KAPL-4843
UC-41, Health and Safety

KNOLLS ATOMIC POWER LABORATORY

ENVIRONMENTAL MONITORING REPORT

CALENDAR YEAR 1999

This report contains data and information for the three government owned sites comprising the Knolls Atomic Power Laboratory operated for the Department of Energy by KAPL, Inc., a Lockheed Martin company, Schenectady, New York

KAPL, Inc.
KNOLLS ATOMIC POWER LABORATORY
Schenectady, New York
Operated for the United States Department of Energy,
Contract DE-AC 12-76SN00052

DISCLAIMER

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

CONTENTS

CONTENTS (Con't)

CONTENTS (Con't)

TABLES

TABLES (Con't)

TABLES (Con't)

FIGURES

1.0 EXECUTIVE SUMMARY

The results of the effluent and environmental monitoring programs at the three Knolls Atomic Power Laboratory (KAPL) Sites are summarized and assessed in this report. Operations at the three KAPL Sites resulted in no significant release of hazardous substances or radioactivity to the environment.

The effluent and environmental monitoring programs conducted by KAPL are designed to determine the effectiveness of treatment and control methods, to provide measurement of the concentrations in effluents for comparison with applicable standards, and to assess resultant concentrations in the environment. The monitoring programs include analyses of samples of liquid and gaseous effluents for chemical constituents and radioactivity as well as monitoring of environmental air, water, sediment, and fish. Radiation measurements are also made around the perimeter of each Site and at off-site background locations.

KAPL environmental controls are subject to applicable Federal, State, and local regulations governing use, emission, treatment, storage and/or disposal of solid, liquid and gaseous materials. Some non-radiological water and air emissions are generated and treated on-site prior to discharge to the environment.

Liquid effluents are controlled and monitored in accordance with permits issued by the New York State Department of Environmental Conservation (NYSDEC) for the Knolls and Kesselring Sites. Liquid effluent monitoring data show that KAPL has maintained a high degree of compliance with permit requirements. At the Knolls Site, sewage discharge limitations are imposed locally by the Town of Niskayuna in accordance with an Outside Users Agreement. At the S1C Site (also known as the KAPL Windsor Site), the only liquid effluent in 1999 was storm water, which was controlled in accordance with permits issued by the Connecticut Department of Environmental Protection (CTDEP).

Air emissions are controlled and monitored in accordance with permits issued by NYSDEC for the Knolls and Kesselring Sites. The S1C Site has permanently secured all registered air emission sources and potential future air emissions are below levels that would require permitting. Where required, the U.S. Environmental Protection Agency (EPA) authorizes radionuclide air emission sources. Non-radiological air emission sources are not required to have stack monitoring. The use and maintenance of air emissions control equipment are sufficient for permit compliance. All air emissions conformed to applicable Federal and State standards.

Knolls and Kesselring Site landfill operations were terminated in 1993 and 1994, respectively. Non-hazardous solid wastes are disposed of off-site through local permitted facilities.

Chemicals are not manufactured at KAPL but are used incidental to Site operations. Those substances characterized as hazardous by Federal and State regulations are controlled through administrative procedures and personnel training. Small amounts of wastes are generated and disposed of off-site by waste vendors operating under permits issued by the cognizant Federal and State regulatory agencies. Handling and storage incidental to shipment of wastes are controlled and monitored by trained personnel in compliance with applicable regulations. KAPL strives to minimize the quantity of hazardous and solid waste that it produces. Waste avoidance, beneficial reuse and recycling are practiced whenever practicable.

Accountability and radiation survey procedures are used at each KAPL Site for the handling, packaging, and transportation of all radioactive materials. Shipments of radioactive materials are performed in accordance with detailed written procedures to ensure compliance with all applicable regulations of the U. S. Department of Transportation (DOT), the U.S. Department of Energy (DOE), and the U.S. Nuclear Regulatory Commission (NRC). All KAPL generated wastes that contain radioactive constituents are regulated under the Atomic Energy Act of 1954 and applicable DOE requirements. The volume of solid radioactive waste that requires disposal is minimized through the use of procedures that limit the amount of materials that become contaminated, by *compaction of* compressible wastes, and by recycling. Radioactive wastes are not disposed of at any of the three KAPL Sites, but are shipped to government owned disposal sites. During 1999, approximately 1277 cubic meters (1670 cubic yards) of low-level radioactive waste were shipped from the KAPL Sites for disposal. This included the last of all radioactive material from closing the S1C Site. This is less than one percent of the amount of radioactive solid waste disposed of annually at government owned disposal sites.

KAPL is in full compliance with DOE and EPA standards governing the release of radioactivity to the environment. The annual average concentration of radioactivity in liquid and gaseous effluents from each Site corresponded to less than one percent of the permissible DOE radioactivity concentration guides at the boundary of each Site. Radionuclide air emissions were also less than one percent of the EPA air emission standard. No radioactivity attributable to 1999 operations at the three KAPL Sites was detected in any of the routine environmental samples. Radiation dose to the general public as a result of KAPL operations was too small to be measured and therefore must be estimated using conservative calculational techniques that provide an upper bound on the potential dose. The maximum potential annual dose to an individual off-site was less than 0.1 millirem per year. This is less than one percent of the numerical guide established by the NRC for commercial reactor sites to demonstrate that radioactive materials in effluents released to unrestricted areas are "as low as is reasonably achievable". The maximum potential annual dose is also less than five percent of the total radiation a person aboard a commercial airplane would receive from cosmic sources during one coast-to-coast flight. The estimated annual collective dose to the entire population within 80 kilometers (50 miles) of any Site was less than 0.3 person-rem, which corresponds to less than one thousandth of one percent of the dose received by that population from normal background radiation.

2.0 INTRODUCTION

The Knolls Atomic Power Laboratory (KAPL) is operated by KAPL, Inc., a Lockheed Martin company, under contract with the U.S. Department of Energy (DOE). KAPL consists of three separate sites: the Knolls Site, the Kesselring Site and the S1C Site, all of which are United States Government owned facilities. The principal function at KAPL is research and development in the design and operation of Naval nuclear propulsion plants. The Kesselring Site is also used for the training of personnel in the operation of these plants. The Naval nuclear propulsion plant at the S1C Site was shut down in 1993 and dismantlement of the Site facilities was completed during 1999.

The Knolls Site is located in the Town of Niskayuna, New York, approximately 3.2 kilometers (two miles) east of the City of Schenectady (Figure 2-1). The Site is situated on 170 acres of land on the south bank of the Mohawk River. Facilities at the Knolls Site include administrative offices, machine shops, a sewage pumping station, wastewater treatment facilities, a boiler house, oil storage facilities, cooling towers, waste storage facilities, and chemistry, physics, and metallurgical laboratories. The surrounding area is a mixture of open land, other light industry, small farms, a closed municipal landfill, and suburban residential areas.

The Kesselring Site is located near West Milton, New York, approximately 27.4 kilometers (17 miles) north of the City of Schenectady, 14.5 kilometers (9 miles) southwest of Saratoga Springs and 21 kilometers (13 miles) northeast of Amsterdam (Figure 2-1). The Site consists of 3900 acres on which are located two operating pressurized-water Naval nuclear propulsion plants and support facilities, including administrative offices, machine shops, training facilities, equipment service buildings, chemistry laboratories, a boiler house, oil storage facilities, cooling towers, waste storage facilities and wastewater treatment facilities. Two other nuclear propulsion plants at the Site have been permanently shut down: the S3G plant during 1991 and the D1G plant during 1996. These plants have been defueled and dismantlement work has commenced, starting with the S3G Prototype reactor plant. Dismantlement work began after completion of the National Environmental Policy Act (NEPA) process in January 1998. This process included public input in the evaluation of environmental impacts that could result from the dismantlement of the plants and is discussed later on in this report. The surrounding area is a rural, sparsely populated region of wooded lands through which flow the Glowegee Creek and several small streams that empty into the Kayaderosseras Creek.

The S1C Site is situated on 10.8 acres of land in the Town of Windsor, Connecticut, approximately eight kilometers (five miles) north of the City of Hartford (Figure 2-2). Beginning in early 1997, dismantlement operations began on the defueled Naval nuclear propulsion plant located at the S1C Site. This plant had been shut down since 1993. Dismantlement work began after completion of the NEPA process in December 1996. This process included public input in the evaluation of environmental impacts that could result from the dismantlement of the plant. Support facilities at the Site included administrative office trailers, craft shops, waste storage facilities, and an equipment service building. Dismantlement of all facilities was completed during 1999. Final Site environmental evaluation is in progress in preparation for Site transfer. The area surrounding the S1C Site is a mixture of open land, industrial regions, tobacco farms and suburban residential areas, through which the Farmington River flows in a generally southeasterly direction to its confluence with the Connecticut River.

Liquid effluents are monitored at the Knolls and Kesselring Sites for the chemical parameters listed in the applicable State Pollutant Discharge Elimination System (SPDES) permits and for radioactivity. Analyses are also performed on effluent and receiving stream water samples for select chemical parameters, some of which have State water quality standards. The S1C Site surface water effluent discharges, other than storm water, were terminated in 1995. At all three KAPL Sites, fish, water, and bottom sediment samples from the receiving streams are collected and analyzed for radioactivity. Non-radiological industrial air emission sources do not require monitoring under the terms of current State air permits due to the very low levels of emissions and the air emission control equipment specified in some of the permits. Airborne effluents from the main radiological emission points are continuously sampled for radioactivity. Other minor radiological emission points are evaluated for the potential for release and a periodic measurement protocol is used to confirm the low emissions. In addition, radiation levels around the perimeter of each operating site and at several off-site background locations are monitored with sensitive dosimeters.

At the S1C Site, significant sampling of areas exposed after facility removal, and surrounding areas, occurred during the 1999 closure activities. Soil, sediment, and water were sampled for radioactivity and various chemicals. Data beyond the routine sampling presented in this report will be presented in separate site closure reports.

The quantities of radioactivity contained in liquid and gaseous effluents during operations in 1999 at the three KAPL Sites were too small to have a measurable effect on normal background radioactivity. Solid radioactive wastes are packaged and shipped from the Sites in accordance with all applicable U.S. Department of Transportation (DOT), DOE, and U.S. Nuclear Regulatory Commission (NRC) regulations.

The use of chemically hazardous substances at the KAPL Sites is strictly limited to the types and quantities essential for operation. Handling, transportation, and disposal of hazardous waste are limited to vendors operating under permits issued by the cognizant Federal and State regulatory agencies. Additionally, all KAPL personnel participate in a training program on the hazards of chemical substances. Other types of solid waste produced on-site, such as cafeteria waste, are disposed of at permitted facilities. Paper, cardboard, glass, wood, and plastic are also segregated for recycling whenever possible. Scrap metals are recycled through local vendors.

Effluent and environmental surveillance programs are conducted at each KAPL Site in accordance with applicable DOE Orders to monitor conformance with applicable Federal and State standards and to confirm that operations have had no significant impact on the environment or the public. The KAPL policy is to minimize releases to levels that are as low as reasonably achievable. A summary of the 1999 routine monitoring data for each KAPL Site is presented and assessed in this report.

During 1999, the three KAPL Sites were inspected 38 times by Federal and/or State environmental inspectors. These inspections did not identify any instances of non-compliance in operations with the exception of a record keeping error found during an EPA multi-media inspection which is further discussed in Section 3.2. Eighty-three periodic environmental related reports were filed with Federal, State, and local agencies. Three of the reports identified minor deviations from permit conditions.

Areas where historical petroleum or chemical spills have been identified were reported to appropriate regulatory authorities. The areas have been remediated or will be in the near future to meet State requirements.

Numerous programs to reduce the potential for environmental effects from KAPL operations have been implemented over the years. The Knolls and Kesselring Sites report to Federal and State officials on detailed hazardous waste reduction plans for specific waste streams.

Section 9.0 of this report provides general information on radiation and radioactivity for those who may not be familiar with radiological terms and concepts.

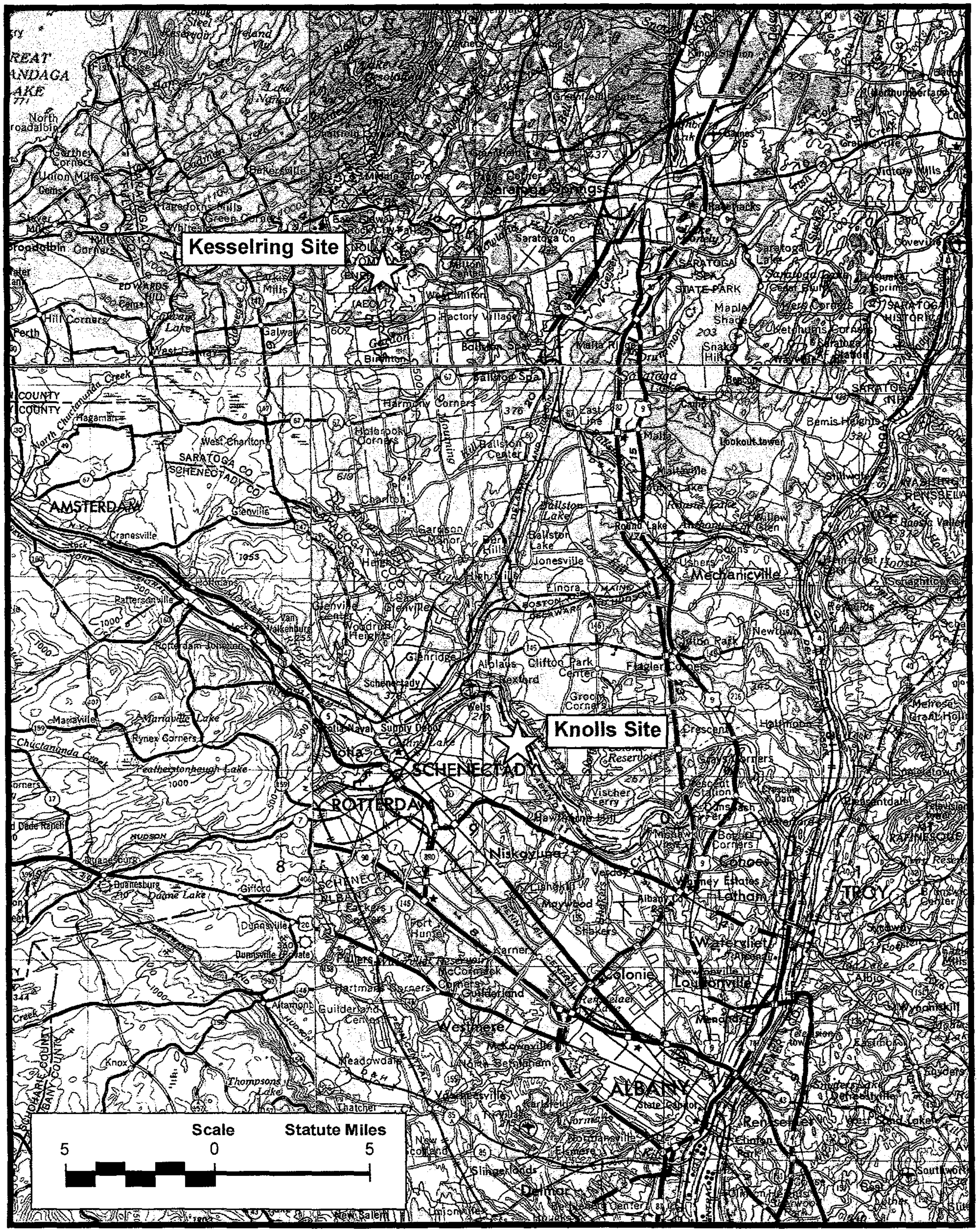


Figure 2-1
Knolls and Kesselring Site Locations in Relation to Surrounding Communities

Figure 2-2
S1C Site Location in Relation to Surrounding Communities

3.0 ENVIRONMENTAL PROGRAM & COMPLIANCE

3.1 ENVIRONMENTAL PROGRAM

Policy

The Knolls Atomic Power Laboratory (KAPL) Sites are committed to conducting operations and activities in a manner that provides and maintains safe and healthful working conditions, protects the environment, and conserves natural resources. The KAPL Sites are committed to environmental excellence through compliance with applicable Federal, State, and local regulations; proactive planning to integrate sound environmental, safety, and health (ESH) principles into every aspect of the work, including hazard identification and risk assessment; and a solid commitment to waste minimization and pollution prevention.

Objectives

The objectives of the KAPL environmental monitoring program are to:

- Demonstrate compliance with regulatory requirements,
- Demonstrate Site operations do not significantly impact the environment,
- Confirm the effectiveness of control methods in preventing increases in environmental radioactivity levels,
- Confirm that the potential radiation exposure received by a member of the public is insignificant compared to the dose received from natural background radioactivity,
- Provide accurate monitoring results to applicable Federal, State, and local officials and to the general public,
- Notify appropriate regulatory agencies of unusual conditions, and
- Maintain an accurate record of effluent releases to the environment from KAPL.

Organization

The Knolls, Kesselring, and S1C Sites have environmental staff professionals to ensure environmental responsibilities are met while also fulfilling the mission of each Site. The Knolls Site ESH organization is the lead ESH organization for all the KAPL Sites. Although each Site has a distinct ESH organization, there is significant interaction between the Sites' ESH organizations and the Knolls Site to optimize personnel expertise, to establish uniform practices, and promote the sharing of best practices. These organizations are responsible to identify, interpret, and communicate ESH requirements to KAPL personnel for implementation, assist KAPL organizations in meeting their ESH responsibilities, monitor ESH activities for compliance, and to interface with regulatory agencies and complete required regulatory reports.

3.2 ENVIRONMENTAL COMPLIANCE

Demonstration of compliance with environmental regulations is an integral part of the mission of each KAPL Site and is necessary for successful site operations. Federal and State regulatory personnel periodically perform inspections of the three Sites. During 1999, the three Sites were inspected 38 times by Federal and/or State environmental inspectors. These inspections did not identify any areas of non-compliance in operations with the exception of a record keeping error identified at both the Knolls and Kesselring Sites during an EPA multi-media inspection, which is discussed below. Eighty-three periodic environmental related reports were filed with Federal, State, and local agencies. Three of the reports identified minor deviations from permit conditions.

In April 1999, the EPA Region II office conducted a multi-media environmental compliance inspection of the Knolls and Kesselring Sites. Several of these inspections are performed at Federal facilities each year as part of an on-going program. A multi-media inspection reviews all areas of environmental regulations; air, water, waste, etc. Such inspections involve a number of EPA personnel who perform an intensive, in-depth review of the facility's environmental compliance.

The inspection entailed document reviews, interviews with facility personnel, observation of work in progress, and inspection of the facility itself. Following a one-week inspection conducted by ten EPA inspectors, operations were found to be in compliance with regulations with one minor exception. EPA found that, in lieu of recording daily fuel consumption for each boiler/heater at the Knolls/Kesselring Sites, KAPL was recording daily cumulative fuel consumption for the boilers at the Kesselring Site and bi-monthly fuel usage for a heater at the Knolls Site. This record keeping error was promptly corrected and resulted in no environmental impact.

In February 2000, the EPA issued Compliance Orders to the DOE and KAPL to close their inspection process and to formally document their inspection finding and KAPL actions required to correct the problem. No fines or penalties were imposed by the EPA in taking this action. Since KAPL corrected the record keeping error shortly after the EPA inspection, no further action is needed by KAPL as a result of these Compliance Orders.

The KAPL Sites have a total of 27 environmental permits issued from regulatory agencies for specific facilities and/or operations. These permits are shown in Table 3-1.

A brief description of KAPL's environmental compliance with key environmental regulations is provided below.

Clean Water Act (CWA)

The legislative protection of the Nation's waters was first enacted in 1899 with the passage of the Rivers and Harbors Act. This Act prohibited the construction of bridges and other structures and the deposit of refuse matter into navigable waters without a permit from the Army Corps of Engineers. In 1948, the Federal Water Pollution Control Act was enacted. This legislation allowed only the courts to grant relief from pollution based upon the economic and practical feasibility considerations. In 1965 the Water Quality Act adopted water quality standards, however, this act was ineffective and difficult to enforce. The Environmental Protection Agency (EPA) was created in 1970. One of this Agency's first goals was to restore and maintain the chemical, physical, and biological integrity of the Nation's waters. The Clean Water Act (CWA) of 1972 was a comprehensive revision of the 1948 Federal Water Pollution Control Act. This legislation focused on conventional pollutants and established technology-based limits for direct dischargers and publicly owned treatment works. It also established pretreatment standards for indirect dischargers. The CWA has been amended several times since 1972. The National Pollutant Discharge Elimination System (NPDES) program was established by the CWA. This program is now administered by NYSDEC under EPA authority for the Knolls and Kesselring Sites and is known as the State Pollutant Discharge Elimination System or SPDES program. In Connecticut, the program is administered by the Connecticut Department of Environmental Protection. These programs are designed to protect surface waters by limiting releases of effluents. Discharge limits are set for each facility to ensure that operations do not adversely impact water quality. Surface water effluent discharges, other than storm water, from the S1C Site in Connecticut were terminated in October 1995.

TABLE 3-1 KAPL ENVIRONMENTAL PERMITS

Permit Number	Permit Type	Issuing Agency	In Compliance	Expiration Date	Other Information
KNOLLS SITE					
NY0005851	SPDES(1)	NYSDEC(2)	Yes	01/01/05	Site Outfalls
4-4224-00024/00001	RCRA(3)	NYSDEC	Yes	07/20/08	RCRA Waste (EPA ID NY6890008992)
EP-00001	AE(4)	NYSDEC	Yes	NA(5)	Heating Boiler
EP-00002	AE	NYSDEC	Yes	NA(5)	Heating Boiler
EP-00003	AE	NYSDEC	Yes	NA(5)	Heating Boiler
EP-00004	AE	NYSDEC	Yes	NA(5)	Heating Boiler
EP-00030	AE	NYSDEC	Yes	NA(5)	ASGTF(6)
EP-00031	AE	NYSDEC	Yes	NA(5)	VIM/GA(7)
443417	PBSF(8)	NYSDEC	Yes	08/23/03	Oil Storage
AMDA (9)	PCB	EPA Region II	Yes	07/31/01	PCB Paint Removal
KNOLL- E4-HC-01	RAE(10)	EPA Region II	Yes	None	Radioactive Materials Laboratory
KESSELRING SITE					
NY0005843	SPDES	NYSDEC	Yes	09/01/03	Site Outfalls
5-4142-00005/00049	RCRA	NYSDEC	Yes	05/31/05	RCRA Waste (EPA ID NY5890008993)
05A01	AE	NYSDEC	Yes	NA(5)	Spray Paint Booth
GRB01	AE	NYSDEC	Yes	NA(5)	Grit Blasting
BH002	AE	NYSDEC	Yes	NA(5)	Heating Boiler
BH004	AE	NYSDEC	Yes	NA(5)	Heating Boiler
5-000070	BCSF(11)	NYSDEC	Yes	07/19/01	Chemical Storage
5-414506	PBSF	NYSDEC	Yes	08/17/02	Oil Storage
AMDA (9)	PCB	EPA Region II	Yes	07/31/01	PCB Paint Removal
KESSELRING-S3G-PA-01	RAE	EPA Region II	Yes	None	Plasma Arc Cutting
KAPL-788-01	RAE	EPA Region II	Yes	None	Radiological Work Facility
S1C SITE					
DEP/HWM 164-021(12)	RCRA	CT-DEP(13)	Yes	06/07/01	RCRA Waste (EPA ID CT6890113792)
CT GSI000637(12)	SW(14)	CT-DEP	Yes	10/01/02	Stormwater Discharge (Industrial)
CT GSN000133	CS	CT-DEP	Yes	10/01/02	Stormwater Discharge (Construction)
604	W(15)	WIWWC(16)	Yes	07/07/03	Construction within Wetlands Buffer
AMDA(17)	PCB	EPA Region I	Yes	08/31/01	PCB Paint Removal

Notes:
(1) State Pollutant Discharge Elimination System
(2) New York State Department of Environmental Conservation
(3) Resource Conservation and Recovery Act
(4) Air Emission
(5) Extended indefinitely in accordance with 6 NYCRR Part 201-4.3
(6) Advanced Steam Generator Test Facility
(7) Vacuum Induction Melting/Gas Atomization system
(8) Petroleum Bulk Storage Facility
(9) EPA Region II Alternate Method of Disposal Approval (AMDA) to remove and dispose of PCB contaminated materials, dated 8/5/96.
(10) Radionuclide Air Emission
(11) Bulk Chemical Storage Facility
(12) This permit was terminated during 1999.
(13) State of Connecticut Department of Environmental Protection
(14) Storm water permit modified 10/30/95 to incorporate storm water runoff previously included in NPDES permit.
(15) Wetlands Permit
(16) Town of Windsor Inland Wetlands and Watercourses Commission
(17) EPA Region I Alternate Methods of Disposal Approval (AMDA) to remove and dispose of PCB contaminated materials, dated 8/8/96. KAPL requested termination of this permit on 8/24/99.

For chemical constituents in wastewater, the specific effluent and environmental standards applicable to Knolls and Kesselring Site operations are taken from the applicable SPDES permit. New York State water quality standards applicable to the Mohawk River and Glowegee Creek are given in Reference (1).

The biological, chemical, and radiological constituents of the Knolls Site sewage are regulated by an Outside Users Agreement with the Town of Niskayuna as defined in Reference (2).

Clean Air Act (CAA)

The Clean Air Act (CAA), which became effective in 1970, is the comprehensive federal law that regulates air emissions from area, stationary, and mobile sources. This law authorizes the EPA to establish National Ambient Air Quality Standards (NAAQS) to protect public health and the environment. The goal of the Act was to set up and achieve NAAQS in every state by 1975. The Act underwent major amendments in 1977 and 1990. The 1977 amendments primarily set new goals (dates) for achieving attainment of the NAAQS since many areas of the country failed to meet the original deadlines. The Act was amended in 1990 primarily to meet unaddressed or insufficiently addressed problems such as acid rain, ground-level ozone, stratospheric ozone depletion, and air toxics.

The CAA and its Amendments provide the regulatory basis for the protection of ambient air quality, control and reduction in the emissions of the pollutants carbon monoxide, particulate matter, and those that contribute to the formation of ozone - volatile organic carbons (VOCs) and nitrogen oxides (NO_x); control and reduction of pollutants likely to increase the risk of death or serious illness (e.g., National Emission Standards for Hazardous Air Pollutants or NESHAPS); control and prevention of accidental releases of regulated hazardous air pollutants or any other extremely hazardous substances; control of the principal contributors to acid rain and other forms of acid deposition (i.e, sulfur dioxide (SO_2) and NO_x); and a mandated Federal permitting program (Title V) for major air emission sources.

The regulatory authority for the majority of the CAA regulations that affect the Knolls and Kesselring Sites in New York State has been delegated by the EPA to the New York State Department of Environmental Conservation (NYSDEC). Two Federal regulations affecting KAPL that are not currently delegated to the State are "Standards of Performance for Small Industrial-Commercial-Institutional Steam Generating Units" (40 CFR 60 – Subpart Dc) and the "National Emission Standards for Emissions of Radionuclides Other Than Radon From Department of Energy Facilities" (40 CFR 61 – Subpart H).

A number of air emission sources at both the Knolls and Kesselring Sites, such as heating boilers are regulated under the NYSDEC Air Permitting Program (See Table 3-1). Additionally, heating boilers at the Kesselring Site and a natural gas-fired water heater for the Advanced Steam Generating Test Facility (ASGTF) at the Knolls Site are also regulated by the EPA under 40 CFR 60 Subpart Dc. The new facility boilers being planned to replace the aging existing facility boilers at the Knolls Site will require EPA notification of construction commencement and initial startup; as well as, periodic fuel usage reporting under Subpart Dc. These boilers will also be permitted by NYSDEC. Upon issuance of this permit by NYSDEC, the Knolls Site will provide a schedule to NYSDEC for incorporating the remaining individually permitted air emission units into a single State Facility Permit. The Knolls and the Kesselring Site's facilities have NYSDEC Air Emission Permits to operate certain non-trivial/exempt sources [See Table 3-1]. The air permits for the boiler operations have Federally enforceable capping provisions that allow the Sites to be classified as "synthetic minors". As such the Sites do not require a Title V facility permit, which normally applies to "major sources" under the CAA. The operations of the Table 3-1 air emission sources have been in accordance with their permit conditions.

Other non-radioactive air emission sources that do not require State permits at the Sites either come under the "Laboratory Hood" and NESHAPs minor source exemptions presently in effect, or are considered exempt or trivial under New York State regulations.

The EPA under 40 CFR 61 Subpart H regulates radionuclide air emission sources at all three KAPL Sites. During 1999, the maximally exposed individual effective dose equivalent, calculated using the EPA computer code CAP-88PC, was less than 0.1 mrem for all three KAPL Sites, which is less than 1% of the 10 mrem/year EPA standard. Annual reports are provided to the EPA, as required by the regulations.

KAPL received EPA approval in 1998 to construct several new sources of radionuclide air emissions at the Knolls Site, a modular hot cell and several gloveboxes, in the existing Building E4 Radioactive Materials Laboratory. Construction for installation of these sources is not yet completed. The EPA will be notified upon startup of the new sources. During 1999, KAPL also received EPA approval to modify an existing source of radionuclide air emissions at the Kesselring Site. The modification allowed the use of a plasma arc cutting method during dismantlement of the S3G prototype. Startup notification was provided to the EPA in July 1999.

The S1C Site has eliminated all air emission sources that would require permitting under Federal or Connecticut air emission regulations.

Resource Conservation and Recovery Act (RCRA)

The Resource Conservation and Recovery Act (RCRA) was passed in 1976 to address the problem of solid and hazardous waste management. The Solid Waste Disposal Act of 1965 was the precursor to RCRA and was limited to municipal type landfill considerations. Under RCRA, hazardous waste generators are responsible for controlling every aspect of the generation, treatment, storage, and disposal of the waste; this is referred to as "cradle-to-grave control." The law requires that the EPA regulate many discarded substances deemed potentially harmful to human health and the environment. Under RCRA, a solid waste can be solid, semi-solid, liquid or gas. RCRA has been amended several times. However, the 1984 Hazardous and Solid Waste Amendments (HSWA) are the most important. These amendments required waste minimization and established a national land disposal restriction program.

The EPA is responsible for all hazardous waste regulations. However, the EPA can delegate this authority to a state when the state passes laws and regulations that meet or exceed EPA regulations and the EPA approves the state plan. Both the NYSDEC and CTDEP have authority for all aspects of RCRA with the exception of a few specific portions associated with the 1984 HSWA to RCRA.

Hazardous waste generators, including KAPL, must follow specific requirements for handling these wastes. For many waste management activities, RCRA requires that owners and operators of operating or post-closure-care hazardous waste management facilities have a permit. During 1999, all three KAPL Sites (Knolls, Kesselring and S1C) operated under state-issued hazardous waste management permits. The Kesselring and Knolls Sites received their NYSDEC 6 NYCRR Part 373 hazardous waste management permits in June 1995 and July 1998, respectively. The S1C Site received its State of Connecticut Hazardous Waste Management Permit renewal in June 1996. As part of Site dismantlement activities, the S1C Site completed closure of the storage facility in April 1999 and as a result terminated its permit.

RCRA Corrective Action (§3004(u)) Program

The 1984 Hazardous and Solid Waste Amendments (HSWA) to RCRA expanded EPA's authority to force treatment, storage, or disposal facilities (TSDFs) to conduct corrective action for releases from a facility. Under this section of RCRA, the EPA or an authorized State must require corrective action for all releases of hazardous waste or constituents from any solid waste management unit at a TSDF seeking a permit under RCRA, regardless of the time at which the waste was placed in such units. The regulations implementing this section of RCRA define the term "solid waste management unit (SWMU)" to include: any discernible unit at which solid wastes have been placed at any time, irrespective of whether the unit was intended for the management of solid or hazardous waste. Such units include any area at a facility at which solid wastes have been routinely and systematically released.

NYSDEC has been granted authority by the EPA to manage their own RCRA 3004(u) corrective action program via New York State Environmental Conservation Law, Article 27, Title 9, Section 27-0913. The 6 NYCRR Part 373 hazardous waste permits issued to both the Knolls Site (in July 1998) and the Kesselring Site (in June 1995, modified in November 1999) require each Site to pursue corrective action.

The basic steps in the corrective action process are: 1) a RCRA Facility Assessment (RFA), 2) RCRA Facility Investigation (RFI), and 3) Corrective Measures (CM). A fourth step, interim corrective measures (ICM), can occur at any time during the corrective action process. Since, during the RFA, NYSDEC determined that neither Site posed an imminent danger to human health or the environment, ICM work will entail cleaning-up well-defined releases as a means to expedite the corrective action process. Actions to address these steps may consist of assessing existing information/data, design and implementation of environmental (e.g., soil, groundwater) sampling plans and, if necessary, ICM work plans, and report preparation. All of these steps are subject to approval by NYSDEC.

CTDEP has not been granted authority for corrective action; therefore, the S1C Site falls under the auspices of the EPA Region I RCRA 3004(u) program. Additionally, because corrective action provisions were never included within the S1C Site hazardous waste management permit, the Site is undergoing a voluntary corrective actions program under the oversight of EPA Region I. To date, all planned sampling has been completed and the Site is in the final phases of the voluntary corrective action process.

Data associated with the RCRA corrective action process will be reported separately.

Federal Facility Compliance Act (FFCA)

The Federal Facility Compliance Act (FFCA) was signed into law in October 1992 as an amendment to the Solid Waste Disposal Act to add provisions concerning the application of certain requirements and sanctions to Federal facilities. With respect to Federal agencies, the FFCA waives sovereign immunity from all civil and administrative penalties and fines; this includes waivers for both coercive and punitive sanctions for violations of the Solid Waste Disposal Act. For mixed waste, the FFCA provided a 3-year delay (until October 1995) in the imposition of fines and penalties so that DOE sites could investigate mixed waste volumes in storage, evaluate treatment capacities, and develop site treatment plans with schedules for mixed waste treatment for approval by their Federal or State regulatory agencies. Mixed waste is waste that contains both hazardous and radioactive material.

On March 31, 1995, the three KAPL Sites (Knolls, Kesselring and S1C) submitted proposed Site Treatment Plans (STPs), developed with the assistance of State and/or EPA involvement, that addressed the development of capacities and technologies for treating KAPL mixed wastes according to land disposal restrictions (LDRs), as required by the FFCA. These plans were approved with modifications, and the FFCA Administrative Consent Orders were issued on October 24, 1995 for both the Knolls and Kesselring Sites and on October 6, 1995 for the S1C Site.

During the STP development process, KAPL determined preferred treatment options for each mixed waste stream. This was accomplished by comparing all feasible treatment options (including on-site treatment, use of mobile treatment systems, commercial treatment, and treatment at other DOE facilities) in several fundamental areas (including regulatory compliance, treatment effectiveness, environment/health/safety concerns, cost, and implementation ability). Based on the small volumes of KAPL waste streams requiring off-site treatment, these evaluations indicated that off-site treatment at other DOE facilities is economically and technically preferable to other options. KAPL identified potential technically capable DOE facilities for each waste stream based on an evaluation of available treatment facility information, then coordinated with the other DOE sites to confirm treatment capability and select preferred options.

In addition to identifying the planned treatment option for each KAPL mixed waste stream, the STPs also identify schedules for shipment of each waste stream to the selected treatment facility, and arrangements for pre-treatment storage and post-treatment residual management for each waste stream. A single schedule milestone, for shipment to the treatment facility within 18 months of the start of facility operations, is incorporated for each waste stream. Thus, pre-treatment storage on-site at each KAPL Site until the selected treatment facilities are available is planned. Projected schedules for the start of operation of selected treatment facilities are identified. The STPs also include commitments to perform additional evaluations and work with NYSDEC, or CTDEP and EPA Region I to determine whether alternative treatment options should be selected in the event completion of a targeted treatment facility is delayed.

With the completion of dismantlement activities at the S1C Site and the last shipment of waste covered under that Site's STP, EPA Region 1 was notified that the S1C Site had met all the conditions of the Administrative Consent Order and requested its termination.

Land Disposal Restrictions (LDR)

Since RCRA was passed in 1976, a nationwide movement has been underway to restrict the land disposal of hazardous wastes. Prior to 1984, this was primarily accomplished by imposing regulatory requirements on facilities that actually land disposed of these wastes. The 1984 HSWA amendments required the EPA to issue four major sets of regulations collectively referred to as the land disposal restrictions (LDR).

The main purpose of the LDR program is to discourage activities that involve placing untreated wastes in or on the land when a better treatment or immobilization alternative exists. LDRs do not allow storage of restricted hazardous wastes, except for the purpose of accumulating such quantities as are necessary to facilitate proper recovery, treatment, or disposal. The amendments require that, prior to land disposal, all wastes meet treatment standards based on the "best demonstrated available technology".

The same restrictions apply to mixed waste, which is composed of a mixture of radioactive material and hazardous waste. Because LDRs apply to mixed wastes and KAPL does not have adequate mixed waste treatment capacity, regulatory agreements have been executed to achieve compliance. Administrative consent agreements were signed between the DOE Schenectady Naval Reactors (SNR) and the NYSDEC for the two KAPL Sites based in New York State (Knolls and Kesselring) and between SNR and EPA Region I for the S1C Site to address KAPL mixed waste compliance with LDRs. (See the discussion above related to the FFCA.)

Hazardous Waste Minimization Program

Each of the KAPL Sites has implemented a hazardous waste minimization program. The program entails a comprehensive plan to prevent and minimize hazardous waste from all KAPL operations. The program is designed to meet the hazardous waste reduction requirements of RCRA, and the overall waste reduction requirements of DOE Orders, and of applicable executive orders. The program focuses mainly on process efficiency improvements, source reduction, inventory control, preventive maintenance, improved housekeeping, recycling, and on increasing employee awareness of and participation in pollution prevention.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

The Comprehensive Environmental Response, Compensation, and Liability Act, commonly referred to as CERCLA or Superfund, was enacted by Congress in 1980. CERCLA's impetus was the emerging realization that inactive hazardous waste sites presented a great risk to public health and the environment and that existing law did not address these abandoned disposal sites. CERCLA was designed to respond to situations involving the past disposal of hazardous substances. As such, it complements RCRA, which regulates on-going hazardous waste handling and disposal.

The National Priorities List, otherwise known as the NPL, is an important facet of CERCLA's response procedures. First established in 1981 under section 105(a)(8)(B) of CERCLA, the NPL is part of the National Contingency Plan (NCP) and must be updated annually to list sites warranting evaluation and/or cleanup under CERCLA.

In May, 1994, EPA Region II designated both Knolls and Kesselring Sites as Site Evaluation Accomplished (SEA) and therefore, neither Site warranted inclusion on the National Priorities List. The S1C Site had previously been designated as No Further Remedial Action Planned (NFRAP; the predecessor designation for SEA) in March 1990. The S1C Site was removed from the CERCLA Information System (CERCLIS) database in April 1995.

Pollution Prevention

Pollution Prevention is a strategy that meets the needs of the present day while laying the groundwork for a cleaner future. The President of the United States signed several Executive Orders that require the government to set prevention-related goals for acquisitions, emission reductions, and solid waste prevention and recycling. This is in keeping with the Pollution Prevention Act of 1990. Finally this set of Executive Orders also brought the government under the direction of the environmental "right-to-know" provisions that have placed the United States at the forefront of environmental progress worldwide.

KAPL performs various functions to ensure pollution prevention strategies are integrated into the core of all business areas at each KAPL Site. Listed below are the main focus topics, which are established to facilitate pollution prevention:

- Effectively institutionalize the pollution prevention ethic through training and awareness in all mission areas,
- Incorporate pollution prevention policy into the acquisition process,
- Achieve Emergency Planning and Community Right-to-Know reporting,
- Address other environmental quality and pollution prevention focus areas, and
- Apply innovative pollution prevention technologies.

KAPL ensures pollution prevention strategies are met by reviewing all chemical purchases and major construction projects to incorporate source reduction strategies for environmentally hazardous substances. Products containing recovered materials are also evaluated during the procurement process to ensure that post-consumer products are procured whenever economically feasible.

A few examples of KAPL's efforts are the procurement of electric carts, conversion from fuel oil to natural gas as the major heating fuel source at the Knolls Site, and at the Kesselring Site the conversion of the boilers from number 6 fuel oil to low sulfur number 2 fuel. In 1999, the Knolls Site built a salt storage shed to safely store large quantities of road salt while protecting groundwater in the surrounding area.

KAPL also maintains and operates an extensive recycling program which entails recycling of office paper, cardboard, plastic, glass, newspapers, telephone books, scrap metal, lead acid batteries, nickel cadmium batteries, scrap lead, cooking oil, plastic and steel barrels, aluminum cans, wood, tires, oil, light bulbs, fluorescent light ballasts, and precious metals.

Toxic Substances Control Act (TSCA)

The U.S. Congress enacted the Toxic Substances Control Act (TSCA) in 1976. TSCA authorizes EPA to secure information on all new and existing chemical substances and to control any of these substances determined to cause an unreasonable risk to public health or the environment. Unlike many other environmental laws, which generally govern discharge of substances, TSCA requires that the health and environmental effects be reviewed prior to a new chemical substance being manufactured for commercial use. TSCA, therefore, closes the gap in environmental regulations by allowing the EPA to prevent toxic problems rather than simply reacting to them after discharge. However, because KAPL does not manufacture chemicals or materials for commercial use, a majority of the implementing TSCA regulations do not apply.

Polychlorinated biphenyls (PCBs) are regulated as a toxic substance under TSCA under 40 CFR Part 761. PCBs were used prior to 1979 mainly as a dielectric fluid in electrical equipment such as transformers and capacitors. PCBs were also added to certain paint coatings prior to 1980 to increase resistance to heat, chemicals, or fire. The KAPL Sites have had PCBs present in electrical transformers, electrical cable insulation, fluorescent light ballasts, and paint coatings. KAPL has removed all known PCB containing electrical transformers from each Site and has, where practical, removed the PCB containing fluorescent ballasts. Additionally, KAPL employs strict controls for the proper handling and disposal of any remaining PCB containing items.

Emergency Planning and Community Right-To-Know (EPCRA)

Under Executive Order 12856, Federal agencies must comply with the planning and reporting provisions of the Emergency Planning and Community Right-to-Know Act (EPCRA).

Sections 302 to 304 of EPCRA are known as Subtitle A and required the creation of emergency response and emergency planning authorities. These authorities are known as the State Emergency Response Commission (SERC) and the Local Emergency Planning Commission (LEPC). This subtitle also requires facilities with extremely hazardous substances above a certain threshold planning quantity (TPQ) to give notice that these substances are present at that facility and to report releases of those substances and other listed hazardous substances in excess of a certain reporting quantity (RQ). KAPL has made all the appropriate notifications and KAPL personnel participate in LEPC meetings in the local community.

Subtitle B, Sections 311 to 313 establishes the reporting requirements under EPCRA. Section 311 requires the submission of material safety data sheets (MSDSs) for extremely hazardous substances in greater than the TPQ or any substance greater than 10,000 pounds. Under Section 312 of EPCRA, each KAPL facility completes an annual Tier II Inventory Report for all hazardous chemicals at each Site in excess of specified quantities during the previous calendar year. The information is submitted to the State, local planning committee, and local fire departments for emergency planning purposes.

Section 313 of EPCRA, establishes the Toxic Release Inventory (TRI) which requires certain facilities with specific standard industrial code (SIC) designations to report annually to the EPA on whether they manufacture, process, or otherwise use any of the listed toxic chemicals at designated thresholds. The FFCA requires all Federal facilities to complete TRI reports if the listed threshold quantities are exceeded. In addition, Federal facilities are required to report under Section 313 regardless of SIC designation/classification whenever thresholds are exceeded. During 1999, none of the KAPL facilities were required to report under Section 313.

Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)

The first federal control over pesticides was the Insecticide Act of 1910. The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) was enacted in 1947 and amended several times. This law was virtually rewritten in 1972 and has been further amended. This statute is complex and gives EPA the authority over the field use of pesticides and requires the registration of all pesticides used in the United States. EPA restricts the application of pesticides through a State-administered certification program. Only State certified commercial applicators or personnel under their supervision are allowed to apply restricted-use pesticides and herbicides at any of the KAPL Sites. The applicator is responsible for providing the appropriate pesticides and application equipment and for the proper disposal of all pesticide waste, including empty containers. There is no pesticide disposal on-site. The washing of pesticide/herbicide application equipment on site is also prohibited.

Authorized Site personnel applying pesticides or herbicides such as cooling tower addition chemicals or bee and wasp pesticides keep a daily use log for every application of a general use pesticide. These persons are trained under the direct supervision of KAPL personnel who are certified pesticide applicators. Annual reports are filed by the certified applicator for all pesticides, herbicides, and rodenticides applied during the previous year. Any such chemical applied by a subcontractor licensed commercial application business or under their guidance is recorded and reported by the subcontractor directly.

4.0 KNOLLS SITE ENVIRONMENTAL MONITORING

4.1 SITE DESCRIPTION

The Knolls Site is located in the Town of Niskayuna, New York, approximately two miles (3.2 kilometers) east of the City of Schenectady. The Site is situated on 170 acres of land on the south bank of the Mohawk River. Facilities at the Knolls Site include administrative offices, machine shops, a sewage pumping station, wastewater treatment facilities, a boiler house, oil storage facilities, cooling towers, waste storage facilities, and chemistry, physics, and metallurgical laboratories. The surrounding area is a mixture of open land, other light industry, small farms, a closed municipal landfill, and suburban residential areas.

The climate in the region of the Knolls Site is primarily continental in character, but is subjected to some modification from the maritime climate that prevails in the extreme southeastern portion of New York State. Winters are usually cold and occasionally fairly severe. Maximum temperatures during the colder winter months often are below freezing and nighttime low temperatures frequently drop to 10°F or lower. Sub-zero temperatures occur rather infrequently, about a dozen times a year. Snowfall in the area is quite variable, averaging approximately 65 inches per year. The mean annual precipitation for the region is approximately 36 inches per year. Westerly winds (W to NW) predominate, and a secondary maximum occurs about the SSE.

The Knolls Site is located in the Mohawk River Valley at an elevation of approximately 330 feet above sea level. Monitoring wells and test borings in the vicinity of the Knolls Site show that unconsolidated materials, consisting of mainly glacial deposits, overlie bedrock. The depth of bedrock beneath the land surface generally ranges between 10 and 70 feet. Rock outcrops are visible on both banks of the Mohawk River between Rexford and a point about three quarters of a mile downstream from the Knolls Site. The outcrops are flat-lying shales and sandstones of the Schenectady formation of Ordovician age. These rocks are characteristically non-porous and impermeable, and form poor aquifers. The structure of most of the consolidated rocks in Schenectady County is relatively simple. Over 90 percent of the entire County is underlain by the Schenectady formation, a series of alternating beds of shale, sandstone, and grit about 2,000 feet thick, which dip gently west and southwest. The Snake Hill formation is exposed along both sides of the Mohawk River near the dam at Lock 7, downstream from the Knolls Site. This formation consists of a considerable thickness of dark gray to black, bluish, and greenish-gray shale. It is the only formation in Schenectady County that is strongly folded, having been thrust westward against and over the Schenectady formation.

The glacial deposits consist almost entirely of glacial till. Basal till at the Knolls Site is a clay rich glacial drift. It is dense, compact, and is known locally as hardpan. The depth under the Site ranges from 0 to 70 feet. The till appears a grayish-blue color but in the upper twelve feet portion it has been weathered to a yellowish brown color. Within the till occasional lenses of graded material, usually fine sand, exist. The till is almost entirely impermeable except for a few lenses of sand, which are capable of transmitting water. It is believed that these lenses are small in size and isolated from one another based upon drilling records. Overlying the till are thin glacial lake sequences (silts and clays) and discontinuous ice-contact deposits (sand and gravel). The ice-contact deposits are capable of transmitting water but their limited extent diminishes the potential for yielding useable water volumes.

The Knolls Site is located adjacent to the Mohawk River that serves as the main watercourse for the Mohawk River Drainage Basin, covering an area of 3456 square miles. The river flows eastward to where it joins the Hudson River in Cohoes, N.Y. The average flow rate of the Mohawk River is 5,688 cubic feet per second (cfs) and the lowest recorded seven-day average flow is 458 cfs (296 million gallons per day) during August 1995. Three streams drain directly to the Mohawk River from the Knolls Site. The East Boundary Stream is located on the Knolls Site between the closed Knolls and Niskayuna Landfills. The East Boundary Stream also receives runoff from a nearby housing development and roadway. The Midline Stream drains the central area of the Site and basically receives only runoff from the Site property. The West Boundary Stream is located adjacent to the Knolls Site on GE Research and Development (R&D) Center property. This stream receives some surface water runoff from a tributary ditch from the Knolls Site, GE R&D Center, and the adjacent roadway. A fourth stream, which is actually a drainage ditch on the west side of the Knolls landfill, is known as the West Landfill Stream. This stream does not directly discharge to the Mohawk River. The flow in all of these streams becomes extremely low during the dry summer weather. These streams are not accessible to the public except at the point where they each meet the Mohawk River.

The groundwater under the Knolls Site is very limited due to the low permeability of the soil that prohibits the development of this area as a potable water supply. There are no underlying principal or primary bedrock or overburden aquifers. Water for Site operations involving potable and limited cooling use is obtained from the Schenectady and Niskayuna Municipal Water System. The majority of water for non-contact cooling at the Knolls Site is obtained from the Mohawk River. There are no production wells for service water on-site.

