

1/11/74/E

# environmental inventory

A HISTORICAL SUMMATION OF ENVIRONMENTAL  
INCIDENTS AFFECTING SOILS AT OR NEAR THE  
U.S.AEC ROCKY FLATS PLANT.

J. B. OWEN

**DRAFT**

L. M. STEWARD

REVIEWED FOR CLASSIFICATION

BY S L CUNNINGHAM

Date 12/14/89 (2)

ADMIN RECORD



ROCKY FLATS  
PLANT

A-SW-000016

I. INTRODUCTION

On September 21 and October 2, 1973, B. W. Colston, Area Manager, Rocky Flats Area Office, U. S. Atomic Energy Commission, requested information concerning contaminated materials and waste storage tanks. On October 4, 1973, the request was broadened to include the development of a comprehensive plan of action dealing with the investigation and unqualified location of all contaminated soil on the Rocky Flats plant site. The plan was to include but not necessarily be limited to defining locations, quantities of soil involved, and preparation of cost estimates and schedules for proper disposal.

The preliminary response to these requests, which was intended for use in briefings, was submitted on October 30, 1973, and included:

1. A color-coded map showing where waste lines exist and what type of materials are transported in the lines. Footing drains, foundation drains, and the general flow of surface runoff were included.
2. A discussion of instances wherein significant quantities of radioactive or other toxic liquids are stored in tanks and the means available to detect leakage and initiate corrective actions if required.
3. A color-coded map indicating burial sites with the type and estimated quantity of material buried. This map indicated locations where significant amounts of contaminated materials were deliberately buried or contained and did not include areas known or suspected to be contaminated due to weather actions, spills, leaking pipelines, etc.
4. A list by type and quantity of all harmful or potentially harmful materials currently being used on plant site.

The following is the expanded and detailed information which was requested and is the result of searching records, reviewing literature, and

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numerous discussions with a large number of employees many of whom have been employed at Rocky Flats since 1952.

In describing the location and types of materials involved, the use of the word "contaminated" has been purposely avoided. This is not to be interpreted as an attempt to avoid the issue but merely to emphasize that no official definition of "contaminated" exists. Section III is devoted to a detailed discussion of "contaminated."

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## II. INFILTRATED SOIL INVENTORY

Soils under and around Buildings 559, 701, 770, 771, 774, 776-777, 779, and 995 have become infiltrated with various radioactive and chemical materials as a consequence of long-term, routine operations. Foundations, footings, pilings, and associated drainages must be considered both radioactively and chemically-infiltrated by leaks, spills, weather actions, etc. The principal radioactive material in these areas is plutonium with minor amounts of other radioisotopes and plutonium decay products ( $^{241}\text{Am}$ ). Estimated activity levels range from below present detection levels to greater than  $10^6$  dpm/100  $\text{cm}^2$ , actual levels are in all probability far less than the maximum. Major chemicals involved include nitrates, chromates ( $\text{Cr}^{+6}$ ), organics (such as  $\text{OCl}_2$ ), and, in some locations, beryllium.

Soils under Building 707, while faced with the same potential for structural infiltration of radioisotopes and chemicals, are not at this time considered operationally affected to the extent noted for other structures.

Soils under and around Buildings 441, 442, 444, 447, 865, 881, 883, 886\*, and 889 are also infiltrated. Soils under Buildings 122, 123, 125, 439, and 440 are involved but to a lesser degree. With the exception of possible extremely low levels of plutonium under and around Buildings 122, 123, and 881 and minor  $^{233}\text{U}$  in Building 881, the major radioisotopes of concern in these areas are enriched and depleted uranium. Chemically, nitrates, chromates, and beryllium infiltration are to be expected, especially in the "400" Complex and under and around Building 865 and 881.

Some uranium infiltration may exist under Buildings 331, 884, and 991, but levels are low, possibly undetectable.

\*While plutonium is handled in Building 886, it is handled in solid form only. Enriched uranium spills are considered as the only major possible contributions.

A summary of the relative degree of soil infiltration under buildings known or suspected to be radioactively or chemically infiltrated at Rocky Flats is shown on Table I.

Details of each building and the surrounding area are included with the following maps.

TABLE I

The following buildings at Rocky Flats are currently known or suspected to be radioactively or chemically infiltrated. It is assumed that the soil under each building is similarly infiltrated.

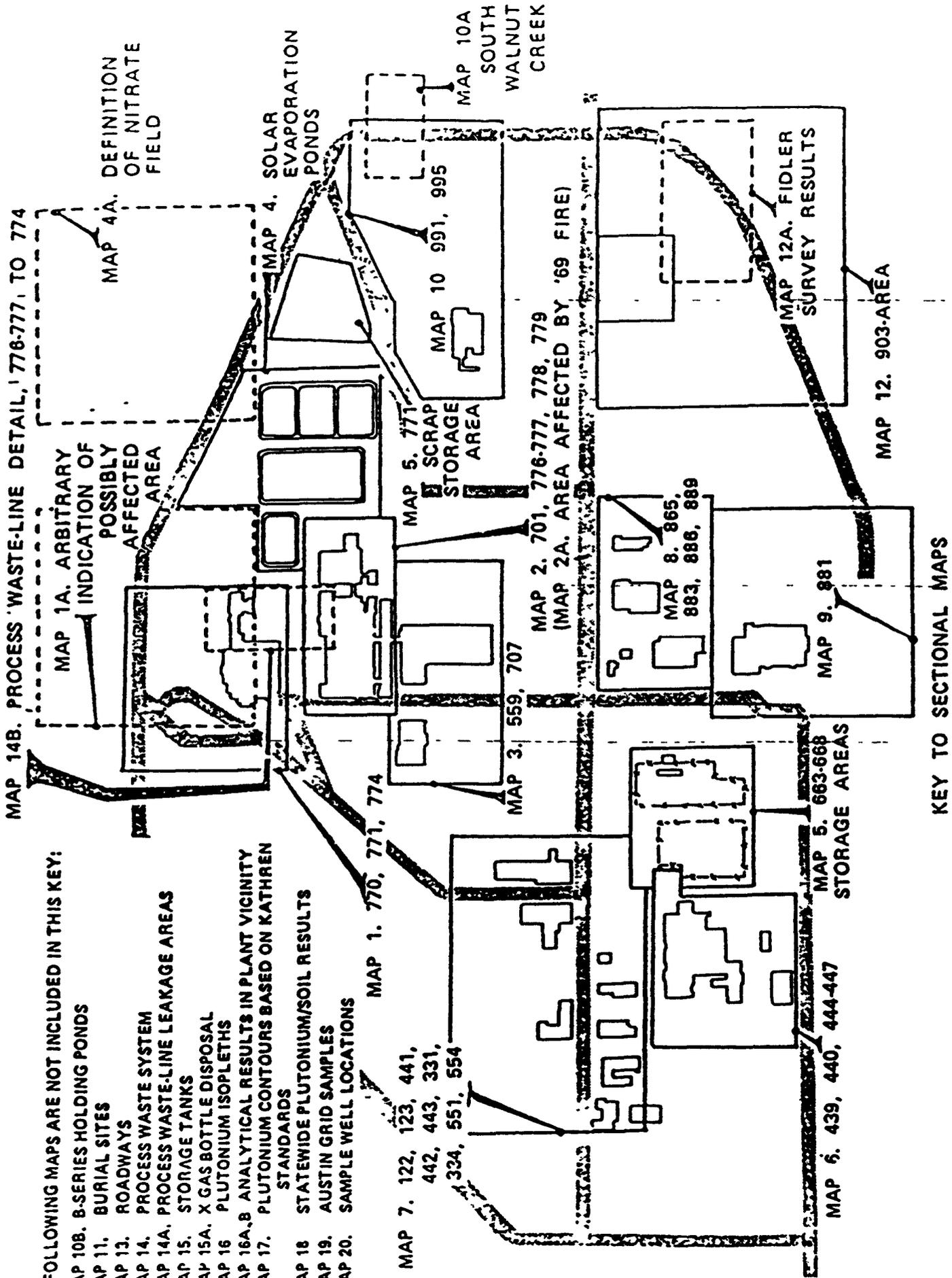
<u>Building</u>	<u>*Type Of Radioactive Infiltration</u>	<u>**Estimated Degree</u>	
		<u>Radioactive Infiltration</u>	<u>Chemical Infiltration</u>
122	Pu	Trace	Trace
123	Pu	Low	Moderate
125	Pu	Trace	Trace
331	EU	Trace	
334	EU	Trace	
439	DU	Trace	
440	DU	Trace	
441	DU	Trace	Moderate
442	DU	Low	Trace
444	DU	Low	Moderate
447	DU	Low	Low
559	Pu	Moderate	High
663	Pu	Trace	Trace
701	Pu	Low	Trace
707	Pu	Low	Trace
770	Pu	Low	Low
771	Pu	High	High
774	Pu	Moderate	Moderate
776	Pu	High	Low
777	Pu	Moderate	Low
778	Pu	Low	Low
779	Pu	Low	Moderate
865	DU	Low	Low
881	EU	Low	High
883	EU	Low	Trace
884	EU	Trace	
886	Pu	Trace	Trace
889	EU	Low	Moderate
991	Pu	Trace	

\*Type of radioactive infiltration refers only to major radioactive material involved. Other radioactive elements are also involved but to lesser extent.

\*\*Degree of infiltration refers to relative cost of cleanup.

THE FOLLOWING MAPS ARE NOT INCLUDED IN THIS KEY:

- MAP 10B. B-SERIES HOLDING PONDS
- MAP 11. BURIAL SITES
- MAP 13. ROADWAYS
- MAP 14. PROCESS WASTE SYSTEM
- MAP 14A. PROCESS WASTE-LINE LEAKAGE AREAS
- MAP 15. STORAGE TANKS
- MAP 15A. X GAS BOTTLE DISPOSAL
- MAP 16. PLUTONIUM ISOPLETHS
- MAP 16A,B ANALYTICAL RESULTS IN PLANT VICINITY
- MAP 17. PLUTONIUM CONTOURS BASED ON KATHREN STANDARDS
- MAP 18. STATEWIDE PLUTONIUM/SOIL RESULTS
- MAP 19. AUSTIN GRID SAMPLES
- MAP 20. SAMPLE WELL LOCATIONS



KEY TO SECTIONAL MAPS

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Incidents by Area

Map 1 (Buildings 770, 771, and 774)

The nature of operations in Buildings 770 (Scrap Storage), 771 (Chemical Recovery), and 774 (Liquid Waste Treatment) are such that infiltration is inevitable. Remarkably, there have been relatively few incidents which have, as a rule, been quickly contained and cleaned. A summary of some of the major incidents follows.

Physical default of process waste storage tanks and drums has been one of the major contributors of chemical and radioactive materials to the soil around these buildings. Leaking process waste tanks in 1957 (south of Building 774) contributed levels of up to 2,500 dpm/g (gross alpha) and leaking drums (north of Building 771) in 1971 contributed levels up to 100,000 dpm/100 cm<sup>2</sup> on asphalt. Both the soil and asphalt (about 200 square feet of asphalt in one incident and about 2,300 in another) were removed for off-site disposal.

As noted on Map 1, the outfall northwest of Building 774 has been the site of some material accumulation. This outfall resulted from the release of plutonium in laundry water and water from laboratory sinks. In 1958, radioactivity of 17,400 dpm/g was detected in the soil at this outfall. Soil samples collected in 1971 indicated 100,000 dpm/g. The plumbing leading to this outfall was corrected and 149 drums of soil were removed for off-site disposal.

The area immediately adjacent to the Building 771 ventilation stack must also be considered an area of interest, however, fallout from this stack is minor compared to process waste infiltration (discussed in conjunction with Map 14). The underground plenum leading to the stack is also of interest.

Chemically, there have been several instances of caustic and acid spills in this area. Hydrofluoric acid (HF) has, on occasion, infiltrated the soil around the HF storage shed, but due to the extreme reactivity of this material, little or no environmental-affective residue would be expected. The potassium hydroxide (KOH) and sodium hydroxide (NaOH) tanks south of Building 771 and north of Building 774, respectively, have also overflowed, leaked, etc. In all cases, these spills have been dramatically diluted with water and, with one possible exception, should have limited environmental consequences. That possible exception would be an overflow in the KOH tanks south of Building 771. It is likely that much of the overflow penetrated soil to the level of the Building 771 foundation and infiltrated soil under the building. However, the presence of springs and subsurface runoff under the building have more than likely reduced the possible concentration to an inconsequential level.

Table II documents major incidents in the Buildings 770-771-774 area.

It should be noted that while corrective action has historically been to remove the affected soils, it is a physical impossibility to remove it all. Therefore, "minor" infiltration inevitably remains and relative "hot spots" are to be expected, even if not detected.

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TABLE II

Major Incidents in the Area of Buildings 770, 771, and 774 (See Map 1)

(Note: Pipeline leaks, etc., are discussed separately.)

Prior to 1956, the process waste holding tank located north of Building 771 overflowed on several occasions with minor impact.

1956 October: Process waste tanks (Building 774) overflowed, minor environmental infiltration.

1957 August: Leaking process waste tanks (Building 774), minor environmental infiltration cleaned up.

September: Building 771 fire - some environmental infiltration, particularly north and near the hatch on the southwest corner of the building. Actual levels unknown, soil and vegetation samples inconclusive.

1958 April: Soil infiltration noted at laundry outfall (Building 773), 17,400 dpm/g.

1963 January: Liquid containing plutonium spilled outside Building 774 entrance. Material cleaned up.

1964 January: Coveralls containing plutonium found on west dock of Building 771. Levels to 100,000 dpm/100 cm<sup>2</sup> found on dock and in locker room. Cleaned up immediately.

1968 May: Sewer line break at Building 771 resulted in sewage lift station tank overflow to Building 773 outfall. Low concentration of radioactive and chemical materials.

1970 May: Soil samples collected from Building 773 outfall; approximately 100,000 dpm/g. Plumbing modified in September 1970 and 149 drums of soil removed for off-site disposal. (Removal completed August 30, 1971.)

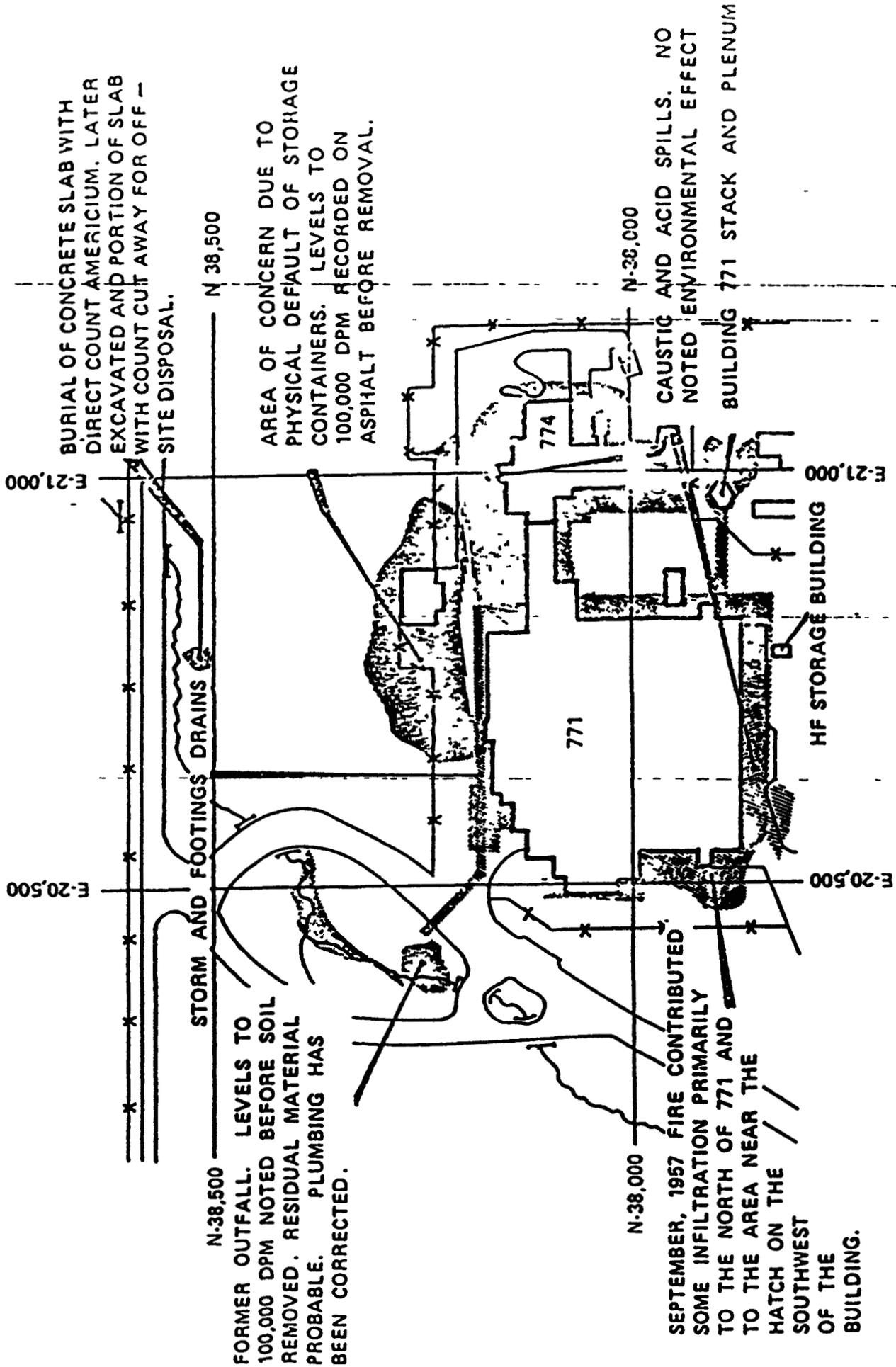
~~1971~~ Scrap drum leakage (June and July) resulted in recorded levels to 300,000 dpm/100 cm<sup>2</sup> on about 2,500 square feet of asphalt north of Building 771. Asphalt removed for off-site disposal. In September, construction excavation between Buildings 771 and 774 exposed tunnel which contains process waste line and which at one time was used as an exhaust ventilation duct for Building 774. The exposed cracks in the tunnel were sealed. Eight drums of soil (approximately 24 dpm/g) were removed for off-site disposal in January, 1972.

September: Building 774 dock - unknown source resulted in estimated levels to 200,000 dpm/100 cm<sup>2</sup>. Thirty-six drums of soil removed for off-site disposal.

1972 March: Approximately 500 gallons of plutonium waste (approximately 350,000 dpm/liter) inadvertently released from Building 774. Pond samples showed only slight increase in activity. Started removing soil around Building 774 waste tanks for installation of new inspectable processing tanks.

August: A punctured scrap box and drum resulted in up to 200,000 dpm/100 cm<sup>2</sup> on approximately 3,600<sup>square</sup> feet inside and approximately 500 square feet outside Building 770. Cleanup began immediately, soil and asphalt removed for off-site disposal.

1973 There were no incidents which were considered to have resulted in environmental infiltration.



BURIAL OF CONCRETE SLAB WITH DIRECT COUNT AMERICIUM. LATER EXCAVATED AND PORTION OF SLAB WITH COUNT CUT AWAY FOR OFF-SITE DISPOSAL.

N-38,500

AREA OF CONCERN DUE TO PHYSICAL DEFAULT OF STORAGE CONTAINERS. LEVELS TO 100,000 DPM RECORDED ON ASPHALT BEFORE REMOVAL.

N-38,000

CAUSTIC AND ACID SPILLS. NO NOTED ENVIRONMENTAL EFFECT BUILDING 771 STACK AND PLENUM

E-21,000

E-21,000

STORM AND FOOTINGS DRAINS

771

HF STORAGE BUILDING

E-20,500

E-20,500

N-38,500

FORMER OUTFALL. LEVELS TO 100,000 DPM NOTED BEFORE SOIL REMOVED. RESIDUAL MATERIAL PROBABLE. PLUMBING HAS BEEN CORRECTED.

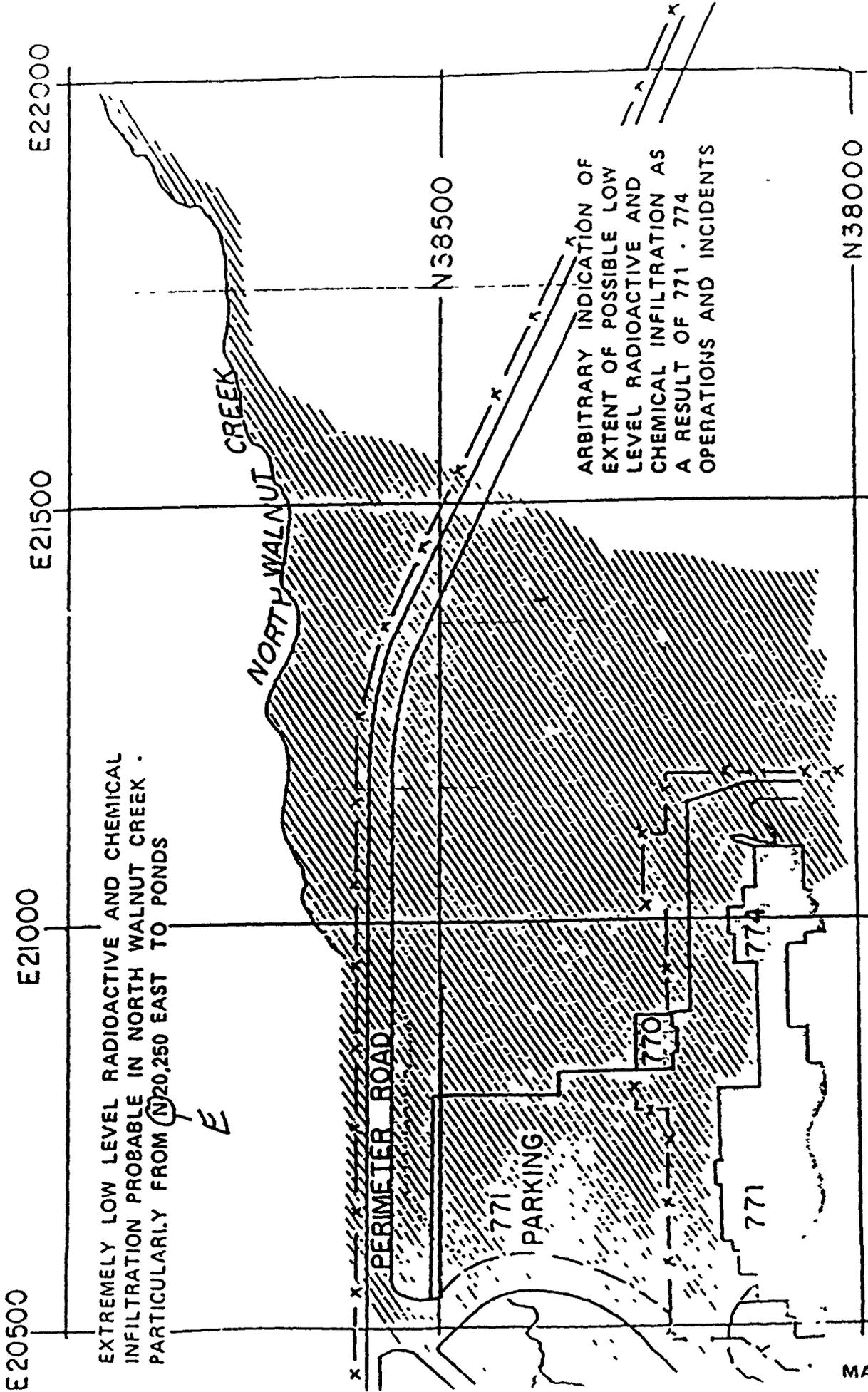
N-38,000

SEPTEMBER, 1957 FIRE CONTRIBUTED SOME INFILTRATION PRIMARILY TO THE NORTH OF 771 AND TO THE AREA NEAR THE HATCH ON THE SOUTHWEST OF THE BUILDING.

Map 1A

This map gives an arbitrary indication of possible affected areas as a result of operational incidents and accidents in the Buildings 770-771-774 area. As indicated, low level nitrate and radioactive infiltration is expected. Soil samples of the area justify this low-level assumption, with plutonium values ranging from undetectable to 64.9 dpm/g.

It must also be emphasized that the variables inherent in soil sampling (i.e., particle size, type of soil, physical location, vegetation cover, etc.) and the state-of-the-art do not permit wholesale drawing of conclusions as to levels, accurate isocurie contours, etc. It is the nature of the technology that a "high" sample could be detected immediately adjacent to an undetectable one and vice versa. Where such contours have been derived, by one means or another, they will be incorporated into this report for reference. Wherever possible, however, actual sample results should be the only judgment criterion and will be so presented herein.



EXTREMELY LOW LEVEL RADIOACTIVE AND CHEMICAL  
INFILTRATION PROBABLE IN NORTH WALNUT CREEK .  
PARTICULARLY FROM N20,250 EAST TO PONDS

ARBITRARY INDICATION OF  
EXTENT OF POSSIBLE LOW  
LEVEL RADIOACTIVE AND  
CHEMICAL INFILTRATION AS  
A RESULT OF 771 - 774  
OPERATIONS AND INCIDENTS

MAP 1A

Map 2 (Buildings 701, 776-777, 778, and 779)

In June 1964, an explosion within a glovebox in Building 776 resulted in extensive release of plutonium to the interior and some to the exterior, primarily north of that building.

A fire on May 11, 1969, released plutonium to all of Building 776-777 and areas of Buildings 771, 778, and 779. The integrity of the buildings involved, however, remained essentially intact and very little environmental infiltration can be attributed to the actual fire. Subsequent extinguishing efforts, and cleanup did, however, provide some contribution (Map 2A).

These two incidents are primarily responsible for soil infiltration in this area. The majority of the affected soil has either been removed or covered with asphalt. As examples, in September 1969, approximately 320 tons of soil and asphalt (containing an estimated 14 mg Pu) were removed from the west side of Building 776. An asphalt-covered area of about 10,000 square feet, north of Building 776-777, has levels of radioactivity of about 700 dpm/g. When this area was surveyed, no particular "hot spots" were found but the material was somewhat deep in places, particularly around a drain in the dock area. A French drain north of Building 776 may have contributed to some plutonium infiltration below the surface although no surface expression has been noted. Radioactive levels of up to 80,000 dpm/100 cm<sup>2</sup> were noted in October 1971, north of the Building 776 compressor shed directly under the gravel and the soil was subsequently removed for disposal.

More recent incidents, such as process waste backing up into a stool and sink in Building 701 (June 1972) have also contributed some degree of infiltration to the area in the vicinity of that structure. Also there has been some minor spillage of carbon tetrachloride into the soil at the storage tank near the southwest corner of Building 701. No significant environmental consequences are expected from this spillage.

Building 779 was erected over the site of one of the original solar evaporation ponds. During excavation (September 1962) levels of radioactivity ranging from 11 to 75 dpm/g were noted, and later, pools of water in these excavations had levels to 150 dpm/l. The radioactive material involved was mostly uranium.

With the exception of the recent tritium incident and minor involvement in the 1969 fire, only one other major incident of environmental significance has been documented in Building 779. In June of 1969, an improperly opened waste drum resulted in radioactive material spread to the first floor, utility room, dock and adjacent grounds, and walkways east and south of the building, mostly by personnel tracking. Levels up to 50,000 dpm/100 cm<sup>2</sup> were recorded, and a number of drums of soil were subsequently removed for off-site disposal.

