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ENVIRONMENTAL ASSESSMENT ABOVE-GRADE STORAGE OF RAFFINATE FILTER CAKE SEPTEMBER 5, 1975

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ENVIRONMENTAL ASSESSMENT

ABOVE-GRADE STORAGE OF RAFFINATE FILTER CAKE

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INTRODUCTION

This document has been prepared in accordance with policies and procedures of the Energy Research and Development Administration (ERDA) as stated in 10 CFR Part 11.

1.0 Proposed Action, Environment Affected, and Anticipated Benefits

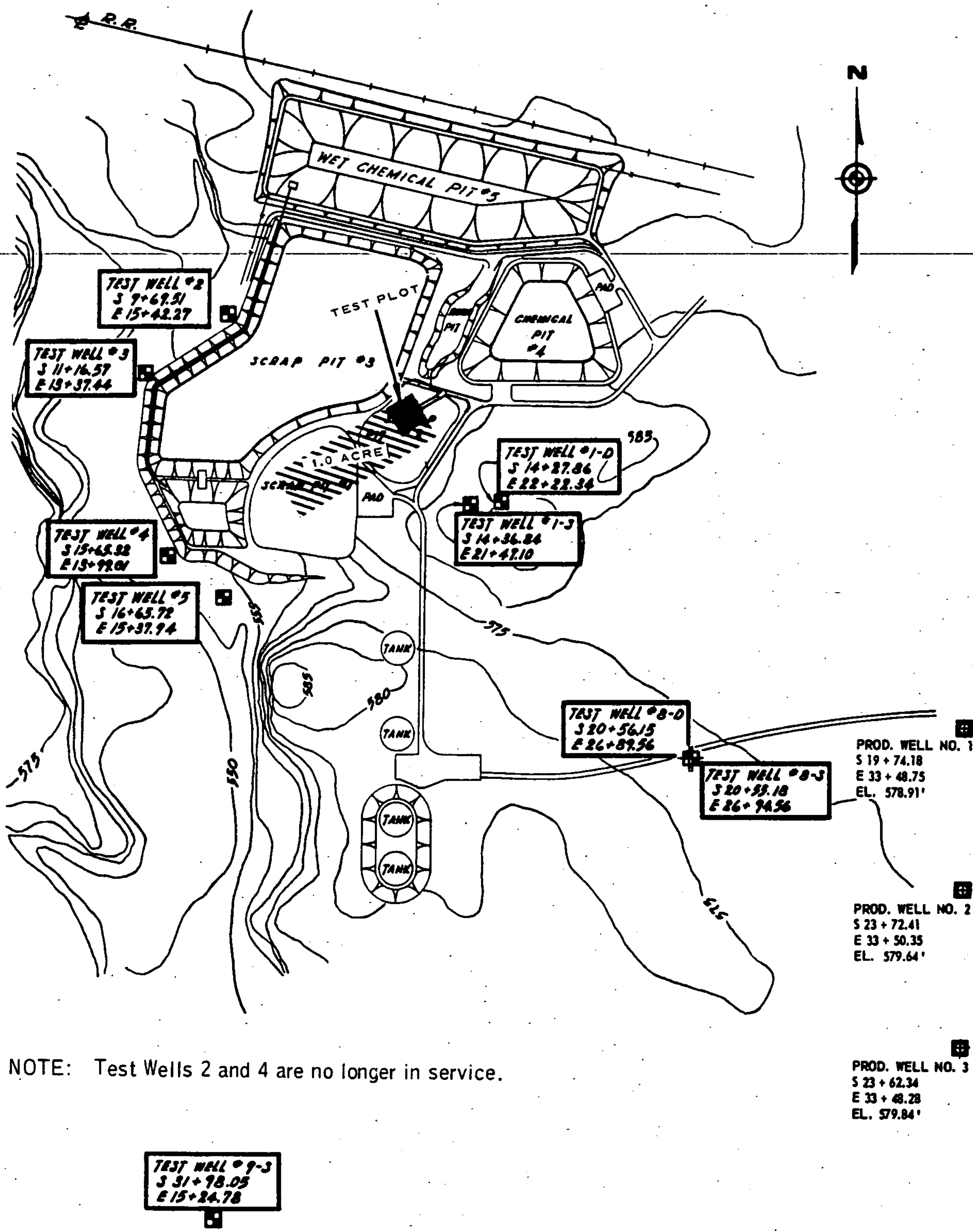
1.1 Proposed Action

This subject project proposes the storage of filter, cake generated by the filtration of raffinate from the Refinery processing of uranium concentrates, above-grade in a manner designed to minimize the spread of contamination to the surrounding environment.

The proposed storage area will be located in the present waste pit area as shown in Figure 1. It will cover a portion of the filled-in Pits 1 and 2 and will be approximately 1.0 acre in area. The construction and proposed operating mode are described in detail in Section 2.0 of this document.