The Mohawk River is classified by the New York State Department of Environmental Conservation (NYSDEC) as a Class A stream. The best usages of Class A waters are considered to be: a source of water for drinking, culinary or food processing purposes, primary and secondary contact recreation, and fishing. The waters shall be suitable for fish propagation and survival. The Knolls Site discharges water from its various operations within the concentration, mass loading, and flow limits set by the State wastewater discharge permit, Reference (3).

4.2 LIQUID EFFLUENT MONITORING

4.2.1 Origins

The principal sources of effluent water are:

1. *Sewage Pumping Station* - Knolls Site sewage is pumped to the Town of Niskayuna sewage treatment facilities. The untreated sewage consists primarily of wastewater from restrooms and janitorial sinks. A small portion (<4%) may also consist of dilute non-hazardous laboratory rinse water, dilute non-hazardous analytical waste, environmental samples, and ammoniated or phosphated process water.

2. *Cooling Towers* - Cooling water, used for central air conditioning, is treated to maintain a pH range of 7.5 to 8.2 to minimize scale buildup, prevent corrosion of systems materials, and to inhibit the growth of algae and slime.

3. *Site Boiler Plant* - Site boiler water is chemically treated, softened and de-alkalized water. Operations that result in releases are (1) periodic blowdowns to control boiler chemistry and (2) ion exchange resin regeneration effluent from the softener and the de-alkalizer. The waters generated by the blowdown and de-alkalizer regeneration operations are neutralized before release.

4. *Non-contact Cooling Water* - Mohawk River and Site service waters are used as non-contact cooling media for several heat exchangers.

5. *Process Water* - Treated/untreated wastewater, primarily from cooling tower blow down and river water strainer system, is generated on-site. Process water treatment typically consists of one or more of the following processes; sedimentation, filtration, ion exchange, activated carbon and/or neutralization.

6. *Site Drainage Water* - Storm drainage water and groundwater also make up a portion of the liquid effluent.

Approximate flows and chemical characteristics of the discharges to the Mohawk River (items 2-6) were incorporated in the Reference (3) State Pollutant Discharge Elimination System (SPDES) permit application.

The concentrations of radioactivity in liquids released from the Knolls Site have always been below all applicable limits. A water reuse system is used whereby liquids from current laboratory operations that may contain radioactivity are collected, processed, and reused in certain laboratory operations to the maximum extent practicable. This minimizes the quantities of radioactivity released from the Knolls Site.

Where practicable, liquids from sources other than current laboratory operations that may contain radioactivity are collected in holdup tanks and are processed in batches. The processing system consists of a series of filters and demineralizers. Each batch of processed liquid is held in tanks and sampled to ensure that the radioactivity content is minimal and in compliance with applicable water quality standards. In addition, each tank of processed water is sampled during release to provide a sensitive determination of the radioactivity actually released. The samples are combined into one or more monthly composite samples that are analyzed to determine the quantity and identity of the radionuclides present.

In addition, small amounts of groundwater that contains low level residual radioactivity from operations conducted during the 1950's and 1960's are released in the Site drainage water. The principal radioactive constituents released to the Mohawk River from all sources are the longer lived fission products, notably strontium-90 and cesium-137.

4.2.2 Effluent Monitoring

The Knolls Site wastewater discharged to the Mohawk River is regulated by a State Pollutant Discharge Elimination System (SPDES) Permit, Reference (3). The SPDES permit specifies the required sampling locations, parameters, and minimum sampling frequencies. The SPDES Permit was renewed during 1999 and became effective on January 1, 2000. The term of the permit is five years and must be renewed by January 2005.

Liquid effluent from the Knolls Site enters the Mohawk River through a submerged drain line (Outfall 002), five small surface outfalls (Outfalls 003A, 003B, 003D, 003E, and 003X), and three natural storm water streams (Outfalls 004, 005, and 006) as shown in Figure 4-1.

Outfall 002 discharges non-contact cooling water, process water, storm water, and groundwater through a submerged drain line directly to the Mohawk River. The Outfall 002 monitoring station consists of a Parshall flume which provides for the measurement and recording of effluent flow rate, total flow, and for the collection of samples proportional to effluent flow. A monthly composite sample is prepared from the proportional samples collected at the monitoring station and is analyzed for radioactivity. In addition, weekly grab samples are taken at Outfall 002 and analyzed for the constituents specified in the SPDES Permit.

Outfalls 003B and 003D discharge Mohawk River water used for once-through non-contact cooling, groundwater, and storm water. These outfalls are monitored on a monthly basis. In 1995, a suspended solids settling tank was installed to remove concentrated river water sediment from strainer backwash effluent. The river water used for non-contact cooling must be strained to remove large particles (>250 microns). This prevents clogging of Knolls Site heat exchangers and instrumentation lines. The inlet and outlet of the settling tank have been designated as Outfalls 003S and 003T. The discharge from 003T is directed to Outfall 003B. The required sampling frequency for this tank is twice per month. Outfalls 003A and 003E discharge groundwater and storm water. These outfalls are monitored quarterly. All monitoring is in accordance with the SPDES Permit. Outfalls 003A, 003B, 003D, and 003E are also voluntarily sampled monthly for radioactivity.

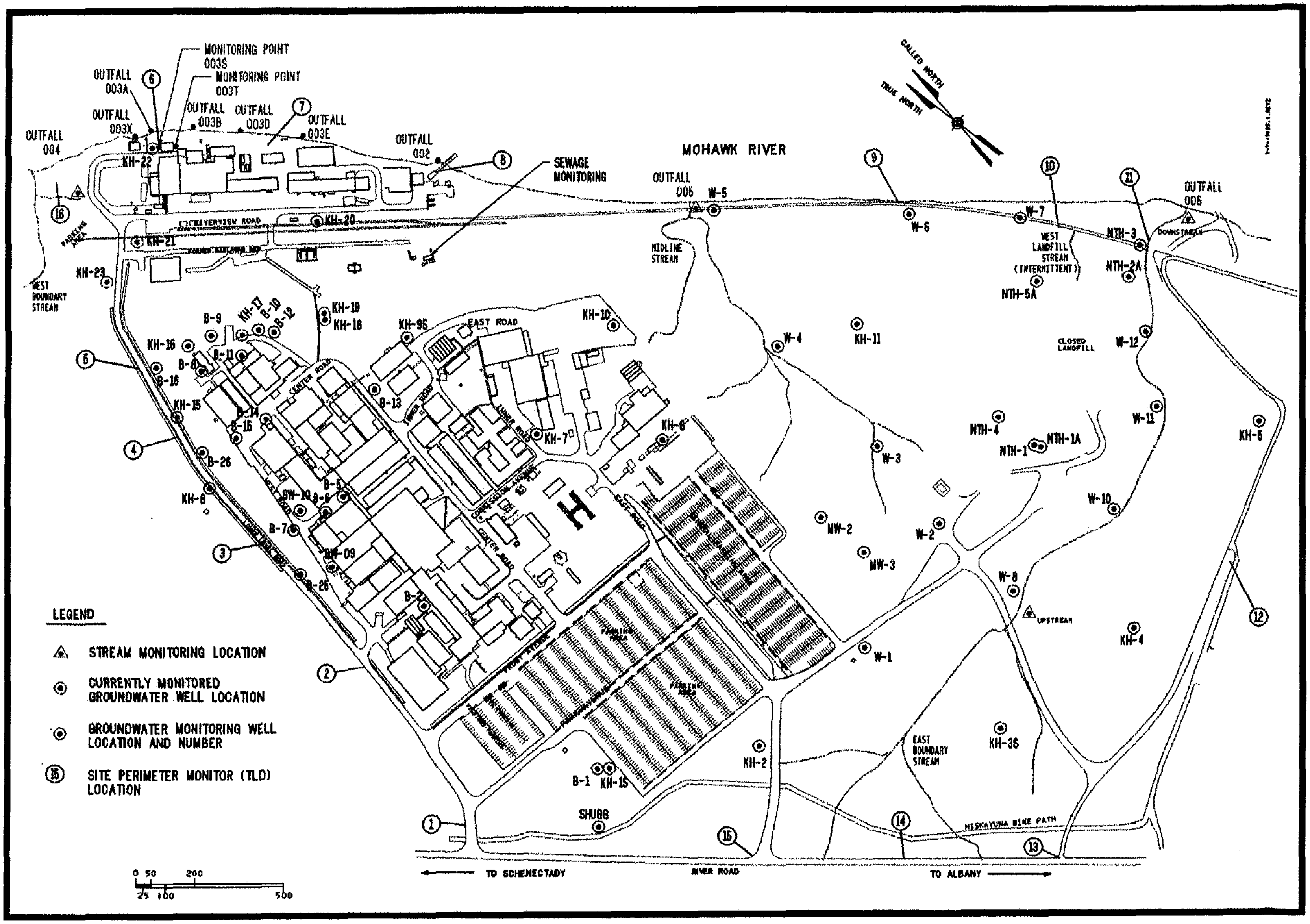


Figure 4-1
Knolls Site, Niskayuna, New York
Stream and Outfall, Groundwater, and PerimeterTLD Monitoring Locations

Outfall 003X was not operated during 1999. Instead, the river water used to backwash the traveling screen was returned to the infiltration gallery and the collected debris removed manually. This screen is used to remove large debris such as twigs and leaves from the intake river water prior to the river water intake pumps. Outfall 003X is required to be monitored when in operation.

Three Knolls Site storm water outfalls are designated as 004, 005, and 006, and correspond to the West Boundary Stream Ditch, Midline Stream, and East Boundary Stream, respectively. The flow in these surface water streams is intermittent and they are sampled quarterly, when possible. The sampling location for Outfall 004 is the ditch that is on KAPL property. This ditch joins the West Boundary Stream. Therefore, the water that is monitored is only from KAPL operations and is not influenced by the GE Research & Development Center. The West Landfill Stream is not monitored as part of the SPDES permitted outfalls. However, the West Landfill Stream is monitored in accordance with the Knolls Site Landfill Post Closure Monitoring Program. This stream is extremely intermittent and is sampled quarterly, when possible.

The Outside Users Agreement negotiated with the Town of Niskayuna specifies the parameters and sampling frequency for the untreated sewage. The minimum sampling frequency is monthly for chemical constituents and quarterly for radioactivity. A 24-hour flow-composited sample is collected weekly. The pumping station is equipped with a pH alarm that will divert the sewage to a holding tank if the pH is out of the specified band.

4.2.3 Effluent Analyses

Periodic grab samples collected from Outfalls 002, 003A, 003B, 003D, 003E, 003S, 003T, 004, 005 and 006 are analyzed for the chemical constituents listed in Reference (3). Outfall 003X was not operated during 1999. Samples from various outfalls are analyzed for additional parameters for informational purposes only and are presented in the appropriate data tables. Twenty-four hour flow-composited samples of the sewage pumped to the Town of Niskayuna are collected and analyzed as required by Reference (2).

The monthly composite sample collected at the Outfall 002 is analyzed for (1) strontium-90 by radiochemical separation and subsequent beta counting, (2) cesium-137 and other gamma-emitting radionuclides by gamma spectrometry, (3) tritium by liquid scintillation counting, (4) gross beta radioactivity by direct sample evaporation and beta counting and (5) alpha radioactivity by solvent extraction and alpha counting. In addition, samples from the small cooling and drainage water outfalls are analyzed for alpha radioactivity and gross beta radioactivity. If the gross beta radioactivity exceeds a specified concentration, analyses for strontium-90, cesium-137 and other gamma emitting radionuclides are performed. Analyses for strontium-90 are performed routinely for those outfalls that drain water from areas containing residual strontium radioactivity from prior operations at the Site.

The quarterly composite sample of the sanitary sewage effluent to the Town of Niskayuna Municipal Treatment Plant is analyzed for strontium-90, cesium-137, cobalt-60, tritium, and uranium.

4.2.4 Assessment

The analytical results for the chemical constituents, flow and temperature monitored in the Knolls Site sewage effluent during 1999 are summarized in Table 4-1. The Knolls Site has operated within all parameters specified in the Outside Users Agreement.

The average radioactivity concentrations in the sanitary sewage effluent to the Town of Niskayuna are shown in Table 4-2. Only naturally occurring uranium and strontium-90 at concentration levels typically found in surface water from past atmospheric weapons testing were detected in the effluent. No radionuclides attributable to KAPL operations were detected in the effluent composite samples. The

TABLE 4-1 CHEMICAL CONSTITUENTS IN KNOLLS SITE SANITARY SEWAGE EFFLUENT DISCHARGED TO THE TOWN OF NISKAYUNA WASTEWATER TREATMENT PLANT, 1999

Parameter (Units)	Number of Samples	Value[1] Knolls Site Sewage Lift Station Minimum	Maximum	Average[2]	Users Agreement[3]	Percent of Limit [4]
Outside Users Agreement #94 3850 Requirements (Reference 2)						
Flow (GPD) *	12[5]	15,400	25,100	19,600	45,000	44
pH (SU) **	430	7.1	8.9	8	6.0-9.5[6]	--
Biochemical Oxygen Demand (mg/l)	51	226	669	327	700	47
Chemical Oxygen Demand (mg/l)	51	512	1240	786	1800	44
Total Suspended Solids (mg/l)	51	240	1380	500	1600	31
Ammonia as N (mg/l)	51	32	112	88	200	44
Nitrate as N (mg/l)	51	0.1	1.5	0.2	4	5
Nitrite (as N) (mg/l)	51	<0.02	0.14	<0.03	4	<1
Total Kjeldal Nitrogen (as N) (mg/l)	51	81	158	120	250	48
Total Organic Nitrogen (as N) (mg/l)	51	<1	70	<32	175	<18
Total Nitrogen [7] (as N) (mg/l)	51	<81.2	<158.2	<120.4	250	<48
Phosphate as P (mg/l)	51	8.3	22	14	30	47
Additional Parameter Monitored						
Oil & Grease (mg/l)	51	20	81	35	100[8]	35

*GPD = Gallons per day
**SU = Standard units

Notes:
(1) A value preceded by < is less than the minimum detection level.
(2) Average values preceded by < contain at least one less than minimum detection level value in the average.
(3) Outside Users Agreement allows for monthly averaging of data unless noted.
(4) Percent of limit for the average value, unless otherwise noted.
(5) Flow is calculated using daily pumping hours for the month times a calibrated pumping rate. The average of the monthly flows reported to Niskayuna is used for this report.
(6) All values are required to be within this range.
(7) Daily average limit; calculated as the sum of nitrate + nitrite + total Kjeldahl nitrogen.
(8) This parameter is not a limit under the Users Agreement, however, the Town of Niskayuna sanitary code prohibits fats, waxes, grease or oils in excess of 100 mg/l.

TABLE 4-2 KNOLLS SITE SANITARY SEWAGE EFFLUENT DISCHARGED TO THE TOWN OF NISKAYUNA WASTEWATER TREATMENT PLANT QUARTERLY COMPOSITE SAMPLE RADIOACTIVITY RESULTS, 1999

Radionuclide	Number of Samples	Average Radioactivity Concentration(1) (pCi/liter)	DOE Order 5400.5 Derived Concentration Guide (DCG) (pCi/liter)	Percent of DCG
Outside Users Agreement #94 3850 Requirements (Reference 2)				
Cs-137	51	<0.67	3000	<0.022
Sr-90	51	0.40 ± 0.25	1000	0.040
Co-60	51	<0.72	5000	<0.014
H-3	51	<128	2000000	<0.006
U-234(2)	51	0.38 ± 0.39(3)	500	0.076
U-235(2)	51	0.0069 ± 0.0019	600	0.0012
U-236(2)	51	<0.00062	500	<0.00012
U-238(2)	51	0.149 ± 0.040	600	0.025
			Total Percentage(4)	**<0.19%**

Notes:

(1) Average values preceded by "<" contain at least one less than minimum detectable concentration value in the average. The (±) value provides the 95% confidence interval for the average value.

(2) The weight percentages of the uranium isotopes in the sample analyzed by mass spectrometry indicate that only naturally occurring uranium is present. The concentrations of the uranium isotopes are typical of background environmental samples.

(3) The lowest possible value for any parameter is zero.

(4) The radioactivity standard for the Town of Niskayuna Sanitary Sewer System corresponds to one percent of the derived concentration guide in DOE Order 5400.5 for the mixture of radionuclides present (Reference 2).

radioactivity concentrations in the sanitary sewage effluent were less than one percent of the DOE derived concentration guide for effluent released to unrestricted areas (Reference 4) as required by the Users Agreement (Reference 2).

The analytical results for the chemical constituents, flow and temperature monitored in the Knolls Site liquid effluent during 1999 are summarized in Table 4-3. The annual average values of all parameters were within the appropriate effluent permit limits or standards where standards exist for Outfalls 002, 003A, 003B, 003D, 003E, 003S, and 003T. In April 1999, one weekly sample required for total residual chlorine for Outfall 002 was inadvertently missed. This was reported to NYSDEC in the April Discharge Monitoring Report.

In August and October 1999, KAPL treated the river water cooling system to control the zebra mussel population within the river water piping system. These treatments were conducted in accordance with the Site SPDES Permit (Reference 3). Two treatments were necessary in 1999 due to the extended period of warm weather. Zebra mussel reproduction is accelerated by warm water temperatures. The process was effective in controlling the zebra mussel population within the river water piping system.

The Mohawk River is voluntarily monitored for various chemical parameters at two locations. The SPDES Permit requires the Mohawk River intake water to be monitored for total suspended solids, iron, and pH. The data for the upstream and downstream locations are presented in Table 4-4. The analytical results for chemical constituents, flow, and temperature for Knolls Site storm water monitoring of surface water streams as required by the SPDES Permit were within the specified parameters. These results are summarized in Tables 4-5 and 4-6.

TABLE 4-3 CHEMICAL CONSTITUENTS AND TEMPERATURE IN KNOLLS SITE LIQUID EFFLUENT, 1999

Parameter (Units)	Number of Samples	Discharge Points 002 and 003A-E Value[1] Minimum	Maximum	Average[2]	Permit Limit[3]	Percent of Limit [4]
Discharge Permit Requirements (Reference 3)						
Discharge Point 002						
Intake pH (SU) *	52	6.5	8.5	7.6	Monitor	- -
pH (SU) *	56	6.7	8.4	7.7	6.5-8.5[5]	- -
Flow (MGD) **	Continuous	1.57	3.30	2.06	Monitor	- -
Temperature (°F)	51	34.9	80.1	57.8	90	- -
Oil & Grease (mg/l)	52	<1	1.9	<1.0	15	13
Total Residual Chlorine (mg/l)	51[6]	0.02	0.04	0.02	0.2 [7]	20
Suspended Solids (mg/l)	52	1	73	6.6	Monitor	- -
Dissolved Sulfide (mg/l)	52	<0.1	<0.1	<0.1	2	<5
Intake Iron (mg/l)	8	0.1	0.34	0.22	Monitor	- -
Iron (mg/l)	53	<0.05	0.82	<0.31	4.0 [8]	20
Manganese (mg/l)	8	0.03	0.07	0.04	0.35	20[9]
Surfactants (mg/l)	8	<0.02	<0.02	<0.02	0.4	<5 [9]
Bromide (mg/l)	8	<1	1.3	<1	1.4	93[9]
Copper (mg/l)	15	<0.05	0.07	<0.05	0.2	<35[9]
Discharge Point 003A [9]						
Flow (MGD) **	4	0.009	0.017	0.012	Monitor	- -
pH (SU) *	4	6.7	7.5	7.2	6.5-8.5	- -
Temperature (°F)	4	45.7	60.6	54	90	67
Oil & Grease (mg/l)	4	<1	<1	<1	15	<7
Suspended Solids (mg/l)	4	<1	<1	<1	Monitor	- -
Discharge Point 003B						
Flow (MGD) **	Continuous	0.77	2.62	1.82	Monitor	- -
pH (SU) *	12	6.7	8.0	7.5	6.5-8.5 [5]	- -
Temperature (°F)	Continuous	33.4	83.6	56.3	90	93
Oil & Grease (mg/l)	12	<1	<1	<1	15	<7
Intake Suspended Solids (mg/l)	24	<1	56	<7	Monitor	- -
Net Suspended Solids (mg/l)	12	<1	3.5	<1	50[10]	7
Iron (mg/l)	4	0.18	0.36	0.29	2	18 [9]
Discharge Point 003D						
Flow (MGD) **	Continuous	0.04	1.21	0.32	Monitor	- -
pH (SU) *	12	6.7	8	7.4	6.5-8.5[5]	- -
Temperature (°F)	Continuous	32.9	84.6	58.2	90	94
Oil & Grease (mg/l)	12	<1	<1	<1	15	9
Suspended Solids (mg/l)	12	1	48	14.1	Monitor	- -
Iron (mg/l)	4	0.3	0.81	0.45	2	41 [9]
Discharge Point 003E [11]						
Flow (MGD)**	4	0.001	0.003	0.002	Monitor	- -
pH (SU) *	4	6.6	7.9	7.4	6.5-8.5	- -
Temperature (°F)	4	40.6	73.6	56.4	90	82

TABLE 4-3 CHEMICAL CONSTITUENTS AND TEMPERATURE IN KNOLLS SITE LIQUID EFFLUENT, 1999 (continued)

Parameter (Units)	Number of Samples	Discharge Points 002, 003B, 003D, 003S, 003T and 003X Value[1] Minimum	Maximum	Average[2]	Permit Limit [3]	Percent of Limit [4]
Discharge Permit Requirements (Reference 3)						
<u>Discharge Point 002, 003B and 003D</u> [12]						
Spectrus CT-1300 (mg/l)	56	<0.05	<0.05	<0.05	0.05[13]	<100
<u>Discharge Point 003S</u>						
Flow (MGD) **	24	0.24	0.45	0.34	Monitor	--
Suspended Solids (mg/l)	24	<1	20	<5.5	Monitor	--
<u>Discharge Point 003T</u>						
Flow (MGD) **	24	0.24	0.45	0.34	Monitor	--
Suspended Solids (mg/l)	24	<1	18	<3.9	Monitor	--
Suspended Solids (% removal)	24	<1	93	<25	Monitor	--
<u>Discharge Point 003X</u>[14]						
pH (SU) *	0				6.5-8.5[5]	--
Oil & Gease (mg/l)	0				15	--
Suspended Solids (mg/l)	0				50	--
Flow (MGD) **	0				Monitor	--
Temperature (°F)	0				90	--

*SU = Standard Units
**MGD = Million gallons per day.

Notes:
(1) A value preceded by < is less than the minimum detection level.
(2) Average values preceded by < contain at least one less than minimum detection level value in the average.
(3) Daily maximum limit unless noted.
(4) Percent of limit for the maximum value, unless otherwise noted.
(5) If intake pH is greater than or equal to 8.2, the upper pH limit is increased to 9.0 but in no case can the effluent pH exceed intake pH by more than 0.5 SU.
(6) One weekly sample was inadvertently missed during April 1999.
(7) Daily average total residual chlorine (TRC) value shall not exceed 0.1 mg/l. Daily maximum TRC value shall not exceed 0.2 mg/l.
(8) Daily average value shall not exceed 2.0 mg/l. Daily maximum value shall not exceed 4.0 mg/l.
(9) Action level specified by Reference (3); percent of limit based on maximum value.
(10) The limit is a net limit. The intake suspended solids is subtracted from the outfall suspended solids. If the net result is negative, the data is reported as <1 mg/l.
(11) Additional monitoring, pH range expansion and permit restrictions are imposed if non-contact cooling water is discharged via this outfall. KAPL currently does not discharge non-contact cooling water from this outfall.
(12) On 08/26/99 and 10/19-20/99 chemical addition was performed for zebra mussel control using BetzDearborn Spectrus CT-1300 and BetzDearborn DT-1400 detoxifying agent.
(13) Daily maximum value. Monitoring for Spectrus CT-1300 is required during chemical application and discharge.
(14) This outfall was not operated during 1999.

TABLE 4-4 CHEMICAL CONSTITUENTS AND TEMPERATURE IN MOHAWK RIVER WATER, 1999

Parameter (Units) [2]	Samples Upstream/ Downstream	Value[1] Upstream Minimum	Upstream Maximum	Upstream Average[3]	Downstream Minimum	Downstream Maximum	Downstream Average[3]	Standard[4]	Percent of Standard[5]
pH (SU) *	56/4	6.5	8.5	7.6	6.5	7.9	7.3	6.5-8.5	- -
Cadmium (mg/l)	3/4	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.005	<100
Ammonia (as N) (mg/l)	4/4	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	2.0 [6]	<5
Temperature (°C)	56/4	0.3	26	12.7	0.2	27	13.2	See Note [7]	- -
Oil & Grease (mg/l)	4/4	<1	<1	<1	<1	<1	<1	See Note [8]	- -
Phosphorus (as P) (mg/l)	4/4	<0.04	0.09	<0.07	0.05	0.1	0.07	See Note [9]	- -
Suspended Solids (mg/l)	28/4	<1	56	<7	1.3	12	6.5	See Note [10]	- -
Iron (mg/l)	8/4	0.1	0.32[11]	0.22	0.15	1.24[11]	0.55[11]	0.3	183[11]
Manganese (mg/l)	4/4	<0.03	0.04	<0.04	0.04	0.21	0.09	0.3	30
Chemical Oxygen Demand (mg/l)	4/4	<5	11	<7	<5	11	<7	No Standard	- -
Surfactants (mg/l)	4/4	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	No Standard	- -
Bromide (mg/l)	4/4	<1	<1	<1	<1	<1	<1	2.0 [12]	<50
Dissolved Oxygen (mg/l)	4/4	6.8	14.1	10.4	8.1	12.6	10.2	See Note [13]	- -
Eh (mv) **	4/4	110	404	295	187	398	314	No Standard	- -
Turbidity (ntu) ***	4/4	2.1	14	5.6	2.3	13	7.7	See Note[14]	- -
Specific Conductance (micro-mhos/cm) ****	4/4	257	380	319	268	379	325	No Standard	- -
Total Dissolved Solids (mg/l)	4/4	133	183	162	135	170	158	500[15]	32
Total Organic Carbon (mg/l)	4/4	3.2	5.1	3.9	3.2	5.0	4.1	No Standard	- -
Sulfate (S, mg/l)	4/4	19	27	24	19	31	25	250	10
Alkalinity (as $CaCO_3$, mg/l)	4/4	80	105	90	75	96	86	No Standard	- -
Chloride (mg/l)	4/4	21	42	30	22	41	30	250	12
Total Hardness (as $CaCO_3$ mg/l)	4/4	117	275	162	94	128	118	No Standard	- -
Nitrate (as N, mg/l)	4/4	0.28	0.86	0.56	0.53	0.93	0.71	10	7
Total Phenols (mg/l)	4/4	<0.001	0.002	<0.001	<0.001	0.002	<0.001	0.001	<100
Calcium (mg/l)	4/4	28.2	39.9	36.0	29.1	40.0	36.5	No Standard	- -
Lead (mg/l)	4/4	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.05	<10
Magnesium (mg/l)	4/4	5.2	7.2	6.3	5.3	7.4	6.5	35	19
Potassium (mg/l)	4/4	1.4	2.4	1.9	<0.5	3	<1.9	No Standard	- -
Sodium (mg/l)	3/4	14	23	20	10	22	17	No Standard	- -
Copper (mg/l)	8/4	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.2	<25
Dissolved Sulfide (mg/l)	4/4	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.05[16]	NA [17]

TABLE 4-4 - Continued

Notes:

(1) A value preceded by < is less than the minimum detection level.

(2) The Knolls Site also performed sampling and analyses of 51 additional baseline parameters as listed in Reference (5) during August 1999. All results were within existing water quality standards as specified by Reference (1). Table 4-14 lists the parameters included in the baseline scan.

(3) Average values preceded by < contain at least one value in the average that is less than the minimum detection level.

(4) Per Reference (1), New York State Quality Standards for Class A Waters: source of water supply for drinking, culinary or food processing purposes; primary and secondary contact recreation; and fishing. The waters shall be suitable for fish propagation and survival.

(5) Percent of standard for the average value for the down river sampling location.

(6) $NH_3 + NH_4^+$ as N.

(7) Per Reference (1), the thermal discharge limits relating to Site operations are as follows:

(a) The water temperature at the surface shall not be raised to more than 32.2°C (90°F) at any point.

(b) At least 50% of the cross-sectional area and/or volume of flow of the stream including a minimum of one-third of the surface as measured from shore to shore shall not be raised by more than 2.8°C (5°F), over the temperature that existed before the addition of heat of artificial origin or to a maximum of 30°C (86°F), whichever is less.

(c) At least 50 percent of the cross-sectional area and/or volume of flow of the stream including a minimum of one-third of the surface as measured from shore to shore shall not be lowered more than five Fahrenheit degrees from the temperature that existed immediately prior to such lowering.

(8) No residue attributable to sewage, industrial wastes or other wastes, nor visible oil film nor globules of grease.

(9) None in amounts that will result in growths of algae, weeds and slimes that will impair the waters for their best usages.

(10) None from sewage, industrial wastes or other wastes that will cause deposition or impair the waters for their best usages.

(11) Water quality of the Mohawk River is variable. The higher iron in the downstream sample is not indicative of KAPL operations.

(12) Guidance value.

(13) For non-trout waters, the minimum daily average shall not be less than 5.0 mg/l, and at no time shall the DO concentration be less than 4.0 mg/l.

(14) No increase that will cause a substantial visible contrast to natural conditions.

(15) Shall be kept as low as practicable to maintain the best usage of waters but in no case shall it exceed 500 mg/l.

(16) Guidance value for total sulfides expressed as hydrogen sulfide.

(17) The minimum detection value for that parameter is higher than the reference standard. That does not mean that the actual level of the contaminant exceeded the standard.

*SU = Standard Units

**mv = millivolts

***ntu = nephelometric turbidity units

****µmhos/cm = micromhos per centimeter

TABLE 4-5 CHEMICAL CONSTITUENTS, RADIOACTIVITY AND TEMPERATURE IN WEST BOUNDARY STREAM DITCH AND MIDLINE STREAM, 1999

Parameter [2] (Units)	No. of Samples WBSD[3]/ Midline Stream	Value[1] West Boundary Stream Ditch (WBSD) Minimum	Maximum	Average[4,5]	Midline Stream Minimum	Maximum	Average[4,5]	Standard[6,7]	Percent of Standard [8] WBSD / Midline Stream
pH (SU)	4/4	7.1	8.2	7.6	7.1	8.2	7.8	6.5-8.5[9]	- -
Cadmium (mg/l)	1/4	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.005	<100/<100
Ammonia (N, mg/l)	1/4	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	2.0[10]	<5/<5
Temperature (°C)	4/4	1.2	15.0	6.6	-0.2	18.3	9.2	See Note [11]	- -
Oil & Grease (mg/)	4/4	<1	2.6	<1.4	<1	<1	<1	15[9]	- -
Phosphorus (P, mg/l)	1/4	0.05	0.05	0.05	0.03	0.09	0.05	See Note [12]	- -
Suspended Solids (mg/l)	4/4	14	18	16	<1	28	<8	Monitor[9]	- -
Iron (mg/l)	1/4	0.36	0.36	0.36	<0.05	0.32	<0.12	0.3	120/<40
Manganese (mg/l)	1/4	<0.02	<0.02	<0.02	<0.02	0.08	<0.04	0.3	<7/<13
Chemical Oxygen Demand (mg/l)	4/4	<5	8	<7.0	<4	15	<7.9	Monitor[9]	- -
Surfactants (mg/l)	1/4	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	No Standard	- -
Bromide (mg/l)	1/4	<1	<1	<1	<1	<1	<1	2.0[13]	<50/<50
Dissolved Oxygen (mg/l)	1/4	13.6	13.6	13.6	8.5	14.0	11.4	See Note [14]	- -
Eh (mv)	1/4	397	397	397	115	358	279	No Standard	- -
Turbidity (ntu)	1/4	21	21	21	1.2	1.9	1.5	See Note [15]	- -
Specific Conductance (micro-mhos/cm)	1/4	1444	1444	1444	1021	1844	1429	No Standard	- -
Total Dissolved Solids (mg/l)	1/4	813[16]	813[16]	813[16]	550[16]	980[16]	782[16]	500[17]	163/156
Total Organic Carbon (mg/l)	1/4	5.7	5.7	5.7	3.2	6.0	4.1	No Standard	- -
Sulfate (S, mg/l)	1/4	44	44	44	53	95	81	250	18/32
Alkalinity ($CaCO_3$, mg/l)	1/4	120	120	120	195	280	239	No Standard	- -
Chloride (mg/l)	1/4	446	446	446[18]	126	445[18]	296[18]	250	178/118
Total Hardness ($CaCO_3$, mg/l)	1/4	235	235	235	330	431	400	No Standard	- -
Nitrate (N, mg/l)	1/4	0.25	0.25	0.25	<0.02	0.39	<0.19	10	2.5/<1.9
Total Phenols (mg/l)	1/4	0.002	0.002	0.002[19]	<0.001	0.002[19]	<0.001	0.001	200/<100
Calcium (mg/l)	1/4	66	66	66	99	129	117	No Standard	- -
Lead (mg/l)	1/4	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.05	<10<10
Magnesium (mg/l)	1/4	17	17	17	20	33	27	35	49/77
Potassium (mg/l)	1/4	1.7	1.7	1.7	<0.5	2.3	<1.8	No Standard	- -
Sodium (mg/l)	1/4	210	210	210	81	186	127	No Standard	- -
Copper (mg/l)	1/4	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.2	<25/<25
Dissolved Sulfide (mg/l)	1/4	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.05[20]	NA[21]
Flow (Estimated)GPD [22]	4/4	1357	452451	218198	<6953	556515	<189517	Monitor[9]	- -
Radioactivity (pCi/l)									
Alpha	8/12	0.30	1.71	0.92 ± 0.97	0.66	1.08	0.86 ± 0.27	30	3/3
Beta	8/12	4.66	19.06	10.26 ± 10.15	2.14	6.22	4.70 ± 2.83	1000	1.0/0.5
Strontium-90	8/12	0.11	7.60	2.15 ± 5.79	0.13	0.39	0.29 ± 0.18	1000	0.2/<0.1
Cesium-137	8/12	<0.26	3.52	1.12 ± 2.54	<0.27	<0.36	<0.30 ± 0.07	3000	<0.1/<0.1

TABLE 4-5 - Continued

Notes:

(1) A value preceded by < is less than the minimum detection level.

(2) The Knolls Site also performed sampling and analysis of 51 additional baseline parameters as listed in Reference (5) during August 1999. All results were within existing water quality standards as specified by Reference (1). Table 4-14 lists the parameters included in the baseline scan.

(3) Flow was extremely intermittent at the West Boundary Stream Ditch sampling location. This sampling location was dry for three of the voluntary sampling events. However, the SPDES required samples were all obtained.

(4) Average values preceded by < contain at least one less than minimum detection level value in the average. The (±) value represents the 95% confidence interval for the average value.

(5) The lowest possible value for any parameter is zero.

(6) New York State Quality Standards for Class A Waters: source of water supply for drinking, culinary or food processing purposes; primary and secondary contact recreation; and fishing. The waters shall be suitable for fish propagation and survival. West Boundary and Midline Streams join the Mohawk River, which is a Class A water.

(7) The radioactivity standard is the derived concentration guide (DCG) listed in DOE Order 5400.5, Reference (4). The DCG for unidentified alpha and beta radioactivity is based on the most restrictive radionuclide possibly present in measurable quantities as a result of KAPL operations.

(8) Percent of standard for the average value.

(9) Required by Reference (3) NYSDEC SPDES permit.

(10) $NH_3 + NH_4^+$ as N.

(11) Per Reference (1), the thermal discharge limits relating to Site operations are as follows:

(a) The water temperature at the surface shall not be raised to more than 32.2°C (90°F) at any point.

(b) At least 50% of the cross-sectional area and/or volume of flow of the stream including a minimum of one-third of the surface as measured from shore to shore shall not be raised by more than 2.8°C (5°F), over the temperature that existed before the addition of heat of artificial origin or to a maximum of 30°C (86°F), whichever is less.

(c) At least 50 percent of the cross-sectional area and/or volume of flow of the stream including a minimum of one-third of the surface as measured from shore to shore shall not be lowered more than five Fahrenheit degrees from the temperature that existed immediately prior to such lowering.

(12) *None in amounts that will result in growths of algae, weeds, and slimes that will impair the waters for their best usages.*

(13) Guidance value.

(14) For non-trout waters, the minimum daily average shall not be less than 5.0 mg/l, and at no time shall the DO concentration be less than 4.0 mg/l.

(15) No increase that will cause a substantial visible contrast to natural conditions.

(16) Elevated levels of total dissolved solids were seen in the Midline Stream and West Boundary Stream Ditch during 1999. The surface water and groundwater of the Knolls Site have a naturally high mineral content.

(17) Shall be kept as low as practicable to maintain the best usage of waters but in no case shall it exceed 500 mg/l.

(18) The high maximum value is attributed to winter de-icing operations.

(19) Attributed to the breakdown of natural organics.

(20) Guidance value for total sulfides expressed as hydrogen sulfide.

(21) The minimum detection value for that parameter is higher than the reference standard. That does not mean that the actual level of the contaminant exceeded the standard.

(22) Flow is estimated by measuring stream depth, width, and velocity. Flow is intermittent and is measured only when samples are collected.

TABLE 4-6 CHEMICAL CONSTITUENTS, RADIOACTIVITY AND TEMPERATURE IN EAST BOUNDARY STREAM, 1999

Parameter[3] (Units)	Samples [1] Upstream/ Downstream	Value[2] Upstream Minimum	Maximum	Average[4,5]	Downstream Minimum	Maximum	Average[4,5]	Standard[6,7]	% Standard[8] Upstream/ Downstream
pH (SU)	6/5	6.5	7.9	7.3	6.8	7.9	7.6	6.5-8.5[9]	- -
Cadmium (mg/l)	6/5	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.005	<100/<100
Ammonia (N, mg/l)	6/5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	2.0[10]	<5/<5
Temperature (°C)	6/5	0.3	17.3	9.7	0.1	13.4	7.9	See Note[11]	- -
Oil & Grease (mg/l)	6/5	<1	<1	<1	<1	<1	<1	15 [9]	- -
Phosphorus (P, mg/l)	6/5	0.02	0.15	0.08	<0.02	0.13	<0.06	See Note [12]	- -
Suspended Solids (mg/l)	6/5	1.5	504[13]	171	<1	7.5	<2.3	Monitor [9]	- -
Iron (mg/l)	6/5	0.27	2.94[13]	1.16	0.07	0.17	0.12	0.3	387/<40 [13]
Manganese (mg/l)	6/5	0.16	1.56[14]	0.75	<0.02	0.03	<0.02	0.3	250/<7 [14]
Chemical Oxygen Demand (mg/l)	6/5	15	50	27	<4	15	<9	Monitor [9]	- -
Surfactants (mg/l)	6/5	<0.02	0.03	<0.02	<0.02	<0.02	<0.02	No Standard	- -
Bromide (mg/l)	6/5	<1	<1	<1	<1	<1	<1	2.0 [15]	<50/<50
Dissolved Oxygen (mg/l)	6/5	3.2[16]	13.1	8.7	10.5	14.0	11.7	See Note [17]	- -
Eh (mv)	6/5	128	372	274	303	358	328	No Standard	- -
Turbidity (ntu)	6/5	2.2	360	122	0.6	5.4	1.9	See Note [18]	- -
Specific Conductance (micro-mhos/cm)	6/5	885	1222	991	882	1115	952	No Standard	- -
Total Dissolved Solids (mg/l)	6/5	458	673[19]	522[19]	512[19]	548[19]	529[19]	500[20]	104/106 [19]
Total Organic Carbon (mg/l)	6/5	4.3	6.5	5.9	3.7	39.0	11.3	No Standard	- -
Sulfate (S, mg/l)	6/5	40	87	62	64	110	84	250	25/34
Alkalinity ($CaCO_3$, mg/l)	6/5	125	325	225	190	260	243	No Standard	- -
Chloride (mg/l)	6/5	50	228	137	69	217	105	250	55/42
Total Hardness ($CaCO_3$, mg/l)	6/5	222	380	308	309	367	347	No Standard	- -
Nitrate (N, mg/l)	6/5	<0.02	0.43	<0.21	<0.02	0.27	<0.08	10	<2.1/<0.8
Total Phenols (mg/l)	6/5	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<100/<100
Calcium (mg/l)	6/5	61	119	93	85	111	102	No Standard	- -
Lead (mg/l)	6/5	<0.005	0.011	<0.007	<0.005	<0.005	<0.005	0.05	<14/<10
Magnesium (mg/l)	6/5	17	27	20	20	27	24	35	57/69
Potassium (mg/l)	6/5	<0.5	3.6	<2.2	<0.5	3.5	<2.4	No Standard	- -
Sodium (mg/l)	6/5	42	102	71	42	94	58	No Standard	- -
Copper (mg/l)	6/5	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.2	<25/<25
Dissolved Sulfide (mg/l)	6/5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.05 [21]	NA[22]
Flow (Estimated) GPD [23]	6/5	<9695	884218	<319577	64765	467899	150511	Monitor [9]	- -
Radioactivity (pCi/l)									
Alpha	12/12	0.60	1.27	0.94 ± 0.57	0.72	1.17	0.89 ± 0.32	30	3/3
Beta	12/12	2.94	8.34	5.13 ± 3.97	3.25	4.50	3.94 ± 0.90	1000	0.5/0.4
Strontium-90	12/12	0.11	0.38	0.24 ± 0.18	0.26	0.50	0.40 ± 0.16	1000	<0.1/<0.1
Cesium-137	12/12	<0.15	<0.38	<0.31 ± 0.17	<0.28	<0.38	<0.33 ± 0.09	3000	<0.1/<0.1

TABLE 4-6 - Continued

Notes:

(1) The increased number of samples for chemical parameters is due primarily to duplicate analysis as part of KAPL's quality assurance. Upstream samples are taken upgradient from the Knolls Site closed landfill. Downstream samples are taken downgradient from this landfill.

(2) A value preceded by < is less than the minimum detection level.

(3) The Knolls Site also performed sampling and analysis of 51 additional baseline parameters as listed in Reference (5) during August 1999. All results were within existing water quality standards as specified by Reference (1). Table 4-14 lists the parameters included in the baseline scan.

(4) Average values preceded by < contain at least one less than minimum detection level value in the average. The (±) value represents the 95% confidence interval for the average value.

(5) The lowest possible value for any parameter is zero.

(6) New York State Quality Standards for Class A Waters: source of water supply for drinking, culinary or food processing purposes; primary and secondary contact recreation; and fishing. The waters shall be suitable for fish propagation and survival. East Boundary Stream joins Mohawk River, which is a Class A water.

(7) The radioactivity standard is the derived concentration guide (DCG) listed in DOE Order 5400.5, Reference (4). The DCG for unidentified alpha and beta radioactivity is based on the most restrictive radionuclide possibly present in measurable quantities as a result of KAPL operations.

(8) *Percent of standard for the average value.*

(9) Required by Reference(3) NYSDEC SPDES permit.

(10) $NH_3 + NH_4^+$ as N.

(11) Per Reference (1), the thermal discharge limits relating to Site operations are as follows:

(a) The water temperature at the surface shall not be raised to more than 32.2°C (90°F) at any point.

(b) At least 50% of the cross-sectional area and/or volume of flow of the stream including a minimum of one-third of the surface as measured from shore to shore shall not be raised by more than 2.8°C (5°F), over the temperature that existed before the addition of heat of artificial origin or to a maximum of 30°C (86°F), whichever is less.

(c) At least 50 percent of the cross-sectional area and/or volume of flow of the stream including a minimum of one-third of the surface as measured from to shore shall not be lowered more than five Fahrenheit degrees from the temperature that existed immediately prior to such lowering.

(12) None in amounts that will result in growths of algae, weeds and slimes that will impair the waters for their best usage.

(13) Total suspended solids (TSS) and iron exceeded the standard in the East Boundary Stream upstream sample during March 1999. KAPL has observed a correlation between high TSS and high iron in outfall samples. Iron also exceeded the standard at a much lower concentration during May 1999. This is attributable to iron naturally present in groundwater and surface water.

(14) Manganese exceeded the standard in East Boundary Upstream during March, May, and August 1999. This is attributable to manganese naturally present in the groundwater and surface water.

(15) Guidance value.

(16) The dissolved oxygen in the sample taken in August from the East Boundary Stream upstream location was below 4 mg/l. This is due to the stagnant, low water conditions experienced at the time of the sampling.

(17) For non-trout waters, the minimum daily average shall not be less than 5.0 mg/l, and at no time shall the DO concentration be less than 4.0 mg/l.

(18) No increase that will cause a substantial visible contrast to natural conditions.

(19) Total dissolved solids frequently exceeded the standard in both East Boundary Upstream and Downstream samples. The surface water and groundwater of the Knolls Site naturally have a high mineral content.

(20) *Shall be kept as low as practicable to maintain the best usage of waters but in no case shall it exceed 500 mg/l.*

(21) The standard listed is as hydrogen sulfide in the undissociated form.

(22) The minimum detection value for that parameter is higher than the reference standard. That does not mean that the actual level of the contaminant exceeded the standard.

(23) Flow differences are due to the estimating technique. Flow is intermittent and is estimated by measuring stream depth, width, and velocity. Flow is measured only when samples are collected.

The radioactivity released in effluent water during 1999 consisted of: (1) less than 0.001 curie of fission and activation products including those listed in Section 4.2.3 Effluent Analyses, and (2) less than one microcurie each of uranium and plutonium. The radioactivity was contained in approximately 5.84×10^9 liters of water released from the Site and was further diluted by mixing in river water following release. The annual average radioactivity concentration in that effluent, prior to additional dilution in Mohawk River water, corresponded to less than 0.1 percent of the DOE derived concentration guide for effluent released to unrestricted areas (Reference 4) for the mixture of radionuclides present.

Liquid effluent monitoring data are reported as required in Reference (3).

4.3 AIRBORNE EFFLUENT MONITORING

4.3.1 Origins

The principal source of industrial gaseous effluent is the Knolls Site steam-generating boiler system. The Knolls Site boilers burn natural gas with number 2 fuel oil used as a backup. The combustion gas products are released through elevated stacks. Another stationary combustion installation source is two natural gas water heaters that exhaust through a common stack. Other operations at the Site which result in gaseous effluents include a vacuum induction melting/gas atomization (VIM/GA) system, a paint spray booth, carpenter shop, metal cut-off wheels, belt grinders, and welding. Numerous non-radiological analytical chemistry laboratory hoods comprise another source of air emissions.

Laboratory operations involving radioactive materials result in a small amount of airborne radioactivity being released. Operations capable of generating airborne radioactivity are serviced by controlled exhaust systems that discharge through elevated stacks. To minimize radioactivity content, the exhaust air is passed through appropriate air cleaning devices, such as high efficiency particulate air (HEPA) filters and activated carbon adsorbers, prior to release.

4.3.2 Effluent Monitoring

The Knolls Site has six non-radiological air emission permits, as specified in Table 3-1. Five of the permitted units are considered to be stationary combustion units and are permitted to limit nitrogen oxide and sulfur dioxide emission. The New York State emission standards for stationary combustion installations are listed in Reference (6). The sixth unit is permitted to limit the emission of hazardous air pollutants. Under the terms of the permits for these emission sources, emission monitoring is not required. The NYSDEC regulations do not require air emission permits for exempt and trivial activities. These include laboratory hoods used for normal analytical or research and development operations, construction and maintenance activities, and small scale shop operations.

Airborne effluents from the main radiological emission points are continuously sampled for particulate radioactivity with particulate filter samplers and with activated charcoal cartridge samplers where iodine or antimony may be present. Exhaust systems servicing major facilities are also continuously monitored for particulate, iodine, and noble gas radioactivity. The monitors continuously record radioactivity levels in the effluents and are equipped with alarm functions to provide an alert should an abnormal level occur. Other minor radiological emission points are evaluated for the potential for release and monitored on a periodic basis, as necessary, to confirm the low emissions.

4.3.3 Effluent Analyses

Particulate filters and activated charcoal cartridges are changed and analyzed on a routine basis. Particulate filters are analyzed by direct counting for gross alpha and beta radioactivity using a sensitive low-background gas proportional counting system. The system provides minimum detectable concentrations for alpha and beta radioactivity of approximately 1×10^{-15} µCi/ml and 5×10^{-15} µCi/ml, respectively. The activated charcoal cartridges are analyzed for iodine and antimony-125 by gamma spectrometry, which provide a minimum detectable concentration of approximately 2×10^{-14} µCi/ml and

1×10^{-13} µCi/ml, respectively. Noble gas radioactivity released is calculated based on integration of recorded data from a continuous noble gas monitor.

4.3.4 Assessment

Two operations at the Knolls Site are currently "capped", or limited, to the following conditions in accordance with an air emission permit issued by NYSDEC:

Boiler Operations (Air Emission Points EP-00001 through EP-00004)

1. A maximum heat input of 162.4 billion BTU's during any 12-month period,

2. The quantity of fuel used during any 12 month period shall not exceed 154.7 million standard cubic feet (SCF) of natural gas or 1.16 million gallons of Number 2 fuel oil or any combination of the two, and

3. The sulfur content of any fuel oil burned shall not exceed 0.5 percent by weight.

VIM/GA Operations (Air Emission Point EP-00031)

1. The emission source is limited to 365 atomization cycles per year.

2. Total solid particulates with a "B" environmental rating shall not exceed 0.050 grains of particulates per cubic foot of exhaust gas, expressed at standard conditions on a dry gas basis.

