2008 Annual Report on Uranium Management Activities

A Joint Report by the Canadian Nuclear Safety Commission and Environment Canada

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2008 Annual Report on Uranium Management Activities

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Canadian Nuclear Safety Commission
280 Slater Street
P.O. Box 1046, Station B
Ottawa, Ontario K1P 5S9
CANADA
Tel.: 613-995-5894 or 1-800-668-5284 (in Canada only)
Facsimile: 613-995-5086
E-mail: info@cnsc-ccsn.gc.ca
Web site: nuclearsafety.gc.ca

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EXECUTIVE SUMMARY

The Canadian Nuclear Safety Commission (CNSC) and Environment Canada have independent but related mandates within the nuclear industry for protecting the environment. The two organizations have signed a Memorandum of Understanding (MOU) to work together on the environmental regulation of nuclear facilities in Canada.

The *2007 Uranium Risk Management Annual Report* documented the results of site-specific risk management activities for uranium releases to the environment from three uranium mining and milling facilities: the Rabbit Lake, Key Lake and Cluff Lake Operations. The 2007 annual report concluded that all risk management activities associated with these facilities were completed.

The scope of the *2008 Annual Report on Uranium Management Activities* is expanded. In addition to documenting uranium treated effluent releases from the three specified uranium mines and mills, reporting includes all uranium mines and mills, as well as other CNSC regulated facilities releasing uranium in treated effluents.

2008 Results

The uranium mining sector was once again the best performing mining sector relative to the *Metal Mining Effluent Regulations* effluent limits, with no exceedances in 2008. CNSC staff assessments also indicated that in 2008, CNSC licensed facilities were not releasing uranium in effluent that would result in significant risk to the environment. However, as available treatment technologies are being continuously developed, it is necessary to periodically review existing facilities to ensure the continued use of best available technology economically achievable (BATEA).This helps ensure that licensees take all reasonable precautions to control releases of nuclear substances and hazardous substances to levels as low as reasonably achievable (ALARA).

The CNSC has introduced an optimization screening objective (OSO) of 0.1 mg/L for uranium in effluent as a means of demonstrating that all reasonable precautions are being taken by licensees to control their releases of uranium to the environment. The objective is based on a review of best treatment performance achieved by facilities nationally and internationally. It represents a very strict performance assessment relative to other jurisdictions, where formal uranium in effluent regulations are more than an order of magnitude higher (e.g., 2–5 mg/L).

The OSO represents a first step towards developing effluent limits for new contaminants and promoting pollution prevention. In 2008, the CNSC initiated a formal review of practices for establishing effluent limits against the requirements of the Nuclear Safety and Control Act (NSCA), incorporating current national and international practices for both radionuclides and hazardous substances. This project, scheduled for completion in 2010, will provide a standardized process for establishing effluent limits which incorporates the principles of pollution prevention, ALARA and Best Available Technology Economically Achievable (BATEA).

Uranium Mines and Mills

The Rabbit Lake Mill Operation continues to be responsible for the highest load of uranium discharged to the environment from Canadian nuclear facilities. However, modifications and upgrades in 2007 and 2008 have resulted in reductions in both effluent concentrations and loadings and by end of year 2008, discharges were consistently below the uranium OSO.

Uranium Processing and Conversion Facilities

Uranium releases in treated effluent from uranium processing and conversion facilities were very low. Uranium in effluent concentrations at the Blind River facility were consistently below the OSO and there have been no routine uranium releases in treated effluent at the Port Hope conversion facility since the 2007 installation of an evaporative treatment process.

Low-Level Waste Management Facilities

Technical reviews of Welcome and Port Granby Waste Management Facilities (WMFs) water treatment systems were conducted in 2008. While these facilities do not pose an unreasonable risk to humans or the environment, the 2008 technical reviews identified the need for performance improvements in the short-term, until the new waste management facility and associated water treatment plant, presently under development, are completed. Studies to determine reasonable modifications to improve treatment and/or overall environmental management practices at these facilities and any resulting regulatory decisions will be documented in the *2009 Annual Report on Uranium Management Activities*.

In 2007 and 2008, leaks of uranium bearing solutions through building foundations to underlying soils and groundwater were detected beneath two Cameco facilities: the Port Hope Conversion Facility and the Rabbit Lake Mill. Both facilities undertook appropriate action to remediate and mitigate the situations to the satisfaction of the CNSC and lessons learned were shared with other facilities.

Introduction

1

YELLOWCAKE

Background

The Canadian Nuclear Safety Commission (CNSC) and Environment Canada have independent but related mandates within the nuclear industry for protecting the environment. The two organizations have developed and signed a Memorandum of Understanding (MOU), agreeing to work together on the environmental regulation of nuclear facilities in Canada. This agreement (see Appendix A) was created to minimize regulatory duplication and comply with the Government of Canada's policy requiring departments to coordinate their activities.

The assessment of releases of radionuclides from nuclear facilities was added to the second Priority Substances List (PSL2) of the C*anadian Environmental Protection Act* (CEPA) to determine if such releases pose significant risk to the environment in Canada. The evaluation was produced under the direction of CNSC technical specialists, and the final report, "Releases of Radionuclides from Nuclear Facilities (Impact on Non-human Biota)", concluded that releases of uranium and uranium compounds contained in effluent from uranium mines and mills are toxic as defined in Section 64 of CEPA.

As part of the risk management activities required for CEPA toxic substances, in December 2004 an Annex was added to the existing MOU between Environment Canada and the CNSC. This Annex identified specific risk management activities for each of the facilities associated with the conclusion of CEPA toxicity, and required the production of an annual report outlining the progress of these risk management activities.

The first risk management annual report, published jointly by Environment Canada and the CNSC in 2007, demonstrated that the specific risk management activities identified within the Annex were achieved within the required timeframe. The report also indicated that in order to promote transparency in reporting, the focus of subsequent risk management activities would also document uranium releases within the broader nuclear fuel cycle in addition to that of the facilities specifically identified in the Annex.

This *2008 Annual Report on Uranium Management Activities* continues to report uranium releases to the environment as specified in the Annex, and reviews management practices related to uranium in effluent within other sectors of the nuclear industry. Section 2 of the report provides monitoring data for facilities regulated by the CNSC that have controlled effluent releases of uranium. Monthly and annual mean uranium concentrations and annual total load (in kg) are presented for 2008. Section 3 addresses the issue of containment of high-concentration uranium solutions, while Section 4 discusses special activities related to the management of uranium releases. Section 5 briefly reviews the results of CNSC/Environment Canada's annual meeting, and Section 6 provides a summary/conclusions and discusses future activities.

Uranium Releases to the Environment

2

COLLECTING WATER SAMPLES AT KEY LAKE

Uranium Releases to the Environment

In May 2000, the CNSC replaced the former Atomic Energy Control Board (AECB). Its creation followed the coming into force of the *Nuclear Safety and Control Act* (NSCA) and its regulations.

The CNSC is mandated under the NSCA to regulate all nuclear facilities and nuclear-related activities in Canada. Under the NSCA there are currently 11 regulations that set out specific requirements; these regulations are further supported by regulatory policies, standards and guidelines. The full set of documents provide guidance to licence applicants regarding acceptable ways of complying with regulatory requirements, and forms the basis for the assessment of licence applications.

The CNSC has adopted Environmental Risk Assessment methodologies that are linked directly to the site-specific receiving environment, to identify contaminants of potential concern (COPC) and aspects of the environment at risk at each facility. Extensive environmental effects monitoring programs have also been implemented at facilities to identify any impacts in the receiving environment and to ensure that licensees have taken all reasonable precautions to control releases. Effluent and environmental monitoring programs are developed on a risk basis and are dependent upon the complexity of the released effluents, the sensitivity of the receiving environment and the anticipated effects on the environment.

The AECB previously regulated uranium from a primarily radiological perspective. Due to the expansion of the mandate within the NSCA to include hazardous substances and protection of the environment, and with the initiation of the PSL2 Assessment, uranium is now also reviewed as a chemical hazard. CNSC staff recently completed a review of international and Canadian provincial regulations related to uranium releases in liquid effluent. The only limits specified in legislation or regulations were those of the U.S. Environmental Protection Agency (EPA) (*Regulation 40 CFR-N Part 440*) and the 1996 *Saskatchewan Mineral Industry Environmental Protection Regulations* (MIEPR).

The above regulations provide similar limits for uranium releases, with EPA consisting of a daily maximum of 4 mg/L and a monthly average (i.e., average of daily values for 30 consecutive days) of 2 mg/L, while the Saskatchewan limits allow for a maximum grab sample concentration of 5 mg/L and a maximum monthly mean of 2.5 mg/L. However, the PSL2 Assessment (Environment Canada & Health Canada, 2003) and the Rabbit Lake Mine and Mill environmental investigations indicated that such limits were not adequately protective of the environment in all circumstances. For example, the Rabbit Lake Operation has, despite consistently achieving monthly mean concentrations less than 2.5 mg/L uranium in effluent, experienced aquatic biological effects that evidence indicated were partly due to uranium releases (Environment Canada & Health Canada, 2003; Robertson & Liber, 2007).

To address this issue, in 2006 the CNSC commissioned a review of treatment technologies to assist staff in their oversight of uranium risk management activities for the Rabbit Lake Operation (see *2007 Uranium Risk Management Annual Report* for more details). This review identified a concentration of uranium in effluent of 0.1 mg/L as a potential treatment design objective that can be achieved with present day standard chemical precipitation technology. This value of 0.1 mg/L is 20 to 50 times lower than the regulatory limits documented by the US EPA and used by the Saskatchewan government in permitting uranium mines.

The CNSC is using this value (0.1 mg/L) as an interim design objective for new facilities. This value is also being used as an optimization screening objective (OSO) for existing facilities to identify those facilities which, while not exceeding any regulatory limits, should review their treatment processes to determine whether the present system can be optimized or upgraded to meet CNSC's expectations for ALARA. While it is recognised that the OSO value is substantially lower than EPA and Saskatchewan regulatory limits, it has been proven to be achievable and demonstrates CNSC's commitment to incorporating the principles of pollution prevention within its regulatory mandate. It should be emphasized that exceeding this value is neither an indication of unreasonable risk to the environment nor an indication of a license violation.

In addition to effluent concentration, it is important to review a facility's total annual load to the receiving environment (i.e., kg/year). Over the operating lifetime of a facility the annual load provides a measure of the amount of uranium that may accumulate in the downstream environment. For example, a facility with relatively high uranium concentrations but a low volume of effluent can discharge the same total mass of uranium as a high-volume effluent with very low uranium concentrations[1]. Hence, for this report, the CNSC OSO of 0.1 mg/L uranium in effluent, and the relative rankings amongst the facilities for the total mass of uranium released in effluent, have been used to assess treatment performance and identify facilities that may require further review.

The CNSC is currently developing formal technical procedures for establishing release limits for hazardous and nuclear substances discharged from nuclear facilities. The objective of this project is to review existing practices against the requirements of the NSCA and against present national and international practices both for radionuclides and hazardous substances. This project will be discussed in greater detail in Section 4.1.

[1] The total load of a contaminant released to the environment is a function of the concentrations of the contaminant and the volume of effluent in which it is being released: concentration * volume = load.

McCLEAN LAKE MINE AND MILL

2.1

2.1 Uranium Mines and Mills

The 2003 CEPA toxic determination was related to the releases from specific uranium mines and mills: the Rabbit Lake mine/mill effluent, the Key Lake dewatering water releases and the Cluff Lake mine/mill effluent. This section provides a summary of uranium releases from these facilities (with the exception of the now decommissioned Cluff Lake Operation) as well as from other uranium mines/mills whose releases were not considered to be CEPA toxic. Figure 1 indicates the locations for these mine/mill operations.

The sources of water potentially requiring control and treatment that are generated at operating uranium mines and mills may include pit dewatering water, mine process water, runoff from waste rock piles and facility aprons, mill process water (i.e., raffinate, scrubbing solutions, barren strip solutions and tailings process water), raise waters or seepage waters from ore, waste rock, tailings management facilities and domestic water. The sources, quantity and quality of water to be handled and treated are site specific and affected by local hydrology as well as the selected mining and milling methods, and the characteristics of the ore, waste rock and tailings produced at each site.

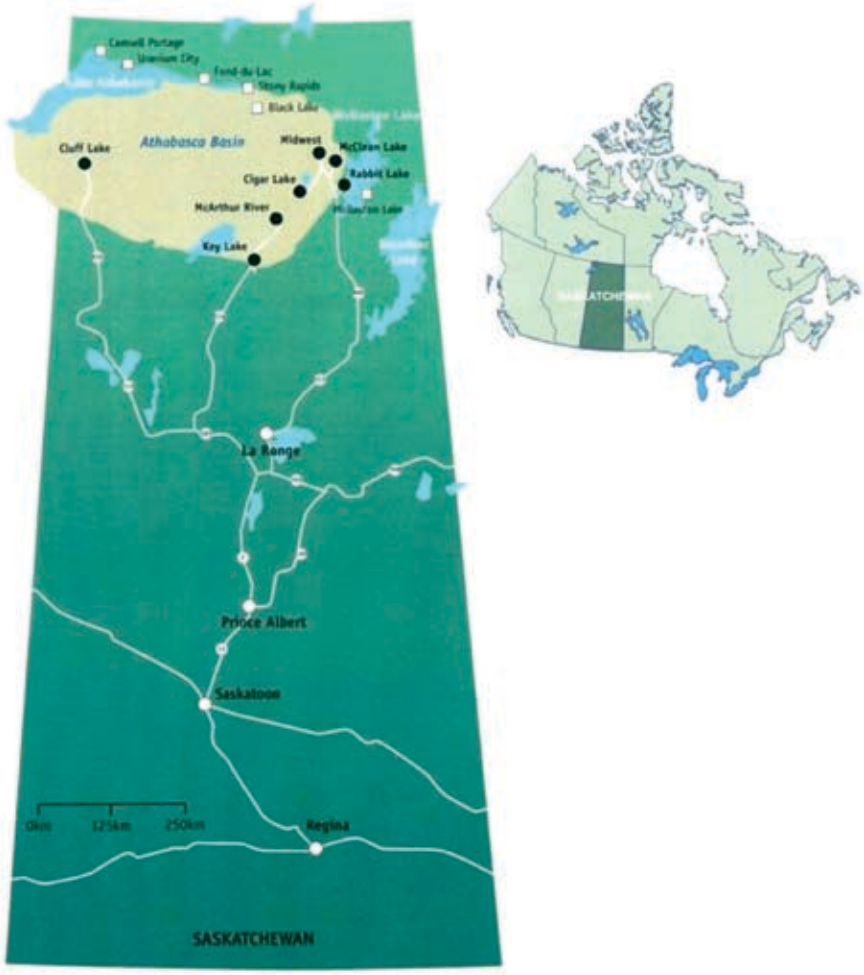
Effluent treatment systems at the operating uranium mines/mills rely primarily on chemical precipitation and separation to remove contaminants of concern. Lime is used to neutralize the highly acidic mill process water and to precipitate metal hydroxides. Barium chloride is used to produce a co-precipitate of radium-barium sulphate with ferric sulphate also used as an absorbent to facilitate flocculent formation. Earlier systems primarily used large sedimentation ponds to settle precipitated contaminants with continuous release of effluent following the retention ponds.

