RADIOLOGICAL CHARACTERIZATION SURVEY PROGRAM

PLAINVILLE, MASSACHUSETTS SITE

ENGELHARD CORPORATION

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Table of Contents

Table of Contents (cont'd.)

Table of Tables

Table of Figures

1.0 INTRODUCTION

This Radiological Characterization Survey Program is a sampling and measurements program has been developed to characterize the radiological constituents and concentrations in the potential environmental pathways at the Engelhard Corporation's Plant on Route 152 in Plainville, Massachusetts. This facility, which formally operated as the D.E. Makepeace Division of Engelhard Industries, Inc., was previously used for the fabrication of nuclear fuel elements under U.S. Atomic Energy Commission (AEC) licenses SNM-185 and SUB-172 from 1957 until the licenses were terminated. License termination occurred after nuclear operations ceased in 1962, a decontamination program was conducted by Engelhard, and the AEC validated that the residual contamination levels and exposure levels at the facility were within then-established regulatory levels.

A subsequent radiation survey of the plant was conducted in July, 1988 by contractors to Engelhard which showed elevated (above background) gamma radiation in certain areas of the building interior and in an external drywell. Alpha radiation measurements and surface wipes taken during the survey also were elevated at a number of these locations. A decontamination program is planned for the interior building walls and floor areas in the locations showing elevated radioactivity. This interior decontamination program is the subject of a separate submittal.

A radiological Site Scoping Survey by Engelhard Contractors was also conducted in 1988 of soil and groundwater samples as part of a separate program to characterize the non-radiological constituents in environmental pathways. The Survey revealed areas of elevated (above background) concentrations of radioactivity in locations generally south of

the current building which previously housed the nuclear manufacturing operations. A discussion of the accumulated data base is provided in Section 4.0. Review of historical facility documents and drawings has also identified former incineration, solid waste handling, and liquid waste disposal operations (See Section 3.0) that also may be sources of elevated radioactivity. The planned follow-up site Radiological Characterization Survey described herein will confirm the locations, if any, and concentrations of radioactive materials in the environmental pathways at the Plainville facility.

2.0 OBJECTIVES OF THE RADIOLOGICAL CHARACTERIZATION SURVEY PROGRAM

The sampling and measurements program that is described in this submittal is designed to achieve the following objectives:

- Locate underground or covered facilities (i.e., piping, leach pits, collection boxes, equipment pads).
- Determine sources of elevated radioactivity, if any, in the soil and underground facilities at the site.
- Develop an inclusive data base that establishes the types and concentrations of radioactive constituents from such sources in the various environmental pathways (i.e. soil, ground and surface water, air) external to the current building.
- Confirm the "affected" and "unaffected" area designations.
- Define the volumes of contaminated material that may require remediation.
- Provide a basis for defining and assessing the viable remedial alternatives for decontamination of the site and for planning the subsequent decontamination effort.
- Determine the site parameters that will be used to define the health and safety program during the decontamination effort.

3.0 RELEVANT PLANT OPERATIONAL HISTORY

The available historical documentation in Engelhard and Nuclear Regulatory Commission (NRC) and AEC files has been reviewed to define the relevant operational history of the Plainville facility. This information has been supplemented by interviews with former employees. The following derives from this review.

Engelhard Corporation (previously the Makepeace Division of Engelhard Industries, Inc.) manufactured nuclear fuel elements at its plant on Route 152 in Plainville, Massachusetts from 1957 until cessation of operations in 1962. Manufacturing operations involved the use of natural uranium, enriched uranium, and depleted uranium. Figure 3-1 shows the plant building in which fuel element fabrication was conducted, and the surrounding area onsite. Fuel element fabrication operations were totally segregated from the non-nuclear manufacturing and other facilities.

There is no existing documentation as to the specific operational practices and procedures used in handling solid wastes generated in the nuclear operations. However, information from interviews with the Plant Engineer and Health Physicist revealed that all radiologically contaminated solid waste produced in the nuclear operations were collected, placed into 55 gallon drums, and trucked offsite to an AEC-approved disposal location. These filled solid waste drums were stored in a fenced area in the (then) courtyard prior to being sent off-site. The potential location of this storage area is shown on Figure 3-2.

An incinerator was constructed and operated on the site starting in approximately March 1960 and presumably through cessation of operations in 1962. The location of the incinerator, which has been established from an aerial photograph of the site and drawings

in NRC files, is shown in Figure 3-2. The original application to operate this incinerator (Durant-59) stated that:

> "the material to be incinerated will consist of uranium contaminated wood, papers, absorbent material, rags, etc. which show a reading of less than 20 mr/hr . . . This material is presently generated at the rate of approximately 200 lbs. per day and will require an average of two hours daily burning time. . . . After each lot of waste material has been burned, the ashes will be removed and placed in steel drums for storage until eventually disposed of by burial at sea. A maximum of 100 drums of ashes will be allowed to accumulate before being disposed."

Presumably these drums were stored in the courtyard with or close to the solid waste drums. It is not known where the drums with ashes were disposed of but it is likely they were shipped to the same AEC-approved disposal site as the solid waste drums.

A subsurface liquid waste disposal system to handle nuclear process waste water was installed at the Plant in 1957. The system was designed to handle wastes that "will consist of treated, monitored and decontamination wastes from natural uranium and enriched uranium processes, and from laundry, shower and laboratory wastes." (Sterling-57) A schematic of the then-proposed system is shown in Figure 3-3. No drawings showing the as-built location of the components of this system have been found. However, the 1957 proposed system plans specified "the subsurface disposal works to receive these liquid wastes will be located some 30 feet east of the south end of the building . . . It is initially proposed to install a large leaching pit constructed of concrete cesspool blocks with an inside diameter of 12 feet and an effective depth of 5 feet with an effective estimated diameter of approximately 18 feet. The bottom of the pit will be paved with 12 inches of filter sand". (Sterling-57) The liquid waste disposal system was monitored to assure that

radionuclide concentrations in the discharge to the leach field were within the then AEC release standards in 10CFR Part 20.

In January 1960, Engelhard requested the Massachusetts Department of Public Health approval for expansion of the liquid waste disposal system by the addition of another leaching pit (Weiss-60) and provided schematic drawings of the pit cross-section (Figure 3-4), and the distribution system (Figure 3-5). In a letter of February 4, 1960 (Taylor-60), the Department approved the addition noting that the pit had already been built, and that the "pit will be used as an overflow for the original leaching pit and is located 24 feet northeast of the original pit." There are no as-built drawings available providing specifics as to actual location of the pit.

In August 1961, during a Department of Public Health inspection of the plant it was noted that "when a load was applied to the system, liquid wastes containing radioactive material overflowed to the surface of the ground". (Taylor-61) The problem, which resulted from blocking of one of the pits by a scum from the waste, was apparently corrected by the addition of sulfuric acid, which cleared the blockage to the satisfaction of the Department and the AEC. (Kirkman-62). A high water alarm was also installed. There is no indication of any further problem with the system. Use of the system for nuclear waste water disposal apparently ended with the cessation of nuclear operations in 1962, although the same system may have continued to be used for non-nuclear waste water disposal until 1972 when industrial waste water was diverted to a new treatment system or until 1976 when remaining shower and sink wastes were diverted to a sanitary sewer.

The final radiological survey conducted by Engelhard Industries in 1963 subsequent

to performing decontamination operations as a basis for requesting license termination (Kirkman-62A) and the AEC inspector's validation survey, appear to have been limited to the building interior, facilities, and equipment. No data is available on radioactivity in the environmental media external to the building or on the outside facility surfaces. The licenses were terminated in the Fall of 1963 based on recommendations from the AEC Compliance Division (Lorenz-63).

In 1986, Engelhard Corporation initiated a multi-phase site assessment to identify any areas of environmental concern at the facility in response to a Request for Information from the United States Environmental Protection Agency relating to prior waste handling practices at the Plainville facility. Among the analyses conducted were gross alpha and beta levels in groundwater from a series of onsite monitoring wells, sediments and surface water in Turnpike Lake, and surface and subsurface soil samples from selected onsite locations including areas in the vicinity of the prior nuclear waste water disposal system and downhill areas that would have been affected by overflows. In addition, concentrations of specific radionuclides were assessed in several soil and sediment samples. The results of these Scoping Survey measurements are discussed in Section 4.0. In brief, the majority of the results showed radioactivity to be at or near background levels. There are however, some locations in the external area at the south end of the site where somewhat elevated levels of radioactivity were detected in soil and sediment.

As a result of the preliminary indications of the potential presence of radioactive materials in the environmental media external to the plant buildings, and the history of past waste management and disposal practices at the facility, the following survey program has

been developed to further characterize radioactivity in the soil, groundwater, surface water sediments, and air at the Plainville site:

- A surface gamma scan of the onsite yard and parking lot areas external to the plant on a referenced grid encompassing the "affected" area and adjacent open and paved areas.
- Emplacement of additional borings in the region at the south end of the site where elevated radioactivity has been detected, and collection and analysis of surface and subsurface soil samples in the grid blocks for gross radioactivity and selected radionuclides. Additional surface soil samples will be collected from any grids with elevated gamma levels. Collection and analysis of additional groundwater samples from existing monitoring wells for selected radionuclides. Collection and radionuclide analysis of additional sediment samples along Turnpike Lake shoreline adjacent to the south end of the site.
- Perimeter (boundary) and onsite monitoring of airborne particulates for specific radionuclides.
- Emplacement of borings through the floor pad of buildings 12 and 3 in the region of the former incinerator and exterior waste storage area, and collection and analysis of surface and subsurface soil samples for gross radioactivity and selected radionuclides.
- Use of sub-surface geophysical techniques to locate the components of both the original and expanded onsite subsurface liquid waste disposal system (piping, leach pits, etc.) generally south and east of the south end of the plant building. Once the

components have been located, soil borings will be emplaced in a pattern through this region to encompass the potential overflow area, and surface and subsurface soil samples will be collected and analyzed for gross radioactivity and selected radionuclides. Additional monitoring wells will be installed in this region (if required) and groundwater samples collected for radionuclide analysis.

The components of this Radiological Characterization Program are described in Section 8.0.

4.0 EXISTING RADIOLOGICAL DATA BASE FROM SCOPING SURVEY

A summary of the existing radiological data base for the external environmental pathways at the Plainville site is provided in this section. The radiological data was obtained during the 3-phase site investigation conducted by Environ Corporation from 1987-1989, and the Radiological Site Scoping Survey performed by Drs. Robert Berlin and Stanley Malsky in 1988 which, in total, constitute a Scoping Survey as defined in the Manual for Conducting Radiological Surveys in Support of License Termination (ORAU-92).

4.1 Radiological Analysis of Soil Samples

Surface and subsurface soil samples were collected by Environ during a soil boring program conducted in 1987-1988. Fifteen surface or near surface samples were collected from locations shown in Figure 4-1 and samples were collected at various depths from nine subsurface soil borings also shown in Figure 4-1. Table 4.1 is a description of each of the soil sampling locations. Gross alpha and beta analyses were performed on the samples. The results of the sample analysis are provided in Table 4.2 and Figure 4-2.

Three near surface samples from locations showing elevated gross alpha and beta readings were then analyzed for concentrations of specific radionuclides considered to be representative of the nuclear materials used in the fuel fabrication activities. The results of these analyses are provided in Table 4-3.

Using the gross alpha and beta readings from the samples at SB3 and SB4 of $\leq$ 0.6 pCi/g and $\leq$ 0.5 pCi/g respectively as representative of background indicates

varying levels of elevated radioactivity in the surface and subsurface soil samples at the other locations sampled generally south of the plant building with the maximum levels occurring in the region around the drywell on the surface and at depth (SB13, 14, and 15) and at hotspots on the surface (SB1, 9, and 17).

A drilling mud sample from MW5, which is located in proximity to the drywell and the potential subsurface leach pits was collected in September, 1987 and analyzed for gross alpha and individual radionuclide concentrations. The results are provided in Table 4.4.

4.2 Radiological Analysis of Groundwater Samples

Thirteen groundwater monitoring wells were installed by Environ at the facility in 1987 and 1988 as shown in Figure 4-3. Wells MW1 - MW9 and MW12 are shallow monitoring wells constructed in the water table zone; and wells MW13 - MW19 are deeper wells constructed in the bedrock aquifer zone. In addition, two existing offsite residential irrigation wells, denoted as MW-10 and MW11 were incorporated into the sampling program. Table 4.5 provides a description of each of the groundwater monitoring well locations.

Upgradient well MW7 is considered to provide background groundwater quality data. Groundwater flow is generally from the southwest to the northeast.

Groundwater samples have been collected from the wells since September, 1987 at different frequencies with the majority of the wells sampled at least annually through December, 1992. The results of the sample analysis for gross alpha and beta for this period are provided in Table 4.6.

None of the wells, once developed, show a pattern over time of gross alpha and beta readings in excess of the 15 pCi/l and 50 pCi/l drinking water standards, respectively, for the dissolved samples.

4.3 Radiological Analysis of Surface Water Samples

Surface water samples for radiological analysis were collected by Environ from 1987 through 1989 at locations in Turnpike Lake, from the creeks and low-lying area downgradient of the Lake, and from plant drain outfalls as shown on Figure 4-4 and described in Table 4.7. The results of the sample analysis for gross alpha and beta for this period are provided in Table 4.8. No specific radionuclide analyses have been performed of surface water samples.

In no case have the gross alpha and beta readings exceeded normal background levels for the region, nor is there any pattern of increasing levels with time.

4.4 Radiological Analysis of Sediment Samples

Sediment samples were collected at locations in Turnpike Lake SW1 - SW4 (See Figure 4-4 and Table 4.7) in September 1987 and analyzed for gross alpha and beta levels. The results of this analyses are provided in Table 4.9. Since SW3 and SW4 are remote from areas used for manufacturing operations and runoff pathways, they are likely representative of background conditions. Comparatively, the gross radioactivity at SW1 indicates elevated radionuclide concentrations at this location which is offshore of the areas where surface water runoff enters the Lake from the facility.

4.5 Radiological Analysis of Fish Samples

Fish samples were collected from Turnpike Lake and the impoundment east of Route 152 during the Phase III investigation. The results of the sample analysis for gross alpha and beta for this period are provided in Table 4.10. The gross alpha and beta readings do not indicate any concentration of radioactivity in the tissue of the fish. No specific radionuclide analyses were performed of the fish samples.

4.6 Radiation Survey of Region Exterior to Plant Building

In July 1988, a radiation survey of the interior and exterior of the plant buildings at Plainville and the surrounding yard areas was conducted. The survey of the exterior areas consisted of measurements of ambient gamma levels at 3 feet above the surface in the north parking lot and adjacent wooded areas to establish background, the region south of the plant in the yard and along the fence, and in and around the drywell in the yard at the southeast corner of the plant. The results of these measurements are as follows:

Location	Gamma Reading (μr/hr)
External background locations	18-22
Yard region south of the plant	20-22
Along the fence at the south end adjacent to Turnpike Lake	20-26
Drywell:	
At surface and over adjacent ground area	18-20
In center of drywell, 2-3' from bottom	75

The gamma radiation level at the bottom of the drywell was elevated, reflecting the existence of a radiological source in this area. An alpha probe was lowered into

the drywell and, while it was not possible to get precise readings, the probe showed somewhat elevated levels (approx. 200 dpm/100 cm^2) above the bottom surface.

Radiological analysis of a sample of the "sediment" collected at the bottom of the drywell was performed in August, 1988. The results are provided in Table 4.11. The gross radioactivity, and the U-238, U-234, and U-235 concentrations in this sample were significantly elevated.

4.7 Potentially Affected and Unaffected Areas

Based on the results of the historical review and the Site Scoping Survey, an initial determination of potentially affected and unaffected areas has been made. The "Potentially Affected" area, as shown in Figure 4-5, encompasses the region exterior to the south end of the plant from the plant to the shore of Turnpike Lake, and to the east of the plant beyond the suspected location of the underground leach pits. This region includes the possible waste storage areas, the incinerator location, drainage outfalls from the plant, subsurface liquid waste disposal system, and areas that may have been impacted by contaminant dispersion from these locations. The remainder of the site has been classified as "Unaffected."

