

**KAPL-4846**

**Knolls Atomic Power Laboratory**

# **Environmental Monitoring Report**

**Calendar Year 2001**

Operated for the U. S. Department of Energy  
by KAPL, Inc., a Lockheed Martin company

**LOCKHEED MARTIN**



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# **KNOLLS ATOMIC POWER LABORATORY**

## **ENVIRONMENTAL MONITORING REPORT**

**CALENDAR YEAR 2001**

**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**





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## 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 Knolls and Kesselring Sites and Site closure activities at the S1C Site (also known as the KAPL Windsor Site) continue to have no adverse effect on human health and the quality of the environment.

The effluent and environmental monitoring programs conducted by KAPL at the Knolls and Kesselring Sites 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 environmental monitoring of air, water, sediment, and fish. Radiation measurements are also made around the perimeter of the Knolls and Kesselring Sites and at off-site background locations.

The environmental monitoring program for the S1C Site continues to be reduced in scope from previous years due to the completion of Site dismantlement activities during 1999 and a return to green field conditions during 2000.

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 from the Knolls and Kesselring Sites are controlled and monitored in accordance with permits issued by the New York State Department of Environmental Conservation (NYSDEC). 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, the only liquid effluent was Site stormwater run-off, which was controlled in accordance with permits issued by the Connecticut Department of Environmental Protection (CTDEP) and the Town of Windsor.

Air emissions from the Knolls and Kesselring Sites are controlled and monitored in accordance with permits issued by NYSDEC. 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. There are no longer any sources of air emissions from the S1C Site.

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 Knolls and Kesselring 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 the Knolls and Kesselring Sites 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 KAPL Sites, but are shipped to government owned disposal sites. During 2001, approximately 335 cubic meters (438 cubic yards) of low-level radioactive waste were shipped from the Knolls and Kesselring Sites for disposal. (Radioactive material is no longer generated or stored at the S1C Site.) This is less than one percent of the amount of radioactive solid waste disposed of annually at government owned disposal sites.

The Knolls and Kesselring Sites are 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 operations conducted during 2001 at the Knolls and Kesselring 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 0.1 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. Final preparation and evaluation of the S1C Site is in progress in anticipation of land transfer for unrestricted future use.

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 that began in 1998, after completion of the National Environmental Policy Act (NEPA) process, is continuing. 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 consists of 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. Former 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. 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. At the Knolls Site, the Outside User's Agreement with the Town of Niskayuna specifies the chemical parameters required for the sanitary sewage effluent. 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 stormwater, 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 Knolls and Kesselring Sites 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 final grading and seeding of the property was completed in 2000.

The quantities of radioactivity contained in liquid and gaseous effluents during operations in 2001 at the Knolls and Kesselring 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 Knolls and Kesselring 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 2001 routine monitoring data for each KAPL Site is presented and assessed in this report.

During 2001, the KAPL Sites were inspected twenty-eight times by Federal and State environmental inspectors, or local agencies. These inspections did not identify any instances of non-compliance in operations.

Areas where historical petroleum or historical 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 Kesselring Site provides an annual report to Federal and State officials on detailed hazardous waste reduction plans for specific waste streams. At the Knolls Site, the amount of hazardous waste generated annually has been reduced below the level that necessitates providing waste reduction plans to Federal or State officials.

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 Kesseling 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 potential compliance concerns, and
- Maintain an accurate record of effluent releases to the environment from KAPL.

#### **Organization**

The Knolls and Kesselring 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. The Knolls Site also provides ESH coverage for the S1C Site during its final closure. Although the Knolls and Kesselring Sites each have a distinct ESH organization, there is significant interaction between the two Sites' ESH organizations to optimize personnel expertise, 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 Knolls and Kesselring Sites. During 2001, the Knolls and Kesselring Sites were inspected twenty-eight times by Federal and/or State environmental inspectors and/or local agencies. These inspections did not identify any areas of non-compliance in operations. There were no inspections of the S1C Site during 2001 by regulatory personnel. Ninety periodic environmental related reports were filed with Federal, State, and local agencies.

**TABLE 3-1 KAPL ENVIRONMENTAL PERMITS**

Permit Number	Permit Type	Issuing Agency	In Compliance	Expiration Date	Other Information
<b>KNOLLS SITE</b>					
NY0005851	SPDES <sup>(1)</sup>	NYSDEC <sup>(2)</sup>	Yes	01/01/05	Site Outfalls
4-4224-00024/00001	RCRA <sup>(3)</sup>	NYSDEC	Yes	07/20/08	RCRA Waste (EPA ID NY6890008992)
4-4224-00024/00039	AE <sup>(4)</sup>	NYSDEC	Yes	None	Heating Boilers <sup>(6)</sup>
EP-00030	AE	NYSDEC	Yes	NA <sup>(5)</sup>	ASGTF <sup>(7)</sup>
EP-00031	AE	NYSDEC	Yes	NA <sup>(5)</sup>	VIM/GA <sup>(8)</sup>
443417	PBSF <sup>(9)</sup>	NYSDEC	Yes	08/23/03	Oil Storage
ADA <sup>(10)</sup>	PCB	EPA Region II	Yes	08/31/06	PCB Paint Removal
KNOLL- E4-HC-01	RAE <sup>(11)</sup>	EPA Region II	Yes	None	Radioactive Materials Laboratory
<b>KESSELRING SITE</b>					
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 <sup>(5)</sup>	Spray Paint Booth
GRB01	AE	NYSDEC	Yes	NA <sup>(5)</sup>	Grit Blasting
BH002	AE	NYSDEC	Yes	NA <sup>(5)</sup>	Heating Boiler
BH004	AE	NYSDEC	Yes	NA <sup>(5)</sup>	Heating Boiler
5-000070	BCSF <sup>(12)</sup>	NYSDEC	Yes	07/19/03	Chemical Storage
5-414506	PBSF	NYSDEC	Yes	08/17/02	Oil Storage
ADA <sup>(10)</sup>	PCB	EPA Region II	Yes	08/31/06	PCB Paint Removal
KESSELRING-S3G-PA-01	RAE	EPA Region II	Yes	None	Plasma Arc Cutting
KESSELRING-D1G-PA-01	RAE	EPA Region II	Yes	None	Plasma Arc Cutting
KAPL-788-01	RAE	EPA Region II	Yes	None	Radiological Work Facility
<b>S1C SITE</b>					
CT GSN000133 <sup>(17)</sup>	CS <sup>(13)</sup>	CT-DEP <sup>(14)</sup>	Yes	10/01/02	Stormwater Discharge (Construction)
604	W <sup>(15)</sup>	WIWWC <sup>(16)</sup>	Yes	07/07/03	Construction within Wetlands Buffer

**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) With the startup of the new K2 Boilerhouse in March 2002, seven boilers currently exist on site. The four old boilers in the K4 Boilerhouse will be removed from service upon the successful startup and completion of testing of the new boilers.
- (7) Advanced Steam Generator Test Facility
- (8) Vacuum Induction Melting/Gas Atomization system. The Certificate to Operate EP-00031 was surrendered on 11/26/01. The VIMGA unit now operates as an exempt source-per NYSDEC
- (9) Petroleum Bulk Storage Facility
- (10) EPA Region II Alternate Decontamination Approval (ADA) to remove and dispose of PCB contaminated materials, dated 8/30/2001. This was formerly known as the Alternate Method of Disposal Approval (AMDA).
- (11) Radionuclide Air Emission
- (12) Bulk Chemical Storage Facility
- (13) Construction stormwater
- (14) State of Connecticut Department of Environmental Protection
- (15) Wetlands Permit
- (16) Town of Windsor Inland Wetlands and Watercourses Commission
- (17) A Notice of Termination for this Permit was submitted to CT-DEP in 11/01



The KAPL Sites had a total of 22 environmental permits during 2001 that were issued from regulatory agencies for specific facilities and/or operations. These permits are shown in Table 3-1.

A 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 stormwater, from the S1C Site in Connecticut were terminated in October 1995. In November 2001, KAPL submitted the necessary paperwork to terminate the S1C Site's discharge permit for stormwater discharges associated with construction activity. At the present time only the Inland Wetlands Permit issued by the Town of Windsor Inland Wetlands and Watercourses Commission remains active.

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 New York State Department of Environmental Conservation renewed the Knolls Site SPDES permit in 1999 which became effective on January 1, 2000. This permit was modified on December 14, 2000 to add a new treatment process, which will affect the copper concentration being discharged to the Mohawk River. In September 2001, the Knolls Site began using a copper ion generator to produce a very low, electrically induced, nominal copper ion concentration of approximately 10 µg/l (10 parts per billion). This should inhibit zebra mussels from settling in the river water noncontact cooling piping system. If this process is successful, it will replace the current annual chemical treatment utilizing a molluscicide.

The 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<sub>x</sub>); 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<sub>2</sub>) and NO<sub>x</sub>); 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 have not yet been implemented by 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. In 2000, the Knolls Site began constructing new facility boilers (K2 Boilerhouse) to replace the aging existing facility boilers (K4 Boilerhouse). KAPL provided the required EPA notification of commencement of construction in calendar year 2000. Performance testing of the new boilers is scheduled for April 2002. The EPA was provided with a notification of initial startup; commencement of performance testing, as well as, periodic fuel usage reporting under Subpart Dc. The new K2 boilers are permitted by NYSDEC. The Knolls Site has provided a schedule to NYSDEC for incorporating the remaining individually permitted air emission units into a single State Facility Permit. The schedule targets August 2002 for submittal of the State Facility Permit Application, which is contingent upon successful startup and testing of the new boilers. 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 certificate to operate emission point EP-00031, Vacuum Induction Melting/Gas Atomization (VIMGA) system was surrendered on November 26, 2001. The VIMGA Unit is now operated as an exempt source under the research & development exemption per NYSDEC regulations. 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 an exemption for ventilating and exhausts from laboratory operations and NESHAPs minor source exemptions presently in effect, or are considered as trivial activities under New York State regulations.

The EPA under 40 CFR 61 Subpart H regulates radionuclide air emission sources at the Knolls and Kesselring Sites. During 2001, the maximally exposed individual effective dose equivalent,

calculated using the EPA computer code CAP-88PC, was less than 0.1 mrem for the Knolls and Kesselring 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. In 2000, KAPL received EPA approval to modify an existing source of radionuclide air emissions at the Kesselring Site. The modification allows the use of a plasma arc cutting method during dismantlement of the D1G prototype. Startup notification for this modification was provided to the EPA on December 11, 2001.

### **Resource Conservation and Recovery Act (RCRA)**

The Resource Conservation and Recovery Act (RCRA), an amendment to the Solid Waste Disposal Act of 1965, was enacted in 1976 to address the safe disposal of municipal and industrial solid and hazardous waste. The goals set by RCRA are:

- To protect human health and the environment from the hazards posed by waste disposal;
- To conserve energy and natural resources through waste recycling and recovery;
- To reduce or eliminate, as expeditiously as possible, the amount of waste generated, including hazardous waste; and
- To ensure that wastes are managed in a manner that is protective of human health and the environment.

To achieve these goals, RCRA established three distinct yet interrelated programs. The hazardous waste program, under RCRA Subtitle C, establishes a system for controlling hazardous waste from the time it is generated until it is ultimately disposed -- in effect, from cradle to grave. The solid waste program, under RCRA Subtitle D, addresses the disposal of nonhazardous industrial solid waste and municipal solid waste. Finally, the underground storage tank program, under RCRA Subtitle I, regulates underground tanks storing hazardous substances and petroleum products. This discussion will focus mainly upon RCRA Subtitle C.

The regulations that EPA promulgated to implement RCRA Subtitle C are structured to first identify the criteria to determine which solid wastes are hazardous, and then establish various requirements for the three categories of waste handlers: generators, transporters, and treatment, storage and disposal facilities (TSDFs). Additionally, the regulations set technical standards for the design and safe operations of TSDFs and serve as a basis for developing and issuing the permits required by the Act for each facility.

RCRA, like most environmental legislation, encourages States to develop their own hazardous waste programs as an alternate to direct implementation of the federal program. To this end, the EPA has delegated its authority to both the NYSDEC and CTDEP for all aspects of RCRA, with the exception of a few specific portions associated with the 1984 Hazardous and Solid Waste Amendments (HSWA) to RCRA.

During 2001, the Knolls and Kesselring Sites continued to operate as both hazardous waste generators and permitted storage facilities. In this latter instance, the Knolls and Kesselring Sites received NYSDEC, 6 NYCRR Part 373 hazardous waste storage permits in July 1998 and June 1995, respectively. As such each Site must follow specific requirements for handling/accumulation of hazardous waste under applicable New York State regulations as well as the conditions for storage of such waste under their respective State-issued hazardous waste management permits.

## **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) adding a fourth major program 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 (July 1998) and the Kesselring Site (June 1995, modified November 1999) require each Site to pursue corrective action.

The basic steps in the corrective action process are: 1) 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.

The Knolls and Kesselring Sites are performing RCRA corrective actions under the oversight of NYSDEC. Each Site has several areas where historical releases of hazardous chemicals require sampling and potential remedial action. Reports of analysis results and actions taken are submitted for NYSDEC approval as they are accomplished, in accordance with established schedules.

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 (which was terminated in 1999), the Site is currently 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 is 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 (SWDA). The FFCA applied certain requirements and sanctions of RCRA to Federal facilities. In short, the FFCA waives sovereign immunity for Federal facilities from all civil and administrative penalties and fines; this includes waivers for both coercive and punitive sanctions for violations of the SWDA. Relative to mixed waste (mixed waste is waste that contains both hazardous and radioactive material), the FFCA gave DOE sites until October 1995 to develop Site Treatment Plans (STPs) with schedules for mixed waste treatment and obtain

approval from Federal or State regulatory agencies.

The Knolls and Kesselring Sites obtained New York State approval of their STPs, via separate Administrative Consent Orders on October 24, 1995.

The STPs for both Sites identify planned treatment options, schedules for shipment to selected treatment facilities, and arrangements for pre-treatment storage and post-treatment residual management for each mixed waste stream. Projected schedules for the start of operation of selected treatment facilities are identified and 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, on-site pre-treatment storage at each KAPL Site is planned until the selected treatment facilities are available. The STPs also include commitments to perform additional evaluations and work with NYSDEC to determine whether alternative treatment options should be selected, in the event completion of a targeted treatment facility is delayed.

Both the Knolls and Kesselring Sites generate very small amounts of mixed waste as a result of research and development for the design and operation of Naval nuclear propulsion plants. On December 31, 2001, KAPL had approximately 22.2 cubic meters of mixed waste in storage. This amount represents less than 0.05 percent of the total amount of mixed waste designated for treatment within the next five years at DOE facilities. If the targeted treatment facilities are completed according to currently identified schedules, all KAPL mixed waste streams will be treated by the end of 2004. The STPs balance the concern of expeditious completion of treatment, cost/efficiency, minimizing shipments, and minimizing risk/liability, and represent the best overall plan for achieving compliance with Land Disposal Restriction requirements for KAPL's mixed waste.

### **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. However, because adequate mixed waste treatment capacity remains an issue, regulatory agreements have been executed to achieve compliance. Administrative Consent Orders were signed between the DOE Schenectady Naval Reactors (SNR) and the NYSDEC for the Knolls and Kesselring Sites to address KAPL mixed waste compliance with LDRs. (See the discussion above related to the FFCA.)

### **Hazardous and Solid Waste Minimization Program**

EPA uses the term waste minimization to mean the reduction, to the extent feasible, of solid and hazardous waste. Both the solid waste program, under RCRA Subtitle D, and the hazardous waste program, under RCRA Subtitle C, have adopted waste minimization elements. EPA encourages

source reduction and recycling of both hazardous and nonhazardous waste streams regulated by RCRA Subtitles C & D. EPA's hierarchy for a solid waste management program includes source reduction, recycling, waste combustion and landfilling in that order.

Both KAPL Sites have implemented a hazardous waste minimization program that entails comprehensive plans to prevent and minimize hazardous waste from all KAPL operations. These plans are designed to meet the hazardous waste reduction requirements of RCRA. The plans focus mainly on process efficiency improvements, source reduction, inventory control, preventive maintenance, improved housekeeping, recycling, and increasing employee awareness of and participation in pollution prevention.

KAPL also has an Affirmative Procurement Plan that fosters the reuse of recycled commodities. When the Resource Conservation and Recovery Act (RCRA) was enacted in 1976, Congress stated that objectives of the statute included the conservation of resources through recycling. Recognizing that recycling works best if there are markets for the materials collected, Congress directed the Federal government to employ its purchasing power to help create and sustain markets by buying products manufactured with the collected (recycled) materials. Section 6002 of RCRA establishes the Federal program that directs Federal purchasing decisions for recycled products. KAPL maintains an Affirmative Procurement Plan that purchases EPA designated items in accordance with the DOE Agency Level Affirmative Procurement Guidelines. EPA designated items with recycled materials include but are not limited to: recycled paper and paper products, retread tires, concrete with fly ash, building insulation, recycled toner cartridges, reprocessed latex paint, recycled engine coolants and oils, etc. Each fiscal year, KAPL supplies information regarding purchases of EPA designated items to the DOE, who formally submits a DOE Agency Wide Report to the Office of Management and Budget (OMB).

### **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. While this is in keeping with the Pollution Prevention Act of

1990, this set of Executive Orders also brought Federal agencies 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 include 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. Also 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, printer cartridges, scrap metal, lead acid batteries, nickel cadmium batteries, scrap lead, cooking oil, plastic and steel barrels, aluminum cans, asphalt, wood, tires, oil, light bulbs, fluorescent light ballasts, and precious metals. The Knolls and Kesselring Sites recycled 847 tons of materials out of the 2259 tons of waste generated during calendar year 2001.

### **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 electrical transformers from each Site and has, where practical, removed the fluorescent ballasts containing PCBs. Additionally, KAPL employs strict controls for the proper

handling and disposal of any remaining items containing PCBs. Both Sites currently have an Alternate Decontamination Approval (ADA) from EPA. This allows KAPL to decontaminate PCB containing components (primarily to remove paint that contains PCBs) when cost and/or disposal path restrictions are prohibitive.

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

Under Executive Order 13148, 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 2001, the EPA lowered the Section 313 reporting thresholds for certain compounds, in particular lead and lead compounds. The Section 313 reporting threshold for lead and lead compounds regardless of the qualifying activity is now 100 pounds. None of the KAPL facilities were required to report under Section 313 in 2001.

### **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 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 mean sea level. Monitoring wells and soil/bedrock borings in the vicinity of the Knolls Site show that unconsolidated materials, consisting mainly of glacial deposits, overlie bedrock. The depth of bedrock beneath the Site generally ranges between 10 and 70 feet. Rock outcrops are visible on both banks of the Mohawk River between the Rexford Bridge, approximately two miles upstream, and a point about three quarters of a mile downstream from the Knolls Site. The outcrops are shales and sandstones of the Ordovician-age Schenectady Formation. These rocks are characteristically non-porous and impermeable, and form poor aquifers. The bedrock structure 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. The glacial till at the Knolls Site is clay rich, dense, compact, and is known locally as hardpan. The depth of the till beneath 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. These lenses are small in size and isolated from one another based on drilling records and on-site monitoring well performance. Overlying the till in the eastern portion of the Site are glacial lake sequences (silts and clays) and thin, discontinuous ice-contact deposits (sands and gravels). 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 small streams that receive drainage from the Site drain to the Mohawk River. The East Boundary Stream is located on the Site between the closed Site and Niskayuna Landfills. The East Boundary Stream also receives runoff from a nearby housing

development and roadway. The Midline Stream originates on-site and drains its central portion. The West Boundary Stream is located adjacent to the Knolls Site on General Electric (GE) Research and Development (R&D) Center property. This stream receives some surface water runoff from a tributary ditch from the Knolls Site. A fourth surface water drainage-way, located on the west side of the Knolls landfill, is referred to as the West Landfill Stream. This drainage-way does not directly discharge to the Mohawk River. The flow in all of these streams becomes extremely low to non-existent during the late summer/early fall. These streams are not accessible to the public, except at the point where they each meet the Mohawk River, nor are they suitable for fishing or swimming.

The groundwater within the immediate vicinity of the Site is very limited due to both low porosity and permeability of the till which prohibits the development as a potable water supply. As such there are no drinking water wells on-site. 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 Site is obtained from the Mohawk River.

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 Pollutant Discharge Elimination System 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 blow downs 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 contain 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**

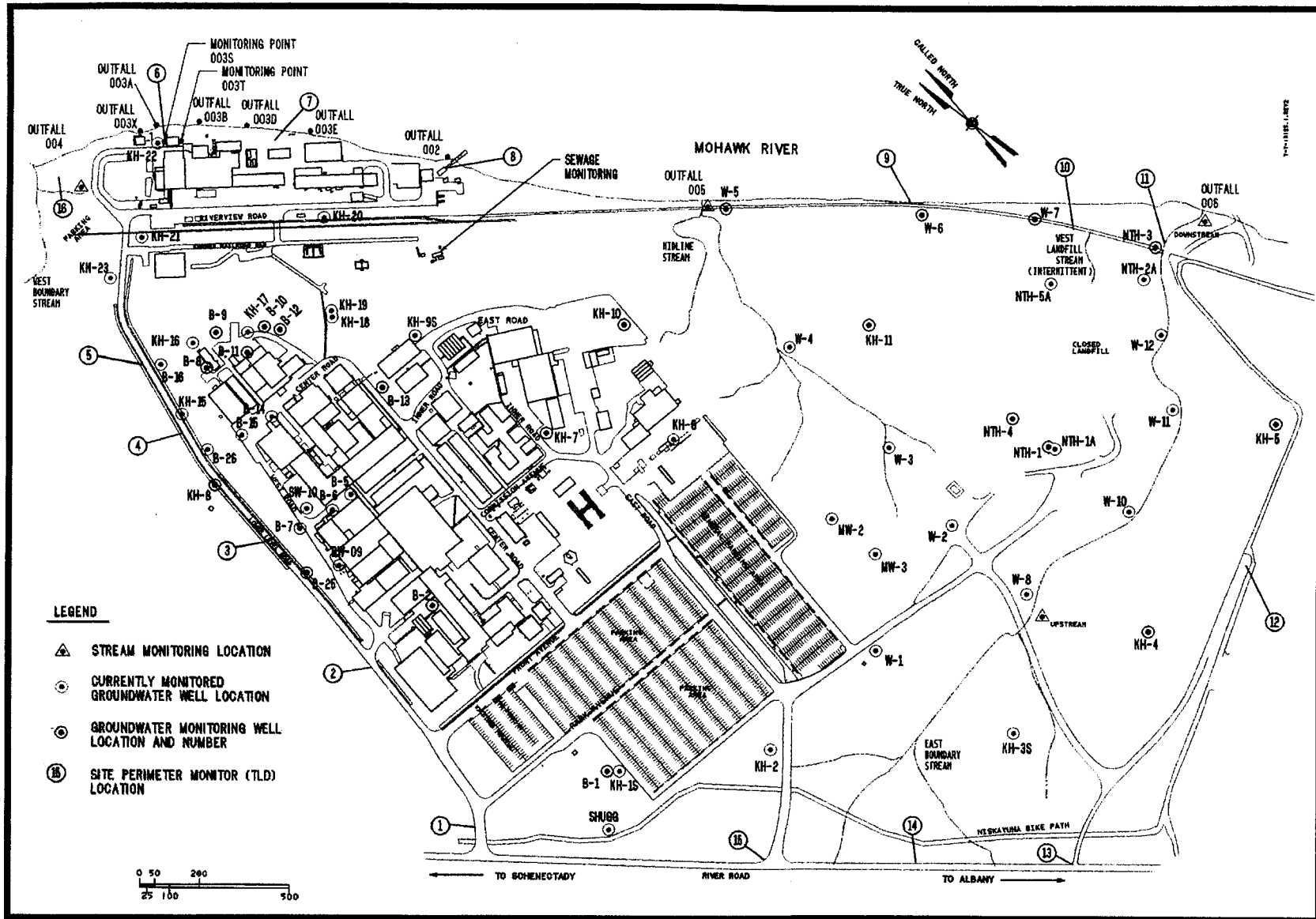
The Knolls Site sanitary sewage is discharged to the Town of Niskayuna Publicly Owned Treatment Works (POTW) in accordance with an Outside User's Agreement, Reference (2). The Agreement specifies the parameters and sampling frequency for the untreated sewage. The minimum sampling frequency is monthly for chemical constituents and quarterly for radioactivity. Typically, a 24-hour flow-composited sample is collected weekly for analysis. The sewage 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.

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, effective on January 1, 2000 and modified on December 14, 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 stormwater streams (Outfalls 004, 005, and 006) as shown in Figure 4-1.

