an approach for its analysis.

5.4 TASK 11: DEVELOPMENT OF ALTERNATIVES

Based on the results of the RI and consideration of preliminary remedial technologies (Task 10), a limited number of alternatives will be developed for source control or off-site remedial actions, or both, on the basis of objectives established for the response. The objectives will be established based on public health and environmental concerns, the nature of the current problem as characterized in the RI, and all applicable guidance and regulatory requirements. The alternatives will be developed in consultation with the U.S. EPA, and will be targeted toward a comprehensive, site-specific approach. The alternatives will include, but may not be limited to, the following (as appropriate):

- Alternatives for process control or modification;
- Alternatives for off-site waste treatment or disposal;
- Alternatives for on-site treatment or disposal;
- Alternatives which attain Federal public health or environmental standards;
- Alternatives which exceed Federal public health or environmental standards;
- Alternatives which reduce the likelihood of threat from the hazardous substances, but do not necessarily attain Federal public health or environmental standards; and
- Alternative treatments for source control, ranging from elimination of the need for long-term management (including monitoring) to treatment that would reduce the toxicity, mobility, or volume of

site waste.

- Alternatives, with little or no treatment, that involve waste containment providing protection of human health and the environment, primarily by preventing potential exposure or reducing the mobility of the waste.

- No action.

There may be overlap among the alternatives developed. Further, alternatives outside of these categories may also be developed. The alternatives will be developed in close consultation with the U.S. EPA and documentation of the rationale for excluding any technologies identified in the RI for the development of alternatives will be presented. Standards currently under development by the U.S. EPA (such as those being developed for proposed drinking water standards for uranium and radon) that may be applicable at the time remediation is initiated at the site will be considered during the data collection and analysis phases of the RI, and in the alternative development phase of the FS. This approach will facilitate thoroughness of the investigations and feasibility determinations.

5.5 TASK 12: INITIAL SCREENING OF ALTERNATIVES

The alternatives developed in Task 11 will be screened to eliminate alternatives that are clearly not feasible or appropriate prior to undertaking detailed evaluations of the remaining alternatives.

Three broad considerations will be used as a basis for the initial screening: effects of the alternative, acceptable engineering practices and cost. More specifically, the following factors will be considered:

- Cost. An alternative whose costs far exceeds that of other alternatives providing similar results will be eliminated from recommendation. Total cost will include the cost of implementing the alternative and the cost of operation and maintenance. Cost may be used to discriminate between various treatment alternatives, but not as the basis for deciding between treatment versus nontreatment. The cost screening will be conducted only after the environmental and public health screening have been performed;

- Environmental Effects. Alternatives posing significant adverse environmental effects will be eliminated. Significant adverse environmental effects will include but not be limited to failure to

meet the Groundwater Protection Standards both on and off the FMPC;

- Environmental Protection. Only those alternatives that satisfy the remedial action alternatives and contribute substantially to the protection of public health, welfare, or the environment will be considered further. In addition to providing protection to human health, welfare, and the environment, alternatives must be evaluated and reported as to whether they attain applicable or relevant and appropriate Federal and State public health and environmental requirements, or other criteria. Source control alternatives will achieve adequate control of source materials. On and off-facility alternatives will minimize or mitigate the threat of harm to public health, welfare, or the environment; and

- Implementability and Reliability. Alternatives that may prove extremely difficult to implement, will not achieve the remedial action objectives in a reasonable time period, or rely on unproven technology, will not be implemented.

- During the initial screening of alternatives, those that will permanently reduce the volume, toxicity, or mobility of the wastes must be examined (Superfund Amendments and Reauthorization Act, Section 121). In addition, alternatives with an unproven technology should not automatically be ruled out from further investigation. [Section 121 (b)(2)]

5.6 TASK 13: DETAILED ANALYSIS OF ALTERNATIVES

The alternatives remaining after the initial screening will be developed and analyzed in detail, and then evaluated as to their cost-effectiveness. The detailed analysis of the alternatives will include technical, environmental, public health, institutional, and cost analyses in accordance with EPA's FS guidelines. The evaluation of cost-effectiveness will be comparative, and will consider the present worth of total costs, a statement of risk, environmental effects, technical feasibility, the extent to which the requirements and standards or environmental regulations will be met, community effects, and any other site-specific factors. Alternative analysis will include, at a minimum, the following considerations:

a. Technical Analysis

The Technical Analysis will, at a minimum examine:

- Appropriate treatment, storage, and disposal technologies;

- How the alternative does (or does not) comply with specific requirements or other environmental programs. When an alternative does not comply, discuss how the alternative prevents or minimizes

the migration of wastes and public health or environmental impacts and describe special design needs that will be implemented to achieve compliance;

- Outline operation, maintenance, and monitoring requirements of the remedy;

- Identify and review potential off-site facilities to ensure compliance with applicable RCRA and other U.S. EPA environmental program requirements, both current and proposed. Potential disposal facilities will be evaluated to determine whether management of off-site wastes could result in a potential for a future release from the disposal facility;

- Identify temporary storage requirements, off-site disposal needs, and transportation plans;

- Whether the alternative results in permanent treatment or destruction of the wastes, and, if not, the potential for future release to the environment;

- Outline safety requirements for remedial implementation (including both on-facility and off-facility health and safety considerations);

- How the alternative will be phased into individual operable units. The description should include a discussion of how various operable units of the total remedy will be implemented individually or in groups, resulting in significant improvement to the environment or savings in cost;

- How the alternative will be segmented into areas to allow implementation in differing phases; and

- The special engineering requirements of the remedy or site preparation considerations.

- During the initial screening of alternatives, those that will permanently reduce the volume, toxicity, or mobility of the wastes must be examined (Superfund Amendments and Reauthorization Act, Section 121). In addition, alternative with an unproven technology should not automatically be ruled out from further investigation. [Section 121 (b)(2)]

b. <u>Environmental Assessment</u>

An Environmental Assessment of each alternative will be performed. The assessment will focus on the site problems and pathways of contamination actually addressed by each alternative. The assessment for each alternative will include, at a minimum, an evaluation of beneficial effects of the response, and an analysis of measures to mitigate adverse effects. The no-action alternative will be fully evaluated to describe the current site situation and anticipated environmental conditions if no actions are taken. The no-action alternative will serve as the

baseline for the analysis.

c. Public Health Analysis

Each alternative will be assessed in terms of the extent to which it mitigates long-term exposure to any residual contamination and protects pubic health both during and after completion of the remedial action. The assessment will describe the levels and characterizations of contaminants on-site, potential exposure routes, and potentially affected population. The effect of "no-action" will be described in terms of short-term effects (e.g., lagoon failure), long-term exposure to hazardous substances, and resulting public health impacts. Each remedial alternative will be evaluated to determine the level of exposure to contaminants and the reduction of impact will be determined by comparing residual levels of each alternative with existing criteria, standards, or guidelines acceptable to EPA. For source control measures or when the criteria, standards, or guidelines are not available, the comparison will be based on the relative effectiveness of technologies. The no-action alternative will serve as the baseline for the analysis.

d. Institutional Analysis

Each alternative will be evaluated based on relevant institutional needs. Specifically, regulatory requirements, permits, community relations, and participatory agency coordination will be assessed.

e. Cost Analysis

Each alternative will be evaluated for cost (and for each phase or segment of the alternative). The cost will be presented as a present worth cost and will include the total cost of implementing the alternative and the annual operating and maintenance costs. Both monetary costs and associated non-monetary costs will be included. A distribution of costs over time will be provided.

5.7 TASK 14: EVALUATION AND SELECTION OF PREFERRED ALTERNATIVES

The results of the detailed analysis of alternatives prepared under Task 13 will be reviewed and the preferred alternative selected. The lowest cost alternative applicable to the existing FMPC situation that are technologically feasible and reliable and which effectively mitigate and minimize damage to and provide adequate protection of the public health, welfares, or the environment will be considered the preferred alternatives.