Thus the entire Buildings 776-777, 778, and 779 areas (including substructures) must be considered at least partially infiltrated with radioactive materials primarily on the north side of the complex, the west side of Building 776, between Buildings 777 and 779, and the courtyard between Buildings 776-777 and 778.

Some chemical infiltration, notably nitrates, chromate, and particularly in and near Building 776, possible organics (CCl<sub>4</sub>), is to be expected, particularly beneath and north of the buildings.

~80,000 DPM NOTED IN 1971.  
REMOVED.

ABOUT 10,000 SQUARE FEET, ASPHALT COVERED,  
ABOUT 700 DPM/G.

PROCESS WASTE BACKUP, 1972. SOIL  
REMOVED.

LOCATION OF OLD SOLAR EVAPORATION  
POND. 11 TO 75 DPM/G NOTED DURING  
CONSTRUCTION. PROBABLE HIGH NITRATE  
LEVELS.

IMPROPERLY OPENED WAST  
DRUM. UP TO 50,000 DPM  
NOTED, SOIL  
REMOVED.

AREAS AFFECTED  
' MAY '69 FIRE...SEE  
FOLLOWING MAP.)

776-777

779

778

ARBITRARY "AREA OF CONCERN":  
NITRATES, CHROMATES, SOME B<sub>6</sub>,  
AND LOW LEVEL ORGANIC  
INFILTRATION EXPECTED

ONE SOURCE OF  
RECENT TRITIUM  
INFILTRATION.

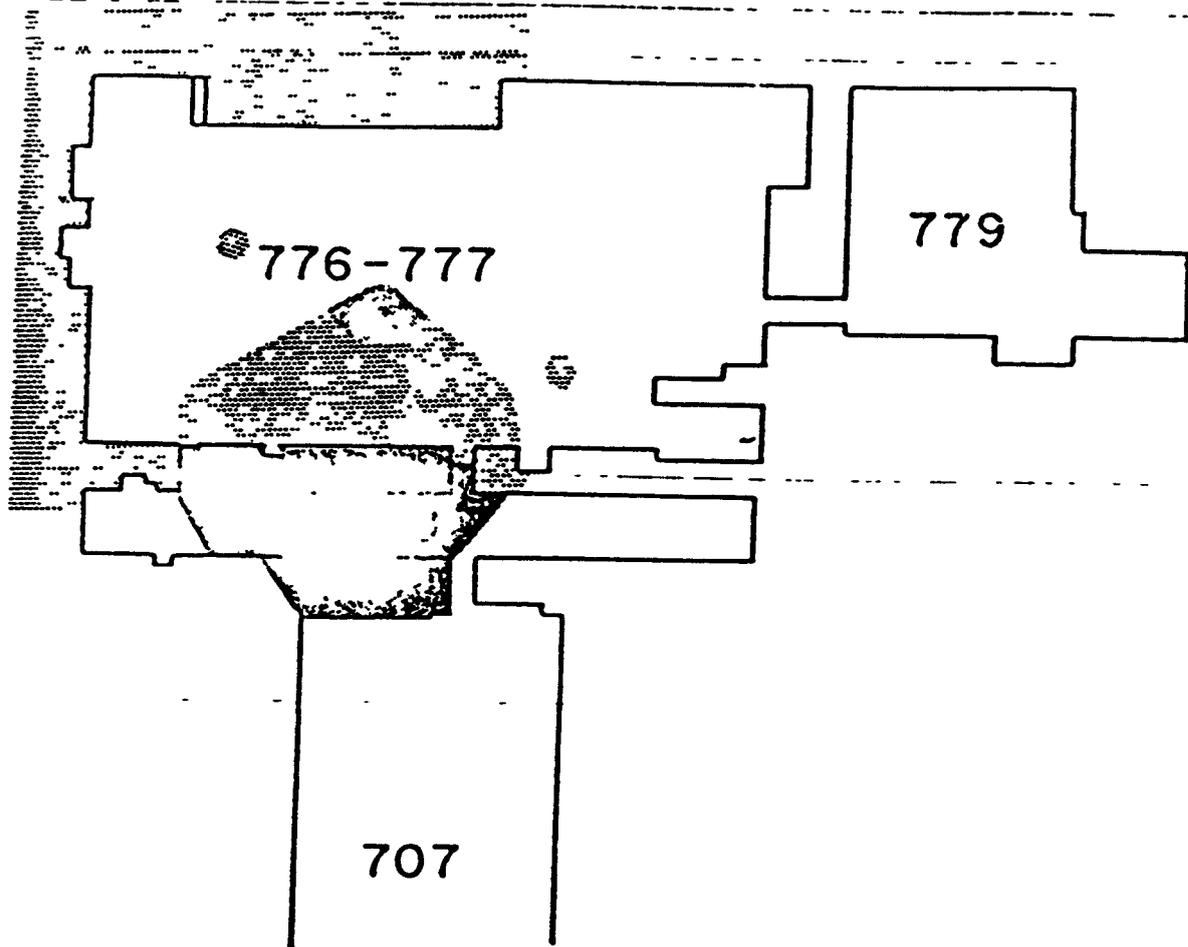
N-37,500

E-21,500

E-21,000

E-20,500

# ROOF AND OUTSIDE AREAS



-   $10^5$  to  $10^6$  cpm
-   $10^4$  to  $10^5$  cpm
-   $10^3$  to  $10^4$  cpm

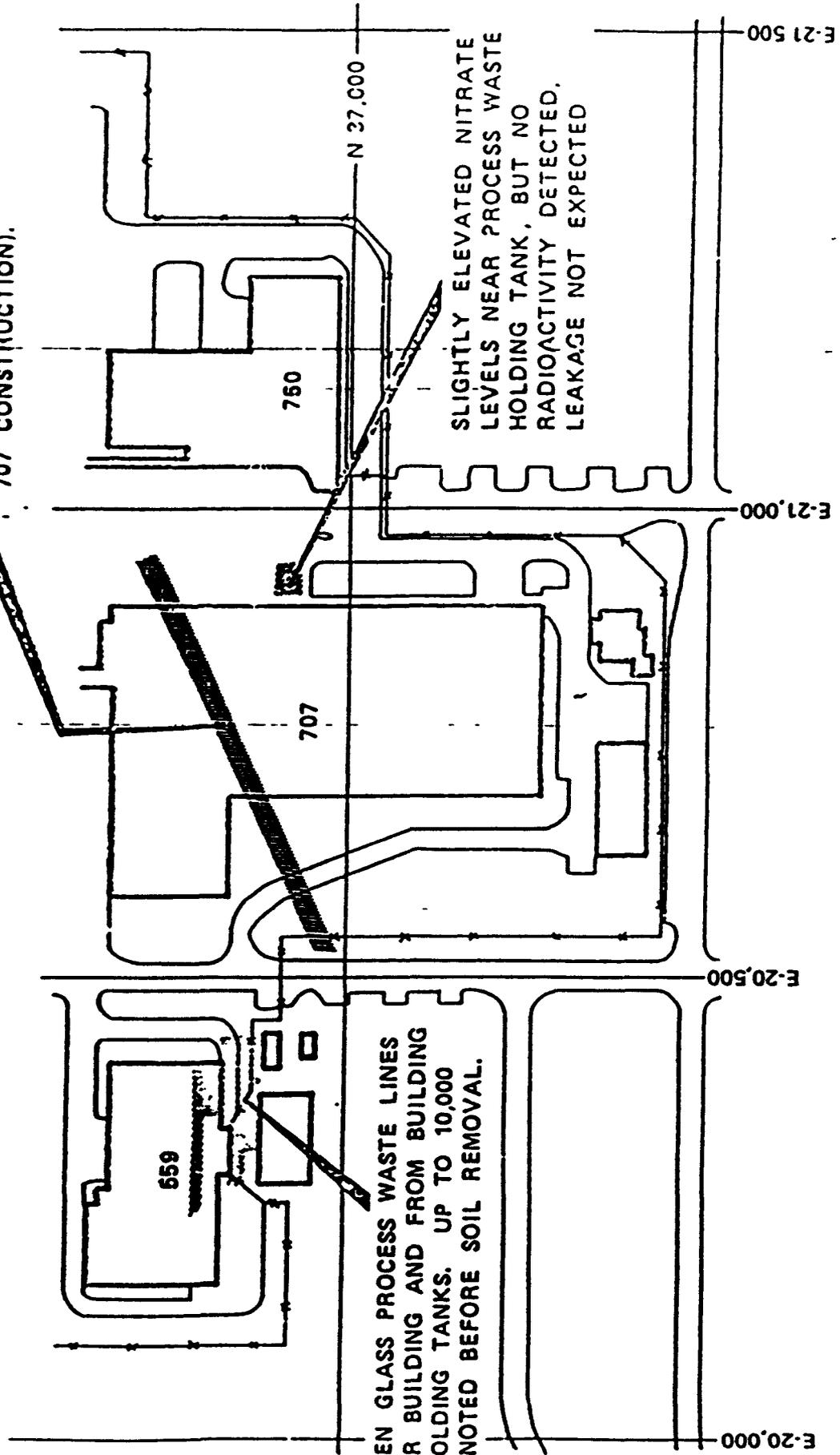
EXTERIOR AREAS OF 776-777 AND 778  
AFFECTED IN AFTERMATH OF MAY, '69  
FIRE.

Map 3 (Buildings 559 and 707)

The Service Laboratory Facility, Building 559, began operation in March 1968. Original process waste pipelines under the building were made of Pyrex<sup>®</sup> glass to combat a persistent corrosion problem. Operations ~~and natural settling of the building~~ have resulted in several breaks in this glass line, which are discussed ~~in conjunction with Map 14.~~

Building 707, the newest production complex, has created no known environmental infiltration. Before construction, however, a section of the original process waste line (see Map 14) was removed and some residual material might be in residence. A sampling well (see Map 20) located near the process waste holding tank (between Buildings 707 and 750) has produced slightly elevated nitrate levels, but this could be due to a number of factors. No radioactivity has been detected ~~in these samples~~, therefore, no leak or infiltration is assumed.

LOCATION OF ORIGINAL  
PROCESS WASTE LINE  
(REMOVED DURING  
707 CONSTRUCTION).



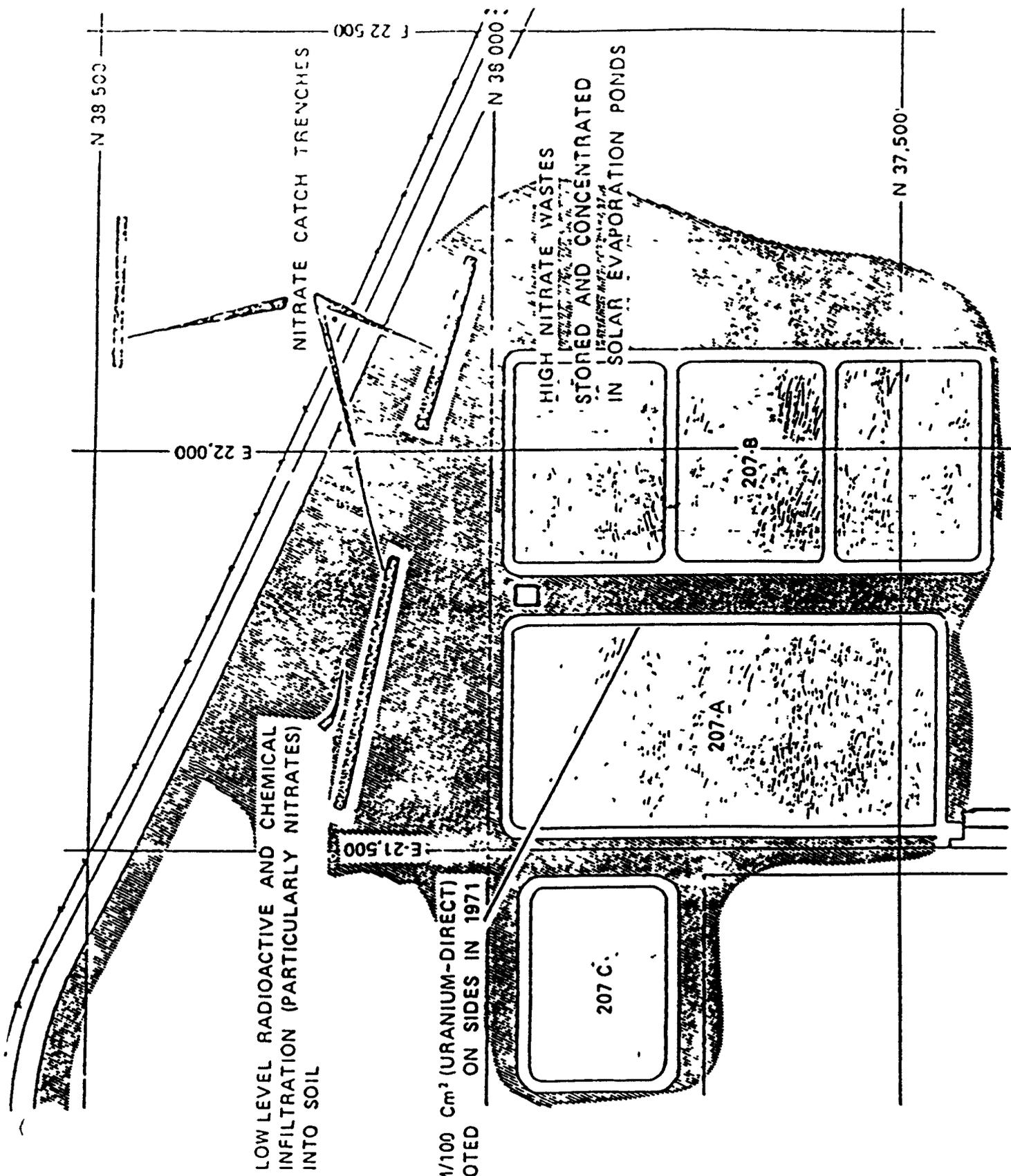
BROKEN GLASS PROCESS WASTE LINES  
UNDER BUILDING AND FROM BUILDING  
TO HOLDING TANKS. UP TO 10,000  
DPM NOTED BEFORE SOIL REMOVAL.

SLIGHTLY ELEVATED NITRATE  
LEVELS NEAR PROCESS WASTE  
HOLDING TANK, BUT NO  
RADIOACTIVITY DETECTED.  
LEAKAGE NOT EXPECTED

Map 4 (Solar Evaporation Ponds)

Since the plant's inception, high-nitrate wastes have been concentrated (by evaporation) in a series of solar-evaporation ponds and over a 20-year time span, some loss of integrity occurred. The leaks resulted in some infiltration, primarily chemical, of the soil under and around these ponds. High winds have also contributed some spread of material. A continuous program of cleaning and sealing the ponds has been necessary. In June of 1971, 30,000 dpm/100 cm<sup>2</sup> were noted at the high watermark on the west side of Pond 207-A, contributed mostly by uranium. Thus, in addition to nitrates, low level radioactive permeation of the soil is probable.

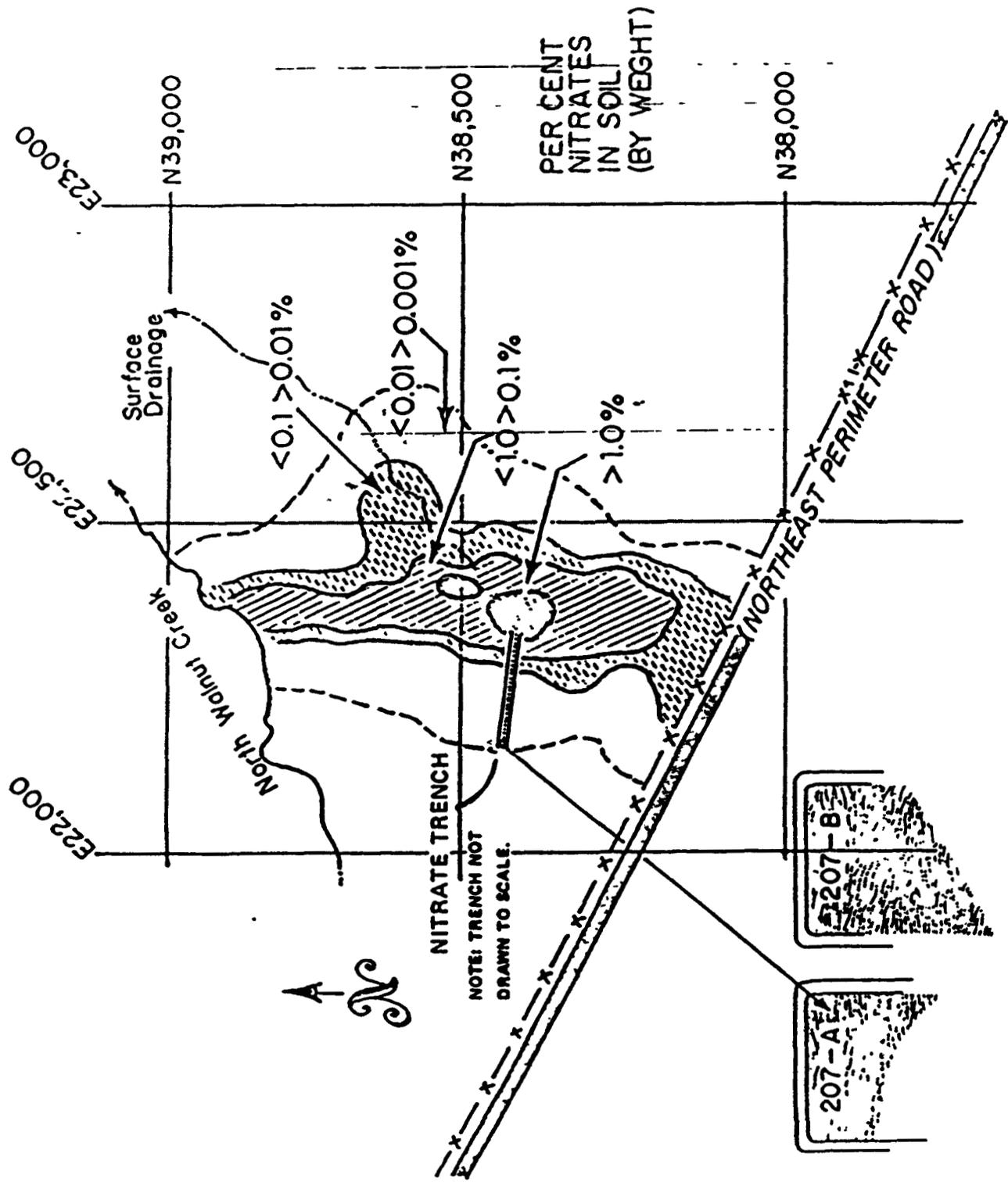
To minimize the nitrate invasion of North Walnut Creek, catch trenches have been placed downslope from the solar ponds. These trenches trap the nitrate-laden runoff which is then pumped back into the solar ponds. Map 4A details nitrate concentrations (percent of NO<sub>3</sub> in soil by weight) as determined by soil sampling (core samples). Again, without sampling every square inch of the affected area, these contours must be considered illustrative only.



LOW LEVEL RADIOACTIVE AND CHEMICAL  
INFILTRATION (PARTICULARLY NITRATES)  
INTO SOIL

30,000 D/M/100 Cm<sup>3</sup> (URANIUM-DIRECT)  
NOTED ON SIDES IN 1971

HIGH NITRATE WASTES  
STORED AND CONCENTRATED  
IN SOLAR EVAPORATION PONDS



MAP 4A

CRAM

Map 5 (Storage Areas for Radioactive Materials (Excluding 903 Area))

Other than Buildings 771 and 774 and the 903 Area, two sites have been predominately used for storage of radioactive scrap for processing or waste for disposal.

An area east of the solar evaporation ponds is still utilized for storage of scrap for processing. In January 1969, 29 of these drums were found to be leaking with resultant levels of up to 200,000 dpm/100 cm<sup>2</sup>. About 200 square feet of soil was removed to a depth of 3 to 5 inches in March 1970 for off-site disposal. The drums were then placed in cargo containers to protect them from the weather. Further leakage resulted in an area of approximately 1,000 square feet affected from 2,000 to 200,000 dpm/100 cm<sup>2</sup> in May 1971 and the soil was removed for off-site disposal. On June 21, 1973, a drum containing a nitric acid solution leaked, affecting an area of about 500 square feet, with levels ranging from about 2,500 dpm/100 cm<sup>2</sup> to in excess of the range of the detection instrument (greater than 2,000,000 dpm/100 cm<sup>2</sup>). Approximately 40 drums of soil were removed for off-site disposal. A soil sample, taken after cleanup operations were completed, indicated 24 dpm/g.

The Building 663 storage area, east of Seventh Avenue (opposite Building 444) and the adjacent storage yard west of Seventh Avenue, have both been affected several times by punctured or leaking waste boxes and drums. Both uranium and plutonium solid wastes, oils, and coolants have been involved. The areas have been scraped and the soil removed, but low level residual plutonium and uranium are present.

Building 663, the storage and shipping facility, has also been affected due to punctured drums and broken waste lines. Thus a total of

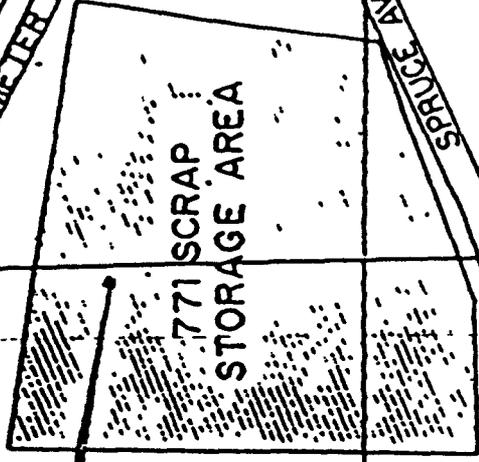
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about 280,000 square feet is possibly involved, to a varying extent, with low level infiltration.

SCRAP STORAGE CONTAINER AREA..  
 ALTHOUGH NOTED LEAKS OR SPILLS  
 HAVE BEEN CLEANED AND INVOLVED  
 SOILS REMOVED, RESIDUAL LOW LEVEL  
 RADIOACTIVE AND CHEMICAL INFILTRATION  
 PROBABLE.

207-B  
 E22000



771 SCRAP  
 STORAGE AREA

FIFTH STREET

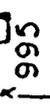
COTTONWOOD AVENUE

N35000

E22500 EIGHTH STREET

E23000

N37500



995



663



662

663-668  
 STORAGE AREAS

PUNCTURED AND LEAKING WASTE  
 DRUMS AND BOXES INVOLVING  
 BOTH SOLID AND LIQUID WASTES,  
 U AND PU. AREAS CLEANED BUT  
 RESIDUAL INFILTRATION CERTAIN  
 AREA IS NOW COVERED WITH  
 GRAVEL CAP. ABOUT 253,000  
 SQUARE FEET INVOLVED.

E20000

SEVENTH STREET



668

E19500

CEDAR AVENUE

N35500

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Map 6 (Buildings 439, 440, and 444-447)

Depleted and enriched uranium and beryllium are the principal materials of concern to this area.

-- -- -- In 1953, high winds blew the lids off waste drums and uranium was released to the dock, driveway, and surrounding grounds. Direct count as high as 7,500 dpm/100 cm<sup>2</sup> and smears as high as 350 dpm were reported. The docks and sidewalks were cleaned up and the driveway areas seal-coated. A broken process waste line (June 1966) north of the building resulted in some possible infiltration as did leaking storage drums south of the building. An open ingot storage area east of Building 444 and a metal storage area south of the building have undoubtedly resulted in low-level infiltration of the soil, as has a uranium machine tool storage area west of the building.

In May 1960, a vacuum collector fire in Building 447 resulted in approximately 44  $\mu$ Ci depleted uranium deposited on the roof of the building. In December 1962, a uranium/beryllium release from Building 444 (due to use of an unfiltered hood) was noted.

Thus, these areas immediately adjacent to Buildings 439, 440, and 444-447, as well as the storage areas noted on Map 6, must be considered radioactively infiltrated to some degree as should the footings and foundations of these buildings.

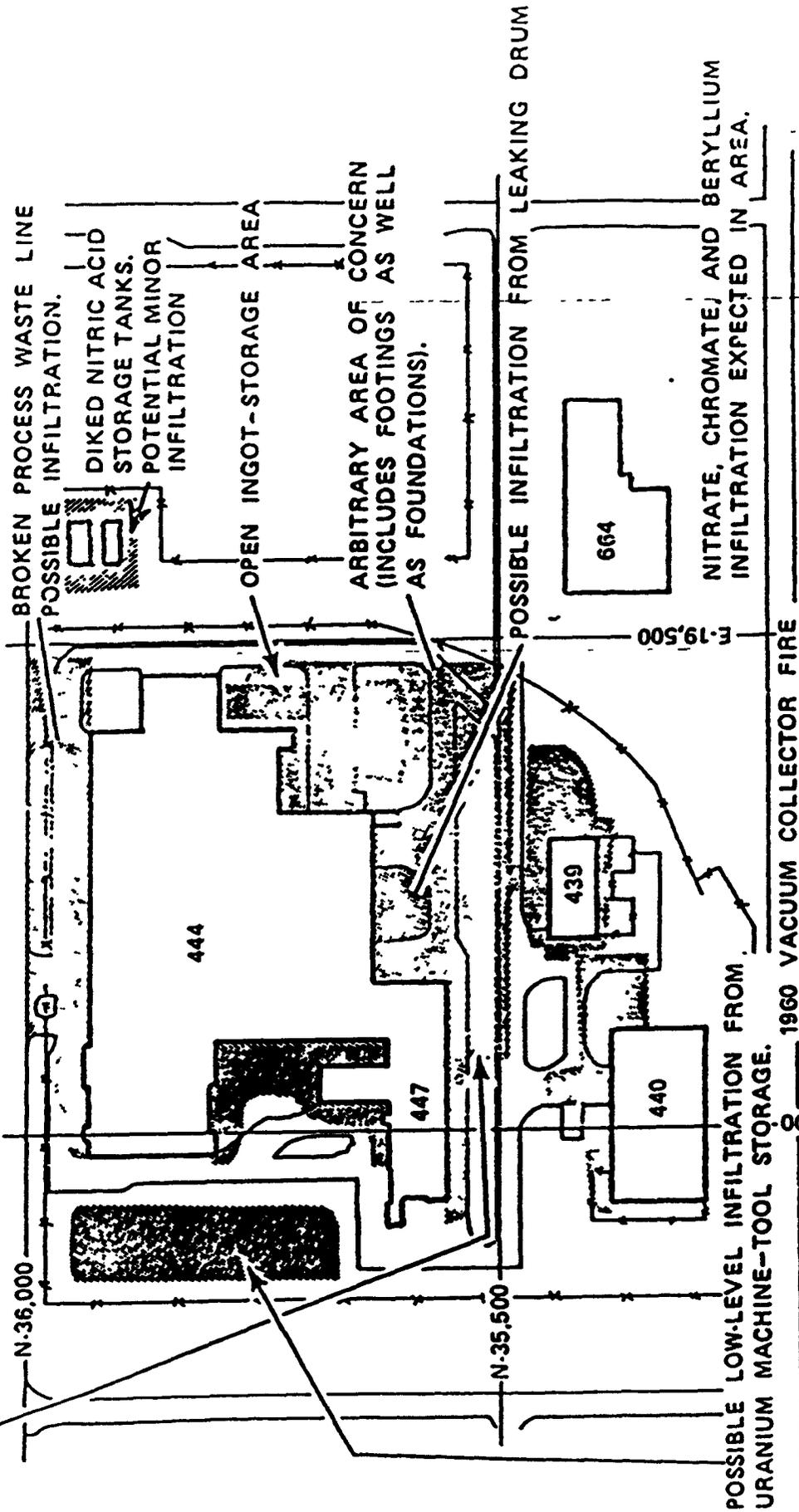
Chemically, no specific incidents have been noted, but routine generation of nitrates and chromates would indicate at least the possibility of these materials being present in soil under and around these buildings.