Outfall 002 discharges non-contact cooling water, process water, stormwater, and groundwater through a submerged drain line directly to the Mohawk River. The Outfall 002 monitoring station consists of a continuous temperature monitor, and 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 stormwater. These outfalls are monitored continuously for flow and temperature. Also grab samples are obtained on a monthly basis for chemical constituent analyses. 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



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

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 stormwater. Process water, including non-contact cooling water is not directed to these outfalls. These outfalls are monitored quarterly utilizing a flow estimate and grab sample for chemical constituent analyses. All monitoring is in accordance with the SPDES Permit. Outfalls 003A, 003B, 003D, and 003E are also voluntarily sampled monthly for radioactivity.

Outfall 003X was not operated during 2001. 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.

The Knolls Site is permitted to chemically treat to eliminate zebra mussels from the river water noncontact cooling water system utilizing the molluscicide, Betz Dearborn CT-1300, up to four times per year. In 2001, the Knolls Site chemically treated for zebra mussel control once in September. The effluent was detoxified prior to discharge to the Mohawk River. A report is submitted to NYSDEC that documents the treatment evolution and compliance with permit conditions. Monitoring is required at all outfalls which discharge treated water. This is normally performed at Outfalls 002, 003B, and 003D.

Following the September treatment, the Knolls Site began utilizing a copper ion (concentration <10 ppb) generator to inhibit zebra mussel larvae from settling in the cooling water system. They will pass through the piping system and be returned to the river. The Knolls Site is required by NYSDEC to submit operational copper data in four quarterly reports. The final report will evaluate the collected data and the effectiveness of the copper ion generating system. The final permit limits will be established by NYSDEC based upon this data. If the system is effective, the Knolls Site will be able to eliminate the annual chemical molluscicide treatment.

Three Knolls Site stormwater outfalls, designated as 004, 005, and 006, 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 for SPDES parameters and monthly for radioactivity, when possible. The sampling location for Outfall 004 is in the associated 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 part of the SPDES program but is monitored in accordance with the Knolls Site Landfill Post Closure Monitoring Program. The flow in this drainage-way is extremely intermittent and it is sampled semi-annually for chemical parameters and monthly for radioactivity, when possible.

#### **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 2001. 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

**TABLE 4-1 CHEMICAL CONSTITUENTS IN KNOLLS SITE SANITARY SEWAGE EFFLUENT DISCHARGED TO THE TOWN OF NISKAYUNA WASTEWATER TREATMENT PLANT, 2001**

Parameter (Units)	Number of Samples	Value <sup>(1)</sup> Knolls Site Sewage Lift Station			Users Agreement Average <sup>(3)</sup>	Percent of Limit <sup>(4)</sup>
		Minimum	Maximum	Average <sup>(2)</sup>		
Outside Users Agreement #94 3850 Requirements (Reference 2)						
Flow (GPD) *	12 <sup>(5)</sup>	13,900	26,700	18,200	45,000	40
pH (SU) **	1,326	7.5	9.0	8.3	6.0-9.5 <sup>(6)</sup>	--
Biochemical Oxygen Demand (mg/l)	51	49	703 <sup>(7)</sup>	345	700	49
Chemical Oxygen Demand (mg/l)	50	188	2200 <sup>(7)</sup>	870	1800	48
Total Suspended Solids (mg/l)	51	66	2440 <sup>(7)</sup>	621	1600	39
Ammonia as N (mg/l)	50	15	125	86	200	43
Nitrate as N (mg/l)	50	< 0.02	0.44	< 0.17	4	< 4
Nitrite (as N) (mg/l)	51	< 0.02	0.42	< 0.11	4	< 3
Total Kjeldal Nitrogen (as N) (mg/l)	50	22	181	128	250	51
Total Organic Nitrogen (as N) (mg/l)	50	7	73	42	175	24
Total Nitrogen <sup>(8)</sup> (as N) (mg/l)	50	22.9	< 181.4	< 128.6	250	< 51
Phosphate as P (mg/l)	50	5.1	30	16	30	53
Additional Parameter Monitored						
Oil & Grease (mg/l)	51	2.7	77	46.9	100 <sup>(9)</sup>	47
*GPD = Gallons per day						
**SU = Standard units						

**Notes:**

- (1) A value preceded by < is less than the method detection limit.
- (2) Average values preceded by < contain at least one less than method detection limit 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 and 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) The average BOD for the month this maximum occurred (November 2001) was 503 mg/l. The average COD for the month this maximum occurred (December 2001) was 1,208 mg/l. The average TSS for the month this maximum occurred (November 2001) was 1,398 mg/l.
- (8) Daily average limit; calculated as the sum of nitrate + nitrite + total Kjeldahl nitrogen.
- (9) 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, 2001**

Radionuclide	Number of Samples	Average Radioactivity Concentration <sup>(1)</sup> (pCi/liter)	DOE Order 5400.5	Percent of DCG
			Derived Concentration Guide (DCG) (pCi/liter)	
Cs-137	51	< 0.84	3000	< 0.028
Sr-90	51	< 0.30	1000	< 0.030
Co-60	51	< 0.84	5000	< 0.017
H-3	51	< 245	2000000	< 0.012
U-234 <sup>(2)</sup>	51	0.14 ± 0.08	500	0.027
U-235 <sup>(2)</sup>	51	0.004 ± 0.003	600	0.0007
U-236 <sup>(2)</sup>	51	< 0.005	500	< 0.001
U-238 <sup>(2)</sup>	51	0.09 ± 0.06	600	0.016
			<b>Total Percentage<sup>(3)</sup></b>	<b>&lt; 0.13%</b>

**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 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).

radionuclides by gamma spectrometry, (3) tritium by liquid scintillation counting, and (4) gross alpha and gross beta radioactivity by direct sample evaporation and subsequent alpha and beta counting. In addition, samples from the small cooling and drainage water outfalls are analyzed for gross 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 2001 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 was detected in the effluent. No radionuclides attributable to KAPL operations were detected in the effluent composite samples. The 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 2001 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. This data was reported to NYSDEC as appropriate in the monthly Discharge Monitoring Report.

**TABLE 4-3 CHEMICAL CONSTITUENTS AND TEMPERATURE  
IN KNOLLS SITE LIQUID EFFLUENT, 2001**

Parameter (Units)	Number of Samples	Discharge Points 002 and 003A-E			Permit Limit <sup>(3)</sup>	Percent of Limit <sup>(4)</sup>
		Value <sup>(1)</sup>				
		Minimum	Maximum	Average <sup>(2)</sup>		
Discharge Permit Requirements (Reference 3)						
Discharge Point 002						
Intake pH (SU) *	54	7.6	8.5	8.0	Monitor	--
pH (SU) *	54	7.6	8.6	8.0	6.5-8.5 <sup>(5)</sup>	--
Flow (MGD) **	Continuous <sup>(6)</sup>	0.81	2.93	1.78	Monitor	--
Temperature (°F)	Continuous <sup>(6)</sup>	35.5	83.4	56.2	90	93
Oil & Grease (mg/l)	52	<1	1.8	<1.0	15	12
Total Residual Chlorine (mg/l)	52	0.05	0.11	0.07	0.2 <sup>(7)</sup>	55
Suspended Solids (mg/l)	52	<1	292	<10	Monitor	--
Dissolved Sulfide (mg/l)	53	<0.1	<0.1	<0.1	2	<5
Intake Iron (mg/l)	7	0.08	3.08	0.85	Monitor	--
Iron (mg/l)	53	0.06	2.56	0.31	4.0 <sup>(8)</sup>	64
Manganese (mg/l)	8	<0.02	0.04	<0.03	0.35 <sup>(9)</sup>	11
Surfactants (mg/l)	8	<0.02	0.03	<0.02	0.4 <sup>(9)</sup>	7.5
Bromide (mg/l)	8	<1	<1	<1	1.4 <sup>(9)</sup>	<5
Intake Copper (mg/l)	33	<0.003	0.004	<0.003	Monitor	
Copper (mg/l)	16	<0.003	0.027	<0.011	Monitor	
Copper, Net (mg/l)	16	0	0.024	<0.008	0.05 <sup>(9)</sup>	48
Discharge Point 003A						
Flow (MGD) **	16	0.0004	0.025	0.013	Monitor	--
pH (SU) *	4	7.5	7.9	7.7	6.5-8.5 <sup>(10)</sup>	--
Temperature (°F)	4	43.3	63.9	49.6	90 <sup>(11)</sup>	--
Oil & Grease (mg/l)	4	<1	<1	<1	15	--
Suspended Solids (mg/l)	4	1.5	81	21.8	Monitor	--
Discharge Point 003B						
Flow (MGD) **	Continuous <sup>(6)</sup>	0.82	3.26	1.79	Monitor	--
pH (SU) *	12	7.7	8.5	8.0	6.5-8.5 <sup>(5)</sup>	--
Temperature (°F)	Continuous <sup>(6)</sup>	33.1	84.2	55.3	90	94
Oil & Grease (mg/l)	12	<1	1.0	<1.0	15	7
Intake Suspended Solids (mg/l)	24	2	508	34	Monitor	--
Suspended Solids (mg/l)	12	<1	5.8	<2.7	35	17
Iron (mg/l)	4	0.11	0.35	0.20	2	18
Copper (mg/l)	16	0.004	0.010	0.007	Monitor	--
Copper, Net (mg/l)	16	0.001	0.007	0.004	0.05 <sup>(9)</sup>	14
Discharge Point 003D						
Flow (MGD) **	Continuous <sup>(6)</sup>	0.01	0.75	0.21	Monitor	--
pH (SU) *	12	7.6	8.5	8.0	6.5-8.5 <sup>(5)</sup>	--
Temperature (°F)	Continuous <sup>(6)</sup>	33.2	79.6	53.1	90	88
Oil & Grease (mg/l)	12	<1	<1	<1	15	<1
Suspended Solids (mg/l)	13	1.5	51	9.8	Monitor	--
Iron (mg/l)	4	0.10	0.61	0.31	2	31
Copper (mg/l)	16	0.004	0.008	0.007	Monitor	--
Copper, Net (mg/l)	16	0.001	0.005	0.003	0.05 <sup>(9)</sup>	10
Discharge Point 003E						
Flow (MGD) **	6	0.00002	0.0045	0.0010	Monitor	--
pH (SU) *	4	7.5	7.9	7.7	6.5-8.5 <sup>(10)</sup>	--
Temperature (°F)	4	40.1	70.0	49.9	90 <sup>(11)</sup>	--
Oil & Grease (mg/l)	4	<1	2.3	<1.3	15	--
Suspended Solids (mg/l)	4	<1	8.5	<3.8	Monitor	--

**TABLE 4-3 CHEMICAL CONSTITUENTS AND TEMPERATURE  
IN KNOLLS SITE LIQUID EFFLUENT, 2001 (continued)**

Parameter (Units)	Number of Samples	Discharge Points 002, 003B, 003D, 003S, 003T and 003X			Permit Limit <sup>(3)</sup>	Percent of Limit <sup>(4)</sup>
		Value <sup>(1)</sup>				
		Minimum	Maximum	Average <sup>(2)</sup>		
<b>Discharge Permit Requirements (Reference 3)</b>						
<b><u>Discharge Point 002, 003B and 003D</u></b>						
Spectrus CT-1300 (mg/l) <sup>(12)</sup>	22	<0.05	<0.05	<0.05	0.05 <sup>(13)</sup>	<100
Copper, Net Loading (lbs/day)	16	0.13	0.3	0.22	3.3	9
<b><u>Discharge Point 003S</u></b>						
Flow (MGD) **	35	0.20	0.45	0.35	Monitor	--
Suspended Solids (mg/l)	24	<1	440	<28	Monitor	--
<b><u>Discharge Point 003T</u></b>						
Flow (MGD) **	35	0.20	0.45	0.35	Monitor	--
Suspended Solids (mg/l)	24	<1	206	<12	Monitor	--
Suspended Solids (% removal)	24	0	96	43	Monitor	--
<b><u>Discharge Point 003X<sup>(14)</sup></u></b>						
Flow (MGD) **	0				Monitor	--
pH (SU) *	0				6.5-8.5 <sup>(5)</sup>	--
Temperature (°F)	0				90	--
Oil & Grease (mg/l)	0				15	--
Suspended Solids (mg/l)	0				50	--

\*SU = Standard Units

\*\*MGD = Million gallons per day.

**Notes:**

- (1) A value preceded by < is less than the method detection limit.
- (2) Average values preceded by < contain at least one less than method detection limit 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) The number of continuous monitoring days may differ slightly due to shutdown during maintenance activities.
- (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).
- (10) When non-contact cooling water is discharged via this outfall and the 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.
- (11) Additional monitoring 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. Percent of limit cannot be calculated using only ground or stormwater temperature data.
- (12) On 09/19/01, chemical addition was performed for zebra mussel control using Betz Dearborn Spectrus CT-1300 and Betz Dearborn 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 2001.

In September 2001 KAPL treated the river water cooling system to control the zebra mussel population within the river water piping system. This treatment was conducted in accordance with the Knolls Site SPDES Permit (Reference 3). The process was effective in controlling the zebra mussel population within the river water piping system. Compliance with the SPDES permit conditions was maintained.

The Mohawk River is voluntarily monitored for various chemical parameters at two locations. The data for the upstream and downstream locations are presented in Table 4-4. The Knolls Site SPDES Permit requires the Mohawk River intake water to be monitored for total suspended solids, iron, and pH. The intake data is used to determine net limits and to determine appropriate pH ranges for the outfalls or for information.

The Knolls Site SPDES permit requires the surface water streams, West Boundary Stream Ditch, Midline Stream, and East Boundary Stream, to be monitored quarterly for five parameters, when flow exists in these streams. The analytical results for chemical constituents, flow, temperature, and pH were within the specified limits. Additional parameters are monitored voluntarily. These results are summarized in Tables 4-5 and 4-6.

The radioactivity released in effluent water during 2001 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  $5.2 \times 10^9$  liters of water released from the Site. The annual average radioactivity concentration in that effluent, prior to entering the 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.

Non-radioactive liquid effluent monitoring data are reported as required in Reference (3). Monitoring reports are available in the Niskayuna Branch of the Schenectady County Public Library.

### **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 known as the Advanced Steam Generator Test Facility (ASGTF) 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) unit, 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 two non-radiological air emission permits, as specified in Table 3-1. One permit allows for the operation of seven stationary combustion units (SCU). These SCUs are the Knolls Site heating boilers, four existing and three new, which are permitted to limit nitrogen oxide,

carbon monoxide, and sulfur dioxide emissions. Upon successful startup and testing, these units will replace the four existing units, which have supported Site operations since 1948. The second permit is for the ASGTF, a small SCU used to produce heat for onsite testing. The New York State emission standards for stationary combustion installations are listed in Reference (6). Under the terms of the permits for these emission sources, actual emission monitoring is not required. The quantities of these pollutants released can be estimated based on the quantity and type of fuel burned and theoretical emission factors.

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 including welding. However, if required, appropriate air pollution control devices must be maintained for exempt units. Under these regulations the air permit for the VIM/GA unit was cancelled by the State since this unit is a research and development unit and is exempt from permit requirement.

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  $1 \times 10^{-15}$   $\mu\text{Ci/ml}$  and  $5 \times 10^{-15}$   $\mu\text{Ci/ml}$ , respectively. The activated charcoal cartridges are analyzed for iodine and antimony-125 by gamma spectrometry, which provides a minimum detectable concentration of approximately  $2 \times 10^{-14}$   $\mu\text{Ci/ml}$  and  $1 \times 10^{-13}$   $\mu\text{Ci/ml}$ , respectively. Noble gas radioactivity released is calculated based on integration of recorded data from a continuous noble gas monitor.

#### **4.3.4 Assessment**

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

Boiler Operations (Air Emission Permit 4-4224-00024/00039 (Air Emission Points EP-0001, EP-00002, EP-00003, EP-00004, EP-00032, EP-00033 and EP-00034))

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,
3. Annual and hourly emissions of the following contaminants are capped as follows:  
Oxides of nitrogen ( $\text{NO}_x$ ) – 23,200 pounds per year and 16.17 pounds per hour  
Carbon monoxide (CO) – 12,995 pounds per year and 9.32 pounds per hour  
Sulfur dioxide ( $\text{SO}_2$ ) – 82,360 pounds per year and 57.41 pounds per hour,

**TABLE 4-4 CHEMICAL CONSTITUENTS AND TEMPERATURE  
IN MOHAWK RIVER WATER, 2001**

Parameter (Units)	No. of Samples	Value <sup>(1)</sup>						Standard <sup>(3)</sup>	Percent of Standard <sup>(4)</sup>
	Upstream/ Downstream	Upstream			Downstream				
		Minimum	Maximum	Average <sup>(2)</sup>	Minimum	Maximum	Average <sup>(2)</sup>		
pH (SU) *	54/1 <sup>(5)</sup>	7.6	8.5	8.0	7.9	7.9	7.9	6.5-8.5	--
Ammonia (as N) (mg/l) <sup>(17)</sup>	4/4	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	2.0 <sup>(6)</sup>	<5
Temperature (°C)	54/4	0.2	27.4	12.1	2.1	24.2	13.2	See Note <sup>(7)</sup>	--
Suspended Solids (mg/l)	24/0 <sup>(5)</sup>	2.0	508 <sup>(9)</sup>	34.2	--	--	--	See Note <sup>(8)</sup>	--
Iron (mg/l)	7/4	0.08	3.08 <sup>(9)</sup>	0.85 <sup>(9)</sup>	0.10	0.63	0.43 <sup>(9)</sup>	0.3	143 <sup>(9)</sup>
Manganese (mg/l)	4/4	0.01	0.07	0.04	0.02	0.06	0.05	0.3	17
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 <sup>(10)</sup>	<50
Dissolved Oxygen (mg/l)	2/2	9.5	11.3	10.4	9.8	11.5	10.6	See Note <sup>(11)</sup>	--
Specific Conductance (µmhos/cm) **	2/2	226	344	285	232	344	288	No Standard	--
Chloride (mg/l) <sup>(17)</sup>	4/4	18	66	35.8	18	104	45	250	18
Nitrate (as N, mg/l) <sup>(17)</sup>	4/4	0.68	0.76	0.72	0.56	0.80	0.65	10	6
Copper (mg/l)	33/3	<0.003	0.004	<0.003	<0.003	<0.005	<0.004	0.2 <sup>(12)</sup>	<2
Dissolved Sulfide (mg/l)	4/4	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.05 <sup>(13)</sup>	NA <sup>(14)</sup>
Volatile Organic Compounds (VOCs) (µg/l) <sup>(15)</sup>	2/2	<1	<1	<1	<1	<1	<1	See Note <sup>(16)</sup>	--

**TABLE 4-4 - Continued**

Notes:

- (1) A value preceded by < is less than the method detection limit.
- (2) Average values preceded by < contain at least one value in the average that is less than the method detection limit.
- (3) 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.
- (4) Percent of standard for the average value for the down river sampling location.
- (5) Sampling plan no longer includes pH and TSS for Mohawk Downstream.
- (6)  $\text{NH}_3 + \text{NH}_4^+$  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) None from sewage, industrial wastes or other wastes that will cause deposition or impair the waters for their best usage.
- (9) Water quality of the Mohawk River is variable.
- (10) Guidance value.
- (11) 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.
- (12) Operation of Copper Ion Generator 9/24/01 triggered increased copper monitoring. The Class A surface water quality standard is 0.2 mg/l for copper.
- (13) Guidance value for total sulfides expressed as hydrogen sulfide.
- (14) The method detection limit value for that parameter is higher than the reference standard. That does not mean that the actual level of the contaminant exceeded the standard.
- (15) EPA method 601 was utilized to analyze for volatile organic compounds listed in Table 4-14. All results were less than the method detection limit of 1 µg/l.
- (16) Water quality standards differ depending upon the specific parameter. The standards range from 0.3 to 50 µg/l.
- (17) Voluntary parameter.

\*SU = Standard Units

\*\*µmhos/cm = micromhos per centimeter

**TABLE 4-5 CHEMICAL CONSTITUENTS, RADIOACTIVITY AND TEMPERATURE IN  
WEST BOUNDARY STREAM DITCH AND MIDLINE STREAM, 2001**

Parameter (Units)	No. of Samples WBSD <sup>(2)</sup> / Midline Stream	Value <sup>(1)</sup>						Percent of Standard <sup>(6)</sup>	
		West Boundary Stream Ditch (WBSD) Outfall 004			Midline Stream Outfall 005			Standard <sup>(4,5)</sup>	WBSD / Midline Stream
		Minimum	Maximum	Average <sup>(3)</sup>	Minimum	Maximum	Average <sup>(3)</sup>		
pH (SU)	2/5	8.0	8.4	8.2	7.8	8.4	8.2	6.5-8.5 <sup>(7)</sup>	--
Ammonia (N, mg/l) <sup>(18)</sup>	1/4	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	2.0 <sup>(8)</sup>	<5/<5
Temperature (°C)	2/6	2.2	3.7	3.0	0.4	18.6	7.8	See Note <sup>(9)</sup>	--
Oil & Grease (mg/l)	2/4	<1	<1	<1	<1	<1	<1	15 <sup>(7)</sup>	--
Suspended Solids (mg/l)	2/4	8.5	18.0	13.3	1.0	6.5	3.1	Monitor <sup>(7)</sup>	--
Iron (mg/l)	1/4	0.10	0.10	0.10	<0.05	0.12	<0.07	0.3	33/<23
Manganese (mg/l)	1/4	<0.02	<0.02	<0.02	<0.01	0.07	<0.03	0.3	<7/<10
Chemical Oxygen Demand (mg/l)	2/4	<5	<5	<5	<5	18	<11.3	Monitor <sup>(7)</sup>	--
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 <sup>(10)</sup>	<50/<50
Dissolved Oxygen (mg/l)	0/1	--	--	--	10.3	10.3	10.3	See Note <sup>(11)</sup>	--
Specific Conductance (µmhos/cm)	0/1	--	--	--	1336	1336	1336	No Standard	--
Chloride (mg/l) <sup>(18)</sup>	1/4	585 <sup>(12)</sup>	585 <sup>(12)</sup>	585 <sup>(12)</sup>	194	556 <sup>(12)</sup>	327	250	234/131
Nitrate (N, mg/l) <sup>(18)</sup>	1/4	0.27	0.27	0.27	0.04	0.15	0.12	10	2.7/1.2
Copper (mg/l)	1/3	<0.005	<0.005	<0.005	<0.003	0.006	<0.005	0.2	<2.5/<2.5
Dissolved Sulfide (mg/l)	1/4	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.05 <sup>(13)</sup>	NA <sup>(14)</sup>
Volatile Organic Compounds <sup>(15)</sup> µg/l	0/1	--	--	--	<1	<1	<1	See Note <sup>(16)</sup>	--
Flow (Estimated)GPD <sup>(17)</sup>	2/4	40397	296248	168323	7345	581723	243072	Monitor <sup>(7)</sup>	--
<b>Radioactivity (pCi/l)</b>									
Gross Alpha	4/11	< 4.63	< 10.19	< 6.66 ± 7.62	< 2.93	< 7.87	< 5.34 ± 3.27	30	22/18
Gross Beta	4/11	4.94	6.28	5.52 ± 1.71	< 2.63	5.34	< 4.16 ± 1.93	1000	0.6/0.4
Strontium-90	4/11	< 0.28	0.46	< 0.39 ± 0.23	< 0.27	0.42	< 0.35 ± 0.11	1000	< 0.1/< 0.1
Cesium-137	4/11	< 0.41	< 1.01	< 0.75 ± 0.77	< 0.26	< 0.41	< 0.30 ± 0.11	3000	< 0.1/< 0.1



**TABLE 4-5 - Continued**

Notes:

- (1) A value preceded by < is less than the method detection limit for chemical analyses or the minimum detection level for radiological analyses. The lowest possible value for any parameter is zero.
- (2) Flow was extremely intermittent at the West Boundary Stream Ditch sampling location. During the second and fourth quarters, voluntary sampling at the WBSD coincides with landfill sampling. There was no flow in the stream during either of the landfill sampling events of 2001.
- (3) Average values preceded by < contain at least one less than method detection limit value or minimum detection level value in the average. The (±) value represents the 95% confidence interval for the average value.
- (4) 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.
- (5) 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.
- (6) Percent of standard for the average value.
- (7) Required by Reference (3) NYSDEC SPDES permit.
- (8)  $\text{NH}_3 + \text{NH}_4^+$  as N.
- (9) 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.
- (10) Guidance value.
- (11) 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.
- (12) The high values are attributed to winter de-icing operations.
- (13) Guidance value for total sulfides expressed as hydrogen sulfide.
- (14) The method detection limit value for that parameter is higher than the reference standard. That does not mean that the actual level of the contaminant exceeded the standard.
- (15) EPA method 601 was utilized to analyze for volatile organic compounds listed in Table 4-14. All results were less than the method detection limit of 1 µg/l.
- (16) Water quality standards differ depending upon the specific parameter. The standards range from 0.3 to 50 µg/l.
- (17) Flow is estimated by measuring stream depth, width, and velocity. Flow is intermittent and is measured only when samples are collected.
- (18) Voluntary parameter.