The following considerations will be used as the basis for selecting the preferred alternatives.

- Reliability

Alternatives that minimize or eliminate the potential for release of hazardous substances into the environment will be considered more reliable than other alternatives. For example, recycling of waste and off-site incineration would be considered more reliable than land disposal. Institutional concerns such as management requirements will also be considered as reliability factors;

- Implementability

  The requirements for implementing the alternatives will be considered, including phasing alternatives into operable units and segmenting alternatives into project areas on the site. The requirements for permits, zoning restrictions, rights of way and public acceptance will also be considered;

- Effects of the Alternative

  The alternative resulting in the greatest improvement to (and least negative impact on) public health, welfare, and environment will be favored;

- Safety Requirements

  The alternatives with the lowest adverse safety impacts and associated costs will be favored;

- Present Worth of Total Cost

  The net present value of capital and operation and maintenance cost of the proposed alternative will be presented.

- Regulatory Compliance

  Except as provided under Section 121 (d)(4), SARA, 1986; alternatives that attain applicable or relevant and appropriate Federal and State public health and environmental requirements, as identified by the U.S. EPA and Ohio EPA, will be considered more favorably than those that do not.

5.8 TASK 15: DRAFT FEASIBILITY STUDY REPORT

A draft FS report will be prepared presenting the results of Tasks 9 through 14. The preliminary report will be issued to the U.S. EPA for review and comment. A preliminary Table of Contents for the report is presented in Table 5.1.

TABLE 5.1

FEASIBILITY STUDY REPORT FORMAT

Executive Summary

1.0 Introduction

- 1.1 Site background information
- 1.2 Nature and extent of problems
- 1.3 Objectives of remedial action

2.0 Screening of Remedial Action Technologies

- 2.1 Technical criteria
- 2.2 Remedial action alternatives developed
- 2.3 Environmental and public health criteria
- 2.4 Other screening criteria
- 2.5 Cost Criteria

3.0 Remedial Action Alternatives

- 3.1 Alternative 1 (No Action)
- 3.2 Alternative 2
- .
- .
- .
- 3.N Alternative N

4.0 Analysis of Remedial Action Alternatives

- 4.1 Noncost criteria analysis
  - 4.1.1 Technical Feasibility
  - 4.1.2 Environmental evaluation
  - 4.1.3 Institutional requirements
  - 4.1.4 Public health evaluation
- 4.2 Cost analysis

5.0 Summary of alternatives

6.0 Recommended remedial action (optional)

7.0 Responsiveness Summary (in final version only)

References
Appendices

5.9 TASK 16: FINAL FEASIBILITY STUDY REPORT

A final FS report will be prepared presenting and reflecting the comments received on the draft FS report. The report will include a discussion of the significant issues and a responsiveness summary based on public comment. Format of the report will be consistent with that of the draft, however, it may be modified to reflect comments. The document will be submitted to the EPA, upon completion.

5.10 TASK 17: ADDITIONAL REQUIREMENTS

Reporting and Community Relations Support requirements, as described in Task 8 of the Remedial Investigation scope of work, will be required for the Feasibility Study as well. The Feasibility Study Reports will address the need and the applicability of long term monitoring at the facility.

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MANAGEMENT PLAN

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6.0 MANAGEMENT PLAN

6.1 INTRODUCTION

The sitewide RI/FS effort involves three entities: The DOE, WMCO and ASI. The DOE has overall responsibility for completion of the project, meeting regulatory requirements, submitting reports, documents, etc. to EPA, and in general, approving the direction and content of the studies. DOE management guidelines and concepts are utilized to ensure the project objectives are being tracked, are acceptable and are completed as scheduled.

WMCO has responsibility for technical execution of the RI/FS. In this capacity, WMCO reviews and approves all technical scopes of work and work efforts of subcontractors, and coordinates RI/FS technical activities on site. Day to day technical direction and approvals are administered by a RI/FS Project Manager.

ASI is the RI/FS prime contractor with direct responsibility for the technical execution and completion of the RI/FS. With ASI technical and professional staff, and with the assistance of subcontractors, all details of the RI/FS scope of work are developed for approval. When approval is granted, the required technical expert teams are mobilized to execute the Workplan according to approved sampling protocols and methodologies. This assures that acceptable and reliable samples are gathered for analysis, and that worker health and safety considerations are satisfied. In addition, data management protocols are also followed for efficient and proper data manipulation and interpretation. Project work and deliverable schedules are developed by ASI for DOE/WMCO's approval. A project Work Breakdown Structure (WBS) is utilized for project control.

6.2 PROJECT ORGANIZATION AND CONTROLS

6.2.1 ORGANIZATION

The FMPC RI/FS project, although basically divided into RI and FS phases, involves diverse technologies, many of which are common to both phases. The project organization has been structured to include experienced technical specialists in these various disciplines. The project organization chart shown on Figure 6.1 shows DOE as Project Sponsor, WMCO as RI/FS Project Manager and ASI as Prime Contractor, and the technical disciplines required for the RI/FS. This chart depicts simple but clear lines of authority between the involved organizations and subordinate activities required for general completion of the work. It does not indicate a comprehensive breakdown of lower tier contractors or activities.