1.2 Environment Affected

The Feed Materials Production Center (FMPC) is an industrial facility owned by the United States Energy Research and Development Administration (ERDA) and operated by the National Lead Company of Ohio. It is located near Fernald in the Great Miami River Valley in southwestern Ohio, approximately 20 miles northwest of Cincinnati. The plant proper occupies 136 acres



NOTE: Test Wells 2 and 4 are no longer in service.

FIGURE 1 Chemical Waste Pits, Showing Above-Grade Storage Location in the center of a 1,050 acre site. Most of the site, including all of the production plant area, is located within Hamilton County, Ohio, but approximately 200 acres are in southern Butler County. The villages of Fernald (pop. 30), New Baltimore (pop. 200), Ross (pop. 3,000), and Shandon (pop. 500) are all located within a few miles of the plant. Hamilton, Ohio (pop. 67,865) is approximately 10 miles northeast.

Figure 2 shows the relative location of these populated areas to the FMPC.

Glacial action gave the FMPC area its basic geological features. Out-wash from retreating glaciers filled in the former course of a large ancient river. Through this fill, the Miami River has cut its present course and the river bed is now located about 60 feet below the original level of the glacial deposits. The area east of the FMPC, in the Miami River flood plain, has fertile soil and is reported to contain some of the best farmland in the state. In the gently rolling uplands west of the flood plain, the thin soil mantle over the glacial drift is less fertile.

Although there are several small industries near the FMPC, the major economic activities in this rural area are farming, dairying, and the raising of beef cattle. Farm crops include sweet corn, field corn, soybeans, and wheat. Truck crops are widely grown and sold at local produce stands and in nearby urban markets.

The glacial fill and the Miami River have provided two other important area products—ground water and gravel. The permeable glacial deposits, called valley-train, house a bountiful deep aquifer from which FMPC and others draw supplies. The Miami River continuously provides part of the aquifer recharge.

Gravel pit operations are a familiar sight in the Miami Valley. Some operations are located along the river, with a sand dike separating gravel washwater from the river. Other operations are within the flood plain, but are several hundred feet from the river.

