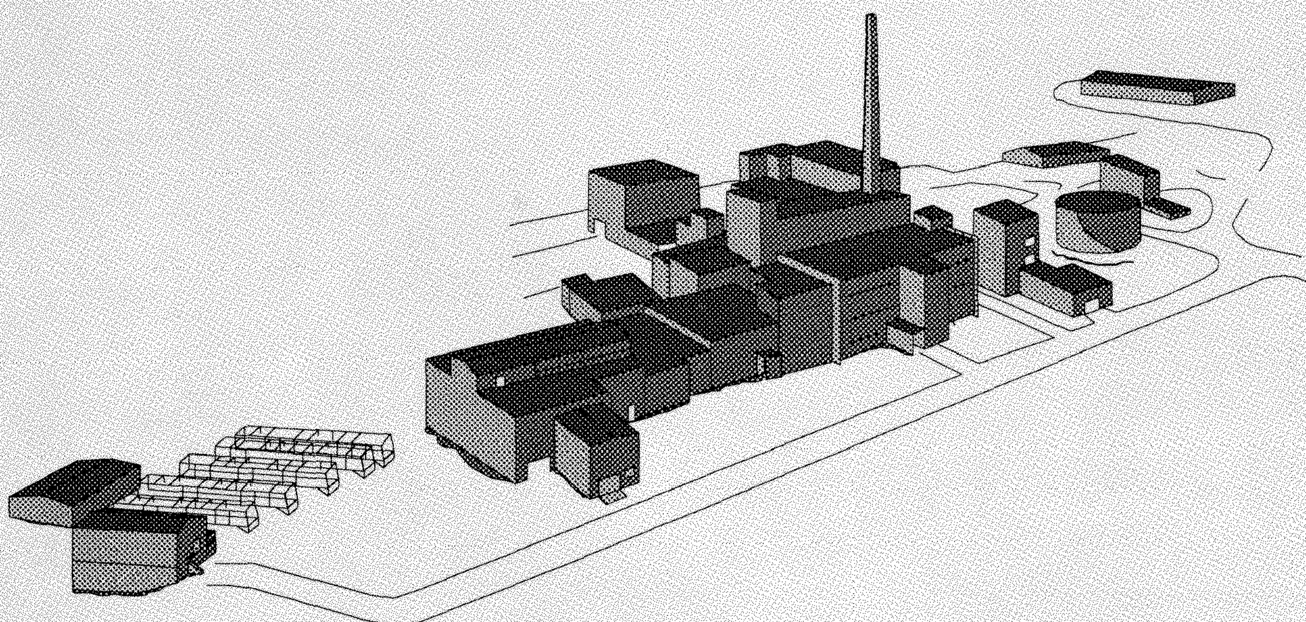
WEST VALLEY DEMONSTRATION PROJECT

SITE ENVIRONMENTAL REPORT

CALENDAR YEAR 1993



West Valley Nuclear Services Company, Inc.

and

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Prepared for:
U.S. Department of Energy
Idaho Operations Office
West Valley Project Office
Under contract DE-AC07-81NE44139

May 1994
Rock Springs Road
West Valley, New York 14171

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Preface

Environmental monitoring at the West Valley Demonstration Project (WVDP) is conducted by the West Valley Nuclear Services Company, Inc. (WVNS), under contract to the U.S. Department of Energy (DOE). The data collected provide an historical record of radionuclide and radiation levels from natural and manmade sources in the survey area. The data also document the quality of the groundwater on and around the site and the quality of the air and water discharged by the WVDP.

This report represents a single, comprehensive source of off-site and on-site environmental monitoring data collected during 1993 by environmental monitoring personnel. The data are found in the appendices following this report. Appendix A is a summary of the site environmental monitoring schedule. Appendix B lists the environmental permits and regulations pertaining to the West Valley Demonstration Project. Appendices C through E contain summaries of data obtained during 1993 and are intended for those interested in more detail than is provided in the main body of the report.

Requests for additional copies of the 1993 Site Environmental Report and questions regarding the report should be referred to the WVDP Community Relations Department, P.O. Box 191, Rock Springs Road, West Valley, New York 14171 (716-942-4610).

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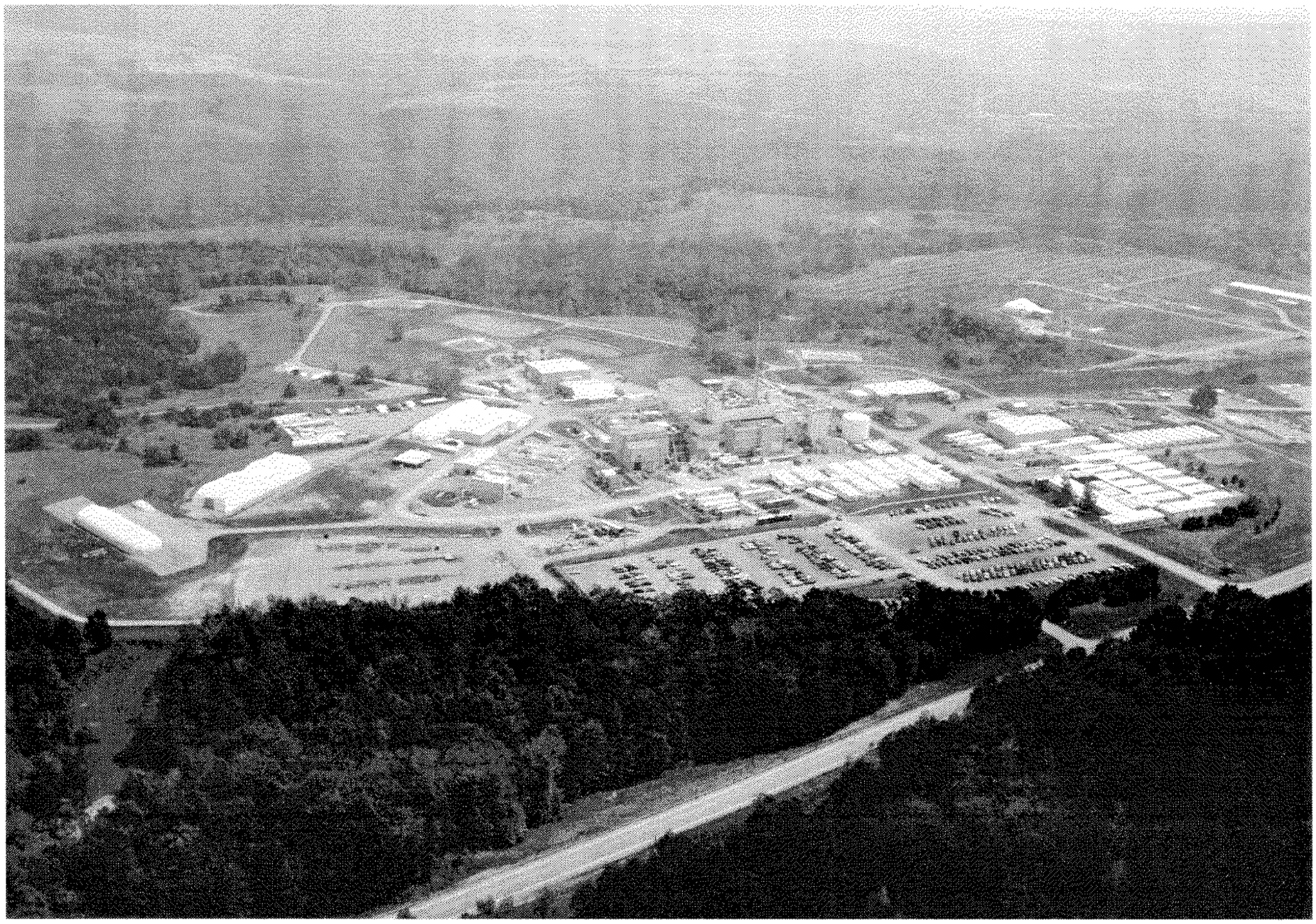

The West Valley Demonstration Project

EXECUTIVE SUMMARY

The West Valley Demonstration Project (WVDP) monitors the environment on and around its facilities to fulfill federal and state requirements. The results of this program show that during the course of activities at the WVDP, public health, safety, and the environment are being protected.

This annual report summarizes the environmental monitoring data collected during 1993. On-site and off-site radiological and nonradiological monitoring in 1993 confirm that site activities, with only one exception, were conducted well within state and federal regulatory limits. (A description of regulatory issues is found in the *Environmental Compliance Summary: Calendar Year 1993*.) The exception, which involved a single pH value at the sanitary and utility wastewater outfall, resulted in no significant effects upon public health or the environment.

The West Valley Demonstration Project is operated under contract to the U.S. Department of Energy by the West Valley Nuclear Services Company, Inc. (WVNS), a subsidiary of Westinghouse Electric Corporation.

The purpose of the West Valley Demonstration Project is to solidify the high-level radioactive waste left at the site from the original nuclear fuel reprocessing activities, develop suitable containers for holding and transporting the solidified waste, arrange transport of the solidified waste to a federal repository, dispose of any Project low-level and transuranic waste resulting from the solidification of high-level waste, and decontaminate and decommission the Project facilities.

The high-level waste was contained in underground storage tanks and had settled into two layers — liquid supernatant and a precipitate sludge. The integrated radwaste treatment system (IRTS), operating through 1990, stripped radioactivity from the liquid supernatant, allowing the major portion of the liquid to be treated as low-level waste. The resulting low-level treated liquid waste was solidified in drums of a special cement mixture and stored on-site in an engineered aboveground vault.

The next step in the process, washing the remaining sludge with water to remove soluble constituents, has continued through 1993. (See *Chapter 1, Environmental Monitoring Program Information*, for a more detailed description.) Approximately 192,600 gallons of water used to wash the sludge were processed, and more than 3,600 drums of cemented low-level waste were produced and stored on-site in 1993. The final step will be vitrification of the remaining high-level waste residues, currently scheduled to start in 1996.

Compliance

The West Valley Demonstration Project operates under Department of Energy (DOE) guidelines for radiation protection of the public and the environment. Limits on radioactivity concentrations and exposures to radiation are specified in DOE Orders. The Project did not exceed or approach any of the limits on radioactivity or radiation doses in 1993, including the emission standards promulgated by the U.S. Environmental Protection Agency (EPA) and incorporated in DOE Orders.

Nonradiological plant effluents are regulated by the New York State Department of Environmental Conservation (NYSDEC) and the EPA. Surface effluent water quality, regulated by NYSDEC, is tested for pH, biochemical oxygen demand, and other chemical constituents under a State Pollutant Discharge Elimination System (SPDES) permit, which identifies discharge water quality limits.

One SPDES permit limit was exceeded in 1993, at outfall 007, after an automatic control valve shut off the flow from the outfall because of an elevated pH in the upstream fluid. About 150 gallons of water above a pH of 9.0, trapped in the valved piping, was released when normal flow was resumed. Appropriate actions were taken to notify NYSDEC in accordance with permit requirements and to modify the piping to prevent a recurrence. This deviation resulted in no significant effect on the environment.

Effects of Project activities upon site groundwaters are regulated by NYSDEC and the EPA. Groundwater sampling and analyses confirm that on-site groundwater quality has been and continues to be affected both radiologically and nonradiologically by past facility operations. Evaluation of well sampling results for 1993 has started to clearly define some of these effects. Although radiological and nonradiological constituents are being detected in localized, on-site groundwaters, these do not affect public health or the off-site environment.

In 1993 the WVDP continued the actions that were required by a RCRA 3008 (h) Administrative Order on Consent agreed to by the EPA, NYSDEC, the DOE, and the New York State Energy Research and Development Authority (NYSERDA) in 1992. This agreement specifies the measures that must be taken to determine information about hazardous wastes or constituents that may have the potential for release to the environment from identified solid waste management units.

The WVDP continued to operate under the 1993 Federal and State Facility Compliance Agreement (FSFCA) that addresses radioactive mixed waste management issues. (See the *Environmental Compliance Summary*.)

Effluent and Environmental Monitoring Program

In 1993 the WVDP environmental monitoring program measured and evaluated radiological and nonradiological site effluents and related on-site and off-site samples. Air and surface water samples were collected to monitor the two major pathways by which radioactive material could migrate off-site.

Testing of animal, soil, and vegetation samples from the area surrounding the Project provided data to calculate the risk of exposure to radioactivity through eating, drinking, or breathing the air. Control (background) samples were also taken to compare with on- or near-site samples.

Air Pathway Monitoring

Airborne particulate radioactivity was sampled continuously at six WNYNSC perimeter locations and four remote locations during 1993. In mid-1993 one perimeter and three remote samplers were added to run in parallel with existing equipment, but in locations with more open space. Comparisons between parallel samplers will show if there are any sampling differences due to nearby trees or buildings. (See *Chapter 2, Environmental Monitoring*.) Sample filters were collected weekly; samples were analyzed weekly for gross alpha and gross beta radioactivity and quarterly for other isotopes. Airborne gross radioactivity around the site boundary was, in all cases, indistinguishable from background concentrations measured at the remote locations.

Direct monitoring of airborne effluents at the main plant stack and other permitted release points showed all discharges to be well below DOE and EPA effluent limitations.

Surface Water Pathway Monitoring

Automatic samplers collected surface water at six locations along site drainage channels. Samples were analyzed for gross alpha, gross beta, and gamma activity, and for tritium and strontium-90. Analyses for carbon-14, iodine-129, uranium and plutonium isotopes, and americium-241 are also program requirements at several collection points.

As a result of past site activities and continuing releases of treated liquids, gross radioactivity concentrations remained slightly higher in Buttermilk Creek below the West Valley Project site than at the upstream background sample point. However, yearly average concentrations in water below the Project site in Cattaraugus Creek during 1993 were indistinguishable from background concentrations measured in Buttermilk Creek upstream of the Project facilities. All Cattaraugus Creek concentrations observed were well below regulatory limits. Concentrations of cesium-137 and other gamma emitters, strontium-90 and other beta emitters, uranium and plutonium isotopes, and tritium were below DOE guidelines at all sampling locations, including Frank's Creek downstream of the Project at the inner site security fence, which is more than 3 miles upstream of Cattaraugus Creek.

The low-level liquid waste treatment facility (LLWTF) contributes most of the activity released from the site in liquid discharges. The 1993 annual average liquid effluent concentrations of radionuclides were below DOE release guidelines at the point of discharge.

Food Pathway Monitoring

Radioactivity that could pass through the food chain was measured by sampling milk, beef, hay, corn, apples, beans, fish, and venison. Marginally detectable differences in strontium-90 between two sets of near-site and background beef or milk samples were found, and potential doses were calculated to be 0.05% of the DOE limit. There also was a detectable difference in hay samples, but these samples were from a location different than the milk or beef samples.

Direct Environmental Radiation Monitoring

Direct environmental radiation was measured continuously during each calendar quarter in 1993 using thermoluminescent dosimeters (TLDs) placed at forty-one locations around the WNYNSC perimeter, along the site access road, at points around the Project site, and at various background locations. No real differences could be found between exposure rates measured at background stations and those at the WNYNSC perimeter locations. TLD measurements also were taken inside the restricted area boundary and reflect low-level radiation from nearby radioactive waste handling and storage facilities.

Nonradiological Monitoring

Nonradiological discharges from the site are regulated by NYSDEC; however, no special monitoring and reporting of nonradiological airborne effluents is required.

Nonradiological liquid discharges to an on-site stream from three permitted release points (outfalls) are monitored as required by the State Pollutant Discharge Elimination System permit. Project effluents are monitored for biochemical oxygen demand, suspended solids, ammonia, iron, pH, oil and grease, and other water quality indicators. Although there was one brief pH excursion in 1993, as noted above, monitoring indicated that nonradiological liquid discharges had no observed effect on the off-site environment.

Groundwater Monitoring

The WVDP is directly underlain by layers of unconsolidated sediments ranging from coarse gravels to fine clays. Permeabilities of these sediments are largely a function of grain sizes, with higher permeabilities reflected in coarser sediments. The targets of groundwater monitoring are those units with relatively higher groundwater velocities that are thus potential pathways for contaminant migration.

The 1993 monitoring well network included both on-site wells for surveillance of solid waste management units and off-site wells to monitor drinking water. The 1993 on-site groundwater monitoring network included 108 groundwater monitoring locations. (See Fig. 3-3 in *Chapter 3, Groundwater Monitoring*.)

The wells provided upgradient and downgradient monitoring of the low-level liquid waste treatment facility (LLWTF) lagoons, the high-level waste tank complex, the Nuclear Regulatory Commission (NRC)-licensed disposal area (NDA), and other solid waste management units. Wells in the groundwater monitoring network were each sampled six times during 1993. The range of analyses performed was determined by technical regulatory guidelines and site-specific characterization needs.

Monitoring well data is grouped by hydrogeologic unit. Data from groundwater monitoring of the sand and gravel unit around the LLWTF lagoons indicate that radionuclides from past plant operations have affected groundwater quality. Compared to background, both tritium and gross beta concentrations in groundwater surrounding the lagoon system are elevated; however, the level of tritium contamination has declined steadily since 1982, as indicated by measurements at the french drain outfall WNSP008. Gross beta activity, which previously had increased, leveled off or declined in 1993 at the sand and gravel LLWTF monitoring points WNSP008 and WNW8605. Gross beta activity continued to increase in sand and gravel monitoring wells WNW8604 and WNW0104 in 1993. Gross beta activity at well WNW0111 continued to be elevated in 1993.

Monitoring data from around the high-level waste tanks do not suggest any effect of the stored high-level radioactive waste on the groundwater. However, significant radiological differences between upgradient and downgradient wells do indicate that previous site activities have affected groundwater in this area. Most notable are elevated levels of gross beta in sand and gravel wells WNW0408, WNW0501, and WNW0502, which are downgradient of the main process plant facilities.

One of the streams originating in a swampy area on the Project premises was found in late 1993 to have increasing gross beta radioactivity. Upon investigation, a small groundwater seep was discovered that appeared to be a major contributor of strontium-90 to this drainage path. A plan is being developed to characterize the source of this seep, its effect on surface water quality, and to provide mitigative action, if necessary.

Other measured parameters such as pH and conductivity have shown significant differences between upgradient and downgradient hydrogeologic unit locations. Downgradient sand and gravel well WNW0103 continued to demonstrate high sodium and hydroxide ion levels in 1993 samples. This well is located in the vicinity of a spill of sodium hydroxide solution that occurred because of a transfer pipe failure in 1984. Downgradient till-sand well WNW0202 also shows an elevated pH. This higher pH is of unknown origin.

Tributyl phosphate was detected in well WNW8605 in 1993. Radioactive contaminants have historically been present in this well. The detection of tributyl phosphate probably indicates migration of contaminants related to wastes generated by the NFS solvent extraction process.

Detectable concentrations of 1,1-dichloroethane at well WNW8612 continued to be found in 1993. Marginal detections of 1,1,1-trichloroethane at WNGSEEP and 1,1-dichloroethane at WNW8609 continued into 1993, maintaining downward trends observed at both locations since 1992. Difluoromethane was detected at wells WNW8612 and WNW0803 during the latter half of 1992 and in diminishing concentrations during 1993.

Groundwater monitoring around the NDA indicates no discernible effects on the deeper unweathered Lavery till deposits in the area, as indicated primarily by measurements for tritium. However, one shallow well (well WNW1107A in the weathered Lavery till) in the vicinity of the New York State-licensed disposal area (SDA), for which NYSERDA is responsible, has shown elevated tritium levels. Other SDA and NDA wells in the shallow hydrogeologic units have shown detectable tritium. Elevated tritium has not been observed in the monitoring wells in the deeper Kent recessional sequence.

Ongoing environmental characterization and facility investigations are being used to assess the groundwater in greater detail.

A control and remediation effort within the NDA included installation in 1990 of a gravel-backfilled interceptor trench downgradient of known tributyl phosphate- and n-dodecane-contaminated soils. As in previous years, no solvent was found in the water collected from this interceptor trench in 1993.

In addition to the on-site monitoring, the potential effect of Project activities on off-site groundwater is monitored by annual sampling of designated private drinking water wells. Monitoring of these wells continues to demonstrate that the site has had no effect on residential drinking water supplies in the vicinity.

Radiological Dose Assessment

Potential radiation doses to the public from airborne and liquid effluent releases of radioactivity from the site during 1993 were estimated using computer models.

The EPA-approved computer program CAP88-PC was used to calculate potential radiation doses from airborne effluents. A conservative total release value for each effluent point was used to prepare the annual National Emission Standards for Hazardous Air Pollutants (NESHAP) emission report to the EPA. Using these values, the highest annual effective dose equivalent (EDE) to a nearby resident was estimated to be 2.0E-04 mrem, which is 0.002% of the 10 mrem EPA standard. The collective dose to all persons within an 80-kilometer (50-mi) radius was estimated to be 2.7E-03 person-rem effective dose equivalent. A more realistic calculation of effluent release values was used in this site environmental report (*Chapter 4, Radiological Dose Assessment*), resulting in a maximum EDE of

1.6E-04 mrem to a nearby resident and a collective dose of 1.9E-03 person-rem to the population from the permitted stacks.

The highest individual calculated EDE for liquid effluents was 3.3E-02 mrem (3.3E-04 mSv), with an annual EDE to the population within 80 kilometers (50 mi) estimated to be 6.8E-02 person-rem (6.8E-04 person-Sv).

The total calculated dose estimates from 1993 Project effluents result in a maximum EDE to an individual of 3.3E-02 mrem (3.3E-04 mSv), which is 0.03% of the 100 mrem DOE limit. Overall, the annual EDE from air and liquid discharges to people within an 80-kilometer (50-mi) radius of the site was calculated to be 7.0E-02 person-rem (7.0E-04 person-Sv).

Concentrations of radionuclides in locally produced foods are at marginally detectable levels above or are statistically indistinguishable from background concentrations.

The potential calculated doses presented above should be considered in relation to an average dose of 300 mrem per year to a U.S. resident from natural background radiation. The dose assessment described in *Chapter 4, Radiological Dose Assessment*, predicts an insignificant effect on the public's health as a result of radiological releases from the WVDP.

Quality Assurance

The environmental monitoring quality assurance (QA) program includes provisions for evaluating and controlling data generated from both on-site and off-site measurements. Both on-site and off-site laboratories and their internal quality assurance programs are routinely reviewed by site personnel. In addition, commercial laboratories must satisfactorily perform blind analyses of standard or duplicate samples submitted by the WVDP Environmental Laboratory.

WVDP monitoring activities are subject to quality control checks from the time of sample collection through sample analysis and data reduction. Each analytical test of the samples analyzed in the on-site environmental laboratory is reviewed in detail. Specific quality checks include external review of sampling procedures, accurate calibrations using primary standard materials, participation in formal laboratory crosscheck programs (for example, with the EPA and the DOE), and appraisals by independent organizations that include the New York State Department of Health (NYSDOH), the U.S. Nuclear Regulatory Commission (NRC), the DOE, and Westinghouse Electric Corporation.

Environmental sample sharing and co-location of measurement points with NYSDOH and the NRC continued in 1993, ensuring that selected samples and locations were routinely measured by two or more independent organizations.

Participation in crosscheck programs, coupled with other internal quality control procedures and external laboratory checks, verified the quality of data gathered in 1993. General program adequacy and specific issues of quality assurance were audited by the WVNS quality assurance department in 1993. Quarterly self-assessments, conducted by an independent team of environmental monitoring staff, identified areas needing improvement and tracked the actions taken. (See *Chapter 5, Quality Assurance*.)

The major auditing activities in 1993 were a visit by a NYSDEC groundwater evaluation team in June and an NRC review team in November. Overall, the environmental monitoring program was found to be of high quality. (See the *Environmental Compliance Summary: Calendar Year 1993* for a more complete discussion.)

INTRODUCTION

History of the West Valley Demonstration Project

In the early 1950s interest in promoting peaceful uses of atomic energy led to the passage of an amendment to the Atomic Energy Act that allowed the Atomic Energy Commission to encourage commercialization of nuclear fuel reprocessing as a way of developing a civilian nuclear industry. The Atomic Energy Commission made its technology available to private industry and invited proposals for the design, construction, and operation of reprocessing plants.

In 1961 the New York Office of Atomic Development acquired 1,335 hectares (3,330 acres) near West Valley, New York and established the Western New York Nuclear Service Center (WNYNSC). Davison Chemical Co. together with the New York State Atomic Research and Development Authority, which later became the New York State Energy Research and Development Authority (NYSERDA), undertook construction and operation of a nuclear fuel reprocessing plant under a co-license issued by the Atomic Energy Commission. Nuclear Fuel Services, Inc. (NFS) was formed by Davison Chemical Co. to operate the plant as a commercial facility. NFS leased the property at the Western New York Nuclear Service Center and in 1966 began operations to recycle fuel from both commercial and federally owned reactors.

In 1972, while the plant was closed for modifications and expansion, federal and state safety regulations, which were more rigorous than those previously in existence, were imposed. Most of the changes concerned the disposal of high-level radioactive liquid waste and the prevention of earthquake damage to the facilities. NFS decided that compliance with the new regulations was not economically feasible, and in 1976 NFS notified NYSERDA that it would not continue in the fuel reprocessing business.

Following this decision, the reprocessing plant was shut down. Under the original agreement between NFS and New York State, the state was ultimately responsible for both the radioactive wastes and the facility. Numerous studies followed the closing, leading eventually to the passage of Public Law 96-368, the West Valley Demonstration Project Act, which authorized the Department of Energy to demonstrate a method for solidifying the 2.5 million liters (660,000 gal) of liquid high-level waste that remained at the West Valley site. Congress anticipated that the technologies developed at West Valley would be used at other facilities throughout the United States.

West Valley Nuclear Services Co., Inc. (WVNS), a subsidiary of Westinghouse Electric Corporation, was chosen by the Department of Energy to be the management and operations contractor for the West Valley Demonstration Project. The WVDP Act specifically states that the facilities and waste on-site shall be made available (by the state of New York) without the transfer of title and for such a period as may be required for the completion of the Project.

The purpose of the West Valley Demonstration Project (WVDP) is to solidify the high-level radioactive waste left at the site from the original nuclear fuel reprocessing activities, develop suitable containers for holding and transporting the solidified waste, arrange transportation of the solidified waste to a federal repository, dispose of any Project low-level and transuranic waste resulting from the solidification of high-level waste, and decontaminate and decommission the Project facilities.

The high-level waste was contained in underground storage tanks and had settled into two layers, a liquid supernatant and a precipitate sludge. WVNS, as prime contractor to the DOE, secured environmental approval and constructed various subsystems that made possible the successful start-up in May 1988 of the integrated radwaste treatment system (IRTS). The system stripped radioactivity from the liquid supernatant, allowing the major portion of the liquid to be treated as low-level waste. Treatment of the supernatant liquid from the high-level waste tanks through the IRTS was completed in 1990.

The next step in the process, washing the remaining sludge with water to remove soluble constituents, began in late 1991 and has continued through 1993. (See *Chapter 1, Environmental Monitoring Program Information* for a more detailed description.) The final step will be vitrification of the remaining high-level waste residues.

This annual environmental monitoring report is published to inform the public about environmental monitoring conditions at the WVDP. The report presents a summary of the environmental monitoring data gathered during the year in order to characterize the performance of the WVDP's environmental management, confirm compliance with standards and regulations, and highlight significant programs.

The geography, economy, climate, ecology, and geology of the region are principal factors in assessing possible effects of site activities on the surrounding population and environment and are an integral consideration in the design and structure of the environmental monitoring program.

Location

The West Valley Demonstration Project site is located about 50 kilometers (30 mi) south of Buffalo, New York (Fig. 1-1). The WVDP site facilities occupy a fenced area of about 80 hectares (200 acres) within the 1,335-hectare (3,330-acre) Western New York Nuclear Service Center. This security-fenced area is referred to as the Project premises, or the restricted area.

The WVDP is located on New York State's Allegheny plateau at an average elevation of 400 meters (1,300 ft). The communities of West Valley, Riceville, Ashford Hollow, and the village of Springville are located within 8 kilometers (5 mi) of the plant. Several roads and a railway pass through the WNYNSC, but the public does not have access to the WNYNSC. Hunting, fishing, and human habitation on the WNYNSC are prohibited.

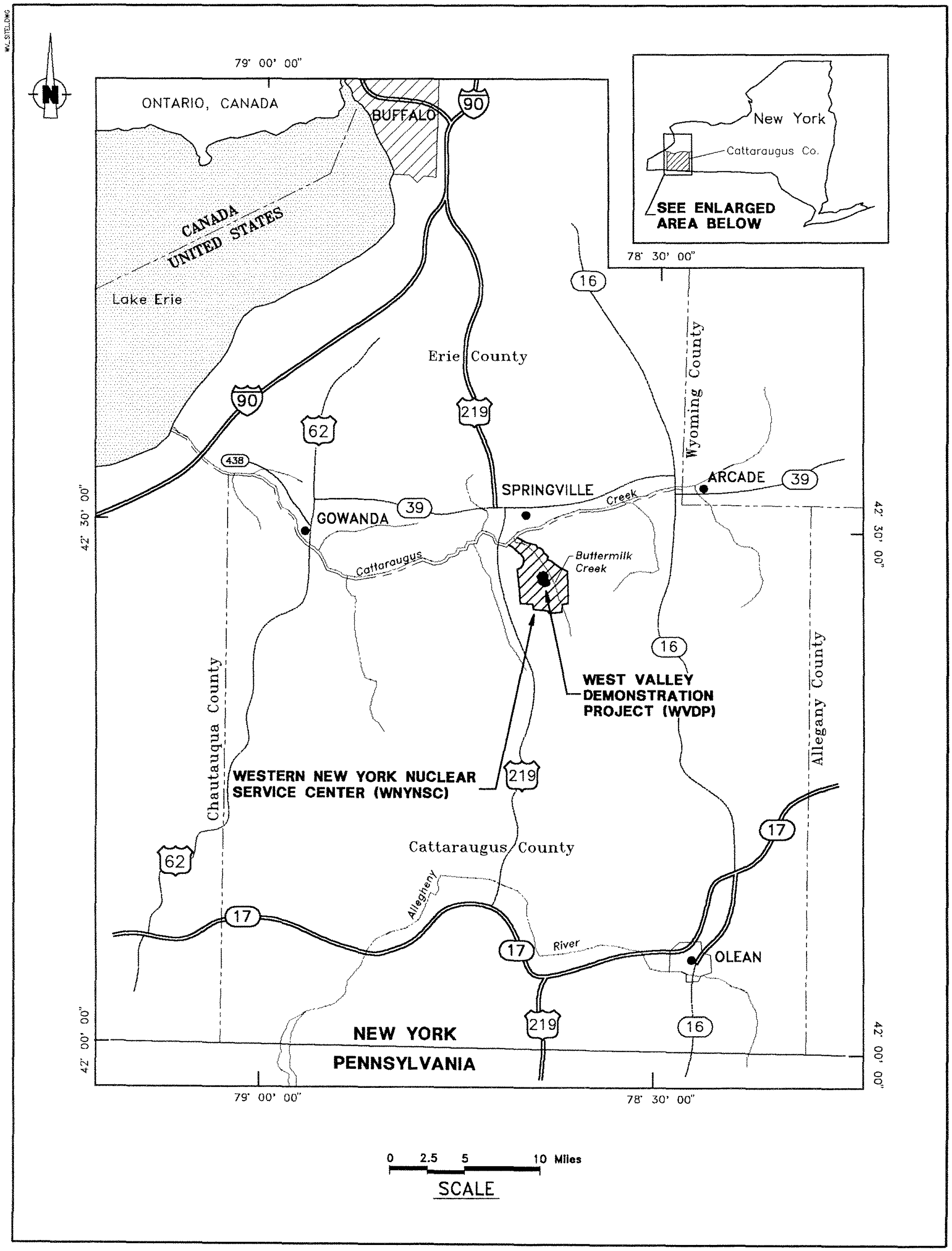

Figure 1-1. Location of the Western New York Nuclear Service Center.

Socioeconomics

The WNYNSC lies within the town of Ashford in Cattaraugus County. The nearby population, approximately 9,200 residents within 10 kilometers (6.2 mi) of the Project, relies primarily on an agricultural economy. No major industries are located within this area.

The land immediately adjacent to the WNYNSC is used primarily for agriculture and arboriculture. Cattaraugus Creek is used locally for swimming, canoeing, and fishing. Although some water to irrigate nearby golf course greens and tree farms is taken from Cattaraugus Creek, no public water supply is drawn from the creek downstream of the WNYNSC before the creek flows into Lake Erie near Buffalo, New York. Waters from Lake Erie are used as a public water supply.

Climate

Although there are recorded extremes of 37°C (98.6°F) and - 42°C (- 43.6°F) in Western New York, the climate is moderate, with an average annual temperature of 7.2°C (45.0°F). Rainfall is relatively high, averaging about 104 centimeters (41 in) per year. The 94.9 centimeters (37.35 in) of precipitation in 1993 was less than usual. Precipitation is evenly distributed throughout the year and is markedly influenced by Lake Erie to the west and, to a lesser extent, by Lake Ontario to the north. Regional winds are generally from the west and south at about 4 m/sec (9 mph).

Biology

The WNYNSC lies within the northern deciduous forest biome, and the diversity of its vegetation is typical of the region. Equally divided between forest and open land, the site provides a habitat especially attractive to white-tailed deer and various indigenous birds, reptiles, and small mammals. No species on the federal endangered list are known to be present on the WNYNSC.

Geology and Groundwater Hydrology

The WVDP site is located on the west shoulder of a steep-sided glacially scoured bedrock valley that is filled with a thick sequence of glacial sediments. (See Figs. 3-1 and 3-2 in *Chapter 3, Groundwater Monitoring*.) The WVDP site is bordered by two stream valleys (Frank's Creek and Quarry Creek) and divided by a third stream valley (Erdman Brook) into two portions, the north and south plateaus. (See Fig. 3-3 in *Chapter 3, Groundwater Monitoring*.)

The uppermost layer of glacial sediments on the south plateau consists of a silty clay till, the Lavery till. The Lavery till does not transmit significant quantities of water except where it is exposed at ground surface, where weathering has created an extensive fracture system. Groundwater flow in the weathered till has both a vertically downward component and a horizontal component to the northeast. Groundwater flow in the unweathered portion of the till, beneath the exposed weathered till, is predominantly vertically downward.

On the north plateau a relatively permeable alluvial sand and gravel layer overlies the glacial sequence of sediments (i.e., the Lavery till, the Kent recessional sequence, and the Kent till). This silty sand and gravel unit is composed of a glacial deposit overlain by post-glacial alluvial deposits. This composite of glacial and post-glacial deposits reaches a thickness of 41 feet in the center of the north plateau, then thins and pinches out along the north plateau's western edge. Groundwater flow in the sand and gravel unit of the north plateau is predominantly horizontal, towards the northeast, recharging from precipitation and fractured bedrock sources and discharging to seeps and streams along the plateau's edge and to evapotranspiration.

Within the Lavery till on the north plateau is a silty, sandy unit of limited areal extent, the Lavery till-sand. Located primarily beneath the center of the north plateau, it ranges in thickness from less than 1 foot to 9 feet. However, the flow of groundwater within the till-sand appears to be very limited. Surface discharge points have not been observed, but gradients indicate flow to the southeast.

Acronyms

Acronyms often are used in technical reports to speed up the reading process. Although using acronyms can be a practical way of referring to agencies or systems with long, unwieldy names, having to look up rarely used acronyms can defeat the purpose of using them. Accordingly, full names of agencies and systems have been used in this report where it will help the reader. However, common acronyms that the reader is apt to be familiar with (e.g., DOE, EPA, NRC, NYSDEC) or that are used often in this report (e.g., WVDP, WNYNSC) are spelled out only at the beginning of sections. A list of acronyms may be found at the end of this report.

The Kent recessional sequence that underlies the Lavery till beneath both north and south plateaus is composed of silt and silty sand with small pockets of gravel. Under the eastern portions of the WVDP site the Kent recessional sequence ranges in thickness up to 75 feet and narrows along the southwest edge where the sediments meet the shoulder of the bedrock valley. Groundwater flow in the Kent recessional sequence is also towards the northeast, recharging from bedrock and from the overlying Lavery till and discharging ultimately to Buttermilk Creek.

Within the Lavery till on the both the north and south plateaus are other localized permeable units capable of letting groundwater flow through. The uppermost few feet of shale bedrock has also demonstrated the ability to let significant quantities of groundwater flow through via fractures.

Information in this Report

Individual chapters in this report include information on compliance with regulations, general information about the monitoring program and significant activities in 1993, summaries of the results of radiological and nonradiological monitoring, and calculations of radiation doses to the population within 80 kilometers of the site. Where appropriate, graphs and tables are included to illustrate important trends and concepts. The bulk of the supporting data is furnished separately in the appendices following the text.

Appendix A summarizes the 1993 environmental monitoring program at both on-site and off-site locations. Samples are designated by a coded abbreviation indicating sample type and location. (A complete listing of the codes is found in the index to *Appendix A*.) *Appendix A* lists the kinds of samples taken, the frequency of collection, the parameters analyzed, the location of the sample points, and a brief rationale for the monitoring activities conducted at each location.

Appendix B provides a list of those radiation protection standards most relevant to the operation of the WVDP as set by the Department of Energy. It also lists federal and state regulations that affect the WVDP and environmental permits held by the site.

Appendix C summarizes analytical data from air, water, sediment, soils, and biological samples (meat, milk, food crops, and fish) as well as direct radiation measurements and meteorological monitoring.

Appendix D provides data from the comparison of results from analysis of identically prepared samples (crosscheck analyses) by both the WVDP and independent laboratories. Radiological concentrations in crosscheck samples of air, water, soil, milk, and vegetation are reported here, as are chemical concentrations from water crosscheck samples. *Appendix D* also lists the comparisons of direct radiation measurements from thermoluminescent dosimeters (TLDs) monitored by the WVDP and measurements from dosimeters placed in the same locations by the Nuclear Regulatory Commission (NRC).

Appendix E summarizes the data collected from on-site groundwater monitoring. Tables and graphs report concentrations at various locations for parameters such as gross alpha and gross beta, tritium, gamma-emitting isotopes, organic compounds, and dissolved metals.

Environmental Monitoring Program

The environmental monitoring program for the West Valley Demonstration Project began in February 1982. The primary program goal is to detect changes in the environment resulting from Project activities and to assess the effect of any such changes on the human population and the environment surrounding the site.

The monitoring network and sample collection schedule have been structured to accommodate specific biological and physical characteristics of the area. Among the several factors considered in designing the environmental monitoring program were the kinds of wastes and other byproducts resulting from the processing of high-level waste; possible routes that radiological and nonradiological contaminants could follow into the environment; geologic, hydrologic, and meteorologic site conditions; quality assurance standards for monitoring and sampling procedures and analyses; and the limits and standards set by federal and state governments and agencies. As new processes and systems become part of the program, additional monitoring is provided.

Monitoring and Sampling

The environmental monitoring program consists of on-site effluent monitoring and on-site and off-site environmental surveillance in which samples are measured for both radiological and

Permits and Regulations

Data gathering, analysis, and reporting to meet stringent federal and state requirements and standards are an integral part of the monitoring program. The current program meets the requirements of DOE Orders 5400.1 and 5400.5 and DOE Regulatory Guide DOE/EH-0173T.

The West Valley Demonstration Project also possesses a State Pollutant Discharge Elimination System (SPDES) permit as required by the New York State Department of Environmental Conservation (NYSDEC), which regulates liquid effluent discharges containing nonradiological pollutants. The SPDES permit identifies the outfalls where liquid effluents are released to site drainage and specifies the sampling and analytical requirements for each outfall.

In addition, the site operates under state-issued air discharge permits for nonradiological plant effluents. Radiological air discharges must also comply with the National Emissions Standards for Hazardous Air Pollutants (NESHAP).

For more information see the ENVIRONMENTAL COMPLIANCE SUMMARY: CALENDAR YEAR 1993. *Environmental permits are listed in* APPENDIX B.

nonradiological constituents. (See the *Glossary* for more detailed definitions of effluent monitoring and environmental surveillance.) Monitoring and surveillance include both the continuous recording of data and the collecting of soil, sediment, water, air, and other samples at specific times.

Monitoring and sampling of environmental media provide two ways of assessing the effects of on-site radioactive waste processing. Monitoring generally is a continuous process of measurement that allows rapid detection of any potential effects on the environment from site activities. Sampling is the collection of media at scheduled times; sampling is slower than direct monitoring in indicating results because the samples collected must be analyzed in a laboratory to obtain data, but it allows much smaller quantities of radioactivity to be detected through the analysis.

Exposure Pathways Monitored at the West Valley Demonstration Project

The major near-term pathways for potential movement of possible contaminants away from the site are by surface water drainage and airborne transport. For this reason the environmental monitoring program emphasizes the collection of air and surface water samples. Samples are collected on-site from locations such as plant ventilation stacks as well as various water effluent points and surface water drainage locations. Samples of air, water, soils, and biota from the environment surrounding the site would indicate any radioactivity that might reach the public from site releases. Extensive groundwater monitoring addresses many long-term pathway concerns.

Water and Sediment Pathways

Process waters are collected in a series of on-site lagoons for treatment before being discharged. This effluent and the effluent at three other discharge points is collected regularly or, in the case of lagoon 3, when the lagoon water is released. The samples are analyzed for both radiological and nonradiological parameters, including gross alpha and gross beta, tritium, strontium-90, gamma isotopes, and pH and conductivity. Additional analyses of composite samples determine metals content, solids, biochemical oxygen demand, nitrates, nitrites, ammonia, sulfate, organic chemicals, and specific isotopic radioactivity.

On-site groundwater and surface water samples are collected regularly and analyzed, at a minimum, for gross alpha and beta radioactivity, tritium, and pH. Selected samples are analyzed for conductivity, chlorides, metals, volatile organic compounds, and other parameters. Potable water on the site is analyzed monthly for radioactivity and annually for chemical constituents. Residential drinking water wells located near the site are sampled annually and analyzed for gross alpha and gross beta radioactivity, tritium, gamma isotopes, pH, and conductivity.

Off-site surface waters, primarily from Cattaraugus Creek and Buttermilk Creek, are sampled both upstream of the Project for background radioactivity and downstream to measure possible Project contributions. Sediments deposited downstream of the facility and at upstream background locations are collected semiannually and analyzed for gross alpha, gross beta, and specific radionuclides. (See *Appendix C-1* for water and sediment data summaries.)

Groundwater Pathways

Groundwater discharge at the WVDP site occurs as springs, seeps along stream channels, direct discharge to streams, evapotranspiration, vertical groundwater outflow, and discharge to artificial draining systems and lagoons. All of these discharges vary with the seasons. Discharge from springs and seeps is highest during the spring. Evapotranspiration is at a maximum during the summer. Groundwater discharge is, in general, lowest during the winter because of the frozen ground surface.

Routine monitoring of groundwater includes sampling for indicator and groundwater quality parameters. Additional sampling for radiological and nonradiological parameters (e.g., volatiles, semivolatiles, metals, pesticides, and PCBs) is included under the expanded groundwater characterization monitoring program.

Air Pathways

Effluent air emissions are continuously monitored for alpha and beta activity. Remote alarms indicate any unusual rise in radioactivity. Air particulate filters, which are retrieved and analyzed weekly for gross radioactivity, are also composited quarterly and analyzed for strontium-90 and specific gamma- and alpha-emitting nuclides.

Iodine-129 and tritium also are measured in effluent ventilation air. At two locations silica gel-filled columns are used to extract water vapor that is then distilled from the desiccant and analyzed for tritium. Four samplers contain activated charcoal adsorbent that is analyzed for radioiodine. The silica gel columns are analyzed weekly; the charcoal is collected weekly and composited for quarterly analysis.

Off-site sampling locations include those considered most representative of background conditions and those most likely to be downwind of airborne releases. Among the criteria used to position off-site air samplers are prevailing wind direction, land usage, and the location of population centers.

Off-site air is continuously sampled at ten locations. Background samplers are located far from the site in Great Valley and Dunkirk, New York. Nearby-community samplers are in Springville and West Valley, New York. (See Fig. A-9 in *Appendix A* for these four off-site air sampling locations.) Six samplers are located on the perimeter of the WNYNSC. (See Fig. 2-2 in *Chapter 2, Environmental Monitoring*.) These samples are analyzed for parameters similar to the effluent air samples. (See *Appendix C-2* for air monitoring data summaries.)

Atmospheric Fallout

An important contributor to environmental radioactivity is atmospheric fallout. Sources of fallout include earlier atmospheric testing of atomic explosives and residual radioactivity from accidents such as occurred at Chernobyl. Four site perimeter locations and one on-site location currently are sampled for fallout using pot-type samplers that are collected every month. Long-term fallout is determined by analyzing soil collected annually at each of the six perimeter and four off-site air samplers. (See *Appendix C-2* for fallout data summaries and *Appendix C-1* for soil data summaries.)

Food Pathways

Another potentially significant pathway is via domesticated farm animals and produce raised near the WVDP and through game animals and fish that include the WVDP in their range. Animal and fish samples from potentially affected areas are gathered and analyzed for radionuclide content in order to reveal any long-term trends. Fish are collected at several locations along Cattaraugus Creek and its tributaries at various distances downstream from the WVDP. Beef, milk, hay, and produce are collected at nearby farms and at selected locations well away from any possible WVDP influence. (See *Appendix C-3* for biological data summaries.)

Direct Radiation Measurement

Direct penetrating radiation is measured using thermoluminescent dosimeters (TLDs) located on- and off-site. Measurement points within the site are placed near selected waste management units and around the inner security fence. Other measurement locations are situated around the site perimeter and access road and at background locations remote from the WVDP. Forty-one measurement points were used in 1993. The TLDs are retrieved quarterly and read out on-site to obtain the integrated gamma exposure. (See *Appendix C-4* for direct radiation data summaries.)

Meteorological Monitoring

Meteorological data are continuously gathered and recorded on-site. Wind speed and direction, barometric changes, dew point, temperature, and rainfall are all measured. Such data are valuable in evaluating long-term geohydrological trends and in developing airborne dispersion models. In the event of an emergency, immediate access to the most recent data is indispensable for predicting the path and concentration of any materials that become airborne. (See *Appendix C-6* for meteorological data summaries.)

Quality Assurance and Control

The work performed by and through the on-site Environmental Laboratory is regularly reviewed by several agencies for accuracy and compliance with applicable regulations. Audits of the laboratory routinely focus on proper record keeping and reporting, timely calibration of equipment, training of personnel, adherence to accepted procedures, and general laboratory safety.

The Environmental Laboratory also participates in several quality assurance crosscheck programs administered by federal or state agencies. (See *Appendix D* for a summary of crosscheck performance.) Outside laboratories contracted to perform analyses for the WVDP also are regularly subjected to performance audits.

Environmental monitoring management continued to strengthen its formal self-assessment program, developing and implementing new strategies and procedures for ensuring high quality data. Experienced senior scientists and specialists in varying disciplines follow an annual schedule of quarterly internal appraisals, produce formal reports with recommended corrective actions, and track the planned actions for their implementation.

ENVIRONMENTAL COMPLIANCE SUMMARY

CALENDAR YEAR 1993

Compliance Status

Environmental compliance activities during 1993 at the West Valley Demonstration Project (WVDP) successfully addressed the full range of environmental laws and regulations, including the management of radioactive mixed wastes under the Resource Conservation and Recovery Act (RCRA). The WVDP continued to operate under a Federal and State Facility Compliance Agreement (FSFCA) that addresses compliance issues relating to radioactive mixed waste management, including compliance with RCRA land disposal restrictions (LDRs). (See **Current Issues and Actions** below.)

No instances of noncompliance were found during inspections and audits conducted by the U.S. Environmental Protection Agency (EPA), the New York State Department of Environmental Conservation (NYSDEC), the New York State Department of Health (NYSDOH), and the Cattaraugus County Health Department. A major review of the environmental monitoring program was carried out by the U.S. Nuclear Regulatory Commission (NRC) in 1993. Although a number of areas for improvement were identified during the NRC review, the surveillance pointed out the overall high quality of the monitoring program.

Management at the WVDP continues to provide strong support for environmental compliance issues, ensuring that all state and federal statutes and regulations, as well as Department of Energy (DOE) Orders, are integrated into the compliance program at the Project.

Clean Air Act (CAA)

The Clean Air Act establishes a comprehensive federal and state framework that regulates air emissions from both stationary and mobile sources: any emission sources of a CAA-regulated substance may require a permit or be subject to registration or notification requirements. Air emission sources such as welding activities and waste processing operations are regulated under the CAA. These sources may discharge to the environment through stacks, ventilators, air ducts, or wall fans. Air emissions from soil piles and open lagoons also fall under CAA regulation.

Under the CAA, radiological emissions are the only hazardous air pollutants over which the EPA maintains direct control. Other nonradiological hazardous air pollutants are regulated by the EPA, but authority to enforce those regulations has been delegated to NYSDEC. In 1993 the WVDP initiated or maintained twelve Permits to Construct nonradiological air emission sources. (See Table B-3 in *Appendix B*.) These new sources include the nitrogen oxide off-gas treatment system for the vitrification facility and laboratory fume hoods in the environmental analytical annex building. One Permit to Construct, for the vitrification (canister welding) heating, ventilation, and air conditioning (HVAC) system, was submitted to NYSDEC and is currently under review. The number of nonradiological emission sources permitted to operate remained constant throughout 1993.

The WVDP operated under eighteen active air permits in 1993. (See Table B-3 in *Appendix B*.) Of the eighteen permits, six are for radiological emissions regulated under the EPA's National Emissions Standards for Hazardous Air Pollutants (NESHAP) program. Permit applications to operate the vitrification melter off-gas and HVAC systems as radiological release points are currently under review by the EPA.

The annual NESHAP inspection by EPA Region II in September 1993 indicated no noncompliance episodes or notices of violation. Calculations to demonstrate compliance with NESHAP standards showed 1993 doses to be less than 1% of the 10 millirem standard.

Emergency Preparedness and Community Right-to-Know Act (EPCRA)

The purposes of EPCRA are to provide local governments and the public with information concerning potential chemical hazards in their communities and to encourage and support emergency planning efforts at the state and local levels.

The EPCRA program requires the WVDP to submit reports that give information about the quantities, locations, and any associated hazards of chemicals used and stored on-site to off-site state and local emergency response organizations.

All required reports were submitted to the appropriate organizations by the required deadlines. In support of the waste minimization and pollution prevention directives from the EPA and NYSDEC, the number of reportable chemicals above their threshold planning quantity stored on-site was reduced from eighteen at the end of 1992 to thirteen at the end of 1993. This information is included in the quarterly reports submitted to the state and local emergency planning and response organizations. These updates ensure that the public and emergency responders have the most recent information about site conditions and operations.

Separate from reporting requirements given above, the DOE voluntarily complies with EPCRA regulations requiring the annual reporting of toxic chemical releases to the EPA and NYSDEC. In July 1993 the WVDP submitted a report for 1992 detailing the routine permitted venting of a sulfuric acid storage tank.

Clean Water Act (CWA)

The Clean Water Act is the primary statute governing water pollution control programs in the United States. It controls discharges to surface water and groundwater through a National Pollutant Discharge Elimination System (NPDES) permit program that requires permits to be issued specifying discharge standards and monitoring and reporting requirements. Authorized states such as New York are allowed to issue equivalent State Pollutant Discharge Elimination System (SPDES) permits.

SPDES-permitted Outfalls

All WVDP point source effluent discharges to surface waters are permitted through the New York SPDES program.

The WVDP has three permitted outfalls, all of which discharge to Erdman Brook. (See Figs. 2-3 and 2-16):

- Outfall 001 (WNSP001) discharges the effluent from the low-level waste treatment facility (LLWTF).

- Outfall 007 (WNSP007) discharges the combined effluent from the site's sewage treatment plant and various nonradioactive industrial and potable water treatment systems. The average monthly flow in 1993 was 7.38 million liters (1.95 million gal).

- Outfall 008 (WNSP008) directs groundwater flow from the northeast side of the site's LLWTF lagoon system through a french drain. The average monthly flow in 1993 was 0.568 million liters (0.15 million gal).

In 1993 treated water from the LLWTF was discharged in seven batches that totaled 39.4 million liters (10.4 million gal) for the year. The annual average concentration of radioactivity at the point of release was 47% of the DOE's derived concentration guides (DCGs). None of the individual releases exceeded the DCGs. (See Table B-1 in *Appendix B*.)

With the exception of a single pH value of 9.86 standard units (s.u.) at outfall 007 during May, all discharge data for 1993 were within SPDES permit limits. This measurement, which was above the permit limit of 9.0 s.u., occurred after an automatic control valve on outfall 007 properly closed when the pH of the effluent increased to 8.4 s.u. In accordance with standard operating procedures, the valve was reopened after confirmation of normal pH levels in the effluent at the nearest upstream sample location. Out-of-specification liquid (about 150 gal) that was trapped in piping downstream of this sampling location was grab-sampled as it was released. The WVDP has modified the outfall piping to allow liquid upstream of the control valve to be returned back into the treatment process. This technique will help ensure that all liquid released is within permit limitations.

There were no excursions attributable to the present sewage treatment plant in 1993. A proposal for the expansion of the sewage treatment plant into a wastewater treatment facility was approved by NYSDEC on March 16, 1993. Construction is presently on schedule with completion targeted for early 1994.

Stormwater Permit Application

Stormwater from municipal or industrial facilities may contain a variety of pollutants. To protect aquatic resources and the public health, regulations require that facilities such as the WVDP obtain permits specifying discharge limits.

The WVDP obtained site-specific data through sampling in 1991 and submitted a stormwater discharge permit application to NYSDEC on September 30, 1992. This permit application continued to be under review by NYSDEC in 1993. (See **Clean Water Act**, *Environmental Compliance Summary: First Quarter 1994.*)

Safe Drinking Water Act (SDWA)

The Safe Drinking Water Act states that each federal agency having jurisdiction over a federally owned or maintained public water system must comply with all federal, state, and local requirements regarding safe drinking water. The drinking water quality program in the state of New York is administered by NYSDOH through county health departments.

The WVDP obtains its drinking water from surface water reservoirs on the Western New York Nuclear Service Center (WNYNSC) site and is considered a nontransient, noncommunity public water supplier. The Project maintains a drinking water treatment facility to serve the on-site population. In this facility the water is purified by settling, filtration, and chlorination before it is distributed on-site.

As an operator of a drinking water supply system, the WVDP collects routine drinking water samples for analysis to ensure water quality. The results of those analyses are reported to the Cattaraugus County Health Department. The Cattaraugus County Health Department also collects independent monthly samples of WVDP drinking water to determine bacterial and residual chlorine content.

A number of important events with regard to the site's drinking water program occurred in 1993:

- The site's gaseous chlorination system was replaced with a hypochlorite disinfection system, enhancing both the chlorination process and operational safety. In June 1993 this new system was inspected by the Cattaraugus County Health Department. No deficiencies were identified.

- Per New York State regulations, a new requirement for quarterly monitoring of drinking water for nitrate was added to the site's program. No violations of any drinking water quality standards for nitrate have been noted.

- At the end of 1993 a new requirement of the New York State Sanitary Code for inorganic chemical monitoring was implemented at the WVDP. Samples collected in December for a number of heavy metals, sulfate, cyanide, and nitrite have been analyzed. Results are currently being evaluated.

- In 1993 the WVDP implemented sampling and testing for lead and copper in the site's drinking water in accordance with new EPA and NYSDOH regulations. Review of sampling results indicated that three locations on-site, out of a total of twenty locations sampled, showed lead levels above the new 15 parts per billion (ppb) action level set by federal and state regulations. As a result, the WVDP has conducted further monitoring, is identifying appropriate remedial measures, and has informed its employees through an EPA-developed public education program. The Cattaraugus County Health Department was informed of the situation and of the actions taken in December 1993. It should be noted that none of the lead concentrations observed exceeded the previously established health-based standard of 50 ppb. (See **Safe Drinking Water Act**, *Environmental Compliance Summary: First Quarter 1994.*)

Other than the lead action-level exceedances noted above, monitoring results in 1993 indicate that the Project's drinking water meets NYSDOH drinking water quality standards.

Medical Waste Tracking

In the past the WVDP used the services of Bertrand Chaffee Memorial Hospital for incineration of medical wastes generated at the Project. When the hospital stopped incinerating wastes, the WVDP retained a commercial medical waste removal firm that picks up waste generated at the site and transports it off-site to an approved medical waste incinerator in the state of Maryland. Fewer than 1.8 kilograms (4 lbs) of medical waste were removed in 1993.

Petroleum Product Spill Reporting

Under an agreement with NYSDEC, the WVDP reports on-site spills of petroleum products of 10 gallons or less onto an impervious surface (such as blacktop) in a monthly log. Spills greater than 10 gallons that do not affect ground- or surface water or enter a drainage system must be reported to NYSDEC within twenty-four hours and entered in the monthly log. Spills of any amount that do affect waters of the state (groundwater, surface water, drainage systems) must be reported immediately to the NYSDEC spill hotline and also are entered in the monthly log.

There were forty minor spills of petroleum products in 1993 totaling approximately 38 liters (10 gal). These spills were typically associated with leaks from heavy industrial construction equipment and vendor delivery vehicles.

Of the forty spills, none required immediate notification of NYSDEC under the reporting protocol. All spills were cleaned up in a timely fashion in accordance with the WVDP Spill Prevention, Control, and Countermeasures Plan. None of the spills resulted in any discernible adverse environmental effect.

Toxic Substances Control Act (TSCA)

In 1993 the WVDP continued to manage radioactively contaminated polychlorinated biphenyl (PCB) waste as mixed hazardous and radioactive wastes. These wastes originated from a dismantled hydraulic power unit inside the former reprocessing facility and from several radiologically contaminated PCB capacitors containing PCB fluids. The toxic aspect of this PCB waste is regulated under the Toxic Substances Control Act (TSCA). To comply with TSCA, the WVDP maintains an annual document log that details PCB usage and storage on-site and any changes in storage or disposal status. (See also **Radioactive Mixed Waste Management Program** below.)

Resource Conservation and Recovery Act (RCRA)

Hazardous Waste

The WVDP has been operating under RCRA interim status for treatment and storage of radioactive mixed waste since its original submittal of a RCRA Part A permit application on June 4, 1990. After the original permit application was filed, several modifications were made via letters to NYSDEC. In April 1991 the WVDP amended its RCRA interim status application to incorporate all these modifications. This included the addition of the hazardous waste storage lockers and specification of RCRA waste codes for contained storage units on-site. Last modified in April 1993, the WVDP's Part A permit application continues to be updated as any changes to the site's hazardous or mixed waste storage status occurs.

Using permitted transportation and disposal services, the WVDP disposed of approximately 7 tons of nonradioactive, hazardous waste off-site in 1993, fewer than the 12 tons disposed off-site in 1992. The materials disposed included expired laboratory standards and unneeded testing chemicals.

On March 22 and 23, 1993 an annual RCRA inspection of the WVDP was carried out by NYSDEC. No violations were found or citations issued.

Nonhazardous, Regulated Material

The WVDP transported 65 tons of nonradioactive, nonhazardous material off-site to permitted facilities in 1993. These shipments consisted of industrial wastewaters and solid wastes such as refractory brick. In 1993 the WVDP also shipped approximately 1,540 tons of sewage treatment waste to a permitted wastewater treatment facility.

Radioactive Mixed Waste (RMW) Management Program

Radioactive mixed waste is waste that contains both a radioactive constituent, which is regulated by the Atomic Energy Act (AEA), and a hazardous waste component, which is regulated under RCRA.

Potential conflicts between RMW regulations under the Atomic Energy Act and under RCRA regulations led to the WVDP initiating discussions with the regulatory agencies to resolve these conflicts through a Federal and State Facility Compliance Agreement (FSFCA). Negotiations on the FSFCA and a RCRA 3008(h) Administrative Order on Consent continued into 1992. The Consent Order was signed in March 1992 and the FSFCA went into effect in March 1993. These agreements provide the means whereby the WVDP can comply with both RCRA regulations and with the requirements of the AEA. (See **Current Issues and Actions** below.)

The Federal Facility Compliance Act (FFC Act) of 1992 was signed into law on October 6, 1992. As a result of this law, the federal government will be subject to the full range of available enforcement tools provided in federal, state, or local environmental law. A waiver of sovereign immunity became effective on October 6, 1992, except as it relates to certain mixed waste storage requirements for which the FFC Act provides a three-year delay period. During this three-year period, the DOE is to prepare plans for the development of treatment capacity and technologies for its facilities that generate and store mixed wastes. The FFC Act also requires the DOE to submit progress reports regarding implementation of the new law and a mixed waste inventory to the EPA and to states in which mixed waste is located. An initial mixed waste inventory report detailing current and future mixed waste-generating activities and treatment capabilities at the WVDP was submitted to DOE Headquarters in January 1993. A final version was provided in March 1993 for inclusion in a DOE-wide report. The Site Treatment Plan (STP) in conceptual form was transmitted to NYSDEC in October 1993. This plan presents treatment options for all mixed wastes identified in the site mixed waste inventory. PCB wastes are included in the site's mixed waste inventory and in the site treatment plan.

Underground Petroleum Storage Tanks

RCRA regulations also cover underground petroleum storage tanks. There are three 2,000-gallon underground petroleum storage tanks at the WVDP. Two of these tanks contain unleaded gasoline. The third tank held high-sulfur diesel fuel through the end of 1993. Low-sulfur diesel fuel, slated for site use in 1994, will be used in some site motor vehicles and industrial equipment.

Inventory in each of the 2,000-gallon fuel storage tanks ranges from 300 to 1,900 gallons. Inventories for these tanks are taken daily and reconciled monthly with the daily readings.

Another 550-gallon underground petroleum storage tank is used for fueling ventilation standby power for the supernatant treatment system (STS).

Registration for all of the tanks mentioned above is renewed every five years with NYSDEC.

New York State-regulated Aboveground Storage

An issue not directly covered under any federal statutes but administered through New York State regulation 6 NYCRR Part 596 concerns the registration of aboveground, hazardous substance, bulk storage tanks. In August 1993 NYSDEC approved reissuance of the WVDP's certificate to maintain twenty-five such tanks. Aboveground petroleum storage is regulated by New York State regulations under 6 NYCRR Parts 612, 613, and 614. The WVDP maintains eight aboveground petroleum storage tanks that are registered with New York State.

Waste Minimization

A number of waste minimization activities were carried out in 1993, including the following:

- The WVDP's goal is to reduce the generation of all categories of radioactive and hazardous waste by 25% over a five-year period, with an annual goal of 5%. In 1993, the program's third year, waste minimization efforts exceeded the three-year goal of a 15% reduction.
- After completion of a successful pilot study, the WVDP instituted a site-wide paper recycling program in March 1993. By the end of 1993 approximately 179,000 pounds of paper had been sent off-site for recycling.
- The WVDP shipped approximately 12,000 pounds of hazardous materials off-site for recycling, reclamation, or recovery. These materials included unused paints, used batteries, and used oil.
- Low-level radioactive waste compacting reduced the volume of waste generated from more than 15,000 cubic feet to less than 4,000 cubic feet.
- Many common materials were recycled or reused, including 1,005 wooden pallets, 951 cardboard boxes, and 48,900 aluminum pop cans.
- An environmental awareness day for all WVDP employees emphasized the importance of waste minimization and pollution prevention.

National Environmental Policy Act (NEPA)

The National Environmental Policy Act establishes the nation's policies for the protection of the environment. Its goals are to prevent or eliminate damage to the environment. The President's Council on Environmental Quality, established by NEPA, carries out this policy. Its regulations are found in the Code of Federal Regulations, Title 40, Parts 1500-1508 (40 CFR 1500-1508). Since 1990 the DOE has been revising its NEPA-compliance program, which was approved by the President's Council on Environmental Quality and was codified in 10 CFR 1021. This regulation went into effect on May 26, 1992.

NEPA requires that all federal agencies proposing major actions that could significantly affect the quality of the human environment prepare detailed environmental statements.

The DOE implements NEPA by requiring an environmental review of all proposed activities. If the proposed action will have an insignificant effect on the environment it is excluded from further environmental review under a categorical exclusion. If the proposed action could have an effect on the environment, then it is reviewed through an environmental assessment. If the results of the assessment indicate no effect on the environment, then a finding of no significant impact is issued. A proposed action that could have a significant effect on the environment is reviewed through an environmental impact statement.

Both environmental assessments and environmental impact statements are available to the public. NEPA requires that the public be notified of and given the opportunity to review and comment on environmental impact statements.

1993 NEPA Activities

Sixteen proposed actions regarding facility maintenance and operation were evaluated under the Department of Energy's NEPA-implementing regulations during 1993. Ten were categorically excluded. Five are eligible for categorical exclusion and are awaiting approval. The last proposed action, which concerns management of low-level waste, is awaiting a determination on the appropriate level of NEPA review.

The Supplement Analysis to the 1982 High-level Waste Stabilization environmental impact statement was approved by DOE headquarters. This analysis presents information on modifications to the design and operational aspects of solidification activities that have changed since the environmental impact statement was issued. The analysis demonstrates that the changes do not significantly affect the environment or the 1982 Record of Decision.

During 1993 an environmental assessment was initiated to evaluate management options concerning the remaining spent nuclear fuel stored at the WVDP.

Preparation of the draft environmental impact statement for Project completion by the DOE and site closure or long-term management by NYSERDA continued in 1993. Six alternatives have been developed and are being evaluated.

Summary of Permits

Environmental permits in effect at the Project during 1993 are listed in Table B-3 of *Appendix B*.

Current Issues and Actions

Resource Conservation and Recovery Act (RCRA)

In 1992 the WVDP completed negotiations with the EPA and NYSDEC for a Federal and State Facility Compliance Agreement (FSFCA) regarding compliance with RCRA regulations pertaining to radioactive mixed waste management, including compliance with RCRA land disposal restrictions (LDRs). The agreement also provides a plan and schedule to address container storage and waste analysis issues at the WVDP. This agreement became effective on March 23, 1993. Implementation of the FSFCA has resolved a 1992 Notice of Noncompliance from the EPA that had detailed mixed waste compliance issues at the WVDP.

The RCRA 3008(h) Administrative Order on Consent is an agreement between NYSDEC, the EPA, NYSERDA, and the DOE about the kind and extent of work needed to identify and evaluate any hazardous waste or hazardous constituent that may have been released at the WVDP site. The Consent Order requires NYSERDA and the West Valley Project Office to conduct investigations at solid waste management units (SWMUs) to determine if there has been a release or if there is a potential for release of hazardous waste constituents.

The following activities were completed under the RCRA 3008(h) Consent Order during calendar year 1993:

- Comments were received from NYSDEC and the EPA on the RCRA Facility Investigation (RFI) Work Plan, which identifies the strategy for investigating solid waste management units at the WVDP. After these comments were successfully incorporated into the Work Plan, sampling for an expanded group of groundwater parameters and soils began. The soil and sediment sampling portion of the investigation was completed in December 1993. Samples collected during the investigation have been analyzed. Results of these analyses will be evaluated during 1994.

The first of two expanded groundwater sampling events was conducted in the last quarter of 1993 to support the RFI Work Plan. The second round of sampling is scheduled for mid-1994. The groundwater samples from these two expanded rounds will be analyzed during 1994.

- As required by the Consent Order, the WVDP informed the EPA and NYSDEC of the existence of a number of minor solid waste management units that had been identified during the investigation process. Additional assessment activities are being implemented to appropriately characterize these areas.

  Pursuant to the Consent Order and following evaluation of analytical results, the RFI Work Plan specifies a schedule for issuing RFI reports in 1995 and 1996. These reports will include data collected during SWMU investigations and will be sent to the EPA and NYSDEC.

Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)

On February 5, 1993, the WVDP was listed in the EPA's Federal Agency Hazardous Waste Compliance docket. This action will result in an evaluation of the WVDP to ascertain its status relative to CERCLA requirements. On October 5, 1993, the WVDP submitted a CERCLA Preliminary Assessment to the EPA for their review. This assessment evaluated waste management at the WVDP along with the likelihood of release and possible effects on human health and the environment. Based on a standardized scoring scheme, these factors were used to rank risks from the site. The DOE concluded in the assessment that no further investigation of the facility pursuant to CERCLA Section 120 is warranted and that the site does not qualify for the National Priorities List. This was based on the score attained in the preliminary assessment and the fact that Project facilities are currently being remediated in accordance with the provisions of the WVDP Act and the RCRA 3008(h) Order on Consent.

Project Assessment Activities in 1993

West Valley Nuclear Services Company, Inc. (WVNS), as management and operating contractor for the DOE at the WVDP, conducted more than eighty reviews of environmentally related activities in 1993. These included departmental self-assessments and internal audits, appraisals, and surveillances. In addition, there were more than ten reviews conducted by organizations external to WVNS (e.g., the DOE, NYSDEC, and the EPA).

More significant external environmental surveillance activities conducted in 1993 included a Comprehensive Groundwater Monitoring Evaluation conducted by NYSDEC and an extensive audit of the WVDP radiological monitoring program by the NRC. There were also routine joint annual inspections by NYSDEC and the EPA to assess compliance with National Emissions Standards for Hazardous Air Pollutants (NESHAP) and Resource Conservation and Recovery Act (RCRA) regulations. While formal reports have not yet been issued, preliminary results do not indicate any significant findings.

NYSDEC conducted the annual SPDES inspection at the WVDP on March 29, 1993, to gauge compliance with Clean Water Act requirements. No citations were issued and the WVDP was found to be in full compliance.

Follow-up to the Department of Energy 1992 Environmental Audit

In November 1992 the U.S. Department of Energy Idaho Field Office performed a comprehensive appraisal of the WVDP. The appraisal team reviewed the WVDP programs for environmental protection, quality assurance, emergency preparedness, and firearms safety. After receiving a final appraisal report from the Idaho Field Office in December 1992, the WVDP issued its final action plan to address their concerns. More than 32% of these concerns have already been resolved by WVNS. Almost all of the remaining action items are long-term commitments related to continuing self-assessment.

Follow-up to Department of Energy 1991 Environmental Audit

A final report by the Department of Energy Headquarters Office of Environmental Audit on the 1991 environmental audit was received by the WVDP in March 1992. The WVDP completed its final action plan and resubmitted it to DOE Headquarters in April 1992. As of January 1994 more than 97% of the identified action items had already been resolved by WVNS.

ENVIRONMENTAL COMPLIANCE SUMMARY

FIRST QUARTER 1994

Compliance Status

The compliance status of the West Valley Demonstration Project's major environmental programs through the first quarter of 1994 is noted below.

Clean Air Act (CAA)

During the first quarter of 1994 the WVDP received Certificates to Operate two new nonradiological emission sources previously under construction. These included vitrification facility exhaust welding fume blower systems as well as the ventilation system for the analytical cell mock-up unit.

Clean Water Act (CWA)

Discussions with NYSDEC relating to the renewal of the WVDP's SPDES permit continued during 1993. The renewed SPDES permit was received by the WVDP in early January 1994. The renewed permit went into effect on February 1, 1994 and comprised an expanded list of monitoring requirements. Major changes to the permit include a revised method for determining releases of iron from the site, monitoring requirements for total dissolved solids, and expanded provisions for the discharge of treated New York State-licensed disposal area (SDA) trench leachate. The permit renewal defines a schedule for the WVDP to establish a plan to prevent or minimize the potential for any spill of toxic or hazardous pollutants to the waters of the state.

Communications with NYSDEC held early in 1994 indicated that any future stormwater monitoring requirements will be incorporated into the WVDP's existing SPDES permit.

Safe Drinking Water Act (SDWA)

The Cattaraugus County Health Department approved reducing the requirement for quarterly sampling for nitrate in the site's drinking water to an annual requirement beginning in 1994. This reduction was based upon the sufficiently low levels of nitrate observed during sampling in 1993. Annual sampling for heavy metals and fluoride, as required by the New York State Sanitary Code, is being formalized in 1994.

The WVDP will be forwarding its Corrosion Control Treatment Plan to the Cattaraugus County Health Department during the first quarter of 1994. This plan will outline steps toward lowering drinking water concentrations of lead on-site to below the mandated action level. (See **Safe Drinking Water Act**, *Environmental Compliance Summary: Calendar Year 1993*.) While remedial steps are being taken, the frequency of sampling and analysis has been increased in order to monitor the situation.

Emergency Preparedness and Community Right-to-Know Act (EPCRA)

Emergency and Hazardous Chemical Inventory (Tier II) reports, due during the first quarter of 1994 for the 1993 reporting period, were transmitted to state and local emergency response organizations by the required deadline. These reports contain listings of materials that may be of concern to personnel responding to an emergency at the WVDP.

Resource Conservation and Recovery Act (RCRA)

The annual Hazardous Waste Generator/Waste Minimization Report was submitted to the New York State Department of Environmental Conservation by the required deadline.

RCRA regulations also cover underground petroleum storage tanks. There are three 2,000-gallon underground petroleum storage tanks at the WVDP. Two of these tanks contain unleaded gasoline. The third tank held high-sulfur diesel fuel through the end of 1993. In early 1994 fuel storage in this tank was converted to a low-sulfur alternative to be used in some site heavy equipment and vehicles.

National Environmental Policy Act (NEPA) Activities

The preparation of the draft EIS for Project completion by the DOE and site closure or long-term management by NYSERDA is continuing.

A draft EIS originally scheduled for release in June 1994 has been delayed to address regulatory questions and emerging regulatory requirements.

Current Issues and Actions

During the first quarter of 1994 the WVDP continued to operate under a Federal and State Facility Compliance Agreement negotiated with NYSDEC and the EPA. The agreement defines specific requirements for the management of radioactive mixed waste, including compliance with land disposal restrictions.

Progress on implementation of the RCRA 3008(h) Consent Order continues. The quarterly progress report for the last quarter of calendar year 1993, including groundwater monitoring results, was submitted on schedule in early 1994.

ENVIRONMENTAL COMPLIANCE SUMMARY

CALENDAR YEAR 1993

Compliance Status

Environmental compliance activities during 1993 at the West Valley Demonstration Project (WVDP) successfully addressed the full range of environmental laws and regulations, including the management of radioactive mixed wastes under the Resource Conservation and Recovery Act (RCRA). The WVDP continued to operate under a Federal and State Facility Compliance Agreement (FSFCA) that addresses compliance issues relating to radioactive mixed waste management, including compliance with RCRA land disposal restrictions (LDRs). (See **Current Issues and Actions** below.)

No instances of noncompliance were found during inspections and audits conducted by the U.S. Environmental Protection Agency (EPA), the New York State Department of Environmental Conservation (NYSDEC), the New York State Department of Health (NYSDOH), and the Cattaraugus County Health Department. A major review of the environmental monitoring program was carried out by the U.S. Nuclear Regulatory Commission (NRC) in 1993. Although a number of areas for improvement were identified during the NRC review, the surveillance pointed out the overall high quality of the monitoring program.

Management at the WVDP continues to provide strong support for environmental compliance issues, ensuring that all state and federal statutes and regulations, as well as Department of Energy (DOE) Orders, are integrated into the compliance program at the Project.

Clean Air Act (CAA)

The Clean Air Act establishes a comprehensive federal and state framework that regulates air emissions from both stationary and mobile sources: any emission sources of a CAA-regulated substance may require a permit or be subject to registration or notification requirements. Air emission sources such as welding activities and waste processing operations are regulated under the CAA. These sources may discharge to the environment through stacks, ventilators, air ducts, or wall fans. Air emissions from soil piles and open lagoons also fall under CAA regulation.

Under the CAA, radiological emissions are the only hazardous air pollutants over which the EPA maintains direct control. Other nonradiological hazardous air pollutants are regulated by the EPA, but authority to enforce those regulations has been delegated to NYSDEC. In 1993 the WVDP initiated or maintained twelve Permits to Construct nonradiological air emission sources. (See Table B-3 in *Appendix B*.) These new sources include the nitrogen oxide off-gas treatment system for the vitrification facility and laboratory fume hoods in the environmental analytical annex building. One Permit to Construct, for the vitrification (canister welding) heating, ventilation, and air conditioning (HVAC) system, was submitted to NYSDEC and is currently under review. The number of nonradiological emission sources permitted to operate remained constant throughout 1993.

The WVDP operated under eighteen active air permits in 1993. (See Table B-3 in *Appendix B*.) Of the eighteen permits, six are for radiological emissions regulated under the EPA's National Emissions Standards for Hazardous Air Pollutants (NESHAP) program. Permit applications to operate the vitrification melter off-gas and HVAC systems as radiological release points are currently under review by the EPA.

The annual NESHAP inspection by EPA Region II in September 1993 indicated no noncompliance episodes or notices of violation. Calculations to demonstrate compliance with NESHAP standards showed 1993 doses to be less than 1% of the 10 millirem standard.

Emergency Preparedness and Community Right-to-Know Act (EPCRA)

The purposes of EPCRA are to provide local governments and the public with information concerning potential chemical hazards in their communities and to encourage and support emergency planning efforts at the state and local levels.

The EPCRA program requires the WVDP to submit reports that give information about the quantities, locations, and any associated hazards of chemicals used and stored on-site to off-site state and local emergency response organizations.

All required reports were submitted to the appropriate organizations by the required deadlines. In support of the waste minimization and pollution prevention directives from the EPA and NYSDEC, the number of reportable chemicals above their threshold planning quantity stored on-site was reduced from eighteen at the end of 1992 to thirteen at the end of 1993. This information is included in the quarterly reports submitted to the state and local emergency planning and response organizations. These updates ensure that the public and emergency responders have the most recent information about site conditions and operations.

Separate from reporting requirements given above, the DOE voluntarily complies with EPCRA regulations requiring the annual reporting of toxic chemical releases to the EPA and NYSDEC. In July 1993 the WVDP submitted a report for 1992 detailing the routine permitted venting of a sulfuric acid storage tank.

Clean Water Act (CWA)

The Clean Water Act is the primary statute governing water pollution control programs in the United States. It controls discharges to surface water and groundwater through a National Pollutant Discharge Elimination System (NPDES) permit program that requires permits to be issued specifying discharge standards and monitoring and reporting requirements. Authorized states such as New York are allowed to issue equivalent State Pollutant Discharge Elimination System (SPDES) permits.

SPDES-permitted Outfalls

All WVDP point source effluent discharges to surface waters are permitted through the New York SPDES program.

The WVDP has three permitted outfalls, all of which discharge to Erdman Brook. (See Figs. 2-3 and 2-16):

- Outfall 001 (WNSP001) discharges the effluent from the low-level waste treatment facility (LLWTF).
- Outfall 007 (WNSP007) discharges the combined effluent from the site's sewage treatment plant and various nonradioactive industrial and potable water treatment systems. The average monthly flow in 1993 was 7.38 million liters (1.95 million gal).
- Outfall 008 (WNSP008) directs groundwater flow from the northeast side of the site's LLWTF lagoon system through a french drain. The average monthly flow in 1993 was 0.568 million liters (0.15 million gal).

In 1993 treated water from the LLWTF was discharged in seven batches that totaled 39.4 million liters (10.4 million gal) for the year. The annual average concentration of radioactivity at the point of release was 47% of the DOE's derived concentration guides (DCGs). None of the individual releases exceeded the DCGs. (See Table B-1 in *Appendix B*.)

With the exception of a single pH value of 9.86 standard units (s.u.) at outfall 007 during May, all discharge data for 1993 were within SPDES permit limits. This measurement, which was above the permit limit of 9.0 s.u., occurred after an automatic control valve on outfall 007 properly closed when the pH of the effluent increased to 8.4 s.u. In accordance with standard operating procedures, the valve was reopened after confirmation of normal pH levels in the effluent at the nearest upstream sample location. Out-of-specification liquid (about 150 gal) that was trapped in piping downstream of this sampling location was grab-sampled as it was released. The WVDP has modified the outfall piping to allow liquid upstream of the control valve to be returned back into the treatment process. This technique will help ensure that all liquid released is within permit limitations.

There were no excursions attributable to the present sewage treatment plant in 1993. A proposal for the expansion of the sewage treatment plant into a wastewater treatment facility was approved by NYSDEC on March 16, 1993. Construction is presently on schedule with completion targeted for early 1994.

Stormwater Permit Application

Stormwater from municipal or industrial facilities may contain a variety of pollutants. To protect aquatic resources and the public health, regulations require that facilities such as the WVDP obtain permits specifying discharge limits.

The WVDP obtained site-specific data through sampling in 1991 and submitted a stormwater discharge permit application to NYSDEC on September 30, 1992. This permit application continued to be under review by NYSDEC in 1993. (See **Clean Water Act**, *Environmental Compliance Summary: First Quarter 1994.*)

Safe Drinking Water Act (SDWA)

The Safe Drinking Water Act states that each federal agency having jurisdiction over a federally owned or maintained public water system must comply with all federal, state, and local requirements regarding safe drinking water. The drinking water quality program in the state of New York is administered by NYSDOH through county health departments.

The WVDP obtains its drinking water from surface water reservoirs on the Western New York Nuclear Service Center (WNYNSC) site and is considered a nontransient, noncommunity public water supplier. The Project maintains a drinking water treatment facility to serve the on-site population. In this facility the water is purified by settling, filtration, and chlorination before it is distributed on-site.

As an operator of a drinking water supply system, the WVDP collects routine drinking water samples for analysis to ensure water quality. The results of those analyses are reported to the Cattaraugus County Health Department. The Cattaraugus County Health Department also collects independent monthly samples of WVDP drinking water to determine bacterial and residual chlorine content.

A number of important events with regard to the site's drinking water program occurred in 1993:

- The site's gaseous chlorination system was replaced with a hypochlorite disinfection system, enhancing both the chlorination process and operational safety. In June 1993 this new system was inspected by the Cattaraugus County Health Department. No deficiencies were identified.

- Per New York State regulations, a new requirement for quarterly monitoring of drinking water for nitrate was added to the site's program. No violations of any drinking water quality standards for nitrate have been noted.

- At the end of 1993 a new requirement of the New York State Sanitary Code for inorganic chemical monitoring was implemented at the WVDP. Samples collected in December for a number of heavy metals, sulfate, cyanide, and nitrite have been analyzed. Results are currently being evaluated.

- In 1993 the WVDP implemented sampling and testing for lead and copper in the site's drinking water in accordance with new EPA and NYSDOH regulations. Review of sampling results indicated that three locations on-site, out of a total of twenty locations sampled, showed lead levels above the new 15 parts per billion (ppb) action level set by federal and state regulations. As a result, the WVDP has conducted further monitoring, is identifying appropriate remedial measures, and has informed its employees through an EPA-developed public education program. The Cattaraugus County Health Department was informed of the situation and of the actions taken in December 1993. It should be noted that none of the lead concentrations observed exceeded the previously established health-based standard of 50 ppb. (See **Safe Drinking Water Act**, *Environmental Compliance Summary: First Quarter 1994.*)

Other than the lead action-level exceedances noted above, monitoring results in 1993 indicate that the Project's drinking water meets NYSDOH drinking water quality standards.

Medical Waste Tracking

In the past the WVDP used the services of Bertrand Chaffee Memorial Hospital for incineration of medical wastes generated at the Project. When the hospital stopped incinerating wastes, the WVDP retained a commercial medical waste removal firm that picks up waste generated at the site and transports it off-site to an approved medical waste incinerator in the state of Maryland. Fewer than 1.8 kilograms (4 lbs) of medical waste were removed in 1993.

Petroleum Product Spill Reporting

Under an agreement with NYSDEC, the WVDP reports on-site spills of petroleum products of 10 gallons or less onto an impervious surface (such as blacktop) in a monthly log. Spills greater than 10 gallons that do not affect ground- or surface water or enter a drainage system must be reported to NYSDEC within twenty-four hours and entered in the monthly log. Spills of any amount that do affect waters of the state (groundwater, surface water, drainage systems) must be reported immediately to the NYSDEC spill hotline and also are entered in the monthly log.

There were forty minor spills of petroleum products in 1993 totaling approximately 38 liters (10 gal). These spills were typically associated with leaks from heavy industrial construction equipment and vendor delivery vehicles.

Of the forty spills, none required immediate notification of NYSDEC under the reporting protocol. All spills were cleaned up in a timely fashion in accordance with the WVDP Spill Prevention, Control, and Countermeasures Plan. None of the spills resulted in any discernible adverse environmental effect.

Toxic Substances Control Act (TSCA)

In 1993 the WVDP continued to manage radioactively contaminated polychlorinated biphenyl (PCB) waste as mixed hazardous and radioactive wastes. These wastes originated from a dismantled hydraulic power unit inside the former reprocessing facility and from several radiologically contaminated PCB capacitors containing PCB fluids. The toxic aspect of this PCB waste is regulated under the Toxic Substances Control Act (TSCA). To comply with TSCA, the WVDP maintains an annual document log that details PCB usage and storage on-site and any changes in storage or disposal status. (See also **Radioactive Mixed Waste Management Program** below.)

Resource Conservation and Recovery Act (RCRA)

Hazardous Waste

The WVDP has been operating under RCRA interim status for treatment and storage of radioactive mixed waste since its original submittal of a RCRA Part A permit application on June 4, 1990. After the original permit application was filed, several modifications were made via letters to NYSDEC. In April 1991 the WVDP amended its RCRA interim status application to incorporate all these modifications. This included the addition of the hazardous waste storage lockers and specification of RCRA waste codes for contained storage units on-site. Last modified in April 1993, the WVDP's Part A permit application continues to be updated as any changes to the site's hazardous or mixed waste storage status occurs.

Using permitted transportation and disposal services, the WVDP disposed of approximately 7 tons of nonradioactive, hazardous waste off-site in 1993, fewer than the 12 tons disposed off-site in 1992. The materials disposed included expired laboratory standards and unneeded testing chemicals.

On March 22 and 23, 1993 an annual RCRA inspection of the WVDP was carried out by NYSDEC. No violations were found or citations issued.

Nonhazardous, Regulated Material

The WVDP transported 65 tons of nonradioactive, nonhazardous material off-site to permitted facilities in 1993. These shipments consisted of industrial wastewaters and solid wastes such as refractory brick. In 1993 the WVDP also shipped approximately 1,540 tons of sewage treatment waste to a permitted wastewater treatment facility.

Radioactive Mixed Waste (RMW) Management Program

Radioactive mixed waste is waste that contains both a radioactive constituent, which is regulated by the Atomic Energy Act (AEA), and a hazardous waste component, which is regulated under RCRA.

Potential conflicts between RMW regulations under the Atomic Energy Act and under RCRA regulations led to the WVDP initiating discussions with the regulatory agencies to resolve these conflicts through a Federal and State Facility Compliance Agreement (FSFCA). Negotiations on the FSFCA and a RCRA 3008(h) Administrative Order on Consent continued into 1992. The Consent Order was signed in March 1992 and the FSFCA went into effect in March 1993. These agreements provide the means whereby the WVDP can comply with both RCRA regulations and with the requirements of the AEA. (See **Current Issues and Actions** below.)

The Federal Facility Compliance Act (FFC Act) of 1992 was signed into law on October 6, 1992. As a result of this law, the federal government will be subject to the full range of available enforcement tools provided in federal, state, or local environmental law. A waiver of sovereign immunity became effective on October 6, 1992, except as it relates to certain mixed waste storage requirements for which the FFC Act provides a three-year delay period. During this three-year period, the DOE is to prepare plans for the development of treatment capacity and technologies for its facilities that generate and store mixed wastes. The FFC Act also requires the DOE to submit progress reports regarding implementation of the new law and a mixed waste inventory to the EPA and to states in which mixed waste is located. An initial mixed waste inventory report detailing current and future mixed waste-generating activities and treatment capabilities at the WVDP was submitted to DOE Headquarters in January 1993. A final version was provided in March 1993 for inclusion in a DOE-wide report. The Site Treatment Plan (STP) in conceptual form was transmitted to NYSDEC in October 1993. This plan presents treatment options for all mixed wastes identified in the site mixed waste inventory. PCB wastes are included in the site's mixed waste inventory and in the site treatment plan.

Underground Petroleum Storage Tanks

RCRA regulations also cover underground petroleum storage tanks. There are three 2,000-gallon underground petroleum storage tanks at the WVDP. Two of these tanks contain unleaded gasoline. The third tank held high-sulfur diesel fuel through the end of 1993. Low-sulfur diesel fuel, slated for site use in 1994, will be used in some site motor vehicles and industrial equipment.

Inventory in each of the 2,000-gallon fuel storage tanks ranges from 300 to 1,900 gallons. Inventories for these tanks are taken daily and reconciled monthly with the daily readings.

Another 550-gallon underground petroleum storage tank is used for fueling ventilation standby power for the supernatant treatment system (STS).

Registration for all of the tanks mentioned above is renewed every five years with NYSDEC.

New York State-regulated Aboveground Storage

An issue not directly covered under any federal statutes but administered through New York State regulation 6 NYCRR Part 596 concerns the registration of aboveground, hazardous substance, bulk storage tanks. In August 1993 NYSDEC approved reissuance of the WVDP's certificate to maintain twenty-five such tanks. Aboveground petroleum storage is regulated by New York State regulations under 6 NYCRR Parts 612, 613, and 614. The WVDP maintains eight aboveground petroleum storage tanks that are registered with New York State.

Waste Minimization

A number of waste minimization activities were carried out in 1993, including the following:

- The WVDP's goal is to reduce the generation of all categories of radioactive and hazardous waste by 25% over a five-year period, with an annual goal of 5%. In 1993, the program's third year, waste minimization efforts exceeded the three-year goal of a 15% reduction.
- After completion of a successful pilot study, the WVDP instituted a site-wide paper recycling program in March 1993. By the end of 1993 approximately 179,000 pounds of paper had been sent off-site for recycling.
- The WVDP shipped approximately 12,000 pounds of hazardous materials off-site for recycling, reclamation, or recovery. These materials included unused paints, used batteries, and used oil.
- Low-level radioactive waste compacting reduced the volume of waste generated from more than 15,000 cubic feet to less than 4,000 cubic feet.
- Many common materials were recycled or reused, including 1,005 wooden pallets, 951 cardboard boxes, and 48,900 aluminum pop cans.
- An environmental awareness day for all WVDP employees emphasized the importance of waste minimization and pollution prevention.

National Environmental Policy Act (NEPA)

The National Environmental Policy Act establishes the nation's policies for the protection of the environment. Its goals are to prevent or eliminate damage to the environment. The President's Council on Environmental Quality, established by NEPA, carries out this policy. Its regulations are found in the Code of Federal Regulations, Title 40, Parts 1500-1508 (40 CFR 1500-1508). Since 1990 the DOE has been revising its NEPA-compliance program, which was approved by the President's Council on Environmental Quality and was codified in 10 CFR 1021. This regulation went into effect on May 26, 1992.

NEPA requires that all federal agencies proposing major actions that could significantly affect the quality of the human environment prepare detailed environmental statements.

The DOE implements NEPA by requiring an environmental review of all proposed activities. If the proposed action will have an insignificant effect on the environment it is excluded from further environmental review under a categorical exclusion. If the proposed action could have an effect on the environment, then it is reviewed through an environmental assessment. If the results of the assessment indicate no effect on the environment, then a finding of no significant impact is issued. A proposed action that could have a significant effect on the environment is reviewed through an environmental impact statement.

Both environmental assessments and environmental impact statements are available to the public. NEPA requires that the public be notified of and given the opportunity to review and comment on environmental impact statements.

1993 NEPA Activities

Sixteen proposed actions regarding facility maintenance and operation were evaluated under the Department of Energy's NEPA-implementing regulations during 1993. Ten were categorically excluded. Five are eligible for categorical exclusion and are awaiting approval. The last proposed action, which concerns management of low-level waste, is awaiting a determination on the appropriate level of NEPA review.

The Supplement Analysis to the 1982 High-level Waste Stabilization environmental impact statement was approved by DOE headquarters. This analysis presents information on modifications to the design and operational aspects of solidification activities that have changed since the environmental impact statement was issued. The analysis demonstrates that the changes do not significantly affect the environment or the 1982 Record of Decision.

During 1993 an environmental assessment was initiated to evaluate management options concerning the remaining spent nuclear fuel stored at the WVDP.

Preparation of the draft environmental impact statement for Project completion by the DOE and site closure or long-term management by NYSERDA continued in 1993. Six alternatives have been developed and are being evaluated.

Summary of Permits

Environmental permits in effect at the Project during 1993 are listed in Table B-3 of *Appendix B*.

Current Issues and Actions

Resource Conservation and Recovery Act (RCRA)

In 1992 the WVDP completed negotiations with the EPA and NYSDEC for a Federal and State Facility Compliance Agreement (FSFCA) regarding compliance with RCRA regulations pertaining to radioactive mixed waste management, including compliance with RCRA land disposal restrictions (LDRs). The agreement also provides a plan and schedule to address container storage and waste analysis issues at the WVDP. This agreement became effective on March 23, 1993. Implementation of the FSFCA has resolved a 1992 Notice of Noncompliance from the EPA that had detailed mixed waste compliance issues at the WVDP.

The RCRA 3008(h) Administrative Order on Consent is an agreement between NYSDEC, the EPA, NYSERDA, and the DOE about the kind and extent of work needed to identify and evaluate any hazardous waste or hazardous constituent that may have been released at the WVDP site. The Consent Order requires NYSERDA and the West Valley Project Office to conduct investigations at solid waste management units (SWMUs) to determine if there has been a release or if there is a potential for release of hazardous waste constituents.

The following activities were completed under the RCRA 3008(h) Consent Order during calendar year 1993:

- Comments were received from NYSDEC and the EPA on the RCRA Facility Investigation (RFI) Work Plan, which identifies the strategy for investigating solid waste management units at the WVDP. After these comments were successfully incorporated into the Work Plan, sampling for an expanded group of groundwater parameters and soils began. The soil and sediment sampling portion of the investigation was completed in December 1993. Samples collected during the investigation have been analyzed. Results of these analyses will be evaluated during 1994.

The first of two expanded groundwater sampling events was conducted in the last quarter of 1993 to support the RFI Work Plan. The second round of sampling is scheduled for mid-1994. The groundwater samples from these two expanded rounds will be analyzed during 1994.

- As required by the Consent Order, the WVDP informed the EPA and NYSDEC of the existence of a number of minor solid waste management units that had been identified during the investigation process. Additional assessment activities are being implemented to appropriately characterize these areas.

  Pursuant to the Consent Order and following evaluation of analytical results, the RFI Work Plan specifies a schedule for issuing RFI reports in 1995 and 1996. These reports will include data collected during SWMU investigations and will be sent to the EPA and NYSDEC.

Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)

On February 5, 1993, the WVDP was listed in the EPA's Federal Agency Hazardous Waste Compliance docket. This action will result in an evaluation of the WVDP to ascertain its status relative to CERCLA requirements. On October 5, 1993, the WVDP submitted a CERCLA Preliminary Assessment to the EPA for their review. This assessment evaluated waste management at the WVDP along with the likelihood of release and possible effects on human health and the environment. Based on a standardized scoring scheme, these factors were used to rank risks from the site. The DOE concluded in the assessment that no further investigation of the facility pursuant to CERCLA Section 120 is warranted and that the site does not qualify for the National Priorities List. This was based on the score attained in the preliminary assessment and the fact that Project facilities are currently being remediated in accordance with the provisions of the WVDP Act and the RCRA 3008(h) Order on Consent.

Project Assessment Activities in 1993

West Valley Nuclear Services Company, Inc. (WVNS), as management and operating contractor for the DOE at the WVDP, conducted more than eighty reviews of environmentally related activities in 1993. These included departmental self-assessments and internal audits, appraisals, and surveillances. In addition, there were more than ten reviews conducted by organizations external to WVNS (e.g., the DOE, NYSDEC, and the EPA).

More significant external environmental surveillance activities conducted in 1993 included a Comprehensive Groundwater Monitoring Evaluation conducted by NYSDEC and an extensive audit of the WVDP radiological monitoring program by the NRC. There were also routine joint annual inspections by NYSDEC and the EPA to assess compliance with National Emissions Standards for Hazardous Air Pollutants (NESHAP) and Resource Conservation and Recovery Act (RCRA) regulations. While formal reports have not yet been issued, preliminary results do not indicate any significant findings.

NYSDEC conducted the annual SPDES inspection at the WVDP on March 29, 1993, to gauge compliance with Clean Water Act requirements. No citations were issued and the WVDP was found to be in full compliance.

Follow-up to the Department of Energy 1992 Environmental Audit

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The WVDP will be forwarding its Corrosion Control Treatment Plan to the Cattaraugus County Health Department during the first quarter of 1994. This plan will outline steps toward lowering drinking water concentrations of lead on-site to below the mandated action level. (See **Safe Drinking Water Act**, *Environmental Compliance Summary: Calendar Year 1993*.) While remedial steps are being taken, the frequency of sampling and analysis has been increased in order to monitor the situation.

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Progress on implementation of the RCRA 3008(h) Consent Order continues. The quarterly progress report for the last quarter of calendar year 1993, including groundwater monitoring results, was submitted on schedule in early 1994.

ENVIRONMENTAL MONITORING

Pathway Monitoring

The effluent and environmental monitoring program provides data on surface waters, soils, sediments, food and produce, and on the effluent air and liquids that could provide pathways for the movement of radionuclides or hazardous substances from the facility to the public. Both radiological and nonradiological parameters are monitored in order to ascertain the effect of Project activities.

Sediments are sampled upstream and downstream of the WVDP. The food pathway is monitored by collecting samples of beef, hay, milk, and produce at both near-site and remote locations, samples of fish upstream and downstream of the site, and venison samples from the on-site deer herd and from background locations. Direct radiation on-site, at the perimeter of the site, and at background locations is also monitored to provide additional data.

The primary focus of the monitoring program, however, is on air and water pathways, as these would be the major means of transport of radionuclides from the site.

Air and Liquid Pathways

Air and liquid effluents are monitored on-site by collecting samples at locations where small amounts of radioactivity or other regulated substances are released or might be released. These include plant ventilation stacks and various water effluent outfalls.

Surface water samples are collected from the tributaries of Cattaraugus Creek that flow through the Western New York Nuclear Service Center and from drainage channels within the Project site.

Both air and water samples are collected at perimeter locations where the highest concentrations of transported radionuclides might be expected. Samples are also collected at remote locations to provide background concentration data.

Sampling Codes

The complete environmental monitoring schedule is detailed in *Appendix A*. This schedule provides information on monitoring and reporting requirements and the types and extent of sampling and monitoring at each location. An explanation of the codes that identify the sample medium and the specific sampling or monitoring location is also found in *Appendix A*. For example, a sample location code such as AFGRVAL indicates an air sample (A), off-site (F), at the Great Valley (GRVAL) sampling station.

These codes are used throughout this report for ease of reference and to be consistent with the data reported in the appendices.

Air Sampler Location and Operation

Air samplers are located at points remote from the West Valley Demonstration Project site, at the perimeter of the site, and on the site itself. Figure 2-1 shows the locations of the on-site air samplers; Figure 2-2 and Figure A-9 in *Appendix A* show the location of the perimeter and remote air samplers.

Air samples are collected by drawing air through a very fine filter with a vacuum pump. The total volume of air drawn through the sampler is measured and recorded. The filter traps particles of dust that are then tested in the laboratory for radioactivity. At the Rock Springs Road and Great Valley locations samples are also collected for iodine-129 and tritium analyses. (A more detailed description of the air sampling program follows below.)

Water Sampler Location and Operation

Automatic samplers collect surface water at points along drainage channels within the WNYNSC that are most likely to show any radioactivity released from the site and at a background station upstream of the site. (Grab samples are collected at several other surface water locations both on- and off-site.) Figure 2-3 shows the location of the on-site surface water monitoring points. (On-site automatic sampler locations are WNSP006, WNNDADR, and WNSW74A.) Figure 2-4 shows the location of the off-site automatic surface water monitoring points. (Off-site locations are WFBCTCB, WFFELBR, and the background location, WFBCBKG.)

Water samplers draw water through a tube extending to an intake below the stream surface. An electronically controlled battery-powered pump first blows air through the sample line to clear any debris. The pump then reverses to collect a sample, reverses again to clear the line, then resets itself. The cycle is repeated after a preset interval. The pump and sample container are housed in an insulated and heated shed to allow sampling throughout the year. (A more detailed description of the water sampling program follows below.)

Radiological Monitoring

Air Monitoring

On-site Ventilation Systems

Permits obtained from state and federal agencies allow air to be released from plant ventilation stacks during normal operations. The air released must meet certain federal and state criteria that ensure that the environment and the public's health and safety are not adversely affected by these releases.

Parameters measured include gross alpha and gross beta, tritium, and various isotopes such as cesium-137 and strontium-90. When comparing concentrations with dose limits for screening purposes, gross alpha and beta radioactivities are assumed to come from americium-241 and strontium-90, respectively, because the derived concentration guides (DCGs) for these isotopes are the most stringent. (Department of Energy standards and DCGs for radionuclides of interest at the West Valley Demonstration Project are found in *Appendix B*.)

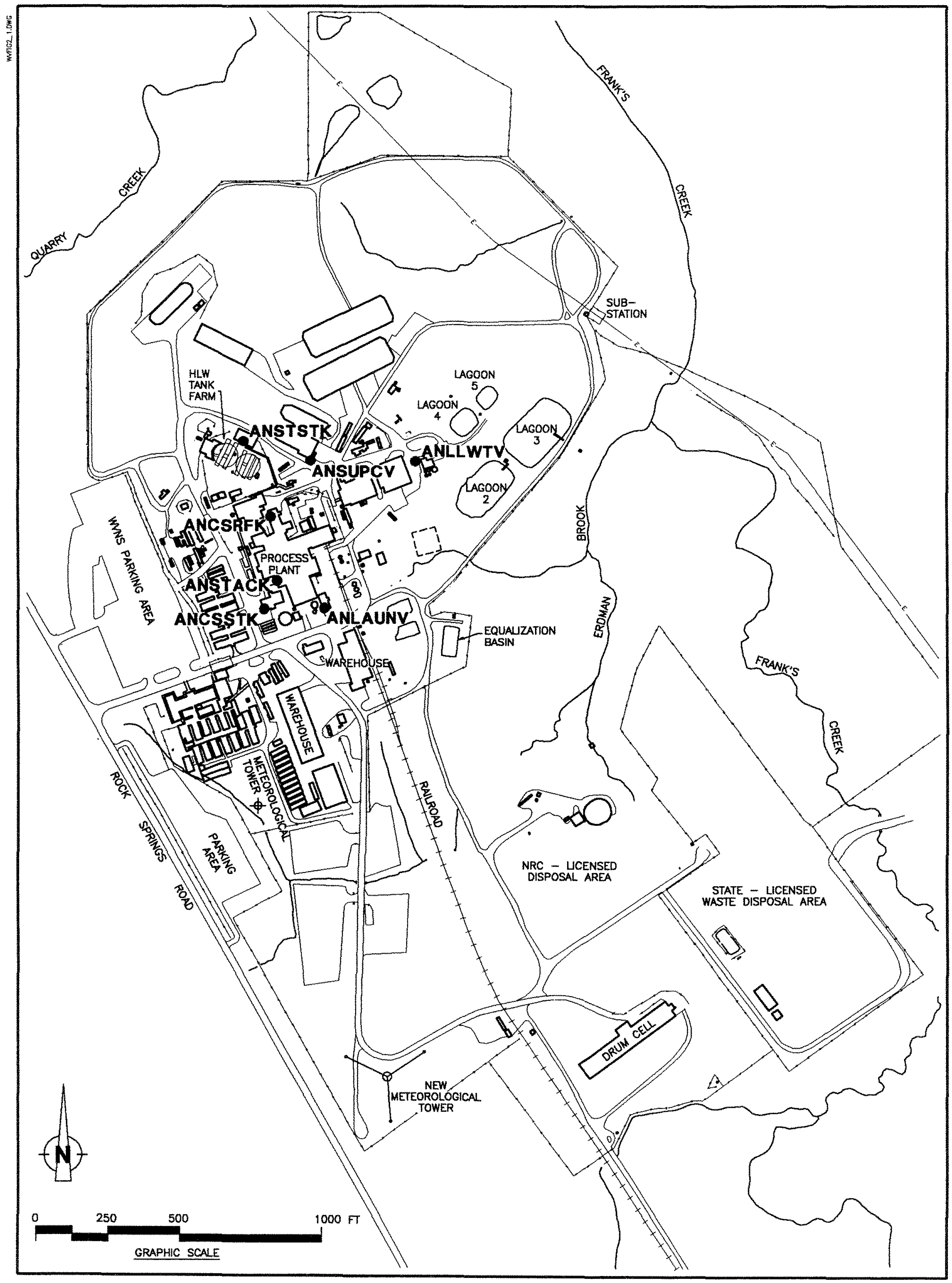


Figure 2-1. Location of On-site Air Effluent Monitoring Points.

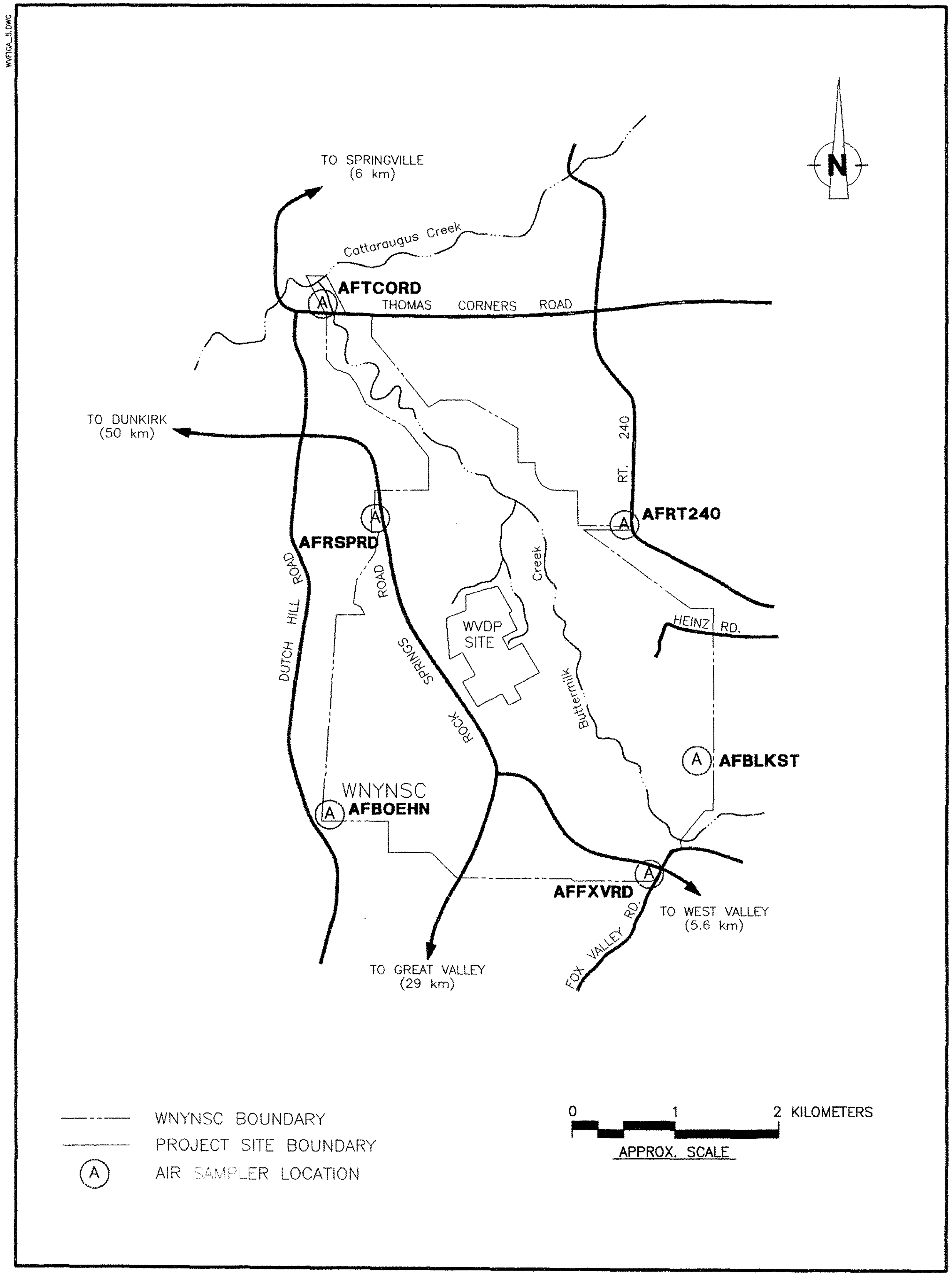


Figure 2-2. Location of Perimeter Air Samplers.

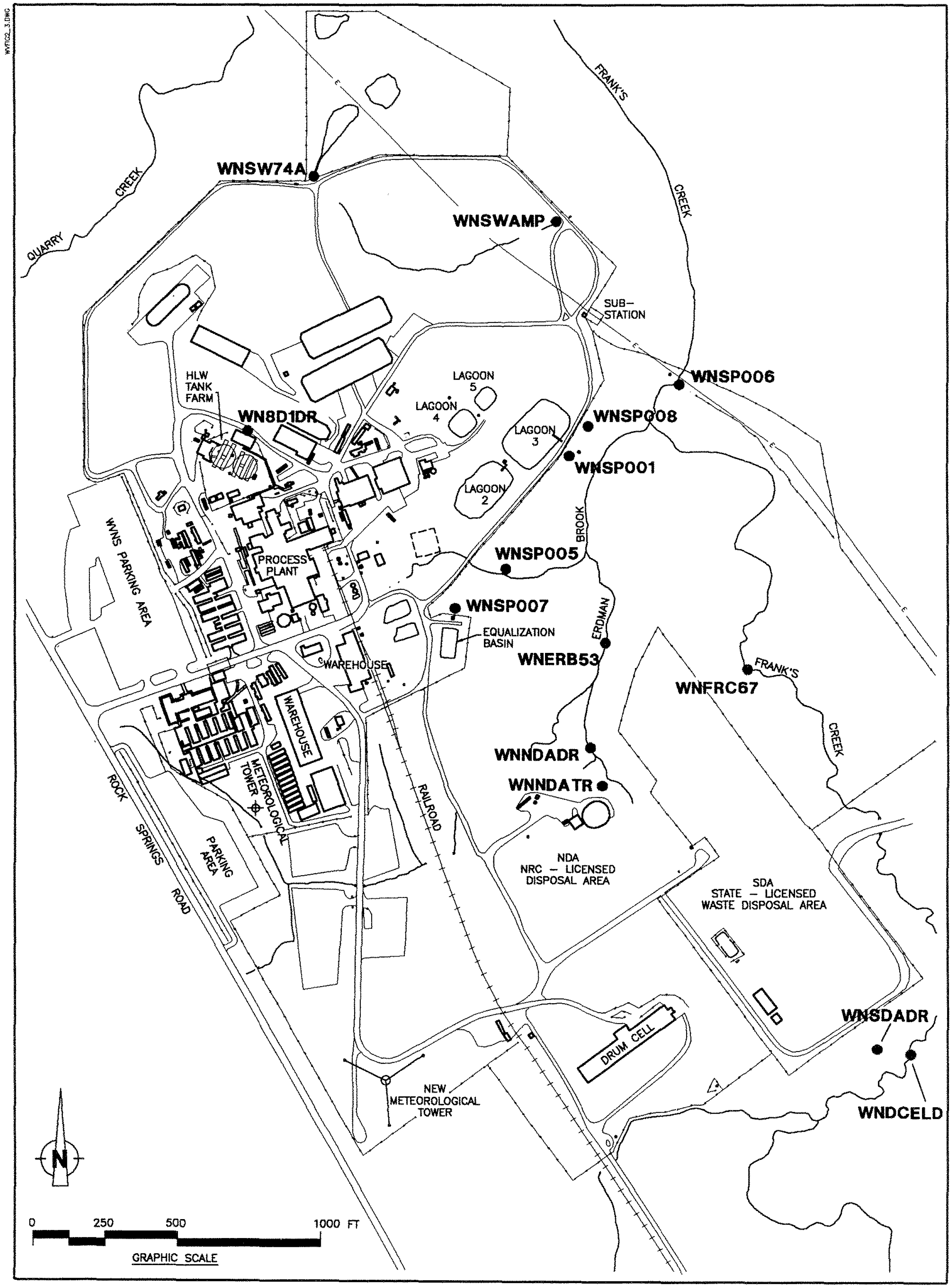


Figure 2-3. Sampling Locations for On-site Surface Water.

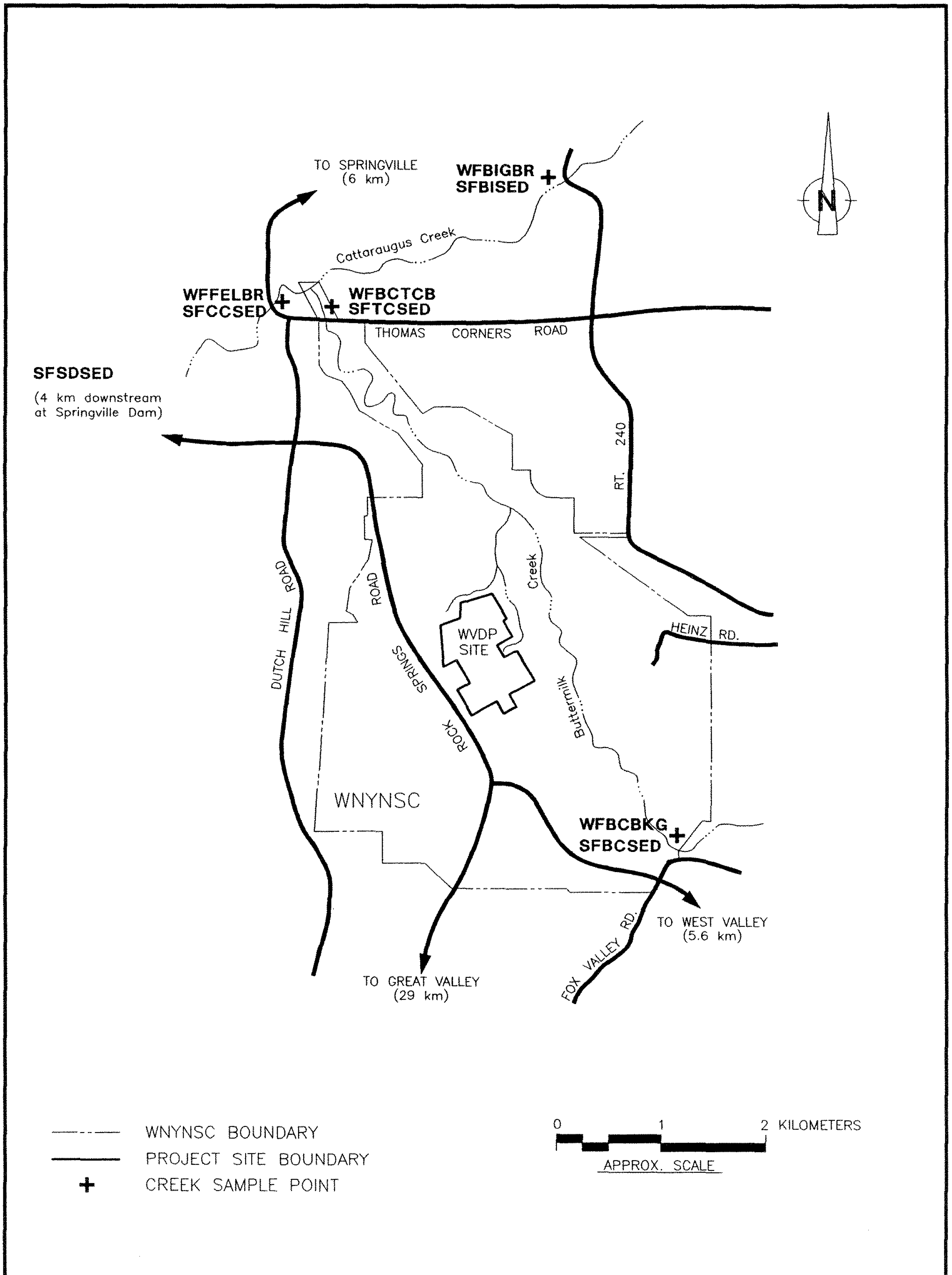


Figure 2-4. Location of Off-site Surface Water Samplers and Sediment Collection.

The exhaust from each permitted fixed ventilation system on-site is continuously filtered, monitored, and sampled as it is released to the atmosphere. Specially designed isokinetic sampling nozzles continuously remove a representative portion of the exhaust air, which is then drawn through very fine glass fiber filters to trap any particles. Sensitive detectors continuously measure the radioactivity on these filters and provide readouts of alpha and beta radioactivity levels.

A separate sampling unit on the ventilation stack of continuously operated systems contains another filter that is removed every week and tested in the laboratory. This sampling system also may contain an activated carbon cartridge used to collect a sample that is analyzed for iodine-129.

In addition to these samples, water vapor from the main plant ventilation stack (ANSTACK) and the supernatant treatment system (ANSTSTK) is collected by trapping moisture in silica gel desiccant columns. The trapped water is distilled from the silica gel desiccant and analyzed for tritium.

Because tritium, iodine, and other isotopic concentrations are quite low, the large-volume samples collected weekly from the main plant stack and from other emission-point samplers provide the only practical means of determining the amount of specific radionuclides released from the facility.

- The Main Plant Ventilation Stack

The main ventilation stack sampling system monitors the most significant airborne effluent point. A high sample collection flow rate through multiple intake nozzles ensures a representative sample for both the weekly filter sample and the on-line monitoring system. The total quantity of gross alpha, gross beta, and tritium (H-3) released each month from the main stack, based on weekly filter measurements, is shown in *Appendix C-2,* Table C-2.1. Figure 2-5 shows the seven-year trends for the main stack samples analyzed for gross alpha and gross beta activity. The figure indicates a steady five-year downward trend in activity observed for both gross alpha and gross beta from 1987 to mid-1992. Since then and throughout 1993 both gross alpha and beta activities appear to have risen slightly.

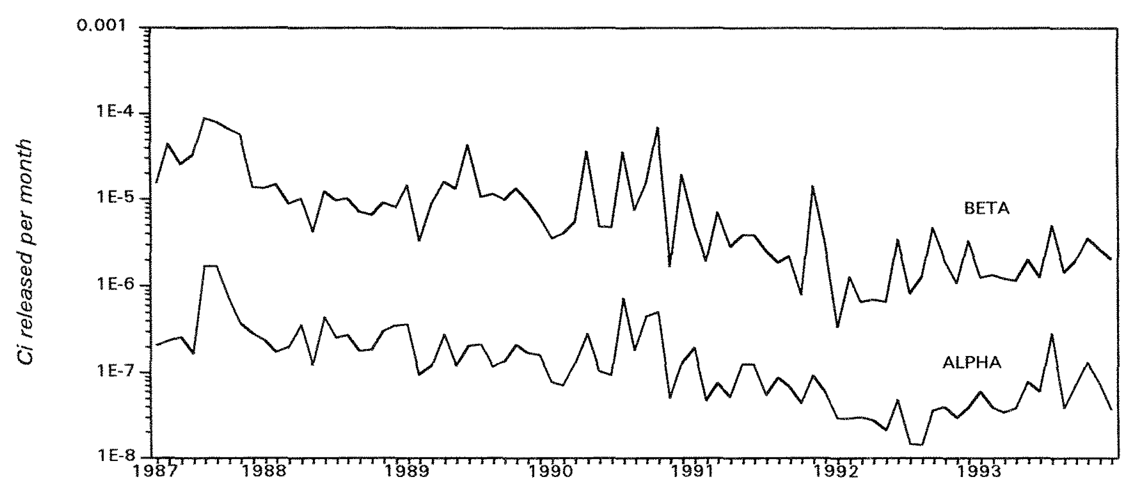
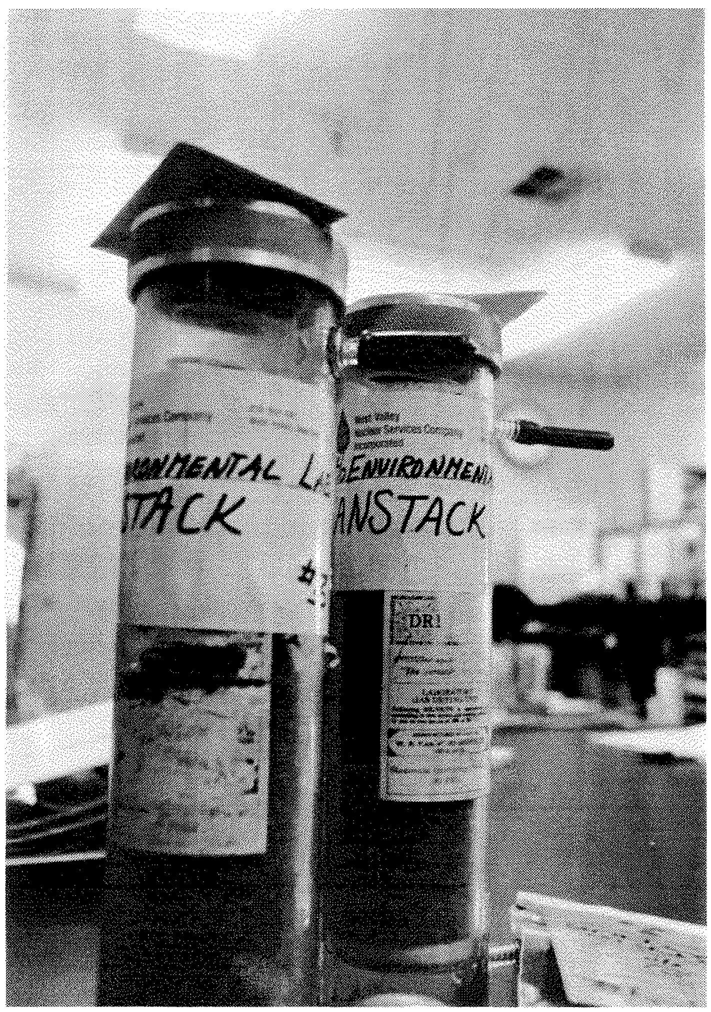


Figure 2-5. Seven-Year Trends of Gross Alpha and Gross Beta Concentrations at the Main Stack Sampling Location (ANSTACK)

Analyses of specific radionuclides in the four quarterly composites of the main stack effluent samples are listed in Table C-2.2. A comparison of the average concentrations of these measured isotopes with Department of Energy derived concentration guides (DCGs) in Table C-2.3 shows that at the point of stack discharge, average radioactivity levels were already below concentration guidelines for airborne radioactivity in an unrestricted environment. Further dilution from the stack to the site boundary reduces the concentration by an average factor of about 200,000.



Silica Gel Columns from the Main Ventilation Stack Sampler

- Other On-site Sampling Systems

Sampling systems similar to those of the main stack monitor airborne effluents from the cement solidification system ventilation stack (ANCSSTK), the contact size-reduction facility ventilation stack (ANCSRFK), and the supernatant treatment system ventilation stack (ANSTSTK). The 1993 samples showed detectable gross radioactivity, including specific beta- and alpha-emitting isotopes, but did not approach any Department of Energy effluent limitations. Tables C-2.4 through C-2.9 in *Appendix C-2* show monthly totals of gross alpha and beta radioactivity and quarterly total radioactivity released for specific radionuclides for each of these sampling locations.

Three other operations are routinely monitored for airborne radioactive releases: the supercompactor volume reduction ventilation system (ANSUPCV), the low-level waste treatment facility ventilation system (ANLLWTF), and the contaminated clothing laundry ventilation system (ANLAUNV). Results for samples collected in 1993 from the supercompactor ventilation (ANSUPCV) are presented in Tables C-2.10 and C-2.11 in *Appendix C-2*. ANLLWTF and ANLAUNV sampling points are monitored for gross alpha and gross beta.

Permitted portable outdoor ventilation enclosures (OVEs) are used occasionally to provide the ventilation necessary for the safety of personnel working with radioactive materials in areas outside of permanently ventilated facilities. Air samples from OVEs are included in annual airborne emission evaluations.

Perimeter and Remote Air Sampling

As in previous years, airborne particulate samples for radiological analysis

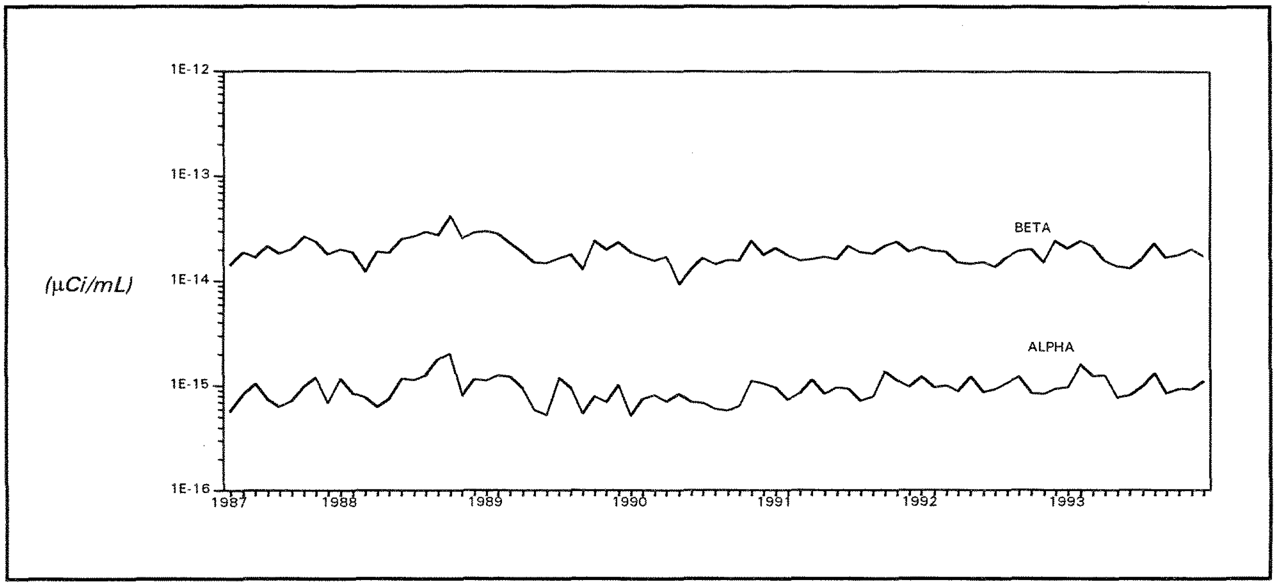


Figure 2-6. Seven-Year Trends of Gross Alpha and Gross Beta Concentrations at the Rock Springs Road Sampling Location (AFRSPRD)

were collected continuously at six locations around the perimeter of the site and at four remote locations at Great Valley, West Valley, Springville, and Dunkirk, New York. (See Fig. 2-2 and Fig. A-9 in *Appendix A*.)

Perimeter locations — on Fox Valley Road, Rock Springs Road, Route 240, Thomas Corners Road, Dutch Hill Road, and the site's bulk storage warehouse — were chosen to provide historical continuity or because the location would probably represent the highest potential airborne concentration of radioactivity. The seven-year trends of concentrations of gross alpha and gross beta at the Rock Springs Road location are shown in Figure 2-6.

The remote locations provide data from nearby communities — West Valley and Springville — and from natural background areas. Concentrations measured at Great Valley (AFGRVAL, 29 km south of the site) and Dunkirk (AFDNKRK, 50 km west of the site) are considered representative of natural background radiation.

The six perimeter samplers and the four remote samplers maintain an average flow of about 40 L/min (1.4 ft^3/min) through a 47-mm glass fiber filter. The sampler heads for each of the locations are set at 1.7 meters above the ground, the height of the average human breathing zone.

Filters from off-site and perimeter samplers are collected weekly and analyzed after a seven-day "decay" period to remove interference from short-lived naturally occurring radioactivity. Gross alpha and gross beta measurements of each filter are made weekly using a low-background gas proportional counter. The gross alpha and gross beta ranges and annual averages for each of the off-site sampling points are provided in Tables 2-1 and 2-2. The concentration ranges observed are similar to those seen in 1992. Near-site sample concentrations are indistinguishable from background and they all reflect normal seasonal variations.

In addition, quarterly composites each consisting of thirteen weekly filters from each sample station are analyzed. Data from these samplers are provided in *Appendix C-2,* Tables C-2.12 through C-2.20 and C-2.23.

Table 2-1

1993 Gross Alpha Activity at Off-site and Perimeter Ambient Air Sampling Locations

Location	Number of Samples	Range μCi/mL	Range Bq/m³	Annual Average μCi/mL	Annual Average Bq/m³
AFFXVRD	52	<0.48–2.71E-15	<0.18–1.00E-04	1.09±1.04E-15	4.03 ±3.85E-05
AFRSPRD	52	<0.67–2.11E-15	<2.48–7.81E-05	9.64±9.66E-16	3.57 ±3.57E-05
AFRT240	52	<0.60–2.72E-15	<0.22–1.01E-04	1.10±1.03E-15	4.07 ±3.81E-05
AFSPRVL	52	<0.64–2.04E-15	<2.37–7.55E-05	0.98±1.01E-15	3.62 ±3.74E-05
AFTCORD	52	<0.63–2.36E-15	<2.33–8.73E-05	9.03±9.95E-16	3.34 ±3.68E-05
AFWEVAL	52	<0.64–1.98E-15	<2.37–7.33E-05	9.21±9.93E-16	3.41 ±3.67E-05
AFGRVAL	52	<0.64–3.81E-15	<0.24–1.41E-04	0.95±1.05E-15	3.53 ±3.89E-05
AFBOEHN	52	<0.26–4.21E-15	<0.10–1.56E-04	0.96±1.07E-15	3.57 ±3.96E-05
AFDNKRK	52	<0.76–2.67E-15	<2.81–9.88E-05	1.18±1.07E-15	4.37 ±3.96E-05
AFBLKST	52	<0.63–2.18E-15	<2.33–8.07E-05	0.98±1.04E-15	3.62 ±3.85E-05

Table 2-2

1993 Gross Beta Activity at Off-site and Perimeter Ambient Air Sampling Locations

Location	Number of Samples	Range μCi/mL	Range Bq/m³	Annual Average μCi/mL	Annual Average Bq/m³
AFFXVRD	52	0.74–3.03E-14	0.27–1.12E-03	1.98±0.33E-14	7.31 ±1.21E-04
AFRSPRD	52	0.72–3.14E-14	0.27–1.16E-03	1.81±0.31E-14	6.69 ±1.13E-04
AFRT240	52	0.71–3.00E-14	0.26–1.11E-03	1.79±0.32E-14	6.63 ±1.16E-04
AFSPRVL	52	0.79–3.17E-14	0.29–1.17E-03	1.83±0.32E-14	6.76 ±1.18E-04
AFTCORD	52	0.64–3.56E-14	0.24–1.32E-03	1.87±0.32E-14	6.92 ±1.20E-04
AFWEVAL	52	0.86–2.92E-14	0.32–1.08E-03	1.80±0.32E-14	6.66 ±1.19E-04
AFGRVAL	52	0.51–3.14E-14	0.19–1.16E-03	1.82±0.33E-14	6.73 ±1.22E-04
AFBOEHN	52	0.39–3.31E-14	0.14–1.22E-03	1.82±0.33E-14	6.73 ±1.24E-04
AFDNKRK	52	0.89–4.01E-14	0.33–1.48E-03	1.99±0.33E-14	7.37 ±1.23E-04
AFBLKST	52	0.76–3.45E-14	0.28–1.28E-03	1.74±0.32E-14	6.43 ±1.19E-04

Detectable concentrations of iodine-129 at the Rock Springs Road location (AFRSPRD) are below a positive detection seen at the Great Valley location (AFGRVAL).Tables C-2.13 and C-2.18 in *Appendix C-2* contain the data for the Rock Springs Road and Great Valley samplers. Although tritium (as hydrogen-tritium oxide [HTO]) was positively detected at the Rock Springs Road location near the site, its concentration was only marginally higher than or identical to concentrations observed at the Great Valley background location. A positive strontium-90 value attained at location AFWEVAL in the fourth quarter of 1993 is comparable to detection limit values attained at the Dunkirk background location.

Global Fallout Sampling

Global fallout is sampled at four of the perimeter air sampler locations and at the base of the original on-site meteorological tower. Precipitation from all of the locations is collected and analyzed every month. Results from these measurements are reported in nCi/m2 per month for gross alpha and gross beta and in mCi/mL for tritium. (The 1993 data from these analyses are found in Appendix C-2, Table C-2.21. Table C-2.22 contains precipitation pH measurement data.)

Fallout-pot data indicate short-term effects; the reporting units for gross alpha and gross beta indicate a rate of deposition rather than the actual concentration of activity within the collected water. Long-term deposition is measured by surface soil samples collected annually near each air sampling station. Soil sample data are found in Table C-1.10 of Appendix C-1.

The measured concentrations are typical of normal background in the region, with one exception. Soil from the Rock Springs Road air sampler has consistently shown a higher than normal cesium-137 concentration. This sampler is known to be within an extended area of elevated cesium activity that was identified by a 1979 survey, well before the Project was initiated. However, a review of 1991 and 1992 data shows that soil from the Route 240 site was reported to contain less cesium-137 than the average for the four remote locations. The higher-than-average value reported in 1993 is considered a statistical anomaly not indicative of an actual, significant increase at that location during the past year.

The 1993 data for the three samplers that have been in operation since 1982 — Fox Valley, Thomas Corners, and Route 240 — averaged about 1.88E-14µCi/mL (6.96E-04 Bq/m^3) of gross beta activity in air. This average is comparable to 1992 data. The average gross beta concentration at the Great Valley background station was 1.58E-14µCi/mL (5.85E-04 Bq/m^3) in 1992, and in 1993 averaged 1.82E-14µCi/mL (6.73E-04 Bq/m^3).

Beginning in mid-1993 the four ambient air samplers at locations AFBOEHN, AFDNKRK, AFGRVAL, and AFWEVAL began running in parallel with identical samplers located within one mile of their original positions in order to study the effects of relocating these sampling points to more open areas, where trees and other obstructions would not interfere with sample collection. The results of this study are currently being evaluated.

Surface Water and Sediment Monitoring

On-site Surface Water Sampling

The largest single source of radioactivity released to surface waters from the Project is the discharge from the low-level waste treatment facility through the lagoon 3 weir (WNSP001, Fig. 2-3) into Erdman Brook, a tributary of Frank's Creek. There were seven batch releases totaling about 39.4 million liters (10.4 million gal) in 1993. In addition to composite samples collected near the beginning and end of each discharge, forty-nine daily effluent grab samples were collected and analyzed.

A water sampling station (WNSP006) is located on Frank's Creek where Project site drainage leaves the security-fenced area. (See Fig. 2-3.) This sampler collects a 50-mL aliquot every half-hour. Samples are retrieved weekly and composited both monthly and quarterly. (See Table C-1.5.) Weekly samples are analyzed for tritium and gross alpha and beta radioactivity as well as pH and conductivity. The monthly composite is analyzed for strontium-90 and gamma-emitting isotopes and total uranium. A quarterly composite is analyzed for carbon-14, iodine-129, alpha-emitting isotopes, and total uranium. (See Table C-1.6.)

