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**1998 Annual Report of Radiological Monitoring
Results for the Chalk River and Whiteshell
Laboratories Sites
Volume 2 - Effluent Monitoring**

T.A. Niemi, N. Soonawala



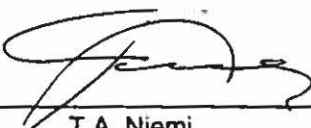
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VOLUME 2 -- EFFLUENT MONITORING

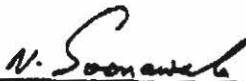
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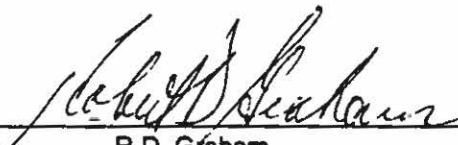
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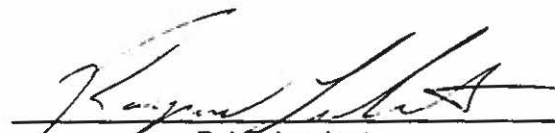
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VOLUME 2 – EFFLUENT MONITORING

by

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Environmental Protection Section, CRL
and

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VOLUME 2 -- EFFLUENT MONITORING

by

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ABSTRACT

This volume of the annual report summarizes
RELEASES of RADIOACTIVE MATERIALS in AIRBORNE and LIQUID EFFLUENTS
from the Chalk River and Whiteshell Laboratories
for the calendar year 1998.

NOTE: Separate volumes of this report summarize the
PERSONNEL RADIATION DOSIMETRY (Volume 1) and
ENVIRONMENTAL MONITORING (Volume 3)
for the same period.

1999 March

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**1998 ANNUAL REPORT OF RADIOLOGICAL MONITORING RESULTS
FOR THE CHALK RIVER AND WHITESHELL LABORATORIES SITES**

VOLUME 2 -- EFFLUENT MONITORING

1. INTRODUCTION

1.1 Purpose and Scope

This report summarizes radioactive effluent releases from AECL's Chalk River Laboratories (CRL) Site located on the Ottawa River near Chalk River, Ontario and from AECL's Whiteshell Laboratories (WL) Site located on the Winnipeg River near Pinawa, Manitoba. These laboratories operate under the terms of the Nuclear Research and Test Establishment Licences granted by the Atomic Energy Control Board (AECB) [1, 2].

The CRL and WL licences require that AECL submits to the AECB an annual report for each calendar year summarizing the results of monitoring of radiation exposures to personnel at the sites, the results of monitoring of radioactive materials in airborne and liquid effluents from the sites, and the results of environmental monitoring at and around the sites. AECL reports the monitoring results in the "Annual Report of Radiological Monitoring Results for the Chalk River Laboratories and Whiteshell Laboratories Sites", AECL-MISC-362. AECL-MISC-362 is in three Volumes. This report, Volume 2 of AECL-MISC-362, addresses the licence requirement regarding airborne and liquid effluent monitoring, for CRL and WL sites for the calendar year 1998. Results of personnel dose monitoring and environmental monitoring are in Volumes 1 and 3 of AECL-MISC-362.

This report reviews and summarizes radioactive effluent releases from the CRL and WL sites as a whole, comparing the data with the Derived Release Limit (DRL¹) (see Section 2.1) values for members of the public outside the site boundaries. The Annual Safety Reports for individual facilities contain more detailed facility-specific information in relation to the DRLs. This report does not cover results of effluent monitoring for operational control purposes within individual facilities.

1.2 Facilities and Operations at CRL and WL

AECL's CRL and WL sites are broad-based installations for nuclear research, development and demonstration, and operate a variety of nuclear facilities. Appendix A of the respective Nuclear Research and Test Establishment Licence lists the main nuclear facilities at each site. In addition, there is a variety of smaller research, development and analytical laboratories at both CRL and WL. The major operating facilities listed in the CRL licence are the NRU Research Reactor, the Molybdenum-99 Production Facility, the Waste Management Areas, the Universal Cells, and the Fuels and Materials Cells (FMC). The major operating facilities listed at the WL licence are the WL Shielded Facilities that include the Hot Cell Facility and the Immobilized Fuel Test Facility, and the Waste Management Area.

1.3 Performance Summary

All emissions of radioactive material from both CRL and WL in 1998 were well below regulatory limits, and very small fractions of applicable DRLs [3, 7, 8, 9].

Average weekly CRL airborne emissions of all radioactive materials from all monitored sources represented in total 2.8% of the DRL¹, a slight decrease from 1997. The decrease was mainly due to somewhat decreased argon-41 emissions from the NRU/NRX reactor stack that, however, remained the most significant airborne radioactive releases from the CRL site, averaging 2.4% of the DRL.

The sum of all monthly liquid effluent releases from CRL averaged 0.22% of the DRL, being slightly higher than in 1997. The Process Sewer remained the dominant source of liquid releases averaging 0.14% of the DRL, a slight decrease compared with 1997. Though somewhat decreased compared with 1997, phosphorus-32 from the NRU continued to be the most significant radionuclide in the Process Sewer releases, averaging 0.066% DRL. The second most significant radionuclide continued to be caesium-137 that averaged 0.046% of the DRL, a slight increase compared with 1997.

¹Unless otherwise stated in text, DRL for CRL in this report refers to the DRL in effect as of 1998 November 01 [3].

The total air emissions from the WL site during 1998 averaged 0.0015% of the DRL. This was an increase compared with 1997, though the releases continued to be very low, as has been the case during the past several years. Iodine-131 from the Immobilized Fuel Test Facility continued to be the nuclide showing the highest release as percentage of DRL, averaging 0.0013% of the DRL which is a very small quantity.

Radioactivity in the WL liquid releases was somewhat lower than in recent years. The sum of the average monthly releases of all monitored parameters was about 0.01% of the DRL. Caesium-137 continued to be the most abundant isotope emitted by any liquid effluent stream, averaging 0.0027% DRL. In 1998, caesium-137 was not detected in the sewage lagoon Effluent.

2. EFFLUENT MONITORING AT CRL AND WL

2.1 Site Effluent Verification Monitoring Programs

AECL maintains comprehensive Site Effluent Verification Monitoring Programs for CRL and WL sites to ensure that radiation exposures as a result of any releases of radioactive material in site effluents remain well below the annual dose limits specified in the Atomic Energy Control (AEC) Regulations, and as low as reasonably achievable, economic and social factors being taken into account (ALARA). The primary objectives of the Site Effluent Verification Monitoring Programs are:

- to verify compliance with regulatory emission limits and conformance with AECL's internal emission levels and guidelines,
- to provide a quantitative record of radioactive emissions to the environment that will permit assessment of potential radiological impacts on people and the environment as result of site operations,
- to provide independent verification of site and facility operational performance with respect to radioactive emissions, and
- to provide warning of abnormal emissions that may require investigation or corrective action.

The Site Effluent Verification Monitoring Programs operate under the direction of AECL's Environmental Protection Program, as described in the AECL Environmental Protection Program Manual, RC-2000-021 [4]. Monitoring is conducted by groups independent of the direct line management of the CRL and WL facilities.

Monitoring locations on airborne and liquid effluent streams are representative of the final discharge to the off-site environment, and may include the combined discharge from a number of facilities. Where necessary, additional monitoring points are maintained at upstream locations as an aid in identifying the specific sources of emissions. Sampling system design ensures that samples are representative of the total content of the stream at that location.

Appendices E and F show maps of the effluent monitoring locations/effluent streams at CRL and WL, respectively.

Effluent streams are monitored for all radionuclides or groups of radionuclides that are known to be or, are likely to be, present in the effluent, and that are likely to be a significant component of emissions via the monitored effluent stream, expressed as a percentage of applicable Derived Release Limits (DRLs – see below). Monitoring is conducted either by direct measurement or by sampling and analysis. In many cases, gross measurement parameters (for example, gross beta particulates) are monitored and reported rather than specific radionuclides, provided that, either the relative composition of radionuclides indicated by the gross parameter is not likely to vary significantly, or the that total emissions of the gross parameter is very small relative to the DRLs. For purposes of comparison with DRLs, the gross parameter is either assumed to consist solely of the most restrictive radionuclide, based on DRL value and, that is likely to be present in measurable quantities or, is assumed to be the radionuclide(s) known to be present as a result of periodic characterization of the effluent using other methods (for example, gamma spectrometry to identify individual gamma emitters, or chemical extraction and analysis of individual beta emitting radionuclides, such as strontium-90).

The significance of measured radioactive materials in airborne and liquid effluents is assessed, in this report, by comparison with DRLs that relate the releases to the potential radiation dose to the identified, most heavily exposed groups of people (this is, critical groups). DRLs are the upper limits for releases of radionuclides in airborne or liquid effluents from a facility or site, calculated in accordance with the principles and methodology in the National Standard of Canada, CAN/CSA-N.288.1 [5]. DRLs for CRL and WL are approved by the AECB, and specified in the CRL and WL Nuclear Research and Test Establishment Licenses [1, 2]. The DRL for a particular radionuclide is derived from the

regulatory limits for members of the public (currently, the effective whole body dose-equivalent of 5 mSv in a year² and applicable organ dose limits) as specified in the Atomic Energy Control Regulations. Analytical models of all significant environmental pathways to an individual in the critical group are used in the calculation. DRLs for CRL and WL have been calculated for a large number (65 to 75) of radionuclides, many of which are currently not detected, or specifically monitored, in site effluents. The intention is to establish, via RDL calculation, which of the nuclides may or may not be significant dose contributors (even in low quantities) and, thus aid in determining which nuclides warrant inclusion in the monitoring program and, in interpreting monitoring results.

The intention of the DRL is to establish a release limit such that compliance with it will give reasonable assurance that the annual regulatory dose limits for members of the public are not exceeded. In accordance with the standard N288.1 [5] weekly DRLs are calculated and applied for airborne effluents and monthly DRLs for liquid effluents. For multiple effluents and radionuclides at a site, verifying that the weighted sum of all releases as a percentage of the respective DRL is less than 100% provides a reasonable assurance that the annual dose limits have not been exceeded. This is a conservative approach since the critical group may differ for different release paths and radionuclides.

Site specific DRLs for WL are contained in references [7] and [8]. For CRL, the DRLs contained in reference [9], cited in previous years' editions of this effluent monitoring report, remained in effect until the end of October 1998. A new set of DRLs contained in reference [3], updating and superceding the previous DRL model and methodology, came into effect on 1999 November 01, with the issuing of the renewed CRL Nuclear Research and Test Establishment Licence [1]. The new DRL values CRL incorporate various subsequent advances in environmental transfer modeling and dose conversion factors, based on, for example, the 1990 recommendations by the International Commission on Radiological Protection (ICRP) [6].

In the body of this report, to facilitate trending, all radioactive releases are compared with DRLs that are based on dose to the most heavily exposed members of the public outside the site boundaries. For CRL, the comparison has been made with the new DRLs [3]. To demonstrate compliance throughout the year for CRL, Figures 1 to 4 and Appendices A and B also present comparisons with the DRLs that were in effect prior to 1998 November 01 [9]. Since the DRL reports [7, 8, 9] contain, for airborne emissions from some facilities at both CRL and WL, more restrictive DRL values based on potential dose to on-site workers (excluding facility operating staff), the Appendices of this report provide detailed weekly data in comparison with both the "boundary" DRL values and with the most restrictive DRL values whether on- or off-site, where they exist.

3. RADIOACTIVITY IN EFFLUENTS FROM CHALK RIVER LABORATORIES

3.1 CRL Airborne Effluents

3.1.1 Sources of Effluents

The major sources of airborne radioactive effluents from CRL are the NRU/NRX reactor stack that exhausts ventilation and cooling air from the NRU and NRX Research Reactors, the 61 metre stack that exhausts the Molybdenum-99 Production Facility (building 206), secondary roof vents exhausting various rooms within the NRU, and the roof vents of the Universal Cells (building 234), Fuels and Materials Cells (building 375), and the Heavy Water Upgrading Plant (building 210). Other monitored sources of airborne radioactive effluents are the roof vents of the Waste Treatment Centre (building 570), the Nuclear Fuel Fabrication Facilities (buildings 405 and 429A), the Hot Cells, the Tritium Laboratory and various other radioisotope laboratories in building 250, the NRX reactor facility that continued to be under decommissioning, the Decontamination Centre (building 468), the Filter Testing Laboratory in building 430, and various radioisotope laboratories in building 107.

3.1.2 Monitoring Program

In 1998, the CRL Air Effluent Verification Monitoring Program covered routine monitoring of argon-41 and fission product noble gases, carbon-14, tritium oxide (HTO), elemental tritium (HT), iodine-131, iodine-125, alpha particulates and beta particulates. Selection of the monitored parameters was based on the significance of the potential for radiation dose to members of the public from CRL's operations.

² The Atomic Energy Control Board has proposed to reduce the public dose limit to 1 mSv in a year, in line with the 1990 recommendations by the International Commission on Radiological Protection (ICRP) [6]. At the time when the reduced dose limit comes into effect, AECL DRL values will reflect the change.

Sampling of air effluent streams is continuous, through sample probes in the ventilation ducts or stacks downstream of any final filters or fans.³ The potentially contaminated air passes through different filters or impingers depending on the radionuclides being monitored. The filters or impinger fluids are collected and replaced at specified frequencies, at a minimum weekly, and transferred to CRL analytical laboratories for analysis.

In 1998, the NRU/NRX reactor stack emissions continued to be monitored at two stations: in building 163 downstream of exhaust filtration systems, about one kilometre upstream of the stack itself, and in building 109 at the base of the stack. The sampling station in building 109 supplemented the station in building 163. Effluent samples from both stations were analyzed throughout 1998.

For most of the CRL air effluent streams, the stack or roof vent flow data required to calculate emissions is an assumed flow value, generally the nominal maximum design flow. This tends to slightly overestimate the actual release. Velocity profile measurements are conducted periodically to determine the actual exhaust flow rates, to confirm that the assumed flows are representative.

Monitoring of tritium in air effluents is by sampling through a water-filled impinger ("bubbler"). Monitoring of carbon-14 is by sampling through a sodium hydroxide-filled impinger. Both fluid samples are analyzed using liquid scintillation counting.

Monitoring of radioactive particulates involves accumulating samples on glass fibre filters. The filters are analyzed for gross beta activity and, where necessary, for alpha activity with a gas flow proportional counter.

Monitoring of radioiodines and other potentially volatile radionuclides is by drawing air samples through triethylene diamine (TEDA) impregnated charcoal filled cartridges in series with the glass fibre particulate filters. Analysis of the particulate filter and charcoal canister is by gamma spectrometry using a hyperpure germanium detector.

Fission product noble gas emissions from the 61-metre stack (Molybdenum-99 Production Facility) are monitored by continuously drawing an air sample through an on-line monitor equipped with a sodium iodide gamma detector. The system generates real time release rates and integrated releases.

Argon-41 emissions from the NRU/NRX reactor stack are monitored and calculated using an Ambient Radiation Monitoring System (ARMS) station, that employ two Geiger tubes for greater range, mounted on the stack duct. Radiation levels on the duct are continuously monitored and the results continuously logged. To quantify the emissions, the system is calibrated against periodic grab samples of stack gases that are analyzed for argon-41. For comparison, argon-41 emissions are also estimated by correlating the periodic grab samples against reactor power output data, since argon-41 production rates are relatively constant in proportion to reactor power. Testing of an on-line gamma spectrometer and flow measurement system to continuously monitor the reactor stack gas sample stream continued.

Quality assurance program for CRL radiological air effluent monitoring activities is documented in Safety and Radiological Process Unit Manual (formerly Radiation Protection Branch) [13].

Map E1 in Appendix E shows monitoring locations for the most significant facilities/effluent streams.

3.1.3 1998 Monitoring Results

Table 1 provides a summary of 1998 air effluent monitoring results for CRL facilities listed in the CRL Research and Test Establishment Licence [1] and, for other CRL facilities that significantly contribute airborne radioactive effluents from CRL. Releases of radioactive materials are presented as average weekly release and as a percentage of the new DRL⁴ [3]. The maximum weekly release as a percentage of the DRL is also provided. Results for the four previous years are shown for comparison. Since alpha emitters have continued to be near or below detection limits, results for alpha particulate monitoring are not included in the data before 1996 in Table 1.

Figures 1, 2 and 3 depict the total annual airborne emissions of argon-41, tritium, and iodine-131, respectively, from the CRL site from 1989 to 1998. The emissions are as percentage of the new weekly DRLs [3], and for comparison, as percentage of the old DRL [9] based on dose to members of the public outside the site boundary.

³ Some individual facilities may also operate sampling stations upstream of final filtration as an operational convenience to aid in identifying specific sources of emissions.

⁴ DRL in effect as of November 01 [3].

Appendix A provides the detailed weekly results of CRL air effluent monitoring for 1998, along with annual summary statistics. Average and maximum weekly emissions are compared with both sets of DRLs, namely those in effect prior to [9] and as of November 01 [3]. For calculating annual averages, results below critical levels (Lc's) are conservatively assumed to be equal to the Lc.

For the NRU/NRX reactor stack, results from both the building 163 and the building 109 sample stations (see Section 3.1.2) are presented in Appendix A. The building 109 results are generally less than the building 163 results, and it is suspected this reflects deposition along the approximately 1 km length of exhaust duct between building 163 and the stack. For consistency with the earlier years' monitoring results, the 1998 building 163 sample results for tritium, gross beta particulates and radioiodines are used in the CRL site summary in Table 1.

All emissions of radioactive material in CRL airborne effluents during 1998 were well below regulatory limits as expressed by the DRLs, and slightly decreased compared with 1997. The sum of the average airborne weekly releases of all radionuclides from all monitored sources, as a percentage of the DRL was 2.76%.

Argon-41 emissions from the NRU/NRX reactor stack decreased slightly during 1998 but remained the dominant radioactive airborne emissions from CRL, averaging 2.43% of DRL, with a maximum weekly release of 3.94% DRL. As indicated in Figure 1, argon-41 emissions have remained well below the values when the NRX reactor was operating (NRX was shut-down in 1992). Argon-41 is produced by irradiation of natural argon in air within the NRU reactor structure, primarily the graphite thermal column.

Average weekly emissions of tritium from all monitored sources totalled 0.0152% of the DRL, being comparable to 1997 values (Figure 2) and well below values prior to 1992 when the NRX reactor was operating. It must be noted that the exceptionally high tritium releases in 1991, significantly above the previous years' levels, was mainly due to a leak in NRU (line 1212).

Annual average releases of iodine-131 increased to 0.18% of the DRL. The main contributor to the increase was an incident in the Fuels and Materials Cells (FMC) facility in September 1998, when unexpectedly large releases occurred during post-irradiation examination of a prototype UO_2 assembly. During normal operations, the NRU/NRX reactor stack remained the main source, releases averaging 0.041% DRL, a decrease compared with 1997. The maximum weekly iodine-131 release from the reactor stack was 0.89% DRL. The maximum weekly release from the FMC facility, as a result of the incident in September, was 3.00% DRL.

The average weekly release of iodine-125 decreased, being 0.023% of the DRL. The main contributor to the emissions and, to the decrease was the iodine-125 medical isotope production facility in the NRU.

Emissions of gross alpha and gross beta particulates in air effluents continued to be very small in comparison with DRLs, averaging 0.00018% of DRL and 0.0011% of DRL, respectively. The most significant source of alpha particulate emissions was a ventilation system (Fan E16/17) in the north end of building 250. The fan exhausts numerous Class C (very low level) radioisotope laboratories. Routine monitoring and reporting of this effluent route began in spring 1997. Subsequent investigation indicated that the source of the alpha emissions in this effluent is historic contamination within the ventilation system ductwork, rather than any current operations within the laboratories served by the system. The dominant source of beta particulate emissions remained the NRU/NRX reactor stack. Beta emissions from both the reactor stack and the Molybdenum -99 Production Facility stack appear to be exhibiting a slight increasing trend but the reason is not clear at this time.

TABLE 1: RADIONUCLIDES IN AIR EFFLUENTS FROM CRL FACILITIES ¹⁾ 1994 -- 1998

NUCLIDE OR PARAMETER Source	DRL * Bq/week	Average Weekly Release										Max. Release 1998	
		1994		1995		1996		1997		1998		1998	
		Bq/week	%DRL	Bq/week	%DRL	Bq/week	%DRL	Bq/week	%DRL	Bq/week	%DRL	(Bq/week)	%DRL
Argon-41													
NRU/NRX Stack	1.46E+16	3.20E+14	2.19E+00	3.80E+14	2.60E+00	4.40E+14	3.01E+00	3.72E+14	2.55E+00	3.55E+14	2.43E+00	5.75E+14	3.94E+00
Fission Product Noble Gases													
61m Mo99 Stack ** (Bq/Mev)	7.39E+15	1.10E+13	1.49E-01	8.30E+12	1.12E-01	5.60E+12	7.58E-02	1.49E+13	2.02E-01	7.78E+12	1.05E-01	1.97E+13	2.67E-01
Carbon-14													
Reactor Stack	1.91E+14							1.23E+10	6.44E-03	1.26E+10	6.59E-03	3.34E+10	1.75E-02
Tritium Oxide (HTO)													
NRU/NRX Stack	3.05E+16	1.20E+12	3.93E-03	7.90E+11	2.59E-03	1.50E+12	4.92E-03	1.44E+12	4.72E-03	2.22E+12	7.28E-03	5.30E+12	1.74E-02
NRU Roof Vents	3.05E+16	1.30E+12	4.26E-03	1.40E+12	4.59E-03	1.70E+12	5.57E-03	1.80E+12	5.90E-03	1.47E+12	4.80E-03	2.20E+12	7.21E-03
Heavy Water Upgrading Plant	3.05E+16	1.90E+11	6.23E-04	1.30E+11	4.26E-04	1.20E+11	3.93E-04	1.24E+12	4.07E-03	9.22E+11	3.02E-03	2.45E+12	8.03E-03
Waste Treatment Centre	3.05E+16	3.90E+08	1.28E-06	6.70E+08	2.20E-06	1.40E+09	4.59E-06	1.16E+09	3.80E-06	7.58E+08	2.49E-06	6.07E+09	1.99E-05
Other	3.05E+16	7.00E+09	2.30E-05	2.30E+10	7.54E-05	3.50E+10	1.15E-04	3.04E+10	9.97E-05	2.73E+10	8.95E-05	2.17E+11	7.11E-04
Total		2.70E+12	8.84E-03	2.34E+12	7.68E-03	3.36E+12	1.10E-02	4.51E+12	1.48E-02	4.64E+12	1.52E-02	***	***
Elemental Tritium (HT)													
Bldg.250 Tritium Laboratory	1.43E+18	6.90E+10	4.83E-06	5.40E+10	3.78E-06	1.30E+11	9.09E-06	6.12E+10	4.28E-06	5.67E+10	3.96E-06	4.81E+11	3.36E-05
Experim. Field Release	1.43E+18	2.10E+11	1.47E-05										
Total		2.79E+11	1.95E-05	5.40E+10	3.78E-06	1.30E+11	9.09E-06	6.12E+10	4.28E-06	5.67E+10	3.96E-06	***	***
Iodine-131													
NRU/NRX Stack	1.36E+11	1.80E+07	1.32E-02	3.40E+07	2.50E-02	5.90E+07	4.34E-02	1.07E+08	7.87E-02	5.61E+07	4.13E-02	1.21E+09	8.90E-01
61m Mo99 Stack	1.36E+11	2.20E+07	1.62E-02	1.50E+07	1.10E-02	1.50E+07	1.10E-02	2.55E+07	1.88E-02	3.03E+07	2.22E-02	1.92E+08	1.41E-01
NRU Roof Vents	1.36E+11	2.20E+06	1.62E-03	2.00E+06	1.47E-03	1.80E+06	1.32E-03	1.33E+06	9.78E-04	1.93E+06	1.42E-03	3.78E+07	2.76E-02
Fuels and Materials Cells	1.36E+11	9.50E+05	6.99E-04	5.10E+05	3.75E-04	3.40E+05	2.50E-04	3.73E+05	2.74E-04	1.54E+08	1.13E-01	4.08E+09	3.00E+00
Decontam. Centre	1.36E+11							2.61E+06	1.92E-03	7.88E+05	5.80E-04	2.06E+07	1.51E-02
Waste Treatment Centre	1.36E+11							6.65E+04	4.89E-05	1.88E+04	1.38E-05	1.26E+05	9.26E-05
Other	1.36E+11	5.70E+06	4.19E-03	3.10E+06	2.28E-03	5.00E+06	3.68E-03	3.50E+06	2.57E-03	3.82E+06	2.81E-03	1.75E+07	4.18E+11
Total		4.89E+07	3.59E-02	5.46E+07	4.02E-02	8.11E+07	5.97E-02	1.40E+08	1.03E-01	2.47E+08	1.81E-01	***	***
Iodine-125													
NRU/NRX Stack	8.98E+10	1.20E+07	1.34E-02	3.20E+06	3.56E-03	2.10E+07	2.34E-02	2.76E+07	3.07E-02	1.86E+07	2.08E-02	7.67E+07	8.54E-02
NRU Roof Vents	8.98E+10	1.60E+06	1.78E-03	6.80E+06	7.57E-03	2.30E+06	2.56E-03	6.32E+06	7.04E-03	2.00E+06	2.22E-03	4.07E+07	4.53E-02
NRX Roof Vent	8.98E+10	1.20E+04	1.34E-05	3.30E+03	3.67E-06								
Decontam. Centre	8.98E+10			5.20E+05	5.79E-04	1.50E+06	1.67E-03	1.70E+06	1.89E-03	8.50E+03	9.47E-06	1.02E+05	1.14E-04
Total		1.36E+07	1.52E-02	1.05E+07	1.17E-02	2.48E+07	2.76E-02	3.56E+07	3.97E-02	2.06E+07	2.30E-02	***	***
Alpha Particulates 2)													
NRU/NRX Stack	5.21E+09					2.70E+03	5.18E-05	2.88E+03	5.53E-05	3.14E+03	6.03E-05	3.99E+03	7.66E-05
NRU Roof Vents	5.21E+09							1.16E+02	2.23E-06	1.15E+02	2.21E-06	1.64E+02	3.15E-06
Recycle Fuel Fab. Laboratories	5.21E+09			7.40E+02	1.42E-05	2.60E+02	4.99E-06	1.26E+02	2.42E-06	1.26E+02	2.42E-06	1.82E+02	3.49E-06
Waste Treatment Centre	5.21E+09	7.50E+01	1.44E-06	1.10E+02	2.11E-06	1.20E+02	2.30E-06	5.89E+01	1.13E-06	5.83E+01	1.12E-06	1.18E+02	2.26E-06
Nuclear Fuel Fab. Laboratories	1.93E+10	2.50E+02	1.30E-06	4.41E+02	2.28E-06	4.62E+02	2.39E-06	2.12E+02	1.10E-06	2.97E+01	1.54E-07	3.13E+02	1.62E-06
Bldg. 250 Misc. Laboratories	5.21E+09							3.86E+03	7.41E-05	4.56E+03	8.76E-05	2.41E+04	4.63E-04
Other	5.21E+09					9.00E+02	1.73E-05	9.60E+02	1.84E-05	1.13E+03	2.16E-05	5.46E+02	1.05E-05
Total		3.25E+02	2.73E-06	1.29E+03	1.86E-05	4.44E+03	7.88E-05	8.21E+03	1.55E-04	9.16E+03	1.75E-04	***	***
Beta Particulates 3)													
NRU/NRX Stack	4.34E+11	6.10E+05	1.41E-04	5.40E+05	1.24E-04	4.80E+05	1.11E-04	1.73E+06	3.89E-04	2.74E+06	6.32E-04	1.08E+07	2.49E-03
NRU Roof Vents	4.34E+11							4.11E+03	9.47E-07	3.65E+03	8.41E-07	2.14E+04	4.93E-06
61m Mo99 Stack	4.34E+11	3.80E+05	8.76E-05	2.00E+05	4.61E-05	2.20E+05	5.07E-05	7.05E+04	1.62E-05	1.53E+06	3.52E-04	5.34E+07	1.23E-02
Universal Cells	4.34E+11							1.70E+04	3.92E-06	4.24E+04	9.77E-06	1.01E+06	2.33E-04
Bldg. 250 (Lab. Building)	4.34E+11							2.08E+05	4.79E-05	2.87E+05	6.62E-05	2.86E+06	6.59E-04
Fuels and Materials Cells	4.34E+11							2.89E+03	6.66E-07	1.04E+04	2.40E-06	1.87E+05	4.31E-05
Other	4.34E+11	3.80E+04	8.76E-06	5.80E+04	1.34E-05	4.40E+04	1.01E-05	3.57E+04	8.22E-06	4.01E+04	9.24E-06	1.95E+05	4.50E-05
Total		1.03E+06	2.37E-04	7.98E+05	1.84E-04	7.44E+05	1.71E-04	2.07E+06	4.77E-04	4.66E+06	1.07E-03	***	***
CRL SITE TOTAL			2.40E+00		2.77E+00		3.19E+00		2.91E+00		2.76E+00		

1) Data for NRU/NRX stack emissions (except Ar-41 and alpha particulates) are based on sampling in Bldg. 163. Results from the monitoring at the Bldg. 109 sample station are included in Appendix A, for comparison.

*DRL in effect as of 1998 November 01, based on members of the public at CRL boundary [3]. ** Units for mixed fission product noble gas releases from 61m stack are Bq.MeV.

2) For comparison to DRLs, particulate alpha emissions are considered to consist entirely of plutonium-239. Particulate alpha emissions from the Nuclear Fuel Fabrication Facility (NFF) are assumed to consist of uranium-234 since plutonium-239 is not present.

3) For comparison to DRLs, gross beta particulate releases are assumed to consist of strontium 90.

