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FERNALD CITIZENS TASK FORCE TOOL BOX

APPLEGATE TASK FORCE
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FERNALD CITIZENS TASK FORCE

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FERNALD CITIZENS TASK FORCE

A U.S. DEPARTMENT OF ENERGY SITE-SPECIFIC ADVISORY BOARD

ACTIVITIES AND PROCESS WORKPLAN
February, 1994

OVERVIEW

It is proposed that the process for involvement of the Fernald Citizens Task Force in the cleanup of the Fernald facility will include five phases. The first two phases, Convening and Orientation and Approach, are complete. Phases III and IV of the process are designed to encompass the development of recommendations for the future use of the Fernald property, corresponding cleanup levels, and the prioritization of cleanup activities. This work will begin with an identification of the unconstrained future use options for the facility, i.e. asking the question "what would you like to see happen with this property?" This "wish list" of sorts will be pared down by then asking "what is likely to happen in this area in the future?" and "what is feasible given the problems at Fernald and current technological capabilities?" The Task Force will look at this smaller set of options in more detail to identify the corresponding cleanup levels, volumes of materials requiring treatment, likely cleanup technologies, and costs. Using this information, the Task Force will make recommendations as to the desired future uses of the Fernald facility and the corresponding cleanup levels. It is important to be clear that the cleanup of the Fernald facility will not create a specific future use, but rather clean up to a level that will provide for the development of some uses while restricting the ability to develop others. The Task Force recommendations will be developed to reflect this distinction. Phase V of the process will focus on monitoring progress of cleanup and will be develop in detail at a later date.

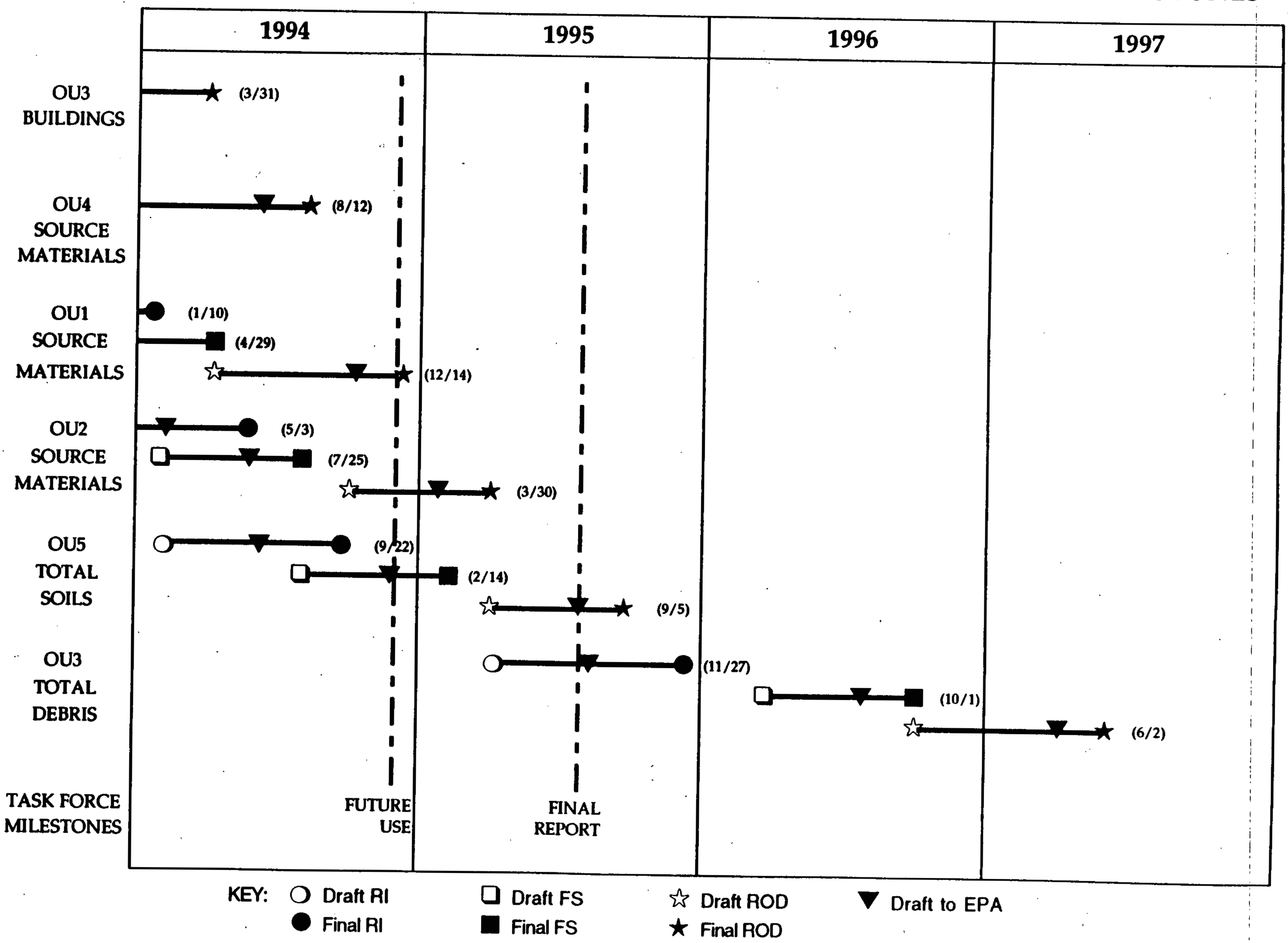
SCHEDULE

The Task Force schedule for phases III and IV have been designed to coincide with the current decision making activities of the Department of Energy and the Environmental Protection Agency. Key decisions with regard to the final disposition of all site soils will be made in conjunction with the final Record of Decision for Operable Unit 5. This Record of Decision is scheduled to be final in September of 1995. The Task Force Final Report is scheduled to be complete in July 1995 coincident with the draft Record of Decision from the Department of Energy, but in reality many of the most important recommendations of the Task Force will be available well before that time. An outline of the key activities of the Task Force with the corresponding timeframes is presented in Figure 1. Figure 2 shows how this process correlates to the activities at Fernald as currently planned.

Figure 1.
ACTIVITY TIMELINE FOR THE FERNALD CITIZENS TASK FORCE

Key Activities	Meetings Covered
PHASE I: CONVENING TASK FORCE (Completed)	*June - August 1993*
PHASE II: ORIENTATION AND APPROACH (Completed)	
SITE ORIENTATION	*September 1993*
DEFINE MISSION	*October 1993*
WASTE DISPOSAL AND LAND USE ORIENTATION	*November 1993*
DEVELOP FUTURE USE APPROACH	*December 1993*
PHASE III: CLEANUP PARAMETERS	
IDENTIFY OPTIONS FOR FUTURE USE	*January 1994*
UNDERSTAND SITE CONDITIONS	*February/March 1994*
TECHNOLOGY AND DEMOGRAPHIC SCREENING OF OPTIONS	*April/May 1994*
DESCRIPTIONS OF "REASONABLE" OPTIONS	*June 1994*
CLEANUP LEVELS ANALYSIS	*July/August 1994*
VOLUME AND COST COMPARISONS	*September 1994*
PREFERRED FUTURE USES AND CLEANUP LEVELS	*October/November 1994*
PHASE IV: IMPLEMENTATION AND PRIORITIES	
VISIONING 10, 25, 50 YEARS INTO FUTURE	*December 1994*
INSTITUTIONAL CONTROLS/USE AND OWNERSHIP CHANGES	*January/February 1995*
CLEANUP PRIORITIES AND TIMING	*March/April 1995*
TASK FORCE FINAL REPORT	*May/June /July 1995*
PHASE V: MONITORING PROGRESS	*To Be Determined*

Figure 2. SCHEDULE OF FERNALD DECISIONS AND KEY TASK FORCE MILESTONES



DESCRIPTION OF ACTIVITIES

This section is designed to provide a brief description of the outcome, process, and input to each of the key activities of the Task Force Process. The prospective activities described for Phases III and IV are meant to describe only those activities that correspond to future use, cleanup levels, and cleanup priorities. In addition the Task Force will address ongoing issues of importance to the site and a portion of each meeting will be devoted to such activities. These items will include, but not be limited to, comments on proposed plans, local issues relevant to the Fernald site, and other activities within the Department of Energy cleanup program. Specific agendas and detailed plans will be developed and distributed prior to each meeting.

PHASE I: CONVENING TASK FORCE (Completed)

June - August 1993

The Department of Energy engaged Dr. Eula Bingham to select a representative group of stakeholders in the cleanup of the Fernald site to be members of the Task Force. Dr.. Bingham also drafted, in consultation with the Department of Energy, the Environmental Protection Agency and the Ohio Environmental Protection Agency , a charter for the Task Force. This phase concluded with the official appointment of the Task Force Members and a Chairperson.

PHASE II: ORIENTATION AND APPROACH (Completed)

SITE ORIENTATION

September 1993

The Task Force met twice for a tour of the site and a day-long retreat. The retreat covered introduction of stakeholders and their interests, the context of the Task Force in the cleanup program, introductions of key individuals, the legal context of the decision making process, physical characteristics of the site, and risk assessment fundamentals.

DEFINE MISSION

October 1993

The Task Force approved its charter, approved ground rules regarding membership, and discussed other organizational issues. The Task Force determined its basic approach to making its recommendations regarding waste disposal, cleanup levels, and cleanup priorities in light of future use.

WASTE DISPOSAL AND LAND USE ORIENTATION

November 1993

The Task Force developed a process and criteria for selecting a coordinator to direct the group's work in Phase II and beyond. Presentations on land use planning and basic waste disposal techniques were made.

DEVELOP FUTURE USE APPROACH
December 1993

A Task Force Coordinator was selected by a selection subcommittee of the Task Force through a competitive bidding process. The Task Force Coordinator was introduced to the Task Force and presented the future use approach that will be pursued. The Task Force also considered the Department of Energy's Site Development Plan as a first step in applying stakeholder interests and goals to land use issues.

PHASE III: CLEANUP PARAMETERS

IDENTIFY OPTIONS FOR FUTURE USE
January 1994

Decisions/Outcome:
A full spectrum of future use options based on what the Task Force envisions would be productive and desirable uses of the property unconstrained by what is seen as feasible at this point in the process. These future use options set the stage for understanding and evaluating future use and cleanup levels for the facility. Keeping these potential future uses in mind, the Task Force will identify the items of information most needed in selecting the ultimate future use and cleanup levels for Fernald.

Process:
The Task Force will "brainstorm" all of the potential future uses of the site. Maps and aerial photographs will be used to help visualize both current and future land uses. Options for future use will be general in scope and may encompass the entire site or provide for different uses for different areas of the site. The cleanup of the facility will not actually create a specific use but will allow for a range of uses tied to the cleanup levels that are achieved. Highly detailed uses are therefore not necessary at this point. These general future use options will be used to set the stage for the information needs of the Task Force over the course of its decision making.

Information Provided to Task Force:
Physical and natural description of Fernald and surrounding areas.
Maps and photographs of Fernald and surrounding areas.
Current Land uses at Fernald and surrounding areas.

UNDERSTAND SITE CONDITIONS
February/March 1994

Decisions/Outcome:
Develop a working understanding of the physical, cultural, economic, demographic, and environmental characteristics of the Fernald facility and surrounding areas.
Develop a working understanding of the contamination of structures, soils, air, surface water, and groundwater and the associated risks both current and future.
Identify all applicable and emerging remediation technologies and associated costs and risks.

Process:
Through presentation and discussion, a complete conceptual model of the site will be established for the Task Force. Information will be developed by FERMCO and the Task Force coordinator and in light of the types of information the Task Force desires relevant to its specific concerns.

Information Provided to Task Force:
Contamination profile, 3D representations, and volumes
Descriptions of significant risks from contamination over time
Environmental profile of all significant receptors
Demographic profile and trends for surrounding area
Description, costs, and effectiveness of most applicable technologies

TECHNOLOGY AND DEMOGRAPHIC SCREENING OF OPTIONS
April/May 1994

Decisions/Outcome:
Identification of the future use options that are considered reasonable in light of the condition of the site and surrounding areas.

Process:
A screening of each of the possible options identified in the first step to determine which are most reasonable in light of the baseline information presented. The Task Force will discuss the potential benefits and limitations of pursuing each of the future use options and try to narrow the number of options that will be developed in detail. This evaluation will be conducted qualitatively and acceptable criteria for long-term solutions to Fernald will be developed by the Task Force to guide in this process.

Information Provided to Task Force:
Baseline information previously generated.

DESCRIPTIONS OF "REASONABLE" OPTIONS
June 1994

Decisions/Outcome:
Descriptions of each of the future use options in sufficient detail to allow for the development of corresponding exposure assumptions for the development of cleanup levels.

Process:
The Task Force will discuss each of the reasonable options identified in the previous step and will develop detailed assumptions regarding the future use scenarios of each so that relative cost comparisons can be developed. These assumptions will be developed in conjunction with risk assessment staff to ensure that sufficient information exists to develop cleanup levels for each option. At this time, all of the ramifications of each option will be explored including, but not limited to, the long-term effectiveness of the technologies employed, risks and concerns of implementation, off-site impacts and considerations, technical feasibility, and the economic, cultural, environmental, and social impacts of the cleanup process and the ultimate condition of the site. If desired by the Task Force, the assistance of outside planning professionals will be elicited.

Information Provided to Task Force:
Detailed information on the technologies associated with each option including long-term effectiveness and implementation parameters.
Description of the parameters that must be taken into consideration in conducting long-term land use planning.

CLEANUP LEVELS ANALYSIS
July/August 1994

Decisions/Outcome:
Develop an understanding of all the variables and processes that go into setting actual cleanup levels. Establish a preferred approach for setting cleanup levels and have calculations performed to identify cleanup levels associated with each future use option.

Process:
Through presentation and discussion, the Task Force will be given an overview of the risk assessment process and all relevant laws and regulations that impact the setting of cleanup levels at Fernald. The task will work directly with risk assessment staff to identify important criteria in conducting the risk assessments to set cleanup levels. If desired by the Task Force, the assistance of outside risk analysis professionals will be elicited.

Information Provided to Task Force:
Descriptions of the risk assessment and ARARs processes.
Identification of the cleanup levels generated according to the specifications of the Task Force.

VOLUME AND COST COMPARISONS
September 1994

Decisions/Outcome:
A summary of the volumes, costs, likely technologies, time frames, and ramifications of implementation of each future use option. At this point, different options may look sufficiently similar in the cleanup levels required that future use "ranges" might be created to encompass a variety of uses available under a given set of cleanup standards.

Process:
Using the risk information identified in the previous step, cost and volume estimates will be prepared by FERMCO in conjunction with the Task Force coordinator to identify the relative costs of each of the options. These costs will then be evaluated by the Task Force versus the expected benefits and other ramifications of each option.

Information Provided to Task Force:
Cost and volume estimates for each option.
Three dimensional representations of cleanup volumes and on-site disposal patterns for each of the options.
Visual representations of the Fernald site following remediation under the various options.

PREFERRED FUTURE USES AND CLEANUP LEVELS
October/November 1994

Decisions/Outcome:
Identification of preferred future uses of land and natural resources at Fernald and the corresponding cleanup levels. An interim report will be prepared at this time to present the recommendations and all corresponding assumptions and observations.

Process:
The Task Force will evaluate the costs and benefits of each future use option or range of options to identify the most acceptable scenario for Fernald.

Information Provided to Task Force:
Summaries of all information gathered to date.

PHASE II: IMPLEMENTATION AND PRIORITIES

VISIONING 10, 25, 50 YEARS INTO FUTURE
December 1994

Decisions/Outcome:
An understanding of how Fernald will change over time during and after remediation and how any future use of the property can be phased in as remediation is completed.

Process:
Presentation and discussion of the timing of the activities involved in achieving the ultimate remediation of Fernald.

Information Provided to Task Force:
Timelines of key activities.
Conceptual site models at 10, 25, and 50 years.

INSTITUTIONAL CONTROLS/USE AND OWNERSHIP CHANGES
January/February 1995

Decisions/Outcome:
Options for ensuring the long-term effectiveness of the remedy and responsibilities and contingencies for the long-term management of the property.

Process:
The Task Force will discuss all of the long-term ramifications of the site cleanup strategy and identify the long-term issues that must be planned for in the implementation and management of the remedy. These issues will include, but not be limited to, ownership of property, management of all long-term waste management units, remedy maintenance and replacement, and desires of future generations in changing land use.

Information Provided to Task Force:
Currently available options for long-term control of land uses.
Planned DOE ownership strategy.

CLEANUP PRIORITIES AND TIMING
March/April 1995

Decisions/Outcome:
Identification of the key concerns of the Task Force for prioritization in the cleanup process and an overall view of cleanup timing from the Task Force's perspective.

Process:
Discussion of the key areas of concern and feasibility of different scheduling approaches for remediation.

Information Provided to Task Force:
Key time and logistical constraints.

TASK FORCE FINAL REPORT
May/June/July 1995

Decisions/Outcome:
A final report of all Task Force observations and recommendations.

Process:
The Task Force will outline the key sections of the final report during the May meeting. The Task Force coordinator will then produce a draft report for review at the June meeting, which will be revised again for ultimate approval at the July meeting.

Information Provided to Task Force:
Draft reports.

PHASE V: MONITORING PROGRESS

The specific timing and activities of this phase will be determined at a later date.

FERNALD CITIZENS TASK FORCE

DRAFT FUTURE USE CRITERIA

ENVIRONMENTAL CRITERIA

1 Identify and preserve significant natural ecosystems with a special emphasis on the following:
naturally occurring wetlands
Paddy's Run
threatened and endangered species

2. Ensure that no future defacement of the environment occurs.

3. Ensure that any waste left on-site be protective of the Great Miami Aquifer, air and soils on and off-site.

4. Any future site use must be protective of the environment.

SOCIAL AND HUMAN CRITERIA

1. Emphasis should be place on future uses that offer benefits to the community

2. Emphasis should be placed on a future use which is dedicated to not repeating the mistakes of the past which resulted in the current conditions at Fernald.

3. All future uses must have acceptable risks to the current and future residents and workers of the Fernald community with a special emphasis on the effects on children.

4. The selection and implementation of any future use of the Fernald facility must include ideas from the public at large (not necessarily limited to the current 5 mile radius for public involvement)

5. All future uses must be conducive with current and projected off-site uses, and compatible with the natural and man-made surroundings.

6. Special emphasis should be placed on a future use which promotes history, research, and education.

7. Emphasis should be placed on a future use which demonstrate how a negative situation can be turned into a positive.

ECONOMIC CRITERIA

1. Emphasis should be placed on future uses which provide some level of continuing employment for area residents, but not necessarily in categories that have traditionally been present at the site.

2. Futures uses and ownership should be structured so that local property taxes are provided.

3. Wherever feasible, existing infrastructure should be used to enhance the attractiveness of the property for future use

4. The cleanup of the Fernald facility should be done in such a way as to reduce the stigma of past practices at the site and assist in the continuing use and development of surrounding properties.

LONG TERM MANAGEMENT CRITERIA

1. A long-term control mechanism for the site must be established to ensure the perpetual moral and financial responsibility of the Federal government for the continued management, monitoring, and emergency response capability regarding all wastes left on the facility.

2. Long-term uses and institutional control mechanisms must be reconciled with local zoning and planning.

3. All selected uses resulting in waste being left on site must have the built in flexibility to provide for future changes in use and better cleanups should financial, technical, or demographic changes warrant.

4. A long-term mechanism must be established to ensure citizen involvement in the control, management, and future decisions at the site

GENERAL USE CRITERIA

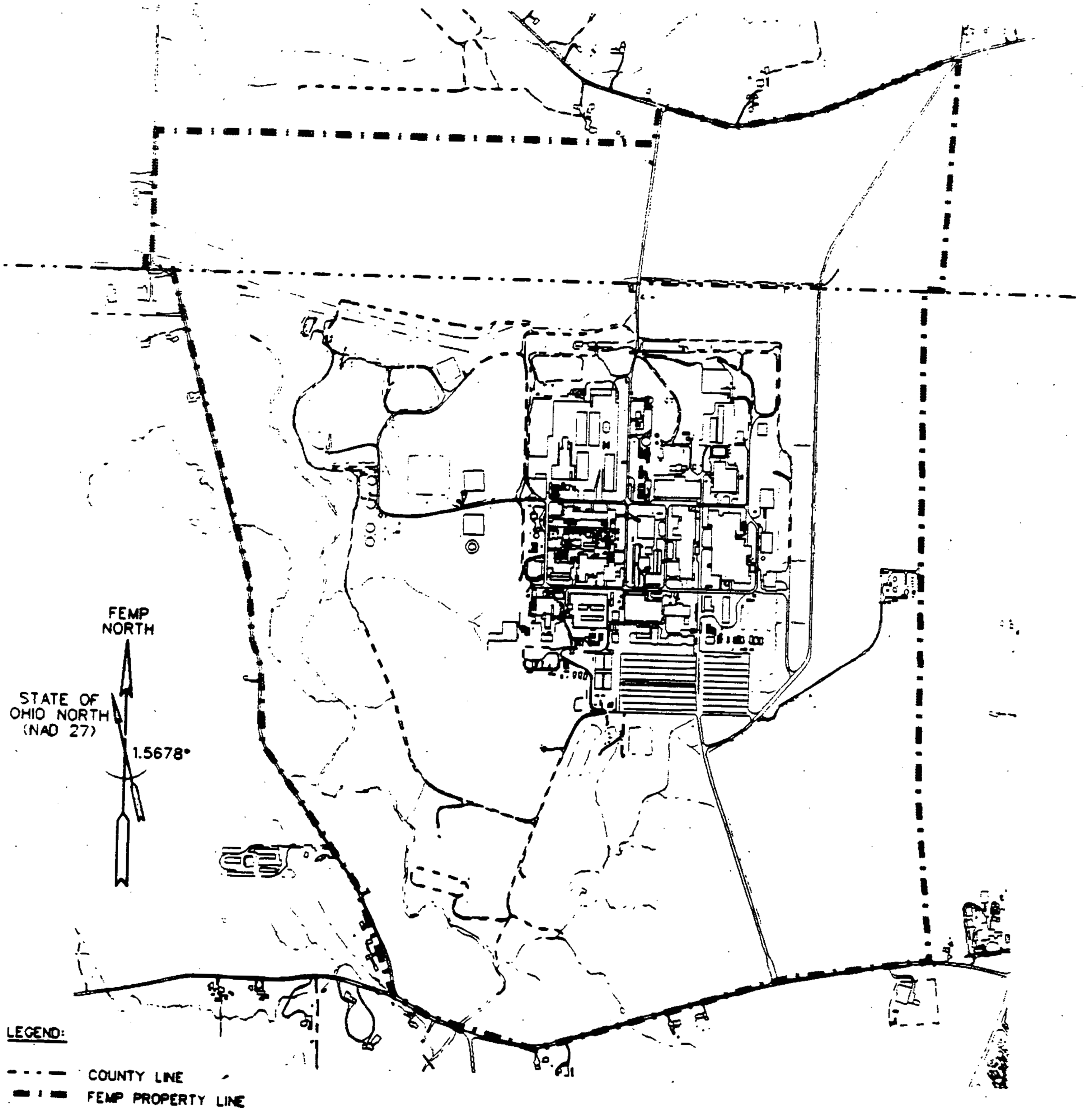
1. Any future use plan must recognize that a mixed use strategy may be the most effective for the long-term use of the site.

2. Emphasis should be placed on reducing the physical barriers and physical evidence of the past use of the site and focus on ways that Fernald can be a better neighbor to the surrounding community

3. Under no circumstances should a future use be permitted at the facility which requires the importing of new hazardous waste.

4. All uses and cleanup plans must explicitly recognize the political, safety and health impacts of off-site waste shipments.

5. Future uses of the site should be focused on non-hazardous activities.



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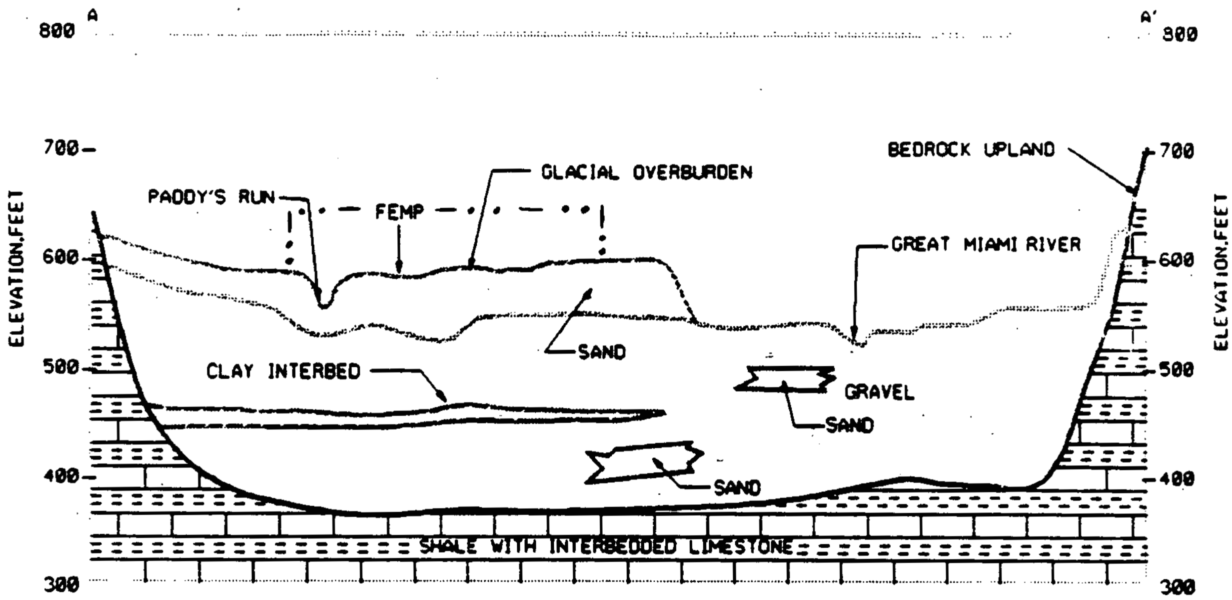
FERNALD SITE MAP

FERNALD REGIONAL GEOLOGIC CROSS-SECTION

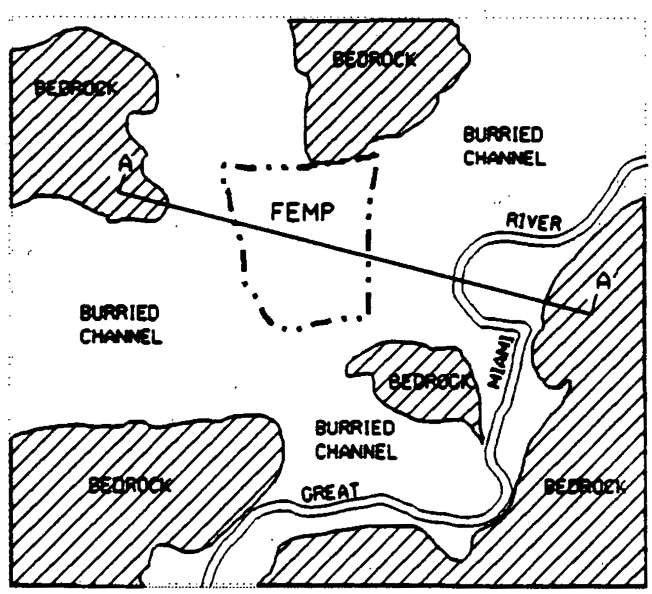


SAND AND GRAVEL SECTION A-A' LOOKING NORTH

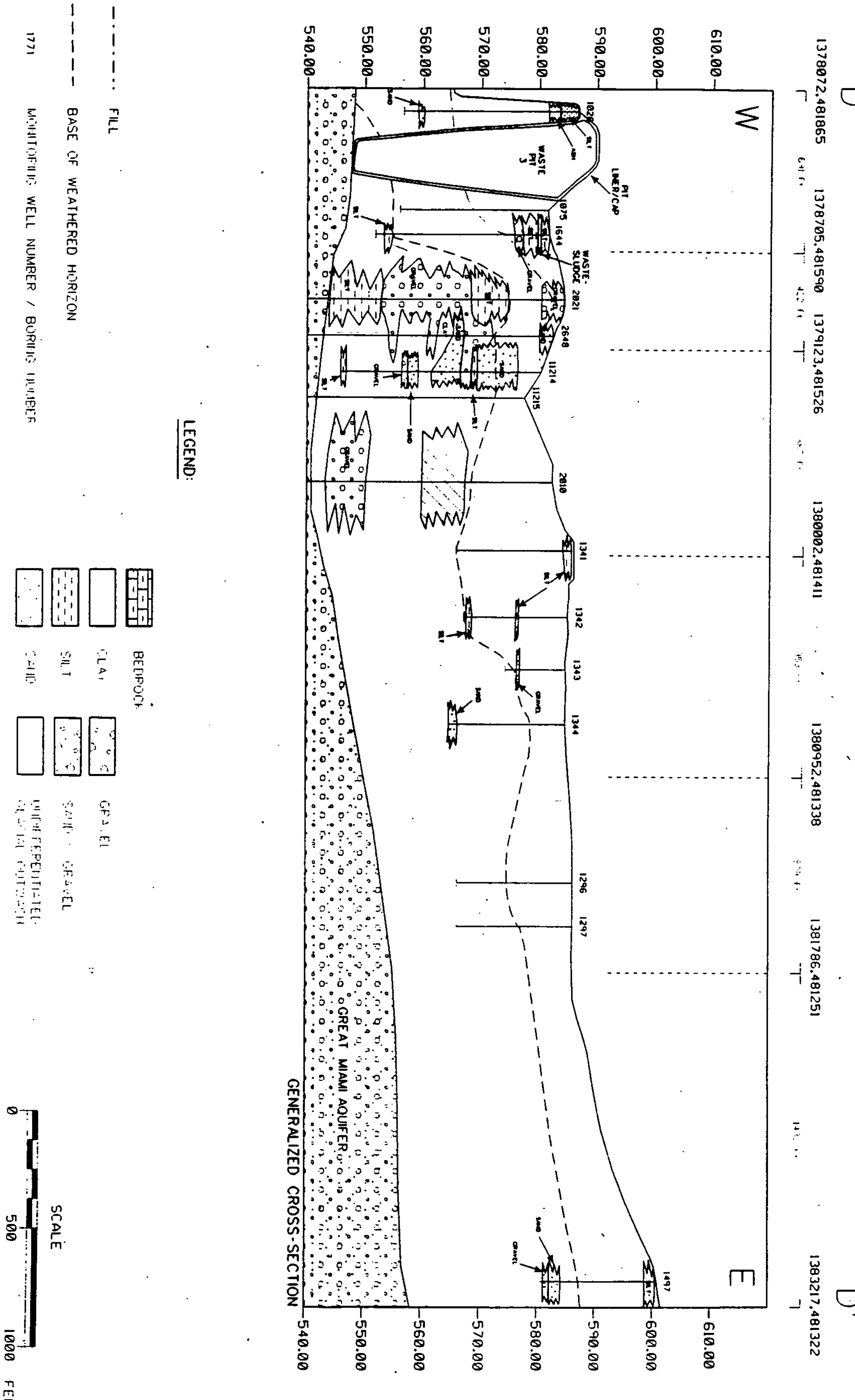
NOTES:

HORIZONTAL SCALE IS APPROXIMATELY 1" = 2500'

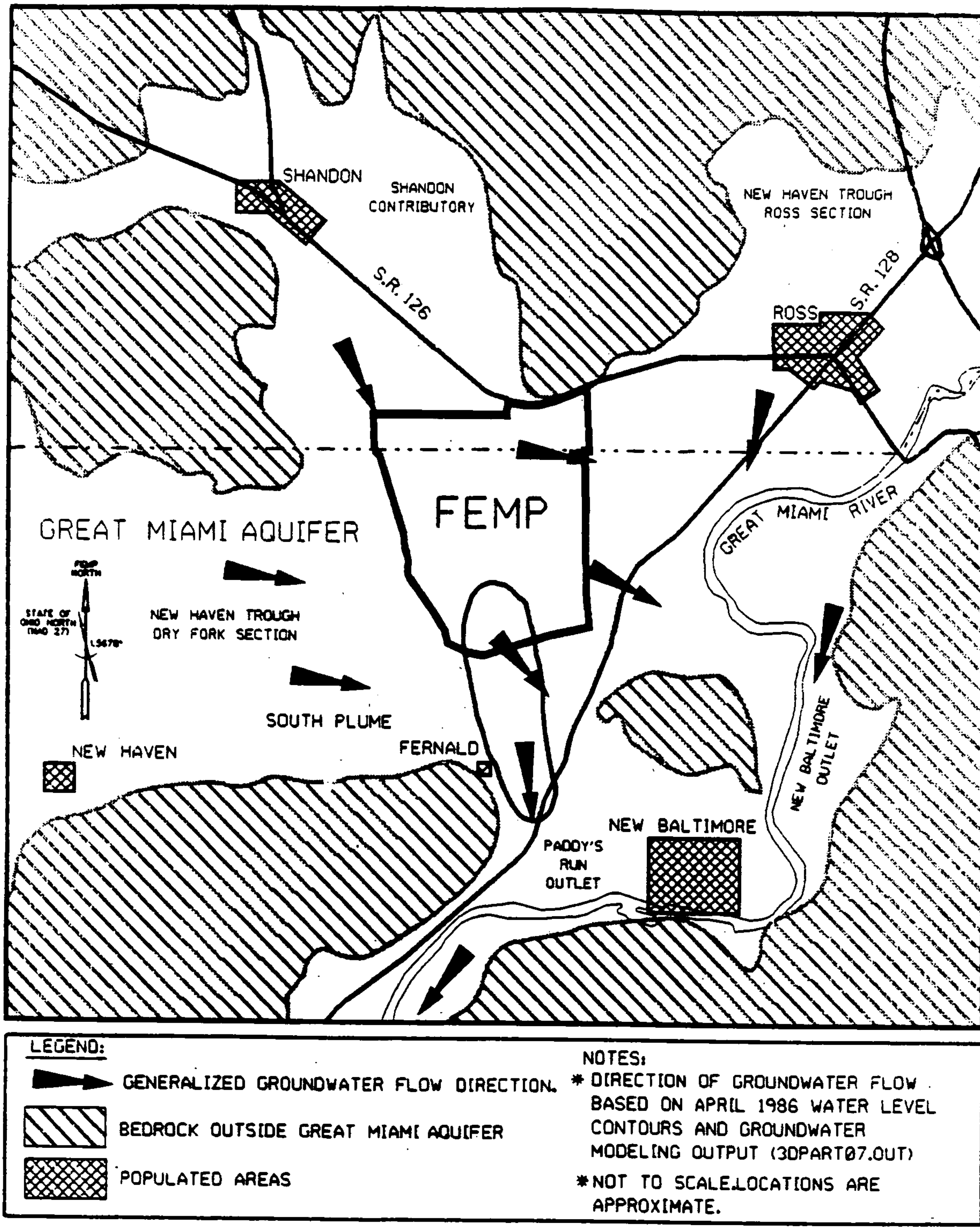
INFORMATION CONCERNING THE DEPTH AND ATTITUDE OF THE BEDROCK SHALE WAS OBTAINED FROM I.T CORPORATION DRAWING 303317-8208.



LOCATION OF CROSS SECTION

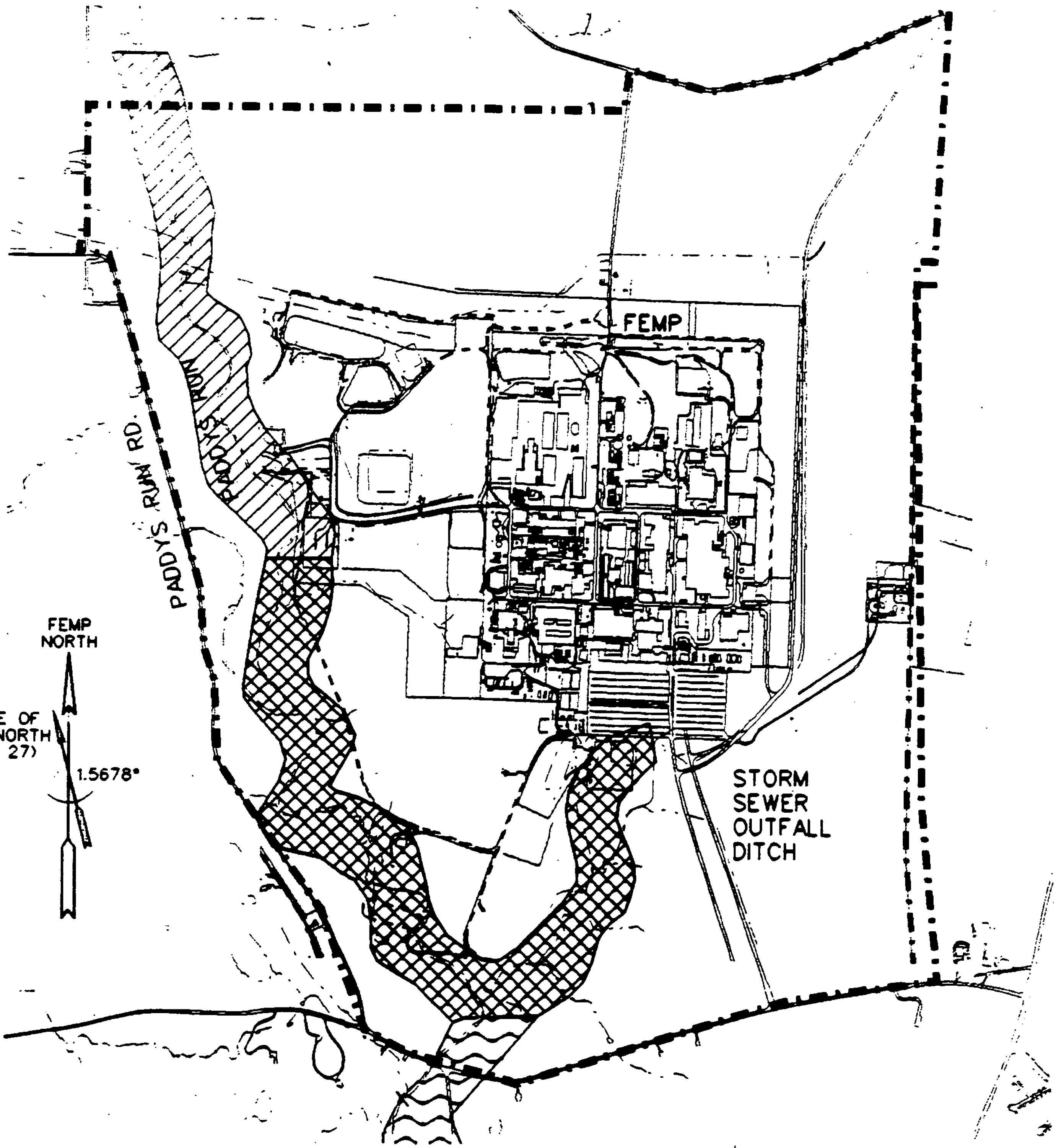


FERNALD SITE GEOLOGIC CROSS-SECTION SHOWING EXAMPLE WASTE PIT



GENERAL GROUND WATER FLOW

Surface Water Infiltration to Great Miami Aquifer



LEGEND:

GLACIAL OVERBURDEN PRESENT: MINIMUM STREAM INFILTRATION EXPECTED

SURFACE WATER INFILTRATION OCCURS REGARDLESS OF WATER TABLE ELEVATION

POSSIBLE SURFACE WATER INFILTRATION DEPENDING ON WATER TABLE ELEVATION

COUNTY LINE

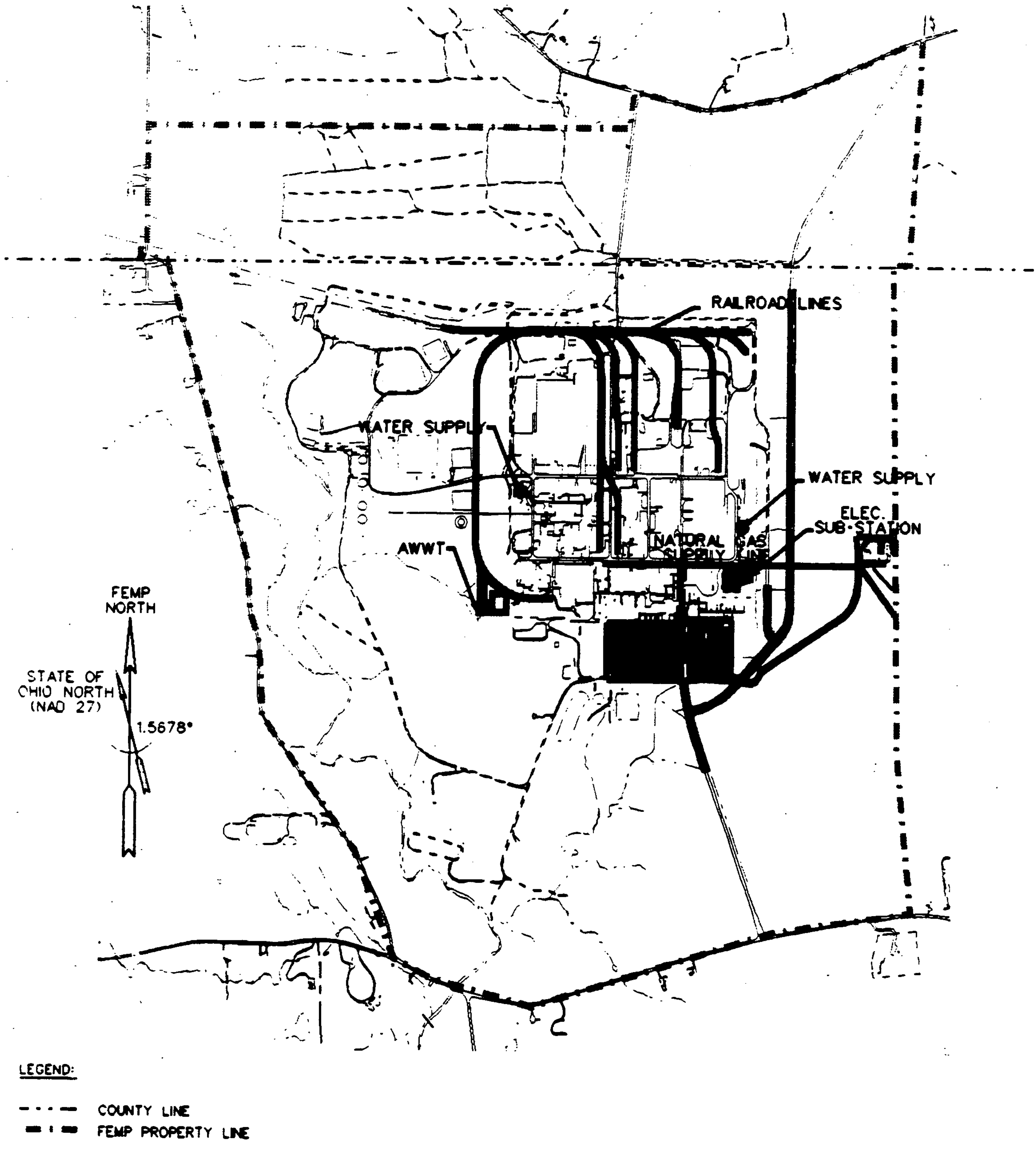
FEMP PROPERTY BOUNDARY

NOTES:

AREAS OF SURFACE WATER INFILTRATION ARE APPROXIMATE.