The north and northeast swamp drainages on the site's north plateau are two major routes for surface water and groundwater flow to the surface. Samples from the north swamp drainage are collected by an automated sampler at location WNSW74A on a weekly basis. (See Fig. 2-3.) Grab samples are collected weekly from the northeast swamp drainage at sampling point WNSWAMP. (See Fig. 2-3.) Samples from both locations are analyzed weekly for gross alpha, gross beta, tritium, pH, and conductivity. Composites of weekly samples are also analyzed for a full range of specific isotopes. Semiannual grab samples from these locations are analyzed for important chemical parameters.

Sampling points WNSP005, which monitors drainage from the facility backyard, and WNFRC67, which monitors surface waters draining from the east side of the SDA, are both grab sampled on a

Springville Dam on Cattaraugus Creek

weekly basis. Samples are analyzed for pH, gross alpha, gross beta, and tritium.

Another sampling point, WN8D1DR, is used to monitor surface and groundwater flow from the high-level waste tank farm area. The sample is collected from a sewer manhole access and is analyzed weekly for gross alpha and beta, tritium, and pH, and a quarterly composite is analyzed for gamma isotopes and strontium-90.

The surface water drainage path downstream of the NDA is monitored at location WNNDADR using an automated sampler. Weekly samples are composited and analyzed on a monthly basis for gross alpha, gross beta, tritium, and gamma-emitting isotopes. Quarterly composites analyzed for strontium-90 and iodine-129 and semiannual grab samples analyzed for chemical parameters provide data useful for confirming the effectiveness of NDA remediation efforts. (See **Special Monitoring** below.)

Downstream of WNNDADR, on Erdman Brook and to the west of the SDA, is sampling point WNERB53. Weekly samples collected from this point are analyzed for pH, gross alpha, gross beta, and tritium. In addition to samples collected by the WVDP at this point, independent samples are collected and analyzed by NYSDOH at this location and at WNFRC67, which monitors waters draining from the east side of the SDA.

Off-site Surface Water Sampling

An off-site sampler (WFFELBR) is located on Cattaraugus Creek at Felton Bridge just downstream of Cattaraugus Creek's confluence with Buttermilk Creek, which is the major surface drainage from the Western New York Nuclear Service Center. (See Fig. 2-4.) The sampler periodically collects an aliquot (a small volume of water, approximately 50 mL every half-hour) from the creek. A chart recorder registers the stream depth during the sampling period so that a flow-weighted weekly sample can be proportioned into a monthly composite. The weekly samples are analyzed for gross alpha, gross beta, and tritium each week, and the sample composite is analyzed for strontium-90 and gamma-emitting isotopes.

In addition to the Cattaraugus Creek sampler, two surface water monitoring stations are located on Buttermilk Creek both upstream and downstream of the WVDP. (See Fig. 2-4.) Samplers collect water from a background location upstream of the Project at Fox Valley Road (WFBCBKG) and from a location at Thomas Corners Road that is downstream of the plant and upstream of Buttermilk Creek's confluence with Cattaraugus Creek (WFBCTCB).

The samplers collect a 25-mL aliquot every half-hour. Samples are retrieved biweekly, composited monthly, and analyzed for tritium, gross alpha, and gross beta radioactivity. A quarterly composite of the biweekly samples is analyzed for gamma-emitting isotopes and strontium-90. Quarterly composite samples from WFBCBKG also are analyzed for carbon-14, iodine-129, alpha isotopes, and total uranium. (Table C-1.3 shows monthly and quarterly radioactivity concentrations upstream of the site at Fox Valley; Table C-1.4 shows monthly and quarterly radioactivity concentrations downstream of the site at Thomas Corners.)

Radioactivity Concentrations On-site: Low-level Waste Treatment Facility

The total amounts of radioactivity from specific radionuclides in the lagoon 3 effluent are listed in Table C-1.1. As a DOE policy, the sum of the percentages of the observed average concentration of each radionuclide versus its corresponding DCG must not exceed 100%. In 1993 the annual average isotopic concentrations from the lagoon 3 effluent discharge weir combined to be less than 47% of the derived concentration guides (DCGs), up from 31% in 1992. (See Table C-1.2.) This increase is due to a shift toward higher concentrations of strontium-90 and uranium-232 in process water. The average concentration of cesium-137 has declined since 1992. An evaluation of these ratio changes is being conducted.

Radioactivity Concentrations On-site: Surface Water Sampling Locations

North Swamp Sampling Location

Results for samples collected at location WNSW74A, which monitors drainage from the northern end of the site to Quarry Creek, are summarized in *Appendix C-1*,Tables C-1.14 and C-1.15. Gross beta concentrations at this location are three to sixteen times higher than those observed at background location WFBCBKG but still fifty times lower than the DCG for strontium-90. Tritium at this location is below the detection limit. The highest monthly strontium-90 result at WNSW74A was less than 2% of its DCG.

Northeast Swamp Sampling Location

Sampling point WNSWAMP also monitors surface water drainage from the site's north plateau. (See *Appendix C-1*, Tables C-1.12 and C-1.13.) Waters from this drainage run into Frank's Creek downstream of location WNSP006. Together with location WNDMPNE, results from this location also indicate the quality of emergent groundwaters in the area. An upward trend in gross beta concentration during 1993 at location WNSWAMP, approaching the Department of Energy DCG for strontium-90, is discussed in *Chapter 3, Groundwater Monitoring,* **Long-term Trends of Gross Beta and Tritium at Selected Groundwater Monitoring Locations**. The average tritium concentration at this location in 1993 was 3.90E-07µCi/mL, which is above that observed at the background location WFBCBKG but well below the DCG for tritium of 2E-03µCi/mL.

NDA Sampling Locations

Gross beta concentrations at location WNNDADR averaged 2.22E-07µCi/mL in 1993.(See Table C-1.22 in *Appendix C-1*.) Concentrations at this location were above those seen at background location WFBCBKG by a factor of 24 to 240 but are all well below the DCG for strontium-90 of 1E-06µCi/mL. In fact, the highest quarterly composite isotopic strontium-90 result was only 12% of its DCG. The overall trend for gross beta concentrations at this location has remained relatively constant over time (Fig. 2-7). Except for seasonal variation, the same is true of tritium.

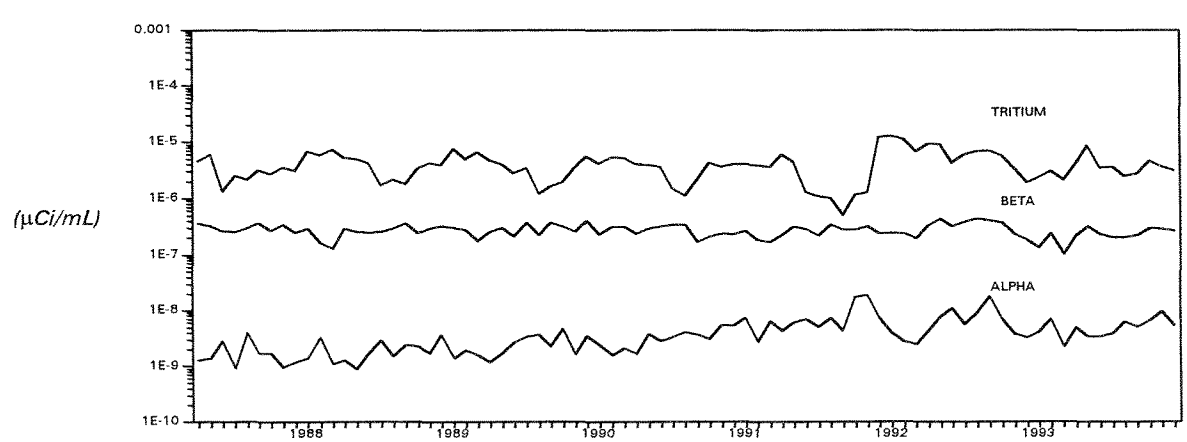


Figure 2-7. Seven-Year Trends of Gross Alpha, Gross Beta, and Tritium Concentrations at Sampling Location WNNDADR

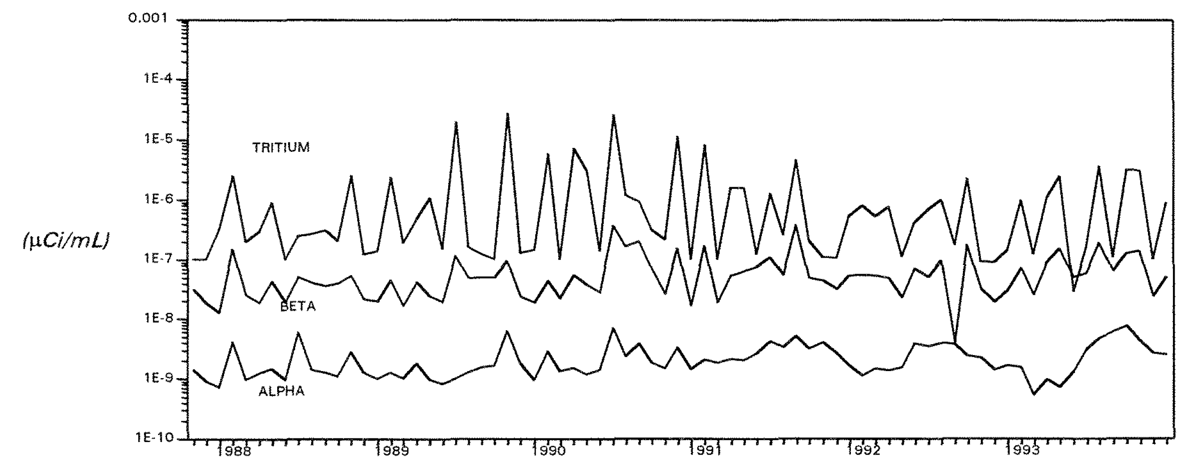


Figure 2-8. Six-Year Trends of Gross Alpha, Gross Beta, and Tritium Concentrations at Sampling Location WNSP006

A key indicator of any possible migration of solvent from the NDA would be the presence of significant iodine-129 in samples from WNNDADR. (See **Special Monitoring** below.) Although second and third quarter 1993 iodine-129 values at WNNDADR were marginally positive, they were not significantly higher than the analytical detection limit. Indeed, iodine-129 values attained for waters collected from the NDA interceptor trench, closer to the NDA, were all below the analytical detection limit. (See *Appendix C-1*, Table C-1.22.) It should be noted that while tritium activity in trench waters is higher than that seen at WNNDADR farther downstream, gross beta activity is actually higher downstream at WNNDADR than in waters from the interceptor trench. One possible explanation for this is that while the source of elevated tritium in the drainage may be the NDA, the major source of elevated gross beta activity may be contaminated soils outside and around the NDA.

Frank's Creek Sampling Location

At sampling location WNSP006 at the Project security fence more than 4 kilometers from the nearest public access point, the most significant beta-emitting radionuclides were measured at less than 3.22E-08μCi/mL (1.19 Bq/L) for cesium-137 and 5.16E-08μCi/mL (1.91 Bq/L) for strontium-90 during the month of highest concentration. This corresponds to 1.1% of the DCG for cesium-137 and 5.2% of the DCG for strontium-90. The annual average concentration of cesium at WNSP006 was less than 0.8% of the DCG and the strontium concentration was 2.7% of the strontium DCG. Tritium, at an annual average of 1.33E-06μCi/mL (4.92E+01 Bq/L), was 0.07% of the DCG value. Of the fifty-two samples collected and analyzed for gross alpha during 1993, eight were above the detection limit. The annual average was less than 5.11E-09μCi/mL gross alpha or 17% of the DCG for americium-241. The six-year trends of gross alpha, gross beta, and tritium concentrations at location WNSP006 are shown in Figure 2-8. The trend of baseline gross beta activity seems to be increasing slightly over time and possibly is related to the migration of historical site contamination. This trend is reflected in radiological measurements of stream flow during periods when lagoon 3 is not discharged and there is less surface runoff.

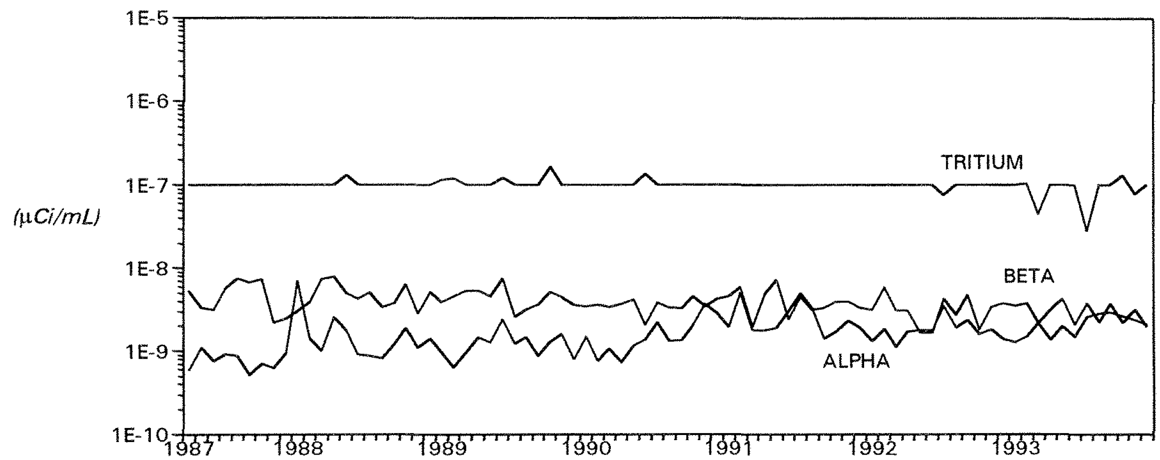


Figure 2-9. Seven-Year Trends of Gross Alpha, Gross Beta, and Tritium Concentrations at Sampling Location WFFELBR

Radioactivity Concentrations Off-site: Surface Water Sampling Locations

Radiological concentration data from off-site sample points show that average gross radioactivity concentrations generally tend to be higher in Buttermilk Creek below the WVDP site, presumably because small amounts of radioactivity from the site enter Buttermilk Creek via Frank's Creek. This is particularly observable during periods of lagoon 3 discharge. Tables 2-3 and 2-4 list the ranges and annual averages for gross alpha and gross beta activity at surface water locations.

Thomas Corners Bridge Sampling Location

These data show that concentrations downstream of the site are only marginally higher than background concentrations upstream of the site. For a perspective, note that if the maximum beta concentration in Buttermilk Creek downstream of the Project at Thomas Corners Bridge, to which dairy cattle have access, were assumed to be entirely from iodine-129, which is the most restrictive beta-emitting isotope, then the radioactivity would represent only 3.8% of the DCGs.

Cattaraugus Creek at Felton Bridge Sampling Location

The highest concentrations in monthly composite water samples from Cattaraugus Creek during 1993 show strontium-90 to be only 0.8% of the DCG for water. No gamma-emitting fuel cycle isotopes were detected in Cattaraugus Creek during 1993. (See Table C-1.7.) Yearly averages for Cattaraugus Creek gross beta activity at Felton Bridge are not significantly higher than background levels. Figure 2-9 shows the seven-year trends for Cattaraugus Creek samples analyzed for gross alpha, gross beta, and tritium. Gross beta activity appears to have declined at this location since 1987.

Sediment Sampling

Sediments are grab-sampled semiannually at or near three of the automatic water sampling locations and at two additional points. (See Fig. 2-4.) Downstream locations are Buttermilk Creek at Thomas Corners Road (SFTCSED), Cattaraugus Creek at Felton Bridge (SFCCSED), and Cattaraugus Creek at the Springville Dam (SFSDSED). Upstream locations are Buttermilk Creek at Fox Valley

Table 2-3

1993 Gross Alpha Activity at Surface Water Sampling Locations

Location	Number of Samples	Range μCi/mL	Range Bq/L	Annual Average μCi/mL	Annual Average Bq/L
OFF-SITE					
WFBIGBR	16	<0.82–2.65E-09	<0.30–0.98E-01	0.40±2.15E-09	1.48±7.96E-02
WFBCBKG	14	<0.65–<2.75E-09	<0.24-<1.02E-01	0.19±1.56E-09	0.70±5.77E-02
WFBCTCB	16	<0.89–3.14E-09	<0.33–1.16E-01	1.18±1.98E-09	4.37±7.33E-02
WFFELBR	12	<0.92–4.74E-09	<0.34–1.75E-01	0.27±2.21E-09	1.00±8.18E-02
ON-SITE					
WNNDADR	12	<2.25–9.48E-09	<0.83–3.51E-01	1.93±5.00E-09	0.71±1.85E-01
WNSWAMP	24	<0.15–1.35E-08	<0.55–5.00E-01	2.30±4.60E-09	0.85±1.70E-01
WNSW74A	69	<0.70–4.53E-10	<0.26–1.68E-01	-0.07±3.16E-09	-0.03±1.17E-01
WNSP006	65	<1.18–8.98E-09	<0.44–3.32E-01	1.90±4.12E-09	0.70±1.52E-01

Table 2-4

1993 Gross Beta Activity at Surface Water Sampling Locations

Location	Number of Samples	Range μCi/mL	Range Bq/L	Annual Average μCi/mL	Annual Average Bq/L
OFF-SITE					
WFBIGBR	16	<1.63–4.23E-09	<0.60–1.57E-01	2.28±1.80E-09	8.44±6.66E-02
WFBCBKG	14	<0.15–5.13E-09	<0.06–1.17E+00	2.81±1.69E-09	1.04±0.62E-01
WFBCTCB	16	0.39–1.91E-08	1.44–7.07E-01	7.47±2.18E-09	2.76±0.80E-01
WFFELBR	12	<1.62–7.71E-09	<0.60–2.85E-01	2.94±1.88E-09	1.09±0.70E-01
ON-SITE					
WNNDADR	12	1.01–3.07E-07	0.37–1.14E+01	2.22±0.13E-07	8.21±0.48E+00
WNSWAMP	24	0.07–1.09E-06	0.25–4.03E+01	7.22±0.22E-07	2.67±0.08E+01
WNSW74A	69	1.07–2.48E-08	3.96–9.18E-01	1.69±0.40E-08	6.25±1.48E-01
WNSP006	65	<0.17–6.36E-07	<0.06–2.35E+01	9.18±0.70E-08	3.40±0.26E+00

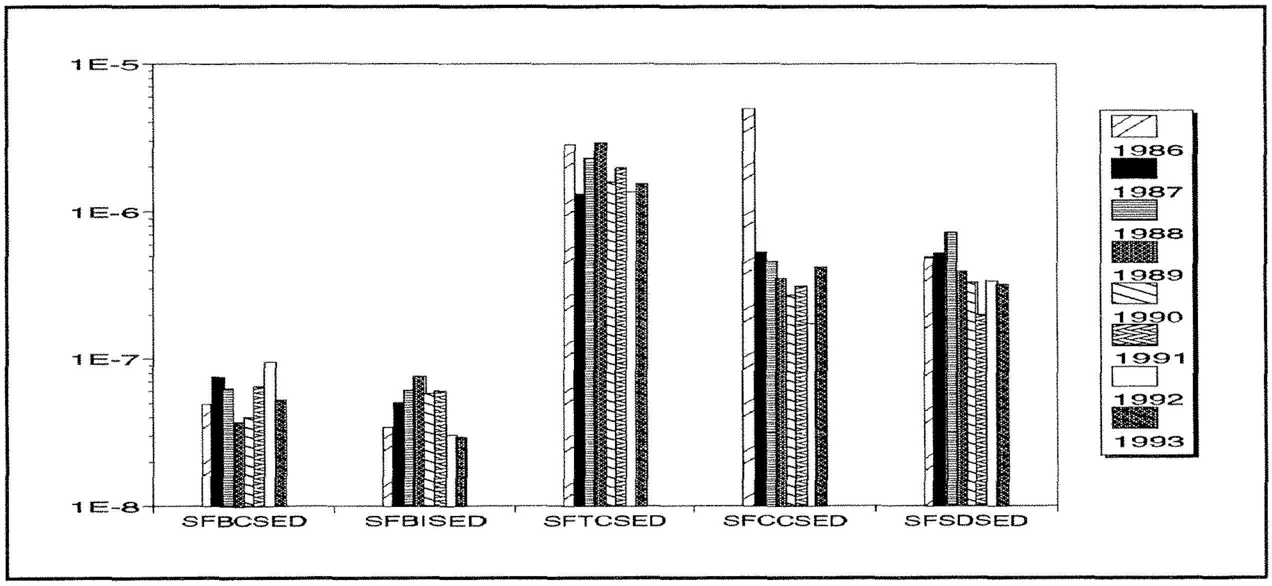


Figure 2-10. Eight-Year Trend of Cesium-137 (μCi/g dry) in Stream Sediment for Two Locations Upstream and Three Locations Downstream of the WVDP

Road (SFBCSED) and Cattaraugus Creek at Bigelow Bridge (SFBISED).

A comparison of annual averaged 1986-1993 cesium-137 concentrations for these five sampling locations is found in Figure 2-10. As reported in previous years, cesium-137 concentrations in sediments collected downstream of the WVDP are higher than those observed in samples collected from background locations (SFBCSED or SFBISED). As the figure indicates, although the measured cesium-137 concentrations for 1993 were higher than the 1992 values in two cases, overall the concentrations appear to be decreasing or staying constant with time at the downstream locations. While the cesium-137 activity in downstream Cattaraugus Creek sediments is elevated relative to upstream values, it is comparable to or less than normal background concentrations in surface soil in Western New York. Use of these sediments in place of normal soil for farming or residential applications would result in a lowered radiation dose or a dose as small as that from the background cesium deposited by world-wide fallout. Although the concentration in Buttermilk Creek below the NFS plant site exceeds that of normal soil, these sediments would qualify for release for unrestricted use such as home building if typical regulatory criteria were applied.

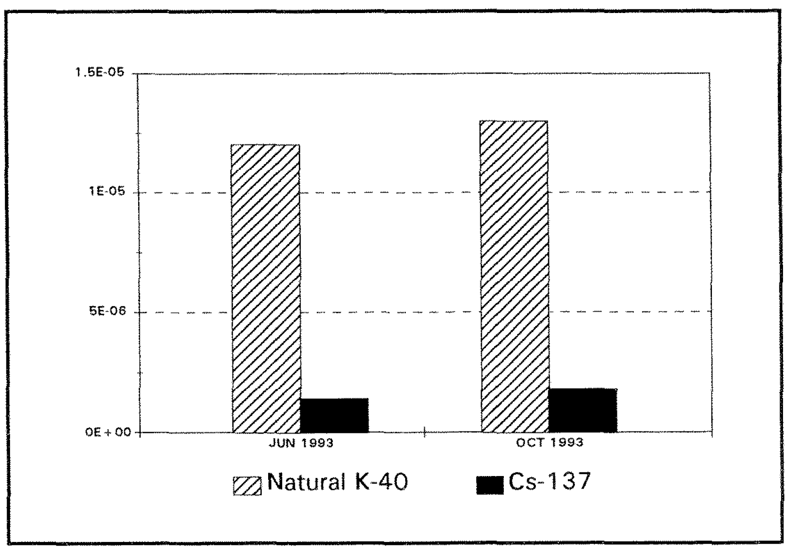


Figure 2-11. Comparison of Cesium-137 with Naturally Occurring Potassium-40 Concentrations in 1993 at Downstream Sampling Location SFTCSED

A comparison of cesium-137 to the naturally occurring gamma-emitter potassium-40 (Fig. 2-11) for the downstream location nearest the Project (Buttermilk Creek at Thomas Corners Road – SFTCSED) indicates that cesium-137 is present at levels lower than naturally occurring gamma emitters. Results of sediment sampling upstream and downstream of the Project are tabulated in *Appendix C-1*, Table C-1.9. When alpha isotopic results for background location SFBCSED are compared to those for SFTCSED, downstream of the site, no significant differences are observed.

Radioactivity in the Food Chain

Each year food samples are collected from locations near the site and from remote locations (Fig. 2-12). Fish and deer are collected during periods when they would normally be taken by sportsmen for consumption. In addition, milk is collected monthly and beef semiannually from cows grazing near the site and at remote locations. Hay, corn, apples, and beans are collected at the time of harvest.

Fish

Ten fish samples are collected semiannually above the Springville dam from the portion of Cattaraugus Creek that is downstream of WNYNSC drainage (BFFCATC). Ten fish samples are also collected annually from Cattaraugus Creek below the dam (BFFCATD), including species that migrate nearly forty miles upstream from Lake Erie. These specimens are representative of sport fishing catches in the creek downstream of the dam at Springville.

Ten control fish are taken semiannually from waters that are not influenced by site runoff (BFFCTRL). These control samples, containing no radioactivity from WVDP effluents, allow comparisons with the concentrations found in fish taken from site-influenced waters. The control samples are representative of the species collected in Cattaraugus Creek downstream from the WVDP. A combined total of fifty fish were collected from the locations described above. Under a collector's permit, these fish are obtained by electrofishing, a method that temporarily stuns the fish, allowing them to be netted for collection. This also allows a more varied selection as compared to sport fishing, with unwanted fish being returned to the creek unharmed.

Radioactivity Concentrations in Fish Samples

The edible portion of each individual fish collected was analyzed for strontium-90 content and the gamma-emitting isotopes cesium-134 and cesium-137. (See Table C-3.4 in *Appendix C-3* for a summary of the results.) Concentrations of strontium-90 in fish collected downstream of the Project in Cattaraugus Creek (BFFCATC) were indistinguishable from upstream control fish (BFFCTRL). Throughout the year concentrations of strontium-90 ranged from below the minimum detectable concentration (see *Glossary*) to a maximum of 5.6±1.3E-07μCi/g at BFFCATC and from below the minimum detectable concentration to 3.9±2.1E-07μCi/g at the control location (BFFCTRL).

Although four fish collected downstream of the site showed marginal positive detections for cesium-137, these cesium concentrations were all within the range of those seen at the background location. No positive detections for cesium-134 were seen at location BFFCATC.

Strontium-90 levels in fish taken below the Springville Dam on Cattaraugus Creek were at or below background levels. Marginal detections of cesium-134 and cesium-137 in below-dam downstream fish (BFFCATD) in 1993 were within the range of background values.

Venison

Specimens from an on-site deer herd also are analyzed for radioactive components. Historically, concentrations of radioactivity in deer flesh

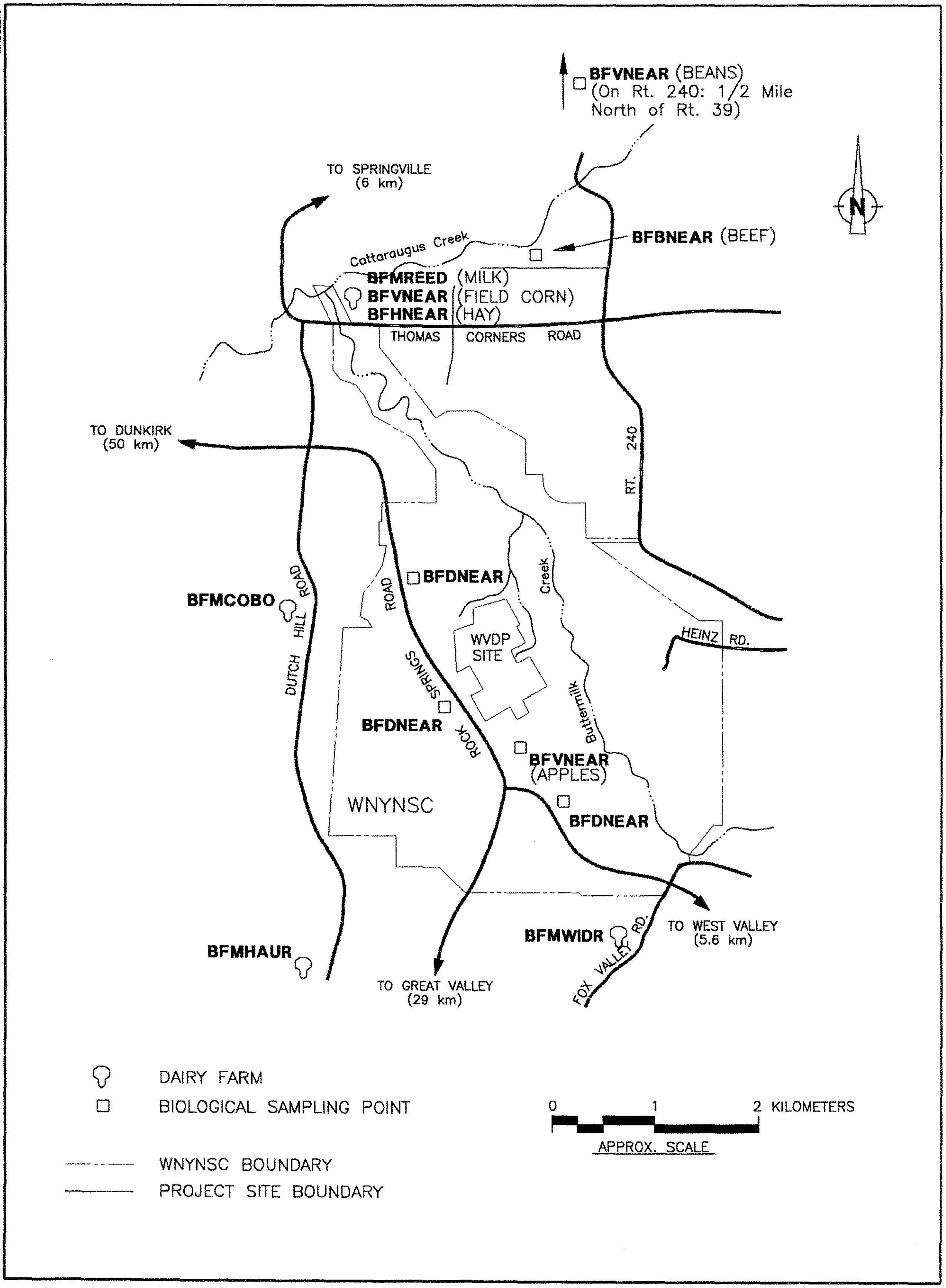


Figure 2-12. Near–site Biological Sampling Points.

have been very low and site activities have not been shown to affect the local herd.

Radioactivity Concentrations in Venison

Venison from three deer taken from the area around the WNYNSC were analyzed and the data compared with those from deer collected in the towns of Friendship, Carrolton, and Yorkshire, New York, far from the site. Low levels of radioactivity were detected for both near-site and control samples for strontium-90, cesium-137, and naturally occurring potassium-40. Results for these samples are shown in Table C-3.2 in *Appendix C-3*. There is no apparent statistical difference in radioactivity concentrations between the control deer and the near-site deer. The range in concentrations observed was similar to previous years. Tritium and cesium-134 were not detected in either near-site or control deer during 1993.

Beef

Historically, very little difference in isotopic concentration has been observed between near-site and control herds. Beef samples taken semiannually from near-site and remote locations are analyzed for tritium, strontium-90, and gamma-emitting isotopes such as cesium-134 and cesium-137.

Radioactivity Concentrations in Beef Samples

Analyses of the two near-site beef samples collected in 1993 resulted in positive values for cesium-137. These results were not, however, statistically different from the minimum detectable concentrations observed for both control samples. Strontium-90 was detected in 1993 in one near-site and one control sample. The value for the near-site sample was the higher of the two, but not significantly so. Results for all near-site and control samples were below the minimum detectable concentrations for tritium and cesium-134. These results are presented in Table C-3.2 in *Appendix C-3*.

Milk

Monthly milk samples were taken in 1993 from dairy farms near the site and from control farms at some distance from the site (Fig. 2-12). Besides the quarterly composite of monthly samples from the maximally exposed herd to the north (BFMREED), a quarterly composite of milk from a nearby herd to the northwest (BFMCOBO) also was prepared. Single annual samples were taken from herds to the south (BFMWIDR) and the southwest (BFMHAUR). Monthly samples from control herds (BFMCTLN and BFMCTLS) were also prepared as quarterly composites. (See Fig. A-9 in *Appendix A* for control sample locations.)

Radioactivity Concentrations in Milk Samples

Each milk sample was analyzed for strontium-90, iodine-129, gamma-emitting isotopes (cesium-134 and -137), and tritium. Strontium-90 was detectable in all near-site and control samples. The strontium-90 results for near-site milk ranged from 9.1E-10 to 2.8E-09μCi/mL (3.4E-02 to 1.0E-01 Bq/L), and the control milk samples ranged from 6.2E-10 to 3.10E-09μCi/mL (2.3E-02 to 1.1E-01 Bq/L). There was no statistical difference between near-site and control milk samples.

Iodine-129 was detected in two near-site samples and two control samples. There was no appreciable difference between these near-site sample results and the control sample iodine-129 results.

Two control samples and four near-site samples showed positive values for cesium-137. Results for tritium analyses also showed a mixture of detectable and less-than-detectable results for both near-site and control locations. The results of these analyses are shown in Table C-3.1 in *Appendix C-3* and indicate no significant difference between near-site and control samples.

Fruit and Vegetables

Results from the analysis of beans, apples, sweet corn, and hay collected during 1993 are presented in Table C-3.3 in *Appendix C-3*. Tritium was marginally detected in both control and near-site corn and in the control bean sample. The levels of tritium in the control corn and bean samples were higher than in the samples collected near the site. In neither case were differences seen as significant.

Positive strontium-90 results were attained in both near-site and control bean samples and in control and near-site hay samples. While there is no significant difference between bean results, the near-site hay concentration of strontium-90 does seem to be statistically higher than the control location, using the 95% confidence interval. This observation is consistent with data obtained in 1991 and 1992 for hay but is not consistent with observations in 1990. Further statistical testing has shown no significant differences between near-site and control samples for 1993. (See **Biological Compartment Concentrations** in *Chapter 4, Radiological Dose Assessment.*)

All cesium-137 concentrations observed were below detection limits with the exception of hay, in which it was marginally detected in both control and near-site samples. The control sample concentration was the higher of the two.

Cobalt-60 values were below minimum detectable concentrations in all samples collected. Overall results obtained for 1993 are comparable to previous years.

Direct Environmental Radiation Monitoring

The current monitoring year, 1993, was the tenth full year in which direct penetrating radiation was monitored at the West Valley Demonstration Project using TL-700 lithium fluoride (LiF) thermoluminescent dosimeters (TLDs). The dosimeters are processed on-site and are used solely for environmental monitoring. The environmental TLD package consists of five TLD chips laminated on a card bearing the location identification and other information. These cards are placed at each monitoring location for one calendar quarter (three months) and are then processed to obtain the integrated gamma radiation exposure.

Monitoring points are located around the WNYNSC perimeter and the access road, at the waste management units, at the site security fence, and at background locations remote from the WVDP site. (See Figs. 2-13 and 2-14 and Fig. A-9 in *Appendix A*.) The TLDs are numbered in order of their installation. The monitoring locations are as follows:

THE PERIMETER OF THE WNYNSC: TLDs #1-16, #20

THE PERIMETER OF THE WVDP SITE-SECURITY FENCE: TLDs #24, #26-29, #32-34

ON-SITE SOURCES OR SOLID WASTE MANAGEMENT UNITS: TLDs #18 and #32-36 (RTS drum cell); #18, #19 and #33 (SDA); #24 (component storage, near the WVDP site security fence); #25 (the maximum measured exposure rate at the closest point of public access); #38 (main plant and cement solidification system); #39 (parking lot security fence closest to the vitrification facility); #40 (high-level waste tank farm)

NEAR-SITE COMMUNITIES: TLDs #21 (Springville); #22 (West Valley)

BACKGROUND: TLDs #17 (Five Points Landfill in Mansfield); #23 (Great Valley); #37 (Dunkirk); #41 (Sardinia).

The statistical uncertainties of individual results and averages of those results were acceptable and measured exposure rates were comparable to those of 1992. There is no significant difference between the pooled quarterly average background

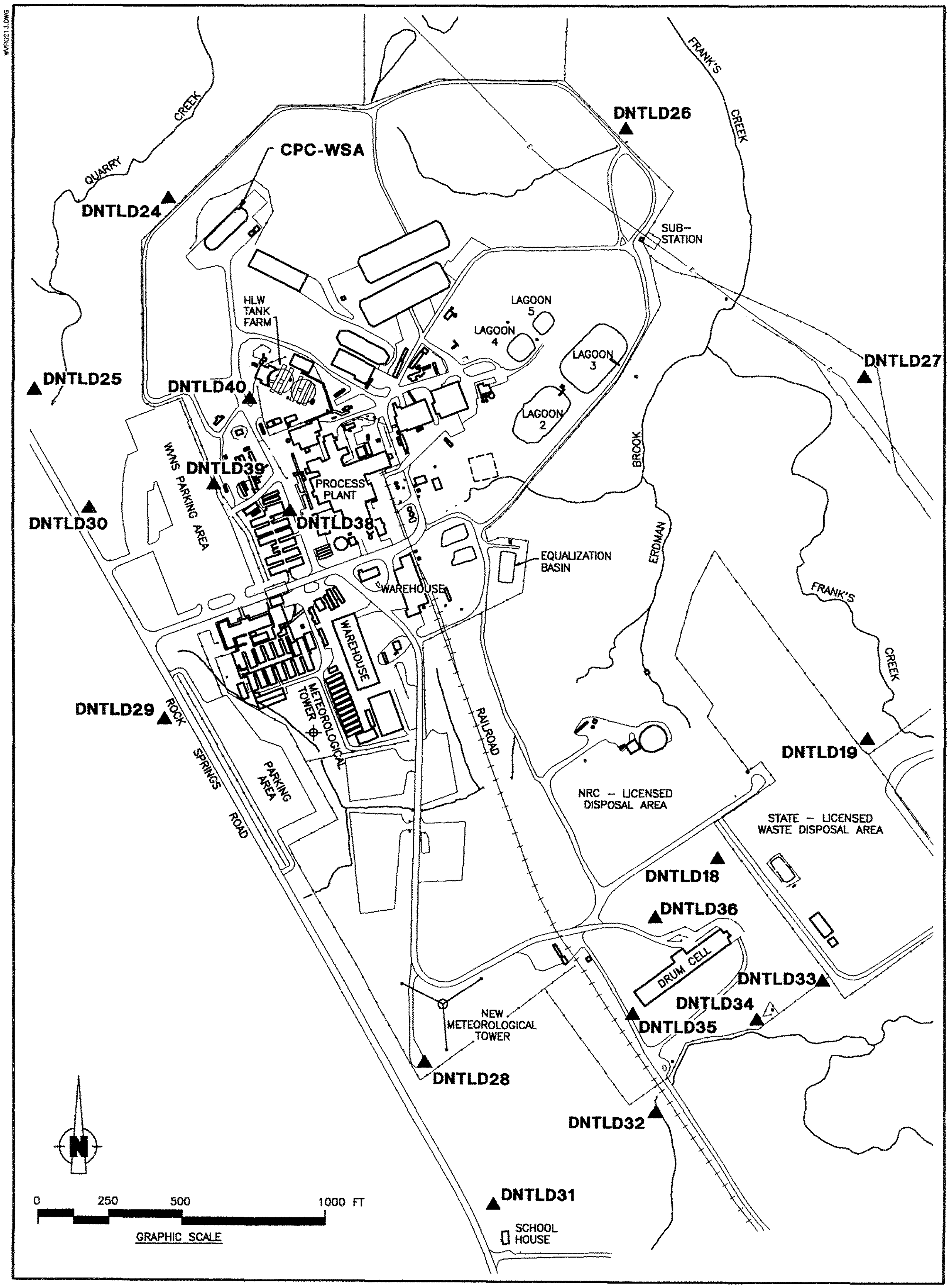


Figure 2-13. Location of On–site Thermoluminescent Dosimetry (TLD).

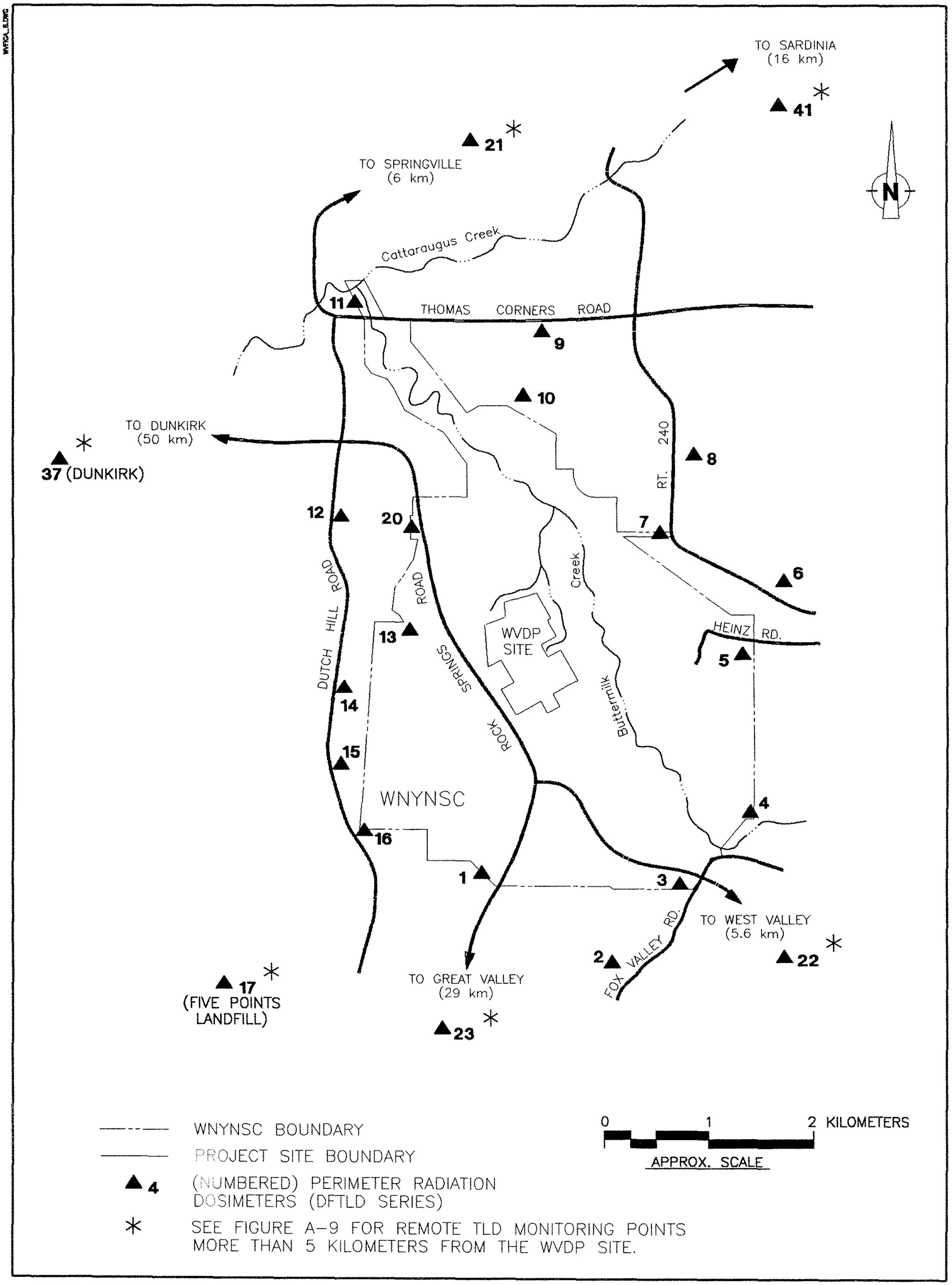


Figure 2-14. Location of Off-site Thermoluminescent Dosimetry (TLD).

TLDs: (#17, #23, #37, and #41) and the pooled average for the WNYNSC perimeter locations for the 1993 reporting period.

Appendix C-4 provides a summary of the results by calendar quarter for each of the environmental monitoring locations along with averages for comparison.

The quarterly averages and individual location results show very slight differences due to seasonal variation. The data obtained for all four calendar quarters compared favorably to the respective quarterly data in 1992. The quarterly average of the seventeen perimeter TLDs was 20.4 milliroentgen (mR) per quarter (19.6 mrem/quarter) in 1993.

The perimeter TLD quarterly averages since 1986, expressed in microroentgen per hour (μR/hr), are shown in Figure 2-15.

On-site Radiation Monitoring

Near the state-licensed disposal area (SDA), the dosimeter at location #19 routinely shows radiation exposures slightly above those seen at WNYNSC perimeter locations. Locations #25, #29, and #30 on the public access road west of the facility and #26 at the east security fence also showed small elevations above background. Although above background, the readings are relatively stable from year to year. (See *Appendix C-4*, Table C-4.1.)

Location #24 on the north inner facility fence is part of the on-site environmental monitoring program and is a co-location site for one Nuclear Regulatory Commission (NRC) TLD. (See *Appendix D*, Table D-6.) This point received an average exposure of 0.48 milliroentgens (mR) per hour during 1993, as opposed to 0.52 mR/hr in 1992 and 0.57 mR/hr in 1991. Sealed containers of radioactive components and debris from the plant decontamination work are stored nearby. The decline in exposure rate over time is due to radioactive decay of the materials stored within. The storage area is well within the WNYNSC boundary and is not accessible by the public.

Locations around the radwaste treatment storage (RTS) building – the drum cell – showed a steady state condition during the 1993 calendar year despite some fluctuations. The average dose rate

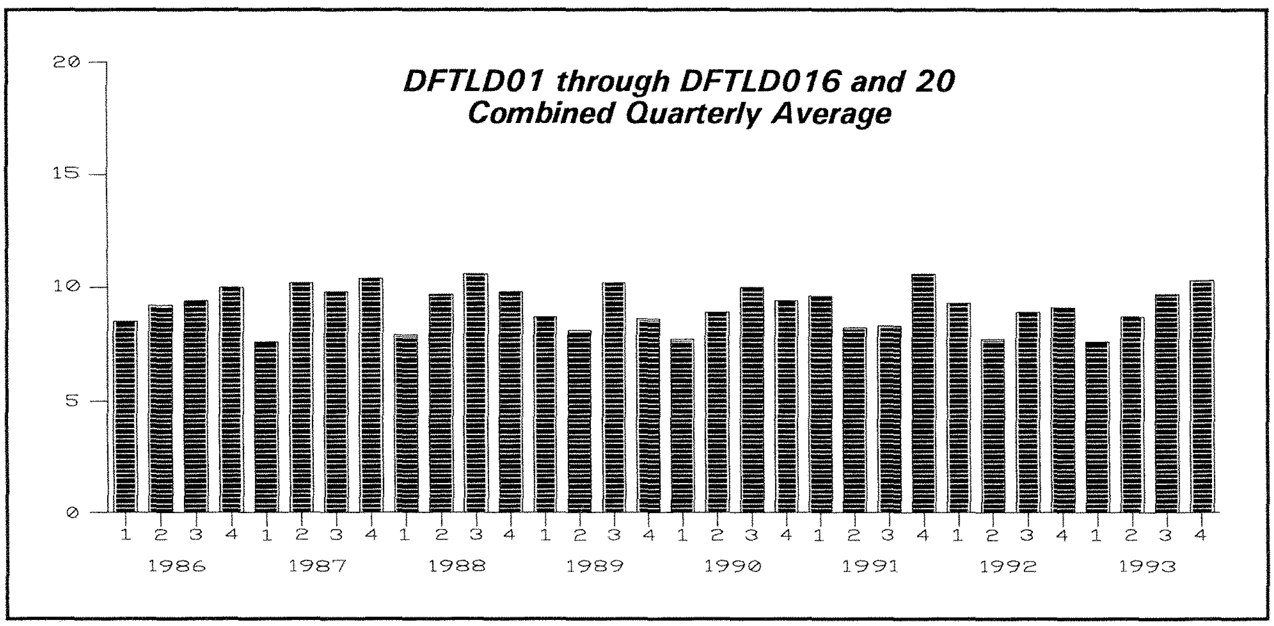


Figure 2-15. Trend of Environmental Radiation Levels (μR/hr)

at these locations (TLDs #18, #32, #33, #34, #35, and #36) was 0.025 mR/hr in 1993, as it was in 1992. These exposure rates, which are above background levels, reflect the placement in the building of drums containing decontaminated supernatant mixed with cement. The drum cell and the surrounding TLD locations are well within the WNYNSC boundary and are not accessible by the public.

Locations #27, #28, and #31 at the security fence are at levels near background. These locations are more distant from radioactive waste storage areas on-site.

Perimeter and Off-site Radiation Monitoring

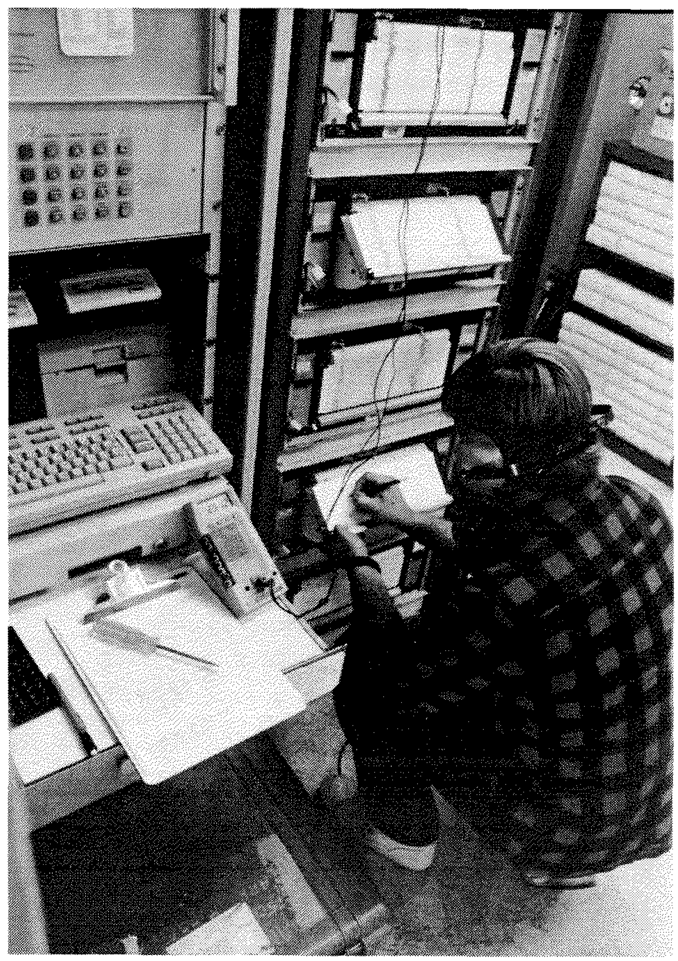
The perimeter TLDs (TLDs #1-16 and #20) are located in the sixteen compass sectors around the facility near the WNYNSC boundary. The quarterly averages for these TLDs (Fig. 2-15) indicate no trends other than normal seasonal fluctuations. TLDs #17, #21-23, #37, and #41 monitor near-site community and background locations. The results from these monitoring points are essentially the same as the perimeter TLDs. Figure C-4.1 in *Appendix C-4* shows the average quarterly exposure rate at each off-site TLD location. Figure C-4.2 shows the average quarterly exposure rate at each on-site TLD.

Meteorological Monitoring

Meteorological monitoring at the WVDP provides representative and verifiable data that characterize the local and regional climatology of the site. These data are used primarily to assess potential effects of routine and nonroutine releases of airborne radioactive materials and to calculate dispersion models for any releases that may exceed DOE effluent limits.

Since dispersive capabilities of the atmosphere are dependent upon wind speed, wind direction, and atmospheric stability (which is a function indicated by the difference in temperature between the 10-meter and 60-meter elevations), these parameters are closely monitored and are available to the emergency response organization at the WVDP.

The on-site 60-meter meteorological tower continuously monitors wind speed and wind direction. (See Fig. 2-1.) Temperatures are measured at both 60-meter and 10-meter elevations. In addition, an independent, remote 10-meter mete-



Checking Data from the Meteorological Tower

orological station located approximately 5 kilometers south of the site on the top of Dutch Hill Road continuously monitors wind speed and wind direction. Dewpoint, precipitation, and barometric pressure are also monitored at the on-site meteorological tower location.

The two meteorological locations supply data to the primary digital and analog data acquisition systems located within the Environmental Laboratory. All on-site systems are provided with either uninterruptible or standby power backup in case of site power failure. Figures C-6.1 and C-6.2 in *Appendix C-6* illustrate 1993 mean wind speed and wind direction at the 10-meter and 60-meter elevations. Regional data at the 10-meter elevation are shown in Figure C-6.3.

Cumulative total and weekly total precipitation data are illustrated in Figures C-6.4 and C-6.5 in *Appendix C-6*. Precipitation in 1993 was approximately 37 inches (9% below the annual average of 41 inches).

Information such as meteorological system calibration records, site log books, and analog strip charts are stored in protected archives. Electronic files containing meteorological data are copied (downloaded) daily and stored off-site. Meteorological towers and instruments are examined three times weekly for proper function and are calibrated semiannually and/or whenever instrument maintenance might affect calibration.

In 1993 the installation of a new meteorological monitoring tower was completed at the southern end of the WVDP, within the security-fenced area. (See Fig. 2-1.) This new tower was installed to replace the original 60-meter tower that had been encroached upon by essential on-site construction. Data collected during a six-month period of parallel operations are currently being evaluated to ascertain differences between the two monitoring locations. After this evaluation is completed, it is anticipated that the old tower will be removed. The new tower's computerized data acquisition system is similar to the present one but has improved data-reporting features.

Special Monitoring

NRC-licensed Disposal Area (NDA) Interceptor Trench and Pretreatment System

Radioactively contaminated solvent was first discovered at the northern boundary of the NRC-licensed disposal area (NDA) in 1983, shortly after the Department of Energy assumed control of the WVDP site. Extensive sampling and monitoring through 1989 revealed the possibility that the solvent could migrate. To contain this subsurface solvent migration, an interceptor trench and liquid pretreatment system (LPS) were built.

The trench was designed to intercept and collect subsurface water, which could be carrying solvent, in order to prevent the solvent from entering the surface water drainage ditch leading into Erdman Brook. The LPS was installed to separate the solvent from the water and to treat the collected water before its transfer to the low-level waste treatment facility. Pretreatment would remove the solvent and reduce the concentration of iodine-129 in the water. The separated solvent would be stored for subsequent treatment and disposal.

In 1993 no water containing solvent was encountered in the trench and no water or solvent has been treated by the LPS. It should be noted that although it does not by itself demonstrate the effectiveness of the interceptor trench, water containing solvent has never been detected in groundwater monitoring wells outside the NDA or in the surface water drainage downstream of the NDA. Radiological and nonradiological monitoring data for waters collected from the trench (WNNDATR) and from the drainage just downstream (WNNDADR) have been discussed in this chapter under the on-site surface water section. Results of sampling of the NDA monitoring wells WNW0909 and WNW0910 are discussed in *Chapter 3*, *Groundwater Monitoring*.

Survey of Trees near the NDA

During a routine radiation survey by the Radiation and Safety Department in 1992, radioactivity was detected in several trees located immediately north of the NDA. The trees were surveyed by placing a calibrated hand-held detector against their trunks. Two species of trees, apple and beech, indicated activity above background. Because leaves could be blown off-site by the wind and apples could be eaten by the local deer herd, samples of tree leaves and apples were collected in late fall 1992 and analyzed for radioactivity.

Results received in 1993 indicated that the concentrations of radionuclides in the apples and leaves are sufficiently low that there is no need for action.

Northeast Swamp Drainage Monitoring

Trend analyses of ground- and surface water monitoring results have indicated increasing gross beta concentrations in waters discharged through the northeast swamp drainage, as monitored at sampling points WNDMPNE and WNSWAMP. Results of investigations into these increases are discussed in *Chapter 3*, *Groundwater Monitoring*.

Waste Tank Farm Underdrain Monitoring

Increases in gross beta and tritium activity were noted at sampling location WN8D1DR beginning in May 1993. This location is described in the site's environmental monitoring plan as the high-level waste (tank) farm underdrain. This underdrain collects surface and groundwaters from the tank farm area and in the past has channeled these waters to a drainage ditch that eventually empties into Quarry Creek after passing monitoring point WNSW74A. Gross beta activity at WN8D1DR peaked on July 14, 1993 at 6.74E-06µCi/mL. Specific isotopic analysis for strontium-90 and technetium-99 showed their concentrations to be 5.63E-08 and 7.12E-06µCi/mL, respectively. These concentrations correspond to 5.6% of the DCG (1E-06µCi/mL) for strontium-90 and 7.1% of the DCG (1E-04µCi/mL) for technetium-99. Tritium peaked on the same day at 1.69E-06µCi/mL, which is 0.08% of its DCG.

The initial investigation into these increases verified that they were not the result of leaks in the high-level waste tanks: a data review confirmed that no increases in activity had been observed in water samples collected from directly under the tanks in the concrete vaults that surround them. All individual isotopic measurements were at levels below their respective DCGs. This was true for both strontium-90 and technetium-99, which were found to be major contributors to the gross beta increase. Samples collected at downstream location WNSW74A during the same period also did not indicate upward tritium or gross beta trends.Tritium and gross beta concentrations in the underdrain have declined to more normal levels since July.

The increases observed are believed to be the results of the migration of historical soil contamination in and around the waste tank farm area, possibly associated with increased rainfall during this period and the springtime start-up of construction activities that disturbed soil in the area. Since July all waters flowing through the underdrain have been diverted to the LLWTF for processing before discharge.

Drum Cell Monitoring

Liquid high-level waste (supernatant from tank 8D-2) processed by the integrated radwaste treatment system produced more than 3,600 drums of cement-solidified waste in 1993. These were added to the 11,900 drums already in place in the drum cell for a total of 15,577 drums at the end of the year.

Most of the gamma radiation emitted from these drums is shielded by the configuration in which the drums are stacked. However, some radiation is emitted through the roof of the drum cell, which is unshielded. This radiation scatters in air and adds to the existing naturally occurring gamma-ray background.

Radiation exposure levels are monitored at various locations around the drum cell perimeter and at the closest location accessible by the public — approximately 300 meters west at the security fence at Rock Springs Road. Baseline measurements had been taken in 1987 and 1988 before the drums were placed. Two types of measurements were taken: instantaneous, using a high-pressure ion chamber (HPIC), and cumulative, using thermoluminescent dosimeters.

The strength of the gamma-ray field can vary considerably from day to day because of changes in meteorological conditions. TLD measurements provide a more accurate estimate of long-term changes in the radiation field because they integrate the radiation exposure over an entire calendar quarter. Such quarterly readings show evidence of a seasonal cycle. Annual variability in background radiation levels can depend on such factors as average temperature, air pressure, humidity, precipitation (including snow cover on the ground), and solar activity during a particular year. The TLD measurements at the Rock Springs Road location (TLDs #28 and #31) are presented in *Appendix C-4*, Table C-4.1.

To assess any increase in the radiation field contributed at the security fence at Rock Springs Road from the drums in the drum cell, HPIC measurements were compared with earlier studies. HPIC measurements made in 1993 and early 1994 indicate that the exposure rates at this location were only slightly above those from background readings obtained at the Environmental Laboratory, which is located about 500 meters away from the drum cell. The most recent data also show that exposure rates at Rock Springs Road are the same as or only slightly greater than those seen before any drums were placed in the drum cell.

Closed Landfill Maintenance

Closure of the on-site nonradioactive construction and demolition debris landfill (CDDL) was completed in August 1986. The landfill area was closed in accordance with NYSDEC requirements for this type of landfill, following a closure plan (Standish 1985) approved by NYSDEC. To meet routine post-closure requirements, the CDDL cover was inspected in July 1993 and was found to be in proper condition. As required, adequate drainage is maintained to ensure that no obvious ponding or soil erosion is occurring and that the grass planted on the clay and soil cap is cut. Groundwater monitoring in the area of the closed landfill is described in *Chapter 3, Groundwater Monitoring*.

Nonradiological Monitoring

Air Monitoring

Nonradiological emissions and plant effluents are controlled and permitted under New York State Department of Environmental Conservation and U.S. Environmental Protection Agency regulations. The regulations that apply to the WVDP are listed in Table B-2 in *Appendix B*. The individual air permits held by the WVDP are identified and described in Table B-3.

The nonradiological air permits are for minor sources of regulated pollutants that include particulates, ammonia, nitric acid mist and oxides of nitrogen, and sulfur. However, because of their insignificant concentrations and small mass discharge, monitoring of these parameters currently is not required.

Surface Water Monitoring

Liquid discharges are regulated under the State Pollutant Discharge Elimination System (SPDES).

The WVDP holds a SPDES permit that identifies the outfalls where liquid effluents are released to Erdman Brook (Fig. 2-16) and that specifies the sampling and analytical requirements for each outfall. This permit was modified in 1990 to include additional monitoring requirements at outfall WNSP001. The WVDP applied for a renewed SPDES permit in 1992. It was received in early January 1994 and went into effect on February 1, 1994 with the expanded monitoring requirements.

Three outfalls were identified in the permit that was effective in 1993:

- outfall WNSP001, discharge from the low-level waste treatment facility
- outfall WNSP007, discharge from the sanitary and utility wastewaters systems
- outfall WNSP008, groundwater effluent from the perimeter of the low-level waste treatment facility storage lagoons.

The conditions and requirements of the current SPDES permit are summarized in Table C-5.1 in *Appendix C-5*.

Some of the more significant features of the SPDES permit are the requirements to report biochemical oxygen demand, iron, and ammonia data as flow-weighted concentrations and to apply a net discharge limit for iron. The net limit allows the Project to account for amounts of iron that are naturally present in the site's incoming water. The flow-weighted limits apply to the total discharge of Project effluents but allow the more dilute waste streams to have a maximum effect in determining compliance with effluent concentration limits specified in the permit.

The SPDES monitoring data for 1993 are displayed in Figures C-5.2 through C-5.37 in *Appendix C-5*. The WVDP reported one noncompliance episode in 1993 (Table C-5.2). This episode is described in the *Environmental Compliance Summary: Calendar Year 1993*.

Semiannual grab samples at locations WNSP006 (Frank's Creek at the security fence), WNSWAMP (northeast swamp drainage), WNSW74A (north swamp drainage), and WFBCBKG (Buttermilk Creek at Fox Valley) were taken in 1993. These samples are screened for organic constituents and selected anions, cations, and metals. Results of these measurements for all of these locations are found in Table C-1.11 in *Appendix C-1*.

Appendix C-1, Table C-1.23 presents TOC/NPOC (total organic carbon/nonpurgeable organic carbon), TOX, and pH data for two locations that help monitor the NDA, WNNDADR and WNNDATR. When NPOC values at WNNDATR are compared to TOC values at WNNDADR and TOX values at both locations are compared, the data suggest either no difference or possibly higher values at WNNDADR, which is farther downstream of the NDA.

Drinking Water Monitoring

As a result of changes to EPA and New York State monitoring requirements, a number of important drinking water monitoring activities were carried out at the site in 1993. (See **Safe Drinking Water Act** in the *Environmental Compliance Summary: Calendar Year 1993*.)

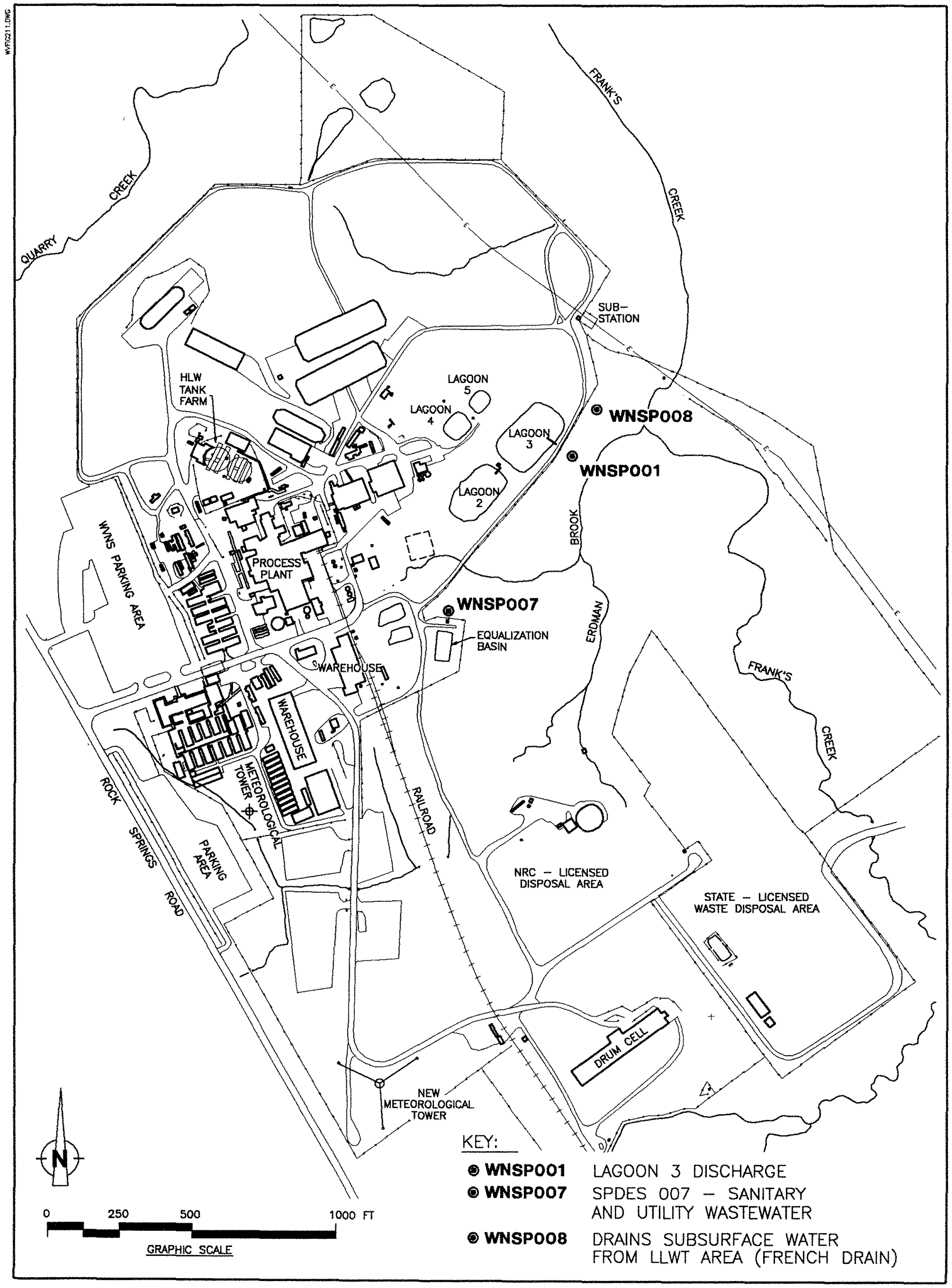


Figure 2-16. SPDES Monitoring Points.

GROUNDWATER MONITORING

Geology of the West Valley Site

The West Valley Demonstration Project is located on the dissected and glaciated Allegheny Plateau at the northern border of Cattaraugus County in southwestern New York. The site is underlain by a thick sequence of Holocene (recent) and Pleistocene (ice age) sediments contained in a steep-sided bedrock valley. From youngest to oldest, these unconsolidated deposits consist of alluvial and glaciofluvial silty coarse-grained deposits, which are found almost exclusively in the northern part of the site, and a sequence of up to three fine-grained glacial tills of Lavery, Kent, and possible Olean age, which are separated by stratified fluvio-lacustrine deposits. These glacial sediments are underlain by bedrock composed of shales and interbedded siltstones of the upper Devonian Canadaway and Conneaut Groups, which dip southward at about 5 m/km (Rickard 1975).

The sediments above the second (Kent) till are generally regarded as containing all of the potential routes for the migration of contaminants from the WVDP site. (See **Hydrogeology of the West Valley Site** below for a description of these units. See also Figs. 3-1 and 3-2, which show relative locations of these sediments on the north and south plateaus.)

The most widespread glacial unit in the site area is the Kent till, deposited between 15,500 and 24,000 years ago toward the end of the Wisconsinan glaciation. At that time the ancestral Buttermilk Creek Valley was covered with ice. As the glacier receded, debris trapped in the ice was left behind in the vicinity of West Valley. Meltwater, confined to the valley by the debris dam at West Valley and the ice front, formed a glacial lake that persisted until the glacier receded far enough northward to uncover older drainage ways. As the ice continued to melt, more material was released and deposited to form the recessional sequence (lacustrine and kame delta deposits) that presently overlies the Kent till. Continued recession of the glacier ultimately led to drainage of the proglacial lake and exposure of its sediments to erosion (LaFleur 1979).

About 15,000 years ago the ice began its last advance (Albanese et al. 1984). Material from this advance covered the recessional deposits with as much as 40 meters (130 ft) of glacial till. This unit, the Lavery till, is the uppermost unit throughout much of the site. The retreat of the Lavery ice left behind another proglacial lake that

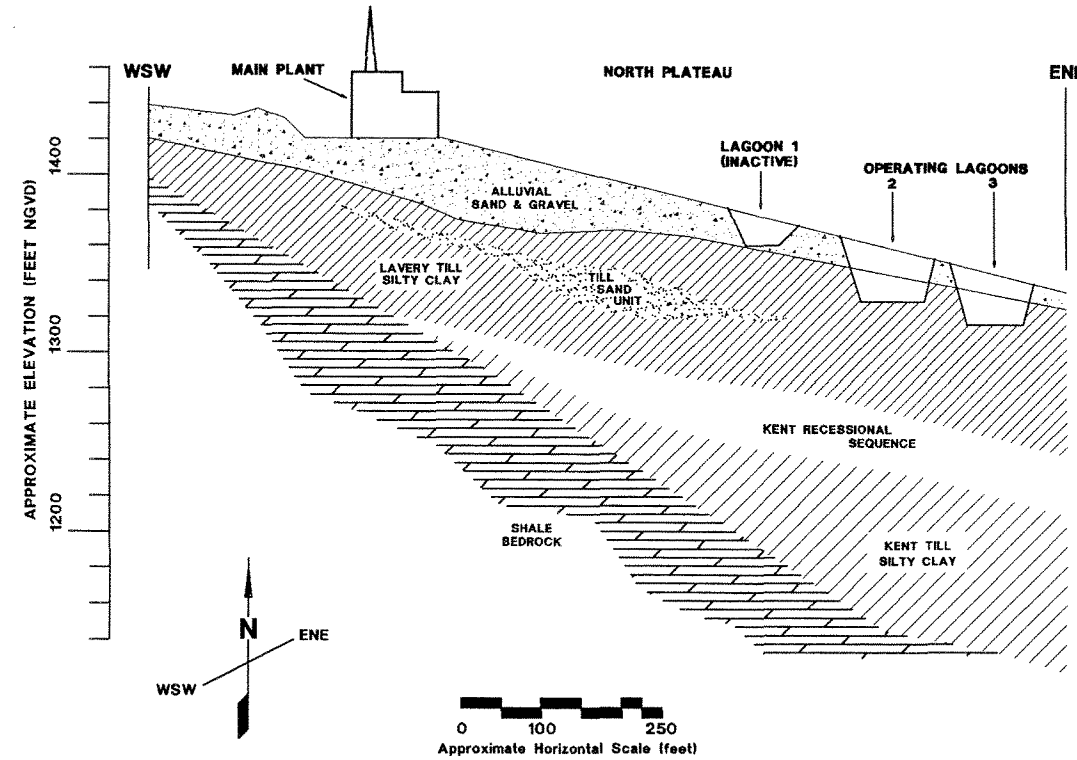


Figure 3-1. Geologic Cross Section Through the North Plateau.

ultimately drained, allowing the modern Buttermilk Creek to flow northward to Cattaraugus Creek. Post-Lavery outwash and alluvial fans, including the fan that overlies the northern part of the WVDP, were deposited on the Lavery till between 15,000 and 14,200 years ago (LaFleur 1979). The modern Buttermilk Creek has cut the present valley since the final retreat of the Wisconsinan glacier.

Surface Water Hydrology

The Western New York Nuclear Service Center lies within the Cattaraugus Creek watershed, which empties into Lake Erie about 43 kilometers (27 mi) southwest of Buffalo. Buttermilk Creek, which is a tributary of Cattaraugus Creek, drains most of the WNYNSC and all of the WVDP facilities.

The WVDP site is contained within the Frank's Creek watershed; Frank's Creek is a tributary of Buttermilk Creek. The WVDP is bounded by Frank's Creek to the east and south and by Quarry Creek (a tributary of Frank's Creek) to the north. Another tributary of Frank's Creek, Erdman Brook, bisects the WVDP into a north and south plateau (Fig. 3-3).

The main plant, waste tanks, and lagoons are located on the north plateau. The drum cell, the NRC-licensed disposal area (NDA), and the state-licensed disposal area (SDA) are on the south plateau.

Hydrogeology of the West Valley Site

Unweathered Lavery Till and Recessional Sequence on the North and South Plateaus

The Lavery till is predominantly an olive gray, silty clay glacial till with scattered lenses of silt and sand. The till ranges up to 30 meters (100 ft) in thickness beneath the active areas of the site, generally increasing towards Buttermilk Creek and the center of the bedrock valley. The Lavery till is the surficial unit on the south plateau and is the host formation for wastes buried in the SDA and NDA; on the north plateau the Lavery till is immediately overlain by the surficial sand and gravel layer. Groundwater flow in the unweathered till is predominantly vertically downward, towards the underlying recessional sequence. The hydraulic conductivity of the unweathered till ranges from 10^{-8} to 10^{-7} cm/sec (10^{-5} to 10^{-4} ft/day). Values of vertical and horizontal hydraulic conductivity obtained from laboratory analysis of undisturbed cores and field analyses of piezometer recovery data suggest that the unweathered till is essentially isotropic, i.e., it has equal flow properties in both vertical and horizontal directions.

The underlying Kent recessional sequence, formerly called the lacustrine unit, consists of alternating deposits of lacustrine clayey silts and coarsely grained kame delta and outwash sands and gravels. These deposits underlie the Lavery till beneath most of the site, pinching out along the southwestern corner where the bedrock valley intersects the sequence. Groundwater flow is predominantly to the northeast, towards Butter-

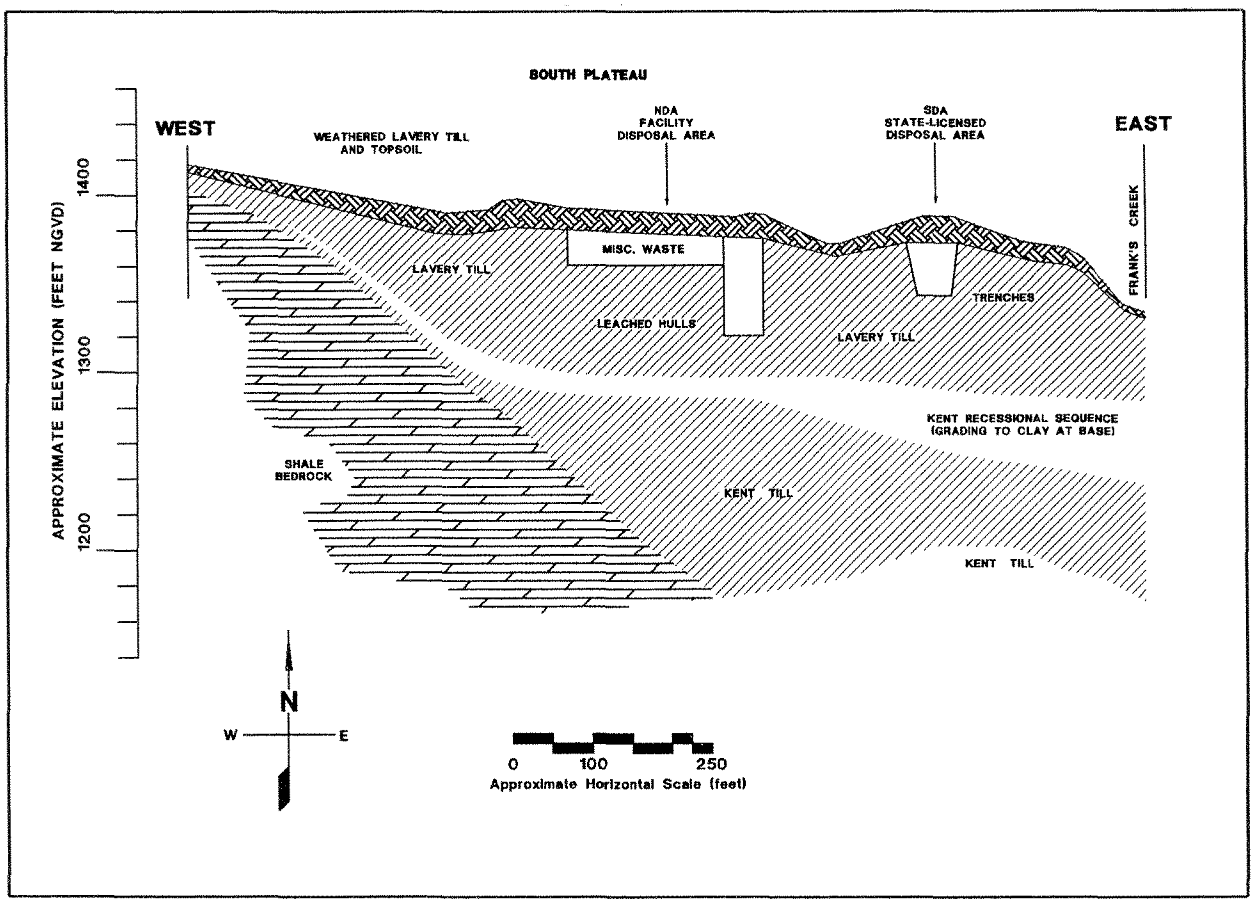


Figure 3-2. Geologic Cross Section Through the South Plateau.

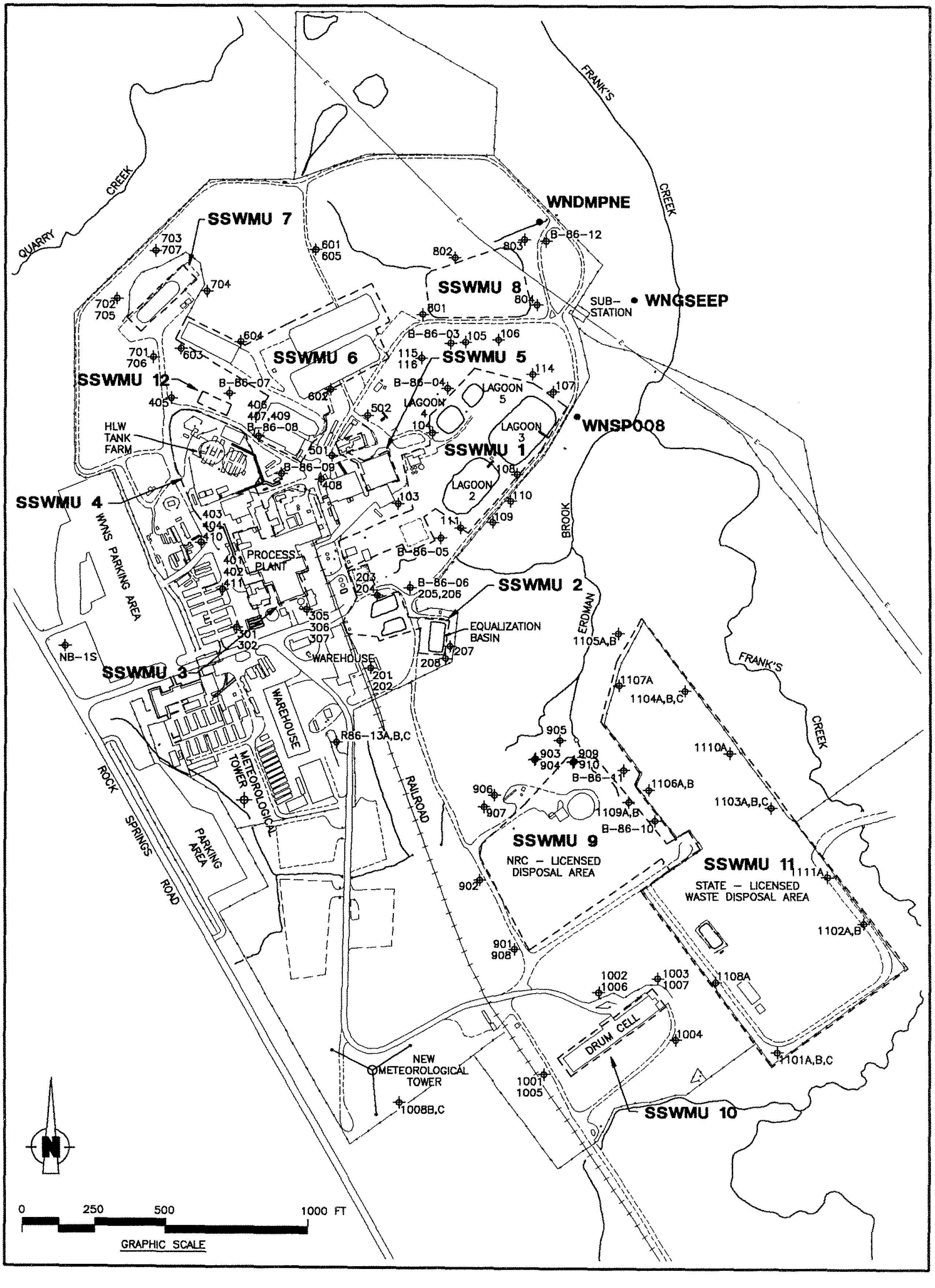


Figure 3-3. Location of On-site Groundwater Monitoring Network Wells.

milk Creek, at an estimated velocity of 13 cm/year (0.4 ft/yr). The hydraulic conductivity is approximately 10^{-6} cm/sec (10^{-3} ft/day). Recharge comes from the overlying till and the bedrock in the southwest, and discharge is to Buttermilk Creek. Underneath the recessional sequence is the less permeable Kent till, which does not provide a pathway for contaminant movement from the WVDP and so is not discussed further.

North Plateau

Surficial Sand and Gravel Layer

The north plateau is covered by a silty sand and gravel layer composed of younger Holocene alluvial deposits that overlie older Pleistocene-age glaciofluvial deposits. Together these two layers range up to 12.5 meters (41 ft) in thickness near the center of the plateau and pinch out along the northern, eastern, and southern edges of the plateau, where they have been truncated by the downward erosion of stream gullies.

Depth to groundwater within this layer varies from 0 meters to 5 meters (0 ft to 16 ft), being deepest generally beneath the central north plateau (beneath the main plant facilities) and intersecting the surface farther north towards the security fence. Groundwater in this layer generally flows across the north plateau from the southwest (near Rock Springs Road) to the northeast (towards Frank's Creek) under an average velocity of 18.6 m/yr (61 ft/yr). The mean hydraulic conductivity is 1.5×10^{-4} cm/sec (0.43 ft/day). Groundwater near the northwestern and southeastern margins of the sand and gravel layer flows radially outward toward Quarry Creek and Erdman Brook, respectively. A very small percentage of groundwater flows downward into the underlying Lavery till.

Lavery Till-sand

On-site investigations from 1989 through 1990 have identified a lenticular sandy unit of limited areal extent and variable thickness within the Lavery till, primarily beneath the north plateau. This unit, called the till-sand, was not specifically identified in previous studies as a hydrologic unit. Groundwater flow through this unit is limited, and surface discharge locations have not been observed.

Measuring a Soil Core Sample

South Plateau

Weathered Lavery Till

On the south plateau, the upper portion of Lavery till exposed at the surface is referred to as the weathered till. It is physically distinct from the underlying unweathered till as it has been oxidized to a brown color and contains numerous fractures and root tubes. The thickness of this layer generally varies from 0.9 meters to 4.9 meters (3 ft to 16 ft). On the north plateau, the weathered till layer is much thinner or nonexistent.

Groundwater in the weathered till that occurs in the upper 4.5 meters (15 ft) flows both horizontally and vertically. This enables the groundwater to move laterally across the plateau before moving downward into the unweathered Lavery till or discharging to nearby incised stream channels. The hydraulic conductivity of the weathered till varies from 10^{-8} to 10^{-5} cm/sec (10^{-5} to 10^{-2} ft/day), with the highest conductivities associated with dense fracture zones.

Groundwater Monitoring Program Overview

Currently, 108 groundwater monitoring points provide radiological and chemical surveillance of both active and inactive super solid waste management units (SSWMUs) and of general site-wide conditions. A full schedule of monitoring for all points was in effect for all of 1993. One additional sampling point, WNNDATR, was added during the second half of the year. On-site groundwater monitoring locations are shown on Figure 3-3. (See **Special Monitoring** in *Chapter 2*.)

Monitoring includes the five different hydrogeologic units discussed above: the sand and gravel unit, the weathered Lavery till, the unweathered Lavery till, the Lavery till-sand unit, and the Kent recessional sequence. Table 3-1 lists the twelve identified super solid waste management units, the hydraulic position of each well within the waste management unit, the geologic unit monitored, and the depth of each well. Figure 3-3 shows the boundaries of these twelve super solid waste management units at the WVDP. (Twenty-one of the wells are in the state-licensed disposal area [SDA] and are the responsibility of the New York State Energy Research and Development Authority [NYSERDA]. Although the state-licensed disposal area is a closed radioactive waste landfill contiguous with the Project premises, the WVDP is not responsible for the facilities or activities relating to it. Under a joint agreement with NYSERDA, however, the Project provides specifically requested technical support to NYSERDA in SDA-related matters.)

Groundwater monitoring fulfills multiple technical and regulatory requirements, which are summarized in the site's Environmental Monitoring Program Plan (West Valley Nuclear Services 1993), the draft Sampling and Analysis Plan for the Groundwater Monitoring Network (West Valley Nuclear Services 1990), the site Groundwater Protection Management Program Plan (West Valley Nuclear Services 1993), and the draft RCRA Facility Investigation Work Plan (West Valley Nuclear Services December 1993).

The data generated as part of the groundwater monitoring program also will be used to support preparation of an environmental impact statement (EIS) that will assess the effect of Project completion and site closure or long-term management.

Four designations are often used to indicate a well's function within a groundwater monitoring program:

Upgradient well. A well installed hydraulically upgradient of the SSWMU under study that is capable of yielding groundwater samples that are representative of local conditions and that are not affected by the unit in question.

Table 3-1

Groundwater Monitoring Network: Super Solid Waste Management Units

SSWMUs and Constituent SWMUs	Well Identification Number	Expanded Characterization Schedule (Table 3-3)	Hydrogeological Unit Monitored	Positive Quarterly Volatile Organic Analyses	Well Position in SSWMU	Depth (ft) Below Grade
SSWMU No. 1 - Low-level Waste Treatment Facilities:						
• Former Lagoon 1	WNW0103	A	S		U	21.00
• LLWTF Lagoons	WNW0104	A	S		U	23.00
• LLWTF Building	WNW0105	A	S		D	28.00
• Interceptors	WNW0106	A	S		D	14.50
• Neutralizer Pit	WNW0107	A	T		D	28.00
	WNW0108		T		D	33.00
	WNW0109	A	T		D	33.00
	WNW0110	A	T		D	33.00
	WNW0111	I	S		D	11.00
	WNW0114		T		D	29.00
	WNW0115	A	T		U	28.00
	WNW0116	A	S		U	11.00
	WNW8603	A	S		D	24.80
	WNW8604	A	S		U	22.60
	WNW8605	A	S		D	12.00
	WNSP008	A	Groundwater French Drain Monitoring Point			
SSWMU No. 2 - Miscellaneous Small Units:						
• Sludge Ponds	WNW0201	A	S		U	20.00
• Solvent Dike	WNW0202	A	TS	V	U	38.00
• Equalization Mixing Basin	WNW0203	A	S		D	18.00
• Paper Incinerator	WNW0204		TS		U	43.00
	WNW0205	A	S		D	11.00
	WNW0206		TS		D	37.80
	WNW0207		S,(T)		D	11.00
	WNW0208		TS		D	23.00
	WNW8606		S		D	12.10

Well position in SSWMU: U = upgradient; D = downgradient; B = background; C = crossgradient.
Hydrogeologic units monitored are: WT = weathered Lavery till; T = unweathered Lavery till; S = sand and gravel; K = Kent recessional sequence; TS = till-sand. Units enclosed in brackets indicate the hydrogeologic unit is only a secondary monitoring unit.
V = quarterly volatile sampling. A,B,C,I = expanded characterization parameters for RFI. (See Table 3-3 for parameter list.)
R = annually for limited radiological sampling.
** Location added to program during rep 6, 1993.*

Table 3-1 (continued)

Groundwater Monitoring Network: Super Solid Waste Management Units

SSWMUs and Constituent SWMUs	Well Identification Number	Expanded Characterization Schedule (Table 3-3)	Hydrogeological Unit Monitored	Positive Quarterly Volatile Organic Analyses	Well Position in SSWMU	Depth (ft) Below Grade
SSWMU No. 3 - Liquid Waste Treatment System:						
• Liquid Waste Treatment System	WNW0301		S		U	16.00
• Cement Solidification System	WNW0302		TS		U	28.00
• Main Process Bldg. (specific areas)	WNW0305	A	S		D	31.00
• Background (north plateau)	WNW0306		K		D	81.00
	WNW0307		S		D	16.00
	WNWNB1S	A	S,(WT)		B	13.00
SSWMU No. 4 - HLW Storage and Processing Area:						
• Vitrification Facility	WNW0401		S,(T)		U	16.00
• Vitrification Test Tanks	WNW0402	A	TS		U	29.00
• HLW Tanks	WNW0403		S		U	13.00
• Supernatant Treatment System	WNW0404		TS		U	36.50
	WNW0405	A	T		C	12.50
	WNW0406	A	S		D	16.80
	WNW0407		K,(T)		D	75.50
	WNW0408	A	S		D	38.00
	WNW0409	A	T		D	55.00
	WNW0410		K		U	78.00
	WNW0411		K,(T)		U	66.00
	WNW8607		S		D	17.60
	WNW8608		S		D	19.00
	WNW8609	B	S	V	D	24.70
SSWMU No. 5 - Maintenance Shop Leach Field:						
• Maintenance Shop Leach Field	WNW0501	A	S	V	U	33.00
	WNW0502	A	S		D	18.00

Well position in SSWMU: U = upgradient; D = downgradient; B = background; C = crossgradient.
Hydrogeologic units monitored are: WT = weathered Lavery till; T = unweathered Lavery till; S = sand and gravel; K = Kent recessional sequence; TS = till-sand. Units enclosed in brackets indicate the hydrogeologic unit is only a secondary monitoring unit.
V = quarterly volatile sampling. A,B,C,I = expanded characterization parameters for RFI. (See Table 3-3 for parameter list.)
R = annually for limited radiological sampling.
** Location added to program during rep 6, 1993.*

Table 3-1 (continued)

Groundwater Monitoring Network: Super Solid Waste Management Units

SSWMUs and Constituent SWMUs	Well Identification Number	Expanded Characterization Schedule (Table 3-3)	Hydrogeological Unit Monitored	Positive Quarterly Volatile Organic Analyses	Well Position in SSWMU	Depth (ft) Below Grade
SSWMU No. 6 - Low-level Waste Storage Area:						
• Hardstands (old & new)	WNW0601	A	S		D	6.00
• Lag Storage	WNW0602	A	S		D	13.00
• Lag Storage Additions	WNW0603		S		U	13.00
	WNW0604	A	S		D	11.00
	WNW0605		S,(T)		D	11.00
	WNW8607		S		U	17.60
	WNW8608		S		U	19.00
SSWMU No. 7 - CPC Waste Storage Area:						
• CPC Waste Storage Area	WNW0701		TS		U	28.00
	WNW0702		T		C	38.00
	WNW0703		T		D	21.00
	WNW0704	A	T		D	15.50
	WNW0705		T		C	21.00
	WNW0706		S		U	11.00
	WNW0707		T,(WT)		D	11.00
SSWMU No. 8 - Construction and Demolition Debris Landfill						
• Former Construction and Demolition Debris Landfill	WNW0801	A	S		U	17.50
	WNW0802	A	S,(T)		D	11.00
	WNW0803	B	S	V	D	18.00
	WNW0804	A	S		D	9.00
	WNGSEEP	B	Groundwater Seepage Monitoring Points	V		
	WNDMPNE	A				
	WNW8612	B	S	V	D	18.10

Well position in SSWMU: U = upgradient; D = downgradient; B = background; C = crossgradient.
Hydrogeologic units monitored are: WT = weathered Lavery till; T = unweathered Lavery till; S = sand and gravel; K = Kent recessional sequence; TS = till-sand. Units enclosed in brackets indicate the hydrogeologic unit is only a secondary monitoring unit.
V = quarterly volatile sampling. A,B,C,I = expanded characterization parameters for RFI. (See Table 3-3 for parameter list.)
R = annually for limited radiological sampling.
** Location added to program during rep 6, 1993.*

Table 3-1 (continued)

Groundwater Monitoring Network: Super Solid Waste Management Units

SSWMUs and Constituent SSWMUs	Well Identification Number	Expanded Characterization Schedule (Table 3-3)	Hydrogeological Unit Monitored	Positive Quarterly Volatile Organic Analyses	Well Position in SSWMU	Depth (ft) Below Grade
SSWMU No. 9 - NRC-licensed Disposal Area:						
• NRC-licensed Disposal Area	WNW0901		K,(T)		U	136.0
• Container Storage Area	WNW0902		K,(T)		U	128.0
• Trench Interceptor Project	WNW0903		K,(T)		D	133.0
	WNW0904	A	T		D	26.00
	WNW0905	A	S		D	23.00
	WNW0906	I	WT		D	10.00
	WNW0907	A	WT,(T)		D	16.00
	WNW0908	A	WT,(T)		U	21.00
	WNW0909	C	WT,(T)	V	D	23.00
	WNW0910	A	T		D	29.60
	WNW8610		K		D	114.0
	WNW8611		K		D	120.0
	WNNDATR*	C	Interceptor Trench Manhole Sump			
SSWMU No. 10 - IRTS Drum Cell:						
• IRTS Drum Cell	WNW1001		K,(T)		U	116.0
	WNW1002		K,(T)		D	113.0
	WNW1003		K		D	138.0
	WNW1004		K,(T)		D	108.0
	WNW1005		WT,(T)		U	19.00
	WNW1006	I	WT,(T)		D	20.00
	WNW1007	A	WT,(T)		D	23.00
• Background (south plateau)	WNW1008B		K,(T)		B	51.00
	WNW1008C	A	WT,(T)		B	18.00

Well position in SSWMU: U = upgradient; D = downgradient; B = background; C = crossgradient.
Hydrogeologic units monitored are: WT = weathered Lavery till; T = unweathered Lavery till; S = sand and gravel; K = Kent recessional sequence; TS = till-sand. Units enclosed in brackets indicate the hydrogeologic unit is only a secondary monitoring unit.
V = quarterly volatile sampling. A,B,C,I = expanded characterization parameters for RFI. (See Table 3-3 for parameter list.)
R = annually for limited radiological sampling.
** Location added to program during rep 6, 1993.*

Table 3-1 (continued)

Groundwater Monitoring Network: Super Solid Waste Management Units

SSWMUs and Constituent SSWMUs	Well Identification Number	Expanded Characterization Schedule (Table 3-3)	Hydrogeological Unit Monitored	Positive Quarterly Volatile Organic Analyses	Well Position in SSWMU	Depth (ft) Below Grade
SSWMU No. 11 - State-licensed Disposal Area:						
• State-licensed Disposal Area (SDA)[NYSERDA]	WNW1101A		WT,(T)		U	16.00
	WNW1101B		T		U	30.00
	WNW1101C		K		U	110.0
	WNW1102A		WT,(T)		D	17.00
	WNW1102B		T		D	31.00
	WNW1103A		WT,(T)		D	16.00
	WNW1103B		T		D	26.00
	WNW1103C		K		D	111.0
	WNW1104A		WT,(T)	V	D	19.00
	WNW1104B		T		D	36.00
	WNW1104C		K		D	114.0
	WNW1105A		T		D	21.00
	WNW1105B		T		D	36.00
	WNW1106A		WT,(T)		U	16.00
	WNW1106B		T		U	31.00
	WNW1107A		WT,(T)	V	D	19.00
	WNW1108A	A	WT,(T)		U	16.00
	WNW1109A		WT,(T)		U	16.00
	WNW1109B	A	T		U	31.00
	WNW1110A		WT,(T)		D	20.00
	WNW1111A		T		D	21.00
SSWMU No. 12 - Hazardous Waste Storage Lockers	(No wells installed for SSWMU No. 12)					
Motor Fuel Storage Area (Monitors underground storage tanks. Not a SSWMU.)	R8613A		S,(T)		C	8.00
	R8613B		S		C	8.00
	R8613C		S		D	6.50

Well position in SSWMU: U = upgradient; D = downgradient; B = background; C = crossgradient.
Hydrogeologic units monitored are: WT = weathered Lavery till; T = unweathered Lavery till; S = sand and gravel; K = Kent recessional sequence; TS = till-sand. Units enclosed in brackets indicate the hydrogeologic unit is only a secondary monitoring unit.
V = quarterly volatile sampling. A,B,C,I = expanded characterization parameters for RFI. (See Table 3-3 for parameter list.)
R = annually for limited radiological sampling.
** Location added to program during rep 6, 1993.*

Table 3-1 (concluded)

Groundwater Monitoring Network: Super Solid Waste Management Units

Well Point Identification	Special Sampling Protocol	Year Installed	Well Depth
WP-A	R	1990	33
WP-C	R	1990	23
WP-D	R	1990	26
WP-E	R	1990	22
WP-F	R	1990	36
WP-G	R	1990	34
WP-H	R	1990	17

Well position in SSWMU: U = upgradient; D = downgradient; B = background; C = crossgradient.
Hydrogeologic units monitored are: WT = weathered Lavery till; T = unweathered Lavery till; S = sand and gravel; K = Kent recessional sequence; TS = till-sand. Units enclosed in brackets indicate the hydrogeologic unit is only a secondary monitoring unit.
V = quarterly volatile sampling. A,B,C,I = expanded characterization parameters for RFI. (See Table 3-3 for parameter list.)
R = annually for limited radiological sampling.
** Location added to program during rep 6, 1993.*

Downgradient well. A well installed hydraulically downgradient of a SSWMU that is capable of detecting the migration of contaminants from the unit under study.

Background well. A well installed hydraulically upgradient of all waste management units that is capable of yielding groundwater samples that are representative of conditions not affected by site activities. In some cases upgradient wells may be downgradient of other units, which makes them unsuitable for use as true background wells. However, they are still useful for providing upgradient information about the unit under study.

Crossgradient well. A well installed to the side of the major downgradient flow path.

Table 3-1 identifies the position of a well relative to the waste management unit monitored. The wells monitoring a given hydrogeologic unit (e.g., sand and gravel, weathered Lavery till) also may be arranged in a generalized upgradient to downgradient order based upon their location within the hydrogeologic unit. The hydraulic position of a well relative to a super solid waste management unit (SSWMU), i.e., upgradient or downgradient, does not necessarily match that same well's position within a hydrogeologic unit. For example, a well that is upgradient in relation to a SSWMU may be located at any position within a hydrogeologic unit, depending on the geographic position of the SSWMU within the hydrogeologic unit. In general, the following text and graphics refer to the hydraulic position of monitoring wells within their respective hydrogeologic units, thus providing a site-wide hydrogeologic unit perspective.

Initial sampling of wells in the current monitoring network began in 1990. All wells were gradually incorporated into the program during 1991, and the entire network followed full sampling schedules in 1992 and 1993 (Table 3-2) except for the two wells that were added to the network in 1992 (WNW0909 and WNW0910). The wells were sampled routinely for indicator and groundwater quality parameters. The planned one-year sampling for U.S. EPA interim primary drinking water standards to establish a baseline for water quality was completed in 1992.

Routine Groundwater Sampling

The two categories of groundwater sampling parameters, collected as noted in Table 3-3, are contamination indicator parameters and groundwater quality parameters. Table 3-2 indicates the sampling schedule for these parameters during 1993. Parameters constituting the indicator and groundwater quality lists have been developed to satisfy the requirements of 40 CFR, Part 265, Subpart F, which governs groundwater monitoring at interim status facilities. Indicator parameters are used as indicators of groundwater contamination while the groundwater quality parameters are used to establish groundwater quality.

Contamination indicator parameters: Samples were collected six times in 1993. Monitoring the contamination indicator parameters helps to identify any potential effect of past or present site operations.

Groundwater quality parameters: Samples were collected twice in 1993. The groundwater quality parameters selected provide information on the major chemical constituents of the groundwater.

The following changes to the 1993 WVDP groundwater monitoring program were phased in beginning with the October 1993 sampling:

- A baseline for groundwater quality was established during the past two years with an intensive eight-times-per-year sampling schedule under the expanded well-monitoring program, which was developed to support site closure and the EIS. Sampling for indicator parameters on a quarterly basis will now allow long-term trending and characterization of seasonal changes.

- All wells have been monitored for volatile organic compounds (VOCs) approximately sixteen times during the past two years, with the vast majority of the wells showing no detection of any of the fifty-eight compounds on the parameter list. All routine groundwater locations that have not shown positive detections will now be sampled annually for VOCs.

  A small group of wells consistently show positive detections of very low concentrations of one to a few compounds. Those wells that showed positive detections in 1991 and 1992 and wells at selected locations downgradient of positive detections will be sampled quarterly for VOCs to evaluate possible contaminant migration.

- Wells will continue to be sampled semiannually for groundwater quality constituents. Sampling for aluminum, phosphate, silicon, and hydrogen sulfide were added to the sampling parameters to help determine ion mass balance, which will support groundwater modeling efforts.

Expanded Characterization Sampling

The WVDP RCRA Facility Investigation (RFI) Work Plan commits the WVDP to providing an expanded characterization of the groundwater in order to more fully assess potential releases of hazardous wastes and/or constituents from SSWMUs on the Project premises. This expanded characterization will consist of two rounds of site-wide sampling of selected wells for full suites of both radiological and nonradiological parameters. The first round in this expanded sampling and analysis occurred during the fourth-quarter sampling in 1993. The second round will occur in the second quarter of 1994.

An evaluation of 1991 and 1992 indicator parameter results identified fifty-two groundwater monitoring locations requiring further chemical and radiological characterization. The evaluation used analysis of variance techniques to statistically assess downgradient locations for significant differences with respect to background values. All fifty-two locations were characterized radiologically. Forty-nine of the fifty-two locations were also characterized for chemical parameters.

Expanded Chemical Characterization

Of the forty-four monitoring locations and five background wells sampled for chemical characterization, thirty are screened in the sand and gravel unit of the north plateau. The weathered till on the south plateau was characterized at eight locations that provide comprehensive coverage, particularly of the NDA. The NDA interceptor trench area was characterized by analyzing samples from the NDA sump manhole (WNNDATR) and from well WNW0909, which is approximately 25 feet downgradient of the trench.

The unweathered Lavery till was characterized at nine locations, seven on the north plateau and two on the south plateau.

The Lavery till-sand was characterized at background well WNW0402 and well WNW0202, which persistently indicates a high pH. No other locations in the Lavery till-sand were judged to require further characterization. No further chemical or radiological characterization was recommended for the Kent recessional sequence because nonradiological indicators were consistent with naturally occuring conditions and none of the radiological parameters showed statistical significance.

To provide the most conservative results, samples from most locations were analyzed for chemicals on the Target Compound List (U.S. Environmental Protection Agency 1991) because these analytes are most commonly associated with haz-

Table 3-2

1993 Groundwater Monitoring Schedule

Date	*Sample Rep**	*Contamination Indicator Parameters Scheduled and Collected*	*Groundwater Quality Parameters Scheduled and Collected*	*Expanded Characterization of Project Monitoring Locations***
1/11/93 - 2/9/93	1	F		
2/16/93 - 3/26/93	2	F	F	
4/19/93 - 5/13/93	3	F		
5/24/93 - 6/22/93	4	F		
7/12/93 - 8/9/93***	5	F		
10/29/93 - 12/31/93	6	S	F	E
Total Sample Sets per Well in 1993:		**6**	**2**	**1**

Key:

** Sample rep is a 6-week period within a semiannual sampling period.*

*** The RCRA Facility Investigation (RFI) Work Plan calls for two rounds of sampling. See Expanded Characterization Sampling in text.*

**** This sampling period marked the transition from sampling eight times per year to sampling four times per year.*

F = All wells sampled for full parameters.

S = Contamination indicator parameter analyses included Appendix IX volatile compounds at only nine selected locations.

E = This sample rep was chosen, together with the second rep of 1994, to further characterize selected Project monitoring locations for full suites of expanded radiological and chemical parameters. (See Tables 3-1 and 3-3 for details of locations and parameters.)

Table 3-3
1993 Schedule of Groundwater Sampling and Analysis

Contamination Indicator Parameters **(Completed six times in 1993)**	*pH* [1] *Conductivity* [1] *Total Organic Carbon (TOC)* [2] *Total Organic Halogens (TOX)* *Gross Alpha* *Gross Beta* *Tritium* *Gamma Isotopic Scan* *Appendix IX Volatile Organic Analysis (VOAs)*	
Groundwater Quality Parameters **(Completed two times in 1993)**	*Aluminum* [3] *Ammonia* *Bicarbonate/Carbonate* *Calcium* *Chloride* *Iron* *Magnesium* *Manganese* *Nitrate+Nitrite-N* *Phenols* *Phosphate* [3] *Potassium*	*Silica* [3] *Sodium* *Sulfate* *Sulfide* [3]
Expanded Characterization Parameters for Project Monitoring Locations Only **(Completed one time in 1993)**	***<u>Schedule A (43 locations)</u>*** *Target Compound List (TCL)* *Radioisotopic* ***<u>Schedule B (6 locations)</u>*** *Modified Appendix IX* [4] *(40 CFR Part 264)* *Radioisotopic* ***<u>Schedule C (2 locations)</u>*** *Modified Appendix IX* [4] *Radioisotopic* *Tributyl phosphate (TBP)* *N-dodecane* ***<u>Schedule I (3 locations)</u>*** *Radioisotopic only*	

[1] *Field measurement.*
[2] *Includes nonpurgeable organic carbon (NPOC) only.*
[3] *Analyses performed only once during 1993 because parameters were added to the schedule at mid-year.*
[4] *Does not include polychlorinated dibenzo-p-dioxins (PCDDs) or polychlorinated dibenzofurans (PCDFs).*

ardous waste sites and represent the greatest threat to human health and the environment.

Samples from five locations where volatile organic compounds have been previously detected and samples from the NDA trench sump manhole were analyzed for compounds from a modified Appendix IX list from 40 CFR 264 (U.S. Environmental Protection Agency 1992). Analyses were not performed for polychlorinated dibenzodioxins (PCDDs) or polychlorinated dibenzofurans (PCDFs). All volatile and semivolatile organic analyses have included a library scan for tentative identification of undetermined peaks.

Expanded Radiological Characterization

Table 3-4 lists the radioisotopes that best represent potential radiological contaminants encountered on the WVDP site. The first column — full radioisotopic — is appropriate for areas where high activity or alpha activity is encountered. The second column — beta-emitting — establishes analytical parameters for areas where nominal levels of beta-gamma activity are encountered.

During this first round of sampling all fifty-two locations that had been identified as requiring further characterization under the expanded monitoring program were characterized for the beta-emitting radioisotopes listed on Table 3-4. The analyses for the full radioisotopic list was used at fifteen locations: four wells with gross alpha significance, i.e., with a statistically significant difference from background value (WNW0905, WNW1006, WNW0908, and WNW0906); seven wells exceeding the New York State Class GA (see *Glossary*) radiological water quality standard for gross beta activity (WNW0408, WNW0111, WNW0501, WNW0502, WNW0104, WNW8604, and WNW8605); and four background wells (WNWNB1S, WNW1008c, WNW0402, and WNW0405). Three of these fifteen wells (WNW1006, WNW0906, and WNW0111) were sampled only for expanded radiological characterization because they exhibited significance only for radiological indicators.

Sampling Methodology

Samples are collected from monitoring wells using either Teflon well bailers or bladder pumps. (All nylon leaders on dedicated bailers were replaced with Teflon-coated stainless steel leaders in midsummer 1993 in order to comply with applicable regulations.)

The method of collection used depends on well construction, water depth, and the water-yielding characteristics of the well. Teflon bailers are used in wells with low standing water volume; bladder pumps are used in wells with good water-yielding characteristics.

To ensure that only representative groundwater is sampled, three well volumes are removed (purged) from the well before the actual samples are collected. If three well volumes cannot be removed because of limited recharge, purging the well to dryness achieves the same results. Conductivity and pH are measured before and after sampling to help determine if the quality of the groundwater changed while samples were being collected.

The Teflon bailer, a tube with a check valve at the bottom and the top, is lowered into the well until it reaches the desired point in the water column. The bailer is lowered slowly to ensure that the water column is not agitated and is then withdrawn from the well with a sample and emptied into a sample container. The bailer, bailer line, and bottom-emptying device used to drain the bailer are dedicated to the well, i.e., are used exclusively for that well at all times.

Bladder pumps use compressed air to gently squeeze a Teflon bladder that is encased in a stainless steel tube located near the bottom of the

Table 3-4

Radioisotopic Parameter List

Isotope	*Full Radioisotopic List*	*Beta-emitting Radioisotopic List*
C-14	X	X
Cs-137	X	X
Co-60	X	X
I-129	X	X
Am-241	X	
Sr-90	X	X
Ra-228	X	
Ra-226	X	
H-3	X	X
Tc-99	X	X
U-232, U-233/234, U-235/236, U-238, Total U	X	
Pu-238, Pu-239/240	X	

well. When the pressure is released, new groundwater flows into the bladder. A series of check valves ensures that the water flows only in one direction. The drive air is always kept separate from the sample and is expelled to the surface by a separate line.

Bladder pumps reduce mixing and agitation of the water in the well. Each bladder pump system is dedicated to its individual well to reduce the likelihood of sample contamination from external materials or cross contamination. The compressor and air control box can be used from well to well because they do not contact the sample.

Immediately after the samples are collected they are put into a cooler and returned to the Project's Environmental Laboratory. The samples are then either packaged for overnight delivery to an off-site contract laboratory or put into controlled storage to await on-site testing.

Ten off-site wells, sampled for radiological parameters, pH, and conductivity, were also part of the groundwater monitoring program during 1993. These wells are used by site neighbors as sources of drinking water (Fig. 3-4).

Groundwater Monitoring Results

Results of the 1993 groundwater monitoring program and the expanded RCRA characterization program are summarized below. (Complete data are tabulated in *Appendix E*.) The 1993 sampling results are grouped and summarized according to the five hydrogeologic units in order to present the results of the groundwater monitoring program on a site-wide basis and to provide intra-unit comparisons. (More detailed assessments of potential releases from SSWMUs will be prepared in accordance with the site's RCRA Facility Investigation Work Plan, as required by the RCRA 3008 (h) Order on Consent.)

Successful implementation of the WVDP's groundwater monitoring program includes proper placing of groundwater monitoring wells, using appropriate methods of sample collection, reviewing analytical data and quality control information, and presenting, summarizing, and evaluating the resulting data appropriately. Data are presented in this report through tables and graphs.

Presentation of Results in Tables

Appendix E tables contain the results of sampling for contamination indicator parameters (Tables E-1 through E-5), groundwater quality parameters (Tables E-6 through E-10), and the results of expanded characterization sampling (Tables E-12 through E-17). Individual analytes within each group of parameters are listed in Table 3-3. Expanded characterization sampling includes Target Compound List (TCL) and Appendix IX volatile organic compounds (Table E-12); n-dodecane and tributyl phosphate (Table E-13); TCL and Appendix IX metals (Table E-14); full (alpha and beta) radioisotopic analyses (Table E-15); beta-emitting radioisotopic analyses (Table E-16), and radiologic analyses of north plateau well points (Table E-17).

The tables in *Appendix E* present the results of the groundwater monitoring program grouped according to the five different hydrogeologic units monitored: the sand and gravel unit, the Lavery till-sand unit, the weathered Lavery till unit, the unweathered Lavery till unit, and the Kent recessional sequence.

The tables summarizing the contamination indicator parameters, the groundwater quality parameters, and the expanded characterization parameters also display each well's hydraulic position relative to other wells within the same hydrogeologic unit. These positions are identified as UP, which refers to either background or upgradient wells, and DOWN - B, DOWN - C, and DOWN - D. Upgradient locations are designated UP because they are upgradient of all the

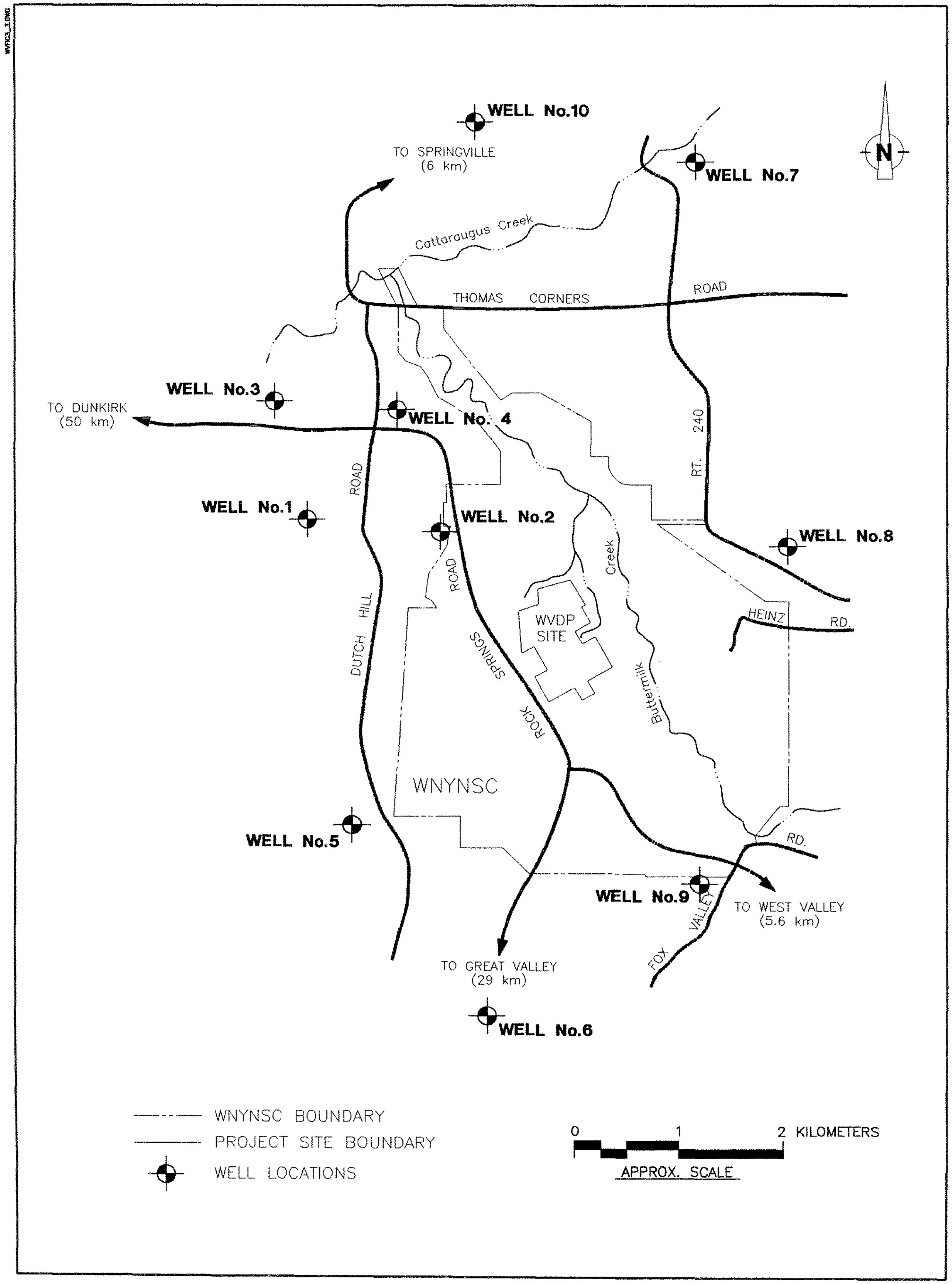


Figure 3-4. Off–site Groundwater Monitoring Points.

other locations. Downgradient locations are designated B, C, or D to indicate their positions along the groundwater flow path relative to each other. For example, wells denoted as DOWN - C in the sand and gravel unit are downgradient of both UP and DOWN - B wells but are upgradient of DOWN - D wells. Grouping the wells by hydraulic position provides a logical basis for presenting the groundwater monitoring data in the tables and figures in this report.

These tables also list the sample collection period. (The sample collection year is divided into two semiannual periods; each semiannual period is divided into evenly spaced six-week periods, called "reps.") During 1993, the sampling schedule was revised from eight reps per year to four reps per year. The change took place at mid-year, when four six-week reps had already occurred. In the second half of 1993 samples were collected during two quarterly reps, yielding a total of six reps for the 1993 year. (See Table 3-2 and Table 3-3.)

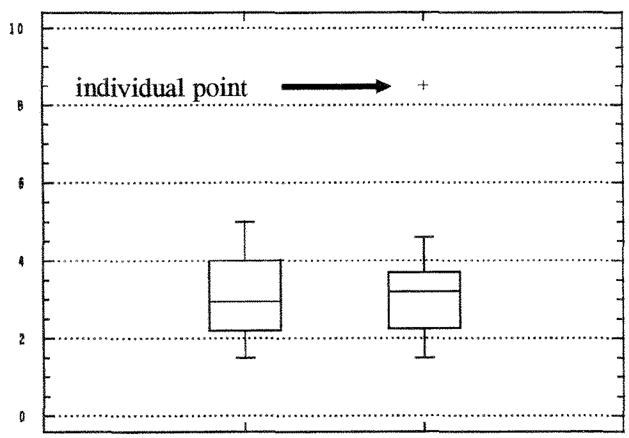


Figure 3-5. Sample Box-and-Whisker Plot

During each of the six reps, all wells were sampled for the contamination indicator parameters listed in Table 3-3. Samples were collected for groundwater quality parameters twice in 1993, during the second and sixth rep. In the sixth rep, fifty-two selected wells were sampled for expanded parameter lists for RFI characterization. (See Table 3-3.)

Presentation of Results in Graphs

A second way in which groundwater monitoring results are presented is through graphs that show relative distributions of the data.

The multiple box-and-whisker plot is used here to present contamination indicator data for individual locations within the same hydrogeologic unit. All the 1993 results obtained for selected parameters (pH, conductivity, total organic carbon, total organic halogens, gross alpha, gross beta, and tritium) were used to construct the box-and-whisker diagrams of each well within a given hydrogeologic unit. Box-and-whisker plots allow results for wells within a hydrogeologic unit to be visually compared to each other.

Figure 3-5 is an example of a multiple box-and-whisker plot.

- The horizontal lines within the small boxes show the median of the data set for a given well.
- The box outline itself shows the range of the middle 50% of the data for a given well (the upper and lower quartiles).
- The whisker extension shows the range of the data for a given well. (Values beyond 1.5 times the length of the box are plotted as individual points.)

The sample counting results for gross alpha, gross beta, and tritium, even if below the minimum detectable concentrations, were used to generate the box-and-whisker plots. Thus, negative values were included. This is most common for the gross alpha analyses, where sample radiological counting results may be lower than the associated instrument background.

All box-and-whisker plots shown at the end of *Chapter 3* present the upgradient wells on the left side of the figure with the upgradient location code prefixed with the letter A. Downgradient locations are plotted to the right and use the letters B through D, as discussed above, to distinguish relative position along the groundwater flow path.

Trend plots or line plots also have been used to show concentrations of a particular parameter over time at monitoring locations of interest. Results for the volatile organic compounds 1,1-dichloroethane (1,1-DCA) and dichlorodifluoromethane (DCDFMeth) are plotted using this format. (See Figs. 3-41 and 3-41a.) Long-term and shorter-term trends of gross beta and tritium for selected groundwater monitoring locations are also shown in Figures 3-42 through 3-43a.

Results of Contamination Indicator Monitoring of the Sand and Gravel Unit

Figures 3-6 through 3-12a are box-and-whisker plots of contamination indicator parameters for the forty-five sample locations monitoring the sand and gravel unit of the north plateau. Background site conditions are monitored by well WNWNB1S (coded ANB1S on the box-and-whisker plots), and upgradient monitoring is provided by wells WNW0301, WNW0401, WNW0403, and WNW0706 (coded A0301, A0401, A0403, and A0706, respectively, in the figures). These wells are shown in the first five positions on the left of the box-and-whisker charts. Tabulated contamination indicator data are presented in *Appendix E*, Table E-1.

Downgradient locations are subdivided into three categories according to the well's general position within the groundwater flow regime. For example, downgradient wells prefixed with B are nearest to the background or upgradient wells (prefixed A), followed by wells prefixed with C, which are located midway along the downgradient flow path. Wells prefixed with a D are farthest downgradient.

Sampling with a Dedicated Bladder Pump

Wells monitoring downgradient conditions in the sand and gravel unit constitute the monitoring network for eight SSWMUs. The SSWMUs monitored by wells in the sand and gravel unit are SSWMU #1, the low-level waste treatment facility; SSWMU #2, miscellaneous small units; SSWMU #3, the liquid waste treatment system; SSWMU #4, the high-level waste storage and processing area; SSWMU #5, the maintenance shop leach fields; SSWMU #6, the low-level waste storage area; SSWMU #7, the chemical process cell waste storage area; and SSWMU #8, the construction and demolition debris landfill. (See Table 3-1, which identifies the SSWMUs and associated individual SWMUs, the hydrogeologic unit monitored, and the depth of each well.)

The box-and-whisker plots for the sand and gravel unit show elevated levels of pH and conductivity at well WNW0103 (Figs. 3-6 and 3-7). Well WNW0103 is located in the vicinity of a spill of caustic sodium hydroxide that occurred in 1984. Results of groundwater quality analyses (*Appendix E*, Table E-6) at WNW0103 indicate that elevated levels of sodium and hydroxide have contributed to these elevated levels of conductivity. However, the levels of pH and conductivity at this well have declined in comparison to 1992 values.

Conductivity levels are also elevated in wells WNW0203, WNW0205, and WNW8606 (Fig.3-7). These wells monitor groundwater conditions upgradient and downgradient of the sludge ponds in SSWMU #2. Elevated conductivity values at these locations probably can be attributed to high concentrations of sodium and chloride. This can be seen in *Appendix E*, Table E-6, which shows major cation and anion concentrations for these wells.

The pH and conductivity levels for all other sand and gravel wells appear to lie within normal environmental ranges for this unit.

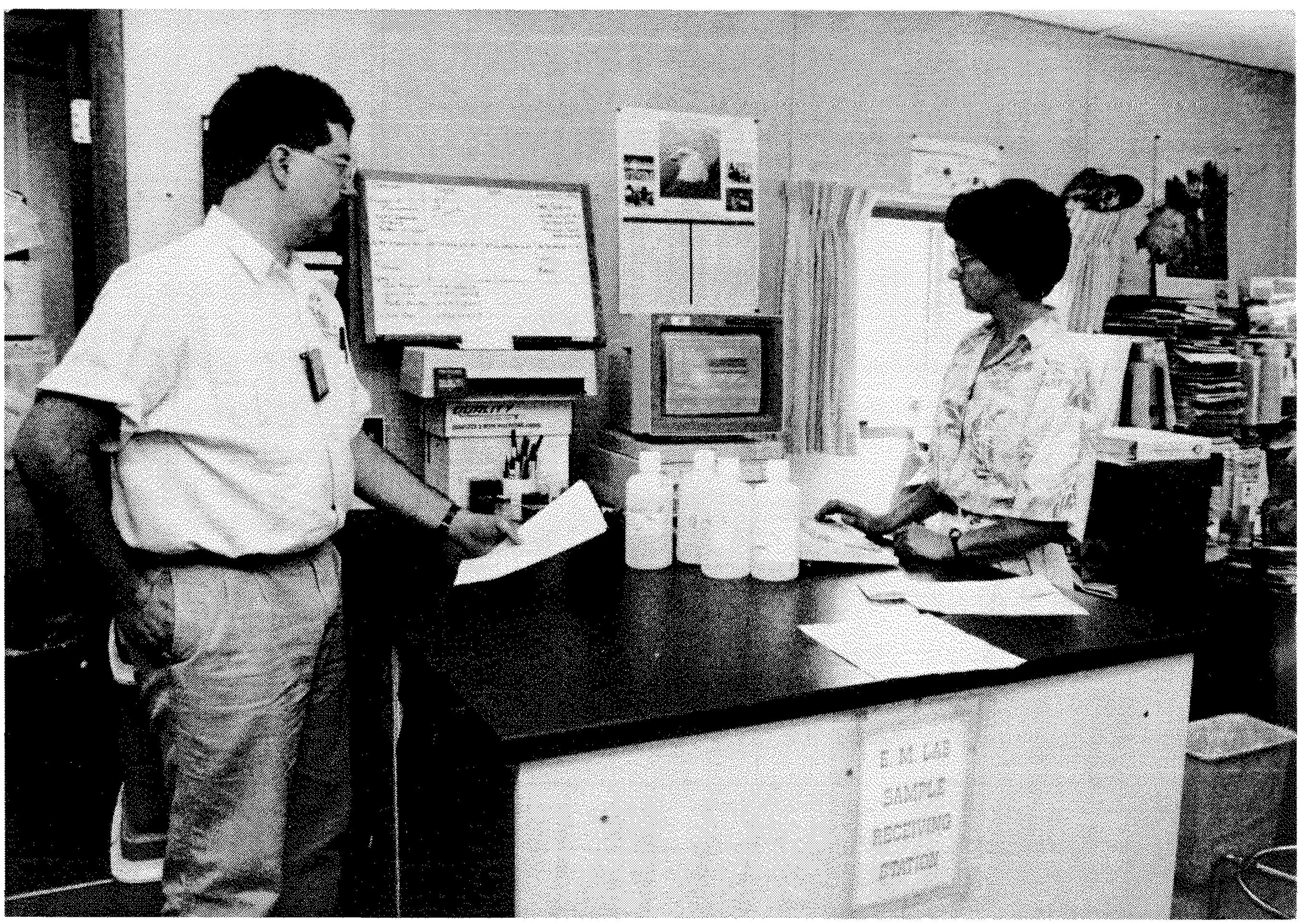
Figures 3-8 and 3-9 are the box-and-whisker plots for total organic carbon (TOC) and total organic halogens (TOX). Well WNW0103 exhibits elevated levels of TOC and TOX. Wells WNW0111 and WNW8605, both near former lagoon 1, show elevated levels of both TOC and TOX. Wells WNW0203, WNW0205, and WNW8606 also show elevated levels of TOC and TOX. Wells WNW8608 and WNDMPNE show elevated levels of TOC, while well WNW0502 exhibits elevated levels of TOX. The remaining wells display TOC and TOX levels that are similar to background.

Results of gross alpha activity (Fig. 3-10) are mostly at or below minimum detectable concentrations except at locations WNW0905 and WNW8605, which showed positive results for all six analyses. However, alpha concentrations at WNW8605 are lower this year than in 1992. Wells WNW0103, WNW0111, WNW0501, and WNW0502 showed positive results for at least four of the six analyses. Gross alpha levels at these six locations, although above background, are only marginally above the minimum detectable concentrations.

Gross beta results are shown in Figures 3-11, 3-11a, and 3-11b. The y-axis on these three figures is magnified in order to display the different concentration levels among wells. Figure 3-11 shows the entire range of concentrations: at this scale only the wells with the highest gross beta levels stand out. The wells clearly visible in this figure, WNW0408, WNW0501, WNW0502, and WNW8605, exhibit the highest concentrations of gross beta in on-site groundwater. Beta levels in these wells are slightly higher than last year's values. Three-year and seven-year trends of gross beta concentrations for these and other selected groundwater locations are shown in Figures 3-42, 3-42a, and 3-42b.

Figure 3-11a and 3-11b show gross beta concentrations on a magnified scale to highlight the remainder of the sand and gravel wells. Background well WNWNB1S had an average gross beta concentration of 2.89E-09µCi/mL for 1993, compared to an average value of 2.83E-04µCi/mL at the well with the highest activity, WNW0408. This represents an approximate 98,000-fold difference in concentration between background and this downgradient location. The available trend data for background well WNWNB1S is included in Figure 3-42a to allow comparison with downgradient trend data. The New York State Class GA groundwater quality standard (applicable to water used for drinking) for gross beta activity (1E-06µCi/mL) was exceeded at wells WNW0104, WNW0111, WNW0408, WNW0501, WNW0502, WNW8604, and WNW8605. Other locations such as WNW0103, WNW0801, WNW8609, and WNDMPNE show elevated concentrations when compared to background wells but are below the groundwater quality standard. The increasing beta activity at location WNDMPNE is the subject of an investigation. (See **Long-term Trends of Gross Beta and Tritium at Selected Groundwater Monitoring Locations**.)

Graphs of tritium concentrations for wells within the sand and gravel unit are presented in Figures 3-12 and 3-12a. Two figures are presented to allow magnification of the y-axis. Wells WNW0602 and WNW8605 contain the highest levels of tritium in the sand and gravel unit. The concentrations observed during 1993 averaged 5.92E-06µCi/mL and 5.21E-06µCi/mL, respectively. This compares to an average of



Receiving Groundwater Samples at the Environmental Laboratory Computerized Receiving Station

4.63E-08µCi/mL for background well WNWNB1S and represents an approximate 100- to 125-fold difference in concentration between background and these downgradient locations. Wells WNW0106, WNW0111, WNW8609, WNW8612, and WNSP008 are slightly elevated above background levels.

In previous annual reports well WNW0408 had been reported to contain elevated levels of tritium that exceeded the EPA primary drinking water standard of 2E-05µCi/mL (which New York State had adopted as its standard for Class GA groundwaters). However, in January 1993 samples collected from the seven wells with known high gross beta concentrations (WNW0104, WNW0111, WNW0408, WNW0501, WNW0502, WNW8604, and WNW8605) were analyzed for tritium with and without first distilling the samples. Lower tritium activities for distilled samples from WNW0408, WNW0501, and WNW0502 were observed, and it was concluded that other, higher energy beta-emitting radionuclides had interfered with the analyses, resulting in an overestimate of the tritium concentration. Distillation removes these interfering radioactivities and yields a more accurate measurement of the tritium activity. (The results from the other four wells revealed less noticeable differences, indicating that interferences were negligible.) It would thus appear that the tritium data for WNW0408, WNW0501, and WNW0502 reported in the 1991 and 1992 Site Environmental Reports actually were artificially elevated and that the standard for tritium, which had been reported in the 1992 Site Environmental Report as having been exceeded at WNW0408, was not exceeded. As a result, this inaccurate data has been deleted from the three-year tritium trend (Fig.3-42a) and should not be used for any other purposes. (Pre-1991 analyses would not have been affected because samples were distilled. All tritium samples collected from the seven contaminated wells and reported in 1993 were distilled before analysis.) There is, however, one routinely monitored well on-site that currently exceeds the standard (WNW1107a).

Monitoring of the wells in the sand and gravel hydrogeologic unit indicates some measurable effects on groundwater, primarily in areas downgradient of the main plant facility and the low-level waste treatment facility. There is no indication that the groundwater from these areas affects human health or the environment because this water is not used for drinking or general facility needs. In addition, the surface water leaving the site, which includes effluent groundwater flow from this surficial sand and gravel unit, meets the appropriate standards.

Comparisons of downgradient location sampling results to both upgradient groundwater monitoring results and groundwater quality standards demonstrate differences that indicate an effect on groundwater, particularly with respect to gross beta activity. The expanded characterization of groundwater for beta-emitting isotopes was implemented to identify the specific radionuclides contributing to the gross beta activity. Strontium-90 has been found to be the primary contributor to gross beta activity, and actions to respond to this finding are being formulated. (See **Discussion of Site Groundwater Monitoring**.)

Results of Contamination Indicator Monitoring of the Lavery Till-Sand Unit

Eight wells monitor groundwater in the Lavery till-sand unit. As noted in the discussion on hydrogeology, the Lavery till-sand unit is limited in its extent and thickness. General upgradient conditions are monitored by wells WNW0302, WNW0402, WNW0404, and WNW0701. Downgradient conditions are monitored by wells WNW0202, WNW0204, WNW0206, and WNW0208. Well WNW0905 has been reclassified this year in the sand and gravel unit following recent geologic interpretation.

Figures 3-13 through 3-19 are box-and-whisker plots for selected contamination indicator parameters for the Lavery till-sand unit. Tabulated data for these parameters are presented in *Appendix E*,

On-screen Review of a Tritium Sample Count

Table E-2. Well WNW0202 continues to show elevated levels of pH. This elevated pH condition reflects the presence of measurable hydroxide alkalinity. Levels of conductivity in well WNW0202 also appear slightly elevated. All other wells appear to lie within normal ranges of pH and conductivity for this unit.

The box-and-whisker plots for TOC and TOX (Figs. 3-15 and 3-16) exhibit no clear distinctions between upgradient and downgradient locations.

Radiological constituents are at or below minimum detectable concentrations in all wells monitoring the till-sand unit (Figs. 3-17 through 3-19), with the exception of well WNW0202. Well WNW0202 shows marginally elevated concentrations of gross beta and tritium. However, these wells were below the New York State groundwater quality standards for these constituents (1.0E-06µCi/mL and 2E-05µCi/mL, respectively).

Results of Contamination Indicator Monitoring of the Unweathered Lavery Till Unit

Twenty-three wells monitor the unweathered Lavery till unit, which extends beneath both the north and south plateaus of the WVDP. General upgradient conditions of the unweathered till are monitored by well WNW0405.

Wells monitoring the unweathered Lavery till are part of the monitoring network for several SSWMUs: SSWMU #1, SSWMU #4, SSWMU #7, SSWMU #9, and SSWMU #11, the SDA, for which NYSERDA is responsible. In addition, most of the wells monitoring SSWMU #10 may provide useful information about this unit even though they are classified as monitoring primarily the weathered Lavery till or the Kent recessional unit. Results of groundwater contamination indicator monitoring for the unweathered Lavery till geologic unit are shown in box-and-whisker Figures 3-20 through 3-26a. Tabulated data are presented in *Appendix E*, Table E-3.

Levels of pH (Fig. 3-20) at well WNW0409 appear to be slightly higher than background and upgradient wells in this unit, while wells WNW0704 and WNW0707 appear to be slightly lower. However, they all lie within normal environmental ranges. Levels of conductivity (Fig. 3-21) appear to be slightly elevated in well WNW0910, which is located downgradient of the NDA and interceptor trench.

Concentrations of both total organic carbon (Fig. 3-22) and total organic halogens (Fig. 3-23) are elevated at well WNW0704. This is a downgradient well located in SSWMU #7. Levels of TOC and TOX for all other wells are similar to or lower than background.

Results of radiological monitoring of unweathered Lavery till wells are shown in Figures 3-24 through 3-26. Results for gross alpha analyses (Fig. 3-24) are mostly at or below the minimum detectable concentration. Results for gross beta (Fig. 3-25) indicate that concentrations at wells WNW0704 and WNW0910 are slightly elevated when compared to other wells in this unit. Gross beta results for these two wells are slightly higher than last year's values. Figure 3-26 shows results of tritium measurements for wells monitoring the unweathered Lavery till. Wells WNW0107, WNW0109, WNW0110, WNW0114, and WNW0115 of SSWMU #1 showed slightly elevated results for tritium. Well WNW1109B, which monitors SSWMU #11 (NYSERDA's SDA) also showed slightly elevated tritium concentrations. Well WNW1109B is located between NYSERDA's SDA and the NDA. (See Fig. 3-3.)

