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HANFORD RADIOACTIVE WASTE MANAGEMENT PLANS

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RICHLAND OPERATIONS OFFICE

AUGUST 1972

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HANFORD RADIOACTIVE WASTE MANAGEMENT PLANS

August 1972

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HANFORD RADIOACTIVE WASTE MANAGEMENT PLAN

1. PROGRAM ADMINISTRATION

1.1 Facility Identification

The Hanford Project, located in South Central Washington, covers an area of about 560 square miles and encompasses the Columbia River for about 45 miles (see Figure 1). The Project includes production reactors (100 Areas); facilities for fuel reprocessing, for handling of fission product wastes, and for associated activities (200 Areas); fuel fabrication facilities (300 Area); a large laboratory complex including prototype test reactors (300 Area); the Fast Flux Test Facility (400 Area); central service facilities (1100 Area); onsite construction services (3000 Area) and administrative offices (700 Area). The 100 Areas are located in the north and northwest part of the project adjacent to the Columbia River. The 200 Areas (East and West) are about in the center of the project on a plateau. The 300 Area is in the southeast portion adjacent to the river. The 1100 Area is about 1-1/2 miles south and just west of the 300 Area while the 3000 Area ia about a mile south. The Fast Flux Test Facility (FFTF), now under construction, is located about 5 miles northwest of the 300 Area. The 700 Area is located in Richland.

The surrounding area is relatively sparsely populated, having 2,500, 60,000 and 300,000 people in radii of 20, 30, and 50 miles, respectively, from the center of the controlled site. The population is heavily oriented toward the south and west. About 70% of the population is in the southern quadrant and 20% in the western quadrant within a radius of 30 miles. At 50 miles radius, 25% of the population is to the south and 55% to the west. The principal activity in the area, other than that associated with Hanford operations, is agriculture.

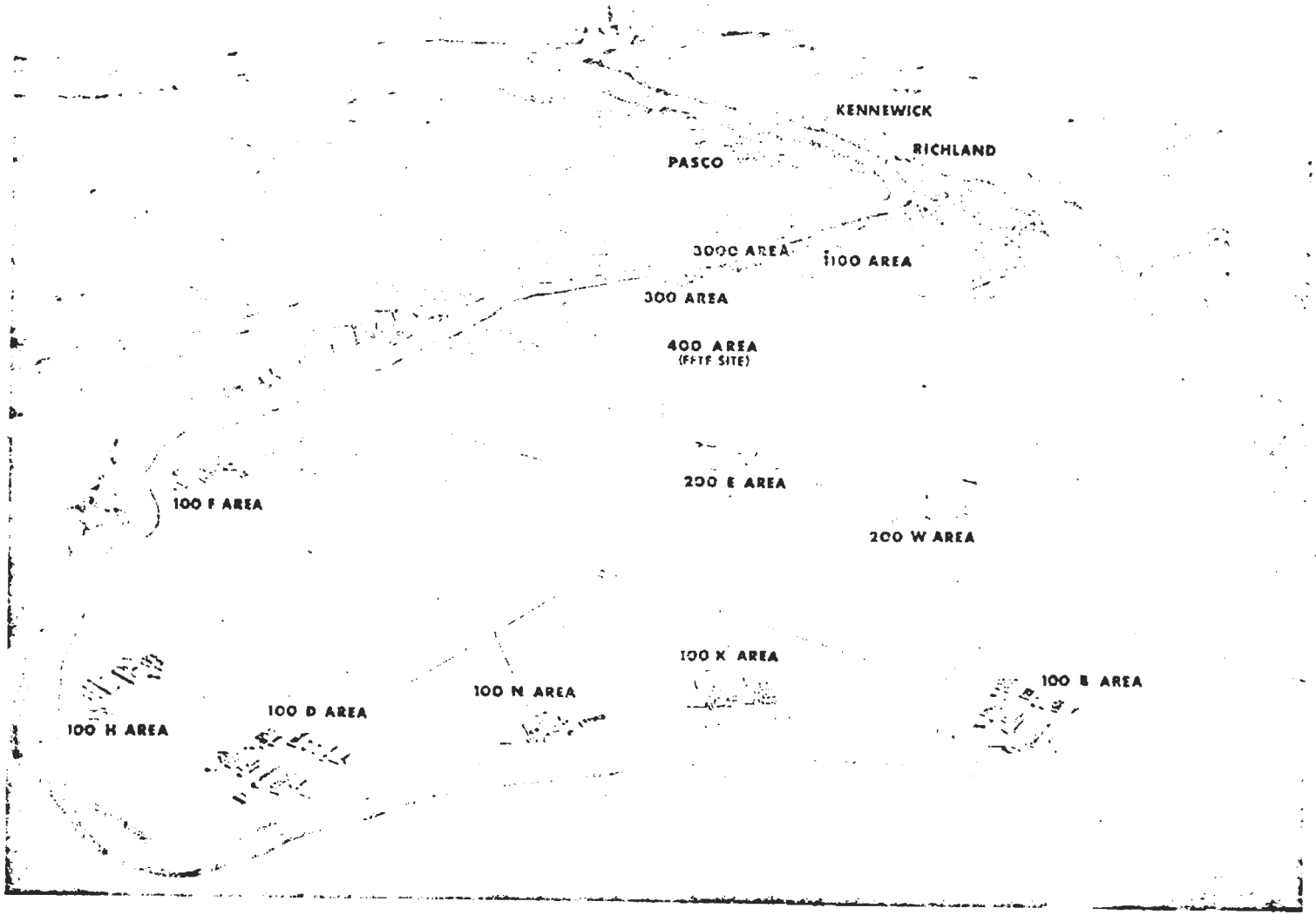


FIGURE 1. Overview of Hanford Site

1.2 Responsible Field Office

The Richland Operations Office has AEC contractual and programmatic responsibility for Hanford Project operations.

1.3 Hanford Contractors

The principal operating contractors at Hanford, their areas of responsibility, and their main locations are:

Contractor	Responsibility	Location, Areas
Atlantic Richfield Hanford Company (ARHCO)	Chemical Separations, Waste Management, and Support Services	200, 1100
Battelle Memorial Institute Pacific Northwest Laboratory (PNL)	Laboratories, Test Reactors	300
Douglas United Nuclear, Inc. (DUN)	Reactors, Fuel Fabrication	100, 300
Westinghouse Hanford Company Hanford Engineering Development Laboratory (HEDL)	Laboratories, FFTF	300, 400
Computer Science Corporation	Computer Services	700*
J. A. Jones Construction Co.	Onsite Construction	3000*
Vitro Engineering Division of Automated Industries, Inc.	Architect/Engineering Services	700*

* For information only since no radioactive wastes are generated in these areas.

1.4 Report Responsibility

Prime responsibility for maintaining an updated site plan rests with O. J. Elgert, Director, Production and Waste Management Programs Division. The lead role in compiling the report has been assigned to N. T. Karagianes, Waste Management and Development Branch, PWMP Division.

1.5 Waste Management Funding

The AEC Headquarters Divisions supporting waste management activities at Hanford and the percentage of total funds charged to each division in FY-1972 was as follows:

Division	% Funding
Production and Materials Management	96.0
Reactor Development & Technology	2.6
Waste Management & Transportation	1.4

2. DESCRIPTION OF WASTE GENERATING PROCESSES

2.1 General Overview

Figure 2 provides a schematic depicting radioactive waste handling on the Hanford Site. The quantities shown are based on actual experience in CY 1971.

2.2 100 Areas

2.2.1 N-Reactor

The radioactivity in 100-N Area liquid wastes are generated in the water passing through or near the N-Reactor core. Most of the radioactivity results from activation of piping corrosion materials: iron, chromium, manganese, zirconium, and cobalt. Some fission products are also generated primarily from the uranium released into the primary loop water from fuel cladding failures which leave a residual of uranium in the pipe film to fission. Figure 3 depicts the liquid streams and their point of discharge.

Hydrazine is added to the primary water to scavenge the oxygen. It decomposes forming ammonia which raises the pH to the alkaline side of neutral. This alkalinity aids in the retention of the dissolved radionuclides in the 1301-N crib where the N-Area liquid wastes are percolated through the ground prior to reaching the river.

Most radioactive species discharged to the crib are retained in the soil by chemical reactions, precipitation, and ion exchange. When the pH is on the alkaline side, the hydroxides and basic salts of zirconium, cerium, and other rare earth and transition elements precipitate and are retained in the soil by filtration. Due largely to the type of clay minerals present in the region, ion exchange of the cations retains the long-lived radionuclides (^{60}Co, ^{90}Sr, ^{137}Cs) in the soil.

When N-Reactor primary piping is internally decontaminated (about once a year), the film that is removed by the inhibited phosphoric acid contains about:

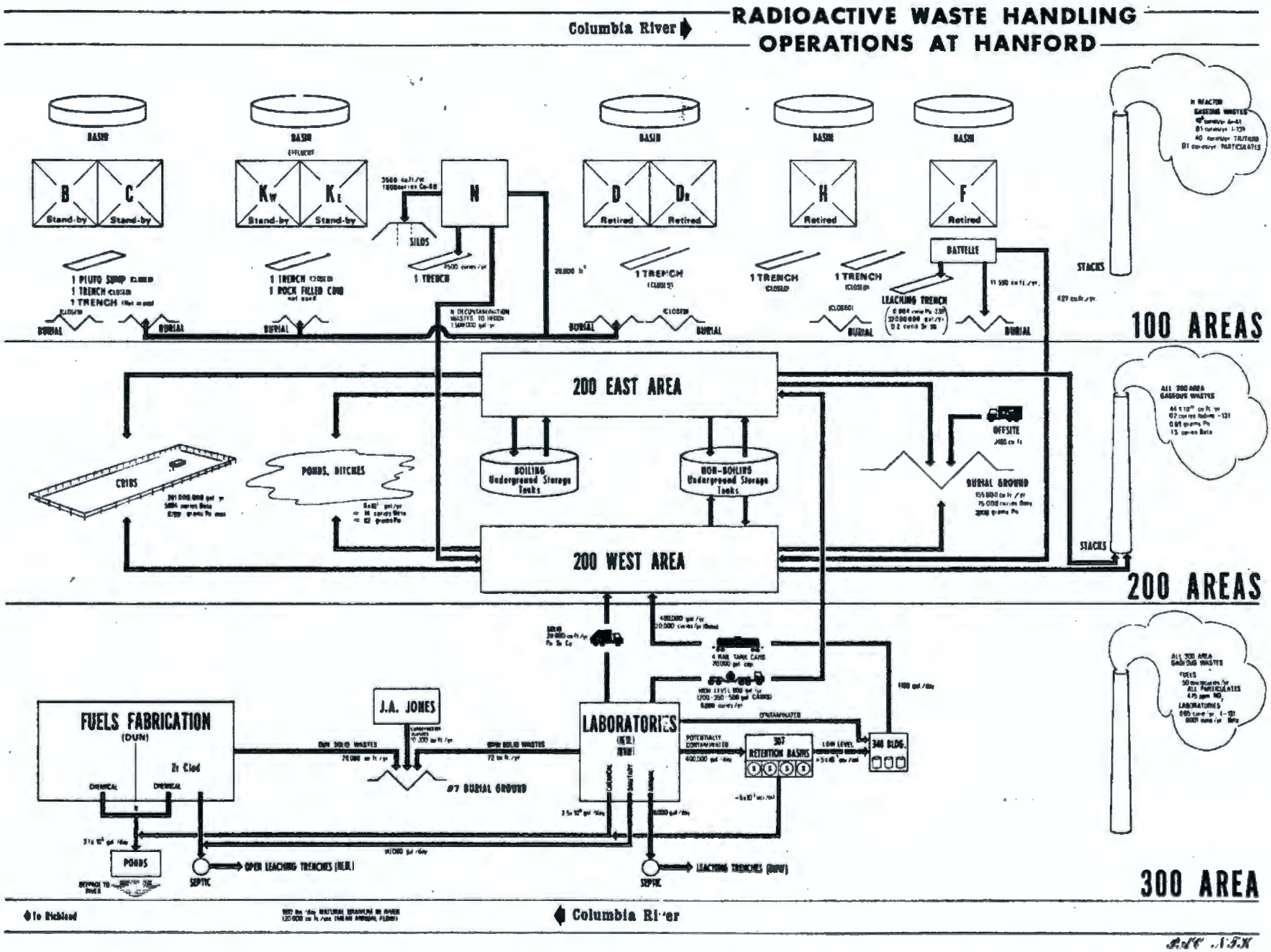


FIGURE 2. Radioactive Waste Handling Operations at Hanford

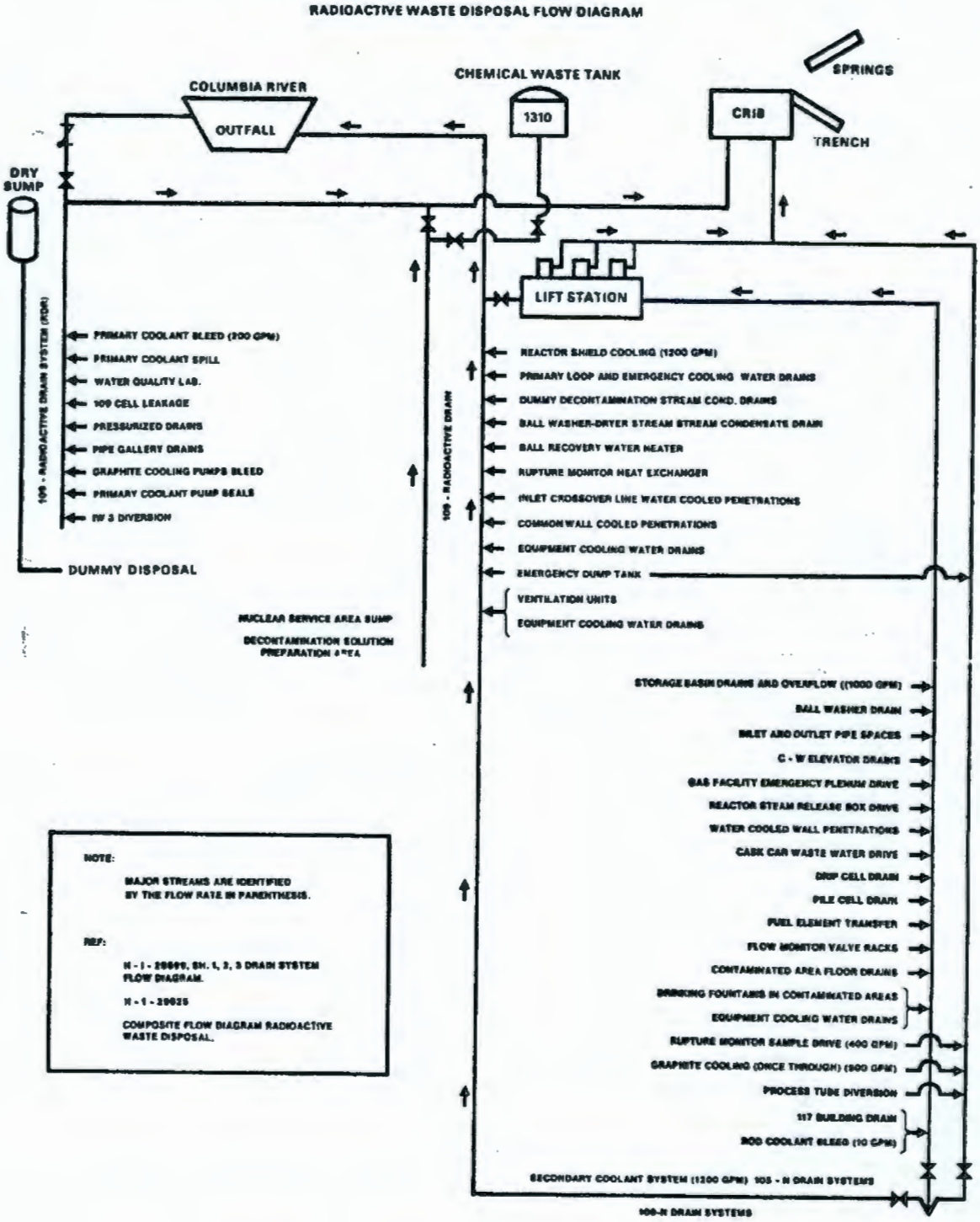


FIGURE 3. 100-N Radioactive Drain System

Radionuclides	Amount, Ci
^{54}Mn	15
^{59}Fe	20
^{58}Co	15
^{60}Co	250
^{90}Sr	0.3
^{95}Zr-Nb	7
^{103}Ru	1
^{106}Ru	15
^{137}Cs	0.01
^{140}BaLa	0.1
^{144}CePr	20
^{124}Sb	1.0

These radionuclides are dissolved by 23,000 gallons of 70% phosphoric acid which is then neutralized with NaOH. The waste volume is increased by primary loop water enroute to the 900,000 gallon storage tank. The tanked waste is shipped to the 200 West Area, for evaporation to a solid.

The 100-Area radioactive gaseous wastes originate in the 105/109-N facility as activation salts that have dried on the outside of the reactor piping and surrounding surfaces. Some of the radioactive salts are entrained by the air currents, and are removed by high efficiency filters prior to discharge through the ventilation stack.

The tritium and radioiodines formed in the reactor primary water are bled out of the primary loop into the ventilation exhaust air. Air that leaks in and is purged out of the reactor core graphite gas atmosphere contains ^{40}Ar which is activated to ^{41}Ar. This outleakage is also carried away by the building ventilation exhaust air. The ventilation air and gases exhausted from the building pass through high efficiency particulate filters and charcoal absorbers before being discharged from the 200 ft ventilation stack.

Solid wastes from 100-N Area are buried in trenches. The wastes contain dried salts and oxides of the activation and fission products found in solution in the primary coolant water. A few metallic components taken from the active reactor zone contain zirconium, iron, and steel activated to ^{95}Zr-Nb, ^{60}Co, ^{54}Mn. These are buried in designated burial ground trenches in the 100 Areas. Wastes containing transuranium elements and/or high concentration (10 mCi/g) of long-lived radionuclides (>5 year half-life) are shipped to the 200 Areas for burial.

The reactor core moderator, graphite, has had some of the carbon activated to ^{14}C. In addition, nitrogen in the reactor gas atmosphere is activated to ^{14}C which in part combines with the graphite.

In the deactivated production reactors and N-Reactor, the thermal shields surrounding the graphite cores are made of cast iron blocks that were subjected to neutron bombardment during reactor operation. The buildup of ^{60}Co proceeded according to the reaction:

$$(^{58}\mathrm{Fe} + \mathrm{n} \longrightarrow {}^{59}\mathrm{Fe} \xrightarrow{\beta} {}^{59}\mathrm{Co} + \mathrm{n} \longrightarrow {}^{60}\mathrm{Co})$$

Estimates of the radioactivity in the blocks are provided in Sections 3 and 4.

2.3 200 Areas

Radioactive waste is generated by a large number of 200 Area facilities over a wide range of volumes and radionuclide concentrations. Table 1 presents these waste sources and the categories of waste generated. Figure 4 provides a schematic of waste handling and discharges in the 200 Areas for CY 1971. The bulk of the radioactive waste is generated by the major processing facilities; Purex, B Plant and Z Plant.

2.3.1 Purex Plant - 202-A

The primary function of the Purex Plant is to chemically process irradiated uranium fuels to recover plutonium (Pu), neptunium (Np), and uranium (U). The primary Purex processing steps include metal dissolution, solvent extraction and ion exchange. Irradiated uranium fuel elements are charged to dissolvers, chemically declad, then dissolved with nitric acid.

TABLE 1. Radioactive Waste Sources

SOURCE	WASTE					
	Liquid				Solid	Gaseous
	High Level		Intermediate Level	Low Level		
	Boiling	Non-Boiling				
200 East Area						
Purex Plant	X	X	X	X	X	X
B Plant	X	X	X	X	X	X
244-AR Vault	-	-	-	X	X	X
241-A, AX, AY Tank Farms	-	-	X	X	X	X
Critical Mass Laboratory	-	-	X	-	X	X
Semiworks	-	-	-	-	-	X
CR Vault	-	-	-	X	X	X
ITS-1 and 2 Concentrators	-	-	X	X	X	X
200 West Area						
T Plant	-	X	X	X	X	X
242-T Concentrator	-	-	X	X	X	X
Laundry	-	-	-	X	X	X
231-Z	-	-	X	X	X	X
U Plant	-	-	-	X	X	X
Z Plant	-	X	X	X	X	X
UO_3 Plant	-	-	X	X	X	X
222-S Laboratory	-	X	X	X	X	X
SX Tank Farm	-	-	X	X	-	X
Redox Plant	-	X	X	X	-	X
Other Contractors						
Pacific Northwest Laboratory	X	X	X	-	X	-
Douglas United Nuclear	-	-	X	-	X	-
Hanford Engineering Development Laboratory	X	X	X	-	X	-

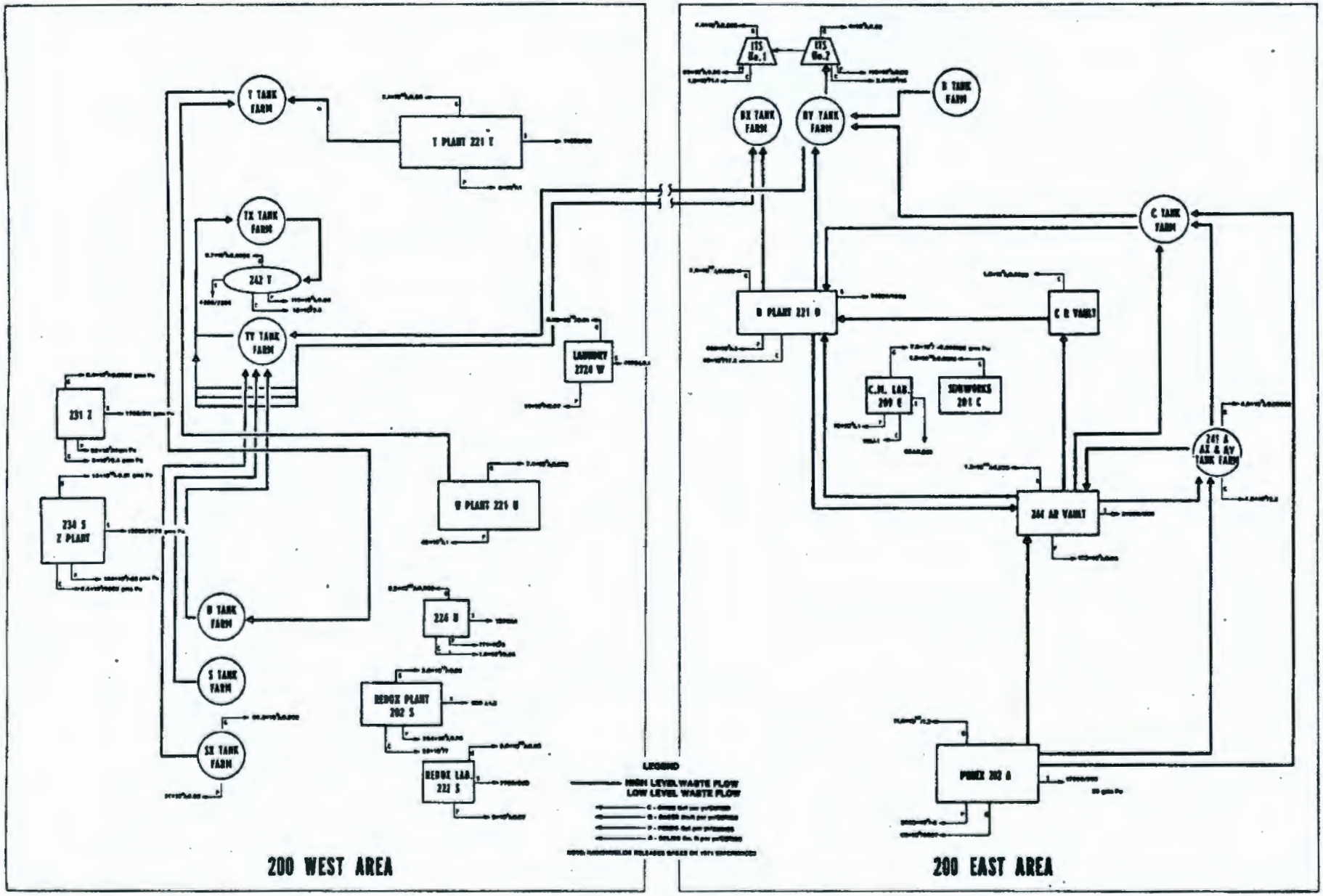


FIGURE 4. 200 Areas Waste Output - 1971

Chemical additions to the dissolver solution are made to produce suitable feed for the solvent extraction operation. The major separation of the Pu, Np and U from fission products is accomplished in the codecontamination cycle. The partition cycle separates Pu from Np and U. The Pu stream is routed through two additional solvent extraction cycles for further purification. After final concentration, the plutonium nitrate solution is loaded into containers for transfer to the plutonium finishing operations. The stream from the partition cycle bearing the Np and U is routed to the final uranium cycle where the Np is separated and returned to the backcycle waste stream, and final purification and concentration of the U is accomplished. The product, uranyl nitrate hexahydrate solution, is stored in large tanks and ultimately transferred to the UO_3 Plant by truck-trailer for conversion to uranium trioxide. A portion of the backcycle waste stream is routed to the Np recovery and purification process which consists of a solvent extraction cycle, a concentrator and an ion exchange column. The neptunium nitrate solution is loaded into plastic containers for storage and shipment offsite. Supporting process systems include organic decontamination and recovery, nitric acid recovery, and waste concentration and treatment.

The Purex Plant produces a complete range of radioactive liquid waste as follows:

1. High level boiling - Current Acid Waste (CAW)
2. High level non-boiling - coating wastes, organic wash wastes, plant flushes
3. Intermediate level - process and steam condensates, dissolver scrubber wastes
4. Low level - cooling water, chemical sewer wastes

Figure 5 provides a simplified process schematic for the Purex Plant, including the destination of the liquid wastes.

Solid wastes from the Purex Plant include rags, paper, etc., which are contaminated with mixed fission products, transuranics or both, and failed process equipment (industrial-type waste).

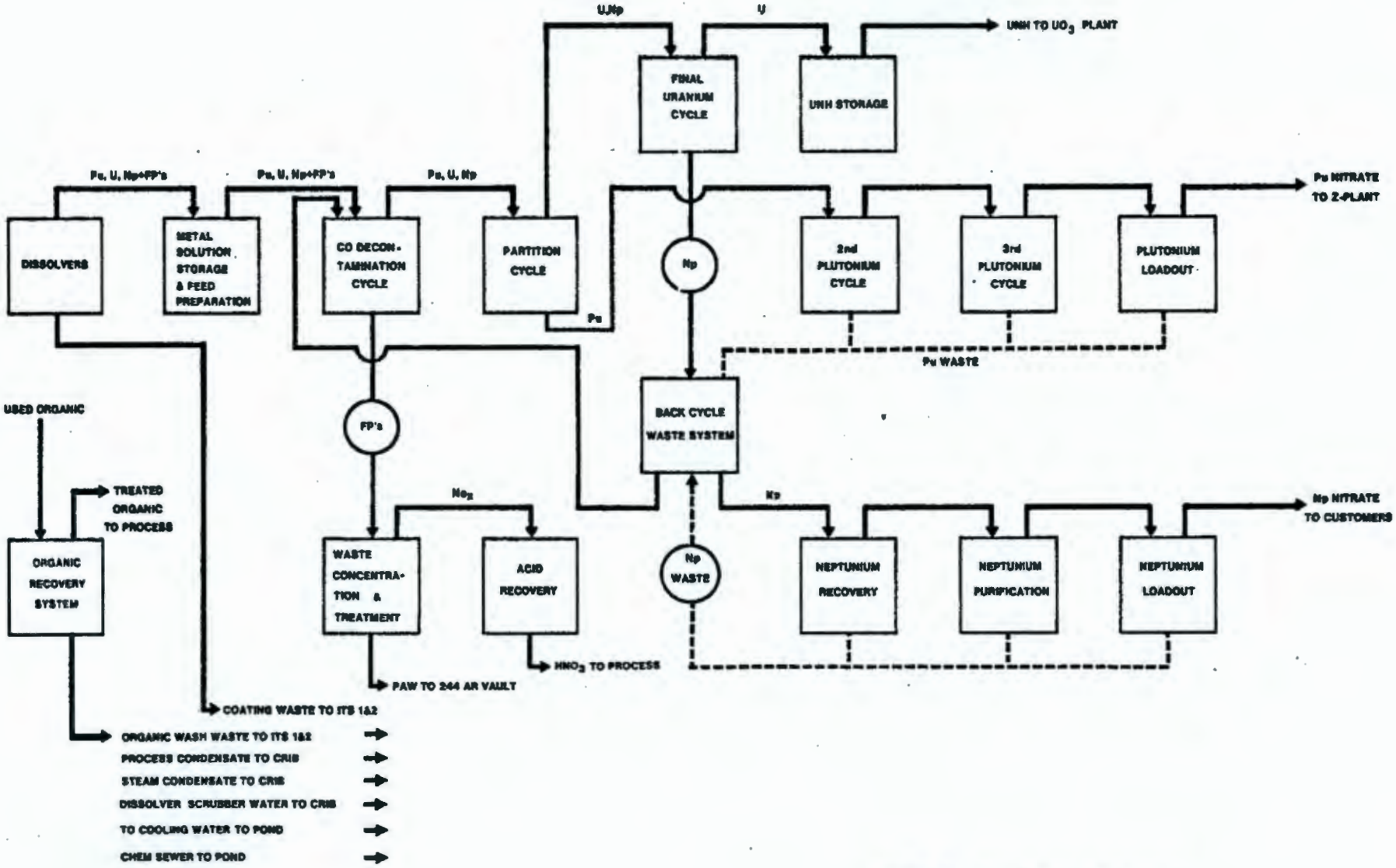


FIGURE 5. Purex Proces Schematic

Gaseous wastes from the Purex Plant are about 25% of the total 200 Area volume discharged to the atmosphere and contain about 85% of the total beta activity.

2.3.2 B Plant - 221-B

The purpose of B Plant is to remove sufficient strontium and cesium from stored and Purex current acid wastes (CAW) so that these wastes can be evaporated to a salt cake without encountering excessive temperatures in the cake. Following recovery, the two fission products are purified and stored as liquids in stainless steel tanks equipped with cooling coils. Both strontium and cesium will be converted to solids, encapsulated and stored in the Waste Encapsulation Facility now under construction and scheduled for operation in June 1973. Figures 6 and 7 depict the flowsheets for cesium and strontium encapsulation.

The solids treatment, solvent extraction, precipitation, and ion exchange processing steps in B Plant for fission product removal and purification produce various waste streams. High-level non-boiling wastes are routed directly to the in-tank waste solidification system for conversion to salt cake. High-level boiling wastes resulting from the processing of current acid wastes (CAW) are stored for an interim period of about three to five years in underground waste storage tanks to allow the short-lived high-heat producing fission products to decay. Figure 8 is a schematic of the B Plant waste fractionization flowsheet. Intermediate and low-level liquid B Plant wastes are sent to cribs and ponds, as follows:

Process condensate - to crib
Steam condensate - to crib
Cooling water - to pond
Chemical sewer - to pond

Solid waste from B Plant is classified as mixed fission product contaminated waste and is a combination of paper, rags, etc., packaged in cardboard waste cartons, and failed equipment (industrial-type waste), which is packaged in wooden or concrete boxes for burial.