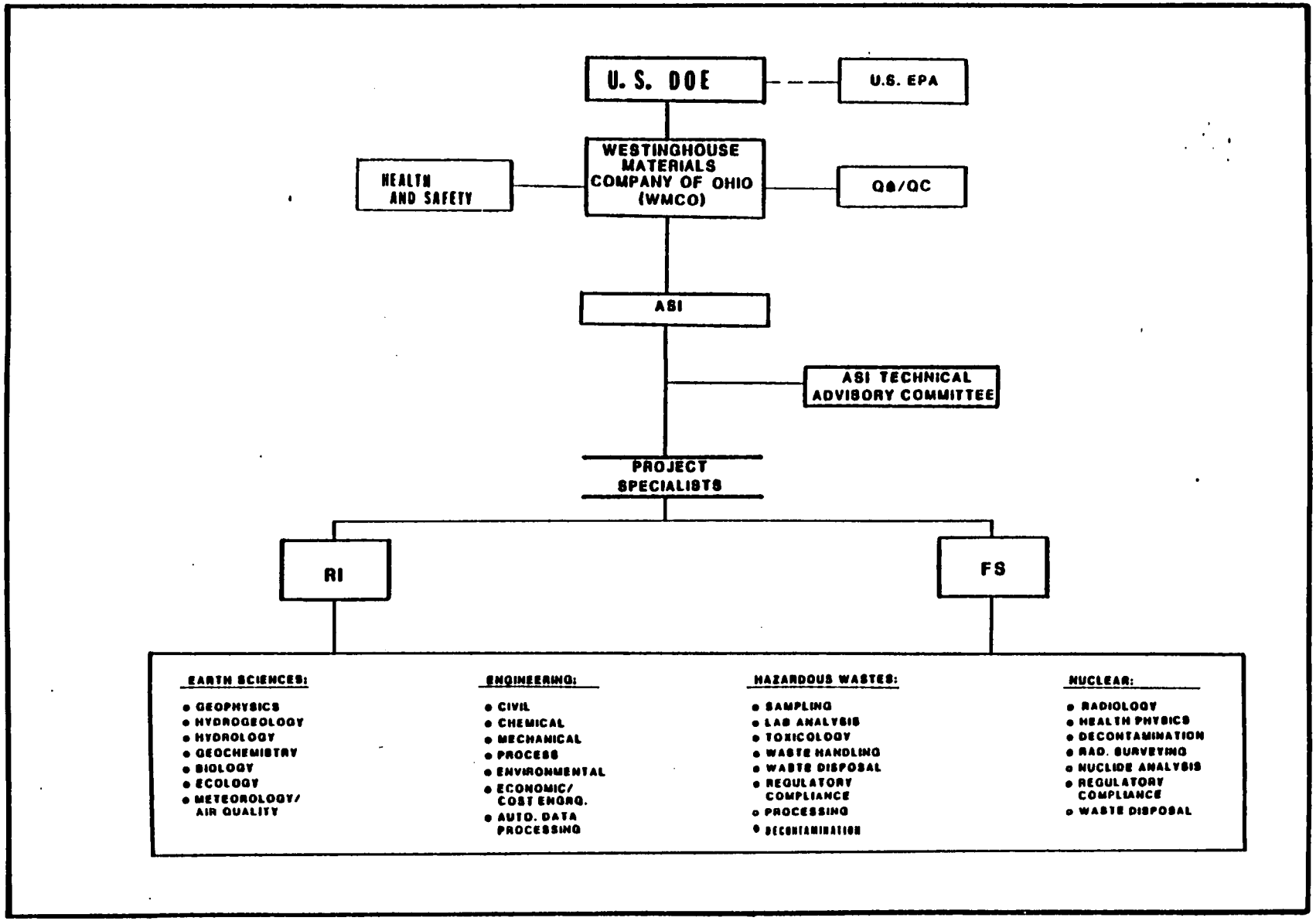

FIGURE 6.1
FMPC RI/FS PROJECT ORGANIZATION

6.2.2 PROJECT AND INFORMATION FLOW CONTROL

A complex project, such as the RI/FS requires control mechanisms for efficient execution. This includes all activities involving technical field work, data analyses, report and document preparation, and project deliverables.

6.3 RESPONSIBILITY AND AUTHORITY

6.3.1 U.S. DEPARTMENT OF ENERGY (DOE)

6.3.1.1 Responsible Management Office

The Department of Energy, Oak Ridge Operations Office (ORO), Fernald Site Office has been designated as the responsible management office for the FMPC RI/FS Project.

6.3.1.2 DOE-ORO Project Management

Mr. Joe LaGrone is the Manager, ORO, and has been assigned the responsibility and is delegated the authority for the management of the RI/FS Project at the FMPC. His responsibilities include:

- Establishing a RI/FS Project Management Office;
- Appointing the Project Coordinator (PC) and delegating to the PC appropriate responsibility and authority for management and direction of the projects within the delegated authority;
- Performing, through the ORO staff, the necessary contracting functions for the project; i.e., negotiating initial contract(s) and revisions for subsequent phases and the execution of all contracts;
- Monitoring the performance of the Project Coordinator and the appropriate staff, and delegating to the RI/FS PC the authority for day-to-day management and direction of the project;
- Providing all necessary management support functions for the RI/FS Project;
- Providing all field office support functions such as safety review, quality assurance, budget guidance, project review, procurement, security, legal and environmental compliance review, and coordination with DOE-HQ; and
- Reviewing and approving project environmental and safety documents as required by Department Orders and/or other Federal Regulations.

6.3.1.3 DOE-ORO Project Coordinator

The DOE-ORO Project Coordinator (PC) is stationed at the FMPC. This responsibility has been assigned to:

Mr. James A. Reafsnyder, Site Manager
U.S. Department of Energy
P.O. Box 398704
Cincinnati, Ohio 45239

The PC will receive DOE field office support as identified in Section 6.3.1.2 above. The PC is responsible for:

- Serving as the designated formal U.S. EPA-DOE point of contact for all project actions;
- Approving items and activities performed by project contractors requiring DOE approval within delegated authority;
- Assigning the responsibility and authority for project management to the DOE project manager;
- Providing support and staff to the project team; and
- Providing the RI/FS Project Manager a Project Management Team made up of the necessary project specific disciplines.

6.3.1.4 DOE-ORO RI/FS Project Manager

The DOE-ORO RI/FS Project Manager (PM) is stationed at the FMPC. This responsibility has been assigned to:

Mr. Rick Collier
U.S. Department of Energy
P.O. Box 398704
Cincinnati, OH 45239

The DOE-ORO RI/FS Project Manager will:

- Prepare, submit, present, and support information on the project in accordance with the U.S. EPA scope of work for the RI/FS;
- Serve as the designated technical U.S. EPA-DOE representative for all project activities;
- Establish the DOE project management team for the project;

- Assure that all items requiring U.S. EPA review and/or approvgal are submitted in a timely manner; and

  Manage the total RI/FS project in accordance with the FFCA work statement and the approved RI/FS Work Plan.

6.3.1.5 DOE-ORO Technical Liaison

The DOE-ORO Technical Liaison (TL) is stationed in Oak Ridge, Tennessee. This responsibility has been assigned to:

Ms. Margaret Wilson
U.S. Department of Energy
P.O. Box E
Oak Ridge, TN 37830

The TL will:

- Support the DOE-ORO-PM on technical and regulatory issues requiring U.S. EPA and State of Ohio interaction.

6.3.2 WESTINGHOUSE MATERIALS COMPANY OF OHIO (WMCO)

WMCO is the DOE contractor responsible for the management, operation, and maintenance of the FMPC. As such, WMCO has been assigned the responsibility and authority for the technical execution of this project.

6.3.2.1 WNCO Project Management

The RI/FS project will be managed for DOE in accordance with established DOE techniques and orders. Management of the project will be monitored by the WMCO RI/FS Project Manager.

The WMCO PM has responsibilities similar to those of the DOE PM.

The RI/FS Project Manager is:

Mr. Robert Conner
Westinghouse Materials Company of Ohio
U.S. DOE Site, Fernald, Ohio
P.O. Box 398704
Cincinnati, OH 45239

Mr. Conner has over seven years experience in managing hazardous waste projects requiring coordination with RCRA, CERCLA, and Regions II, III, V and X U.S. EPA. He has participated in, and is familiar with Remedial Investigations (RI's), Feasibility Studies (FS's), and remedial activities.

Mr. Conner will have as his alternate Mr. Dennis Carr (PE). Mr.

Carr has experience in the management of low level radiological wastes at the FMPC. In addition, his experience includes liaison with regulatory agencies, preparation of RCRA permit applications and RI/FS activities under CERCLA.

The WMCO RI/FS Project Manager will:

- Manage the project in accordance with approved project scope, schedule, and cost;
- Establish a Quality Assurance Program;
- Provide technical and management direction to contractors in accordance with DOE-ORO policy;
- Provide project change control within the established technical objectives, funding and schedule milestones under a formal change control procedure;
- Develop, submit and implement detailed Project Management plans and initiate revisions, as necessary;
- Review and submit for approval the critical path schedule and coordination procedures covering the project activities;
- Conduct management, cost, schedule, and technical performance reviews, including problem identification and planned resolution timetable;
- Provide overall management and administration for project contractors;
- Prepare RI/FS project completion and final cost/ technical reports;
- Prepare and coordinate appropriate project documentation as required by EPA and DOE;
- Interact as requested by DOE-PM with the EPA on RI/FS plicy matters and maintain public/private sector interface and liaison.
- Develop, install, administer, monitor, evaluate, and report progress through the use of appropriate project management control system (e.g., change control, configuration management, performance measurement system);
- Ensure the technical correctness and adequacy of the site characterization, data collection, data analysis and conclusions;

- Review content and publication of all project technical reports;
- Issue required technical reports for the DOE-ORO office;
- Assist DOE in providing for public communication and information dissemination. Coordinate project conferences, symposiums, or workshops;
- Provide the DOE-ORO Project Manager with timely information on significant project events;
- Ensure that all items requiring DOE review and/or approval are submitted on a timely basis to permit adequate evaluations;
- Serve as Chairman of the Change Control Board. Assure that corrective actions are implemented; and
- Provide weekly, monthly, and quarterly RI/FS reports as required to the DOE-ORO Project Manager.