Map 15 (Other Areas)

In addition to the noted areas, some potential for minor clerucal infiltration exists in the vicinity of various storage and holding tanks (Map 15). This potential is, in most cases, extremely slight, particularly in those locations where tanks are diked. In the past, before diking was installed, minor spills have occurred and have been discussed in conjunction with the sectional maps.

Map 15A shows the approximate location where empty bottles of nickel carbonyl were buried after the nickel carbonyl was destroyed. The gas was destroyed by burning (during the 1957 fire in Building 771 or when ready for discard). Explosive charges were used to destructively vent the cylinders and ignite any residual gas. No known infiltration or affective residues were generated during these operations or as a result of the burials.

1953 INCIDENT RELEASED URANIUM TO DOCK, SIDEWAYS AND DRIVEWAYS,  
CLEANED AND/OR SEAL-COATED.



1960 VACUUM COLLECTOR FIRE (447) AND 1962 RELEASE FROM UNFILTERED HOOD (444) HAVE PROBABLY ADDED TO LEVELS IN THE VICINITY OF THESE BUILDINGS.

MAP G.

Map 7 (Buildings 122, 123, 331, 334, 441, 442, 443, 551, and 554)

Building 122 (Medical Facility), with its extremely low level waste-liquid generation, operated with a 55-gallon drum as a waste tank. Rusting of this drum and subsequent leakage resulted in some low-level infiltration of soil under the building and the removal of a section of the floor inside (southeast corner) the building. Significant infiltration is not suspected and has not been detected in areas around the building.

Building 123 (Health Physics Laboratories) generates low-level radioactive liquid waste as well as chemical wastes. Known or suspected underground waste-line leakage has contributed some material to the soil beneath the building. Leakage, however, also appears to be into the lines due to high hydrostatic pressure, thus minimizing the potential.

Building 441 was originally a laboratory handling small quantities of radioactive material as well as quantities of various chemicals. Thus, the soil and piping beneath the building must be considered suspect in regard to both chemical and radioactive infiltration.

The Laundry, Building 442, is also potentially affected by both radioactive and chemical materials, notably depleted uranium and beryllium, and in 1964 the Laundry was infiltrated by enriched uranium, impregnated in clothes from Building 883. The soil in the vicinity of this building has also been affected by instances of radioactivity release. For example, in December 1963, rag-cleaning barrels stored near the building either leaked or spilled. The liquid drained east into the ditch on the northwest side of the building. Radioactivity was detected as far east as the east end of Building 551. Cleaning efforts and subsequent runoff has reduced concentrations in that area to a low level.

Building 443, the Steam Boiler Plant, has had no known radioactive material involvement. Routine operations do involve chemicals,

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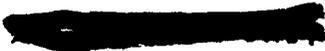
DRAFT

particularly sulfuric acid and sodium hydroxide. The only incident of note occurred when a quantity of sulfuric acid was spilled to the environs of the building. The acid drained eastward (on the south side of Building 442) to a trap dug in the center of the lot which is now used for Building 444 parking. This soil in the area would undoubtedly be somewhat acidic, but no adverse effect on the environment has been noted.

A portion of Building 331, the Plant Garage, was at one time used for a special R&D effort involving depleted and enriched uranium. No incidents or releases were noted during this operation and no environmental residue is expected. Due to the repair and storage of vehicles there is possibility of organics such as oil and gasoline in the soil beneath the building.

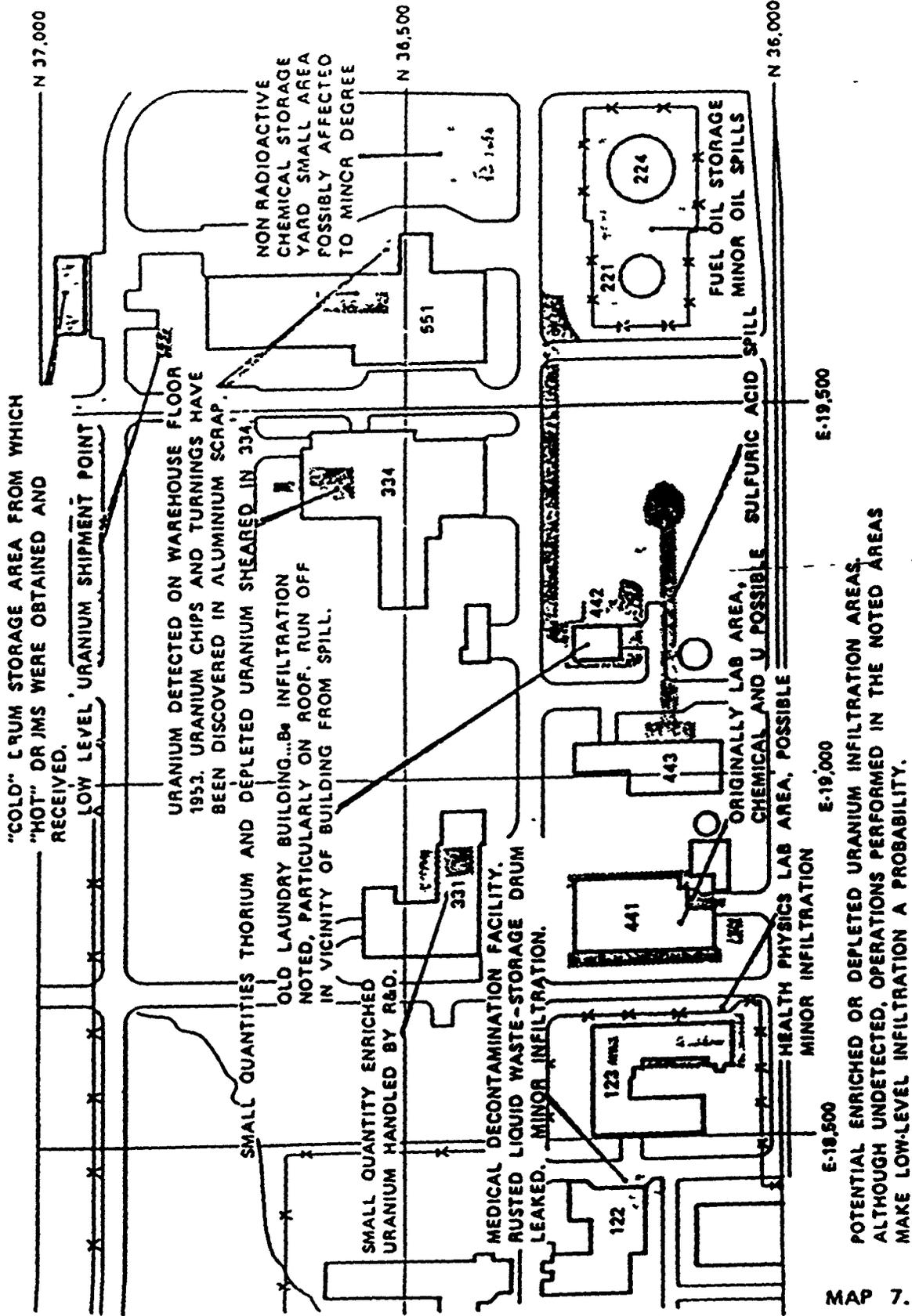
Building 334, the main Maintenance Shop, was also used for special work involving the shearing of some depleted uranium. Some thorium has also been handled in Building 334, again, with no known incident. No environmental encroachment of any material has been detected or is expected as a result of operations in this building.

The Warehouse, Building 551, and adjacent grounds, have been areas of concern several times. For example, detectable uranium was discovered on the Warehouse floor in April 1953. Uranium chips and turnings were discovered in an aluminum scrap pile near the Warehouse in 1963 and again in 1964. These were removed and the grounds cleaned. In July 1963 and again in 1970, Rocky Flats received equipment and drums from off site which contained uranium above the Rocky Flats acceptable level. In 1970 the entire shipment of 55-gallon drums was returned to that vendor. These and other minor incidents lead to at least suspect areas under and around Buildings 551 and 554 (where the "hot" drums were received). A small drum storage area east of Building 552 is suspect for the same reason.



DRUM

There have been some minor leaks and spills from drums and storage containers in the non-radioactive chemical storage area east of Building 551. While a small area might have been affected, quantities involved have been so small that no impact has been noted nor expected. This area is used primarily to store drum quantities of acids, oils, soaps, and solvents.



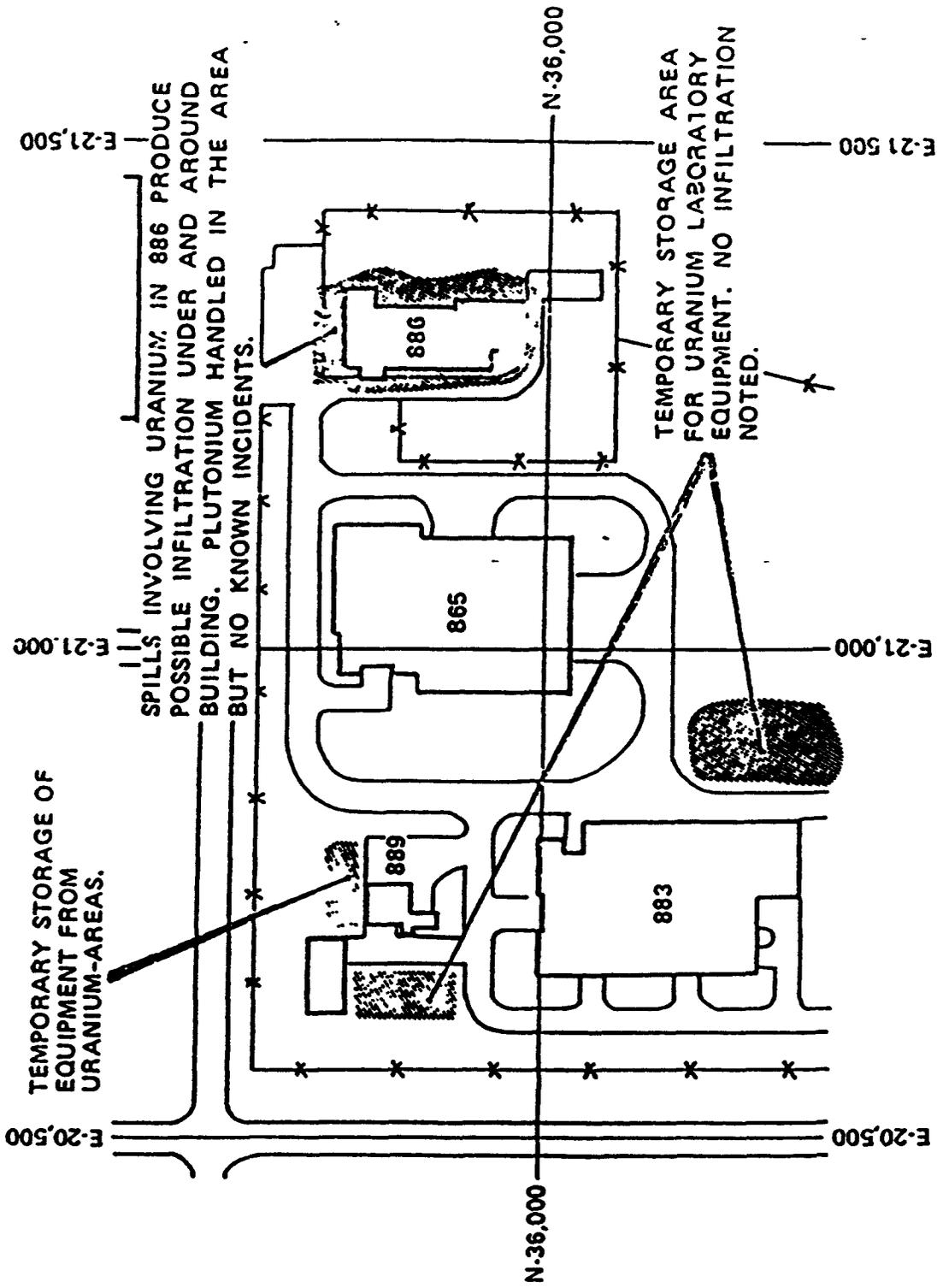
POTENTIAL ENRICHED OR DEPLETED URANIUM INFILTRATION AREAS.  
 ALTHOUGH UNDETECTED, OPERATIONS PERFORMED IN THE NOTED AREAS  
 MAKE LOW-LEVEL INFILTRATION A PROBABILITY.

MAP 7.

SECRET

Map 8 (Buildings 865, 883, 886, and 889)

Due to the nature of operations in these buildings, soil infiltration is expected to some degree under and possibly around these buildings. Spills involving uranium in Building 886 have occurred, with an inherent possibility of substructure infiltration. No specific incidents have been documented in the other buildings (with the exception of a January 1969 incident wherein the roofing was blown off Building 889 with no environmental effect). At one time, however, some equipment from a uranium laboratory was stored outside (just east) of Building 883 and west of Building 889. Present practice includes temporary storage of equipment from uranium areas on a pad north of Building 889 prior to processing. Therefore, these would also be areas of interest, although no incident or infiltration has been noted.



MAP 8.

Map 9 (Building 881)

Building 881, originally a production building, was partially converted to a general support building in 1964. Although few incidents involving the building have been documented, it represents an area of interest, primarily due to the age of the structure (one of the original plant buildings). Both uranium (east dock February 1960) and plutonium (laboratory area October 1961 and 1968) incidents have been noted in the building and waste lines have been broken with resultant probable infiltration. Low levels of plutonium have been detected in the air tunnel and the cooling tower northeast of the building.

In addition to burial sites (see map), some exterior areas near Building 881 have been involved with radioactive material. An area of several hundred square feet northwest of the building was involved in 1958 when a concrete slab, removed from the east side of Building 776, was deposited there. The slab was broken up and removed and the area cleaned. Conversion activities also resulted in some possible infiltration, primarily to the northeast of the building.

In May 1973, oil (#6 fuel oil) from an undetermined source was discovered on the hillside below Building 881. Prompt action prevented the spread of the oil into Woman Creek or any holding pond. Leak tests on the Building 881 fuel tank and lines (the only known possible sources) did not show any leakage, but to date the oil continues to emerge through the Building 881 footings drain. A concrete skimmer dam has been built to trap the oil, which drains in extremely small quantities. The oil-soaked straw which was used to trap the material, as well as most of the soil involved, has been removed.



Map 10 (Buildings 991 and 995)

Building 991 and the associated storage vaults (tunnels 996, 997, 998, and 999) are also original plant structures and thus under suspicion due to age. Incidents involving very small quantities of plutonium, as well as uranium and beryllium, have been noted in Building 991, and extensive research activities have undoubtedly spread some trace concentrations of materials in the vicinity of the building.

Although radioactive materials have been continuously stored in the vault areas, routine surveys have indicated that with the possible exception of 996, which might be slightly uranium infiltrated, the vaults have remained remarkably "cold." Any environmental leakage has been in rather than out as determined by salt infiltration into the tunnel areas.

Building 995, the Sewage Treatment Facility, has historically been the recipient of effects from incidents in other areas of the plant. For example, the overflow incident in Building 701 (June 1972) contributed elevated levels of radioactive material (plutonium) to the Building 995 effluent and drying beds. In 1972, plumbing changes were initiated to channel all wastes through Building 995. The increased load thus generated lead to increasing radioactivity levels in sewage sludges which are shipped off site for disposal. Surge overflows and incidents involving spillage of the dried or drying sludge have created an area of concern which extends from the outlet of the South Walnut Creek diversion culvert to and through the B-series holding ponds, and surrounding the treatment area including both sides of the perimeter road east of Building 995.

The original process waste outfall (from Building 774) was located just west of the Building 995 outfall. The line was later rerouted to discharge further upstream. In 1972, the line was routed through Building 990 and then, through the sanitary sewer lines, into Building 995. The abandoned line is still in place. The area of the original outfall as well as the abandoned line are noted on Map 10 as areas of interest.

Map 10A details soil sample results from a recent survey in the vicinity of Building 995. These results are only illustrative, as actual levels vary with flow rates through the creek bed.

The B-series holding ponds are located in this area. Sediment sample results from all holding ponds taken in 1971 by the Radiobiology Department of Colorado State University (CSU), are detailed in Map 10B. The values given are questionable due to the analytical technique employed. Values shown may be high due to the presence of isotopic uranium or low due to inadequate sampling technique.

Regardless of the accuracy of the values shown in Map 10B, the B-series ponds must be considered an area of concern regarding both chemical and radioactive infiltration. Studies have shown that these ponds have performed what they were designed to do, provide residence time and holding capacity to allow materials to settle out, and in so doing have become infiltrated with those materials. It should be noted that the concentrations decrease throughout the system, which is further indication of the effectiveness of the ponds.

INFILTRATED AREA DUE TO  
LONG TERM OPERATIONS.  
SEE FOLLOWING MAP.

ORIGINAL PROCESS WASTE OUTFALL  
LINE IS STILL IN PLACE, CAPPED...  
POTENTIAL INFILTRATION CONSIDERED  
SLIGHT.

SEWAGE HOLDING TANKS.

990

SOME MINOR INCIDENTS INVOLVING Pu, U, AND  
Be HAVE BEEN REPORTED IN 991. INVOLVEMENT  
SHOULD BE VERY LIGHT BOTH UNDER AND  
AROUND BUILDING, AND IN STORAGE TUNNELS.

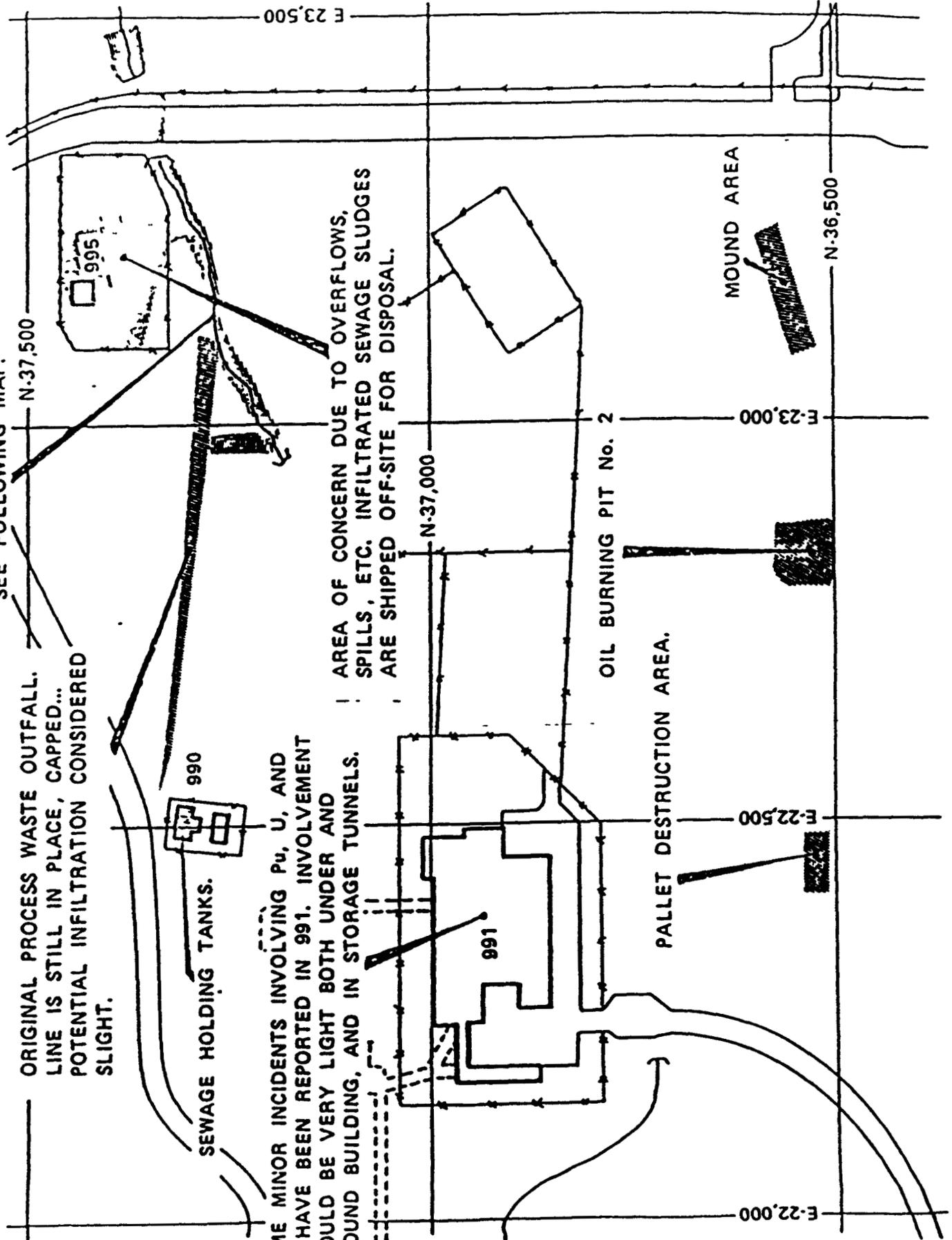
991

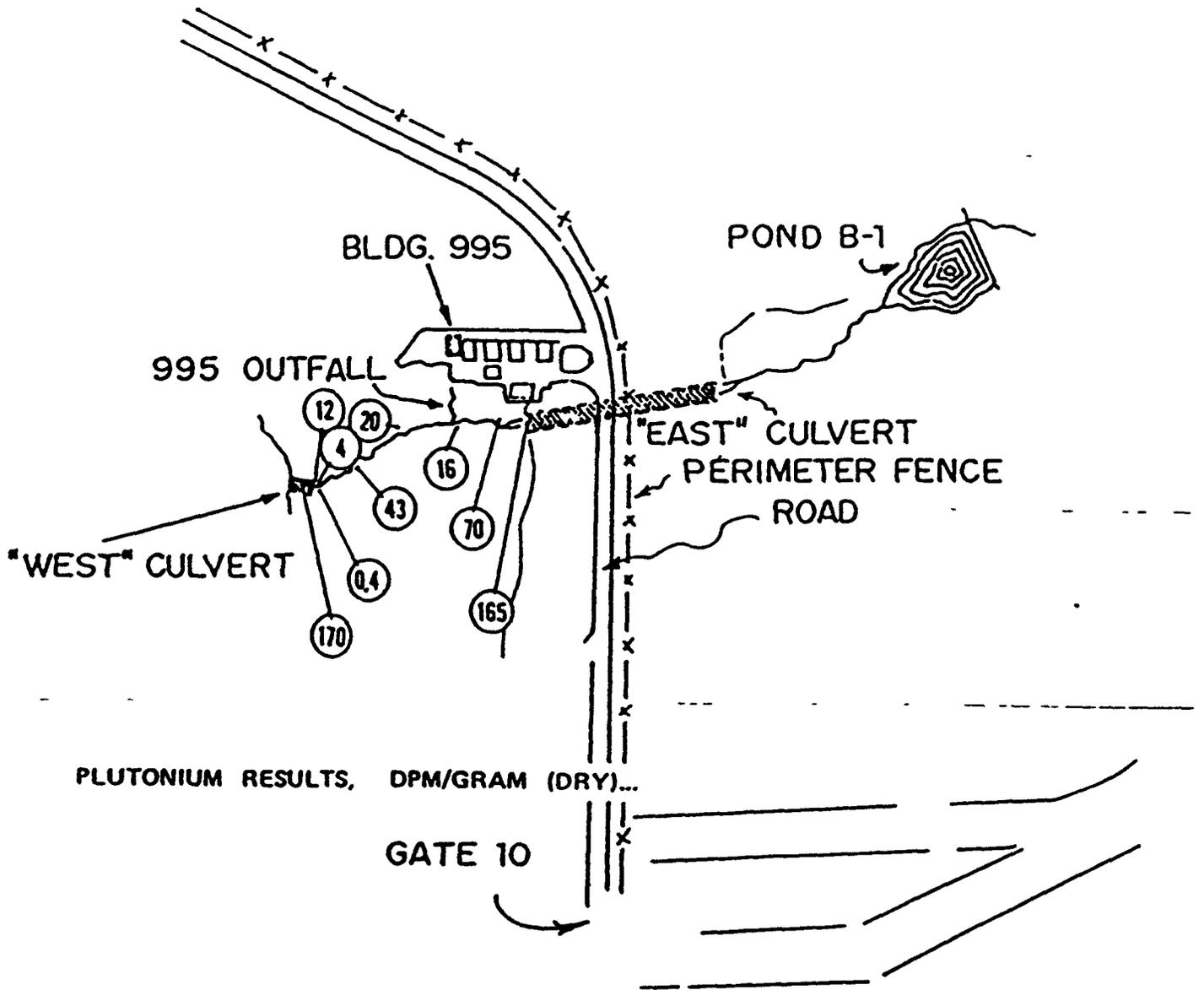
AREA OF CONCERN DUE TO OVERFLOWS,  
SPILLS, ETC. INFILTRATED SEWAGE SLUDGES  
ARE SHIPPED OFF-SITE FOR DISPOSAL.

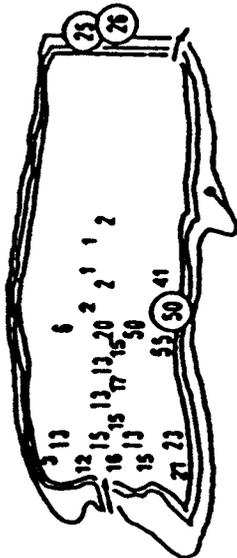
OIL BURNING PIT No. 2

PALLET DESTRUCTION AREA.