Batch release discharge has been used to replace continuous discharge in many systems. In these systems, treated water is transferred to monitoring ponds and a composite sample of the monitoring pond feed water is collected for analysis. If the analysis of the monitoring pond feed sample confirms that the water meets all necessary quality parameters, the monitoring pond is discharged to the environment. If the water quality does not meet the discharge quality parameters, the monitoring pond volume is recycled for re-treatment.

Multistage treatment processes are being or have been added to the Key Lake, McArthur River, Rabbit Lake and Cigar Lake Operations to improve treatment for molybdenum, selenium and uranium. Assessments have identified these three elements as Contaminants of potential concern (COPCs) for longer-term chronic impact on certain aquatic and terrestrial species.

Figure 1 | Location of Uranium Mine and/or Milling Operations in the Athabasca Basin of Northern Saskatchewan

From Rabbit Lake Solution Processing Project Environment Impact Statement Executive Summary, January 2008



The use of membrane technologies (e.g., reverse osmosis process) has been used at the Key Lake Operation for the treatment of metal-enriched groundwater. This process is non-specific for different contaminants. This process is also being considered at other operations where multiple COPCs are present and high quality effluent is required.

A review of effluent quality from uranium mine and mill facilities indicates that the concentration of contaminants in the mine waters and mill process waters are affected by the ore characteristics. As such, it is important to characterize the ore being processed to better predict and respond to changes in milling and effluent treatment requirements. Furthermore, increased flexibility in these processes to accommodate changes in ore characteristics or mining/milling processes is required. This is especially true where multiple sources of ore from different mines may be handled.

The *Metal Mining Effluent Regulations* (MMER) apply to effluent releases from all metal mines including uranium mines and mills. These limits identify the minimal level of effluent treatment and are incorporated directly into the CNSC licenses for all uranium mining facilities. As in 2007, the uranium mining sector of the metal mining industry was the best performing mining sector relative to the MMER effluent limits, with no exceedances in 2008.

The use of site specific ecological risk assessments (ERAs), combined with the information obtained from the receiving environment monitoring programs, has resulted in the CNSC requiring additional effluent treatment at the various uranium mines/mills for contaminants beyond those encompassed by the MMER such as uranium, molybdenum and selenium. At this time no other limits have been formally placed into CNSC uranium mining licenses. However, operational control for these additional effluent COPCs have been incorporated into the facilities Environmental Code of Practice (ECOP).

Section 4.1 of the CNSC's *Uranium Mines and Mills Regulations* requires facilities to have an ECOP that includes 'action levels'—that is, a specific dose of radiation or other parameter that, if reached, may indicate a loss of control of part of a licensee's radiation protection program or environmental protection program and triggers a requirement for specific action to be taken.

The objective of the ECOP is to develop tiered response levels that would indicate when a facility is deviating from normal operational releases. These levels provide early indication of potential loss of control, thereby providing adequate time for the implementation of corrective measures to ensure control is maintained. Two types of response levels are developed at each facility: action levels and administration levels.

An action level is the principal control level, which may indicate a loss of control of an aspect of the operation as it pertains to environmental protection, whereas an administrative level is an additional control level that may indicate minor deviations from normal or expected operations and are intended to prevent a loss of control from occurring. Reaching an administrative level does not indicate a loss of control. Action and administration levels are measured in terms of concentration or activity level.

2008 Results

Table 1 provides the monthly mean and annual average concentrations of uranium in water discharged to the environment during 2008 for the active uranium mines and mills in northern Saskatchewan. Mass loadings of uranium are also presented. All discharges to the environment are measured on a regular basis according to site-specific monitoring programs included in the license conditions approved by the CNSC and in the Province of Saskatchewan operating permit. Uranium is only one of a large number of effluent constituents actually monitored and reported to the CNSC in each facility's annual report.

Specific monitoring procedures may vary from site to site; however, these procedures generally consist of continuous sampling of the treated effluent. For batch discharge systems, the effluent is sampled as it is being discharged to monitoring ponds (Pond Fill Composite) and analyzed prior to release to the environment to ensure regulatory limits will be met upon discharge.

During the release of each monitoring pond to the environment, a Pond Release Composite (PRC) sample is also taken using a time cycle composite sampler based on pond volume (i.e., when the pond level reaches 80%, 60%, 40%, 20% and empty). Inline pH and turbidity meters are generally used to monitor the discharge. If the pH or turbidity goes off specification, the pond release is automatically stopped. For continuous release effluent discharges, the treatment process is monitored to ensure consistent operation and a timed composite sample of the final effluent is collected and analyzed.

In addition to the above monitoring, monthly composite samples from seven consecutive pond discharges is also collected and analyzed for a larger suite of parameters.

The figures provided in the following sections present the monthly discharge concentrations of uranium for each of the mine sites. Figures 9a and 9b present the mass loadings of uranium to the environment from each facility.

Table 1 | Discharge Concentrations and Loadings of Uranium From Canadian Mines and Mills, 2008 (NR = No Release)

2008 Monthly Arithmetic Mean	Mine/Mill						
	Key Lake (Mill)	Key Lake (Dewatering)	Rabbit Lake	McArthur River	McClean JEB	McClean SUE	Cigar Lake
January	0.019	0.001	0.207	0.025	0.004	0.001	NR
February	0.008	0.001	0.348	0.029	0.006	0.001	NR
March	0.010	0.001	0.459	0.021	0.004	0.001	NR
April	0.028	0.001	0.124	0.031	0.004	0.002	NR
May	0.020	0.0005	0.070	0.025	0.003	0.001	0.0004
June	0.007	0.001	0.093	0.024	0.002	0.001	0.0002
July	0.012	0.0009	0.121	0.030	0.002	0.012	0.0001
August	0.010	0.0009	0.114	0.019	0.001	0.001	0.0001
September	0.007	0.0008	0.140	0.030	0.005	0.001	0.0001
October	0.007	0.0009	0.067	0.061	0.002	0.001	0.0001
November	0.007	0.0006	0.053	0.025	0.002	0.001	0.0002
December	0.006	0.001	0.053	0.008	0.005	0.001	0.0001
Annual Avg. (mg/L)	0.012	0.0009	0.158	0.027	0.003	0.002	0.0002
Std. Dev. (mg/L)	0.0069	0.0002	0.1265	0.0123	0.002	0.003	0.0001
Loading (kg)	15.6	8.8	610	68.7	5.5	1.9	0.03

As shown in Table 1 above, all of the mines/mills were well below the Saskatchewan license limit of 2.5 mg/L maximum monthly mean, with all except the Rabbit lake operation meeting the OSO of 0.1 mg/L. The following sections discuss each of these reported facilities.

2.1.1 Rabbit Lake Mine and Mill

The Rabbit Lake Operation is a uranium mining and milling facility located in northern Saskatchewan on the west side of Wollaston Lake, approximately 450 km north of La Ronge, Saskatchewan. It is the oldest active uranium mining and milling operation in Canada.

Currently, the mill is operated on a week-on, week-off basis. The water treatment plant operates on a continuous basis, which includes continuous release of treated water from precipitation pond #3 to the receiving environment. Unlike batch-release systems, this continuous operation precludes the testing and recycling of pond waters not meeting water quality expectations. Instead, effluent quality relies on monitoring throughout the process to control reagent addition and precipitate removal effectiveness, and also depends on the use of relatively large final settling and buffering ponds.

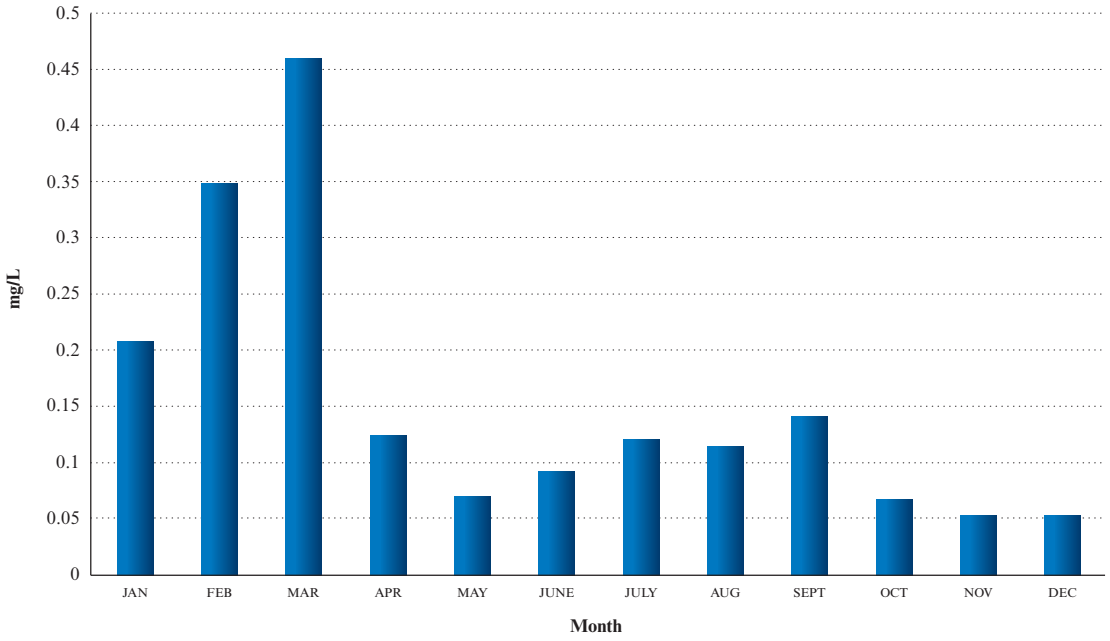
The Rabbit Lake Operation was the primary facility that resulted in the CEPA toxic determination for uranium releases from uranium mining and milling facilities. The *2007 Uranium Risk Management Annual Report*[2] provides detailed documentation of activities completed to the end of 2007 that resulted in a substantial reduction in uranium releases to the environment. A CNSC condition in the November 2003 Rabbit Lake Uranium Mine and Mill Licence required improvements to the effluent treatment to reduce uranium concentrations within a

[2] nuclearsafety.gc.ca/eng/readingroom/reports/uranium/

42-month period. By May 2007, an 86% reduction in concentration of uranium in the effluent and an 85% reduction in total discharge of uranium to the environment had been achieved as a result of consistently reducing effluent uranium concentrations below 0.1 mg/L. Thus, the core modifications to the minewater treatment system and the aboveground tailings management facility wastewater were successful in decreasing uranium effluent concentrations and total loadings to the environment.

As shown in Figure 2 below, difficulties arose with the treatment system in the first three months of 2008. In January, the buildup of ice on the inside walls of the thickener due to extreme weather conditions damaged the mixing rakes. The system was taken offline, thawed and repaired after replacement parts arrived on site. Modifications, including the addition of more tank insulation, the placement of 'lily pads' (heat retention pads) on the surface of the waste solution, and the inclusion of an additional steam line were completed to prevent future incidents of this nature. Once these repairs and modifications were in place, the system once again began to achieve the OSO.