6.3.2.2 WMCO Fiscal Management

The project contract administrator is generally responsible for the completeness, and legal correctness of all contracts. The contract administrator reviews and approves all project subcontracts which have the potential for obligating the DOE. Within this scope, the administrator monitors contract funding and billing.

The WMCO project contract administrator is:

Ms. Kimberly Eilerman
Westinghouse Materials Company of Ohio
U.S. DOE Site, Fernald Ohio
P.O. Box 398704
Cincinnati, OH 45237

6.3.3 ADVANCED SCIENCES, INC. (ASI)

ASI is the prime contractor for the RI/FS Project. As such, ASI has the responsibility to supply the technical, managerial, and fiscal control expertise necessary to efficiently execute the technical aspects of this project.

6.3.3.1 ASI Technical Management

1) ASI Project Director

Responsibility for the technical performance of this project has been delegated to the ASI Project Director:

Mr. Richard T. Wilde
Advanced Sciences, Inc.
10845 Hamilton-Cleves Road
Ross, OH 45061

Mr. Wilde has broad experience in the conduct and management of multi-disciplinary projects including those associated with energy development, hazardous waste management, and regulatory permitting and stipulations. He is familiar with regulations dealing with RCRA, CERCLA and Superfund, and has participated in both technical and permitting aspects of such projects. Mr. Wilde has direct experience with regulatory and management agencies and has worked with EPA and DOE.

Mr. Wilde has eighteen years of nuclear experience with eleven years in DOE waste management at the DOE Hanford reservation. His expertise is in (EIS) Environmental Impact Statement for high level and hazardous waste, program planning and control, risk assessment and hydrologic analysis. His degrees are in physics.

On this project Mr. Wilde has assigned lead assignments to key individuals in the required RI/FS tasks.

The ASI Project Director is responsible to DOE through WMCO for the day-to-day project activities. The director's responsibilities also includes:

- Serving as the designated RI/FS contractor point of contact for project administration;
- Preparing and submitting reports and other project information as required by DOE;
- Establishing and coordinating the project team;
- Development and maintenance of a project Work Breakdown Structure;
- Establishment of project schedules and budgets;
- Development and implementation of a project management and control plan;
- Resource allocations to, and expenditure control of, subcontractors;
- Review and approval of project technical plans, procedures and reports;

- Appointing and delegating appropriate authority for direction and conduct of specialized tasks;
- Establish and coordinate a QAPP for the RI/FS;
- Providing project support facilities and staff; and
- Conduct periodic project cost, schedule, and technical performance reviews with identification and resolution of problems.

Development and Maintenance of the Project Management Plan which includes:

- A project Work Breakdown Structure (WBS);
- The project master schedule;
- Project baseline budgets;
- Specification of budget and schedule tracking and reporting; and
- Assignment of project task responsibilities.

Implementation of a Computerized Project Planning and Management Reporting System.

This system is programmed to produce project progress reports consistent with DOE management practices.

Development and Publication of the ASI Project Instruction and Protocol Manual.

This manual describes procedures, forms and requirements for project communication control, data control, procurement control, work authorization, and reports.

2) ASI Site Manager

The ASI Site Manager will be responsible to the Project Director for the RI/FS field operations.

The ASI Site Manager is:

Mr. Robert G. Lenyk
10845 Hamilton-Cleves Road
Ross, OH 45061

Mr. Lenyk has sixteen years of nuclear, specialty chemical, and environmental experience in process, design and project management. Mr. Lenyk has worked at the FMPC for several years

as program manager for the DOE on-site Architect-Engineer firm. He is knowledgable in all aspects of the operations at FMPC. His most recent experience was the development of the Environmental Safety and Health Conceptual Design Report for FMPC. Mr. Lenyk's degrees are BS-Chemical Engineer, MS-Chemical Engineer and MBA.

The ASI Site Manager is responsible for:

- Day-to-day field investigations planning and coordination;
- Ensuring that field operations conform to the project Health and Safety requirements and QA/QC protocols;
- Coordination with WMCO operations managers;
- Field office administration;
- Ensuring that field work is properly authorized;
- Adherence to project schedules and budgets; and
- Publishing weekly reports required by the Project Director.

The ASI Site Manager will be assisted by the project Health and Safety Officer and QA/QC specialist.

3) <u>ASI Task Leaders</u>

The ASI Project Director will appoint Discipline Leaders for the various technical RI/FS tasks. These Discipline Leaders will be responsible to the ASI Project Director for planning, implementation and control of their assigned tasks which will include, but are not limited to, the following specialties:

- Procurement of field equipment and supplies;
- Organizing field teams;
- Directing field investigative tasks;
- Making day-to-day assignments;
- Collecting field data and shipping samples for analysis; and
- Other tasks as necessary to the field effort.

6.3.3.2 ASI Fiscal Management

The ASI Vice President in charge of finance is responsible for financial accounting for the project.

The ASI finance director is:

Mr. Don Morgan
2620 San Mateo Blvd., NE
Suite D
Albuquerque, NM 87110

The ASI Fiscal Manager's responsibilities include:

- Implementation of corporate accounting procedures for the RI/FS project;
- Application of DOE cost-accounting principles for project fiscal control, billing, and reporting;
- Assignment of individual account numbers identifiable as RI/FS WBS elements;
- Payment of project obligations in a timely manner;
- Billing DOE through WMCO for services and approved materials in a timely manner; and
- Providing fiscal input to the management plan Task Leader for project computer updates and progress reports.

6.3.3.3 ASI Project Health and Safety

The ASI Project Health and Safety program will be supervised by the Health and Safety Officer (HSO).

The HSO is:

Mr. Richard F. Haaker
2620 San Mateo Blvd., NE
Suite D
Albuquerque, NM 87110

The ASI Health and Safety Officer is responsible to the Project Director for:

- Development and implementation of a Health and Safety plan;

- Ensuring the health and safety of workers and the general public during project operations;
- Development of health and safety standards;
- Implementation of personnel protection methods;
- Establishment of personnel training programs;
- Implementation of hazardous monitoring and control methods;
- Reporting project health and safetry concerns to DOE/WMCO; and
- Responding to public and/or governmental inquires regarding health and safety matters.

6.3.3.4 ASI Quality Assurance Officer

The ASI Quality Assurance Officer (QAO) is:

Mr. Larry T. Murphy
10845 Hamilton-Cleves Road
Ross, OH 45061

The ASI Quality Assurance Officer is responsible to the Project Director for:

- Implementation of the QA Project Plan;
- Official organizational contact for all QA matters;
- Review, evaluation and approval of QA project plans prior to review, evaluation and approval/non-approval;
- Providing guidance in the development of QA project plans;
- Preparing and submitting all QA reports to the appropriate line managers in their organization;
- Assuring that appropriate corrective actions are taken on all QA tasks when, where and however needed;
- Ensuring that data of known quality and integrity are available for each planning and report phase.

6.4 WORK BREAKDOWN STRUCTURE (WBS)

6.4.1 PROJECT CONTROL

The management plan is based on the project Work Breakdown Structure (WBS). The WBS is an hierarchical breakdown of project activities which define the total project. It provides an integrated framework for planning and assigning management and technical responsibilities, as well as monitoring and reporting progress and status of all project activities. This WBS has been structured to parallel the project Statement of Work which is Attactment I to the FFCA.

Each task and sub-task in the WBS is assigned a unique number, or "Element Code". These numbers are used for progress measurement, reporting, and accounting. The WBS is the project baseline description and will be changed only through formal agreement with U.S. EPA. All project management facets including work authorization, planning, scheduling, estimating, budgeting, cost collections, problem analysis, and plan maintenance are integrated within the WBS.