NOT TO SCALE. LOCATIONS ARE APPROXIMATE

000019



Location of Existing Fernald Infrastructure

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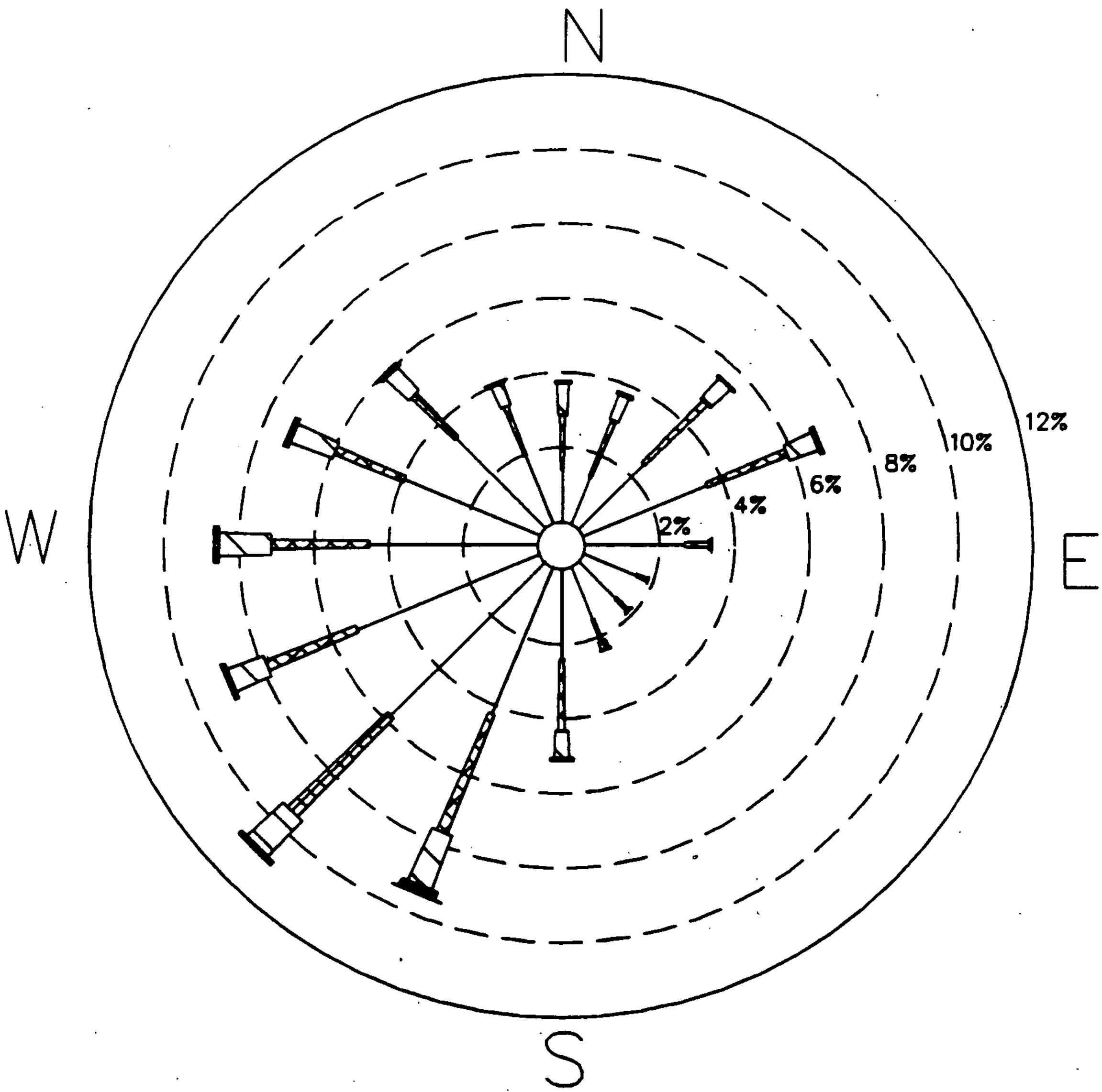
Description of Existing Fernald Infrastructure

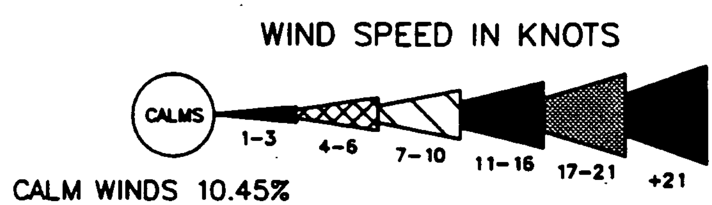
System	Capacity	Max. Capacity Peak Load	Expansion Capability	Critical Component	Present Conditions
ELECTRICITY	138 KV/13.2 kV main	6,5000 KVA/Month	Good	Feeder Lines	Feeder Lines In Bad Shape
PLANT AIR	5-1,600 scfm	3,200 SCFM	Good	Compressors	Good
INSTRUMENT AIR	90 PSIG (621 kPaG)	3,200 SCFM	Good	Compressors	Good
FUEL GAS	40 PSIG (276 kPaG)	100,000,000 CFT/Month	Good	Reducing Station	Good
SANITARY WATER	1,000,000 GPD	420,000 GPD	Good	Treatment Filters, Pumping Station	Good
PROCESS WATER	1,000 GPM	250 GPM	Good	System Pumps	Good
STEAM	150,000 lbs/Hour	90,000 lbs/Hour	Good	Feed Water System, Plant Air, Boilers	Fair - Damage repaired from fire
SANITARY SEWER	350,000 GPD	173,000 GPD	Not Possible	Trickling Filters and Pumps	Fair
STORMWATER	10,400,000 G	Variable	Good	Pumping Stations	Good
COOLING WATER	10,000 GPM	6,600 GPM	Fair	Process Area Entry Points	Base of cooling tower in need to repair - could use new cooling pumps
ROADWAYS	2 Entry Points to Process Area	Not Applicable	Fair	Process Area Entry Points	Roadways are in good condition, west side truck scale needs repair
RAIL SYSTEM	Determined by Trestle and Car Weight/Size	Currently the usage is low	Fair	Trestle and Inplant Track	New rail car mover, track is in fair condition, some replacements of cross ties needed and track leveling, trestle needs evaluation

WIND ROSE FOR THE FERNALD SITE

6033



NOTE: Frequencies indicate direction from which the wind is blowing.
Readings are at 33 feet above ground.



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FERNALD CITIZENS TASK FORCE

NATURAL RESOURCES ISSUES AT FERNALD

The cleanup of Fernald is being conducted according regulations promulgated pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). In CERCLA, natural resources are defined as "land, fish, wildlife, biota, air, water, groundwater, drinking water supplies and other such resources." While response actions taken under CERCLA may act to protect or restore these natural resources, the cleanup activities themselves can sometimes have an adverse effect on natural resources. The greatest potential adverse effect to natural resources during remediation is destruction of plant and animal species and their habitat, most critically for threatened and endangered species and mature habitats such as woodlands which would require a long time to recover. Key habitats include:

The Riparian Woodlands: The riparian woodlands encompass approximately 60 acres of relatively undisturbed floodplain bordering Paddys Run and the Storm Sewer Outfall ditch. Mature and dead trees in the northern part of the woodland provide habitat for several species of bats, birds, and mammals.

The Pine Plantations: The pine plantations are overcrowded and among the least diverse habitats at Fernald. Many of the Austrian pines are infected with tip blight which will eventually kill the trees.

Introduced Grasslands: Approximately half of Fernald is covered by non-native (introduced) grasslands which are regularly disturbed by cattle grazing or mowing. Very few mammals are found in pasture areas.

Wetlands: The 35.9 acres of wetlands at Fernald include 26.6 acres of forested wetlands, 7 acres of drainage ditches, and 2.4 acres of persistent emergent wetlands. Forested wetlands provide a unique and diverse habitat in association with the woodlands and grasslands.

Paddys Run: Aquatic organisms including invertebrates and fish would be affected by streambed habitat alteration, including excessive erosion due to remediation activities.

Several State and Federal regulations affect conduct of operations at Fernald involving natural resources. These regulations are described below:

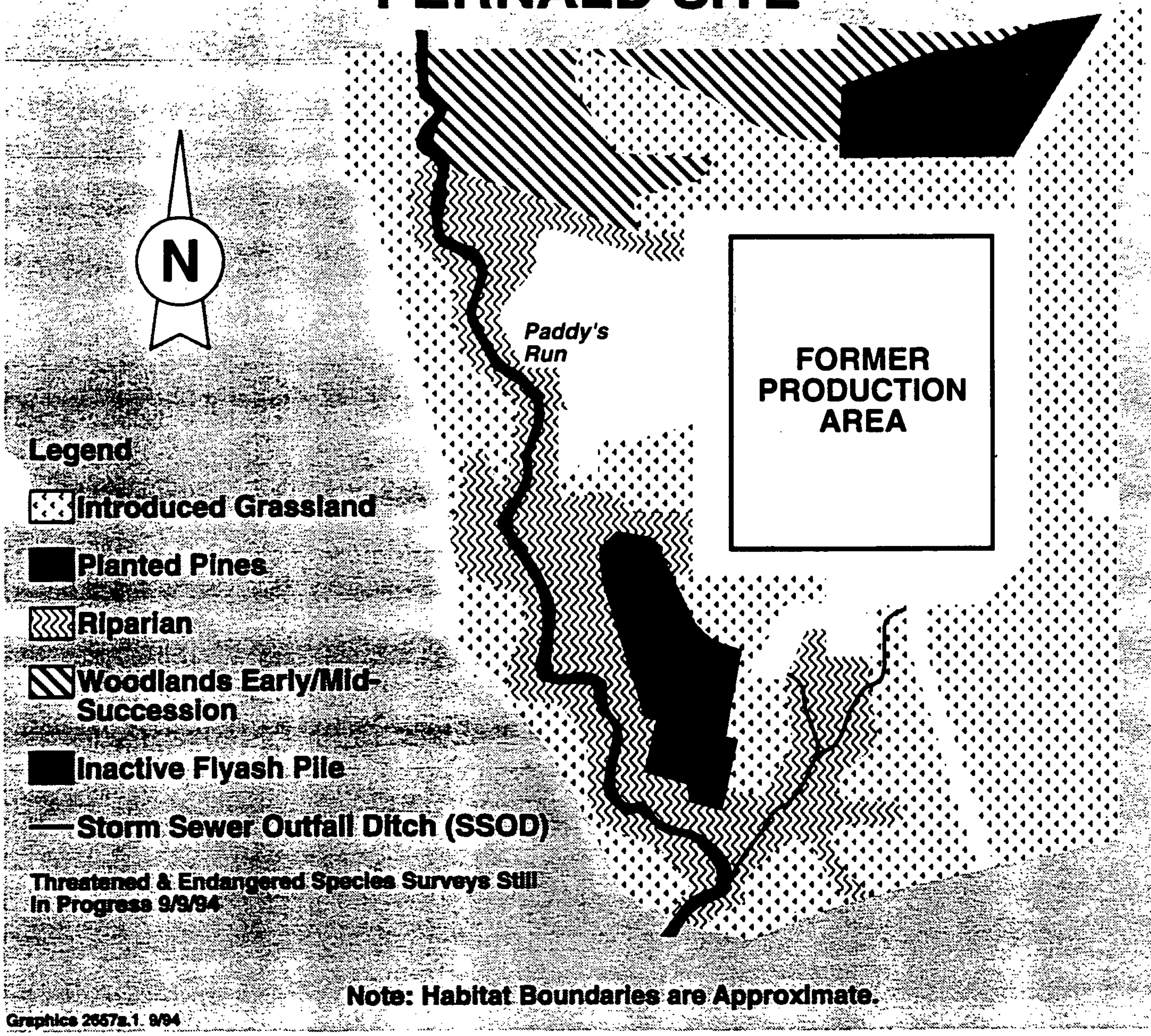
The 1972 Water Pollution Control Act, and subsequent policy, states that impacts to wetlands must be avoided and minimized with mitigation occurring when impacts are unavoidable. Mitigation of wetlands means that the loss of a wetland must be compensated for either the restoration of degraded wetlands by enhancement or preservation of existing wetlands, or construction of new wetlands.

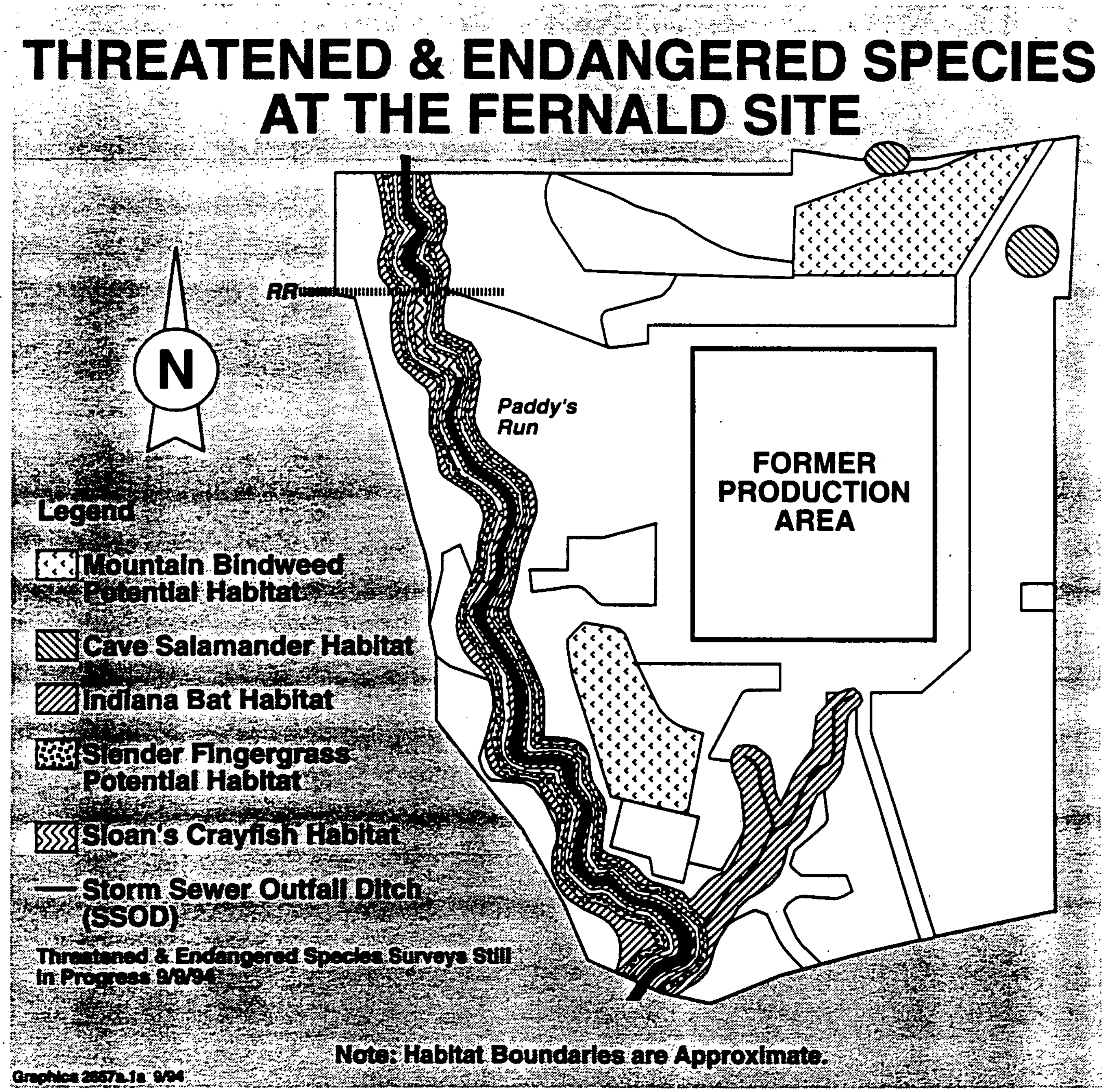
The National Environmental Policy Act (NEPA), and DOE implementing regulations, require that impacts to the environment be addressed during evaluation of alternatives.

The Endangered Species Act states that all Federal Agencies must seek to conserve threatened and endangered species.

The National Historic Preservation Act, the Ohio Preservation Office, and the Advisory Council on Historical Preservation, may require mitigation of historic properties affected by remediation. Mitigation would consist primarily of removing archeological artifacts from a site, recording the information prior to the site's disturbance, and managing the artifacts after their removal. No such areas have been identified at Fernald.

HABITAT TYPES PRESENT AT THE FERNALD SITE




THREATENED & ENDANGERED SPECIES
AT THE FERNALD SITE
RR
N
Paddy's
Run
FORMER
PRODUCTION
AREA
Legend
Mountain Bindweed
Potential Habitat
Cave Salamander Habitat
Indiana Bat Habitat
Slender Fingergrass
Potential Habitat
Sloan's Crayfish Habitat
Storm Sewer Outfall Ditch
(SSOD)
Threatened & Endangered Species Surveys Still
In Progress 9/9/94
Note: Habitat Boundaries are Approximate.
Graphics 2857a.1a 9/94

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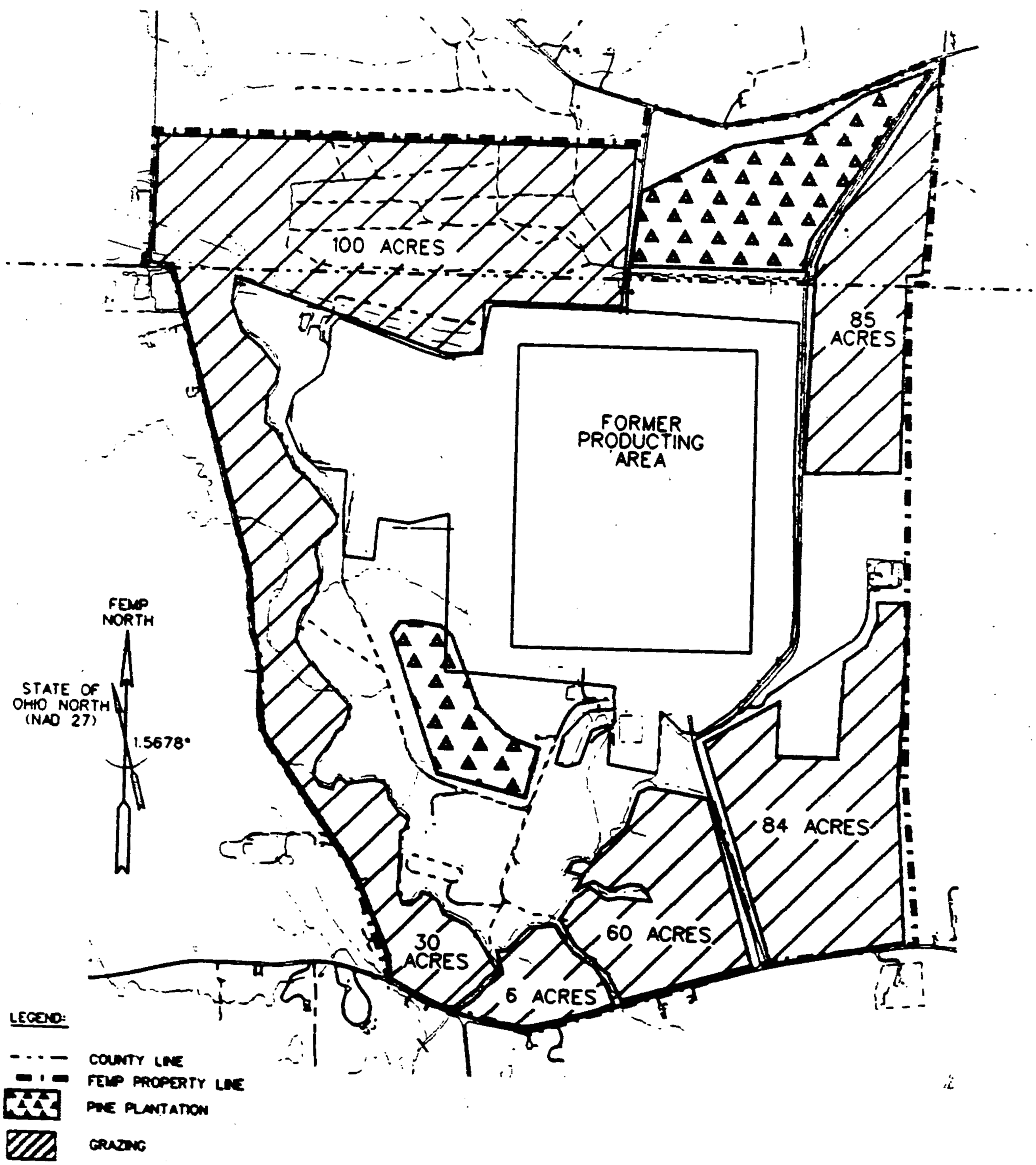


CURRENT FERNALD LAND USES

V-1

TASK FORCE IDENTIFIED FUTURE USE FOR FERNALD

COMPLETELY UNRESTRICTED USE
Unrestricted onsite use of land, surface water, and groundwater.

GRAZING
Would allow for surface grazing of cattle and other livestock.

RESIDENTIAL LEVEL USE
Would allow for on site unrestricted housing using a public water supply.

Residential housing
Full health care retirement village

ENVIRONMENTAL AND PASSIVE RECREATIONAL USES
Would allow for relatively infrequent and non-invasive use of surface lands. No groundwater use.

Wildflowers, scenic preserve
Memorial to site activities
Tree sanctuary
Wetlands preserve and research center
Connection to Great Miami River to increase public access
Ecology center
Green space
Creation of environmental monitoring zone for research
Park

LONG TERM WASTE DISPOSAL
Above or below ground storage facility requiring minimal human activity.

Long-term storage of on-site wastes
Yard waste composting center

INDUSTRIAL USES
Significant industrial activity and worker access, but infrequent direct contact with soils, groundwater use limited to industrial activities.

Industrial Park
Power Plant (gas, nuclear)
Atomic "Deprocessor"
Water processing/water sales
Recycling center
Waste Water Treatment facility
Federal Facility Compliance Act Treatment Center
Laboratory
Airport

LIMITED ACTIVITY COMMERCIAL USES

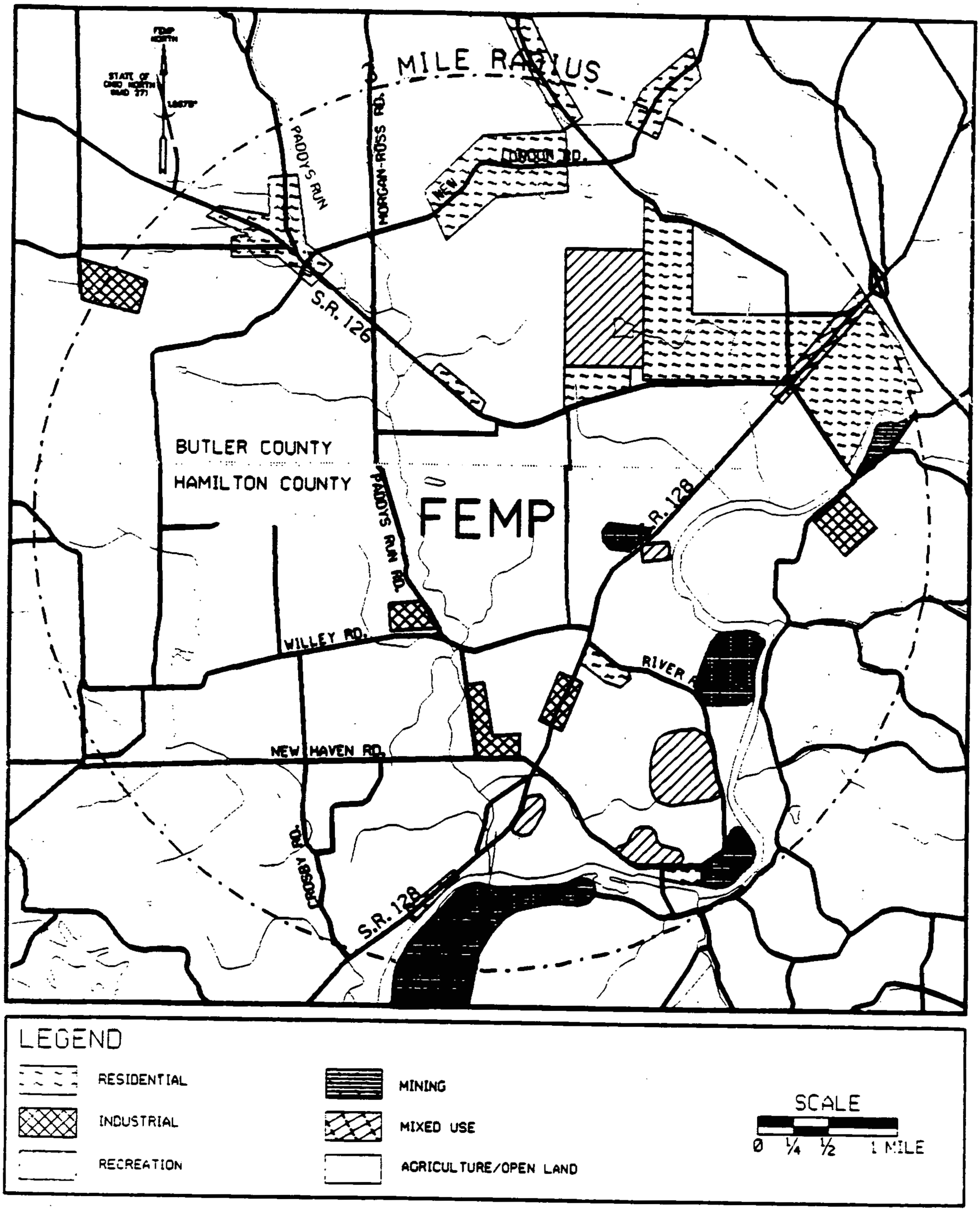
Infrequent use of site, limited subsurface activity, no use of groundwater.

- Archives, DOE records
- Warehouses
- Memorial park/cemetery

HIGH TRAFFIC COMMERCIAL AND EDUCATIONAL USES

Frequent use of site, limited subsurface activity, no use of groundwater.

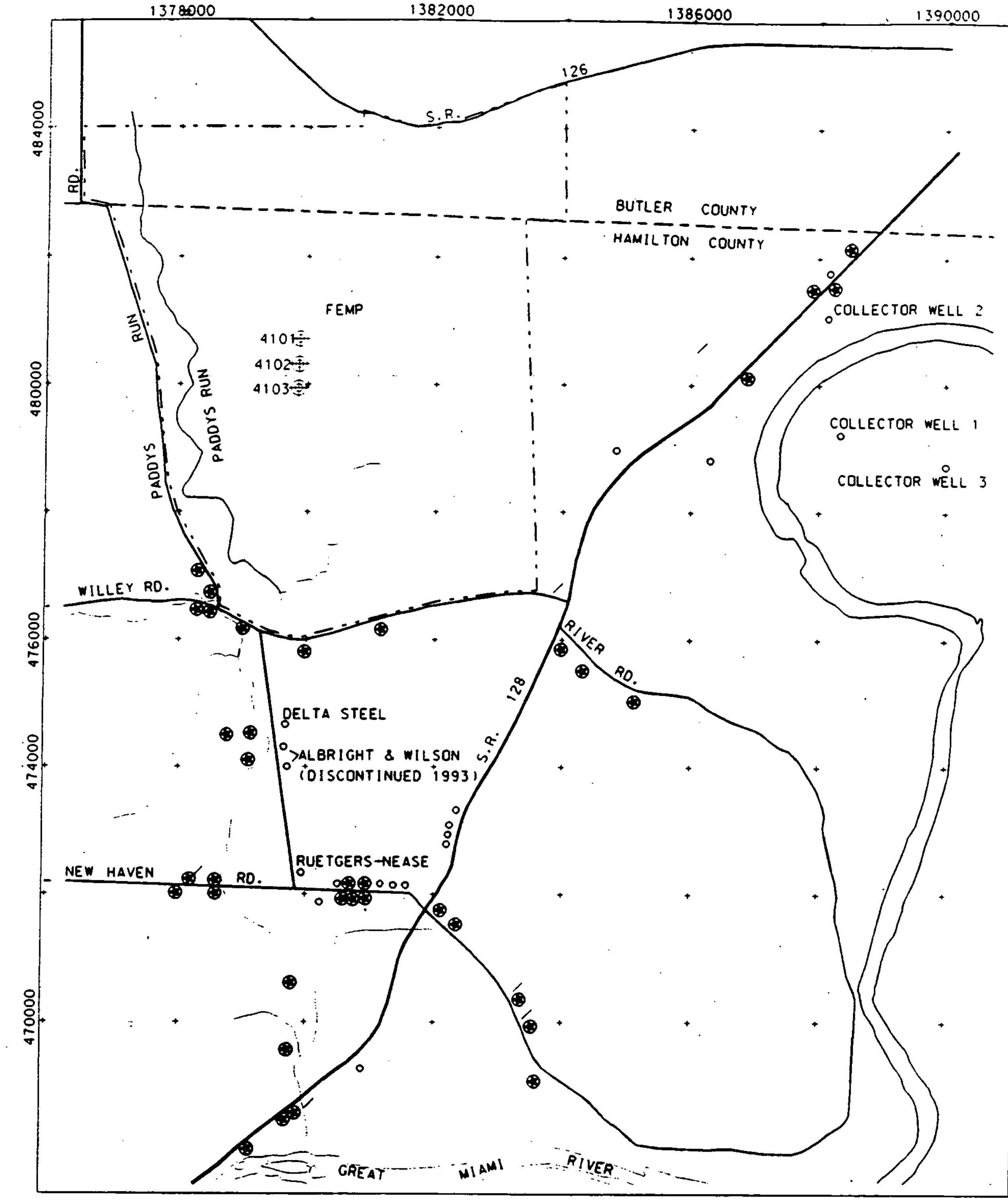
- Transportation hub
- Professional Sports complex
- Community sports complex
- Federal penitentiary
- Government offices
- Hospital (national medical center)
- Museum of Nuclear Power and Energy
- Research facility/Technology development
- Police/fire/CPR training facility
- Reading room/accessible historical
- Nuclear/environmental training/education center
- Vocational training
- Community college



000029

CURRENT LAND USES OF SURROUNDING PROPERTY

Known Downgradient Groundwater Users



NOTE:

THIS FIGURE MAY NOT SHOW EVERY GROUNDWATER USER IN THE AREA. LOCATIONS SHOWN ARE APPROXIMATE.

DATA TAKEN FROM DOE 1990. GROUNDWATER REPORT

LEGEND:

- PRIVATE/RESIDENTIAL WELL
- INDUSTRIAL/COMMERCIAL WELL
- WELL LOCATED AT LARGE FARM
- COUNTY LINE
- FEMP PROPERTY BOUNDARY

SCALE

2400 1200 0 2400 FEET

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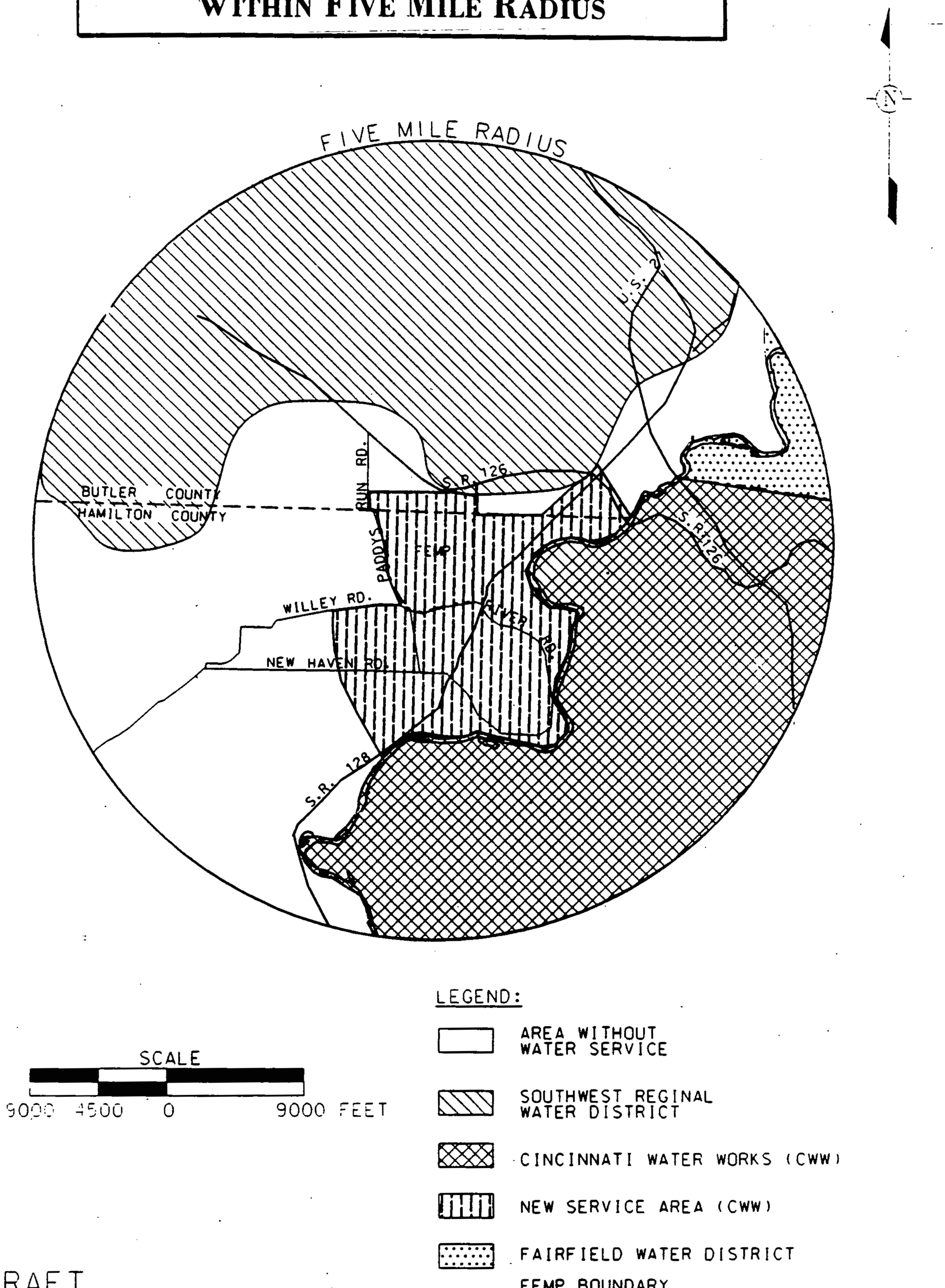
MAJOR WATER USERS WITHIN FIVE MILE RADIUS



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000031

FERNALD CITIZENS TASK FORCE

POPULATIONS AND DEMOGRAPHICS OF SURROUNDING COMMUNITIES

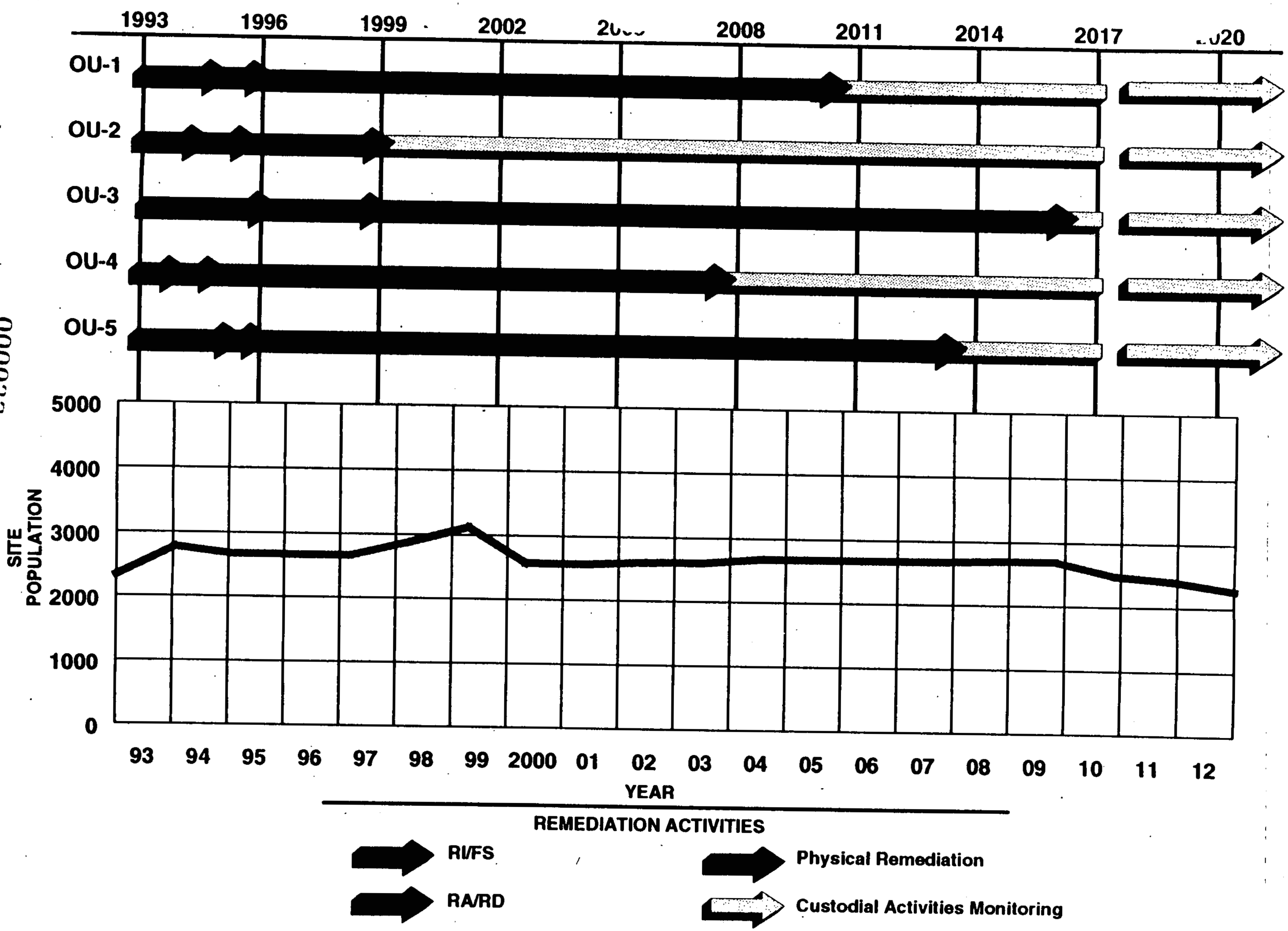
The Fernald site is located is two Ohio counties, Hamilton and Butler, and their combined population is 1.2 million people. Hamilton County has about 866,228 people, while Butler County has a population of 291,479. Most of the communities surrounding the Fernald site are unincorporated towns varying from an estimated population of 20 in Fernald proper to about 6,383 in Ross. Most of the communities have been characterized as agricultural or as "bedroom communities" for commuters in the Greater Cincinnati area.

The area immediately in the vicinity of Fernald is racially and ethnically homogenous. There is no appreciable minority population in the rural area around Fernald. The nearest city to Fernald is Harrison, which is about 8 miles from the site. According to the Census, there are about 4 African-Americans, 7 Native Americans, and 27 people of Hispanic origin living in Harrison - or about .5 percent of the total population. There are 13,134 African-Americans and 1,467 people of Hispanic origin living in Butler County, but they reside predominately in or near the City of Hamilton, beyond a 12-mile radius from the Fernald facility. To date these communities have not shown an interest in Fernald. Hamilton County has a substantial minority population, but it is centered in the City of Cincinnati and its suburbs. The nearest historically black college is over 150 miles away. Native American lands or significant historical sites are not implicated at Fernald.

The average income for residents of Butler County is $21,772, while it is $22,959 for Hamilton County residents. The unemployment rate for Butler and Hamilton counties, respectively, is 6.6 and 4.5 percent. In Butler County, about 30 percent of the employed work as professionals; the percentage is 34.6 percent for Hamilton County. The remainder of the work force in these counties is employed predominately in the manufacturing and service sectors. About 10 percent of the population in Butler County lives below the poverty level; it is 13.3 percent in Hamilton County. According to the Census, 18.7 percent of the population in Butler County has attended school for 16 years or more, and about 76 percent of the population has had 12 years or more. 23.7 percent of the residents in Hamilton County have had 16 years or more of school, and 75.6 percent have had 12 years or more.