Figure 2 | 2008 Average Monthly Uranium Discharge Concentrations (Rabbit Lake)



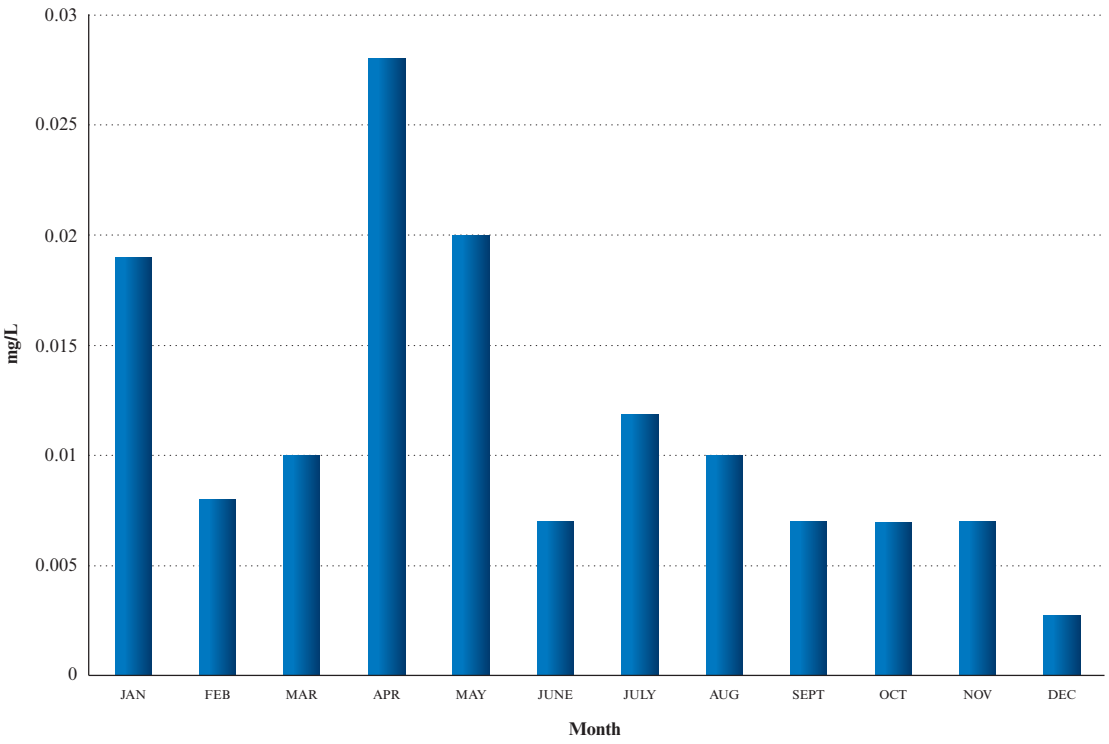
The Rabbit Lake Operation continues to release the largest total amount (load) of uranium to the environment relative to other operating mines. This total load is a function of both greater effluent concentrations as well as high treated effluent volumes arising from the large number of sources requiring treatment. Hence, uranium reduction remains a key element in the continuous improvement plans for this facility. Releases should decrease further in 2009, assuming a full year of availability of the solution recovery thickener (SRT) system, as well as continued fine-tuning and modification of the overall treatment process. Additional uranium reductions are projected as an added benefit of the inclusion of the planned Mo/Se treatment circuit to the system.

2.1.2 Key Lake Mill

The Key Lake Operation is located in north-central Saskatchewan, approximately 70 km east-southeast of Cree Lake (see Figure 1). Mining at Key Lake ceased in 1997, with the milling of Key Lake ore continuing into 1998–99. In 2000, Key Lake commenced milling ore from the nearby McArthur River underground mine.

The Key Lake Operation has two primary release points to the aquatic environment: the treated mill effluent, released to the David Creek drainage and the treated dewatering water (intercepted groundwater), released to the McDonald Creek drainage. Table 1 and Figure 3 demonstrate that the monthly and annual average has consistently remained well below the OSO of 0.1 mg/L. The total annual load from the mill (15.6 kg) is also well below that reported for the Rabbit Lake Operation.

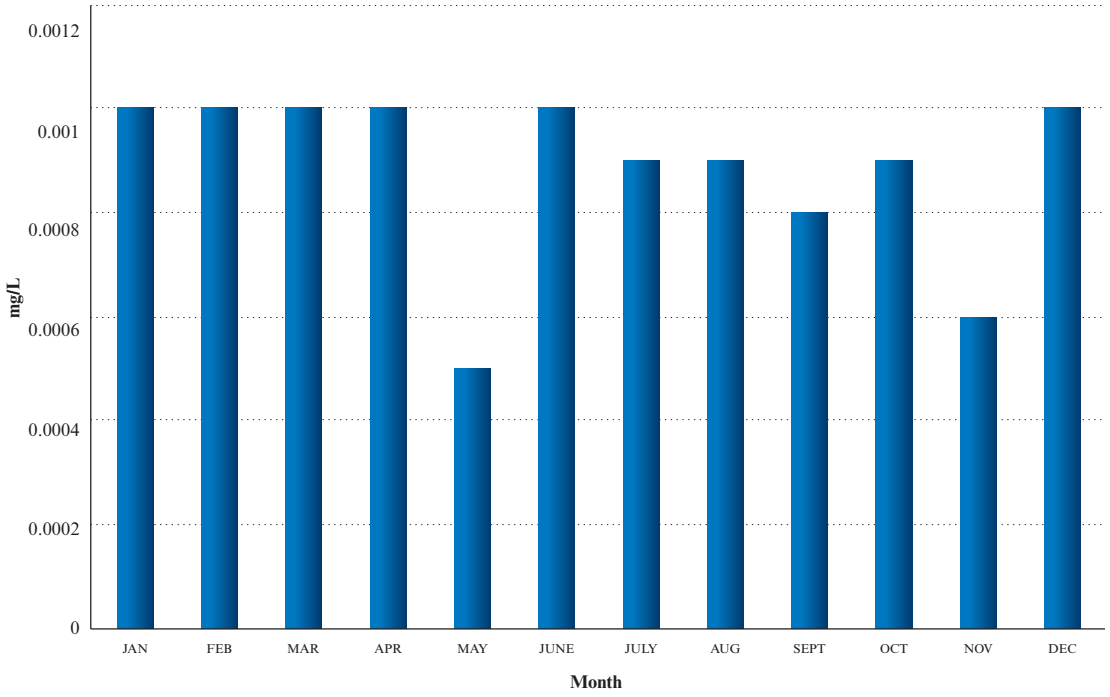
Figure 3 | 2008 Average Monthly Uranium Discharge Concentrations – Mill Effluent (Key Lake)



Releases from the dewatering system at the Key Lake Operation were specifically mentioned within the PSL2 report (Environment Canada & Health Canada, 2003) CEPA toxic determination. This was based on historical releases prior to the installation of the reverse osmosis treatment system. The *2007 Uranium Risk Management Annual Report* provides details of the history, performance and receiving environment quality associated with these releases.

The high level of performance achieved by the reverse osmosis treatment plant is clearly evident in the data presented in Table 1 and Figure 4. The annual average of approximately 0.0009 mg/L is more than two orders of magnitude lower than the OSO of 0.1 mg/L. The total 2008 annual load from this treatment system is also relatively low (8.8 kg).

Figure 4 | 2008 Average Monthly Uranium Discharge Concentrations – Dewatering (Key Lake)



2.1.3 McClean Lake Mine and Mill

The McClean Lake Operation consists of a uranium mine and milling facility and is located in the northeastern corner of the province of Saskatchewan (see Figure 1). Mining commenced in 1995 and the mill began production in June 1999.

The JEB Water Treatment Plant receives contaminated water feeds mainly from the mill and JEB Tailings Management Facility areas, removes dissolved metals and suspended solids, then discharges to the Sink/Vulture Treated Effluent Management System.

The SUE Water Treatment Plant receives contaminated water feeds from the SUE and Caribou Mine sites, removes dissolved metals and suspended solids, then discharges to the Sink/Vulture Treated Effluent Management System. Diversion works have been constructed at the SUE and Caribou sites for surface water control and to minimize the amount of water that can become contaminated. The treatment system utilizes a combination of sedimentation ponds and settling ponds to assist with the water treatment. The treatment process consists of a first stage treatment for nickel and other heavy metals precipitation, followed by a second stage treatment for arsenic and radium precipitation. The second settling pond discharges through sand filters to reduce the residual suspended solids in the treated water during discharge to Sink Reservoir.

The data in Table 1 and Figures 5 and 6 demonstrate that the monthly means for both treatment plants have consistently achieved concentrations an order of magnitude or more lower than the OSO. The two releases together result in an annual total load of approximately 7.5 kg of uranium discharged to Sink Reservoir. Figure 5 shows an increase in effluent uranium concentrations for July 2008. This was due to treatment plant feed from the SUE B pit which had undergone very little sedimentation prior to entering the treatment system. The normal feed for the plant was from the SUE C pit with adequate sedimentation and buffering prior to treatment. The SUE Water Treatment Plant also does not contain a high pH precipitation process that is required for effective removal of uranium. Despite these factors all of the monthly means were below the OSO.

Figure 5 | 2008 Average Uranium Discharge Concentrations – SUE Water Treatment Plant (McClean Lake)

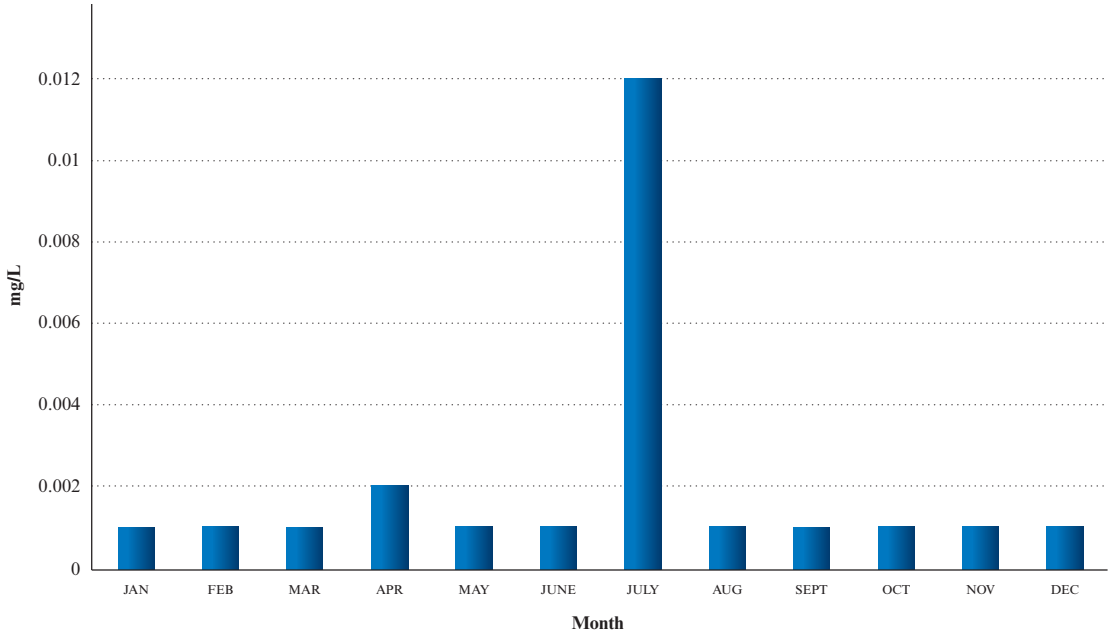
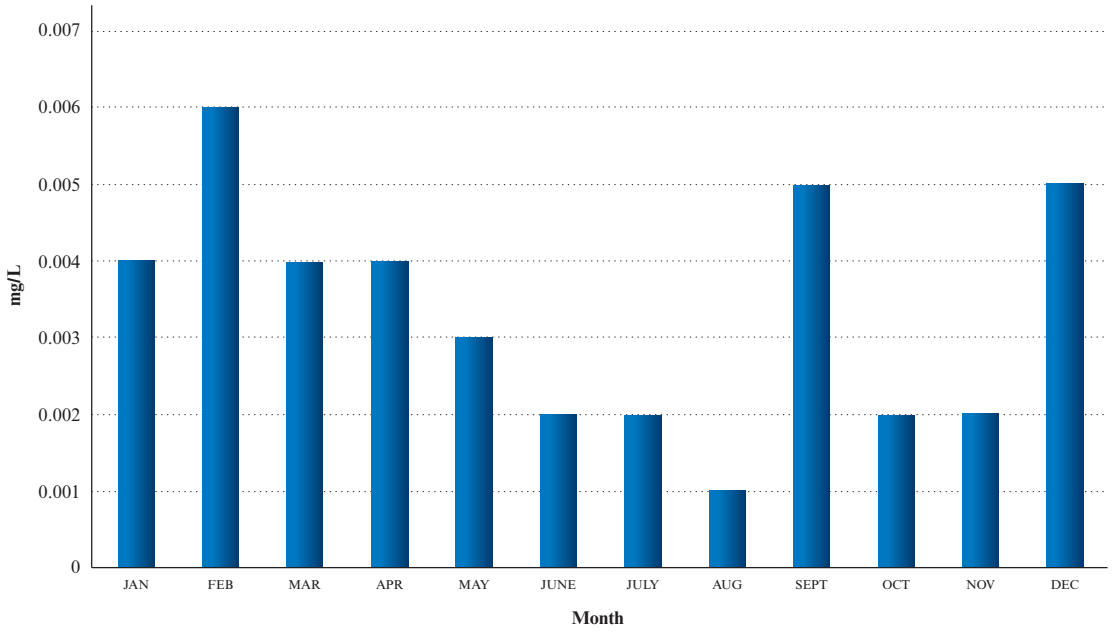


Figure 6 | 2008 Average Uranium Discharge Concentrations – JEB Water Treatment Plant (McClean Lake)



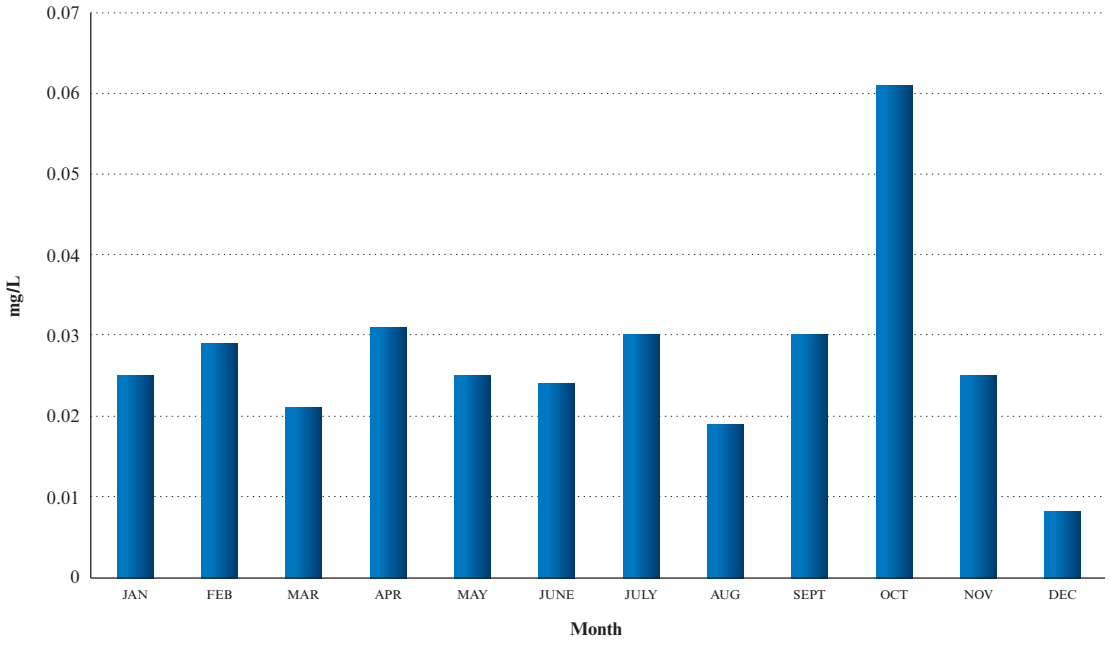
2.1.4 McArthur River

Located in north-central Saskatchewan approximately 300 km north of La Ronge (see Figure 1), Cameco Corporation's McArthur River Operation mines the world's largest high-grade uranium deposit. It began operations in 1999, extracting ore using the raisebore mining method. The high-grade ore is processed underground and pumped in slurry form to the surface, where it is loaded into specially designed containers and transported by truck to Cameco's Key Lake Mill 80 km to the south. At Key Lake, the uranium is extracted, processed and packaged in the form of 'yellowcake', then is shipped offsite for further refining and conversion.