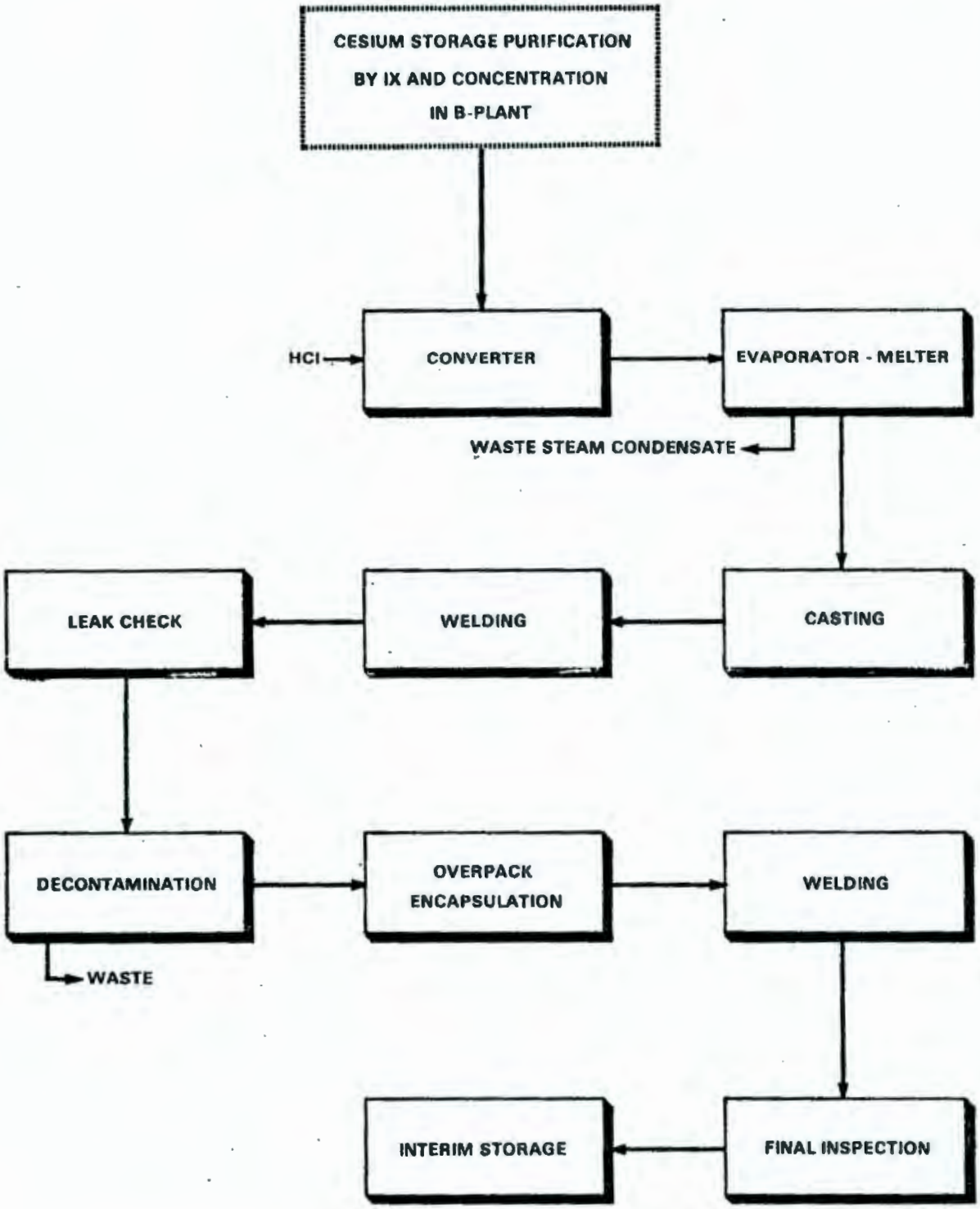


FIGURE 6. Cesium Chloride Encapsulation Process Flow Diagram

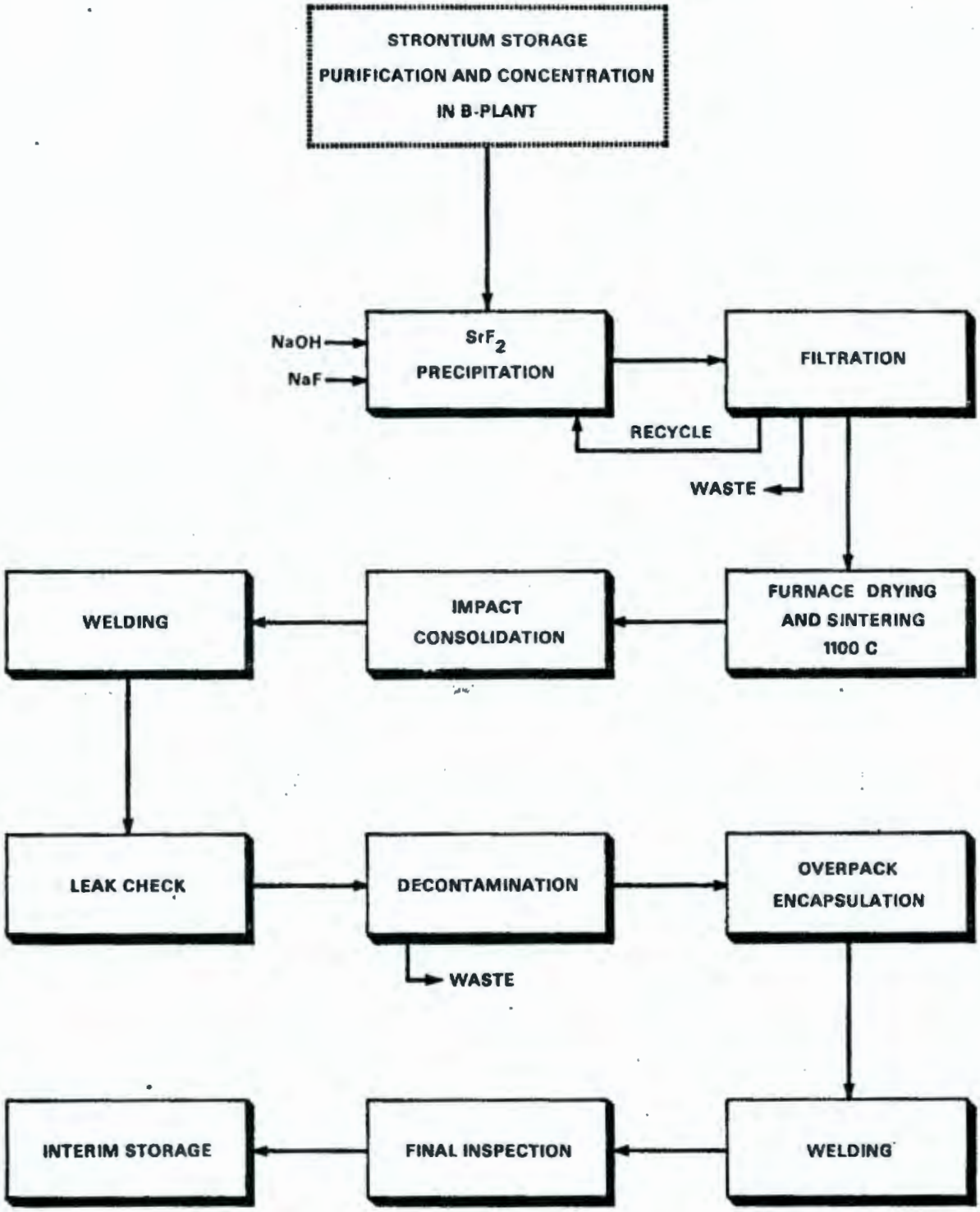


FIGURE 7. Strontium Fluoride Encapsulation Process Flow Diagram

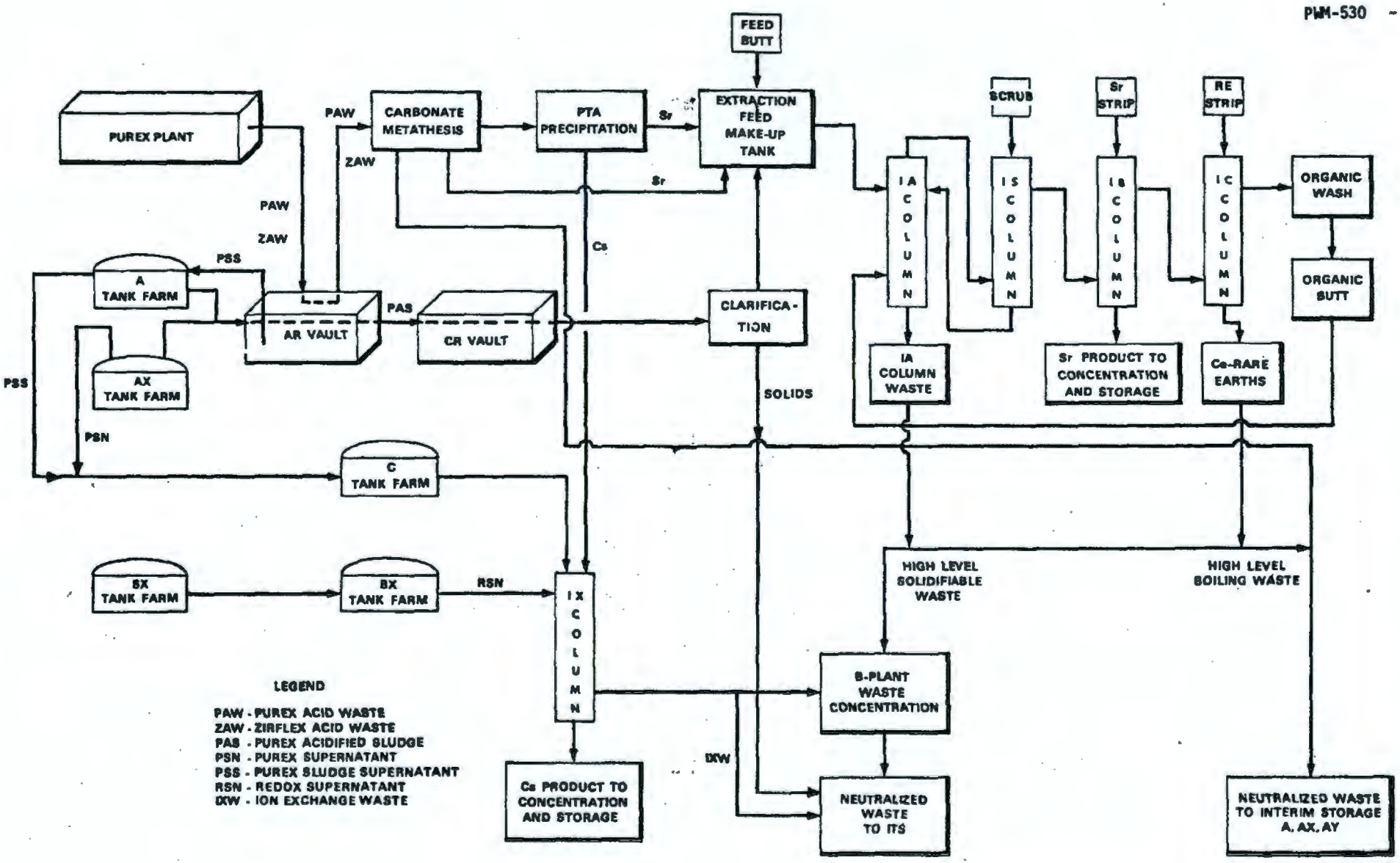


FIGURE 8. Waste Fractionization Flowsheet

B Plant gaseous wastes make up about 5 to 10% by volume of the 200 Area total and less than 1% of the beta activity discharged to the atmosphere.

2.3.3 Z Plant

The major quantity of plutonium discharged to the ground via liquid and solid wastes is from the Plutonium Finishing Section operations (Z Plant) in the 200-W Area. This section operates the Plutonium Reclamation and Plutonium Processing facilities.

The Plutonium Reclamation facility processes plutonium scrap in a variety of forms and plutonium content and produces a pure plutonium nitrate product. Americium is subsequently recovered from the solvent extraction high salt aqueous waste stream generated during the plutonium processing. Generally, the scrap is leached or dissolved in a nitric acid media and is then adjusted chemically for feed to the extraction battery. Solvent extraction removes the impurities and produces a pure plutonium nitrate product. The salt waste stream is further treated for trace plutonium and americium recovery. Contaminated waste streams consist of high salt aqueous solutions and degraded organic solutions, which are routed to a specific retention crib. Beginning in April 1973 these streams will be sent to underground storage tanks. The aqueous streams will be converted to salt cake while the organic stream will be stored for future incineration.

The Plutonium Processing plant converts plutonium nitrate feed to either plutonium oxide or metal, depending upon customer requirements. The plutonium is precipitated with oxalic acid, filtered and calcined (for plutonium oxide product) and then fluorinated and reduced to metal (for the metal product). Waste streams consist of solids and the oxalate precipitation filtrate, which are recycled for plutonium recovery in the reclamation facility. Aspirator jet water, steam condensates and miscellaneous waste streams with very low concentrations of plutonium are routed to a subsurface disposal crib. These waste streams will also be routed to underground storage tanks in April 1973.

The plant vacuum system, servicing both of the processing facilities, generates potentially contaminated water waste that is routed to a pond.

Z Plant gaseous wastes make up about 30% by volume of the 200 Area total and none of the beta activity discharged to the environs.

Figure 9 is a flowchart of the plutonium finishing operations.

2.4 300 Area

The wastes generated in the 300 Area are characterized into two general types, (1) uranium and (2) fission product and plutonium bearing. The uranium wastes are primarily from fuel canning operations plus some from laboratory facilities handling only uranium and thorium. The plutonium and fission product bearing wastes are generated primarily in the laboratories conducting development work on separation processes, waste solidification and reactor fuels.

All fission product and/or transuranic bearing liquid and solid wastes are sent to the 200 Areas for disposal. The uranium and thorium bearing wastes are sent to 300 Area burial or to seepage ponds. The 300 Area liquid waste disposal system is depicted on the bottom of Figure 2. Figure 10 shows the solid waste burial sites.

Gaseous wastes in the 300 Area are filtered and monitored prior to discharge through stacks. The CY 1971 releases are shown in Figure 2.

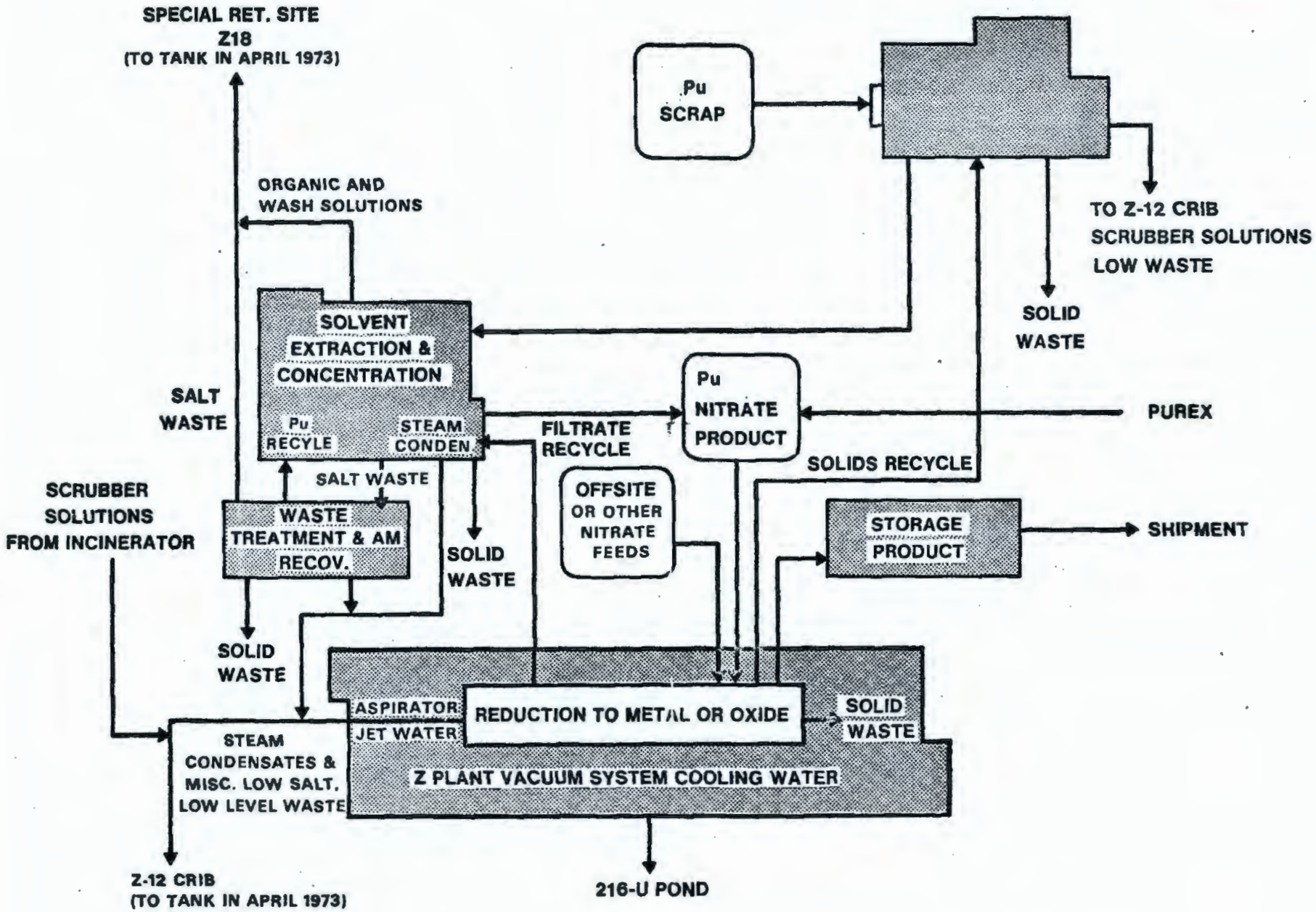


FIGURE 9. Plutonium Recovery and Finishing Operations

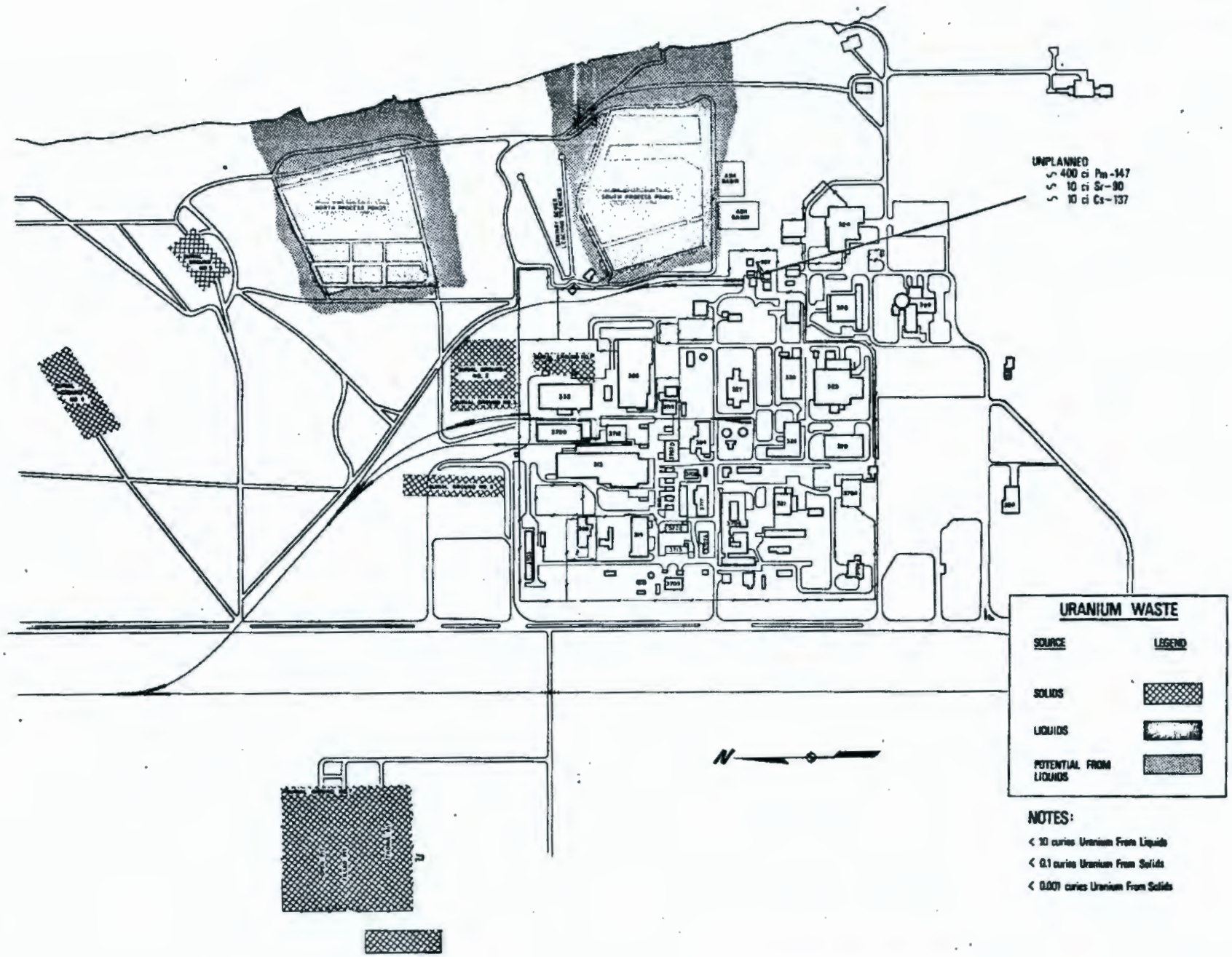


FIGURE 10. 300 Area

3. WASTE MANAGEMENT FACILITIES

3.1 Identification and Location of Facilities

3.1.1 100 Area

Figures 11 through 16 provide the identification and location of waste management facilities in the reactor areas. The facilities include retention basins, cribs, fuel storage basins, etc.

3.1.2 200 Area

Figures 17 and 18 identify the waste management facilities. The facilities include cribs, ponds, trenches, solid waste burial sites, underground waste storage tank locations, chemical processing plants, etc.

3.1.3 300 Area

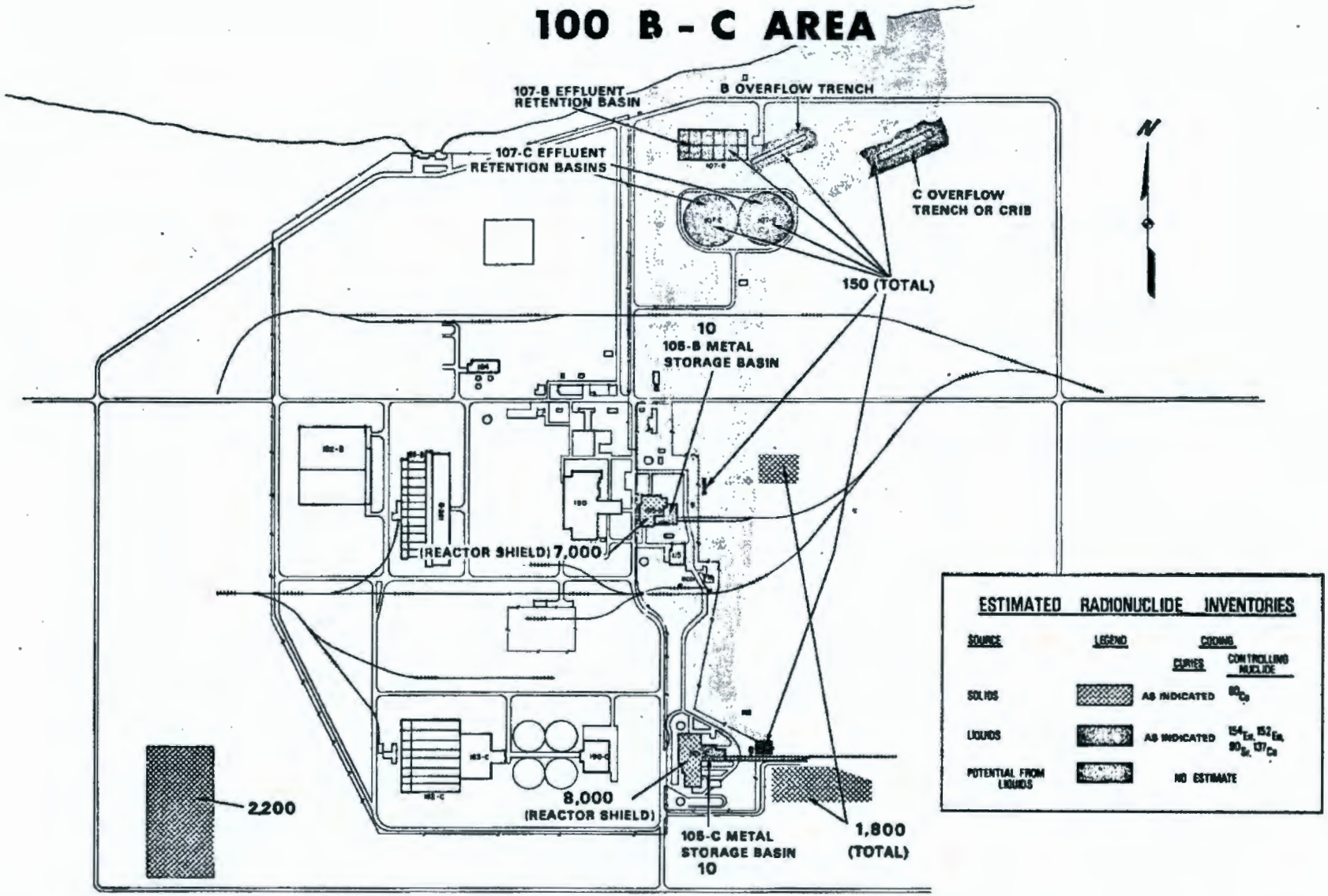
Figure 10 depicts the waste management facilities for the 300 Area Laboratory Complex. Facilities include retention basins, ponds and solid waste burial sites.

3.2 Waste Treatment Facilities

3.2.1 N-Reactor - 100 Area

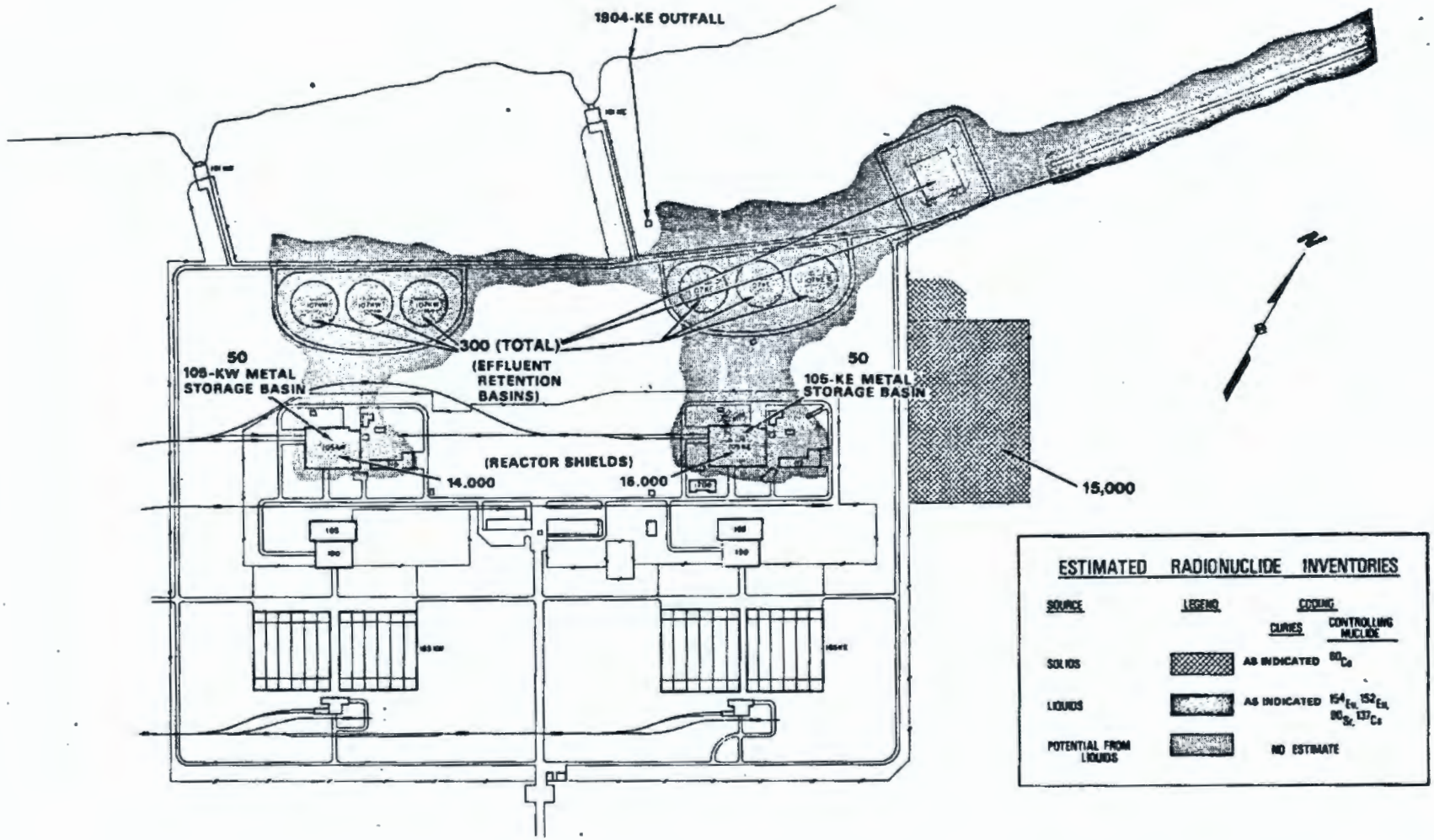
Figure 3 shows the liquid streams from N-Reactor which go to the crib (125 ft x 290 ft x 3 ft) and overflow into a 1600-ft long trench. The water passes through a minimum of 2000 ft of soil before it reaches the Columbia River. Approximately one-half of the water reaches the river in four to ten days. The remaining one-half follows longer flow paths taking several weeks to several months to reach the river.

Liquid effluents discharged annually to the 1301-N crib contain about 4500 curies. Other than tritium, about 10 curies leave the crib via the riverbank springs. The crib inventory and concentrations of the influent and effluent water are given in Table 2.



RADIOACTIVITY IS ESTIMATED THROUGH CALENDAR YEAR 1971.

FIGURE 11. 100 B - C Area



RADIOACTIVITY IS ESTIMATED THROUGH CALENDAR YEAR 1971.