COMMUNITY	POPULATION	CAUCASIAN	AFRICAN-AMERICAN	OTHER[1]	MEDIAN HOUSEHOLD INCOME
Hamilton County	866,228	77.7%	20.9%	1.4%	$29,498
Cincinnati	364,040	60.5%	37.9%	1.6%	$21,006
Crosby Township	2,665	99.6%	.4%		$28,706
New Baltimore[2]	350				
Fernald[2]	20				
New Haven[2]	300				
City of Harrison	7,528	99%	.0004%	.001%	$33,866
Butler	291,479	94%	5%	1%	$32,440
Morgan Township	4,972	99.5%	.001%	.004%	$39,247
Ross Township	6,383	99.5%	.1%	.4%	$38,680
Ohio-Kentucky-Indiana Region	1.7 Million				

1 Includes Native Americas, Hispanics
2 Demographic breakdowns not available



PROJECTED REMEDIATION SCHEDULE AND SITE WORKER POPULATION

000033

FERNALD CITIZENS TASK FORCE

DESCRIPTION OF NEW PUBLIC WATER SUPPLY

DOE is sharing in the cost to provide potable water to western Hamilton County which includes Crosby Township and the Fernald site. This endeavor will provide safe drinking water from the Cincinnati Water Works Bolton Plant to those residents effected by contamination from Fernald as well as expediting the expansion of public water to Western Hamilton County.

Phase IA of Hamilton County Department of Public Works Western Hamilton County Water Plan is comprised of four discrete projects. DOE's approximate cost share for all projects is in the form of a grant estimated to be $5.3 million. The projected completion date for all projects is December 1995.

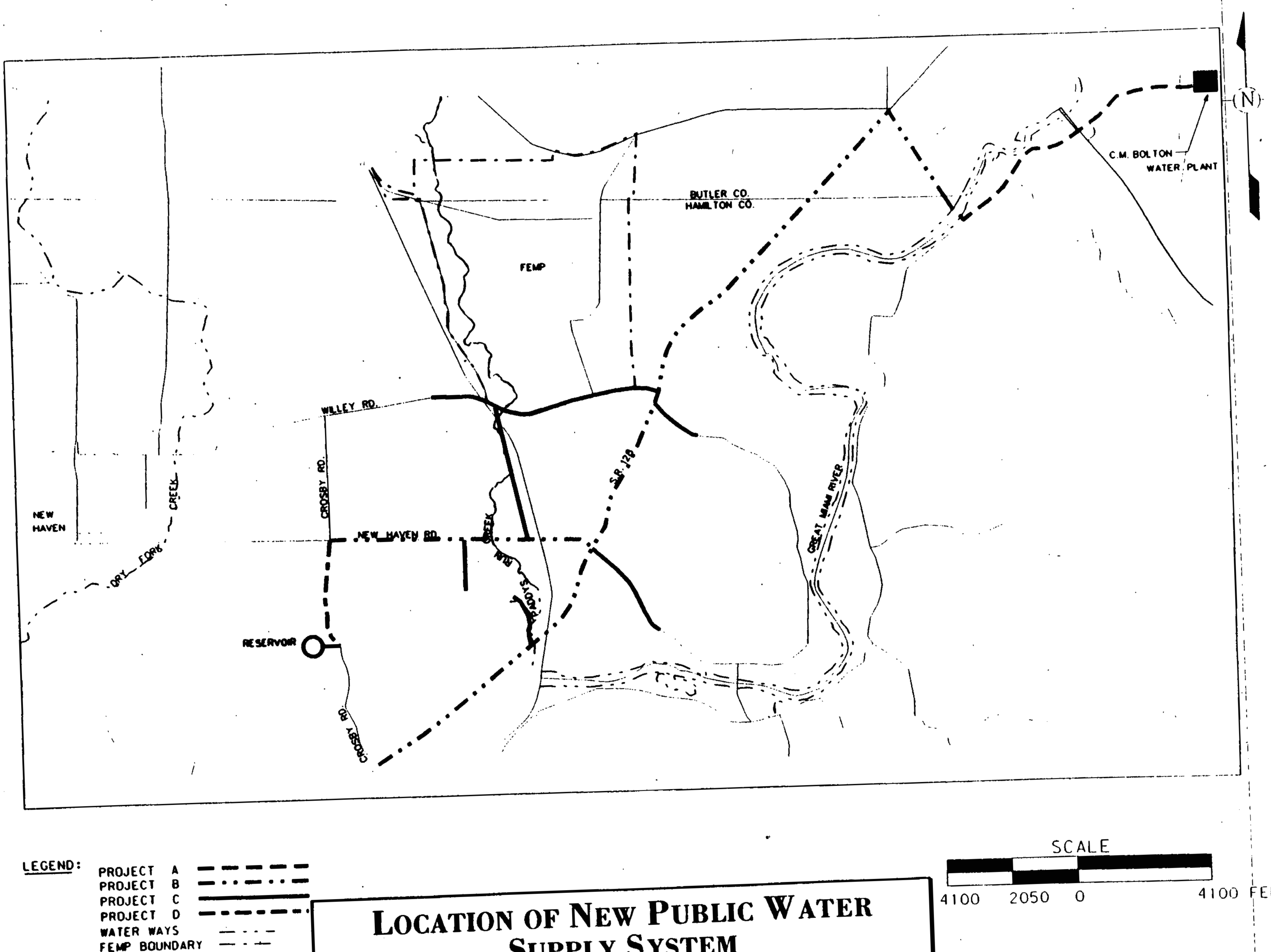
The four projects are generally described as follows:

Project A: Transmission and distribution mains and appurtenances beginning at Cincinnati Water Works Bolton Plant on River Road and ending at the Hamilton/Butler County line on S.R. 126 (old Colerain) near Ross.

Project B: Transmission and distribution mains and appurtenances beginning at the Hamilton/Butler County line and extending Southwardly on S.R. 128 to Crosby Road. Additionally, includes a transmission and distribution main on New Haven Road westwardly from S.R. 128 to Crosby Road.

Project C: Transmission and distribution mains appurtenances along portions of Willey Road, Paddy's Run Road, East Miami River Road, New Haven Road, and access road to Stone Mountain subdivision.

Project D: Transmission and distribution mains along Crosby road south from New Haven Road to new reservoir site. Also included is construction of a half million gallon reservoir and appurtenances.



LOCATION OF NEW PUBLIC WATER SUPPLY SYSTEM

Major Areas of Contamination at Fernald

COMPONENTS	DESCRIPTION	PATHWAYS AND CONTAMINANTS OF CONCERN[a]	LEADING REMEDIAL ALTERNATIVE
Pit Sludges (OU1)	Contents of waste pits 1 through 6 and the Clearwell plus cap and liner materials in direct contact with waste; sludges generated in the AWWT (similar characteristics to waste pit sludges)	Ingestion of water from the Great Miami Aquifer (GMA) provides the largest contribution to overall risk for both carcinogens and chemical toxicants. The total carcinogenic risks are approximately 1 in 10 (10^{-1}) for all exposure routes. Ingestion of groundwater containing metals (arsenic) and ^{238}uranium contributes almost half of this receptor's total risk followed by external exposure to surface soils/pit materials and inhalation of dust. Uranium and thorium isotopes and arsenic are the major carcinogens for these exposure pathways. Other pathways with cancer risk exceeding 1 in 10,000 (10^{-4}) or hazard quotient greater than 1 include: ingestion of food affected by dust; direct contact with soils and pit materials; domestic and agricultural use of groundwater; and ingestion of meat and dairy products from cows grazed and watered on-site.[b]	Removal, treatment (thermal drying) and Off-site disposal at permitted facility
Flyash Piles (OU2)	OU2 consists of the following subunits: the Active Flyash Pile, South Field, Inactive Flyash Pile, lime sludge, and solid waste landfill	The highest total carcinogenic risk (RME on-property farmer) for all of Operable Unit 2 is about 1 in 270 (3.7×10^{-3}). The risks and hazards from OU2 result primarily from the three subunits which contribute most to the ground water contamination (i.e., Active Flyash Pile, South Field, and Inactive Flyash Pile). The major pathway for the carcinogenic risk is soil containing ^{228}thorium, ^{228}radium, and beryllium. The second major pathway is ingestion of water from the Great Miami Aquifer due to the presence of ^{238}uranium.[c]	Off-site disposal of Thorium- Radium contaminated materials and In-Situ or other on-site containment for low hazard waste
Total Soils (all OUs)	Contaminated soils and rubble amenable to or requiring decontamination by treatments such as soil washing prior to disposition (i.e., Soil under OU1 waste pits, waste and contaminated soil excavated from OU2, soil and rubble from OU3, soil from OU4 and OU5)	If this material is treated as proposed, the primary risk will be from airborne dust generated during excavation. The contaminants of concern in soils under the waste pits should be the same as those which leach into the GMA (i.e., arsenic and uranium). For OU2 wastes, the most likely contaminants of concern are ^{228}thorium, ^{228}radium, ^{238}uranium, arsenic, and beryllium. Soil and rubble from OU3 is not well characterized at this time. Contaminants of concern will probably include radium, thorium, uranium, and miscellaneous organics. For OU4 and 5 soils, cancer and noncancer risk are highest to the on-property farmer. The cancer risk for this individual is about 1 in 15 (6.5×10^{-2}) with uranium and arsenic being the contaminants of concern. The primary chemical toxicant is also uranium with a Hazard Index of 270.	Deferred to OU5 Feasibility Study/Proposed Plan

a The information in this column is taken the exposure assessment for the on-property reasonable maximum exposure (RME) resident farmer
b REMEDIAL INVESTIGATION REPORT FOR OPERABLE UNIT 1, Volume 5, Appendix E, section E.7.1
c REMEDIAL INVESTIGATION REPORT FOR OPERABLE UNIT 2, Volume 4, Section 6.3.6, Operable Unit 2 Cumulative Risk

000037

MAJOR AREAS OF CONTAMINATION AT FERNALD (CONTINUED)

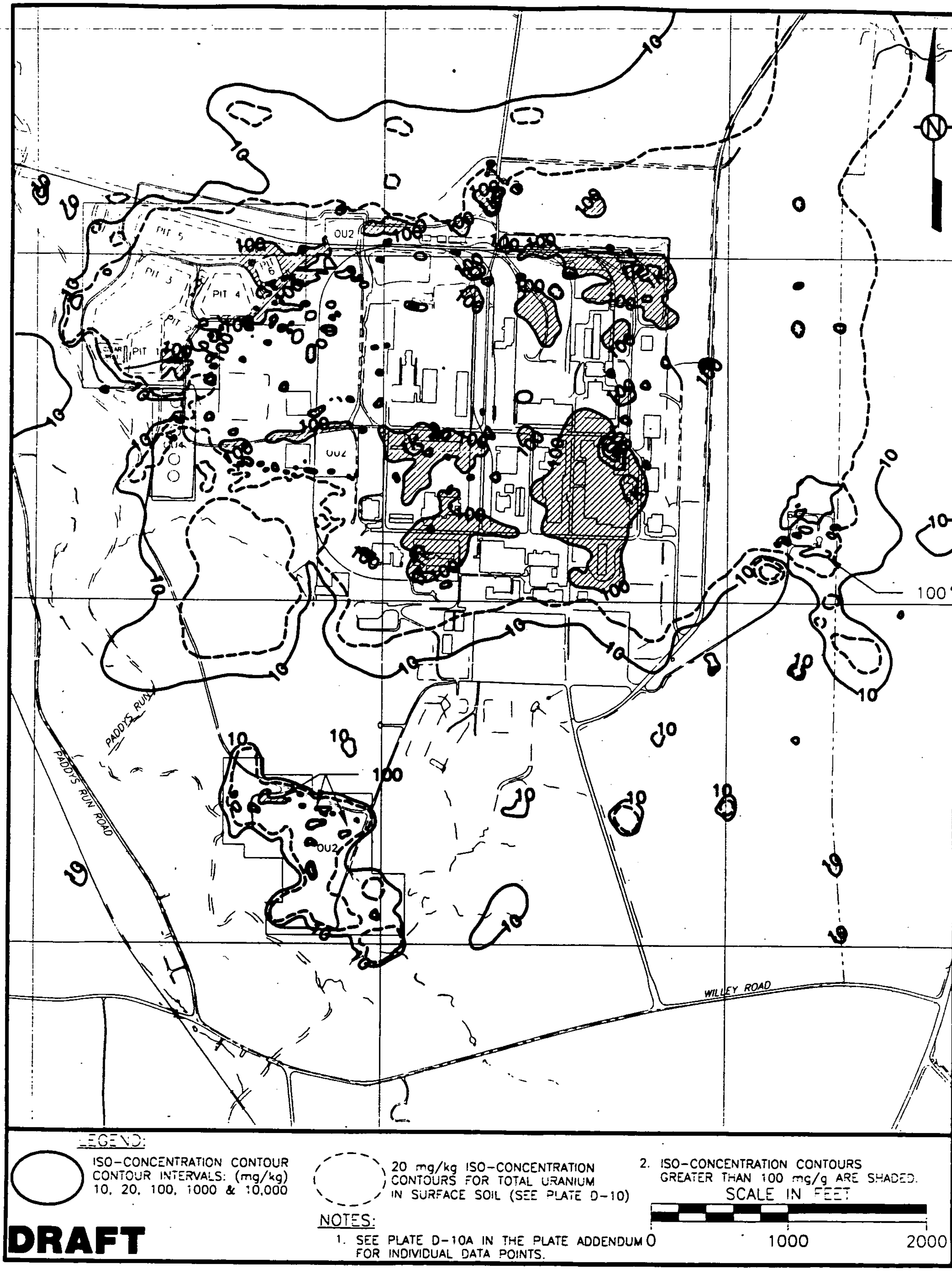
COMPONENTS	DESCRIPTION	PATHWAYS AND CONTAMINANTS OF CONCERN[a]	LEADING REMEDIAL ALTERNATIVE
K-65 Wastes (OU4)	Silo contents, contaminated bentonite clay inside silos used to reduce radon emissions, and decant sump sludge	The Incremental Lifetime Cancer Risk (ILCR) to the RME on-property farmer is 100%. The risk is primarily attributable to ^{226}radium and ^{228}thorium in soil from the external radiation exposure route. The risks contributed by air (about 1 in 20 or 5×10^{-2}) and groundwater (about 1 in 14,000 or 7×10^{-5}) are minor in comparison to soil.[d]	Removal, vitrification, off-site disposal
Structural Debris (OU3 and OU4)	OU4 structural debris (silo 4), OU3 structural debris from Interim Remedial Action (porous, consolidated material not easily decontaminated)	Detailed risk assessment information will not be available until the draft Remedial Investigation (RI) Report is completed on 03/13/96. The major contaminant by volume will be uranium. The prohibition on the disposal of mixed waste (hazardous and radioactive) will require thorough characterization for RCRA hazardous wastes. Short term increases in risk to off-site populations during remediation would occur via air and surface water pathways.[e]	Demolition, removal, on-site storage[c]
Transite (OU3)	OU3 structural debris	Transite is an asbestos containing material. Friable (loose) asbestos would pose the greatest risk to off-site receptors as an airborne contaminant	Dismantlement, interim storage, on-site disposal
Misc. Equipment (OU3)	OU3 Safe Shutdown program	This component is to be secured and place in storage/disposal. Radioactive contamination concentrations may be high resulting in risk from direct radiation. Some components may be associated with hazardous waste management units.	Dismantlement, interim storage, on-site disposal
Metals (OU3)	OU3 structural debris and recyclable materials	This component poses some risk to off-site populations during dismantlement of structures. Additional risk may be attributed to any secondary waste generated during decontamination. After decontamination, this component will be suitable for recycling.	Dismantlement, interim storage, on-site disposal

a The information in this column is taken the exposure assessment for the on-property reasonable maximum exposure (RME) resident farmer
b REMEDIAL INVESTIGATION REPORT FOR OPERABLE UNIT 1, Volume 5, Appendix E, section E.7.1
c REMEDIAL INVESTIGATION REPORT FOR OPERABLE UNIT 2, Volume 4, Section 6.3.6
d REMEDIAL INVESTIGATION REPORT FOR OPERABLE UNIT 4, Volume 3, Appendix D.7
e The OPERABLE UNIT 3 PROPOSED PLAN/ENVIRONMENTAL ASSESSMENT FOR INTERIM REMEDIAL ACTION contains some information on potential contaminants.

CHARACTERISTICS OF KEY FERNALD CONTAMINANTS

KEY CONTAMINANTS	CHARACTERIZATION OF THREAT	HALF-LIFE OR PERSISTENCE	BACKGROUND LEVELS[A]	LEGAL STANDARDS: DRINKING WATER	LEGAL STANDARDS SOIL/OTHER
Uranium	Cancer of the lung and lymphoma; kidney toxicity	^{238}U = 4.5 billion years, decays to lead	^{238}U(+ 2 progeny) = 1.22 pCi per gram of soil	(Proposed)[b]: 20 μg U_{total} per liter (parts per billion) of water (30 pCi per liter)[f]	
Thorium	Cancer of the bone and liver	^{228}Th = 1.91 years ^{232}Th = 14.1 billion years	^{228}Th = 1.43 pCi/g	(Current)[c]: 15 pCi gross alpha activity per liter of water (excluding Rn and U)	
Radium	Cancer of skin and bones	^{226}Ra = 1602 years ^{228}Ra = 6.7 years	^{226}Ra (+5 progeny) = 1.45 pCi/g ^{228}Ra (+1 progeny) = 1.19 pCi/g	(Current): 5 pCi per liter total Radium. (Proposed): 20 pCi per liter each (^{226}Ra and ^{228}Ra)	Soil: 5 pCi total radium per gram (surface) and 15 pCi radium per gram (subsurface)[d]
Radon	Cancer of the lungs	^{222}Rn Effective-Half-Life=30 minutes		(Proposed): 300 pCi radon per liter of water	Air: 20 pCi/-m^2-s emission rate per source[e] (e.g., K-65 silos)
Asbestos	Cancer, asbestosis	Sable		(Current): 7 million fibers per liter	NESHAP-No visible emissions; OSHA PEL-0.2 fibers per cc[g]
Arsenic	Skin cancer (ingestion) lung cancer (inhalation)[h]	Stable	8.45 mg/kg	(Current[c] - under review): 0.05 mg per liter (50 ppb)	
Beryllium	Dermatitis, acute pneumonitis, probable human carcinogen	Stable	0.6 mg/kg	(Current)[c]: 0.004 mg/l (4 ppb)	
Cadmium	Kidney/liver toxicity	Stable	0.82 mg/kg	(Current)[c]: 0.005 mg/l (5 ppb)	
Cobalt	Allergen, pneumoconiosis	Stable			
Organics (e.g., PCB's, PAH's)	Cancer of the skin and stomach	Very persistent	0.00 mg/kg[f]	Chemical specific	

*Footnotes are on the back



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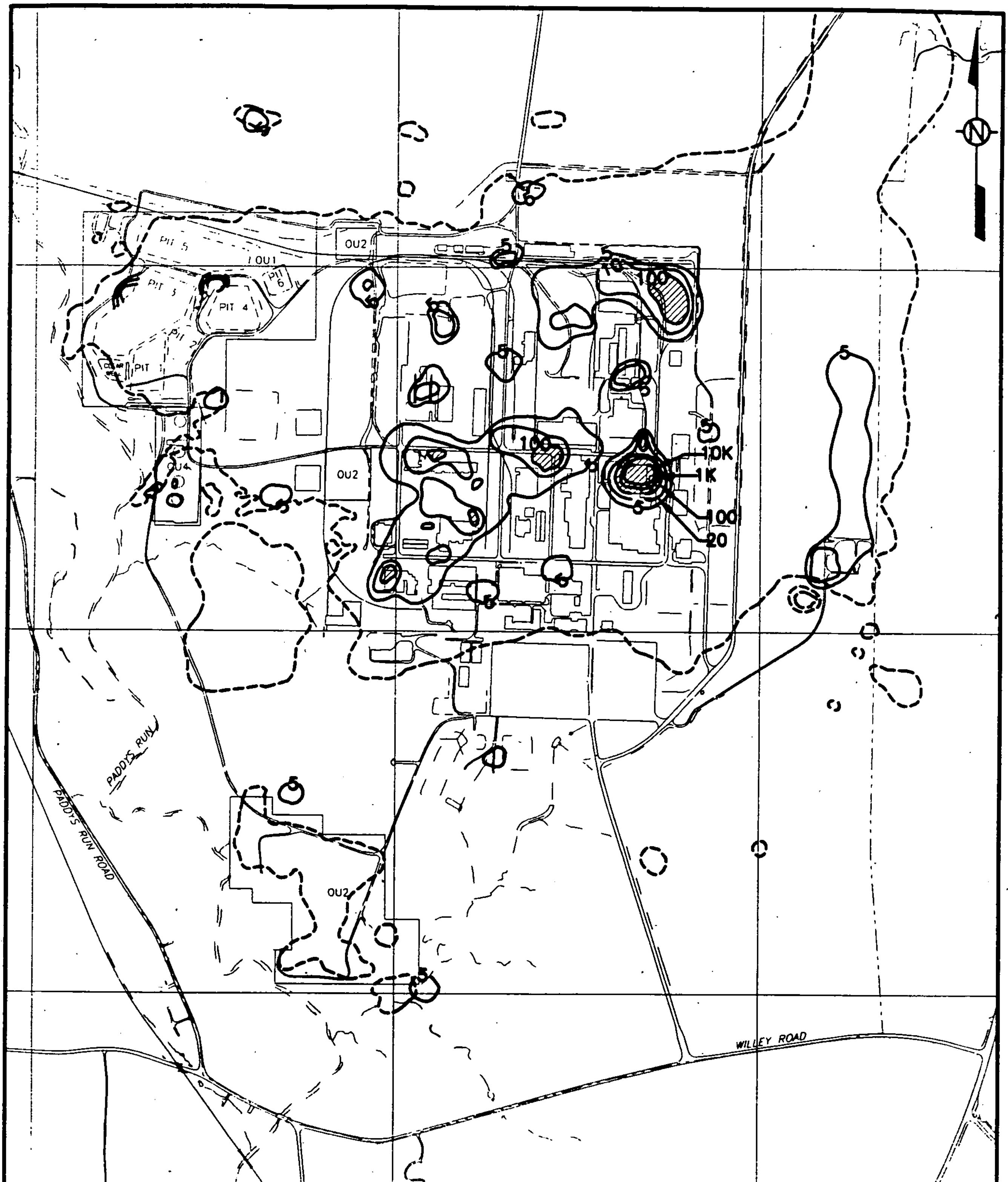
TOTAL URANIUM IN SURFACE SOILS (FIRST SIX INCHES)



LEGEND:

ISO-CONCENTRATION CONTOUR
CONTOUR INTERVALS: (mg/kg)
5, 20, 100, 1000 & 10,000

20 mg/kg ISO-CONCENTRATION CONTOURS FOR TOTAL URANIUM IN SURFACE SOIL (SEE PLATE D-10)

NOTES:
1. SEE PLATE D-15 IN THE PLATE ADDENDUM FOR INDIVIDUAL DATA POINTS.
2. ISO-CONCENTRATION CONTOURS GREATER THAN 100 mg/kg ARE SHADED.

SCALE IN FEET
0 1000 2000

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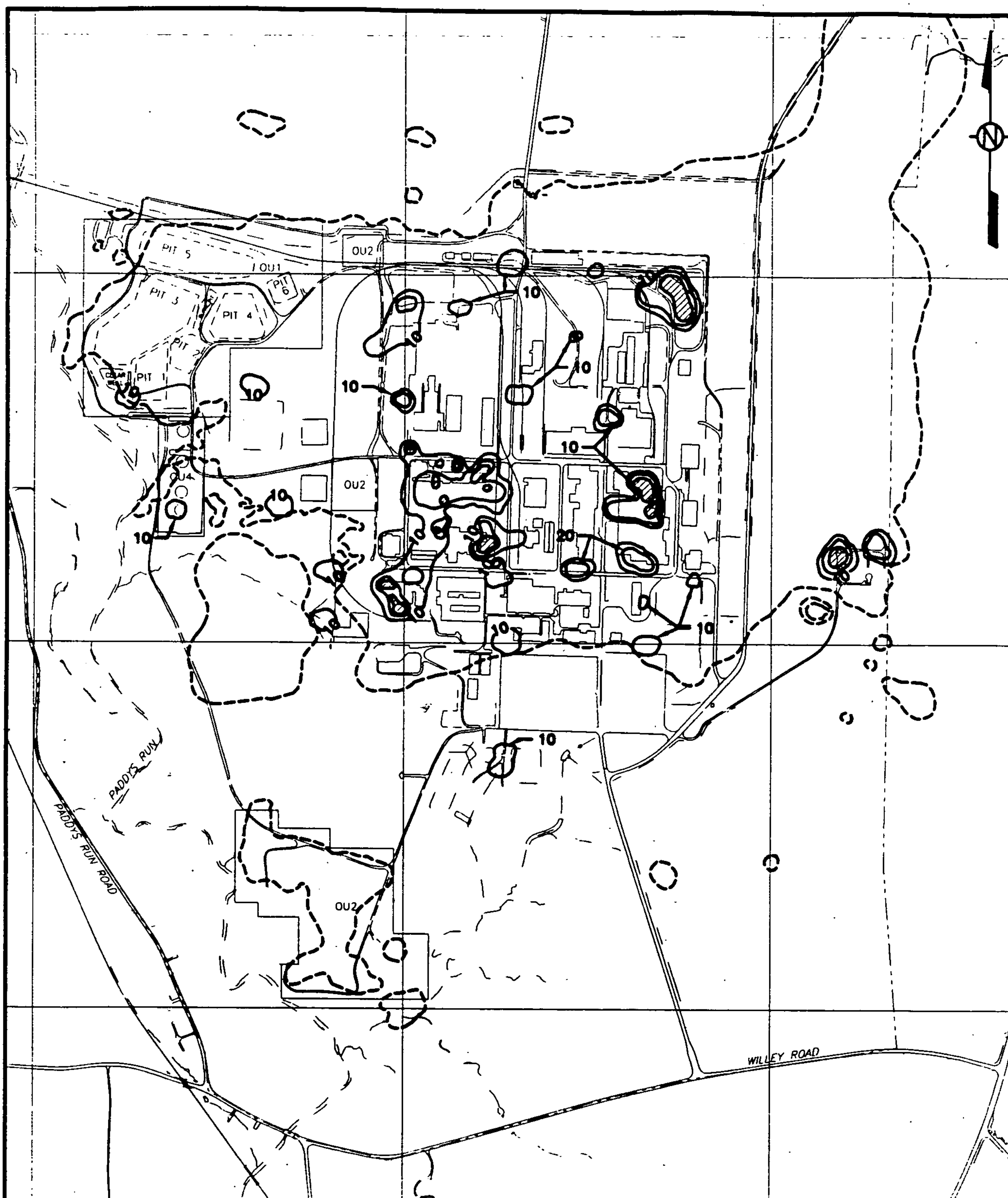
000040

TOTAL URANIUM IN SUBSURFACE SOILS (3'-5')



LEGEND:

ISO-CONCENTRATION CONTOUR
CONTOUR INTERVALS: (mg/kg)
10, 20, 100

20 mg/kg ISO-CONCENTRATION CONTOURS FOR TOTAL URANIUM IN SURFACE SOIL (SEE PLATE D-10A)

2. ISO-CONCENTRATION CONTOURS GREATER THAN 100 mg/kg ARE SHADED.

NOTES:

1. SEE PLATE D-18 IN THE PLATE ADDENDUM FOR INDIVIDUAL DATA POINTS.

SCALE IN FEET

0 1000 2000 FEET

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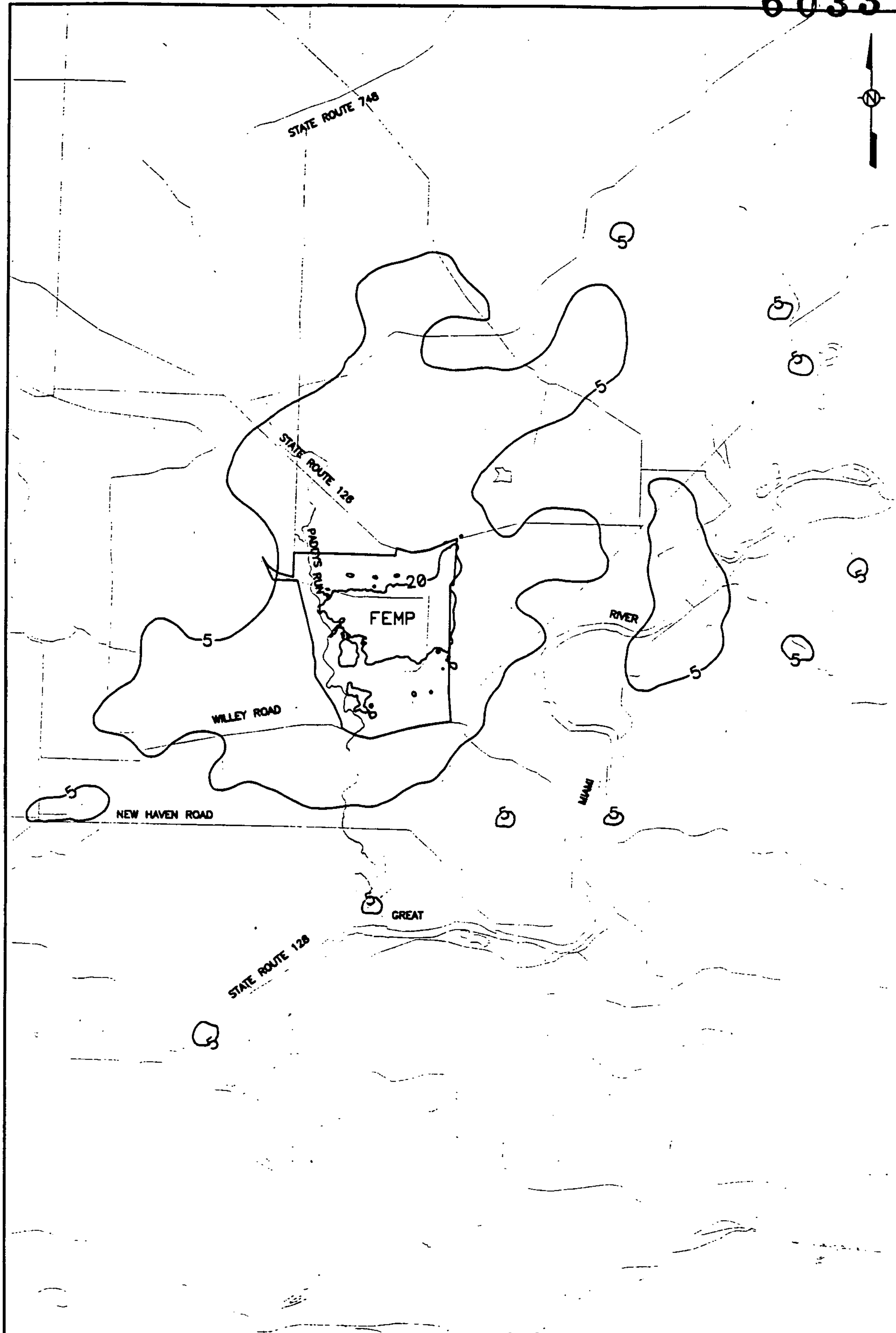
000041

Total Uranium in Subsurface Soils (10'-15')



NOTES

1. 95th PERCENTILE SURFACE SOIL BACKGROUND VALUE 3.73 mg/kg
2. RANGE OF SURFACE SOIL BACKGROUND VALUES 2.56–4.03 mg/kg

LEGEND

5 AND 20 mg/kg ISOCONCENTRATION CONTOUR FOR TOTAL URANIUM IN SOIL

FEMP BOUNDARY

0 4000 [illegible]

SCALE IN FEET

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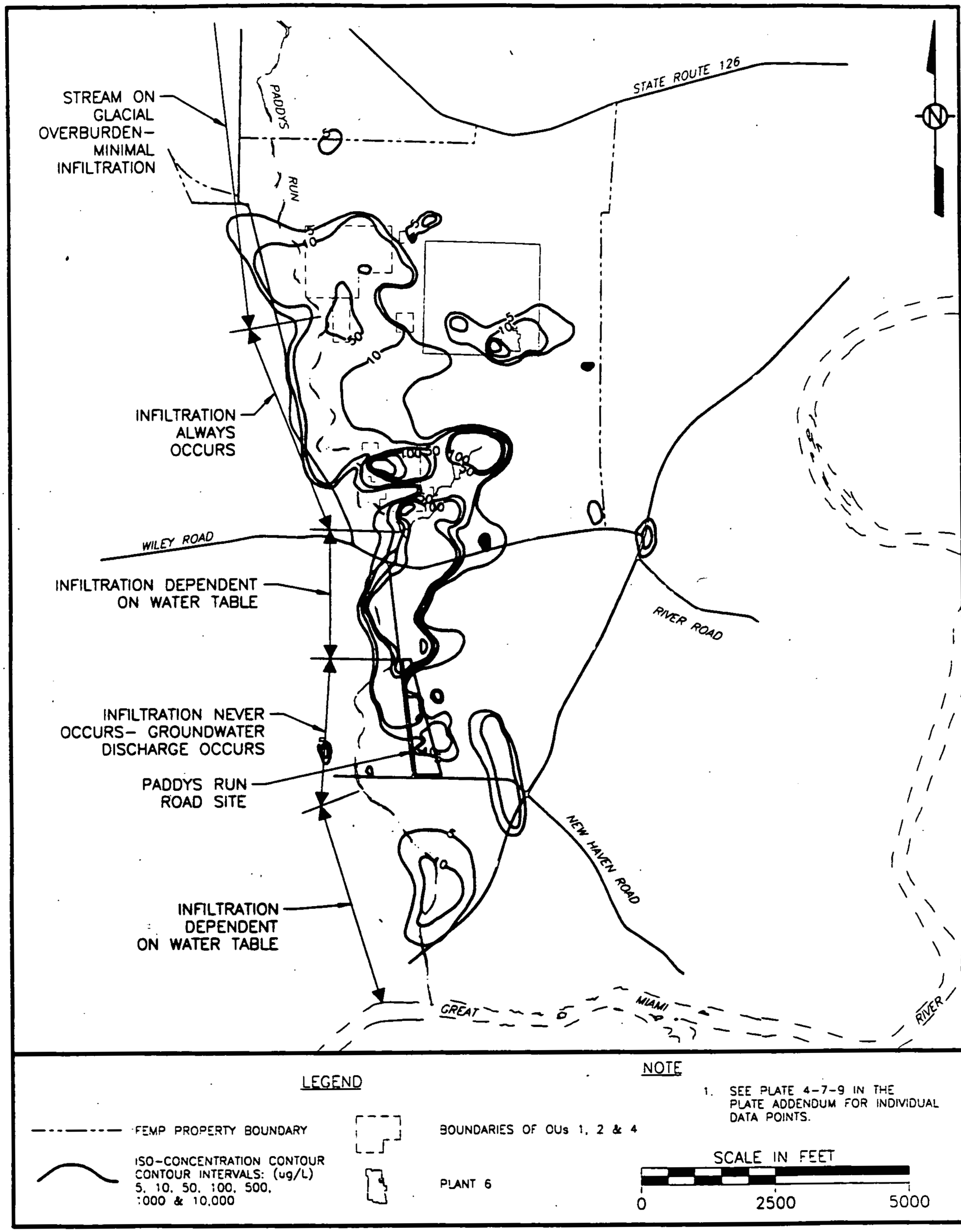
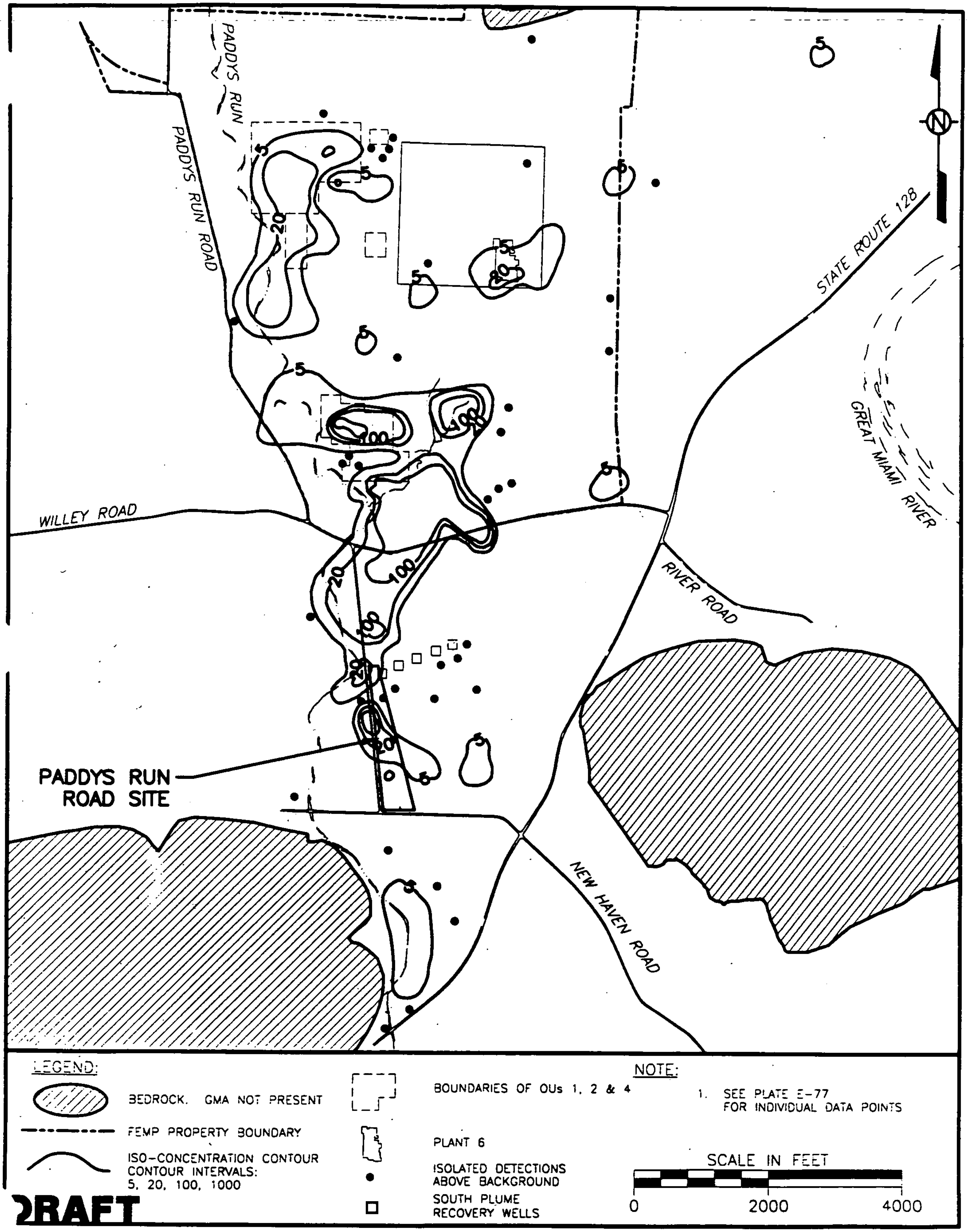
Total Uranium in Off-Site Surface Soils



TOTAL URANIUM IN GROUNDWATER (MAXIMUM OBSERVED CONCENTRATIONS)



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Total Uranium in Groundwater (1993)

OTHER HAZARDOUS MATERIAL STORED AT FERNALD

CHEMICAL NAME	MAXIMUM QUANTITY	PHYSICAL STATE	DESCRIPTION OF HAZARD[1]
Anhydrous Ammonia	250 lbs.	Gas	Acute exposure causes severe burns to any tissue contacted.
Chlorine Gas	1,200 lbs.	Gas	Acute exposure causes irritation of eyes, nose and throat; pulmonary edema; headache; dizziness; etc.
Diesel Fuel	21,200 lbs.	Liquid	Acute exposure causes irritation of eyes, nose and throat; inhalation causes central nervous system depression, chemical pneumonia.
Freon	1,085 lbs.	Liquid or gas	Generally considered non-toxic. May be dissolved in an organic solvent - effects of acute exposure mimic the symptoms of the solvent (i.e., if the solvent is alcohol, symptoms include central nervous system depression).
Hydrochloric Acid	1,100 lbs.	Liquid	Acute exposure causes irritation/chemical burns to eyes, nose and throat; pulmonary edema.
Hydrofluoric Acid (10 %)	5,900 lbs.	Liquid	Acute exposure causes irritation of the eyes, nose, and throat, respiratory system burns; pulmonary edema; lung inflammation.
Magnesium Oxide	106,475 lbs.	solid	Acute exposure causes slight irritation of the eyes and nose.
Methanol	395,120 lbs.	Liquid	Vapors may cause irritation of the mucous membranes, bronchitis, etc.; ingestion (including skin absorption) causes inebriation, headache, dizziness, cerebral and pulmonary edema are possible.
Nitric Acid	20,040 lbs.	Liquid	Acute exposure to vapor causes irritation of the eyes, nose, throat and respiratory system-high exposures can cause pulmonary edema, cyanosis, and death; contact with liquid causes tissue destruction.
Phosphoric Acid	33,960	Liquid	Acute exposure causes irritation of the eyes, nose, and throat, respiratory system burns; pulmonary edema; lung inflammation.
Propane	9,721 lbs.	Liquid or gas	Simple asphyxiant, contact with liquid causes frostbite.
Sodium Hydroxide	254,655 lbs.	Liquid or solid	Acute exposure to dust or vapor causes irritation to eyes, nose, throat, and respiratory system; intense exposures may result in pulmonary edema and pneumonitis.
Sulfuric Acid	88,720 lbs.	Liquid	Acute exposure to vapor causes eye, skin, and respiratory system irritation. Excessive inhalation causes nausea, headache, and even asphyxiation. Chronic exposure has caused kidney and liver cancer in rats.
Unleaded Gasoline	7,944 lbs.	Liquid	Acute exposure causes irritation of eyes, skin, and respiratory tract; inhalation may cause dizziness, nausea, headache, possible unconsciousness; increased liver and kidney cancer in laboratory animals.
Urea	21,859 lbs	Solid	Acute exposure may cause irritation of skin, eyes, throat, and respiratory tract.; Inhalation may cause shortness of breath, headaches and confusion; ingestion causes pain, nausea, vomiting, and irritation.

1 The Description of Hazard comes from the Health Hazard section of Material Safety Data Sheets used at Fernald

RISK OVERVIEW

Risk to human health from the Fernald site results from the potential exposure to hazardous materials that were used during the processing of uranium and other site activities. Materials are considered hazardous if they exhibit one or more of the following traits:

Carcinogenic: resulting in cancer through continued exposure.