The concentrations of gross beta and tritium detected in these unweathered Lavery till wells are below the applicable standard of 1E-06μCi/mL for gross beta and 2E-05μCi/mL for tritium. Although some above-background results are reported for gross beta and tritium, concentrations are relatively low and indicate a negligible effect on groundwater within the unit.

Results of Contamination Indicator Monitoring of the Kent Recessional Sequence

Seventeen wells monitor groundwater conditions within the recessional sequence. However, several of these wells are consistently dry and therefore can not be sampled on a regular basis. The water-bearing wells are all situated on the site's south plateau and represent the deepest groundwater monitoring points on-site.

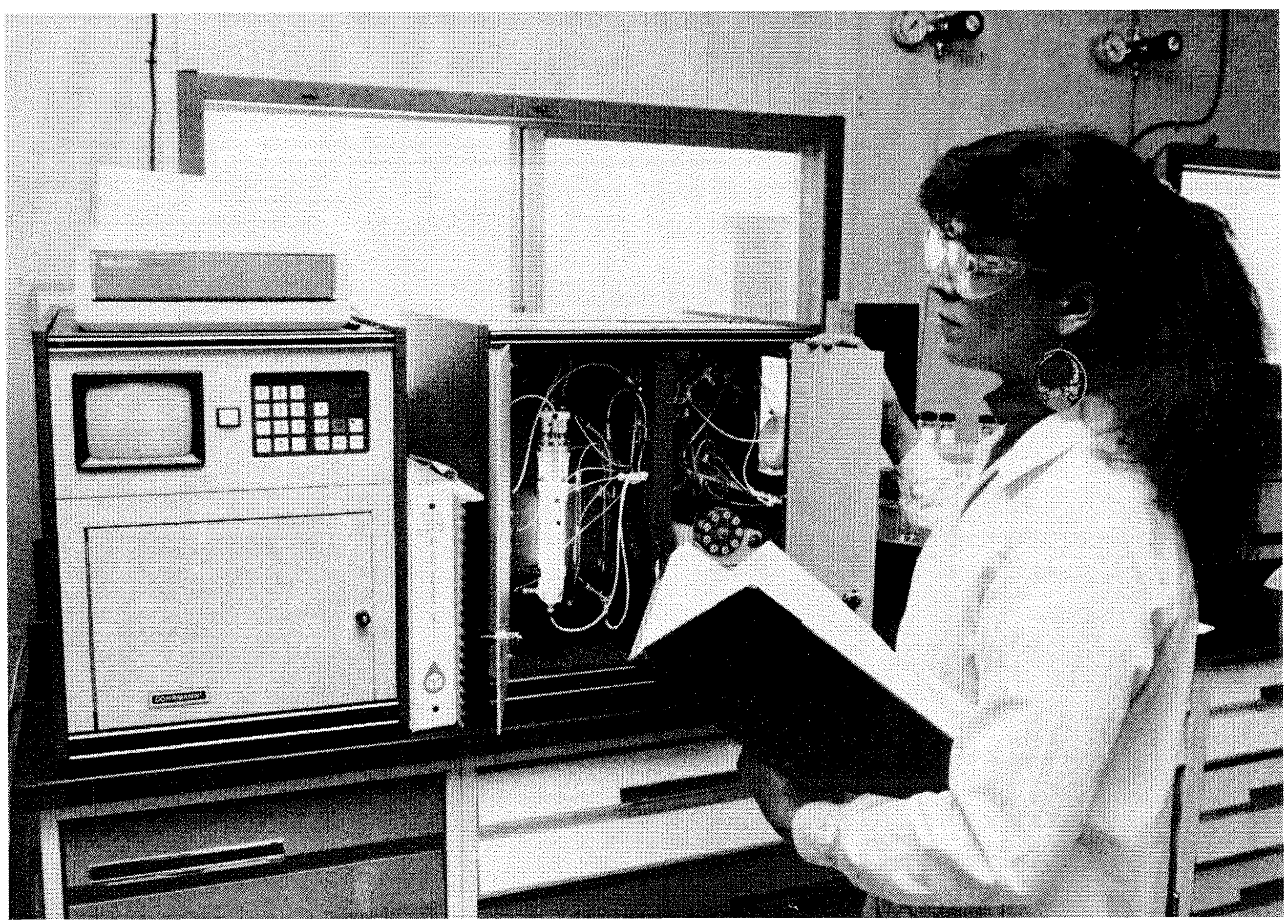
Background conditions are monitored by well WNW1008B, which is 51 feet below grade. Three additional wells, WNW0901, WNW0902, and WNW1001, provide upgradient monitoring of the unit. These wells range in depth from 116 to 136 feet below grade. General downgradient monitoring is provided by eight wells that range in depth from 108 to 138 feet.

The Kent recessional sequence is monitored as part of the groundwater monitoring program associated with SSWMU #9, SSWMU #10, and SSWMU #11.

Results of contamination indicator monitoring of the Kent recessional sequence are shown in Figures 3-27 through 3-33. The box-and-whisker plots of pH and conductivity show some variations across well locations. Values of pH (Fig. 3-27) at WNW1002 appear slightly lower than background and upgradient wells, while pH at WNW8610 appears slightly higher. However, all values lie within normal ranges of environmental variability. Conductivity values (Fig. 3-28) appear slightly elevated at wells WNW0903, WNW1002, WNW1104C, WNW8610, and WNW8611. Because of dryness, well WNW1104C could be sampled only once in 1993. TOC values (Fig. 3-29) appear to be slightly elevated in downgradient locations when compared to the background and upgradient locations. TOX values (Fig. 3-30) show no apparent differences between upgradient and downgradient locations.

Results of sampling for radiological contamination indicator parameters (Figs. 3-31 through 3-33) suggest the lack of any direct site-induced effects on the waters of the recessional sequence. Gross alpha concentrations in all wells are at or below the minimum detectable levels. NYSERDA's SDA wells WNW1103C and WNW1104C contain marginally elevated levels of gross beta activity. Tritium concentrations at well WNW8610 appear to be marginally above the minimum detectable concentrations.

All levels of radioactivity measured within the recessional sequence are well below applicable groundwater standards. These results indicate



Checking a Total Organic Carbon Analyzer Run

that little, if any, effect on the groundwater in this unit has occurred through site operations.

Results of Contamination Indicator Monitoring of the Weathered Lavery Till Unit

Eighteen wells are used to monitor groundwater in the weathered Lavery till unit, which is the surficial hydrogeologic unit on the site's south plateau. Three SSWMUs are monitored as part of groundwater monitoring in the weathered Lavery till: SSWMU #9, SSWMU #10, and SSWMU #11.

Well WNW1008C monitors background conditions in the weathered Lavery till. Wells WNW0908 and WNW1005 monitor general upgradient conditions. Wells monitoring this unit range in depth from 10 to 23 feet below grade.

The results of monitoring of pH (Fig. 3-34) fall within a range of about 6.5 to 8.0 for wells within this geologic unit. The range of conductivity is relatively wide across this unit, with background and upgradient locations ranging from low to high values. Downgradient values for conductivity are within the ranges of the upgradient and background results (Fig. 3-35).

Results for total organic carbon and total organic halogens (Figs. 3-36 and 3-37) indicate elevated levels of these constituents at wells WNW0909 and WNW1107A. Levels of TOC also appear slightly elevated at well WNW0906.

Gross alpha concentrations (Fig. 3-38) for downgradient wells are similar to upgradient wells for this unit. Gross beta concentrations (Fig. 3-39) at well WNW0909 appear elevated and at wells WNW1007 and WNW1107A appear to be marginally elevated. Several of the wells within the unit, including WNW0906, WNW0907, WNW0908, and WNW1108A, exhibit very limited recharge rates, making it difficult to obtain sufficient volumes for sampling. The variation in gross alpha levels indicated in Figure 3-38 for WNW0908 represents a range of below minimum detectable concentrations that are associated with elevated levels of dissolved solids in the samples. The positive results of gross beta activity in upgradient well WNW0908 may also be related to the elevated levels of dissolved solids for gross alpha activity. All gross beta results are well below the groundwater quality standard of 1.0E-06µCi/mL.

Several wells monitoring the weathered Lavery till exhibited detectable levels of tritium activity (Figs. 3-40 and 3-40a). Levels of tritium in well WNW1107A are slightly above the EPA primary drinking water standard of 2.0E-05µCi/mL. Several other wells (WNW0909, WNW1102A, WNW1103A, WNW1104A, WNW1106A, and WNW1109A) consistently had above-background levels of tritium.

Results of Sampling for Groundwater Quality Parameters

Results of the two rounds of sampling for groundwater quality parameters are in *Appendix E*, Tables E-6 through E-10. The results for the major cations (calcium, magnesium, and sodium) and anions (chloride, sulfate, bicarbonate/carbonate) indicate that the major constituents of the groundwater beneath the site are essentially calcium and bicarbonate ions. Magnesium, sodium, chloride, and sulfate are secondary constituents. Small localized areas in each of the geologic units contain high sulfide or chloride concentrations.

Concentrations of sodium and chloride are high in sand and gravel wells WNW0103, WNW0210, WNW0203, WNW0205, WNW0305, WNW0307, WNW0401, WNW0408, and WNW8606. Several of these wells are located downgradient of Rock Springs Road, which is salted during the winter months. Wells

WNW0205 and WNW8606 are located downgradient of the sludge pond in SSWMU #2. Background well WNWNB1S nearly exceeded the nitrate+nitrite-nitrogen quality standard of 10.0 mg/L by exhibiting a mean 1993 concentration of 9.85 mg/L. High bicarbonate concentrations were observed in wells WNW0207, WNW0603, WNW0803, WNW0905, and WNW8605.

Concentrations of sodium and chloride are slightly elevated in Lavery till-sand wells WNW0302 and WNW0402. Concentrations of chloride in wells WNW0208, WNW0404, and WNW0701 are very low compared to the rest of the wells. The concentration of sulfate is high in well WNW0701. This well is located in the northwestern portion of the north plateau, where many wells are high in sulfate. This may be due to variations in the natural geochemistry of that portion of the site. The high pH found at well WNW0202 is the cause of the dissimilarity of its chemistry to the rest of the till-sand wells. Bicarbonate concentration is low in this well as the high pH has caused it to be converted to carbonate. Concentrations of iron, manganese, and magnesium are lower, while sodium and potassium appear higher. This may be related to changes in the solubility of these ions in a high pH environment.

The majority of wells in the unweathered till are low in chloride, with the exception of WNW0405. South plateau well WNW0910 contains a high concentration of sulfate. This well is located downgradient of the NDA and interceptor trench.

Several wells in the recessional sequence (WNW1002, WNW1003, WNW1101C, WNW8610, and WNW8611) contain high levels of sulfate, while others (WNW0901, WNW0902, WNW1001) contain high levels of chloride. These differences might be attributable to variations in the natural geochemistry of the geologic unit.

Weathered till well WNW1008C, which is representative of background conditions, contains the highest levels of chloride in this unit. This relatively high concentration may be influenced by road salting in the winter along Rock Springs Road, which is located not far from this well. WNW0909 also contains relatively high concentrations of chloride and ammonia. Several wells (WNW0908, WNW1006, WNW1007, WNW1107A, WNW1108A, and WNW1110A) contain high concentrations of sulfate. Well WNW1006 also contains a high concentration of sulfide.

Results of Sampling for Appendix IX and Target Compound List Metals

The sampling program for RFI characterization included analyzing samples from selected Project wells for total metals. The analytical techniques used included methods from SW-846, Test Methods for Evaluating Solid Waste (U.S. Environmental Protection Agency November 1986). The results of this sampling are tabulated in *Appendix E*, Table E-14. The results may be compared to New York State groundwater quality standards for Class GA groundwater. (See *Glossary*.) These standards are derived from Title 6 of the New York Code of Rules and Regulations (NYCRR), Chapter X, Part 703.5. Groundwater meeting these standards is best suited for a source of drinking water. In the absence of Class GA standards for specific constituents, New York State draft guidelines are used (New York State Department of Environmental Conservation 1991). The groundwater action levels determined by the WVDP media policy document, the Environmental Media Management Plan (West Valley Nuclear Services Co., Inc. January 1992), are also used if they are more stringent than the above. These standards provide a conservative reference for comparison to site groundwater sampling results, even though site groundwater is not used for either on- or off-site drinking water.

Comparison of the New York State Class GA standards for metals concentrations in groundwater to site groundwater results indicates several instances in which metal concentrations in site groundwater exceeded the respective quality standards:

Sand and gravel wells exceeded the standards for arsenic (WNW0105), chromium (WNW0106, WNW0116, WNW0203, WNW0502, WNW0601), lead (WNW0105, WNW0106, WNW0116, WNW0601, WNW0602, WNW0803, WNW0804, WNW8604), and copper (WNW0205). It is interesting to note that background well WNWNB1S contains relatively high concentrations of chromium and copper when compared to the New York State Class GA standard and to other wells in the hydrogeologic unit. New York State guideline standards for antimony were exceeded at WNW0501, WNW0502, WNW8604, and WNW8605.

Sand and gravel monitoring location WNSP008 closely approaches the New York State Class GA standards for mercury, while well WNW0601 is slightly below the New York State guidelines for nickel and zinc. Four wells (WNW0406, WNW0408, WNW0501, WNW8612) contain lead levels above the WVDP Media Management Plan action levels but below the New York State Class GA standard.

New York State Class GA standards for arsenic were exceeded in the weathered Lavery till well WNW0907. New York State Class GA standards for lead were exceeded in unweathered Lavery till well WNW0904; samples from well WNW0115 appear elevated and are slightly below the lead standard.

Concentrations of barium, beryllium, cadmium, cobalt, selenium, silver, tin, and vanadium are below detection limits or well below the New York State Class GA standards and guidelines in all hydrogeologic units.

Results of Routine and Expanded RFI Sampling for Organic Compounds

All wells in the groundwater monitoring program are analyzed routinely for volatile organic compounds (VOCs) from Appendix IX 40 CFR Part 264 as part of the contamination indicator parameter sampling. (See Table 3-3, which summarizes the 1993 sampling schedule.) Groundwater collected for routine VOC sampling is analyzed by off-site contract laboratories according to method 8240 (Test Methods for Evaluating Solid Waste, SW-846 [U.S.EPA 1986]). The routine analysis of VOCs for contamination indicator parameter sampling generated data on fifty-eight volatile organic compounds.

During the expanded RFI characterization, selected Project wells exhibiting statistical significance for indicator parameters with respect to background were sampled. Data was generated for approximately 200 organic compounds, including volatile organics, semivolatile organics, pesticides, and PCBs from Appendix IX (40 CFR Part 264). Compounds on the Target Compound List (TCL) also were chosen for sampling of the majority of well locations because the list focuses on compounds that are most commonly associated with hazardous waste sites and that represent the greatest threat to human health and the environment. The full Appendix IX list, excluding two families of compounds (PCDDs and PCDFs), was used for five well locations where VOCs have previously been detected and for the NDA interceptor trench sump manhole (WNNDATR). The analytical methodologies in SW-846, Test Methods for Evaluating Solid Waste, used to analyze the RFI sampling data were volatile organic compounds — method 8240, semivolatiles — method 8270, pesticides/PCBs — method 8080, and cyanide — method 9010.

Table E-11 in *Appendix E* lists the individual compounds and the practical quantitation limit

(PQL) for compounds in Appendix IX and the TCL. The practical quantitation limit is the lowest concentration of the compound that can be reliably determined within the method-specified level of precision and accuracy under routine laboratory conditions. The PQLs used here include those that are specified by contract with the vendor laboratories and are more stringent than those listed in Appendix IX and reproduced in Table E-11.

The results of routine and RFI groundwater sampling for volatile organic compounds during 1993 reveal continued positive detections of 1,1-dichloroethane (1,1-DCA) and dichlorodifluoromethane (DCDFMeth) at well WNW8612. The concentrations of 1,1-DCA in well WNW8612 in 1993 increased from those seen in 1992, ranging from approximately 30 μg/L to 36 μg/L during the year. The concentration of DCDFMeth at WNW8612 during 1993 is similar to that of 1992, maintaining a level between approximately 4.5 μg/L and 9.5 μg/L during the year.

The compound DCDFMeth has continued to be detected at well WNW0803. First detected in August 1992, the concentration has fluctuated between 5 μg/L and 32 μg/L during 1993.

Tributyl phosphate (TBP) was detected in well WNW8605 at 280 μg/L. Repeat analysis of the same sample showed 300 μg/L, but this is considered an estimated value because re-analysis occurred after the acceptable holding time. This well is located downgradient of the former lagoon 1 in SSWMU #1 and historically has been characterized by elevated levels of beta and tritium activity. While not of particular importance to the RCRA-regulated efforts to identify hazardous wastes or constituents, the detection of TBP probably indicates contaminant migration related to wastes generated by the NFS solvent extraction process.

Acetone has been detected at well WNW0909. However, this detection is considered speculative because this compound commonly appeared as a laboratory contaminant and because positive detections have been separated by periods of reporting below the PQL of 5 μg/L.

The compound 1,1,1-trichloroethane (1,1,1-TCA), first detected at WNGSEEP in 1990, has remained below the PQL since mid-1992 and during all of 1993. The same is true for 1,1-DCA at well WNW8609, which was also first detected in 1990 and which declined to less than the PQL of 5 μg/L in 1992 and has remained below the PQL during 1993.

The compounds 1,1,1-TCA and 1,1-DCA are solvents commonly used by industry for degreasing processes, although their origins at the WVDP have not been specifically identified. DCDFMeth is also known as Freon-12, a coolant widely used for air conditioning and refrigeration. Tributyl phosphate was the organic solvent used by NFS during fuel reprocessing activities. Analytical results of sampling for these compounds at the above locations are shown in *Appendix E*, Table E-12.

Groundwater wells WNW8612 and WNW0803 and monitoring point WNGSEEP are located on the northeastern edge of the Project premises, downgradient of the main plant and the former construction and demolition debris landfill (CDDL). The detection of 1,1,1-TCA at WNGSEEP is the subject of the Groundwater Seep Investigation Report: 1,1,1-Trichloroethane Detection (West Valley Nuclear Services 1992), which was prepared to fulfill the RCRA 3008(h) Order on Consent.

Analysis of volatile organic compounds by method 8240 uses an instrument known as a gas chromatograph/mass spectrometer (GC/MS). This instrument has the ability to identify the presence of compounds below the PQLs listed in Table E-11. Such detections, taken on an individual basis, must be viewed with caution since they may be false. However, when the same compound is repeatedly detected at levels below the PQL at the same groundwater location, it may actually indicate the presence of that compound, but at levels below that which can be accurately measured. The repeated detection of compounds below their associated PQLs has occurred at the following groundwater monitoring locations:

- WNW0202: toluene below its PQL of 5 μg/L and acetone below its PQL of 10 μg/L.
- WNW0803: 1,1-DCA below its PQL of 5 μg/L and chloroethane below its PQL of 10 μg/L.
- WNW1002: Toluene below its PQL of 5 μg/L and benzene below its PQL of 5 μg/L.
- WNW8609: 1,1,1-TCA below its PQL of 5 μg/L.
- WNW8612: 1,1,1-TCA below its PQL of 5 μg/L.
- WNW1104A: toluene below its PQL of 5 μg/L, benzene below its PQL of 5 μg/L, and total xylene below its PQL of 5 μg/L.
- WNNDATR: 1,4-dioxane (1,4-diethylene dioxide) below its PQL of 150 μg/L.

In addition to analyzing for compounds below their PQL, the GC/MS can also detect the presence of compounds for which it has not been calibrated. When this occurs, the unknown substance can be tentatively identified by performing a library scan of all known organic compounds to find the one that best fits the data. The tentatively identified compounds reported during the RFI sampling in the sixth rep are as follows:

- WNW0803: chlorodifluoromethane at 18 μg/L.
- WNW0909: chloroiodomethane at 5.9 μg/L.

Further sampling and analysis for VOC analytes will continue at all of the locations mentioned above to track the detection of these compounds. (See Tables 3-2 and 3-3 for the groundwater sampling and analysis schedule.) Figures 3-41 and 3-41a are trend plots for selected VOCs.

Semivolatile organic compounds, pesticides, and PCB analyses for the remainder of the forty-nine selected Project wells were all reported as nondetectable.

It should be pointed out that the VOC detections mentioned above have been compared with relevant New York State groundwater quality standards. This comparison has been performed for VOCs appearing both above and below their appropriate PQLs. In summary, positive detections of 1,1-DCA and DCDFMeth, identified as principle organic contaminants, have exceeded the 5 μg/L limit for Class GA groundwaters. There is no indication that the groundwater from these areas affects human health or the environment because this water is not used for drinking or general facility needs. Other VOC detections on-site show concentrations below the applicable groundwater quality standards.

Long-term Trends of Gross Beta and Tritium at Selected Groundwater Monitoring Locations

Trend graphs showing results of groundwater monitoring from 1986 through 1993 for gross beta (Fig. 3-42) and tritium (Fig. 3-43) were prepared for selected locations. These graphs show annual averaged results for these constituents over a seven-year period. Results are presented on a logarithmic scale to adequately represent locations of differing concentrations. These specific groundwater monitoring locations were selected for trending because they have shown elevated or rising levels of these constituents (WNW8605 and WNW8604, Fig. 3-42), or falling trends (Fig. 3-43).

The results for gross beta activity (Fig. 3-42) indicate a steadily rising trend for location WNW8604. Well WNW8604 is located to the north of lagoon 4 in SSWMU #1 and is 23.0 feet below grade. Well WNW8603, which is north of WNW8604, at a depth of 25.4 feet, shows much lower levels of gross beta activity and a more gradual upward trend. Although the specific source of the increasing gross beta activity at WNW8604 has not been identified, this well is positioned downgradient of wells with higher levels of activity (WNW0408 and WNW0502, both downgradient of the main plant facility) and is crossgradient to the low-level waste treatment facility. Lagoon 1, formerly part of the low-level waste treatment facility, was previously identified as a source of contamination and is believed to be contributing to the gross beta activity at wells WNW8605 and WNW0111. The concentration of gross beta activity at location WNW8604 is lower than that measured for WNW8605. Identification, continued monitoring, and follow-up evaluation of this area will provide the information necessary for either near-term response or eventual facility closure.

Monitoring point WNDMPNE, located in the swamp drainage ditch northeast of the CDDL, has been added to the trend graph this year to chart rising gross beta activity observed during 1993. The stream that flows past this point conveys groundwater baseflow, surface runoff, and spring seepage to Frank's Creek and is adjacent to surface monitoring point WNSWAMP. (See Fig. A-2 or Fig. 2-3.) In July 1993 the beta activity at this point was 9.21E-07µCi/mL. Field investigations in the area of WNDMPNE identified a small seep located between the CDDL and the former NFS hardstand area that was feeding into the swamp drainage ditch. It was determined that the small seep was the contributor to the beta activity. Since the radioisotopic composition is significantly reduced before discharge from the WVDP premises, it was concluded that there was no threat to human health and the environment. However, the frequency of sampling was increased from monthly to weekly to more closely monitor the activity at the location. Investigation will continue in order to determine the extent and source of the radioactivity. Beta concentrations in November 1993 for WNDMPNE decreased from July, but this may simply be evidence of seasonality.

Monitoring point WNGSEEP, which has shown elevated levels of some VOCs, as discussed above, exhibits a fairly level long-term trend for gross beta activity (Fig. 3-42).

Figure 3-43 shows the seven-year trend for tritium concentrations for the same monitoring points presented in Figure 3-42. All points, including WNW8604, which show rising beta activity, indicate a gradually declining trend for tritium.

Figures 3-42a and 3-43a present gross beta and tritium concentrations for selected wells over the three-year period that the WVDP's current groundwater monitoring program has been in place. (The results presented in these two figures are individual sample results rather than the annual averages presented in Figs. 3-42 and 3-43.) Well WNWNB1S is a site background well that is included in the figures as a point of reference. The wells selected for these three-year trend graphs represent on-site locations with elevated levels of gross beta and tritium activity. All wells shown in these figures monitor the sand and gravel hydrogeologic unit.

Gross beta and tritium concentrations at these locations are generally consistent, with a slightly rising trend noted for gross beta. Well WNW0111 shows a relatively large degree of variability of tritium concentrations. This well is located near former lagoon 1 and well WNW8605 in SSWMU #1. Concentrations shown in these two figures are above the background concentrations shown for well WNWNB1S.

Results of Expanded Characterization for Radiological Parameters

To provide information concerning possible sources of contamination and contaminant migration pathways, samples from downgradient wells in each geologic unit were first analyzed for gross alpha, gross beta, and tritium. If any of these indicators showed statistically significant differences in comparison to the background samples, the wells were sampled and analyzed for additional parameters. Where high activity or alpha activity was encountered, samples were analyzed for a full set of radiological isotopes. (See Table E-15.) Where nominal levels of beta-emitting activity were encountered, samples were analyzed only for beta-emitting isotopes. (See Table E-16.) Samples from background wells for each geologic unit were all analyzed for the full list of isotopic parameters in order to provide a comparison with the downgradient wells. Table 3-5 summarizes the results of the expanded isotopic characterization compared to background values.

Sand and Gravel

Nine locations in the sand and gravel unit were analyzed for the full list of isotopes (Table E-15), and twenty-one wells were analyzed for the beta-emitting isotopes (Table E-16).

The background well for the sand and gravel unit, WNWNB1S, generally exhibited the lowest radioisotopic activity and thus indicates that higher radioisotopic values in downgradient wells probably can be attributed to environmental and manmade sources.

Strontium-90 (Sr-90)

The data in Table E-16 indicate that, with the exception of wells WNW0106 and WNW8612, Sr-90 was higher than background levels in samples from all wells and discharge points in the sand and gravel unit that were analyzed for this expanded characterization. The two groups of wells and discharge points with Sr-90 activities of two or more orders of magnitude greater than background (WNW0104, WNW0111, WNW0116, WNW8604, WNW8605, WNDMPNE, WNW0408, WNW0501, WNW0502, WNW0601, WNW8609, and WNW0801) are located northeast of the main plant, the old hardstand area, and inactive lagoon 1. These same wells show elevated levels of tritium.

Strontium-90 in sand and gravel wells and discharge points with levels between one to two orders of magnitude above background (WNW0103, WNW8603, WNW0602, WNW0201, WNSP008, WNW0203, WNW0804) are usually found east and northeast of the main plant, in the french drain northwest of lagoons 2 and 3, an area around the demineralization basin, and east of the CDDL. All other locations (WNGSEEP, WNW0105, WNW0205, WNW0305, WNW0406, WNW0604, WNW0803, and WNW0802) exhibited Sr-90 levels that are less than one order of magnitude of background.

The elevated level of Sr-90 in WNW0408 and WNW0502 is the major contributor to the elevated gross beta levels in these wells.

Iodine-129 (I-129)

Iodine-129 was the third most abundant radioisotope in the sand and gravel unit. Well WNW8605, located near lagoon 1, showed I-129 levels between one and two orders of magnitude above background, while wells WNW0103, WNW0104, WNW0105, WNW0106, WNW0111, WNW0116, WNW0406, WNW8604, WNW0502, WNW0602, WNW0802, WNW0803, WNW0905, WNW8612, and discharge point WNSP008, located northeast of the main plant, exhibited levels of less than one order of magnitude above background. All other wells sampled had I-129 activities very close to background. The activities

Table 3-5

Expanded Groundwater Characterization: Number of Wells and Discharge Points in Hydrogeologic Units Exceeding Background Values by Orders of Magnitude

Alpha-emitting Isotopes

Hydrogeologic Unit	OMAB	Am-241	Ra-228	Ra-226	U-232	U-233	U-235	U-236	U-238	Total U	Pu-238	Pu-239
Sand and Gravel Unit	0-1	9	4	9	5	7	6	9	3	1	9	9
	1-2	0	3	0	4	2	3	0	4	7	0	0
	>2	0	2	0	0	0	0	0	2	1	0	0
Weathered Lavery Till	0-1	4	1	3	4	1	1	4	1	1	4	4
	1-2	0	3	0	0	3	3	0	3	3	0	0
	>2	0	0	1	0	0	0	0	0	0	0	0
Unweathered Lavery Till	0-1	1	1	1	1	1	1	1	1	1	1	1
	1-2	0	0	0	0	0	0	0	0	0	0	0
	>2	0	0	0	0	0	0	0	0	0	0	0
Lavery Till-sand Unit	0-1	1	1	1	1	1	1	1	1	1	1	1
	1-2	0	0	0	0	0	0	0	0	0	0	0
	>2	0	0	0	0	0	0	0	0	0	0	0

Beta-emitting Isotopes

Hydrogeologic Unit	OMAB	C-14	Cs-137	Co-60	I-129	Sr-90	Tc-99
Sand & Gravel Unit	0-1	30	31	31	30	12	25
	1-2	1	0	0	1	7	6
	>2	0	0	0	0	12	0
Weathered Lavery Till	0-1	9	9	9	9	7	9
	1-2	0	0	0	0	1	0
	>2	0	0	0	0	1	0
Unweathered Lavery Till	0-1	10	10	10	8	10	10
	1-2	0	0	0	2	0	0
	>2	0	0	0	0	0	0
Lavery Till-sand Unit	0-1	2	2	2	2	2	2
	1-2	0	0	0	0	0	0
	>2	0	0	0	0	0	0

OMAB = Orders of magnitude above background.
Note: Only the background wells for the unweathered Lavery till and the Lavery till-sand unit were analyzed for alpha-emitting isotopes.

measured in WNW0201, WNW0203, WNW0205, WNW0601, and WNW0604 were less than the activities measured in background wells.

Technetium-99 (Tc-99)

Technetium-99, the second most abundant isotope, was evident in activities between one and two orders of magnitude greater than background in wells WNW0104, WNW0105, WNW8603, WNW8605, WNW0408, and WNW0502. Wells WNW0106, WNW0116, WNW0406, WNW0501, WNW0801, WNW0802, WNW0905, WNW8604, WNW8612, and discharge points WNSP008 and WNDMPNE exhibited Tc-99 activities within one order of magnitude above background, with the remaining analyzed wells being below background. All wells and discharge points with Tc-99 greater than background are generally located in the areas northeast of the main plant, north of the construction and demolition debris landfill (CDDL), or near lagoon 1, indicating that Tc-99 also partly contributes to the elevated gross beta in this area.

Cesium-137 (Cs-137)

Cesium-137 was not encountered at activities above background in any of the tested wells. However, Cs-137 in wells WNW0103, WNW0104, WNW0111, WNW0203, WNW0601, WNW8605, WNW8612, and discharge points WNDMPNE and WNGSEEP did approach background activities, only surpassing it when analysis uncertainties were accounted for.

Cobalt 60 (Co-60)

Cobalt-60 also was not evident at above-background activities in any wells but did approach background in wells WNW0104, WNW0201, WNW0601, WNW8605, and discharge points WNDMPNE and WNGSEEP. These points slightly surpassed background only when uncertainties were added to mean activity values.

Carbon-14 (C-14)

Carbon-14 was encountered in well WNW0408 at activity levels between one and two orders of magnitude above background and in well WNW0502 at activities within one order of magnitude of background. The remaining twenty-eight samples all exhibited activities below background even after accounting for analytic uncertainties. The activity of C-14 in the above-background samples indicates that the associated gross beta in the two affected wells is partly due to C-14. Background well WNWNBIS exhibited C-14 activities below the detection limit of 7.0E-08 μCi/mL, so the detection limit was used as the screening criteria.

Americium-241 (Am-241)

Americium-241 was not found above background activity in any well finished in the sand and gravel unit. It approached background in well WNW8605 but this was determined to be not significant.

Radium-228 (Ra-228)

Radium-228 was found at activities between one and two orders of magnitude above background in wells WNW0104, WNW0111, and WNW0905 and at activities greater than two orders of magnitude above background in wells WNW8604 and WNW8605, which are near lagoons 4 and 1, respectively.

Uranium-232 (U-232)

Uranium-232 was encountered at activities between one and two orders of magnitude above background in wells WNW0111 and WNW8605. The elevated U-232 activity in well WNW8605 is probably due to earlier releases from lagoon 1 during previous fuel reprocessing activities.

Uranium-234 (U-234)

Uranium-234 was encountered in above-background activities in eight sand and gravel unit wells (WNW0104, WNW0111, WNW8604, WNW8605, WNW0408, WNW0501, WNW0502, and WNW0905). Wells WNW8605 and WNW0905 exhibited activities between one and two orders of magnitude above background. These are probably due to releases from lagoon 1 during earlier fuel reprocessing activities and past NDA disposal activities, respectively. The activity in wells WNW0104, WNW0111, WNW8604, WNW0408, WNW0501, and WNW0502 was within one order of magnitude above background and is probably associated with earlier fuel reprocessing plant activities.

Uranium-235 (U-235)

Uranium-235 was encountered in above-background activity in wells WNW8605, WNW0408, WNW0502, and WNW0905, with well WNW0502 being within one order of magnitude above background and the other three wells between one and two orders of magnitude above background. The above-background activities in wells WNW0408 and WNW0502 are probably associated with past fuel reprocessing activities; well WNW8605 activity is probably associated with discontinued lagoon 1 activities and well WNW0905 possibly with past NDA disposal activities.

Uranium-236 (U-236)

Uranium-236 was found within one order of magnitude above background in wells WNW0104, WNW8604, WNW8605, WNW0408, WNW0502, and WNW0905; all other sand and gravel wells exhibited lower than background activities. As with U-234, the U-235 activities are probably associated with discontinued main plant, lagoon 1, and past NDA activities.

Uranium-238 (U-238)

Uranium-238 was found at greater than two orders of magnitude above background in wells WNW0111, WNW0905, WNW8605, and WNW0408, while wells WNW0104, WNW8604, WNW0501, and WNW0502 exhibited activities between one and two orders of magnitude above background. The elevated activity in these wells is probably due to main plant, lagoon 1, and past NDA activities that involved fuel storage, reprocessing, and burial.

Total uranium (total U), which is reported in µg/mL, is found in these same wells at concentrations between one and two orders of magnitude above background (wells WNW0104, WNW0111, WNW8604, WNW8605, WNW0408, WNW0501, WNW0502) and greater than two orders of magnitude above background in well WNW0905. These concentrations are similarly associated with fuel storage reprocessing and burial activities. Uranium-234, -235, -236, -238, and total U were not tested for in any other sand and gravel wells.

Plutonium-238 (Pu-238)/Plutonium-239 (Pu-239)

Plutonium-238 was not found above background activity in any well finished in the sand and gravel unit. Plutonium-239 showed activities within one order of magnitude above background in wells WNW0104, WNW8604, WNW8605, WNW0408, and WNW0501. This activity probably is associated with main plant and lagoon 1 activities during earlier fuel storage and reprocessing. No other sand and gravel wells exhibited activities above background.

Alpha radiation at activities above the usual norm of very low activities in the sand and gravel wells is probably attributable to the above-background activities of uranium isotopes that may be a product of fuel storage and reprocessing activities. (See Fig. 3-10.)

Weathered Lavery Till

Eight weathered Lavery till wells were statistically significant with respect to background well WNW1008C and thus were analyzed for additional parameters. WNW0906, WNW0908, WNW1006, and WNW1008C were sampled for the full radioisotopic set of parameters. The NDA interceptor trench sump manhole (WNNDATR) and wells WNW0907, WNW0909, WNW1007, and WNW1108A were sampled for beta-emitting isotopes.

The weathered Lavery till background well, WNW1008C, was analyzed for the full set of isotopic parameters for comparison with the downgradient wells and the sump. Well WNW1008C exhibited very low radioisotope activities and thus indicates that higher radioisotopic activity values probably can be attributed to environmental and manmade sources.

Carbon-14 (C-14)

Carbon-14 was evident in wells WNW0907, WNW0909, and WNW1006 at activities less than one order of magnitude above background and may be partly responsible for the slightly elevated gross beta in these wells. The remaining wells exhibited activities below background levels.

Cesium-137 (Cs-137)

Cesium-137 was not above background in any wells tested in the weathered till. Cesium-137 did surpass background activities in all wells only when analytic uncertainties were added to the mean values. However, these values were very close to background.

Cobalt-60 (Co-60)

Cobalt-60 also did not exhibit above background activities in any tested wells, and, as with Cs-137, only slightly surpassed background when analytic uncertainties were added to mean values.

Iodine-129 (I-129)

Iodine-129 was encountered in wells WNW0907, WNW0908, and WNW0909 as well as discharge sump WNNDATR at activities of less than one order of magnitude above background. No other tested wells exhibited activities above background.

Americium-241 (Am-241)

Americium-241 exhibited activities within one order of magnitude above background in wells WNW0906, WNW0908, and WNW1006.

Strontium-90 (Sr-90)

Strontium-90 was evident in wells WNW1007 and WNW1108A at activities of less than one order of magnitude above background. Well WNW0909 exhibited activity greater than two orders of magnitude above background, and discharge point WNNDATR exhibited activities between one and two orders of magnitude above background. No other tested wells exhibited activities above background, although some activities approached background. The elevated Sr-90 in well WNW1007 may be partly responsible for the elevated gross beta in this well. While well WNW1108A did not show highly elevated gross beta, it was above background, and thus Sr-90 may also be partly responsible for these beta activities.

Radium-226 (Ra-226)

Radium-226 was evident in well WNW0908 at activities of more than two orders of magnitude above background, while wells WNW0906 and WNW1006 exhibited activities of less than one order of magnitude above background. The elevated Ra-226 in well WNW0908 is partly responsible for the elevated gross alpha activity in this well and also contributes to the above-background alpha activity in wells WNW0906 and WNW1006.

Radium-228 (Ra-228)

Radium-228 was evident in wells WNW0906, WNW0908, and WNW1006 at activities between one and two orders of magnitude above background. The Ra-226 and Ra-228 activities may be partly due to the clayey composition of the till, which contains natural sources of radium. Both Ra-226 and Ra-228 contribute to the above-background gross alpha activities in these wells.

Technetium-99 (Tc-99)

Technetium-99 is found in wells WNW0907, WNW0908, WNW0909, WNW1007, and WNW1108A, and in discharge sump WNNDATR at activities within one order of magnitude above background. Technetium-99 partly contributes to the elevated gross beta in wells WNW0908 and WNW1007 and may be a product of discontinued waste transport and past burial practices associated with the NDA.

Plutonium-238/239 (Pu-238/239)

Plutonium-238 and -239 were not evident in any tested wells at activities above background. Pu-238 and -239 activities did approach background but did not surpass it.

Uranium Isotopes

Uranium-232, -234, -235, -238, and total U are evident in wells WNW0906, WNW0908, and WNW1006 at between one and two orders of magnitude above background. These uranium isotopes are responsible for the above-background gross alpha in wells WNW0906, WNW0908, and WNW1006.

Unweathered Lavery Till

The sample results from nine unweathered Lavery till wells exhibited statistically significant differences with respect to background well WNW0405 and thus were analyzed for additional parameters. Samples from background well WNW0405 were analyzed for the full radioisotopic set of parameters; the nine downgradient wells (WNW0107, WNW0109, WNW0110, WNW0904, WNW0115, WNW0409, WNW0704, WNW0910, and WNW1109B) were sampled for only the beta-emitting isotopes. Well WNW0405 generally exhibited the lowest radioisotopic values in this geologic unit and thus indicates that higher radioisotopic activity values in downgradient wells probably can be attributed to environmental and manmade sources.

Carbon-14 (C-14)

Carbon-14 is not evident in any tested wells at activities above background. Carbon-14 activities in wells WNW0107 and WNW0910 approached background activities but did not surpass them. Carbon-14 activities may be partly derived from naturally occurring C-14 that may be incorporated into the till, itself derived from pre-Lavery lacustrine sediments that may have been rich in organic material and thus a source of carbon.

Iodine-129 (I-129)

Iodine-129 is evident in wells WNW0107, WNW0110, WNW0115, WNW0704, WNW0904, and WNW0910 at activities within one order of magnitude above background; wells WNW0109 and WNW1109B are between one and two orders of magnitude above background activities. The I-129 contamination in wells WNW0109 and WNW1109B may be caused partly by past wastewater management activities and and discontinued NDA burial activities, respectively.

Strontium-90 (Sr-90)

Strontium-90 showed activity within one order of magnitude above background in well WNW0704 and is probably responsible for the elevated gross beta in this well. No other tested wells show Sr-90 activities above background, although WNW1109B did approach background but did not surpass it. One possible source for this isotope at well WNW0704 would be the chemical processing cell waste storage area (CPCWSA). However, no release from this storage area has ever been documented.

Technetium-99 (Tc-99)

Technetium-99 was encountered in wells WNW0107 and WNW1109B at activities within one order of magnitude above background. Possible sources of Tc-99 in WNW1109B might be attributable to NDA/SDA disposals. No other tested well exhibited Tc-99 activities above background.

Cesium-137 (Cs-137)

Cesium-137 was not found above background activities in any tested wells. However, it did slightly surpass background in all wells except WNW0910 and WNW1109B when analytic uncertainties were accounted for.

Cobalt-60 (Co-60)

Cobalt-60 also did not exhibit above-background activities in any tested wells. However, it did slightly surpass background in all wells except WNW0910 when analytic uncertainties were accounted for.

Lavery Till-sand

The sample results from well WNW0202 in the Lavery till-sand unit exhibited statistically significant differences from background well WNW0402 and so samples were analyzed for beta-emitting isotopes.

Well WNW0202 exhibited activity levels within one order of magnitude above background for only I-129, Sr-90, and Tc-99. These beta-emitting isotopes are responsible for the elevated gross beta that is evident in this well with respect to background.

Discussion of Site Groundwater Monitoring

Significant achievements were made in characterizing the site groundwaters in 1993. Beginning with a statistical analysis of 1991 and 1992 indicator parameters, further characterization for wider suites of radiological and nonradiological parameters was conducted at nearly 50% of the monitoring locations in an effort to better understand the apparent differences in water quality with respect to background values. Results of the first round of this expanded characterization have indicated that issues of radiological water quality deserve the most attention. Although several metals and organic compounds exceeded drinking water standards, these part-per-billion concentrations pose less serious potential threats to the environment than the elevated beta-emitting isotopes.

Strontium-90 in localized areas north and east of the main plant in the uppermost, water-bearing sand and gravel unit has been implicated as being the isotope primarily responsible for the elevated gross beta reported historically in those areas. Figure 3-44 illustrates the strong influences of strontium-90 concentrations on gross beta radioactivities. Understanding that this isotope is relatively mobile (less attenuated by soil interaction), recent efforts have begun to focus on the issues of defining a source (or sources) and on understanding the present extent of migration. An example of these recent efforts was illustrated when an increasing trend of gross beta was observed at location WNDMPNE in December 1993. Follow-up sampling and analysis in that vicinity has led to the identification of an upgradient groundwater seepage location that appeared to be a major contributor to the radioactivity. In response to this finding, short-term remedial alternatives are being considered together with a long-term assessment plan that would coincide with the timetable already in place for the RCRA facility investigations. Assessment of the radiological doses associated with this elevated activity is expected to be a key element in the development of media-specific cleanup levels for such radioisotopes as strontium-90. In the meantime, the Department of Energy is committed to reducing the potential off-site migration of radiological contaminants by treating discharges, if necessary, to safeguard the public. The potential hazards associated with metals and organic compounds in the site groundwater will continue to be pursued under the terms of the RCRA 3008 (h) Administrative Order on Consent.

Off-site Groundwater Monitoring Program

During 1993 all of the off-site groundwater residential wells were sampled for radiological constituents, pH, and conductivity. Sampling and analysis indicated no evidence of contamination by the WVDP of these off-site water supplies. Analytical results are found in Table C-1.8 in *Appendix C-1*.

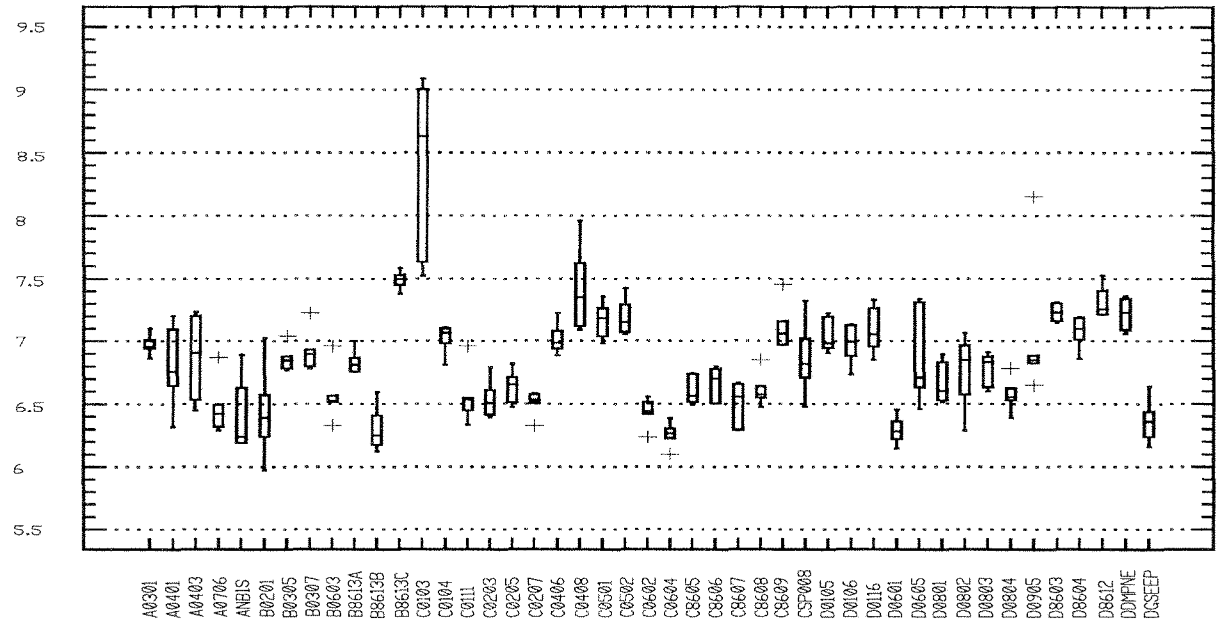


Figure 3-6. pH in Groundwater Samples from the Sand and Gravel Unit

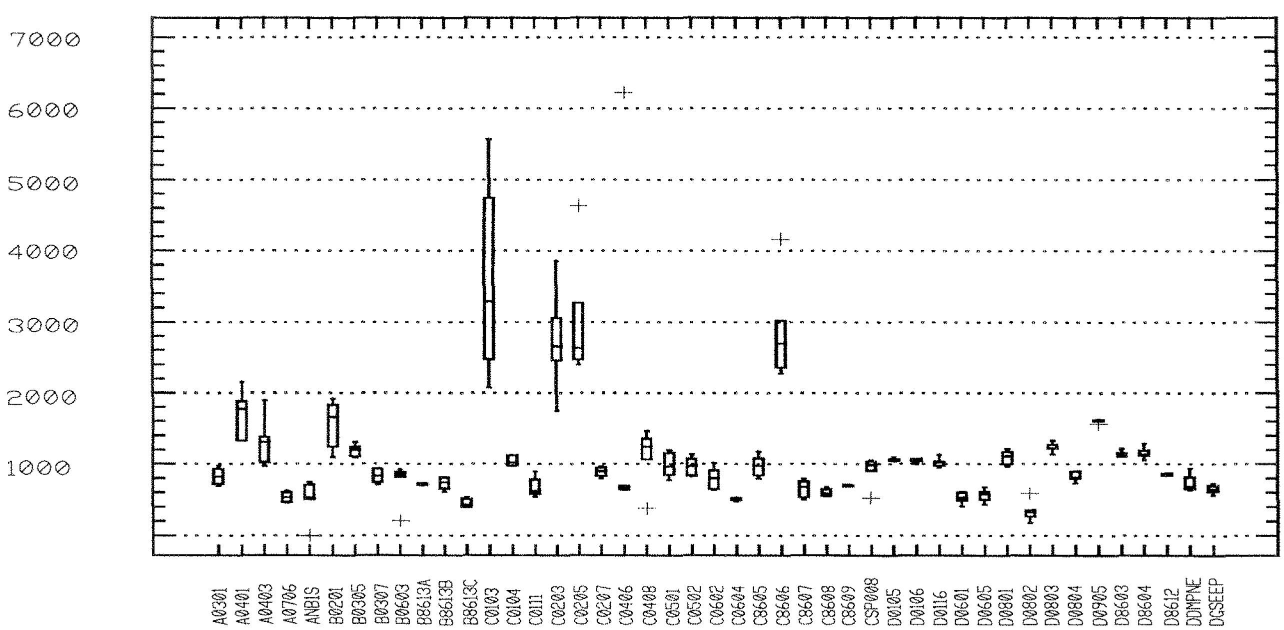


Figure 3-7. Conductivity (μmhos/cm@25°C) in Groundwater Samples from the Sand and Gravel Unit

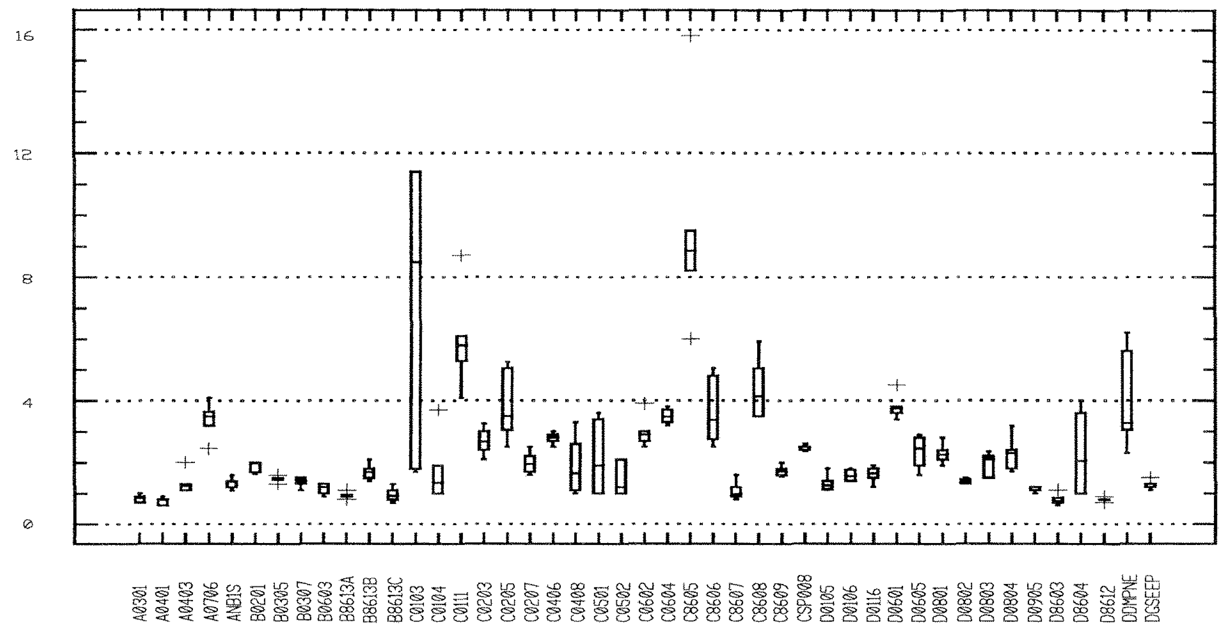


Figure 3-8. Total Organic Carbon (mg/L) in Groundwater Samples from the Sand and Gravel Unit

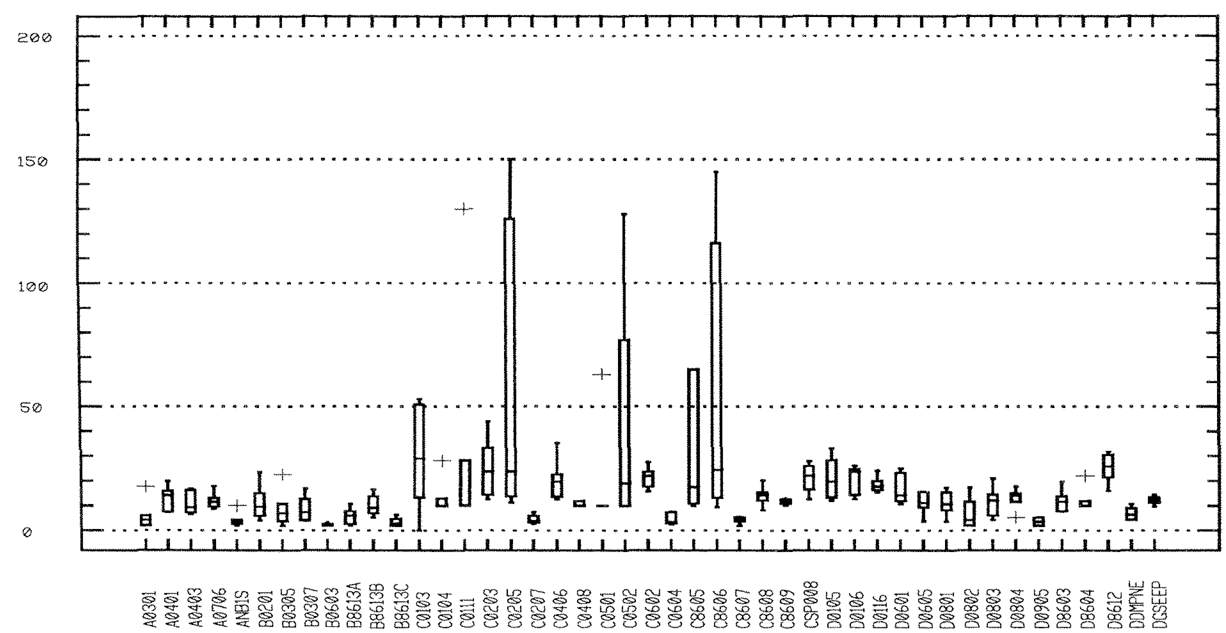


Figure 3-9. Total Organic Halogens (μg/L) in Groundwater Samples from the Sand and Gravel Unit

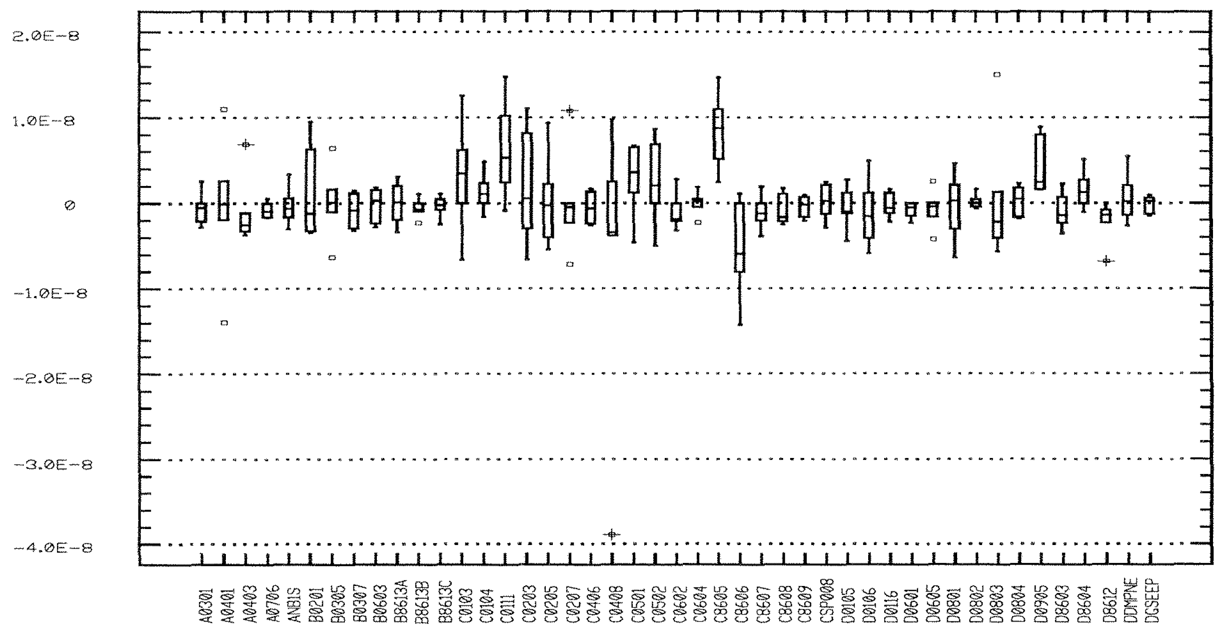


Figure 3-10. Gross Alpha (μCi/mL) in Groundwater Samples from the Sand and Gravel Unit

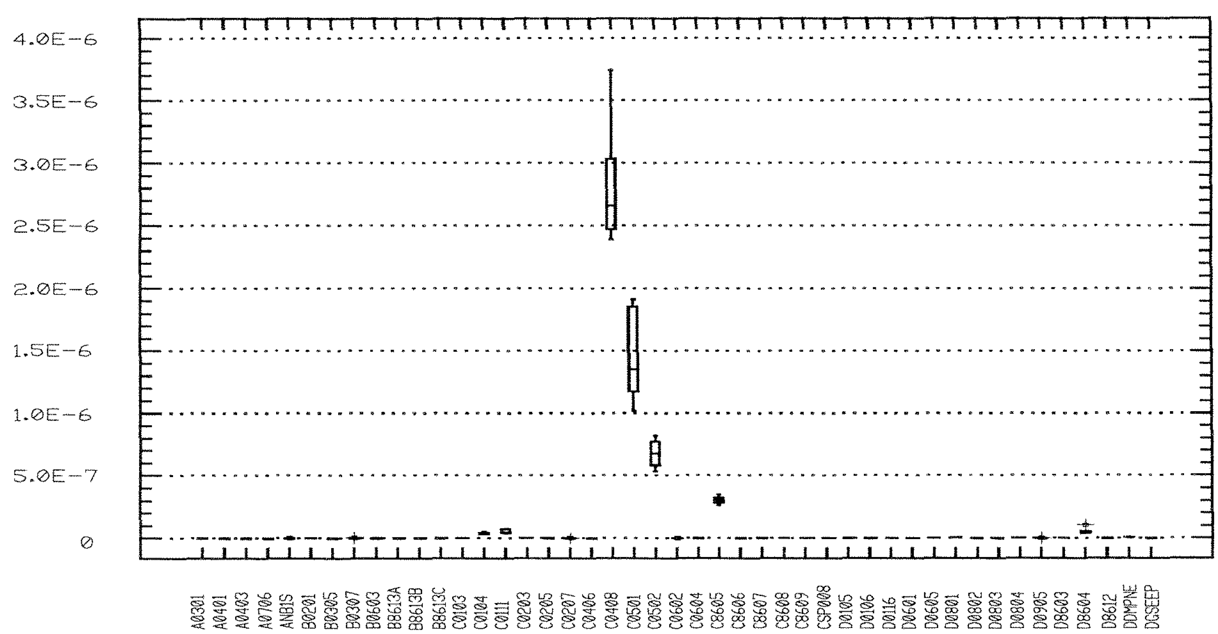


Figure 3-11. Gross Beta (μCi/mL) in Groundwater Samples from the Sand and Gravel Unit (Figs. 3-11a and 3-11b follow with magnified scales.)

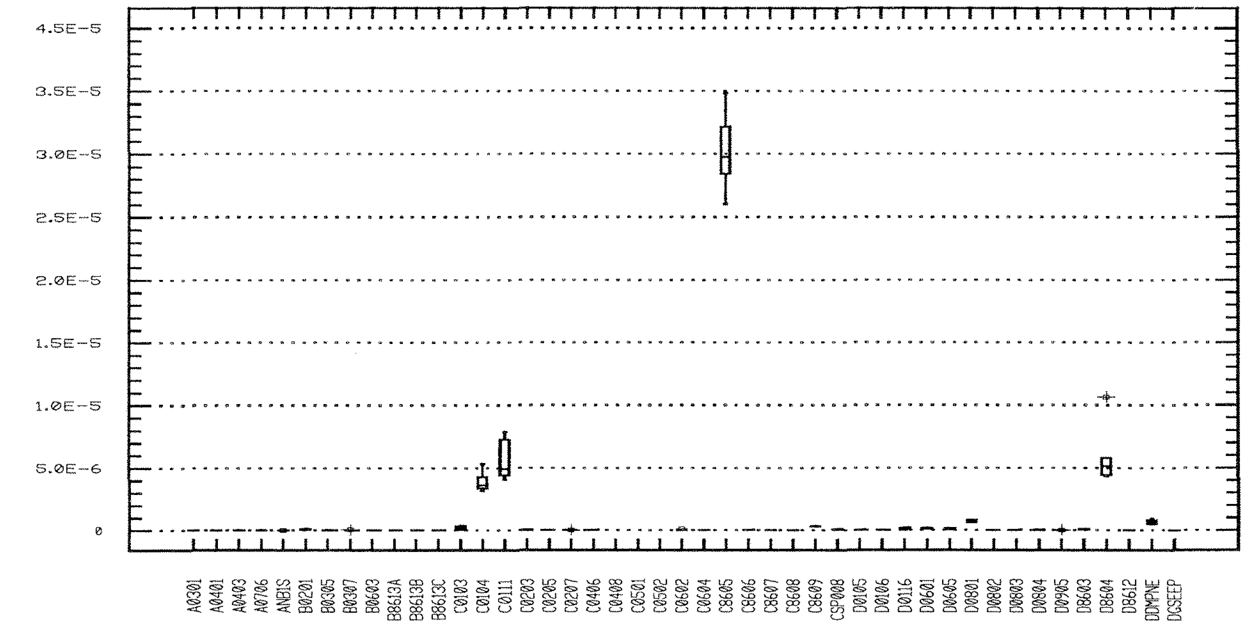


Figure 3-11a. Gross Beta (µCi/mL) in Groundwater Samples from the Sand and Gravel Unit (magnified scale of Fig. 3-11)

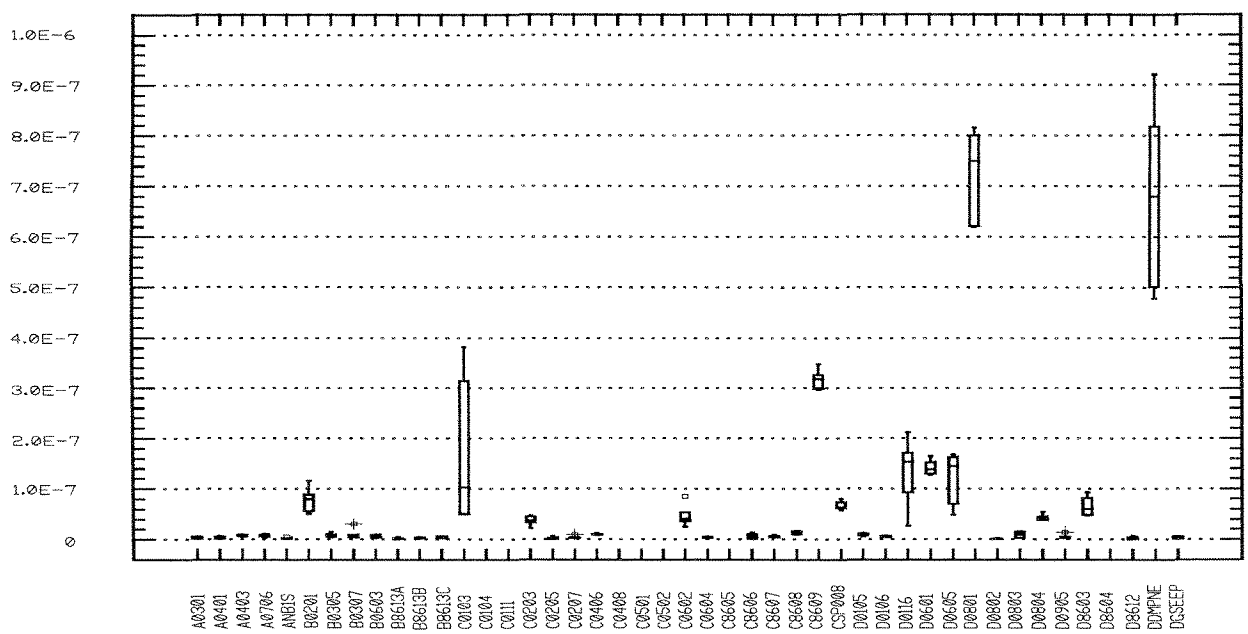


Figure 3-11b. Gross Beta (µCi/mL) in Groundwater Samples from the Sand and Gravel Unit (magnified scale of Fig. 3-11a)

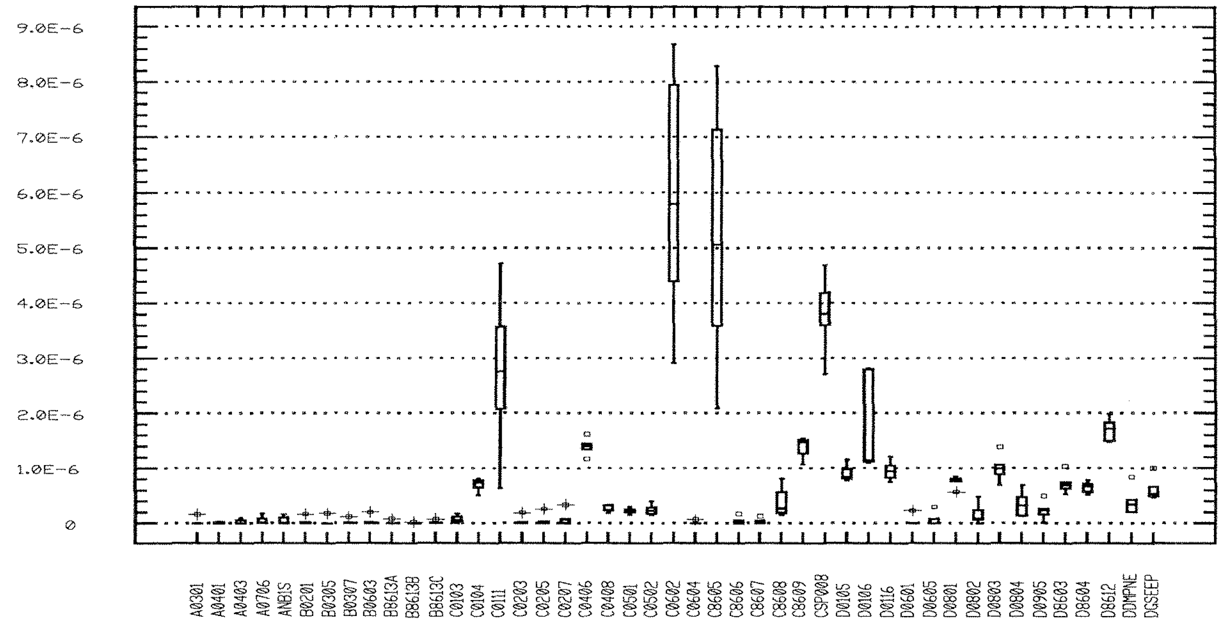


Figure 3-12. Tritium Activity (μCi/mL) in Groundwater Samples from the Sand and Gravel Unit (Fig. 3-12a follows with magnified scale.)

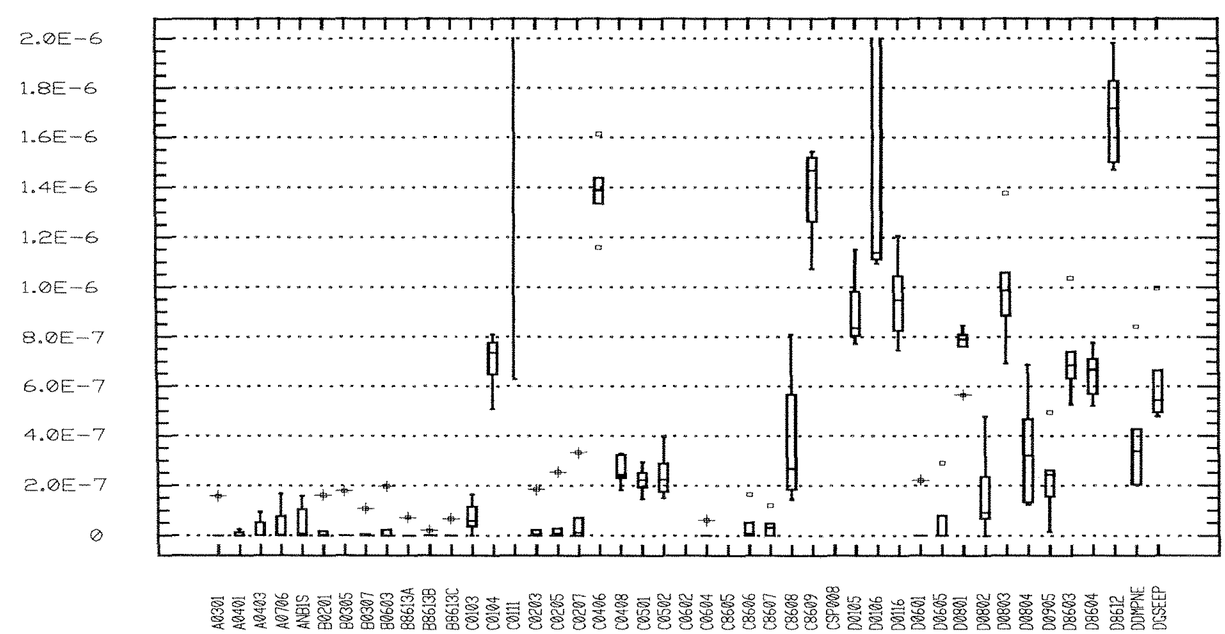


Figure 3-12a. Tritium Activity (μCi/mL) in Groundwater Samples from the Sand and Gravel Unit (magnified scale of Fig. 3-12)

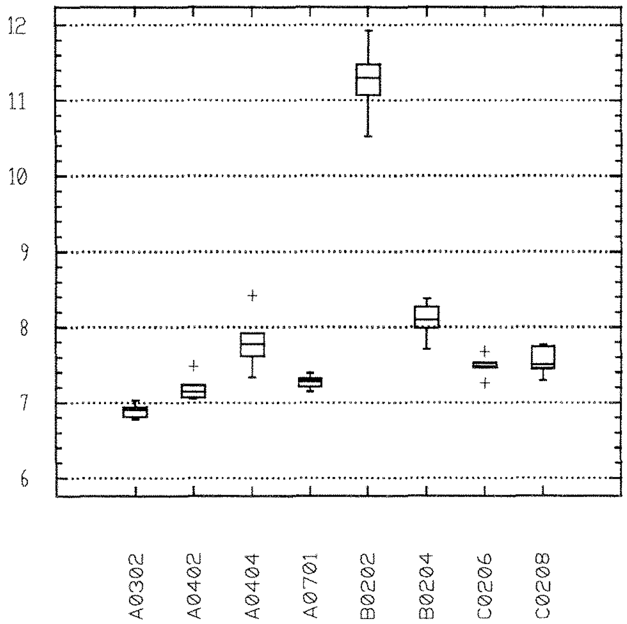


Figure 3-13. pH of Groundwater Samples from the Till-Sand Unit

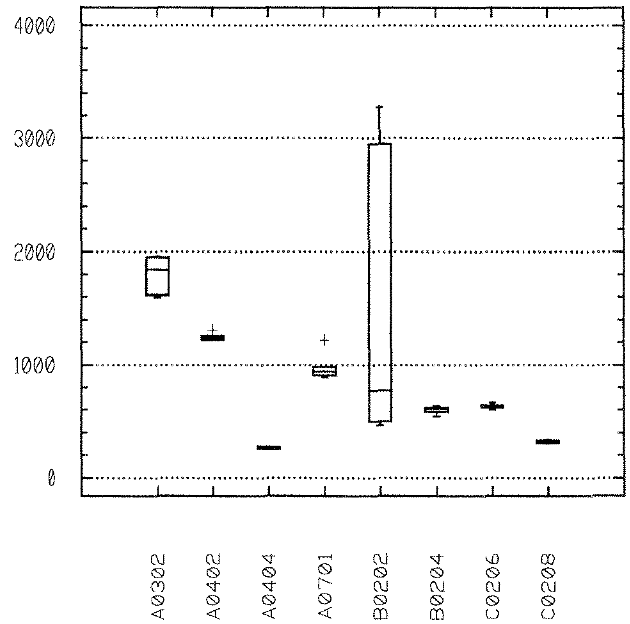


Figure 3-14. Conductivity (μmhos/cm@25°C) of Groundwater Samples from the Till-Sand Unit

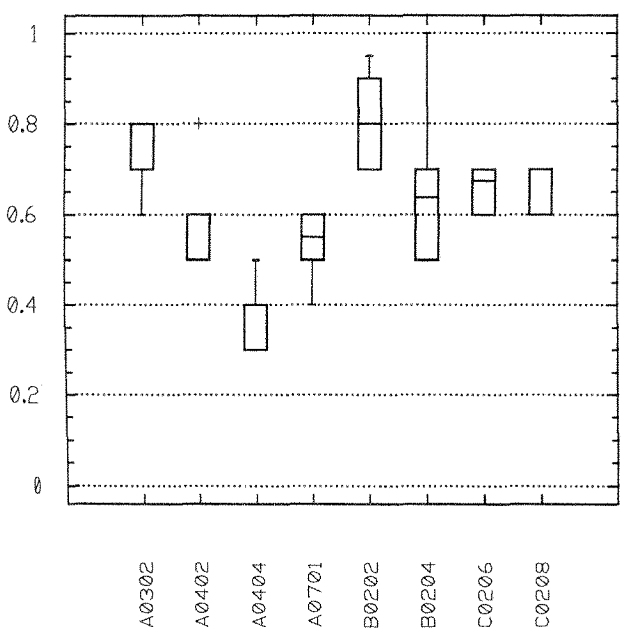


Figure 3-15. Total Organic Carbon (mg/L) in Groundwater Samples from the Till-Sand Unit

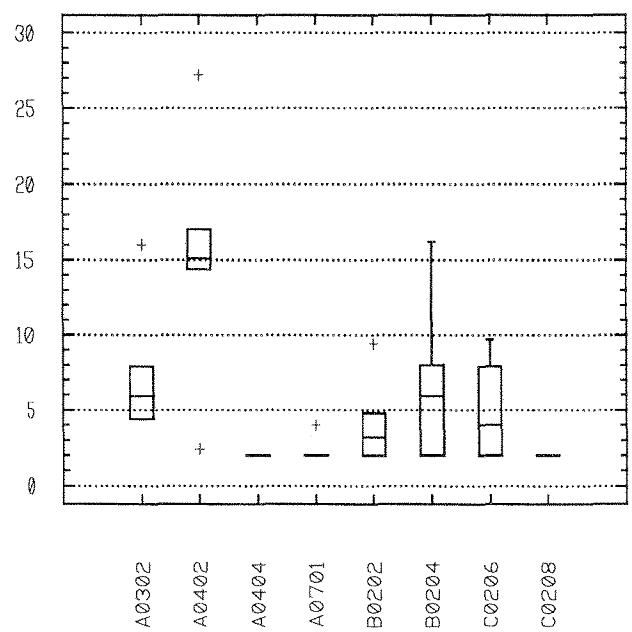


Figure 3-16. Total Organic Halogens (μg/L) in Groundwater Samples from the Till-Sand Unit

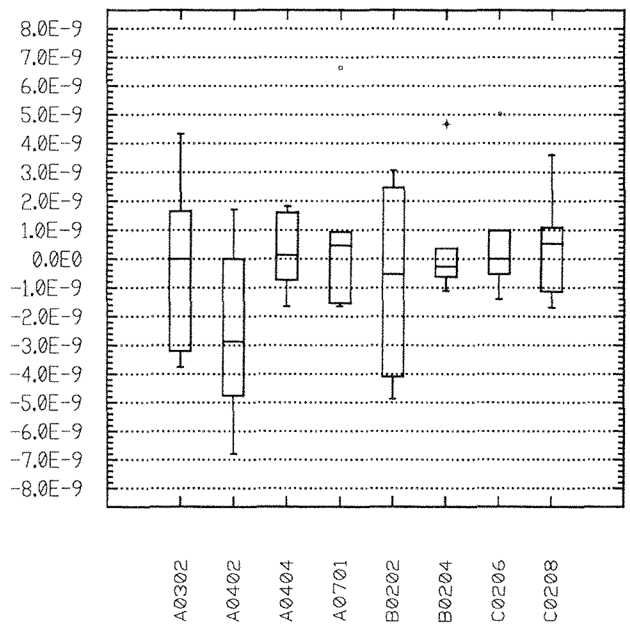


Figure 3-17. Gross Alpha (μCi/mL) in Groundwater Samples from the Till-Sand Unit

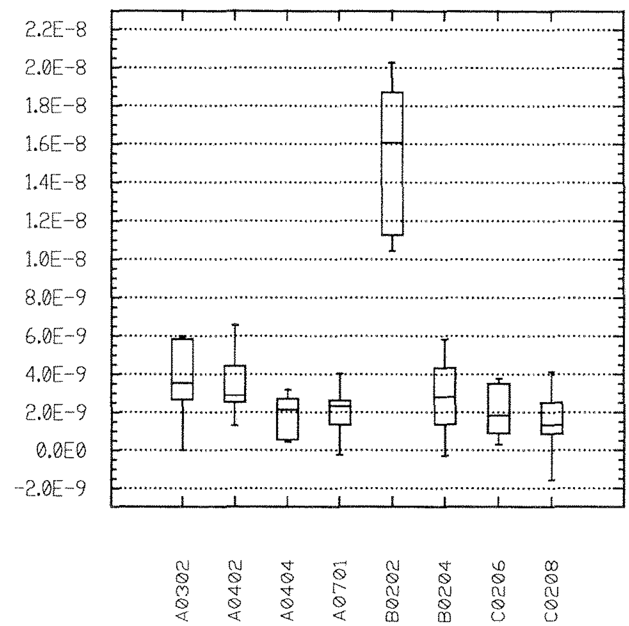


Figure 3-18. Gross Beta (μCi/mL) in Groundwater Samples from the Till-Sand Unit

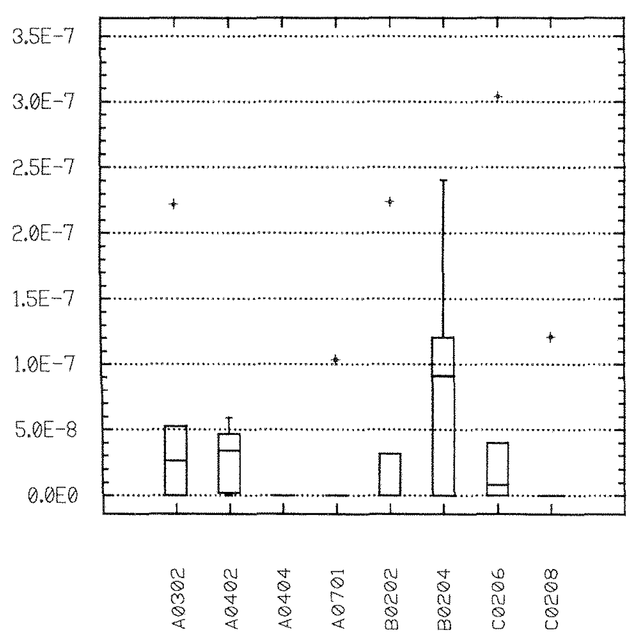


Figure 3-19. Tritium Activity (μCi/mL) in Groundwater Samples from the Till-Sand Unit

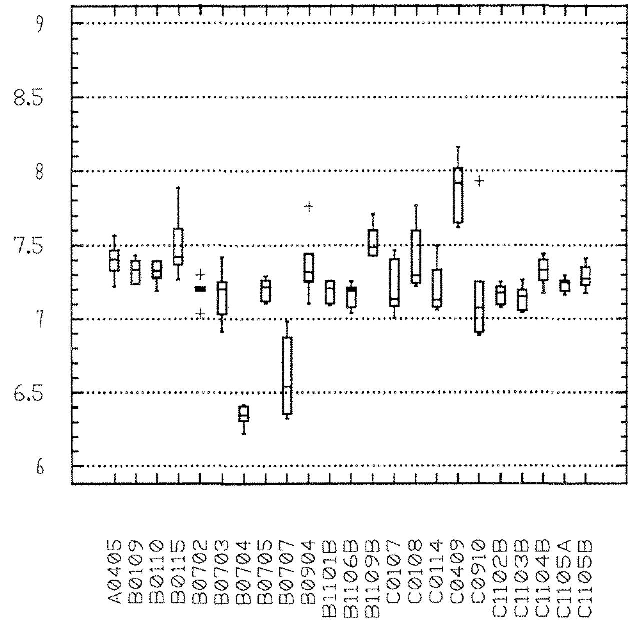


Figure 3-20. pH of Groundwater Samples from the Unweathered Lavery Till Unit

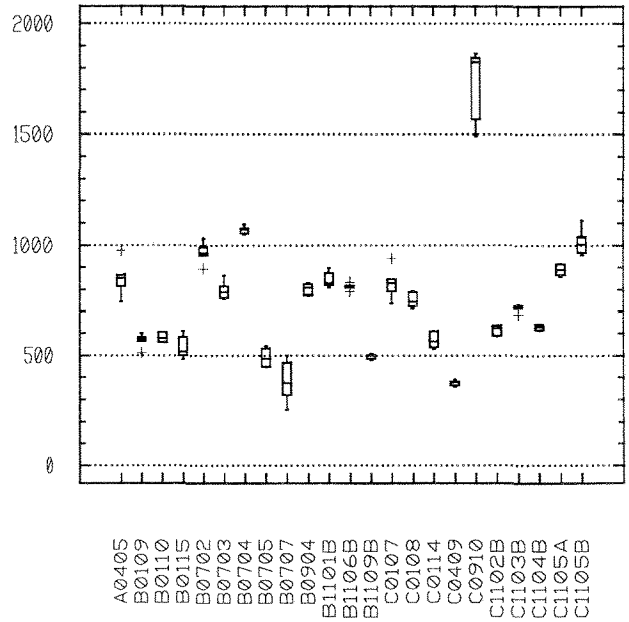


Figure 3-21. Conductivity (μmhos/cm@25°C) of Groundwater Samples from the Unweathered Lavery Till Unit

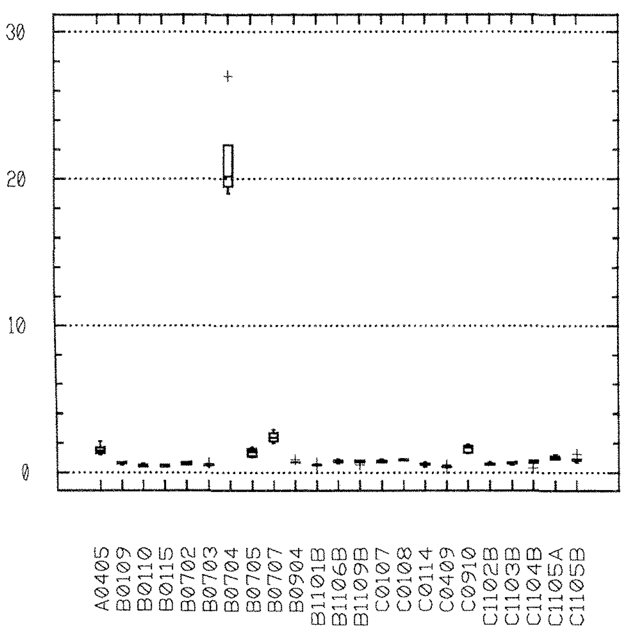


Figure 3-22. Total Organic Carbon (mg/L) in Groundwater Samples from the Unweathered Lavery Till Unit

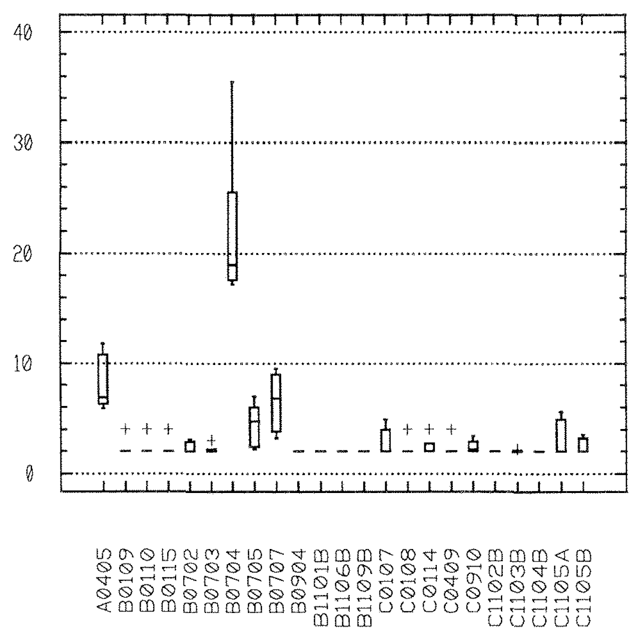


Figure 3-23. Total Organic Halogens (μg/L) in Groundwater Samples from the Unweathered Lavery Till Unit

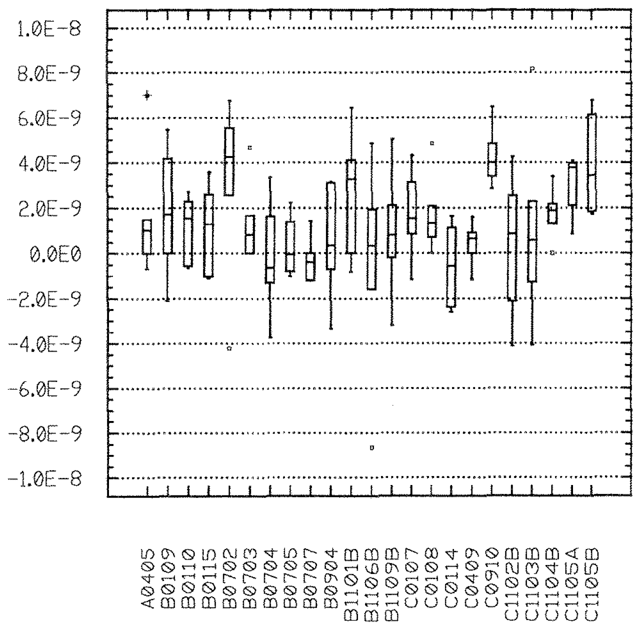


Figure 3-24. Gross Alpha (µCi/mL) in Groundwater Samples from the Unweathered Lavery Till Unit

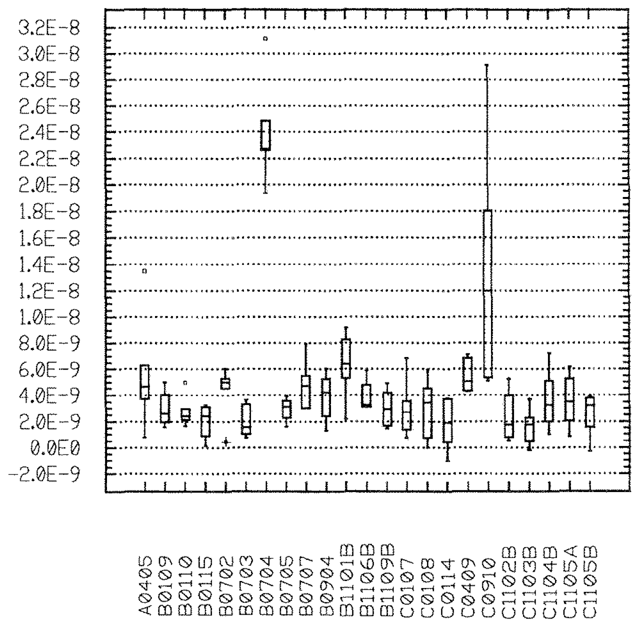


Figure 3-25. Gross Beta (µCi/mL) in Groundwater Samples from the Unweathered Lavery Till Unit

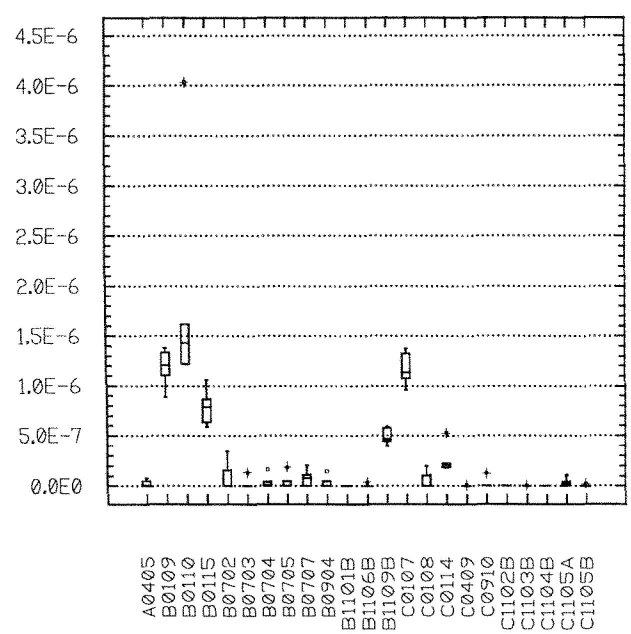


Figure 3-26. Tritium Activity (µCi/mL) in Groundwater Samples from the Unweathered Lavery Till Unit (Fig. 3-26a follows with magnified scale.)

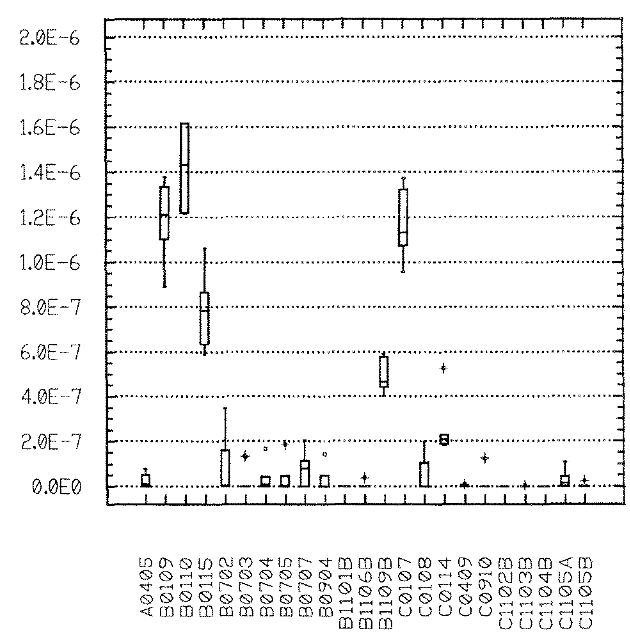


Figure 3-26a. Tritium Activity (µCi/mL) in Groundwater Samples from the Unweathered Lavery Till Unit (magnified scale of Fig. 3-26a)

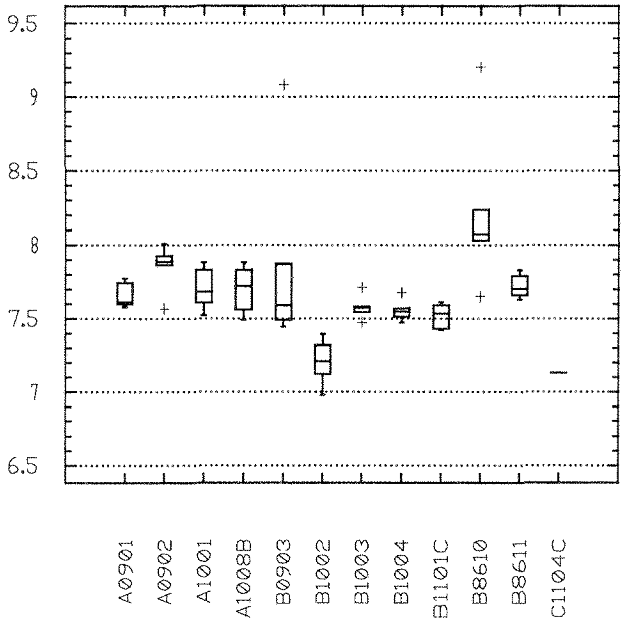


Figure 3-27. pH of Groundwater Samples from the Kent Recessional Sequence

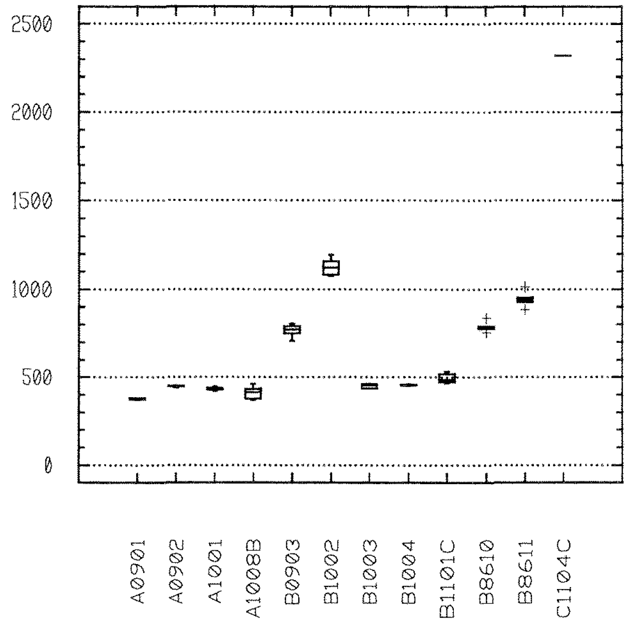


Figure 3-28. Conductivity (μmhos/cm@25°C) of Groundwater Samples from the Kent Recessional Sequence

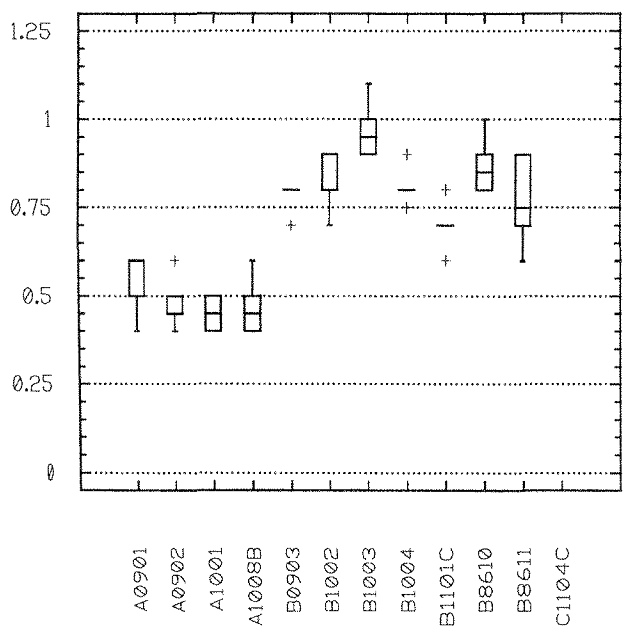


Figure 3-29. Total Organic Carbon (mg/L) in Groundwater Samples from the Kent Recessional Sequence

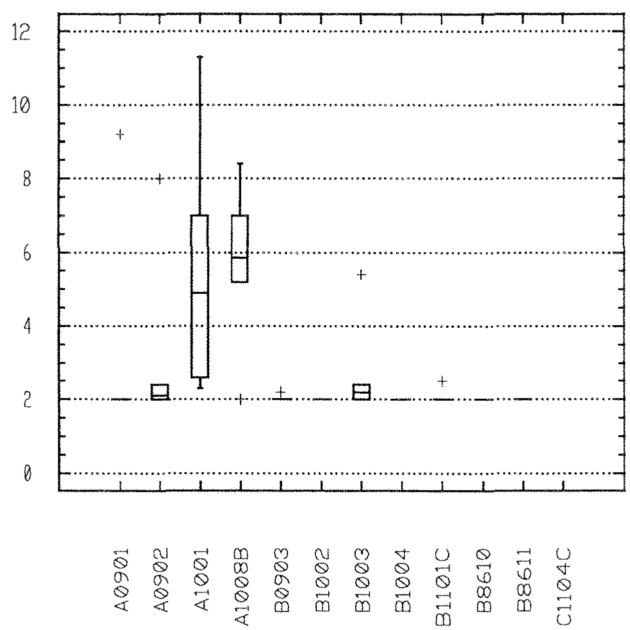


Figure 3-30. Total Organic Halogens (μg/L) in Groundwater Samples from the Kent Recessional Sequence

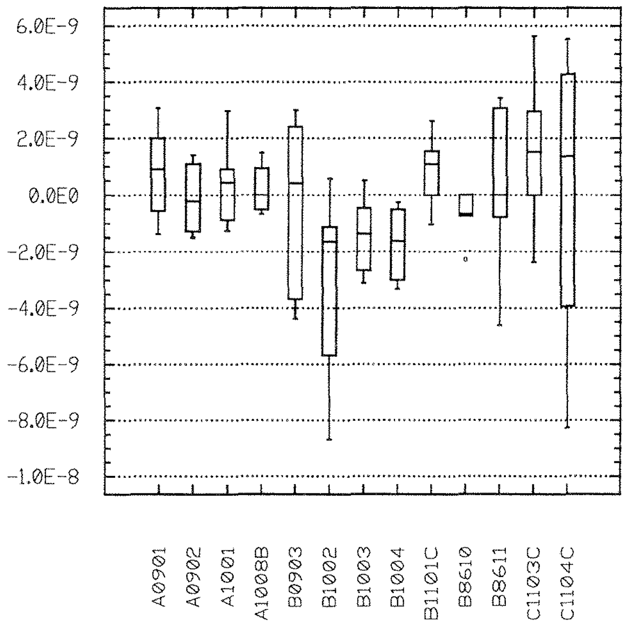


Figure 3-31. Gross Alpha (μCi/mL) in Groundwater Samples from the Kent Recessional Sequence

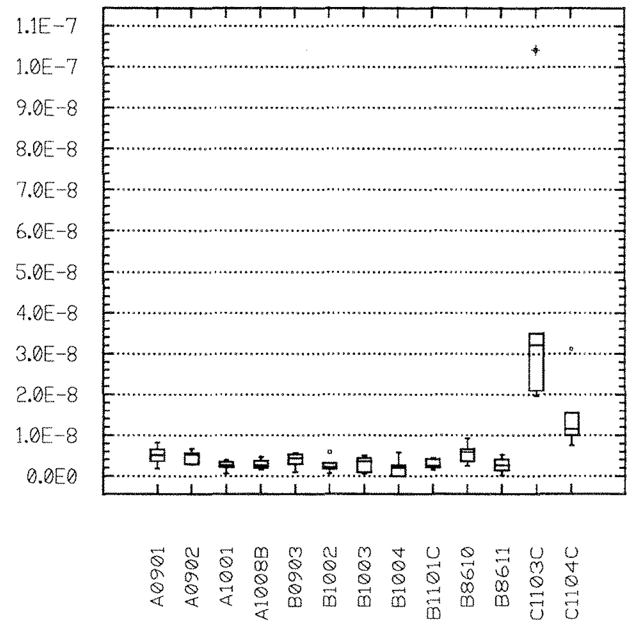


Figure 3-32. Gross Beta (μCi/mL) in Groundwater Samples from the Kent Recessional Sequence

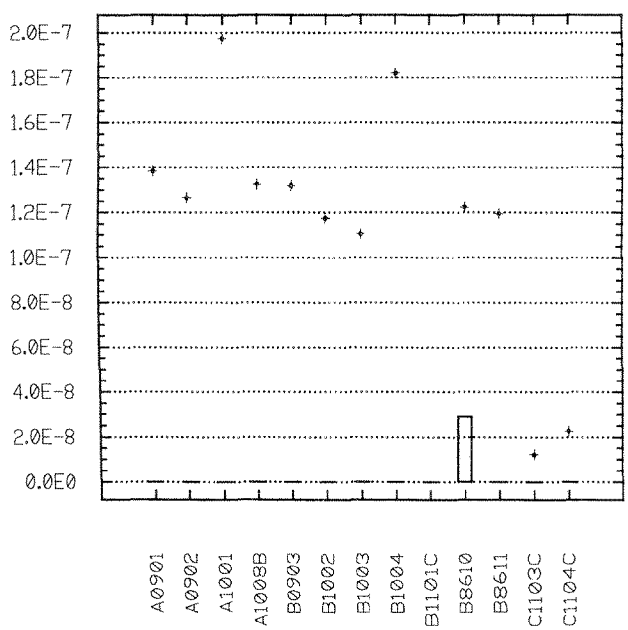


Figure 3-33. Tritium Activity (μCi/mL) in Groundwater Samples from the Kent Recessional Sequence

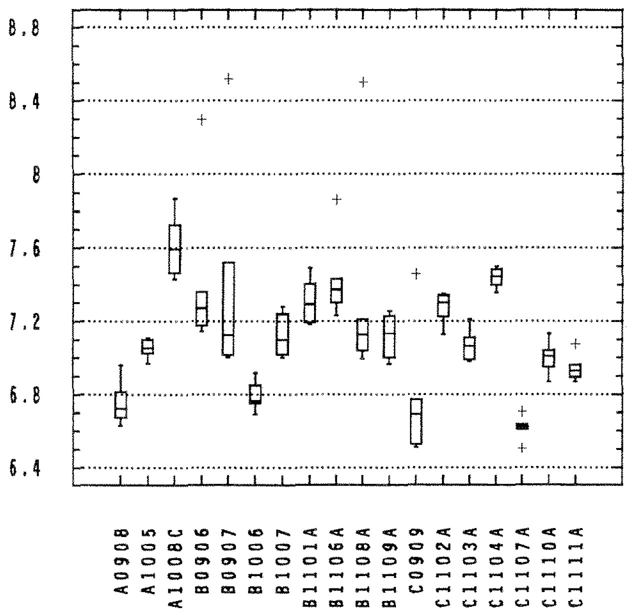


Figure 3-34. pH of Groundwater Samples from the Weathered Lavery Till Unit

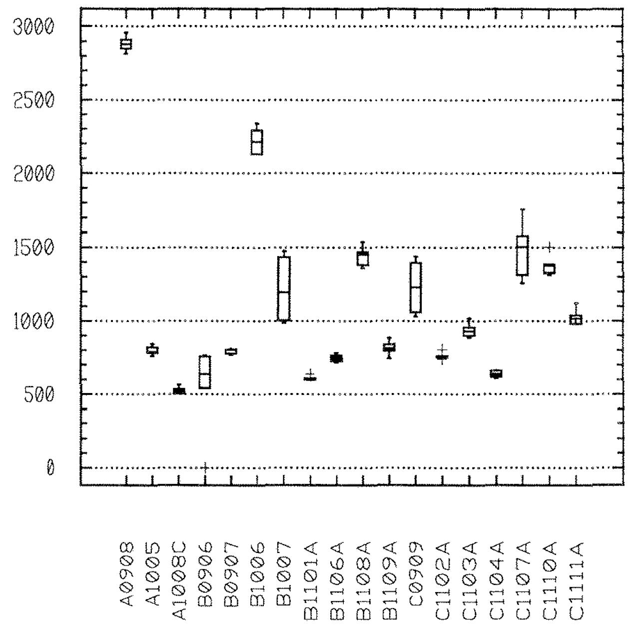


Figure 3-35. Conductivity (μmhos/cm@25°C) of Groundwater Samples from the Weathered Lavery Till Unit

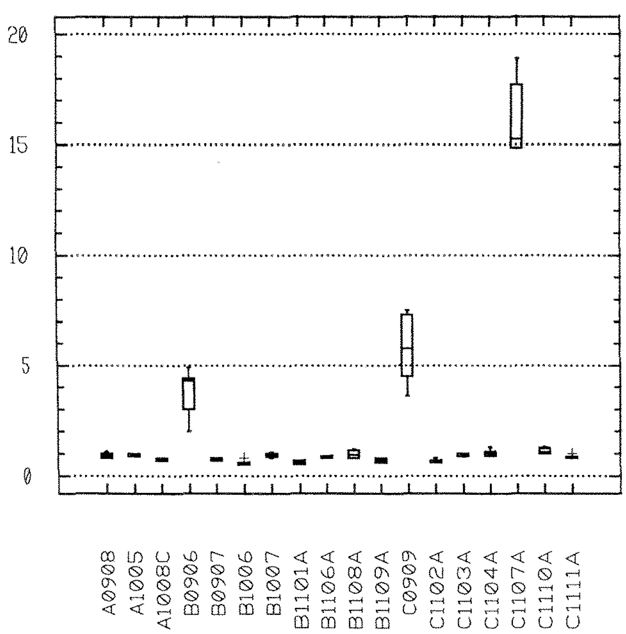


Figure 3-36. Total Organic Carbon (mg/L) in Groundwater Samples from the Weathered Lavery Till Unit

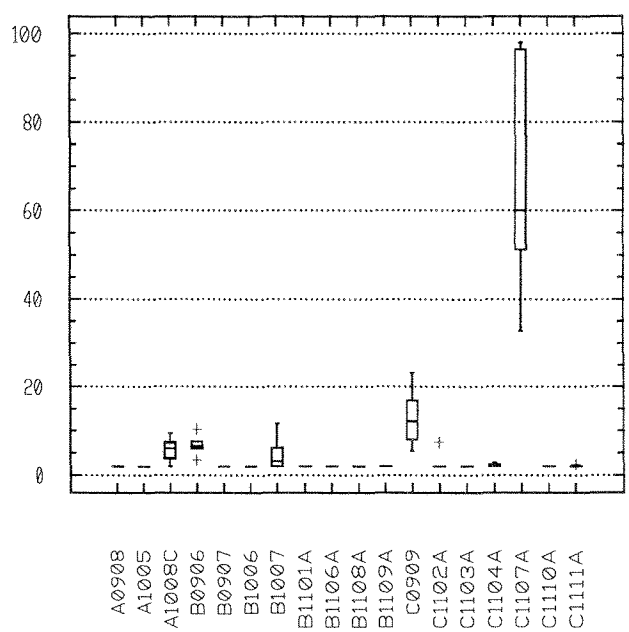


Figure 3-37. Total Organic Halogens (μg/L) in Groundwater Samples from the Weathered Lavery Till Unit

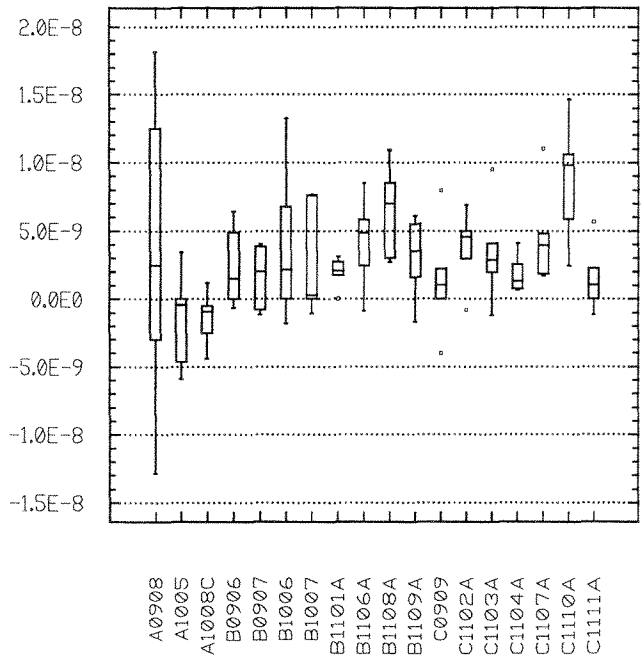


Figure 3-38. Gross Alpha (μCi/mL) in Groundwater Samples from the Weathered Lavery Till Unit

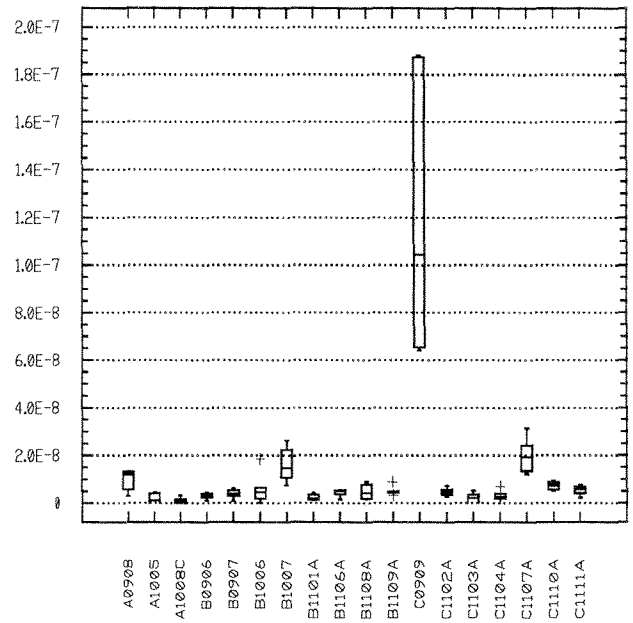


Figure 3-39. Gross Beta (μCi/mL) in Groundwater Samples from the Weathered Lavery Till Unit

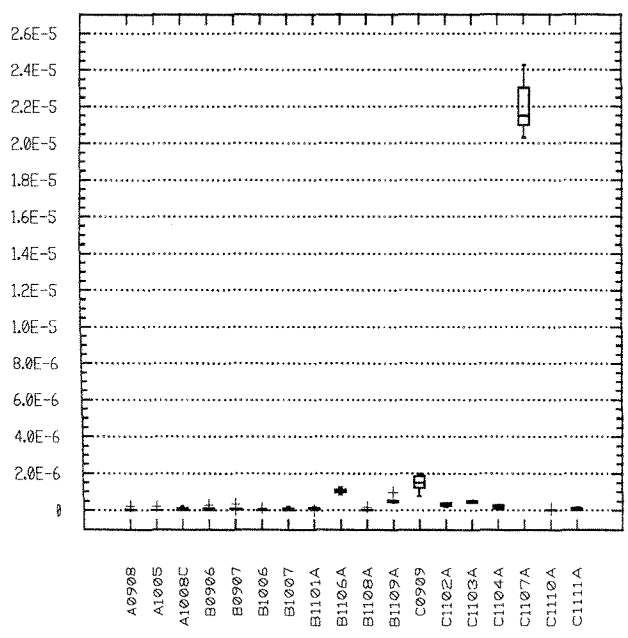


Figure 3-40. Tritium Activity (μCi/mL) in Groundwater Samples from the Weathered Lavery Till Unit (Fig. 3-40a follows with magnified scale.)

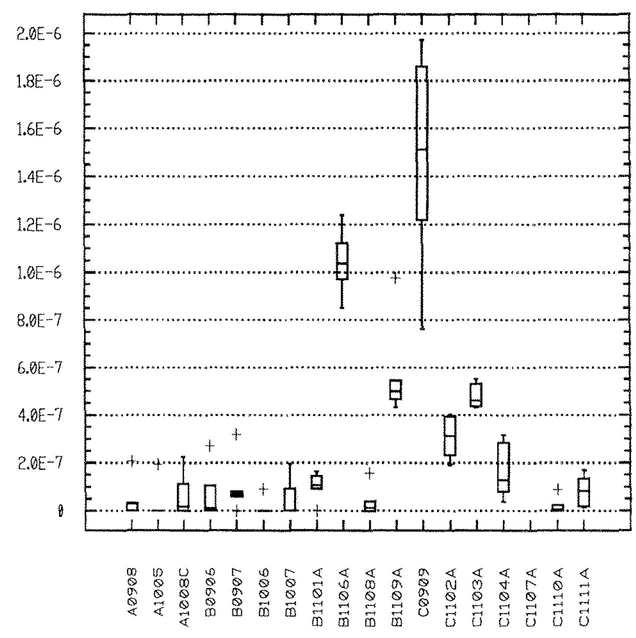


Figure 3-40a. Tritium Activity (μCi/mL) in Groundwater Samples from the Weathered Lavery Till Unit (magnified scale of Fig. 3-40)

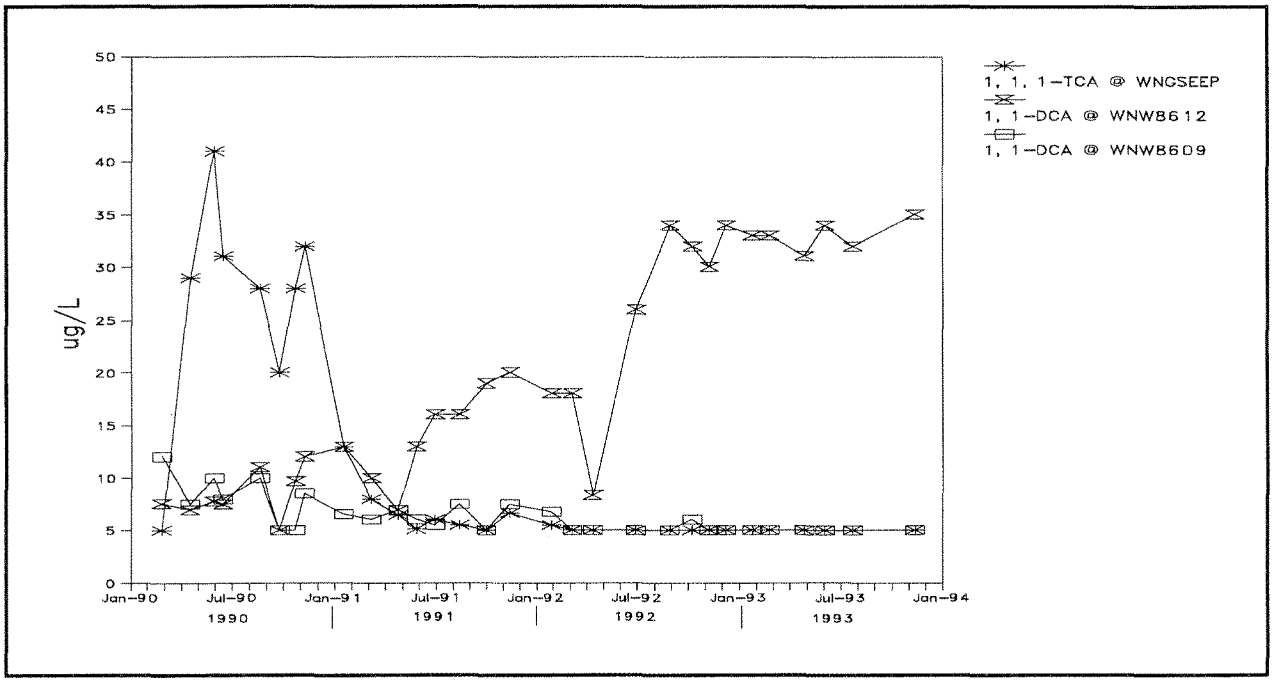


Figure 3-41. Four-Year Trends (1990 through 1993) of 1,1-DCA and 1,1,1-TCA (μg/L) at Selected Groundwater Locations

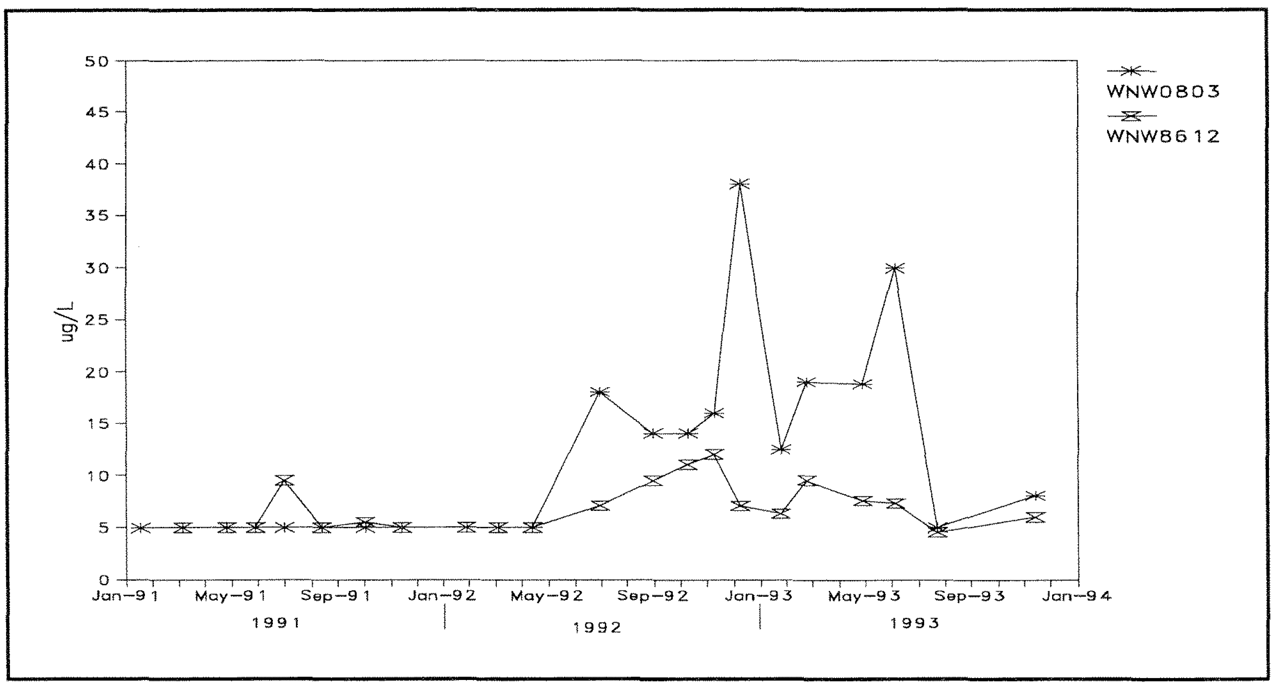


Figure 3-41a. Three-Year Trends (1991 through 1993) of Dichlorodifluoromethane (DCDFMeth) (μg/L) at Selected Groundwater Locations

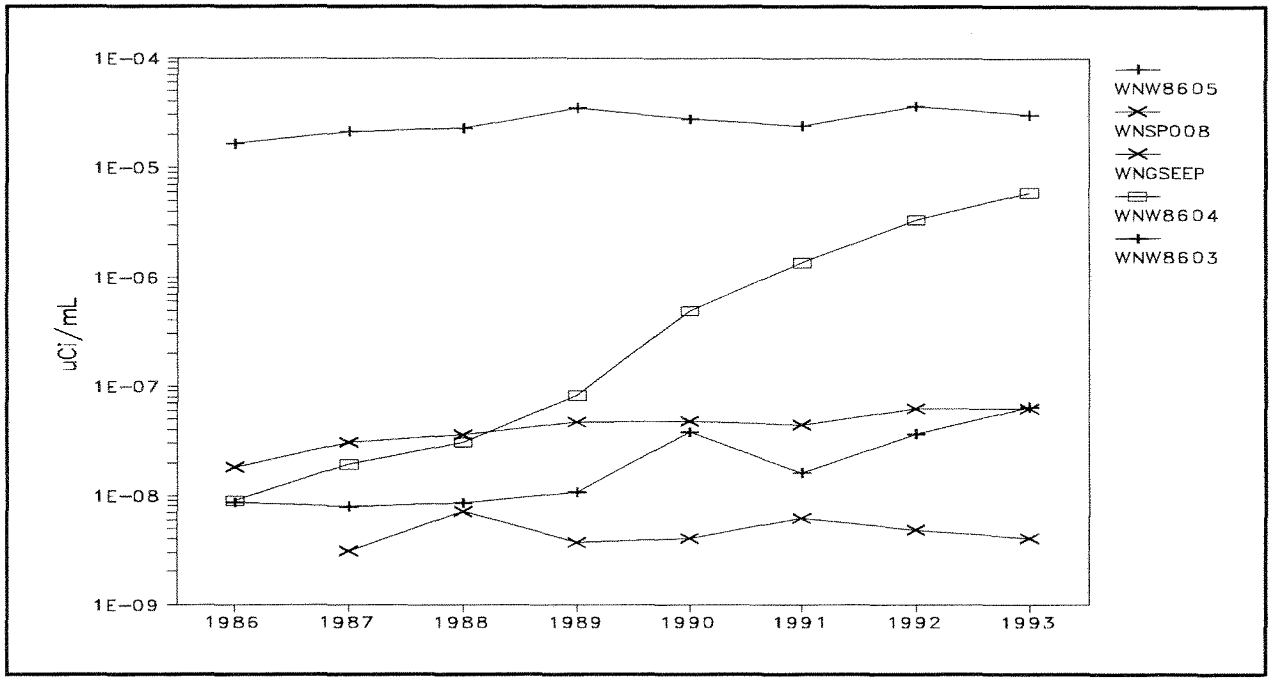


Figure 3-42. Eight-Year Trends of Averaged Gross Beta Activity (μCi/mL) at Selected Locations in the Sand and Gravel Unit

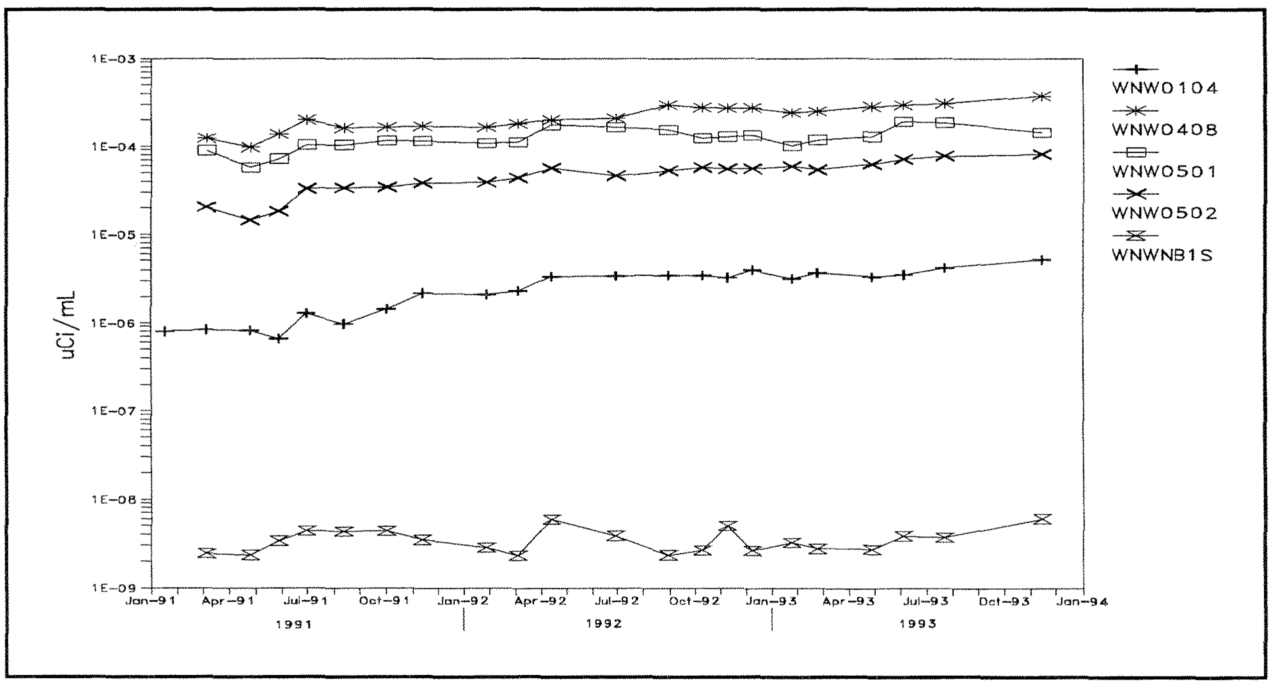


Figure 3-42a. Three-Year Trends of Gross Beta Activity (μCi/mL) at Five Selected Wells

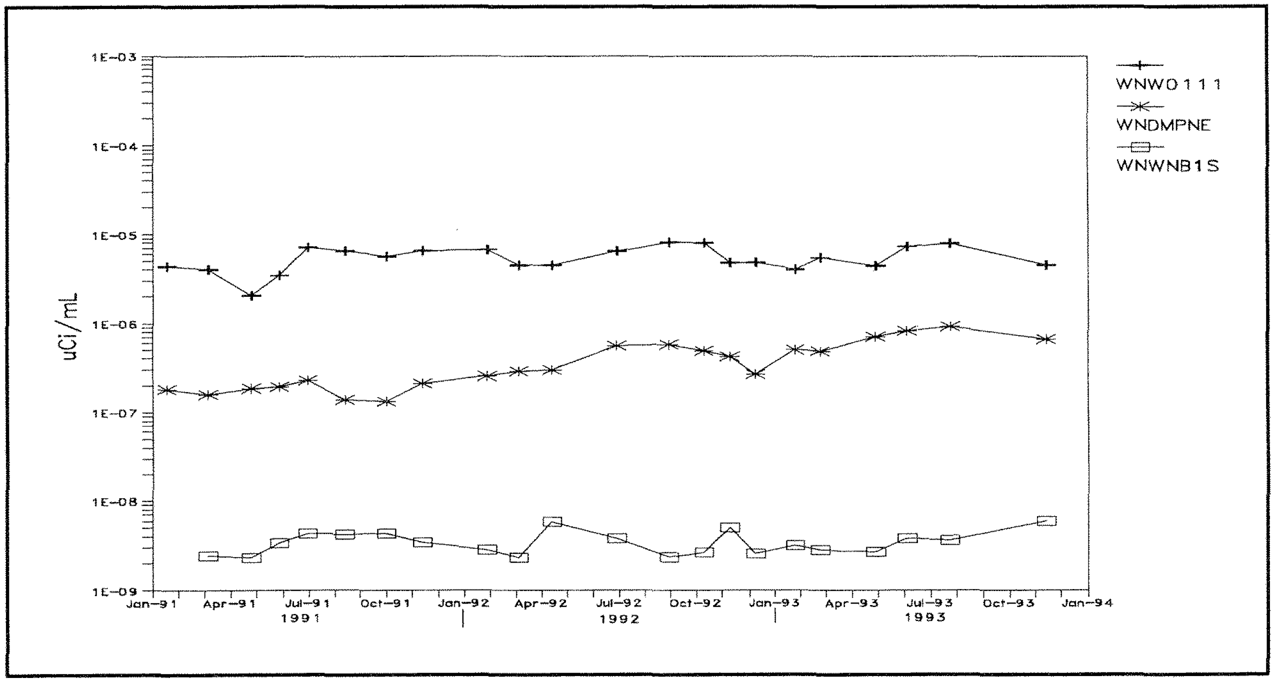


Figure 3-42b. Three-Year Trends of Gross Beta Activity (μCi/mL) at Three Selected Wells

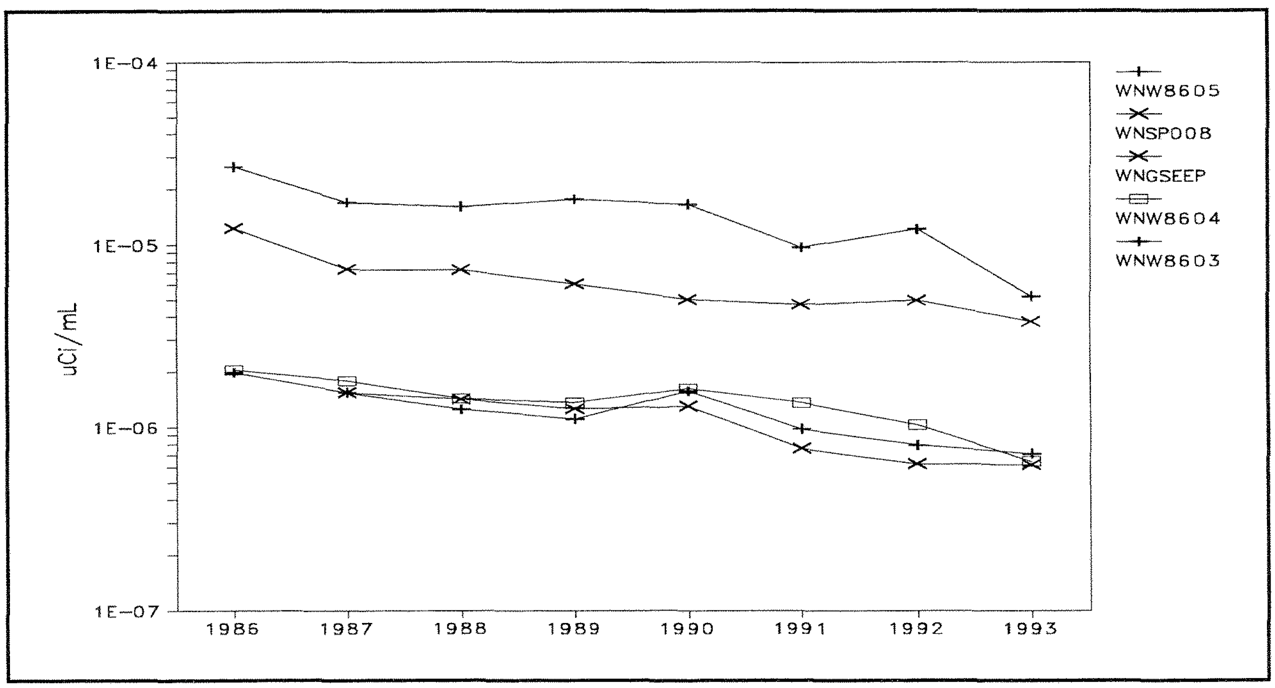


Figure 3-43. Eight-Year Trends of Averaged Tritium Activity (μCi/mL) at Selected Locations in the Sand and Gravel Unit

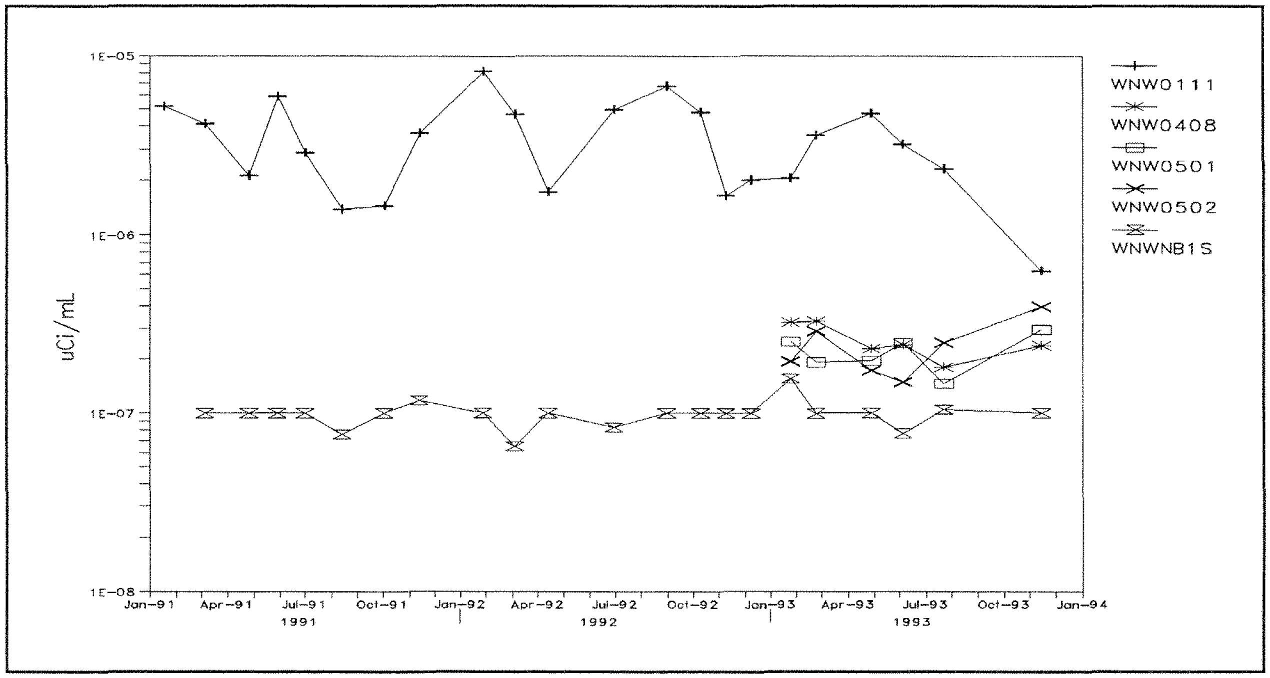


Figure 3-43a. Three-Year Trends of Tritium Activity (μCi/mL) at Selected Wells

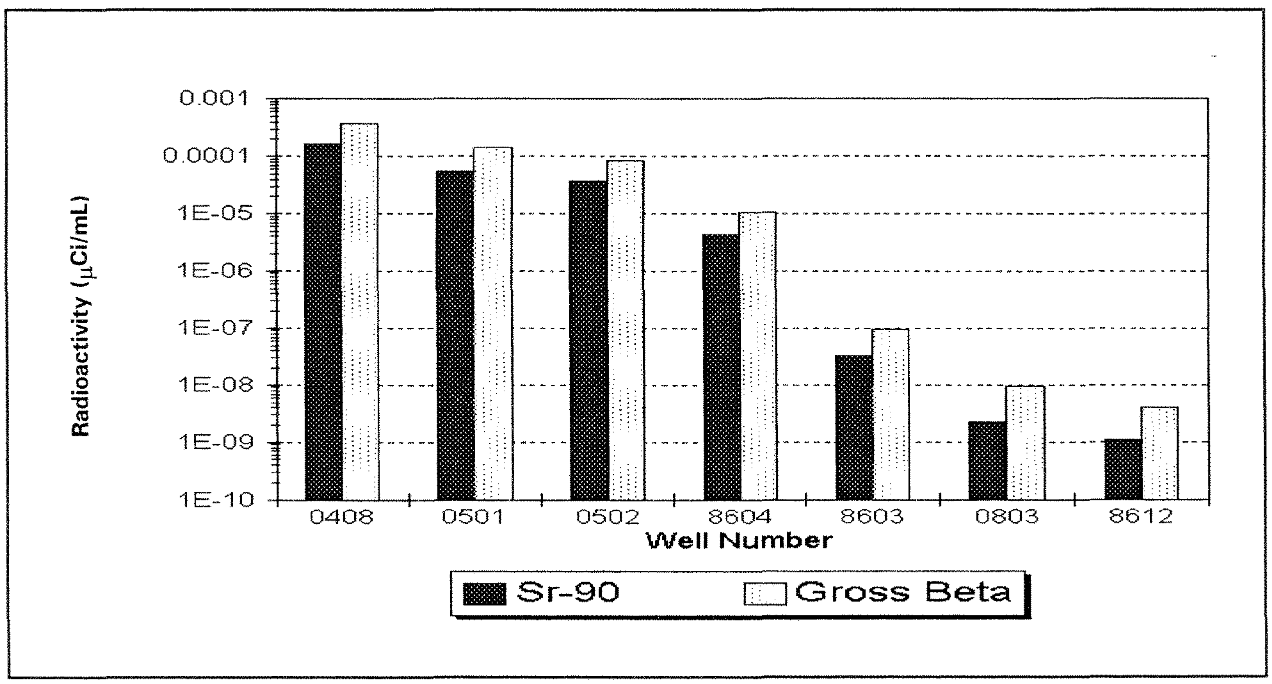


Figure 3-44. Gross Beta and Strontium-90 Relationships along Groundwater Flow Path

RADIOLOGICAL DOSE ASSESSMENT

Each year the potential radiological dose to the public from the West Valley Demonstration Project is assessed to determine if an individual could possibly have received an exposure exceeding the limits established by the regulatory agencies. The results of these conservative dose calculations demonstrate that the potential maximum dose to an off-site resident is well below permissible standards and is consistent with the as low as reasonably achievable philosophy of radiation protection.