***Maximum releases from different facilities do not necessarily occur simultaneously and therefore are not additive.

**Figure 1: CRL Airborne Argon-41 Emissions
1989 -- 1998**

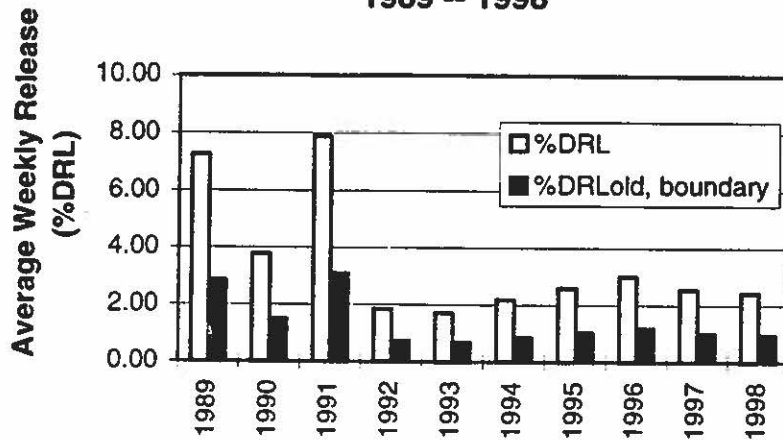
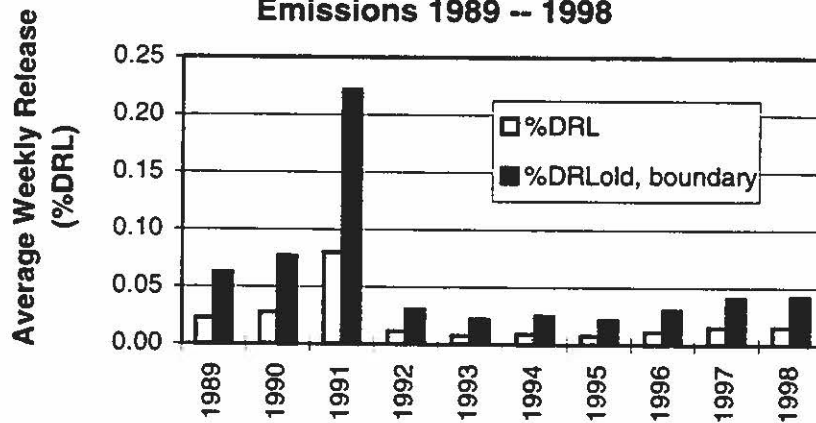
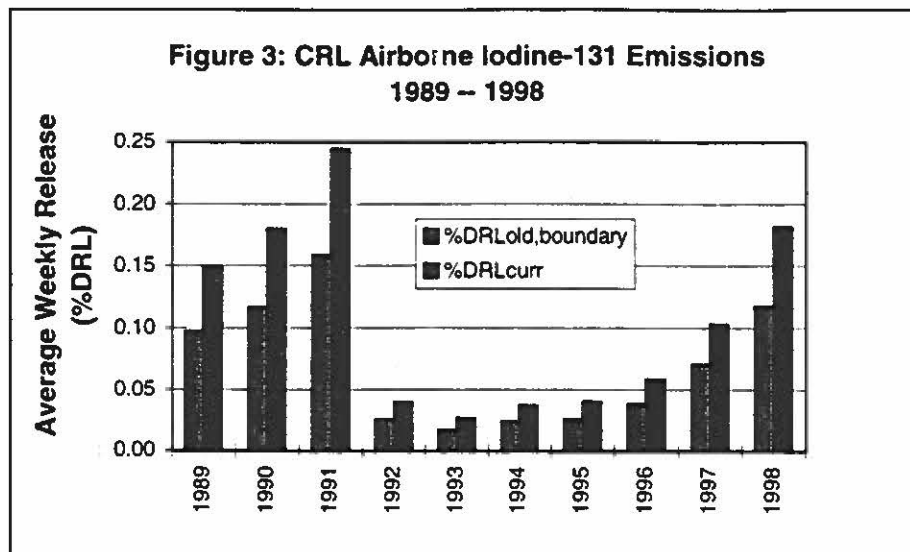


**Figure 2: CRL Airborne Tritium (HTO)
Emissions 1989 -- 1998**





3.2 CRL Liquid Effluents

3.2.1 Sources of Effluents

Small quantities of radionuclides are released from the CRL site in liquid effluent streams discharging either directly to the Ottawa River, or indirectly to the Ottawa River by way of Maskinonge Lake and Chalk (Sturgeon) Lake. The main sources of CRL liquid effluent discharges directly into the Ottawa River are:

- The Process Sewer that carries cooling water and sump discharges from the NRU reactor, from the Heavy Water Upgrading Plant and various other facilities, as well as decontaminated water produced after processing liquid wastes in the Waste Treatment Centre.
- The Sanitary Sewer that collects domestic type waste water from throughout the CRL site, as well as effluent from the Controlled Area 2 (formerly Active Area) laundry.
- The 04 Storm Sewer that carries surface runoff, roof drainage, and subsurface drainage from the majority of the Controlled Area 2, as well as some equipment cooling water.
- The 03 Stream that carries surface runoff, and subsurface drainage mainly from CRL Site Controlled Area 1 (reported prior to 1997 under the CRL Environmental Monitoring Program in AECL-MISC-362 Vol. 3).
- The 05 Stream that carries surface runoff, and subsurface drainage mainly from west parts of CRL Site Controlled Area 2 (reported prior to 1997 under the CRL Environmental Monitoring Program in AECL-MISC-362 Vol. 3).
- The Perch Creek, that carries drainage from Perch Lake whose drainage basin contains several of CRL's Waste Management Area facilities.

The three main effluent streams discharging indirectly by way of Maskinonge Lake are Duke Stream, Bulk Storage Stream and Lower Bass Lake Inlet Stream, which drain the region containing the remaining CRL radioactive Waste Management Area facilities.

3.2.2 Monitoring Program

The Process Sewer, Sanitary Sewer, 04 Storm Sewer, 03 Stream, 05 Stream, and Perch Creek all of which flow directly into the Ottawa River, are monitored close to their final points of discharge.

Releases by way of Maskinonge Lake are monitored at three streams discharging into Maskinonge Lake, namely Duke Stream, Bulk Storage Stream and Lower Bass Lake Inlet Stream. On some of these streams, there are also sampling points at various upstream locations that are used as an operational aid to determining the specific sources of emissions.

The Process Sewer, Sanitary Sewer and 04 Storm Sewer are sampled at the final point of discharge by means of automatic samplers that collect sub-samples at a high frequency, usually once every 15 minutes. The composite water samples are usually collected from the samplers and transferred daily to the CRL analytical environmental laboratory. While screening analyses may be carried out using portions of some of the daily samples, weekly and/or monthly composite samples are prepared from the daily samples for quantitative analysis. Continuous integrated flow measurements on these streams (in the case of the Process Sewer, the measured flow of cooling water to the NRU reactor) are used in conjunction with the analytical sample results to calculate total discharge.

The effluent streams carrying drainage from the Waste Management Areas (Perch Creek, Duke Stream, Bulk Storage Stream, Lower Bass Lake Inlet Stream, 03 Stream and 05 Stream), in which the concentrations of radionuclides do not vary significantly over short time periods, are generally sampled by means of weekly manual grab samples. Flow measurements used in calculation of total discharge loadings from Perch Creek, Duke Stream, Bulk Storage Stream, Lower Bass Lake Inlet Stream, were obtained either by continuous data logging, or manual measurement at the time of sampling, of water level at weirs in the streams. Flow values for 03 Stream and 05 Stream were estimated based on dye tracer dilution flow measurements in 1991 and 1996.

Laboratory analyses to determine concentrations of gross radiological parameters or specific radionuclides of concern are carried out at specified frequencies.

Analysis for tritium is performed by liquid scintillation counting. Analyses for gross beta are carried out by evaporating acidified samples to dryness on a planchet and counting on a gas flow proportional counter.

"Nominal" beta analyses of the CRL Process Sewer effluent are done in the same manner after a period of 5 to 7 days, corresponding approximately to the travel time to the nearest downstream community drinking water intake, allowing for decay of short lived activation products such as sodium-24.

Samples for gross alpha analysis are prepared in the same manner as the gross beta samples, and counted using a gas flow proportional counter.

Samples are analysed for individual gamma emitters by slowly evaporating the samples in polyethylene lined trays, compressing the liner into a compact source and analysing by high resolution gamma spectrometry.

Specific analysis for strontium-90 is by radiochemically separating and precipitating the strontium as strontium carbonate* from the water sample, and counting the precipitate with a gas flow proportional counter.

Phosphorus-32 analysis is by chemical precipitation of the phosphorus, and counting by liquid scintillation methods.

Specific analysis for plutonium isotopes is by radiochemical separation of the sample, and counting using alpha spectrometry.

The quality assurance program for CRL radiological liquid effluent monitoring activities is documented in CRL Environmental Research Branch Environmental Monitoring QA Manual [12].

Map E1 in Appendix E shows the monitoring locations.

3.2.3 1998 Monitoring Results

Table 2 provides a summary of the 1998 monitoring results for the six effluent streams flowing directly into the Ottawa River, and the total releases into Maskinonge Lake. Results are presented as average monthly release and as percentages of the monthly DRLs⁵ [3]. Data for the four previous years are shown for comparison. Note that in the new DRL report [3], a separate, more restrictive set of DRL values was established for discharges by way of Maskinonge Lake, based on hypothetical dose to recreational users of Sturgeon (Chalk) Lake located within the Canadian Forces Base (CFB) in Petawawa. The DRLs for direct discharges to the Ottawa River are based on permanent residents on the shores of the

⁵ DRLs in effect as of 1998 November 01 [3].

Ottawa River. The dose impact of Maskinonge Lake discharges on Ottawa River residents would be less than their relative impact on users of Sturgeon (Chalk) Lake. Thus, the summation of emissions in Table 2 conservatively over-estimates the potential dose impact to either group of people.

Appendix B provides detailed monthly monitoring results for CRL liquid effluent streams, along with annual summary statistics, and radionuclide characterization data obtained by gamma spectrometry. Results below detection limits are conservatively assumed to be equal to the detection limit for purposes of reporting monthly emissions and calculating annual averages.

Figures 4a and 4b depict graphically the trend in total annual CRL site emissions of all radionuclides from all effluent streams from 1994 to 1998, expressed as percent of DRL in effect as of 1998 November 01 [3], and the DRL in effect prior to 1998 November 01 [10]. The contributions of three most significant radionuclides in CRL liquid effluents, namely caesium-137, phosphorus-32 and tritium, are indicated.

All liquid emissions from CRL in 1998 were a small fraction of the respective DRLs. The total releases from all effluent streams averaged 0.216% of the DRLs, being slightly higher than in 1997, but significantly below 1991 levels, as a result of the shutdown of the NRX reactor early in 1992.

Radioactive effluents from the Process Sewer decreased, but remained the dominant radioactive liquid releases from CRL, monthly average releases totalling 0.144% of the DRL. The decrease was mainly due to the decreased phosphorus-32 releases from the NRU. P-32 continued to be the most significant radionuclide in the Process Sewer releases, averaging 0.066% of the DRL, followed by caesium-137, averaging 0.046% of the DRL. The maximum monthly release of P-32 was 0.167% of the DRL, a slight decrease compared with 1997. P-32 (half life 14 days), and other short-lived activation products such as sodium-24 and arsenic-76, are produced as a result of neutron activation of minerals in water used for once through cooling of loop test sections in the NRU reactor when the U-1 Loop and /or U-2 Loop are not available to provide cooling.

Caesium-137 emissions consisted, in 1998, primarily of discharges from the Waste Treatment Centre operations (buildings 570, 205, and 102). Cs-137 releases were somewhat higher than in 1997, averaging 0.046% of the DRL. The maximum monthly release was 0.11% of the DRL, an increase compared with 1997.

The AECB-approved planned releases of stored accumulated very low-grade heavy water from the CRL Heavy Water Upgrading Plant via the Process Sewer continued. Tritium releases from the Process Sewer averaged 0.0013% of the DRL, a slight increase compared with 1997.

Most other radionuclides in the Process Sewer emissions were near or less than detection limits (see Table B1). In general, releases by other CRL liquid effluent streams were somewhat higher than in 1997 (see Table 2), but remained a small fraction of total site emissions. Gross beta activity in discharges to Maskinonge Lake increased, averaging 0.034% of the DRL. A significantly increased value was observed in releases via Lower Bass Lake Inlet in December, due to ground water pumping during construction of remedial action system designed to intercept historic contamination plume work in the Waste Management Areas (see Table B3).

TABLE 2: Radioactive Liquid Releases from Chalk River Laboratories 1994 -- 1998

Nuclide/ Parameter	DRL (1) Bq/month	ANNUAL AVERAGE RELEASE										MAX. RELEASE	
		1994		1995		1996		1997		1998		1998	
		Bq/month	%DRL	Bq/month	%DRL	Bq/month	%DRL	Bq/month	%DRL	Bq/month	%DRL	Bq/month	%DRL
PROCESS SEWER													
Cs-137	6.80E+12	4.40E+09	6.47E-02	6.00E+09	8.82E-02	4.51E+09	6.63E-02	2.20E+09	3.24E-02	3.13E+09	4.60E-02	7.46E+09	1.10E-01
P-32	2.13E+12	###	###	1.50E+09	7.04E-02	2.00E+09	9.39E-02	2.60E+09	1.22E-01	1.40E+09	6.56E-02	3.55E+09	1.67E-01
Na-24	4.85E+15	2.50E+11	5.15E-03	3.20E+11	6.60E-03	1.90E+11	3.91E-03	8.96E+10	1.85E-03	1.39E+11	2.87E-03	4.77E+11	9.83E-03
Co-60	3.85E+13	2.60E+09	6.75E-03	1.80E+09	4.68E-03	1.84E+09	4.78E-03	1.45E+09	3.77E-03	2.41E+09	6.25E-03	7.39E+09	1.92E-02
Cs-134	5.08E+12	3.00E+08	5.91E-03	4.00E+08	7.87E-03	5.65E+08	1.11E-02	2.30E+08	4.53E-03	1.91E+08	3.75E-03	3.57E+08	7.02E-03
HTO (Tritium Oxide)	6.65E+17	9.70E+11	1.46E-04	1.66E+12	2.49E-04	3.53E+12	5.30E-04	7.35E+12	1.11E-03	8.89E+12	1.34E-03	2.98E+13	4.48E-03
As-76	2.95E+14	5.20E+09	1.76E-03	4.47E+00	1.51E-12	5.23E+09	1.77E-03	7.85E+09	2.66E-03	8.01E+09	2.72E-03	1.78E+10	6.04E-03
Total Alpha**	2.60E+12	1.40E+08	5.38E-03	1.00E+08	3.85E-03	8.98E+07	3.45E-03	1.60E+08	6.15E-03	2.27E+08	8.74E-03	5.12E+08	1.97E-02
I-131	2.60E+13	6.40E+08	2.46E-03	1.20E+09	4.62E-03	5.35E+08	2.06E-03	4.00E+08	1.54E-03	2.67E+08	1.03E-03	5.27E+08	2.03E-03
Sr-90	3.54E+13	2.70E+08	7.63E-04	3.00E+08	8.47E-04	1.08E+09	3.06E-03	4.60E+08	1.30E-03	3.44E+08	9.71E-04	8.51E+08	2.40E-03
Ce-144	1.80E+14	4.30E+08	2.39E-04	1.00E+08	5.56E-05	4.73E+08	2.63E-04	3.00E+08	1.67E-04	3.97E+08	2.21E-04	1.29E+09	7.14E-04
Other Nuclides (2)		1.20E+10	4.50E-03	1.10E+10	2.63E-03	6.68E+09	5.87E-03	6.90E+09	8.60E-03	1.07E+10	4.55E-03	***	***
Sum%DRL			9.78E-02		1.90E-01		1.97E-01		1.86E-01		1.44E-01		
SANITARY SEWER													
HTO (Tritium Oxide)	6.65E+17	1.40E+10	4.80E-05	3.90E+10	1.30E-04	6.50E+10	2.30E-04	9.60E+09	1.44E-06	5.76E+09	8.66E-07	1.03E+10	1.55E-06
Gross Beta*	3.54E+13	3.00E+07	2.20E-05	3.00E+07	2.20E-05	7.10E+07	5.10E-05	5.10E+07	1.44E-04	3.44E+07	9.71E-05	6.81E+07	1.92E-04
Gross Alpha (†)	2.60E+12					8.70E+05	5.10E-05	5.40E+06	2.08E-04	3.86E+06	1.49E-04	1.18E+07	4.54E-04
Sum%DRL			7.00E-05		1.52E-04		3.32E-04		3.53E-04		2.47E-04	***	***
04 STORM SEWER													
HTO (Tritium Oxide)	6.65E+17	8.60E+11	2.90E-03	9.40E+11	3.20E-03	7.90E+11	2.70E-03	7.90E+11	1.19E-04	9.14E+11	1.37E-04	2.23E+12	3.35E-04
Gross Beta*	3.54E+13	4.90E+08	3.60E-04	4.80E+08	3.40E-04	6.40E+08	4.60E-04	6.10E+08	1.72E-03	4.94E+08	1.39E-03	1.03E+09	2.91E-03
Gross Alpha (Estim.**)	2.60E+12					2.80E+06	1.08E-04	1.30E+07	5.00E-04	2.96E+07	1.14E-03	1.64E+08	6.31E-03
Sum%DRL			3.26E-03		3.54E-03		3.27E-03		2.34E-03		2.67E-03	***	***
03 STREAM													
HTO (Tritium Oxide)	6.65E+17	2.03E+10	3.05E-06	1.54E+10	2.32E-06	1.62E+11	2.44E-05	2.17E+11	3.26E-05	4.25E+10	6.39E-06	9.07E+10	1.36E-05
Gross Beta*	3.54E+13	1.75E+07	4.94E-05	1.40E+07	3.95E-05	1.05E+08	2.97E-04	2.00E+08	5.65E-04	1.10E+08	3.12E-04	2.25E+08	6.36E-04
Gross Alpha (Estim.**)	2.60E+12							1.67E+06	6.41E-05	7.61E+06	2.93E-04	1.83E+07	7.03E-04
Sum%DRL			5.25E-05		4.19E-05		3.21E-04		6.62E-04		6.11E-04	***	***
05 STREAM													
HTO (Tritium Oxide)	6.65E+17	4.45E+10	6.69E-06	1.77E+10	2.66E-06	1.64E+10	2.47E-06	5.00E+09	7.52E-07	4.70E+09	7.07E-07	9.01E+09	1.35E-06
Gross Beta*	3.54E+13	1.31E+06	3.70E-06	2.76E+06	7.80E-06	1.44E+06	4.07E-06	3.60E+06	1.02E-05	2.46E+06	6.94E-06	7.83E+06	2.21E-05
Gross Alpha (Estim.**)	2.60E+12							2.25E+05	8.65E-06	4.31E+05	1.66E-05	1.37E+06	5.27E-05
Sum%DRL			1.04E-05		1.05E-05		6.53E-06		1.96E-05		2.42E-05	***	***
PERCH CREEK													
HTO (Tritium Oxide)	6.65E+17	2.40E+12	8.20E-03	2.60E+12	9.00E-03	3.40E+12	1.20E-02	1.90E+12	2.86E-04	1.81E+12	2.71E-04	9.99E+12	1.50E-03
Gross Beta*	3.54E+13	1.40E+09	1.00E-03	1.50E+09	1.10E-03	2.60E+09	1.90E-03	1.80E+09	5.08E-03	1.67E+09	4.72E-03	1.00E+10	2.82E-02
Gross Alpha (Estim.**)	2.60E+12					9.20E+06	3.54E-04	1.00E+07	3.85E-04	1.11E+07	4.25E-04	5.06E+07	1.95E-03
Sum%DRL			9.20E-03		1.01E-02		1.43E-02		5.76E-03		5.42E-03	***	***
DISCHARGES TO MASKINONGE LAKE***													
HTO (Tritium Oxide)	2.38E+16	1.70E+12	5.80E-03	1.50E+12	5.10E-03	1.50E+12	4.96E-03	1.21E+12	4.10E-03	1.08E+12	4.56E-03	2.10E+12	8.84E-03
Gross Beta*	2.60E+11	5.70E+06	4.20E-06	7.80E+06	5.60E-06	8.80E+06	6.21E-06	2.60E+07	1.00E-02	9.90E+07	3.81E-02	9.99E+08	3.84E-01
Gross Alpha (Estim.**)	1.13E+10					2.45E+05	2.17E-03	5.85E+05	5.18E-03	2.29E+06	2.03E-02	6.39E+06	5.66E-02
Sum%DRL			5.80E-03		5.11E-03		7.13E-03		1.93E-02		6.29E-02	***	***
DRL SITE TOTAL													
Sum%DRL			1.16E-01		2.09E-01		2.22E-01		2.14E-01		2.16E-01		

- 1) DRL = Derived Release Limit in effect as of 1998 November 01 [3].
 2) Other radionuclides identified by gamma spectroscopy, predominantly short-lived activation products.
 3) Releases below detection limits are considered equal to the detection limit (i.e., not "0" as applied for alpha and beta releases in earlier reports)
 *** Routine monitoring for phosphorus-32 was initiated in 1995.
 For comparison with DRLs, gross beta releases are assumed to consist of strontium-90.
 For comparison with DRLs, gross alpha releases are assumed to consist of americium-241.
 Sum of discharges via Duke, Lower Bass lake Inlet, and Bulk Storage Streams.
 *** Maximum monthly releases for different effluent streams and nuclides do not necessarily occur simultaneously, and therefore are not additive.

**Figure 4a: Radionuclides in CRL Liquid Effluents
Annual Average Releases
1994 - 1998 (%DRL)**

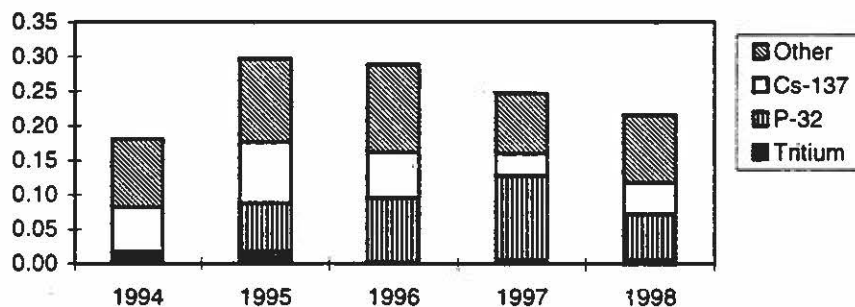
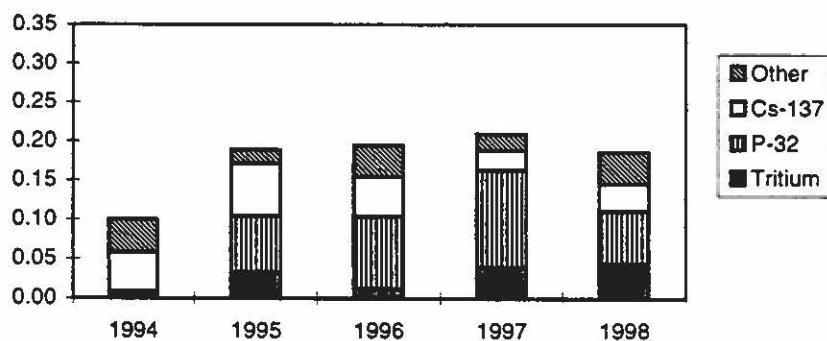


**Figure 4b: Radionuclides in CRL Liquid Effluents
Annual Average Releases 1994 - 1998 (%DRL old)**



4. RADIOACTIVITY IN EFFLUENTS FROM WHITESHELL LABORATORIES

4.1 WL Airborne Effluents

4.1.1 Sources of Effluents

The major sources of airborne radioactive effluents from WL are:

- the reactor building (building 100) stack;
- the Active Liquid Waste Treatment Centre (building 200);
- the Hot Cells Facility;
- the Immobilized Fuel Test Facility;
- Laboratory 2-136 in building 300; and
- the Incinerator and the Compactor/Baler in the Waste Management Area.

4.1.2 Monitoring Program

The air effluents from Buildings 300, 100 and 200 are sampled continuously throughout the year. The incinerator and compactor/baler are also sampled continuously but only during the periods when they are operating.

Air to be monitored is drawn by sample probes located in the exhausts of the facilities, pumped through filters and then returned to the exhausts. The types of filters used depend on the radionuclides to be monitored. Glass fiber or Millipore filters are used for sampling for gross beta, gross alpha or gamma spectrometry. Canisters filled with TEDA impregnated charcoal or silver zeolite are used for radioiodines and other potentially volatile radionuclides. The filters are collected regularly and radiochemically counted.

Filters are analyzed for gross alpha, gross beta and/or by gamma spectrometry as appropriate. Gamma spectrometric analysis includes a range of radionuclides including radon, thoron, arsenic-76, caesium-137, iodine-131, cerium-144, ruthenium-106, zirconium-95 and niobium-95 and antimony-125. Tritium (for effluents from the reactor building) is monitored by passing the air to be sampled through water bubblers and then analyzing the water by liquid scintillation counting.

Activities measured in the laboratory are used in conjunction with measured exhaust stack flow rates to calculate the release in becquerels (Bq). The lower limit of detection (LLD) is the product of the release factor of the source and the laboratory Minimum Detectable Activity (MDA).

Derived Release Limits (DRLs) have been calculated for 74 radionuclides for airborne effluents at WL [7, 8]. The DRLs used in the summary tables in the body of the text of this report, are for members of the public at the boundary of the WL. Appendix C also provides comparison to the DRLs based on dose to on-site personnel from airborne radioactive releases from the WL site. For gross alpha or gross beta activities, the DRL applied is the lowest from amongst the radionuclides that could be causing that activity, i.e., strontium-90 for gross beta and americium-241 for gross alpha. Sampling procedures, field operating procedures, laboratory procedures, equipment performance checks, quality verification procedures and laboratory administrative procedures are described in detail in WL Environmental Monitoring QA Manual [14].

Map F1 in Appendix F shows the release points/monitoring locations.

4.1.3 1998 Monitoring Results

Table 3 provides a summary of air effluent monitoring results for WL during 1998. Results for the three previous years are also shown for comparison. Average weekly emissions, in becquerels and as percentage of DRLs, and the maximum weekly emissions as percentage of DRLs are shown for tritium, gross beta and iodine-131 for facilities in buildings 300, 200 and 100. The releases from the various sources at WL for various radionuclides, expressed in percentages of DRLs, are added for each year to provide an indicator of the performance of the site. It can be noted that the highest such sum is for 1996 and equals 0.0057%. The corresponding sum for 1998 is 0.0015%. It is thus established that the releases in all cases are very small, well below one thousandth of the DRLs, and that this situation has been stable over several years. The year to year variations within these extremely small numbers are of no consequence.

Tables C1 to C4 in Appendix C show the detailed weekly results for 1998 for airborne effluents from the sources in buildings 300, 100 and 200 at WL. Each table is for a given source or sources and shows the weekly releases in becquerels for all 52 weeks of the year for the sampled radionuclides. Releases below the LLD are shown by the symbol "<" and, as in previous reports, are not included in the totals for the year. Also shown in the tables are: the total releases for the year; the average, minimum and maximum weekly releases; the average and maximum weekly releases as percentages of DRLs; and the LLDs. The average is the total divided by 52. The minimum is the minimum reported emission above the LLD. Tables C5 and C6 show similar results for the Incinerator and Compactor/Baler, but only for the periods when these facilities were operating.

TABLE 3: RADIONUCLIDES IN AIR EFFLUENTS FROM WL FACILITIES -- 1995 TO 1998

	DRL* (Bq/wk)	AVERAGE WEEKLY RELEASE								1998 Max Weekly Release (%DRL)
		1995 (Bq/wk)	1995 (% DRL)	1996 (Bq/wk)	1996 (% DRL)	1997 (Bq/wk)	1997 (% DRL)	1998 (Bq/wk)	1998 (%DRL)	
Tritium										
Reactor Building	9.76E+15	4.8E+09	4.9E-05	9.7E+09	9.9E-05	2.0E+09	2.1E-05	1.9E+09	1.9E-05	5.7E-5
Beta**										
Reactor Building	3.21E+10	7.9E+03	2.5E-05	5.8E+03	1.8E-05	7.1E+03	2.2E-05	3.8E+03	1.2E-05	2.3E-5
ALWTC	9.83E+09	5.6E+03	5.7E-05	1.1E+04	1.1E-04	3.6E+03	3.6E-05	1.7E+03	1.8E-05	5.1E-5
Hot Cell Facility	1.05E+10	1.7E+04	1.6E-04	1.0E+04	9.7E-05	8.0E+03	7.7E-05	6.1E+03	5.8E-05	1.3E-4
IFTF	1.05E+10	4.8E+03	4.6E-05	4.9E+03	4.7E-05	3.0E+03	2.8E-05	4.1E+03	3.9E-05	1.0E-4
Incinerator	1.50E+11	7.1E+02	4.7E-07	1.5E+04	9.9E-06	2.7E+03	1.8E-06	2.9E+04	1.9E-05	6.5E-4
Compactor/Bailer	4.64E+09	2.8E+02	6.0E-06	2.1E+02	4.5E-06	3.4E+02	7.4E-06	3.9E+02	8.4E-06	1.6E-4
Total Beta		3.6E+04	2.9E-04	4.7E+04	2.9E-04	2.5E+04	1.7E-04	4.5E+04	1.5E-04	
Iodine-131										
ALWTC	6.82E+09	2.96E+03	4.33E-05	<	<	<	<	<	<	<
Hot Cell Facility	7.25E+09	3.13E+04	4.29E-04	<	<	<	<	<	<	<
IFTF	7.25E+09	2.46E+03	3.40E-05	3.8E+05	5.3E-03	1.4E+04	1.9E-04	9.6E4	1.3E-03	3.4E-2
Total Iodine-131		3.7E+04	5.1E-04	3.8E+05	5.3E-03	1.4E+04	1.9E-04	9.6E4	1.3E-03	
Total			0.0009		0.0057		0.0004		0.0015	

* DRL for members of the public at the WL boundary.

** The DRL for strontium-90 is applied to beta activity.

4.2 WL Liquid Effluents

4.2.1 Sources of Effluents

The primary source of liquid radioactive effluents at WL is the process water outfall (Outfall) which discharges continuously to the Winnipeg River. The discharge from the outfall is composed of holding tank discharges including discharges from the Active Liquid Waste Treatment Centre, storm run-off, and miscellaneous cooling water. The secondary source of liquid effluents is the sewage lagoon which is discharged twice a year (June and October in 1998) to the Winnipeg River. The sewage lagoon collects sanitary sewage and waste water from most buildings on the site.

Some drainage ditches also discharge to the Winnipeg River, but their contribution to the radioactivity in the effluent from the site is insignificant compared to the outfall and the lagoon. These streams are also monitored and the results are presented in AECL-MISC-362 Volume 3, "Annual Report of Radiological Monitoring Results for Chalk River and Whiteshell Laboratories Sites", a companion volume to this report.

4.2.2 Monitoring Program

The outflow from the process outfall is continuously sampled by an automatic sampler. A daily screen sample (three 1 mL aliquots), representative of the release during the preceding 24 hours, is collected for gross beta analysis. A weekly sample (4 L), representative of effluent released from the outfall during the preceding week, is also collected and analyzed for gross alpha, gross beta and scanned by gamma spectrometry. Monthly composite samples (at least 20 L) are collected and analyzed for gross alpha, gross beta, total uranium, plutonium, tritium, radiostrontium and scanned by gamma spectrometry. Sampling procedures, field operating procedures, laboratory procedures, equipment performance checks, quality verification procedures and laboratory administrative procedures are described in detail in WL Effluent and Environmental Monitoring QA Manual.

Derived Release Limits for 63 radionuclides have been calculated for liquid effluents at WL [7]. In earlier reports in this series, the less restrictive DRL for plutonium-239 was applied to gross alpha for liquid effluents. The rationale, which is still valid, was that no americium-241 is present in liquid effluents at WL. However, in this report and in future reports from now on, the more restrictive DRL for americium-241 will be applied for the sake of uniformity. The overall conclusions would not be affected by this change in the DRL selected for alpha emitters in liquids.

The sewage lagoon water is released to the river twice annually, in June and October. It is sampled continuously during the release period and the samples returned for laboratory analysis.

Map F1 in Appendix F shows the effluent streams/monitoring locations.

4.2.3 1998 Monitoring Results

Table 4 provides a summary radioactive material in liquid releases from WL for the years 1995 to 1998. The average monthly releases, expressed as percent of DRLs, are added for the various sources on site to provide a quantitative indicator of the performance of the site. In all cases, the releases were well below one thousandth of the DRL. It must be noted that data in Table 4 differs somewhat from similar summary tables in reports for previous years. In this report, the DRL for Am-241 is selected for gross alpha, while in previous reports it was the DRL for Pu-239. The average monthly releases for years 1995 to 1997, when expressed as percentages of DRL, have been recalculated in Table 4 to conform with the currently selected DRLs. These changes have not appreciably affected the site release expressed in percent of DRL. For years 1995 to 1997, the changes to the "total percent DRL" caused by the changed DRLs are as follows:

	1995 (%DRL)	1996 (%DRL)	1997 (%DRL)
Previous DRL selection [11]	0.015	0.010	0.010
Current DRL selection (Table 4)	0.018	0.012	0.012

It is evident that the changes caused by the shift in DRL selection are insignificant for the total releases from the WL site expressed as % DRL. We intend to continue with the present selection of DRLs in future years.

Appendix D provides detailed monthly monitoring results and annual summary statistics for radioactive liquid releases from WL. Table D1 in Appendix D shows the release from the outfall for gross alpha, gross beta and 11 radionuclides. The LLDs, the average monthly releases for each radionuclide and the discharge volumes are also shown. The LLDs

the product of the MDA for a given radionuclide and the minimum monthly flow, assumed to be $1\text{E}+08$ L. Data for the lagoon are shown in Table D2.