3. The emission control equipment shall be kept in a satisfactory state of maintenance and repair and shall not be removed without prior approval from NYSDEC.

Records are required to be maintained for a period of five years to verify compliance with the permit conditions. Fuel analyses for oil used by the Knolls Site boilers confirm that the number 2 fuel oil contained less than 0.5 percent sulfur by weight.

Annual compliance with the capping requirements are calculated each year. The annual capping certification statement is sent to NYSDEC. Although not required by a cap placed on the operation of Air Emission Point EP-00030, ASTGF, the emissions from this facility are included in the capping certification.

The radioactivity released in exhaust air during 1999 consisted of: (1) less than 0.00001 curie of uranium, (2) less than 0.000001 curie of plutonium, (3) less than 0.0001 curie of particulate fission and activation products, and (4) approximately 1.6 curies of krypton-85.

The airborne radioactivity was contained in a total air exhaust volume of 1.34×10^{12} liters. The average radioactivity concentration in the exhaust air was well below the applicable standards listed in Reference (4). The radioactivity concentration for the year at the nearest Site boundary, based on the annual diffusion parameters, averaged less than 0.01 percent of the DOE derived concentration guide for effluent released to unrestricted areas (Reference 4) for the mixture of radionuclides present. Airborne effluent monitoring data are reported as required in Reference (7).

All other point source emissions are operated with the appropriate air emissions control equipment.

4.4 ENVIRONMENTAL MONITORING

4.4.1 Scope

The Knolls Site environmental monitoring program includes: a) the routine collection and analysis of samples of Mohawk River water, sediment, and fish; surface water streams; groundwater; and local municipal waters; b) continuous monitoring of radiation levels off-site and at the perimeter of the Site, and c) the continuous sampling of air at stations located in the predominant upwind and downwind directions from the Knolls Site.

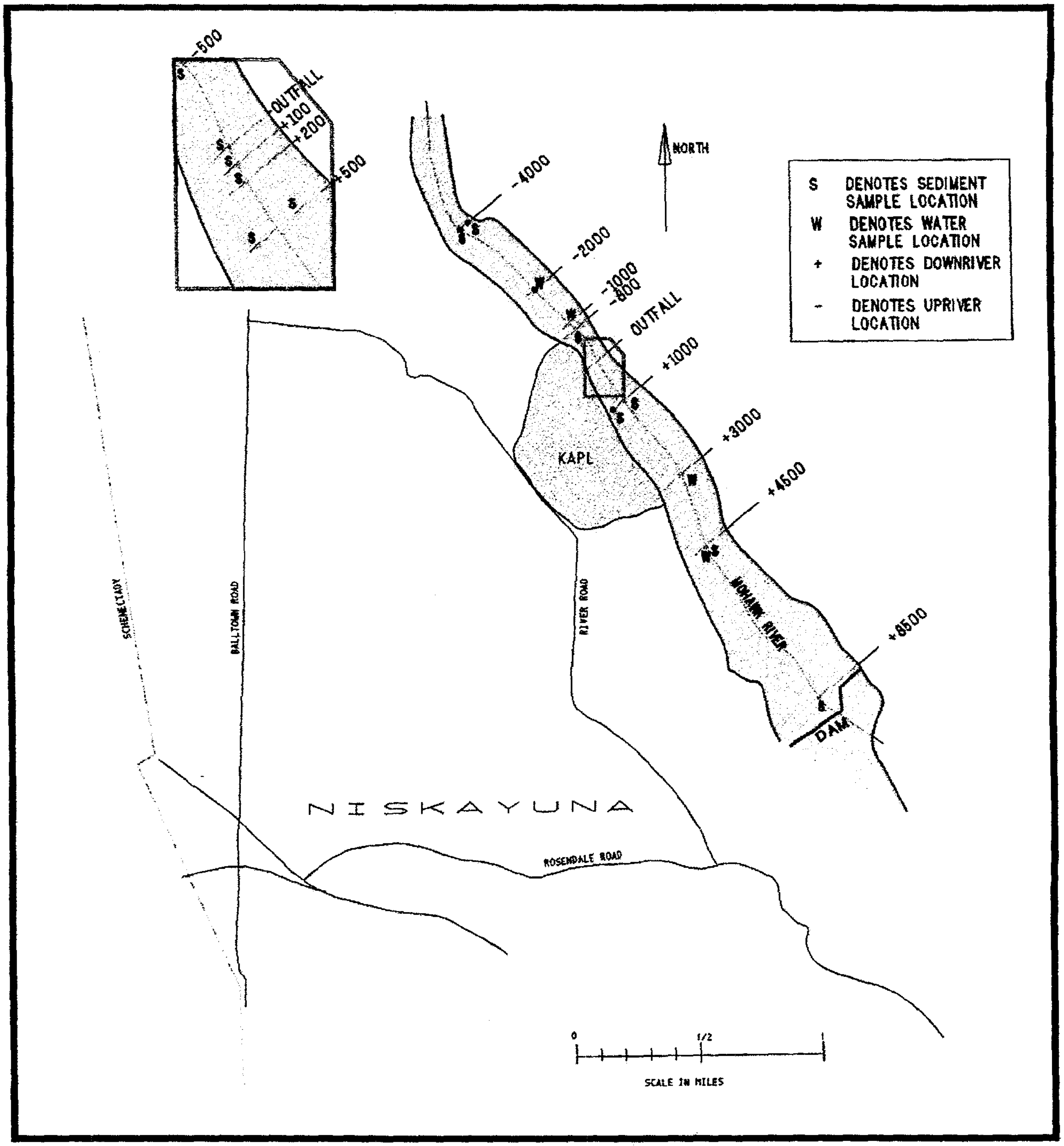


Figure 4-2
Knolls Site, Niskayuna, New York
Mohawk River Sampling Locations

Mohawk River water and bottom sediment samples are collected for radioactivity analyses at locations upriver and downriver from the main Knolls Site outfall as shown in Figure 4-2. Samples are collected during each of three calendar quarters; ice coverage and/or winter weather prevents sampling during the first calendar quarter. A Birge-Ekman dredge, which samples an area of approximately 15 cm × 15 cm to an average depth of 2.5 cm, is used for the collection of sediment samples. In addition, bottom feeding fish and recreational sport fish are collected from the Mohawk River upriver and downriver from the main Knolls Site outfall for gamma spectrometry and radiochemical analyses.

The municipal water systems servicing the area surrounding the Knolls Site are those of Schenectady, Niskayuna and Latham/Colonie, New York. Supply wells for the Schenectady and Niskayuna systems are located upriver and downriver, respectively, from the Knolls Site. Although there is no direct mechanism for Knolls Site effluent to enter the water supplies, samples are collected monthly from the Schenectady and Niskayuna municipal water systems. A monthly sample is also collected from the Latham/Colonie municipal water system that obtains a portion of its water from the Mohawk River approximately five miles downriver from the Knolls Site. Monthly samples are composited quarterly and analyzed for radioactivity.

Surface water is sampled quarterly for water quality and monthly for radioactivity (except Mohawk River samples which are collected quarterly) at the following locations: Mohawk River upriver and downriver from the Knolls Site outfall, the West Boundary and Midline Streams near the point of entry to the Mohawk River, and the East Boundary Stream upstream and downstream of the closed landfill. The West Boundary Stream Ditch sample point is on KAPL property, prior to where the ditch enters the West Boundary Stream. The West Boundary Stream enters the Mohawk River upstream from the Knolls Site. A fourth intermittent surface drainage stream, the West Landfill Stream, is also monitored when possible. Required SPDES parameters in compliance with Reference (3) and additional voluntary monitoring are also performed on a routine basis. Stream sample points are shown on Figure 4-1.

Radiation levels at the boundary of the Knolls Site are monitored with thermoluminescent dosimeters (TLDs) at the 16 locations shown in Figure 4-1. Six lithium fluoride TLD chips, selected for uniform sensitivity, are placed at each monitoring location, and the dosimeters are changed and processed quarterly. Dosimeters are also placed at off-site locations to determine typical background radiation levels.

Environmental air samplers are operated in the predominant upwind and downwind directions from the Site to measure normal background airborne radioactivity, and to confirm that Knolls Site effluents have no measurable effect on normal background airborne radioactivity levels.

The Knolls Site contains a permanently capped landfill that covers an area of approximately 3.7 acres on the east side of the Site. The landfill was officially closed in October 1993. The groundwater and surface water surrounding the closed landfill is routinely monitored and the results are reported quarterly in compliance with Reference (8). Knolls Site groundwater data are discussed separately in section 4.5.

During 1999, non-hazardous solid waste from office and cafeteria trash collection operations and construction and demolition debris generated by Knolls Site personnel were disposed of by a subcontractor at permitted off-site facilities. Where practical the subcontractor is required to recycle such products as glass, tin, newspapers, plastic and cardboard. Office paper and wood are recycled under other contracts.

4.4.2 Analyses

The individual quarterly samples of Mohawk River water and quarterly composite samples of Schenectady, Niskayuna, and Latham/Colonie municipal waters are analyzed for alpha and gross beta radioactivity. The boundary stream samples are analyzed for alpha and gross beta radioactivity, and for other radionuclides as appropriate. The methods used are described in section 4.2.3, Effluent Analyses.

The Mohawk River sediment samples are analyzed for alpha radioactivity by chemical extraction with subsequent direct counting and mass spectrometry, for gross beta radioactivity by direct counting of a dried sample, and for cesium-137 and other gamma emitting radionuclides with a gamma spectrometer system. Selected samples collected at seven locations upriver, opposite, and downriver from the main Knolls Site outfall are also analyzed for strontium-90 by chemical extraction and beta counting. The downriver samples for strontium analyses are selected from locations that previous monitoring had indicated would be locations of highest concentrations. In addition, a more sensitive gamma spectrometry analyses is performed annually on some of the sediment samples. This more sensitive analysis is intended to fully characterize the low levels of naturally and non-naturally occurring gamma emitting radionuclides in the sediment.

Edible portions of the fish collected from the Mohawk River are analyzed for gamma emitting radionuclides with a high purity germanium spectrometer system, for strontium-90 by chemical extraction and beta counting, and for plutonium-239 and plutonium-240 by chemical separation followed by mass spectrometry.

The water samples collected from the Mohawk River and the three main surface water streams are analyzed for the constituents listed in Tables 4-4, 4-5 and 4-6. Additional parameters were monitored in the East Boundary Stream during the third quarter of 1999 in accordance with the Knolls Site Landfill Closure Plan. Samples are also collected from the West Landfill stream when possible. The results of these samples are listed in Table 4-7. The analyses are performed in accordance with 40 CFR Part 136 utilizing the procedures provided in Standard Methods, Reference (9) or other EPA approved methods.

The environmental air sample filters are changed and analyzed on a routine basis by direct counting for gross alpha and gross beta radioactivity using the method described in section 4.3.3.

4.4.3 Assessment

The results of the analyses of Mohawk River water for chemical quality are summarized in Table 4-4. The results show no significant difference between the average values for chemical constituents upriver and downriver from the Knolls Site. Results of routine analyses for chemical constituents, radioactivity and temperature in the West Boundary Stream Ditch and Midline Stream, East Boundary Stream, and West Landfill Stream are summarized in Tables 4-5, 4-6 and 4-7, respectively. Except as discussed below, analyzed parameters were well below comparable standards for Class A waters such as that section of the Mohawk River which borders the Knolls Site. The surface water database shows that there is no water quality degradation attributable to the Knolls Site.

Voluntary surface water monitoring is also performed at various locations on-site to demonstrate the following:

- Current Site operations and permitted water discharges do not affect the Mohawk River,
- Material storage areas and hazardous waste transportation routes do not impact storm water discharges, and
- The presence of a closed landfill does not significantly effect nearby surface water streams.

The data from samples analyzed during 1999 continued to indicate there is no adverse impact from current Site operations on the Mohawk River or the closed landfill on the surrounding surface water streams. Instances where surface water standards or guidance values have been exceeded are discussed below.

<u>Current Site Operations</u>

The New York State surface water quality standard for iron was occasionally exceeded in upstream Mohawk River samples. The Mohawk River upstream sample data show that a number of parameters are elevated above downstream sample results. The elevated upstream results are not related to KAPL operations and represent contributions from off-site water sources. Some of the elevated metal results may be attributed to variations in water quality chemistry caused by naturally

TABLE 4-7 CHEMICAL CONSTITUENTS AND TEMPERATURE IN THE WEST LANDFILL STREAM, 1999

Parameter (Units) [1]	No. of Samples [2]	Value[3]	Standard	Percent of Standard[4]
pH (SU)	1	6.3[5]	6.5-8.5	- -
Cadmium (mg/l)	1	<0.005	0.005	<100
Ammonia (N, mg/l)	1	<0.1	2.0 [6]	<5
Temperature (°C)	1	1.0	See Note [7]	- -
Oil & Grease (mg/l)	1	<1	See Note [8]	- -
Phosphorus (P, mg/l)	1	0.11	See Note [9]	- -
Suspended Solids (mg/l)	1	22	See Note [10]	- -
Iron (mg/l)	1	0.91[11]	0.3	303 [11]
Manganese (mg/l)	1	0.11	0.3	37
Chemical Oxygen Demand (mg/l)	1	11	No Standard	- -
Surfactants (mg/l)	1	<0.02	No Standard	- -
Bromide (mg/l)	1	<1	2.0 [12]	<50
Dissolved Oxygen (mg/l)	1	13.4	See Note [13]	- -
Eh (mv)	1	277	No Standard	- -
Turbidity (ntu)	1	15	See Note [14]	- -
Specific Conductance (umhos/cm)	1	342	No Standard	- -
Total Dissolved Solids (mg/l)	1	150	500 [15]	30
Total Organic Carbon (mg/l)	1	5.2	No Standard	- -
Sulfate (S, mg/l)	1	35	250	14
Alkalinity ($CaCO_3$, mg/l)	1	130	No Standard	- -
Chloride (mg/l)	1	3.4	250	1.4
Total Hardness ($CaCO_3$, mg/l)	1	165	No Standard	- -
Nitrate (N, mg/l)	1	0.12	10	1.2
Total Phenols (mg/l)	1	<0.001	0.001	<100
Calcium (mg/l)	1	46.7	No Standard	- -
Lead (mg/l)	1	<0.005	0.05	<10
Magnesium (mg/l)	1	11.6	35	33
Potassium (mg/l)	1	1.4	No Standard	- -
Copper (mg/l)	1	<0.05	0.2	<25
Sodium (mg/l)	1	3.2	No Standard	- -
Dissolved Sulfide (mg/l)	1	<0.1	0.05 [16]	NA [17]

Radioactivity (pCi/l)		Minimum	Maximum	Average [18]		
Alpha	7	0.11	0.27	0.20 ± 0.20	30	0.7
Beta	7	1.56	3.49	2.50 ± 2.40	1000	0.2

Notes:

(1) The Knolls Site also performed sampling and analysis of 51 additional baseline parameters as listed in Reference (5) during March 1999. All results were within existing water quality standards as specified by Reference (1). Table 4-14 lists the parameters included in the baseline scan.

(2) This stream is intermittent. It is checked at least quarterly for flow.

(3) A value preceded by < is less than the minimum detection level.

(4) Percent of standard for the average value.

(5) The low pH result falls below the standard range. It is most likely due to a slow responding field pH meter used at this location.

(6) $NH_3 + NH_4^+$ as N.

(7) Per Reference (1), the thermal discharge limits relating to site operations are as follows:

(a) The water temperature at the surface shall not be raised to more than 32.2 C (90 F) at any point.

(b) At least 50% of the cross-sectional area and/or volume of flow of the stream including a minimum of one-third of the surface as measured from shore to shore shall not be raised by more than 2.8 C (5 F), over the temperature that existed before the addition of heat of artificial origin or to a maximum of30 C (86 F), whichever is less.

(c) At least 50 *percent of the cross-sectional area and/or volume of flow of the stream including a minimum of one-third of the surface as measured from* shore to shore shall not be lowered more than five Fahrenheit degrees from the temperature that existed immediately prior to such lowering.

(8) No residue attributable to sewage, industrial wastes or other wastes, nor visible oil film nor globules of grease.

(9) None in amounts that will result in growths of algae, weeds and slimes that will impair the waters for their best usages.

(10) None from sewage, industrial wastes or other wastes that will cause deposition or impair the waters for their best usages.

(11) Iron exceeded the standard during March 1999. This is attributable to iron naturally present in the groundwater and surface water.

(12) Guidance value.

(13) For non-trout waters, the minimum daily average shall not be less than 5.0 mg/l, and at no time shall the DO concentration be less than 4.0 mg/l.

(14) No increase that will cause a substantial visible contrast to natural conditions.

(15) Shall be kept as low as practicable to maintain the best usage of waters but in no case shall it exceed 500 mg/l.

(16) *The standard listed is as hydrogen sulfide in the undissociated form.*

(17) The minimum detection value for that parameter is higher than the reference standard. That does not mean that the actual level of the contaminant exceeded the standard.

(18) The (±) value represents the 95% confidence interval for the average value.

occurring metals, either dissolved or suspended in the samples.

The Midline Stream may be influenced by material storage near the Knolls Site warehouse and an on-site gas pad. The West Boundary Stream ditch captures runoff from an on-site road. Therefore, the Knolls Site SPDES Permit requires the storm water for these areas to be monitored. However, additional voluntary monitoring is also performed and is presented in Table 4-5.

The State water quality standards for iron and total dissolved solids were exceeded in West Boundary Stream Ditch and Midline Stream. The high results for iron and total dissolved solids are attributed to a naturally high mineral content in the surface water and possibly winter snow/ice removal operations.

Surface Water Near The Closed Landfill

The former Knolls Site landfill (permanently closed and capped in 1993) is bounded by the East Boundary Stream, the West Landfill Stream (which is highly intermittent), and the Mohawk River to the south. Sample data for the East Boundary Stream and West Landfill Stream are presented in Tables 4-6 and 4-7, respectively. The East Boundary Stream upstream sample data show that a number of parameters are elevated above downstream sample results. The New York State surface water quality standards for iron and manganese were occasionally exceeded in the East Boundary Stream upstream sample location and only the iron standard was exceeded in the West Landfill Stream. Additionally, the State water quality standard for total dissolved solids was exceeded in the East Boundary Stream upstream and downstream locations. The elevated results for iron and manganese are attributed to a naturally high mineral content in the surface water. The seasonally high total dissolved solids may be attributed to on-site and off site snow/ice removal operations. The elevated upstream results are not related to KAPL operations and may represent contributions from offsite sources.

During the first quarter, sufficient water was present in the West Landfill Stream to allow sampling to occur. Most results were lower or comparable to East Boundary Stream upstream and East Boundary Stream downstream results. However, some results from the West Landfill Stream ditch suggest that water quality in this drainage ditch may be influenced by a leachate component from the closed landfill. All baseline parameters were below detectable levels. The surface water from the West Landfill Stream does not directly enter the Mohawk River.

The Mohawk River data, as previously discussed, does not indicate any measurable impact from the former landfill.

Radioactivity

Results of the radioactivity analyses performed on samples of Mohawk River and municipal waters are summarized in Table 4-8. The results for the alpha and gross beta radioactivity concentrations show no significant difference between river water samples upstream and downstream from the Knolls Site or in Schenectady, Niskayuna, and Latham/Colonie municipal waters.

The results of radioactivity measurements for alpha, gross beta, strontium-90, cesium-137, plutonium, and uranium in Mohawk River bottom sediment samples are summarized in Table 4-9. The 1999 data show no significant differences between upstream and downstream radioactivity concentrations for alpha, gross beta, strontium-90, cesium-137, plutonium, and uranium. Slightly higher concentrations of radioactivity have been measured in the past in samples collected from locations within one thousand feet downriver from the main Knolls Site outfall. This localized concentration of radioactivity is attributable to operations conducted prior to 1964, when, subject to applicable Federal regulations and State and local agreements through the Mohawk River Advisory Committee, limited amounts of radioactivity were released to the Mohawk River. These low levels of radioactivity in the river sediment do not present a health risk since the radioactivity is deposited as bottom sediment, which is not subject to becoming airborne and is unlikely to interact with the aquatic environment.

The results of the detailed gamma spectrum analyses performed on Mohawk River bottom sediment samples also indicated low levels of potassium-40 and daughters of uranium and thorium. The potassium-40 and the daughters of uranium and thorium are naturally-occurring radionuclides. No detectable cobalt-60 was found in any sample. However, localized low levels of cobalt-60, which are attributable to operations prior to 1964, have been observed occasionally in past river sediment samples.

The analytical results for the fish collected from the Mohawk River are summarized in Table 4-10 and Table 4-11. The results indicate the presence of naturally occurring potassium-40. The results of sensitive analyses for strontium-90 and plutonium indicate little or no detectable strontium-90 and plutonium-239 and plutonium-240 in both upriver and downriver fish. The measured concentrations of radioactivity indicate no effect from Knolls Site operations. In addition, the results of a previous biological survey (Reference (10)) confirm that the low levels of radioactivity in the Mohawk River bottom sediment near the main Knolls Site outfall are not taken up and propagated through the food chain.

TABLE 4-8 RESULTS OF MONITORING MOHAWK RIVER WATER AND MUNICIPAL WATER, 1999

		Radioactivity Concentrations (pCi/liter)[1,2,3]					
Location and Source	**Number of**	**Gross Beta Values**			**Alpha Values**		
of Water Sample	**Samples**	**Minimum**	**Maximum**	**Average**	**Minimum**	**Maximum**	**Average**
Mohawk River Water							
Upstream	6	1.32 ± 0.52	3.54 ± 0.72	2.36 ± 0.93	0.11 ± 0.16	0.33 ± 0.23	0.20 ± 0.10
Downstream	6	1.08 ± 0.50	3.76 ± 0.73	2.19 ± 1.02	<0.09	0.42 ± 0.25	<0.26 ± 0.15
Schenectady							
Municipal Water	12	1.64 ± 1.10	2.94 ± 1.24	2.24 ± 0.85	<0.09	0.31 ± 0.22	<0.24 ± 0.16
Niskayuna							
Municipal Water	12	1.54 ± 1.16	2.58 ± 1.21	2.19 ± 0.74	0.24 ± 0.20	0.49 ± 0.27	0.35 ± 0.18
Latham/Colonie							
Municipal Water	12	1.97 ± 1.12	2.88 ± 1.25	2.41 ± 0.65	0.08 ± 0.13	0.12 ± 0.16	<0.10 ± 0.03

Notes:
(1) The (±) value for average values provides the 95% confidence interval for the average value. The lowest possible value for any parameter is zero.
(2) A value preceded by < is less than the minimum detection level for that sample and parameter.
(3) Average values preceded by < contain at least one less than minimum detection level value in the average.

TABLE 4-9 RESULTS OF ANALYSES OF MOHAWK RIVER SEDIMENT, 1999

Number of Samples and Type of Results	Radioactivity Concentration (pCi/gm, dry weight)[1] Area Sampled Relative to Effluent Point		
	Upstream	Opposite	Downstream
Alpha Concentration			
Number of Samples	12	3	24
Average Concentration	0.47 ± 0.07	0.39 ± 0.39	0.41 ± 0.04
Minimum Concentration	0.29 ± 0.05	0.28 ± 0.05	0.27 ± 0.05
Maximum Concentration	0.62 ± 0.07	0.57 ± 0.07	0.66 ± 0.07
Gross Beta Concentration			
Number of Samples	12	3	24
Average Concentration	29.6 ± 2.8	21.6 ± 7.5	26.7 ± 1.5
Minimum Concentration	23.9 ± 5.0	19.0 ± 4.5	18.0 ± 4.3
Maximum Concentration	37.6 ± 6.1	24.9 ± 5.0	32.6 ± 5.7
Sr-90 Concentration			
Number of Samples	12	3	6
Average Concentration	<0.01 ± 0.01	<0.01 ± 0.01	<0.03 ± 0.02
Minimum Concentration	<0.01	<0.01	<0.01
Maximum Concentration	0.02 ± 0.02	<0.01	0.05 ± 0.02
Cs-137 Concentration			
Number of Samples	12	3	24
Average Concentration	<0.12 ± 0.04	0.05 ± 0.04	<0.10 ± 0.02
Minimum Concentration	<0.03	0.04 ± 0.01	<0.03
Maximum Concentration	0.22 ± 0.04	0.07 ± 0.01	0.17 ± 0.03
Plutonium Concentration[2]			
Number of Samples	6	3	6
Average Concentration	0.004 ± 0.002	0.0007 ± 0.0007	0.006 ± 0.001
Minimum Concentration	0.001 ± 0.001	0.0004 ± 0.0001	0.004 ± 0.001
Maximum Concentration	0.005 ± 0.001	0.0010 ± 0.0002	0.007 ± 0.001
Uranium Concentration			
Number of Samples	6	3	6
Average Concentration	0.72 ± 0.14	0.39 ± 0.03	0.79 ± 0.03
Minimum Concentration	0.54 ± 0.01	0.37 ± 0.01	0.75 ± 0.01
Maximum Concentration	0.89 ± 0.01	0.40 ± 0.01	0.82 ± 0.01

Notes:

(1) The sediment is sampled to a depth of approximately 2.5 cm. The (±) values for minimum and maximum concentrations represent the statistical error at two standard deviations. The (±) values for average concentrations provide the 95% confidence interval for the average value. A value preceded by < is less than the minimum detectable activity. Average values preceded by < contain at least one less than minimum detectable activity value in the average.

(2) Plutonium concentration values are the sum of results for Pu-239 and Pu-240.

The results for the Knolls Site perimeter and off-site radiation monitoring locations are summarized in Table 4-12. The average of the total annual exposures for the perimeter measurements is within the distribution of the off-site measurements, and is not significantly different. This shows that Knolls Site operations in 1999 had no significant effect on natural background radiation levels at the Site perimeter.

The analytical results for the environmental air samples indicate that there were no significant differences between the average upwind and downwind radioactivity concentrations. The average upwind gross alpha and gross beta radioactivity concentrations were 1.3×10^{-15} µCi/ml and 1.6×10^{-14} µCi/ml, respectively. The average downwind gross alpha and gross beta radioactivity concentrations were 1.4×10^{-15} µCi/ml and 1.6×10^{-14} µCi/ml, respectively. Gamma spectrometry analyses performed on groups of environmental samples indicated only background quantities of naturally occurring radionuclides.

4.4.4 Special Mohawk River Survey

KAPL conducted an extensive sediment and biological sampling program of the Mohawk River during the summer of 1992. This sampling program was performed to update information on the quantity and distribution of radioactivity in the river sediment attributable to KAPL operations prior to 1964 and to demonstrate that the residual radioactivity has no effect on man or the environment. Samples included 185 sediment core samples and numerous samples of fish, macrophyton, periphyton, plankton, benthic macroinvertebrates, and water.

The results of this sampling program, as discussed in Reference (11), show that the distribution of residual radioactivity in the Mohawk River sediment in the vicinity of the Knolls Site is well understood. The majority of radioactivity present is confined to an area, along the south side of the Mohawk River, which extends from the KAPL Building J-6 outfall (Outfall 002) to 500 feet downriver. The radioactivity generally is located at least 8 inches below the top of the sediment surface. Elevated radioactivity concentrations were also detected further downriver; however, the concentrations are lower, and the radioactivity is located even deeper in the sediment. Comparison of the sediment sampling results to those obtained from a similar survey done in 1981 generally show that the residual radioactivity is located deeper in the sediment, due to deposition of new sediment in the outfall area. The total radioactivity of KAPL origin present in the sediment above the Lock 7 dam is estimated to be less than 0.65 curies, of which greater than 90% is attributable to cesium-137 and strontium-90 (and its short-lived decay product yttrium-90). Cesium-137 and strontium-90 have half-lives of about 30 years and 29 years, respectively. The remainder of the radioactivity content is comprised of plutonium, uranium, americium-241, and cobalt-60. The total radioactivity present in the sediment of KAPL origin is less than 10% of the naturally occurring radioactivity found in the sediment in the same region.

The results of the fish and other biological sampling conducted show no detectable radioactivity of KAPL origin in any biological sample. These results continue to demonstrate that the residual radioactivity in the sediment is not being taken up in the food chain.

A radiological assessment of the residual radioactivity in the sediment concludes that, even using very conservative assumptions and hypothetical scenarios, no measurable dose to a member of the public would result, even if all the radioactivity in the sediment were released back into the river water. The major conclusion of the radiological assessment is that the radioactivity of KAPL origin in the Mohawk River sediment does not pose a health risk to any member of the public.

TABLE 4-10 GAMMA SPECTROMETRY RESULTS FOR MOHAWK RIVER FISH, 1999

Sample Location[2]	Fish (#)	No. of Samples	Radioactivity Concentrations (pCi/gm, wet weight)[1] K-40 Maximum	K-40 Average[3]	Cs-137 Maximum	Cs-137 Average
Upriver	White Sucker (3) Redhorse Sucker (1) Carp (1)	2	2.69 ± 0.24	2.68 ± 0.13	<0.007	<0.007
Upriver	Smallmouth Bass (4) Largemouth Bass (2) Walleye (3)	4	3.23 ± 0.27	2.89 ± 0.40	<0.009	<0.007
Downriver	White Sucker (3) Carp (1)	2	2.54 ± 0.25	2.08 ± 5.91	<0.007	<0.006
Downriver	Smallmouth Bass (11) Yellow Perch (8) Pumpkinseed (3) Redhorse Sucker (2)	4	3.08 ± 0.27	2.67 ± 0.70	<0.008	<0.007

Notes:

(1) A value preceded by < is less than the minimum detection level for that sample and parameter. Average values preceded by < contain at least one less than minimum detection level value in the average. The (±) value provides the statistical uncertainty at the 95% confidence interval.

(2) Upriver samples were obtained in July 1999 above Lock 8 and below Lock 9. (Lock 8 and Lock 9 are located approximately 9 miles and 14 miles, upriver respectively, from the Knolls Site outfall.) Downriver samples were also obtained in July 1999; these fish were collected along the KAPL shoreline between the KAPL Outfall 002 and Lock 7.

(3) The lowest possible value for any parameter is zero.

TABLE 4-11 RADIOCHEMICAL ANALYSIS RESULTS FOR MOHAWK RIVER FISH, 1999

Sample Location[2]	Fish Type	Radioactivity Concentration[1] (pCi/gm, wet weight) Sr-90	Pu-239/240
Upriver	Carp	<0.003	<0.0001
Upriver	Smallmouth Bass	0.005 ± 0.004	<0.0003
Upriver	Largemouth Bass	<0.003	<0.0019
Downriver	Carp	0.007 ± 0.004	<0.0001
Downriver	Smallmouth Bass	0.006 ± 0.004	<0.0001
Downriver	Largemouth Bass	0.006 ± 0.004	<0.0001

Notes:
(1) A value preceded by < is less than the minimum detection level for that sample and parameter. The (±) value provides the statistical uncertainty at the 95% confidence interval.
(2) Upriver samples were obtained in July 1999 above Lock 8 and below Lock 9. (Lock 8 and Lock 9 are located approximately 9 miles and 14 miles, upriver respectively, from the Knolls Site outfall.) Downriver samples were also obtained in July 1999; these fish were collected along the KAPL shoreline from KAPL Outfall 002 downriver to Lock 7.

TABLE 4-12 PERIMETER AND OFF-SITE RADIATION MONITORING RESULTS, KNOLLS SITE, 1999

Monitoring Location[1]	Total Annual Exposure[2] (millirem)
1	82 ± 4
2	84 ± 7
3	81 ± 4
4	87 ± 5
5	82 ± 5
6	78 ± 3
7	78 ± 5
8	73 ± 5
9	79 ± 6
10	77 ± 2
11	81 ± 6
12	83 ± 3
13	73 ± 5
14	79 ± 6
15	86 ± 5
16	81 ± 5
Off-Site Locations	74 ± 19[3]

Notes:
(1) See Figure 4-1 for perimeter monitoring locations.
(2) The (±) values for individual locations provide the 95% confidence interval for the exposure due to random uncertainty.
(3) Approximately 95% of the natural background measurements are expected to be within this range.

4.5 GROUNDWATER MONITORING

4.5.1 Scope

The Knolls Site groundwater monitoring network consists of 58 wells as follows:

(1) Three Niskayuna test holes (NTH-A), located around the Knolls Site Landfill to assess any potential impact of the landfill on groundwater quality,

(2) Thirteen groundwater assessment wells (W and MW) installed to assess any effect of previous waste handling and disposal practices on groundwater quality,

(3) Sixteen hillside wells (B), which are used to establish hydraulic gradients for the determination of the direction of groundwater flow around a former radioactive material processing facility and determine water quality parameters,

(4) A dug well (Shugg),

(5) Twenty wells (KH) installed to evaluate site-wide hydrogeological conditions,

(6) Three original (1978) landfill monitoring wells (NTH) which are now inactive, and

(7) Two wells, SW-10 and DW-09, installed in the vicinity of the former D3/D4 yard to assess the effectiveness of a soil remediation project.

Groundwater from 36 of the 58 wells is sampled and analyzed for either chemical quality or radioactivity. The five wells (NTH-1A, NTH-2A, NTH-5A, W-11 and W-12) associated with the landfill groundwater monitoring portion of the program and the remediation assessment wells (SW-10, DW-09, B-5, B-6, and B-7) fulfill regulatory agency requirements. The remainder of the program is voluntary. Figure 4-1 is a map showing the location of the Knolls Site monitoring wells.

4.5.2 Origin

Generally, groundwater underlying the Knolls Site is contained in highly impermeable and non-porous soil and bedrock. As a consequence there is only slight movement of the water, generally believed to be toward the northeast, to the Mohawk River. Because of the impermeable and non-porous nature of the soil and bedrock, there is no commercial or public development of the groundwater in the vicinity of the Site. Groundwater contaminants can be introduced through two possible routes. The first route, surface recharging, carries atmospheric contaminants such as acid rain and airborne radioactivity from natural and manmade sources (such as past nuclear weapons testing), and surface contaminants from operational and historical land use; such as de-icing compounds, fertilizers, and pesticides. The second route is leaching of shallow non-radioactive buried wastes in the Knolls Site sanitary landfill and other burial areas in the vicinity of the landfill where small amounts of waste chemicals from laboratory operations were buried many years ago, consistent with common industrial practices at the time. Also, in parts of the Knolls Site, soil contains low levels of radioactivity from operations over 30 years ago that are detectable above background levels. There are no radioactive waste burial grounds at the Knolls Site, and therefore there is no groundwater contamination from such a source.

4.5.3 Analyses

During 1999, KAPL conducted quarterly radiological and chemical monitoring of the five landfill wells, plus annual monitoring for selected other on-site wells, including the remediation assessment wells, to ensure that KAPL operations do not have any adverse effect on the groundwater quality in the area.

As part of the Knolls Site Landfill post-closure monitoring program approved by NYSDEC, KAPL monitors five overburden wells; one upgradient (NTH-1A) and four downgradient wells (NTH-2A, NTH-5A, W-11, and W-12). The wells are sampled annually for the baseline scan parameters and quarterly for the routine scan parameters per Reference (8). These parameters are listed in Table 4-14. Also required by NYSDEC under the 1997 remediation agreement, five additional monitoring wells (SW-10, DW-09, B-5, B-6, and B-7) are monitored to assess the effectiveness of a soil remediation program in the former D3/D4 yard area. The program entailed removal of soils containing VOCs in order to construct a building on the site. The program was driven by the need to construct a building on the site and not by any environmental need.

In 1999, the voluntary groundwater monitoring program was revised to reduce the number of analytical parameters and the number of groundwater wells sampled. This revision is based on the long duration of the program and the consistency of the analytical results. The revised program focuses on those wells and the attendant chemical profile that best assesses the effect of Site operations, both current and historical, on groundwater quality. The wells selected for monitoring in the annual monitoring program are listed in Table 4-13. The parameters included in the voluntary annual monitoring program are listed in Table 4-14. The selection is based on the well location and consideration of subsurface hydrogeologic conditions. For data discussion purposes, the wells are grouped into the following categories as listed in Table 4-13: Landfill, Land Area, Hillside (includes remediation assessment wells), Lower Level, and Background.

In 1999, the majority of the Land Area Wells were monitored for Field Parameters, metals and VOCs. The Hillside Wells and a majority of the Lower Level Wells were monitored for Field Parameters and VOCs.

All field parameters except for turbidity are measured in the field. Chemical parameters are analyzed by a vendor laboratory using procedures provided in Standard Methods, Reference (9), or other EPA approved methods. The vendor analytical laboratory is required to be State certified in potable water analyses and wastewater chemical analyses. Samples are analyzed for radiological parameters using the methods described in section 4.2.3, Effluent Analyses.

4.5.4 Assessment

Results of the groundwater monitoring for radioactivity are summarized in Table 4-15. Some wells had slightly higher gross beta and/or alpha radioactivity than the background wells. This is attributed to slightly higher levels of dissolved naturally occurring uranium, thorium, and their respective daughter products. Naturally occurring potassium-40 would also contribute to the gross beta radioactivity. Strontium-90 was detected above background levels in several wells. Strontium-90 and its daughter product, yttrium-90, also contribute to the gross beta radioactivity. Tritium above background levels was also detected in well KH-17.

All gross beta, alpha, strontium-90, and tritium results were within the approximate range of previously reported values. The maximum concentration of strontium-90, which has the most restrictive derived concentration guide of any radionuclide, measured in any well was less than two percent of the DOE derived concentration guide (Reference 4). The tritium result from the sample of well KH-17, 1550 pCi/l, is less than 0.1 percent of the DOE derived concentration guide. Well points were installed in the vicinity of KH-17 in 1998 and sampled to investigate the elevated tritium when it was first detected. Additional well points were installed downgradient from KH-17 in 1999 and sampled. Tritium was only detected in well points placed close to KH-17 indicating the extent is very localized. Because there are no current operations using water containing tritium at the concentration found in KH-17, the source of the tritium is suspected to be from a historical spill in the area. The tritium in well KH-17 shows a decreasing trend from samples obtained during 1998. Additional tritium sampling in the KH-17 area is planned to be conducted during 2000.

TABLE 4-13 KNOLLS SITE GROUNDWATER SAMPLING PLAN, 1999

LANDFILL MONITORING PROGRAM

WELL CATEGORY	WELL ID	RADIOACTIVITY	ROUTINE SCAN	BASELINE SCAN
LANDFILL	NTH-1A	Q	Q	A
	NTH-2A	Q	Q	A
	NTH-5A	Q	Q	A
	W-11	Q	Q	A
	W-12	Q	Q	A

ANNUAL MONITORING PROGRAM

WELL CATEGORY	WELL ID	RADIOACTIVITY	ANNUAL MONITORING LISTS		
			FIELD	METALS	VOCs
LAND AREA	W-1	Q	A	A	A
	W-2	A	A	A	A
	W-3	A	A	A	A
	W-4	A	A	A	A
	W-8	A	A	A	A
	W-10	A	A	A	A
	MW-2	A	A	A	A
	MW-3	A	A	A	A
	KH-1S	A	A	A	A
	KH-2	A			
	KH-3S	A			
HILLSIDE	B-5	A	A		A
	B-6	A	A		A
	B-7	A	A		A
	SW-10	A	A		A
	DW-09	A	A		A
	B-15	A	A		A
	B-16	A	A		A
	B-26	A	A		A
	KH-6	A	A		A
	KH-9S	A	A		A
	KH-15	A	A		A
	KH-16	A	A		A
	KH-17	A	A		A
	KH-18	A	A		A
LOWER LEVEL	KH-19	A	A		A
	KH-20	A			
	KH-21	A	A		A
	KH-22	A	A		A
	KH-23	A	A		A
BACKGROUND	SHUGG	A			

Notes:

A = Annually
Q = Quarterly

TABLE 4-14 GROUNDWATER MONITORING PARAMETERS

Parameters Tested			
ROUTINE SCAN	**BASELINE SCAN**		**ANNUAL MONITORING LISTS**
Static Water Level[1] Specific Conductance[1] Temperature[1] pH[1] Eh[1] Ammonia Nitrate COD TOC TDS Sulfate Alkalinity Phenols Chloride Hardness Turbidity Potassium Sodium Iron Manganese Magnesium Lead Cadmium Calcium	Static Water Level[1] Specific Conductance[1] Temperature[1] pH[1] Eh[1] Total Kjeldahl Nitrogen (TKN) Ammonia Nitrate Chemical Oxygen Demand (COD) Biochemical Oxygen Demand (BOD) Total Organic Carbon (TOC) Total Dissolved Solids (TDS) Sulfate Alkalinity Phenols Chloride Hardness Turbidity[2] Color Boron Potassium Sodium Iron Manganese Magnesium Calcium Aluminum Cyanide Toxic Metals: Antimony Arsenic Beryllium Barium Cadmium Chromium (total and hexavalent) Copper Lead Mercury Nickel Selenium Silver Thallium Zinc	Volatile Organics (VOCs) EPA 601: Chloromethane Bromomethane Dichlorodifluoromethane Vinyl Chloride Chloroethane Methylene Chloride Trichlorofluoromethane 1,1-Dichloroethane 1,1-Dichloroethene t-1,2-Dichloroethene Chloroform 1,2-Dichloroethane 1,1,1-Trichloroethane Carbon Tetrachloride Bromodichloromethane 1,2-Dichloropropane t-1,3-Dichloropropene Trichloroethylene Dibromochloromethane 1,1,2-Trichloroethane cis-1,3-Dichloropropene 2-Chloroethylvinylether Bromoform 1,1,2,2-Tetrachloroethane Tetrachloroethylene EPA 602: Benzene Toluene Ethylbenzene Chlorobenzene p-Dichlorobenzene m-Dichlorobenzene o-Dichlorobenzene Xylenes	Field Parameters List: Static Water Level[1] Specific Conductance[1] Temperature[1] pH[1] Turbidity[2] Metals List: Potassium Sodium Iron Manganese Magnesium Calcium Aluminum Antimony Arsenic Beryllium Barium Boron Cadmium Chromium (total and hexavalent) Copper Lead Mercury Nickel Selenium Silver Thallium Zinc VOCs List: EPA 601 Acetone[3] Hexane[3]

Notes:
(1) Measured in the field.
(2) Measured in the laboratory.
(3) Additional parameters required to be sampled at B-5, B-6, B-7, DW-09, and SW-10 per the remediation agreement.

TABLE 4-15 RESULTS OF KNOLLS SITE GROUNDWATER MONITORING FOR RADIOACTIVITY, 1999

Locations		Gross Beta	Alpha	Sr-90	Cs-137	H-3
		Radioactivity Concentrations[1,2] pCi/liter				(x 10^2 pCi/l)
Landfill Area						
March	NTH-1A	<0.8	0.3 ± 0.2	<0.2	<0.8	<1.4
	NTH-2A	4.4 ± 1.7	2.6 ± 0.6	0.4 ± 0.3	<0.8	<1.4
	NTH-5A	<0.7	<0.1	0.2 ± 0.2	<0.8	<1.4
	W-11	8.0 ± 2.1	0.4 ± 0.3	<0.2	<0.8	<1.4
	W-12	2.4 ± 1.2	0.6 ± 0.3	0.4 ± 0.3	<0.8	<1.4
May	NTH-1A	1.0 ± 1.0	0.6 ± 0.3	<0.2	<0.8	<1.4
	NTH-2A	7.1 ± 1.9	3.0 ± 0.6	0.6 ± 0.3	<0.8	<1.4
	NTH-5A	1.2 ± 1.1	0.5 ± 0.3	<0.2	<0.8	<1.4
	W-11	5.1 ± 1.6	0.2 ± 0.2	<0.2	<0.8	<1.4
	W-12	4.0 ± 1.4	1.5 ± 0.5	0.4 ± 0.3	<0.9	<1.4
August	NTH-1A	3.1 ± 1.2	0.7 ± 0.3	<0.2	<0.8	<1.4
	NTH-2A	6.1 ± 1.8	2.4 ± 0.6	1.0 ± 0.4	<1.0	<1.4
	NTH-5A	2.4 ± 1.3	0.8 ± 0.3	<0.2	<0.8	<1.4
	W-11	3.5 ± 1.4	0.3 ± 0.2	0.3 ± 0.3	<0.8	<1.4
	W-12	8.2 ± 2.9	5.0 ± 4.3	(3)	<0.7	<1.4
November	NTH-1A	1.5 ± 1.1	0.9 ± 0.4	<0.2	<0.8	<1.1
	NTH-2A	2.5 ± 1.3	1.0 ± 0.4	0.2 ± 0.2	<0.8	<1.1
	NTH-5A	<0.8	0.5 ± 0.3	<0.2	<0.8	<1.1
	W-11	5.6 ± 1.6	0.3 ± 0.2	<0.2	<0.8	<1.1
	W-12	3.6 ± 1.4	0.4 ± 0.3	0.7 ± 0.3	<0.8	<1.1
Land Area						
August	W-2	4.8 ± 1.5	0.7 ± 0.3	<0.2	<0.8	<1.4
	W-3	3.8 ± 1.4	0.2 ± 0.2	<0.2	<1.0	<1.4
	W-4	3.3 ± 1.3	0.3 ± 0.2	<0.2	<0.8	<1.4
	W-8	3.9 ± 1.3	<0.1	<0.2	<1.0	<1.4
	W-10	4.5 ± 1.5	1.2 ± 0.4	<0.2	<1.0	<1.4
	MW-2	<0.8	0.6 ± 0.3	<0.2	<1.0	<1.4
	MW-3	1.4 ± 1.1	1.0 ± 0.4	<0.2	<1.0	<1.4
Hillside Area						
August	B-5	2.4 ± 2.9	1.2 ± 0.4	<0.2	<0.7	<1.4
	B-6	7.6 ± 2.8	4.1 ± 0.7	0.3 ± 0.2	<1.0	<1.4
	B-7	5.5 ± 2.2	1.4 ± 0.4	0.2 ± 0.2	<0.8	<1.4
	B-15	16.6 ± 4.8	2.1 ± 0.5	2.5 ± 0.6	<1.0	<1.4
	B-16	2.9 ± 1.5	2.0 ± 0.5	<0.2	<1.0	<1.4
	B-26	2.6 ± 1.5	1.7 ± 0.5	<0.2	<0.8	<1.4
	KH-6	2.7 ± 1.5	1.4 ± 0.4	<0.2	<1.0	<1.4
	KH-9S	9.8 ± 3.4	1.5 ± 0.4	<0.2	<0.8	<1.4
	KH-15	4.0 ± 1.5	2.0 ± 0.5	<0.2	<0.8	<1.4
	KH-16	4.8 ± 1.7	3.6 ± 0.7	<0.2	<1.0	<1.4
	KH-17	<1.3	1.9 ± 0.5	<0.2	<0.8	15.5±2.0[4]
	KH-18	6.5 ± 3.1	1.8 ± 0.5	0.4 ± 0.3	<1.0	<1.4
	SW-10	6.3 ± 3.6	3.3 ± 0.7	0.5 ± 0.3	<1.0	<1.4
	DW-09	9.3 ± 2.1	10.4 ± 1.2	0.4 ± 0.3	<0.8	<1.4
Lower Level						
August	KH-19	3.0 ± 1.5	1.2 ± 0.4	<0.2	<0.8	<1.4
	KH-20	6.2 ± 3.7	0.1 ± 0.2	<0.2	<0.8	<1.4
	KH-21	42.3 ± 5.5	4.4 ± 0.8	17.5 ± 1.0	<1.0	<1.4
	KH-22	4.8 ± 1.7	1.5 ± 0.5	1.0 ± 0.3	<0.8	<1.4
	KH-23	5.9 ± 1.7	0.3 ± 0.2	<0.2	<1.0	<1.4
Background Wells - for comparison						
March	W-1	1.9 ± 1.3	0.4 ± 0.2	0.2 ± 0.2	<0.8	<1.4
May	W-1	2.0 ± 1.2	0.5 ± 0.3	<0.2	<0.8	<1.4
August	W-1	1.1 ± 1.0	0.6 ± 0.3	<0.2	<1.0	<1.4
	KH-1S	1.8 ± 1.1	0.9 ± 0.4	<0.2	<0.8	<1.4
	KH-2	57.3 ± 5.6	2.3 ± 0.5	0.2 ± 0.2	<0.8	<1.4
	KH-3S	3.4 ± 1.3	0.4 ± 0.2	0.2 ± 0.2	<0.6	<1.4
	Shugg	2.3 ± 1.3	0.6 ± 0.3	0.2 ± 0.2	<0.8	<1.4
November	W-1	2.9 ± 1.3	0.2 ± 0.2	<0.2	<0.8	<1.1

Notes:

(1) A value preceded by < is less than the minimum detection level for that sample and parameter. The (±) value represents the statistical error at two standard deviations.

(2) The lowest possible value for any parameter is zero.

(3) There was insufficient water volume from the well for this analysis.

(4) See the discussion in section 4.5.4 regarding this tritium result.

Tables 4-16, 4-17, and 4-18, summarize the 1999 groundwater monitoring results. Generally, the majority of analytical results are indicative of natural groundwater quality. Most variations in the data are attributable to natural water quality, variability in laboratory results at or near the minimum detection limit or interference associated with groundwater turbidity. The turbidity is the result of natural particulate materials entering the well from the surrounding clay and silt-rich geologic materials. Turbid water samples can show elevated metal results that are not indicative of dissolved, mobile metals. Also, monitoring wells in proximity to roadways and parking lots commonly show elevated salt parameters (e.g., total dissolved solids, sodium, chlorides, and specific conductivity) related to winter road maintenance operations. Further, some monitoring wells located in the vicinity of former material/waste staging areas contain elevated levels of dissolved manganese.

