

U.S. ARMY CORPS OF ENGINEERS

**FINAL
PRELIMINARY ASSESSMENT**

**Middlesex Municipal Landfill
Formerly Utilized Sites Remedial Action Program (FUSRAP) Site
Borough of Middlesex, New Jersey**

September 2010

**Prepared by: U.S. Army Engineer District, New York
U.S. Army Engineer District, Kansas City**

Table of Contents

Executive Summary	iii
1.0 Introduction.....	1
1.1 Purpose.....	1
1.2 Site History	2
2. 0 Site Location, Climatic Conditions, Operational History, Current Site Description, and Operational History and Waste Characteristics	4
2.1 Location	4
2.2 Local Climatic Conditions	4
2.3 Current Site Description	5
2.4 Operational History.....	5
2.5 Waste Charecteristics.....	7
2.5.1 Non-Radioactive	7
2.5.2 Radioactive	8
3.0 Physical Conditions	9
3.1 Geology.....	9
3.2 Hydrogeology	9
4.0 PATHWAYS	11
4.1 Soil and Air Pathways.....	11
4.2 Groundwater Pathway.....	15
4.3 Surface Water Pathways	18
5.0 Combined Pathway Conclusion.....	20
6.0 Summary and Conclusions	21
7.0 References.....	22
8.0 Figures.....	24

Executive Summary

The United States Army Corps of Engineers (USACE) conducted a Preliminary Assessment (PA) of the Middlesex Municipal Landfill (MML) site (the Site) under the authority of the Formerly Utilized Sites Remedial Action Program (FUSRAP) in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) [42 U.S.C. 9601 et seq., as amended] and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP [40 CFR 300]).

The purpose of this PA is to review all readily available information to determine the need for further action by the USACE to ensure protection of human health and the environment.

The Middlesex Municipal Landfill is an inactive landfill which was closed to disposal activities in 1974 and which has been covered with varying depths of cover material. No new disposal or storage activities are taking place. The Site consists of parcels belonging to the Borough of Middlesex and the Middlesex Presbyterian Church and occupies approximately 37 acres. In 1984 and 1986 Bechtel National Inc. performed site characterization, remedial action consisting of soil excavation and removal, and a final survey of the area previously identified as impacted for the DOE under the FUSRAP. These remedial actions addressed a total of approximately five acres of the site where soils from the Middlesex Sampling Plant (MSP) were disposed. The site was then released without restrictions to the Borough of Middlesex.

In September of 2008 the Department of Energy (DOE) Office of Legacy Management conducted a radiological survey of the Site. This survey identified small areas of low-level surface radiation. The findings of this survey lead the DOE to declare the site eligible for inclusion in the FUSRAP in March of 2009. The DOE then referred the site to the USACE for appropriate action.

The USACE has reviewed existing, readily available, data on the Site. Based on that review; evidence does not indicate a release of non radiological (chemical) material from the nation's early atomic energy program has occurred; there is evidence of a release and/or threat of release into the environment of hazardous substances (specifically radioactive materials in soil) resulting from work performed as part of the Nation's early atomic energy program that is not a federally permitted release. USACE recommends that further evaluation of the MML site is warranted under the CERCLA process. A Site Investigation report is scheduled to be released in late 2010.

1.0 Introduction

The United States Army Corps of Engineers (USACE) conducted a Preliminary Assessment (PA) of the Middlesex Municipal Landfill (MML) site (the Site) under the authority of the Formerly Utilized Sites Remedial Action Program (FUSRAP) in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) [42 U.S.C. 9601 et seq., as amended] and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP [40 CFR 300]. Also used as a reference for this PA was the Environmental Protection Agency (EPA) “Guidance for Performing Preliminary Assessments Under CERCLA” (EPA, 1991). The purpose of this PA is to review information to determine the need for further action by USACE to ensure protection of human health and the environment.

In 1974 the Department of Energy (DOE) created the FUSRAP to address sites used during the early atomic energy program that had residual contamination exceeding current regulatory limits. In the Energy and Water Development Appropriations Act, 1998 [Public Law 105-62, 111 Stat. 1320, 1326] Congress transferred responsibility for administration and execution of cleanup at eligible FUSRAP sites to the USACE. In the Energy and Water Development Appropriations Act, 2000 [Public Law 106-60, 113 Stat. 483, 502] Congress mandated that FUSRAP response actions undertaken by the Secretary of the Army, acting through the Chief of Engineers, be subject to CERCLA and the NCP.

In March of 1999, the USACE and the DOE signed a Memorandum of Understanding (MOU) between the two agencies for the purpose of delineating the responsibilities of each party relating to the administration and execution of the FUSRAP. Pursuant to that MOU, when a new site is considered for inclusion in the FUSRAP, the DOE is responsible for performing historical research to determine if the site was used for activities that supported the Nation’s early atomic energy program. If the DOE concludes that the site was used for the purpose, the Agency will provide the USACE with a determination of eligibility for inclusion in the FUSRAP. The USACE is then responsible for determining whether the eligible site should be designated for cleanup. To make that determination, the USACE first prepares a PA in accordance with CERCLA and the NCP to determine if a response action is appropriate.

1.1 Purpose

The purpose of a PA at eligible FUSRAP sites is to determine if there is an unpermitted release or threat of release, as those terms are defined in Section 101 (22) of CERCLA, of a hazardous substance related to the Nation’s early atomic energy program at the site that may present a threat to the public health or to the environment. If a PA determines that there is such a release or threat of release, that may present a threat to the public health or the environment, and if the release resulted from work performed as part of the Nation’s early atomic energy program, a FUSRAP response action subject to CERCLA requirements is warranted. In such circumstances, the PA will recommend appropriate action to address the release or threat of release. If no such

release or threat of release is found, the PA will recommend no further action. The scope of USACE's review during performance of the MML PA included site visits by USACE personnel, reviews of historic documentation from past DOE efforts at the Site, and other sources of information related to the Site.

1.2 Site History

In order to understand the historic nature of the MML it is necessary to discuss briefly the operations at the nearby Middlesex Sampling Plant (MSP).

Between 1943 and 1955 the MSP stored and assayed uranium and thorium ores for both the Manhattan Engineer District (MED) and U.S. Atomic Energy Commission (AEC). Drums and ore containers were stored on this open ground. Occasionally, handling and transfer operations would result in spillage of small amounts of ore. Consequently, this area became contaminated by small pieces of pitchblende interspersed with the muddy soil. Recovery of this small amount of ore was not feasible under the conditions that existed. In 1948, the Atomic Energy Commission decided that this storage area should be paved. The area was graded smooth prior to black topping. The excess soil from the grading operation was transported to the MML. Although there is no documentation to indicate when the contamination of the landfill occurred, a review of MSP files documenting operations conducted from 1946 to 1966 indicates the contaminated soil was probably shipped to the landfill between November 1947 and October 1948. This soil, contaminated by previous ore spillage, was dispersed over approximately five acres of the landfill and was used as fill or cover material for sanitary landfill operations.

In 1960 elevated gamma radiation levels were detected at the MML by civil defense monitors during a local civil defense exercise. A radiological survey of the Site was conducted by the AEC and determined that external gamma radiation levels of up to 50 times local background levels existed over an area of one half acre. The AEC removed approximately 650 cubic yards (yd³) of contaminated material and covered the area with approximately two feet of clean cover material.

In 1963 approximately five acres of the landfill site were sold to the Middlesex Presbyterian Church who proceeded to construct a church on the property. It was later determined from discussions with local residents and authorities that the church had been constructed on "non-fill" ground, a fact confirmed by an AEC survey conducted in 1974. However, results from this 1974 survey did indicate contamination remaining in an area of approximately three acres. An additional 1978 survey confirmed the presence of additional on-site contamination.

In 1984 and 1986 Bechtel National Inc. performed site characterization, remedial action consisting of soil excavation and removal, and a final survey of the area previously identified as impacted for the DOE under the FUSRAP. These remedial actions addressed a total of approximately five acres of the site where soils from the MSP were disposed (See Figure 1). The site was then released without restrictions to the Borough of Middlesex.

In 2001 and 2002 the New Jersey Department of Environmental Protection (NJDEP) requested that the Borough conduct a radiological survey of the entire landfill area. That survey showed evidence of elevated radiation levels along the southern boundary of the Site. The source or sources of the elevated readings was not determined in this survey and no further characterization of the area was performed. The identified area was more than 800 feet south of the historic area remediated by DOE and had not been identified by past DOE radiological surveys. Between 2002 and 2003 investigations at the Site were performed by Sadat Associates Inc. These activities consisted of surface gamma scan surveys, test pit excavation and soil borings.

According to the Borough of Middlesex they plan to build a recreation center on the MML. In March of 2008 the NJDEP contacted DOE to determine whether the USACE could perform a detailed gamma scan and investigation to confirm the site conditions and to potentially include the property into the FUSRAP for additional remediation.

In September of 2008 the DOE Office of Legacy Management conducted a radiological survey of the Site. This survey identified small areas of low-level surface radiation (See Figure 1). The findings of this survey lead the DOE to declare the site eligible for inclusion in the FUSRAP in March of 2009. The DOE then referred the site to the USACE for appropriate action.

The Site is currently identified in the US EPA Superfund Information System by the CERCLIS ID# NJD980505499.

The site is identified by the NJDEP as Site Number 5655 with Program Interest Number 024189.

2.0 Site Location, Climatic Conditions, Operational History, Current Site Description, and Operational History and Waste Characteristics

2.1 Location

The MML Site is located in the Borough of Middlesex, New Jersey. The Borough of Middlesex is located in the northwest corner of Middlesex County. It is situated approximately 16 miles southwest of the city of Newark, NJ (See Figure 2). The geologic coordinates for the Site are approximately 40° 34' 36" N latitude, 74° 29' 43" W longitude.

The Site consists of two parcels, one of which belongs to the Borough of Middlesex and one which belongs to the Middlesex Presbyterian Church (See Figure 3). Parcel 1, belonging to the Church is located at 1190 Mountain Avenue and is identified as Block 219, Lot 1. Parcel 2 is the remaining Municipal Landfill which is located on Mountain Avenue and is identified as Block 219, Lot 2. The total extent of the Site's land area is approximately 37 acres. (FR 1989)

The Landfill is bounded on the western border by Mountain Avenue, on the south by Pershing Avenue, and on the north by the Municipal Building and facilities. The Bound Brook provides the eastern boundary of the former Landfill. The site surface is generally level, except along the eastern boundary, where the elevation decreases towards Bound Brook. Chain-link fencing delineates portions of the west and south perimeters.

The Site is located approximately 0.5 miles north-northwest of the MSP Site.

2.2 Local Climatic Conditions

The average daily temperatures for the Borough of Middlesex range from an average low of 21° F in January to an average high of 85° F in July. The Borough of Middlesex is located at approximately 85 feet above mean sea level.