As expressed As DRLs, the airborne and liquid emissions from WL have been low in 1998 and the previous years. Figure 5 summarizes the data presented in Tables 3 and 4 on site-wide airborne and liquid emissions, expressed as totals of percentages of DRLs (the lowermost rows of the tables). It can be noted that over this time period, the highest sum of the site-wide weekly DRLs, is $1.8\text{E}-04$ times the cumulative DRLs (liquid emissions in 1995).

Figure 5 summarizes annual monitoring results for air and liquid effluents from the WL site from 1995 to 1998, as percent of DRLs.

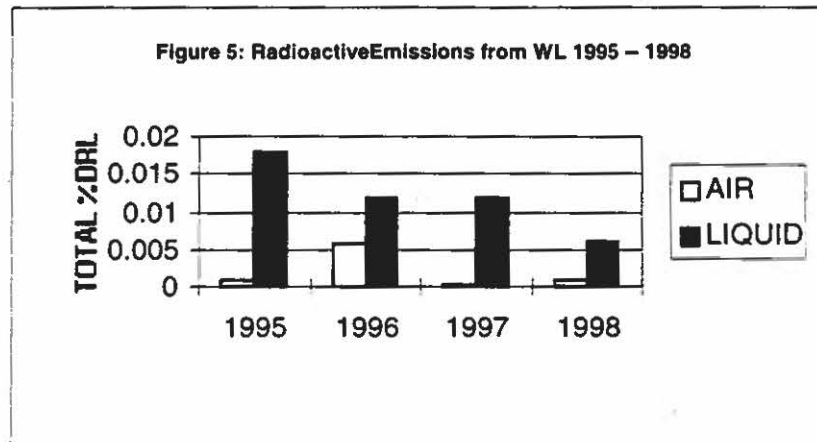


TABLE 4: RADIONUCLIDES IN LIQUID EFFLUENTS FROM WL 1995 – 1998

	AVERAGE MONTHLY RELEASE									
	DRL* (Bq/month)	1995 Bq/month	1995 (% DRL)	1996 Bq/month	1996 (%DRL)	1997 Bq/month	1997 (% DRL)	1998 Bq/month	1998 (%DRL)	Max 1998 (% DRL)
OUTFALL										
Gross Alpha	3.30E+11	1.1E+07	3.3E-03	8.3E+06	2.5E-03	7.96E+06	2.4E-03	7.9E+06	2.4E-03	7.0E-03
Gross Beta	~~	3.4E+08	~~	2.1E+08	~~	2.38E+08	~~	6.1E+07	~~	~~
Cobalt-60	3.18E+12	8.7E+05	2.7E-05	6.1E+05	1.9E-05	7.96E+05	2.50E-05	8.2E+04	2.6E-06	1.7E-05
Strontium-90	4.11E+12	9.0E+07	2.2E-03	6.7E+07	1.6E-03	8.46E+07	2.06E-03	1.5E7	3.7E-4	1.4E-3
Caesium-134	1.12E+12	3.0E+06	2.7E-04	3.0E+06	2.8E-04	8.52E+05	7.61E-05	<	<	<
Caesium-137	1.59E+12	2.0E+08	1.2E-02	1.2E+08	7.2E-03	1.12E+08	7.06E-03	4.2E+07	2.7E-03	6.0E-03
SEWAGE LAGOON										
Gross Alpha	3.3E+11	2.4E+05	7.3E-05	1.5E+05	4.5E-05	3.2E+05	9.8E-05	9.1E+04	2.8E-05	3.3E-04
Gross Beta	~~	3.7E+06	~~	2.4E+06	~~	2.27E+06	~~	1.6E+06	~~	~~
Strontium-90	4.11E+12	7.1E+05	1.7E-05	5.9E+05	1.4E-05	4.87E+05	1.18E-05	4.6E+05	1.13E-5	9.5E-05
Caesium-137	1.59E+12	1.0E+05	6.5E-06	9.0E+05	5.6E-05	5.18E+04	3.26E-06	<	<	
TOTAL			0.018		0.012		0.012		0.006	

Notes:

- 1) Averages shown for sewage lagoon equal the total of 2 releases divided by 12.
- 2) DRL for Am-241 is applied to alpha. In previous reports DRL for Pu-239 was applied to alpha. Percent DRL values for 1995 to 1997 have been recalculated.
- 3) DRLs are for members of public at the site boundary.

QUALITY ASSURANCE

5.1 CRL Environmental Laboratories (Liquid Effluent Monitoring)

5.1.1 Instrument Performance

In 1998, the following quality verification tests were performed on the radiochemical counting equipment used for liquid effluent monitoring at CRL Environmental Laboratory:

Gross Alpha and Gross Beta Analyses - Re-calibration for discrimination of alpha and beta activities and determination of efficiencies was performed every two months. Control blanks and reference standards were checked weekly. An alpha background non-compliance was detected in February. Performance returned to normal after the counter was cleaned and re-calibrated. Gross beta performance remained in compliance.

Alpha Spectroscopy - Efficiency and energy calibrations and backgrounds were measured with every sample set. The system remained in compliance.

Gamma Spectroscopy - Efficiency and energy calibrations of standard geometries were determined annually and re-checked weekly. Environmental backgrounds were determined five times per year. The system remained within compliance.

Tritium - Instrument performance was tested weekly and remained in compliance. Background and reference control samples were included with each sample set. All excursions beyond control limits were within statistical probabilities for such excursions.

5.1.2 Analytical Reproducibility

Duplicate sources are prepared from weekly composites of the daily Process Sewer discharge samples for gamma spectroscopic analysis. One source is analyzed immediately and the other is allowed to decay for three weeks before counting to minimize the effects of short lived radionuclides. The average annual discharge rates of ^{137}Cs and ^{60}Co using the 52 sets of duplicate sources were in good agreement. The ^{137}Cs means differed by less than 7% and ^{60}Co by less than 1%. Individual weekly data agree within a counting uncertainty of 2 sigma in the majority of cases.

Tritium analyses are performed daily on samples from the Process Sewer, the Sanitary Sewer, and as of 1998 June, on the O-4 Sewer. Composites of the daily samples are prepared for these discharge points, and the composites are analyzed on a weekly schedule (monthly for O-4). Differences between the tritium concentration in the composite sample and the average concentration of the daily samples that make up the composite were tracked throughout the year. Contributions from short-lived beta emitters other than tritium in the Process Sewer make this comparison suitable as a guide, but good agreement should be found in samples from the Sanitary and O-4 Sewers. In 1998, averages of daily samples and their monthly counterparts from the O-4 Sewer showed no systematic bias and an 8 percent standard deviation. For the Sanitary Sewer, where tritium concentrations are usually only a factor of two to three above the Minimum Detectable Activity (MDA), no bias was again observed, but the standard deviation between daily averages and the weekly composite samples was 21 percent.

5.1.3 Inter-Laboratory Comparisons

In 1998, CRL Environmental Laboratory did not participate in laboratory inter-comparisons directly relevant to effluent monitoring since the programs run by the COG or by the US Environmental Protection Agency (EPA), in which CRL has previously participated, did not operate.

5.1.4 Program Improvements

In 1998, a project to bring the radiological liquid effluent and environmental monitoring QA program [12] to compliance with the National Standard of Canada, CAN/CSA-Z753-95, "Requirements for the Competence of Environmental Laboratories" was initiated. A review performed in 1998 indicated that many technical aspects of QA required by the CAN/CSA-Z753-95 were in place. Improvement efforts were focused on control documentation for recently commissioned counting instruments.

5.2 CRL Air Effluent Monitoring Laboratory

In 1998, the following quality verification tests were performed for CRL air effluent verification monitoring:

Gross Alpha and Beta Analysis: Reference standards and control blanks are measured with every sample set. In addition all trays are counted on a regular basis to check for residual contamination, and are cleaned as required.

Gamma Spectrometry: Energy calibration is carried out for every sample set. Backgrounds are counted with every sample set to detect any gross system contamination. In addition long-count backgrounds are done regularly to characterize the trace background composition.

5.3 WL Effluent and Environmental Laboratories

5.3.1 Radiochemical Counting Equipment

During 1998, 3607 quality verification tests were performed on the radiochemical counting equipment used by the Environmental Monitoring section at WL. Test results are in Table 5.

TABLE 5. Summary of QA Tests on Radiochemical Counting Equipment, 1998

	PERFORMANCE		PRECISION	
	No of Tests	% Pass	No. of Tests	% Pass
Gross Alpha				
Counter #8	196	100	92	86
Counter #9	858	93	257	99.6
Gross Beta				
Counter #8 (see note)	197 (112)	77 (99)	92 (38)	69 (100)
Counter #9	858	97	257	100
Gamma	800	99		

Note: The detector for counter #8 was replaced part way through 1998. Figures in brackets are for after the change.

5.3.2 Outfall Sampling

As a part of Environmental Monitoring's Outfall Sampling Program, 317 quality verification tests were performed in 1998. Performance, accuracy and precision were verified by means of spike and duplicate tests on weekly and composite samples from the Outfall and also by laboratory and field blank and spiked blank tests. The results are summarized in Table 6. Quality Assurance tests fully complied with the acceptance criteria described in the WL Environmental Monitoring Laboratory's QA Manuals [14]. Details of the tests are in references [15] and [16].

TABLE 6. Summary of QA Tests on Outfall Samples, 1998

Lab Method	# of QA Tests	% Pass
Gross Alpha, Gross Beta,	53	91
Plutonium	13	85
Tritium	87	100
Uranium	164	95
1998 Total	317	95

ACKNOWLEDGEMENT

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- Unpublished document; sole source of copies is Information Centre, AECL, Chalk River, Ontario, K0J 1P0.

General Notes for Appendix A Data Tables on Following Pages:

- DRL old:*** Refers to the DRL values in effect prior to 1998 November 1, as per Table 6.8 of reference [9], based on the most highly exposed group whether on- or off-site.
- DRL boundary-old:*** Refers to the DRL values in effect prior to 1998 November 1, as per Table 6.10 of reference [9], based on the most highly exposed group outside the CRL site boundary.
- DRL:*** Refers to the DRL values in effect after 1999 November 1, as per reference [3], based on the most highly exposed group outside the CRL site boundary.
- Gross Beta:*** For comparison with DRL old (i.e., on-site) gross beta is assumed to be Cs-137, the most restrictive beta emitter for on-site personnel. For comparison with DRL boundary [9] and the current DRL [3], gross beta assumed to be Sr-90, the most restrictive beta emitter for members of the public off-site.
- Gross Alpha:*** For all comparison with DRLs, gross alpha is assumed to be Pu-239, except as noted for uranium fuel fabrication facilities.
- <Lc:*** Indicates that the result is less than the Critical Level (Lc).
- ≤:*** Indicates that the weekly monitoring result contains one or more individual daily, etc., monitoring results carrying the "<" indicator, and that the sum of the individual results is higher than 35% of the entire weekly result. [NOTE: sampling and analysis for some of the effluent streams/parameters is performed from 1 to 7 times a week.]

Appendix A
CRL Air Effluent Monitoring Data for 1998
Table A-1

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Release Point		NRU/NRX REACTOR STACK						
Bldg./Sample Location		109	109	109	109	109		109
Radionuclide		Iodine-125	131Iodine	Gross Alpha	Gross Beta	Tritium Oxide		Ar-41
Week/Unit		Bq/week	Bq/week	Bq/week	Bq/week	Bq/week	Week*)	Bq/week
1	971231 to 980107	6.72E+06	1.00E+07	<Lc	8.63E+02	1.41E+06	98-Jan-10	5.51E+14
2	980107 to 980114	9.99E+06	7.76E+06	≤	1.29E+03	4.54E+05	98-Jan-17	1.87E+14
3	980114 to 980121	9.95E+06	6.00E+06	≤	1.32E+03	3.34E+05	98-Jan-24	5.64E+14
4	980121 to 980128	1.65E+07	6.44E+06	≤	1.40E+03	3.91E+05	98-Jan-31	5.75E+14
5	980128 to 980204	2.58E+07	9.30E+06		1.60E+03	6.89E+05	98-Feb-07	5.61E+14
6	980204 to 980211	2.23E+07	5.78E+06		1.31E+03	2.62E+05	98-Feb-14	1.82E+14
7	980211 to 980218	1.41E+07	7.33E+06	≤	1.31E+03	4.03E+05	98-Feb-21	4.69E+14
8	980218 to 980225	2.05E+07	1.09E+07	<Lc	1.32E+03	6.56E+05	98-Feb-28	4.96E+14
9	980225 to 980304	2.06E+07	1.02E+07	<	1.45E+03	5.63E+05	98-Mar-07	2.22E+14
10	980304 to 980311	9.66E+06	1.01E+07	<Lc	1.29E+03	6.48E+05	98-Mar-14	3.82E+14
11	980311 to 980318	1.01E+07	3.17E+07	<Lc	1.24E+03	6.65E+05	98-Mar-21	3.89E+14
12	980318 to 980325	1.24E+07	8.45E+06	<Lc	1.31E+03	2.78E+05	98-Mar-28	2.02E+14
13	980325 to 980401	1.07E+07	8.17E+06	≤	1.31E+03	9.03E+05	98-Apr-04	4.03E+14
14	980401 to 980408	8.30E+06	9.76E+06		1.33E+03	9.62E+05	98-Apr-11	4.64E+14
15	980408 to 980415	5.98E+06	8.40E+06	≤	8.89E+02	3.93E+05	98-Apr-18	1.58E+14
16	980415 to 980422	6.57E+06	1.02E+07		1.49E+03	1.28E+06	98-Apr-25	4.32E+14
17	980422 to 980429	9.56E+06	3.81E+07		1.63E+03	4.72E+05	98-May-02	4.73E+14
18	980429 to 980506	1.65E+07	3.09E+07	≤	1.46E+03	2.01E+06	98-May-09	2.06E+14
19	980506 to 980513	2.23E+07	1.64E+07	<Lc	8.77E+02	9.77E+05	98-May-16	3.09E+14
20	980513 to 980520	1.39E+07	2.91E+07		1.61E+03	7.44E+05	98-May-23	1.10E+13
21	980520 to 980527	1.26E+07	1.49E+07	≤	1.47E+03	4.55E+05	98-May-30	2.81E+14
22	980527 to 980603	1.92E+07	1.26E+07	<Lc	1.32E+03	1.33E+06	98-Jun-06	2.91E+14
23	980603 to 980610	1.06E+07	4.49E+06	<Lc	1.31E+03	2.77E+06	98-Jun-13	4.02E+14
24	980610 to 980617	9.88E+06	1.15E+07	≤	1.34E+03	3.21E+06	98-Jun-20	2.08E+14
25	980617 to 980624	1.84E+07	9.78E+06	≤	1.63E+03	3.98E+06	98-Jun-27	4.53E+14
26	980624 to 980701	6.80E+07	8.34E+06	≤	1.48E+03	3.17E+06	98-Jul-04	4.04E+14
27	980701 to 980708	2.49E+07	9.26E+06	≤	1.25E+03	2.30E+06	98-Jul-11	1.57E+14
28	980708 to 980715	2.79E+07	8.31E+06	<Lc	1.42E+03	1.79E+06	98-Jul-18	4.38E+14
29	980715 to 980722	4.07E+07	6.64E+06	≤	1.29E+03	2.12E+06	98-Jul-25	3.79E+14
30	980722 to 980729	2.07E+07	9.00E+06	≤	1.29E+03	3.54E+06	98-Aug-01	1.72E+14
31	980729 to 980805	4.41E+07	7.14E+06	<Lc	8.58E+02	1.35E+06	98-Aug-08	4.41E+14
32	980805 to 980812	3.74E+07	7.36E+06		1.31E+03	2.57E+06	98-Aug-15	4.15E+14
33	980812 to 980819	2.01E+07	7.30E+06	≤	1.45E+03	2.42E+06	98-Aug-22	1.69E+14
34	980819 to 980826	1.88E+07	9.11E+06	≤	1.47E+03	2.02E+06	98-Aug-29	3.67E+14
35	980826 to 980902	1.86E+07	6.32E+06	<Lc	1.30E+03	4.55E+06	98-Sep-05	3.82E+14
36	980902 to 980909	1.47E+07	6.25E+06	≤	8.72E+02	2.95E+06	98-Sep-12	4.62E+14
37	980909 to 980916	1.55E+07	7.91E+06	<Lc	1.28E+03	4.34E+06	98-Sep-19	8.46E+13
38	980916 to 980923	1.07E+07	6.50E+06		1.88E+03	1.38E+06	98-Sep-26	3.97E+14
39	980923 to 980930	1.19E+07	1.47E+07	≤	1.29E+03	2.26E+06	98-Oct-03	3.38E+14
40	980930 to 981007	7.52E+06	3.40E+07	<Lc	1.27E+03	3.42E+06	98-Oct-10	3.70E+14
41	981007 to 981014	9.40E+06	2.26E+07	<Lc	8.55E+02	1.82E+06	98-Oct-17	4.51E+14
42	981014 to 981021	9.69E+06	5.94E+07	≤	1.57E+03	2.59E+06	98-Oct-24	4.64E+14
43	981021 to 981028	9.75E+06	3.30E+07	≤	1.28E+03	1.70E+06	98-Oct-31	1.81E+14
44	981028 to 981104	5.80E+06	6.10E+07	<Lc	1.26E+03	1.40E+06	98-Nov-07	4.70E+14
45	981104 to 981111	7.41E+06	3.26E+07	<Lc	1.27E+03	1.47E+06	98-Nov-14	2.86E+14
46	981111 to 981118	9.01E+06	1.39E+09	≤	1.56E+03	2.44E+06	98-Nov-21	4.75E+14
47	981118 to 981125	6.17E+06	7.53E+08	<Lc	1.26E+03	2.03E+06	98-Nov-28	1.31E+14
48	981125 to 981202	6.59E+06	2.32E+08	<Lc	1.25E+03	1.58E+06	98-Dec-05	3.86E+14
49	981202 to 981209	5.81E+06	7.55E+07	<Lc	1.25E+03	1.59E+06	98-Dec-12	2.67E+14
50	981209 to 981216	3.98E+06	3.68E+07	<Lc	1.25E+03	1.81E+06	98-Dec-19	5.36E+14
51	981216 to 981223	6.77E+07	1.97E+07	<Lc	1.25E+03	1.61E+06	98-Dec-26	4.45E+14
52	981223 to 981230	6.05E+06	1.16E+07	<Lc	4.20E+02	5.62E+05	99-Jan-02	5.20E+14
Sum (Bq/a):		8.72E+08	3.20E+09		6.76E+04	8.70E+07		1.85E+16
Average (Bq/week):		1.68E+07	6.16E+07		1.30E+03	1.67E+06		3.55E+14
Minimum (Bq/week):		3.98E+06	4.49E+06		4.20E+02	2.62E+05		1.10E+13
Maximum (Bq/week):		6.80E+07	1.39E+09		1.88E+03	4.55E+06		5.75E+14
DRL-old:		1.30E+11	2.10E+11		3.00E+07	7.80E+11		9.25E+15
Ave(% DRLold):		1.29E-02	2.93E-02		4.33E-03	2.15E-04		3.84E+00
Max(% DRLold):		5.23E-02	6.62E-01		6.27E-03	5.83E-04		6.21E+00
DRL boundary-old:		1.30E+11	2.10E+11		3.60E+10	1.70E+12		3.70E+16
Ave(% DRL boundary-old):		1.29E-02	2.93E-02		3.61E-06	9.84E-05		9.59E-01
Max(% DRL boundary-old):		5.23E-02	6.62E-01		5.22E-06	2.68E-04		1.55E+00
DRL (Bq/week):		8.98E+10	1.36E+11		5.21E+09	4.34E+11		1.46E+16
Ave(% DRL):		1.87E-02	4.53E-02		2.49E-05	3.86E-04		2.43E+00
Max (% DRL):		7.57E-02	1.02E+00		3.61E-05	1.05E-03		3.94E+00
Stack LLD (Bq/week)					1.26E+03			

Note:*) Monitoring week for Ar-41 begins and ends at midnight Saturday.
LLD= Lower Limit of Detection. Lc =Critical Level.

Appendix A
CRL Air Effluent Monitoring Data for 1998
Table A-2

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Release Point		NRU/NRX REACTOR STACK					
Bldg./Sample Location		109	163	163	163	163	163
Radionuclide		Carbon-14	Iodine-125	Iodine-131	Gross Alpha	Gross Beta	Tritium Oxide
Week/Unit		Bq/week	Bq/week	Bq/week	Bq/week	Bq/week	Bq/week
1	971231 to 980107	1.39E+10	5.64E+06	8.97E+06	3.40E+03	4.17E+06	4.51E+12
2	980107 to 980114	8.29E+09	2.89E+07	8.76E+06	3.38E+03	1.79E+06	2.52E+12
3	980114 to 980121	1.51E+10	6.63E+06	6.32E+06	3.30E+03	4.39E+05	2.30E+12
4	980121 to 980128	1.85E+10	1.33E+07	8.03E+06	3.30E+03	6.26E+05	2.65E+12
5	980128 to 980204	1.45E+10	1.33E+07	1.16E+07	2.98E+03	8.69E+05	3.35E+12
6	980204 to 980211	7.94E+09	2.25E+07	8.07E+06	1.29E+03	3.37E+05	3.07E+12
7	980211 to 980218	1.28E+10	1.26E+07	7.37E+06	3.99E+03	4.59E+05	2.21E+12
8	980218 to 980225	9.91E+09	4.77E+07	1.17E+07	3.61E+03	5.89E+05	2.66E+12
9	980225 to 980304	1.02E+10	1.76E+07	7.23E+06	3.70E+03	6.50E+05	2.42E+12
10	980304 to 980311	6.92E+09	8.77E+06	9.97E+06	3.11E+03	1.16E+06	1.92E+12
11	980311 to 980318	1.91E+10	8.26E+06	3.28E+07	2.99E+03	6.66E+05	4.06E+12
12	980318 to 980325	1.46E+10	7.46E+06	9.29E+06	3.59E+03	5.98E+05	1.60E+12
13	980325 to 980401	8.73E+09	1.14E+07	1.03E+07	3.43E+03	6.61E+05	1.75E+12
14	980401 to 980408	8.74E+09	9.44E+06	1.46E+07	3.02E+03	8.53E+05	1.96E+12
15	980408 to 980415	5.69E+09	8.80E+06	1.13E+07	3.49E+03	6.66E+05	1.39E+12
16	980415 to 980422	1.40E+10	8.07E+06	1.70E+07	3.05E+03	1.01E+06	1.57E+12
17	980422 to 980429	2.17E+10	9.12E+06	4.15E+07	3.47E+03	8.16E+05	1.93E+12
18	980429 to 980506	1.42E+10	1.95E+07	3.69E+07	3.15E+03	1.78E+06	2.23E+12
19	980506 to 980513	1.23E+10	3.11E+07	1.99E+07	2.59E+03	8.81E+05	1.48E+12
20	980513 to 980520	1.46E+10	1.95E+07	3.94E+07	3.31E+03	9.04E+05	1.64E+12
21	980520 to 980527	Sample lost	1.57E+07	1.70E+07	3.45E+03	6.23E+05	1.28E+12
22	980527 to 980603	1.96E+10	2.85E+07	1.23E+07	<Lc	2.08E+06	1.77E+12
23	980603 to 980610	1.57E+10	1.54E+07	6.67E+06	3.02E+03	3.18E+06	1.91E+12
24	980610 to 980617	1.08E+10	1.05E+07	1.30E+07	3.20E+03	3.48E+06	2.48E+12
25	980617 to 980624	1.67E+10	2.17E+07	1.00E+07	3.05E+03	2.16E+06	2.00E+12
26	980624 to 980701	3.34E+10	7.24E+07	9.13E+06	3.64E+03	4.23E+06	2.67E+12
27	980701 to 980708	1.95E+10	3.38E+07	9.78E+06	<Lc	2.85E+03	3.24E+06
28	980708 to 980715	5.30E+09	6.58E+07	8.01E+06	3.40E+03	2.57E+06	1.68E+12
29	980715 to 980722	2.43E+10	5.01E+07	7.88E+06	<Lc	2.95E+03	3.25E+06
30	980722 to 980729	2.36E+10	2.35E+07	9.16E+06	3.09E+03	3.57E+06	2.23E+12
31	980729 to 980805	9.99E+09	2.02E+07	6.95E+06	3.09E+03	3.18E+06	2.07E+12
32	980805 to 980812	2.19E+10	7.67E+07	7.49E+06	2.57E+03	2.61E+06	2.44E+12
33	980812 to 980819	1.47E+10	2.32E+07	8.37E+06	3.14E+03	4.56E+06	1.97E+12
34	980819 to 980826	9.42E+09	2.23E+07	1.02E+07	3.18E+03	2.33E+06	2.01E+12
35	980826 to 980902	1.42E+10	2.23E+07	6.34E+06	2.99E+03	4.77E+06	1.78E+12
36	980902 to 980909	1.17E+10	1.65E+07	5.57E+06	2.98E+03	5.96E+06	1.93E+12
37	980909 to 980916	7.03E+09	1.73E+07	8.71E+06	3.22E+03	6.12E+06	1.62E+12
38	980916 to 980923	4.89E+09	1.13E+07	6.95E+06	3.27E+03	3.05E+06	2.01E+12
39	980923 to 980930	1.45E+10	9.88E+06	1.28E+07	<Lc	2.52E+03	3.23E+06
40	980930 to 981007	4.71E+09	7.23E+06	3.45E+07	3.35E+03	5.10E+06	1.97E+12
41	981007 to 981014	1.45E+10	1.57E+07	2.02E+07	3.23E+03	4.21E+06	1.84E+12
42	981014 to 981021	9.19E+09	1.11E+07	5.54E+07	2.93E+03	4.42E+06	1.83E+12
43	981021 to 981028	1.68E+10	6.95E+06	2.61E+07	3.21E+03	2.35E+06	2.23E+12
44	981028 to 981104	1.86E+09	9.29E+06	5.40E+07	3.17E+03	3.04E+06	2.02E+12
45	981104 to 981111	1.35E+10	5.76E+06	2.90E+07	2.91E+03	4.62E+06	2.14E+12
46	981111 to 981118	6.44E+09	8.88E+06	1.21E+09	3.48E+03	1.08E+07	1.88E+12
47	981118 to 981125	9.34E+09	1.02E+07	6.25E+08	3.03E+03	8.37E+06	2.00E+12
48	981125 to 981202	3.03E+09	6.20E+06	2.47E+08	2.88E+03	3.76E+06	1.63E+12
49	981202 to 981209	1.14E+10	3.02E+06	6.18E+07	3.15E+03	3.06E+06	1.99E+12
50	981209 to 981216	7.53E+09	3.13E+06	2.98E+07	3.97E+03	3.62E+06	5.30E+12
51	981216 to 981223	1.13E+10	9.44E+06	1.68E+07	2.87E+03	2.84E+06	3.43E+12
52	981223 to 981230	3.01E+09	5.83E+06	1.27E+07	<Lc	2.47E+03	2.39E+06
Sum (Bq/a)		6.42E+11	9.69E+08	2.92E+09	1.63E+05	1.43E+08	1.15E+14
Average (Bq/week)		1.26E+10	1.86E+07	5.61E+07	3.14E+03	2.74E+06	2.22E+12
Minimum (Bq/week)		1.86E+09	3.02E+06	5.57E+06	1.29E+03	3.37E+05	1.28E+12
Maximum (Bq/week)		3.34E+10	7.67E+07	1.21E+09	3.99E+03	1.08E+07	5.30E+12
DRLold(Bq/week)		1.70E+14	1.30E+11	2.10E+11	3.00E+07	7.80E+11	1.10E+16
Ave(% DRLold)		7.40E-03	1.43E-02	2.67E-02	1.05E-02	3.52E-04	2.02E-02
Max(% DRLold)		1.96E-02	5.90E-02	5.76E-01	1.33E-02	1.38E-03	4.82E-02
DRL boundary-old(Bq/week)		1.70E+14	1.30E+11	2.10E+11	3.60E+10	1.70E+12	1.10E+16
Ave(%DRL boundary-old)		7.40E-03	1.43E-02	2.67E-02	8.73E-06	1.61E-04	2.02E-02
Max(%DRL boundary-old)		1.96E-02	5.90E-02	5.76E-01	1.11E-05	6.35E-04	4.82E-02
DRL (Bq/vweek)		1.91E+14	8.98E+10	1.36E+11	5.21E+09	4.34E+11	3.05E+16
Ave(%DRL)		6.59E-03	2.08E-02	4.13E-02	6.03E-05	6.32E-04	7.28E-03
Max (%DRL)		1.75E-02	8.54E-02	8.90E-01	7.66E-05	2.49E-03	1.74E-02
Stack LLD (Bq/week)					3.11E+03		

LLD= Lower Limit of Detection, Lc =Critical Level.