The WBS Dictionary (Table 6) presents a tabulation of WBS task code numbers and identifying task titles.

For convenience, the FMPC RI/FS Project has been partitioned into three major, distinct activity fields: The RI work, The FS work, and The Project Support Work. Figure 6.2 is the Project Summary WBS which presents an overview of the entire project. The WBS categories representing the three major RI/FS activities are further depicted in Figures 6.3, 6.4, and 6.5.

A complete and accurate description of each WBS task will be prepared. This will provide for proper task sequencing of all task prerequisites, requirements, and deliverables.

6.5 MASTER SCHEDULE AND DELIVERABLES

The deliverables to be made to the U.S. EPA Region V under this RI/FS project are specified below and are in accordance with Attachment I (Scope of Work) of the FFCA.

The monthly project tracking reports will be provided within 20 calendar days after the end of each month and in accordance with Task 7 of the Scope of Work.

TABLE 6.1

FERNALD RI/FS PROJECT WBS DICTIONARY

WBS TASK	TASK TITLE
TOP	Fernald FMPC RI/FS Project
A	Fernald FMPC RI
A1.0	SOW Task 1, Description of Current Situation
A1.1	Outline RI Purpose
A1.2	Develop Background Data
A1.3	Summarize Existing/Potential FMPC Problems
A1.4	History of Response Actions & Results
A1.5	Site Familiarization
A1.6	Define FMPC Boundary Conditions
A2.0	SOW Task 2, Work Plan Requirements
A2.1	Preinvestigation Evaluation
A2.2	Define Nature & Extent of Problem
A2.3	Permit Requirements Plan
A2.4	Develop Sampling Plans/Analyses
A2.5	Develop Health and Safety Plan
A2.6	Develop QAPP
A2.7	Develop Community Information
A2.8	Develop Data Management Plan
A3.0	SOW Task 3, Site Investigation
A3.1	Characterization and Hazard Analysis
A3.2	Hydrogeologic Investigation
A3.3	Groundwater Quality Investigation
A3.4	Soil and Sediment Investigation
A3.5	Surface Water Quality Investigation
A3.6	Air Investigation
A3.7	Off-Site Water Investigation
A3.8	Ecological Investigation
A4.0	SOW Task 4, Site Investigation Analysis
A4.1	Analysis and Summary of all Site Investigations
A4.2	RI Data Analysis
A4.3	Exposure Assessment
A4.4	Analyze Results
A4.5	Develop Groundwater Protection Standards

TABLE 6.1 (Cont'd)

WBS TASK	TASK TITLE
A5.0	SOW Task 5, Laboratory and Bench Scale Studies
A5.1	Select Technologies
A5.2	Develop Test Plans
A5.3	Conduct Tests
A5.4	Analyze Test Data, Assess Technologies for FMPC
A5.5	Report Conclusions
A6.0	SOW Task 6, Reports
A6.1	Prepare Draft RI Report
A6.2	Publish Final RI Report
A7.0	SOW Task 7, Additional Requirements
A7.1	Develop Monthly Technical Progress
A7.2	Develop/Acquire CLP Lab. Certification
A8.0	SOW Task 8, Community Relations Support
A8.1	Support DOE/WMCO Community Relations Efforts as Required
B	Fernald FMCP FS
B9.0	Task 9, Description of Current Situation
B9B1	Description Situation, Use Task 1 Information
B9B2	Identify Exposure Pathways
B9B3	Recommend, Describe Site Specific Remedial Technology
B10.0	SOW Task 10, Work Plan
B11.0	SOW Task 11, Development of Alternatives
B11.1	Develop Remedial Alternates for Each Problem Area Identified in Task 9
B11.2	Develop List of all Remedial Alternates
B12.0	SOW Task 12, Initial Screening of Alternatives

TABLE 6.1 (Cont'd)

WBS TASK	TASK TITLE
B12.1	Screen Remedial Alternates
B12.2	Evaluate and Compare Alternatives
B13.0	SOW Task 13, Detailed Analysis of Alternatives
B13.1	Conduct Technical Analyses
B13.2	Perform EA for Each Alternate
B13.3	Perform Public Health Analyses
B13.4	Conduct Institutional Analyses
B13.5	Perform Cost Analyses
B14.0	SOW Task 14, Evaluation and Selection of Preferred Alternatives
B15.0	SOW Task 15, Draft Feasibility Study Report
B16.0	SOW Task 16, Final Feasibility Study Report
B17.0	SOW Task 17, Additional Requirements
C	Project Support
C1.0	Project Administration
C1.1	Develop Administrative Procedures
C1.2	Implement Data Management System
C1.3	Procedure Required Certifications
C1.4	Obtain Necessary Permits
C1.5	Print/Publish Reports
C1.6	Business Operations
C2.0	Project Management
C2.1	Maintain Cost/Schedule Controls
C2.2	Develop Project Management Plan
C2.3	Project Coordination
C2.4	Advisory Committee Activities
C3.0	Logistic Support
C3.1	Establish Site Office
C3.2	Provide Necessary Resources