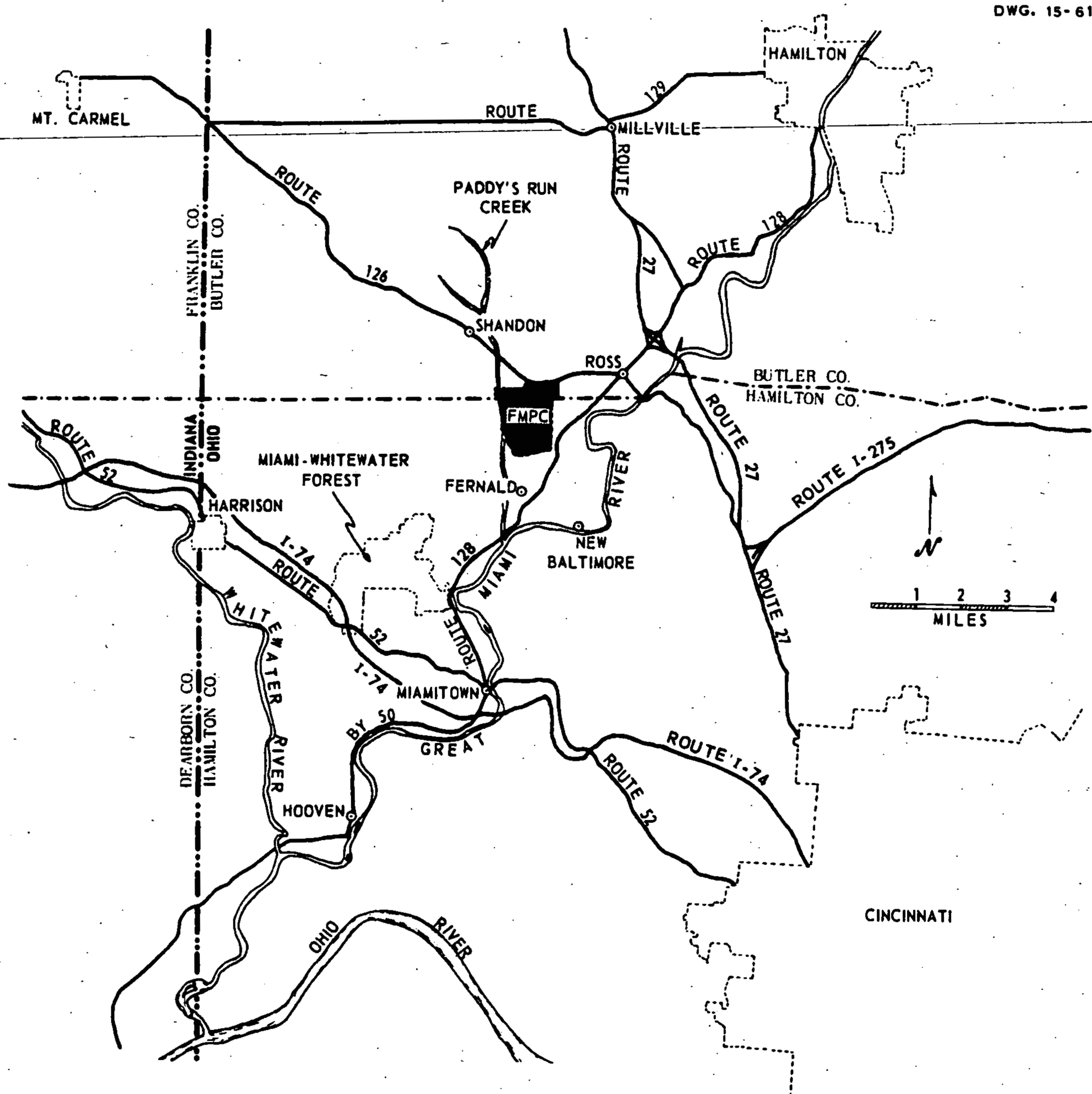


FIGURE 2 Area Map Showing Relative Locations

The river receives substantial amounts of industrial and municipal wastes upstream from the FMPC. The cities of Dayton, Middletown, Hamilton, and Fairfield are major contributors. Little recreational use is made of the river. Downstream from the FMPC, the population is sparse and industries are small and scattered. About 18 miles away, the Miami meets the Ohio River.

The topography in the immediate vicinity of the chemical waste pit area is flat to gently rolling. Paddy's Run Creek, a small stream in which a flow generally only exists during the period January to May, flows west of the chemical waste pit area, and its valley is the most significant topographical feature of the immediate area. Paddy's Run Creek meanders through the western portion of the FMPC site, passing the southern boundary near the southwest corner of the site.

Paddy's Run Creek joins the Miami River approximately two miles south of the FMPC site and 1-1/2 miles downstream from New Baltimore.

FMPC and the immediately surrounding area is shown in Figure 2.

1.3 Anticipated Benefits

1.3.1 The proposed plan would provide an economical and environmentally acceptable method for storing the raffinate cake generated during the remainder of the uranium concentrate processing campaign.

The estimated preparation cost for the 1.0 acre site is $12,000, operational cost for the remainder of the concentrate campaign including the cost of filtering the raffinate is $183,320 and retirement cost for the above-grade site is estimated to be $8,400. This gives a total estimated cost for handling the raffinate generated during the remainder of the campaign of $203,720. This compares to approximately $400,000 for the construction of a new pit. Another alternate involving filtration of the raffinate plus a portion of Pit 5 sludge and return of the filter cake to Pit 5 has been estimated to cost $315,570.

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1.3.2 The project would provide a full-scale demonstration of above-grade storage as a technique for permanent disposal of radioactive waste sludges. This technique might then be applied to the retirement of Pit 5 at the FMPC, the sludge pits at Weldon Spring, and any other pits under ERDA control that require retirement.

2.0 EVALUATION OF ENVIRONMENTAL IMPACT

2.1 Project Description

Above-grade storage of radioactively-filtered sludges was conceived as an alternate to pit storage of these materials. It was thought that location of the material above-grade in a controlled manner would minimize the transfer of water-soluble salts and/or radioactive contaminants to the undergound aquifer, would permit drying of the material and result in consolidation to a relatively small volume. It was also felt that above-grade storage would be cheaper than pit storage.

Results of laboratory testing of samples of the raffinate cake and Pit 5 sludge filter cake are summarized as follows:

1. The original filter cake contained about 70% moisture, and had a density of about 72 pounds per cubic foot (lb/ft). Therefore, each cubic foot of cake contained about 50 pounds of evaporable water.

2. The original cake had a consistency of very soft mud. If carefully emplaced, its angle of repose was high; however, it would support very little weight.

3. The cake gained strength rapidly with loss of water. At a 20% weight loss it was estimated that a pile of the material would support a man's weight and at 35% loss would support heavy equipment. This translates to a water loss of 14.4 and 25.2 lb/ft^3, respectively.

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4. Drying tests indicated water removal proceeds at a nearly constant rate per unit surface area until a large percentage of the total water is removed. As drying proceeds, the surface remains saturated as water diffuses to the surface. The evaporation rate therefore approaches that from a free water surface.

5. As drying proceeds, the cake shrinks in volume and the shrinkage volume is almost equal to the volume of water removed. The final dried cake volume was approximately 40% of the original volume and its density was 54 lb/ft^3.