Appendix A
CRL Air Effluent Monitoring Data for 1998
Table A-3

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Release Point		NRU ROOF VENTS					
Bldg./Sample Location		150 Fans	150 Fans and Loops	150 Fans	150 Fans and Loops	150 Fans	150 Fans and Loops
Radionuclide		Iodine-125	Iodine-131	Iodine-125	Iodine-131	Tritium Oxide	Gross Alpha
Week/Unit		Bq/week	Bq/week	Bq/week	Bq/week	Bq/week	Bq/week
1	971231 to 980107	8.57E+06	1.34E+06	8.57E+06	1.34E+06	1.15E+12	1.22E+02
2	980107 to 980114	5.01E+06	1.88E+06	5.01E+06	1.88E+06	1.32E+12	1.09E+02
3	980114 to 980121	2.00E+06	1.18E+06	2.00E+06	1.18E+06	1.53E+12	1.38E+02
4	980121 to 980128	1.79E+06	9.78E+05	1.79E+06	9.78E+05	1.63E+12	9.96E+01
5	980128 to 980204	3.80E+04	1.80E+06	3.80E+04	1.80E+06	1.57E+12	1.22E+02
6	980204 to 980211	2.62E+06	2.05E+06	2.62E+06	2.05E+06	1.35E+12	1.04E+02
7	980211 to 980218	1.58E+06	1.22E+06	1.58E+06	1.22E+06	1.51E+12	1.23E+02
8	980218 to 980225	1.85E+06	1.12E+06	1.85E+06	1.12E+06	1.50E+12	1.09E+02
9	980225 to 980304	1.29E+06	8.12E+05	1.29E+06	8.12E+05	1.47E+12	1.42E+02
10	980304 to 980311	7.99E+05	7.37E+05	7.99E+05	7.37E+05	1.55E+12	1.32E+02
11	980311 to 980318	9.85E+05	9.93E+05	9.85E+05	9.93E+05	1.25E+12	1.24E+02
12	980318 to 980325	7.70E+05	9.10E+05	7.70E+05	9.10E+05	1.32E+12	1.22E+02
13	980325 to 980401	1.13E+06	8.44E+05	1.13E+06	8.44E+05	1.50E+12	1.03E+02
14	980401 to 980408	7.24E+05	8.90E+05	7.24E+05	8.90E+05	1.67E+12	1.63E+02
15	980408 to 980415	4.74E+05	5.36E+05	4.74E+05	5.36E+05	1.56E+12	1.25E+02
16	980415 to 980422	6.74E+05	6.68E+05	6.74E+05	6.68E+05	1.60E+12	1.05E+02
17	980422 to 980429	1.03E+06	4.43E+04	1.03E+06	4.43E+04	2.13E+12	1.64E+02
18	980429 to 980506	1.14E+07	6.52E+05	1.14E+07	6.52E+05	2.20E+12	1.11E+02
19	980506 to 980513	4.07E+07	8.99E+05	4.07E+07	8.99E+05	1.96E+12	1.04E+02
20	980513 to 980520	6.52E+06	7.53E+05	6.52E+06	7.53E+05	1.22E+12	1.43E+02
21	980520 to 980527	1.91E+06	2.74E+05	1.91E+06	2.74E+05	1.81E+12	1.50E+02
22	980527 to 980603	7.96E+06	3.42E+05	7.96E+06	3.42E+05	1.74E+12	1.04E+02
23	980603 to 980610	2.15E+05	5.27E+05	2.15E+05	5.27E+05	1.84E+12	1.08E+02
24	980610 to 980617	3.88E+04	3.67E+06	3.88E+04	3.67E+06	1.37E+12	1.45E+02
25	980617 to 980624	3.82E+05	3.76E+07	3.82E+05	3.76E+07	1.71E+12	1.05E+02
26	980624 to 980701	1.58E+05	7.03E+06	1.58E+05	7.03E+06	2.12E+12	1.43E+02
27	980701 to 980708	6.06E+04	7.08E+05	6.06E+04	7.08E+05	1.05E+12	9.81E+01
28	980708 to 980715	9.61E+04	4.26E+05	9.61E+04	4.26E+05	1.60E+12	1.21E+02
29	980715 to 980722	1.33E+05	4.60E+05	1.33E+05	4.60E+05	1.59E+12	1.02E+02
30	980722 to 980729	5.10E+04	6.06E+05	5.10E+04	6.06E+05	1.25E+12	1.01E+02
31	980729 to 980805	1.25E+05	7.20E+05	1.25E+05	7.20E+05	1.11E+12	1.02E+02
32	980805 to 980812	2.45E+05	9.52E+05	2.45E+05	9.52E+05	1.27E+12	1.03E+02
33	980812 to 980819	1.85E+05	4.10E+05	1.85E+05	4.10E+05	1.46E+12	1.07E+02
34	980819 to 980826	2.97E+05	4.59E+05	2.97E+05	4.59E+05	1.63E+12	1.04E+02
35	980826 to 980902	1.62E+05	3.82E+05	1.62E+05	3.82E+05	1.26E+12	1.57E+02
36	980902 to 980909	9.65E+04	1.83E+05	9.65E+04	1.83E+05	9.57E+11	1.06E+02
37	980909 to 980916	1.13E+05	5.59E+05	1.13E+05	5.59E+05	1.27E+12	1.12E+02
38	980916 to 980923	1.32E+05	5.81E+05	1.32E+05	5.81E+05	1.28E+12	1.02E+02
39	980923 to 980930	1.20E+05	8.52E+05	1.20E+05	8.52E+05	1.12E+12	1.02E+02
40	980930 to 981007	8.11E+04	1.16E+06	8.11E+04	1.16E+06	1.37E+12	1.01E+02
41	981007 to 981014	1.01E+05	8.36E+05	1.01E+05	8.36E+05	1.28E+12	1.01E+02
42	981014 to 981021	9.11E+04	1.08E+06	9.11E+04	1.08E+06	1.09E+12	1.09E+02
43	981021 to 981028	1.52E+05	9.53E+05	1.52E+05	9.53E+05	1.71E+12	1.00E+02
44	981028 to 981104	1.10E+05	8.81E+05	1.10E+05	8.81E+05	1.51E+12	9.97E+01
45	981104 to 981111	8.15E+04	9.87E+05	8.15E+04	9.87E+05	1.36E+12	1.20E+02
46	981111 to 981118	7.46E+04	5.60E+06	7.46E+04	5.60E+06	1.31E+12	1.05E+02
47	981118 to 981125	8.48E+04	3.74E+06	8.48E+04	3.74E+06	1.26E+12	1.00E+02
48	981125 to 981202	9.68E+04	4.69E+06	9.68E+04	4.69E+06	1.38E+12	1.06E+02
49	981202 to 981209	1.28E+05	1.45E+06	1.28E+05	1.45E+06	2.03E+12	9.96E+01
50	981209 to 981216	1.07E+05	6.69E+05	1.07E+05	6.69E+05	1.33E+12	9.84E+01
51	981216 to 981223	1.38E+05	4.96E+05	1.38E+05	4.96E+05	1.01E+12	9.87E+01
52	981223 to 981230	1.48E+05	6.78E+05	1.48E+05	6.78E+05	1.14E+12	9.94E+01
Sum (Bq/a):		1.04E+08	1.00E+08	1.04E+08	1.00E+08	7.62E+13	5.97E+03
Average (Bq/week):		2.00E+06	1.93E+06	2.00E+06	1.93E+06	1.47E+12	1.15E+02
Minimum (Bq/week):		3.80E+04	4.43E+04	3.80E+04	4.43E+04	9.57E+11	9.81E+01
Maximum (Bq/week):		4.07E+07	3.76E+07	4.07E+07	3.76E+07	2.20E+12	1.64E+02
DRLold(Bq/week):		1.20E+11	7.00E+10	1.20E+11	7.00E+10	7.80E+13	3.00E+07
Ave(% DRLold):		1.66E-03	2.75E-03	1.66E-03	2.75E-03	1.88E+00	3.83E-04
Max(% DRLold):		3.39E-02	5.37E-02	3.39E-02	5.37E-02	2.82E+00	5.47E-04
DRL boundary-old(Bq/week):		1.10E+16	2.10E+11	1.10E+16	2.10E+11	1.10E+16	3.60E+10
Ave(%DRL boundary-old):		1.82E-08	9.18E-04	1.82E-08	9.18E-04	1.33E-02	3.19E-07
Max(%DRL boundary-old):		3.70E-07	1.79E-02	3.70E-07	1.79E-02	2.00E-02	4.56E-07
DRL (Bq/week)		8.98E+10	1.36E+11	8.98E+10	1.36E+11	3.05E+16	5.21E+09
Ave(%DRL)		2.22E-03	1.42E-03	2.22E-03	1.42E-03	4.80E-03	2.21E-06
Max (%DRL)		4.53E-02	2.76E-02	4.53E-02	2.76E-02	7.21E-03	3.15E-06
Stack LLD (Bq/week)							1.08E+02

LLD= Lower Limit of Detection. Lc =Critical Level.

Appendix A
CRL Air Effluent Monitoring Data for 1998
Table A-4

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Release Point		NRU VENTS		LAB. BLDG.107 -- Miscellaneous Vents		Mo-99 PRODUCTION FACILITY (61 Meter Stack)					
Bldg./Sample Location		150 Fans and Loops		107		107		206 Stack	206 Stack	206 Stack	206 Stack
Radionuclide		Gross Beta		Gross Alpha		Gross Beta		Noble Gases	Iodine-131	Gross Alpha	Gross Beta
Week/Unit		Bq/week		Bq/week		Bq/week		Bq/week	Bq/week	Bq/week	Bq/week
1	971231 to 980107	1.76E+03		1.06E+02	<Lc	1.58E+03	4.84E+12	2.31E+07	≤	1.45E+02	7.80E+03
2	980107 to 980114	2.49E+03	<Lc	1.04E+02	<Lc	1.42E+03	7.42E+12	2.15E+07	<Lc	2.39E+02	2.91E+04
3	980114 to 980121	1.61E+03	<Lc	1.06E+02		2.94E+03	4.69E+12	2.43E+07	≤	2.44E+02	4.39E+04
4	980121 to 980128	1.95E+03	<Lc	1.02E+02	<Lc	1.58E+03	8.64E+12	1.77E+07	≤	4.37E+02	8.92E+04
5	980128 to 980204	2.68E+03	<Lc	1.05E+02		2.60E+03	1.07E+13	1.79E+07	≤	2.42E+02	1.60E+04
6	980204 to 980211	2.15E+03		1.07E+02		1.46E+03	9.13E+12	1.70E+07	<Lc	1.46E+02	2.33E+04
7	980211 to 980218	1.78E+03		1.42E+02	<Lc	1.34E+03	6.12E+12	2.24E+07	≤	3.07E+02	2.91E+04
8	980218 to 980225	2.02E+03	<Lc	1.07E+02	<Lc	1.28E+03	9.14E+12	3.62E+07	≤	2.46E+02	3.84E+04
9	980225 to 980304	1.57E+03	<Lc	1.05E+02		1.86E+03	1.93E+13	5.38E+07	≤	3.08E+02	3.76E+05
10	980304 to 980311	1.24E+03	<Lc	1.04E+02	<Lc	1.21E+03	1.97E+13	1.04E+07	≤	2.89E+02	2.27E+05
11	980311 to 980318	2.37E+03		1.35E+02	<Lc	1.88E+03	1.64E+13	1.46E+06	<Lc	2.31E+02	7.12E+04
12	980318 to 980325	1.73E+03		1.78E+02		1.77E+03	7.79E+12	6.07E+06	<Lc	2.43E+02	7.13E+04
13	980325 to 980401	1.49E+03	<Lc	1.06E+02		1.99E+03	8.66E+12	2.21E+07	≤	2.60E+02	5.22E+04
14	980401 to 980408	1.24E+03	<Lc	1.07E+02	<Lc	1.20E+03	9.73E+12	9.58E+06	≤	2.78E+02	6.05E+04
15	980408 to 980415	2.09E+03	<Lc	1.07E+02	<Lc	2.14E+03	6.72E+12	7.22E+06	≤	1.97E+02	4.15E+04
16	980415 to 980422	1.96E+03		1.45E+02		2.45E+03	9.28E+12	2.31E+07	≤	2.48E+02	7.22E+04
17	980422 to 980429	1.47E+03	<Lc	1.07E+02	<Lc	1.39E+03	1.02E+13	1.45E+07	≤	2.79E+02	1.71E+05
18	980429 to 980506	5.02E+03	<Lc	1.06E+02		7.79E+03	8.98E+12	3.11E+07	≤	2.44E+02	6.50E+04
19	980506 to 980513	1.46E+03		1.43E+02		1.90E+03	8.47E+12	2.56E+07	≤	2.29E+02	3.72E+04
20	980513 to 980520	1.54E+03	<Lc	1.06E+02	<Lc	1.27E+03	8.02E+12	2.27E+07	≤	2.44E+02	3.16E+04
21	980520 to 980527	2.01E+03	<Lc	1.06E+02	<Lc	1.34E+03	2.69E+12	1.02E+07	≤	2.45E+02	1.89E+04
22	980527 to 980603	2.12E+03		1.79E+02	<Lc	1.08E+03	5.83E+12	1.53E+07	≤	2.62E+02	2.40E+04
23	980603 to 980610	1.40E+03	<Lc	1.06E+02	<Lc	1.23E+03	1.34E+13	1.33E+07	≤	3.10E+02	1.23E+04
24	980610 to 980617	1.49E+04		5.40E+02		8.51E+03	1.00E+13	1.92E+08	≤	3.14E+02	4.11E+04
25	980617 to 980624	5.16E+03		1.09E+02	<Lc	2.31E+03	6.93E+12	1.37E+08	<Lc	2.46E+02	7.05E+05
26	980624 to 980701	8.61E+03	<Lc	1.07E+02		8.40E+03	7.07E+12	3.80E+07	≤	3.13E+02	1.55E+06
27	980701 to 980708	2.14E+04	<Lc	1.01E+02		3.85E+04	9.56E+12	3.16E+07	<Lc	1.85E+02	5.45E+05
28	980708 to 980715	3.24E+03	<Lc	1.15E+02	<Lc	2.00E+03	4.50E+12	3.63E+07	≤	3.34E+02	1.73E+05
29	980715 to 980722	1.56E+03	<Lc	1.04E+02	<Lc	1.60E+03	5.76E+12	5.40E+07	≤	2.89E+02	4.63E+05
30	980722 to 980729	1.76E+03	<Lc	1.04E+02	<Lc	1.49E+03	7.48E+12	3.46E+07	≤	2.55E+02	9.31E+05
31	980729 to 980805	1.64E+03	<Lc	1.04E+02		2.51E+03	4.46E+12	3.69E+07	≤	1.92E+02	1.75E+06
32	980805 to 980812	1.45E+03	<Lc	1.05E+02		1.41E+03	5.88E+12	6.41E+07	≤	2.27E+02	1.91E+06
33	980812 to 980819	1.87E+03	<Lc	1.06E+02		1.70E+03	7.44E+12	3.22E+07	≤	1.94E+02	1.45E+06
34	980819 to 980826	1.46E+03	<Lc	1.07E+02		4.16E+03	2.84E+12	8.62E+07	<Lc	2.46E+02	7.50E+05
35	980826 to 980902	1.99E+03	<Lc	1.05E+02	<Lc	1.47E+03	5.01E+12	6.75E+07	≤	3.09E+02	2.64E+05
36	980902 to 980909	1.49E+03	<Lc	1.05E+02	<Lc	1.53E+03	8.60E+12	3.57E+07	<Lc	1.93E+02	3.12E+05
37	980909 to 980916	2.15E+03	<Lc	1.04E+02	<Lc	2.21E+03	9.35E+12	3.22E+07	≤	2.70E+02	3.98E+05
38	980916 to 980923	2.23E+03	<Lc	1.05E+02	<Lc	2.28E+03	8.95E+12	3.00E+07	≤	2.41E+02	3.56E+05
39	980923 to 980930	2.69E+03	<Lc	1.74E+02	<Lc	2.76E+03	6.36E+12	2.56E+07	≤	2.55E+02	1.95E+05
40	980930 to 981007	3.05E+03	<Lc	1.03E+02	<Lc	2.71E+03	6.74E+12	1.01E+07	≤	2.37E+02	7.83E+05
41	981007 to 981014	1.55E+03	<Lc	1.04E+02	<Lc	1.53E+03	8.19E+12	1.31E+07	<Lc	1.90E+02	4.30E+05
42	981014 to 981021	1.80E+03	<Lc	1.03E+02		1.68E+03	5.65E+12	1.07E+07	≤	2.06E+02	2.93E+05
43	981021 to 981028	2.92E+03	<Lc	1.03E+02	<Lc	2.91E+03	6.09E+12	1.39E+07	≤	2.52E+02	1.00E+06
44	981028 to 981104	5.47E+03	<Lc	1.02E+02	<Lc	2.65E+03	5.82E+12	1.78E+07	<Lc	2.34E+02	5.20E+05
45	981104 to 981111	1.55E+03	<Lc	1.03E+02	<Lc	1.48E+03	6.18E+12	2.60E+07	≤	2.84E+02	5.34E+07
46	981111 to 981118	2.12E+04	<Lc	1.03E+02		5.66E+03	5.25E+12	2.44E+07	≤	2.84E+02	6.65E+06
47	981118 to 981125	1.88E+04		1.03E+02	<Lc	2.89E+03	5.04E+12	1.84E+07	≤	2.66E+02	6.73E+05
48	981125 to 981202	4.98E+03		1.70E+02	<Lc	1.38E+03	4.11E+12	1.84E+07	≤	2.66E+02	2.72E+05
49	981202 to 981209	2.25E+03	<Lc	1.01E+02	<Lc	1.40E+03	5.90E+12	1.58E+07	≤	2.80E+02	4.21E+05
50	981209 to 981216	4.02E+03	<Lc	1.01E+02		6.28E+03	4.32E+12	1.04E+07	≤	2.16E+02	3.77E+05
51	981216 to 981223	1.98E+03	<Lc	1.70E+02	<Lc	2.03E+03	5.09E+12	7.61E+06	≤	3.89E+02	3.92E+05
52	981223 to 981230	1.50E+03	<Lc	1.02E+02	<Lc	1.54E+03	1.01E+13	6.27E+06	≤	4.73E+01	8.99E+05
Sum (Bq/a):		1.90E+05		6.38E+03		1.62E+05	4.05E+14	1.57E+09		1.31E+04	7.95E+07
Average (Bq/week):		3.65E+03		1.23E+02		3.11E+03	7.78E+12	3.03E+07		2.52E+02	1.53E+06
Minimum (Bq/week):		1.24E+03		1.01E+02		1.08E+03	2.69E+12	1.46E+06		4.73E+01	7.80E+03
Maximum (Bq/week):		2.14E+04		5.40E+02		3.85E+04	1.97E+13	1.92E+08		4.37E+02	5.34E+07
DRL old(Bq/week)		1.60E+09		3.00E+07		1.60E+09	1.60E+15	2.10E+11		3.00E+07	1.20E+11
Ave(% DRLold)		2.28E-04		4.09E-04		1.94E-04	4.86E-01	1.44E-02		8.39E-04	1.27E-03
Max(% DRLold)		1.34E-03		1.80E-03		2.41E-03	1.23E+00	9.14E-02		1.46E-03	4.45E-02
DRLboundary-old(Bq/week)		1.70E+12		3.60E+10		1.70E+12	4.10E+16	2.10E+11		3.60E+10	1.70E+12
Ave(%DRLboundary-old)		2.15E-07		3.41E-07		1.83E-07	1.90E-02	1.44E-02		6.99E-07	8.99E-05
Max(%DRLboundary-old)		1.26E-06		1.50E-06		2.26E-06	4.80E-02	9.14E-02		1.21E-06	3.14E-03
DRL (Bq/vweek)		4.34E+11		5.21E+09		4.34E+11	7.39E+15	1.36E+11		5.21E+09	4.34E+11
Ave(%DRL)		8.41E-07		2.36E-06		7.16E-07	1.05E-01	2.22E-02		4.83E-06	3.52E-04
Max (%DRL)		4.93E-06		1.04E-05		8.87E-06	2.67E-01	1.41E-01		8.39E-06	1.23E-02
Stack LLD (Bq/week)		1.82E+03		1.05E+02		1.76E+03				2.45E+02	

LLD= Lower Limit of Detection. Lc =Critical Level.

Appendix A
CRL Air Effluent Monitoring Data for 1998
Table A-5

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Release Point	UNIVERSAL CELLS FACILITY			LAB. BLDG. 250 VENTS			TRIT.LAB
Bldg./Sample Location	234 Cells	234 Cells	234 Cells	250	250	250	250
Radionuclide	Iodine-131	Gross Alpha	Gross Beta	Gross Alpha	Gross Beta	Trit. Oxide	Tritium Elemental
Week/Unit	Bq/week	Bq/week	Bq/week	Bq/week	Bq/week	Bq/week	Bq/week
971231 to 980107	3.41E+05	≤ 2.28E+02	1.10E+04	2.09E+03	6.59E+04	1.04E+10	1.73E+09
980107 to 980114	1.49E+05	4.69E+02	7.75E+03	9.14E+02	2.63E+04	1.40E+10	2.58E+09
980114 to 980121	4.51E+05	5.46E+02	≤ 6.67E+03	9.11E+02	1.90E+04	1.03E+10	6.44E+09
980121 to 980128	5.22E+04	≤ 3.61E+02	≤ 1.29E+04	≤ 8.38E+02	<Lc 1.30E+04	9.56E+09	1.74E+10
980128 to 980204	2.40E+05	≤ 3.81E+02	6.39E+03	9.02E+02	1.38E+04	1.60E+10	2.27E+10
980204 to 980211	1.05E+05	<Lc 2.29E+02	4.32E+03	<Lc 8.70E+02	<Lc 1.16E+04	9.80E+09	7.15E+10
980211 to 980218	6.77E+04	≤ 3.97E+02	<Lc 4.73E+03	≤ 9.81E+02	≤ 1.15E+04	1.12E+10	5.54E+09
980218 to 980225	8.03E+04	4.77E+02	≤ 5.65E+03	≤ 9.68E+02	≤ 1.17E+04	1.30E+10	3.52E+10
980225 to 980304	4.96E+04	4.45E+02	8.79E+03	<Lc 8.64E+02	<Lc 1.13E+04	3.67E+09	1.96E+10
980304 to 980311	1.04E+05	≤ 3.69E+02	1.14E+04	1.11E+03	<Lc 9.92E+03	2.46E+09	5.99E+08
980311 to 980318	2.30E+07	≤ 3.57E+02	1.01E+06	1.33E+03	<Lc 1.55E+04	1.61E+09	4.33E+09
980318 to 980325	8.90E+05	4.24E+02	3.69E+04	1.16E+03	≤ 1.23E+04	1.75E+09	1.13E+09
980325 to 980401	6.59E+05	<Lc 3.74E+02	1.85E+04	8.79E+02	<Lc 1.10E+04	1.98E+09	1.20E+10
980401 to 980408	5.38E+05	≤ 3.77E+02	1.58E+04	≤ 8.78E+02	<Lc 9.83E+03	1.01E+09	6.51E+08
980408 to 980415	1.00E+06	3.33E+02	1.83E+04	2.41E+04	2.93E+05	1.14E+09	2.84E+09
980415 to 980422	1.77E+05	≤ 3.91E+02	8.44E+03	9.15E+03	4.51E+05	1.68E+09	1.36E+09
980422 to 980429	7.03E+04	≤ 3.79E+02	≤ 5.11E+03	1.72E+04	1.50E+06	1.54E+09	3.82E+08
980429 to 980506	7.11E+04	4.24E+02	<Lc 6.96E+03	1.13E+03	1.06E+06	1.73E+09	3.24E+08
980506 to 980513	5.79E+04	≤ 3.09E+02	5.41E+03	1.57E+04	1.80E+06	2.19E+10	3.18E+09
980513 to 980520	4.30E+04	≤ 3.07E+02	≤ 4.05E+03	7.53E+03	3.96E+05	4.44E+09	1.02E+09
980520 to 980527	<Lc 4.67E+04	≤ 4.73E+02	≤ 5.61E+03	1.15E+04	6.01E+05	3.68E+09	4.92E+08
980527 to 980603	4.07E+04	≤ 3.79E+02	8.63E+03	8.84E+03	5.08E+05	1.48E+09	2.22E+09
980603 to 980610	2.86E+05	≤ 4.54E+02	5.58E+03	9.53E+03	6.24E+05	1.20E+10	6.29E+10
980610 to 980617	2.56E+06	≤ 4.31E+02	3.74E+04	1.42E+04	6.97E+05	1.39E+10	3.37E+09
980617 to 980624	4.12E+06	≤ 3.80E+02	2.05E+04	6.62E+03	2.48E+05	2.57E+10	1.87E+11
980624 to 980701	1.17E+06	<Lc 3.79E+02	≤ 1.08E+04	5.66E+03	1.72E+05	8.57E+10	1.55E+11
980701 to 980708	2.56E+05	3.34E+02	<Lc 5.47E+03	3.46E+03	1.11E+05	8.20E+09	3.44E+09
980708 to 980715	1.59E+05	≤ 4.05E+02	<Lc 7.06E+03	6.23E+03	2.30E+05	1.50E+10	1.30E+10
980715 to 980722	9.48E+04	5.18E+02	<Lc 5.64E+03	3.78E+03	9.53E+04	1.47E+10	7.74E+09
980722 to 980729	6.09E+04	≤ 4.15E+02	≤ 5.31E+03	3.29E+03	5.58E+04	2.17E+11	5.80E+10
980729 to 980805	2.42E+04	≤ 4.56E+02	6.16E+03	1.83E+03	6.37E+04	2.95E+10	6.96E+09
980805 to 980812	3.37E+04	≤ 2.62E+02	≤ 4.77E+03	1.42E+03	3.36E+04	2.07E+10	9.98E+10
980812 to 980819	<Lc 4.27E+04	≤ 3.10E+02	≤ 4.50E+03	5.84E+03	1.05E+05	1.08E+10	1.61E+11
980819 to 980826	3.73E+04	≤ 3.87E+02	≤ 5.24E+03	3.62E+03	9.66E+04	8.56E+09	6.63E+10
980826 to 980902	5.23E+04	≤ 3.74E+02	≤ 5.44E+03	2.35E+03	3.71E+04	1.91E+10	2.88E+11
980902 to 980909	1.79E+05	≤ 3.58E+02	<Lc 4.36E+03	3.59E+03	6.21E+04	1.23E+10	1.47E+10
980909 to 980916	4.51E+04	≤ 3.91E+02	≤ 1.14E+04	2.31E+03	2.01E+04	9.68E+09	5.46E+10
980916 to 980923	2.40E+05	≤ 4.52E+02	≤ 1.42E+04	1.85E+03	3.88E+04	1.45E+10	1.49E+11
980923 to 980930	1.31E+05	≤ 3.48E+02	≤ 8.39E+03	3.75E+03	8.15E+04	1.72E+10	8.92E+09
980930 to 981007	4.77E+06	<Lc 3.64E+02	2.83E+05	8.04E+03	1.63E+05	1.23E+11	1.11E+10
981007 to 981014	2.65E+06	≤ 3.44E+02	7.23E+04	4.24E+03	8.28E+04	4.77E+10	1.45E+11
981014 to 981021	8.37E+05	≤ 4.38E+02	1.32E+04	1.10E+03	1.03E+05	1.94E+10	2.24E+10
981021 to 981028	9.48E+05	<Lc 3.63E+02	1.58E+04	4.68E+03	1.72E+05	9.20E+10	4.81E+11
981028 to 981104	4.33E+05	≤ 4.13E+02	≤ 1.29E+04	2.51E+03	1.26E+05	2.98E+10	1.34E+10
981104 to 981111	2.27E+05	≤ 3.88E+02	≤ 7.64E+03	2.28E+03	9.77E+04	3.07E+10	1.43E+10
981111 to 981118	1.70E+05	<Lc 3.63E+02	≤ 1.45E+04	8.54E+02	1.71E+05	2.69E+10	5.32E+10
981118 to 981125	6.00E+04	4.09E+02	≤ 1.04E+04	1.08E+03	3.51E+05	2.45E+10	9.42E+10
981125 to 981202	1.77E+05	≤ 4.75E+02	≤ 5.90E+03	8.42E+02	2.23E+04	3.71E+10	4.11E+11
981202 to 981209	9.77E+06	≤ 3.86E+02	2.87E+05	1.38E+04	2.86E+06	3.67E+10	1.01E+11
981209 to 981216	1.96E+06	≤ 3.40E+02	5.65E+04	3.88E+03	5.65E+05	2.19E+10	4.42E+10
981216 to 981223	6.84E+05	≤ 4.04E+02	3.48E+04	3.89E+03	4.66E+05	1.40E+10	2.34E+09
981223 to 981230	2.42E+05	<Lc 8.21E+01	4.37E+03	8.47E+02	1.39E+05	1.09E+10	1.36E+09
Sum (Bq/a):	6.07E+07	1.99E+04	2.20E+06	2.37E+05	1.49E+07	1.19E+12	2.95E+12
Average (Bq/week):	1.17E+06	3.82E+02	4.24E+04	4.56E+03	2.87E+05	2.30E+10	5.67E+10
Minimum (Bq/week):	2.42E+04	8.21E+01	4.05E+03	8.38E+02	9.83E+03	1.01E+09	3.24E+08
Maximum (Bq/week):	2.30E+07	5.46E+02	1.01E+06	2.41E+04	2.86E+06	2.17E+11	4.81E+11
DRLold(Bq/week):	7.00E+10	3.00E+07	1.60E+09	3.00E+07	1.60E+09	7.80E+13	7.80E+13
Ave(% DRLold):	1.67E-03	1.27E-03	2.65E-03	1.52E-02	1.80E-02	2.94E-02	7.27E-02
Max(% DRLold):	3.29E-02	1.82E-03	6.31E-02	8.03E-02	1.79E-01	2.78E-01	6.17E-01
DRLboundary-old(Bq/week):	2.10E+11	3.60E+10	1.70E+12	3.60E+10	1.70E+12	1.10E+16	1.10E+16
Ave(% DRLboundary-old):	5.55E-04	1.06E-06	2.49E-06	1.27E-05	1.69E-05	2.09E-04	5.15E-04
Max(% DRLboundary-old):	1.10E-02	1.52E-06	5.94E-05	6.69E-05	1.68E-04	1.97E-03	4.37E-03
DRL (Bq/week):	1.36E+11	5.21E+09	4.34E+11	5.21E+09	4.34E+11	3.05E+16	1.43E+18
Ave(% DRL):	8.58E-04	7.33E-06	9.77E-06	8.76E-05	6.62E-05	7.53E-05	3.96E-06
Max(% DRL):	1.69E-02	1.05E-05	2.33E-04	4.63E-04	6.59E-04	7.11E-04	3.36E-05
Stack LLD (Bq/week):	3.71E+02	3.71E+02	7.73E+03	9.02E+02	1.18E+04		

LLD= Lower Limit of Detection. Lc =Critical Level.