Introduction

This chapter describes the methods used to estimate dose to the general public resulting from exposure to radionuclides released by the Project to the surrounding environment during 1993.

Estimated doses are compared directly to current radiation standards established by the Department of Energy (DOE) and the Environmental Protection Agency (EPA) for protection of the public. Doses are also compared to the dose the public receives from natural background radiation and to doses reported in previous years for the Project.

Radioactivity

Atoms that emit radiation are called radionuclides. Radionuclides are unstable isotopes that have the same number of protons and electrons as any other isotope of the element but different numbers of neutrons, resulting in different atomic masses. For example, the element hydrogen has two stable isotopes, H-1 and H-2 (deuterium), and one radioactive isotope, H-3 (tritium). The numbers following the element's symbol identify the atomic mass, which is the number of protons plus neutrons in the nucleus.

Once a radioactive atom decays by emitting radiation, the resulting daughter atom also may be either radioactive or stable. Each radioactive isotope has a unique half-life that represents the time it takes for 50% of the atoms to decay. Strontium-90 and cesium-137 have half-lives of about thirty years, while plutonium-239 has a half-life of 24,000 years. Emitted radiation may consist of electromagnetic rays such as x-rays and gamma rays or alpha or beta particles. Each radionuclide may emit one or more of these radiations at characteristic energies that can be used to identify them.

Radiation Dose

The energy released from a radionuclide is eventually deposited in matter encountered along the path of radiation, resulting in a radiation dose to the absorbing material. The absorbing material can be either inanimate matter or living tissue. Alpha particles leave a dense track of ionization as they travel through tissue and thus deliver the most dose per unit mass. However, alpha particles are not penetrating and must be taken into the body by inhalation or ingestion to cause harm. Beta and gamma radiation can penetrate the protective skin layer of the body from the outside to deliver a whole body dose or expose internal organs. However, beta and gamma radiation deposit much less energy in tissue per unit mass relative to alpha radiation.

Units of Measurement

The U.S. unit of measurement for dose equivalent is the rem. The international unit of measurement of dose equivalent is the sievert (Sv), which is equal to 100 rem. The millirem (mrem) and millisievert (mSv), used more frequently to report the low dose equivalents encountered in environmental exposures, are the equivalent of one-thousandth of a rem or sievert. The dose equivalent concept was developed by the radiation community to allow comparison of dose from different types of radiation.

The effective dose equivalent (EDE) was developed to account for the relative risk of radiation exposure to a particular organ or tissue. The EDE is calculated by multiplying the organ dose equivalent by the organ-weighting factors developed by the International Commission on Radiological Protection (ICRP) in Publications 26 (1977) and 30 (1979). The weighting factor is a ratio of the risk from a specific organ or tissue dose to the total risk resulting from whole body irradiation. All organ-weighted dose equivalents are then summed to obtain the EDE.

The dose from internally deposited radionuclides usually is calculated for a fifty-year period following one year of intake and is called the fifty-year committed effective dose equivalent (CEDE). The CEDE sums the dose to an individual over fifty years to account for the biological retention of radionuclides in the body. The total EDE is calculated by adding the dose equivalent from external, penetrating radiation to the CEDE. Unless otherwise specified, all doses discussed here are EDE values, which include the CEDE for internal emitters.

A collective population dose is expressed in units of person-rem or person-sievert because the individual doses are summed over the entire potentially exposed population. The average individual dose can therefore be obtained by dividing the collective dose by the number in the population.

Sources of Radiation

Members of the public are routinely exposed to different sources of ionizing radiation from both natural and manmade sources. Figure 4-1 shows the relative contribution to the annual dose in millirem (mrem) from these sources in comparison to the estimated annual dose from the WVDP. The National Council on Radiation Protection and Measurements (NCRP) Report 93 (1987) estimates that the average annual effective dose equivalent (EDE) received by an individual living in the U.S. is about 360 mrem (3.6 mSv) from both natural and manmade sources of radiation.

While most of the radiation dose affecting the general public is natural background radiation, manmade sources of radiation also contribute to the average radiation dose to individual members of the public. Such sources include diagnostic and

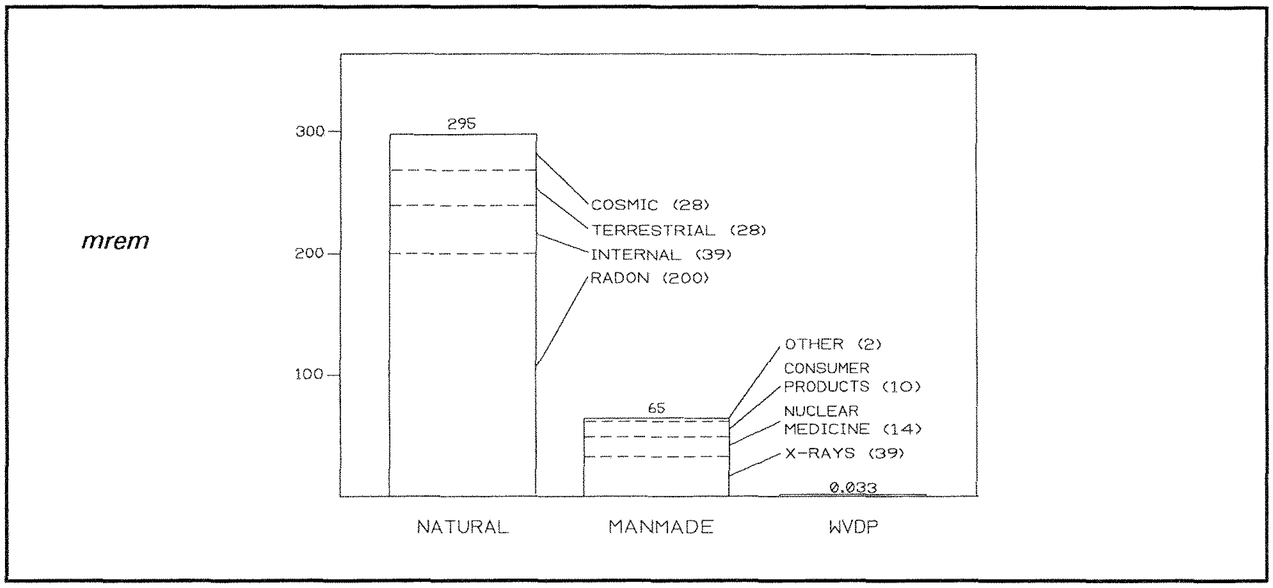


Figure 4-1. Comparison of Annual Background Radiation Dose to the Dose from 1993 WVDP Effluents

therapeutic x-rays, nuclear medicine, fallout from atmospheric nuclear weapons tests, effluents from nuclear fuel cycle facilities, and consumer products such as smoke detectors and cigarettes.

As can be seen in Figure 4-1, natural sources of radiation contribute 295 mrem (2.95 mSv) and manmade sources contribute 65 mrem (0.65 mSv) of the total annual dose of 360 mrem. The WVDP contributes a very small amount (0.033 mrem [0.00033 mSv] per year) to the total annual manmade radiation dose to the maximally exposed individual residing near the WVDP. This is much less than the average dose received from using consumer products.

Health Effects of Low-level Radiation

The primary effect of low levels of chronic radiation in an exposed individual is generally assumed to be an increased risk of cancer. Radionuclides entering the body through air, water, or food are usually distributed in different organs of the body. For example, isotopes of iodine concentrate in the thyroid. Strontium, plutonium, and americium isotopes concentrate in the skeleton. When inhaled, uranium and plutonium isotopes remain in the lungs for a long period of time. Some radionuclides such as tritium, carbon-14, or cesium-137 are distributed uniformly throughout the body. Therefore, depending on the radionuclide, some organs may receive quite different doses. Moreover, at the same dose levels, certain organs (such as the breast) are more prone to developing a fatal cancer than other organs (such as the thyroid).

Because of the uncertainty and difficulty in measuring increased cancer resulting from exposure to ionizing radiation, to be conservative, a linear model is used to predict health effects from low levels of radiation. This model assumes that there is an effect on the exposed person at all dose levels even though the body may effectively repair damage incurred from low levels of beta and gamma radiations.

Exposure Pathways

The radionuclides present at the West Valley Demonstration Project site are left over from the reprocessing of commercial nuclear fuel during the 1960s and early 1970s. A very small fraction of these radionuclides is released off-site annually through ventilation systems and liquid discharges. An even smaller fraction actually contributes to the radiation dose to the surrounding population through exposure pathways.

An exposure pathway consists of a source of contamination or radiation that is transported by environmental media to a receptor location where exposure to contaminants may occur. For example, a member of the public could potentially be exposed to low levels of radioactive particulates carried by prevailing winds.

The potential pathways of exposure to Project emissions are inhalation of gases and particulates, ingestion of local food products, ingestion of fish, beef, and deer tissues, and exposure to external penetrating radiations emanating from contaminated materials. The drinking water pathway was excluded based on usage surveys of the local population surrounding and residing downstream of the WVDP site. Table 4-1 summarizes the potential exposure pathways for the general off-site population.

Dose Assessment Methodology

The general dose assessment methodology was to first assess radionuclide concentrations measured in environmental media to ascertain if any detectable effects from WVDP activities and releases have occurred. Even if the assessment of environmental media concentrations determined that there were no effects, airborne and waterborne releases from the WVDP were modeled to estimate annual doses to individuals and the local population. This two-tiered approach to assessing potential effects and doses resulting from WVDP emissions ensures that a complete evaluation is conducted. This general methodology also allows the collective annual dose to the local population to be calculated.

Predictive Computer Modeling

Because of the difficulty of measuring the small amounts of radionuclides emitted from the site beyond those that occur naturally in the environment, computer codes were used to model the environmental dispersion of radionuclides emitted from on-site monitored ventilation stacks and liquid discharge points. The EDE to the maximally exposed off-site individual and the collective EDE to the population were calculated. These models have been approved by the Department of Energy and the Environmental Protection Agency to demonstrate compliance with radiation standards.

Radiological dose was evaluated for the three major exposure pathways: external irradiation, inhalation, and ingestion of local food products. The dose contributions from each radionuclide and pathway combination were then summed to obtain the reported total dose estimates.

Environmental Media Concentrations

Near-site and control samples of fish, milk, beef, venison, and local produce were collected and analyzed for various radionuclides, including tritium, cobalt-60, strontium-90, iodine-129, cesium-134, and cesium-137. The measured radionuclide concentrations reported in *Appendix C-3*, Tables C-3.1 through C-3.4 are the basis for comparing near-site and background concentrations.

If statistically significant differences were found between near-site and background sample concentrations, the excess near-site sample concentration was used to conduct further dose assessment. If no significant difference in concentrations was found, then it was concluded that there was no impact from site operations and further dose assessment was not conducted.

The dose to nearby residents from the consumption of foods with radionuclide concentrations

Table 4-1

Potential Exposure Pathways under Existing WVDP Conditions

Potentially Exposed Populations	Exposure Pathway and Transporting Medium	Reason for Inclusion/Exclusion
Current off-site residents	*Inhalation: gases and particulates from air*	*Off-site transport of contaminants from WVDP stacks or resuspended particulates from soils*
	Ingestion: cultivated crops	*Local agricultural products irrigated with contaminated ground- or surface water; foliar deposition and uptake of airborne contaminants*
	Ingestion: surface and groundwater	*No documented use of local surface water and downgradient groundwater wells by local residents*
	Ingestion: fish, beef, venison, and milk	*Fish exposed to contaminants in water or sediments may be consumed; beef, venison, and milk consumption following deposition of transported airborne contaminants and surface waters*
	External exposure: radiation emanating from particulates and gases from air or surface water	*Transport of air particulates and gases to off-site receptors; transport of contaminants in surface water and direct exposure during stream use and swimming*

above background concentrations was calculated by multiplying the excess concentrations by the maximum adult annual consumption rate for each type of food and the unit dose conversion factor for ingestion of the measured radionuclide. The consumption rates are based on site-specific data and recommendations in NRC Regulatory Guide 1.109 for terrestrial food chain dose assessments (U.S. Nuclear Regulatory Commission 1977). The internal dose conversion factors were obtained from Internal Dose Conversion Factors for Calculation of Dose to the Public (U.S. Department of Energy 1988).

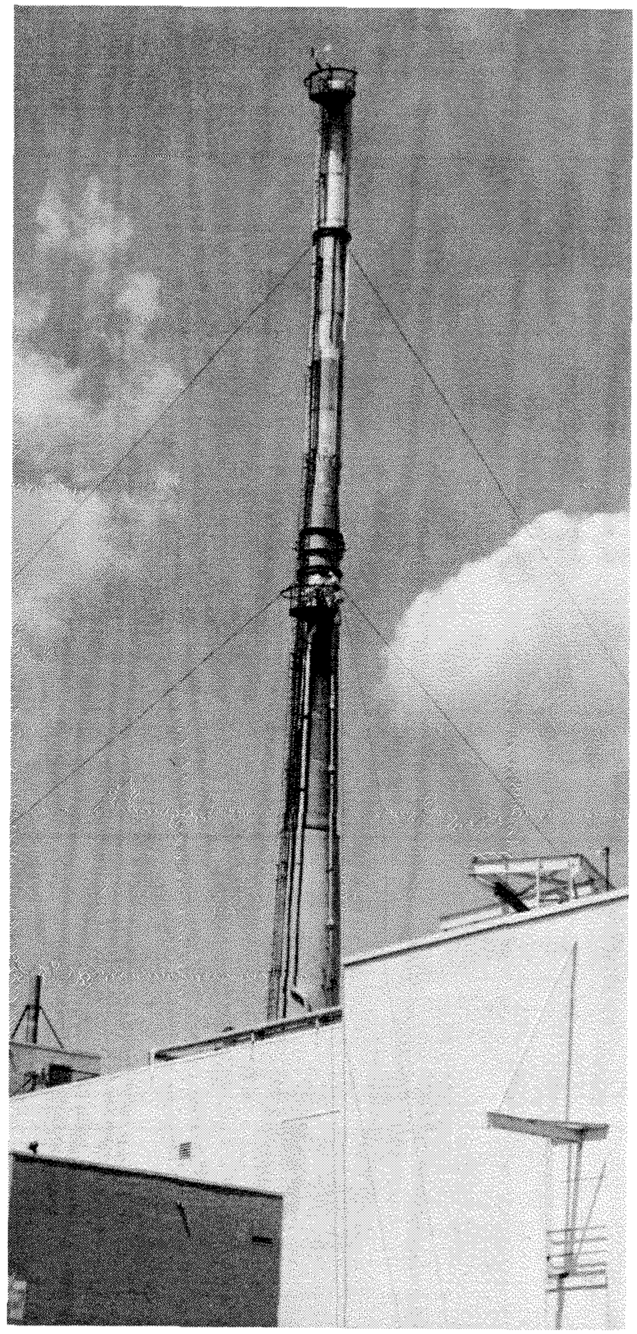
Airborne Releases

Releases of airborne radioactive materials from nominal 10-meter stacks and from the main 60-meter stack were modeled using the EPA-approved CAP88-PC computer code. This air dispersion code estimates effective dose equivalents for the ingestion, inhalation, air immersion, and ground surface pathways. Site-specific data for radionuclide release rates in curies per year, wind data, and the current local population were used as input parameters. Resulting output from the CAP88-PC code was then used to determine the total EDE to a maximally exposed individual and the collective dose to the local population within an 80-kilometer (50-mile) radius of the WVDP.

As reported in *Chapter 2, Environmental Monitoring*, five 10-meter stacks were monitored for radioactive air emissions during 1993. The activity that was released to the atmosphere from these stacks is listed in Tables C-2.1 through C-2.11 in *Appendix C-2* and was used as input to the CAP88-PC code.

The main plant stack, which vents to the atmosphere at a height of 63 meters (208 ft), was considered an elevated release; all other releases were considered ground-level releases.

Wind data collected from the on-site meteorological tower during 1993 were used as input to the CAP88-PC code. Data collected at the 60-meter and 10-meter heights were used in combination with elevated and ground-level effluent release data, respectively.



The Main Plant Ventilation Stack at the West Valley Demonstration Project

Waterborne Releases

The EDE to the maximally exposed off-site individual and the collective EDE to the population due to routine waterborne releases and natural drainage are calculated using dose conversion factors as reported in Radiological Parameters for Assessment of WVDP Activities (Faillace and Prowse 1990). Since the effluents eventually reach Cattaraugus Creek, which is not used as a source of drinking water, the most important individual exposure pathway is the consumption of fish by local sportsmen. It is assumed that a person may consume as much as 21 kilograms (46 lbs) of fish caught in the creek. Exposure to external radiation from shoreline or water contamination also is included in the model for estimating radiation dose. Population dose estimates assumed that radionuclides were further diluted in Lake Erie before reaching municipal drinking water supplies to be being ingested by the local population. The computer code LADTAP II (Simpson and McGill 1980) was used to calculate the dose conversion factors for routine waterborne releases and dispersion of these effluents. Input data included site-specific stream flow and dilution, drinking water usage, and stream usage factors. A detailed description of LADTAP II is given in Radiological Parameters for Assessment of WVDP Activities (Faillace and Prowse 1990).

Seven planned batch releases of liquid radioactive effluents from lagoon 3 occurred during 1993. The radioactivity that was discharged in these effluents is listed in *Appendix C-1*, Table C-1.1, and was used with the dose conversion factors to calculate the EDE to the maximally exposed off-site individual and the collective EDE to the population.

In addition to the batch releases from lagoon 3 (WNSP001), effluents from the sewage treatment facility (WNSP007) and the french drain (WNSP008) are routinely released. The activities measured from these release points were included in the EDE calculations. The measured radioactivities from the sewage treatment facility and french drain are presented in *Appendix C-1*, Table C-1.21 and Table C-1.26.

In addition to the above discharges there are two natural streams originating on the Project premises for which there are measurable amounts of radioactivity. These are drainages from the north swamp (WNSW74A) and northeast swamp (WNSWAMP). The measured radioactivity from these points is reported in *Appendix C-1* (Tables C-1.12 through C-1.15). These release points are included in the EDE calculations for the maximally exposed off-site individual and the collective population.

Biological Compartment Concentrations

Radionuclide concentrations in samples of fish, milk, beef, venison, and local crops were assessed to determine if near-site concentrations were significantly above concentrations for corresponding background samples.

Fish

Muscle tissue from fish collected from June 1993 through October 1993 in Cattaraugus Creek upstream (background samples) and downstream of the site above and below the Springville dam was analyzed. Ten tissue samples were collected at each of the three locations and analyzed primarily for strontium-90 and gamma-emitting radionuclides. (See Table C-3.4.) Average radionuclide concentrations from samples downstream of the site were found to be statistically indistinguishable from average background concentrations at the 95% confidence levels.

Milk

Milk samples were collected from various nearby dairy farms throughout 1993. Control samples were collected from farms 25-30 kilometers (15-20 mi) to the south and north of the WVDP. Milk samples were measured primarily for tritium, strontium-90, iodine-129, cesium-134, cesium-137, and other detectable gamma-emitting radionuclides. (See Table C-3.1.) Ten near-site milk samples were collected and compared with eight background samples. Radionuclide concentrations in routine milk samples from near-site locations were not significantly different from background concentrations except for strontium-90. Comparisons of annual average near-site to background milk showed a small net difference. This apparent difference in strontium-90 concentrations was used to project a hypothetical maximum dose of 0.02 mrem to an individual who consumed 310 liters of milk at this net concentration.

Beef

Near-site and control samples of locally raised beef were collected in 1993. These samples were measured for tritium, strontium-90, cesium-134, cesium-137, and detectable gamma-emitting radionuclides. Two samples of beef muscle tissue were collected from background locations and two from near-site locations. All individual concentrations of tritium and cesium-134 were below detection limits in background and near-site samples. Strontium-90 and cesium-137 concentrations were above detection limits, but cesium-137 was not statistically different from the background samples. (See Table C-3.2.) Although a very slight difference was postulated based on a single strontium-90 measurement, a hypothetical dose of 0.03 mrem was calculated for an individual who consumed 110 kilograms (240 lbs) of meat from this animal.

Venison

Meat samples from three near-site and three control deer were collected in 1993. (See Table C-3.2.) These samples were measured for tritium, strontium-90, cesium-134, cesium-137, and other gamma-emitting radionuclides. Cesium-134 concentrations were below detection limits in background and near-site samples. Tritium, strontium-90, and cesium-137 were detectable, but average concentrations for background and near-site samples were statistically identical.

Produce (hay, corn, beans, and apples)

Near-site and background samples of hay, corn, beans, and apples were collected during 1993 and analyzed for tritium, strontium-90, cesium-134, cesium-137, and other detectable gamma-emitting radionuclides. (See Table C-3.3.) Single samples of each type of produce were collected and compared with single background sample results. Tritium, cesium-134, and cesium-137 were all below detection limits or statistically the same as background concentrations. Strontium-90 concentrations were found to be higher in the near-site sample of hay than in the background samples of hay.

To further assess strontium-90 concentrations in hay, individual concentrations for near-site and background samples from 1987 through 1993 were statistically compared using conventional one-way analysis of variance. In addition, since the distributional nature of the data was not known, a Mann-Whitney rank sum nonparametric test was performed. The analysis of variance showed average strontium-90 from near-site and controls to be identical at the 95% level of confidence. The rank sum nonparametric test showed similar results, indicating no significant difference between average strontium-90 concentrations for hay collected in 1993 and background and near-site locations.

Predicted Dose from Airborne Emissions

Applicable Standards

Airborne emissions of radionuclides are regulated by the EPA under the Clean Air Act. Department of Energy facilities are subject to 40 CFR 61, subpart H, National Emission Standards for Hazardous Air Pollutants (NESHAP). The applicable standard for radionuclides is a maximum of 10 mrem (0.10 mSv) EDE to any member of the public in any year.

Maximum Dose to an Off-site Resident

Based on the airborne radioactivity released from the permitted point sources at the site during 1993, it was estimated that a person living in the vicinity of the WVDP could have received a total EDE of 1.6E-04 mrem (1.6E-06 mSv). This hypothetical maximally exposed individual was assumed to reside continuously 1.4 kilometers northwest of the site and to eat only locally produced foods. Approximately 86% and 71% of the estimated total dose from 1993 airborne emissions were due to iodine-129 from the 60-meter and 10-meter stacks, respectively.

The maximum potential total dose to an off-site resident was also assessed by individual exposure pathways. Ingestion accounted for 86% and 76%, inhalation for 10% and 19%, and external exposures for 4% and 5% of the total calculated doses from the 60-meter and 10-meter stacks, respectively.

The maximum total EDE of 1.6E-04 mrem (1.6E-06 mSv) from the permitted stacks and vents is far below measurable levels. This dose is comparable to much less than one minute of natural background radiation received by an average member of the U.S. population and is well below the 10 mrem (1.0E-01 mSv) NESHAP standard promulgated by the EPA.

For the purpose of demonstrating compliance with the NESHAP regulations, a less realistic but more conservative assessment also was conducted. In this case, effluent samples that were below the detection limit were assumed equal to the limit, thus giving an overestimate of the release. Using this conservative approach and including releases from three non-permitted point sources would increase the 1993 EDE to the maximally exposed off-site individual by 25%, to 2.0E-04 mrem (2.0E-06 mSv).

Collective Population Dose

The CAP88-PC version of AIRDOS-EPA was used to estimate the collective EDE to the population. According to census projections for 1992, an estimated 1.7 million people resided within 80 kilometers (50 mi) of the WVDP. This population received an estimated 1.9E-03 person-rem (1.9E-05 person-Sv) total EDE from radioactive airborne effluents released from the permitted WVDP point sources during 1993. The resulting average EDE per individual was 1.1E-06 mrem (1.1E-08 mSv).

There are no standards limiting the collective EDE to the population. However, the calculated average individual EDE is orders of magnitude lower than the 300 mrem (3 mSv) that an average member of the U.S. population receives in one year from natural background radiation. Using the more conservative approach outlined above and including the non-permitted point sources would increase the collective EDE to 2.7E-03 person-rem (2.7E-05 person-Sv).

Predicted Dose from Waterborne Releases

Applicable Standards

Currently there are no EPA standards establishing limits on the radiation dose to members of the public from liquid effluents

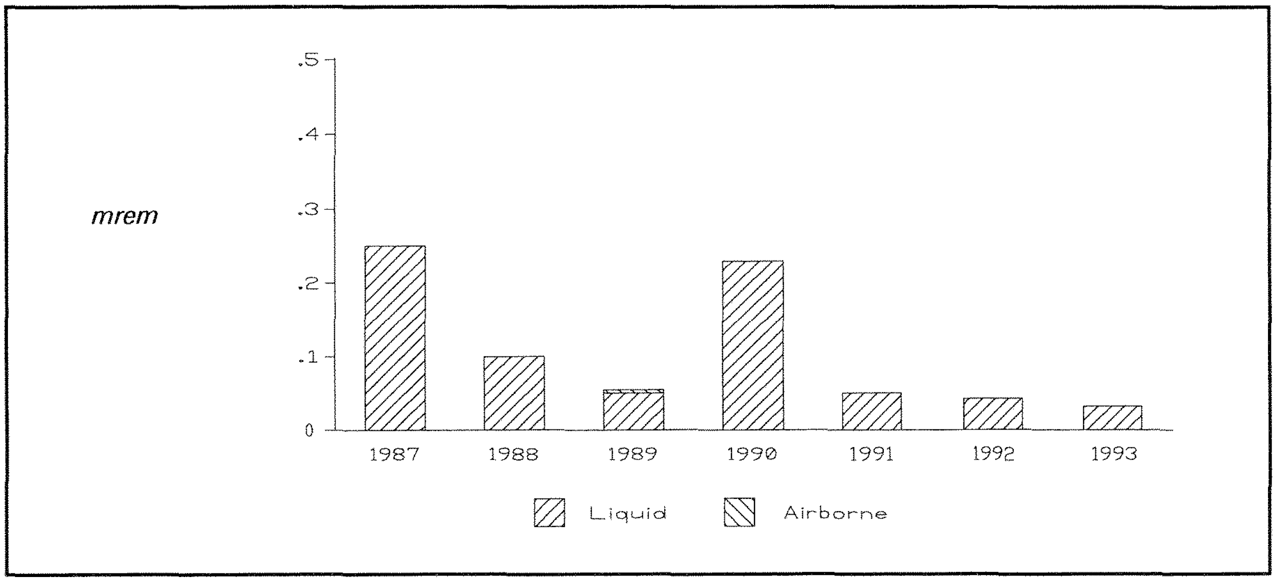


Figure 4-2. Effective Dose Equivalent from Liquid and Airborne Effluents to a Maximally Exposed Individual Residing near the WVDP

except as applied in 40 CFR 141 and 40 CFR 143, Drinking Water Guidelines (U.S. Environmental Protection Agency 1984 a,b). The potable water wells sampled for radionuclides are upgradient of the West Valley Demonstration Project and therefore are not a potential source of radiation exposure from Project activities. Since Cattaraugus Creek is not used as a drinking water supply, a comparison of the predicted concentrations and doses to the EPA standard is not relevant (although the EPA limits are easily met in creek sample values). The estimated radiation dose was compared with the applicable guidelines provided in DOE Order 5400.5.

Maximum Dose to an Off-site Individual

Based on the radioactivity in effluents released from the WVDP (lagoon 3, sewage treatment plant, and french drain) during 1993, an off-site individual could have received a potential maximum EDE of 1.1E-02 mrem (1.1E-04 mSv). Approximately 48% of this dose is from cesium-137 and 26% from strontium-90. This dose is about 27,000 times lower than the 300 mrem (3 mSv) that an average member of the U.S. population receives in one year from natural background radiation. The maximum individual EDE due to natural drainage from the north plateau (north swamp and northeast swamp) is 2.2E-02 mrem (2.2E-04 mSv). Approximately 48% of the dose is due to carbon-14. It should be noted that this relatively large carbon-14 contribution to the maximum predicted EDE is based on a single measurement in the first quarter of 1993. Subsequent measurements in the last three quarters gave values roughly 200 times less. (See Table C-1.15.) The combined EDE to the maximally exposed individual from liquid effluent is 3.3E-02 mrem (3.3E-04 mSv). This dose is about 9,000 times lower than that of the 300 mrem (3 mSv) that an average member of the U.S. population receives in one year from natural background radiation.

Collective Dose to the Population

As a result of radioactivity released in liquid effluents from the WVDP (lagoon 3, sewage treatment plant, and french drain) during 1993, the population living within 80 kilometers (50 mi)

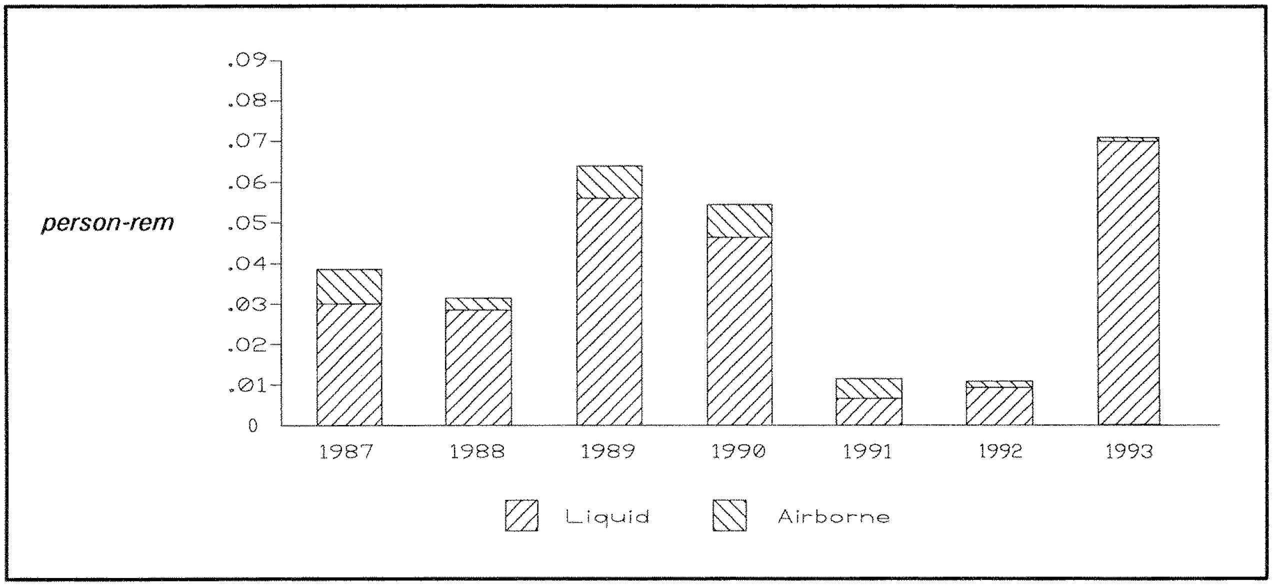


Figure 4-3. Collective Effective Dose Equivalent from Liquid and Airborne Effluents to the Population Residing within 80 Kilometers of the WVDP

of the site received a collective EDE of 2.7E-02 person-rem (2.7E-04 person-Sv). The collective dose to the population from the natural outfalls (north swamp and northeast swamp) is 4.2E-02 person-rem (4.2E-04 person-Sv). This estimate is based on a population of 1.7 million living within the 80-kilometer radius. The resulting average EDE from the lagoon 3, sewage treatment plant, french drain, and north plateau drainage (north swamp and northeast swamp) per individual is 4.1E-05 mrem (4.1E-07 mSv), or approximately 7 million times lower than the 300 mrem (3 mSv) that an average person receives in one year from natural background radiation.

Predicted Dose from all Pathways

The potential dose to the public from both airborne and liquid effluents released from the Project during 1993 is the sum of the individual dose contributions. The hypothetical maximum EDE from all pathways to a nearby resident was 3.3E-02 mrem (3.3E-04 mSv). This dose is 0.03% of the 100 mrem (1 mSv) annual limit in DOE Order 5400.5.

The total collective EDE to the population within 80 kilometers (50 mi) of the site was 7.0E-02 person-rem (7.0E-04 person-Sv), with an average EDE of 4.1E-05 mrem (4.1E-07 mSv) per individual.

Table 4-2 summarizes the dose contributions from all pathways and compares the individual doses to the applicable standards.

Figure 4-2 shows the dose to the maximally exposed individual over the last seven years. The estimated dose for 1993 is lower than the dose reported in previous years.

Figure 4-3 shows the collective dose to the population over the last seven years. The increase in the collective population dose is due primarily to the increased concentration of radionuclides in the lagoon 3 discharges and to the inclusion of the surface drainage from the north plateau in the dose estimates for the first time.

Table 4-2

Summary of Annual Effective Dose Equivalents to an Individual and Population from WVDP Effluents in 1993

Exposure Pathway	*Annual Effective Dose Equivalent*	
	Maximum Individual [1] *mrem (mSv)*	*Collective* [2] *person-rem (person-Sv)*
Airborne Releases [3]	*1.6E-04 (1.6E-06)*	*1.9E-03 (1.9E-05)*
% EPA Standard (10 mrem)	*1.6E-03*	*N/A*
Waterborne Releases [4]	*1.1E-02 (1.1E-04)*	*2.7E-02 (2.7E-04)*
Total, Including North Plateau Drainage	*3.3E-02 (3.3E-04)*	*7.0E-02 (7.0E-04)*
% DOE Standard (100 mrem)	*3.3E-02*	*N/A*
% Natural Background (300 mrem; 510,000 person-rem)	*1.1E-02*	*1.4E-05*

[1] *Maximally exposed individual at a residence 1.4 kilometers northwest from the main plant.*

[2] *Population of 1.7 million within 80 kilometers of the site.*

[3] *From calculated permitted point sources using AIRDOS-EPA (CAP88-PC for individual and population).*

[4] *Calculated using methodology described in Radiological Parameters for Assessment of WVDP Activities (Faillace and Prowse 1990).*

Exponents are expressed as "E" in this report; a value given as $1.2x10^{-4}$ in scientific notation is reported as 1.2E-04 in the text and tables.

N/A - Not applicable.

Risk Assessment

Estimates of cancer risk from ionizing radiation have recently been presented by the International Commission on Radiological Protection (1990), the National Council on Radiation Protection and Measurement (1987), and the National Research Council Committee on Biological Effects of Ionizing Radiation (1990). These reports estimate that the probability of fatal cancer induction to the public of all ages ranges from 1 to 5E-04 cancer fatalities/rem. The most recent risk coefficient by the International Commission on Radiological Protection of 5E-04 was used to estimate risk to a maximally exposed off-site individual. The resulting risk to this hypothetical individual from airborne and waterborne releases was a 2.0E-08 probability of a cancer fatality (1 chance in 50 million). This risk is well below the range of 1E-06 to 1E-05 per year considered acceptable by the International Commission on Radiological Protection Report 26 (1977) for any individual member of the public.

Summary

Radionuclide concentrations in biological samples (fish, milk, beef, venison, and local produce) were determined to be below detectable levels or statistically identical to background concentrations. Thus, no specific dose assessment was performed using environmental media concentrations. Predictive computer modeling was performed for airborne and waterborne releases. This analysis resulted in doses to the hypothetical maximally exposed individual that were orders of magnitude below all applicable EPA standards and DOE Orders, which limit the release of radioactive materials and dose to individual members of the public. The collective population dose was also assessed and found to be orders of magnitude below natural background radiation doses. Based on the dose assessment, the West Valley Demonstration Project was found to be in compliance with all applicable radiological guidelines and standards during 1993.

QUALITY ASSURANCE

The quality assurance (QA) program at the West Valley Demonstration Project provides for and documents consistency, precision, and accuracy in collecting and analyzing environmental samples and in interpreting and reporting environmental monitoring data.

Organizational Responsibilities

WVNS Quality Assurance is responsible for ensuring the quality of site activities, including the environmental monitoring program. Laboratory management and staff are directly responsible for carrying out sampling and analytical activities in a manner consistent with good quality assurance practices.

Program Design

The quality assurance program for environmental monitoring at the WNYNSC is consistent with DOE Order 5700.6C, Quality Assurance, and the WVDP's Environmental Quality Assurance Plan (West Valley Nuclear Services 1991) and is based directly upon the eighteen-element program outlined in Quality Assurance Program Requirements for Nuclear Facilities (American Society of Mechanical Engineers 1989), which describes the major aspects of a good quality assurance program. The program focuses upon assigning responsibilities and upon thorough planning, specification, control, and documentation of all aspects of an activity:

√ *Responsibility*. Responsibilities involved in overseeing and managing an activity must be clearly defined. Personnel who check and verify the activity must be independent of those who perform the activity.

√ *Planning*. The activity must be planned beforehand and the plan followed. All activities must be documented. Similarly, purchases of any equipment or items must be planned, specified precisely, and verified for correctness upon receipt.

√ *Control of design, procedures, items, and documents*. Any activity, equipment, or construction must be clearly described or defined and tested and changes in the design tested and documented. Procedures must clearly state how activities will be conducted. Only approved procedures may be used. Any equipment or particular items must be clearly identified, inspected, calibrated, and tested before use. Calibration status must be clearly labeled. Items that do not conform must be identified and separated from other items and the nonconformity documented.

√ *Documentation.* Records must be kept of all activities in order to verify what was done. Records must be clearly traceable to an item or activity.

√ *Corrective action.* If a problem should arise, the cause of the problem must be identified, a corrective action planned, responsibility assigned, and the problem remedied.

√ *Audits.* Scheduled audits and self-assessments must be conducted to verify compliance with all aspects of the quality assurance program and determine its effectiveness.

Vendors providing analytical services for the environmental monitoring program are contractually required to maintain a quality assurance program consistent with these elements.

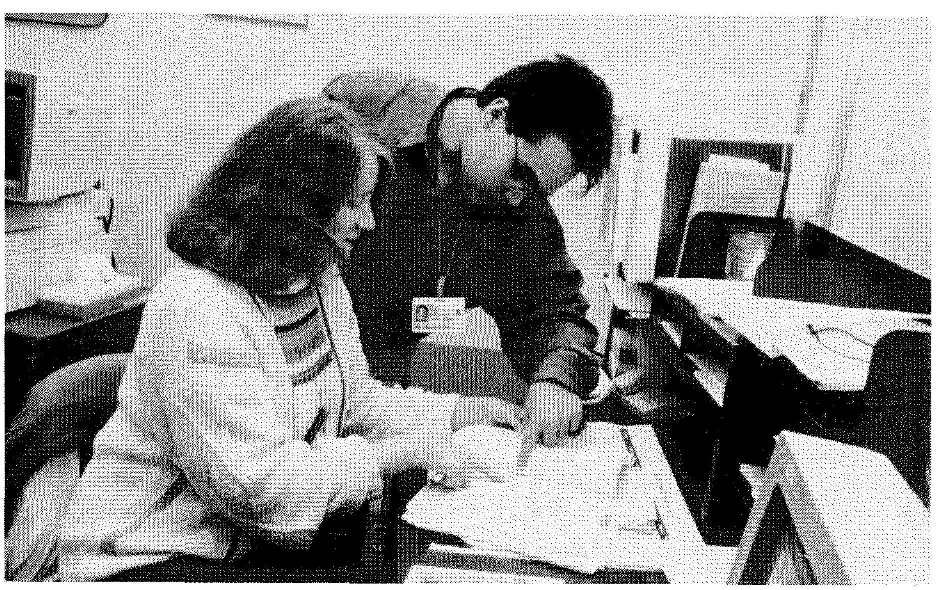
Procedures

Activities affecting the quality of environmental monitoring data are conducted according to approved procedures that clearly describe how the activity should be performed and what precautions are to be taken in connection with the activity. Any person performing an activity that could affect the quality of environmental monitoring data is trained in that procedure and must demonstrate proficiency.

New procedures are developed each time an activity is added to the monitoring program. Procedures are reviewed annually and updated when necessary. Documents are controlled so that only current procedures are used.

Quality Control in the Field

Quality control (QC), an integral component of environmental monitoring quality assurance, is a way of verifying that samples are being collected and analyzed according to established quality assurance procedures: quality control ensures that sample collection and analysis is consistent and repeatable and is a means of tracking down possible sources of error. For example, sample locations are clearly marked in the field to ensure that future samples are collected in the same locations; collection equipment in place in the field is routinely inspected, calibrated, and maintained; and automated sampling stations are kept locked to prevent tampering.



Review of Regulatory Requirements

Samples are collected into appropriate containers and labeled immediately with pertinent information. Date, time, person doing the collecting, and special field sampling conditions are recorded and kept as part of the record for that sample. If necessary, samples are preserved as soon as possible after collection.

In order to monitor quality problems that might be introduced by the sampling process, duplicate field samples, field blank samples, and trip blank samples are collected. Background samples are collected for baseline environmental information.

Field Duplicates

Field duplicates are samples collected for the same analyte at the same location at the same time, after which they are treated as separate samples. If the sampling matrix is homogenous, field duplicates provide a means of assessing the precision of collection methods and are collected at a minimum rate of one per twenty analyses.

Field Blanks

A field blank is a sample of laboratory-distilled water that is put into a sample container at a field collection site and is processed from that point as a routine sample. Field blanks are used to detect contamination introduced by the sampling procedure. They are processed at a minimum rate of one per twenty analyses.

If the same collection equipment is used for more than one site, a special form of field blank known as an equipment blank may be collected by pouring laboratory-distilled water through cleaned collecting equipment and into a sample container. Equipment blanks are collected to detect any cross-contamination that may be passed from one sampling location to another by the equipment. Many wells and surface water collection stations have dedicated collecting equipment that remains at that location. Special equipment blanks are not necessary at these locations because the equipment is used exclusively at that station.

Trip Blanks

Trip blanks are prepared by pouring laboratory-distilled water into sample bottles in the laboratory. The bottles are then placed into sample coolers where they remain throughout the sampling. Trip blanks are collected only when volatile organics are being monitored in order to detect any volatile organic contamination from the containers, coolers, or from handling during collection, storage, or shipping.

Environmental Background Samples

To monitor each pathway for possible radiological contamination, samples of air, water, vegetation, meat, and milk are taken from locations remote from the site. Samples that are clearly outside of site influence show natural radiological concentrations and serve as backgrounds or "controls," another form of field quality control sample. Background samples provide baseline information to compare with information from near-site or on-site samples so that any possible influence from the site can be determined.

Quality Control in the Laboratory

More than 15,000 samples were handled as part of site monitoring in 1993. Approximately 60% of these samples were analyzed on-site, with the rest being sent to vendor laboratories. Samples analyzed by laboratories off-site must maintain a level of quality control similar to on-site laboratories, as specified in contracts between the site and the vendor laboratories. Vendor laboratories are required to participate in all relevant crosschecks and to maintain all relevant certifications.

In order to monitor the accuracy and precision of data, laboratory quality control practices specific to each analytical method are clearly described in approved references or procedures. Laboratory quality control consists of proper training of analysts, maintenance and calibration of measuring equipment and instrumentation, and specific methods of processing samples as a means of monitoring laboratory performance.

Analytical instruments and counting systems are calibrated at specified frequencies and logs of instrument calibration and maintenance are kept. Calibration methods for each instrument are specified in procedures or in manufacturers' directions. Standards traceable to the National Institute of Standards and Technology (NIST) are used to calibrate counting and test instrumentation.

Laboratory quality control samples consist of three general types: standards (including spikes), used to assess accuracy; blanks, to assess the possibility of contamination; and duplicates, to assess precision.

Standards

Laboratory standards are materials containing a known concentration of the analyte of interest, such as a pH buffer or a plutonium-239 counting standard, and are either NIST-traceable standards or standard reference materials from other nationally recognized sources. At a minimum, one reference standard is analyzed for every ten sample analyses, or one per day, to determine if the method is producing results within acceptable limits.

The results from analyses of standards are plotted on control charts, which specify acceptable limits. If the analysis produces results within acceptable limits, then analysis of actual environmental samples may proceed and the results are deemed usable.

Laboratory Spikes

Another form of standard analysis is a laboratory spike in which a known amount of analyte is added to a sample or blank before the sample is analyzed. The percent recovery of the analyte is an indication of how much of the analyte of interest is being detected in the analysis of actual samples; hence, a spike also is an assessment of the accuracy of the method. Acceptance limits are documented for spike recovery and spike results are recorded on control charts.

Laboratory Blanks

Laboratory blanks are prepared from a matrix similar to that of the sample but known to contain none of the analyte of interest. For instance, distilled water, taken through the same preparatory procedure as a sample, serves as a laboratory blank for both radiological and chemical water analyses. A positive result for an analyte in a blank indicates that something is wrong with the analysis and that corrective action should be taken. In general, one laboratory blank is processed daily or with each "run" of samples for a given analyte.

A special form of laboratory blank for radiological samples is an instrument background count, which is a count taken of a planchet or vial containing no sample. The count serves three purposes:

1) to determine if contamination is present in the counting instrument

2) to determine if the instrument is responding in an acceptable manner

3) to determine the background correction that should be applied in calculations of radiological activity.

A background count is taken before each day's counting. Background counts are recorded on control charts with defined acceptance limits. An unacceptable count requires corrective action before analyses can proceed.

Laboratory Duplicates

Duplicates are analyzed to assess precision in the analytical process. Laboratory duplicates are created by splitting existing samples before analysis; each split is treated as a separate sample. If the analytical process is in control, results for each split should be within documented criteria of acceptability.

Crosschecks

WVNS participates in formal radiological crosscheck programs conducted by the DOE and the EPA. The DOE requires participation in the semiannual EML Quality Assessment Program (QAP) by any laboratory analyzing samples for environmental monitoring at DOE sites. WVNS also participates in crosschecks from the EPA's Environmental Monitoring Systems Laboratory (EMSL). Crosscheck samples for radiological analyses are analyzed by both the Environmental Laboratory on-site and by the vendor laboratories and are reported by WVNS.

Ninety-seven radiological crosscheck analyses were performed by or for WVNS and reported by WVNS in 1993. Results from radiological crosschecks are summarized in *Appendix D*, Tables D-1, D-2, and D-3. Eighty-one results (83.5%) were within control limits. Most out-of-control results were part of QAP-39, which is summarized in Table D-2. Excluding the QAP-39 results, the percentage in control for 1993 was 94.0% (63 of 67 results.) The performance on QAP-39 is being followed up by formal corrective action.

WVNS also participates in nonradiological crosschecks as submitted by the EPA and by NYSDOH. Successful completion of NYSDOH performance evaluation samples is necessary to maintain laboratory certification. Results from nonradiological crosschecks are summarized in *Appendix D*, Tables D-4 and D-5. Forty-nine analyses were performed, and forty-six were within control limits (93.9%).

By contract, vendor laboratories are required to perform satisfactorily on crosschecks, defined as 80% of results falling within control limits. Crosscheck results outside of control limits for both radiological and nonradiological analyses are addressed by formal corrective actions in order to determine any conditions that could adversely affect sample data and to ensure that actual sample results are reliable.

Table D-6 summarizes environmental thermoluminescent dosimeter (TLD) analytic results from WVNS and results from NRC TLDs placed in the same locations but collected and analyzed by the NRC. Although not a formal crosscheck, the agreement of these two sets of results demonstrates the precision of these measurements and substantiates confidence in results from the remainder of the environmental TLD locations.

Personnel Training

Anyone performing environmental monitoring program activities must be trained in the appropriate procedures and qualified accordingly before carrying out the activity as part of the site environmental monitoring program.

Record Keeping

Control of records is an integral part of the environmental monitoring program. Field data sheets, chain-of-custody forms, requests for analysis, sample-shipping documents, sample logs, bench logs, laboratory data sheets, equipment maintenance logs, calibration logs, training records, crosscheck performance records, data packages, and weather measurements, in addition to other records, are all maintained as documentation of the environmental monitoring program. All records pertaining to the program are routinely reviewed and securely stored.

A Laboratory Information Management System (LIMS) is used to log samples, print labels, store and process data, track quality control samples, track samples, produce sampling and analytical worklists, and generate reports. Vendor laboratories, where possible, provide data in electronic form for direct entry into the LIMS.

Chain-of-Custody Procedures

Field data sheets, completed when samples are collected, serve as chain-of-custody records for routine samples. Samples are brought in from the field and logged at the sample receiving station, after which they are stored in a sample lock-up before analysis or shipping.

Samples sent to other laboratories for analysis are accompanied by a chain-of-custody/analytical request form. Signature control must be maintained by the agent transporting the samples. Vendor laboratories are required by contract to maintain internal chain-of-custody records and to store the samples under secure conditions.

Audits and Appraisals

During 1993 NYSDEC conducted a comprehensive groundwater monitoring evaluation and the NRC conducted an extensive audit of the WVDP radiological monitoring program. While formal reports have not yet been issued, preliminary results do not indicate any significant findings. (See *Environmental Compliance Summary: Calendar Year 1993.*)

Self-Assessments

Four routine quarterly internal appraisals (self-assessments) of the environmental monitoring program and the Environmental Laboratory were conducted in 1993.

During the course of these appraisals, thirteen findings requiring corrective action and fourteen observations requiring preventive action were identified. In general, findings and observations were largely due to lapses in documentation or to transfer of responsibilities for components of the program when environmental monitoring and laboratory functions were reorganized in 1993. These deficiencies have been or are being addressed through formal corrective action procedures. In addition, several comments regarding possible program improvements were noted and several commendable practices were identified.

Along with the findings and observations, nothing was found during the course of the self-assessments that would compromise data in this report or in the program in general.

Data Management and Data Validation

Information on environmental monitoring program samples is maintained and tracked in the LIMS and includes collection, chain-of-custody transfer, shipping information, analytical results, and final validation status.

All analytical data produced in the Environmental Laboratory at the bench level must be reviewed and signed off by a qualified person other than the one who performed the analysis. A similar in-house review is contractually required from vendor laboratories.

All software used to generate data is subjected to a verification procedure before use.

All data, from both on- and off-site laboratories, is formally validated by the data validation group. As part of the validation procedure, quality control samples analyzed in conjunction with the sample calculations are checked. After validation is complete and transcription between hardcopy and the LIMS is verified, the sample result is formally approved and released for use in reports.

The data are then evaluated and reports are prepared. Before each technical report can be issued it must undergo a peer review in which the document, including the data, is comprehensively reviewed by one or more persons who are thoroughly grounded in the necessary field of work.

The multiple levels of scrutiny built into data generation, validation, and reporting ensure that reliable and accurate data are reported from the environmental monitoring program.

Data Reporting

Radiological measurements require that analytical or instrumental background counts be subtracted from sample counts to obtain net values. Therefore, sometimes a result will be lower than the minimum detection limit of an analytical technique. Consequently, individual sample measurements can result in values of zero and negative numbers.

Although a negative value does not represent a physical reality, a valid long-term average of many measurements can be obtained only if the very small and negative values are included in the population calculations.

For individual measurements, uncertainties are reported as two times the standard deviation, which represents a 95% confidence interval around the measurement. Means for which the 95% confidence interval does not include zero may be assumed to indicate detectable amounts of activity.

The calculation of averages from measurements from a particular sampling location is straightforward by taking a simple arithmetic mean. What is not so clear, even as a professional consensus, is how to represent the uncertainty associated with an average from data collected from a given sample point throughout a set period of time, such as weekly samples collected over a year.

One method in use by other facilities is to represent an average of a set of samples by using an arithmetic mean of the central values and then using the standard error of the mean to represent the range of variation in the sample values alone. This method does not consider the relative value of the uncertainties associated with the measurements.

Thus, in situations where the analytical results of a group of samples are near the minimum detectable concentration and may all include zero within their confidence interval, the 95% confidence interval for the mean may not include zero; therefore, the average may appear to be statistically greater than zero even though it is doubtful that any individual sample contained detectable radioactivity.

In this report we have opted to express the confidence interval of the average of repeated independent samples collected at a sample location periodically over the year by pooling the error terms from the individual measurements going into the average, given that the standard deviations of the samples are relatively comparable. In this manner, we are expressing a reasonable and representative estimate of the uncertainty term for the (annual, monthly) average value, as follows:

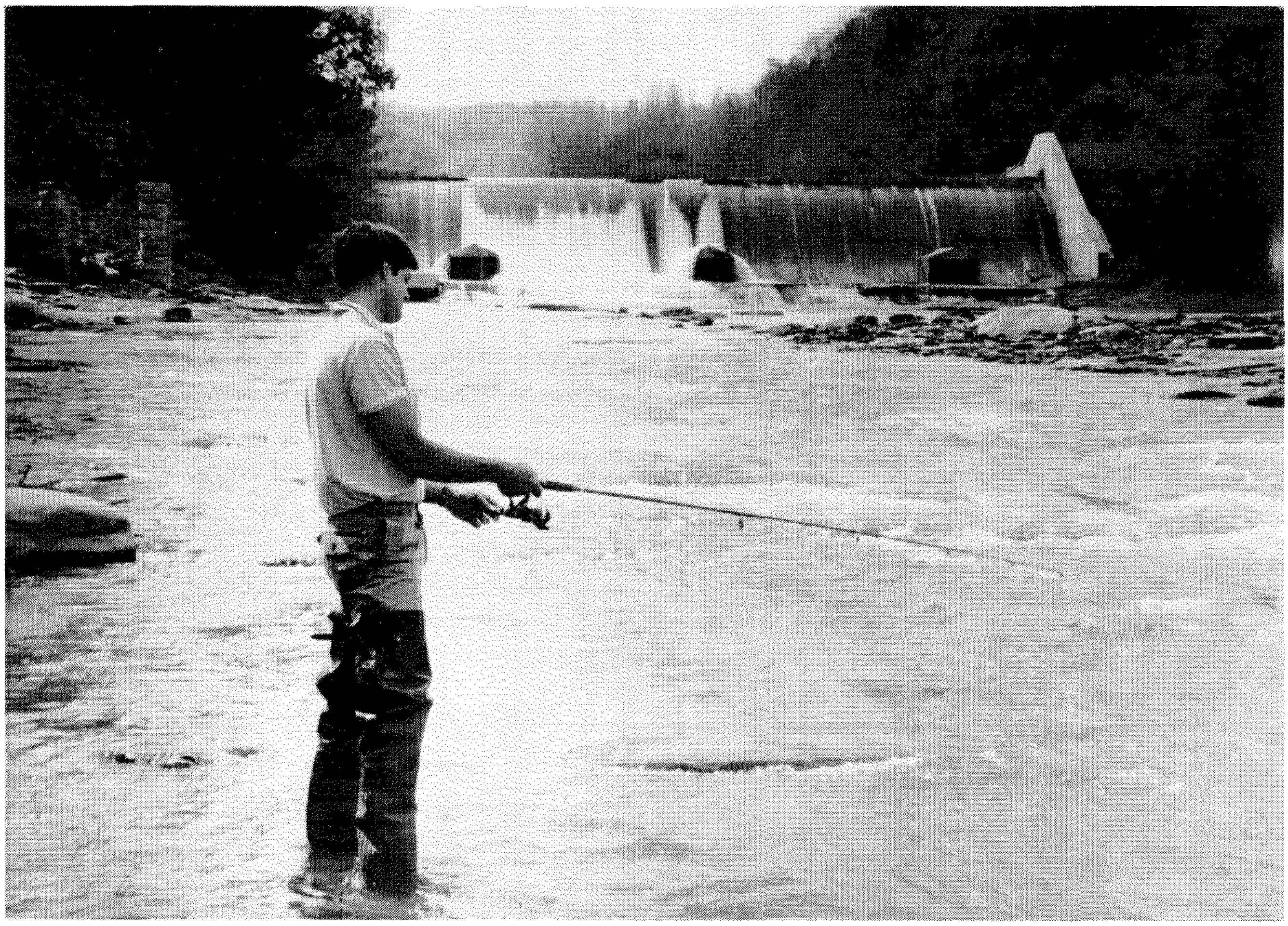
$$e_m = \frac{\sqrt{e_1^2 + e_2^2 + \ldots + e_n^2}}{\sqrt{n}}$$

where e_1 through e_n represent the confidence interval or error terms for each of n measurements, and e_m equals the confidence interval for the mean.

In previous years samples for which the confidence interval was larger than the result were reported with "less than" values. This year, to allow the readers to perform similar calculations with data groups, as has been the past practice of the report preparers, the actual calculated value, whether positive, negative, or zero, is being reported. The associated confidence interval will be expressed as e_m, above.

Appendix A

1993 Environmental Monitoring Program



Environmental Sampling — an Art as well as a Science

1993 Environmental Monitoring Program

The following schedule represents the West Valley Demonstration Project's routine environmental monitoring program for 1993. This schedule meets or exceeds the minimum program needed to satisfy the requirements of DOE Order 5400.1. It also meets requirements of DOE 5400.5 and DOE/EH-0173T. Specific methods and recommended monitoring program elements are found in DOE/EP-0096, *Effluent Monitoring,* and DOE/EP-0023, *Environmental Surveillance*, which are the bases for selecting most of the schedule specifics. Additional monitoring is mandated by operational safety requirements (OSRs) and air and water discharge permits (40 CFR 61 and SPDES), which also require formal reports. Specific requirements are identified in the schedule under MONITORING/REPORTING REQUIREMENTS.

Schedule of Environmental Sampling

The following table is a schedule of environmental sampling at the West Valley Demonstration Project. Locations of the sampling points are shown in Figures A-1 through A-9. The index below is a list of the codes for various sample locations. Table headings in the schedule are as follows:

- ***Sample Location Code.*** The physical location where the sample is collected is described. The code consists of seven characters. The first character identifies the sample medium as **A**ir, **W**ater, **S**oil/Sediment, **B**iological, or **D**irect Measurement. The second character specifies o**N**-site or o**F**f-site. The remaining characters describe the specific location (e.g., **AFGRVAL** is **A**ir o**F**f-site at **GR**eat **VAL**ley).

- ***Monitoring/Reporting Requirements.*** The bases for monitoring that location and any additional references to permits or OSRs are noted, as are the reports generated from sample data.

- ***Sampling Type/Medium.*** This describes the collection method and the physical characteristics of the medium.

- ***Collection Frequency.*** This indicates how often the samples are collected or retrieved.

- ***Total Annual Sample Collections.*** The number of discrete physical samples collected annually for each group of analytes.

- ***Analyses Performed/Composite Frequency.*** Parameters analyzed for the samples taken at each collection event, plus the frequency of composite and parameters analyzed for the composite samples.

Summary of Monitoring Program Changes in 1993

Location Code	*Description of Changes*
WNSWAMP	An automated sampler was to be installed at this site in 1993; this is now projected for 1994. Sample frequency is being upgraded from monthly to weekly and analytes are being added.
ANLLWTV **ANLAUNV**	On-site effluent ventilation monitoring points were upgraded in 1993 at the low-level waste treatment and contaminated clothing laundry exhausts. Inclusion in the routine monitoring program is projected for 1994.
ANLAGAM **ANNDAAM**	Installations for on-site monitoring of ambient air near the lag storage area and the NDA, possible "diffuse sources," were begun.
WNNDATR	Groundwater sample site added for routine monitoring of the NDA trench interceptor project.
All **SSWMU** **Monitoring** **Wells**	Sampling frequency and parameters monitored have been changed to reflect completion of the 1991 and 1992 sampling program. This included reducing the frequency of sampling for VOCs to quarterly at selected on-site wells showing historical VOC contamination. Remaining on-site wells are sampled for VOCs annually. Drinking water parameters were monitored for the required one-year duration and have been dropped from the routine program. Sampling for individual SSWMUs is subject to change to address specific concerns arising from ongoing RFI evaluations. Changes will be reflected in annual updates to Appendix A. Designations of "upgradient," "crossgradient," and "downgradient" have been changed for some wells upon further hydrogeological analysis for RFI purposes.
WNSDADR	Added surface water runoff analysis from SDA trench 14 membrane cover project for compliance with SPDES.
WNW0910	Non-RCRA well installed in 1992 downgradient of the NDA. Samples from this well were added to the routine monitoring program in 1993.
WNNDADR	Added TOC and TOX to routine monitoring requirements.
Well Points	Sampling of well points added for annual monitoring for radiological parameters.
WNCOOLW **WNDMPNE** **WNDNKEL** **WNERB53** **WNFRC67** **WNSP005** **WNSP008** **WNSW74** **WNSWAMP**	Sites added to Monthly Environmental Monitoring Trend Report in November 1993.

Index of Environmental Monitoring Program Sample Points

** Not detailed on map.*

On-site Groundwater and Seeps (Fig. A-3) (continued) **Page**

** Not detailed on map. ** **ANRGFOP** is located at the site meteorological tower. Other fallout samples are taken at off-site ambient air collection locations as are the SF Soil Series samples. *** Taken at corresponding off-site ambient air sampler locations.*

Index of Environmental Monitoring Program Sample Points
(concluded)

1993 MONITORING PROGRAM
ON-SITE EFFLUENT MONITORING:

AIR EFFLUENTS

Sample Location Code	Monitoring/Reporting Requirements	Sampling Type/Medium	Collection Frequency	Total Annual Sample Collections	Analyses Performed/ Composite Frequency
ANSTACK Main Plant Ventilation Exhaust Stack **ANSTSTK** Supernatant Treatment System (STS) Ventilation Exhaust **ANCSSTK** Cement Solidification System (CSS) Ventilation Exhaust **ANCSRFK** Contact Size-reduction Facility Exhaust	Airborne radioactive effluent points including LWTS and vitrification off-gas Required by: • OSR-GP-1 • 40 CFR 61 Reported in: • Monthly Environmental Monitoring Trend Report • Annual Effluent and On-site Discharge Report • Annual Site Environmental Report • Air Emissions Annual Report (NESHAP)	Continuous off-line air particulate monitors →	Continuous measurement of fixed filter, replaced weekly →	N/A →	Real-time alpha and beta monitoring
		Continuous off-line air particulate filters →	Weekly →	52 each location →	Gross alpha/beta, gamma isotopic*
				Weekly filters composited to 4 each location →	Quarterly composite for Sr-90, Pu/U isotopic, Total U, Am-241, gamma isotopic
		Continuous off-line desiccant columns for water vapor collection →	Weekly →	52 each of two locations →	H-3 (**ANSTACK** and **ANSTSTK** only)
		Continuous off-line charcoal cartridges →	Weekly →	Weekly cartridges composited to 4 each location →	Quarterly composite for I-129

* Weekly gamma isotopic only if gross activity rises significantly.

1993 MONITORING PROGRAM
ON-SITE EFFLUENT MONITORING:

AIR EFFLUENTS

Sampling Rationale

ANSTACK DOE/EH-0173T, 3.0; OSR-GP-1, 1.A, 2.B; and DOE/EP-0096, 3.3.

Monitors and samples HEPA-filtered ventilation from most process areas, including cell ventilation, vessel off-gas, FRS and head end ventilation, analytical area.

ANSTSTK DOE/EH-1073T, 3.0; OSR-GP-1, 1.B, 2.B; and DOE/EP-0096, 3.3.

Monitors and samples HEPA-filtered ventilation from building areas involved in treatment of high-level waste supernatant.

ANCSSTK DOE/EH-0173T, 3.0; OSR-GP-1, 1.B, 2.B; and DOE/EP-0096, 3.3.

Monitors and samples HEPA-filtered ventilation from process areas and cell used for decontaminated high-level radioactive supernatant solidification with cement.

ANCSRFK DOE/EH-0173T, 3.0; OSR-GP-1, 1.B, 2.B; and DOE/EP-0096, 3.3.

Monitors and samples HEPA-filtered ventilation from process area where radioactive tanks, pipes, and other equipment are reduced in volume by cutting with a plasma torch.

1993 MONITORING PROGRAM
ON-SITE EFFLUENT MONITORING:

AIR EFFLUENTS

Sample Location Code	Monitoring/Reporting Requirements	Sampling Type/Medium	Collection Frequency	Total Annual Sample Collections	Analyses Performed/ Composite Frequency
ANSUPCV Supercompactor Exhaust	Airborne radioactive effluent point Required by: • OSR-GP-1 • 40 CFR 61 Reported in: • Monthly Environmental Monitoring Trend Report • Annual Effluent and On-site Discharge Report • Annual Site Environmental Report • Air Emissions Annual Report (NESHAP)	Continuous off-line air particulate monitor during operation →	Continuous measurement of fixed filter →	N/A →	Real-time beta monitoring
		Continuous off-line air particulate filter →	Weekly →	52 →	Filters for gross alpha/beta, gamma isotopic* upon collection
				Collected filters composited to 4 →	Quarterly composites for Sr-90, Pu/U isotopic, Total U, Am-241, gamma isotopic
ANLLWTV** Low-level Waste Treatment Ventilation **ANLAUNV**** Contaminant Clothing Laundry Ventilation	Airborne radioactive effluent points Required by: • OSR-GP-1 • 40 CFR 61 Reported in: • Monthly Environmental Monitoring Trend Report • Annual Effluent and On-site Discharge Report • Annual Site Environmental Report • Air Emissions Annual Report (NESHAP)	Continuous off-line air particulate filters →	Weekly →	52 each location →	Filters for gross alpha/beta
		→	Semiannual assessment for NESHAP parameters		

* Weekly gamma isotopic only if gross activity rises significantly. ** Although new equipment was installed in 1993, only the existing systems were operated during 1993.

1993 MONITORING PROGRAM
ON-SITE EFFLUENT MONITORING:

AIR EFFLUENTS

	Sampling Rationale
ANSUPCV	DOE/EH-0173T, 3.0; OSR-GP-1, 1.B, 2.B; and DOE/EP-0096, 3.3. Monitors and samples HEPA-filtered ventilation from area where low-level radioactive waste volume is reduced by compaction.
ANLLWTV	DOE/EH-0173T, 3.0; OSR-GP-1, 1.B, 2.B; and DOE/EP-0096, 3.3. Samples ventilation from low-level waste treatment facility.
ANLAUNV	DOE/EH-0173T, 3.0; OSR-GP-1, 1.B, 2.B; and DOE/EP-0096, 3.3. Samples ventilation from contaminated clothing laundry.

1993 MONITORING PROGRAM
ENVIRONMENTAL SURVEILLANCE:

ON-SITE AMBIENT AIR

Sample Location Code	Monitoring/Reporting Requirements	Sampling Type/Medium	Collection Frequency	Total Annual Sample Collections	Analyses Performed/ Composite Frequency
ANLAGAM Lag Storage Area Ambient Air **ANNDAAM** NDA Area Ambient Air	Possible "diffuse source" of air emissions* Reported in: • Annual Site Environmental Report	Continuous air particulate filter	→ Weekly	→ 52 each location	→ Gross alpha/beta
				Weekly filter composited to 4 each location	→ Quarterly composite for Sr-90, gamma isotopic, Pu/U isotopic, Total U, Am-241

* Although installation began in 1993, these monitors were not brought on-line during the year. Addition to the monitoring program is projected 1994.

ON-SITE AMBIENT AIR

Sampling Rationale

ANLAGAM DOE/EH-0173T, 3.3.2.

Monitors ambient air in lag storage area, a possible "diffuse source" of air emissions.

ANNDAAM DOE/EH-0173T, 3.3.2.

Monitors ambient air in NDA area, a possible "diffuse source" of air emissions.

1993 MONITORING PROGRAM
ON-SITE EFFLUENT MONITORING:

LIQUID EFFLUENTS

Sample Location Code	Monitoring/Reporting Requirements	Sampling Type/Medium	Collection Frequency	Total Annual Sample Collections	Analyses Performed/ Composite Frequency
WNSP001 Lagoon 3 Discharge Weir	Primary point of liquid effluent batch release Required by: • OSR-GP-2 • SPDES Permit Reported in: • Monthly SPDES DMR • Annual Effluent and On-site Discharge Report • Annual Site Environmental Report • Monthly Environmental Monitoring Trend Report (months when lagoon is discharged)	Grab liquid	→ Daily, during lagoon 3 discharge*	→ 40-80	→ Daily for gross beta, conductivity, pH, flow
				7-12	→ Every 6 days a sample is analyzed for gross alpha/beta, H-3, Sr-90, gamma isotopic
				Daily samples composited to 4-8	→ Weighted monthly composite for gross alpha/beta, H-3, C-14, Tc-99, Sr-90, I-129, gamma isotopic, Pu/U isotopic, Total U, Am-241
		Composite liquid	→ Twice during discharge, near start and near end	→ 8-16	→ Two 24-hour composites for Al, NH_3, As, BOD-5, Fe, Zn, pH, suspended solids, SO_4, NO_3, NO_2, Cr^{+6}, Cd, Cu, Pb, Ni
		Grab liquid	→ Twice during discharge, near start and near end	→ 8-16	→ Settleable solids, pH, cyanide amenable to chlorination, oil and grease, dichlorodifluoromethane, trichlorofluoromethane, 3,3-dichlorobenzidine, tributyl phosphate, vanadium
		Composite liquid	→ Annually	→ 1	→ Annually, a 24-hour composite for: Cr, Se, Ba, Sb
		Grab liquid	→ Annually	→ 1	→ Chloroform
		Grab liquid	→ Semiannually	→ 2	→ Bis(2-ethylhexyl) phthalate, 4-dodecene

* Lagoon 3 is discharged between four and eight times per year, as necessary, averaging ten days per discharge.

1993 MONITORING PROGRAM
ON-SITE EFFLUENT MONITORING:

LIQUID EFFLUENTS

Sampling Rationale

WNSP001 DOE 5400.5 and DOE/EH-0173T, 2.3.3.

By DOE Order all liquid effluent streams from DOE facilities shall be evaluated and their potential for release of radionuclides addressed.

New York State SPDES permit no. NY0000973.

These regulations for radiological parameters are met by daily grab-sampling during periods of lagoon 3 discharge. Sampling for chemical constituents is performed near the beginning and end of discharge periods to meet the site SPDES permit. Both grab samples and 24-hour composite samples are collected.

1993 MONITORING PROGRAM
ON-SITE EFFLUENT MONITORING:

LIQUID EFFLUENTS

Sample Location Code	Monitoring/Reporting Requirements	Sampling Type/Medium	Collection Frequency	Total Annual Sample Collections	Analyses Performed/ Composite Frequency
WNSP006 Frank's Creek at security fence	Combined facility liquid discharge Required by: • OSR-GP-2 Reported in: • Monthly Environmental Monitoring Trend Report • Annual Site Environmental Report	Timed continuous composite liquid	→ Weekly	→ 52	→ Gross alpha/beta, H-3, pH, conductivity
				Weekly samples composited to 12	→ Monthly composite for gamma isotopic and Sr-90 (monthly composite sent to NYSDOH)
				Weekly samples composited to 4	→ Quarterly composite for C-14, I-129, Pu/U isotopic, Total U, Am-241
		Grab liquid	→ Semiannually	→ 2	→ NPOC, TOX, Ca, Mg, Na, K, Ba, Mn, Fe, Cl, SO_4, NO_3+NO_2-N, F, HCO_3, CO_3
WNSP007 Sanitary Waste Discharge	Liquid effluent point for sanitary and utility plant combined discharge Required by: • SPDES Permit Reported in: • Monthly SPDES DMR • Monthly Environmental Monitoring Trend Report • Annual Effluent and On-site Discharge Report • Annual Site Environmental Report	24-hour composite liquid	→ 3 each month	→ 36	→ Gross alpha/beta, H-3, suspended solids, NH_3, BOD-5, Fe
				3 samples each month composited to 12	→ Sr-90, gamma scan
		Grab liquid	→ Weekly	→ 52	→ pH, settleable solids
		Grab liquid	→ Annually	→ 1	→ Chloroform
WNSTPBS Sanitary Waste Sludge	Operational STP Monitoring	Grab sludge	→ On demand (at least monthly)	→ 12	→ Gross alpha/beta, H-3
WNSDADR SDA Trench 14 Cover Runoff	Surface water runoff point from SDA trench 14 cover Required by: • Interim Measures Compliance Reported in: • Quarterly reports to DEC	Grab liquid	→ Monthly	→ 12	→ pH, TSS, oil & grease, flow, gross alpha/beta, H-3, gamma isotopic
				Monthly samples composited to 4	→ Quarterly composite for Sr-90, I-129

1993 MONITORING PROGRAM
ON-SITE EFFLUENT MONITORING:

LIQUID EFFLUENTS

Sampling Rationale

WNSP006 DOE/EH-0173T, 5.10.1.1.

By DOE Order all liquid effluent streams from DOE facilities shall be evaluated and their potential for release of radionuclides addressed.

WNSP007 DOE 5400.5 and DOE/EH-0173T, 2.3.3.

Sampling rationale is based on New York State SPDES permit no. NY0000973 and DOE 5400.5 criteria for discharge of radioactivity to and from the sewage treatment plant.

WNSTPBS DOE 5400.5.

Composite of STP surge tank, sludge holding tank, and clarifier sludge analyzed for operational screening.

WNSDADR NYSERDA interim measures compliance.

WVDP support of NYSERDA.

Grab sample monitoring surface water runoff from SDA trench 14 membrane cover.

1993 MONITORING PROGRAM
ENVIRONMENTAL SURVEILLANCE:

ON-SITE SURFACE WATER

Sample Location Code	Monitoring/Reporting Requirements	Sampling Type/Medium	Collection Frequency	Total Annual Sample Collections	Analyses Performed/ Composite Frequency
WNSWAMP N.E. Swamp Drainage	Site surface drainage Reported in: • Annual Effluent and On-site Discharge Report • Monthly Environmental Monitoring Trend Report	Grab liquid	→ Weekly*	→ 52	→ Gross alpha/beta, H-3, pH, conductivity
				Weekly samples composited to 12	→ Monthly composite for gamma isotopic, Sr-90
				Weekly samples composited to 4	→ Quarterly composite for C-14, I-129, Pu/U isotopic, Total U, Am-241
		Grab liquid	→ Semiannually	→ 2	→ NPOC, TOX, Ca, Mg, Na, K, Ba, Mn, Fe, Cl, SO_4, NO_3+NO_2-N, F, HCO_3, CO_3
WNSW74A North Swamp Drainage	Site surface drainage Reported in: • Annual Effluent and On-site Discharge Report • Monthly Environmental Monitoring Trend Report	Timed continuous composite liquid	→ Weekly	→ 52	→ Gross alpha/beta, H-3, pH, conductivity
				Weekly samples composited to 12	→ Monthly composite for gamma isotopic, Sr-90
				Weekly samples composited to 4	→ Quarterly composite for C-14, I-129, Pu/U isotopic, Total U, Am-241
		Grab liquid	→ Semiannually	→ 2	→ NPOC, TOX, Ca, Mg, Na, K, Ba, Mn, Fe, Cl, SO_4, NO_3+NO_2-N, F, HCO_3, CO_3
WN8D1DR High-level Waste Farm Underdrain	Drains subsurface water from HLW storage tank area Reported in: • Monthly Environmental Monitoring Trend Report	Grab liquid	→ Weekly	→ 52	→ Gross alpha/beta, H-3, pH
				Weekly samples composited to 12	→ Monthly composite for gamma isotopic, Sr-90

* Sample collected simultaneously for NYSDOH.

ON-SITE SURFACE WATER

Sampling Rationale

WNSWAMP DOE/EH-0173T, 5.10.1.1.

NE site surface water drainage; provides for the sampling of this discrete drainage path for uncontrolled surface waters just before they leave the site's controlled boundary. Waters collected represent surface and subsurface drainages from the construction and demolition debris landfill (CDDL), old hardstand areas, and other possible north plateau sources of radiological or nonradiological contamination.

WNSW74A DOE/EH-0173T, 5.10.1.1.

N site surface water drainage; provides for the sampling of this discrete drainage path for uncontrolled surface waters just before they leave the site's controlled boundary. Waters collected represent surface and subsurface drainages from lag storage areas and other possible north plateau sources of radiological or nonradiological contamination.

WN8D1DR DOE/EH-0173T, 5.10.1.3.

Monitors the potential influence on subsurface drainage surrounding the high-level waste tank farm.

1993 MONITORING PROGRAM
ENVIRONMENTAL SURVEILLANCE:

ON-SITE SURFACE WATER

Sample Location Code	Monitoring/Reporting Requirements	Sampling Type/Medium	Collection Frequency	Total Annual Sample Collections	Analyses Performed/ Composite Frequency
WNSP008 French Drain	Drains subsurface water from LLWT lagoon area Required by: • SPDES Permit Reported in: • Monthly SPDES DMR • Annual Effluent and On-site Discharge Report • Annual Site Environmental Report • Monthly Environmental Monitoring Trend Report	Grab liquid	→ 3 each month	→ 36	→ pH, conductivity, BOD-5, Fe
		Grab liquid	→ Monthly	→ 12	→ Gross alpha/beta, H-3
		Grab liquid	→ Annually	→ 1	→ Ag, Zn
WNSP005 Facility Yard Drainage	Combined drainage from facility yard area. Reported in: • Internal Review • Monthly Environmental Monitoring Trend Report	Grab liquid	→ Monthly	→ 12	→ Gross alpha/beta, H-3, pH
WNCOOLW Cooling Tower Basin	Cools plant utility steam system water Reported in: • Internal Review • Monthly Environmental Monitoring Trend Report	Grab liquid	→ Monthly	→ 12	→ Gross alpha/beta, H-3, pH

1993 MONITORING PROGRAM
ENVIRONMENTAL SURVEILLANCE:

ON-SITE SURFACE WATER

Sampling Rationale

WNSP008 DOE/EH-0173T, 5.10.1.3.

French drain of subsurface water from lagoon (LLWTF) area. NYSDEC SPDES permit also provides for the sampling of this discrete drainage path for uncontrolled subsurface waters before they flow into Erdman Brook. Waters collected represent subsurface drainages from downward infiltration around the LLWTF and lagoon systems. This point would also monitor any subsurface spillover from the overfilling of lagoons 2 and 3. Sampling of significance for both radiological and nonradiological contamination.

This site is also monitored as part of the groundwater program. (See SSWMU #1.)

WNSP005 Facility yard surface water drainage; generally in accordance with DOE/EH-0173T, 5.10.1.1. Formerly in accordance with NYSDEC SPDES permit no. NY0000973.

Provides for the sampling of this discrete drainage path for uncontrolled surface waters just after outfall 007 discharge into the drainage and before they flow to Erdman Brook. Waters collected represent surface and subsurface drainages primarily from the main plant yard area. Historically this point was used to monitor sludge pond(s) and utility room discharges to the drainage. These two sources have been rerouted. Migration of residual site contamination around the main plant dictates surveillance of this point for radiological parameters primarily.

WNCOOLW Facility cooling tower circulation water; generally in accordance with DOE/EH-0173T, 5.10.1.1.

Operational sampling carried out to confirm no migration of radiological contamination into the primary coolant loop of the HLWTF and/or plant utility steam systems. Migration from either source might indicate radiological control failure. Process knowledge indicates that radiological monitoring is of primary significance.

1993 MONITORING PROGRAM
ENVIRONMENTAL SURVEILLANCE:

ON-SITE SURFACE WATER

Sample Location Code	Monitoring/Reporting Requirements	Sampling Type/Medium	Collection Frequency	Total Annual Sample Collections	Analyses Performed/ Composite Frequency
WNFRC67 Frank's Creek E of SDA	Drains NYS Low-level Waste Disposal Area Reported in: • Internal Review • NYSERDA • Monthly Environmental Monitoring Trend Report	Grab liquid	→ Monthly	→ 12	→ Gross alpha/beta, H-3, pH
WNERB53 Erdman Brook N of disposal areas	Drains NYS and WVDP disposal areas Reported in: • Internal Review • NYSERDA • Monthly Environmental Monitoring Trend Report	Grab liquid	→ Weekly	→ 52	→ Gross alpha/beta, H-3, pH
WNNDADR Drainage between NDA and SDA	Drains WVDP disposal and storage areas Reported in: • Internal Review • Monthly Environmental Monitoring Trend Report	Timed continuous composite liquid	→ Weekly	→ 52	→ pH
				Weekly samples composited to 12	→ Monthly composite for gross alpha/beta, gamma isotopic, H-3
				Weekly samples composited to 4	→ Quarterly composite for Sr-90, I-129
		Grab liquid	→ Weekly	→ 52	→ NPOC, TOX
WNDCELD Drainage S of Drum Cell	Drains WVDP storage area Reported in: • Internal Review	Grab liquid	→ Monthly	→ 12	→ pH, gross alpha/beta, gamma isotopic, H-3
				Monthly samples composited to 4	→ Quarterly composite for Sr-90, I-129
WNNDATR* Trench Interceptor Project	On-site groundwater interception Reported in: • Annual Site Environmental Report	Grab liquid	→ Monthly	→ 12	→ Gross alpha/beta, H-3, gamma isotopic, NPOC, TOX
				Monthly samples composited to 4	→ I-129

* Coordinated with Waste Management Operations.

ON-SITE SURFACE WATER

Sampling Rationale

WNFRC67 DOE/EH-0173T, 5.10.1.1.

Monitoring the potential influence of both the New York State low-level waste disposal area (SDA) and drum cell drainage into Frank's Creek east of the SDA and upstream of the confluence with Erdman Brook.

WNERB53 DOE/EH-0173T, 5.10.1.1.

Monitors the potential influence of the drainages from the SDA and the WVDP disposal area into Erdman Brook upstream of the confluence with Frank's Creek.

WNNDADR DOE/EH-0173T, 5.10.1.1.

Monitors the potential influence of the WVDP storage and disposal area drainage into lagoon road creek upstream from confluence with Erdman Brook.

WNDCELD DOE/EH-0173T, 5.10.1.1

Monitors potential influence of drum cell drainage into Frank's Creek south of the SDA and upstream of WNFRC67.

WNNDATR DOE Order 5400.1, IV.9.

Monitors groundwater in the vicinity of the NDA interceptor trench project. The grab sample is taken directly from a sump in the trench collection system at manhole #4.

1993 MONITORING PROGRAM
ENVIRONMENTAL SURVEILLANCE:

ON-SITE POTABLE WATER

Sample Location Code	Monitoring/Reporting Requirements	Sampling Type/Medium	Collection Frequency	Total Annual Sample Collections	Analyses Performed/ Composite Frequency
WNDNK Series Site Potable Water includes: **WNDNKMS** Maintenance Shop Drinking Water **WNDNKMP** Main Plant Drinking Water	Sources of potable water within site perimeter Reported in: • Internal Review • Cattaraugus County • Monthly Environmental Monitoring Trend Report (**WNDNKEL** only)	Grab liquid	→ Monthly	→ 12 each per location	→ Gross alpha/beta, H-3, pH, conductivity
WNDNKEL Environmental Lab Drinking Water		Grab liquid	→ Annually*	→ 1 each location	→ Toxic metals, pesticides, chemical pollutants
WNDNKUR Potable Water Storage Tank (UR)		Grab liquid	→ Quarterly*	→ 4 each location	→ NO_3

* **WNDNKEL** and **WNDKUR** only.

1993 MONITORING PROGRAM
ENVIRONMENTAL SURVEILLANCE:

ON-SITE POTABLE WATER

	Sampling Rationale
WNDNK Series	Site drinking water; generally according to DOE/EH-0173T, 5.10.1.3. Potable water sampling carried out to confirm no migration of radiological and/or nonradiological contamination into the site's drinking water supply.
WNDNKMS	Site drinking water; generally according to DOE/EH-0173T, 5.10.1.3. Potable water sampled at the maintenance shop in order to monitor a point that is at an intermediate distance from the point of potable water generation and that is used heavily by site personnel.
WNDNKMP	Site drinking water; generally according to DOE/EH-0173T, 5.10.1.3. Same rationale as WNDNKMS but sampled at the main plant water fountain.
WNDNKEL	Site drinking water; generally according to DOE/EH-0173T, 5.10.1.3. Potable water sampled at the Environmental Laboratory in order to monitor the point farthest away from the point of potable water generation.
WNDNKUR	Site drinking water; generally according to DOE/EH-0173T, 5.10.1.3. Sampled at the utility room so as to monitor the point closest to the point of potable water generation.

1993 MONITORING PROGRAM
ENVIRONMENTAL SURVEILLANCE:

SURFACE WATER

Sample Location Code	Monitoring/Reporting Requirements	Sampling Type/Medium	Collection Frequency	Total Annual Sample Collections	Analyses Performed/ Composite Frequency
WNSTAW Series On-site standing water ponds not receiving effluent includes: **WNSTAW4** Border pond SW of AFRT240 **WNSTAW5** Border pond SW of DFTLD13 **WNSTAW6** Borrow pit NE of Project facilities **WNSTAW9** North reservoir near intake **WNSTAWB** Background pond at Sprague Brook maintenance building	Water within vicinity of plant airborne or water effluent Reported in: • Internal Review	Grab liquid →	Annually →	1* each location →	Gross alpha/beta, H-3, pH, conductivity, chloride, Fe, Mn, Na, NO_3+NO_2-N, SO_4

* Sampling depends upon on-site ponding conditions during the year.

1993 MONITORING PROGRAM
ENVIRONMENTAL SURVEILLANCE:

SURFACE WATER

Sampling Rationale

WNSTAW Series	DOE/EH-0173T, 5.10.1.1. Monitoring of on- and off-site standing waters at locations listed below. Although none receive effluent directly, the potential for contamination is present except at the background location. Former collecting sites 1, 2, 3, 7, and 8 were deleted from the monitoring program because they were built over or are now dry.
WNSTAW4	Border pond located south of AFRT240. Chosen to be a location for obtaining high potential concentration based on meteorological data. Perimeter location adjacent to a working farm. Drainage extends through private property and is accessible to public.
WNSTAW5	Border pond located west of Project facilities near the perimeter fence and DFTLD13. Chosen to be a location for obtaining high potential concentration based on meteorological data. Location is adjacent to private residence and potentially accessible by the general public.
WNSTAW6	Borrow pit northeast of Project facilities just outside of inner security fence. Considered to be the closest standing water to the main plant and high-level waste facilities (in lieu of the availability of WNSTAW1).
WNSTAW9	North reservoir near intake. Chosen to provide data in the event of potentially contaminated site potable water supply. Location is south of main plant facilities.
WNSTAWB	Pond located near the Sprague Brook maintenance building. Considered a background location; approximately 14 kilometers north of the WVDP.

1993 MONITORING PROGRAM
ENVIRONMENTAL SURVEILLANCE:

ON-SITE GROUNDWATER

Sample Location Code	Monitoring/Reporting Requirements	Sampling Type/Medium	Collection Frequency	Total Annual Sample Collections	Analyses Performed/ Composite Frequency
Low-level Waste Treatment Facilities (SSWMU #1)	Groundwater monitoring wells around site super solid waste management units (SSWMUs)	Grab liquid	→ Quarterly	→ 4 each well	→ Gross alpha/beta, H-3, gamma isotopic, NPOC, TOX, VOA*
WNW **0103 U** **0104 U** **0105** **0106**	Reported in: • Annual Site Environmental Report	Direct measurement of sample discharge water	→ Before and after grab sample collection	→ 8 each well	→ Temperature, pH, conductivity
0107 **0108** **0109** **0110** **0111**	• RFI Reports	Grab liquid	→ Semiannually	→ 2 each well	→ Cl, Mn, Na, K, Ca, Mg, Fe, SO_4, NH_3, NO_3+NO_2-N, HCO_3, CO_3, Al, PO_4, Si, sulfide
0114 **0115 U** **0116 U** **8603** **8604 U** **8605**		Grab liquid	→ Annually	→ 1 each well**	→ Isotopic characterization, chemical characterization, VOA
Surface: **WNSP008**					
Miscellaneous Small Units (SSWMU #2)					
WNW **0201 U** **0202 U** **0203** **0204 U** **0205** **0206** **0207** **0208** **8606**					

NOTE: "U" designates upgradient, "B" designates background, and "C" designates crossgradient wells; the remainder are downgradient.

* VOA samples collected quarterly only at wells with positive detections (above or below detection limits) in 1991 and 1992 sampling program and selected downgradient wells.

** Samples for isotopic or chemical characterization collected only if well has shown concentrations above those of background wells. VOAs collected annually from all remaining wells.

1993 MONITORING PROGRAM
ENVIRONMENTAL SURVEILLANCE:

ON-SITE GROUNDWATER

Sampling Rationale

On-site Groundwater	DOE Order 5400.1, IV.9; DOE/EH-0173T, 5.10.1.3; 40 CFR Parts 264 and 265, Subpart F. The on-site WVDP groundwater monitoring program focuses on radiological and chemical surveillance of both active and inactive super solid waste management units (SSWMUs). The program allows for the determination of water quality. In addition, using wells situated hydraulically upgradient (background) and downgradient of SSWMUs allows for both detection of groundwater contamination and evaluation of the effects associated with the individual SSWMUs. The groundwater monitoring program is covered in the "Sampling and Analysis Plan (SAP) Groundwater Monitoring Network," Draft W, October 1990, in the annual Site Groundwater Protection Management Program Plan, WVDP-091, and in the 1991 RFI Work Plan.
SSWMU #1	Low-level waste treatment facilities, including four active lagoons — lagoons 2, 3, 4, and 5 — and an inactive, filled-in lagoon, lagoon 1.
SSWMU #2	Miscellaneous small units, including the sludge pond, the solvent dike, the paper incinerator, and the kerosene tank.

1993 MONITORING PROGRAM
ENVIRONMENTAL SURVEILLANCE:

ON-SITE GROUNDWATER

Sample Location Code	Monitoring/Reporting Requirements	Sampling Type/Medium	Collection Frequency	Total Annual Sample Collections	Analyses Performed/ Composite Frequency
Liquid Waste Treatment System (SSWMU #3) **WNW** **0301** U **0302** U **0305** xx**0306** **0307** **NB1S B** HLW Storage and Processing Tank (SSWMU #4) **WNW** **0401** U **0402** U **0403** U **0404** U **0405** **0406** **0407** **0408** **0409** xx**0410** U xx**0411** U **8607** **8608** **8609**	Groundwater monitoring wells around site super solid waste management units (SSWMUs) Reported in: • Annual Site Environmental Report • RFI Reports	Grab liquid	→ Quarterly	→ 4 each well	→ Gross alpha/beta, H-3, gamma isotopic, NPOC, TOX, VOA*
		Direct measurement of sample discharge water	→ Before and after grab sample collection	→ 8 each well	→ Temperature, pH, conductivity
		Grab liquid	→ Semiannually	→ 2 each well	→ Cl, Mn, Na, K, Ca, Mg, Fe, SO_4, NH_3, NO_3+NO_2-N, HCO_3, CO_3, Al, PO_4, Si, sulfide
		Grab liquid	→ Annually	→ 1 each well**	→ Isotopic characterization, chemical characterization, VOA

NOTES: "U" designates upgradient, "B" designates background, and "C" designates crossgradient wells; the remainder are downgradient.

xx Installed wells that are dry and not used for groundwater monitoring.

* VOA samples collected quarterly only at wells with positive detections (above or below detection limits) in 1991 and 1992 sampling program and selected downgradient wells.

** Samples for isotopic or chemical characterization collected only if well has shown concentrations above those of background wells. VOAs collected annually from all remaining wells.

1993 MONITORING PROGRAM
ENVIRONMENTAL SURVEILLANCE:

ON-SITE GROUNDWATER

Sampling Rationale

On-site Groundwater	DOE Order 5400.1, IV.9; DOE/EH-0173T, 5.10.1.3; 40 CFR Parts 264 and 265, Subpart F. The on-site WVDP groundwater monitoring program focuses on radiological and chemical surveillance of both active and inactive super solid waste management units (SSWMUs). The program allows for the determination of water quality. In addition, using wells situated hydraulically upgradient (background) and downgradient of SSWMUs allows for both detection of groundwater contamination and evaluation of the effects associated with the individual SSWMUs. The groundwater monitoring program is covered in the "Sampling and Analysis Plan (SAP) Groundwater Monitoring Network," Draft W, October 1990, in the annual Site Groundwater Protection Management Program Plan, WVDP-091, and in the 1991 RFI Work Plan.
SSWMU #3	Liquid waste treatment system containing liquid effluent from the supernatant treatment system.
SSWMU #4	High-level waste storage and processing area, including the high-level radioactive waste tanks, the supernatant treatment system, and the vitrification facility.

1993 MONITORING PROGRAM
ENVIRONMENTAL SURVEILLANCE:

ON-SITE GROUNDWATER

Sample Location Code	Monitoring/Reporting Requirements	Sampling Type/Medium	Collection Frequency	Total Annual Sample Collections	Analyses Performed/ Composite Frequency
Maintenance Shop Leach Fields (SSWMU #5) **WNW** **0501** U **0502** Low-level Waste Storage Area (SSWMU #6) **WNW** **0601** **0602** **0603** U **0604** **0605** **8607** U **8608** U CPC Waste Storage Area (SSWMU #7) **WNW** **0701 U** **0702 C** **0703** **0704** **0705 C** **0706 U** **0707**	Groundwater monitoring wells around site super solid waste management units (SSWMUs) <u>Reported in</u>: • Annual Site Environmental Report • RFI Reports	Grab liquid	→ Quarterly	→ 4 each well	→ Gross alpha/beta, H-3, gamma isotopic, NPOC, TOX, VOA*
		Direct measurement of sample discharge water	→ Before and after grab sample collection	→ 8 each well	→ Temperature, pH, conductivity
		Grab liquid	→ Semiannually	→ 2 each well	→ Cl, Mn, Na, K, Mg, Ca, Fe, SO_4, NH_3, NO_3+NO_2-N, HCO_3, CO_3, Al, PO_4, Si, sulfide
		Grab liquid	→ Annually	→ 1 each well**	→ Isotopic characterization, chemical characterization, VOA

NOTES: "U" designates upgradient, "B" designates background, and "C" designates crossgradient wells; the remainder are downgradient.

* VOA samples collected quarterly only at wells with positive detections (above or below detection limits) in 1991 and 1992 sampling program and selected downgradient wells.

** Samples for isotopic or chemical characterization collected only if well has shown concentrations above those of background wells. VOAs collected annually from all remaining wells.

ON-SITE GROUNDWATER

Sampling Rationale

On-site Groundwater	DOE Order 5400.1, IV.9; DOE/EH-0173T, 5.10.1.3; 40 CFR Parts 264 and 265, Subpart F. The on-site WVDP groundwater monitoring program focuses on radiological and chemical surveillance of both active and inactive super solid waste management units (SSWMUs). The program allows for the determination of water quality. In addition, using wells situated hydraulically upgradient (background) and downgradient of SSWMUs allows for both detection of groundwater contamination and evaluation of the effects associated with the individual SSWMUs. The groundwater monitoring program is covered in the "Sampling and Analysis Plan (SAP) Groundwater Monitoring Network," Draft W, October 1990, in the annual Site Groundwater Protection Management Program Plan, WVDP-091, and in the 1991 RFI Work Plan.
SSWMU #5	Maintenance shop sanitary leach field, formerly used by NFS and WVNS to process domestic sewage generated by the maintenance shop.
SSWMU #6	Low-level waste storage area includes metal and fabric structures housing low-level radioactive wastes being stored for future disposal.
SSWMU #7	Chemical process cell (CPC) waste storage area contains packages of pipes, vessels, and debris from decontamination and cleanup of the chemical process cell in the former reprocessing plant.

1993 MONITORING PROGRAM
ENVIRONMENTAL SURVEILLANCE:

ON-SITE GROUNDWATER

Sample Location Code	Monitoring/Reporting Requirements	Sampling Type/Medium	Collection Frequency	Total Annual Sample Collections	Analyses Performed/ Composite Frequency
Construction and Demolition Debris Landfill (SSWMU #8)	Groundwater monitoring wells around site super solid waste management units (SSWMUs)	Grab liquid	→ Quarterly	→ 4 each well	→ Gross alpha/beta, H-3, gamma isotopic, NPOC, TOX, VOA*
WNW **0801** U **0802** **0803** **0804** **WNGSEEP** **WNDMPNE** **8612**	Reported in: • Annual Site Environmental Report • RFI Reports • Monthly Environmental Monitoring Trend Report (**WNDMPNE** only)	Direct measurement of sample discharge water	→ Before and after grab sample collection	→ 8 each well	→ Temperature, pH, conductivity
		Grab liquid	→ Semiannually	→ 2 each well	→ Cl, Mn, Na, K, Mg, Fe, Ca, SO_4, NH_3, NO_3+NO_2-N, HCO_3, CO_3, Al, PO_4, Si, sulfide
NRC-licensed disposal area (SSWMU #9)		Grab liquid	→ Annually	→ 1 each well**	→ Isotopic characterization, chemical characterization, VOA
WNW **0901** U **0902** U **0903** **0904** **0905** **0906** **0907** **0908** U **0909** **0910***** **8610** **8611**					
RTS Drum Cell (SSWMU #10)					
WNW **1001** U **1002** **1003** **1004** **1005** U **1006** **1007** **1008b** B **1008c** B					

NOTES: "U" designates upgradient, "B" designates background, and "C" designates crossgradient wells; the remainder are downgradient.

* VOA samples collected quarterly only at wells with positive detections (above or below detection limits) in 1991 and 1992 sampling program and selected downgradient wells.

** Samples for isotopic or chemical characterization collected only if well has shown concentrations above those of background wells. VOAs collected annually from all remaining wells.

*** Quarterly for alpha, beta, and tritium only.

1993 MONITORING PROGRAM
ENVIRONMENTAL SURVEILLANCE:

ON-SITE GROUNDWATER

Sampling Rationale

On-site Groundwater	DOE Order 5400.1, IV.9; DOE/EH-0173T, 5.10.1.3; 40 CFR Parts 264 and 265, Subpart F. The on-site WVDP groundwater monitoring program focuses on radiological and chemical surveillance of both active and inactive super solid waste management units (SSWMUs). The program allows for the determination of water quality. In addition, using wells situated hydraulically upgradient (background) and downgradient of SSWMUs allows for both detection of groundwater contamination and evaluation of the effects associated with the individual SSWMUs. The groundwater monitoring program is covered in the "Sampling and Analysis Plan (SAP) Groundwater Monitoring Network," Draft W, October 1990, and in the annual Site Groundwater Protection Management Program Plan, WVDP-091, and in the 1991 RFI Work Plan.
SSWMU #8	Construction and demolition debris landfill; used by NFS and the WVDP to dispose of nonhazardous and nonradioactive materials.
SSWMU #9	NRC-licensed disposal area (NDA); contains radioactive wastes generated by NFS and the WVDP.
SSWMU #10	Radioactive waste treatment drum cell; contains stored cement-stabilized low-level radioactive waste.

1993 MONITORING PROGRAM
ENVIRONMENTAL SURVEILLANCE:

ON-SITE GROUNDWATER

Sample Location Code	Monitoring/Reporting Requirements	Sampling Type/Medium	Collection Frequency	Total Annual Sample Collections	Analyses Performed/ Composite Frequency
State-licensed Disposal Area (SSWMU #11) **WNW** **1101a** U **1101b** U **1101c** U **1102a** **1102b** **1103a** **1103b** **1103c** **1104a** **1104b** **1104c** **1105a** **1105b** **1106a** U **1106b** U **1107a** **1108a** U **1109a** U **1109b** U **1110a** **1111a** Fuel Storage Area (not a SSWMU) **WNW** **8613A C** **8613B C** **8613C**	Groundwater monitoring wells around site super solid waste management units (SSWMUs) Reported in: • Annual Site Environmental Report • RFI Reports	Grab liquid	→ Quarterly	→ 4 each well	→ Gross alpha/beta, H-3, gamma isotopic, NPOC, TOX, VOA*
		Direct measurement of sample discharge water	→ Before and after grab sample collection	→ 8 each well	→ Temperature, pH, conductivity
		Grab liquid	→ Semiannually	→ 2 each well	→ Cl, Mn, Na, K, Mg, Ca, Fe, SO_4, NH_3, NO_3+NO_2-N, HCO_3, CO_3, Al, PO_4, Si, sulfide
		Grab liquid	→ Annually	→ 1 each well**	→ Isotopic characterization, chemical characterization, VOA
Well Points (not in a SSWMU) **WP-A** **WP-C** **WP-D** **WP-E** **WP-F** **WP-G** **WP-H**	Well points downgradient of main plant	Grab liquid	→ Annually	→ 1 each well	→ Gross alpha/beta, H-3, gamma isotopic

NOTES: "U" designates upgradient, "B" designates background, and "C" designates crossgradient wells; the remainder are downgradient.

* VOA samples collected quarterly only at wells with positive detections (above or below detection limits) in 1991 and 1992 sampling program and selected downgradient wells.

** Samples for isotopic or chemical characterization collected only if well has shown concentrations above those of background wells. VOAs collected annually from all remaining wells.

1993 MONITORING PROGRAM ENVIRONMENTAL SURVEILLANCE:

ON-SITE GROUNDWATER

Sampling Rationale

On-site Groundwater	DOE Order 5400.1, IV.9; DOE/EH-0173T, 5.10.1.3; 40 CFR Parts 264 and 265, Subpart F. The on-site WVDP groundwater monitoring program focuses on radiological and chemical surveillance of both active and inactive super solid waste management units (SSWMUs). The program allows for the determination of water quality. In addition, using wells situated hydraulically upgradient (background) and downgradient of SSWMUs allows for both detection of groundwater contamination and evaluation of the effects associated with the individual SSWMUs. The groundwater monitoring program is covered in the "Sampling and Analysis Plan (SAP) Groundwater Monitoring Network," Draft W, October 1990, in the annual Site Groundwater Protection Management Program Plan, WVDP-091, and in the 1991 RFI Work Plan.
SSWMU #11	The state-licensed disposal area (SDA) was operated by NFS as a commercial low-level disposal facility and also received wastes from NFS reprocessing operations.
Fuel Storage Area	Monitors groundwater in the vicinity of underground fuel storage tanks; this is not included in any of the SSWMUs.
Well Points	Monitor groundwater of known contamination in the north plateau area. All are downgradient of the main plant.

1993 MONITORING PROGRAM
ENVIRONMENTAL SURVEILLANCE:

OFF-SITE SURFACE WATER

Sample Location Code	Monitoring/Reporting Requirements	Sampling Type/Medium	Collection Frequency	Total Annual Sample Collections	Analyses Performed/ Composite Frequency
WFBCTCB* Buttermilk Creek, upstream of Cattaraugus Creek confluence at Thomas Corners Road	Restricted surface waters receiving plant effluents <u>Reported in:</u> • Annual Site Environmental Report • Monthly Environmental Monitoring Trend Report	Timed continuous composite liquid	→ Biweekly	→ 26	→ pH
				Biweekly samples composited to 12	→ Monthly composite for gross alpha/beta, H-3
				Biweekly samples composited to 4	→ Quarterly composite for gamma isotopic and Sr-90
WFFELBR* Cattaraugus Creek at Felton Bridge	Unrestricted surface waters receiving plant effluents <u>Reported in:</u> • Monthly Environmental Monitoring Trend Report • Annual Site Environmental Report	Timed continuous composite liquid	→ Weekly	→ 52	→ Gross alpha/beta, H-3, pH
				Weekly samples composited to 12	→ Flow-weighted monthly composite for gamma isotopic and Sr-90
WFBCBKG* Buttermilk Creek near Fox Valley	Unrestricted surface water background <u>Reported in:</u> • Monthly Environmental Monitoring Trend Report • Annual Site Environmental Report	Timed continuous composite liquid	→ Biweekly	→ 26	→ pH
				Biweekly samples composited to 12	→ Monthly composite for gross alpha/beta, H-3
				Biweekly samples composited to 4	→ Quarterly composite for gamma isotopic, Sr-90, C-14, I-129, Pu/U isotopic, Total U, Am-241
		Grab liquid	→ Semiannually	→ 2	→ NPOC, TOX, Ca, Mg, Na, K, Ba, Mn, Fe, Cl, SO_4, NO_3-NO_2-N, F, HCO_3, CO_3
WFBIGBR Cattaraugus Creek at Bigelow Bridge	Unrestricted surface water background	Grab liquid	→ Monthly	→ 12	→ Gross alpha/beta, H-3, Sr-90, and gamma isotopic

*Monthly composite at this sample location also sent to NYSDOH.

OFF-SITE SURFACE WATER

Sampling Rationale

WFBCTCB DOE/EH-0173T, 5.10.1.1.

Buttermilk Creek is the surface water receiving all WVDP effluents. **WFBCTCB** monitors the potential influence of WVDP drainage into Buttermilk Creek upstream of confluence with Cattaraugus Creek.

WFFELBR DOE/EH-0173T, 5.10.1.1.

As Buttermilk Creek is the surface water that receives all WVDP effluents and empties into Cattaraugus Creek, **WFFELBR** monitors the potential influence of WVDP drainage into Cattaraugus Creek directly downstream of confluence with Buttermilk Creek.

WFBCBKG DOE/EH-0173T, 5.10.1.1.

Monitors background conditions of Buttermilk Creek upstream of the WVDP. Allows for comparison to downstream conditions.

WFBIGBR DOE/EH-0173T, 5.10.1.1.

Monitors background conditions of Cattaraugus Creek at Bigelow Bridge, upstream of the WVDP. Allows for comparison to downstream conditions.

1993 MONITORING PROGRAM
ENVIRONMENTAL SURVEILLANCE:

OFF-SITE DRINKING WATER

Sample Location Code	Monitoring/Reporting Requirements	Sampling Type/Medium	Collection Frequency	Total Annual Sample Collections	Analyses Performed/ Composite Frequency
WFWEL Series Wells near WVDP outside WNYNSC perimeter **WFWEL01** 3.0 km WNW **WFWEL02** 1.5 km NW **WFWEL03** 4.0 km NW **WFWEL04** 3.0 km NW **WFWEL05** 2.5 km SW **WFWEL06** (background) 29 km S **WFWEL07** 4.0 km NNE **WFWEL08** 2.5 km ENE **WFWEL09** 3.0 km SE **WFWEL10** 7.0 km N	Drinking water supply; groundwater near the facility Reported in: • Annual Site Environmental Report	→ Grab liquid	→ Annual	→ 1 each location	→ Gross alpha/beta, H-3, gamma isotopic, pH, conductivity

1993 MONITORING PROGRAM
ENVIRONMENTAL SURVEILLANCE:

OFF-SITE DRINKING WATER

Sampling Rationale

Off-site Drinking Water **WFWEL** Series	DOE 5400.1, IV.9; DOE/EH-0173T, 5.10.1.2. Eight of the ten listed off-site private residential drinking water wells represent the nearest unrestricted uses of groundwater close to the WVDP. The ninth sample (**WFWEL10**) is from a public water supply from deep wells. The tenth drinking water well, **WFWEL06**, is located 29 kilometers south of the Project and is considered a background drinking water source.

1993 MONITORING PROGRAM
ENVIRONMENTAL SURVEILLANCE:

OFF-SITE AIR

Sample Location Code	Monitoring/Reporting Requirements	Sampling Type/Medium	Collection Frequency	Total Annual Sample Collections	Analyses Performed/ Composite Frequency
AFFXVRD 3.0 km SSE at Fox Valley **AFTCORD** 3.7 km NNW at Thomas Corners Road **AFSPRVL** 7 km N at Springville **AFWEVAL** 6 km SSE at West Valley **AFDNKRK** 50 km W at Dunkirk (background) **AFBOEHN** 2.3 km SW on Dutch Hill Road **AFRT240** 2.0 km NE on Route 240 **AFRSPRD** 1.5 km NW on Rock Springs Road **AFGRVAL** 29 km S at Great Valley **AFBLKST** Bulk storage warehouse 2.2 km ESE at Buttermilk Road	Particulate air samples around WNYNSC perimeter <u>Reported in</u>: • Annual Site Environmental Report • Monthly Environmental Monitoring Trend Report (**AFBOEHN**, **AFRT240**, **AFRSPRD**, and **AFGRVAL** only)	Continuous air particulate filter	→ Weekly	→ 52 each location Weekly filters composited to 4 each location	→ Gross alpha/beta → Quarterly composite for Sr-90, gamma isotopic Total U, U/Pu isotopic, Am-241 for **AFRSPRD** and **AFGRVAL** only
		Continuous desiccant column for water vapor collection	→ Weekly	→ 52 each location (**AFRSPRD** and **AFGRVAL** only)	→ H-3
		Continuous charcoal cartridge	→ Monthly	→ 12 composited to 4 each location (**AFRSPRD** and **AFGRVAL** only)	→ Quarterly composite for I-129

1993 MONITORING PROGRAM
ENVIRONMENTAL SURVEILLANCE:

OFF-SITE AIR

Sampling Rationale

AFFXVRD DOE/EH-0173T, 5.7.4.
AFTCORD
AFRT240 Air samplers put into service by NFS as part of the site's original monitoring program. Perimeter locations chosen to obtain data from places most likely to provide highest concentrations, based on meteorological data.

AFRSPRD Perimeter location chosen to obtain data from the place most likely to provide highest ground-level release concentrations; choice of location based on meteorological data. AFRSPRD is on WVDP property but outside the main plant operations fence line. I-129 and H-3 are sampled here because the sampling trains were easy to incorporate and the location was most likely to receive effluent releases.

AFBOEHN Perimeter location chosen to obtain data from the place most likely to provide highest elevated release concentrations based on meteorological data. AFBOEHN is located on privately owned property at the perimeter.

AFGRVAL DOE/EP-0023, 4.2.3

Off-site (remote) sampler considered to be representative of natural background radiation. Located on privately owned property 29 kilometers south of the site (typically upwind). I-129 and H-3 are sampled here also.

AFDNKRK DOE/EP-0023, 4.2.3

Off-site (remote) sampler considered to be representative of natural background radiation. Located 50 kilometers west of the site (upwind) on privately owned property.

AFWEVAL DOE/EP-0023, 4.2.3

Off-site (remote) sampler located on private property in nearby community within 15 kilometers of the site (southeast).

AFSPRVL DOE/EP-0023, 4.2.3.

Off-site (remote) sampler located on private property in nearby community within 15 kilometers of the site (north).

AFBLKST DOE/EP-0023, 5.7.4.

Off-site monitoring of bulk storage warehouse, near site perimeter.

1993 MONITORING PROGRAM
ENVIRONMENTAL SURVEILLANCE:

FALLOUT, SEDIMENT, AND SOIL

Sample Location Code	Monitoring/Reporting Requirements	Sampling Type/Medium	Collection Frequency	Total Annual Sample Collections	Analyses Performed/ Composite Frequency
AFDHFOP 2.5 km SW **AFFXFOP** 3.0 km SSE **AFTCFOP** 3.7 km NNW **AF24FOP** 2.0 km NE **ANRGFOP** Met tower (original) on-site	Collection of fallout particulate and precipitation around WNYNSC perimeter Reported in: • Annual Site Environmental Report	Integrating liquid	→ Monthly	→ 12 each location	→ Gross alpha/beta, H-3, pH, gamma isotopic
SF Soil Series Surface soil (at each of ten air samplers)	Long-term fallout accumulation Reported in: • Annual Site Environmental Report	Surface plug composite soil	→ Annually	→ 1 each location	→ Gamma isotopic, Sr-90, Pu-239, Am-241, plus U-isotopic and Total U at SFRSPRD, SFBOEHN, and SFGRVAL
SFCCSED Cattaraugus Creek at Felton Bridge **SFSDSED** Cattaraugus Creek at Springville Dam **SFBISED** Cattaraugus Creek at Bigelow Bridge (background) **SFTCSED** Buttermilk Creek at Thomas Corners Road **SFBCSED** Buttermilk Creek at Fox Valley Road (background)	Deposition in sediment downstream of facility effluents Reported in: • Annual Site Environmental Report	Grab stream sediment	→ Semiannually (semiannual SFSDSED to NYSDOH) → Annually	→ 2 each location → 1 each location (**SFTCSED** and **SFBCSED** only; annual **SFBCSED** to NYSDOH)	→ Gross alpha/beta, gamma isotopic, and Sr-90 → U/Pu isotopic, Total U, Am-241
SN On-site Soil Series: **SNSW74A** (Near WNSW74A) **SNSWAMP** (Near WNSWAMP) **SNSP006** (Near WNSP006)	Reported in: • Special Report	Surface plug or grab	→ Annually	→ 1 each location	→ Gamma isotopic, Sr-90, Pu-239, Am-241, U-isotopic, Total U, Al, Sb, As, Ba, Be, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Hg, Ni, K, Se, Ag, Na, Tl, V, Zn

FALLOUT, SEDIMENT, AND SOIL

Sampling Rationale

AFDHFOP **AFFXFOP** **AFTCFOP**	DOE/EP-0023, 4.7.
AF24FOP	Collection of fallout particles and precipitation around the site perimeter at established air sampling locations. Indicates short-term effects.
ANRGFOP	Collection of fallout particles and precipitation on-site at the meteorological tower. Indicates short-term effects.
SF Soil Series	DOE/EH-0173T, 5.9.1.
	SFWEVAL (West Valley), **SFFXVRD** (Fox Valley Road), **SFSPRVL** (Springville), **SFTCORD** (Thomas Corners), **SFRT240** (Route 240), **SFDNKRK** (Dunkirk), **SFBOEHN** (Boehn Road-Dutch Hill), **SFGRVAL** (Great Valley), **SFRSPRD** (Rock Springs Road), **SFBLKST** (bulk storage warehouse): Collection of long-term fallout data at established air sampler locations via soil sampling.
SFTCSED	Sediment deposition in Buttermilk Creek immediately downstream of all facility liquid effluents.
SFBCSED	Sediment deposition in Buttermilk Creek upstream of facility effluents (background).
SFCCSED	Sediment deposition in Cattaraugus Creek at Felton Bridge. Location is first access point to Cattaraugus Creek downstream of the confluence with Buttermilk Creek.
SFSDSED	Sediment deposition in Cattaraugus Creek at Springville dam. Reservoir provides ideal settling and collection location for sediments downstream of Buttermilk Creek confluence. Located downstream of **SFCCSED**.
SFBISED	Sediment deposition in Cattaraugus Creek at Bigelow Bridge. Location is upstream of the Buttermilk Creek confluence and serves as a Cattaraugus Creek background location.
SN Soil Series	DOE/EH-0173T, 5.9.1. On-site soil.
SNSW74A	Surface soil (sediment) near **WNSW74A**. Location to be specifically defined by geographic coordinates. Corresponds to site drainage pattern flow (i.e., most likely area of radiological deposition/accumulation).
SNSWAMP	Surface soil (sediment) near **WNSWAMP**. Location to be specifically defined by geographic coordinates. Corresponds to site drainage pattern flow (i.e., most likely area of radiological deposition/accumulation).
SNSP006	Surface soil (sediment) near **WNSP006**. Location to be specifically defined by geographic coordinates. Corresponds to site drainage pattern flow (i.e., most likely area of radiological deposition/accumulation).

1993 MONITORING PROGRAM
ENVIRONMENTAL SURVEILLANCE:

OFF-SITE BIOLOGICAL

Sample Location Code	Monitoring/Reporting Requirements	Sampling Type/Medium	Collection Frequency	Total Annual Sample Collections	Analyses Performed/ Composite Frequency
BFFCATC Cattaraugus Creek downstream of the Buttermilk Creek confluence **BFFCTRL** Control sample from nearby stream not affected by WVDP (7 km or more upstream of site effluent point)	Fish in waters up- and downstream of facility effluents Reported in: • Annual Site Environmental Report	Individual collection, biological	Semiannually, (Samples at **BFFCATC** and **BFFCTRL** shared with NYSDOH) →	20 fish each location →	Gamma isotopic and Sr-90 in edible portions of each individual fish
BFFCATD Cattaraugus Creek downstream of Springville Dam			Annual (**BFFCATD** only) →	10 fish →	Gamma isotopic and Sr-90 in edible portions of each individual fish
BFMREED Dairy farm, 3.8 km NNW **BFMCOBO** Dairy farm, 9 km WNW **BFMCTLS** Control location 25 km S **BFMCTLN** Control location 30 km N	Milk from animals foraging around facility perimeter Reported in: • Annual Site Environmental Report	Grab biological →	Monthly (**BFMREED, BFMCOBO, BFMCTLS, BFMCTLN**. Samples at **BFMREED** and **BFMCOBO** shared with NYSDOH) →	12 monthly samples composited to 4 each location →	Quarterly composite for gamma isotopic, Sr-90, H-3, and I-129
BFMWIDR Dairy farm, 3.5 km SE of site **BFMHAUR** Dairy farm 2.5 km SSW			Annual (**BFMWIDR, BFMHAUR**) →	1 each location →	Gamma isotopic, Sr-90, H-3, and I-129

OFF-SITE BIOLOGICAL

Sampling Rationale

BFFCATC **BFFCATD**	DOE/EH-0173T, 5.11.1.1. Radioactivity may enter a food chain in which fish are a major component and are consumed by the local population.
BFFCTRL	Background control fish sample.
BFMREED **BFMCOBO** **BFMWIDR** **BFMHAUR**	DOE/EH-0173T, 5.8.2.1. Milk from animals foraging around facility perimeter. Milk is consumed by all age groups and is frequently the most important food that could contribute to the radiation dose. Dairy animals pastured near the site and at two background locations allow adequate monitoring.
BFMCTLS **BFMCTLN**	Background control milk samples collected far from site.

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ENVIRONMENTAL SURVEILLANCE:

OFF-SITE BIOLOGICAL

Sample Location Code	Monitoring/Reporting Requirements	Sampling Type/Medium	Collection Frequency	Total Annual Sample Collections	Analyses Performed/ Composite Frequency
BFVNEAR Nearby locations **BFVCTRL** Remote locations (16 km or more from facility) **BFHNEAR** Beef cattle/milk cow forage from near-site location	Fruit and vegetables grown near facility perimeter, downwind if possible Reported in: • Annual Site Environmental Report	Grab biological (fruits and vegetables)	→ Annually, at harvest (**BFVNEAR** and **BFVCTRL**)	→ 3 each (split with NYSDOH)	→ Gamma isotopic and Sr-90 analysis of edible portions, H-3 in free moisture
BFHCTLS or **BFHCTLN** Beef cattle/milk cow forage from control location south or north		Grab biological	→ Annually (**BFHNEAR**, **BFHCTLS**, or **BFHCTLN**)	→ 1 each location	→ Gamma isotopic, Sr-90
BFBNEAR Beef animal from nearby farm in downwind direction **BFBCTRL** Beef animal from control location 16 km or more from facility	Meat (beef foraging near facility perimeter, downwind if possible) Reported in: • Annual Site Environmental Report	Grab biological	→ Semiannually	→ 2 each location	→ Gamma isotopic and Sr-90 analysis of meat, H-3 in free moisture
BFDNEAR Deer in vicinity of the site **BFDCTRL** Control deer 16 km or more from facility	Meat (deer foraging near facility perimeter) Reported in: • Annual Site Environmental Report	Individual collection biological	→ Annually, during hunting season (**BFDNEAR** sample split with NYSDOH)	→ 3	→ Gamma isotopic and Sr-90 analysis of meat, H-3 in free moisture
			During year as available (**BFDCTRL** sample split with NYSDOH)	→ 3	→ Gamma isotopic and Sr-90 analysis of meat, H-3 in free moisture

1993 MONITORING PROGRAM
ENVIRONMENTAL SURVEILLANCE:

OFF-SITE BIOLOGICAL

Sampling Rationale

BFVNEAR DOE/EH-0173T, 5.8.2.2.

Fruits and vegetables collected from areas near the site. Collected, if possible, from areas near the site predicted to have worst case downwind concentrations of radionuclides in air and soil. Sample analysis reflects steady state/chronic uptake or contamination of foodstuffs as a result of site activities. Possible pathway to humans or indirectly through animals.

BFVCTRL DOE/EH-0173T, 5.8.2.2

Fruits and vegetables collected from area remote from the site. Background fruits and vegetables collected for comparison with near-site samples. Collected in area(s) of no possible site impact.

BFHNEAR DOE/EH-0173T, 5.8.2.2

Hay collected from areas near the site. See note under near-site fruits and vegetables (**BFVNEAR**). Indirect pathway to humans through animals. Collected with either beef or milk sample location.

BFHCTLS DOE/EH-0173T, 5.8.2.2.
BFHCTLN

Hay collected from areas remote from the site. Background hay collected for comparison with near-site samples. Collected in area(s) of no possible site impact.

BFBNEAR DOE/EH-0173T, 5.8.2.3.

Beef collected from animals raised near the site. Following the rationale for vegetable matter collected near site (**BFVNEAR** and **BFHNEAR**), edible flesh portion of beef animals is analyzed to determine possible radionuclide content passable directly to humans. For animals foraging downwind in areas of maximum probable site impact.

BFBCTRL DOE/EH-0173T, 5.8.2.3.

Beef collected from animals raised far from the site. Background beef collected for comparison with near-site samples. Collected in area(s) of no possible site impact.

BFDNEAR DOE/EH-0173T, 5.8.3.

Venison from deer herd found living near the site. Same as for beef **(BFBNEAR).**

BFDCTRL DOE/EH-0173T, 5.8.3.

Venison from deer herd living far from the site. Background deer meat collected for comparison with near-site samples. Collected in area(s) of no possible site impact.

1993 MONITORING PROGRAM
ENVIRONMENTAL SURVEILLANCE:

OFF-SITE DIRECT RADIATION

Sample Location Code	Monitoring/Reporting Requirements	Sampling Type/Medium	Collection Frequency	Total Annual Sample Collections	Analyses Performed/ Composite Frequency
DFTLD Series Thermoluminescent dosimetry (TLD) Off-site: **#1-16** At each of 16 compass sectors at nearest accessible perimeter point **#17** "5 Points" landfill, 19 km SW (background) **#20** 1,500 m NW (downwind receptor) **#21** Springville 7 km N **#22** West Valley 5 km SSE **#23** Great Valley 9 km S (background) **#37** Dunkirk 50 km NW (background) **#41** Sardinia-Savage Road 24 km NE (background)	Direct radiation around facility Reported in: • Monthly Environmental Monitoring Trend Report (month of quarterly collection) • Annual Site Environmental Report	Integrating LiF TLD →	Quarterly →	5 TLDs at each of 23 locations collected 4 times per year →	Quarterly gamma radiation exposure

1993 MONITORING PROGRAM
ENVIRONMENTAL SURVEILLANCE:

OFF-SITE DIRECT RADIATION

Sampling Rationale

DOSIMETRY Off-site	DOE/EH-0173T, 5.5 and DOE/EP-0023, 4.6.3. TLDs offer continuous integrated environmental gamma-ray monitoring and have been deployed systematically about the site. Off-site TLDs are used to verify that site activities have not adversely affected the surrounding environs. In addition to general NRC crosschecks, a biennial HPIC gamma radiation measurement is completed at all TLD locations.

1993 MONITORING PROGRAM
ENVIRONMENTAL SURVEILLANCE:

ON-SITE DIRECT RADIATION

Sample Location Code	Monitoring/Reporting Requirements	Sampling Type/Medium	Collection Frequency	Total Annual Sample Collections	Analyses Performed/ Composite Frequency
DNTLD Series Thermoluminescent dosimetry (TLD) On-site: **#18, #19, #33** At three corners of SDA **#24, #26-32, #34** (9) at security fence around site **#35, #36, #38-40** (5) On-site near operational areas **#25** Rock Springs Road 500 m NNW of plant	Direct radiation on facility grounds <u>Reported in</u>: • Monthly Environmental Monitoring Trend Report (month of quarterly collection) • Annual Site Environmental Report	Integrating LiF TLD	→ Quarterly	→ 5 TLDs at each of 18 sites collected 4 times per year	→ Quarterly gamma radiation exposure

1993 MONITORING PROGRAM
ENVIRONMENTAL SURVEILLANCE:

ON-SITE DIRECT RADIATION

Sampling Rationale

DOSIMETRY On-site	DOE/EH-0173T, 5.4 and 5.5. On-site TLDs monitor waste management units and verify that the potential dose rate to the general public (i.e., Rock Springs Road) is below 100 mrem/annum from site activities. Potential TLD sampling locations are continually evaluated with respect to site activities.

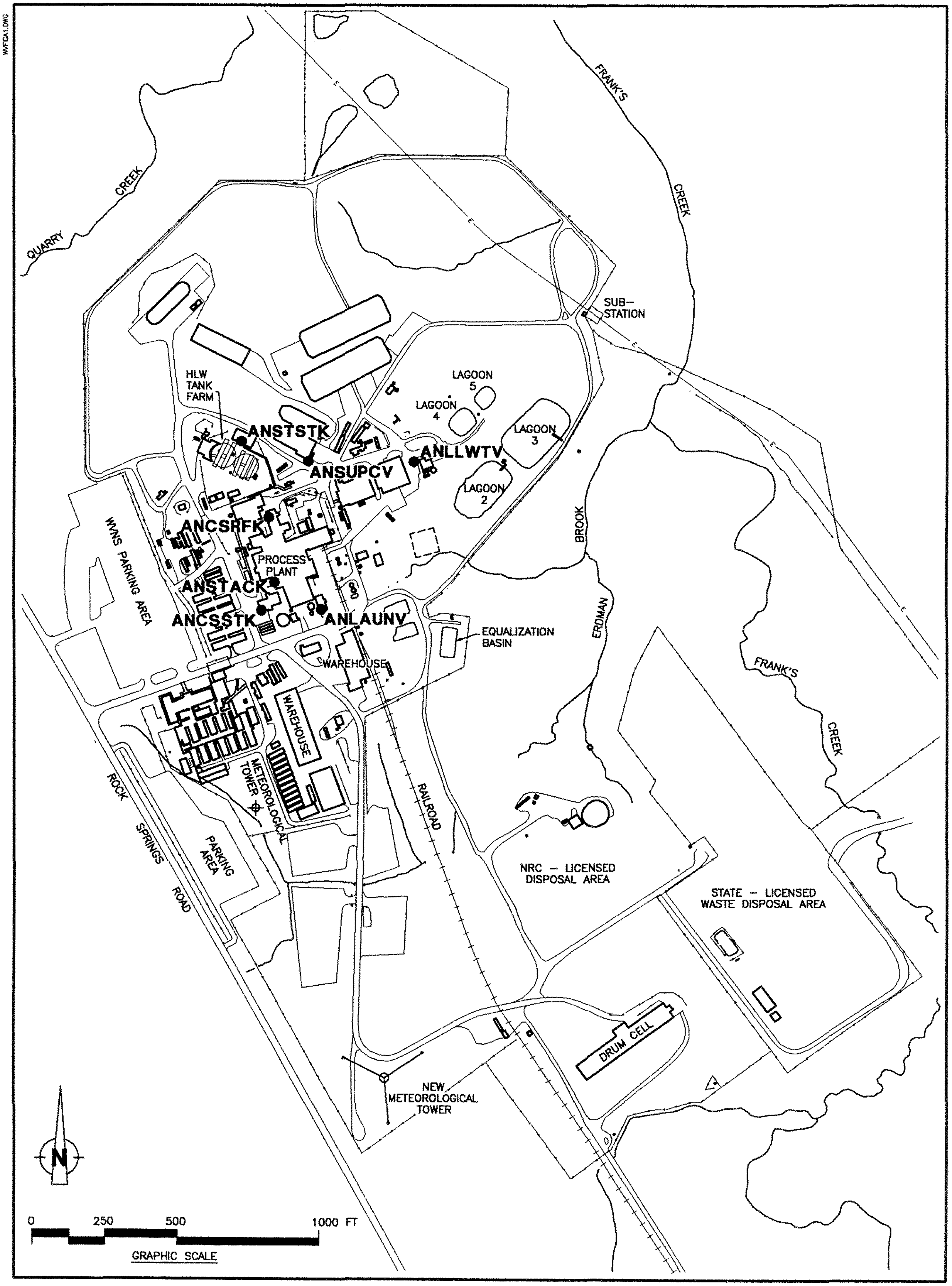


Figure A-1. On-site Air Effluent Monitoring Points.

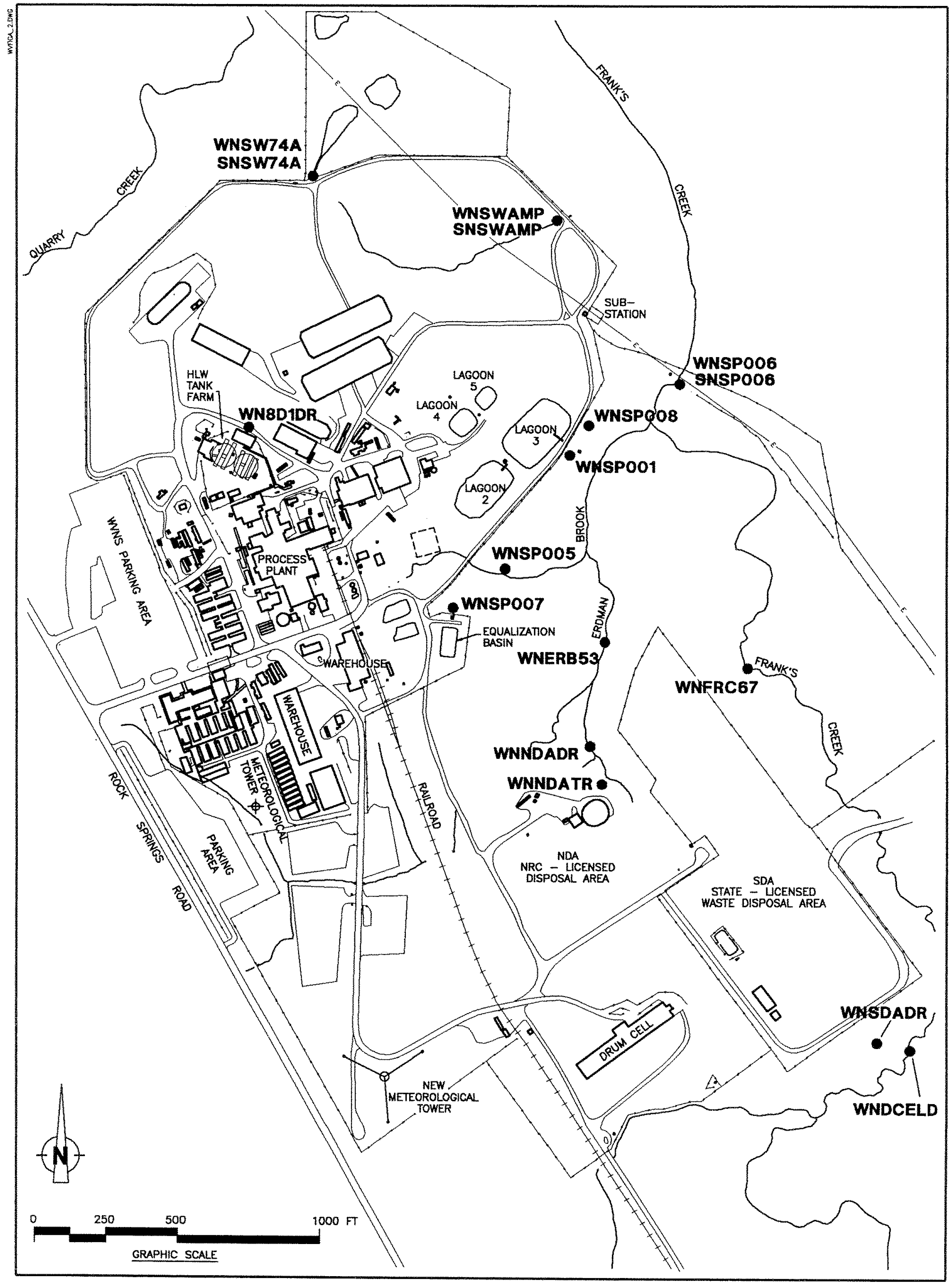


Figure A-2. Sampling Locations for On-site Surface Water and Soil.

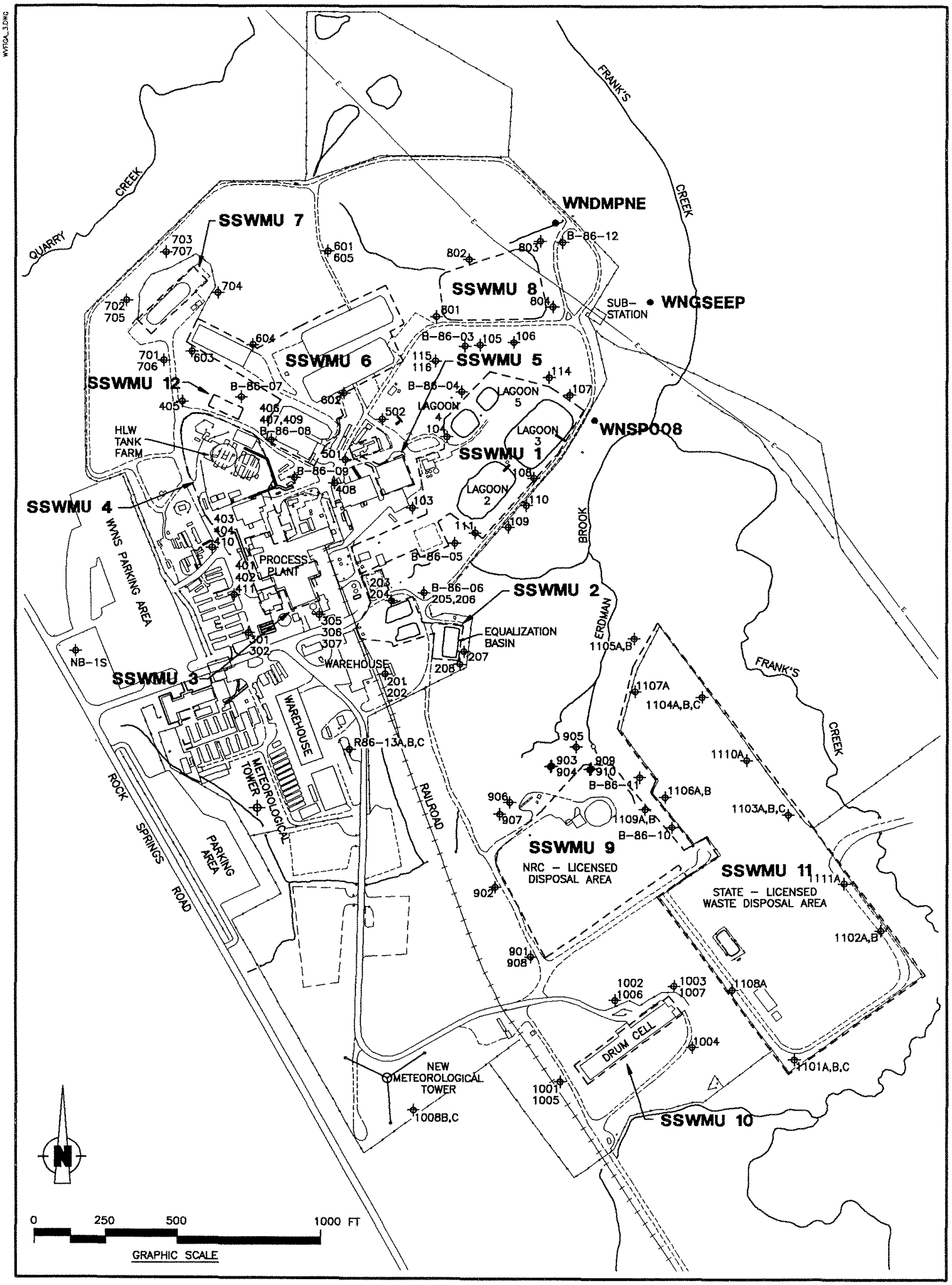


Figure A-3. On-site Groundwater Monitoring Network.