6. Addition of water to the partially or fully dried material does not result in swelling or decrepitation. In other words, the shrinkage is irreversible. Fully dried cake when immersed in water reimbibed 39% of the water originally held but did not swell noticeably.

The estimated quantity of raffinate cake to be generated during the remainder of the Refinery concentrate campaign was 2,000,000 gallons. This is equivalent to 267,000 cubic feet and would cover an area of one acre to a depth of about 6 feet. These values were selected for use in the planning phase of the Above-Grade Storage project.

An estimate was made of the time required for a 6-foot thick layer of cake to dry sufficiently to support heavy equipment and permit final covering and retirement. This estimate was based on the results of the laboratory drying tests and the available information on meteorological conditions in this area. As indicated above, a water loss of 25.2 lb/ft^3 was estimated to be required to enable the cake to support heavy equipment. In a 6-foot bed this is equivalent to the evaporation of 29 inches of water. Drying rate calculations resulted in an estimated "net" free surface evaporation of 24 inches of water per year. By "net" evaporation is meant the difference between loss of water brought about by solar heat input and convective air drying less the gain of water from rainfall. This would indicate sufficient drying should occur in two years. On a conservative basis it might take 3 to 4 years.

In order to check the validity of the laboratory results and calculations described above, a field demonstration test is being conducted. A 60-foot by 60-foot test area was prepared following the precepts envisioned for the full-scale one acre site. The test plot was located on the covered Chemical Waste Pit No. 2. This—along with the tentative location for the 1.0 acre site—is shown in Figure 1.

The basic precepts of Above-Grade Storage may be summarized as follows:

1. Provide a raised well-drained storage area where the cake can be carefully emplaced in a well-shaped pile of the desired height.

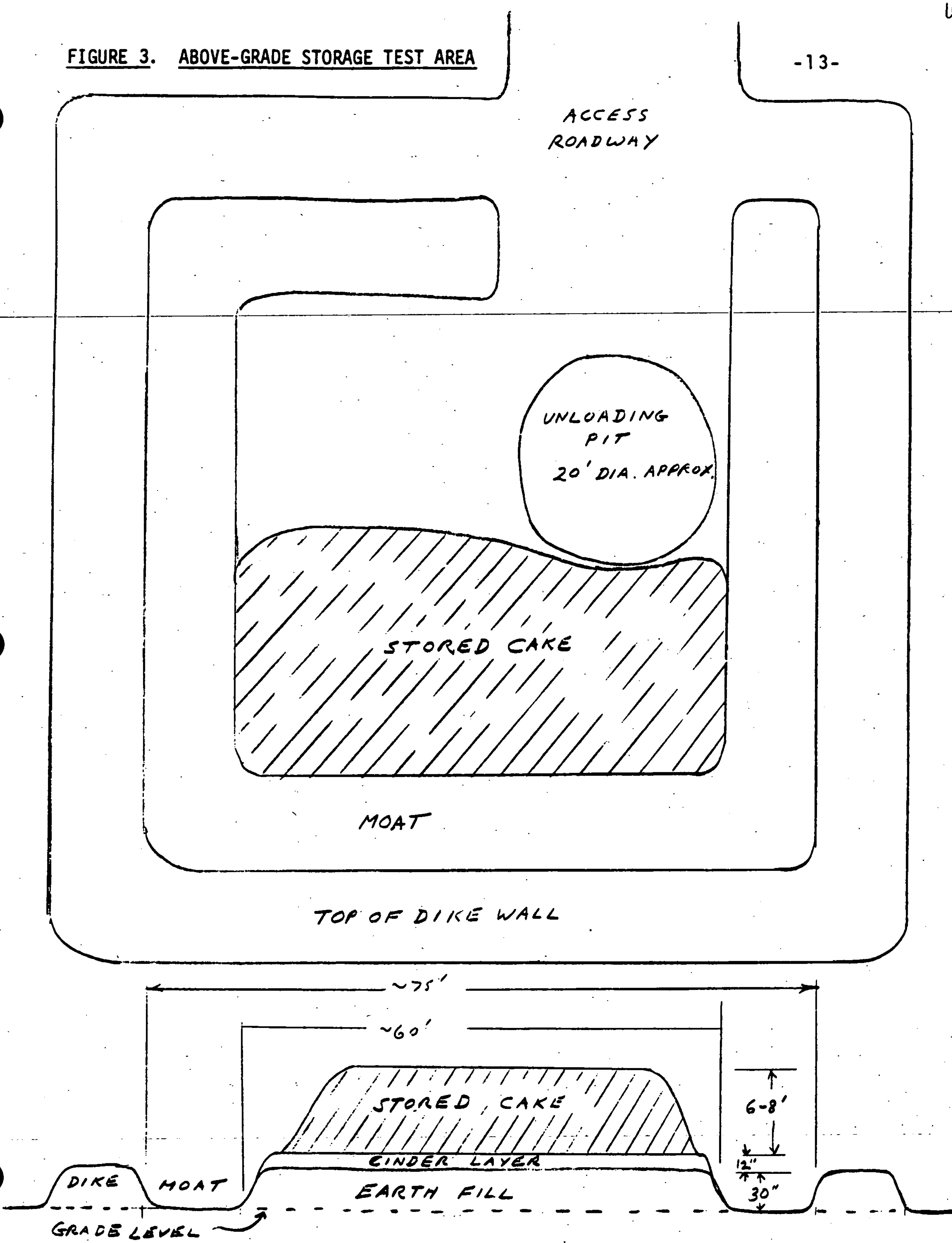
2. Minimize the spread of chemical and radioactive contamination from the stored cake during the drying period.