Table A-6

Release Point		FUELS AND MATERIALS CELLS FACILITY			D2O UPGRADING PLANT		RFFL	
Bldg./Sample Location		375	375	375	210	375	375	
Radionuclide		Iodine-131	Gross Alpha	Gross Beta	Tritium Oxide	Gross Alpha	Gross Beta	
Week/Unit		Bq/week	Bq/week	Bq/week	Bq/week	Bq/week	Bq/week	
1	971231 to 980107	1.23E+05	<Lc 1.28E+02	<Lc 1.94E+03	2.65E+11	<Lc 1.23E+02	<Lc 1.86E+03	
2	980107 to 980114	4.07E+04	<Lc 1.28E+02	<Lc 1.74E+03	4.16E+11	<Lc 1.23E+02	<Lc 1.67E+03	
3	980114 to 980121	1.91E+05	≤ 1.30E+02	1.82E+03	5.50E+11	<Lc 1.25E+02	<Lc 1.53E+03	
4	980121 to 980128	8.00E+04	≤ 1.41E+02	<Lc 1.94E+03	1.07E+12	<Lc 1.20E+02	<Lc 1.86E+03	
5	980128 to 980204	1.60E+05	<Lc 1.29E+02	<Lc 1.96E+03	5.19E+11	<Lc 1.24E+02	≤ 2.19E+03	
6	980204 to 980211	8.81E+04	< 1.63E+02	2.08E+03	7.00E+11	<Lc 1.25E+02	<Lc 1.66E+03	
7	980211 to 980218	3.40E+04	<Lc 1.29E+02	<Lc 1.64E+03	8.41E+11	≤ 1.52E+02	<Lc 1.58E+03	
8	980218 to 980225	<Lc 2.17E+04	<Lc 1.31E+02	≤ 2.41E+03	7.08E+11	<Lc 1.26E+02	<Lc 1.51E+03	
9	980225 to 980304	3.69E+04	<Lc 1.29E+02	1.86E+03	8.15E+11	≤ 1.25E+02	<Lc 1.62E+03	
10	980304 to 980311	<Lc 2.33E+04	≤ 1.93E+02	<Lc 1.48E+03	1.74E+12	<Lc 1.23E+02	<Lc 1.42E+03	
11	980311 to 980318	5.35E+04	<Lc 1.23E+02	<Lc 2.31E+03	1.53E+12	<Lc 1.19E+02	<Lc 2.22E+03	
12	980318 to 980325	3.71E+07	<Lc 1.30E+02	1.99E+04	1.36E+12	<Lc 1.25E+02	5.95E+03	
13	980325 to 980401	1.59E+05	≤ 1.38E+02	3.58E+03	1.35E+12	<Lc 1.25E+02	<Lc 1.58E+03	
14	980401 to 980408	6.58E+04	<Lc 1.31E+02	1.69E+03	1.59E+12	<Lc 1.26E+02	2.05E+03	
15	980408 to 980415	<Lc 2.44E+04	<Lc 1.31E+02	<Lc 2.62E+03	1.40E+12	<Lc 1.26E+02	<Lc 2.52E+03	
16	980415 to 980422	1.87E+04	1.69E+02	<Lc 1.67E+03	1.11E+12	<Lc 1.27E+02	<Lc 1.61E+03	
17	980422 to 980429	<Lc 2.48E+04	≤ 1.31E+02	1.72E+03	9.58E+11	<Lc 1.26E+02	<Lc 1.63E+03	
18	980429 to 980506	<Lc 2.26E+04	<Lc 1.30E+02	9.94E+03	9.74E+11	<Lc 1.25E+02	5.13E+03	
19	980506 to 980513	<Lc 2.20E+04	1.67E+02	≤ 1.53E+03	1.18E+12	<Lc 1.25E+02	<Lc 1.46E+03	
20	980513 to 980520	<Lc 2.20E+04	≤ 1.47E+02	<Lc 1.55E+03	5.96E+11	1.26E+02	≤ 1.59E+03	
21	980520 to 980527	<Lc 2.39E+04	<Lc 1.30E+02	<Lc 1.64E+03	8.52E+11	≤ 1.82E+02	<Lc 1.58E+03	
22	980527 to 980603	2.00E+04	1.32E+02	2.19E+03	1.65E+12	<Lc 1.26E+02	<Lc 1.27E+03	
23	980603 to 980610	<Lc 2.05E+04	<Lc 1.30E+02	4.55E+03	2.39E+12	<Lc 1.25E+02	1.50E+03	
24	980610 to 980617	3.20E+04	<Lc 1.32E+02	1.38E+04	1.50E+12	<Lc 1.27E+02	7.67E+03	
25	980617 to 980624	2.65E+04	<Lc 1.31E+02	<Lc 2.83E+03	2.45E+12	<Lc 1.26E+02	4.24E+03	
26	980624 to 980701	<Lc 1.97E+04	<Lc 1.32E+02	3.68E+03	1.53E+12	<Lc 1.26E+02	<Lc 2.50E+03	
27	980701 to 980708	2.76E+04	<Lc 1.23E+02	5.71E+03	2.16E+12	1.19E+02	5.47E+03	
28	980708 to 980715	2.88E+05	< 1.50E+02	5.18E+03	1.39E+12	<Lc 1.35E+02	≤ 3.11E+03	
29	980715 to 980722	3.11E+04	<Lc 1.28E+02	<Lc 1.96E+03	1.02E+12	<Lc 1.23E+02	<Lc 1.88E+03	
30	980722 to 980729	<Lc 1.74E+04	≤ 1.52E+02	≤ 1.84E+03	1.25E+12	<Lc 1.22E+02	<Lc 1.75E+03	
31	980729 to 980805	4.57E+04	<Lc 1.28E+02	<Lc 1.73E+03	1.20E+12	1.51E+02	<Lc 1.66E+03	
32	980805 to 980812	2.67E+04	≤ 1.29E+02	2.12E+03	1.23E+12	<Lc 1.24E+02	<Lc 1.63E+03	
33	980812 to 980819	<Lc 1.53E+04	1.98E+02	≤ 1.86E+03	1.39E+12	<Lc 1.24E+02	<Lc 1.55E+03	
34	980819 to 980826	*) 2.50E+05	≤ 1.32E+02	<Lc 1.78E+03	1.01E+12	<Lc 1.26E+02	<Lc 1.71E+03	
35	980826 to 980902	*) 1.74E+09	<Lc 1.29E+02	7.21E+03	1.54E+12	<Lc 1.24E+02	<Lc 1.73E+03	
36	980902 to 980909	*) 4.08E+09	≤ 1.37E+02	1.87E+05	5.58E+11	<Lc 1.24E+02	<Lc 1.80E+03	
37	980909 to 980916	*) 2.00E+09	<Lc 1.27E+02	1.24E+05	6.87E+11	<Lc 1.22E+02	<Lc 2.60E+03	
38	980916 to 980923	*) 4.94E+07	<Lc 1.29E+02	2.51E+04	5.25E+11	1.24E+02	<Lc 2.69E+03	
39	980923 to 980930	*) 2.43E+07	<Lc 1.27E+02	2.82E+04	4.80E+11	≤ 1.23E+02	<Lc 3.25E+03	
40	980930 to 981007	*) 3.37E+06	<Lc 1.26E+02	1.44E+04	3.15E+11	<Lc 1.21E+02	<Lc 3.18E+03	
41	981007 to 981014	1.98E+05	≤ 1.97E+02	3.45E+03	3.14E+11	<Lc 1.22E+02	<Lc 1.80E+03	
42	981014 to 981021	2.18E+05	<Lc 1.27E+02	<Lc 1.77E+03	2.68E+11	<Lc 1.22E+02	<Lc 1.70E+03	
43	981021 to 981028	5.48E+05	<Lc 1.26E+02	<Lc 3.57E+03	4.16E+11	<Lc 1.21E+02	<Lc 3.43E+03	
44	981028 to 981104	5.31E+06	1.34E+02	<Lc 3.24E+03	2.58E+11	≤ 1.21E+02	≤ 3.56E+03	
45	981104 to 981111	3.84E+07	≤ 1.42E+02	4.74E+03	2.14E+11	<Lc 1.21E+02	<Lc 1.74E+03	
46	981111 to 981118	1.31E+07	<Lc 1.26E+02	≤ 3.41E+03	2.92E+11	<Lc 1.21E+02	≤ 3.33E+03	
47	981118 to 981125	3.84E+06	<Lc 1.25E+02	<Lc 3.54E+03	3.13E+11	<Lc 1.20E+02	<Lc 3.40E+03	
48	981125 to 981202	1.68E+06	<Lc 1.24E+02	2.59E+03	2.99E+11	<Lc 1.20E+02	<Lc 1.62E+03	
49	981202 to 981209	9.04E+05	1.59E+02	2.25E+03	2.44E+11	≤ 1.20E+02	<Lc 1.65E+03	
50	981209 to 981216	2.70E+05	≤ 1.24E+02	6.32E+03	2.06E+11	<Lc 1.19E+02	≤ 4.27E+03	
51	981216 to 981223	1.41E+05	<Lc 1.24E+02	≤Lc 2.49E+03	1.82E+11	≤ 1.46E+02	<Lc 2.39E+03	
52	981223 to 981230	≤ 6.82E+04	<Lc 1.25E+02	≤ 1.91E+03	1.40E+11	<Lc 1.20E+02	<Lc 1.81E+03	
Sum (Bq/a):		8.00E+09	7.13E+03	5.41E+05	4.79E+13	6.56E+03	1.26E+05	
Average (Bq/week):		1.54E+08	1.37E+02	1.04E+04	9.22E+11	1.26E+02	2.43E+03	
Minimum (Bq/week):		1.53E+04	1.23E+02	1.48E+03	1.40E+11	1.19E+02	1.27E+03	
Maximum (Bq/week):		4.08E+09	1.98E+02	1.87E+05	2.45E+12	1.82E+02	7.67E+03	
DRLold(Bq/week):		7.00E+10	3.00E+07	1.60E+09	7.80E+13	3.00E+07	1.60E+09	
Ave(% DRLold):		2.20E-01	4.57E-04	6.51E-04	1.18E+00	4.21E-04	1.52E-04	
Max(% DRLold):		5.83E+00	6.60E-04	1.17E-02	3.14E+00	6.07E-04	4.79E-04	
DRLboundary-old(Bq/week):		2.10E+11	3.60E+10	1.70E+12	1.10E+16	3.60E+10	1.70E+12	
Ave(% DRLboundary-old):		7.32E-02	3.81E-07	6.12E-07	8.38E-03	3.51E-07	1.43E-07	
Max(% DRLboundary-old):		1.94E+00	5.50E-07	1.10E-05	2.23E-02	5.06E-07	4.51E-07	
DRL (Bq/vweek):		1.36E+11	5.21E+09	4.34E+11	3.05E+16	5.21E+09	4.34E+11	
Ave(% DRL):		1.13E-01	2.63E-06	2.40E-06	3.02E-03	2.42E-06	5.59E-07	
Max (%DRL):		3.00E+00	3.80E-06	4.31E-05	8.03E-03	3.49E-06	1.77E-06	
Stack LLD (Bq/week)		2.54E+04	1.34E+02	2.17E+03		1.26E+02	2.10E+03	

*) Includes accidental release from Cells 10&11, semi-quantitative estimations from operational control monitoring
LLD= Lower Limit of Detection. Lc =Critical Level.

Appendix A
CRL Air Effluent Monitoring Data for 1998
Table A-7

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Release Point		NUCLEAR FUEL FABRICATION LABORATORIES			
Bldg./Sample Location		405 LEU	405 LEU	429B HEU	429B HEU
Radionuclide		Gross Alpha	Gross Beta	Gross Alpha	Gross Beta
Week/Unit		Bq/week	Bq/week	Bq/week	Bq/week
1	971231 to 980107	<Lc	1.94E+02	<Lc	2.22E+02
2	980107 to 980114	<Lc	1.93E+02	<Lc	1.99E+02
3	980114 to 980121	<Lc	1.97E+02	<Lc	1.82E+02
4	980121 to 980128	<Lc	1.89E+02	<Lc	2.53E+02
5	980128 to 980204	<Lc	1.95E+02	<Lc	2.24E+02
6	980204 to 980211	<Lc	1.96E+02	<Lc	1.98E+02
7	980211 to 980218	<Lc	1.95E+02	<Lc	1.89E+02
8	980218 to 980225	<Lc	1.98E+02	<Lc	1.80E+02
9	980225 to 980304	<Lc	1.95E+02	<Lc	1.94E+02
10	980304 to 980311	<Lc	1.93E+02	<Lc	1.70E+02
11	980311 to 980318	<Lc	3.13E+02	<Lc	2.65E+02
12	980318 to 980325	<Lc	1.97E+02	<Lc	2.06E+02
13	980325 to 980401	<Lc	1.96E+02	<Lc	1.89E+02
14	980401 to 980408	<Lc	1.98E+02	<Lc	1.68E+02
15	980408 to 980415	<Lc	1.99E+02	<Lc	3.01E+02
16	980415 to 980422	<Lc	2.00E+02	<Lc	1.92E+02
17	980422 to 980429	<Lc	1.98E+02	<Lc	1.95E+02
18	980429 to 980506	<Lc	1.96E+02	<Lc	4.98E+02
19	980506 to 980513	<Lc	1.97E+02	<Lc	1.74E+02
20	980513 to 980520	<Lc	1.96E+02	<Lc	1.78E+02
21	980520 to 980527	<Lc	1.97E+02	<Lc	1.88E+02
22	980527 to 980603	<Lc	2.66E+02	<Lc	6.15E+02
23	980603 to 980610	<Lc	1.97E+02	<Lc	1.74E+02
24	980610 to 980617	<Lc	2.00E+02	<Lc	3.96E+02
25	980617 to 980624	<Lc	1.99E+02	<Lc	3.63E+02
26	980624 to 980701	<Lc	1.99E+02	<Lc	2.98E+02
27	980701 to 980708	<Lc	1.86E+02	<Lc	2.70E+02
28	980708 to 980715	<Lc	2.12E+02	<Lc	2.81E+02
29	980715 to 980722	<Lc	1.93E+02	<Lc	2.25E+02
30	980722 to 980729	<Lc	1.92E+02	<Lc	2.10E+02
31	980729 to 980805	<Lc	1.93E+02	<Lc	1.98E+02
32	980805 to 980812	<Lc	1.95E+02	<Lc	1.95E+02
33	980812 to 980819	<Lc	1.96E+02	<Lc	1.86E+02
34	980819 to 980826	<Lc	1.98E+02	<Lc	2.05E+02
35	980826 to 980902	<Lc	1.95E+02	<Lc	2.06E+02
36	980902 to 980909	<Lc	1.95E+02	<Lc	2.15E+02
37	980909 to 980916	<Lc	1.92E+02	<Lc	3.10E+02
38	980916 to 980923	<Lc	1.94E+02	<Lc	3.21E+02
39	980923 to 980930	<Lc	1.92E+02	<Lc	3.89E+02
40	980930 to 981007	<Lc	1.91E+02	<Lc	3.80E+02
41	981007 to 981014	<Lc	1.92E+02	<Lc	2.15E+02
42	981014 to 981021	<Lc	1.94E+02	<Lc	2.03E+02
43	981021 to 981028	<Lc	1.91E+02	<Lc	4.10E+02
44	981028 to 981104	<Lc	1.89E+02	<Lc	3.72E+02
45	981104 to 981111	<Lc	1.90E+02	<Lc	2.08E+02
46	981111 to 981118	<Lc	1.91E+02	<Lc	5.21E+02
47	981118 to 981125	<Lc	1.88E+02	<Lc	4.06E+02
48	981125 to 981202	<Lc	1.88E+02	<Lc	1.94E+02
49	981202 to 981209	<Lc	1.88E+02	<Lc	1.97E+02
50	981209 to 981216	<Lc	1.87E+02	<Lc	1.02E+03
51	981216 to 981223	<Lc	2.52E+02	<Lc	2.86E+02
52	981223 to 981230	<Lc	1.89E+02	<Lc	2.16E+02
Sum (Bq/a):		1.04E+04	1.71E+05	7.72E+02	1.43E+04
Average (Bq/week):		1.99E+02	3.29E+03	1.49E+01	2.74E+02
Minimum (Bq/week):		1.86E+02	2.00E+03	1.41E+01	1.68E+02
Maximum (Bq/week):		3.13E+02	6.38E+03	2.01E+01	1.02E+03
DRLold(Bq/week):		3.00E+07	1.60E+09	3.00E+07	1.60E+09
Ave(% DRLold):		6.64E-04	2.06E-04	4.95E-05	1.71E-05
Max(% DRLold):		1.04E-03	3.99E-04	6.70E-05	6.38E-05
DRLboundary-old(Bq/week):		3.60E+10	1.70E+12	1.70E+11	1.70E+12
Ave(%DRLboundary-old)		5.53E-07	1.94E-07	8.74E-09	1.61E-08
Max(%DRLboundary-old)		8.69E-07	3.75E-07	1.18E-08	6.00E-08
DRL (Bq/week)		1.93E+10	4.34E+11	1.93E+10	4.34E+11
Ave(%DRL)		1.03E-06	7.58E-07	7.69E-08	6.31E-08
Max (%DRL)		1.62E-06	1.47E-06	1.04E-07	2.35E-07
Stack LLD (Bq/week)		1.94E+02		1.47E+01	2.36E+02

Notes: For comparison with DRLs, gross alpha from NFFF (Buildings 405 and 459) are assumed to be U-234.
Lc = Lower Limit of Detection. Lc = Critical Level.

Appendix A
CRL Air Effluent Monitoring Data for 1998
Table A-8

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Release Point		DECONTAMINATION CENTRE				
Bldg./Sample Location		468	468	468	468	468
Radionuclide		Iodine-125	Iodine-131	Gross Alpha	Gross Beta	Tritium Oxide
Week/Unit		Bq/week	Bq/week	Bq/week	Bq/week	Bq/week
1	971231 to 980107	<Lc 2.62E+03	<Lc 6.24E+03	<Lc 4.19E+01	<Lc 6.32E+02	4.04E+07
2	980107 to 980114	1.17E+04	8.45E+05	<Lc 4.16E+01	<Lc 5.67E+02	4.42E+08
3	980114 to 980121	<Lc 5.67E+03	9.83E+05	4.29E+01	2.51E+03	1.15E+09
4	980121 to 980128	<Lc 7.14E+03	2.22E+06	5.48E+01	2.06E+03	5.72E+07
5	980128 to 980204	<Lc 4.57E+03	7.10E+05	4.25E+01	1.65E+03	1.19E+09
6	980204 to 980211	<Lc 2.62E+03	8.57E+04	<Lc 4.23E+01	<Lc 5.63E+02	1.55E+08
7	980211 to 980218	<Lc 3.03E+03	1.45E+05	4.26E+01	<Lc 5.36E+02	2.15E+09
8	980218 to 980225	<Lc 3.02E+03	1.70E+04	8.61E+01	1.34E+03	6.85E+08
9	980225 to 980304	5.51E+03	1.20E+06	<Lc 4.21E+01	<Lc 5.51E+02	2.46E+07
10	980304 to 980311	<Lc 3.04E+03	2.18E+05	<Lc 4.18E+01	<Lc 4.83E+02	1.88E+09
11	980311 to 980318	5.96E+03	9.38E+05	4.07E+01	1.32E+03	1.44E+09
12	980318 to 980325	<Lc 3.38E+03	6.57E+04	<Lc 4.24E+01	1.56E+03	8.93E+10
13	980325 to 980401	<Lc 2.62E+03	1.44E+05	<Lc 4.24E+01	9.18E+02	5.77E+10
14	980401 to 980408	<Lc 2.14E+03	1.31E+04	<Lc 4.27E+01	<Lc 4.79E+02	9.87E+09
15	980408 to 980415	<Lc 3.02E+03	6.36E+04	<Lc 4.29E+01	<Lc 8.57E+02	1.31E+09
16	980415 to 980422	1.02E+05	7.51E+03	<Lc 4.31E+01	<Lc 5.46E+02	2.31E+09
17	980422 to 980429	2.36E+04	2.47E+04	<Lc 4.28E+01	5.61E+02	1.73E+10
18	980429 to 980506	3.62E+04	6.94E+03	<Lc 4.24E+01	2.75E+03	2.44E+09
19	980506 to 980513	1.47E+04	1.33E+05	<Lc 4.26E+01	6.38E+02	2.36E+09
20	980513 to 980520	1.11E+04	5.26E+04	<Lc 4.24E+01	7.22E+02	1.39E+08
21	980520 to 980527	<Lc 4.28E+03	2.06E+04	<Lc 4.26E+01	<Lc 5.36E+02	5.87E+07
22	980527 to 980603	<Lc 3.71E+03	1.75E+05	4.32E+01	2.23E+03	1.23E+09
23	980603 to 980610	2.23E+03	4.37E+03	<Lc 4.26E+01	<Lc 4.94E+02	5.61E+07
24	980610 to 980617	9.10E+03	5.47E+04	7.23E+01	<Lc 1.02E+03	4.25E+08
25	980617 to 980624	<Lc 7.87E+03	1.73E+06	<Lc 4.29E+01	1.40E+03	7.65E+09
26	980624 to 980701	2.82E+03	5.30E+04	<Lc 4.30E+01	<Lc 8.48E+02	4.27E+08
27	980701 to 980708	<Lc 2.62E+03	3.01E+04	<Lc 4.02E+01	2.42E+03	2.90E+08
28	980708 to 980715	<Lc 3.04E+03	1.89E+04	9.22E+01	1.56E+03	3.42E+08
29	980715 to 980722	<Lc 3.02E+03	7.51E+03	<Lc 4.17E+01	<Lc 6.39E+02	4.40E+08
30	980722 to 980729	<Lc 3.02E+03	7.51E+03	<Lc 4.15E+01	7.56E+02	2.36E+08
31	980729 to 980805	3.13E+03	4.12E+03	7.00E+01	7.44E+02	2.59E+07
32	980805 to 980812	5.67E+03	6.85E+03	<Lc 4.22E+01	<Lc 5.55E+02	9.93E+06
33	980812 to 980819	<Lc 2.14E+03	1.88E+03	<Lc 4.22E+01	1.32E+03	6.43E+08
34	980819 to 980826	<Lc 2.62E+03	5.67E+03	5.76E+01	7.68E+02	4.82E+07
35	980826 to 980902	5.71E+04	2.06E+07	9.89E+01	2.39E+03	1.05E+08
36	980902 to 980909	5.59E+03	7.55E+05	<Lc 4.21E+01	1.12E+03	3.25E+07
37	980909 to 980916	<Lc 3.39E+03	1.58E+05	<Lc 4.15E+01	<Lc 8.82E+02	8.26E+08
38	980916 to 980923	7.47E+03	1.98E+06	<Lc 4.20E+01	<Lc 9.13E+02	8.39E+07
39	980923 to 980930	<Lc 5.22E+03	1.32E+05	<Lc 4.15E+01	<Lc 1.11E+03	5.24E+08
40	980930 to 981007	3.26E+03	9.79E+04	<Lc 4.12E+01	1.96E+03	2.94E+09
41	981007 to 981014	9.22E+02	3.95E+04	<Lc 4.15E+01	8.55E+02	2.43E+09
42	981014 to 981021	<Lc 2.13E+03	3.23E+04	8.32E+01	6.71E+02	1.28E+09
43	981021 to 981028	<Lc 3.73E+03	2.33E+05	5.53E+01	<Lc 1.17E+03	2.45E+08
44	981028 to 981104	<Lc 3.02E+03	3.37E+04	4.13E+01	<Lc 1.06E+03	7.58E+07
45	981104 to 981111	1.71E+03	5.43E+04	<Lc 4.11E+01	7.81E+02	1.49E+09
46	981111 to 981118	1.31E+04	2.26E+06	<Lc 4.11E+01	1.61E+03	4.58E+09
47	981118 to 981125	<Lc 2.63E+03	1.53E+05	<Lc 4.07E+01	2.20E+03	1.14E+09
48	981125 to 981202	<Lc 5.51E+03	1.37E+06	<Lc 4.06E+01	1.70E+03	5.93E+08
49	981202 to 981209	8.12E+03	1.94E+06	6.80E+01	2.59E+03	7.35E+07
50	981209 to 981216	<Lc 5.26E+03	1.00E+06	<Lc 4.03E+01	2.25E+03	5.13E+09
51	981216 to 981223	3.46E+03	1.33E+05	4.09E+01	<Lc 8.13E+02	5.86E+07
52	981223 to 981230	<Lc 1.51E+03	2.26E+04	<Lc 4.08E+01	<Lc 6.15E+02	6.89E+07
Sum (Bq/a):		4.42E+05	4.10E+07	2.50E+03	6.12E+04	2.26E+11
Average (Bq/week):		8.50E+03	7.88E+05	4.81E+01	1.18E+03	4.34E+09
Minimum (Bq/week):		9.22E+02	1.88E+03	4.02E+01	4.79E+02	9.93E+06
Maximum (Bq/week):		1.02E+05	2.06E+07	9.89E+01	2.75E+03	8.93E+10
DRLold(Bq/week):		1.20E+11	7.00E+10	3.00E+07	1.60E+09	7.80E+13
Ave(% DRLold):		7.08E-06	1.13E-03	1.60E-04	7.36E-05	5.56E-03
Max(% DRLold):		8.50E-05	2.94E-02	3.30E-04	1.72E-04	1.14E-01
DRLboundary-old(Bq/week):		1.30E+11	2.10E+11	3.60E+10	1.70E+12	1.10E+16
Ave(% DRLboundary-old):		6.54E-06	3.75E-04	1.34E-07	6.93E-08	3.94E-05
Max(% DRLboundary-old):		7.85E-05	9.81E-03	2.75E-07	1.62E-07	8.12E-04
DRL (Bq/week):		8.98E+10	1.36E+11	5.21E+09	4.34E+11	3.05E+16
Ave(% DRL):		9.47E-06	5.80E-04	9.22E-07	2.71E-07	1.42E-05
Max (%DRL):		1.14E-04	1.51E-02	1.90E-06	6.34E-07	2.93E-04
Stack LLD (Bq/week):		3.62E+03	6.10E+03	4.19E+01	7.88E+02	

LLD= Lower Limit of Detection. Lc =Critical Level.

Appendix A
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Release Point		WASTE TREATMENT CENTRE				FILTER TESTING & EFFLUENT MONITORING LABORATORIES		
Bldg./Sample Location		570	570	570	570	430	430	430
Radionuclide		Iodine-131	Gross Alpha	Gross Beta	Tritium Oxide	Iodine-131	Gross Alpha	Gross Beta
Week/Unit		Bq/week	Bq/week	Bq/week	Bq/week	Bq/week	Bq/week	Bq/week
1	971231 to 980107	1.41E+04	<Lc 5.18E+01	2.90E+03	2.99E+07	6.56E+05	<Lc 3.94E+01	3.79E+03
2	980107 to 980114	<Lc 5.49E+03	<Lc 5.14E+01	1.29E+03	4.23E+07	3.76E+04	<Lc 3.92E+01	<Lc 5.33E+02
3	980114 to 980121	<Lc 7.66E+03	1.05E+02	2.20E+03	8.42E+06	3.53E+04	5.37E+01	1.11E+03
4	980121 to 980128	<Lc 8.72E+03	5.09E+01	1.64E+03	5.79E+07	1.26E+04	<Lc 3.83E+01	<Lc 5.94E+02
5	980128 to 980204	2.31E+04	6.98E+01	9.87E+02	6.96E+07	4.57E+04	9.27E+01	<Lc 6.01E+02
6	980204 to 980211	1.38E+04	<Lc 5.23E+01	2.08E+03	4.70E+07	1.58E+04	<Lc 3.98E+01	1.24E+03
7	980211 to 980218	2.56E+04	<Lc 5.20E+01	7.89E+02	1.32E+08	5.30E+03	7.97E+01	<Lc 5.04E+02
8	980218 to 980225	9.32E+03	5.35E+01	1.21E+03	9.76E+07	2.84E+04	<Lc 4.02E+01	9.19E+02
9	980225 to 980304	9.27E+03	<Lc 5.20E+01	3.18E+03	1.41E+08	9.21E+06	<Lc 3.96E+01	2.56E+04
10	980304 to 980311	1.61E+04	<Lc 5.16E+01	2.35E+03	7.59E+07	4.14E+06	<Lc 3.93E+01	8.77E+03
11	980311 to 980318	4.61E+04	<Lc 4.97E+01	<Lc 9.31E+02	1.42E+08	1.42E+07	<Lc 3.79E+01	3.32E+04
12	980318 to 980325	6.50E+04	<Lc 5.24E+01	1.18E+03	1.05E+09	1.23E+07	1.07E+02	1.96E+04
13	980325 to 980401	3.71E+04	<Lc 5.24E+01	6.80E+02	3.82E+08	9.21E+06	5.36E+01	1.30E+04
14	980401 to 980408	2.78E+04	<Lc 5.27E+01	8.51E+02	1.32E+09	4.64E+06	<Lc 4.01E+01	7.58E+03
15	980408 to 980415	9.27E+03	1.07E+02	2.05E+03	9.02E+08	1.11E+06	5.43E+01	<Lc 8.06E+02
16	980415 to 980422	<Lc 6.96E+03	7.16E+01	2.11E+03	6.28E+08	6.45E+05	4.10E+01	<Lc 5.14E+02
17	980422 to 980429	<Lc 7.76E+03	<Lc 5.29E+01	1.73E+03	3.59E+08	2.19E+05	<Lc 4.03E+01	9.77E+02
18	980429 to 980506	<Lc 8.57E+03	<Lc 5.23E+01	3.55E+03	3.74E+08	1.68E+05	8.01E+01	1.45E+03
19	980506 to 980513	<Lc 3.83E+03	<Lc 5.26E+01	3.78E+03	5.40E+08	2.13E+05	9.39E+01	8.28E+02
20	980513 to 980520	4.66E+03	7.04E+01	2.38E+03	4.32E+08	2.18E+05	8.02E+01	<Lc 4.77E+02
21	980520 to 980527	<Lc 6.65E+03	<Lc 5.26E+01	2.01E+03	4.11E+08	2.35E+05	9.38E+01	<Lc 5.04E+02
22	980527 to 980603	2.80E+04	<Lc 5.28E+01	3.20E+03	3.26E+08	8.86E+04	<Lc 4.02E+01	6.31E+02
23	980603 to 980610	2.32E+03	<Lc 5.26E+01	4.65E+03	3.26E+08	3.19E+06	<Lc 4.00E+01	2.31E+04
24	980610 to 980617	<Lc 3.83E+03	<Lc 5.32E+01	9.84E+03	2.97E+08	7.87E+06	6.80E+01	1.05E+05
25	980617 to 980624	<Lc 3.84E+03	<Lc 5.30E+01	3.53E+03	3.89E+08	1.49E+07	<Lc 4.04E+01	6.39E+04
26	980624 to 980701	1.45E+04	7.14E+01	<Lc 1.05E+03	2.36E+08	1.42E+07	4.09E+01	1.87E+04
27	980701 to 980708	9.32E+03	<Lc 4.97E+01	4.47E+03	4.46E+08	9.75E+06	<Lc 3.78E+01	2.88E+04
28	980708 to 980715	2.32E+03	<Lc 5.66E+01	4.36E+03	2.06E+09	3.48E+06	5.80E+01	6.91E+03
29	980715 to 980722	<Lc 7.66E+03	5.22E+01	8.87E+02	5.38E+08	1.43E+06	7.90E+01	2.36E+03
30	980722 to 980729	<Lc 5.44E+03	6.90E+01	7.73E+02	1.39E+08	5.33E+05	3.95E+01	1.08E+03
31	980729 to 980805	8.01E+03	<Lc 5.15E+01	7.58E+02	2.98E+08	3.72E+05	6.58E+01	7.00E+02
32	980805 to 980812	<Lc 4.31E+03	<Lc 5.21E+01	3.20E+03	1.72E+08	1.99E+05	6.65E+01	1.60E+03
33	980812 to 980819	2.32E+03	<Lc 5.21E+01	3.23E+03	1.06E+09	5.64E+04	4.01E+01	1.00E+03
34	980819 to 980826	<Lc 5.44E+03	<Lc 5.29E+01	<Lc 7.19E+02	7.63E+08	3.19E+04	6.76E+01	8.42E+02
35	980826 to 980902	1.63E+04	<Lc 5.21E+01	9.11E+02	1.53E+08	1.06E+04	5.33E+01	5.74E+02
36	980902 to 980909	3.48E+04	<Lc 5.20E+01	8.98E+02	2.42E+08	2.47E+04	9.29E+01	1.79E+03
37	980909 to 980916	<Lc 3.84E+03	<Lc 5.12E+01	<Lc 1.09E+03	1.13E+08	4.11E+03	7.84E+01	<Lc 8.30E+02
38	980916 to 980923	4.17E+04	8.70E+01	<Lc 1.13E+03	1.70E+08	9.44E+06	3.99E+01	9.40E+04
39	980923 to 980930	1.86E+04	6.89E+01	1.84E+03	9.27E+07	1.16E+07	6.55E+01	1.01E+05
40	980930 to 981007	5.59E+04	<Lc 5.09E+01	3.54E+03	2.94E+08	1.75E+07	7.80E+01	1.07E+05
41	981007 to 981014	2.08E+04	5.19E+01	<Lc 7.55E+02	4.07E+09	8.44E+06	5.25E+01	3.19E+04
42	981014 to 981021	4.21E+04	<Lc 5.11E+01	1.02E+04	5.27E+09	2.55E+06	<Lc 3.89E+01	4.15E+03
43	981021 to 981028	1.26E+05	<Lc 5.08E+01	8.89E+03	7.09E+08	7.75E+06	5.20E+01	2.37E+04
44	981028 to 981104	3.70E+04	<Lc 5.04E+01	3.92E+03	2.32E+09	6.94E+06	<Lc 3.84E+01	3.99E+04
45	981104 to 981111	2.32E+04	<Lc 5.07E+01	1.95E+04	6.07E+09	1.16E+06	6.48E+01	5.63E+03
46	981111 to 981118	2.33E+04	5.14E+01	1.29E+04	7.84E+08	5.03E+05	7.78E+01	1.67E+04
47	981118 to 981125	3.26E+04	<Lc 5.03E+01	5.58E+03	5.52E+08	1.47E+06	7.69E+01	3.00E+04
48	981125 to 981202	9.27E+03	<Lc 5.02E+01	7.92E+03	1.28E+09	2.91E+06	5.14E+01	9.97E+03
49	981202 to 981209	1.89E+04	6.73E+01	1.58E+03	1.62E+08	1.02E+07	7.66E+01	4.02E+04
50	981209 to 981216	<Lc 6.60E+03	<Lc 4.98E+01	3.59E+03	5.70E+07	3.95E+06	<Lc 3.79E+01	1.93E+04
51	981216 to 981223	<Lc 6.10E+03	<Lc 4.99E+01	<Lc 1.00E+03	6.45E+07	5.83E+05	5.11E+01	1.37E+03
52	981223 to 981230	<Lc 5.01E+03	1.18E+02	<Lc 7.59E+02	8.10E+07	3.34E+05	<Lc 3.83E+01	1.34E+03
Sum (Bq/a):		9.76E+05	3.03E+03	1.67E+05	3.94E+10	1.99E+08	2.97E+03	9.07E+05
Average (Bq/week):		1.88E+04	5.83E+01	3.20E+03	7.58E+08	3.82E+06	5.72E+01	1.74E+04
Minimum (Bq/week):		2.32E+03	4.97E+01	6.80E+02	8.42E+06	4.11E+03	3.78E+01	4.77E+02
Maximum (Bq/week):		1.26E+05	1.18E+02	1.95E+04	6.07E+09	1.75E+07	1.07E+02	1.07E+05
DRLold (Bq/week):		7.00E+10	3.00E+07	1.60E+09	7.80E+13	7.00E+10	3.00E+07	1.60E+09
Ave(% DRLold):		2.68E-05	1.94E-04	2.00E-04	9.72E-04	5.46E-03	1.91E-04	1.09E-03
Max(% DRLold):		1.80E-04	3.93E-04	1.22E-03	7.78E-03	2.50E-02	3.57E-04	6.69E-03
DRLboundary-old (Bq/week):		2.10E+11	3.60E+10	1.70E+12	1.10E+16	2.10E+11	3.60E+10	1.70E+12
Ave(% DRLboundary-old):		8.94E-06	1.62E-07	1.88E-07	6.89E-06	1.82E-03	1.59E-07	1.03E-06
Max(% DRLboundary-old):		6.00E-05	3.28E-07	1.15E-06	5.52E-05	8.33E-03	2.97E-07	6.29E-06
DRL (Bq/week):		1.36E+11	5.21E+09	4.34E+11	3.05E+16	1.36E+11	5.21E+09	4.34E+11
Ave(% DRL):		1.38E-05	1.12E-06	7.38E-07	2.49E-06	2.81E-06	1.10E-06	4.02E-06
Max (% DRL):		9.26E-05	2.26E-06	4.49E-06	1.99E-05	1.29E-02	2.05E-06	2.47E-05
Stack LLD (Bq/week)		6.08E+03	5.23E+01	9.29E+02		4.11E+03	4.15E+01	5.96E+02

Lower Limit of Detection. Lc =Critical Level.