5.0 RESIDUAL CONTAMINATION GUIDELINES

The historical documentation of nuclear fuel fabrication operations at the Plainville plant has clearly shown that, from a nuclear standpoint, only uranium was handled and processed at the plant. Thus, the characterization program will focus on establishing levels and distribution of the relevant uranium isotopes. These are U238, U235, and U234.

The NRC enriched uranium unrestricted release standard of 30 pCi/g total uranium (NRC-81, Austin-92) will be used to determine whether the soil and sediment concentrations measured in this characterization program demonstrate the need for decontamination. A reference standard of 20 μg/l (30 pCi/l) of total uranium will be used to assess groundwater samples as well as the total gross alpha and beta primary drinking water standards of 15 pCi/l and 50 pCi/l, respectively.

Some of the locations at which soil and sediment may be characterized may contain other nonradiological metals, which could result in the soils/sediments being classified as hazardous wastes or mixed wastes under current U.S. EPA and Commonwealth of Massachusetts criteria. Testing of selected soil/sediment samples for TC metals will assess whether those samples potentially could be classified as hazardous or mixed wastes.

6.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

Mr. Donald Chabot, the Engelhard Plant Engineer at the Plainville facility, will be Engelhard's onsite program manager for the performance of the radiological characterization program. Mr. Chabot is responsible for site characterizations and remediation activities at the site. As program manager, he will supervise the activities of the contractors performing the onsite sampling and measurement programs, assure that the proposed work scope is achieved, and that the compiled data base is sufficient to permit achieving the objective of the Radiological Characterization Survey Program. Mr. Chabot will also oversee health and safety during the program. He will be Engelhard's point of contact with the NRC.

The selected geophysical survey contractor will have experience in performing similar surveys under comparable conditions. Relevant company and personnel experience, and the quality of the survey results will be a primary consideration in selection of the contractor.

The media sampling and measurements program will be performed by Drs. Robert Berlin and William Duggan with the assistance of experienced radiological technicians. Both Drs. Berlin and Duggan have extensive experience with the Plainville operations and in the management and performance of radiological characterization programs at other sites. Both have conducted these programs using NRC guidelines and state-of-the-art instrumentation, and in accordance with current QA/QC standards as defined in NUREG/CR-5849. They will be responsible for collection and transport of media samples, measurement of exposure rates, supervision of a drilling contractor,

selection and oversight of a qualified analytical laboratory, completion and interpretation of the resultant database, and preparation of the site characterization report inclusive of the preliminary dose assessment. If necessary, they will assist Engelhard in the evaluation of decontamination alternatives and in the selection of a viable decontamination approach.

Resumes for Mr. Chabot and Drs. Berlin and Duggan are provided in Appendix A.

A drilling contractor will be used (as necessary) for the emplacement of additional subsurface borings and wells. The selected contractor will be experienced in performing drilling at contaminated sites, and will thus employ personnel who are trained in use of appropriate health and safety precautions and equipment. Consideration will be given to the use of the drilling contractor who satisfactorily emplaced borings and wells during the prior scoping survey program.

Two analytical laboratories will be used, one for primary analysis of the collected samples and a second for analysis of field duplicate samples. The selected laboratories will be NRC/EPA qualified facilities, participate in industrial and regulatory QA/QC verification programs, and be experienced in performing the radiological and any necessary TCLP analyses. (See Section 9.0 for further discussion of laboratory analyses.)

7.0 SUBSURFACE INVESTIGATIONS - GEOPHYSICAL TECHNIQUES

The historical review of facility operations suggests the need for sub-surface investigations. A liquid waste disposal system was used to discharge liquid effluents through leach pits. Consistent with the overall objective of site clean-up, it will be necessary to identify and characterize the locations of the components of the disposal system.

The disposal system was operated on the site until 1962 to treat waste water from licensed operations. While the pit construction details are available through design drawings, the exact location of the piping and leach pits are unknown. However, the general region of the components has been identified.

The suspected region for the liquid waste disposal system comprises approximately 80,000 ft^2, a major part of which is covered by an asphalt parking lot. There are several non-intrusive geophysical technologies which may be appropriate depending on the search target and search conditions. These include ground penetrating radar (GPR), electro-magnetic detection, and magnetometry and are discussed below.

Ground Penetrating Radar

In Ground Penetrating Radar (GPR), a pulse of radio waves is sent into the ground. Interfaces between different materials reflect the waves toward the surface, where they are detected in a receiving antenna and recorded. The sending and receiving antennae are moved around the site, generating a profile of subsurface conditions.

Materials with high electrical conductivity strongly attenuate the radio signal, which can limit the effectiveness of GPR. However, GPR can accurately show areas which have

been excavated or contain inhomogeneities, making it one of the most accurate geophysical techniques for identifying subsurface disturbed areas.

Electromagnetic Conductivity

This technique measures the conductivity of the ground, which may have been changed by emplacement of fill or waste materials. The method is generally effective to about three meters, but metallic objects can be detected to greater depths. It can determine horizontal variations, but is limited in identifying vertical extent. Power lines, utilities, and other metal structures (e.g., cars) can affect results.

Magnetometry

A magnetometer measures the total magnetic field and vertical gradient of the earth. This is useful in characterization efforts since ferromagnetic objects such as pipes increase the magnetic susceptibility. This method can also be affected by power lines, utilities, and other metal structures.

A qualified geophysical subcontractor will be employed to use one or more of the above-described techniques to identify the location of the subsurface components. A 2-3 day investigation is planned to cover the 80,000 ft^2 area. The results of the study will be used to establish sampling and measurement locations that will permit characterization of the regions that may have been contaminated by discharge through the subsurface facilities.

8.0 SAMPLING AND MEASUREMENTS PROGRAM

A sampling and measurements (characterization) program will be conducted at the Plainville site to supplement the radiological data base previously compiled by the Scoping Survey in the environmental media external to the Plant, (See Section 4.0) and to provide a sufficient data base to permit the full radiological characterization of the site and thus establish the basis for defining remedial alternatives. The program, which will be consistent with the guidelines in NUREG/CR-5849, will consist of:

- A gamma radiation survey of the exterior regions, from the building to the site boundary.
- Collection and analysis of surface and subsurface soil samples for U238, U235, and U234 concentrations from the regions of the site south of the building, under and adjacent to the Building 12 floor pad, and the location of components of the subsurface liquid waste disposal system (piping, leach pits, etc.) south and east of the south end of the building.
- Collection and analysis of groundwater samples for gross activity, U238, U235, and U234 concentrations from certain of the existing groundwater monitoring wells and (as necessary) from additional wells installed in regions of elevated soil concentrations.
- Collection and analysis of sediment samples for U238, U235, and U234 concentrations from the shoreline of Turnpike Lake adjacent to the south end of the site.

- Collection and analysis of airborne particulates for gross activity, U238, U235 and U234 concentrations onsite and at selected perimeter locations.

These program components are discussed in detail below.

8.1 Surface Radiation Survey

A surface gamma scan will be initially conducted over the onsite open yard and parking lot areas external to the Plant (See Figure 8-1) to identify areas of elevated surface radiation levels. A grid will be established over the area to reference the radiological survey. A grid interval of 10 meters(m) will be used in the potentially affected area (Figure 4-5) except where the existing data indicates the presence of a radiological source where a decreased interval will be used. One hundred percent coverage of the potentially affected area will be achieved. A minimum of 10 percent coverage will be attained by scanning in the unaffected area of the site using a larger grid interval. The scan will be conducted using a calibrated sodium iodide gamma scintillator, portable rotameter scaler, or equivalent, and will involve observing the variation in count rate from ambient (background) levels as the grid blocks are slowly traversed with the probe swinging in front of the body. Areas of increased count rate will be marked (flagged) and these locations noted on a survey form.

Confirmatory stationary gamma radiation measurements will then be made in those grid blocks showing elevated readings from the scan. The exposure rate will be determined at 1 cm and 1 m above the surface and recorded on a survey form.

8.2 Surface and Subsurface Soil Sampling

Soil sampling and analysis is the most significant component of the

characterization program. It is the primary basis for assessing the types, distribution, and concentration of the radiological constituents in the soil. Both surface and subsurface sampling will be required at the Plainville site; surface sampling to assess any deposition of radioactive material from effluent streams (i.e., spills, seepage from containers, airborne and effluent water particle deposition); and subsurface sampling to assess any contamination from the liquid waste distribution system.

8.2.1 Surface Sampling

Surface soil samples will be collected at the following locations in the potentially affected area (as shown on Figure 8-2):

- Identified locations based on the results of the prior gross radioactivity analysis of soil samples (See Section 4.1).
  - Adjacent to the drywell at the southeast corner of the building in the vicinity of prior sampling locations SB13 and 14. Eight samples will be collected in the grid blocks surrounding the drywell.
  - In the six grid blocks encompassing locations SB1, SB9, and SB17 which showed high gross radioactivity readings in the prior sampling. Twelve samples will be collected.
  - At each grid intersection along the area south of the building to the property boundary (Turnpike Lake shoreline) encompassing the region from the prior sampling locations SB25 through SB16. Approximately 35 additional samples will be collected (to be determined after grid locations are established).
- In any grid block in other external areas shown to exhibit elevated gamma

levels by the surface radiation survey (See Section 8.1).

- Soil samples will also be collected from randomly selected locations in Unaffected Areas of the site.

In addition, split samples will be collected from 10% of the sample locations. Selected samples will be analyzed for U238, U235, and U234 concentrations to establish the isotopic activity ratios and the remainder of the samples will then be analyzed for U238 and U235 by gamma spectrometry.

Surface soil samples will encompass the upper 15cm of soil. Approximately 1 kg. of soil will be collected and packaged for analysis. The sample container will be labeled, secured, and pertinent data recorded on field record forms and chain-of custody documents. This same procedure will be followed for all samples sent for laboratory analysis.

8.2.2 Subsurface Sampling

Subsurface samples will be collected from borings at the following locations in the affected area (See Figure 8-3) to depths determined from the results of the prior subsurface sampling program and from the use of gamma logging techniques.

- Identified locations based on the results of the prior gross radioactivity analysis of subsurface soil samples (See Section 4.1).
- Through the bottom of the drywell at the southeast corner of the building, and in the grids adjacent to and surrounding the drywell to encompass the region inclusive of locations SB13 and 14. Five borings will be drilled.

- At selected grid locations along the area south of the plant building to the property boundary (Turnpike Lake shoreline) encompassing the region from the prior sampling locations SB25 through SB16. Approximately 12 borings will be drilled in this region.

- Through the floor pad of building No. 12 and in the exterior region adjacent to building 12 to determine if any residue remains from the waste storage facility. Four borings will be drilled.

- In the grids encompassing the components of the subsurface liquid waste disposal system (piping, leach pits, etc.) identified by the subsurface geophysical measurements generally to the south and east of the south end of the plant. Since the piping and other components of this system are likely to be found in the regions to be investigated in association with borings around the drywell and south of the of the plant (see prior discussion), the borings and subsurface samples collected to characterize any contamination from the liquid waste disposal system will be concentrated in the region of the leach pits and discharge overflow once these are located.

In addition, 10% split samples will be collected in the subsurface investigations. Selected samples will be analyzed for U238, U235, and U234 concentrations to establish the isotopic activity ratios and the remainder of the samples will then be analyzed for U238 and U235 by gamma spectrometry.

The initial depth of borings at the south end will be determined from the gross activity measurements taken in the prior scoping subsurface investigations which

showed variable levels of contamination to a depth of approximately eight feet. In other regions, analysis as to buried component depths and possible extent of contaminant dispersion will provide a basis for assessing initial depths. Hole depths will be conservatively drilled to below the limit assessed for contamination. Gamma logging, using a scintillation detector, will be used to indicate locations and relative levels of radioactivity (above background) in the soil. Readings will be made at the surface, 15 cm below the surface, and at 30 cm intervals below until background gamma levels are recorded, extending the depths of the hole as necessary to reach background levels. Soil samples will be collected for radionuclide analysis at approximately 60 cm (two feet) intervals inclusive of the bottom of the hole in the "clean" region. Assuming an average hole depth of 6-7 feet, or four soil samples per hole, (including the surface) gives approximately 110 samples (including splits) excluding the unknown number of samples from the borings in the region of the subsurface liquid disposal system.

8.3 Groundwater Sampling

Groundwater will be sampled to determine whether and to what extent radiological contaminants may have migrated from the surrounding soil through the pathways. Groundwater grab samples will be collected from the following locations;

- The 19 existing monitoring wells (See Figure 4-3 and Table 4.4)
- Water found at the bottom of any the auger holes
- Any monitoring wells to be established downgradient of the discharge area of the subsurface liquid waste disposal system (assume 2 wells)

Ten percent split quality control samples will also be collected. All groundwater samples will be analyzed for gross alpha and beta activity, U238, U235, and U234.

8.4 Sediment Sampling

Sediment sampling from Turnpike Lake will provide an indication of whether undissolved radionuclides are present from runoff from contaminated surface soil, and/or building outfalls and thus give an early indication whether the potential for surface water contamination exists.

Seven sediment samples plus one duplicate sample will be collected along the Turnpike Lake shoreline. Location SW1 and SW2, which were sampled in the prior investigations (see Section 4.4) will be sampled, as will a background location (near SW4) and four additional shoreline locations where surface water runoff enters the Lake or in proximity to contaminated surface soil. The samples (and an additional split) will be analyzed for gross radioactivity, U238 and U235 by gamma spectrometry after isotopic activity ratios to U234 have been established.

8.5 Air Sampling

Sampling and analysis of ambient airborne particulates will be performed at selected perimeter (boundary) locations and in the region of potential soil remediation to determine current concentrations of airborne radionuclides and establish a baseline to compare airborne concentrations during soil movement activities. Five perimeter locations and two onsite locations (See Figure 8-5) will be sampled using a high-volume air sampler with a glass fiber filter. The samples will be collected for eight

hours. The eight samples (including one split) will be analyzed for U238, U235, and U234 as described above.

8.6 Background Level Determinations

Exposure rate measurements will be performed at 6-8 unaffected locations within 0.5 to 2 km of the site to establish background exposure rates. Background soil samples will also be collected from locations of external background exposure rate measurements. Statistical analysis will be performed of the results of these background measurements to assure that the average values determined are representative of the true averages, as described in NUREG/CR-5849. Additional background sampling or measurements will be performed if necessary to satisfy the criteria. Since it is anticipated that contamination levels may be close to background, establishment of statistically significant background levels is important in the interpretation of the data.

8.7 Summary of Sampling and Measurement Program

The sampling and measurement program described in Section 8.1 - 8.6 is summarized in Table 8.1.

9.0 ANALYTICAL LABORATORY

9.1 Criteria for Selection

The selected independent analytical laboratory(s) will be a licensed facility experienced in the performance of radiochemical and gamma spectroscopy analysis of similar types of samples, and will adhere to the analytical and QA/QC requirements of NUREG/CR-5849 and the other guidance documents discussed in Section 11.0. In addition, the laboratory(s) will participate in the EPA Environmental Radioactivity Laboratory Intercomparison Studies (cross-check) Program and/or the comparable program conducted by the Environmental Measurements Laboratory (EML).

Two laboratories will be selected; one for the basic analytical program and one for the analysis of splits of field samples.

Chain-of-custody documentation will be required for all samples from packaging at the site to receipt at the laboratory and through completion of analysis. The laboratories will also be required to perform, as appropriate, TCLP analysis of soil samples.

9.2 Analysis and Reporting

Selected soil, sediment and air filter samples will initially be analyzed for U238, U235, and U234 concentrations using wet chemistry separation to establish the isotopic activity ratios between these constituents. Once these ratios have been confirmed, these samples will be analyzed for U238 and U235 by gamma spectrometry and total uranium calculated on the basis of the isotopic activity ratios. Gross alpha and beta levels in water samples will be counted in a low background gas proportional counter.

Subsequent isotopic analysis on water samples will use gamma spectrometry.

The laboratories will provide a report incorporating the tabulated analytical results (with error and LLD) and identifying parameters for each sample. A QC report will also be provided for each type and batch of samples, as will copies of the chain-of-custody documents. These will be appended to the site characterization report.