Flammable or Explosive: unstable or easily ignited presenting high risks of burns and loss of life.

Corrosive: causing major irritation or damage to body tissues.

Toxic: causing non-cancer illnesses or death.

Hazardous materials have entered the environment surrounding the Fernald production area through airborne distribution, surface runoff, and infiltration to soils and groundwater. Exposure can occur through a number of different routes, all of which must be considered in the evaluation and cleanup of the site:

Inhalation: Contaminants that are suspended in air can be transported by wind and are susceptible to inhalation by humans. Suspension of contaminants was common during operations at Fernald and account for much of the soil contamination away from the production area, however, most radioactive materials at Fernald are relatively heavy and fall out of the air after short distances. Resuspension of contamination will occur during excavation activities during cleanup and controlling this phenomenon will be a significant aspect of all cleanup plans.

Ingestion: The most prominent pathway for ingestion of contaminants at Fernald is from drinking contaminated water from the Great Miami Aquifer. Ingestion of contaminants can also occur from the inadvertent ingestion of contaminated soils or foods.

Direct Contact: Direct contact with some contaminants can cause problems through skin adsorption or skin irritation, however, for most contaminants of concern at Fernald this is not considered to be a problem.

The predominant contaminant of concern at Fernald is the radioactive material uranium, however, there are other hazardous chemicals and materials on site. Three major classes of hazardous materials on site include radionuclides, chemical toxins, and asbestos.

EXPOSURE TO RADIONUCLIDES

Some radionuclides may present risk from chemical toxicity, however, it is the risk of cancer from exposure to radiation that usually dominates risk assessments. Radioactivity occurs when an unstable atom spontaneously decays. This decay can result in three different types of radiation. Not all compounds emit all three types of radiation. Some radioactive materials must be taken inside the body for exposure to radiation to occur while some may occur even when the radioactive materials are outside the body as described below. Radiation from ^{238}uranium decay is predominantly particulate (alpha and beta) with a relatively small percent abundance of gamma emitters.

Alpha Particles (radiation) outside the body cannot penetrate through the outer, dead, layer of skin. However, once inside the body, alpha radiation poses a much higher risk than beta or gamma radiation.

Beta Particles (radiation) cannot penetrate from outside the body to the internal organs and is, therefore, only a threat to shallow tissues such as the skin and outer eyes (cornea) unless ingested. The most energetic beta particles in the uranium decay series cannot travel more than 30 feet in air.

Gamma Rays (radiation) have the characteristic of traveling long distances and penetrating deeply into matter. Gamma radiation can penetrate deep into body tissues and cause injury to internal organs.

EXPOSURE TO CHEMICAL TOXINS

Most chemical toxins present at Fernald must be taken into the body for adverse health effects to occur, however chemicals are present on site representing each of the hazards identified above. Chemicals may enter the body through inhalation, ingestion, injection, and by absorption through the skin.

EXPOSURE TO ASBESTOS CONTAINING MATERIAL (ACM)

Asbestos is a strong, incombustible fiber widely used in the past for fireproofing and insulation. Asbestos-containing materials (ACM) utilized at Fernald includes transite wall and roof panels, some floor tiles, pipe insulation, and loose insulation. Inhalation is the primary route of exposure for asbestos. The term "friable" is often used to identify materials which present a high potential to generate airborne concentrations of asbestos. Friable means capable of being crumbled, pulverized, or reduced to powder by hand pressures. The small, buoyant fibers are easily inhaled or swallowed, causing a number of serious diseases including: asbestosis, a chronic disease of the lungs that makes breathing more and more difficult; and two forms of cancer (1) mesothelioma, a cancer (specific to asbestos exposure) of the membranes that line the chest and abdomen, and (2) bronchogenic carcinoma, a malignancy of the interior of the lung.

EXPOSURE TO MULTIPLE CONTAMINANTS

Interactions between two hazardous materials may have widely varying effects on their combined threat to human health. Some chemicals may be synergistic, resulting in an increased hazard, while others may be antagonistic, actually reducing the hazard when both are present. Current risk science has not fully characterized the relationships between different chemicals and thus these results have not been been adequately quantified for use in risk assessments. At Fernald, risk characterization does not consider antagonistic or synergistic effects and an assumption of additivity is made.

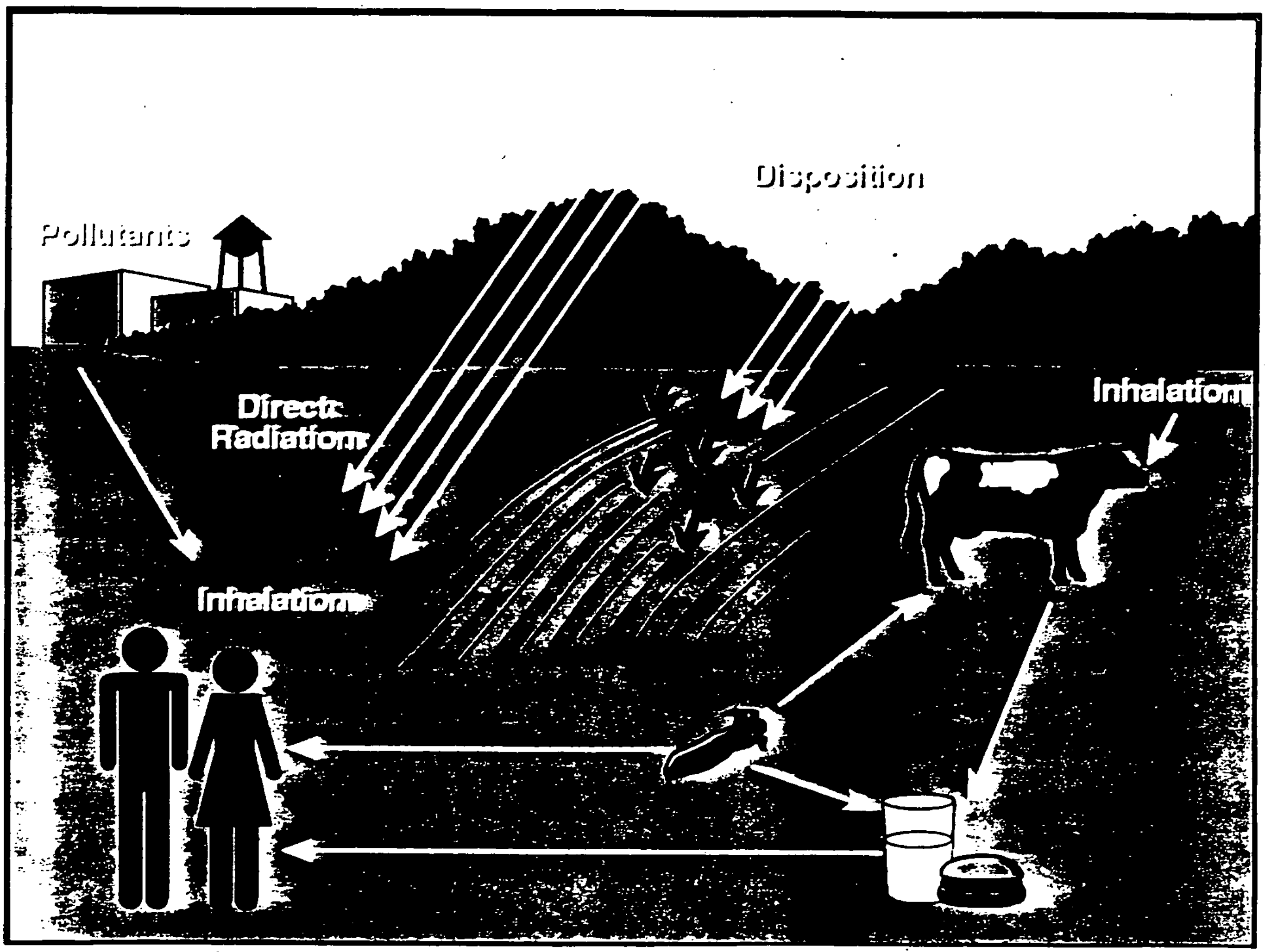
INTRODUCTION TO RISK ASSESSMENT

WHAT IS RISK	Risk is the potential for negative health impact as a result of exposure to contamination. Health impacts are generally classified as carcinogenic or toxic. Carcinogenic risks are quantified as the risk of contracting cancer over a lifetime and are usually stated in exponential notation. For example, a risk of 10^{-6} means that there is a one in one million chance that an individual exposed to a certain contamination at a certain level over a lifetime would contract cancer. Current Superfund regulations consider the range of 10^{-4} to 10^{-6} excess lifetime risk of cancer to be acceptable. Toxic health impacts are non-cancerous illnesses and are quantified using a health index. A health index of 1 or above is considered hazardous. Calculations of risk are used to identify threats and calculate cleanup levels.
HOW RISK IS MEASURED	Risk is a function of how much of a contaminant is present (dose), how dangerous a chemical is to humans (toxicity), how the chemical enters the body (method of exposure), and how often a person is exposed to the chemical (level of exposure): **RISK = DOSE x TOXICITY x METHOD OF EXPOSURE x LEVEL OF EXPOSURE**
DOSE	The dose of a contaminant is represented as the concentration of the compound of concern at the point of human contact. These concentrations may be present in soil, sediments, surface water, ground water, or air. If human contact occurs in more than one of these media, the dose in each case must be taken into account to identify the cumulative risk from the contaminant.
TOXICITY	The U.S. EPA and other government programs have calculated the toxicity of many hazardous compounds. Much of this information is gained from statistical evidence from laboratory tests on animals. Not all compounds have well understood toxicity values. Special consideration is given to receptors that may be especially susceptible to the toxic effects such as children or pregnant women.
METHOD OF EXPOSURE	Exposure to contamination may occur from many pathways including direct ingestion from air inhalation, water consumption, accidental consumption of soil or wind blown particulates, or eating contaminated foods. Exposure can also occur through direct contact with contaminants resulting in radiation or dermal (skin) absorption.
LEVEL OF EXPOSURE	The level of exposure is defined by the activities taking place at the point of exposure. Components of the level of exposure include the amount of time (e.g., hours per day of direct exposure), or volume (e.g., liters of water consumed per day).

Significant Pathways and Receptors for Contamination at Fernald

PATHWAYS	ON-PROPERTY RESIDENTS	OFF-PROPERTY RESIDENTS	VISITOR	GROUNDS KEEPER	TRESPASSER	GMR USER	HOME BUILDER	OFFSITE USER OF MEAT/ MILK PRODUCTS
Inhalation of Dusts	Yes	Yes	Yes	Yes	Yes		Yes	
Inhalation of Radon	Yes							
Ingestion of Soil/Sediment	Yes			Yes	Yes	Yes	Yes	
Ingestion of Drinking Water	Yes	Yes						
Dermal Contact with Soil/Sediment	Yes			Yes	Yes	Yes	Yes	
Irradiation from Soils and Sediments (Outdoors)	Yes		Yes	Yes	Yes	Yes	Yes	
Ingestion of Homegrown Fruits and Vegetables	Yes	Yes						
Ingestion of Meat and Milk	Yes	Yes						Yes

Potential Air Pathways for Contamination at Fernald



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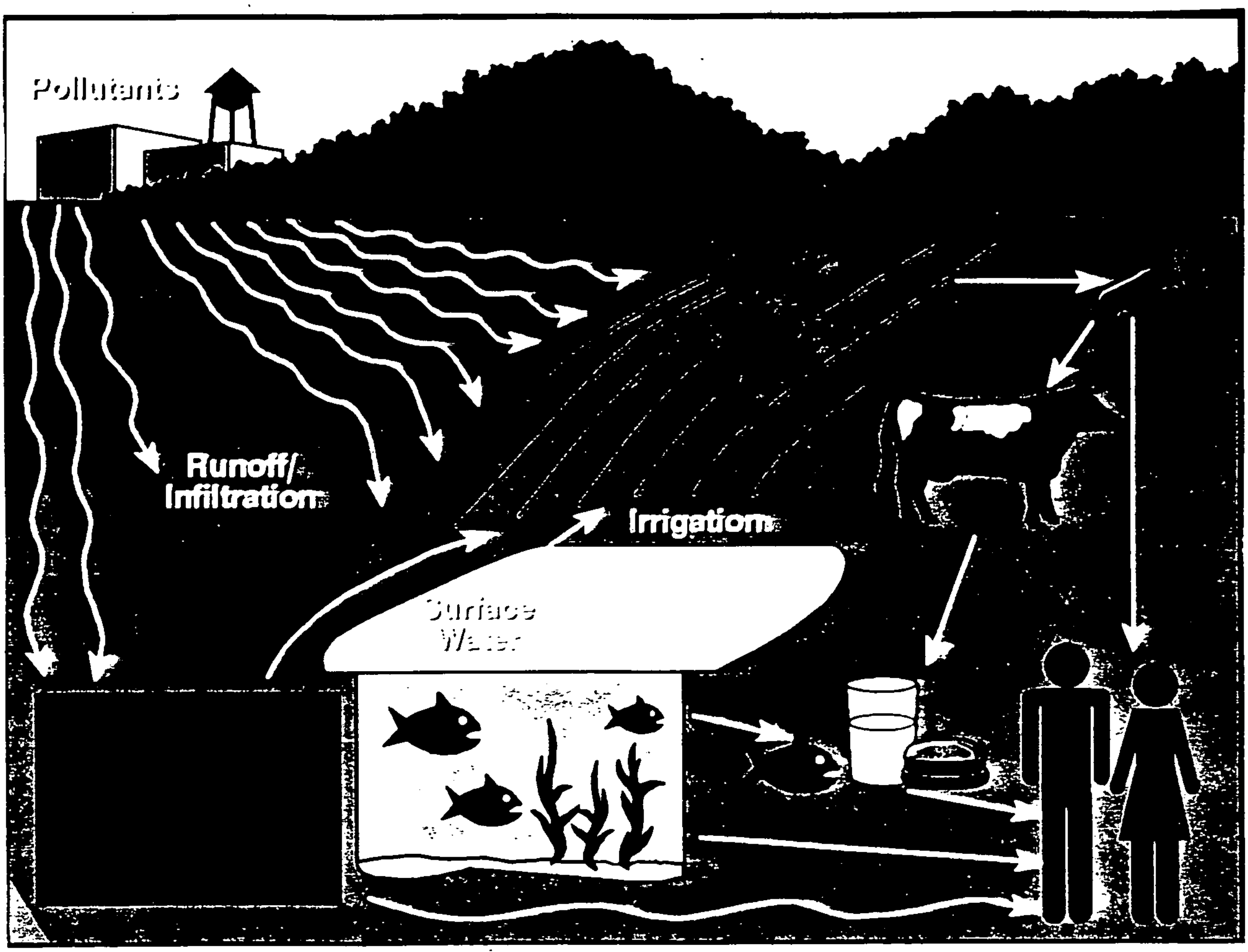
Potential Water Pathways for Contamination at Fernald



Short-Term Risk Summary

SOURCE	CONSEQUENCES	RECEPTOR	PATHWAYS	MITIGATION TECHNIQUES	MITIGATION EFFECTIVENESS
Waste hauling vehicles	Physical effects[a]	Public along the transportation route	Public highways and railways	Minimize off-site shipments, use alternative conveyance	Transfers risk to other receptors, pathways, and time frames; high-volume conveyance may reduce risk
Waste handling equipment and material	Physical effects[a]	On-site and off-site workers	All related activities	Engineering controls, safety training, minimize distance	Real reduction in risk; minimizing waste volume changes short-term to long-term problem
Resuspended material and contaminated soil, radon	Increased cancer risk from inhalation of radionuclides	On-site nonremediation worker, near-property resident	Inhalation	Dust control: capture; removal; suppression and encapsulation	Feasibility and effectiveness depends on project size and duration
Handling of radioactive material and contaminated wastes on site	Increased cancer risk from radiation	On-site remediation worker	Inhalation, direct contact	Engineering controls, minimize distance, shielding	Real reduction of risk, consistent with occupational health and safety
Handling of radioactive material and contaminated wastes off site	Increased cancer risk from radiation	Off-site workers and public along transportation route	Inhalation, direct contact	Reduced volume of off-site disposal	Transfers risk to other receptors, pathways and time frames
Resuspended contaminated soil/materials, volatile chemicals	Increased cancer risk from chemical inhalation	On-site nonremediation worker, near property resident	Inhalation (no respiratory protection device)	Control of fugitive emissions, capture; suppression, and encapsulation	Feasibility and effectiveness depends on project size and duration
Resuspended contaminated soil/materials, volatile chemicals	Chemical toxicity	On-site remediation workers, near-property resident	Inhalation (no respiratory protection device)	Control of fugitive emissions, capture; suppression, and encapsulation	Feasibility and effectiveness depends on project size and duration
Removal of asbestos-containing material	Increased risk of asbestosis and cancer	On-site remediation worker	Inhalation	Engineering controls, personal protective equipment, training	Able to reduce risk to acceptable levels

a Physical effects include injuries and fatalities and are assumed to be proportional to the number of hours that an activity is performed. Historical data indicates the risk of fatalities is much lower than the risk of injuries.

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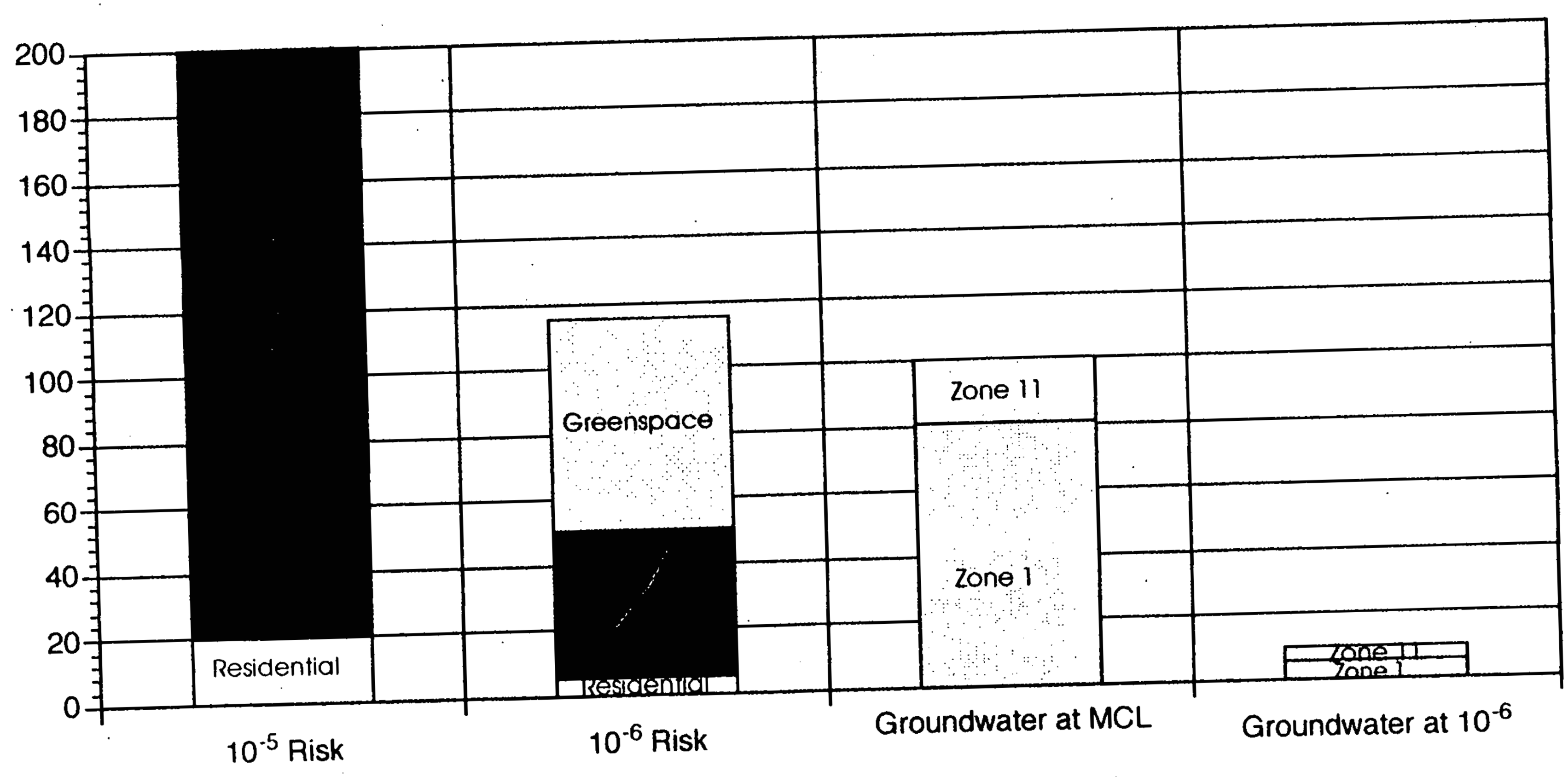
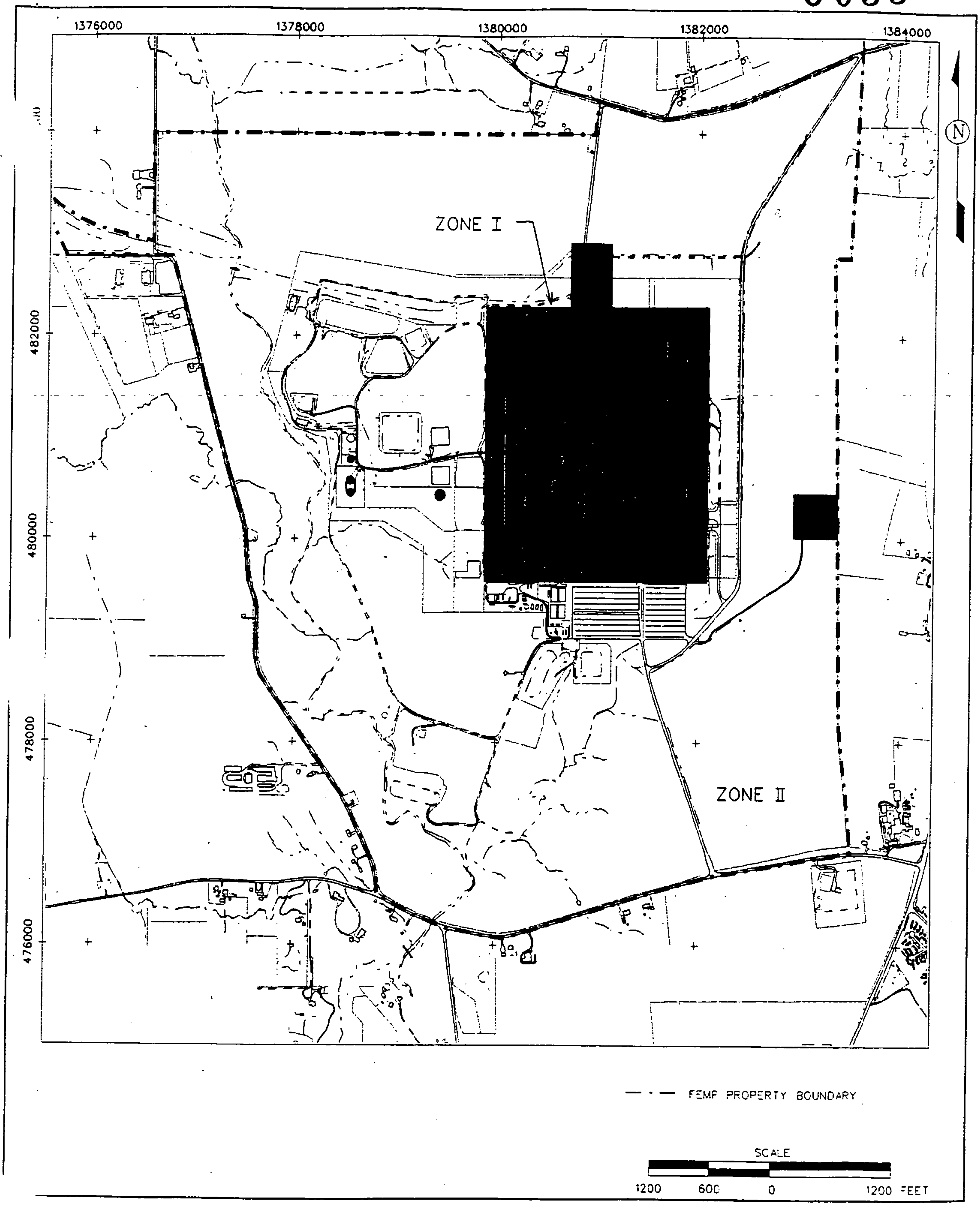
KEY CHARACTERISTICS OF LEADING REMEDIAL ALTERNATIVES FOR SOURCE COMPONENTS

Pit Sludges (OU1)[c]	780,000	Off-Site Disposal at Envirocare	780,000	39,000	0	0	$513,050
Flyash Piles (OU2)[d]	250,300	On-Site Disposal	3,600[e]	180	246,700	10	$64,429
K-65 Wastes (OU4)[f]	13,995	Vitrify and Off-Site Disposal at NTS	13,995	700	0	0	$101,052
Structural Debris (OU3, OU4)	114,511	On-Site Disposal	0	0	114,511	5	$41,678
Transite (OU3)	1,800	On-Site Disposal	0	0	1,800	0.1	$655
Misc. equipment (OU3)	86,066	On-Site Disposal	40,930	2,047	45,136	2	$49,829
Steel (OU3)	2,242	Recycle and On-Site Disposal	7,700	112	0	0	$1,830
TOTALS			846,225	42,039	408,147	17.1	$772,523
Off-Site Soil Volumes at 10^{-5}	190,000	On-Site Disposal				8	$69,160
Off-Site Soil Volumes at 10^{-6}	5,200,000	On-Site Disposal				208	$1,892,800

a assumes 20 cubic yards per truckload
b assumes 25,000 yd3 per acre
c includes soils from cap and liner
d includes the solid waste landfill, lime sludge ponds, active and inactive flyash piles
e includes waste that does not meet waste acceptance criteria for on-site cell
f includes bentonite grout, sludge, dry waste and water.

Comparison of Soil Cleanup Levels (in ppm)

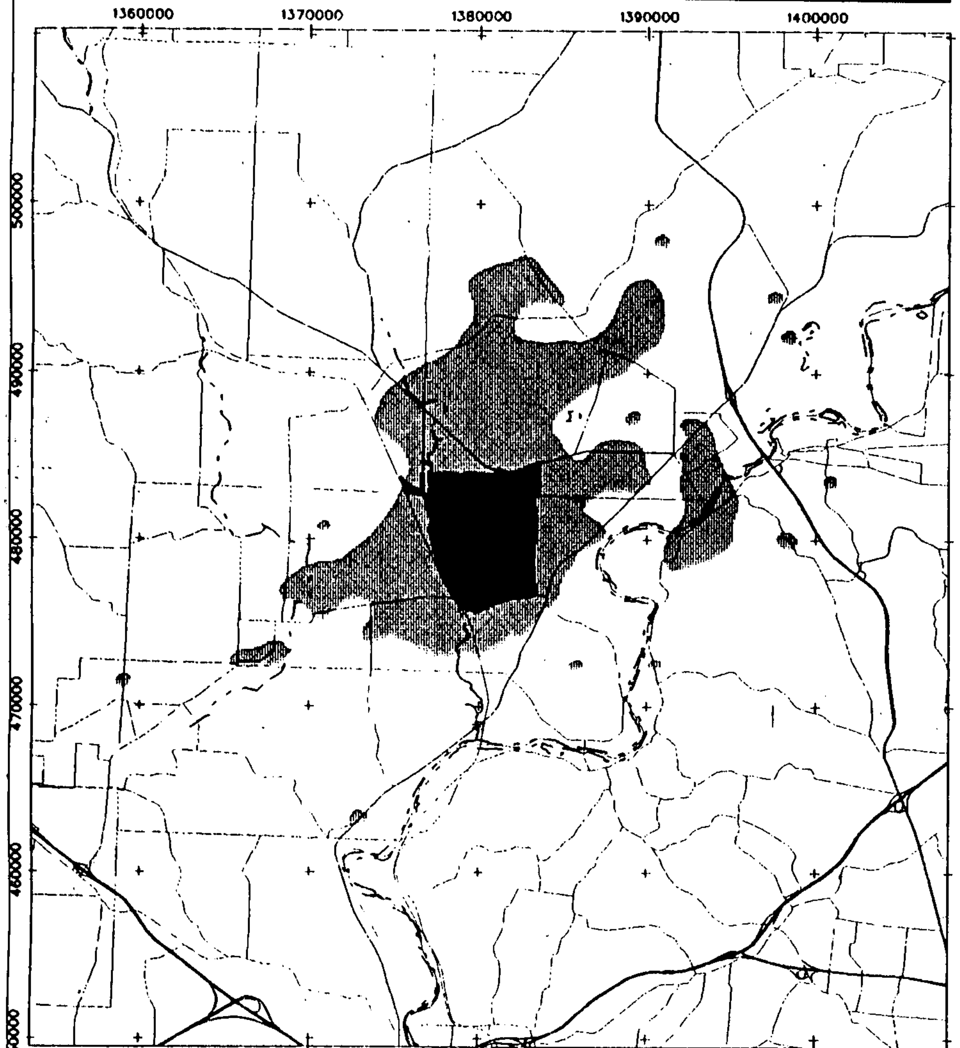




GROUNDWATER PROTECTION ZONES

VIII-3

OFF-SITE SOILS REQUIRING REMEDIATION AT 10-6 RISK

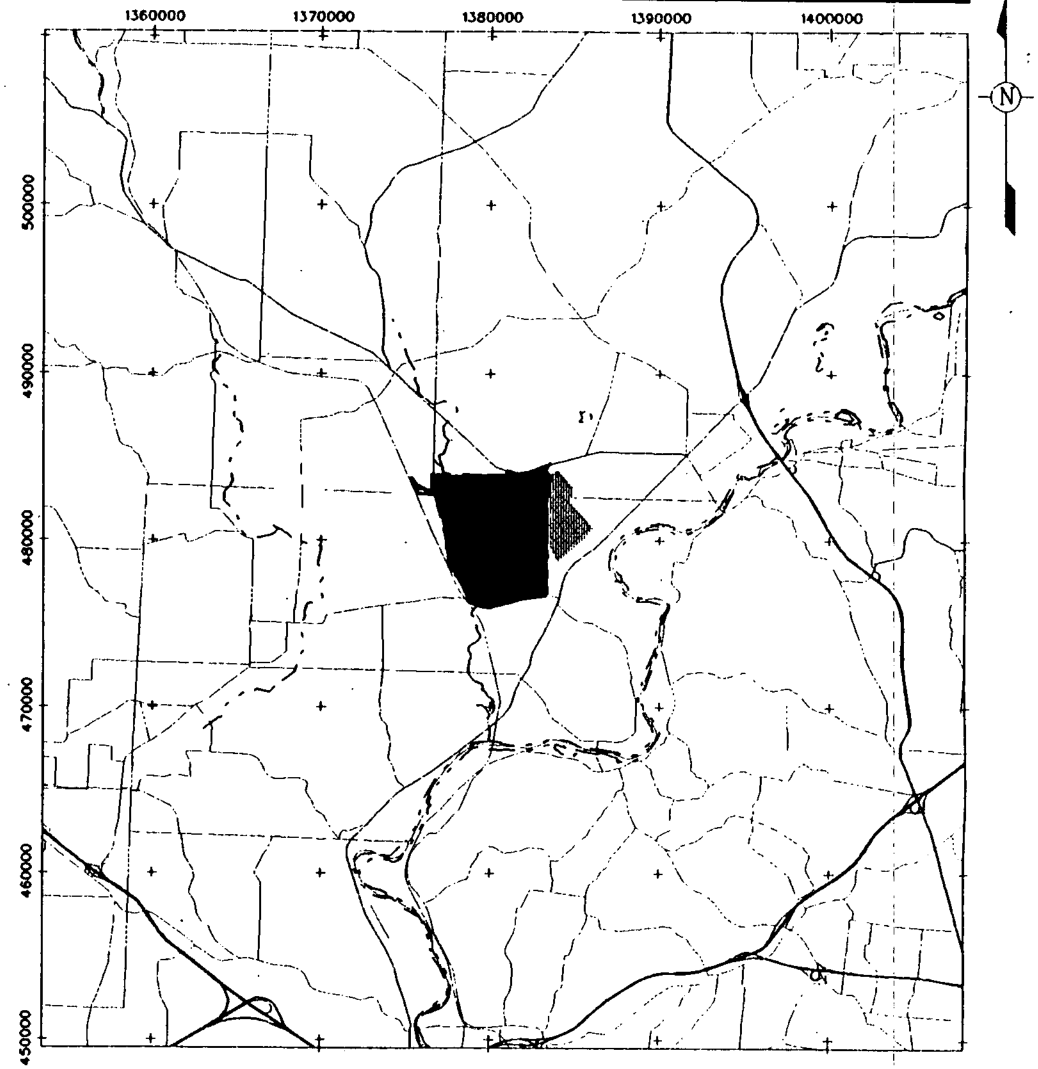


LEGEND:

10[-6] RISK EXCAVATION FOOTPRINT (5,020,000 yd.^{3})

— - - — FEMP BOUNDARY

OFF-SITE SOILS REQUIRING REMEDIATION AT 10-5 RISK



LEGEND:

10[-5] RISK EXCAVATION FOOTPRINT (190,000 yd.^{3})

— - - — FEMP BOUNDARY

SCALE

9000 4500 0 9000 FEET

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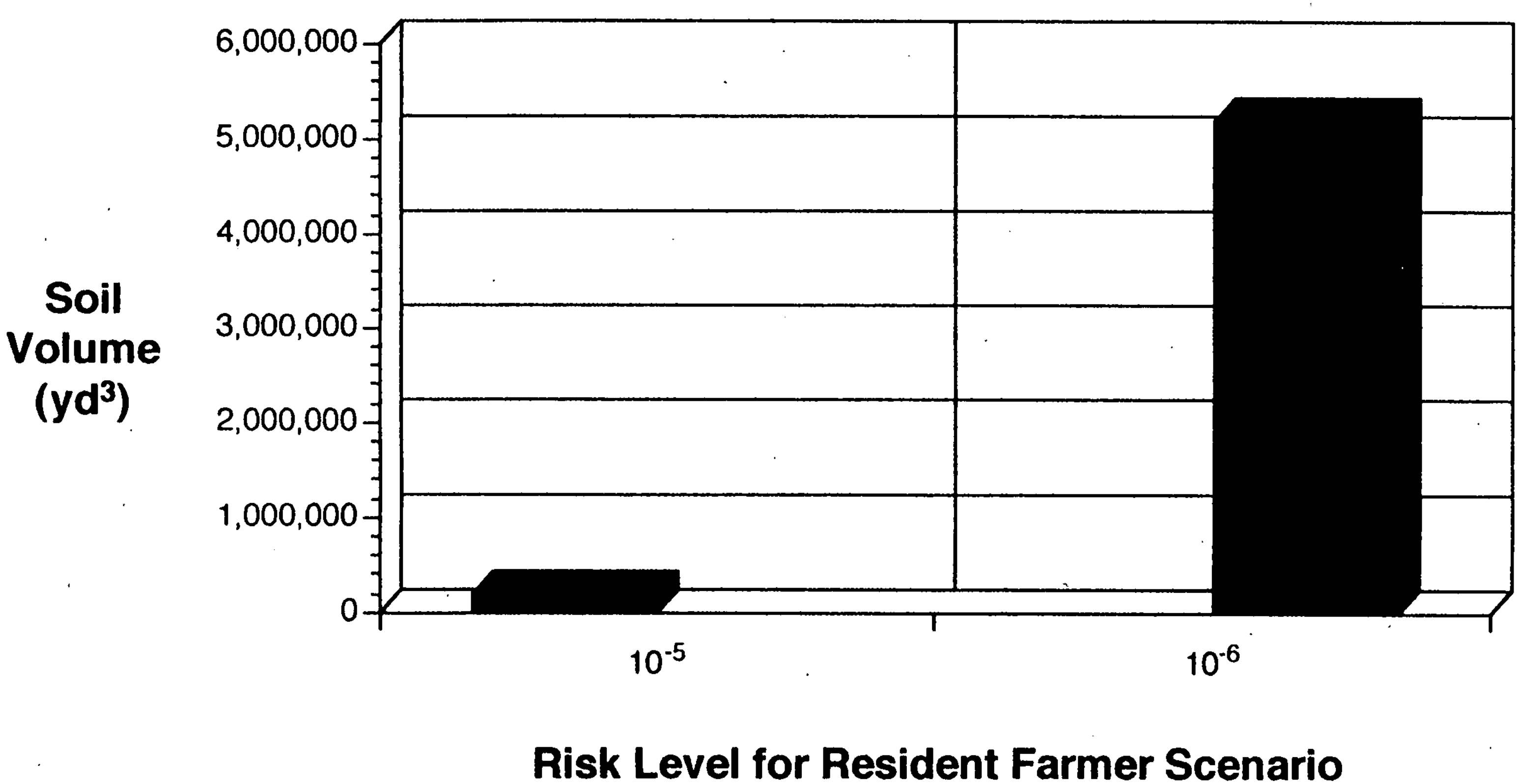
Comparison of Off-Site Soil Volumes at 10^{-5} and 10^{-6} Risk



OVERVIEW OF WASTE MANAGEMENT TECHNOLOGIES

The management of radioactive materials differs from other chemical hazards in that most radioactive materials cannot be destroyed. Thus, the challenge to cleanup and management of most radioactive materials is to find the safest and most effective way of storing the material while natural decay reduces the radioactivity of the material to acceptable levels. For ^{238}Uranium with a half life of 4,500,000,000 years, this effectively means storing the material in perpetuity. There is really only one solution: storage. The key issues then become *how* to store the material and *where* to store the material. In addition, depending on where the material is located and its physical state, technologies which stabilize or concentrate the contamination may be appropriate. Stabilization technologies such as vitrification and cementation, are used to reduce the mobility of radioactive materials and improve the handling properties for transport and disposal. It is important to note that these technologies do not reduce the radioactivity of the materials. Concentration technologies such as soil washing and thermal drying are useful when a radionuclide is present in soil or sludge at varying concentrations. By concentrating the contamination into a smaller volume of material, the cost and size of disposal cells and transportation requirements can be minimized. Storage, stabilization, and concentration options under consideration at Fernald are discussed below.

VITRIFICATION

Vitrification is a treatment process that converts contaminated materials into a chemically inert and stable glass and crystalline product that has extremely durable mechanical and chemical properties. The high temperatures utilized in the process will destroy organics and fix metals into the nonleachable stabilized melt. In vitrification, the waste mixture must have sufficient mineral content to form the glassy/crystalline matrix. If the waste is low in silica or alumina compounds, they may be added in the form of sand or soil. While there are several proven methods for vitrification, the one most appropriate for FEMP waste utilizes a ceramic lined melter with large submerged plate electrodes and relies on the conductivity of the molten glass. This technology has been used quite extensively for the treatment and disposal of high level nuclear waste.

Vitrification, as a waste stabilization method, has the advantage of operating as a closed system. The feed, limited to 4 inches, is gravity fed on a conveyor into the reactor. The waste is destroyed at a nominal temperature of 3000° F. The off-gas and particulates are drawn off by an induction fan and treated through a cyclone, a baghouse, and an acid gas scrubber. Solid waste is withdrawn from the lower section of the chamber via separate molten glass and metal taps. Both particulate and gas streams can be recycled to the reactor. The residue streams from the vitrification unit are molten metal, scrubber water, and off-gas. The concentration of hazardous constituents in the residuals are such that further treatment is not required.

After organic contaminants are destroyed by the process, the residual solids are fluxed into the molten glass. The residual solids (such as ash and heavy metal oxides) and nontoxic solid components such as silica, alumina, and lime, are incorporated into the glass and become part of its matrix. The degree to which the residual contaminants are retained in the molten glass during processing is dependent upon the type of molten-glass process, the processing conditions, and the chemical elements comprising the glass.

The final product is generally reduced in volume by factors of from 2 to 100, depending on the soil characteristics and product quality requirements. When cooled, the inorganics, metals and radionuclides remain fixed and immobilized in a glass matrix that does not dissolve in water, has high leach resistance, and exhibits strength properties better than those of concrete. The glass possesses hydration properties similar to those of obsidian, which hydrates at rates of less than 1 mm/10,000 years. At these rates, the life of the glass matrix can be expected to exceed 1 million years.

The Battelle PNL has provided preliminary screening of the vitrification process as a satisfactory method for stabilizing the contents of the silos. This method is based on well-developed technologies from commercial metal and glass melting industries.

CEMENTATION

There are four primary goals of cementation:

- Improve the handling characteristics
- Improve the physical characteristics
- Decrease the surface area across which the transfer or loss of chemical constituents can occur
- Limit the solubility of any contaminants contained in the waste.

Cementation immobilizes hazardous constituents in waste by incorporation of it into the structure of the solidified material. In typical cases the process utilizes water additives and pozzolans such as fly ash, kiln dust, or cement to solidify solids and sludge containing organic and inorganic chemical. The final product is monolithic material with structural strength and significantly reduced leaching potential.

Most waste that is in a slurry form can be mixed directly with cement. The suspended solids will be incorporated into the solidified matrix. This process is especially effective for waste with high concentrations of heavy metals, since most mulivalent cations are converted into insoluble hydroxides or carbonates at the pH of the cement mixture. Metal ions may also be incorporated into the crystal structure of the cement minerals that are formed. Materials in the waste such as sulfides, asbestos, latex, and solid plastic wastes may actually increase the strength and stability of the waste concrete.

The presence of certain compounds in the waste and the mixing water can be detrimental to the setting and curing of the mixture of waste and cement. Soil components, such as organic materials, silt, clay, or lignite, may delay the setting and curing of common cement for several days. All insoluble materials passing through a 200 mesh sieve are undesirable, as they may coat the larger particles and weaken the bond between the particles and the cement. Soluble salts of manganese, tin, zinc, copper, and lead may cause large variations in setting time and significant reduction in physical strength. Other compounds that retard the setting of cement, even at low concentrations, include sodium salts or arsenate, borate, phosphate, iodate, and sulfide. Materials containing large amounts of sulfate not only retard the setting of cement but, by reacting to form calcium sulfoaluminate hydrate, they cause swelling and spalling in the solidified waste containing cement. If nitrates are present they may interfere with this process as well.