FIGURE 12. 100 KE - KW Area

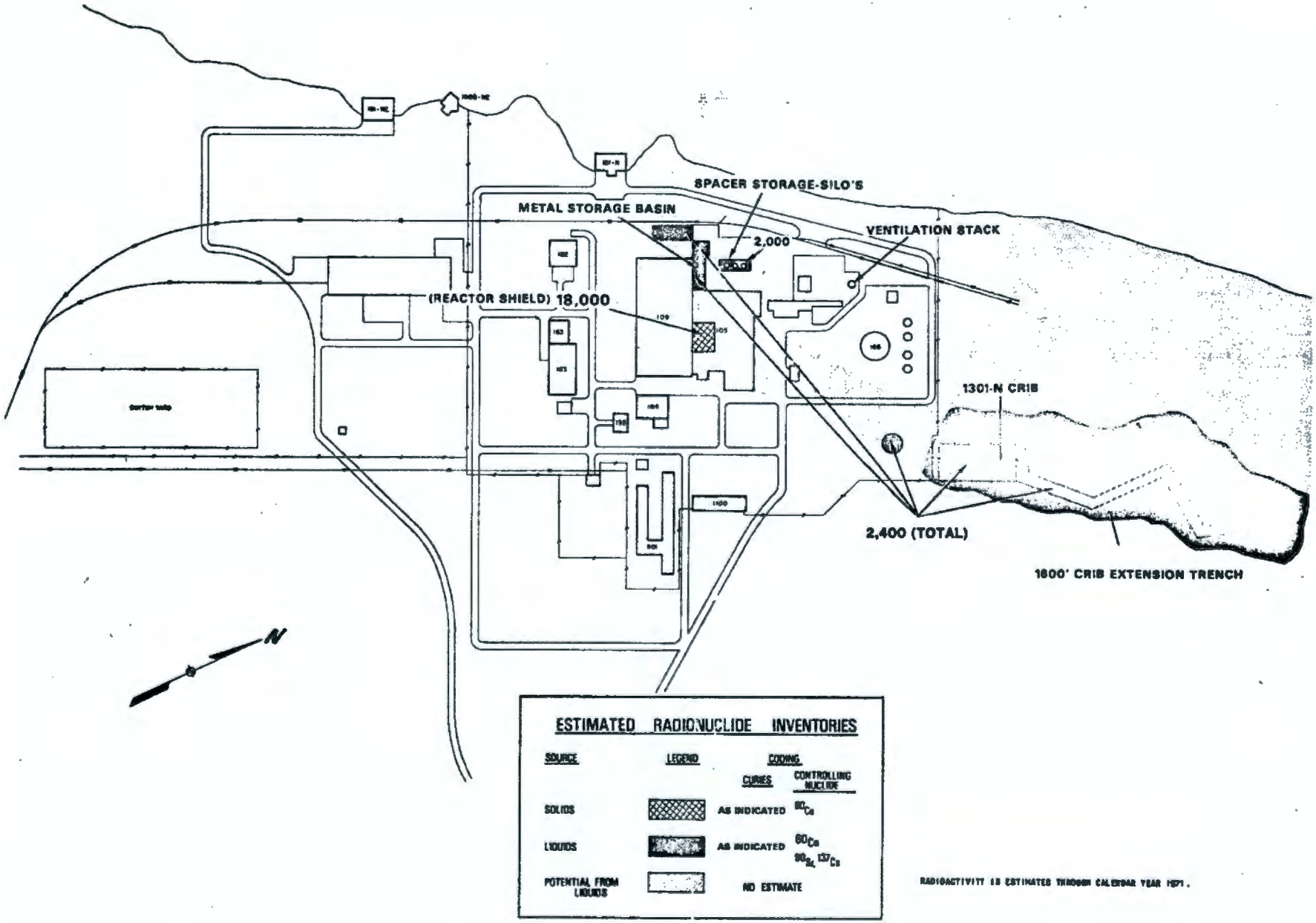


FIGURE 13. 100 N Area

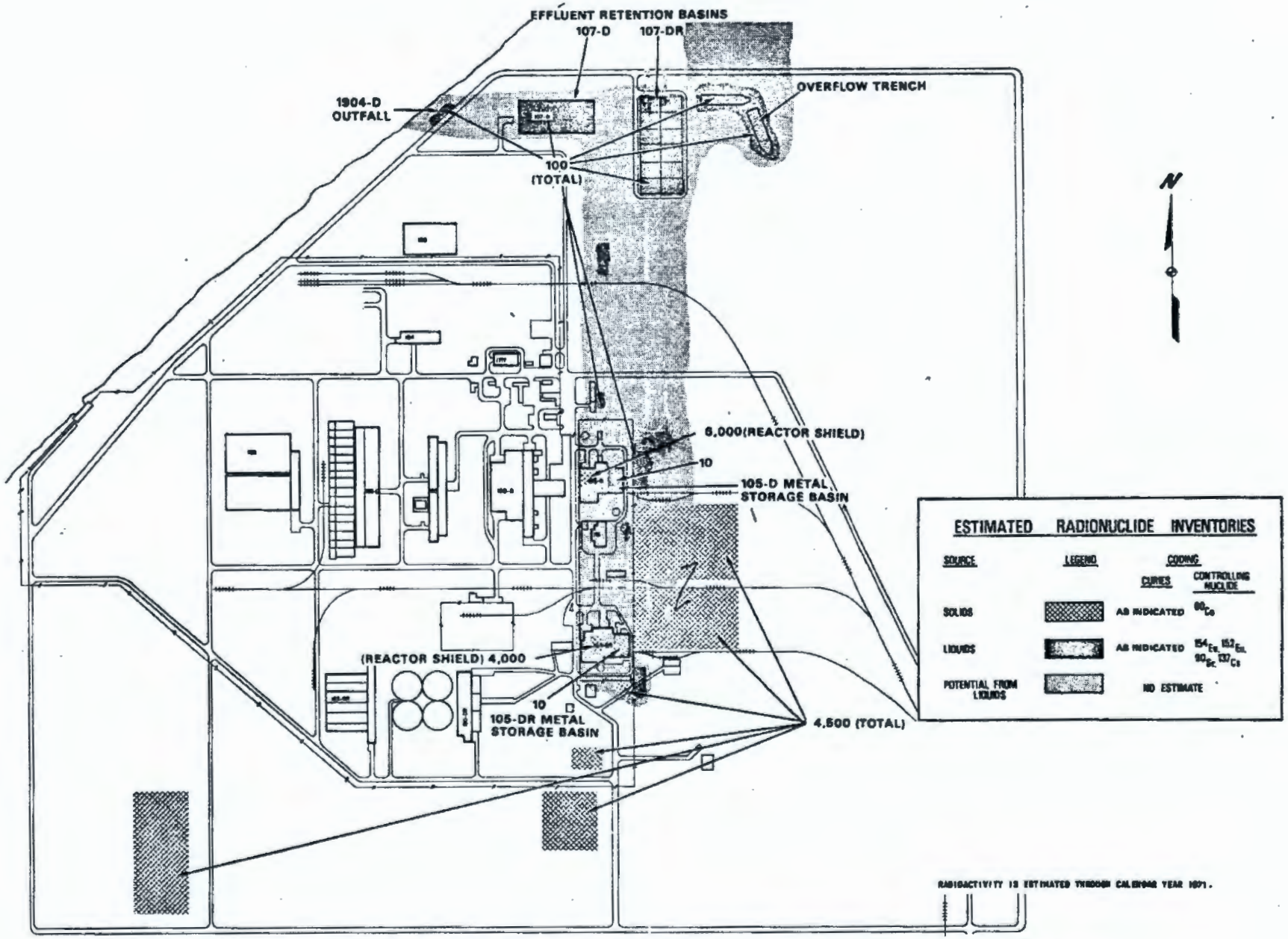
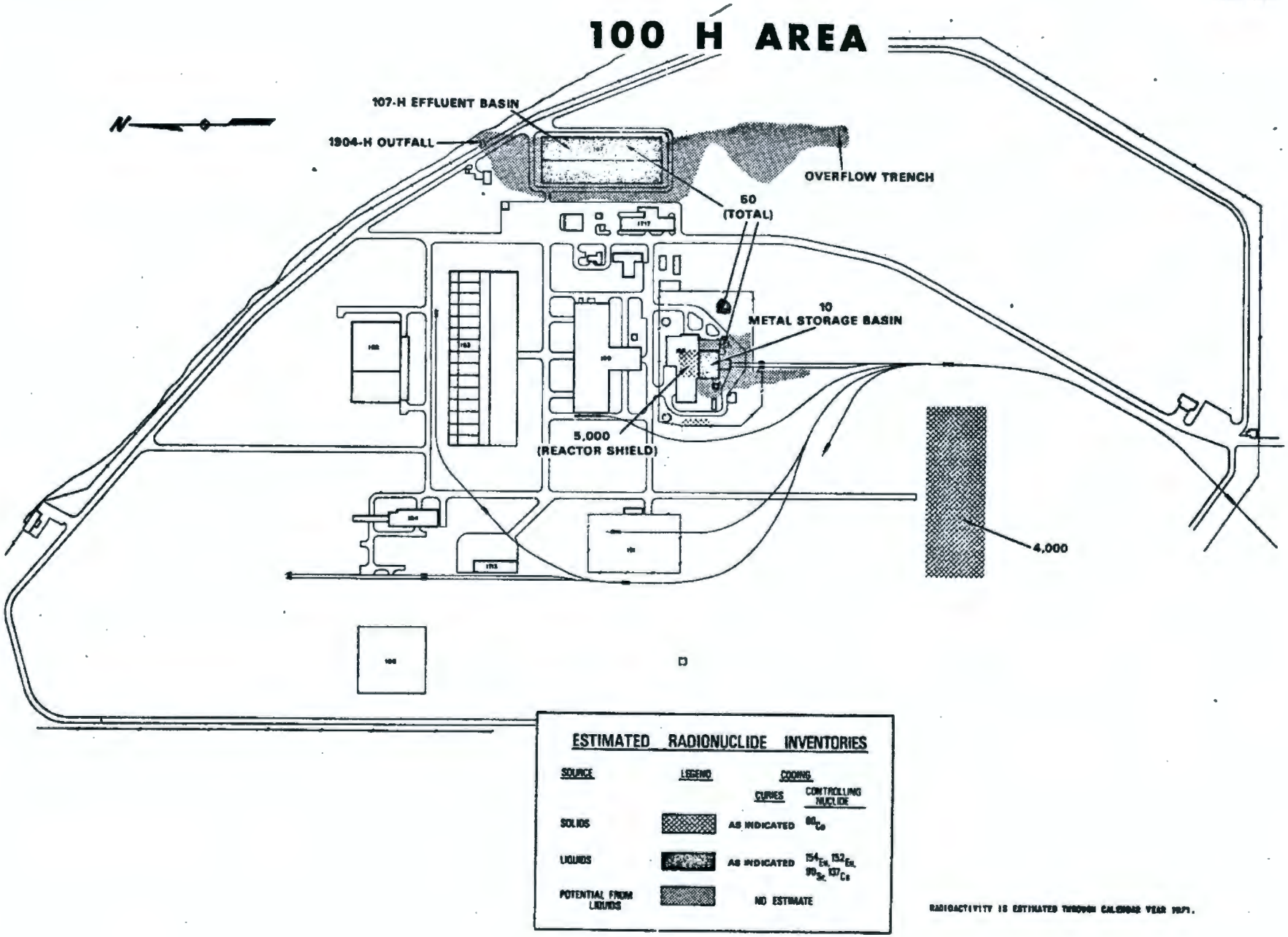


FIGURE 14. 100 D - DR Area



RADIOACTIVITY IS ESTIMATED THROUGH CALENDAR YEAR 1971.

FIGURE 15. 100 H Area

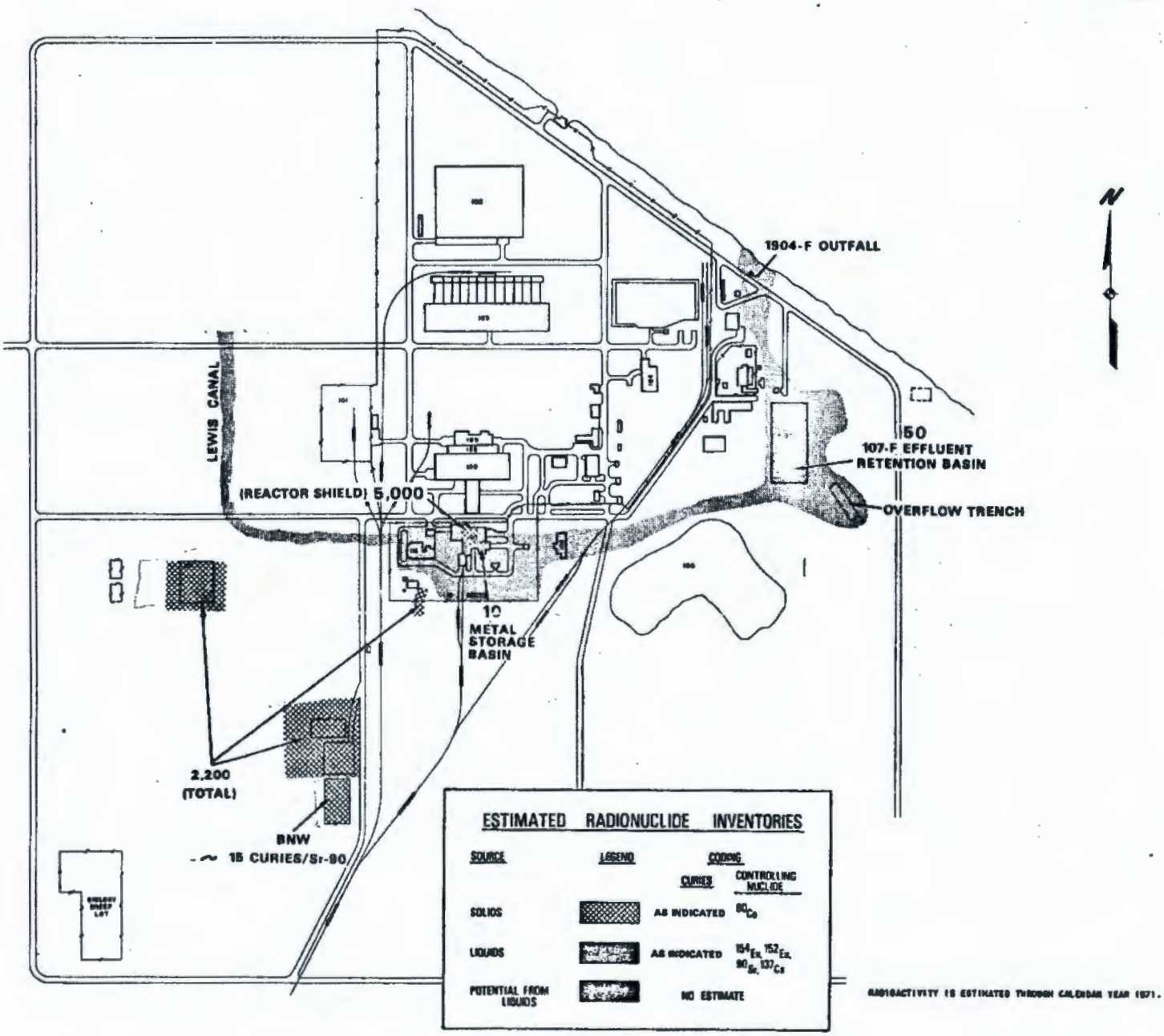


FIGURE 16. 100 F Area

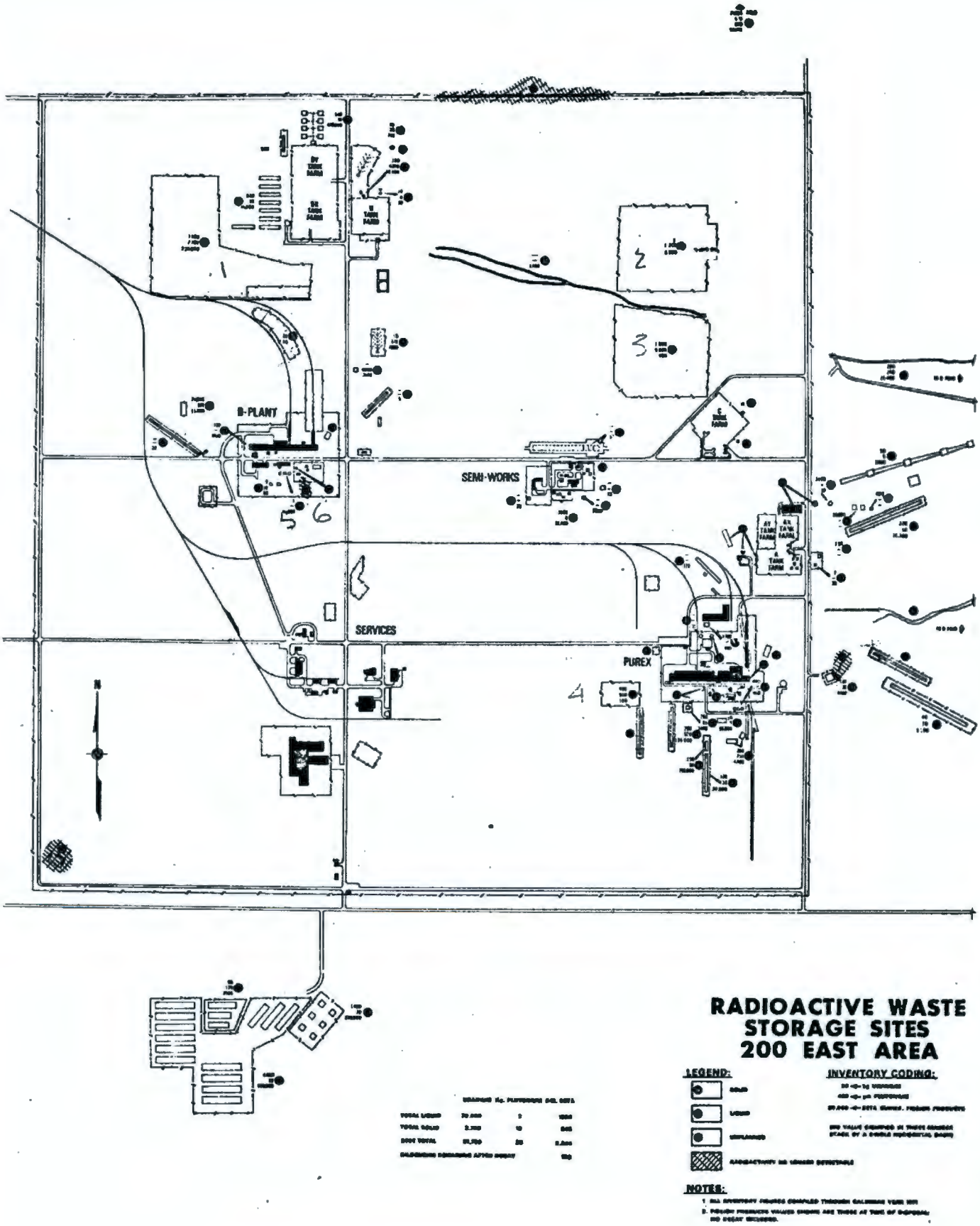


FIGURE 17. Radioactive Waste Storage Site, 200 East Area

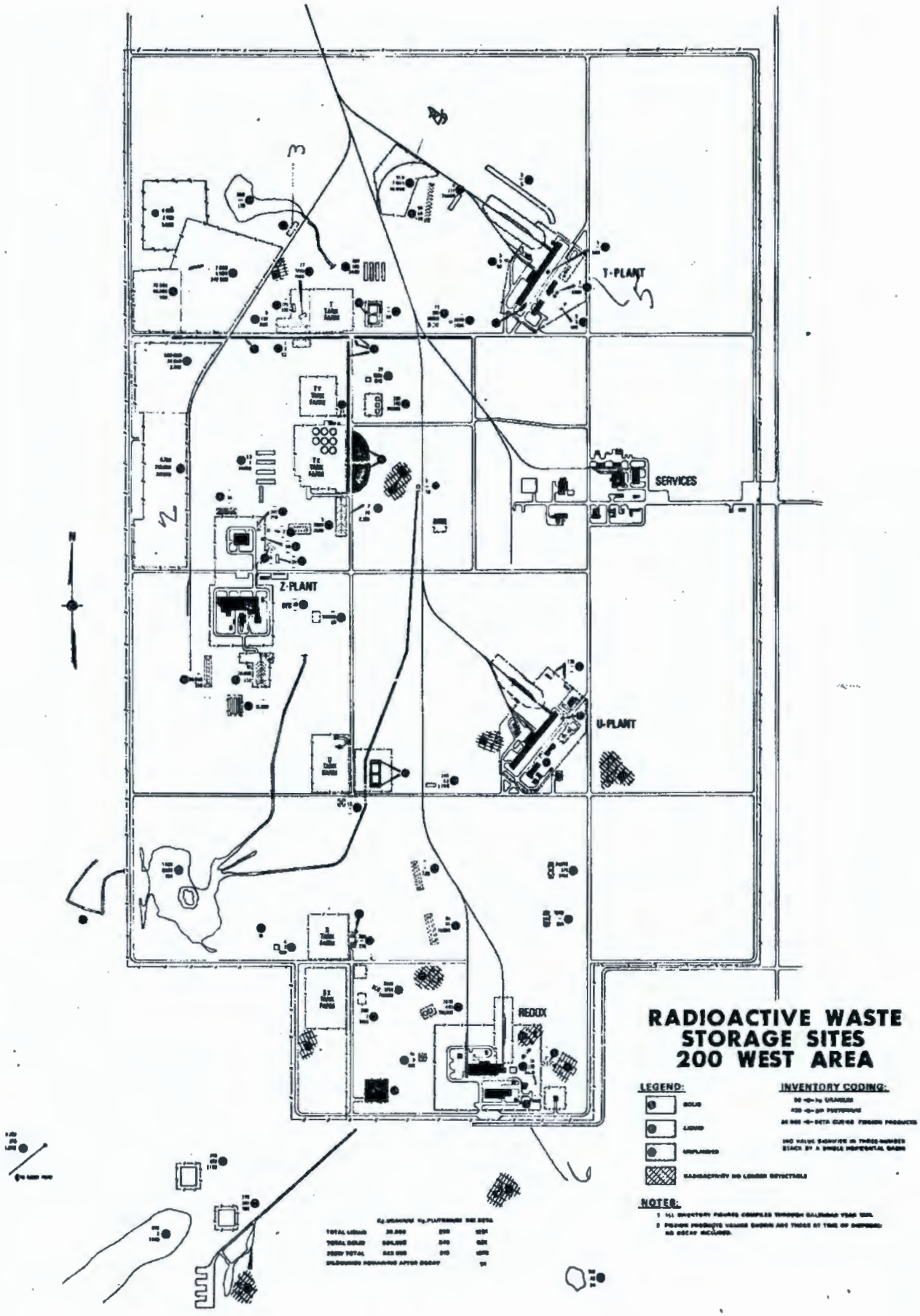


FIGURE 18. Radioactive Waste Storage Site, 200 West Area

TABLE 2. Radioactivity from N-Reactor Liquid Effluent Streams

	Mean Concentrations		
	Crib Influent, pCi/ml	Crib Output Riverbank Springs, pCi/ml	Crib Inventory, Ci
^{32}P	22.0	0.01	15
^{51}Cr*	50.0	15.0	40
^{54}Mn	30.0	0.01	800
^{58}Co	1.5	-	14
^{59}Fe	8.0	0.05	80
^{60}Co	20.0	0.2	2000
^{89}Sr	7.0	0.11	10
^{90}Sr	5.1	0.59	50
^{95}Zr	15.0	0.01	150
^{99}Mo	300.0	2.5	20
^{106}Ru	5.0	-	80
^{131}I	60.0	1.6	6
^{134}Cs	8.0	-	90
^{137}Cs	40.0	0.05	350
^{140}Ba	100.0	0.1	20
TOTAL			3725

* Most of this radionuclide release will be eliminated in FY-73 due to rod recirculation modification.

The current quantities of long-lived radionuclides released to the Columbia River from N-Reactor effluents are:

Radionuclides	Half-Life, year	Amount, Ci/yr
^{90}Sr	28	1.0
^{137}Cs	30	0.05
^{60}Co	5	0.15
^{3}H	13	1000.0*

The N-reactor ventilation stack discharges about 200,000 cfm of air. Radioactivity released in the discharged air contains:

Radioactivity	Mean Concentration, pCi/cc	Annual Release, Ci
Particulate	1×10^{-12}	1×10^{-3}
^{131}I	3×10^{-11}	5×10^{-2}
^{133}I	4×10^{-11}	7×10^{-2}
Tritium Oxide	2×10^{-8}	40
Noble Gases, ^{41}Ar	6×10^{-5}	10^{5}

3.2.2 200 Areas

Liquid wastes from a number of facilities are treated prior to their discharge. Approximately one-half of the process condensate overheads from concentration of Purex first cycle waste is routinely recycled to the process. Process condensate overheads from concentration of B Plant high-level wastes are monitored and recycled if found above prescribed standards for crib discharge. Process condensate overheads from the self-boiling 241-A-AX-AY waste storage tanks are treated via an ion exchange column to

* Will reduce to about 200 Ci/yr after the coproduct elements have been shipped to Savannah River (1973).

remove ^{137}Cs and ^{90}Sr. Process condensate overheads from the in-tank solidification Units 1 and 2 can be recycled if above prescribed standards for crib discharge. Provision of ion-exchange capability for removal of ^{90}Sr and ^{137}Cs from these condensates is planned. Process condensates from the 242-T waste evaporator are batch collected and monitored. They can be recycled if above prescribed standards for crib discharge. Liquid wastes from the operation of Z Plant are not currently treated prior to crib discharge; however, Project 72-1-e, presently under construction, will route essentially all of the plutonium bearing waste from this facility to underground waste storage tanks.

Intermediate-level liquid wastes are released to the ground via subterranean structures called cribs. A crib is constructed by digging a ditch about 15 feet deep and up to 1400 feet long, backfilling with rock and covering with an impermeable membrane and soil. A distributor running the length of the crib is designed to distribute the liquid uniformly along the crib length (see Figure 19). The released liquid percolates through the soil. The soil column between the bottom of the crib and the groundwater is 150 to 300 feet thick and contains up to fifty percent silts and sands having a high clay content. Percolation rates through these materials are slow, causing the liquid to spread laterally and involve much more soil than that directly beneath the crib. When it is necessary to discharge organic wastes or aqueous wastes containing complexing agents to the ground, the volume is limited such that the soil can retain the material above the groundwater by capillarity. Field data indicate that up to 10% of the soil volume can be held by capillarity with little or no downward motion. This capability is a direct result of the arid conditions that have existed in this area for the past 10,000 years. A typical crib disposal site is shown in Figure 20.

While the coarse gravels have little capacity to sorb or filter radioactive materials, the clays make good filter beds and have good ion exchange properties with capacities up to one milliequivalent per gram. The ion

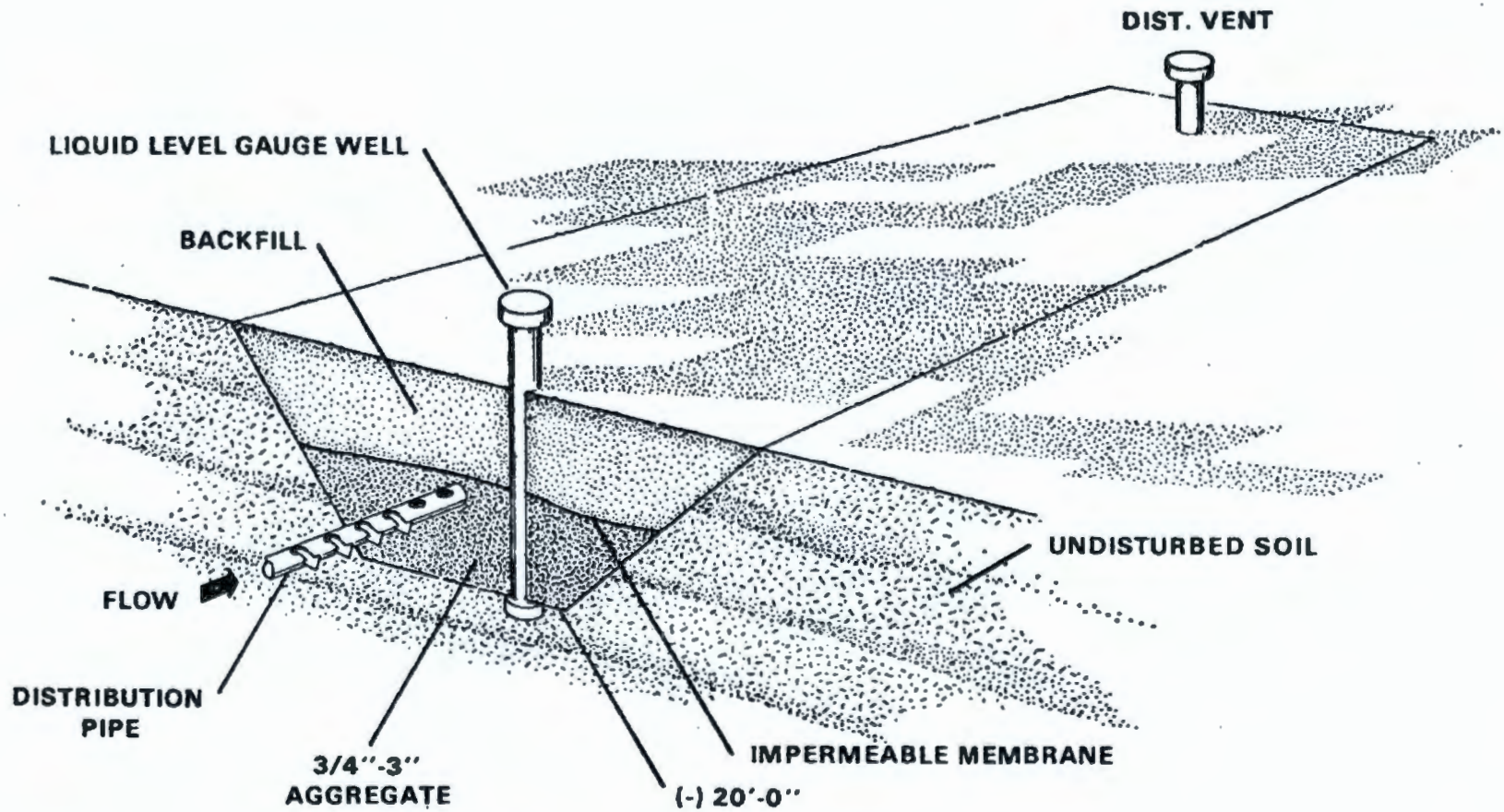


FIGURE 19. Typical Crib for Water Effluents

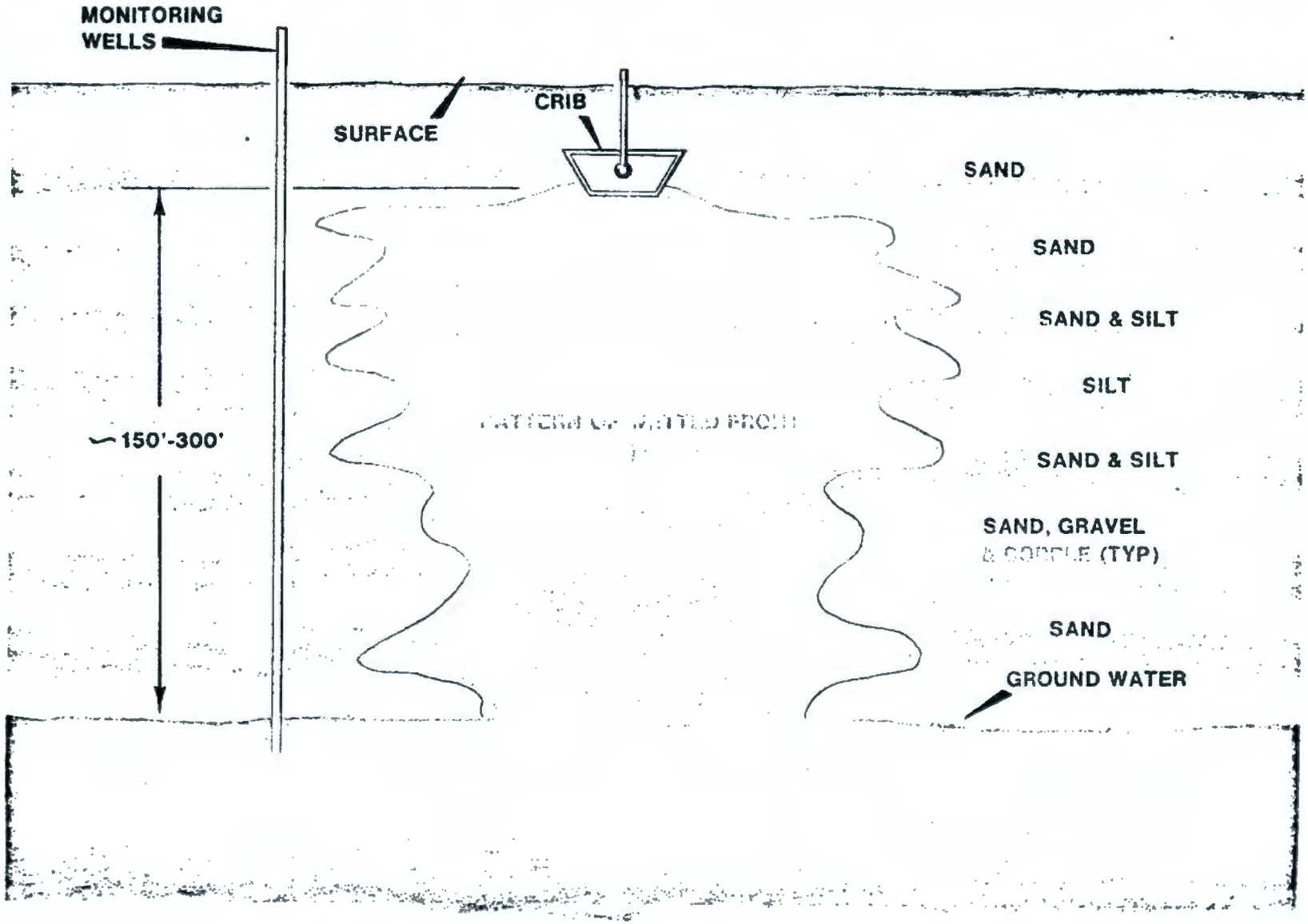


FIGURE 20. Schematic of Disposal Site for Intermediate Level Wastes

exchange capacity of the clays varies widely with the type of ion being sorbed (Figure 21). Tritium and nitrate ions, for example, are sorbed little if at all. Ruthenium is held relatively well, but a small fraction of the ruthenium is of such ionic form that little sorption takes place. The tritium, nitrate, and a small fraction of ruthenium then flow to and with the groundwater at essentially the same rate as the water. These materials enter the groundwater at concentrations slightly above the appropriate limits for drinking water, but are rapidly diluted below such limits as they flow toward the Columbia River.

Cesium and strontium are more tightly held by the soil, most being held within the first 30 feet below the crib. When these ions are detected in the groundwater at concentrations approaching one-tenth of the maximum permissible concentration for drinking water, the crib site is deactivated, and the process effluents are routed to a new crib. Plutonium is held very tightly by the soils with essentially all of the plutonium being held within 10 feet of the point of release.

A total of 176 cribs have been used for disposal of intermediate-level liquid wastes since startup of the 200 Area Facilities.[1,2,3,4] Of these, 144 have been deactivated and 32 are presently in use. Essentially all of the radionuclides discharged to these sites are retained on the soil column above the water table. It is intended to discontinue the use of cribs as soon as economically and technically practicable.

The chemical processing operation uses very large quantities of water, most of which never comes in contact with radioactive materials. These low-level aqueous wastes, which are primarily cooling water with some steam condensates, are discharged to ponds for evaporation and/or percolation through the ground to the groundwater.

Approximately 12.5×10^{10} gallons of cooling water and steam condensates have been discharged to 30 surface ponds and ditches in the 200 Areas since the start of chemical processing operations.[5] Approximately 225 acres of land have been used for these waste disposal operations.