The State of New Jersey averages about 120 days of precipitation per year, and the mean annual precipitation is about 120 cm (48 inches). August is the wettest month, with an average of 12 cm (4.8 inches) of precipitation measured at Somerville, New Jersey, about 13 km (7.8 miles) west of Middlesex. The highest amount of precipitation recorded for a single day is 23 cm (8.9 inches), and the highest monthly total is 37 cm (14 inches). Floods sometimes accompany heavy rains, which are sometimes associated with storms of tropical origin. Occasional short droughts occur during the growing season, but prolonged droughts are rare, generally occurring only once every 15 years. The prevailing winds are from the northwest during October through April and from the southwest during the summer months. (DOE 1984)

2.3 Current Site Description

The MML is currently an inactive landfill which has been covered with varying depths of fill material and cover. The cover material varies in thickness from a minimum of 0.5 feet to as much as 6 feet (Sadat 2007). No new disposal or storage activities are taking place. The presence of miscellaneous debris and trash, scattered across the site, indicates that local residents continue to use the site for disposal of household trash. There are also indications that the site is sometimes being used for unauthorized recreational use. (DOE 2008)

The Landfill and adjacent properties on the north, east, and south are zoned for single-family and planned residential options. One property west of the site across from Mountain Avenue is zoned for a municipal center. Similar zoning plus zoning for single-family, apartment, general business, and two-family, commercial/light manufacturing/wholesale, industrial/industrial park are also located within several kilometers of the site (DOE 1984).

The Site is accessible to railroad and interstate transportation systems. Several schools, hospitals, and other institutional facilities are located within 3.2 km (2 mi) of the Site. The Middlesex Presbyterian Church is located on the north side of the Landfill. The Middlesex Presbyterian Church and associated playground, located at 1190 Mountain Avenue is occupied by numerous children and adults during the week for child care activities and on the weekend by numerous children and adults for worship services.

The municipal building located at 1200 Mountain Ave. is occupied by Borough employees during the work week.

2.4 Operational History

Historic radioactive contamination at the Site was a result of the AEC's disposal of materials from the MSP.

In order to understand the historic nature of the MML it is necessary to discuss briefly the operations at the nearby MSP.

Between 1943 and 1955 the MSP stored and assayed uranium and thorium ores for both the Manhattan Engineer District (MED) and U.S. Atomic Energy Commission (AEC). Drums and ore containers were stored on this open ground. Occasionally, handling and transfer operations would result in spillage of small amounts of ore. Consequently, this area became contaminated by small pieces of pitchblende interspersed with the muddy soil. Recovery of this small amount of ore was not feasible under the conditions that existed. In 1948, the Atomic Energy Commission decided that this storage area should be paved. The area was graded smooth prior to black topping. The excess soil from the grading operation was transported to the MML. The area where the AEC disposed of materials from the MSP began landfill activities in the mid 1940's. Although there is no documentation to indicate when the radioactive contamination of

the landfill occurred, a review of MSP files documenting operations conducted from 1946 to 1966 indicates the contaminated soil was probably shipped to the landfill between November 1947 and October 1948. This soil, contaminated by previous ore spillage, was dispersed over approximately five acres of the landfill and was used as fill or cover material for sanitary landfill operations. In 1948, the landfill area was a gully that extended from within 30-61 meters (100-200 feet) of Mountain Avenue to Bound Brook.

In addition to radioactively contaminated soil material, a series of memorandums related to the disposal of a potentially contaminated concrete rubble from the MSP indicates that contaminated rubble may have been approved for disposal at the Landfill Site. (USGO 1949).

In 1960 elevated gamma radiation levels were detected at the Site by civil defense monitors during a local civil defense exercise. A radiological survey of the Site was conducted by the AEC which determined that external gamma radiation levels of up to 50 times local background levels existed over an area of one half acre. The AEC removed approximately 650 cubic yards (yd³) of contaminated material and covered the area with approximately two feet of clean cover material.

The surface of the Landfill reportedly rose about 2.4-3.0 meters (8-10 feet) from 1961 until it was closed in 1974. By 1974, the area was level to within about 30 meters (100 feet) of the Brook. (DOE 1984)

In 1963 approximately five acres of the landfill site were sold to the Middlesex Presbyterian Church who proceeded to construct a church on the property.

The first indication that additional radioactive material was present at the MML came in 1974. At the request of the Division of Operational Safety, AEC Headquarters, a radiological survey of certain adjoining properties belonging to the Borough of Middlesex and the Middlesex Presbyterian Church was performed during the period of March 25 to April 4, 1974.

Survey results confirmed the existence of a contaminated area lying between and bordering on two properties, the grounds of the Middlesex Presbyterian Church, and property owned by the Borough of Middlesex. An area of approximately 3 acres was found to contain subsurface deposits of radioactive materials characterized by gamma emission readings of three to 60 times naturally occurring background levels. The deposits were found to exist at depths ranging from less than 1 foot to 18 feet. Analysis results indicated the presence of above-background concentrations of radium and uranium. The average concentration of radium over the 3 acre area was found to be approximately 11 pCi/g, with localized concentrations of up to 140 pCi/g. (DOE 1989)

In 1984 and 1986 Bechtel National Inc. performed site characterization, remedial action consisting of soil excavation and removal, and a final survey of the area previously identified as impacted for the DOE under the FUSRAP. These remedial actions addressed a total of approximately five (5) acres of the site where soils from the MSP were disposed. The site was then released without restrictions to the Borough of Middlesex.

In 2001 and 2002 the New Jersey Department of Environmental Protection (NJDEP) requested that the Borough conduct a radiological survey of the entire landfill area. That survey, performed by Integrated Environmental Management Inc., showed evidence of elevated radiation levels along the southern boundary of the Site. The source or sources of the elevated readings was not determined in this survey and no further characterization of the area was performed. The identified area was more than 800 feet south of the historic area remediated by DOE and had not been identified by past DOE radiological surveys. (IEM 2002)

Between 2002 and 2003 investigations at the Site were performed by Sadat Associates Inc. These activities consisted of surface gamma scan surveys, test pit excavation and soil borings along with surface water and groundwater sampling (Sadat 2007) (See Figure 4).

In September of 2008 the DOE Office of Legacy Management contracted DeNuke Inc. to conduct a radiological survey of the Site. This survey identified small areas of low-level surface radiation (See Figure 1). The findings of this survey lead the DOE to declare the site eligible for inclusion in the Formerly Utilized Sites Remedial Action Program in March of 2009. The DOE then referred the site to the USACE for appropriate action.

A review of 13 readily available Site aerial photographs was conducted. Photographs from 1931, 1940, 1947, 1956, 1957, 1963, 1970, 1972, 1979, 1987, 1995, 2002, and 2006 were reviewed (NETR 2010). Notable observations from this review include:

- 1931 Rectangular area of soil disturbance in central South East portion of Site.
- 1940 Small area of fill activities evident in current central portion of Site.
- 1947 Obvious large fill activities evident.
- 1956 Fill activities expand to the North.
- 1963 Fill activities expand to the South.
- 1931, 1970, and 1972 Ground scarring and possible fill activities along the Site's far southern border with Pershing Avenue and far South East is evident.
- 1979 Site revegetated with grasses, shrubs, few trees
- 1987 DOE removal action area evident.
- 1995 Site revegetated with grasses, shrubs, trees

2.5 Waste Charecteristics

2.5.1 Non-Radioactive

As the Site is an inactive landfill, much of the subsurface contains trash and various other waste products as well as significant levels of methane. Based on historic documentation from DOE's past removal actions, there is evidence which indicates that appreciable quantities of nonradiological hazardous wastes may be present in the Landfill, though there is not sufficient evidence at this time to indicate that these wastes are related to historic AEC or MED activities.

High concentrations of arsenic, chromium, and lead were detected in a composite soil sample analyzed from a borehole drilled in 1983. Cyanide and some organics were also present. Ground penetrating radar surveys performed during the 1984 DOE effort also indicate the presence of buried metal material, including the possibility of buried drums. (DOE 1984)

Six boreholes were drilled in January 1984. The presence of appreciable amounts of methane hampered drilling operations and limited sample collection. High concentrations of chromium, arsenic, and lead were found along with hazardous organics such as PCBs, benzo(a)pyrene, and naphthalene. (DOE 1984)

2.5.2 Radioactive

Historic radioactive contamination on the site was FUSRAP related uranium and thorium ores that were removed from the MSP and disposed of at the MML.

In 1961 the AEC removed the portion of the contaminated materials lying nearest the surface, about 650 yd³, and covered the area with approximately two feet of clean fill. The contaminated soil was removed to the AEC New Brunswick Laboratory site in New Brunswick, New Jersey. (FR 1989]

A second remedial action at the MML Site was conducted in two phases in 1984 and 1986. Prior to these removal activities, the DOE had the following observations based on survey data from surveys performed in 1974 and 1978 :

- The distribution of contaminated materials within the Landfill is very spotty, both vertically and horizontally.
- There is little or no correlation between surface radiation levels and subsurface radionuclide concentrations. (DOE 1984)

Excavation of contaminated soil from the landfill began during the summer of 1984, and by November of that year approximately 15,000 yd³ had been removed. Subsurface data that was gathered during the excavation showed that the extent of contamination was greater than that originally estimated. Excavation activities were halted in November 1984 and backfilling was completed. Excavation resumed in May 1986 and was completed in July of that year. Initially excavated material was screened for radiation. Material found not to be contaminated was stockpiled for use as back fill (see Figure 4, Material Flow Chart). The amount of material excavated during 1986 was approximately 16,000 yd³, bringing the total amount of contaminated soil excavated from the landfill to approximately 31,000 yd³. In addition, in 1986 backfilling of the landfill was completed, turf was established, and demobilization and general site cleanup were completed. (DOE 1989)

3.0 Physical Conditions

3.1 Geology

Middlesex County is located in the center of New Jersey and stretches from the Rahway River south to Mercer and Monmouth Counties and from Raritan Bay on the Atlantic Ocean west to Somerset County. The county straddles two physiographic provinces, the Piedmont Province and the Coastal Plain. The Piedmont Province is a low rolling plain divided by a series of higher ridges. This area is comprised of slightly folded and faulted sedimentary rocks of Triassic and Jurassic age. The Coastal Plain is the largest physiographic province in New Jersey. The bedrock geology within this region ranges from Lower Cretaceous to Miocene. The two regions are separated by a fall line consisting of waterfalls and rapids that stretches from the Carteret through Princeton Junction to Trenton. (DOE 1989)

The Middlesex Landfill is located within the Piedmont Province of central New Jersey. The ground surface at the Landfill ranges from 11 meters (35 feet) Mean Sea Level (MSL) near Bound Brook to about 16 meters (53 feet) MSL near Mountain Avenue. Before landfill operations began in the mid 1940s, the area was a gully that extended from within 30 to 61 m (100 to 200 ft) of Mountain Avenue to the brook. As a result of filling activities, the area is now mostly level out to a steep slope within about 33 meters (100 feet) of the brook. (DOE 1984)

3.2 Hydrogeology

The groundwater table varies seasonally. During DOE remediation activities it had been reported to be as high as 12 meters (40 feet) MSL at two wells located near the eastern edge of the excavation area. Groundwater may be found about 3 meters (10 feet) below the surface of the Landfill. The general direction of groundwater flow at the Landfill is east-northeast toward Bound Brook. (DOE 1984)

Groundwater at the Landfill is found in both the unconsolidated overburden deposits and in the bedrock. The overburden is about 3.4 to 10 meters (11 to 34 feet) thick and consists of unconsolidated deposits ranging from clay to sand. The upper overburden consists of fill from landfill activities and floodplain deposits from Bound Brook. The materials are underlain by glacial-fluvial deposits. Bedrock beneath the Site consists of fractured shales, siltstones, and sandstone belonging to the Passaic Formation of the Brunswick Group. The Passaic Formation is Triassic in age.