The majority of ore processing equipment at McArthur River is located underground, with the exception of the slurry loadout building where the high-grade ore slurry is loaded for shipment. The minewater treatment plant, storage ponds and the final effluent discharge point are located on the surface. Treated effluent is discharged from the secondary water treatment plant pumphouse through a 1,250 m pipeline to a muskeg receiving area adjacent to shaft #3. As there is no mill at this site there is no specific uranium removal process at the facility.

Site-specific risk assessments required by the CNSC have identified uranium as a COPC and it is specifically targeted for reduction within the McArthur River facility's continuous improvement program. Improvements have been achieved over the last few years due to modifications in water management activities and optimization of the overall treatment process. For 2008, monthly uranium in effluent concentrations were consistently below the OSO (Figure 7) with a total annual load of approximately 70 kg being released in 2008 at this site (Figure 9). These continuing uranium reduction activities at McArthur are preventative in nature as releases from this facility were not determined to be CEPA toxic.

Figure 7 | 2008 Average Uranium Discharge Concentrations – (McArthur River)

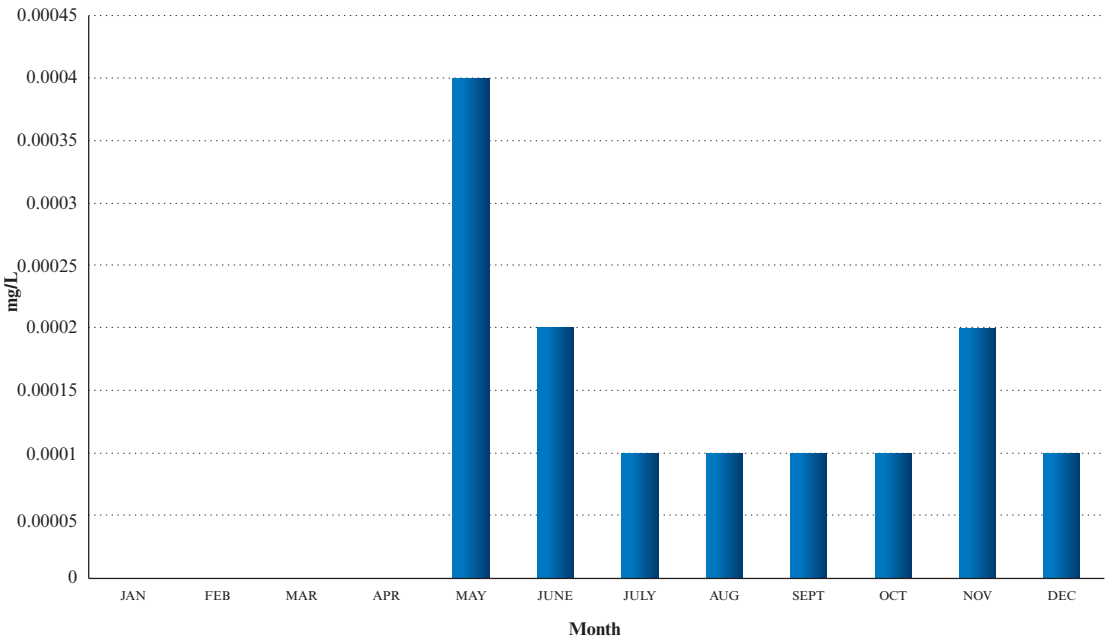


2.1.5 Cigar Lake Mine

The Cigar Lake Project was in the construction and development phase when an inflow event in 2006 resulted in the flooding of the underground works. Throughout 2008, site activities focussed on remediation associated with sealing the inflow and developing a mine dewatering plan. With limited activity in the mine workings, the minewater treatment plant ran infrequently in 2008. During remediation and dewatering activities, some minewater was pumped from the underground mine and was treated to remove contaminants. Effluent is monitored prior to discharge to the receiving environment (composite sample collected during the filling of monitoring ponds) and at the 'final point of control' (i.e., during batch discharge). Results for 2008 uranium discharge concentrations are provided below in Figure 8.

Effluent released from the Cigar Lake Mine water treatment system consistently achieved the OSO (0.1 mg/L) with a total annual load of 0.03 kg released to the environment. Releases are expected to increase as the facility becomes operational, however, effluent concentrations below the OSO are expected to be achievable.

Figure 8 | 2008 Average Monthly Uranium Discharge Concentrations (Cigar Lake)



2.1.6 Mining Releases Summary

The review of uranium releases at the operating uranium mines and mills indicates that no facilities are exceeding their Saskatchewan license limit and that the majority of the facilities are readily achieving the OSO of 0.1 mg/L Figure 9B. Figure 9A provides a summary of the uranium mass loadings for 2008. The highest annual loading of uranium in effluent continues to be the Rabbit Lake Operation. Releases are expected to further decrease in 2009 assuming a full year of availability of the solution recovery thickener (SRT) system as well as continued fine-tuning and modification of the overall treatment process. Uranium in effluent will continue to be carefully monitored at the uranium mines and mills with uranium being specifically targeted for further reduction by a number of mines/mills under the continuous improvement initiatives within the environmental management system required by the CNSC.

Figure 9A | 2008 Uranium Mines – Mass Loadings

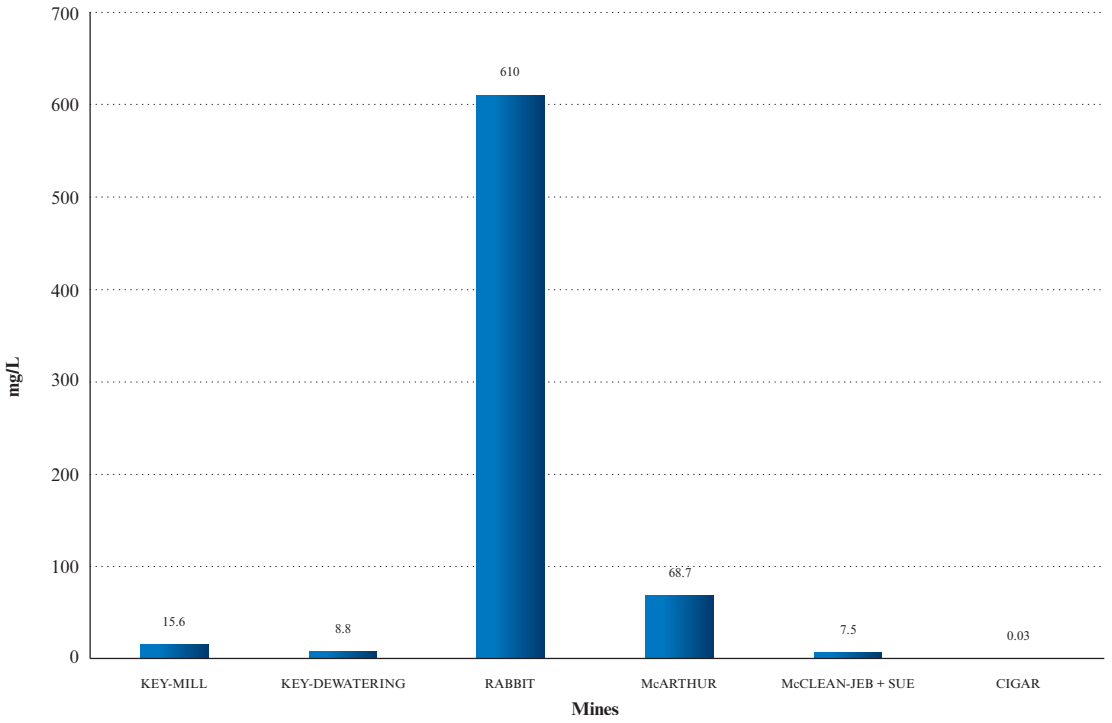
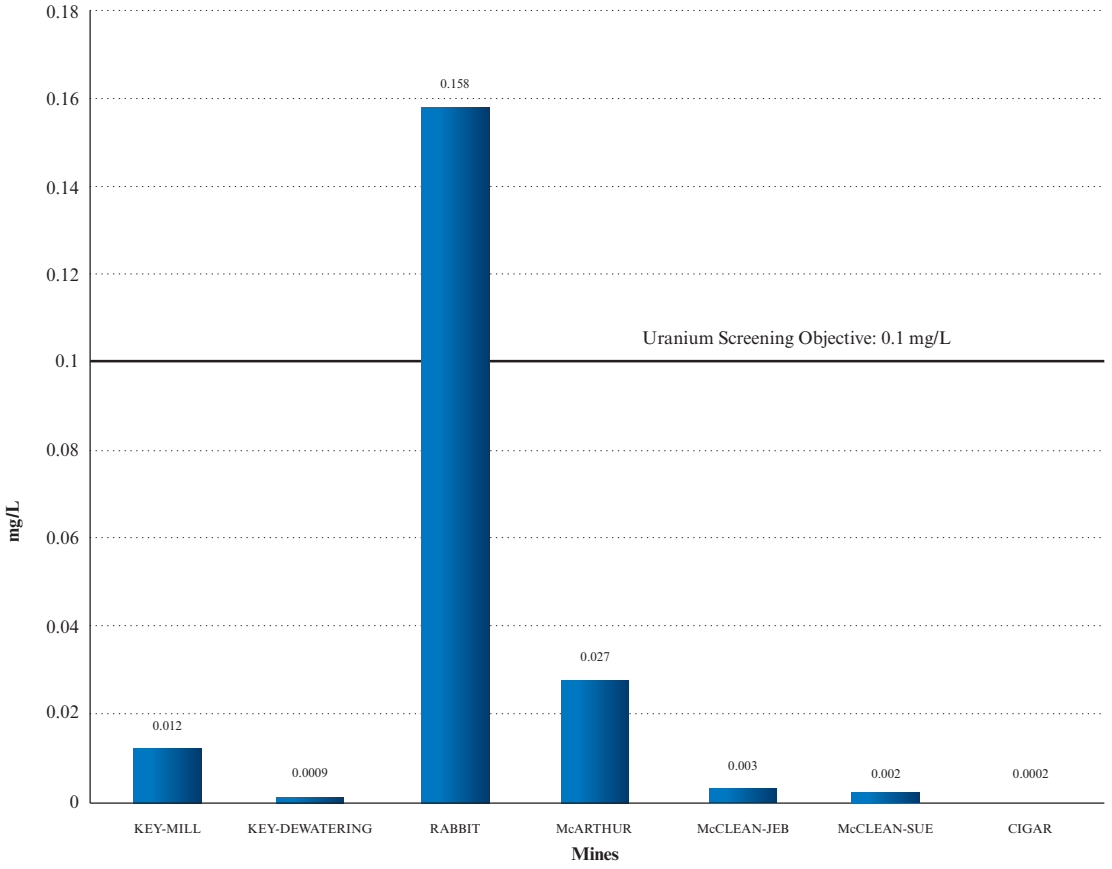


Figure 9B | 2008 Uranium Mines – Annual Average Concentrations



BLIND RIVER REFINERY

2.2

2.2 Uranium Processing and Conversion Facilities

2.2.1 Blind River Refinery

Cameco Corporation of Saskatoon, Saskatchewan, owns and operates a Class IB Nuclear Fuel Refining Facility. The facility, located near the town of Blind River, Ontario (see Figure 10), refines yellowcake received from various sources to produce uranium trioxide (UO_3)—an intermediate product of the fuel cycle. The primary recipient of the product is Cameco's Port Hope Conversion Facility.

The facility is licensed to produce up to 18,000 tonnes of uranium as UO_3 during any calendar year. The facility converts various milled uranium concentrates (i.e., yellowcake) to UO_3 powder through chemical processes. In addition, the facility operates a hazardous waste incinerator that handles contaminated combustible waste from both the Blind River Refining Facility and the Port Hope Conversion Facility.

Cameco Blind River Refinery has only one liquid effluent discharge point to Lake Huron, which releases through a diffuser. Uranium monthly mean concentrations for releases to water and the total uranium loading for 2008 are provided in Table 2 below. Monthly means were consistently below the OSO (0.1 mg/L) and the total amount of uranium released was low (2.1 kg).

Figure 10 | Location of Cameco Blind River Refinery, Blind River, Ontario

Table 2 | 2008 Uranium Releases to Water (Blind River Refinery)

Month	Mean mg/L	Minimum mg/L	Maximum mg/L
January	0.008	0.005	0.014
February	0.006	0.004	0.009
March	0.007	0.004	0.01
April	0.011	0.003	0.026
May	0.004	0.003	0.006
June	0.014	0.007	0.018
July*	0.005	N/A*	N/A*
August	0.026	0.003	0.044
September	0.012	0.007	0.015
October	0.008	0.008	0.01
November	0.016	0.008	0.027
December	0.010	0.007	0.013
Average	0.0106		
Standard Deviation	0.006		

Total Uranium Loading (2008): 2.1 kg

* Note: Cameco Blind River refinery operations were shut down and only one sample was taken during July 2008.