10.0 PROGRAM SCHEDULE AND MILESTONES

The bar chart schedule in Figure 10-1 indicates that a draft report will be available approximately 25 weeks after initiation of the program, contingent on suitable weather for performing the field sampling and measurements. Engelhard will consult with the NRC should any unplanned circumstances arise that cause revisions in the program milestones or schedule. The following interim milestones are projected for the Program:

Milestone	Completion Time (weeks)
1. Preparation of Health and Safety Plan; QA/QC Plan; data sheets	4
2. Preparation of geophysical bid package	3
3. Receipt of geophysical bids	5
4. Award of geophysical contract	6
5. Preparation of driller bid package	4
6. Receipt of driller bids	6
7. Award of driller contract	7
8. Selection of Analytical Laboratory (s)	2
9. Site Gamma scan/survey	8
10. Geophysical onsite program	8
11. Geophysical survey report	9
12. Surface Soil Sampling	9
13. Subsurface drilling and sampling	10
14. Groundwater sampling	10
15. Surface Water Sampling	9

Milestone	Completion Time (weeks)
16. Sediment Sampling	9
17. Air Particulate Sampling	10
18. Laboratory analyses of all samples available (Report)	17
19. Draft Site Characterization Report	25

11.0 DOCUMENTATION AND REPORTING

11.1 Field and Laboratory Measurements Reports

Every aspect of the sampling, measurements and analysis program will be documented and archived for future reference. Thus, all field data, notes, measurements, calibrations, and other pertinent information will be recorded and maintained.

The following information will be documented for all individual instrumental measurements and laboratory analytical results:

1. Location of measurement or sample referenced to the grid
2. Date of measurement or sample collection and name and signature of field professional
3. Measured concentrations of specific radionuclides (pCi/l for air and water samples; pCi/g for soil and sediment samples) and radiation sources (gamma in μr/hr, alpha in dpm/100 cm^2)
4. Analytical error at 95% confidence level for all analyses
5. Analysis date and name and signature of analyst
6. Instrumentation specifications and calibration data
7. Name and signature of person verifying results
8. Lower limit of detection (LLD)

In addition, the following information will be provided for the overall program:

a. Description of survey and sampling equipment

b. Survey and sampling procedures

c. Analytical procedures (by reference to standard procedures)

d. Calculational methods

e. Calibration procedures

f. Calculation of LLD

g. QA/QC program parameters

The results of the Site Radiological Characterization Survey Program will be presented in tabular form and also on scale drawings of the site (as appropriate). Accompanying textual material will interpret the results in the context of site conditions and provide items a-g above as appropriate for each data base. The results of the geophysical program will be summarized in connection with the discussion of locations sampled and analyzed for radionuclides in subsurface soil. Copies of laboratory reports and field data sheets incorporating items 1-8 above and subcontractor reports will also be provided.

11.2 Site Characterization Report

A Site Characterization Report will be prepared incorporating the following material:

1. General Information - Site background and setting, and a preliminary evaluation of the type and distribution of radiological contamination.

2. Preliminary Dose Assessment - Estimate of radiological dose, and modeling the potential dispersion of the characterized source along identified exposure pathways to the potentially exposed population.

3. Physical Characteristics of the Site - The Plainville site physical characteristics

have been defined during prior site investigations conducted by Engelhard. (Environ-90) This data will be used to establish pathway dispersion and receptor parameters and to assist in the planning of this decontamination program.

4. Extent and Distribution of Contamination - The database compiled during the Site sampling, measurements and analysis program, and its interpretation.

5. Conclusions - The extent that the data demonstrates compliance with current cleanup criteria, and the need for any additional characterization to establish and assess remedial designs.

Appendices will be provided incorporating data sheets and subcontractor reports.

12.0 REGULATORY STANDARDS AND GUIDANCE

Engelhard intends to conduct the Radiological Characterization Survey Program at the Plainville site in accordance with existing NRC guidance for the content and performance of such programs. The program will conform to the provisions of the draft "Guidance Manual for Conducting Radiological Surveys in Support of License Termination" (NUREG/CR-5849) of June, 1992.

The relevant provisions of the following guidance documents provide further elaboration as to the specific field and laboratory techniques to be used, and the program to be performed by Engelhard and its subcontractors is also intended to achieve their objectives:

- "Survey Procedures Manual for the ORAU Environmental Survey and Site Assessment Program," Oak Ridge Associated University, March, 1990.
- "Monitoring and Compliance with Decommissioning Termination Survey Criteria," NUREG/CR-2082, June 1981.
- "Laboratory Procedures Manual for the Environmental Survey and Site Assessment Program," Revision 5, Oak Ridge Associated University, February, 1990.
- Quality Assurance Manual for the Oak Ridge Associated University's Environmental Survey and Site Assessment Program," Revision 3, Oak Ridge Associated University, February 1990.
- "Quality Assurance for Radiological Monitoring Programs - Effluent Streams and the Environment," USNRC Regulatory Guide, 4-15, Revision 1, February 1979.
- Guidance on the Application of Quality Assurance for Characterizing, a Low-Level Radioactive Waste Disposal Site," NUREG - 1383, October 1990.

13.0 HEALTH AND SAFETY

Established health and safety policies and procedures will be adhered to in performance of the onsite radiological sampling and measurements program. The objective of the health and safety activities will be to assure that exposures to radioactivity and nonradiological contaminants and releases to the environment are controlled to as-low-as-reasonably achievable (ALARA) levels, to minimize the risk of injury, and to assure compliance with applicable Federal and State regulations.

13.1 Health and Safety Organization and Responsibilities

Donald Chabot, the Engelhard program manager for the Radiological Characterization Program, will provide management oversight in health and safety. Robert Berlin will be the project radiation safety officer (RSO). The RSO will establish project health and safety criteria, develop the health and safety plan, validate that personnel have the appropriate training and medical certification, ensure that appropriate protective clothing and procedures are employed, and that exposure and contamination levels are monitored. The program manager will approve the health and safety plan, and audit the ongoing health and safety program to assure that protective work rules established for the project are adhered to, and that the required contamination control and radiation control support surveys are conducted.

13.2 Health and Safety Concerns

The primary health and safety concerns during the characterization program will be potential worker exposure through inhalation, ingestion, and direct radiation during soil movement activities (i.e. drilling and sample collection) and the common potential

hazards found on industrial sites. Surface radiation levels measured during the Scoping Survey indicate that exposure levels to workers during other measurement activities will be quite low.

The protective measures and guidelines established for the project will be based on the levels measured during the Scoping Survey and will be revised if actual conditions during the characterization survey require a different level of protection.

There are no current plant operations being conducted in the potentially affected area or adjacent locations. The only personnel in the area at the time of the sampling and intrusive investigations will be those involved in the performance of the Characterization Survey.

13.3 Health and Safety Plan

A health and safety plan will be prepared by the RSO specific to the onsite sampling and measurements program and approved by the Engelhard Program Manager. The plan will cover personnel qualifications and responsibilities, applicable health and safety standards, procedures to follow for a range of accident or emergency conditions, use of protective clothing and equipment, emergency services and contacts, radiation and contamination monitoring (survey) and decontamination, designation of work and clean zones, and documentation requirements. Copies of this plan will be provided to all personnel working on the site.

13.4 Training

All personnel assigned to the performance of the sampling and measurements program will have received the required health and safety training prior to their

assignment at the Plainville site. The RSO will also conduct health and safety instruction specific to this program and site conditions (level of hazard) and background of the personnel.

13.5 Records

A record of health and safety-related activities will be kept as part of the site log. Records of equipment survey results, instances of personal contamination and steps taken to remove the contaminant, and accidents and responses to them will be documented in the site log.

14.0 QUALITY ASSURANCE AND QUALITY CONTROL (QA/QC)

The onsite sampling and measurements program will be conducted in accordance with NRC and industry QA/QC policies and procedures. Thomas Brown, the Engelhard Corporate Manager of Environmental Affairs, will be QA Officer for the characterization program. Mr. Brown, who will not be directly involved in the onsite program, will provide Engelhard's QA oversight of the work and will coordinate his findings with the Project Manager. Mr. Brown will be the focal point for QA activities and in this role conduct periodic audits of field operations and review selected field and analytical data to validate adherence to procedures and achievement of acceptable data quality. Any deficiencies will be documented and project personnel will be required to resolve these deficiencies. Mr. Brown's resume is provided in Appendix A.

In implementing the QA program, guidelines for acceptable QA practices and procedures will be based on (1) NRC Regulatory Guide 4.15, "Quality Assurance for Radiological Monitoring Programs - Effluent Streams and the Environment," 1979 and (2) ANSI/ASME NQA-1, "Quality Assurance Program Requirements for Nuclear Facilities," 1989. Laboratory subcontractor QA procedures will be evaluated as part of the selection process to assure compliance with Engelhard and regulatory QA standards.

Specific procedures of direct relevance to the sampling and measurements program include:

- Instrument calibration and operational checks - calibration dates will be verified on all instrumentation and analytical equipment prior to use and, if out-of-calibration, the instruments will be tagged and removed from the site. The instrumentation will

be calibrated based on NIST - traceable standards (or equivalent) and calibration records will be maintained. Appropriate operational checks will be made on all instruments prior to each days use.

- Radiological Surveys - all sampling and measurements will be performed by Messrs. Berlin and Duggan and trained radiological technicians working under their supervision. The program will be performed in accordance with standard, written procedures. Each component of the characterization survey will be documented to develop a record suitable for stand alone internal audit and regulatory review. Survey procedures developed for the project will be based on guidance provided in NUREG/CR-5849. The Project Manager will approve all procedures and a subsequent revisions.
- Sample Chain-of-Custody - Acceptable chain-of-custody will be maintained on all samples at all times from collection through analysis and final disposition. This will involve either the direct surveillance by an individual assigned to the project, storage of the sample in a tamper-free container, or in a controlled access facility. Chain-of-custody forms will be used to record individual responsibility for a sample and transferral to another individual. Custody of each sample will be documented from field to transport to laboratory. Completed chain-of-custody records will be kept and will be available as part of the QA/QC documentation.
- Laboratory Quality Control - the selected analytical laboratory(s) will participate in the EML and/or EPA cross check programs, will have an established reputation for radiological analysis, be subject to NRC and/or EPA audit, and perform radiological

analyses and QA/QC in a manner consistent with standard government laboratory procedures. QA samples (i.e. duplicates, spikes, and blanks) will be used to monitor the laboratory performance at a minimum rate of 10% QA samples for each batch of samples.

- Data Management - The data management program will conform with the guidance provided in NUREG/CR-5849. In-progress field procedural information and data will be recorded in bound logs or pre-developed forms. Original sample log-in books and laboratory analytical results will remain in the laboratory's files. Original field site data (records, logs) will remain in custody of the Project Manager during report preparation and archived in Engelhard files for 5 years after release of the site. Duplicates of important records and data will be kept in Engelhard's corporate office in Iselin, New Jersey. Only copies of original field and laboratory data will be released to non-program personnel. Laboratory data will be reported at uncertainties at the 95% confidence level and detection sensitivities will be based on 4.66 times the standard deviation of the background count rate in conformance with NRC guidance. Detection sensitivities will be reported. All calculations using the recorded field data or laboratory results will be reviewed and formally validated.

REFERENCE

(Durant -59) Letter, J.H. Durant of Engelhard Industries to USAEC, Reference: License SNM-185 Docket 70-139, December 15, 1959.

(Sterling-57) Letter, C.I. Sterling of Department of Public Health of the Commonwealth of Massachusetts to D.E. Makepeace Company, Re: Plainville - RaN - Radioactive Waste Disposal from D.E. Makepeace Company, Route 152, August 20, 1957.

(Weiss-60) Letter, N.M. Weiss of Engelhard Industries Inc. to Department of Public Health, Commonwealth of Massachusetts, January 14, 1960.

(Taylor-60) Letter, W.H. Taylor of Department of Public Health to D.E. Makepeace Division, Re: Plainville - Enlargement of Radioactive Waste Disposal System at Engelhard Industries, D.E. Makepeace Division, Route 152, February 4, 1960.

(Taylor-61) Letter, W.H. Taylor of Department of Public Health to D.E. Makepeace Division, Re: Plainville - Radioactive Liquid Waste Disposal System at Engelhard Industries, D.E. Makepeace Division, Route 152, August 9, 1961.

(Kirkman-62) Internal AEC Memo, R.W. Kirkman to L. Dubinski, subject - Engelhard Industries, Inc., Attleboro, Massachusetts, License Nos. SNM-185 (Docket 70-139) and SUB-172 - Alleged Deficiencies in Waste Disposal System, May 7, 1962.

(Kirkman - 62A) Internal AEC Memo, R.W. Kirkman to L. Dubinski, subject: Engelhard, Inc. (D.E. Makepeace Division) Request for Cancellation of License SNM-185 and SUB-172, December 21, 1962.

(Lorenz-63) Internal AEC Memo, W.R. Lorenz to R.B. Chitwood subject: Engelhard Industries, Inc. Makepeace Division, Attleboro, Massachusetts, License No. SNM-185 and SUB-172 - Request for Close-Out Inspection, August 13, 1963.

(ORAU-92) Oak Ridge Associated Universities (J.D. Berger), "Manual for Conducting Radiological Surveys in Support of License Termination," NUREG/CR-5849, June 1992.

REFERENCE (cont'd.)

(NRC-81) U.S. Nuclear Regulatory Commission, Branch Technical Position "Disposal or Onsite Storage of Thorium or Uranium Waste From Past Operations," 46FR52061, 1981.

(Austin-92) Letter, J. H. Austin of U.S. NRC to D. Chabot of Engelhard, Docket No. 70-139, November 23, 1992.

TABLE 4.1

SOIL BORING LOCATIONS

SB01 -	On southern shoreline of facility near SW01
SB02 -	On southern shoreline of facility near SW02
SB03 -	East of central side of main building, near Route 152, adjacent to MW04
SB04 -	West of building 11, northwest part of site; adjacent to MW07; background boring
SB05 through SB12 -	Along southern property boundary (lake shore); numbers increase eastward
SB13 and SB14 -	Adjacent to drywell at southeast corner of building
SB15 -	Dry well sediments at southeast corner of building
SB16 through SB25 -	Along southern property boundary (lake shore); numbers increase eastward

TABLE 4.2
SUMMARY OF ANALYTICAL RESULTS FOR SOIL SAMPLES
(GROSS ALPHA AND BETA)

Sampling Location	Sampling Date	Depth [ft]	Gross Alpha [pCi/g]	Gross Beta [pCi/g]
SB01	87.0902	0.0-0.5	42	136
SB02	87.0902	0.0-0.5	0.90	0.55
SB03	87.0729	0.0-4.0	0.60	0.49
SB04	87.0728	0.0-4.0	0.34	0.39
SB05	88.0819	0.0-0.5	10	36
SB05	88.0819	0.0-0.5	16	40
SB05	88.0819	0.-0.5	20	39
SB06	88.0819	0.0-0.5	10	35
SB07	88.0819	0.0-0.5	14	39
SB08	88.0817	0.0-2.0	21	7.1
SB08	88.0817	2.0-4.0	19	50
SB08	88.0817	4.0-6.0	14	39
SB09	88.0817	0.0-2.0	66	13.7
SB09	88.0817	0.0-2.0	22	66
SB09	88.0817	2.0-4.0	16	38
SB10	88.0817	0.0-2.0	13	6.8
SB10	88.0817	2.0-4.0	13	49
SB10	88.0817	6.0-8.0	13	43
SB11	88.0817	0.0-2.0	6.2	2.9
SB11	88.0817	2.0-4.0	8.6	48
SB11	88.0817	6.0-8.0	11	41

TABLE 4.2 (cont'd.)
SUMMARY OF ANALYTICAL RESULTS FOR SOIL SAMPLES
(GROSS ALPHA AND BETA)

Sampling Location	Sampling Date	Depth [ft]	Gross Alpha [pCi/g]	Gross Beta [pCi/g]
SB12	88.0816	0.0-2.0	11.1	3.5
SB12	88.0817	0.0-2.0	18.9	5.9
SB12	88.0817	2.0-4.0	12	36
SB12	88.0817	6.0-8.0	8.2	41
SB13	88.0818	0.0-2.0	69	12.4
SB13	88.0818	2.0-4.0	870	220
SB13	88.0818	6.0-8.0	400	260
SB14	88.0818	0.0-2.0	77	32.8
SB14	88.0818	0.0-2.0	56	67
SB14	88.0818	2.0-4.0	75	100
SB14	88.0818	6.0-8.0	110	110
SB15	88.0818	0.0-2.0	63	84
SB16	88.0818	0.0-0.5	5.6	1.6
SB17	88.0818	0.0-0.5	30	8.2
SB18	88.0818	0.0-.05	8.7	3.8
SB19	88.0818	0.0-0.5	10.1	5.0
SB20	88.0818	0.0-0.5	10	3.5
SB21	88.0818	0.0-0.5	19	4.2
SB22	88.0818	0.0-0.5	15	3.2
SB23	88.0818	0.0-0.5	11.1	4.9
SB24	88.0881	0.0-0.5	9.4	3.6
SB25	88.0818	0.0-0.5	3.8	2.7

Table 4.3
Summary of Radiological Analyses of Selected Soil Samples

Radionuclide Concentration (pCi/g)

Sample Location	Sampling Date	Gr. Alpha	Gr. Beta	U-234	U-235	U-238	Pu-238	Pu-239	Th-228	Th-230	Th-232	Ra	Ra-226	Ra-228	K-40
SB05: 0.0 to 0.5 ft.	88.0818	20.00	35.00	0.78	0.02	0.52	<.04	<.03	0.13	0.09	0.13	NA	0.74	0.99	14.00
SB09: 0.0 to 2.0 ft.	88.0818	22.00	66.00	0.26	0.79	12.00	<.07	<.04	<.04	0.03	0.09	NA	0.30	0.87	18.00
SB14: 0.0 to 2.0 ft.	88.0818	56.00	67.00	0.31	<.1	<.1	<.029	<.004	<.004	0.25	0.06	NA	0.65	0.82	23.00

Legend:

NA = Not Analyzed for

<5 = Indicates non-detection with a detection limit of 5

TABLE 4.4
Radiological Analysis of Drilling Mud from MW05*

Radionuclide	Concentration (pCi/l)
Gross Alpha	1300
Gross Beta	NA
U238	5.40
U234	28.00
U235	0.66
Th-230	<0.3
Ra(Total)	1.50
Ra226	NA
Th-232	0.71
Th-228	111.00
Ra-228	NA
Pu-238	2.70
Pu-139	14.00

NA - not analyzed for

* This sample represented a mud-line mixture of groundwater and soil at the base of the monitoring well before development commenced.