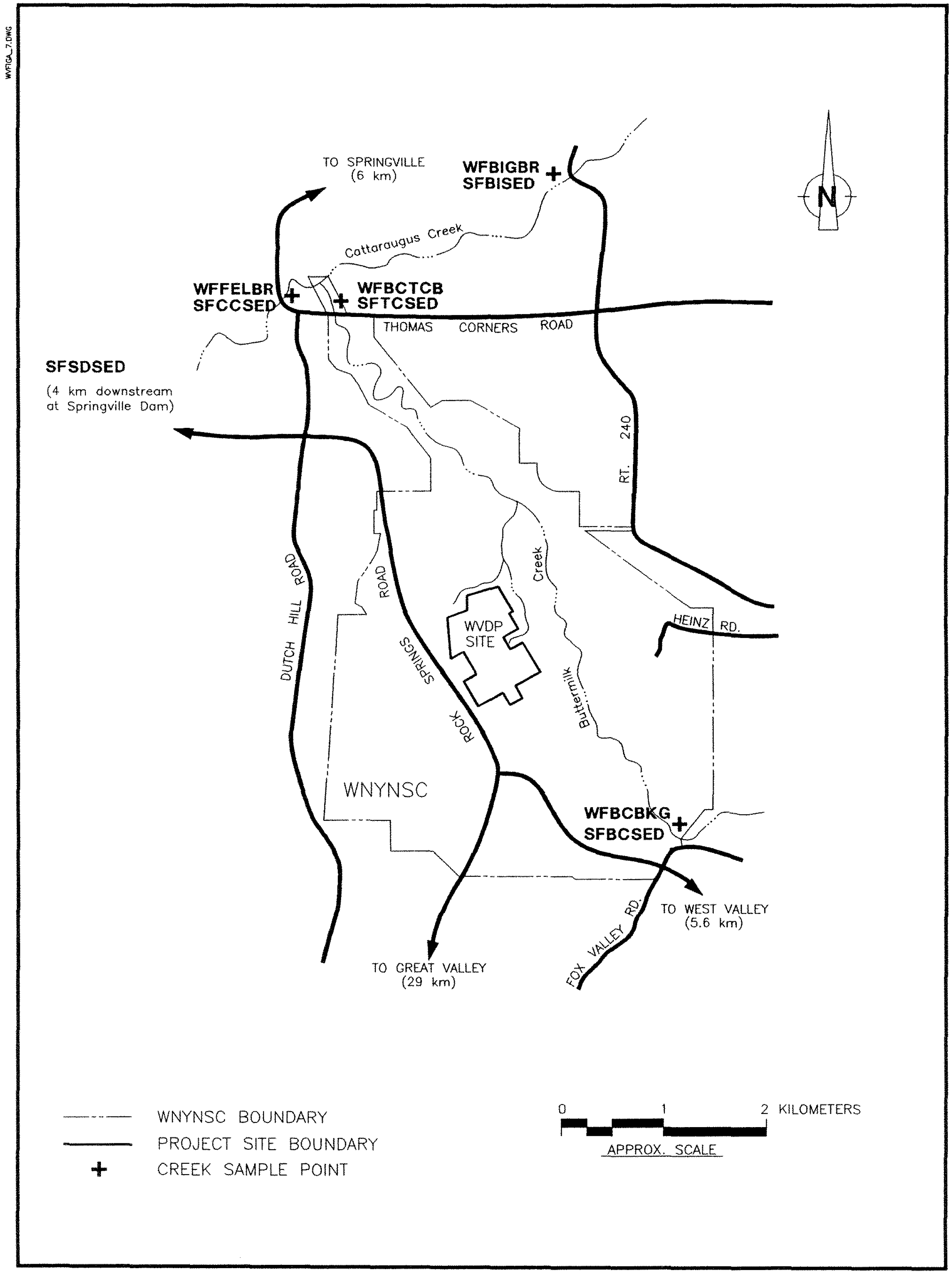


Figure A-4. Location of Off–site Surface Water Samplers and Sediment Collection.

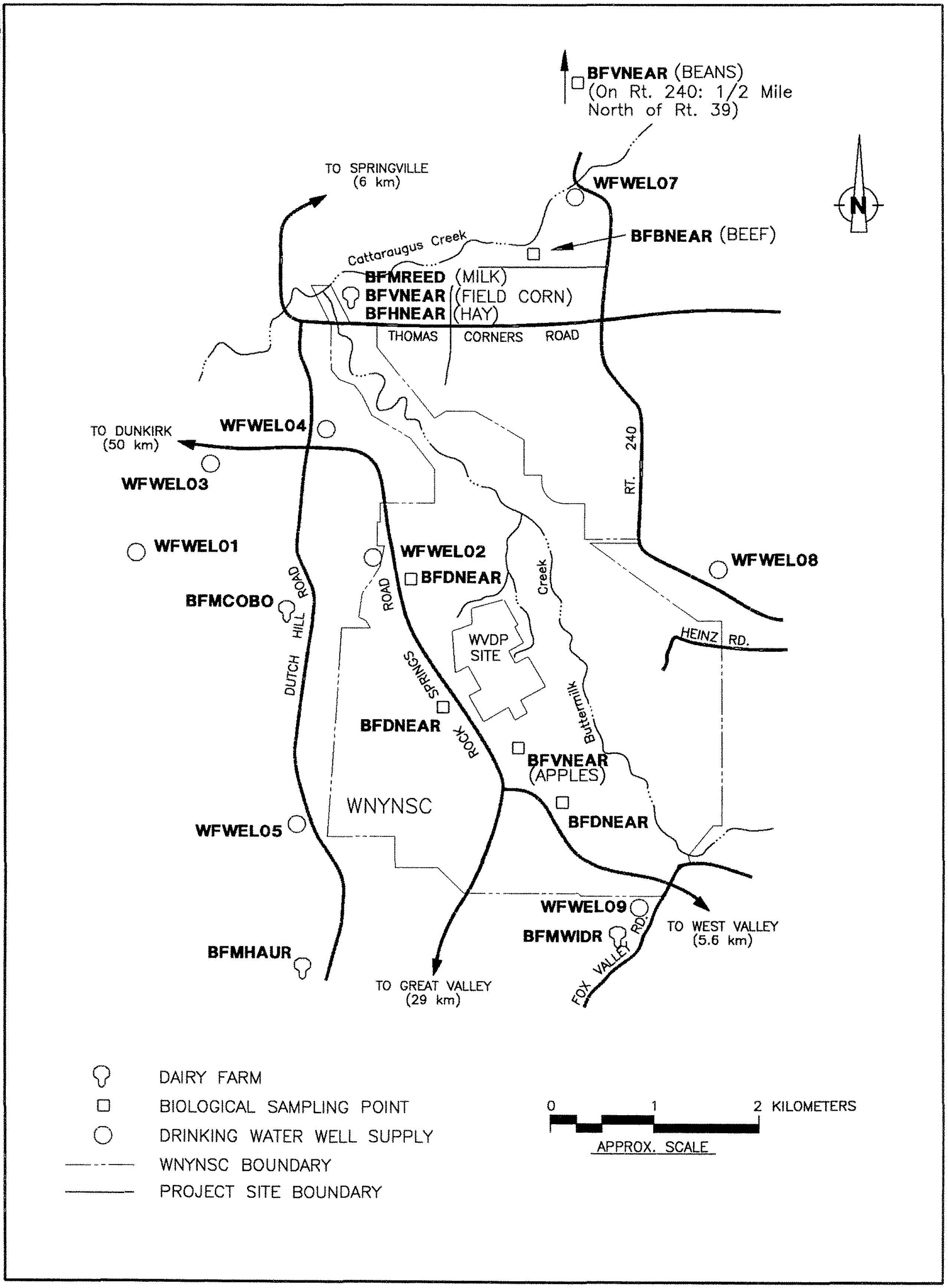


Figure A-5. Near–site Drinking Water and Biological Sample Points.

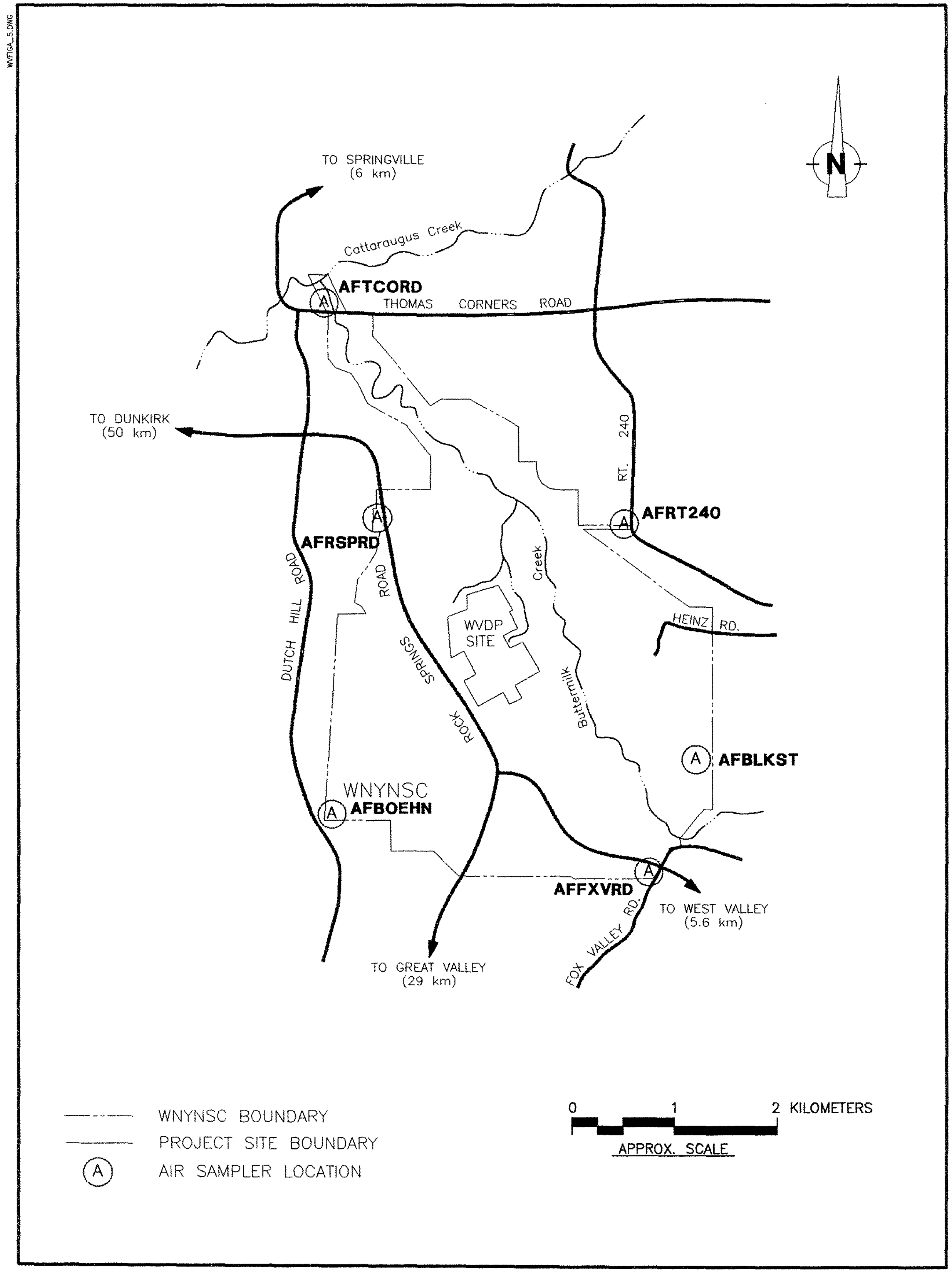


Figure A-6. Location of Perimeter Air Samplers.

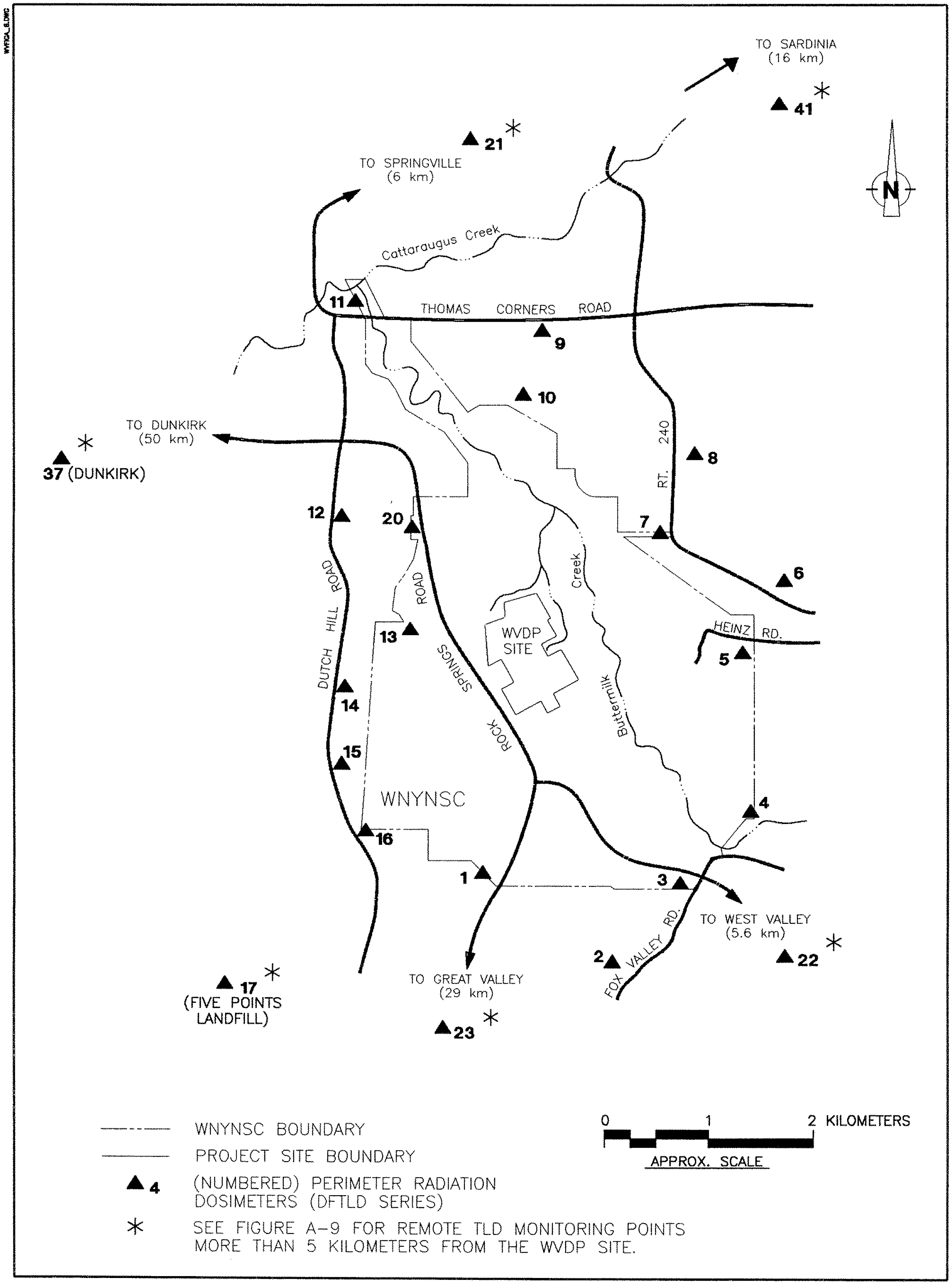


Figure A-7. Location of Off-site Thermoluminescent Dosimetry (TLD).

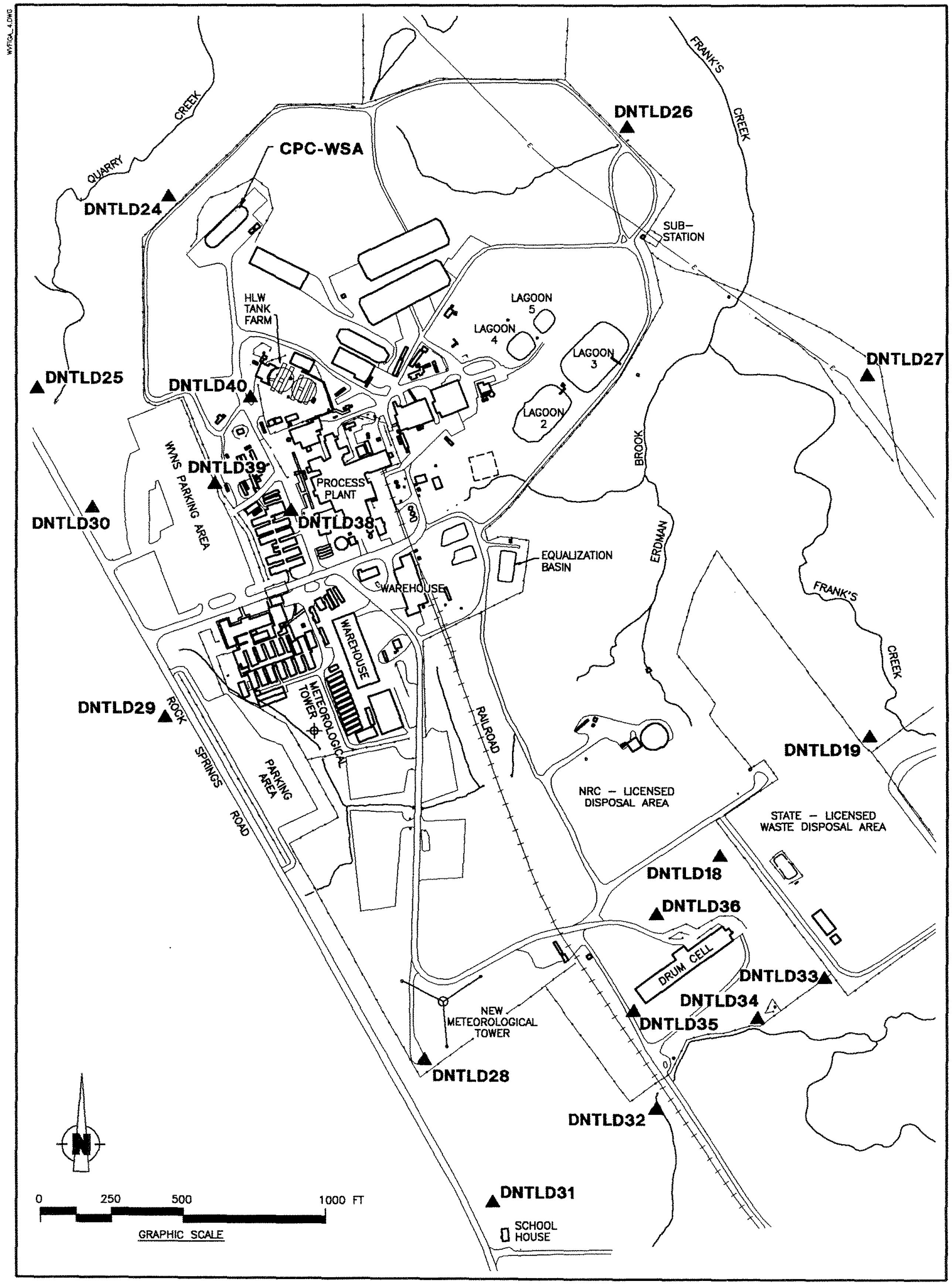


Figure A-8. Location of On-site Thermoluminescent Dosimetry (TLD).

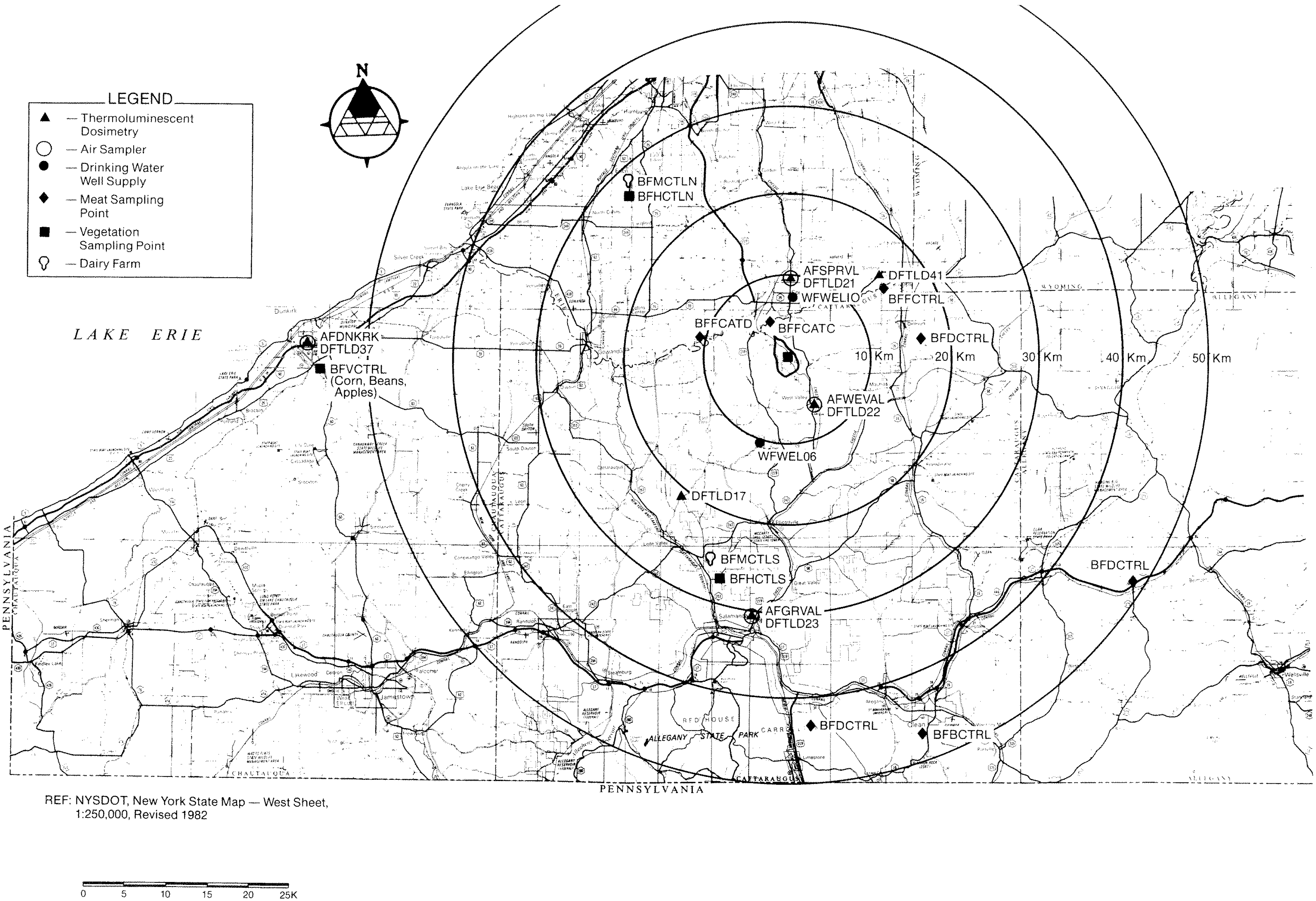


Figure A-9. Environmental Sample Points more than 5 kilometers from the WVDP Site

Appendix B

Regulations and Standards

Table B - 1

*Department of Energy Radiation Protection Standards and Concentration Guides**

Effective Dose Equivalent Radiation Standard for Protection of the Public

Continuous exposure of any member of the public from routine activities: 100 mrem/year (1 mSv/yr) from all exposure pathways

Department of Energy Concentration Guides (DCGs) for Ingestion of Drinking Water and Inhaled Air (μCi/mL)

Radionuclides:	*In Air*	*In Water*	*Radionuclides:*	*In Air*	*In Water*
H-3	1E-07	2E-03	**Th-232**	7E-15	5E-08
C-14	6E-09	7E-05	**U-232**	2E-14	1E-07
Fe-55	5E-09	2E-04	**U-233**	9E-14	5E-07
Co-60	8E-11	5E-06	**U-234**	9E-14	5E-07
Ni-63	2E-09	3E-04	**U-235**	1E-13	6E-07
Sr-90	9E-12	1E-06	**U-236**	1E-13	5E-07
Zr-93	4E-11	9E-05	**U-238**	1E-13	6E-07
Nb-93m	4E-10	3E-04	**Np-239**	5E-09	5E-05
Tc-99	2E-09	1E-04	**Pu-238**	3E-14	4E-08
Ru-106	3E-11	6E-06	**Pu-239**	2E-14	3E-08
Rh-106m	6E-08	2E-04	**Pu-240**	2E-14	3E-08
Sb-125	1E-09	5E-05	**Pu-241**	1E-12	2E-06
Te-125m	2E-09	4E-05	**Am-241**	2E-14	3E-08
I-129	7E-11	5E-07	**Am-243**	2E-14	3E-08
Cs-134	2E-10	2E-06	**Cm-243**	3E-14	5E-08
Cs-135	3E-09	2E-05	**Cm-244**	4E-14	6E-08
Cs-137	4E-10	3E-06	**Gross Alpha (as Am-241)**	2E-14	3E-08
Pm-147	3E-10	1E-04			
Sm-151	4E-10	4E-04	**Gross Beta (as Sr-90)**	9E-12	1E-06
Eu-152	5E-11	2E-05			
Eu-154	5E-11	2E-05			
Eu-155	3E-10	1E-04			

* *Ref: DOE Order 5400.5 (February 8, 1990). Effective May 8, 1990.*

Table B - 2

Environmental Standards and Regulations

The following environmental standards and laws are applicable, in whole or in part, to the West Valley Demonstration Project:

DOE Order 5400.1. November 9, 1988. *General Environmental Protection Program*, including Change 1 (June 29, 1990).

DOE Order 5400.5. February 8, 1990. Radiation Protection of the Public and the Environment, including Change 2 (January 7, 1993).

DOE Order 5480.1B. September 1986. *Environment, Safety, and Health Program for DOE Operations*, including Change 4 (March 27, 1990).

DOE Order 5484.1. February 1981. *Environmental Protection, Safety, and Health Protection Information Reporting Requirements*, including Change 7 (October 17, 1990).

Clean Air Act (CAA) . 42 USC 1857 et seq., as amended, and implementing regulations.

Federal Water Pollution Control Act [Clean Water Act (CWA)]. 33 USC 1251, as amended, and implementing regulations.

Resource Conservation and Recovery Act (RCRA). 42 USC 6905, as amended, and implementing regulations.

National Environmental Policy Act (NEPA). PL 911-190. 42 USC 4321-4347, January 1, 1970, as amended, and implementing regulations.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). 42 USC 960 (including Superfund Amendments and Reauthorization Act of 1986), and implementing regulations.

Toxic Substances Control Act (TSCA). 15 USC 2610, as amended, and implementing regulations.

Emergency Planning and Community Right-to-Know Act (EPCRA) of 1986, Title 3, 40 CFR Part 302, 350, 355, 370, and 372.

Safe Drinking Water Act (SDWA). 40 CFR Part 141-149, as amended, and implementing regulations.

Environmental Conservation Law of New York State.

The standards and guidelines applicable to releases of radionuclides from the West Valley Demonstration Project are found in DOE Order 5400.5.

Ambient water quality standards contained in the State Pollutant Discharge Elimination System (SPDES) permit issued for the facility are listed in *Appendix C-5* in each annual Site Environmental Report.

Airborne discharges are also regulated by the Environmental Protection Agency under the National Emissions Standards for Hazardous Air Pollutants (NESHAP), 40 CFR 61 Subpart H. December 15, 1985.

The above list covers the major activities at the West Valley Demonstration Project but does not constitute a comprehensive enumeration.

Table B - 3

West Valley Demonstration Project Environmental Permits (as of December 31, 1993)

Type of Permit	*Issued by*	*Expiration*	*Permit Number*
Certificates to Operate Air Contamination Source			
Boiler	NYSDEC	6/94	042200-0114-00002
Boiler	NYSDEC	6/94	042200-0114-00003
Incinerator (closed) [1]	NYSDEC	6/94	042200-0114-00004
Low-level Waste Treatment Facility Nitric Acid Storage Tank	NYSDEC	6/94	042200-0114-0010
Cement Storage Silo Ventilation System	NYSDEC	6/94	042200-0114-CSS01
Analytical and Process Chemistry Laboratory Equipment	NYSDEC	6/94	042200-0114-15F-1
Sulfuric Acid Tank #35157 Vent	NYSDEC	6/94	042200-0114-35157
Nitric Acid Tank #33154 Vent	NYSDEC	6/94	042200-0114-33154
Sodium Hydroxide Tank #14D-2 Vent	NYSDEC	6/94	042200-0114-14D-2
Sodium Hydroxide Tank #14D-2A Vent	NYSDEC	6/94	042200-0114-14D2-A
Source-capture Welding System	NYSDEC	6/94	042200-0114-MS001
Nitric Acid Tank (250-gal) Vent	NYSDEC	6/94	042200-0114-MDB07
Blueprinter Ventilation System	NYSDEC	6/94	042200-0114-00012
State Pollutant Discharge Elimination System Permit [2]	NYSDEC		NY0000973
Certificates to Operate Radioactive Air Source [3]			
Building 01-14 Ventilation System	EPA		WVDP-187-01
Contact Size-reduction and Decontamination Facility	EPA		WVDP-287-01
Supernatant Treatment Ventilation System	EPA		WVDP-387-01
Low-level Waste Supercompactor Ventilation System	EPA		WVDP-487-01
Outdoor Ventilation System	EPA		WVDP-587-01
Process Building Ventilation System	EPA		WVDP-687-01
Vitrification Melter Off-gas System	EPA		Under review by the EPA
Vitrification HVAC System	EPA		Under review by the EPA

[1] *Source and/or permit to be deleted in 1994.*
[2] *Renewal application was submitted to the New York State Department of Environmental Conservation in May 1990.*
[3] *National Emissions Standards for Hazardous Air Pollutants (NESHAP) temporary permits are valid until the final permits are issued.*
[4] *Applications filed to extend expiration dates to June 1994.*
[5] *Certificate to Operate pending.*
[6] *Permit to Construct to be extended in 1994.*
[7] *To be converted to Certificate to Operate in 1994.*
[8] *Permit renewed December 1994.*
[9] *Will operate under RCRA interim status until NYSDEC requests Part B of the RCRA application.*
N/A - Not applicable.

Table B - 3 (concluded)

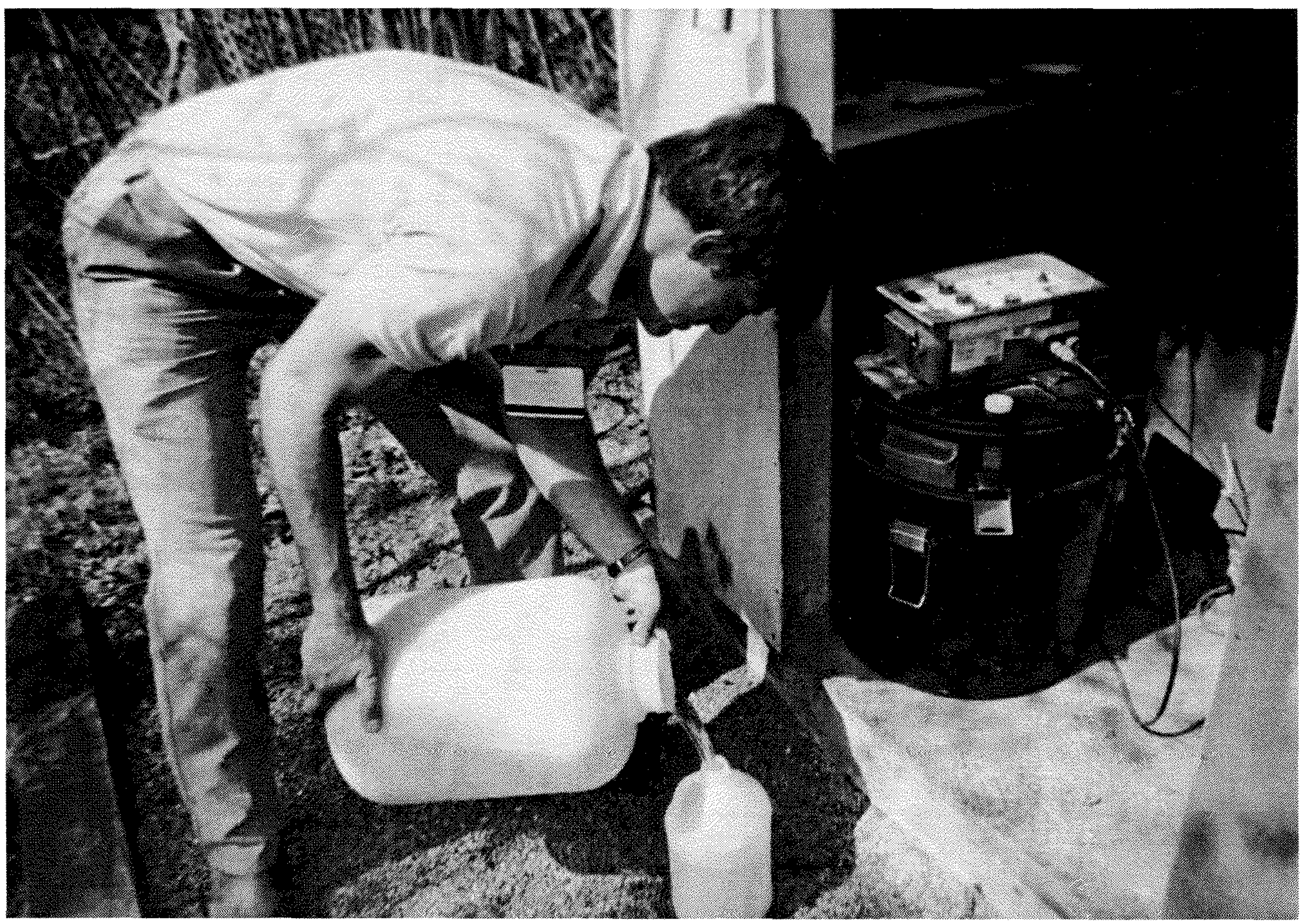
West Valley Demonstration Project Environmental Permits (as of December 31, 1993)

Type of Permit	Issued by	Expiration	Permit Number
Permits to Construct			
CTS Solids Transfer System	NYSDEC	12/94	042200-0114-CTS02
CTS Vessel Vent System	NYSDEC	12/94	042200-0114-CTS03
CTS Dust Collection Hood	NYSDEC	12/94	042200-0114-CTS04
SVS Solids Transfer System	NYSDEC	6/93[4]	042200-0114-SVS01
SVS Vessel Vent System	NYSDEC	6/93[4]	042200-0114-SVS02
SVS Melter Off-gas	NYSDEC	6/93[4]	042200-0114-SVS04
Vitrification Facility Exhaust Welding Fume Blower	NYSDEC	12/93[5]	042200-0114-00013
Vitrification Melter Off-gas Treatment System	NYSDEC	4/94[6]	9-0422-00005/00036
Vitrification Facility Painting and Welding Blower	NYSDEC	4/94[7]	042200-0114-00014
Vitrification Facility Painting Blower	NYSDEC	5/94[7]	042200-0114-00015
Vitrification Facility HVAC System (Canister Welding)	NYSDEC		Under review by NYSDEC
Environmental Analytical Annex	NYSDEC	5/94	042200-0114-00016 to 26
Analytical Cell Mock-up Unit	NYSDEC	5/94	042200-0114-00027
Depredation Permit	U.S. Dept. of the Interior, Fish & Wildlife Service	12/93[8]	PRT-747595
Depredation License	NYSDEC, Division of Fish & Wildlife	12/93[8]	DWP93-035
Hazardous Waste Treatment and Storage Interim Status Application (RCRA Part A) [9]	NYSDEC		N/A

[1] *Source and/or permit to be deleted in 1994.*
[2] *Renewal application was submitted to the New York State Department of Environmental Conservation in May 1990.*
[3] *National Emissions Standards for Hazardous Air Pollutants (NESHAP) temporary permits are valid until the final permits are issued.*
[4] *Applications filed to extend expiration dates to June 1994.*
[5] *Certificate to Operate pending.*
[6] *Permit to Construct to be extended in 1994.*
[7] *To be converted to Certificate to Operate in 1994.*
[8] *Permit renewed December 1994.*
[9] *Will operate under RCRA interim status until NYSDEC requests Part B of the RCRA application.*
N/A - Not applicable.

Appendix C - 1

Summary of Water and Sediment Monitoring Data



Collecting a Sample at a Continuous-stream Sampling Station

Table C - 1.1

Total Radioactivity of Liquid Effluents Released from Lagoon 3 in 1993 (curies)

	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	TOTAL	Average (μCi/mL)
Alpha	2.48±0.88E-04	1.42±0.58E-04	1.18±0.46E-04	3.48±0.81E-04	8.56±1.41E-04	2.17±0.36E-08
Beta	1.18±0.04E-04	1.04±0.03E-02	9.04±0.24E-03	1.20±0.02E-02	4.32±0.06E-02	1.10±0.02E-06
H-3	1.93±0.04E-01	1.71±0.05E-01	2.83±0.06E-01	3.38±0.08E-01	9.85±0.12E-01	2.50±0.03E-05
Sr-90	3.57±0.11E-03	1.98±0.08E-03	1.40±0.05E-03	2.28±0.09E-03	9.23±0.17E-03	2.34±0.04E-07
Cs-137	2.66±1.69E-04	0.96±1.10E-04	1.75±0.99E-04	1.30±1.60E-04	6.67±2.76E-04	1.69±0.70E-08
Co-60	0.00±2.32E-04	0.00±1.37E-04	0.00±1.35E-04	0.00±1.86E-04	0.00±3.54E-04	0.00±9.00E-09
K-40	0.00±3.21E-03	0.00±2.02E-03	1.51±1.72E-03	1.29±2.46E-03	2.79±4.84E-03	0.71±1.23E-07
U-232	2.67±0.18E-04	8.22±0.63E-05	9.71±0.58E-05	1.74±0.08E-04	6.20±0.22E-04	1.57±0.06E-08
U-233/234	1.50±0.09E-04	4.17±0.51E-05	5.10±0.39E-05	9.33±0.59E-05	3.36±0.13E-04	8.54±0.32E-09
U-235	5.24±5.35E-07	4.43±4.30E-07	7.60±4.29E-07	9.29±5.07E-07	2.66±0.96E-06	6.74±2.42E-11
U-236	1.33±0.68E-06	1.07±2.72E-07	5.21±3.43E-07	1.07±0.53E-06	3.03±0.97E-06	7.68±2.46E-11
U-238	7.03±0.56E-05	2.47±0.32E-05	1.97±0.20E-05	4.19±0.35E-05	1.57±0.08E-04	3.97±0.19E-09
Pu-238	9.30±5.71E-07	6.95±4.43E-07	3.80±3.75E-07	6.62±1.86E-06	8.62±2.03E-06	2.19±0.52E-10
Pu-239/240	1.71±3.72E-07	3.98±3.86E-07	1.61±2.50E-07	5.97±6.80E-07	1.33±0.90E-06	3.37±2.29E-11
Am-241	3.34±3.42E-07	-0.32±1.83E-07	-0.16±2.76E-07	5.18±3.93E-07	8.04±6.17E-07	2.04±1.57E-11
I-129	7.39±1.07E-05	1.96±0.25E-05	5.28±0.23E-05	5.23±0.49E-05	1.99±0.12E-04	5.04±0.31E-09
C-14	1.84±0.71E-04	6.32±5.06E-05	1.24±0.60E-04	-7.67±5.17E-05	2.94±1.18E-04	7.47±2.98E-09
Tc-99	1.04±0.02E-02	1.14±0.06E-02	1.63±0.06E-02	1.66±0.08E-02	5.47±0.12E-02	1.39±0.03E-06
Total U(g)	1.62±0.18E+02	5.25±0.76E+01	3.66±0.24E+01	9.98±1.20E+01	3.51±0.14E+02	8.91±0.36E-03 μg/mL

Table C - 1.2

Comparison of 1993 Lagoon 3 Liquid Effluent Radioactivity Concentrations with Department of Energy Guidelines

Isotope	Discharge Activity[a] (Ci)	Radioactivity[a] (Becquerels)	Concentration (μCi/mL)	DCG (μCi/mL)	% of DCG
Gross Alpha	8.56±1.41E-04	3.17±0.52E+07	2.17±0.36E-08	N/A[b]	N/A
Gross Beta	4.32±0.06E-02	1.60±0.02E+09	1.10±0.02E-06	N/A[b]	N/A
H-3	9.85±0.12E-01	3.64±0.04E+10	2.50±0.03E-05	2.00E-03	1.25
Sr-90	9.23±0.17E-03	3.42±0.06E+08	2.34±0.04E-07	1.00E-06	23.44
Cs-137	6.67±2.76E-04	2.47±1.02E+07	1.69±0.70E-08	3.00E-06	0.56
Co-60	0.00±3.54E-04	0.00±1.31E+07	0.00±9.00E-09	5.00E-06	<0.18
K-40	2.79±4.84E-03	1.03±1.79E+08	0.71±1.23E-06	N/A	N/A
U-232[c]	6.20±0.22E-04	2.29±0.08E+07	1.57±0.06E-08	1.00E-07	15.73
U-233/234[c]	3.36±0.12E-04	1.25±0.05E+07	8.54±0.32E-09	5.00E-07	1.71
U-235[c]	2.66±0.96E-06	9.83±3.53E+04	6.74±2.42E-11	6.00E-07	0.01
U-236[c]	3.03±0.97E-06	1.12±0.36E+05	7.68±2.46E-11	5.00E-07	0.02
U-238[c]	1.57±0.08E-04	5.79±0.28E+06	3.97±0.19E-09	6.00E-07	0.66
Pu-238	8.62±2.03E-06	3.19±0.75E+05	2.19±0.52E-10	4.00E-08	0.55
Pu-239/240	1.33±0.90E-06	4.91±3.33E+04	3.37±2.29E-11	3.00E-08	0.11
Am-241	8.04±6.17E-07	2.97±2.28E+04	2.04±1.57E-11	3.00E-08	0.07
I-129	1.99±0.12E-04	7.35±0.45E+06	5.04±0.31E-09	5.00E-07	1.01
C-14	2.94±1.18E-04	1.09±0.44E+07	7.47±2.98E-09	7.00E-05	0.01
Tc-99	5.47±0.12E-02	2.02±0.05E+09	1.39±0.03E-06	1.00E-04	1.39
TOTAL % of DCGs					**46.69**

[a] *Total volume released: 3.94E+10 mL.*

[b] *Derived concentration guides (DCGs) are not applicable to gross alpha, gross beta, or potassium-40 activity.*

[c] *Total U (g) = 3.51±0.14E+02; Average U (μg/mL) = 8.91±0.36E-03.*

N/A - Not applicable.

Table C - 1.3

1993 Radioactivity Concentrations (µCi/mL) in Surface Water Upstream of the WVDP at Fox Valley (WFBCBKG)

Month	Alpha	Beta	H-3	Sr-90	Cs-137
January	0.63±1.09E-09	1.34±1.52E-09	0.00±1.00E-07		
February	-2.47±8.39E-10	3.93±1.64E-09	8.12±7.69E-08		
March	0.00±6.50E-10	3.41±1.66E-09	2.47±8.04E-08		
1st Qtr				1.74±2.13E-09	0.00±6.14E-09
April	-0.47±1.30E-09	1.28±1.65E-09	0.00±1.00E-07		
May	0.28±1.10E-09	2.67±1.63E-09	0.00±1.00E-07		
June	1.88±1.95E-09	2.90±1.83E-09	0.00±1.00E-07		
2nd Qtr				3.51±2.47E-09	0.26±5.79E-09
July	-4.04±7.92E-10	2.02±1.82E-09	7.31±8.02E-08		
August	0.00±2.42E-09	3.53±1.75E-09	0.00±1.00E-07		
September	1.70±2.40E-09	3.05±1.81E-09	0.00±1.00E-07		
3rd Qtr				3.08±2.19E-09	0.00±5.95E-09
October	-1.96±2.03E-09	4.16±1.93E-09	1.03±0.77E-07		
November	0.92±1.59E-09	2.76±1.53E-09	2.80±7.93E-08		
December	0.00±1.10E-09	2.65±1.51E-09	0.00±1.00E-07		
4th Qtr				5.51±2.50E-09	0.00±8.49E-09

Table C - 1.4

1993 Radioactivity Concentrations (µCi/mL) in Surface Water Downstream of the WVDP at Thomas Corners (WFBCTCB)

Month	Alpha	Beta	H-3	Sr-90	Cs-137
*January**	2.47±1.81E-09	6.07±1.99E-09	0.00±1.00E-07		
February	-2.61±8.87E-10	3.88±1.65E-09	0.00±1.00E-07		
*March**	0.58±1.14E-09	5.27±1.87E-09	0.00±1.00E-07		
1st Qtr				2.35±2.16E-09	0.00±8.90E-09
*April**	0.47±1.60E-09	6.58±1.97E-09	0.00±1.00E-07		
May	8.52±9.64E-10	5.34±2.00E-09	0.00±1.00E-07		
June	1.08±1.80E-09	6.20±2.15E-09	0.00±1.00E-07		
2nd Qtr				3.17±2.39E-09	0.00±5.79E-09
*July**	2.24±2.32E-09	8.30±2.38E-09	1.56±0.79E-07		
August	-0.27±2.40E-09	1.10±0.25E-08	0.00±1.00E-07		
*September**	2.53±2.48E-09	1.86±0.30E-08	1.04±7.62E-08		
3rd Qtr				5.51±2.27E-09	0.00±5.95E-09
*October**	-0.41±2.67E-09	4.76±2.33E-09	0.00±1.00E-07		
November	3.01±2.47E-09	6.29±1.92E-09	2.69±7.62E-08		
*December**	1.82±2.14E-09	7.41±2.02E-09	1.88±7.60E-08		
4th Qtr				4.75±2.17E-09	2.55±5.93E-09

* *Month of discharge from WNSP001.*

Table C - 1.5

1993 Monthly Radioactivity Concentrations (μCi/mL) in Surface Water Downstream of the WVDP at Frank's Creek (WNSP006)

Month	Alpha	Beta	H-3
*January**	1.56±2.04E-09	7.24±0.52E-08	9.72±1.04E-07
February	0.54±2.55E-09	2.54±0.33E-08	1.22±0.83E-07
*March**	0.98±2.70E-09	9.01±0.59E-08	1.11±0.10E-06
*April**	0.73±2.40E-09	1.52±0.10E-07	2.46±0.17E-06
May	1.32±2.47E-09	5.18±0.47E-08	3.00±8.58E-08
June	3.09±4.54E-09	6.00±0.53E-08	1.61±0.87E-07
*July**	4.81±7.35E-09	1.91±0.09E-07	3.70±0.26E-06
August	1.42±6.25E-09	6.54±0.65E-08	1.10±0.81E-07
*September**	1.22±7.75E-09	1.27±0.07E-07	3.16±0.21E-06
*October**	2.40±4.39E-09	1.41±0.11E-07	3.12±0.22E-06
November	2.04±2.68E-09	2.45±0.48E-08	1.02±0.78E-07
*December**	1.08±2.57E-09	5.10±0.62E-08	8.80±0.99E-07

** Month of discharge from WNSP001.*

Table C - 1.6

1993 Quarterly Radioactivity Concentrations (μCi/mL) in Surface Water Downstream of the WVDP at Frank's Creek (WNSP006)

	C-14	Sr-90	I-129	Cs-137	U-233/234
1st Qtr	-6.50±7.90E-09	2.66±0.40E-08	8.60±5.10E-10	1.12±2.60E-08	4.60±1.50E-10
2nd Qtr	1.70±1.00E-08	2.58±0.41E-08	-0.20±4.16E-10	0.38±2.18E-08	3.40±1.30E-10
3rd Qtr	-7.65±9.05E-09	3.68±0.51E-08	5.70±3.80E-10	1.14±1.95E-08	8.00±2.10E-10
4th Qtr	-8.30±9.10E-09	1.96±0.37E-08	-0.12±7.48E-10	0.68±2.37E-08	2.40±1.00E-10

	U-235	U-238	Pu-238	Pu-239/240	Am-241
1st Qtr	1.40±3.50E-11	3.20±1.20E-10	0.33±3.29E-11	0.66±4.66E-10	3.20±4.20E-11
2nd Qtr	0.28±2.77E-11	3.50±1.30E-10	0.30±3.05E-11	2.70±4.60E-11	1.20±3.10E-10
3rd Qtr	0.87±3.46E-11	4.55±1.59E-10	0.51±5.08E-11	0.51±5.08E-11	3.47±1.37E-10
4th Qtr	0.23±2.29E-11	2.20±0.90E-10	0.35±3.46E-11	0.35±3.46E-11	3.00±4.00E-11

Table C - 1.7

1993 Monthly Radioactivity Concentrations (μCi/mL) in Surface Water Downstream of Buttermilk Creek at Felton Bridge (WFFELBR)

Month	Alpha	Beta	H-3	Sr-90	Cs-137
*January**	0.00±1.26E-09	3.46±1.81E-09	0.00±1.00E-07	2.70±1.81E-09	0.00±9.49E-09
February	0.00±1.49E-09	3.72±1.70E-09	0.04±1.04E-07	5.38±2.25E-09	0.00±6.14E-09
*March**	0.00±2.16E-09	2.16±1.82E-09	4.48±7.75E-08	1.09±1.74E-09	4.09±8.90E-09
*April**	1.36±1.64E-09	3.14±1.72E-09	0.00±1.00E-07	2.39±1.97E-09	0.00±6.14E-09
May	-1.14±1.98E-09	4.20±1.86E-09	0.00±1.00E-07	2.58±2.16E-09	0.00±9.55E-09
June	1.49±2.18E-09	2.07±1.80E-09	0.00±1.00E-07	3.23±2.20E-09	2.18±5.79E-09
*July**	-2.55±2.50E-09	3.73±1.84E-09	2.82±7.54E-08	7.52±2.60E-09	0.00±5.95E-09
August	0.00±2.81E-09	2.23±1.81E-09	0.00±1.00E-07	2.92±2.02E-09	1.27±5.95E-09
*September**	0.49±2.88E-09	3.69±1.95E-09	0.00±1.00E-07	2.94±1.95E-09	0.00±5.95E-09
*October**	2.14±2.57E-09	1.89±2.15E-09	1.27±0.78E-07	4.70±2.14E-09	0.00±5.95E-09
November	1.96±2.35E-09	3.12±2.16E-09	4.09±7.74E-08	4.88±2.48E-09	0.00±8.49E-09
*December**	-0.47±2.08E-09	1.88±1.96E-09	0.00±1.00E-07	1.76±2.03E-09	0.00±8.49E-09

** Month of discharge from WNSP001.*

Table C - 1.8

1993 Radioactivity Concentrations (μCi/mL) in Potable Well Water around the WVDP

Well	pH	Conductivity (μmhos/cm @25 °C)	Alpha	Beta	H-3	Cs-137
WFWEL01	7.51	394	1.55±2.68E-09	1.78±1.85E-09	0.00±1.00E-07	0.00±3.13E-08
WFWEL02	6.86	316	0.42±1.85E-09	1.16±1.74E-09	5.13±7.68E-08	0.00±1.83E-08
WFWEL03	6.81	827	0.00±3.81E-09	6.22±3.40E-09	0.00±1.00E-07	0.00±3.13E-08
WFWEL04	8.11	1,731	-2.40±8.15E-09	0.00±6.58E-09	0.00±1.00E-07	0.70±1.83E-08
WFWEL05	6.68	290	1.20±2.07E-09	4.05±2.07E-09	0.00±1.00E-07	0.00±3.13E-08
WFWEL06	7.45	286	0.82±1.96E-09	0.58±1.66E-09	0.00±1.00E-07	0.00±3.13E-08
WFWEL07	7.45	381	1.90±2.64E-09	0.12±1.62E-09	3.80±7.70E-08	0.00±1.83E-08
WFWEL08	7.32	485	0.00±2.66E-09	4.28±3.08E-09	0.00±1.00E-07	0.00±3.13E-08
WFWEL09	7.85	642	0.00±3.11E-09	4.17±3.10E-09	0.00±1.00E-07	0.00±1.83E-08
WFWEL10	7.17	572	-0.84±2.87E-09	3.82±3.08E-09	0.00±1.00E-07	0.00±1.83E-08

Table C - 1.9

1993 Radioactivity Concentrations in Stream Sediments around the WVDP (μCi/g dry weight from upper 15 cm)

Location	Date	Alpha	Beta	K-40	Cs-137	Sr-90	Co-60
SFBCSED	6/93	9.70±5.00E-06	4.20±0.40E-05	1.50±0.10E-05	7.00±3.60E-08	2.10±4.10E-08	1.60±2.50E-08
SFBCSED	11/93	1.10±0.60E-05	5.90±0.40E-05	2.70±0.30E-05	3.40±2.50E-08	1.20±0.20E-07	0.00±2.30E-08
SFBISED	6/93	1.70±0.60E-05	4.70±0.40E-05	1.40±0.10E-05	3.80±2.70E-08	1.40±7.30E-08	3.80±2.60E-08
SFBISED	10/93	4.30±4.00E-06	2.50±0.30E-05	1.20±0.10E-05	2.00±1.40E-08	2.20±0.10E-06	-0.09±1.23E-08
SFCCSED	6/93	1.60±0.60E-05	3.40±0.30E-05	1.30±0.10E-05	4.40±0.40E-07	5.40±4.40E-08	-0.17±1.52E-08
SFCCSED	10/93	1.50±0.60E-05	3.60±0.30E-05	1.20±0.10E-05	4.00±0.40E-07	3.10±2.80E-08	0.27±1.83E-08
SFSDSED	6/93	9.70±5.00E-06	3.80±0.30E-05	1.20±0.10E-05	1.60±0.40E-07	5.40±4.40E-08	-0.09±2.16E-08
SFSDSED	10/93	1.30±0.60E-05	4.25±0.35E-05	1.45±0.10E-05	4.00±0.50E-07	6.65±3.05E-08	-0.06±2.42E-08
SFTCSED	6/93	1.20±0.55E-05	3.55±0.30E-05	1.20±0.10E-05	1.40±0.10E-06	9.25±4.76E-08	1.09±1.79E-08
SFTCSED	10/93	1.10±0.50E-05	4.30±0.30E-05	1.30±0.10E-05	1.80±0.20E-06	1.70±0.40E-07	0.81±1.77E-08

Location	Date	U-233/234	U-235	U-238	Pu-238	Pu-239/240	Am-241
SFBCSED	6/93	1.20±0.30E-07	5.60±7.40E-09	5.70±2.10E-08	1.30±9.40E-09	-3.30±8.70E-09	0.69±1.17E-08
SFBCSED	11/93	1.90±0.40E-07	9.80±9.50E-09	1.40±0.30E-07	4.10±7.50E-09	0.41±4.12E-09	0.10±1.00E-08
SFTCSED	6/93	8.15±2.40E-08	3.52±5.77E-09	6.25±2.00E-08	2.75±7.11E-09	-0.34±6.05E-09	3.00±7.91E-09
SFTCSED	10/93	1.00±0.30E-07	3.00±7.80E-09	7.40±2.80E-08	0.53±5.31E-09	2.70±6.80E-09	0.52±1.34E-08

Location	Date	U-232
SFBCSED	6/93	0.37±7.81E-09
SFBCSED	11/93	-1.10±7.20E-09
SFTCSED	6/93	0.89±1.11E-08
SFTCSED	10/93	0.96±1.14E-08

Table C - 1.10

1993 Radioactivity Concentrations in Surface Soil Collected at Air Sampling Stations around the WVDP (μCi/g dry weight from upper 15 cm)

Location	K-40	Cs-137	Sr-90	Am-241	Pu-239/240
SFFXVRD	1.10±0.10E-05	7.50±3.50E-08	1.40±0.70E-07	0.83±9.64E-09	0.30±2.99E-08
SFRSPRD	1.25±0.10E-05	1.55±0.16E-06	2.30±0.71E-07	3.35±6.75E-09	-0.10±2.13E-08
SFRT240	1.30±0.10E-05	1.00±0.10E-06	2.80±0.80E-07	1.00±0.90E-08	0.35±3.59E-08
SFSPRVL	1.30±0.10E-05	6.10±0.60E-07	2.70±0.60E-07	1.50±1.00E-08	0.27±2.73E-08
SFTCORD	2.00±0.20E-05	5.40±0.60E-07	2.00±0.70E-07	0.98±9.79E-09	0.95±1.06E-07
SFWEVAL	1.00±0.10E-05	7.10±0.70E-07	2.70±0.60E-07	7.20±7.00E-09	0.33±3.31E-08
SFGRVAL	1.40±0.10E-05	6.10±0.60E-07	4.30±0.80E-07	0.56±1.42E-08	-0.51±1.34E-08
SFBOEHN	1.70±0.20E-05	6.70±0.70E-07	2.60±0.50E-07	6.60±8.70E-09	0.16±1.59E-08
SFDNKRK	4.80±0.50E-06	1.40±0.30E-07	1.60±4.70E-08	0.99±9.87E-09	-0.78±2.04E-08
SFBLKST	2.50±0.20E-05	3.20±0.60E-07	3.60±7.40E-08	6.20±8.10E-09	6.60±7.30E-08

Location	U-233/234	U-235	U-238
SFRSPRD	1.04±0.28E-07	1.22±4.85E-09	8.50±2.63E-08
SFGRVAL	1.30±0.40E-07	1.30±1.30E-08	1.30±0.40E-07
SFBOEHN	1.00±0.30E-07	9.40±9.20E-09	9.70±2.80E-08

Table C - 1.11

1993 Surface Water Quality at Locations WFBCBKG, WNSP006, WNSWAMP, and WNSW74A

Location	Date	pH	Conductivity (μmhos/cm@25°C)	NPOC (mg/L)	TOX (μg/L)	Chloride (mg/L)	Sulfate (mg/L)	Nitrate/ Nitrite (mg/L)	Fluoride (mg/L)	Bicarbonate Alkalinity (as $CaCO_3$)	Carbonate Alkalinity (as $CaCO_3$)
WFBCBKG	06/09	7.65*	N/A	2.8	7.8	13.9	19.9	0.290	<0.10	94.5	<1.0
WFBCBKG	11/10	7.76*	N/A	2.4	7.6	10.0	22.4	0.270	<0.10	67.5	<1.0
WNSP006	06/09	7.75**	502**	5.8	33.0	52.8	39.8	2.400	0.12	120.0	<1.0
WNSP006	11/10	7.68**	676**	3.4	30.8	50.1	24.4	1.000	<0.10	91.3	<1.0
WNSWAMP	06/09	7.26	N/A	5.2	6.6	108.0	27.5	1.000	<0.10	172.0	<1.0
WNSWAMP	11/10	7.17**	687	3.8	9.2	97.0	32.3	1.400	<0.10	181.0	<1.0
WNSW74A	06/09	7.65**	690**	6.3	13.0	55.1	42.7	<0.050	0.11	156.0	<1.0
WNSW74A	11/10	7.52**	591**	3.8	7.6	57.3	54.4	0.670	<0.10	146.0	<1.0

Location	Date	Ca Total (μg/L)	Mg Total (μg/L)	Na Total (μg/L)	K Total (μg/L)	Ba Total (μg/L)	Mn Total (μg/L)	Mn Soluble (μg/L)	Fe Total (μg/L)	Fe Soluble (μg/L)
WFBCBKG	06/09	38,700.0	5,450	10,600.0	2,100	92.0	92.0	N/A	2,160.0	N/A
WFBCBKG	11/10	24,600.0	3,550	8,860.0	1,180	53.0	30.0	N/A	519.0	N/A
WNSP006	06/09	52,150.0	7,800	33,650.0	3,365	62.5	131.0	N/A	3,635.0	N/A
WNSP006	11/10	41,400.0	6,530	35,800.0	2,540	47.0	110.0	N/A	587.0	N/A
WNSWAMP	06/09	83,700.0	10,600	33,200.0	1,710	113.0	N/A	740.0	747.0	N/A
WNSWAMP	11/10	100,000.0	13,200	41,000.0	1,910	119.0	N/A	266.0	117.0	N/A
WNSW74A	06/09	65,000.0	7,180	31,900.0	1,160	15.0	52.0	N/A	N/A	140.0
WNSW74A	11/10	73,300.0	9,080	33,200.0	1,720	55.0	32.0	N/A	N/A	112.0

** Average of biweekly measurements during a semiannual period.*

*** Average of weekly measurements during semiannual period.*

N/A - Not applicable.

Table C - 1.12

1993 Monthly Radioactivity Concentrations (μCi/mL) in Surface Water at the Northeast Swamp Location (WNSWAMP)

Month	Alpha	Beta	H-3
January	1.32±1.49E-09	6.77±0.48E-08	3.94±7.98E-08
February	2.32±4.02E-09	5.25±0.14E-07	5.37±0.82E-07
March	0.77±2.62E-09	4.73±0.14E-07	2.99±0.82E-07
April	3.34±3.46E-09	7.75±0.17E-07	4.62±0.83E-07
May	-0.84±4.37E-09	7.95±0.18E-07	4.88±0.85E-07
June	0.00±4.09E-09	6.78±0.20E-07	1.83±0.92E-07
July	0.00±3.88E-09	6.47±0.20E-07	5.80±0.87E-07
August	-1.28±5.60E-09	7.20±0.21E-07	3.80±0.85E-07
September	3.01±6.53E-09	9.10±0.24E-07	4.79±0.83E-07
October	2.98±5.66E-09	8.81±0.26E-07	4.39±0.83E-07
November	3.99±4.48E-09	6.64±0.22E-07	3.45±0.87E-07
December	4.11±5.07E-09	9.38±0.25E-07	4.47±0.82E-07

Table C - 1.13

1993 Quarterly Radioactivity Concentrations (μCi/mL) in Surface Water at the Northeast Swamp Location (WNSWAMP)

	C-14	Sr-90	I-129	Cs-137	U-233/234
4th Qtr	-2.50±9.20E-09	4.12±0.15E-07	4.40±7.80E-10	0.38±1.30E-08	1.30±0.80E-10

	U-235	U-238	Pu-238	Pu-239/240	Am-241
4th Qtr	0.25±2.45E-11	8.10±6.10E-11	0.35±3.46E-11	4.50±5.90E-11	1.90±3.10E-11

Table C - 1.14

1993 Monthly Radioactivity Concentrations (μCi/mL) in Surface Water at the North Swamp Location (WNSW74A)

Month	Alpha	Beta	H-3
January	0.50±2.94E-09	1.77±0.44E-08	1.79±8.68E-08
February	-0.55±2.42E-09	1.65±0.31E-08	0.00±1.00E-07
March	-1.37±5.17E-09	2.09±0.42E-08	7.32±7.58E-08
April	0.04±3.12E-09	1.69±0.42E-08	0.10±9.74E-08
May	-0.70±3.56E-09	1.80±0.40E-08	0.00±1.00E-07
June	1.25±3.18E-09	1.79±0.41E-08	0.50±9.72E-08
July	0.48±2.91E-09	1.52±0.39E-08	1.24±9.14E-08
August	-1.40±4.00E-09	1.70±0.39E-08	2.36±9.48E-08
September	0.10±2.68E-09	1.57±0.37E-08	3.68±8.36E-08
October	-0.06±2.21E-09	1.58±0.36E-08	2.95±9.18E-08
November	1.09±2.53E-09	1.30±0.34E-08	0.41±9.47E-08
December	0.77±3.04E-09	1.45±0.36E-08	0.00±1.00E-07

Table C - 1.15

1993 Quarterly Radioactivity Concentrations (μCi/mL) in Surface Water at the North Swamp Location (WNSW74A)

	C-14	Sr-90	I-129	Cs-137	U-233/234
1st Qtr	2.10±0.10E-06	9.12±2.65E-09	0.30±1.13E-09	0.47±2.82E-08	6.30±6.50E-11
2nd Qtr	2.75±0.90E-08	1.02±0.29E-08	2.65±3.85E-10	0.34±2.72E-08	9.30±6.86E-11
3rd Qtr	-1.20±0.90E-08	8.93±2.86E-09	-1.50±2.90E-10	0.04±1.95E-08	1.90±1.10E-10
4th Qtr	-0.33±9.25E-09	7.79±2.67E-09	0.00±6.50E-10	0.00±2.37E-08	8.80±5.90E-11

	U-235	U-238	Pu-238	Pu-239/240	Am-241
1st Qtr	0.28±2.84E-11	4.80±5.40E-11	0.28±2.84E-11	-0.28±4.36E-11	2.80±5.30E-11
2nd Qtr	0.27±2.67E-11	4.65±5.40E-11	0.28±2.89E-11	0.42±3.10E-11	2.00±4.26E-11
3rd Qtr	0.35±3.52E-11	1.40±1.00E-10	0.45±4.49E-11	1.30±7.80E-11	2.50±4.30E-11
4th Qtr	0.21±2.15E-11	5.40±4.70E-11	0.32±3.23E-11	4.20±5.50E-11	4.40±1.20E-10

Table C - 1.16

1993 Monthly Radioactivity Concentrations (μCi/mL) and pH in Surface Water at Location WNFRC67

Month	Alpha	Beta	H-3	pH
January	2.01±6.82E-10	2.58±1.84E-09	1.62±0.81E-07	7.40
February	0.00±8.64E-10	3.87±1.62E-09	0.00±1.00E-07	7.35
March	0.00±1.82E-09	3.91±1.74E-09	5.60±7.85E-08	7.17
April	5.67±8.29E-10	2.07±1.65E-09	1.44±8.42E-08	7.66
May	0.60±1.87E-09	4.49±1.75E-09	0.00±1.00E-07	7.72
June	1.25±2.14E-09	8.53±2.98E-09	0.00±1.00E-07	7.83
July	-1.28±1.88E-09	8.87±2.52E-09	9.33±8.15E-08	7.78
August	0.00±2.42E-09	7.35±2.72E-09	0.00±1.00E-07	7.80
September	-1.42±2.07E-09	1.12±0.28E-08	0.00±1.00E-07	7.77
October	0.80±1.11E-09	6.31±2.73E-09	0.00±1.00E-07	7.70
November	0.94±1.85E-09	0.61±3.42E-09	3.57±7.79E-08	7.51
December	-5.87±8.13E-10	4.27±1.97E-09	9.84±7.63E-08	7.47

Table C - 1.17

1993 Monthly Radioactivity Concentrations (μCi/mL) and pH in Surface Water at Location WNERB53

Month	Alpha	Beta	H-3	pH
January	1.08±1.79E-09	1.75±0.28E-08	6.23±7.84E-08	7.59
February	0.77±3.42E-09	2.72±0.39E-08	1.51±0.78E-07	7.62
March	0.06±2.71E-09	2.45±0.37E-08	2.70±4.08E-07	7.47
April	-0.18±1.68E-09	1.61±0.32E-08	1.33±0.79E-07	7.83
May	1.30±2.97E-09	2.18±0.37E-08	1.83±8.76E-08	7.90
June	0.87±4.27E-09	2.38±0.39E-08	8.34±8.54E-08	7.92
July	-1.96±5.53E-09	2.33±0.40E-08	1.15±0.85E-07	7.92
August	-0.88±5.23E-09	2.27±0.45E-08	0.00±1.00E-07	7.88
September	-2.87±4.18E-09	2.30±0.42E-08	0.00±1.00E-07	7.83
October	-0.29±3.75E-09	2.67±0.47E-08	1.34±0.83E-07	7.76
November	0.99±2.21E-09	1.90±0.40E-08	1.52±0.79E-07	7.64
December	2.44±2.82E-09	2.87±0.40E-08	2.54±0.80E-07	7.64

Table C - 1.18

1993 Monthly Radioactivity Concentrations (μCi/mL) and pH in Surface Water at Location WNCOOLW

Month	Alpha	Beta	H-3	pH
January	0.99±3.36E-09	2.62±0.38E-08	0.00±1.00E-07	7.95
February	2.22±4.36E-09	2.16±0.44E-08	2.12±7.68E-08	7.83
March	0.00±2.45E-09	3.09±0.49E-08	0.00±1.00E-07	7.99
April	-0.69±3.04E-09	2.59±0.47E-08	6.10±7.82E-08	7.99
May	-1.54±3.69E-09	2.56±0.45E-08	0.00±1.00E-07	8.12
June	-2.47±4.84E-09	2.49±0.46E-08	0.00±1.00E-07	8.30
July	0.00±9.22E-09	3.13±0.51E-08	5.24±8.14E-08	8.59
August	0.00±5.89E-09	1.51±0.41E-08	0.00±1.00E-07	8.54
September	-0.60±3.13E-09	1.10±0.30E-08	4.44±7.88E-08	8.38
October	3.16±3.10E-09	2.00±0.40E-08	8.95±7.76E-08	8.39
November	4.19±5.03E-09	2.14±0.46E-08	1.09±7.70E-08	8.18
December	-0.77±2.60E-09	1.37±0.35E-08	0.00±1.00E-07	8.17

Table C - 1.19

1993 Monthly Radioactivity Concentrations (μCi/mL) and pH in Surface Water at Location WNSP005

Month	Alpha	Beta	H-3	pH
January	1.83±1.34E-08	1.49±0.17E-07	0.00±1.00E-07	7.76
February	0.00±3.64E-09	8.69±1.06E-08	1.23±0.76E-07	7.40
March	-1.63±3.92E-09	1.08±0.12E-07	0.00±1.00E-07	7.29
April	0.00±4.07E-09	1.61±0.14E-07	1.27±0.79E-07	7.25
May	0.00±3.12E-09	5.82±0.75E-08	0.00±1.00E-07	7.58
June	-0.86±3.76E-09	5.65±0.91E-08	0.00±1.00E-07	7.57
July	2.69±5.82E-09	6.73±0.92E-08	0.75±7.32E-08	7.62
August	-0.01±4.14E-09	3.39±0.79E-08	0.00±1.00E-07	7.62
September	0.00±5.14E-09	7.62±0.99E-08	0.00±1.00E-07	7.51
October	2.29±3.17E-09	7.58±1.02E-08	2.93±7.55E-08	7.56
November	1.96±4.78E-09	7.98±0.97E-08	4.03±7.63E-08	7.52
December	3.38±5.85E-09	1.13±0.11E-07	3.23±7.63E-08	7.27

Table C - 1.20

1993 Monthly Radioactivity Concentrations (μCi/mL), pH, and Conductivity at Site Potable Water Location WNDNKEL

Month	Alpha	Beta	H-3	pH	Conductivity (μmhos/cm @25°C)
January	-1.73±3.39E-10	0.08±1.57E-09	1.82±0.79E-07	7.24	131.3
February	-1.87±6.36E-10	2.47±1.44E-09	0.00±1.00E-07	7.46	175.7
March	0.00±1.16E-09	1.76±1.44E-09	0.00±1.00E-07	7.42	197.9
April	0.00±4.70E-10	0.74±1.50E-09	0.00±1.00E-07	7.37	135.1
May	0.00±1.12E-09	1.67±1.39E-09	0.00±1.00E-07	7.80	189.2
June	-4.82±9.53E-10	2.92±1.65E-09	0.00±1.00E-07	7.73	220.0
July	-4.15±9.97E-10	4.61±1.70E-09	0.00±1.00E-07	7.63	233.0
August	0.59±1.63E-09	1.05±1.66E-09	0.00±1.00E-07	7.69	250.0
September	0.00±1.46E-09	2.84±1.61E-09	0.98±6.92E-08	7.63	249.0
October	1.31±1.28E-09	0.53±1.69E-09	4.03±7.63E-08	7.81	245.0
November	-3.01±5.90E-10	2.38±1.76E-09	5.17±7.74E-08	7.66	210.0
December	-5.02±6.96E-10	2.53±1.48E-09	7.24±7.66E-08	7.55	162.9

Table C - 1.21

1993 Monthly Radioactivity Concentrations (μCi/mL) in Surface Water at Location WNSP007

Month	Alpha	Beta	H-3	Sr-90	Cs-137
January	-1.87±9.24E-10	7.16±2.10E-09	1.29±9.34E-08	2.67±2.15E-09	0.00±2.14E-08
February	-0.57±1.42E-09	5.74±2.03E-09	0.00±1.00E-07	4.53±2.08E-09	0.00±2.64E-08
March	-0.96±1.91E-09	9.55±2.33E-09	3.01±9.26E-08	9.62±2.82E-09	0.00±3.22E-08
April	-0.45±1.36E-09	9.67±2.41E-09	0.00±1.00E-07	9.25±2.72E-09	0.00±1.74E-08
May	0.28±1.28E-09	8.79±2.35E-09	0.44±9.32E-08	2.44±2.15E-09	0.00±2.56E-08
June	0.18±1.74E-09	9.35±2.44E-09	0.78±9.28E-08	2.25±2.10E-09	0.96±1.96E-08
July	-0.27±2.16E-09	8.69±2.36E-09	5.91±7.83E-08	3.30±1.98E-09	0.00±1.96E-08
August	-1.83±2.64E-09	8.49±2.59E-09	0.00±1.00E-07	5.38±2.22E-09	1.85±1.94E-08
September	-0.67±2.48E-09	1.15±0.26E-08	1.47±9.33E-08	4.80±2.43E-09	0.00±1.94E-08
October	1.35±1.63E-09	9.68±2.60E-09	1.48±8.72E-08	9.91±2.95E-09	0.00±1.94E-08
November	0.46±2.08E-09	7.47±4.24E-09	3.12±8.48E-08	9.39±2.70E-09	0.00±1.83E-08
December	1.26±2.69E-09	1.02±0.36E-08	7.82±7.70E-08	9.92±2.82E-09	0.22±1.83E-08

Table C - 1.22

1993 Radioactivity Concentrations (μCi/mL) in Surface Water at Locations WNNDADR and WNNDATR

Location WNNDADR

Month	Alpha	Beta	H-3	Cs-137	Sr-90	I-129
January	4.11±3.49E-09	1.33±0.07E-07	2.26±0.12E-06	0.00±2.14E-08		
February	2.86±6.86E-09	2.35±0.10E-07	2.97±0.14E-06	0.00±3.22E-08		
March	-0.94±2.25E-09	1.01±0.09E-07	2.08±0.12E-06	0.00±1.74E-08		
1st Qtr					5.05±0.52E-08	3.20±4.50E-10
April	2.10±4.96E-09	2.15±0.13E-07	4.13±0.18E-06	0.00±3.22E-08		
May	2.98±3.38E-09	3.07±0.15E-07	8.58±0.31E-06	1.40±2.56E-08		
June	-1.01±3.42E-09	2.27±0.13E-07	3.44±0.16E-06	0.00±2.56E-08		
2nd Qtr					1.22±0.09E-07	5.60±3.50E-10
July	1.99±3.90E-09	1.99±0.12E-07	3.62±0.16E-06	0.51±1.96E-08		
August	1.05±6.15E-09	2.02±0.12E-07	2.42±0.13E-06	0.00±1.94E-08		
September	0.00±5.05E-09	2.14±0.13E-07	2.66±0.14E-06	0.70±1.94E-08		
3rd Qtr					8.28±0.68E-08	5.70±2.60E-10
October	-3.36±6.58E-09	2.90±0.17E-07	4.49±0.18E-06	0.00±1.94E-08		
November	9.48±6.19E-09	2.79±0.15E-07	3.56±0.16E-06	1.34±1.83E-08		
December	3.85±5.33E-09	2.57±0.14E-07	3.05±0.14E-06	0.00±3.13E-08		
4th Qtr					1.06±0.08E-07	-3.30±8.00E-10

Location WNNDATR

Month	Alpha	Beta	H-3	Cs-137	I-129
January	2.61±4.51E-09	4.42±0.46E-08	8.91±0.31E-06	0.00±2.14E-08	
February	4.28±9.28E-09	5.94±0.75E-08	3.85±0.12E-05	0.00±3.22E-08	
March	-1.53±4.24E-09	3.94±0.62E-08	7.08±0.26E-06	0.26±3.22E-08	
1st Qtr					0.18±1.43E-09
April	0.00±4.23E-09	5.14±0.72E-08	3.41±0.10E-05	0.00±1.96E-08	
May	-1.42±7.36E-09	7.60±0.81E-08	4.20±0.13E-05	0.00±2.56E-08	
June	0.00±2.25E-09	3.50±0.58E-08	1.18±0.04E-05	0.00±1.96E-08	
2nd Qtr					3.30±3.70E-10
July	4.00±4.78E-09	5.08±0.69E-08	1.49±0.05E-05	0.00±1.96E-08	
August	-1.57±3.77E-09	4.58±0.63E-08	1.06±0.04E-05	0.76±1.94E-08	
September	-1.13±2.70E-09	3.41±0.56E-08	4.59±0.19E-06	0.00±1.94E-08	
3rd Qtr					-0.76±3.88E-10
October	-1.10±7.19E-09	5.44±0.71E-08	1.26±0.04E-05	0.00±1.94E-08	
November	1.77±4.20E-09	4.92±0.60E-08	9.69±0.39E-06	0.10±1.83E-08	
December	1.77±5.64E-09	8.30±0.84E-08	1.99±0.06E-05	0.00±1.83E-08	
4th Qtr					2.20±6.90E-10

Table C - 1.23

1993 TOC, NPOC, TOX, and pH for Locations WNNDADR and WNNDATR

Location WNNDADR

	TOC* (mg/L)	TOX (µg/L)	pH (standard units)
January	5.5	7.8	7.6
February	6.4	13.9	7.7
March	4.2	7.7	7.4
April	7.6	17	7.9
May	9.6	22.7	7.9
June	9.2	15.6	7.6
July	9.8	25.2	7.9
August	9.3	64.5	7.8
September	10.0	21.9	7.8
October	9.6	21.42	7.9
November	7.8	15.4	7.9
December	7.4	12.4	7.8

Location WNNDATR

	NPOC* (mg/L)	TOX (µg/L)
January	NA	NA
February	NA	NA
March	2.5	12.4
April	3.4	17.6
May	3.1	14.8
June	3.8	6.4
July	3.4	18.9
August	3.4	9.2
September	5.4	10.8
October	4.4	15.5
November	3.9	6.6
December	4.2	12.8

NA - Not available.

** Total organic carbon (TOC) and nonpurgeable organic carbon (NPOC) are two variants of the same analysis. In samples that have little or no purgeable carbon component, NPOC and TOC values can be directly compared.*

Table C - 1.24

1993 Radioactivity Concentrations (μCi/g dry weight from upper 15 cm) in On-site Soil Sediments

Location	U-232	U-233/234	U-235	U-236	U-238	Total U (μg/g)
SNSP006	1.60±0.40E-08	1.20±0.30E-07	4.30±5.60E-09	0.33±3.27E-09	7.90±2.10E-08	3.20±0.90E-01
SNSW74A	2.40±0.80E-09	9.10±2.90E-08	0.53±5.26E-09	0.53±5.26E-09	7.80±2.70E-08	2.50±1.00E-01
SNSWAMP	4.30±1.40E-09	1.10±0.30E-07	3.50±6.00E-09	0.39±3.94E-09	6.20±2.00E-08	2.60±0.90E-01

	K-40	Cs-137	Sr-90	Am-241	Pu-239/240
SNSP006	1.80±0.20E-05	2.20±0.20E-05	2.80±0.20E-06	3.10±2.80E-08	2.20±1.40E-08
SNSW74A	1.20±0.10E-05	3.90±0.40E-06	4.50±0.80E-07	5.60±3.00E-08	8.80±4.60E-08
SNSWAMP	2.20±0.20E-05	7.40±0.70E-06	3.60±0.20E-06	1.80±0.60E-07	6.30±4.40E-08

Table C - 1.25

1993 Metals Concentrations (mg/kg dry) in On-site Soils

Location Code	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium
SNSP006	15,900	<1.5	18.2	90.8	0.78	0.33
SNSW74A	10,295	<1.5	18.0	69.6	0.41	<0.25
SNSWAMP	14,100	1.6	20.7	128.0	0.70	<0.27

	Calcium	Chromium	Cobalt	Copper	Iron	Lead
SNSP006	2,790	21.7	13.9	24.3	29,100	26.4
SNSW74A	11,315	12.0	9.0	14.4	20,000	18.4
SNSWAMP	21,500	19.0	12.9	22.9	27,600	18.7

	Magnesium	Manganese	Mercury	Nickel	Potassium	Selenium
SNSP006	5,930	545	<0.02	33.9	3,000	<0.12
SNSW74A	4,810	710	0.02	12.2	1,038	<0.12
SNSWAMP	6,120	779	0.02	31.0	2,290	<0.14

	Silver	Sodium	Thallium	Vanadium	Zinc
SNSP006	<0.38	116.0	<0.12	24.4	72.2
SNSW74A	<0.38	66.6	<0.12	19.3	61.6
SNSWAMP	<0.40	108.0	<0.14	19.6	108.0

Table C - 1.26

1993 Monthly Radioactivity Concentrations (μCi/mL) in Surface Water at French Drain Location WNSP008

Month	Gross Alpha	Gross Beta	H-3
January	1.91±4.99E-09	6.79±0.64E-08	4.42±0.18E-06
February	-0.03±4.73E-09	6.19±0.82E-08	4.21±0.18E-06
March	2.08±4.08E-09	7.44±0.89E-08	3.58±0.16E-06
April	1.74±4.37E-09	5.67±0.80E-08	4.21±0.18E-06
May	-0.95±4.30E-09	5.76±0.64E-08	3.72±0.14E-06
June	-1.02±3.14E-09	6.74±0.60E-08	2.83±0.15E-06
July	-2.04±3.03E-09	6.05±0.73E-08	3.81±0.17E-06
August	-2.30±4.50E-09	5.66±0.82E-08	2.98±0.15E-06
September	2.09±6.48E-09	6.48±0.83E-08	3.45±0.16E-06
October	4.51±3.12E-09	8.55±0.66E-08	4.11±0.17E-06
November	3.13±5.20E-09	8.00±1.00E-08	3.19±0.15E-06
December	0.35±5.80E-08	6.17±0.81E-08	3.17±0.15E-06

Table C - 1.27

1993 Quarterly Radioactivity Concentrations (μCi/mL) in Surface Water at Location WFBCBKG

	C-14	I-129	U-232	U-233/234	U-235	U-236
1st Qtr	-0.92±7.35E-09	-2.30±5.40E-10	-4.60±8.20E-11	3.30±4.40E-11	0.26±2.56E-11	0.26±2.56E-11
2nd Qtr	1.70±1.00E-08	3.80±3.70E-10	4.30±5.00E-10	1.10±0.70E-10	0.25±2.55E-11	0.25±2.55E-11
3rd Qtr	-1.30±9.10E-09	-1.40±5.10E-10	1.50±3.90E-11	6.40±7.10E-11	0.38±3.76E-11	0.38±3.76E-11
4th Qtr	-2.40±0.90E-08	-5.60±6.6E-10	-1.60±7.40E-11	5.30±5.50E-11	0.24±2.41E-11	0.24±2.41E-11

	U-238	Total U (μg/mL)	Pu-238	Pu-239/240	Am-241
1st Qtr	4.30±4.80E-11	1.40±0.20E-04	0.32±3.19E-11	-0.64±3.73E-11	1.10±2.90E-11
2nd Qtr	5.60±5.80E-11	1.60±0.20E-04	0.25±2.49E-11	0.25±2.49E-11	1.50±3.70E-11
3rd Qtr	7.90±7.70E-11	1.90±0.30E-04	2.20±5.70E-11	0.44±4.42E-11	0.52±5.24E-11
4th Qtr	4.10±4.60E-11	2.70±0.40E-04	-0.97±5.68E-11	2.40±6.20E-11	3.90±4.60E-11

Appendix C - 2

Summary of Air Monitoring Data

Table C - 2.1

1993 Airborne Radioactive Effluent Monthly Totals (curies) from the Main Ventilation Stack (ANSTACK)

Month	Alpha	Beta	H-3
January	5.96±2.38E-08	1.25±0.08E-06	3.90±0.06E-03
February	3.22±1.98E-08	1.34±0.08E-06	2.35±0.05E-03
March	3.02±1.74E-08	1.20±0.07E-06	2.45±0.08E-03
April	3.84±1.71E-08	1.14±0.07E-06	2.91±0.05E-03
May	7.71±2.94E-08	1.96±0.11E-06	4.03±0.05E-03
June	5.98±2.27E-08	1.25±0.08E-06	1.33±0.20E-03
July	2.81±0.44E-07	5.00±0.15E-06	2.48±0.04E-03
August	3.84±2.25E-08	1.42±0.09E-06	2.07±0.04E-03
September	6.80±2.57E-08	1.92±0.10E-06	4.64±0.07E-03
October	1.28±0.33E-07	3.52±0.13E-06	2.79±0.04E-03
November	7.46±2.62E-08	2.60±0.11E-06	7.18±0.21E-04
December	3.72±2.06E-08	2.00±0.10E-06	1.45±0.03E-03
TOTALS	9.25±0.91E-07	2.46±0.03E-05	3.11±0.03E-02

Table C - 2.2

1993 Airborne Radioactive Effluent Quarterly Totals (curies) from the Main Ventilation Stack (ANSTACK)

	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	TOTAL
Co-60	0.70±2.26E-08	0.00±2.48E-08	2.25±0.28E-08	-1.75±3.42E-08	1.21±4.81E-08
Sr-90	4.78±0.50E-07	6.34±0.79E-07	2.02±0.13E-06	1.98±1.03E-06	5.11±0.19E-06
I-129	4.24±0.24E-06	4.71±0.25E-06	6.88±0.25E-06	2.89±0.24E-06	1.87±0.05E-05
Cs-134	1.58±2.52E-08	0.77±2.59E-08	-0.58±2.78E-08	0.39±3.09E-08	2.16±5.50E-08
Cs-137	1.99±0.20E-06	2.64±0.26E-06	4.46±0.52E-06	4.12±0.52E-06	1.32±0.08E-05
Eu-154	0.00±7.55E-08	-3.97±8.19E-08	4.72±6.55E-08	-0.08±1.01E-07	-0.01±1.64E-07
U-232	-0.58±2.41E-08	-1.40±3.09E-08	-3.14±7.86E-09	1.52±4.17E-08	-0.78±5.78E-08
U-233/234	1.46±1.51E-08	0.45±4.63E-09	7.08±9.43E-09	0.90±8.98E-09	2.30±2.05E-08
U-235	0.65±6.64E-09	0.45±4.63E-09	0.55±5.53E-09	0.90±8.98E-09	0.26±1.33E-08
U-236	3.27±8.55E-09	0.45±4.63E-09	0.55±5.53E-09	0.90±8.98E-09	0.52±1.43E-08
U-238	0.65±6.64E-09	0.45±4.63E-09	0.55±5.53E-09	1.52±1.70E-08	1.68±1.96E-08
Pu-238	7.55±8.30E-09	1.06±1.03E-08	6.29±2.36E-08	2.83±1.80E-08	1.09±0.32E-07
Pu-239/240	2.36±1.36E-08	2.91±1.59E-08	7.86±2.62E-08	2.83±1.80E-08	1.60±0.38E-07
Am-241	3.27±1.76E-08	3.70±1.85E-08	1.65±0.34E-07	7.98±3.09E-08	3.15±0.53E-07
Total U (grams)	1.96±2.89E-02	-1.80±4.73E-02	0.81±2.28E-02	4.89±7.20E-02	5.87±9.37E-02

Table C - 2.3

Comparison of 1993 Main Stack Exhaust Radioactivity Concentrations with Department of Energy Guidelines

Isotope	Half-life (years)	Total Ci Released[a]	Bequerels	Average Concentration (μCi/mL)	DCG (μCi/mL)	% of DCG
Alpha	N/A	9.25±0.91E-07	3.42±0.34E+04	1.24±0.12E-15	N/A[b]	–
Beta	N/A	2.46±0.03E-05	9.10±0.11E+05	3.31±0.04E-14	N/A[b]	–
H-3	12.35	3.11±0.03E-02	1.15±0.01E+09	4.18±0.04E-11	1.00E-07	0.0
Co-60	5.27	1.21±4.81E-08	0.45±1.78E+03	1.62±6.46E-17	8.00E-11	0.0
Sr-90	29.124	5.11±0.19E-06	1.89±0.07E+05	0.69±2.57E-14	9.00E-12	<0.1
I-129	1.57E+07	1.87±0.05E-05	6.93±0.18E+05	2.52±0.07E-14	7.00E-11	0.0
Cs-134	2.06	2.16±5.50E-08	0.80±2.04E+03	2.90±7.40E-17	2.00E-10	0.0
Cs-137	30	1.32±0.08E-05	4.88±0.30E+05	0.18±1.08E-13	4.00E-10	0.0
Eu-154	8.8	-0.01±1.64E-07	-0.03±6.07E+03	-0.01±2.20E-16	5.00E-11	0.0
U-232[c]	72	-0.78±5.78E-08	-0.29±2.14E+03	-1.04±7.77E-17	2.00E-14	<0.4
U-233/234[c]	2.45E+05	2.30±2.05E-08	8.51±7.59E+02	3.09±2.76E-17	9.00E-14	0.0
U-235[c]	7.10E+08	0.26±1.33E-08	0.94±4.92E+03	0.34±1.79E-16	1.00E-13	0.0
U-236[c]	3.45E+06	0.52±1.43E-08	1.91±5.29E+02	0.70±1.92E-16	1.00E-13	0.0
U-238[c]	4.47E+09	1.68±1.96E-08	6.22±7.25E+02	2.26±2.63E-17	1.00E-13	0.0
Pu-238	87.07	1.09±0.32E-07	4.04±1.20E+03	0.15±4.37E-15	3.00E-14	<0.5
Pu-239/240	2.40E+04	1.60±0.38E-07	5.91±1.41E+03	0.22±5.11E-15	2.00E-14	<1.1
Am-241	432	3.15±0.53E-07	1.16±0.20E+04	0.42±7.07E-15	2.00E-14	<2.1
TOTAL % of DCGs[d]						**<4.3**

[a] *Total volume released at 50,000 cfm = 7.44E+14 mL/year.*

[b] *Derived concentration guides (DCGs) are not specified for gross alpha or gross beta activity.*

[c] *Total Uranium = 5.87±9.37E-02 g; Average = 7.89±12.6E-11 μg/mL.*

[d] *Total percent DCGs for applicable measured radionuclides.*

N/A - Not applicable.

DCGs are listed for reference only. They are applicable to average concentration at the site boundary but not to stack concentrations, as might be inferred from their inclusion in this table.

Table C - 2.4

1993 Airborne Radioactive Effluent Monthly Totals (curies) from the Cement Solidification System Ventilation Stack (ANCSSTK)

Month	Alpha	Beta
January	2.14±3.40E-09	3.01±0.87E-08
February	3.72±3.52E-09	2.35±0.76E-08
March	3.80±3.37E-09	2.12±0.74E-08
April	3.48±2.83E-09	2.90±0.83E-08
May	4.49±4.29E-09	1.15±0.97E-08
June	3.07±3.46E-09	7.13±9.00E-09
July	5.80±5.01E-09	3.23±9.98E-09
August	5.02±4.25E-09	6.88±8.92E-09
September	2.01±3.70E-09	1.18±0.89E-08
October	3.01±3.88E-09	2.29±9.93E-09
November	0.99±3.16E-09	1.18±0.85E-08
December	1.94±3.73E-09	1.77±9.00E-09
TOTALS	3.95±1.30E-08	1.60±0.31E-07

Table C - 2.5

1993 Airborne Radioactive Effluent Quarterly Totals (curies) from the Cement Solidification System Ventilation Stack (ANCSSTK)

	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	TOTAL
Co-60	2.34±6.35E-09	0.42±7.87E-09	3.81±6.84E-09	0.60±4.93E-09	0.72±1.32E-08
Sr-90	2.97±5.93E-09	0.66±7.26E-09	0.78±1.51E-08	0.65±5.69E-09	1.21±1.87E-08
I-129	9.76±2.93E-09	1.96±0.46E-08	1.58±0.52E-08	-1.17±6.15E-09	4.40±0.98E-08
Cs-134	5.20±6.77E-09	5.28±8.04E-09	2.69±7.35E-09	1.52±4.66E-09	1.47±1.36E-08
Cs-137	3.59±5.83E-09	-1.16±7.48E-09	-0.67±6.23E-09	5.96±5.42E-09	0.77±1.26E-08
Eu-154	0.99±1.82E-08	-0.48±2.45E-08	-0.20±2.28E-08	0.98±1.57E-08	1.28±4.12E-08
U-232	-2.29±3.49E-09	2.26±2.53E-09	-0.11±2.61E-09	1.73±2.01E-08	1.72±2.07E-08
U-233/234	0.94±9.26E-10	0.94±9.52E-10	-0.29±1.65E-09	1.68±2.76E-09	1.58±3.48E-09
U-235	0.94±9.26E-10	0.94±9.52E-10	0.14±1.42E-09	0.18±1.84E-09	0.51±2.68E-09
U-236	0.94±9.26E-10	0.94±9.52E-10	0.14±1.42E-09	0.18±1.84E-09	0.51±2.68E-09
U-238	0.83±1.41E-09	0.45±1.22E-09	0.14±1.42E-09	0.18±1.84E-09	1.64±2.98E-09
Pu-238	0.10±1.03E-09	0.17±1.72E-09	-0.22±1.27E-09	0.18±1.82E-09	0.24±2.99E-09
Pu-239/240	0.10±1.03E-09	0.17±1.72E-09	0.11±1.09E-09	-1.46±2.60E-09	-1.08±3.46E-09
Am-241	1.35±1.46E-09	-0.66±1.16E-09	2.36±1.91E-09	0.87±2.28E-09	3.92±3.50E-09
Total U (grams)	-1.77±6.04E-03	4.46±4.79E-03	0.04±5.83E-03	2.87±3.04E-02	3.15±3.19E-02

Table C - 2.6

1993 Airborne Radioactive Effluent Monthly Totals (curies) from the Contact Size-reduction Facility Ventilation Stack (ANCSRFK)

Month	Alpha	Beta
January	2.80±2.22E-09	3.33±0.57E-08
February	0.16±1.67E-09	1.65±0.45E-08
March	1.09±1.81E-09	2.71±0.52E-08
April	3.97±2.01E-09	1.26±0.45E-08
May	1.73±2.42E-09	2.44±0.66E-08
June	1.55±1.94E-09	2.22±0.60E-08
July	-0.80±2.32E-09	2.28±0.67E-08
August	1.91±2.27E-09	1.85±0.58E-08
September	7.54±3.05E-09	2.36±0.59E-08
October	3.87±2.69E-09	2.27±0.72E-08
November	2.51±2.78E-09	3.54±0.78E-08
December	1.28±2.84E-09	2.51±0.80E-08
TOTALS	2.76±0.82E-08	2.84±0.22E-07

Table C - 2.7

1993 Airborne Radioactive Effluent Quarterly Totals (curies) from the Contact Size-reduction Facility Ventilation Stack (ANCSRFK)

	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	TOTAL
Co-60	-1.76±0.38E-09	-1.03±3.37E-09	1.00±4.56E-09	-1.04±3.88E-09	-2.82±6.88E-09
Sr-90	0.37±2.35E-09	-1.12±3.88E-09	-1.26±3.07E-09	0.73±4.38E-09	-1.28±7.01E-09
I-129	9.00±3.21E-09	-0.14±4.11E-09	4.04±3.03E-09	1.32±4.24E-09	1.42±0.74E-08
Cs-134	-1.20±3.67E-09	0.48±2.82E-09	0.36±4.91E-09	-1.19±3.81E-09	-1.56±7.75E-09
Cs-137	-3.39±3.70E-09	0.74±2.82E-09	0.14±4.56E-09	2.34±3.73E-09	-0.17±7.51E-09
Eu-154	0.71±1.02E-08	-0.67±1.03E-08	0.84±1.52E-08	0.06±1.17E-08	0.94±2.40E-08
U-232	-0.15±3.64E-09	-0.58±1.06E-09	0.12±1.76E-09	1.35±1.23E-08	1.28±1.30E-08
U-233/234	3.39±8.95E-10	0.51±5.23E-10	-0.39±1.71E-09	0.16±1.63E-09	0.16±2.58E-09
U-235	0.71±6.97E-10	2.60±6.67E-10	-0.61±1.10E-09	-0.33±1.90E-09	-0.61±2.40E-09
U-236	0.71±6.97E-10	0.51±5.23E-10	0.74±7.53E-10	0.16±1.63E-09	0.36±2.00E-09
U-238	0.71±1.27E-09	4.81±8.01E-10	0.74±7.53E-10	0.33±2.30E-09	1.59±2.85E-09
Pu-238	0.52±5.18E-10	0.87±8.72E-10	-3.23±8.40E-10	0.16±1.63E-09	-0.02±2.09E-09
Pu-239/240	0.52±5.18E-10	0.87±8.72E-10	0.65±6.43E-10	0.16±1.63E-09	0.36±2.02E-09
Am-241	2.50±6.39E-10	0.15±1.53E-09	0.58±5.75E-10	3.84±9.99E-10	0.85±2.02E-09
Total U (grams)	1.51±2.50E-03	0.38±2.44E-03	-1.10±4.23E-03	2.04±1.88E-02	2.12±1.96E-02

Table C - 2.8

1993 Airborne Radioactive Effluent Monthly Totals (curies) from the Supernatant Treatment System Ventilation Stack (ANSTSTK)

Month	Alpha	Beta
January	1.71±1.73E-09	1.37±0.41E-08
February	-0.59±1.21E-09	8.66±3.44E-09
March	2.01±1.54E-09	1.22±0.37E-08
April	0.86±1.13E-09	1.13±0.37E-08
May	-0.14±1.59E-09	1.32±0.47E-08
June	0.15±1.23E-09	1.41±0.43E-08
July	-0.81±1.63E-09	1.46±0.47E-08
August	0.88±1.63E-09	1.37±0.44E-08
September	0.45±1.56E-09	1.09±0.42E-08
October	1.20±1.70E-09	3.63±4.53E-09
November	2.26±1.80E-09	5.26±3.94E-09
December	0.15±1.59E-09	1.54±4.23E-09
TOTALS	8.13±5.34E-09	1.23±0.14E-07

Table C - 2.9

1993 Airborne Radioactive Effluent Quarterly Totals (curies) from the Supernatant Treatment System Ventilation Stack (ANSTSTK)

	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	TOTAL
Co-60	1.20±3.42E-09	0.75±2.68E-09	1.79±3.82E-09	1.20±3.49E-09	4.93±6.75E-09
Sr-90	0.72±3.20E-09	-2.10±3.29E-09	-2.72±3.05E-09	1.00±3.07E-09	-3.09±6.30E-09
I-129	1.60±0.02E-07	1.59±0.02E-07	2.36±0.02E-07	4.45±0.24E-07	1.00±0.03E-06
Cs-134	0.00±2.50E-09	1.21±3.40E-09	-1.21±3.19E-09	-0.61±3.32E-09	-0.61±6.24E-09
Cs-137	0.97±2.36E-09	2.04±3.23E-09	1.07±0.38E-08	5.02±3.91E-09	1.87±0.68E-08
Eu-154	-0.84±8.04E-09	0.50±1.21E-08	1.07±1.21E-08	0.92±1.26E-08	2.41±2.27E-08
U-232	1.28±1.81E-09	-0.75±1.74E-09	-0.22±1.01E-09	-3.07±8.37E-09	-2.76±8.80E-09
U-233/234	0.67±6.65E-10	0.50±4.89E-10	0.14±1.01E-09	0.11±1.07E-09	0.36±1.69E-09
U-235	0.67±6.65E-10	0.50±4.89E-10	0.71±7.14E-10	0.11±1.07E-09	0.29±1.53E-09
U-236	0.67±6.65E-10	0.50±4.89E-10	0.71±7.14E-10	1.06±1.07E-10	0.29±1.53E-09
U-238	3.34±8.62E-11	2.46±6.27E-10	0.71±7.14E-10	0.11±1.07E-09	0.46±1.44E-09
Pu-238	0.50±5.09E-10	0.58±5.85E-10	0.60±6.07E-10	0.10±1.05E-09	0.27±1.44E-09
Pu-239/240	-2.53±6.68E-10	0.58±5.85E-10	0.60±6.07E-10	0.10±1.05E-09	-0.03±1.50E-09
Am-241	3.89±6.40E-10	4.42±5.80E-10	3.57±9.34E-10	0.11±1.07E-09	1.29±1.66E-09
Total U (grams)	2.20±3.14E-03	-0.52±3.01E-03	0.20±2.77E-03	-0.39±1.28E-02	-0.20±1.38E-02

Table C - 2.10

1993 Airborne Radioactive Effluent Monthly Totals (curies) from the Supercompactor Ventilation Stack (ANSUPCV)

Month	**Alpha**	**Beta**
January	0.77±2.71E-10	2.60±0.74E-09
February	0.26±2.42E-10	2.90±0.68E-09
March	0.26±2.31E-10	2.20±0.65E-09
April	2.06±2.14E-10	1.39±0.62E-09
May	-1.30±2.65E-10	9.74±7.43E-10
June	0.00±2.22E-10	7.90±5.93E-10
July	-0.53±3.22E-10	1.48±0.69E-09
August	-0.53±2.56E-10	1.06±0.60E-09
September	3.48±3.28E-10	1.62±0.68E-09
October	2.68±3.16E-10	1.67±0.86E-09
November	3.50±3.12E-10	1.23±0.72E-09
December	0.00±2.79E-10	4.04±7.58E-10
TOTALS	1.06±0.95E-09	1.83±0.24E-08

Table C - 2.11

1993 Airborne Radioactive Effluent Quarterly Totals (curies) from the Supercompactor Ventilation Stack (ANSUPCV)

	1st Qtr	**2nd Qtr**	**3rd Qtr**	**4th Qtr**	**TOTAL**
Co-60	-3.02±5.82E-10	4.35±6.27E-10	2.35±7.42E-10	0.42±4.45E-10	0.41±1.22E-09
Sr-90	0.71±4.49E-10	-2.62±6.00E-10	0.00±4.26E-10	-0.11±1.01E-09	-0.30±1.33E-09
Cs-134	0.23±6.26E-10	0.98±5.55E-10	-3.06±6.97E-10	-0.53±4.09E-10	-0.24±1.16E-09
Cs-137	1.91±5.95E-10	7.11±5.78E-10	4.44±5.77E-10	3.87±4.58E-10	1.73±1.11E-09
Eu-154	0.58±2.13E-09	2.58±1.73E-09	-0.67±2.04E-09	-0.24±1.34E-09	2.25±3.68E-09
U-232	2.75±5.20E-10	1.47±1.60E-10	-0.23±1.47E-10	1.16±2.22E-09	1.56±2.29E-09
U-233/234	0.33±1.64E-10	0.44±1.12E-10	0.11±1.12E-10	0.12±1.24E-10	1.00±2.60E-10
U-235	0.84±8.22E-11	0.89±8.80E-11	0.11±1.12E-10	0.62±1.60E-10	0.91±2.30E-10
U-236	0.84±8.22E-11	0.89±8.80E-11	0.11 ±1.12E-10	0.12±1.24E-10	0.41±2.06E-10
U-238	-0.42±1.11E-10	0.44±1.12E-10	0.58±1.42E-10	1.60±2.13E-10	2.20±3.01E-10
Pu-238	0.84±8.35E-11	0.12±1.20E-10	0.98±9.59E-11	-0.76±2.05E-10	-0.45±2.69E-10
Pu-239/240	0.84±8.35E-11	0.12±1.20E-10	0.98±9.59E-11	-0.31±1.80E-10	-0.05±2.51E-11
Am-241	1.82±1.47E-10	0.40±1.08E-10	1.69±1.64E-10	2.00±2.22E-10	5.91±3.31E-10
Total U (grams)	4.18±8.35E-04	3.73±3.78E-04	0.98±4.18E-04	2.09±3.33E-03	2.98±3.48E-03

Table C - 2.12

1993 Radioactivity Concentrations in Airborne Particulates (μCi/mL) at the Fox Valley Air Sampler (AFFXVRD)

Month	Alpha	Beta	Sr-90	Cs-137
January	8.09±9.07E-16	2.15±0.32E-14		
February	9.76±9.66E-16	2.57±0.34E-14		
March	1.29±1.03E-15	2.10±0.31E-14		
1st Qtr			0.82±1.12E-16	0.91±2.21E-16
April	1.50±1.02E-15	1.59±0.29E-14		
May	1.10±1.08E-15	1.50±0.31E-14		
June	8.14±9.18E-16	1.59±0.31E-14		
2nd Qtr			-0.60±1.06E-16	1.80±2.53E-16
July	0.75±1.06E-15	1.80±0.33E-14		
August	1.58±1.22E-15	2.56±0.37E-14		
September	0.93±1.05E-15	1.95±0.33E-14		
3rd Qtr			-1.15±1.29E-16	0.58±2.75E-16
October	9.17±9.78E-16	1.83±0.33E-14		
November	1.33±1.10E-15	2.32±0.35E-14		
December	1.29±1.14E-15	1.90±0.34E-14		
4th Qtr			-0.07±1.32E-16	-1.59±1.89E-16

Table C - 2.13

1993 Radioactivity Concentrations in Airborne Particulates (μCi/mL) at the Rock Springs Road Air Sampler (AFRSPRD)

Month	Alpha	Beta	H-3	Sr-90	Cs-137	I-129
January	9.56±9.54E-16	2.05±0.31E-14	0.38±2.42E-13			
February	1.58±1.12E-15	2.40±0.33E-14	1.24±1.58E-13			
March	1.23±1.02E-15	2.16±0.32E-14	4.44±2.32E-13			
1st Qtr				-0.24±1.40E-16	0.71±1.87E-16	4.30±1.31E-16
April	1.25±0.94E-15	1.57±0.28E-14	3.90±3.41E-13			
May	6.64±8.76E-16	1.25±0.27E-14	1.14±0.68E-12			
June	6.97±8.10E-16	1.32±0.27E-14	1.51±8.47E-13			
2nd Qtr				-0.32±1.72E-16	1.00±1.62E-16	8.78±7.73E-17
July	8.24±9.84E-16	1.62±0.30E-14	1.05±1.08E-12			
August	1.30±1.05E-15	2.29±0.33E-14	0.10±1.17E-12			
September	5.32±8.48E-16	1.67±0.29E-14	2.11±8.67E-13			
3rd Qtr				0.32±1.48E-16	0.09±1.61E-16	-0.17±1.01E-16
October	8.72±9.35E-16	1.78±0.32E-14	1.77±6.32E-13			
November	6.99±9.22E-16	2.00±0.33E-14	0.41±4.85E-13			
December	1.10±1.10E-15	1.74±0.33E-14	2.11±3.59E-13			
4th Qtr				-1.33±2.07E-16	1.20±2.33E-16	2.22±8.87E-17

Table C - 2.14

1993 Radioactivity Concentrations in Airborne Particulates (μCi/mL) at the Route 240 Air Sampler (AFRT240)

Month	Alpha	Beta	Sr-90	Cs-137
January	9.51±9.70E-16	2.22±0.33E-14		
February	1.65±1.16E-15	2.54±0.34E-14		
March	1.15±0.98E-15	2.31±0.33E-14		
1st Qtr			0.90±1.06E-16	-0.67±2.48E-16
April	1.39±0.96E-15	1.30±0.26E-14		
May	9.31±9.99E-16	1.16±0.28E-14		
June	5.69±8.08E-16	1.24±0.28E-14		
2nd Qtr			-0.40±1.20E-16	1.02±2.49E-16
July	0.97±1.07E-15	1.31±0.29E-14		
August	1.40±1.14E-15	2.00±0.33E-14		
September	0.91±1.08E-15	1.63±0.33E-14		
3rd Qtr			-2.06±9.91E-17	-3.18±2.24E-16
October	7.04±9.08E-16	1.78±0.33E-14		
November	1.33±1.10E-15	2.20±0.34E-14		
December	1.47±1.18E-15	1.99±0.34E-14		
4th Qtr			-0.07±1.23E-16	0.39±2.89E-16

Table C - 2.15

1993 Radioactivity Concentrations in Airborne Particulates (μCi/mL) at the Springville Air Sampler (AFSPRVL)

Month	Alpha	Beta	Sr-90	Cs-137
January	1.01±0.99E-15	2.26±0.33E-14		
February	1.04±1.01E-15	2.52±0.34E-14		
March	1.15±0.98E-15	2.25±0.33E-14		
1st Qtr			0.65±1.07E-16	-2.11±2.30E-16
April	1.12±0.91E-15	1.67±0.30E-14		
May	0.98±1.03E-15	1.38±0.30E-14		
June	1.44±1.08E-15	1.32±0.29E-14		
2nd Qtr			-0.73±1.44E-16	-1.26±2.10E-16
July	4.65±9.54E-16	1.63±0.31E-14		
August	1.02±1.06E-15	2.00±0.33E-14		
September	8.36±9.97E-16	1.67±0.31E-14		
3rd Qtr			-2.98±9.87E-17	-1.84±2.85E-16
October	7.12±9.41E-16	1.73±0.33E-14		
November	1.13±1.09E-15	1.91±0.34E-14		
December	1.02±1.12E-15	1.68±0.34E-14		
4th Qtr			1.00±1.51E-16	1.43±2.53E-16

Table C -2.16

1993 Radioactivity Concentrations in Airborne Particulates (µCi/mL) at the Thomas Corners Road Air Sampler (AFTCORD)

Month	Alpha	Beta	Sr-90	Cs-137
January	7.02±9.36E-16	2.49±0.35E-14		
February	1.29±1.12E-15	2.78±0.37E-14		
March	1.83±1.20E-15	2.47±0.35E-14		
1st Qtr			-0.51±1.93E-16	0.43±3.11E-16
April	1.49±1.04E-15	1.67±0.30E-14		
May	8.58±9.84E-16	1.11±0.27E-14		
June	9.15±9.13E-16	1.26±0.28E-14		
2nd Qtr			-0.12±1.30E-16	1.17±2.75E-16
July	4.55±9.38E-16	1.41±0.30E-14		
August	5.03±9.00E-16	2.06±0.33E-14		
September	4.62±8.73E-16	1.44±0.29E-14		
3rd Qtr			0.08±1.09E-16	-2.38±2.20E-16
October	5.93±9.05E-16	1.83±0.34E-14		
November	8.07±9.84E-16	2.26±0.35E-14		
December	1.19±1.15E-15	1.83±0.34E-14		
4th Qtr			-0.95±1.20E-16	-0.58±2.33E-16

Table C - 2.17

1993 Radioactivity Concentrations in Airborne Particulates (µCi/mL) at the West Valley Air Sampler (AFWEVAL)

Month	Alpha	Beta	Sr-90	Cs-137
January	7.89±8.24E-16	1.91±0.28E-14		
February	1.70±1.06E-15	2.13±0.29E-14		
March	1.20±0.90E-15	1.78±0.27E-14		
1st Qtr			-4.60±6.90E-17	0.71±1.94E-16
April	1.25±0.88E-15	1.43±0.26E-14		
May	6.75±9.54E-16	1.34±0.30E-14		
June	6.57±8.56E-16	1.30±0.29E-14		
2nd Qtr			0.12±1.32E-16	-0.33±2.09E-16
July	0.98±1.16E-15	1.46±0.32E-14		
August	5.41±9.54E-16	2.13±0.35E-14		
September	0.67±1.19E-15	1.80±0.40E-14		
3rd Qtr			1.00±1.72E-16	-0.65±2.80E-16
October	8.49±9.79E-16	2.10±0.35E-14		
November	1.17±1.08E-15	2.33±0.35E-14		
December	0.68±1.00E-15	2.11±0.36E-14		
4th Qtr			6.16±2.12E-16	1.23±2.58E-16

Table C - 2.18

1993 Radioactivity Concentrations in Airborne Particulates (μCi/mL) at the Great Valley Air Sampler (AFGRVAL)

Month	Alpha	Beta	H-3	Sr-90	Cs-137	I-129
January	9.85±9.84E-16	1.82±0.30E-14	1.21±3.85E-13			
February	1.19±1.05E-15	2.21±0.32E-14	2.54±1.99E-13			
March	9.06±9.10E-16	1.90±0.31E-14	5.19±3.64E-13			
1st Qtr				-0.85±2.01E-16	1.06±2.03E-16	5.21±1.54E-16
April	7.69±8.00E-16	1.57±0.29E-14	3.37±4.04E-13			
May	1.41±1.55E-15	1.64±0.41E-14	4.41±3.21E-13			
June	5.98±8.48E-16	1.59±0.31E-14	0.03±5.20E-13			
2nd Qtr				-0.38±1.93E-16	0.26±2.41E-16	0.92±1.15E-16
July	0.92±1.10E-15	1.70±0.32E-14	2.99±6.65E-13			
August	1.00±1.06E-15	2.54±0.37E-14	0.26±6.92E-13			
September	4.57±9.11E-16	1.75±0.32E-14	1.82±6.77E-13			
3rd Qtr				-0.98±1.70E-15	0.00±3.26E-15	-1.63±1.25E-15
October	5.30±8.60E-16	1.39±0.30E-14	0.00±6.08E-13			
November	1.82±1.21E-15	2.11±0.33E-14	0.32±4.84E-13			
December	0.84±1.02E-15	1.80±0.33E-14	1.07±3.09E-13			
4th Qtr				-0.52±2.05E-16	-0.62±2.46E-16	0.91±1.16E-16

Table C - 2.19

1993 Radioactivity Concentrations in Airborne Particulates (μCi/mL) at the Dunkirk Air Sampler (AFDNKRK)

Month	Alpha	Beta	Sr-90	Cs-137
January	1.33±1.09E-15	2.21±0.33E-14		
February	1.10±1.04E-15	2.54±0.34E-14		
March	1.11±0.98E-15	2.22±0.33E-14		
1st Qtr			-0.27±1.69E-16	1.39±2.38E-16
April	1.61±1.07E-15	1.64±0.30E-14		
May	1.12±1.10E-15	1.69±0.32E-14		
June	1.05±1.00E-15	1.81±0.33E-14		
2nd Qtr			0.44±1.22E-16	0.48±2.55E-16
July	1.04±1.13E-15	1.86±0.33E-14		
August	1.69±1.24E-15	3.00±0.39E-14		
September	1.21±1.13E-15	2.07±0.34E-14		
3rd Qtr			8.28±9.99E-16	0.08±1.38E-15
October	6.49±9.02E-16	1.45±0.31E-14		
November	1.30±1.10E-15	1.98±0.33E-14		
December	1.08±1.11E-15	1.63±0.33E-14		
4th Qtr			0.15±1.22E-16	-0.12±1.69E-16

Table C - 2.20

1993 Radioactivity Concentrations in Airborne Particulates (µCi/mL) at the Dutch Hill Air Sampler (AFBOEHN)

Month	**Alpha**	**Beta**	**Sr-90**	**Cs-137**
January	8.30±9.29E-16	1.95±0.31E-14		
February	1.21±1.05E-15	2.18±0.32E-14		
March	1.25±1.00E-15	2.05±0.31E-14		
1st Qtr			-2.09±8.76E-17	0.74±2.11E-16
April	1.04±0.90E-15	1.46±0.29E-14		
May	7.56±9.90E-16	1.46±0.31E-14		
June	7.71±8.95E-16	1.60±0.31E-14		
2nd Qtr			-0.65±1.19E-16	1.78±2.30E-16
July	0.64±1.01E-15	1.82±0.33E-14		
August	1.13±1.07E-15	2.55±0.36E-14		
September	1.14±1.15E-15	1.64±0.33E-14		
3rd Qtr			-1.68±9.01E-16	4.08±8.47E-16
October	7.96±9.40E-16	1.69±0.32E-14		
November	1.43±1.78E-15	2.08±0.49E-14		
December	0.95±1.08E-15	1.69±0.33E-14		
4th Qtr			0.14±1.32E-16	-0.12±2.00E-16

Table C - 2.21

Radioactivity in Fallout During 1993 (nCi/m^2/mo)

Dutch Hill (AFDHFOP)

Month	Gross Alpha	Gross Beta	H-3 (μCi/mL)
January	<2.42E-02	2.98E-01	<1.00E-07
February	<9.58E-03	2.04E-01	<1.00E-07
March	<8.53E-03	1.81E-01	<1.00E-07
April	1.92E-01	6.32E-01	<1.00E-07
May	<2.55E-02	4.51E-01	<1.00E-07
June	<4.70E-02	1.23E+00	<1.00E-07
July	3.37E-02	4.82E-01	<1.00E-07
August	3.01E-02	4.94E-01	<8.28E-08
September	1.14E-01	1.08E+00	<1.00E-07
October	<2.90E-02	3.39E-01	<1.00E-07
November	2.95E-02	4.02E-01	<1.00E-07
December	6.65E-02	4.57E-01	<1.00E-07

Fox Valley Road (AFFXFOP)

Month	Gross Alpha	Gross Beta	H-3 (μCi/mL)
January	<3.54E-02	7.42E-01	<1.00E-07
February	2.30E-02	4.49E-01	<1.00E-07
March	3.84E-02	1.90E-01	<1.00E-07
April	2.48E-02	2.88E-01	<1.00E-07
May	1.93E-02	1.36E-01	<1.00E-07
June	4.53E-02	6.12E-01	<1.00E-07
July	5.09E-02	5.12E-01	<1.00E-07
August	5.53E-02	6.43E-01	<1.00E-07
September	1.54E-01	1.14+00	<1.00E-07
October	<4.45E-02	4.16E-01	<1.00E-07
November	2.98E-02	3.73E-01	<1.00E-07
December	6.18E-02	4.17E-01	<1.00E-07

Route 240 (AF24FOP)

Month	Gross Alpha	Gross Beta	H-3 (μCi/mL)
January	<2.26E-02	3.96E-01	<1.00E-07
February	1.71E-02	3.08E-01	<1.00E-07
March	1.38E-02	1.61E-01	<7.68E-08
April	1.64E-02	1.63E-01	<1.00E-07
May	2.77E-02	1.60E-01	<1.00E-07
June	<1.36E-02	4.25E-01	<1.00E-07
July	3.33E-02	4.59E-01	<8.16E-08
August	3.17E-02	5.27E-01	<1.00E-07
September	<4.95E-02	9.63E-01	<1.00E-07
October	<3.64E-02	4.16E-01	<7.42E-08
November	4.92E-02	4.16E-01	<8.32E-08
December	4.47E-02	4.79E-01	<1.00E-07

Thomas Corners Road (AFTCFOP)

Month	Gross Alpha	Gross Beta	H-3 (μCi/mL)
January	<2.67E-02	5.11E-01	<1.00E-07
February	<2.28E-02	4.05E-01	<1.00E-07
March	4.10E-02	2.55E-01	2.23±.81E-07
April	2.53E-02	3.16E-01	<1.00E-07
May	2.40E-02	1.62E-01	<1.00E-07
June	2.89E-02	3.02E-01	<1.00E-07
July	9.43E-02	5.15E-01	<1.00E-07
August	4.19E-02	7.39E-01	<8.10E-08
September	<6.19E-02	7.97E-01	<1.00E-07
October	<4.04E-02	5.78E-01	<1.00E-07
November	4.99E-02	5.02E-01	<1.00E-07
December	6.28E-02	6.56E-01	<1.00E-07

Rain Gage (ANRGFOP)

Month	Gross Alpha	Gross Beta	H-3 (μCi/mL)
January	<3.23E-02	6.50E-01	<1.00E-07
February	<2.25E-02	5.88E-01	<7.48E-08
March	<1.53E-02	2.60E-01	<7.84E-08
April	4.07E-02	3.28E-01	<1.00E-07
May	<9.56E-03	1.96E-01	<1.00E-07
June	<2.88E-02	5.93E-01	<1.00E-07
July	4.25E-02	4.75E-01	<1.00E-07
August	4.87E-02	3.65E-01	<1.00E-07
September	<6.17E-02	9.01E-01	<1.00E-07
October	<4.22E-02	4.10E-01	<7.87E-08
November	4.48E-02	2.07E-01	9.91±7.68E-08
December	4.62E-02	6.52E-01	<1.00E-07

Table C - 2.22

pH of Precipitation Collected in Fallout Pots in 1993

Month	Dutch Hill (AFDHFOP)	Fox Valley Road (AFFXFOP)	Route 240 (AF24FOP)	Thomas Corners Road (AFTCFOP)	Rain Gage (ANRGFOP)
January	3.79	4.16	3.69	4.02	3.95
February	4.05	4.19	4.10	4.19	4.16
March	3.56	4.90	3.70	4.99	4.06
April	7.25	4.36	3.61	3.88	6.59
May	7.46	5.26	3.50	4.29	7.43
June	7.29	3.97	3.61	3.61	4.02
July	4.40	3.98	4.51	3.98	4.92
August	3.67	3.73	3.61	3.68	5.93
September	4.13	4.08	3.86	3.92	3.96
October	6.39	5.12	4.20	4.02	5.90
November	3.97	4.19	3.97	4.09	6.92
December	3.95	4.15	4.04	4.14	4.19

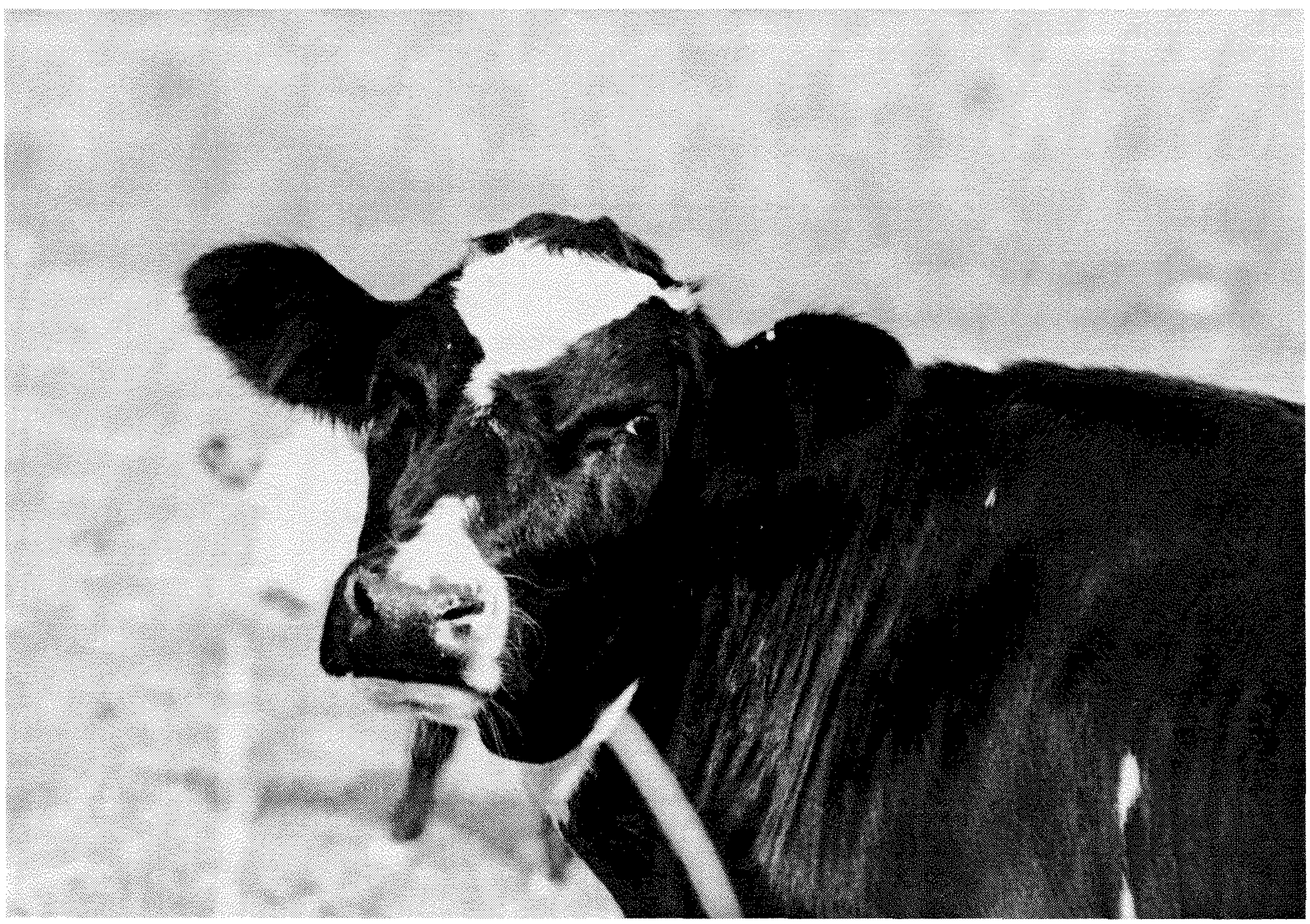
Table C - 2.23

1993 Radioactivity Concentrations in Airborne Particulates (μCi/mL) at Location AFBLKST

Month	Alpha	Beta	Sr-90	Cs-137
January	9.47±9.66E-16	1.98±0.31E-14		
February	9.32±9.73E-16	2.38±0.33E-14		
March	1.60±1.26E-15	1.79±0.33E-14		
1st Qtr			0.67±1.12E-16	0.34±2.43E-16
April	6.95±7.70E-16	1.36±0.27E-14		
May	5.60±9.27E-16	1.19±0.29E-14		
June	7.49±9.46E-16	1.26±0.30E-14		
2nd Qtr			-0.63±1.35E-16	0.90±2.16E-16
July	0.63±1.14E-15	1.27±0.32E-14		
August	0.75±1.00E-15	2.37±0.36E-14		
September	0.97±1.06E-15	1.37±0.30E-14		
3rd Qtr			0.20±1.29E-16	1.94±2.73E-16
October	1.30±1.09E-15	1.73±0.32E-14		
November	1.28±1.11E-15	2.31±0.36E-14		
December	1.43±1.17E-15	2.04±0.35E-14		
4th Qtr			-1.16±1.29E-16	0.17±2.65E-16

Appendix C - 3

Summary of Biological Data



Milk and Meat Samples are Collected from Local Bovine Herds

Table C - 3.1

1993 Radioactivity Concentrations in Milk (μCi/mL)

Location	H-3	Sr-90	I-129	Cs-134	Cs-137	K-40
BFMCOBO (WNW FARM)						
1st Qtr	5.40±7.40E-08	1.80±0.20E-09	3.70±2.90E-10	-0.10±2.52E-09	2.70±2.40E-09	9.69±0.97E-07
2nd Qtr	0.51±1.16E-07	1.70±0.20E-09	-4.00±2.20E-10	-1.50±2.50E-09	1.50±2.60E-09	6.20±0.60E-07
3rd Qtr	3.20±8.50E-08	2.30±0.20E-09	0.78±3.21E-10	2.10±2.40E-09	3.20±2.40E-09	1.30±0.10E-06
4th Qtr	4.70±8.70E-08	2.80±0.40E-09	1.30±2.90E-10	0.22±2.47E-09	1.50±2.40E-09	1.30±0.10E-06
BFMCTLN (CONTROL)						
1st Qtr	1.00±0.80E-07	7.10±1.40E-10	3.50±3.10E-10	0.78±2.07E-09	1.20±2.00E-09	7.96±0.80E-07
2nd Qtr	0.27±1.15E-07	1.30±0.20E-09	-1.20±3.00E-10	0.51±2.35E-09	0.39±2.28E-09	2.00±0.20E-06
3rd Qtr	8.30±8.80E-08	2.60±0.20E-09	1.40±2.90E-10	1.70±2.80E-09	2.80±2.60E-09	1.40±0.10E-06
4th Qtr	1.20±0.90E-07	3.10±0.40E-09	0.04±2.53E-10	1.90±2.80E-09	5.00±2.90E-09	1.60±0.20E-06
BFMCTLS (CONTROL)						
1st Qtr	4.50±7.40E-08	1.20±0.20E-09	3.60±3.00E-10	0.99±2.24E-09	0.79±2.16E-09	1.61±0.16E-06
2nd Qtr	-0.61±1.14E-08	1.40±0.20E-09	-3.50±2.30E-10	1.10±1.90E-09	0.91±1.81E-09	1.30±0.10E-06
3rd Qtr	3.80±8.50E-08	1.40±0.30E-09	1.10±3.20E-10	0.15±2.42E-09	1.60±2.40E-09	1.40±0.10E-06
4th Qtr	3.40±8.20E-08	6.20±2.00E-10	-4.80±3.40E-10	-0.52±2.21E-09	1.80±2.80E-09	5.50±0.60E-07
BFMREED (NNW FARM)						
1st Qtr	2.20±7.50E-08	9.10±1.90E-10	5.60±3.50E-10	-2.20±2.90E-09	1.50±2.70E-09	1.01±0.10E-06
2nd Qtr	0.35±1.15E-07	1.50±0.20E-09	-0.03±2.96E-10	-1.80±2.50E-09	1.90±2.50E-09	1.90±0.20E-06
3rd Qtr	5.50±8.85E-08	2.05±0.30E-09	1.28±3.43E-10	0.14±2.75E-09	2.75±2.72E-09	1.25±0.10E-06
4th Qtr	1.40±0.70E-07	2.10±0.50E-09	-3.90±2.90E-10	-0.44±1.97E-09	-0.34±2.32E-09	1.40±0.10E-06
BFMHAUR (SE FARM)						
Annual	1.60±0.80E-07	2.50±0.30E-09	0.72±4.64E-10	0.64±2.35E-09	2.10±2.70E-09	1.40±0.10E-06
BFMWIDR (SSW FARM)						
Annual	7.90±8.40E-08	2.00±0.30E-09	1.20±4.20E-10	0.59±2.54E-09	3.50±2.60E-09	1.40±0.10E-06

Table C - 3.2

1993 Radioactivity Concentrations in Meat (μCi/g Dry)

Location	% Moisture	H-3	Sr-90	Cs-134	Cs-137	K-40
DEER FLESH BACKGROUND (BFDCTRL 1)	72.5	0.31 ±1.16E-07	6.60 ±8.10E-09	-4.20 ±7.50E-09	3.80 ±0.40E-07	1.00 ±0.10E-05
DEER FLESH BACKGROUND (BFDCTRL 2)	76.1	-1.60 ±1.50E-07	6.80 ±9.80E-09	0.66 ±1.12E-08	2.50 ±0.20E-07	1.30 ±0.10E-05
DEER FLESH BACKGROUND (BFDCTRL 3)	75.3	0.55 ±1.61E-07	1.30 ±0.90E-08	-2.20 ±9.70E-09	1.60 ±0.20E-07	1.70 ±0.20E-05
DEER FLESH NEAR-SITE (BFDNEAR 1)	73.8	1.40 ±1.50E-07	1.20 ±0.60E-08	-0.58 ±1.12E-08	6.10 ±1.40E-08	1.40 ±0.10E-05
DEER FLESH NEAR-SITE (BFDNEAR 2)	72.9	0.09 ±1.66E-07	1.20 ±0.60E-08	0.69 ±1.28E-08	1.70 ±0.20E-07	1.10 ±0.10E-05
DEER FLESH NEAR-SITE (BFDNEAR 3)	75.8	0.54 ±1.30E-07	1.00 ±0.50E-08	0.92 ±1.27E-08	1.20 ±0.20E-07	1.30 ±0.10E-05
BEEF FLESH BACKGROUND (BFBCTRL 6/93)	71.3	-8.10 ±9.00E-08	0.00 ±4.50E-09	-2.90 ±7.40E-09	5.10 ±7.00E-09	1.00 ±0.10E-05
BEEF FLESH BACKGROUND (BFBCTRL 12/93)	72.1	4.50 ±6.10E-08	1.10 ±0.60E-08	0.11 ±1.05E-08	0.70 ±1.05E-08	1.10 ±0.10E-05
BEEF FLESH NEAR-SITE (BFBNEAR 6/93)	75.2	2.50 ±9.50E-08	0.22 ±2.41E-09	0.79 ±8.21E-09	1.70 ±0.80E-08	1.00±0.10E-05
BEEF FLESH NEAR-SITE (BFBNEAR 12/93)	76.5	1.00 ±5.20E-08	1.60 ±0.50E-08	0.55 ±9.53E-09	1.20 ±1.00E-08	1.30±0.10E-05

Table C - 3.3

1993 Radioactivity Concentrations in Food Crops (µCi/g Dry)

Location	% Moisture	H-3	Sr-90	K-40	Co-60	Cs-137
BEANS						
BACKGROUND (BFVCTRL)	90.3	1.30±1.00E-06	3.10±0.80E-07	3.20±0.30E-06	0.17±5.95E-09	4.00±6.30E-09
NEAR-SITE (BFVNEAR)	82.8	0.06±1.15E-06	2.40±0.60E-07	4.10±0.40E-06	0.89±5.05E-09	-1.70±5.30E-09
CORN						
BACKGROUND (BFVCTRL)	87.9	3.50±2.60E-07	0.08±1.18E-08	2.10±0.20E-05	-0.46±1.86E-08	0.53±1.85E-08
NEAR-SITE (BFVNEAR)	68.6	1.12±1.04E-07	0.01±1.02E-08	7.25±0.75E-06	0.75±8.95E-09	5.25±9.55E-09
APPLES						
BACKGROUND (BFVCTRL)	89.4	7.90±9.20E-08	7.80±9.00E-09	5.90±0.60E-06	1.30±2.00E-08	0.80±2.13E-08
NEAR-SITE (BFVNEAR)	82.8	0.83±1.01E-07	-2.80±9.50E-09	1.20±0.10E-05	0.42±2.13E-08	2.00±2.30E-08
HAY						
BACKGROUND (BFHCTLN)	7.06	NA	8.70±1.40E-08	2.30±0.20E-05	0.00±2.40E-08	3.00±2.60E-08
NEAR-SITE (BFHNEAR)	9.22	NA	1.90±0.20E-07	3.10±0.30E-05	1.20±2.30E-08	2.60±2.40E-08

NA - Not available.