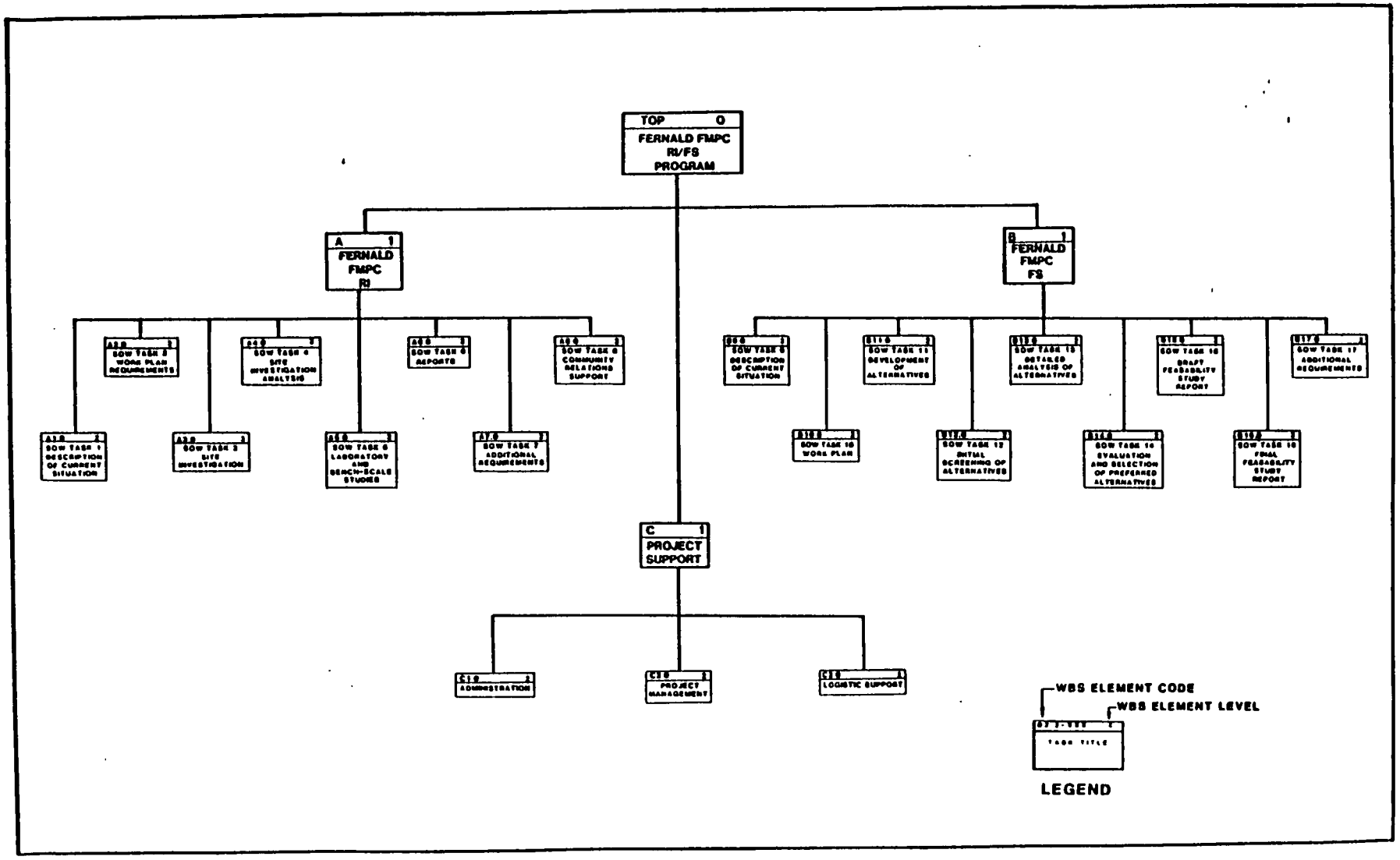

FIGURE 6.2
PROJECT SUMMARY WORK BREAKDOWN STRUCTURE

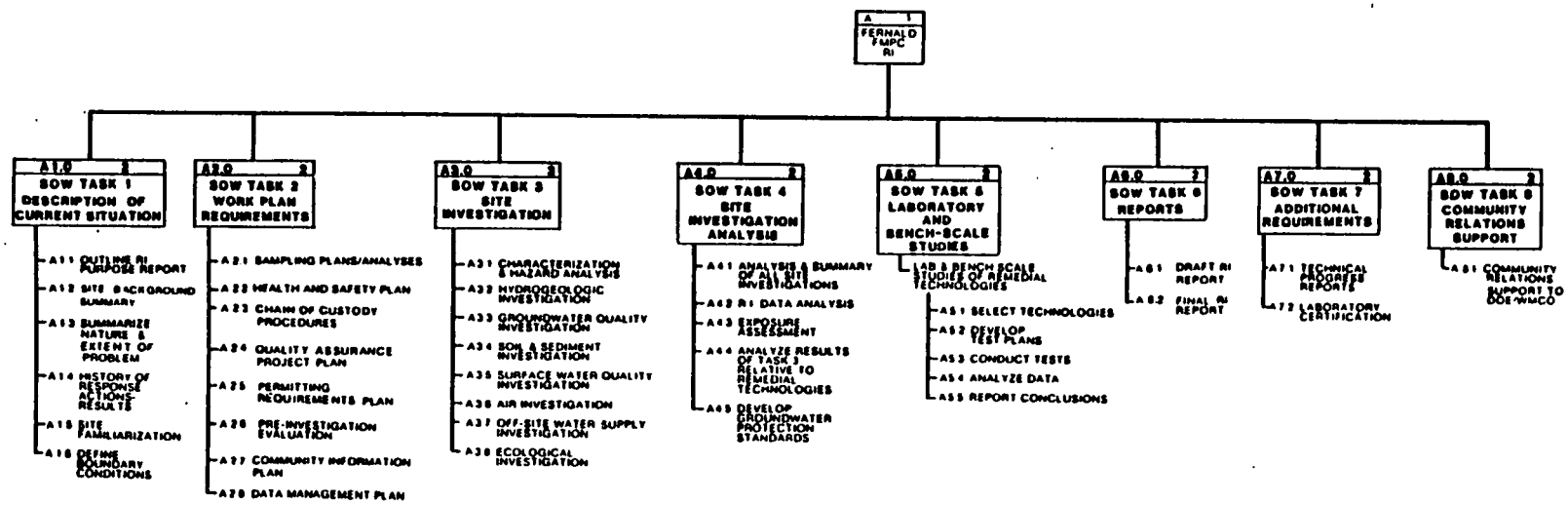

FIGURE 6.3
RI WORK BREAKDOWN STRUCTURE

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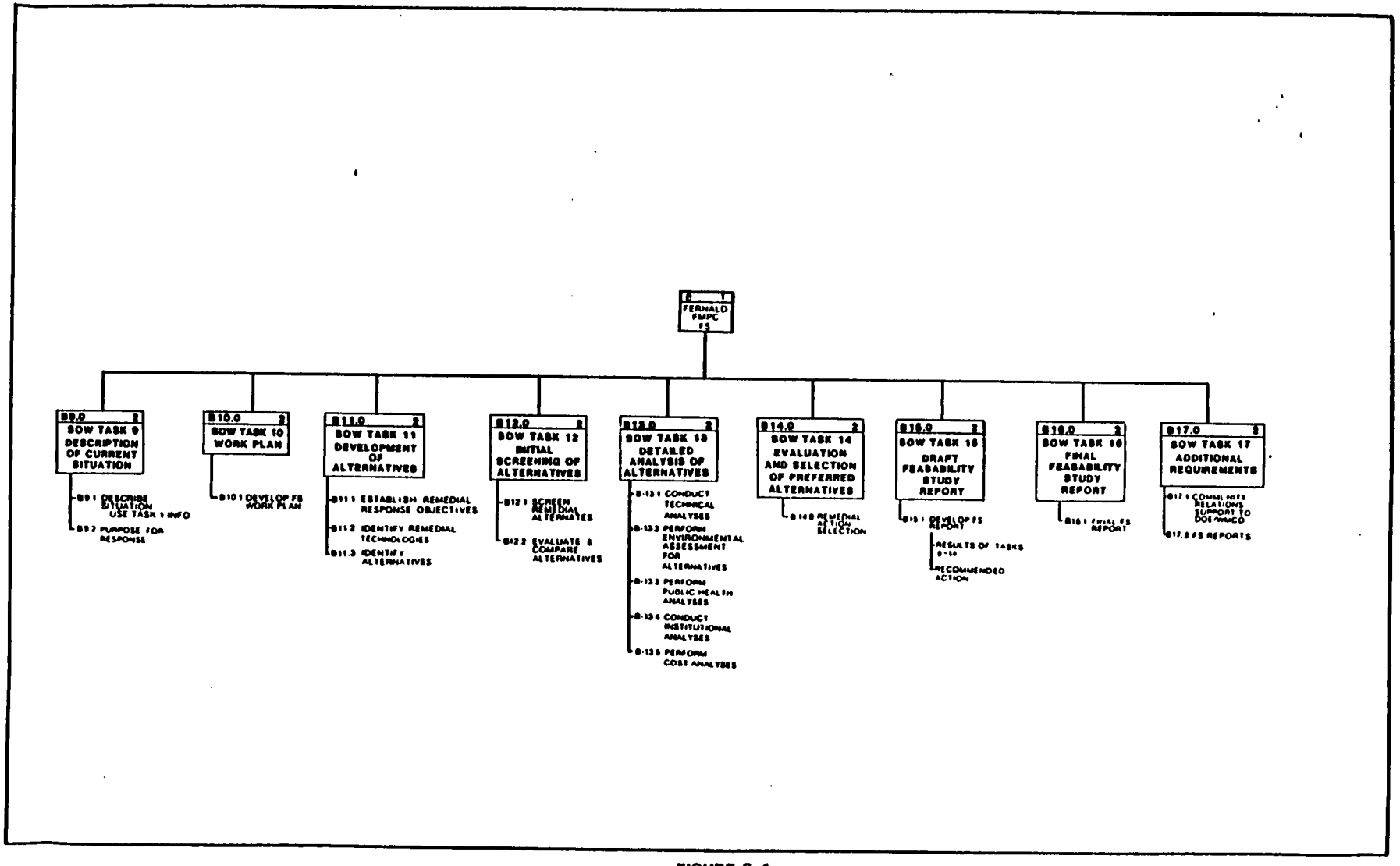