TABLE 4.5

GROUNDWATER MONITORING WELL LOCATIONS

MW01 - West side of main building near waste treatment plant

MW02 - North central side of main building near gate No. 1

MW03 - Downgradient of sanitary leach field, northeast of main building

MW04 - East of center of main building near Route 152

MW05 - In parking lot, downgradient of dry well, near gate No. 3

MW06 - In center courtyard area near former waste storage area

MW07 - West of pewter building, northwest part of site; background well

MW08 - On southwest side of drive-in property

MW09 - On south central side of drive-in property, downgradient of MW08

MW10 - Residential irrigation well across Route 152

MW11 - Residential irrigation well across Route 152

MW12 - Upgradient of sanitary leach field, northeast side of main building

MW13 - Bedrock well adjacent to MW01

MW14 - Bedrock well adjacent to MW03

MW15 - Bedrock well adjacent to MW04

MW16 - Bedrock well adjacent to MW03

MW17 - Bedrock well adjacent to MW04

MW18 - Bedrock well adjacent to MW05

MW19 - Bedrock well adjacent to MW08

Table 4.6

SUMMARY OF ANALYTICAL RESULTS FOR GROUND WATER SAMPLES
(GROSS ALPHA AND BETA)

SAMPLING LOCATION	SAMPLING DATE	GROSS ALPHA [pCi/l]	DEVIATION [pCi/l]	GROSS BETA [pCi/l]	DEVIATION [pCi/l]
MW01	87.0902	40.0		39.0	
MW01	88.0831	5.1		1.2	
MW01	89.0915	<2		2.8	
MW02	87.0902	1.0		3.0	
MW02	88.0830	<2		7.8	
MW02	89.0915	<2		9.2	
MW02	89.0915	9.1		15.0	
MW03	87.0901	5.0		8.0	
MW03	88.0830	<2		7.1	
MW03	89.0921	6.0		16.0	
MW03	91.0318	0.0	+/-2.7	0.0	+/-3.4
MW03	91.1112	3.2	+/-2.7	3.3	+/-3.4
MW03	92.1218	0.2	+/-1.6	9.0	+/-3.3
MW04	87.0901	5.0		8.0	
MW04	88.0830	<2		7.1	
MW04	89.0914	8.0		20.0	
MW04	91.0318	0.0	+/-2.5	0.0	+/-3.3
MW04	91.1113	1.5	+/-1.7	2.2	+/-3.1
MW04	92.1218	0.0	+/-1.6	6.9	+/-3.2
MW05	87.1110	3.6		17.0	

Table 4.6

SUMMARY OF ANALYTICAL RESULTS FOR GROUND WATER SAMPLES
(GROSS ALPHA AND BETA)

SAMPLING LOCATION	SAMPLING DATE	GROSS ALPHA [pCi/l]	DEVIATION [pCi/l]	GROSS BETA [pCi/l]	DEVIATION [pCi/l]
MW05	88.0830	<2		5.2	
MW05	89.0915	16.0		20.0	
MW05	91.0318	0.0	+/-2.5	0.0	+/-3.3
MW05	91.1113	2	+/-1.8	0.4	+/-3.0
MW05	92.1218	0.0	+/-1.3	3.1	+/-2.7
MW06	87.0901	20.0		22.0	
MW06	88.0831	2.5		3.6	
MW06	89.0915	16.0		16.0	
MW06	91.0318	2.2	+/-1.6	1.2	+/-2.8
MW06	91.1113	0.4	+/-1.9	0.0	+/-3.1
MW06	92.1218	0.4	+/-1.4	1.5	+/-2.7
MW07	87.0901	8.2		14.9	
MW07	88.0831	<1		3.0	
MW07	89.0914	6.4		6.7	
MW08	87.0831	2.9		7.0	
MW08	88.0831	<3		9.7	
MW08	89.0914	5.0		5.1	
MW09	87.0831	16.0		17.7	
MW09	88.0831	<1		4.2	
MW09	89.0914	3.8		7.9	

Table 4.6

SUMMARY OF ANALYTICAL RESULTS FOR GROUND WATER SAMPLES
(GROSS ALPHA AND BETA)

SAMPLING LOCATION	SAMPLING DATE	GROSS ALPHA [pCi/l]	DEVIATION [pCi/l]	GROSS BETA [pCi/l]	DEVIATION [pCi/l]
MW10	87.1110	<1		6.4	
MW11	87.1110	10.0		15.0	
MW11	92.1218	2.2	+/-2.5	0.8	+/-3.0
MW12	88.0831	<1		3.3	
MW12	88.0831	<1		4.5	
MW12	89.0915	<2		2.5	
MW13	89.0915	<3		4.5	
MW14	88.0830	<1		3.9	
MW14	89.0914	<2		10.0	
MW14	91.0320	0.0	+/-1.3	0.0	+/-2.9
MW14	91.1112	1	+/-1.7	2.3	+/-3.1
MW14	92.1218	0.0	+/-1.3	0.3	+/-2.6
MW15	88.0830	<2		4.2	
MW15	89.0914	<2		3.2	
MW15	91.0320	1.5	+/-1.9	0.6	+/-3.0
MW15	91.0320	1.5	+/-1.8	0.0	+/-2.9
MW15	91.1113	2.6	+/-2.0	2.5	+/-3.1
MW15	91.1113	3.3	+/-2.7	2.4	+/-3.4
MW15	92.1218	0.0	+/-2.8	4.2	+/-3.3

Table 4.6

SUMMARY OF ANALYTICAL RESULTS FOR GROUND WATER SAMPLES
(GROSS ALPHA AND BETA)

SAMPLING LOCATION	SAMPLING DATE	GROSS ALPHA [pCi/l]	DEVIATION [pCi/l]	GROSS BETA [pCi/l]	DEVIATION [pCi/l]
MW16	89.0914	<2		8.0	
MW17	89.0914	<3		23.0	
MW17	91.0320	3.0	+/-2.2	0.0	+/-3.0
MW17	91.1114	2.6	+/-2.2	0.7	+/-3.2
MW17	92.1218	0.0	+/-3.1	3.2	+/-3.3
MW18	89.0915	<2		7.8	
MW18	91.0320	1.1	+/-1.4	15.5	+/-3.1
MW18	91.1113	1.7	+/-2.2	3.6	+/-3.2
MW18	92.1218	0.0	+/-2.5	1.3	+/-3.5
MW19	89.0914	<3		6.8	

TABLE 4.7
Surface Water/Sediment Sampling Stations

SW01 -	East side of southern embankment of Turnpike Lake south of facility
SW02 -	West side of southern embankment of Turnpike Lake south of facility
SW03 -	Turnpike Lake southwest of facility
SW04 -	Turnpike Lake northwest of facility (background station)
SW05 -	Creek downstream of southern spillway
SW06 -	Low-lying area downstream of SW05
SW07 -	Creek downstream of SW05
SW08 -	Culvert at eastern end of drive-in
SW09 -	Southwest of SW02, near boundary of southern embankment
SW10 -	Southern spillway from Turnpike Lake
SW11 -	Roof drain outfall near SW01
SW12 -	Northern spillway from Turnpike Lake
SW13 -	Confluence of creeks from southern and northern spillways, northeast of drive-in
SW14 -	Inflow to Lake Mirimichi
SW15 -	Turnpike Lake offshore near SW09
SW16 -	Turnpike Lake offshore between SW01 and SW10
SW17 -	Offshore at southern end of southern embankment
SW18 -	Roof drain outfall near SW02
SW19 -	In Turnpike Lake near SW11
SW20 -	In Turnpike Lake near SW18
SW21 -	Turnpike Lake, surface off path near SW09
SW22 -	Storm drain outfall (city water passing through furnace to storm drain) near SW01

TABLE 4.8
Summary of Surface Water Analysis Results
(Gross Alpha and Beta)

Monit. Point	Date Measured Yr. Mo. Date	Gr. Alpha (pCi/l)	Gr. Beta (pCi/l)
SW01	87.0902	0.90	1.30
	98.0801	<1	2.70
SW02	87.0902	0.50	0.80
	89.0801	<1	1.80
SW03	87.0901	0.00	1.30
	89.0801	<1	2.20
SW04	87.0901	0.20	1.50
	89.0801	<1	2.10
SW05	88.0816	1.00	NA
	89.0801	<1	2.40
SW08	88.0816	0.70	NA
SW10	88.0812	0.40	1.80
SW10	88.0825	0.70	NA
SW10	88.0826	<1	NA
SW10	88.0827	<1	NA
SW10	88.0828	<2	NA
SW10	88.0829	<2	NA
SW10	88.0830	<2	NA
SW10	88.0831	<2	NA
SW11	88.0824	0.50	NA
SW12	88.0812	0.40	2.10
SW13	88.0816	0.70	2.80
SW14	88.0816	<0.5	1.50
SW14	88.0816	0.20	2.40
SW15	88.0819	2.20	<1
SW16	88.0819	1.80	<1

TABLE 4.8 (cont'd)
Summary of Surface Water Analysis Results
(Gross Alpha and Beta)

Monit. Point	Date Measured Yr. Mo. Date	Gr. Alpha (pCi/l)	Gr. Beta (pCi/l)
SW17	88.0819	1.30	<1
SW18	88.0824	0.60	NA
SW19	88.0825	<0.2	NA
SW19	88.0826	<2	NA
SW19	88.0827	<2	NA
SW19	88.0828	<2	NA
SW19	88.0829	<2	NA
SW19	88.0830	<2	NA
SW19	88.0831	<0.9	NA
SW20	88.0825	0.30	NA
SW20	88.0826	<1	NA
SW20	88.0827	<1	NA
SW20	88.0828	<1	NA
SW20	88.0829	<2	NA
SW20	88.0830	<1	NA
SW20	88.0831	<0.9	NA
SW21	88.0825	0.40	NA
SW21	88.0826	<1	NA
SW21	88.0827	<1	NA
SW21	88.0828	<2	NA
SW21	88.0829	<1	NA
SW21	88.0830	<2	NA
SW21	88.0831	<0.9	NA
SW22	88.0824	0.80	NA

Legend:

NA = Not analyzed for
<5 = Indicates non-detection with a detection limit of 5

TABLE 4.9
Summary of Sediment Analysis Results
(Gross Alpha and Beta)

Monit. Point	Date Measured Yr. Mo. Date	Depth (ft.)	Gr. Alpha (pCi/l)	Gr. Beta (pCi/l)
SW01	87.0902	0.0 to 0.5	126.00	27.50
SW02	87.0902	0.0 to 0.5	3.20	2.51
SW03	87.0902	0.0 to 0.5	0.44	0.92
SW04	87.0902	0.0 to 0.5	0.70	1.15

Table 4.10
Summary of Analytical Results for Fish Tissue Analyses (Gross Alpha and Beta)

Field ID Number	Location	Fish Species	Tissue	Gross Beta [pCi/g]	Gross Beta [pCi/g]
3	Private Impoundment	Pumpkinseed Sunfish	Muscle	<0.1	4.2
8	Private Impoundment	Redfin Pickerel	Muscle	0.17	2.2
11	Turnpike Lake - South Embankment	Pumpkinseed Sunfish	Muscle	<0.1	1.0
13	Turnpike Lake - South Embankment	Pumpkinseed Sunfish	Muscle	<0.06	0.93
14	Turnpike Lake - South Embankment	Pumpkinseed Sunfish	Muscle	<0.1	2.0
15	Turnpike Lake - South Embankment	Black Bullhead	Muscle	<0.05	1.5
16	Turnpike Lake - South Embankment	Black Bullhead	Muscle	<0.07	0.76
18	Turnpike Lake - South Embankment	Black Bullhead	Muscle	<0.05	1.4
21	Turnpike Lake Background	Redfin Pickerel	Muscle	<0.05	2.7
23	Turnpike Lake Background	Pumpkinseed Sunfish	Muscle	<0.07	1.1

Note: All results are reported on a wet weight basis.