The standards and guidance values used to compare groundwater monitoring results are those in 6 NYCRR Part 703.5, quality standards for class GA groundwater, Water Quality Standards in 6 NYCRR Part 703.3 and the standards and guidance values in the Technical and Operational Guidance Series (1.1.1) Water Quality Standards and Guidance Values.

Table 4-18 summarizes the results of the VOC analyses. Only the constituents that were reported by the vendor analytical laboratory as present at or above the minimum detectable level in any one well are listed. Table 4-14 contains the complete listing of parameters included in VOC analysis.

Landfill

Knolls Site Landfill well results (Table 4-16) for some parameters (such as specific conductivity, ammonia, nitrate, COD,TOC, TDS, alkalinity, chloride, hardness, BOD, phenols, iron, manganese, sodium, calcium, potassium, magnesium, boron, sulfate, and barium) were elevated in most downgradient wells compared to the upgradient well, NTH-1A. The TDS, pH, turbidity, iron, manganese, sodium, magnesium and phenols results of several wells exceeded NYSDEC groundwater quality standards and guidance values. The turbidity and in part the iron results in NTH-1A samples indicate that such exceedances are attributable to natural groundwater quality. Filtered iron and manganese results show that elevated iron and manganese results are caused in part by sample turbidity. Well W-12 was dry during the third quarter sampling event. Therefore, there is no baseline data for this well in 1999.

Overall, results for the landfill wells are within representative ranges for inorganic constituents typical of leachate from sanitary landfills per Reference (12).

Historically, phenols have been infrequently and sporadically detected. The 1999 results show phenols were detected in NTH-2A and NTH-5A just above the detection level during the first quarter. These results are consistent with the infrequent detection of phenols, which is most likely due to natural degradation of organic material within the landfill, or to analytical variability at reported levels at or near the minimum detection limit.

The VOC, dichlorodifluoromethane, was not detected in downgradient well NTH-5A in the past three years (1997 through 1999). Historically, this VOC has been detected in downgradient well NTH-5A at concentrations below the corresponding groundwater standard.

Land Area

Other than the natural water quality variations and the turbidity/elevated metal relationship and road salting effects, the Land Area well data (Tables 4-17 and 4-18) show some effect associated with the former land disposal areas and a former staging area on groundwater water quality. Most wells show elevated metals in unfiltered samples. The unfiltered metals in the upgradient well, KH-1S, were high in comparison to previous years; however, the turbidity in this well was also high. The filtered results were within the expected ranges. Also, the iron and manganese filtered results in MW-2 deviate from that of previous years; exceeding water quality standards. Other MW-2 data show no similar deviation.

TABLE 4-16 RESULTS OF KNOLLS SITE GROUNDWATER MONITORING BASELINE/ROUTINE SCAN OF LANDFILL WELLS, 1999

		Parameter[1,2]										
		Field					Indicator, mg/l					
Well	Sample Date	Elev. (Feet)	Temp. (C)	pH (su)	Specific Conductivity (umhos/cm)	Eh (mv)	Ammonia	Nitrate	COD	TOC	TDS	Sulfate
NTH-1A[3]	03/15/99	315.17	7.9	7.0	490	352	<0.1	<0.02	<5	1.7	260	86
	05/06/99	316.88	9.1	7.0	440	394	<0.1	<0.02	<5	2.0	150	34
	08/04/99	311.79	11.7	7.2	591	249	<0.1	<0.02	<5	1.9	340	91
	11/03/99	311.51	11.2	6.9	568	274	<0.1	<0.02	<5	2.2	322	89
NTH-2A	03/15/99	233.54	5.4	6.6	1209	390	<0.1	0.04	11	4.5	670	77
	05/06/99	233.00	9.2	6.8	1400	399	<0.1	0.13	61	6.0	773	62
QA Duplicate	05/06/99	NA	9.4	6.8	1384	399	<0.1	0.12	26	3.8	795	62
	08/04/99	232.47	13.2	6.7	1363	274	0.1	0.02	<5	5.6	765	59
	11/03/99	234.13	13.1	6.7	1034	332	<0.1	0.05	15	4.7	630	124
QA Duplicate	11/03/99	NA	13.1	6.7	1018	333	<0.1	0.05	15	4.5	632	122
NTH-5A	03/15/99	269.99	2.3	6.4	147	405	<0.1	<0.02	<5	1.7	85	24
QA Duplicate	03/15/99	NA	2.3	6.4	144	392	<0.1	<0.02	<5	1.4	88	24
	05/06/99	267.33	9.5	7.0	493	377	<0.1	0.02	11	3.9	253	60
	08/04/99	263.22	13.3	7.0	995	319	<0.1	<0.02	<5	5.4	1122	71
QA Duplicate	08/04/99	NA	13.3	6.9	994	309	<0.1	<0.02	<5	5.4	578	70
	11/03/99	267.98	11.2	6.5	384	312	<0.1	<0.02	<5	2.1	195	41
W-11	03/15/99	258.73	2.4	6.8	1058	217	0.4	<0.02	<5	<1	530	41
	05/06/99	258.46	9.1	7.1	1078	286	<0.1	0.03	15	5.4	533	230
	08/04/99	257.67	18.2	6.9	1033	204	0.5	<0.02	<5	<1	578	44
	11/03/99	258.57	10.7	6.9	1025	209	0.3	<0.02	<5	<1	558	42
W-12	03/15/99	241.14	3.2	7.2	611	329	<0.1	<0.02	11	4.3	353	150
	05/06/99	240.55	8.7	7.1	862	306	0.3	0.03	<5	2.8	575	42
	08/04/99	Dry										
	11/03/99	241.58	11.3	6.8	795	332	<0.1	<0.02	32	5.2	510	190
FIELD BLANK (NTH-5A)	03/15/99	NA	6.9	7.6	3	380	<0.1	<0.02	<5	<1	<5	<2
FIELD BLANK (NTH-2A)	05/06/99	NA	21.1	6.0	4	390	<0.1	0.03	<5	<1	13	<2
FIELD BLANK (NTH-5A)	08/04/99	NA	27.7	7.7	6	291	<0.1	<0.02	<5	<1	<5	<2
FIELD BLANK (NTH-2A)	11/03/99	NA	16.5	7.5	3	298	<0.1	0.02	<5	<1	<5	<2
STANDARDS [6]		[7]	[7]	6.5-8.5[8]	[7]	[7]	2	10	[7]	[7]	500 [8]	250

Notes:
(1) A value preceded by < is less than the minimum detection level.
(2) See Table 4-18 for additional parameters.
(3) Upgradient well
(4) Nephelometric turbidity unit
(5) Unfiltered/filtered results
(6) Water Quality Standards, 6NYCRR 703.5
(7) No groundwater standard or guidance value available
(8) Water Quality Standards, 6NYCRR 703.3
(9) Per 6NYCRR703.5, the combined iron & manganese concentration shall not exceed 0.5 mg/l.
(10) Technical and Operational Guidance Series (TOGS) 1.1.1, Guidance Value
(11) Cobalt platinum unit
NA – Not applicable

TABLE 4-16 RESULTS OF KNOLLS SITE GROUNDWATER MONITORING BASELINE/ROUTINE SCAN OF LANDFILL WELLS, 1999 (Continued)

		Parameter[1,2]								
		Indicator, mg/l or as indicated					Metals[5], mg/l			
Well	Sample Date	Alkalinity	Chloride	Hardness	Phenols	Turbidity (NTU)[4]	Iron	Manganese	Lead	Sodium
NTH-1A[3]	03/15/99	165	3.8	266	<0.001	60	0.96	0.45	<0.005	12.2
	05/06/99	185	2.7	95	<0.001	1.6	0.09	<0.02	<0.005	3.4
	08/04/99	230	10	310	<0.001	29	2.07 / <0.05	0.57 / 0.20	<0.005 / <0.005	9.4 / 9.0
	11/03/99	220	5.4	321	<0.001	4.1	0.27	0.28	<0.005	19
NTH-2A	03/15/99	475	72	654	0.002	111	2.66	1.38	<0.005	27.4
	05/06/99	540	118	561	<0.001	57	0.09	0.22	<0.005	20.5
QA Duplicate	05/06/99	535	118	518	<0.001	46	0.06	0.10	<0.005	35.5
	08/04/99	555	99	759	<0.001	22	1.20 / 0.08	2.18 / 1.61	<0.005 / <0.005	48.0 / 48.9
	11/03/99	455	35	596	<0.001	2.5	1.04	0.32	<0.005	25
QA Duplicate	11/03/99	420	34	570	<0.001	3.0	0.99	0.32	<0.005	26
NTH-5A	03/15/99	45	2.4	73	<0.001	110	0.79	0.06	<0.005	2.9
QA Duplicate	03/15/99	46	2.3	68	0.002	105	0.61	0.05	<0.005	2.7
	05/06/99	164	5.4	218	<0.001	5.4	0.22	0.04	<0.005	7.2
	08/04/99	505	5.3	1490	<0.001	20	0.09 / 0.07	0.38 / 0.30	<0.005 / <0.005	21.4 / 22.3
QA Duplicate	08/04/99	510	4.2	690	<0.001	14	0.25 / 0.07	0.32 / 0.31	<0.005 / <0.005	21.9 / 22.6
	11/03/99	105	2.8	233	<0.001	16	0.45	0.03	<0.005	5.6
W-11	03/15/99	432	57	584	<0.001	130	3.66	0.43	0.005	27.7
	05/06/99	235	8.0	424	<0.001	6.4	0.15	<0.02	<0.005	12.9
	08/04/99	440	72	469	<0.001	75	0.93 / 0.39	0.16 / 0.13	<0.005 / <0.005	35.4 / 37.0
	11/03/99	445	59	489	<0.001	58	1.02	0.20	<0.005	36
W-12	03/15/99	200	4.7	277	<0.001	220	0.42	0.03	<0.005	9.0
	05/06/99	440	61	436	<0.001	14	0.42	0.14	<0.005	27.6
	08/04/99	Dry								
	11/03/99	270	6.0	314	<0.001	2.6	0.12	0.06	<0.005	12
FIELD BLANK (NTH-5A)	03/15/99	2.0	<1	<5	<0.001	<0.2	<0.05	<0.02	<0.005	<0.5
FIELD BLANK (NTH-2A)	05/06/99	2.0	<1	<5	<0.001	<0.2	<0.05	<0.02	<0.005	<0.5
FIELD BLANK (NTH-5A)	08/04/99	1.0	<1	<5	<0.001	<0.2	<0.05 /<0.05	<0.02 / <0.02	<0.005 / <0.005	<0.5 / <0.5
FIELD BLANK (NTH-2A)	11/03/99	2.0	<1	<5	<0.001	0.2	<0.05	<0.02	<0.005	<0.5
STANDARDS [6]		[7]	250	[7]	0.001	5	0.3[9]	0.3[9]	0.025	20

See Notes on previous page.

TABLE 4-16 RESULTS OF KNOLLS SITE GROUNDWATER MONITORING BASELINE/ROUTINE SCAN OF LANDFILL WELLS, 1999 (Continued)

		Parameter[1,2]			
		Metals[5], mg/l			
Well	Sample Date	Calcium	Potassium	Magnesium	Cadmium
NTH-1A[3]	03/15/99	74.7	<0.5	19.3	<0.005
	05/06/99	27.1	<0.5	6.8	<0.005
	08/04/99	93.1 / 90.2	1.2 / 0.7	18.9 / 18.3	<0.005 / <0.005
	11/03/99	100	0.9	17	<0.005
NTH-2A	03/15/99	185	1.3	46.7	<0.005
	05/06/99	173	1.7	31.5	<0.005
QA Duplicate	05/06/99	159	2.5	29.4	<0.005
	08/04/99	209 / 197	4.9 / 4.8	57.7 / 32.2	<0.005 / <0.005
	11/03/99	199	3.2	24	<0.005
QA Duplicate	11/03/99	190	3.5	23	<0.005
NTH-5A	03/15/99	20.8	<0.5	5.2	<0.005
QA Duplicate	03/15/99	19.1	<0.5	4.8	<0.005
	05/06/99	64.0	0.5	14.1	<0.005
	08/04/99	145 / 154	1.6 / 1.6	43.9 / 30.1	<0.005 / <0.005
QA Duplicate	08/04/99	185 / 157	1.6 / 1.6	55.5 / 30.7	<0.005 / <0.005
	11/03/99	49	0.6	11	<0.005
W-11	03/15/99	148	2.5	52.1	<0.005
	05/06/99	132	3.4	22.8	<0.005
	08/04/99	137 / 140	4.9 / 5.1	30.8 / 31.5	<0.005 / <0.005
	11/03/99	151	5.1	27	<0.005
W-12	03/15/99	77.2	2.3	20.3	<0.005
	05/06/99	126	3.6	29.4	<0.005
	08/04/99	Dry			
	11/03/99	94	1.6	19	<0.005
FIELD BLANK (NTH-5A)	03/15/99	<0.5	<0.5	<0.5	<0.005
FIELD BLANK (NTH-2A)	05/06/99	<0.5	<0.5	<0.5	<0.005
FIELD BLANK (NTH-5A)	08/04/99	<0.5 / <0.5	<0.5 / <0.5	<0.5 / <0.5	<0.005 / <0.005
FIELD BLANK (NTH-2A)	11/03/99	1.1	<0.5	<0.5	<0.005
STANDARDS [6]		[7]	[7]	35[10]	0.005

See Notes on previous page.

TABLE 4-16 RESULTS OF KNOLLS SITE GROUNDWATER MONITORING BASELINE/ROUTINE SCAN OF LANDFILL WELLS, 1999 (continued)

		Parameter [1,2]								
	Sample	Metals[5], mg/l								
Well	Date	Aluminum	Antimony	Arsenic	Beryllium	Barium	Boron	Copper	Chromium	Chromium, VI
NTH-1A[3]	08/04/99	1.5 / <0.1	<0.06/<0.06	<0.005/<0.005	<0.005/<0.005	0.05 / 0.03	<0.05 / <0.05	<0.05 / <0.05	<0.005 / <0.005	<0.02
NTH-2A	08/04/99	0.2 / <0.1	<0.06/<0.06	<0.005/<0.005	<0.005/<0.005	0.21 / 0.19	0.22 / 0.21	<0.05 / <0.05	<0.005 / <0.005	<0.02
NTH-5A	08/04/99	0.2 / <0.1	<0.06/<0.06	<0.005/<0.005	<0.005/<0.005	0.08 / 0.08	<0.05 / <0.05	<0.05 / <0.05	<0.005 / <0.005	<0.02
QA DUPE	08/04/99	<0.1 / <0.1	<0.06/<0.06	<0.005/<0.005	<0.005/<0.005	0.08 / 0.08	<0.05 / <0.05	<0.05 / <0.05	<0.005 / <0.005	<0.02
BLANK	08/04/99	<0.1 / <0.1	<0.06/<0.06	<0.005/<0.005	<0.005/<0.005	<0.01 / <0.01	<0.05 / <0.05	<0.05 / <0.05	<0.005 / <0.005	<0.02
W-11	08/04/99	0.3 / <0.1	<0.06/<0.06	<0.005/<0.005	<0.005/<0.005	0.31 / 0.32	0.14 / 0.15	<0.05 / <0.05	<0.005 / <0.005	<0.02
W-12	08/04/99	Dry								
STANDARDS [6]		[7]	0.003	0.025	0.003[10]	1	1	0.2	0.050	0.050

		Parameter[1,2]									
		Metals[5], mg/l						mg/l	Indicator, mg/l or as indicated		
Well	Sample Date	Mercury	Nickel	Selenium	Silver	Thallium	Zinc	Cyanide	TKN	BOD	Color (cpu)[11]
NTH-1A[3]	08/04/99	<0.0004 /<0.0004	<0.05 /<0.05	<0.005 /<0.005	<0.02/<0.02	0.01/<0.01	0.01/<0.01	<0.01	<1	<2	5
NTH-2A	08/04/99	<0.0004 /<0.0004	<0.05 /<0.05	<0.005 /<0.005	<0.02/<0.02	0.01/<0.01	0.01/<0.01	<0.01	<1	28	5
NTH-5A	08/04/99	<0.0004 /<0.0004	<0.05 /<0.05	<0.005 /<0.005	<0.02/<0.02	0.01/<0.01	0.01/<0.01	<0.01	<1	<2	5
QA DUPE	08/04/99	<0.0004 /<0.0004	<0.05 /<0.05	<0.005 /<0.005	<0.02/<0.02	0.01/<0.01	0.01/<0.01	<0.01	<1	<2	5
BLANK	08/04/99	<0.0004 /<0.0004	<0.05 /<0.05	<0.005 /<0.005	<0.02/<0.02	0.01/<0.01	0.01/<0.01	<0.01	<1	<2	<5
W-11	08/04/99	<0.0004 /<0.0004	<0.05 /<0.05	<0.005 /<0.005	<0.02/<0.02	0.01/<0.01	0.01/<0.01	<0.01	2.0	<2	5
W-12	08/04/99	Dry									
STANDARDS [6]		0.0007	0.10	0.010	0.050	0.0005[10]	2.0[10]	0.2	[7]	[7]	[7]

See notes on previous page.

TABLE 4-17 RESULTS OF KNOLLS SITE GROUNDWATER MONITORING, LAND AREA WELLS, 1999

		Parameter[1]									
		Field				Indicator	Metals[2], mg/l				
Well	Sample Date	Elevation (ft)	Temperature (C)	pH (su)	Specific Conductivity (umhos/cm)	Turbidity (ntu)[3]	Iron	Manganese	Lead	Sodium
KH-1S[4]	08/10/99	328.82	15.4	7.6	522	>1000	300 / 0.12	14.6 / 0.22	<0.005 / <0.005	16.8 / 8.4
MW-2	08/09/99	306.47	10.6	7.1	668	42	3.33 / 0.78	0.63 / 0.60	<0.005 / <0.005	17.6 / 17.2
MW-3	08/09/99	305.73	11.6	7.0	680	13	0.43 / 0.25	0.23 / 0.22	<0.005 / <0.005	16.2 / 16.5
W-1	08/10/99	305.39	11.5	7.8	674	160	12.1 / <0.05	0.17 / 0.05	<0.005 / <0.005	82.6 / 79.8
W-10	08/09/99	283.65	9.9	7.3	944	18	1.01 / <0.05	0.31 / 0.28	<0.005 / <0.005	61.4 / 72.0
W-2	08/10/99	304.91	11.8	7.8	786	150	3.39 / <0.05	0.28 / 0.23	<0.005 / <0.005	94.6 / 92.8
W-3	08/09/99	297.20	12.0	7.2	894	810	17 / <0.05	0.99 / 0.51	<0.005 / <0.005	96.2 / 91.0
W-3, Duplicate	08/09/99	NA	12.0	7.3	895	840	14 / <0.05	0.91 / 0.50	<0.005 / <0.005	93.2 / 92.0
W-4	08/09/99	282.69	13.5	7.1	876	850	30 / <0.05	0.60 / 0.13	0.013 / <0.005	17.0 / 16.1
W-8	08/09/99	301.27	10.6	8.0	446	53	2.06 / <0.05	0.07 / 0.04	<0.005 / <0.005	50.3 / 54.1
FIELD BLANKS	08/09/99	NA	21.4	8.4	3	2	<0.5 / <0.5	<0.5 / <0.5	<0.005 / <0.005	<0.5 / <0.5
	08/10/99	NA	19.9	8.3	4	0.3	<0.5 / <0.5	<0.5 / <0.5	<0.005 / <0.005	<0.5 / <0.5
STANDARDS [5]		[6]	[6]	6.5-8.5[7]	[6]	5	0.3[9]	0.3[9]	0.025	20

Notes:
(1) A value preceded by a < is less than the minimum detection level.
(2) Unfiltered/filtered results
(3) Nephelometric turbidity unit
(4) Upgradient well
(5) Water Quality Standards, 6 NYCRR 703.5
(6) No groundwater standard or guidance value available
(7) Water Quality Standards, 6NYCRR 703.3
(8) Technical and Operational Guidance Series (TOGS) 1.1.1, Guidance Values
(9) Per NYCRR 703.5, the combined concentration of iron and manganese shall not exceed 0.5 mg/l
NA – Not applicable

TABLE 4-17 RESULTS OF KNOLLS SITE GROUNDWATER MONITORING, LAND AREA WELLS, 1999 (Continued)

Well	Sample Date	Parameter[1] Metals[2], mg/l Calcium	Potassium	Magnesium	Cadmium	Aluminum	Antimony	Arsenic	Beryllium	Barium	Boron
KH-1S[4]	08/10/99	408 / 72	45.6 / 2.3	41.0 / 18.1	<0.005 /<0.005	220 / 0.2	<0.06 /<0.06	<0.005 /<0.005	<0.005 /<0.005	2.00 /0.06	<0.5 /<0.5
MW-2	08/09/99	120 / 117	1.1 / 1.0	18.8 / 17.9	<0.005 /<0.005	0.9 / 0.2	<0.06 /<0.06	<0.005 /<0.005	<0.005 /<0.005	0.04 /0.03	<0.5 /<0.5
MW-3	08/09/99	112 / 112	0.6 / 0.6	19.0 / 19.2	<0.005 /<0.005	0.3 / 0.2	<0.06 /<0.06	<0.005 /<0.005	<0.005 /<0.005	0.02 /0.02	<0.5 /<0.5
W-1	08/10/99	56 / 56	7.9 / 3.3	16.2 / 12.9	<0.005 /<0.005	9.9 / 0.2	<0.06 /<0.06	<0.005 /<0.005	<0.005 /<0.005	0.20 /0.13	0.11 /0.09
W-10	08/09/99	99 / 98	5.4 / 5.1	22.4 / 22.1	<0.005 /<0.005	0.8 / 0.2	<0.06 /<0.06	<0.005 /<0.005	<0.005 /<0.005	0.09 /0.05	0.09 /0.08
W-2	08/10/99	59 /58	8.4 / 6.9	18.8 / 18.2	<0.005 /<0.005	2.9 / 0.2	<0.06 /<0.06	<0.005 /<0.005	<0.005 /<0.005	0.06 /0.04	0.34 /0.33
W-3	08/09/99	92 / 87	12 / 7.5	19.9 / 17.9	<0.005 /<0.005	9.6 / 0.2	<0.06 /<0.06	<0.005 /<0.005	<0.005 /<0.005	0.12 /0.05	0.28 /0.26
W-3, Duplicate	08/09/99	88 / 88	10.6 / 7.4	19.9 / 19.6	<0.005 /<0.005	8.3 / 0.2	<0.06 /<0.06	<0.005 /<0.005	<0.005 /<0.005	0.10 /0.05	0.26 /0.24
W-4	08/09/99	135 / 120	7.2 / 2.0	28.0 / 27.0	<0.005 /<0.005	16 / 0.2	<0.06 /<0.06	<0.005 /<0.005	<0.005 /<0.005	0.17 /0.04	<0.5 /<0.5
W-8	08/09/99	34 / 34	3.5 / 2.9	9.4 / 9.0	<0.005 /<0.005	1.6 / 0.1	<0.06 /<0.06	<0.005 /<0.005	<0.005 /<0.005	0.09 /0.08	0.28 /0.25
FIELD BLANKS	08/09/99	0.19 / 0.07	<0.5 / <0.5	<0.5 / <0.5	<0.005 /<0.005	0.1 / 0.1	<0.06 /<0.06	<0.005 /<0.005	<0.005 /<0.005	0.01 /<0.01	<0.5 /<0.5
	08/10/99	<0.5 / <0.5	<0.5 / <0.5	<0.5 / <0.5	<0.005 /<0.005	0.1 / 0.1	<0.06 /<0.06	<0.005 /<0.005	<0.005 /<0.005	0.01 /<0.01	<0.5 /<0.5
STANDARDS [5]		[6]	[6]	35	0.005	[6]	0.003	0.025	0.003[8]	1	1

Well	Sample Date	Parameter[1] Metals[2], mg/l Copper	Chromium	Chromium, VI	Mercury	Nickel	Selenium	Silver	Thallium	Zinc
KH-1S[4]	08/10/99	0.76/<0.05	0.362/<0.005	<0.02	0.0005/<0.0004	0.57/<0.05	<0.005/<0.005	<0.02/<0.02	<0.01/<0.01	1.29/<0.01
MW-2	08/09/99	<0.05/<0.05	<0.005/<0.005	<0.02	<0.0004/<0.0004	<0.05/<0.05	<0.005/<0.005	<0.02/<0.02	<0.01/<0.01	<0.01/<0.01
MW-3	08/09/99	<0.05/<0.05	<0.005/<0.005	<0.02	<0.0004/<0.0004	<0.05/<0.05	<0.005/<0.005	<0.02/<0.02	<0.01/<0.01	<0.01/<0.01
W-1	08/10/99	<0.05/<0.05	0.013/<0.005	<0.02	<0.0004/<0.0004	<0.05/<0.05	<0.005/<0.005	<0.02/<0.02	<0.01/<0.01	0.02/<0.01
W-10	08/09/99	<0.05/<0.05	<0.005/<0.005	<0.02	<0.0004/<0.0004	<0.05/<0.05	<0.005/<0.005	<0.02/<0.02	<0.01/<0.01	<0.01/<0.01
W-2	08/10/99	<0.05/<0.05	<0.005/<0.005	<0.02	<0.0004/<0.0004	<0.05/<0.05	<0.005/<0.005	<0.02/<0.02	<0.01/<0.01	<0.01/<0.01
W-3	08/09/99	<0.05/<0.05	0.018/<0.005	<0.02	<0.0004/<0.0004	<0.05/<0.05	<0.005/<0.005	<0.02/<0.02	<0.01/<0.01	0.03/<0.01
W-3, Duplicate	08/09/99	<0.05/<0.05	0.017/<0.005	<0.02	<0.0004/<0.0004	<0.05/<0.05	<0.005/<0.005	<0.02/<0.02	<0.01/<0.01	0.02/<0.01
W-4	08/09/99	<0.05/<0.05	0.026/<0.005	<0.02	<0.0004/<0.0004	<0.05/<0.05	<0.005/<0.005	<0.02/<0.02	<0.01/<0.01	0.05/<0.01
W-8	08/09/99	<0.05/<0.05	<0.005/<0.005	<0.02	<0.0004/<0.0004	<0.05/<0.05	<0.005/<0.005	<0.02/<0.02	<0.01/<0.01	<0.01/<0.01
FIELD BLANKS	08/09/99	<0.05/<0.05	<0.005/<0.005	<0.02	<0.0004/<0.0004	<0.05/<0.05	<0.005/<0.005	<0.02/<0.02	<0.01/<0.01	<0.01/<0.01
	08/10/99	<0.05/<0.05	<0.005/<0.005	<0.02	<0.0004/<0.0004	<0.05/<0.05	<0.005/<0.005	<0.02/<0.02	<0.01/<0.01	<0.01/<0.01
STANDARDS [5]		0.20	0.050	0.05	0.0007	0.10	0.010	0.05	0.0005[8]	2.0[8]

See notes on previous page.

TABLE 4-18 RESULTS OF KNOLLS SITE GROUNDWATER MONITORING, LANDFILL, LAND AREA, HILLSIDE, AND LOWER LEVEL WELLS, VOLATILE ORGANIC ANALYSIS, 1999

		Parameter[1]				
	Sample	Volatile Organic Compound[2], ug/l				
Well	Date	Tetrachloroethylene	Trichloroethylene	Vinyl chloride	Total 1,2-Dichloroethene	1,1-Dichloroethene
W-3	08/09/99	<1	<1	<1	11	<1
W-3, Duplicate	08/09/99	<1	<1	<1	10	<1
B-15	08/11/99	<1	57	<1	7	<1
B-5	08/12/99	<1	1400	3	81	9
B-5, Duplicate	08/12/99	<1	1500	3	85	9
DW-09	08/12/99	50	4	<1	12	<1
STANDARDS[3]		5	5	2	5	5
DETECTION LEVEL		1	1	1	1	1

Notes: (1) Results for field blanks were all less than the detection level for the parameter listed.

(2) See Table 4-14 for a complete listing of VOC parameters analyzed. The results for those parameters not listed in this table were less than the method detection limit.

(3) Division of Water, Technical Operation Guidance Series (TOGS) (1.1.1) Ambient Water Quality Standards and Guidance Values (Rev. 6/98)

Monitoring will continue to further assess this apparent change. Total1,2-dichloroethene, was detected above the water quality standard in down-gradient well W-3. This well is in the vicinity of an area where small amounts of laboratory chemicals were buried years ago. VOC migration is believed to be limited since results from a monitoring well (i.e., W-4) downgradient of W-3 are less than the minimum detection limit. Results of the toxic metals analysis from all wells are below the corresponding groundwater standard and are attributable to natural water quality.

Hillside

The Hillside well (B) monitoring, which consists of field parameters and VOC analysis, show the effects of former staging practices on overburden water quality. The field parameter data is consistent with the effects of natural groundwater compositional variations. VOC results (Table 4-18) for all monitoring wells are consistent with previous years, with VOCs only being detected in B-5, B-15, and DW-09 (its second year of monitoring). The origin of these VOCs is attributed to historical solvent storage and dispensing operations and not to waste burial. No VOCs were detected in monitoring wells downgradient of these wells. A 1994 investigation revealed that the VOCs are mostly restricted to porous backfill associated with building foundations and utility lines, not migration through indigenous soils. Remediation of these soils was performed in 1996 and early 1997 to support construction of a new building and associated utilities. This general area is subject to further investigation under the Site's hazardous waste management facility permit's corrective action provisions.

Lower Level

The Lower Level wells monitor bedrock water quality. No volatile organic compounds were detected; therefore, results are not listed in Table 4-18. The field data show the effects of natural groundwater compositional variations. The data are generally consistent with that previously reported.

Conclusion

The overall conclusion of the groundwater monitoring program is that previous operations and waste disposal practices have resulted in some small, although measurable, effects on the groundwater quality in localized areas of the Knolls Site. Based on upstream and downstream monitoring of the Mohawk River, there is no detectable effect on river water quality as a result of past or current Knolls Site operations. The groundwater is limited in quantity and is not used as a drinking water supply. In addition, the Knolls Site is not located over any principal or primary bedrock or overburden aquifers. Therefore, the groundwater associated with the Knolls Site does not pose a significant threat to public health.

4.6 CONTROL OF CHEMICALLY HAZARDOUS SUBSTANCES

4.6.1 Origins

Chemicals are not manufactured at the Knolls Site. Minimal quantities of hazardous wastes do result from the necessary use of chemicals in Site operations. To ensure the safe use of chemicals and disposal of the resulting wastes, Knolls Site maintains a hazardous waste control program. Hazardous wastes are not disposed of through any KAPL sewer systems or disposed of on-site.

4.6.2 Control Program

The control program minimizes the quantity of waste material generated, ensures safe use and storage of the materials on Site and provides for proper disposal of the wastes by vendors that operate under permits issued by Federal and State agencies.

A principal part of the waste minimization program is the control of acquisition of hazardous substances for use at the Knolls Site. Purchase orders for chemicals are reviewed to ensure that the materials are actually necessary for Site operations, that the amount ordered is not excessive, and that methods for proper disposal are in place before the material is ordered. Hazardous substance storage controls include as a minimum; labeling, revetment as appropriate, segregation based on compatibility, limited storage volumes and weather protection as appropriate. When required, large volumes of chemicals and petroleum products are stored in accordance with the New York State Chemical Bulk Storage regulations as specified in Reference (13) and the Petroleum Bulk Storage regulations in Reference (14). The Knolls Site currently does not store any chemicals in quantities that are subject to chemical bulk storage regulations. Additionally, in the past few years, many hazardous substances have been replaced by non-hazardous substitutes. KAPL also formally evaluates the hazardous waste that is generated and provides NYSDEC with an annual Hazardous Waste Reduction Plan. Progress in reducing waste at the Knolls Site is tracked in this plan. Significant reductions in hazardous waste streams have been accomplished since the early 1990's. The replacement of the Knolls Site Boiler House make-up water treatment system and the addition of a de-alkalizer have resulted in over a 90% reduction of the hazardous waste generated at the Knolls Site since 1994. Reductions of more than 99% have also been achieved in photographic hazardous waste streams by the installation of three silver recovery units, and the replacement of one photographic waste stream with a dry type laser system.

All personnel are provided with general information on Knolls Site policies for the procurement, use and disposal of hazardous substances. For individuals who use hazardous substances in operations, specific training is provided to ensure that they are knowledgeable of safe handling techniques and emergency response procedures. After chemicals are used and no longer needed, they are accumulated in designated staging and storage areas where they are segregated and packaged for shipment. Waste is temporarily stored only as necessary to accumulate sufficient volume for shipment to a waste disposal vendor. Hazardous and mixed (radioactive/hazardous) waste storage facilities are operated at the Knolls Site under a permit obtained from NYSDEC. The Knolls Site has an inspection program to routinely verify that hazardous substances are properly stored and controlled in accordance with approved procedures. In addition, the Knolls Site hazardous waste control program is subject to annual on-site inspections by NYSDEC.

4.6.3 Disposal

Disposal of hazardous waste is in compliance with the Resource Conservation and Recovery Act (RCRA). The waste generated is transported by vendors to treatment/storage/disposal facilities for final disposition. The transportation vendors and the treatment/storage/disposal facilities operate under permits issued by the cognizant Federal and State regulatory agencies. KAPL requires the disposal facility to provide itemized written verification that the waste was actually received. During 1999, the Knolls Site shipped approximately 20.6 tons of RCRA and New York State hazardous waste for off-site disposal. Approximately 7.6 tons of this waste consisted of waste from one-time planned activities. The remaining 13.0 tons of chemical hazardous waste sent for disposal was generated as a result of routine operations and processes. This quantity includes 0.2 tons of photograph solutions sent for precious metal recovery and 0.1 tons of universal waste nickel cadmium and mercury batteries that were exempt from inclusion in the Knolls Site New York State Hazardous Waste Report. The Knolls Site reduces the potential environmental impact of the waste by selecting the ultimate disposal methods that minimize or eliminate future environmental intrusion.

Elementary neutralization of a small volume of laboratory waste that is solely hazardous for pH also occurs on site. This process is exempt from regulation as a RCRA treatment process. The neutralized solution is discharged to the Town of Niskayuna sewer system in accordance with the Outside Users Agreement.

4.7 TRANSPORTATION OF RADIOACTIVE MATERIALS

Operation of the Knolls Site results in the generation of various types of radioactive materials that require detailed procedures for handling, packaging, transportation, and, if necessary, disposal at a government operated disposal site.

Radioactive materials that do not require disposal are handled and transferred in accordance with detailed material control and accountability procedures. Internal reviews are made prior to the shipment of any radioactive material from the Knolls Site, to ensure that the material is properly identified, surveyed, and packaged in accordance with Federal requirements.

Low level radioactive solid waste materials that require disposal include filters, metal scrap, rags, resin, paper, and plastic materials. The volume of this waste is minimized through the use of special work procedures that limit the amount of materials that become contaminated during work on radioactive systems and components. In addition, loose waste is mechanically compacted to minimize the volume being disposed. Radioactive liquids are solidified in cement prior to shipment. All radioactive wastes are packaged in accordance with written procedures to meet the applicable DOT regulations given in Reference (15). The waste packages also comply with all applicable requirements of the NRC, the DOE, and the disposal sites.

The shipments of low level radioactive solid wastes were made by authorized common carriers to government owned disposal sites located outside New York State. During 1999, approximately 177 cubic meters (232 cubic yards) of low level radioactive waste containing approximately 8.8 curies were shipped from the Site for disposal. A mixed waste shipment of approximately 0.45 cubic meters containing approximately 0.0013 curies was sent to Idaho National Engineering and Environmental Laboratory for treatment. Another mixed waste shipment of 0.32 cubic meters containing 0.000018 curies was sent to Waste Control Specialists in Andrews, Texas for treatment. Mixed waste is waste that contains both radioactive constituents regulated by the Department of Energy and hazardous constituents regulated by the New York State Department of Environmental Conservation. In addition, approximately 26 tons of slightly radioactive metal were sent to an out-of-state radioactive material *recycling facility as recyclable material.*

4.8 RADIATION DOSE ASSESSMENT

The effluent and environmental monitoring results show that radioactivity present in liquid and gaseous effluents from 1999 operations at the Knolls Site had no measurable effect on normal background radioactivity levels. Therefore, any radiation doses from Site operations to off-site individuals were too small to be measured and must be calculated using conservative methods. Estimates of: (1) the radiation dose to the maximally exposed individual in the vicinity of the Knolls Site, (2) the average dose to members of the public residing in the 80 kilometer (50 mile) radius assessment area surrounding the Site, and (3) the collective dose to the population residing in the assessment area are summarized in Section 7.0, Radiation Dose Assessment and Methodology.

The results show that the estimated doses were less than 0.1 percent of that permitted by the radiation protection standards of the DOE listed in Reference (4) and that the estimated dose to the population residing within 80 kilometers (50 miles) of the Knolls Site was less than 0.001 percent of the natural background radiation dose to the population. In addition, the estimated doses were less than one percent of that permitted by the NRC numerical guide listed in Reference (16) for whole-body dose, demonstrating that doses are as low as is reasonably achievable. The dose attributed to radioactive air emissions was less than one percent of the EPA standard in Reference (7).

The collective radiation dose to the public along the travel route from Knolls Site shipments of radioactive materials during 1999 was calculated using data given by the NRC in Reference (17). Based on the type and number of shipments made, the collective annual radiation dose to the public along the transportation routes, including transportation workers, was less than one person-rem. This is less than 0.001 percent of the dose received by the same population from natural background radiation.

5.0 KESSELRING SITE ENVIRONMENTAL MONITORING

5.1 SITE DESCRIPTION

The Kesselring Site consists of 3900 acres on which two operating pressurized-water Naval nuclear propulsion plants and support facilities are located, including administrative offices, machine shops, waste storage facilities, oil storage facilities, training facilities, equipment service buildings, chemistry laboratories, a boiler house, cooling towers, and wastewater treatment facilities. Two other nuclear propulsion plants are permanently shut down, defueled, and are being dismantled. The Site is located near West Milton, New York, approximately 17 miles (27.4 kilometers) north of the City of Schenectady, and 9 miles (14.5 kilometers) southwest of Saratoga Springs (see Figure 2-2). The surrounding area is a rural, sparsely populated region of wooded lands through which flow the Glowegee Creek and several small streams that empty into the Kayaderosseras Creek.

As a result of the end of the Cold War and the downsizing of the Navy, the S3G and D1G Prototype reactor plants were shutdown in May 1991 and March 1996, respectively. All spent nuclear fuel was removed from the S3G Prototype reactor and shipped off-site in July 1994. All spent nuclear fuel was removed from the D1G Prototype reactor and shipped off-site in February 1997. Since there was no further need for these plants, a decision was needed on their disposal. The National Environmental Policy Act (NEPA) requires Federal agencies to analyze the potential environmental impacts of their proposed actions to assist them in making informed decisions. The U.S. Department of Energy Office of Naval Reactors (Naval Reactors) evaluated the alternatives for disposal of the S3G and D1G Prototype reactor plants. These alternatives included: promptly dismantling the plants, deferring dismantlement for 30 years, and the "no-action" alternative which would keep the plants in a protective storage condition on-site indefinitely. A key element of Naval Reactors' decision making has been a thorough understanding of the environmental impacts associated with each alternative. In following the NEPA process, Naval Reactors prepared a Draft Environmental Impact Statement to assess the various alternatives and to provide necessary background, data and analysis to help decision makers and the public understand the potential environmental impacts of each alternative. Following consideration of public comments, Naval Reactors prepared a Final Environmental Impact Statement, Reference (18), which identified prompt dismantlement as the preferred alternative. In a Record of Decision dated January 20, 1998, Naval Reactors decided to promptly dismantle the defueled S3G and D1G reactor plants. Dismantlement operations began, starting on the S3G plant, shortly after this decision was made. The project is planned to be completed as soon as practicable subject to available appropriated funding. Two additional nuclear propulsion plants, S8G and MARF, will continue to be operated at the Site for the foreseeable future.

The climate in the region of the Kesselring Site is primarily continental in character, but is subjected to some modification from the maritime climate, which prevails in the extreme southeastern portion of New York State. Winters are usually cold and occasionally fairly severe. Maximum temperatures during the colder winter months often are below freezing and nighttime low temperatures frequently drop to 10^{0}F or lower. Sub-zero temperatures occur rather infrequently, about a dozen times a year. Snowfall in the area is quite variable, averaging approximately 65 inches per year. Over some of the higher elevation areas near by, snow fall ranges up to 75 inches or more for a season. The mean annual precipitation for the area is approximately 36 inches per year. The prevailing winds are from the west.

The area surrounding the Kesselring Site has a complex geological history due to the processes of erosion, glaciation, folding and faulting. The geological formations of the West Milton area are comprised of two major types; bedrock, which ranges in age from Precambrian to Ordovician, and unconsolidated deposits of Pleistocene and Recent age. Bedrock underlying the area crops out only on some steep hillsides and in some stream valleys. It is covered by the unconsolidated deposits in the remainder of the area. These unconsolidated deposits range in thickness from zero to 200 feet with an average thickness of 50 feet. Bedrock underlying the West Milton area may be divided into two groups; (1) metamorphosed rocks of Precambrian age, and (2) sedimentary rocks of Paleozoic age. The older metamorphosed rocks consist of gneiss, schist, quartzite, and limestone (marble) of sedimentary origin; and syenite and granite of igneous origin. These rocks are referred to as crystalline rocks. The Paleozoic rocks likewise consist of several types of rocks including sandstone, dolomite, limestone and shale. The unconsolidated deposits can be subdivided into four groups: (1) till - an unstratified, dense heterogeneous mixture of glacially deposited rock particles ranging in size from clay to gravel, (2) ice-contact deposits - kames and eskers composed of stratified sand and gravel, (3) glaciolacustrine deposits - a homogeneous stratified layer of sand silt and clay, and (4) recent fluvial deposits consisting of sand and gravel.

Generally, the coarser grained, stratified, unconsolidated deposits form better aquifers than the fine grained and unstratified unconsolidated deposits or bedrock foundations. Only small areas are underlain by these coarse grained deposits. Percolating water from rainfall and snowmelt recharge the shallow, unconfined aquifers beneath the Site and in turn, streams are recharged by shallow groundwater. The Kayaderosseras Creek is underlain by coarse grained glacial and fluvial valley-fill deposits from which all Kesselring Site service (drinking) water is produced. The Site drinking water well field is located near the eastern boundary of the Site within the Creek's floodplain. The Kesselring Site obtains all water for its operation from on-site production wells that are hydrogeologically separate from current and historical operational areas.

The Kesselring Site is located in the transition zone between the Adirondack Mountains and the Hudson-Mohawk Valley lowland. The Kayaderosseras Creek forms the main drainage system in the vicinity of the Site. The average flow in the Kayaderosseras Creek is 138 cubic feet per second (cfs) and the minimum recorded seven-day average flow for a 10-year period is 17 cfs.

The Glowegee Creek, Crook Brook, and Hogback Brook drain the Site. Crook Brook directly joins the Kayaderosseras. Hogback Brook is a tributary to the Glowegee, which is the receiving water for Site drainage. The average flow in the Glowegee is 37.5 cfs and the minimum recorded seven-day average flow for a 10 year period is 0.92 cfs. The Glowegee Creek joins with the Kayaderosseras approximately one mile east of West Milton.

The Glowegee and Kayaderosseras Creeks are classified under New York State Codes, Rules and Regulations as Class C - Trout Streams. Under this classification the waters are suitable for fishing and fish propagation. Additionally the water quality shall be suitable for primary and secondary contact recreation, even though other factors may limit the use for that purpose. The New York State Department of Environmental Conservation (NYSDEC) has permitted the Site to discharge effluent from various site operations to the Glowegee Creek as specified in the Site State Pollutant Discharge Elimination System (SPDES) permit. Environmental monitoring has shown no measurable water quality degradation in the Glowegee Creek due to Site operations.

5.2 LIQUID EFFLUENT MONITORING

5.2.1 Origins

The primary sources of the effluent water at the Kesselring Site are:

1. Site Boiler Discharges - Site boiler water is treated demineralized water. Operations that result in releases are (1) periodic blowdowns to control the concentration of solids and (2)

neutralization of ion exchange resin regeneration effluent. The water generated by these operations is neutralized before discharge.

2. Sewage Treatment Plant - The plant is a tertiary treatment facility employing extended aeration/contact stabilization activated sludge process and chemical precipitation of phosphorous followed by sand filtration. Waste sludge is stored in a holding tank and is periodically removed by a licensed subcontractor for disposal at a state-approved facility.

3. Cooling Tower Water - Cooling water is treated to minimize scale formation, to prevent corrosion of system materials and to inhibit the growth of algae and slime. The pH is normally maintained in the range of 7.4 to 8.2.

4. Retention Basin Liquids - The retention basins receive wastewater from reactor plant facilities including blowdown water from steam generators and drainage water from the engine rooms.

5. Site Drainage Water - Storm water and groundwater also make up a portion of the liquid effluent.

6. Site Service Water - Site service water is used for drinking water and non-contact cooling purposes. Chlorine is added to the site service water system as a drinking water disinfectant.

With the exception of the sewage treatment plant effluent, all of the above sources of effluent water are discharged into the Kesselring Site Lagoon and through a wastewater treatment system before ultimate off-site discharge into the Glowegee Creek. The site lagoon is a five million gallon holding basin that was designed to accumulate effluent water for the purposes of pH control, thermal equalization, chlorine dissipation, and settling of solid particles.

Some of the liquid effluent discharged from the retention basins contain low levels of radioactivity. The source of this radioactivity is small quantities of activation products. The activation products may include tritium and radionuclides of corrosion and wear products.

Tritium is present in the reactor coolant as the result of neutron interaction with naturally occurring deuterium present in the water. Corrosion and wear activation products are present as small insoluble metal oxide particles, with cobalt-60 the predominant radionuclide.

To minimize releases of radioactivity to the environment, a water reuse system is employed. Water is collected and processed through the process system consisting of a series of filters and demineralizers. After purification, the majority of water is reused as reactor coolant makeup and in other radioactive systems, thereby reducing the amount of radioactivity that could be released as liquid effluent.

Liquid discharges that might contain tritium are either sampled and analyzed individually, or sampled and combined into a monthly composite that is then analyzed for tritium.

The low concentrations of radioactivity in the liquids released from the Kesselring Site have always been below all applicable Federal and State limits and have not resulted in any detectable radioactivity in the Glowegee Creek.

5.2.2 Effluent Monitoring

Liquid effluents from the Kesselring Site enter the Glowegee Creek through two surface channels (Outfalls 001 and 002) and a submerged drain line from the sewage treatment plant (Outfall 003) shown in Figure 5-1.

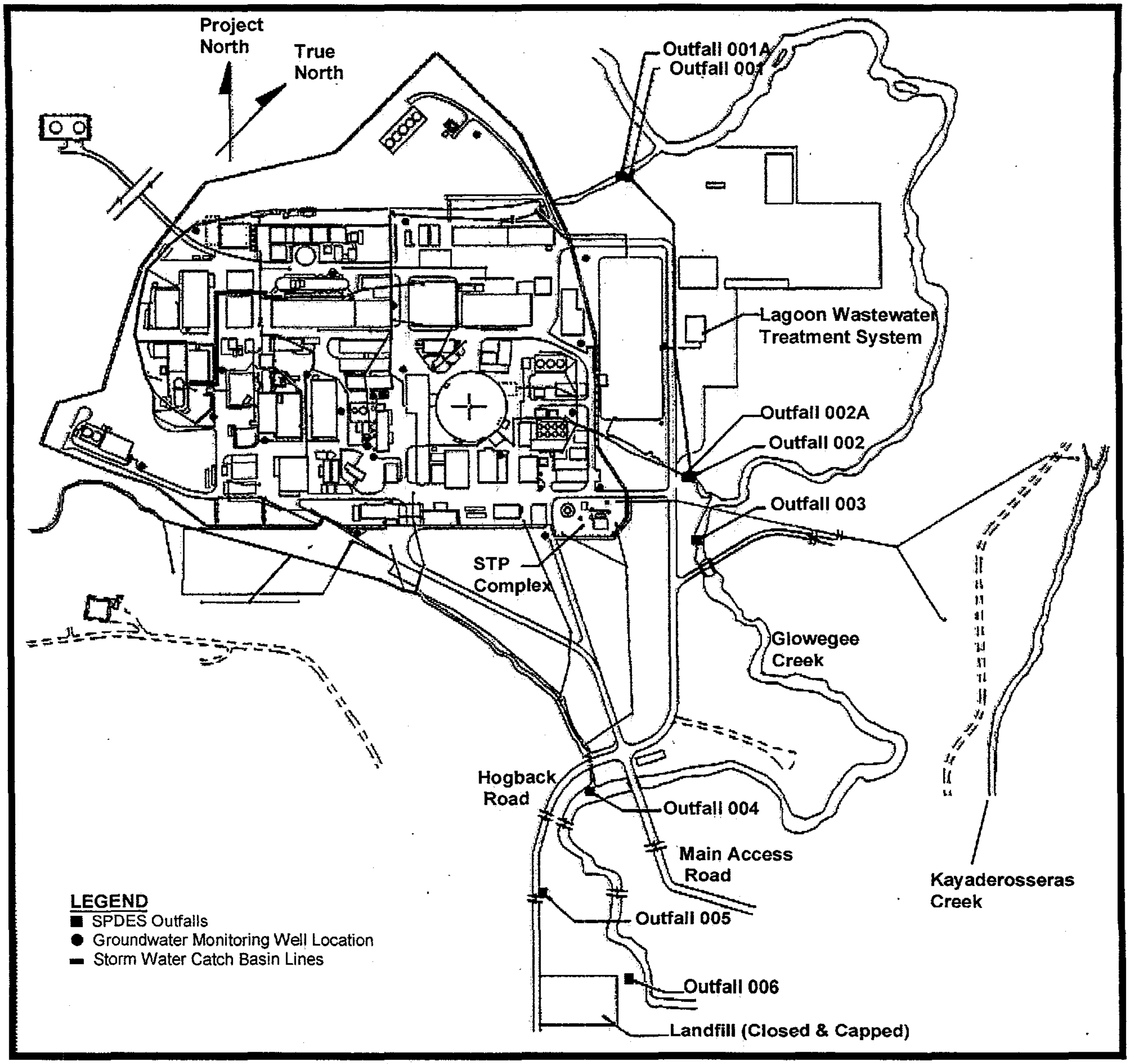


Figure 5-1
Kesselring Site, Near West Milton, New York
Glowegee Creek Sampling Locations and Outfall Locations

A series of gates are located in the main discharge channel upstream of the lagoon to provide a means to contain effluent if concentrations should ever exceed applicable discharge limits. In addition, a continuous pH and temperature monitoring system is installed in the main discharge channel to the lagoon. This system automatically shuts the control gate and provides an alarm if there is ever an out-of-specification pH or temperature level.