SOIL WASHING

Soil Washing is a process whereby a solvent (water or acid) is introduced to contaminated soil, mixed, and then decanted from the soil to remove one or more contaminant and isolate them from the soil. Similar technologies have been used extensively in the mining industry to extract uranium from mineral ores. Removal efficiency depends on the characteristics of the soil and type of contamination. While volatile organics can be removed with up to 90 percent efficiency, semivolatile organics and inorganics will be removed with less efficiency. Cleanup levels to support unrestricted or residential land uses are not likely to be achieved. Soil washing will contain concentrated contamination which can then be treated. The eventual waste disposal volume may be significantly less than the original soil volume. The remaining fraction will contain a major portion of the original soil volume and could be returned to the excavation site as backfill depending on the removal efficiency achieved and selected future land use.

Mineral acids are the likely agents to remove radionuclides at Fernald. Mineral acids dissolve constituents into the liquid phase for subsequent separation. Hydrochloric, nitric, and sulfuric acids have been used for uranium, thorium, and radium extraction from ores and soils. Supplemental chemical additives, such as inorganic salts and/or oxidizing agents, have been used with mineral acids to improve extraction efficiency for specific radionuclides. The acids and other chemicals utilized in soil washing may present additional hazards which need to be considered in design and operation.

THERMAL DRYING

The waste materials are dried by processing through equipment designed to apply heat and remove the water and other liquids. Drying reduces the volume of waste but does not have a significant effect on the toxicity, mobility, or volume of contaminants. Some drying processes can handle large volumes of waste–in the range of tons per day.

One type of drying facility potentially suitable for processing the large quantities of material at Fernald is a rotary kiln. Rotary kilns are capable of processing solids, sludges, slurries, liquids and solids simultaneously. The flow of material through a rotary kiln is determined by the kiln's slope and rotation speed, as well as by the characteristics of the waste material being processed. Mechanical tumbling of the waste material in the rotary kiln–similar to that of a clothes dryer–exposes the wet material to continuous and uniform heat.

As the material moves through the kiln, surface water and any absorbed moisture evaporates before the dried material is discharged. The kiln is installed on a slight slope so that the bed of solids advances through the kiln by the force of gravity.

Also being considered for utilization at Fernald are flash dryers, spray dryers, and multiple hearth dryers.

ON SITE DISPOSAL

The on site disposal option will utilize an engineered facility that, depending on the characteristics of the materials to be disposed of, satisfies the requirements for disposal of low-level radioactive waste or mixed waste. Conceptually, the disposal facility includes the following design features:

- Multilayered cap system - including vegetative soil layer, geotextile, high permeability drainage layer, intruder barrier (roller compacted concrete), low permeability clay layer, and common fill;
- Solidified waste forms;
- Multilayered liner system - including reinforced concrete mat (beneath the waste forms), high permeability drainage layers (2 layers in the liner system), low permeability clay layers (2 layers in the liner system), and geotextile; and
- Leachate collection and detection systems.

The disposal facility is intended for permanent waste disposal purposes with a design life of 1,000 years. The structure is designed to withstand high-intensity earthquakes and severe weather conditions; e.g., tornado, snow, and rainwater intrusion. It can accept unsorted low-level radioactive or mixed waste in bulk and/or containerized forms. Hydrogeological investigations and siting studies are underway to identify the best on site location for the disposal facility.

OFF SITE DISPOSAL

The contaminated soils and sediments may be transported to a regulated disposal facility such as the Nevada Test Site (NTS), Envirocare, or Portsmouth for permanent disposal. As a condition of NTS disposal, no untreated wet, raw waste, or free liquids will be accepted. An additional NTS requirement is that the waste can be characterized as either mixed or low-level radioactive waste. If identified as mixed waste, it will only be accepted in a solidified form. Radioactive waste from Fernald is currently shipped to NTS; however, depending on the level of uranium in the material and whether any organics are present, the soil could qualify for disposal at other low-level disposal facilities in closer proximity to Fernald. Waste transport may be provided by truck or railroad and packaged in low specific activity (LSA) boxes.

Comparison of Waste Management Options

Waste Mgmt Options	Waste Component	Effectiveness	Long Term Reliability and Operational Requirements	Potential Risk During Remediation	Relative Cost
Vitrification	Contents of Silos, Pit Waste, Dirty Fraction from soil washing (on site only)	Very effective in stabilizing wastes. Significantly reduces mobility of radionuclides and inorganics by binding into a glass-like matrix. Destroys organics. Reduces radon emissions by fusing material into nonporous glass. Considered to be an innovative technology and best demonstrated available technology for high-level nuclear waste. Volume reduction by factors of from 2 to 100 may be achieved. Although very stable, vitrified waste is still radioactive, and may be higher in activity than the original waste stream before volume reduction.	The non-crystalline solid is very effective for reducing the leachability of the contaminants from the waste form. Radioactive waste must still be disposed. The vitrified waste exhibits strength properties better than those of concrete. Waste form has properties similar to many minerals and will remain stable for very long periods of time.	Potential for gamma radiation exposures during material handling and processing will require shielding and/or remote operations. Potential for radon releases prior to solidification of the vitrified waste, for volatilization of organics prior to thermal destruction, and for release of metals and radionuclides during high heat melt.	High capital cost and unit cost for processing, but volume reduction results in lower disposal costs.
Soil washing	Soil	Reduces radionuclides, metals, and organics concentrations. Reduction of radionuclide concentrations to free-release or residential levels may not be achievable.	Concentrated contaminants in "dirty" fraction will require disposal as low level radioactive waste. Process will generate wet waste which require further processing/drying prior to disposal.	Industrial accidents; air and liquid waste streams; worker exposure during processing. Acids or other chemicals used as extractants may pose hazards.	Moderate

Comparison of Waste Management Options (Continued)

Waste Mgmt Options	Waste Component	Effectiveness	Long Term Reliability and Operational Requirements	Potential Risk During Remediation	Relative Cost
Cementation	Contents of silos, Pit Waste, Dirty Fraction from soil washing (on site only)	Cement is mixed with the waste using equipment that is similar to that used in the concrete industry. It includes a feed system, mixing vessels, and a curing area. The solidified mass significantly reduces mobility of radionuclides, metals, inorganics and organics. The process may cause an increase of the waste volume up to 150% depending on characteristics of the waste stream. Flyash and/or waste water could be used in the process, thereby providing a means for disposal of other waste as well. If will facilitate storage, transportation and disposal.	A relatively new application of an existing process but has not been proven, long term stability and leachability are not strongly documented. Could be an effective interim step if approval of off-site disposal is not obtained. In the future may have to remove and ship off site for disposal. Immobilizes but does not destroy wastes, long-term disposal still required.	During processing the handling of the soil could cause airborne dust leading to exposure to workers.	Moderate
Thermal Drying	Pit wastes	Drives off moisture, thereby enabling waste to meet disposal facility acceptance criteria. Does not significantly alter toxicity, mobility, or volume of contaminants. A slight reduction in volume would result from reducing the moisture content and void ratio. Not adversely impacted by the heterogencity of the waste pit contents.	Contaminants are not physically or chemically fixed in the waste matrix.	Drying is a commonly applied technology throughout various industries therefore the risks would be standard.	High

Comparison of Waste Management Options (Continued)

Waste Mgmt Options	Waste Component	Effectiveness	Long Term Reliability and Operational Requirements	Potential Risk During Remediation	Relative Cost
Disposal On-site	All	Isolation of the waste will protect human health and the environment from contact with or exposure to radiation or toxic materials as long as the integrity of the disposal facility is maintained. The design includes features to protect against intrusion, infiltration, erosion, leaching, and penetrating radiation exposure.	Engineered cell designed for a 1,000 year life with minimal maintenance. However, site is over sole source aquifer and is in relatively populated area. If engineering and institutional controls fail, there is greater potential risk to human health and the environment. Long term monitoring and maintenance will be required to ensure continued performance.	Increased level of activity on site will result in increased potential for radiation exposures and associated accidents. Permanent disruption/restricted use of up to 100 acres of the site. Potential disruption of on-site wetlands.	High
Disposal Off-Site	All	Isolation of the waste will protect human health and the environment from contact with or exposure to radiation or toxic materials as long as the integrity of the disposal facility is maintained. The design and disposal site location includes features to protect against intrusion, infiltration, erosion, leaching, and penetrating radiation exposure.	Two potential disposal locations are in very dry climatic regions with no surface water in the vicinity, no usable groundwater, and no human populations for many miles. Under such conditions, there is a high degree of confidence that the disposal facility will continue to perform as designed for long periods of time.	Shipping waste from Fernald will result in increased potential for transportation accidents.	High

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FERNALD CITIZENS TASK FORCE

FUTURE USE SCENARIOS DEVELOPED FOR EVALUATION

Cleanup levels used in developing scenarios were based on one of four land use categories or protection of groundwater as identified below:

CATEGORY	EXPOSURE ASSUMPTIONS	SOIL LEVELS AT 10^{-5} RISK	SOIL LEVELS AT 10^{-6} RISK
Resident Farmer	Assumes full-time life-long resident growing crops for human consumption and grazing livestock.	20 ppm	5 ppm
Industrial	Assumes maximum exposure to on-site groundskeeper.	100 ppm	15 ppm
Developed Park	Assumes free access recreational facility with developed sports, picnic, and rest room facilities.	430 ppm	50 ppm
Green Space	Assumes unlimited access to nature trails, but with no developed facilities.	1090 ppm	115 ppm
Protection of Aquifer	Assumes soil concentrations required to prevent contamination leaching into aquifer above MCLs. Site in two zones according to geology and solubility.	Zone I: 20 ppm Zone II: 100 ppm (see map)	Zone I: 5 ppm Zone II: 10 ppm (see map)

A Total of 21 scenarios were developed for evaluation as a result of the Future Site exercise and protection of the aquifer. Most of the scenarios follow the cleaner border concept which emerged from the FutureSite exercise. The scenarios are listed below and a map of each is shown on the following pages.

Scenario 1	Resident Border/Industrial Center at 10^{-5}
Scenario 1a	Resident Border/Industrial Center at 10^{-6}
Scenario 2	Resident Border/Park Center at 10^{-5}
Scenario 2a	Resident Border/Park Center at 10^{-6}
Scenario 3	Resident Border/Green Space Center at 10^{-5}
Scenario 3a	Resident Border/Green Space Center at 10^{-6}
Scenario 4	Industrial Border/Park Center at 10^{-5}
Scenario 4a	Industrial Border/Park Center at 10^{-6}
Scenario 5	Industrial Border/Green Space Center at 10^{-5}
Scenario 5a	Industrial Border/Green Space Center at 10^{-6}
Scenario 6	Park Border/Green Space Center at 10^{-5}
Scenario 6a	Park Border/Green Space Center at 10^{-6}
Scenario 7	Total Green Space at 10^{-5}
Scenario 7a	Total Green Space at 10^{-6}
Scenario 8	North Green Space /South Industrial at 10^{-5}
Scenario 8a	North Green Space /South Industrial at 10^{-6}
Scenario 9	Total Resident at 10^{-5}
Scenario 9a	Total Resident at 10^{-6}
Scenario 10	Protection of Aquifer to MCLs (10^{-5})
Scenario 10a	Protection of Aquifer and Perched Groundwater to MCLs (10^{-5})
Scenario 10b	Protection of Aquifer to 10^{-6}

EVALUATION CRITERIA

In evaluating future use scenarios, the Task Force has identified a number of issues that important. Wherever possible, these issues have been quantified. Where quantification was not possible, issues have been evaluated and discussed qualitatively. Issues that were considered in developing information for future use scenarios include:

LONG-TERM SAFETY

Effectiveness, monitoring, and ownership of the Fernald property are crucial to the long-term acceptability of any cleanup scenario.

SHORT-TERM RISKS

Risks to workers and residents resulting from the cleanup activities themselves are of significant concern.

ON-SITE DISPOSAL REQUIREMENTS

The volume of soil that will be excavated and the ultimate size of any on-site disposal facility will determine the overall impact of the cleanup on the community during and after construction.

IMPACT ON NATURAL RESOURCES

Disruption of the quantities of soil projected for Fernald will have a significant impact on the flora, fauna, sensitive habitats, farmlands, and wetlands that comprise the Fernald site and surrounding properties.

TRANSPORTATION AND OFF-SITE DISPOSAL REQUIREMENTS

The Task Force is senstive to the impacts on communities along transportation routes and at the ultimate disposal facility. Thus the volume of off-site disposal is an important consideration.

COMMUNITY IMPACTS AND BENEFITS

Long-term economic, social, and aesthetic impacts on the local community and work force of the Fernald cleanup are of significant importance.

COST

As a taxpayer-funded project, the total cost of cleanup is important.

COMPARISON OF FUTURE USE SCENARIOS

SCENARIO	VOLUME OF ON-SITE SOILS (yd^3)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1	716,000	52	35,800	103	$481,000	Does not protect GMA. 913,000 yd^3 additional soil removal required.	Disrupts 646 acres of terrestrial habitat and 35.9 acres of wetlands
1a	2,033,000	105	101,650	296	$997,000	Does not protect GMA. 1,976,000 yd^3 additional soil removal required.	Disrupts 1008 acres of terrestrial habitat and 35.9 acres of wetlands
2	716,000	52	35,800	103	$481,000	Does not protect GMA. 913,000 yd^3 additional soil removal required.	Disrupts 646 acres of terrestrial habitat and 35.9 acres of wetlands
2a	1,714,000	94	87,500	255	$897,000	Does not protect GMA. 2,260,000 yd^3 additional soil removal required.	Disrupts 1008 acres of terrestrial habitat and 35.9 acres of wetlands
3	716,000	52	35,800	103	$481,000	Does not protect GMA. 913,000 yd^3 additional soil removal required.	Disrupts 646 acres of terrestrial habitat and 35.9 acres of wetlands
3a	1,714,000	92	85,700	241	$887,000	Does not protect GMA. 2,295,000 yd^3 additional soil removal required.	Disrupts 1008 acres of terrestrial habitat and 35.9 acres of wetlands

COMPARISON OF FUTURE USE SCENARIOS (continued)

SCENARIO	VOLUME OF ON-SITE SOILS (yd^3)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4	547,000	45	27,350	84	$421,000	Does not protect GMA. 922,000 yd^3 additional soil removal required.	Disrupts 546 acres of terrestrial habitat and 35.9 acres of wetlands
4a	830,000	57	41,500	129	$557,000	Does not protect GMA. 2,492,000 yd^3 additional soil removal required.	Disrupts 1008 acres of terrestrial habitat and 35.9 acres of wetlands
5	547,000	45	27,350	84	$421,000	Does not protect GMA. 922,000 yd^3 additional soil removal required.	Disrupts 546 acres of terrestrial habitat and 35.9 acres of wetlands
5a	794,000	55	39,700	115	$547,000	Does not protect GMA. 2,528,000 yd^3 additional soil removal required.	Disrupts 1000 acres of terrestrial habitat and 35.9 acres of wetlands
6	542,000	45	27,100	78	$421,000	Does not protect GMA. 927,000 yd^3 additional soil removal required.	Disrupts 546 acres of terrestrial habitat and 35.9 acres of wetlands
6a	588,000	47	29,400	78	$467000	Does not protect GMA. 2,734,000 yd^3 additional soil removal required.	Disrupts 1000 acres of terrestrial habitat and 35.9 acres of wetlands

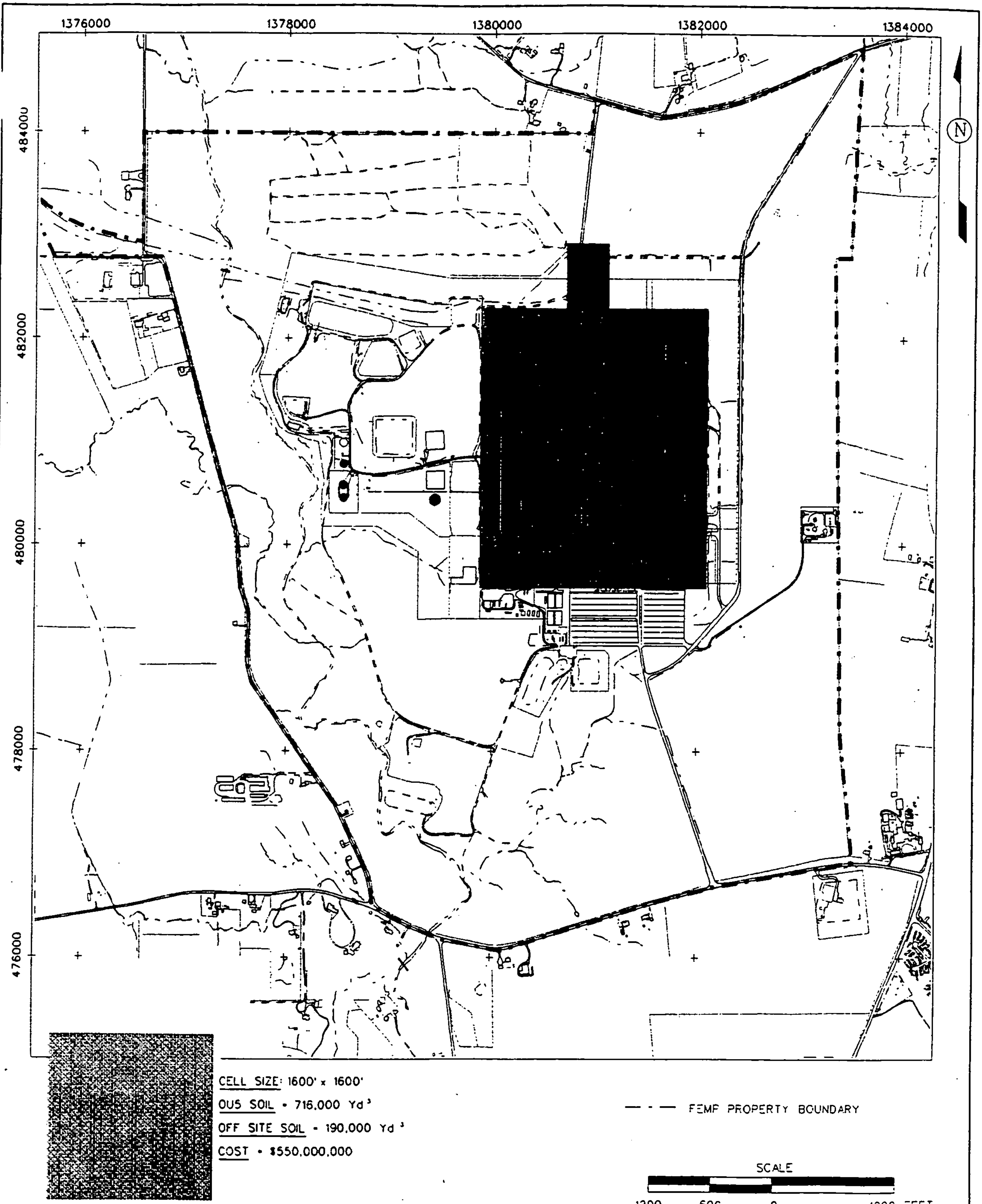
COMPARISON OF FUTURE USE SCENARIOS (continued)

Scenario	Volume of On-Site Soils (yd^3)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
7	542,000	45	27,100	78	$421,000	Does not protect GMA. 927,000 yd^3 additional soil removal required.	Disrupts 300 acres of terrestrial habitat and 10.2 acres of wetlands
7a	545,000	45	27,250	73	$447,000	Does not protect GMA. 2,777,000 yd^3 additional soil removal required.	Disrupts 560 acres of terrestrial habitat and 11.4 acres of wetlands
8	542,000	45	27,100	78	$421,000	Does not protect GMA. 927,000 yd^3 additional soil removal required.	Disrupts 613 acres of terrestrial habitat and 10.2 acres of wetlands
8a	573,00	47	28,650	75	$457,000	Does not protect GMA. 2,749,000 yd^3 additional soil removal required.	Disrupts 789 acres of terrestrial habitat and 11.4 acres of wetlands
9	941,000	61	47,050	135	$571,000	Protective of GMA but 1,048,000 yd^3 of additional soil removal required to protect perched groundwater	Disrupts over 650 acres of terrestrial habitat and 35.9 acres of wetlands

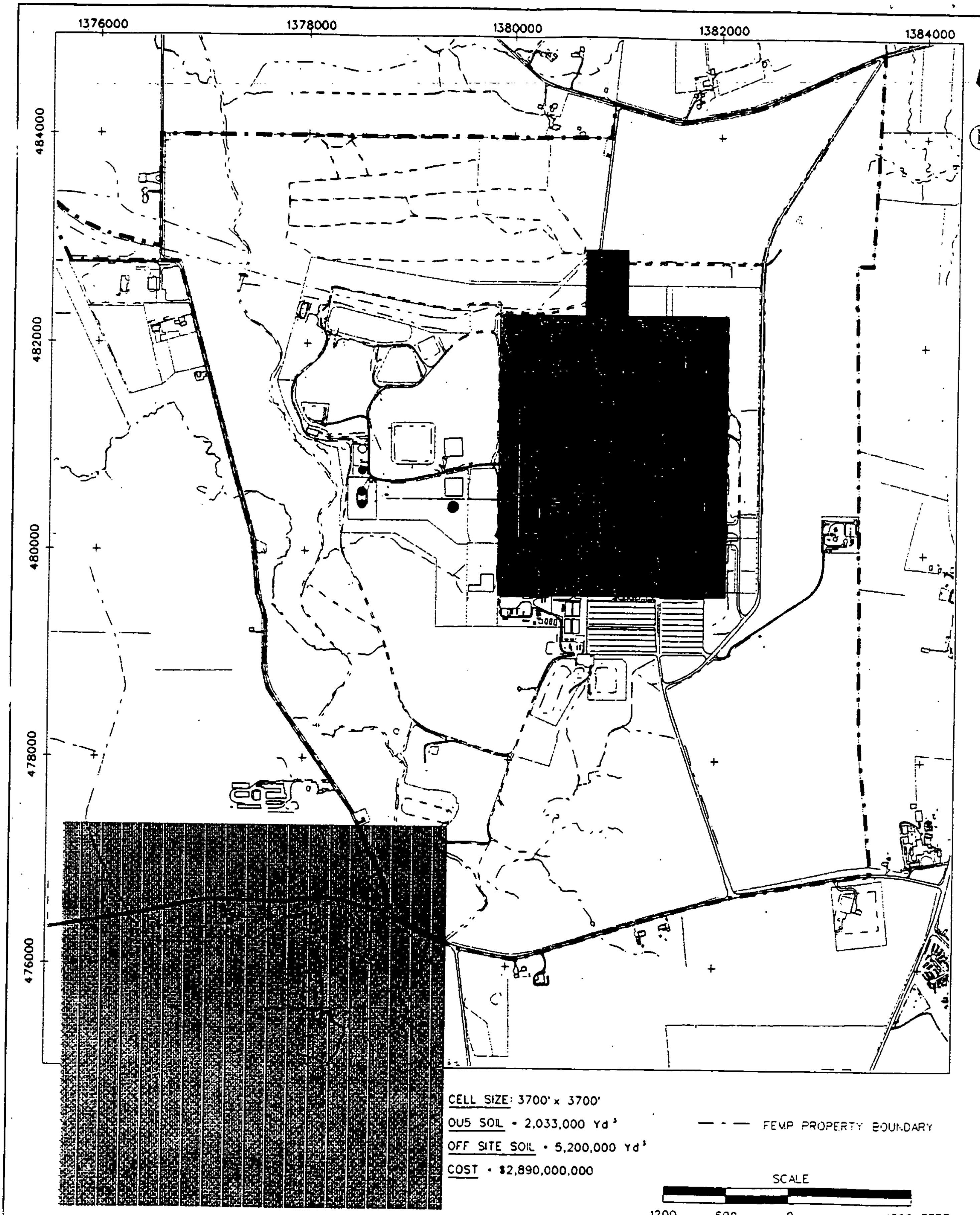
COMPARISON OF FUTURE USE SCENARIOS (continued)

SCENARIO	VOLUME OF ON-SITE SOILS (yd^3)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
9a	3,618,000	168	180,900	512	$1,587,000	Protective of GMA but 652,000 yd^3 of additional soil .to protect perched groundwater	Disrupts over 1,000 acres of terrestrial habitat and 35.9 acres of wetlands
10	1,114,000	45	55,700	161	$475,000	Protective of GMA.to MCLs	Over 650 acres of terrestrial habitat and 35.9 acres of wetlands
10a	1,503,000	60	75,150	218	$700,000	Protective of GMA and perched gw to MCLs.	Over 650 acres of terrestrial habitat and 35.9 acres of wetlands
10b	3,385,000	135	169,250	490	$1,500,000	Protective of GMA and perched groundwater to 10^{-6}	Over 1,000 acres of terrestrial habitat and 35.9 acres of wetlands
Off-Site Soils For 10^{-5} Scenarios	190,000	8	9,500	28	$69,160	Protective of GMA	236 acres of terr. habitat and unknown acres of wetlands
Off-Site Soils For 10^{-6} Scenarios	5,200,000	208	260,000	754	$1,893,000	Protective of GMA	6,474 acres of terr. habitat and unknown acres of wetlands

a) Includes all soils and debris from all OUs for on-site disposal
b) 25,000 yd^3 per acre
c) 20 yd^3 per truck
d) Approximately 6,900 yd^3 per 130 unit train
e) All scenarios present potential impacts to Paddys Run and threatened and endangered species