3. After sufficient drying of the material has occurred, reshape the pile to cover a minimum area and cover it with earth to a sufficient depth to permit the growth of grass and shrubs.

The field demonstration test which is now in progress follows the above precepts as closely as possible. A sketch of the test area is shown in Figure 3.

As shown, the test area consists of a square "island" of raised ground measuring approximately 60 feet on an edge. In this area, earth was piled and compacted to a depth of about 30 inches above the surface of Pit 2. About one foot of coal cinders was piled on top of the earth. A pit was prepared on one side of the raised area with a diameter of about 20 feet and roadfill gravel and sand were emplaced leading into the edge of the pit. Trucks loaded with the raffinate cake from the filters in Plant 8 discharged their loads into this pit, and a mobile crane with clamshell was used to lift the filter cake from the dumping pit and place it to a depth of 6 to 8 feet on the southern half of the raised storage area.

FIGURE 3. ABOVE-GRADE STORAGE TEST AREA



A moat eight feet wide with outer raised earth dike walls about 10 feet wide surrounds the raised storage area except on the north end where the roadway leads into the dumping pit. The moat catches any rainwater which drains from the storage area or any filter cake which falls from the pile or is washed in by heavy rains.

Loading of cake into the area began on May 22, and was completed on June 9, 1975. In all, 29 truckloads of wet filter cake containing approximately 70% by weight water and with a total weight of 275 tons were placed on the southern half of the storage area. Loading of this quantity of material from the dumping pit to the storage area required approximately 7 hours operating time with the mobile crane.

No difficulty was encountered in emplacing the cake on the storage area and little or no spillage of cake into the moat occurred. During the two-month period since the test started, several heavy rains of up to 1.0 inch have occurred. This heavy precipitation has caused only minor erosion of the filter cake into the surrounding moat area, and there has been no escape of solids or liquids beyond the exterior diking. A noticeable shrinkage in the height of the pile (8-10 inches) has occurred. Samples of cake taken from the pile and analyzed for moisture indicated that the initial drying rate has been satisfactory. The cake has dried to the point that it now easily supports the weight of a man with no appreciable indentation of the surface. No evidence of dusting from the pile has been observed.

The field test has pointed up a factor which tends to lower the rate of moisture removal by evaporation. The filter cake contains perhaps as much as 30 to 50 percent soluble nitrate salts on a water-free basis. The major cation associated with the nitrate is calcium with smaller amounts of magnesium, sodium, and potassium ions existing in the solution phase. The vapor pressure lowering effect caused by the nitrate salts in solution lowers the driving force for evaporation significantly. The evaporation rate will continue to drop off as moisture is removed and as the solution from which the evaporation occurs becomes more and more concentrated in the nitrate salts. The salt concentration also tends to increase at the surface of the pile as the surface evaporation causes diffusion of the liquid phase towards the surface. If further evaluation of field test results indicates the soluble salts cannot be tolerated in the stored cake, provisions will be made in the full-scale procedure for washing them out of the cake before it is emplaced on the one acre site. This should be fairly easily accomplished by activating the washing sprays on the raffinate filters.

As presently planned, the full-scale, above-grade storage area will be an expansion of the test area just discussed. The only significant change being contemplated (other than possible washing of the filter cake) is the use of plastic sheeting between the earth and cinder layer. The purpose of this plastic is to act as a moisture barrier and prevent the diffusion of water from the ground into the stored cake. The other details of construction will be the same as shown in Figure 3 for the test area except the size will now be about 1.0 acre. The operating procedure will be the same as that described for the demonstration test except that new unloading pits will be needed as the pile expands. The old pits will be filled-in as the storage pile encroaches on them.