Table C - 3.4

1993 Radioactivity Concentrations in Fish Flesh from Cattaraugus Creek

Cattaraugus Creek (BFFCATC) above Springville Dam

	1st Half (μCi/g dry)			2nd Half (μCi/g dry)		
	Sr-90	**Cs-134**	**Cs-137**	**Sr-90**	**Cs-134**	**Cs-137**
Median	7.8E-08	<5.1E-08	<4.8E-08	4.5E-08	<1.1E-07	<1.6E-07
Maximum	5.6E-07	<1.0E-07	5.7E-08	1.3E-07	<1.8E-07	1.8E-07
Minimum	1.7E-08	<3.6E-08	<3.5E-08	<1.7E-08	<6.2E-08	<6.0E-08
Moisture (Average %)	78.7			76.4		

Cattaraugus Creek (BFFCTRL) Background

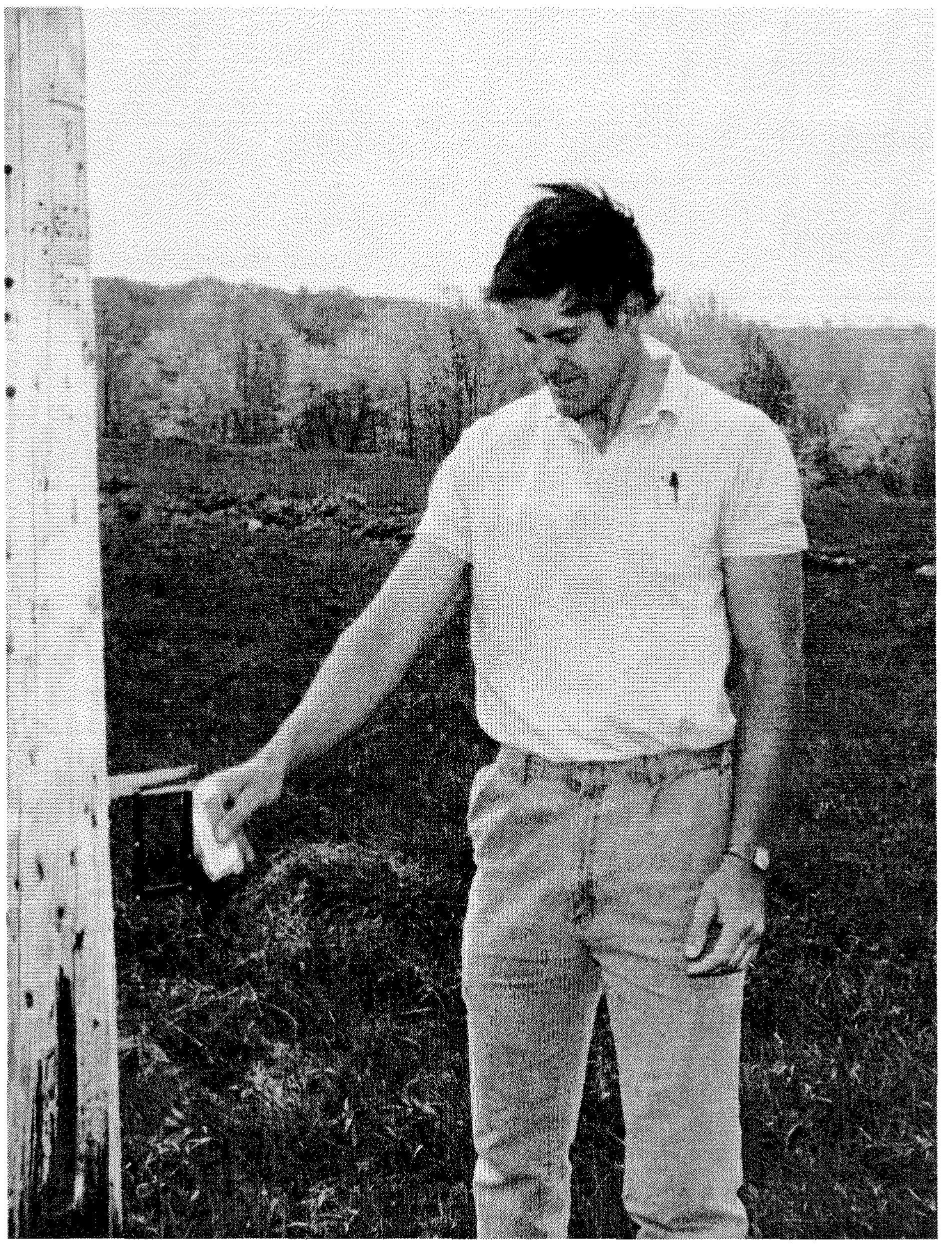
	1st Half (μCi/g dry)			2nd Half (μCi/g dry)		
	Sr-90	**Cs-134**	**Cs-137**	**Sr-90**	**Cs-134**	**Cs-137**
Median	3.1E-08	<6.0E-08	<5.7E-08	1.7E-08	<9.3E-08	<8.3E-08
Maximum	4.6E-08	<1.1E-07	5.3E-08	3.9E-07	<1.5E-07	<1.4E-07
Minimum	<3.4E-08	<4.9E-08	<4.3E-08	<1.0E-08	<5.3E-08	<4.8E-08
Moisture (Average %)	78.6			79.2		

Cattaraugus Creek (BFFCATD) below the Springville Dam (annual)
(μCi/g dry)

	Sr-90	**Cs-134**	**Cs-137**
Median	4.3E-08	<4.0E-08	<4.9E-08
Maximum	5.0E-07	4.0E-07	1.0E-07
Minimum	<6.7E-09	<2.5E-08	<2.5E-08
Moisture (Average %)	72.6		

Appendix C - 4

Summary of Direct Radiation Monitoring Data



Exchanging an Environmental TLD Package

Table C - 4.1

Summary of 1993 Quarterly Averages of TLD Measurements

(Roentgen ± 3 SD/Quarter)

Location Number*	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Location Average
1	0.016±0.003	0.020±0.003	0.022±0.001	0.025±0.003	0.021±0.003
2	0.016±0.002	0.020±0.006	0.022±0.003	0.025±0.002	0.021±0.003
3	0.016±0.003	0.019±0.003	0.020±0.004	0.024±0.005	0.020±0.004
4	0.016±0.003	0.019±0.003	0.020±0.003	0.025±0.003	0.020±0.003
5	0.015±0.003	0.020±0.005	0.024±0.003	0.025±0.004	0.021±0.004
6	0.016±0.002	0.019±0.007	0.023±0.005	0.024±0.003	0.021±0.004
7	0.015±0.003	0.020±0.004	0.019±0.003	0.023±0.005	0.019±0.004
8	0.016±0.002	0.019±0.001	0.022±0.002	0.024±0.003	0.020±0.002
9	0.015±0.003	0.019±0.004	0.020±0.003	0.023±0.002	0.019±0.003
10	0.015±0.001	0.020±0.003	0.020±0.002	0.026±0.002	0.020±0.002
11	0.017±0.004	0.022±0.003	0.022±0.003	0.026±0.003	0.021±0.003
12	0.016±0.003	0.019±0.003	0.021±0.002	0.027±0.003	0.021±0.003
13	0.017±0.002	0.022±0.004	0.023±0.005	0.027±0.006	0.022±0.004
14	0.017±0.003	0.021±0.005	0.022±0.003	0.026±0.004	0.022±0.004
15	0.014±0.004	0.019±0.003	0.019±0.002	0.025±0.003	0.019±0.003
16	0.016±0.005	0.021±0.003	0.022±0.002	0.025±0.003	0.021±0.003
17	0.017±0.002	0.021±0.002	0.021±0.001	0.027±0.002	0.022±0.002
18**	0.050±0.029	0.045±0.009	0.043±0.003	0.050±0.007	0.047±0.012
19**	0.019±0.001	0.024±0.005	0.024±0.001	0.032±0.005	0.025±0.003
20	0.016±0.001	0.020±0.004	0.019±0.003	0.025±0.005	0.020±0.003
21	0.016±0.002	0.020±0.003	0.022±0.001	0.025±0.004	0.021±0.003
22	0.016±0.005	0.020±0.003	0.021±0.003	0.026±0.008	0.021±0.005
23	0.016±0.004	0.019±0.003	0.021±0.003	0.024±0.004	0.020±0.003
24**	1.066±0.078	1.126±0.259	0.992±0.095	1.161±0.117	1.086±0.137
25	0.026±0.006	0.033±0.002	0.033±0.003	0.038±0.009	0.032±0.005
26	0.023±0.002	0.030±0.002	0.028±0.007	0.034±0.002	0.029±0.003
27	0.017±0.002	0.023±0.005	0.022±0.001	0.027±0.005	0.022±0.003
28	0.018±0.003	0.023±0.003	0.023±0.002	0.028±0.003	0.023±0.003
29	0.018±0.002	0.026±0.005	0.025±0.003	0.029±0.003	0.025±0.003
30	0.022±0.004	0.029±0.002	0.030±0.003	0.033±0.005	0.028±0.003
31	0.018±0.005	0.021±0.003	0.023±0.002	0.026±0.004	0.022±0.003
32	0.029±0.004	0.031±0.002	0.031±0.003	0.037±0.004	0.032±0.003
33	0.035±0.006	0.040±0.007	0.041±0.006	0.046±0.004	0.041±0.006
34	0.061±0.009	0.065±0.012	0.061±0.004	0.069±0.011	0.064±0.009
35	0.083±0.014	0.080±0.007	0.076±0.006	0.085±0.016	0.081±0.011
36	0.056±0.008	0.061±0.010	0.052±0.004	0.062±0.006	0.057±0.007
37	0.017±0.003	0.020±0.003	0.020±0.005	0.024±0.003	0.020±0.003
38**	0.033±0.005	0.044±0.010	0.042±0.006	0.048±0.010	0.042±0.008
39**	0.066±0.011	0.085±0.011	0.075±0.008	0.082±0.006	0.077±0.009
40**	0.173±0.018	0.211±0.020	0.187±0.011	0.231±0.025	0.200±0.018
41	0.015±0.004	0.019±0.005	0.021±0.002	0.024±0.003	0.020±0.003
Quarterly Average*	0.022±0.004	0.026±0.004	0.027±0.003	0.031±0.004	0.026±0.004

** Locations are shown on Figures A-7, A-8, and A-9.*

*** TLDs 18, 19, 24, 38, 39, and 40 are not included in the quarterly averages.*

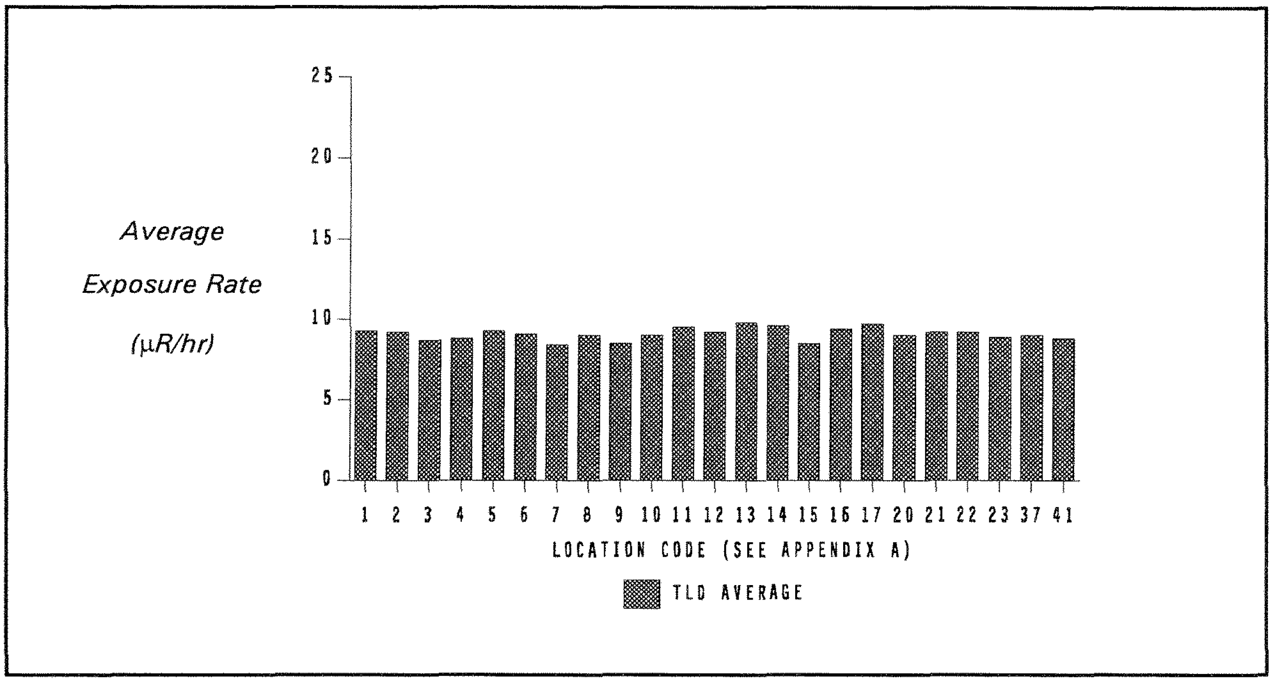


Figure C - 4.1

1993 Average Quarterly Gamma Exposure Rates around the West Valley Demonstration Project Site

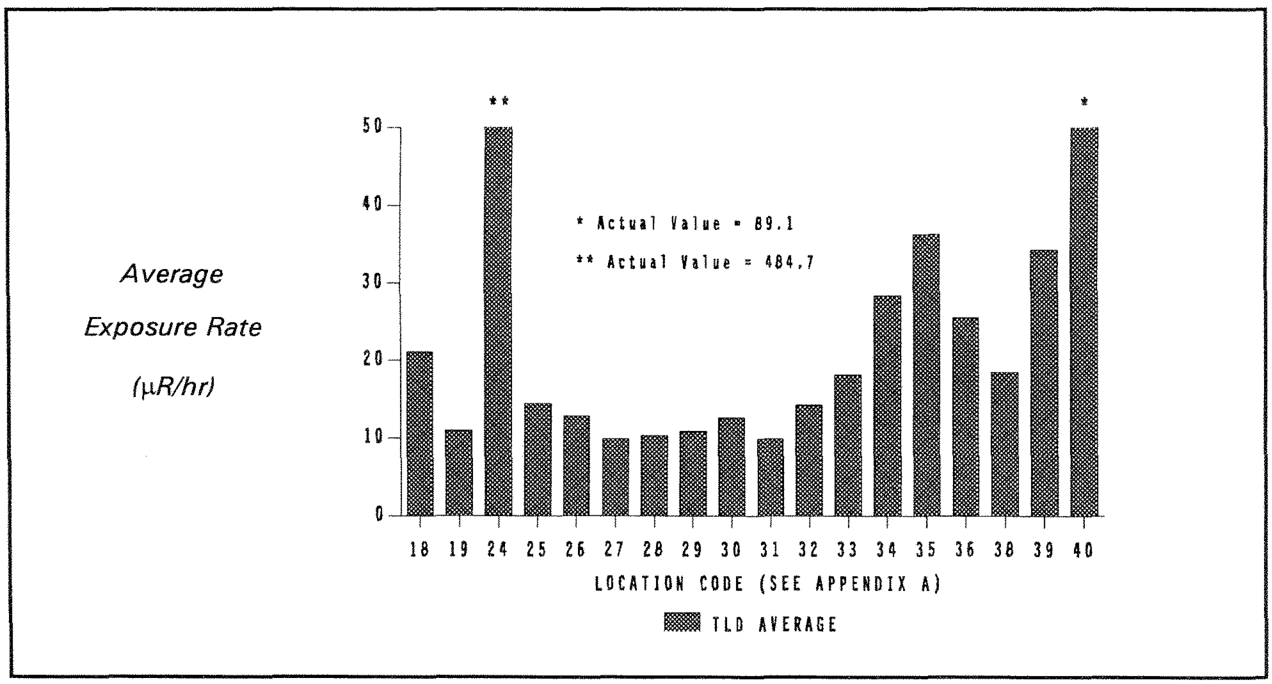


Figure C - 4.2

1993 Average Quarterly Gamma Exposure Rates on the West Valley Demonstration Project Site

Appendix C - 5

Summary of Nonradiological Monitoring Data

Table C - 5.1
West Valley Demonstration Project State Pollutant Discharge Elimination System (SPDES) Sampling Program (effective September 1990)

Outfall	Parameter	Limit	Sample Frequency
001 (Process and Storm Wastewater)	Flow	Monitor	2 per discharge
	Aluminum, total	14.0 mg/L	2 per discharge
	Ammonia (NH_3)	*	2 per discharge
	Arsenic, dissolved	0.15 mg/L	2 per discharge
	BOD-5	**	2 per discharge
	Iron, total	**	2 per discharge
	Zinc, total recoverable	0.48 mg/L	2 per discharge
	Suspended solids	45.0 mg/L	2 per discharge
	Cyanide amenable to chlorination	0.022 mg/L	2 per discharge
	Settleable solids	0.3 mL/L	2 per discharge
	pH (range)	6.0 - 9.0	2 per discharge
	Oil and grease	15.0 mg/L	2 per discharge
	Sulfate	Monitor	2 per discharge
	Nitrate	Monitor	2 per discharge
	Nitrite	Monitor	2 per discharge
	Chromium (hexavalent), total rec.	Monitor	2 per discharge
	Cadmium, total recoverable	0.007 mg/L	2 per discharge
	Copper, total recoverable	0.03 mg/L	2 per discharge
	Lead, total recoverable	0.15 mg/L	2 per discharge
	Nickel, total	2.7 mg/L	2 per discharge
	Dichlorodifluoromethane	0.01 mg/L	2 per discharge
	Trichlorofluoromethane	0.01 mg/L	2 per discharge
	3,3-dichlorobenzidine	0.01 mg/L	2 per discharge
	Tributyl phosphate	32 mg/L	2 per discharge
	Vanadium	0.19 mg/L	2 per discharge
	Chromium, total	0.050 mg/L	annual
	Selenium, total	0.040 mg/L	annual
	Barium	0.5 mg/L	annual
	Antimony	1.0 mg/L	annual
	Chloroform	0.3 mg/L	annual
	Bis (2-ethylhexyl) phthalate	1.6 mg/L	semiannual
	4-dodecene	0.6 mg/L	semiannual
007 (Sanitary and Utility Wastewater)	Flow	Monitor	3 per month
	Ammonia	*	3 per month
	BOD-5	**	3 per month
	Iron, total	**	3 per month
	Suspended solids	45.0 mg/L	2 per month
	Settleable solids	0.3 mL/L	weekly
	pH (range)	6.0 - 9.0	weekly
	Chloroform	0.020 mg/L	annual
008 (French Drain Wastewater)	Flow	Monitor	3 per month
	BOD-5	**	3 per month
	Iron, total	**	3 per month
	pH (range)	6.0 - 9.0	3 per month
	Silver, total	0.008 mg/L	annual
	Zinc, total	0.100 mg/L	annual

* *Reported as flow-weighted average of outfalls 001 and 007. Limit is 2.1 mg/L.*
** *Reported as flow-weighted average of outfalls 001, 007, and 008. Limits are 5.0 mg/L for BOD-5 and 0.31 mg/L for iron. Iron data are net limits reported after background concentrations are subtracted.*

Table C - 5.2

West Valley Demonstration Project 1993 SPDES Noncompliance Episodes

Date	Outfall	Parameter	Limit	Value	Comments
May 5,1993	*WNSP007*	pH	6.0-9.0	9.86	*See Compliance Summary*

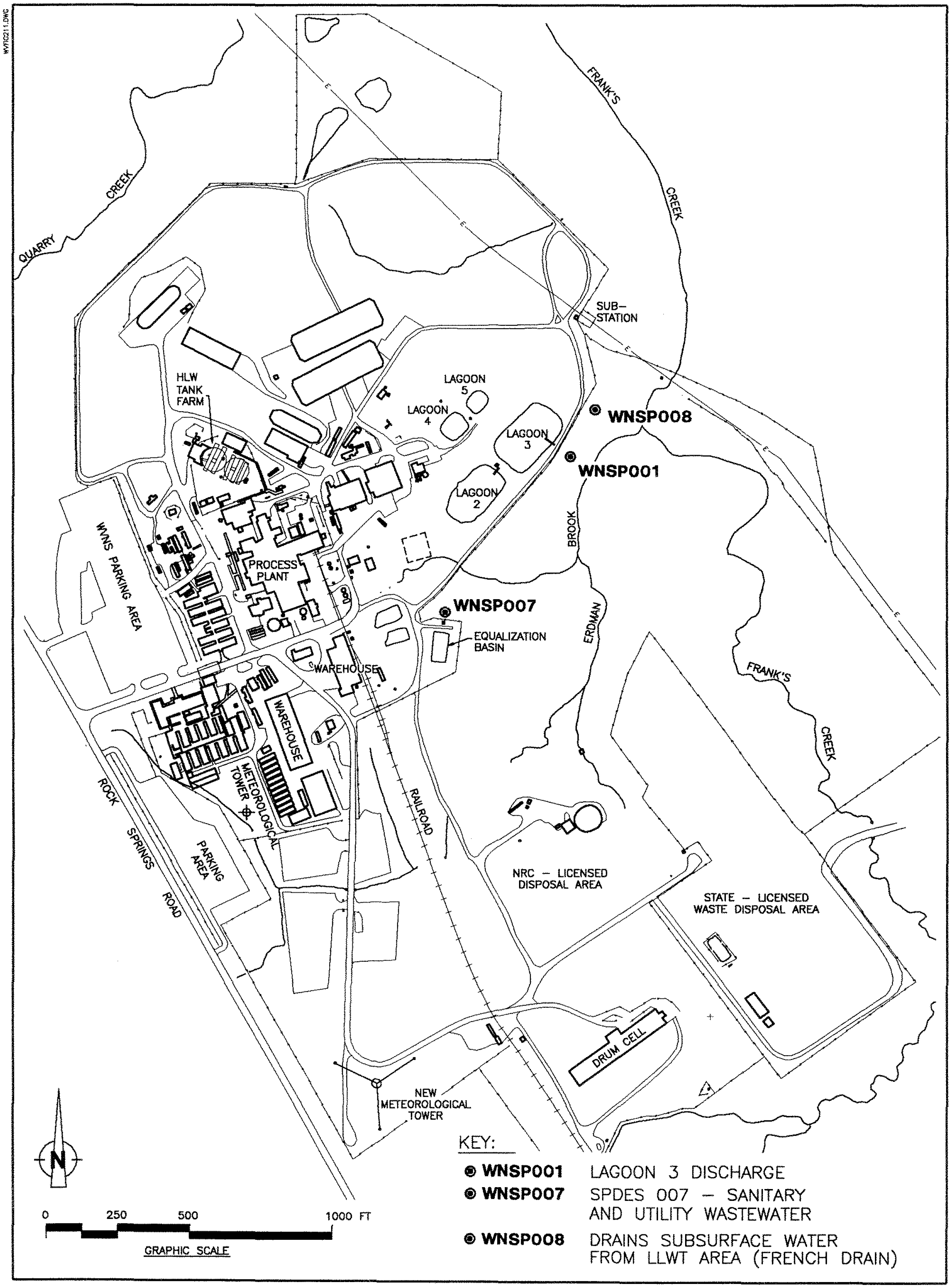


Figure C-5.1. SPDES Monitoring Points.

Figure C - 5.2

BIOCHEMICAL OXYGEN DEMAND-5 (mg/L)

Outfall 001

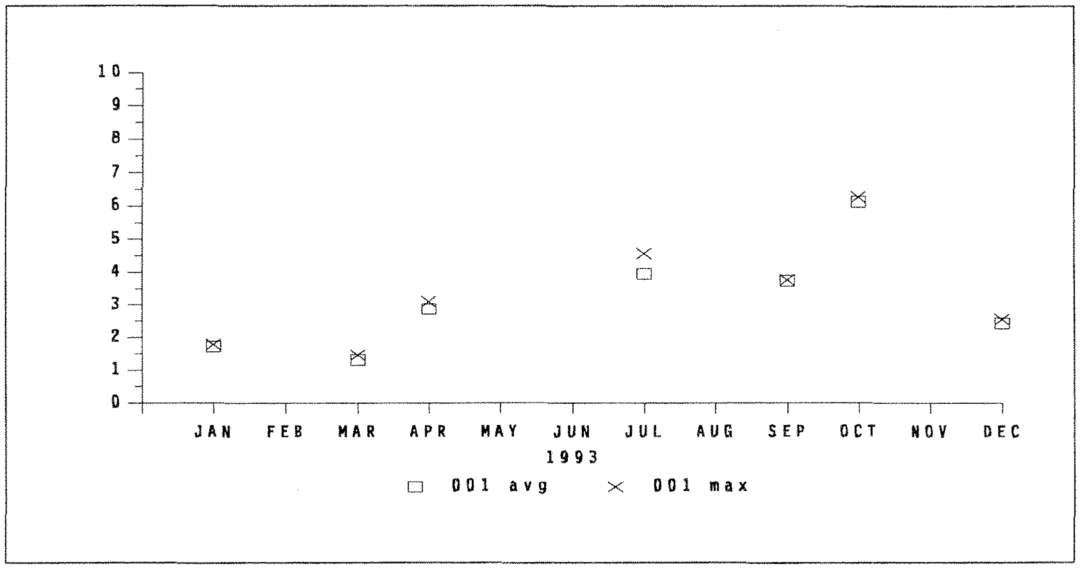


Figure C - 5.3

BIOCHEMICAL OXYGEN DEMAND-5 (mg/L)

Outfalls 007 and 008

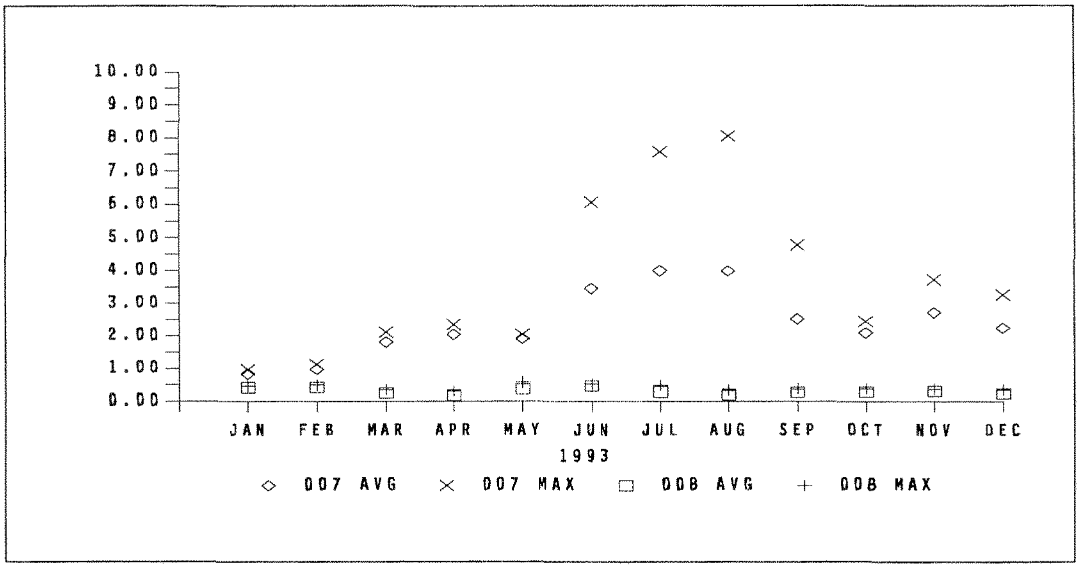
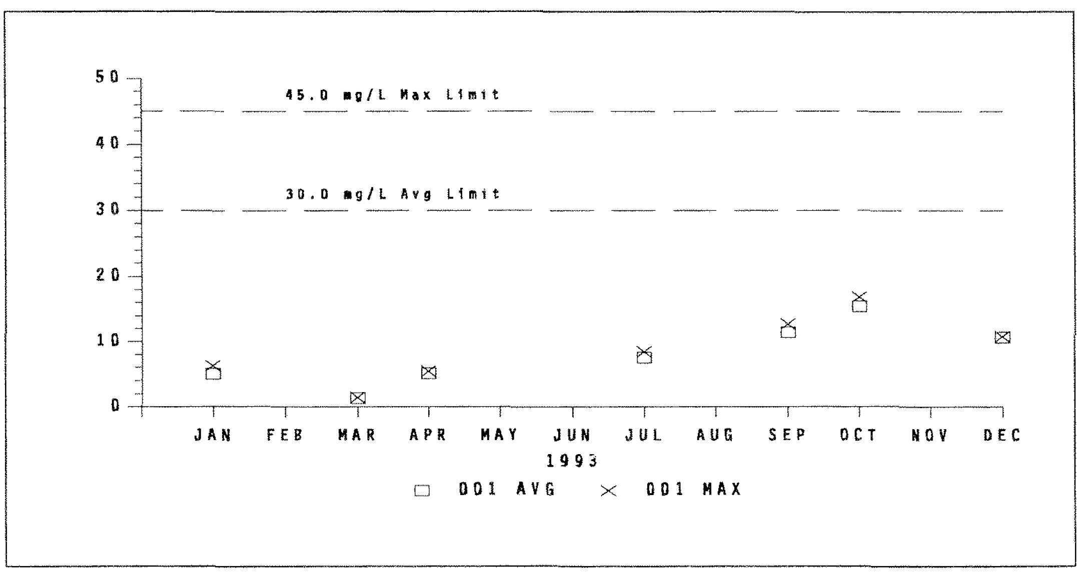


Figure C - 5.4

SUSPENDED SOLIDS (mg/L)

Outfall 001



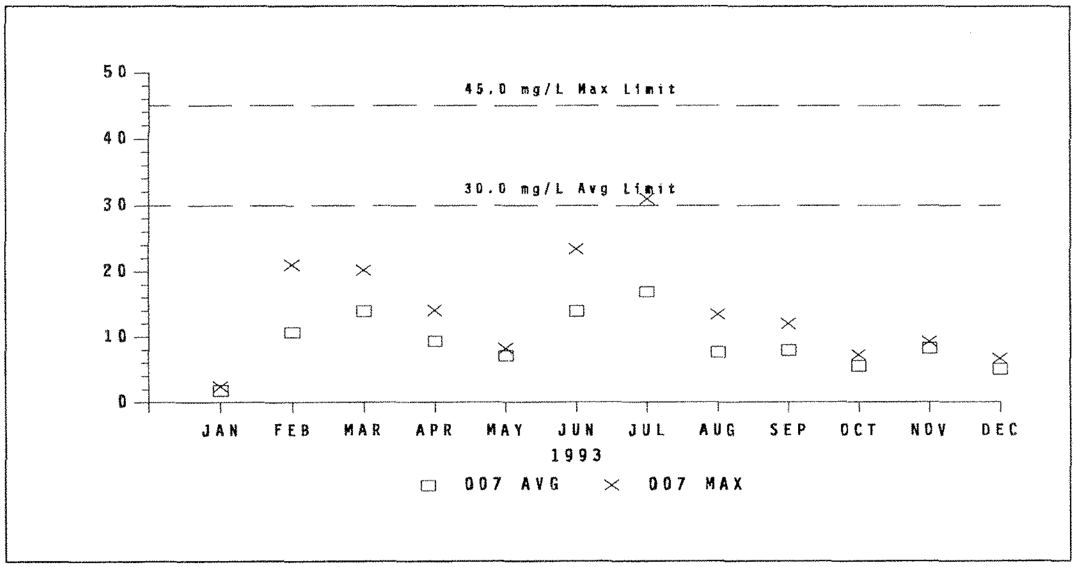


Figure C - 5.5

SUSPENDED SOLIDS (mg/L)

Outfall 007

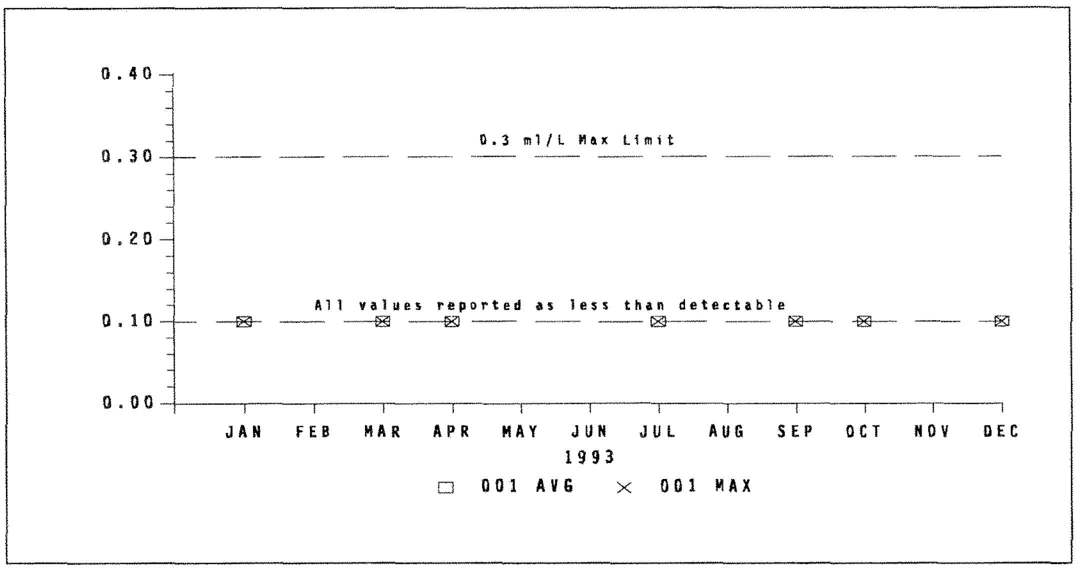


Figure C - 5.6

SETTLEABLE SOLIDS (ml/L)

Outfall 001

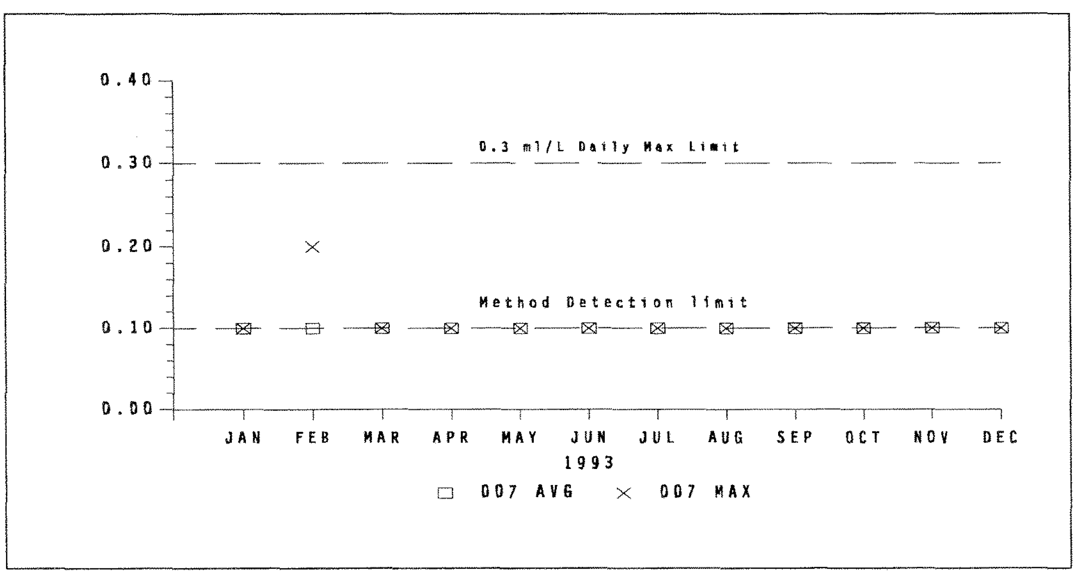


Figure C - 5.7

SETTLEABLE SOLIDS (ml/L)

Outfall 007

Figure C - 5.8

AMMONIA
(mg/L)

Outfall 001

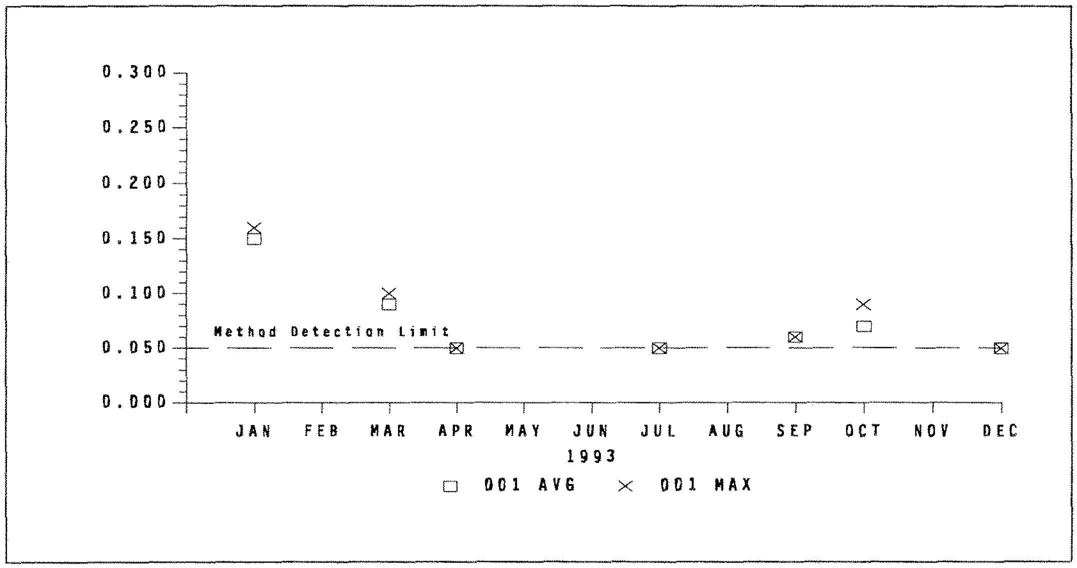


Figure C - 5.9

AMMONIA
(mg/L)

Outfall 007

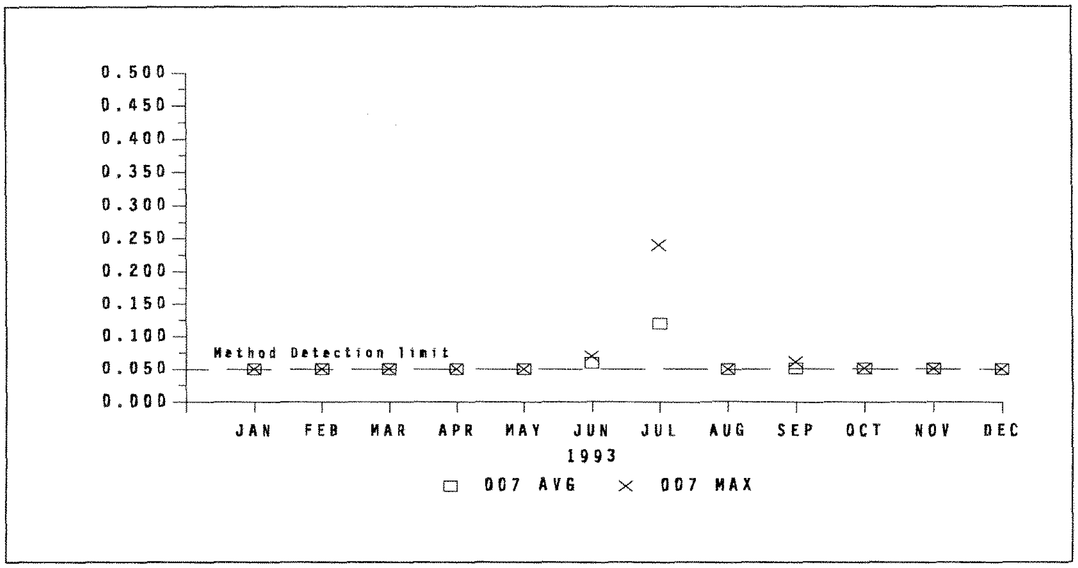
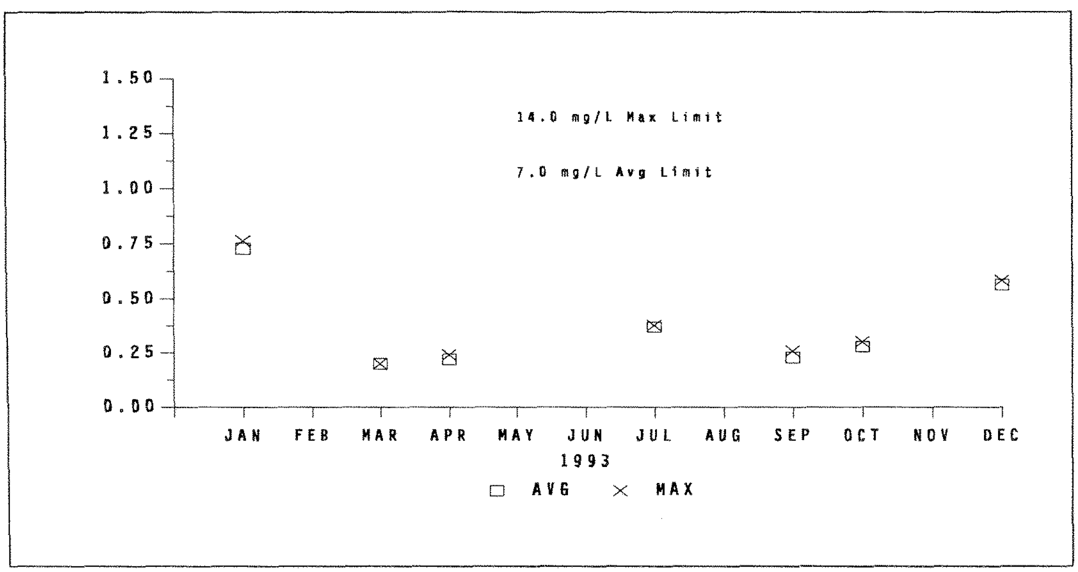


Figure C - 5.10

METALS (ALUMINUM)
(mg/L)

Outfall 001



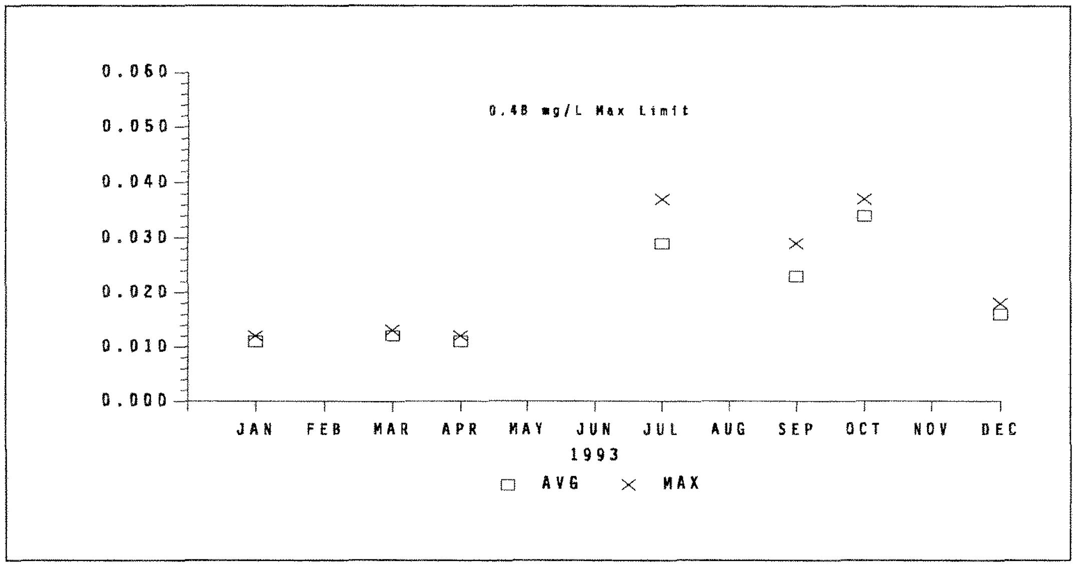


Figure C - 5.11

METALS (ZINC)
(mg/L)

Outfall 001

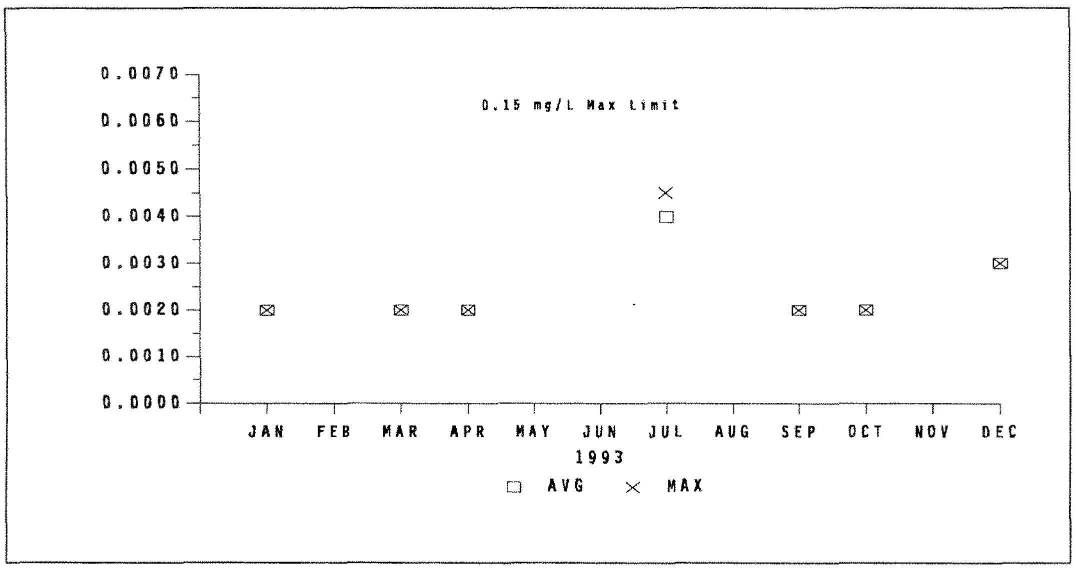


Figure C - 5.12

METALS (ARSENIC)
(mg/L)

Outfall 001

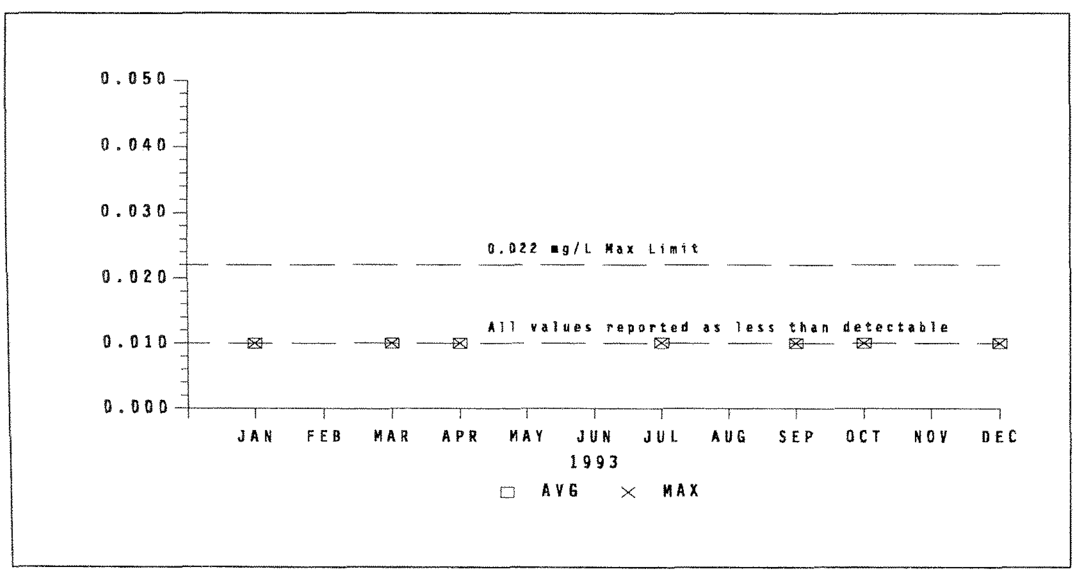


Figure C - 5.13

CYANIDE
(mg/L)

Outfall 001

Figure C - 5.14

METALS (IRON)
(mg/L)

Outfall 001

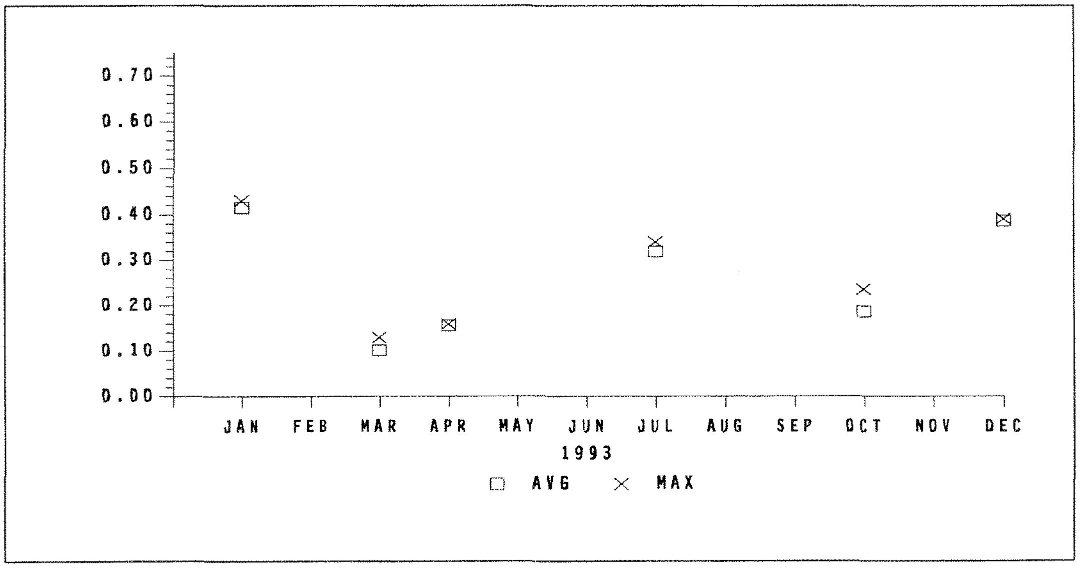


Figure C - 5.15

METALS (IRON)
(mg/L)

Outfalls 007
and 008

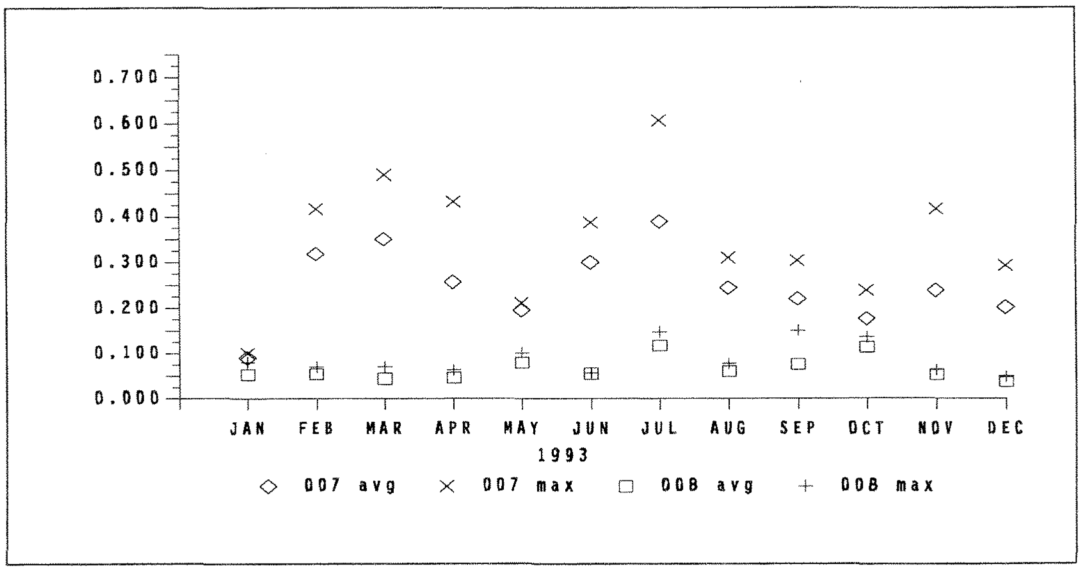
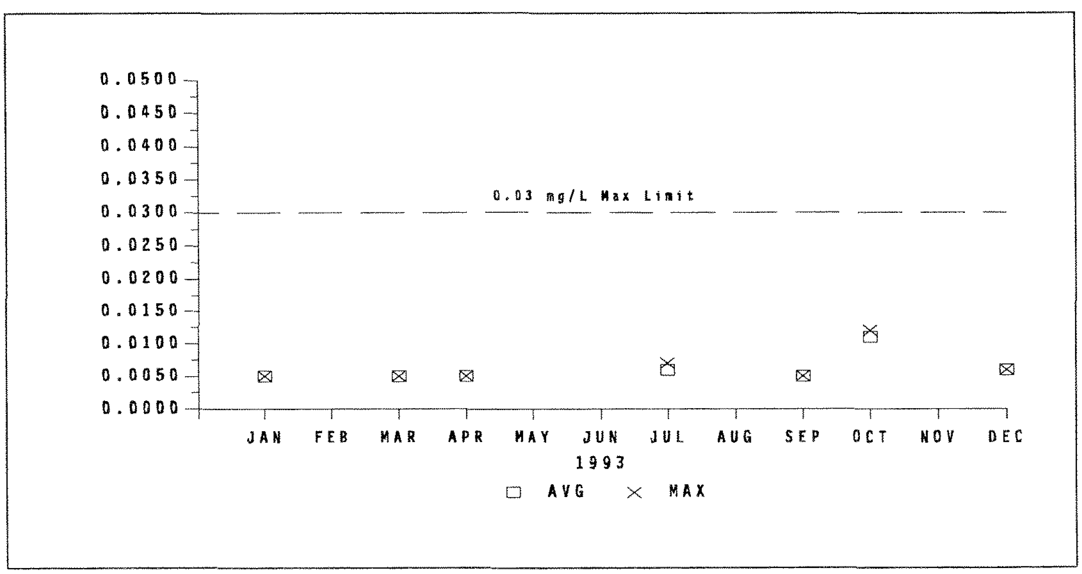


Figure C - 5.16

METALS (COPPER)
(mg/L)

Outfall 001



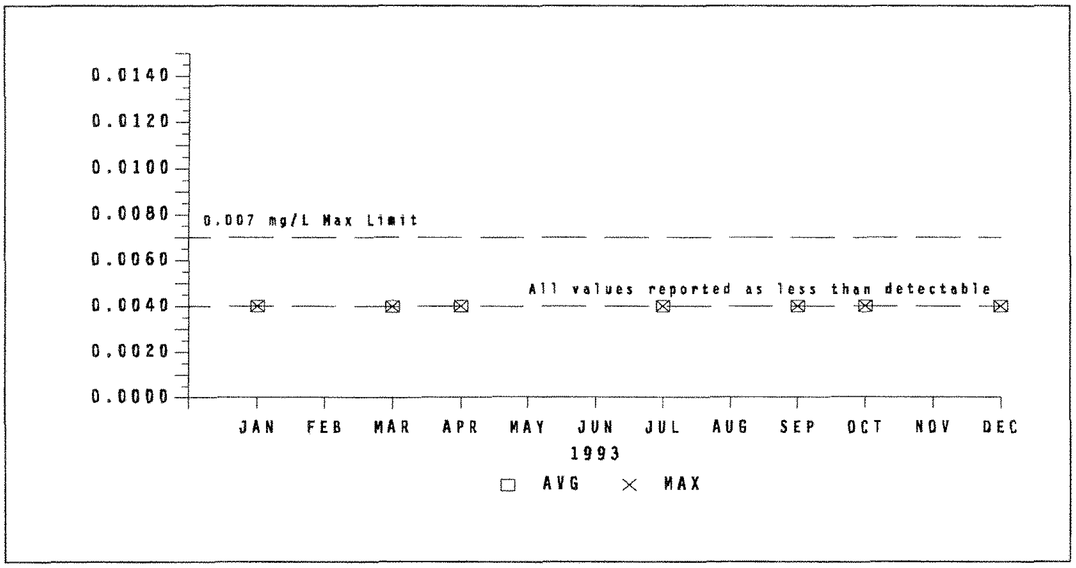


Figure C - 5.17

METALS (CADMIUM)
(mg/L)

Outfall 001

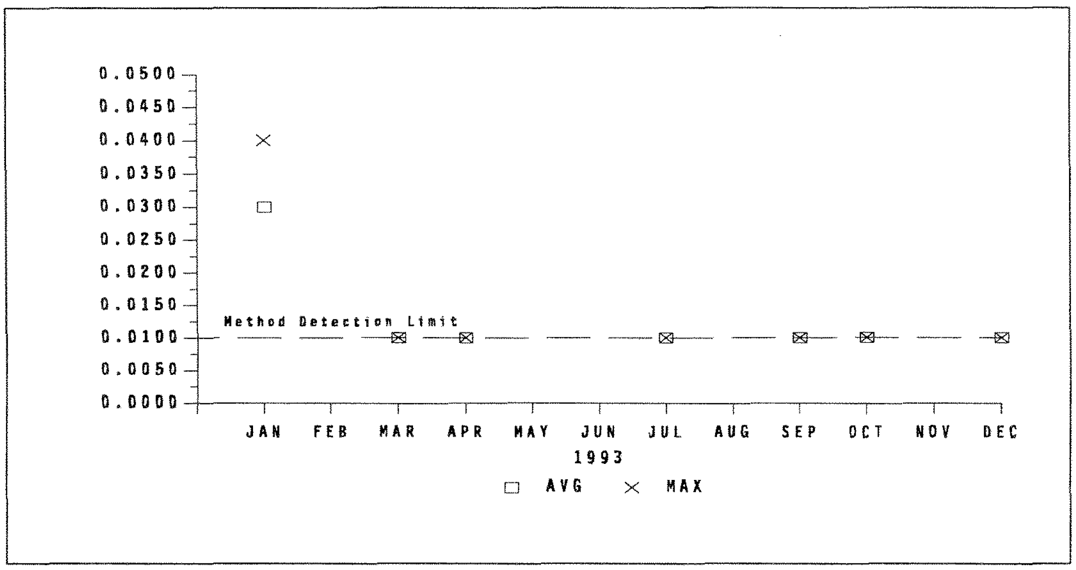


Figure C - 5.18

METALS (CHROMIUM, VI)
(mg/L)

Outfall 001

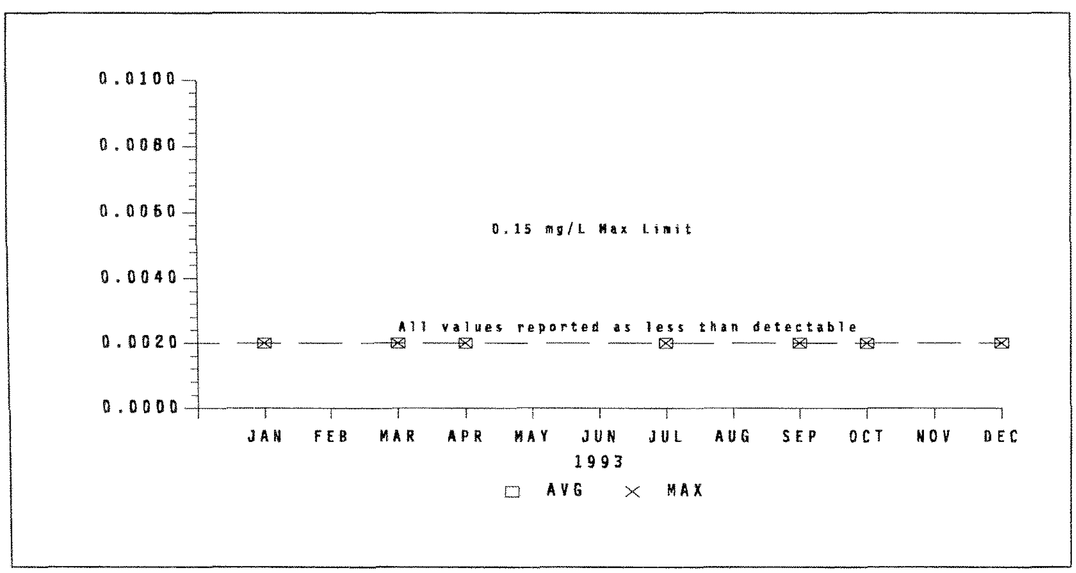


Figure C - 5.19

METALS (LEAD)
(mg/L)

Outfall 001

Figure C - 5.20

NITRATE (NO_3-N)
(mg/L)

Outfall 001

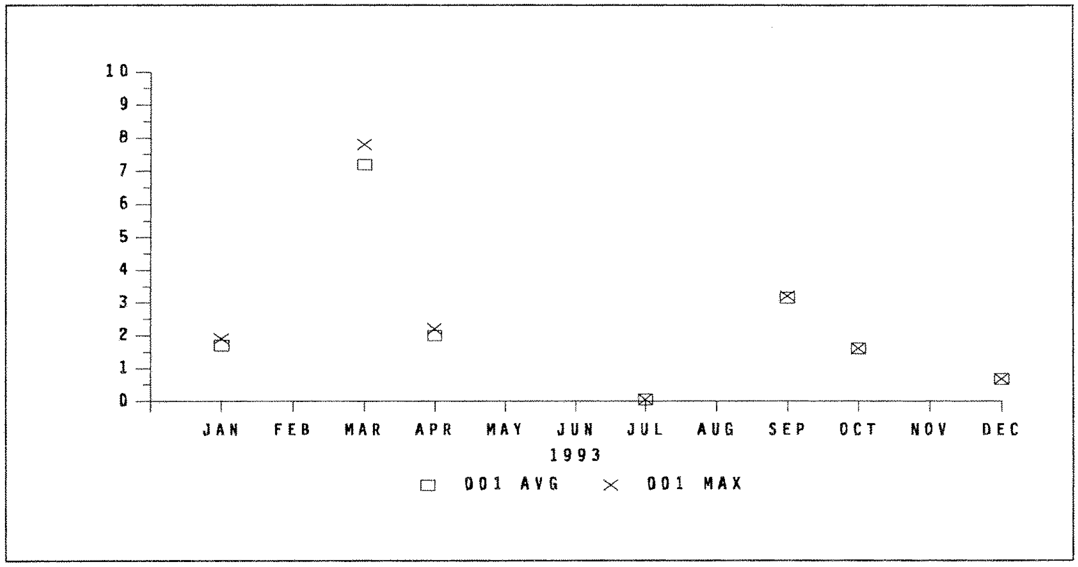


Figure C - 5.21

NITRITE (NO_2-N)
(mg/L)

Outfall 001

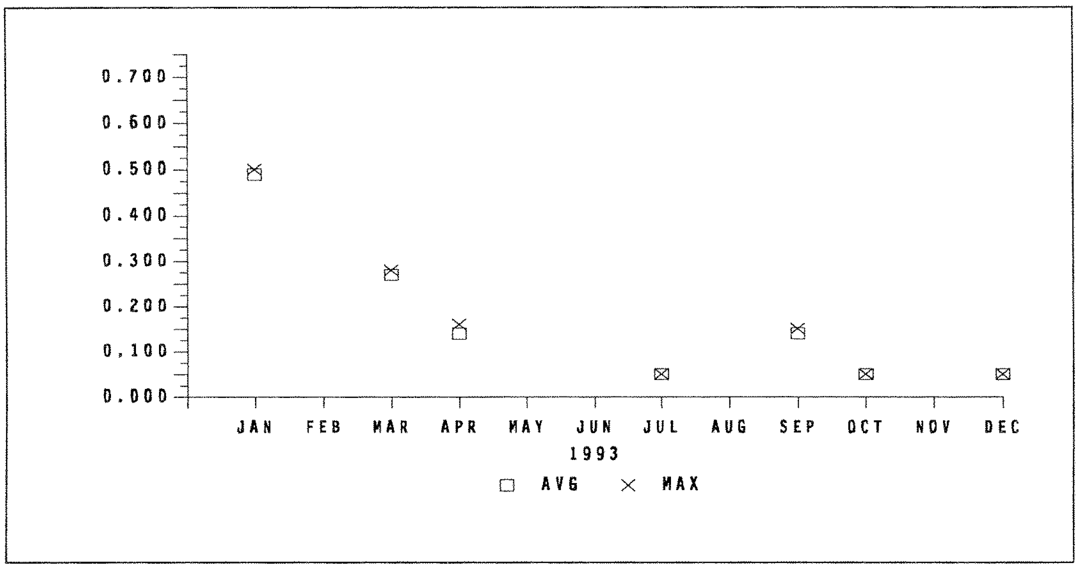
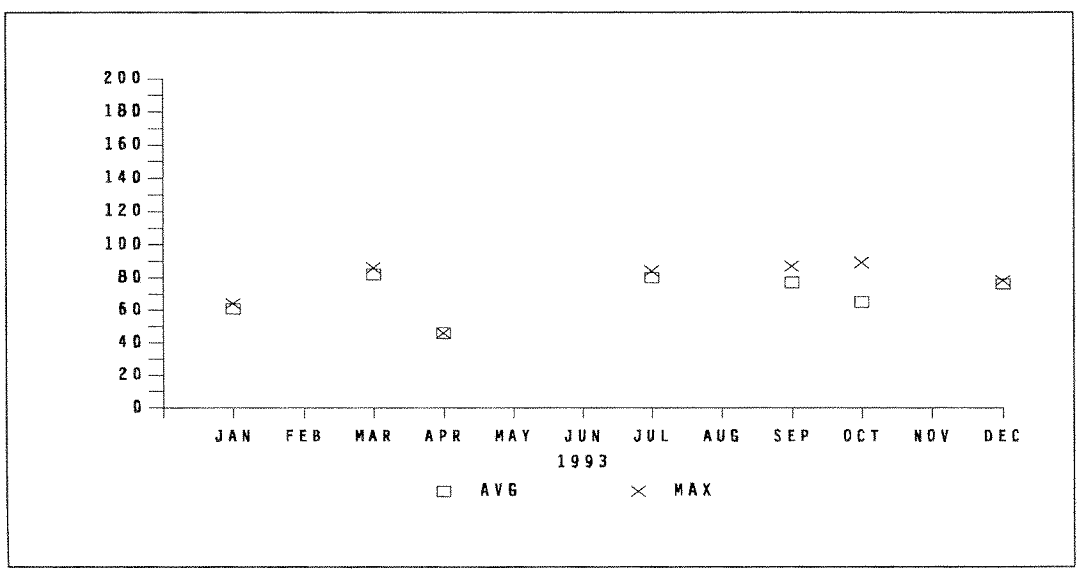


Figure C - 5.22

SULFATE-S
(mg/L)

Outfall 001



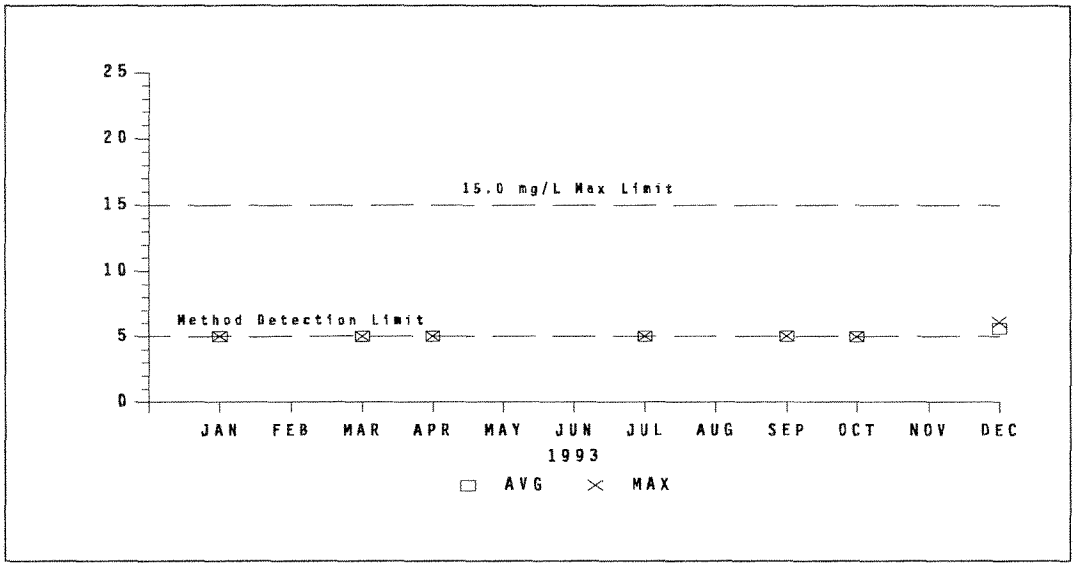


Figure C - 5.23

OIL AND GREASE (mg/L)

Outfall 001

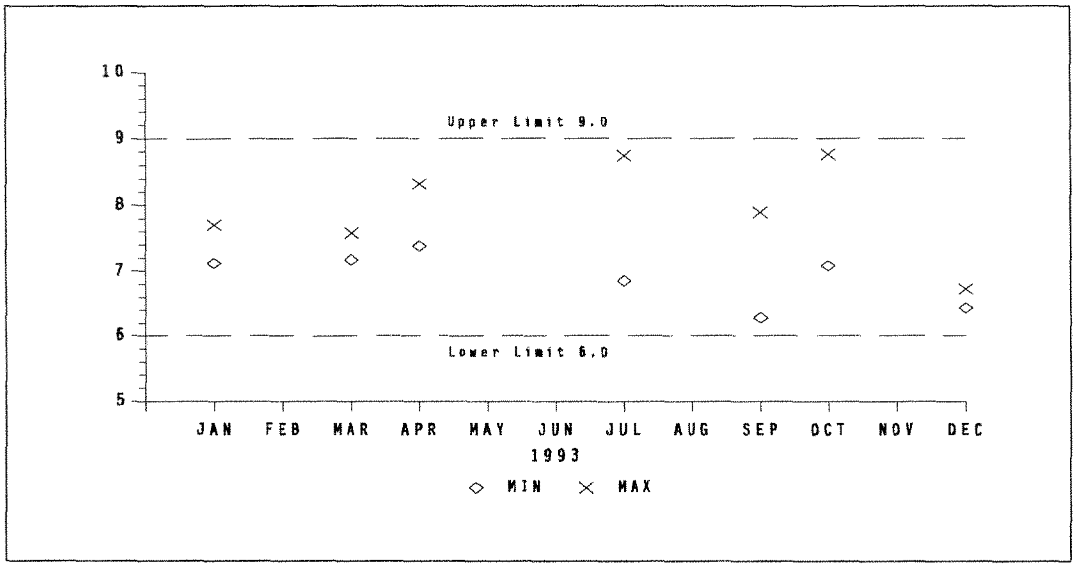


Figure C - 5.24

pH (standard units)

Outfall 001

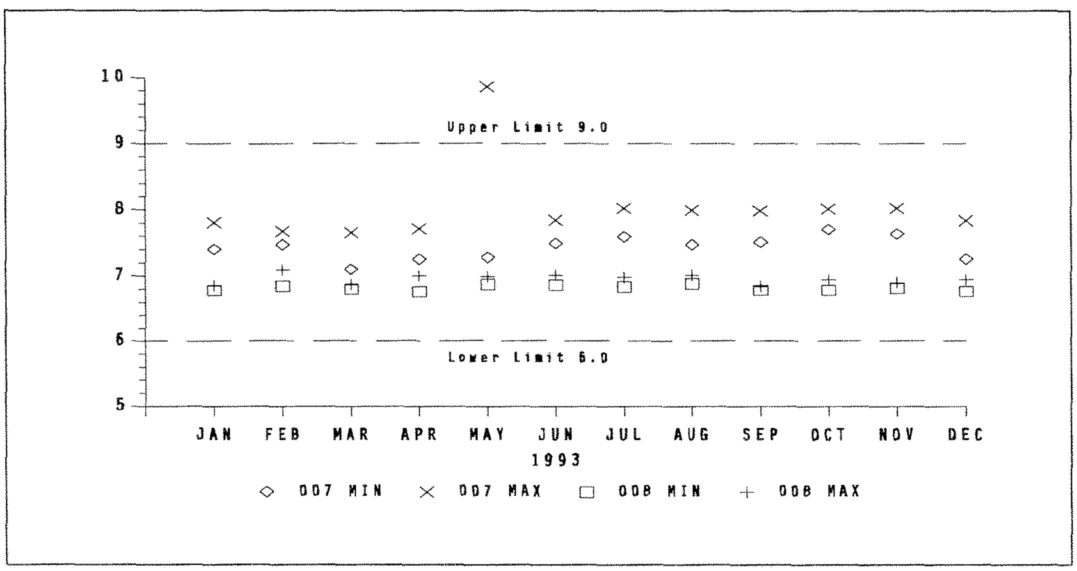


Figure C - 5.25

pH (standard units)

Outfalls 007 and 008

Figure C - 5.26

DISCHARGE RATE (MGD)

Outfall 001

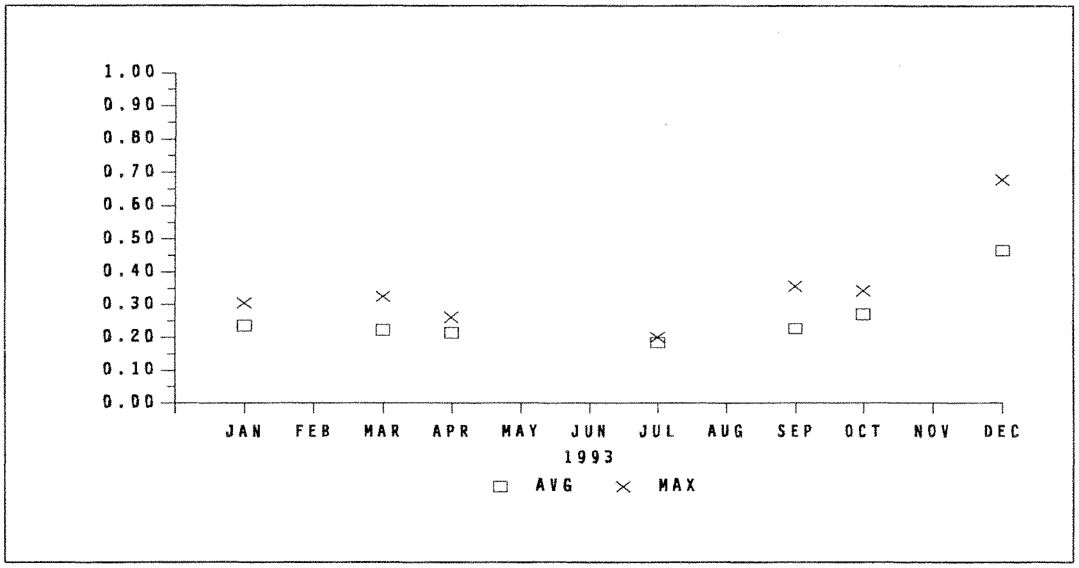


Figure C - 5.27

DISCHARGE RATE (GPD X 1,000)

Outfall 007

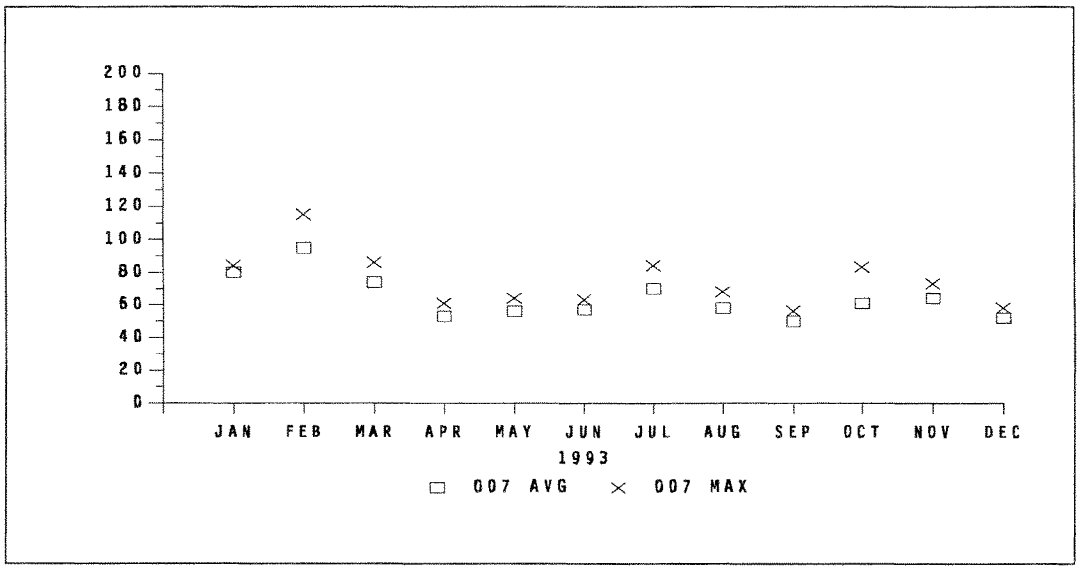
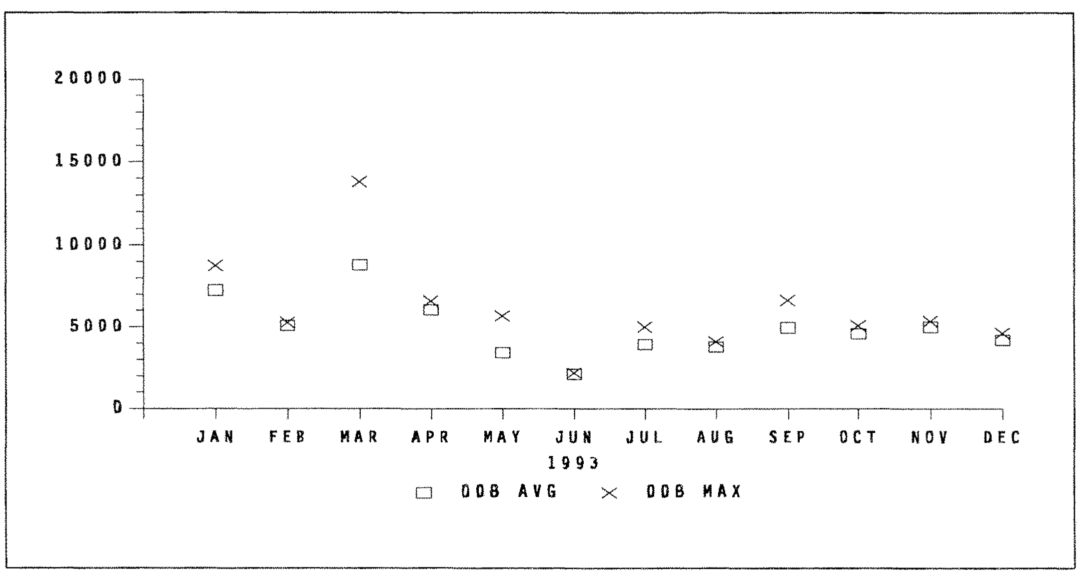


Figure C - 5.28

DISCHARGE RATE (GPD)

Outfall 008



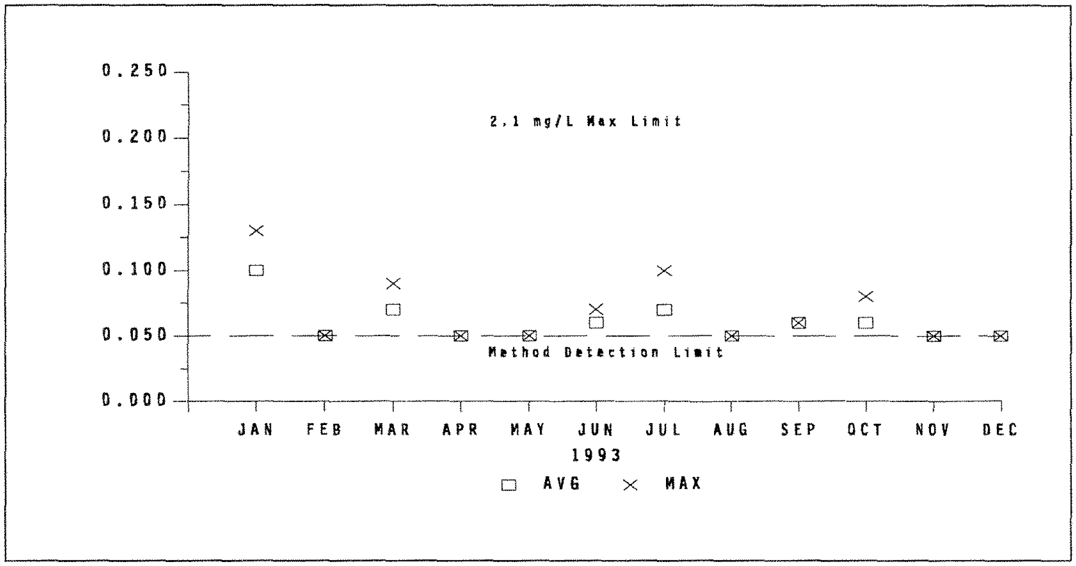


Figure C - 5.29

FLOW-WEIGHTED AVERAGES (mg/L)

Ammonia

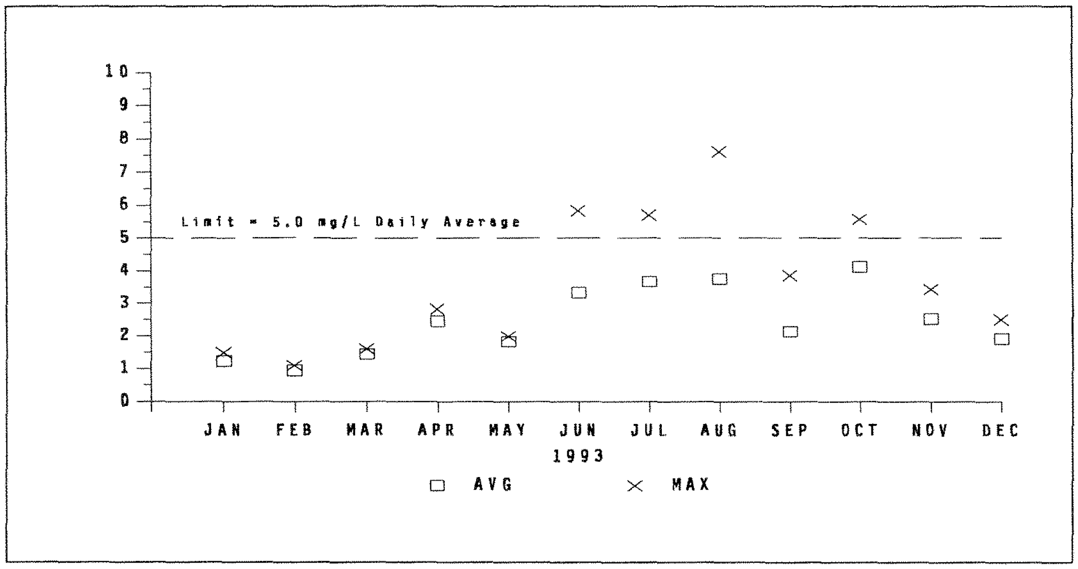


Figure C - 5.30

FLOW-WEIGHTED AVERAGES (mg/L)

Biochemical Oxygen Demand-5

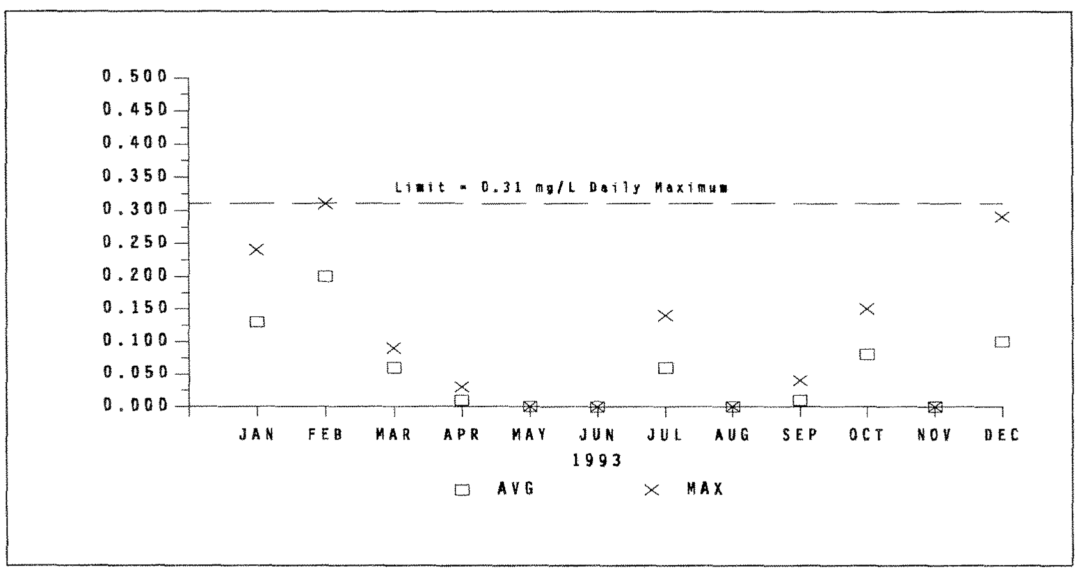


Figure C - 5.31

FLOW-WEIGHTED AVERAGES (mg/L)

Iron

Figure C - 5.32

NICKEL (mg/L)

Outfall 001

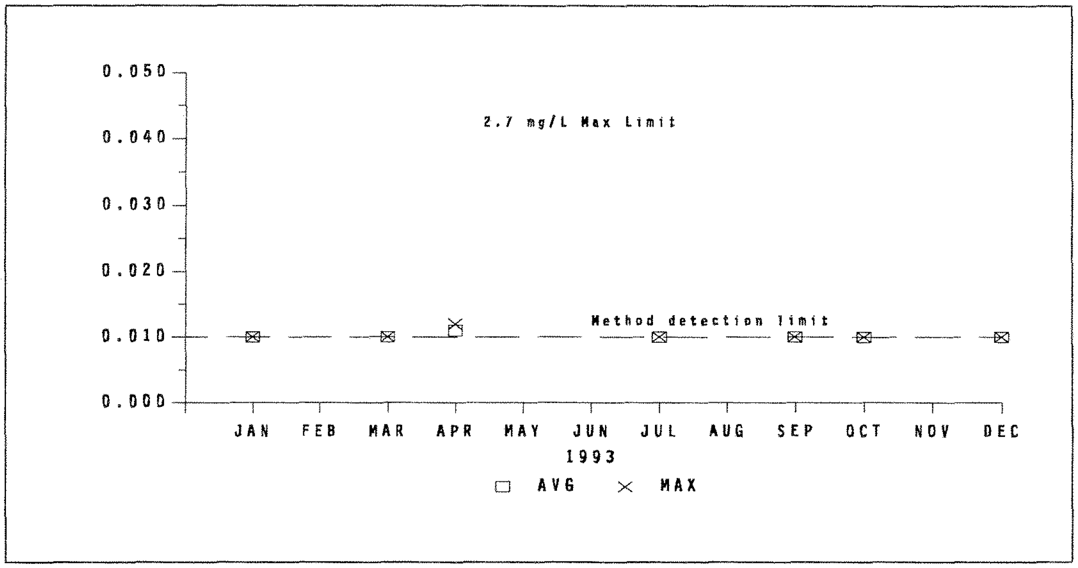


Figure C - 5.33

TRICHLOROFLUOROMETHANE (mg/L)

Outfall 001

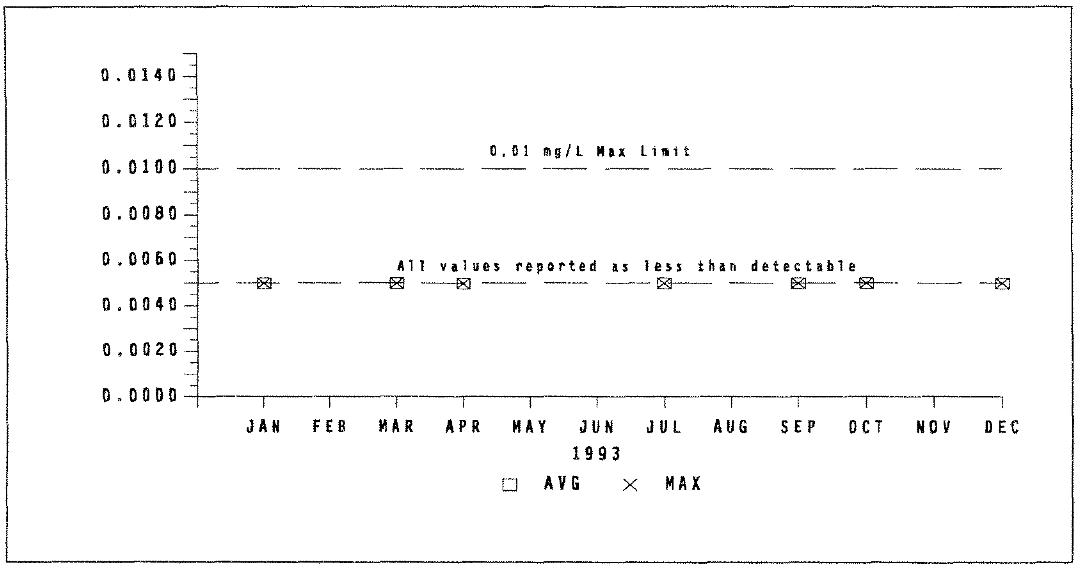
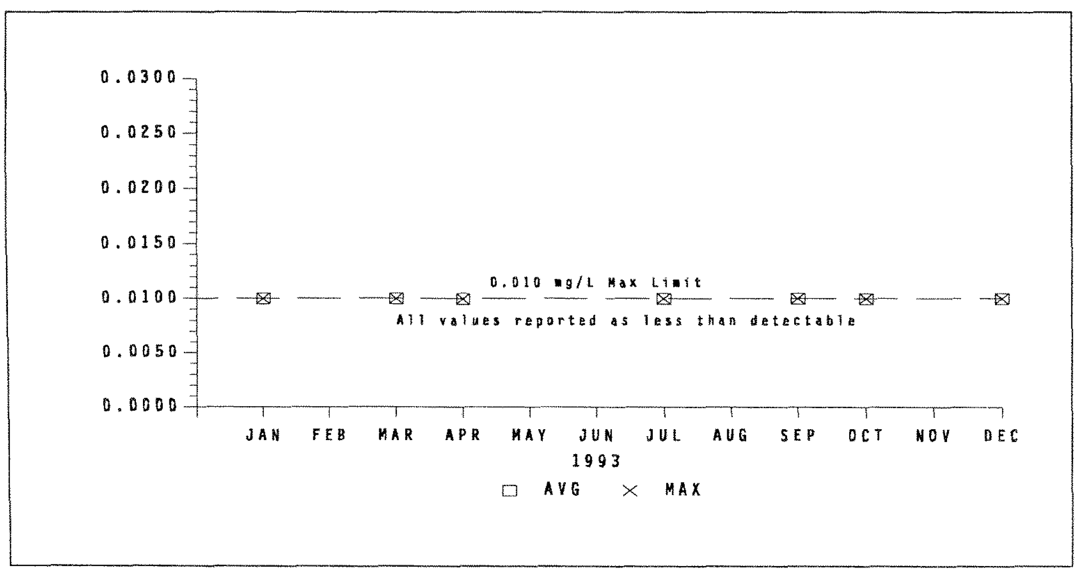


Figure C - 5.34

3,3-DICHLOROBENZIDINE (mg/L)

Outfall 001



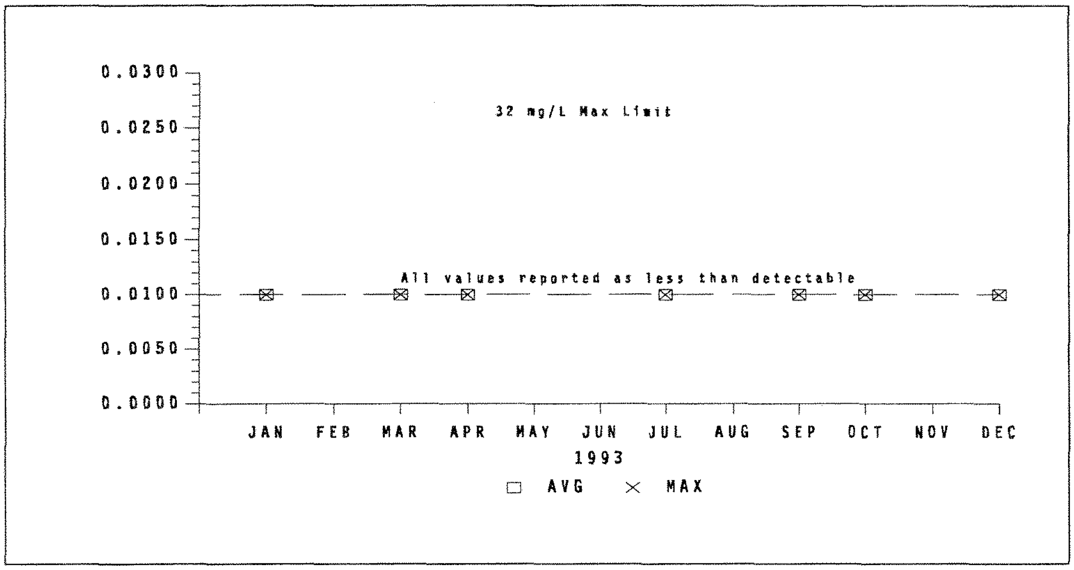


Figure C - 5.35

TRIBUTYL PHOSPHATE
(mg/L)

Outfall 001

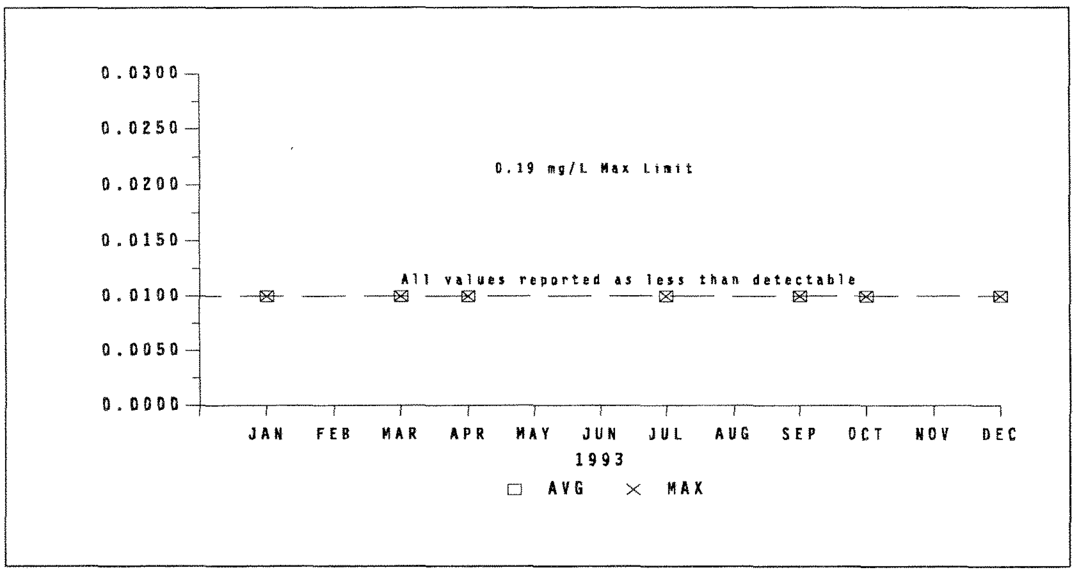


Figure C - 5.36

VANADIUM
(mg/L)

Outfall 001

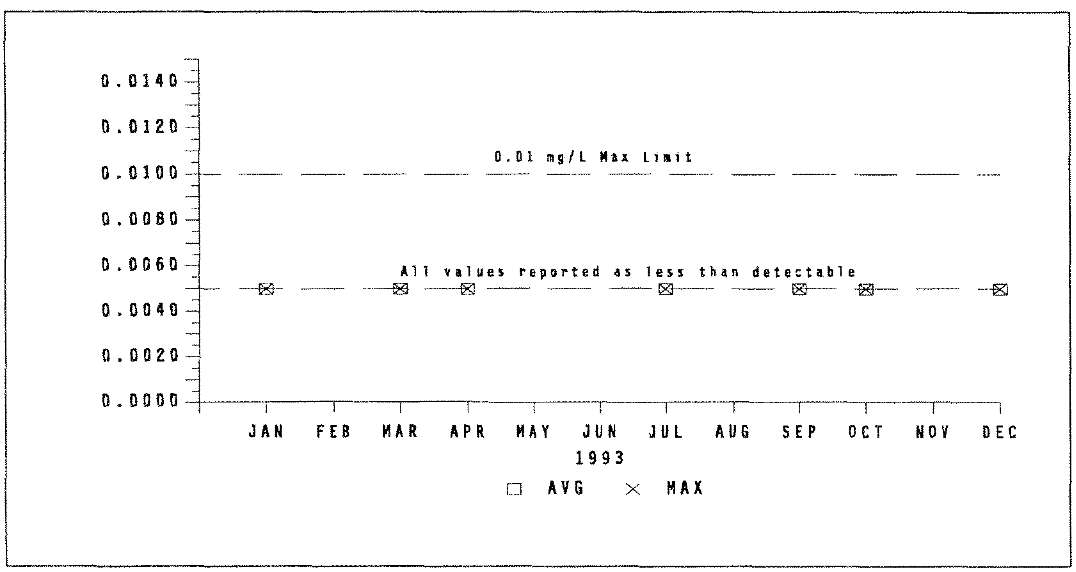


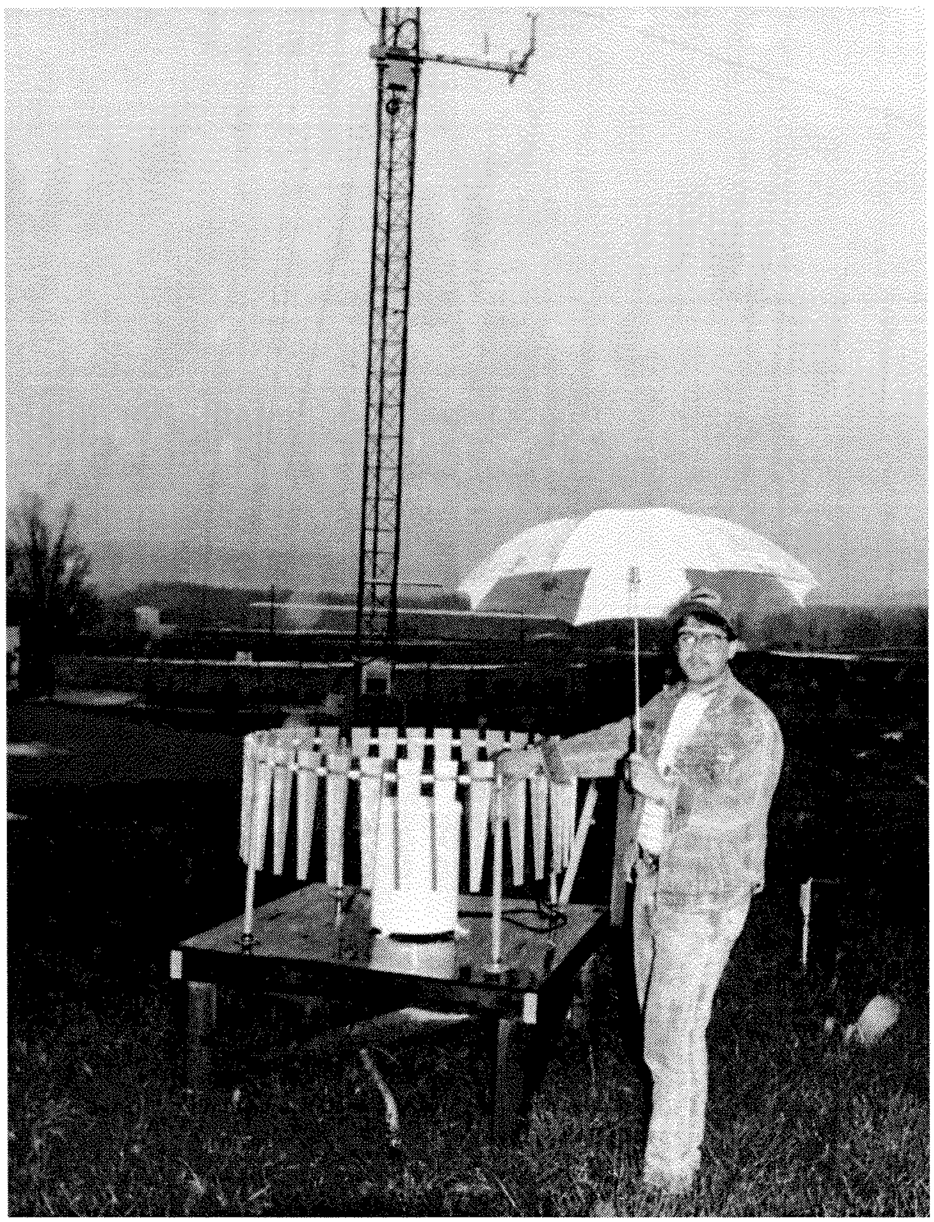
Figure C - 5.37

DICHLORODIFLUOROMETHANE
(mg/L)

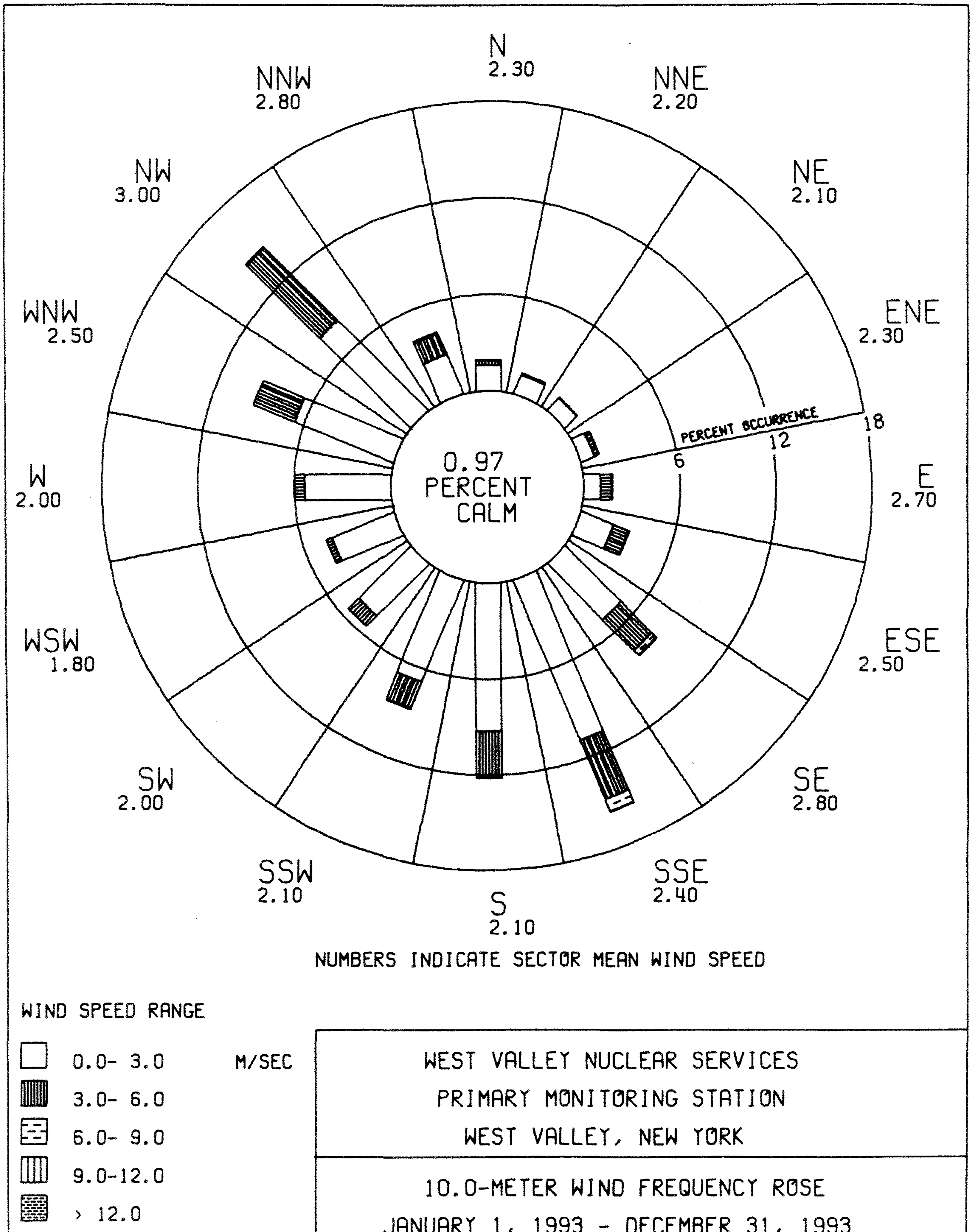
Outfall 001

Appendix C - 6

Summary of Meteorological Data



On-site Meteorological Tower and Rain Gage



N
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SW
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WSW
1.80
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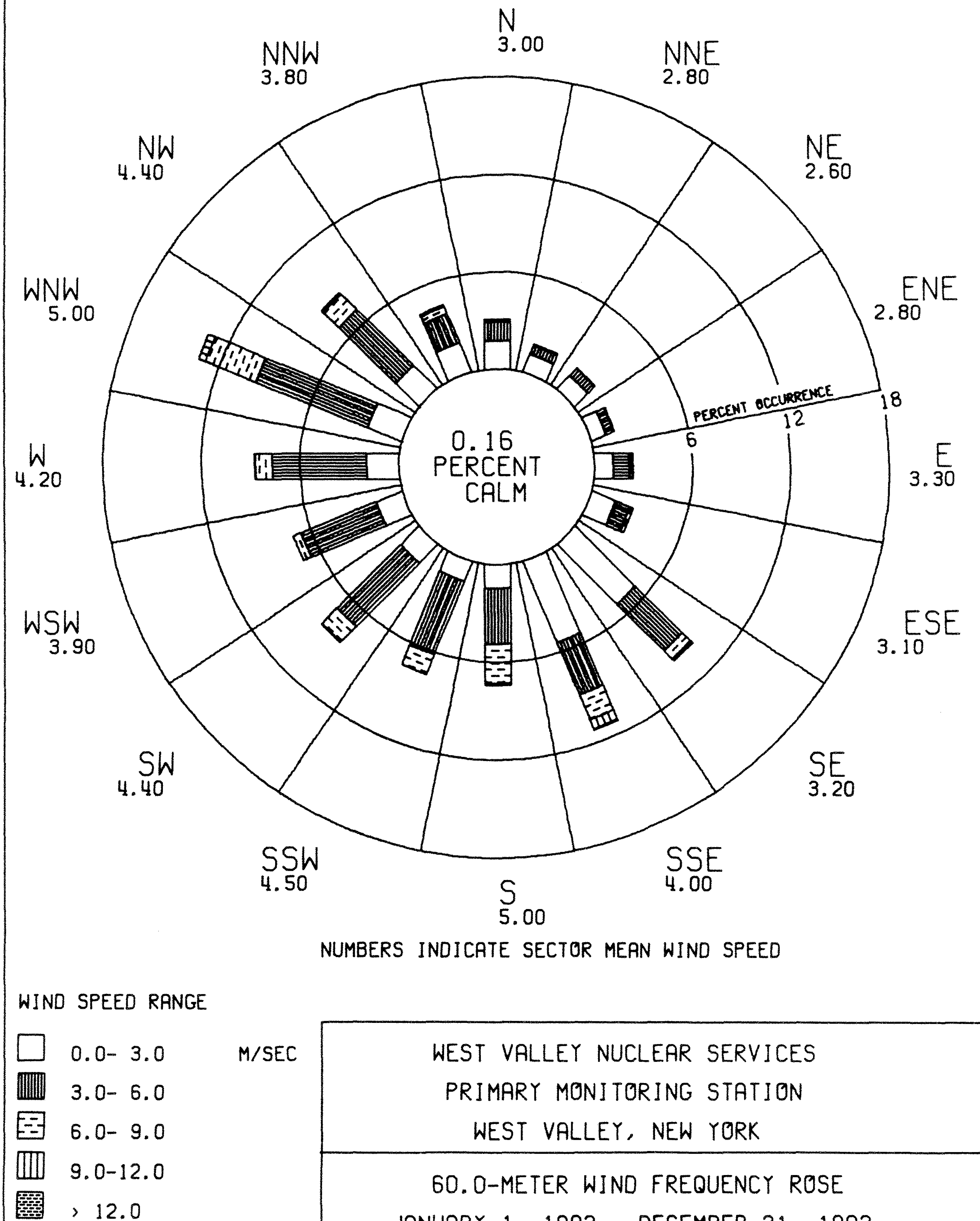
WNW
2.50
NW
3.00
NNW
2.80
PERCENT OCCURRENCE
6
12
18
0.97 PERCENT CALM
NUMBERS INDICATE SECTOR MEAN WIND SPEED
WIND SPEED RANGE
0.0- 3.0 M/SEC
3.0- 6.0
6.0- 9.0
9.0-12.0
› 12.0
WEST VALLEY NUCLEAR SERVICES
PRIMARY MONITORING STATION
WEST VALLEY, NEW YORK
10.0-METER WIND FREQUENCY ROSE
JANUARY 1, 1993 - DECEMBER 31, 1993

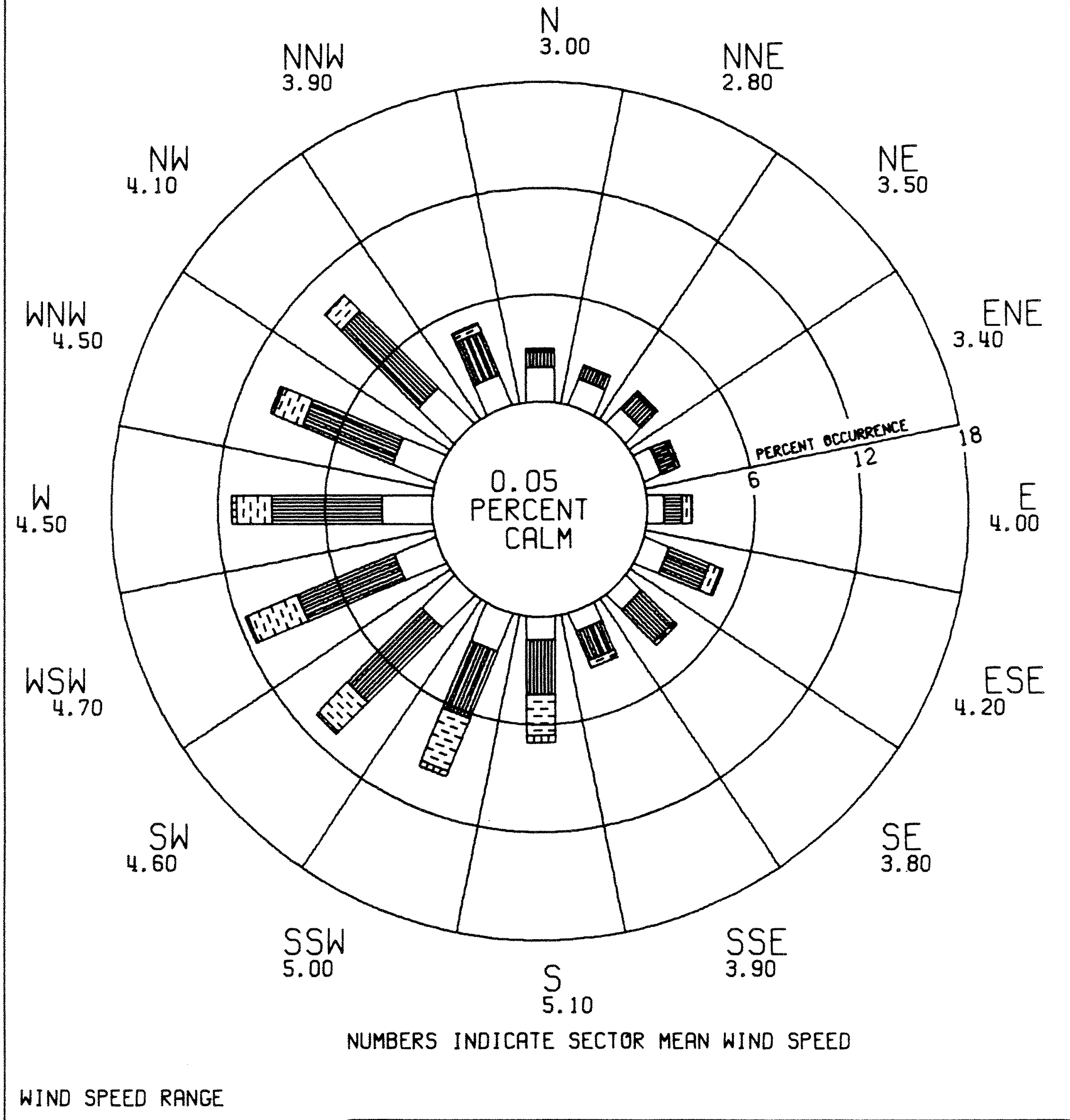
Figure C - 6.1



WEST VALLEY NUCLEAR SERVICES
PRIMARY MONITORING STATION
WEST VALLEY, NEW YORK

60.0-METER WIND FREQUENCY ROSE
JANUARY 1, 1993 - DECEMBER 31, 1993

Figure C - 6.2



WEST VALLEY NUCLEAR SERVICES
REGIONAL MONITORING STATION
WEST VALLEY, NEW YORK

10.0-METER WIND FREQUENCY ROSE
JANUARY 1, 1993 - DECEMBER 31, 1993

Figure C - 6.3

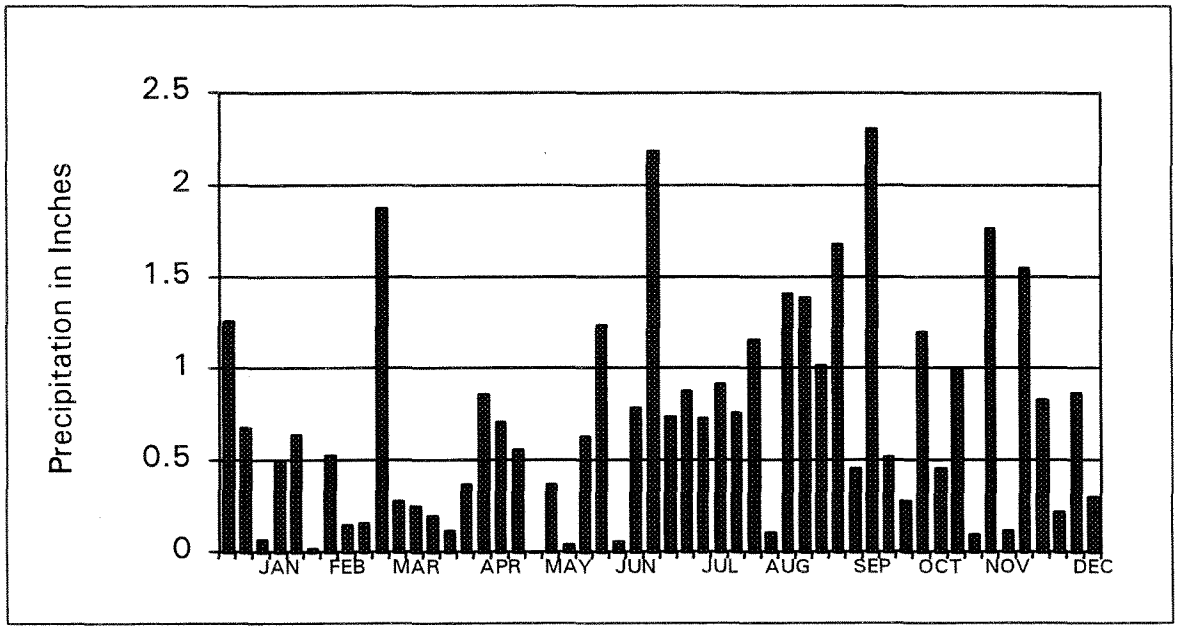


Figure C - 6.4. 1993 Weekly Rainfall

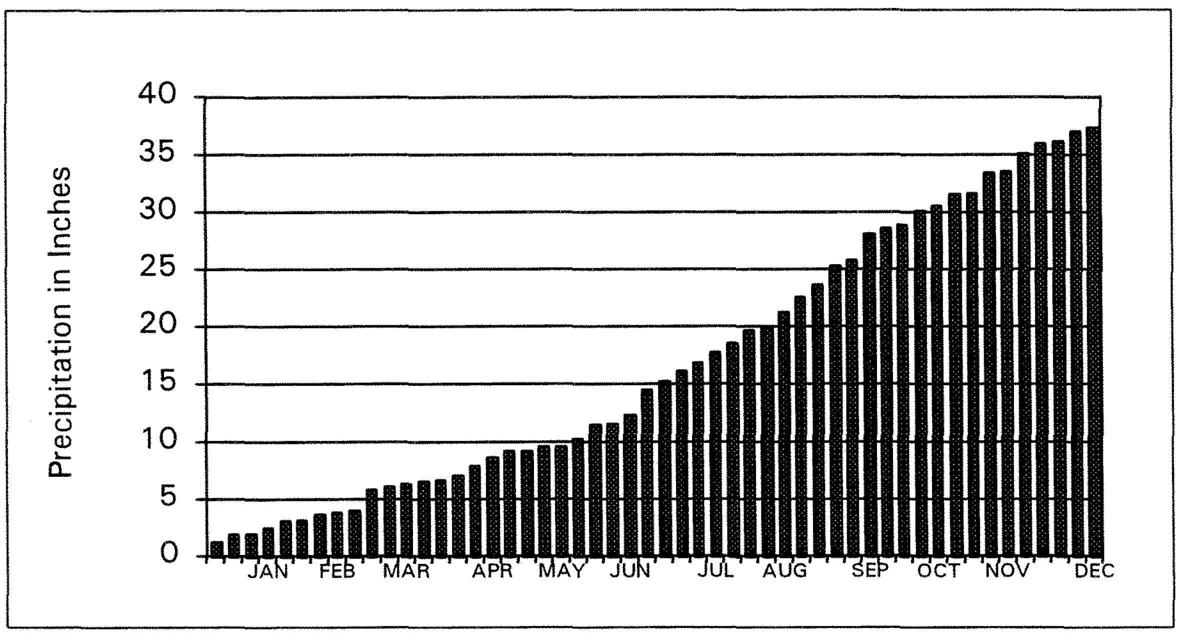


Figure C - 6.5. 1993 Cumulative Rainfall

Table C - 6.1

1993 Site Rainfall Collection Data

Week Ending:	Weekly (inches)	Cumulative (inches)	Week Ending:	Weekly (inches)	Cumulative (inches)
January 7	1.26	1.26	*July 8*	0.74	15.3
January 14	0.68	1.94	*July 15*	0.88	16.18
January 21	0.07	2.01	*July 22*	0.73	16.91
January 28	0.5	2.51	*July 29*	0.92	17.83
February 4	0.64	3.15	*August 5*	0.76	18.59
February 11	0.02	3.17	*August 12*	1.16	19.75
February 18	0.53	3.7	*August 19*	0.11	19.86
February 25	0.15	3.85	*August 26*	1.41	21.27
March 4	0.16	4.01	*September 2*	1.39	22.66
March 11	1.88	5.89	*September 9*	1.02	23.68
March 18	0.28	6.17	*September 16*	1.68	25.36
March 25	0.25	6.42	*September 23*	0.46	25.82
April 1	0.2	6.62	*September 30*	2.31	28.13
April 8	0.12	6.74	*October 7*	0.52	28.65
April 15	0.37	7.11	*October 14*	0.28	28.93
April 22	0.86	7.97	*October 21*	1.2	30.13
April 29	0.71	8.68	*October 28*	0.46	30.59
May 6	0.56	9.24	*November 4*	1.0	31.59
May 13	0	9.24	*November 11*	0.1	31.69
May 20	0.37	9.61	*November 18*	1.77	33.46
May 27	0.04	9.65	*November 25*	0.12	33.58
June 3	0.63	10.28	*December 2*	1.55	35.13
June 10	1.24	11.52	*December 9*	0.83	35.96
June 17	0.06	11.58	*December 16*	0.22	36.18
June 24	0.79	12.37	*December 23*	0.87	37.05
July 1	2.19	14.56	*December 31*	0.3	37.35

Table C - 6.2

1993 Annual Temperature Summary at the 10-meter Primary Meteorological Tower

	Average Temperature		Maximum Temperature		Minimum Temperature	
	°C	°F	°C	°F	°C	°F
January	-2.5	27.5	15.5	59.9	-16.7	1.9
February	-7.2	19.0	5.8	42.4	-20.2	-4.4
March	-1.1	30.0	14.9	58.8	-19.5	-3.1
April	7.5	45.5	25.2	77.4	-5.3	22.5
May	12.9	55.2	28.4	83.1	-0.3	31.5
June	17.5	63.5	29.0	84.2	4.2	39.6
July	20.7	69.3	32.3	90.1	8.8	47.8
August	19.7	67.5	30.2	86.4	5.8	42.4
September	13.8	56.8	28.0	82.4	-1.6	29.1
October	8.6	47.5	24.7	76.5	-3.4	25.9
November	3.3	37.9	16.4	61.5	-8.4	16.9
December	-3.0	26.6	8.7	47.7	-23.3	-9.9
Annual	7.6	45.7	32.3	90.1	-23.3	-9.9

Appendix D

Summary of Quality Assurance Crosscheck Analyses

Table D - 1

Comparison of Radiological Concentrations in Crosscheck Samples
between the West Valley Demonstration Project and the Environmental Measurements Laboratory (EML) Quality Assessment Program 38

Isotope	Matrix	Actual	Reported	Ratio	Accept ?	Analyzed by
Be-7	Air	2.74E+01	2.40E+01	.88	Yes	TI
Co-60	Air	1.70E+00	1.50E+00	.88	Yes	TI
Sr-90	Air	1.52E-01	1.60E-01	1.05	Yes	TI
Cs-134	Air	1.96E+00	1.70E+00	.87	Yes	TI
Cs-137	Air	3.07E+00	2.80E+00	.91	Yes	TI
Pu-238	Air	3.63E-02	2.40E-02	.66	Pass	TI
Pu-239	Air	2.34E-02	1.90E-02	.81	Yes	TI
Am-241	Air	4.14E-02	5.20E-02	1.26	Pass	TI
U(*μg*)	Air	1.80E+00	7.40E-01	.41	No	TI
K-40	Soil	3.21E+02	3.60E+02	1.12	Yes	TI
Sr-90	Soil	4.17E+01	3.50E+01	.84	Yes	TI
Cs-137	Soil	9.23E+02	1.10E+03	1.19	Yes	TI
Pu-239	Soil	1.16E+01	1.40E+01	1.21	Pass	TI
Am-241	Soil	6.50E+00	5.40E+00	.83	Yes	TI
U(*Bq*)	Soil	7.69E+01	3.20E+01	.42	No	TI
K-40	Veg	3.83E+02	4.80E+02	1.25	Pass	TI
Sr-90	Veg	2.37E+02	1.00E+02	.42	No	TI
Cs-137	Veg	2.46E+01	3.00E+01	1.22	Pass	TI
H-3	Water	9.70E+01	9.90E+01	1.02	Yes	EL
Co-60	Water	4.53E+01	4.90E+01	1.08	Yes	EL
Sr-90	Water	1.03E+00	1.30E+00	1.26	Pass	EL
Cs-134	Water	4.24E+01	4.40E+01	1.04	Yes	EL
Cs-137	Water	5.08E+01	5.60E+01	1.10	Yes	EL
Pu-238	Water	4.94E-01	5.00E-01	1.01	Yes	TI
Pu-239	Water	8.28E-01	7.20E-01	.87	Yes	TI
Am-241	Water	4.40E-01	3.70E-01	.84	Yes	TI
U(*μg*)	Water	1.17E-02	1.10E-02	.94	Yes	TI

Units for air filters: Bq/filter; soil and vegetation: Bq/kg; water: Bq/L. Uranium units as listed in the table.

Samples analyzed by the Environmental Laboratory (EL) or Teledyne Isotopes (TI).

Acceptance limits of reported to actual ratio: ***Yes*** *indicates a ratio within warning limits of 0.8 to 1.2;* ***Pass*** *indicates a ratio within control limits of 0.5 to 1.5 but outside warning limits;* ***No*** *indicates a ratio outside control limits.*

Table D - 2

Comparison of Radiological Concentrations in Crosscheck Samples
between the West Valley Demonstration Project and the Environmental Measurements Laboratory (EML) Quality Assessment Program 39

Isotope	Matrix	Actual	Reported	Ratio	Accept ?	Analyzed by
Co-60	Air	2.05E+01	1.80E+01	.88	Yes	TI
Sr-90	Air	7.62E-01	1.20E+00	1.57	No	TI
Cs-134	Air	1.22E+01	1.10E+01	.90	Yes	TI
Cs-137	Air	1.88E+01	1.70E+01	.90	Yes	TI
Pu-238	Air	1.29E-01	1.40E-01	1.09	Yes	TI
Pu-239	Air	8.00E-02	9.60E-02	1.20	Yes	TI
Am-241	Air	6.54E-02	9.30E-02	1.42	Pass	TI
U-234	Air	6.50E-02	1.10E-01	1.69	No	TI
U-238	Air	6.50E-02	8.50E-02	1.31	Pass	TI
U(μg)	Air	5.41E+00	2.00E-01	.04	No	TI
K-40	Soil	2.86E+01	7.40E+01	2.59	No	TI
Sr-90	Soil	5.40E+00	4.80E+00	.89	Yes	TI
Cs-137	Soil	1.14E+01	1.40E+01	1.23	Pass	TI
Pu-239	Soil	1.52E+00	1.20E+00	.79	Pass	TI
Am-241	Soil	2.48E-01	3.60E+00	14.52	No	TI
U-234	Soil	2.48E+01	3.50E+00	.14	No	TI
U-238	Soil	2.55E+01	3.60E+00	.14	No	TI
U(μg)	Soil	1.97E+00	7.10E+00	3.60	No	TI
K-40	Veg	8.42E+02	9.60E+02	1.14	Yes	TI
Sr-90	Veg	2.21E+02	1.80E+01	.08	No	TI
Cs-137	Veg	8.92E+01	1.20E+02	1.35	Pass	TI
H-3	Water	2.70E+02	2.50E+02	.93	Yes	EL
Co-60	Water	9.96E+01	8.60E+01	.86	Yes	EL
Sr-90	Water	2.52E+00	3.40E+00	1.35	Pass	EL
Cs-134	Water	5.61E+01	4.40E+01	.78	Pass	EL
Cs-137	Water	7.55E+01	6.30E+01	.83	Yes	EL
Pu-238	Water	1.14E+00	1.20E+03	1,052.63	No	TI
Pu-239	Water	3.38E-01	3.40E+03	10,059.17	No	TI
Am-241	Water	1.39E+00	1.50E+02	107.91	No	TI
U(μg)	Water	8.42E-02	8.30E-02	.99	Yes	TI

Units for air filters: Bq/filter; soil and vegetation: Bq/kg; water: Bq/L. Uranium units as listed in the table.

Samples analyzed by the Environmental Laboratory (EL) or Teledyne Isotopes (TI).

*Acceptance limits of reported to actual ratio: **Yes** indicates a ratio within warning limits of 0.8 to 1.2; **Pass** indicates a ratio within control limits of 0.5 to 1.5 but outside warning limits; **No** indicates a ratio outside control limits.*

Table D - 3

Comparison of Radiological Concentrations in Crosscheck Samples
between the West Valley Demonstration Project and the U.S. Environmental Protection Agency's Environmental Monitoring Systems Laboratory (EMSL)

Sample	Analyte	Matrix	Actual	Reported	Accept ?	Analyzed by
PE-A (April 1993)	Alpha	Water	95.0	97.67	Yes	EL
	Ra-226	Water	24.9	19.00	Yes	TI
	Ra-228	Water	19.0	22.33	Yes	TI
	U(Nat)	Water	28.9	32.33	Yes	TI
PE-B (April 1993)	Beta	Water	177.0	160.00	Yes	EL
	Sr-89	Water	41.0	35.67	Yes	TI
	Sr-90	Water	29.0	27.67	Yes	TI
	Co-60	Water	39.0	36.67	Yes	EL
	Cs-134	Water	27.0	23.00	Yes	EL
	Cs-137	Water	32.0	28.33	Yes	EL
PE-A (Oct 1993)	Alpha	Water	40.0	48.67	Yes	EL
	Ra-226	Water	9.9	9.63	Yes	TI
	Ra-228	Water	12.5	15.00	Yes	TI
	U(Nat)	Water	15.1	15.00	Yes	TI
PE-B (Oct 1993)	Beta	Water	58.0	57.33	Yes	EL
	Sr-89	Water	15.0	14.00	Yes	TI
	Sr-90	Water	10.0	10.33	Yes	TI
	Co-60	Water	10.0	10.33	Yes	EL
	Cs-134	Water	12.0	7.33	Yes	EL
	Cs-137	Water	10.0	9.00	Yes	EL
GAM (June 1993)	Co-60	Water	15.0	15.67	Yes	EL
	Cs-134	Water	5.0	7.00	Yes	EL
	Cs-137	Water	5.0	5.00	Yes	EL
GAM (Nov 1993)	Co-60	Water	30.0	27.33	Yes	EL
	Cs-134	Water	59.0	43.00	No	EL
	Cs-137	Water	40.0	38.33	Yes	EL

Units for water and milk = pCi/L; for air filters = pCi/filter.

Samples analyzed by the Environmental Laboratory (EL) or Teledyne Isotopes (TI), as indicated.

Explanation of codes: PE-A = performance evaluation (alpha); PE-B = performance evaluation (beta); GAM = gamma in water; TRW = tritium in water; AF = air filter; Milk = milk sample; ABW = alpha and beta in water.

Acceptance limits as defined for individual analytes and matrices by EMSL differ from crosscheck to crosscheck. ***Yes*** *indicates a result within warning limits;* ***Pass*** *indicates a result within control limits but outside warning limits;* ***No*** *indicates a result outside control limits.*

Table D - 3 (concluded)

Comparison of Radiological Concentrations in Crosscheck Samples between the West Valley Demonstration Project and the U.S. Environmental Protection Agency's Environmental Monitoring Systems Laboratory (EMSL)

Sample	Analyte	Matrix	Actual	Reported	Accept ?	Analyzed by
TRW (June 1993)	H-3	Water	9,844.0	8,875.67	Yes	EL
TRW (Nov 1993)	H-3	Water	7,398.0	7,496.00	Yes	EL
AF (Aug 1993)	Alpha	Filter	19.0	21.67	Yes	EL
	Beta	Filter	47.0	53.33	Pass	EL
	Cs-137	Filter	9.0	8.00	Yes	EL
Milk (Sept 1993)	Sr-89	Milk	30.0	24.33	Yes	TI
	Sr-90	Milk	25.0	23.33	Yes	TI
	I-131	Milk	120.0	130.00	Yes	TI
	Cs-137	Milk	49.0	54.33	Yes	TI
	Total K	Milk	1,679.0	1,633.33	Yes	TI
ABW (July 1993)	Alpha	Water	15.0	14.00	Yes	EL
	Beta	Water	43.0	37.67	Yes	EL
ABW (Oct 1993)	Alpha	Water	20.0	13.67	Pass	EL
	Beta	Water	15.0	18.67	Yes	EL

Units for water and milk = pCi/L; for air filters = pCi/filter.

Samples analyzed by the Environmental Laboratory (EL) or Teledyne Isotopes (TI), as indicated.

Explanation of codes: PE-A = performance evaluation (alpha); PE-B = performance evaluation (beta); GAM = gamma in water; TRW = tritium in water; AF = air filter; Milk = milk sample; ABW = alpha and beta in water.

Acceptance limits as defined for individual analytes and matrices by EMSL differ from crosscheck to crosscheck. ***Yes*** *indicates a result within warning limits;* ***Pass*** *indicates a result within control limits but outside warning limits;* ***No*** *indicates a result outside control limits.*

Table D - 4

Comparison of Water Quality Parameters in Crosscheck Samples

between the West Valley Demonstration Project and the U.S. Environmental Protection Agency 1993 Discharge Monitoring Report Quality Assurance Program #13 for the National Pollutant Discharge Elimination System (NPDES)

Analyte	Units	Actual (EPA)	Reported (WVNS)	Accept ?	Analyzed by
Aluminum	µg/L	1,100	1,300	Pass	Recra
Arsenic	µg/L	280	294	Yes	Recra
Beryllium	µg/L	63.0	64.5	Yes	Recra
Cadmium	µg/L	8.12	8.00	Yes	Recra
Chromium	µg/L	62.0	61.6	Yes	Recra
Cobalt	µg/L	480	502	Yes	Recra
Copper	µg/L	62.0	65.2	Yes	Recra
Iron	µg/L	3,800	3970	Yes	Recra
Lead	µg/L	79.2	79.6	Yes	Recra
Manganese	µg/L	2,200	2,270	Yes	Recra
Mercury	µg/L	.983	1.020	Yes	Recra
Nickel	µg/L	130	155	No	Recra
Selenium	µg/L	23.0	21.5	Yes	Recra
Vanadium	µg/L	8,000	8,040	Yes	Recra
Zinc	µg/L	1,100	1,130	Yes	Recra
pH	SU	8.70	8.78	Yes	EL
Total Suspended Solids	mg/L	43.2	31.5	No	EL
Oil and Grease	mg/L	15.0	13.7	Yes	Recra
Ammonia-N	mg/L	5.50	5.57	Yes	EL
Nitrate-N	mg/L	34.0	34.4	Yes	Recra
Kjeldahl-N	mg/L	9.30	8.94	Yes	Recra
Total K	mg/L	3.20	2.61	Yes	Recra
Total Organic Carbon	mg/L	8.61	9.00	Yes	EL
BOD-5	mg/L	14.0	8.46	Pass	EL
Cyanide	mg/L	.250	.242	Yes	Recra
Phenolics	mg/L	.0271	.0333	Yes	Recra
Total Residual Chlorine	mg/L	.729	.727	Yes	Recra

Analyses were conducted by Recra Environmental Inc. or the Environmental Laboratory (EL) as indicated in the table.

*Acceptance limits determined by the EPA: **Yes** indicates a result within warning limits; **Check** indicates a result within control limits but outside warning limits; **No** indicates a result outside control limits.*

Table D - 5

Comparison of Water Quality Parameters in Crosscheck Samples
between the West Valley Demonstration Project and the New York State Department of Health (NYSDOH) in 1993

Analyte	Units	Actual (NYSDOH)	Reported (WVNS)	Accept ?	Analyzed by
BOD-5	mg/L	43.4	39.6	Yes	EL
		71.5	62.9	Yes	EL
		16.9	14.9	Yes	EL
		51.4	43.2	Yes	EL
Total Organic Carbon	mg/L	27.0	27.9	Yes	EL
		44.7	46.2	Yes	EL
		10.2	10.2	Yes	EL
		31.6	31.3	Yes	EL
Total Dissolved Solids	mg/L	344.0	341.0	Yes	EL
		150.0	149.0	Yes	EL
Total Suspended Solids	mg/L	33.2	33.3	Yes	EL
		74.2	72.7	Yes	EL
		18.6	18.0	Yes	EL
		76.8	78.3	Yes	EL
pH	SU	9.39	9.38	Yes	EL
		4.80	4.69	No	EL
		2.57	2.60	Yes	EL
		7.42	7.41	Yes	EL
NH_3-N	mg/L	4.57	4.79	Yes	EL
		6.67	7.09	Yes	EL
		1.72	1.69	Yes	EL
		3.93	3.89	Yes	EL

Samples analyzed by the Environmental Laboratory (EL). Analysis for total dissolved solids added in 1993.