TABLE 4.11
Radiological Analysis of "Sediment" Sample from Drywell

Radionuclide	Concentration (pCi/l)
Gross Alpha	83
Gross Beta	84
U238	26
U234	38
U235	4.30
Th-230	0.22
Ra-226	0.41
Th-232	0.07
Th-228	0.43
Ra-228	0.55
Po-238	0.01
Po-239	<0.0004

TABLE 8.1
Plainville Facility Radiological Sampling and Measurement Program

Media to Be Investigated	Type of Sample/Measure.	Sampling/Measure. Location	Frequency	Number of Samples	Radiological Analysis
Yard and lot surface	(1)Gamma scan	Over entire site	once	Continuous traverse	gamma radiation
	(2)Exposure rate	Elevated level grids	"	At stationery points in grid	gamma radiation
Surface soil	Grab in top 15cm	Adjacent to drywell	"	8	U238, U235, and U234
		At SB1, SB9, and SB17	"	12	" "
		At grid intersections south of plant	"	35	" "
		In elevated gamma grids	"	TBD[1]	" "
		Splits	"	6[2]	" "
Subsurface soil	Grab or split spoon	Under and adjacent to drywell	"	20[3]	" "
		At grid intersections south of plant	"	48	" "
		Under and adjacent to building 12	"	16	" "
		In region of subsurface liquid waste disposal	"	TBD[4]	" "
		Splits	"	9[2]	" "
Groundwater	Grab	Existing monitoring wells	"	19	Gross α β; U238, U235, U234
		Bottom of auger holes	"	TBD[5]	" "
		New monitoring wells	"	2	" "
		Splits	"	3[2]	" "

TABLE 8.1
Plainville Facility Radiological Sampling and Measurement Program

Media to Be Investigated	Type of Sample/Measure.	Sampling/Measure. Location	Frequency	Number of Samples	Radiological Analysis
Sediment	Grab	Turnpike Lake Shoreline	Once	7	U238, U235, and U234
		Split	"	1	" "
Airborne Particulates	8 hour grab	Site perimeter	"	5	" "
		Potential remediation area	"	2	" "
		Split	"	1	" "
Background					
Gamma	Exposure rate	Within 0.5 - 2.0 km of site		6-8	gamma radiation
Soil	Grab	Within 0.5 - 2.0 km of site		6-8	U238, U235, and U234

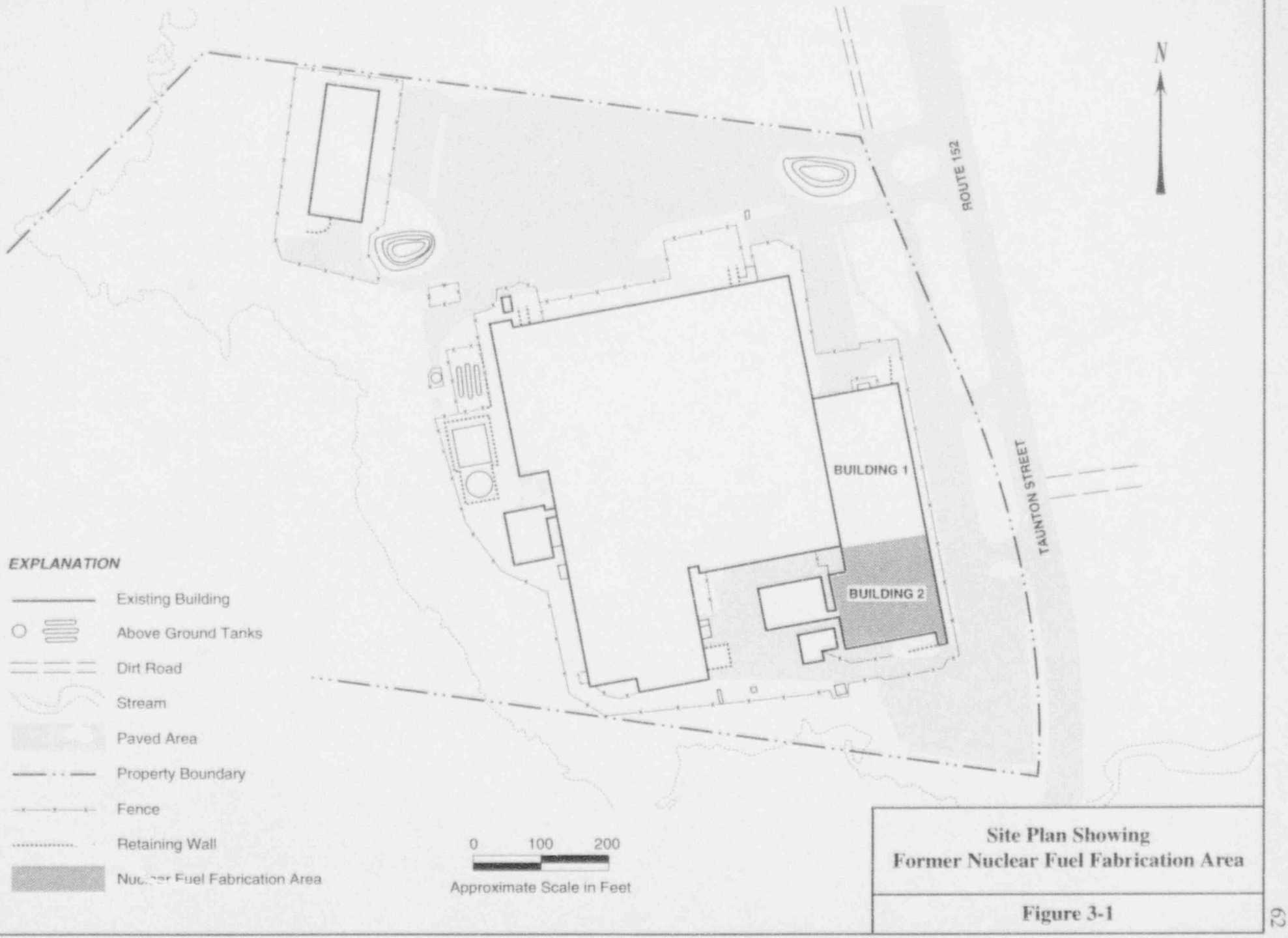
1) TBD = to be determined based on results of gamma exposure rate measurements.

2) Number of splits is approximate and will increase by 1 for every 10 additional samples collected.

3) Number of subsurface soil samples assumes four soil samples/borehole

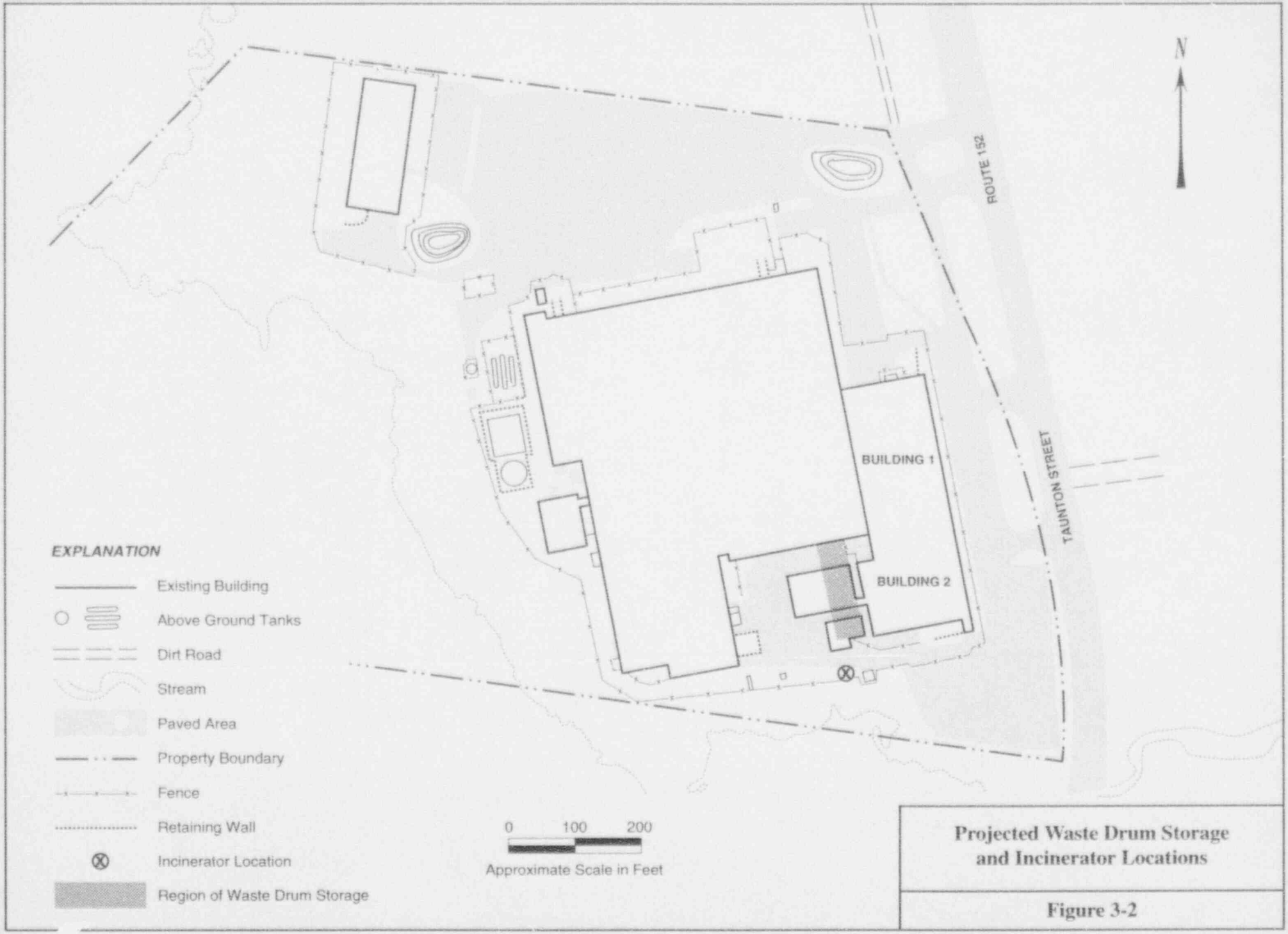
4) TBD = to be determined based on results of geophysical survey

5) TBD = to be determined upon examination of each borehole



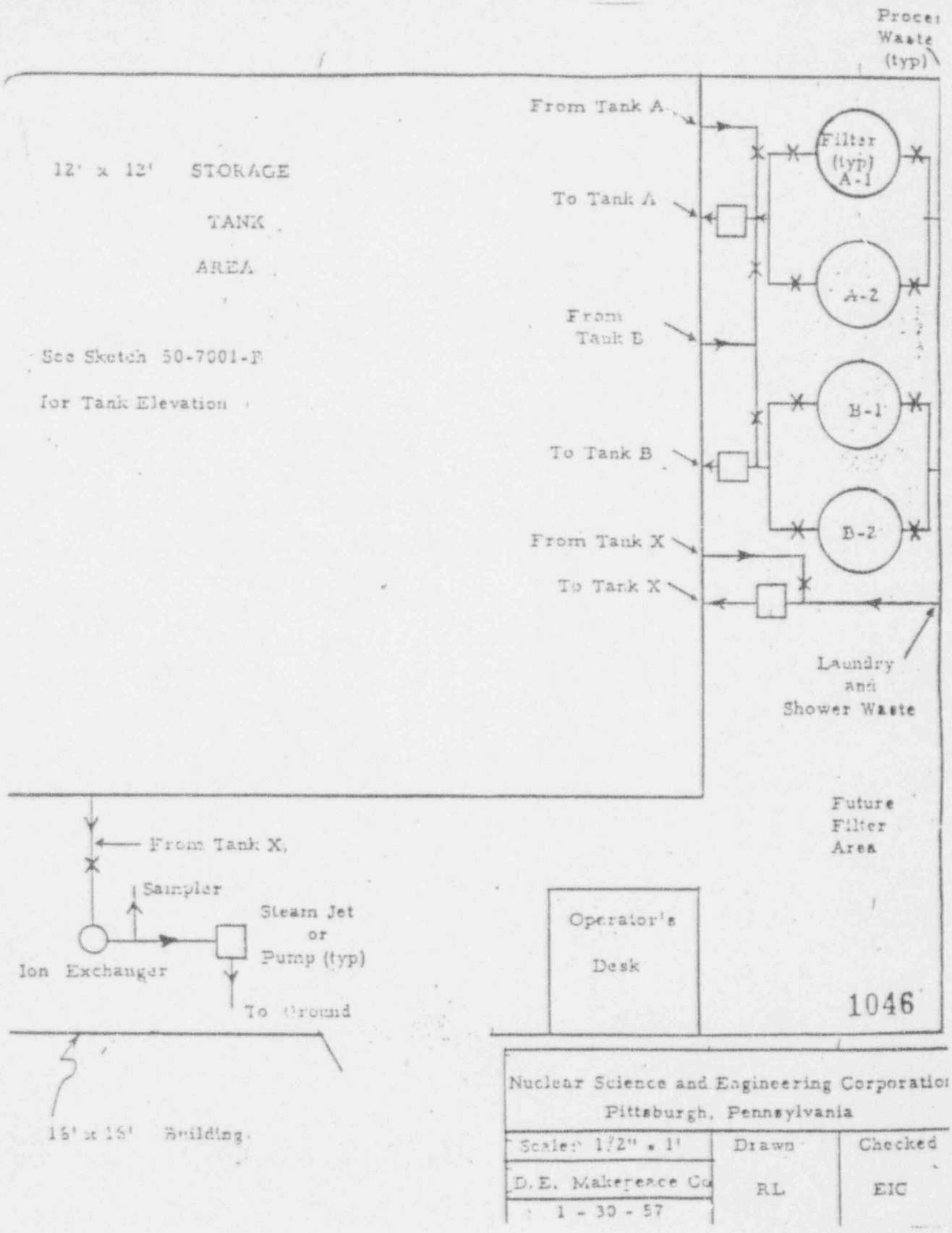
Site Plan Showing
Former Nuclear Fuel Fabrication Area

Figure 3-1



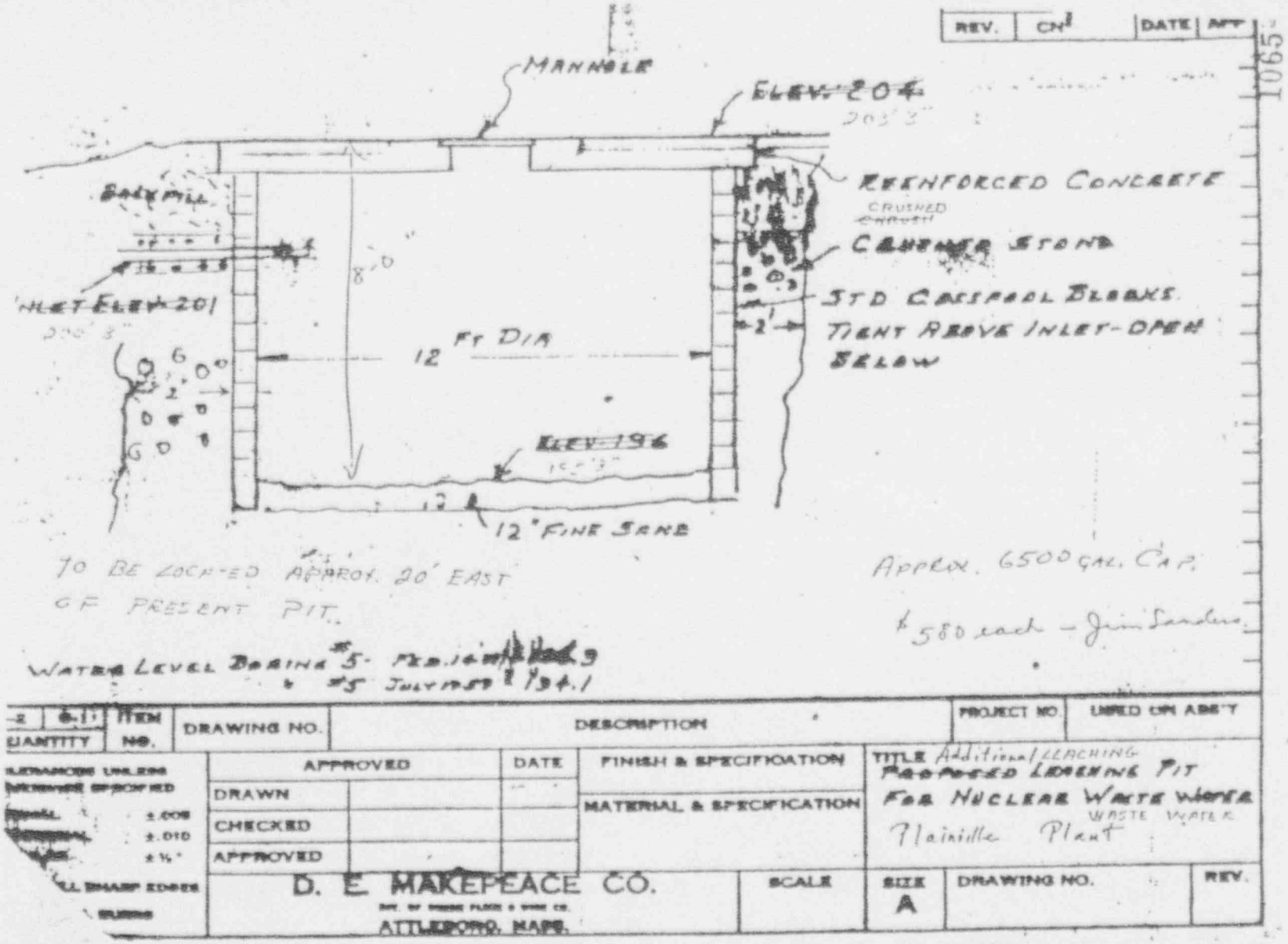
Projected Waste Drum Storage and Incinerator Locations