At the conclusion of the Refinery Concentrate campaign, the stored cake would be allowed to dry until it attained sufficient strength and dryness to permit handling by heavy equipment. As mentioned above, it is estimated that this would require 3 to 4 years drying time. When a suitable state of dryness is reached the pile will be reshaped into a truncated cone form. Based on anticipated shrinkage from laboratory tests, it is estimated that the final cone would cover an area of about one-third acre and would be about 20-feet high. The dried cake would then be covered with a layer of asphalt as a water retardant and finally with a layer of earth which would be planted with grass and shrubs.

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2.2 Characteristics of the Cake

The cake to be stored is generated by the filtration of a lime neutralized raffinate stream produced by a solvent extraction process used to convert uranium concentrates to purified uranium trioxide (UO_3). The uranium concentrates are dissolved in nitric acid and fed to a liquid-liquid solvent extraction process for purification. In primary extraction the uranyl nitrate feed stream is contacted in pulse columns with a countercurrent organic solvent stream which consists of tributyl phosphate (TBP) diluted with kerosene. The uranium transfers to the organic phase leaving virtually all the impurities in the aqueous raffinate stream. The raffinate is neutralized with lime (CaO) and filtered, producing the raffinate filter cake which requires storage. In the original plant design the raffinate was processed for nitrate recovery with the resulting nitric acid being recycled to digestion and the dry metal oxide stored in concrete silos. This process proved to be unsatisfactory because of high maintenance and operating costs and was abandoned. The raffinate was then neutralized with lime and sent to settling ponds where the solids settled and remained while the clear decant liquor was discharged to the river. Filling of the settling pit with sludge has necessitated changing of this procedure.

As it comes from the filter the raffinate cake has a moisture content of about 70% and is equivalent to a soft slimy mud. The soluble salt content of the cake is high. The primary anion is nitrate (approximately 10% by weight) with a significant amount of sulfate and minor amounts of phosphate and halogens. The primary cation is calcium with significant quantities of magnesium and iron, plus minor concentration of many other elements. The cake also contains small quantities of uranium and its radioactive daughters, primarily ^{226}Radium. A barium carbonate treatment is used in the Refinery process to convert the radium to an insoluble form and prevent its discharge to the river with the raffinate filtrate stream. The soluble uranium in the raffinate is precipitated with lime before filtration. Therefore, these elements will be present in the filter cake in a relatively insoluble form.

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2.3 Storage Area Description

The Above-Grade Storage area will be located on portions of the filled-in Pits 1 and 2 as shown in Figure 1.

Five chemical waste pits have been constructed at the FMPC. The location relative to the production area and other features is shown on Figure 4. The pits are identified by number based on the chronological sequence of their construction. They are further identified as "dry" or "wet" pits. This distinction is made on the basis of the physical state of the material as it is placed in the pit.

Pits 1 and 2 were basically dry pits, and are filled and covered with earth. Pit 4, also a dry pit, is the existing depository for the dry solid wastes.

Pits 3 and 5 were constructed as wet chemical waste pits. Pit 3, completed in 1959, was lined with 1.5 to 2 feet of blue clay, to minimize leakage of water from the pit. Pit 3 was filled in 1968, and Pit 5 was built. Pit 5 was lined with a 1/16" EPDM Elastomeric (rubber) membrane, found to be most suitable for the service in laboratory tests. Pit 5 was filled in early 1975, and filtering of raffinate was started. As a temporary measure, the cake from this operation is being stored in an extension of Pit 3.

The following table gives a description and status of each of the chemical waste pits.

Pit No.	Pit Type	Pit Volume (C.F.)	Status (As of 7/1/74)
1	Dry	1,080,000	Filled and covered.
2	Dry	351,000	Filled and covered.
3	Wet	6,115,500	Filled to extent possible - currently being used for storage of raffinate filter cake.
4	Dry	1,431,000	81% filled.
5	Wet	2,773,000	Filled; no attempt made at covering or other retirement as yet.

2.3.1 Radioactive Wastes Stored - Chemical Waste Pits

A tabulation of sludges and settled solids stored as of July 1, 1974, in Chemical Waste Pits 2, 3, and 5 is as follows:

Uranium:	Normal	138,709 Kg
	Slightly Enriched	49,667 "
	Total	194,632 Kg
Thorium:		5,358 "
	Total	199,990 Kg
Total Radioactivity		66.7 Ci
Total Volume (Est.)		7,506,000 C.F.

A tabulation of radioactively-contaminated solid (dry) wastes stored as of July 1, 1974, in Chemical Waste Pits 1, 2, and 4 is as follows:

Uranium:	Normal	142,084 Kg
	Slightly Enriched	23,443 "
	Depleted	2,319,349 "
	Total	2,484,876 Kg
Thorium:		60,700 "
	Total	2,545,576 Kg
Total Radioactivity		835 Ci
Total Volume (Est.)		2,570,000 C.F.