Acceptance range determined by NYSDOH. ***Yes*** *indicates a result within warning limits;* ***Pass*** *indicates a result within control limits but outside warning limits;* ***No*** *indicates a result outside control limits. The first two results for each analyte were part of the January crosscheck; the second two results were part of the July crosscheck.*

Table D - 6

Comparison of the West Valley Demonstration Project's
Thermoluminescent Dosimeters (TLDs) to the Co-located Nuclear Regulatory Commission (NRC) TLDs in 1993

NRC TLD#	WVDP TLD#	NRC mR/90 days	WVDP mR/Qtr	WVDP/NRC Ratio
1st Quarter 1993				
2	22	Missing	16.3	NA
3	5	14.0	15.1	1.08
4	7	14.4	14.8	1.03
5	9	Missing	14.8	NA
7	14	14.0	16.6	1.19
8	15	13.0	14.3	1.10
9	25	27.8	26.4	.95
11	24	979.0	1,066.4	1.09
2nd Quarter 1993				
2	22	18.4	19.5	NA
3	5	15.4	20.2	1.31
4	7	16.4	19.5	1.19
5	9	20.2	19.3	.96
7	14	Missing	21.3	NA
8	15	16.7	19.0	1.14
9	25	32.8	32.8	1.00
11	24	925.0	1,125.9	1.22
3rd Quarter 1993				
2	22	Missing	20.7	NA
3	5	17.6	23.7	1.35
4	7	16.7	18.8	1.13
5	9	16.9	19.5	1.15
7	14	18.7	22.4	1.20
8	15	17.0	19.3	1.14
9	25	30.1	32.7	1.09
11	24	936.0	991.8	1.06
4th Quarter 1993				
2	22	NR	25.9	NA
3	5	NR	24.6	NA
4	7	NR	22.7	NA
5	9	NR	23.0	NA
7	14	NR	25.7	NA
8	15	NR	24.8	NA
9	25	NR	37.7	NA
11	24	NR	1,160.9	NA

The data are evaluated and co-located TLDs with ratios outside the control limits of 0.5 to 1.5 are investigated to determine the discrepancy.

"Missing" indicates that a TLD was no longer in place at the time of collection. NR - Not reported; NA - Not available.

Results for 4th quarter NRC TLDs were not available at the time this report was prepared.

Appendix E

Summary of Groundwater Monitoring Data

Table E - 1
1993 Contamination Indicator Parameters for the Sand and Gravel Unit

Location Code	Hydraulic Position	pH	Conductivity *µmhos/cm @25°C*	TOC *mg/L*	TOX *mg/L*	Gross Alpha *µCi/mL*	Gross Beta *µCi/mL*	H-3 *µCi/mL*	Cs-137 *µCi/mL*	Co-60 *µCi/mL*
WNW0301	UP(1)	7.01	685	0.7	0.003	-2.77±2.72E-09	3.69±3.15E-09	0.00±1.00E-07	0.00±3.22E-08	0.00±3.47E-08
WNW0301	UP(2)	7.10	861	0.8	0.002	2.55±3.73E-09	5.33±3.25E-09	0.00±1.00E-07	0.00±1.96E-08	0.00±2.22E-08
WNW0301	UP(3)	6.86	926	0.9	0.018	0.00±4.70E-09	2.69±3.83E-09	0.00±1.00E-07	0.00±1.96E-08	0.00±2.22E-08
WNW0301	UP(4)	6.95	974	0.9	<0.006	-2.09±4.10E-09	5.64±3.73E-09	0.00±1.00E-07	0.00±2.56E-08	0.00±3.64E-08
WNW0301	UP(5)	6.94	779	1.0	0.005	-1.03±2.02E-09	1.50±3.92E-09	1.57±0.76E-07	0.00±1.96E-08	0.00±2.22E-08
WNW0301	UP(6)	6.96	718	0.7	<0.002	0.00±6.30E-09	2.51±4.47E-09	0.00±1.00E-07	0.00±1.94E-08	0.44±2.38E-08
WNW0401	UP(1)	6.68	1,331	0.8	0.015	2.60±5.11E-09	4.31±4.54E-09	0.00±1.00E-07	0.00±1.74E-08	0.00±2.17E-08
WNW0401	UP(2)	7.09	1,335	0.6	0.008	-1.91±7.13E-09	2.79±6.00E-09	2.55±8.81E-08	0.70±2.59E-08	0.66±2.89E-08
WNW0401	UP(3)	6.83	1,852	0.6	0.020	0.00±9.48E-09	3.25±5.62E-09	0.00±1.00E-07	2.98±6.14E-09	3.82±6.90E-09
WNW0401	UP(4)	7.20	1,700	0.8	0.007	-0.21±8.06E-09	4.92±5.82E-09	0.00±1.00E-07	1.14±2.56E-08	0.00±3.64E-08
WNW0401	UP(5)	6.32	2,155	0.8	0.016	1.10±1.32E-08	7.08±8.01E-09	1.29±7.56E-08	0.00±1.96E-08	0.00±2.22E-08
WNW0401	UP(6)	6.65	1,883	0.9	0.013	-1.40±1.44E-08	-0.11±1.06E-08	0.00±1.00E-07	0.32±1.94E-08	0.00±2.38E-08
WNW0403	UP(1)	7.12	1,266	1.1	0.009	-1.11±3.77E-09	6.08±4.09E-09	0.00±1.00E-07	2.42±3.22E-08	0.00±3.47E-08
WNW0403	UP(2)	7.20	1,024	1.1	0.007	-2.84±4.16E-09	6.66±4.81E-09	0.00±1.00E-07	1.91±3.22E-08	0.00±3.47E-08
WNW0403	UP(3)	6.45	1,375	1.3	0.016	-3.70±5.41E-09	7.57±5.85E-09	0.00±1.00E-07	0.00±3.22E-08	0.00±3.47E-08
WNW0403	UP(4)	7.23	1,343	1.2	0.007	-3.21±6.30E-09	8.42±6.15E-09	5.08±7.71E-08	0.00±2.56E-08	0.00±3.64E-08
WNW0403	UP(5)	6.53	1,889	1.3	0.017	0.69±1.65E-08	9.91±7.42E-09	9.31±7.90E-08	0.00±1.96E-08	0.00±2.22E-08
WNW0403	UP(6)	6.69	968	2.0	0.009	-0.21±1.25E-08	0.93±1.18E-08	0.00±1.00E-07	0.00±1.83E-08	0.00±1.94E-08
WNW0706	UP(1)	6.29	624	4.1	0.018	0.57±1.92E-09	1.17±0.37E-08	0.00±1.00E-07	0.00±3.22E-08	0.00±3.47E-08
WNW0706	UP(2)	6.87	603	3.7	0.010	-1.57±2.30E-09	3.25±2.98E-09	0.00±1.00E-07	0.00±3.22E-08	0.00±3.47E-08
WNW0706	UP(3)	6.32	547	3.2	0.013	-0.84±2.62E-09	7.20±3.19E-09	7.66±7.49E-08	1.15±3.22E-08	0.00±3.47E-08
WNW0706	UP(4)	6.49	526	3.4	0.011	-1.19±2.34E-09	9.47±3.29E-09	0.33±9.44E-08	0.76±2.56E-08	0.00±3.64E-08
WNW0706	UP(5)	6.44	469	2.5	0.009	-0.66±2.24E-09	5.20±3.05E-09	1.67±0.77E-07	0.00±1.96E-08	0.00±2.22E-08
WNW0706	UP(6)	6.41	457	3.6	0.013	0.00±2.20E-09	9.12±3.04E-09	0.00±1.00E-07	0.13±1.83E-08	0.00±1.94E-08
WNWNB1S	UP(1)	6.24	538	1.2	0.004	-0.45±2.31E-09	3.17±2.71E-09	1.57±0.78E-07	1.53±3.22E-08	0.00±3.47E-08
WNWNB1S	UP(2)	6.89	745	1.1	0.004	-0.78±1.54E-09	2.04±2.76E-09	0.00±1.00E-07	0.00±3.22E-08	0.00±3.47E-08
WNWNB1S	UP(3)	6.19	655	1.3	<0.002	0.57±2.95E-09	0.91±2.68E-09	0.00±1.00E-07	0.00±1.74E-08	0.40±2.17E-08
WNWNB1S	UP(4)	6.63	706	1.2	0.004	-1.65±4.57E-09	2.24±3.80E-09	1.61±7.69E-08	0.00±2.56E-08	0.00±3.64E-08
WNWNB1S	UP(5)	7.01	786	1.4	0.003	-3.02±4.40E-09	2.97±3.67E-09	1.04±0.76E-07	0.00±1.96E-08	0.00±2.22E-08
WNWNB1S	UP(6)	6.32	507	1.6	0.010	3.35±4.03E-09	5.99±4.70E-09	0.00±1.00E-07	0.00±3.13E-08	0.00±3.28E-08
WNW0201	DOWN - B(1)	6.47	1,245	2.0	0.015	0.00±6.35E-09	8.44±1.07E-08	0.00±1.00E-07	1.79±3.22E-08	0.00±3.47E-08
WNW0201	DOWN - B(2)	6.57	1,096	2.0	0.007	-3.22±5.57E-09	5.58±0.91E-08	1.72±7.14E-08	1.02±3.22E-08	0.00±3.47E-08
WNW0201	DOWN - B(3)	5.97	1,917	1.7	<0.004	-3.46±8.31E-09	1.15±0.15E-07	0.00±1.00E-07	0.00±1.96E-08	0.00±2.22E-08
WNW0201	DOWN - B(4)	7.02	1,700	1.7	<0.006	-0.24±1.05E-08	7.46±1.20E-08	0.17±4.86E-08	0.51±1.96E-08	0.00±2.22E-08
WNW0201	DOWN - B(5)	6.24	1,831	1.7	0.023	0.95±1.12E-08	8.80±1.54E-08	1.61±0.76E-07	0.00±1.96E-08	0.00±2.22E-08
WNW0201	DOWN - B(6)	6.31	1,623	1.7	0.013	6.26±9.14E-09	5.02±1.18E-08	0.00±1.00E-07	0.00±1.94E-08	0.90±2.38E-08
WNW0305	DOWN - B(1)	6.78	1,174	1.5	0.022	-0.86±5.98E-09	8.45±4.69E-09	0.00±1.00E-07	1.15±3.22E-08	0.00±3.47E-08
WNW0305	DOWN - B(2)	7.04	1,085	1.5	0.011	-1.0±1.95E-09	5.25±4.83E-09	0.00±1.00E-07	0.00±1.74E-08	0.00±2.17E-08
WNW0305	DOWN - B(3)	6.88	1,102	1.5	<0.004	1.06±6.24E-09	6.50±4.75E-09	0.00±1.00E-07	0.00±2.56E-08	0.00±3.64E-08
WNW0305	DOWN - B(4)	6.77	1,237	1.3	0.004	6.36±8.26E-09	4.28±4.45E-09	0.00±1.00E-07	0.00±1.96E-08	0.00±2.22E-08
WNW0305	DOWN - B(5)	6.81	1,214	1.5	<0.002	-3.80±7.49E-09	9.76±6.03E-09	1.78±0.76E-07	0.00±1.96E-08	0.00±2.22E-08
WNW0305	DOWN - B(6)	6.88	1,302	1.6	0.010	1.64±5.56E-09	1.55±0.63E-08	0.00±1.00E-07	0.00±1.94E-08	0.00±2.38E-08
WNW0307	DOWN - B(1)	6.87	934	1.4	0.017	-1.71±4.11E-09	9.61±4.27E-09	0.00±1.00E-07	0.00±3.22E-08	0.00±3.47E-08
WNW0307	DOWN - B(2)	7.22	823	1.5	0.013	1.43±2.80E-09	4.72±3.84E-09	0.00±1.00E-07	0.00±3.22E-08	0.00±3.47E-08
WNW0307	DOWN - B(3)	6.92	839	1.1	<0.004	-3.20±3.14E-09	3.89±3.58E-09	0.00±1.00E-07	0.00±2.56E-08	0.00±3.64E-08
WNW0307	DOWN - B(4)	6.78	746	1.4	0.004	0.00±3.77E-09	5.40±3.19E-09	0.47±6.72E-08	0.00±2.56E-08	0.00±3.64E-08
WNW0307	DOWN - B(5)	6.80	711	1.5	0.005	-2.96±3.07E-09	5.53±3.32E-09	1.08±0.77E-07	0.00±1.96E-08	0.00±2.22E-08
WNW0307	DOWN - B(6)	6.93	926	1.3	0.009	1.13±3.83E-09	3.00±0.50E-08	0.00±1.00E-07	0.00±1.94E-08	0.00±2.38E-08

NR - Not reported. These results have not been reported because the data validation process indicated the data were not reliable.
NA - Not available.

Table E - 1 (continued)
1993 Contamination Indicator Parameters for the Sand and Gravel Unit

Location Code	Hydraulic Position	pH	Conductivity *µmhos/cm @25°C*	TOC *mg/L*	TOX *mg/L*	Gross Alpha *µCi/mL*	Gross Beta *µCi/mL*	H-3 *µCi/mL*	Cs-137 *µCi/mL*	Co-60 *µCi/mL*
WNW0603	DOWN - B(1)	6.52	818	1.3	0.002	-2.32±3.38E-09	8.91±3.58E-09	0.00±1.00E-07	0.00±1.74E-08	0.00±2.17E-08
WNW0603	DOWN - B(2)	6.53	880	1.0	<0.002	1.82±3.57E-09	4.77±3.48E-09	0.00±1.00E-07	0.00±1.74E-08	0.00±2.17E-08
WNW0603	DOWN - B(3)	6.96	816	1.3	0.003	0.00±4.38E-09	9.24±4.00E-09	2.33±7.52E-08	1.14±2.56E-08	0.00±3.64E-08
WNW0603	DOWN - B(4)	6.52	883	0.9	0.002	0.62±4.80E-09	3.60±3.37E-09	0.00±1.00E-07	0.00±1.96E-08	0.00±2.22E-08
WNW0603	DOWN - B(5)	6.56	205	1.1	<0.002	-2.83±3.93E-09	9.63±5.18E-09	1.96±0.78E-07	0.00±1.96E-08	0.00±2.22E-08
WNW0603	DOWN - B(6)	6.33	922	1.3	0.003	1.51±5.13E-09	5.27±6.04E-09	0.00±1.00E-07	0.00±3.13E-08	2.07±3.28E-08
WNW8613A	DOWN - B(1)	6.76	713	0.8	0.007	1.50±4.64E-09	5.25±3.19E-09	0.00±1.00E-07	0.00±3.22E-08	0.00±3.47E-08
WNW8613A	DOWN - B(2)	6.86	730	0.9	0.005	2.04±2.97E-09	3.46±3.18E-09	0.00±1.00E-07	0.00±1.74E-08	0.00±2.17E-08
WNW8613A	DOWN - B(3)	6.75	728	1.0	0.011	-3.36±4.04E-09	1.54±3.16E-09	0.00±1.00E-07	0.00±2.56E-08	0.00±3.64E-08
WNW8613A	DOWN - B(4)	7.00	709	0.9	<0.002	-1.30±2.56E-09	2.36±2.77E-09	0.00±1.00E-07	0.89±2.56E-08	0.00±3.64E-08
WNW8613A	DOWN - B(5)	6.84	730	0.9	0.003	3.08±4.50E-09	2.45±3.35E-09	7.21±7.99E-08	0.58±1.96E-08	0.00±2.22E-08
WNW8613A	DOWN - B(6)	6.78	702	1.1	0.008	-1.90±5.27E-09	0.81±4.13E-09	0.00±1.00E-07	0.00±3.13E-08	0.00±3.28E-08
WNW8613B	DOWN - B(1)	6.41	701	1.8	0.014	0.00±3.26E-09	1.94±2.53E-09	1.89±7.63E-08	0.00±1.74E-08	0.00±2.17E-08
WNW8613B	DOWN - B(2)	6.59	658	1.6	0.009	1.13±2.21E-09	3.53±3.11E-09	0.00±1.00E-07	0.00±1.74E-08	0.00±2.17E-08
WNW8613B	DOWN - B(3)	6.27	813	1.4	0.005	-1.08±2.99E-09	3.41±4.12E-09	0.00±1.00E-07	0.00±1.96E-08	0.00±2.22E-08
WNW8613B	DOWN - B(4)	6.17	784	1.5	0.007	-0.77±2.61E-09	2.64±4.49E-09	0.00±1.00E-07	0.00±1.96E-08	0.00±2.22E-08
WNW8613B	DOWN - B(5)	6.12	808	1.8	0.010	-0.91±3.08E-09	4.34±3.95E-09	0.00±1.00E-07	0.00±1.96E-08	0.00±2.22E-08
WNW8613B	DOWN - B(6)	6.23	605	2.1	0.017	-2.31±3.99E-09	4.18±4.18E-09	0.00±1.00E-07	0.60±3.13E-08	0.00±3.28E-08
WNW8613C	DOWN - B(1)	7.45	513	0.9	0.005	0.45±2.65E-09	3.17±2.71E-09	0.00±1.00E-07	0.00±1.74E-08	0.78±2.17E-08
WNW8613C	DOWN - B(2)	7.48	420	0.8	<0.002	-0.80±1.56E-09	5.28±3.00E-09	0.00±1.00E-07	1.00±1.74E-08	0.00±2.17E-08
WNW8613C	DOWN - B(3)	7.53	439	1.0	0.006	-0.44±1.93E-09	3.32±2.81E-09	6.66±7.50E-08	0.00±2.56E-08	0.00±3.64E-08
WNW8613C	DOWN - B(4)	7.38	394	0.7	<0.002	0.00±3.16E-09	6.70±2.75E-09	0.00±1.00E-07	0.00±2.56E-08	0.00±3.64E-08
WNW8613C	DOWN - B(5)	7.51	532	1.3	<0.002	1.12±2.20E-09	6.57±2.96E-09	0.00±1.00E-07	0.00±1.96E-08	0.00±2.22E-08
WNW8613C	DOWN - B(6)	7.59	397	1.1	0.004	-2.44±3.39E-09	3.34±3.33E-09	0.00±1.00E-07	0.00±1.83E-08	0.00±1.94E-08
WNSP008	DOWN - C(1)	6.78	1,036	2.6	0.026	2.16±4.24E-09	6.21±0.66E-08	4.69±0.19E-06	0.00±3.22E-08	0.00±3.47E-08
WNSP008	DOWN - C(2)	6.48	1,050	2.5	0.028	-1.01±5.24E-09	6.43±0.86E-08	4.19±0.17E-06	0.00±1.74E-08	0.00±2.17E-08
WNSP008	DOWN - C(3)	6.86	528	2.4	0.021	1.61±4.98E-09	5.79±0.80E-08	3.96±0.17E-06	0.00±1.74E-08	0.41±2.17E-08
WNSP008	DOWN - C(4)	7.32	983	2.5	0.023	-0.95±5.47E-09	6.59±0.85E-08	3.60±0.15E-06	0.00±1.96E-08	0.00±2.22E-08
WNSP008	DOWN - C(5)	7.02	993	2.5	0.013	-1.23±2.41E-09	7.34±0.90E-08	3.66±0.16E-06	0.00±1.96E-08	0.00±2.22E-08
WNSP008	DOWN - C(6)	6.71	909	2.4	0.016	2.52±4.93E-09	8.03±1.05E-08	2.71±0.13E-06	0.00±1.94E-08	0.48±2.38E-08
WNW0103	DOWN - C(1)	7.52	4,735	1.7	0.051	-6.61±9.16E-09	3.14±0.35E-07	4.69±8.22E-08	0.00±1.96E-08	1.11±2.22E-08
WNW0103	DOWN - C(2)	7.63	5,565	1.8	n/a	0.42±1.82E-08	3.82±0.39E-07	1.65±0.82E-07	0.06±1.96E-08	0.00±2.22E-08
WNW0103	DOWN - C(3)	8.71	3,420	7.5	0.029	6.19±8.58E-09	1.39±0.27E-07	1.15±0.82E-07	0.00±2.56E-08	0.00±3.64E-08
WNW0103	DOWN - C(4)	9.09	3,160	11.4	0.053	1.25±1.27E-08	4.98±1.64E-08	1.05±0.78E-07	0.00±1.96E-08	0.00±2.22E-08
WNW0103	DOWN - C(5)	8.55	2,475	11.4	0.029	2.82±9.58E-09	6.68±2.27E-08	3.68±9.12E-08	0.13±1.96E-08	0.82±2.22E-08
WNW0103	DOWN - C(6)	9.00	2,076	9.6	0.013	0.00±1.09E-08	5.05±1.66E-08	7.12±8.19E-08	1.40±1.83E-08	0.70±1.94E-08
WNW0104	DOWN - C(1)	7.10	966	1.9	<0.010	0.96±4.21E-09	3.17±0.05E-06	5.07±0.84E-07	0.00±2.56E-08	0.00±3.64E-08
WNW0104	DOWN - C(2)	7.08	977	< 1.0	<0.010	4.86±5.04E-09	3.72±0.06E-06	7.20±0.89E-07	0.00±1.96E-08	0.00±2.22E-08
WNW0104	DOWN - C(3)	6.81	1,002	3.7	<0.010	2.34±3.24E-09	3.38±0.06E-06	7.77±0.89E-07	0.00±1.96E-08	0.00±2.22E-08
WNW0104	DOWN - C(4)	6.98	1,041	1.7	0.013	1.18±2.32E-09	3.53±0.06E-06	8.10±0.90E-07	0.96±1.96E-08	1.38±2.22E-08
WNW0104	DOWN - C(5)	7.11	1,122	< 1.0	0.028	0.00±3.04E-09	4.26±0.07E-06	6.48±0.88E-07	0.00±1.96E-08	0.00±2.22E-08
WNW0104	DOWN - C(6)	7.05	1,120	< 1.0	<0.010	-1.61±9.47E-09	5.32±0.08E-06	7.53±0.86E-07	0.00±3.13E-08	0.00±3.28E-08
WNW0111	DOWN - C(1)	6.55	538	5.3	0.010	2.45±2.94E-09	4.06±0.05E-06	2.07±0.12E-06	0.00±2.56E-08	0.00±3.64E-08
WNW0111	DOWN - C(2)	6.33	612	5.8	<0.010	4.71±3.96E-09	5.41±0.06E-06	3.57±0.16E-06	0.00±1.96E-08	0.00±2.22E-08
WNW0111	DOWN - C(3)	6.53	622	12.2	<0.010	5.93±4.11E-09	4.42±0.06E-06	4.72±0.19E-06	1.65±2.56E-08	0.00±3.64E-08
WNW0111	DOWN - C(4)	6.96	783	8.7	0.028	1.02±0.60E-08	7.27±0.08E-06	3.18±0.15E-06	0.00±1.96E-08	0.00±2.22E-08
WNW0111	DOWN - C(5)	6.58	891	4.1	0.047	1.47±0.74E-08	7.91±0.08E-06	2.33±0.13E-06	0.00±1.96E-08	0.00±2.22E-08
WNW0111	DOWN - C(6)	6.45	584	6.1	0.130	-0.81±4.79E-09	4.46±0.06E-06	6.28±0.85E-07	0.73±3.13E-08	0.00±3.28E-08

NR - Not reported. These results have not been reported because the data validation process indicated the data were not reliable.
NA - Not available.

Table E - 1 (continued)
1993 Contamination Indicator Parameters for the Sand and Gravel Unit

Location Code	Hydraulic Position	pH	Conductivity *μmhos/cm @25°C*	TOC *mg/L*	TOX *mg/L*	Gross Alpha *μCi/mL*	Gross Beta *μCi/mL*	H-3 *μCi/mL*	Cs-137 *μCi/mL*	Co-60 *μCi/mL*
WNW0203	DOWN - C(1)	6.79	1,751	2.1	0.033	-2.93±7.02E-09	3.33±0.92E-08	0.00±1.00E-07	0.00±3.22E-08	0.00±3.47E-08
WNW0203	DOWN - C(2)	6.39	3,060	3.0	0.026	1.10±1.08E-08	2.19±1.55E-08	0.99±7.19E-08	0.55±1.74E-08	0.00±2.17E-08
WNW0203	DOWN - C(3)	6.52	3,860	3.3	0.013	-0.66±1.59E-08	4.71±1.76E-08	0.00±1.00E-07	2.03±2.56E-08	0.00±3.64E-08
WNW0203	DOWN - C(4)	6.61	2,670	2.4	0.021	-0.27±1.20E-08	3.55±1.20E-08	2.30±8.25E-08	0.64±1.96E-08	0.00±2.22E-08
WNW0203	DOWN - C(5)	6.49	2,460	2.7	0.014	0.38±1.19E-08	3.85±1.42E-08	1.83±0.76E-07	1.66±1.96E-08	0.00±2.22E-08
WNW0203	DOWN - C(6)	6.41	2,655	2.7	0.044	0.81±1.59E-08	4.47±1.56E-08	0.00±1.00E-07	1.86±1.94E-08	0.00±2.38E-08
WNW0205	DOWN - C(1)	6.82	2,515	3.1	0.150	-5.44±7.95E-09	0.99±8.21E-09	0.63±9.17E-08	0.00±3.22E-08	0.00±3.47E-08
WNW0205	DOWN - C(2)	6.71	2,470	5.1	0.126	-0.40±1.10E-08	3.02±9.24E-09	2.77±7.31E-08	0.00±3.22E-08	0.00±3.47E-08
WNW0205	DOWN - C(3)	6.63	2,745	2.5	0.011	0.19±1.10E-08	3.31±9.30E-09	0.00±1.00E-07	0.70±1.96E-08	0.00±2.22E-08
WNW0205	DOWN - C(4)	6.47	3,265	3.4	0.014	-0.24±1.05E-08	0.65±1.03E-08	0.68±9.73E-08	0.96±1.96E-08	1.50±2.22E-08
WNW0205	DOWN - C(5)	6.67	2,400	5.3	0.024	2.20±9.65E-09	-0.13±1.04E-08	2.54±0.77E-07	1.40±1.96E-08	1.34±2.22E-08
WNW0205	DOWN - C(6)	6.51	4,630	3.6	0.023	0.93±1.29E-08	0.24±1.78E-08	0.00±1.00E-07	0.89±1.83E-08	0.00±1.94E-08
WNW0406	DOWN - C(1)	6.88	642	2.9	0.017	1.70±2.49E-09	9.64±3.26E-09	1.61±0.11E-06	0.00±1.74E-08	0.00±2.17E-08
WNW0406	DOWN - C(2)	7.08	6,220	2.7	0.022	-2.00±2.27E-09	8.04±3.42E-09	1.38±0.10E-06	0.00±1.74E-08	0.00±2.17E-08
WNW0406	DOWN - C(3)	6.95	677	3.0	0.035	1.34±3.72E-09	1.09±0.33E-08	1.39±0.10E-06	0.00±3.22E-08	0.00±3.47E-08
WNW0406	DOWN - C(4)	7.22	674	2.5	0.023	-2.34±2.64E-09	1.26±0.42E-08	1.16±0.10E-06	1.14±2.56E-08	0.00±3.64E-08
WNW0406	DOWN - C(5)	6.94	695	2.8	0.014	0.79±4.72E-09	1.10±0.38E-08	1.44±0.10E-06	0.00±1.96E-08	0.62±2.22E-08
WNW0406	DOWN - C(6)	7.02	637	2.9	0.013	-2.58±4.46E-09	9.15±4.35E-09	1.33±0.10E-06	1.03±1.94E-08	0.00±2.38E-08
WNW0408	DOWN - C(1)	7.35	378	3.3	<0.010	-0.33±1.11E-08	2.39±0.01E-04	3.23±0.85E-07	1.47±1.96E-08	0.00±2.22E-08
WNW0408	DOWN - C(2)	7.62	1,063	1.4	<0.010	0.97±1.68E-08	2.47±0.01E-04	3.27±0.85E-07	1.52±2.56E-08	0.00±3.64E-08
WNW0408	DOWN - C(3)	7.12	1,159	1.9	<0.010	-0.38±1.95E-08	2.78±0.01E-04	2.29±0.83E-07	3.42±3.14E-08	0.00±3.64E-08
WNW0408	DOWN - C(4)	7.96	1,327	2.6	<0.010	-2.32±2.85E-08	2.54±0.02E-04	2.42±0.84E-07	0.38±1.96E-08	0.00±2.22E-08
WNW0408	DOWN - C(5)	7.35	1,463	1.1	NR	-3.56±6.98E-09	3.03±0.02E-04	1.81±0.82E-07	0.00±1.96E-08	0.51±2.22E-08
WNW0408	DOWN - C(6)	7.09	1,354	< 1.0	0.012	0.25±1.55E-08	3.74±0.02E-04	2.41±0.80E-07	0.00±1.83E-08	0.00±1.94E-08
WNW0501	DOWN - C(1)	7.26	778	2.1	<0.010	3.01±3.62E-09	1.02±0.00E-04	2.51±0.84E-07	0.00±1.96E-08	0.00±2.22E-08
WNW0501	DOWN - C(2)	7.14	849	1.7	<0.010	4.16±4.99E-09	1.18±0.00E-04	1.93±0.82E-07	0.00±2.56E-08	0.00±3.64E-08
WNW0501	DOWN - C(3)	6.98	930	3.6	<0.010	6.48±5.18E-09	1.27±0.00E-04	1.97±0.82E-07	0.00±2.56E-08	0.00±3.64E-08
WNW0501	DOWN - C(4)	7.36	1,157	3.4	<0.010	6.69±6.56E-09	1.91±0.00E-04	2.48±0.84E-07	0.00±1.96E-08	0.00±2.22E-08
WNW0501	DOWN - C(5)	7.04	1,195	< 1.0	0.063	1.27±4.30E-09	1.86±0.00E-04	1.47±0.81E-07	0.00±1.96E-08	0.00±2.22E-08
WNW0501	DOWN - C(6)	7.23	1,005	< 1.0	<0.010	-4.54±7.84E-09	1.44±0.00E-04	2.94±0.79E-07	0.00±1.83E-08	0.00±1.94E-08
WNW0502	DOWN - C(1)	7.42	822	2.1	<0.010	1.78±3.50E-09	5.81±0.02E-05	1.95±0.84E-07	0.13±1.96E-08	0.00±2.22E-08
WNW0502	DOWN - C(2)	7.16	836	2.1	<0.010	0.00±2.62E-09	5.32±0.02E-05	2.88±0.84E-07	0.00±2.56E-08	0.00±3.64E-08
WNW0502	DOWN - C(3)	7.05	925	1.4	<0.010	6.85±5.48E-09	6.27±0.02E-05	1.73±0.82E-07	0.00±2.56E-08	0.00±3.64E-08
WNW0502	DOWN - C(4)	7.29	1,014	< 1.0	0.077	8.63±6.39E-09	7.21±0.03E-05	1.49±0.82E-07	0.00±1.96E-08	0.00±2.22E-08
WNW0502	DOWN - C(5)	7.13	1,129	< 1.0	0.128	2.38±4.67E-09	7.71±0.03E-05	2.49±0.84E-07	0.00±1.96E-08	0.00±2.22E-08
WNW0502	DOWN - C(6)	7.07	1,068	< 1.0	0.028	-4.96±8.58E-09	8.20±0.03E-05	3.96±0.82E-07	0.00±1.83E-08	0.00±1.94E-08
WNW0602	DOWN - C(1)	6.44	649	3.0	0.027	-1.95±2.85E-09	3.65±0.53E-08	4.40±0.18E-06	1.40±3.22E-08	0.00±3.47E-08
WNW0602	DOWN - C(2)	6.56	641	2.9	0.018	0.00±1.83E-09	4.30±0.58E-08	7.03±0.26E-06	0.00±1.74E-08	0.86±2.17E-08
WNW0602	DOWN - C(3)	6.42	1,012	2.5	0.021	2.82±8.73E-09	8.48±0.79E-08	2.91±0.14E-06	0.00±1.96E-08	0.00±2.22E-08
WNW0602	DOWN - C(4)	6.44	762	2.9	0.022	-3.19±4.95E-09	3.89±0.62E-08	7.94±0.29E-06	0.00±1.96E-08	0.00±2.22E-08
WNW0602	DOWN - C(5)	6.51	834	2.7	0.016	-2.02±6.26E-09	2.51±0.58E-08	8.68±0.30E-06	0.26±1.96E-08	0.00±2.22E-08
WNW0602	DOWN - C(6)	6.23	907	3.9	0.024	-1.64±3.22E-09	5.33±0.85E-08	4.55±0.19E-06	0.00±1.83E-08	0.00±1.94E-08
WNW0604	DOWN - C(1)	6.10	493	3.2	0.008	0.42±2.47E-09	2.86±2.38E-09	0.00±1.00E-07	0.00±3.22E-08	0.00±3.47E-08
WNW0604	DOWN - C(2)	6.25	517	3.6	0.003	0.46±1.56E-09	2.62±2.64E-09	0.00±1.00E-07	0.00±1.74E-08	0.00±2.17E-08
WNW0604	DOWN - C(3)	6.28	473	3.4	0.007	-0.72±2.38E-09	4.39±2.84E-09	0.00±1.00E-07	0.82±2.28E-08	0.00±3.02E-08
WNW0604	DOWN - C(4)	6.38	526	3.3	0.004	0.00±2.06E-09	2.99±2.55E-09	0.00±1.00E-07	0.00±2.56E-08	0.00±3.64E-08
WNW0604	DOWN - C(5)	6.23	526	3.7	0.003	-2.27±3.86E-09	5.04±3.04E-09	6.03±8.70E-08	0.00±1.96E-08	1.29±2.22E-08
WNW0604	DOWN - C(6)	6.30	531	3.8	0.002	1.81±4.34E-09	5.85±2.66E-09	0.00±1.00E-07	0.00±1.83E-08	0.00±1.94E-08

NR - Not reported. These results have not been reported because the data validation process indicated the data were not reliable.
NA - Not available.

Table E - 1 (continued)
1993 Contamination Indicator Parameters for the Sand and Gravel Unit

Location Code	Hydraulic Position	pH	Conductivity *µmhos/cm @25°C*	TOC *mg/L*	TOX *mg/L*	Gross Alpha *µCi/mL*	Gross Beta *µCi/mL*	H-3 *µCi/mL*	Cs-137 *µCi/mL*	Co-60 *µCi/mL*
WNW8605	DOWN - C(1)	6.74	840	8.8	0.011	1.10±0.74E-08	3.22±0.02E-05	7.14±0.26E-06	0.00±2.56E-08	0.00±3.64E-08
WNW8605	DOWN - C(2)	6.49	1,051	8.9	0.011	8.33±6.45E-09	3.48±0.02E-05	8.29±0.30E-06	0.00±1.96E-08	0.00±2.22E-08
WNW8605	DOWN - C(3)	6.55	898	15.8	< 0.010	1.46±0.77E-08	3.10±0.02E-05	6.23±0.24E-06	0.00±1.96E-08	0.00±2.22E-08
WNW8605	DOWN - C(4)	6.74	1,078	9.5	0.024	9.13±6.33E-09	2.84±0.02E-05	3.59±0.16E-06	0.00±1.96E-08	0.00±2.22E-08
WNW8605	DOWN - C(5)	6.58	1,172	6.0	NR	2.42±4.74E-09	2.84±0.02E-05	2.09±0.12E-06	0.89±1.96E-08	0.00±2.22E-08
WNW8605	DOWN - C(6)	6.51	796	8.2	0.065	5.15±9.45E-09	2.60±0.02E-05	3.90±0.17E-06	0.00±3.13E-08	0.00±3.28E-08
WNW8606	DOWN - C(1)	6.80	2,675	2.8	0.116	-6.01±8.78E-09	1.05±0.96E-08	1.46±8.94E-08	1.20±1.74E-08	0.00±2.17E-08
WNW8606	DOWN - C(2)	6.78	2,275	4.8	0.145	-0.46±1.28E-08	0.00±9.47E-09	0.00±1.00E-07	0.00±3.22E-08	0.00±3.47E-08
WNW8606	DOWN - C(3)	6.68	2,725	2.5	0.010	0.00±1.06E-08	1.39±0.89E-08	5.11±7.46E-08	0.00±3.22E-08	0.00±3.47E-08
WNW8606	DOWN - C(4)	6.50	3,025	3.5	0.017	-7.19±8.14E-09	7.84±9.82E-09	0.00±1.00E-07	0.00±2.56E-08	0.00±3.64E-08
WNW8606	DOWN - C(5)	6.72	2,365	5.0	0.032	1.14±9.50E-09	0.41±1.06E-08	1.64±0.76E-07	0.00±1.96E-08	0.00±2.22E-08
WNW8606	DOWN - C(6)	6.50	4,165	3.3	0.013	-1.42±2.03E-08	0.20±1.04E-08	0.00±1.00E-07	0.70±1.94E-08	0.00±2.38E-08
WNW8607	DOWN - C(1)	6.29	537	1.0	< 0.002	0.00±1.29E-09	6.96±2.81E-09	0.00±1.00E-07	0.00±1.74E-08	0.00±2.17E-08
WNW8607	DOWN - C(2)	6.66	633	1.0	< 0.004	1.95±4.22E-09	4.58±2.84E-09	2.67±7.77E-08	0.76±1.74E-08	0.00±2.17E-08
WNW8607	DOWN - C(3)	6.66	505	0.8	0.005	-0.65±2.83E-09	5.02±2.72E-09	1.19±0.76E-07	0.00±3.22E-08	1.72±3.47E-08
WNW8607	DOWN - C(4)	6.62	721	0.9	0.004	-1.68±4.67E-09	5.73±3.09E-09	4.71±7.98E-08	0.00±1.96E-08	0.00±2.22E-08
WNW8607	DOWN - C(5)	6.49	798	1.2	0.005	-1.96±2.72E-09	4.14±3.85E-09	3.68±7.74E-08	0.00±1.96E-08	0.00±2.22E-08
WNW8607	DOWN - C(6)	6.29	756	1.6	0.006	-3.81±4.57E-09	9.15±4.94E-09	0.00±1.00E-07	0.00±1.94E-08	0.00±2.38E-08
WNW8608	DOWN - C(1)	6.47	567	5.9	0.012	-1.97±1.93E-09	9.78±3.35E-09	1.44±0.85E-07	0.00±3.22E-08	0.00±3.47E-08
WNW8608	DOWN - C(2)	6.56	546	4.0	0.015	1.07±2.57E-09	1.06±0.32E-08	8.09±0.90E-07	0.64±3.22E-08	0.00±3.47E-08
WNW8608	DOWN - C(3)	6.58	608	3.5	0.015	1.72±3.38E-09	1.30±0.34E-08	5.66±0.94E-07	0.00±3.22E-08	0.00±3.47E-08
WNW8608	DOWN - C(4)	6.85	677	3.5	0.014	-1.30±3.61E-09	1.65±0.39E-08	2.55±0.97E-07	0.00±2.56E-08	0.00±3.64E-08
WNW8608	DOWN - C(5)	6.55	647	4.3	0.020	-2.13±3.11E-09	1.51±0.41E-08	2.80±0.91E-07	0.00±1.96E-08	0.00±2.22E-08
WNW8608	DOWN - C(6)	6.64	554	5.1	0.008	-2.51±3.59E-09	1.80±0.47E-08	1.96±0.84E-07	0.00±1.94E-08	0.00±2.38E-08
WNW8609	DOWN - C(1)	6.97	685	1.6	0.013	0.00±2.62E-09	2.99±0.15E-07	1.08±0.09E-06	0.41±1.74E-08	0.00±2.17E-08
WNW8609	DOWN - C(2)	7.04	702	2.0	0.011	-1.59±3.82E-09	3.22±0.15E-07	1.54±0.10E-06	0.00±3.22E-08	0.00±3.47E-08
WNW8609	DOWN - C(3)	7.16	688	1.6	0.011	0.71±3.69E-09	3.15±0.14E-07	1.42±0.10E-06	0.00±1.74E-08	0.00±2.17E-08
WNW8609	DOWN - C(4)	7.45	696	1.8	0.013	-0.38±4.81E-09	3.26±0.16E-07	1.52±0.11E-06	0.00±2.28E-08	0.00±3.02E-08
WNW8609	DOWN - C(5)	6.97	709	1.7	0.012	0.97±4.23E-09	3.48±0.17E-07	1.52±0.11E-06	0.77±1.96E-08	0.00±2.22E-08
WNW8609	DOWN - C(6)	7.08	713	1.8	0.010	-2.07±5.73E-09	2.97±0.18E-07	1.26±0.10E-06	0.19±1.94E-08	0.00±2.38E-08
WNDMPNE	DOWN - D(1)	7.09	656	3.2	0.009	1.21±3.34E-09	5.02±0.17E-07	2.66±0.81E-07	1.28±3.22E-08	0.00±3.47E-08
WNDMPNE	DOWN - D(2)	7.36	641	3.1	0.008	2.05±2.32E-09	4.80±0.18E-07	4.10±0.81E-07	0.44±3.22E-08	0.00±3.47E-08
WNDMPNE	DOWN - D(3)	7.21	710	6.2	0.004	-0.80±2.71E-09	6.97±0.23E-07	4.27±0.84E-07	0.38±2.56E-08	0.00±3.64E-08
WNDMPNE	DOWN - D(4)	7.25	818	3.4	0.005	-1.35±1.88E-09	8.17±0.22E-07	2.02±0.90E-07	0.00±2.56E-08	0.00±3.64E-08
WNDMPNE	DOWN - D(5)	7.34	937	2.3	0.004	-2.65±8.21E-09	9.21±0.25E-07	8.42±0.86E-07	0.64±1.96E-08	0.71±2.22E-08
WNDMPNE	DOWN - D(6)	7.06	666	5.6	0.011	5.44±5.62E-09	6.62±0.23E-07	2.05±0.84E-07	1.03±3.13E-08	1.10±3.28E-08
WNGSEEP	DOWN - D(1)	6.16	566	1.1	0.010	0.53±3.10E-09	2.95±2.77E-09	5.74±0.84E-07	0.51±3.22E-08	0.00±3.47E-08
WNGSEEP	DOWN - D(2)	6.64	670	1.3	0.012	0.63±2.15E-09	5.93±2.96E-09	5.10±0.84E-07	0.00±1.74E-08	0.00±2.17E-08
WNGSEEP	DOWN - D(3)	6.24	620	1.2	0.013	-1.24±2.43E-09	2.40±2.82E-09	6.64±0.83E-07	0.00±2.56E-08	0.00±3.64E-08
WNGSEEP	DOWN - D(4)	6.37	704	1.3	0.013	-2.76±3.02E-09	6.03±2.86E-09	4.78±0.93E-07	0.74±2.28E-08	0.76±3.02E-08
WNGSEEP	DOWN - D(5)	6.35	726	1.3	0.014	0.95±4.94E-09	4.52±3.04E-09	9.97±0.88E-07	0.00±1.96E-08	0.00±2.22E-08
WNGSEEP	DOWN - D(6)	6.44	618	1.5	0.011	0.00±2.27E-09	2.30±4.39E-09	4.94±0.86E-07	0.85±3.13E-08	0.00±3.28E-08
WNW0105	DOWN - D(1)	6.90	1,061	1.3	0.015	-0.94±3.20E-09	8.71±5.80E-09	8.32±0.88E-07	1.53±3.22E-08	0.00±3.47E-08
WNW0105	DOWN - D(2)	7.19	1,074	1.1	0.033	1.18±6.14E-09	6.06±4.48E-09	7.70±0.88E-07	1.91±3.22E-08	0.00±3.47E-08
WNW0105	DOWN - D(3)	7.01	1,037	1.8	0.028	-2.06±4.07E-09	1.21±0.45E-08	9.81±0.88E-07	0.23±1.74E-08	0.00±2.17E-08
WNW0105	DOWN - D(4)	7.22	1,050	1.2	0.012	-1.22±5.32E-09	1.18±0.57E-08	8.04±0.93E-07	0.00±2.56E-08	0.00±3.64E-08
WNW0105	DOWN - D(5)	6.95	1,070	1.1	0.025	2.70±5.30E-09	1.29±0.56E-08	1.15±0.09E-06	0.00±1.96E-08	0.00±2.22E-08
WNW0105	DOWN - D(6)	6.94	1,101	1.4	0.013	-4.43±7.66E-09	9.13±6.52E-09	8.40±0.90E-07	0.00±1.94E-08	0.00±2.38E-08

NR - Not reported. These results have not been reported because the data validation process indicated the data were not reliable.
NA - Not available.

Table E - 1 *(continued)*
1993 Contamination Indicator Parameters for the Sand and Gravel Unit

Location Code	Hydraulic Position	pH	Conductivity *μmhos/cm @25°C*	TOC *mg/L*	TOX *mg/L*	Gross Alpha *μCi/mL*	Gross Beta *μCi/mL*	H-3 *μCi/mL*	Cs-137 *μCi/mL*	Co-60 *μCi/mL*
WNW0106	DOWN - D(1)	6.89	1,060	1.4	0.026	-4.08±4.00E-09	6.19±4.42E-09	1.15±0.10E-06	0.00±1.74E-08	0.00±2.17E-08
WNW0106	DOWN - D(2)	7.13	1,074	1.4	0.023	4.91±7.60E-09	5.16±4.44E-09	1.09±0.10E-06	0.00±1.74E-08	0.00±2.17E-08
WNW0106	DOWN - D(3)	6.88	1,073	1.8	0.024	-2.60±4.83E-09	7.58±4.80E-09	1.11±0.09E-06	0.00±2.56E-08	0.00±3.64E-08
WNW0106	DOWN - D(4)	7.10	1,035	1.6	0.013	-5.86±5.14E-09	4.36±5.56E-09	1.13±0.10E-06	2.03±2.56E-08	0.00±3.64E-08
WNW0106	DOWN - D(5)	7.13	999	1.8	0.025	1.17±5.11E-09	5.70±5.35E-09	2.81±0.14E-06	0.00±1.96E-08	0.12±2.22E-08
WNW0106	DOWN - D(6)	6.73	1,042	1.5	0.014	0.00±4.01E-09	4.72±4.76E-09	2.79±0.14E-06	0.89±1.94E-08	0.00±2.38E-08
WNW0116	DOWN - D(1)	6.99	1,037	1.2	0.015	0.00±2.62E-09	2.72±0.58E-08	1.00±0.09E-06	0.77±3.22E-08	0.00±3.47E-08
WNW0116	DOWN - D(2)	7.11	1,025	1.9	0.017	-1.06±4.66E-09	1.47±0.12E-07	8.94±0.91E-07	0.00±1.74E-08	1.82±2.17E-08
WNW0116	DOWN - D(3)	7.26	947	1.5	0.018	-2.16±5.19E-09	9.23±0.90E-08	1.04±0.09E-06	0.00±3.22E-08	0.00±3.47E-08
WNW0116	DOWN - D(4)	7.33	972	1.8	0.016	-1.13±5.24E-09	1.59±0.14E-07	8.25±0.93E-07	0.45±1.96E-08	0.00±2.22E-08
WNW0116	DOWN - D(5)	6.95	1,025	1.6	0.020	1.19±5.27E-09	1.71±0.15E-07	1.21±0.09E-06	0.00±1.96E-08	0.00±2.22E-08
WNW0116	DOWN - D(6)	6.85	1,128	1.7	0.024	1.62±5.48E-09	2.12±0.17E-07	7.46±0.89E-07	0.00±1.94E-08	0.00±2.38E-08
WNW0207	DOWN - D(1)	6.54	796	2.5	0.006	-2.26±3.30E-09	3.44±2.99E-09	0.28±7.97E-08	1.66±3.22E-08	0.00±3.47E-08
WNW0207	DOWN - D(2)	6.57	962	2.2	0.004	-0.90±3.04E-09	-2.01±6.22E-09	0.00±1.00E-07	0.62±1.74E-08	0.00±2.17E-08
WNW0207	DOWN - D(3)	6.52	850	1.9	0.007	0.00±5.04E-09	2.62±3.56E-09	7.26±7.60E-08	0.00±2.56E-08	0.00±3.64E-08
WNW0207	DOWN - D(4)	6.51	949	1.7	0.004	-7.13±8.38E-09	4.06±3.64E-09	2.09±8.57E-08	0.00±1.96E-08	0.00±2.22E-08
WNW0207	DOWN - D(5)	6.58	945	1.6	0.003	1.08±0.90E-08	4.16±4.38E-09	3.32±0.78E-07	0.51±1.96E-08	0.00±2.22E-08
WNW0207	DOWN - D(6)	6.33	834	2.0	0.003	0.00±3.79E-09	9.21±5.92E-09	0.00±1.00E-07	1.40±1.94E-08	0.79±2.38E-08
WNW0601	DOWN - D(1)	6.45	413	3.8	0.023	-0.38±1.94E-09	1.27±0.09E-07	0.00±1.00E-07	1.66±3.22E-08	0.00±3.47E-08
WNW0601	DOWN - D(2)	6.14	495	3.6	0.011	0.00±1.16E-09	1.44±0.09E-07	0.00±1.00E-07	0.77±3.22E-08	0.00±3.47E-08
WNW0601	DOWN - D(3)	6.36	600	3.8	0.025	-1.47±2.15E-09	1.33±0.09E-07	0.00±1.00E-07	1.14±2.56E-08	0.00±3.64E-08
WNW0601	DOWN - D(4)	6.22	568	3.7	0.014	-2.26±2.72E-09	1.52±0.10E-07	0.00±1.00E-07	0.00±1.96E-08	0.00±2.22E-08
WNW0601	DOWN - D(5)	6.30	617	3.4	0.012	0.00±1.84E-09	1.64±0.10E-07	2.20±0.78E-07	0.00±1.96E-08	0.00±2.22E-08
WNW0601	DOWN - D(6)	6.26	508	4.5	0.015	-0.59±2.01E-09	1.29±0.09E-07	0.00±1.00E-07	0.00±3.13E-08	0.00±3.28E-08
WNW0605	DOWN - D(1)	6.63	438	2.5	0.013	-1.62±1.59E-09	1.62±0.10E-07	0.00±1.00E-07	0.00±3.22E-08	0.00±3.47E-08
WNW0605	DOWN - D(2)	6.67	557	2.4	0.010	0.00±1.35E-09	1.68±0.10E-07	0.00±1.00E-07	1.40±3.22E-08	1.92±3.47E-08
WNW0605	DOWN - D(3)	6.75	611	2.8	0.016	0.00±3.06E-09	1.60±0.10E-07	0.00±1.00E-07	2.41±2.56E-08	0.00±3.64E-08
WNW0605	DOWN - D(4)	7.31	603	1.6	0.004	-0.72±2.46E-09	4.82±0.65E-08	7.87±8.14E-08	0.00±1.96E-08	0.00±2.22E-08
WNW0605	DOWN - D(5)	7.34	676	1.9	0.009	-4.25±4.40E-09	7.00±0.75E-08	2.89±0.78E-07	0.70±1.96E-08	0.00±2.22E-08
WNW0605	DOWN - D(6)	6.46	503	2.9	0.016	2.48±2.97E-09	1.28±0.09E-07	0.00±1.00E-07	0.00±3.13E-08	0.00±3.28E-08
WNW0801	DOWN - D(1)	6.83	969	1.9	0.011	-0.90±3.96E-09	7.09±0.25E-07	7.85±0.87E-07	0.00±3.22E-08	0.00±3.47E-08
WNW0801	DOWN - D(2)	6.90	1,004	2.1	0.011	2.10±2.92E-09	6.20±0.25E-07	8.08±0.85E-07	0.00±1.96E-08	0.00±2.22E-08
WNW0801	DOWN - D(3)	6.53	1,173	2.4	0.017	4.61±4.93E-09	8.15±0.31E-07	7.61±0.85E-07	0.25±2.56E-08	0.00±3.64E-08
WNW0801	DOWN - D(4)	6.51	1,083	2.8	0.015	-6.36±5.88E-09	8.00±0.32E-07	5.65±0.94E-07	0.00±1.96E-08	0.00±2.22E-08
WNW0801	DOWN - D(5)	6.57	1,142	2.4	0.008	-3.03±5.94E-09	7.91±0.32E-07	8.46±0.84E-07	0.51±1.96E-08	0.00±2.22E-08
WNW0801	DOWN - D(6)	6.63	1,212	2.1	0.004	1.44±7.47E-09	6.22±0.28E-07	7.96±0.90E-07	0.00±1.83E-08	1.20±1.94E-08
WNW0802	DOWN - D(1)	6.29	175	1.3	0.003	1.61±1.82E-09	-3.10±2.03E-09	9.63±7.66E-08	0.00±1.74E-08	0.00±2.17E-08
WNW0802	DOWN - D(2)	7.06	269	1.4	< 0.002	-0.62±1.22E-09	1.38±5.42E-09	8.51±7.57E-08	0.00±1.74E-08	0.00±2.17E-08
WNW0802	DOWN - D(3)	6.74	332	1.4	0.012	-0.44±1.93E-09	0.74±3.24E-09	2.35±0.79E-07	0.51±1.96E-08	0.00±2.22E-08
WNW0802	DOWN - D(4)	6.96	359	1.5	0.005	0.00±1.71E-09	0.86±2.21E-09	0.00±1.00E-07	0.00±2.56E-08	0.00±3.64E-08
WNW0802	DOWN - D(5)	6.96	587	1.3	0.017	0.00±6.57E-09	-1.11±2.46E-09	4.78±0.77E-07	0.00±1.96E-08	0.00±2.22E-08
WNW0802	DOWN - D(6)	6.58	324	1.5	< 0.002	0.46±2.03E-09	2.74±2.31E-09	6.89±8.16E-08	0.00±1.83E-08	0.00±1.94E-08
WNW0803	DOWN - D(1)	6.91	1,235	2.1	0.021	-3.94±5.75E-09	9.32±5.40E-09	8.86±0.89E-07	0.00±1.74E-08	0.00±2.17E-08
WNW0803	DOWN - D(2)	6.84	1,218	2.2	0.014	1.31±4.45E-09	2.58±6.84E-09	9.55±0.88E-07	0.00±3.22E-08	0.00±3.47E-08
WNW0803	DOWN - D(3)	6.60	1,327	2.4	0.013	2.17±7.19E-09	1.52±0.69E-08	1.02±0.09E-06	0.00±2.56E-08	0.00±3.64E-08
WNW0803	DOWN - D(4)	6.63	1,271	2.1	0.011	-5.65±6.78E-09	3.43±5.38E-09	6.92±0.96E-07	0.00±1.96E-08	1.50±2.22E-08
WNW0803	DOWN - D(5)	6.82	1,133	1.5	0.006	-5.60±8.19E-09	1.41±0.73E-08	1.38±0.10E-06	0.45±1.96E-08	0.60±2.22E-08
WNW0803	DOWN - D(6)	6.87	1,213	1.5	0.004	1.50±0.98E-08	9.75±5.98E-09	1.06±0.10E-06	0.57±1.83E-08	1.19±1.94E-08

NR - Not reported. These results have not been reported because the data validation process indicated the data were not reliable.
NA - Not available.

Table E - 1 (concluded)
1993 Contamination Indicator Parameters for the Sand and Gravel Unit

Location Code	Hydraulic Position	pH	Conductivity *µmhos/cm @25°C*	TOC *mg/L*	TOX *mg/L*	Gross Alpha *µCi/mL*	Gross Beta *µCi/mL*	H-3 *µCi/mL*	Cs-137 *µCi/mL*	Co-60 *µCi/mL*
WNW0804	DOWN - D(1)	6.39	808	2.2	0.015	-1.64±3.22E-09	4.01±0.61E-08	4.66±0.82E-07	1.79±3.22E-08	0.00±3.47E-08
WNW0804	DOWN - D(2)	6.78	895	3.3	0.018	2.25±4.38E-09	3.80±0.67E-08	2.53±0.79E-07	1.30±3.22E-08	0.00±3.47E-08
WNW0804	DOWN - D(3)	6.56	900	2.4	0.014	0.00±1.94E-09	4.49±0.73E-08	3.87±0.81E-07	0.00±1.96E-08	0.00±2.22E-08
WNW0804	DOWN - D(4)	6.55	817	1.8	0.012	-1.83±6.22E-09	3.77±0.61E-08	1.34±0.88E-07	0.00±2.56E-08	0.00±3.64E-08
WNW0804	DOWN - D(5)	6.53	797	1.7	0.014	1.77±4.91E-09	4.34±0.75E-08	6.87±0.82E-07	0.00±1.96E-08	0.00±2.22E-08
WNW0804	DOWN - D(6)	6.62	736	2.4	0.005	1.03±4.52E-09	5.44±0.75E-08	1.24±0.81E-07	0.45±1.83E-08	0.00±1.94E-08
WNW0905	DOWN - D(1)	6.88	1,616	1.0	0.004	1.58±6.91E-09	-0.34±5.57E-09	2.60±0.82E-07	2.42±3.22E-08	0.00±3.47E-08
WNW0905	DOWN - D(2)	6.87	1,560	1.2	<0.002	7.98±7.00E-09	4.51±7.67E-09	2.28±0.81E-07	0.00±1.74E-08	0.00±2.17E-08
WNW0905	DOWN - D(3)	6.65	1,615	1.1	<0.002	1.90±8.35E-09	5.10±8.09E-09	1.57±0.80E-07	0.00±1.96E-08	0.00±2.22E-08
WNW0905	DOWN - D(4)	6.82	1,616	1.2	0.003	1.58±6.88E-09	1.39±0.83E-08	1.50±8.80E-08	0.00±2.56E-08	0.00±3.64E-08
WNW0905	DOWN - D(5)	8.15	1,623	1.2	0.005	2.98±7.93E-09	2.95±7.52E-09	4.94±0.82E-07	0.00±1.96E-08	0.18±2.22E-08
WNW0905	DOWN - D(6)	6.82	1,600	1.2	0.005	0.89±1.51E-08	3.72±7.44E-09	2.59±0.85E-07	0.00±1.83E-08	0.00±1.94E-08
WNW8603	DOWN - D(1)	7.16	1,152	0.9	0.008	2.25±5.40E-09	4.69±0.81E-08	7.42±0.86E-07	0.00±1.74E-08	0.00±2.17E-08
WNW8603	DOWN - D(2)	7.31	1,134	1.1	0.014	-3.51±3.97E-09	4.86±0.82E-08	6.33±0.85E-07	0.00±3.22E-08	0.00±3.47E-08
WNW8603	DOWN - D(3)	7.26	1,103	0.8	0.011	-1.08±5.61E-09	5.36±0.81E-08	7.17±0.83E-07	0.00±1.74E-08	0.00±2.17E-08
WNW8603	DOWN - D(4)	7.30	1,102	0.7	0.008	-4.39±8.87E-09	8.17±0.98E-08	5.26±0.90E-07	0.00±1.96E-08	0.00±2.22E-08
WNW8603	DOWN - D(5)	7.14	1,109	0.6	0.012	0.69±4.53E-09	6.66±1.00E-08	1.04±0.09E-06	0.00±1.96E-08	0.00±2.22E-08
WNW8603	DOWN - D(6)	7.19	1,212	0.7	0.020	-1.64±3.22E-09	9.27±1.24E-08	6.54±0.87E-07	0.00±1.94E-08	0.00±2.38E-08
WNW8604	DOWN - D(1)	7.19	1,125	2.3	<0.010	1.39±4.73E-09	4.34±0.07E-06	6.31±0.90E-07	1.14±2.56E-08	0.00±3.64E-08
WNW8604	DOWN - D(2)	7.08	1,055	1.8	<0.010	0.00±3.86E-09	4.44±0.07E-06	7.10±0.89E-07	1.65±2.56E-08	2.09±3.64E-08
WNW8604	DOWN - D(3)	7.18	1,131	4.0	<0.010	1.25±2.45E-09	4.92±0.09E-06	7.76±0.89E-07	0.00±1.96E-08	2.08±2.22E-08
WNW8604	DOWN - D(4)	7.11	1,139	3.6	<0.010	5.16±5.06E-09	5.80±0.10E-06	7.04±0.89E-07	0.06±1.96E-08	0.00±2.22E-08
WNW8604	DOWN - D(5)	7.01	1,191	< 1.0	0.012	2.75±5.38E-09	5.40±0.10E-06	5.20±0.87E-07	0.00±1.96E-08	0.00±2.22E-08
WNW8604	DOWN - D(6)	6.86	1,285	< 1.0	NR	-1.00±5.64E-09	1.06±0.01E-05	5.68±0.84E-07	0.00±1.83E-08	0.00±1.94E-08
WNW8612	DOWN - D(1)	7.40	842	0.7	0.027	-1.76±4.23E-09	0.20±3.27E-09	1.74±0.11E-06	0.00±1.74E-08	0.00±2.17E-08
WNW8612	DOWN - D(2)	7.52	843	0.9	0.031	0.00±3.58E-09	1.74±3.71E-09	1.70±0.11E-06	0.00±1.74E-08	0.00±2.17E-08
WNW8612	DOWN - D(3)	7.21	845	0.8	0.016	-0.98±3.40E-09	1.65±3.93E-09	1.83±0.11E-06	0.25±2.28E-08	0.00±3.02E-08
WNW8612	DOWN - D(4)	7.23	866	0.8	0.021	-3.60±4.01E-09	4.63±3.95E-09	1.47±0.11E-06	0.82±2.56E-08	0.00±3.64E-08
WNW8612	DOWN - D(5)	7.21	864	0.8	0.024	-6.82±5.46E-09	7.16±4.43E-09	1.98±0.11E-06	0.96±1.96E-08	1.38±2.22E-08
WNW8612	DOWN - D(6)	7.28	876	0.8	0.032	-2.28±6.27E-09	-0.14±4.01E-09	1.50±0.11E-06	0.90±2.60E-08	0.00±2.87E-08

NR - Not reported. These results have not been reported because the data validation process indicated the data were not reliable.
NA - Not available.

Table E - 2
1993 Contamination Indicator Parameters for the Till-Sand Unit

Location Code	Hydraulic Position	pH	Conductivity *µmhos/cm @25°C*	TOC *mg/L*	TOX *mg/L*	Gross Alpha *µCi/mL*	Gross Beta *µCi/mL*	H-3 *µCi/mL*	Cs-137 *µCi/mL*	Co-60 *µCi/mL*
WNW0302	UP(1)	6.91	1,594	0.6	0.016	-3.20±7.67E-09	5.85±5.91E-09	0.00±1.00E-07	0.00±3.22E-08	0.00±3.47E-08
WNW0302	UP(2)	7.03	1,621	0.8	0.008	1.65±5.60E-09	0.00±5.73E-09	0.00±1.00E-07	1.78±2.56E-08	0.00±3.64E-08
WNW0302	UP(3)	6.81	1,798	0.7	0.004	-3.76±7.37E-09	3.93±7.89E-09	5.27±7.70E-08	0.00±2.56E-08	0.00±3.64E-08
WNW0302	UP(4)	6.78	1,894	0.7	<0.006	0.00±8.45E-09	2.66±5.92E-09	5.26±7.99E-08	0.00±1.96E-08	0.00±2.22E-08
WNW0302	UP(5)	6.94	1,958	0.8	0.006	0.00±1.18E-08	3.13±8.69E-09	2.22±0.77E-07	0.00±1.96E-08	0.00±2.22E-08
WNW0302	UP(6)	6.89	1,953	0.7	0.004	0.43±1.04E-08	5.98±9.93E-09	0.00±1.00E-07	0.00±1.94E-08	0.00±2.38E-08
WNW0402	UP(1)	7.04	1,219	0.5	0.016	1.70±3.34E-09	4.44±3.36E-09	0.21±6.22E-08	0.00±1.74E-08	0.00±2.17E-08
WNW0402	UP(2)	7.06	1,229	0.6	0.017	0.00±7.14E-09	1.32±4.16E-09	4.67±7.57E-08	0.00±1.74E-08	0.00±2.17E-08
WNW0402	UP(3)	7.15	1,221	0.6	0.027	-2.26±5.43E-09	2.67±4.74E-09	3.54±7.36E-08	0.90±1.74E-08	0.00±2.17E-08
WNW0402	UP(4)	7.48	1,243	0.6	0.014	-4.75±8.21E-09	2.54±5.20E-09	5.91±8.13E-08	0.00±1.96E-08	0.00±2.22E-08
WNW0402	UP(5)	7.13	1,256	0.5	0.015	-1.73±6.77E-09	3.10±5.32E-09	3.29±8.06E-08	0.00±1.96E-08	0.00±2.22E-08
WNW0402	UP(6)	7.23	1,309	0.8	0.002	-6.80±8.16E-09	6.58±7.81E-09	0.00±1.00E-07	0.00±3.13E-08	0.00±3.28E-08
WNW0404	UP(1)	7.33	275	0.3	<0.002	2.81±9.54E-10	2.17±2.16E-09	0.00±1.00E-07	0.00±1.74E-08	0.00±2.17E-08
WNW0404	UP(2)	7.61	273	0.4	<0.002	1.61±2.27E-09	3.18±2.47E-09	0.00±1.00E-07	1.40±3.22E-08	0.00±3.47E-08
WNW0404	UP(3)	7.78	256	0.4	<0.002	0.00±1.85E-09	0.56±2.37E-09	0.00±1.00E-07	0.00±1.74E-08	0.00±2.17E-08
WNW0404	UP(4)	8.42	262	0.4	<0.002	1.83±2.38E-09	2.70±2.41E-09	0.00±1.00E-07	0.00±2.56E-08	0.00±3.64E-08
WNW0404	UP(5)	7.78	264	0.3	<0.002	-0.74±1.78E-09	2.12±2.27E-09	0.00±1.00E-07	1.02±1.96E-08	0.00±2.22E-08
WNW0404	UP(6)	7.92	252	0.5	<0.002	-1.64±1.97E-09	0.45±2.30E-09	0.00±1.00E-07	0.00±1.94E-08	0.28±2.38E-08
WNW0701	UP(1)	7.14	984	0.4	<0.002	-1.64±3.95E-09	2.56±3.78E-09	0.00±1.00E-07	0.00±3.22E-08	0.00±3.47E-08
WNW0701	UP(2)	7.39	960	0.6	<0.004	0.00±4.41E-09	1.33±3.62E-09	0.00±1.00E-07	0.21±1.74E-08	0.00±2.17E-08
WNW0701	UP(3)	7.26	910	0.5	<0.002	-1.52±3.65E-09	4.02±3.78E-09	0.00±1.00E-07	0.00±1.74E-08	0.00±2.17E-08
WNW0701	UP(4)	7.29	891	0.5	<0.002	0.92±4.80E-09	-0.26±3.76E-09	0.00±1.00E-07	0.51±1.96E-08	0.00±2.22E-08
WNW0701	UP(5)	7.31	926	0.6	<0.002	0.93±3.16E-09	2.59±3.89E-09	1.03±0.76E-07	0.00±1.96E-08	0.00±2.22E-08
WNW0701	UP(6)	7.20	1,218	0.6	<0.002	6.62±7.78E-09	2.04±3.17E-09	0.00±1.00E-07	0.00±1.83E-08	0.00±1.94E-08
WNW0202	DOWN - B(1)	11.48	3,280	0.7	0.004	-1.06±5.50E-09	2.03±0.53E-08	0.00±1.00E-07	0.00±1.74E-08	0.00±2.17E-08
WNW0202	DOWN - B(2)	11.31	1,001	0.9	0.005	0.00±1.45E-09	1.12±0.45E-08	0.00±1.00E-07	1.28±3.22E-08	0.00±3.47E-08
WNW0202	DOWN - B(3)	11.93	2,950	0.7	0.009	3.05±8.46E-09	1.64±1.14E-08	3.17±7.69E-08	0.00±2.56E-08	0.00±3.64E-08
WNW0202	DOWN - B(4)	10.52	539	0.8	<0.002	-2.43±5.08E-09	1.87±0.52E-08	0.00±1.00E-07	0.00±2.56E-08	0.00±3.64E-08
WNW0202	DOWN - B(5)	11.07	501	1.0	<0.002	-4.09±5.67E-09	1.57±0.39E-08	2.24±0.76E-07	0.00±1.96E-08	0.00±2.22E-08
WNW0202	DOWN - B(6)	11.29	467	0.8	<0.002	2.47±3.61E-09	1.04±0.53E-08	0.00±1.00E-07	0.13±1.94E-08	1.47±2.38E-08
WNW0204	DOWN - B(1)	8.10	548	0.5	0.008	-0.54±2.79E-09	2.51±2.70E-09	0.00±1.00E-07	1.31±1.74E-08	0.00±2.17E-08
WNW0204	DOWN - B(2)	7.71	622	0.7	<0.002	0.00±4.24E-09	-0.31±2.69E-09	9.81±7.60E-08	0.00±3.22E-08	0.00±3.47E-08
WNW0204	DOWN - B(3)	8.38	585	0.5	0.016	-0.62±3.24E-09	1.36±2.60E-09	8.43±7.50E-08	0.00±2.56E-08	0.00±3.64E-08
WNW0204	DOWN - B(4)	7.98	616	0.6	0.005	-1.11±2.18E-09	4.33±2.70E-09	1.21±0.82E-07	0.00±2.56E-08	0.00±3.64E-08
WNW0204	DOWN - B(5)	8.09	611	0.7	0.007	0.36±4.02E-09	5.84±3.31E-09	2.40±0.77E-07	0.00±1.96E-08	0.92±2.22E-08
WNW0204	DOWN - B(6)	8.26	639	1.0	<0.002	4.66±4.84E-09	3.08±2.93E-09	0.00±1.00E-07	0.00±1.94E-08	0.00±2.38E-08
WNW0206	DOWN - C(1)	7.47	602	0.6	0.010	0.00±2.26E-09	1.07±2.31E-09	0.00±1.00E-07	0.00±3.22E-08	0.00±3.47E-08
WNW0206	DOWN - C(2)	7.25	641	0.7	0.008	-1.41±3.91E-09	0.32±2.87E-09	1.67±8.10E-08	0.00±1.74E-08	0.00±2.17E-08
WNW0206	DOWN - C(3)	7.48	623	0.6	<0.004	-1.18±2.88E-09	2.58±2.75E-09	4.01±7.31E-08	0.00±2.56E-08	0.00±3.64E-08
WNW0206	DOWN - C(4)	7.46	638	0.7	<0.004	-0.54±2.36E-09	0.90±2.32E-09	0.00±1.00E-07	0.06±1.96E-08	0.98±2.22E-08
WNW0206	DOWN - C(5)	7.52	665	0.7	<0.002	5.01±5.17E-09	3.51±3.34E-09	3.04±0.78E-07	0.51±1.96E-08	0.00±2.22E-08
WNW0206	DOWN - C(6)	7.68	636	0.7	<0.002	0.98±3.34E-09	3.77±3.39E-09	0.00±1.00E-07	0.00±1.94E-08	0.00±2.38E-08
WNW0208	DOWN - C(1)	7.54	339	0.6	<0.002	1.07±2.32E-09	2.52±2.29E-09	0.00±1.00E-07	0.34±1.74E-08	0.95±2.17E-08
WNW0208	DOWN - C(2)	7.47	329	0.7	<0.002	1.10±1.60E-09	1.69±2.47E-09	0.00±1.00E-07	2.68±3.22E-08	0.00±3.47E-08
WNW0208	DOWN - C(3)	7.76	318	0.6	<0.002	-1.14±1.67E-09	0.99±2.39E-09	0.00±1.00E-07	1.09±2.56E-08	0.00±3.64E-08
WNW0208	DOWN - C(4)	7.45	307	0.6	<0.002	0.00±1.56E-09	-1.54±2.53E-09	0.00±1.00E-07	0.00±2.56E-08	0.00±3.64E-08
WNW0208	DOWN - C(5)	7.74	308	0.6	<0.002	-1.69±2.86E-09	0.86±2.44E-09	1.21±0.75E-07	0.00±1.96E-08	0.00±2.22E-08
WNW0208	DOWN - C(6)	7.30	316	0.7	<0.002	3.60±2.90E-09	4.14±1.96E-09	0.00±1.00E-07	0.45±1.94E-08	0.00±2.38E-08

Table E - 3
1993 Contamination Indicator Parameters for the Unweathered Lavery Till Unit

Location Code	Hydraulic Position	pH	Conductivity *μmhos/cm@25 °C*	TOC *mg/L*	TOX *mg/L*	Gross Alpha *μCi/mL*	Gross Beta *μCi/mL*	Tritium *μCi/mL*	Cs-137 *μCi/mL*	Co-60 *μCi/mL*
WNW0405	UP(1)	7.22	815	1.7	0.007	1.50±3.59E-09	5.35±3.83E-09	0.00±1.00E-07	0.00±3.22E-08	0.00±3.47E-08
WNW0405	UP(2)	7.46	746	1.6	0.006	-0.68±3.00E-09	0.77±3.10E-09	1.40±8.09E-08	0.00±1.74E-08	0.00±2.17E-08
WNW0405	UP(3)	7.34	867	1.2	0.012	0.78±4.56E-09	1.35±0.47E-08	5.05±7.37E-08	0.00±1.96E-08	0.00±2.22E-08
WNW0405	UP(4)	7.56	841	1.3	0.007	0.00±4.35E-09	6.30±4.30E-09	0.51±7.30E-08	0.00±2.56E-08	0.00±3.64E-08
WNW0405	UP(5)	7.33	975	1.4	0.011	7.01±7.24E-09	3.72±4.77E-09	7.65±7.82E-08	0.00±1.96E-08	0.00±2.22E-08
WNW0405	UP(6)	7.46	865	2.1	0.006	1.27±8.27E-09	3.94±5.38E-09	0.00±1.00E-07	0.00±1.94E-08	0.00±2.38E-08
WNW0109	DOWN - B(1)	7.24	600	0.6	<0.002	1.65±2.41E-09	1.93±2.31E-09	8.91±0.89E-07	0.00±1.74E-08	0.00±2.17E-08
WNW0109	DOWN - B(2)	7.43	583	0.6	<0.004	1.77±3.07E-09	4.01±2.55E-09	1.13±0.10E-06	0.00±1.74E-08	1.41±2.17E-08
WNW0109	DOWN - B(3)	7.39	570	0.7	<0.002	0.00±3.46E-09	2.43±2.79E-09	1.29±0.10E-06	0.00±1.74E-08	0.00±2.17E-08
WNW0109	DOWN - B(4)	7.35	573	0.6	<0.002	-2.10±2.38E-09	5.00±2.80E-09	1.38±0.10E-06	0.38±2.56E-08	0.00±3.64E-08
WNW0109	DOWN - B(5)	7.23	562	0.5	<0.002	4.20±5.13E-09	2.80±2.56E-09	1.34±0.10E-06	0.00±1.96E-08	0.00±2.22E-08
WNW0109	DOWN - B(6)	7.32	510	0.7	<0.002	5.46±4.05E-09	1.56±2.59E-09	1.10±0.10E-06	1.53±1.94E-08	1.32±2.38E-08
WNW0110	DOWN - B(1)	7.28	607	0.5	<0.002	-0.55±2.85E-09	2.96±2.76E-09	4.03±0.17E-06	0.00±1.74E-08	0.00±2.17E-08
WNW0110	DOWN - B(2)	7.39	605	0.6	<0.004	-0.66±2.90E-09	4.96±4.10E-09	1.22±0.10E-06	0.00±3.22E-08	1.40±3.47E-08
WNW0110	DOWN - B(3)	7.39	559	0.5	<0.002	2.27±3.52E-09	2.69±2.35E-09	1.36±0.10E-06	0.00±3.22E-08	0.00±3.47E-08
WNW0110	DOWN - B(4)	7.35	559	0.4	<0.002	2.24±4.38E-09	2.16±2.54E-09	1.50±0.11E-06	0.00±2.56E-08	0.00±3.64E-08
WNW0110	DOWN - B(5)	7.19	587	0.4	<0.002	2.70±4.67E-09	2.13±2.93E-09	1.62±0.10E-06	0.00±1.96E-08	0.00±2.22E-08
WNW0110	DOWN - B(6)	7.30	570	0.5	<0.002	0.87±2.94E-09	1.64±3.08E-09	1.22±0.10E-06	0.00±1.94E-08	0.00±2.38E-08
WNW0115	DOWN - B(1)	7.40	583	0.4	<0.002	2.59±2.69E-09	3.24±2.45E-09	5.88±0.85E-07	0.00±3.22E-08	0.00±3.47E-08
WNW0115	DOWN - B(2)	7.44	609	0.4	<0.004	-1.09±2.14E-09	2.64±2.61E-09	8.65±0.90E-07	1.28±3.22E-08	0.00±3.47E-08
WNW0115	DOWN - B(3)	7.61	522	0.5	<0.002	-1.01±2.43E-09	3.09±2.50E-09	8.60±0.85E-07	0.00±3.22E-08	0.00±3.47E-08
WNW0115	DOWN - B(4)	7.88	498	0.5	<0.002	2.05±2.84E-09	0.88±2.91E-09	6.34±0.90E-07	1.14±2.56E-08	0.00±3.64E-08
WNW0115	DOWN - B(5)	7.37	514	0.4	<0.002	0.56±2.45E-09	0.15±2.46E-09	1.06±0.09E-06	0.51±1.96E-08	0.00±2.22E-08
WNW0115	DOWN - B(6)	7.27	483	0.5	<0.002	3.60±3.32E-09	2.17±2.19E-09	7.09±0.89E-07	1.02±1.94E-08	0.00±2.38E-08
WNW0702	DOWN - B(1)	7.03	1,032	0.5	0.003	2.56±3.74E-09	4.73±2.77E-09	0.00±1.00E-07	0.00±3.22E-08	0.00±3.47E-08
WNW0702	DOWN - B(2)	7.19	970	0.7	<0.002	5.01±6.12E-09	0.44±4.03E-09	0.67±6.45E-08	1.66±3.22E-08	0.00±3.47E-08
WNW0702	DOWN - B(3)	7.20	956	0.5	<0.002	5.54±4.65E-09	6.04±4.69E-09	0.00±1.00E-07	0.00±3.22E-08	0.00±3.47E-08
WNW0702	DOWN - B(4)	7.30	893	0.5	0.003	-4.22±3.70E-09	5.28±4.49E-09	0.00±1.00E-07	0.76±2.56E-08	0.00±3.64E-08
WNW0702	DOWN - B(5)	7.21	953	0.5	<0.002	6.76±6.28E-09	4.52±4.62E-09	1.58±0.76E-07	0.51±1.96E-08	0.00±2.22E-08
WNW0702	DOWN - B(6)	7.21	991	0.7	<0.002	3.52±6.08E-09	5.29±3.29E-09	3.47±0.84E-07	1.45±3.13E-08	0.00±3.28E-08
WNW0703	DOWN - B(1)	6.91	862	0.5	0.002	0.75±3.29E-09	1.27±3.20E-09	0.00±1.00E-07	1.53±3.22E-08	0.00±3.47E-08
WNW0703	DOWN - B(2)	7.03	814	0.6	<0.002	4.66±4.30E-09	1.02±3.42E-09	0.00±1.00E-07	0.00±3.22E-08	0.00±3.47E-08
WNW0703	DOWN - B(3)	7.20	792	0.4	<0.002	0.00±3.77E-09	1.86±2.92E-09	0.00±1.00E-07	0.00±3.22E-08	0.00±3.47E-08
WNW0703	DOWN - B(4)	7.20	787	0.5	<0.002	0.00±4.85E-09	0.74±3.88E-09	0.00±1.00E-07	0.00±1.96E-08	0.00±2.22E-08
WNW0703	DOWN - B(5)	7.25	757	0.5	<0.002	1.67±5.18E-09	3.30±3.33E-09	1.33±0.76E-07	0.13±1.96E-08	1.29±2.22E-08
WNW0703	DOWN - B(6)	7.42	762	0.5	0.003	0.93±4.06E-09	3.63±2.92E-09	0.00±1.00E-07	0.00±3.13E-08	0.00±3.28E-08
WNW0704	DOWN - B(1)	6.22	1,077	19.0	0.018	-0.04±3.00E-09	2.48±0.58E-08	0.00±1.00E-07	0.00±3.22E-08	0.00±3.47E-08
WNW0704	DOWN - B(2)	6.34	1,072	19.5	0.026	-1.23±6.36E-09	1.93±0.62E-08	1.63±7.86E-08	1.31±1.74E-08	0.00±2.17E-08
WNW0704	DOWN - B(3)	6.30	1,049	20.5	0.017	-3.74±5.47E-09	2.27±0.57E-08	0.00±1.00E-07	0.00±1.74E-08	0.00±2.17E-08
WNW0704	DOWN - B(4)	6.40	1,068	19.9	0.018	-1.30±5.67E-09	2.28±0.68E-08	4.21±8.08E-08	0.58±1.96E-08	0.00±2.22E-08
WNW0704	DOWN - B(5)	6.35	1,093	22.3	0.020	1.61±7.07E-09	2.26±0.80E-08	1.64±0.79E-07	0.00±1.96E-08	0.00±2.22E-08
WNW0704	DOWN - B(6)	6.41	1,055	27.0	0.036	3.34±8.02E-09	3.11±0.95E-08	0.00±1.00E-07	0.00±3.13E-08	0.00±3.28E-08
WNW0705	DOWN - B(1)	7.11	448	1.5	0.002	-0.79±1.89E-09	2.27±2.57E-09	0.00±1.00E-07	0.00±1.74E-08	0.00±2.17E-08
WNW0705	DOWN - B(2)	7.26	451	1.7	0.004	0.50±2.94E-09	1.61±2.80E-09	0.31±8.93E-08	0.00±1.74E-08	0.00±2.17E-08
WNW0705	DOWN - B(3)	7.19	469	1.1	0.002	-1.02±2.46E-09	3.24±2.80E-09	4.60±7.46E-08	1.28±3.22E-08	0.00±3.47E-08
WNW0705	DOWN - B(4)	7.29	504	1.3	0.006	-0.59±2.60E-09	3.95±2.70E-09	0.00±1.00E-07	1.14±2.56E-08	0.00±3.64E-08
WNW0705	DOWN - B(5)	7.12	532	1.1	0.006	2.22±3.83E-09	3.57±2.93E-09	1.84±0.77E-07	0.00±1.96E-08	0.00±2.22E-08
WNW0705	DOWN - B(6)	7.24	543	1.6	0.007	1.38±3.32E-09	3.00±2.41E-09	0.00±1.00E-07	0.00±1.83E-08	0.00±1.94E-08

Table E - 3 (continued)
1993 Contamination Indicator Parameters for the Unweathered Lavery Till Unit

Location Code	Hydraulic Position	pH	Conductivity μmhos/cm@25 °C	TOC mg/L	TOX mg/L	Gross Alpha μCi/mL	Gross Beta μCi/mL	Tritium μCi/mL	Cs-137 μCi/mL	Co-60 μCi/mL
WNW0707	DOWN - B(1)	6.35	254	2.6	0.006	0.00±1.15E-09	3.00±2.62E-09	0.00±1.00E-07	1.66±3.22E-08	0.00±3.47E-08
WNW0707	DOWN - B(2)	6.98	393	2.7	0.003	-0.79±1.90E-09	2.99±2.52E-09	7.93±7.51E-08	1.45±1.74E-08	0.00±2.17E-08
WNW0707	DOWN - B(3)	6.43	320	2.1	0.004	0.00±1.86E-09	5.16±2.61E-09	1.13±0.76E-07	0.00±8.90E-09	0.00±9.53E-09
WNW0707	DOWN - B(4)	6.87	469	2.2	0.009	-1.18±2.31E-09	5.46±2.85E-09	7.74±8.01E-08	0.00±1.96E-08	0.00±2.22E-08
WNW0707	DOWN - B(5)	6.65	498	2.0	0.010	-1.22±2.94E-09	4.23±2.65E-09	2.04±0.77E-07	0.00±1.96E-08	0.00±2.22E-08
WNW0707	DOWN - B(6)	6.32	356	2.9	0.008	1.42±2.46E-09	7.93±2.90E-09	0.00±1.00E-07	0.00±1.83E-08	0.00±1.94E-08
WNW0904	DOWN - B(1)	7.35	829	0.7	<0.002	3.14±4.86E-09	2.43±3.57E-09	0.00±1.00E-07	0.00±1.74E-08	0.00±2.17E-08
WNW0904	DOWN - B(2)	7.44	798	0.7	<0.002	0.70±2.38E-09	5.26±3.80E-09	0.00±1.00E-07	0.00±3.22E-08	0.00±3.47E-08
WNW0904	DOWN - B(3)	7.10	817	0.7	<0.002	0.00±3.50E-09	4.68±4.12E-09	0.00±1.00E-07	0.89±1.96E-08	0.00±2.22E-08
WNW0904	DOWN - B(4)	7.25	775	0.7	<0.002	-0.72±5.06E-09	6.05±3.28E-09	0.00±1.00E-07	0.00±2.56E-08	0.00±3.64E-08
WNW0904	DOWN - B(5)	7.76	823	0.7	<0.002	3.10±4.80E-09	1.31±3.58E-09	1.43±0.76E-07	0.00±1.96E-08	0.00±2.22E-08
WNW0904	DOWN - B(6)	7.28	772	0.9	<0.002	-3.33±4.87E-09	3.71±3.34E-09	4.79±7.65E-08	0.00±1.83E-08	0.00±1.94E-08
WNW1101B	DOWN - B(1)	7.10	897	0.5	<0.002	0.00±2.12E-09	5.31±3.68E-09	0.00±1.00E-07	0.00±3.22E-08	0.00±3.47E-08
WNW1101B	DOWN - B(2)	7.26	875	0.5	<0.002	2.52±3.69E-09	2.19±3.70E-09	0.00±1.00E-07	0.00±1.74E-08	0.00±2.17E-08
WNW1101B	DOWN - B(3)	7.09	832	0.5	<0.002	4.04±3.54E-09	6.72±4.86E-09	0.00±1.00E-07	0.96±1.96E-08	0.00±2.22E-08
WNW1101B	DOWN - B(4)	7.18	821	0.5	<0.002	4.13±5.72E-09	9.18±4.36E-09	0.00±1.00E-07	0.89±1.96E-08	0.00±2.22E-08
WNW1101B	DOWN - B(5)	7.23	829	0.6	<0.002	-0.81±5.75E-09	6.09±4.94E-09	0.00±1.00E-07	0.00±1.96E-08	0.00±2.22E-08
WNW1101B	DOWN - B(6)	7.25	807	0.4	<0.002	6.44±4.77E-09	8.27±3.98E-09	0.00±1.00E-07	0.70±1.83E-08	0.00±1.94E-08
WNW1106B	DOWN - B(1)	7.17	816	0.6	<0.002	0.00±4.47E-09	3.41±3.52E-09	0.00±1.00E-07	0.00±1.74E-08	0.00±2.17E-08
WNW1106B	DOWN - B(2)	7.21	832	0.8	<0.002	0.72±2.43E-09	3.12±3.20E-09	0.00±1.00E-07	0.51±3.22E-08	1.10±3.47E-08
WNW1106B	DOWN - B(3)	7.08	808	0.8	<0.002	-5.51±3.57E-09	5.89±4.83E-09	3.68±7.56E-08	0.00±2.56E-08	0.00±3.64E-08
WNW1106B	DOWN - B(4)	7.04	817	0.7	<0.002	4.86±5.72E-09	3.12±3.85E-09	0.00±1.00E-07	0.00±1.96E-08	0.00±2.22E-08
WNW1106B	DOWN - B(5)	7.25	808	0.9	<0.002	-1.57±5.32E-09	3.09±4.42E-09	0.00±1.00E-07	0.00±1.94E-08	0.00±2.38E-08
WNW1106B	DOWN - B(6)	7.21	792	0.8	<0.002	1.94±2.68E-09	4.76±4.02E-09	0.00±1.00E-07	0.00±1.83E-08	0.00±1.94E-08
WNW1109B	DOWN - B(1)	7.42	503	0.5	<0.002	0.00±2.74E-09	1.46±2.59E-09	4.41±0.81E-07	2.17±3.22E-08	0.00±3.47E-08
WNW1109B	DOWN - B(2)	7.60	494	0.8	<0.002	1.59±2.32E-09	4.15±2.76E-09	4.41±0.84E-07	1.03±1.74E-08	0.00±2.17E-08
WNW1109B	DOWN - B(3)	7.51	503	0.8	<0.002	-0.19±2.12E-09	4.89±3.99E-09	5.77±0.82E-07	0.00±2.28E-08	0.00±3.02E-08
WNW1109B	DOWN - B(4)	7.46	480	0.7	<0.002	2.10±2.91E-09	1.66±2.61E-09	4.00±0.90E-07	0.00±2.56E-08	0.00±3.64E-08
WNW1109B	DOWN - B(5)	7.43	507	0.8	<0.002	-3.19±2.95E-09	3.77±3.42E-09	4.91±0.87E-07	0.00±1.94E-08	1.27±2.38E-08
WNW1109B	DOWN - B(6)	7.71	485	0.8	<0.002	5.02±3.48E-09	2.05±2.29E-09	5.92±0.84E-07	0.00±1.83E-08	1.35±1.94E-08
WNW0107	DOWN - C(1)	7.00	847	0.7	<0.002	3.13±3.76E-09	6.84±3.89E-09	1.08±0.09E-06	0.00±1.74E-08	0.00±2.17E-08
WNW0107	DOWN - C(2)	7.46	845	0.8	<0.004	4.33±5.10E-09	3.56±3.20E-09	1.32±0.10E-06	0.00±3.22E-08	0.00±3.47E-08
WNW0107	DOWN - C(3)	7.14	736	0.9	<0.002	1.30±3.62E-09	2.81±2.71E-09	1.07±0.09E-06	0.00±1.74E-08	0.00±2.17E-08
WNW0107	DOWN - C(4)	7.40	792	0.7	0.005	0.86±5.58E-09	1.33±4.03E-09	9.57±0.92E-07	0.00±2.56E-08	0.00±3.64E-08
WNW0107	DOWN - C(5)	7.13	812	0.7	<0.002	1.80±4.31E-09	0.71±3.96E-09	1.18±0.09E-06	0.00±1.96E-08	0.00±2.22E-08
WNW0107	DOWN - C(6)	7.09	940	0.7	<0.002	-1.14±6.73E-09	2.58±4.17E-09	1.37±0.10E-06	0.00±1.94E-08	0.00±2.38E-08
WNW0108	DOWN - C(1)	7.30	794	0.8	<0.002	0.78±3.42E-09	3.39±3.64E-09	0.00±1.00E-07	0.00±3.22E-08	0.00±3.47E-08
WNW0108	DOWN - C(2)	7.77	788	0.8	<0.004	2.08±3.04E-09	0.00±2.91E-09	0.00±1.00E-07	1.79±3.22E-08	0.00±3.47E-08
WNW0108	DOWN - C(3)	7.22	757	0.9	<0.002	1.89±4.09E-09	0.71±3.04E-09	1.06±0.76E-07	0.00±3.22E-08	0.00±3.47E-08
WNW0108	DOWN - C(4)	7.60	713	0.8	<0.002	0.72±3.72E-09	3.46±3.60E-09	0.00±1.00E-07	0.00±2.56E-08	0.00±3.64E-08
WNW0108	DOWN - C(5)	7.24	726	0.8	<0.002	4.84±4.48E-09	4.50±3.37E-09	2.00±0.77E-07	1.15±1.96E-08	0.00±2.22E-08
WNW0108	DOWN - C(6)	7.28	735	0.9	<0.002	0.00±2.54E-09	5.95±3.70E-09	0.00±1.00E-07	0.00±1.94E-08	0.00±2.38E-08
WNW0114	DOWN - C(1)	7.13	611	0.7	<0.002	1.13±2.21E-09	3.72±2.52E-09	1.86±0.80E-07	0.00±3.22E-08	0.00±3.47E-08
WNW0114	DOWN - C(2)	7.49	557	0.6	<0.004	-2.37±2.32E-09	-1.05±2.57E-09	1.91±0.79E-07	0.00±3.22E-08	0.00±3.47E-08
WNW0114	DOWN - C(3)	7.12	537	0.6	<0.002	-1.12±2.69E-09	0.45±2.54E-09	2.21±0.77E-07	0.00±3.22E-08	0.00±3.47E-08
WNW0114	DOWN - C(4)	7.33	529	0.5	0.003	0.00±3.14E-09	0.77±2.37E-09	1.80±0.79E-07	0.00±1.96E-08	0.00±2.22E-08
WNW0114	DOWN - C(5)	7.06	567	0.4	<0.002	1.65±3.96E-09	3.01±2.93E-09	5.25±0.81E-07	0.00±1.96E-08	0.00±2.22E-08
WNW0114	DOWN - C(6)	7.08	610	0.6	<0.002	-2.60±4.50E-09	3.75±3.74E-09	2.26±0.82E-07	1.85±1.94E-08	0.00±2.38E-08

Table E - 3 (concluded)
1993 Contamination Indicator Parameters for the Unweathered Lavery Till Unit

Location Code	Hydraulic Position	pH	Conductivity *µmhos/cm@25 °C*	TOC *mg/L*	TOX *mg/L*	Gross Alpha *µCi/mL*	Gross Beta *µCi/mL*	Tritium *µCi/mL*	Cs-137 *µCi/mL*	Co-60 *µCi/mL*
WNW0409	DOWN - C(1)	7.62	375	0.4	<0.002	0.51±1.74E-09	4.30±4.06E-09	0.00±1.00E-07	0.00±1.74E-08	1.13±2.17E-08
WNW0409	DOWN - C(2)	7.65	391	0.4	<0.004	0.78±2.43E-09	5.01±2.73E-09	0.81±7.86E-08	0.00±1.74E-08	0.00±2.17E-08
WNW0409	DOWN - C(3)	7.91	364	0.4	<0.002	-1.16±1.69E-09	4.26±2.81E-09	0.00±1.00E-07	0.00±3.22E-08	0.00±3.47E-08
WNW0409	DOWN - C(4)	8.16	380	0.4	<0.002	1.61±2.50E-09	7.14±2.88E-09	0.00±1.00E-07	0.00±1.96E-08	0.00±2.22E-08
WNW0409	DOWN - C(5)	7.92	381	0.3	<0.002	0.91±2.18E-09	5.08±2.91E-09	0.00±1.00E-07	0.00±1.94E-08	0.00±2.38E-08
WNW0409	DOWN - C(6)	8.02	358	0.5	<0.002	0.00±2.34E-09	6.85±2.62E-09	0.00±1.00E-07	0.13±1.94E-08	0.00±2.38E-08
WNW0910	DOWN - C(1)	7.25	1,490	1.8	0.003	2.84±6.83E-09	1.80±0.63E-08	0.00±1.00E-07	1.65±1.74E-08	1.40±2.17E-08
WNW0910	DOWN - C(2)	7.15	1,567	1.7	<0.002	4.83±7.05E-09	2.91±0.83E-08	0.00±1.00E-07	0.00±1.74E-08	0.00±2.17E-08
WNW0910	DOWN - C(3)	6.91	1,847	1.3	<0.002	0.34±1.05E-08	1.38±0.75E-08	0.00±1.00E-07	0.06±1.96E-08	0.00±2.22E-08
WNW0910	DOWN - C(4)	6.89	1,842	1.4	0.002	4.28±8.49E-09	1.02±0.83E-08	0.00±1.00E-07	0.00±1.96E-08	0.00±2.22E-08
WNW0910	DOWN - C(5)	7.93	1,865	1.9	<0.002	3.73±7.30E-09	5.10±8.79E-09	1.23±0.78E-07	0.00±1.95E-08	0.00±2.30E-08
WNW0910	DOWN - C(6)	7.00	1,811	1.7	0.003	0.65±1.08E-08	5.33±9.25E-09	0.00±1.00E-07	0.00±1.83E-08	0.00±1.94E-08
WNW1102B	DOWN - C(1)	7.08	636	0.6	<0.002	1.71±2.84E-09	3.98±2.89E-09	0.00±1.00E-07	0.45±2.59E-08	1.24±2.89E-08
WNW1102B	DOWN - C(2)	7.21	625	0.5	<0.002	0.00±3.57E-09	2.23±2.99E-09	0.00±1.00E-07	0.00±3.22E-08	0.00±3.47E-08
WNW1102B	DOWN - C(3)	7.09	636	0.5	<0.002	-2.12±2.40E-09	5.25±3.70E-09	0.00±1.00E-07	0.96±1.96E-08	1.19±2.22E-08
WNW1102B	DOWN - C(4)	7.15	588	0.5	<0.002	4.26±5.02E-09	1.29±2.86E-09	0.00±1.00E-07	0.64±1.96E-08	0.00±2.22E-08
WNW1102B	DOWN - C(5)	7.21	622	0.7	<0.002	-4.12±3.81E-09	0.54±3.41E-09	0.00±1.00E-07	0.00±1.94E-08	0.00±2.38E-08
WNW1102B	DOWN - C(6)	7.25	589	0.6	<0.002	2.52±3.69E-09	0.77±3.20E-09	0.00±1.00E-07	0.70±1.83E-08	0.00±1.94E-08
WNW1103B	DOWN - C(1)	7.04	731	0.5	<0.002	-1.28±3.07E-09	1.54±3.02E-09	0.00±1.00E-07	0.00±3.22E-08	0.00±3.47E-08
WNW1103B	DOWN - C(2)	7.11	718	0.7	<0.002	0.39±2.94E-09	3.69±3.46E-09	0.00±1.00E-07	0.76±2.59E-08	0.00±2.89E-08
WNW1103B	DOWN - C(3)	7.26	715	0.7	<0.002	0.75±1.47E-09	1.97±3.56E-09	0.00±1.00E-07	0.19±1.96E-08	0.97±2.22E-08
WNW1103B	DOWN - C(4)	7.05	683	0.7	<0.002	2.28±3.95E-09	2.26±3.25E-09	0.31±8.87E-08	0.64±1.96E-08	0.00±2.22E-08
WNW1103B	DOWN - C(5)	7.19	718	0.7	0.002	-4.07±4.79E-09	-0.21±3.81E-09	0.00±1.00E-07	0.00±1.94E-08	0.00±2.38E-08
WNW1103B	DOWN - C(6)	7.19	727	0.6	<0.002	8.16±5.66E-09	0.47±3.53E-09	0.00±1.00E-07	0.00±1.83E-08	0.00±1.94E-08
WNW1104B	DOWN - C(1)	7.17	640	0.8	<0.002	1.31±2.57E-09	2.58±2.83E-09	0.00±1.00E-07	0.77±3.22E-08	0.00±3.47E-08
WNW1104B	DOWN - C(2)	7.40	644	0.3	<0.002	1.88±3.25E-09	0.99±3.32E-09	0.00±1.00E-07	0.00±1.74E-08	0.00±2.17E-08
WNW1104B	DOWN - C(3)	7.26	614	0.7	<0.002	1.88±4.42E-09	7.22±3.98E-09	0.00±1.00E-07	1.34±1.96E-08	0.00±2.22E-08
WNW1104B	DOWN - C(4)	7.26	615	0.7	<0.002	2.17±3.74E-09	1.97±2.85E-09	0.00±1.00E-07	0.26±1.96E-08	0.00±2.22E-08
WNW1104B	DOWN - C(5)	7.39	631	0.8	<0.002	0.00±4.40E-09	5.10±3.23E-09	0.00±1.00E-07	0.00±1.94E-08	0.00±2.38E-08
WNW1104B	DOWN - C(6)	7.44	630	0.7	<0.002	3.40±3.33E-09	3.96±3.71E-09	0.00±1.00E-07	0.83±1.83E-08	0.00±1.94E-08
WNW1105A	DOWN - C(1)	7.29	916	1.2	<0.002	3.71±3.84E-09	0.80±3.25E-09	2.39±7.72E-08	0.00±3.22E-08	1.29±3.47E-08
WNW1105A	DOWN - C(2)	7.26	879	0.9	0.005	3.97±4.11E-09	2.77±3.62E-09	4.30±7.38E-08	2.17±3.22E-08	0.00±3.47E-08
WNW1105A	DOWN - C(3)	7.16	866	1.0	<0.002	3.87±3.39E-09	2.04±4.12E-09	0.41±5.87E-08	0.00±2.56E-08	0.00±3.64E-08
WNW1105A	DOWN - C(4)	7.19	915	1.0	0.006	0.86±6.08E-09	5.25±4.30E-09	0.00±1.00E-07	1.78±2.56E-08	1.23±3.64E-08
WNW1105A	DOWN - C(5)	7.23	899	1.1	<0.002	4.10±4.92E-09	4.19±4.18E-09	0.00±1.00E-07	0.00±1.94E-08	0.00±2.38E-08
WNW1105A	DOWN - C(6)	7.26	859	0.9	<0.002	2.10±7.72E-09	6.17±4.49E-09	1.07±0.78E-07	0.35±1.83E-08	0.00±1.94E-08
WNW1105B	DOWN - C(1)	7.31	1,113	1.3	<0.002	1.88±5.83E-09	-0.27±4.53E-09	0.00±1.00E-07	0.00±1.74E-08	0.00±2.17E-08
WNW1105B	DOWN - C(2)	7.24	1,031	0.9	0.004	1.75±4.84E-09	3.05±3.98E-09	0.00±1.00E-07	0.00±1.74E-08	0.00±2.17E-08
WNW1105B	DOWN - C(3)	7.23	968	0.9	<0.002	5.00±4.00E-09	3.95±4.76E-09	0.00±1.00E-07	0.19±1.96E-08	0.00±2.22E-08
WNW1105B	DOWN - C(4)	7.17	956	0.7	<0.002	6.13±6.34E-09	3.78±3.68E-09	0.00±1.00E-07	0.00±2.56E-08	0.00±3.64E-08
WNW1105B	DOWN - C(5)	7.35	1,038	0.8	<0.002	1.85±5.73E-09	3.36±4.15E-09	0.00±1.00E-07	1.02±1.94E-08	0.00±2.38E-08
WNW1105B	DOWN - C(6)	7.41	978	0.8	0.003	6.78±5.43E-09	1.54±3.96E-09	2.26±8.91E-08	0.24±3.13E-08	1.91±3.28E-08

Table E - 4
1993 Contamination Indicator Parameters for the Kent Recessional Sequence

Location Code	Hydraulic Position	pH	Conductivity *μmhos/cm@25 °C*	TOC *mg/L*	TOX *mg/L*	Gross Alpha *μCi/mL*	Gross Beta *μCi/mL*	H-3 *μCi/mL*	Cs-137 *μCi/mL*	Co-60 *μCi/mL*
WNW0901	UP(1)	7.77	374	0.4	<0.002	0.40±2.37E-09	6.54±3.02E-09	0.00±1.00E-07	0.41±1.74E-08	0.00±2.17E-08
WNW0901	UP(2)	7.74	384	0.5	<0.002	3.08±2.59E-09	1.88±2.49E-09	0.00±1.00E-07	0.00±1.74E-08	0.00±2.17E-08
WNW0901	UP(3)	7.61	384	0.5	<0.002	-1.36±2.36E-09	8.22±3.13E-09	0.00±1.00E-07	0.00±1.96E-08	0.00±2.22E-08
WNW0901	UP(4)	7.62	376	0.6	0.009	2.02±2.37E-09	6.22±2.73E-09	0.00±1.00E-07	0.06±1.96E-08	0.00±2.22E-08
WNW0901	UP(5)	7.60	373	0.5	<0.002	1.44±2.82E-09	3.97±2.75E-09	1.38±0.75E-07	0.00±1.96E-08	0.00±2.22E-08
WNW0901	UP(6)	7.58	379	0.6	<0.002	-0.57±2.94E-09	3.68±2.48E-09	0.00±1.00E-07	0.00±1.83E-08	0.56±1.94E-08
WNW0902	UP(1)	8.01	447	0.4	<0.002	-0.91±2.20E-09	2.75±2.67E-09	0.00±1.00E-07	1.66±3.22E-08	0.00±3.47E-08
WNW0902	UP(2)	7.56	450	0.5	<0.002	1.40±2.01E-09	3.06±2.81E-09	0.00±1.00E-07	0.00±1.74E-08	0.00±2.17E-08
WNW0902	UP(3)	7.89	452	0.5	0.002	-1.50±2.19E-09	5.60±2.74E-09	0.00±1.00E-07	0.00±1.96E-08	0.00±2.22E-08
WNW0902	UP(4)	7.86	451	0.5	<0.002	0.48±2.09E-09	5.14±2.66E-09	0.00±1.00E-07	0.00±2.56E-08	0.00±3.64E-08
WNW0902	UP(5)	7.88	441	0.6	0.002	1.11±3.07E-09	6.65±3.08E-09	1.26±0.75E-07	0.00±1.96E-08	0.00±2.22E-08
WNW0902	UP(6)	7.93	446	0.5	0.008	-1.28±3.06E-09	5.36±2.73E-09	0.00±1.00E-07	0.00±1.83E-08	0.00±1.94E-08
WNW1001	UP(1)	7.52	428	0.4	0.011	-0.87±2.08E-09	3.44±2.73E-09	0.00±1.00E-07	0.00±1.74E-08	1.15±2.17E-08
WNW1001	UP(2)	7.88	437	0.4	0.002	0.87±1.70E-09	2.30±2.51E-09	0.00±1.00E-07	0.00±3.22E-08	0.00±3.47E-08
WNW1001	UP(3)	7.61	423	0.5	0.003	2.98±2.38E-09	2.20±2.71E-09	0.00±1.00E-07	0.00±1.96E-08	0.00±2.22E-08
WNW1001	UP(4)	7.83	439	0.4	0.004	0.91±2.18E-09	2.98±2.44E-09	0.00±1.00E-07	1.47±1.96E-08	0.00±2.22E-08
WNW1001	UP(5)	7.64	435	0.5	0.007	0.00±2.26E-09	3.95±2.95E-09	1.97±0.77E-07	0.00±1.94E-08	0.00±2.38E-08
WNW1001	UP(6)	7.72	448	0.5	0.005	-1.26±3.90E-09	0.61±2.64E-09	0.00±1.00E-07	0.00±1.83E-08	0.00±1.94E-08
WNW1008B	UP(1)	7.63	461	0.4	0.006	0.00±2.46E-09	2.74±2.66E-09	0.00±1.00E-07	0.00±1.74E-08	0.00±2.17E-08
WNW1008B	UP(2)	7.83	372	0.5	0.006	1.49±1.69E-09	2.05±2.79E-09	0.00±1.00E-07	1.28±3.22E-08	0.00±3.47E-08
WNW1008B	UP(3)	7.81	434	0.4	0.008	0.00±1.02E-09	4.74±3.07E-09	0.00±1.00E-07	0.00±1.96E-08	0.00±2.22E-08
WNW1008B	UP(4)	7.56	403	0.4	0.007	0.95±2.28E-09	3.70±2.52E-09	0.00±1.00E-07	0.00±2.56E-08	0.00±3.64E-08
WNW1008B	UP(5)	7.49	377	0.5	0.005	-0.52±2.28E-09	2.68±2.92E-09	1.32±0.76E-07	0.00±1.94E-08	0.00±2.38E-08
WNW1008B	UP(6)	7.88	426	0.6	<0.002	-0.67±4.38E-09	1.59±2.86E-09	0.00±1.00E-07	0.32±1.83E-08	0.00±1.94E-08
WNW0903	DOWN - B(1)	7.55	806	0.8	<0.002	0.00±3.67E-09	3.00±3.64E-09	0.00±1.00E-07	0.00±3.22E-08	0.00±3.47E-08
WNW0903	DOWN - B(2)	7.87	705	0.7	<0.002	3.00±3.60E-09	4.21±3.78E-09	0.00±1.00E-07	0.00±1.74E-08	0.00±2.17E-08
WNW0903	DOWN - B(3)	7.49	755	0.8	<0.002	2.42±2.74E-09	0.92±4.00E-09	0.00±1.00E-07	0.00±2.56E-08	0.00±3.64E-08
WNW0903	DOWN - B(4)	7.44	788	0.8	<0.002	-3.69±4.34E-09	5.65±3.71E-09	0.00±1.00E-07	0.00±1.96E-08	0.00±2.22E-08
WNW0903	DOWN - B(5)	9.08	789	0.8	<0.002	0.83±2.83E-09	4.46±4.10E-09	1.32±0.76E-07	0.00±1.96E-08	0.00±2.22E-08
WNW0903	DOWN - B(6)	7.63	749	0.8	0.002	-4.40±4.31E-09	5.27±3.82E-09	0.00±1.00E-07	0.00±1.83E-08	0.00±1.94E-08
WNW1002	DOWN - B(1)	7.16	1,082	0.8	<0.002	-2.12±5.08E-09	2.07±4.01E-09	0.00±1.00E-07	0.00±1.74E-08	0.00±2.17E-08
WNW1002	DOWN - B(2)	7.40	1,075	0.8	<0.002	-1.16±3.93E-09	2.37±4.92E-09	0.00±1.00E-07	0.00±3.22E-08	0.00±3.47E-08
WNW1002	DOWN - B(3)	7.32	1,090	0.8	<0.002	-2.20±4.86E-09	1.77±5.26E-09	0.00±1.00E-07	0.00±1.96E-08	1.46±2.22E-08
WNW1002	DOWN - B(4)	6.98	1,152	0.7	<0.002	0.59±7.03E-09	5.85±5.51E-09	0.00±1.00E-07	1.08±1.94E-08	0.00±2.38E-08
WNW1002	DOWN - B(5)	7.25	1,158	0.9	<0.002	-5.70±8.83E-09	0.62±5.87E-09	1.17±0.78E-07	0.00±1.94E-08	0.00±2.38E-08
WNW1002	DOWN - B(6)	7.12	1,195	0.9	<0.002	-8.69±9.02E-09	3.16±5.52E-09	0.00±1.00E-07	0.00±1.83E-08	0.00±1.94E-08
WNW1003	DOWN - B(1)	7.58	459	0.9	0.005	-1.30±1.90E-09	5.02±2.88E-09	0.00±1.00E-07	0.64±3.22E-08	0.00±3.47E-08
WNW1003	DOWN - B(2)	7.71	462	1.0	<0.002	5.00±9.80E-10	0.59±2.66E-09	0.00±1.00E-07	0.00±1.74E-08	0.00±2.17E-08
WNW1003	DOWN - B(3)	7.54	437	0.9	<0.002	-0.48±2.08E-09	3.90±2.87E-09	0.00±1.00E-07	1.65±2.56E-08	0.00±3.64E-08
WNW1003	DOWN - B(4)	7.47	448	0.9	0.002	-1.46±3.16E-09	4.37±2.55E-09	0.00±1.00E-07	0.45±1.96E-08	0.00±2.22E-08
WNW1003	DOWN - B(5)	7.57	435	1.0	<0.002	-3.12±2.88E-09	0.93±2.98E-09	1.10±0.77E-07	0.00±1.94E-08	0.00±2.38E-08
WNW1003	DOWN - B(6)	7.57	461	1.1	0.002	-2.68±3.21E-09	3.41±2.58E-09	0.00±1.00E-07	0.00±1.83E-08	0.00±1.94E-08

NA - Not available.

Table E - 4 (concluded)
1993 Contamination Indicator Parameters for the Kent Recessional Sequence

Location Code	Hydraulic Position	pH	Conductivity μmhos/cm@25 °C	TOC mg/L	TOX mg/L	Gross Alpha μCi/mL	Gross Beta μCi/mL	H-3 μCi/mL	Cs-137 μCi/mL	Co-60 μCi/mL
WNW1004	DOWN - B(1)	7.47	456	0.8	<0.002	-0.27±3.68E-09	2.22±2.68E-09	0.00±1.00E-07	0.19±2.59E-08	0.00±2.89E-08
WNW1004	DOWN - B(2)	7.57	453	0.8	<0.002	-0.51±2.23E-09	-0.29±2.50E-09	0.00±1.00E-07	0.00±1.74E-08	0.00±2.17E-08
WNW1004	DOWN - B(3)	7.53	454	0.8	<0.002	-1.04±2.04E-09	5.78±3.12E-09	0.00±1.00E-07	1.15±1.96E-08	0.00±2.22E-08
WNW1004	DOWN - B(4)	7.51	456	0.9	<0.002	-2.21±3.43E-09	1.93±2.31E-09	0.00±1.00E-07	0.00±2.56E-08	0.00±3.64E-08
WNW1004	DOWN - B(5)	7.56	452	0.8	<0.002	-3.02±3.55E-09	2.68±3.20E-09	1.82±0.77E-07	0.00±1.94E-08	0.00±2.38E-08
WNW1004	DOWN - B(6)	7.67	460	0.8	<0.002	-3.33±3.96E-09	0.01±3.34E-09	0.00±1.00E-07	0.64±1.83E-08	0.00±1.94E-08
WNW1101C	DOWN - B(1)	7.42	533	0.6	<0.002	1.03±2.02E-09	4.14±2.78E-09	0.00±1.00E-07	0.00±1.74E-08	0.00±2.17E-08
WNW1101C	DOWN - B(2)	7.61	520	0.7	<0.002	0.00±2.37E-09	2.20±2.78E-09	0.00±1.00E-07	0.00±3.22E-08	0.00±3.47E-08
WNW1101C	DOWN - B(3)	7.48	492	0.7	<0.002	1.56±1.76E-09	2.88±3.26E-09	0.00±1.00E-07	0.00±2.56E-08	0.00±3.64E-08
WNW1101C	DOWN - B(4)	7.59	472	0.7	<0.002	2.61±3.07E-09	2.08±2.43E-09	0.00±1.00E-07	0.00±2.56E-08	0.00±3.64E-08
WNW1101C	DOWN - B(5)	7.43	482	0.8	<0.002	-1.03±3.51E-09	1.39±3.02E-09	0.00±1.00E-07	0.00±1.94E-08	0.00±2.38E-08
WNW1101C	DOWN - B(6)	7.58	464	0.7	0.003	1.18±1.64E-09	4.34±2.78E-09	0.00±1.00E-07	0.00±1.83E-08	0.00±1.94E-08
WNW8610	DOWN - B(1)	8.11	755	0.8	<0.002	-0.67±2.96E-09	3.62±3.43E-09	0.00±1.00E-07	0.00±3.22E-08	0.00±3.47E-08
WNW8610	DOWN - B(2)	8.03	788	0.9	<0.002	-0.67±2.28E-09	6.46±4.06E-09	0.00±1.00E-07	0.00±1.74E-08	0.00±2.17E-08
WNW8610	DOWN - B(3)	8.04	786	0.8	<0.002	0.00±2.76E-09	5.29±4.00E-09	0.00±1.00E-07	0.64±1.96E-08	0.00±2.22E-08
WNW8610	DOWN - B(4)	8.24	776	0.8	<0.002	-2.29±4.95E-09	9.24±3.57E-09	0.00±1.00E-07	0.00±2.56E-08	0.00±3.64E-08
WNW8610	DOWN - B(5)	9.20	776	1.0	<0.002	-0.73±4.74E-09	6.63±3.68E-09	1.22±0.76E-07	0.00±1.96E-08	1.27±2.22E-08
WNW8610	DOWN - B(6)	7.65	835	0.9	<0.002	0.00±2.74E-09	2.50±3.66E-09	2.90±7.56E-08	0.00±1.83E-08	0.00±1.94E-08
WNW8611	DOWN - B(1)	7.79	939	0.9	<0.002	0.00±3.16E-09	3.35±3.33E-09	0.00±1.00E-07	0.00±3.22E-08	0.00±3.47E-08
WNW8611	DOWN - B(2)	7.66	929	0.7	<0.002	3.07±3.69E-09	1.93±3.90E-09	0.00±1.00E-07	0.48±1.74E-08	0.00±2.17E-08
WNW8611	DOWN - B(3)	7.73	884	0.7	<0.002	3.43±4.76E-09	1.38±3.89E-09	0.00±1.00E-07	0.00±1.96E-08	0.00±2.22E-08
WNW8611	DOWN - B(4)	7.68	954	0.6	<0.002	-0.78±2.65E-09	4.03±3.81E-09	0.00±1.00E-07	0.00±2.56E-08	1.54±3.64E-08
WNW8611	DOWN - B(5)	7.83	935	0.8	<0.002	0.00±3.83E-09	5.26±4.34E-09	1.20±0.76E-07	0.00±1.96E-08	0.00±2.22E-08
WNW8611	DOWN - B(6)	7.63	1,012	0.9	<0.002	-4.62±6.41E-09	0.24±4.11E-09	0.00±1.00E-07	0.00±1.83E-08	0.00±1.94E-08
WNW1103C	DOWN - C(1)	NA	NA	NA	NA	0.00±3.45E-09	3.37±0.85E-08	0.00±1.00E-07	0.21±7.25E-08	0.00±9.04E-08
WNW1103C	DOWN - C(2)	NA	NA	NA	NA	-2.37±5.68E-09	1.04±0.12E-07	0.00±1.00E-07	0.00±1.06E-07	0.00±1.14E-07
WNW1103C	DOWN - C(3)	NA	NA	NA	NA	5.63±6.62E-09	3.50±1.02E-08	0.00±1.00E-07	0.00±5.90E-08	0.00±8.39E-08
WNW1103C	DOWN - C(4)	NA	NA	NA	NA	2.02±4.86E-09	3.08±0.90E-08	1.21±6.94E-08	0.00±1.96E-08	0.00±2.22E-08
WNW1103C	DOWN - C(5)	NA	NA	NA	NA	2.96±6.41E-09	2.10±0.74E-08	0.00±1.00E-07	0.00±5.67E-08	0.00±6.96E-08
WNW1103C	DOWN - C(6)	NA	NA	NA	NA	1.04±2.03E-09	1.97±0.55E-08	0.00±1.00E-07	0.00±3.13E-08	0.00±3.28E-08
WNW1104C	DOWN - C(1)	NA	NA	NA	NA	0.27±1.20E-08	1.13±0.58E-08	0.00±1.00E-07	0.00±1.74E-08	1.19±2.17E-08
WNW1104C	DOWN - C(2)	NA	NA	NA	NA	-3.94±5.46E-09	3.12±1.05E-08	0.00±1.00E-07	0.00±1.74E-08	0.00±2.17E-08
WNW1104C	DOWN - C(3)	7.13	2,320	NA	NA	-8.27±9.92E-09	1.18±1.21E-08	2.25±8.07E-08	0.00±1.96E-08	0.00±2.22E-08
WNW1104C	DOWN - C(4)	NA	NA	NA	NA	0.55±1.11E-08	1.00±1.18E-08	0.00±1.00E-07	1.15±1.96E-08	0.00±2.22E-08
WNW1104C	DOWN - C(5)	NA	NA	NA	NA	0.00±1.84E-08	1.55±1.01E-08	0.00±1.00E-07	1.00±2.05E-08	0.00±2.32E-08
WNW1104C	DOWN - C(6)	NA	NA	NA	NA	4.28±8.39E-09	0.75±1.30E-08	0.00±1.00E-07	1.27±3.13E-08	0.00±3.28E-08

NA - Not available.

Table E - 5
1993 Contamination Indicator Parameters for the Weathered Lavery Till Unit

Location Code	Hydraulic Position	pH	Conductivity *µmhos/cm@25 °C*	TOC *mg/L*	TOX *mg/L*	Gross Alpha *µCi/mL*	Gross Beta *µCi/mL*	H-3 *µCi/mL*	Cs-137 *µCi/mL*	Co-60 *µCi/mL*
WNW0908	UP(1)	6.67	2,815	1.0	<0.002	-0.30±1.55E-08	1.05±1.08E-08	0.00±1.00E-07	0.00±1.74E-08	0.00±2.17E-08
WNW0908	UP(2)	6.63	2,960	0.8	<0.002	0.66±1.59E-08	1.33±1.16E-08	0.00±1.00E-07	0.00±3.22E-08	0.00±3.47E-08
WNW0908	UP(3)	6.69	2,910	0.8	<0.002	1.81±1.45E-08	1.30±1.20E-08	0.00±1.00E-07	0.00±2.56E-08	0.00±3.64E-08
WNW0908	UP(4)	6.75	2,880	0.9	0.002	-0.16±2.02E-08	0.31±1.12E-08	0.00±1.00E-07	0.00±1.96E-08	0.00±2.22E-08
WNW0908	UP(5)	6.81	2,850	1.1	<0.002	1.25±1.50E-08	0.57±1.39E-08	2.06±0.76E-07	0.35±1.96E-08	0.00±2.22E-08
WNW0908	UP(6)	NA	NA	0.9	<0.002	-1.29±1.88E-08	1.30±1.30E-08	3.13±7.48E-08	0.00±1.83E-08	0.00±1.94E-08
WNW1005	UP(1)	7.04	821	0.9	<0.002	-0.89±4.61E-09	4.45±3.53E-09	0.00±1.00E-07	0.00±1.74E-08	1.26±2.17E-08
WNW1005	UP(2)	7.11	786	0.9	<0.002	3.44±4.77E-09	-0.44±3.84E-09	0.00±1.00E-07	0.00±1.74E-08	0.00±2.17E-08
WNW1005	UP(3)	7.06	763	0.9	<0.002	0.00±1.73E-09	1.22±3.87E-09	0.00±1.00E-07	1.01±2.56E-08	0.00±3.64E-08
WNW1005	UP(4)	7.02	784	0.9	<0.002	-4.65±5.47E-09	4.10±3.10E-09	0.00±1.00E-07	0.89±1.96E-08	0.00±2.22E-08
WNW1005	UP(5)	6.97	801	1.0	<0.002	-5.88±6.92E-09	0.90±4.30E-09	1.92±0.77E-07	0.00±1.94E-08	0.00±2.38E-08
WNW1005	UP(6)	7.10	845	1.0	<0.002	0.00±9.22E-09	-2.40±5.50E-09	0.00±1.00E-07	1.78±1.83E-08	0.98±1.94E-08
WNW1008C	UP(1)	7.43	514	0.7	0.006	-0.52±1.77E-09	1.18±2.58E-09	0.00±1.00E-07	0.00±3.22E-08	0.00±3.47E-08
WNW1008C	UP(2)	7.72	537	0.7	0.004	1.19±2.33E-09	1.66±2.56E-09	3.93±7.63E-08	1.28±3.22E-08	0.00±3.47E-08
WNW1008C	UP(3)	7.72	508	0.7	0.007	-1.08±2.12E-09	1.51±2.74E-09	0.00±1.00E-07	0.00±1.96E-08	1.07±2.22E-08
WNW1008C	UP(4)	7.46	508	0.8	0.006	-2.53±3.93E-09	3.32±2.51E-09	0.00±1.00E-07	0.00±2.56E-08	0.00±3.64E-08
WNW1008C	UP(5)	7.87	536	0.8	0.010	-0.75±3.28E-09	0.18±3.00E-09	2.25±0.77E-07	0.00±1.94E-08	0.00±2.38E-08
WNW1008C	UP(6)	7.46	567	0.8	<0.002	-4.40±4.56E-09	-1.62±3.72E-09	1.14±0.79E-07	1.15±1.83E-08	0.00±1.94E-08
WNW0906	DOWN - B(1)	7.27	756	4.4	0.006	4.91±4.81E-09	2.43±2.93E-09	0.00±1.00E-07	0.00±3.22E-08	0.00±3.47E-08
WNW0906	DOWN - B(2)	7.14	NA	4.4	0.007	1.90±2.77E-09	4.50±3.57E-09	0.00±1.00E-07	0.00±3.22E-08	0.00±3.47E-08
WNW0906	DOWN - B(3)	7.27	574	4.2	0.007	1.14±3.17E-09	4.12±3.36E-09	1.89±7.74E-08	0.00±2.56E-08	0.00±3.64E-08
WNW0906	DOWN - B(4)	7.18	711	3.0	0.008	-0.65±3.82E-09	4.03±2.74E-09	0.00±1.00E-07	0.00±1.96E-08	0.00±2.22E-08
WNW0906	DOWN - B(5)	8.29	764	2.0	0.003	6.44±4.99E-09	1.10±2.99E-09	2.70±0.78E-07	0.58±1.96E-08	0.00±2.22E-08
WNW0906	DOWN - B(6)	7.36	543	4.9	0.010	0.00±4.10E-09	2.90±2.61E-09	1.06±0.79E-07	1.02±1.83E-08	0.00±1.94E-08
WNW0907	DOWN - B(1)	7.11	806	0.7	<0.002	4.04±5.25E-09	3.03±3.68E-09	6.79±7.64E-08	0.26±3.22E-08	0.00±3.47E-08
WNW0907	DOWN - B(2)	7.52	810	0.8	<0.002	1.68±4.65E-09	4.11±3.99E-09	7.02±7.97E-08	0.51±3.22E-08	1.54±3.47E-08
WNW0907	DOWN - B(3)	7.01	770	0.7	<0.002	-0.78±3.41E-09	3.83±4.04E-09	8.04±7.52E-08	0.00±2.56E-08	0.00±3.64E-08
WNW0907	DOWN - B(4)	7.00	784	0.7	<0.002	2.34±4.04E-09	5.48±3.60E-09	0.00±1.00E-07	0.00±1.96E-08	0.00±2.22E-08
WNW0907	DOWN - B(5)	8.52	777	0.8	<0.002	3.86±4.63E-09	0.90±3.64E-09	3.18±0.79E-07	0.00±1.96E-08	0.00±2.22E-08
WNW0907	DOWN - B(6)	7.13	777	0.8	<0.002	-1.18±6.12E-09	6.25±4.36E-09	5.84±7.92E-08	0.00±1.83E-08	0.00±1.94E-08
WNW1006	DOWN - B(1)	6.75	2,130	0.5	<0.002	0.22±1.28E-08	6.47±8.31E-09	0.00±1.00E-07	0.00±1.74E-08	0.00±2.17E-08
WNW1006	DOWN - B(2)	6.85	2,130	0.6	<0.002	2.17±9.51E-09	1.84±7.66E-09	0.00±1.00E-07	1.59±1.74E-08	0.00±2.17E-08
WNW1006	DOWN - B(3)	6.77	2,230	0.5	<0.002	-0.39±1.06E-08	1.85±1.01E-08	0.00±1.00E-07	0.00±2.56E-08	2.40±3.64E-08
WNW1006	DOWN - B(4)	6.75	2,290	0.6	<0.002	0.68±1.17E-08	4.97±7.91E-09	0.00±1.00E-07	0.25±2.56E-08	1.74±3.64E-08
WNW1006	DOWN - B(5)	6.92	2,195	0.8	<0.002	-0.22±1.58E-08	0.44±1.08E-08	8.98±7.67E-08	0.00±1.94E-08	0.00±2.38E-08
WNW1006	DOWN - B(6)	6.69	2,340	0.6	<0.002	1.32±1.59E-08	0.00±1.04E-08	0.00±1.00E-07	0.00±1.83E-08	0.00±1.94E-08
WNW1007	DOWN - B(1)	7.28	1,473	0.9	0.004	0.00±7.46E-09	2.62±0.75E-08	0.00±1.00E-07	2.30±3.22E-08	0.00±3.47E-08
WNW1007	DOWN - B(2)	7.24	1,432	0.9	<0.002	7.66±6.13E-09	2.23±0.82E-08	0.00±1.00E-07	0.00±3.22E-08	0.00±3.47E-08
WNW1007	DOWN - B(3)	7.02	1,206	0.8	<0.002	0.00±6.45E-09	1.88±0.79E-08	0.00±1.00E-07	0.00±1.96E-08	0.00±2.22E-08
WNW1007	DOWN - B(4)	7.05	1,186	0.9	0.006	0.59±7.79E-09	1.07±0.56E-08	0.00±1.00E-07	0.00±1.96E-08	0.00±2.22E-08
WNW1007	DOWN - B(5)	7.00	988	1.0	0.012	-1.05±7.40E-09	7.54±6.57E-09	1.96±0.76E-07	0.19±1.94E-08	0.00±2.38E-08
WNW1007	DOWN - B(6)	7.15	1,004	1.1	<0.002	7.61±7.90E-09	1.09±0.60E-08	9.22±7.86E-08	0.13±1.83E-08	0.00±1.94E-08
WNW1101A	DOWN - B(1)	7.40	637	0.6	<0.002	1.78±2.61E-09	1.25±2.60E-09	1.45±0.77E-07	0.00±3.22E-08	0.00±3.47E-08
WNW1101A	DOWN - B(2)	7.18	607	0.5	<0.002	2.40±2.89E-09	4.35±3.22E-09	0.00±1.00E-07	0.00±3.22E-08	0.00±3.47E-08
WNW1101A	DOWN - B(3)	7.19	602	0.5	<0.002	3.12±2.73E-09	1.47±3.36E-09	1.19±0.76E-07	0.00±1.96E-08	0.00±2.22E-08
WNW1101A	DOWN - B(4)	7.30	597	0.6	<0.002	2.74±3.79E-09	2.05±2.76E-09	1.63±0.77E-07	0.00±1.96E-08	0.00±2.22E-08
WNW1101A	DOWN - B(5)	7.49	609	0.7	<0.002	0.00±4.92E-09	3.47±3.21E-09	9.29±7.50E-08	0.00±1.94E-08	0.00±2.38E-08
WNW1101A	DOWN - B(6)	7.28	610	0.7	<0.002	1.74±2.42E-09	1.40±3.60E-09	9.65±7.77E-08	0.00±3.13E-08	0.00±3.28E-08

NR - Not reported. These results have not been reported because the data validation process indicated the data were not reliable.
NA - Not available.

Table E - 5 (continued)
1993 Contamination Indicator Parameters for the Weathered Lavery Till Unit

Location Code	Hydraulic Position	pH	Conductivity *μmhos/cm@25 °C*	TOC *mg/L*	TOX *mg/L*	Gross Alpha *μCi/mL*	Gross Beta *μCi/mL*	H-3 *μCi/mL*	Cs-137 *μCi/mL*	Co-60 *μCi/mL*
WNW1106A	DOWN - B(1)	7.32	783	0.9	<0.002	-0.90±4.68E-09	5.18±4.30E-09	8.52±0.86E-07	0.00±1.74E-08	0.00±2.17E-08
WNW1106A	DOWN - B(2)	7.86	728	0.9	<0.002	5.81±4.88E-09	1.50±3.07E-09	1.02±0.09E-06	0.07±1.74E-08	0.00±2.17E-08
WNW1106A	DOWN - B(3)	7.43	719	0.8	<0.002	2.44±2.76E-09	5.45±4.40E-09	1.24±0.10E-06	0.00±2.56E-08	0.00±3.64E-08
WNW1106A	DOWN - B(4)	7.23	738	0.8	0.002	4.97±5.85E-09	5.21±3.89E-09	1.06±0.10E-06	0.00±2.56E-08	0.00±3.64E-08
WNW1106A	DOWN - B(5)	7.30	765	0.9	<0.002	4.74±4.92E-09	3.82±3.82E-09	9.72±0.95E-07	0.00±1.94E-08	0.00±2.38E-08
WNW1106A	DOWN - B(6)	7.43	755	0.9	<0.002	8.48±5.54E-09	5.40±4.43E-09	1.12±0.09E-06	0.00±3.13E-08	0.00±3.28E-08
WNW1108A	DOWN - B(1)	7.04	1,537	1.2	<0.002	7.57±8.90E-09	9.05±5.44E-09	0.00±1.00E-07	0.90±1.74E-08	0.00±2.17E-08
WNW1108A	DOWN - B(2)	8.50	1,468	1.0	<0.002	2.72±5.33E-09	4.01±5.71E-09	4.15±7.55E-08	0.07±1.74E-08	0.00±2.17E-08
WNW1108A	DOWN - B(3)	7.09	1,447	0.8	<0.002	3.02±4.18E-09	1.68±9.25E-09	1.59±0.78E-07	0.00±2.56E-08	0.00±3.64E-08
WNW1108A	DOWN - B(4)	6.99	1,455	0.9	<0.002	6.46±8.95E-09	7.88±7.28E-09	0.00±1.00E-07	0.00±2.56E-08	0.00±3.64E-08
WNW1108A	DOWN - B(5)	7.16	1,383	0.8	<0.002	8.52±7.88E-09	4.88±6.66E-09	0.00±1.00E-07	0.00±1.94E-08	0.00±2.38E-08
WNW1108A	DOWN - B(6)	7.21	1,359	1.2	<0.002	1.09±0.87E-08	2.00±6.11E-09	2.69±7.71E-08	0.00±1.83E-08	0.00±1.94E-08
WNW1109A	DOWN - B(1)	6.96	884	0.8	<0.002	-1.67±4.00E-09	4.90±4.23E-09	9.78±0.89E-07	0.00±1.74E-08	0.00±2.17E-08
WNW1109A	DOWN - B(2)	7.18	823	0.7	<0.002	2.38±4.11E-09	3.15±4.60E-09	4.66±0.84E-07	1.02±3.22E-08	0.00±3.47E-08
WNW1109A	DOWN - B(3)	7.23	799	0.6	<0.002	1.62±3.89E-09	4.33±4.86E-09	5.30±0.80E-07	0.00±1.96E-08	0.00±2.22E-08
WNW1109A	DOWN - B(4)	7.00	808	0.6	<0.002	6.10±6.30E-09	8.74±4.32E-09	5.45±0.86E-07	0.00±1.96E-08	0.00±2.22E-08
WNW1109A	DOWN - B(5)	7.08	841	0.7	<0.002	4.71±6.66E-09	4.26±3.59E-09	4.69±0.86E-07	0.00±1.94E-08	0.00±2.38E-08
WNW1109A	DOWN - B(6)	7.25	745	0.8	<0.002	5.51±4.41E-09	4.60±4.31E-09	4.31±0.83E-07	0.48±3.13E-08	0.00±3.28E-08
WNW0909	DOWN - C(1)	6.73	1,060	4.7	0.017	-4.01±3.93E-09	7.66±0.90E-08	1.60±0.11E-06	0.00±1.74E-08	0.94±2.17E-08
WNW0909	DOWN - C(2)	6.77	1,029	4.5	0.016	2.22±4.35E-09	6.40±0.84E-08	1.22±0.10E-06	0.14±1.74E-08	0.00±2.17E-08
WNW0909	DOWN - C(3)	6.64	1,217	3.6	0.009	7.22±7.96E-09	6.51±0.94E-08	7.63±0.88E-07	0.00±2.28E-08	0.64±3.02E-08
WNW0909	DOWN - C(4)	6.51	1,240	7.5	0.023	0.00±1.08E-08	1.87±0.15E-07	1.42±0.11E-06	0.00±1.96E-08	0.00±2.22E-08
WNW0909	DOWN - C(5)	7.46	1,393	7.3	0.008	2.04±6.92E-09	1.32±0.15E-07	1.97±0.11E-06	0.19±1.96E-08	0.00±2.22E-08
WNW0909	DOWN - C(6)	6.53	1,438	6.9	0.005	0.00±8.35E-09	1.88±0.20E-07	1.86±0.12E-06	0.83±1.83E-08	0.00±1.94E-08
WNW1102A	DOWN - C(1)	7.12	806	0.7	<0.002	-0.83±4.29E-09	5.56±4.29E-09	2.99±0.79E-07	0.00±1.74E-08	1.43±2.17E-08
WNW1102A	DOWN - C(2)	7.34	756	0.6	0.007	2.97±3.56E-09	3.67±3.62E-09	2.33±0.80E-07	0.00±3.22E-08	0.00±3.47E-08
WNW1102A	DOWN - C(3)	7.35	756	0.6	<0.002	4.44±3.71E-09	4.48±4.31E-09	3.26±0.78E-07	0.00±1.96E-08	0.00±2.22E-08
WNW1102A	DOWN - C(4)	7.34	737	0.6	<0.002	4.96±5.82E-09	7.29±4.14E-09	3.94±0.81E-07	0.00±1.96E-08	0.00±2.22E-08
WNW1102A	DOWN - C(5)	7.22	759	0.8	<0.002	4.65±4.82E-09	2.66±3.63E-09	1.92±0.83E-07	1.40±1.94E-08	0.00±2.38E-08
WNW1102A	DOWN - C(6)	7.26	752	0.7	<0.002	6.89±5.10E-09	5.69±4.05E-09	4.03±0.82E-07	0.00±3.13E-08	0.00±3.28E-08
WNW1103A	DOWN - C(1)	6.99	1,018	0.9	<0.002	4.10±6.96E-09	5.28±5.46E-09	4.63±0.80E-07	0.00±1.74E-08	0.00±2.17E-08
WNW1103A	DOWN - C(2)	7.21	951	0.9	<0.002	2.68±3.92E-09	3.01±5.45E-09	4.60±0.83E-07	1.72±3.22E-08	0.00±3.47E-08
WNW1103A	DOWN - C(3)	6.98	956	1.0	<0.002	3.06±7.22E-09	3.55±5.41E-09	5.51±0.82E-07	1.28±1.96E-08	0.00±2.22E-08
WNW1103A	DOWN - C(4)	7.11	915	0.9	<0.002	-1.21±4.10E-09	1.40±4.21E-09	4.31±0.88E-07	0.77±1.96E-08	0.00±2.22E-08
WNW1103A	DOWN - C(5)	7.04	902	1.0	<0.002	1.97±7.53E-09	-0.66±4.86E-09	4.37±0.86E-07	0.00±1.94E-08	0.00±2.38E-08
WNW1103A	DOWN - C(6)	7.09	888	0.9	<0.002	9.50±7.36E-09	-0.65±5.15E-09	5.30±0.84E-07	0.00±3.13E-08	0.00±3.28E-08
WNW1104A	DOWN - C(1)	7.41	647	1.3	<0.002	0.64±3.79E-09	3.19±3.30E-09	1.74±0.77E-07	0.00±3.22E-08	0.00±3.47E-08
WNW1104A	DOWN - C(2)	7.50	662	1.0	<0.002	1.26±3.01E-09	-0.61±3.21E-09	3.86±7.56E-08	0.00±2.56E-08	2.12±3.64E-08
WNW1104A	DOWN - C(3)	7.40	630	1.1	0.002	1.40±3.88E-09	1.94±3.08E-09	2.83±0.80E-07	0.00±2.56E-08	0.00±3.64E-08
WNW1104A	DOWN - C(4)	7.48	611	0.9	<0.002	4.09±4.81E-09	2.36±2.56E-09	3.16±0.79E-07	0.00±2.56E-08	0.00±3.64E-08
WNW1104A	DOWN - C(5)	7.36	617	1.0	0.003	2.54±5.49E-09	3.98±2.98E-09	8.55±8.27E-08	0.00±1.96E-08	0.00±2.22E-08
WNW1104A	DOWN - C(6)	7.47	663	0.9	<0.002	0.77±1.50E-09	7.08±4.18E-09	8.08±7.79E-08	0.00±3.13E-08	0.00±3.28E-08
WNW1107A	DOWN - C(1)	6.63	1,314	14.8	0.098	3.47±8.34E-09	1.36±0.60E-08	2.43±0.08E-05	0.00±1.74E-08	0.00±2.17E-08
WNW1107A	DOWN - C(2)	6.70	1,570	15.3	0.096	1.85±7.32E-09	1.87±1.12E-08	2.30±0.07E-05	0.96±1.74E-08	0.00±2.17E-08
WNW1107A	DOWN - C(3)	6.50	1,759	14.9	0.033	1.10±0.88E-08	3.15±1.00E-08	2.20±0.07E-05	0.58±1.96E-08	0.99±2.22E-08
WNW1107A	DOWN - C(4)	6.61	1,255	15.2	0.051	0.48±1.14E-08	2.42±0.87E-08	2.10±0.07E-05	0.00±2.56E-08	0.00±3.64E-08
WNW1107A	DOWN - C(5)	6.63	1,577	17.7	0.060	1.69±9.64E-09	1.99±0.86E-08	2.10±0.07E-05	0.00±1.94E-08	0.00±2.38E-08
WNW1107A	DOWN - C(6)	6.61	1,432	18.9	0.060	4.40±6.09E-09	1.22±0.87E-08	2.03±0.06E-05	0.00±1.83E-08	0.00±1.94E-08

NR - Not reported. These results have not been reported because the data validation process indicated the data were not reliable.
NA - Not available.

