Environment

Saskatchewan Research Council

Gunnar Mine Rehabilitation Project

Demolition Plan

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Executive Summary

This Demolition Plan has been developed to meet the requirement *to 'submit to Mr. Don Howard, the Director, Wastes and Decommissioning Division, of the Canadian Nuclear Safety Commission, by no later than October 15, 2010, a plan for demolishing, during the year 2011, buildings and structures that fail the structural safety assessment'* by no later than October 15, 2010 for the Gunnar Mine Site, as specified in Commission Order 10-1 issued by the Canadian Nuclear Safety Commission (CNSC) on July 23, 2010. A detailed and specific 'demolition plan' will be prepared by the contractor prior to commencement of work. This will include Occupational Health and Safety (OH&S) plan for the work being conducted.

The demolished volume of all the buildings and their internal contents is estimated to be 90,000 m^3. Previously, significant salvage of materials has taken place on the Site and the current conditions of all structures and materials have deteriorated to the extent that the remaining materials are of little salvage value. Demolition and disposal is, therefore, the only option considered for clean-up.

Temporary Storage for Demolition Debris

A multiple storage cell concept in which waste transport distances are minimized and wastes are segregated according to origin or potential contaminants is recommended.

Three isolated storage cells (where a cell means a discrete engineered area that is designed for the storage of debris), one on the waste rock dump (Cell 1), two at the footprints of the mill and acid plant buildings (Cells 2 and 3 respectively), would minimize haul distances, eliminate the need to remove the foundation and backfill the vertical rock cuts. Each storage cell takes advantage of the steepest portion of the slope and natural drainage runs divert drainage around each storage cell. This is desirable from an environmental protection perspective to minimize infiltration and groundwater mounding beneath the sites.

A preliminary estimate of the total capacity is 110,000 m^3. An average cover thickness of 2 m is recommended since the waste surface will be highly irregular with many voids to be filled. For estimating purposes, 80% of the total capacity is assumed to be waste and 20% is waste rock cover material. The 90,000 m^3 of capacity available for waste is essentially the same as the waste volume estimated.

All of the potentially radioactive materials would be placed in the Mill Cell 2 storage cell to provide segregation. No hazardous wastes or bulk chemicals would be placed in the storage cells. Crushed waste rock or other suitable borrow material is required for the temporary storage cells and use as grading material. An estimate 81,000 m^3 is required.

The demolition debris from 2010 has been secured. Further consideration of the long term storage for the 2010 debris to remain in place will be included in the Waste Management Plan.

Permits from Saskatchewan would be required for the storage cell concept.

Waste Management

All ACM products would be co-disposed on site in the temporary storage cell on the waste rock dump. All hazardous wastes would be taken off-site to a licensed disposal facility. Selected bulk chemicals and substances may be neutralized on-site for disposal as inert debris. Where bulk chemicals cannot be neutralized onsite they will be shipped offsite as non-hazardous wastes.

Waste transport and disposal will be conducted in accordance with applicable federal and provincial regulations.

Schedule

The preliminary schedule suggests a one year time-frame to demolish the facilities. This may be difficult to achieve given the extensive nature of asbestos abatement required. To mitigate against the possibility that abatement of hazardous materials and demolition of the unsafe buildings and structures cannot be completed by October 31, 2011 the following is proposed:

- Those buildings and structures that do not fail the structural assessment would be left until approval of the Gunnar Environmental Impact Statement (EIS). These include:
  - Community centre/mall
  - The dock warehouse
  - Water tank
  - Acid tanks

- If additional time is required for abatement and demolition, then two buildings that failed the structural safety assessment could be made safe by removing secondary deficiencies and then taken down in 2012. These include:
  - Mine Dry
  - Maintenance Shops

This approach will ensure that worker and public safety is held paramount and sufficient contingency is built into the program to ensure a realistic schedule for execution of the work.