Figure 3-2



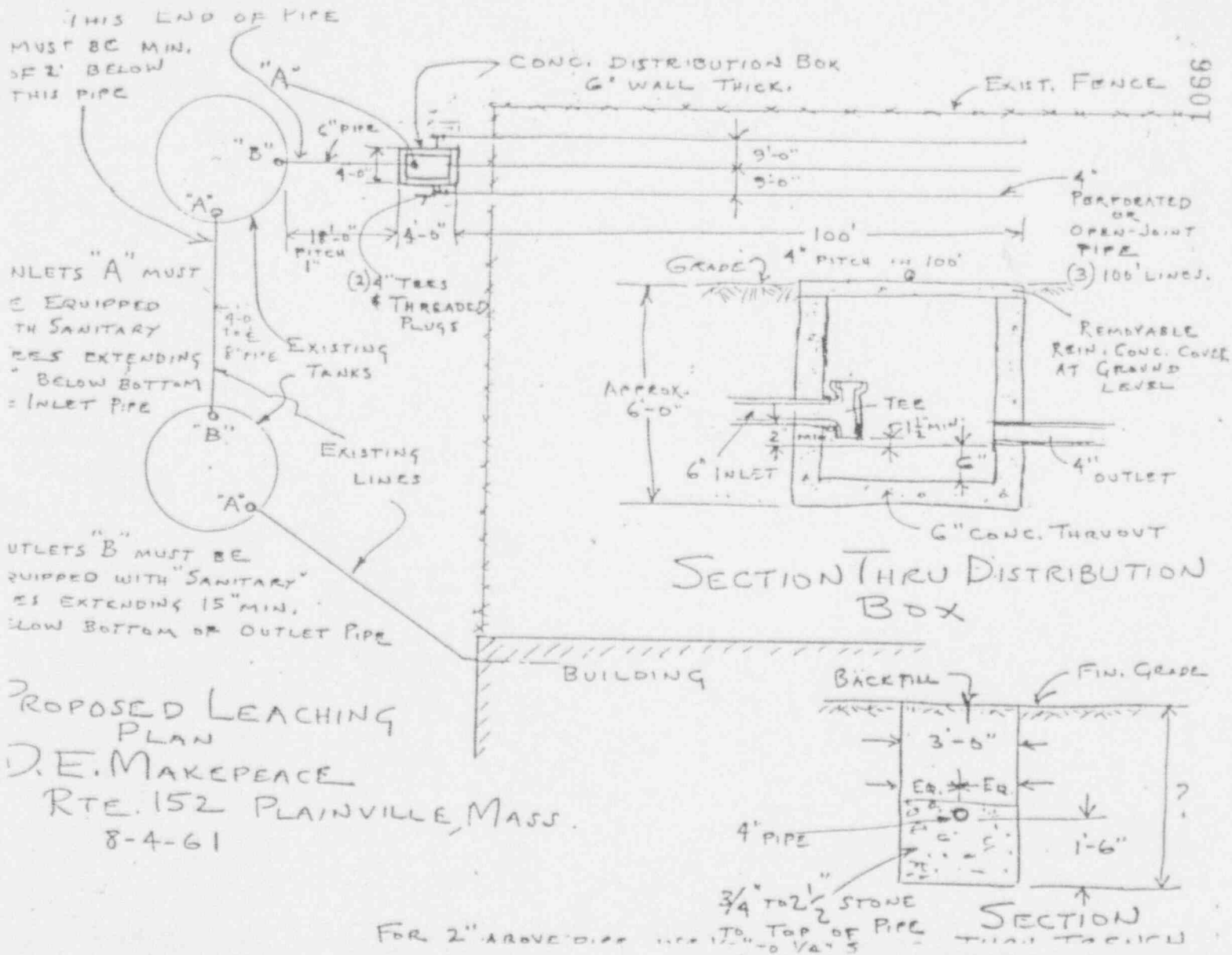
Sketch 50-7001-A
Waste Area Layout

Figure 3-3



Additional Leaching Pit
for Nuclear Waste Water

Figure 3-4



NLETS "A" MUST E EQUIPPED TH SANITARY ES EXTENDING " BELOW BOTTOM = INLET PIPE

UTLETS "B" MUST BE QUIPPED WITH "SANITARY" ES EXTENDING 15" MIN. LOW BOTTOM OF OUTLET PIPE

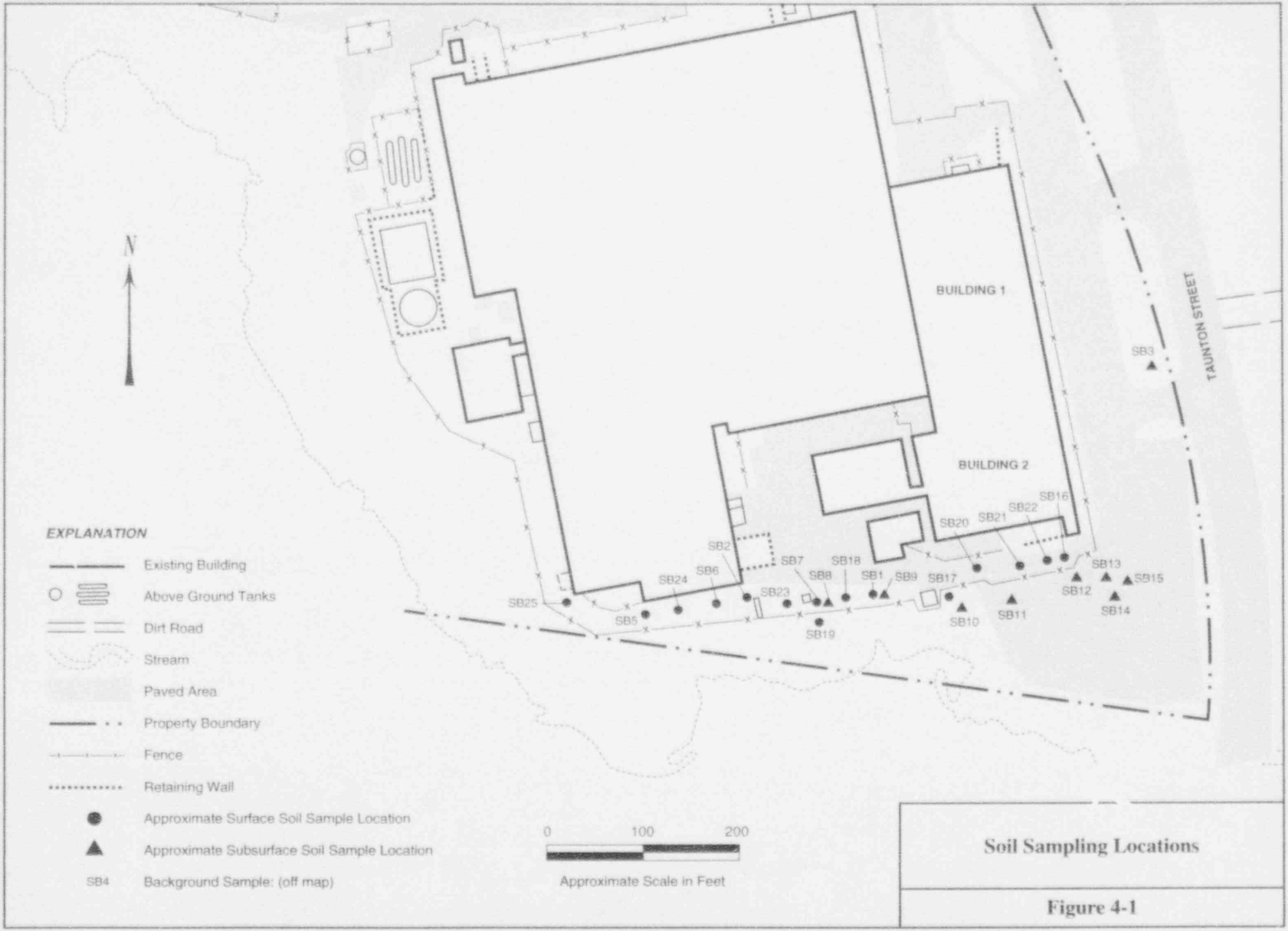
FOR 2" ABOVE PIPE ... TO TOP OF ... -0 1/2" ...

PROPOSED LEACHING PLAN

D. E. MAKEPEACE
RTE. 152 PLAINVILLE, MASS.
8-4-61

Proposed Leaching Plan

Figure 3-5

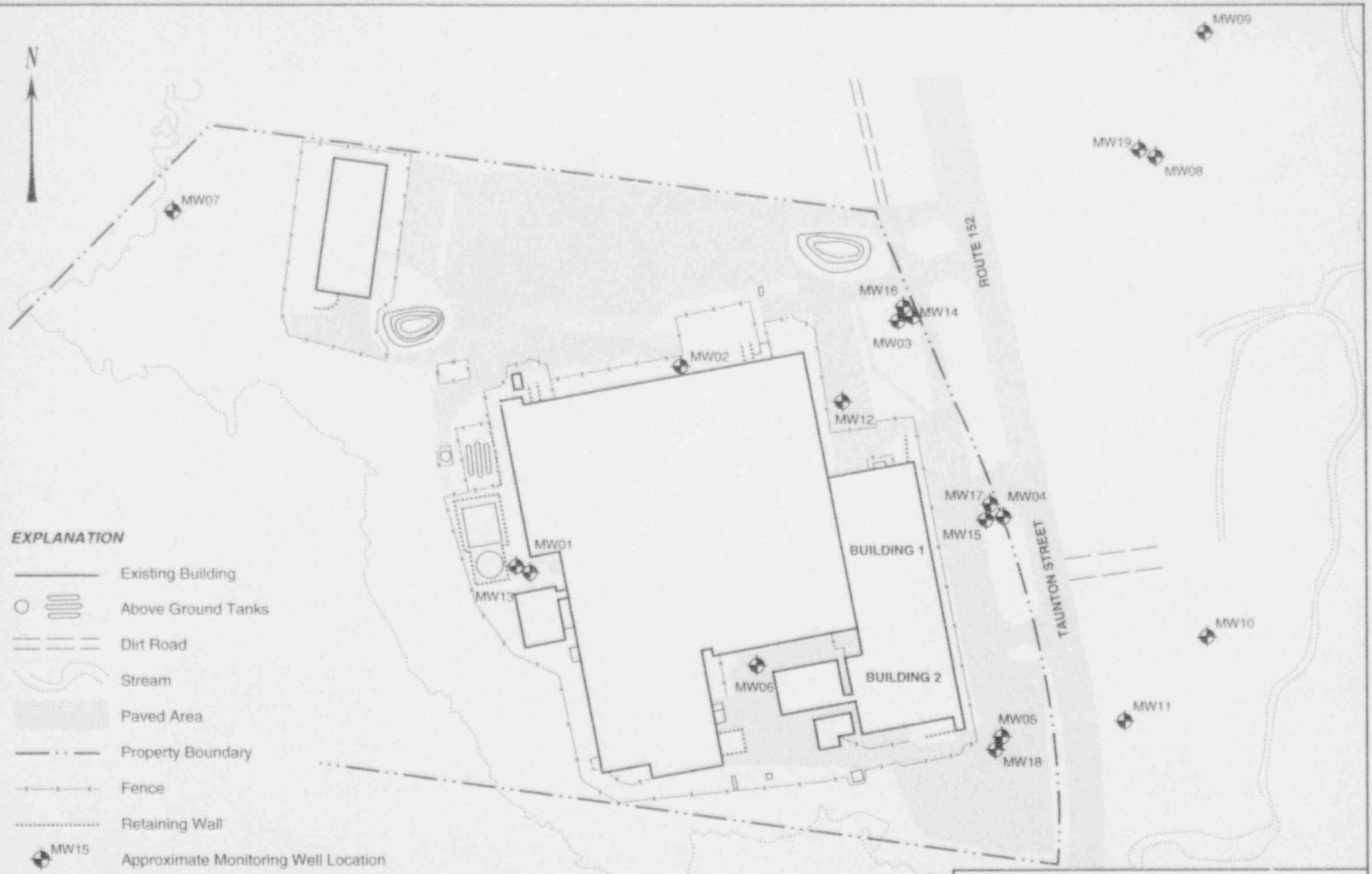


Soil Sampling Locations

Figure 4-1

Gross Alpha and Beta Distribution in Site Soils

Figure 4-2



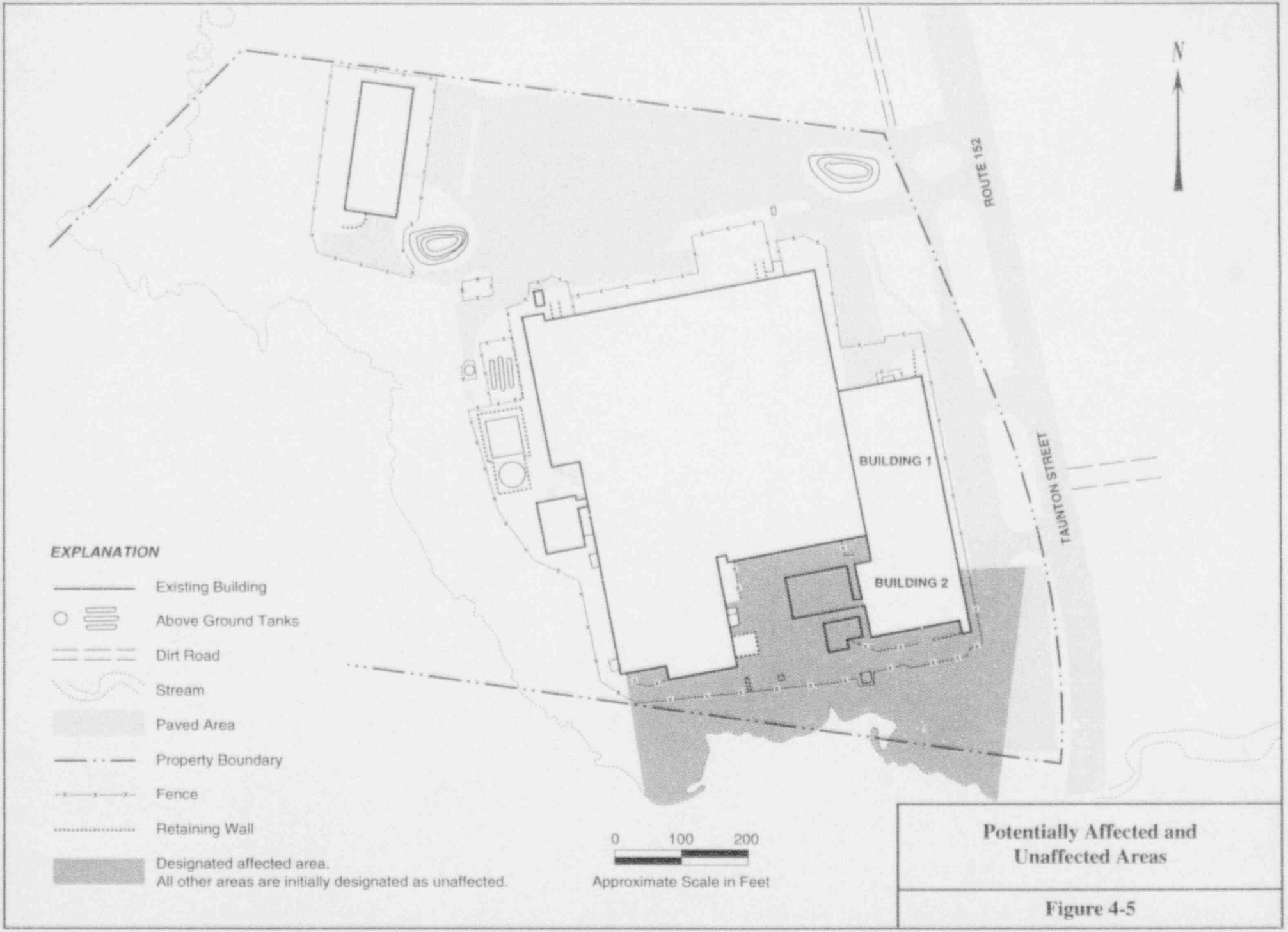
NOTE Wells MW10 and MW11 are shallow private wells and are not constructed to monitoring well standards. Samples from these wells may not be representative of true groundwater quality.