MOUND AREA

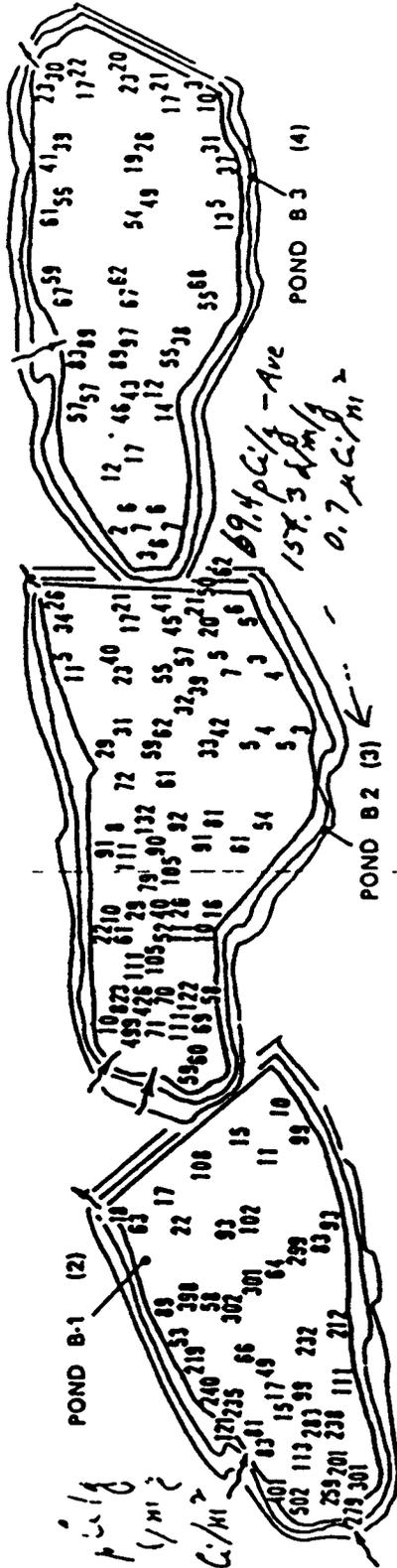






POND A-1

*Av. - 151 pCi/g  
336 d/mi<sup>2</sup>  
1.5 μCi/mi<sup>2</sup>*

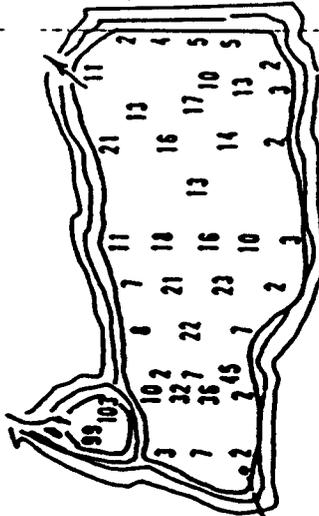


POND B-1 (12)

*35.5 pCi/g  
78.4 d/mi<sup>2</sup>  
0.4 μCi/mi<sup>2</sup>*

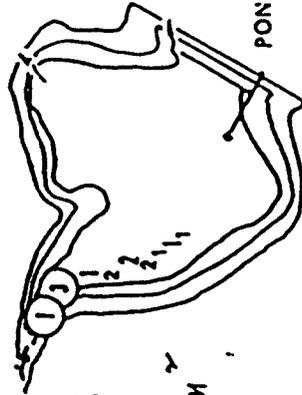
*89.4 pCi/g - Ave  
157.3 d/mi<sup>2</sup>  
0.7 μCi/mi<sup>2</sup>*

POND B-2 (3)



POND B-4 (5)

*Ave = 16.2 pCi/g  
36 d/mi<sup>2</sup>  
0.2 μCi/mi<sup>2</sup>*



POND C (9)

PLUTONIUM CONCENTRATIONS IN HOLDING POND SEDIMENTS (PICOCURIES/GRAM-DRY) CONSECUTIVE SAMPLES TAKEN IN APRIL AND MAY, 1971, BY RADIOBIOLOGY DEPT., COLORADO STATE UNIVERSITY. PONDS ARE NOT DRAWN TO SCALE.

NOTE: These values may be high due to the presence of isotopic uranium or low due to inadequate sampling technique.

Map 11 (Burial Sites - Except the 903 Area)

Locations where radioactive materials or chemicals have been deliberately buried or contained are detailed on Map 11. Detailed descriptions of each burial site, except the 903 Area which is discussed separately, are as follows:

Oil Burning Pit No. 1 ✓

Ten drums of oil containing depleted uranium were burned in August 1956 and the residue covered with backfill.

Oil Burning Pit No. 2 (1957 and 1961-1965) ✓

A total of 1,082 drums of oil containing uranium were burned. The residues and some flattened drums were covered with backfill.

Mound Area (1954-1958)

A total of 1,405 drums of oil and solid waste were buried. Mostly depleted uranium with some enriched uranium and suspected low-level plutonium in this area. Complete retrieval and off-site disposal were achieved in May 1970 with no plutonium detected. A proposal to construct a new holding pond in this area resulted in sampling the soil in the vicinity of the excavated mound. Results ranged from 0.8 to 112.5 dpm/g and are thought to be due to infiltration from the 903 Area rather than to an influence from the mound or oil disposal pit (No. 2).

Trench T-1 (1954-1962) ✓

Approximately 25,000 kg of depleted uranium chips in 125 drums were deposited in this trench and covered with about 2 feet of fill dirt.

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Trenches T-2 through T-8 (1954-1968) ✓

The trenches were disposal sites for approximately 100,000 kg of sanitary sewage sludge and about 275 flattened empty drums contaminated with uranium. Earlier pits involve mostly uranium with an increasing plutonium fraction in later pits. Activity ranges from 800 to 8,000 dpm/g.

T-4 also contains some uranium-plutonium infiltrated asphalt planking from the 207 ponds. Estimated total alpha radioactivity is between 100

and 150 mCi. *T 5 metal in W. end, T 6 no metal, T 7 metal in west end, T 8 metal in W. end, T 9 see W. extension of T 7, metal throughout but most in E. half and*  
Asphalt Disposal Area (1969) *sludges in W. half. Radioactivity found & sample analyzed for Pu & U*

Approximately 320 tons of plutonium-infiltrated asphalt and soil (from the Building 776 fire, May 1969) buried under 1 to 2 feet fill dirt. Less than 1 mCi plutonium is estimated to be dispersed in approximately 250 cubic yards of material with an estimated alpha activity of about 7 dpm/g. *& also from Central Area between 8<sup>th</sup> & 10<sup>th</sup> Sts*

Soil Burial (1972) ✓

Approximately 60 cubic yards of plutonium-infiltrated soil from the Building 774 waste storage-tank area, now covered with about 3 feet of fill dirt. Estimated activity less than 250 dpm/g (total long-lived alpha). This soil was placed on top of the asphalt disposal area and covered with approximately 3 feet of fill dirt.

Incinerator Ash Pits I-1 through I-4 (1952-1968) ✓

Estimated 100 grams depleted uranium burned with general combustible waste over 16-year period. Ashes buried in trenches.

*Also - metal detected by "Rayscope" in Pit I-3*

Original Sanitary Landfill (1952-1968)

An estimated 20 kg depleted uranium ash is buried along with normal plant waste, including small quantities of various chemicals. The 20 kg of depleted uranium resulted when 60 kg was inadvertently burned and only 40 kg was recovered.

Oil Disposal Pit (1958)

Approximately 30 to 50 drums of oil sludge from a storage tank cleanout were emptied into a pit, which was then backfilled. No radioactivity involved.

Sanitary Landfill (Started in 1968) ✓

From August 1968 to February 1970, approximately 1,000 kg of sanitary sewage sludge (800 to 8,000 dpm/g) were buried in the landfill. (Estimated total of 1 to 1.5 mCi alpha radioactivity buried with sludge.) Estimated annual (Dow/contractor) waste is 9,000,000 pounds. Materials with less than minimum detectable radioactivity levels (500 dpm/60 square centimeters direct or 50 dpm/square foot smear) are accepted for burial. Recent surveys have also disclosed other radioisotopes (e.g., tritium) in small quantities.

Lithium Destruction Areas (1956-1970)

Approximately 400 to 500 pounds of metallic lithium were destroyed and the residues, primarily non-toxic lithium carbonate, buried. Smaller quantities of other reactive metals (sodium, calcium, and magnesium) and some solvent type chemical compounds were also destroyed in this location.

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Scrap Metal Disposal (Approximately 1958)

Scrap metal components, mostly from original construction, were buried in this area. Although no detectable radioactive or chemical materials were observed, some pieces were recovered from process areas and low level radioactivity of a small percentage of the scrap is possible.

Cooling Tower Blowdown Retention Ponds

These are small ponds which were used to contain water from cooling towers. Hexavalent chromium is present. Some small quantity of lithium was also destroyed in the two eastern-most ponds. These ponds were covered with fill.



Map 12 (903 Storage Area)

Most of this area is now covered with an asphalt pad. It is the primary source of both on and off-site plutonium. From 1958 through 1967, approximately 5,240 drums of oil containing radioactivity were stored in this location. Of these drums, about 3,570 contained plutonium. The leakage of this material via corroded drums resulted in the concentrations described here.

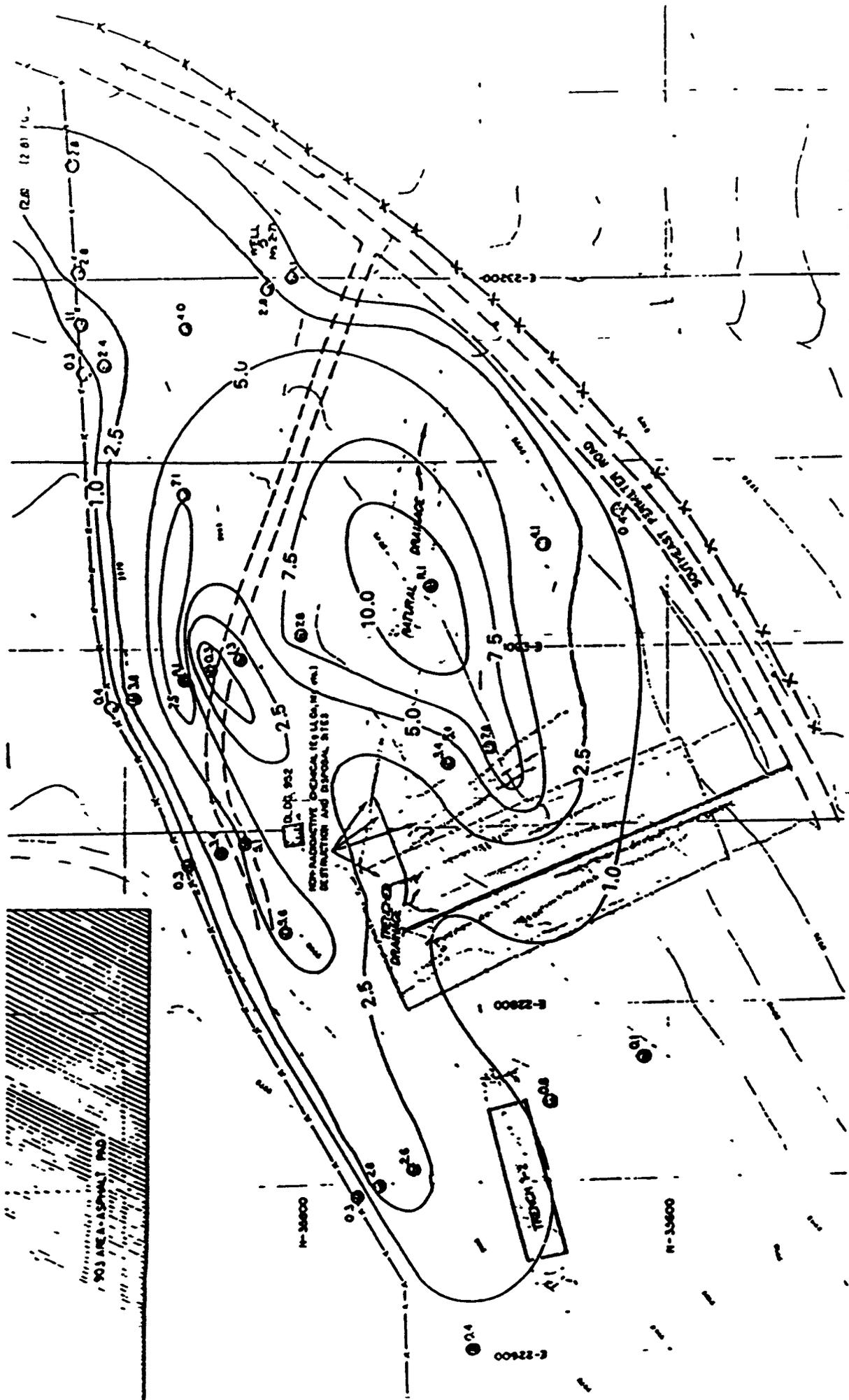
Of the approximately 85 grams of plutonium originally deposited at the site, an estimated 68 grams remain dispersed over an area of 98,000 square feet, which was covered with asphalt and fill material in November 1969.

During the removal of the corroded drums and the subsequent covering operations, some radioactive material was resuspended and distributed by wind action to the east of the present pad area. Transport by runoff of rain and snow melt was also observed. The total quantity of <sup>239</sup>Pu dispersed in soil other than that covered by the pad is estimated to be less than 16 grams spread over a total area of over 2,000 acres. Inside the Rocky Flats boundary, about 672 acres contain nearly half the estimated plutonium. The remainder is spread over about 1,400 acres of public and private property.

In conjunction with the radioactive infiltrations noted in the original survey, further work has confirmed additional "hot spots" south of the actual pad area (Map 12A). The values indicated and contoured on this map were determined by FIDLER survey, and extrapolated from the detection of radiations emitted from americium. Total plutonium in this area has been estimated to be 7 grams as determined by a rough mechanical interpretation of the preliminary data.

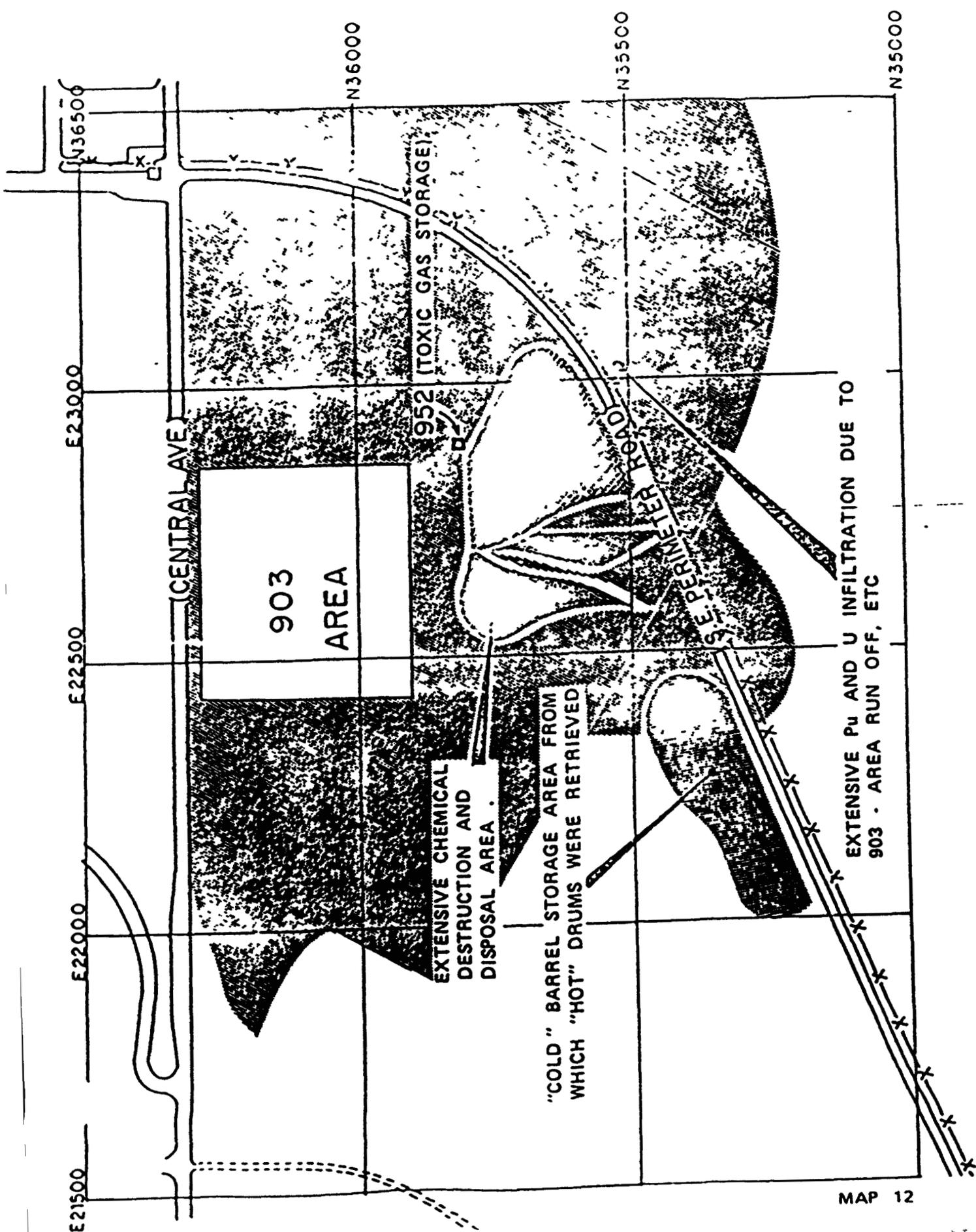
The area has also been extensively used as a chemical destruction and disposal area. Type and quantities of materials disposed here are unknown, but considerable quantities of metals such as lithium, calcium, and

magnesium are known to have been destroyed in the area since 1966. Thus chemical infiltration of the soil is a certainty, but no environmental detriment has been noted.



AMERICIUM CONCENTRATIONS ( $\mu\text{Ci}/\text{m}^3$ ) DETECTED BY FIDLER SURVEY. MULTIPLY NOTED CONCENTRATIONS BY  $10^4$  TO OBTAIN APPROXIMATE PLUTONIUM CONCENTRATIONS IN  $\text{mCi}/\text{km}^2$  OR BY  $10^1$  TO OBTAIN  $\sim\mu\text{Ci}/\text{m}^2$ .

MAP 12A.

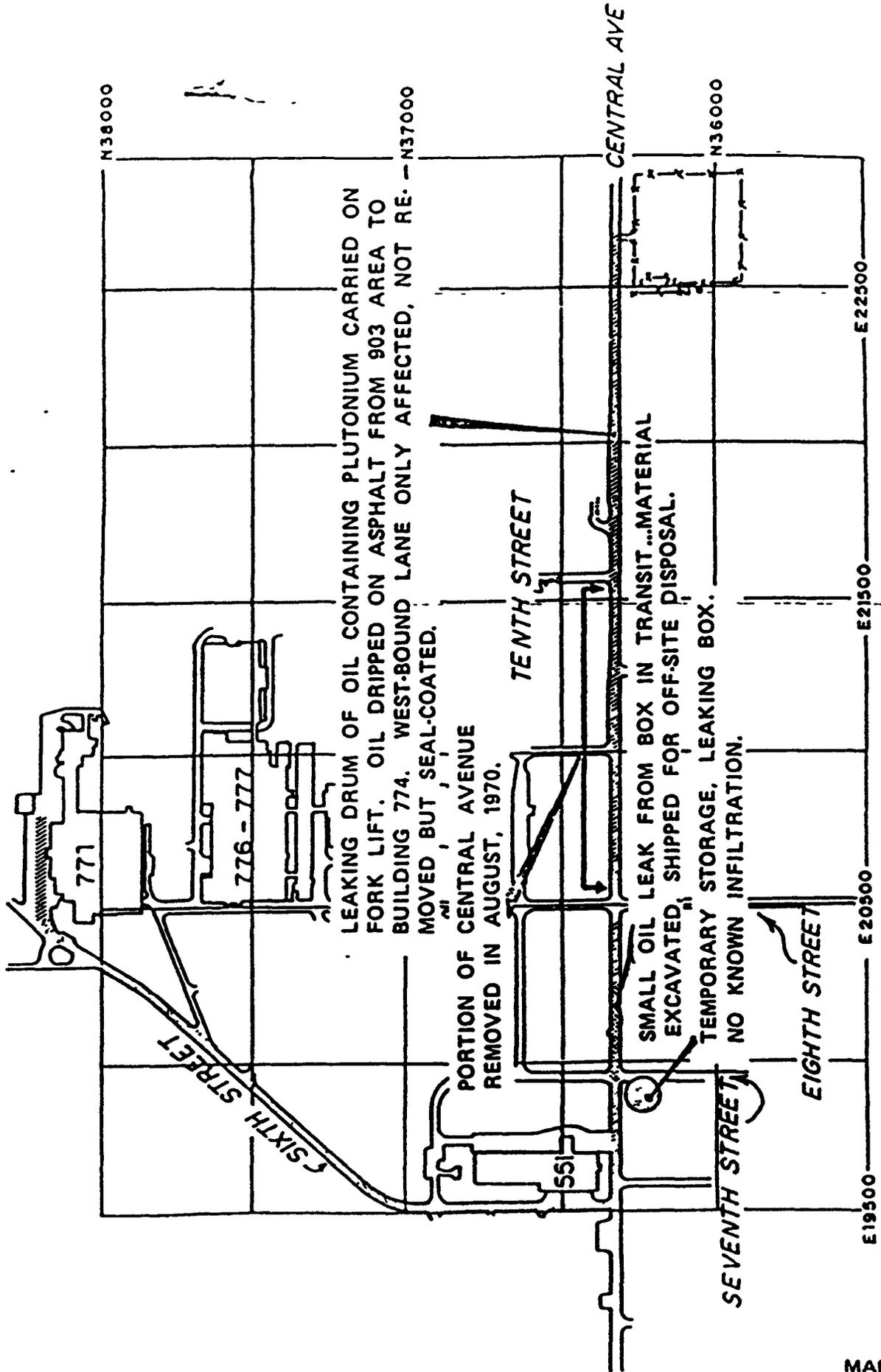


MAP 12

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Map 13 (Roadways)

Incidents involving radioactive infiltration of roadways have been noted. In May 1965, a box containing radioactive waste from Building 776 was moved to the Storage Area near Building 663. Intermittent leakage from that box affected a strip of asphalt about 18 inches wide which was removed from the roadway. The box was stored on plastic sheeting (at Seventh and Central) until removal could be effected. No known infiltration resulted from that storage. In June 1968, a leaking drum in transit from the 903 Area to Building 774 resulted in approximately 140,000 dpm/100 cm<sup>2</sup> on the west bound lane of Central Avenue to and along Sixth Avenue. The entire affected roadway was seal-coated. Some low-level material was spread to the ditch on the west side of Central Avenue. In August 1970, one section of the roadway between Eighth and Tenth Streets was removed and placed in the previously described asphalt dump.



ROADWAYS OF CONCERN.

Map 14 (Process Waste Lines)

Map 14 details the process waste system at Rocky Flats, tankage, and possible major materials present in those tanks.

In an effort to reduce corrosion, original process waste lines had a saran-lined inner pipe enclosed in a protective clay tile pipe. This saran lining was very susceptible to leakage. Leaks were noted in 1952 and by 1956 most of the original pipe had been replaced with stainless steel. To date, all but about 600 feet of this line has been replaced. The remaining section was thoroughly tested in 1971 and was not leaking.

An exhaustive leak-test survey was conducted in 1971 by an off-site contractor. This leak test was conducted under pressure and disclosed several minor leaks, mostly in low-pressure (essentially gravity-flow) lines. Repairs were started immediately. Attempts were made to repair the higher pressure leaks in place. When these attempts failed, an alternate line was installed. The low leak-rate detected around joints in the gravity flow line is to be expected since this type line is not designed to operate under pressure. Lines have been observed under operational pressures and no leakage observed.

With the exception of Building 559 and between Buildings 776 and 774 as noted below, no radioactive infiltration has been detected outside the lines even in the vicinity of the leaks, but some chemical infiltration, particularly nitrate solutions, is probable. These areas are noted as "areas of concern" on Map 14A primarily in the interests of conservatism. As pipelines have been replaced, soils and liquids have been monitored and, with the noted exceptions, have not resulted in detectable concentrations. However, extremely low-level radioactive and chemical infiltration must be presumed.

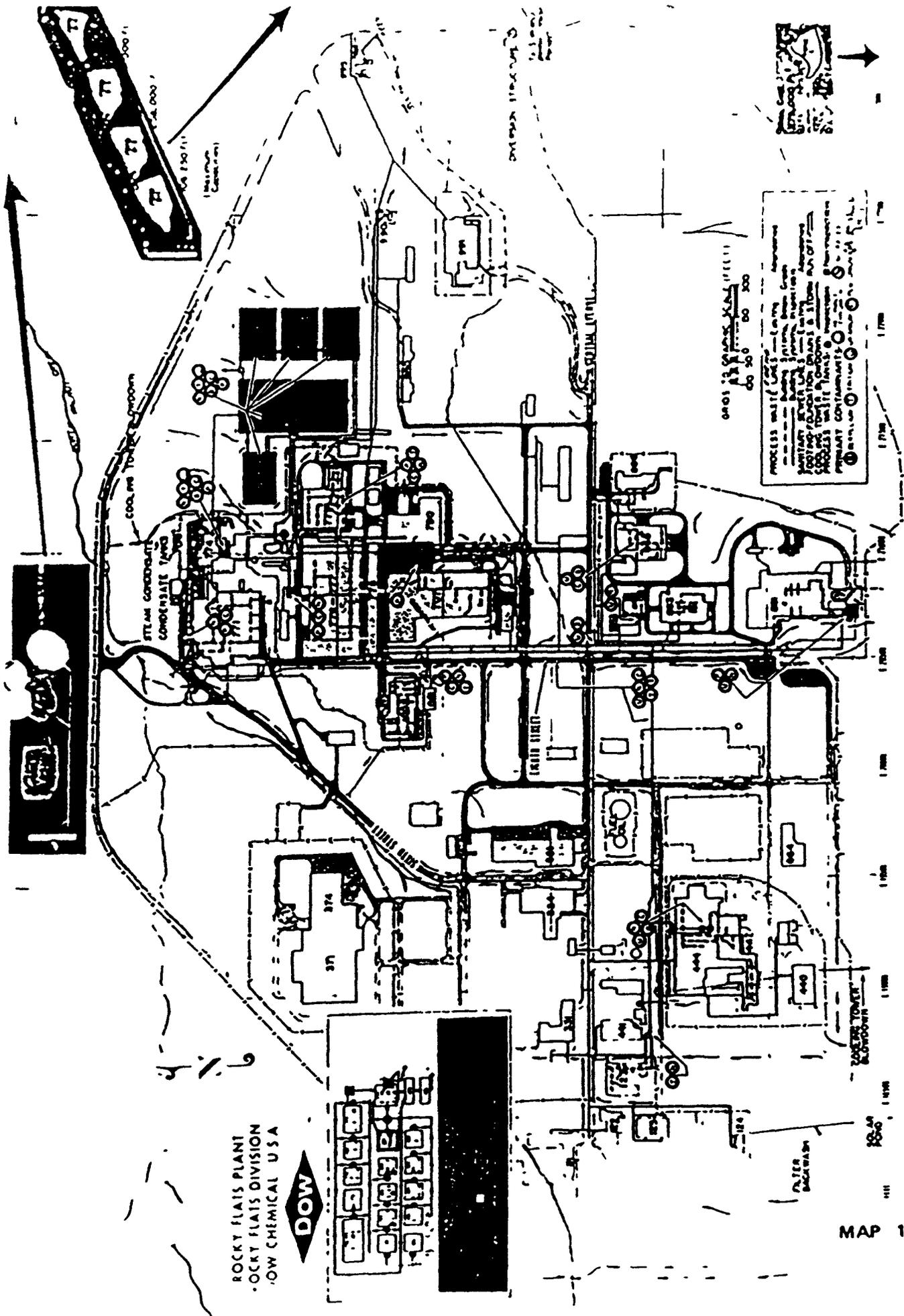
Process waste lines between Buildings 776-777, 779, and 774 and between Buildings 771 and 774 have broken and leaked several times. Valve

leakage has occurred in the valve pit near waste storage tank 207. Although noted incidents in this area have resulted in clean up (soil removal), residual infiltration is a surety. Thus the entire area from Buildings 776-777 and 779 Complex to Building 774 should be considered an area of concern as shown on Map 14B.