2.2.2 Port Hope Conversion Facility

Cameco Corporation also owns and operates a Class IB Nuclear Fuel Conversion Facility in Port Hope, Ontario (see Figure 11). The facility primarily converts uranium trioxide (UO_3) powder produced by Cameco's Blind River Refinery to uranium dioxide (UO_2), which is used in the manufacture of CANDU reactor fuel and uranium hexafluoride (UF_6), which, in turn, is exported for further processing into fuel for light water reactors. In addition, there is a specialty metals plant that has been used to convert uranium tetrafluoride into uranium metal shapes for shielding and counterweights for certain types of aircraft. The facility also includes analytical and research laboratories, radioactive waste storage, and recycling and decontamination capabilities.

Figure 11 | Location of Cameco Port Hope Conversion Facility, Port Hope, Ontario

Since the 2007 installation of an evaporative treatment system, all process wastewater streams from the facility are collected, treated, and reprocessed or evaporated. Hence, there are no longer any routine releases of uranium process water to the Port Hope harbour.

2.2.3 Uranium Processing and Conversion Facilities Summary

The Blind River and Port Hope facilities' monthly mean uranium release concentrations were consistently below the OSO during 2008. The total annual uranium load to the aquatic environment from these facilities was also low. The Port Hope conversion facility no longer discharges treated process water to the harbour, hence, there are no routine treated effluent uranium releases to report.

DENISON MINE SHAFT, ELLIOT LAKE

2.3

2.3 Waste Management Facilities

2.3.1 Elliot Lake Waste Management Facilities

Elliot Lake Historic Sites Facility

For more than 40 years there were as many as nine operating uranium mines in the area of Elliot Lake, Ontario. The last of these mines to permanently close were the Quirke and Panel Mines, which both closed in 1990, and the Stanleigh Mine, which closed in 1996.

Following the completion of decommissioning work in 2003, all sites were operated and maintained by Rio Algom Limited under a Radioactive Waste Facility Operating Licence issued by the CNSC in 2004. The licence was renewed for an indefinite term (licence number WFOL-W5-3101.02/indf) effective January 1, 2006.

The mining structures on these properties have been demolished and the site restored in a manner that protects the environment and public health and safety.

Rio Algom Limited continues to operate and maintain eight tailings management areas and five effluent treatment plants in the watershed.

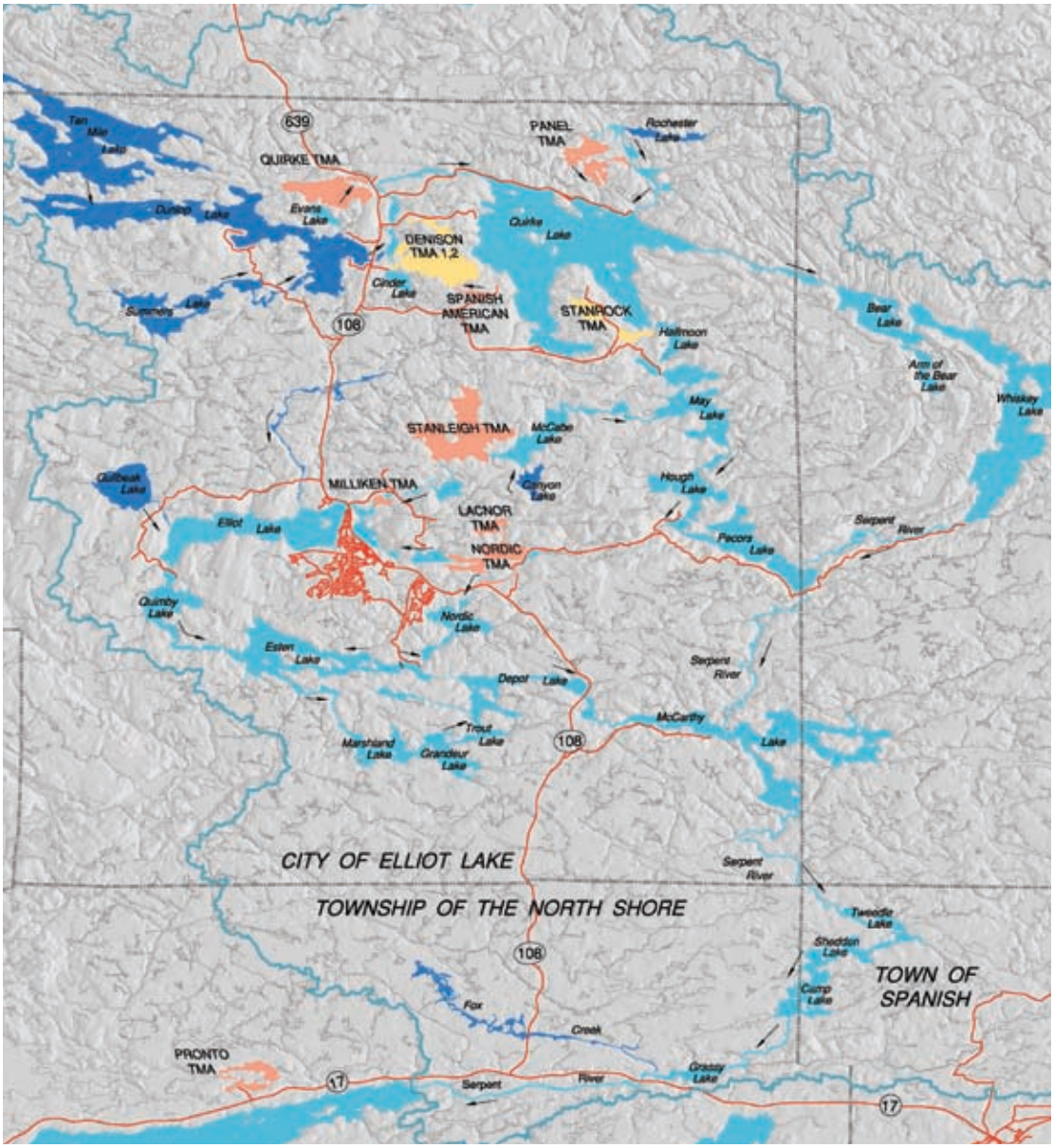
Denison Mining Facility

Denison Mines Inc. possesses CNSC Uranium Mine Decommissioning Licences for their two closed uranium mine facilities in Elliot Lake, Ontario. Both of these sites—the Denison Mine and the Stanrock Mine—have been decommissioned for a number of years. Mine structures have been removed from both sites and mine shafts have been capped and decommissioned according to CNSC requirements.

The CNSC license covers the facilities and associated physical works, such as dam structures, roads, effluent treatment plants, fencing and tailings management areas that are subject to inspection programs and local and area-wide environmental monitoring programs. The Denison Mine site contains two tailings management areas that are under water cover and contain a total of 63 million tonnes of uranium mine tailings. The Stanrock site is a dry tailings management area containing a total of 6 million tonnes of uranium mine tailings. Denison Mines Inc. possesses 69 million tonnes of the total 168 million tonnes of uranium tailings and associated materials in the Elliot Lake area.

Figure 12 depicts the Serpent River Watershed, the City of Elliot Lake and the location of the tailings management areas (TMAs). These sites are located within a radius of approximately 20 kilometres of the City of Elliot Lake and drainage from all sites, with the exception of the Pronto site, enters the Serpent River Watershed.

Figure 12 | Location of Elliot Lake Waste Management Facilities, Ontario



Source: *2008 Serpent River Watershed Monitoring Program Annual Water Quality Report*, March 20, 2009.

As shown in Table 3, all of the releases are below the OSO (0.1 mg/L), with the total annual load generally being in the tens of kilograms or lower. The importance of reviewing total load as well as concentration is also evident from this table. Despite consistently low uranium concentrations, releases from Denison Tailings Management Areas (TMA-1, TMA-2 and Rio Algom Limited's Spanish-American TMA) were approximately 100 kg. Hence, a review of releases associated with these TMAs will be completed to determine if further continuous improvement activities are merited or can be implemented.

Table 3 | 2008 Uranium Release to the Environment (Elliot Lake Waste Management Facilities)

Waste Management Facility	Annual Avg. (mg/L)	Standard Deviation (mg/L)	Total Loadings (kg)
Rio Algom			
Pronto	0.013	0.007	18.1
Nordic, Lacnor & Buckles	0.005	0.003	16.6
Panel	0.007	0.001	9.4
Quirke	0.017	0.004	53.5
Stanleigh	0.003	0.001	25.4
Denison Mines			
TMA-1, TMA-2,and Spanish-American TMA: Stollery Lake Outlet (D-2)	0.073	0.021	102.6
Seepage from TMA-2: Lower Williams (D-3)	0.009	0.008	3.1
Stanrock TMA: Orient Lake Outlet (DS-4)	0.003	0.001	3.3

2.3.2 Welcome and Port Granby Waste Management Facilities

The Welcome and Port Granby Waste Management Facilities are regulated by CNSC through Waste Nuclear Substance licences that came into effect on May 16, 2002. The facilities are located in Ontario, approximately 100 km east of the City of Toronto (see Figure 13). The nuclear industry has a long history in this community, commencing with the 1932 opening of the Eldorado Gold Mines Limited radium extraction refinery. The facility was situated on an existing industrial site adjacent to the Port Hope harbour. From 1933 to 1948, low-level radioactive wastes (LLRW) from the Eldorado Port Hope Refinery were deposited at several waste management sites within the Port Hope area. In 1948, the wastes from these sites were consolidated with the construction of the Welcome Waste Management Facility. This site continued to receive LLRW until 1955, at which time the Port Granby Waste Management Facility was opened.

A private company, Cameco Corporation, was created through the merger of Eldorado Mining and Refining Limited (a federal Crown corporation) and Saskatchewan Mining Development Corporation (a provincial Crown corporation). Under the terms of the merger agreement, the federal government (presently Natural Resources Canada) retained responsibility for the wastes at the Welcome WMF and the Port Granby WMF. Cameco, however, agreed to manage the facilities on behalf of the federal government until the implementation of a long-term Waste Management Plan. Since the cessation of waste placement, management of these facilities has involved the interception and treatment of contaminated leachate from the waste and the discharge of treated effluent to Lake Ontario.

Both these facilities are scheduled to be remediated under the Port Hope Area Initiative (PHAI). Two new long-term waste management facilities (LTWMF), including wastewater treatment systems capable of achieving modern standards are scheduled to be completed within the next five to seven years. An engineered aboveground mound design with multilayer cover and base liner was selected for the new LTWMF in Port Hope and Port Granby.

The 2008 monthly mean uranium concentrations and the associated total annual load for uranium in the effluent streams for the Welcome and the Port Granby WMFs are provided in Table 4.

Figure 13 | Location of Welcome and Port Granby Waste Management Facilities

Table 4 | 2008 Monthly Average Uranium Concentrations Released to the Environment (Welcome and Port Granby WMFs)

Month	Welcome WMF (mg/L)	Port Granby WMF (mg/L)
January	0.19	1.90
February	0.32	2.60
March	0.16	1.40
April	0.16	1.70
May	0.25	2.10
June	0.25	2.70
July	0.14	2.20
August	0.09	1.40
September	0.12	1.80
October	0.17	0.62
November	0.13	0.50
December	0.20	0.62
Annual Average (mg/L)	0.18	1.63
Standard Deviation (mg/L)	0.07	0.65
Load (kg)	21.1	115.1

Releases at the Welcome WMF (with the exception of August 2008) have exceeded the OSO (0.1 mg/L). However, as a result of the lower concentrations of effluent released than those at the Port Granby facility, the total annual load is relatively low (21.1 kg) for 2008.

Releases from the Port Granby WMF are markedly higher than those at the Welcome facility. In 2008, releases were consistently well above the OSO. These elevated concentrations produced a total annual load of 115 kg, which is second only to the Rabbit Lake Operation (an active uranium mine).

These releases were not considered CEPA toxic by the PSL2 Risk Assessment, primarily as a result of their dilution into a large receiving body (Lake Ontario). However, in 2008 a number of CNSC regulatory actions were initiated at these two WMFs in response to their uranium in effluent performance, public concern and the need to review these older facilities against the modern requirements of the NSCA and to demonstrate adequate provision to control the discharge of contaminants to the environment.

In addition to the existing monitoring program, CNSC staff collected both effluent and Lake Ontario samples for chemical analyses and toxicity testing for independent regulatory confirmation that these effluents posed no immediate risk to aquatic biota. Based on Environment Canada test protocols, the toxicity tests demonstrated that the effluent from both facilities was not acutely toxic to aquatic life.

On October 17, 2008, CNSC issued to Cameco Corporation a Request for Information pursuant to Subsection 12(2) of the *General Nuclear Safety and Control Regulations: Effluent Discharge Releases at the Welcome and Port Granby Waste Management Facilities*. Cameco was requested to address the following two sections of the Action Plans proposed for these facilities with the 12(2) Request for Information:

A. Specifications of the Current Systems (completed by March 2009)

B. Evaluation of the Level of Risks to Human Health and the Environment (completed by November 2009)

This information was used to determine reasonable measures that might be taken with respect to treatment modifications of the existing facilities and/or management procedures to optimize treatment performance in the short term until the wastes are transferred to the new WMF and the associated treatment plants are operational.

The 2009 annual reports for these facilities will provide updates of activities undertaken as a result of these investigations. The treatment technologies to be incorporated within the proposed new treatment facility are presently under development; however, the ability to achieve a uranium in effluent concentration of 0.1 mg/L has been set as a design objective. The Ontario Ministry of the Environment and Environment Canada have been kept informed of and support these regulatory activities.