Appendix A
CRL Air Effluent Monitoring Data for 1998
TABLE A-10

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Release Point		NRX ROOF VENTS (Main Building and Bays)			
Bldg./Sample Location		100	204	100	204
Radionuclide		Gross Alpha	Gross Alpha	Gross Beta	Gross Beta
Week/Unit		Bq/week	Bq/week	Bq/week	Bq/week
1	971231 to 980107	<Lc 9.77E+00	<Lc 1.16E+02	<Lc 1.47E+02	2.71E+03
2	980107 to 980114	<Lc 9.70E+00	<Lc 1.16E+02	<Lc 1.32E+02	2.29E+03
3	980114 to 980121	1.00E+01	2.10E+02	<Lc 1.21E+02	2.27E+03
4	980121 to 980128	<Lc 9.50E+00	<Lc 1.13E+02	<Lc 1.47E+02	3.25E+03
5	980128 to 980204	<Lc 9.80E+00	1.18E+02	<Lc 1.49E+02	2.63E+03
6	980204 to 980211	<Lc 9.87E+00	1.18E+02	<Lc 1.31E+02	2.83E+03
7	980211 to 980218	<Lc 9.82E+00	1.17E+02	<Lc 1.25E+02	2.99E+03
8	980218 to 980225	<Lc 9.97E+00	1.20E+02	<Lc 1.19E+02	5.09E+03
9	980225 to 980304	<Lc 9.81E+00	1.17E+02	<Lc 1.29E+02	3.76E+03
10	980304 to 980311	<Lc 9.73E+00	1.18E+02	<Lc 1.13E+02	3.54E+03
11	980311 to 980318	<Lc 9.39E+00	1.12E+02	<Lc 1.76E+02	4.94E+03
12	980318 to 980325	<Lc 9.89E+00	1.18E+02	<Lc 1.22E+02	3.94E+03
13	980325 to 980401	<Lc 9.88E+00	1.18E+02	<Lc 1.25E+02	4.23E+03
14	980401 to 980408	<Lc 9.94E+00	1.25E+02	<Lc 1.12E+02	4.02E+03
15	980408 to 980415	1.35E+01	<Lc 1.19E+02	<Lc 2.00E+02	4.21E+03
16	980415 to 980422	<Lc 1.00E+01	<Lc 1.20E+02	<Lc 1.27E+02	4.14E+03
17	980422 to 980429	1.01E+01	1.26E+02	<Lc 1.29E+02	9.46E+03
18	980429 to 980506	<Lc 9.88E+00	1.18E+02	<Lc 1.84E+02	8.44E+03
19	980506 to 980513	<Lc 9.93E+00	1.22E+02	<Lc 1.16E+02	4.64E+03
20	980513 to 980520	<Lc 9.89E+00	1.19E+02	<Lc 1.18E+02	3.64E+03
21	980520 to 980527	<Lc 9.92E+00	1.18E+02	<Lc 1.25E+02	5.31E+03
22	980527 to 980603	<Lc 9.96E+00	1.20E+02	<Lc 1.01E+02	6.28E+03
23	980603 to 980610	<Lc 9.92E+00	1.19E+02	<Lc 1.15E+02	4.21E+03
24	980610 to 980617	<Lc 1.00E+01	<Lc 1.20E+02	<Lc 2.38E+02	5.26E+03
25	980617 to 980624	<Lc 1.00E+01	1.19E+02	<Lc 2.15E+02	6.37E+03
26	980624 to 980701	<Lc 1.00E+01	1.19E+02	<Lc 1.98E+02	3.89E+03
27	980701 to 980708	9.48E+00	1.12E+02	4.51E+02	4.04E+03
28	980708 to 980715	<Lc 1.07E+01	1.29E+02	3.93E+02	9.46E+03
29	980715 to 980722	<Lc 9.73E+00	1.16E+02	1.49E+02	6.09E+03
30	980722 to 980729	<Lc 9.68E+00	<Lc 1.15E+02	2.37E+02	5.66E+03
31	980729 to 980805	<Lc 9.72E+00	1.17E+02	<Lc 1.31E+02	4.19E+03
32	980805 to 980812	<Lc 9.83E+00	1.17E+02	<Lc 1.29E+02	5.95E+03
33	980812 to 980819	<Lc 9.84E+00	<Lc 1.17E+02	<Lc 1.23E+02	3.60E+03
34	980819 to 980826	<Lc 9.98E+00	1.19E+02	<Lc 1.36E+02	5.53E+03
35	980826 to 980902	<Lc 9.83E+00	1.26E+02	<Lc 1.37E+02	4.37E+03
36	980902 to 980909	<Lc 9.82E+00	1.17E+02	1.69E+02	2.21E+03
37	980909 to 980916	<Lc 9.67E+00	1.15E+02	<Lc 2.06E+02	2.85E+03
38	980916 to 980923	<Lc 9.78E+00	1.17E+02	<Lc 2.13E+02	7.76E+03
39	980923 to 980930	<Lc 9.67E+00	<Lc 1.15E+02	<Lc 2.58E+02	3.64E+03
40	980930 to 981007	<Lc 9.61E+00	<Lc 1.14E+02	<Lc 2.52E+02	3.92E+03
41	981007 to 981014	1.30E+01	<Lc 1.15E+02	<Lc 1.42E+02	2.54E+03
42	981014 to 981021	9.75E+00	1.16E+02	<Lc 1.35E+02	3.82E+03
43	981021 to 981028	<Lc 9.59E+00	1.15E+02	<Lc 2.72E+02	3.96E+03
44	981028 to 981104	<Lc 9.52E+00	<Lc 1.13E+02	<Lc 2.47E+02	4.98E+03
45	981104 to 981111	9.68E+00	<Lc 1.14E+02	3.64E+02	6.26E+03
46	981111 to 981118	1.61E+01	<Lc 1.14E+02	2.55E+02	1.95E+05
47	981118 to 981125	1.27E+01	1.13E+02	<Lc 2.69E+02	3.74E+04
48	981125 to 981202	1.27E+01	1.14E+02	<Lc 1.29E+02	4.30E+03
49	981202 to 981209	9.55E+00	1.14E+02	<Lc 1.31E+02	3.68E+03
50	981209 to 981216	<Lc 9.40E+00	1.17E+02	4.93E+02	8.67E+03
51	981216 to 981223	<Lc 9.42E+00	1.12E+02	<Lc 1.90E+02	4.06E+03
52	981223 to 981230	No sample 1)	No sample 1)	No sample 1)	No sample 1)
Sum (Bq/a):		5.19E+02	6.08E+03	9.33E+03	4.59E+05
Average (Bq/week):		1.02E+01	1.19E+02	1.83E+02	8.99E+03
Minimum (Bq/week):		9.39E+00	1.12E+02	1.01E+02	2.21E+03
Maximum (Bq/week):		1.61E+01	2.10E+02	4.93E+02	1.95E+05
DRLold(Bq/week):		3.00E+07	3.00E+07	1.60E+09	1.60E+09
Ave(% DRLold):		3.39E-05	3.97E-04	1.14E-05	5.62E-04
Max(% DRLold):		5.37E-05	7.00E-04	3.08E-05	1.22E-02
DRLboundary-old(Bq/week):		3.60E+10	3.60E+10	1.70E+12	1.70E+12
Ave(%DRLboundary-old)		2.83E-08	3.31E-07	1.08E-08	5.29E-07
Max(%DRLboundary-old)		4.47E-08	5.83E-07	2.90E-08	1.15E-05
DRL (Bq/vweek)		5.21E+09	5.21E+09	4.34E+11	4.34E+11
Ave(%DRL)		1.95E-07	2.29E-06	4.21E-08	2.07E-06
Max (%DRL)		3.09E-07	4.03E-06	1.14E-07	4.50E-05
Stack LLD (Bq/week)		9.80E+00	1.17E+02	1.58E+02	3.47E+03

Samples collected in January 1999 because of Christmas shut-down. LLD= Lower Limit of Detection. Lc =Critical Level.

TABLE B1: CRL Process Sewer -- Monthly Release Data for 1998 (Jan – July)

Nuclide	CRL PROCESS SEWER -- MONTHLY AVERAGE RELEASES										
	Avg. LLD	Avg. LLD	DRL*	DRLold							
	Bq/L	GBq/mo	GBq/mo	GBq/mo	Jan	Feb	Mar	Apr	May	Jun	Jul
¹ H	124	4.09E+02	6.65E+08	2.90E+07	1.80E+04	1.81E+04	1.39E+04	7.26E+03	3.25E+03	1.85E+03	1.05E+03
²³ Na	46.60	1.54E+02	4.85E+06	2.20E+06	2.52E+02	< 2.50E+00	< 1.55E+00	< 1.70E+00	< 1.09E+00	1.63E+02	3.31E+02
³¹ P	0.01	2.24E-02	2.13E+03	2.10E+03	3.27E+00	2.47E+00	8.00E-02	3.00E-02	2.70E-02	1.28E+00	3.09E+00
⁴⁵ Sc	0.03	9.43E-02	1.40E+04	4.10E+06	6.00E-01	< 1.00E-01	< 4.70E-02	< 1.00E-01	< 3.40E-02	7.21E-01	8.01E-01
⁵¹ Cr	0.17	5.61E-01	2.05E+07	9.30E+07	3.20E+00	9.00E-01	< 3.21E-01	< 4.00E-01	< 2.17E-01	4.65E+00	6.02E+00
⁵⁵ Mn	0.03	9.78E-02	5.57E+05	3.20E+06	< 1.60E-01	1.00E-01	< 4.80E-02	< 1.00E-01	< 3.30E-02	1.19E-01	< 1.70E-01
⁵⁶ Fe	0.07	2.18E-01	7.62E+05	3.10E+06	< 5.00E-01	< 2.00E-01	< 9.40E-02	< 1.00E-01	< 6.80E-02	7.03E-01	3.33E+00
⁵⁹ Co	0.03	1.11E-01	3.85E+04	4.40E+04	3.40E+00	1.00E+00	5.34E-01	2.00E-01	7.70E-02	2.65E+00	3.49E+00
⁶⁶ Zn	0.08	2.62E-01	6.72E+04	9.30E+04	< 5.00E-01	2.00E-01	< 1.16E-01	2.00E-01	< 8.20E-02	5.88E-01	7.92E-01
⁷⁵ As	1.46	4.83E+00	2.95E+05	2.20E+05	1.71E+01	5.20E+00	< 4.64E-01	< 9.00E-01	< 6.30E-01	1.07E+01	1.78E+01
⁸⁶ Sr	0.004	1.30E-02	3.54E+04	1.40E+05	4.35E-01	8.51E-01	1.98E-01	6.60E-02	6.70E-02	1.79E-01	1.91E-01
⁹⁰ Zr	0.06	2.06E-01	7.14E+05	6.30E+06	1.60E+00	3.00E-01	< 9.60E-02	< 1.00E-01	< 6.20E-02	1.64E+00	1.53E+00
⁹⁴ Mo	0.03	9.85E-02	5.75E+06	3.00E+05	1.60E+00	4.00E-01	< 5.10E-02	< 2.30E+00	5.30E-02	7.73E-01	9.52E-01
¹⁰¹ Ru	0.03	9.03E-02	8.26E+06	7.40E+06	2.40E-01	1.00E-01	< 4.70E-02	< 1.00E-01	< 3.20E-02	1.32E-01	1.35E-01
¹⁰² Ru	0.25	8.32E-01	1.41E+05	5.60E+05	< 1.00E+00	< 5.00E-01	< 4.21E-01	< 4.00E-01	< 2.93E-01	< 9.51E-01	< 1.34E+00
¹³¹ I	0.03	9.30E-02	2.60E+04	1.40E+05	4.00E-01	2.00E-01	< 5.00E-02	< 1.00E-01	< 3.40E-02	3.59E-01	5.27E-01
¹³² Te*	0.09	2.98E-01	1.00E+05	2.00E+05	4.00E-01	2.00E-01	< 2.21E-01	< 1.50E+00	< 5.60E-02	3.78E-01	3.60E-01
¹³⁴ Cs	0.03	1.03E-01	5.08E+03	6.70E+03	2.00E-01	2.00E-01	< 1.68E-01	2.00E-01	6.80E-02	1.81E-01	< 2.46E-01
¹³⁷ Cs	0.03	8.41E-02	6.80E+03	8.90E+03	1.80E+00	4.80E+00	3.09E+00	1.90E+00	4.91E-01	1.49E+00	1.37E+00
¹⁴⁰ Ba	0.13	4.28E-01	2.71E+05	4.40E+06	9.00E-01	5.00E-01	< 2.22E-01	< 4.00E-01	< 1.54E-01	8.52E-01	< 5.53E-01
¹⁴¹ Ce	0.02	7.20E-02	1.39E+06	4.80E+06	6.00E-01	< 1.00E-01	< 4.60E-02	< 1.00E-01	< 3.30E-02	2.54E-01	9.60E-01
¹⁴⁴ Ce	0.46	1.51E+00	7.47E+05	4.10E+06	1.30E+00	< 5.00E-01	< 3.44E-01	< 4.00E-01	< 2.23E-01	< 6.97E-01	< 8.66E-01
¹⁴⁴ Ce	0.10	3.18E-01	1.80E+05	6.70E+05	< 4.00E-01	< 2.00E-01	< 1.88E-01	< 3.00E-01	< 1.25E-01	< 3.77E-01	< 4.72E-01
²³⁸ Pa	0.05	1.65E-01	N/A	2.30E+07	< 2.00E-01	< 5.00E-01	< 9.00E-02	< 1.00E-01	< 6.20E-02	1.93E-01	< 2.47E-01
²³⁸ Np	0.33	1.08E+00	1.55E+06	3.00E+07	3.90E+00	1.30E+00	< 4.74E-01	< 5.00E-01	< 3.21E-01	3.13E+00	< 2.02E+00
Nominal β+	0.39	1.29E+00	N/A	N/A	3.06E+01	8.00E-01	4.98E+00	3.50E+00	1.67E+01	2.57E+01	1.99E+00
Gross α++	0.09	2.98E-01	2.60E+03	5.90E+03	2.01E-01	1.70E-01	1.54E-01	2.97E-01	1.26E-01	5.12E-01	3.91E-01
²³⁹ Pu	3.00E-06	9.89E-06	4.63E+03	5.60E+04	1.38E-03	8.33E-04	2.10E-03	1.35E-03	1.32E-03	9.20E-04	1.15E-03
²⁴⁰ Pu	1.77E-06	5.85E-06	4.15E+03	4.80E+04	1.04E-03	1.16E-03	6.74E-03	5.11E-04	4.77E-04	3.20E-04	7.01E-04
Flow (L/day)					9.56E+07	9.59E+07	8.96E+07	8.30E+07	8.30E+07	1.22E+08	1.29E+08

< Means that results are less than or equal to Lower Limit of Detection (LLD).

* DRL from reference [3]. "DRL" old is from reference [9].

+ Nominal beta is a gross beta screening analysis done after about one week decay of short lived fission products. DRL not applicable.

++For comparison with DRLs, gross alpha is assumed to be Am-241.

Table B2: CRL Process Sewer -- Monthly Release Data for 1998 (July -- December and Annual Statistics)

Nuclide	Avg. LLD	Avg. LLD	DRL	DRLold	CRL PROCESS SEWER -- MONTHLY AVERAGE RELEASES										Max. Monthly Release						
	Bq/L	GBq/mo	GBq/mo	GBq/mo	Aug		Sept	Oct	Nov	Dec	Annual	Average	%DRL	%DRLold	GBq	%DRL	%DRLold				
¹ H	124	4.09E+02	6.65E+08	2.90E+07	4.11E+03	1.46E+03		2.82E+03	5.04E+03	2.98E+04	4.32E+04	8.65E+03	1.34E-03	2.98E-02	2.98E+04	4.48E-03	1.03E-01				
²³ Na	46.60	1.54E+02	4.85E+06	2.20E+06	1.21E+02	1.81E+02	<	4.77E+02	<	2.29E+00	2.06E+02	7.81E+02	1.95E+02	2.87E-03	8.88E-03	4.77E+02	9.83E-03	2.17E-02			
³¹ P	0.01	2.24E-02	2.13E+03	2.10E+03	1.54E+00	6.23E-01		7.44E-01	5.98E-02	3.55E+00	6.51E+00	1.30E+00	6.56E-02	6.20E-02	3.55E+00	1.67E-01	1.69E-01				
⁴⁵ Sc	0.03	9.43E-02	1.40E+04	4.10E+06	4.49E-01	6.81E-01	<	8.53E-02	<	5.86E-02	1.48E-01	1.42E+00	2.84E-01	2.28E-03	6.93E-06	8.01E-01	5.72E-03	1.95E-05			
⁵¹ Cr	0.17	5.61E-01	2.05E+07	9.30E+07	3.91E+00	4.86E+00	<	6.08E-01	<	4.44E-01	4.34E+00	1.42E+01	2.83E+00	1.21E-05	3.05E-06	6.02E+00	2.94E-05	6.47E-06			
⁵⁵ Mn	0.03	9.78E-02	5.57E+05	3.20E+06	1.43E-01	<	1.33E-01	<	8.61E-02	<	5.89E-02	<	1.01E-01	5.22E-01	1.04E-01	1.87E-05	3.26E-06	1.70E-01	3.05E-05	5.31E-06	
⁵⁶ Fe	0.07	2.18E-01	7.62E+05	3.10E+06	1.27E+00	2.03E+00	<	1.71E-01	<	1.16E-01	4.67E-01	4.05E+00	8.11E-01	9.90E-05	2.62E-05	3.33E+00	4.37E-04	1.07E-04			
⁵⁹ Co	0.03	1.11E-01	3.85E+04	4.40E+04	3.92E+00	5.73E+00		2.53E-01	2.15E-01	7.39E+00	1.75E+01	3.50E+00	6.25E-03	7.96E-03	7.39E+00	1.92E-02	1.68E-02				
⁶⁶ Zn	0.08	2.62E-01	6.72E+04	9.30E+04	<	3.75E-01	3.84E-01	<	2.03E-01	<	1.42E-01	1.36E+00	2.71E-01	4.75E-04	2.91E-04	7.92E-01	1.18E-03	8.52E-04			
⁷⁴ As	1.46	4.83E+00	2.95E+05	2.20E+05	8.63E+00	6.88E+00	<	1.34E+01	<	9.32E-01	1.55E+01	4.33E+01	8.66E+00	2.72E-03	3.93E-03	1.78E+01	6.04E-03	8.10E-03			
⁹⁰ Sr	0.004	1.30E-02	3.54E+04	1.40E+05	4.26E-01	8.18E-01		2.78E-01	2.48E-01	3.68E-01	2.14E+00	4.28E-01	9.71E-04	3.06E-04	8.51E-01	2.40E-03	6.08E-04				
⁹⁰ Zr	0.06	2.06E-01	7.14E+05	6.30E+06	6.87E-01	9.38E-01	<	9.29E-02	<	1.05E-01	8.00E-01	2.62E+00	5.25E-01	9.28E-05	8.33E-06	1.64E+00	2.30E-04	2.61E-05			
⁹⁴ Mo	0.03	9.85E-02	5.75E+06	3.00E+05	4.19E-01	4.41E-01	<	1.59E-01	<	2.01E-01	8.82E-01	2.10E+00	4.20E-01	1.19E-05	1.40E-04	2.30E+00	4.00E-05	7.67E-04			
¹⁰¹ Ru	0.03	9.03E-02	8.26E+06	7.40E+06	<	1.11E-01	1.34E-01	<	9.15E-02	<	7.38E-02	<	1.04E-01	5.14E-01	1.03E-01	1.31E-06	1.39E-08	2.40E-01	2.91E-06	3.24E-06	
¹⁰¹ Ru	0.25	8.32E-01	1.41E+05	5.60E+05	<	9.48E-01	<	1.23E+00	<	7.55E-01	<	5.20E-01	2.09E+00	5.54E+00	1.11E+00	6.17E-04	1.98E-04	2.09E+00	1.48E-03	3.73E-04	
¹³¹ I	0.03	9.30E-02	2.60E+04	1.40E+05	2.34E-01	<	2.99E-01	<	1.06E-01	<	3.95E-01	5.03E-01	1.54E+00	3.07E-01	1.03E-03	2.19E-04	5.27E-01	2.03E-03	3.76E-04		
¹³² Te	0.09	2.98E-01	1.00E+05	2.00E+05	<	4.49E-01	<	5.19E-01	<	6.23E-01	<	2.59E-01	3.37E-01	2.19E+00	4.37E-01	4.42E-04	2.19E-04	1.50E+00	1.50E-03	7.50E-04	
¹³⁴ Cs	0.03	1.03E-01	5.08E+03	6.70E+03	2.35E-01	2.33E-01	<	1.06E-01	<	9.43E-02	3.57E-01	1.03E+00	2.05E-01	3.75E-03	3.06E-03	3.57E-01	7.02E-03	5.32E-03			
¹³⁷ Cs	0.03	8.41E-02	6.80E+03	8.90E+03	4.92E+00	7.46E+00		4.61E+00	2.75E+00	2.83E+00	2.26E+01	4.51E+00	4.60E-02	5.07E-02	7.46E+00	1.10E-01	8.38E-02				
¹⁴⁰ Ba	0.13	4.28E-01	2.71E+05	4.40E+06	<	5.19E-01	<	6.45E-01	<	4.58E-01	<	3.14E-01	8.98E-01	2.83E+00	5.67E-01	1.97E-04	1.29E-05	9.00E-01	3.32E-04	2.05E-05	
¹⁴¹ Ce	0.02	7.20E-02	1.39E+06	4.80E+06	1.51E-01	<	1.77E-01	<	8.30E-02	<	5.64E-02	1.89E-01	6.56E-01	1.31E-01	1.65E-05	2.74E-06	9.60E-01	6.91E-05	2.00E-05		
¹⁴² Ce	0.46	1.51E+00	7.47E+05	4.10E+06	<	6.63E-01	<	7.08E-01	<	3.58E+00	<	4.68E-01	<	1.52E+00	6.94E+00	1.39E+00	1.26E-04	3.39E-05	3.58E+00	4.79E-04	8.73E-05
¹⁴⁴ Ce	0.10	3.18E-01	1.80E+05	6.70E+05	<	4.11E-01	<	4.52E-01	<	3.28E-01	<	2.29E-01	1.29E+00	2.71E+00	5.41E-01	2.21E-04	8.08E-05	1.29E+00	7.14E-04	1.92E-04	
²³³ Pa	0.05	1.65E-01	N/A	2.30E+07	<	1.97E-01	<	2.37E-01	<	1.58E-01	<	2.06E-01	<	2.27E-01	1.02E+00	2.05E-01	N/A	8.91E-07	5.00E-01	N/A	2.17E-06
²³⁸ Np	0.33	1.08E+00	1.55E+06	3.00E+07	<	1.74E+00	<	1.50E+00	<	1.86E+00	<	6.89E-01	<	1.16E+00	6.95E+00	1.39E+00	1.00E-04	4.63E-06	3.90E+00	2.52E-04	1.30E-05
Nominal β+	0.39	1.29E+00	N/A	N/A	2.04E+01	3.45E+00		4.18E+00	1.58E+00	1.53E+02	1.83E+02	3.65E+01	N/A	N/A	1.53E+02	N/A	N/A				
Total α++	0.09	2.98E-01	2.60E+03	5.90E+03	3.38E-01	1.970E-01		5.87E-03	1.99E-01	1.56E-01	8.95E-01	2.27E-01	8.74E-03	3.85E-03	5.12E-01	1.97E-02	8.68E-03				
²³⁸ Pu	3.00E-06	9.89E-06	4.63E+03	5.60E+04	1.66E-03	3.61E-04		1.19E-03	1.05E-03	9.52E-04	5.21E-03	1.04E-03	2.57E-05	1.86E-06	2.10E-03	4.54E-05	3.75E-06				
²³⁸⁻²⁴⁰ Pu	1.77E-06	5.85E-06	4.15E+03	4.80E+04	5.59E-04	7.53E-05		7.80E-04	3.56E-04	3.16E-04	2.09E-03	4.17E-04	2.62E-05	8.69E-07	6.74E-03	1.62E-04	1.40E-05				
Flow					1.20E+08	1.30E+08		1.36E+08	9.95E+07	9.84E+07											
													Site Tot.	1.44E-01	1.72E-01						

< Means that result are less than or equal to lower limit of detection (LLD). *DRL from reference [3]. *DRL old" is from reference [9].

+Nominal beta is a gross beta screening analysis done after about one week decay of short lived fission products. DRL not applicable.

++ For comparison with DRLs, gross alpha is assumed to be Am-241.