Since 1998, the Kesselring Site has operated a wastewater treatment system at the outlet of the lagoon. This treatment system is designed primarily to minimize total suspended solids levels that result from algae blooms. This is necessary in order to maintain Site operations and to ensure continued compliance with the SPDES Permit requirements. This system is intended to minimize the growth of algae by means of spray recirculation and indirect chlorination. The system also removes residual chlorine from the lagoon effluent using an automated sodium bisulfite system.

Effluent samples from the lagoon wastewater treatment system (Outfalls 001 and 002) and the sewage treatment plant (Outfall 003) are collected and analyzed as required by the SPDES Permit (Reference 19).

Storm water from the Kesselring Site enters the Glowegee Creek from storm water Outfalls 001A, 002A, 004, 005, and 006 (Figure 5-1). Outfalls 001A and 002A were used for Site discharge prior to the construction of the lagoon. These outfalls currently collect only storm water.

Outfall 004, which discharges into the Glowegee Creek just below the main access road bridge, collects drainage from the parking lot and the southern part of the Site. Discharges through this outfall are controlled locally or remotely by a sluice gate. This gate provides control for contaminants (i.e., oils and chemicals) which could reach this drainage way in the event of a spill, fire, or other emergency. Storm water also collects in Outfall 005 from Hogback Road and enters the Glowegee Creek. Outfall 006 collects storm water runoff from the landfill that was closed and capped in 1993. Currently, no routine sampling or monitoring is required for stormwater Outfalls 001A, 002A, 004, 005 and 006

5.2.3 Effluent Analyses

The analyses performed for chemical constituents on effluent samples from each discharge point and the sewage treatment plant are listed in Tables 5-1, 5-2 and 5-3. Analyses for chemical constituents are performed using procedures described in Standard Methods, Reference (9), or other EPA approved procedures.

Each liquid discharge that might contain tritium is sampled. The samples are combined into a monthly composite for each frequently used release point. Samples from other tritium release points are analyzed individually. Tritium analyses are performed by liquid scintillation counting.

5.2.4 Assessment

The analytical results for the measurements of chemical constituents summarized in Tables 5-1, 5-2, and 5-3 show that all average values are within the applicable effluent standards.

The radioactivity released in Kesselring Site liquid effluent during 1999 totaled less than 0.02 curies of tritium. The activity was contained in approximately 6.9×10^8 liters of water. The resulting annual average radioactivity concentration in the effluent corresponded to less than 0.1 percent of the DOE derived concentration guide for effluent released to unrestricted areas, (Reference 4) for the mixture of radionuclides present.

Liquid effluent monitoring data are reported as required in Reference (19).

TABLE 5-1 MONITORING OF KESSELRING SITE LIQUID EFFLUENT, OUTFALL 001, 1999

Parameter (units)	Number of Samples	SPDES Permit Limit	Minimum[1]	Maximum[1]	Average[2]	Percent of Limit (Using Average Value)
Discharge Requirements (Reference 19)						
Flow (MGD)*	365	Report[3]	0.00	0.86	0.26	----
Temperature (Deg. F)	262	(Note 4)	35	72	53	----
Residual Chlorine (mg/l)	262	0.04	< 0.02	< 0.02	< 0.02	< 50
pH (SU)**	51	6.0 - 9.0	6.9	8.3	7.7	----
Grease and Oil (mg/l)	16	15	<1	<1	<1	< 7
Total Suspended Solids (mg/l)	16	45	<1	22	<9	<20
Nitrite as N (mg/l)	12	(Note 5)	< 0.02	<0.02	< 0.02	----
Iron						
(mg/l)	25	0.4	0.06	0.38	0.19	48
(lb/day)	25	(Note 6)	0.14	1.04	0.49	----
Total Phosphorus						
(mg/l)	16	Report[3]	0.04	0.28	0.14	----
(kg/month)	16	(Note 7)	1	11	5	----
Zinc						
(mg/l)	28	Report[3]	<0.005	0.190	<0.044	----
(lb/day)	28	(Note 8)	<0.02	0.57[9]	<0.12	----
Boron (mg/l)	12	0.5	< 0.05	0.16	<0.06	<12
Sulfite (mg/l)	12	2.0	< 2.0	< 2.0	< 2.0	< 100
Additional Parameters Monitored (Not Required by Permit - Reference 19)						
Detergent (MBAS) (mg/l)	12	N/A	< 0.02	0.02	< 0.02	N/A
Ammonia - N (mg/l)	12	N/A	< 0.1	0.1	< 0.1	N/A
Copper (mg/l)	12	N/A	< 0.05	< 0.05	< 0.05	N/A
Cadmium (mg/l)	12	N/A	< 0.005	< 0.005	< 0.005	N/A
Specific Conductance (umhos/cm)	12	N/A	540	1110	829	N/A
Total Chromium (mg/l)	12	N/A	< 0.005	< 0.005	< 0.005	N/A

See Notes on Page 5-8

TABLE 5-2 MONITORING OF KESSELRING SITE LIQUID EFFLUENT, OUTFALL 002, 1999

Parameter (units)	Number of Samples	SPDES Permit Limit	Minimum[1]	Maximum[1]	Average[2]	Percent of Limit (Using Average Value)
Discharge Requirements (Reference 19)						
Flow (MGD)*	365	Report[3]	0.00	0.86	0.24	----
Temperature (Deg. F)	269	(Note 4)	35	72	53	----
Residual Chlorine (mg/l)	269	0.04	<0.02	<0.02	< 0.02	< 50
pH (SU)**	52	6.0 - 9.0	7.1	8.4	7.7	----
Grease and Oil (mg/l)	16	15	<1.0	2.6	<1.1	< 7
Total Suspended Solids (mg/l)	16	50	<1	22	<9	<18
Nitrite as N (mg/l)	12	(Note 5)	<0.02	<0.02	<0.02	----
Iron						
(mg/l)	26	0.4	0.05	0.34	0.19	48
(lb/day)	26	(Note 6)	0.10	1.09	0.41	----
Total Phosphorus						
(mg/l)	16	Report[3]	0.04	0.27	0.14	----
(kg/month)	16	(Note 7)	1	10	4	----
Zinc						
(mg/l)	28	Report[3]	<0.010	0.310	<0.054	----
(lb/day)	28	(Note 8)	<0.02	1.16[9]	<0.13	----
Boron (mg/l)	12	0.5	< 0.05	0.14	<0.06	<12
Sulfite (mg/l)	12	2.0	< 2.0	< 2.0	< 2.0	< 100
Additional Parameters Monitored (Not Required by Permit - Reference 19)						
Detergent (MBAS) (mg/l)	12	N/A	< 0.02	< 0.02	< 0.02	N/A
Ammonia - N (mg/l)	12	N/A	< 0.1	<0.1	< 0.1	N/A
Copper (mg/l)	12	N/A	< 0.05	< 0.05	< 0.05	N/A
Cadmium (mg/l)	12	N/A	< 0.005	< 0.005	< 0.005	N/A
Specific Conductance (umhos/cm)	12	N/A	526	1130	845	N/A
Total Chromium (mg/l)	12	N/A	< 0.005	< 0.005	< 0.005	N/A

See Notes on Page 5-8

NOTES FOR TABLES 5-1 AND 5-2

(1) A value preceded by < is less than the minimum detection level for that sample and parameter.

(2) Average values preceded by < contain at least one less than minimum detection level value in the average.

(3) The Reference 19 permit requires the data to be reported but does not specify a limit for this discharge parameter.

(4) During the period from May through October, the temperature of the discharges from Site operations shall not exceed 75 degrees F except that if the ambient stream temperature exceeds 75 degrees F, the temperature of the discharge shall be equal to stream temperature, to a maximum of 78 degrees F.

During the period from November through April, the temperature of the discharge from Site operations shall not exceed 75 degrees F. In addition, no discharges will occur which will raise the temperature of the stream by more than 5 degrees F, or to a maximum of 55 degrees F, whichever is less, except that if the upstream *temperature is > 55 degrees F, the discharge to the stream shall be such that the downstream temperature is less than, or equal to upstream temperature.*

(5) The Reference 19 permit requires the data to be reported for each outfall. In addition, a flow-weighted average limit of 0.04 mg/l for outfalls 001, 002, and 003 is also specified.

(6) Total Site mass discharge limit of 4.0 lbs/day for outfalls 001, 002, and 003 combined.

(7) An action level of 50 kg/month has been assigned for the total mass discharge from outfalls 001, 002, and 003 combined. An action level is not a limit, but a specified effluent level that requires additional short term monitoring upon exceedance.

(8) Total Site mass discharge limit of 0.5 lbs/day for outfalls 001, 002, and 003 combined

(9) On two occasions in 1999, the zinc level exceeded the permit limit. These events had no adverse impact to the Glowegee Creek.

* MGD– Million Gallons per Day
** SU - Standard Units
N/A - Not Applicable

TABLE 5-3 MONITORING OF KESSELRING SITE SEWAGE TREATMENT PLANT EFFLUENT, OUTFALL 003, 1999

Parameter (units)	Number of Samples	SPDES Permit Limit	Minimum(1)	Maximum(1)	Average(2)	Percent of Limit (Using Average Value)
Discharge Requirements (Ref. 19)						
Flow (MGD)*	250	0.09(3)	0.01	0.03	0.02	22
pH (SU)**	250	6.0 - 9.0	6.7	8.1	7.5	----
Settleable Solids (ml/l)	250	< 0.1	< 0.1	< 0.1	< 0.1	< 100
Dissolved Oxygen (mg/l)	250	> 5.0	8.0	12.9	10.1	(Note 4)
Nitrite-N (mg/l)	12	Report(5)	< 0.02	0.61	<0.08	----
Cyanide, Free (mg/l)	12	0.09	< 0.01	<0.01	< 0.01	< 11
Ammonia-N (mg/l)	16	24.4	< 0.1	0.6	<0.2	< 1
Detergent (MBAS) (mg/l)	12	0.7	< 0.02	0.05	< 0.02	< 3
Boron (mg/l)	12	1.2(6)	< 0.05	0.10	< 0.05	< 4
Dissolved Copper (mg/l)	12	Report(7)	< 0.05	< 0.05	< 0.05	----
BOD 5 (mg/l)	16	30(8)	< 2	<2	< 2	< 7
Suspended Solids (mg/l)	15	30(8)	< 1.0	4.5	<1.5	<5
Total Phosphorus						
(mg/l)	12	Report(6)	0.13	0.98	0.35	----
(kg/month)	12	(Note 9)	0.3	2.1	0.7	----
Zinc						
(mg/l)	13	(Note 7)	< 0.01	0.14	<0.04	----
(lbs/day)	13	Report(10)	<0.001	0.018(10)	<0.006	----
Total Copper (lbs/day)	12	0.06	<0.01	<0.01	< 0.01	< 17
Iron						
(mg/l)	12	0.3(6)	< 0.05	0.08	< 0.05	< 17
(lbs/day)	12	(Note 11)	< 0.01	0.01	< 0.01	----
Aluminum (mg/l)	12	2.0(6)	<0.1	0.2	<0.1	<5
Butyl Benzyl Phthalate (mg/l)	12	0.1(6)	< 0.01	0.01	< 0.01	< 10
Additional Parameters Monitored (Not Required by Permit - Ref. 19)						
Temperature (Deg. F)	237	N/A	40	76	57	N/A

Notes:

(1) A value preceded by <is less than the minimum detection level for that sample and parameter.
(2) Average values preceded by < contain at least one less than minimum detection level value in the average.
(3) 30-day average.
(4) The average value is well above the limit which is a minimum value.
(5) The Reference 19 permit requires that the data to be reported for each outfall. In addition, a flow-weighted average limit of 0.04 mg/l for outfalls 001, 002, and 003 is also specified.
(6) Values are action levels which are not a limit but a specified effluent level which requires additional short term monitoring upon exceedance.
(7) The Reference 19 permit requires that the data to be reported but does not specify a limit for this discharge parameter.
(8) The maximum limit for the 30-day arithmetic mean is 30 mg/l, the maximum limit for the 7-day arithmetic mean is 45 mg/l.
(9) An action level of 50 kg/month has been assigned for the total mass discharged from outfalls 001, 002, and 003 combined. An action level is not a limit but a specified effluent level that requires additional short term monitoring upon exceedance.
(10) Total Site mass discharge limit of 0.5 lbs/day for outfalls 001, 002, and 003 combined. This zinc mass limit was exceeded on two occasions in 1999. These events had not adverse impact to the Glowegee Creek.
(11) Total Site mass discharge limit of 4.0 lbs/day for outfalls 001, 002, and 003 combined.

* MGD = Million Gallons per Day
** SU = Standard Units
N/A = Not Applicable

5.3 AIRBORNE EFFLUENT MONITORING

5.3.1 Origins

The principal sources of industrial gaseous effluents are two 21 million and one 30 million BTU/hr steam generating boilers. The Number 2 fuel oil that is used to fire all of the boilers contains less than 0.5 weight percent sulfur. Combustion gases from the boilers are released through two elevated exhaust stacks. Other operations such as carpenter shops, welding hoods, abrasive cleaning, and spray painting constitute point sources of airborne effluents.

Small quantities of particulate radioactivity, principally cobalt-60, are processed through controlled exhaust systems during reactor coolant sampling, draining, and venting operations. Gaseous radioactivity contained in the exhaust air consists principally of carbon-14, short-lived isotopes of xenon and krypton, argon-41, and tritium. Carbon-14 and argon-41 are the result of neutron interaction with isotopes of dissolved oxygen, nitrogen, and argon in the coolant. Other radioactive gases such as xenon and krypton are produced by neutron interaction with trace quantities of uranium impurities in structural members within the reactor. Prior to release from the exhaust stacks, the exhaust air is passed through high efficiency particulate air (HEPA) filter systems to minimize particulate radioactivity content.

5.3.2. Effluent Monitoring

Emissions of oxides of nitrogen (NO_x) from the Site's steam boilers are controlled by NYSDEC issued permits that limit total fuel use to no more than 700,000 gallons in any 12-month period. Volatile organic compound (VOC) emissions from two paint spray operations are similarly controlled by NYSDEC issued permits that limit hours of operation of these facilities. For both the Site boilers and paint spray operations, monthly usage records are tracked and tabulated to ensure permit compliance. Emissions of oxides of sulfur (SO_x) are also monitored in the Site boiler units via analysis of fuel sulfur content. These results are submitted to EPA on a semi-annual basis as required by EPA's New Source Performance Standards (NSPS) for these size stationary combustion installations. Due to a change in New York State regulations in July 1996, all other industrial emission points at the Kesselring Site do not require permits due to very low emission levels.

The air exhausted from the reactor plants is continuously monitored for particulate radioactivity with monitors that are equipped with alarm functions to provide an alert should an out-of-specification release occur. The air exhausted from all radiological facilities is continuously sampled for particulate radioactivity. Reactor plant air emissions are also continuously sampled for radioiodine with activated charcoal cartridges. Sampling is performed for tritium and carbon-14 using appropriate absorbers.

5.3.3 Effluent Analyses

The air particulate sample filters from the radiological emission points are changed routinely and analyzed by direct counting for beta-gamma radioactivity. A minimum detectable concentration of approximately 5×10^{-15} μCi/ml is achieved for cobalt-60. The activated charcoal cartridges are analyzed for radioiodine by gamma spectrometry to a minimum detection level of approximately 5×10^{-15} μCi/ml for iodine-131. The tritium and carbon-14 absorbers are analyzed by liquid scintillation spectrometry. The minimum detectable concentrations of tritium and carbon-14 in air are approximately 5×10^{-11} μCi/ml for typical sampling parameters. The quantity of gaseous radioactivity released is calculated based on reactor plant operating parameters.

5.3.4 Assessment

Emissions of NO_x and VOCs continue to be well within the limits established by NYSDEC in the respective permits associated with the Site boiler units and paint spray operations. Emissions of SO_x from the Site boiler units are also well within the EPA's NSPS emission standards for stationary combustion installations.

The radioactivity contained in exhaust air during 1999 consisted of: (1) less than 0.001 curie each of krypton-85 and particulate fission and activation products having half-lives greater than three hours, (2) approximately 1.2 curie of noble gases with half-lives of 12 days or less, principally argon-41, xenon-133 and xenon-135, (3) approximately 0.14 curie of tritium, and (4) approximately 0.6 curie of carbon-14.

The radioactivity was contained in a total volume of 5.3×10^{11} liters of air. The average radioactivity concentration in the effluent air was well below the applicable standards listed in Reference (4). The average annual radioactivity concentration at the nearest Site boundary, based on average annual diffusion parameters, was less than 0.01 percent of the DOE derived concentration guide for effluent release to unrestricted areas (Reference 4) for the mixture of radionuclides present. Airborne effluent monitoring data are reported as required in Reference (7).

All other point source emissions also conform to the applicable Federal and State clean air standards.

5.4 ENVIRONMENTAL MONITORING

5.4.1 Scope

The environmental monitoring program at the Kesselring Site includes: (1) the periodic collection of Glowegee Creek water samples for chemical analyses, (2) the continuous monitoring of water temperature and pH above and below the Site discharge locations to the Glowegee Creek, (3) a survey of the aquatic life upstream, near the discharge channels and downstream in the Glowegee Creek, (4) the collection of fish upstream and downstream of discharge locations to the Glowegee Creek, (5) the collection of quarterly samples of Glowegee Creek water and sediment at five locations, (6) the continuous monitoring of radiation levels at perimeter and off-site locations and (7) the operation of continuous air samplers at stations located in the primary upwind and downwind directions from the Site.

Grab samples of Glowegee Creek water are collected weekly and monthly upstream and downstream of the discharge outfalls for chemical analysis. In addition, continuous monitoring and recording of the creek temperature are conducted upstream of the Site, between the discharge channels, and downstream of the Site. The Glowegee Creek pH is monitored continuously above and below the Site. Flow measuring equipment is installed in both discharge channels. In addition, flow is monitored by the U.S. Geological Survey (USGS) one half mile downstream of the Site at the West Milton Road gaging station (USGS No. 01330000).

An aquatic life sampling and evaluation program is conducted in the Glowegee Creek. This survey includes the identification and population assessment of periphyton, benthic macroinvertebrates, and fish. The periphyton samples are collected from rocks located along the stream bottom and the benthic macroinvertebrates are collected using a Surber bottom sampler and kick sampling techniques. Chain electro-fishing techniques are used to collect the fish, which are identified, measured, and returned to the creek unharmed. Only a few of the fish from one upstream and one downstream location are retained for radioanalysis.

Three samples of sediment and one composite water sample are collected quarterly for radioanalysis across the creek at the five locations shown in Figure 5-1.

Radiation levels at the eight Site perimeter locations shown in Figure 5-2 and four off-site locations are monitored with sensitive, thermoluminescent dosimeters (TLDs).

Environmental air samplers are operated in the primary upwind and downwind directions from the Site to measure normal background airborne radioactivity and to confirm that Kesselring Site effluents have no measurable effect on normal background levels.

The Kesselring Site operated its own sanitary landfill for the disposal of non-radioactive and non-hazardous solid wastes until October 1993, when landfill operations permanently ceased. NYSDEC approved the final Landfill Closure Plan, and landfill closure construction was completed in October 1994. The closed landfill is maintained in accordance with a Post Closure Monitoring and Maintenance Manual, which has been approved by NYSDEC. Groundwater and surface water monitoring of the landfill is performed in accordance with this manual.

5.4.2 Analyses

The routine quarterly samples of Glowegee Creek water and bottom sediment samples are analyzed with a high-purity germanium gamma spectrometer system. In addition, a more sensitive gamma spectrometry analyses is performed annually on the fish and some of the water and sediment samples collected from the Glowegee Creek. The more sensitive analysis is intended to fully characterize the low levels of naturally and non-naturally occurring gamma-emitting radionuclides. Creek water samples are also analyzed for the chemical constituents listed in Tables 5-4 and 5-5 using the analytical techniques described in Standard Methods, Reference (9), or other EPA approved methods.

The environmental air particulate sample filters are changed and analyzed routinely by direct counting for beta radioactivity and by high-purity germanium gamma spectrum analysis.

5.4.3 Assessment

The 1999 analytical results for the Glowegee Creek water samples for chemical constituents, pH, and temperature are summarized in Table 5-4 and 5-5. The Glowegee Creek fish survey results from 1999 are summarized in Table 5-6. The concentrations of chemical constituents in liquid effluent from the Kesselring Site resulted in no adverse effect on the quality of Glowegee Creek observable aquatic life. This is substantiated by results of the fish and aquatic life surveys that confirmed the existence of a diverse and healthy aquatic community in the creek water. The 1999 survey data are consistent with historical fish and aquatic life survey data. The different relative abundance of fish species at each sampling location reflects their different preferred habitats.

The gamma spectrum analysis results for fish collected from the Glowegee Creek are shown in Table 5-7. The results show no radioactivity attributable to Site operations. The only radionuclide observed in both fish samples was potassium-40. This naturally occurring radionuclide is frequently observed in fish.

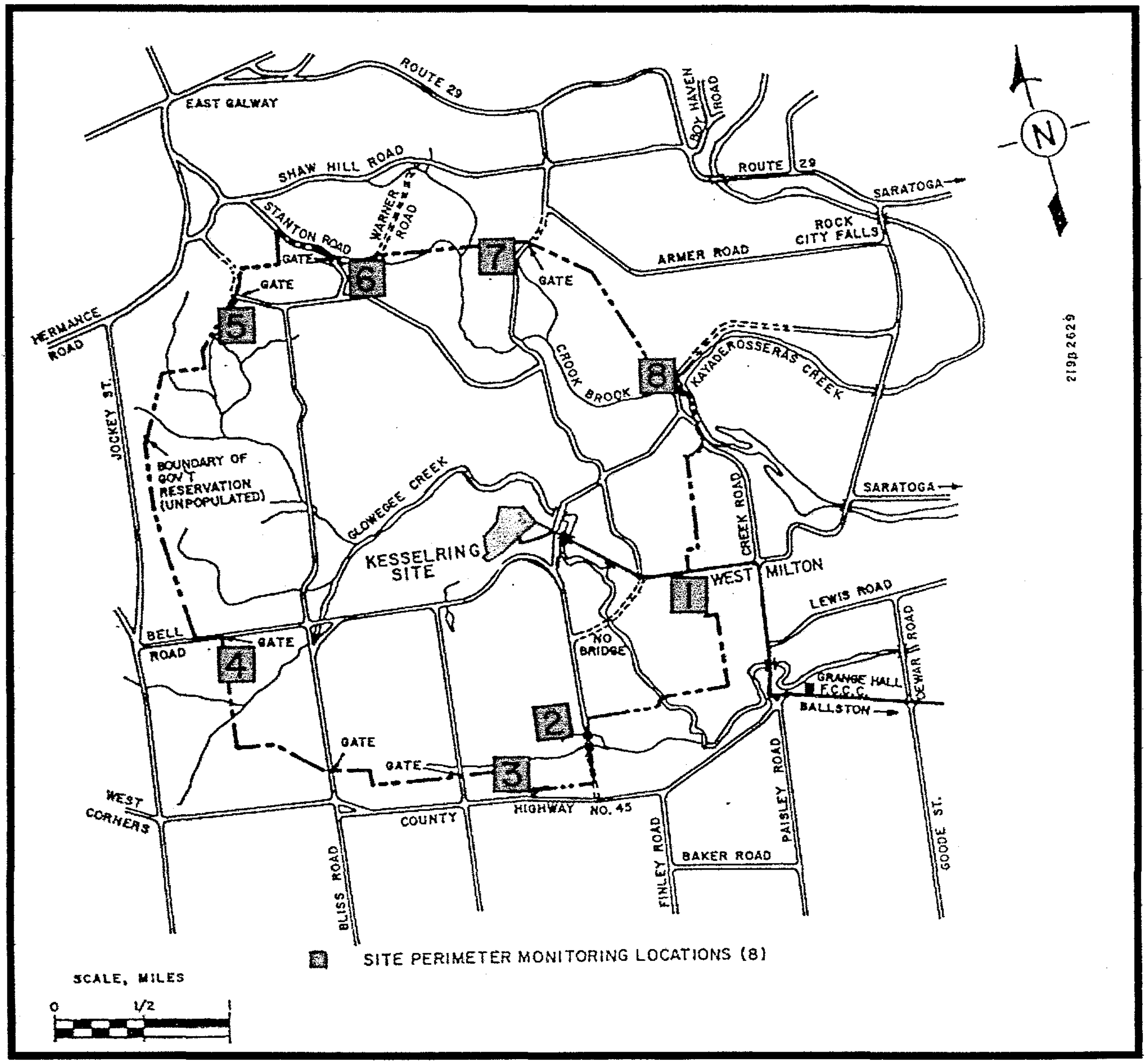


Figure 5-2
Kesselring Site, Near West Milton, New York
Perimeter Monitoring Locations

TABLE 5-4 MONITORING OF GLOWEGEE CREEK UPSTREAM OF OUTFALL 001,1999[1,2]

Parameter (units)	Number of Samples	Minimum	Maximum	Average[3]	Standard
pH (SU*) (See Note 4)	52	7.3	8.8	8.1	6.5 - 8.5
Temperature (Deg F.)	279	29	76	49	No Standard
Residual Chlorine (mg/l)	53	< 0.02	< 0.02	< 0.02	0.005 (See Note 5)
Total Organic Carbon (mg/l)	12	2.8	6.2	4.1	No Standard
Dissolved Oxygen (mg/l)	12	6.6	14.7	10.2	6.0 (Daily Ave Min), not < 5.0
Grease and Oil (mg/l)	12	< 1	< 1	< 1	See Note 6
Ammonia (mg/l)	12	< 0.1	< 0.1	< 0.1	1.1 (See Note 7)
Total Copper (mg/l)	12	< 0.05	< 0.05	< 0.05	0.011 (See Notes 5 and 8)
Total Zinc (mg/l)	12	< 0.01	0.07	< 0.02	0.098 (See Note 8)
Total Cadmium (mg/l)	12	< 0.005	< 0.005	< 0.005	0.002 (See Notes 5 and 8)
Color (cpu**)	12	15	30	21	See Note 9
Total Phosphorus (mg/l)	12	< 0.02	0.18	< 0.05	See Note 10
Hardness (mg/l)	12	51	152	122	No Standard
Total Chromium (mg/l)	12	< 0.005	< 0.005	< 0.005	0.087 (See Note 8)
Hexavalent Chromium (mg/l)	12	< 0.02	< 0.02	< 0.02	0.011 (dissolved form) (See Note 5)
Free Cyanide (mg/l)	12	< 0.01	< 0.01	< 0.01	0.005 (See Note 5)
Specific Conductance (umho/cm)	12	242	389	325	No Standard
Turbidity (ntu)	12	0.5	17.0	2.8	See Note 11
MBAS (Surfactants) (mg/l)	12	< 0.02	< 0.02	< 0.02	No Standard
Iron (mg/l)	12	< 0.05	0.21	< 0.12	0.300
Boron (mg/l)	12	< 0.05	0.07	< 0.05	10
Nitrite (mg/l)	12	< 0.02	< 0.02	< 0.02	0.020
Total Suspended Solids (mg/l)	12	< 1.0	14.0	< 2.0	See Note 12

Notes:
(1) A value preceded by < is less than the minimum detection level for that sample and parameter.
(2) New York State Class C Water: The best usage of Class C waters is fishing.
(3) Average values preceded by < contain at least one value less than the minimum detection level in the sample set.
(4) Upstream pH maximum values exceeded the standard on occasion.
(5) The minimum detection value for that parameter is higher than the reference standard. That does not mean that the actual level of the parameter actually exceeded the standard.
(6) No residue attributable to sewage, industrial wastes or other wastes, nor visible oil film nor gobules of grease.
(7) The standard is a calculated value for un-ionized ammonia, based on water temperature and pH. Standard expressed is in terms of total ammonia (as N) at the given temperature and pH.
(8) The standard is a calculated value based upon the hardness of the water. The value shown is the calculated value for the average hardness.
(9) None in the amounts that will adversely affect the color thereof, or impair the waters for their best usage.
(10) None in the amounts that will result in growths of algae, weeds, and slimes that will impair the waters for best usages.
(11) No increase that will cause a substantial visible contrast to natural conditions.
(12) None from sewage, industrial wastes, or other wastes that will cause deposition or impair the water for their best usages.

* SU = standard units
** cpu = cobalt platinum units

TABLE 5-5 MONITORING OF GLOWEGEE CREEK DOWNSTREAM OF OUTFALL 003, 1999[1,2]

Parameter (units)	Number of Samples	Minimum	Maximum	Average[3]	Standard
pH (SU*)	52	7.2	8.5	7.9	6.5 - 8.5
Temperature (Deg F.)	279	30	77	50	No Standard
Residual Chlorine (mg/l)	53	< 0.02	< 0.02	< 0.02	0.005 (See Note 5)
Total Organic Carbon (mg/l)	12	2.9	6.0	4.0	No Standard
Dissolved Oxygen (mg/l)	12	5.9	14.4	9.7	6.0 (Daily Ave Min), not < 5.0
Grease and Oil (mg/l)	12	< 1	< 1	< 1	See Note 6
Ammonia (mg/l)	12	< 0.10	< 0.10	< 0.10	1.2 (See Note 7)
Total Copper (mg/l)	12	< 0.05	< 0.05	< 0.05	0.012 (See Notes 5 and 8)
Total Zinc (mg/l)	12	< 0.005	0.05	< 0.014	0.105 (See Note 8)
Total Cadmium (mg/l)	12	< 0.005	< 0.005	< 0.005	0.003 (See Notes 5 and 8)
Color (cpu**)	12	15	30	21	See Note 9
Total Phosphorus (mg/l)	12	< 0.02	0.13	< 0.05	See Note 10
Hardness (mg/l as CaCO3)	12	64	173	134	No Standard
Total Chromium (mg/l)	12	< 0.005	< 0.005	< 0.005	0.094 (See Note 8)
Hexavalent Chromium (mg/l)	12	< 0.02	< 0.02	< 0.02	0.011 (dissolved form)
Free Cyanide (mg/l)	12	< 0.01	< 0.01	< 0.01	0.005 (See Note 5)
Specific Conductance (umho/cm)	12	260	544	398	No Standard
Turbidity (ntu)	12	1.2	43.0	6.2	See Note 11
MBAS (surfactants) (mg/l)	12	< 0.02	< 0.02	< 0.02	No Standard
Iron (mg/l)	12	< 0.05	0.41	< 0.24	0.300
Boron (mg/l)	12	< 0.05	0.07	< 0.05	10
Nitrite (mg/l)	12	< 0.02	< 0.02	< 0.02	0.020
Total Suspended Solids (mg/l)	12	< 1.0	28.0	< 6.0	See Note 12

See Notes on previous page.

TABLE 5-6 GLOWEGEE CREEK FISH SURVEY, 1999

Location	Species	Number Collected	Length (mm)
400 Feet Upstream	Blacknose Dace	179	35-71
	Bluntnose Minnow	1	62
U-2	Brook Stickleback	3	34-47
	Brook Trout	-	-
	Brown Bullhead	1	118
	Brown Trout	2	40-45
	Common Shiner	283	36-106
	Creek Chub	108	45-113
	Cutlips Minnow	44	36-122
	Fathead Minnow	-	-
	Golden Shiner	-	-
	Largemouth Bass	-	-
	Longnose Dace	12	50-86
	Pearl Dace	3	55-69
	Pumpkinseed	1	61
	Tessellated Darter	27	50-68
	White Sucker	48	67-138
20 Feet Upstream	Blacknose Dace	241	38-82
	Bluntnose Minnow	2	62-79
U-1	Brook Stickleback	18	38-52
	Brook Trout	9	44-231
	Brown Bullhead	-	-
	Brown Trout	1	152
	Common Shiner	752	36-104
	Creek Chub	114	33-131
	Cutlips Minnow	31	35-122
	Fathead Minnow	31	49-71
	Golden Shiner	-	-
	Largemouth Bass	-	-
	Longnose Dace	27	48-90
	Pearl Dace	2	52-56
	Pumpkinseed	2	62-79
	Tessellated Darter	28	46-74
	White Sucker	53	66-147
Between Discharge	Blacknose Dace	406	41-68
Channels	Bluntnose Minnow	1	46
	Brook Stickleback	12	36-50
M-1	Brook Trout	-	-
	Brown Bullhead	-	-
	Brown Trout	5	40-48
	Common Shiner	691	38-112
	Creek Chub	107	46-140
	Cutlips Minnow	21	40-111
	Fathead Minnow	23	49-73
	Golden Shiner	2	69-77
	Largemouth Bass	-	-
	Longnose Dace	49	45-78
	Pearl Dace	4	49-60
	Pumpkinseed	1	84
	Tessellated Darter	18	50-75
	White Sucker	31	78-132

TABLE 5-6 GLOWEGEE CREEK FISH SURVEY, 1999 (Continued)

Location	Species	Number Collected	Length (mm)
2900 Feet Downstream	Blacknose Dace	285	30-74
	Bluntnose Minnow	21	61-86
D-2	Brook Stickleback	-	-
	Brook Trout	-	-
	Brown Bullhead	-	-
	Brown Trout	3	45-132
	Common Shiner	237	40-102
	Creek Chub	35	36-87
	Cutlips Minnow	44	40-130
	Fathead Minnow	2	46-55
	Golden Shiner	-	-
	Largemouth Bass	-	-
	Longnose Dace	57	54-93
	Pearl Dace	-	-
	Pumpkinseed	1	73
	Tessellated Darter	12	49-76
	White Sucker	32	57-122
3200 Feet Downstream	Blacknose Dace	292	29-67
	Bluntnose Minnow	48	56-87
D-1	Brook Stickleback	-	-
	Brook Trout	-	-
	Brown Bullhead	-	-
	Brown Trout	15	41-179
	Common Shiner	662	41-146
	Creek Chub	117	45-105
	Cutlips Minnow	83	34-116
	Fathead Minnow	2	44-49
	Golden Shiner	-	-
	Largemouth Bass	-	-
	Longnose Dace	2	57-83
	Pearl Dace	-	-
	Pumpkinseed	-	-
	Tessellated Darter	91	47-76
	White Sucker	89	66-180
5500 Feet Downstream	Blacknose Dace	794	37-69
	Bluntnose Minnow	1	63
	Brook Stickleback	-	-
D-3	Brook Trout	1	161
	Brown Bullhead	-	-
	Brown Trout	4	40-150
	Common Shiner	264	49-123
	Creek Chub	77	39-114
	Cutlips Minnow	117	50-135
	Fathead Minnow	1	51
	Golden Shiner	-	-
	Largemouth Bass	-	-
	Longnose Dace	204	49-91
	Pearl Dace	-	-
	Pumpkinseed	1	65
	Tessellated Darter	6	64-75
	White Sucker	11	65-134

TABLE 5-7 RESULTS OF ANALYSES OF GLOWEGEE CREEK FISH, 1999

Sample Location	Radioactivity Concentration[1] (pCi/g wet wt) K-40	Cs-137	Co-60
Combination of 400 ft. and 20 ft. Upstream of Discharge Channel 001	1.69±0.19	<0.01	<0.01
5500 ft. Downstream from Discharge Channel 002	1.93±0.20	<0.01	<0.01

Note:
(1) A value preceded by < is less than the minimum detection level for that sample parameter. The (±) value represents the statistical error at two standard deviations.

TABLE 5-8 RESULTS OF ANALYSES OF GLOWEEGEE CREEK SEDIMENT AND WATER, 1999

Sample Location	No. of Samples Sediment/Water	Cobalt-60 Radioactivity Concentration: Sediment (pCi/gm, dry wt)[1, 2] Minimum	Maximum	Average	Water (pCi/l)[2] Minimum	Maximum	Average
Upstream of Discharge Channel 001	9/4	<0.02	<0.02	<0.02	<9.6	<16	<12
Opposite Discharge Channel 001	12/4	<0.02	<0.02	<0.02	<8.8	<17	<13
Between Discharge Channels 001 & 002	12/4	<0.02	<0.02	<0.02	<11	<13	<12
Opposite Discharge Channel 002	12/4	<0.02	<0.02	<0.02	<8.8	<16	<13
Downstream of Discharge Channel 003	12/4	<0.02	<0.03	<0.02	<8.8	<13	<11

Notes:
(1) Dry weight is based on sample weight with free water removed.
(2) A value preceded by < is less than the minimum detection level for that sample and parameter.

TABLE 5-9 PERIMETER AND OFF-SITE RADIATION MONITORING RESULTS, KESSELRING SITE, 1999

Perimeter Location No.[1]	Total Annual Exposure (millirem)[2]
1	78 ± 7
2	68 ± 2
3	71 ± 1
4	71 ± 2
5	74 ± 4
6	58 ± 2[3]
7	77 ± 3
8	74 ± 1
Off-site locations	77 ± 11[4]

Notes:
(1) See Figure 5-2 for monitoring locations.
(2) The (±) values for individual locations are expressed at the 2 sigma confidence level based on the calculated measurement error.
(3) Based on data for 3 quarters only. First quarter TLDs were vandalized.
(4) Approximately 95% of natural background radiation measurements are expected to be within this range.

Results of the gamma analysis of sediment and water samples are shown in Table 5-8. The data show that there is no significant difference between radioactivity concentrations measured upstream and downstream. Only naturally occurring radionuclides were detected in the Glowegee Creek water samples. Results of the detailed gamma spectrum analyses performed on sediment samples also indicate low concentrations of potassium-40, cesium-137, and daughters of uranium and thorium. Potassium-40 and the daughters of uranium and thorium are naturally-occurring radionuclides and are not associated with site operations. The EPA has attributed similar low levels of cesium-137 to fallout from low yield atmospheric nuclear weapon tests. Since the beginning of prototype operations more than 35 years ago, the release of radioactivity into the Glowegee Creek has been small and has had no significant effect on the natural background radioactivity in the sediment.

The total annual radiation exposures measured with TLDs at the boundary of the Kesselring Site and at remote, off-site monitoring locations are summarized in Table 5-9. There is no statistically significant difference between the perimeter and the off-site measurements. This shows that Kesselring Site operations in 1999 had no measurable effect on natural background radiation levels at the Site perimeter.

The results for the environmental air samples show that there was no significant difference between the average upwind and downwind radioactivity concentrations. The average upwind and downwind radioactivity concentrations were 2.6×10^{-14} μCi/ml and 1.5×10^{-14} μCi/ml, respectively. Gamma spectrum analyses indicated the presence of small quantities of radium-226, thorium-232 and their daughter products. Also present were small quantities of beryllium-7 and potassium-40. These radionuclides are all naturally occurring.

5.5 GROUNDWATER AND SURFACE WATER MONITORING

5.5.1 Scope

The Kesselring Site groundwater monitoring program consists of two categories; 1) a regulatory agency required program (the closed Hogback Road Landfill) and 2) a voluntary program (former solid waste disposal sites and security area, of which starting in 1999 consists only of the security area, as discussed below). In 1999, the voluntary program was revised to reduce the number of analytical parameters and groundwater wells. This revision was based on the long duration of the monitoring program and the consistency of the analytical results. The revised program focuses on those wells and the attendant chemical profile that best assesses the effect of Site operations, both current and historical, on groundwater quality.

In 1999, KAPL received NYSDEC approval of the Post-Closure Monitoring & Maintenance Operations Manual and implemented the new program for the closed landfill during the second quarter of the year. The revised monitoring program consists of an expansion from 7 shallow aquifer monitoring well locations to 4 shallow, 3 deep (bedrock), one cyclical monitoring well, and 2 surface water sampling locations. The specific sampling location changes are illustrated in Table 5-10, where both the old and new program sampling locations are shown. The locations of all existing landfill monitoring points are shown in Figure 5-3. This monitoring program is performed to comply with New York State solid waste landfill closure requirements.

The historical database show no water quality impact associated with the former solid waste disposal sites, and only marginal impact associated with the security area. The data from the 14 groundwater wells associated with the four former disposal sites monitoring programs, as shown in Figure 5-4 (areas 1 through 4), show no impact by the disposal areas. Therefore, monitoring at these areas has been discontinued.

There are 19 wells associated with the security area groundwater monitoring program (Figure 5-5). The nine years of groundwater data show no significant changes in water quality. Low levels of volatile organic compounds (VOCs) have been detected in only a few wells throughout the program. The revised monitoring program will continue to monitor for these VOCs. The groundwater data has shown no toxic metals attributable to Site operations.

In addition to the operational/disposal Site monitoring, groundwater monitoring of the Site's drinking water is performed.

5.5.2 Origin

Contaminants in the landfill wells are associated with past disposal practices. The landfill, operated since 1951 and closed in 1994, has been used predominantly for the disposal of sanitary wastes. Prior to enactment of Federal and State regulations for solid waste disposal activities that banned disposal of certain wastes in such facilities, the landfill was used to dispose of asbestos scraps, scrap metal including lead, some oil and oily water, solvents, paint, and chemicals.

The four former disposal sites at the Kesselring Site were used for construction and demolition waste, limited amounts of acid waste, and some waste burning. These disposal practices were conducted prior to enactment of Federal and State regulations governing the disposal of these materials.

The sources of elevated parameters in and adjacent to the security area are the result of historical and present activities. Identified potential sources are historical material handling practices, construction activities, and the use of deicing materials (i.e., road salt, calcium chloride).

5.5.3 Analyses

Analyses are performed on all groundwater samples in accordance with standard analytical methods as described in Reference (9) or other EPA approved methods and are performed by a New York State Department of Health Certified laboratory. The groundwater monitoring plan, Table 5-10, identifies the Kesselring Site monitoring wells and summarizes the frequency of analyses. The results for all samples collected in 1999 are discussed in Section 5.5.4.

As required by the New York State regulations (Reference 5), the landfill monitoring wells are sampled on a quarterly basis. The samples are analyzed for either baseline or routine parameters (Reference 5). The results are shown in Table 5-11.

Within the security area, the 19 monitoring wells are sampled annually for VOC and field parameter analyses. The results of the analyses are shown on Table 5-12.

The Kesselring Site also conducts radiological monitoring on the groundwater monitoring wells at the landfill area, the four former disposal sites, and the security area. The monitoring well locations are shown in Figures 5-3, 5-4, and 5-5. The results of the analyses are shown in Table 5-13.

Groundwater from five production wells located along the Site's eastern property boundary is used to supply the drinking water system at the Kesselring Site and is monitored to ensure compliance with New York State drinking water supply regulations defined in Reference (20). The analytical results of these required samples are shown in Table 5-14.

5.5.4 Assessment

<u>Landfill</u>:

Analytical results obtained during 1999 under both the original and the revised post-closure monitoring plan (Table 5-11) continue to show that certain parameters in groundwater are elevated in most of the downgradient wells when compared to the upgradient (background) wells. Individual parameters include; specific conductivity, alkalinity, hardness, total dissolved solids (TDS), total organic carbon (TOC), chloride, sulfate, iron, magnesium, manganese, potassium, sodium, calcium, 1,1-dichloroethane, chloroethane, dichlorodifluoromethane, trichloroethylene, and vinyl chloride. A number of other parameters, including biochemical oxygen demand (BOD), chemical oxygen demand (COD), ammonia, nitrate, barium, boron, and zinc while elevated in 1999, often exhibit variability and are generally elevated in only a few downgradient wells. During the second quarter 1999, surface water sampling was added to the monitoring program under the revised plan. Results show the presence of constituents similar to those in groundwater with the exclusion of specific conductivity, TOC, and VOCs.