**TABLE 4-6 CHEMICAL CONSTITUENTS, RADIOACTIVITY AND TEMPERATURE IN  
EAST BOUNDARY STREAM, 2001**

Parameter (Units)	No. of Samples <sup>(1)</sup>	Value <sup>(2,3)</sup>						Standard <sup>(5,6)</sup>	Percent of Standard <sup>(7)</sup> Upstream/ Downstream
	Upstream/ Downstream	Upstream			Downstream / Outfall 006				
		Minimum	Maximum	Average <sup>(4)</sup>	Minimum	Maximum	Average <sup>(4)</sup>		
pH (SU)	1/6	7.6	7.6	7.6	7.5	8.2	7.8	6.5-8.5 <sup>(8)</sup>	--
Ammonia (N, mg/l) <sup>(20)</sup>	1/7	<0.1	<0.1	<0.1	<0.1	0.2	<0.1	2.0 <sup>(9)</sup>	<5/<5
Temperature (°C)	1/3	15.1	15.1	15.1	1.1	19.8	8	See Note <sup>(10)</sup>	--
Oil & Grease (mg/l)	0/5	--	--	--	<1	<1	<1	15 <sup>(8)</sup>	--
Suspended Solids (mg/l)	0/5	--	--	--	<1	19	<5.6	Monitor <sup>(8)</sup>	--
Iron (mg/l)	1/7	0.39	0.39	0.39	<0.05	0.78	<0.31	0.3	130/103 <sup>(11)</sup>
Manganese (mg/l)	1/7	0.61	0.61	0.61	<0.02	0.21	<0.09	0.3	203/30 <sup>(12)</sup>
Chemical Oxygen Demand (mg/l)	0/5	--	--	--	<5	13	<9.1	Monitor <sup>(8)</sup>	--
Surfactants (mg/l)	1/7	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	No Standard	--
Bromide (mg/l)	1/7	<1	<1	<1	<1	<1	<1	2.0 <sup>(13)</sup>	<50/<50
Dissolved Oxygen (mg/l)	1/2	9.6	9.6	9.6	5.7	5.9	5.8	See Note <sup>(14)</sup>	--
Specific Conductance (µmhos/cm)	1/2	978	978	978	837	842	840	No Standard	--
Chloride (mg/l) <sup>(20)</sup>	1/7	134	134	134	56	529	228	250	54/91
Nitrate (N, mg/l) <sup>(20)</sup>	1/7	0.07	0.07	0.07	<0.02	0.23	<0.10	10	0.7/<1
Copper (mg/l)	0/5	--	--	--	<0.003	0.006	<0.004	0.2	--/2
Dissolved Sulfide (mg/l)	1/7	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.05 <sup>(15)</sup>	NA <sup>(16)</sup>
Volatile Organic Compound <sup>(17)</sup> (µg/l)	1/2	<1	<1	<1	<1	<1	<1	See Note <sup>(18)</sup>	--
Flow (Estimated) GPD <sup>(19)</sup>	1/6	33934	33934	33934	15082	269316	91921	Monitor <sup>(8)</sup>	--
<u>Radioactivity (pCi/l)</u>									
Gross Alpha	11/11	< 3.79	< 4.69	< 4.35 ± 0.68	< 3.90	< 4.53	< 4.23 ± 0.52	30	14/14
Gross Beta	11/11	3.92	5.08	4.61 ± 0.81	3.70	5.59	4.64 ± 1.48	1000	0.5/0.5
Strontium-90	11/11	< 0.28	0.35	< 0.31 ± 0.05	< 0.31	< 0.36	< 0.33 ± 0.04	1000	< 0.1/< 0.1
Cesium-137	11/11	< 0.27	< 0.53	< 0.34 ± 0.20	< 0.35	< 0.36	< 0.36 ± 0.01	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 program. Upstream samples are taken upgradient from the Knolls Site closed landfill during landfill sampling events in the 2<sup>nd</sup> and 4<sup>th</sup> quarters. Downstream samples are taken downgradient from this landfill on a quarterly basis.
- (2) A value preceded by < is less than the method detection limit for chemical analyses or minimum detection level for radiological analyses.
- (3) The lowest possible value for any parameter is zero.
- (4) Average values preceded by < contain at least one less than method detection limit value or minimum detection level value in the average. The (±) value represents the 95% confidence interval for the average value.
- (5) 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.
- (6) 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.
- (7) Percent of standard for the average value.
- (8) Required by Reference (3) NYSDEC SPDES permit for the downstream location.
- (9)  $\text{NH}_3 + \text{NH}_4^+$  as N.
- (10) 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.
- (11) Iron exceeded the standard in the East Boundary Stream downstream sample during March 2001 and in the upstream sample during May 2001. This is attributable to iron naturally present in groundwater and surface water.
- (12) Manganese exceeded the standard in East Boundary Upstream during May 2001. This is attributable to manganese naturally present in the groundwater and surface water.
- (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) The standard listed is as hydrogen sulfide in the undissociated form.
- (16) The method detection limit value for that parameter is higher than the reference standard. That does not mean that the actual level of the contaminant exceeded the standard.
- (17) EPA method 601 was used to analyze for volatile organic compounds listed in Table 4-14. All results were less than the method detection limit of 1 µg/l.
- (18) Water quality standards differ depending upon the specific parameter. The standards range between 0.3 and 50 µg/l.
- (19) 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.
- (20) Voluntary parameter.

4. The maximum allowable heat input to all the boilers cannot exceed 113.2 million BTUs per hour. This condition is self canceling upon decommissioning of the old boilers, and
5. The sulfur content of any fuel oil burned shall not exceed 0.5 percent by weight and the fuel oil must conform to the specifications for Number 2 fuel oil per ASTM D396-78, as amended.

Records are required to be maintained for a period of five years to verify compliance with the permit conditions. Fuel oil supplier certification statements and fuel analyses for oil used by the Knolls Site boilers confirm that the number 2 fuel oil burned in the Knolls Site boilers contained less than 0.5 percent sulfur by weight and conforms to the ASTM Standards for distillate fuel oil. A semiannual report demonstrating compliance with the fuel oil sulfur limitation is sent to EPA and NYSDEC.

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 2001 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 0.19 curies of krypton-85.

The airborne radioactivity was contained in a total air exhaust volume of  $1.25 \times 10^{12}$  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.

#### VIM/GA Operations

On November 26, 2001, NYSDEC accepted the surrender of the Certificate to Operate EP-00031 and provided concurrence that the VIM/GA Unit can operate as an exempt source (without the need for a permit) under current regulations. As an exempt source KAPL is still required to operate the VIM/GA Unit in accordance with good engineering practices and ensure that the unit and its emission control equipment is kept in a satisfactory state of maintenance and repair, which will ensure insignificant emissions.

### **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.

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 x 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 Midline Stream near the point of entry to the Mohawk River, the West Boundary Stream Ditch, 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-way, the West Landfill Stream, is also monitored when possible. Required SPDES parameters in compliance with Reference (3) are analyzed and additional voluntary monitoring is 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.

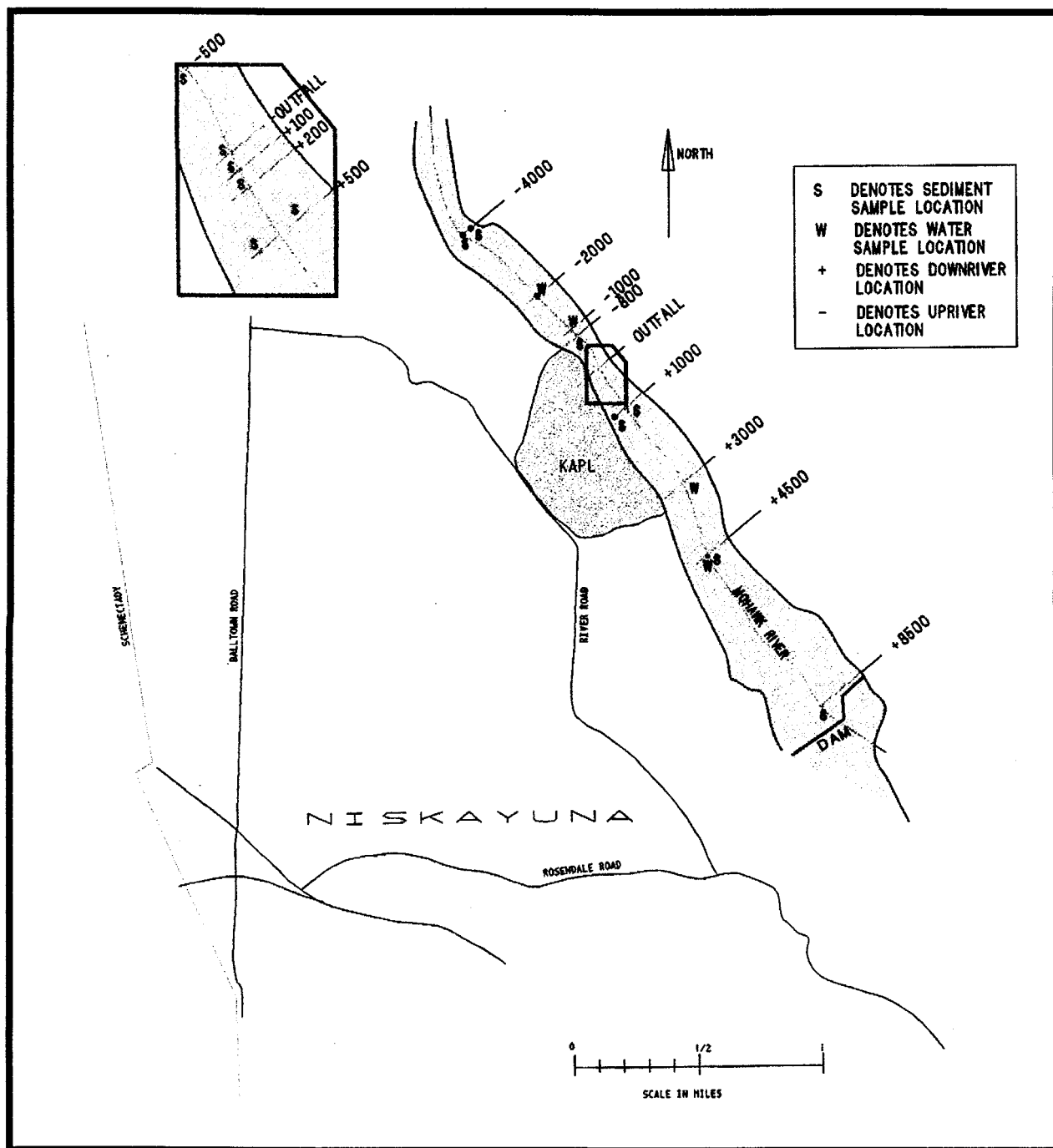
Environmental air samplers are operated in the predominant upwind and downwind directions from the Site to measure normal background airborne radioactivity, and to confirm that Knolls Site effluents have no measurable effect on normal background airborne radioactivity levels.

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 to NYSDEC in compliance with Reference (8). Knolls Site groundwater data are discussed separately in section 4.5.

#### **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 gross alpha and gross beta radioactivity. The stream samples are analyzed for gross 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, 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. Seven samples from the second quarter sample set collected at locations upriver, opposite, and downriver from the main Knolls Site outfall are also analyzed for strontium-90 by chemical extraction and beta counting. Five samples from the second quarter sample set are also analyzed for uranium and plutonium content by mass spectrometry. The downriver samples for strontium, uranium, and plutonium 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.



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

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. Samples are also collected from the West Landfill Stream when possible during groundwater monitoring operations. 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 that 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 stormwater discharges, and
- The presence of a closed landfill does not significantly effect nearby surface water streams.

The data from samples analyzed during 2001 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.

#### **Current Site Operations**

The Mohawk River upstream sample data show that some 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 occurring metals, either dissolved or suspended in the samples. Iron in the Mohawk River occasionally exceeds the State water quality standard. This typically occurs during heavy rainfall events when the river tends to be muddy.

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,

**TABLE 4-7 CHEMICAL CONSTITUENTS, RADIOACTIVITY, AND TEMPERATURE IN THE WEST LANDFILL STREAM, 2001**

Parameter (Units)	No. of Samples <sup>(1)</sup>	Value <sup>(2)</sup>	Standard	Percent of Standard <sup>(3)</sup>
pH (SU) <sup>(15)</sup>	0	See Note <sup>(4)</sup>	6.5-8.5	--
Ammonia (N, mg/l)	0		2.0 <sup>(5)</sup>	--
Temperature (°C)	0		See Note <sup>(6)</sup>	--
Oil & Grease (mg/l)	0		See Note <sup>(7)</sup>	--
Suspended Solids (mg/l)	0		See Note <sup>(8)</sup>	--
Iron (mg/l)	0		0.3	--
Manganese (mg/l)	0		0.3	--
Chemical Oxygen Demand (mg/l)	0		No Standard	--
Surfactants (mg/l)	0		No Standard	--
Bromide (mg/l)	0		2.0 <sup>(9)</sup>	--
Dissolved Oxygen (mg/l) <sup>(15)</sup>	0		See Note <sup>(10)</sup>	--
Specific Conductance (µmhos/cm) <sup>(15)</sup>	0		No Standard	--
Chloride (mg/l)	0		250	--
Nitrate (N, mg/l)	0		10	--
Copper (mg/l)	0		0.2	--
Dissolved Sulfide (mg/l)	0		0.05 <sup>(11)</sup>	--
Volatile Organic Compounds <sup>(12)</sup> (µg/l) <sup>(15)</sup>	0		See Note <sup>(13)</sup>	--
<b>Radioactivity (pCi/l)</b>				
		Minimum    Maximum    Average <sup>(14)</sup>		
Gross Alpha	4	< 1.26    < 1.57    < 1.42 ± 1.97	30	4.7
Gross Beta	4	2.44    4.62    3.53 ± 13.85	1000	0.35

**Notes:**

- (1) Flow in this stream is intermittent and the stream is very frequently dry. No samples were obtained during the quarterly sampling events for chemical parameters due to the stream being dry.
- (2) A value preceded by < is less than the method detection limit for chemical analyses or minimum detection level for radiological analyses.
- (3) Percent of standard for the average value.
- (4) This stream is only sampled for chemical constituents concurrent with groundwater sampling of the landfill. Flow was not present during 2<sup>nd</sup> and 4<sup>th</sup> quarters of 2001 when ground water sampling occurred.
- (5) Ammonia + ammonium as nitrogen.
- (6) 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.
- (7) No residue attributable to sewage, industrial wastes or other wastes, nor visible oil film nor globules of grease.
- (8) None from sewage, industrial wastes or other wastes that will cause deposition or impair the waters for their best usage.
- (9) Guidance value.
- (10) 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.
- (11) The standard listed is as hydrogen sulfide in the undissociated form.
- (12) EPA method 601 is utilized to analyze for volatile organic compounds listed in Table 4-14.
- (13) Water quality standards differ depending upon the specific parameter.
- (14) The (±) value represents the 95% confidence interval for the average value.
- (15) Required monitoring per Reference (8).



the Knolls Site SPDES Permit requires the stormwater for these areas to be monitored. Additional voluntary monitoring is also performed and is presented in Table 4-5. The State water quality standard for chloride was exceeded in West Boundary Stream Ditch and Midline Stream. The high chloride results were attributed to 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 frequently dry), 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 and downstream locations were sampled concurrently with groundwater monitoring activities once during 2001. The East Boundary Stream upstream sample data show several 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. On one occasion iron was elevated and exceeded surface water quality standards. The iron and manganese results are mostly attributed to a naturally high mineral content in the surface water. The elevated upstream results are not related to KAPL operations and may represent contributions from offsite sources.

During 2001 sufficient water was not present in the West Landfill Stream to allow sampling to occur concurrent with groundwater monitoring. Previous results from the West Landfill Stream suggest that water quality in this surface water drainage-way may be influenced by a leachate component of the closed landfill. The 2001 monitoring data for radioactivity is contained in Table 4-7. 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 gross 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 2001 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

**TABLE 4-8 RESULTS OF MONITORING MOHAWK RIVER WATER AND MUNICIPAL WATER, 2001**

Location and Source of Water Sample	Number of Samples	Radioactivity Concentrations (pCi/liter) <sup>(1,2,3)</sup>					
		Gross Beta Values			Gross Alpha Values		
		Minimum	Maximum	Average	Minimum	Maximum	Average
Mohawk River Water							
Upstream	6	2.08 ± 0.72	2.85 ± 0.77	2.41 ± 0.30	< 1.42	1.89 ± 1.47	< 1.69 ± 0.22
Downstream	6	1.75 ± 0.72	3.07 ± 0.81	2.48 ± 0.54	< 1.47	< 1.82	< 1.68 ± 0.17
Schenectady Municipal Water							
	12	2.02 ± 1.27	3.26 ± 1.44	2.52 ± 0.85	< 1.68	3.16 ± 2.23	< 2.47 ± 0.97
Niskayuna Municipal Water							
	12	< 1.96	2.87 ± 1.42	< 2.37 ± 0.70	< 1.80	< 2.59	< 2.33 ± 0.59
Latham/Colonie Municipal Water							
	12	< 1.91	2.77 ± 1.35	< 2.23 ± 0.60	< 1.40	< 2.53	< 2.12 ± 0.78

**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.

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 detailed 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.

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 each perimeter location is within the expected distribution of the off-site measurements at the 95% confidence interval. This shows that Knolls Site operations in 2001 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  $1.6 \times 10^{-15}$   $\mu\text{Ci/ml}$  and  $1.6 \times 10^{-14}$   $\mu\text{Ci/ml}$ , respectively. The average downwind gross alpha and gross beta radioactivity concentrations were  $1.5 \times 10^{-15}$   $\mu\text{Ci/ml}$  and  $1.7 \times 10^{-14}$   $\mu\text{Ci/ml}$ , respectively. Gamma spectrometry analyses performed on groups of environmental samples indicated only background quantities of naturally occurring radionuclides.

**TABLE 4-9 RESULTS OF ANALYSES OF MOHAWK RIVER SEDIMENT, 2001**

Number of Samples and Type of Results	Radioactivity Concentration (pCi/gm. dry weight) <sup>(1)</sup>		
	Area Sampled Relative to Effluent Point		
	Upstream	Opposite	Downstream
<b>Alpha Concentration</b>			
Number of Samples	12	3	24
Average Concentration	0.47 ± 0.11	0.41 ± 0.32	0.52 ± 0.11
Minimum Concentration	0.18 ± 0.04	0.29 ± 0.05	0.27 ± 0.05
Maximum Concentration	0.94 ± 0.09	0.55 ± 0.07	1.59 ± 0.12
<b>Gross Beta Concentration</b>			
Number of Samples	12	3	24
Average Concentration	30.0 ± 2.8	27.1 ± 8.8	29.6 ± 2.0
Minimum Concentration	25.0 ± 5.2	23.6 ± 5.0	22.2 ± 4.9
Maximum Concentration	38.4 ± 6.3	30.7 ± 5.7	41.5 ± 6.6
<b>Sr-90 Concentration</b>			
Number of Samples	4	1	2
Average Concentration	< 0.04 ± 0.02	< 0.03	< 0.04 ± 0.01
Minimum Concentration	< 0.02		< 0.04
Maximum Concentration	0.05 ± 0.02		< 0.04
<b>Cs-137 Concentration</b>			
Number of Samples	12	3	24
Average Concentration	0.10 ± 0.03	0.05 ± 0.04	0.11 ± 0.04
Minimum Concentration	0.04 ± 0.01	0.03 ± 0.01	0.04 ± 0.01
Maximum Concentration	0.16 ± 0.04	0.06 ± 0.01	0.40 ± 0.06
<b>Plutonium Concentration<sup>(2)</sup></b>			
Number of Samples	2	1	2
Average Concentration	0.003 ± 0.009	0.001 ± 0.001	0.004 ± 0.001
Minimum Concentration	0.002 ± 0.001		0.004 ± 0.001
Maximum Concentration	0.003 ± 0.001		0.004 ± 0.001
<b>Uranium Concentration</b>			
Number of Samples	2	1	2
Average Concentration	0.87 ± 0.92	0.28 ± 0.01	0.89 ± 0.17
Minimum Concentration	0.80 ± 0.01		0.88 ± 0.01
Maximum Concentration	0.94 ± 0.01		0.90 ± 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.

**TABLE 4-10 GAMMA SPECTROMETRY RESULTS FOR MOHAWK RIVER FISH, 2001**

Sample Location <sup>(2)</sup>	Fish (#)	No. of Samples	Radioactivity Concentrations (pCi/gm, wet weight) <sup>(1)</sup>			
			K-40		Cs-137	
			Maximum	Average	Maximum	Average
Upriver	Carp (2)	3	1.69 ± 0.19	1.67 ± 0.05	< 0.007	< 0.006
Upriver	Largemouth Bass (3) Smallmouth Bass (4)	4	2.29 ± 0.22	1.93 ± 0.39	< 0.007	< 0.007
Downriver	Carp (1) Redhorse Sucker (3)	3	2.23 ± 0.22	1.74 ± 1.10	< 0.007	< 0.007
Downriver	Smallmouth Bass (4) Walleye (3)	4	2.11 ± 0.22	2.01 ± 0.11	< 0.009	< 0.008

**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 September 2001 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 September 2001; these fish were collected along the KAPL shoreline between the KAPL Outfall 002 and Lock 7.

**TABLE 4-11 RADIOCHEMICAL ANALYSIS RESULTS FOR MOHAWK RIVER FISH, 2001**

Sample Location <sup>(2)</sup>	Fish Type	Radioactivity Concentration <sup>(1)</sup>	
		(pCi/gm, wet weight)	
		Sr-90	Pu-239/240
Upriver	Largemouth Bass	0.035 ± 0.022	< 0.0008
Upriver	Smallmouth Bass	< 0.030	< 0.0008
Upriver	Carp	< 0.024	< 0.0008
Downriver	Largemouth Bass	< 0.031	< 0.0008
Downriver	Smallmouth Bass	< 0.027	< 0.0008
Downriver	Carp	< 0.022	< 0.0008

**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 September 2001 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 September 2001; 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, 2001**

Monitoring Location <sup>(1)</sup>	Total Annual Exposure <sup>(2)</sup> (millirem)
1	74 ± 4
2	77 ± 6
3	76 ± 9
4	84 ± 4
5	84 ± 6
6	75 ± 6
7	80 ± 6
8	78 ± 4
9	75 ± 3
10	79 ± 2
11	82 ± 7
12	81 ± 6
13	69 ± 9
14	72 ± 6
15	85 ± 7
16	79 ± 4
Off-Site Locations	72 ± 13 <sup>(3)</sup>

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.

#### 4.4.4 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.

## **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 monitoring requirements. The remainder of the groundwater monitoring 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 35 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 2001, the landfill wells were sampled twice and the remediation assessment wells were sampled once in accordance with regulatory agency (NYSDEC) agreements. All other monitoring program wells, both radiological and chemical, were sampled once.

Table 4-13 summarizes the scope of the groundwater monitoring program. Table 4-14 lists the specific analyses for each chemical parameter group (field parameters, metals and volatile organic compounds). For the voluntary program, the selection of wells and parameter groups is based on the historical groundwater monitoring program results, site operational history, well locations, and subsurface hydrogeologic information. 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.

As part of the NYSDEC approved Knolls Site Landfill post-closure monitoring program (Reference (8)), KAPL monitors five overburden wells; one upgradient (NTH-1A) and four downgradient wells (NTH-2A, NTH-5A, W-11, and W-12). The parameters monitored under the revised plan allow for adequate groundwater quality assessment based on the large historical database. Also required by NYSDEC under the 1997 remediation agreement, five additional wells (SW-10, DW-09, B-5, B-6, and B-7) are monitored annually to assess the effectiveness of a soil remediation program in the former D3/D4 yard area. The program entailed removal of soils containing VOCs and was driven by the need to construct a building on the Site and not by any environmental concern.