Table B3: CRL - Other Liquid Effluent Streams -- Monthly Release Data for 1998

Effluent Stream - Other Liquid Effluent Streams - Monthly Release Data for 1996																					
Effluent Stream Nuclide/Parameter	DRL GBq	DRLold GBq/month	Avg. LLD Bq/L	Avg. LLD GBq/mo	Release During Month GBq/month												Monthly Average Release				
					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total GBq	Avg. GBq	STDEV GB	% DRL	%DRLold
04 Storm Sewer																					
Tritium	6.65E+08	2.90E+07	1.20E+02	2.32E+01	4.88E+02	4.70E+02	5.00E+02	9.79E+02	1.30E+03	4.99E+02	5.29E+02	7.12E+02	1.27E+03	2.23E+03	1.01E+03	9.81E+02	1.10E+04	9.14E+02	5.17E+02	1.37E-04	3.15E-03
Gross Beta	3.54E+04	1.40E+05	9.20E-02	1.79E-02	1.85E-01	3.20E-01	6.00E-01	8.90E-01	1.03E+00	3.51E-01	3.49E-01	2.54E-01	4.37E-01	8.18E-01	3.81E-01	3.09E-01	5.92E+00	4.84E-01	2.76E-01	1.39E-03	3.53E-04
Gross Alpha (Estim*)	2.60E+03	5.90E+03	1.61E-01	3.13E-02	9.00E-03	2.00E-02	8.96E-03	1.90E-02	3.72E-02	1.64E-01	5.77E-03	1.46E-02	1.59E-02	2.16E-02	2.04E-02	1.88E-02	3.55E-01	2.96E-02	4.31E-02	1.14E-03	5.02E-04
Flow (L/day)					5.51E+06	5.85E+06	5.76E+06	6.60E+06	4.60E+06	6.67E+06	6.36E+06	6.10E+06	5.83E+06	6.48E+06	8.53E+06	8.34E+06		6.39E+06	1.11E+06		
Sanitary Sewer																					
Tritium	6.65E+08	2.90E+07	1.22E+02	1.69E+00	5.72E+00	7.21E+00	7.69E+00	1.03E+01	4.25E+00	5.46E+00	4.13E+00	5.25E+00	4.07E+00	5.12E+00	4.84E+00	5.02E+00	6.91E+01	5.78E+00	1.82E+00	8.66E-07	1.99E-05
Gross Beta	3.54E+04	1.40E+05	1.00E-01	1.39E-03	1.64E-02	1.53E-02	2.86E-02	5.40E-02	3.06E-02	6.14E-02	4.34E-02	6.81E-02	2.27E-02	2.36E-02	2.46E-02	2.40E-02	4.13E-01	3.44E-02	1.79E-02	9.71E-05	2.46E-05
Gross Alpha (I)	2.60E+03	5.90E+03	4.40E-01	6.09E-03	1.37E-03	1.81E-03	2.70E-03	1.60E-03	2.98E-03	1.18E-02	6.58E-04	8.75E-03	2.63E-03	3.15E-03	1.70E-03	7.20E-03	4.64E-02	3.86E-03	3.47E-03	1.49E-04	6.55E-05
Flow (L/day)					4.20E+05	3.88E+05	4.62E+05	5.27E+05	3.99E+05	4.37E+05	5.22E+05	5.00E+05	4.44E+05	4.25E+05	4.53E+05	4.79E+05		4.55E+05	4.52E+04		
03 Stream																					
Tritium	6.65E+08	2.90E+07	1.29E+02	2.26E+01	3.71E+01	2.35E+01	4.84E+01	9.07E+01	6.13E+01	4.73E+01	5.13E+01	3.51E+01	8.06E+00	3.16E+01	6.44E+01	4.09E+01	5.40E+02	4.25E+01	2.13E+01	6.39E-06	1.47E-04
Gross Beta	3.54E+04	1.40E+05	4.33E-02	7.59E-03	1.45E-01	4.00E-02	1.00E-01	1.40E-01	1.30E-01	2.25E-01	1.23E-01	8.10E-02	5.13E-02	7.03E-02	1.32E-01	7.06E-02	1.31E+00	1.10E-01	5.12E-02	3.12E-04	7.88E-05
Gross Alpha (Estim*)	2.60E+03	5.90E+03	6.09E-02	1.07E-02	< 8.74E-03	< 1.21E-02	< 8.74E-03	4.48E-03	1.79E-03	< 1.83E-02	7.17E-03	< 8.99E-03	1.12E-02	2.64E-03	4.09E-03	< 8.74E-03	9.49E-02	7.61E-03	4.58E-03	2.93E-04	1.29E-04
Flow (L/day)**					5.76E+06	5.76E+06	5.76E+06	5.76E+06	5.76E+06	5.76E+06	5.76E+06	5.76E+06	5.76E+06	5.76E+06	5.76E+06	5.76E+06		5.76E+06	0.00E+00		
05 Stream																					
Tritium	6.65E+08	2.90E+07	1.28E+02	1.68E+00	1.81E+00	3.12E+00	3.60E+00	7.90E+00	1.21E+00	9.37E-01	2.78E+00	8.81E+00	9.01E+00	4.69E+00	5.47E+00	7.08E+00	5.84E+01	4.70E+00	2.92E+00	7.07E-07	1.62E-05
Gross Beta	3.54E+04	1.40E+05	4.27E-02	5.60E-04	3.18E-03	2.23E-03	1.59E-03	1.80E-03	1.15E-03	1.81E-03	3.41E-03	9.47E-04	3.25E-03	1.29E-03	9.83E-04	7.83E-03	2.95E-02	2.46E-03	1.91E-03	6.94E-06	1.75E-06
Gross Alpha (Estim*)	2.60E+03	5.90E+03	6.09E-02	8.00E-04	< 5.24E-04	2.69E-04	7.39E-04	2.52E-04	3.36E-04	< 1.37E-03	1.34E-04	2.52E-04	3.89E-04	2.96E-04	3.62E-04	2.52E-04	5.18E-03	4.31E-04	3.35E-04	1.66E-05	7.31E-06
Flow (L/day)**					4.32E+05	4.32E+05	4.32E+05	4.32E+05	4.32E+05	4.32E+05	4.32E+05	4.32E+05	4.32E+05	4.32E+05	4.32E+05	4.32E+05		4.32E+05	0.00E+00		
Perch Creek																					
Tritium	6.65E+08	2.90E+07	1.25E+02	2.24E+01	1.05E+03	7.85E+02	2.76E+03	9.89E+03	6.53E+02	4.73E+02	5.54E+02	1.39E+02	6.83E+02	1.43E+03	1.32E+03	1.84E+03	2.17E+04	1.81E+03	2.67E+03	2.71E-04	6.23E-03
Gross Beta	3.54E+04	1.40E+05	4.16E-01	7.47E-02	1.33E+00	8.20E-01	4.26E+00	1.00E+01	5.10E-01	1.68E-01	5.57E-01	2.53E-02	4.55E-01	1.88E-01	7.10E-01	1.06E+00	2.01E+01	1.67E+00	2.85E+00	4.72E-03	1.19E-03
Gross Alpha (Estim*)	2.60E+03	5.90E+03	6.27E-02	1.13E-02	7.76E-03	3.72E-03	2.45E-02	5.08E-02	3.00E-03	2.39E-03	3.44E-03	4.78E-04	3.22E-03	1.09E-02	1.32E-02	9.34E-03	1.33E-01	1.11E-02	1.41E-02	4.25E-04	1.87E-04
Flow (L/day)					3.74E+06	2.52E+06	7.59E+06	3.72E+07	2.49E+06	1.27E+06	2.19E+06	2.35E+05	2.59E+06	3.29E+06	3.39E+06	4.45E+06		5.91E+06	1.00E+07		
Discharges To Mashkonge Lake:																					
Duke Stream																					
Tritium	2.38E+07	2.90E+07	1.23E+02	1.44E+00	9.79E+02	8.58E+02	1.44E+03	1.87E+03	6.87E+02	9.45E+02	6.04E+02	4.87E+02	6.82E+02	8.22E+02	1.18E+03	9.23E+02	1.15E+04	9.54E+02	3.86E+02	4.01E-03	3.29E-03
Gross Beta	2.60E+02	1.40E+05	4.42E-02	5.14E-04	5.09E-03	2.59E-03	3.80E-03	6.60E-03	2.48E-03	4.15E-03	4.34E-03	2.08E-03	2.89E-02	4.13E-04	4.83E-03	3.01E-03	6.83E-02	5.69E-03	7.49E-03	2.19E-03	4.06E-06
Gross Alpha (Estim*)	1.13E+01	5.90E+03	6.38E-02	7.42E-04	< 6.45E-04	< 3.82E-04	< 7.75E-04	7.51E-04	8.52E-05	< 1.34E-03	6.96E-05	1.70E-04	1.96E-04	9.59E-05	< 8.88E-04	6.38E-05	5.28E-03	4.40E-04	4.00E-04	3.89E-03	7.45E-06
Flow (L/day)					3.08E+05	2.52E+05	5.11E+05	7.72E+05	2.74E+05	4.21E+05	2.88E+05	2.18E+05	3.25E+05	4.44E+05	4.48E+05	3.28E+05		3.82E+05	1.52E+05		
Lwr. Bass Lake Inlet																					
Tritium	2.38E+07	2.90E+07	1.22E+02	3.24E+00	1.10E+02	1.03E+02	1.79E+02	1.81E+02	7.32E+01	8.77E+01	6.38E+01	9.36E+01	6.57E+01	1.10E+02	1.45E+02	7.97E+01	1.31E+03	1.09E+02	3.92E+01	4.59E-04	3.77E-04
Gross Beta	2.60E+02	1.40E+05	4.37E-02	1.16E-03	7.32E-03	5.13E-03	8.00E-03	7.60E-03	4.54E-03	2.77E-03	6.84E-03	3.15E-03	4.77E-03	1.38E-02	4.05E-03	9.95E-01	1.06E+00	8.86E-02	2.85E-01	3.41E-02	6.33E-05
Gross Alpha (Estim*)	1.13E+01	5.90E+03	6.12E-02	1.63E-03	< 9.17E-04	1.19E-04	< 2.26E-03	1.24E-03	4.50E-04	< 2.61E-03	5.05E-04	1.35E-04	3.53E-03	1.05E-03	8.52E-04	< 1.51E-03	1.52E-02	1.27E-03	1.05E-03	1.12E-02	2.14E-05
Flow (L/day)					7.55E+05	7.67E+05	1.49E+06	1.28E+06	7.24E+05	8.24E+05	6.49E+05	6.93E+05	6.79E+05	7.91E+05	8.39E+05	9.94E+05		8.74E+05	2.59E+05		
Bulk Storage Stream																					
Tritium	2.38E+07	2.90E+07	1.24E+02	2.33E+00	1.42E+01	1.24E+01	1.83E+01	5.69E+01	1.49E+01	2.85E+01	1.72E+01	1.95E+01	1.17E+01	2.47E+01	2.07E+01	1.61E+01	2.55E+02	2.13E+01	1.22E+01	8.93E-05	7.33E-05
Gross Beta	2.60E+02	1.40E+05	4.53E-02	8.51E-04	2.34E-03	1.46E-03	1.66E-03	4.80E-03	1.31E-03	6.40E-03	4.59E-03	2.23E-03	1.54E-02	3.03E-03	1.32E-02	6.92E-04	5.71E-02	4.76E-03	4.78E-03	1.83E-03	3.40E-06
Gross Alpha (Estim*)	1.13E+01	5.90E+03	6.48E-02	1.22E-03	2.28E-04	< 7.07E-04	1.85E-04	7.35E-04	2.51E-04	< 2.44E-03	7.85E-05	3.20E-04	7.98E-05	1.15E-03	2.28E-04	< 6.45E-04	7.05E-03	5.87E-04	6.69E-04	5.20E-03	9.95E-06
Flow (L/day)					4.89E+05	4.22E+05	5.35E+05	1.26E+06	4.04E+05	7.70E+05	4.92E+05	5.49E+05	3.93E+05	9.09E+05	7.18E+05	4.25E+05		6.19E+05	2.59E+05		

NOTE: DRL is from reference [3]. For comparison with DRLs, gross beta is assumed to be Sr-90, the dominant beta emitter in these effluent streams. For comparison with DRL, gross alpha is assumed to be Am-241.

* Gross alpha emissions for these effluent streams are estimates based on semi-quantitative analyses, assuming a typical overall sample counting efficiency of 3%. Actual counting efficiencies vary from about 1% to 5% depending on the amounts of solids in the sample.

(†) Gross alpha efficiency for Sanitary Sewer samples is assumed to be 1%.

**Conservative average monthly estimate, based on dye tracer dilution flow measurements in 1991 and 1996.

< Means that the result is less than the Lower Limit of Detection, LLD.

TABLE B4: CRL - Other Liquid Effluent Streams -- Gamma Spectrometry Characterization 1998 (Page 1 - Table continues next page)

	Concentration												Average	StdDev	Max
	Jan (Bq/L)	Feb (Bq/L)	Mar (Bq/L)	Apr (Bq/L)	May (Bq/L)	Jun (Bq/L)	Jul (Bq/L)	Aug (Bq/L)	Sep (Bq/L)	Oct (Bq/L)	Nov (Bq/L)	Dec (Bq/L)			
04 Storm Sewer															
Gross Beta	1.85E-01	3.20E-01	6.00E-01	8.90E-01	1.03E+00	3.51E-01	3.49E-01	2.54E-01	4.37E-01	8.18E-01	3.81E-01	3.09E-01	4.94E-01	2.76E-01	1.03E+00
Gamma Spectrometry															
Sc-46	< 9.29E-03	< 6.67E-02	< 9.03E-03	< 1.05E-02	< 1.08E-02	< 2.93E-02	< 7.82E-03	< 8.28E-03	< 1.41E-02	< 1.49E-02	< 8.27E-03	< 7.95E-03	< 1.64E-02	1.69E-02	6.67E-02
Cr-51	< 5.89E-02	< 4.18E-02	< 6.22E-02	< 9.23E-02	< 7.88E-02	< 4.01E-02	< 5.45E-02	< 4.95E-02	< 5.57E-02	< 4.99E-02	< 4.67E-02	< 5.01E-02	< 5.67E-02	1.52E-02	9.23E-02
Mn-54	< 9.39E-03	< 4.29E-02	< 9.01E-03	< 1.05E-02	< 1.10E-02	< 7.20E-03	< 7.54E-03	< 8.45E-03	< 8.55E-03	< 7.94E-03	< 8.04E-03	< 1.54E-02	< 1.22E-02	9.94E-03	4.29E-02
Fe-59	< 1.93E-02	< 1.92E-02	< 1.75E-02	< 2.15E-02	< 2.11E-02	< 1.43E-02	< 1.53E-02	< 1.62E-02	< 1.67E-02	< 1.56E-02	< 1.64E-02	< 1.61E-02	< 1.74E-02	2.31E-03	2.15E-02
Co-60	< 1.04E-02	< 1.49E-02	< 1.11E-02	< 1.41E-02	1.72E-02	< 1.89E-02	< 8.63E-03	< 1.05E-02	1.38E-02	1.30E-02	< 1.02E-02	< 9.27E-03	1.27E-02	3.23E-03	1.89E-02
Zn-65	< 1.66E-02	< 2.59E-02	< 2.07E-02	< 2.27E-02	< 2.43E-02	< 1.68E-02	< 1.88E-02	< 1.89E-01	< 6.23E-02	< 7.18E-02	< 1.92E-02	< 1.87E-02	< 4.23E-02	4.98E-02	1.89E-01
Nb-95	< 9.58E-03	< 1.17E-02	< 8.91E-03	< 1.96E-02	< 1.10E-02	< 7.59E-03	< 7.87E-03	< 8.49E-03	8.73E-03	< 8.17E-03	< 8.29E-03	< 8.57E-03	< 9.87E-03	3.30E-03	1.96E-02
Ru-103	< 8.35E-03	< 1.16E-02	< 8.88E-03	< 1.27E-02	< 1.20E-02	< 7.21E-03	< 7.66E-03	< 7.56E-03	< 8.60E-03	< 7.66E-03	< 7.40E-03	< 7.51E-03	< 8.93E-03	1.97E-03	1.27E-02
Ru-106	< 7.88E-02	< 1.02E-01	< 8.63E-02	< 9.70E-02	< 1.04E-01	< 6.75E-02	< 6.95E-02	< 7.17E-02	< 7.81E-02	< 7.17E-02	< 6.92E-02	< 6.71E-02	< 8.02E-02	1.37E-02	1.04E-01
Sb-125	< 2.04E-02	< 2.77E-02	< 2.25E-02	< 2.47E-02	< 2.74E-02	< 1.74E-02	< 1.92E-02	< 1.85E-02	< 2.06E-02	< 1.89E-02	< 1.80E-02	< 1.76E-02	< 2.10E-02	3.70E-03	2.77E-02
I-131	< 9.66E-03	< 1.36E-02	< 1.89E-02	< 4.69E-02	< 1.23E-02	< 8.37E-03	< 8.46E-03	< 7.94E-03	< 9.26E-03	< 8.51E-03	< 7.66E-03	< 9.42E-03	< 1.34E-02	1.10E-02	4.69E-02
Cs-134	< 9.77E-03	2.11E-02	< 1.03E-02	< 1.13E-02	< 1.22E-02	< 8.17E-03	< 8.45E-03	< 9.22E-03	< 9.52E-03	< 8.84E-03	< 9.24E-03	< 8.63E-03	< 1.06E-02	3.52E-03	2.11E-02
Cs-137	3.80E-02	2.11E-02	1.57E-02	2.69E-02	4.15E-02	< 9.26E-03	1.41E-02	1.26E-02	1.94E-02	1.38E-02	3.27E-02	2.96E-02	2.29E-02	1.07E-02	4.15E-02
Ba-140	< 4.42E-02	< 5.06E-02	< 4.03E-02	< 4.44E-02	< 4.94E-02	< 3.61E-02	< 3.76E-02	< 3.80E-02	< 4.03E-02	< 3.80E-02	< 3.60E-02	< 4.13E-02	< 4.13E-02	4.89E-03	5.06E-02
Ce-141	< 9.18E-03	< 2.71E-02	< 7.18E-03	< 1.23E-02	< 1.06E-02	< 6.20E-03	< 6.14E-03	< 6.01E-03	< 7.24E-03	< 6.40E-03	< 5.66E-03	< 6.23E-03	< 9.18E-03	6.01E-03	2.71E-02
Ce-144	< 3.65E-02	< 4.45E-02	< 2.86E-02	< 4.12E-02	< 4.43E-02	< 2.38E-02	< 2.34E-02	< 2.37E-02	< 2.88E-02	< 2.49E-02	< 2.26E-02	< 2.36E-02	< 3.05E-02	8.66E-03	4.45E-02
Pa-233	< 1.72E-02	< 2.42E-02	< 1.79E-02	< 2.68E-02	< 2.26E-02	< 1.46E-02	< 1.60E-02	< 1.43E-02	< 1.69E-02	< 1.54E-02	< 1.35E-02	< 1.43E-02	< 1.78E-02	4.35E-03	2.68E-02
Average of weekly samples															
Sanitary Sewer															
Gross Beta	1.40E+00	1.41E+00	2.21E+00	2.91E+00	2.73E+00	5.01E+00	2.97E+00	3.90E+00	1.83E+00	1.98E+00	1.55E+00	1.43E+00	2.44E+00	1.12E+00	5.01E+00
Gamma Spectrometry															
Sc-46	< 9.10E-03	< 8.57E-03	< 9.28E-03	< 8.09E-03	< 9.21E-03	8.61E-02	< 9.26E-03	< 6.74E-03	< 8.11E-03	< 7.57E-03	< 6.38E-03	< 6.21E-03	< 1.29E-02	1.68E-02	6.61E-02
Cr-51	< 1.04E-01	< 8.29E-02	< 7.52E-02	< 8.32E-02	< 1.01E-01	5.52E-01	< 9.02E-02	< 6.51E-02	< 6.36E-02	< 5.77E-02	< 4.87E-02	< 5.45E-02	< 1.15E-01	1.39E-01	5.52E-01
Mn-54	< 7.59E-03	< 7.39E-03	< 8.17E-03	< 6.93E-03	< 8.05E-03	< 1.25E-02	< 8.84E-03	< 5.55E-03	< 7.31E-03	< 6.74E-03	< 5.56E-03	< 5.09E-03	< 7.48E-03	1.95E-03	1.25E-02
Fe-59	< 2.25E-02	< 2.00E-02	< 2.09E-02	< 1.70E-02	< 2.05E-02	< 3.55E-02	< 2.23E-02	< 1.59E-02	< 1.80E-02	< 1.54E-02	< 1.38E-02	< 1.39E-02	< 1.96E-02	5.86E-03	3.55E-02
Co-60	7.09E-02	< 6.29E-03	1.89E-02	1.99E-02	1.53E-02	2.71E-01	3.76E-02	2.49E-02	2.39E-02	2.65E-02	2.65E-02	1.21E-02	< 4.61E-02	7.27E-02	2.71E-01
Zn-65	< 1.73E-02	< 1.79E-02	< 1.95E-02	< 1.52E-02	< 1.75E-02	5.34E-02	< 2.05E-02	< 1.30E-02	< 1.65E-02	< 1.64E-02	< 1.32E-02	< 1.27E-02	< 1.94E-02	1.10E-02	5.34E-02
Nb-95	< 1.28E-02	< 1.09E-02	< 1.06E-02	< 9.87E-03	< 1.19E-02	2.11E-01	< 1.31E-02	< 9.18E-03	< 9.58E-03	< 9.11E-03	< 8.49E-03	< 8.11E-03	< 2.71E-02	5.80E-02	2.11E-01
Ru-103	< 1.17E-02	< 9.79E-03	< 9.70E-03	< 1.07E-02	< 1.33E-02	< 1.61E-02	< 1.16E-02	< 8.05E-03	< 8.53E-03	< 8.30E-03	< 6.82E-03	< 6.97E-03	< 1.01E-02	2.73E-03	1.61E-02
Ru-106	< 6.80E-02	< 6.53E-02	< 6.91E-02	< 6.98E-02	< 7.95E-02	< 1.02E-01	< 7.41E-02	< 4.51E-02	< 6.29E-02	< 5.92E-02	< 4.57E-02	< 4.48E-02	< 6.55E-02	1.63E-02	1.02E-01
Sb-125	< 1.69E-02	< 1.62E-02	< 1.84E-02	< 1.77E-02	< 2.04E-02	< 2.62E-02	< 2.06E-02	< 1.19E-02	< 1.65E-02	< 1.62E-02	< 1.22E-02	< 1.15E-02	< 1.71E-02	4.18E-03	2.62E-02
I-131	< 8.80E-02	< 4.25E-02	< 2.79E-02	< 3.72E-02	< 5.73E-02	< 6.99E-02	< 4.75E-02	< 6.44E-02	< 2.42E-02	4.46E-02	3.68E-02	< 3.85E-02	< 4.82E-02	1.85E-02	8.80E-02
Cs-134	< 8.41E-03	< 8.06E-03	< 9.36E-03	< 8.06E-03	< 9.19E-03	< 1.25E-02	< 1.01E-02	< 6.22E-03	< 8.02E-03	< 5.63E-03	< 6.23E-03	1.40E-02	< 8.81E-03	2.49E-03	1.40E-02
Cs-137	7.99E-02	< 7.08E-03	8.12E-02	6.40E-02	6.24E-02	2.53E-01	1.02E-01	9.27E-02	6.37E-02	2.71E-01	8.25E-02	1.26E-01	1.07E-01	7.77E-02	2.71E-01
Ba-140	< 1.64E-01	< 1.01E-01	< 7.91E-02	< 8.35E-02	< 1.14E-01	< 1.78E-01	< 1.15E-01	< 1.17E-01	< 6.79E-02	< 6.29E-02	< 6.12E-02	< 8.33E-02	< 1.02E-01	3.78E-02	1.78E-01
Ce-141	< 1.03E-02	< 8.89E-03	< 8.11E-03	< 9.87E-03	< 1.21E-02	< 1.61E-02	< 1.25E-02	< 6.94E-03	< 8.93E-03	< 6.44E-03	< 5.51E-03	< 6.06E-03	< 9.31E-03	3.10E-03	1.61E-02
Ce-144	< 2.38E-02	< 2.21E-02	< 2.40E-02	< 2.93E-02	< 3.35E-02	< 4.19E-02	< 3.52E-02	< 1.58E-02	< 2.56E-02	< 2.01E-02	< 1.59E-02	< 1.50E-02	< 2.52E-02	8.44E-03	4.19E-02
Pa-233	< 3.00E-02	< 2.42E-02	< 2.17E-02	< 2.41E-02	< 2.98E-02	< 3.45E-02	< 2.61E-02	< 1.81E-02	< 1.88E-02	< 1.59E-02	< 1.36E-02	< 1.58E-02	< 2.27E-02	6.56E-03	3.45E-02

< Means that the result is less than the Lower Limit of Detection, LLD.

TABLE B4: CRL - Other Liquid Effluent Streams -- Gamma Spectrometry Characterization 1998 (Page 2 -- Continuation from previous page)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average	StdDev	Max
	(Bq/L)	(Bq/L)	(Bq/L)	(Bq/L)	(Bq/L)	(Bq/L)	(Bq/L)	(Bq/L)	(Bq/L)	(Bq/L)	(Bq/L)	(Bq/L)	(Bq/L)	(Bq/L)	(Bq/L)
Duke Stream															
Gross Beta	5.33E-01	3.68E-01	2.65E-01	2.43E-01	3.24E-01	3.52E-01	5.38E-01	2.72E-01	3.18E-01	3.08E-01	3.08E-01	2.62E-01	3.41E-01	9.81E-02	5.38E-01
Gamma Spectrometry															
Co-60	1.00E-02	8.45E-03	9.71E-03	< 4.79E-03	< 4.64E-03	< 6.23E-03	2.03E-02	< 4.72E-03	2.23E-02	1.51E-02	9.75E-03	< 5.36E-03	< 1.01E-02	6.07E-03	2.23E-02
Ru-106	< 5.60E-02	< 4.28E-02	< 5.77E-02	< 4.49E-02	< 3.29E-02	< 4.33E-02	< 5.06E-02	< 2.95E-02	< 3.90E-02	< 4.29E-02	< 3.43E-02	< 4.93E-02	< 4.36E-02	8.83E-03	5.77E-02
Cs-137	< 1.50E-02	< 5.05E-03	< 6.18E-03	8.37E-03	< 4.17E-03	< 2.77E-03	1.42E-02	< 3.93E-03	1.28E-02	< 4.96E-03	< 4.04E-03	< 6.91E-03	< 7.37E-03	4.29E-03	1.50E-02
Ce-144	< 2.30E-02	< 1.94E-02	< 2.27E-02	< 1.81E-02	< 1.24E-02	< 1.39E-02	< 2.17E-02	< 9.30E-03	< 1.63E-02	< 1.68E-02	< 1.36E-02	< 2.19E-02	< 1.74E-02	4.49E-03	2.30E-02
Lower Bass Lake															
Gross Beta	3.13E-01	2.39E-01	1.92E-01	1.69E-01	2.24E-01	1.20E-01	3.76E-01	1.30E-01	2.51E-01	6.24E-01	1.38E-01	2.86E+01	2.61E+00	8.18E+00	2.86E+01
Gamma Spectrometry															
Co-60	< 3.92E-03	6.36E-02	< 6.17E-03	< 3.88E-03	< 3.92E-03	< 4.45E-03	< 5.87E-03	< 3.51E-03	< 4.48E-03	< 4.08E-03	< 3.77E-03	< 5.17E-03	< 9.40E-03	1.71E-02	6.36E-02
Ru-106	< 3.22E-02	< 6.10E-02	< 5.65E-02	< 2.83E-03	< 3.14E-02	< 3.47E-02	< 4.58E-02	< 2.70E-02	< 3.55E-02	< 3.74E-02	< 3.14E-02	< 5.48E-02	< 3.75E-02	1.57E-02	6.10E-02
Cs-137	< 3.76E-03	9.16E-02	< 6.10E-03	< 3.46E-03	< 3.82E-03	< 3.95E-03	< 5.66E-03	< 3.11E-03	< 4.07E-03	< 4.54E-03	< 4.65E-03	< 6.47E-03	< 1.18E-02	2.52E-02	9.16E-02
Ce-144	< 1.49E-02	< 2.32E-02	< 2.24E-02	< 1.37E-02	< 1.23E-02	< 1.18E-02	< 2.08E-02	< 8.86E-03	< 1.13E-02	< 1.55E-02	< 1.29E-02	< 1.94E-02	< 1.56E-02	4.73E-03	2.32E-02
Bulk Storage Stream															
Gross Beta	1.54E-01	1.24E-01	9.94E-02	1.08E-01	1.15E-01	2.97E-01	3.33E-01	1.16E-01	1.40E-01	1.19E-01	5.24E-01	4.65E-02	1.81E-01	1.36E-01	5.24E-01
Gamma Spectrometry															
Co-60	9.00E-03	< 5.19E-03	< 4.86E-03	< 4.86E-03	< 6.48E-03	< 5.77E-03	< 4.40E-03	< 4.29E-03	< 6.47E-03	< 6.00E-03	< 4.65E-03	< 4.53E-03	< 5.54E-03	1.34E-03	9.00E-03
Ru-106	< 5.30E-02	< 4.18E-02	< 4.06E-02	< 4.74E-02	< 6.31E-02	< 4.66E-02	< 3.47E-02	< 3.38E-02	< 3.83E-02	< 4.94E-02	< 3.92E-02	< 3.58E-02	< 4.36E-02	8.64E-03	6.31E-02
Cs-137	< 5.90E-03	< 4.90E-03	< 4.70E-04	< 4.86E-03	< 5.79E-03	< 5.56E-03	< 4.81E-03	< 6.58E-03	< 5.61E-03	8.46E-04	< 4.28E-03	< 4.17E-03	< 4.48E-03	1.92E-03	6.58E-03
Ce-144	< 2.20E-02	< 1.44E-02	< 1.86E-02	< 1.90E-02	< 2.70E-02	< 2.03E-02	< 1.13E-02	< 1.35E-02	< 1.55E-02	< 2.11E-02	< 1.71E-02	< 1.17E-02	< 1.76E-02	4.64E-03	2.70E-02
Perch Creek Weir															
Gross Beta	1.14E+01	1.17E+01	2.00E+01	7.78E+00	7.27E+00	4.66E+00	9.08E+00	3.07E+00	6.27E+00	1.83E+00	5.99E+00	6.82E+00	7.99E+00	4.81E+00	2.00E+01
⁹⁰ Sr & ⁹⁰ Y		7.41E+00			4.34E+00			4.63E+00			7.77E+00		6.04E+00	1.80E+00	7.77E+00
Gamma Spectrometry															
Co-60		< 1.35E-02			< 1.23E-02			< 1.12E-02			< 1.10E-02		< 1.20E-02	1.15E-03	1.35E-02
Ru-106		< 1.35E-01			< 1.02E-01			< 9.54E-02			< 1.09E-01		< 1.10E-01	1.73E-02	1.35E-01
Cs-137		< 1.38E-02			< 1.11E-02			< 1.09E-02			< 1.08E-02		< 1.17E-02	1.44E-03	1.38E-02
Ce-144		< 5.75E-02			< 4.73E-02			< 3.31E-02			< 4.51E-02		< 4.58E-02	1.00E-02	5.75E-02

¹) Quarterly sampling and analysis

< Means that the result is less than the Lower Limit of Detection, LLD.

TABLE C1: WL AIRBORNE EFFLUENTS 1998

Week #	Week Ending	B300, 2-136 STACK		BLD300, HCF STACK		
		Beta (Bq)	Alpha (Bq)	Beta (Bq)	Sb-125 (Bq)	Alpha (Bq)
1	05-Jan-98	<	<	1.70E+03	<	<
2	12-Jan-98	<	<	5.90E+03	<	<
3	19-Jan-98	1.80E+02	<	7.60E+03	<	<
4	26-Jan-98	8.10E+01	<	8.80E+03	7.30E+03	<
5	02-Feb-98	9.10E+02	<	7.50E+03	5.30E+05	<
6	09-Feb-98	<	<	6.20E+03	<	<
7	16-Feb-98	1.70E+03	<	1.40E+04	<	<
8	23-Feb-98	9.20E+01	<	1.20E+04	<	<
9	02-Mar-98	7.70E+01	<	1.00E+04	<	<
10	09-Mar-98	9.90E+01	<	1.00E+04	<	<
11	16-Mar-98	<	<	4.40E+03	<	<
12	23-Mar-98	<	<	4.20E+03	<	<
13	30-Mar-98	9.60E+01	<	6.50E+03	<	<
14	06-Apr-98	<	<	6.20E+03	<	<
15	13-Apr-98	1.20E+02	<	6.20E+03	<	<
16	20-Apr-98	<	<	5.00E+03	<	<
17	27-Apr-98	8.30E+01	<	6.20E+03	<	<
18	04-May-98	<	<	7.00E+03	<	<
19	11-May-98	8.30E+01	<	6.40E+03	2.10E+05	<
20	18-May-98	1.70E+02	<	4.50E+03	<	<
21	25-May-98	<	<	4.60E+03	<	<
22	01-Jun-98	1.20E+02	<	6.20E+03	<	<
23	08-Jun-98	<	<	6.70E+03	<	<
24	15-Jun-98	<	<	3.00E+03	<	<
25	22-Jun-98	<	<	7.00E+03	<	<
26	29-Jun-98	<	<	6.10E+03	<	<
27	06-Jul-98	<	<	4.60E+03	1.40E+05	<
28	13-Jul-98	7.80E+01	<	5.10E+03	<	<
29	20-Jul-98	<	<	9.30E+03	<	<
30	27-Jul-98	8.50E+01	<	9.80E+03	<	<
31	03-Aug-98	4.00E+02	<	3.80E+03	<	2.60E+03
32	10-Aug-98	7.80E+01	<	8.70E+03	<	<
33	17-Aug-98	2.40E+02	<	5.80E+03	<	<
34	24-Aug-98	<	<	1.00E+04	6.20E+04	<
35	31-Aug-98	<	<	3.20E+03	<	<
36	07-Sep-98	1.00E+02	<	4.90E+03	<	<
37	14-Sep-98	8.50E+01	<	7.30E+03	1.00E+05	<
38	21-Sep-98	<	<	5.50E+03	<	<
39	28-Sep-98	<	<	2.10E+03	<	<
40	05-Oct-98	<	<	1.00E+04	<	<
41	12-Oct-98	<	<	3.70E+03	<	<
42	19-Oct-98	<	<	4.40E+03	<	<
43	26-Oct-98	<	<	5.60E+03	<	<
44	02-Nov-98	1.10E+02	<	8.50E+03	<	<
45	09-Nov-98	<	<	6.00E+03	<	<
46	16-Nov-98	9.00E+01	<	5.10E+03	<	<
47	23-Nov-98	<	<	5.70E+03	<	<
48	30-Nov-98	<	<	2.90E+03	<	<
49	07-Dec-98	1.00E+02	<	4.20E+03	<	<
50	14-Dec-98	<	<	1.70E+03	<	<
51	21-Dec-98	<	<	3.60E+03	<	<
52	28-Dec-98	<	<	7.60E+02	<	<
TOTAL		5.18E+03	0.00E+00	3.16E+05	1.05E+06	2.60E+03
AVERAGE		9.96E+01	0.00E+00	6.08E+03	2.02E+04	5.00E+01
MINIMUM		7.7E+01	0.00E+00	7.60E+02	7.30E+03	2.60E+03
MAXIMUM		1.70E+03	0.00E+00	1.40E+04	5.30E+05	2.60E+03
LLD		75	75	600	1.43E+04	600
DRL (Bq/wk)		9.48E+07	2.87E+06	9.48E+07	2.22E+09	2.87E+06
AVG as %DRL		1.05E-04	1.05E-04	1.79E-03	1.79E-03	1.79E-03
MAX as %DRL		1.79E-03	1.79E-03	1.05E+10	6.80E+11	2.60E+08
DRL _b (Bq/wk)		1.05E+10	2.60E+08	1.05E+10	6.80E+11	2.60E+08
AVG as %DRL _b		9.53E-07	0.00E+00	5.82E-05	2.97E-06	1.92E-05
MAX as %DRL _b		1.63E-05	0.00E+00	1.34E-04	7.79E-05	1.00E-03

- 1) The DRL for Sr-90 is applied to beta, and DRL for Am-241 is applied to alpha
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3) LLD is Lower Limit of Detection. Symbol "<" indicates reading lower than LLD.