The Passaic Formation is the major bedrock aquifer throughout a large part of central and northeastern New Jersey occurring throughout the Newark Group. Aquifer conditions generally exist as unconfined to partially confined in the upper 60 m (200 ft) and confined at greater depths. Regionally, the depth range of the Passaic Formation aquifer is 9 to 450 m (30 to 1,500 ft) below existing grade. The common well yield rate of the aquifer is 40 to 1,900 liters per

minute (L/m) [10 to 500 gallons per minute (gpm)]. Well yields have been known to exceed 5,700 L/m (1,500 gpm). Water is generally hard and may have high concentrations of iron and sulfate (USGS, 1999).

The upper aquifer in the overburden material (including the lower part of the fill materials) is separated from the lower bedrock aquifer by a layer of lower permeability (6.5×10^{-6} to 7.0×10^{-7} cm/s) clay formed from weathered shale bedrock. The lower aquifer, which is the major reservoir in the region, occurs in the fractured upper surface of the Passaic (previously known as the Brunswick) Formation. (DOE 1984)

Because the permeability of the clay layer is not extremely low and both aquifers have the same groundwater level, it is possible that the aquifers may be partially connected. However, the limited water quality data that are available for comparing the upper and lower aquifers at the Landfill indicate that there may not be much exchange between the two aquifers.

The groundwater table varies seasonally and was reported as high as 12 m (40 ft) MSL at two wells located near the eastern edge of the 1986 DOE excavation area. Groundwater may be found about 3 m (10 ft.) below the ground surface and flow is east-northeast toward Bound Brook.

Surface runoff flows east towards Bound Brook, which in turn flows northwest and discharges into Green Brook. Green Brook discharges into the Raritan River about 3.0 kilometers (1.9 miles) southwest of the site. The nearest potable surface water supply ($4.4 \text{ m}^3/\text{s}$ [100 mgd]) is drawn from the Raritan River at the confluence with the Millstone River, about 4.2 kilometers (2.6 miles) upstream of the confluence of Green Brook. (DOE 1984)

The 100-year flood level at the Landfill is about 13 m (44 ft) MSL (see Figure 6). Therefore, during the 100-year flood, the eastern edge of the site would be flooded about two-thirds of the way up the slope (DOE 1984).

3.3 Animals, Vegetation, and Sensitive Environments

Middlesex is located within the glaciated area of the Appalachian oak forest section of the eastern deciduous forest. This forest section is characterized by oak, hickory, maple, basswood, elm, and ash, with alder, willow, ash, elm, and hygrophytic shrubs common in moist, poorly drained habitats. However, because the Landfill is located within an urban setting and was used for disposal of wastes, little forest habitat is present. (DOE 1984)

The bald eagle, peregrine falcon, piping plover, and roseate tern may occur at the Middlesex site as occasional transients, however, no habitats critical for the survival of these species occur in the vicinity of the site. Thus, no impacts to these species would be anticipated from wastes currently contained at the site or from any additional remedial actions that may be taken at the site. No federal lands managed for ecological protection occur within a 3.2 kilometers (2 miles) radius of the Site. (ANL 1989)

4.0 PATHWAYS

4.1 Soil and Air Pathways

The MML is an inactive landfill which has been covered with varying depths of cover material (0.5 to 6 feet). Potentially contaminated material exists in the Site subsurface soil.

Past DOE removal activities were conducted in about a five (5) acre area to remove known radiological subsurface contamination and clean (radiologically screened and sorted) material and offsite backfill material were placed where the cleanup was conducted (Fig 4) (DOE 1987). Surveys conducted as part of these efforts did not investigate the entire landfill and only minimal chemical sampling was conducted. These surveys focused on the areas remediated and radiological contamination.

Recent surveys have indicated the presence of radiological contamination in the site subsurface both in and outside of the area of concern in the previous DOE removal actions.

Chemical (non radiological) contamination is being addressed by the Borough of Middlesex. The Borough's Remedial Action Work Plan (RAWP) is under review by NJDEP.

The landfill site is surrounded by residences which approach to the edge of the site along Pershing Ave. to the south, to the edge of the site along Mountain Road to the west, and to within ¼ mile of the edge of Bound Brook on the eastern and northern edges of the Site.

The site is readily accessible to foot traffic and small motorized vehicles. The presence of miscellaneous debris, scattered across the site, indicates that local residents continue to use the site for unauthorized disposal of household trash. There are also indications that the site is being used for unauthorized recreational use.

The Borough is considering using the Site for recreational purposes and portions of the Site may be impacted by a flood control project. Alternatives in the RAWP also discuss the potential of excavation of chemical contamination.

Potential construction activities could complete the soil and air pathways to facilitate exposure to site radiological and non radiological contamination.

Radiological Characterization:

Minimal disturbance of site soils has occurred since the 1986 site remediation conducted by DOE. The Post Remedial Action Report (PRAR) (DOE 1987) for the remediated area concluded:

“Based on all data collected, the MML site conforms to all applicable DOE radiological guidelines established for release of this site for unrestricted use.”

The soil criteria adopted in the PRAR was:

Residual concentrations of radionuclides in soil shall be specified as above-background concentrations averaged over an area of 100 sq meters.

If the average concentration in any surface or below surface area less than or equal to 25 sq meters exceeds the Authorized Limit or guideline by a factor of the square root of (100/A), where A is the area of the elevated region in square meters, Limits for hot spots will be applied. These Hot Spot limits depend on the extent of the elevated local concentrations. In addition, every reasonable effort shall be made to remove any source of radionuclide that exceeds 30 times the appropriate soil limit irrespective of the average concentration in the soil.

The generic guidelines for residual concentrations of the Ra-226, Ra-228, Th-230, and Th-232 are:

- 5 picoCuries/gram (pCi/g), averaged over the first 15 cm of soil below the surface
- 15 pCi/g, averaged over 15cm-thick layers of soil more than 15 cm below the surface.

Analytical results for samples collected for the PRAR indicated radium-226 concentrations ranging from 0.1 to 43.2 pCi/g, with an average concentration of 1.9 pCi/g. For thorium-232, concentrations ranged from 0.1 to 32.0 pCi/g, with an average concentration of 1.6 pCi/g. Uranium-238 concentrations ranged from 0.3 to 37.6 pCi/g, with an average concentration of 6.5 pCi/g.

It should be noted that New Jersey has promulgated regulations since the DOE removal actions that would effectively lower the unrestricted release criteria below the levels reported as remaining onsite.

Verification (post remediation in excavated area) Survey conducted by Oak Ridge National Laboratory (ORNL) and Oak Ridge Associated Universities (ORAU) in 1987 (ORAU 1987) concluded the following:

“The verification activities included document reviews, confirmatory laboratory analyses, and independent direct measurements and sample analysis. Based on the results and findings of these activities it is ORAU’s opinion that the remedial action has been effective in satisfying the established DOE criteria. It is also ORAU’s - opinion that the documentation supporting the remedial action process is adequate and accurate.”

The ORAU survey identified 11 small areas on the surface of previously remediated and backfilled areas that required further investigation. Ten small nuggets of uranium ore were removed from these areas. A soil sample at the 11th area met the release criteria (ORAU 1987). The survey did not attempt to characterize the subsurface backfill material.

Elevated areas outside the excavated area were found during the ORAU gamma survey. These areas were remediated to a depth of 1 ft. Confirmation sampling reported Ra-226 results as high as 14.3 pCi/g (ORAU 1987). This was deemed acceptable compared to the subsurface criteria.

The finding of uranium ore on the surface of backfilled areas during this survey raises questions as to the effectiveness of the radiological screening process and prompted NJDEP to request further site investigations. Additionally, the pre and post surveys conducted by DOE in support of the remediation efforts did not cover the entire landfill site.

During 2002 and 2003 a Site Remedial Investigation (RI) was completed by the Borough of Middlesex consultant, Sadat Services (See Figure 4) (Sadat 2007). The Soil Remediation Standards were revised by the NJDEP in 2008, however, and they are requiring Middlesex Borough to compare analytical soil data to the current standard. Although not yet approved by the NJDEP, the RI concluded:

”The soil quality does not appear impacted by radiological constituents above NJDEP criteria, and the results of a Final Status Survey satisfy the criteria established for release for restricted use. No further investigation of radiological contaminants in soil is proposed.”

The most recent survey of the entire Site was conducted by DOE in 2008 (Fig. 1) (DOE 2008) and reported the following:

“Gamma scans identified 8 small discrete locations of elevated direct radiation and 7 larger areas, ranging from about 250 ft² to 2100 ft², with generally higher near-surface radiation levels and containing multiple discrete elevated locations. Several of the larger areas and individual locations with the highest direct radiation levels were located near the extreme southern boundary of the property.”

The highest discrete direct contact radiation levels, registering 120,000 cpm and 100,000 cpm on survey instruments, were identified in the narrow grassy strip between the fence and Pershing Avenue. Other discrete locations in this general area ranged up to 90,000 cpm. The dose equivalent level at the point of highest count rate identified by the scans was 70 microrem per hour at contact and 25 microrem per hour at 1 meter above the surface. For comparison, the background dose equivalent level in this area is approximately 5 microrem/h at a height of 1 meter. (DOE 2008)

There were also four locations with elevated measured detections of radiation identified in the survey located in the northwest portion of the site, in the vicinity of the area which was previously remediated. The highest discrete location identified was 72,000 cpm. An area of generally elevated levels contained multiple discrete locations of ≤ 2 ft² with a maximum instrument reading of 50,000 cpm (DOE 2008).

A sample from the generally elevated area in the northwest portion of the site contained 39.4 pCi/g of Ra-226, 22.3 pCi/g of U-238, and 35.0 pCi/g of Th-232. This combination of radionuclides is similar to that identified in previous sampling from this portion of the site. The

sample from the 72 k cpm discrete location near the fence in the northwest portion of the site contained concentrations of Ra-226, U-238, and Th-232 at approximately background levels. This indicated that the elevated radiation is likely due to a discrete, rather than diffuse source (DOE 2008).

In samples from the southern portion of the site, the radionuclide is primarily Ra-226. The maximum concentration of Ra-226 in these samples was 135 pCi/g at a depth of 6-10 inches. The sample from the 0-6 inch depth at this location contained 108 pCi/g of Ra-226. Concentrations of uranium in these samples are significantly lower than those of Ra-226. This combination of radionuclides differs from that in samples from the remediated northern portion of the Landfill and raises doubt as to whether the contaminants in the southern portions of the site are from the same process or source (DOE 2008).

Based on the above data, there is evidence of an unpermitted release and/or threat of release into soil or air of radioactive materials resulting from work performed as part of the Nation's early atomic energy program.

Non Radiological (Chemical) Characterization:

As a municipal landfill chemical contamination is not unexpected at the Site. As discussed in section 2.5.1, high concentrations of arsenic, chromium, and lead were detected in the 1983 DOE investigation. Cyanide and some organics were also present (DOE 1984). Surveys performed in DOE's 1984 investigation also identified the presence of buried metal material, including the possibility of buried drums.