All field parameters except for turbidity are measured in the field using procedures provided in Standard Methods, Reference (9), or other EPA approved methods analyzes chemical parameters. The analytical laboratory is State certified in potable water analyses and wastewater chemical analyses. Samples are analyzed by KAPL 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 gross 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, strontium-90, and tritium results were within the range of previously reported values. Starting in 2001, the groundwater samples were analyzed for gross alpha radioactivity rather than alpha radioactivity by a separation analysis. The maximum concentration of strontium-90, which has the most restrictive derived concentration guide of any radionuclide measured in any well was

**TABLE 4-13 KNOLLS SITE GROUNDWATER SAMPLING PROGRAM, 2001**

WELL CATEGORY	WELL ID	RADIOACTIVITY	MONITORING PARAMETER GROUP		
			FIELD	METALS	VOCs
LANDFILL	NTH-1A	A	B		B
	NTH-2A	A	B		B
	NTH-5A	A	B		B
	W-11	A	B		B
	W-12	A	B		B
LAND AREA	W-1	A	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  
B = Biannually



**TABLE 4-14 GROUNDWATER MONITORING PARAMETERS, 2001**

MONITORING PARAMETER GROUPS		
FIELD	METALS	VOLATILE ORGANIC COMPOUNDS
Static Water Level Specific Conductance Temperature pH Turbidity <sup>(1)</sup>	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	EPA 601: Chloromethane Bromomethane Dichlorodifluoromethane Vinyl Chloride Chloroethane Methylene Chloride Trichlorofluoromethane 1,1-Dichloroethane 1,1-Dichloroethylene t-1,2-Dichloroethylene 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: <sup>(2)</sup> Benzene Toluene Ethylbenzene Chlorobenzene p-Dichlorobenzene m-Dichlorobenzene o-Dichlorobenzene Xylenes  Acetone <sup>(3)</sup> Hexane <sup>(3)</sup>

**Notes:**

- (1) Measured in the laboratory.
- (2) EPA 602 parameters not required at the landfill wells.
- (3) Additional parameters required to be sampled at B-5, B-6, B-7, DW-09, and SW-10 per NYSDEC agreement.

**TABLE 4-15 RESULTS OF KNOLLS SITE GROUNDWATER MONITORING FOR RADIOACTIVITY, 2001**

Locations		Radioactivity Concentrations <sup>(1,2)</sup>				
		Gross Beta	Gross Alpha	Sr-90	Cs-137	H-3
		pCi/liter				(x 10 <sup>2</sup> pCi/l)
<b>Landfill Area</b>						
May	NTH-1A	< 2.0	< 1.1	< 0.6	< 1.0	< 2.4
	NTH-2A	4.7 ± 2.1	< 2.4	0.7 ± 0.4	< 0.8	< 2.4
	NTH-5A	< 2.7	< 1.9	< 0.6	< 0.8	< 2.4
	W-11	4.2 ± 2.0	< 2.2	< 0.7	< 0.8	< 2.4
	W-12	5.2 ± 1.8	2.9 ± 1.8	< 0.6	< 1.0	< 2.4
<b>Land Area</b>						
February	W-2	6.9 ± 1.9	< 4.4	< 0.6	< 1.0	< 2.5
	W-3	4.0 ± 1.6	< 4.7	< 0.6	< 0.8	< 2.5
	W-4	3.4 ± 1.6	< 4.7	< 0.5	< 1.0	< 2.5
	W-8	4.2 ± 1.5	< 2.5	< 0.6	< 0.8	< 2.5
	W-10	5.5 ± 1.8	< 5.1	< 0.5	< 1.0	< 2.5
	MW-2	< 1.8	< 1.8	< 0.6	< 0.8	< 2.5
	MW-3	2.4 ± 1.3	< 2.3	< 0.6	< 0.9	< 2.5
<b>Hillside Area</b>						
February	B-5	8.2 ± 3.7	< 18.5	< 0.6	< 0.8	< 2.5
	B-6	7.3 ± 2.2	< 7.2	< 0.5	< 0.8	< 2.5
	B-7	7.6 ± 2.4	< 10.5	< 0.7	< 1.0	< 2.5
	B-15	17.0 ± 3.1	< 14.5	4.0 ± 0.8	< 0.8	< 2.5
	B-16	< 2.4	< 4.8	< 0.5	< 1.0	< 2.5
	B-26	3.1 ± 1.6	< 5.1	< 0.6	< 1.0	< 2.5
	KH-6	< 2.0	< 2.9	< 0.5	< 1.0	< 2.5
	KH-9S	3.0 ± 1.7	< 8.5	< 0.5	< 0.8	< 2.5
	KH-15	5.0 ± 1.7	< 3.0	< 0.7	< 1.0	< 2.5
	KH-16	5.6 ± 2.0	< 5.9	< 0.6	< 0.8	< 2.5
	KH-17	4.5 ± 1.7	< 4.1	< 0.6	< 1.0	7.7 ± 1.6
	KH-18	7.3 ± 2.2	< 7.9	< 0.7	< 0.8	< 2.5
	SW-10	5.3 ± 2.0	< 3.6	< 0.6	< 1.0	< 2.5
	DW-09	13.5 ± 2.8	11.3 ± 7.7	< 0.6	< 0.8	< 2.5
<b>Lower Level</b>						
February	KH-19	4.2 ± 1.7	< 5.3	< 0.6	< 1.0	< 2.5
	KH-20	6.9 ± 1.7	< 14.8	< 0.7	< 0.8	< 2.5
	KH-21	31.1 ± 3.8	< 4.5	9.4 ± 0.9	< 1.0	< 2.5
	KH-22	2.1 ± 1.2	< 2.2	< 0.5	< 0.8	< 2.5
	KH-23	7.8 ± 1.9	4.3 ± 3.3	< 0.9	< 1.0	< 2.5
<b>Background Wells - for comparison</b>						
May	W-1	3.2 ± 1.4	< 1.8	< 0.5	< 1.0	< 2.4
February	W-1	2.9 ± 1.4	< 3.3	< 0.5	< 0.8	< 2.5
	KH-1S	< 2.1	3.2 ± 2.5	< 0.6	< 0.8	< 2.5
	KH-2	12.3 ± 2.5	< 6.3	< 0.5	< 1.0	< 2.5
	KH-3S	4.5 ± 1.5	2.1 ± 1.7	< 0.5	< 0.8	< 2.5
	Shugg	4.3 ± 1.5	< 2.7	< 0.6	< 0.8	< 2.5

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.

less than two percent of the DOE derived concentration guide (Reference 4). The tritium result from the sample of well KH-17, 770 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. These well points were sampled again during 2001. 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 continues to show a decreasing trend from samples obtained since 1998.

Tables 4-16, 4-17, 4-18, and 4-19 summarize the 2001 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 method 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 commonly show elevated metal results that are caused by particle mineralogy and is not indicative of dissolved, mobile metals.

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 4-19 summarizes the positive results of the VOC analyses. Only the parameters that were detected by the laboratory are listed.

### **Landfill**

Knolls Site Landfill well results (Table 4-16) for specific conductance and pH were consistent with past monitoring results. In the fourth quarter of 2001, dichlorodifluoromethane was detected in NTH-5A at 6 µg/l, slightly above the 5 µg/l water quality standard. Dichlorodifluoromethane has been previously detected in NTH-5A. No VOCs were detected in any of the other monitored wells.

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

### **Land Area**

Other than the natural water quality variations, the turbidity/elevated metal relationship, and road salting effects, the Land Area data (Tables 4-17 and 4-19) show some effect associated with the historical land disposal areas on groundwater quality. Total 1,2-dichloroethylene, tetrachloroethylene, and trichloroethylene (TCE) were detected in downgradient well W-3 consistent with previous monitoring results. Migration is believed to be limited since these VOCs were not detected in the nearest monitoring well (W-4) downgradient of W-3. Toxic metal results from all wells are below the corresponding groundwater standard and are attributable to natural water quality.

### **Hillside**

The Hillside monitoring consists of field parameters and VOC analysis. The field parameter data is consistent with the effects of natural groundwater compositional variations (Table 4-18). VOC results show the effects of former outdoor material storage practices on overburden water quality. VOC results (Table 4-19) for all monitoring wells are consistent with previous years, with VOCs being

**TABLE 4-16 RESULTS OF KNOLLS SITE GROUNDWATER MONITORING  
OF LANDFILL WELLS, 2001**

Well Location	Sample Date	Elevation (feet) <sup>(1)</sup>	Temperature (C)	pH (su)	Specific Conductance (µmhos/cm)	VOCs <sup>(2)</sup> (µg/l)
NTH-1A <sup>(3)</sup>	05/07/01	317.22	8.4	6.9	377	<1
	11/12/01	310.06	11.3	7.5	586	<1
NTH-2A	05/07/01	232.88	7.9	6.9	1288	<1
QA Duplicate	05/07/01	NA	7.9	6.9	1282	<1
	11/12/01	231.39	11.2	7.0	1358	<1
NTH-5A	05/07/01	267.77	7.9	6.7	317	<1
QA Duplicate	11/12/01	262.69	11.7	6.8	1024	See Table 4-19
	11/12/01	NA	11.5	6.8	1023	See Table 4-19
W-11	05/07/01	258.59	9.6	7.1	1071	<1
	11/12/01	257.98	10.8	6.9	1058	<1
W-12	05/07/01	240.29	8.3	7.1	665	<1
	11/12/01	239.65	10.5	7.0	1245	<1
FIELD BLANK (NTH-2A)	05/07/01	NA	25.0	6.5	2	See Table 4-19
FIELD BLANK (NTH-5A)	11/12/01	NA	7.6	5.5	10	<1
STANDARDS <sup>(4)</sup>		(5)	(5)	6.5-8.5	(5)	(10)
METHODS <sup>(6)</sup>		(7)	170.1	150.1	120.1	601
MDL <sup>(8)</sup>		NA	NA	NA	5	(10)
PQL <sup>(9)</sup>		NA	NA	NA	10	(10)

ALL SAMPLES COLLECTED WHOLE AND UNFILTERED.

**Notes:**

- (1) The latest site-wide topological mapping project results were used for the fourth quarter 2001 elevation calculation. The changes are (in feet): NTH-1A +0.25, NTH-2A +0.12, NTH-5A +0.10, W-11 +0.43, W-12 +0.09.
- (2) See Table 4-14 for a listing of the Volatile Organic Compounds (VOCs). Landfill wells are analyzed for VOCs only using EPA Method 601. < 1 indicates all parameters were less than the MDL. No VOCs were detected in the trip blanks.
- (3) Upgradient well.
- (4) Water Quality Regulations for Surface Waters and Groundwaters, 6 NYCRR Parts 700-705 (3/98 Revision).
- (5) No standard or guidance value available.
- (6) EPA Method number most commonly used.
- (7) Electronic Water Level Indicator.
- (8) Method Detection Limit.
- (9) Practical Quantitation Limit.
- (10) Standards vary between 0.3 µg/l and 50 µg/l.

NS = Not Sampled  
NA = Not Applicable

**TABLE 4-17 RESULTS OF KNOLLS SITE GROUNDWATER MONITORING OF LAND AREA WELLS, 2001**

Well	Sample Date	Parameter									
		Field Parameters <sup>(1)</sup>					Metals <sup>(1,2)</sup>				
		Elevation (ft)	Temperature (C)	pH (su)	Specific Conductance (µmhos/cm)	Turbidity (ntu) <sup>(3)</sup>	Iron (mg/l)	Manganese (mg/l)	Lead (mg/l)	Sodium (mg/l)	Calcium (mg/l)
KH-1S <sup>(4)</sup>	02/09/01	334.32	7.2	7.3	493	825	6.94/<0.05	3.46/0.01	0.015 / <0.005	6.4/5.8	123/69
MW-2	02/08/01	308.02	8.3	6.8	308	19	0.96/<0.05	0.01/<0.02	<0.005 / <0.005	4.8/4.9	41/40
MW-3	02/09/01	308.58	6.9	6.5	353	25	0.49/<0.05	0.03/<0.02	<0.005 / <0.005	9.5/9.7	52/51
W-1	02/09/01	314.87	9.1	7.8	662	62	2.42/<0.05	0.11/0.06	<0.005 / <0.005	33/42	72/63
W-10	02/07/01	287.40	8.7	7.2	941	15	0.47/<0.05	0.19/0.17	<0.005 / <0.005	30/33	109/116
W-2	02/07/01	305.61	8.2	7.7	934	145	1.33/<0.05	0.37/0.28	<0.005 / <0.005	61/57	84/77
W-3	02/08/01	301.26	8.6	7.2	949	15	2.23/<0.05	0.74/0.64	<0.005 / <0.005	39/39	110/111
W-3, Duplicate	02/08/01	301.26	8.6	7.2	943	13	3.19/<0.05	0.79/0.66	<0.005 / <0.005	41/40	116/117
W-4	02/08/01	283.01	7.3	7.0	857	810	36/<0.05	0.66/0.12	0.010 / <0.005	14/13	128/116
W-8	02/07/01	300.81	8.5	7.8	497	385	15.6/0.05	0.29/0.05	<0.005 / <0.005	41.8/42.2	45.5/40.0
FIELD BLANKS	02/07/01	NA	1.5	6.9	2	0.62	<0.05/<0.05	<0.02/<0.02	<0.005 / <0.005	<0.5 / <0.5	<0.5/<0.5
FIELD BLANKS	02/08/01	NA	2.5	8.6	2	<0.2	<0.05/<0.05	<0.02/<0.02	<0.005 / <0.005	<0.5 / <0.5	<0.5/<0.5
STANDARDS <sup>(5)</sup>		<sup>(6)</sup>	<sup>(6)</sup>	6.5-8.5 <sup>(7)</sup>	<sup>(6)</sup>	5	0.3 <sup>(9)</sup>	0.3 <sup>(9)</sup>	0.025	20	<sup>(6)</sup>

Notes:

1. A value preceded by < is less than the method detection limit.
  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, 6 NYCRR 703.3.
  8. Technical and Operational Guidance Series (TOGS) 1.1.1, Guidance Values.
  9. Per 6 NYCRR 703.5, the combined concentration of iron and manganese shall not exceed 0.5 mg/l.
  10. The holding time for analysis was exceeded by the laboratory. However, the data is considered valid since there is no historical data indicating hexavalent chromium in these wells.
- NA - Not Applicable

**TABLE 4-17 RESULTS OF KNOLLS SITE GROUNDWATER MONITORING OF LAND AREA WELLS, 2001 (Continued)**

Well	Sample Date	Parameter									
		Metals <sup>(1,2)</sup>									
		Potassium (mg/l)	Magnesium (mg/l)	Cadmium (mg/l)	Aluminum (mg/l)	Antimony (mg/l)	Arsenic (mg/l)	Beryllium (mg/l)	Barium (mg/l)	Boron (mg/l)	Zinc (mg/l)
KH-1S <sup>(4)</sup>	02/09/01	2.9/1.9	31/22	<0.001/<0.001	2.8/<0.1	<0.06 / <0.06	<0.005 / <0.005	<0.005 / <0.005	0.27/0.05	<0.05/<0.05	0.06/0.01
MW-2	02/08/01	<0.5/<0.5	6.5/6.2	<0.001/<0.001	0.6/<0.1	<0.06 / <0.06	<0.005 / <0.005	<0.005 / <0.005	0.01/<0.01	<0.05/<0.05	<0.01/<0.01
MW-3	02/09/01	<0.5/<0.5	8.6/8.5	<0.001/<0.001	0.2/<0.1	<0.06 / <0.06	<0.005 / <0.005	<0.005 / <0.005	0.01/0.01	<0.05/<0.05	<0.01/<0.01
W-1	02/09/01	2.9/2.5	22/20	<0.001/<0.001	1.3/<0.1	<0.06 / <0.06	<0.005 / <0.005	<0.005 / <0.005	0.15/0.10	<0.05/<0.05	0.02/<0.01
W-10	02/07/01	3.6/3.9	40.6/43	<0.001/<0.001	0.3/<0.1	<0.06 / <0.06	<0.005 / <0.005	<0.005 / <0.005	0.03/0.03	<0.05/<0.05	<0.005/<0.005
W-2	02/07/01	7.0/6.2	15.8/15.1	<0.005/<0.005	0.7/<0.1	<0.06 / <0.06	<0.005 / <0.005	<0.005 / <0.005	0.06/0.04	0.33/0.30	<0.005/<0.005
W-3	02/08/01	4.1/3.6	33/30	<0.001/ <0.001	1.2/<0.1	<0.06 / <0.06	<0.005 / <0.005	<0.005 / <0.005	0.09/0.04	0.22/0.22	<0.01/<0.01
W-3, Duplicate	02/08/01	4.5/3.7	34/30	<0.001/<0.001	1.6/<0.1	<0.06 / <0.06	<0.005 / <0.005	<0.005 / <0.005	0.12/0.05	0.23/0.22	<0.01/<0.01
W-4	02/08/01	7.7/1.6	47/37	<0.001/<0.001	18/<0.1	<0.06 / <0.06	0.009 / <0.005	<0.005 / <0.005	0.21/0.04	0.07/0.07	0.08/0.01
W-8	02/07/01	6.3/2.9	20.4/9.4	<0.001/<0.001	8.3/<0.1	<0.06 / <0.06	<0.005 / <0.005	<0.005 / <0.005	0.18/0.09	0.24/0.23	0.019/<0.005
FIELD BLANKS	02/07/01	<0.5 / <0.5	<0.5 / <0.5	<0.001/<0.001	<0.1/<0.1	<0.06 / <0.06	<0.005 / <0.005	<0.005 / <0.005	<0.01 / <0.01	<0.05/<0.05	<0.005 / <0.005
FIELD BLANKS	02/08/01	<0.5 / <0.5	<0.5 / <0.5	<0.001/<0.001	<0.1/<0.1	<0.06 / <0.06	<0.005 / <0.005	<0.005 / <0.005	<0.01 / <0.01	<0.05/<0.05	<0.005 / <0.005
STANDARDS <sup>(5)</sup>		<sup>(6)</sup>	35 <sup>(6)</sup>	0.005	<sup>(6)</sup>	0.003	0.025	0.003 <sup>(8)</sup>	1	1	2.0 <sup>(8)</sup>

Notes:

1. A value preceded by < is less than the method detection limit.
  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, 6 NYCRR 703.3.
  8. Technical and Operational Guidance Series (TOGS) 1.1.1, Guidance Values.
  9. Per 6 NYCRR 703.5, the combined concentration of iron and manganese shall not exceed 0.5 mg/l.
  10. The holding time for analysis was exceeded by the laboratory. However, the data is considered valid since there is no historical data indicating hexavalent chromium in these wells.
- NA - Not Applicable

TABLE 4-17 RESULTS OF KNOLLS SITE GROUNDWATER MONITORING OF LAND AREA WELLS, 2001 (Continued)

Well	Sample Date	Parameter								Organics VOCs <sup>(4)</sup> (µg/l)
		Metals <sup>(1,2)</sup>								
		Copper (mg/l)	Chromium (mg/l)	Chromium, VI <sup>(11)</sup> (mg/l)	Mercury (mg/l)	Nickel (mg/l)	Selenium (mg/l)	Silver (mg/l)	Thallium (mg/l)	
KH-1S <sup>(4)</sup>	02/09/01	<0.05 / <0.05	0.009/0.006	<0.02 <sup>(10)</sup>	<0.0004 / <0.0004	<0.05 / <0.05	<0.005 / <0.005	<0.02 / <0.02	<0.01 / <0.01	<1
MW-2	02/08/01	<0.05 / <0.05	<0.005/<0.005	<0.02 <sup>(10)</sup>	<0.0004 / <0.0004	<0.05 / <0.05	<0.005 / <0.005	<0.02 / <0.02	<0.01 / <0.01	<1
MW-3	02/09/01	<0.05 / <0.05	<0.005/<0.005	<0.02 <sup>(10)</sup>	<0.0004 / <0.0004	<0.05 / <0.05	<0.005 / <0.005	<0.02 / <0.02	<0.01 / <0.01	<1
W-1	02/09/01	<0.05 / <0.05	0.006/<0.005	<0.02 <sup>(10)</sup>	<0.0004 / <0.0004	<0.05 / <0.05	<0.005 / <0.005	<0.02 / <0.02	<0.01 / <0.01	<1
W-10	02/07/01	<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	<1
W-2	02/07/01	<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	<1
W-3	02/08/01	<0.05 / <0.05	0.006/<0.005	<0.02 <sup>(10)</sup>	<0.0004 / <0.0004	<0.05 / <0.05	<0.005 / <0.005	<0.02 / <0.02	<0.01 / <0.01	See Table 4-19
W-3, Duplicate	02/08/01	<0.05 / <0.05	0.007<0.005	<0.02 <sup>(10)</sup>	<0.0004 / <0.0004	<0.05 / <0.05	<0.005 / <0.005	<0.02 / <0.02	<0.01 / <0.01	See Table 4-19
W-4	02/08/01	<0.05 / <0.05	0.033/<0.005	<0.02 <sup>(10)</sup>	<0.0004 / <0.0004	<0.05 / <0.05	<0.005 / <0.005	<0.02 / <0.02	<0.01 / <0.01	<1
W-8	02/07/01	<0.05 / <0.05	0.015/<0.005	<0.02	<0.0004 / <0.0004	<0.05 / <0.05	<0.005 / <0.005	<0.02 / <0.02	<0.01 / <0.01	<1
FIELD BLANKS	02/07/01	<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	<1
FIELD BLANKS	02/08/01	<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	<1
STANDARDS <sup>(5)</sup>		0.20	0.050	0.05	0.0007	0.10	0.010	0.05	0.0005 <sup>(8)</sup>	

Notes:

1. A value preceded by < is less than the method detection limit.
  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, 6 NYCRR 703.3.
  8. Technical and Operational Guidance Series (TOGS) 1.1.1, Guidance Values.
  9. Per 6 NYCRR 703.5, the combined concentration of iron and manganese shall not exceed 0.5 mg/l.
  10. The holding time for analysis was exceeded by the laboratory. However, the data is considered valid since there is no historical data indicating hexavalent chromium in these wells.
  11. Hexavalent chromium results are unfiltered.
- NA - Not Applicable

**TABLE 4-18 RESULTS OF KNOLLS SITE GROUNDWATER MONITORING OF HILLSIDE AREA  
AND LOWER LEVEL WELLS, 2001**

Locations	Parameter					
	Sample Date	Elevation (ft)	Temperature (C)	pH (su)	Specific Conductance (µmhos/cm)	Volatile Organic Compounds (µg/l)
Hillside Area						
B-5	02/13/01	324.58	17.4	7.1	4110	See Table 4-19
B-5 Duplicate	02/13/01	324.58	17.4	7.2	4110	See Table 4-19
B-6	02/13/01	322.95	14.8	7.4	3830	< 1
B-7	02/13/01	331.47	11.4	7.8	2770	< 1
SW-10	02/13/01	324.61	9.8	7.3	1810	< 1
DW-09	02/13/01	323.00	12.2	7.1	1840	See Table 4-19
B-15	02/13/01	318.83	11.7	7.2	3280	See Table 4-19
B-16	02/09/01	270.00	6.5	7.1	1057	< 1
B-26	02/12/01	291.36	6.1	7.5	1168	< 1
KH-6	02/13/01	316.77	8.8	6.9	823	< 1
KH-9S	02/12/01	327.72	8.6	7.1	3190	< 1
KH-15	02/09/01	281.86	10.2	7.1	964	< 1
KH-16	02/12/01	319.56	7.4	7.1	1849	< 1
KH-17	02/12/01	323.02	6.9	7.0	1065	< 1
KH-18	02/12/01	285.33	6.8	6.6	2400	< 1
Lower Level						
KH-19	02/12/01	235.75	5.4	9.3	1269	< 1
KH-21	02/09/01	242.07	11.5	6.8	2170	< 1
KH-21 Duplicate	02/09/01	242.07	11.5	6.8	2130	< 1
KH-22	02/09/01	226.63	1.6	7.4	476	< 1
KH-23	02/09/01	244.25	8.7	7.8	808	< 1
Field Blanks						
B-5	02/13/01	NA	11.2	7.0	3	< 1
KH-16	02/12/01	NA	4.9	6.9	3	< 1
KH-21	02/09/01	NA	4.2	6.5	<0.02	< 1

Notes:  
NA - Not applicable



**TABLE 4-19 RESULTS OF KNOLLS SITE GROUNDWATER MONITORING,  
LANDFILL, LAND AREA, HILLSIDE, AND LOWER LEVEL WELLS,  
VOLATILE ORGANIC ANALYSIS, 2001**

Well	Sample Date	Parameter <sup>(1)</sup>							
		Volatile Organic Compound <sup>(2)</sup>							
		Tetra-chloro-ethylene (µg/l)	Trichloro-ethylene (µg/l)	1,1-Dichloro-ethylene (µg/l)	Total 1,2-Dichloro-ethylene (µg/l)	Vinyl chloride (µg/l)	Dichloro-difluoro-methane (µg/l)	Chloroform (µg/l)	Carbon Tetra-chloride (µg/l)
NTH-5A	11/12/01	<1	<1	<1	<1	<1	6	<1	<1
NTH-5A, Duplicate	11/12/01	<1	<1	<1	<1	<1	6	<1	<1
W-3	02/08/01	43	3	<1	2	<1	<1	<1	<1
W-3, Duplicate	02/08/01	42	3	<1	2	<1	<1	<1	<1
B-15	02/13/01	<1	64	<1	trans-1,2 DCE <1 cis-1,2-DCE 8	<1	<1	8	1
B-5	02/13/01	<1	1800	9	trans-1,2 DCE 1 cis-1,2-DCE 81	2	<1	<1	<1
B-5, Duplicate	02/13/01	<1	1700	10	trans-1,2 DCE 1 cis-1,2-DCE 78	2	<1	<1	<1
DW-09	02/13/01	7	<1	<1	trans-1, 2-DCE <1 cis-1, 2-DCE 7	<1	<1	<1	<1
Standards <sup>(3)</sup>		5	5	5	5	2	5	<1	<1
Method Detection Limit		1	1	1	1	1	1	1	1

**Notes:**

- Results for field blanks were all less than the method detection limit for the parameters listed. However, chloroform was detected in the field blank for NTH2A on 5/7/01 at 2 µg/l. Chloroform is a trihalomethane, a water chlorination by-product. The field blank water comes from the subcontractor's deionized water system.
- See Table 4-14 for the complete list of VOCs that were analyzed. The results for those parameters not listed in this table were less than the method detection limit.
- Division of Water, Technical Operation Guidance Series (TOGS) (1.1.1) Ambient Water Quality Standards and Guidance Values (rev. 6/98)

detected in B-5, B-15, and DW-09. 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 building and associated utilities. In the KH-17 eight year monitoring history, TCE was detected in 2000 at the method detection limit (1 µg/l) for the first time. TCE was not detected in 2001 in samples collected during the first and fourth quarters. The 2000 TCE result is attributed to sample cross-contamination and not to groundwater quality.