In response to the 12(2) Requests for Information and in relation to each section of the Action Plans for these facilities, Cameco performed the requested analyses and developed a series of reports providing information on the current design of the water treatment system, characterization of the receiving environment and modelling of potential exposure sources and pathways to reach the public and environment.

As a result of the assessment of the information submitted under the 12(2) Requests for Information, CNSC required Cameco to take actions to prevent or mitigate effects on the environment and to control the releases of nuclear and hazardous substances within the sites and into the environment. Those actions included structural improvements to the system to minimize the emergency discharges and ensure better mixing of treated effluent discharged into

Lake Ontario. As a preventive measure, CNSC required Cameco to include additional monitoring parameters in their monitoring programs and to continue toxicity testing until completion of the facilities remediation.

2.3.3 Waste Management Facilities Summary

The existing water collection and treatment system at the Welcome and Port Granby WMFs is currently meeting the licence discharge limits for radium-226, arsenic and pH. Although a discharge limit for uranium is not included in the Welcome and Port Granby WMF Licences, Cameco is required to measure uranium in treated effluent and reports the results to the CNSC. As shown in Table 4, the discharged effluent quality from those facilities exceeded the OSO of 0.1 mg/L for uranium, indicating the need for follow-up optimization of the treatment process. The total annual uranium load in treated effluent from Port Granby WMF to the aquatic environment is higher than any other CNSC regulated facility with the exception of the Rabbit Lake mine.

Regulatory actions were taken with respect to both waste management facilities, requiring performance reviews of the treatment facilities and their receiving environments as well as demonstrations that these releases did not pose an immediate risk to humans or the environment. Comprehensive reviews of the treatment facilities and the immediate receiving environment were to be submitted in 2009. Studies to determine reasonable modifications to improve treatment and/or overall environmental management practices at the facilities in the short-term (i.e., until the wastes are transferred to the new WMF and the newly designed water treatment facility is operational) were also to be submitted in 2009. The results of these studies and regulatory decisions will be documented in the 2009 annual report.

Considering the upcoming full remediation of the Welcome and Port Granby WMFs and the recent improvements made to these facilities, CNSC is of the opinion that these facilities can continue to operate in accordance with their licence requirements until the remediation occurs under the Port Hope Area Initiative.

Containment Practices for Facilities Managing High Concentration Uranium Solutions

3

PORT HOPE UF_6 PLANT

Containment Practices for Facilities Managing High Concentration Uranium Solutions

Leaks of uranium bearing solutions through building foundations to underlying soils and groundwater were detected beneath two Cameco facilities: the Port Hope Conversion Facility (2007) and the Rabbit Lake Mill (2008) This section documents the regulatory and licensee actions taken in response to these events. The results of 'root cause' investigations were communicated to other CNSC licensees, emphasizing the importance of ensuring adequate maintenance of foundations and sumps as well as strictly maintaining separation between primary and secondary containment.

PORT HOPE CONVERSION FACILITIES

3.1

3.1 Port Hope Conversion Facilities

Following the July 2007 discovery of subsurface contamination, Cameco voluntarily shutdown its UF_6 plant. To address the situation, the CNSC took regulatory action requiring Cameco to complete the following activities:

- removal of surficial layer of contaminated soils
- independent third-party root cause investigation
- replacement of foundation floor
- installation of new coating on the floor (tested with process chemical used at the plant)
- replacement of old tanks
- local and site-wide subsurface soil and groundwater characterization
- site-wide Environmental Risk Assessment
- site-wide installation of groundwater interception wells
- site-wide Environmental Management Plan

The plant remained shut down from mid-July 2007 to mid-September 2008, only reopening after upgrading the facility's subsurface civil structures and liquid management systems. The plant restarted in the third week of September 2008 in accordance with a restart plan reviewed and accepted by CNSC staff.

Cameco's UO_2 plant went into extended maintenance from mid-October 2008 to mid-January 2009 for planned maintenance and to implement lessons learned from the UF6 plant rehabilitation. These activities confirmed similar uranium solution seepage through the sump floor to the groundwater. As a result a number of remediation and facility improvements were initiated including:

- comprehensive soil and groundwater sampling and mapping
- excavation of contaminated soils
- installation of interception wells
- replacement of old tanks
- change floor and floor coating
- modification of operating procedures

Through its enhanced regulatory oversight, CNSC staff verified that Cameco completed the Corrective Action Plans, which were reviewed and accepted by CNSC staff for each plant. Both plants remained shut down until Cameco completed the required corrective actions.

An enhanced preventative maintenance program was implemented to ensure a similar loss through the foundation was not occurring at Cameco's Blind River Refinery. In addition to the normal scheduled maintenance activities, assessment of the facility, foundation and subsurface soils was completed to ensure there was no process solution loss through the foundations.

Core samples were collected from the floor areas in the UO_3 plant and analyzed for uranium. These samples showed no indication of uranium migration through the protective floor. Soil samples were also collected from directly beneath the plant floor. Uranium results from soil samples indicated background level concentrations in the area and demonstrated the absence of subsurface contamination. Cameco was also required to review operation, maintenance and monitoring procedures against the lessons learned from the root cause investigations, with modifications made as required.

RABBIT LAKE MILL

3.2

3.2 Rabbit Lake Mill

On January 26, 2008, seepage was discovered in the Low pH Clarifier excavation adjacent to the Rabbit Lake Mill. The event was reported to both the CNSC and the Saskatchewan Ministry of Environment (SMoE). Cameco described the initial actions taken in a letter to the CNSC dated January 30, 2008, which included temporarily halting the excavation; conducting a job hazard analysis; collecting initial gamma and airborne radiation readings in the work area; and conducting a review of hygiene protective measures, equipment cleaning and personal protective equipment requirements. Laboratory results concluded that the radiological issue was dissolved uranium rather than gamma or airborne radiation. Water samples from the excavation were routinely collected and analyzed during the investigation and a dye tracer test was conducted.

CNSC advised Cameco that a more detailed review and an Action Plan would be expected prior to mill startup, including the identification of any work that needed to be done before startup. The Rabbit Lake Operation identified and completed this work in the first quarter of 2008.

On March 5, 2008, Cameco provided the CNSC with a status update on the spill information and associated investigation. A remedial Action Plan and schedule for addressing the issues related to mill containment, along with a plan and schedule for a hydrogeological investigation, were also presented.

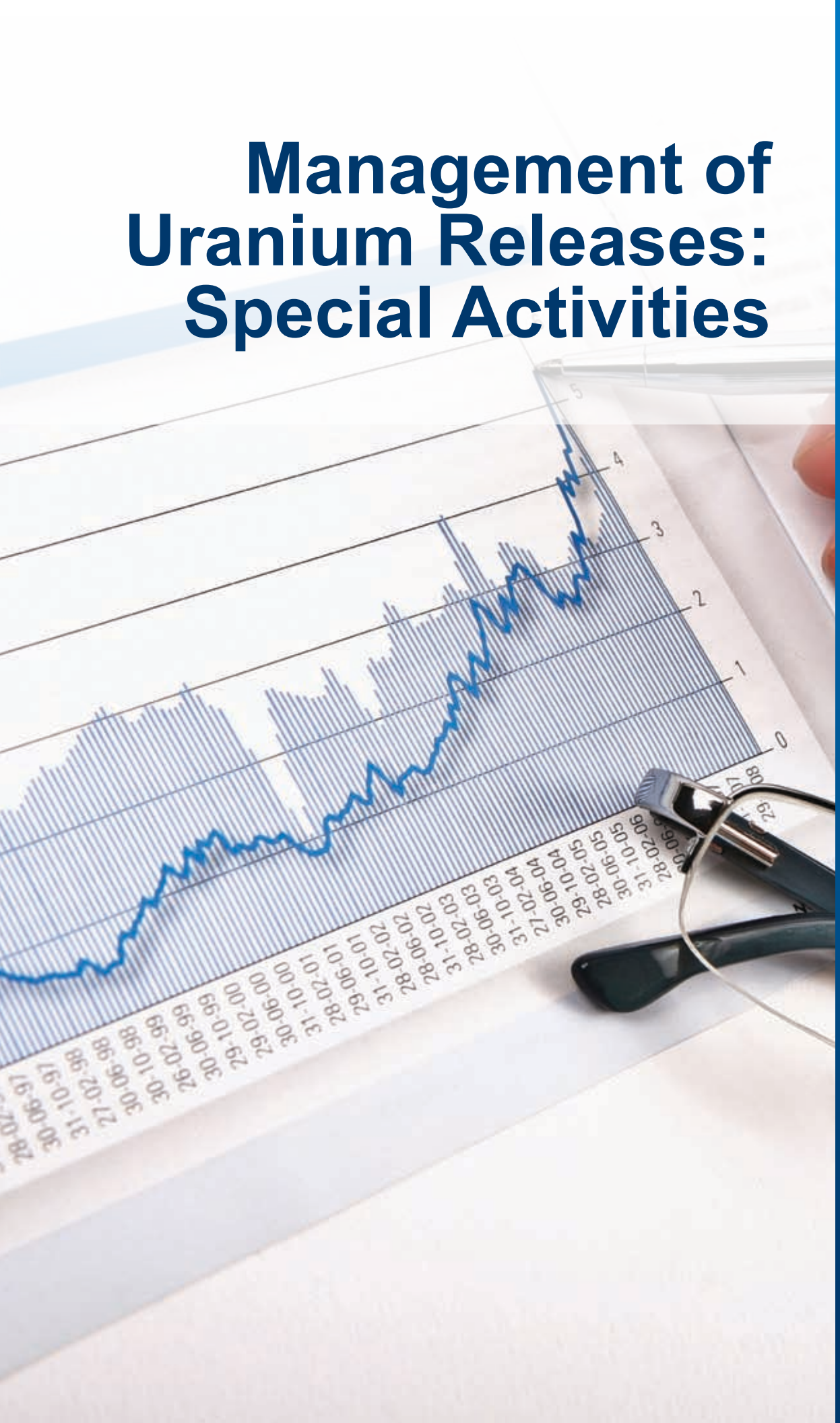
Mill environmental aspects and a Hazard Risk Assessment were reviewed and a plan was developed to examine and repair all mill containment, including floor sumps, joints, seals, protective coatings and concrete. The areas for repair were prioritized and repair work was implemented immediately. Testing was conducted to ensure the integrity of all repairs and inspection and periodic maintenance frequencies were updated as necessary. The practice of using areas of the mill floor for process containment was also examined and changed.

Areas of the Rabbit Lake Mill that were selected for repair and secondary containment under the Secondary Containment Upgrade (SCU) Project were prioritized and completed following the initial Rabbit Lake Risk Assessment Plan. Priority areas were completed and work continued to progress on lower priority areas. Findings from the TapRoot® investigation were entered into the Cameco Incident Reporting System (CIRS) for tracking and resolution.

On July 18th, 2008, Cameco submitted its completed hydrological investigation, which indicated that the initial loss of containment area, was fully contained by the excavated sump, and that potential groundwater contamination from other sources was also contained in the Rabbit Lake in-pit drainage system. Additional groundwater monitoring wells were installed and are being monitored.

Management of Uranium Releases: Special Activities

4



4.1 CNSC Effluent Charter: Process for Establishing Release Limits for Nuclear Facilities

The NSCA and the regulations provide the authority and general framework for setting regulatory limits on effluents from nuclear facilities. However, neither the NSCA nor the regulations contain specific numerical effluent limits. In the absence of specified limits, the CNSC has regulated effluent quality through the incorporation of other applicable federal legislation (e.g., *Metal Mining Effluent Regulations* for uranium mines) directly into licenses. This approach does not address a number of radionuclides nor many other potential hazardous substances within effluent waste streams. The CNSC has required the development of *Environmental Codes of Practice for Uranium Mines and Mills*, which have established action and administrative levels for COPCs identified through Ecological Risk Assessments or past operating practice. These control levels are based on the normal operating levels of the effluent treatment systems and are used to identify and trigger corrective actions for deviations from the normal operating conditions.

With the additional responsibilities associated with the NSCA for both environmental protection and hazardous substances, and in response to the CNSC's desire for more transparent use of limits directly within the license, it was determined that a formal review of the CNSC's current practice relative to other international and national means of establishing release limits was required.

To this end, CNSC staff initiated the Charter Project, entitled "The Process for Establishing Release Limits for Nuclear Facilities". The overall objective of the project is to develop and document a formal procedure for establishing effluent limits for both nuclear and hazardous substances released from nuclear facilities that meet the principles of pollution prevention and regulatory requirements under the NSCA.

This project has four core elements:

- Documentation of international practices for establishing release limits for radionuclides at nuclear facilities.
- Documenting international, national and provincial practices for establishing release limits on hazardous substances.
- Documenting present practices for limits and other forms of regulatory controls on releases of radionuclides and hazardous substances at CNSC regulated facilities.
- Assessing the advantages and disadvantages of the various methodologies and providing recommendations as to those most appropriate for use within the CNSC regulatory mandate.

Uranium is one of the effluent constituents specifically being addressed within this project. The following activities have been completed with respect to uranium releases:

- Documenting uranium releases, release limits and other parameters used for its control both nationally and internationally.
- Assessing the approach—and the basis behind the approach—for setting uranium limits in Canada, then comparing these limits to those used in Australia, the United States and the European Union.

Initial planning for the Charter Project commenced in late 2008 and has a planned completion date of 2010.

CNSC/Environment Canada 2008 Annual Meeting

5

CNSC/Environment Canada 2008 Annual Meeting

The Annex to the MOU states:

"The Department and Commission staff will meet annually or more frequently by mutual consent to assess progress on the implementation of this Annex and on the effectiveness of the control measures to reduce the effluent toxicity of the above mentioned facilities."