The most recent chemical sampling across the entire site was conducted in 2002, 2003, and 2005 as part of the Borough's Remedial Investigation (RI) of the Site. This was conducted by the Borough's consultant, Sadat Services. The RI report was issued by the Borough as a combined RI and RAWP (Sadat 2007). As was previously mentioned, this report has not yet been approved by NJDEP.

The RI/RAWP identifies areas of the MML that are contaminated with Total Petroleum Hydrocarbons (TPH), Poly Chlorinated Biphenyls, antimony, arsenic, cadmium, lead, thallium, Polycyclic Aromatic Hydrocarbons (PAH), and benzyl compounds. These areas are to be addressed by the proposed Remedial Action (RA). Pesticides and Volatile organic compounds (VOC) were also detected. Methane gas is a common issue at landfills and is in the Site subsurface at MML also. Methane is also being addressed by the Borough's RA. The Soil Remediation Standards were revised by the NJDEP in 2008 and they are requiring Middlesex Borough to compare analytical soil data to the current standard.

The site cover materials were sampled in 2005 and results indicate greater than screening level concentrations of arsenic, thallium, PAHs, and pesticides (Sadat 2007).

Based on the above data, there is evidence of a release and/or threat of a release into soils or air of chemicals. While some materials were disposed of at the Site from MSP any residual non

radiological contaminants would be minor and indistinguishable from other landfill wastes. Given the readily available information and a review of the MML Site operational history, sampling results, and the operational history of the MSP, it is unlikely that chemical contamination at the site is related to the Nation's early atomic energy program.

4.2 Groundwater Pathway

The borough of Middlesex is located in the northwest corner of Middlesex County. Middlesex County is located in the center of New Jersey and stretches from the Rahway River south to Mercer and Monmouth Counties and from Raritan Bay on the Atlantic Ocean west to Somerset County. It is located between two physiographic provinces, the Piedmont Province and the Coastal Plain. The Piedmont Plain is a low rolling plain divided by a series of higher ridges. This area is comprised of slightly folded and faulted sedimentary rocks of Triassic and Jurassic age. The Coastal Plain is the largest physiographic province in New Jersey. Geography within this region ranges from Lower Cretaceous to Miocene. The two regions are separated by a fall line consisting of waterfalls and rapids that stretches from the Carteret through Princeton Junction to Trenton.

The Middlesex Municipal Landfill is located within the Piedmont Province of central New Jersey. The ground surface at the Landfill ranges from 11 m (35 ft) MSL near Bound Brook to about 16 m (53 ft) MSL near Mountain Avenue. Before landfill operations began, the area was a gully that extended from within 30 to 61 m (100 to 200 ft) of Mountain Avenue to the brook. As a result of filling activities, the area is now mostly level out to a steep slope within about 33 m (100 ft) of the brook.

The Passaic Formation aquifer is used for domestic, municipal, and industrial water supply in Middlesex County and surrounding counties with pumping rates ranging from approximately 10 to 1,200 L/m (2.6 to 317 gpm) (Michalski, 1990).

Onsite Groundwater Characterization

The most recent and comprehensive study of Site ground water was conducted as part of the Borough of Middlesex's Site RI (Sadat 2007).

During the 2002 groundwater sampling, results indicated exceedances of both radiological and chemical parameters. Samples from monitoring wells MW-1, MW-5, and 81-16 exceeded the gross alpha and total radium Maximum Contaminant Levels (MCL). Samples from MW-2, MW-3, MW-6, and 81-11 exceeded the gross alpha MCL. A table of MCLs and wells which exceeded these criteria during the 2002 groundwater sampling event is provided below.

Parameter	NJDEP MCL	MW-1	MW-3	MW-5	MW-6	81-11	81-16
Gross Alpha	15	147 ± 40	100 ± 66	160 ± 43	26 ± 10	16.3 ± 9	69 ± 20
Gross Beta	50	188 ± 32	215 ± 66	159 ± 28	17.9 ± 6	33.3 ± 8	86 ± 15
Radium 226	5	2.9 ± 0.5	1.3 ± 0.3	3.5 ± 0.6	2.9 ± 0.5	1.3 ± 0.3	2.7 ± 0.5
Radium 228	5	4.2 ± 0.8	2.9 ± 0.9	5.4 ± 0.9	1.4 ± 0.4	1.9 ± 0.6	4.3 ± 0.8
Total Radium	5	7.1 ± 1.3	4.2 ± 1.2	8.9 ± 1.5	4.3 ± 0.9	3.2 ± 0.9	7.0 ± 1.3

Several samples exceeded the NJDEP's Ground Water Quality Standards (GWQS) for ammonia, TDS, metals, and select VOCs in the shallow groundwater during the 2002 sampling event. Radiological parameters were all less than MCLs in the bedrock wells.

The Borough's revised RI report of the MML Site concluded the following: "The additional groundwater sampling conducted as part of the 2003 RI activities confirmed exceedances of NJDEP's GWQS for ammonia, TDS, metals, and select VOCs in the shallow groundwater. The additional radiological shallow groundwater data collected as part of the 2003 RI indicated significant decreases in concentrations of radiological parameters. While two (2) wells, MW-6 and well 81-16 exceeded the screening level for gross alpha and/or gross beta, they did not exceed limits for 226 Ra and 228 Ra. No further action is proposed for radiological contamination in the shallow groundwater." No other well samples exceeded radiological MCLs (Sadat 2007).

The 2003 RI data reported uranium-238 concentrations ranging from 0.1 pCi/l to 0.5 pCi/l. Uranium was the primary contaminant of concern in the groundwater at MSP (USACE 2005). It is probable that if MSP materials were impacting Site groundwater, then uranium levels in groundwater would be higher. Accordingly, it is unlikely that the source of sporadic MCL exceedances in Site ground water is related to the Nation's early atomic energy program.

Based on additional deep groundwater sampling data, iron and manganese were confirmed to exceed NJDEP GWQS. These are believed to be due to natural regional sources. In addition, one VOC, carbon tetrachloride, was detected at an estimated value which slightly exceeds the new GWQS. Based on the 2002 and 2003 remedial investigations, no radiological impacts to the deep groundwater at the MML property were found. Furthermore, based on the deep groundwater quality, it does not appear that the deep groundwater is being impact by the shallow groundwater. (Sadat 2007)

No exposures to contaminated groundwater immediately beneath the site are occurring or are expected to occur in the future. No on-site wells currently draw drinking water from the groundwater and there are no known plans to use this groundwater in the future. The Borough of Middlesex is addressing chemical contamination in the shallow groundwater beneath the site as part of their Site RAWP (Sadat 2007).

Based on the above data and a review of the MML Site operational history it is unlikely that there has been an unpermitted release and/or threat of release into Site ground water resulting from work performed as part of the Nation's early atomic energy program.

Offsite Groundwater

Offsite ground water in the area of MML has been investigated as part of the MSP FUSRAP site both by USACE and ATSDR. As part of the MSP Ground Water RI USACE requested well completion permits on file with NJDEP Bureau of Water Allocation (BWA).

The MSP Ground Water RI did determine that there were 316 wells within one (1) mile of the MSP site (USACE 2005). Since the MML and MSP sites are close together this represents a rough estimate of the wells in a one and a half (1.5) mile radius around the MML Site.

Of the 316 BWA permitted wells 81 were used for domestic consumption, 6 for industrial purposes, 2 for irrigation, and 227 for monitoring, remediation, gas venting, or other non consumption purposes. Completion depths of wells used for potable purposes in the vicinity of MML range from 21 to 122 meters (70 to 400 feet) below ground (USACE 2005).

ATSDR sampled 17 private consumption wells as part of their Public Health Assessment of the MSP site. Radiological and non radiological potential contaminant levels in private wells were below levels of concern or at background levels (ATSDR 2000).

Nineteen (19) municipal wells were identified within a 6.4 km (4-mi) radius of the site. The nearest public well field to the site, the Elizabethtown Water Company's Sebring's Mills well field, is located approximately 0.6 miles northwest and upgradient of the site. Historically this well field would draw from the unconfined Passaic Formation Aquifer, but has not operated since 1978 (ATSDR 2000).

Although the use of private drinking water wells in the area represents a potential for a completed groundwater pathway, no exposures to potentially contaminated groundwater flowing offsite are occurring or are expected to occur.

Based on the above data and a review of the MML Site operational history it is unlikely that there has been a release or threat of release into offsite groundwater of radioactive materials or chemicals related to the Nation's early atomic energy program.

4.3 Surface Water Pathways

Surface runoff flows east towards Bound Brook, which in turn flows northwest and discharges into Green Brook. Green Brook discharges into the Raritan River about 3.0 km (1.9 mi) southwest of the site. The nearest potable surface water supply (4.4 m³/s [100 mgd]) is drawn from the Raritan River at the confluence with the Millstone River, about 4.2 km (2.6 mi) upstream of the confluence of Green Brook.

A private industry withdraws a very small amount of water (0.2 m³/s [4.6 mgd]) from the Raritan River about 0.8 km (0.5 mi) downstream from the confluence with Green Brook.

The 100-year flood level at the Landfill is about 13 m (44 ft) MSL. Therefore, during the 100-year flood, the eastern edge of the site would be flooded about two-thirds of the way up the slope (Fig. 5). The discharge associated with the 100-year flood is estimated to be about 115 m³/s (4,050 ft³/s) at the Landfill. Available tax and flood zone maps show that the 100 year flood and 500 yr floods would cover over 50% of the landfill width in some areas.

Based on drainage areas and stream-flow measurements on Bound Brook and Cedar Brook at South Plainfield, it is estimated that the low flow of Bound Brook at the Landfill is about 0.2 m³/s (8.8 ft³/s) during the month of August.

The most recent and comprehensive study of Site surface water was conducted as part of the Borough of Middlesex's RI. The Borough's RI concluded: "The 2002 RI indicated one (1) pesticide, α -chlordane, slightly exceeded the SWQC. The results of the 2003 RI confirmed the presence of α -chlordane at concentrations above the applicable SWQC including the upstream samples. This pesticide is believed to be due to regional sources. No further action is proposed."

"No exceedances of the applicable NJDEP/EPA radiological criteria were found during the 2002 RI, and no further investigation of radiological contamination in surface water was performed as part of the 2003 RI. No further action proposed for surface water."

Two seeps on the eastern slope of the landfill were identified during the Borough's RI. It was not determined if the seeps were landfill leachate or shallow ground water. The Borough's contractor intends to sample the seeps and recommend RA if necessary pending these sample results (Sadat 2007).

No exposures to potentially contaminated surface water at the Site are occurring; the potential exists for future exposures through flooding and seeps that may result in contamination of surface water.

Based on the above data, there is evidence of a release or threat of release (seeps and flooding) into the surface water of radioactive materials related to the Nation's early atomic energy program that is not a federally permitted release in compliance with a legally enforceable license, permit, regulation, or order issued pursuant to the AEA.