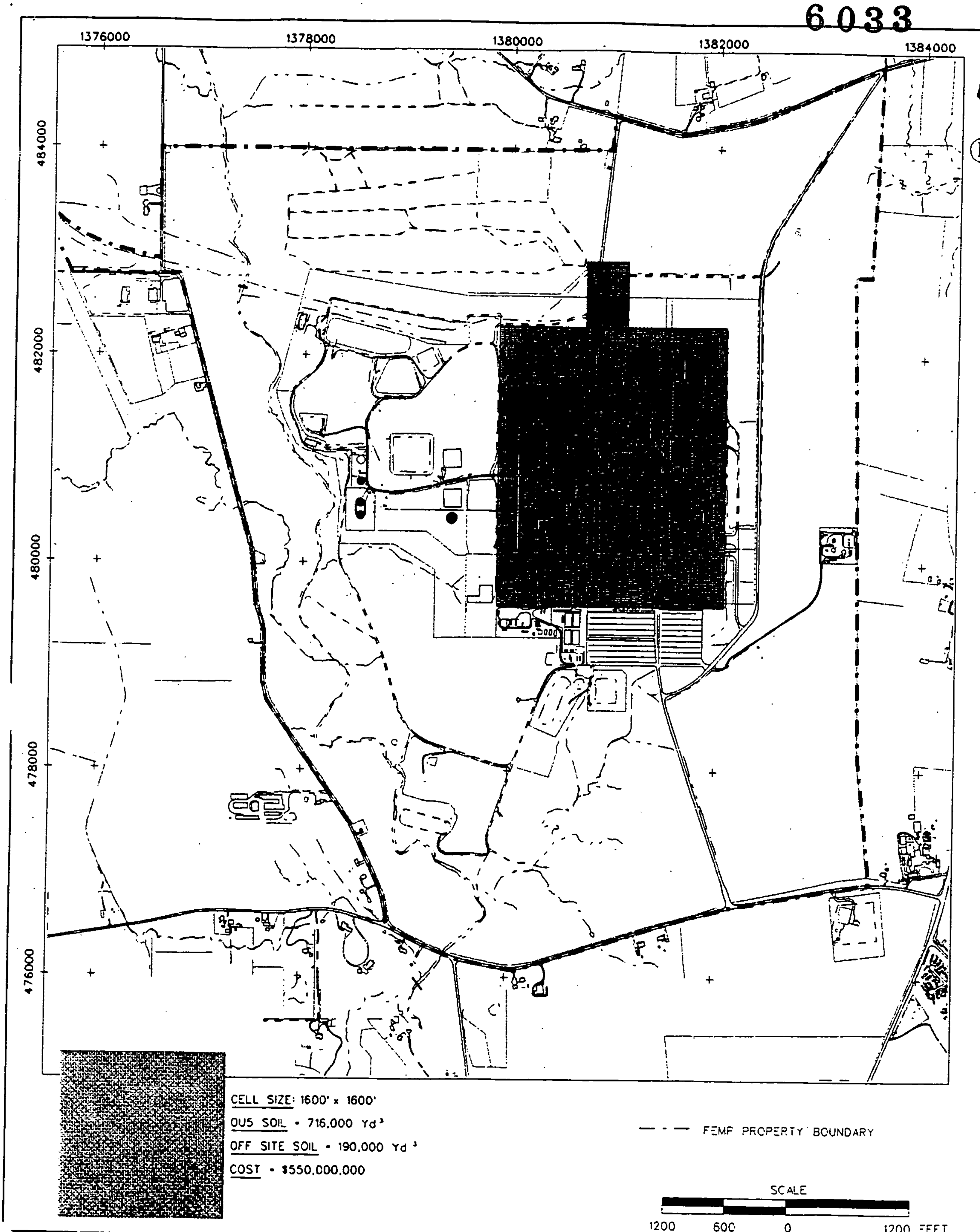


FUTURE USE SCENARIO 1.
RESIDENT BORDER/INDUSTRIAL CENTER AT 10-5



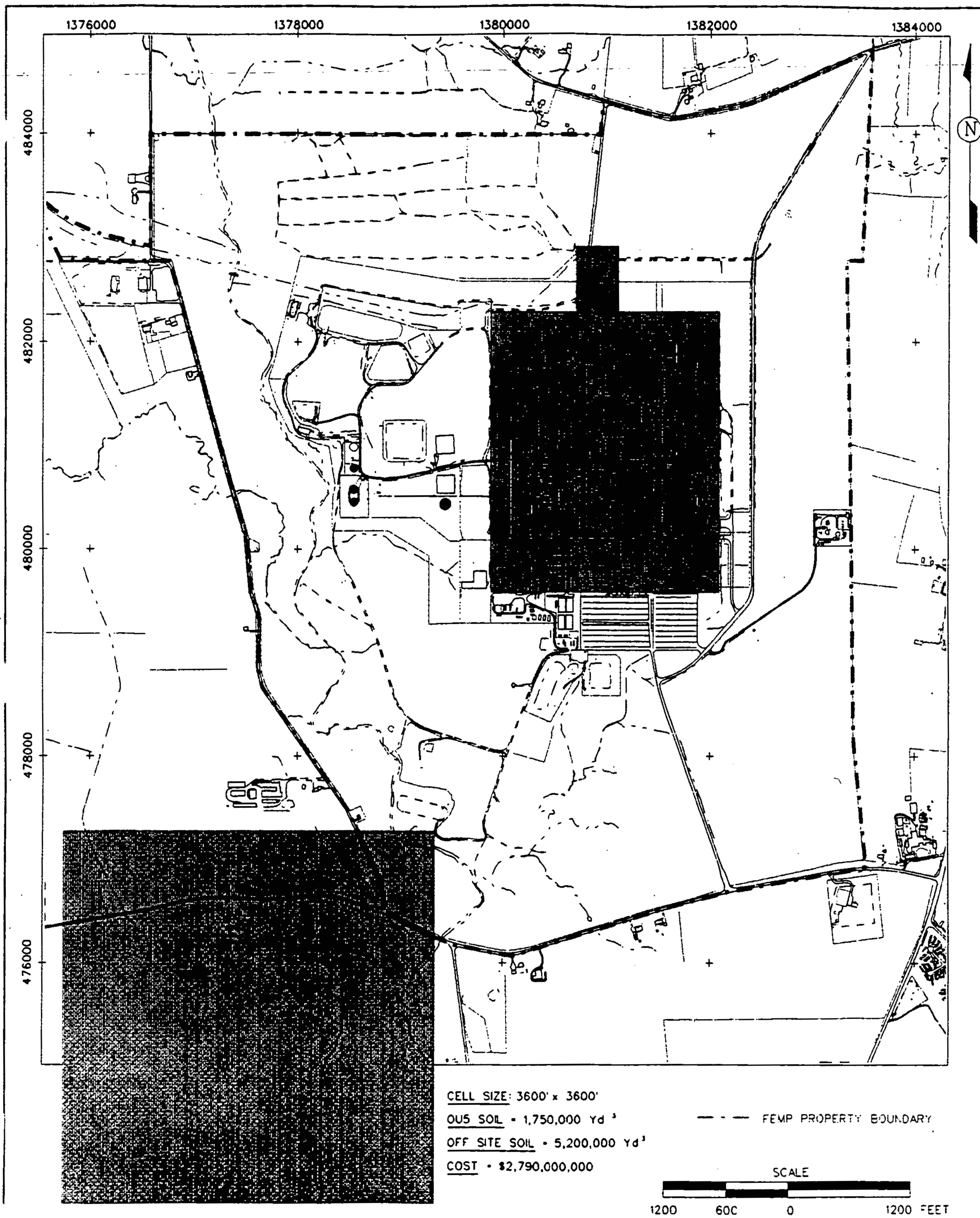
FUTURE USE SCENARIO 1A.
RESIDENT BORDER/INDUSTRIAL CENTER AT 10-6

X-8



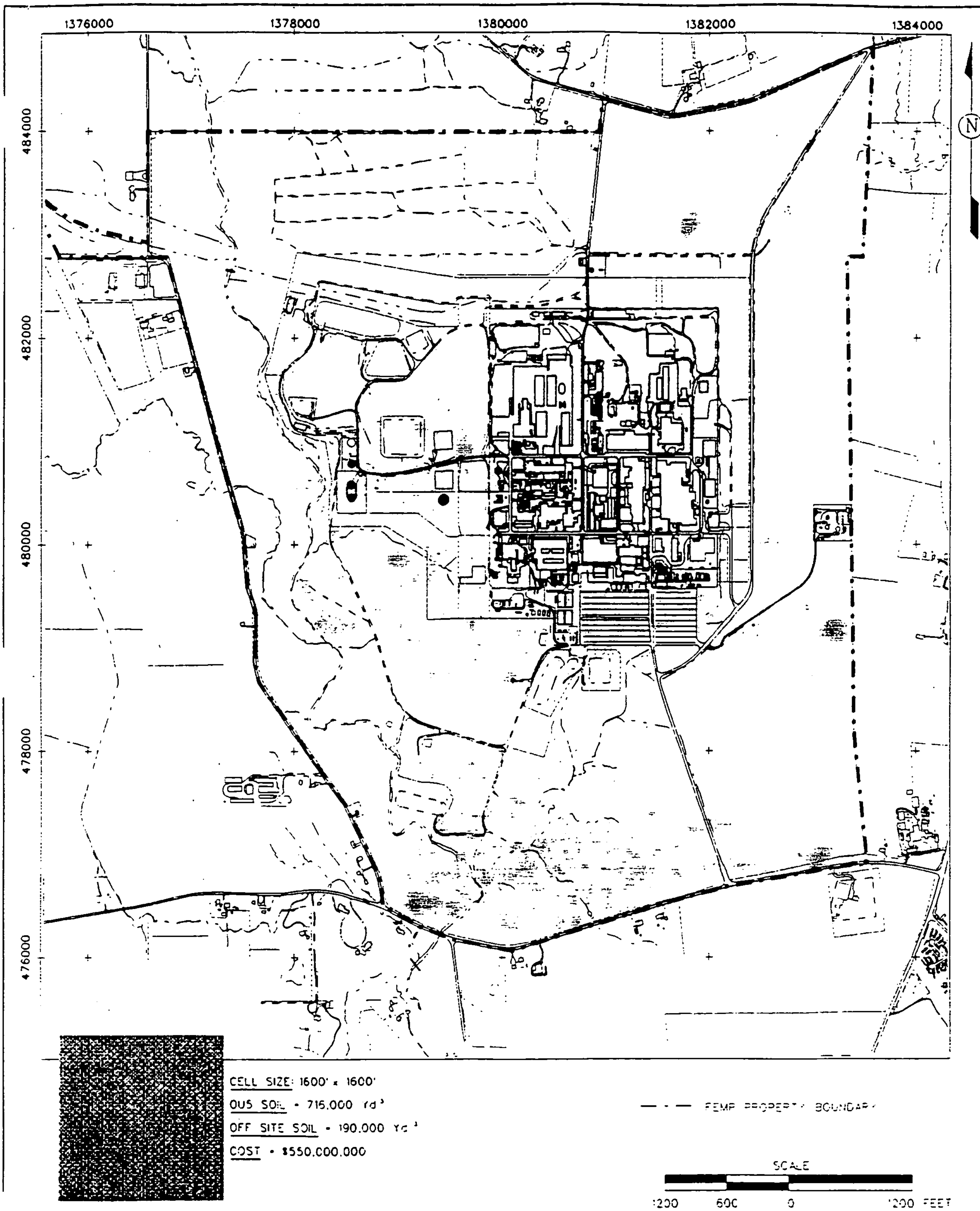
FUTURE USE SCENARIO 2. RESIDENT BORDER/PARK CENTER AT 10-5

X-9



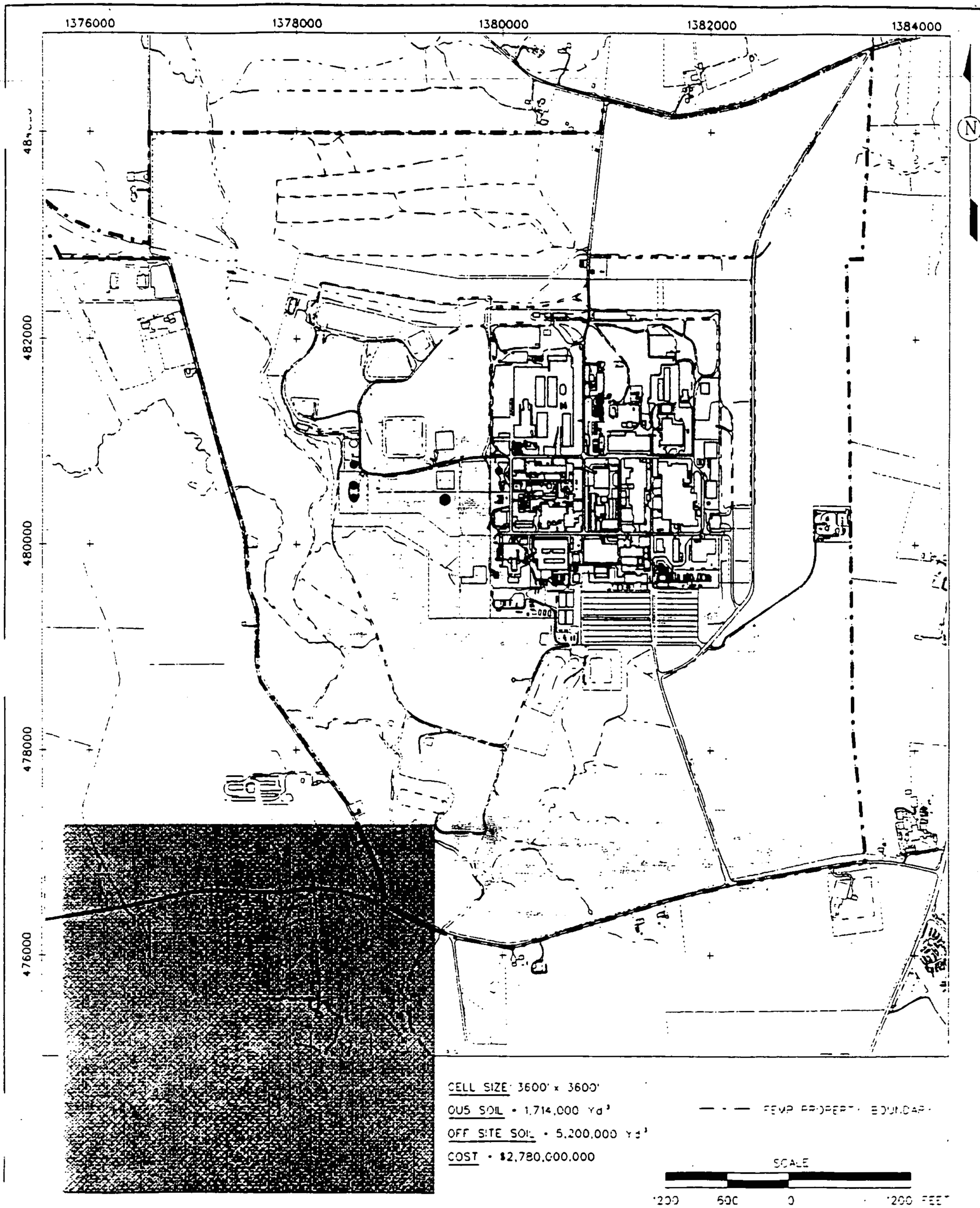
FUTURE USE SCENARIO 2A. RESIDENT BORDER/PARK CENTER AT 10-6

X-11



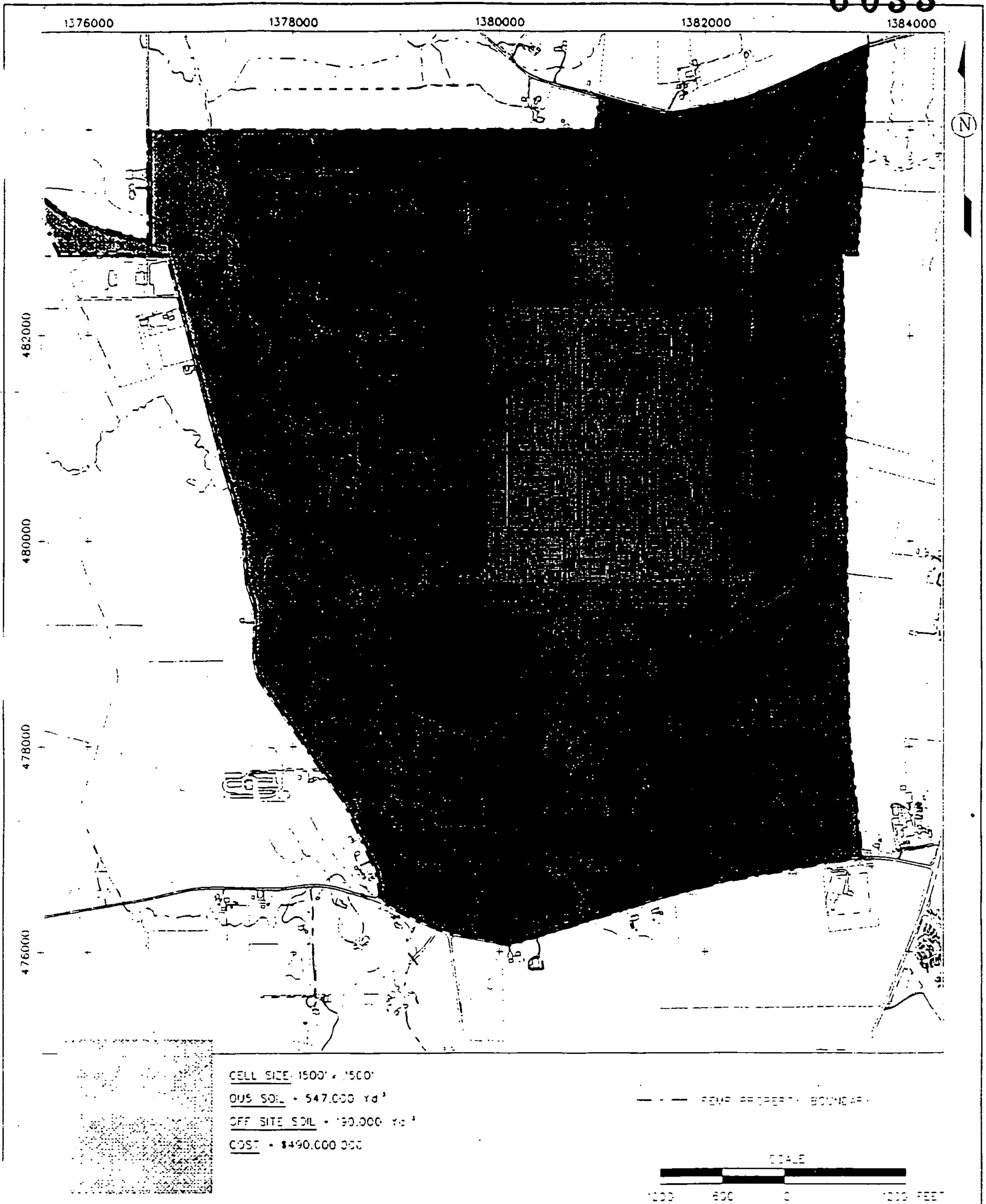
FUTURE USE SCENARIO 3.
RESIDENT BORDER/GREENSPACE CENTER AT 10-5

X-12



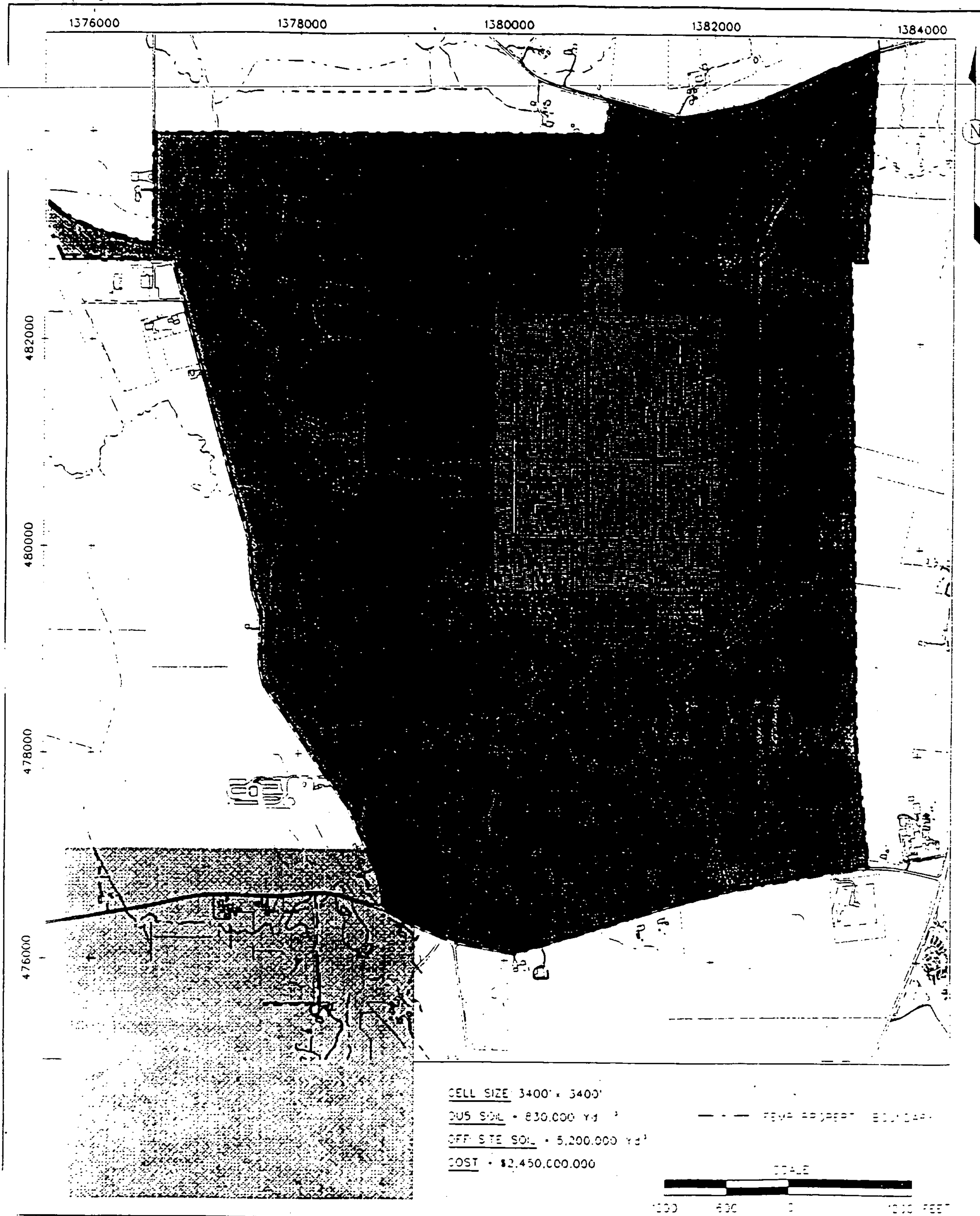
FUTURE USE SCENARIO 3A.
RESIDENT BORDER/GREENSPACE CENTER AT 10-6

X-13



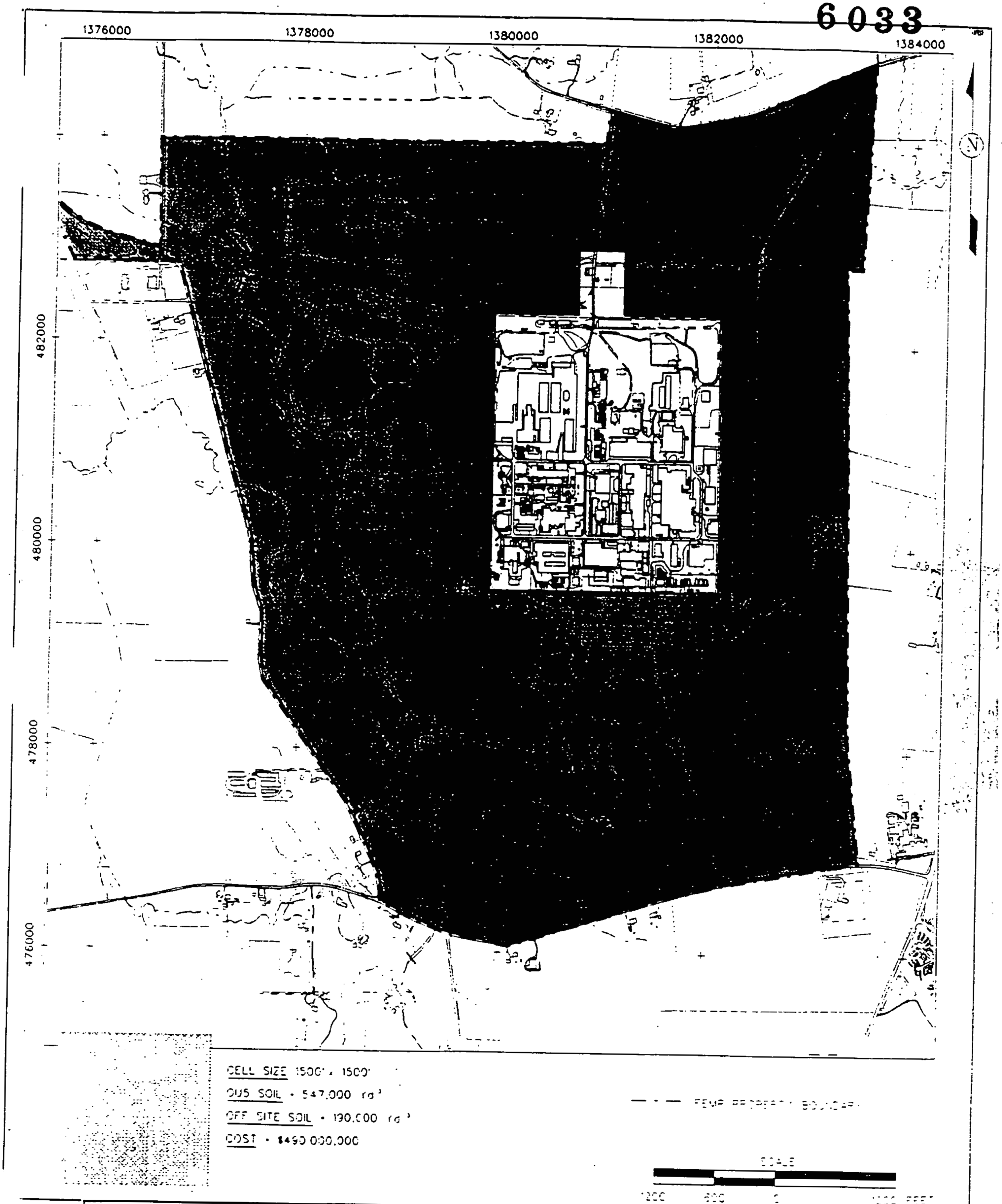
FUTURE USE SCENARIO 4.
INDUSTRIAL BORDER/PARK CENTER AT 10-5

X-14



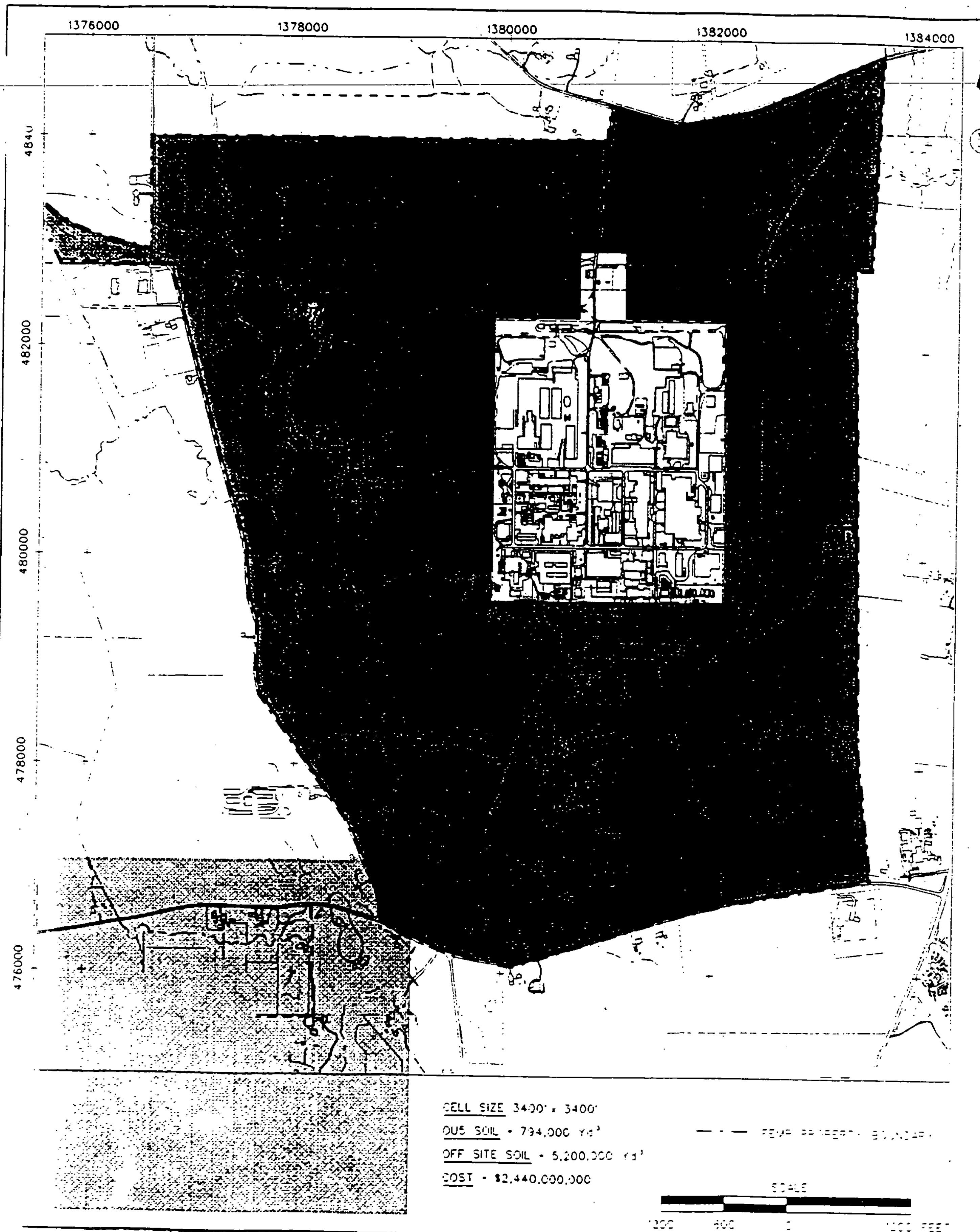
FUTURE USE SCENARIO 4A.
INDUSTRIAL BORDER/PARK CENTER AT 10-6

X-15



FUTURE USE SCENARIO 5.
INDUSTRIAL BORDER/GREEN SPACE CENTER AT 10-5

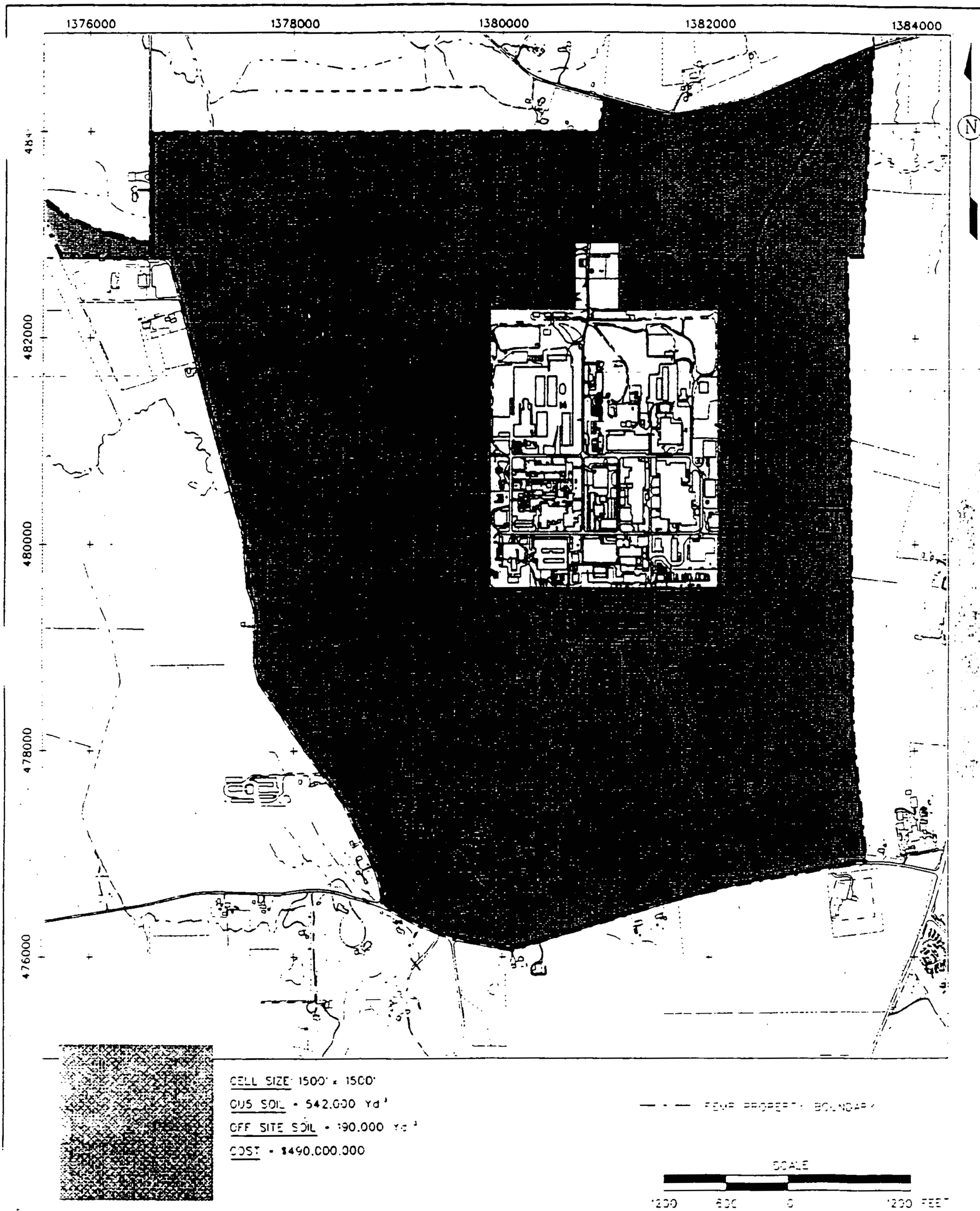
X-16



Future Use Scenario 5a.
Industrial Border/Green Space Center at 10-6

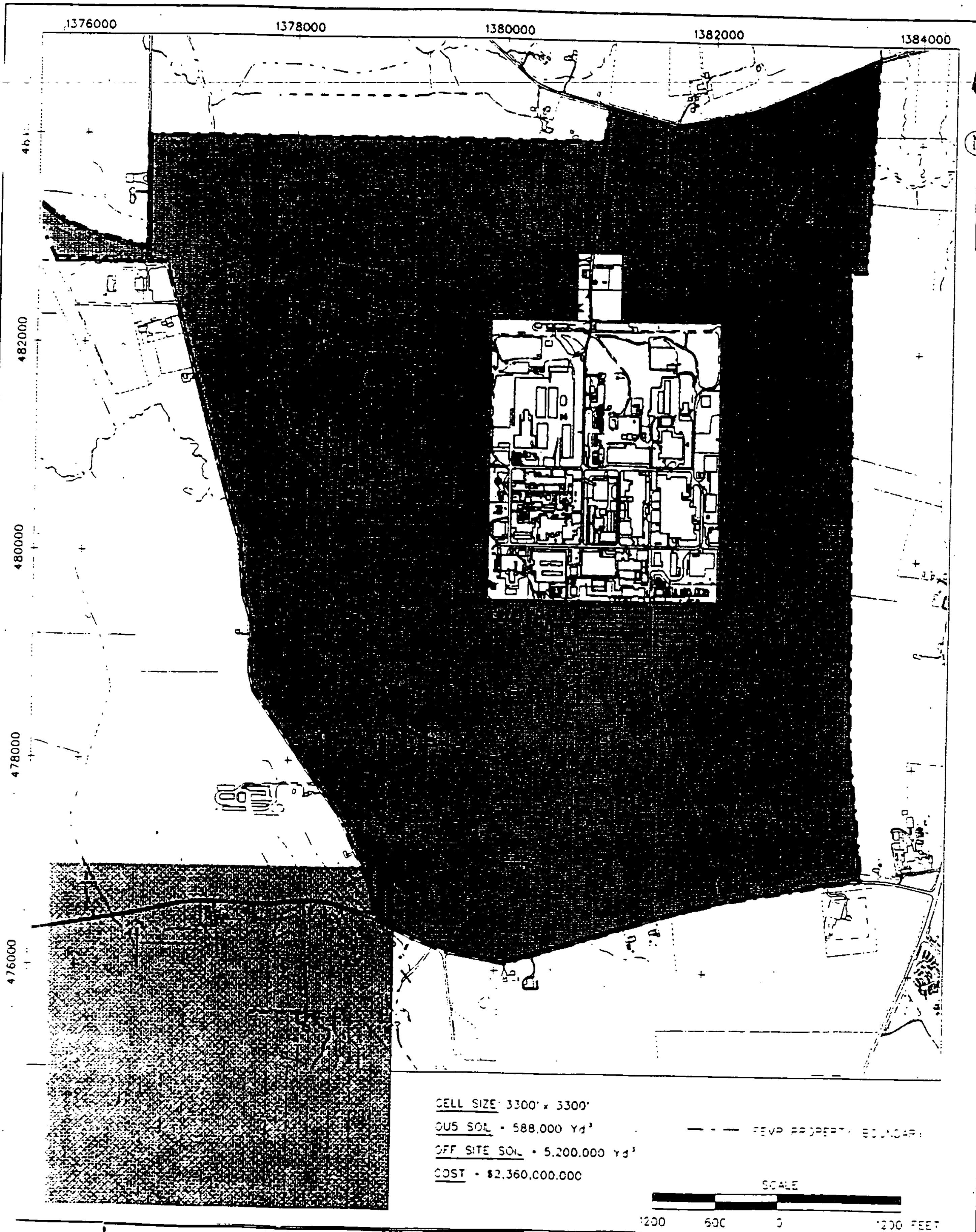
X-17

000080



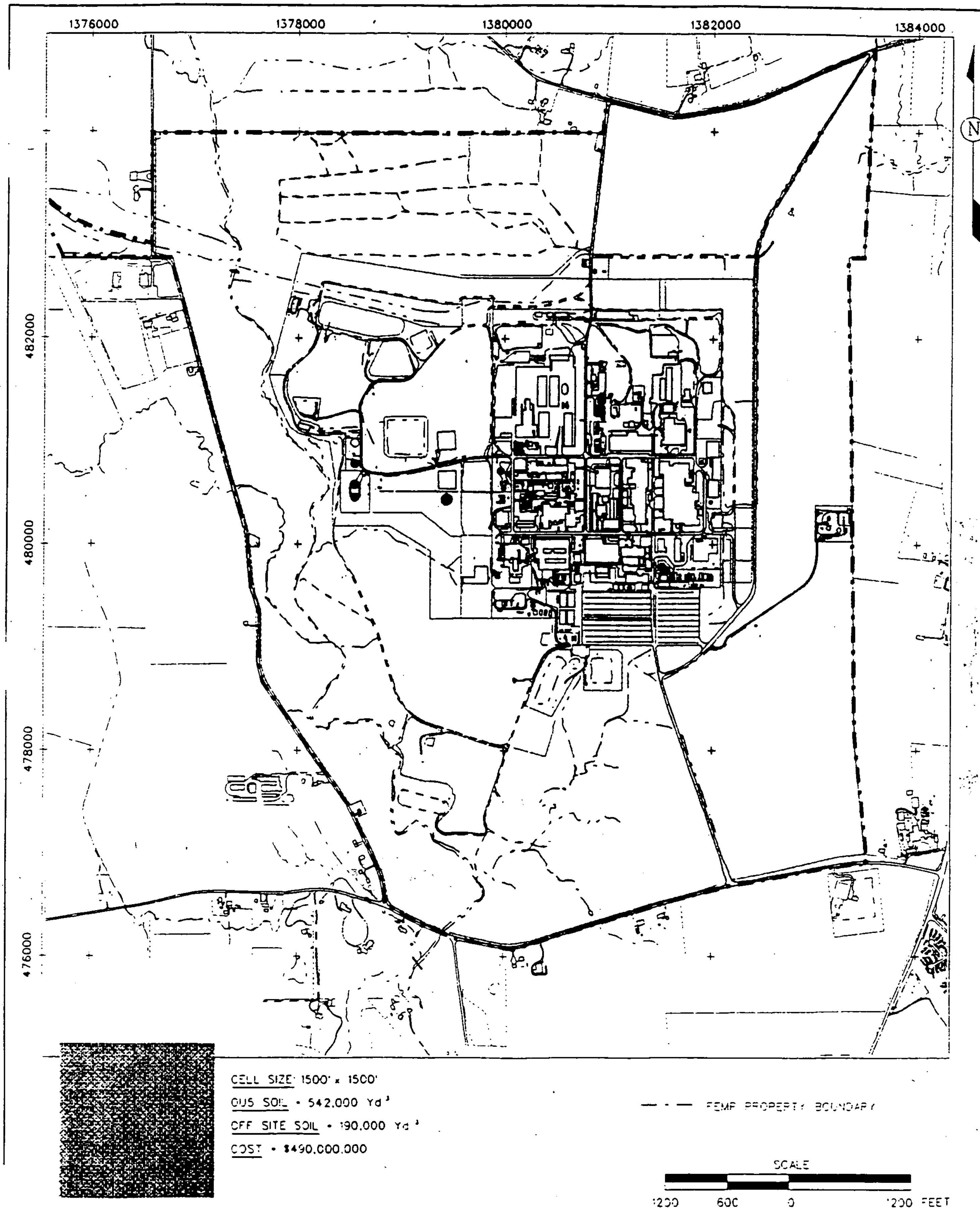
Future Use Scenario 6.
Park Border/Green Space Center at 10^{-5}