### **Lower Level**

The Lower Level wells are installed in bedrock and are sampled for field parameters and VOCs. Field analysis data is shown in Table 4-18. No VOCs were detected; therefore, results are not listed in Table 4-19. 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 AND SOLID WASTE**

### **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 Chemical 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, many hazardous substances have been replaced by non-hazardous substitutes. KAPL stresses the "Know Before Do" principle. To this end, facility personnel must identify and minimize waste prior to performing a waste generating process. KAPL also evaluates the hazardous waste that is generated and determines if additional waste minimization can be achieved. In the past, the Knolls Site has provided NYSDEC with an annual Hazardous Waste Reduction Plan. However, due to successful waste minimization efforts, the small quantity of routine hazardous waste currently generated at the Knolls Site falls below the threshold established by NYSDEC for submittal of this formal 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 Chemical 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 2001, the Knolls Site shipped approximately 9.4 tons of RCRA and New York State hazardous waste for off-site disposal. This includes 0.9 tons of mixed waste. 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.

Non-hazardous chemical waste is also sent off-site for disposal. The transportation vendors and the treatment/storage/disposal facilities are typically the same as those used for hazardous waste disposal. These facilities also 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. Approximately 357 tons of non-hazardous waste was sent for off-site

disposal via incineration, wastewater treatment, chemical treatment, or land disposal.

#### **4.6.4 Solid Waste Disposal/Recycling**

During 2001, approximately 782 tons of non-hazardous solid waste from office and cafeteria trash collection operations and construction and demolition debris and classified scrap paper generated by Knolls Site personnel were disposed of by a subcontractor at permitted off-site facilities. KAPL also recycles such products as glass, tin, aluminum, newspapers, magazines, plastic, cardboard, office paper, wood, asphalt, lead, precious metals, computers, metal and plastic drums, cafeteria grease, recycled oil, fluorescent light bulbs and batteries. Approximately, 507 tons of materials were recycled.

#### **4.7 TRANSPORTATION OF RADIOACTIVE MATERIALS**

Operation of the Knolls Site results in the generation of various types of radioactive materials. Detailed procedures are used 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. 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 2001, approximately 95 cubic meters (124 cubic yards) of low level radioactive waste containing approximately 1.8 curies were shipped from the Site for disposal. In addition, approximately 27 tons of slightly radioactive metal were sent to an out-of-state radioactive material recycling facility as recyclable material. The recycled metal was returned to the DOE for controlled reuse. Approximately 22.5 tons of metal, determined through detailed instrument surveys not to require controls as radioactive material, were sent for disposal at a hazardous waste landfill in accordance with the Secretary of Energy restrictions on recycling such metal.

#### **4.8 RADIATION DOSE ASSESSMENT**

The effluent and environmental monitoring results show that radioactivity present in liquid and gaseous effluents from 2001 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 2001 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°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, snowfall 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 prototype plant facilities including blowdown water from steam generators and drainage water from the engine rooms.
5. *Site Drainage Water* - Stormwater 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.

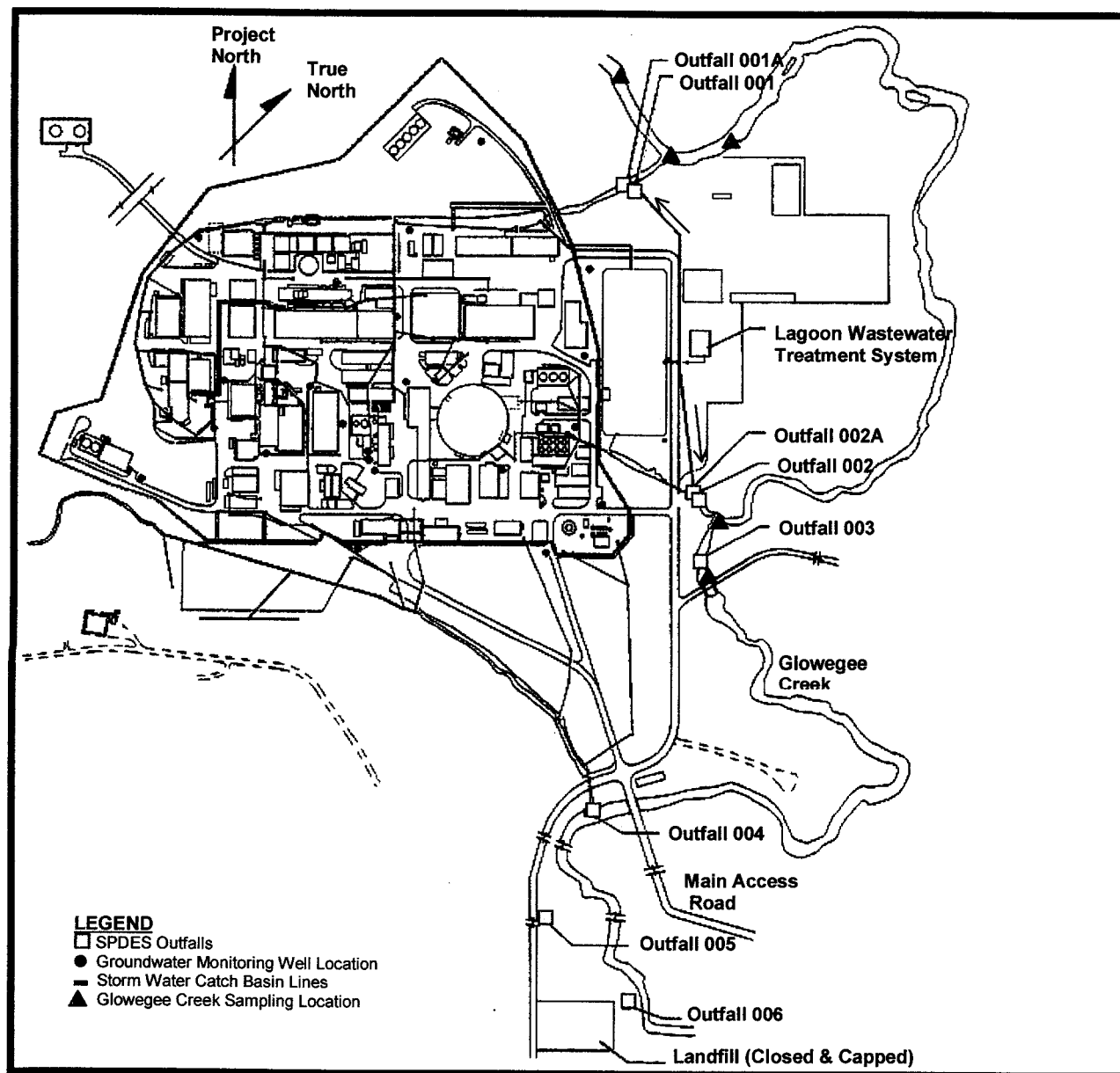
To minimize releases of radioactivity to the environment, a water reuse system is employed. Water is collected and processed through the process system consisting of a series of filters and demineralizers. After purification, the majority of water is reused as reactor coolant makeup and in other radioactive 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. 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.



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

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).

Stormwater from the Kesselring Site enters the Glowegee Creek from stormwater 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 stormwater.

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. Stormwater also collects in Outfall 005 from Hogback Road and enters the Glowegee Creek. Outfall 006 collects stormwater 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 2001 totaled less than 0.02 curies of tritium. The activity was contained in approximately  $5.94 \times 10^8$  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 CHEMICAL CONSTITUENTS AND TEMPERATURE IN KESSELRING SITE LIQUID EFFLUENT, OUTFALL 001, 2001**

Parameter (units)	Number of Samples	Value			SPDES Permit Limit	Percent of Limit (Using Average Value)
		Minimum <sup>(1)</sup>	Maximum <sup>(1)</sup>	Average <sup>(2)</sup>		
Discharge Requirements (Reference 19)						
Flow (MGD)*	365	0.00	0.96	0.15	Report <sup>(3)</sup>	---
Temperature (Deg. F)	209	34.5	72.8	52.8	(Note 4)	---
Residual Chlorine (mg/l)	209	< 0.02	< 0.02	< 0.02	0.04	< 50
pH (SU)**	55	6.8	8.34	7.58	6.0 - 9.0	---
Grease and Oil (mg/l)	12	< 1	< 1	< 1	15	< 7
Total Suspended Solids (mg/l)	13	3.3	24.0	12.1	45	27
Nitrite as N (mg/l)	13	< 0.02	<0.02	< 0.02	(Note 5)	---
Iron						
(mg/l)	12	0.12	0.40	0.22	0.4	55
(lb/day)	12	0.05	0.73	0.31	(Note 6)	---
Total Phosphorus						
(mg/l)	13	0.11	0.3	0.19	Report <sup>(3)</sup>	---
(kg/month)	13	0.3	12.7	4.0	(Note 7)	---
Zinc						
(mg/l)	12	0.014	0.147	0.037	Report <sup>(3)</sup>	---
(lb/day)	12	0.004	0.126	0.046	(Note 8)	---
Boron (mg/l)	12	< 0.05	<0.05	<0.05	0.5	< 10
Sulfite (mg/l)	13	< 2.0	< 2.0	< 2.0	2.0	< 100
Additional Parameters Monitored (Not Required by Permit - Reference 19)						
Detergent (MBAS) (mg/l)	12	< 0.02	0.02	< 0.02	N/A	N/A
Ammonia - N (mg/l)	12	< 0.10	0.20	< 0.11	N/A	N/A
Copper (mg/l)	12	< 0.05	< 0.05	< 0.05	N/A	N/A
Cadmium (mg/l)	12	< 0.001	< 0.005	< 0.004	N/A	N/A
Specific Conductance (µmhos/cm)	12	468	1030	711	N/A	N/A
Total Chromium (mg/l)	12	< 0.005	0.007	< 0.005	N/A	N/A

See Notes on Page 5-8

**TABLE 5-2 CHEMICAL CONSTITUENTS AND TEMPERATURE IN KESSELRING SITE LIQUID EFFLUENT, OUTFALL 002, 2001**

Parameter (units)	Number of Samples	Value			SPDES Permit Limit	Percent of Limit (Using Average Value)
		Minimum <sup>(1)</sup>	Maximum <sup>(1)</sup>	Average <sup>(2)</sup>		
Discharge Requirements (Reference 19)						
Flow (MGD)*	365	0.00	1.49	0.28	Report <sup>(3)</sup>	----
Temperature (Deg. F)	209	34.1	72.9	52.9	(Note 4)	----
Residual Chlorine (mg/l)	209	< 0.02	< 0.02	< 0.02	0.04	< 50
pH (SU)**	54	7.0	8.5	7.6	6.0 - 9.0	----
Grease and Oil (mg/l)	12	<1.0	7.4	< 1.6	15	< 11
Total Suspended Solids (mg/l)	13	1.5	25.0	11.2	45	25
Nitrite as N (mg/l)	13	< 0.02	< 0.02	< 0.02	(Note 5)	----
Iron						
(mg/l)	12	0.12	0.31	0.19	0.4	48
(lb/day)	12	0.15	1.19	0.58	(Note 6)	----
Total Phosphorus						
(mg/l)	13	0.09	0.29	0.18	Report <sup>(3)</sup>	----
(kg/month)	13	1	18.1	8	(Note 7)	----
Zinc						
(mg/l)	12	0.011	0.070	0.028	Report <sup>(3)</sup>	----
(lb/day)	12	0.011	0.244	0.084	(Note 8)	----
Boron (mg/l)	12	< 0.05	< 0.05	< 0.05	0.5	< 10
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	< 0.02	< 0.02	< 0.02	N/A	N/A
Ammonia - N (mg/l)	12	< 0.1	< 0.1	< 0.1	N/A	N/A
Copper (mg/l)	12	< 0.05	< 0.05	< 0.05	N/A	N/A
Cadmium (mg/l)	12	< 0.001	< 0.005	< 0.004	N/A	N/A
Specific Conductance (µmhos/cm)	12	466	1000	698	N/A	N/A
Total Chromium (mg/l)	12	< 0.005	< 0.005	< 0.005	N/A	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 method detection limit for that sample and parameter.
- (2) Average values preceded by < contain at least one less than method detection limit 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.

\* MGD– Million Gallons per Day

\*\* SU - Standard Units

N/A - Not Applicable

**TABLE 5-3 CHEMICAL CONSTITUENTS AND TEMPERATURE IN KESSELRING SITE  
SEWAGE TREATMENT PLANT EFFLUENT, OUTFALL 003, 2001**

Parameter (units)	Number of Samples	Value			SPDES Permit Limit	Percent of Limit (Using Average Value)
		Minimum <sup>(1)</sup>	Maximum <sup>(1)</sup>	Average <sup>(2)</sup>		
Discharge Requirements (Ref. 19)						
Flow (MGD)*	249	0.000	0.040	0.018	0.09 <sup>(3)</sup>	20
pH (SU)**	251	7.0	8.1	7.6	6.0 - 9.0	---
Settleable Solids (ml/l)	251	< 0.1	< 0.1	< 0.1	< 0.1	< 100
Dissolved Oxygen (mg/l)	251	7.4	13.0	10.0	> 5.0	(Note 4)
Nitrite-N (mg/l)	14	< 0.02	0.30	<0.03	Report <sup>(5)</sup>	---
Cyanide, Free (mg/l)	13	< 0.01	< 0.01	< 0.01	0.09	< 11
Ammonia-N (mg/l)	14	< 0.1	<0.1	<0.1	24.4	< 0.4
Detergent (MBAS) (mg/l)	13	< 0.02	0.05	< 0.02	0.7	< 3
Boron (mg/l)	13	< 0.05	< 0.05	< 0.05	1.2 <sup>(6)</sup>	< 4
Dissolved Copper (mg/l)	13	< 0.05	< 0.05	< 0.05	Report <sup>(7)</sup>	---
BOD 5 (mg/l)	14	< 2	2	< 2	30 <sup>(8)</sup>	< 7
Suspended Solids (mg/l)	14	< 1.0	20.0	<2.0	30 <sup>(8)</sup>	< 7
Total Phosphorus						
(mg/l)	14	1.2	2.8	1.9	Report <sup>(6)</sup>	---
(kg/month)	14	2.8	7.2	4.3	(Note 9)	---
Zinc						
(mg/l)	18	< 0.015	0.185	<0.052	(Note 7)	---
(lbs/day)	18	< 0.002	0.039	< 0.011	Report <sup>(10)</sup>	---
Total Copper (lbs/day)	13	< 0.005	< 0.011	< 0.008	0.06	< 13
Iron						
(mg/l)	18	< 0.05	0.09	< 0.05	0.3 <sup>(6)</sup>	< 17
(lbs/day)	18	< 0.005	0.017	< 0.009	(Note 11)	---
Aluminum (mg/l)	13	< 0.1	1.7	< 0.2	2.0 <sup>(6)</sup>	< 10
Butyl Benzyl Phthalate (mg/l)	13	< 0.01	< 0.01	< 0.01	0.1 <sup>(6)</sup>	< 10

**Additional Parameters Monitored (Not Required by Permit - Ref. 19)**

Temperature (Deg. F)	242	39.0	75.0	56.4	N/A	N/A
----------------------	-----	------	------	------	-----	-----

**Notes:**

- (1) A value preceded by < is less than the method detection limit for that sample and parameter.
- (2) Average values preceded by < contain at least one less than method detection limit 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.
- (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 ( $\text{NO}_x$ ) 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 ( $\text{SO}_x$ ) 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. 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 gamma spectrometry. A minimum detectable concentration of approximately  $5 \times 10^{-15}$   $\mu\text{Ci/ml}$  is achieved for cobalt-60. The activated charcoal cartridges are analyzed for radioiodine by gamma spectrometry to a minimum detection level of approximately  $5 \times 10^{-15}$   $\mu\text{Ci/ml}$  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  $5 \times 10^{-11}$   $\mu\text{Ci/ml}$  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<sub>x</sub> 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<sub>x</sub> 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 2001 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 0.6 curie of noble gases with half-lives of 12 days or less, principally argon-41, xenon-133 and xenon-135, (3) approximately 0.1 curies of tritium, and (4) approximately 0.12 curies of carbon-14.

The radioactivity was contained in a total volume of  $5.6 \times 10^{11}$  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 during 2001 included: (1) the periodic collection of Gloweggee Creek water samples for chemical analyses, (2) the monitoring of water temperature and pH above and below the Site discharge locations to the Gloweggee Creek, (3) a survey of the aquatic life upstream, near the discharge channels and downstream in the Gloweggee Creek, (4) the collection of fish upstream and downstream of discharge locations to the Gloweggee Creek, (5) the collection of quarterly samples of Gloweggee 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.

During 2001, grab samples of Gloweggee Creek were collected weekly and monthly upstream and downstream of the discharge outfalls for chemical analysis. In addition, continuous monitoring and recording of the creek temperature was conducted upstream of the Site, between the discharge channels, and downstream of the Site. The Gloweggee Creek pH was 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 Gloweggee 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**

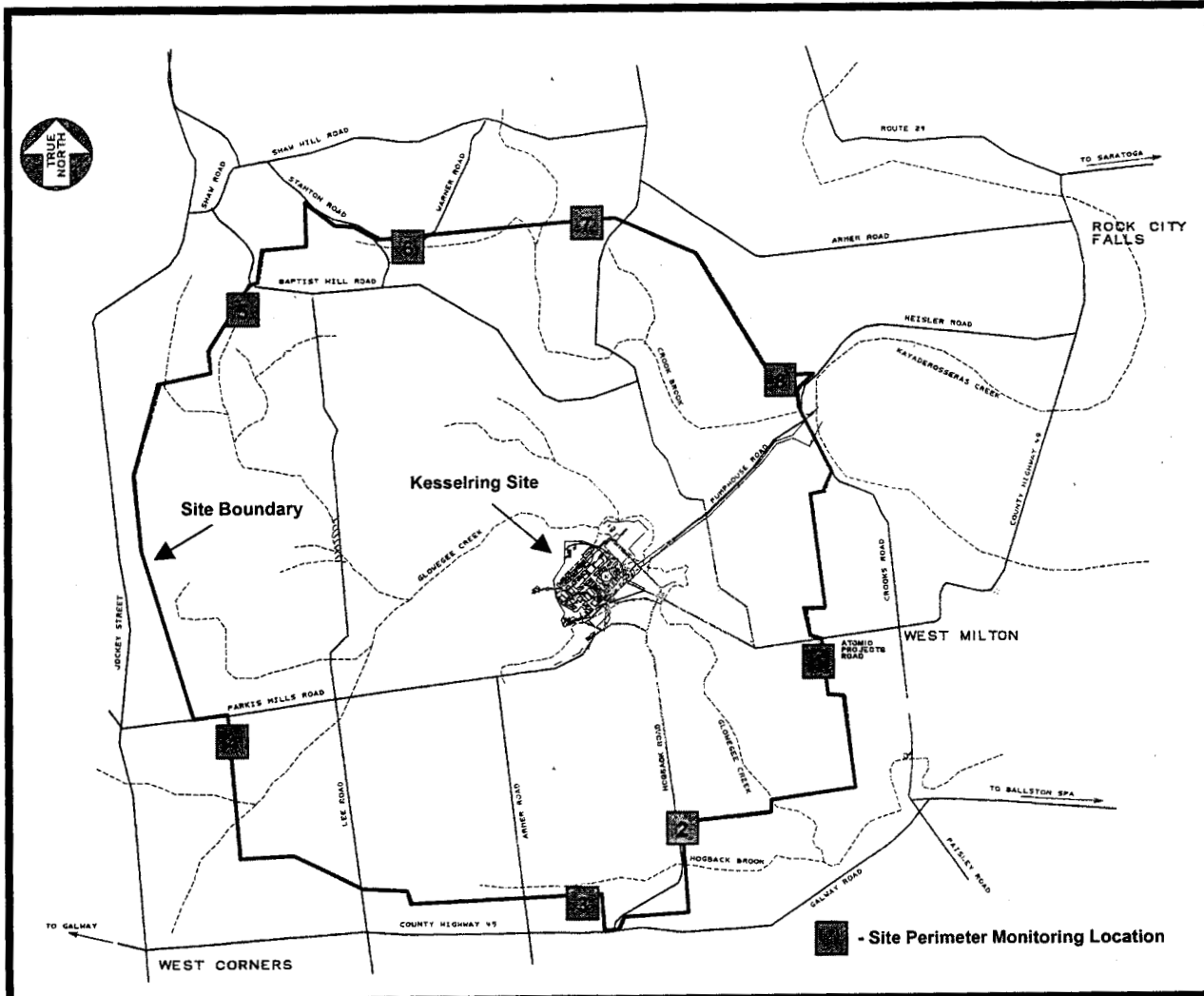
The routine quarterly samples of Glowegee Creek water and bottom sediment samples are analyzed with a high-purity germanium gamma spectrometer system. In addition, a more sensitive gamma spectrometry analyses is performed annually on the fish and some of the water and sediment samples collected from 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 high-purity germanium gamma spectrum analysis.

#### **5.4.3 Assessment**

The 2001 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 2001 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 2001 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, 2001 <sup>(1,2)</sup>**

Parameter (units)	Number of Samples	Value			Standard
		Minimum	Maximum	Average <sup>(3)</sup>	
pH (SU*) (See Note 4)	53	7.4	8.8	8.1	6.5 - 8.5
Temperature (Deg F.)	208	30	80	48	No Standard
Residual Chlorine (mg/l)	53	< 0.02	< 0.02	< 0.02	0.005 (See Note 5)
Total Organic Carbon (mg/l)	12	2.6	8.2	4.4	No Standard
Dissolved Oxygen (mg/l)	12	9.1	19.6	12.8	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	1.0 (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	< 0.005	< 0.010	< 0.006	0.101 (See Note 8)
Total Cadmium (mg/l)	12	< 0.001	< 0.005	< 0.004	0.002 (See Notes 5 and 8)
Color (cpu**)	12	10	30	20	See Note 9
Total Phosphorus (mg/l)	12	< 0.02	0.02	< 0.02	See Note 10
Hardness (mg/l)	12	78	136	126	No Standard
Total Chromium (mg/l)	12	< 0.005	0.007	< 0.005	0.090 (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 (µmhos/cm)	12	228	359	298	No Standard
Turbidity (ntu)	12	0.8	29.0	4.2	See Note 11
MBAS (Surfactants) (mg/l)	12	< 0.02	< 0.02	< 0.02	No Standard
Iron (mg/l)	12	0.08	0.29	0.13	0.300
Boron (mg/l)	12	< 0.05	< 0.05	< 0.05	10
Nitrite (mg/l)	12	< 0.02	< 0.02	< 0.02	0.020
Total Suspended Solids (mg/l)	12	< 1.0	10.0	< 2.8	See Note 12

Notes:

- (1) A value preceded by < is less than the method detection limit 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 method detection limit in the sample set.
- (4) Upstream pH maximum values exceeded the standard on occasion.
- (5) The method detection limit 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 applies to the dissolved form and is a calculated value based upon the hardness of the water. The value shown is the calculated value for the average upstream 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, 2001<sup>(1,2)</sup>**

Parameter (units)	Number of Samples	Value			Standard
		Minimum	Maximum	Average <sup>(3)</sup>	
pH (SU*)	53	7.6	8.4	7.9	6.5 - 8.5
Temperature (Deg F.)	208	31	78	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	2.5	8.0	4.2	No Standard
Dissolved Oxygen (mg/l)	12	8.4	19.4	11.8	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	1.0 (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	0.005	< 0.050	< 0.011	0.101 (See Note 8)
Total Cadmium (mg/l)	12	< 0.001	< 0.005	< 0.004	0.002 (See Notes 5 and 8)
Color (cpu**)	12	15	25	22	See Note 9
Total Phosphorus (mg/l)	12	< 0.02	0.08	< 0.03	See Note 10
Hardness (mg/l as CaCO3)	12	78	151	129	No Standard
Total Chromium (mg/l)	12	< 0.005	< 0.005	< 0.005	0.090(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 (µmhos/cm)	12	246	400	333	No Standard
Turbidity (ntu)	12	1.2	36.0	5.7	See Note 11
MBAS (surfactants) (mg/l)	12	< 0.02	< 0.02	< 0.02	No Standard
Iron (mg/l)	12	< 0.05	0.32	< 0.19	0.300
Boron (mg/l)	12	< 0.05	< 0.05	< 0.05	10
Nitrite (mg/l)	12	< 0.02	< 0.02	< 0.02	0.020
Total Suspended Solids (mg/l)	12	< 1.0	20.0	< 4.3	See Note 12

See Notes on previous page.