TABLE C2: WL AIRBORNE EFFLUENTS 1998

Week #	Week Ending	BLDG 300 IFTF STACK				
		Beta (Bq)	Sb-125 (Bq)	I-131 (Bq)	Cs-137 (Bq)	Alpha (Bq)
1	05-Jan-98	1.50E+03	<	<	<	<
2	12-Jan-98	1.60E+03	1.40E+05	<	<	<
3	19-Jan-98	4.50E+03	<	<	<	<
4	26-Jan-98	2.90E+03	<	<	<	<
5	02-Feb-98	3.50E+03	<	<	<	<
6	09-Feb-98	6.40E+03	<	<	<	<
7	16-Feb-98	2.10E+03	<	<	<	<
8	23-Feb-98	3.70E+03	<	<	<	<
9	02-Mar-98	1.40E+03	<	<	<	<
10	09-Mar-98	5.60E+03	<	<	<	<
11	16-Mar-98	2.40E+03	<	<	<	<
12	23-Mar-98	1.70E+03	<	<	<	<
13	30-Mar-98	3.90E+03	<	6.00E+05	<	<
14	06-Apr-98	2.90E+03	<	3.10E+04	<	<
15	13-Apr-98	2.90E+03	<	8.30E+05	<	<
16	20-Apr-98	2.60E+03	<	6.80E+04	<	<
17	27-Apr-98	3.00E+03	<	<	<	<
18	04-May-98	4.30E+03	<	<	<	<
19	11-May-98	8.00E+03	<	<	<	<
20	18-May-98	3.70E+03	<	<	<	<
21	25-May-98	1.10E+04	<	5.30E+05	<	<
22	01-Jun-98	4.90E+03	<	1.70E+05	<	<
23	08-Jun-98	8.90E+03	<	9.20E+04	<	<
24	15-Jun-98	3.30E+03	<	<	<	<
25	22-Jun-98	4.10E+03	<	<	<	<
26	29-Jun-98	2.90E+03	<	<	<	<
27	06-Jul-98	3.30E+03	<	<	<	<
28	13-Jul-98	3.30E+03	<	<	<	<
29	20-Jul-98	4.60E+03	<	3.40E+04	<	<
30	27-Jul-98	7.00E+03	<	<	<	<
31	03-Aug-98	2.80E+03	<	<	<	<
32	10-Aug-98	5.00E+03	<	<	<	<
33	17-Aug-98	4.40E+03	<	<	<	<
34	24-Aug-98	3.90E+03	<	<	<	<
35	31-Aug-98	5.70E+03	<	<	<	<
36	07-Sep-98	1.90E+03	<	<	<	<
37	14-Sep-98	1.60E+03	<	<	<	<
38	21-Sep-98	4.60E+03	<	<	<	<
39	28-Sep-98	6.70E+02	<	<	<	<
40	05-Oct-98	3.10E+03	<	<	<	<
41	12-Oct-98	7.70E+02	<	<	<	<
42	19-Oct-98	7.00E+03	<	<	<	<
43	26-Oct-98	3.40E+03	<	<	<	<
44	02-Nov-98	4.40E+03	<	2.5E+06	<	<
45	09-Nov-98	1.00E+03	<	6.3E+04	<	<
46	16-Nov-98	1.80E+03	<	5.5E+04	<	<
47	23-Nov-98	3.30E+03	<	<	<	<
48	30-Nov-98	6.10E+03	<	<	2.30E+04	<
49	07-Dec-98	9.10E+03	<	<	<	<
50	14-Dec-98	7.60E+03	<	<	<	<
51	21-Dec-98	8.40E+03	<	<	<	<
52	28-Dec-98	5.30E+03	<	<	<	<
TOTAL		2.14E+05	1.40E+05	4.97E+06	2.30E+04	0.00E+00
AVERAGE		4.11E+03	2.69E+03	9.56E+04	4.42E+02	0.00E+00
MINIMUM		6.70E+02	1.40E+05	3.1E+04	2.30E+04	0.00E+00
MAXIMUM		1.10E+04	1.40E+05	2.50E+06	2.30E+04	0.00E+00
LLD		6.2E+02	1.5E+04	4.6E+03	7.5E+03	6.2E+02
DRL (Bq/wk)		9.48E+07	2.22E+09	7.25E+09	1.90E+08	2.87E+06
AVG as %DRL		4.34E-03	1.21E-04	1.32E-03	2.33E-04	0.00E+00
MAX as %DRL		1.16E-02	6.31E-03	3.45E-02	1.21E-02	0.00E+00
DRL _b (Bq/wk)		1.05E+10	6.80E+11	7.25E+09	3.74E+10	2.60E+08
AVG as %DRL _b		3.93E-05	3.96E-07	1.32E-03	1.18E-06	0.00E+00
MAX as %DRL _b		1.05E-04	2.06E-05	3.45E-02	6.14E-05	0.00E+00

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TABLE C3: WL AIRBORNE EFFLUENTS 1998

ALWTC									
Week #	Week Ending	V1F			V2F				
		Beta (Bq)	Cs-137 (Bq)	Alpha (Bq)	Beta (Bq)	Sb-125 (Bq)	Cs-137 (Bq)	Alpha (Bq)	Total Beta (Bq)
1	05-Jan-98	2.86E+02	<	1.68E+02	2.51E+02	<	<	<	5.37E+02
2	12-Jan-98	8.61E+02	1.40E+04	8.02E+02	5.02E+02	<	<	<	1.36E+03
3	19-Jan-98	2.78E+03	<	8.38E+02	5.42E+02	<	<	8.00E+01	3.32E+03
4	26-Jan-98	2.32E+03	<	5.41E+02	2.52E+02	<	1.82E+03	1.60E+02	2.57E+03
5	02-Feb-98	1.26E+03	<	1.68E+02	4.33E+02	<	<	1.91E+02	1.69E+03
6	09-Feb-98	1.73E+03	<	3.54E+02	4.40E+02	<	<	2.95E+02	2.17E+03
7	16-Feb-98	1.37E+03	<	1.09E+03	3.68E+02	<	<	2.28E+02	1.74E+03
8	23-Feb-98	8.96E+02	<	4.10E+02	5.14E+02	8.15E+03	<	9.23E+02	1.41E+03
9	02-Mar-98	8.89E+02	<	4.93E+02	4.76E+02	<	<	6.65E+01	1.37E+03
10	09-Mar-98	9.80E+02	<	1.00E+03	1.30E+03	<	<	1.00E+03	2.28E+03
11	16-Mar-98	4.70E+03	<	1.00E+03	3.40E+02	<	<	1.20E+02	5.04E+03
12	23-Mar-98	7.40E+02	<	1.60E+02	2.30E+02	<	<	1.70E+02	9.70E+02
13	30-Mar-98	9.90E+02	<	3.60E+02	2.80E+02	<	<	1.00E+02	1.27E+03
14	06-Apr-98	9.70E+02	<	5.50E+02	4.90E+02	<	<	1.30E+02	1.46E+03
15	13-Apr-98	8.10E+02	<	2.80E+02	2.50E+02	<	<	1.10E+02	1.06E+03
16	20-Apr-98	1.60E+03	<	4.30E+02	7.10E+02	<	<	6.50E+01	2.31E+03
17	27-Apr-98	1.30E+03	<	4.50E+02	3.90E+02	<	<	<	1.69E+03
18	04-May-98	2.60E+03	<	8.10E+02	8.50E+02	<	<	2.50E+02	3.45E+03
19	11-May-98	8.90E+02	<	5.30E+02	3.20E+02	<	<	1.20E+02	1.21E+03
20	18-May-98	4.40E+02	<	4.20E+02	3.50E+02	<	<	1.10E+02	7.90E+02
21	25-May-98	1.70E+03	<	2.80E+02	8.00E+02	<	<	2.60E+02	2.50E+03
22	01-Jun-98	1.70E+03	<	3.20E+02	1.00E+03	<	<	1.40E+02	2.70E+03
23	08-Jun-98	1.90E+03	<	4.00E+02	2.40E+02	<	<	<	2.14E+03
24	15-Jun-98	3.80E+03	<	8.20E+02	4.40E+02	<	<	1.60E+02	4.24E+03
25	22-Jun-98	1.40E+03	<	9.20E+02	8.20E+02	<	<	1.80E+02	2.22E+03
26	29-Jun-98	2.00E+03	<	6.70E+02	4.20E+02	<	<	1.20E+02	2.42E+03
27	06-Jul-98	1.00E+03	<	3.90E+02	9.50E+02	<	<	1.40E+02	1.95E+03
28	13-Jul-98	7.80E+02	<	0	4.80E+02	<	<	2.60E+02	1.26E+03
29	20-Jul-98	6.40E+02	<	2.30E+02	6.00E+02	<	<	1.00E+02	1.24E+03
30	27-Jul-98	1.00E+03	<	8.30E+02	4.90E+02	<	<	2.50E+02	1.49E+03
31	03-Aug-98	9.60E+02	<	5.70E+02	4.10E+02	<	<	7.80E+01	1.37E+03
32	10-Aug-98	1.70E+03	<	9.30E+02	7.30E+02	<	<	2.80E+02	2.43E+03
33	17-Aug-98	1.40E+03	<	0	4.10E+02	<	<	3.00E+02	1.81E+03
34	24-Aug-98	1.30E+03	<	3.90E+02	3.30E+02	<	<	1.20E+02	1.63E+03
35	31-Aug-98	1.10E+03	<	0	4.10E+02	<	<	<	1.51E+03
36	07-Sep-98	5.20E+02	<	1.00E+03	2.40E+02	<	<	2.10E+02	7.60E+02
37	14-Sep-98	1.70E+03	<	2.10E+02	4.40E+02	<	<	7.60E+01	2.14E+03
38	21-Sep-98	8.10E+02	<	2.10E+02	4.90E+02	<	<	6.40E+01	1.30E+03
39	28-Sep-98	7.70E+02	<	5.50E+02	3.50E+02	<	<	1.80E+02	1.12E+03
40	05-Oct-98	5.50E+02	<	1.90E+02	2.20E+02	<	<	7.20E+01	7.70E+02
41	12-Oct-98	6.00E+02	<	3.60E+02	3.70E+02	<	<	1.30E+02	9.70E+02
42	19-Oct-98	8.70E+02	<	3.30E+02	5.30E+02	<	<	5.70E+01	1.40E+03
43	26-Oct-98	7.70E+02	<	2.20E+02	5.00E+02	<	<	<	1.27E+03
44	02-Nov-98	1.20E+03	<	5.30E+02	2.20E+02	<	<	6.30E+01	1.42E+03
45	09-Nov-98	6.80E+02	<	5.90E+02	4.40E+02	<	<	5.40E+01	1.12E+03
46	16-Nov-98	1.50E+03	<	2.00E+02	2.60E+02	<	<	6.30E+01	1.76E+03
47	23-Nov-98	1.50E+03	<	4.50E+02	3.20E+02	<	<	1.20E+02	1.82E+03
48	30-Nov-98	1.20E+03	<	<	3.40E+02	<	<	1.40E+02	1.54E+03
49	07-Dec-98	1.00E+03	<	5.90E+02	3.90E+02	<	<	7.70E+02	1.39E+03
50	14-Dec-98	8.50E+02	<	6.90E+02	4.00E+02	<	<	1.70E+02	1.25E+03
51	21-Dec-98	7.90E+02	<	5.20E+02	2.90E+02	<	<	2.30E+02	1.08E+03
52	28-Dec-98	4.20E+02	<	1.70E+02	8.10E+01	<	<	5.30E+01	5.01E+02
	TOTAL	6.65E+04	1.40E+04	2.44E+04	2.37E+04	8.15E+03	1.82E+03	8.96E+03	9.02E+04
	AVERAGE	1.28E+03	1.40E+04	4.70E+02	4.56E+02	8.15E+03	1.82E+03	1.79E+02	1.74E+03
	MINIMUM	2.86E+02	1.40E+04	1.60E+02	8.10E+01	8.15E+03	1.82E+03	5.30E+01	5.01E+02
	MAXIMUM	4.70E+03	1.40E+04	1.09E+03	1.30E+03	8.15E+03	1.82E+03	1.00E+03	5.04E+03
	LLD	1.6E+02	1.9E+03	1.6E+02	52	1.2E+03	6.3E+02	52	
	DRL (Bq/wk)	3.60E+07	7.19E+07	1.09E+06	3.60E+07	8.40E+08	7.19E+07	1.09E+06	3.60E+07
	AVG as %DRL	3.56E-03	1.95E-02	4.31E-02	1.27E-03	9.70E-04	2.53E-03	1.64E-02	4.31E-02
	MAX as %DRL	1.31E-02	1.95E-02	1.00E-01	3.61E-03	9.70E-04	2.53E-03	9.17E-02	1.00E-01
	DRL _b (Bq/wk)	9.83E+09	3.52E+10	2.50E+08	9.83E+09	6.4E+11	3.52E+10	2.5E+08	9.83E+09
	AVG as %DRL _b	1.30E-05	3.97E-05	1.88E-04	4.64E-06	1.27E-6	5.17E-06	7.17E-05	1.77E-05
	MAX as %DRL _b	4.78E-05	3.97E-05	4.36E-04	1.32E-05	1.27E-06	5.17E-06	4.00E-04	5.13E-05

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**TABLE C4: WL AIRBORNE EFFLUENTS 1998
REACTOR BUILDING**

Week #	Week Ending	Beta (Bq)	Tritium(Bq)	Alpha (Bq)
1	05-Jan-98	4.59E+03	1.46E+09	<
2	12-Jan-98	2.66E+03	1.32E+09	3.31E+02
3	19-Jan-98	3.07E+03	1.10E+09	<
4	26-Jan-98	3.91E+03	1.40E+09	<
5	02-Feb-98	5.40E+03	1.50E+09	3.31E+02
6	09-Feb-98	7.51E+03	4.90E+08	1.43E+03
7	16-Feb-98	6.26E+03	1.50E+09	5.51E+02
8	23-Feb-98	6.26E+03	1.50E+09	5.51E+02
9	02-Mar-98	4.14E+03	2.00E+09	3.09E+02
10	09-Mar-98	4.69E+03	1.60E+09	3.09E+02
11	16-Mar-98	3.86E+03	4.60E+09	5.29E+02
12	23-Mar-98	2.99E+03	1.40E+08	3.09E+02
13	30-Mar-98	5.48E+03	1.60E+09	5.29E+02
14	06-Apr-98		<	<
15	13-Apr-98	5.60E+03	2.40E+09	<
16	20-Apr-98	1.58E+03	1.10E+09	1.17E+03
17	27-Apr-98	2.41E+03	1.90E+09	<
18	04-May-98	4.07E+03	2.00E+09	<
19	11-May-98	3.52E+03	2.40E+09	<
20	18-May-98	2.22E+03	5.60E+09	<
21	25-May-98	1.11E+03	5.06E+09	1.17E+03
22	01-Jun-98	4.07E+03	3.10E+09	9.69E+02
23	08-Jun-98	2.35E+03	2.86E+09	1.19E+03
24	15-Jun-98	2.22E+03	2.86E+09	3.09E+02
25	22-Jun-98	2.77E+03	2.00E+09	<
26	29-Jun-98	2.22E+03	2.70E+09	<
27	06-Jul-98	3.19E+03	2.66E+09	3.09E+02
28	13-Jul-98	2.91E+03	2.40E+09	5.29E+02
29	20-Jul-98	3.88E+03	2.00E+09	5.29E+02
30	27-Jul-98	3.68E+03	2.30E+09	<
31	03-Aug-98	3.60E+03	1.60E+09	3.31E+02
32	10-Aug-98	4.47E+03	2.00E+09	<
33	17-Aug-98	4.38E+03	1.60E+09	8.25E+02
34	24-Aug-98	3.64E+03	1.30E+09	8.25E+02
35	31-Aug-98	4.24E+03	9.00E+08	<
36	07-Sep-98	4.02E+03	8.00E+08	<
37	14-Sep-98	4.43E+03	2.20E+09	<
38	21-Sep-98	3.50E+03	1.60E+09	4.99E+02
39	28-Sep-98	4.38E+03	6.60E+08	4.34E+02
40	05-Oct-98	4.61E+03	2.20E+09	3.69E+02
41	12-Oct-98	2.74E+03	2.00E+09	<
42	19-Oct-98	4.07E+03	2.00E+09	<
43	26-Oct-98	3.52E+03	1.70E+09	<
44	02-Nov-98	4.03E+03	1.90E+09	<
45	09-Nov-98	2.41E+03	1.80E+09	<
46	16-Nov-98	2.83E+03	1.80E+09	<
47	23-Nov-98	4.47E+03	1.70E+09	<
48	30-Nov-98	3.55E+03	1.00E+09	<
49	07-Dec-98	3.13E+03	9.60E+08	<
50	14-Dec-98	3.96E+03	1.20E+09	<
51	21-Dec-98	5.62E+03	1.10E+09	<
52	28-Dec-98	5.82E+03	7.00E+08	<
	TOTAL	1.96E+05	9.63E+10	1.46E+04
	AVERAGE	3.84E+03	1.85E+09	5.42E+02
	MINIMUM	1.11E+03	1.40E+08	3.09E+02
	MAXIMUM	7.51E+03	5.60E+09	1.43E+03
	LLD	3.0E+02	1.9E+05	3.0E+02
	DRL (Bq/wk)	3.21E+10	5.99E+15	8.10E+08
	AVG as %DRL	1.20E-05	3.09E-05	6.69E-05
	MAX as %DRL	2.34E-05	9.35E-05	1.77E-04
	DRL _b (Bq/wk)	3.21E+10	9.76E+15	8.10E+08
	AVG as %DRL _b	1.20E-05	1.90E-05	6.69E-05
	MAX as %DRL _b	2.34E-05	5.74E-05	1.77E-04

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TABLE C5: WL AIRBORNE EFFLUENTS 1998

INCINERATOR			
SAMPLE PERIOD	BETA (Bq)	Cs-137 (Bq)	ALPHA (Bq)
Apr-06 to Apr-07	2.20E+05	2.87E+05	3.58E+03
Apr-20 to Apr-21	3.51E+03	5.40E+03	<
Jun-18 to Jun-22	2.81E+03	4.40E+03	<
Oct-01	6.10E+03	1.03E+04	<
Oct-14	7.13E+03	1.10E+04	<
Oct-15	3.14E+03	4.12E+03	<
Oct-19 to Oct-22	9.71E+05	9.63E+05	2.10E+04
Oct-26 to Oct-30	1.35E+05	9.38E+04	1.75E+03
Nov-02	1.85E+03	2.44E+03	<
Nov-25	5.51E+03	5.44E+03	<
Nov-27	1.17E+02	1.81E+03	<
Dec-15	1.59E+05	8.05E+04	2.21E+03
TOTAL (Bq)	1.52E+06	1.47E+06	2.85E+04
AVERAGE(Bq/wk)	2.91E+04	2.83E+04	5.49E+02
MAXIMUM (Bq)	9.71E+05	9.63E+05	2.10E+04
MINIMUM (Bq)	1.17E+02	1.81E+03	1.75E+03
LOWER LIMIT DETECTION	72	870	72
DRL (Bq/wk)	1.30E+11	1.90E+11	2.85E+09
AVG as %DRL	2.24E-05	1.49E-05	1.93E-05
MAX as %DRL	9.00E-08	9.53E-07	6.14E-05
DRLboundary(Bq/wk)	1.50E+11	5.40E+11	3.82E+09
AVERAGE(%DRL_b)	1.94E-05	5.23E-06	1.44E-05
MAX(%DRL_b)	6.47E-04	1.78E-04	5.50E-04

TABLE C6: WL AIRBORNE EFFLUENTS 1998
COMPACTOR/BALER

SAMPLE PERIOD	BETA (Bq)	Cs-137 (Bq)	ALPHA
Feb-17 to Feb-24	9.86E+02	<	4.30E+01
Apr-13	3.18E+03	3.12E+03	1.77E+02
Apr-23	1.51E+03	1.39E+03	4.91E+02
Jul-21	1.71E+03	1.72E+03	<
Sep-14	2.08E+03	1.45E+03	1.95E+02
Sep-29	1.41E+03	1.62E+03	9.16E+01
Dec-02	6.71E+02	<	<
Dec-10	1.53E+03	9.39E+02	1.67E+02
Dec-15	7.24E+03	5.37E+03	3.69E+02
TOTAL (Bq)	2.03E+04	1.56E+04	1.53E+03
AVERAGE(Bq/wk)	3.91E+02	3.00E+02	2.95E+01
MAXIMUM (Bq)	7.24E+03	5.37E+03	4.91E+02
MINIMUM (Bq)	6.71E+02	9.39E+02	4.30E+01
LOWER LIMIT DETECTION	7.30E+01	8.82E+02	7.30E+01
DRL (Bq/wk)	1.90E+09	3.26E+09	4.88E+07
AVG as %DRL	2.06E-05	9.20E-06	6.05E-05
MAX as %DRL	3.53E-05	2.88E-05	8.81E-05
DRLboundary(Bq/wk)	4.64E+09	1.66E+10	1.20E+08
AVERAGE(%DRL_b)	8.42E-06	1.81E-06	2.46E-05
MAX(%DRL_b)	1.56E-04	3.23E-05	4.09E-04

1. The DRL for Sr-90 is applied to beta, and DRL for Am-241 is applied to alpha.
2. All DRLs are for members of the public at the boundary.
3. LLD is Lower Limit of Detection. Symbol "<" indicates result lower than LLD.

TABLE D1: RADIOACTIVE MATERIALS IN WL LIQUID EFFLUENTS TO THE WINNIPEG RIVER – PROCESS OUTFALL 1998

NUCLIDE	DRL Bq/month	MDA Bq/L	LLD Bq/month	1998 MONTHLY RELEASES (Bq)												TOTAL Bq	AVERAGE Bq	MAXIMUM Bq
				JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPT	OCT	NOV	DEC			
GR-ALPHA	3.3E+11	3.00E-03	3.00E+05	4.97E+06	3.64E+06	3.59E+06	3.40E+06	9.54E+06	1.36E+07	7.31E+06	5.23E+06	2.32E+07	6.57E+06	4.32E+06	9.68E+06	9.51E+07	7.92E+06	2.32E+07
GR-BETA	4.11E+12	1.00E-03	1.00E+05	8.17E+07	3.90E+07	6.48E+07	6.46E+07	1.09E+08	8.56E+07	5.65E+07	5.16E+07	6.63E+07	3.23E+07	3.64E+07	3.99E+07	7.28E+08	6.06E+07	1.09E+08
CO-60	3.18E+12	2.49E-03	2.49E+05	<	<	<	<	<	<	5.46E+05	<	<	<	<	4.35E+05	9.81E+05	8.18E+04	5.46E+05
SR-89	2.30E+14	2.00E-03	2.00E+05	3.99E+06	6.05E+05	1.87E+07	1.74E+07	5.84E+07	2.16E+07	1.08E+07	6.75E+06	6.61E+06	7.17E+06	1.04E+07	1.57E+06	1.64E+08	1.37E+07	5.84E+07
SR-90	4.11E+12	2.00E-03	2.00E+05	1.36E+07	7.69E+06	1.86E+07	1.74E+07	5.84E+07	2.16E+07	1.08E+07	6.75E+06	6.61E+06	7.17E+06	1.04E+07	1.57E+06	1.81E+08	1.50E+07	5.84E+07
CS-137	1.59E+12	2.22E-03	2.22E+05	8.41E+07	5.74E+07	9.53E+07	2.59E+07	5.05E+07	4.33E+07	3.73E+07	2.55E+07	3.18E+07	1.84E+07	1.40E+07	2.30E+07	5.07E+08	4.22E+07	9.53E+07
U-235	5.72E+12	7.04E-03	7.04E+05	6.02E+05	<	<	<	<	<	<	<	<	<	<	<	6.02E+05	5.02E+04	6.02E+05
RA-226	NA	3.68E-03	3.68E+05	2.25E+07	8.90E+05	2.57E+06	1.08E+06	<	<	<	2.44E+06	1.83E+06	8.44E+05	<	3.06E+06	3.52E+07	2.93E+08	2.25E+07
PU-239	2.42E+12	1.00E-03	1.00E+05	9.94E+05	1.90E+05	1.08E+05	8.55E+06	3.16E+06	6.65E+05	2.54E+05	1.34E+05	3.55E+06	5.66E+05	4.44E+05	2.61E+05	1.89E+07	1.57E+06	8.55E+06
PU-238	2.77E+12	1.00E-03	1.00E+05	4.01E+05	1.90E+05	1.79E+05	4.83E+05	3.54E+05	4.77E+05	1.83E+05	1.24E+05	1.58E+05	5.01E+05	3.33E+05	5.94E+05	3.98E+06	3.31E+05	5.94E+05
TH-232	NA	5.01E-03	5.01E+05	1.52E+07	<	<	<	<	<	<	5.54E+05	<	4.22E+05	<	<	1.62E+07	1.35E+06	1.52E+07
TRITIUM	4.89E+16	2.0E-02	2.00E+06	8.03E+07	3.48E+08	3.59E+08	6.55E+08	7.95E+08	6.57E+08	5.22E+08	3.45E+08	4.94E+08	3.47E+08	4.01E+08	4.51E+08	5.45E+09	4.54E+08	7.95E+08
BE-7	NA	2.46E-02	2.46E+06	<	<	<	1.17E+07	1.91E+07	9.67E+06	1.00E+07	<	6.33E+06	<	4.53E+06	<	6.13E+07	5.11E+06	1.91E+07
Dischg Vol (L)				1.91E+08	1.73E+08	1.79E+08	2.55E+08	2.69E+08	2.42E+08	1.41E+08	1.05E+08	1.48E+08	1.05E+08	1.11E+08	1.45E+08	2.06E+09	1.72E+08	2.69E+08

1. DRL for Am-241 is applied to gross alpha; DRL for Sr-90 is applied to gross beta.
2. Minimum Detectable Activity (MDA) based upon 20.3-L sample, counting time 800 minutes.
3. Lower Limit of Detection (LLD) is product of MDA and minimum assumed monthly discharge, 1E+08 L.

TABLE D2: RADIOACTIVE RELEASES FROM WL – LAGOON 1998

Nuclide	DRL Bq/month	MDA Bq/L	LLD Bq/Dischg.	June Bq	Oct Bq	Total Bq	Average (Total/12) Bq	Average %DRL	Max Dischg. %DRL
Gross Alpha	3.3E+11	3.00E-03	8.10E+04	<	1.09E+06	1.09E+06	9.08E+04	2.75E-05	3.30E-04
Gross Beta	4.11E+12	1.00E-03	2.70E+04	1.63E+07	3.49E+06	1.98E+07	1.65E+06	4.01E-05	3.97E-04
Sr-89+90				3.92E+06	1.63E+06	5.55E+06			
Sr-90	4.11E+12	2.00E-03	5.40E+04	3.92E+06	1.63E+06	5.55E+06	4.63E+05	1.13E-05	9.54E-05
Cs-137	1.59E+12	2.22E-03	5.99E+04	<	<				
Dischg. Vol(L)				1.02E+08	2.68E+07	1.29E+08			

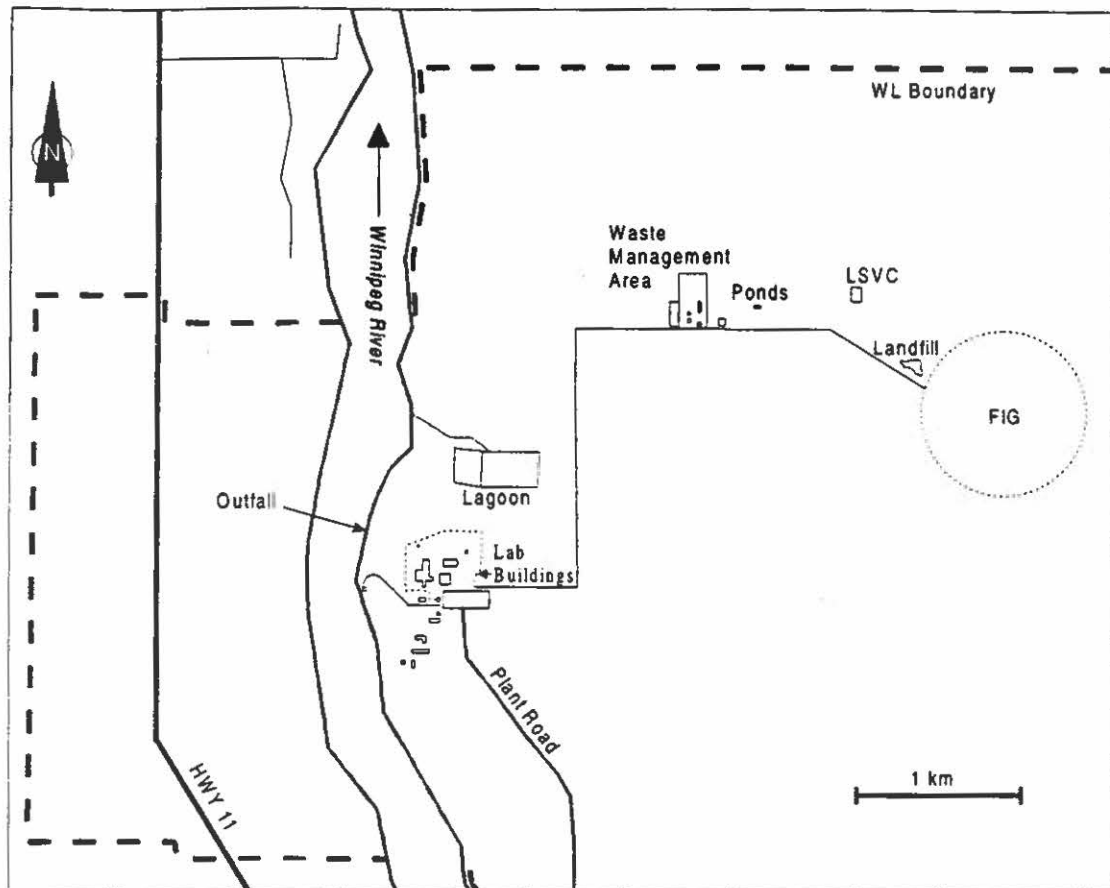
1. DRL for americium-241 is applied to gross alpha; DRL for Sr-90 is applied to gross beta, both for members of public at site boundary.
2. Minimum Detectable Activity (MDA) based upon 20.3-L sample, counting time 800 minutes.
3. Lower Limit of Detection (LLD) is product of MDA and minimum assumed discharge, 2.7E+07 L.

The map displays the St. Lawrence River and surrounding regions. Key features include:

- Monitoring Locations:** Indicated by small black dots. Labeled locations include:
 - Old Storm Sewer
 - Princess Sewer
 - Old Storm Sewer
 - Sanitary Sewer
 - Old Storm
 - Plant Road
 - Porter Creek Weir
 - Porter Creek Weir
 - Maskinonge Lake Outlet
 - Toussaint Lake
 - Sturgeon Lake (Chalk Lake)
- Roads:** Represented by solid black lines. Labeled roads include:
 - Plant Road
- Streams:** Represented by thin black lines. Labeled streams include:
 - Porter Creek
 - Maskinonge Lake Outlet
- CRL Boundary:** Represented by a dashed line.
- Waste Management Area:** Represented by a solid black rectangle. Labeled areas include:
 - Plant Road
- Controlled Areas:**
 - Controlled Area 1:** Represented by a light gray rectangle.
 - Controlled Area 2:** Represented by a white rectangle with a black border. Labeled areas include:
 - Controlled Area 2
 - Controlled Area 2
- Other Labels:**
 - NRL/MRX Reactor Stack
 - Old Storm Sewer
 - Princess Sewer
 - Old Storm Sewer
 - Sanitary Sewer
 - Old Storm
 - Maskinonge Lake
 - Maskinonge Lake Outlet
 - Toussaint Lake
 - Sturgeon Lake (Chalk Lake)
 - Ottawa River

Environmental Research Branch, CRL
29 March 1999

MAP F1: WL EFFLUENT MONITORING LOCATIONS



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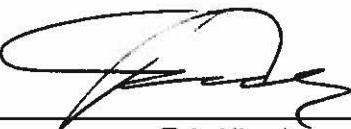
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VOLUME 3 - ENVIRONMENTAL MONITORING

Prepared by

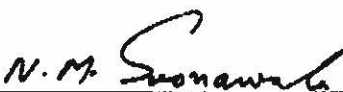


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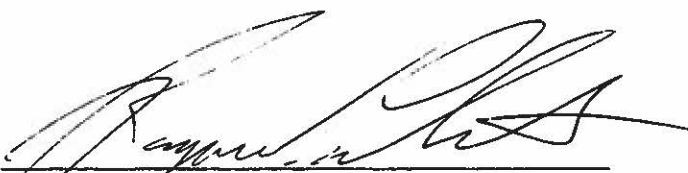


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R.J.P. Lambert
AECL Environmental Protection Program Authority

99 April 30

Date

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