Monitoring Well Locations

Figure 4-3

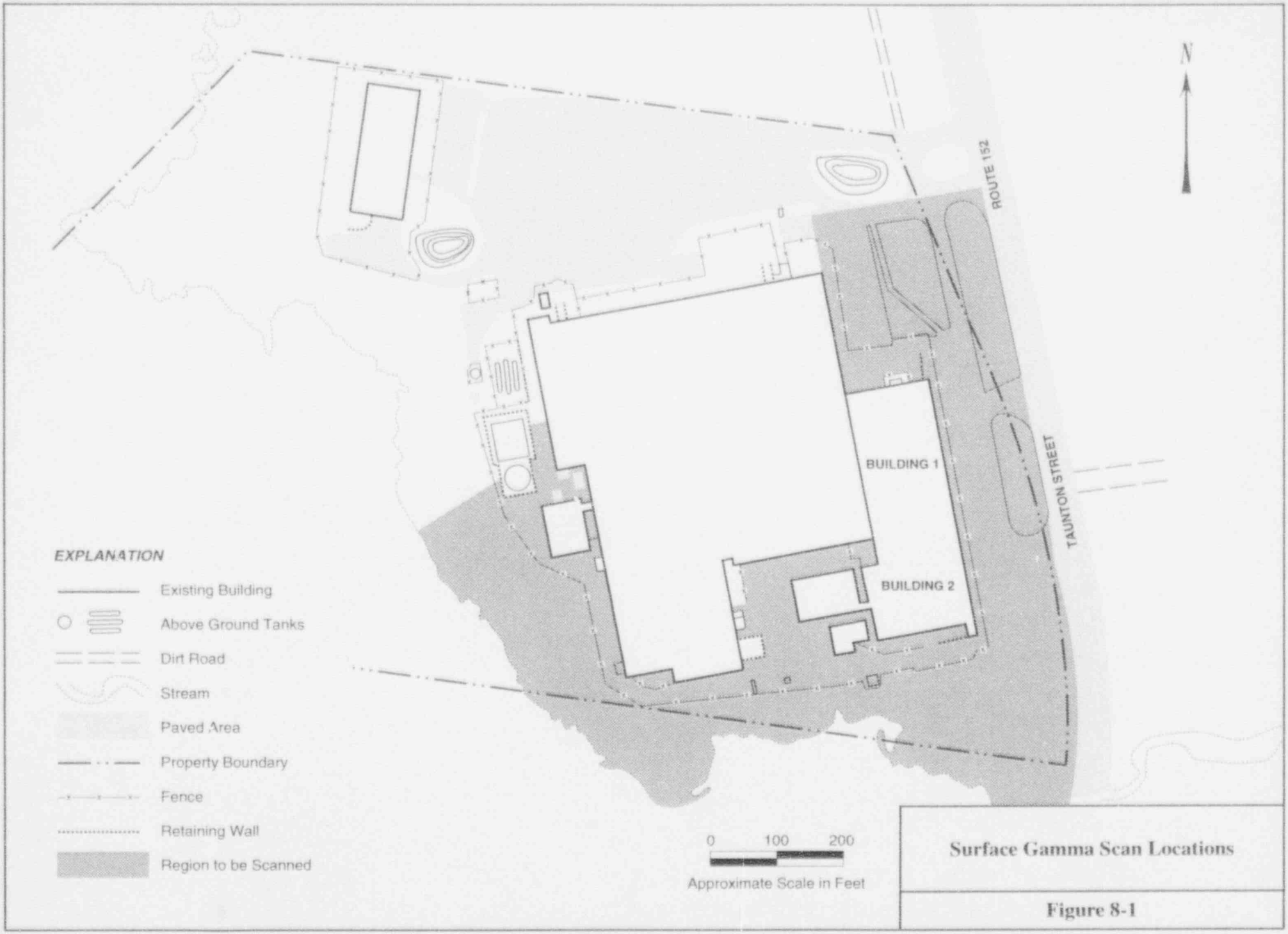
Surface Water and Sediment Sampling Locations

Figure 4-4



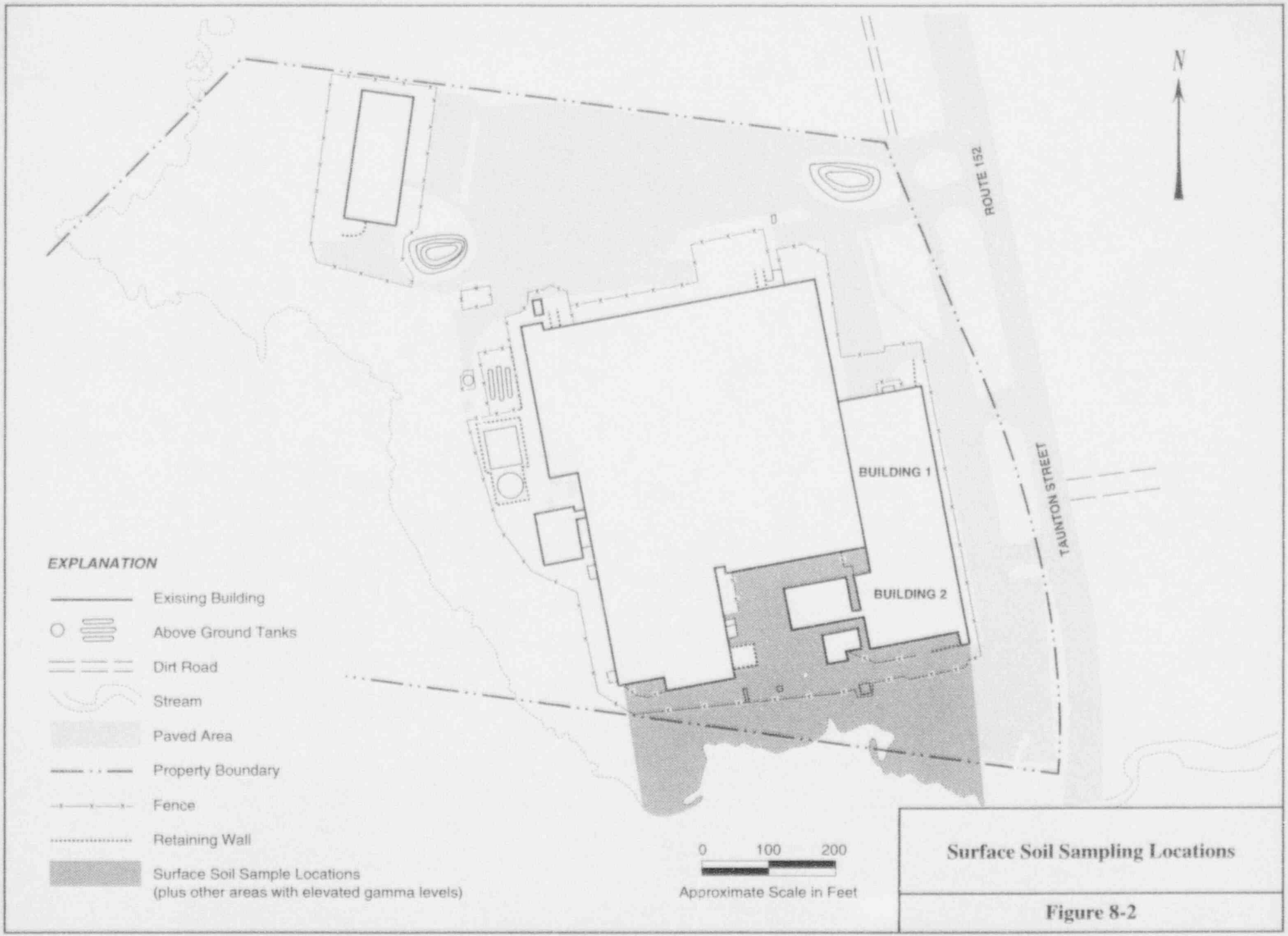
Potentially Affected and Unaffected Areas