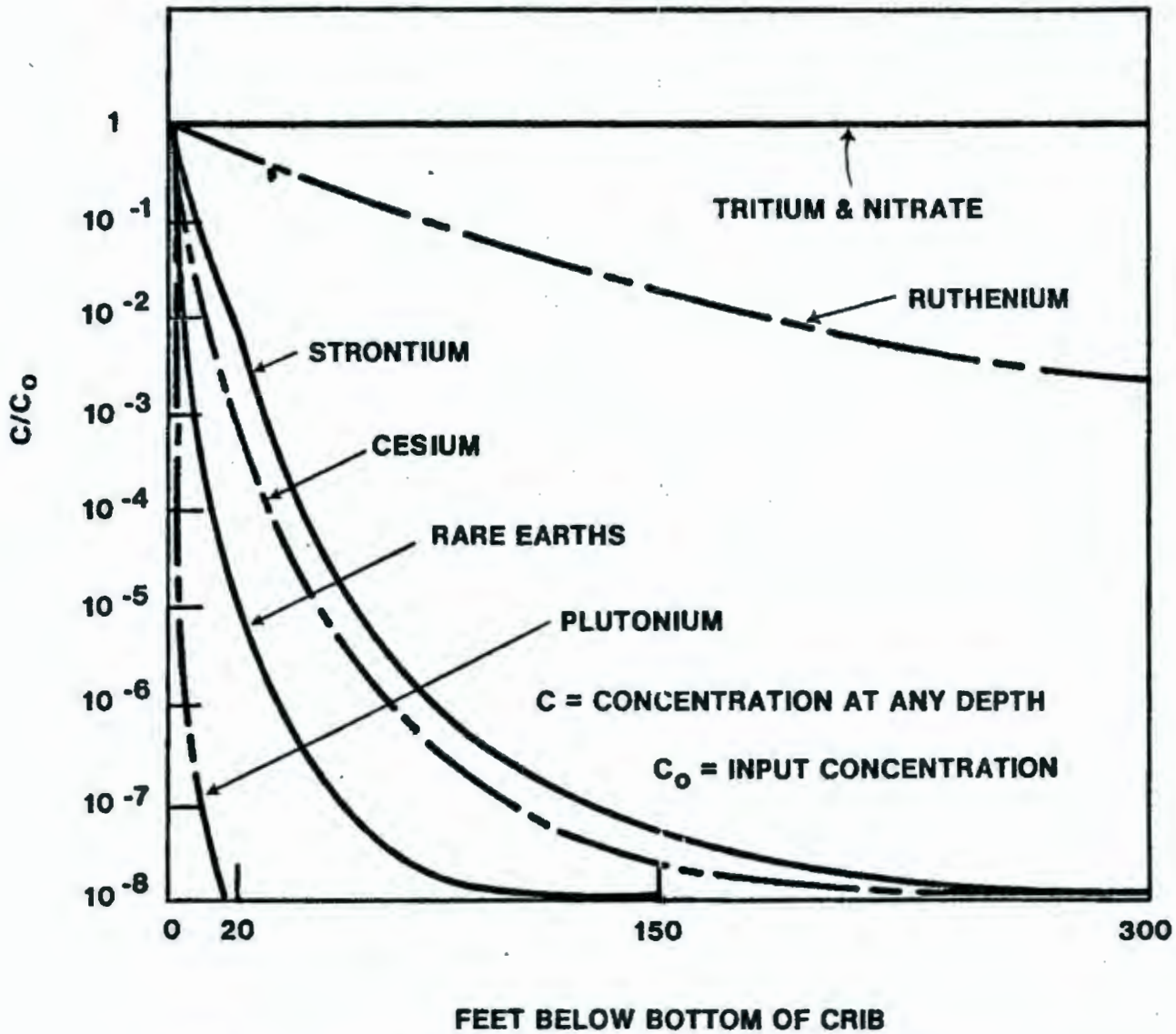


FIGURE 21. Approximate Sorption Patterns for Typical Hanford Disposal Crib

Radionuclides discharged to these sites, primarily from accidental releases due to equipment failures, are filtered or sorbed and held in the soil beneath the pond or ditch area. Figure 22 shows a typical pond.

Gaseous effluents from the 200 Areas facilities are air streams with relatively low concentrations of radionuclides either in gaseous or particulate form. Multiple filtration is relied upon to remove particulate matter while a "silver reactor" and/or wet scrubbers are used to remove radionuclides such as radioiodine. Figure 23 shows a typical ventilation flow pattern for a chemical processing plant. Air is drawn through a washer and filter and is blown into a processing area. The air passes sequentially from the less contaminated to the more contaminated zones. After passing through the most contaminated zone, the air is drawn through an exhaust duct to high efficiency particulate filters and is then sent through a stack to the atmosphere. In all cases a program of monitoring, sampling and analysis is maintained to assure that radioactivity discharged to the atmosphere is within appropriate limits.

A wide variety of high efficiency filters is used as indicated in Table 3.

TABLE 3. Ventilation Filters

Type	Plant	Rated Efficiency, %*
Three-Stage Glass	Z Plant	99.99
Two-Stage Glass	B Plant, AR Vault	99.99
Two-Stage Glass Wool	Purex	99.9
Sand	UO_3, T Plant	99.5

* For 0.3 micron particles

Air that comes in close contact with process materials picks up process chemicals and radioactive contaminants. These gases are segregated into separate vent systems according to pressure requirement and

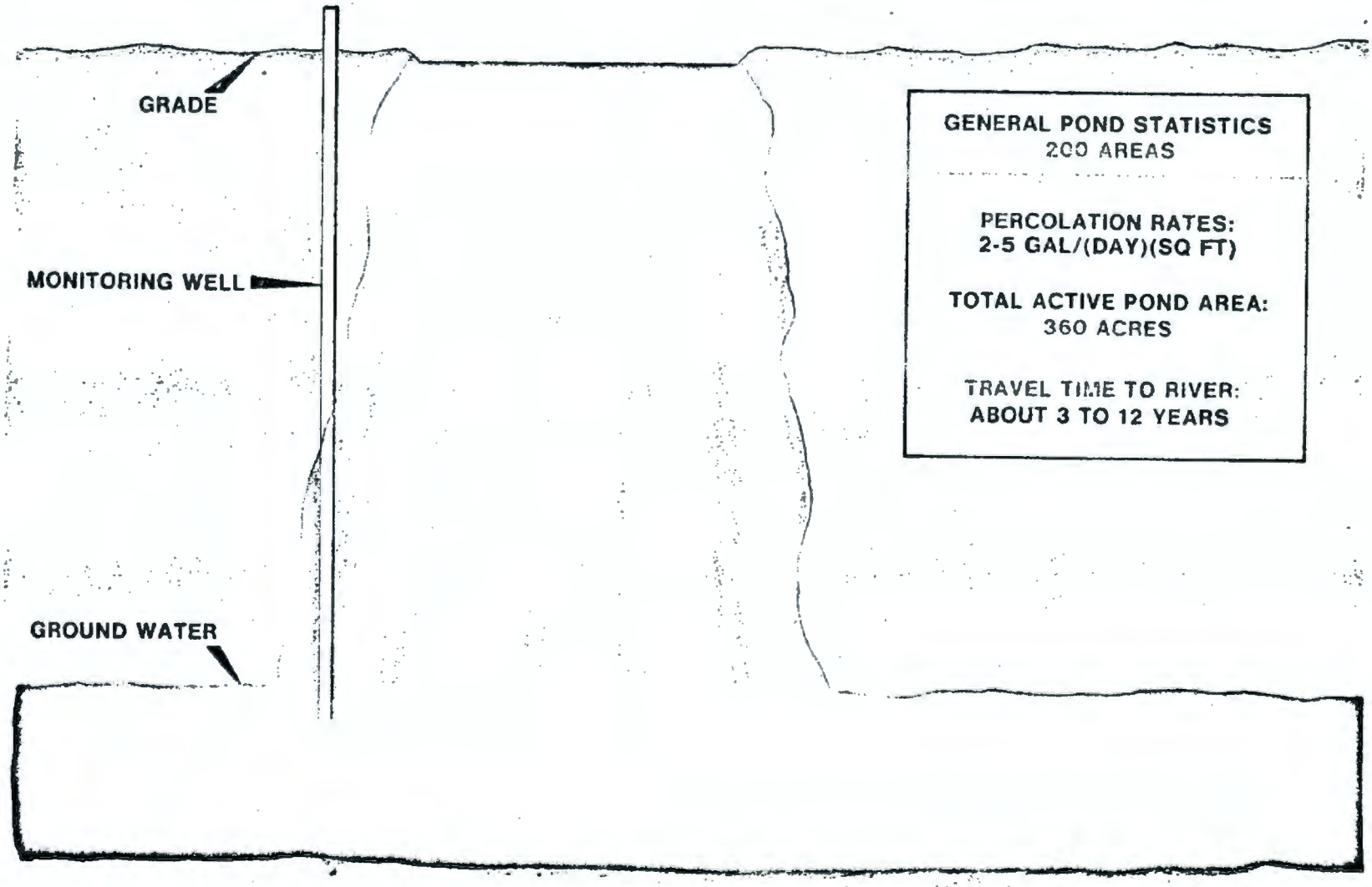


FIGURE 22. Schematic View of Typical Pond Receiving Low Level Aqueous Waste

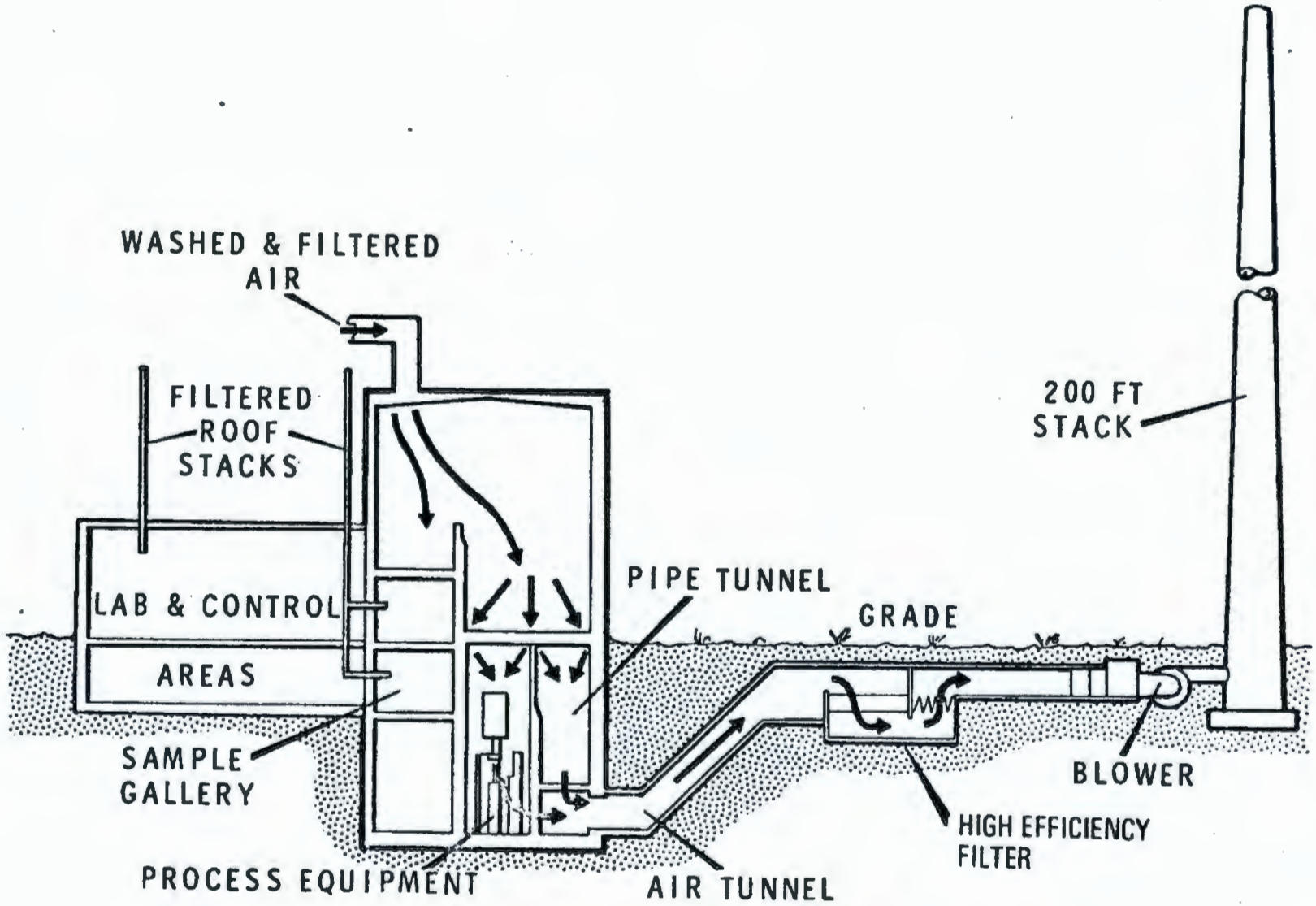


FIGURE 23. Schematic of Ventilation of Typical Separations Plant

compatibility of the process gases. The gases are processed for removal of noxious materials in a variety of ways as indicated in Table 4. Once the noxious materials have been reduced to acceptable levels, the process vent gases are exhausted to the ventilation system for additional filtration and return to the atmosphere.

TABLE 4. Gaseous Wastes Process Vent Systems

Equipment grouped according to:

- Pressure requirements
- Compatibility of process off-gases

Noxious materials removed

- Iodine absorber - Purex
- Ammonia scrubber - Purex, B Plant
- NO_x absorber - Purex, U Plant
- HF scrubber - Z Plant

Exhaust filtered and released to ventilation system

The radioactivity released to the atmosphere via 200 Area gaseous effluents during CY 1971 is shown in Table 5.

TABLE 5. Gaseous Wastes Released to the Atmosphere - 200 Areas - CY 1971

Volume	4.43×10^{11} ft^3
Alpha, assumed source - Pu	<0.68 grams
Alpha, assumed source - U	3720 grams
Beta	1.33 curies
Iodine-131	0.204 curies

3.2.3 300 Area

High-, intermediate- and low-level liquid wastes are generated in the 300 Area laboratory and reactor fuel canning complex. High- and intermediate-level wastes are sent to the 200 Areas for disposal. Low-level wastes are sent to ponds (see Figure 2).

Gaseous wastes are treated by scrubbers, chemical reactors and/or filtration prior to release to the atmosphere. The system or systems used depend upon the type of activity being performed in each respective facility.

3.3 Waste Storage Facilities

3.3.1 100 Areas

In the deactivated 100-Areas burial grounds, reactors and water effluent systems are dirt-filled, and posted in compliance with Manual Chapter AEC-RL-0510. The retired solid waste burial and storage sites are marked with concrete posts topped with identifying medallions. The burial and storage sites have been surveyed and given a legal description using the Washington State (Lambert) coordinate system. There are burial trenches in use that are controlled as Radiation Zones.

At 100-N Area, three below-grade silos contain the activated fuel spacers that were discharged with the uranium fuel elements from N-Reactor. These silos each 26 ft deep by 18 ft in diameter contain about 2000 Ci of ^{60}Co in the activated iron matrix of these spacer elements.

Also, ^{14}C is known to be present in the graphite of the reactor moderators, but the concentration is not well-defined. Current plans call for sampling the reactor graphite cores in the deactivated facilities to determine concentration and quantity of ^{14}C present.

The radioactive inventory of stored wastes, including the N-Reactor, the deactivated and standby production reactors, their metal storage basin, effluent systems, and the surrounding soil, and the solid waste burial grounds, are given in Table 6.

3.3.2 200 Areas

Liquid wastes containing high concentrations of radionuclides from the chemical processing plants at Hanford have been stored on an interim basis in underground tanks at Hanford since startup. The complex of waste storage tanks includes 149 tanks ranging from 50,000 to 1,000,000 gallons,

TABLE 6. 100 Areas Approximate Inventories of Stored Waste

Location	Radioactive Inventory: Half-Life <1 Year, Ci	Radioactive Inventory: Half-Life >1 Year, Ci
100-B		
2 B-C Reactors		15,000 (^{60}Co)
2 Metal Storage Basins		20 (^{90}Sr, ^{137}Cs, ^{239}Pu)
3 107 Basins and Soil		150 (^{152}Eu, ^{239}Pu)
Solid Wastes	3,500 (^{54}Mn, ^{95}Zr)	4,000 (^{60}Co)
100-D		
2 D-DR Reactors		10,000 (^{60}Co)
2 Metal Storage Basins		20 (^{90}Sr, ^{137}Cs, ^{239}Pu)
2 107 Basins and Soil		100 (^{152}Eu, ^{239}Pu)
Solid Wastes		4,500 (^{60}Co)
100-F		
1 F Reactor		5,000 (^{60}Co)
1 Metal Storage Basin		10 (^{90}Sr, ^{137}Cs, ^{239}Pu)
1 107 Basin and Soil		50 (^{152}Eu, ^{239}Pu)
Solid Wastes		2,200 (^{60}Co)
100-H		
1 H Reactor		5,000 (^{60}Co)
1 Metal Storage Basin		10 (^{90}Sr, ^{137}Cs, ^{239}Pu)
1 107 Basin and Soil		50 (^{152}Eu, ^{239}Pu)
Solid Wastes		4,000 (^{60}Co)
100-K		
2 KE-KW Reactors		30,000 (^{60}Co)
2 Metal Storage Basins		100 (^{90}Sr, ^{137}Cs, ^{239}Pu)
6 107 Basins and Soil		300 (^{152}Eu, ^{239}Pu)
Solid Wastes	3,500 (^{65}Zn	15,000 (^{60}Co)
100-N		
1 N Reactor		18,000 (^{60}Co)
Crib	1,300 (^{54}Mn, ^{95}Zr)	2,400 (^{60}Co, ^{137}Cs, ^{90}Sr)
Spacer Storage	150,000 (^{59}Fe)	2,000 (^{60}Co)

NOTE: ^{14}C data in the reactors and reactor systems are insufficient to quantify at this time.

which are constructed of reinforced concrete with a carbon steel liner on the bottom and side walls; and the two new AY tanks, 1,000,000 gallons each, of a tank-in-tank design with a primary containment steel liner and a surrounding secondary liner to the fill line.[6,7] Two additional tanks of this latter design are under construction and scheduled for completion in January 1973. All tanks are grouped in 13 tank farms within a three-mile radius. General information about these tanks is given in Table 7. As shown in Figure 24 the earth serves as shielding and as a sink for the dissipation of the heat from radioactive decay. The first such tanks built were for non-boiling wastes, the characteristics of which are shown in Figure 25 along with some tank construction data. These tanks are vented to the atmosphere through air-cooled reflux condensers and cooling coils are not provided. Instrumentation is provided to measure the sludge and supernatant temperature, and the liquid and sludge levels in the tanks. A grid of dry wells in each tank farm is used to monitor the soil for radioactivity, thus serving as a secondary leak detection system. Later tanks were built to contain wastes with greater heat generating characteristics as shown in Figure 26. These tanks are of the same general construction as those described for non-boiling wastes. Additional features were provided, however, to permit self-concentration, the vapors being routed through headers to a de-entrainer and water-cooled condensers, which are vented to the atmosphere after passing through a wire mesh de-entrainer, high efficiency filters, and exhaust blowers. Condensates can go to an underground disposal site (Figure 27) or be returned to the waste tank to avoid overconcentration. The tanks referred to in Figure 27 are provided with airlift circulators for the agitation of the tank contents to prevent localized temperature buildup in the supernatant from the tank liquid head and the resultant bumping caused by sudden steam release. Each A and SX farm tank is closely encompassed by a complex of vertical and horizontal dry wells (Figure 28) so that any leak may be detected by monitoring for radioactivity in the soil surrounding the tank. Each AX and AY farm tank has a drainage grid beneath the tank liner which connects to an associated leak detection well. The AY farm tanks have an annular

TABLE 7. Waste Storage Tanks at Hanford

Tank Farm	Tanks Per Farm	Capacity Per Tank, gallons	Capacity Per Farm, gallons	Year Constructed	Cost Per Farm*	Cost Per gallon
T	16	54,500(4) 530,000(12)	6,578,000	1943-44	$ 3,087,000	$0.469
U	16	54,500(4) 530,000(12)	6,578,000	1943-44	2,969,000	0.451
B	16	54,500(4) 530,000(12)	6,578,000	1943-44	3,019,000	0.459
C	16	54,500(4) 530,000(12)	6,578,000	1943-44	2,938,000	0.447
BX	12	530,000	6,360,000	1946-47	2,208,000	0.347
TX	18	758,000	13,644,000	1947-48	5,859,000	0.429
BY	12	758,000	9,096,000	1950-51	2,651,000	0.291
S	12	758,000	9,096,000	1950-51	3,961,000	0.435
TY	6	758,000	4,548,000	1951-52	1,846,000	0.406
SX	15	1,000,000	15,000,000	1953-54	3,983,000	0.266
A	6	1,000,000	6,000,000	1954-55	5,865,000	0.978
AX	4	1,000,000	4,000,000	1963-64	2,577,000	0.644
AY	2	1,000,000	2,000,000	1968-70	3,125,000	1.562
AZ	2	1,000,000	2,000,000	1971-73	4,400,000	2.200
	153		98,056,000**		$48,488,000	$0.499 Avg
	29 124					

* Includes original tank farm cost plus improvements, including instrumentation, agitation systems, and transfer lines from separations plants. Operating costs are not included. The A and AX farm costs include the actual cost of $761,000 for Project CAC-970, Essential Waste Routing System, and an estimated cost of $280,000 for Project IAP-609, Purex Tank Farm Vent System Expansion. The costs for these two projects are equally divided between A and AX farms.

** A total of seven boiling and six non-boiling tanks have leaked. These have been pumped to residual heels except Tanks SX-107 and 108 which contain only salt cake.

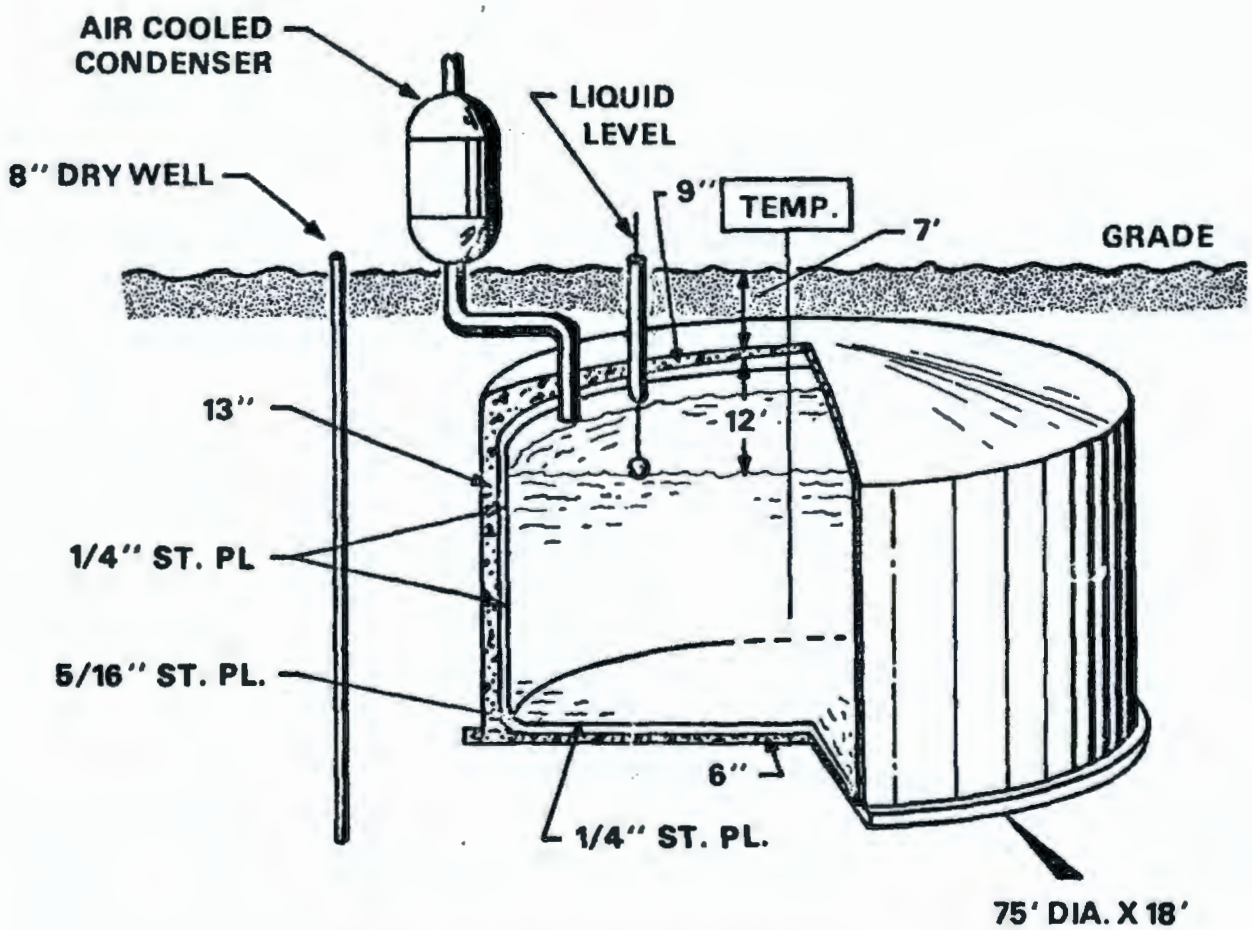
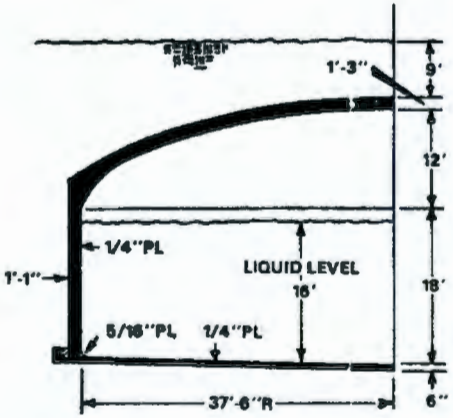
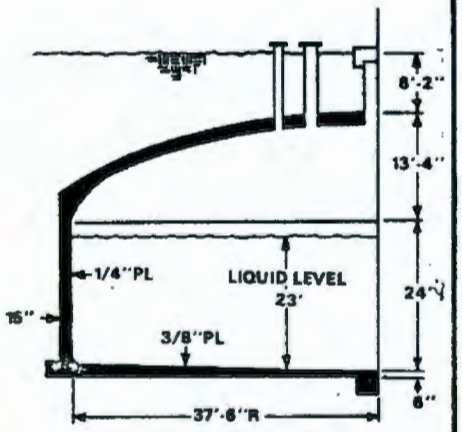


FIGURE 24. Storage Tank for Nonboiling Wastes

SPECIFIC GRAVITY	1.2	1.25	
MAXIMUM TEMPERATURE	220 °F	220 °F	
HEAT EVOLUTION (PER TANK)	NEGLIGIBLE	LESS THAN 10^5 BTU/HR (0.15 BTU/GAL./HR.)	
BOILING PERIOD	NONE	NONE	
VAPOR PRESSURE	NONE	NONE	
STORAGE WASTE VOLUME	4,000 GAL/T	4,000 GAL./T	
pH	8 TO 10	8 TO 10	
CORROSION	CONCRETE DOME EXPOSED TO VAPORS	CONCRETE DOME EXPOSED TO VAPORS	
SLUDGE	NO CONTROL REG. OF SLUDGE TEMP.	NO CONTROL REG. OF SLUDGE TEMP.	
CIRCULATION	NONE	NONE	



U.T.B.C & BX TANKS
533,000 GAL.



S.BY.TX & TY TANKS
750,000 GAL.

FIGURE 25. Characteristics of Wastes Used for Design of Non-boiling Waste Tanks

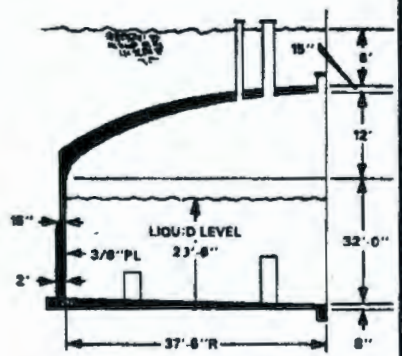
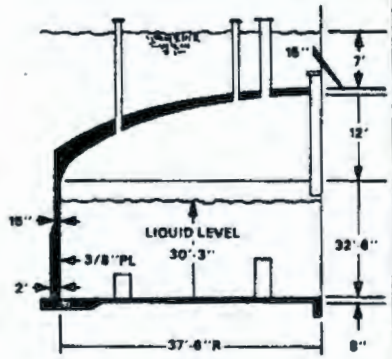
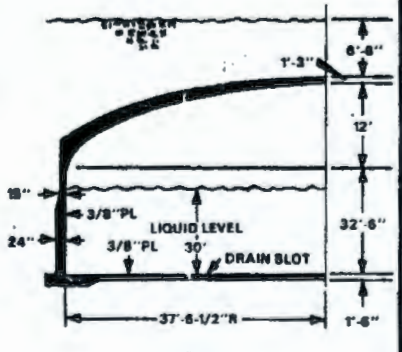
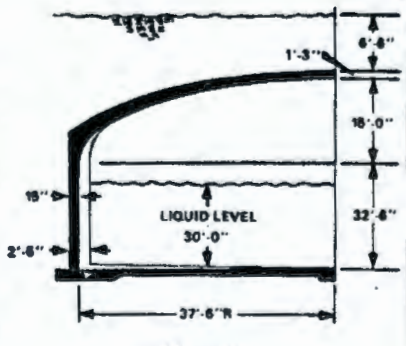
SPECIFIC GRAVITY	1.25		2.0	
MAXIMUM TEMPERATURE	250° F		250° F	
HEAT EVOLUTION (PER TANK)	10^6 BTU/HR (1 BTU/GAL/HR)		10^7 BTU/HR (10 BTU/GAL/HR)	
BOILING PERIOD	1 TO 5 YEARS		5 TO 10 YEARS	
VAPOR PRESSURE	NONE		NONE	
STORAGE WASTE VOLUME	~ 900 GAL/T		~ 80 GAL/T	
pH	8 TO 10		8 TO 10	
CORROSION	CONCRETE DOME EXPOSED TO VAPORS		CONCRETE DOME EXPOSED TO VAPORS	
SLUDGE	NO CONTROL OF SLUDGE TEMP.		NO CONTROL OF SLUDGE TEMP.	
CIRCULATION	AIR LIFT CIRCULATORS NON-REPLACEABLE		AIR LIFT CIRCULATORS NON-REPLACEABLE	
SPECIFIC GRAVITY	1.8		1.8	
MAXIMUM TEMPERATURE	250° F		250° F	
HEAT EVOLUTION (PER TANK)	10^7 BTU/HR (10 BTU/GAL/HR)		10^7 BTU/HR (10 BTU/GAL/HR)	
BOILING PERIOD	1 TO 5 YEARS		1 TO 5 YEARS	
VAPOR PRESSURE	NONE		-6 TO +6.0 IN H_2O GAGE	
STORAGE WASTE VOLUME	~ 80 GAL/T		~ 80 GAL/T	
pH	8 TO 10		8 TO 10	
CORROSION	CONCRETE DOME EXPOSED TO VAPORS		CONCRETE DOME NOT EXPOSED TO VAPORS	
SLUDGE	NO CONTROL OF SLUDGE TEMP.		NO CONTROL OF SLUDGE TEMP.	
CIRCULATION	AIR LIFT CIRCULATORS NON-REPLACEABLE		AIR LIFT CIRCULATORS NON-REPLACEABLE	