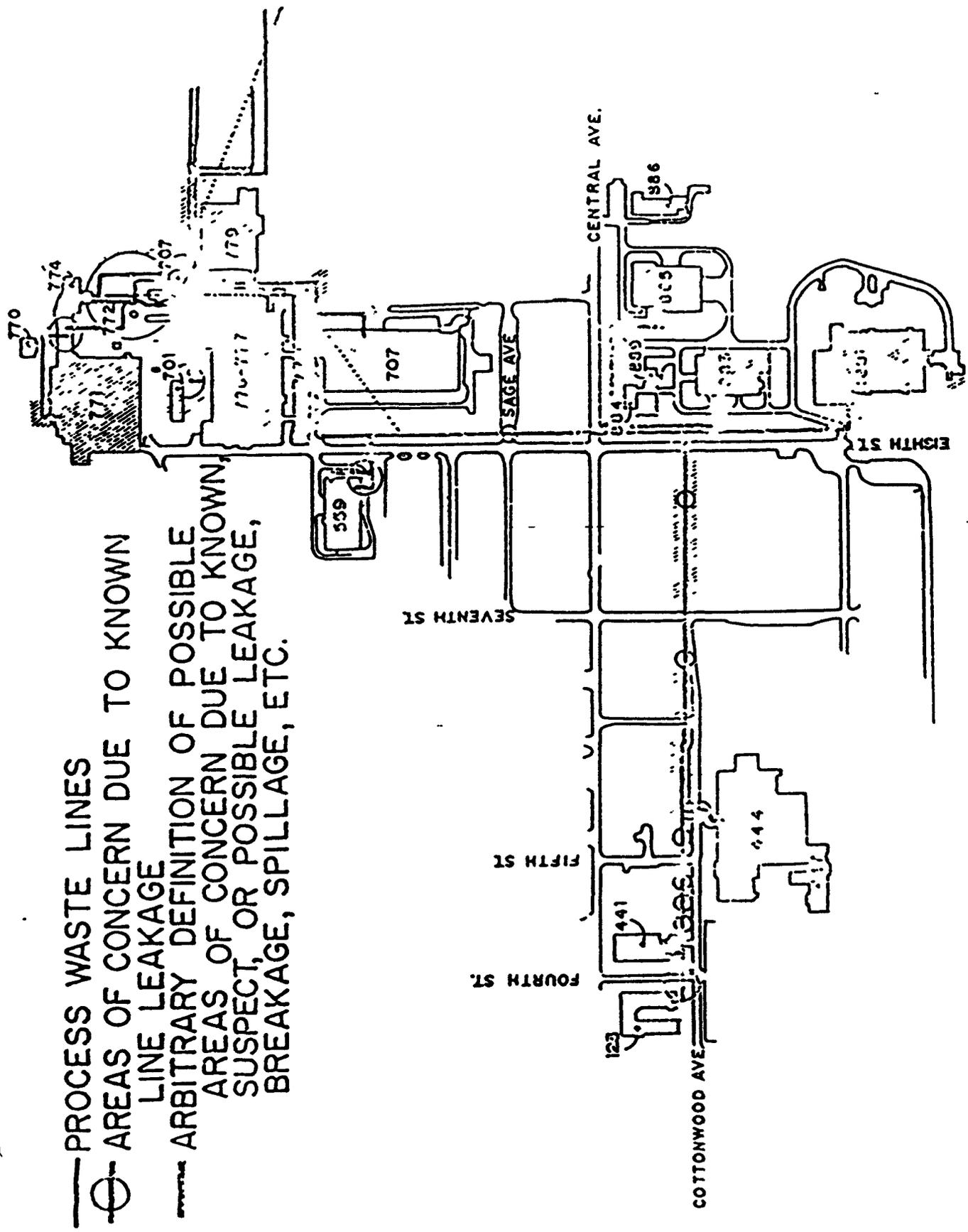
Building 559, a Service Laboratory Facility commissioned in 1968, was originally built with Pyrex<sup>®</sup> glass waste lines. Less than one year later, a break was discovered in the line from the building to the pump house. Several hundred square feet of infiltrated soil was removed as radioactive waste as a result of the leakage. This same type of line is buried beneath Building 559. In 1972, the south half of this two section line was discovered to be leaking. A PVC pipe bypass was installed. Vertical core sections taken under the building confirm some infiltration directly under the pipeline (approximately 250 dpm/g). Core samples taken outside the building, however, did not detect measurable quantities, indicating that any infiltration is contained beneath the building proper.

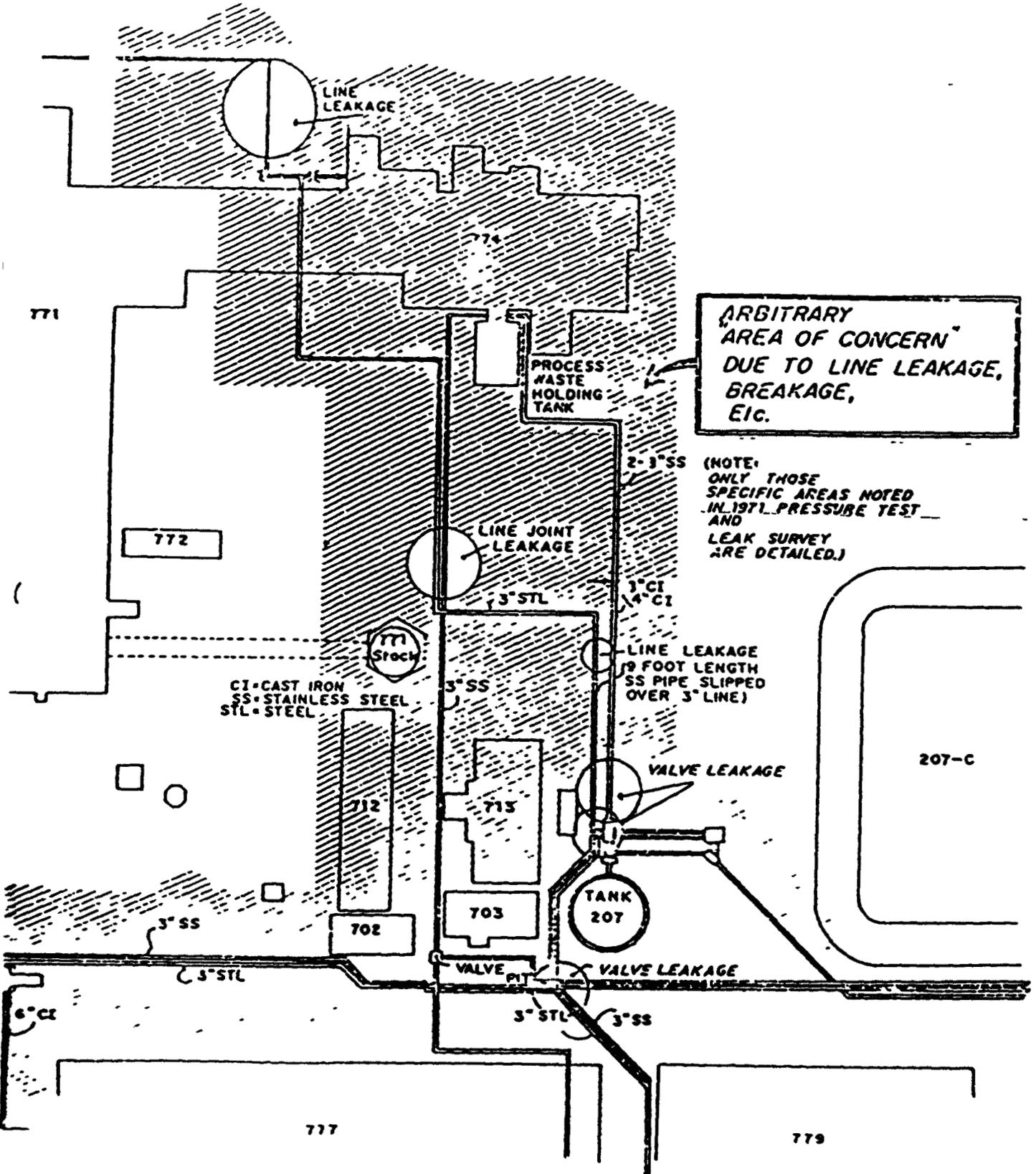
The remaining waste lines in Building 559 were static-leak tested following the bypass installation. Current plans call for yearly static-test to prevent recurrence.

Abandoned process waste lines under Building 707 (removed), under the new Filter Plenum for Building 779 (removed), and at the original outfall near Building 990 (still in place) as well as smaller sections elsewhere (i.e., west of Building 771) should be noted. Although not considered as sources for further contributions, some soil has been infiltrated in the immediate vicinity of the lines or original locations.



— PROCESS WASTE LINES  
 ⊕ AREAS OF CONCERN DUE TO KNOWN  
 LINE LEAKAGE  
 - - - - - ARBITRARY DEFINITION OF POSSIBLE  
 AREAS OF CONCERN DUE TO KNOWN,  
 SUSPECT, OR POSSIBLE LEAKAGE,  
 BREAKAGE, SPILLAGE, ETC.





MAP 14B

**(M) No 2 Fuel Oil Tanks**  
 (M) Y BURIED (Uninspectable) TANKS )  
 iding Cap. (Gal.)

991	5000
865	2000
883	500
821	1800
881A	750
779	500
776(2)	1000 (Ea.)
771	2000
707	4000
559	1034
443	1500
331	6000

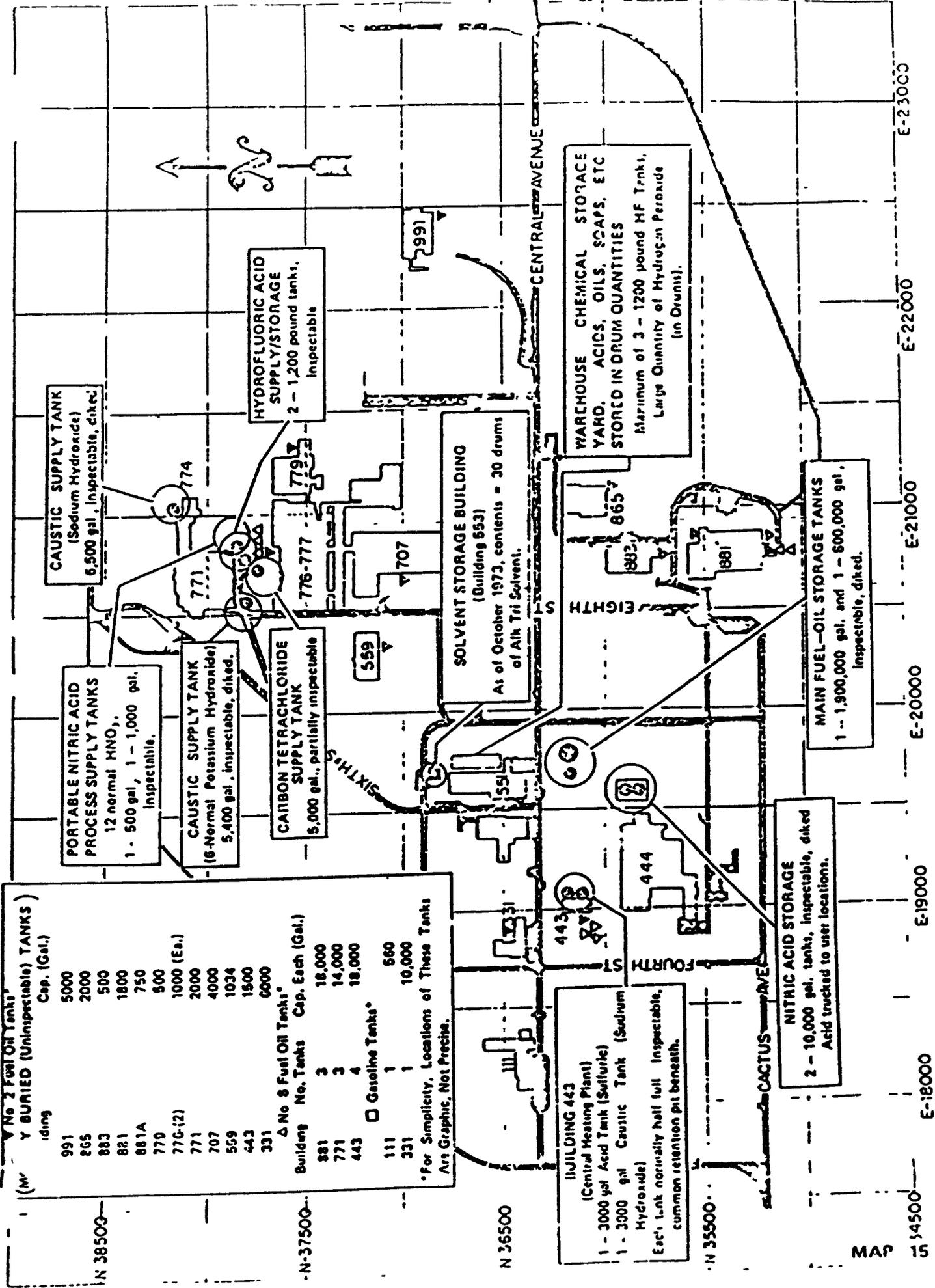
**Δ No 8 Fuel Oil Tanks\***

Building	No. Tanks	Cap. Each (Gal.)
881	3	18,000
771	3	14,000
443	4	18,000

**□ Gasoline Tanks\***

111	1	560
331	1	10,000

\*For Simplicity, Locations of These Tanks  
 Are Graphic, Not Precise.



CAUSTIC SUPPLY TANK  
 (Sodium Hydroxide)  
 6,500 gal., inspectable, diked.

PORTABLE NITRIC ACID  
 PROCESS SUPPLY TANKS  
 12 normal HNO<sub>3</sub>.  
 1 - 500 gal., 1 - 1,000 gal.  
 inspectable.

CAUSTIC SUPPLY TANK  
 (6-Normal Potassium Hydroxide)  
 5,400 gal., inspectable, diked.

CARBON TETRACHLORIDE  
 SUPPLY TANK  
 5,000 gal., partially inspectable

HYDROFLUORIC ACID  
 SUPPLY/STORAGE  
 2 - 1,200 pound tanks,  
 inspectable

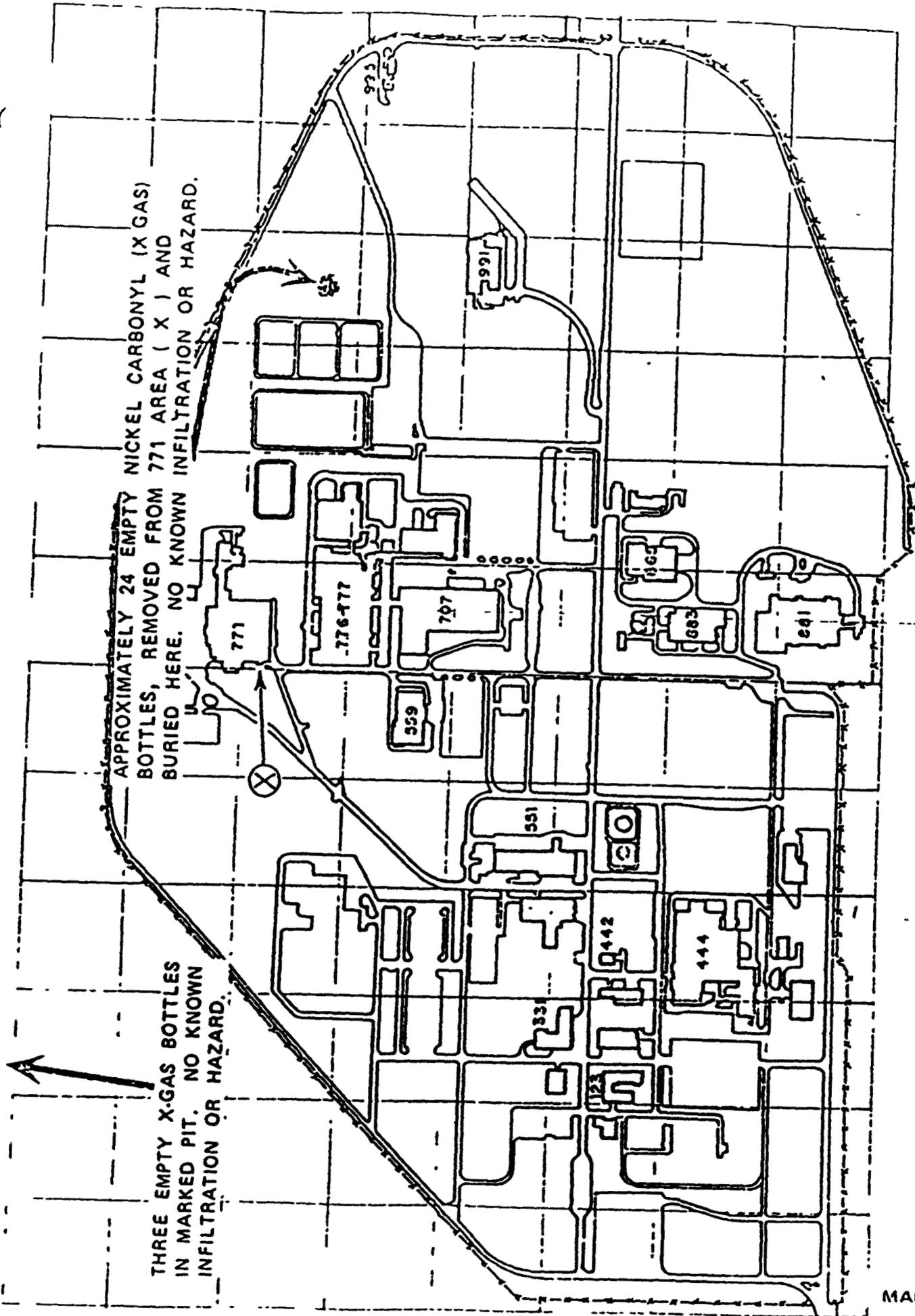
SOLVENT STORAGE BUILDING  
 (Building 553)  
 As of October 1973, contents = 30 drums  
 of Aik Tri Solvent.

WAREHOUSE CHEMICAL STORAGE  
 YARD, ACIDS, OILS, SCAPS, ETC  
 STORED IN DRUM QUANTITIES  
 Maximum of 3 - 1200 pound HF Tanks,  
 Large Quantity of Hydrogen Peroxide  
 (in Drums).

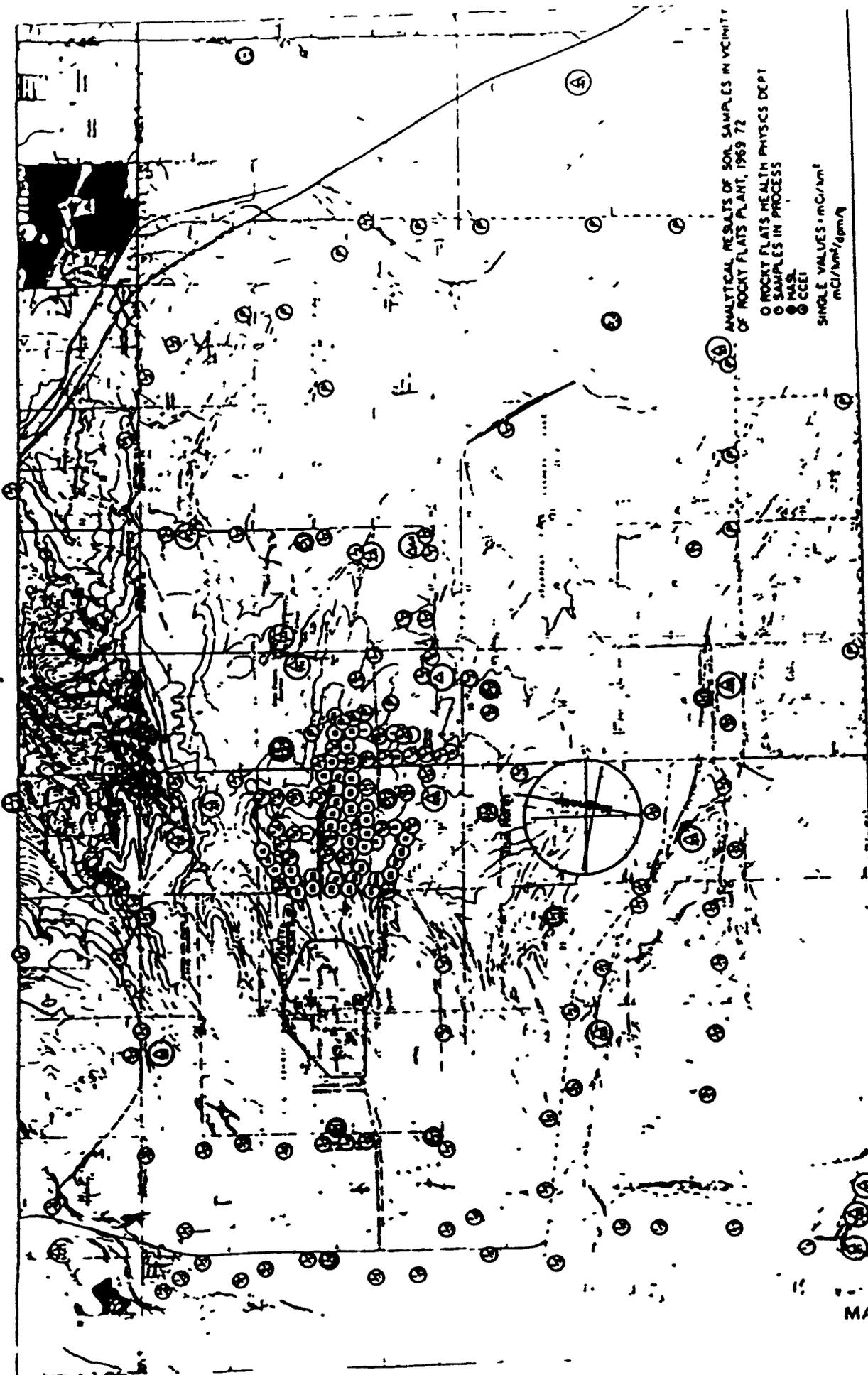
MAIN FUEL-OIL STORAGE TANKS  
 1 - 1,900,000 gal. and 1 - 600,000 gal.,  
 inspectable, diked.

NITRIC ACID STORAGE  
 2 - 10,000 gal. tanks, inspectable, diked  
 Acid trucked to user locations.

BUILDING 443  
 (Central Heating Plant)  
 1 - 3000 gal Acid Tank (Sulfuric)  
 1 - 3000 gal Caustic Tank (Sodium  
 Hydroxide)  
 Each Tank normally half full inspectable,  
 common retention pit beneath.



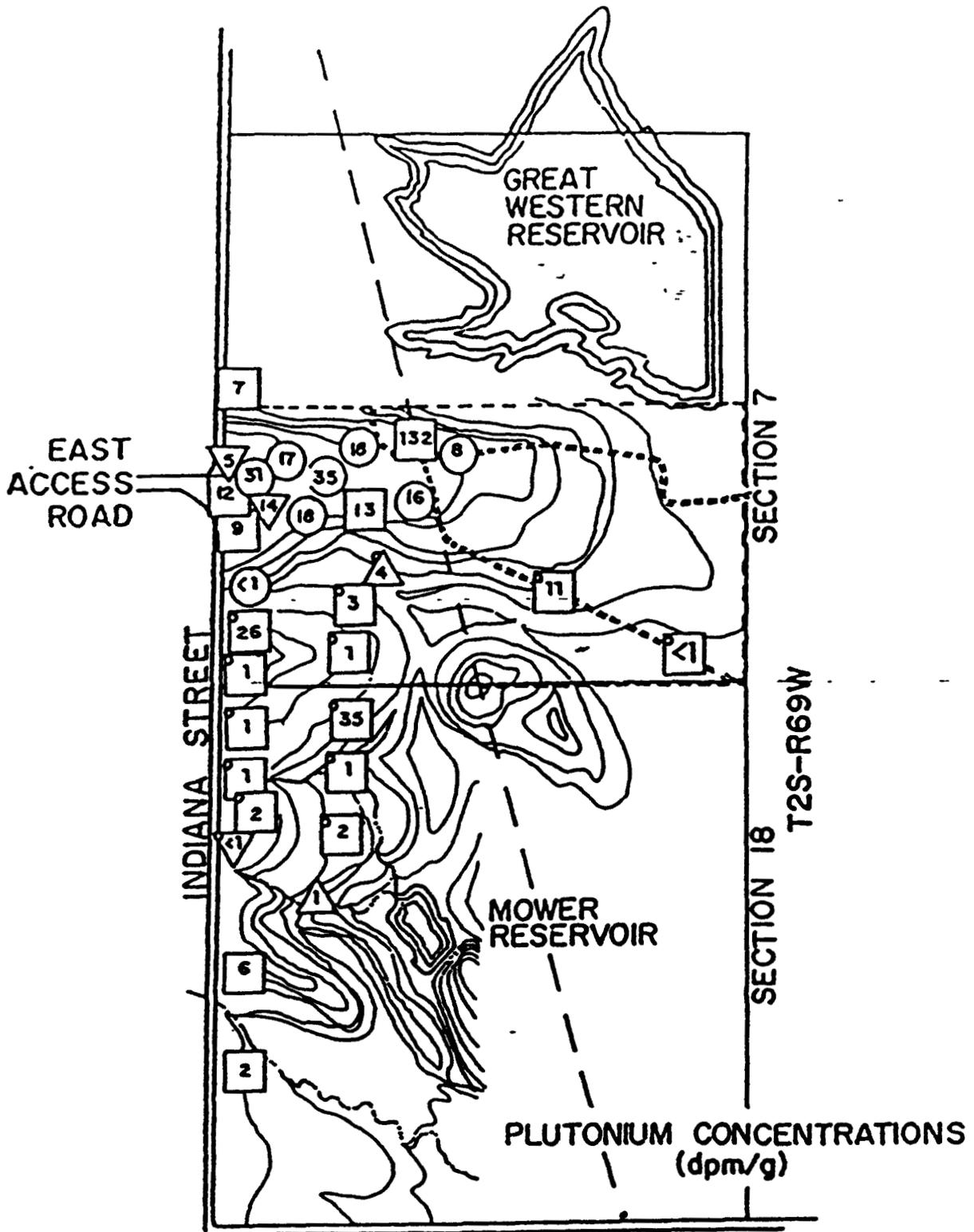
MAP 15A.