Sediment Characterization

The most recent and comprehensive study of Site sediments was conducted as part of the Borough of Middlesex's RI (Sadat 2007). The Borough's RI concluded:

“The 2002 RI data indicated slight exceedances of LEL for Aroclor 1254. The 2003 RI sediment data indicated concentrations of Aroclor 1254 above the LEL in three (3) samples SED-9, -10, and -11. Total PCB concentrations in samples SED-10 and SED-11 exceeded the LEL for total PCBs. Due to the detection of elevated concentrations of total PCBs at a concentration of three times the LEL in SED-10, further investigation was performed for sediments to delineate extent of PCBs. The additional sediment sampling performed in July 2004 indicated no exceedances of the LEL around SED-10. Therefore, it appears that the original exceeding concentration at SED-10 may have been an anomaly. No further investigation is proposed.”

“The organochlorine pesticide, endrin, was also found to exceed its LEL in two (2) samples, SED-10 and SED-11. Endrin was non-detect in the previous 2002 sediment samples. Additional delineation sampling for pesticides performed in July 2004 indicated no exceedances of the LEL. No further sediment investigation of pesticides is proposed.”

“The results of the 2002 RI indicated exceedances of the LEL for chromium, copper, nickel and zinc. The 2003 RI sediment sampling indicated concentrations of arsenic and nickel above the LEL from upstream location SED-12. All other samples indicated metals concentrations below their LEL. Therefore, no further investigation for metals is proposed.”

“The PAH, benzo[g,h,i]perylene, was detected in sample SED-10 at a concentration that slightly exceeded the LEL. The 2002 RI sediment data indicated PAHs above the LEL in one (1) upstream sample, SED-6. Since the concentrations only slightly exceed the LEL and appear to be from upstream sources, no further investigation is recommended.”

Currently, no exposures to potentially contaminated sediments at the Site are occurring. The potential exists for future exposures through flooding and seeps that may result in contamination of sediments.

Based on the above data, there is evidence of a release or threat of release, through flooding and seeping, into site sediments of radioactive materials related to the Nation's early atomic energy program that is not a federally permitted release in compliance with a legally enforceable license, permit, regulation, or order issued pursuant to the Atomic Energy Act.

5.0 Combined Pathway Conclusion

The 1984 and 1986 DOE cleanup addressed known accessible radiological contamination, thus limiting the soil and air exposure pathways. Limited radiological data exists on areas of the landfill outside of the DOE remediated areas. Limited data exists on potential subsurface contaminant levels and depths. The data that is available, however, indicate that radiological and chemical contamination from various sources remains in some areas of the Site.

Completion of the soil and air pathway by such activities as construction activities at the Site is possible. This presents a potential for a hazard to human health and the environment. There is evidence to indicate a release of radioactive materials from the nation's early atomic energy program to Site soils has occurred. Evidence indicates a release of non radiological hazardous material (chemicals) from the nation's early atomic energy program to Site soils has not occurred.

Site groundwater is impacted with hazardous substances not related to the Nation's early atomic energy program and it is being addressed by the Borough of Middlesex. The potential for off-site receptor exposures via the groundwater pathway is highly unlikely and not expected in the future. There is no evidence of a release or threat of release into Site or offsite groundwater of radioactive materials or chemicals related to the Nation's early atomic energy program.

Evidence does not indicate a release of hazardous material (radiological and chemical) from the nation's early atomic energy program to surface waters has occurred. Due to the Site proximity to surface water and potential for flooding, a potential release of hazardous substances to the surface water pathway does exist primarily from potential contact with contaminated soils.

Although data gaps limit the assessment of exposures, the potential does exist for exposure to current and future occupants of the Site and persons offsite to Site contaminants. The completion of surface water, groundwater, soil and/or air exposure pathways would present a hazard to human health and the environment.

6.0 Summary and Conclusions

The Middlesex Municipal Landfill is an inactive landfill which has been covered with varying depths of cover material. Soil contaminated by previous ore spillage at MSP was dispersed over approximately five acres of the landfill and was used as fill or cover material for sanitary landfill operations.

Previous remedial actions addressed portions of the Site where soils from the MSP were disposed. Recent radiological surveys of the Site were conducted. The findings of the surveys lead the DOE to declare the site eligible for inclusion in the FUSRAP. The DOE then referred the site to the USACE for appropriate action.

The USACE has reviewed existing, readily available data on the Site. Based on that review; evidence does not indicate a release of non radiological (chemical) material from the nation's early atomic energy program has occurred; there is evidence of a release and/or threat of release into the environment of hazardous substances (specifically radioactive materials in soil) resulting from work performed as part of the Nation's early atomic energy program that is not a federally permitted release. A more detailed analysis such as a CERCLA Site Investigation is recommended and is currently underway. A Site Investigation report is scheduled to be released in late 2010.

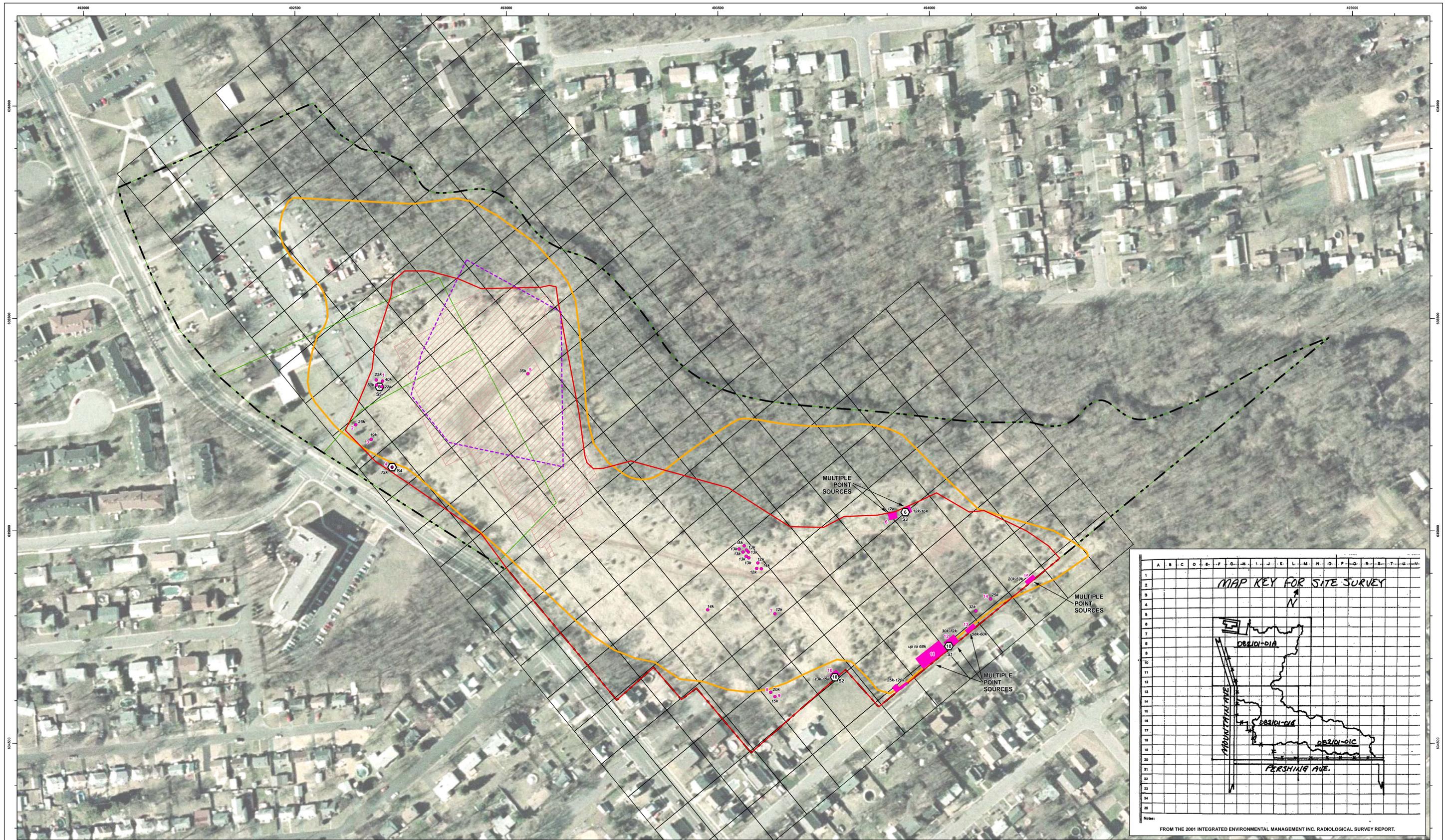
7.0 References

- ANL 1989 Determination of Ecologically Vital Groundwaters at Selected Sites in the FUSRAP, Argonne National Lab, August 1989
- ATSDR 2000 *Public Health Assessment for Middlesex Sampling Plant*. U.S. Department of Health and Human Services, Agency for Toxic Substances and Disease Registry, 2000.
- DOE 1984 DOE Memorandum from Franklin F. Coffman (Director, Office of Terminal Waste Disposal and Remedial Action, Office of Nuclear Energy) to File, RE: *Action Description Memorandum (ADM) Review: Proposed 1984 Remedial Actions at Middlesex, New Jersey*, dated 09/07/1984
- DOE 1987 Formerly Utilized Sites Remedial Action Program (FUSRAP) *Post-Remedial Action Report for the Middlesex Municipal Landfill Site*, Middlesex, New Jersey (DOE/OR/20722-135), Feb 1987
- DOE 1989 *Certification Docket for the Remedial Action Performed at the Middlesex Municipal Landfill in Middlesex, New Jersey in 1984 and 1986*, dated May 1989 (Multiple documents)
- DOE 2008 Report, DeNuke, Former Middlesex Municipal Landfill, Middlesex, New Jersey, dated December 18, 2008
- FR 1989 Federal Register / Vol. 54, No. 87 / Monday, May 8, 1989 / Notices (Statements of Certification for Middlesex site)
- IEM 2002 Surface Radiological Assessment of MML, Integrated Environmental Management, Inc., 2002
- Michal 1990 Hydrogeology of the Brunswick (Passaic) Formation and Implications for Groundwater Monitoring Practice, Groundwater Monitoring Review, (10) no.4, p. 134-143, 1990 Michalski, A.
- Sadat 2007 Revised Remedial Investigation Report Addendum/Remedial Action Workplan for the Former Middlesex Municipal Landfill Mountain and Pershing Avenues Middlesex Borough, Middlesex County, New Jersey, Case # NJ980505499, Prepared by Sadat Associates, April 2006, Revised August 17, 2007
- NETR 2010 Website, HistoricalAerials.com, National Environmental Title Research, LLC, May 2010.