FIGURE 26. Characteristics of Wastes Used for Design of Boiling Waste Tanks

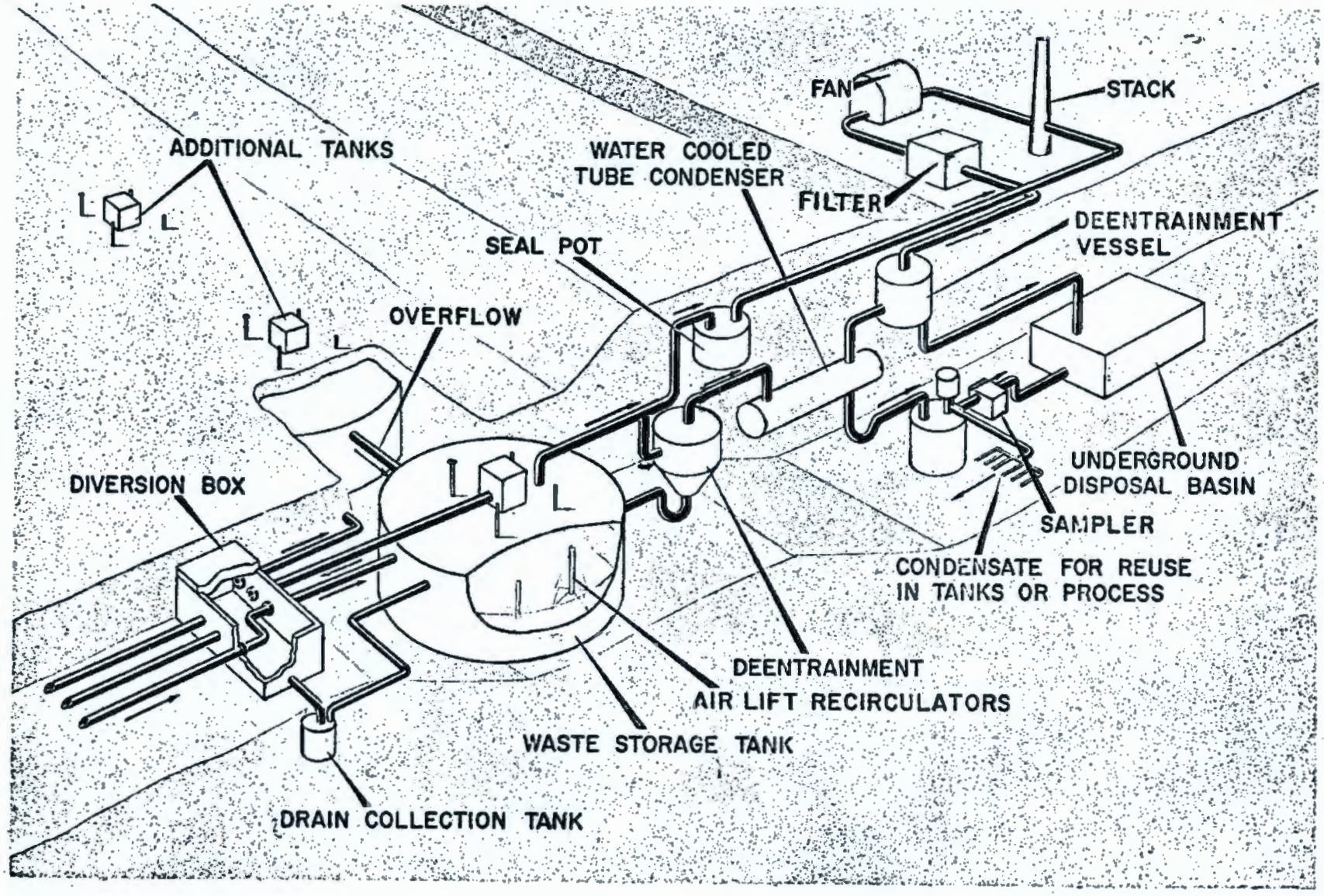


FIGURE 27. Typical High Level Waste Storage Facility

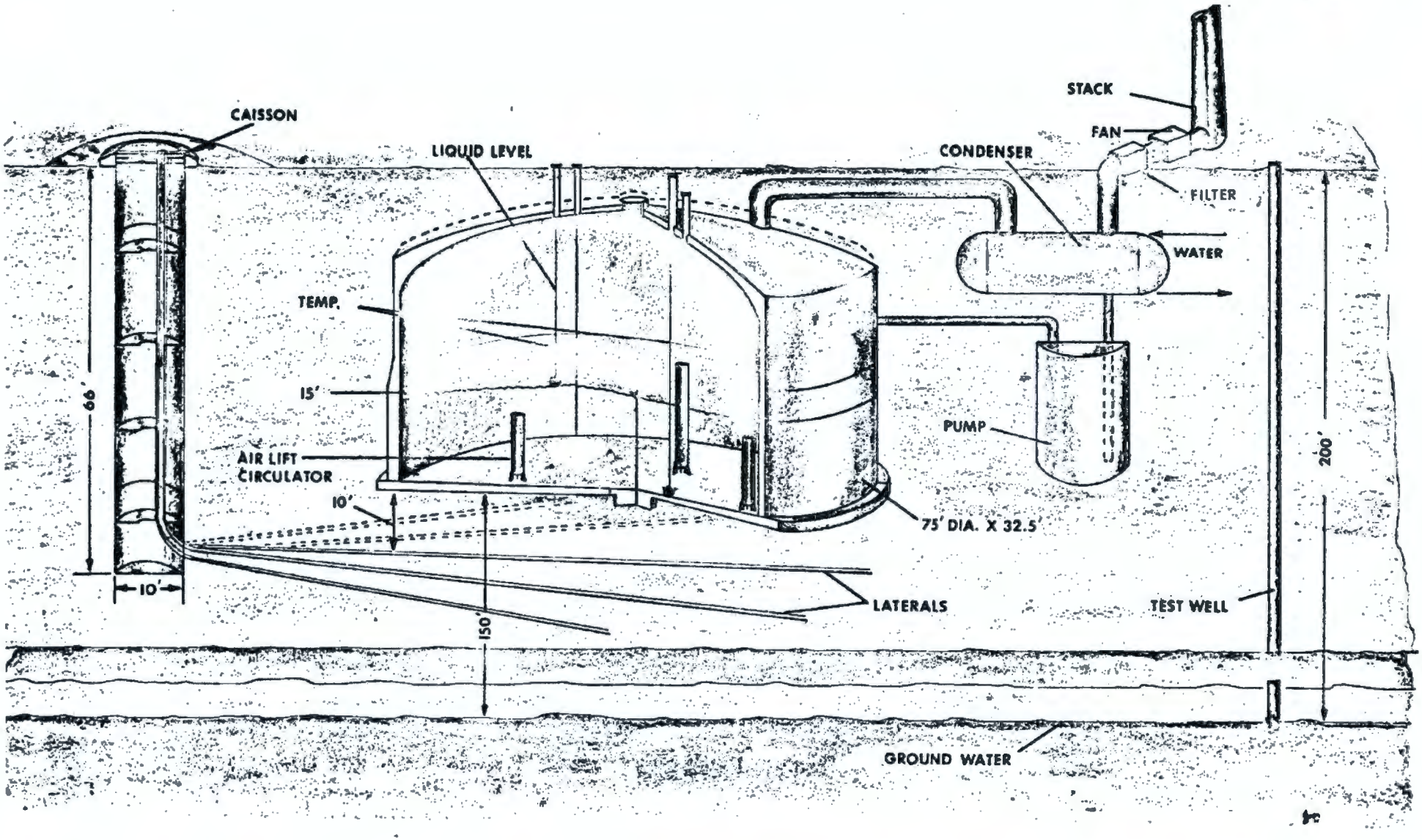


FIGURE 28. Control and Safety Features for High Level Radioactive Waste Storage

space between the concentric steel liners with liquid detection equipment. A temperature element, liquid level instrumentation, and a radiation detector are located in each well. Any leakage which might be detected can be removed by pumping. Two additional tanks (AZ tank farm) similar to the AY farm tanks are under construction.

Extensive piping interties exist within and between tank farms so it is possible to transfer liquid to or from any tank in the system.

More than five million cubic feet of contaminated solids have been buried on the 200 Area plateau since the start of chemical processing operations. These wastes consist of so-called "dry wastes" (soiled clothing, laboratory supplies, tools, etc.,--packed in cardboard, wood or metal containers) and industrial wastes (primarily items of failed process equipment packaged in heavy metal or concrete boxes). Transuranic bearing wastes have been packaged in sealed metal containers and segregated in the burial trenches since May 1, 1970.[8] In addition, a prototype concrete-lined V-trench is being tested for storing transuranic-bearing solid wastes. Contaminated solid wastes are buried in 19 sites on the 200 Area plateau using ~150 acres.[9] A typical solid waste burial trench is shown in Figure 29.

Large items of failed process equipment from the Purex Plant have been packaged, placed on railroad flat cars and stored in two tunnels. Figure 30 shows a schematic drawing of the newer tunnel used for this purpose. At present there are 15 cars in storage; the two tunnels have a capacity for 48 cars.

3.3.3 300 Area

The only storage facilities in the 300 Area are burial grounds and these are depicted in Figure 10. Prior to 1967, however, two other burial grounds, North and Wye, were used for disposal of mixed fission product and plutonium bearing wastes. These burial grounds are located several miles north and west of the 300 Area. A description of these sites is provided in Table 8.

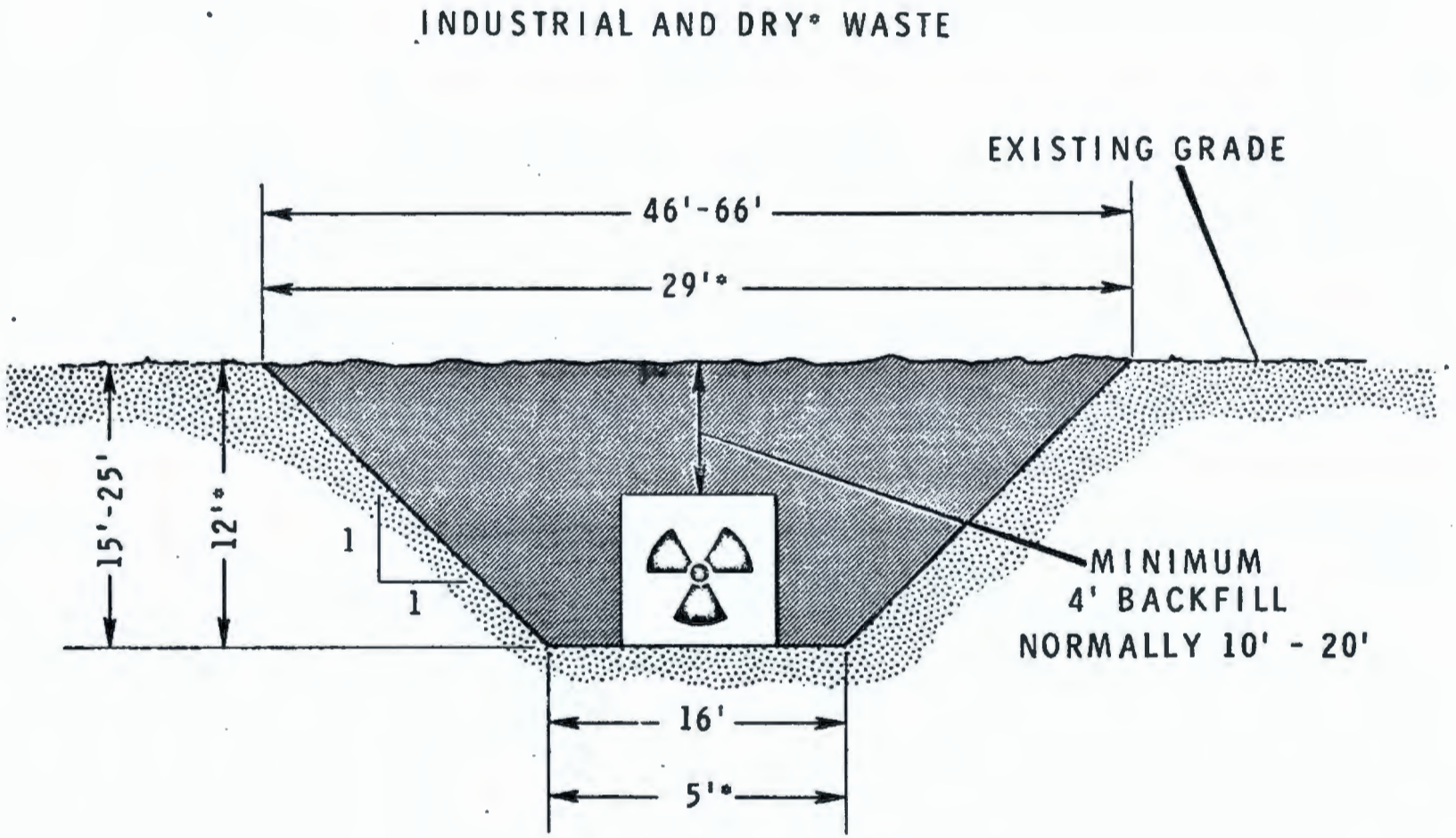


FIGURE 29. Solid Waste Burial Trenches

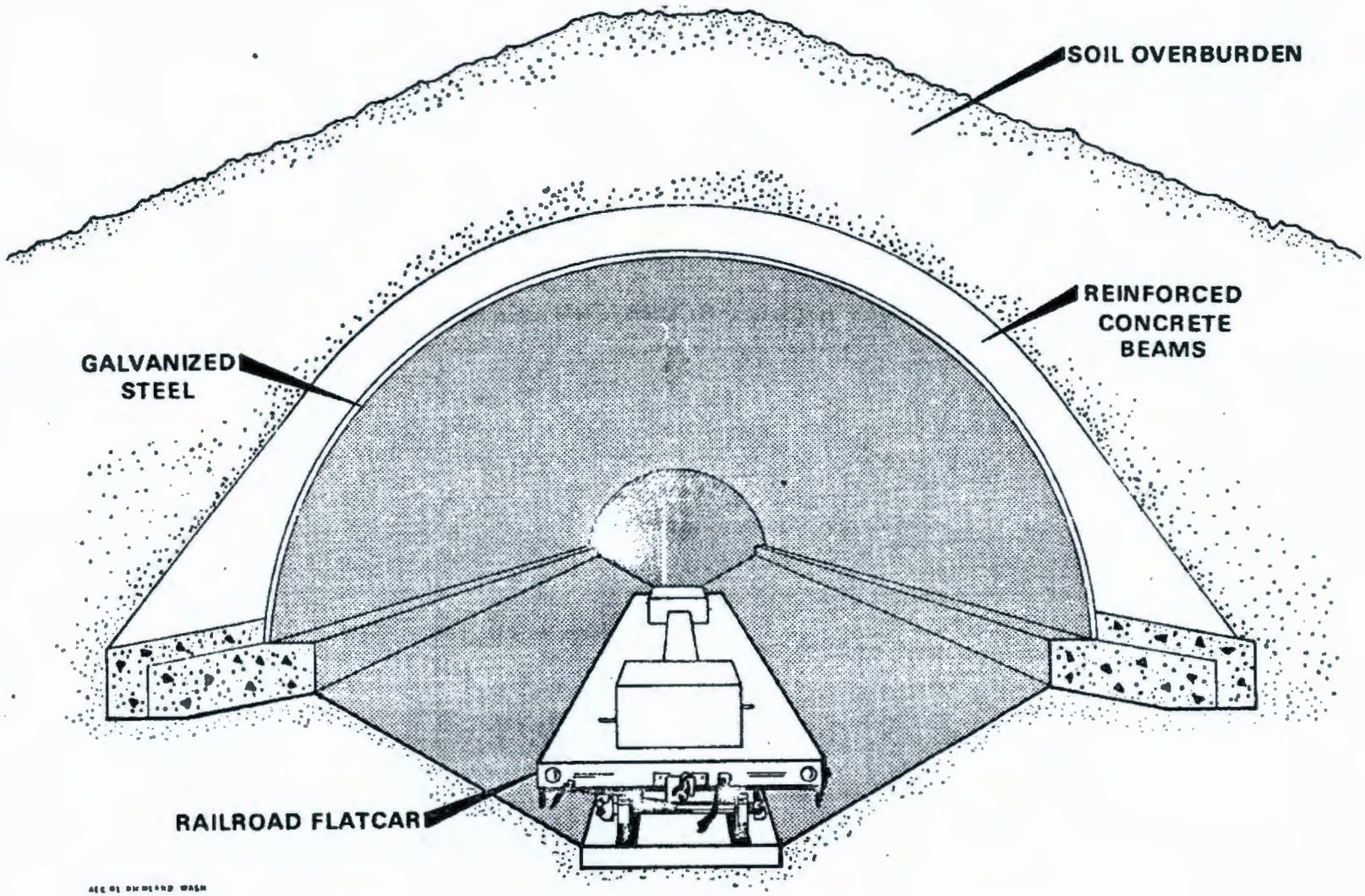


FIGURE 30. Tunnel for Storage of Radioactive Equipment

TABLE 8. North and Wye Burial Sites

Site Description	Status	Size Acres	Site Contents β-γ, Ci	Site Contents Pu, g
300 North Burial Ground	Retired - filled and marked. Broad spectrum of low- to high-level solid radioactive wastes, primarily fission products and plutonium. Cartoned low-level wastes were buried in trenches; medium- to high-level wastes in caissons or buried pipe facilities.	6.1	<2000	100-1000
300 Wye Burial Ground	Retired - filled and marked. Broad spectrum of low- to high-level solid radioactive wastes, primarily fission products and plutonium. Cartoned low-level wastes were buried in trenches; medium- to high-level caissons or buried pipe facilities.	8.6	<2000	1000-5000

3.4 Effluent Control Systems

3.4.1 N-Reactor - 100 Area

At N-Reactor the gross gamma radiation and gamma energies emanating from the water out of each process tube and the diversion system header are periodically measured and compared with similar measurements from adjacent tubes. This system is used primarily for detection of fuel ruptures. Based on signals from the monitoring system, water from any process tube can be diverted from the primary loop to a high pressure diversion system with direct disposal to the crib, while the reactor is being shut down to control the further release of fission products. The 1301-N crib then serves to retain those released fission products to prevent further migration to the environment. Effluent from the internal decontamination of the N-Reactor primary piping is routed to the 1310-N waste tank where it is then sent by tank car to the 200 Areas for disposal.

Gaseous Effluents. Gaseous effluents exhausted from 100-N ventilation stack have passed through high efficiency filters for particle removal and through charcoal for iodine removal. Filtering efficiency is about 99%+ and 95% for particulates and ^{131}I, respectively.

3.4.2 200 Areas

Liquid wastes from the 200 Areas are not discharged directly to the groundwater but rather to cribs and ponds where most of radionuclides are retained by the soil close to the surface at the discharge points.[2] Essentially all streams discharged in this manner are sampled by one of several methods--grab sample, batch sample, or continuous sample--in order to determine the quantities of radionuclides released. Monthly compositing of individual samples is done prior to analysis for specific radionuclides. Individual samples are analyzed daily for process control purposes. Discharge rates are measured or estimated by a variety of methods. Plans and cost estimates have been developed to provide more proportional sampling and flow measurement capability on critical streams.

On continuously discharged streams where the potential for radioactive release is significant, radiation detectors are provided which monitor either the main stream or a sample stream. Radiation recorders and alarms are also provided which sound an audible alarm in the dispatcher's office when the activity exceeds a predetermined amount. In many locations either manual or automatic diversion of the high activity stream to another location is possible. In the event of an incident where limits could be or are exceeded, operations would be shut down.

At B Plant, monitoring and limited diversion capabilities are provided on the Cell 23 process condensate (216-B-12 crib), steam condensate and cooling water from the B-Plant concentrators and other vessels which can be both heated and cooled (216-B-55 crib), and normal cooling water (216-B-3 pond via 207-B retention basin) effluent systems. The streams destined for the 216-B-12 and 216-B-55 cribs can be manually diverted to the Cell 23 concentrator feed tank for short periods of time if excessive radioactivity is detected.

The B-Plant cooling water that drains to the 207-B retention basis is collected in 15-inch and 24-inch sewer lines which join several hundred feet from the 221-B Building and continue to the retention basin as a single 24-inch line. Five subheaders and a line from TK-5-1 are normally

routed to the 15-inch sewer line although any of them may be routed to the 24-inch sewer line by opening a sectionalizing valve on the desired subheader. Each crossover line joining the individual subheaders and the line from TK-5-1 to the 15-inch sewer line is continuously monitored for gamma activity through a test riser. High radioactivity is indicated by an alarm in the dispatcher's office. The 15-inch sewer line is also continuously monitored at a manhole located inside a sample shack outside the 221-B Building. If activity is detected in the line, a diverter station upstream from the junction with the 24-inch sewer line automatically diverts this stream to the leaching trench (216-B-59). Cooling water from Cells 20 and 23 is routed directly into the 24-inch sewer line which is also continuously monitored at a manhole outside 221-B Building. However, the contents of the 24-inch sewer line flow directly to the retention basin with no diversion capability.

The 207-B retention basin, located northeast of the B Plant, consists of two 472,500-gallon basins. These basins are separated by an overflow divider that is 5-1/2 feet high. Each basin is equipped with a 16-inch outlet gate valve to either the emergency trench (216-B-63) or the 216-B-3 pond via the B-2 ditch. During normal operation, one basin is filling while the other is emptying. Each basin is sampled to determine whether to release it to the pond or the emergency trench. It is also necessary to measure the depth of water in the basin to determine the volume of each batch discharged. The total radioactivity in B Plant cooling water discharged to the ground each month is calculated using the total recorded volume discharged during the month and the analysis of the composite sample accumulated from each batch sample.

At the Purex Plant the cooling water stream to the 216-A-25 pond is monitored but no diversion capability exists. A monitor with a high-level alarm and jet cutoff has been installed on the ammonia scrubber effluent line to prevent the discharge of high radioactivity to the 216-A-36-B crib. When high radioactivity is detected by the monitor, the ammonia scrubber catch-tank jets are deactivated. The ranges for the automatic jets have been set to permit responsive action before the effluent overflows from

the catch tanks to the canyon sumps. Plans are underway to install monitoring capability of the steam condensate stream to the 216-A-30 crib.

In the tank farms, capability exists for monitoring the effluent stream from the A, AX, AY Tank Farm process condensate ion exchange column and the steam condensate stream from the A, AX, AY Tank steam coils, both of which normally flow to the 216-A-8 crib. In case of high radioactivity in the steam condensate stream it can be diverted automatically to the ion exchange feed tank. If high radioactivity occurs in the process condensate stream, the ion exchange column feed pump can be shut down and the condensate recycled to any of several boiling waste tanks until the problem is resolved. At the 244-AR Vault the combined cooling water and steam condensate stream is continuously monitored and can be diverted to the 216-A-40 trench rather than the 216-A-25 pond if high radioactivity is detected.

The A, AX, AY Tank Farm process condensate condenser coil cooling water stream is also continuously monitored. In case of high radioactivity from one condenser, its cooling load can be transferred to another condenser.

At Z Plant both the high salt waste normally routed to the 216-Z-18 crib and the low salt waste normally routed to the 216-Z-12 crib are sampled batchwise and can be recycled for reprocessing if the plutonium content is above desired limits. Cooling water, steam condensates, and similar low-level wastes from Battelle's operations in the 231-Z Building, in addition to that from Atlantic Richfield Hanford Company's Z Plant operations, are discharged to the 216-Z-19 ditch for routing to the 216-U-10 pond. It has been proposed that proportional sampling, flow measurement, and alpha monitoring capabilities be installed to improve control and accountability associated with this effluent stream.

In the 200 Areas engineered systems are provided to detect and/or limit quantities of radioactive gaseous effluents released to the atmosphere via stacks from the various processing facilities. As a minimum requirement, a portion of each effluent stream is sampled continuously by

passing it through a paper filter which can be changed periodically and analyzed in the laboratory for deposited radioactivity. Where the potential for radioactive releases is more significant, a radiation detector is also provided which monitors either the continuous sampler filter paper or a separate filter paper installed for this purpose. Radiation recorders and alarms are also provided and when the activity exceeds a predetermined amount an audible alarm sounds in a continuously occupied operation's office. In the event of an incident where limits could be or are exceeded, operations would be shut down. In nearly all locations the alarm setting is at a level known to be well below release limits, based on past experience rather than on precise calibration. The monitors are periodically tested for response to specific radionuclides. Planning is presently underway for the development of calibration methods using traceable standards.

3.4.3 300 Area

Waste water diverters are provided at the 324, 325 and 307 facilities. At the 324 and 325 Buildings, normally clean cooling water which because of equipment failure could contain multicurie amounts of radioactivity are monitored prior to release to the retention sewer. If radioactivity were detected these streams would be automatically diverted to a 17,000-gallon holding tank. The contents of that tank could be passed through an ion exchange bed or discharged to the area-wide contaminated waste system depending upon the actual amount of radioactive material present. Waste water, normally free of radioactive material but flowing from facilities where accidental contamination is possible, is monitored prior to entry into the 307 basins. Normally the water is pumped from the basins to the process sewer and flows to the 300 Area ponds. This stream is called retention waste since the water would be retained in the basins by automatic shutdown of the pumps when radioactivity is detected. The radioactive water can be transferred to the contaminated waste system by a second pumping system. The monitors are capable of diverting waste water containing beta or gamma emitting nuclides at concentrations of 5×10^{-5} μCi/cc.

Where radioactive materials may become airborne, particulate matter is normally removed from exhaust air by two high-efficiency particulate air (HEPA) filter banks in series and where appropriate, gaseous radioiodine is collected on charcoal absorbers. Where the amount of radioactive material which might become airborne is small ($\sim$1 μCi) only one HEPA filter may be provided.

3.5 Site Administration Limits on Effluents

Table 9 provides a summary of AEC-RL Manual Chapter 0510 Waste Disposal Release Guides.

The release guides are based on extrapolation from actual release measurements and extensive assessment of environmental consequences. The release guides were an estimate of the release rate which could result in an exposure to a hypothetical individual in the environs who could receive an annual dose equal to that allowed by AEC Manual Chapter 0524 Standards for Radiation Protection Appendix Section II.A., because his assumed location or habits caused his exposure to be maximum. This approach was found to be more limiting than the alternate of averaging exposure among a suitable sample of persons in the environs.

Proportioning among the several release points was accomplished by assigning the release guide to the facilities whose normal operation released the nuclide being evaluated. Other contributors of the same nuclide (300 Area laboratories, for example) were limited to one-tenth of the theoretical amount necessary to cause the limiting effect. Thus, if all facilities were simultaneously releasing a particular nuclide at release guide rates, the exposure to the individual in the environs with hypothetical maximizing habits might have exceeded the applicable limit. Experience indicated that simultaneous releases did not occur. However, in order to avoid such a circumstance, normal release rates were limited to one-tenth of the release guide and actual experience has been smaller.

The release guides have not been adjusted to reflect the reduction in plutonium production which greatly reduced the releases from those facilities which were the major contributors at the time the release

TABLE 9. Summary of AEC-RL Manual Chapter 0510 Waste Disposal Release Guides

Liquid Wastes

Open Ponds <5 × 10^{-5} μCi/ml

Underground - 200 Area Cribs only - <100 μCi/ml

Surface Stream - Columbia River - N Reactor Only

^{32}P	100 Ci/mo
^{131}I	20 Ci/mo
^{76}As	1000 Ci/mo
^{239}Np	2000 Ci/mo
^{51}Cr	5000 Ci/mo

Gaseous Wastes

100 Area	200-ft Stack (Ci/wk)	Short Stack (Ci/wk)
^{90}Sr	1 × 10^{-1}	1 × 10^{-2}
^{131}I	3	3 × 10^{-1}
Pu	1 × 10^{-3}	1 × 10^{-4}
U (nat)	4 × 10^{-3}	4 × 10^{-4}
Total of all others except ^{3}H, ^{14}C and N.G.	2	2 × 10^{-1}

200 Area	200-ft Stack (Ci/wk)	Short Stack (Ci/wk)
^{90}Sr	1	1 × 10^{-1}
^{131}I	30*	3
Pu (total)	1 × 10^{-2}	1 × 10^{-3}
U (nat)	4 × 10^{-2}	4 × 10^{-3}
Total of all others except ^{3}H, ^{14}C and N.G.	20	2

300 Area	150-ft Stack (Ci/wk)	Short Stack (Ci/wk)
^{90}Sr	5 × 10^{-2}	1 × 10^{-2}
^{131}I	2 × 10^{-1}	2 × 10^{-1}
Pu	5 × 10^{-3}	1 × 10^{-3}
U	2 × 10^{-2}	4 × 10^{-3}
Total of all others except ^{3}H, ^{14}C and N.G.	10	2

* Must not exceed 500 Ci/quarter year from all sources in 200 Areas.

guides were calculated. Since the remaining facilities have demonstrated their ability to conform to release guides which are more restrictive than necessary to meet the original objective, there are no plans to adjust release guides upward.

4. RADIOACTIVE WASTES STORED

4.1 High-Level Waste

High-level radioactive waste inventory informaton is provided in Tables 1 and 2 of the classified addendum. The data shown for the end of FY71 are actual experience, and subsequent values are predicted based on the anticipated progress of the Hanford High-Level Liquid Radioactive Waste Management Program.[10] The waste is segregated according to program activity areas and its physical nature. The radionuclide inventories of the non-boiling and In-Tank Solidification (ITS) bottoms sludges are estimated.

For boiling waste the sludge, supernate, and radionuclide inventories begin depletion in late FY72 and continue through FY74. Sludge and supernates bearing significant concentrations of strontium and cesium are removed from the tanks for strontium and cesium extraction in B Plant. The denuded waste materials are then routed to the ITS System for conversion to a salt cake.

In non-boiling wastes the supernate is continuously being depleted by converting it to a salt cake in the ITS System for waste immobilization. This volume reduction will continue past FY74 until essentially all non-boiling liquid has been immobilized. The volume of the sludge in non-boiling waste remains essentially constant. The changes in this volume in FY72 and FY73 are due to the conversion of non-boiling waste tanks to ITS bottoms tanks.

The inventory of sludge and radionuclides continuously builds up in the ITS solids system due to the conversion of current and aged non-boiling and B Plant liquid wastes to salt cake. This program will continue past FY74.. The liquid and associated radionuclide inventory in the solidification system is an operating inventory. It may fluctuate up or down depending on how many bottoms tanks are on line, the rate of salt cake fill of the bottoms tanks, and when and how many bottoms tanks are brought on line. In FY72, 73 and 74 there is a significant increase in inventory due to bringing new bottoms tanks on line. Then the inventory decreases due to filling these tanks with salt cake.

4.2 Solid Radioactive Waste

4.2.1 100 Areas

General information, unit costs and a cost analysis on solid radioactive wastes in the 100 Areas are provided in Tables 10, 11, and 12.

4.2.2 200 Areas

General and cost information on solid radioactive wastes for the 200 Areas are provided in Tables 13, 14, and 15.

A significant estimated period-to-period change in the waste generation rate is indicated for the last half of FY 1972. The increased volume over the prior and following six month periods (20,000 to 23,000 cubic feet; a change of approximately 50 percent) is due to contaminated soil generated from the restoration of an incident site and the accelerated disposal of accumulated, failed or obsolete equipment from the Purex Plant.

4.2.3 300 Area

Solid waste information for the 300 Area is provided in Table 16. The volumes shown in Table 16 are for informational purposes only since they are included in the 200 Area totals.