ANALYTICAL RESULTS OF SOIL SAMPLES IN VICINITY  
 OF ROCKY FLATS PLANT, 1969-72

○ ROCKY FLATS HEALTH PHYSICS DEPT  
 ○ SAMPLES IN PROCESS  
 ○ MAS  
 ○ CCEI  
 ○ SINGLE VALUES - mCi/m<sup>2</sup>/gram

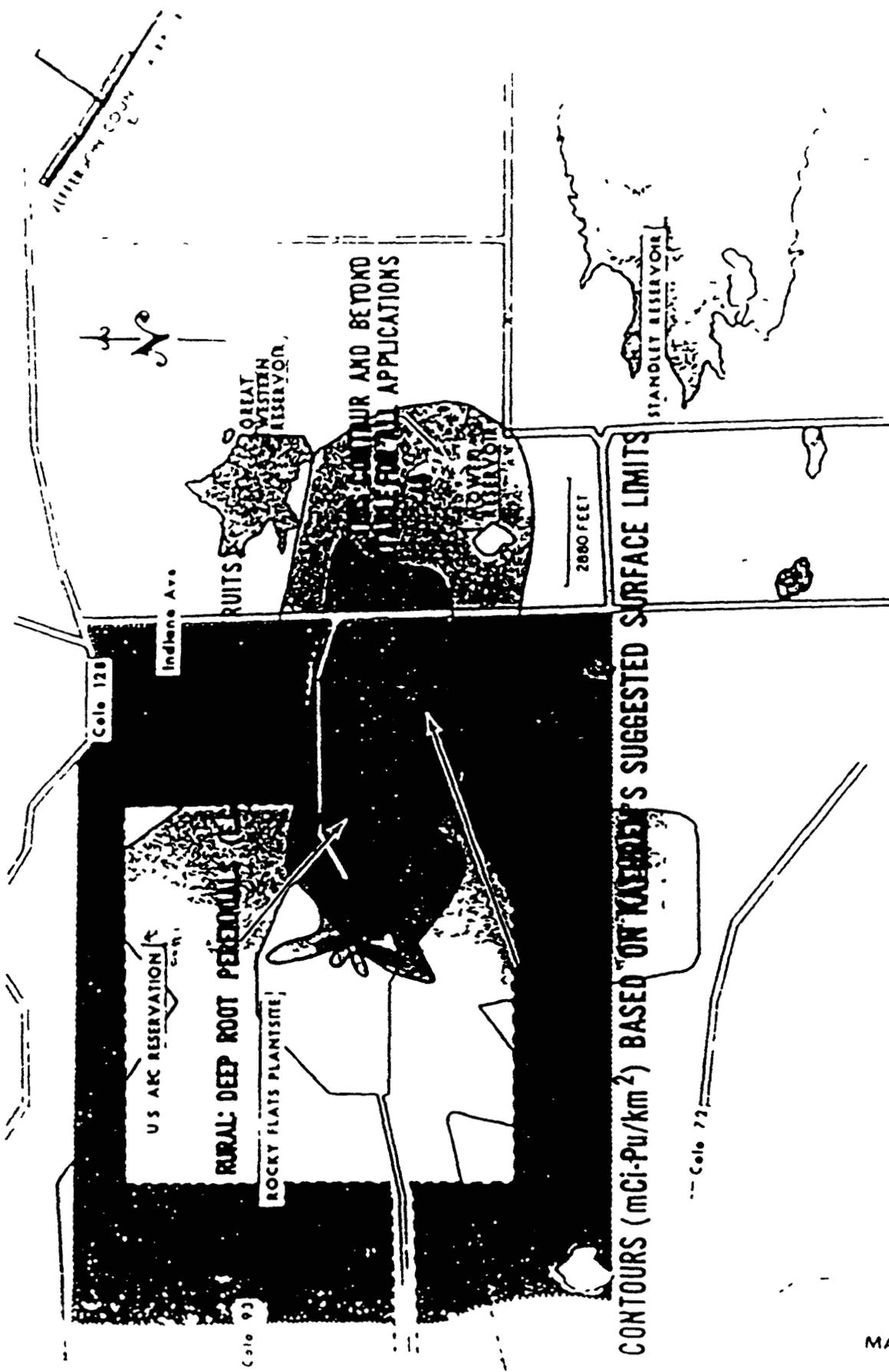
MAP 16A.



**SAMPLE DATES:**

- NOV. 1972
- JULY 1971
- ▽ JAN. 1972
- △ MAY '69-JULY '70

\* DENOTES AREA WHERE SOIL HAD BEEN RECENTLY DISTURBED BY PLOWING.



CONTOURS (mCi-Pu/km<sup>2</sup>) BASED ON KAMENIK'S SUGGESTED SURFACE LIMITS



## III. "CONTAMINATED"

The word "contaminated" has become common to the vocabulary of groups and individuals involved or interested in environmental sciences and affairs. This is particularly true with regard to nuclear energy; however, there is no realistic or practical definition of "contaminated." Webster's New Collegiate Dictionary (copyrighted 1969) defines "contaminate" as:

1. To soil, stain, or infect by contact or association.
2. To make unfit for use by introduction of unwholesome or undesirable elements."

U. S. Department of Health, Education, and Welfare Radiological Health Handbook (revised edition January 1970) defines "radioactive contamination" as:

"Deposition of radioactive material in any place where it is not desired, particularly where its presence may be harmful. The harm may be in vitiating an experiment or a procedure or in actually being a source of danger to personnel."

A more appropriate definition would be to relate contamination levels to the intended use or application of the material, area, etc. Earlier editions of Webster's New Collegiate Dictionary (copyrighted 1961) made an attempt in this direction defining "contaminate" as follows:

1. To soil, stain, or corrupt by contact; to pollute.
2. To render (water otherwise satisfactory) unfit for a specified use, as by the introduction of bacteria, sewage, etc."

████████████████████

It is obvious that even this definition is inadequate and it becomes understandable why most people use "contaminated" in an apprehensive manner and to achieve or express a state of concern.

Our society has established and accepted a system which makes it possible to live with "contaminated." The system consists of groups of recognized experts who examine factual and theoretical data to establish and recommend concentration limits or guide values which are not expected to result in irreparable damage or insult to man or his environment. These groups of experts have been assigned names such as International Commission on Radiological Protection (ICRP), National Council on Radiation Protection (NCRP), Federal Radiation Council (FRC), Council on Environmental Quality, and others. It is true that the concentration limits or guide values recommended by these groups are challenged by other individuals and groups but the system and concentration philosophy are generally accepted.

The U. S. Atomic Energy Commission has incorporated recommendations of these groups into AEC Manual Chapters 0510, "Prevention, Control, and Abatement of Air and Water Pollution," and 0524, "Standards for Radiation Protection." Concentration values have been recommended and accepted for air and water. However, due to wide variations in many factors related to resuspension and other physical and chemical properties, no recommendations or concentration values exist for soil.

The fact that recommendations or values do not exist for soil does not mean that no efforts have been made to establish values or that values have not been established and actually used for specific circumstances. One of the most widely accepted and recent (1968) discussions of radioactivity concentration guides for plutonium in soil was presented by R. L. Kathren, Battelle Northwest, Richland, Washington, entitled "Towards Interim Acceptable Surface Contamination Levels for Environmental  $PuO_2$ ," BNWL-SA-1510, which is attached as Appendix A. Los Alamos Scientific Laboratory has been commissioned by the Division of Operational Safety of

the U. S. Atomic Energy Commission to provide an interim or provisional standard for plutonium in soil. J. K. Healy is presently preparing a report entitled "A Proposed Interim Standard for Plutonium in Soils." A review of the draft and discussions with Mr. Healy indicate no significant differences or variations from the information and conclusions presented by Mr. Kathren.

Since man does not consume soil, the hazard to man from "contaminated" soil must come from resuspension of the material into the air which man inhales, transfer of the material into water which man drinks, uptake of the material by plants or animals which man eats, absorption of the material through man's skin, or introduction through the broken skin of man. An additional hazard may result when soil is "contaminated" with radioactive materials which emit beta particles, x-rays, or gamma rays which penetrate man's skin in excess of the amounts set forth in AEC Manual Chapter 0524; however, with the exception of radiographic sources, these types of radioactive materials are not handled at Rocky Flats.

With the preceding paragraph in mind, it is possible to recommend a definition of "contaminated" soil in terms of risk or hazard as related to air and water concentration values. It must be stressed that the following recommended definition is not an attempt to imply that areas of potential concern do not exist on the Rocky Flats Plant site but is one which has been used and should continue in use until such time that one of the official groups of experts recommends concentration values for soil and the U. S. Atomic Energy Commission incorporates the recommendations into the AEC Manual.

Contaminated soil will be deemed to exist whenever monitoring of air or water indicates concentration values in excess of the values set forth in the AEC Manual.

For those materials which are not included in the AEC Manual, the values set forth by other officially recognized agencies

will be used. When two or more concentration values for the same material are specified by different agencies, the most restrictive value will apply.

Note

By specifying monitoring of air or water this definition excludes the plutonium in soil concentration value of 2.0 disintegrations per minute per gram of dry soil or square centimeter of surface area which was adopted by the Colorado State Board of Health on March 21, 1973, as the level above which utilization of special techniques of construction are required.

This definition is generally accepted and used for most materials and will be used in the preparation of recommendations regarding actions, cost estimates, and schedules related to chemical "contamination." However, it is recognized that consideration must also be given to possible decommissioning of the plant and social, political, psychological, or other factors when dealing with the subject of radioactive "contamination" in soil. Therefore, the recommendations will also include consideration of the following ranges of plutonium in soil:

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Greater Than

<u>Case</u>	<u><math>\mu\text{Ci}/\text{m}^2</math></u>	<u><math>\text{mCi}/\text{km}^2</math></u>	<u><math>\text{d}/\text{m}/100 \text{ cm}^2</math></u>	<u><math>\text{d}/\text{m}/\text{g}^*</math></u>
I	Not limited by concentration considerations.			
	A. 903 and nearby area			
	B. Projections of area affected by 903 Area (Based on Computer Derived Contours)			
	C. Burial Sites			
II	0.01	10	220	2
III	0.04	40	880	9
IV	0.10	100	2,200	22
V	0.40	400	8,800	88
VI	2.0	2,000	44,000	440
VII	4.0	4,000	88,000	880

\*Assumes a soil density of 1 gram per cubic centimeter and a soil sample depth of 1 centimeter.

Note

Cases II through VII are based on projections of actual sample results using the Austin Grid.

A detailed discussion of each of the above cases is as follows:

Case I - Not limited by concentration considerations

A. 903 and Nearby Area (Maps 12 and 12A)

The 146,000 square feet under the asphalt pad and approximately 223,000 square feet of nearby area primarily east

of the asphalt pad require special consideration. Ten inches of fill dirt was applied to the 903 Area prior to installation of the asphalt pad and the nearby area was later covered with 4 inches of fill dirt. There are also small areas under the asphalt pad where containment operations prior to covering the area with fill dirt involved covering the area with as much as 16 inches of dirt. It is assumed that excavation of this 369,000 square foot area would not involve the asphalt pad but would involve all of the fill dirt as well as the original soil.

The nearby area to the southeast of the asphalt pad involves approximately 120,000 square feet but there is no fill dirt in this area. This area does include the lithium destruction areas which if excavation were carried out should be included in the operation.

Based on these facts and assumptions, it is estimated that excavation of the lithium destruction area and the entire remaining area to a depth of 3 inches below the original surface would involve a total of 500,000 cubic feet.

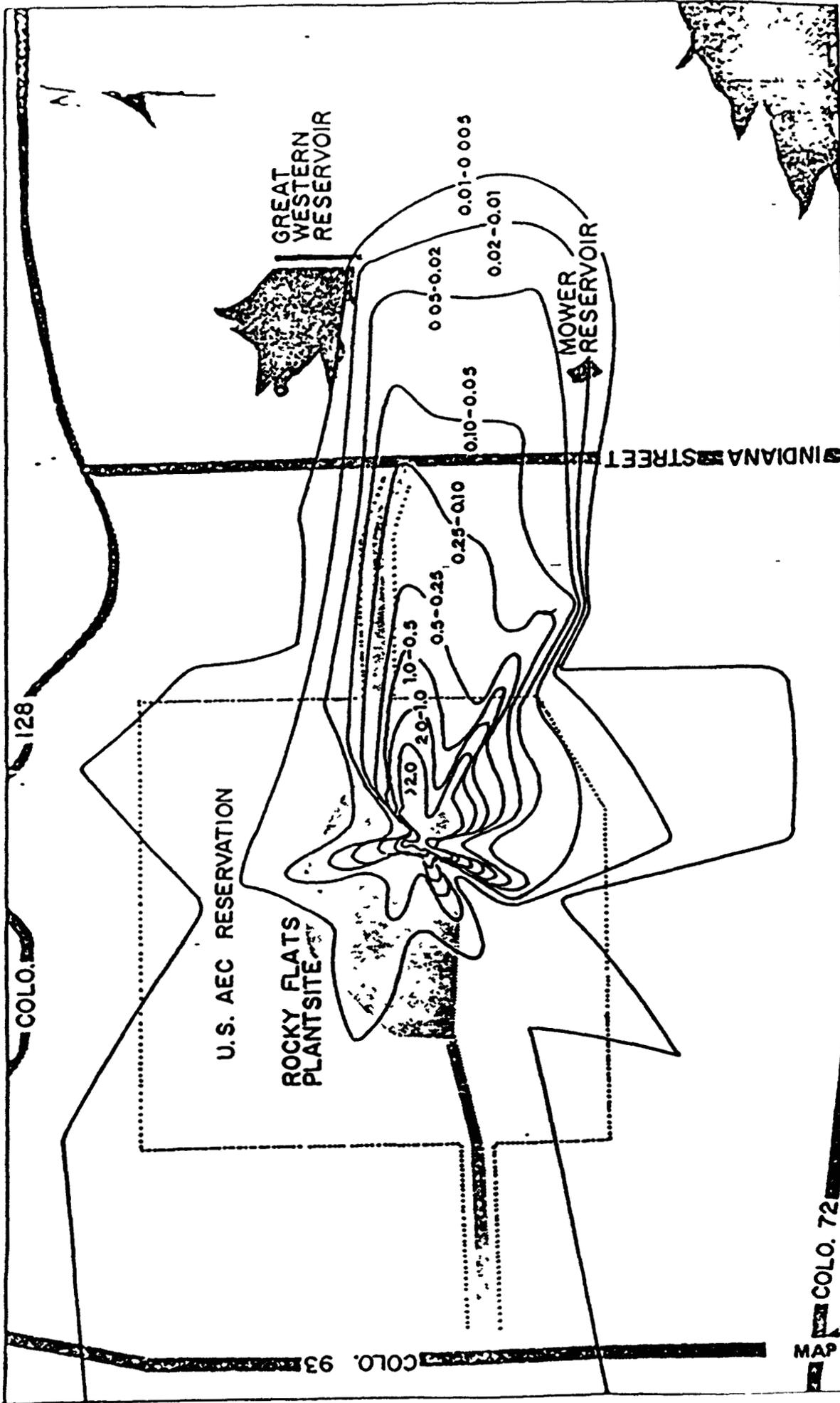
**B. Projections of Area Affected by 903 Area (Based on Computer Derived Contours)**

Computer derived contours of plutonium contributions from the 903 Area are presented in Map 16. (Units are AEC prescribed  $\mu\text{Ci}/\text{m}^2$ .) These contours are based on the evaluation of over 300 soil sample analyses as of April 1972, assuming a soil density of 1 gram per cubic centimeter. This assumption plus the combining of analytical values from a variety of agencies and

individuals and the error of assuming large area involvement based on diverse sample results, limits the applicability of these contours to an illustrative, generalized area only. A more realistic evaluation of the nature of the material spread can be obtained by observing actual sample locations and results (Maps 16A and 16B).

The projections are based on the units employed in generating the isopleths (i.e., 0.01, 0.05, 0.50, and greater than  $2.0 \mu\text{Ci}/\text{m}^2$ ) and assuming excavation to 3 inches below the original surface plus consideration of the special conditions discussed concerning the 903 and nearby area.

1. Total excavation, estimated total area =  $182 \times 10^6$  square feet ( 4,197 acres), volume =  $46 \times 10^6$  cubic feet. (Case I, Map I)
2. Excavation of all soil greater than  $0.01 \mu\text{Ci}/\text{m}^2$ .  
Approximate Area =  $84.9 \times 10^6$  square feet, volume =  $21.5 \times 10^6$  cubic feet. (Case I, Map II)
3. Excavation of all soil greater than  $0.05 \mu\text{Ci}/\text{m}^2$ ,  
Approximate Area =  $33.2 \times 10^6$  square feet, volume =  $8.7 \times 10^6$  cubic feet. (Case I, Map III)
4. Excavation of all soil greater than  $0.5 \mu\text{Ci}/\text{m}^2$ ,  
Approximate Area =  $14.5 \times 10^6$  square feet, volume =  $4.0 \times 10^6$  cubic feet. (Case I, Map IV)
5. Excavation of all soil greater than  $2 \mu\text{Ci}/\text{m}^2$ , Approximate Area =  $3.1 \times 10^6$  square feet, Approximate volume =  $1.2 \times 10^6$  cubic feet. (Case I, Map V)



MAP 16  
 COLO. 72  
 U.S. AEC RESERVATION  
 ROCKY FLATS PLANT SITE  
 GREAT WESTERN RESERVOIR  
 MOWER RESERVOIR  
 INDIANA STREET  
 COLO. 128  
 COMPUTER DERIVED PLUTONIUM ISOPLETHS (MICROCURI/SQUARE METER) BASED ON EVALUATION OF OVER 300 SOIL SAMPLES, ASSUMING A SOIL DENSITY OF 1 GRAM /CC AND COMPATIBILITY OF SAMPLES FROM VARIOUS AGENCIES.

No real evaluation of the potential impact of the 903 Area is possible without reference to possible health and safety involvement of the material. Although no standards for plutonium in soil currently exist, considerable work has been done in this area. Map 17 details computer-derived plutonium in soil contours based on interim acceptable levels proposed by R. L. Kathren in 1968 (see Appendix A). These contours are presented for reference only and are subject to the same limitations previously discussed. They do, however, point out one approach to evaluation of the possible risk which this area represents.

As a further indication of the problems involved with identifying an area as "contaminated", Map 18 indicates some of the values for plutonium in soil found throughout the State of Colorado. Once again the problem of comparing results obtained by different agencies using different sampling techniques and analytical methods confuses the actual picture.

#### C. Burial Sites (Case I, Map VI)

Excavation of locations, other than the 903 Area, where materials have been intentionally buried, contained, or where release of liquid effluents which contained radioactivity in concentrations less than the established guide value but resulted in the radioactivity accumulating in the soil would involve the following estimated volumes:

##### 1. Oil Burning Pit #1

This area is now located under Building 335 and involves approximately 70 cubic feet of depleted uranium residue.

2. Oil Burning Pit #2

This area involves approximately 10,000 cubic feet of residue which resulted from the burning of oil containing uranium.

3. Trench T-1

The estimated dimensions of this trench are 15' wide x 200' long x 5' deep. The trench contains approximately 25,000 kg of depleted uranium chips in drums covered with about two feet of fill dirt. Assuming that the top one foot of fill dirt is not involved, excavation would result in 12,000 cubic feet of depleted uranium residue.

4. Trenches T-2 through T-8

Estimated dimensions of these trenches are the same as T-1 (15'x200'x5'). Excavation of these trenches would result in approximately 84,000 cubic feet consisting primarily of domestic sewage sludge containing small quantities of uranium and trace amounts of plutonium, a few flattened drums involving uranium, and some asphalt planking from the 207 ponds which contains uranium and a trace amount of plutonium.

5. Asphalt and Soil Disposal Area

This area contains about 8,000 cubic feet of asphalt and 1,600 cubic feet of soil primarily from the areas near Buildings 774 and 776. There is about two feet of fill dirt between the asphalt and soil and it is

estimated that excavation would involve a total of about 15,000 cubic feet of material with a very low concentration of plutonium.

6. Incinerator Ash Pits I-1 through I-4

Estimated dimensions of these pits are 8' wide x 150' long x 3' deep. The pits contain the ashes from the incinerator. A small amount of depleted uranium is suspected. Excavation would involve approximately 30,000 cubic feet of soil and ashes.

7. Original Sanitary Landfill

Estimated volume of this area is  $2 \times 10^6$  cubic feet. Excavation would involve this entire volume and about 20 kg of depleted uranium.

8. Current Sanitary Landfill

Estimated present volume of this area is  $4 \times 10^6$  cubic feet. The area is still in use and the volume is, therefore, increasing each day. Excavation would include approximately 1,000 kg of domestic sewage sludge containing trace amounts of plutonium and a small amount of tritium from a source which at the present is unknown but is the subject of a separate study.

9. South Walnut Creek

The area from the original Building 774 outfall east to and including the B series holding ponds has become involved due to the release of liquid effluents from

Buildings 774 and 995. At the time of release, these effluents were below the established concentration guide values, however, the radioactivity has accumulated in the stream bed and bottoms of the ponds. Excavation would involve an estimated 225,000 cubic feet of sludge containing plutonium and uranium.

#### 10. Other Areas

As previously discussed, excavation of the lithium destruction areas is included in the 903 Area. Excavation of other nonradioactively involved areas such as the oil sludge disposal south of Building 881 and nonradioactive scrap west of Building 559 would result in an estimated 2,000 cubic feet of material.

A summary of the volume of material involved in Case I is presented as Table III.

TABLE III

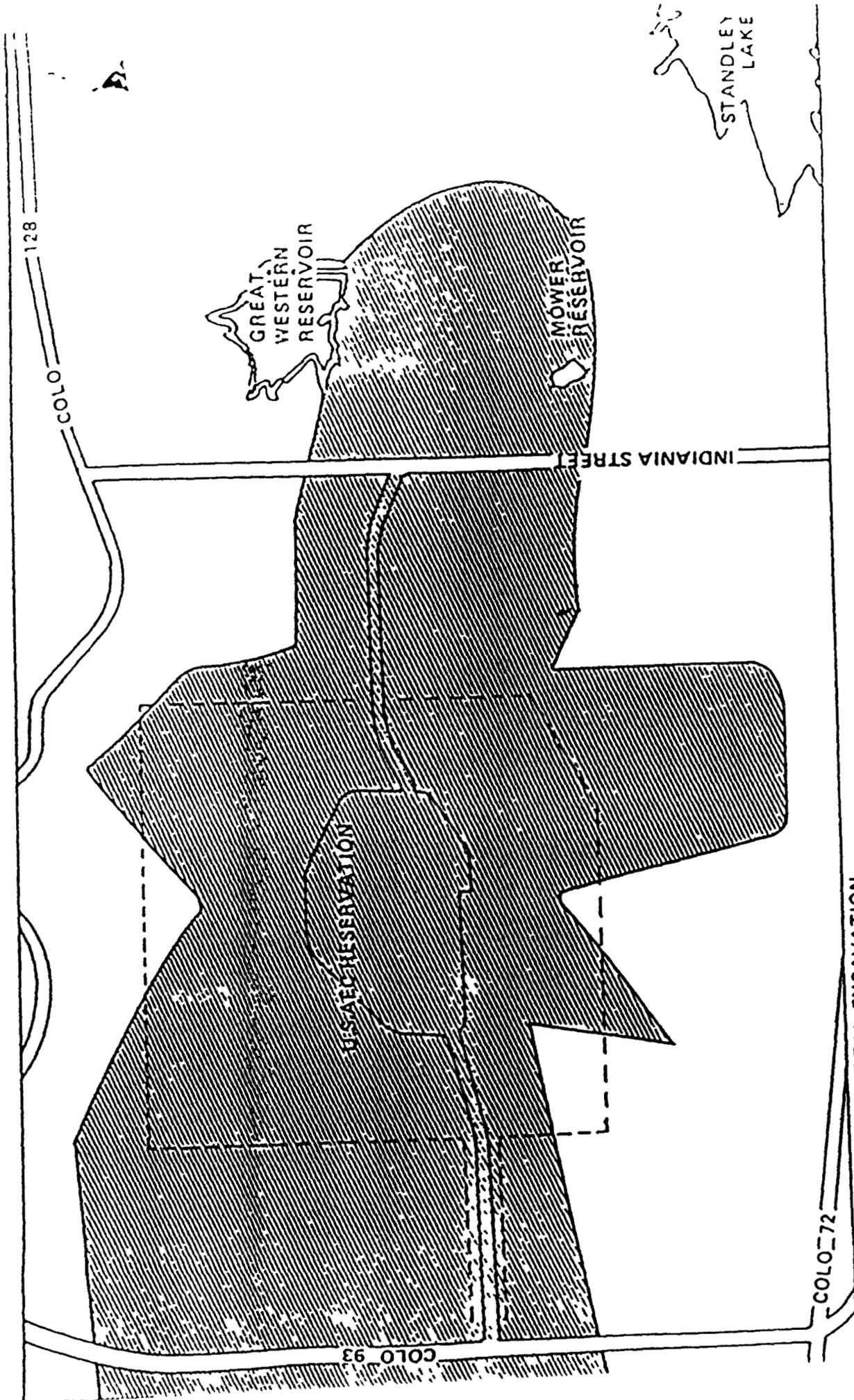
## Summary of Volume to be Excavated - Case I

<u>Area</u>	<u>Estimated Total Cubic Feet Involved</u>
A. 903 and Nearby Area	500,000
*B. Projections of Areas Affected by 903 Area, Computer Derived Contours	
1. Total Excavation	46.0 x 10 <sup>6</sup>
2. Greater Than 0.01 $\mu\text{Ci}/\text{m}^2$	21.5 x 10 <sup>6</sup>
3. Greater than 0.05 $\mu\text{Ci}/\text{m}^2$	8.7 x 10 <sup>6</sup>
4. Greater than 0.5 $\mu\text{Ci}/\text{m}^2$	4.0 x 10 <sup>6</sup>
5. Greater than 2.0 $\mu\text{Ci}/\text{m}^2$	1.2 x 10 <sup>6</sup>

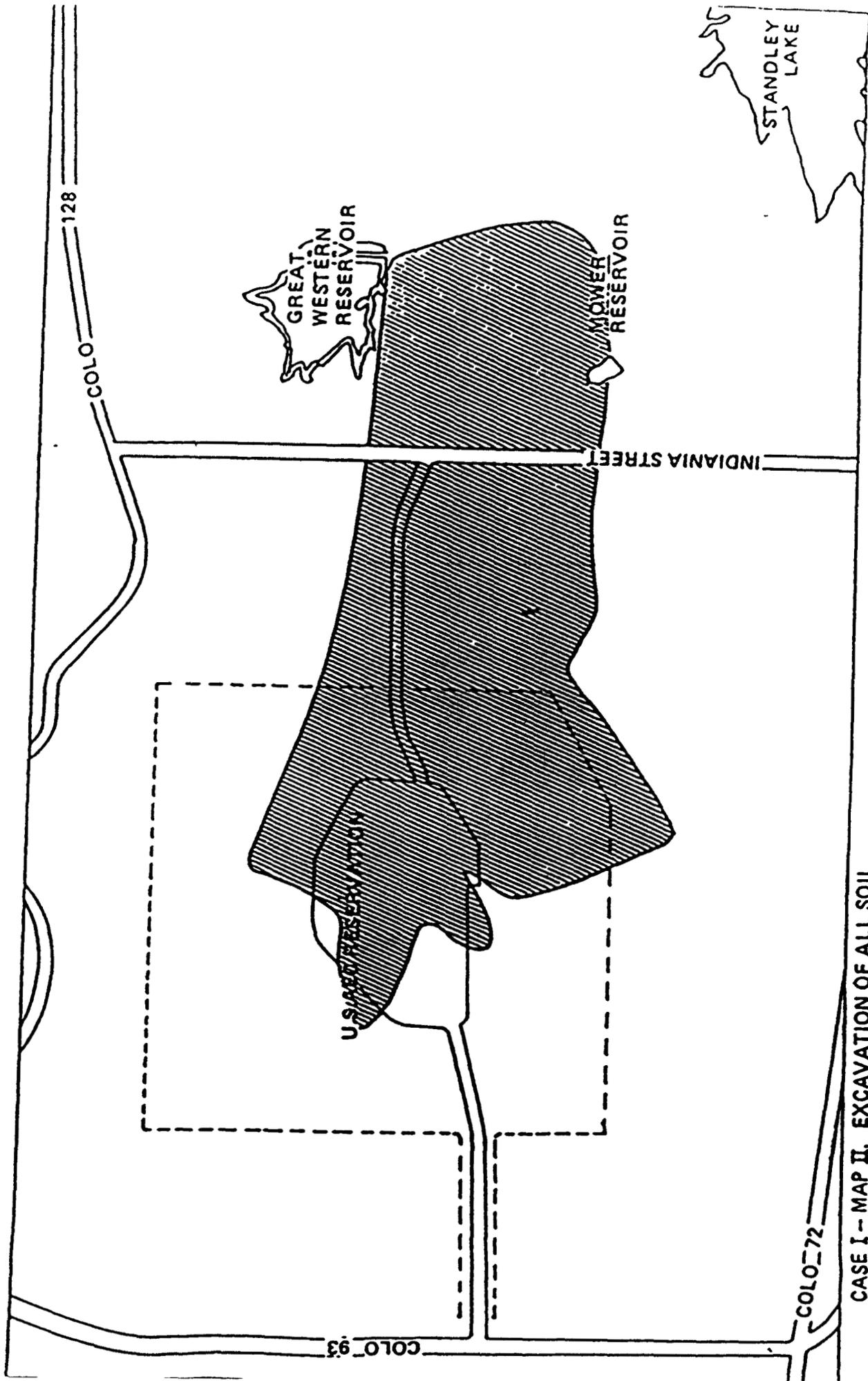
\*Includes allowance for special conditions included in (A).