**TABLE 5-6 GLOWEGEE CREEK FISH SURVEY, 2001**

<b>Location</b>	<b>Species</b>	<b>Number Collected</b>	<b>Length (mm)</b>
400 Feet Upstream	Blacknose Dace	105	30-72
	Bluegill	-	-
U-2	Bluntnose Minnow	-	-
	Brown Bullhead	-	-
	Brown Trout	1	271
	Common Shiner	176	22-101
	Creek Chub	71	27-107
	Cutlips Minnow	20	50-122
	Golden Shiner	1	84
	Largemouth Bass	-	-
	Longnose Dace	5	65-97
	Northern Redbelly Dace	-	-
	Pumpkinseed	-	-
	Tessellated Darter	13	33-76
	White Sucker	30	30-147
	Yellow Bullhead	-	-
20 Feet Upstream	Blacknose Dace	206	27-75
	Bluegill	-	-
U-1	Bluntnose Minnow	3	60-64
	Brown Bullhead	-	-
	Brown Trout	-	-
	Common Shiner	404	33-108
	Creek Chub	82	28-169
	Cutlips Minnow	13	29-113
	Fathead Minnow	12	47-66
	Golden Shiner	7	72-78
	Longnose Dace	7	33-104
	Northern Redbelly Dace	20	42-63
	Pumpkinseed	6	79-103
	Tessellated Darter	12	62-79
	White Sucker	32	38-148
	Yellow Bullhead	-	-
Between Discharge Channels	Blacknose Dace	335	22-76
	Bluegill	-	-
	Bluntnose Minnow	4	60-73
M-1	Brook Stickleback	2	34-38
	Brown Trout	-	-
	Common Shiner	458	29-88
	Creek Chub	162	25-125
	Cutlips Minnow	10	51-100
	Fathead Minnow	23	40-62
	Golden Shiner	5	61-102
	Longnose Dace	12	43-93
	Northern Redbelly Dace	6	43-62
	Pumpkinseed	-	-
	Tessellated Darter	17	33-76
	White Sucker	35	29-142
	Yellow Bullhead	-	-

**TABLE 5-6 GLOWEGEE CREEK FISH SURVEY, 2001 (Continued)**

Location	Species	Number Collected	Length (mm)
2900 Feet Downstream	Blacknose Dace	110	29-78
	Bluegill	-	-
D-2	Bluntnose Minnow	10	48-73
	Brown Bullhead	-	-
	Brown Trout	-	-
	Common Shiner	89	29-102
	Creek Chub	29	20-111
	Cutlips Minnow	9	65-118
	Fathead Minnow	-	-
	Largemouth Bass	-	-
	Longnose Dace	21	37-108
	Northern Redbelly Dace	-	-
	Pearl Dace	1	66
	Tessellated Darter	25	33-73
	White Sucker	17	48-190
	Yellow Bullhead	-	-
3200 Feet Downstream	Blacknose Dace	44	33-78
	Bluegill	-	-
D-1	Bluntnose Minnow	43	55-78
	Brown Bullhead	-	-
	Brown Trout	-	-
	Common Shiner	220	26-117
	Creek Chub	81	31-180
	Cutlips Minnow	1	74
	Fathead Minnow	3	52-62
	Largemouth Bass	-	-
	Longnose Dace	6	52-92
	Northern Redbelly Dace	-	-
	Pumpkinseed	-	-
	Tessellated Darter	25	33-75
	White Sucker	108	38-172
	Yellow Bullhead	-	-
5500 Feet Downstream	Blacknose Dace	336	35-76
	Bluegill	-	-
	Bluntnose Minnow	2	60-74
D-3	Brown Bullhead	-	-
	Brown Trout	2	195-360
	Common Shiner	149	32-109
	Creek Chub	56	29-135
	Cutlips Minnow	22	54-138
	Fathead Minnow	-	-
	Largemouth Bass	1	77
	Longnose Dace	57	44-106
	Northern Redbelly Dace	-	-
	Pumpkinseed	-	-
	Tessellated Darter	7	52-76
	White Sucker	15	42-152
	Yellow Bullhead	-	-

**TABLE 5-7 RESULTS OF ANALYSES OF GLOWEGEE CREEK FISH, 2001**

Sample Location	Radioactivity Concentration <sup>(1)</sup> (pCi/g wet wt)		
	K-40	Cs-137	Co-60
Combination of 400 ft. and 20 ft. Upstream of Discharge Channel 001	0.89 ± 0.13	< 0.01	< 0.01
5500 ft. Downstream from Discharge Channel 002	1.04 ± 0.15	< 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 GLOWEGEE CREEK  
SEDIMENT AND WATER, 2001**

Sample Location	No. of Samples Sediment/Water	Cobalt-60 Radioactivity Concentration					
		Sediment (pCi/gm. dry wt) <sup>(1, 2)</sup>			Water (pCi/l) <sup>(2)</sup>		
		Minimum	Maximum	Average	Minimum	Maximum	Average
Upstream of Discharge Channel 001	9/3	< 0.02	< 0.02	< 0.02	< 11	< 15.6	< 14
Opposite Discharge Channel 001	10/4	< 0.02	< 0.03	< 0.02	< 3.2	< 17.8	< 12.4
Between Discharge Channels 001 & 002	10/4	< 0.02	< 0.03	< 0.02	< 8.7	< 14.1	< 11.2
Opposite Discharge Channel 002	10/4	< 0.02	< 0.03	< 0.02	< 9.6	< 14.1	< 11.9
Downstream of Discharge Channel 003	12/4	< 0.02	< 0.02	< 0.02	< 9.6	< 14.1	< 11.2

- 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, 2001**

Perimeter Location No. <sup>(1)</sup>	Total Annual Exposure (millirem) <sup>(2)</sup>
1	76 ± 6
2	67 ± 5
3	70 ± 3
4	72 ± 2
5	70 ± 3
6	71 ± 2
7	77 ± 3
8	73 ± 1
Off-site locations	75 ± 12 <sup>(3)</sup>

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) 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 40 years ago, the release of radioactivity into the Glowegee Creek has been small and has had no adverse 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 2001 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 less than  $4.67 \times 10^{-15}$   $\mu\text{Ci/ml}$  and less than  $4.42 \times 10^{-15}$   $\mu\text{Ci/ml}$ , 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 and surface water programs consist of monitoring the closed Hogback Road Landfill in accordance with NYSDEC regulations and the voluntary monitoring of wells within the developed area. Additionally, voluntary radiological monitoring of groundwater is performed.

In 2001, the Hogback Road Landfill groundwater and surface water program consisted of monitoring four shallow (overburden) wells (HB-1A, LMW-4, HB-5A2, and LMW-6), three deep (bedrock) wells (HB-1B, HB-5B, and HB-11B), and six (five overburden, one bedrock) wells (HB-7A, HB-8A, HB-9A, HB-11A, HB-12A, and HB-4B) which are monitored on a cyclical basis, and two surface water sampling locations (SW-1 and SW-2). The groundwater and surface water monitoring program is shown in Table 5-10. The locations of all existing landfill monitoring points are shown in Figures 5-3.

KAPL completed three quarterly rounds of sampling in 2001 prior to receiving NYSDEC authorization to modify the Landfill monitoring program as allowed under the State's 5-year post-closure re-evaluation protocol (6NYCRR 360-2.15(k)(4)). This process allows for NYSDEC review of the historic data generated from the landfill, and for the appropriate adjustment to the monitoring locations, parameters and periodicity. As a result of reviewing over 10 years of data, NYSDEC approved a revised monitoring program. The Landfill program now consists of annual sampling (in the Fall) of 5 wells (four overburden and one bedrock) for a focused list of analytical parameters as determined from the historical data review.

NYSDEC approval of the monitoring program revision was received prior to conducting the fourth quarter 2001 sampling round, and thus fourth quarter sampling was not required. The next sampling round at the Landfill will occur in the Fall 2002.

The voluntary developed area groundwater program (Figure 5-4) consists of 19 monitoring wells that are sampled annually. The voluntary former disposal areas groundwater program consisted of a total of 12 monitoring wells distributed within four separate areas, (Figure 5-5). In 1999, KAPL evaluated each of the sites with regard to; the nature of the disposal source material, hydrogeology, and historic analytical database, concluding that no threat exists to groundwater from any environmental constituents associated with the sites. These wells are currently sampled and analyzed only for radiological parameters to maintain negative radiological data associated with these sites.

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

### **5.5.2 Origin**

Elevated parameters 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 five 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 developed area are predominantly the result of past activities. Identified potential sources are historical material handling practices, construction activities, and the use of de-icing materials (i.e., road salt, calcium chloride).

### **5.5.3 Analyses**

All groundwater samples are analyzed by a New York State Department of Health certified laboratory for chemical parameters in accordance with Reference (9) or other EPA approved methods. The groundwater monitoring program, Table 5-10, summarizes the frequency of analyses. The sample results are discussed in Section 5.5.4.

The landfill monitoring wells are sampled on a quarterly basis (fourth quarter excluded). The samples are analyzed for either baseline or routine parameters (Reference 5). The results are shown in Table 5-11.

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

The Kesselring Site also conducts voluntary radiological monitoring on the groundwater wells at the landfill area, the four former disposal sites, and the developed area. The 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 sampled to ensure compliance with New York State drinking water supply regulations defined in Reference (20). The sample results are shown in Table 5-14.

### **5.5.4 Assessment**

#### **Landfill:**

Analytical results obtained during 2001 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 conductance, alkalinity, hardness, total dissolved solids (TDS), chloride, sulfate, magnesium, manganese, potassium, sodium, and calcium. A number of other parameters, including chemical oxygen demand (COD), total organic carbon (TOC), total kjeldahl nitrogen (TKN), ammonia, nitrate, barium, and iron, while elevated in 2001, often exhibit variability and are generally elevated in only a few downgradient wells. Surface water sampling results show the presence of constituents similar to those in groundwater with the exception of specific conductance, TOC, and VOCs.

Groundwater 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 samples include: TDS, chloride, phenols, iron, "iron & manganese", manganese, sodium, and dichlorodifluoromethane. Most elevated metals are associated with suspended solids in the samples. Filtered sample analyses are conducted when field measurements show

elevated sample turbidities greater than 50 nephelometric turbidity units (ntus). Filtered samples typically show either non-detectable or significantly lower levels of these metals.

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

Only two other VOCs (1,1 dichloroethane and chloroethane) were detected at concentrations below groundwater quality standards in the low part per billion (ppb) range in groundwater well samples collected in 2001. Consistent with historical monitoring results, only volatile chlorinated hydrocarbons were detected and are not seen to be increasing in concentration over time.

#### **Developed Area:**

The groundwater program includes field parameters and VOC analyses as discussed in Section 5.5.1. Field parameters include groundwater elevation, temperature, pH, specific conductance and turbidity. Two field parameters, turbidity and specific conductance, were found to be elevated in most of the 19 developed area wells sampled in 2001 and are consistent with historical data.

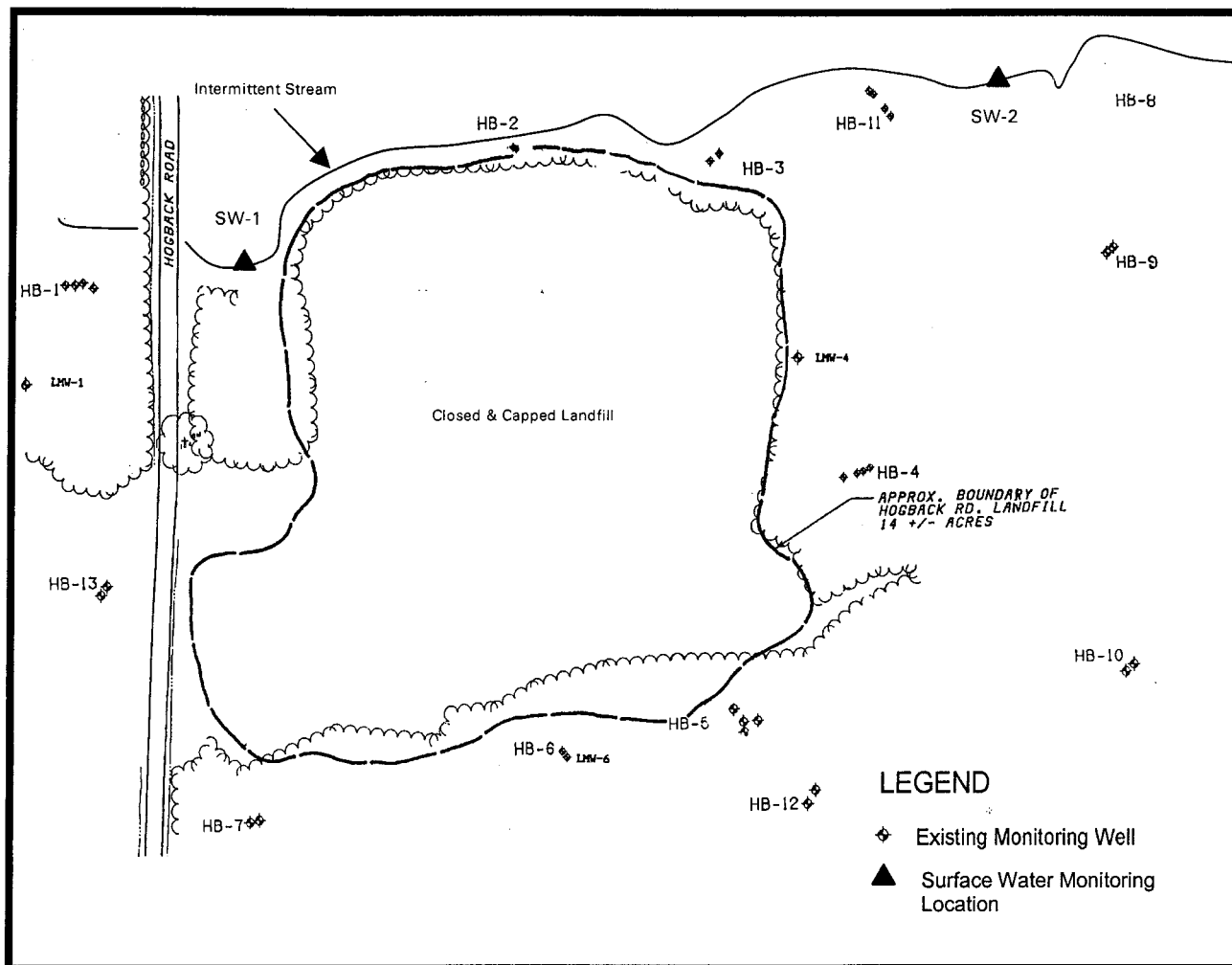
A total of seven VOCs were detected at low concentrations. The VOCs are reported at concentrations ranging from the method detection limit of 1 part per billion (ppb), to a high of 19 ppb. The detected compounds are presented in Table 5-12 and consist of trihalomethanes (bromodichloromethane, dibromochloromethane and chloroform) from the routine operations of Site systems, which contain chlorine compounds. Trihalomethanes (produced when chlorine compounds contact humic material in soil), dichlorodifluoromethane (from historic operations of Site chiller systems), trichloroethylene and tetrachloroethylene (from the historic usage of cleaning compounds), and various chlorinated VOCs have been detected in similarly low concentrations in developed area wells since 1990. The detectable VOCs in well MW-1 are the result of flushing site service water through a fire hydrant located near the well. The VOCs are present as a result of the chlorine in the site service water (chlorinated drinking water) and are the result of current operations.

#### **Radioactivity:**

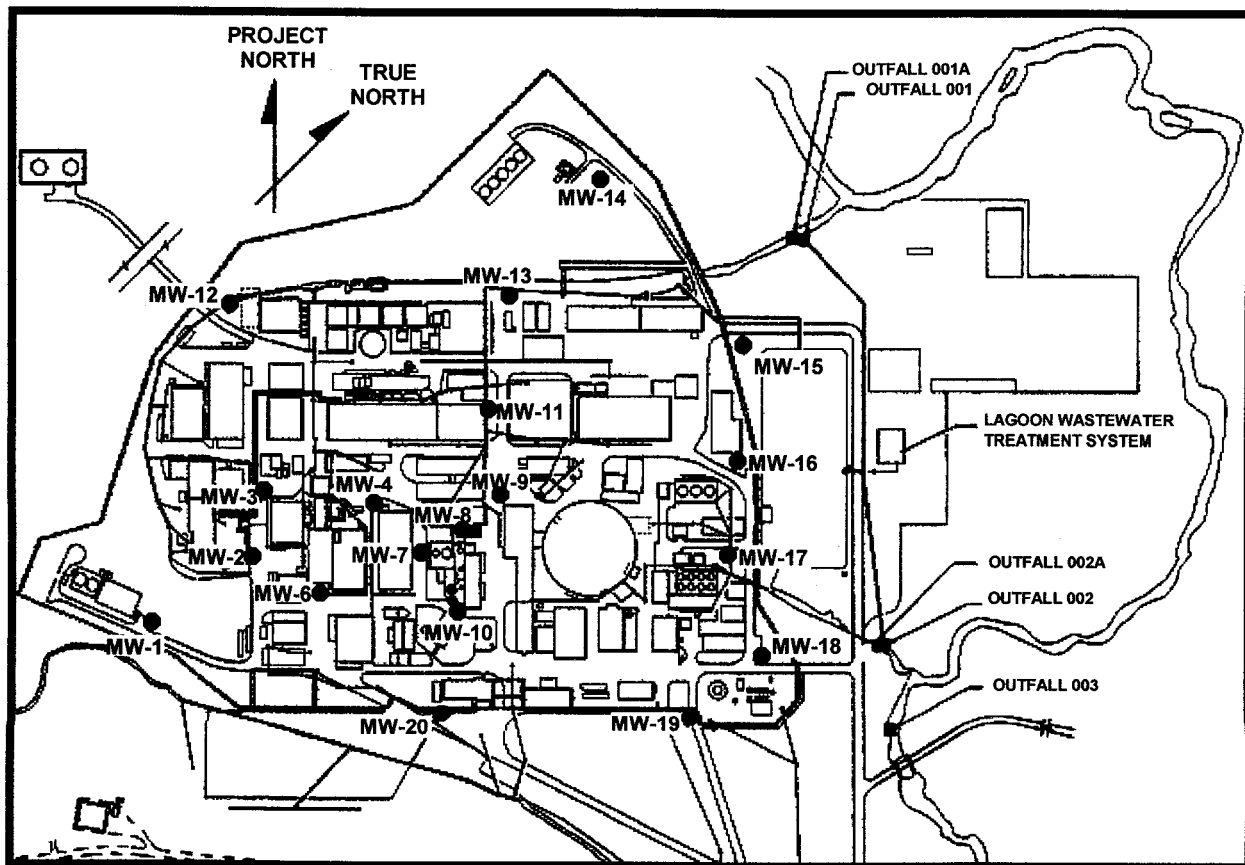
The groundwater sample results for radioactivity are summarized in Table 5-13. The levels of cesium-137, cobalt-60, and tritium were below the detection limits in all wells. The concentrations for these radionuclides were less than 0.1 percent of the respective Reference (4) derived concentration guide values.

#### **Site Service (Drinking) Water:**

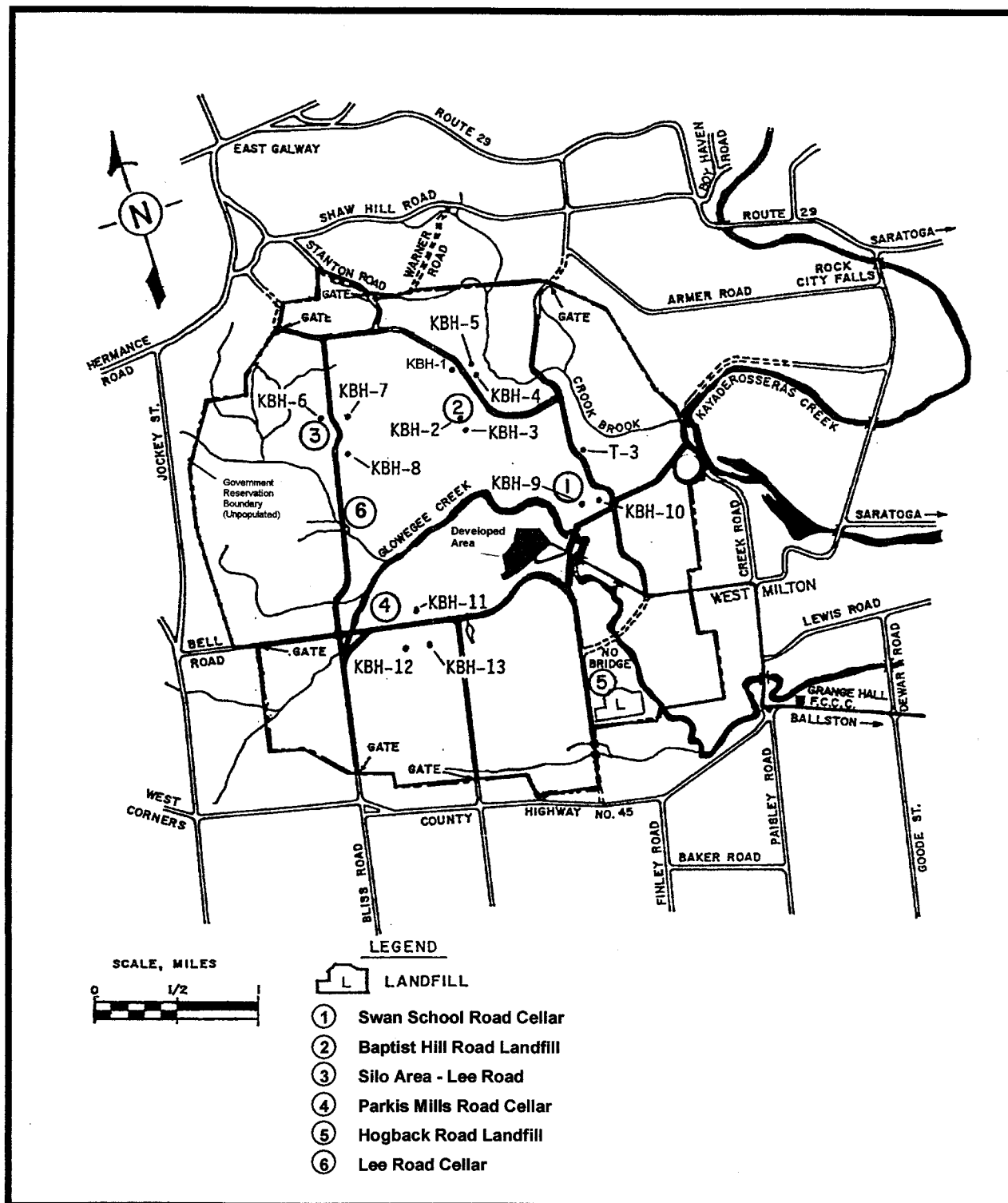
Since groundwater is used for drinking water at the Kesselring Site, sampling is performed to ensure its quality meets New York State drinking water regulations (Reference (20)). The sample results are shown in Table 5-14. The Site service water well field is hydrogeologically separate from the Site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



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



**Figure 5-4**  
**Kesselring Site, Near West Milton, New York**  
**Developed Area Groundwater Monitoring Wells**



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

**TABLE 5-10 KESSELRING SITE GROUNDWATER AND SURFACE WATER  
MONITORING PLAN, 2001**

ID	Radioactivity	Baseline/ Routine <sup>(1,2)</sup>	Field Parameters & Volatile Organic Compounds Only
<b>Developed Area</b>			
MW-1	A		A
MW-2 to 4	A		A
MW-6 to 20	A		A
<b>Land Disposal Areas</b>			
KBH-1 through KBH-13 & T-3	A		
<b>Landfill</b>			
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 <sup>(3)</sup>		A/Q	
SW-2 <sup>(3)</sup>		A/Q	
HB-7A	A	--	
HB-8A	A	--	
HB-9A	A	--	
HB-11A	A	Baseline 1 <sup>st</sup> Qtr.	
HB-12A	A	Baseline 2 <sup>nd</sup> Qtr.	
HB-4B	A	Baseline 3 <sup>rd</sup> Qtr.	