Preliminary Assessment
Middlesex Municipal Landfill

- ORAU 1987 Oak Ridge Associated Universities Memorandum from Luis Velasquez to James Berger, RE: Final Verification Report - Middlesex Landfill Remedial Action, dated 09/29/1987
- USACE 2005 *Groundwater Operable Unit Remedial Investigation Report, Middlesex Sampling Plant, Middlesex, New Jersey (USACE, 2005)*
- USGS 1999 United States Geological Survey 1999. *Aquifer and Well Characteristics in New Jersey*, March 2,
- USGO 1949 U.S. Government Office Memorandum from D.E. Lynch to the Files, RE: Visit to the Perry Warehouse in Connection With Radioactive Wastes, dated 07/29/1949

8.0 Figures



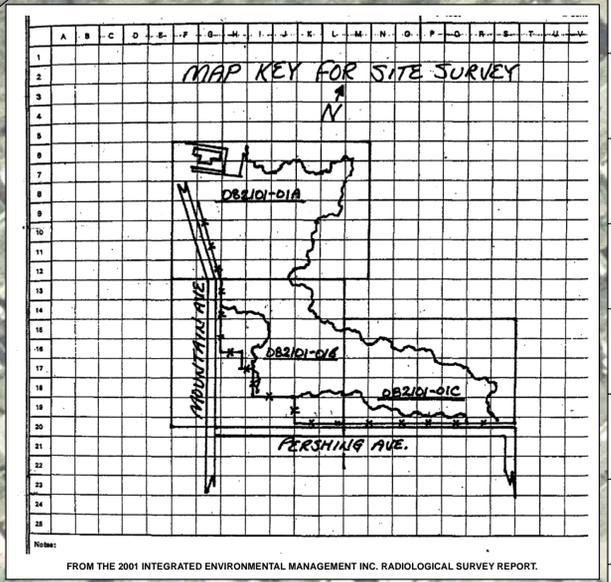
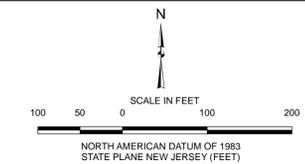
LEGEND
 Locations of Elevated Surface Radiation¹
 5 Location Identifier³
 Small Discrete Point
 Area of Multiple Discrete Elevated Locations
 S¹ Soil Sample Location, Depth in Inches, and Identifier²
 12k Instrument Reading in Counts per Minute

Site Boundary³
 Approximate Area with Assessed Subsurface Contamination³
 Approximate Extent of Fill Material³
 Parcel Boundary³
 Areas Cleaned in 1984 and 1986⁴

DeNuke Radiological Survey Boundary (2008)⁵
 100-Foot Grid⁵

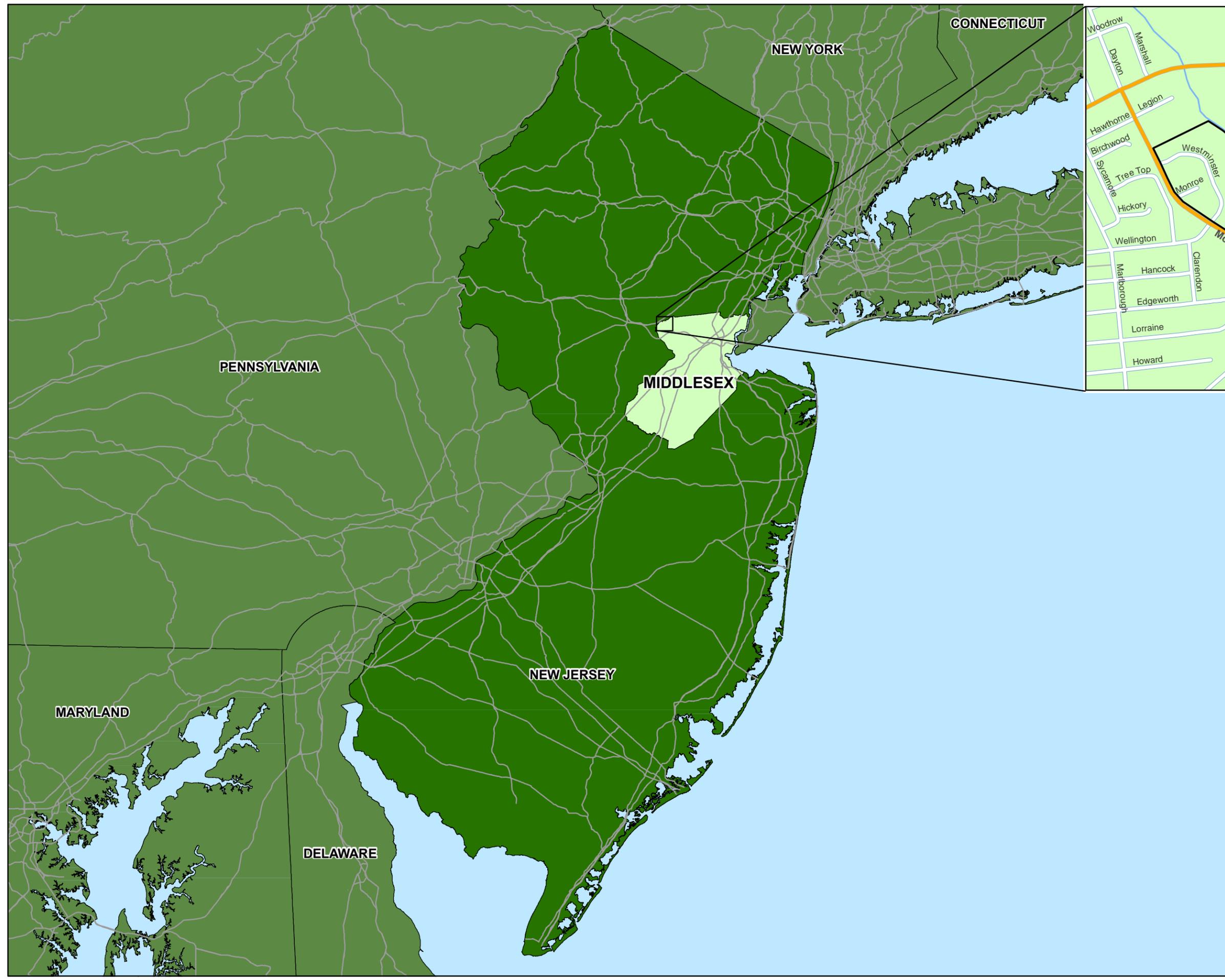
Data Sources:
¹ Table 1 of the DeNuke Radiological Survey Report.
² Table 2 of the DeNuke Radiological Survey Report.
³ 09/15/2008 Site Plan drawing from Sadleir Associates Inc.
⁴ Figure 2 from the Post-Remedial Action Report for the Middlesex Municipal Landfill Site.
⁵ Digitized from Figure 2 of the DeNuke Radiological Survey Report.
 * Locations with no identifier were digitized from the DeNuke reference grid survey forms.
 Aerial Photo: USGS Atlantic Coastal Imagery 2006

Activities greater than 12,000 counts per minute, represented by magenta areas, may have radium-226 activities of greater than 2.5 picocuries per gram.
 The background radium-226 concentration in approximately 1 picocurie per gram.
 All areas outside locations of magenta elevated surface radiation are <12,000 counts per minute.



U.S. DEPARTMENT OF ENERGY
 GRAND JUNCTION, COLORADO
 Work Performed by
S.M. Stoller Corporation
 UNDER DOE CONTRACT
 NO. DE-AM01-07LM00060
 Middlesex North, NJ, Site
 Gamma Survey Results and Sample Locations
 Survey Conducted September 2008
 DATE PREPARED: January 30, 2009
 FILENAME: S0507700

MML PA Figure 1



Legend

-  North
-  Site Outline
-  Highway
-  Middlesex County
-  Site Outline

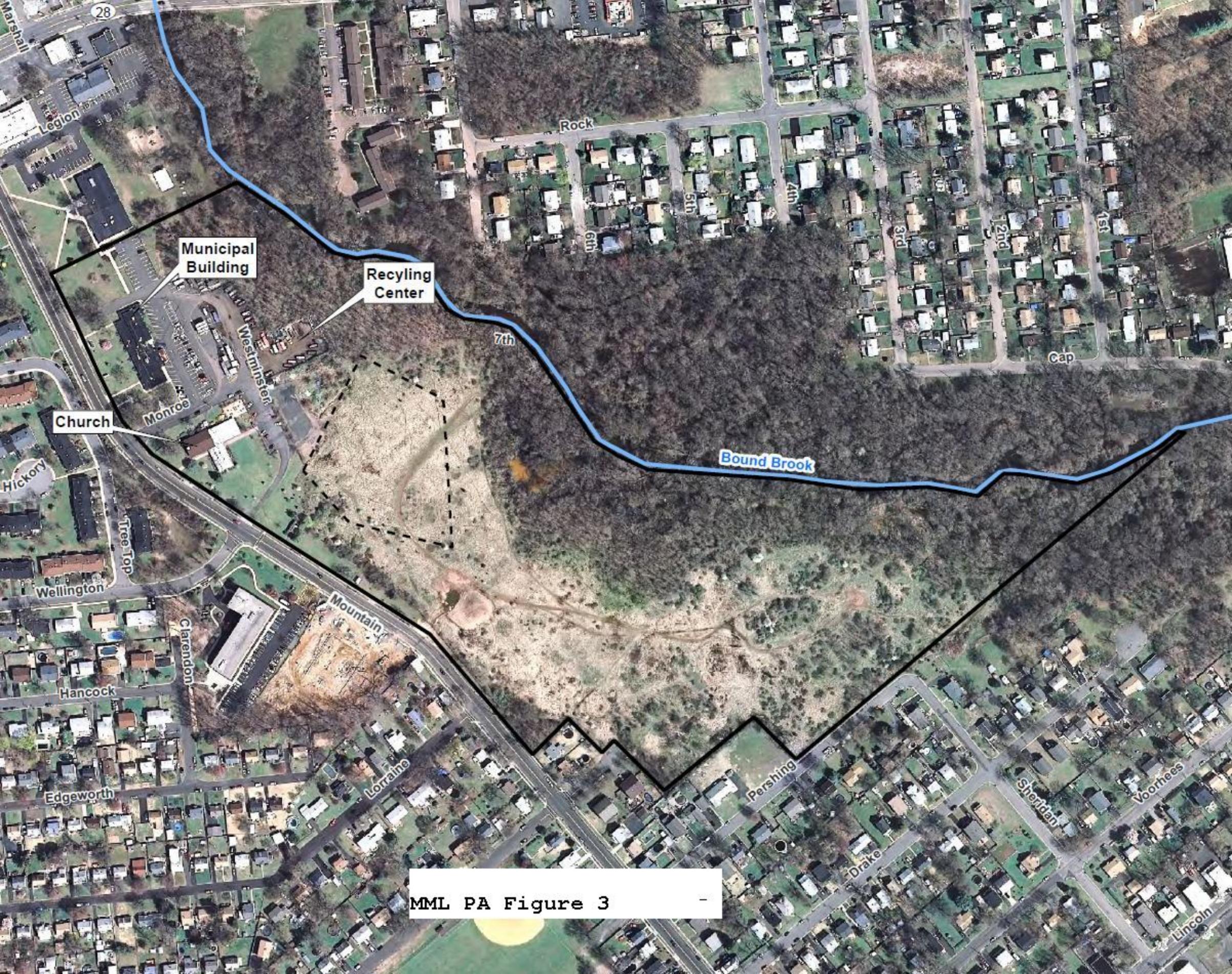
Scale

0 5 10 20 30 40 Miles

**MIDDLESEX MUNICIPAL LANDFILL
SITE LOCATION**

**MIDDLESEX MUNICIPAL LANDFILL
MIDDLESEX, NEW JERSEY**

10/09 **MML PA Figure 2**



Municipal Building

Recycling Center

Church

Bound Brook

Mountain

MML PA Figure 3

GENERAL NOTES
 THE CURRENT SHAPE OF THE BOUND BROOK WAS BASED ON A 1974 AERIAL PHOTOGRAPH.
 THIS DRAWING IS BASED ON THE FOLLOWING MAPS:
 1. COUNTY MAP OF MIDDLESEX COUNTY, NEW JERSEY, REVISED JANUARY, 1988, AND JANUARY, 1986, RESPECTIVELY.
 2. FIGURE 2 FROM "SITE ASSESSMENT REPORT, MIDDLESEX MUNICIPAL LANDFILL," PREPARED BY METCALF & EDDY, FEBRUARY, 1988.
 3. ATTACHMENT 1 FROM "U.S. ATOMIC ENERGY COMMISSION RADIATION SURVEY REPORT OF THE MIDDLESEX LANDFILL SITE," JUNE 27, 1974.
 4. ZENITH/MOR SURVEY FROM CLINTON, NEW JERSEY, DATED 8/27/02.
 5. SURVEY OF SOIL BORING LOCATIONS BY RENOLDIS GROUP, DATED 9/25/03.