## C. Burial Sites

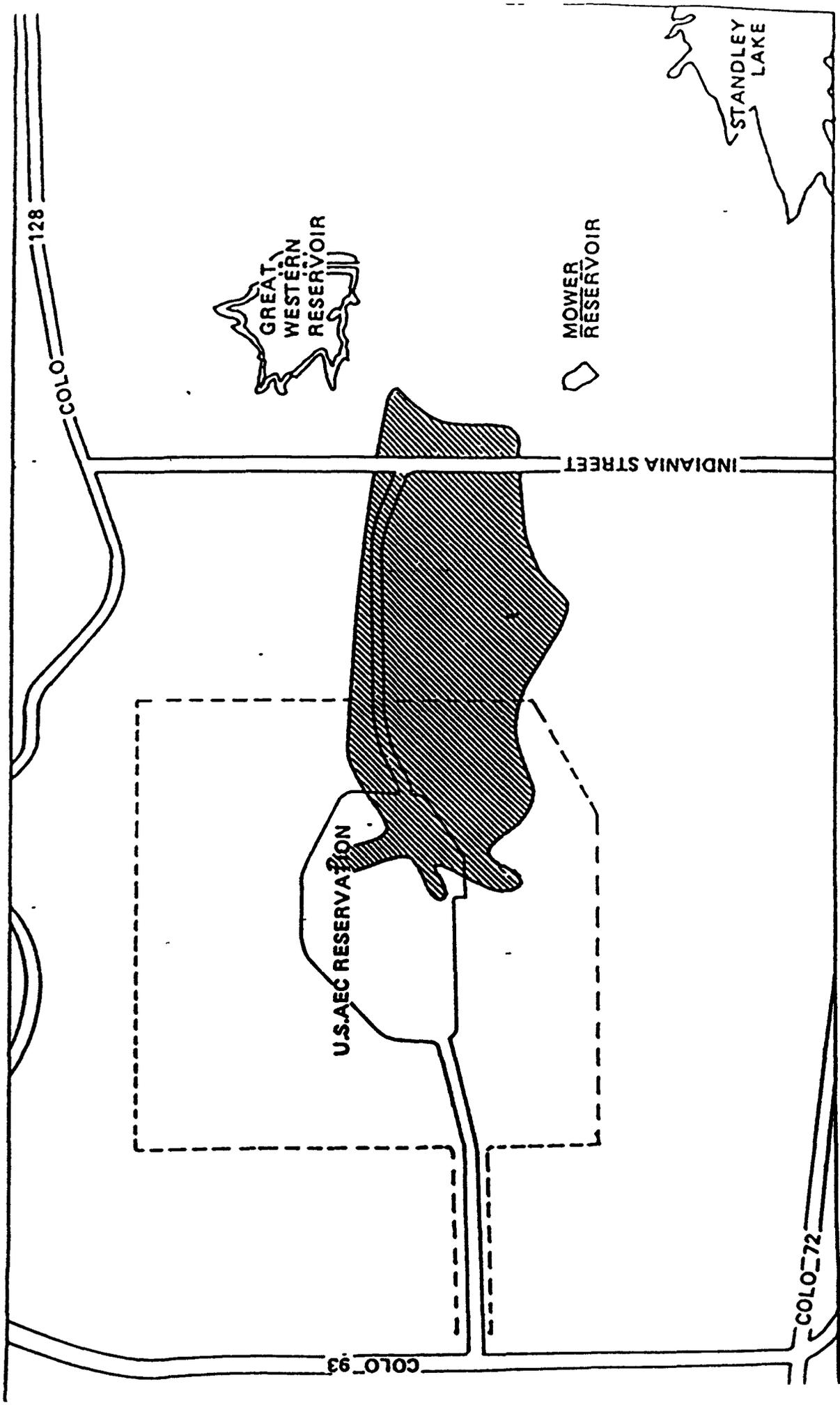
1. Oil Burning Pit #1	70
2. Oil Burning Pit #2	10,000
3. Trench T-1	12,000
4. Trenches T-2 through T-8	84,000
5. Asphalt and Soil Disposal Area	15,000
6. Incinerator Ash Pits	30,000
7. Original Sanitary Landfill	2 x 10 <sup>6</sup>
8. Current Sanitary Landfill	4 x 10 <sup>6</sup>
9. South Walnut Creek	225,000
10. Other Areas	<u>2,000</u>
Estimated Total Burial Sites Not Including (A).	6.4 x 10 <sup>6</sup>



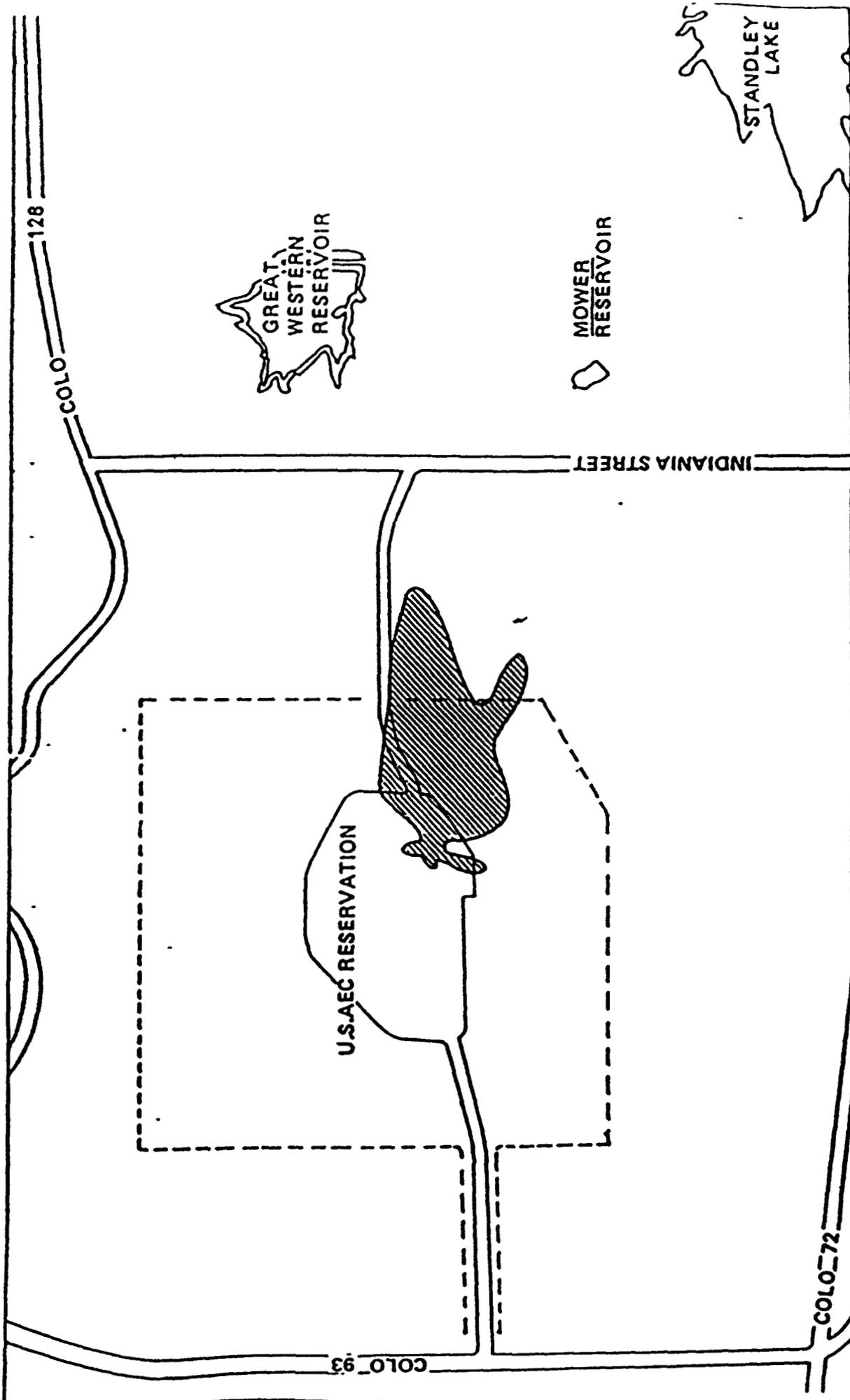
CASE I - MAP I. TOTAL EXCAVATION.



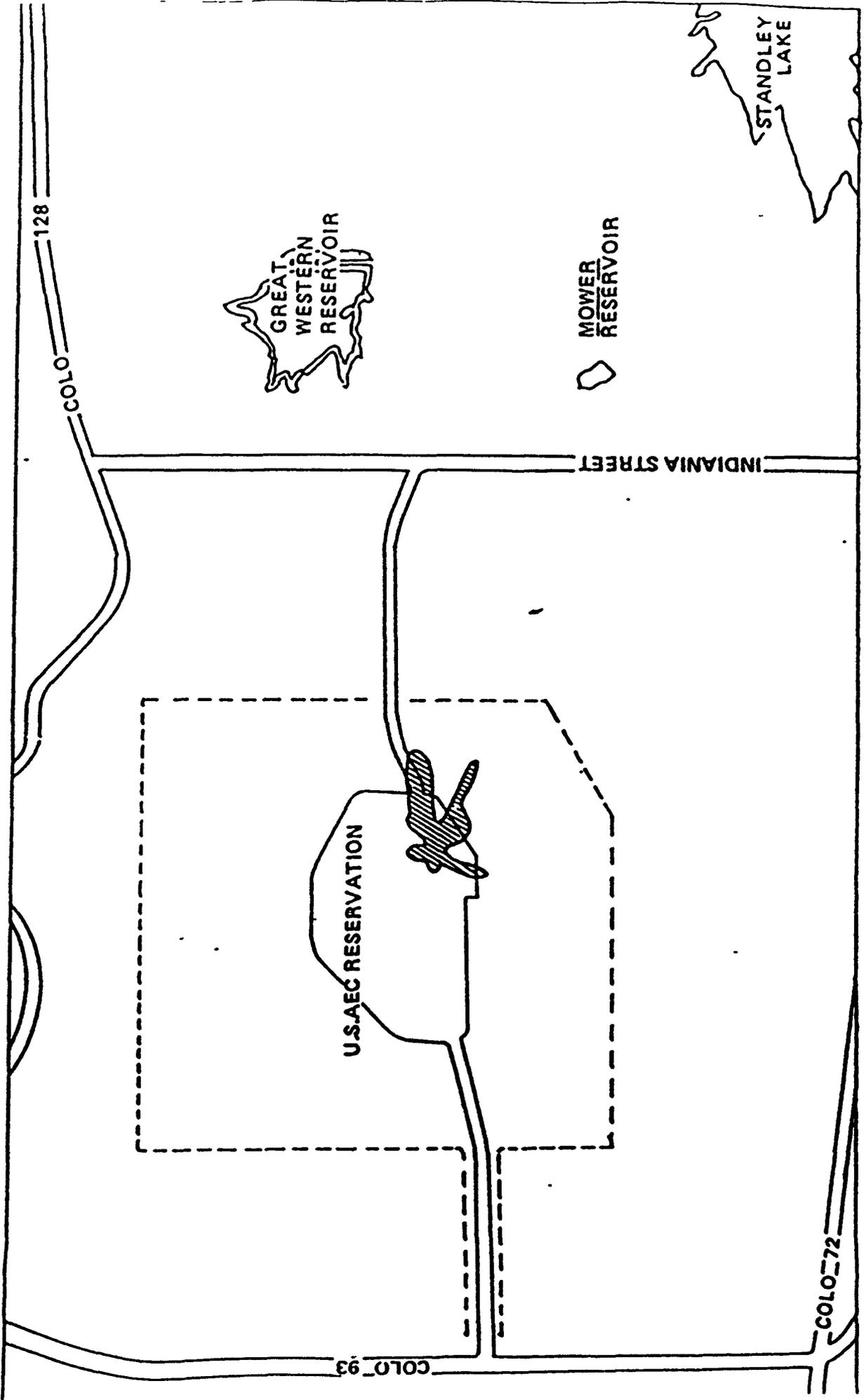
CASE I - MAP II. EXCAVATION OF ALL SOIL  
GREATER THAN 0.01  $\mu\text{Ci}/\text{M}^3$  PLUTONIUM.



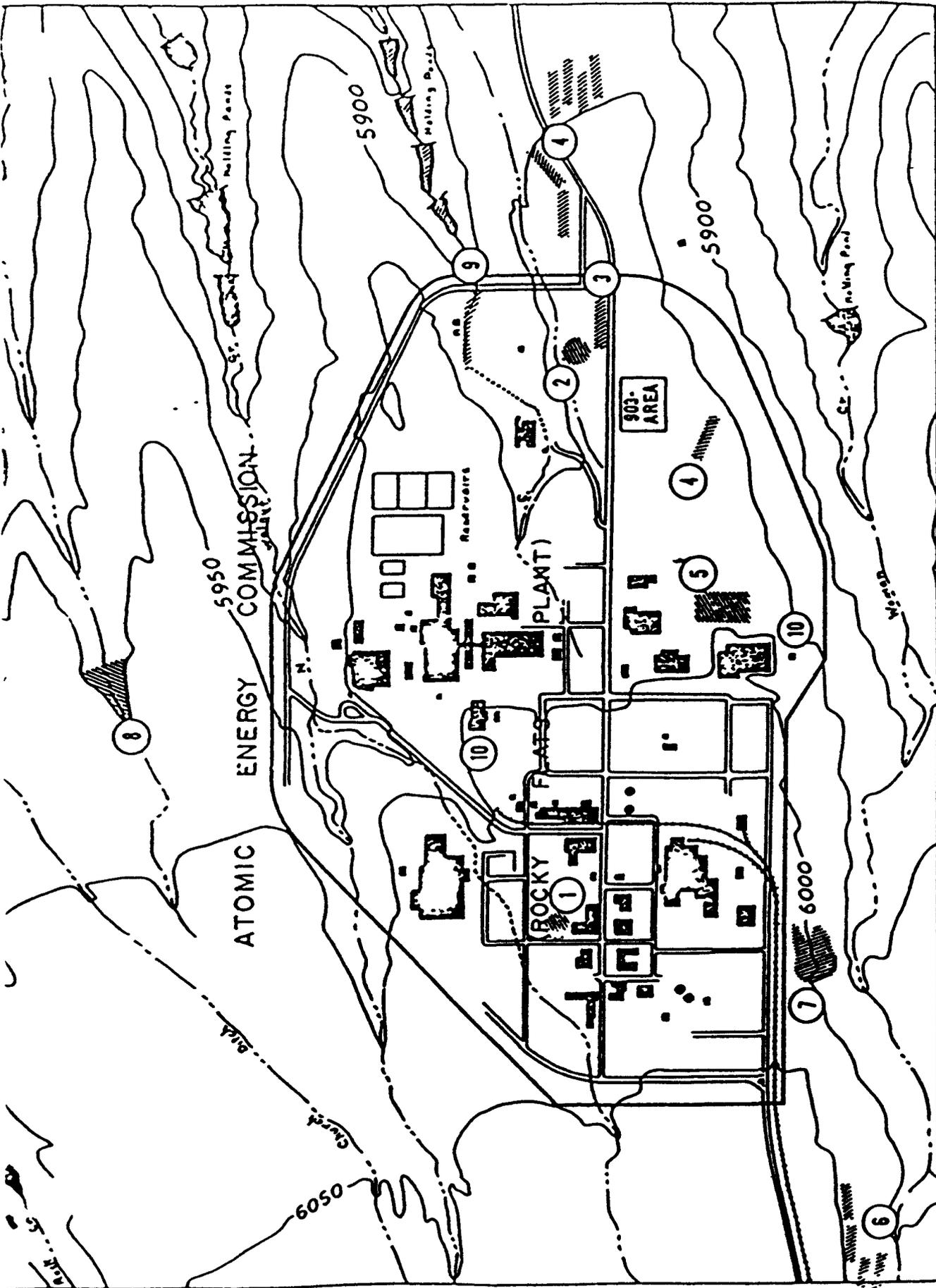
CASE I - MAP III. EXCAVATION OF ALL SOIL GREATER THAN 0.05  $\mu\text{Ci}/\text{M}^2$  PLUTONIUM.



CASE I - MAP IV. EXCAVATION OF ALL SOIL  
 GREATER THAN 0.5  $\mu\text{Ci}/\text{M}^3$  PLUTONIUM.



CASE I - MAP V. EXCAVATION OF ALL SOIL  
GREATER THAN 2.0  $\mu\text{Ci}/\text{M}^2$  PLUTONIUM.



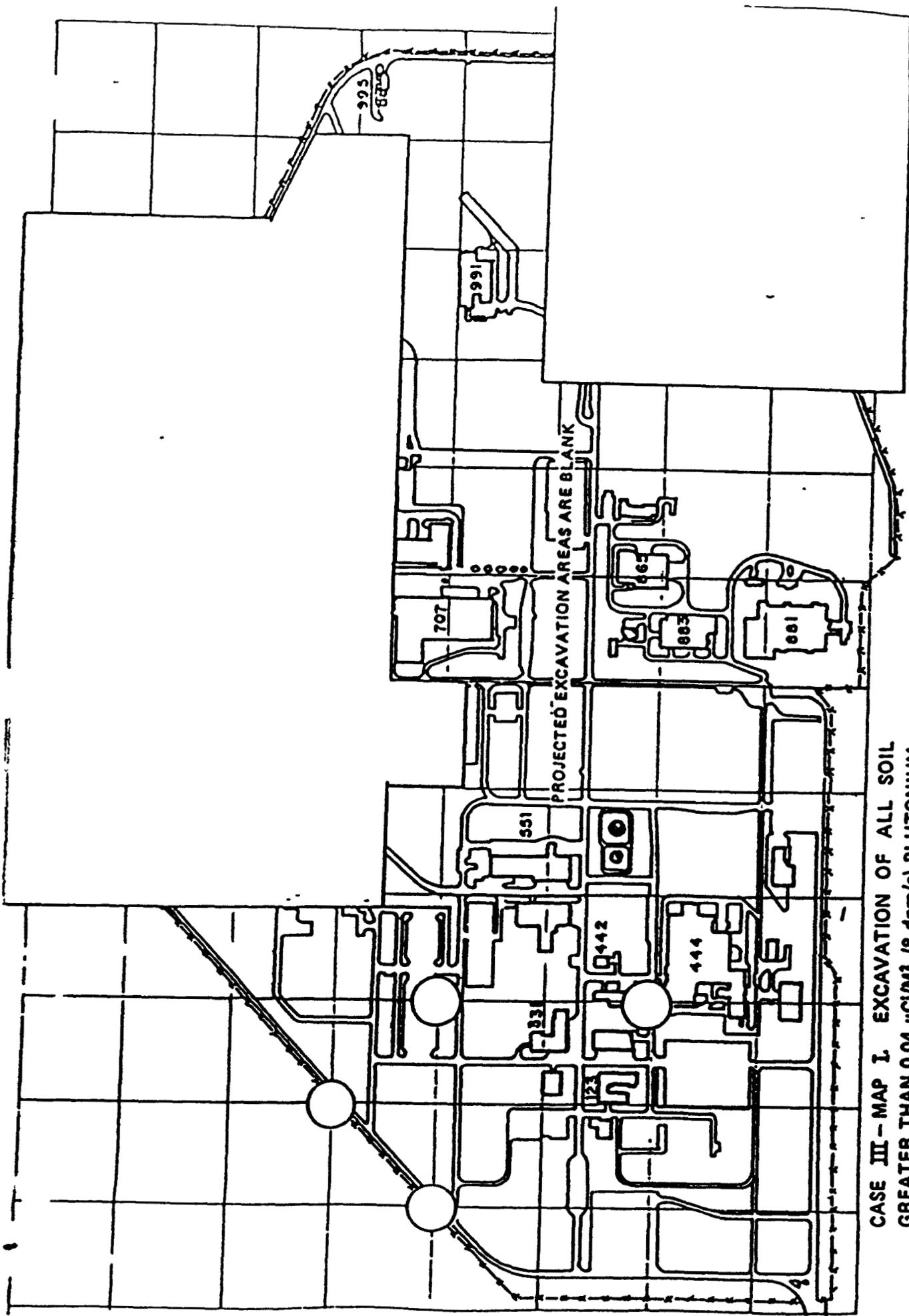
CASE I - MAP VI

Cases II through VII are based on results of soil samples taken at various locations and for various reasons on the plant site, primarily within the controlled area. These results have been plotted on a grid system which was established by the Austin Company during the original construction of the Rocky Flats Plant. Map 19 presents these results plotted on the Austin Grid System. It must be stressed that in the interest of conservatism the values presented are the maximum level observed within that grid or at a particular sample point. Actual values range from less than the minimum detectable amount to the value presented with as many as six samples in some locations and as few as one sample in others.

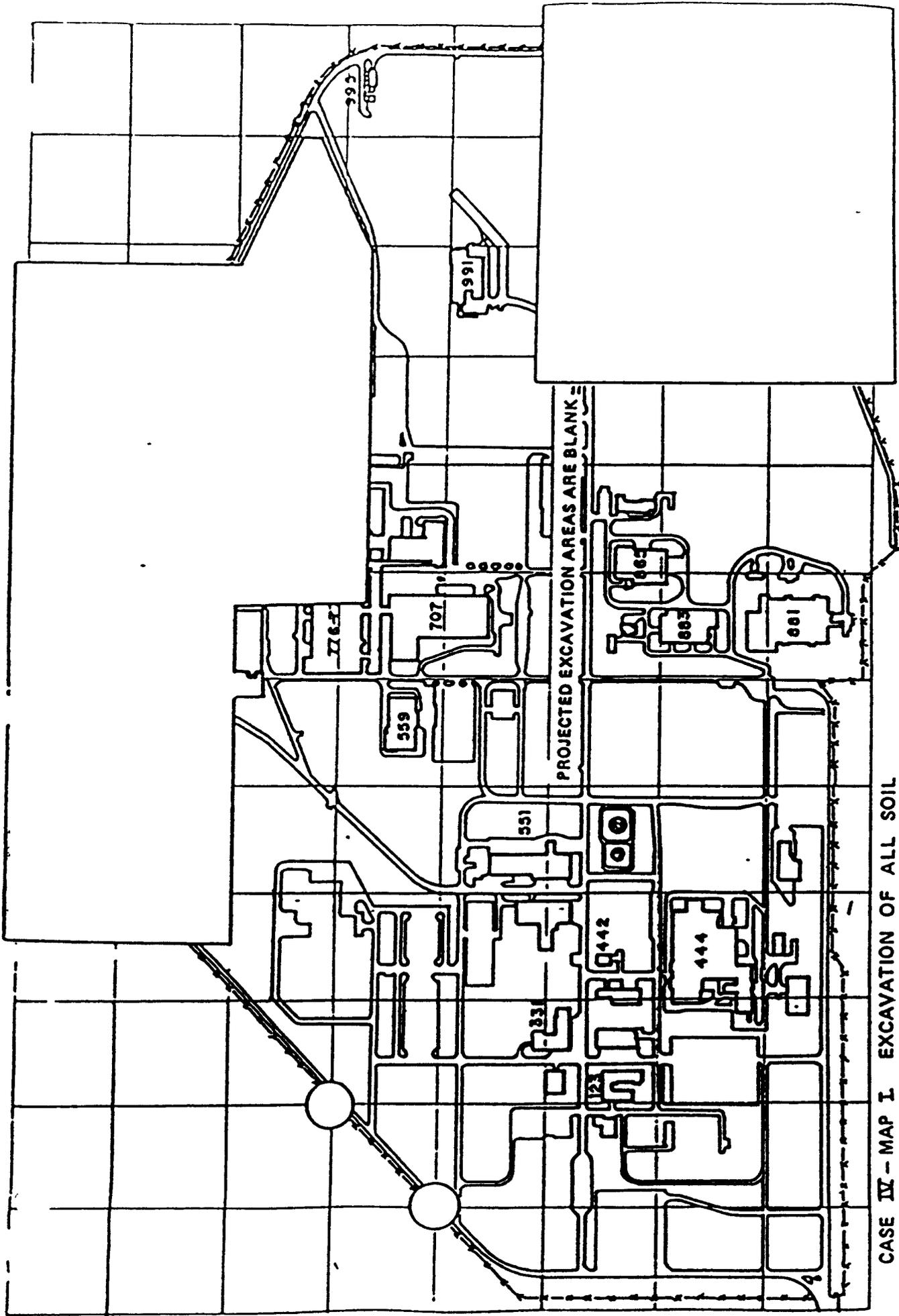
The following maps and Table IV present the estimated volume and area involved for each case. Allowances have been made to exclude space occupied by buildings, to reflect uncertainties by not excluding entire grids where low results seem questionable, and for the special conditions and considerations discussed in Case I-A.