FIGURE 6.4
FS WORK BREAKDOWN STRUCTURE

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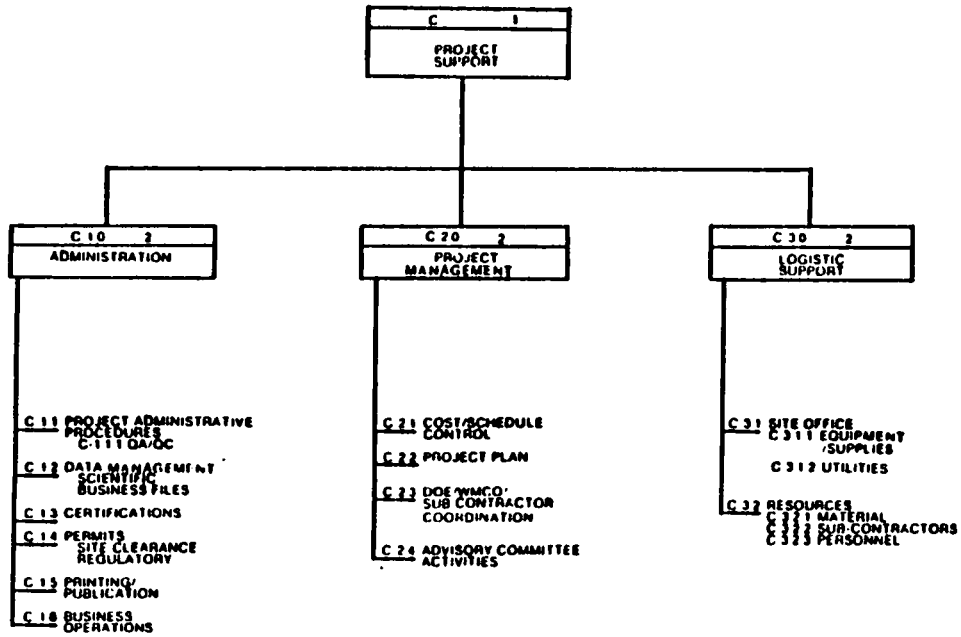


FIGURE 6.5
PROJECT SUPPORT WORK BREAKDOWN STRUCTURE

6.5.1 PROJECT DELIVERABLES

Deliverable	Schedule
o Detailed plans (specified Under Task 2.a-e	No later than January 30, 1987
o RI/FS Work Plan revision ~~(if necessary)~~	Within 45 calendar days of receipt of EPA Region V comments.
o Final FS Work Plan to EPA	August 15, 1988
o Draft RI to DOE	December 12, 1988 ~~Within 700 calendar days of an EPA Region V approved RI/FS Work Plan~~
o Draft FS to EPA	June 1, 1989 ~~Within 800 calendar days of an EPA Region V approved RI/FS Work Plan.~~
o Final RI to EPA	July 17, 1989 ~~Within 60 calendar days of receipt of EPA Region V comments and/or public meeting~~
o Final FS	January 31, 1990 ~~Within 60 calendar days of receipt of EPA Region V comments.~~

6.5.2 SCHEDULES

A ~~master~~ Top Level schedule depicting estimated individual task completions has been developed for overall project direction and control as shown in Figure 6.6

FMPC RIFS/EIS/CIS/DFO

RI/FS TOPLEVEL

ATC NO.	DESCRIPTION	CODE	EARLY START	EARLY FINISH
10	EXECUTE RIFS CONTRACT	RI00	18JUL86	18JUL86
160	TASK 1-DESCRIPTION OF CURRENT SITUATION	RI01	18JUL86	19NOV87
140	FINAL CURRENT SITUATION TO EPA	RI01	20NOV87	20NOV87
244	TASK 2-WORK PLAN REQUIREMENTS	RI02	18JUL86	24JAN88
240	FINAL RI WORK PLAN TO EPA	RI02	25JAN88	25JAN88
399	TASK 3 - SITE INVESTIGATION	RI03	18AUG87	31DEC88
310	START DRILLING WELLS	RI03	18AUG87	18AUG87
320	WELLS COMPLETE	RI03	1APR88	1APR88
394	FINAL REPORT - AGRI PROD/PATHWAYS	RI03	1JAN88	1JAN88
382	COMPLETE SURFACE SOIL ANALYSES	RI03	1APR88	1APR88
350	SURFACE WATER/SEDIMENT ANALYSES COMPLETE	RI03	2MAR88	2MAR88
393	SITE INVESTIGATION COMPLETE	RI03	1JAN89	1JAN89
498	TASK 4-SITE INVESTIGATION ANALYSIS	RI04	6JUL87	29NOV88
410	PLACE DBMS CONTRACT	RI04	6JUL87	6JUL87
430	DBMS TO WMCO	RI04	30NOV88	30NOV88
470	ANALYSIS COMPL-GRND H2O MDL RPT TO WMCO	RI04	30NOV88	30NOV88
490	ENVIRON ASSESSMENT COMPLETE	RI04	1JUL88	1JUL88
540	TASK 5-LAB & BENCH SCALE STUDIES	RI05	11DEC87	30JUL88
530	LAB REPORT ISSUED TO DOE	RI05	31JUL88	31JUL88
680	TASK 6-REMEDIAL INVESTIGATION RPT	RI06	3SEP88	16JUL89
620	DRAFT RI RPT TO DOE	RI06	12DEC88	12DEC88
670	FINAL RI REPORT TO EPA	RI06	17JUL89	17JUL89
700	TASK 7 - PROJECT MANAGEMENT	RI07	18JUL86	30MAR90
800	TASK 8-COMMUNITY RELATIONS SUPPORT	RI08	18JUL86	30MAR90
900	TASK 9 - FFCA	RI09	18JUL86	30MAR90
1060	TASK 10-UPDATE DESCRIP OF CUR SIT	FS10	1JUN88	15JAN89
1050	CURRENT SIT UPDATE TO EPA	FS10	16JAN89	16JAN89
1180	TASK 11-FEASIBILITY STUDY WORK PLAN	FS11	1DEC87	15SEP88
1160	FINAL FS WP TO EPA	FS11	15AUG88	15AUG88