X-18



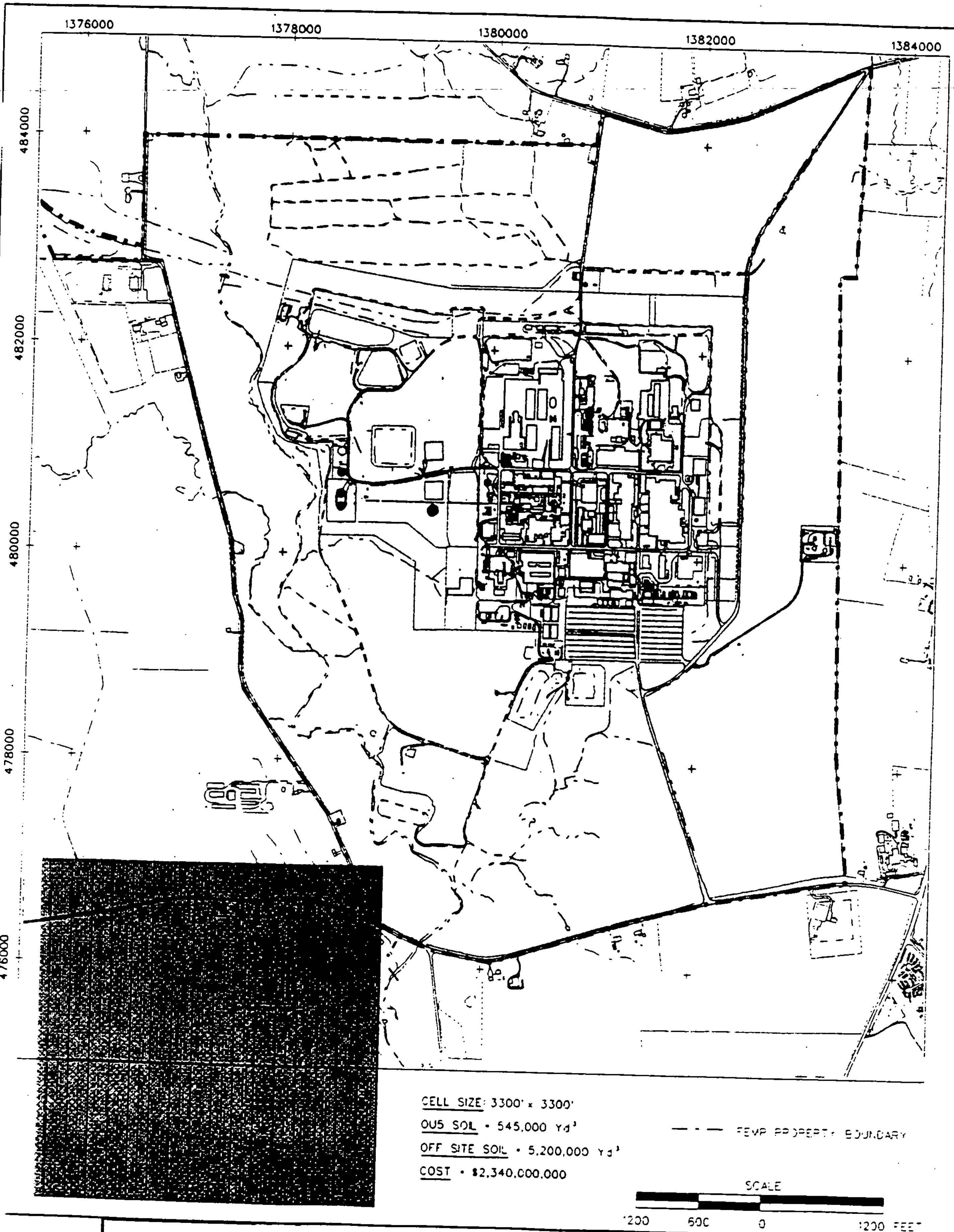
FUTURE USE SCENARIO 6A.
PARK BORDER/GREEN SPACE CENTER AT 10-6

X-19

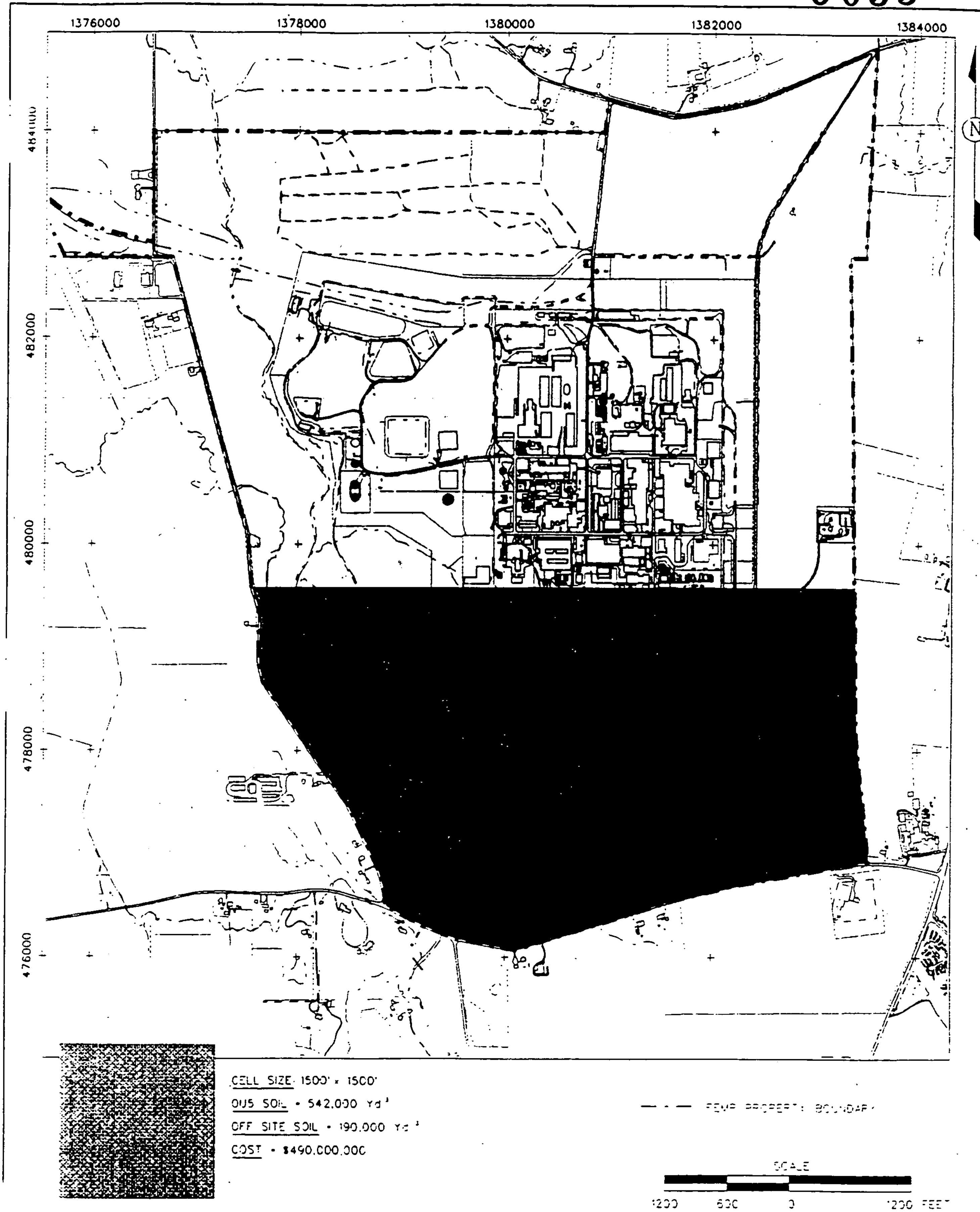


**FUTURE USE SCENARIO 7.
TOTAL GREENSPACE AT 10^{-5}**

X-20

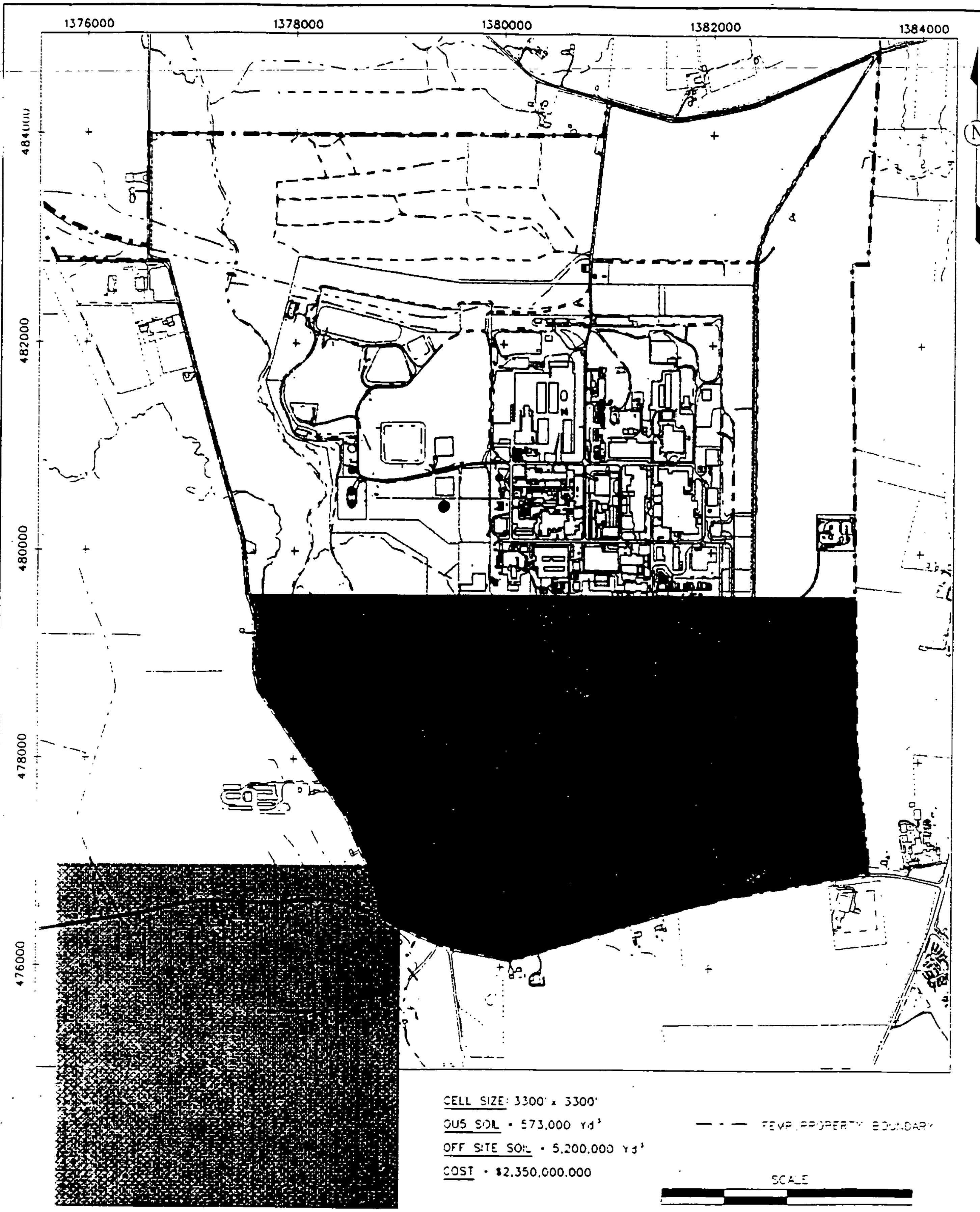


FUTURE USE SCENARIO 7A.
TOTAL GREENSPACE AT 10-6



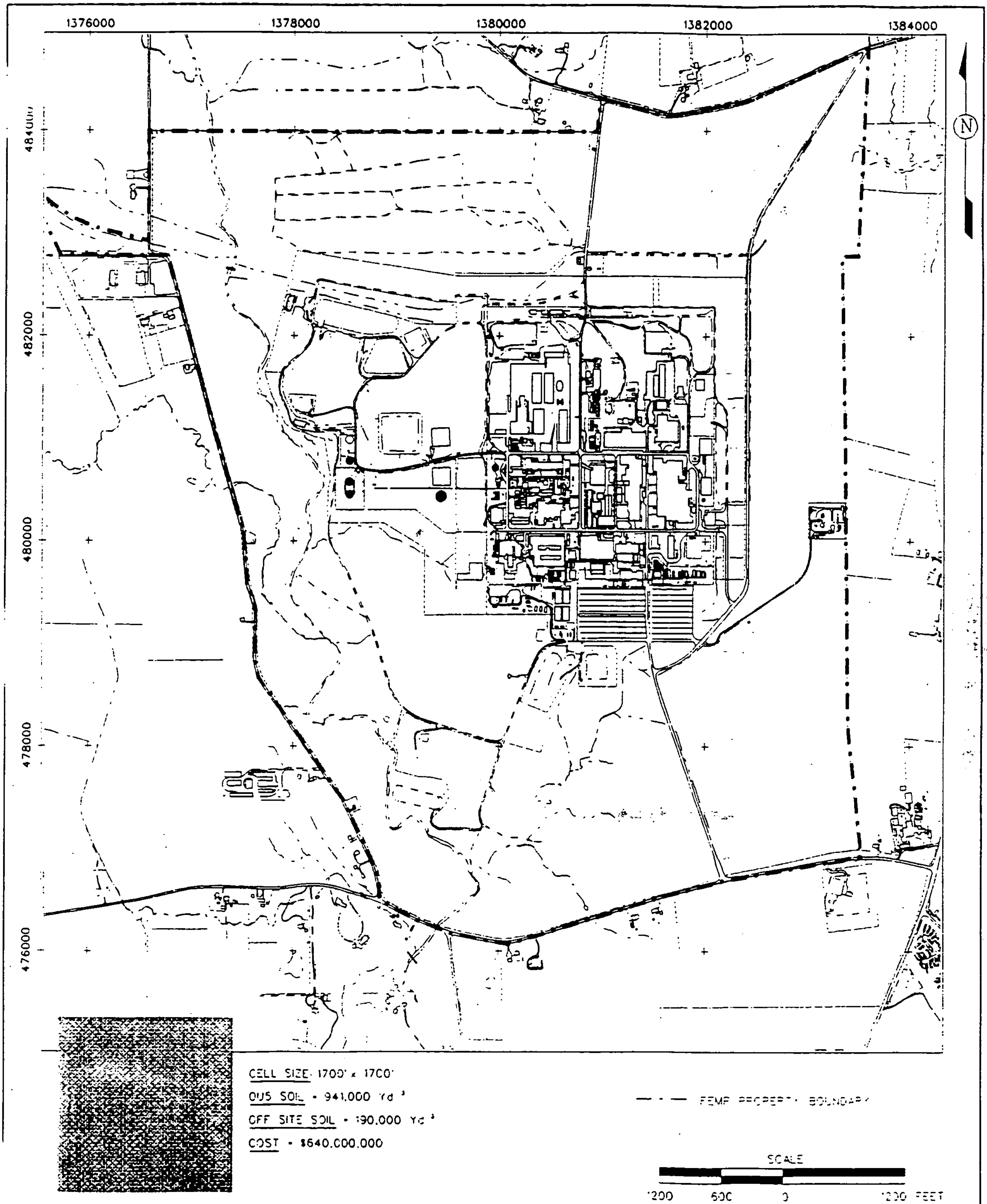
**FUTURE USE SCENARIO 8.
NORTH GREENSPACE /SOUTH INDUSTRIAL AT 10^{-5}**

X-22



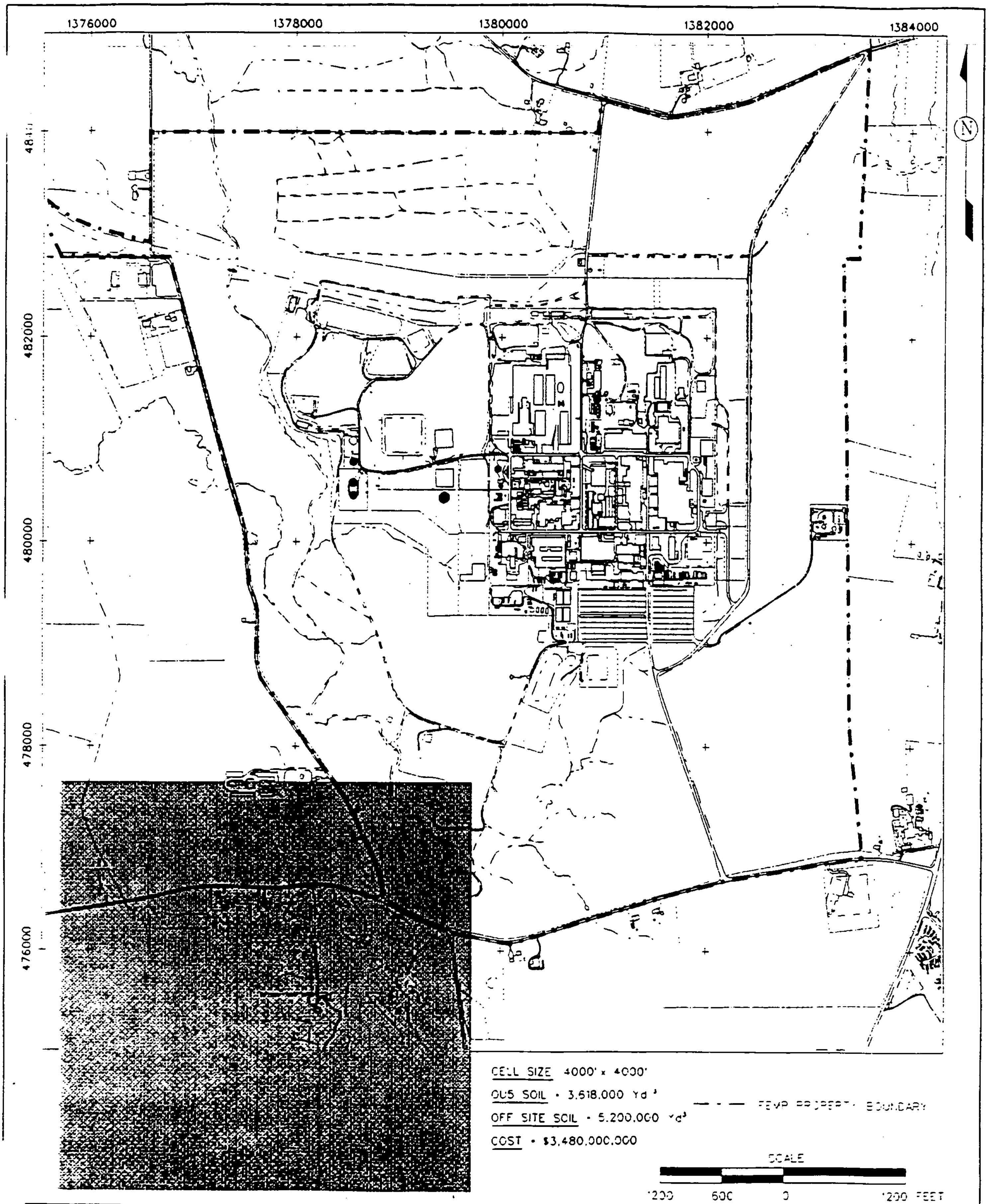
FUTURE USE SCENARIO 8A.
NORTH GREENSPACE /SOUTH INDUSTRIAL AT 10-6

6033



Future Use Scenario 9. Total Resident at 10^{-5}

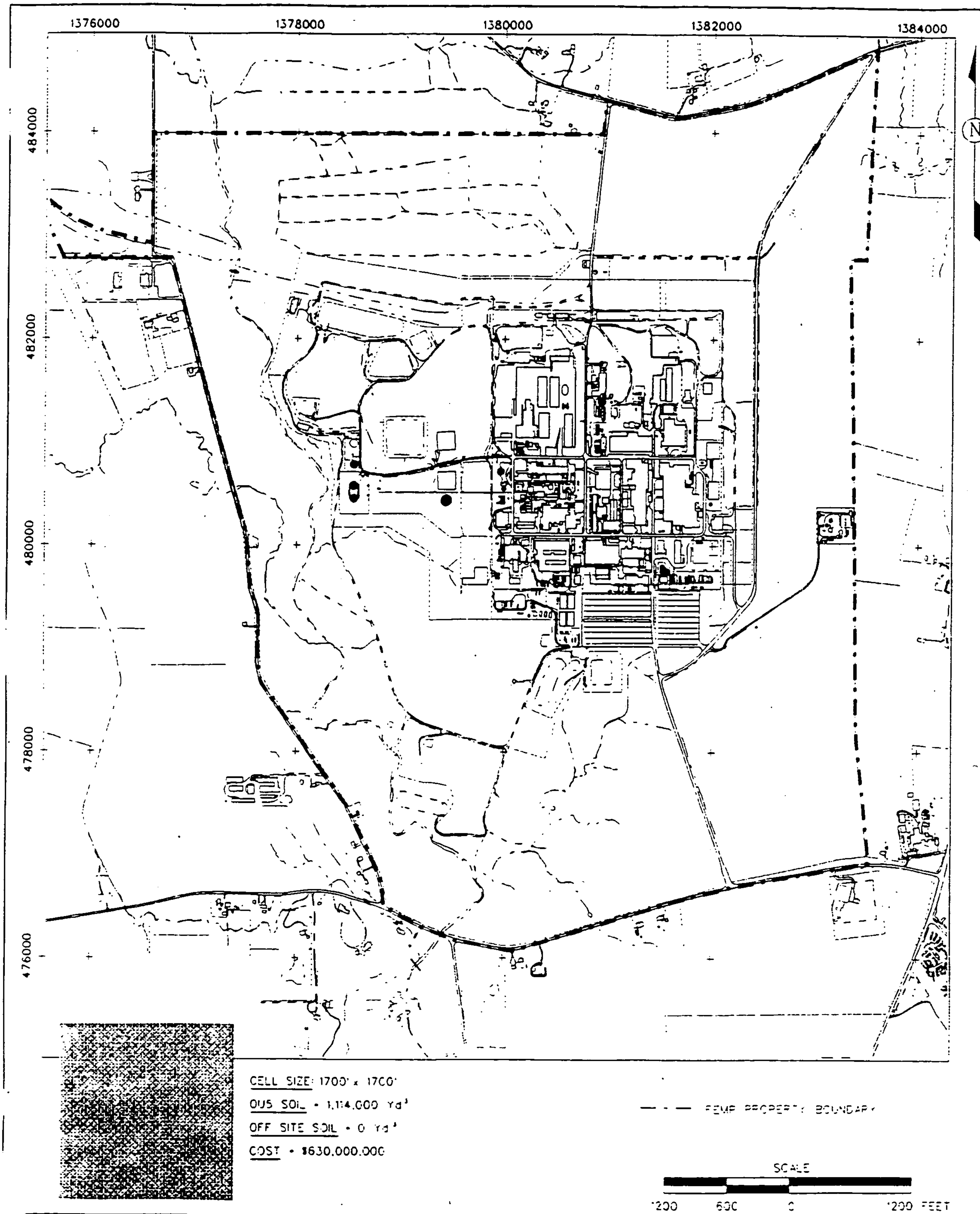
X-24



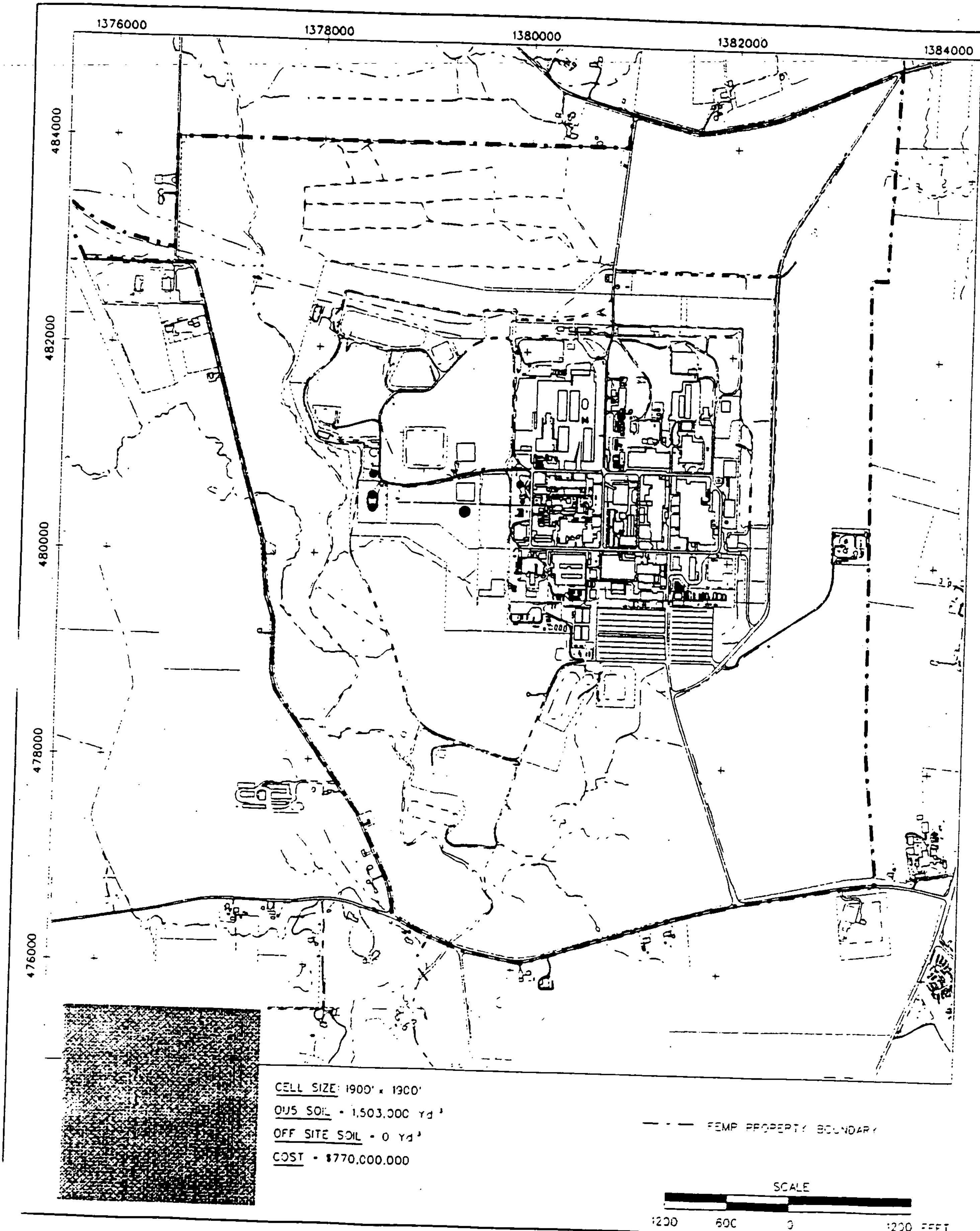
FUTURE USE SCENARIO 9A.
TOTAL RESIDENT AT 10-6

000088

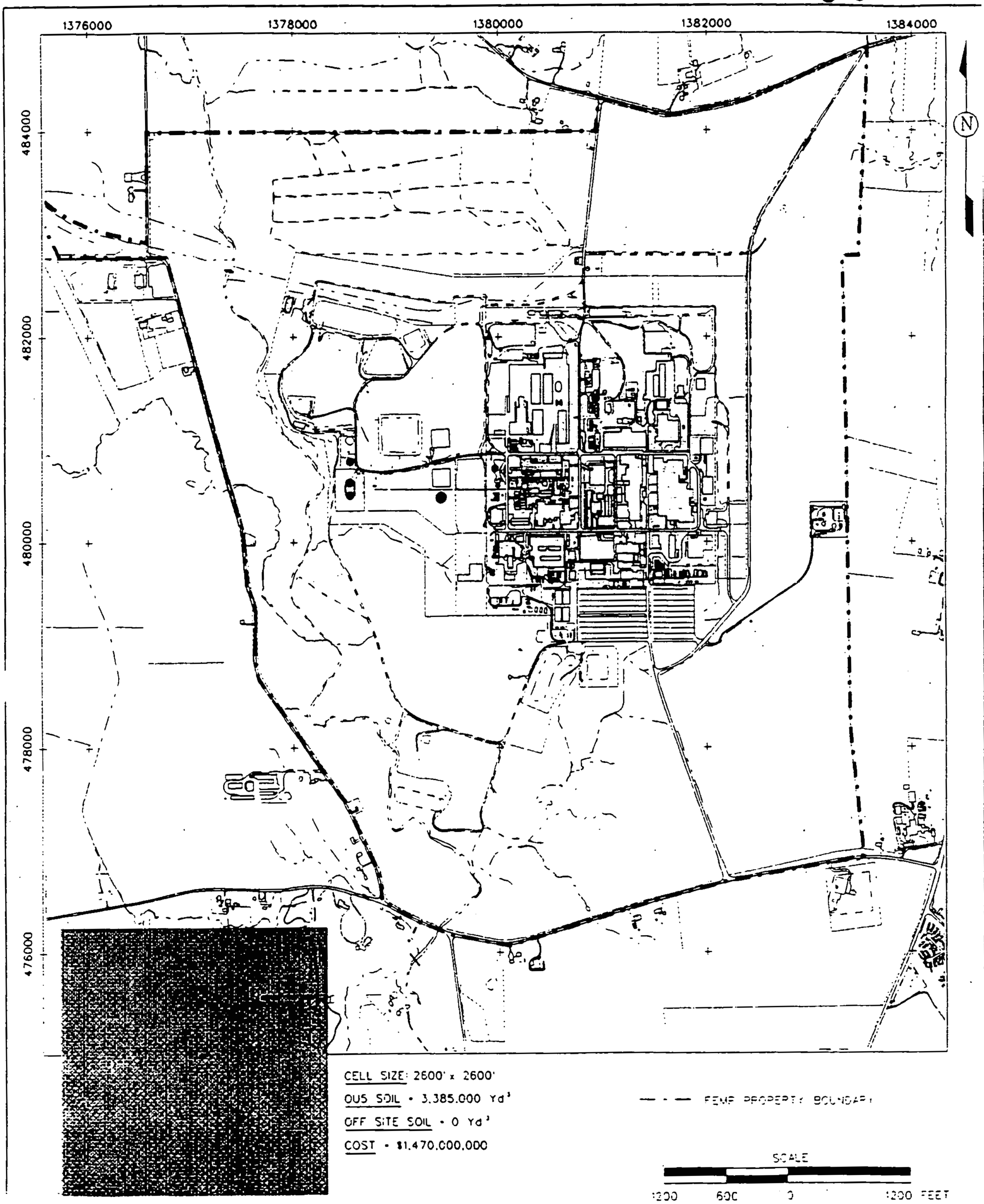
X-25



10. PROTECTIVE OF GMA



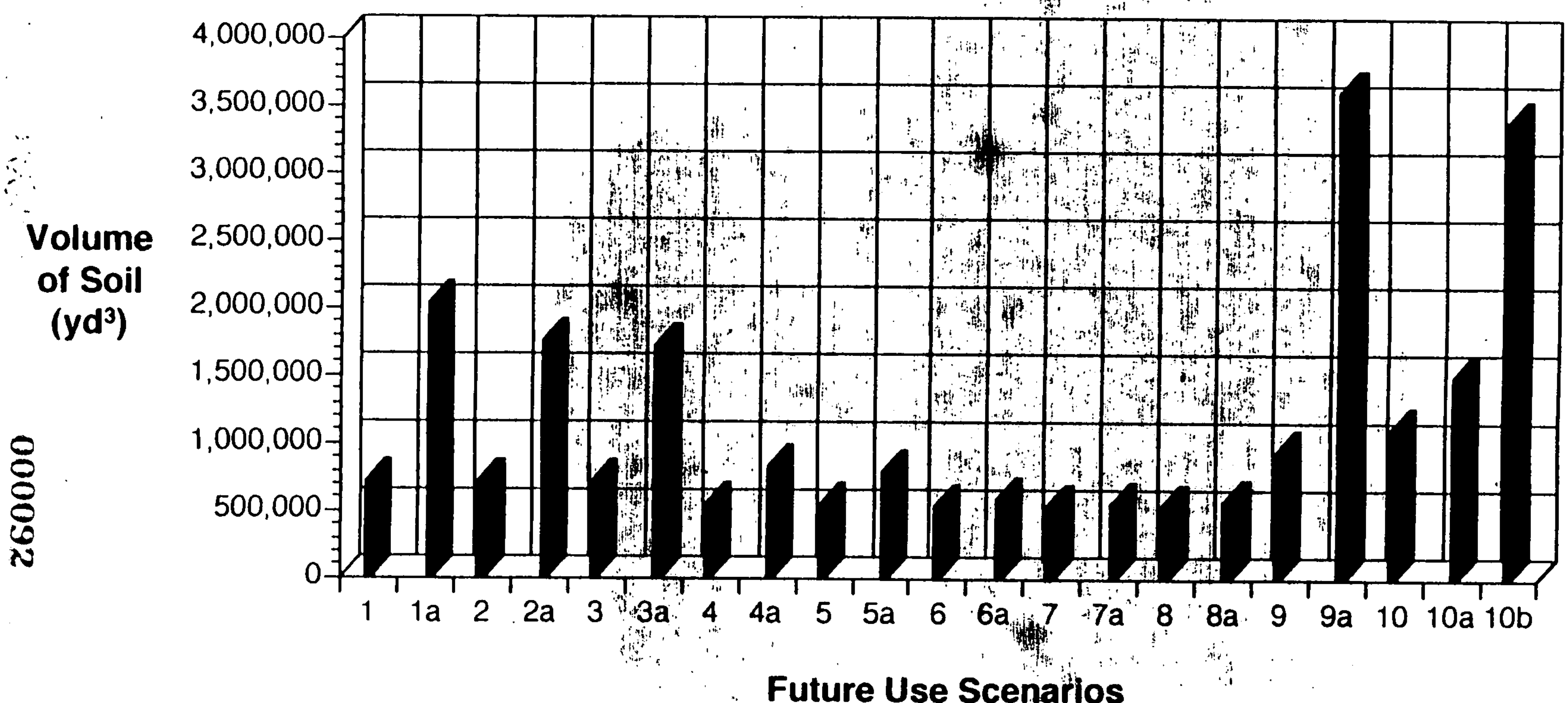
10a. PROTECTIVE OF GMA + PERCHED GW AT 10^{-5} RISK



10b. PROTECTIVE OF GMA + PERCHED GW AT 10^6 RISK

X-28

Comparison of On-Site Soil Volumes for Future Use Scenarios



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AQUIFER RESTORATION OPTIONS

GROUNDWATER REMEDIATION OPTION	DESCRIPTION	TOTAL PROJECT COST	INSTITUTIONAL CONTROLS	TIME TO ACHIEVE RESTORATION
No Active Restoration of Aquifer (Soil Cleanup to PRGs Only)	Provide drinking water through public water supply.	$5 million	Restriction on use of GMA to properties east and south of Fernald site.	Indefinite
No Active Restoration of Aquifer but Clean Soils to Protect Aquifer (Natural Attenuation Cleans Aquifer Over Time)	Provide drinking water through public water supply.	$5 million	Restriction on use of GMA to properties east and south of Fernald site.	Several hundred years
Extract Groundwater to Achieve Containment at Current Leading Edge of Plume and Clean Soils to Protect Aquifer (Treat and Discharge to Great Miami River)	Provide public water supply. Continue pumping south plume wells Install additional pumping wells as needed	$1 billion	Restriction on use of GMA to all properties up stream of south plume.	100+ years
Extract Groundwater to Achieve Containment On-Site and Clean Soils to Protect Aquifer (Treat and Discharge to Great Miami River)	Provide public water supply. Continue pumping south plume wells Install additional pumping wells Install wells at south boundary	$1 billion	Restriction on use of GMA to all properties up stream of south plume.	100+ years
Pump and Treat Aquifer to Achieve MCLs Throughout (Discharge to Great Miami River)	Provide public water supply. Continue pumping south plume wells Install additional pumping wells Install wells at south boundary Additional wells in plume	$400 million	Restriction on use of GMA to all properties up stream of south plume.	35 years
Pump and Treat Aquifer to Achieve 10^{-6} Risk Throughout (Discharge to Great Miami River)	Provide public water supply. Continue pumping south plume wells Install additional pumping wells Install wells at south boundary Additional wells in plume	$800 million	Restriction on use of GMA to all properties up stream of south plume.	70 years

FUTURE USE SCENARIOS *vs.* AQUIFER PROTECTION

The impact of soil uranium contamination on the concentrations of uranium in groundwater are critical to groundwater protection. Factors which determine allowable soil concentrations include the thickness of the clay layer between surface soils and the Great Miami Aquifer, the solubility of the uranium in the soil, and the potential for surface runoff into surface water bodies which could transfer contamination to the aquifer. At Fernald, the high solubility of the uranium contamination in the production area result in the soil concentrations to required to protect the aquifer in this area to be extremely low. On the groundwater protection map, this area is designated as Zone I. The higher solubility of uranium in areas surrounding the production area allow for a higher soil concentration to be protective of the aquifer. This area has been designated as Zone II.

In addition, there are perched groundwater zones beneath the production areas that are capable of yielding greater than 1 gallon per minute. Under residential conditions, these groundwater zones would have to be protected or removed to allow for on-site wells.

Groundwater Protection at 10^{-5}
Using a 10^{-5} risk standard would result in desired concentrations of contaminants in the aquifer to be roughly equivalent to MCLs. The resulting soil concentrations under this scenario are 20 ppm in Zone I and 100 ppm in Zone II.

Groundwater Protection at 10^{-5}
A 10^{-6} risk standard would require concentrations of contaminants in the aquifer to be calculated at the 10^{-6} risk level which is significantly more stringent than MCLs. The resulting soil concentrations for this scenario are 5 ppm in Zone I and 10 ppm in Zone II.

These stringent soil concentrations effectively eliminate most land use options:

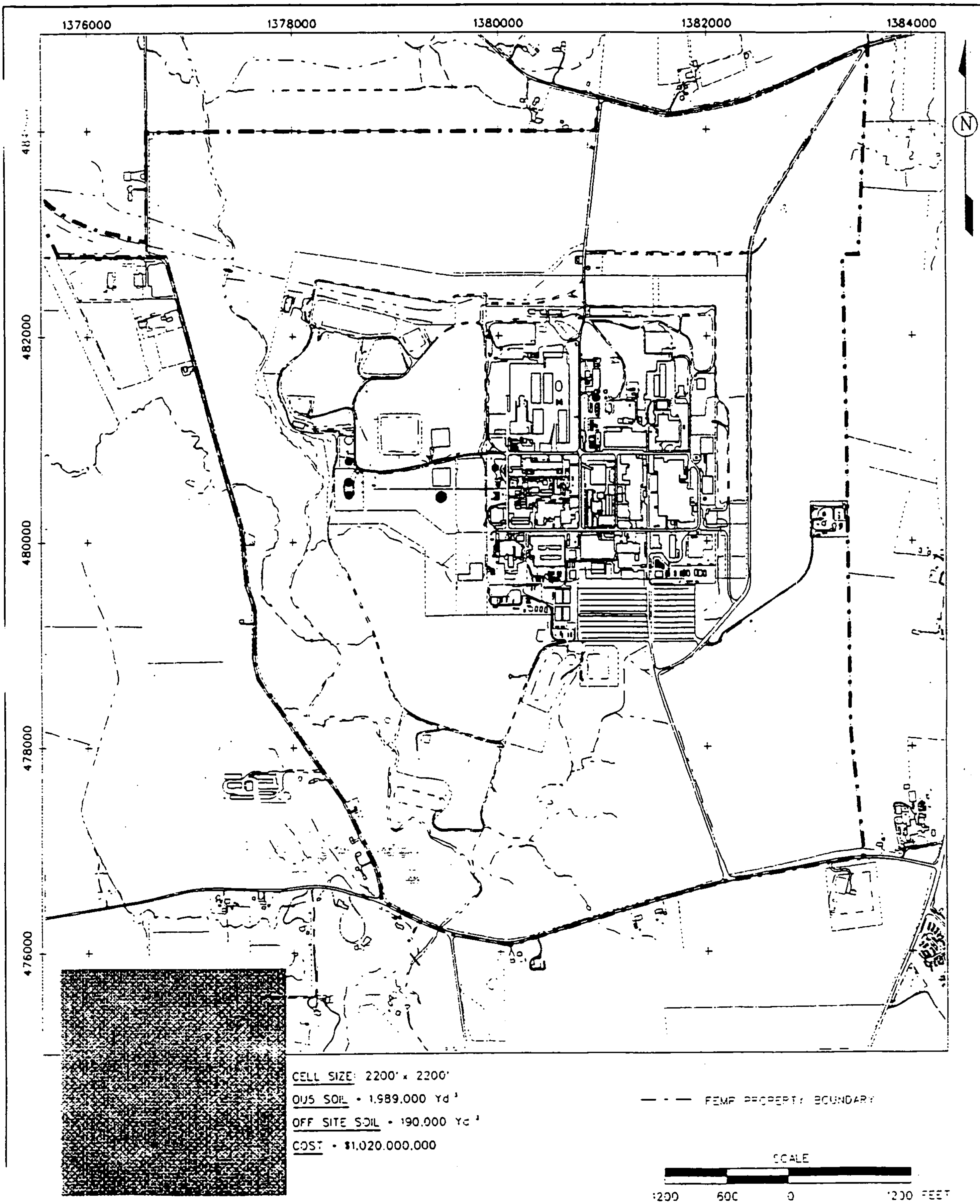
Acceptable Border Uses		Acceptable Center Uses	
at 10^{-5} Risk (100 ppm)	at 10^{-6} Risk (10 ppm)	at 10^{-5} Risk (20 ppm)	at 10^{-6} Risk (5 ppm)
Resident Farmer Industrial	Resident Farmer	Resident Farmer	Resident Farmer

Given these constraints, only five of the 21 future use scenarios are viable:

- **Scenario 9** Total Resident at 10^{-5}
- **Scenario 9a** Total Resident at 10^{-6}
- **Scenario 10** Protection of Aquifer to MCLs (10^{-5})
- **Scenario 10a** Protection of Aquifer and Perched Groundwater to MCLs (10^{-5})
- **Scenario 11** Protection of Aquifer to 10^{-6}

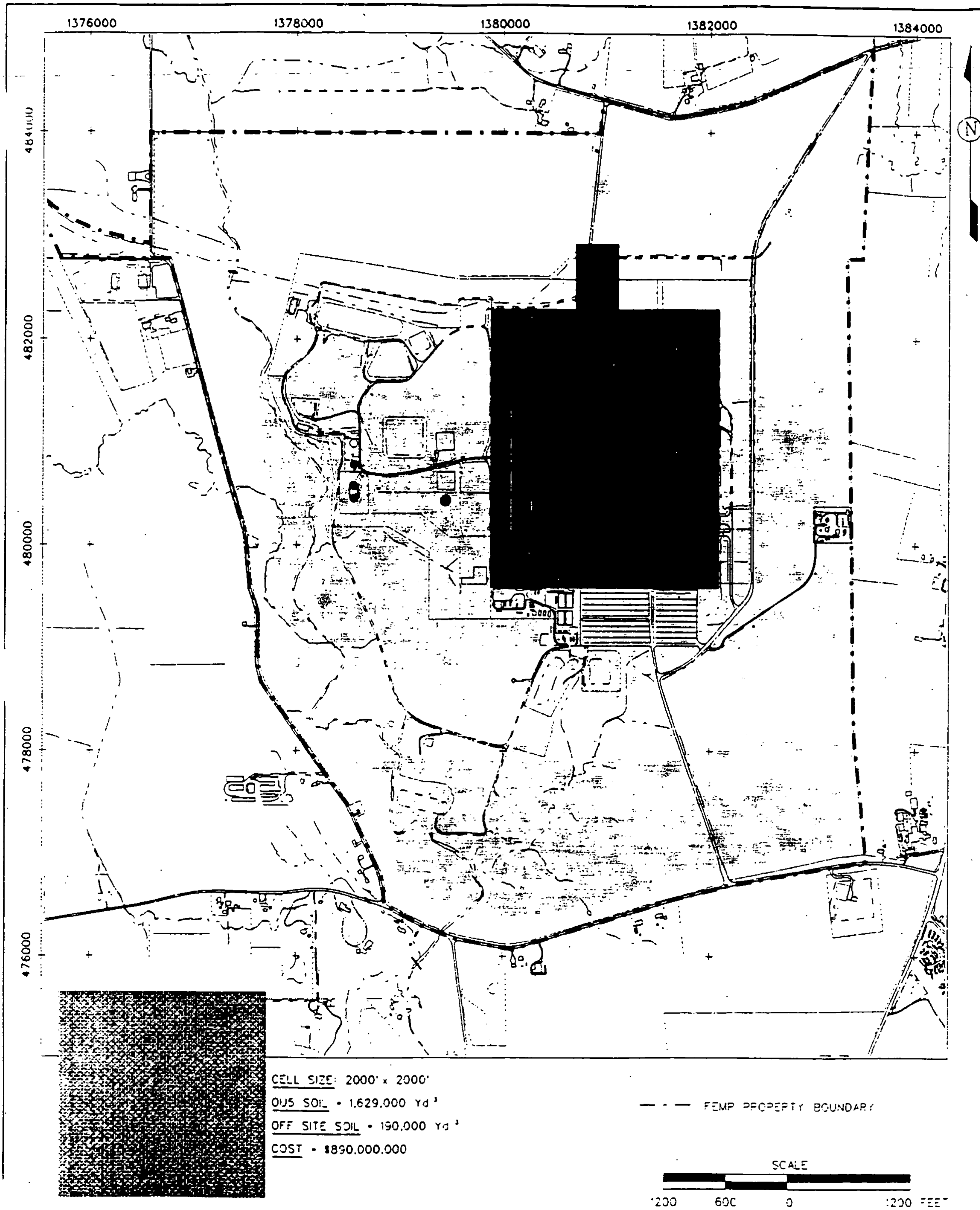
Which ultimately results in only four uniquely different scenarios available at Fernald:

- **Scenario A** Total Resident at 10^{-5} (20 ppm throughout site)
- **Scenario B** Resident Border/Industrial Center at 10^{-5} (20 ppm throughout site but no cleanup of perched ground water)
- **Scenario C** Total Industrial at 10^{-5} (100 ppm border, 20 ppm center with no cleanup of perched ground water)
- **Scenario D** Total Resident at 10^{-6}



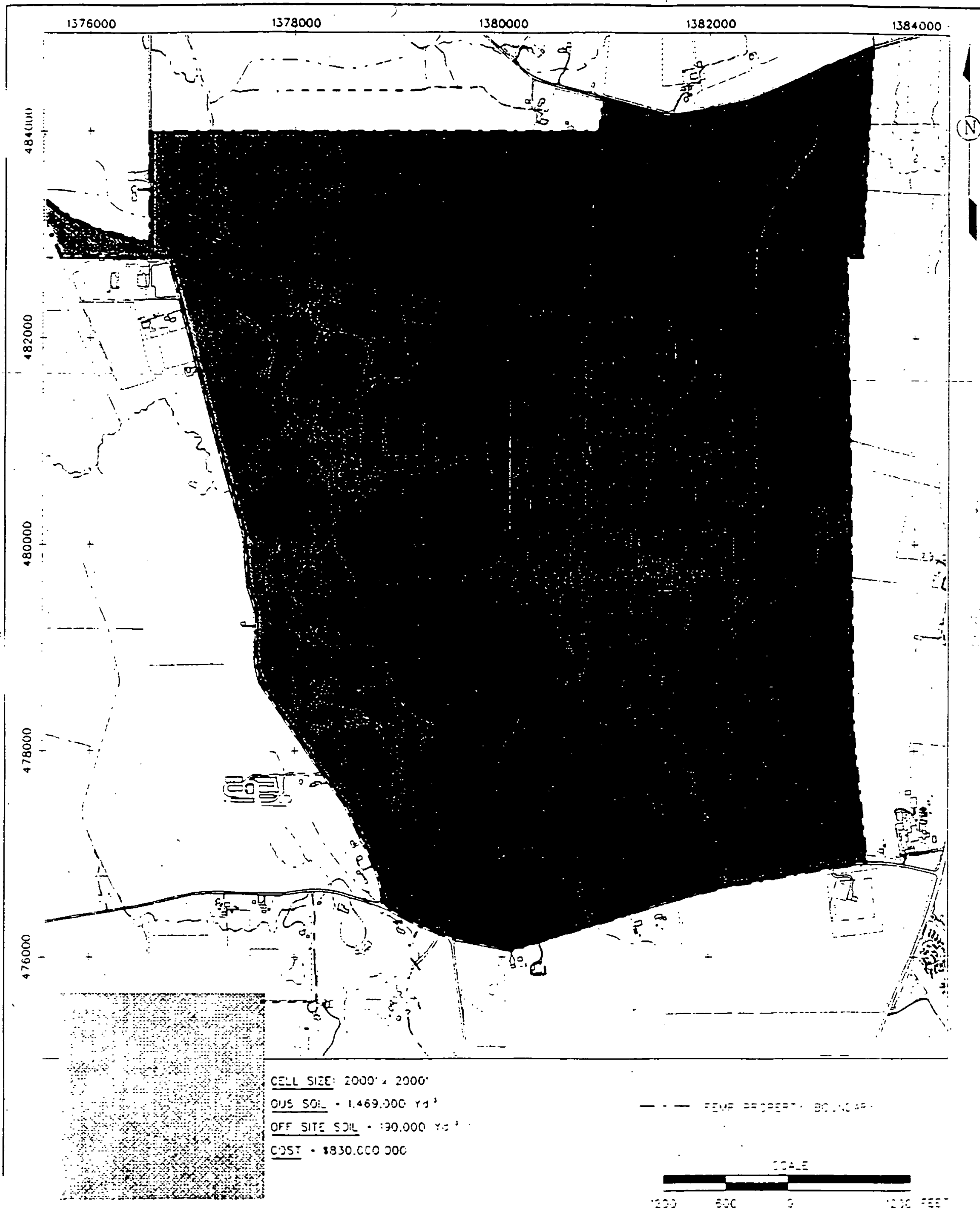
AQUIFER PROTECTION SCENARIO A.
TOTAL RESIDENTIAL AT 10^{-5}

X-33



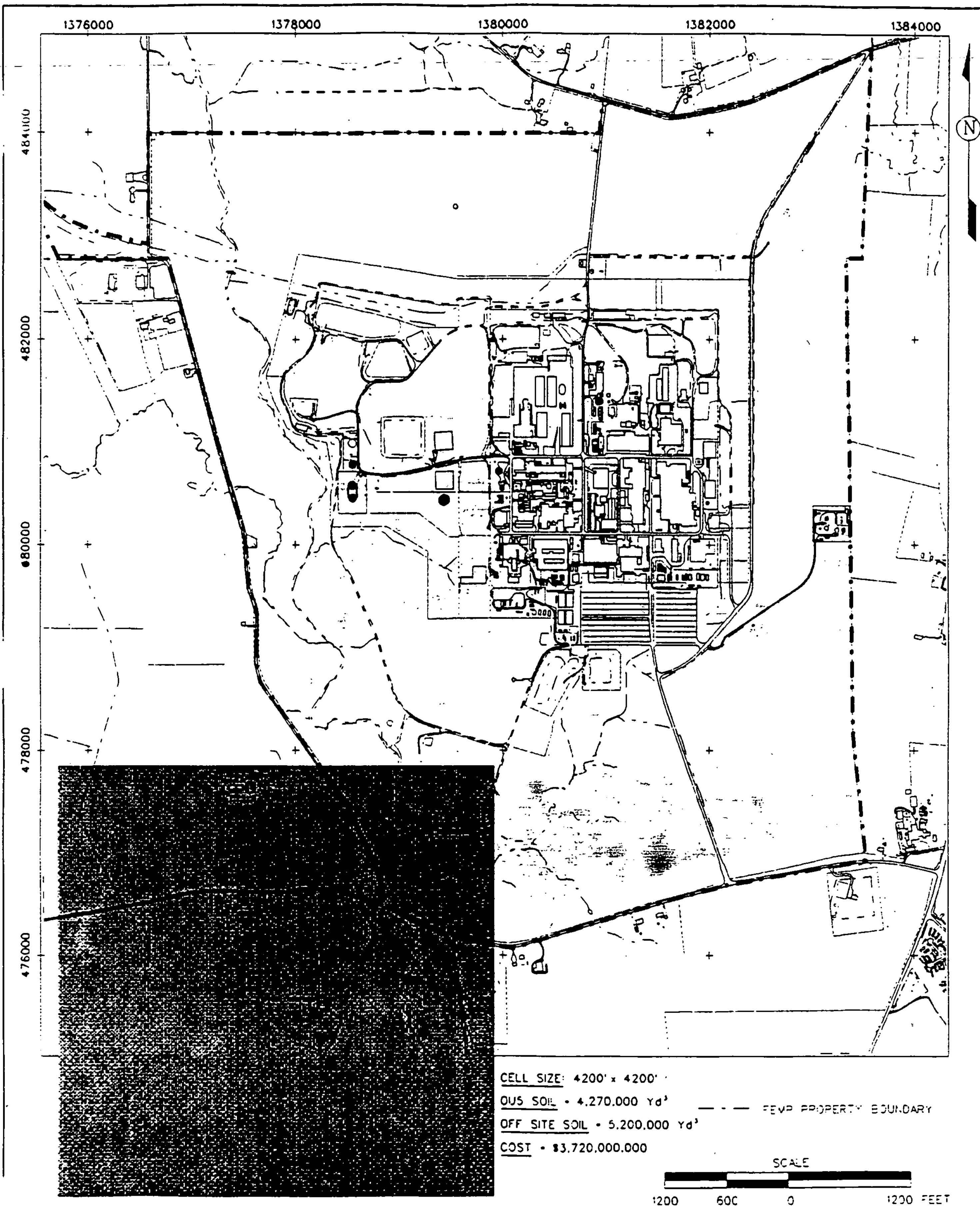
AQUIFER PROTECTION SCENARIO B.
INDUSTRIAL CENTER/RESIDENTIAL BORDER AT 10^{-5}

X-34



AQUIFER PROTECTION SCENARIO C. TOTAL INDUSTRIAL AT 10^{-5}

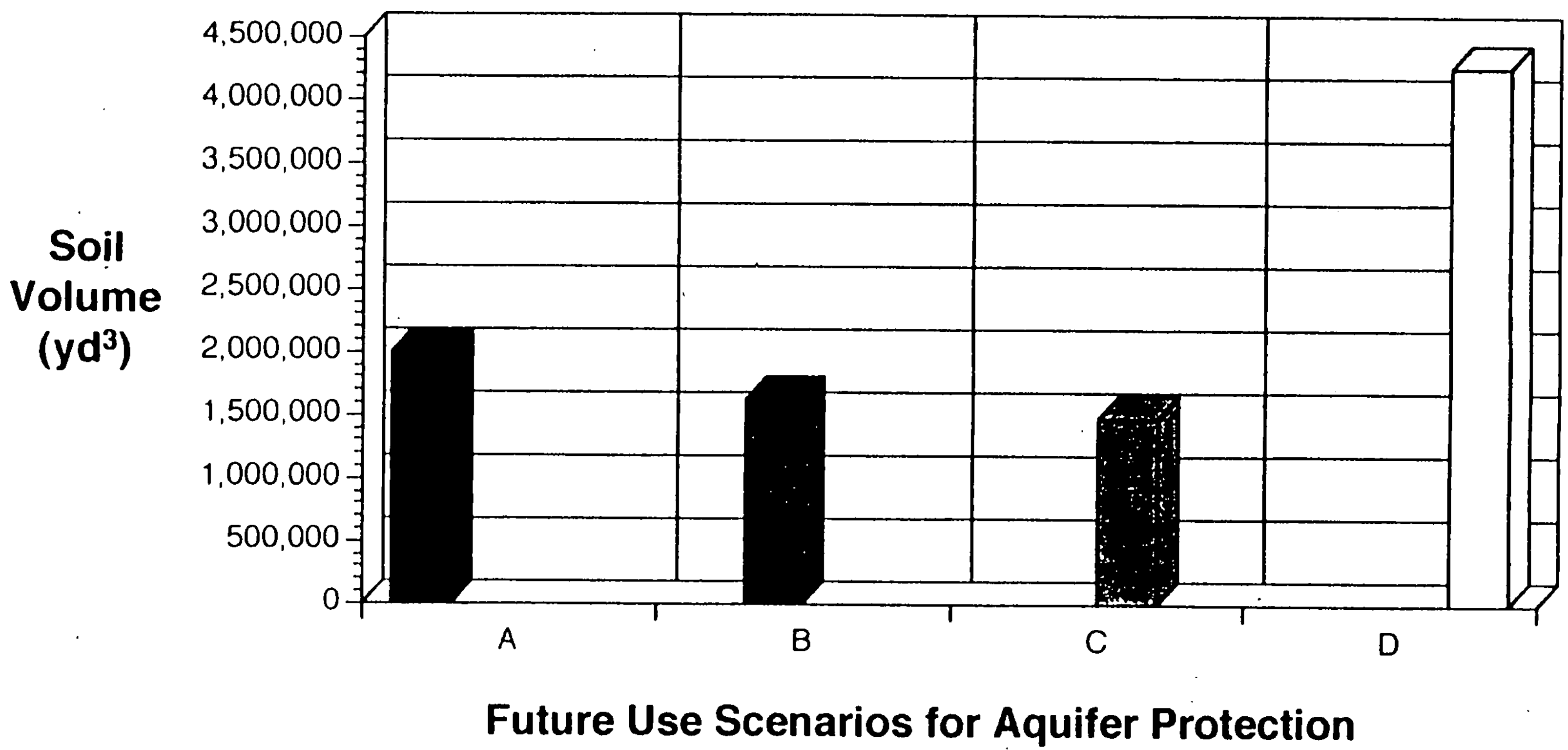
X-35



AQUIFER PROTECTION SCENARIO D. TOTAL RESIDENTIAL AT 10^{-6}

X-36

Comparison of Soil Volumes for Future Use Scenarios for Aquifer Protection



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GLOSSARY

activity - The number of nuclear decays per unit time in a sample of a radioactive substance.

advanced waste water treatment - The objective of the system being built for the Fernald site is to provide advanced treatment of site waste water streams to remove radionuclides. There are two phases: Phase I, for stormwater runoff and Phase II, for waste waters generated as a result of conducting cleanup activities. The system is scheduled to begin operating in early 1995.

ALARA - As Low As Reasonably Achievable, or keeping radiation emissions and exposures to levels set as far below regulatory limits as is reasonably possible in order to protect public health and the environment.

alpha radiation - The most energetic but least penetrating form of radiation. It can be stopped by a sheet of paper and cannot penetrate human skin. However, if an alpha-emitting isotope is inhaled or ingested, it will cause highly concentrated local damage.

antagonism - The interaction of two chemicals having an opposing,or neutralizing effect on each other.

aquifer - A permeable body of rock capable of yielding quantities of groundwater to wells and springs.