Ground or surface water quality standards per Reference (1) or guidance values per Reference (21) were exceeded for a number of parameters. Parameters that have exceeded standards only in downgradient well samples include: TDS, ammonia, chloride, phenols, aluminum, barium, iron, "iron & manganese", magnesium, manganese, selenium, sodium, 1,1-dichloroethane, dichlorodifluoromethane, and chloroethane. Most detected metals are associated with suspended solids in the samples. Under the revised program filtered sample analyses are conducted when

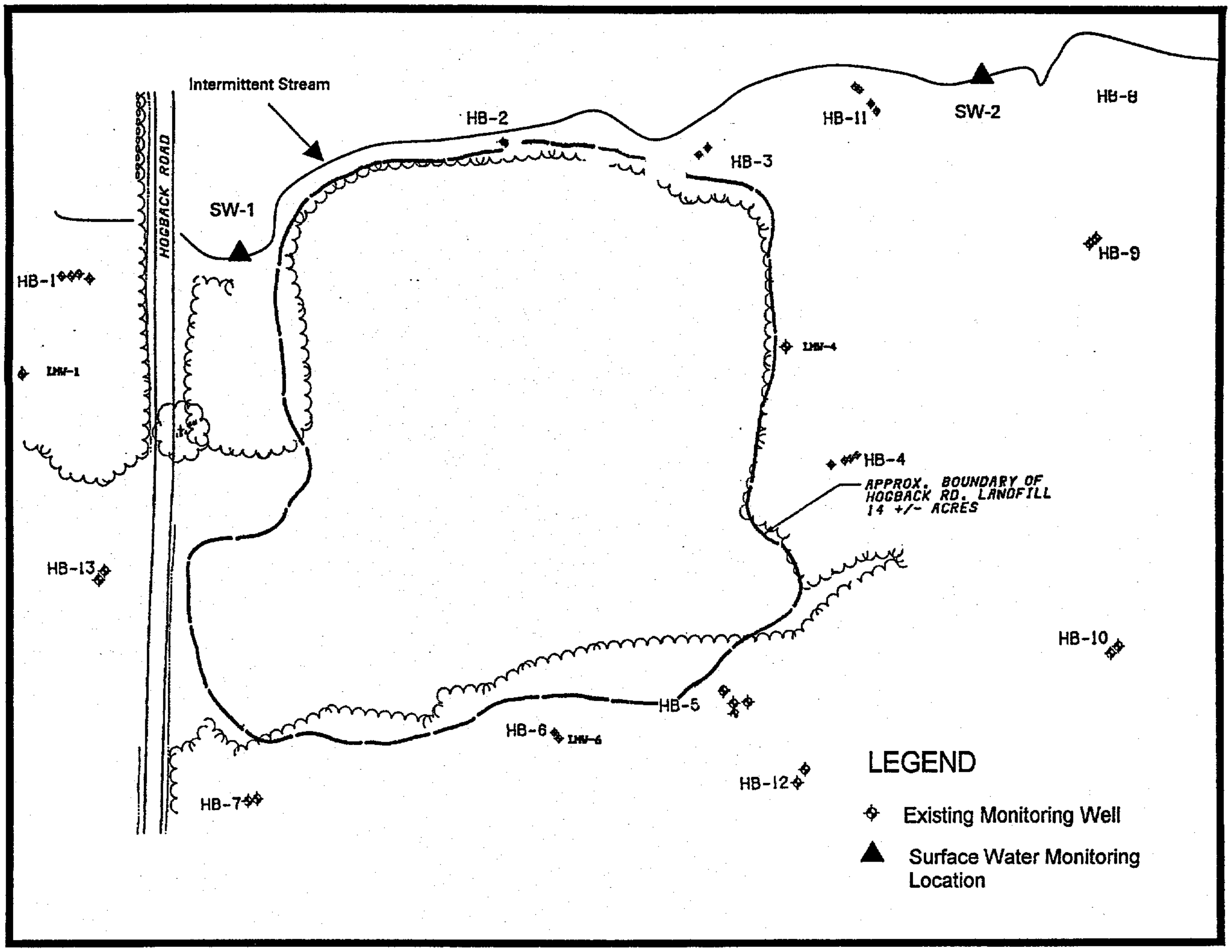


Figure 5-3
Kesselring Site, Near West Milton, New York
Landfill Groundwater Monitoring Wells

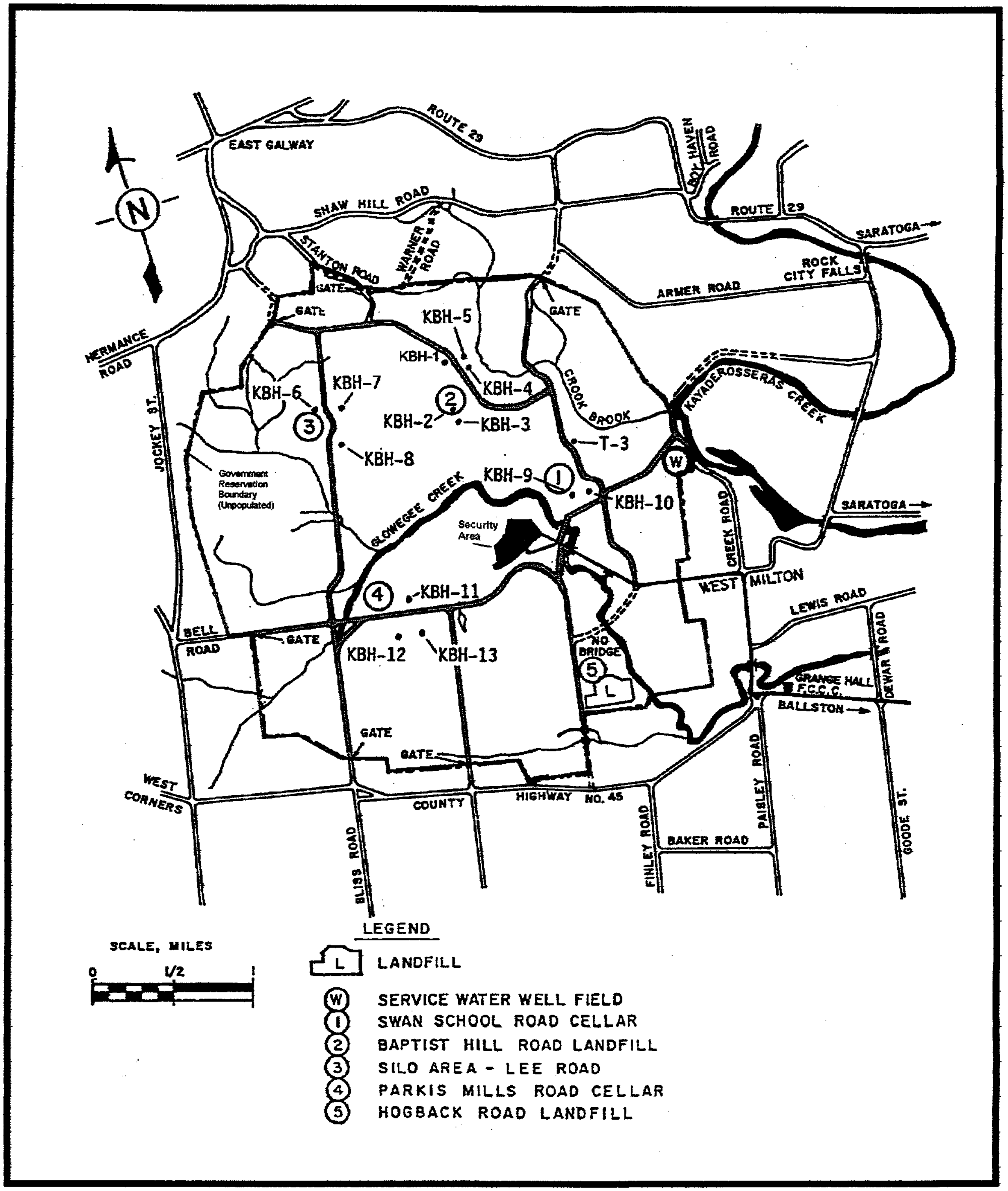


Figure 5-4
Kesselring Site, Near West Milton, New York
Disposal Areas – Groundwater Monitoring Wells

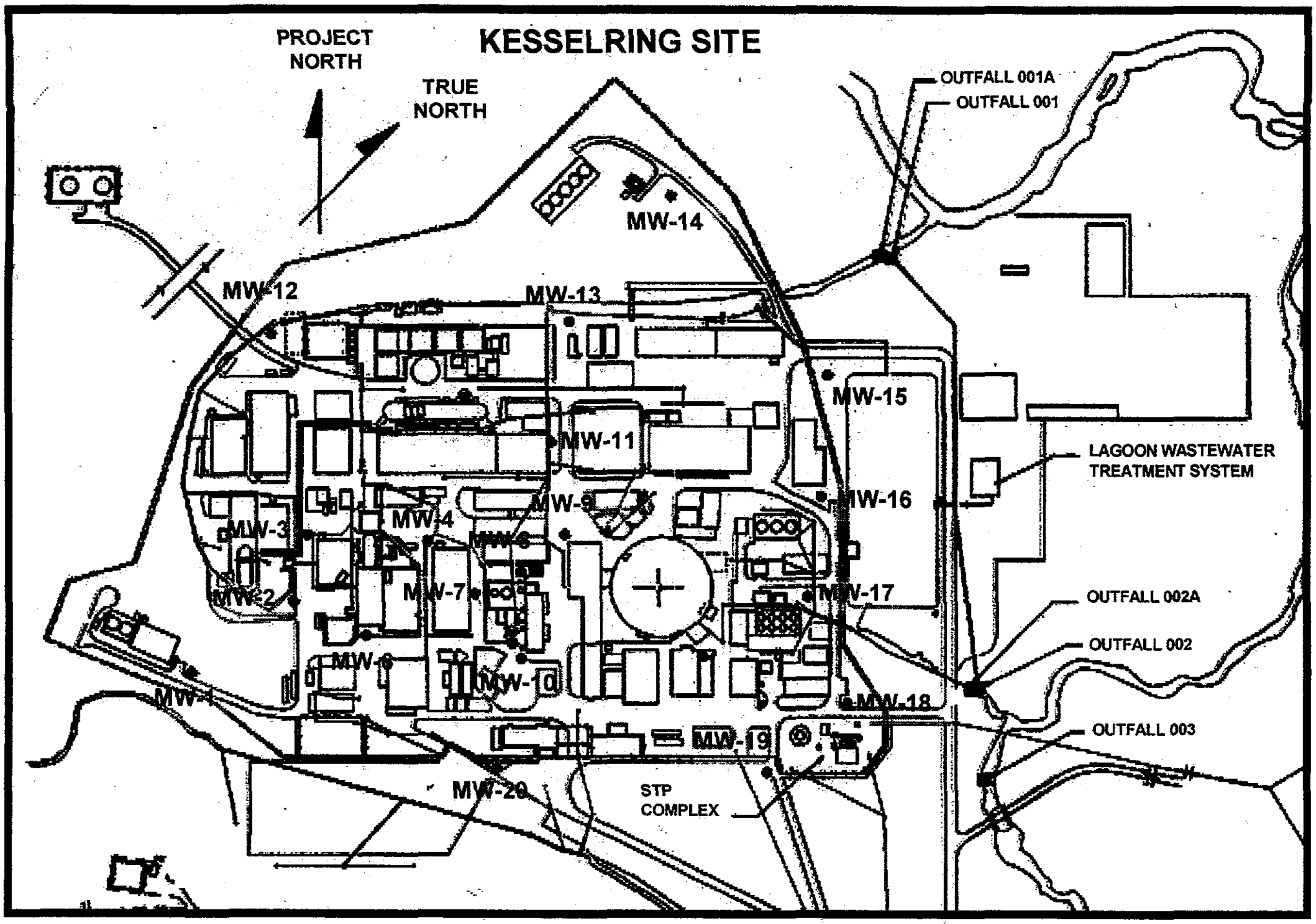


Figure 5-5
Kesselring Site, Near West Milton, New York
Security Area Groundwater Monitoring Wells

field measurements indicate an elevated sample turbidity greater than 50 nephelometric turbidity units (ntu) and typically show either non-detectable results or significantly lower levels of these metals.

The groundwater inorganic contaminants detected in downgradient well samples are within, or below, representative ranges for inorganic constituents typical of leachate from sanitary landfills per Reference (12).

Several VOCs at low parts per billion (ppb) concentrations were detected in samples collected in 1999. Consistent with historical monitoring results, only volatile chlorinated hydrocarbons were detected in downgradient monitoring well samples.

Former Disposal Sites:

The groundwater monitoring of the former disposal sites has been discontinued as discussed in Section 5.5.1.

Security Area:

The groundwater monitoring program has been revised and now entails field parameter measurements and VOC analyses as discussed in Section 5.5.1. Field parameters include groundwater elevation, temperature, pH, Eh, specific conductivity and turbidity. Two field parameters, turbidity and specific conductivity, were found to be elevated in most of the 19 security area monitoring wells sampled in 1999 and are consistent with historical data.

A total of seven VOCs were detected at low concentrations. Three VOCs are reported at the detection limit of 1 part per billion (ppb), while the other four ranged from 2 to 4 ppb. The detected compounds are presented in Table 5-12 and consist of cooling system fluids (trichlorofluoromethane, dichlorofluoromethane), cleaning solvents (trichloroethylene, tetrachloroethene, 1,1-dichloroethene), and two compounds not typically detected at the facility (xylenes-total and chloroform). Various chlorinated VOCs have been detected in low concentrations in security area wells since 1990.

Radioactivity:

Results of groundwater monitoring for radioactivity are summarized in Table 5-13. The levels of cesium-137 and cobalt-60 were below the detection limit in all wells. Tritium was detectable in six wells at levels very close to the detection limit. These low levels are attributed to naturally occurring tritium. The concentrations for these radionuclides were less than 0.1 percent of the respective Reference (4) derived concentration guide values.

Site Service (Drinking) Water:

Since groundwater is used for drinking water at the Kesselring Site, monitoring is performed to ensure its quality meets New York State drinking water regulations (Reference (20)). The results of all required Site service water monitoring are shown in Table 5-14. The Site service water well field is hydrogeologically separate from the Site landfill and former disposal sites and is consequently not effected by materials at those locations.

Conclusion:

Past waste disposal practices at the landfill have resulted in observable effects on groundwater quality downgradient of the landfill. However, historical data indicates that these constituents are not appreciably migrating or increasing in concentration. Based on historical monitoring results there is no apparent impact on groundwater quality associated with the four former solid waste disposal areas. Monitoring results within the security area show that some parameters are elevated. These results are attributed to continuing winter de-icing operations and other past operational practices. The 1999 groundwater data demonstrate no noticeable changes from historical monitoring results.

TABLE 5-10 KESSELRING SITE GROUNDWATER AND SURFACE WATER MONITORING PLAN, 1999

ID		Radioactivity	Baseline/ Routine[1,2]	Field Parameters & Volatile Organic Compounds Only
Security Area				
MW-1		A		A
MW-2 to 4		A		A
MW-6 to 20		A		A
Land Disposal Areas				
KBH-1 through KBH-13 & T-3		A		
Landfill				
Former Program			(3)	
LMW-1		A	Q/Q	
HB-2A		A	Q/Q	
HB-3A		A	Q/Q	
LMW-4		A	Q/Q	
HB-5A2		A	Q/Q	
LMW-6		A	Q/Q	
HB-7A		A	Q/Q	
Revised Program				
HB-1A		A	A/Q	
LMW-4		A	A/Q	
HB-5A2		A	A/Q	
LMW-6		A	A/Q	
HB-1B		A	A/Q	
HB-5B		A	A/Q	
HB-11B		A	A/Q	
SW-1[4]			A/Q	
SW-2[4]			A/Q	
HB-7A |		A	Baseline and Routine 2nd Qtr.	
HB-8A |	CYCLIC	A	Baseline and Routine 3rd Qtr.	
HB-9A |	WELLS	A	Baseline and Routine 4th Qtr.	
HB-11A |		A		
HB-4B |		A		

Notes: A = Annual
Q = Quarterly

(1) See Table 4-14 for a listing of parameters.
(2) Filtered metals are performed as necessary for verification of elevated metals which are attributable to sample turbidity (suspended clay/silt particles).
(3) All quarterly landfill sampling under the former program was for baseline list parameters.
(4) Surface Water

TABLE 5-11 RESULTS OF KESSELRING SITE LANDFILL WATER MONITORING, 1999

		ROUTINE PARAMETERS																
		FIELD (1)							INDICATOR (mg/l, or as indicated)									
ID	SAMPLE DATE	GW Elev./ SW Depth (feet)	Temper-ature (°C)	pH[2] (su)	Eh (mV)	Specific Conductivity (umhos/cm)[3]	Turbidity (ntu)[3]	Dissolved Oxygen (mg/l)	Alkalinity	Ammonia-N	COD	Chloride	Hardness, as $CaCO_3$	Nitrate-N	Phenols, Total	Sulfate	TDS	TOC
Groundwater - Unconsolidated																		
HB-1A[4]	06/08/99	484.55	11.9	7.4	183	247	498	--	87	<0.1	<5	<1	102	<0.02	<0.001	8.1	85	2.3
HB-1A[4]	09/09/99	480.77	13.9	7.9	177	230	203	--	110	<0.1	7.5	<1	113	<0.02	<0.001	4	100	2.1
HB-1A[4]	11/10/99	483.83	11.9	6.2	199	321	233	--	100	<0.1	61	<1	112	<0.02	<0.001	5.2	118	2
LMW-1[4]	03/11/99	487.44	5.4	7.8	175	284	52	--	100	<0.1	<5	<1	111	<0.02	<0.001	14	115	<1
HB-2A	03/11/99	471.1	6.5	7.1	183	742	540	--	150	0.3	22	73	216	0.11	<0.001	16	308	6.3
HB-3A	03/11/99	466.75	6.5	6.9	182	751	>1000	--	320	<0.1	135	17	552	1.7	<0.001	19	340	4.1
LMW-4	03/11/99	466.57	6.6	6.8	191	1423	740	--	330	0.3	22	90	514	0.58	<0.001	80	620	6.4
LMW-4	06/08/99	464.96	13.7	6.6	75	2230	281	--	650	1	22	244	699	0.2	NS	155	1120	5.4
LMW-4	11/10/99	464.25	12.5	6.9	165	696	>1000	--	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
HB-5A2	03/11/99	451.93	6.5	6.4	-104	3270	90	--	590	0.2	7.5	497	898	0.21	<0.001	51	1500	4.5
HB-5A2	06/08/99	451.28	13.7	6.6	72	1502	23	--	565	0.1	<5	164	465	0.1	<0.001	26	675	3.4
HB-5A2	11/10/99	450.61	10.2	6.3	48	1657	351	--	610	0.2	11	417	895	0.04	<0.001	50	1362	3.3
LMW-6	03/11/99	457.95	8.1	6.4	1	1720	11	--	490	<0.1	<5	100	585	0.05	<0.001	131	795	2.4
LMW-6	06/08/99	457.8	13.5	6.7	191	1489	13.6	--	450	<0.1	<5	142	480	0.08	<0.001	46	722	8.9
LMW-6	09/09/99	457.41	12.4	6.3	141	1410	10.3	--	495	<0.1	7.5	110	614	<0.02	<0.001	65	748	2.6
LMW-6	11/10/99	458.77	12.9	6.6	84	670	10	--	515	<0.1	<5	93	591	<0.02	<0.001	130	879	2.2
HB-7A	03/11/99	464.7	5.4	7.1	8	874	130	--	340	<0.1	<5	20	396	0.69	<0.001	39	392	1.6
HB-7A	06/08/99	462.39	11	6.5	211	981	61	--	440	<0.1	<5	17	388	0.74	<0.001	37	368	1.2
HB-7A QC	03/11/99	--	--	--	--	--	--	--	350	<0.1	<5	20	414	0.69	<0.001	39	398	1
HB-8A	09/09/99	448.42	13.5	6.5	126	900	122	--	350	<0.1	<5	52	428	<0.02	<0.001	38	425	1.2
HB-9A	11/10/99	453.12	10.8	6.6	183	679	105	--	264	<0.1	7.5	51	398	0.1	<0.001	33	388	<1
HB-9A QC	11/10/99	--	--	--	--	--	--	--	260	<0.1	11	51	430	0.1	<0.001	33	372	1.1
Standard / Criteria (5)																		
Groundwater		NC	NC	6.5-8.5	NC	NC	5	NC	NC	2	NC	250	NC	10	0.001	250	500	NC

TABLE 5-11 RESULTS OF KESSELRING SITE LANDFILL WATER MONITORING, 1999 (Continued)

		ROUTINE PARAMETERS																
		FIELD (1)							INDICATOR (mg/l, or as indicated)									
ID	SAMPLE DATE	GW Elev./ SW Depth (feet)	Temper-ature (°C)	pH[2] (su)	Eh (mV)	Specific Conductivity (umhos/cm)[3]	Turbidity (ntu)[3]	Dissolved Oxygen (mg/l)	Alkalinity	Ammonia-N	COD	Chloride	Hardness, as $CaCO_3$	Nitrate-N	Phenols, Total	Sulfate	TDS	TOC
Groundwater - Bedrock																		
HB-1B[4]	06/08/99	485.59	13.1	6.6	228	487	37	- -	265	2.4	<5	1.2	124	0.18	<0.001	4.4	228	1.5
HB-1B[4]	09/09/99	482.5	10.9	6.4	178	590	54	- -	260	2.5	<5	1	101	0.1	0.004	5.3	242	<1
HB-1B[4]	11/10/99	485.33	9.7	7.7	163	343	32	- -	265	4	7.5	1.2	108	0.15	<0.001	5.1	245	1
HB-5B	06/08/99	451.49	14	7.3	-18	2350	56	- -	545	0.6	<5	482	667	<0.02	<0.001	34	1370	2.1
HB-5B	09/09/99	449.81	11.6	7	10	2200	27	- -	520	0.2	7.5	501	930	<0.02	<0.001	42	1360	2.5
HB-5B	11/10/99	450.89	10.6	6.7	28	1927	16	- -	550	0.4	11	492	733	<0.02	<0.001	45	1448	2.1
HB-5B QC	09/09/99	- -	- -	- -	- -	- -	- -	- -	570	0.2	<5	497	930	<0.02	<0.001	42	1370	2.3
HB-11B	06/08/99	460.81	12.4	6.7	139	1205	192	- -	460	0.4	104	49	789	0.04	<0.001	28	492	1.3
HB-11B	09/09/99	458.95	12.8	6.5	109	500	13.3	- -	360	<0.1	11	41	390	<0.02	<0.001	23	462	2
HB-11B	11/10/99	459.96	11.8	6.6	175	660	8	- -	365	0.2	<5	44	370	0.06	<0.001	23	468	2.3
HB-11B QC	06/08/99	- -	- -	- -	- -	- -	- -	- -	450	0.4	176	49	620	0.23	<0.001	28	485	3.4
Surface Water																		
SW-1	06/08/99	0.5	20.1	6.5	178	704	140	4.5	150	0.1	90	18	136	0.13	NS	2.6	152	6
SW-1	11/10/99	0.2	9.8	6.6	272	590	80	5.6	70	<0.1	69	6.9	120	0.15	<0.001	47	150	4.4
SW-2	06/08/99	0.5	18.3	6.9	120	583	7	5.5	240	<0.1	7.5	31	249	0.09	<0.001	16	292	4.4
SW-2	11/10/99	0.4	9.3	6.6	125	477	18	6	270	<0.1	41	38	313	0.04	<0.001	40	372	4
SW-2 QC	06/08/99	- -	- -	- -	- -	- -	- -	- -	240	<0.1	26	31	254	0.09	<0.001	16	302	2.7
SW-2 QC	11/10/99	- -	- -	- -	- -	- -	- -	- -	250	<0.1	41	39	296	0.56	<0.001	41	388	3
Standard / Criteria (5)																		
Groundwater		NC	NC	6.5-8.5	NC	NC	5	NC	NC	2	NC	250	NC	10	0.001	250	500	NC
Surface Water		NC	NC	6.5-8.5 6.0-9.5[6]	NC	NC	NC	5.0 (min.) 3.0 (min.)[6]	NC	1.5	NC	NC	NC	NC	NC	NC	500	NC

TABLE 5-11 RESULTS OF KESSELRING SITE LANDFILL WATER MONITORING, 1999 (Continued)

		ROUTINE PARAMETERS (continued)						
		METALS (mg/l) (7,8)						
ID	SAMPLE DATE	Calcium	Iron	Lead	Magnesium	Manganese	Potassium	Sodium
Groundwater - Unconsolidated								
HB-1A(4)	06/08/99	30/25	0.34/<0.05	<0.005	6.7/5.9	0.13/<0.01	0.5/<0.5	1.4/2.3
HB-1A(4)	09/09/99	32.8/29.2	2.66/<0.05	<0.005	7.5/6.8	0.24/<0.02	0.7/0.5	2/2
HB-1A(4)	11/10/99	33/32	0.68/<0.05	<0.005	7.3/7.1	0.06/<0.02	0.5/<0.5	2.1/2.2
LMW-1(4)	03/11/99	32/30.8	0.52/<0.05	<0.005	7.5/7.3	0.02/<0.02	0.8/<0.5	2/1.9
HB-2A	03/11/99	69/66.5	32.6/<0.05	<0.005	10.8/10.8	0.75/0.45	0.9/0.9	33.4/35
HB-3A	03/11/99	182/101	5/<0.05	<0.005	23.7/16.5	3.44/0.03	1.4/0.9	10.4/10.7
LMW-4	03/11/99	168/123	13.1/<0.05	0.023/<0.005	23.1/16.5	0.51/0.13	2.9/2.6	52.4/44.8
LMW-4	06/08/99	240/224	5.17/0.07	<0.005	24/25	0.65/0.52	7.8/7.7	127/123
LMW-4	11/10/99	95	0.99	<0.005	14	0.3	1.9	24
HB-5A2	03/11/99	301/296	<0.05	<0.005	36.3/35.7	1.32/1.8	2.2/3	183/178
HB-5A2	06/08/99	160/159	4.15/0.24	<0.005	16/14	0.99/1	4.8/4.7	88/87
HB-5A2	11/10/99	317/270	13/0.68	<0.005	25/22	0.24/0.21	5.4/5	131/128
LMW-6	03/11/99	167/178	1.63/<0.05	<0.005	40.8/48	1.29/1.42	2.4/<0.5	64.5/73
LMW-6	06/08/99	161/165	0.86/<0.05	<0.005	19/20	1.86/1.83	1.7/1.8	69/74
LMW-6	09/09/99	214/177	1.1/<0.05	<0.005	19.5/19	3.89/3.55	2.1/2.1	93.3/91.8
LMW-6	11/10/99	202	2.34	<0.005	21	0.22	3.1	75
HB-7A	03/11/99	116/113	1.03/<0.05	<0.005	25.7/24.7	0.1/<0.02	0.8/0.5	13.6/14.3
HB-7A	06/08/99	121/94	1.33/<0.05	<0.005	21/18	0.19/<0.02	1.3/1.1	15/15
HB-7A QC	03/11/99	123/117	1.02/<0.05	<0.005	26/25.3	0.1/<0.02	2.2/1.2	14.5/14.8
HB-8A	09/09/99	138/108	10/<0.05	<0.005	20/17.7	0.51/<0.02	2.8/0.9	38.8/38.3
HB-9A	11/10/99	125/92	1.88/0.06	<0.005	21/17	0.11/<0.02	1.4/1.1	23/22
HB-9A QC	11/10/99	136/92	2.2/0.08	<0.005	22/17	0.14/<0.02	1.5/1.1	23/22

TABLE 5-11 RESULTS OF KESSELRING SITE LANDFILL WATER MONITORING, 1999 (Continued)

		ROUTINE PARAMETERS (continued)						
		METALS (mg/l) (7,8)						
ID	SAMPLE DATE	Calcium	Iron	Lead	Magnesium	Manganese	Potassium	Sodium
Groundwater - Bedrock								
HB-1B(4)	06/08/99	30/18	0.34/<0.05	<0.005	12/11	<0.01	5/5.1	61/65
HB-1B(4)	09/09/99	19.6/17.4	0.22/<0.05	<0.005	12.7/11.8	<0.02	5.8/5.7	70/70
HB-1B(4)	11/10/99	22	0.19	<0.005	13	0.02	5.6	58
HB-5B	06/08/99	221/207	5.12/0.36	<0.005	28/28	0.58/0.52	5.7/5.5	172/172
HB-5B	09/09/99	279/240	9.6/1.74	<0.005	56.7/31	0.8/0.8	4.2/4.4	236/200
HB-5B	11/10/99	249	9.29	<0.005	27	0.17	8	144
HB-5B QC	09/09/99	280/243	10.5/1.25	<0.005	56/31	0.83/0.82	4.4/4	228/197
HB-11B	06/08/99	276/116	10/0.12	0.007/<0.005	24/22	0.35/0.02	2.8/2.2	49/48
HB-11B	09/09/99	121/117	0.19/<0.05	<0.005	21.4/21.4	<0.02	2.5/2.5	38.8/38.8
HB-11B	11/10/99	117	0.16	<0.005	19	<0.02	2.4	34
HB-11B QC	06/08/99	210/111	6.08/0.06	<0.005	23/21	0.21/0.02	2.4/2.1	48/46
Surface Water								
SW-1(4)	06/08/99	41/41	0.82/0.05	<0.005	8.4/8.7	0.43/0.08	0.5/<0.5	13/14
SW-1(4)	11/10/99	36	0.32	<0.005	7.4	0.11	<0.5	8.2
SW-2	06/08/99	80/80	0.1/<0.05	<0.005	12/13	0.16/0.05	1/1.1	16/18
SW-2	11/10/99	102	1.44	<0.005	14	0.18	2	26
SW-2 QC	06/08/99	82/85	0.08/<0.05	<0.005	12/13	0.14/0.08	1/1.1	17/18
SW-2 QC	11/10/99	95	0.99	<0.005	14	0.3	1.9	24
Standard / Criteria (5)								
Groundwater		NC	0.3	0.025	35.0(g)	0.3	NC	20
Surface Water		NC	0.300	(9)	NC	NC	NC	NC

TABLE 5-11 RESULTS OF KESSELRING SITE LANDFILL WATER MONITORING, 1999 (Continued)

		BASELINE PARAMETERS (10)													
		INDICATOR (mg/l, or as indicated)			METALS (mg/l) (7,8)						VOLATILES (ug/l) (7)				
ID	SAMPLE DATE	BOD (5 day)	Color	TKN	Aluminum	Barium	Boron	Chromium	Selenium	Zinc	1,1- Dichloro-ethane	Chloro-ethane	Dichloro-difulouro-methane	Trichloro-ethylene	Vinyl Chloride
Groundwater - Unconsolidated															
HB-1A(4)	06/08/99	<2	10	1.4	1.6/0.1	0.02/0.02	<0.05	<0.005	<0.005	0.03/<0.01	<1	<1	<1	<1	<1
HB-1A(4)	09/09/99	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
HB-1A(4)	11/10/99	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
LMW-1(4)	03/11/99	<2	<5	<1	0.3/<0.1	0.01/<0.01	<0.05	<0.005	<0.005	0.01/<0.01	<1	<1	<1	<1	<1
HB-2A	03/11/99	4	<5	<1	0.3/<0.1	0.16/0.08	<0.05	<0.005	<0.005	0.02/<0.01	<1	<1	<1	<1	<1
HB-3A	03/11/99	<2	<5	<1	6/0.1	0.24/0.02	<0.05	<0.005	<0.005	0.07/<0.01	<1	<1	<1	<1	<1
LMW-4	03/11/99	<2	<5	<1	2.4/0.1	0.2/0.09	0.16/0.11	<0.005	<0.005	0.07/0.01	2	1	4	<1	<1
LMW-4	06/08/99	<2	5	2.2	0.8/<0.1	0.18/0.14	0.56/0.54	<0.005	<0.005	0.03/<0.01	4	4	6	<1	<1
LMW-4	11/10/99	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
HB-5A2	03/11/99	<2	<5	<1	0.4/0.2	0.3/0.27	0.09/0.08	<0.005	<0.005	0.02/0.02	3	8	1	<1	<1
HB-5A2	06/08/99	<2	5	<1	0.2/<0.1	0.15/0.16	<0.05	<0.005	<0.005	<0.01	6	17	3	<1	1
HB-5A2	11/10/99	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
LMW-6	03/11/99	<2	<5	<1	<0.1	0.08/0.08	0.06/<0.05	<0.005	<0.005	0.01/0.01	<1	<1	<1	1	<1
LMW-6	06/08/99	<2	<5	<1	0.1/0.1	0.06/0.07	<0.05	<0.005	<0.005	0.16/<0.01	<1	<1	<1	1	<1
LMW-6	09/09/99	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
LMW-6	11/10/99	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
HB-7A	03/11/99	<2	<5	<1	0.5/<0.1	0.04/0.04	<0.05	<0.005	<0.005	0.01/<0.01	<1	<1	<1	2	<1
HB-7A	06/08/99	<2	5	<1	0.8/<0.1	0.05/0.03	<0.05	<0.005	<0.005	<0.01	<1	<1	<1	2	<1
HB-7A QC	03/11/99	<2	<5	<1	0.5/<0.1	0.05/0.04	<0.05	<0.005	<0.005	0.01/<0.01	<1	<1	<1	2	<1
HB-8A	09/09/99	<2	5	<1	4.5/<0.1	0.18/0.08	0.2/0.2	0.008/<0.005	0.51/<0.005	0.33/<0.01	2	<1	<1	<1	<1
HB-9A	11/10/99	<2	5	<1	1/<0.1	0.06/0.03	<0.05	<0.005	<0.005	0.01/<0.01	1	<1	<1	<1	<1
HB-9A QC	11/10/99	<2	5	<1	1.2/<0.1	0.05/0.03	<0.05	<0.005	<0.005	0.08/0.01	2	<1	<1	<1	<1
Standard / Criteria (5)															
Groundwater		NC	15	NC	NC	1	1	0.05	0.01	2.0(g)	5	5	5	5	2

TABLE 5-11 RESULTS OF KESSELRING SITE LANDFILL WATER MONITORING, 1999 (Continued)

		BASELINE PARAMETERS [10]													
		INDICATOR (mg/l, or as indicated)			METALS (mg/l) (7,8)						VOLATILES (ug/l) (7)				
ID	SAMPLE DATE	BOD (5 day)	Color	TKN	Aluminum	Barium	Boron	Chromium	Selenium	Zinc	1,1- Dichloro-ethane	Chloro-ethane	Dichloro-difulouro-methane	Trichloro-ethylene	Vinyl Chloride
Groundwater - Bedrock															
HB-1B[4]	06/08/99	10	5	3.4	0.3/<0.1	2.05/1.67	0.72/0.71	<0.005	<0.005	0.01/<0.01	<1	<1	<1	<1	<1
HB-1B[4]	09/09/99	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
HB-1B[4]	11/10/99	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
HB-5B	06/08/99	<2	5	<1	0.1/<0.1	0.74/0.67	0.1/0.11	<0.005	<0.005	0.01/<0.01	<1	2	2	<1	<1
HB-5B	09/09/99	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
HB-5B	11/10/99	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
HB-5B QC	09/09/99	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
HB-11B	06/08/99	<2	5	3.1	1.1/0.1	0.51/0.23	0.21/0.23	<0.005	<0.005	0.06/<0.01	<1	<1	<1	<1	<1
HB-11B	09/09/99	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
HB-11B	11/10/99	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
HB-11B QC	06/08/99	<2	<5	2.5	0.6/<0.1	0.33/0.22	0.21/0.21	<0.005	<0.005	0.02/<0.01	<1	<1	<1	<1	<1
Surface Water															
SW-1[4]	06/08/99	<2	20	3.1	0.7/<0.1	0.03/0.02	<0.05	<0.005	<0.005	0.04/<0.01	<1	<1	<1	<1	<1
SW-1[4]	11/10/99	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
SW-2	06/08/99	<2	10	<1	0.2/<0.1	0.04/0.04	0.05/0.05	<0.005	<0.005	0.02/<0.01	<1	<1	<1	<1	<1
SW-2	11/10/99	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
SW-2 QC	06/08/99	2	10	<1	0.1/<0.1	0.04/0.04	0.05/0.05	<0.005	<0.005	<0.01	<1	<1	<1	<1	<1
SW-2 QC	11/10/99	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Standard / Criteria (5)															
Groundwater		NC	15	NC	NC	1	1	0.05	0.01	2.0(g)	5	5	5	5	2
Surface Water		NC	NC	NC	0.100	NC	10	(9)	0.0046	(9)	NC	NC	NC	NC	NC

NOTES for TABLE 5-11

(1) Compounds that are not detected during analysis are reported in the table as less than (<) the detection limit.

(2) Laboratory analyzed pH was used during 3/11/99 due to a malfunction of the field pH instrument.

(3) Parameters were laboratory analyzed prior to the second quarter 1999 and have been subsequently field analyzed.

(4) Upgradient well

(5) Groundwater standards taken from 6NYCRR Part 703.3, dated September 1991 and from Part 703.5, dated March 1998. Additional water standards and guidance values taken from Technical & Operational Guidance Series (TOGS) 1.1.1,Ambient Water Quality Standards and Guidance Values, Revised; June 1998.

(6) NYSDEC standard for a Class D waterway (intermittent stream) . This is the actual classification of the water body being sampled.

(7) Compounds analyzed but not detected in any of the presented sampling rounds are not listed in the table. All samples were analyzed for either Baseline or Routine parameters. These parameters are presented in Table 4-14.

(8) For samples with turbidity >50 ntu's, metals are analyzed for both total (unfiltered) *and* for filtered results. When the total concentrations for a metal are below detection limits, the filtered value is not presented. Filtered sample analysis data is shown following the total result, (i.e. total # / filtered #)

(9) Standard is determined by formula:
Chromium – A(C) (0.86) exp (0.819 [ln (ppm hardness)] + 0.6848
Lead - A(C) (1.46203 - [ln (hardness) (0.145712)]) exp (1.273 [ln (hardness)] - 4.297)
Zinc - A(C) exp (0.85 [ln (ppm hardness)] + 0.50)

(10) During the 4th Quarter, only HB-09A was sampled for the additional Baseline parameters. These results were compared to the most recent background well data (6/8/99).

(g) = Groundwater Guidance Value.
NS = Not Sampled
NC = No Criteria Available (no standards or guidance values per 6NYCRR Part 703 or TOGS 1.1.1)
-- No Analysis Data

mg/l – milligrams/liter
BOD – biochemical oxygen demand
ug/l – micrograms/liter
mv – millvolts
umhos/cm – micromhos/centimeter
ntu – nephelometric turbity units
cpu – cobalt platium unit
COD – chemical oxygen demand
TDS – total dissolved solids
TKN – total kjeldahl nitrogen - N
TOC – total organic carbon
QC - duplicate sample

TABLE 5-12 RESULTS OF KESSELRING SITE GROUNDWATER MONITORING, SECURITY AREA WELLS, 1999

		Volatile Organic Compound, ug/l						
		Freons		Solvents			Other	
Well	Sample Date	Dichloro-difluoromethane	Trichloro-fluoromethane	1,1-dichloro-ethylene	Trichloro-ethylene	Tetrachloro-ethylene	Chloroform	Xylenes, total
MW-1[(1)]	11/17/99	<1	<1	<1	<1	<1	3	<1
MW-2	11/22/99	<1	<1	1	<1	<1	<1	<1
MW-4	11/23/99	4	<1	<1	4	<1	<1	<1
MW-6	11/22/99	<1	<1	<1	<1	1	<1	<1
MW-8	11/19/99	<1	<1	<1	<1	<1	<1	1
MW-16	11/17/99	<1	2	<1	<1	<1	<1	<1
Standard[(2)]		5	5	5	5	5	5	5
Detection Level		1	1	1	1	1	1	1

(1) Upgradient well

(2) Division of Water, Technical Operation Guidance Series (TOGS) (1.1.1) Ambient Water Quality Standards and Guidance Values.

TABLE 5-13 RESULTS OF KESSELRING SITE GROUNDWATER MONITORING FOR RADIOACTIVITY[1] – 1999

Location	Cs-137	Co-60	Tritium
	pCi/liter		pCi/liter x10^2
LANDFILL AREA			
HB-1A	<1.0	<1.0	<1.8
HB-1B	<1.0	<0.9	<1.8
HB5A2	<1.0	<0.9	<1.8
HB-5B	<1.0	<0.9	<1.8
HB-7A	<1.0	<0.9	<1.8
LMW-6	<1.1	<1.0	<1.8
HB-11B	<1.0	<0.9	<1.8
SECURITY AREA			
MW-1[2]	WELL DRY,NOT SAMPLED		
MW-2	<1.0	<0.9	<1.4
MW-3	<0.9	<0.9	<1.4
MW-4	<1.0	<0.9	<1.4
MW-6	<1.0	<0.9	<1.4
MW-7	<0.9	<0.9	<1.4
MW-8	<0.9	<0.9	<1.4
MW-9	<1.0	<0.9	<1.4
MW-10	<1.0	<1.0	<1.4
MW-11	<1.0	<0.9	1.7±0.7
MW-12	<1.0	<0.9	1.4
MW-13	<1.0	<1.0	2.6±0.8
MW-14	<1.0	<0.9	1.5±0.7
MW-15	<1.0	<1.0	<1.4
MW-16	<1.0	<0.9	1.7±0.7
MW-17	<1.0	<0.8	<1.4
MW-18	<1.0	<0.9	1.6±0.7
MW-19	<1.0	<0.9	<1.4
MW-20	<1.0	<0.9	2.0±0.7
BAPTIST HILL ROAD LANDFILL			
KBH-1[2]	<1.0	<1.0	<1.5
KBH-2	<1.0	<1.0	<1.6
KBH-3	<1.0	<0.8	<1.6
KBH-4	<1.0	<0.9	<1.5
KBH-5	WELL DAMAGED, NOT SAMPLED		
SILO AREA			
KBH-6[2]	<1.0	<1.0	<1.5
KBH-7	WELL DRY, NOT SAMPLED		
KBH-8	WELL DRY, NOT SAMPLED		
SWAN SCHOOL ROAD CELLAR			
KBH-9	WELL DRY, NOT SAMPLED		
KBH-10	<1.0	<0.9	<1.5
PARKIS MILLS ROAD CELLAR			
KBH-11[2]	WELL DRY, NOT SAMPLED		
KBH-12	WELL DRY, NOT SAMPLED		
KBH-13	WELL DRY, NOT SAMPLED		

Notes: (1) A value preceded by < is less than minimum detection level for that sample and parameter. The (±) value represents the statistical error at two standard deviations.
(2) Background well for comparison purposes.

TABLE 5-14 – CHEMICAL CONSTITUENTS IN KESSELRING SITE DRINKING WATER, 1999

Parameter/Units [2]	Number of Samples	Value [1] Minimum	Maximum	Average [3]	Standard[4]	Percent of Standard [5]
Drinking Water Standards (Reference 20)						
Nitrates (mg/l as N)	1	0.23	0.23	0.23	10	2.3
Nitrites (mg/l as N)	1	<0.02	<0.02	<0.02	1	<2
Total Coliform [6] [8]	44	<1	<1	<1	None Detectable	--
Residual Chlorine (mg/l) [8][9]	599	<0.001	24.0	0.84	Detectable	--
Fluoride	1	0.21	0.21	0.21	2.2	9.5
Total Cyanide	1	<0.01	<0.01	<0.01	0.2	<5
Arsenic	1	<0.005	<0.005	<0.005	0.05	<10
Barium	1	<0.01	<0.01	<0.01	2.0	<0.5
Beryllium	1	<0.004	<0.004	<0.004	0.004	<100
Cadmium	1	<0.005	<0.005	<0.005	0.005	<100
Chromium	1	<0.005	<0.005	<0.005	0.1	<5
Mercury	1	<0.0004	<0.0004	<0.0004	0.002	<20
Selenium	1	<0.005	<0.005	<0.005	0.01	<50
Antimony	1	<0.006	<0.006	<0.006	0.006	<100
Nickel	1	<0.05	<0.05	<0.05	0.1	<50
Thallium	1	<0.002	<0.002	<0.002	0.002	<100
Benzene [7]	2	<0.0005	<0.0005	<0.0005	0.005	<10
Bromobenzene [7]	2	<0.0005	<0.0005	<0.0005	0.005	<10
Bromochloromethane [7]	2	<0.0005	<0.0005	<0.0005	0.005	<10
Bromomethane [7]	2	<0.0005	<0.0005	<0.0005	0.005	<10
N-Butylbenzene [7]	2	<0.0005	<0.0005	<0.0005	0.005	<10
sec-Butylbenzene [7]	2	<0.0005	<0.0005	<0.0005	0.005	<10
tert-Butylbenzene [7]	2	<0.0005	<0.0005	<0.0005	0.005	<10
Carbon Tetrachloride [7]	2	<0.0005	<0.0005	<0.0005	0.005	<10
Chlorobenzene [7]	2	<0.0005	<0.0005	<0.0005	0.005	<10
Chloroethane [7]	2	<0.0005	<0.0005	<0.0005	0.005	<10
Chloromethane [7]	2	<0.0005	<0.0005	<0.0005	0.005	<10
2-Chlorotoluene [7]	2	<0.0005	<0.0005	<0.0005	0.005	<10
4-Chlorotoluene [7]	2	<0.0005	<0.0005	<0.0005	0.005	<10
Dibromomethane [7]	2	<0.0005	<0.0005	<0.0005	0.005	<10
1,2-Dichlorobenzene [7]	2	<0.0005	<0.0005	<0.0005	0.005	<10
1,3- Dichlorobenzene [7]	2	<0.0005	<0.0005	<0.0005	0.005	<10
1,4- Dichlorobenzene [7]	2	<0.0005	<0.0005	<0.0005	0.005	<10
Dichlorodifluoromethane [7]	2	<0.0005	<0.0005	<0.0005	0.005	<10
1,1-Dichloroethane [7]	2	<0.0005	<0.0005	<0.0005	0.005	<10
1,2-Dichloroethane [7]	2	<0.0005	<0.0005	<0.0005	0.005	<10
1,1-Dichloroethene [7]	2	<0.0005	<0.0005	<0.0005	0.005	<10
cis-1,2-Dichloroethene [7]	2	<0.0005	<0.0005	<0.0005	0.005	<10
trans-1,2-Dichloroethene [7]	2	<0.0005	<0.0005	<0.0005	0.005	<10
1,2-Dichloropropane [7]	2	<0.0005	<0.0005	<0.0005	0.005	<10
1,3-Dichloropropane [7]	2	<0.0005	<0.0005	<0.0005	0.005	<10
2,2-Dichloropropane [7]	2	<0.0005	<0.0005	<0.0005	0.005	<10
1,1-Dichloropropene [7]	2	<0.0005	<0.0005	<0.0005	0.005	<10
cis-1,3-Dichloropropene [7]	2	<0.0005	<0.0005	<0.0005	0.005	<10
trans-1,3-Dichloropropene [7]	2	<0.0005	<0.0005	<0.0005	0.005	<10
Ethylbenzene [7]	2	<0.0005	<0.0005	<0.0005	0.005	<10
Hexachlorobutadiene [7]	2	<0.0005	<0.0005	<0.0005	0.005	<10
Isopropylbenzene [7]	2	<0.0005	<0.0005	<0.0005	0.005	<10
p-Isopropyltoluene [7]	2	<0.0005	<0.0005	<0.0005	0.005	<10
Methylene Chloride [7]	2	<0.0005	<0.0005	<0.0005	0.005	<10
n-Propylbenzene [7]	2	<0.0005	<0.0005	<0.0005	0.005	<10
Styrene [7]	2	<0.0005	<0.0005	<0.0005	0.005	<10
1,1,1,2-Tetrachloroethane [7]	2	<0.0005	<0.0005	<0.0005	0.005	<10
1,1,2,2- Tetrachloro-ethane [7]	2	<0.0005	<0.0005	<0.0005	0.005	<10
Tetrachloroethene [7]	2	<0.0005	<0.0005	<0.0005	0.005	<10
Toluene [7]	2	<0.0005	<0.0005	<0.0005	0.005	<10

TABLE 5-14 – CHEMICAL CONSTITUENTS IN KESSELRING SITE DRINKING WATER, 1999 (continued)

Parameter/Units [2]	Number of Samples	Value [1] Minimum	Maximum	Average [3]	Standard[4]	Percent Of Standard [5]
Drinking Water Standards (Reference 19)						
1,2,3-Trichlorobenzene [7]	2	<0.0005	<0.0005	<0.0005	0.005	<10
1,2,4-Trichlorobenzene [7]	2	<0.0005	<0.0005	<0.0005	0.005	<10
1,1,1-Trichloroethane [7]	2	<0.0005	<0.0005	<0.0005	0.005	<10
1,1,2-Trichloroethane [7]	2	<0.0005	<0.0005	<0.0005	0.005	<10
Trichloroethene [7]	2	<0.0005	<0.0005	<0.0005	0.005	<10
Trichlorofluoromethane [7]	2	<0.0005	<0.0005	<0.0005	0.005	<10
1,2,3-Trichloropropane [7]	2	<0.0005	<0.0005	<0.0005	0.005	<10
1,2,4-Trimethylbenzene [7]	2	<0.0005	<0.0005	<0.0005	0.005	<10
1,3,5-Trimethylbenzene [7]	2	<0.0005	<0.0005	<0.0005	0.005	<10
m-Xylene [7]	2	<0.0005	<0.0005	<0.0005	0.005	<10
o-Xylene [7]	2	<0.0005	<0.0005	<0.0005	0.005	<10
p-Xylene [7]	2	<0.0005	<0.0005	<0.0005	0.005	<10
Vinyl Chloride [7]	2	<0.0005	<0.0005	<0.0005	0.005	<10

Notes:

(1) A value preceded by < is less than the minimum detection level for that sample and parameter.
(2) All samples were collected at the entry point to the distribution system unless otherwise noted.
(3) Average values preceded by < contain at least one less than minimum detection level value in the average.
(4) Maximum Contaminant level per 10 NYCRR Subpart 5.
(5) Percent of standard for the average value.
(6) The minimum detectable concentration by the membrane filter method is one colony per 100 ml (N/100ml). All forty-eight revealed non-detectable coliform.
(7) Samples were collected at the water source prior to treatment.
(8) Samples were collected at a location within the distribution system.
(9) The Kesselring Site has a disinfection waiver issued by the New York state Department of Health in accordance with 10 NYCRR Subpart 5

5.6 CONTROL OF CHEMICALLY HAZARDOUS SUBSTANCES

Chemicals are not manufactured or disposed of at the Kesselring Site. To ensure the safe use of chemicals and disposal of the resulting wastes, Kesselring Site maintains hazardous substance control and waste minimization programs similar to those at the Knolls Site. Since 1990, significant reductions in hazardous waste streams have been accomplished at the Kesselring Site. Some hazardous waste streams have been eliminated through the use of non-hazardous substitutes. Reclamation of silver from photographic and silver nitrate hazardous waste has resulted in a 100% reduction in these waste streams. Hazardous substance storage controls include as a minimum; labeling, revetment as appropriate, segregation based on compatibility, limited storage volumes and weather protection, as appropriate. When required, large volumes of chemicals and petroleum products are stored in accordance with the New York State Chemical Bulk Storage regulations as specified in Reference (13) and the Petroleum Bulk Storage regulations in Reference (14). Minimal quantities of hazardous wastes do result from the necessary use of chemicals in Site operations. Hazardous and mixed (radioactive and hazardous) waste storage facilities are operated at the Kesselring Site under provisions of the regulation implementing the Resource Conservation and Recovery Act (RCRA) and the Federal Facility Compliance Act. The Kesselring Site operates a hazardous waste storage facility and a mixed radioactive and hazardous waste storage facility under a Part 373 permit issued by NYSDEC. During 1999 the Kesselring Site shipped approximately 26.8 tons of RCRA and New York State hazardous waste offsite for disposal.

Elementary neutralization of small volume laboratory waste, and ion exchange regeneration wastewater also occur on-site. This process is exempt from regulation as a RCRA treatment process. The neutralized discharge is controlled under the Kesselring Site wastewater discharge permit. The boiler house ion exchanger is the primary source of wastewater with a pH prior to neutralization of less than 2 or greater than 12.5.

5.7 TRANSPORTATION OF RADIOACTIVE MATERIALS

Operations at the Kesselring Site results in the generation of various types of radioactive materials that require detailed procedures for handling, packaging, transportation, and, if necessary, disposal at a government operated disposal site.

Radioactive materials that do not require disposal are handled and transferred in accordance with detailed material control and accountability procedures. Internal reviews are made prior to the shipment of any radioactive material from the Site, to ensure that the material is properly identified, surveyed, and packaged in accordance with Federal, State, and local requirements.

Low level radioactive solid waste material that requires disposal includes filters, metal scrap, resin, rags, paper, and plastic materials. The volume of waste contaminated with radioactivity that is generated and shipped is minimized through recycling and the use of special work procedures that limit the amount of material that becomes contaminated during work on radioactive systems and reactor components. In addition, compressible wastes are compacted in order to further reduce the volume of waste to be disposed. Radioactive liquids are solidified prior to shipment. All radioactive wastes are packaged to meet applicable regulations of the DOT given in Reference (15). The waste packages also comply with all applicable requirements of the NRC, the DOE, and the disposal sites.