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) Surface water sample



**TABLE 5-11 RESULTS OF KESSELRING SITE WATER MONITORING, HOGBACK ROAD LANDFILL, 2001 <sup>(1,2)</sup>**

		ROUTINE PARAMETERS						
		METALS (mg/l) <sup>(6)</sup>						
Sample Location	Sample Date	Calcium	Iron	Lead	Magnesium	Manganese	Potassium	Sodium
Groundwater-Unconsolidated								
HB-1A	03/15/01	17.9/13.1	5.75/<0.05	<0.005	2.5/1.9	0.26/<0.02	0.9/<0.5	0.9/1.3
HB-1A	06/07/01	11.5/10	0.34/<0.05	<0.005	1.11/1.11	0.09/<0.02	0.2/0.4	0.7/1.6
HB-1A	09/18/01	29	0.55	<0.005	6.4	0.04	<0.5	1.6
LMW-4	03/15/01	419/199	15.8/<0.05	0.012/<0.005	48/38	1.28/0.58	8.1/8.2	59/58
LMW-4	06/07/01	114/78.2	6.41/<0.05	<0.005	13.9/8	0.32/0.11	2.6/2.2	15.4/11
LMW-4	09/18/01	WELL DRY	NS	NS	NS	NS	NS	NS
HB-5A2	03/15/01	222/202	6.18/0.49	<0.005	31/24	1.9/1.71	7.1/7.9	67/68
HB-5A2	06/07/01	176	2.07	<0.005	17.8	0.68	1.9	29.9
HB-5A2	09/18/01	192/169	3.45/1.37	<0.005	23/20	1.94/1.87	2.3/13	20/27
LMW-6	03/15/01	181/164	2.66/<0.05	<0.005	39.8/33	5.24/3.22	2.1/2.1	51.4/50
LMW-6	06/07/01	178	0.68	<0.005	32	0.62	2.3	26
LMW-6	09/18/01	164/152	0.72/<0.05	<0.005	33/31	2.14/1.37	3.3/3.3	48/46
HB-11A	09/18/01	132/121	1.58/<0.05	<0.005	28/29	0.62/0.34	1.4/1.7	31/32
HB-11A QC	09/18/01	149/117	2.2/0.31	<0.005	29/28	0.96/0.26	1.5/1.4	31/31
Groundwater-Bedrock								
HB-1B	03/15/01	20.3	0.4	<0.005	14.8	<0.02	6.1	52
HB-1B	06/07/01	18.9	<0.05	<0.005	11.7	<0.02	4.6	28.8
HB-1B	09/18/01	21	<0.05	<0.005	15	<0.02	5	41
HB-5B	03/15/01	204/200	5.32/0.14	<0.005	47/49	0.55/0.54	6.9/6.3	104/106
HB-5B	06/07/01	168	7.77	<0.005	23.2	0.6	2.9	35.2
HB-5B	09/18/01	181	6.69	<0.005	35	0.53	8.5	62
HB-11B	03/15/01	124	0.52	<0.005	27	0.02	1.9	29
HB-11B	06/07/01	118	<0.05	<0.005	23.7	0.02	1.8	18.9
HB-11B	09/18/01	119	0.2	<0.005	25	<0.02	1.9	25
Surface Water								
SW-1	03/15/01	33.4	0.22	<0.005	6.2	0.04	0.7	35
SW-1	06/07/01	28.5	0.15	<0.005	4.73	0.06	0.2	4.8
SW-1	09/18/01	LOCATION DRY	NS	NS	NS	NS	NS	NS
SW-2	03/15/01	37.1	0.1	<0.005	6.6	0.04	0.8	36
SW-2	06/07/01	55.8	0.54	<0.005	7.7	0.19	0.6	12.6
SW-2	09/18/01	LOCATION DRY	NS	NS	NS	NS	NS	NS
SW-2 QC	03/15/01	42	0.11	<0.005	7	0.04	0.9	37
SW-2 QC	06/07/01	52.9	0.75	<0.005	7.3	0.23	0.6	12.3
Standard / Criteria <sup>(4)</sup>								
Groundwater		NC	0.3	0.025	35.0(g)	0.3	NC	20
Surface Water		NC	0.300	<sup>(7)</sup>	NC	NC	NC	NC

**TABLE 5-11 RESULTS OF KESSELRING SITE WATER MONITORING, HOGBACK ROAD LANDFILL, 2001 (CONTINUED)**

		ROUTINE PARAMETERS						
		METALS (mg/l) <sup>(6)</sup>						
Sample Location	Sample Date	Calcium	Iron	Lead	Magnesium	Manganese	Potassium	Sodium
<b>Groundwater-Unconsolidated</b>								
HB-1A	03/15/01	17.9/13.1	5.75/<0.05	<0.005	2.5/1.9	0.26/<0.02	0.9/<0.5	0.9/1.3
HB-1A	06/07/01	11.5/10	0.34/<0.05	<0.005	1.11/1.11	0.09/<0.02	0.2/0.4	0.7/1.6
HB-1A	09/18/01	29	0.55	<0.005	6.4	0.04	<0.5	1.6
LMW-4	03/15/01	419/199	15.8/<0.05	0.012/<0.005	48/38	1.28/0.58	8.1/8.2	59/58
LMW-4	06/07/01	114/78.2	6.41/<0.05	<0.005	13.9/8	0.32/0.11	2.6/2.2	15.4/11
LMW-4	09/18/01	WELL DRY	NS	NS	NS	NS	NS	NS
HB-5A2	03/15/01	222/202	6.18/0.49	<0.005	31/24	1.9/1.71	7.1/7.9	67/68
HB-5A2	06/07/01	176	2.07	<0.005	17.8	0.68	1.9	29.9
HB-5A2	09/18/01	192/169	3.45/1.37	<0.005	23/20	1.94/1.87	2.3/13	20/27
LMW-6	03/15/01	181/164	2.66/<0.05	<0.005	39.8/33	5.24/3.22	2.1/2.1	51.4/50
LMW-6	06/07/01	178	0.68	<0.005	32	0.62	2.3	26
LMW-6	09/18/01	164/152	0.72/<0.05	<0.005	33/31	2.14/1.37	3.3/3.3	48/46
HB-11A	09/18/01	132/121	1.58/<0.05	<0.005	28/29	0.62/0.34	1.4/1.7	31/32
HB-11A QC	09/18/01	149/117	2.2/0.31	<0.005	29/28	0.96/0.26	1.5/1.4	31/31
<b>Groundwater-Bedrock</b>								
HB-1B	03/15/01	20.3	0.4	<0.005	14.8	<0.02	6.1	52
HB-1B	06/07/01	18.9	<0.05	<0.005	11.7	<0.02	4.6	28.8
HB-1B	09/18/01	21	<0.05	<0.005	15	<0.02	5	41
HB-5B	03/15/01	204/200	5.32/0.14	<0.005	47/49	0.55/0.54	6.9/6.3	104/106
HB-5B	06/07/01	168	7.77	<0.005	23.2	0.6	2.9	35.2
HB-5B	09/18/01	181	6.69	<0.005	35	0.53	8.5	62
HB-11B	03/15/01	124	0.52	<0.005	27	0.02	1.9	29
HB-11B	06/07/01	118	<0.05	<0.005	23.7	0.02	1.8	18.9
HB-11B	09/18/01	119	0.2	<0.005	25	<0.02	1.9	25
<b>Surface Water</b>								
SW-1	03/15/01	33.4	0.22	<0.005	6.2	0.04	0.7	35
SW-1	06/07/01	28.5	0.15	<0.005	4.73	0.06	0.2	4.8
SW-1	09/18/01	LOCATION DRY	NS	NS	NS	NS	NS	NS
SW-2	03/15/01	37.1	0.1	<0.005	6.6	0.04	0.8	36
SW-2	06/07/01	55.8	0.54	<0.005	7.7	0.19	0.6	12.6
SW-2	09/18/01	LOCATION DRY	NS	NS	NS	NS	NS	NS
SW-2 QC	03/15/01	42	0.11	<0.005	7	0.04	0.9	37
SW-2 QC	06/07/01	52.9	0.75	<0.005	7.3	0.23	0.6	12.3
<b>Standard / Criteria <sup>(4)</sup></b>								
Groundwater		NC	0.3	0.025	35.0(g)	0.3	NC	20
Surface Water		NC	0.300	(7)	NC	NC	NC	NC

**TABLE 5-11 RESULTS OF KESSELRING SITE WATER MONITORING, HOGBACK ROAD LANDFILL, 2001 (CONTINUED)**

BASELINE PARAMETERS														
Sample Location	Sample Date	INDICATOR			METALS (mg/l) <sup>(6)</sup>						VOLATILES (µg/l)			
		BOD (5 day) (mg/l)	Color (cpu)	TKN (mg/l)	Aluminum	Barium	Boron	Chromium	Copper	Zinc	1,1 Dichloro-ethane	Chloro-ethane	Dichloro-difluoro-methane	Trichloro-ethylene
Groundwater-Unconsolidated														
HB-1A	03/15/01	<2	5	<1	4.4/<0.1	0.04/<0.01	<0.05	0.008/<0.005	<0.05	0.11/0.01	<1	<1	<1	<1
HB-1A	06/07/01	<2	10	2.2	0.5/<0.1	0.01/<0.01	<0.05	<0.005	<0.05	0.02/0.01	<1	<1	<1	<1
HB-1A	09/18/01	<2	10	1.4	0.4	0.02	<0.05	<0.005	<0.05	0.01	<1	<1	<1	<1
LMW-4	03/15/01	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
LMW-4	06/07/01	<2	20	<1	0.4/<0.1	0.12/0.06	<0.05	<0.005	<0.05	0.03/0.02	2	2	7	<1
LMW-4	09/18/01	WELL DRY		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
HB-5A2	03/15/01	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
HB-5A2	06/07/01	<2	10	<1	<0.1	0.13	<0.05	<0.005	<0.05	0.01	2	2	<1	<1
HB-5A2	09/18/01	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
LMW-6	03/15/01	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
LMW-6	06/07/01	<2	5	<1	<0.1	0.05	<0.05	<0.005	<0.05	0.02	<1	<1	1	<1
LMW-6	09/18/01	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
HB-11A	09/18/01	<2	5	5.6	0.4/<0.1	0.11/0.08	0.17/0.17	<0.005	<0.05	0.02/<0.01	<1	<1	3	<1
HB-11A QC	09/18/01	<2	5	2.8	0.9/0.2	0.15/0.08	0.17/0.17	<0.005	<0.05	0.04/0.02	<1	<1	3	<1
Groundwater-Bedrock														
HB-1B	03/15/01	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
HB-1B	06/07/01	7	5	2	<0.1	1.97	0.61	<0.005	<0.05	0.01	<1	<1	<1	<1
HB-1B	09/18/01	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
HB-5B	03/15/01	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
HB-5B	06/07/01	<2	25	1.1	<0.1	0.35	<0.05	<0.005	<0.05	0.04	<1	3	2	<1
HB-5B	09/18/01	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
HB-11B	03/15/01	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
HB-11B	06/07/01	<2	5	<1	<0.1	0.27	0.14	<0.005	<0.05	0.01	<1	<1	<1	<1
HB-11B	09/18/01	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Surface Water														
SW-1	03/15/01	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
SW-1	06/07/01	<2	25	1.4	<0.1	<0.01	<0.05	<0.005	<0.05	0.02	<1	<1	<1	<1
SW-1	09/18/01	LOCATION DRY			NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
SW-2	03/15/01	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
SW-2	06/07/01	<2	20	3.1	<0.1	0.03	<0.05	<0.005	<0.05	<0.01	<1	<1	<1	<1
SW-2	09/18/01	LOCATION DRY			NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
SW-2 QC	03/15/01	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
SW-2 QC	06/07/01	<2	20	1.1	<0.1	0.03	<0.05	<0.005	<0.05	0.01	<1	<1	<1	<1
Standard / Criteria <sup>(4)</sup>														
Groundwater		NC	15	NC	NC	1	1	0.05	0.2	2.0 (g)	5	5	5	5
Surface Water		NC	NC	NC	0.100	NC	10	(7)	(7)	(7)	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 method detection limit.
- (2) Compounds analyzed but not detected in any of the presented sampling rounds are not listed in the table.
- (3) The following field parameters were laboratory analyzed instead of field analyzed due to problems with field instrumentation: 3/15/01 - pH, Eh, and specific conductance, and 6/7/01 - Eh.
- (4) 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.  
  
(g) = Groundwater Guidance Value.
- (5) Surface water samples are collected from a Class D waterway (intermittent stream) with a NYSDEC standard for pH of 6.0 to 9.5 su, and a dissolved oxygen standard of greater than 3.0 mg/l. The pH and dissolved oxygen standards for the Glowegee Creek (Class C waterway) are 6.5 to 8.5 su, and greater than 5.0 mg/l, respectively, and are presented for informational purposes.
- (6) 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 method detection limits, the filtered value is not presented. Filtered sample analysis data is shown following the total result, (i.e. total # / filtered #)
- (7) Standard is determined by formula utilizing dissolved form concentrations:  
 Chromium –  $A(C) (0.86) \exp (0.819 [\ln (\text{ppm hardness})] + 0.6848)$   
 Copper –  $A(C) (0.96) \exp (0.8545 [\ln (\text{ppm hardness})] - 1.702)$   
 Lead –  $A(C) (1.46203 - [\ln (\text{hardness}) (0.145712)]) \exp (1.273 [\ln (\text{hardness})] - 4.297)$   
 Zinc –  $A(C) \exp (0.85 [\ln (\text{ppm hardness})] + 0.50)$

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

µg/l = micrograms / liter

mv = millivolts

µmhos/cm = micromhos / centimeter

ntu = nephelometric turbidity units

cpu = cobalt platinum unit

BOD = Biochemical Oxygen Demand

COD = Chemical Oxygen Demand

TDS = Total Dissolved Solids

TKN = Total Kjeldahl Nitrogen-N

TOC = Total Organic Carbon

A(C) = Aquatic (Chronic Exposure) Standard

**TABLE 5-12 RESULTS OF KESSELRING SITE GROUNDWATER MONITORING,  
DEVELOPED AREA WELLS, 2001**

		Volatile Organic Compound, µg/l						
	Sample	Bromo-		Dibromo-	Dichloro-	1,1-dichloro-	Trichloro-	Tetrachloro-
Well	Date	dichloro-	Chloroform	chloro-	difluoro-	ethane	ethylene	ethylene
		methane		methane	methane			
MW-1 <sup>(1)</sup>	10/17/2001	7	19	1	<1	<1	<1	<1
MW-1 QC <sup>(1)</sup>	10/17/2001	6	17	1	<1	<1	<1	<1
MW-4	10/17/2001	<1	<1	<1	16	<1	4	<1
MW-4 QC	10/17/2001	<1	<1	<1	10	<1	4	<1
MW-6	10/17/2001	<1	<1	<1	<1	<1	<1	1
Standard <sup>(2)</sup>		5	5	5	5	5	5	5
Method Detection Limit		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<sup>(1)</sup> 2001**

Location	Cs-137	Co-60	Tritium
	pCi/liter		pCi/liter x10 <sup>2</sup>
<b><u>LANDFILL AREA</u></b>			
HB-1A	< 1.0	< 0.9	< 3.1
HB-1B	< 1.0	< 0.9	< 3.1
HB-5A2	< 0.9	< 1.0	< 3.1
HB-5B	< 0.9	< 0.9	< 3.1
HB-11A	< 0.9	< 1.0	< 3.1
HB-11B	< 0.9	< 0.9	< 3.1
<b><u>DEVELOPED AREA</u></b>			
MW-1 <sup>(2)</sup>	< 1.0	< 1.0	< 3.0
MW-2	< 1.0	< 1.0	< 2.9
MW-3	< 1.0	< 1.0	< 2.9
MW-4	< 1.0	< 1.0	< 3.0
MW-6	< 0.9	< 1.0	< 2.9
MW-7	< 0.9	< 0.9	< 3.0
MW-8	< 1.0	< 1.0	< 2.9
MW-9	< 1.0	< 1.0	< 3.0
MW-10	< 1.0	< 1.0	< 3.0
MW-11	< 0.9	< 1.0	< 3.0
MW-12	< 0.9	< 1.0	< 3.0
MW-13	< 1.0	< 1.0	< 3.0
MW-14	< 1.0	< 1.0	< 3.1
MW-15	< 0.9	< 1.0	< 3.0
MW-16	< 0.9	< 0.9	< 3.0
MW-17	< 1.0	< 0.9	< 3.0
MW-18	< 1.0	< 1.0	< 3.0
MW-19	< 0.9	< 0.9	< 3.0
MW-20	< 1.0	< 1.0	< 3.0
<b><u>BAPTIST HILL ROAD LANDFILL</u></b>			
KBH-1 <sup>(2)</sup>	< 1.0	< 1.0	< 3.0
KBH-2	< 1.0	< 0.9	< 2.9
KBH-3	< 1.0	< 1.0	< 2.9
KBH-4	< 1.0	< 0.9	< 2.9
KBH-5	Well Damaged, Not Sampled		
<b><u>SILO AREA</u></b>			
KBH-6 <sup>(2)</sup>	< 1.0	< 1.0	< 3.0
KBH-7	< 1.0	< 1.0	< 3.0
KBH-8	Well Dry, Not Sampled		
<b><u>SWAN SCHOOL ROAD CELLAR</u></b>			
KBH-9	< 0.9	< 0.9	< 2.9
KBH-10	< 0.9	< 1.0	< 2.9
T-3	< 1.0	< 1.0	< 3.0
<b><u>PARKIS MILLS ROAD CELLAR</u></b>			
KBH-11 <sup>(2)</sup>	< 1.0	< 1.0	< 2.9
KBH-12	Well Dry, Not Sampled		
KBH-13	< 1.0	< 1.0	< 2.9

Notes: (1) A value preceded by < is less than minimum detection level for that sample and parameter.  
(2) Background well for comparison purposes.

**TABLE 5-14 – CHEMICAL CONSTITUENTS IN KESSELRING SITE DRINKING WATER, 2001**

Parameter/Units <sup>(3)</sup>	Number of Samples	Value <sup>(1) (2)</sup>			Standard <sup>(5)</sup>	Percent of Standard <sup>(6)</sup>
		Minimum	Maximum	Average <sup>(4)</sup>		
Drinking Water Standards (Reference 20)						
Nitrates (mg/l as N)	1	0.21	0.21	0.21	10	2.1
Nitrites (mg/l as N)	1	< 0.02	< 0.02	< 0.02	1	< 2
Total Coliform <sup>(7)</sup>	33	< 1	< 1	< 1	None Detectable	--
Residual Chlorine (mg/l)	426	0.10	3.36	1.71	Detectable	--

Notes:

- (1) A value preceded by < is less than the method detection limit for that sample and parameter.  
(2) A value preceded by > is greater than the maximum detection level for that sample and parameter  
(3) All samples were collected at the entry point to the distribution system unless otherwise noted.  
(4) Average values preceded by < contain at least one less than method detection limit value in the average.  
(5) Maximum Contaminant level per 10 NYCRR Subpart 5.  
(6) Percent of standard for the average value.  
(7) The minimum detectable concentration by the membrane filter method is one colony per 100 ml (N/100 ml).

**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. Monitoring results within the developed area show that some parameters are elevated. These results are attributed to normal operations of the Site, to include systems that contain chlorine compounds, and other past operational practices. The 2001 groundwater data demonstrate no significant changes from historical monitoring results.

**5.6 CONTROL OF CHEMICALLY HAZARDOUS SUBSTANCES AND SOLID WASTE****5.6.1 Chemical Control Program**

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. During 2001, reclamation of silver from photographic and silver nitrate hazardous waste has resulted in a 95% reduction in these waste streams. A complete reduction was not possible for this waste stream during 2001 because a small amount of silver nitrate was cross contaminated with mercury rendering the waste stream non-recyclable. 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 2001 the Kesselring Site shipped approximately 37.7

tons of RCRA and New York State hazardous waste offsite for disposal. This includes 5.4 tons of mixed waste.

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.

Nonhazardous chemical waste is also sent off-site for disposal. The transportation vendors and the treatment/storage/disposal facilities are typically the same as those used for hazardous waste disposal. These facilities also operate under permits issued by the cognizant Federal and State regulatory agencies. KAPL also requires the disposal facility to provide itemized written verification that the waste was actually received. Approximately, 15.5 tons of nonhazardous chemical waste was sent for offsite disposal via incineration, wastewater treatment, chemical treatment and/or land disposal.

#### **5.6.2 Solid Waste Disposal/Recycling**

During 2001, approximately 632 tons of non-hazardous solid waste from construction and demolition debris, and refuse collection by Kesselring Site personnel were disposed of by a subcontractor at permitted off-site facilities. The Kesselring Site recycles such products as glass, plastic, aluminum, newspapers, magazines, scrap metal, corrugated cardboard, office paper, computers, precious metals, lead, oil, fluorescent light bulbs, wood, asphalt, printer cartridges, and batteries. Approximately, 340 tons of materials were recycled.

### **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 2001, approximately 240 cubic meters (314 cubic yards) of routine low level radioactive waste containing 0.96 curies were shipped from the Site for disposal. Additionally, 15.0 cubic meters (19.6 cubic yards) of mixed waste containing 0.1247 curies were 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 2001, approximately 34 tons of slightly radioactive metal were sent to a vendor for recycling for reuse within the DOE Program.

## **5.8 RADIATION DOSE ASSESSMENT**

The effluent and environmental monitoring results show that the radioactivity in liquid and gaseous effluents from 2001 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 2001 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 consists of 10.8 acres of land near Windsor, Connecticut, approximately eight kilometers (five miles) north of the City of Hartford. From 1959 to 1993, the S1C Prototype Nuclear Propulsion Plant tested propulsion plant equipment as part of the research and development of Naval nuclear propulsion plants. It was also used to train Navy personnel in the operation of Naval nuclear propulsion plants. The S1C Prototype reactor plant was permanently shut down in March 1993, reflecting the end of the Cold War and downsizing of the U.S. Naval fleet. All spent nuclear fuel was removed from the S1C Prototype reactor plant and was shipped off-site. After completion of the public National Environmental Policy Act process in 1996, a Record of Decision was issued for prompt dismantlement of the S1C Prototype Site. All of the structures on the Site were removed by the end of 1999. The Site has been graded and returned to green field conditions.

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.

Stormwater runoff from the Site enters the Farmington River by the Combustion Engineering Site Brook. The length of the brook 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.

A State of Connecticut General Permit for the Discharge of Stormwater and Dewatering Wastewaters Associated with Construction Activities, Reference (23), and an Inland Wetlands and Water Course Permit issued by the Town of Windsor, Reference (24), remained in effect during 2001 to support completion of Site restoration (grading, seeding, and the closure of on-site wells) work. Both of these permits are governed by a State of Connecticut Professional Engineer Certified Site Stormwater Pollution Prevention Plan and Stormwater Pollution Control Plan. A notice of termination request for the Reference (23) permit was filed with the Connecticut Department of Environmental Protection in November 2001. The Reference (24) permit is to remain open pending EPA review of the S1C Site Chemical Sampling and Analysis Report.

### **6.2 STORMWATER MONITORING**

The only source of effluent water during 2001 at the S1C Site was stormwater runoff. No monitoring of stormwater runoff was required in 2001.

### **6.3 ENVIRONMENTAL MONITORING**

#### **6.3.1 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 and the Farmington River, fish from the Farmington River, and radiation surveys of the Combustion Engineering Site Brook.

Water and sediment samples were collected from the Combustion Engineering Site Brook in 2001. (See Figure 6-1.) Sediment samples were obtained from 15 locations along the approximately three-quarters of a mile length of the brook. Water samples were taken at five of these locations. Sediment samples were taken from approximately the top two centimeters of sediment. Three additional sediment samples were taken in the mouth of the brook at the Farmington River. Additionally, direct radiation measurements were 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. Sediment samples were collected with a Birge-Ekman dredge that samples a 15 cm x 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.

### **6.3.2 Analyses**

The samples of the water, bottom sediment, and fish are analyzed with a high-purity germanium gamma spectrometer system. This sensitive analysis is intended to fully characterize the low levels of naturally and non-naturally occurring gamma-emitting radionuclides.