Figure 4-5



Surface Gamma Scan Locations

Figure 8-1

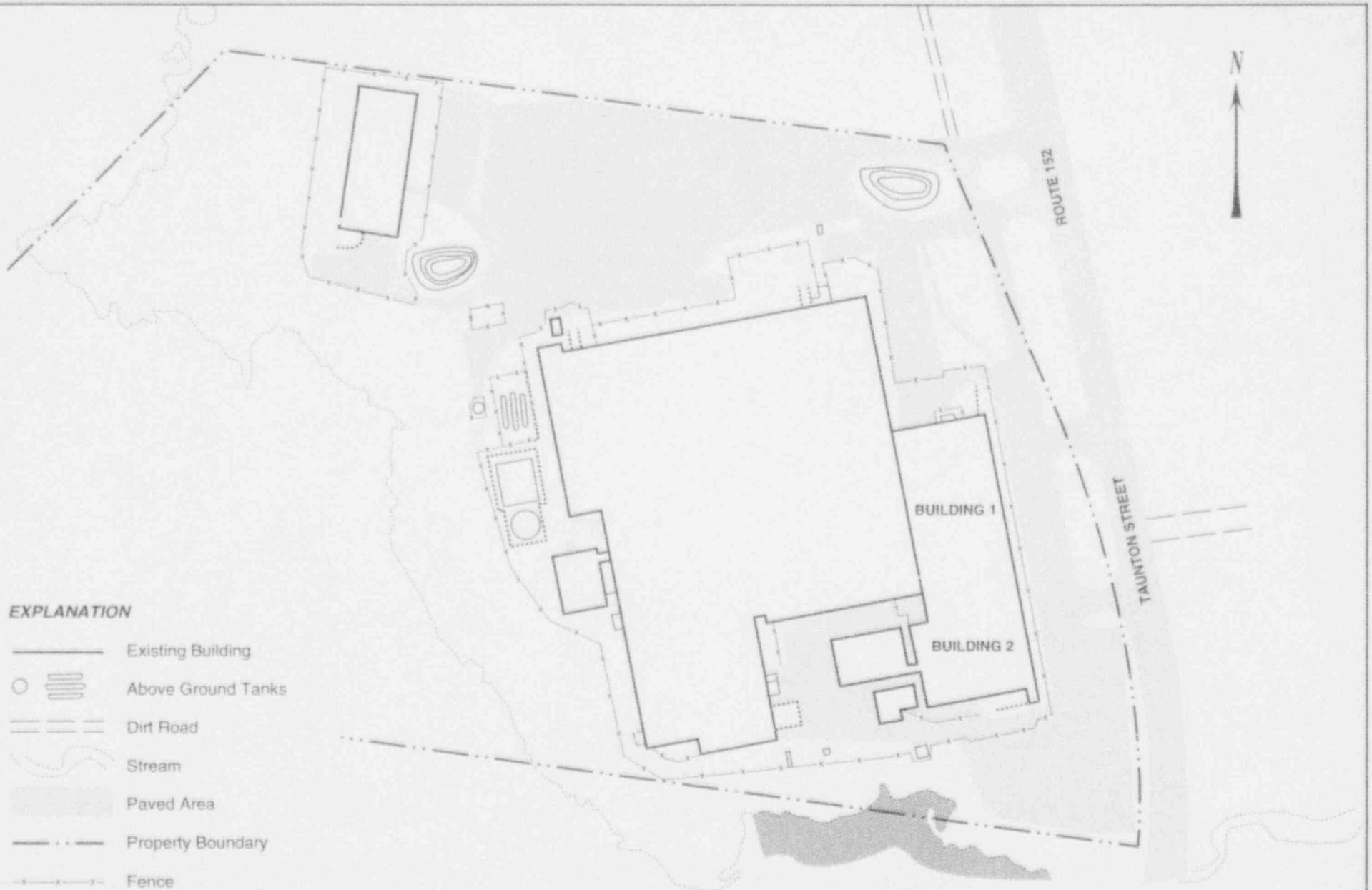


Surface Soil Sampling Locations

Figure 8-2

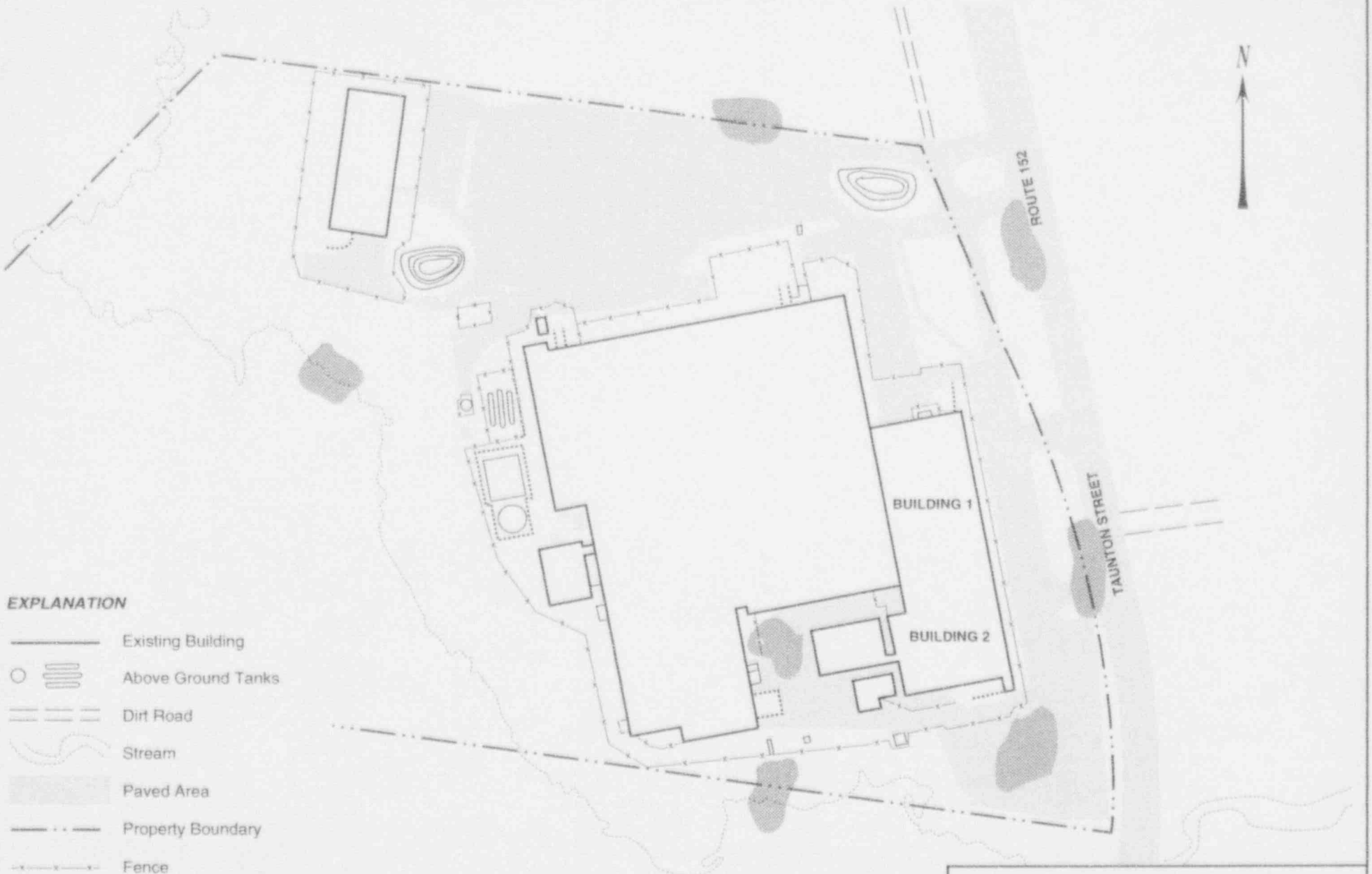
Subsurface Soil Sampling Locations

Figure 8-3



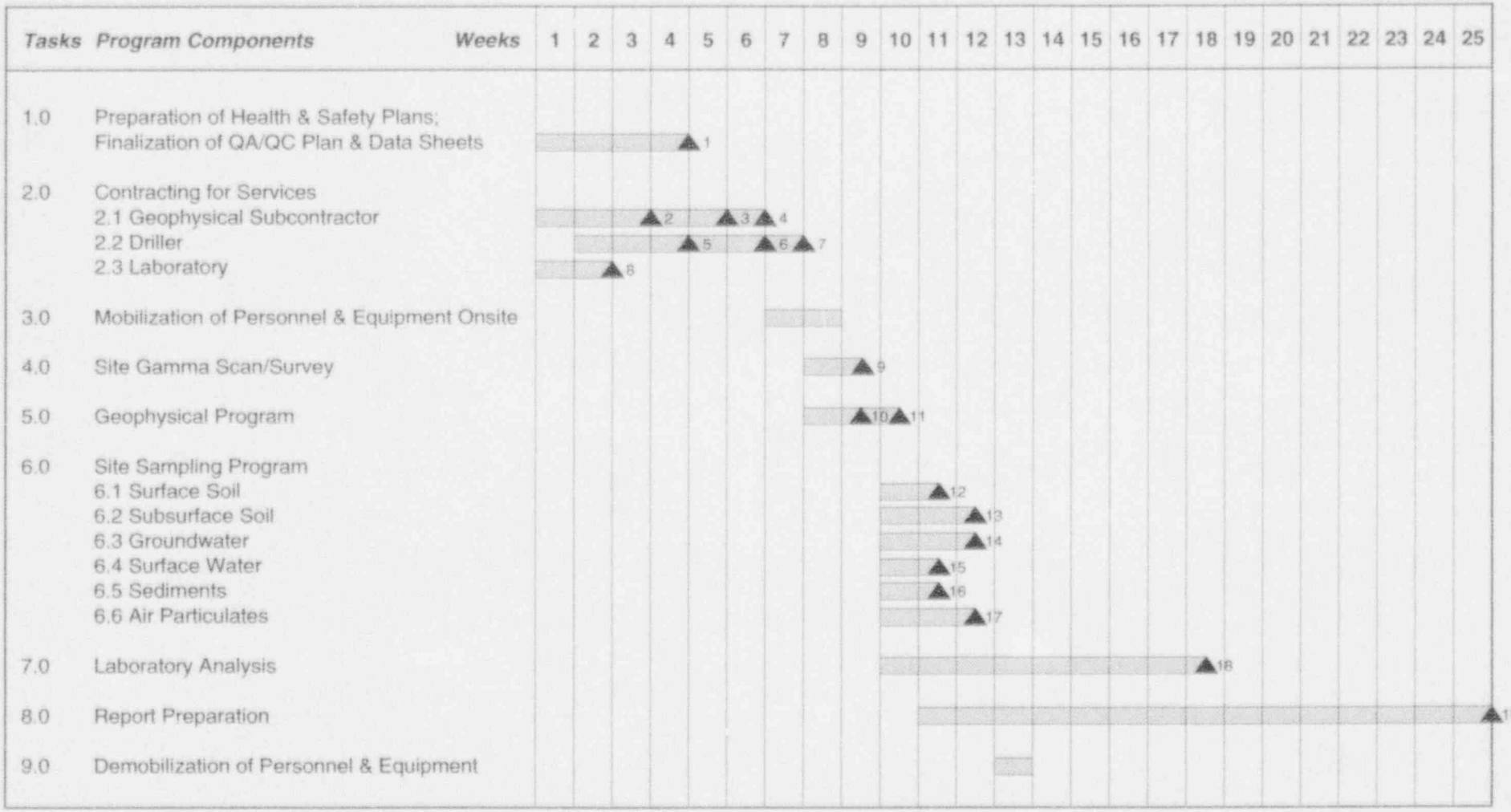
Sediment Sampling Locations

Figure 8-4



Air Particulate Sampling Locations

Figure 8-5



Program Schedule

Figure 10-1

APPENDIX A

PERSONNEL RESUMES

Thomas S. Brown

Corporate Manager, Environmental Affairs
Engelhard Corporation
101 Wood Avenue
Iselin, New Jersey 08830

Credentials:

B.S. Chemical Engineering
Drexel University

M.S. Environmental Health Engineering
University of Texas

Experience:

1978 - Present

Engelhard Corporation

Corporate Manager, Environmental Affairs: Corporate oversight and leadership of environmental compliance programs.

Operations Manager, Seneca Plant: Budget responsibility and accountability for managing four operating departments and utilities and maintenance. Covered start-up of relocated operations.

Operations Manager, Delancy Street Plant: Budget responsibility and accountability for managing three operating departments during period of plant shutdown and relocation.

Manager, Plant Services, Delancy Street Plant: Budget responsibility and accountability for managing five service departments, environmental engineering, project engineering, maintenance, construction, and utilities.

Manager, Environmental Engineering, former Engelhard Industries Division: Budget responsibility and accountability for managing divisional group supporting all division plants in areas of environmental compliance.

Environmental Engineer, former Engelhard Industries Division: Responsible for programs supporting plant compliance with waste water, hazardous waste, and toxic substance rules.

1975 - 1978

Delaware River Basin Commission

Acting director of joint industry/government funded program investigating need for and availability of disposal capacity for "exotic" wastes.

Section chief of water quality section responsible for obtaining and publishing water quality data for the mainstream of the Delaware River.

Participated in review of projects proposed for Commission approval to determine conformance with Commission rules.

1973 - 1975 Gibbs & Hill, Consulting Engineers

Environmental engineer participating in various municipal and industrial waste water treatment design projects.

1969 - 1973 Manville Corporation

Research engineer participating in various projects investigating applicability of various technologies to water and waste water treatment.

DONALD P. CHABOT

WORK EXPERIENCE

ENGELHARD CORPORATION – Route 152, Plainville, MA 02762

Senior Environmental Engineer (December 1989 to present)

Fully responsible for taking all the actions necessary for full compliance with all federal, state, and local environmental regulations as it relates to designated sites. Develop and administer various environmental and contractor safety programs. Develop written plans and actions to satisfy regulatory agencies. Site remediation responsibility for compliance with RCRA's Corrective Action, DEP's MCP, NRC's Site Decomissioning Management Plan requirements.

Environmental Engineer (December 1986 to December 1989)

Developed plans, designed specifications, produced cost estimates and other data needed to pursue the acquisition of new technology or the correction of existing technology to comply with current or anticipated laws or environmental matters. Project engineering responsibility for the application of technical knowledge and expertise in conjunction with engineering, organizational and planning skills to successfully manage all aspects of environmental projects. Assessed the affects of current and proposed manufacturing technology on the environment, specifically water and air as well as the generation of hazardous waste. Managed operation of plant environmental systems including wastewater treatment, fume scrubbers, dust collectors, hazard alarms, cooling towers, and city water. Developed and administrate various environmental programs: hazardous waste, hazardous material inventory control, waste minimization, source reduction, pretreatment, SARA 313, regulatory permitting, and etc.

Plant Engineer (November 1985 to December 1986)

Project management responsibility for aspects of facility projects. Assessed the affects of proposed manufacturing technology on production processes. Managed operation of plant systems and utilities.

PHILLIP A. HUNT CHEMICAL – One Wellington Road, Lincoln, RI 02895

Plant Engineer (August 1982 to November 1985

Engineered and executed planned maintenance, repairs and replacements. Supervised maintenance force. Engineered and supervised projects. Responsible for generation and distribution of power and other utilities.

REFINEMET INTERNATIONAL – 162 Main Street, Woonsocket, RI 02895

Process Engineer/
Production Manager
(1978 to 1981)

Duties included design and implementation of process improvements, laboratory benchwork, quality control, equipment design and specifications.

EDUCATION

B.S., Chemical Engineering, Georgia Institute of Technology, 1978

Robert E. Berlin
RR1-13 Sterling Pines
Tuxedo, New York 10987
(914) 351-2880 (Home)
(212) 920-0294 (College Office)

EXPERTISE: Health Physics and Industrial Safety
Radiological Assessment
Waste Management

ACADEMIC EXPERIENCE

Associate Professor, Manhattan College

1983-Present

- Mechanical Engineering Department-Teach undergraduate design courses. Coordinate and teach graduate programs in nuclear power and waste management/facility restoration. Reactor Administrator, Manhattan College Zero Power Reactor. Licensed Senior Reactor Operator. Radiation Safety Officer for reactor facility.

- Environmental Engineering Department-Teach graduate courses in hazardous waste management.

1985-Present Visiting Lecturer, Columbia University School of Public Health

INDUSTRIAL EXPERIENCE

1983-Present

Consultant in Radioactive Waste Management, Facility Restoration, and Radiological Health. Development and performance of facility restoration programs, radiological impact assessments, contamination studies, monitoring programs. Regulatory liaison and preparation of license applications, EAs, ERs, RI/FS. Technology assessments and site applications. Development of H&S plan and manuals, QA plans, and operating manuals. Facilities include CERCLA designated Denver Radium Site; thorium-contaminated sites in Michigan, Illinois, and Florida; former fuel fabrication facility in Massachusetts; U.S. Radium site in New Jersey and DOE/ORNL waste burial site.

1980-1983 President, Waste Management Group, Inc.:

- Provided consultation services to government agencies and industrial firms in the management of hazardous chemical and radioactive waste forms. Developed industrial safety, health physics and monitoring programs, performed environmental impact assessments, and assisted in regulatory compliance and licensing action.

- Prepared monitoring manuals for mining and milling facilities; waste management and transportation section of EIS for TMI-2 accident cleanup; and developed methodology for impact assessments for DOE site remedial action program. (FUSRAP).

1973-1980 Associate, Dames & Moore

- Performance of a range of programs at LLW sites, uranium facilities, and contaminated sites involving the modeling of sources, pathway dispersion, and receptor impacts through air and water pathways; validation of performance of performance objectives; determination of stabilization covers based on diffusion analysis; and assessment of impacts of projected accident conditions.

- Development of industrial safety and health physics programs for a variety of nuclear facilities with primary emphasis on contaminated facilities and waste disposal sites. Work included definition of procedures, preparation of operating manuals, development of job descriptions and organizational responsibilities in accordance with Federal and State Regulatory Standards.

- Project Manager of Dames & Moore's technical support to NRC in generating the 10 CFR Part 61 regulation for LLW disposal.

- Development of criteria and guidelines for LLW management practices at DOE laboratories consistent with 10 CFR 61, performance of LLW management facility assessments at ORNL, and preparation of guidelines for review and approval of LLW disposal sites.

- Preparation of EAs and ERs, and conduct of regulatory compliance programs for some 20 uranium projects as part of licensing and compliance activities.

- Development and performance of site remedial action programs (Maxey Flats and West Valley burial sites, and radium and thorium processing industrial facilities); design and application of air and water monitoring programs (U.S. DOE sites); and generic and site-specific migration studies.

- Represent clients in public information sessions and regulatory hearings, on the health-related and environmental effects of nuclear and waste management facilities.

1970

- Assistant to Chairman, NYS Atomic and Space Development Authority, Managed demonstration programs on power plant siting, environmental assessment and waste disposal.

1966-1970

- Manager of Direct Energy Conversion Projects, RCA. Responsible for development of Thermoelectric Technology for space and commercial applications.

ROBERT E. BERLIN

1960-1966

- Division Director, US Atomic Energy Commission. Technical and contractual management of SNAP nuclear technology and portable reactor construction projects.

1956-1960

- Senior Engineer, Pratt & Whitney Aircraft performed structural analysis of advanced reactor systems for space applications.

ACADEMIC BACKGROUND

Dr.P.H., Public Health/Environmental Science Concentration, Columbia University, School of Public Health, 1985

M.S., Industrial Engineering, New York University, 1970

M.S., Engineering Science, Rensselaer Polytechnic Institute, 1959

B.S., Mechanical Engineering, City College of New York, 1956

REGISTRATION: Professional Engineer, New York

PUBLICATIONS: R. Berlin, C. Stanton, "Radioactive Waste Management," J. Wiley & Sons, 1988.
Numerous papers and reports on radioactive waste management, thermoelectric technology, and radiological health.

EXPERIENCE:

Rensselaer Polytechnic Institute

Research Assistant 1984 - 1987

Instructor 1983 - 1984

- Research involved design and analysis of blanket and divertor systems for fusion reactors using the novel Integrated-Blanket Coil concept. As a member of the design team for the TITAN project, collaborated with UCLA, Los Alamos Laboratory, the Fusion Engineering Design Center at Oak Ridge and GA Technologies.
- Prepared and taught two laboratory courses at the senior and graduate levels involving use of the sub-critical reactor facility and various data acquisition systems, including CAMAC.

Stone & Webster Engineering Corporation

Career Development Engineer 1982 - 1983

- Responsibilities involved analysis and evaluation of engineered safeguard systems, including containment pressure and temperature effects; determination of non-accident power plant radiation source terms; and evaluation of shielding requirements.

EDUCATION:

Rensselaer Polytechnic Institute, Troy, New York

Ph.D. Nuclear Engineering and Science, 1987

Thesis: Application of the Integrated-Blanket Coil Concept to the Compact Reversed-Field Pinch Fusion Reactor.

M.S. Nuclear Engineering, 1982

Thesis: Heat Transfer in a Shipping Cask Containing Bundled Spent Fuel Pins

B.S. Nuclear Engineering, 1980

PUBLICATIONS:

Duggan, W.P. "Pathway Analysis to Establish Clean-up Criteria" Mixed Waste Regulation Conference, Atlanta, GA, June 17-18, 1991.

Berlin, R.E., Stanton, C., and Duggan, W.P. "Developing a Graduate Program in Nuclear Waste Management/Facility Restoration" Waste Management, '91, Tuscon, AZ, Feb. 24-28, 1991.

Duggan, W.P. and D. Steiner "Integrated-Blanket Coil Applications to the TITAN Reversed-Field Pinch Reactor" Proceedings of the Twelfth Symposium on Fusion Engineering, Monterey, CA, Oct. 12-16, 1987, p. 1279.

Duggan, W.P. and D. Steiner "Applications on the Integrated-Blanket Coil Concept to the Compact Reversed-Field Pinch Reactor" presented at the Seventh Topical Meeting on the Technology of Fusion Energy Reno, NV, June 1986.

PROFESSIONAL AND CIVIC

Adjunct Assistant Professor, Rensselaer Polytechnic Institute
Engineer-In-Training, Commonwealth of Massachusetts
Member, American Nuclear Society
Member, Health Physics Society
Treasurer, Greater New York Chapter Health Physics Society
Member Sigma Xi
Associate Member, American Society of Mechanical Engineers
Director, Rensselaer Alumni Association Club of Westchester
National Chairman, Rensselaer Fund Phonathon

WILLIAM P. DUGGAN, Ph.D.

30 Von Beaste Lane

(914) 268 - 2568 (Home) Congers, New York 10920 (718) 920 - 0112 (College Office)

EXPERIENCE:

Manhattan College

Assistant Professor, Mechanical Engineering 1990 - Present

- Supervisor of the College's Critical Reactor and nuclear engineering laboratory. Research in radiological environmental contamination and waste management. Instruction of undergraduate and graduate students in nuclear engineering and radiological topics, as well as basic engineering courses such as thermodynamics.

Private Consultant 1990 - Present

- Performance of projected pathway analyses and calculation of dose commitments for a former uranium fuel fabrication facility.
- Facility investigation and upgrade of thorium-contaminated industrial site. Impact assessment of remediation alternatives included evaluation of pathways and calculation of potential dose commitments to workers and off-site public. Project required establishment and execution of field health physics program.
- Project Manager of technical and management assistance contract for the New York State Energy Research and Development Authority (NYSERDA), the agency responsible for construction and operation of New York's LLRW disposal facility. Tasks included planning for interim storage needs, preparing NYSERDA's program plan, and assisting in facility design and licensing.
- Facility Investigation for geothermal power plant complex seeking to develop disposal facility for filtercake material with high radium concentrations. Duties involved assessment, through analysis and sampling, of exposures to workers and the public from radon emanations and particulate dispersion, and client support in the permitting process and public hearings.

Dames & Moore

Consultant 1990 - 1992

Senior Engineer 1989 - 1990

Project Engineer 1987 - 1989

- Project Manager for Firm's Basic Ordering Agreement with Brookhaven National Laboratory. Management and technical responsibility for environmental services task order projects, including NEPA documentation; permitting under RCRA, NESHAPs, and other environmental regulations; and appraisal of the environmental monitoring program.
- Project Manager for Dames & Moore Licensing and assessment support of Illinois LLRW Disposal Facility License application by Chem-Nuclear Systems, Inc. Coordinated multi-discipline efforts in preparation of license applications and evaluation of safety and environmental impacts for two sites.
- Performance assessment of West Valley Demonstration Project Class B and C LLRW Drum Cell. Evaluated compliance with 10 CFR Part 61 objectives, particularly with respect to intruder scenarios. Prepared position paper for WVDP use.
- Technical support in development of the Environmental Assessment and Safety Analysis Report for the West Valley Demonstration Project. Principal duties included accident analyses and system hazard classification as part of the Safety and Environmental Assessment Group.
- Technical support in preparation of a generic Safety Analysis Report for a Low Level Radioactive Waste disposal facility based on below-grade vault technology. Responsibilities included development of the environmental monitoring plan and auxiliary system requirements.
- Technical support for radon investigations as part of site assessments. Responsibilities included planning sampling program, interpreting results, and identifying possible mitigating actions.
- Project Engineer in support of an application for onsite disposal of radioactive waste under 10 CFR Part 20.302. The submittal was the first under the guidance of NUREG 1101.