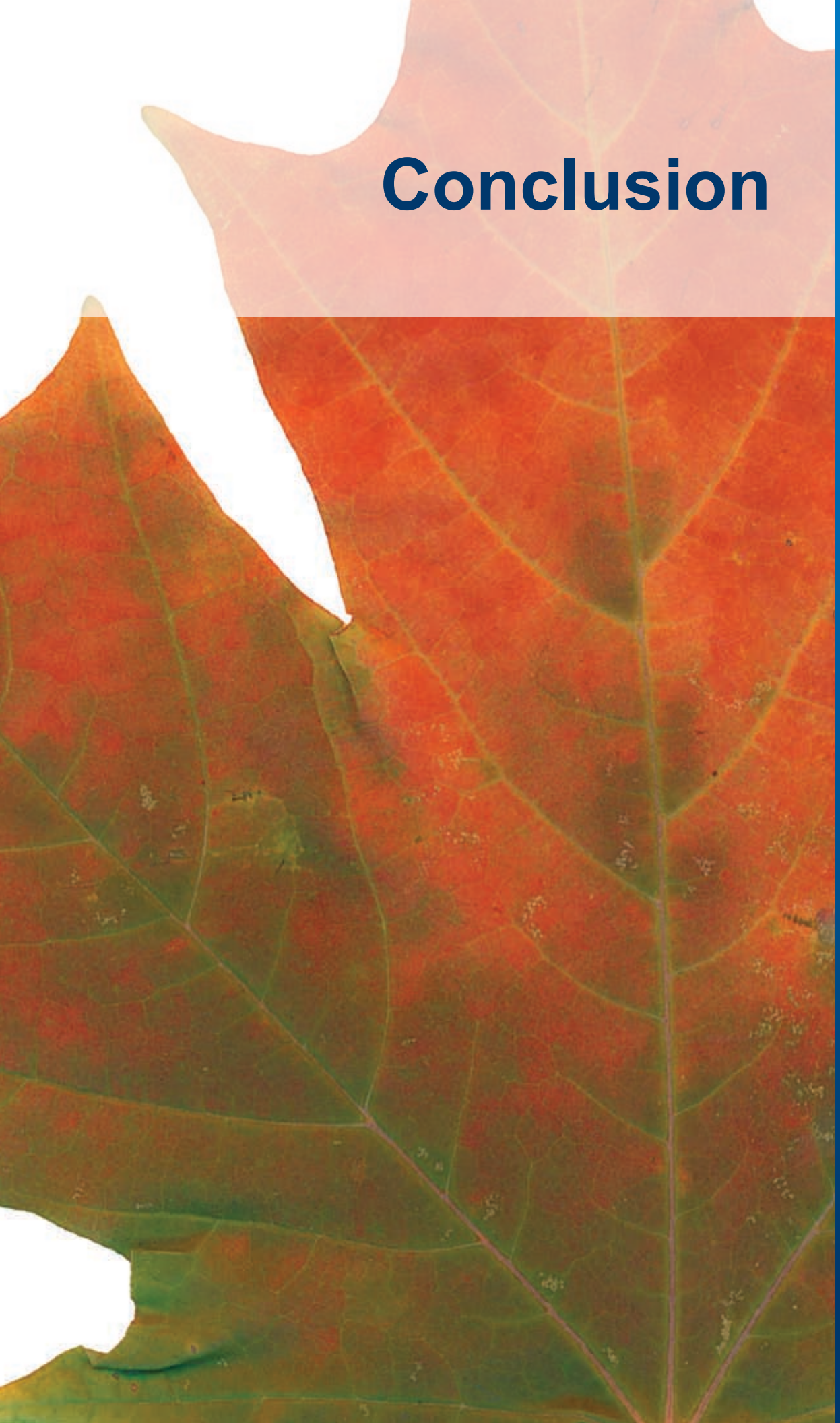
CNSC staff (from the Directorate of Environmental and Radiation Protection and Assessment) and Environment Canada staff (from the Environmental Protection Operations Division, Ontario) meet formally at least once a year. At these meetings, any issues relating to the Annex to the MOU are addressed. In addition, numerous other activities related to sharing regulatory and technical expertise are coordinated. The 2008 meeting occurred at CNSC headquarters on December 16, 2008.

These meetings have also served as a venue for the coordination of additional cooperative activities not specific to the Annex. In 2008, routine coordinated regulatory activities continued with respect to CNSC licensees. Additional special activities in 2008 included:

- Participation of CNSC staff in the National *Metal Mining Effluent Regulations* Technical Advisory Panels for each of the uranium mines.
- Provision by CNSC staff of technical support and information to the Canadian Council of Ministers of the Environment for the development of a national uranium water quality guideline.
- Coordination with Environment Canada and the Department of Fisheries and Oceans to address issues related to fish impingement and entrainment at nuclear facilities.

Conclusion

6



Conclusion

Environment Canada and the CNSC developed and signed an MOU wherein the parties agreed to consult and cooperate with respect to the overall regulation of nuclear facilities in Canada. In 2004, risk management of uranium releases to the environment from uranium mining and milling facilities was formalized in an Annex to the MOU and identified specific activities for each of the facilities associated with the conclusion of uranium toxicity under CEPA.

All required risk management activities associated with the Annex have been completed on schedule and appropriate treatment technologies identified and implemented. With the completion of the site-specific activities identified in the Annex, the focus has now shifted to the generic management of uranium within the broader nuclear fuel cycle. Overall control of uranium emissions involves the prevention of unplanned or uncontrolled releases and the minimization of controlled releases.

CNSC staff assessments indicate that present licensed facilities are not releasing uranium in effluent that would result in significant risk to the environment. However, in accordance with the NSCA and its regulations, licensees are further expected to "take all reasonable precautions to control releases" and to keep all releases (including hazardous substances) as low as reasonably achievable (ALARA). To evaluate licensee performance, CNSC staff reviewed uranium in effluent releases against an Optimisation Screening Objective of 0.1 mg/L derived from a review of treatment performance from chemical precipitation treatment technology. This value serves to identify facilities which, while not exceeding any regulatory limits, should review their treatment processes to determine whether the present system can be optimized or upgraded to meet CNSC's expectations for ALARA. This represents a substantial enhancement of regulatory expectations relative to other jurisdictions, where uranium in effluent limits range from 2–5 mg/L (U.S. EPA and Saskatchewan MIEPR regulations).

It is evident from the 2008 results that the Rabbit Lake Operation continued to be the facility discharging the highest load of uranium to the environment. Substantial reductions in effluent uranium concentrations and loadings occurred from the facility modifications in 2007. Further modifications and upgrades to the system completed in 2008 have succeeded and are expected to further reduce uranium releases. At the end of the year the concentration of uranium in effluent was consistently below the OSO of 0.1 mg/L.

The Welcome and Port Granby WMFs, originally designed as interim facilities are out-dated and hence, have difficulties in meeting the OSO. Regulatory action was taken at both these facilities, requiring reviews of both treatment facility and receiving environment performance and demonstration that these releases were not posing an immediate risk to humans or the environment. Comprehensive reviews of the treatment facilities and the immediate receiving environment were to be submitted in 2009. In addition, studies to determine reasonable modifications to improve treatment and/or overall environmental management practices at the facilities in the short-term (i.e., until the wastes are transferred to the new WMF and the newly designed water treatment facility is operational) were also to be submitted in 2009. The results of these studies and regulatory decisions will be documented in the *2009 Annual Report on Uranium Management Activities*.

The prevention of accidental or uncontrolled releases involves facility designs incorporating engineered controls and barriers, and administrative procedures such as preventative maintenance programs, documentation and training on operating procedures. Site-specific reviews of facility design and management practices focusing on uranium solutions and mixtures will continue in order to ensure CNSC licensees are implementing best practices. Other risk management initiatives will focus on controlled releases of uranium from CNSC-licensed waste management facilities.

The review of formal regulatory limits both internationally and nationally has shown that, based on the CEPA toxic determination for uranium releases from mines and mills, present limits used by other jurisdictions would not be considered adequately protective of the aquatic environment. The need to develop formal and transparent license limits and other means to control the effluent loadings of uranium and other hazardous substances was partly responsible for the initiation of the CNSC Charter Project entitled "The Process for Establishing Release Limits for Nuclear Facilities". Initial planning for the Charter Project commenced in late 2008, with a planned completion date of 2010.

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Appendix A

COPY OF THE MEMORANDUM OF UNDERSTANDING AND ASSOCIATED ANNEX

Note: Digital version available at: http://www.ec.gc.ca/Toxics/docs/substances/RN/EN/mou.cfm

APPENDIX A: Memorandum of Understanding (MOU) Between the Canadian Nuclear Safety Commission (CNSC) and Environment Canada (EC)

WHEREAS the Canadian Nuclear Safety Commission (hereinafter, "the Commission") and Environment Canada (hereinafter, "the Department") have independent but related mandates in regard to the protection of the environment and activities carried out under their respective mandates have the potential to affect the programs and responsibilities of the other;

WHEREAS the Regulatory Policy1 of the Government of Canada requires that federal departments and agencies take full advantage of opportunities to coordinate their activities with each other;

WHEREAS the Commission regulates, pursuant to the *Nuclear Safety and Control Act* (NSCA), the development, production and use of nuclear energy and the production and use of nuclear substances, prescribed equipment and prescribed information in order to:

i. prevent unreasonable risk to the environment and to the health and safety of persons;

ii. prevent unreasonable risk to national security; and

iii. achieve conformity with measures of control and international obligations to which Canada has agreed;

WHEREAS the Department under the *Department of the Environment Act* has powers, duties and functions relating to the preservation and enhancement of the quality of the natural environment, including water, air and soil quality; renewable resources, including migratory birds and other non-domestic flora and fauna; water; meteorology; the enforcement of rules and regulations arising from the advice of the International Joint Commission relating to boundary waters and questions arising between the United States and Canada in so far as they relate to the preservation and enhancement of environmental quality;

WHEREAS the Department regulates, pursuant to the *Canadian Environmental Protection Act* (CEPA, 1999), has the mandate to:

i. ensure that preventive and remedial measures are taken to protect the environment;

ii. establish nationally consistent levels of environmental quality;

iii. apply knowledge, science and technology to resolve environmental problems;

iv. protect the environment from the release of toxic substances; and

v. assess whether substances in use in Canada are toxic or capable of becoming toxic;

WHEREAS the Department has been assigned responsibility for the administration and enforcement of subsection 36(3) of the *Fisheries Act*, which deals with the deposit of deleterious substances into water frequented by fish;

THEREFORE, the Commission and the Department agree to consult and cooperate in accordance with the following sections of this Memorandum of Understanding in order to minimize regulatory duplication and to use government resources effectively.

I. Principles

1. The parties, in carrying out their respective mandates will cooperate and support each other, as appropriate, in meeting their responsibilities in relation to environmental conservation and protection and in other areas of mutual interest.
2. The parties will take all reasonable steps, consistent with their respective mandates, to see that their environmental protection policies and measures are complementary and designed to provide effective environmental protection.
3. The parties will provide each other the opportunity to advise on policies and programs that may affect the mandate of the other, in a manner that allows for timely and substantive advice.
4. The parties will foster strong working relations by establishing mechanisms and links to share information, taking into account legal constraints on the sharing of confidential business information.

II. Implementation

The Department agrees to:

1. Inform and advise the Commission on the Department's current policies, programs, standards and regulations concerning the protection of the environment, and the management of toxic substances of concern to the Commission;
2. Provide the opportunity to the Commission to provide guidance, information and advice prior to developing, amending or terminating the policies, programs, standards or regulations referred to in the above paragraph that may affect the facilities and activities regulated by the Commission;
3. Cooperate with the Commission on regulatory matters of mutual concern involving the nuclear industry, including:
    a. developing and managing programs and processes for the implementation of obligations pursuant to the *Canadian Environmental Protection Act* (CEPA,1999), as they relate to facilities and activities regulated by the Commission;
    b. consulting with the Commission, on request, in the review of applications before the Commission, and where appropriate, providing advice on matters concerning the protection of the environment;
    c. promoting awareness among licensees of the Commission of the Department's mandated requirements;
    d. verifying compliance with the regulatory requirements of either the Commission or the Department;
    e. sharing environmental information; and
    f. informing the Commission of any review or investigation by the Department of a non-com-

pliance incident under its jurisdiction that may have occurred at a facility regulated by the Commission; and where appropriate, consulting and coordinating with the Commission, prior to taking regulatory enforcement actions at facilities, or on activities licensed by the Commission;

4. Consult and cooperate with the Commission in the development of any national or international standard, agreement, convention, or commitment that could affect the regulation of the nuclear industry by the Commission;
5. Cooperate with the Commission in matters of mutual interest related to nuclear emergency preparedness and response;
6. Cooperate with the Commission on the conduct of environmental studies, assessments or research projects of potential interest to the regulation of the nuclear industry, and in the sharing of expert assistance and financial resources for such purpose; and
7. Coordinate public communication and consultation activities with the Commission on matters of mutual interest and responsibility.

The Commission agrees to:

1. Inform and advise the Department on the Commission's current policies, programs, standards and regulations concerning the protection of the environment and the management of toxic substances in relation to nuclear facilities and activities;
2. Provide the opportunity to the Department to provide guidance, information and advice prior to developing, amending or terminating the policies, programs, standards or regulations referred to in the above paragraph that may involve the use, release or management of substances designated as toxic under CEPA, and other contaminants of mutual environmental concern;
3. Cooperate with the Department on joint regulatory matters concerning the nuclear industry, including:
    a. developing and managing programs and processes for the implementation of obligations pursuant to the Nuclear Safety and Control Act (NSCA), as they relate to facilities and activities regulated by the Department;
    b. providing the Department with the opportunity, on request and where appropriate, to review applications before the Commission and provide advice on matters concerning the protection of the environment;
    c. promoting awareness of the Department's requirements among licensees of the Commission;
    d. verifying licensee compliance with the regulatory requirements of either the Commission or the Department;
    e. providing the Department with the opportunity, on request and where appropriate, to participate in joint compliance inspections of facilities and activities licensed by the Commission;
    f. sharing environmental information; and
    g. informing the Department of any review or investigation by the Commission of a non-compliance incident under its jurisdiction that may involve substances designated as toxic under CEPA or other contaminants of mutual environmental concern; and where appropriate, consulting and coordinating with the Department, prior to taking regulatory enforcement actions involving the environment.