### **6.3.3 Assessment**

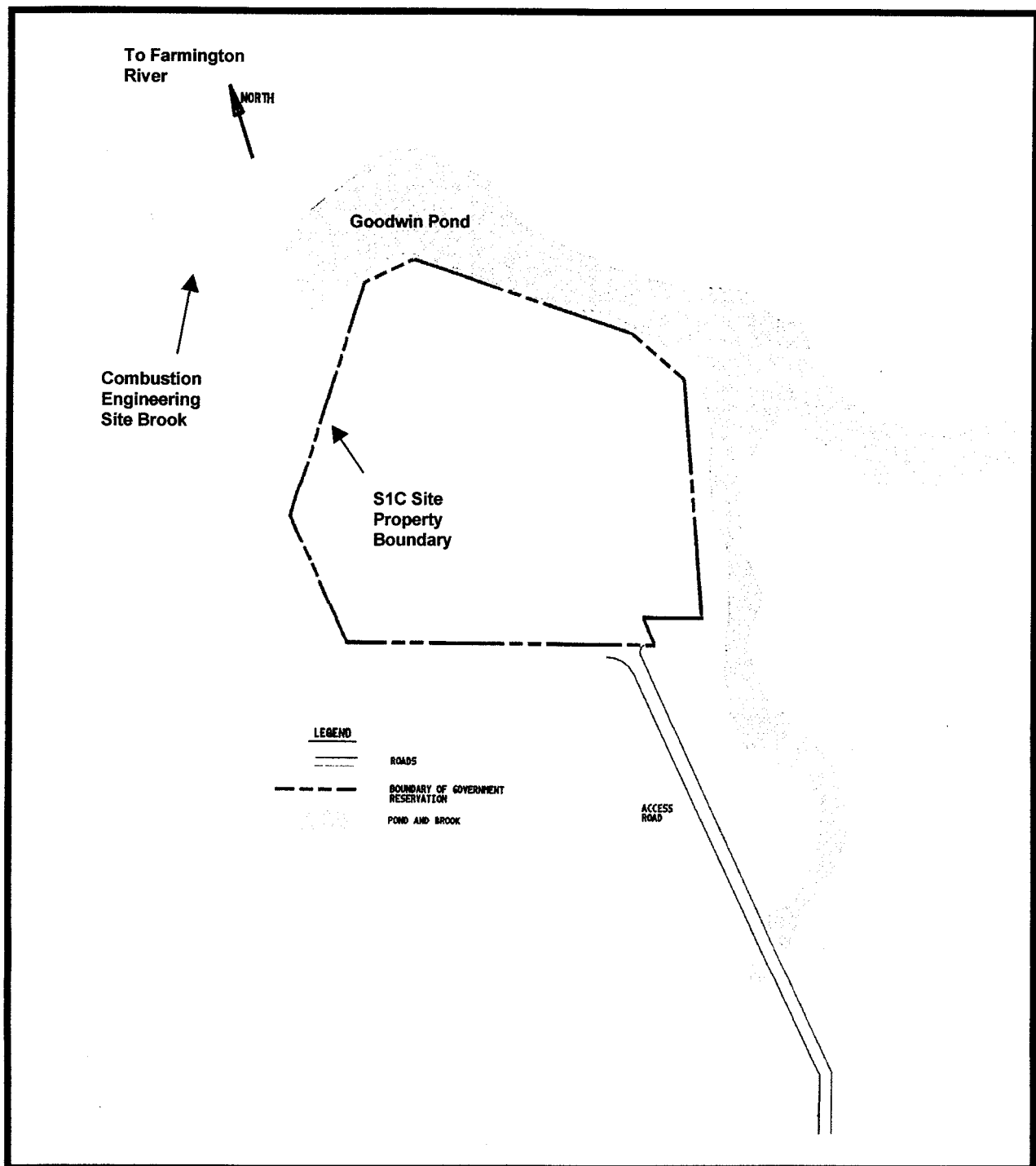
Low levels of cobalt-60 ranging from less than 0.011 to 0.178 picocuries per gram, with an average concentration of less than 0.060 picocuries per gram, were measured in the Combustion Engineering Site Brook sediment during 2001. This level of cobalt-60 radioactivity, which is similar to previously measured levels, is attributable to S1C Site operations conducted prior to 1979. For comparison, natural soil has several picocuries per gram of naturally occurring radionuclides, and the measured levels of cobalt-60 are over a factor of ten less than those required for unrestricted release of a site regulated by the Nuclear Regulatory Commission.

No gamma emitting radionuclides were detected in the water samples collected from the Combustion Engineering Site Brook. The 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. Results of the detailed gamma spectrum analysis performed on the sediment samples indicated no radionuclides attributable to S1C Site operations. 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 detected. No gamma emitting radionuclides were detected in the Farmington River water samples.

In addition, uranium-235 radioactivity was measured in some of the Combustion Engineering Site Brook sediment samples at a maximum concentration of 1.05 picocuries per gram. The uranium-235 radioactivity is not found at the Brook locations closest to the S1C Site outfall and is not a result of past 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 historical S1C Site operations detected in the fish.



**Figure 6-1**  
**S1C Site, Windsor, Connecticut**

**TABLE 6-1 RESULTS OF ANALYSES OF FARMINGTON RIVER SEDIMENT, 2001**

Sample Location	Number of Samples	Radioactivity Concentration (pCi/g, wet wt.) <sup>(1)</sup>		
		Cobalt-60		
		Minimum	Maximum	Average
Upriver from Site Release Location	3	< 0.012	< 0.020	< 0.018
Opposite Site Release Location	3	< 0.019	< 0.025	< 0.022
Downriver from Site Release Location	3	< 0.015	< 0.021	< 0.019

Note:

- (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.

**TABLE 6-2 RESULTS OF ANALYSES OF FARMINGTON RIVER FISH, 2001**

Sample Location	Number of Fish in Sample Analyzed	Radioactivity Concentration <sup>(1)</sup> (pCi/g, wet wt.)		
		K-40	Cs-137	Co-60
Upriver from Site Release Location	4	2.17 ± 0.21	< 0.010	< 0.007
Downriver from Site Release Location	4	2.33 ± 0.22	0.011 ± 0.010	< 0.008

Note:

- (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. The (±) value provides the 95% confidence interval for the average value.

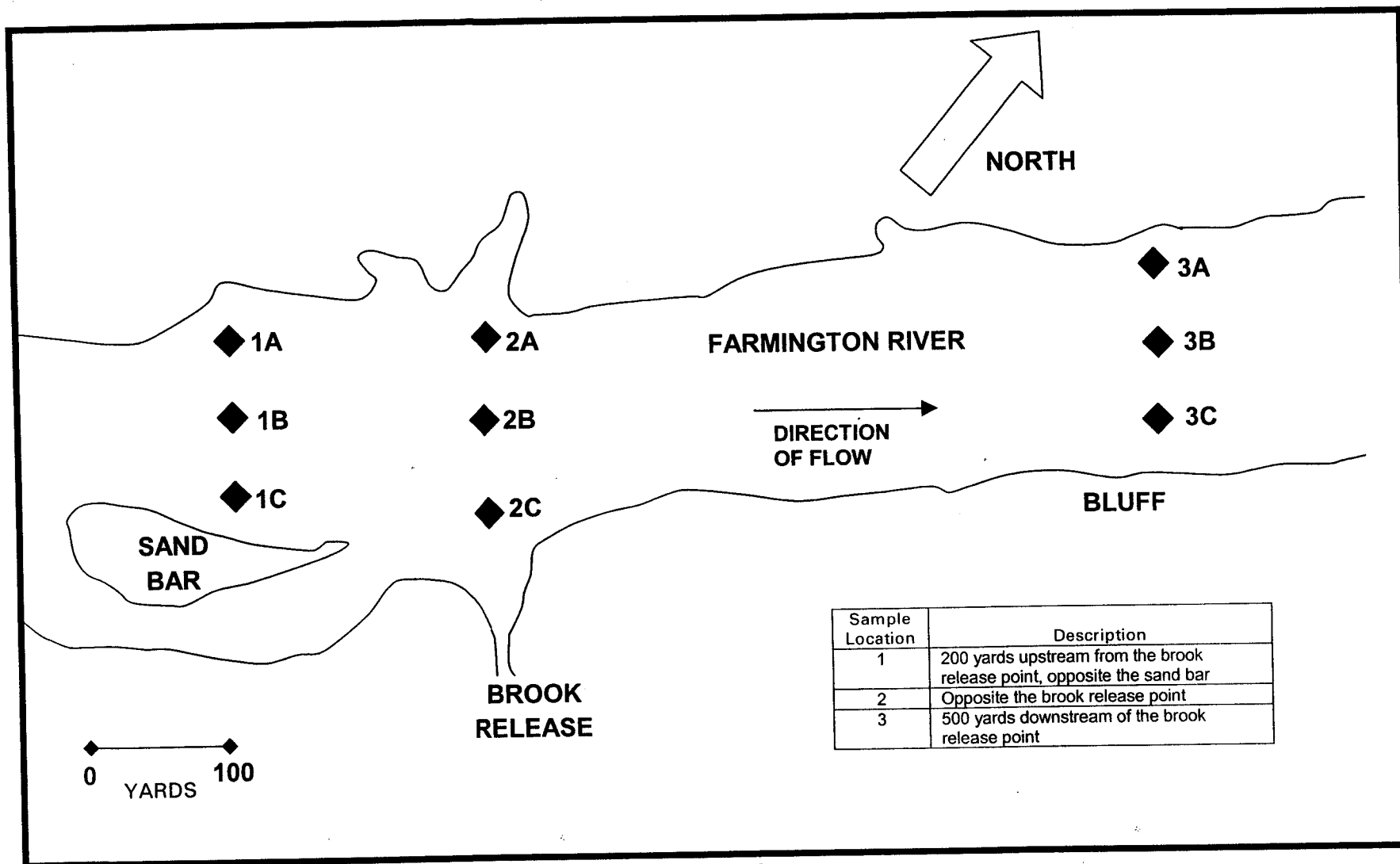


Figure 6-2  
S1C Site, Windsor, Connecticut  
Farmington River Sample Locations

## **6.4 GROUNDWATER MONITORING**

There are no radioactive or chemical waste disposal sites at the S1C Site. The S1C Site groundwater monitoring program was discontinued in 2000. All on-site monitoring wells were decommissioned in accordance with Chapter 482, Section 25-128 of the Regulations of Connecticut State Agencies.

## **6.5 CONTROL OF CHEMICALLY HAZARDOUS SUBSTANCES**

During 2001, a small amount of waste was generated from the decommissioning of on-site observation wells. Approximately 36 pounds of non-RCRA hazardous liquid waste and 140 pounds of PCB bulk product waste were shipped off-site for disposal.

## **6.6 SITE CLOSURE RADIOLOGICAL SURVEYS**

As part of the S1C Site closure process, a detailed radiological survey plan was developed and executed to identify any radioactivity associated with the Site's activities. This plan was reviewed with and agreed to by the Environmental Protection Agency (EPA) - Region I and the State of Connecticut Department of Environmental Protection (CTDEP). The plan established requirements for performing extensive surveys and measurements with sensitive instruments over all areas where radioactive material had been worked on, stored, or transported. Post-dismantlement radiological surveys and measurements were performed in more than 40 discrete areas of the Site. A confirmatory survey of the entire Site was performed after completing the final dismantlement activity and removing all radioactive materials. The results of the independent CTDEP surveys and analyses of solid samples identified no radioactivity associated with S1C Site operations. Based on the survey and sampling results, work involving radioactivity during operations at the S1C has had no adverse effect on the quality of the environment; no further action with regard to radioactivity associated with the S1C Site is required. EPA Region I and CTDEP agreed with this conclusion. Hence, the S1C Site is acceptable for unrestricted future use with respect to radioactivity.

## **6.7 SITE CLOSURE CHEMISTRY REVIEW**

As part of the closure process, the Site completed a detailed chemical sampling and analysis plan. The draft report of these results has been completed and submitted to EPA Region I and CTDEP. The draft report concludes that the former S1C Site should have no adverse impact on the quality of the environment or on future Site users, that no further action is warranted and that the property is acceptable for transfer and unrestricted future use.



## 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 the Knolls Atomic Power Laboratory, Knolls and Kesselring Sites. 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 the Knolls and Kesselring Sites, 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 Figure 7-1 for a map of the 80 kilometer (50 mile) assessment areas surrounding the two 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 (25) and (26) and the Reference (27) liquid pathway model.

Estimates of potential doses via air pathways were calculated using CAP-88PC, the EPA approved computer code package provided in Reference (28). 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 (29). 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 (27). 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 (30).

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.

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, 2001**

KAPL Site	All Pathways		Air Pathways Only		Effective Dose Equivalent From Natural Background Radiation (mrem) <sup>(4)</sup>
	Effective Dose Equivalent Maximum Individual/Average Member (mrem)	Percent Of Standard <sup>(1,2)</sup>	Effective Dose Equivalent Maximum Individual/Average Member (mrem)	Percent of Standard <sup>(3)</sup>	
Knolls Site	< 0.1/< 0.001	< 0.1/< 0.001	< 0.1/< 0.001	< 1.0/< 0.01	72
Kesselring Site	< 0.1/< 0.001	< 0.1/< 0.001	< 0.1/< 0.001	< 1.0/< 0.01	75

Notes:

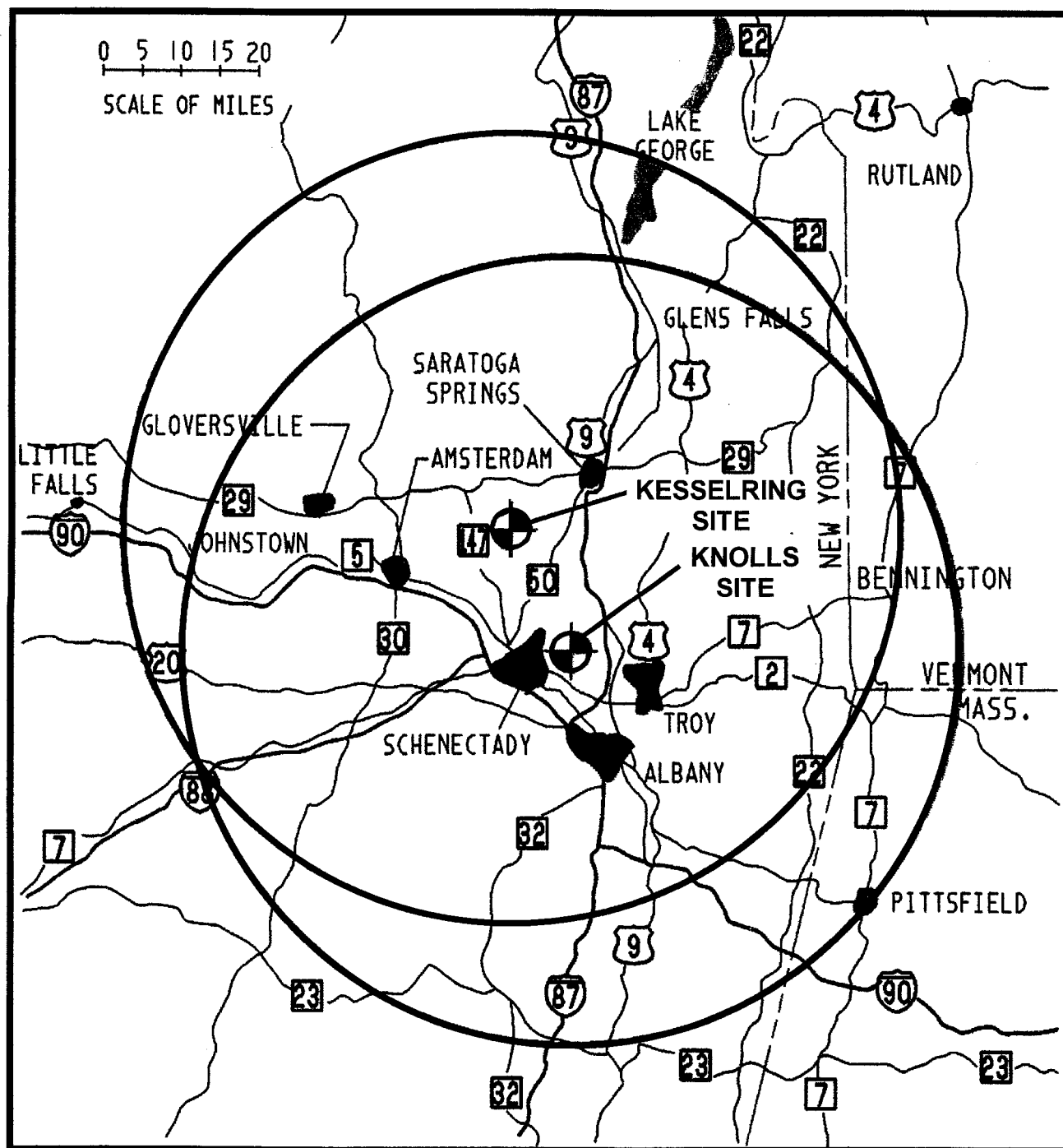
- (1) Based on the DOE radiation protection standard for individuals in off-site areas of 100 mrem/yr effective dose equivalent as given in Reference (4).
- (2) The maximum annual dose to an individual at each site did not exceed 1% of the NRC's guide for demonstrating that radioactive materials in effluents 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 31.

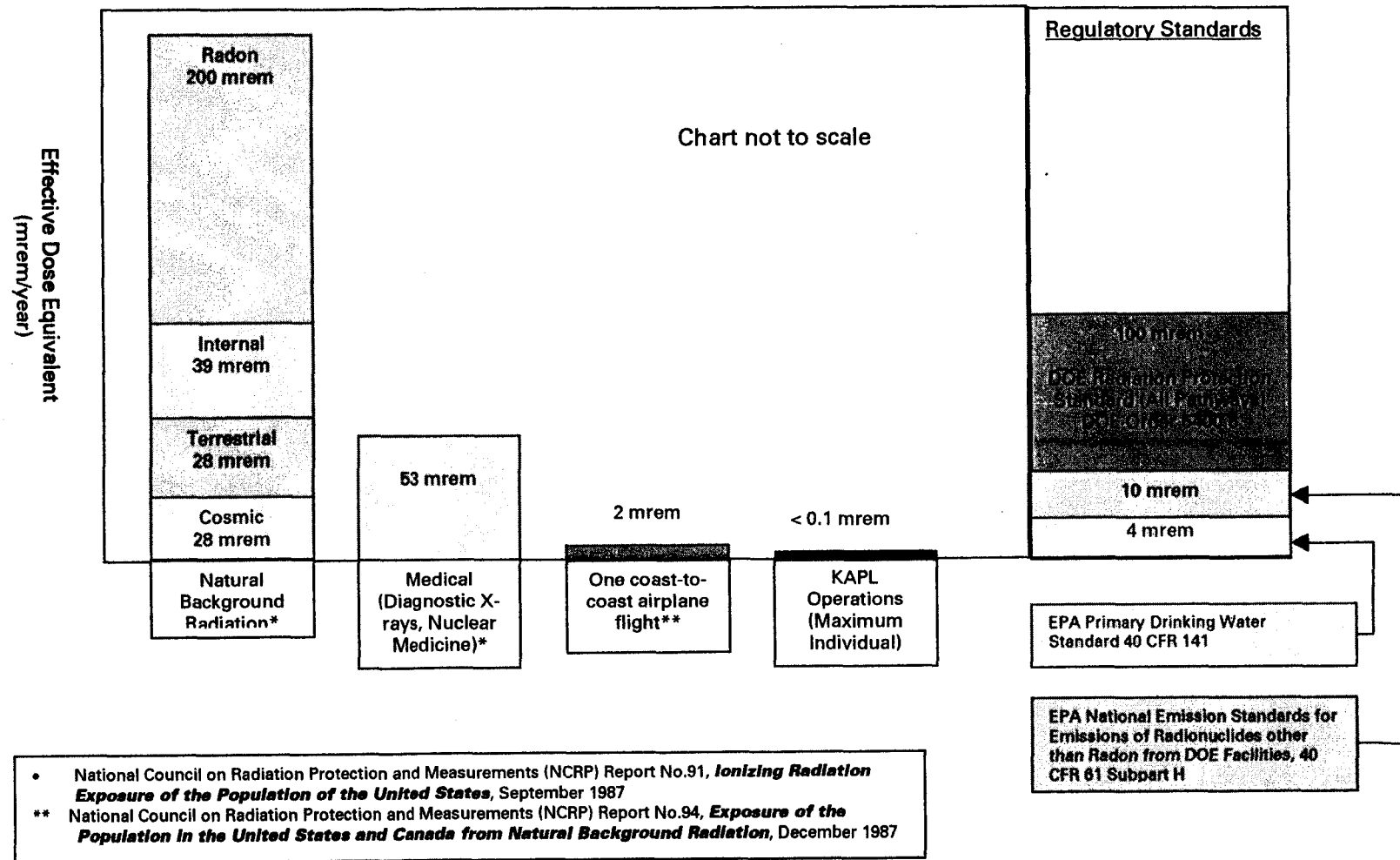
**TABLE 7-2 ESTIMATED ANNUAL COLLECTIVE (POPULATION) DOSES FOR RESIDENTS WITHIN 80 KILOMETERS OF KNOLLS AND KESSELRING SITES, 2001**

KAPL Site	Population <sup>(1)</sup> (Millions)	Effective Dose Equivalent From KAPL Operations (Person-Rem)	Effective Dose Equivalent From Natural Background Radiation <sup>(2)</sup> (Person-Rem)
Knolls Site	1.29	< 0.1	93,000
Kesselring Site	1.15	< 0.1	86,000
		< 0.2	179,000

Notes:

- (1) Total population residing within 80 kilometers (50 miles) of each site based on 1990 census data as reported in Reference (30).
- (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 31.





**Figure 7-2**  
**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 32, 33, and 34, 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 (32) and (34), 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. 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 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, 2001**

Sample Date <sup>(1)</sup>	Sample Type	Analysis	KAPL Result <sup>(2)</sup>	EML Result <sup>(2,3)</sup>	Reported/ EML	Control Limit <sup>(4)</sup>
03/01/01	Soil	Potassium-40	12.4 ± 3.2	12.6	0.98	0.80 - 1.37
		Strontium-90	1.86 ± 0.15	1.86	1.00	0.61 - 3.91
		Cesium-137	48.4 ± 2.8	47.0	1.03	0.80 - 1.29
		Plutonium-239	0.777 ± 0.005	0.692	1.12	0.71 - 1.33
03/01/01	Water	Tritium	2.10 ± 0.47	2.14	0.98	0.74 - 2.29
		Cobalt-60	2.64 ± 0.20	2.65	1.00	0.80 - 1.20
		Strontium-90	0.108 ± 0.017	0.119	0.91	0.64 - 1.50
		Cesium-137	1.99 ± 0.22	1.97	1.01	0.80 - 1.24
		Plutonium-239	0.0495 ± 0.0010	0.0443	1.12	0.75 - 1.26
		Uranium-total	0.077 ± 0.001	0.080	0.96	0.80 - 1.26
		Gross Alpha	50.2 ± 4.0	51.4	0.98	0.58 - 1.26
		Gross Beta	37.1 ± 3.2	35.1	1.06	0.56 - 1.50
03/01/01	Air Filter	Gross Alpha	96.9 ± 4.3	107.2	0.90	0.57 - 1.47
		Gross Beta	77.0 ± 3.2	69.7	1.11	0.76 - 1.52
09/01/01	Soil	Potassium-40	16.2 ± 4.2	16.8	0.96	0.80 - 1.37
		Strontium-90	0.813 ± 0.109	0.827	0.98	0.61 - 3.91
		Cesium-137	16.7 ± 1.0	16.5	1.01	0.80 - 1.29
		Plutonium-239	0.244 ± 0.007	0.242	1.01	0.71 - 1.33
09/01/01	Water	Tritium	6.33 ± 0.58	5.59	1.13	0.74 - 2.29
		Cobalt-60	5.45 ± 0.42	5.65	0.96	0.80 - 1.20
		Strontium-90	0.0997 ± 0.0165	0.101	0.99	0.64 - 1.50
		Cesium-137	1.22 ± 0.14	1.22	1.00	0.80 - 1.24
		Plutonium-239	0.0497 ± 0.0005	0.0440	1.13	0.75 - 1.26
		Uranium-total	0.087 ± 0.001	0.094	0.92	0.80 - 1.26
		Gross Alpha	32.1 ± 3.3	31.1	1.03	0.58 - 1.26
		Gross Beta	194.8 ± 6.7	215.4	0.90	0.56 - 1.50
09/01/01	Air Filter	Gross Alpha	129.3 ± 5.1	144.8	0.89	0.57 - 1.47
		Gross Beta	308.9 ± 6.2	344.8	0.90	0.76 - 1.52

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  $3.7 \times 10^{10}$  (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 ( $\mu\text{Ci}$ ), 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 wristwatch has about one microcurie ( $\mu\text{Ci}$ ) 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 residues 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<sup>2</sup> 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 ( $\pm$ ) assigned to numerical data. A  $2\sigma$  ( $\sigma$ , 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 ( $\pm$ ) interval. The 95% is the confidence level. (See ( $\pm$ ) 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  $3.7 \times 10^{10}$  (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 ( $\mu\text{Ci}$ )** - One millionth of a curie ( $10^{-6}$  curie). The typical radium dial watch might contain  $1\mu\text{Ci}$  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, ( $\pm$ ) 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 ( $\text{CaF}_2$ ) or lithium fluoride ( $\text{LiF}$ ) encased in appropriate materials and strategically located at site perimeter and off-site locations. Thermoluminescent Dosimeters derive their name from a property that  $\text{CaF}_2$  and  $\text{LiF}$  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.



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