NOT FOR CONSTRUCTION

- LEGEND**
- MANHOLE
 - TID AND RASON SAMPLES COLLECTED BY BECHTEL NATIONAL, INC., AS PART OF THE ENVIRONMENTAL MONITORING PROGRAM 1960-1988
 - MONITORING WELL SAMPLES COLLECTED BY BECHTEL NATIONAL, INC., AS PART OF THE ENVIRONMENTAL MONITORING PROGRAM 1960-1988
 - SURFACE WATER SAMPLES COLLECTED BY BECHTEL NATIONAL, INC., AS PART OF THE ENVIRONMENTAL MONITORING PROGRAM 1960-1988
 - LEACHATE SEEPS DISCOVERED BY MDEP REPRESENTATIVES DURING A SITE INSPECTION FEBRUARY 3, 1986.
 - FENCE
 - PROPERTY BOUNDARY
 - APPROXIMATE EXTENT OF FILL MATERIAL
 - APPROXIMATE AREA WITH SUBSURFACE RESIDUAL CONTAMINATION
 - APPROXIMATE WETLANDS AREA
 - SAMPLING LOCATIONS:
 - SB-1: SOIL BORINGS—February 8-12, and May 7 and 17, 2002
 - PZ-1: TEST POINTS—February 8, 2002
 - SS-1: SOIL GAS POINTS—SS February 12, 2002; G—May 17, 2002
 - TP-1: TEST PITS—February 4-7, and May 6, 2002
 - TP-2: TEMPORARY WELL POINTS—February 13, 2002
 - SW/SED: SURFACE WATER / SEDIMENT—May 8, 2002
 - SHALLOW MONITORING WELLS
 - BERDICK MONITORING WELLS
 - SOIL BORING — AUGUST 13-18, 2003
 - SOIL GAS LOCATIONS G-56 (12/23/2003)
 - SOIL GAS LOCATIONS G-762 (07/09/2004)
 - DELINEATION SOIL BORING, NOVEMBER 17, 2003
 - SW/SED SURFACE WATER / SEDIMENT
 - PROPOSED SHALLOW GROUNDWATER MONITORING WELL

Certificate of Authorization
 No. 246A28015200

BAR SCALE
 100 50 0 100 200
 1 INCH = 100 FT

NO.	DATE	REMARKS
1	10/29/04	ADD BLOW UP OF SED-10 AND TAKE OUT BLOWUPS FOR SB6 AND TP-3

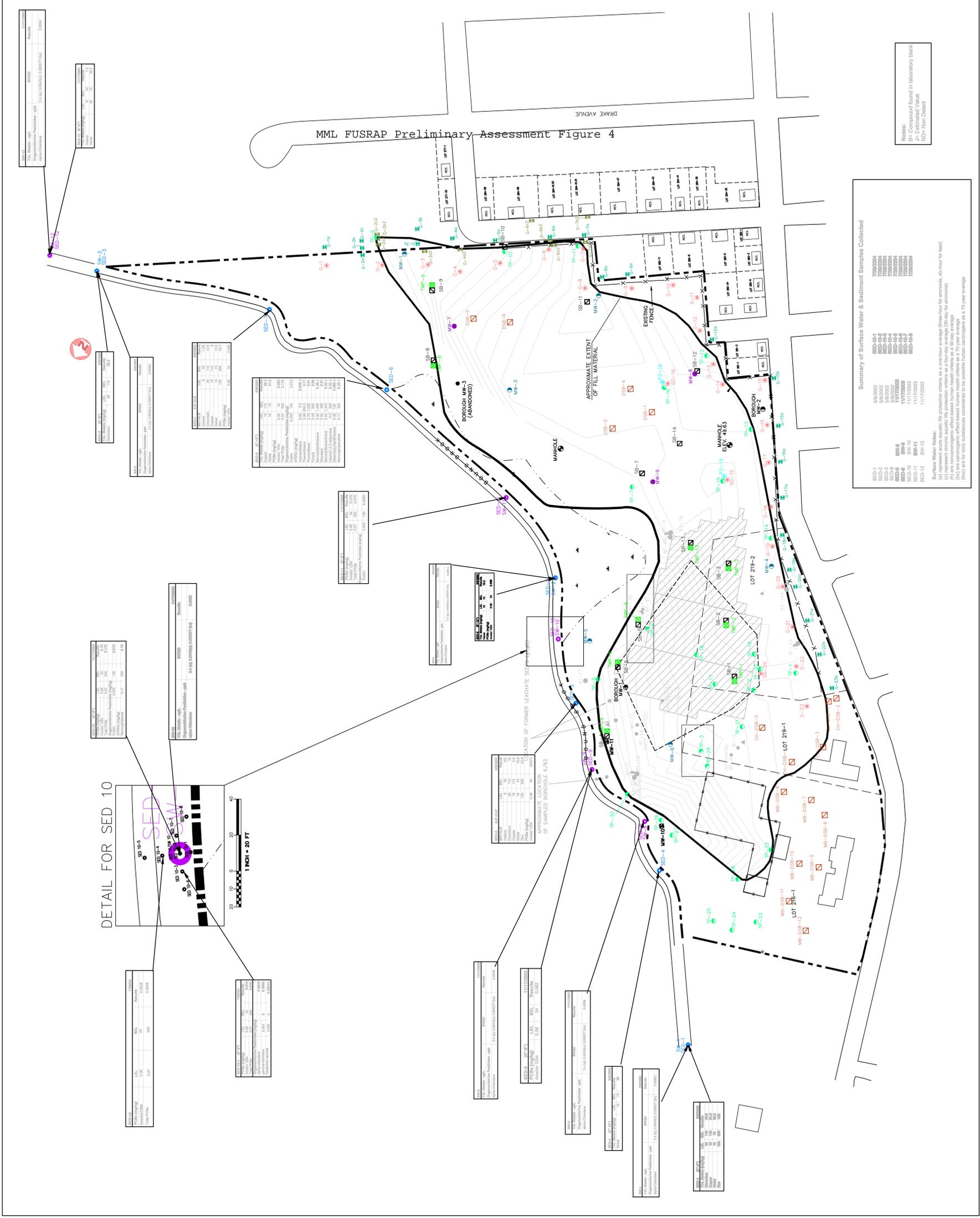
SADAT ASSOCIATES INC.
 Engineering & Environmental Sciences
 1545 Lambertson Rd., Trenton, NJ 08611
 (609) 828 9600 FAX (609) 828 9601.

SITE NAME
 FORMER MIDDLESEX MUNICIPAL LANDFILL
 MIDDLESEX BOROUGH
 MIDDLESEX COUNTY, NEW JERSEY

DRAWING TITLE: FIGURE A-8
SURFACE WATER/SEDIMENT SAMPLE RESULTS

Date:	04/28/04	Drawn by:	KK	Design by:	SMS
Scale:	1"=100'	Checked by:	KK	Project Mgr:	SMS
Job No.:	99084-0404	Sheet:	08		

© Sadat Associates, Inc. 2004 / TABLE A-8



Notes:
 B- Compound found in laboratory blank
 ND- Not Detected

Summary of Surface Water & Sediment Samples Collected

Sample ID	Location	Date	Analysis
SED-1	SB-1	5/8/2002	...
SED-2	SB-2	5/8/2002	...
SED-3	SB-3	5/8/2002	...
SED-4	SB-4	5/8/2002	...
SED-5	SB-5	5/8/2002	...
SED-6	SB-6	5/8/2002	...
SED-7	SB-7	5/8/2002	...
SED-8	SB-8	5/8/2002	...
SED-9	SB-9	5/8/2002	...
SED-10	SB-10	5/8/2002	...
SED-11	SB-11	5/8/2002	...
SED-12	SB-12	5/8/2002	...
SED-13	SB-13	5/8/2002	...
SED-14	SB-14	5/8/2002	...
SED-15	SB-15	5/8/2002	...
SED-16	SB-16	5/8/2002	...
SED-17	SB-17	5/8/2002	...
SED-18	SB-18	5/8/2002	...
SED-19	SB-19	5/8/2002	...
SED-20	SB-20	5/8/2002	...
SED-21	SB-21	5/8/2002	...
SED-22	SB-22	5/8/2002	...
SED-23	SB-23	5/8/2002	...
SED-24	SB-24	5/8/2002	...
SED-25	SB-25	5/8/2002	...
SED-26	SB-26	5/8/2002	...
SED-27	SB-27	5/8/2002	...
SED-28	SB-28	5/8/2002	...
SED-29	SB-29	5/8/2002	...
SED-30	SB-30	5/8/2002	...
SED-31	SB-31	5/8/2002	...
SED-32	SB-32	5/8/2002	...
SED-33	SB-33	5/8/2002	...
SED-34	SB-34	5/8/2002	...
SED-35	SB-35	5/8/2002	...
SED-36	SB-36	5/8/2002	...
SED-37	SB-37	5/8/2002	...
SED-38	SB-38	5/8/2002	...
SED-39	SB-39	5/8/2002	...
SED-40	SB-40	5/8/2002	...
SED-41	SB-41	5/8/2002	...
SED-42	SB-42	5/8/2002	...
SED-43	SB-43	5/8/2002	...
SED-44	SB-44	5/8/2002	...
SED-45	SB-45	5/8/2002	...
SED-46	SB-46	5/8/2002	...
SED-47	SB-47	5/8/2002	...
SED-48	SB-48	5/8/2002	...
SED-49	SB-49	5/8/2002	...
SED-50	SB-50	5/8/2002	...
SED-51	SB-51	5/8/2002	...
SED-52	SB-52	5/8/2002	...
SED-53	SB-53	5/8/2002	...
SED-54	SB-54	5/8/2002	...
SED-55	SB-55	5/8/2002	...
SED-56	SB-56	5/8/2002	...
SED-57	SB-57	5/8/2002	...
SED-58	SB-58	5/8/2002	...
SED-59	SB-59	5/8/2002	...
SED-60	SB-60	5/8/2002	...
SED-61	SB-61	5/8/2002	...
SED-62	SB-62	5/8/2002	...
SED-63	SB-63	5/8/2002	...
SED-64	SB-64	5/8/2002	...
SED-65	SB-65	5/8/2002	...
SED-66	SB-66	5/8/2002	...
SED-67	SB-67	5/8/2002	...
SED-68	SB-68	5/8/2002	...
SED-69	SB-69	5/8/2002	...
SED-70	SB-70	5/8/2002	...
SED-71	SB-71	5/8/2002	...
SED-72	SB-72	5/8/2002	...
SED-73	SB-73	5/8/2002	...
SED-74	SB-74	5/8/2002	...
SED-75	SB-75	5/8/2002	...
SED-76	SB-76	5/8/2002	...
SED-77	SB-77	5/8/2002	...
SED-78	SB-78	5/8/2002	...
SED-79	SB-79	5/8/2002	...
SED-80	SB-80	5/8/2002	...
SED-81	SB-81	5/8/2002	...
SED-82	SB-82	5/8/2002	...
SED-83	SB-83	5/8/2002	...
SED-84	SB-84	5/8/2002	...
SED-85	SB-85	5/8/2002	...
SED-86	SB-86	5/8/2002	...
SED-87	SB-87	5/8/2002	...
SED-88	SB-88	5/8/2002	...
SED-89	SB-89	5/8/2002	...
SED-90	SB-90	5/8/2002	...
SED-91	SB-91	5/8/2002	...
SED-92	SB-92	5/8/2002	...
SED-93	SB-93	5/8/2002	...
SED-94	SB-94	5/8/2002	...
SED-95	SB-95	5/8/2002	...
SED-96	SB-96	5/8/2002	...
SED-97	SB-97	5/8/2002	...
SED-98	SB-98	5/8/2002	...
SED-99	SB-99	5/8/2002	...
SED-100	SB-100	5/8/2002	...