2.3.2 Subsurface Ground Water at the Chemical Waste Pits

Test wells, drilled around the waste pits in 1959, and redeveloped in 1963 and 1965, permit monitoring of ground water in the area. The location of these wells is shown in Figure 1. Sampling of these wells, performed on a quarterly basis, furnishes data on any pollutant dispersion from the waste pits into subsurface aquifers. Nitrates and chlorides were found in the first samples from the wells in amounts slightly higher than background, which appeared to indicate that the natural clay liners used in Pits No. 1 through 4 were not completely impervious; however, no increase in uranium or radioactivity was detected. In the ensuing years the concentrations of nitrates and chlorides have steadily declined. It is concluded that (1) permeation from Pits 1, 2, 3, and 4 through the clay linings has essentially ceased, and (2) if there are any losses of liquids with accompanying pollutants through the rubber lining of Pit 5, such losses are not significant enough to affect the quality of the water in the subsurface aquifers.

There is no reason to expect increased contamination of the subsurface aquifers by the proposed Above-Grade Storage of raffinate cake. The storage area will be located on existing covered pits which are filled with radioactively contaminated solid waste so any contaminants that migrated from the stored cake into the ground would enter the existing pits. In addition, a moisture barrier will be installed between the storage pile and the ground. As noted above, this is primarily to prevent upward diffusion of ground water into the cake but would also serve to prevent downward diffusion of contaminants.

2.3.3 Surface Waters at the Chemical Waste Pits

Surface drainage from the chemical waste pit area flows toward Paddy's Run Creek unless its direction of flow is altered. To control this flow during operations to cover Pit 3, the topography at Pits 1, 2, 4, and the covered portion of Pit 3 has been changed and a system of ditches constructed to channel surface waters into the Clearwell and Pit 4. The surface water from Pit 4 is pumped into Pit 5 for settlement of suspended solids. Similarly, the suspended solids in surface drainage entering the Clearwell are settled therein, with the supernatant being subsequently discharged to the Miami River.

The top-of-dike level of Pit 5 is raised 10 feet or more above the surrounding area. Thus, the only surface drainage from Pit 5 is from the heavily grassed exposed outside dike slopes. This drainage is clean and uncontaminated, and flows to Paddy's Run Creek.

The Above-Grade Storage area will be designed to control surface runoff water and prevent any contamination of surface waters flowing to Paddy's Run. As shown in Figure 3 the storage area will be surrounded by a moat which will catch the surface water from the pile of stored cake. The moat will also be designed to retain any cake which might slip from the pile. Very little slippage has occurred on the test pile to date; however, should any significant slippage occur, it would be controlled by the moat and could be returned to the pile by the crane. The water in the moat can be monitored and pumped to the Clearwell for controlled discharge to the river. This procedure will be followed during the time the cake is being emplaced on the storage area (about 1.0 year) and during the drying period of 3-4 years. As noted above, the cake will then be reshaped to a more compact conical form, covered with a water repellant asphalt layer and with a layer of earth which will be planted with grass and shrubs. At that point, there will be no need to control drainage since the water will not contact the cake.

2.3.4 Air-borne Pollutants at the Chemical Waste Pits

Air-borne particulates are not a problem in the FMPC chemical waste pit area. Boundary air sampling stations nearest the area (see Figure 4) show particulate concentrations no higher than those found at similar stations elsewhere on the site.

Wet chemical waste pits by their very nature contribute no air-borne particulates. Even the solids remaining in an inactive wet pit drained of supernatant liquors retain sufficient water content to eliminate dusting as a problem. Since the liquors in an active wet pit are maintained in a basic state, there is no active evolution of fumes or gases. No odor is present except on occasion a faint smell of ammonia is detectable only at the very edge of the pit.

Dry chemical waste pits at FMPC are usually not a source of air-borne contamination by virtue of the type of materials deposited therein. Very little of the dry solids are of a granular nature or are otherwise of a type susceptible to dusting. Water and hoses are available at the dry pit and could be used if any dusting is detected.

There is no reason to expect any significant increase in air-borne contamination from the proposed Above-Grade Storage of Raffinate Cake. As described above, it was discovered in the laboratory phase of the project that the cake surface remains wet as drying proceeds which would prevent pick-up of the material by wind. This characteristic of the material has also been borne out so far by the field demonstration test. The material has been in place for 2.0 months of hot