ARARs - Applicable or relevant and appropriate requirements, a comprehensive set of laws and regulations that are relevant to guide the selection of cleanup activity at a particular site.

asbestos - A strong and incombustible fiber widely used in the past for fireproofing and insulation. The small, buoyant fibers are easily inhaled or swallowed, causing a number of serious diseases including: asbestosis, a chronic disease of the lungs that makes breathing more and more difficult; cancer; and mesothelioma, a cancer (specific to asbestos exposure) of the membranes that line the chest and abdomen.

attenuation - The process by which a compound is reduced in concentration over time, through absorption, adsorption, degradation, dilution, and/or transformation.

baseline risk assessment - The study and estimation of risk from taking no activity. Involves estimates of probability and consequence.

Becquerel (Bq) - The International System (SI) unit for activity of radioactive material. One becquerel is that quantity of radioactive material in which one atom is transformed per second or undergoes one disintegration per second.

beta radiation - High-energy electrons (beta particles) emitted from certain radioactive material. Can pass through 1 to 2 centimeters of water or human flesh and can be shielded by a thin sheet of aluminum. Beta particles are more deeply penetrating than alpha particles but, because of their smaller size, cause less localized damage.

bioassay - Measurement of radioactive material deposited within or excreted from the body. This process includes whole body and organ counting as well as urine, fecal, and other specimen analysis.

bioremediation - Use of living organisms to clean up oil spills or remove other pollutants from soil, water, or wastewater.

buffer zone - The smallest region beyond the disposal unit that is required as controlled space for monitoring and for taking mitigative measures, as may be required.

carcinogen - A cancer-causing agent.

CERCLA - Comprehensive Environmental Response, Compensation, and Liability Act (also known as Superfund), the federal law that guides cleanup of hazardous waste sites.

curie - A unit of radioactivity that represents the amount of radioactivity associated with one gram of radium. To say that a sample of radioactive material exhibits one curie of radioactivity means that the element is emitting radiation at the rate of 3.7 million times a second. Named after Marie Curie, an early nuclear scientist.

daughter product - An element formed by the radioactive decay of another element; often daughter products are radioactive themselves

decay - The process whereby radioactive particles undergo a change from one form, or isotope, to another, releasing radioactive particles and/or energy.

decontamination - The removal of unwanted material (typically radioactive material) from facilities, soils, or equipment by washing, chemical action, mechanical cleansing or other techniques.

dioxin - One of the most hazardous of all chemicals, can cause both acute and long-term effects ranging from chloracne, a skin disease, to cancer, reproductive failures, and reduced resistance to infectious disease.

dose - Quantity of radiation or energy absorbed; measured in rads. (See **rad**).

dose equivalent - A term used to express the amount of effective radiation received by an individual. A dose equivalent considers the type of radiation, the amount of body exposed, and the risk of exposure. Measured in rems. (See **rem**).

effluent - A waste discharged as a liquid.

electron - An elementary particle with a unit negative charge and a mass 1/1837 that of the proton. Electrons surround the positively charged nucleus and determine the chemical properties of the atom.

elemental compound - Any of the 109 substances that cannot be broken down further without changing its chemical properties. Singly or in combination, the elements constitute all matter.

emergent wetlands - A wetland class characterized by erect, rooted, herbaceous hydrophytes (i.e., the roots of these plants grow in the saturated zone and the plant body emerges into the atmosphere).

exposure - A measurement of the displacement of electrons from atoms caused by x-rays or by gamma radiation. Acute exposure generally refers to a high level of exposure of short duration; chronic exposure is lower-level exposure of long duration.

fission - The splitting of a heavy nucleus into two or more radioactive nuclei, accompanied by the emission of gamma rays, neutrons and a significant amount of energy. Fission usually is initiated by the heavy nucleus absorbing a neutron, but it also can occur spontaneously.

feasibility study (FS) - the Superfund study following a remedial investigation which identifies, develops, evaluates and selects remedial action alternatives.

gamma rays - Penetrating electromagnetic waves or rays emitted from nuclei during radioactive decay, similar to x-rays. Dense materials such as concrete and lead are used to provide shielding against gamma radiation.

geohydrology - The science dealing with underground water, often referred to as hydrogeology.

groundwater - Water beneath the earth's surface that fills pores between materials such as sand, soil or gravel. Groundwater is a major source of water for agricultural and industrial purposes and is an important source of drinking water for about half of all Americans.

half-life - The time required for a radioactive substance to lose 50 percent of its activity by decay. The half-life of the radioisotope plutonium-239, for example, is about 24,000 years. Starting with a pound of plutonium-239, in 24,000 years there will be one-half pound of plutonium-239, in another 24,000 years there will be one-fourth pound, and so on. (A pound of material remains, but it gradually becomes a stable element.)

hazardous waste - A solid waste or combination of solid wastes that, because of quantity, concentration or physical, chemical or infectious characteristics, may cause or significantly contribute to an increase in mortality or an increase in serious, irreversible, or incapacitating reversible illness or pose a substantial hazard to human health or the environment when improperly treated, stored, transported, disposed or otherwise managed. About 290 million tons of hazardous wastes are generated in the United States each year. A small percentage (about 4 percent) is recycled. The rest is treated, stored or disposed. Of the hazardous wastes disposed, most are injected as a liquid into the ground in specially designed injection wells. A large quantity is placed in surface impoundments (pits, ponds and lagoons). A small portion is placed directly on the land or buried.

high-level radioactive wastes - Highly radioactive material, containing fission products, traces of uranium and plutonium, and other transuranic elements, that results from chemical reprocessing of spent fuel. Originally produced in liquid form, high-level waste must be solidified before disposal.

ion - Atomic particle, atom or chemical radical bearing an electric charge, either negative or positive.

ionization - Removal of electrons from an atom, for example, by means of radiation, so that the atom becomes charged.

ionizing radiation - Radiation that has enough energy to remove electrons from substances it pass through, forming ions.

isotopes - Atoms of the same element that have equal numbers of protons, but different numbers of neutrons. Isotopes of an element have the same atomic number by different atomic mass. For example, uranium-238 and uranium-235.

leachate - The solution formed when soluble components have been removed from a material.

leaching - To remove a soluble substance from a material by dissolving it in a liquid, and then removing the liquid from what is left.

low-level radioactive waste - discarded radioactive material such as rags, construction rubble, glass, etc., that is only slightly or moderately contaminated. This waste usually is disposed of by land burial.

Maximum Concentration Limit (MCL) - The regulatory limit for various constituents, usually organics and inorganics; there are different levels for different media, such as air, soil, and water. The MCL cannot be exceeded.

metals - The term "trace metals" refers to metals that are present either in the environment or in the human body in very low concentrations, such as copper, iron, and zinc. Heavy metals are those trace metals whose densities are at least five times greater than water, such as cadmium, lead, mercury, and uranium. Toxic metals are all those metals whose concentrations in the environment are now considered to be harmful, at least to some people in some places.

millirem - A unit of radiation dosage equal to one-thousandth of a rem. A member of the public can safely receive up to 500 millirems per year, according to federal standards, but the U.S. EPA ordinarily limits public exposure to 25 to 100 mrem/year.

mixed waste - Contains both radioactive and hazardous components.

mobility - The ability of constituents to move, such as through various environmental media.

naturally occurring radioactive materials (NORM) - The natural radioactivity in the environment. Natural radiation consists of cosmic rays, filtered through the atmosphere from outer space, and radiation from the naturally radioactive elements in the earth (primarily uranium, thorium, radium and potassium). Also known as natural radiation.

Nevada Test Site (NTS) - A government-owned repository for radioactive wastes.

pathways - The means by which contaminants move. Possible pathways include air, surface water, groundwater, plants and animals.

PCB - Polychlorinated biphenyl, a synthetic, organic chemical once widely used in electrical equipment, specialized hydraulic systems, heat transfer systems, and other industrial products. Highly toxic and a potent carcinogen. Any hazardous wastes that contain more than 50 parts per million of PCBs are subject to regulation under the Toxic Substances Control Act.

picocuries - Measurement of radioactivity. A picocurie is one million millionth, or a trillionth, of a curie, and represents about 2.2 radioactive particle disintegrations per minute.

plume - A defined area of groundwater containing contamination that originates from a particular source such as a waste unit.

plutonium - An artificially produced element that is fissile and radioactive. It is created when an atom of uranium-238 captures a slow neutron in its nucleus.

pneumoconiosis - A disease of the lungs caused by the habitual inhalation of irritant mineral or metallic particles.

risk assessment - the study and estimation of risk from a current or proposed activity. Involves estimates of the probability and consequence of an action.

rad - Radiation absorbed dose, a measurement of ionizing radiation absorbed by any material. A rad measures the absorption of a specific amount of work (100 ergs) in a gram of matter.

radiation - Fast particles and electromagnetic waves emitted from the nucleus of an atom during radioactive disintegration.

radioactive - Giving off, or capable of giving off, radiant energy in the form of particles (alpha or beta radiation) or rays (gamma radiation) by the spontaneous disintegration of the nuclei of atoms. Radioisotopes of elements lose particles and energy through the process of radioactive decay. Elements may decay into different atoms or a different state of the same atom.

radioactive waste - A solid, liquid or gaseous material of negligible economic value that contains radionuclides in excess of threshold quantities except for radioactive material form post-weapons-test activities.

radioisotope - An unstable isotope of an element that eventually will undergo radioactive decay (i.e., disintegration). Radioisotopes with special properties are produced routinely for use in medical treatment and diagnosis, industrial tracers, and for general research.

radionuclide - A radioactive species of an atom.

radon - A radioactive gas produced by the decay of one of the daughters of radium. Radon is hazardous in unventilated areas because it can build up to high concentrations and, if inhaled for long periods of time, may cause lung cancer.

rem - Roentgen equivalent man, a unit used in radiation protection to measure the amount of damage to human tissue from a dose of ionizing radiation. Incorporates the health risks from radiation.

stochastic effects - Malignant and hereditary disease for which the probability of an effect occurring, rather that its severity, is regarded as a function of dose without a threshold for radiation protection purposes.

synergism - The cooperative interaction of two or more chemicals or other phenomena producing a greater total effect than the sum of their individual effects.

teratogen - Substance that causes malformation or serious deviation from normal development of blastocysts, embryos and fetuses.

threshold dose - The minimum dose of radiation that will produce a detectable effect.

transuranic wastes - Waste materials contaminated with isotopes above uranium in the periodic table. Transuranic waste is long-lived, but only moderately radioactive.

uranium - The heaviest element found in nature. Approximately 997 out of every 1000 uranium atoms are uranium-238. The remaining 3 atoms are the fissile uranium-235. The uranium-235 atom splits, or fissions, into lighter elements when its nucleus is struck by a neutron.

Natural uranium consists of three primary isotopes; U^{238}, U^{235}, and U^{234}. The typical isotopic abundances of different commercial classes of uranium are listed in the table below.

TYPICAL ISOTOPIC ABUNDANCES
Grams of Isotope per 100 Grams Natural Uranium

ISOTOPE	NATURAL URANIUM	TYPICAL COMMERCIAL FEED ENRICHMENT	DEPLETED
U^{238}	99.27	97.01	99.75
U^{235}	0.72	2.96	0.25
U^{234}	0.006	0.03	0.0005

Normal uranium is uranium metal which has been processed (extracted) from naturally occurring ores and has the approximate percent abundances of principle isotopes as natural uranium.

vitrification - A method of immobilizing waste that produces a glass-like solid that permanently captures the radioactive materials.

Volatile organic compounds (VOCs) - chemicals that contain carbon and commonly also contain hydrogen, oxygen and other elements. The prefix "volatile" means that the compound evaporates rapidly. Most industrial solvents are volatile. VOCs are found in some liquid and air waste releases.

wetlands - Areas that are inundated by surface or ground water with a frequency sufficient to support and, under normal circumstances does or would support, vegetative or aquatic life that requires saturated or seasonably saturated soil conditions for growth and reproduction. Wetlands generally include swamps, marshes, bogs, and similar areas such as sloughs, potholes, wet meadows, river overflow, mud flats, and natural ponds.

FERNALD CITIZEN TASK FORCE
CHART OF CONVERSION FACTORS

1 milligram per kilogram (mg/kg) = 1 part per million (ppm) =
1 microgram per gram (µg/g)

1 µg uranium/g soil = 1 ppm = 0.67 pCi/g

1 microgram per kilogram (µg/kg) = 1 part per billion (ppb) =
1 nanogram per gram (ng/g)

1 milligram per liter (mg/L) = 1 part per million (ppm)

1 microgram per liter (µg/L) = 1 part per billion (ppb)

1 microgram uranium per liter water = .67 pCi/L

Scientific Notation: very large and very small numbers are often expressed in scientific, or exponential, notation. The exponent identifies how many times the base number is multiplied by itself. In the example 10^2, 10 is the base number and 2 is the exponent. Therefore, 10^2 means multiply 10 by 10 which equals 100. An easy way to remember exponential notation (in base 10) is to write a one followed by the number of zeros equal to the exponent. For example, 10^2 would be expressed as 1 followed by 2 zeros, or 100. 10^6 would be written as a 1 followed by 6 zeros or 1,000,000.

Metric System unit prefixes: prefixes are often employed as substitutes for exponential notation (e.g., k, or kilo = 10^3 = 10 X 10 X 10 = 1000). Most commonly used prefixes are multiples of 1000, or 10^3. We can relate these prefixes to simple fractions. That is, if the prefix is positive, the in the numerator(the top number of a fraction), the multiple is greater than one and the exponent is positive (e.g. 10^3 = 1 X 1000/1). If the prefix relates to the denominator, the multiple is less than 1 and the exponent is negative (e.g., 10^{-3} = 1 X 1/1000 or 0.001).

TABLE OF METRIC SYSTEM PREFIXES

PREFIX	SYMBOL	EXPONENTIAL NOTATION	DECIMAL EQUIVALENT
mega-	M	10^6	1,000,000
kilo-	k	10^3	1,000
centi-	c	10^{-2}	0.01
milli-	m	10^{-3}	0.001
micro-	µ	10^{-6}	0.000001
nano-	n	10^{-9}	0.000000001
pico-	p	10^{-12}	0.000000000001

CURRENT STATUS OF WASTE DISPOSITION DRIVERS/ISSUES AT FERNALD

SEPTEMBER 10, 1994

INTRODUCTION

The Waste Disposition Subcommittee, in its effort to assist the Task Force in making a recommendation regarding future use of the Fernald site, has gathered information on waste disposition drivers and other issues that will also impact waste disposition at Fernald. This information includes what decisions the Department of Energy has already made and the decisions the Department of Energy is in the process of making. The decisions themselves are articulated and implemented via three major processes, but the drivers and issues are not limited to these three processes. The subcommittee has monitored the progress the Department of Energy has made in completing these processes and the effects the other issues have had on these processes as well. The subcommittee has identified five drivers/issues that could potentially impact waste disposition at Fernald:

I. Operable Unit Plans-Remedial Investigation/Feasibility Study Activities
II. Federal Facilities Compliance Act
III. Programmatic Environmental Impact Statement
IV. Midwest Compact Issues/Commercial (non-Department of Energy) Waste Disposition
V. Technology Development

The last of the five, technology development, is analyzed in the context of the subcommittee's mission statement.

Each of the five will be discussed separately.

I. OPERABLE UNIT PLANS-REMEDIAL INVESTIGATION/FEASIBILITY STUDY ACTIVITIES

A. Legal Requirements Satisfied by the Operable Unit Plans-Remedial Investigation/Feasibility Study Activities

1. Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA): This is federal law that was passed in 1980 and was amended in 1986 (by SARA, the Superfund Amendments and Reauthorization Act). The Comprehensive Environmental Response, Compensation, and Liability Act (aka Superfund) requires that a Remedial Investigation and Feasibility Study be issued for the site, and the final decisions on how the site will be cleaned up will be contained in a Record of Decision. The Amended Consent Agreement between United States Environmental Protection Agency and the Department of Energy divided the site into five Operable Units so that like wastes

could be grouped together for more-specific analysis. Each Operable Unit will issue a written report for its

a) Remedial Investigation (RI),
b) Feasibility Study/Proposed Plan (FS/PP), and
c) Record of Decision (ROD).

Each Operable Unit has a different timeline for issuing the required documents. The United States Environmental Protection Agency is the regulatory (oversight) agency to whom the Department of Energy sends the required documents.

2. Resource Conservation and Recovery Act (RCRA): This is federal law that was passed in 1976 and was amended several times, most notably by the Hazardous and Solid Waste Amendments in 1984 and the Federal Facilities Compliance Act (FFCAct) in 1992 (discussed later). The Resource Conservation and Recovery Act gives the Department of Energy specific requirements to meet for managing hazardous waste facilities and also governs procedures used for dealing with hazardous waste releases that might occur at these facilities. The requirements for compliance with the Resource Conservation and Recovery Act have been merged into the Operable Unit Plans, which the United States Environmental Protection Agency already oversees. The Resource Conservation and Recovery Act also provides for state regulatory control, meaning that the Ohio Environmental Protection Agency also has a voice in approving the Operable Unit Plans via both the Consent Decree and the Amended Consent Decree between the Ohio Environmental Protection Agency and the Department of Energy. Those two documents reserve Ohio's right to sue the Department of Energy if Ohio does not approve of the clean-up plans contained in the Records of Decision for each Operable Unit.

3. National Environmental Policy Act (NEPA): This is federal law that was passed in 1969. The United States Environmental Protection Agency does not recognize the National Environmental Policy Act, but the Department of Energy has chosen to comply with it. The National Environmental Policy Act requires that Environmental Impact Statements be issued to document what environmental effects will result from the activities of various federal agencies such as the Department of Energy. The Department of Energy (Fernald) is incorporating the Environmental Impact Statements into each Operable Unit plan to comply with the National Environmental Policy Act. On the national (or complex-wide) level, the Department of Energy is developing a Programmatic Environmental Impact Statement for the activities of all its hazardous waste sites (discussed later).

B. Operable Unit 1: Hazardous Waste, Schedules, and Plans

1. Operable Unit 1 contains the waste pits (numbered 1 through 6), the clear well, and the burn pit.

2. Operable Unit 1's Remedial Investigation was issued in October of 1993. The Feasibility Study came out in March of 1994, and the Proposed Plan came out in August of 1994. The Record of Decision is due in November of 1994.

3. Operable Unit 1's Proposed Plan calls for shipments of waste to be sent by train to Envirocare of Utah, a permitted commercial disposal facility.

C. Operable Unit 2: Hazardous Waste, Schedules, and Plans

1. Operable Unit 2 contains the flyash pile, the lime sludge ponds, the solid waste landfill, and the South Field area.

2. Operable Unit 2's Remedial Investigation was issued in February of 1994. Operable Unit 2's original Proposed Plan came out in late April of 1994, and Operable Unit 2 has been revising it during the summer of 1994. Operable Unit 2's Record of Decision is due in January of 1995.

3. Operable Unit 2's revised Proposed Plan, as described at a June public meeting, will call for a solid waste disposal cell to be built on site to contain wastes from Operable Unit 2, Operable Unit 3, and Operable Unit 5. The contaminated water will be treated through the waste water project.

D. Operable Unit 3: Hazardous Waste, Schedules, and Plans

1. Operable Unit 3 contains the production and "suspect" areas. Basically, Operable Unit 3 includes the contaminated buildings and such.

2. Operable Unit 3's Interim Record of Decision was signed in June of 1994. This was issued to authorize the initiation of work.

3. Operable Unit 3 buildings such as Plant 7 are already in the process of being disassembled. Further disassembly is required.

E. Operable Unit 4: Hazardous Waste, Schedules, and Plans

1. Operable Unit 4 contains silos 1, 2, 3, and 4. They contain the K-65 sludges and the cold metal oxides.

2. Operable Unit 4's Remedial Investigation came out in April of 1993. The Proposed Plan came out in February of 1994 (after a delay), and the Record of Decision came out in August of 1994.

3. Operable Unit 4's Proposed Plan says that the waste from the silos will be vitrified and then shipped to the Nevada Test Site.

F. Operable Unit 5: Hazardous Waste, Schedules, and Plans

1. Operable Unit 5 consists of basically all that's left over, including most of the soil. Technically, it is all the "environmental media."

2. Operable Unit 5 completed its Remedial Investigation in June of 1994. The Proposed Plan is due in November of 1994. The Record of Decision will be issued in July of 1995.

3. Operable Unit 5 plans to treat its soil to prevent leaching and then place it into Operable Unit 2's proposed disposal cell.

II. FEDERAL FACILITIES COMPLIANCE ACT

A. Legal Requirements Satisfied by the Site Treatment Plan (STP)

Federal Facilities Compliance Act (FFCAct): The FFCAct is federal law that went into effect in October of 1992. Its purpose was to force the Department of Energy to comply with applicable mixed waste storage and disposal requirements which the Department of Energy had been violating for a variety of reasons. Under the Federal Facilities Compliance Act, the Department of Energy was given a three-year grace period during which they would not be fined for violating applicable storage and disposal requirements for mixed waste if they showed progress in planning how the mixed waste would be treated at each of the 49 Department of Energy sites nationwide that have mixed waste. Each of those 49 sites has to produce a Site Treatment Plan for submission to a state regulator. In Fernald's case, the Site Treatment Plan will be submitted to the Ohio Environmental Protection Agency, and, among other topics, it will address how the Department of Energy plans to treat the 12,000 Drum Equivalents of mixed waste on site. The Site Treatment Plan is written using a three step process- the conceptual version, the draft version, and the final version. Department of Energy personnel at Fernald write the Site Treatment

Plan; they follow an annotated outline distributed by Department of Energy headquarters so that each of the 49 are similar. Department of Energy headquarters, in conjunction with representatives from the National Governors Association, will also determine which sites are selected as regional treatment centers for mixed waste. Otherwise, the document will be written by local officials, who will also collaborate with the other Ohio Department of Energy sites that have mixed waste (Battelle, Mound, Portsmouth, and RMI).

B. Conceptual Site Treatment Plan (CSTP)

The Conceptual Site Treatment Plan was submitted to the Ohio Environmental Protection Agency in October of 1993. The Conceptual Site Treatment Plan identified every potential treatment option for each of the more than 300 different types of mixed waste that Fernald has. The idea was to identify the "treatment universe" for each type of waste.

C. Draft Site Treatment Plan (DSTP)

The Draft Site Treatment Plan was sent to the Ohio Environmental Protection Agency in August of 1994. The Draft Site Treatment Plan does not resemble the Conceptual Site Treatment Plan much at all. The purpose of the Draft Site Treatment Plan is to identify similar types of mixed waste to form mixed waste groups, and, for each of those groups of mixed waste, to select a preferred option in three different categories:

1. on-site options (including mobile and portable);
2. off-site, in-state options (other Ohio Department of Energy sites); and
3. off-site, out-of-state options.

The second of the three above-listed categories is being required by the Ohio Environmental Protection Agency for potential regional treatment and disposal plans. The Ohio Environmental Protection Agency is also requiring disposal plans to be listed in the Draft Site Treatment Plan. For some of the mixed waste groups, the Department of Energy has already identified which of the three preferred options will be the final treatment choice. At present, only one group of mixed waste is slated to be shipped to Fernald from another site; it will be from Portsmouth and will undergo treatment at the Fernald Minimum Additive Waste Stabilization facility. The Department of Energy currently estimates that approximately one percent (1%) of its mixed waste inventory will be moved off one site and shipped elsewhere.

D. Final Site Treatment Plan (FSTP)

The Final Site Treatment Plan is due to the Ohio Environmental Protection Agency in February of 1995. The Final Site Treatment Plan should resemble the Draft Site Treatment Plan with the addition of three more elements:

1. Ohio Environmental Protection Agency's input (regulatory),
2. Stakeholder input, and
3. More definite Operable Unit plans, here and elsewhere.

E. National Coordination of the Site Treatment Plans

Each of the 49 Department of Energy sites with mixed waste are currently being evaluated to determine the suitability of siting a permanent regional treatment/disposal there. Department of Energy headquarters is being aided in this process by representatives of the National Governors Association from the 22 states that have mixed waste. Three criteria have already been used to reduce the number of potential sites from 49 to 26. These three criteria-

1. whether located within 61 meters of an active fault,
2. whether located within a 100-year flood plain, and
3. whether space existed to establish a 100 meter buffer zone,

will not be the only three factors used to eliminate sites from consideration. No final decisions have been reached regarding other possible criteria. Another 10 sites were moved to a low-priority list in late July of 1994 and will not be considered as primary disposal sites. Currently, 16 sites are still being considered as disposal locations, and Fernald is one of them. The Department of Energy has stressed that the Site Treatment Plans will not include any decisions not contained within the Operable Unit Record of Decisions and also that all applicable state and federal laws will be followed when siting these disposal facilities, meaning that Fernald should not be a finalist (but is still on the list for political reasons, according to Graham Mitchell of the Ohio Environmental Protection Agency).

III. PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT

A. Legal Requirements Satisfied by the Programmatic Environmental Impact Statement (PEIS)

The National Environmental Policy Act (NEPA) is federal law passed in 1969 in order to create a mechanism by which the environmental impact of federal activities could be gauged. The Department of Energy has ordered each of its sites that have the combined Environmental Restoration activities and Waste Management programs to prepare an Environmental Impact Statement (see the Operable Unit Plans-Remedial Investigation/Feasibility Study Activities section above). These are to be compiled into a complex-wide document that evaluates the environmental impact of the Department of Energy's clean-up efforts as a whole.

B. Schedule and Implementation of the Programmatic Environmental Impact Statement

The Implementation Plan for the Programmatic Environmental Impact Statement was released in January of 1994. The Department of Energy had planned to conduct public participation workshops in the late spring of 1994 in nine cities, of which Cincinnati was one. These plans were frozen by Department of Energy headquarters in the summer of 1994. A draft of the Programmatic Environmental Impact Statement is scheduled for a December 1, 1994 release with a final version due out between May and July of 1995. The document will contain an analysis of the impact of the Department of Energy's waste management activities and also environmental restoration activities where they coincide with waste management. This analysis will be an explication of several different options open to the Department of Energy with regard to selecting treatment and disposal centers. The document will not quite reach the detail involved with writing about the complex on a site-by-site basis; it will emphasize regional and national decisions. Secretary O'Leary will then choose from the options presented in the Programmatic Environmental Impact Statement when she issues a Record of Decision charting the Department's planned course of action. Then, each site will base its Environmental Impact Statement on the Record of Decision, or if sites issued Environmental Impact Statements prior to the release of the Record of Decision, the Environmental Impact Statements will be amended to reflect any changes. The National Governors Association will heavily influence this process, albeit informally, just as it is influencing the Site Treatment Plans that are being issued under the Federal Facilities Compliance Act. This information came from Steve Simpson at the Department of Energy's Office of NEPA Oversight in Washington, D.C., and represents the Department's plan as of July, 1994.

IV. MIDWEST COMPACT ISSUES (COMMERCIAL LOW LEVEL WASTE)

A. Legal Requirements Satisfied by Ohio's Involvement in the Midwest Compact

The Low-Level Radioactive Waste Policy Act (LLRWPA) of 1980 is federal law that was passed in order to make each individual state responsible for disposing of its own low-level radioactive waste. Prior to 1980, there were only three disposal facilities in the nation that accepted commercial (non Department of Energy) low-level radioactive waste-

1. Richland, Washington;
2. Beatty, Nevada; and
3. Barnwell, South Carolina.

Under the Low Level Radioactive Waste Policy Act, states were urged to join "compacts," which are groups of states formed for the purpose of developing regional disposal sites for commercial low-level waste. The kicker was that if a state chose not to join a compact, it could not prevent other states or other compacts from shipping their waste to that "going-it-alone" state's disposal facility, which was a strong incentive for a state to join a compact. Ohio joined the Midwest Compact as a result of the Low Level Radioactive Waste Policy Act.

B. How the Midwest Compact Functions

The seven states that comprised the Midwest Compact at its inception in December of 1985 were Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio, and Wisconsin. Each of the seven determined that a environmentally safe disposal facility could be located within its borders. In February of 1987, the Midwest Compact Commission selected Michigan, Minnesota, Ohio, and Wisconsin as potential sites of the first regional disposal facility. Those states were given 90 days to leave the Compact without being fined if they so chose. None did. In June of 1987, Michigan was selected by the Midwest Compact Commission as the site of the first regional disposal facility on the basis that Michigan generated the most commercial low-level waste (mostly from nuclear reactors and hospitals). Ohio was designated as the first alternate to Michigan, as Ohio is the second-largest generator of waste in the Midwest Compact. Michigan's failure to plan the construction of its regional facility resulted in its expulsion from the Midwest Compact in 1991 and in Michigan's waste being stored at over 50 sites within its borders. Ohio is currently designated as host to the first regional disposal facility. This facility must accept waste from the other Midwest Compact states for either 20 years or until the facility's capacity is reached; the capacity has been set at 2.25 million cubic feet by the Midwest Compact Commission working in conjunction with the state of Ohio. This capacity exceeds the 20 year projections for waste generation by the Midwest Compact by 50% to allow for unforeseen occurrences like the decommissioning of a nuclear power plant.

C. Ohio's Current Efforts to Develop a Regional Disposal Facility

The Governor and the General Assembly received recommendations from two different bodies in September of 1993-

1. the Ohio Blue Ribbon Commission, and
2. the Ohio Low-Level Radioactive Waste Advisory Committee.

The Blue Ribbon Commission's recommendation was titled "Recommendations on Siting Criteria and Development Requirements for a Regional Low-Level Radioactive Waste Disposal Facility in Ohio." It included information pertaining to the selection of a site and the issues and concerns surrounding that process. In the site selection section, the Commission recommended that the facility not be sited over a sole source aquifer. The Advisory Committee's product was its "Report and Recommendations on the Development and Operation of a Regional Low-Level Radioactive Waste Disposal Facility in Ohio." Its focus was on developing a governmental infrastructure that would be responsible for building and monitoring the disposal facility. The General Assembly is expected to consider legislation on the topic of a regional disposal facility in early 1995. This legislation would only initiate the process of planning the disposal facility; the facility's doors wouldn't actually open for another 5 to 8 years. In the meantime, Ohio's commercial waste generators, approximately 55 to 60 in number, are storing their own waste.

D. Impact of Ohio's Efforts on Fernald

The issues of Midwest Compact commercial low-level waste and the Department of Energy's clean-up of Fernald may be completely unrelated, but lingering questions do remain. The Ohio Environmental Protection Agency says that compact waste and Department of Energy (federal) waste are not to be mentioned together, as they are totally separate and distinct issues. Also, the co-mingling of state and federal funds does not seem likely. There are reasons for concern-

1. potential extra space in the disposal cell,
2. Barnwell, South Carolina deciding to close its doors to the Midwest Compact's commercial waste, and
3. the expense and public outcry involved in siting and building another cell in Ohio.

None of these concerns should cause Fernald to be considered as a disposal facility for commercial low-level radioactive waste, however.

Current plans for the proposed disposal cell at Fernald call for the cell to be capped; an Ohio Midwest Compact disposal facility would have to remain accessible for 20 years following the facility's doors first opening.

V. TECHNOLOGY DEVELOPMENT

A. Legal Requirements Satisfied by Technology Development

There are none. The Comprehensive Environmental Response, Compensation, and Liability Act does express a preference for treatment and also for development of innovative technologies. This guidance is taken seriously by the Department of Energy. Technology development's potential effect on waste disposition at Fernald comes from the costs associated with testing new methods that might be effective in treating or disposing of waste or testing proven methods of treating or disposing of particular types of waste on other types of waste, usually after some tinkering is done.

B. How Technology Development Will Affect Fernald

1. As noted above in the Site Treatment Plan section, Fernald is scheduled to receive one mixed waste group from Portsmouth to be treated in the Minimum Additive Waste Stabilization facility (MAWS).

2. In May of 1994, Fernald extended an invitation to Portsmouth to send some of that site's contaminated soil to Fernald for testing in either the Uranium Soils Integrated Demonstration (USID) or the Minimum Additive Waste Stabilization facility. The Uranium Soils Integrated Demonstration, which was the method expected to be selected, required three drums of contaminated Portsmouth soil to conduct the testing. As a result, Fernald has written a "Draft Policy for Receiving Non-RCRA Waste from Off-Site Locations for Treatability Studies at the FEMP." The policy addresses issues like liability and unacceptable materials while creating a procedure to guide such applications for treatability testing. The subcommittee chair sent a letter to ask questions regarding

a) the lack of a clearly defined waste volume ceiling, and
b) the lack of a clearly defined time limit on waste storage.

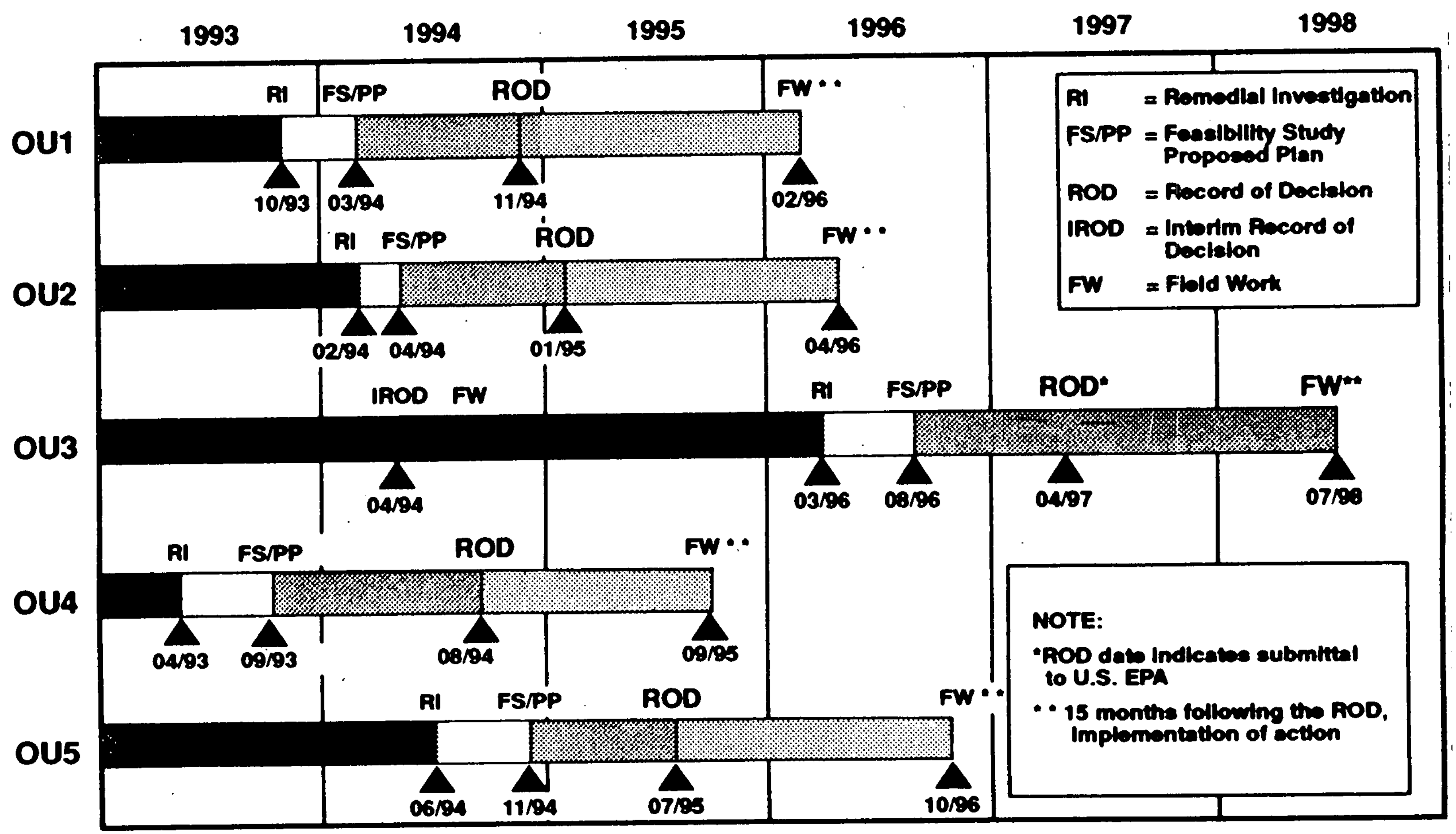
Ken Alkema of the Fernald Environmental Management Company has said that any treatability testing proposals will be subject to public review before final approval is given.

3. A mixed waste sludge known as "Cotter's Concentrate" that is currently being stored and characterized at the Nevada Test Site could potentially be shipped to Fernald. The sludge was originally produced at Mound and was subsequently shipped to Nevada. The characterization of the sludge is not scheduled for completion until October 1994, which might mean its ultimate fate will not be listed in any of the Site Treatment Plans. Nevada citizens indicated to John Applegate that it might be shipped to Fernald. This situation could require monitoring.

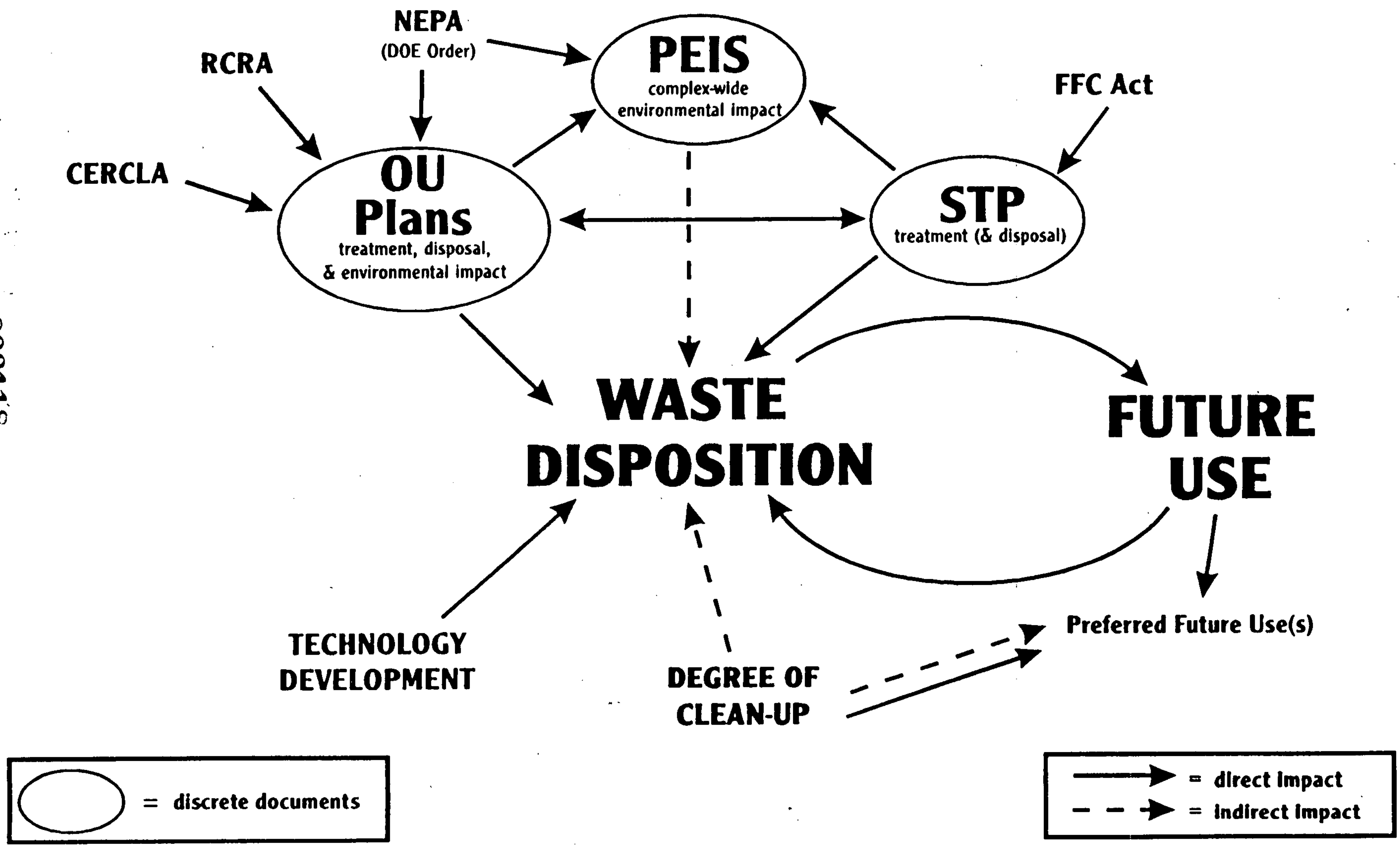
CONCLUSION

The Waste Disposition Subcommittee gathered this information in order to determine what decisions that will affect future use (via waste disposition) the Department of Energy has made to date and what decisions have yet to be made. Records of Decision have not been issued for four of the five Operable Units, yet the Department of Energy is pushing ahead with some of the clean-up of the Operable Unit areas. The destruction of Operable Unit 3's Plant 7 is an example. The Draft Site Treatment Plan was issued at the end of August, yet it might not list all the mixed waste that might be shipped to Fernald if other sites haven't either produced or characterized all their mixed wastes by the time all the Site Treatment Plans are issued. Also, Fernald has not been taken off the list of sites that could be selected as disposal sites. The status of the Programmatic Environmental Impact Statement is currently in limbo. The Midwest Compact may become a major issue at some future date. The direction these drivers take will ultimately determine not only waste disposition at Fernald but future use as well. The Waste Disposition Subcommittee will continue to monitor these drivers.

FERNALD SCHEDULE OF REMEDIATION ACTIVITIES



WASTE DISPOSITION DRIVERS AND THEIR EFFECTS UPON FUTURE USE



GRAPHICS #2812 (7/94)

FERNALD CITIZENS TASK FORCE

WASTE DISPOSITION DRIVERS AND THEIR EFFECTS UPON FUTURE USE

Acronym List

CERCLA :	Comprehensive Environmental Response , Compensation, and Liability Act
FCC Act:	Federal Facilities Compliance Act
NEPA:	National Environmental Policy Act
RCRA:	Resource Conservation and Recovery Act
OU:	Operable Unit(s)
PEIS:	Programmatic Environmental Impact Statement
STP:	Site Treatment Plan

GRAPHICS #2812