4. Consult and cooperate with the Department in the development of any national or international standards, agreements or conventions concerning the protection of the environment;
5. Cooperate with the Department in matters of mutual interest related to nuclear emergency preparedness and response;
6. Cooperate with the Department on the conduct of environmental studies, assessments or research projects of potential interest to the regulation of nuclear facilities and activities, and in the sharing of expert assistance and financial resources in the conduct of these studies, assessments or research projects; and
7. Coordinate public communication and consultation activities with the Department on matters of mutual interest and responsibility.

III. Terms of the MOU

1. The primary points of contact under this MOU, and responsible for its administration, are the Vice-President, Operations Branch, CNSC, and the Regional Director General, Ontario Region, Environment Canada who will meet annually during the normal planning process.
2. The parties will make every reasonable effort to resolve at the working level any conflicts that arise from this Memorandum of Understanding. Failing resolution at the working level, conflicts may be referred for resolution to the offices named pursuant to paragraph 1 above, or to the signatories to this Memorandum.
3. Subject to paragraph 4, the parties will provide or honour without charge to the other party the services agreed to and the commitments made in this Memorandum of Understanding.
4. The parties recognize that the delivery of certain services agreed to in this Memorandum of Understanding, or the honouring of certain commitments made in this Memorandum, may be subject to cost recovery regulations or may require, on a case by case basis, financial arrangements between the Commission and the Department to offset, in whole or part, the associated costs. Where such arrangements are necessary, the parties agree to consult and cooperate to develop mutually satisfactory arrangements.
5. The parties agree to consult in advance concerning any significant changes in the level or nature of service that either party may request, or intends to request, of the other party pursuant to this Memorandum of Understanding.
6. The parties agree to collaborate on identifying opportunities for training and staff exchanges in areas of mutual interest.
7. This Memorandum of Understanding becomes effective on the date of the last signature, and shall remain in effect until modified or withdrawn. The Memorandum may be revised by the mutual consent of the Department and the Commission. Either party may withdraw from the agreement by providing at least six (6) months notice in writing to the other party, specifying its intention to withdraw and the effective date of withdrawal.

Signed in duplicate in the English and French languages.

Signed on: 23/09/03

For the Canadian Nuclear Safety Commission:

President

Signed on: 10/7/03

For Environment Canada:

Deputy Minister

ANNEX 1 TO THE MEMORANDUM OF UNDERSTANDING (MOU) BETWEEN ENVIRONMENT CANADA AND THE CANADIAN NUCLEAR SAFETY COMMISSION

Risk Management Process For Radionuclides As Assessed Under The *Canadian Environmental Protection Act*, 1999

Assessment of Radionuclides under the Canadian Environmental Protection Act, 1999

Pursuant to the provisions of the *Canadian Environmental Protection Act*, 1999 (CEPA, 1999), Environment Canada (the Department) completed an assessment of releases of radionuclides from nuclear facilities, consisting of sectoral assessments for impacts on non-human biota.

The assessment concludes that uranium and uranium compounds contained in effluents from uranium mines and mills meet the environmental toxicity criteria set out in paragraph 64(a) of CEPA, 1999. The assessment recommends that the investigation of options to reduce exposure to uranium and uranium compounds contained in effluents from such facilities be considered a high priority.

Considerations / Principles for Cooperation

Pursuant to paragraph 3(*a*) under Section II (Implementation) of the MOU between the Department and the Canadian Nuclear Safety Commission (the Commission) and under the terms of this Annex, the Department and the Commission agree to develop and implement a program to reduce or control the exposure of non-human biota to uranium and uranium compounds contained in effluents from such facilities.

Under the *Nuclear Safety and Control Act* (NSCA), the Commission has the mandate to ensure that the operation of nuclear facilities, such as uranium mines and mills, does not pose unreasonable risks to the environment. The NSCA came into force on May 31, 2000. Environmental protection is integral to the new regulatory mandate, and the NSCA provides a broad range of regulatory powers respecting environmental protection.

It has been determined that it is possible to prevent or control the amount of uranium and uranium compounds released to the environment in effluents from uranium mines and mills under the NSCA. The Department and the Commission will work cooperatively to ensure preventive or control measures are developed and implemented in a manner that is consistent with and comparable to CEPA 1999.

It is on this basis, and to avoid regulatory duplication, that it has been recommended that the Minister of the Environment and the Minister of Health take no further action at this time, pursuant to subsection 77(6) of CEPA 1999. The Commission will develop preventive or control measures under the NSCA with support from the Department.

Nothing in this Annex modifies or restricts the mandate, responsibilities or authorities of the Minister of the Environment, of the Minister of Health or of the Canadian Nuclear Safety Commission.

Development of Preventive or Control Measures

The Commission will appoint a risk manager and initiate the process to develop preventive or control measures for releases of uranium and uranium compounds from specified uranium mines and mills where the effluent has been identified as likely to be causing harm to aquatic organisms, within three months of the date of the release of the final CEPA assessment report. These mines and mills include Rabbit Lake, Key Lake and Cluff Lake.

Commission staff will consult with stakeholders on the proposed preventive or control measures in a public process.

Commission staff will consult with the Department during the options review and approval process.

While developing the preventive or control measures under the NSCA, the Commission can utilize, depending on the circumstances, licence conditions, orders, or requests for analyses and modification of designs, equipment or procedures, to ensure that effluent releases are not likely to cause significant environmental harm.

Preventive or control measures will include an Environmental Emergency Plan to prevent or mitigate the environmental effects of accidental releases of uranium and uranium compounds in effluent within the site of the licensed activity and into the environment.

In the case of the Rabbit Lake Mine/Mill, a study of technical options to improve the quality of effluent of the mine/mill will be completed within 26 months of November 1 2003, which corresponds to the coming into force of the Rabbit Lake licence renewal. The design, installation and commissioning of the control measures will be completed within the following 16 months.

In the case of the Key Lake Mine/Mill, environmental performance objectives will be developed and implemented within 12 months of the date of release of the CEPA assessment report. Commission staff will verify that effluent management improvements and the treatment facilities that have been installed are effective and that the effluent is no longer causing significant toxicity.

Environmental performance objectives identified in the preventive or control measures will be based on implementation of all reasonable precautions to control the release of uranium and uranium compounds in effluent within the site of the licensed activity and into the environment as a result of a Commission-licensed activity.

In the case of the Cluff Lake Mine/Mill, the mine/mill has ceased operations and was granted a Decommissioning Licence for a five-year term, valid until July 31, 2009. The Cluff Lake Mine/Mill is, therefore, not subject to immediate risk management measures.

The Commission will continue to ensure that uranium and uranium compounds contained in effluent from all nuclear facilities are not causing significant environmental harm.

The Department will identify a point of contact to coordinate assistance to the Commission.

The Department will assist the Commission through the provision of training and guidance documents, and/or the conduct of specific studies.

The Department and Commission staff will meet annually or more frequently by mutual consent to assess progress on the implementation of this Annex and on the effectiveness of the control measures to reduce the effluent toxicity of the above-mentioned facilities.

Releases of radionuclides from nuclear facilities will be regularly monitored by the Commission to evaluate whether risk management initiatives are needed for ionizing radiation. The Department and Commission staff will meet annually or more frequently by mutual consent to review and assess any new information related to the environmental risk from ionizing radiation and take action if necessary.

The Department and the Commission agree to prepare and make public a joint annual report outlining progress on the implementation of this Annex within six months after the end of the calendar year for which it is prepared. Signed in duplicate in the English and French languages.

Signed on: Dec 13, 2004

For the Canadian Nuclear Safety Commission:

President

Signed on: DEC 0 2 2004

For Environment Canada:

Deputy Minister

1. Government of Canada Regulatory Policy, 1999

Appendix B: Glossary

µg/L (micrograms per litre)
A concentration measurement that describes the quantity of a substance within a liquid medium. 1 µg/L is the same as one part per billion (1 ppb), meaning there would be 1 g of uranium distributed in 1 billion litres of water.

ALARA (as low as reasonably achievable)
Every reasonable effort to maintain exposures as far below the regulated dose limits as practical, taking into account the state of technology, economics of improvements in relation to the state of technology, economics of improvements in relation to benefits to the public health and safety and other societal/ socioeconomic considerations, and in relation to the use of nuclear energy and licensed material in the public interest.

Biota
All living organisms, including humans.

CEPA toxic
Substance determined to be toxic as defined under the *Canadian Environmental Protection Act* (CEPA 1999).
"A substance is toxic if it is entering or may enter the environment in a quantity or concentration or under conditions that

(a) *have or may have an immediate or long-term harmful effect on the environment or its biological diversity;*

(b) *constitute or may constitute a danger to the environment on which life depends; or*

(c) *constitute or may constitute a danger in Canada to human life or health."*

Chemical speciation
A process that determines the chemical form(s) of a substance (i.e.,, changes to oxidation state, chemical structure or isotopic composition). The composition of chemical forms (speciation) of a substance is dependent upon the physical and chemical conditions of the system (e.g., pH, temperature). The speciation or chemical form of an element greatly influences the way it behaves within a treatment plant or in the environment.

Class I nuclear facility
These facilities include the following:

- nuclear fission or fusion reactors
- vehicles equipped with reactors
- particle accelerators
- uranium, thorium or plutonium processing and product manufacturing plants
- disposal facilities for nuclear substances generated at another nuclear facility

Code of Practice: Effluent
An administrative framework applied to identify when effluent quality is deteriorating, indicating the potential loss of treatment control. Effluent contaminant concentrations are identified and, if exceeded, require the operator to perform specific actions (as documented in the Code of Practice) to decrease contaminant concentrations. The Code of Practice identifies specific treatment plant actions as well as reporting requirements to the CNSC.

Commissioning
The process during which systems and components of facilities and activities, having been constructed, are made operational and verified to be in accordance with design specifications and to have met the required performance criteria. Commissioning may include both non-radioactive and radioactive testing.

Decommissioning
Administrative and technical actions taken to allow the removal of some or all of the regulatory controls from a facility. This does not apply to a repository or to certain nuclear facilities used for mining and milling of radioactive materials, for which closure is used.

Deleterious substances

" (a) *any substance that, if added to any water, would degrade or alter or form part of a process of degradation or alteration of the quality of that water so that it is rendered or is likely to be rendered deleterious to fish or fish habitat or to the use by man of fish that frequent that water, or*

(b) *any water that contains a substance in such quantity or concentration, or that has been so treated, processed or changed, by heat or other means, from a natural state that it would, if added to any other water, degrade or alter or form part of a process of degradation or alteration of the quality of that water so that it is rendered or is likely to be rendered deleterious to fish or fish habitat or to the use by man of fish that frequent that water, and without limiting the generality of the foregoing includes*

(c) *any substance or class of substances prescribed pursuant to paragraph (2)(a),*

(d) *any water that contains any substance or class of substances in a quantity or concentration that is equal to or in excess of a quantity or concentration prescribed in respect of that substance or class of substances pursuant to paragraph (2)(b), and*

(e) *any water that has been subjected to a treatment, process or change prescribed pursuant to paragraph (2)(c).*"

Dewatering water

Groundwater intercepted by pumps to prevent it from flowing into open pits or into the underground workings of a mine.

Effluent

The waste stream (in particulate, gaseous or liquid form) from a facility released into the environment.

Ion exchange process

A usually reversible exchange of one ion with another, either on a solid surface or within a lattice. A commonly used method for treatment of liquid waste.

Loadings

A quantity of a substance (e.g., water, sediment, nutrients, pollutants) introduced into a receiving media. Loading may be from humans (e.g., pollutant loading) or natural (e.g., natural background loading) sources, and is typically described as the mass (of introduced substance) per unit volume air or water (the receiving media).
Liquid effluent loadings are calculated by multiplying the concentration of a contaminant in the effluent by the volume of effluent released. For example, releasing 20,000 L of effluent containing 1 µg/L of uranium results in the release of 20 g of uranium to the environment; hence, the loading to the environmental system in this case is 20 g.

Mass balance analyses

A scientific approach that studies the sources, movement and destination of any substance, such as a contaminant, within a system.
The system may be an artificial one (e.g., a treatment plant) or a natural system (e.g., a lake). For example, a mass balance budget for a particular pollutant is the amount that enters a lake minus the amount that is tied up in the sediment, broken down by chemical or biological processes, or removed by some other means. This should equal the amount that flows out of the lake system. This exercise enables scientists to assess the possible long-term effects of a pollutant and possible remediation actions.

Memorandum of Understanding (MOU)

A document describing a bilateral or multilateral agreement between parties. It expresses a convergence of will between the parties, indicating an intended common line of action.

Modelling parameters

Numerical values used to characterize properties of contaminants (e.g., octanol-water partitioning coefficient) and environmental media (e.g., organic matter fraction of soil) that are used in models to predict the environmental fate and transport of contaminants for the Environmental Risk Assessment.

Precipitation pond
A precipitation pond retains treated water, allowing increased time for chemical reactions to occur between treatment agents and contaminants. This results in the 'precipitation' or settling of solids and associated contaminants from the water column.

Priority Substances Lists (PSL1 and PSL2)
The Priority Substances Lists (PSL1 and PSL2) were established by the Ministers of the Environment and of Health. They identify substances to be assessed on a priority basis to determine whether they are toxic (as defined under Section 64 of the CEPA) and pose a risk to the health of Canadians or to the environment.

Radionuclide
A nucleus of an atom that possesses properties of spontaneous disintegration (i.e., radioactivity). Nuclei are distinguished by their mass and atomic number.

Reverse osmosis
Movement of a solvent out of a solution under pressure through a semipermeable membrane into pure solvent or a less concentrated solution at lower pressure. This process can be used to increase the radionuclide concentration in a solution.