# Box 61
# Cluff Lake Decommissioning Project

*[Excerpted from pages 185-187 of the 2012 NAS Report "Uranium Mining in Virginia".]*

Perhaps the best available data on the environmental effects resulting from a modern uranium mine and processing facility are associated with the former Cluff Lake mine and processing facility, located in the Athabasca Basin of northern Saskatchewan, Canada, that treated high-grade ores ranging from 1 to 30 percent $U_3O_8$. Unlike most of the other mining operations that have been discussed in this section, uranium mining and processing at Cluff Lake didn't begin until the 1980s—an era in which environmental concerns were significantly enhanced and regulations were more stringent than in earlier periods. Two pits at Cluff Lake ("D" and "Claude") were mined first, followed by an underground mine ("OP/DP"), followed by three other pits ("DJN," "DJX," and "DJ"). All mining and processing at Cluff Lake ceased in 2002 after 22 years of operations, and with 62 million pounds of $U_3O_8$ produced. In addition to the mill, operational facilities at Cluff Lake also included a tailings management area with a two-stage liquid effluent treatment system and surface water diversion ditches, a residential camp area, and various other site infrastructure. Although tailings management and water treatment strategies have improved since the 1980s, the environmental assessment performed as part of the Cluff Lake decommissioning project provides a glimpse of what could occur if a modern uranium mining and processing operation were sited in Virginia.

A Canadian Nuclear Safety Commission (CNSC) environmental assessment to guide the decommissioning work was completed in 2003 (CNSC, 2003), and actual decommissioning was initiated in 2004. CNSC (2003) concluded that the primary environmental effects on completion of the decommissioning would be migration of contaminants from existing sources (e.g., tailings and waste rock piles) to both groundwater and surface water. Most surface waters in the vicinity of the former mine/mill complex received no direct discharge and therefore were negligibly or only slightly affected by previous operations. Island Lake, however, was adversely affected because of its location immediately downstream of the mill effluent treatment systems. Measured mean annual concentrations of total dissolved solids, sulfate, chloride, uranium, and molybdenum in Island Lake in 2002 were two or three orders of magnitude higher than during the baseline (i.e., premining) monitoring period.

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Acid mine drainage (AMD) from the Claude waste rock pile caused contamination of the Claude pit, resulting in greatly elevated levels of sulfate, total dissolved solids, uranium, nickel, arsenic, and radium-226. The relatively poor water quality of the Claude pit necessitated pumping water from the pit to maintain a water level below that of the adjacent lake to prevent transport of contaminants off-site. Groundwater has been similarly affected by AMD from the Claude waste rock, which has formed a shallow, acidic ($pH < 4$) groundwater plume with elevated levels of dissolved nickel (>10 mg/L) and uranium (>100 mg/L) migrating away from the waste rock pile.

Suggested Citation: "6 Potential Environmental Effects of Uranium Mining, Processing, and Reclamation." National Research Council. *Uranium Mining in Virginia: Scientific, Technical, Environmental, Human Health and Safety, and Regulatory Aspects of Uranium Mining and Processing in Virginia*. Washington, DC: The National Academies Press, 2012. doi:10.17226/13266.

FIGURE 6.1 Tailings management area at Cluff Lake in 1999, Saskatchewan, Canada. The tailings are held behind an earthen dam. SOURCE: AREVA Resources Canada, Inc.

Additional potential environmental hazards at the Cluff Lake site include the flooded mine workings and the tailings management area (Figure 6.1). The flooded underground mines represent a source of groundwater contamination and, if allowed to overflow, a potential surface water contamination source as well. The tailings management area was constructed as an unlined abovegrade facility, using an earthen dam to retain both solid and liquid tailings and enable chemical treatment of the mill effluent prior to discharge into Snake Creek and Island Lake. The tailings management area represents the principal on-site source of potential long-term environmental effects, although geotechnical evaluations of the earthen dam determined it to be stable, structurally sound, and in compliance with all design specifications. Given its location in a topographic low, constructed surface diversions were employed to isolate the tailings management area from the erosive effects of inflowing surface water.

A variety of mitigation options were considered as part of the environmental assessment process to address the remaining significant environmental issues at Cluff Lake with the explicit goal of minimizing long-term active mitigation activities (e.g., groundwater pumping, water treatment). Preferred mitigation strategies identified included (1) backfilling the pits with waste rock and capping with compacted till, (2) capping the Claude waste rock pile with a dry cover to minimize infiltration and AMD, (3) sealing of surface openings in underground mines to prevent overflows, (4) covering the tailings management area with a secondary layer of till, and (5) allowing natural recovery of Island Lake water quality. Although these options are likely to mitigate the remaining environmental problems at Cluff Lake to a significant degree, experience has shown that the environmental legacy of uranium mining is persistent over long periods of time. Monitoring and assessment (including a structured follow-up program to evaluate the perfor-mance of the mitigation strategies) will play an important role in guiding implementation of any additional mitigation at the site (CNSC, 2003).