The shipments of low level radioactive solid wastes were made by authorized common carriers to government owned disposal sites located outside of New York State. During 1999, approximately 182.2 cubic meters (238 cubic yards) of routine low level radioactive waste containing 0.6 curies were shipped from the Site for disposal. Additionally, 12.9 cubic meters (16.9 cubic yards) of mixed waste containing 0.0014 curies were also shipped for disposal. Mixed waste is waste that contains both radioactive constituents regulated by the Department of Energy and hazardous constituents regulated by the New York State Department of Environmental Conservation. The Kesselring Site also ships out slightly radioactive metal to an out-of-state radioactive material recycling facility. During 1999, approximately 23 tons of slightly radioactive metal were sent as recyclable material.

5.8 RADIATION DOSE ASSESSMENT

The effluent and environmental monitoring results show that the radioactivity in liquid and gaseous effluents from 1999 operations at the Kesselring Site had no measurable effect on background radioactivity levels. Therefore, any radiation doses from Site operations to off-site individuals were too small to be measured and must be calculated using conservative methods. Estimates of: (1) the radiation dose to the maximally exposed individual in the vicinity of the Kesselring Site, (2) the average dose to members of the public residing in the 80 kilometer (50 mile) radius assessment area surrounding the Site, and (3) the collective dose to the population residing in the assessment area are summarized in Section 7.0 Radiation Dose Assessment and Methodology.

The results show that the estimated doses were less than 0.1 percent of that permitted by the DOE radiation protection standards listed in Reference (4) and that the estimated dose to the population residing within 80 kilometers (50 miles) of the Kesselring Site was less than 0.001

percent of the natural background radiation dose to the population. In addition, the estimated doses were less than one percent of that permitted by the NRC numerical guide listed in Reference (16) for whole body dose demonstrating that doses are as low as is reasonably achievable. The dose attributed to radioactive air emissions was less than one percent of the EPA standard in Reference (7).

The collective radiation dose to the public along travel routes from Kesselring Site shipments of radioactive materials during 1999 was calculated using data given by the NRC in Reference (17). Based on the type and number of shipments made, the collective annual radiation dose to the public along the transportation routes, including transportation workers, was less than one person-rem. This is less than 0.001 percent of the dose received by the same population from natural background radiation.

6.0 S1C SITE ENVIRONMENTAL MONITORING

6.1 SITE DESCRIPTION

The S1C Site is situated on 10.8 acres of land near Windsor, Connecticut, approximately five miles (eight kilometers) north of the City of Hartford. Facilities at the S1C Site included a defueled Naval nuclear propulsion plant prototype which was permanently shutdown in 1993 and was dismantled, as were support facilities such as administrative office trailers, craft shops, waste storage facilities, and an equipment service building. Dismantlement of all facilities was completed during 1999.

Since 1997, the defueled prototype reactor plant had been undergoing dismantlement operations after completion of the National Environmental Policy Act process in December 1996, similar to the process described for the Kesselring Site S3G and D1G Prototype reactor plants in Section 5.1. After consideration of public comments on the Draft Environmental Impact Statement (EIS), Naval Reactors prepared the Final EIS, Reference (22) which identified prompt dismantlement as the preferred alternative. In a Record of Decision dated December 30, 1996, Naval Reactors decided to promptly dismantle the defueled reactor plant.

The area surrounding the S1C Site is a mixture of open land, industrial areas, tobacco and shrub farms, and suburban residential areas. The Combustion Engineering Site is adjacent to the S1C Site. The S1C Site lies in a broad basin of gently rolling terrain called the Connecticut River Valley. The valley begins well to the north, in Massachusetts, and follows the Connecticut River to Long Island Sound. The valley is bordered on the east by the Green Mountains and on the west by the Berkshire Mountains. The Farmington River's course is within a half mile of the S1C Site to the north and joins the Connecticut River about 5 miles east of the Site.

The climate in the region of the S1C Site is typical for a northern temperate climate zone. The prevailing west to east movement of air in the region carries the majority of weather systems into the area from the west. The location of the Site, relative to the continent and ocean, is significant in that rapid weather changes can result when storms move northward along the Mid-Atlantic coast. Seasonally, weather characteristics vary from the cold and dry continental-polar air of winter to the warm, maritime air of summer. Typical minimum and maximum temperatures are 18°F and 83°F respectively and the average temperature is approximately 50°F. Annual snowfall is 50-55 inches per year and precipitation averages approximately 44 inches per year. Prevailing winds are north to northwest during the winter and south to southwest during the rest of the year.

The topography in the area of the S1C Site exhibits moderate relief due to the erosion of the hills formed during the Jurassic period. Most areas within two miles of the Site lie between 150 and 250 feet above sea level. A few hills to the west reach 400 feet. The Site elevation is approximately 180 feet.

The bedrock geology in the vicinity of the S1C Site is quite simple. Portland arkose lies in a broad belt at a depth of 90-150 feet. Successive layers under this arkose are as follows: (1) the Hampden basalt layer, which is about 100 to 150 feet thick, (2) the East Berline formation that is a gray to reddish-brown siltstone about 500 feet thick, (3) Holyoke basalt about 300 feet thick, and (4) the lowest level which is New Haven arkose. The combined layers comprise the Newark Group of the Triassic age.

The surficial makeup is primarily composed of Deltaic deposits of sand, silt, and gravel. Its origin is probably the western highlands and its accumulation resulted from glaciation. Surface drainage is good, and permeability varies with silt content. Terrace deposits occur immediately north of the Site, and the nearby creek banks are composed largely of till. Both contain varying amounts of clay in addition to the components found in the Deltaic deposits. These surficial deposits are mixed and layered in a complex manner.

Drainage water from the Site enters the Farmington River by the Combustion Engineering Site Brook. The length of the drainage path from the Site to the river is approximately three-quarters of a mile. The flow rate in the Farmington River, which has been monitored since August 1928 at Rainbow, Connecticut, located downstream from the S1C Site, averages approximately 1000 cubic feet per second (cfs). The Connecticut River is gauged upriver and downriver from its confluence with the Farmington River just east of the Town of Windsor. The average flow rate past the upriver station is approximately 16,270 cfs.

Ground water is an important resource for the area in industrial usage. Three high priority aquifers are designated within ten miles of the S1C Site. They are located at Bradley Airport, Windsor Locks, and near Broad Brook in East Windsor. The valley of the Farmington River across the Talcott Mountains is also designated a high priority aquifer by the State of Connecticut Water Resources Planning Program of the Department of Environmental Protection. The "high priority" designation is defined as being a "large deposit of permeable rock, sand or gravel within which significant amounts of ground water may be found."

Water is supplied to the S1C Site by the municipal water supply from the Metropolitan District Commission (MDC).

6.2 LIQUID EFFLUENT MONITORING

6.2.1 Origins

The only source of effluent water during 1999 at the S1C Site was site drainage water and stormwater runoff. The site drainage system that received stormwater was permitted under a State of Connecticut Department of Environmental Protection General Stormwater Discharge Permit associated with industrial activity. During 1999, the S1C Site completed the closure of its permitted hazardous waste container storage area. This closure resulted in a change in the applicability of the State of Connecticut Department of Environmental Protection General Stormwater Discharge associated with Industrial Activity (Reference 23). The S1C Site was no longer required to monitor stormwater discharges. The Reference (23) permit was terminated and several of the Site's permitted drainage systems were removed. The State of Connecticut General Permit for the Discharge of Stormwater and Dewatering Wastewaters Associated with Construction Activities, Reference (24), remains in effect until completion of Site restoration (grading, seeding, etc.) work.

Effluent from the sanitary sewer has not been treated in the on-site septic system since August 1998 when the system was laid-up in preparation for its removal. The on-site septic system was removed during 1999.

Liquids that may have contained radioactivity were collected in drums and solidified prior to off-site disposal as a low-level radioactive waste. The sources of radioactivity in liquids and the radionuclides associated with S1C Site were those associated with past prototype plant operations.

6.2.2 Effluent Monitoring

Stormwater from the S1C Site (Figure 6-1) was released through the permitted stormwater system that encompassed the entire Site, access road, and east parking lot. A total of five discharge locations in these areas were designated for annual monitoring under the Reference (23) permit. As discussed above, the Reference (23) permit was terminated during 1999. As a result no monitoring was required to be performed. The remaining Site activity is governed by References (24), and (25), which include a State of Connecticut Professional Engineer certified Site Stormwater Pollution Prevention Plan and Stormwater Pollution Control Plan. Effluent monitoring is not required by References (24) or (25). Procedures for preventing pollution to the stormwater discharges are in place including inspections of the Site, access road, and east parking lot; training programs; grounds keeping; control of all hazardous materials used on Site; and establishment and maintenance of erosion sedimentation controls.

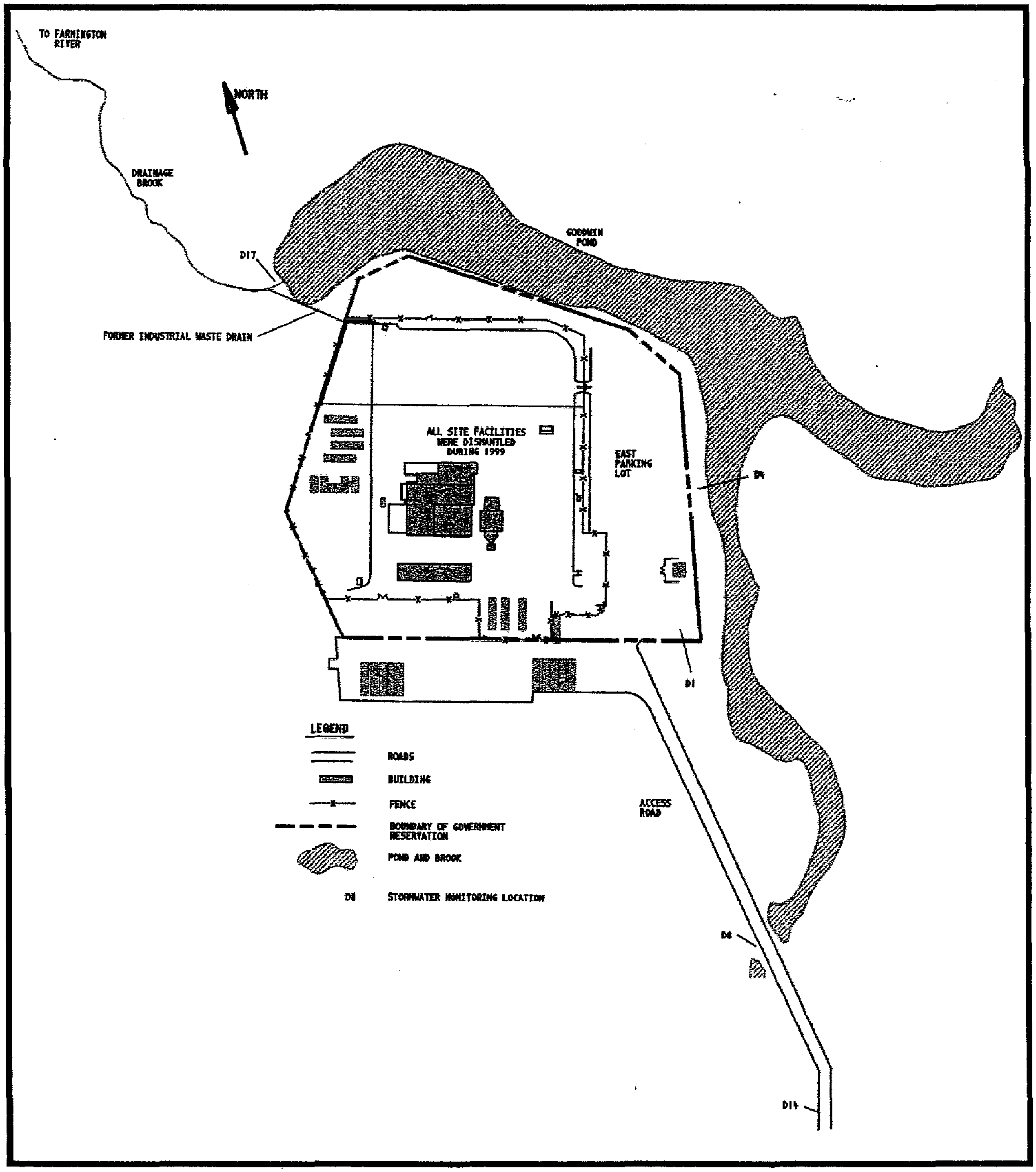


Figure 6-1
S1C Site, Windsor, Connecticut

6.3 AIRBORNE EFFLUENT MONITORING

6.3.1 Origins

Operations that had the potential for the release of airborne radioactivity were serviced by controlled exhaust systems. Prior to release, the exhaust air was passed through high efficiency particulate air (HEPA) filters, to minimize radioactivity content. The sources of airborne radioactivity and the radionuclides associated with S1C Site operations were those that are associated with prototype site dismantlement operations.

6.3.2 Effluent Monitoring

The air exhausted from all radiological air emission points was continuously sampled for particulate radioactivity. Air samples were collected for routine analysis using gamma spectrometry techniques.

6.3.3 Effluent Analyses

The air particulate sample filters were analyzed for radioactivity on a routine basis. The filters were analyzed for gamma radioactivity by direct counting with a system that provides a minimum detectable concentration for cobalt-60 of approximately 3.5×10^{-15} μCi/ml.

6.3.4 Assessment

The radioactivity contained in exhaust air during 1999 consisted of less than 0.00001 curies of cobalt-60.

The airborne radioactivity was contained in a total air exhaust volume of 8.30×10^{9} liters. The average radioactivity concentration in the exhaust air was well below the applicable standards listed in Reference (4). The annual radioactivity concentration at the nearest Site boundary, allowing for typical diffusion conditions, was less than 0.01 percent of the DOE derived concentration guide for effluent released to unrestricted areas (Reference 4) for the mixture of radionuclides present. Airborne effluent monitoring data are reported as required in Reference (7).

6.4 ENVIRONMENTAL MONITORING

6.4.1 Scope

The environmental monitoring program for the S1C Site included the routine collection and radioanalysis of water and sediment samples from the Combustion Engineering Site Brook, Goodwin Pond and the Farmington River, fish from the Farmington River, periodic radiation surveys of the Combustion Engineering Site Brook, the continuous monitoring of radiation levels at twelve perimeter locations, and at off-site locations ranging from 6.6 to 28.2 kilometers (4.1 to 17.5 miles) from the Site.

Water and sediment samples were collected from the Combustion Engineering Site Brook and Goodwin Pond which is the source of the brook. On a quarterly basis, samples are collected from the Combustion Engineering Site Brook and Goodwin Pond. Some samples were not obtained during the first calendar quarter due to ice coverage. Sediment samples are obtained from 15 locations along the approximately three-quarters of a mile length of the brook. Water samples are taken at five of these locations. Sediment samples are scooped from approximately the top two centimeters of sediment. Three additional sediment samples are taken in the mouth of the brook when accessible from the Farmington River. The Goodwin Pond samples are taken near the discharge point of an abandoned storm drain line that had discharged from the Site to the pond. This pipe was sealed in the early 1960's. Semi-annually, direct radiation measurements are made at the same 15 locations along the brook.

Farmington River water and sediment samples were collected at three locations across the river at locations upstream, opposite, and downstream from the release point, as shown in Figure 6-2. Samples were collected during the last three calendar quarters of 1999; ice coverage on the river prevented collection during the first quarter. Sediment samples were collected with a Birge-Ekman dredge that samples a 15 cm×15 cm area to a depth of approximately 2.5 cm. In addition, fish were collected from the Farmington River upstream and downstream from the release point and analyzed for radioactivity.

Environmental air samplers were operated in the primary upwind and downwind directions from the Site to measure normal background airborne radioactivity and to confirm that S1C Site effluents have no measurable effect on normal background levels. The operation of the environmental air samplers was terminated during November 1999 because no radioactive material remained on-site.

Radiation levels at the 12 Site perimeter locations shown in Figure 6-3 and at several off-site locations were monitored with sensitive, thermoluminescent dosimeters (TLDs). The monitoring of perimeter and off-site radiation levels was also terminated during November 1999 because all radioactive material had been moved off-site.

6.4.2 Analyses

The routine quarterly samples of the water and bottom sediment are analyzed with a high-purity germanium gamma spectrometer system. In addition, a more sensitive gamma spectrometry analysis is performed annually on the fish and some of the water and sediment samples collected from the river. The more sensitive analysis is intended to fully characterize the low levels of naturally and non-naturally occurring gamma-emitting radionuclides. The environmental air sample filters were analyzed by direct counting for gamma radioactivity analysis.

6.4.3 Assessment

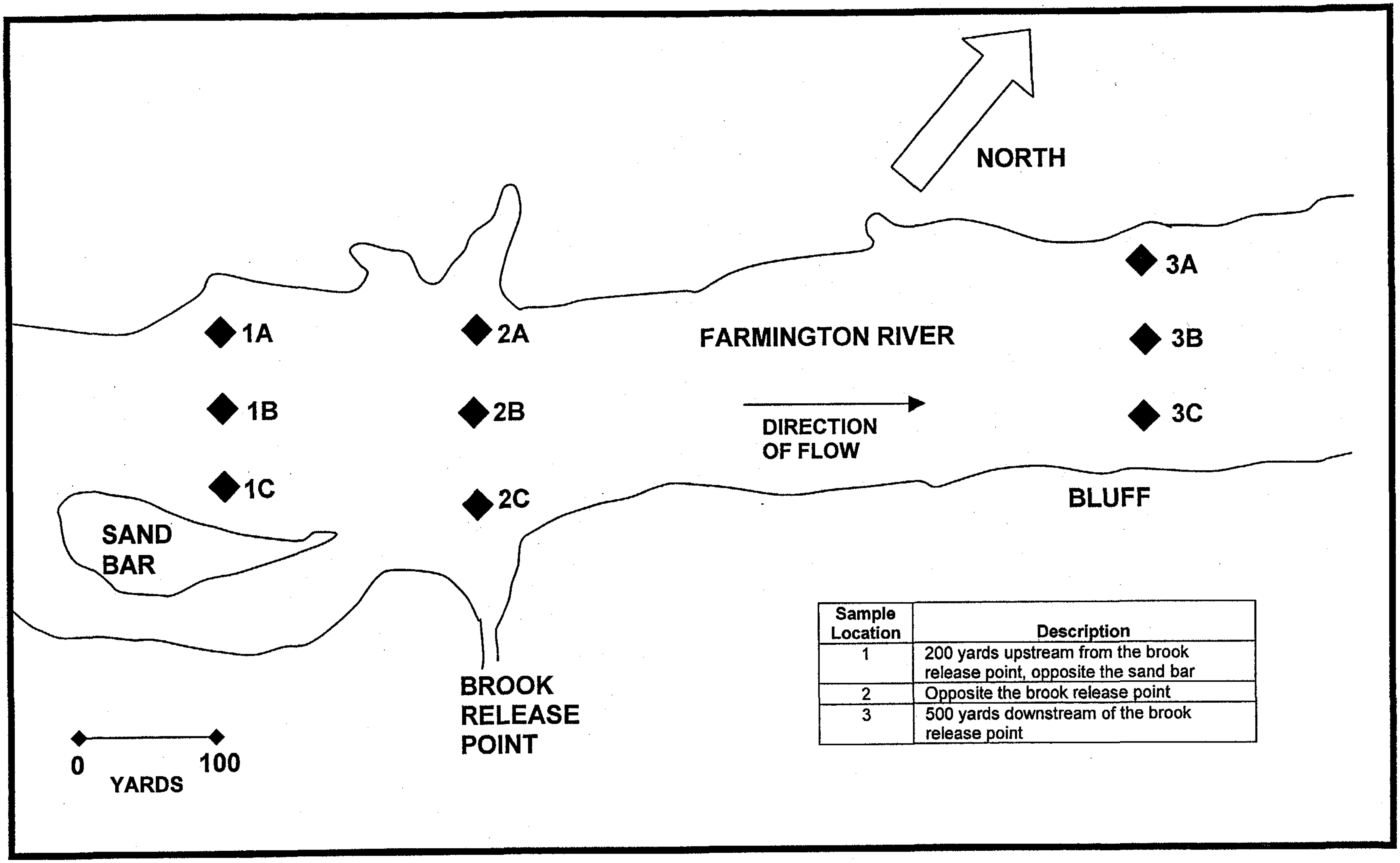
Low levels of cobalt-60 ranging from less than 0.013 to 0.35 picocuries per gram, with an average concentration of <0.064 picocuries per gram, were measured in the Combustion Engineering Site Brook sediment during 1999. This level of cobalt-60, which is similar to previously measured values, is attributable to operations conducted prior to 1979. Cobalt-60 was not detected in the Goodwin Pond sediment samples. No gamma emitting radionuclides were detected in the water samples collected from the Combustion Engineering Site Brook or Goodwin Pond. The radiation measurements were typical of normal background. The drainage brook flows through the property of Combustion Engineering and is not readily accessible to the public.

The results for the Farmington River sediment analyses are shown in Table 6-1. The data show that there is no significant difference between radioactivity concentrations measured upriver and downriver except for one localized area directly opposite the Combustion Engineering Site Brook outfall. The low levels of cobalt-60 present at this location are attributable to operations in previous years and are similar to previously observed values. Results of the detailed gamma spectrum analysis performed on the sediment samples indicated no radionuclides attributable to Site operations other than cobalt-60. Low levels of cesium-137, which are attributable to radioactive fallout from nuclear weapons tests, naturally occurring potassium-40 and daughters of uranium and thorium were also detected. No gamma emitting radionuclides were detected in the Farmington River water samples.

In addition, uranium-235 was measured in some of the Combustion Engineering Site Brook sediment samples at a maximum concentration of 3.37 picocuries per gram. The uranium-235 is not found at the drainage brook locations closest to the S1C Site outfall and is not a result of S1C Site operations.

The results of analyses of fish collected from the river are shown in Table 6-2. There were no radionuclides attributable to S1C Site operations observed in the fish.

The results for the environmental air samples show that there was no significant difference between the average upwind and downwind radioactivity concentrations. The average upwind and downwind radioactivity concentrations were 8.1×10^{-15} µCi/ml and 8.6×10^{-15} µCi/ml, respectively.



Sample Location	Description
1	200 yards upstream from the brook release point, opposite the sand bar
2	Opposite the brook release point
3	500 yards downstream of the brook release point

Figure 6-2
S1C Site, Windsor, Connecticut
Farmington River Sample Locations

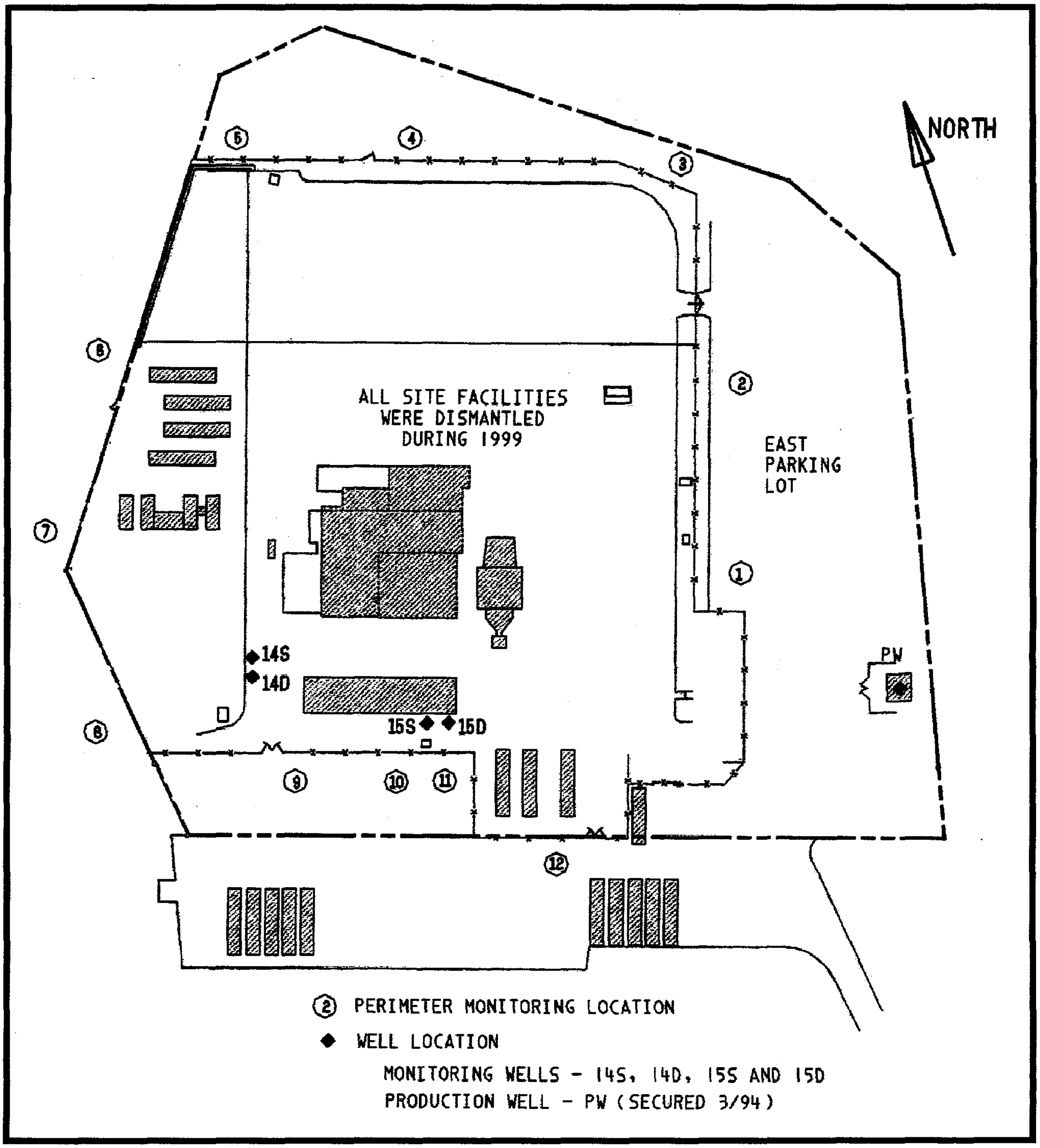


Figure 6-3
S1C Site, Windsor, Connecticut
Perimeter and Groundwater Monitoring Locations

TABLE 6-1 RESULTS OF ANALYSES OF FARMINGTON RIVER SEDIMENT, 1999

Sample Location	Number of Samples	Radioactivity Concentration (pCi/g, dry wt.)[1,2] Cobalt-60		
		Minimum	Maximum	Average
Upriver from Site Release Location	9	< 0.013	< 0.021	< 0.018
Opposite Site Release Location	9	< 0.015	0.044 ± 0.010	< 0.022
Downriver from Site Release Location	9	<0.015	< 0.021	<0.018

Notes:
(1) A value preceded by < is less than the minimum detection level for that sample and parameter. Average values preceded by < contain at least one less than minimum detection level value in the average. The (±) value represents the statistical error at two standard deviations.
(2) Dry weight is based on sample weight with free water removed.

TABLE 6-2 RESULTS OF ANALYSES OF FARMINGTON RIVER FISH, 1999

Sample Location	Sample Number	Radioactivity Concentration[1][2] (pCi/g, wet wt.)		
		K-40	Cs-137	Co-60
Upriver from Site Release Location	1	3.40±0.28	<0.010	< 0.008
Downriver from Site Release Location	1	3.05±0.26	<0.009	< 0.008

Notes:
(1) A value preceded by < is less than the minimum detection level for that sample and parameter. The (±) value represents the statistical error at two standard deviations.
(2) The values presented are average values of the samples analyzed.

TABLE 6-3 PERIMETER AND OFF-SITE RADIATION MONITORING RESULTS, S1C SITE, 1999

Perimeter Location [1]	Total Annual Exposure (millirem)[2]
1	79 ± 1
2	80 ± 1
3	75 ± 1
4	79 ± 4
5	77 ± 2
6	80 ± 3
7	81 ± 1
8	80 ± 1
9	77 ± 1
10	78 ± 3
11	72 ± 3
12	72 ± 3
Off-Site locations	79 ± 7[3]

Notes:
(1) Refer to Figure 6-3.
(2) The (±) value for individual locations are expressed at the 2 σ confidence level based on the calculated measurement error.
(3) Approximately 95% of natural background radiation measurements are expected to be within this range.

The results for the perimeter and off-site radiation monitoring program are summarized in Table 6-3. Radiation levels at the perimeter locations ranged from 72 to 81 mrem, with an average of 78 mrem for the year. There is no statistically significant difference between the perimeter and the off-site measurements. This shows that S1C Site operations in 1999 had no measurable effect on natural background radiation levels at the Site perimeter.

6.5 GROUNDWATER MONITORING

There are no radioactive or chemical waste disposal sites at the S1C Site. Accordingly, the groundwater monitoring program consists of sampling the groundwater for evidence of Stretford solution, a chemical used to remove sulfur from combustion gases. The source of the Stretford solution is a spill that occurred at a non-KAPL facility located adjacent to the S1C Site. Two pairs of monitoring wells, each pair consisting of one deep and one shallow well, were installed on the S1C Site to provide an early indication of any potential threat of the spreading of the spill to the Site. The location of these wells is shown in Figure 6-3. The groundwater monitoring program at the S1C Site is summarized in Table 6-4. The monitoring program consists of four sampling evolutions at the four monitoring wells with corresponding analyses for 23 parameters.

Samples from the four monitoring wells have been taken by KAPL personnel and the owner of the adjacent facility since 1984. During 1999, results from these wells, as presented in Table 6-5, indicate that the groundwater in the vicinity of the former site production wells is not being influenced by the plume of contamination. Operation of an interceptor well, installed at the spill location by the owner, has been temporarily discontinued by the owner as agreed to by the State of Connecticut.

6.6 CONTROL OF CHEMICALLY HAZARDOUS SUBSTANCES

Chemicals are not manufactured or disposed of at the S1C Site. The S1C Site maintains a hazardous substance control program similar to that at the Knolls Site. Hazardous wastes do result from Site demolition and dismantlement activities.

The S1C Site recycled 319 tons of metal in 1999. KAPL completed demolition and disposal of nine buildings, eight of which had been painted with paint that contained PCBs. During 1999, the S1C Site shipped approximately 2.02 tons of Resource Conservation and Recovery Act (RCRA) hazardous waste, 1.93 tons of RCRA/PCB waste, 0.64 tons of RCRA/asbestos waste, 0.52 tons of RCRA/PCB/asbestos waste, 1.326 tons of mixed waste, 8105.2 tons of PCB bulk product waste, 47 tons of PCB waste, 86.8 tons of PCB/asbestos waste, 366.6 tons of asbestos waste, and 209.8 tons of non-RCRA chemical waste off-site for disposal. During 1999, 12,668 tons of concrete, asphalt, and metal demolition debris were shipped off-site for recycling.

6.7 TRANSPORTATION OF RADIOACTIVE MATERIALS

Various types of radioactive materials were generated at the S1C Site that required detailed procedures for handling, packaging, transportation, and, if necessary, disposal at a government operated disposal site.

Radioactive materials are handled and transferred in accordance with detailed material control and accountability procedures. Internal reviews are made prior to the shipment of any radioactive materials from the S1C Site, to ensure that the material is properly identified, surveyed, and packaged in accordance with Federal, State, and local requirements.

Low level radioactive solid waste materials either activated or contaminated with radioactivity that require disposal included demolition debris, metal scrap, rags, paper, and plastic. The Site minimized the volume of solid waste that must be disposed of as radioactive through reuse, recycling, and the use of special work procedures that limit the amount of material that becomes contaminated. All radioactive

TABLE 6-4 S1C SITE GROUNDWATER MONITORING, 1999

Parameter (All Results are mg/l unless noted)	Groundwater Monitoring Locations			
	14S	14D	15S	15D
pH (Standard Units)[1]	Q	Q	Q	Q
TDS[2]	Q	Q	Q	Q
Sodium	Q	Q	Q	Q
Nitrate	Q	Q	Q	Q
Sulfate	Q	Q	Q	Q
Cyanide	Q	Q	Q	Q
Chloride	Q	Q	Q	Q
ADA[3]	Q	Q	Q	Q
Vanadium	Q	Q	Q	Q
Conductivity (µmhos/cm)	Q	Q	Q	Q
Manganese	Q	Q	Q	Q
Calcium Hardness	Q	Q	Q	Q
Total Hardness	Q	Q	Q	Q
Manganese	Q	Q	Q	Q
COD[4]	Q	Q	Q	Q
Phosphorus	Q	Q	Q	Q
Iron	Q	Q	Q	Q
Silica Total	Q	Q	Q	Q
TOC[5]	Q	Q	Q	Q
MOA[6]	Q	Q	Q	Q
PA[7]	Q	Q	Q	Q
Temp (°F)[1]	Q	Q	Q	Q
Total Chromium	Q	Q	Q	Q

Notes: Q = Quarterly

(1) Determined in the field.
(2) TDS = Total Dissolved Solids
(3) ADA = Anthraquinone Disulfonic Acid
(4) COD = Chemical Oxygen Demand
(5) TOC = Total Organic Carbon
(6) MOA = Methyl Orange Alkalinity
(7) PA = Phenolphthalein Alkalinity

TABLE 6-5 RESULTS OF S1C SITE GROUNDWATER MONITORING WELLS, 1999

Parameter (all units are mg/l except where noted)[1][2]

Well	Sample Date	pH (SU)	TDS[3]	Sodium	(N) Nitrate	Sulfate	Cyanide	Chloride	ADA[3]	Vanadium	Specific Conductivity (µmhos/cm)	Manganese	Ca Hardness	Total Hardness	Magnesium	COD[3]	MOA[3]	PA[3]	Phosphorus	Iron	Total Silica	TOC[3]	Total Chromium	Temp. (°F)
14S	3/25/99	7.55	237	7.14	2.29	19	<0.01	15.1	<0.001	<0.02	377	0.03	126	188	13.6	<5	142	ND	0.04	1.03	32.1	0.85	<0.05	50.2
	6/2/99	7.35	273	11.0	2.23	24	<0.01	57.2	<0.001	<0.02	454	<0.01	126	142	15	<5	160	ND	0.03	<0.06	8.6	0.57	<0.05	57.9
	9/23/99	7.57	294	10.4	2.3	23	<0.01	24.3	<0.001	<0.02	479	0.02	156	224	15.5	<5	186	ND	0.04	0.48	21	0.74	<0.05	55.5
	12/20/99	7.53	248	9.07	2.35	24	<0.01	14.	<0.001	<0.02	434	<0.01	139	202	14.0	<5	167	ND	0.02	<0.06	17.1	0.77	<0.05	50.8
14D	3/25/99	8.29	228	9.26	1.10	26	<0.01	39.3	<0.001	<0.02	368	0.04	110	166	12.1	ND	102	ND	0.03	1.03	53.5	0.49	<0.05	51.8
	6/2/99	8.15	230	11.2	1.11	25	<0.01	40.3	<0.001	<0.02	377	0.05	112	170	12.5	<5	106	ND	0.06	1.27	57.8	0.38	<0.05	55.8
	9/23/99	8.09	226	10.8	1.07	19	<0.01	37.9	<0.001	<0.02	382	<0.01	105	160	11.2	<5	114	ND	0.03	0.25	21	0.5	<0.05	56.7
	12/20/99	8.13	219	11.1	1.11	20	<0.01	38.8	<0.001	<0.02	383	0.02	102	155	11.4	<5	108	ND	0.14	0.48	42.8	0.44	<0.05	50.7
15S	3/25/99	8.19	219	7.54	0.90	19	<0.01	26.4	<0.001	<0.02	368	<0.01	108	174	13.2	<5	130	ND	0.02	<0.06	17.1	0.55	<0.05	54.5
	6/2/99	8.01	236	9.4	0.95	18	<0.01	27.7	<0.001	<0.02	388	<0.01	116	176	13.2	<5	130	ND	0.03	<0.06	19.3	0.43	<0.05	57.3
	9/23/99	8.05	236	9.2	0.91	18	<0.01	28.4	<0.001	<0.02	386	<0.01	121	168	12.3	<5	138	ND	0.02	<0.06	18	0.58	<0.05	57.2
	12/20/99	8.09	225	9.53	0.98	20	<0.01	29.2	<0.001	<0.02	396	<0.01	112	172	12.8	<5	125	ND	0.03	<0.06	15.0	0.41	<0.05	51.9
15D	3/25/99	8.25	257	11.4	1.26	19	<0.01	42.8	<0.001	<0.02	408	0.01	120	178	12.5	<5	116	ND	0.02	0.35	32.1	0.62	<0.05	56.1
	6/2/99	8.07	260	14.2	1.11	19	<0.01	42.4	<0.001	<0.02	423	<0.01	120	178	12.5	<5	120	ND	0.02	0.25	15	0.43	<0.05	57.2
	9/23/99	8.09	256	13.5	1.04	18	<0.01	40	<0.001	<0.02	416	<0.01	119	178	11.9	35	134	ND	0.02	<0.06	16	0.52	<0.05	56
	12/20/99	8.06	236	13.6	1.10	20	<0.01	40.1	<0.001	<0.02	418	<0.01	114	171	12.0	<5	122	ND	0.02	<0.06	15.0	0.48	<0.05	51.4
Standards[4]		5.0-9.0	500[5]	20	10	250	0.2[6]	250	0.1[7]	0.1	—	0.05[5]	—	—	—	—			—	0.3		—	0.05	—

Notes:
(1) A value preceded by < is less than the minimum detection level for that sample and parameter.
(2) ND = None Detected
(3) See Table 6-4 notes for definition.
(4) State of Connecticut, Department of Health, Standards for Quality of Private Drinking Water Supplies.
(5) USEPA Water Quality Standards.
(6) CT-DEP Action level is any detectable.
(7) Action level established by CT-DEP.
SU = standard units

wastes were packaged in accordance with written site procedures to ensure that all applicable regulations of the DOT were met, Reference (15). The waste packages also complied with all applicable requirements of the DOE and the disposal sites.

Shipments of low level radioactive solid wastes are made by authorized common carriers to government owned disposal sites located outside the State of Connecticut. During 1999, approximately 918 cubic meters (1200 cubic yards) of routine low level waste containing 11,400 curies were shipped from the Site for disposal. In addition, approximately 417 tons of radioactive metal were shipped to an out-of-state radioactive material recycling facility. All radioactive material was shipped off-site in 1999 in support of Site closure.

6.8 RADIATION DOSE ASSESSMENT

The effluent and environmental monitoring results show that radioactivity released in gaseous effluents from 1999 operations at the S1C Site had no discernible effect on normal background radioactivity levels. Therefore, radiation doses from S1C Site operations to off-site individuals were too small to be measured and must be calculated using conservative methods. Estimates of: (1) the radiation dose to the maximally exposed individual in the vicinity of the S1C Site, (2) the average dose to members of the public residing in the 80 kilometer (50 mile) radius assessment area surrounding the Site, and (3) the collective dose to the population residing in the assessment area are summarized in Section 7.0 Radiation Dose Assessment and Methodology.

The results show that the estimated doses were less than 0.1 percent of that permitted by the DOE radiation protection standards listed in Reference (4), and that the estimated dose to the population residing within 80 kilometers (50 miles) of the S1C Site was less than 0.001 percent of the natural background radiation dose to the population. In addition, the estimated doses were less than one percent of that permitted by the NRC numerical guide listed in Reference (16) for whole-body dose demonstrating that doses are as low as is reasonably achievable. The dose attributed to radioactive air emissions was less than one percent of the EPA standard in Reference (7).

The collective radiation dose to the public along travel routes from S1C Site shipments of radioactive materials during 1999 was calculated using data given by the NRC in Reference (17). Based on the type and number of shipments made, the collective annual radiation dose to the public along the transportation routes, including transportation workers, was less than one person-rem. This is less than 0.001 percent of the dose received by the same population from natural background radiation.

7.0 RADIATION DOSE ASSESSMENT AND METHODOLOGY

Measurements for radioactivity in environmental media representing an exposure pathway to man indicated no radioactivity attributable to operations at any of the three Sites that comprise the Knolls Atomic Power Laboratory. Therefore, potential doses to the general public from liquid and airborne effluents were too small to be measured and are estimated using conservative calculational techniques based on assumed pathways for releases to return to man.

The exposure pathways via air and water considered for purposes of estimating radiation exposures were:

1. *Air Pathways*

   a. External exposure from airborne radioactivity and radioactivity deposited on the ground,

   b. Ingestion of food products, and

   c. Inhalation of airborne radioactivity.

2. *Water Pathways*

   a. Ingestion of water and fish,

   b. Ingestion of food products grown on irrigated land,

   c. External exposure from irrigated land, and

   d. Boating, swimming, and shoreline recreation.

For each KAPL Site, calculations were made to estimate: (1) the radiation dose to the maximally exposed individual in the vicinity of the Site, (2) the average dose to members of the public residing in the 80 kilometer (50 mile) radius assessment area surrounding the Site, and (3) the collective dose to the population residing in the assessment area. See Figures 7-1 and 7-2 for maps of the 80 kilometer (50 mile) assessment areas surrounding the KAPL Sites.

The fundamental equation for calculation of the annual dose from a single radionuclide is:

$D = XUK$ where:

D = annual dose

X = the concentration of the radionuclide in the media of the exposure pathway of interest

U = the annual exposure time (hours) or intake (ml or kg) associated with the exposure pathway of interest

K = The annual dose factor for external exposure to a radionuclide or the dose commitment for a 50 year period from the current year's intake of a radionuclide

In estimating potential doses via the water pathway, the contribution from each radionuclide present in the liquid effluents to the effective dose equivalent was calculated using DOE dose conversion factors from References (26) and (27) and the Reference (28) liquid pathway model.

Estimates of potential doses via air pathways were calculated using CAP-88PC, the EPA approved computer code package provided in Reference (29). The code package was prepared to implement the dose assessment required to demonstrate compliance with Reference (7). It includes the computer code AIRDOS2 and a file of the 50-year committed effective dose equivalent conversion factors calculated by the computer code DARTAB, which uses the dose factor database RADRISK using weighting factors from ICRP-26. AIRDOS2 is an updated version of AIRDOS-EPA that was used previously.

In AIRDOS2 the area surrounding the site is divided into a circular grid defined by 16 pie-shaped segments, which are subdivided into sectors by annular rings out to 80 kilometers (50 miles). The computer code calculates the air concentration and surface deposition in each sector for each radionuclide released from the Site using site specific average atmospheric dispersion parameters. Dispersion parameters for each Site are based on on-site meteorological data summarized in accordance with Reference (30). Next the radionuclide concentrations in meat, milk, and fresh vegetables produced in each sector are estimated using the terrestrial food chain models given in Reference (28). The code then calculates the effective dose equivalent to persons residing in each sector through the following exposure modes: (1) immersion in air containing radionuclides, (2) exposure to radionuclides deposited on ground surfaces, (3) inhalation of radionuclides in air, and (4) ingestion of food produced in the sector. The collective (population) effective dose equivalent is obtained by summing the product of the dose and population for each sector. The population residing within 80 kilometers (50 miles) of each site is based on the 1990 census data as reported in Reference (31).

The calculated doses are summarized in Tables 7-1 and 7-2. Inhalation of airborne radioactivity was the calculated principal exposure pathway for the hypothetical maximally exposed individual at the Knolls Site. At the Kesselring Site the calculated principal exposure pathway for this hypothetical person was the ingestion of foodstuffs. At the S1C Site, the calculated principal exposure pathway was external exposure to deposition on ground surfaces.

A comparison of the estimated (calculated) radiation dose to the maximum individual from KAPL operations with the average radiation dose received from other sources is shown in Figure 7-3. Data in Figure 7-3 show that the maximum radiation dose that may have been received as a result of KAPL operations is much lower than the DOE radiation protection standard and the drinking water and air emission standards established by the EPA, and considerably lower than the average dose received from other sources (natural and man-made) of radiation.

TABLE 7-1 ESTIMATED ANNUAL DOSE TO THE MAXIMUM INDIVIDUAL AND AVERAGE MEMBERS OF THE ASSESSMENT AREA POPULATIONS, 1999

KAPL Site	All Pathways		Air Pathways Only		Effective Dose Equivalent From Natural Background Radiation (mrem)[4]
	Effective Dose Equivalent Maximum Individual/ Average Member (mrem)	Percent of Standard[1,2]	Effective Dose Equivalent Maximum Individual/ Average Member (mrem)	Percent of Standard[3]	
Knolls Site	<0.1/<0.001	<0.1/<0.001	<0.1/<0.001	<1.0/<0.01	74
Kesselring Site	<0.1/<0.001	<0.1/<0.001	<0.1/<0.001	<1.0/<0.01	77
S1C Site	<0.1/<0.001	<0.1/<0.001	<0.1/<0.001	<1.0/<0.01	79

Notes:

(1) Based on the DOE radiation protection standard for individuals in off-site areas of 100 mrem/yr effective dose equivalent as given in Reference (4).

(2) The maximum annual dose to an individual at each site did not exceed 1% of the NRC's guide for demonstrating that radioactive materials in effluents are "as low as is reasonably achievable" given in Reference (16).

(3) Based on the EPA national air emission standard for radionuclide emissions of 10 mrem/yr effective dose equivalent as given in Reference (7).

(4) Dose based on average off-site background radiation level determined for each site with TLDs as reported in prior sections for the respective sites. It does not include the estimated average annual effective dose equivalent of 39 mrem that a member of the population receives from naturally occurring radionuclides in the human body or the 200 mrem received from exposure to radon and its decay products as reported in Reference 32.

TABLE 7-2 ESTIMATED ANNUAL COLLECTIVE (POPULATION) DOSES FOR RESIDENTS WITHIN 80 KILOMETERS OF KAPL SITES, 1999

KAPL Site	Population[1] (Millions)	Effective Dose Equivalent From KAPL Operations (Person-Rem)	Effective Dose Equivalent From Natural Background Radiation[2] (Person-Rem)
Knolls Site	1.29	<0.1	95,000
Kesselring Site	1.15	<0.3	89,000
S1C Site	3.43	<0.1	271,000
		<0.5	455,000

Notes:

(1) Total population residing within 80 kilometers (50 miles) of each site based on 1990 census data as reported in Reference (31).

(2) Person-Rem estimate based on average off-site radiation level determined for each site with TLDs as reported in prior sections for the respective sites. It does not include the estimated average annual effective dose equivalent of 39 mrem that a member of the population receives from naturally occurring radionuclides in the human body or the 200 mrem received from exposure to radon and its decay products as reported in Reference 32.