Table E - 5 (concluded)
1993 Contamination Indicator Parameters for the Weathered Lavery Till Unit

Location Code	Hydraulic Position	pH	Conductivity *μmhos/cm@25 °C*	TOC *mg/L*	TOX *mg/L*	Gross Alpha *μCi/mL*	Gross Beta *μCi/mL*	H-3 *μCi/mL*	Cs-137 *μCi/mL*	Co-60 *μCi/mL*
WNW1110A	DOWN - C(1)	7.04	1,379	1.1	<0.002	5.87±9.96E-09	9.39±7.01E-09	0.00±1.00E-07	0.83±1.74E-08	0.00±2.17E-08
WNW1110A	DOWN - C(2)	7.13	1,386	1.0	<0.002	1.06±0.74E-08	7.32±7.78E-09	2.39±7.72E-08	0.00±1.74E-08	0.00±2.17E-08
WNW1110A	DOWN - C(3)	6.95	1,376	1.0	<0.002	1.04±1.07E-08	7.52±8.00E-09	8.88±7.81E-08	0.00±1.96E-08	0.00±2.22E-08
WNW1110A	DOWN - C(4)	6.97	1,328	1.0	<0.002	2.45±5.88E-09	8.73±6.38E-09	0.00±1.00E-07	1.14±2.56E-08	0.00±3.64E-08
WNW1110A	DOWN - C(5)	7.04	1,314	1.3	<0.002	9.24±8.20E-09	5.18±6.82E-09	0.00±1.00E-07	0.00±1.94E-08	0.00±2.38E-08
WNW1110A	DOWN - C(6)	6.87	1,502	1.3	<0.002	1.47±1.09E-08	5.69±7.67E-09	1.30±7.43E-08	0.00±1.83E-08	0.00±1.94E-08
WNW1111A	DOWN - C(1)	6.92	1,121	0.8	<0.002	2.25±6.98E-09	6.25±5.62E-09	1.86±7.73E-08	0.00±3.22E-08	1.26±3.47E-08
WNW1111A	DOWN - C(2)	6.93	1,035	0.8	0.002	2.13±5.90E-09	2.32±4.70E-09	1.32±7.72E-08	2.00±1.02E-08	0.00±2.17E-08
WNW1111A	DOWN - C(3)	7.07	978	0.8	<0.002	5.65±4.95E-09	6.94±6.36E-09	1.70±0.76E-07	0.00±2.56E-08	0.00±3.64E-08
WNW1111A	DOWN - C(4)	6.87	983	0.8	<0.002	-1.18±4.00E-09	5.63±4.81E-09	4.05±8.52E-08	0.70±1.96E-08	0.00±2.22E-08
WNW1111A	DOWN - C(5)	6.89	1,000	1.0	<0.002	0.00±9.53E-09	7.72±4.76E-09	1.36±0.82E-07	0.00±1.94E-08	0.00±2.38E-08
WNW1111A	DOWN - C(6)	6.96	1,038	0.9	<0.002	0.00±4.58E-09	4.23±7.32E-09	1.27±0.79E-07	0.00±1.83E-08	0.00±1.94E-08

NR - Not reported. These results have not been reported because the data validation process indicated the data were not reliable.
NA - Not available.

Table E-6
Groundwater Quality Parameters (mg/L) for the Sand and Gravel Unit

Location Code	Hydraulic Position	Chloride	Sulfate	Nitrate + Nitrite-N	Ammonia	Bicarbonate Alkalinity*	Carbonate Alkalinity*	Phenols	Phosphate	Silica	Sulfide
WNW0301	UP(2)	107	368	2.3	<0.05	222	<1.0	0.006	NA	NA	NA
WNW0301	UP(6)	81.0	NA	2.7	<0.05	226	<1.0	NA	0.23	9.4	< 1.0
WNW0401	UP(2)	286	24.6	5.6	<0.05	179	<1.0	0.006	NA	NA	NA
WNW0401	UP(6)	451	21.7	7.6	<0.05	139	<1.0	NA	0.14	6.6	< 1.0
WNW0403	UP(2)	193	35.2	8.7	<0.05	133	<1.0	<0.005	NA	NA	NA
WNW0403	UP(6)	147	19.5	12	<0.05	110	<1.0	NA	0.095	5.0	< 1.0
WNW0706	UP(2)	6.4	103	0.42	<0.05	206	<1.0	<0.005	NA	NA	NA
WNW0706	UP(6)	1.2	81.9	0.65	<0.05	133	<1.0	NA	0.25	3.3	< 1.0
WNWNB1S	UP(2)	48.8	16.1	13	<0.05	238	<1.0	0.005	NA	NA	NA
WNWNB1S	UP(6)	53.4	25.8	6.7	<0.05	105	<1.0	NA	<0.050	6.8	< 1.0
WNW0201	DOWN - B(2)	206	37.7	1.0	<0.05	181	<1.0	0.009	NA	NA	NA
WNW0201	DOWN - B(6)	360	30.2	1.3	<0.05	162	<1.0	NA	<0.050	4.5	< 1.0
WNW0305	DOWN - B(2)	204	32.4	0.21	0.10	233	<1.0	0.006	NA	NA	NA
WNW0305	DOWN - B(6)	233	18.6	0.26	0.32	207	<1.0	NA	0.017	8.3	1.4
WNW0307	DOWN - B(2)	125	34.8	0.32	0.10	182	<1.0	0.006	NA	NA	NA
WNW0307	DOWN - B(6)	NR	NA	0.44	0.14	157	<1.0	NA	0.12	6.9	1.1
WNW0603	DOWN - B(2)	2.7	120	0.66	<0.05	420	<1.0	<0.005	NA	NA	NA
WNW0603	DOWN - B(6)	7.8	164	1.3	<0.05	342	<1.0	NA	0.13	9.8	1.3
WNW8613A	DOWN - B(2)	126	320	1.6	<0.05	193	<1.0	<0.005	NA	NA	NA
WNW8613A	DOWN - B(6)	79.5	21.3	2.1	<0.05	182	<1.0	NA	0.58	7.7	< 1.0
WNW8613B	DOWN - B(2)	100	188	2.4	<0.05	100	<1.0	<0.005	NA	NA	NA
WNW8613B	DOWN - B(6)	91.0	44.8	3.2	<0.05	72.5	<1.0	NA	1.2	3.3	< 1.0
WNW8613C	DOWN - B(2)	14.5	219	0.90	<0.05	156	<1.0	<0.005	NA	NA	NA
WNW8613C	DOWN - B(6)	5.5	32.6	2.9	<0.05	144	<1.0	NA	0.66	6.0	< 1.0
WNSP008	DOWN - C(2)	140	60.0	0.21	<0.05	270	<1.0	<0.005	NA	NA	NA
WNSP008	DOWN - C(6)	94.2	45.8	0.24	<0.05	265	<1.0	NA	0.050	5.6	1.2
WNW0103	DOWN - C(2)	2,120	52.8	< 0.05	0.54	174	<1.0	0.008	NA	NA	NA
WNW0103	DOWN - C(6)	< 173	27.1	< 0.05	1.34	196	283	NA	1.3	< 130	1.4
WNW0104	DOWN - C(2)	167	33.7	1.8	<0.03	210	<1.0	<0.001	NA	NA	NA
WNW0104	DOWN - C(6)	179	35.5	1.9	2.01	327	<1.0	NA	<0.050	12	< 1.0
WNW0111	DOWN - C(2)	13.0	67.4	< 0.05	0.30	231	<1.0	<0.001	NA	NA	NA
WNW0111	DOWN - C(6)	19.6	50.3	0.88	0.27	34.4	<1.0	NA	< 0.10	7.8	< 1.0
WNW0203	DOWN - C(2)	784	146	1.5	<0.05	208	<1.0	<0.005	NA	NA	NA
WNW0203	DOWN - C(6)	600	54.8	1.7	<0.05	250	<1.0	NA	<0.050	4.0	< 1.0
WNW0205	DOWN - C(2)	581	186	1.2	<0.05	156	<1.0	<0.005	NA	NA	NA
WNW0205	DOWN - C(6)	1,160	70.0	0.66	<0.05	192	<1.0	NA	<0.050	2.5	< 1.0
WNW0406	DOWN - C(2)	22.3	130	0.92	0.10	212	<1.0	0.006	NA	NA	NA
WNW0406	DOWN - C(6)	25.0	73.2	0.60	0.18	215	<1.0	NA	<0.050	9.6	< 1.0
WNW0408	DOWN - C(2)	219	31.0	0.75	<0.03	174	<1.0	<0.001	NA	NA	NA
WNW0408	DOWN - C(6)	282	34.8	1.4	0.12	338	<1.0	NA	<0.050	13	< 1.0
WNW0501	DOWN - C(2)	151	27.4	0.70	<0.03	161	<1.0	<0.001	NA	NA	NA
WNW0501	DOWN - C(6)	161	36.3	5.6	2.27	302	<1.0	NA	<0.050	12	< 1.0
WNW0502	DOWN - C(2)	129	33.4	4.5	<0.03	190	<1.0	<0.001	NA	NA	NA
WNW0502	DOWN - C(6)	174	35.2	6.2	1.04	301	<1.0	NA	<0.050	12	< 1.0
WNW0602	DOWN - C(2)	59.8	211	< 0.05	0.09	206	<1.0	0.006	NA	NA	NA
WNW0602	DOWN - C(6)	106	42.8	< 0.05	0.08	113	<1.0	NA	<0.050	5.8	< 1.0

NR - Not reported. These results have not been reported because the data validation process indicated the data were not reliable.
NA - Not available.
** as mgCaCo3/L*

Table E-6 (continued)
Groundwater Quality Parameters (mg/L) for the Sand and Gravel Unit

Location Code	Hydraulic Position	Calcium Total	Calcium Diss.	Magnesium Total	Magnesium Diss.	Sodium Total	Sodium Diss.	Potassium Total	Potassium Diss.	Iron Total	Iron Diss.	Manganese Total	Manganese Diss.	Aluminum Total	Aluminum Diss.
WNW0301	UP(2)	110	115	12.6	10.5	22.1	24.6	3.32	1.51	22.0	0.976	0.604	0.024	NA	NA
WNW0301	UP(6)	102	110	11.4	9.87	22.9	24.3	3.76	1.37	16.7	<0.040	0.411	0.065	9.43	<0.090
WNW0401	UP(2)	128	132	13.9	13.6	106	101	1.36	1.35	0.664	0.119	0.033	0.026	NA	NA
WNW0401	UP(6)	175	181	19.1	19.9	155	160	1.87	1.90	0.752	0.129	0.027	0.020	0.240	<0.200
WNW0403	UP(2)	125	137	10.5	9.84	39.1	39.5	1.85	1.23	5.76	0.130	0.092	0.013	NA	NA
WNW0403	UP(6)	125	125	8.83	8.89	28.8	27.8	1.44	1.54	1.31	0.042	0.086	0.008	0.790	<0.200
WNW0706	UP(2)	89.1	88.2	18.1	11.5	2.99	4.96	4.50	0.948	47.3	1.01	0.968	0.017	NA	NA
WNW0706	UP(6)	69.3	76.3	10.7	10.8	3.65	2.13	1.79	<1.00	4.28	<0.040	0.230	<0.005	9.60	<0.200
WNWNB1S	UP(2)	94.4	104	10.9	11.5	28.1	26.3	1.11	1.12	0.350	<0.015	0.006	<0.003	NA	NA
WNWNB1S	UP(6)	37.9	44.4	4.68	5.37	55.6	45.1	1.16	1.23	0.630	<0.040	0.012	<0.005	0.358	0.099
WNW0201	DOWN - B(2)	102	103	10.1	10.1	84.0	83.5	4.16	4.23	0.330	<0.015	0.339	0.335	NA	NA
WNW0201	DOWN - B(6)	131	145	13.1	14.8	136	146	4.58	5.04	0.046	<0.040	0.383	0.445	<0.090	<0.090
WNW0305	DOWN - B(2)	88.8	98.8	9.88	10.8	94.4	104	2.37	2.57	1.05	<0.015	1.19	1.28	NA	NA
WNW0305	DOWN - B(6)	115	127	12.5	13.3	111	117	3.25	3.25	0.616	<0.040	2.36	2.58	0.359	<0.090
WNW0307	DOWN - B(2)	69.4	71.4	7.78	7.84	76.2	78.2	1.94	1.90	2.35	0.450	0.424	0.238	NA	NA
WNW0307	DOWN - B(6)	90.8	86.6	9.93	9.10	67.4	74.3	2.30	2.31	8.79	0.311	1.66	0.413	1.22	<0.090
WNW0603	DOWN - B(2)	138	149	23.0	24.3	6.11	6.84	2.11	1.46	3.67	0.048	0.419	0.194	NA	NA
WNW0603	DOWN - B(6)	153	151	21.8	21.5	8.10	6.69	2.20	1.95	2.62	<0.040	0.533	0.381	1.46	<0.200
WNW8613A	DOWN - B(2)	86.5	90.8	16.6	15.7	16.9	18.6	3.34	2.08	11.8	0.259	0.765	0.014	NA	NA
WNW8613A	DOWN - B(6)	90.2	93.8	15.6	15.1	20.6	19.8	3.30	2.69	4.06	<0.040	0.431	0.015	4.45	<0.090
WNW8613B	DOWN - B(2)	58.4	70.6	10.6	10.7	30.9	37.5	3.50	2.76	15.6	0.238	0.766	0.075	NA	NA
WNW8613B	DOWN - B(6)	62.7	70.4	9.69	10.1	23.0	24.3	3.50	3.10	121	3.26	0.775	0.265	5.96	<0.090
WNW8613C	DOWN - B(2)	60.6	61.8	13.1	10.6	3.17	3.99	4.02	3.73	13.6	0.058	0.451	0.065	NA	NA
WNW8613C	DOWN - B(6)	91.3	58.9	22.9	9.57	14.3	15.4	5.71	3.36	58.2	0.553	1.82	0.029	20.7	0.627
WNSP008	DOWN - C(2)	115	NR	14.4	NR	72.2	NR	1.33	1.89	0.042	0.164	2.24	10.6	NA	NA
WNSP008	DOWN - C(6)	104	109	13.3	13.7	61.0	61.2	1.59	1.82	0.117	<0.040	0.827	0.832	<0.090	<0.090
WNW0103	DOWN - C(2)	232	237	10.4	10.7	855	874	3.30	3.59	0.147	0.033	0.294	0.290	NA	NA
WNW0103	DOWN - C(6)	NR	40.1	<1.00	1.28	NR	713	<1.00	1.13	0.918	1.25	0.114	0.431	0.378	0.468
WNW0104	DOWN - C(2)	101	96.2	15.6	14.8	52.6	52.7	2.32	1.65	1.33	0.006	0.097	0.079	NA	NA
WNW0104	DOWN - C(6)	111	114	16.0	15.7	60.3	65.7	2.20	2.15	0.292	0.018	0.081	0.088	0.237	0.042
WNW0111	DOWN - C(2)	76.7	73.2	11.1	10.8	19.6	19.1	5.42	5.52	0.359	0.555	4.94	3.91	NA	NA
WNW0111	DOWN - C(6)	64.1	62.8	8.99	8.89	10.1	10.1	4.73	4.39	0.529	0.212	2.56	2.48	0.049	0.040
WNW0203	DOWN - C(2)	150	150	14.0	13.7	397	395	4.38	4.26	2.00	0.283	0.132	0.118	NA	NA
WNW0203	DOWN - C(6)	173	183	15.6	16.3	319	336	5.27	5.26	2.40	0.279	0.078	0.038	0.762	<0.090
WNW0205	DOWN - C(2)	32.2	33.1	4.23	4.17	426	418	3.04	2.83	1.49	0.267	0.028	0.010	NA	NA
WNW0205	DOWN - C(6)	114	118	14.9	15.2	743	814	5.71	5.74	0.633	0.243	0.031	0.032	<0.090	<0.090
WNW0406	DOWN - C(2)	97.4	102	13.1	11.8	10.5	10.9	2.79	2.00	8.58	0.176	2.70	1.30	NA	NA
WNW0406	DOWN - C(6)	93.4	98.3	13.0	13.2	14.2	15.3	3.05	2.45	2.35	0.202	3.63	3.71	2.27	0.278
WNW0408	DOWN - C(2)	94.7	92.8	18.9	18.8	67.2	66.6	2.84	2.84	1.88	0.037	0.098	0.086	NA	NA
WNW0408	DOWN - C(6)	152	153	23.6	23.3	87.8	88.1	3.31	3.29	0.616	0.047	0.199	0.055	0.406	0.032
WNW0501	DOWN - C(2)	91.0	91.3	14.3	13.1	43.3	44.2	3.68	1.43	5.82	0.009	0.131	0.008	NA	NA
WNW0501	DOWN - C(6)	104	111	14.6	15.1	48.1	52.6	2.28	2.11	2.27	0.089	0.082	0.023	1.68	0.031
WNW0502	DOWN - C(2)	89.8	88.3	13.3	13.2	41.7	41.2	1.71	1.41	5.63	0.040	0.062	0.004	NA	NA
WNW0502	DOWN - C(6)	119	111	17.1	15.6	51.6	47.5	2.35	1.95	2.41	0.038	0.033	0.004	0.372	0.043
WNW0602	DOWN - C(2)	95.6	96.8	12.7	12.4	16.1	15.9	1.98	1.46	3.76	0.100	4.57	3.58	NA	NA
WNW0602	DOWN - C(6)	104	114	12.7	13.2	54.5	56.1	2.12	2.04	4.37	0.189	5.15	4.54	2.48	0.252

NR - Not reported. These results have not been reported because the data validation process indicated the data were not reliable.
NA - Not available.

Table E-6 (continued)
Groundwater Quality Parameters (mg/L) for the Sand and Gravel Unit

Location Code	Hydraulic Position	Chloride	Sulfate	Nitrate + Nitrite-N	Ammonia	Bicarbonate Alkalinity*	Carbonate Alkalinity*	Phenols	Phosphate	Silica	Sulfide
WNW0604	DOWN - C(2)	7.6	144	< 0.05	1.03	186	<1.0	<0.005	NA	NA	NA
WNW0604	DOWN - C(6)	16.5	65.4	<0.05	1.24	168	<1.0	NA	<0.050	5.6	< 1.0
WNW8605	DOWN - C(2)	76.4	91.4	< 0.05	1.30	353	<1.0	<0.001	NA	NA	NA
WNW8605	DOWN - C(6)	24.3	46.7	< 0.05	0.10	381	<1.0	NA	<0.050	9.7	< 1.0
WNW8606	DOWN - C(2)	536	240	1.3	<0.05	157	<1.0	0.010	NA	NA	NA
WNW8606	DOWN - C(6)	1,070	65.7	0.81	<0.05	185	<1.0	NA	<0.050	2.5	< 1.0
WNW8607	DOWN - C(2)	7.9	99.7	1.3	<0.05	212	<1.0	<0.005	NA	NA	NA
WNW8607	DOWN - C(6)	24.0	168	0.98	<0.05	199	<1.0	NA	0.073	4.5	< 1.0
WNW8608	DOWN - C(2)	30.3	73.6	0.76	0.86	188	<1.0	0.007	NA	NA	NA
WNW8608	DOWN - C(6)	18.4	71.6	0.32	0.76	186	<1.0	NA	0.056	5.6	< 1.0
WNW8609	DOWN - C(2)	41.5	39.6	4.4	<0.05	267	<1.0	0.005	NA	NA	NA
WNW8609	DOWN - C(6)	45.6	32.9	3.6	<0.05	250	<1.0	NA	<0.050	12	< 1.0
WNDMPNE	DOWN - D(2)	79.8	61.6	1.2	0.09	184	<1.0	<0.005	NA	NA	NA
WNDMPNE	DOWN - D(6)	73.5	37.4	0.90	<0.05	186	<1.0	NA	0.061	6.6	< 1.0
WNGSEEP	DOWN - D(2)	77.6	87.2	0.89	<0.05	144	<1.0	<0.005	NA	NA	NA
WNGSEEP	DOWN - D(6)	60.1	52.0	0.79	<0.05	148	<1.0	NA	<0.050	5.0	< 1.0
WNW0105	DOWN - D(2)	173	38.4	1.1	<0.05	230	<1.0	<0.005	NA	NA	NA
WNW0105	DOWN - D(6)	170	32.6	1.3	<0.05	220	<1.0	NA	0.11	8.1	< 1.0
WNW0106	DOWN - D(2)	151	48.0	0.18	<0.05	269	<1.0	<0.005	NA	NA	NA
WNW0106	DOWN - D(6)	135	32.7	0.22	<0.05	246	<1.0	NA	0.24	6.7	1.5
WNW0116	DOWN - D(2)	155	90.0	1.6	<0.05	245	<1.0	0.007	NA	NA	NA
WNW0116	DOWN - D(6)	18.6	27.3	1.9	<0.05	200	<1.0	NA	0.10	8.2	1.2
WNW0207	DOWN - D(2)	2.7	33.6	< 0.05	0.16	493	<1.0	<0.005	NA	NA	NA
WNW0207	DOWN - D(6)	5.1	30.8	< 0.05	0.24	400	<1.0	NA	0.050	14	< 1.0
WNW0601	DOWN - D(2)	51.4	353	0.11	<0.05	100	<1.0	<0.005	NA	NA	NA
WNW0601	DOWN - D(6)	41.9	129	0.15	<0.05	104	<1.0	NA	0.39	3.0	< 1.0
WNW0605	DOWN - D(2)	51.7	120	0.51	<0.05	148	<1.0	<0.005	NA	NA	NA
WNW0605	DOWN - D(6)	39.8	52.5	0.08	<0.05	125	<1.0	NA	<0.050	4.5	< 1.0
WNW0801	DOWN - D(2)	257	40.0	1.4	<0.05	186	<1.0	<0.005	NA	NA	NA
WNW0801	DOWN - D(6)	213	28.1	1.2	<0.05	182	<1.0	NA	<0.050	7.8	< 1.0
WNW0802	DOWN - D(2)	13.6	39.8	< 0.05	<0.05	140	<1.0	<0.005	NA	NA	NA
WNW0802	DOWN - D(6)	39.1	22.8	0.07	<0.05	85.1	<1.0	NA	<0.050	10	< 1.0
WNW0803	DOWN - D(2)	68.8	292	< 0.05	<0.05	414	<1.0	<0.005	NA	NA	NA
WNW0803	DOWN - D(6)	117	129	0.33	<0.05	299	<1.0	NA	<0.050	12	< 1.0
WNW0804	DOWN - D(2)	65.6	305	0.15	0.09	334	<1.0	<0.005	NA	NA	NA
WNW0804	DOWN - D(6)	41.4	22.2	0.16	<0.05	240	<1.0	NA	0.084	5.6	< 1.0
WNW0905	DOWN - D(2)	<1.0	530	< 0.05	0.09	395	<1.0	<0.005	NA	NA	NA
WNW0905	DOWN - D(6)	9.1	519	< 0.05	0.07	432	<1.0	NA	<0.050	15	< 1.0
WNW8603	DOWN - D(2)	207	29.6	2.1	<0.05	220	<1.0	<0.005	NA	NA	NA
WNW8603	DOWN - D(6)	196	26.4	2.4	<0.05	210	<1.0	NA	<0.050	11	< 1.0
WNW8604	DOWN - D(2)	201	33.3	7.6	<0.03	245	<1.0	<0.001	NA	NA	NA
WNW8604	DOWN - D(6)	234	34.8	1.5	1.44	372	<1.0	NA	<0.050	13	< 1.0
WNW8612	DOWN - D(2)	79.3	86.0	< 0.05	<0.05	179	<1.0	<0.005	NA	NA	NA
WNW8612	DOWN - D(6)	81.8	60.8	< 0.05	<0.05	234	<1.0	NA	<0.050	12	< 1.0

NR - Not reported. These results have not been reported because the data validation process indicated the data were not reliable.
NA - Not available.
** as mgCaCo₃/L*

Table E-6 (concluded)
Groundwater Quality Parameters (mg/L) for the Sand and Gravel Unit

Location Code	Hydraulic Position	Calcium Total	Calcium Diss.	Magnesium Total	Magnesium Diss.	Sodium Total	Sodium Diss.	Potassium Total	Potassium Diss.	Iron Total	Iron Diss.	Manganese Total	Manganese Diss.	Aluminum Total	Aluminum Diss.
WNW0604	DOWN - C(2)	64.2	70.6	10.6	11.4	6.46	7.16	0.905	0.910	5.17	4.54	17.0	18.0	NA	NA
WNW0604	DOWN - C(6)	68.8	76.3	10.7	11.5	7.37	6.56	1.03	1.05	4.09	4.85	18.6	20.1	<0.090	<0.090
WNW8605	DOWN - C(2)	99.5	98.1	16.2	16.4	69.4	68.2	8.51	8.68	4.34	4.23	9.64	9.67	NA	NA
WNW8605	DOWN - C(6)	74.6	77.6	12.0	12.6	48.4	50.0	7.34	7.98	3.49	3.00	8.36	8.76	0.043	0.046
WNW8606	DOWN - C(2)	33.5	33.9	4.28	4.27	385	400	2.63	2.69	0.330	0.255	0.018	0.006	NA	NA
WNW8606	DOWN - C(6)	98.9	105	13.5	14.1	687	708	5.22	5.84	0.216	0.174	0.026	0.022	<0.200	<0.200
WNW8607	DOWN - C(2)	101	104	12.6	12.3	9.50	9.30	3.52	3.59	0.083	<0.015	0.006	0.006	NA	NA
WNW8607	DOWN - C(6)	115	117	14.5	14.9	14.5	18.3	2.33	2.33	0.111	<0.040	0.005	<0.005	0.200	<0.200
WNW8608	DOWN - C(2)	80.0	NR	9.84	NR	10.1	NR	1.97	NR	1.17	NR	10.6	NR	NA	NA
WNW8608	DOWN - C(6)	77.6	79.8	9.26	9.61	14.4	13.8	3.12	3.14	1.02	0.430	8.08	8.82	0.405	<0.200
WNW8609	DOWN - C(2)	109	108	14.8	14.0	13.7	12.5	1.38	1.31	0.020	<0.015	0.009	0.010	NA	NA
WNW8609	DOWN - C(6)	103	119	14.2	15.4	14.7	14.9	1.44	1.64	0.042	<0.040	0.008	0.008	0.090	<0.090
WNDMPNE	DOWN - D(2)	86.4	87.1	10.8	10.8	26.7	26.8	1.47	1.59	0.330	0.280	0.730	0.757	NA	NA
WNDMPNE	DOWN - D(6)	82.6	88.1	11.3	11.8	29.2	29.8	1.92	1.98	0.354	0.111	0.426	0.425	0.254	<0.090
WNGSEEP	DOWN - D(2)	92.5	99.2	12.8	13.2	20.0	20.6	1.51	1.61	0.070	<0.020	<0.005	<0.005	NA	NA
WNGSEEP	DOWN - D(6)	78.7	84.2	11.8	12.4	24.0	24.6	1.61	1.81	0.172	<0.040	0.006	<0.005	0.124	<0.090
WNW0105	DOWN - D(2)	125	127	20.0	20.0	45.5	45.5	1.51	1.24	10.4	0.020	3.48	3.38	NA	NA
WNW0105	DOWN - D(6)	127	130	20.5	21.7	52.4	54.1	1.34	1.40	18.5	<0.040	3.53	3.67	0.200	<0.090
WNW0106	DOWN - D(2)	130	138	20.0	19.0	43.7	47.4	2.33	1.49	8.74	<0.015	5.74	5.54	NA	NA
WNW0106	DOWN - D(6)	131	126	21.4	20.1	48.4	51.3	3.11	2.84	14.2	1.96	6.73	6.42	7.10	3.58
WNW0116	DOWN - D(2)	111	118	15.3	15.0	58.8	61.4	2.44	1.66	7.16	0.254	1.56	0.921	NA	NA
WNW0116	DOWN - D(6)	119	126	16.6	16.9	71.9	73.0	2.14	1.88	4.77	0.184	1.71	1.22	1.68	0.236
WNW0207	DOWN - D(2)	152	157	27.0	27.2	7.12	7.57	1.51	1.24	4.05	0.642	2.17	2.16	NA	NA
WNW0207	DOWN - D(6)	134	146	22.3	23.5	7.66	6.65	1.35	1.39	1.85	1.70	2.04	2.29	<0.200	<0.200
WNW0601	DOWN - D(2)	51.2	57.6	10.1	8.30	16.6	18.5	2.63	0.699	28.0	0.957	0.431	0.113	NA	NA
WNW0601	DOWN - D(6)	57.9	61.9	9.02	8.33	23.9	24.7	2.56	1.15	23.5	1.27	0.508	0.065	10.4	0.614
WNW0605	DOWN - D(2)	64.9	70.6	11.1	10.5	21.8	23.4	2.22	1.43	6.67	0.193	0.099	0.010	NA	NA
WNW0605	DOWN - D(6)	57.7	62.2	8.47	9.00	23.5	24.2	1.78	1.71	2.16	0.045	0.051	0.009	0.867	<0.200
WNW0801	DOWN - D(2)	121	115	13.2	13.1	63.4	63.3	1.73	1.69	0.780	<0.020	0.713	0.643	NA	NA
WNW0801	DOWN - D(6)	126	132	16.1	16.8	75.6	78.5	2.13	2.22	0.554	<0.040	0.804	0.831	0.378	<0.090
WNW0802	DOWN - D(2)	45.1	51.1	3.58	3.75	5.95	7.67	1.53	0.710	1.72	<0.020	0.165	0.108	NA	NA
WNW0802	DOWN - D(6)	39.1	49.6	3.63	4.39	10.3	12.1	<1.00	<1.00	0.945	0.171	0.326	0.179	0.728	0.220
WNW0803	DOWN - D(2)	206	204	36.5	35.8	23.2	22.9	1.45	1.47	0.470	0.030	0.370	0.342	NA	NA
WNW0803	DOWN - D(6)	170	185	33.8	36.0	25.4	25.9	1.83	1.58	0.850	<0.040	0.401	0.425	0.853	<0.090
WNW0804	DOWN - D(2)	147	152	18.3	17.0	23.0	25.2	3.61	2.18	14.2	<0.020	1.70	1.26	NA	NA
WNW0804	DOWN - D(6)	100	107	12.2	13.0	30.3	31.7	1.88	1.69	1.41	<0.040	0.072	0.005	0.919	<0.090
WNW0905	DOWN - D(2)	207	210	75.7	74.4	13.1	12.7	3.79	3.73	1.75	1.71	0.518	0.509	NA	NA
WNW0905	DOWN - D(6)	221	262	78.7	86.9	12.6	13.0	3.79	4.25	2.21	2.44	0.569	0.671	0.250	<0.090
WNW8603	DOWN - D(2)	128	133	21.2	21.6	49.3	49.9	2.08	2.08	<0.015	<0.015	0.007	0.008	NA	NA
WNW8603	DOWN - D(6)	130	133	23.1	23.4	59.6	59.0	2.23	2.51	<0.040	<0.040	0.010	0.012	<0.090	<0.090
WNW8604	DOWN - D(2)	114	116	18.5	19.1	51.6	52.2	2.28	2.03	0.027	0.005	0.022	0.024	NA	NA
WNW8604	DOWN - D(6)	135	134	23.0	22.4	57.7	57.9	2.48	2.70	0.029	0.023	0.042	0.038	0.034	0.042
WNW8612	DOWN - D(2)	124	123	25.8	24.8	14.9	14.4	1.08	1.04	0.850	0.430	0.108	0.111	NA	NA
WNW8612	DOWN - D(6)	114	127	25.8	28.1	16.0	16.4	1.16	1.29	0.782	0.570	0.115	0.123	0.090	<0.090

NR - Not reported. These results have not been reported because the data validation process indicated the data were not reliable.
NA - Not available.

Table E - 7
Groundwater Quality Parameters (mg/L) for the Till-Sand Unit

Location Code	Hydraulic Position	Chloride	Sulfate	Nitrate + Nitrite-N	Ammonia	Bicarbonate Alkalinity*	Carbonate Alkalinity*	Phenols	Phosphate	Silica	Sulfide
WNW0302	UP(2)	328	37.0	0.88	<0.05	268	<1.0	0.005	NA	NA	NA
WNW0302	UP(6)	NR	NA	1.0	<0.05	245	<1.0	NA	<0.010	13	< 1.0
WNW0402	UP(2)	242	30.0	< 0.05	<0.05	233	<1.0	<0.005	NA	NA	NA
WNW0402	UP(6)	262	31.5	< 0.05	<0.05	211	<1.0	NA	0.12	12	< 1.0
WNW0404	UP(2)	<1.0	29.3	0.06	<0.05	112	<1.0	0.006	NA	NA	NA
WNW0404	UP(6)	1.5	19.3	0.07	<0.05	105	<1.0	NA	0.067	8.5	< 1.0
WNW0701	UP(2)	<1.0	266	< 0.05	0.18	190	<1.0	<0.005	NA	NA	NA
WNW0701	UP(6)	1.1	481	0.09	0.14	194	<1.0	NA	0.095	10	< 1.0
WNW0202	DOWN - B(2)	12.4	50.4	< 0.05	0.49	<1.0	23.8	<0.005	NA	NA	NA
WNW0202	DOWN - B(6)	35.5	30.4	< 0.05	0.52	<1.0	134	NA	<0.050	8.6	< 1.0
WNW0204	DOWN - B(2)	85.9	44.0	< 0.05	0.14	165	<1.0	<0.005	NA	NA	NA
WNW0204	DOWN - B(6)	91.6	41.1	< 0.05	0.14	138	<1.0	NA	<0.050	10	< 1.0
WNW0206	DOWN - C(2)	76.0	187	< 0.05	0.07	199	<1.0	<0.005	NA	NA	NA
WNW0206	DOWN - C(6)	80.9	33.1	< 0.05	0.07	158	<1.0	NA	0.70	11	< 1.0
WNW0208	DOWN - C(2)	<1.0	56.0	< 0.05	0.16	145	<1.0	<0.005	NA	NA	NA
WNW0208	DOWN - C(6)	1.0	23.1	< 0.05	0.15	132	<1.0	NA	0.084	9.6	1.2

NR - Not reported. These results have not been reported because the data validation process indicated that the data were unreliable.
NA - Not available.
** as mg$CaCO_3$/L*

Table E - 7 (concluded)
Groundwater Quality Parameters (mg/L) for the Till-Sand Unit

Location Code	Hydraulic Position	Calcium Total	Calcium Diss.	Magnesium Total	Magnesium Diss.	Sodium Total	Sodium Diss.	Potassium Total	Potassium Diss.	Iron Total	Iron Diss.	Manganese Total	Manganese Diss.	Aluminum Total	Aluminum Diss.
WNW0302	UP(2)	167	175	21.3	22.0	99.9	102	1.95	2.01	0.130	<0.015	0.035	0.032	NA	NA
WNW0302	UP(6)	202	216	25.2	26.5	121	125	1.96	2.04	0.253	<0.040	0.034	0.031	0.127	<0.090
WNW0402	UP(2)	153	166	27.4	27.9	30.7	31.7	1.70	1.69	1.17	1.16	0.137	0.140	NA	NA
WNW0402	UP(6)	166	161	30.0	29.6	40.8	39.8	1.92	1.76	2.98	1.07	0.162	0.140	1.16	<0.090
WNW0404	UP(2)	35.5	36.1	5.40	5.08	8.62	8.34	0.887	0.668	0.703	<0.015	0.018	0.003	NA	NA
WNW0404	UP(6)	35.1	34.3	5.36	5.38	9.33	8.11	<1.00	0.846	0.313	0.249	0.007	0.006	0.520	0.210
WNW0701	UP(2)	149	153	27.0	26.1	14.8	15.1	1.73	1.26	4.15	0.086	0.360	0.299	NA	NA
WNW0701	UP(6)	203	206	35.6	35.8	18.8	18.0	1.80	1.54	2.99	0.459	0.465	0.403	2.78	<0.200
WNW0202	DOWN - B(2)	42.2	52.6	1.30	1.02	22.3	24.0	9.09	10.3	0.220	<0.015	0.004	<0.003	NA	NA
WNW0202	DOWN - B(6)	214	35.8	<1.00	<1.00	24.7	23.7	16.7	9.17	0.115	<0.040	0.006	<0.005	0.284	<0.090
WNW0204	DOWN - B(2)	78.3	76.8	17.4	17.0	11.9	12.0	2.00	1.93	1.19	0.094	0.099	0.082	NA	NA
WNW0204	DOWN - B(6)	82.9	87.2	17.5	18.7	13.6	12.7	1.91	1.96	0.463	0.125	0.095	0.096	0.210	<0.200
WNW0206	DOWN - C(2)	78.0	81.6	18.3	17.9	11.4	11.9	2.12	1.06	6.15	0.320	0.238	0.172	NA	NA
WNW0206	DOWN - C(6)	95.0	95.2	21.5	20.6	14.0	12.8	2.37	1.15	10.2	0.735	0.335	0.224	6.03	<0.200
WNW0208	DOWN - C(2)	36.5	37.9	8.97	9.12	15.2	15.3	0.944	0.938	0.280	<0.015	0.034	0.029	NA	NA
WNW0208	DOWN - C(6)	39.4	41.3	9.28	9.87	17.0	16.5	1.15	<1.00	1.06	<0.040	0.062	0.051	1.10	<0.200

NR - Not reported. These results have not been reported because the data validation process indicated that the data were unreliable.
NA - Not available.

Table E-8
Groundwater Quality Parameters (mg/L) for the Unweathered Lavery Till Unit

Location Code	Hydraulic Position	Chloride	Sulfate	Nitrate + Nitrite-N	Ammonia	Bicarbonate Alkalinity*	Carbonate Alkalinity*	Phenols	Phosphate	Silica	Sulfide
WNW0405	UP(2)	36.6	220	1.1	<0.05	202	<1.0	<0.005	NA	NA	NA
WNW0405	UP(6)	70.9	122	0.35	<0.05	231	<1.0	NA	<0.050	6.8	< 1.0
WNW0109	DOWN - B(2)	<1.0	112	0.08	<0.05	226	<1.0	<0.005	NA	NA	NA
WNW0109	DOWN - B(6)	2.0	79.3	0.14	<0.05	211	<1.0	NA	0.067	7.8	1.5
WNW0110	DOWN - B(2)	<1.0	101	< 0.05	<0.05	245	<1.0	<0.005	NA	NA	NA
WNW0110	DOWN - B(6)	<1.0	84.1	0.08	<0.05	244	<1.0	NA	<0.050	7.8	1.5
WNW0115	DOWN - B(2)	3.4	130	< 0.05	<0.05	109	<1.0	<0.005	NA	NA	NA
WNW0115	DOWN - B(6)	2.7	79.5	< 0.05	0.07	148	<1.0	NA	0.32	6.4	1.2
WNW0702	DOWN - B(2)	<1.0	306	0.27	<0.05	220	<1.0	<0.005	NA	NA	NA
WNW0702	DOWN - B(6)	1.1	305	0.12	<0.05	218	<1.0	NA	0.24	8.6	< 1.0
WNW0703	DOWN - B(2)	<1.0	314	< 0.05	<0.05	190	<1.0	<0.005	NA	NA	NA
WNW0703	DOWN - B(6)	1.2	211	< 0.05	<0.05	180	<1.0	NA	<0.050	8.5	< 1.0
WNW0704	DOWN - B(2)	2.0	143	< 0.05	0.10	521	<1.0	<0.005	NA	NA	NA
WNW0704	DOWN - B(6)	1.3	87.8	< 0.05	0.34	424	<1.0	NA	<0.050	4.6	< 1.0
WNW0705	DOWN - B(2)	4.3	43.0	< 0.05	<0.05	195	<1.0	<0.005	NA	NA	NA
WNW0705	DOWN - B(6)	22.2	36.9	< 0.05	<0.05	215	<1.0	NA	0.089	8.3	< 1.0
WNW0707	DOWN - B(2)	8.0	46.8	0.52	<0.05	159	<1.0	<0.005	NA	NA	NA
WNW0707	DOWN - B(6)	7.6	40.7	0.45	<0.05	126	<1.0	NA	0.51	4.3	< 1.0
WNW0904	DOWN - B(2)	4.5	219	0.18	0.07	244	<1.0	<0.005	NA	NA	NA
WNW0904	DOWN - B(6)	6.9	146	0.19	<0.05	232	<1.0	NA	0.46	8.3	< 1.0
WNW1101B	DOWN - B(2)	1.1	424	0.50	<0.05	290	<1.0	<0.005	NA	NA	NA
WNW1101B	DOWN - B(6)	1.0	88.0	0.51	<0.05	253	<1.0	NA	<0.050	9.5	< 1.0
WNW1106B	DOWN - B(2)	<1.0	342	0.07	<0.05	262	<1.0	<0.005	NA	NA	NA
WNW1106B	DOWN - B(6)	1.2	156	< 0.05	<0.05	293	<1.0	NA	0.19	11	< 1.0
WNW1109B	DOWN - B(2)	<1.0	61.0	< 0.05	0.08	192	<1.0	0.007	NA	NA	NA
WNW1109B	DOWN - B(6)	1.3	66.5	< 0.05	0.08	186	<1.0	NA	<0.050	12	< 1.0
WNW0107	DOWN - C(2)	3.4	176	0.1	<0.05	276	<1.0	<0.005	NA	NA	NA
WNW0107	DOWN - C(6)	3.5	211	0.11	<0.05	272	<1.0	NA	0.067	7.9	1.5
WNW0108	DOWN - C(2)	3.8	220	0.37	0.06	215	<1.0	<0.005	NA	NA	NA
WNW0108	DOWN - C(6)	1.2	162	0.50	<0.05	202	<1.0	NA	0.045	8.1	1.4
WNW0114	DOWN - C(2)	8.6	89.0	0.18	<0.05	225	<1.0	<0.005	NA	NA	NA
WNW0114	DOWN - C(6)	11.9	44.2	1.2	<0.05	249	<1.0	NA	0.11	12	2.1
WNW0409	DOWN - C(2)	<1.0	66.8	0.21	<0.05	146	<1.0	0.005	NA	NA	NA
WNW0409	DOWN - C(6)	1.0	48.7	0.14	<0.05	121	<1.0	NA	0.45	8.3	1.1
WNW0910	DOWN - C(2)	8.3	856	0.12	0.69	335	<1.0	<0.005	NA	NA	NA
WNW0910	DOWN - C(6)	1.6	909	< 0.05	0.30	337	<1.0	NA	0.074	11	< 1.0
WNW1102B	DOWN - C(2)	1.0	61.0	0.13	<0.05	293	<1.0	<0.005	NA	NA	NA
WNW1102B	DOWN - C(6)	1.2	45.8	0.12	<0.05	282	<1.0	NA	<0.050	12	< 1.0
WNW1103B	DOWN - C(2)	1.6	135	0.09	0.10	320	<1.0	<0.005	NA	NA	NA
WNW1103B	DOWN - C(6)	<1.0	87.6	0.09	<0.05	299	<1.0	NA	<0.050	12	< 1.0
WNW1104B	DOWN - C(2)	2.8	324	0.55	<0.05	274	<1.0	0.005	NA	NA	NA
WNW1104B	DOWN - C(6)	1.1	93.1	< 0.05	0.05	228	<1.0	NA	<0.050	9.7	< 1.0
WNW1105A	DOWN - C(2)	<1.0	209	0.71	<0.05	204	<1.0	0.026	NA	NA	NA
WNW1105A	DOWN - C(6)	<1.0	247	0.23	0.27	193	<1.0	NA	<0.050	8.2	1.2
WNW1105B	DOWN - C(2)	<1.0	262	1.3	<0.05	219	<1.0	0.008	NA	NA	NA
WNW1105B	DOWN - C(6)	<1.0	317	0.49	0.08	201	<1.0	NA	0.064	8.8	1.2

NR - Not reported. These results have not been reported because the data validation process indicated the data were not reliable.
NA - Not available.
* *as mgCaCo3/L*

Table E-8 (concluded)
Groundwater Quality Parameters (mg/L) for the Unweathered Lavery Till Unit

Location Code	Hydraulic Position	Calcium Total	Calcium Diss.	Magnesium Total	Magnesium Diss.	Sodium Total	Sodium Diss.	Potassium Total	Potassium Diss.	Iron Total	Iron Diss.	Manganese Total	Manganese Diss.	Aluminum Total	Aluminum Diss.
WNW0405	UP(2)	98.6	103	16.0	15.7	23.8	22.8	1.94	1.86	0.670	0.058	0.034	0.024	NA	NA
WNW0405	UP(6)	116	124	21.8	20.6	41.7	41.4	2.52	2.44	NR	1.15	0.074	NR	0.118	<0.090
WNW0109	DOWN - B(2)	73.8	83.6	19.4	17.7	16.7	18.3	1.67	1.53	1.99	<0.015	0.038	0.003	NA	NA
WNW0109	DOWN - B(6)	75.5	77.9	19.1	19.5	20.0	18.9	2.23	1.49	2.89	<0.040	0.046	0.031	2.57	<0.090
WNW0110	DOWN - B(2)	74.1	78.9	23.2	22.5	22.2	23.2	1.69	1.78	0.041	<0.015	0.004	0.003	NA	NA
WNW0110	DOWN - B(6)	75.1	69.4	22.2	20.6	24.0	25.0	1.74	1.72	<0.040	<0.040	<0.005	<0.005	<0.090	<0.090
WNW0115	DOWN - B(2)	87.4	83.6	15.3	12.1	15.4	16.5	3.74	1.72	13.6	0.655	0.187	0.013	NA	NA
WNW0115	DOWN - B(6)	68.5	64.2	17.0	13.5	16.4	17.8	5.68	2.84	24.7	1.99	0.289	0.103	15.1	3.66
WNW0702	DOWN - B(2)	133	143	29.9	30.6	39.8	41.3	2.31	2.42	0.255	0.015	0.010	0.005	NA	NA
WNW0702	DOWN - B(6)	124	135	28.4	30.7	43.6	45.4	2.14	2.18	0.505	<0.040	0.011	<0.005	0.418	<0.200
WNW0703	DOWN - B(2)	135	145	26.1	25.5	21.1	21.6	2.25	1.85	3.34	<0.015	0.050	<0.003	NA	NA
WNW0703	DOWN - B(6)	117	126	24.1	25.6	20.2	20.1	1.80	1.76	1.01	<0.040	0.097	0.067	0.730	<0.200
WNW0704	DOWN - B(2)	194	205	27.0	26.5	6.34	6.14	2.51	2.56	0.505	0.194	6.92	7.41	NA	NA
WNW0704	DOWN - B(6)	185	208	26.2	27.6	5.91	6.56	2.59	2.74	0.310	0.147	9.85	9.47	0.182	<0.090
WNW0705	DOWN - B(2)	65.0	75.7	9.38	9.52	3.24	3.53	1.31	0.890	3.04	<0.015	0.056	0.013	NA	NA
WNW0705	DOWN - B(6)	85.2	85.2	13.6	14.4	8.42	7.21	1.31	1.19	1.11	<0.040	0.315	0.377	0.891	<0.200
WNW0707	DOWN - B(2)	58.5	61.2	11.3	9.54	4.65	4.25	2.35	1.06	9.85	<0.015	0.212	0.050	NA	NA
WNW0707	DOWN - B(6)	50.0	54.1	8.87	8.42	6.55	5.41	2.29	1.31	8.19	0.041	0.124	0.010	5.92	<0.200
WNW0904	DOWN - B(2)	95.5	92.6	31.6	30.3	19.4	19.5	3.14	1.71	3.03	0.053	0.115	0.047	NA	NA
WNW0904	DOWN - B(6)	102	111	30.2	32.6	23.4	31.0	1.96	2.35	5.32	0.348	0.278	0.008	4.89	0.419
WNW1101B	DOWN - B(2)	114	128	36.5	40.1	30.2	32.2	3.29	3.70	0.093	<0.017	0.008	<0.005	NA	NA
WNW1101B	DOWN - B(6)	99.0	111	30.4	33.0	27.6	28.6	2.84	3.27	0.042	<0.040	0.008	0.016	<0.090	<0.090
WNW1106B	DOWN - B(2)	82.4	90.3	31.5	34.9	22.3	24.9	2.20	2.20	1.07	<0.030	0.031	0.003	NA	NA
WNW1106B	DOWN - B(6)	96.1	99.0	38.4	40.1	27.7	28.2	2.64	2.30	2.93	<0.040	0.052	0.038	2.45	<0.090
WNW1109B	DOWN - B(2)	59.7	59.8	18.8	18.3	12.1	12.0	1.56	1.50	0.450	<0.030	0.055	0.049	NA	NA
WNW1109B	DOWN - B(6)	55.7	58.5	17.8	19.3	11.9	11.3	1.47	1.44	0.771	<0.040	0.048	0.041	0.580	<0.090
WNW0107	DOWN - C(2)	132	135	25.3	27.7	18.1	17.9	2.31	2.34	0.025	<0.015	<0.003	<0.003	NA	NA
WNW0107	DOWN - C(6)	133	132	32.2	33.0	21.0	21.1	2.27	2.36	0.336	<0.040	0.023	0.006	0.265	<0.090
WNW0108	DOWN - C(2)	99.7	102	26.2	26.5	23.3	23.9	2.13	1.97	0.803	<0.015	0.076	0.049	NA	NA
WNW0108	DOWN - C(6)	92.0	102	23.8	25.7	22.4	23.1	1.90	1.92	0.424	<0.040	0.010	<0.005	0.338	<0.090
WNW0114	DOWN - C(2)	88.3	93.1	13.0	13.0	8.97	9.56	1.49	1.33	0.879	<0.015	0.015	<0.003	NA	NA
WNW0114	DOWN - C(6)	97.8	104	12.5	14.8	5.88	6.58	1.32	1.37	1.30	<0.040	0.028	0.005	0.317	<0.090
WNW0409	DOWN - C(2)	40.4	46.0	8.50	8.94	18.4	20.3	4.74	5.43	1.38	<0.015	0.020	<0.003	NA	NA
WNW0409	DOWN - C(6)	40.7	40.9	9.90	9.59	21.2	20.0	5.38	4.67	1.05	<0.040	0.016	<0.005	0.981	<0.090
WNW0910	DOWN - C(2)	172	182	93.0	97.5	35.8	38.1	12.4	12.4	4.01	0.254	0.393	0.453	NA	NA
WNW0910	DOWN - C(6)	205	250	94.6	110	43.7	47.2	10.3	10.5	0.279	0.125	0.340	0.237	<0.200	<0.090
WNW1102B	DOWN - C(2)	83.3	80.6	37.2	33.9	17.2	15.3	2.22	1.98	0.353	<0.017	0.015	0.009	NA	NA
WNW1102B	DOWN - C(6)	74.4	79.4	30.6	32.8	14.7	15.0	1.84	1.82	0.482	<0.040	0.009	<0.005	0.239	<0.090
WNW1103B	DOWN - C(2)	87.0	89.6	42.2	41.0	28.3	26.4	2.36	2.32	0.070	<0.017	0.016	0.013	NA	NA
WNW1103B	DOWN - C(6)	81.2	89.4	35.2	38.0	24.9	26.3	1.96	1.89	0.056	<0.040	<0.005	0.005	<0.090	<0.090
WNW1104B	DOWN - C(2)	73.2	25.7	24.0	8.40	25.2	9.01	1.78	0.602	0.057	<0.030	0.004	0.002	NA	NA
WNW1104B	DOWN - C(6)	68.6	79.1	23.6	26.1	25.6	26.3	1.50	1.70	<0.040	<0.040	0.012	0.028	<0.090	<0.090
WNW1105A	DOWN - C(2)	114	119	25.8	26.2	23.1	23.2	1.76	1.79	0.190	<0.030	0.020	0.002	NA	NA
WNW1105A	DOWN - C(6)	126	130	27.7	28.7	23.8	25.6	1.90	2.00	NR	<0.040	0.020	NR	<0.090	<0.090
WNW1105B	DOWN - C(2)	123	136	29.5	32.0	32.2	34.7	2.22	2.40	0.303	<0.030	0.010	0.003	NA	NA
WNW1105B	DOWN - C(6)	133	139	31.5	32.7	36.2	36.8	2.12	2.41	NR	<0.040	0.010	NR	<0.090	<0.090

NR - Not reported. These results have not been reported because the data validation process indicated the data were not reliable.
NA - Not available.

Table E - 9
Groundwater Quality Parameters (mg/L) for the Kent Recessional Sequence

Location Code	Hydraulic Position	Chloride	Sulfate	Nitrate + Nitrite-N	Ammonia	Bicarbonate Alkalinity*	Carbonate Alkalinity*	Phenols	Phosphate	Silica	Sulfide
WNW0901	UP(2)	13.6	4.7	< 0.05	0.75	204	<1.0	0.007	NA	NA	NA
WNW0901	UP(6)	10.2	2.1	< 0.05	0.53	172	<1.0	NA	0.056	9.7	< 1.0
WNW0902	UP(2)	20.0	2.8	< 0.05	0.55	202	<1.0	0.026	NA	NA	NA
WNW0902	UP(6)	22.2	2.2	< 0.05	0.51	193	<1.0	NA	<0.050	11	< 1.0
WNW1001	UP(2)	35.2	30.2	< 0.05	0.61	169	<1.0	<0.005	NA	NA	NA
WNW1001	UP(6)	29.9	3.5	< 0.05	0.54	171	<1.0	NA	0.072	9.7	< 1.0
WNW1008B	UP(2)	43.1	<1.0	< 0.05	0.39	189	<1.0	<0.005	NA	NA	NA
WNW1008B	UP(6)	32.4	2.2	< 0.05	0.36	161	<1.0	NA	<0.050	10	< 1.0
WNW0903	DOWN - B(2)	2.6	265	< 0.05	0.44	290	<1.0	0.011	NA	NA	NA
WNW0903	DOWN - B(6)	1.6	138	< 0.05	0.38	280	<1.0	NA	0.089	11	< 1.0
WNW1002	DOWN - B(2)	3.9	1200	< 0.05	0.78	478	<1.0	<0.005	NA	NA	NA
WNW1002	DOWN - B(6)	1.2	255	< 0.05	0.78	455	<1.0	NA	0.36	17	< 1.0
WNW1003	DOWN - B(2)	10.2	1700	< 0.05	0.72	266	<1.0	<0.005	NA	NA	NA
WNW1003	DOWN - B(6)	11.5	4.0	< 0.05	0.54	212	<1.0	NA	0.19	9.7	< 1.0
WNW1004	DOWN - B(2)	3.6	51.0	< 0.05	0.44	273	<1.0	0.007	NA	NA	NA
WNW1004	DOWN - B(6)	1.0	14.7	< 0.05	0.42	232	<1.0	NA	<0.050	13	< 1.0
WNW1101C	DOWN - B(2)	3.9	160	0.06	<0.05	189	<1.0	<0.005	NA	NA	NA
WNW1101C	DOWN - B(6)	1.2	34.2	< 0.05	0.05	198	<1.0	NA	0.29	7.7	< 1.0
WNW8610	DOWN - B(2)	<1.0	180	< 0.05	0.26	302	<1.0	0.005	NA	NA	NA
WNW8610	DOWN - B(6)	<1.0	151	< 0.05	0.21	259	<1.0	NA	0.43	11	< 1.0
WNW8611	DOWN - B(2)	5.0	409	0.11	<0.05	275	<1.0	<0.005	NA	NA	NA
WNW8611	DOWN - B(6)	1.2	246	0.15	<0.05	253	<1.0	NA	0.33	13	< 1.0

NR - Not reported. These results have not been reported because the data validation process indicated the data were not reliable.
NA - Not available.
** as mg*$CaCO_3$*/L*

Table E - 9 (concluded)
1993 Groundwater Quality Parameters (mg/L) for the Kent Recessional Sequence

Location Code	Hydraulic Position	Calcium Total	Calcium Diss.	Magnesium Total	Magnesium Diss.	Sodium Total	Sodium Diss.	Potassium Total	Potassium Diss.	Iron Total	Iron Diss.	Manganese Total	Manganese Diss.	Aluminum Total	Aluminum Diss.
WNW0901	UP(2)	30.6	31.9	9.17	8.88	29.5	28.7	4.16	3.96	0.631	0.094	0.093	0.089	NA	NA
WNW0901	UP(6)	35.4	36.5	9.62	9.94	32.8	32.8	4.18	4.21	1.02	0.070	0.118	0.100	0.458	<0.090
WNW0902	UP(2)	45.1	57.6	15.0	18.5	30.3	28.2	2.54	2.74	0.668	0.348	0.094	0.052	NA	NA
WNW0902	UP(6)	41.1	44.0	13.0	13.9	31.6	32.9	3.23	3.40	0.516	0.356	0.081	0.082	<0.090	<0.090
WNW1001	UP(2)	30.5	28.3	8.87	7.84	42.2	42.9	4.08	3.04	3.90	0.260	0.105	0.055	NA	NA
WNW1001	UP(6)	32.1	34.1	8.40	8.77	46.8	49.0	2.80	2.73	0.588	0.398	0.072	0.056	0.123	<0.090
WNW1008B	UP(2)	32.8	32.2	8.25	12.7	37.0	39.8	3.06	3.18	1.01	0.494	0.095	0.085	NA	NA
WNW1008B	UP(6)	39.7	40.1	9.37	9.36	42.8	43.3	2.97	3.08	1.33	0.169	0.104	0.089	0.349	<0.090
WNW0903	DOWN - B(2)	70.0	71.7	34.2	33.7	38.9	39.0	4.59	3.49	3.18	0.118	0.200	0.160	NA	NA
WNW0903	DOWN - B(6)	70.0	83.6	29.9	36.5	45.9	45.5	3.35	3.48	1.31	0.255	0.157	0.159	0.463	<0.090
WNW1002	DOWN - B(2)	156	128	64.0	55.4	37.3	39.7	4.55	3.50	28.0	0.266	0.830	0.105	NA	NA
WNW1002	DOWN - B(6)	145	36.0	94.1	9.66	41.2	32.9	2.73	3.90	5.59	1.10	0.186	0.132	1.27	0.462
WNW1003	DOWN - B(2)	81.0	27.1	30.3	8.22	52.0	52.5	7.38	2.45	58.7	0.360	1.10	0.073	NA	NA
WNW1003	DOWN - B(6)	28.8	29.6	82.2	8.42	60.6	60.5	2.43	2.31	0.739	<0.040	0.119	0.110	0.387	<0.090
WNW1004	DOWN - B(2)	38.4	40.6	16.5	16.8	27.2	28.2	2.08	1.69	1.39	0.254	0.090	0.077	NA	NA
WNW1004	DOWN - B(6)	44.9	45.8	17.8	18.3	30.7	30.0	1.65	1.56	0.322	0.271	0.080	0.052	0.102	<0.090
WNW1101C	DOWN - B(2)	59.1	56.8	11.4	10.0	25.5	26.3	4.29	3.68	3.50	0.070	0.141	0.025	NA	NA
WNW1101C	DOWN - B(6)	56.8	61.8	9.55	10.2	27.6	29.7	3.10	3.09	1.10	<0.040	0.170	0.140	0.518	<0.090
WNW8610	DOWN - B(2)	38.9	28.7	33.4	32.5	69.4	68.8	5.70	5.47	1.14	0.059	0.049	0.028	NA	NA
WNW8610	DOWN - B(6)	57.9	37.6	48.3	46.6	75.2	79.8	6.06	5.57	13.2	0.087	0.360	0.026	4.63	<0.090
WNW8611	DOWN - B(2)	86.2	79.4	34.2	30.7	60.4	63.3	4.17	2.92	19.2	0.447	0.371	0.013	NA	NA
WNW8611	DOWN - B(6)	101	89.7	42.6	37.2	72.7	76.3	4.55	3.30	19.9	1.43	0.485	0.168	6.93	0.891

NR - Not reported. These results have not been reported because the data validation process indicated the data were not reliable.
NA - Not available.

Table E - 10
Groundwater Quality Parameters (mg/L) for the Weathered Lavery Till Unit

Location Code	Hydraulic Position	Chloride	Sulfate	Nitrate + Nitrite-N	Ammonia	Bicarbonate Alkalinity*	Carbonate Alkalinity*	Phenols	Phosphate	Silica	Sulfide
WNW0908	UP(2)	3.4	3020	< 0.05	<0.05	282	<1.0	0.005	NA	NA	NA
WNW0908	UP(6)	4.6	1490	< 0.05	<0.05	269	<1.0	NA	0.11	10	< 1.0
WNW1005	UP(2)	6.2	107	< 0.05	<0.05	373	<1.0	<0.005	NA	NA	NA
WNW1005	UP(6)	2.4	15.5	< 0.05	<0.05	410	<1.0	NA	<0.050	15	< 1.0
WNW1008C	UP(2)	37.7	18.2	< 0.05	<0.05	222	<1.0	0.017	NA	NA	NA
WNW1008C	UP(6)	31.8	20.9	< 0.05	0.08	225	<1.0	NA	0.050	13	< 1.0
WNW0906	DOWN - B(2)	4.9	305	1.0	<0.05	255	<1.0	0.006	NA	NA	NA
WNW0906	DOWN - B(6)	5.6	61.1	< 0.05	<0.05	192	<1.0	NA	0.11	9.2	< 1.0
WNW0907	DOWN - B(2)	<1.0	240	< 0.05	<0.05	343	<1.0	0.022	NA	NA	NA
WNW0907	DOWN - B(6)	1.4	103	0.12	<0.05	298	<1.0	NA	<0.050	11	< 1.0
WNW1006	DOWN - B(2)	<1.0	1310	< 0.05	0.12	369	<1.0	0.008	NA	NA	NA
WNW1006	DOWN - B(6)	1.5	1260	< 0.05	0.12	346	<1.0	NA	<0.050	14	1.3
WNW1007	DOWN - B(2)	6.0	592	< 0.05	<0.05	313	<1.0	0.015	NA	NA	NA
WNW1007	DOWN - B(6)	3.3	23.8	< 0.05	<0.05	330	<1.0	NA	0.21	10	< 1.0
WNW1101A	DOWN - B(2)	1.3	133	0.14	<0.05	270	<1.0	<0.005	NA	NA	NA
WNW1101A	DOWN - B(6)	1.3	69.9	0.11	<0.05	237	<1.0	NA	<0.050	10	< 1.0
WNW1106A	DOWN - B(2)	1.0	200	< 0.05	0.05	293	<1.0	<0.005	NA	NA	NA
WNW1106A	DOWN - B(6)	2.6	123	< 0.05	<0.05	287	<1.0	NA	<0.050	12	< 1.0
WNW1108A	DOWN - B(2)	<1.0	556	0.34	<0.05	288	<1.0	<0.005	NA	NA	NA
WNW1108A	DOWN - B(6)	1.6	452	0.22	<0.05	282	<1.0	NA	<0.050	9.0	< 1.0
WNW1109A	DOWN - B(2)	<1.0	220	0.14	<0.05	233	<1.0	0.008	NA	NA	NA
WNW1109A	DOWN - B(6)	1.4	176	< 0.05	<0.05	237	<1.0	NA	<0.050	9.1	< 1.0
WNW0909	DOWN - C(2)	20.8	208	0.10	0.42	400	<1.0	0.014	NA	NA	NA
WNW0909	DOWN - C(6)	13.1	166	< 0.05	0.42	610	<1.0	NA	0.056	16	< 1.0
WNW1102A	DOWN - C(2)	1.5	200	< 0.05	<0.05	255	<1.0	<0.005	NA	NA	NA
WNW1102A	DOWN - C(6)	1.3	130	0.09	<0.05	248	<1.0	NA	<0.050	10	< 1.0
WNW1103A	DOWN - C(2)	2.1	260	< 0.05	<0.05	326	<1.0	<0.005	NA	NA	NA
WNW1103A	DOWN - C(6)	1.3	176	< 0.05	<0.05	317	<1.0	NA	<0.050	12	< 1.0
WNW1104A	DOWN - C(2)	1.0	220	0.10	<0.05	269	<1.0	<0.005	NA	NA	NA
WNW1104A	DOWN - C(6)	2.1	94.4	< 0.05	<0.05	228	<1.0	NA	<0.050	15	< 1.0
WNW1107A	DOWN - C(2)	7.1	588	0.22	0.06	511	<1.0	<0.005	NA	NA	NA
WNW1107A	DOWN - C(6)	5.9	307	< 0.05	0.18	496	<1.0	NA	<0.050	18	< 1.0
WNW1110A	DOWN - C(2)	5.2	520	0.18	<0.05	417	<1.0	0.007	NA	NA	NA
WNW1110A	DOWN - C(6)	2.6	394	0.24	<0.05	421	<1.0	NA	<0.050	12	< 1.0
WNW1111A	DOWN - C(2)	1.8	274	< 0.05	<0.05	397	<1.0	<0.005	NA	NA	NA
WNW1111A	DOWN - C(6)	1.1	171	< 0.05	<0.05	392	<1.0	NA	<0.050	13	< 1.0

NR - Not reported. These results have not been reported because the data validation process indicated the data were not reliable.
NA - Not available.
** as mg$CaCO_3$/L*

Table E - 10 (concluded)
Groundwater Quality Parameters (mg/L) for the Weathered Lavery Till Unit

Location Code	Hydraulic Position	Calcium Total	Calcium Diss.	Magnesium Total	Magnesium Diss.	Sodium Total	Sodium Diss.	Potassium Total	Potassium Diss.	Iron Total	Iron Diss.	Manganese Total	Manganese Diss.	Aluminum Total	Aluminum Diss.
WNW0908	UP(2)	530	602	177	149	19.2	16.2	5.50	4.70	2.04	0.053	0.064	0.009	NA	NA
WNW0908	UP(6)	447	484	142	155	21.3	22.7	5.53	6.33	0.205	0.040	0.176	0.007	<0.090	<0.090
WNW1005	UP(2)	98.2	100	36.8	36.9	10.8	10.7	2.44	1.78	1.57	<0.025	0.053	0.027	NA	NA
WNW1005	UP(6)	113	119	39.0	40.0	11.4	10.8	1.98	1.89	0.710	0.058	0.086	0.087	0.505	<0.090
WNW1008C	UP(2)	68.8	75.5	17.6	18.1	12.2	12.5	0.740	0.955	0.100	<0.030	0.134	0.077	NA	NA
WNW1008C	UP(6)	73.4	80.8	17.3	18.7	13.6	13.7	<1.00	<1.00	0.263	0.065	0.159	0.190	0.310	<0.200
WNW0906	DOWN - B(2)	61.2	45.1	21.2	13.9	24.2	30.3	3.57	3.04	0.415	0.411	0.059	0.092	NA	NA
WNW0906	DOWN - B(6)	61.4	58.5	20.2	18.9	23.7	26.6	2.66	2.70	0.400	0.121	0.022	<0.005	0.322	0.218
WNW0907	DOWN - B(2)	100	105	39.0	38.1	10.0	9.58	1.71	1.98	<0.030	<0.030	0.019	0.023	NA	NA
WNW0907	DOWN - B(6)	100	106	39.5	40.1	10.6	9.39	2.02	2.25	0.049	<0.040	0.034	0.014	<0.200	<0.200
WNW1006	DOWN - B(2)	401	406	133	140	20.2	21.4	3.19	3.83	0.130	0.282	0.097	0.219	NA	NA
WNW1006	DOWN - B(6)	388	407	148	148	23.8	22.2	3.82	3.90	0.557	0.301	0.945	1.12	<0.090	<0.090
WNW1007	DOWN - B(2)	166	171	65.5	62.7	16.6	15.8	18.1	18.3	0.896	<0.025	0.025	0.005	NA	NA
WNW1007	DOWN - B(6)	135	160	48.2	57.4	16.0	17.9	NR	NR	1.70	1.54	0.173	0.332	1.43	1.35
WNW1101A	DOWN - B(2)	89.9	97.5	26.9	28.0	12.1	12.6	1.76	1.86	0.083	<0.017	0.021	0.016	NA	NA
WNW1101A	DOWN - B(6)	81.8	90.8	23.0	25.0	11.4	10.9	1.56	1.74	<0.040	<0.040	0.021	0.029	<0.090	<0.090
WNW1106A	DOWN - B(2)	92.5	89.1	36.8	36.1	11.1	10.4	2.38	2.30	0.053	<0.030	0.031	0.017	NA	NA
WNW1106A	DOWN - B(6)	96.9	109	37.3	40.0	12.3	11.2	2.63	2.64	0.158	<0.040	0.042	0.036	0.102	<0.090
WNW1108A	DOWN - B(2)	172	190	62.5	67.8	23.3	23.0	3.50	3.69	0.710	0.047	0.039	0.016	NA	NA
WNW1108A	DOWN - B(6)	189	190	69.8	66.9	19.0	23.1	3.97	4.49	1.26	<0.040	0.080	0.013	1.03	<0.090
WNW1109A	DOWN - B(2)	116	120	27.9	28.2	10.3	10.4	2.18	2.29	<0.030	<0.030	0.064	0.057	NA	NA
WNW1109A	DOWN - B(6)	109	118	28.6	29.8	11.6	11.2	2.40	2.40	0.171	<0.040	0.01	0.020	0.144	<0.090
WNW0909	DOWN - C(2)	132	141	36.9	38.7	15.4	16.1	3.28	3.15	2.28	0.783	1.74	1.84	NA	NA
WNW0909	DOWN - C(6)	231	262	54.2	57.3	8.64	8.91	2.54	2.54	10.7	9.39	6.04	6.41	0.83	<0.090
WNW1102A	DOWN - C(2)	113	120	40.5	41.4	9.92	10.2	2.54	2.61	0.077	<0.017	0.022	0.015	NA	NA
WNW1102A	DOWN - C(6)	96.2	114	33.0	37.3	9.29	8.54	2.15	2.47	0.049	<0.040	0.017	0.018	<0.090	<0.090
WNW1103A	DOWN - C(2)	142	146	54.9	53.5	14.3	13.8	2.61	2.57	0.140	<0.017	0.086	0.058	NA	NA
WNW1103A	DOWN - C(6)	116	126	44.2	47.8	13.2	13.6	2.27	2.42	0.178	<0.040	0.087	0.058	0.108	<0.090
WNW1104A	DOWN - C(2)	79.5	82.1	24.6	25.1	9.30	9.55	1.57	1.64	0.053	<0.030	0.005	0.006	NA	NA
WNW1104A	DOWN - C(6)	87.2	90.9	25.7	26.3	10.9	10.1	1.80	1.90	<0.040	<0.040	<0.005	0.012	<0.090	<0.090
WNW1107A	DOWN - C(2)	252	236	83.4	85.6	12.6	13.0	2.60	2.70	0.493	<0.030	4.84	5.20	NA	NA
WNW1107A	DOWN - C(6)	203	222	75.9	78.7	11.7	11.6	2.47	2.70	1.06	2.47	9.57	7.83	<0.090	<0.090
WNW1110A	DOWN - C(2)	150	144	97.5	95.7	27.5	27.8	3.74	3.71	0.093	<0.030	0.014	0.004	NA	NA
WNW1110A	DOWN - C(6)	161	183	99.1	106	29.2	29.8	3.92	4.03	0.104	<0.040	0.017	0.037	<0.090	<0.090
WNW1111A	DOWN - C(2)	144	150	66.0	65.5	20.1	19.8	3.12	3.14	0.113	<0.017	0.053	<0.005	NA	NA
WNW1111A	DOWN - C(6)	126	138	55.4	59.0	16.2	16.3	2.62	2.79	<0.040	<0.040	0.075	0.088	<0.090	<0.090

NR - Not reported. These results have not been reported because the data validation process indicated the data were not reliable.
NA - Not available.

Table E-11

Typical Practical Quantitation Limits (PQLs) in μg/L for Appendix IX and Target Compound List Compounds

COMPOUND	PQL	COMPOUND	PQL
Volatiles			
Acetone	10	Methacrylonitrile	5
Acetonitrile	100	Methyl bromide	10
Acrolein	5	Methyl chloride	10
Acrylonitrile	5	Methyl ethyl ketone	10
Allyl chloride	100	Methyl iodide	5
Benzene	10	Methyl methacrylate	5
Bromodichloromethane	10	4-Methyl-2-pentanone	10
Bromoform	10	Methylene bromide	5
Bromomethane	10	Methylene chloride	10
2-Butanone	10	Pentachloroethane	5
Carbon disulfide	10	2-Picoline	5
Carbon tetrachloride	10	Propionitrile	5
Chlorobenzene	10	Pyridine	30
Chlorodibromomethane	10	Styrene	10
Chloroethane	10	1,1,1,2-Tetrachloroethane	10
Chloroform	10	1,1,2,2-Tetrachloroethane	10
Chloromethane	10	Tetrachloroethylene	10
Chloroprene	5	Toluene	10
1,3-Dibromo-3-chloropropane	5	1,1,1-Trichloroethane	10
Dibromochloromethane	10	1,1,2-Trichloroethane	10
1,2-Dibromoethane	10	1,2,3-Trichloropropane	5
Dichlorodifluoromethane	5	Vinyl acetate	5
1,1-Dichloroethane	10	Vinyl chloride	10
1,2-Dichloroethane	10	Xylene (total)	10
1,1-Dichloroethylene	10	cis-1,2-Dichloropropene	10
1,2-Dichloropropane	10	trans-1,2-Dichloroethylene	10
1,4-Dioxane	150	trans-1,3-Dichloropropene	10
Ethyl benzene	10	trans-1,4-Dichloro-2-butene	5
Ethyl methacrylate	5	Trichloroethylene	10
2-Hexanone	10	Trichlorofluoromethane	5
Isobutyl alcohol	50	1,2-Dichloroethylene (total)	10

Table E-11 *(continued)*

Typical Practical Quantitation Limits (PQL) in μg/L for Appendix IX and Target Compound List Compounds

COMPOUND	PQL	COMPOUND	PQL
Semivolatiles			
Acenaphthene	10	1,4-Dichlorobenzene	10
Acenaphthylene	10	3,3-Dichlorobenzidine	10
Acetophenone	10	2,4-Dichlorophenol	10
2-Acetylaminofluorene	10	2,6-Dichlorophenol	10
4-Aminobiphenyl	10	Diethyl phthalate	10
Aniline	10	Dimethoate	10
Anthracene	10	7,12-Dimethylbenz[a]anthracene	10
Aramite	10	3,3-Dimethylbenzidine	10
Benzo[a]anthracene	10	2,4-Dimethylphenol	10
Benzo[a]pyrene	10	Dimethyl Phthalate	10
Benzo[b]fluoranthene	10	4,6-Dinitro-2-methylphenol	25
Benzo[ghi]perylene	10	4,6-Dinitro-o-cresol	50
Benzo[k]fluoranthene	10	2,4-Dinitrophenol	50, TCL=25
Benzyl alcohol	10	2,4-Dinitrotoluene	10
Bis(2-chlorethyl)ether	10	2,6-Dinitrotoluene	10
Bis(2-chloroethoxy)methane	10	Diphenylamine	10
Bis(2-ethylhexyl)phthalate	10	Ethyl methanesulfonate	10
Bis(2-chloro-1- methlethyl) ether	10	Famphur	10
Bis(2-chloroisopropyl)ether	10	Fluoranthene	10
4-Bromophenyl phenyl ether	10	Fluorene	10
Butyl benzyl phthalate	10	Hexachlorobenzene	10
Carbazole	10	Hexachlorobutadiene	10
4-Chloroaniline	10	Hexachlorocyclopentadiene	10
Chlorobenzilate	10	Hexachloroethane	10
4-Chloro-3-methyl phenol (P-Chloro-m-cresol)	10	Hexachlorophene	10
2-Chloronaphthalene	10	Hexachloropropene	10
2-Chlorphenol	10	Indeno(1,2,3,-cd)pyrene	10
4-Chlorophenyl phenyl ether	10	Isodrin	10
Chrysene	10	Isophorone	10
Di-n-butyl phthalate	10	Isosafrole	10
Di-n-octyl phthalate	10	Kepone	10
Diallate	10	Methapyrilene	10
Dibenz[a,h]anthracene	10	Methyl methanesulfonate	10
Dibenzofuran	10	3-Methylcholanthrene	10
1,2-Dichlorobenzene	10	2-Methylnaphthalene	10
1,3-Dichlorobenzene	10	2-Methylphenol	10

Table E-11 (continued)

Typical Practical Quantitation Limits (PQL) in μg/L for Appendix IX and Target Compound List Compounds

COMPOUND	PQL	COMPOUND	PQL
4-Methylphenol	10	p-Nitrophenol	50
1,4-Naphthoquinone	10	p-Phenylenediamine	10
1-Naphthylamine	10	Parathion	10
2-Naphthylamine	10	Pentachlorobenzene	10
2-Nitroaniline	25	Pentachloronitrobenzene	10
3-Nitroaniline	25	Pentachlorophenol	50, TCL=25
4-Nitroaniline	25	Phenacetin	10
Nitrobenzene	10	Phenanthrene	10
5-Nitro-o-toluidine	10	Phenol	10
2-Nitrophenol	10	Pronamide	10
4-Nitrophenol	10	Pyrene	10
4-Nitroquinoline 1-oxide	10	Safrole	10
N-Nitrosodi-n-butylamine	10	1,2,4,5-Tetrachlorobenzene	10
N-Nitrosodiethylamine	10	2,3,4,6-Tetrachlorophenol	10
N-Nitrosodimethylamine	10	Tetraethyl dithiopyrophosphate	10
N-Nitrosodipropylamine	10	1,2,4-Trichlorobenzene	10
N-Nitrosodiphenylamine	10	2,4,5-Trichlorophenol	25
N-Nitrosomethylethylamine	10	2,4,6-Trichlorophenol	25
N-Nitrosomorpholine	10	alpha,alpha-Dimethylphenethylamine	10
N-Nitrosopiperidine	10	m-Cresol	10
N-Nitrosopyrrolidine	10	m-Dichlorobenzene	10
Naphthalene	10	m-Dinitrobenzene	10
0,0,0-Triethyl phosphorothioate	10	m-Nitroaniline	50
0,0-Diethyl 0-2-pyrazinyl-phosphorothioate	10	o-Cresol	10
2,2-oxybis(1-Chloropropane)	10	o-Dichlorobenzene	10
p-(Dimethylamino)azobenzene	10	o-Nitroaniline	50
p-Chloroaniline	10	o-Nitrophenol	10
p-Chloro-m-cresol	10	o-Toluidine	10
p-Cresol	10	sym-Trinitrobenzene	10
p-Dichlorobenzene	10	Cyanide	10
p-Nitroaniline	50	Sulfide	1,000

Table E-11 *(concluded)*

Typical Practical Quantitation Limits (PQL) in µg/L for Appendix IX and Target Compound List Compounds

COMPOUND	PQL	COMPOUND	PQL
Pesticides and PCBs			
Aldrin	0.05	Methoxychlor	0.5
alpha Chlordane	0.5	Methyl parathion	10
gamma Chlordane	0.5	PCB-1242	0.5
Chlordane (total)	0.5	PCB-1254	1.0
2,4-D	10	PCB-1221	0.5
4,4-DD	0.10	PCB-1232	0.5
4,4-DDE	0.10	PCB-1248	0.5
4,4-DDT	0.10	PCB-1260	1.0
Dieldrin	0.10	PCB-1016	0.5
Dinoseb	10	Phorate	10
Disulfoton	10	Silvex	2.0
Endosulfan I	0.10	2,4,5-T	2.0
Endosulfan II	0.10	Toxaphene	1.0
Endosulfan sulfate	0.10	alpha-BHC	0.05
Endrin	0.10	beta-BHC	0.05
Endrin aldehyde	0.20	delta-BHC	0.05
Hepatachlor	0.05	gamma-BHC (Lindane)	0.05
Hepatachlor epoxide	0.05		

Table E-12

1,1,1-Trichloroethane (1,1,1-TCA), 1,1-Dichloroethane (1,1-DCA), and Dichlorodifluoromethane (DCDFMethane) Sampling Results at Selected Groundwater Monitoring Locations

Location	Date	1,1,1-TCA (μg/L)	1,1-DCA (μg/L)	DCDFMethane (μg/L)
WNGSEEP	01/27/93	<5.0*	<5.0	<5.0
	03/03/93	<5.0*	<5.0	<5.0
	05/06/93	<5.0*	<5.0	<5.0
	06/07/93	<5.0	<5.0	<5.0
	07/27/93	<5.0	<5.0	<5.0
	11/18/93	<5.0	<5.0	<5.0
WNW8609	01/11/93	<5.0*	<5.0*	<5.0
	02/18/93	<5.0	<5.0*	<5.0
	04/21/93	<5.0	<5.0*	<5.0
	05/25/93	<5.0*	<5.0*	<5.0
	07/26/93	<5.0	<5.0	<5.0
	11/11/93	<5.0	<5.0*	<5.0
WNW8612	01/26/93	<5.0*	33.0	6.3
	03/03/93	<5.0*	33.0	9.5
	05/06/93	<5.0*	31.0	7.5
	06/07/93	<5.0*	34.5	7.3
	07/26/93	<5.0*	30.0	4.5
	11/15/93	<5.0*	35.8	6.0
WNW0803	01/26/93	<5.0*	<5.0	12.5
	03/02/93	<5.0	<5.0	19.0
	05/06/93	<5.0	<5.0	19.0
	06/07/93	<5.0*	<5.0	30.0
	07/26/93	<5.0	<5.0	5.0
	11/15/93	<5.0	<5.0	8.0

* *Compound was detected below practical quantitation limit (PQL).*

Table E-13

Expanded Characterization: N-Dodecane and Tributyl Phosphate Sampling Results

Location	N-Dodecane (μg/L)	Tributyl Phosphate (μg/L)
WNW0909	<60.0	<10.0
WNW8605	*Not analyzed*	290.0
WNNDATR	<60.00	<10.0

Table E - 14
Target Compound List and Appendix IX Metals (µg/L) Sampling Results

Location Code & Geologic Unit	Hydraulic Position	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Lead
Quality Standards[1]		3[2]	25	1,000	3[2]	5(10)[3]	50	N/A	200	15(25)[3]
Sand and Gravel										
WNWNB1S	UP	<3.00	<3.00	78.4	<3.00	<0.20	31.2	<20.0	28.8	< 2.0
WNW0201	DOWN - B	<3.00	<3.00	251	<3.00	<0.20	<10.0	<20.0	<10.0	< 4.0
WNW0305	DOWN - B	<5.00	<3.00	121	<3.00	0.30	<10.0	<20.0	10.0	< 6.0
WNSP008	DOWN - C	<3.00	<3.00	80.2	<3.00	0.35	<10.0	<20.0	<10.0	<5.00
WNW0103	DOWN - C	<3.00	13.0	<40.0	<3.00	0.20	39.8	<20.0	<10.0	14
WNW0104	DOWN - C	<12.0	<1.00	154	<1.00	<2.00	6.10	<3.00	6.20	15
WNW0203	DOWN - C	<3.00	<3.00	274	<3.00	<0.20	95.0	<20.0	40.0	<17
WNW0205	DOWN - C	<3.00	<3.00	197	<3.00	0.30	44.9	<20.0	202	<19
WNW0406	DOWN - C	<3.00	<3.00	116	<3.00	<0.20	<10.0	<20.0	<10.0	21
WNW0408	DOWN - C	<12.0	<1.00	332	<1.00	<2.00	14.6	<3.00	4.70	22
WNW0501	DOWN - C	14.9	<1.00	252	<1.00	<2.00	22.6	<3.00	5.00	24
WNW0502	DOWN - C	18.6	1.00	279	<1.00	<2.00	298	5.10	4.00	<26
WNW0602	DOWN - C	<3.00	<3.00	158	<3.00	0.20	33.0	<20.0	<10.0	28
WNW0604	DOWN - C	<3.00	3.00	76.3	<3.00	<0.20	13.6	<20.0	20.4	<30
WNW8605	DOWN - C	16.0	5.80	87.8	<1.00	<2.00	<3.00	<3.00	<3.00	<32
WNW8609	DOWN - C	<3.00	<3.00	188	<3.00	<0.20	<10.0	<20.0	10.2	<34
WNDMPNE	DOWN - D	<3.00	<3.00	98.2	<3.00	<0.20	<10.0	<20.0	<10.0	<36
WNGSEEP	DOWN - D	<3.00	<3.00	133	<3.00	<0.20	<10.0	<20.0	<10.0	<38
WNW0105	DOWN - D	<3.00	31.0	196	<3.00	0.20	<10.0	<20.0	<10.0	40
WNW0106	DOWN - D	<3.00	3.00	171	<3.00	0.20	85.7	<20.0	14.7	52
WNW0116	DOWN - D	<3.00	<3.00	129	<3.00	0.20	181	<20.0	<10.0	54
WNW0601	DOWN - D	<3.00	<3.00	83.1	<3.00	0.20	692	<20.0	19.8	70
WNW0801	DOWN - D	<3.00	<3.00	143	<3.00	<0.20	<10.0	<20.0	<10.0	<72
WNW0802	DOWN - D	<3.00	<3.00	400	<3.00	<0.20	<10.0	<20.0	<10.0	<74
WNW0803	DOWN - D	<3.00	<3.00	217	<3.00	<0.20	<10.0	<20.0	10.3	76
WNW0804	DOWN - D	<3.00	<3.00	114	<3.00	0.50	20.1	<20.0	<10.0	78
WNW0905	DOWN - D	<4.00	4.00	<40.0	<3.00	<0.20	<10.0	<20.0	<10.0	<80
WNW8603	DOWN - D	<3.00	<3.00	289	<3.00	<0.20	<10.0	<20.0	<10.0	<82
WNW8604	DOWN - D	15.8	<1.00	286	<1.00	<2.00	4.65	<3.00	<3.00	43
WNW8612	DOWN - D	<3.00	4.00	278	<3.00	<0.20	<10.0	<20.0	<10.0	23
Till-sand										
WNW0402	UP	<3.00	<3.00	607	<3.00	<0.20	<10.0	<20.0	10.5	< 2.0
WNW0202	DOWN - B	<3.00	5.00	309	<3.00	<0.20	<10.0	<20.0	15.5	< 4.0
Unweathered Till										
WNW0405	UP	<3.00	<3.00	55.7	<3.00	<0.20	446	<20.0	13.6	< 2.0
WNW0109	DOWN - B	<3.00	<3.00	106	<3.00	<0.20	<10.0	<20.0	<10.0	5
WNW0110	DOWN - B	<3.00	<3.00	127	<3.00	<0.20	<10.0	<20.0	<10.0	< 7.0
WNW0115	DOWN - B	<3.00	7.00	244	<3.00	<0.20	20.7	<20.0	12.2	24
WNW0704	DOWN - B	<3.00	<3.00	46.3	<3.00	<0.20	<10.0	<20.0	<10.0	<26
WNW0904	DOWN - B	<4.00	9.00	91.1	<3.00	<0.20	<10.0	<20.0	19.3	38
WNW1109B	DOWN - B	<4.00	3.00	236	<3.00	<0.20	<10.0	<20.0	<10.0	<40
WNW0107	DOWN - C	<3.00	<3.00	52.8	<3.00	<0.20	<10.0	<20.0	28.3	<42
WNW0409	DOWN - C	<3.00	<3.00	152	<3.00	<0.20	<10.0	<20.0	<10.0	<44
WNW0910	DOWN - C	<4.00	<3.00	<40.0	<3.00	1.90	<10.0	<20.0	<10.0	<46
Weathered Till										
WNW0908	UP	<4.00	<3.00	<30.0	<3.00	<0.20	<10.0	<20.0	11.0	< 2.0
WNW1008C	UP	<3.00	7.00	216	<3.00	<0.20	<10.0	<20.0	<10.0	7
WNW0907	DOWN - B	<4.00	50.0	48.0	<3.00	<0.20	<10.0	<20.0	<10.0	< 9.0
WNW1007	DOWN - B	<3.00	<3.00	51.0	<3.00	2.40	<10.0	<20.0	13.7	11
WNW1108A	DOWN - B	<4.00	3.00	<40.0	<3.00	0.60	<10.0	<20.0	17.3	13
WNW0909	DOWN - C	<3.00	9.00	120	<3.00	<0.20	<10.0	<20.0	13.8	17

[1] *Quality Standards are NYS Class GA standards unless otherwise specified.*
[2] *NYS Guideline*
[3] *WVDP action level, which is more stringent than the NYS Class GA Standard, is noted in parentheses.*
NA - Not available.

Table E - 14 (concluded)
Target Compound List and Appendix IX Metals (μg/L) Sampling Results

Location Code & Geologic Unit	Hydraulic Position	Mercury	Nickel	Selenium	Silver	Thalium	Tin	Vanadium	Zinc
Quality Standards[1]		2	700[2]	10	50	4[2]	21,000[2]	250[2]	300
Sand and Gravel									
WNWNB1S	UP	<0.20	<30.0	<3.00	<0.20	<3.00	NA	<20.0	20.5
WNW0201	DOWN - B	<0.20	<30.0	<3.00	<0.20	<3.00	NA	<20.0	<10.0
WNW0305	DOWN - B	<0.20	<30.0	<3.00	<0.20	<3.00	NA	<20.0	<10.0
WNSP008	DOWN - C	1.36	<30.0	<3.00	<0.20	<3.00	NA	<20.0	297
WNW0103	DOWN - C	<0.20	<30.0	<3.00	<0.20	<3.00	NA	<20.0	14.1
WNW0104	DOWN - C	<0.15	<6.00	<1.00	<3.00	<1.00	NA	<3.00	12.9
WNW0203	DOWN - C	<0.20	154	<3.00	<0.20	<3.00	NA	<20.0	21.2
WNW0205	DOWN - C	<0.20	<30.0	<3.00	<0.20	<3.00	NA	<20.0	145
WNW0406	DOWN - C	<0.20	<30.0	<3.00	<0.20	<3.00	NA	<20.0	13.5
WNW0408	DOWN - C	<0.15	180	<1.00	<3.00	<1.00	NA	<3.00	13.2
WNW0501	DOWN - C	<0.15	39.0	<1.00	<3.00	<1.00	NA	3.10	23.7
WNW0502	DOWN - C	<0.15	29.4	<1.00	<3.00	<1.00	NA	<3.00	6.80
WNW0602	DOWN - C	<0.20	59	<3.00	<0.20	<3.00	NA	<20.0	19.4
WNW0604	DOWN - C	<0.20	146	<3.00	<0.20	<3.00	NA	<20.0	15.8
WNW8605	DOWN - C	<0.15	<6.00	3.60	3.50	<1.00	NA	<3.00	5.60
WNW8609	DOWN - C	<0.20	<30.0	<3.00	<0.20	<3.00	2000	<20.0	10.9
WNDMPNE	DOWN - D	<0.20	<30.0	<3.00	<0.50	<3.00	NA	<20.0	17.5
WNGSEEP	DOWN - D	<0.20	<30.0	<3.00	<0.50	<3.00	2000	<20.0	<10.0
WNW0105	DOWN - D	<0.20	<30.0	<3.00	<0.20	<3.00	NA	<20.0	<10.0
WNW0106	DOWN - D	<0.20	111	<3.00	<0.20	<3.00	NA	<20.0	57.0
WNW0116	DOWN - D	<0.20	30.0	<3.00	<0.20	<3.00	NA	<20.0	15.5
WNW0601	DOWN - D	<0.20	533	<3.00	<0.20	<3.00	NA	<20.0	59.3
WNW0801	DOWN - D	<0.20	<30.0	<3.00	<0.50	<3.00	NA	<20.0	<10.0
WNW0802	DOWN - D	<0.20	<30.0	<3.00	<0.50	<3.00	NA	<20.0	21.9
WNW0803	DOWN - D	<0.20	<30.0	<3.00	<0.50	<3.00	2000	<20.0	12.5
WNW0804	DOWN - D	<0.20	<30.0	<3.00	<0.50	<3.00	NA	<20.0	24.2
WNW0905	DOWN - D	<0.20	<30.0	<3.00	<10.0	<3.00	NA	<20.0	<10.0
WNW8603	DOWN - D	0.52	<30.0	<3.00	<0.20	<3.00	NA	<20.0	<10.0
WNW8604	DOWN - D	<0.15	<6.00	<1.00	<3.00	<1.00	NA	<3.00	5.90
WNW8612	DOWN - D	<0.20	<30.0	<3.00	<0.50	<3.00	2000	<20.0	<10.0
Till-sand									
WNW0402	UP	<0.20	<30.0	<3.00	<0.20	<3.00	NA	<20.0	<10.0
WNW0202	DOWN - B	<0.20	<30.0	<3.00	<0.20	<3.00	NA	<20.0	12.9
Unweathered Till									
WNW0405	UP	<0.20	169	<3.00	<0.20	<3.00	NA	<20.0	<10.0
WNW0109	DOWN - B	<0.20	<30.0	<3.00	0.2	<3.00	NA	<20.0	18.7
WNW0110	DOWN - B	<0.20	<30.0	<3.00	0.20	<3.00	NA	<20.0	<10.0
WNW0115	DOWN - B	<0.20	<30.0	<3.00	<0.20	<3.00	NA	21.8	85.3
WNW0704	DOWN - B	<0.20	76.0	<3.00	<0.20	<3.00	NA	<20.0	<10.0
WNW0904	DOWN - B	<0.20	<30.0	<3.00	<10.0	<3.00	NA	<20.0	19.4
WNW1109B	DOWN - B	<0.20	<30.0	<3.00	<10.0	<3.00	NA	<20.0	10.0
WNW0107	DOWN - C	<0.20	<30.0	<3.00	<0.20	<3.00	NA	<20.0	13.8
WNW0409	DOWN - C	<0.20	<30.0	<3.00	<0.20	<3.00	NA	<20.0	<10.0
WNW0910	DOWN - C	<0.20	<30.0	<3.00	<10.0	<4.00	NA	<20.0	10.6
Weathered Till									
WNW0908	UP	<0.20	<30.0	3.00	<10.0	<4.00	NA	<20.0	<10.0
WNW1008C	UP	<0.20	<30.0	<3.00	<10.0	<3.00	NA	<20.0	<10.0
WNW0907	DOWN - B	<0.20	<30.0	<3.00	<10.0	<3.00	NA	<20.0	<10.0
WNW1007	DOWN - B	<0.20	<30.0	<3.00	<10.0	<3.00	NA	<20.0	14.2
WNW1108A	DOWN - B	<0.20	<30.0	<3.00	<10.0	<3.00	NA	<20.0	14.5
WNW0909	DOWN - C	<0.20	52.2	<3.00	<0.50	<3.00	2000	<20.0	16.9

[1] Quality Standards are NYS Class GA standards unless otherwise specified.
[2] NYS Guideline
[3] WVDP action level, which is more stringent than the NYS Class GA Standard, is noted in parentheses.
NA - Not available.

Table E - 15
Expanded Characterization: Alpha- and Beta-emitting Radioisotopic Results (µCi/mL)

Location Code & Geologic Unit	Hydraulic Position	Am-241	C-14	I-129	Pu-238	Pu-239/240
Sand and Gravel						
WNWNB1S	A	1.80±0.80E-10	-2.20±1.20E-08	-1.10±5.70E-10	1.20±1.50E-10	0.68±6.78E-11
WNW0104	C	1.40±3.60E-11	-0.76±1.15E-08	1.50±0.60E-09	0.60±6.05E-11	-1.20±7.10E-11
WNW0111	C	1.30±3.30E-11	-0.12±1.16E-08	1.70±0.70E-09	0.53±5.27E-11	0.53±5.27E-11
WNW0408	C	1.30±3.30E-11	8.30±0.20E-07	4.60±5.40E-10	3.80±9.80E-11	0.77±7.68E-11
WNW0501	C	1.50±3.80E-11	4.50±6.60E-09	3.40±5.90E-10	0.77±7.71E-11	0.77±7.77E-11
WNW0502	C	2.80±4.70E-11	2.00±0.10E-07	1.50±0.50E-09	0.59±5.89E-11	0.59±5.89E-11
WNW8605	C	1.40±0.80E-10	2.40±1.20E-08	1.20±0.10E-08	6.40±7.10E-11	4.90±6.50E-11
WNW0905	D	0.27±2.72E-11	-0.50±1.22E-08	-0.06±5.41E-10	7.00±7.80E-11	0.41±4.10E-11
WNW8604	D	2.15±7.51E-11	0.32±1.16E-08	1.23±0.56E-09	0.70±7.53E-11	0.91±8.09E-11
Unweathered Till						
WNW0405	A	2.30±3.80E-11	-0.23±1.01E-08	0.11±1.08E-09	2.20±1.60E-10	2.70±1.70E-10
Weathered Till						
WNW1008C	A	1.30±3.50E-11	-0.54±1.29E-08	7.50±5.90E-10	-0.78±4.54E-11	-0.78±4.54E-11
WNW0908	A	2.20±3.60E-11	0.17±1.15E-08	8.30±7.20E-10	0.55±5.55E-11	0.55±5.55E-11
WNW0906	B	3.70±4.80E-11	-2.30±1.10E-08	4.70±5.70E-10	0.51±5.06E-11	0.51±5.06E-11
WNW1006	B	6.90±6.00E-11	-0.03±1.22E-08	-1.60±5.30E-10	0.36±3.56E-11	1.80±4.60E-11
Till-Sand						
WNW0402	A	1.50±4.00E-11	-1.60±1.00E-08	-1.40±0.60E-09	0.31±3.07E-11	0.31±3.07E-11

Location Code & Geologic Unit	Hydraulic Position	Ra-226	Ra-228	Sr-90	Tc-99	U-232
Sand and Gravel						
WNWNB1S	A	-0.09±1.53E-07	0.31±7.21E-10	5.00±7.50E-10	-1.40±2.90E-09	0.53±1.44E-10
WNW0104	C	1.10±0.90E-10	1.10±1.00E-09	2.60±0.10E-06	1.70±0.40E-08	4.90±6.90E-11
WNW0111	C	2.70±1.10E-10	2.10±1.10E-09	1.90±0.10E-06	0.72±2.74E-09	1.20±0.20E-09
WNW0408	C	4.80±1.50E-10	-6.40±0.17E-09	1.60±0.10E-04	3.20±0.50E-08	3.20±5.80E-11
WNW0501	C	1.80±1.00E-10	-6.00±0.11E-09	5.40±0.10E-05	1.00±0.30E-08	2.30±6.20E-11
WNW0502	C	3.50±1.00E-10	-8.40±0.12E-09	3.70±0.10E-05	2.10±0.40E-08	-0.17±2.58E-10
WNW8605	C	5.10±1.00E-10	6.50±1.60E-09	1.10±0.10E-05	2.30±0.40E-08	3.60±0.70E-09
WNW0905	D	0.61±1.12E-10	4.30±8.30E-10	-0.34±6.34E-10	-0.57±2.22E-09	-0.22±5.20E-11
WNW8604	D	7.05±0.95E-10	2.85±1.15E-09	4.50±0.10E-06	1.29±0.33E-08	-0.24±2.14E-10
Unweathered Till						
WNW0405	A	1.70±0.20E-09	8.70±9.00E-10	1.30±0.70E-09	0.00±1.90E-09	-0.46±1.44E-11
Weathered Till						
WNW1008C	A	6.30±9.50E-11	0.31±8.22E-10	0.46±1.13E-09	0.41±2.03E-09	0.36±2.53E-11
WNW0908	A	9.70±1.10E-07	4.60±8.20E-10	1.40±6.90E-10	1.20±2.60E-09	1.00±0.10E-11
WNW0906	B	1.90±0.80E-10	-2.60±7.50E-10	-5.00±8.30E-10	0.11±1.41E-09	3.50±6.70E-11
WNW1006	B	6.10±1.50E-10	4.40±8.20E-10	-3.80±6.90E-10	0.24±2.41E-09	-1.40±3.60E-11
Till-sand						
WNW0402	A	1.20±8.00E-08	2.10±0.70E-08	-0.60±6.23E-10	0.87±2.02E-09	0.72±1.20E-10

Location Code & Geologic Unit	Hydraulic Position	U-233/234	U-235	U-236	U-238	TOTAL U *(µg/mL)*
Sand and Gravel						
WNWNB1S	A	1.50±1.00E-10	0.36±3.58E-11	0.36±3.58E-11	0.36±3.58E-11	3.00±3.00E-05
WNW0104	C	3.20±1.30E-10	0.31±3.12E-11	2.80±4.70E-11	2.20±1.10E-10	5.10±0.80E-04
WNW0111	C	9.80±2.30E-10	0.31±3.12E-11	0.31±3.12E-11	4.80±1.60E-10	1.20±0.20E-03
WNW0408	C	6.90±2.40E-10	4.30±7.30E-11	0.48±4.81E-11	5.90±2.20E-10	1.50±0.20E-03
WNW0501	C	1.60±1.00E-10	0.31±3.10E-11	0.31±3.10E-11	1.30±0.80E-10	3.30±0.50E-04
WNW0502	C	2.00±1.20E-10	3.40±5.70E-11	1.90±4.80E-11	6.40±7.10E-11	4.60±0.70E-04
WNW8605	C	2.00±0.30E-09	5.60±6.70E-11	2.80±4.70E-11	1.30±0.30E-09	1.30±0.20E-03
WNW0905	D	4.10±0.50E-09	1.50±0.90E-10	-0.58±3.39E-11	3.20±0.40E-09	3.70±0.60E-03
WNW8604	D	3.10±1.30E-10	0.34±4.44E-11	1.17±4.44E-11	1.57±0.94E-10	9.30±1.40E-04
Unweathered Till						
WNW0405	A	5.30±1.70E-10	-0.63±3.68E-11	0.32±3.16E-11	3.20±1.30E-10	9.60±1.40E-04
Weathered Till						
WNW1008C	A	2.10±1.10E-10	0.62±4.40E-11	0.31±3.11E-11	1.60±1.00E-10	2.80±0.40E-04
WNW0908	A	6.10±0.60E-09	1.70±0.90E-10	0.27±2.68E-11	4.00±0.50E-09	1.20±0.20E-02
WNW0906	B	2.70±0.40E-09	1.10±0.70E-10	0.27±2.67E-11	1.60±0.30E-09	3.70±0.60E-03
WNW1006	B	4.80±0.60E-09	1.10±0.70E-10	0.27±2.74E-11	3.40±0.40E-09	8.30±1.20E-03
Till-sand						
WNW0402	A	3.70±1.50E-10	0.35±3.53E-11	0.35±3.53E-11	3.30±1.40E-10	1.10±0.20E-05

Table E - 16
Expanded Characterization: Beta-emitting Radioisotopic Results (μCi/mL)

Location Code & Geologic Unit	Hydraulic Position	C-14	I-129	Sr-90	Tc-99
Sand and Gravel					
WNW0201	B	-0.41±1.20E-08	-6.50±5.30E-10	2.30±0.20E-08	-0.48±1.71E-09
WNW0305	B	-0.45±1.00E-08	3.90±4.90E-10	2.00±0.50E-09	0.50±1.28E-09
WNW0103	C	-0.65±1.00E-08	-4.10±8.00E-10	1.50±0.20E-08	0.10±2.01E-09
WNW0203	C	-0.71±1.00E-08	-5.10±8.50E-10	1.40±0.20E-08	0.45±2.23E-09
WNW0205	C	-0.41±1.01E-08	-1.00±0.80E-09	3.80±1.10E-09	-1.10±1.80E-09
WNW0406	C	-0.89±1.00E-08	-3.00±8.80E-10	2.00±1.00E-09	1.90±2.60E-09
WNW0602	C	1.20±1.20E-08	1.00±0.50E-09	7.30±1.80E-09	0.72±1.81E-09
WNW0604	C	1.20±1.20E-08	-1.10±4.30E-10	8.30±8.80E-10	0.00±1.40E-09
WNW8609	C	-0.47±1.19E-08	2.40±0.60E-09	1.30±0.10E-07	-0.58±1.64E-09
WNSP008	C	-1.15±1.00E-08	1.03±0.62E-09	3.25±0.22E-08	2.95±1.88E-09
WNW0105	D	-0.50±1.00E-08	8.00±5.30E-10	5.30±7.70E-10	2.20±0.50E-08
WNW0106	D	0.34±1.01E-08	1.30±0.50E-09	0.00±6.00E-10	9.30±3.10E-09
WNW0116	D	-1.60±1.00E-08	1.50±0.50E-09	1.00±0.10E-08	8.80±2.20E-09
WNW0601	D	-1.60±1.20E-08	-6.50±4.30E-10	5.80±0.40E-08	1.10±2.40E-09
WNW0801	D	-3.50±1.20E-08	4.40±8.20E-10	5.50±0.10E-07	1.10±3.00E-09
WNW0802	D	1.10±1.20E-08	6.90±5.10E-10	5.20±8.70E-10	-0.53±2.53E-09
WNW0803	D	0.85±1.23E-08	1.10±0.80E-09	2.30±0.80E-09	1.10±0.40E-08
WNW0804	D	-3.60±1.20E-08	3.30±5.10E-10	2.50±0.30E-08	0.40±2.72E-09
WNW8603	D	0.00±1.00E-09	1.20±7.70E-10	3.30±0.30E-08	2.10±0.40E-08
WNW8612	D	-0.41±1.22E-08	-1.04±6.82E-10	-0.01±1.08E-09	-0.98±2.26E-09
WNDMPNE	D	-2.90±1.20E-08	-1.40±4.90E-10	2.60±0.10E-07	6.10±3.60E-09
WNGSEEP	D	-4.10±1.20E-08	-2.50±5.50E-10	8.10±9.10E-10	1.90±2.90E-09
Unweathered Till					
WNW0109	B	-1.50±1.00E-08	1.60±1.00E-09	0.67±7.21E-10	-0.40±1.27E-09
WNW0110	B	-8.10±10.0E-09	6.10±7.30E-10	-4.20±6.20E-10	-0.33±1.17E-09
WNW0115	B	-6.70±10.0E-09	9.90±9.40E-10	-3.40±6.10E-10	-0.34±2.22E-09
WNW0704	B	-1.60±1.00E-08	-4.80±8.00E-10	7.80±1.60E-09	1.40±2.40E-09
WNW0904	B	-9.00±11.4E-09	5.20±5.70E-10	0.25±1.14E-09	-1.10±2.20E-09
WNW1109B	B	-2.40±1.10E-08	1.20±0.60E-09	3.10±8.90E-10	-0.24±2.43E-09
WNW0107	C	1.90±10.1E-09	5.20±8.30E-10	0.15±1.28E-09	1.20±2.10E-09
WNW0409	C	-6.60±11.9E-09	-9.50±4.70E-10	0.52±6.68E-10	0.49±3.26E-09
WNW0910	C	6.00±73.6E-10	4.00±5.20E-10	-0.22±1.09E-09	0.63±3.02E-09
Weathered Till					
WNW0907	B	8.40±12.3E-09	8.60±5.00E-10	-2.50±6.70E-10	0.99±2.00E-09
WNW1007	B	-1.90±1.10E-08	-0.12±6.17E-10	0.65±1.47E-09	0.49±3.17E-09
WNW1108A	B	-1.00±1.10E-08	0.89±4.91E-10	0.92±1.90E-09	1.60±3.00E-09
WNW0909	C	8.70±7.60E-09	5.10±0.50E-09	7.20±0.50E-08	0.91±2.26E-09
WNNDATR	C	-7.70±12.1E-09	5.40±7.40E-10	1.60±0.20E-08	-1.00±2.10E-09
Till-sand					
WNW0202	B	-1.70±1.20E-08	-3.90±6.70E-10	-1.60±8.20E-10	-0.50±1.54E-09

Table E - 17

1993 Radiological Concentrations (μCi/mL) at Well Points

Location	Alpha	Beta	H-3	Cs-134	Co-60	K-40
WP-A	0.00±1.95E-09	1.19±0.14E-07	1.55±0.05E-05	0.00±3.13E-08	0.00±3.28E-08	0.00±4.22E-07
WP-C	0.34±1.47E-09	3.23±0.15E-07	5.37±0.16E-05	0.00±3.13E-08	0.00±3.28E-08	3.15±4.22E-07
WP-D	0.00±2.23E-09	3.35±0.06E-06	2.48±0.80E-7	0.00±3.13E-08	0.00±3.28E-08	1.97±4.22E-07
WP-E	1.29±4.39E-09	1.94±0.02E-05	4.02±0.83E-7	0.00±1.83E-08	0.00±1.94E-08	0.00±2.99E-07
WP-F	0.46±1.56E-08	2.72±0.02E-04	4.26±0.83E-7	0.00±1.83E-08	0.67±1.94E-08	0.00±2.99E-07
WP-G	0.90±3.06E-09	9.52±1.24E-08	2.99±0.14E-6	0.00±1.83E-08	0.00±1.94E-08	0.95±2.99E-07
WP-H	8.03±6.74E-09	1.55±0.05E-06	1.35±0.04E-5	0.00±1.83E-08	0.00±1.94E-08	0.84±2.99E-07

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Glossary

ACTION PLAN. An action plan addresses assessment findings and root causes identified in a Tiger Team Assessment Report. It is intended to set forth specific actions that the site will undertake to remedy deficiencies noted in a Tiger Team Assessment Report. The plan includes a timetable and funding requirements for implementation of the planned activities.

ALLUVIUM. Sedimentary material deposited by flowing water such as a river.

ALLUVIAL FAN. A cone-shaped deposit of alluvium made by a stream where it runs out onto a level plain.

AQUIFER. A water-bearing unit of permeable rock or soil that will yield water in usable quantities to wells. *Confined aquifers* are bounded above and below by less permeable layers. Groundwater in a confined aquifer is under a pressure greater than the atmospheric pressure. *Unconfined aquifers* are bounded below by less permeable material but are not bounded above. The pressure on the groundwater in an unconfined aquifer at the top of the aquifer is equal to that of the atmosphere.

BACKGROUND RADIATION. Includes both natural and manmade radiation such as cosmic radiation and radiation from naturally radioactive elements and from commercial sources and medical procedures.

BECQUEREL (Bq). A unit of radioactivity equal to one nuclear transformation per second.

CLASS A, B, AND C LOW-LEVEL WASTE. Waste classifications from the Nuclear Regulatory Commission's 10 CFR Part 61 rule. Maximum concentration limits are set for specific isotopes. Class A waste disposal is minimally restricted with respect to the form of the waste. Class B waste must meet more rigorous requirements to ensure physical stability after disposal. Greater concentration limits are set for the same isotopes in Class C waste, which also must meet physical stability requirements. Moreover, special measures must be taken at the disposal facility to protect against inadvertent intrusion.

CLASS GA GROUNDWATERS. Class GA waters are fresh groundwaters that can be used as a source of potable water supply. The New York Code of Rules and Regulations, Title 6, Part 703.5, "Water quality standards for taste-, color-, and odor-producing toxic and other deleterious substances" specifies the standards for specific substances or groups of substances in Table 1 of subdivision (f).

COMPLIANCE FINDINGS. Conditions that, in the judgment of a Tiger Team Assessment, may not satisfy applicable environmental or safety and health regulations, DOE Orders and memoranda, enforcement actions, agreements with regulatory agencies, or permit conditions.

CONFIDENCE COEFFICIENT OR FACTOR. The chance or probability, usually expressed as a percentage, that a confidence interval includes some defined parameter of a population. The confidence coefficients usually associated with confidence intervals are 90%, 95%, and 99%.

COSMIC RADIATION. High-energy subatomic particles from outer space that bombard the earth's atmosphere. Cosmic radiation is part of natural background radiation.

COUNTING ERROR. The variability caused by the inherent random nature of radioactive disintegration and the detection process.

CURIE (Ci). A unit of radioactivity equal to 37 billion (3.7×10^{10}) nuclear transformations per second.

Glossary

DETECTION LEVEL. The minimum concentration of a substance that can be measured with a 99% confidence that the analytical concentration is greater than zero.

DERIVED CONCENTRATION GUIDE (DCG). Concentrations of radionuclides in air and water by which a person continuously exposed and inhaling 8,400 cubic meters of air or ingesting 730 liters of water per year would receive an annual effective dose equivalent of 100 mrem per year from either mode of exposure. The committed dose equivalent is included in the DCGs for radionuclides with long half-lives. (See *Appendix B*.)

DISPERSION. The process whereby solutes are spread or mixed as they are transported by groundwater as it moves through sediments.

DOSIMETER. A portable device for measuring the total accumulated exposure to ionizing radiation.

DOWNGRADIENT. The direction of water flow from a reference point to a selected point of interest. (See GRADIENT.)

EFFECTIVE DOSE. See EFFECTIVE DOSE EQUIVALENT under RADIATION DOSE.

EFFLUENT. Flowing out or forth; an outflow of waste. In this report, effluent refers to the liquid or gaseous waste streams released into the environment from the facility.

EFFLUENT MONITORING. Sampling or measuring specific liquid or gaseous effluent streams for the presence of pollutants.

ENVIRONMENTAL MONITORING. The collection and analysis of samples or the direct measurements of environmental media. Environmental monitoring consists of two major activities: effluent monitoring and environmental surveillance.

ENVIRONMENTAL SURVEILLANCE. The collection and analysis of samples, or the direct measurement of air, water, soil, foodstuff, and biota from DOE sites in order to determine compliance with applicable standards and permit requirements.

EXPOSURE. The subjection of a target (usually living tissue) to radiation.

FALLOUT. Radioactive materials mixed into the earth's atmosphere. Fallout constantly precipitates onto the earth.

FINDING. A compliance term. A finding is a statement of fact concerning a condition in the Environmental, Safety, and Health program that was investigated during an appraisal. Findings include best management practice findings, compliance findings, and noteworthy practices. A finding may be a simple statement of proficiency or a description of deficiency (i.e., a variance from procedures or criteria).

GRADIENT. Change in value of one variable with respect to another variable, especially vertical or horizontal distance.

GRAY. A unit of absorbed dose.

Glossary

GROUNDWATER. Subsurface water in the pore spaces of soil and geologic units.

HALF-LIFE. The time in which half the atoms of a radionuclide disintegrate into another nuclear form. The half-life may vary from a fraction of a second to thousands of years.

HIGH-LEVEL WASTE (HLW). The highly radioactive waste material that results from the reprocessing of spent nuclear fuel, including liquid waste produced directly in reprocessing and any solid waste derived from the liquid, that contains a combination of transuranic waste and fission products in concentrations sufficient to require permanent isolation.

HYDRAULIC CONDUCTIVITY. The ratio of flow velocity to driving force for viscous flow under saturated conditions of a specified liquid in a porous medium; the ratio describing the rate at which water can move through a permeable medium.

ION. An atom or group of atoms with an electric charge.

ION EXCHANGE. The reversible exchange of ions contained in solution with other ions that are part of the ion-exchange material.

ISOTOPE. Different forms of the same chemical element that are distinguished by having the same number of protons but different number of neutrons in the nucleus. An element can have many isotopes. For example, the three isotopes of hydrogen are protium, deuterium, and tritium.

KAME DELTA. A conical hill or short irregular ridge of gravel or sand deposited in contact with glacier ice.

LACUSTRINE SEDIMENTS. A sedimentary deposit consisting of material pertaining to, produced by, or formed in a lake or lakes.

LAND DISPOSAL RESTRICTIONS (LDR). Land disposal restrictions are regulations promulgated by the U.S. EPA governing the land disposal of hazardous wastes. The wastes must be treated using the best demonstrated available technology or must meet certain treatment standards before being disposed.

LEACHED HULLS. Stainless steel cladding that remains after acid dissolution of spent fuel.

LOW-LEVEL WASTE. Radioactive waste not classified as high-level waste, transuranic waste, spent fuel, or uranium mill tailings. (See CLASS A, B, and C LOW-LEVEL WASTE.)

MAXIMALLY EXPOSED INDIVIDUAL. A hypothetical person who remains in an uncontrolled area who would, when all potential routes of exposure from a facility's operations are considered, receive the greatest possible dose equivalent.

MEAN. The average value of a series of measurements.

MILLIREM (MREM). A unit of radiation dose equivalent that is equal to one one-thousandth of a rem. An individual member of the public can receive up to 500 millirems per year according to DOE standards. This limit does not include radiation received for medical treatment or the 100 to 360 mrem that people receive annually from background radiation.

Glossary

MINIMUM DETECTABLE CONCENTRATION. The smallest amount or concentration of a radioactive or nonradioactive element that can be reliably detected in a sample.

MIXED WASTE. A waste that is both radioactive and hazardous. Also referred to as RADIOACTIVE MIXED WASTE (RMW).

OUTFALL. The end of a drain or pipe that carries wastewater or other effluents into a ditch, pond, or river.

PARTICULATES. Solid particles and liquid droplets small enough to become airborne.

PERSON-REM. The sum of the individual radiation dose equivalents received by members of a certain group or population. It may be calculated by multiplying the average dose per person by the number of persons exposed. For example, a thousand people each exposed to one millirem would have a collective dose of one person-rem.

PLUME. The distribution of a pollutant in air or water after being released from a source.

PROGLACIAL LAKE. A lake occupying a basin in front of a glacier; generally in direct contact with the ice.

QUALITY FACTOR. The extent of tissue damage caused by different types of radiation of the same energy. The greater the damage, the higher the quality factor. More specifically, the factor by which absorbed doses are multiplied to obtain a quantity that indicates the degree of biological damage produced by ionizing radiation. (See RADIATION DOSE.) The factor is dependent upon radiation type (alpha, beta, gamma, or x-ray) and exposure (internal or external).

RAD. Radiation absorbed dose. One hundred ergs of energy absorbed per gram.

RADIATION. The process of emitting energy in the form of rays or particles that are thrown off by disintegrating atoms. The rays or particles emitted may consist of alpha, beta, or gamma radiation.

> ***ALPHA RADIATION.*** The least penetrating type of radiation. Alpha radiation can be stopped by a sheet of paper or outer dead layer of skin.
>
> ***BETA RADIATION.*** Electrons emitted from a nucleus during fission and nuclear decay. Beta radiation can be stopped by an inch of wood or a thin sheet of aluminum.
>
> ***GAMMA RADIATION.*** A form of electromagnetic, high-energy radiation emitted from a nucleus. Gamma rays are essentially the same as x-rays and require heavy shielding such as lead, concrete, or steel to be stopped.
>
> ***INTERNAL RADIATION.*** Radiation originating from a source within the body as a result of the inhalation, ingestion, or implantation of natural or manmade radionuclides in body tissues.

RADIATION DOSE:

> ***ABSORBED DOSE.*** The amount of energy absorbed per unit mass in any kind of matter from any kind of ionizing radiation. Absorbed dose is measured in rads or grays.

Glossary

DOSE EQUIVALENT (DE). Also known simply as "dose." A measure of external radiation, dose is the product of the absorbed dose, the quality factor, and any other modifying factors. Dose equivalent is used to compare the biological effects of different kinds of radiation on a common scale. The unit of dose equivalent is the rem or sievert.

COLLECTIVE DOSE EQUIVALENT. The sum of the dose equivalents for all the individuals comprising a defined population. The per capita dose equivalent is the quotient of the collective dose equivalent divided by the population. The unit of collective dose equivalent is person-rem or person-sievert.

EFFECTIVE DOSE EQUIVALENT (EDE). An expression of the health risk of doses of radiation to an individual. Since some organs are more sensitive than others, each organ is given a weighting factor. This tissue-specific weighting factor is multiplied by the organ dose for each organ and the numbers are added together to obtain the effective dose equivalent. The effective dose equivalent includes the COMMITTED EFFECTIVE DOSE EQUIVALENT (from internal deposition of radionuclides) and the dose equivalent (from penetrating radiation from external sources). Units of measurement are rems or sieverts.

COLLECTIVE EFFECTIVE DOSE EQUIVALENT. The sum of the effective dose equivalents for the individuals comprising a defined population. Units of measurement are person-rems or person-sieverts. The per capita effective dose equivalent is obtained by dividing the collective dose equivalent by the population. Units of measurement are rems or sieverts.

COMMITTED DOSE EQUIVALENT. A measure of internal radiation. The predicted total dose equivalent to a tissue or organ over a fifty-year period after a known intake of a radionuclide into the body. It does not include contributions from sources of external penetrating radiation. Committed dose equivalent is measured in rems or sieverts.

COMMITTED EFFECTIVE DOSE EQUIVALENT. 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 measured in rems or sieverts.

RADIOACTIVITY. A property possessed by some elements such as uranium whereby alpha, beta, or gamma rays are spontaneously emitted.

RADIOISOTOPE. A radioactive isotope of a specified element. Carbon-14 is a radioisotope of carbon. Tritium is a radioisotope of hydrogen.

RADIONUCLIDE. A radioactive nuclide. Radionuclides are variations (isotopes) of elements. They have the same number of protons and electrons but different numbers of neutrons, resulting in different atomic masses.There are several hundred known nuclides, both manmade and naturally occurring.

REM. An acronym for Roentgen Equivalent Man. A unit of radiation exposure that indicates the potential effect of radiation on human cells.

SIEVERT. A unit of dose equivalent from the International System of Units. Equal to one joule per kilogram.

Glossary

SPENT FUEL. Nuclear fuel that has been exposed in a nuclear reactor; this fuel contains uranium, activation products, fission products, and plutonium.

STANDARD DEVIATION. An indication of the dispersion of a set of results around their average.

THERMOLUMINESCENT DOSIMETER (TLD). A device that luminesces upon heating after being exposed to radiation. The amount of light emitted is proportional to the amount of radiation to which the luminescent material has been exposed.

TIGER TEAM. A special investigatory group operating under the authority of the Department of Energy's Tiger Team Assessment program. Tiger Team assessments are part of a ten-point initiative to conduct independent oversight compliance and management assessments of Environmental Safety & Health programs at Department of Energy facilities. Tiger Teams include individuals from the Department of Energy, Department of Energy contractors, and private consulting organizations.

TIGER TEAM ASSESSMENT PROGRAM. A program to provide the Secretary of Energy with concise information on the current Environmental Safety & Health compliance status of each facility, root causes for noncompliance, adequacy of Department of Energy and site contractor Environmental Safety & Health management programs, response actions to address identified problem areas, and Department of Energy-wide Environmental Safety & Health compliance trends.

UPGRADIENT. Referring to the flow of water or air, it is analogous to upstream. A point that is "before" an area of study that is used as a baseline for comparison with downstream data. See GRADIENT and DOWNGRADIENT.

WATERSHED. The area contained within a drainage divide above a specified point on a stream.

WATER TABLE. The upper surface in a body of groundwater. The surface in an unconfined aquifer or confining bed at which the pore water pressure is equal to atmospheric pressure.

Acronyms

AEA. Atomic Energy Act

ANOVA. Analysis of Variance

BEIR. Committee on Biological Effects of Ionizing Radiation

BOD. Biochemical Oxygen Demand

CAA. Clean Air Act

CDDL. Construction and Demolition Debris Landfill

CEDE. Committed Effective Dose Equivalent

CERCLA. Comprehensive Environmental Response, Compensation, and Liability Act

CSRF. Contact Size-reduction Facility

CSS. Cement Solidification System

CWA. Clean Water Act

CX. Categorical Exclusion

DCG. Derived Concentration Guide

DE. Dose Equivalent

DOE. (U.S.) Department of Energy

DOE-HQ. Department of Energy, Headquarters Office

DOE-ID. Department of Energy, Idaho Field Office

EA. Environmental Assessment

EDE. Effective Dose Equivalent

EE. Environmental Evaluation

EID. Environmental Information Document

EIS. Environmental Impact Statement

ELAP. Environmental Laboratory Accreditation Program

Acronyms

EML. Environmental Measurements Laboratory

EMSL. Environmental Monitoring Systems Laboratory (Las Vegas)

EPA. (U.S.) Environmental Protection Agency

EPCRA. Emergency Preparedness and Community Right-to-Know Act

ES&H. Environmental Safety and Health

FFC Act. Federal Facility Compliance Act

FONSI. Finding of No Significant Impact

FSFCA. Federal and State Facility Compliance Agreement

FY. Fiscal Year

GC/MS. Gas Chromatograph/Mass Spectrometer

HLW. High-level (Radioactive) Waste

HPIC. High-pressure Ion Chamber

ICRP. International Commission on Radiological Protection

INEL. Idaho National Engineering Laboratory

IRTS. Integrated Radwaste Treatment System

LDR. Land Disposal Restriction

LIMS. Laboratory Information Management System

LLD. Lower Limit of Detection

LLW. Low-level (Radioactive) Waste

LLWTF. Low-level Liquid Waste Treatment Facility

LPS. Liquid Pretreatment System

LWTS. Liquid Waste Treatment System

MDC. Minimum Detectable Concentration

Acronyms

MDL. Method Detection Limit

NCRP. National Council on Radiation Protection and Measurements

NDA. Nuclear Regulatory Commission-licensed Disposal Area

NEPA. National Environmental Policy Act

NESHAP. National Emissions Standards for Hazardous Air Pollutants

NFS. Nuclear Fuel Services, Inc.

NIST. National Institute of Standards and Technology

NOI. Notice of Intent

NPOC. Nonpurgeable Organic Carbon

NPDES. National Pollutant Discharge Elimination System

NRC. Nuclear Regulatory Commission

NYCRR. New York Code of Rules and Regulations

NYSDEC. New York State Department of Environmental Conservation

NYSDOH. New York State Department of Health

NYSERDA. New York State Energy Research and Development Authority

NYSGS. New York State Geological Survey

OSHA. Occupational Safety and Health Act

OSR. Operational Safety Requirement

PCB. Polychlorinated Biphenyl

PQL. Practical Quantitation Limit

QA. Quality Assurance

QC. Quality Control

RCRA. Resource Conservation and Recovery Act

Acronyms

RESL. Radiological and Environmental Science Laboratory

RFI. RCRA Facility Investigation

RMW. Radioactive Mixed Waste

RTS. Radwaste Treatment System

SAIC. Science Applications International Corporation

SAR. Safety Analysis Report

SARA. Superfund Amendments and Reauthorization Act

SD. Standard Deviation

SDA. (New York) State-licensed Disposal Area

SDWA. Safe Drinking Water Act

SI. International System of Units (Systeme Internationale)

SPDES. State Pollutant Discharge Elimination System

STS. Supernatant Treatment System

SWMU. Solid Waste Management Unit

SSWMU. Super Solid Waste Management Unit

TCL. Target Compound List

TI. Teledyne Isotopes

TIMS. Thermal Ionization Mass Spectrometry

TLD. Thermoluminescent Dosimetry

TOC. Total Organic Carbon

TOX. Total Organic Halogens

TPQ. Threshold Planning Quantity

TSCA. Toxic Substances and Control Act

Acronyms

USGS. U.S. Geological Survey

VOC. Volatile Organic Compound

WNYNSC. Western New York Nuclear Service Center

WVDP. West Valley Demonstration Project

WVNS. West Valley Nuclear Services Company, Inc.

WVPO. West Valley (DOE) Project Office

Units of Measure

Radioactivity

Symbol	Name
Ci	curie
mCi	millicurie (1E-03 Ci)
μCi	microcurie (1E-06 Ci)
nCi	nanocurie (1E-09 Ci)
pCi	picocurie (1E-12 Ci)
fCi	femtocurie (1E-15 Ci)
aCi	attocurie (1E-18 Ci)
Bq	becquerel (27 pCi)

Volume

Symbol	Name
cm^3	cubic centimeter
L	liter
mL	milliliter
m^3	cubic meter
gal	gallons
ft^3	cubic feet
ppm	parts per million
ppb	parts per billion

Dose

Symbol	Name
Sv	sievert (100 rems)
Gy	gray (100 rads)

Time

Symbol	Name
y	year
d	day
h	hour
m	minute
s	second

Length

Symbol	Name
m	meter
km	kilometer (1E+03 m)
cm	centimeter (1E-02 m)
mm	millimeter (1E-03 m)
μm	micrometer (1E-06 m)

Area

Symbol	Name
ha	hectare (10,000 m^2)

Concentration

Symbol	Name
μCi/mL	microcuries per milliliter
mL/L	milliliter per liter
μCi/g	microcuries per gram

Mass

Symbol	Name
g	gram
kg	kilogram (1E+03 g)
mg	milligram (1E-03 g)
μg	microgram (1E-06 g)
ng	nanogram (1E-09 g)
t	metric ton (1E+06 g)

Flow Rate

Symbol	Name
MGD	million gallons per day
CFM	cubic feet per minute
LPM	liters per minute

Distribution

R. Natoli	DOE-HQ	P. Piciulo	NYSERDA
T. McIntosh	DOE-HQ		
		R. Fakudiny	NYSGS
T. Burns	DOE-ID	F. Galpin	USEPA-Washington, D.C.
T. Perkins	DOE-ID	J. MacGruder	USEPA-Region II
C. Ljungberg	DOE-ID	P. Giardina	USEPA-Region II
M. Olsen	DOE-ID	J. Gorman	USEPA-Region II
		J. Nevius	USEPA-Region II
		W. Kappel	USGS
G. Comfort	NRC-HQ		
M. Austin	NRC-Region 1	B. Snyder	SNI
J. Furia	NRC-Region 1	L. Maybee	SNIHD
P. Counterman	NYSDEC-Albany	E. Wohlers	CCHD
P. Merges	NYSDEC-Albany		
T. DiGiulio	NYSDEC-Albany		
M. Wang	NYSDEC-Albany	W. Paxon	U.S. Congressman, 27th Dist.
J. Spagnoli	NYSDEC-Region 9	J. Quinn	U.S. Congressman, 30th Dist.
R. Baker	NYSDEC-Region 9	A. Houghton	U.S. Congressman, 31st Dist.
B. Bartz	NYSDEC-Region 9	D. Moynihan	U.S. Senator, New York
P. Eisman	NYSDEC-Region 9	A. D'Amato	U.S. Senator, New York
M. Jackson	NYSDEC-Region 9	J. Present	New York Senator, 56th Dist.
F. Shattuck	NYSDEC-Region 9	W. Stachowski	New York Senator, 58th Dist.
J. Krajewski	NYSDEC-Region 9	T. Reynolds	New York Assemblyman, 147th Dist.
		P. McGee	New York Assemblyman, 149th Dist.
B. Ignatz	NYSDOH-Buffalo		
K. Rimawi	NYSDOH-Albany		

Concord Public Library, Springville, New York

Community Relations, WVNS (Technical File)

Buffalo News, Buffalo, New York *

Salamanca Republican Press, Salamanca, New York *

Springville Journal, Springville, New York *

* News release summary

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D.F. Burke
J.D. Chamberlain
F.J. Cohen
S.L. Conklin
T.S. Ellis
H.J. Farner
J.R. Fox
W.T. Frederick
J.R. Gerber
P.J. Gorton
K.M. Grasso
T.X. Grasso
P.J. Hadden-Carter
J.P. Jackson
C.S. King
W.N. Kean
D. Kennedy
E.A. Lurier
A.J. Martin
E.A. Matthews
M.F. McGarry
S.P. McKenzie
N.A. McNeil
R. Monsalve-Jones
A.S. Nagel
A.J. Nello
F.A. O'Connor
R.W. Oldham
J. Paul
M.P. Pendl
E.M. Ramos-Velita
C.L. Repp
C.J. Roberts
C.T. Roesch
L.C. Salvatori
V. Samargian
M.J. Saraf
L.A. Schreiner
R.L. Schubert
T.G. Seltzer
A.K. Shukla
K.S. Skiba
S.J. Szalinski
W.A. Trembath
J.S. Tygert
D.L. Wiltse
C.A. Werner
C.M. Wrotniak
Z.Z. Zadins