4.3 Other Radioactive Materials

4.3.1 100 Areas

The reactor cooling water effluent from each of the single pass production reactors carried very low concentrations of long-lived radionuclides (^{60}Co, ^{90}Sr, ^{137}Cs, ^{152}Eu, and ^{239}Pu). These were deposited in the soil surrounding the 107 retention basins and at some places along the 5-ft diameter effluent water lines where leaks occurred. Radionuclide deposition also occurred in the soil at the bottom of the overflow trenches and the outfall structures. The contaminated soil column alongside and under these locations is known to extend a foot or more, possibly several hundred feet. Studies are proposed to investigate and characterize the extent to which the radionuclides have migrated. In addition, each reactor block contains unknown, but substantial quantities of ^{14}C in the graphite and ^{60}Co in the

TABLE 10. Radioactive Solid Waste - 100 Areas

	FY 1971		FY 1972		FY 1973		FY 1974
	July-Dec.	Jan.-June	July-Dec.	Jan.-June	July-Dec.	Jan.-June	
1. Generating Organization DUN and BNW							
2. Generation Rate, ft^3							
FP/IA Contaminated	25,695	23,573	22,049	18,508	18,250	18,250	36,500
U Contaminated	--	--	--	--	--	--	--
TRU Contaminated	--	--	--	--	--	--	--
Total	25,695	23,573	22,049	18,508	18,250	18,250	36,500
3. Volume, ft^3 Treated by[U]							
Compaction Reduction Factor							
Incineration Reduction Factor							
Other (List Reduction Factor							
Total Input for Volume Reduction							
4. Storage/Burial							
Location							
Acreage Utilized	0.3	0.2	0.2	0.15	0.15	0.15	0.3
Cumulative	64.1	64.3	64.5	64.65	64.8	64.95	65.2
Volume Buried/Stored, ft^3							
FP/IA Contaminated	25,695	23,573	22,049	18,508	18,250	18,250	36,500
Cumulative	1,086,664	1,110,237	1,132,286	1,150,794	1,169,044	1,187,294	1,223,794
U Contaminated							
Cumulative							
TRU Contaminated							
Cumulative							
Total	25,695	23,573	22,049	18,508	18,250	18,250	36,500
Cumulative	1,086,664	1,110,237	1,132,286	1,150,794	1,169,044	1,187,294	1,223,794
Total Curies as Buried	3,209	3,409	3,400	3,000	3,000	3,000	6,000
Cumulative Curies as Buried	2×10^6	2×10^6	2×10^6	2×10^6	2×10^6	2×10^6	2×10^6
Cumulative Curies with Decay Correction	35,000	34,000	33,000	32,000	32,000	31,000	30,000
Estimated Range for Packages							
Gross Beta-Gamma, Ci							
Alpha, Ci							
Radiation Level, mrem/hr							
Estimated Typical Value for Packages							
Gross Beta-Gamma, Ci	1-500 mCi		1-500 mCi		1-500 mCi		1-500 mCi
Alpha, Ci	none		none		none		none
Radiation Level, mrem/hr	1-5000 mrem/hr		same		same		same
Principal Contributors of Activity (Nuclide)	^{60}Co, ^{65}Zn, ^{59}Fe, ^{54}Mn		^{60}Co, ^{59}Fe, ^{54}Mn		same		same
Total Pu, g Cumulative	None Buried in 100 Areas						
Total U, kg Cumulative	None Buried in 100 Areas						

TABLE 11. Radioactive Solid Waste - Unit Costs - 100 Areas

DUN	FY-1971	FY-1972	FY-1973	FY-1974
Unit Costs ($/ft^3)				
For Treated Wastes				
Compaction				
Incineration				
Other Treatment				
For Untreated Wastes				
Packaging and Handling				
For All Solid Wastes				
Freight Shipping Charges(1)				
Storage/Burial	$0.40	$1.22	$0.65	$0.53
BNW (100-F)				
Unit Costs ($/ft^3)				
For Treated Wastes				
Compaction				
Incineration				
Other Treatment				
For Untreated Wastes				
Packaging and Handling	$0.44	$0.66	$0.70	$0.70
For all Solid Wastes				
Freight Shipping Charges				
Storage/Burial				

1. Shipping costs are included in burial costs and are not listed separately.

TABLE 12. Radioactive Solid Waste - 100 Areas Storage/Burial Cost Analysis Report

Fiscal Year 1971
Organization - Douglas United Nuclear, Inc.
Budget & Reporting Classification 02-10-01-20

($ in 000,s)

Elements	Input, ft^3	Direct Labor, Man-Years	Direct Labor, $	Current Maintenance	Other Direct Costs	Indirect Costs	Technical Support	Total Fund Cost	Depreciation	Total Costs
1. Receiving and Handling										
2. Monitoring and Measurement										
3. Storage or Burial		0.05	$1	$11		$3	$3	$18	$4	$22
4. Environmental Monitoring		0.10	2			1	2	5		5
TOTAL	68,343		$3	$11		$4	$5	$23	$4	$27

	Fund	Total
Cost ($) Allocated to Transuranic Waste	--	--
Cost ($) Allocated to Nontransuranic Waste	$23	$27
Unit Cost ($)/($ft^3$)	$ 0.34	$ 0.40

TABLE 12. (contd)

Fiscal Year 1972
Organization - Douglas United Nuclear, Inc.
Budget & Reporting Classification 02-10-01-20

($ in 000,s)

Elements	Input, ft^3	Direct Labor, Man-Years	Direct Labor, $	Current Maintenance	Other Direct Costs	Indirect Costs	Technical Support	Total Fund Cost	Depreciation	Total Costs
1. Receiving and Handling										
2. Monitoring and Measurement										
3. Storage or Burial		0.05	$1	$40(1)		$11	$3	$55	$4	$59
4. Environmental Monitoring		0.10	2			1	2	5		5
TOTAL	52,250	0.15	$3	$40		$12	$5	$60	$4	$64

	Fund	Total
Cost ($) Allocated to Transuranic Waste	--	--
Cost ($) Allocated to Nontransuranic Waste	$60	$64
Unit Cost ($)/($ft^3$)	$ 1.15	$ 1.22

(1) Charges for additional fill over deactivated burial pits

TABLE 12. (contd)

Fiscal Year 1973
Organization - Douglas United Nuclear, Inc.
Budget & Reporting Classification 01-04-01-1

($ in 000,s)

Elements	Input, ft^3	Direct Labor, Man-Years	Direct Labor, $	Current Maintenance	Other Direct Costs	Indirect Costs	Technical Support	Total Fund Cost	Depreciation	Total Costs
1. Receiving and Handling										
2. Monitoring and Measurement										
3. Storage or Burial		0.05	$1	$15(1)		$5	$3	$24	$4	$28
4. Environmental Monitoring		0.10	2			1	2	5		5
TOTAL	50,500	0.15	$3	$15		$6	$5	$29	$4	$33

	Fund	Total
Cost ($) Allocated to Transuranic Waste	--	--
Cost ($) Allocated to Nontransuranic Waste	$29	$33
Unit Cost ($)/($ft^3$)	$ 0.58	$ 0.65

(1) Charges for additional fill over deactivated burial pits

TABLE 12. (contd)

Fiscal Year 1974
Organization - Douglas United Nuclear, Inc.
Budget & Reporting Classification 01-04-01-1

($ in 000,s)

Elements	Input, ft^3	Direct Labor, Man-Years	Direct Labor, $	Current Maintenance	Other Direct Costs	Indirect Costs	Technical Support	Total Fund Cost	Depreciation	Total Costs
1. Receiving and Handling										
2. Monitoring and Measurement										
3. Storage or Burial		0.05	$1	$10		$4	$3	$18	$4	$22
4. Environmental Monitoring		0.10	2			1	2	5		5
TOTAL	50,500	0.15	$3	$10		$5	$5	$23	$4	$27

	Fund	Total
Cost ($) Allocated to Transuranic Waste	--	--
Cost ($) Allocated to Nontransuranic Waste	$23	$27
Unit Cost ($)/($ft^3$)	$ 0.46	$ 0.53

TABLE 12. (contd)

Fiscal Year 1971
Organization - PNL
Budget & Reporting Classification Overheads

($ in 000,s)

Elements	Input, ft^3	Direct Labor, Man-Years	Direct Labor, $	Current Maintenance	Other Direct Costs	Indirect Costs	Technical Support	Total Fund Cost	Depreciation	Total Costs
1. Receiving and Handling				0						
2. Monitoring and Measurement				0						
3. Storage or Burial			$17(2)	0						
4. Environmental Monitoring			(3)	0						
TOTAL	16,043		$17	0		$53		$53		$70

	Fund	Total
Cost ($) Allocated to Transuranic Waste	--	--
Cost ($) Allocated to Nontransuranic Waste	--	$70
Unit Cost ($)/($ft^3$)	--	$ 0.44

(2) By work order to services contractor

(3) Fraction of the Hanford Environmental Surveillance Program not specifically identified.

TABLE 12. (contd)

Fiscal Year 1972
Organization - PNL
Budget & Reporting Classification Overheads

($ in 000,s)

Elements	Input, ft^3	Direct Labor, Man-Years	Direct Labor, $	Current Maintenance	Other Direct Costs	Indirect Costs	Technical Support	Total Fund Cost	Depreciation	Total Costs
1. Receiving and Handling				0						
2. Monitoring and Measurement				0						
3. Storage or Burial			$17(2)	0						
4. Environmental Monitoring			(3)	0						
TOTAL	8307		$17	0		$38		$15	0	$55

	Fund	Total
Cost ($) Allocated to Transuranic Waste	--	--
Cost ($) Allocated to Nontransuranic Waste	--	$55
Unit Cost ($)/($ft^3$)	--	$ 0.66

(2) By work order to services contractor.

(3) Fraction of the Hanford Environmental Surveillance Program not specifically identified.

TABLE 12. (contd)

Fiscal Year 1973 (same for 1974)
Organization - PNL
Budget & Reporting Classification 01-04-01-01-1

($ in 000,s)

Elements	Input, ft^3	Direct Labor, Man-Years	Direct Labor, $	Current Maintenance	Other Direct Costs	Indirect Costs	Technical Support	Total Fund Cost	Depreciation	Total Costs
1. Receiving and Handling										
2. Monitoring and Measurement										
3. Storage or Burial			$11 (2)							
4. Environmental Monitoring			(3)							
TOTAL	6000		$11			$31		$42		$42

	Fund	Total
Cost ($) Allocated to Transuranic Waste	--	--
Cost ($) Allocated to Nontransuranic Waste	--	$42
Unit Cost ($)/($ft^3$)	--	$ 0.70

(2) By work order to services contractor.

(3) Fraction of the Hanford Environmental Surveillance Program not specifically identified.

TABLE 13. Radioactive Solid Waste - 200 Areas

	FY 1971		FY 1972		FY 1973		FY 1974
	July-Dec.	Jan.-June	July-Dec.	Jan.-June	July-Dec.	Jan.-June	
1. Generating Organization ARHCO, BNW, HEDL, JAJ & Offsite[1]							
2. Generation Rate, ft^3							
FP/IA Contaminated	55,935	69,790	52,009	73,500	54,000	47,500	97,500
U Contaminated	--	--	--	--	--	--	--
TRU Contaminated	14,043	18,459	14,377	16,500	11,500	11,000	20,500
Total	69,978	88,249	66,386	90,000[2]	65,500	58,500	118,000
3. Volume, ft^3 Treated by							
Compaction					2,300	11,500	25,500
Reduction Factor					3/1	3/1	3/1
Incineration							
Reduction Factor							
Other (List)							
Reduction Factor							
Total Input for Volume Reduction					2,300	11,500	25,500
4. Storage/Burial							
Location 200 Areas							
Acreage Utilized	1.98	3.37	1.43	2.64	1.97	1.72	3.48
Cumulative	144.59	147.96	149.39	152.03	154.0	155.72	159.20
Volume Buried/Stored, ft^3[3]							
FP/IA Contaminated	55,935	69,790	52,009	73,500	54,000	47,500	97,500
Cumulative	5,015,585	5,085,375	5,137,384	5,211,000	5,265,000	5,312,500	5,410,000
U Contaminated[4]	--	--	--	--	--	--	--
Cumulative	--	--	--	--	--	--	--
TRU Contaminated	14,043	18,459	14,377	16,500	11,500	11,000	20,500
Cumulative[5]	19,480	37,939	52,316	69,000	80,500	91,500	112,000
Total	69,978	88,249	66,386	90,000	65,500	58,500	118,000
Cumulative	5,035,065	5,123,314	5,189,700	5,280,000	5,345,200	5,403,700	5,521,700
Total Curies as Buried	19,000	9,000	6,000	13,000	10,000	10,000	21,000
Cumulative Curies as Buried	852,000	861,000	867,000	880,000	890,000	900,000	921,000
Cumulative Curies with Decay Cor.[6]	118,000	119,000	120,000	122,000	123,000	124,000	127,000
Estimated Range for Packages							
Gross Beta-Gamma, Ci/ft^3	0 to 60	same	same	same	same	same	same
Alpha, Ci/ft^3	0 to 0.5	same	same	same	same	same	same
Radiation Level, mrem/hr	0 to 300,000	same	same	same	same	same	same
Estimated Typical Value for Packages							
Gross Beta-Gamma, Ci/ft^3	0.1	same	same	same	same	same	same
Alpha, Ci/ft^3	0.002	same	same	same	same	same	same
Radiation Level, mrem/hr	30	same	same	same	same	same	same
Principal Contributors of Activity (Nuclide) Pu isotopes, Am & Mixed fission products							
Total Pu (g)	2,150	2,050	1,850	2,000	1,800	1,500	3,100
Cumulative	360,050	362,100	363,950	365,950	367,750	369,250	372,350
Total U, kg, 200 Areas	120	1,030	90	1,000	100	1,000	1,100
Cumulative	585,300	586,330	586,420	587,420	587,520	588,520	589,620

1. ARHCO provides burial service.
2. Includes 14,000 ft^3 of contaminated soil from incident site restoration (cleanup)
3. See item 4a for volume breakdown by waste generator.
4. U contaminated waste buried in the 200 Areas is included in FP/IA and TRU; data for the last half of FY 1972. forward represent forecasted burials in the 300 Area burial grounds.
5. Cumulative values represent TRI volume since segregation was initiated in CY 1970.
6. Decayed curies do not include ~195,000 curies of tritium, ~1500 curies of ^{60}Co (as of 12/31/71); also, ~6500 curies in the Purex tunnels (as of 12/31/71).

TABLE 13. (contd)

	FY 1971		FY 1972		FY 1973		FY 1974
	July-Dec.	Jan.-June	July-Dec.	Jan.-June	July-Dec.	Jan.-June	
4a. Volume Buried Stored (ft^3) (Breakdown by Waste Generator)							
ARHCO:							
FP/IA	37,601	40,852	30,983	55,000	35,500	29,500	61,000
TRU	11,638	12,608	10,745	10,000	8,500	5,500	11,500
Total	49,239	53,460	41,728	65,000	44,000	35,000	72,500
JA Jones:							
FP/IA	6,210	13,338	13,617	10,250	10,250	10,250	20,500
TRU	193	200	153	125	125	125	250
Total	6,403	13,538	13,770	10,375	10,375	10,375	20,750
BNW:							
FP/IA	4,255	9,206	2,693	3,000	3,000	3,000	6,000
TRU	1,025	2,155	2,439	2,200	2,200	2,200	4,400
Total	5,280	11,361	5,132	5,200	5,200	5,200	10,400
WADCO:							
FP/IA	7,869	6,127	4,716	5,000	5,000	5,000	10,000
TRU	1,187	1,000	976	1,000	1,000	1,000	2,000
Total	9,056	7,127	5,692	6,000	6,000	6,000	12,000
DUN							
FP/IA	0	267	0	25	25	25	50
U	--	--	--	10,000	10,000	10,000	20,000
TRU	0	15	64	0	0	0	0
Total	0	283	64	10,025	10,025	10,025	10,025
Offsite:							
EP/IA	0	0	0	15	0	0	0
TRU	0	2,481	0	3,280	0	2,480	2,480
Total	0	0	0	3,295	0	0	2,480
Totals (Data Rounded Starting Fy 1972 Jan.-June)							
U				10,000	10,000	10,000	20,000
FP/IA	55,935	69,790	52,009	73,500	54,000	47,500	97,500
TRU	14,043	18,459	14,377	16,500	11,500	11,000	20,500
Total	69,978	88,249	66,386	100,000	75,500	68,500	138,000

TABLE 14. Radioactive Solid Waste - Unit Costs - 200 Areas

	FY 1971		FY 1972		FY 1973		FY 1974
	July-Dec.	Jan.-June	July-Dec.	Jan.-June	July-Dec.	Jan.-June	
Unit Costs ($/ft^3)							
For Treated Wastes[1]							
Compaction	$	$	$	$	$ 3.51	$ 2.96	$ 2.75
Incineration							
Other Treatment							
For Untreated Wastes(1)							
Packaging and Handling	2.13	2.20	2.25	2.28	2.40	2.32	2.25
For All Solid Wastes							
Freight Shipping Charges	0	0	0	0	0	0	0
Storage/Burial	0.82	0.82	0.82	0.82	1.06	1.06	1.10

1. For Treated and Untreated Waste calculations only ARHCO-generated volumes were used.

TABLE 15. Radioactive Solid Waste - 200 Areas - Storage/Burial Cost Analysis Report

Fiscal Year 1971
Organization - Atlantic Richfield Hanford Co.
Budget & Reporting Classification 01-04-01-01-1

($ in 000s)

Elements	Input ft^3	Direct Labor Man-Years	Direct Labor $	Current Mainten-ance	Other Direct Costs	Indirect Costs	Technical Support	Total Fund Cost	Depre-ciation	Total Costs
1. Receiving and Handling		1.1	$11	$	$22	$20	$	$ 53	$3	$ 56
2. Monitoring and Measurement		0.3	3		3	4		10		10
3. Storage/Burial		1.9	19	2	19	23		63		63
TOTAL	158 228	3.3	$33	$2	$44	$47	$	$126	$3	$129

	Fund	Total
Cost Allocated to Transuranic Waste	$ 26	$ 27
Cost Allocated to Nontransuranic Waste	$100	$102
Unit Cost/ft^3	$ 0.80	$ 0.82

FY 1972 through FY 1974 are in FY 1972 dollars

TABLE 15. (contd)

Fiscal Year 1972
Organization - Atlantic Richfield Hanford Company
Budget & Reporting Classification 01-04-01-01-1

($ in 000s)

Elements	Input ft^3	Direct Labor Man-Years	Direct Labor $	Current Mainten-ance	Other Direct Costs	Indirect Costs	Technical Support	Total Fund Cost	Depre-ciation	Total Costs
1. Receiving and Handling		1.1	$11	$	$22	$20	$	$ 53	$4	$ 57
2 Monitoring and Measurement		0.3	3		3	4		10		10
3. Storage/Burial		2.0	19	2	23	26		70		70
TOTAL	166 000	3.4	$33	$2	$48	$50	$	$133	$4	$137

	Fund	Total
Cost Allocated to Transuranic Waste	$ 25	$ 26
Cost Allocated to Nontransuranic Waste	$108	$111
Unit Cost/ft^3	$ 0.80	$ 0.82

FY 1972 through FY 1974 are in FY 1972 dollars

TABLE 15. (contd)

Fiscal Year 1973
Organization - Atlantic Richfield Hanford Company
Budget & Reporting Classification 01-04-01-01-1

($ in 000s)

Elements	Input ft^3	Direct Labor Man-Years	Direct Labor $	Current Mainten-ance	Other Direct Costs	Indirect Costs	Technical Support	Total Fund Cost	Depre-ciation	Total Costs
1. Receiving and Handling		1.3	$13	$	$26	$23	$	$ 62	$4	$ 66
2. Monitoring and Measurement		0.5	5		6	7		18		18
3. Storage/Burial		2.0	20	3	26	29		78		78
TOTAL	153 000	3.8	$38	$3	$58	$59	$	$158	$4	$162

	Fund	Total
Cost Allocated to Transuranic Waste	$ 25	$ 26
Cost Allocated to Nontransuranic Waste	$133	$136
Unit Cost/ft^3	$ 1.03	$ 1.06

FY 1972 through FY 1974 are in FY 1972 dollars

TABLE 15. (contd)

Fiscal Year 1974
Organization - Atlantic Richfield Hanford Company
Budget and Reporting Classification 01-04-01-01-1

($ in 000s)

Elements	Input ft^3	Direct Labor Man-Years	Direct Labor $	Current Mainten-ance	Other Direct Costs	Indirect Costs	Technical Support	Total Fund Cost	Depre-ciation	Total Costs
1. Receiving and Handling		1.4	$14	$	$27	$24	$	$ 65	$5	$ 70
2. Monitoring and Measurement		0.5	5		7	7		19		19
3. Storage/Burial		2.2	22	3	27	31		83		83
TOTAL	155 000	4.1	$41	$3	$61	$62	$	$167	$5	$172

	Fund	Total
Cost Allocated to Transuranic Waste	$ 25	$ 26
Cost Allocated to Nontransuranic Waste	$143	$146
Unit Cost/ft^3	$ 1.08	$ 1.10

FY 1972 through FY 1974 are in FY 1972 dollars

TABLE 16. Radioactive Solid Waste - 300 Area

	FY 1971		FY 1972		FY 1973		FY 1974
	July-Dec.	Jan.-June	July-Dec.	Jan.-June	July-Dec.	Jan.-June	
1. Generating Organization							
DUN (ARHCO Custody)							
2. Generation Rate, ft^3							
FP/IA Contaminated							
U Contaminated	21,789	13,329	13,000	10,000	10,000	10,000	20,000
TRU Contaminated							
Total	21,789	13,329	13,000	10,000	10,000	10,000	20,000
3. Volume, ft^3 Treated by							
Compaction							
Reduction Factor							
Incineration							
Reduction Factor							
Other (List)							
Reduction Factor							
Total Input for Volume Reduction							
4. Storage/Burial							
Location 300 Area							
Acreage Utilized			0.3	0.3	0.3	0.3	0.6
Cumulative	17	17	17.3	17.6	17.9	18.2	18.8
Volume Buried/Stored, ft^3							
FP/IA Contaminated							
Cumulative							
U Contaminated	21,789	13,329	13,000	10,000	10,000	10,000	20,000
Cumulative	760,838	774,167	787,167	797,167	807,167	817,167	837,167
TRU Contaminated							
Cumulative							
Total	21,789	13,329	13,000	10,000	10,000	10,000	20,000
Cumulative	760,838	774,167	787,167	797,167	807,167	817,167	837,167
Total Curies as Buried	1×10^{-4}	1×10^{-4}	1×10^{-4}	1×10^{-4}	1×10^{-4}	1×10^{-4}	1×10^{-4}
Cumulative Curies as Buried	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Cumulative Curies with Decay Correction	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Estimated Range for Packages							
Gross Beta-Gamma, Ci	0.01 to 1.0 mCi		same		same		same
Alpha, Ci							
Radiation Level, mrem/hr	Not Detectable		same		same		same
Estimated Typical Value for Packages							
Gross Beta-Gamma, Ci	0.05 μCi		same		same		same
Alpha, Ci							
Radiation Level, mrem/hr	Not Detectalbe		same		same		same
Principal Contributors of Activity (Nuclide)	Uranium up to 2.1% enriched		same		same		same
Total Pu, g	none	none	none	none	none	none	none
Cumulative	none	none	none	none	none	none	none
Total U, kg	3	2	3	2	3	2	5
Cumulative	230	232	235	237	240	242	247

thermal shield cast iron blocks which also must be characterized. The estimated radioactivity and configurations are given in Figures 11 through 16.

4.3.2 200 Areas

Available radionuclide distribution data on a number of cribs indicate that approximately 99 percent of the radionuclides of concern (e.g., ^{90}Sr, ^{137}Cs) for long-term surveillance are contained in the first 30 feet of soil beneath the crib bottom.[11-14] As of December 31, 1971, cribs in the 200 Areas contain approximately 68 kilocuries of ^{90}Sr and ^{137}Cs (decayed value) and 300 kilograms of plutonium. Removal of 99 percent of these radioisotopes would require removal of an estimated 104 million cubic yards of overburden and 11.5 million cubic yards of contaminated soil.[4]

The 11.5 million yards of contaminated soil include an estimated 2 million cubic yards of highly contaminated soil located near the crib surface, 9 million cubic yards of moderately contaminated soil, and 0.5 million cubic yards of soil contaminated with plutonium (Z Plant cribs) and uranium. A recent study[4] indicates that removal of contaminated soil from all cribs may not be required.

Approximately ten curies of mixed fission products were retained in the 216-S-207 retention basin in 1954 from Redox Plant coil leaks.[15] Use of the basin was discontinued in 1954 and the concrete surfaces were subsequently covered with ~125,000 cubic feet of soil. It is estimated that <1 curie of long-lived ^{90}Sr and ^{137}Cs remains in the basin. The contamination is associated with the concrete vice the covering soil.

Sludges which have accumulated in other basins are periodically removed and buried as solid wastes.

Essentially all of the radionuclides discharged to ditches and ponds are contained in sediments on the bottoms. It is estimated that removal of dirt to a depth of approximately 3 feet would be required to remove the major quantity (~99%) of the radioactivity present.[11] As of December 31, 1971, ponds and ditches contain approximately 2000 curies of

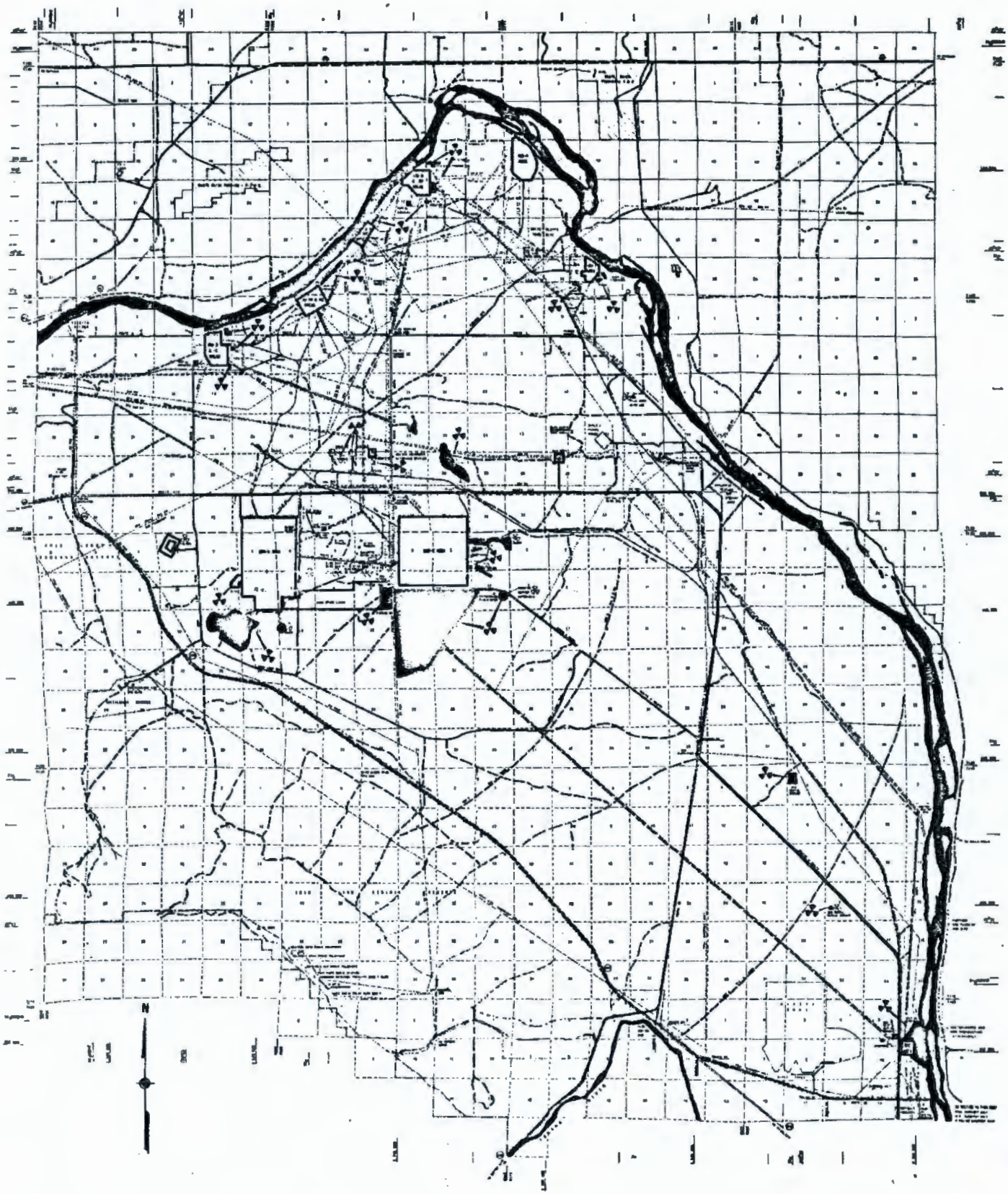
^{90}Sr and ^{137}Cs and 9 kilograms of plutonium. Removal of approximately 31 million cubic yards of earth would be required for restoration of these areas.

Radioactivity discharged to the soils from line leaks and spills totals approximately 9300 curies of mixed fission products plus 12,000 curies of ^{137}Cs and 360 curies of ^{90}Sr.[15-17] The major discharges occurred in 1968 and 1969 when two waste transfer lines failed. Removal of approximately 0.5 million cubic yards of earth would be required for restoration of these areas.[4]

The estimated radioactivity and configurations of contaminated areas which are within the 200 Areas are shown in Figures 17 and 18. Contaminated areas outside of the limited areas are shown in Figure 31.

4.3.3 300 Area

A leak in the transfer line from the 307 retention basins to the 340 contaminated waste system was discovered December 9, 1969.[18] The failure occurred in a line intended to carry only mildly contaminated waste from the retention waste system which would not pass standards for disposal at the 300 Area. Because of relative elevation of the transfer line and the contaminated waste sewer, the bottom half of a short carbon steel transition section was eroded away and contaminated waste leaked to the soil. At the time of discovery, approximately 900 curies of short-lived radionuclides (mainly ^{147}Pm) and 10 curies each of ^{90}Sr and ^{137}Cs were present in the soil column beneath the leak. Greater than 90% of the contamination is believed to be confined within a cylindrical section of earth approximately 25 feet deep and 12 feet in diameter (see Figure 10).



PNM-530

FIGURE 31. Radioactive Waste Storage Sites Outside Limited Areas

5. PLANS AND BUDGET PROJECTIONS

5.1 Interim Storage of High-Level Liquid Waste

5.1.1 Summary and Milestone Chart

The Hanford Waste Solidification Program calls for the conversion of stored and currently generated high-level wastes from liquids to less mobile salt cakes before December 31, 1975. Prior to this conversion, the high-level liquid wastes containing significant quantities of ^{90}Sr and ^{137}Cs are processed in B Plant, the waste fractionization facility, for removal of these radioisotopes. The ^{90}Sr and ^{137}Cs products are stored in B Plant prior to encapsulation. Figure 32 is a block diagram showing the major points of the solidification program.[10] Some of these processes are currently in operation and some are still in the development, design, or construction state.

Currently two in-tank solidification (ITS) systems are in operation; ITS-1 and 2 in the 200 East Area and the 242-T Evaporator in the 200 West Area. The primary functions of the ITS units are to concentrate the non-boiling waste currently being generated so that no new tankage is required, and to produce the less mobile salt cake. Ideally, the feed stream would be concentrated as far as possible so the inventory of concentrated bottoms is minimized and the maximum amount of solids would be formed and dropped out. Each of the ITS systems contains an evaporator and a series of bottoms tanks (bottoms loop). After concentration in the evaporator, the bottoms stream is routed through the bottoms loop. Heat losses to ground and the tank ventilation systems progressively lower the bottoms temperature so that eventually the stream is saturated and solids are formed and deposited in the bottoms tanks. The saturated bottoms supernatant stream is blended with fresh feed and recycled back to the evaporator. Figures 33, 34 and 35 provide schematics of the ITS No. 1, ITS No. 2 and 242-T Evaporator systems.[19-21] These existing units are atmospheric evaporators and while the boil-off is generally adequate for space recovery considerations, they are not capable of efficient operation as the waste feed approaches the saturation concentration. Thus, the amount of solidification that can be performed with these units is limited.