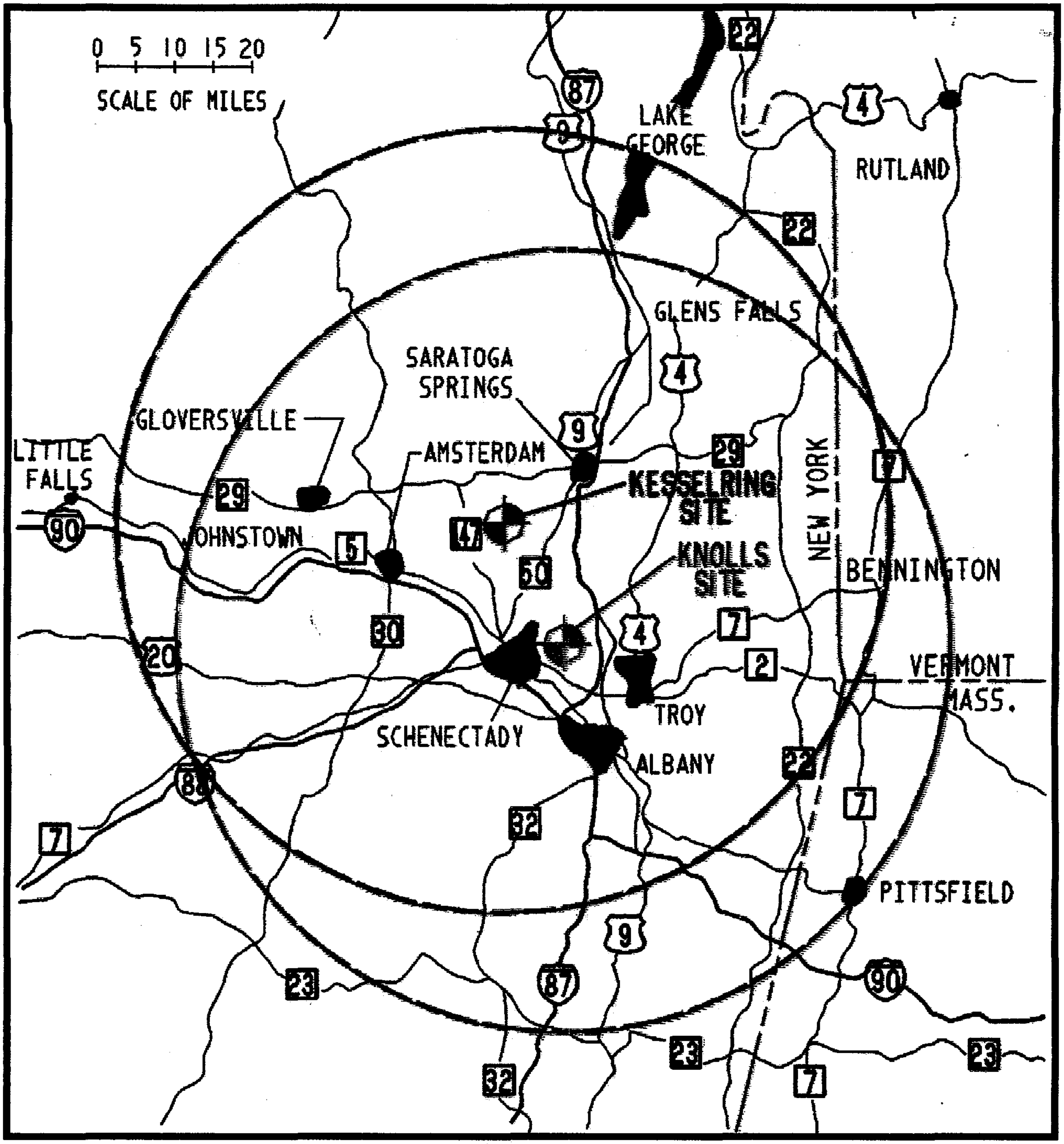


Figure 7-1
Eighty Kilometer (50 mile) Assessment Area Map
for Knolls and Kesselring Sites

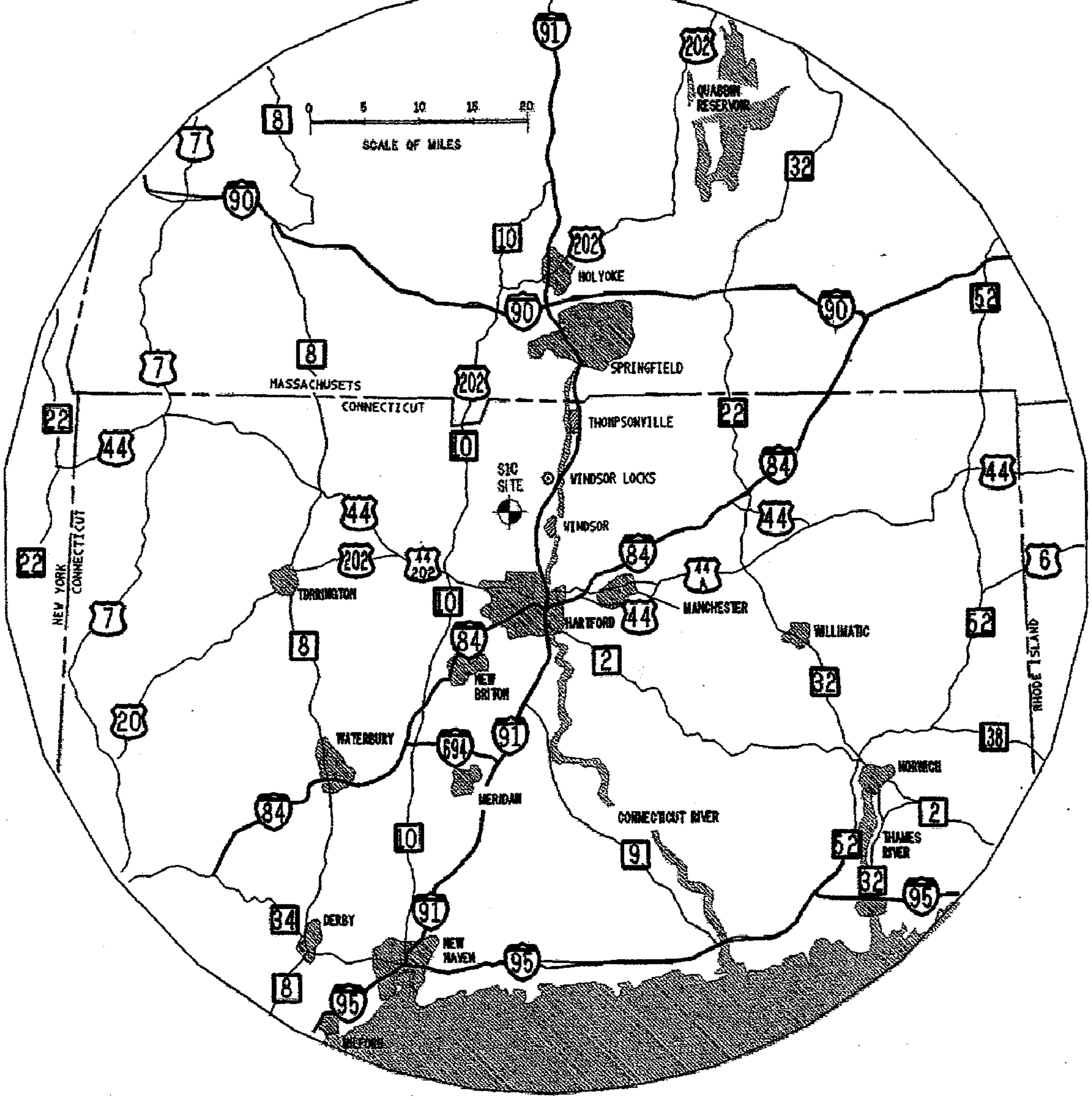
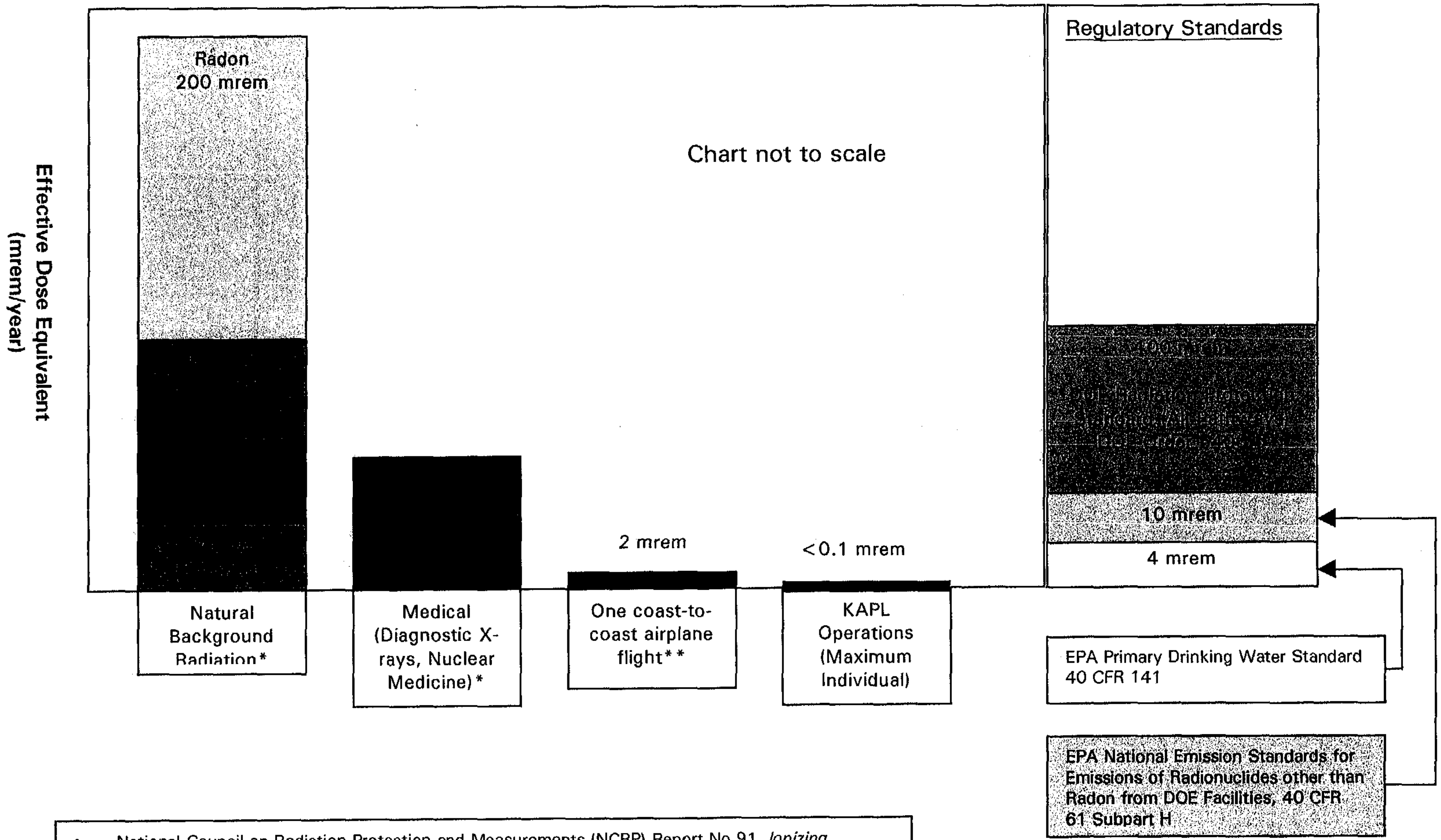


Figure 7-2
Eighty Kilometer (50 mile) Assessment Area Map for the S1C Site



- * National Council on Radiation Protection and Measurements (NCRP) Report No.91, *Ionizing Radiation Exposure of the Population of the United States*, September 1987
- ** National Council on Radiation Protection and Measurements (NCRP) Report No.94, *Exposure of the Population in the United States and Canada from Natural Background Radiation*, December 1987

Figure 7-3
Comparison of the Estimated Radiation Dose from KAPL Operations with Doses from other Sources

8.0 QUALITY ASSURANCE PROGRAM

This section contains a description of the KAPL Quality Assurance Program conducted to ensure the accuracy and precision of effluent and environmental sampling, analysis, and reporting. The program is based on the guidance contained in several DOE, EPA, and NRC documents on the subject. (References 33, 34, and 35, respectively)

The program consists of the following elements:

1. Internal quality assurance procedures

   a. Personnel training and qualification

   b. Written procedures for sampling, sample analysis, and computation methods

   c. Calibration of sampling and sample analysis equipment

   d. Internal quality assurance sample analyses

   e. Data review and computation check

2. Participation in the DOE Environmental Measurements Laboratory Quality Assurance Program

3. Subcontractor quality assurance procedures

4. Program audits

The internal quality assurance procedures start with the training of all personnel involved in the collection and analysis of samples, in accordance with established KAPL policies. Personnel are not permitted to perform sampling and sample analysis until they are trained and have demonstrated the ability to properly perform their duties. Written procedures, based on the methods recommended in References (33) and (35), cover collection and analysis of samples, the computation of results, and the calibration of sampling and analytical equipment, as required. Radioactivity counting equipment is, whenever possible, calibrated using standards that are traceable to the National Institute of Standards and Technology. Internal quality assurance procedures also provide for a system of duplicate (or replicate) analyses of the same sample and the analyses of spiked samples to demonstrate precision and accuracy. All measurement data are assessed to detect anomalies, unusual results, and trends.

KAPL participates in the interlaboratory quality assurance program, conducted by the DOE Environmental Measurements Laboratory. (The EPA no longer conducts the Environmental Monitoring Systems Laboratory Performance Evaluation Studies Program.) This provides an independent verification of the accuracy and precision of KAPL analyses of effluent and environmental monitoring samples. The results of KAPL participation in the DOE quality assurance program are summarized in Table 8-1. The data demonstrate satisfactory KAPL performance.

Vendor subcontractor laboratories perform non-radioactive effluent and environmental sample analyses. KAPL maintains a quality assurance program to ensure the accuracy and precision of the subcontractor analytical results. This includes submitting known standards, blanks, and replicate samples along with routine samples for analysis. If unsatisfactory results are obtained, follow-up investigations are performed to correct the problems. KAPL also requires that vendor laboratories performing analyses for the Knolls and Kesselring Sites be certified by the New York State Department of Health under the Environmental Laboratory Approval Program (ELAP) and that vendor laboratories performing effluent and environmental analyses for the S1C Site be certified by Connecticut

Department of Health Services.

Periodic audits are conducted that examine all phases of the effluent and environmental monitoring programs to ensure compliance with all KAPL procedures and applicable Federal and State regulations.

TABLE 8-1 KAPL PERFORMANCE IN DOE ENVIRONMENTAL MEASUREMENTS LABORATORY (EML) QUALITY ASSESSMENT PROGRAM, 1999

Sample Date [1]	Sample Type	Analysis	KAPL Result[2]	EML Result[2,3]	Reported/ EML	Control Limit[4]
03/01/99	Soil	Potassium-40	9.86 ± 1.30	9.80	1.01	0.78 - 1.53
		Strontium-90	0.960 ± 0.051	0.876	1.10	0.60 - 3.66
		Cesium-137	17.5 ± 1.6	17.8	0.98	0.83 - 1.32
		Plutonium-239	0.224 ± 0.012	0.219	1.02	0.69 - 1.74
03/01/99	Water	Tritium	3.49 ± 0.19	3.27	1.07	0.71 - 1.79
		Iron-55	2.28 ± 0.11	2.63	0.87	0.44 - 1.53
		Cobalt-60	1.32 ± 0.065	1.38	0.96	0.80 - 1.20
		Strontium-90	0.0946 ± 0.0076	0.111	0.85	0.75 - 1.50
		Cesium-137	1.17 ± 0.04	1.06	1.10	0.80 - 1.26
		Plutonium-239	0.0311 ± 0.0003	0.0273	1.14	0.80 - 1.39
		Uranium-total	0.022 ± 0.001	0.021	1.06	0.80 - 1.34
		Gross Alpha	30.7 ± 1.6	29.5	1.04	0.61 - 1.32
		Gross Beta	31.5 ± 1.5	29.7	1.06	0.55 - 1.54
03/01/99	Air Filter	Gross Alpha	50.5 ± 1.9	43.5	1.16	0.50 - 1.55
		Gross Beta	43.0 ± 1.4	42.2	1.02	0.72 - 1.67
09/01/99	Soil	Potassium-40	22.7 ± 2.9	21.1	1.08	0.78 - 1.53
		Strontium-90	0.337 ± 0.061	0.351	0.96	0.60 - 3.66
		Cesium-137	5.50 ± 0.56	5.51	1.00	0.83 - 1.32
		Plutonium-239	0.0814 ± 0.0016	0.0865	0.94	0.69 - 1.74
09/01/99	Water	Tritium	2.45 ± 0.47	2.18	1.12	0.71 - 1.79
		Iron-55	1.34 ± 0.10	1.43	0.94	0.44 - 1.53
		Cobalt-60	1.43 ± 0.12	1.42	1.01	0.80 - 1.20
		Strontium-90	0.0441 ± 0.0086	0.0465	0.95	0.75 - 1.50
		Cesium-137	2.12 ± 0.13	2.05	1.03	0.80 - 1.26
		Plutonium-239	0.0259 ± 0.0005	0.0235	1.10	0.80 - 1.39
		Uranium-total	0.030 ± 0.002	0.030	1.00	0.80 - 1.34
		Gross Alpha	41.5 ± 3.7	42.7	0.97	0.61 - 1.32
		Gross Beta	23.7 ± 2.7	20.0	1.18	0.55 - 1.54
09/01/99	Air Filter	Gross Alpha	84.3 ± 4.9	74.9	1.13	0.50 - 1.55
		Gross Beta	70.5 ± 2.7	71.9	0.98	0.72 - 1.67

Notes:
(1) The sample date is assigned by EML.
(2) The results are expressed in pCi/ml of water, or pCi/g of soil, except for uranium where the units are μg/ml and for air filters where the units are pCi/filter.
(3) The expected result is that reported by EML.
(4) The control limit range is provided by EML and is based on the reported result divided by the EML expected result.

9.0 RADIATION AND RADIOACTIVITY - GENERAL INFORMATION

This section provides general information on radiation and radioactivity for those who may not be familiar with the terms and concepts.

Man has always lived in a sea of natural background radiation. This background radiation was and is as much a part of the earth's environment as the light and heat from the sun's rays. There are three principal sources of natural background radiation: cosmic radiation from the sun and outer space, radiation from the natural radioactivity in soil and rocks (called 'terrestrial radiation'), and internal radiation from the naturally radioactive elements that are part of our bodies. A basic knowledge of the concepts of radiation and radioactivity is important in understanding how effective control programs are in reducing radiation exposures and radioactivity releases to levels that are as low as is reasonably achievable.

9.1 RADIATION

In simple terms, radiation is a form of energy. Microwaves, radio waves, x-rays, light, and heat are all common forms of radiation. The radiation from radioactive materials (radionuclides) is in the form of particles or rays. During the decay of radionuclides, alpha, beta, and gamma radiation are emitted.

Alpha radiation consists of small, positively charged particles of low penetrating power that can be stopped by a sheet of paper. Radionuclides that emit alpha particles include radium, uranium, and thorium.

Beta radiation consists of negatively charged particles that are smaller than alpha particles but are generally more penetrating and may require up to an inch of wood or other light material to be stopped. Examples of beta emitters are strontium-90, cesium-137, and cobalt-60.

Gamma radiation is an energy emission like an x-ray. Gamma rays have great penetrating power but are stopped by up to several feet of concrete or several inches of lead. The actual thickness of a particular shielding material required depends on the quantity and energy of the gamma rays to be stopped. Most radionuclides emit gamma rays along with beta or alpha particles.

Each radionuclide emits a unique combination of radiations that is like a "finger print" of that radionuclide. Alpha or beta particles and/or gamma rays are emitted in various combinations and energies. Radionuclides may be identified by measuring the type, relative amounts, and energy of the radiations emitted. Measurement of half-life and chemical properties may also be used to help identify radionuclides.

9.1.1 Radiation Dose Assessment

Body tissue can be damaged if enough energy from radiation is absorbed. The amount of energy absorbed by body tissue during radiation exposure is called "absorbed dose". The potential biological effect resulting from a particular dose is based on a technically defined quantity called "dose equivalent." The unit of dose equivalent is called the rem. Another quantity called "effective dose equivalent" is a dose summation that is used to estimate health-effects risk when the dose is received from sources that are external to the body and from radioactive materials that are within the various body tissues. The unit of effective dose equivalent is also the rem. As will be seen from the following discussion, the rem unit is relatively large compared with the level of doses received from natural background radiation or projected as a result of releases of radioactivity to the environment. The millirem (mrem), which is one thousandth of a rem, is frequently used instead of the rem. The rem and mrem are better understood by relating to concepts that are more familiar.

Radiation comes from both natural and man-made sources. Natural background radiation includes cosmic radiation from the sun and outer space, terrestrial radiation from radioactivity in soil, radioactivity in the body, and inhaled radioactivity.

The National Council on Radiation Protection and Measurements estimates that the average member of the population of the United States receives an annual effective dose equivalent of approximately 300 mrem from natural background radiation. This is composed of approximately 28 mrem from cosmic radiation, 28 mrem from terrestrial radiation, 39 mrem from radioactivity within the body and 200 mrem from inhaled radon and its decay products. The cosmic radiation component varies from 26 mrem at sea level to 50 mrem in Denver (at 1600 meters). The terrestrial component varies from 16 mrem on the Atlantic and Gulf coastal plain to 63 mrem in the Rocky Mountains. The dose from inhaled radon and its decay products is the most variable.

The average natural background radiation level measured in the vicinity of the KAPL Sites is approximately 70 mrem per year. Individual locations will vary based on soil composition, soil moisture content and snow cover.

In addition to natural background radiation, people are also exposed to man-made sources of radiation, such as medical and dental x-rays. The average radiation dose from these sources is about 53 mrem per year. Other man-made sources include consumer products, such as color television sets. An individual's radiation exposure from color television averages 0.3 mrem per year. An airplane trip results in increased radiation exposure. A round-trip flight between Los Angeles and New York results in a dose of about 5 mrem.

9.2 RADIOACTIVITY

All materials are made up of atoms. In the case of a radioactive material, these atoms are unstable and give off energy in the form of rays or tiny particles in order to reach a stable state. Each type of radioactive atom is called a radionuclide. Each radionuclide emits a characteristic form of radiation as it gives off energy. Radionuclides change as radiation occurs, and this transition is called radioactive decay. The rate at which a particular radionuclide decays is measured by its half-life. Half-life is the time required for one-half the radioactive atoms in a given amount of material to decay. For example, the half-life of the man-made radionuclide cobalt-60 is 5.3 years. This means that during a 5.3-year period, half of the cobalt-60 atoms initially present will have decayed. In the next 5.3 year period, half the remaining cobalt-60 atoms will have decayed, and so on.

The half-lives of radionuclides differ greatly. The half-life of naturally occurring radon-220, for instance, is only 55 seconds. In contrast, uranium-238, another naturally occurring radionuclide has a half-life of 4.5 billion years.

Through the decay process, each radionuclide changes into a different nuclide or atom - often becoming a different chemical element. For example, naturally occurring radioactive thorium-232, after emitting its radiation, transforms to a second radionuclide, which transforms to a third, and so on. Thus, a chain of eleven radionuclides is formed including radon-220, before nonradioactive lead-208 is formed. Each of the radionuclides in the series has its own characteristic half-life and type of radiation. The chain finally ends when the newest nuclide is not radioactive. The uranium chain starts with uranium-238 and proceeds through 13 radionuclides, ending with stable lead-206. All of these naturally occurring radionuclides are present in trace amounts in the soil in your backyard as well as in many other environmental media.

9.2.1. Measuring Radioactivity

The curie (Ci) is the common unit used for expressing the magnitude of radioactive decay in a sample containing radioactive material. Specifically, the curie is that amount of radioactivity equal to 3.7×10^{10} (37 billion) disintegrations per second. For environmental monitoring purposes, the curie is usually too large a unit to work with conveniently and is broken down into smaller values such as the microcurie (μCi), which is one millionth of a curie (10^{-6} curie) and the pico-curie (pCi), which is one trillionth of a curie (10^{-12} curie). The typical radium dial wrist watch has about one microcurie (μCi) of radium on the dial. The average person has about one tenth (0.1) microcurie of naturally occurring potassium-40 in his body. Typical soil and sediment samples contain about one pico-curie of natural uranium per gram.

9.2.2. Sources of Radioactivity

Of the radioactive atoms that exist in nature, some have always existed and natural processes continually form others. For example, uranium has always existed, is radioactive, and occurs in small but variable concentrations throughout the earth. Radioactive carbon and tritium, on the other hand, are formed by cosmic radiation striking atoms in the atmosphere. Radionuclides can also be created by man. For example, they are created in nuclear reactors and consist of fission products and activation products. The fission products are the residue of the uranium fission process that produces the energy within the reactor. The fission process also produces neutrons that interact with structural and other materials in the reactor to form activation products. Because of the nature of the fission process, many fission products are unstable and, hence, radioactive. Most fission products have short lives and are retained within the nuclear fuel itself; however, trace natural uranium impurities in reactor structural materials release small quantities of fission products to the reactor coolant.

It should be noted that a certain level of "background" fission-product radioactivity also exists in the environment, primarily due to atmospheric nuclear weapons testing. Although the level is very low, these fission products are routinely detected in air, food, and water when analyzed with extremely sensitive instruments and techniques.

9.3 CONTROL OF RADIATION AND RADIOACTIVITY

To reduce to as low as is reasonably achievable the exposure of persons to ionizing radiation, controls on the use and disposal of radioactive materials and comprehensive monitoring programs to measure the effectiveness of these controls are required. Effluent streams that may contain radioactive materials must be treated by appropriate methods to remove the radioactive materials and the effluent monitored to ensure that these materials have been reduced to concentrations that are as low as is reasonably achievable and are well within all applicable guidelines and requirements.

10.0 GLOSSARY

Activation Products - As cooling water circulates through the reactor, certain impurities present in the water and even components of the water itself can be converted to radioactive nuclides (they become "activated"). Important activation products present in reactor coolant water include radionuclides of corrosion and wear products (cobalt-60, iron-59, cobalt-58, chromium-51), of impurities dissolved in the water (argon-41, sodium-24, carbon-14) and of atoms present in the water molecules (tritium). Of these, the predominant radionuclide and also the one with the most restrictive limits is cobalt-60.

Algae – Simple rootless plants that grow in bodies of water in relative proportion to the amount of nutrients available. Algae blooms, or sudden growth spurts can affect water quality adversely.

Alkalinity – The measurable ability of solutions or aqueous suspensions to neutralize an acid.

Alpha Radioactivity - A form of radioactivity exhibited by certain radionuclides characterized by emission of an alpha particle. Many naturally occurring radionuclides including radium, uranium, and thorium decay in this manner.

Benthic Macroinvertebrates - Small organisms inhabiting the bottom of lakes and streams or attached to stones or other submersed objects. The study of macroinvertebrate communities gives an indication of the overall quality of the body of water from which they are taken.

Beta-Gamma Radioactivity - A form of radioactivity characterized by emission of a beta particle and/or gamma rays. Many naturally occurring radionuclides such as lead-212, bismuth-212, and bismuth-214 decay in this manner.

Biochemical Oxygen Demand (BOD) - The BOD test is used to measure the content of organic material in both wastewater and natural waters. BOD is an important parameter for stream and industrial waste studies and control of waste treatment plants because it measures the amount of oxygen consumed in the biological process of breaking down organic materials in the water.

Birge-Ekman Dredge - A device used for sampling the bottom sediment in rivers, streams, lakes, etc. The Birge-Ekman dredge is lowered to the bottom on a line and its spring-loaded "jaws" are remotely tripped from the surface. It samples an area of approximately 230 cm^2 to an average depth of 2.5 cm.

BTU (British Thermal Unit) - A unit commonly used to quantify the heat output of boilers, furnaces, etc. Specifically, the amount of heat necessary to raise 1 lb. of water one degree Fahrenheit.

Chain Electro-Fishing Techniques - A technique of collecting samples of fish from a body of water whereby the fish are stunned with an electric current, categorized, and returned to the water unharmed.

Chemical Oxygen Demand (COD) – A measure of the oxygen required to oxidize all compounds in water, organic and inorganic.

Collective Dose Equivalent and Collective Effective Dose Equivalent - Are the sums of the dose equivalents or effective dose equivalents of all individuals in an exposed population within an 80-km radius, for the purposes of this Order, and they are expressed in units of person-rem.

Committed Dose Equivalent - Is the predicted total dose equivalent to a tissue or organ over a 50-year period after a known intake of a radionuclide into the body. It does not include contributions from external dose. Committed dose equivalent is expressed in units of rem.

Committed Effective Dose Equivalent - Is the sum of the committed dose equivalents to various tissues in the body, each multiplied by the appropriate weighting factor. Committed effective dose equivalent is expressed in units of rem.

Composite Sample – A sample that is comprised of a number of grab samples over the compositing period. In some cases the composite sample obtained may be proportional to effluent flow and is called a proportional sample or flow-composited sample.

Conductivity - A measure of water's capacity to convey an electric current. This property is related to the total concentration of the ionized substances in a water and the temperature at which the measurement is made.

Confidence Interval - Statistical terminology for the error interval (±) assigned to numerical data. A 2σ (σ, the lower case Greek letter "Sigma") confidence interval means there is 95% confidence that the true value (as opposed to the measured one) lies within the (±) interval. The 95% is the confidence level. (See (±) value, Standard Deviation of the Average.)

Corrosion and Wear Products - Piping and components used in construction of a nuclear reactor are fabricated from extremely durable, corrosion and wear resistant materials. Even under the best circumstances, however, small amounts of these materials enter the reactor cooling water due to wear of moving parts and corrosion of the water contact surfaces of reactor plant components. While in no way affecting operational characteristics or reactor plant integrity, some of these corrosion and wear products may become activated as they pass through the reactor core. This necessitates that the reactor coolant be processed by filtration or other methods of purification before it is discharged or reused. (See Activation Products).

Curie (Ci) - The curie is the common unit used for expressing the magnitude of radioactive decay in a sample containing radioactive material. Specifically, the curie is that amount of radioactivity equal to 3.7×10^{10} (37 billion) disintegrations per second. For environmental monitoring purposes, the curie is usually too large a unit to conveniently work with and is broken down to smaller values. (See Microcurie and Pico-curie.)

Derived Concentration Guide (DCG) - is the concentration of a radionuclide in air or water that, under conditions of continuous exposure for one year by one exposure mode (i.e., ingestion of water, submersion in air, or inhalation), would result in an effective dose equivalent of 100 mrem (0.1 rem).

Dose Equivalent - The quantity that expresses the biological effects of radiation doses from all types (alpha, beta-gamma) of radiation on a common scale. The unit of dose equivalent is the rem.

Duplicate Sample – A sample that is created by splitting existing samples before analysis and treating each split sample as a separate sample. The samples are then analyzed as a quality assurance method to assess the precision in the analytical process.

Ecosystem - The integrated, interdependent system of plant and animal life existing in an environmental framework. Understanding of an entire ecosystem is important because changes or damage to one component of the system may have effects on others.

Effective Dose Equivalent - The effective dose equivalent is the sum of the dose equivalent to the whole body from external sources plus the dose equivalents to specific organs times a weighting factor appropriate for each organ. The weighting factor relates the effect of individual organ exposure relative to the effect of exposure to the whole body. The unit of effective dose equivalent is the rem.

Eh - A measure of the oxidation-reduction potential of water expressed in units of millivolts. The oxidation-reduction potential affects the behavior of many chemical constituents present in water in the environment.

Field Blank – A field blank is a sample of laboratory distilled water that is put into a sample container at the field collection site and is processed from that point as a routine sample. Field blanks are used as a quality assurance method to detect contamination introduced by the sampling procedure.

Fission Products - During operation of a nuclear reactor, heat is produced by the fission (splitting) of "heavy" atoms, such as uranium, plutonium or thorium. The residue left after the splitting of these "heavy" atoms is a series of intermediate weight atoms generally termed "fission products." Because of the nature of the fission process, many fission products are unstable and, hence, radioactive. Most fission products have short lives and are retained within the nuclear fuel itself; however, trace natural uranium impurities in reactor structural materials release small quantities of fission products to the reactor coolant.

It should be noted that a certain level of "background" fission product radioactivity exists in the environment, primarily due to atmospheric nuclear weapons testing. The level is very low, but may be detectable when environmental samples are analyzed with extremely sensitive instruments and techniques such as those used by the Knolls Atomic Power Laboratory.

Grab Sample – A single sample that is collected and is representative of the stream or effluent.

Half Life - A value assigned to a radionuclide that specifies how long it takes for one half of a given quantity of radioactivity to decay away. Half-lives may range from fractions of a second to millions of years.

High Purity Germanium Gamma Spectrometer System - A High Purity Germanium gamma spectrometer system is a sophisticated set of components designed for characterizing and quantifying the radionuclides present in a sample. This system makes use of the fact that during the decay of most radionuclides, one or more gamma rays are emitted at energy levels characteristic of the individual radionuclide. For example, during the decay of cobalt-60, two gamma rays of 1.17 and 1.33 million electron volts (MeV) are emitted while the decay of argon-41 produces one gamma ray of 1.29 MeV. The high purity germanium detector used in this system is capable of detecting and very precisely resolving differences in gamma ray energy levels and sending this information along to electronic components where it is processed and evaluated.

Long-Lived Gamma Radioactivity - Two very important characteristics of radionuclides are the length of time it takes for a given amount to decay away and the type of radiation emitted during decay. From an environmental standpoint, some of the most significant radionuclides are those whose "life" is relatively long and that also emit penetrating gamma radiation during decay. Two radionuclides of concern in these respects are cobalt-60 (a corrosion and wear activation product) and cesium-137 (a fission product). (See Half-Life, Beta-Gamma Radioactivity.)

mg/l (Milligrams per liter) - A unit of concentration commonly used to express the levels of impurities present in a water sample. A milligram is a thousandth of a gram. A milligram per liter is equal to a part per million.

Microcurie (µCi) - One millionth of a curie (10^{-6} curie). The typical radium dial watch might contain 1µCi of radioactive material. (See Curie and Pico-curie.)

Millirem (mrem) - One thousandth of a rem (10^{-3} rem).

Minimum Detectable Concentration (MDC) - Depending on the sample medium, the smallest amount or concentration of a radioactive or nonradioactive analyte that can be reliably detected using a specific analytical method.

Outfall - A point of discharge (e.g., drain or pipe) of liquid effluent into a stream, river, ditch, or other water body.

Parshall Flume - A specially constructed channel designed such that discharge water flow rate can be accurately measured. The Parshall Flume may also be instrumented to record the total volume of flow over long periods of time.

Pasquill Stability Class - A classification that defines the relative stability and dispersive capability of the atmosphere. Classification is highly dependent upon the change in temperature with height.

PCBs - Also known as polychlorinated biphenyls, are halogenated aromatic hydrocarbons formed by the chlorination of biphenyl molecules. PCB's were commonly used in transformers as a dielectric fluid because of their stability.

Periphyton - Communities of microorganisms growing on stones, sticks, and other submerged surfaces. The quantities and types of periphyton present are very useful in assessing the effects of pollutants on lakes and streams.

Person-Rem - The sum of the individual dose equivalents or effective dose equivalents received by each member of a certain group or population. It is calculated by multiplying the average dose per person by the number of persons within a specific geographic area. For example, a thousand people each exposed to 0.001 rem would have a collective dose of one person-rem.

pH - A measure of the acidity or alkalinity of a solution on a scale of 0 to 14 (low is acidic, high is alkaline or caustic, 7 is neutral.

Pico-curie (pCi) - One trillionth of a curie (10^{-12} curie). Typical soil and sediment samples contain approximately one pCi of natural uranium per gram. (See Curie and Millicurie.)

±Value (plus or minus value) - The (±) value is an expression of the error in sample results. The magnitude of the (±) value depends on the number of samples, the size of the sample, intrinsic analytical errors and the degree of confidence required. The (±) value assigned to data in this report is for the 95% confidence level. (See Confidence Interval.)

Radionuclides - Atoms that exhibit radioactive properties. Standard practice for naming radionuclides is to use the name or atomic symbol of an element followed by its atomic weight (e.g., cobalt-60 or Co-60, a radionuclide of cobalt). There are several hundred known radionuclides, some of which are man-made and some of which are naturally occurring. Radionuclides can be differentiated by the types of radiation they emit, the energy of the radiation and the rate at which a known amount of the radionuclide decays away. (See Half Life.)

Rem - The unit of dose equivalent and effective dose equivalent.

RCRA (Resource Conservation and Recovery Act) - A Federal law that established a structure to track and regulate hazardous wastes from the time of generation to disposal. The law requires safe and secure procedures to be used in treating, transporting, storing, and disposing of hazardous substances. RCRA is designed to prevent new, uncontrolled hazardous waste sites.

Settleable Solids - A measurement of the amount of solids that will settle out of a sample of water in a certain interval of time. This parameter commonly applies to water being processed in sewage treatment plants and is used to control the operation and evaluate the performance of these plants.

Short-Lived Gamma Radioactivity - Radioactive material of relatively short life that decays with the emission of gamma rays. It is generally not important with respect to environmental discharges because of the short life span. Some examples of short-lived gamma emitting radionuclides are argon-41 (an activation product gas), krypton-88 (a fission product gas), and xenon-138 (a fission product gas).

Spiked Sample - A sample to which a known quantity of the material that is being analyzed for has been added for quality assurance testing.

Standard Deviation of the Average - A term used to characterize the error assigned to the mean of a set of analyzed data. (See Confidence Interval, (±) Value).

Suspended Solids - Particulate matter, both organic and inorganic suspended in water. High levels of suspended solids not only affect the aesthetic quality of water by reducing clarity, but may also indirectly indicate other undesirable conditions present. The analysis for suspended solids is performed by passing a sample of water through a filter and weighing the residue.

Surber Bottom Sampler - A device for collecting samples of benthic macroinvertebrates from the bottom of relatively shallow, fast moving streams.

Thermoluminescent Dosimeters (TLDs) - TLDs are sensitive monitoring devices that record accumulated dose due to radiation. The TLDs used by the Knolls Atomic Power Laboratory for environmental monitoring consist of small chips of calcium fluoride (CaF_2) or lithium fluoride (LiF) encased in appropriate materials and strategically located at site perimeter and off-site locations. Thermoluminescent Dosimeters derive their name from a property that CaF_2 and LiF crystals exhibit when exposed to radiation and subsequently heated-that of emitting light proportional to the amount of radiation exposure received (thermoluminescence). The emitted light can then be read out on special instrumentation and correlated to the amount of radiation dose accumulated. The TLDs used by the Knolls Atomic Power Laboratory for environmental monitoring are specially selected for their accuracy and consistency of results.

Turbidity - A cloudy condition in water due to suspended silt or organic matter.

Upgradient – Referring to the flow of groundwater, upgradient is analogous to upstream and is a point that is "before" an area of study that is used as a baseline for comparison with downgradient or downstream data.

Volatile Organic Compound (VOC) - An organic (carbon-containing) compound that evaporates (volatilizes) readily at room temperature.

Weight Percent - A term commonly used to describe the amount of a substance in a material. For example, oil containing 0.5 lb. sulfur per 100 lb. oil would contain 0.5 percent by weight sulfur.

Weighting Factor - Is tissue-specific and represents the fraction of the total health risk resulting from uniform, whole-body irradiation that could be contributed to that particular tissue.

11.0 REFERENCES

1. Title 6, New York Codes, Rules and Regulations, Parts 700-705, *Water Quality Regulations for Surface Waters and Groundwaters*

2. Town of Niskayuna Sewer District No. 6 Outside Users Agreement No. 94 3850 between KAPL, Inc. and The Town Board of Niskayuna dated July 19, 1994

3. New York State Department of Environmental Conservation, Authorization to Discharge under the State Pollutant Discharge Elimination System, Permit No. NY 0005851

4. U.S. DOE Order 5400.5, *Radiation Protection of the Public and the Environment*

5. Title 6, New York Codes, Rules and Regulations, Part 360, *Solid Waste Management Facilities*

6. Title 6, New York Codes, Rules and Regulations, Part 227, *Stationary Combustion Installations*

7. Title 40, Code of Federal Regulations, Part 61, Subpart H, *National Emission Standards for Emissions of Radionuclides Other Than Radon From Department of Energy (DOE) Facilities*

8. *Knolls Atomic Power Laboratory Existing Landfill Closure Report for the Knolls Site* - Revised August 2, 1991.

9. *Standard Methods for the Examination of Water and Wastewater*, 19th Edition, American Public Health Association. 1995

10. Knolls Atomic Power Laboratory, *Mohawk River Biological Survey*, ES-80-1, April 1980

11. Knolls Atomic Power Laboratory, *Mohawk River Survey Report*, KAPL-4808, May 1995

12. EPA-625/6-87/016, *Handbook: Groundwater*, March 1987

13. Title 6, New York Codes, Rules and Regulations, Parts 595-599, *Chemical Bulk Storage Regulations*

14. Title 6, New York Codes, Rules and Regulations, Parts 612-614, *Petroleum Bulk Storage Regulations*

15. Title 49, Code of Federal Regulations, Parts 171-175 and 177-178, *Transportation of Hazardous Materials*

16. Title 10, Code of Federal Regulations, Part 50, Appendix I, *Numerical Guide for Design Objectives and Limiting Conditions for Operation to meet the criteria "As Low As Is Reasonably Achievable" for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents*

17. NUREG 0170, *Final Environmental Statement of the Transportation of Material by Air and Other Modes*. U.S. Nuclear Regulatory Commission. Vol. 1, December 1977

18. DOE/EIS-0274, Final Environmental Impact Statement, Disposal of the S3G and D1G Prototype Reactor Plants, U. S. Department of Energy, Office of Naval Reactors, November 1997

19. New York State Department of Environmental Conservation, Authorization to Discharge under the State Pollutant Discharge Elimination System, Permit No. N.Y. 0005843

20. Title 10, New York Codes, Rules and Regulations, Part 5, *Drinking Water Supplies*

21. New York State Department of Environmental Conservation, *Division of Water Technical and Operational Guidance Series (1.1.1) Water Quality Standards and Guidance Values*, October 1993

22. DOE/EIS-0275, Final Environmental Impact Statement, S1C Prototype Reactor Plant Disposal, U. S. Department of Energy, Office of Naval Reactors, November 1996

23. State of Connecticut Department of Environmental Protection General Stormwater Discharge Permit, Permit No. GSI000637

24. State of Connecticut General Permit for the Discharge of Stormwater and Dewatering Wastewaters Associated with Construction Activities (Permit # GSN000133) 20 July 1998

25. Town of Windsor, Connecticut Inland Wetlands and Water Course Permit #604, dated 7 July 1998

26. DOE/EH-0070, *External Dose-Rate Conversion Factors for Calculation of Dose to the Public*, July 1988

27. DOE/EH-0071, *Internal Dose Conversion Factors for Calculation of Dose to the Public*, July 1988

28. Nuclear Regulatory Guide 1.109, *Calculation of Annual Doses of Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I*. Rev. 1, October 1977

29. EPA 402-B-92-001, Users Guide for CAP-88PC, Version 1.0, March 1992

30. EPA-450/4-87-013, *On-Site Meteorological Program Guidance for Regulatory Modeling Applications*, June 1987

31. *Site Population Distribution Analysis*, 1990 Census Data, prepared by Oak Ridge National Laboratory. January 1993

32. National Council on Radiation Protection and Measurements (NCRP) Report No. 93, *Ionizing Radiation Exposure of the Population of the United States*, September, 1987

33. DOE/EP-0023, *A Guide For Environmental Radiological Surveillance at USDOE Installations*, July 1981.

34. EPA-600/7-77-088, *Handbook for Analytical Quality Control in Radioanalytical Laboratories*, August 1977.

35. Nuclear Regulatory Guide 4.15, *Quality Assurance For Radiological Monitoring Programs (Normal Operations) - Effluent Streams and the Environment*, February 1979

12.0 EXTERNAL DISTRIBUTION

	No. of Copies
USDOE, Office of Environmental Guidance and Compliance	10
USDOE, Technical Information Center	3
USDOE, Headquarters Library	1
USDOE, Office of Naval Reactors	50
USDOE, Schenectady Naval Reactors Office	5
USDOE, Schenectady Naval Reactors Office West Milton Field Office	1
Mr. Charles Schumer United States Senator	1
Mr. Daniel P. Moynihan United States Senator	1
Mr. Christopher Dodd United States Senator	1
Mr. Joseph Lieberman United States Senator	1
Mr. Michael R. McNulty United States Congressman	1
Mr. John Sweeney United States Congressman	1
Mr. John Larson United States Congressman	1
Mr. Hugh T. Farley New York State Senator	1
Mr. Joseph L. Bruno New York State Senator	1
Mr. Robert A. D'Andrea New York State Assemblyman	1
Mr. James Tedisco New York State Assemblyman	1
Mr. Paul D. Tonko New York State Assemblyman	1

	No. of Copies
Mr. John Kissel Connecticut State Senate	1
Mr. Eric Coleman Connecticut State Senate	1
Ms. Mary Eberle Connecticut State Representative	1
Ms. Ruth C. Fahrbach Connecticut State Representative	1
Ms. Annette Carter Connecticut State Representative	1
Mr. Robert D. McEvoy, County Manager Schenectady County, New York	1
Chairperson Schenectady County, New York, Legislature	1
Mr. Jeff Edwards, Chairperson Environmental Advisory Council Schenectady County, New York	1
Mr. Jack Parisi, Director Environmental Health Schenectady County Public Health Service	1
Mr. Ken Posson, Director Emergency Management Office Schenectady County, New York	1
Mr. Albert P. Jurczynski, Mayor Schenectady, New York	1
Mr. Luke Smith, Supervisor Town of Niskayuna, New York	1
Commissioner of Public Works Town of Niskayuna, New York	1
Mr. William Lee, Chairperson Conservation Advisory Council Niskayuna, New York	1
Mr. Robert Maswick Latham Water District Town of Colonie, New York	1
Mr. Richard Lucia, Chairperson Saratoga County, New York, Board of Supervisors	1

	No. of Copies
Mr. Peter Balet, Chairperson Environmental Management Council Saratoga County, New York	1
Mr. A. Dewey, Director Office of Emergency Services Saratoga County, New York	1
Mr. George M. Hodgson, Jr., Director Environmental Management Services Saratoga County, New York	1
Mr. Kenneth Klotz, Mayor Saratoga Springs, New York	1
Mr. John P. Ramano, Mayor Ballston Spa, New York	1
Mr. W. Trieble, Supervisor Town of Milton, New York	1
Ms. Faith McMahon, Mayor Bloomfield, Connecticut	1
Ms. Mary Hogan, Mayor Windsor, Connecticut	1
Mr. David Kilbon, First Selectman East Granby, Connecticut	1
Mr. William Simanski, First Selectman Granby, Connecticut	1
Ms. Anita L. Mielert, First Selectman Simsbury, Connecticut	1
Mr. Edward A. Ferrari, First Selectman Windsor Locks, Connecticut	1
Mr. Ray Walker, Fire Marshal Windsor, Connecticut	1
Chairperson Air and Water Pollution Abatement Commission Windsor, Connecticut	1
Dr. Charles Petrillo, Director of Health Windsor, Connecticut	1
Mr. Karl Wagener, Executive Director Connecticut State Council on Environmental Quality	1

	No. of Copies
Ms. Mindy S. Lubber, Regional Administrator Region I United States Environmental Protection Agency	5
Ms. Anne Fenn, Federal Facility Coordinator Region I United States Environmental Protection Agency	1
Mr. James J. Cherniack, Regional Radiation Representative Region I United States Environmental Protection Agency	1
Ms. Kim Tisa, PCB Coordinator Region I United States Environmental Protection Agency	1
Mr. Stanley Scott, Branch Chief Planning, Analysis and Grants Branch Region 1 United States Environmental Protection Agency	1
Mr. James Gaffey, Chemical Engineer Office of Environmental Stewardship Region 1 United States Environmental Protection Agency	1
Ms. Jeanne M. Fox, Regional Administrator Region II United States Environmental Protection Agency	5
Ms. Jeannette Dadusc, Federal Facility Coordinator Region II United States Environmental Protection Agency	1
Mr. Paul A. Giardina, Chief Radiation and Indoor Air Branch Region II United States Environmental Protection Agency	1
Mr. Davis Greenlaw, PCB Coordinator Toxic Substances Section Region II United States Environmental Protection Agency	1
Mr. James Reidy, Chief RCRA Programs Branch Region II United States Environmental Protection Agency	1
Ms. Antonia C. Novello, M.D., M.P.H., Commissioner New York State Department of Health	5

	No. of Copies
Dr. Karim Rimawi, Director New York State Bureau of Environmental Radiation Protection New York State Department of Health	1
Mr. Glenn Bruso, Senior Sanitary Engineer Glens Falls District Office New York State Department of Health	1
Mr. John P. Cahill, Commissioner New York State Department of Environmental Conservation	5
Mr. Steven B. Hammond, Director Division of Solid and Hazardous Materials New York State Department of Environmental Conservation	1
Paul J. Merges, Ph.D., Director Bureau of Radiation & Hazardous Site Management New York State Department of Environmental Conservation	1
Mr. Michael J. O'Toole, Jr., Director Division of Environmental Remediation New York State Department of Environmental Conservation	1
Mr. N. G. Kaul, Director Division of Water New York State Department of Environmental Conservation	1
Mr. Joseph F. Kelleher, P. E., Section Chief Physical Systems Section New York State Department of Environmental Conservation	1
Mr. Robert Warland, Director Division of Air Resources New York State Department of Environmental Conservation	1
Mr. Edwin Dassatti, Chief Bureau of Hazardous Waste Facilities New York State Department of Environmental Conservation	1
Mr. Roger Murphy, P. E., Chief, Western Engineering Section Bureau of Radiation and Hazardous Site Management New York State Department of Environmental Conservation	1
Ms. Lynn Winterberger, Environmental Engineer Bureau of Radiation and Hazardous Site Management New York State Department of Environmental Conservation	1
Mr. Steven Schassler, Director Region 4 New York State Department of Environmental Conservation	3

	No. of Copies
Mr. Clifton Van Guilder, Regional Hazardous Substance Engineer Region 4 New York State Department of Environmental Conservation	1
Mr. Rick Leone, Regional Air Resource Engineer Region 4 New York State Department of Environmental Conservation	1
Mr. Peter Mack, Regional Environmental Quality Supervisor Region 4 New York State Department of Environmental Conservation	1
Mr. Thomas Cullen, Regional Solid Waste Engineer Region 4 New York State Department of Environmental Conservation	1
Mr. Fredrick W. Sievers, P.E., Regional Water Engineer Region 4 New York State Department of Environmental Conservation	1
Ms. Margaret Rogers, Engineering Geologist Region 4 New York State Department of Environmental Conservation	1
Mr. Stewart A. Buchanan, Director Region 5 New York State Department of Environmental Conservation	3
Mr. Randy C. Galusha, Environmental Engineer Region 5 New York State Department of Environmental Conservation	1
Mr. George Stahler, Regional Solid and Hazardous Materials Engineer Region 5 New York State Department of Environmental Conservation	1
Mr. William Wasilauski, Regional Water Engineer Region 5 New York State Department of Environmental Conservation	1
Mr. Gus Carayiannis, Solid Waste Engineer Region 5 New York State Department of Environmental Conservation	1
Mr. Michael A. Stawarz, Regional Air Engineer Region 5 New York State Department of Environmental Conservation	1
Mr. Norma D. Gyle, Commissioner Connecticut State Department of Public Health	1

	No. of Copies
Mr. Arthur Rocque, Commissioner Connecticut State Department of Environmental Protection	3
Mr. Robert L. Smith, Chief Bureau of Water Management Connecticut State Department of Environmental Protection	1
Mr. Richard Barlow, Chief Bureau of Waste Management Connecticut State Department of Environmental Protection	1
Mr. Carmine DiBattista, Chief Bureau of Air Management Connecticut State Department of Environmental Protection	1
Dr. Edward Wilds, Director Division of Radiation, Bureau of Air Management Connecticut State Department of Environmental Protection	5
Combustion Engineering Windsor, Connecticut	1
Schenectady County Public Library Main Branch Schenectady, New York	1
Windsor Public Library Windsor, Connecticut	1