Surface Water Notes:
 (A) Represent acute aquatic life protection criteria as a one-hour average (three-hour for ammonia, six-hour for lead).
 (B) Represent chronic aquatic life protection criteria as a four-day average (30-day for ammonia).
 (C) Represent chronic human health protection criteria as a 70-year average.
 (D) are carcinogenic effect-based human health criteria as a 70-year average.
 (E) are toxic substances considered to be possible human carcinogens as a 70-year average.

MML PA Figure 4

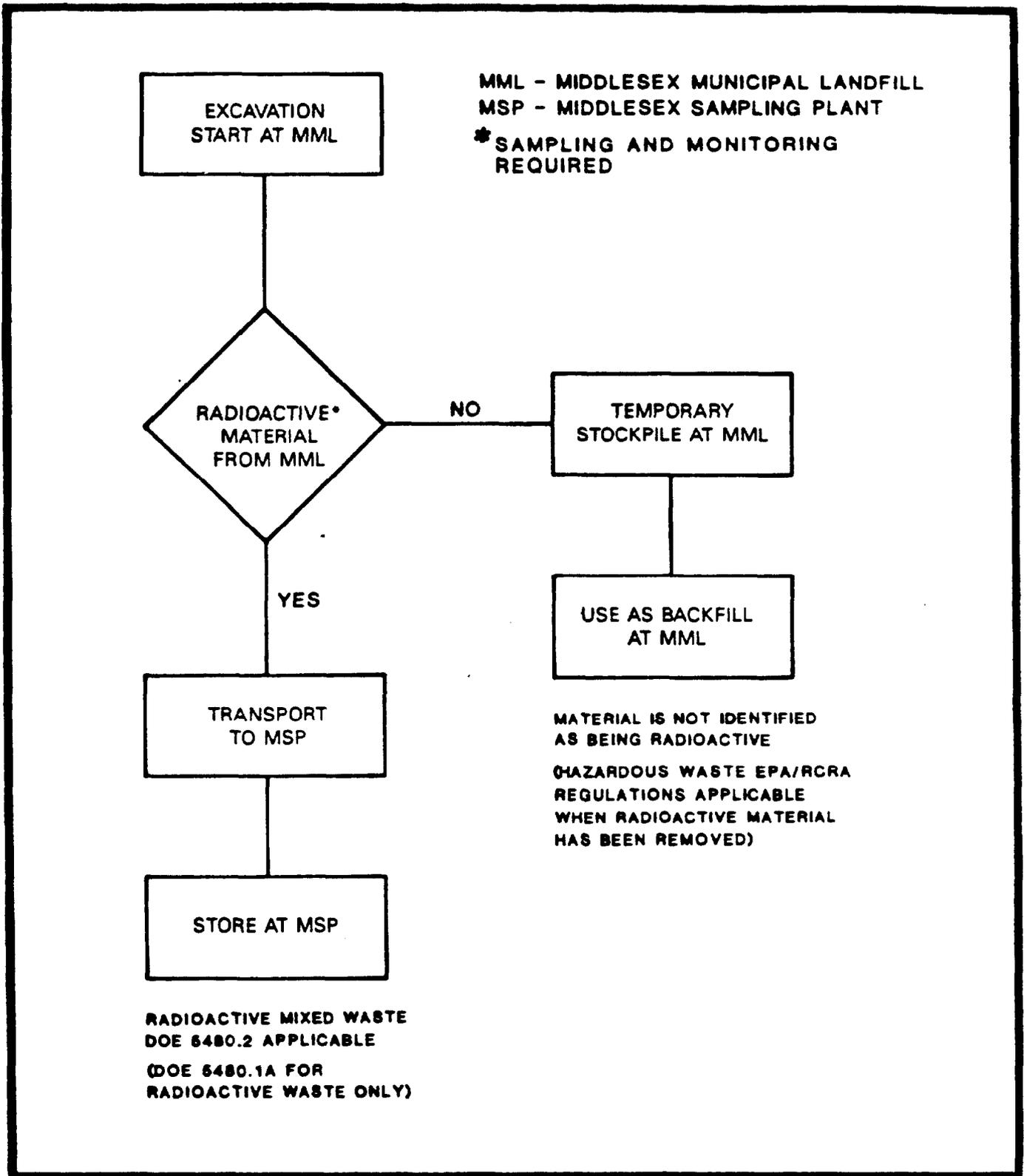


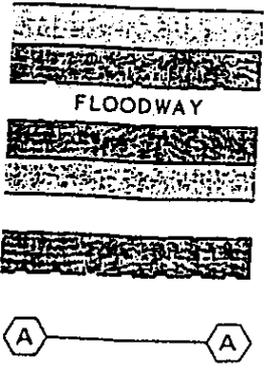
FIGURE 3 LOGIC DIAGRAM FOR SORTING MATERIALS EXCAVATED FROM MIDDLESEX MUNICIPAL LANDFILL

MML FUSRAP Preliminary Assessment Figure 5



KEY TO MAP

- 500-Year Flood Boundary ————
- 100-Year Flood Boundary ————
- FLOODWAY FRINGE ————
- 100-Year Flood Boundary ————
- 500-Year Flood Boundary ————
- Approximate 100-Year Flood Boundary ————
- Cross Section Line ————
- Elevation Reference Mark ————
- River Mile ————

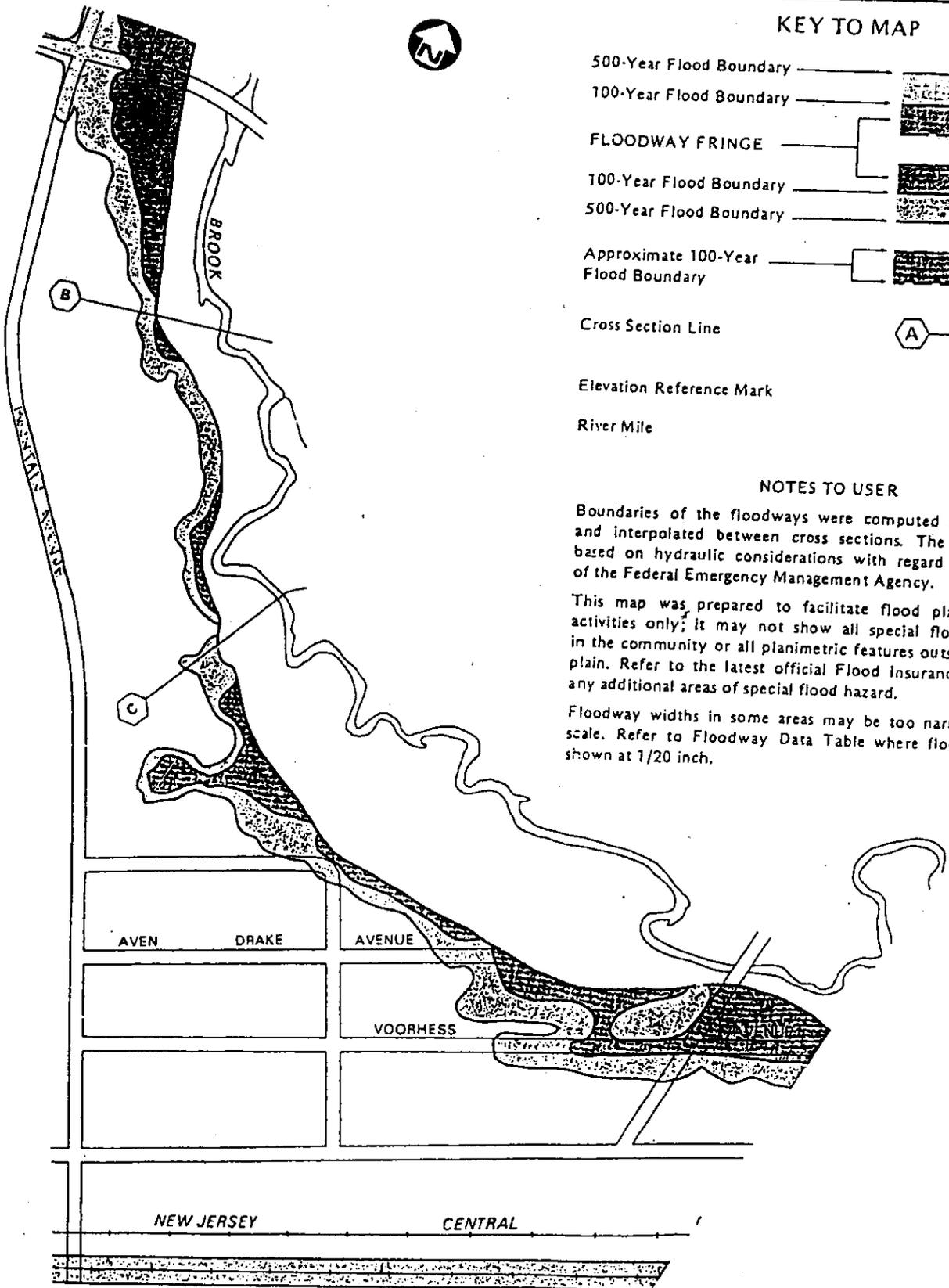


NOTES TO USER

Boundaries of the floodways were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the Federal Emergency Management Agency.

This map was prepared to facilitate flood plain management activities only; it may not show all special flood hazard areas in the community or all planimetric features outside of the flood plain. Refer to the latest official Flood Insurance Rate Map for any additional areas of special flood hazard.

Floodway widths in some areas may be too narrow to show to scale. Refer to Floodway Data Table where floodway width is shown at 1/20 inch.



Sadat Associates, Inc. Princeton, New Jersey	
Middlesex Municipal Landfill FEMA Floodway Map Middlesex Borough, New Jersey	
Scale	1" = 500 feet
Filename	MAPFRAME.WB1
Figure A-2	

Source: Flood Emergency Management Agency Flood Boundary and Floodway Map, revised March 18, 1986