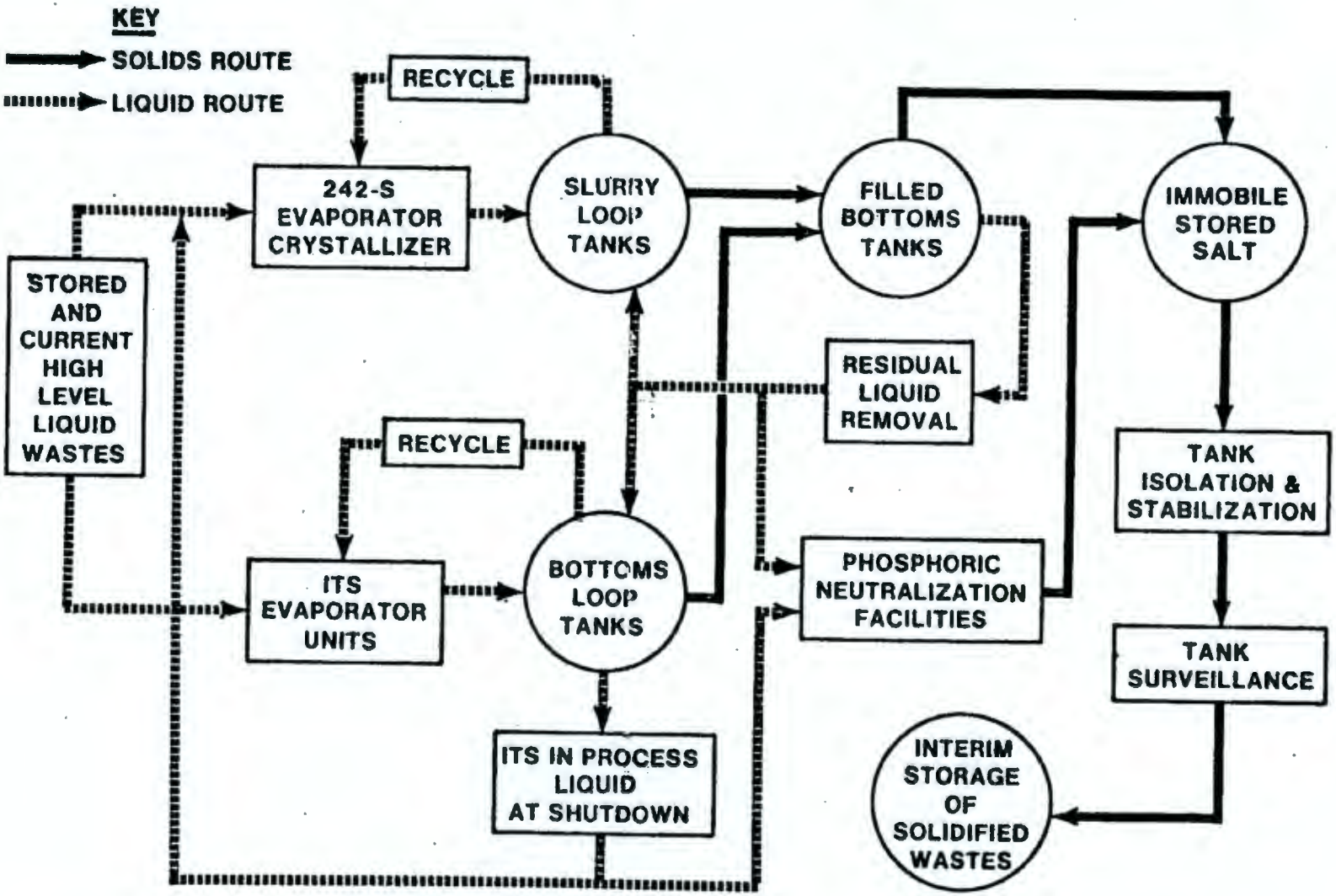


FIGURE 32. Hanford Waste Solidification Program

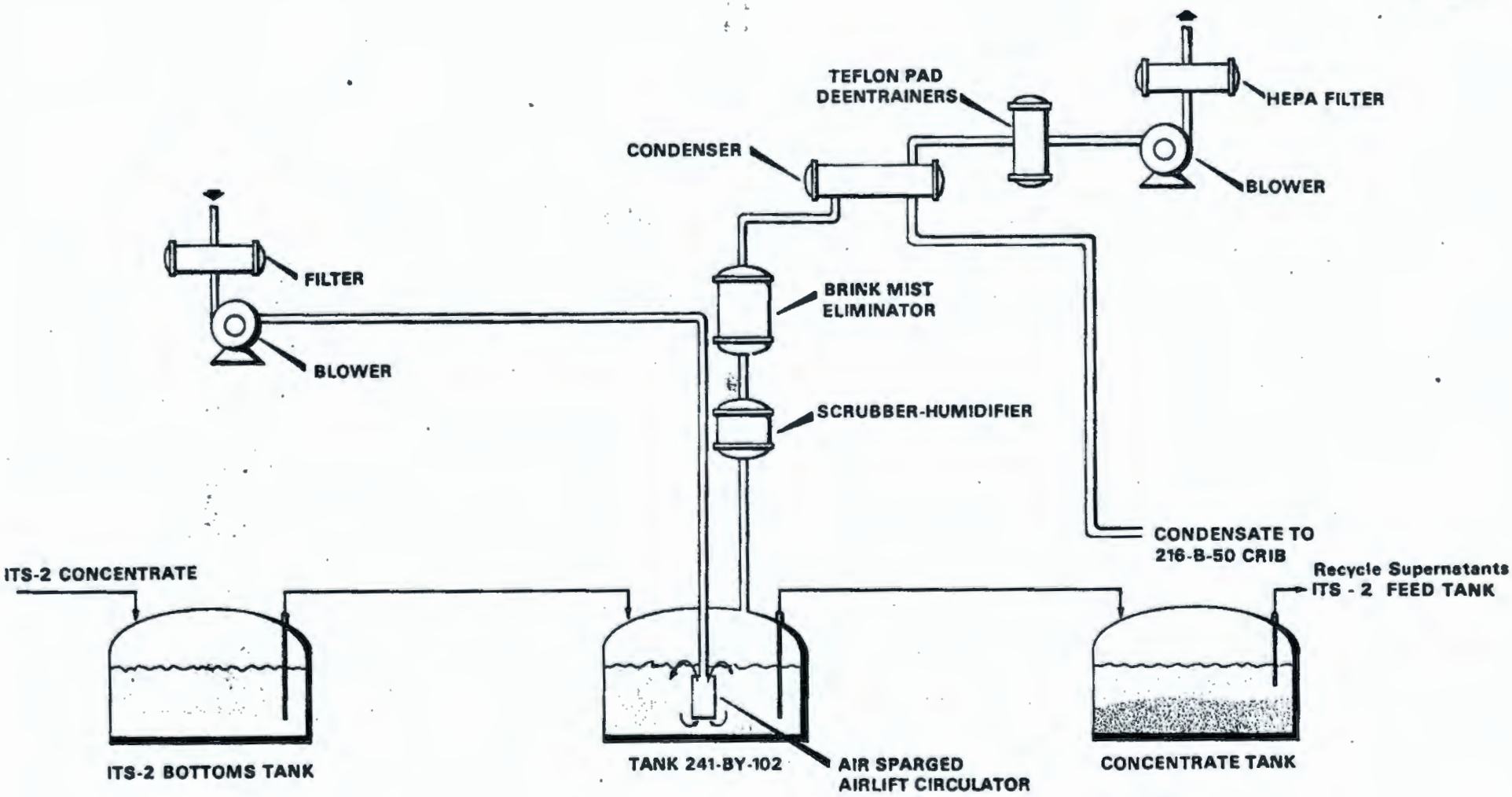


FIGURE 33. ITS-1 Schematic

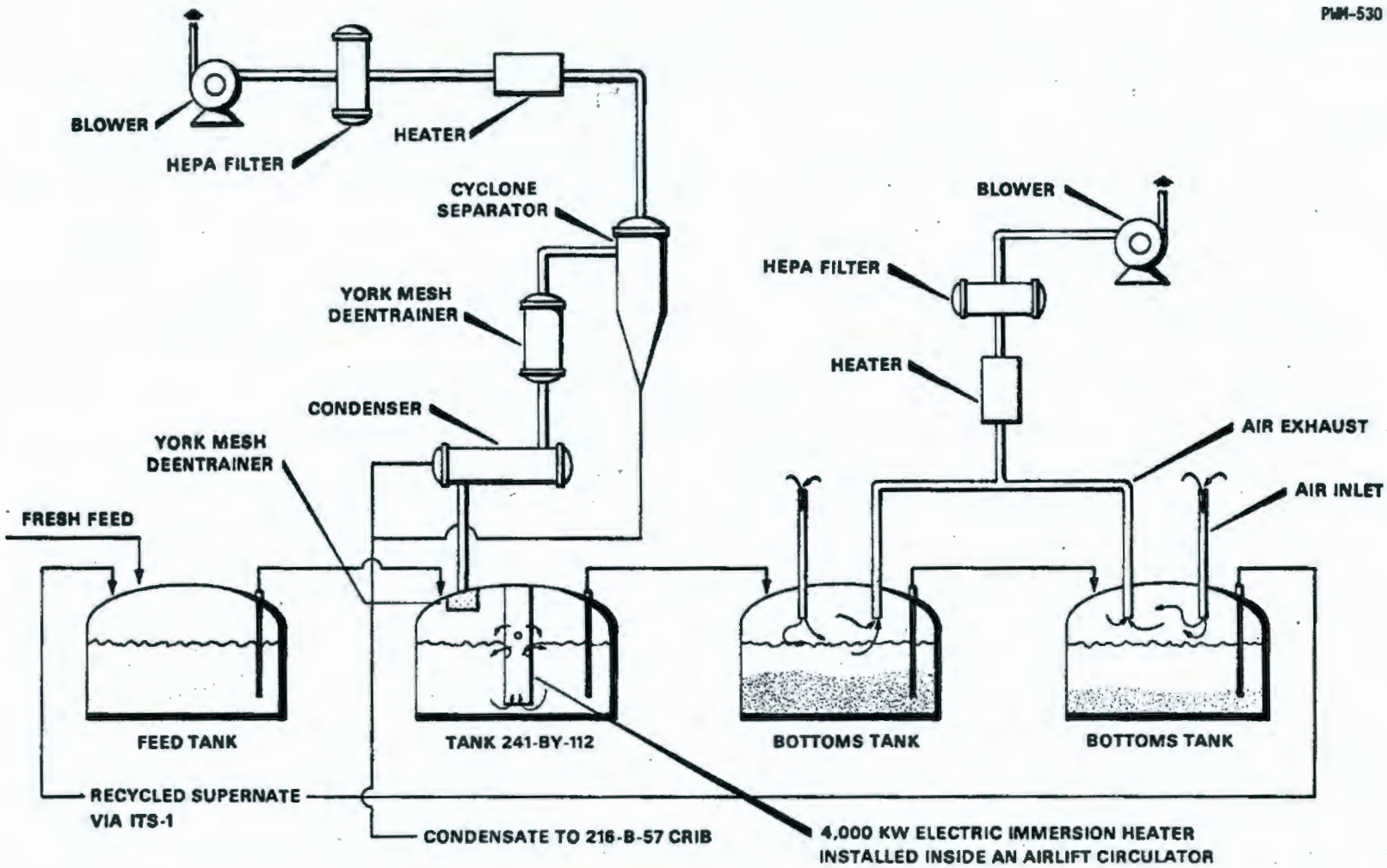


FIGURE 34. ITS-2 Schematic

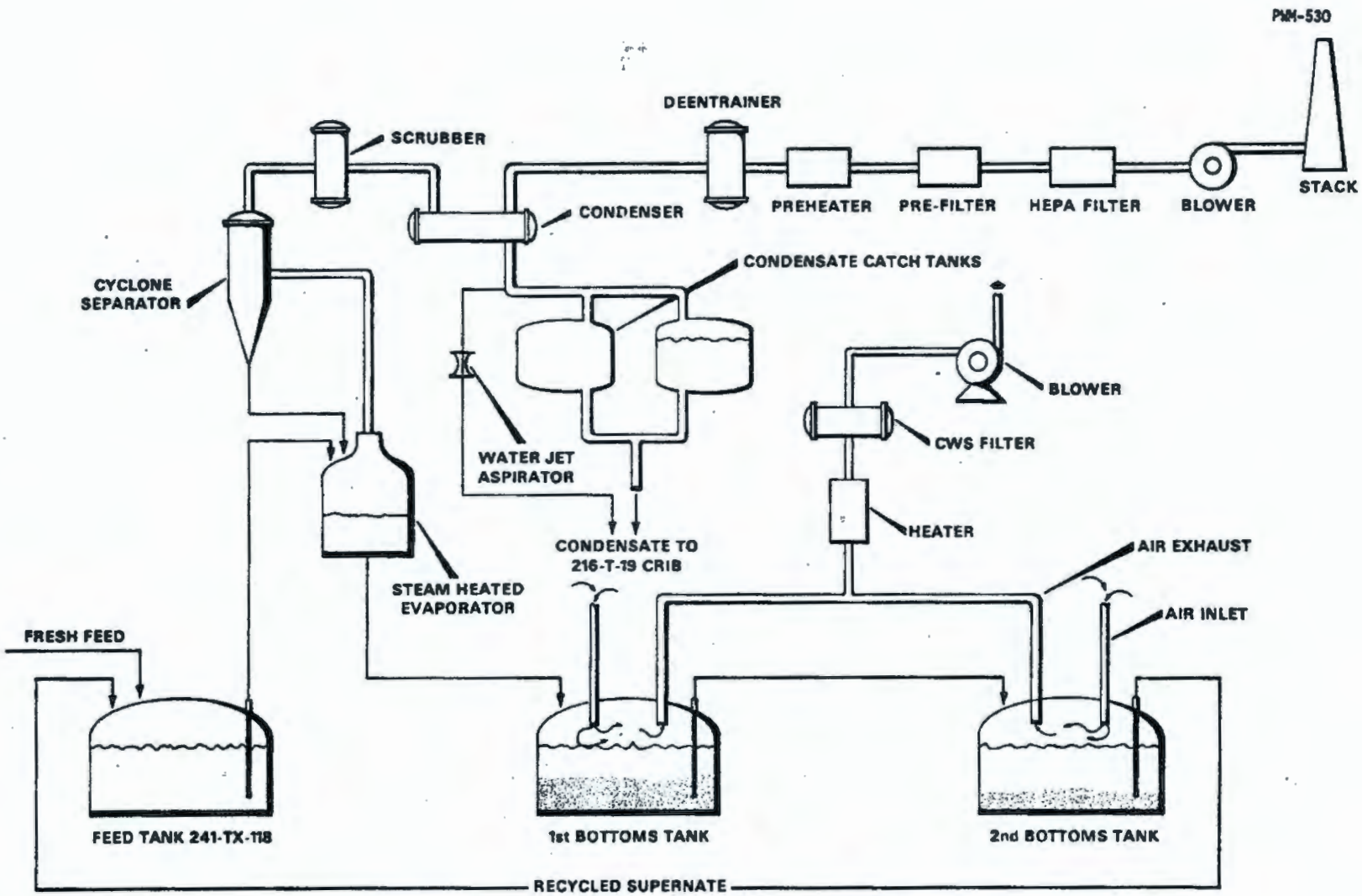


FIGURE 35. 242-T Evaporator Schematic

The 242-S vacuum evaporator-crystallizer now under construction in the 200 West Area will operate at reduced pressure (0.8 psia) and temperature and will be capable of achieving a larger degree of solidification with the higher caustic (boiling point) wastes. The evaporator is designed to produce a slurry containing 25 to 30% solids which is routed to a series of settling tanks. The supernatant is returned to the evaporator for additional concentration.

When the bottoms tanks are filled with solids and removed from the bottoms loop, they contain residual supernatant as interstitial liquor equal to approximately 30% of the salt cake volume. Before the tank can be considered safe for storage with a minimum of surveillance, the major portion of this liquid must be removed since the integrity of the tank liner and shell cannot be assumed for any long period. The current program for accomplishing this liquor removal is via the installation of screened well points (salt wells) to the bottom of the tanks. This method is currently in use. However, to date, the pumping end point as determined by the minimum practical volume of remaining liquid in the waste tank has not been established.

The saturated liquors pumped via salt wells from filled bottoms tanks will be routed for further concentration in the ITS units or the 242-S evaporator-crystallizer. After the solidification of high-level liquid wastes is on a current basis (prior to 12/31/75), the ITS units will be shut down and deactivated. The 242-S evaporator-crystallizer will continue operation through at least FY 1980 to solidify current wastes and wastes contained in the ITS bottoms loop at the time of their shutdown. Some of the concentrated wastes from the bottoms loop will be routed to the 242-S evaporator-crystallizer for additional concentration while the remaining wastes will be solidified in place by the addition of phosphoric acid.

The salt cakes produced from the ITS units have not as yet been extensively characterized. Differential thermal analysis is routinely performed on ITS feeds; the absence of exotherms in the feed and salt

cake analyses indicates the salt cakes should be thermally stable to the temperatures expected. In addition, techniques are being developed to reliably core sample typical product salt cakes so that characteristics such as: residual moisture, fission product content and distribution, thermal conductivity, and thermal and radiation stability can be further defined.

After removal of the liquid from the salt cakes the tanks must be isolated to prevent liquid additions to the tanks where stabilization is in progress or completed. Isolation normally involves the following operations:

1. All liquid lines into and out of the tank are cut and capped or blanked.
2. Adequate tank ventilation is installed.
3. All remaining risers are sealed.

Salt cake in stabilized waste tanks must be sufficiently immobile that the eventual loss of integrity of the storage tank does not result in significant migration of the radioactive material. The collapse of the tank dome must be prevented so that the tank contents will not be exposed. The stored solidified wastes must be stable at the expected storage conditions of temperature and pressure.

Safety analyses of near surface underground salt cake storage have demonstrated the acceptability of the concept provided the above conditions are met.[22]

Stabilized tanks will be sampled for characterization analyses and monitored for a period of time to ensure the stability of the solids in the tanks. The criteria for this characterization and surveillance are currently being developed. The following items are being considered:

Characterization

1. Analysis and documentation of the tank radionuclides and chemical contents.
2. Determination of residual moisture contents.

3. Measurement of the solids heat generation rate and thermal conductivity, both "as sampled" and dried.
4. Stability of the solids as a function of temperature and radiation exposure--tendencies to liquify and/or evolve gases or radionuclides will be investigated.

Monitoring

1. Solids temperatures will be monitored until equilibrium is reached and/or safety is ensured.
2. Selected tank solids will be periodically photographed and/or sampled to detect changes in moisture content and solids form.
3. The vapor space of selected tanks will be monitored and/or sampled to ensure that hazardous gases and radionuclides are not evloved.

Figure 36 provides a management planning guide for the In-tank Solidification Program at Hanford.

5.1.2 Expected Accomplishments - FY 1973

The major accomplishments expected in 1973 cover the general areas of ITS systems, 242-S systems, phosphoric acid neutralization, filled bottoms tanks, immobilization-stabilization, tank surveillance, waste fractionization and encapsulation. These items encompass the Hanford Waste Solidification Program, and there are several milestones concerned with each item prerequisite to the successful achievement of the Program.

5.1.2.1 ITS Systems. In FY 1973, a significant reduction in the total beta activities discharged to 200 East Area cribs is planned by the ion exchange treatment of the ITS-2 evaporator condensate. Improvements are expected in the evaporation rate from the ITS-1 unit by relocating its position via line routings of ITS-1 in the bottoms loop. A precise liquid level monitoring system will be installed in the tank farms to provide improved assurance of waste tank integrity; coupled with this monitoring system is a computerized data acquisition system which will provide timely interpretation of the liquid level readings. Construction will be completed on the ITS systems bottoms tanks, HCP-657. This construction finalizes all tanks necessary for the bottoms loops from the 242-T and ITS-1 and 2 units.

Milestone Chart Key

No.	
1	ITS Bottoms Tank Construction, HCP-657
2	242-S Evaporator-Crystallizer and Bottoms System (S, SX Farm), HCP-655
3	Demonstration of Phosphoric Neutralization - BX Farm
4	242-S Evaporator-Crystallizer Attainment of 20 gpm Average Boiloff Rate
5	Demonstrate Acceptable Interstitial Liquid Removal From Salt Filled Waste Tanks
6	Ion Exchange Treatment of ITS-2 Condensate
7	Relocate ITS-1 Position in ITS-2 Bottoms Loop
8	Install Liquid Level Monitoring System Including Computerized Data Output
9	Test Parameters on Pilot Crystallizer
10	Demonstrate Salt Core Sampling Methods
11	Establish Surveillance Guidelines for Interim Storage
12	Stabilization and Isolation of Leaking Tanks
13	Construction of AZ Farm Tanks, HAP-647
14	Encapsulation Plant Construction, HAP-631
15	Demonstration Cooler Evaluation
16	Isolation and Stabilization of Tanks Filled with Salt in FY-1972
17	242-S Bottoms Tank Construction, U Farm
18	242-S Slurry Transport Line to TX, TY
19	Z-Plant Aqueous Waste to 242-T
20	200-E Encasement Replacement of Direct-Buried Lines
21	Isolation and Stabilization of Tanks Filled with Salt in FY-1973
22	All Seven SX Tank Sludges Being Air Cooled
23	Cesium-137 Recovered in B-Plant From Stored Waste (PSN)
24	Cesium-137 Recovered in B-Plant From Purex Sluicing Supernatants (PSS)
25	Isolation and Stabilization of Tanks Filled with Salt in FY-1974
26	Beneficial Use of U Farm Bottoms Tanks for 242-S system
27	Isolation and Stabilization of Nonbottoms Tanks Containing Sludges and Salt Cakes

Milestone Chart Key

No.	
28	Strontium-90 Recovered in B-Plant From Purex Sludges
29	Strontium-90 Recovered in B-Plant From CAW
30	Cesium-137 Recovered From Current Acid Waste (CAW)
31	Z-Plant Aqueous Waste Routed to 242-S
32	Isolation and Stabilization of Tanks Filled with Salt in FY-1975
33	Beneficial Use of Slurry Line, 242-S to TX, TY Farms
34	Curtail Operation of ITS Systems
35	In-Tank Solidification of High-Level Waste on a Current Basis
36	Phosphoric Acid Neutralization Facilities, 200-E and 200-W Areas
37	Beneficial Use of Phosphoric Acid Neutralization Facilities, 200-E and 200-W Areas
38	Surveillance Testing Development Completed
39	Surveillance Equipment Installed in All Bottoms Tanks
40	Isolation and Stabilization of All Bottoms Tanks
41	Encapsulation of Cs and Sr on Current Basis
42	Isolation and Stabilization Including Surveillance in All Nonboiling Tanks

FISCAL YEAR	1973	1974	1975	1976	1977	1978	1979
START OF MAJOR PROJECTS AND PROGRAMS		17, 18		36			
KEY INTERIM ACCOMPLISHMENTS IN THE COURSE OF MAJOR PROJECTS AND PROGRAMS	4, 6, 7, 8, 16	19, 20, 21, 22	25	31			
COMPLETION OF MAJOR PROJECTS AND PROGRAMS	1, 2, 12, 13, 14	23, 24	26, 27, 28, 29, 30	32, 33, 34, 35, 37		39, 40, 41	42
ACHIEVEMENT OF SIGNIFICANT TECHNICAL DECISIONS	3, 5, 9, 10, 11, 15			38			

XX MILESTONES ESSENTIAL TO ACHIEVEMENT OF AEC COMMITMENT

XX OTHER MILESTONES

FIGURE 36. Planning Guide - Management of High-Level Liquid Wastes Milestone Chart

5.1.2.2 242-S Systems. Test runs are in progress on the pilot crystallizer evaporator which were devised to investigate operating parameters for the 242-S system. This pilot unit should provide technology and training needed for successful operation of the 242-S evaporator-crystallizer. Construction will be completed on the 242-S evaporator-crystallizer and associated bottoms tanks in S and SX tank farms so that startup is expected in June 1973. It is expected that a 20-gallon a minute average condensate rate will be achieved on the unit before the end of 1973.

5.1.2.3 Phosphoric Acid Neutralization. Construction of the prototype phosphoric acid facility will be completed and demonstration of the chemical reaction between phosphoric acid and evaporator recycle will be accomplished. It is expected that this facility will be the model for the operating units to be constructed later in the program in 200 East and West Areas.

5.1.2.4 Filled Bottoms Tank Projects. It is estimated that about four bottoms tanks will be filled with salt from the ITS units. The salt well demonstration on Tank 116-TX will have completed pumping all the practical amount of residual liquor so that the efficiency and operability of this method of interstitual mother liquor removal can be evaluated or studied further.

5.1.2.5 Immobilization and Isolation. The stabilization and isolation of the tanks which have leaked in the past will be completed. The prototype core sampling equipment will have been demonstrated in salt located in Tank 116-TX.

5.1.2.6 Tank Surveillance. Guidelines will have been developed for the tank surveillance program. Some equipment will have been demonstrated to assure stabilization for the interim storage period.

5.1.2.7 Encapsulation. Construction should be completed by April 1973 on the Encapsulation Plant.

5.1.2.8 Waste Fractionization. Completion and beneficial use of Tank 102-AZ will occur in late FY 1973. Tank 101-AZ will be held in a partial state of construction pending any possible future use.

5.1.3 Expected Accomplishments - FY 1974

5.1.3.1 ITS Systems. It is expected that the interplant waste transfer system, HAP-666, will be completed providing replacement of some direct-buried lines in the 200 East Area for transporting high-level non-boiling waste between tank farms. Also, facilities will be constructed to transport Z Plant aqueous waste to the 242-T Evaporator vice the discharge to cribs.

5.1.3.2 Filled Bottoms Tank Projects. It is estimated that nine bottoms tanks will be filled with salt from the 242-S evaporator and ITS units. These tanks will be set aside for immobilization and stabilization purposes.

5.1.3.3 242-S Systems. Construction will begin on two projected designs to increase the use of the 242-S evaporator-crystallizer. A slurry transport line connecting 242-S with TX and TY tank farms will enable use of these farms for salt collection after ITS shutdown. The conversion of U farm tanks to receive slurry from 242-S will enable 242-S to continue operation on current wastes through FY 1980.

5.1.3.4 Immobilization and Stabilization. The bottoms tanks which were filled with salt in FY 1973 will be immobilized and stabilized by the end of FY 1974. Four of the eight SX tanks slated for air cooling of contained sludges will be incorporated into the SX sludge cooling facilities during the year.

5.1.3.5 Waste Fractionization. Purex sluicing and stored supernatants containing ^{137}Cs will have been processed through B Plant by the end of the fiscal year.

5.1.4 Expected Accomplishments FY 1975 Through FY 1979

Major accomplishments expected in FY 1975 include the completion of construction of the U farm tanks to contain 242-S evaporator-crystallizer slurry product. It is estimated that 17 bottoms tanks will be filled with salt during the year and that the nine tanks filled the previous year will have been isolated and stabilized during FY 1975. In addition, the

project to isolate and stabilize approximately 40 non-bottoms tanks will have been completed. The strontium-90 contained in the high-level boiling waste tank farms A and AX and the 106-C tank will be recovered in B Plant via the AR Vault acidification process. Cesium-137 separation from CAW will be completed in B Plant.

Major accomplishments expected from FY 1976 to FY 1979 include the shutdown of the ITS-1 and -2 and 242-T evaporator systems in FY 1976, and completion of the processing of stored wastes through the evaporator systems. In the same year, it is expected to complete construction of the facilities to transport Z Plant wastes to 242-S evaporator-crystallizer. In addition, the 242-S evaporator-crystallizer slurry will be routed to the TX and TY tank farms and installation of phosphoric acid neutralization facilities in the 200 East and West Areas to solidify some wastes in the ITS bottoms recycle loop will be completed. It is also planned to complete the immobilization and stabilization of the approximately 17 tanks that were filled with salt cake the previous year.

In FY 1978, the stabilization of filled bottoms tanks should be completed. In addition, the solidification of all partially filled "in process" tanks which have been held for contingency storage tanks should be completed. The encapsulation of SrF_2 and CsCl will be complete on those isotopes separated from Hanford wastes through FY 1975.

5.1.5 Annual Budget Projections

Table 17 provides estimated operating, capital and technology costs for the In-Tank Solidification. The costs have been separated, where possible, into 01 and 02 program segments. All costs are in thousands of FY 1974 dollars.

Capital projects have been listed where specifically identifiable and costs are on an obligation, not expenditure, basis.

Operating costs as reported consist of fully allocated costs including overhead charges. Cost in FY 1974 reflect May 1972 budget submissions with costs for FY 1975 through FY 1979 being of study quality. Operating costs

TABLE 17. Interim Storage of High-Level Liquid Waste

Cost Projections[1]
Cost-Budget Classification - 02-10-15-01
(Dollars in Thousands)

	FY 1974	FY 1975	FY 1976	FY 1977	FY 1978	FY 1979
Operating Cost						
Waste Fractionization	$12,400	$11,300	$11,350	$ 1,000	$ 1,050	$ 1,100
Waste Concentration, Storage & Surveillance	9,650	7,900	5,450	4,750	2,050	1,150
Sr-Cs Encapsulation, Storage & Handling	2,450[3]	1,650[3]	2,900	3,350	2,650	150
Total Operating Cost[2]	$24,500	$20,850	$19,700	$ 9,100	$ 5,750	$ 2,400
Capital						
Equipment	$ 800	$ 950	$ 650	$ 300	$ 150	$ 150
Projects[4]						
Non-Boiling Waste Slurry TX System	2,800	--	--	--	--	--
Total Capital	$ 3,600	$ 950	$ 650	$ 300	$ 150	$ 150
TOTAL COST	$28,100	$21,800	$20,350	$ 9,400	$ 5,900	$ 2,550

Notes: [1]Costs are in thousands of FY 1974 dollars.
[2]Excludes reactor decommissioning and crib cleanup costs
[3]Encapsulation manpower is drawn from Purex on a sequential basis through FY 1975. Cost Fluctuation in FY 1974 and 1975 reflect this intermittent operation.
[4]Past projections have included a $2 million contingency item for Salt Waste Bottoms Spares in each of FY 1974 and FY 1976. While these items might eventually be required, current estimates indicate sufficient storage space is available to handle projected waste volumes.

include standby, startup, shutdown, termination, and surveillance costs as they occur. Operating costs include process technology costs but exclude process development, research and development and engineering studies costs where specifically identifiable.

Operating costs for the 02 program correspond to the events listed in the following schedule:

Event	Date*
242-S Evaporator Startup	4/73
Purex/UO_3 Production Complete	3/75
Purex/UO_3 Deactivated	9/75
ITS 1 and 2 Concentrators Deactivated	11/75
242-T Evaporator Deactivated	11/75
B Plant Production Complete	1/76
B Plant Deactivated	7/76
242-S Evaporator Ceases Continuous Operation	7/77
Encapsulation Production Complete	10/77
Encapsulation Plant Deactivated	4/78

* Beginning of month

For the 01 program, nonoperating costs represent a significant portion of the total program cost. Therefore, 01 program costs for research and development and engineering studies have been separately identified and included in the cost projections. Process development costs for the 02 waste management program represent only a small portion of the 02 waste management cost and have not been included in the cost reports.

All succeeding cost tables were developed using the preceding procedures and assumptions and in order to avoid duplication these procedures and assumptions will not be repeated later in the text.

5.2 Long-Term Storage of Solidified High-Level Radioactive Waste

5.2.1 Summary and Milestone Chart

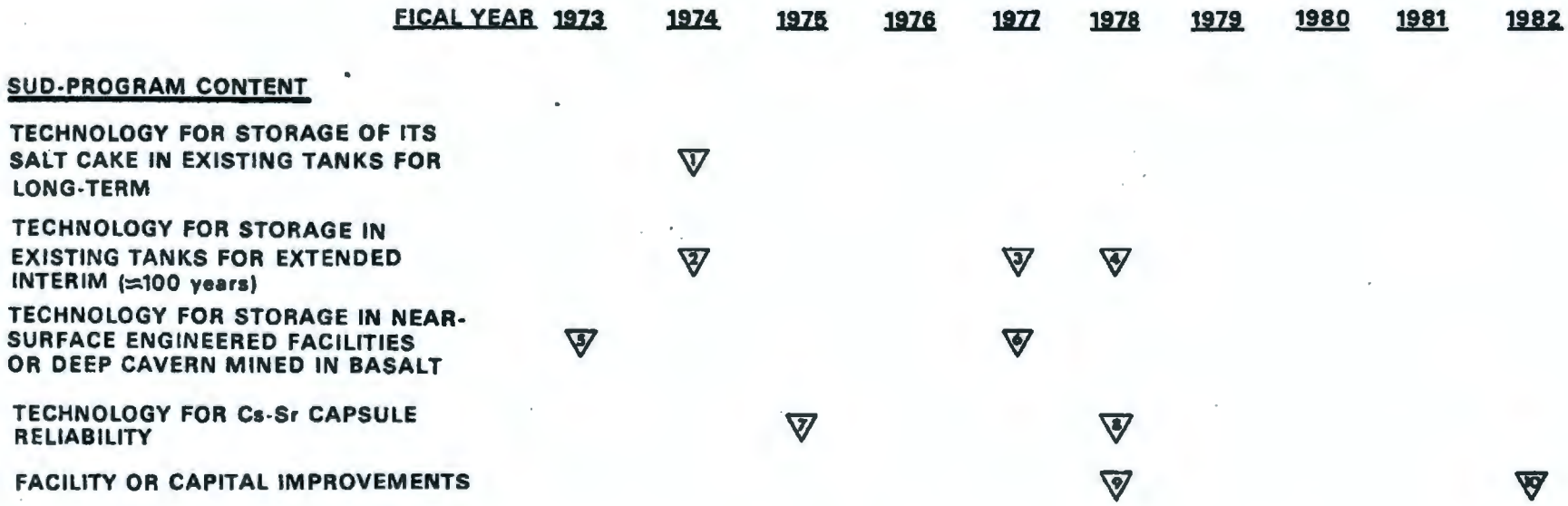
Hanford high-level radioactive wastes must be placed in long-term or improved interim storage status. A technology program was prepared which provides the decision bases for such action.[23] The proposed technical investigations cover different modes of isolating the wastes from the environment. This technology will enable future decision making to respond to emerging national criteria.

Under the present Waste Mangement Program at the Hanford site, the long-lived ^{90}Sr and ^{137}Cs are being separated from the bulk of the waste. These will be doubly encapsulated in Hastelloy or stainless steel as dry solids for interim storage in a facility now under construction. The remaining radioactive liquids and slurries from chemical processing are being concentrated to low-risk solid forms (salt cake) for near-term storage in about 70 tanks. These two waste forms, salt cake and cesium-strontium capsules, are considered high-level wastes in this discussion.

Each of the five alternative plans for disposing of the salt cakes includes investigation of the long-term stability of the encapsulated, separated ^{137}Cs and ^{90}Sr. Plans are included for improving the chemical form and redesigning the container if study shows the stability of the present design of capsules is inadequate.

When this technology program is complete between FY 1978 and FY 1983, information will be available to commence detailed design for the storage of these high-level wastes, with actual emplacement of waste commencing no later than FY 1986.

A milestone chart for the technology program is presented in Figure 37. The dates are consistent with established AEC goal dates. The milestone chart represents only one of the five possible plans, namely alternative Case A2, which is considered the base case for planning purposes. In Case A2 a decision is made in FY 1977 to leave the salt



(1) INFORMATION COMPILED FOR A DECISION ON SALT CAKES IN EXISTING TANKS FOR LONG-TERM.

(2) CHANGE TECHNOLOGY PROGRAM EMPHASIS TO OBJECTIVE OF EXTENDED INTERIM STORAGE.

(3) TECHNOLOGY AVAILABLE FOR DECISION ON EXTENDED INTERIM STORAGE.

(4) COMPLETE TECHNOLOGY FOR STORAGE IN EXISTING TANKS FOR EXTENDED INTERIM.

(5) START OR CONTINUE WORK ON SALT CAKE REMOVAL, VOLUME REDUCTION, AND ALTERNATE STORAGE FORMS (IMMOBILIZATION).

(6) STOP DEVELOPMENT WORK ON ALTERNATIVES TO CASE A2.

(7) START TEST PROGRAM FOR CAPSULES FROM ENCAPSULATION PLANT.

(8) COMPLETE TECHNOLOGY FOR ALTERNATE MODE OF Cs-Sr CAPSULE STORAGE (IF REQUIRED).

(9) START DESIGN OF CAPITAL IMPROVEMENTS OR FACILITIES FOR EXTENDED INTERIM STORAGE.

(10) POSSIBLE EARLY DATE FOR DESIGNATION OF HIGH-LEVEL WASTES AS "SATISFACTORY STATUS FOR EXTENDED INTERIM STORAGE."

FIGURE 37. High-Level Radioactive Waste Technology Program from the Base Plan, Alternative Case A2 Milestone Chart

cake waste in the existing tanks for the intermediate-term (about 100 years or more). In FY 1978 design and construction is started on any needed facilities.