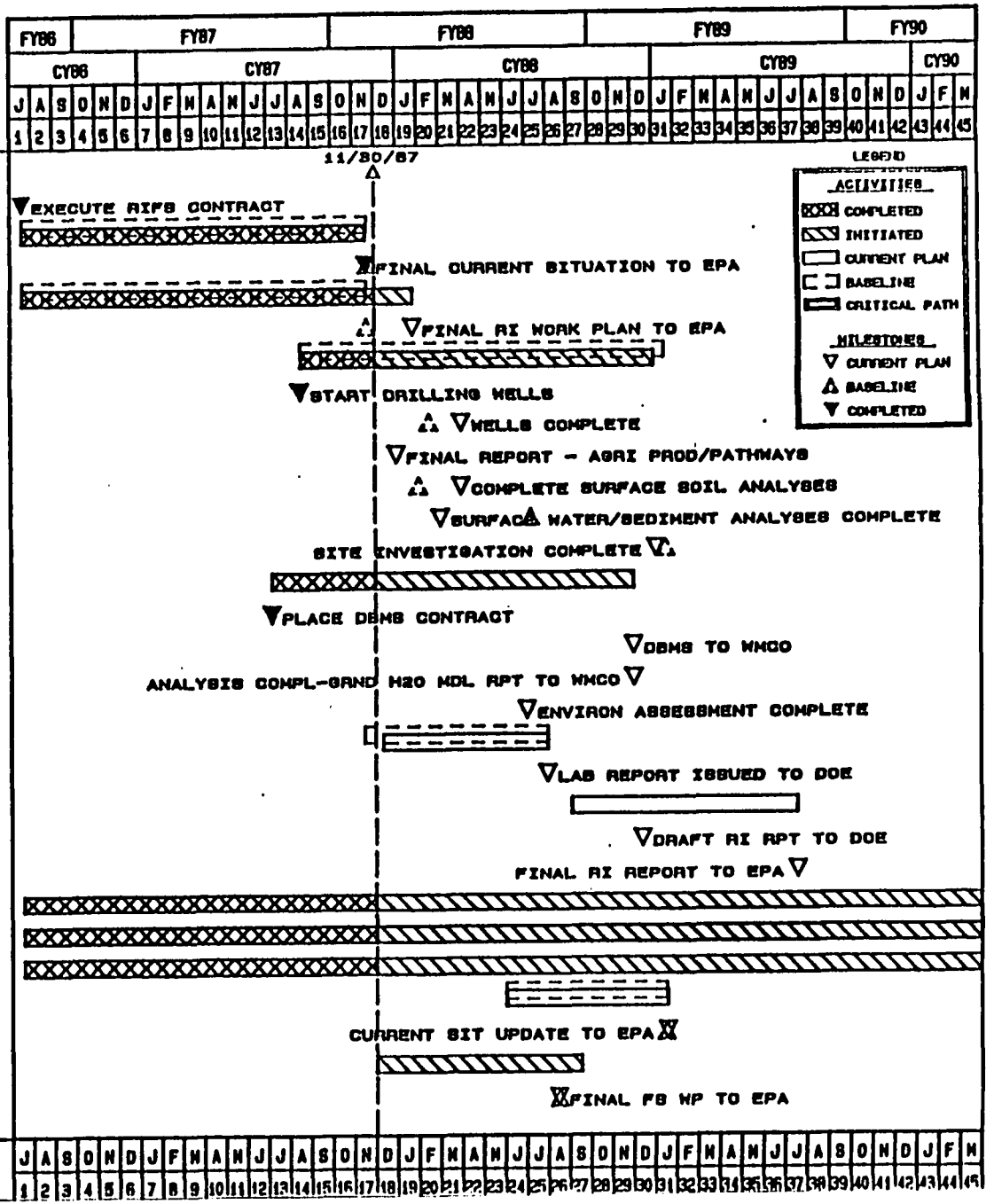
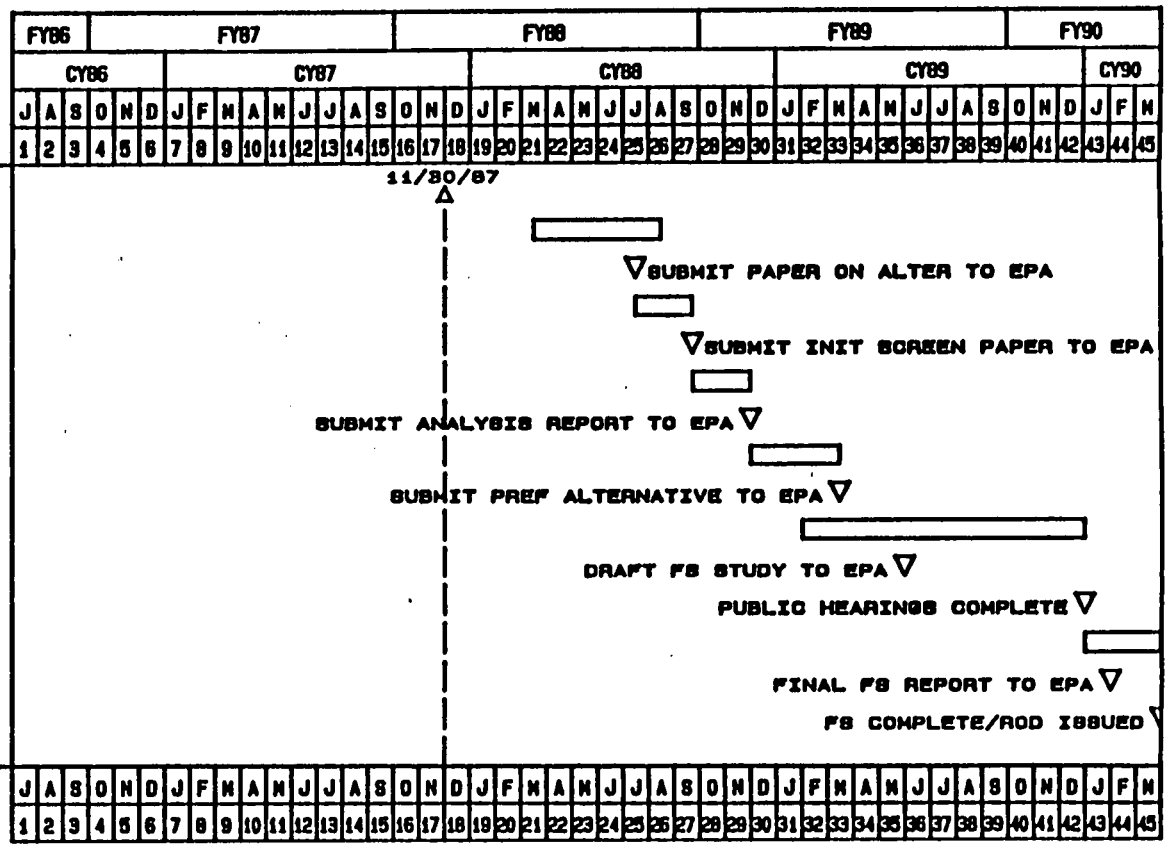


FIGURE 66
PROJECT MASTER SCHEDULE

FMPC RIFS/EIS/CIS/DFO

RI/FS TOPLEVEL

ARC NO.	DESCRIPTION	CODE	EARLY START	EARLY FINISH
1270	TASK 12 - DEV OF ALTERNATIVES	FS12	16MAR88	15AUG88
1250	SUBMIT PAPER ON ALTER TO EPA	FS12	16JUL88	16JUL88
1350	TASK 13-INITIAL SCREEN OF ALTERNATIVES -	FS13	16JUL88	22SEP88
1340	SUBMIT INIT SCREEN PAPER TO EPA	FS13	23SEP88	23SEP88
1440	TASK 14-DETAILED ANALYSIS OF ALTERNATVS	FS14	23SEP88	30NOV88
1430	SUBMIT ANALYSIS REPORT TO EPA	FS14	1DEC88	1DEC88
1540	TASK 15-EVAL/SELECT PREF ALTERNATIVE	FS15	1DEC88	15MAR89
1530	SUBMIT PREF ALTERNATIVE TO EPA	FS15	16MAR89	16MAR89
1690	TASK 16-DRAFT FEASIBILITY STUDY REPORT -	FS16	2FEB89	30DEC89
1620	DRAFT FS STUDY TO EPA	FS16	1JUN89	1JUN89
1680	PUBLIC HEARINGS COMPLETE	FS16	31DEC89	31DEC89
1740	TASK 17-FINAL FS REPORT	FS17	31DEC89	30MAR90
1701	FINAL FS REPORT TO EPA	FS17	31JAN90	31JAN90
1730	FS COMPLETE/ROD ISSUED	FS17	31MAR90	31MAR90



LEGEND

ACTIVITIES
- COMPLETED
- INITIATED
- CURRENT PLAN
- BASELINE
- CRITICAL PATH

MILESTONES
- CURRENT PLAN
- BASELINE
- COMPLETED

FIGURE 6.6
PROJECT MASTER SCHEDULE

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