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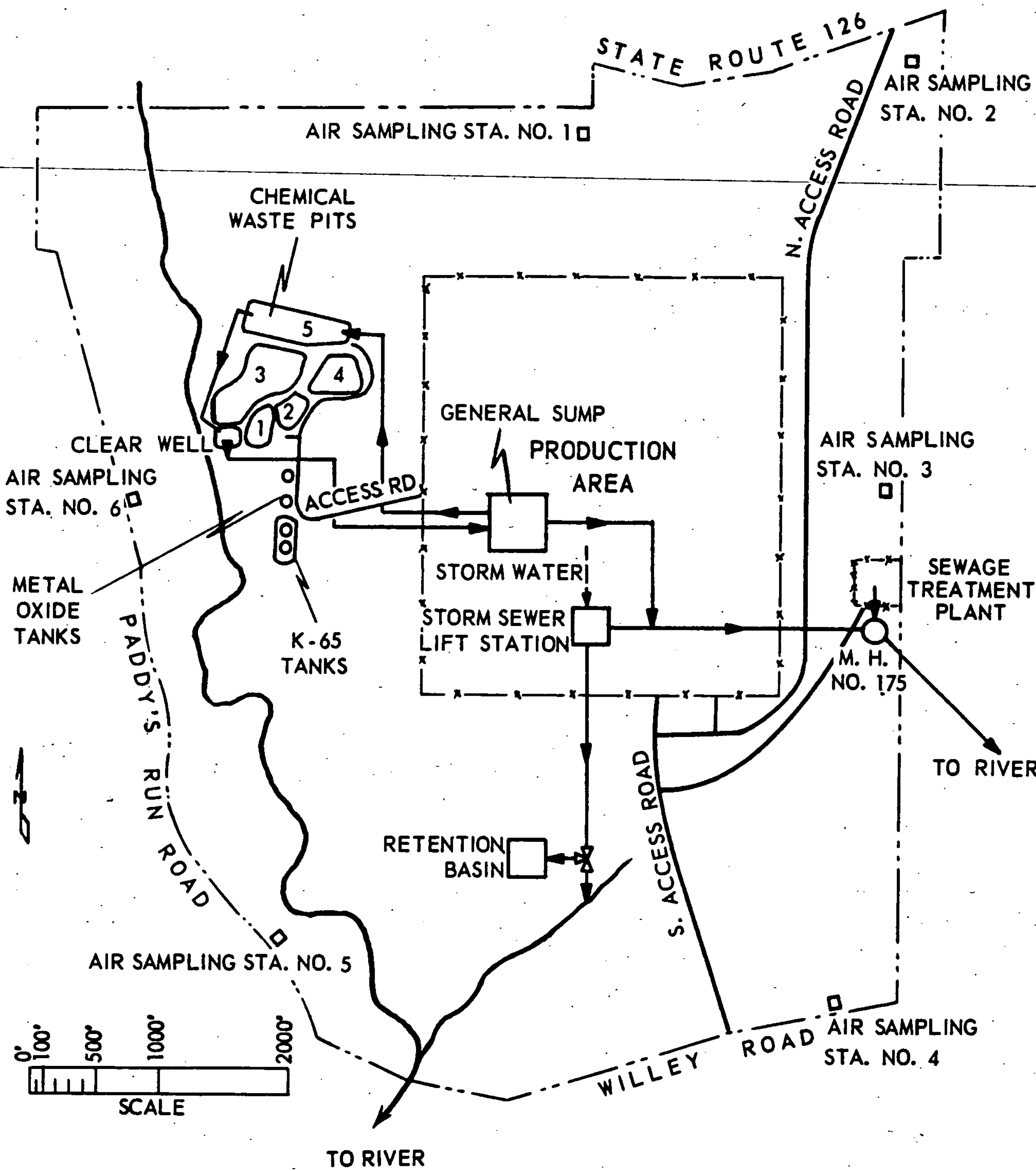

FIGURE 4 Waste Treatment, Storage Locations, and Perimeter Air Sampling Locations

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weather and the surface layer has lost about 20% of its original moisture; however, it is still slippery and wet and there is no evidence of dusting. Should surface dryness become a problem it could be controlled by water spraying.

2.4 Land Use

The proposed Above-Grade Storage will cover an area of about 1.0 acre during the filling and drying stages. After final retirement it will cover about 0.3 acre. This land is already occupied by Waste Pits 1 and 2, and there appears to be little prospect for any other use for it.

If there should be developed an economic process for the recovery of the uranium values from raffinate cake, the Above-Grade Storage pile would be easily accessible for retrieval and in a dry, easily handle-able condition. In this respect, it would be much preferable to pit stored sludge.

3.0 Conflicts with State, Regional and Local Programs

The proposed installation will not in any way violate or be in conflict with any known laws, ordinances, or regulations of the State of Ohio or any of its subdivisions or regulatory agencies.

4.0 Alternates

A number of alternates to the Above-Grade Storage proposal are currently being considered at FMPC. As indicated above in the Benefits Section, two of these alternates are; 1) Filtration of a portion of Pit 5 sludge and return of cake along with the raffinate cake to Pit 5, and 2) Construction of a new Pit 6. Both of these alternates are considerably more expensive than Above-Grade Storage and do not offer the advantage of compact storage of the material in a manner isolated from groundwater.