5.2.2 Discussion of Program Alternatives

5.2.2.1 Case A1. The first alternative is to leave the waste as salt cake in existing tanks for the long-term (decision in FY 1973).[23,25] Starting in FY 1973 and continuing in FY 1974, an extensive investigation of environmental interactions is required: soil properties, water table response, geology, biological interactions, and earthquake risk. Other studies will seek means of providing additional stabilization of the waste and tanks in place. Surveillance techniques will be developed. This alternative, if adopted, would result in design and construction of any needed facilities in FY 1978.

Accompanying this case, and each of the other alternatives discussed below, is an investigation of the long-term reliability of the Cs-Sr capsules. Facility design for an improved storage mode (if needed) would commence in FY 1978.

5.2.2.2 Case A2. The second alternative is to leave the waste as salt cake in existing near-surface tanks for an extended interim period (100 years or longer). This alternative with a decision date of FY 1977 permits the most near-term flexibility in planning and hence is designated the base case.

This case includes environmental interaction studies similar to those of Case A1 in FY 1973. In FY 1974 the emphasis shifts to effects relevant over the shorter time span of this case, namely about 100 years. Additional laboratory studies in FY 1973 and 1974 are concerned with salt cake removal methods, volume reduction methods and ways of converting the waste to more stable chemical forms.[26,27] In subsequent years, further laboratory work is carried out in these areas and pilot plant studies are conducted on the more feasible processes.

With the completion of environmental effect studies in FY 1977, a favorable decision on in-tank storage for the extended interim period

would be made. Work on the backup processes mentioned above would terminate. In FY 1978 design would start on any needed capital facilities for this case. Designation of the waste, as in a satisfactory state for extended interim storage, might take place as early as FY 1982.

5.2.2.3 Case B. The next alternative is to relocate the waste in a new near-surface high-integrity engineered storage facility (decision in FY 1977). The technology for this case includes the same study of environmental interactions as is found in Case A2 in FY 1973 and FY 1974. The development of salt cake removal, volume reduction, and immobilization methods follows the same path as in Case A2. Differences in program due to the case emerge after the decision for the engineered storage facility in FY 1977. Design for the facility will start in FY 1978. An extra degree of environmental protection will be provided by a design of specially-engineered storage vault. Safety of the stored waste will be increased by use of a more immobile waste product form. The design will also include the means of mining the waste from the tanks and moving it. (This latter technology will be available at that time.)

Following design and construction, the new facility will be available about FY 1983. In conformance with the AEC plan, movement of the waste out of the waste tanks will follow, but in no case will relocation be started later than FY 1986.

5.2.2.4 Case C. The next alternative develops a storage mode that removes the waste from man's immediate environment to a cavern in basalt deep beneath the earth's surface (decision in FY 1978).

The technical program in FY 1973, FY 1974, and through FY 1977 is the same as in Cases A2 and B. Environmental studies, conversion to a more stable form, and means of mining and moving the waste will be developed similarly. Some preliminary work in deep drilling and geological testing will be underway in 1974 as part of Cases A2 and B.[28] After decisions in FY 1977 elminate the near-surface alternatives, the deep cavern program will be re-emphasized with a decision in FY 1978 for further work. Pilot

plant demonstrations of salt cake removal will be continued that year. In FY 1979 a deep cavern test program will be undertaken. This project involves sinking a shaft and mining a test cavern beneath many layers of impermeable basalt and isolated far from groundwaters. A final decision on the deep cavern approach could be made by FY 1981, with design of facilities starting the same year, leading to initial emplacement of wastes in FY 1986.

5.2.2.5 Case D. The final alternative is to transport the waste to a Federal repository for long-term storage (decision in FY 1978). By the time this decision is made, much of the applicable technology would have been developed as described in Cases A2, B, and C. Further laboratory work would be carried out on volume reduction, packaging, and transportation. Prototype and demonstration work in these areas is also planned. Detailed design of required facilities could start in FY 1981. Actual removal of wastes for shipment could start well before the AEC goal date of FY 1986.

5.2.3 Annual Budget Projections

Estimated annual technology costs for all the above alternatives are shown in Table 18. The base Case A2 figures are accentuated by underlining and a cost breakout is given in Table 19. This is the case which was described above and used as basis for the Milestone Chart.

5.3 Management of Low- and Intermediate-Level Liquid Waste

5.3.1 Summary - 100 Areas (N-Reactor)

Present plans call for the shutdown of N-Reactor at the end of FY 1974. Therefore no major improvements are planned for FY 1973 and beyond. However, low- and intermediate-level effluents discharged at N-Reactor are below AEC guidelines. Reduction efforts will continue through FY 1974 using operating funds.

5.3.2 Summary and Milestone Charts - 200 Areas

Since the beginning of the Hanford project, large volumes of low- and intermediate-level radioactive liquid wastes have been safely

TABLE 18. Storage of Hanford High-Level Radioactive Wastes Technology Cost Projections (dollars in millions)

Showing Costs Associated with the Principal Decision Paths for the Five Alternatives

FY 1973			1.4		
			Other		Decision for Long-Term Storage in Existing Tanks
1974			5.4		2.4
1975			9.2		2.6
1976			9.9		2.4
1977			7.9		2.1
		Other	Decision for Near-Surface Engineered Facility	Decision for Storage in Existing Tanks for Extended Interim Period	
1978		2.7	1.4	0.8	0.9
	Decision for Federal Repository	Decision for Deep Cavern			
1979	0.7	3.4	0.1	0.1	0.1
1980	1.1	4.4	0.1	0.1	0.1
1981	1.0	3.6	0.1	0.1	0.1
1973-1981 Totals	39.3	49.2	35.7	34.9	12.1
Case	D	C	B	A2 (base case)	A1

NOTES: FY-1973 costs are in FY 1973 dollars. All other costs are in FY-1974 dollars. Costs shown in this table were developed by escalating costs from a similar table in ARH-2435 (Reference 23) to bring the costs from FY-1972 dollars to the FY-1973, 1974 costs shown.

TABLE 19. Storage of High-Level Waste (Case A2)

Technology Cost Projections[1]
Cost-Budget Classification - 01 & 02
(Dollars in Thousands)

	FY 1974	FY 1975	FY 1976	FY 1977	FY 1978	FY 1979
Operating Cost[2] - 02						
Decision for long-term storage in existing tanks	$ 700[2]	$ 450	$ 450	$ 450	$ --	$ --
Development and Studies[3] - 01						
Research and Development	$ 1,100	$ 1,000	$ 700	$ 700	$ --	$ --
Engineering Studies	3,600	7,700	8,800	6,700	800	100
Subtotal 01 Development and Studies	$ 4,700	$ 8,700	$ 9,500	$ 7,400	$ 800	$ 100
Total 01 & 02 Cost	$ 5,400	$ 9,150	$ 9,950	$ 7,850	$ 800	$ 100

Notes:
1. Costs are in thousands of FY 1974 dollars and consist of costs from Table 18 for Case A2 rounded to the nearest $50,000.
2. Consists of process technology costs plus overhead. FY 1973 cost includes $60 for process development.
3. Costs include research and development, process development, engineering studies, and capital equipment necessary to provide technology for long-term high-level waste storage program. Increased from costs reported in ARH-2425 RD to include escalation to FY 1974 dollars.

discharged to the 200 Area cribs and surface ponds as process and steam condensates and as cooling waters. In 1967 a planned program for treatment of these waste streams was identified which would provide major reductions in the quantity of plutonium and fission products to the ground.[11] Two subsequent studies have identified reductions possible using existing funds[29] and with limited additional funding[30] for modifications to existing facilities. Facilities designed and constructed since 1967 have included waste effluent treatment and/or recycle to provide discharge of waste meeting MPC_w limits.

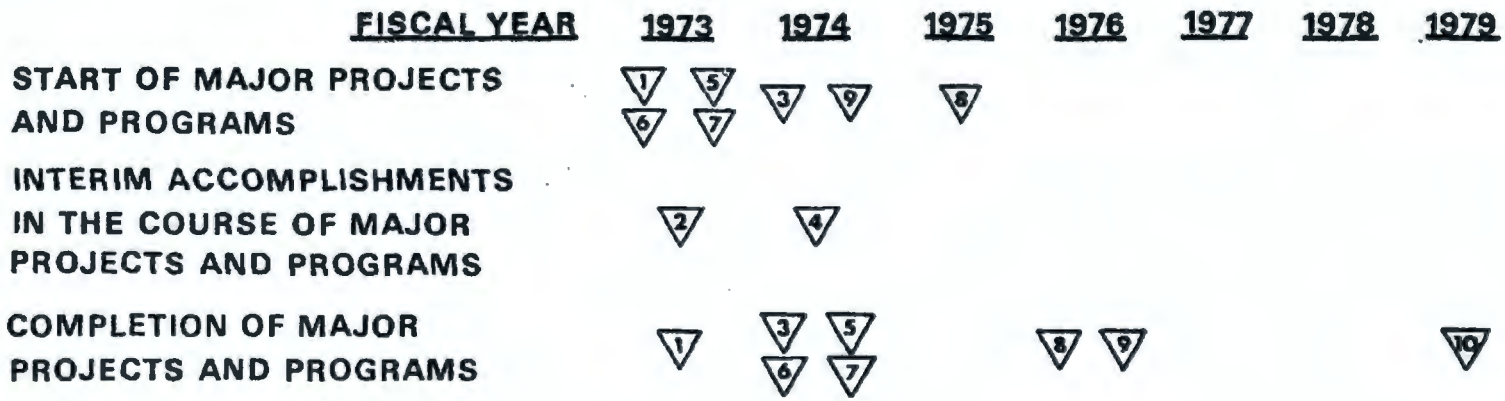
During the past several years, significant reductions of radioactivity discharged to the ground have been realized by changes in operating procedures and minor expenditures of funds for process and equipment improvements. However, several waste streams continue to discharge the major quantity of plutonium and/or fission product activities to the ground. Plans have been made which, when implemented, will prevent further major discharges via these waste streams.

Treatment of additional liquid waste streams to meet established standards for release of radioactivity to uncontrolled areas is technically possible. However, such treatment is not economically practical because of the high cost and the limited operating life of many of the facilities. A planning guide for the management of low- and intermediate-level liquid wastes is shown in Figure 38.

5.3.3 Expected Accomplishments - Fiscal Year 1973 - 200 Areas

It is expected that facilities will be in place by April 1973, to divert the Plutonium Finishing Plant (Z Plant) high- and low-salt liquid wastes from the ground (cribs) to underground storage tanks for neutralization and solidification via the 242-T waste evaporator.[31] Facilities will also be provided to recover carbon tetrachloride from Z Plant spent organic extractant. The degraded organic phosphate residue will be stored for subsequent disposal. Beneficial use of these facilities will provide a major reduction in discharges of plutonium to the ground.

MILESTONE CHART



KEY

1 PLUTONIUM EFFLUENT CLEANUP; Z PLANT HIGH AND LOW SALT WASTES
2 ION EXCHANGE TREATMENT; ITS2 ITS-2 PROCESS CONDENSATE
3 ROUTE PUREX NH_3 WASTES FOR EVAPORATION
4 IMPROVED PUREX PROCESS CONDENSATE RECYCLE
5 IMPROVED MONITORING, SAMPLING & DIVERSION; AR VAULT COOLING WATER
6 IMPROVED MONITORING, SAMPLING & DIVERSION; B PLANT COOLING WATER
7 IMPROVED MONITORING, SAMPLING & DIVERSION; B PLANT STEAM & PROCESS CONDENSATES
8 LIQUID ORGANIC WASTE INCINERATOR CONSTRUCTION
9 REROUTE Z PLANT HIGH AND LOW-SALT WASTES TO 242-S EVAPORATOR
10 COMPLETE INCINERATION OF LIQUID ORGANIC WASTES

FIGURE 38. Planning Guide - Management of Low- and Intermediate-Level Liquid Wastes

Ion exchange treatment of the ITS-2 evaporator process condensate will be provided in FY-73. Beneficial use of this treatment facility should provide a significant reduction in the long-lived ^{137}Cs discharged via this waste stream.

The shutdown of the Redox Plant on July 1, 1972, does not provide a significant reduction in the radioactivity discharged to the ground since the waste evaporated here will be routed to alternate facilities. However, some reduction in the volume of condenser cooling water to the ground in the 200 West Area should be realized.

5.3.4 Expected Accomplishments - Fiscal Year 1974 - 200 Areas

It is expected that facilities will be in place, prior to FY74 operation of the Purex Plant, to route Purex Plant ammonia scrubber wastes to an existing plant waste evaporator for decontamination. The waste evaporator bottoms would be routed to underground storage tanks. The overhead condensates, containing less than one percent of the initial radioactivity, would be routed to an existing crib. Further plant modifications to permit total recycle of first cycle waste concentrator overheads is also planned. Beneficial use of these facilities will provide major reductions in the plutonium and fission products discharged to the ground via these waste streams.

Installation of improved flow measurement, sampling, radiation monitoring and diversion capability for low-level, high-risk cooling water from the AR Vault and B Plant is planned for FY73-74.[32] Although these streams normally discharge only small quantities of radioactivity, the potential for large, uncontrolled discharges is ever present. Similar monitoring and diversion capabilities and diversion capabilities are also planned for for intermediate-level B Plant steam and process condensate streams.

5.3.5 Expected Accomplishments - Fiscal Years 1975-1979 - 200 Areas

By the end of FY 1975, many of ARHCO's major facilities will have been shut down.[10] The ITS-1, ITS-2, and 242-T waste evaporators, the 244-AR Vault, the Purex and UO_3 Plants are scheduled for standby or

deactivation. Waste volumes and radioactivity discharged to the ground from the remaining operating facilities (242-S, 222-S Laboratory, B Plant, Z Plant) will be minimal.

As ponds and cribs are no longer required as disposal sites for liquid wastes they would be removed from service. Radioactivity stored at crib sites would require continued surveillance by monitoring groundwaters beneath the cribs. Radioactivity stored in pond sediments would be buried in place or removed for burial in solid waste burial sites.

Final disposition of liquid organic wastes currently stored and those subsequently collected will utilize a liquid organic waste incinerator which is scheduled for construction in FY75-76.[33] Wastes discharged to the ground from operation of this facility will meet standards for surface discharge.

Operation of Z Plant beyond 1975 will require a new encased line for routing Z Plant wastes to the 242-S waste evaporator, and capability for neutralizing these wastes prior to evaporation.[34] An alternate to the liquid organic waste incinerator and the rerouting of the Z Plant wastes to the 242-S evaporator is a fluid bed calciner which could process both the Z Plant aqueous wastes plus the stored and currently generated wastes. Liquid wastes from the fluid bed calciner, if installed, would also meet surface discharge limits.

5.3.6 Annual Budget Projections - 200 Areas

Cost projections for the low- and intermediate-level waste program are provided in Table 20.

5.3.7 Summary - 300 Area

All low-level liquid discharges in the 300 Area are below AEC guidelines and no major improvements are planned at this time. However, continued efforts will be made to maintain effluents at a minimum using operating funds. Intermediate-level wastes are sent to the 200 Areas for disposal.

TABLE 20. Management of Low- and Intermediate-Level Liquid Wastes

Cost Projections[1]
Cost-Budget Classification - 02-10-15-02
(Dollars in Thousands)

Operating Cost	FY 1974	FY 1975	FY 1976	FY 1977	FY 1978	FY 1979
Capital	$ 1,150	$ 950	$ 550	$ 500	$ 350	$ 350
Equipment						
Projects:	$ 50	$ 50	$ 50	$ 50	$ 50	$ 50
Plutonium Effluent Cleanup						
Total Capital	2,100	--	--	--	--	--
	$ 2,150	$ 50	$ 50	$ 50	$ 50	50
TOTAL COST	$ 3,300	$ 1,000	$ 600	$ 550	$ 400	$ 400

Notes: [1]Costs are in thousands of FY 1974 dollars.

5.4 Management of Radioactive Solid Waste

5.4.1 Summary - 100 Areas

No major developments are planned for the 100 Areas at this time. Future planning will include such items as reactor decommissioning, site stabilization, etc.

5.4.2 Summary and Milestone Chart - 200 Areas

The 200 Areas contaminated solid waste program is defined to include contaminated wastes in the following categories: current solid waste and trash flowing from plant operations, contaminated disconnected equipment in storage, and buried solid waste. The principal emphasis is on waste contaminated with transuranic activity, or alpha waste, although high-level beta-gamma radiation is also involved.

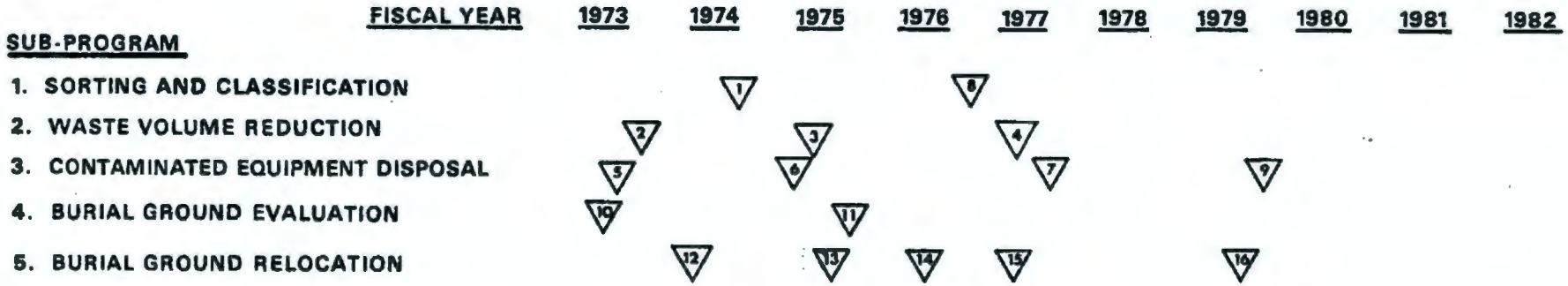
The program is planned to develop answers for the long-term disposal of these wastes. Over the next ten years, research and development will be performed, prototype demonstration programs carried out and capital equipment installed and operated. Toward the end of the period (FY 1980) a significant fraction of these wastes will be undergoing processing to low-level radioactive forms or to processed forms suitable for long-term storage. The ultimate disposition will be in approved long-term burial grounds or in some form of engineered storage.

A milestone chart is presented in Figure 39. This table shows the breakdown of the five sub-programs in the solid waste program.

5.4.3 Sub-Programs

5.4.3.1 Sorting and Classification. The purpose of this work is to develop instrumentation which will nondestructively assay the contents of packaged solid waste for sorting and accounting purposes. Identification and inventorying of low-level waste is essential before determining its disposition. As a corollary the measurements will determine whether the package can be treated as fission product-contaminated waste or must be handled as transuranic-element-contaminated waste (alpha waste).

MILESTONE CHART



(1) INSTRUMENTATION TO DETECT RADIOACTIVITY LEVELS AND IDENTIFY TRANSURANICS DEVELOPED.

(2) COMPACTION DEMONSTRATED IN PLANT AND ADDITIONAL UNITS PROCURED.

(3) EVALUATION OF INCINERATION ALTERNATIVES NEAR COMPLETION. DECISION ON ALTERNATIVES. START DETAILED DESIGN AND CONSTRUCTION OF LOW-LEVEL WASTE INCINERATOR.

(4) LOW-LEVEL INCINERATOR OPERATING.

(5) FACILITY BUDGET JUSTIFICATION.

(6) EQUIPMENT DISMANTLING TECHNIQUES DEVELOPED IN LABORATORY. ALTERNATIVE SELECTED. DECONTAMINATION METHODS TESTED. START OF DESIGN AND CONSTRUCTION.

(7) PILOT PLANT IN OPERATION DISMANTLING AND DECONTAMINATING EQUIPMENT FOR DISPOSAL.

(8) IN-PLANT DEMONSTRATION OF SORTING AND CLASSIFICATION INSTRUMENTATION COMPLETE. METHOD NOW IN PLANT USE.

(9) PILOT PLANT CONVERTED TO MANUFACTURING OPERATION.

(10) COMMENCE BURIAL SITE EVALUATION AND INVENTORY.

(11) REPORT ISSUED ON LONG-TERM ADEQUACY OF BURIAL GROUND SITES. RECOMMENDATION ISSUED FOR POSSIBLE RELOCATION.

(12) STUDY ALTERNATIVES FOR EQUIPMENT AND PROCEDURE CONCEPTS.

(13) FACILITY BUDGET JUSTIFICATION.

(14) EVALUATION OF U PLANT FOR STORAGE OF ALPHA WASTE COMPLETE.

(15) SELECT DESIGN CONCEPTS. START DESIGN AND CONSTRUCTION FOR EQUIPMENT FOR REMOVAL OF BURIAL GROUND WASTES.

(16) DEMONSTRATION OF BURIAL GROUND WASTE RELOCATION. (WYE BURIAL GROUND)

FIGURE 39. Program for Technology Development and Management of Solid Waste

The program will require two years of further development of current instrumentation.[35] During FY 1973 the emphasis will be on developing a technique for identifying over 30 nuclides from one spectrum by computer control. During FY 1974 the equipment will be refined and adapted for use under plant conditions. Two years of inplant testing (1975-1976) will be followed by transfer of the equipment to operations personnel. General inplant use of nondestructive assay equipment will commence in FY 1977.

5.4.3.2 Waste Volume Reduction. The sub-program has the objective of a major volume reduction in the flow of contaminated solid waste (principally alpha) from the plants. In the early years 1973-1974, the emphasis is on compaction and incineration. Compaction has already undergone considerable development; this additional work will involve testing of a new design under plant conditions in FY 1973. If successful, other compactors will be obtained.

In FY 1975 design and construction of a proposed new incinerator will commence, leading to plant operation in FY 1977.[36]

In FY 1973 a parallel R&D effort will continue the evaluation of attractive alternatives to incineration, such as oxidation in sulphuric acid. Modifications to the proposed low-level waste incinerator could be implemented before design starts.

Culmination of this program in 1977 will see both compaction and incineration established as inplant processes.

5.4.3.3 Burial Ground Evaluation. The objective of this sub-program is to thoroughly characterize the suitability of existing and potential burial sites for long-term storage of wastes (principally alpha). One part of the program involves assessing the radioactive materials currently present. This activity will proceed through FY 1974 using advanced counting methods and aerial survey.

The other part of the study involves determining the environmental interactions and long-term effects at the present and future burial locations. The information will be obtained from existing data and from

analyses at the various sites. The burial ground report on the environmental effects is expected late in FY 1975. The evaluations should permit the determination of which burial grounds need stabilization, which need relocation, and which potential new sites are acceptable for long-term storage.

5.4.3.4 Contaminated Equipment Disposal. The purpose of this subprogram is to establish the technology for disposing of large, bulky, contaminated equipment (principally alpha contaminated). The scope of the study includes development of methods of breakdown or disassembly; methods of decontamination of the resulting pieces, including surface cleaning; and demonstration.[37,38] Construction and operation of a pilot plant in FY 1977 is planned.

During FY 1973 some exploration of methods of disassembly such as shaped-explosive demolition or laser cutting will be accomplished. Design studies will scope a facility for this work. During FY 1974 the dismantling techniques for the pilot plant will be firmed up.

Decontamination agents, including molten salt fluxes, will be tested on simulated equipment pieces and a decontamination flowsheet will be adopted.

Design and construction of the pilot plant will commence in FY 1975 and be completed in 1977. From 1977 to 1979 the demonstration program will be conducted, leading to turnover of the facility to manufacturing supervision in 1980. At this time systematic processing of stored contaminated equipment would occur. Such waste would be converted into consolidated material residues suitable for long-term burial, and into concentrated residues to be handled as alpha waste in whatever facility has been designated for permanent storage of alpha waste.

5.4.3.5 Burial Ground Relocation. The purpose of this study is to develop the technology for acceptably relocating burial grounds, should this prove necessary. Again, the emphasis is on burial sites with transuranic element (alpha) contamination. During FY 1974 conceptual studies of equipment and procedures would be undertaken. An important part of this study

is designing controls against contaminated dust release. Also, a movable facility might be required, to enable the equipment to be moved from one burial site to the next. Design studies would continue in FY 1975 with some design verification tests.[38] Choice of a design mode would be followed in FY 1977 by detailed design. Other work in FY 1975 would involve studying an alternative to reburial, namely indefinite storage of exhumed solid waste in an existing building such as 221-U canyon. Operation of the burial ground relocation equipment would start in FY 1979, with completion of the first demonstration, of the Wye burial ground relocation, in FY 1980 of FY 1981.

Burial ground relocation demonstration in FY 1979 will provide some of the needed capability for handling the potential exhumed alpha wastes of the site.

5.4.4 Annual Budget Projections

Potential budget costs are shown in Tables 21 and 22. The technology costs include research and development, engineering studies, and technology costs associated with planned new processes. Capital costs include both equipment and prototype facilities.

5.4.5 Summary - 300 Area

No major improvements are planned for the 300 Area since all fission product and/or transuranium-bearing solid wastes are sent to the 200 Areas for burial. Development work will be carried out by the 200 Area contractor.

5.5 Management of Airborne Radioactive Waste

5.5.1 Summary - 100 Area (N-Reactor)

No major improvements are planned for the N-Reactor due to its projected shutdown. Gaseous effluents from N-Reactor are well within AEC guidelines.

5.5.2 Summary and Milestone Chart - 200 Areas

Studies of radioactive wastes discharged to the environs have shown that gaseous waste emmission guides are being met for the discharge of radioiodine, mixed fission products, uranium-239, plutonium-239 and

TABLE 21. Management of Solid Waste Contaminated with Radioactivity

Cost Projections[1]
Cost-Budget Classification - 01-04-01-01-1
(Dollars in Thousands)

	FY 1974	FY 1975	FY 1976	FY 1977	FY 1978	FY 1979
Operating Cost						
Sorting and Classification	$ --	$ --	$ --	$ 100	$ 100	$ 100
Waste Volume Reduction	--	--	1,650	1,650	1,650	1,650
Burial Ground Evaluation	--	--	--	--	--	--
Contaminated Equipment Disposal	--	--	400	1,650	1,650	1,650
Burial Ground Relocation	--	--	--	--	--	650
Other	400[2]	300	200	150	150	150
Total Operating Cost	$ 400	$ 300	$ 2,250	$ 3,550	$ 3,550	$ 4,200
Capital						
Equipment	$ 50	$ 50	$ 50	$ 50	$ 50	$ 50
Projects:						
Low-Level Waste Incinerator Facilities[3]	5,000	--	--	--	--	--
Contaminated Equipment Disposal	--	7,000	--	--	--	--
Burial Ground Relocation	--	--	--	10,000[4]	--	--
Total Capital	$ 5,050	$ 7,050	$ 50	$10,050	$ 50	$ 50
TOTAL COST	$ 5,450	$ 7,350	$ 2,300	$13,600	$ 3,600	$ 4,250

Notes: [1]Costs are in thousands of FY 1974 dollars.
[2]This estimate differs from the Table 14 estimate of $167 for FY 1974 as a result of escalation to FY 1974 dollars and the inclusion of costs for stabilization of old burial grounds.
[3]Could be 02 or 01 program cost.
[4]Actual estimate is $4,000-$10,000.

TABLE 22. Management of Solid Waste Contaminated with Radioactivity

Research and Development Cost Projections[1]
Cost-Budget Classification - 01-04-01-03
(Dollars in Thousands)

	FY 1974	FY 1975	FY 1976	FY 1977	FY 1978	FY 1979
Research & Development Cost						
Sorting and Classification	$ 60	$ 110	$ 110	$ --	$ --	$ --
Waste Volume Reduction	175	60	--	--	--	--
Burial Ground Evaluation	175	60	--	--	--	--
Contaminated Equipment Disposal	210	110	90	90	--	--
Burial Ground Relocation	90	110	110	110	--	--
Subtotal Research & Development Cost	$ 710	$ 450	$ 310	$ 200	$ --	$ --
Total Research & Development Cost - Rounded	$ 700	$ 450	$ 300	$ 200	--	--

Notes: [1]Costs are in thousands of FY 1974 dollars.

Strontium-90 from 200 Area facilities. A planning guide for the management of 200 Areas airborne radioactive wastes is provided in Figure 40.

5.5.3 Expected Accomplishments FY 1973 - 200 Areas

Two general plant projects are scheduled to be started in FY 1973. Ventilation improvements will be made at the 222-S Laboratory and at the Plutonium Finishing Plant.[39]

5.5.4 Expected Accomplishments FY 1974 - 200 Areas

The two general plant projects initiated in FY 1973 will be completed. In addition, a FY 1972 project, which provides vessel vent modification to the 244-AR Vault, will be completed in FY 1974.[40] Construction of a fourth filter cell in B Plant will be initiated in FY 1974.[41]

5.5.5 Expected Accomplishments - FY 1975-79 - 200 Areas

Construction of the fourth filter cell at B Plant will be completed in FY 1975. At this time no other major changes have been identified beyond FY 1975.

5.5.6 Annual Budget Projections - 200 Areas

Cost projections for the airborne radioactive waste program are provided in Table 23.

5.5.7 Summary - 300 Area

Gaseous effluents from the 300 Area are well within AEC guidelines and at this time no major improvements are planned.

5.6 Summary of Budget Projections - 200 Areas

Table 24 provides a summary tabulation of budget projections (FY 1974 to FY 1979) for the 200 Areas.

MILESTONE CHART

FISCAL YEAR	1973	1974	1975	1976	1977	1978	1979
START OF MAJOR PROJECTS AND PROGRAMS	1, 2	4					
INTERIM ACCOMPLISHMENTS IN THE COURSE OF MAJOR PROJECTS AND PROGRAMS							
COMPLETION OF MAJOR PROJECTS AND PROGRAMS		1, 2, 3	4				

* FY-1972 START

KEY

1 EXHAUST VENTILATION IMPROVEMENTS, 222-S
2 VENTILATION IMPROVEMENTS, Z PLANT (27)
3 244-AR VAULT VESSEL VENT MODIFICATIONS (28)
4 FOURTH FILTER - B PLANT (29)

FIGURE 40. Milestone Chart, Airborne Radioactive Waste

TABLE 23. Management of Airborne Radioactive Waste[1]

Cost Projections[2]
Cost-Budget Classification - 02-10
(Dollars in Thousands)

	FY 1974	FY 1975	FY 1976	FY 1977	FY 1978	FY 1979
Operating Cost	$ 1,100	$ 1,100	$ 700	$ 650	$ 600	$ 600
Capital						
Equipment	10	10	10	50	50	50
Projects						
Fourth Filter Cell, B Plant (GP)	450	--	--	--	--	--
TOTAL COST	$ 1,560	$ 1,110	$ 710	$ 700	$ 650	$ 650

Notes: [1]Airborne radioactive wastes are defined as radioactive materials (particulates, mists, fumes, etc.) contained in gaseous effluents. As such, costs are incurred in process buildings, tank farms and in general air monitoring. These costs are not reported separately, but are charged to other programs.

[2]Costs are in thousands of FY 1974 dollars.

TABLE 24. Cost Projections[1] - 200 Areas

(Dollars in Thousands)

	FY 1974	FY 1975	FY 1976	FY 1977	FY 1978	FY 1979
02 Program						
Operating Cost						
5.1 Interim Storage of High-Level Liquid Waste	$24,500	$20,850	$19,700	$ 9,100	$ 5,750	$ 2.400
5.2 Long-Term Storage of High-Level Waste[2]	700	450	450	450	--	--
5.3 Management of Low- and Intermediate-Level Liquid Wastes	1,150	950	550	500	350	350
5.5 Management of Airborne Radioactive Waste	1,100	1,100	700	650	600	600
Adjustment for Duplication[3]	(490)	(530)	(290)	(270)	(270)	(270)
Total Operating Cost	26,960	22,820	21,110	10,430	6,430	3,080
Total Capital	6,210	1,010	710	400	250	250
Subtotal 02 Program	$33,170	$23,830	$21,820	$10,830	$ 6,680	$ 3,330
01 Program						
Operating Cost						
5.4 Management of Solid Waste Contaminated with Radioactivity	$ 400	$ 300	$ 2,250	$ 3,550	$ 3,550	$ 4,200
Research & Development, Engineering Studies Cost						
5.2 Long-Term Storage of High-Level Wastes	4,700	8,700	9,500	7,400	800	100
5.4 Management of Solid Waste Contaminated with Radioactivity	700	450	300	200	--	--
Total R&D, Engineering Studies and Operating Cost	5,800	9,450	12,050	11,150	4,350	4,300
Total Capital	5,050	7,050	50	10,050	50	50
Subtotal 01 Program	$10,850	$16,500	$12,100	$21,200	$ 4,400	$ 4,350
TOTAL 01 & 02 Waste Management Programs	$44,020	$40,330	$33,920	$32,030	$11,080	$ 7,680

Notes: [1]Costs are in thousands of FY 1974 dollars.
[2]Costs consist primarily of process technology costs.
[3]Airborne and solid waste costs duplicated in other categories.

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