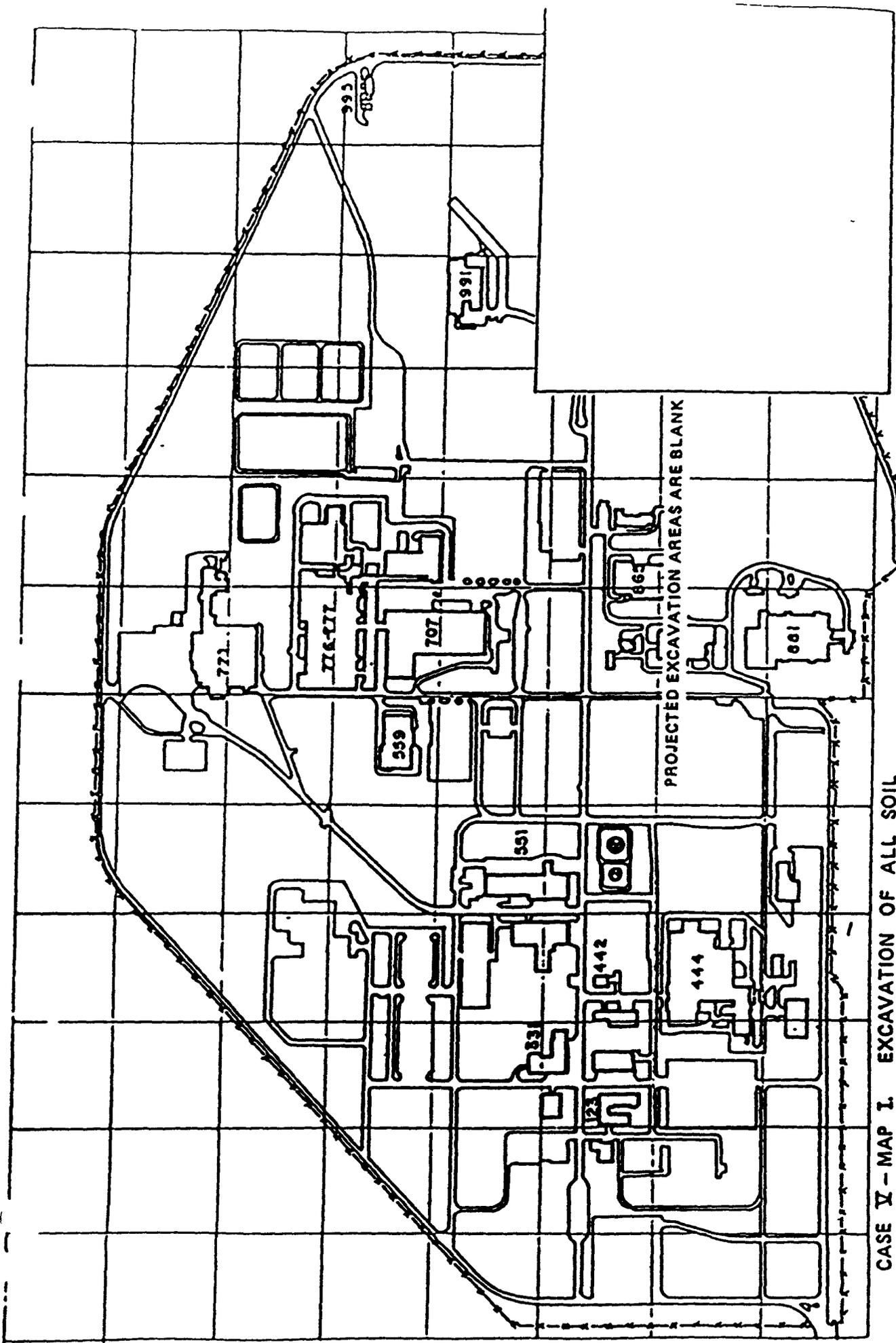




CASE III - MAP I. EXCAVATION OF ALL SOIL  
 GREATER THAN 0.04  $\mu\text{Ci}/\text{M}^3$  (8 dpm/g) PLUTONIUM.

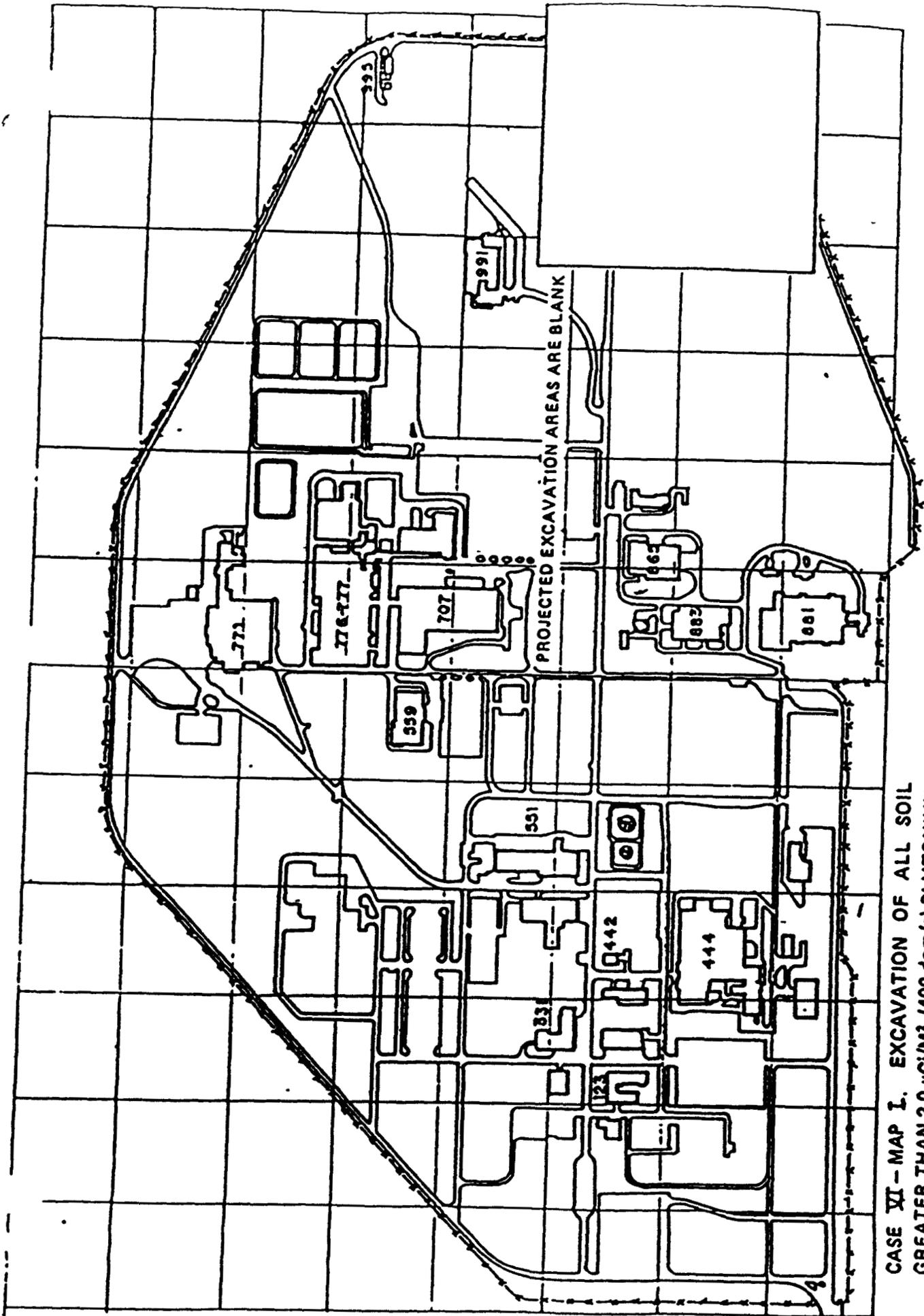


CASE IV - MAP I EXCAVATION OF ALL SOIL  
 GREATER THAN 0.10  $\mu\text{Ci}/\text{M}^2$  (20 dpm/g) PLUTONIUM.

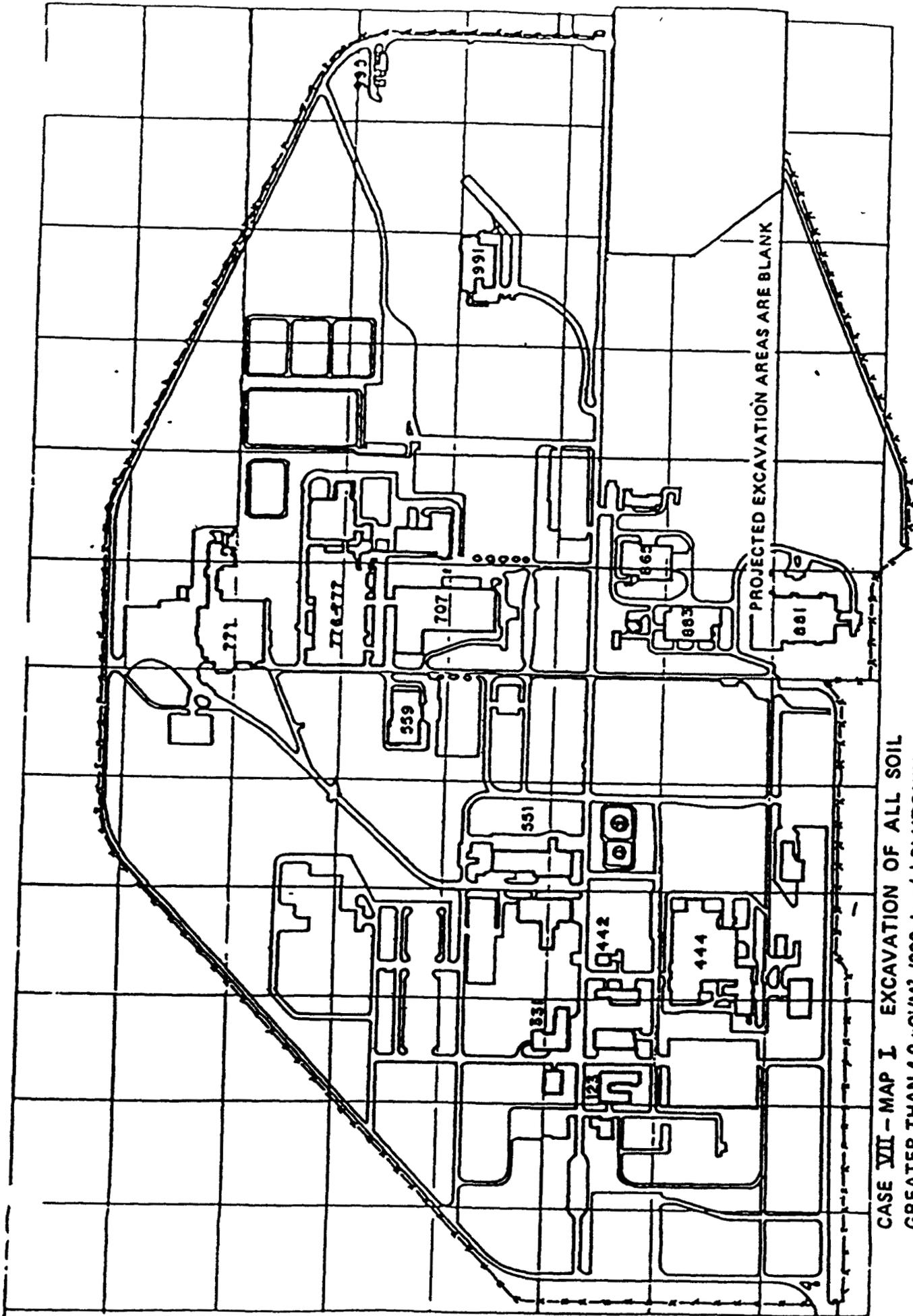


PROJECTED EXCAVATION AREAS ARE BLANK

CASE V - MAP I. EXCAVATION OF ALL SOIL  
GREATER THAN 0.40  $\mu\text{Ci}/\text{M}^2$  (80 dpm/g) PLUTONIUM.



CASE XI - MAP I. EXCAVATION OF ALL SOIL  
GREATER THAN 2.0  $\mu\text{Ci}/\text{M}^2$  (400 dpm/g) PLUTONIUM.



CASE VII - MAP I EXCAVATION OF ALL SOIL  
 GREATER THAN 4.0  $\mu\text{Ci}/\text{M}^3$  (800  $\text{dpm}/\text{g}$ ) PLUTONIUM.

TABLE IV

Estimated Volume to Be Excavated - Cases II through VII  
Assuming Removal to Three Inches Below Original Surface

<u>Case</u>	<u>Estimated Square Feet</u>	<u>Estimated Cubic Feet Involved</u>	<u>Allowance For Case I-A Cubic Feet</u>	<u>Estimated Total Cubic Feet Involved</u>
II (2 dpm/g)	$16.0 \times 10^6$	$4.0 \times 10^6$	$0.5 \times 10^6$	$4.5 \times 10^6$
III (9 dpm/g)	$7.4 \times 10^6$	$1.8 \times 10^6$	$0.5 \times 10^6$	$2.3 \times 10^6$
IV (22 dpm/g)	$5.9 \times 10^6$	$1.5 \times 10^6$	$0.5 \times 10^6$	$2.0 \times 10^6$
V (88 dpm/g)	$2.6 \times 10^6$	$0.6 \times 10^6$	$0.5 \times 10^6$	$1.1 \times 10^6$
VI (440 dpm/g)	$1.2 \times 10^6$	$0.3 \times 10^6$	$0.4 \times 10^6$	$0.7 \times 10^6$
VII (880 dpm/g)	$0.75 \times 10^6$	$0.19 \times 10^6$	$0.4 \times 10^6$	$0.59 \times 10^6$

## IV. CONCLUSIONS AND RECOMMENDATIONS

Lacking an official definition of "contaminated" makes it impossible to reach sound, logical conclusions or to make recommendations supported by data or policies in usual sense of these words. However, it is possible and necessary to recognize that areas of concern in terms of both radioactive and chemical infiltration do exist at Rocky Flats, if not in terms of risk or hazard at least in terms of political, social, or psychological factors. The following is, therefore, presented for consideration by management in the prudent planning of future operations of the Rocky Flats Plant:

1. Conclusion

There is no data to indicate that any material, either radioactive or chemical, in its present location and status ~~which~~ represents any risk or hazard to man or the environment.

Discussion

Air and water sample results have at various times indicated the presence of radioactive materials and chemicals but have historically been below the concentration guide values set forth in the AEC Manual.

The 903 Area is recognized as having the greatest potential for exceeding the guide values and has been under continual surveillance since 1958 by Rocky Flats Health Physics. During recent years, the State of Colorado, Department of Health, and the U. S. Atomic Energy Commission Health and Safety Laboratory have conducted independent surveillance activities primarily in sampling the air near the area. None of the air samples taken outside of the immediate area of the asphalt pad have exceeded the concentration guide values. Wells located at each corner of the asphalt pad have never indicated the presence of any ground water.

Sampling of air at other locations both on and off the plant site has produced similar results.

Map 20 indicates the location of wells particularly near process waste holding tanks. The wells are routinely sampled and analyzed for both radioactive materials and chemicals such as plutonium, uranium plus plutonium, nitrates, and pH. With the exception of nitrate concentrations in the vicinity of the 207 solar evaporation ponds, all materials monitored have historically been below the concentration guide values. Installation and operation of the trenches north of the 207 ponds plus the previously discussed repair of these ponds have controlled the nitrate concentration of surface water to within the concentration guide values.

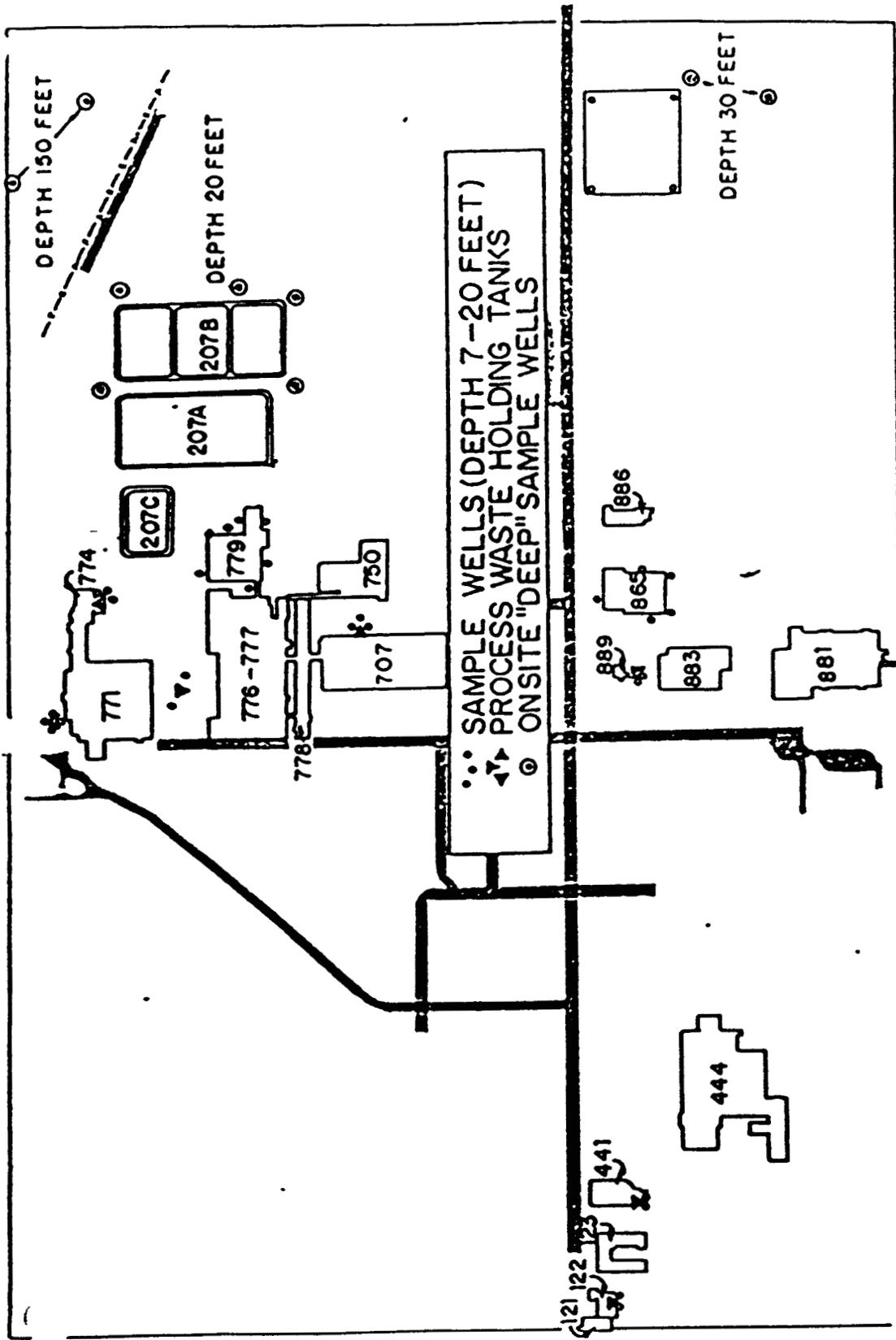
Completion of the new Process Waste Treatment Facility, Building 374, will eliminate the need to use the 207 solar evaporation ponds to contain and evaporate solutions containing large amounts of nitrates and thereby reduce this source of concern starting in 1976.

## 2. Conclusion

The technology required for proper controlled excavation of any area is unknown.

## Discussion

Should excavation of any of the areas discussed be undertaken it would be necessary to provide for the control of airborne materials and to assure that a technique was used which accomplished actual and complete removal, not merely mixing or dilution of the material to less than present minimum detectable amounts or which spread the material to the newly exposed virgin surface. The efficiency or



MAP 20.

degree of effectiveness required of such provisions and techniques would obviously depend upon a decision as to what level of infiltration remaining would be acceptable.

There have been a number of techniques suggested such as separation on the basis of density, washing, or vacuuming, but no data ~~is~~ *is all* available to even suggest, let alone confirm, how efficient these techniques may be.

### 3. Conclusion

Without a known excavation technique or process it is not possible to estimate capital equipment costs of any excavation. Rocky Flats does have an established and accepted method of determining the cost of disposing of solid radioactive wastes but capital equipment costs are not included.

### Discussion

Other sites such as Hanford and the National Reactor Testing Station (NRTS) have estimated capital costs involved in the proposed excavation of locations such as the Z-9 trench at Hanford or the location where until November 1970 Rocky Flats wastes were buried at NRTS. These estimates, \$1 million at Hanford and about \$10 million at NRTS, are for conditions much different than those areas under consideration in this discussion but they may serve to define the limits of the question.

AEC Manual Chapter 0511, "Radioactive Waste Management," requires that materials known or suspected to contain transuranium nuclides, such as plutonium, in excess of 10 nCi/g (22,000 dpa/g) must be packaged for retrievable storage. It is reasonable to assume that all of the excavation material involved in this discussion would

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contain less than 10 nCi of plutonium per gram of soil and could, therefore, be packaged for not readily retrievable storage in the same manner that Rocky Flats now packages non-plutonium wastes, nitrate salts, and domestic sewage sludge for shipment to NRTS. The costs to purchase the packaging materials, warehousing, trucking on-site, monitoring, inspecting, loading for off-site shipment, and freight to NRTS for these types of waste now amount to \$6.08/cubic foot in a 55-gallon drum and \$2.90/cubic foot in a 4'x4'x7' - 3/4" plywood box. Due to weight restrictions, it is most likely that it would be necessary to reduce the dimensions of the box to 4'x2'x7' which would result in a cost of \$5.80/cubic foot. Rounding both of these figures to \$6.00/cubic foot and using the estimated volumes from Tables III and IV, estimated disposal costs for each case under discussion not including capital equipment would be as follows:

<u>Case</u>	<u>Estimated Total Cubic Feet Involved</u>	<u>Estimated Cost of Disposal Not Including Capital Equipment (Dollars)</u>
I-A	0.5 x 10 <sup>6</sup>	3 x 10 <sup>6</sup>
B-1	46.0 x 10 <sup>6</sup>	276 x 10 <sup>6</sup>
B-2	21.5 x 10 <sup>6</sup>	129 x 10 <sup>6</sup>
B-3	8.7 x 10 <sup>6</sup>	52.2 x 10 <sup>6</sup>
B-4	4.0 x 10 <sup>6</sup>	24 x 10 <sup>6</sup>
B-5	1.2 x 10 <sup>6</sup>	7.2 x 10 <sup>6</sup>
C-1	70	420
C-2	10,000	60,000
C-3	12,000	72,000
C-4	84,000	504,000
C-5	15,000	90,000
C-6	30,000	180,000
C-7	2.0 x 10 <sup>6</sup>	12 x 10 <sup>6</sup>
C-8	4.0 x 10 <sup>6</sup>	24 x 10 <sup>6</sup>
C-9	225,000	1.35 x 10 <sup>6</sup>
C-10	2,000	12,000
C-Total	6.4 x 10 <sup>6</sup>	38.4 x 10 <sup>6</sup>
II	4.5 x 10 <sup>6</sup>	27 x 10 <sup>6</sup>
III	2.3 x 10 <sup>6</sup>	13.8 x 10 <sup>6</sup>
IV	2.0 x 10 <sup>6</sup>	12 x 10 <sup>6</sup>
V	1.1 x 10 <sup>6</sup>	6.6 x 10 <sup>6</sup>
VI	0.7 x 10 <sup>6</sup>	4.2 x 10 <sup>6</sup>
VII	0.59 x 10 <sup>6</sup>	3.54 x 10 <sup>6</sup>

4. Conclusion

Again, without a known excavation technique or process, it is not possible to accurately estimate the rate at which any excavation of any location can be accomplished. However, there are other known factors and estimates which can be used to define some of the limits.

Discussion

Hanford's estimate of the excavation rate for the Z-9 trench is 7.7 cubic feet per shift. Without further elaboration it can be seen that in no way could this rate reasonably satisfy the need should the decision be made to excavate any of the areas included in this discussion.

A factor which is more likely to be limiting and for which there is experience to use as a measure is Rocky Flats ability to load and ship wastes and the ability of NRTS to receive and handle them. Current generation rates at Rocky Flats have required an average of 12 shipments per month for the last six months. These shipments have averaged 1,400 cubic feet per shipment. During the last six months of 1972, Rocky Flats and NRTS demonstrated the ability to handle an average of 22 shipments per month. These shipments averaged about 1,200 cubic feet per shipment. Assuming that the shipping rate for any excavation would be in addition to the current generation and would average 10 shipments per month and 1,200 cubic feet per shipment (12,000 cubic feet per month or 144,000 cubic feet per year) and using the estimated volumes from Tables III and IV estimated time to excavate and ship, each case under discussion would be as follows:

<u>Case</u>	<u>Estimated Total Cubic Feet Involved</u>	<u>Estimated Time Required to Excavate And Ship to NRTS (Years)</u>
I-A	0.5 x 10 <sup>6</sup>	3.5
B-1	46.0 x 10 <sup>6</sup>	319.4
B-2	21.5 x 10 <sup>6</sup>	149.3
B-3	8.7 x 10 <sup>6</sup>	60.4
B-4	4.0 x 10 <sup>6</sup>	27.8
B-5	1.2 x 10 <sup>6</sup>	8.3
C-1	70	
C-2	10,000	0.1
C-3	12,000	0.1
C-4	84,000	0.6
C-5	15,000	0.1
C-6	30,000	0.2
C-7	2.0 x 10 <sup>6</sup>	13.9
C-8	4.0 x 10 <sup>6</sup>	27.8
C-9	225,000	1.6
C-10	2,000	
C-Total	6.4 x 10 <sup>6</sup>	44.4
II	4.5 x 10 <sup>6</sup>	31.2
III	2.3 x 10 <sup>6</sup>	16.0
IV	2.0 x 10 <sup>6</sup>	13.9
V	1.1 x 10 <sup>6</sup>	7.6
VI	0.7 x 10 <sup>6</sup>	4.9
VII	0.59 x 10 <sup>6</sup>	4.1

5. Conclusion

Any known excavation technique or process would remove all vegetation and in some areas all of the top soil.

Discussion

It would be necessary to carefully consider and weigh this impact on the environment against any anticipated benefit from excavation of any area. Cost to replace top soil and reestablish the vegetation must be a part of any excavation plan but are not included in the previously presented estimate.

Recommendations

1. The Division of Operational Safety should be encouraged to continue efforts to establish official and accepted concentration guide values for plutonium and other materials in soil.
2. An agreement exists between the U. S. Atomic Energy Commission and the State of Colorado that no actions will be taken to remove the radioactive materials in the 903 Area until such time that a suitable alternate location is established away from Rocky Flats. Under the present conditions and lacking a proven excavation technique, it is likely that excavation of this area at this time presents a greater potential hazard than leaving the area intact. This is also true of the area southeast of the asphalt pad where there is good ground cover with its associated stabilization effect. It is not recommended that excavation of the 903 or any other area be undertaken at this time.
3. It is recommended that the roads on both sides of the security fence east of the 903 Area be seal coated or asphalted from Central Avenue south to approximately Austin Grid E-22,500 or that traffic be restricted to only that which is essential to environmental sampling, security patrols, and fire watch activities.

In summary, it is not recommended that excavation of any area be undertaken at this time. We will continue current preventative actions, maintain and improve the current surveillance and monitoring programs, continue to study and thereby improve our understanding of the existing conditions, and develop techniques and management programs should excavation of any area be deemed desirable or necessary in the future.