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List of Abbreviations and Units

Sv = Sievert
mSv = milliSieverts, one thousandth of a Sievert, or 0.001 Sv
μSv = microSieverts or one millionth of a Sievert, or 0.000 001 Sv
R = Rem or Roentgen Equivalent Man (1 Sv = 100 Rem)
μR/h = microRem per hour
Bq = Bequerel, stands for disintegrations per seconds
Bq/g = Bequerel per gram
Bq/L = Bequerel per litre

ft = foot
m = meter
mm = millimetre or 0.001 m
km = kilometre or 1,000 m
m^3 = cubic metres
m^2 = square metres
ha = hectare, measurement of area with one hectare equals 10,000 m^2

^{226}Ra = Radium-226 a naturally occurring radioisotope, formed by the decay of uranium-238
^{222}Rn or Radon = Radon-222, is an inert gas and is a decay product of Radium-226.
^{210}Pb = Lead – 210
^{210}Po = Polonium-210
U_3O_8 = Uranium Oxide

^oC = degrees Celsius
s = seconds
h = hours
a = annum or year
h/a = hours per annum
L = litre
tons = United States or Avoirdupois measure of weight equal to 2,000 pounds
tonnes = SI measure of weight equal to 1,000 kilograms (slightly different from one ton)
mg/L = milligrams per litre
μg/L = micrograms per litre
mg/g = milligrams per gram
ACM = Asbestos Containing Material
ALARA = As Low As Reasonably Achievable
CNSA = Canadian Nuclear Safety Act
CNSC = Canadian Nuclear Safety Commission
CPM = Counts per Minute
CRSO = Corporation Radiation Safety Officer
DOE = Department of Energy
DPM = Disintegrations per Minute
DPS = Disintegrations per Second
DQO = Data Quality Objectives
EIS = Environmental Impact Statement
HAZWOPER = The Hazardous Waste Operations and Emergency Response Standard
LC50 = Lethal Concentration 50
MSDS = Material Safety Data Sheet
NSCA = Nuclear Safety and Control Act
NRC = Nuclear Regulatory Commission

OH&S = Occupational Health & Safety
PCB = Polychlorinated Biphenyl
PLM = Polarized Light Microscopy
PPE = Personal Protective Equipment
RPP = Radiation Protection Plan
SCMR = Surface Coating Materials Regulation
SKOH&SA = Saskatchewan Occupational Health and Safety Act
SKOH&SR = Saskatchewan Occupational Health and Safety Regulations
SOR = Statutory Orders and Regulations
SRC = Saskatchewan Research Council
TDGR = Transportation of Dangerous Goods Regulation
TCLP = Toxicity Characteristic Leaching Procedure
UN Number = United Nations Number
US = United States

GLOSSARY

ALARA - "As Low As Reasonably Achievable", a basic concept of radiation protection, frequently mentioned in regulations, that exposure to ionizing radiation and releases of radioactive materials should be reduced as far below regulatory limits as is reasonably achievable considering economic, technological, and societal factors, among others; ALARA is not an enforceable dose limit.

cleanup criteria - the cleanup levels (dpm/unit surface area, etc.) which are set in a cleanup for each type of radioactive contamination present at a site.

counts per minute - the quantity of ionizing radiation detected by a particular ionizing radiation survey instrument; depending on the instrument's sensitivity and efficiency, the number of counts reported may be a smaller or larger fraction of the amount of radiation actually present.

dpm - disintegrations per minute: the number of atoms of a radioactive substance decaying (emitting ionizing radiation and changing to another substance) per minute,

free release - a term used by various US agencies (i.e. NRC, EPA, and DOE) which originally meant decontamination of radioactively contaminated material to a level that would allow "unrestricted use" according to the public's perception of that term.

friable - means material that, when dry, is or can be crumbled, pulverized or powdered by hand pressure.

hazardous substance - means a substance designated in section 3 of E10.2 Hazardous Substance and Waste Dangerous Good Regulation (e.g. asbestos, lead, PCBs).

isotopes - forms of the same element whose nuclei have the same number of protons, but different numbers of neutrons, e.g., uranium-234, uranium-235, and uranium-238.

millirem - The röntgen (roentgen) equivalent in man (or mammal[1]) or rem (symbol rem) is a traditional historical unit of radiation dose equivalent. It is the product of the absorbed dose in rads and a weighting factor, WR, which accounts for the effectiveness of the radiation to cause biological damage. A rem is a large amount of radiation, so the millirem (mrem), which is one thousandth of a rem, is often used for the dosages commonly encountered, such as the amount of radiation received from medical x-rays and background sources.

(cleanup for) unrestricted use - the term "cleanup for unrestricted use" is usually literally interpreted by the public to mean the thorough and complete cleanup of a site, i.e. there will be no harm to the user's health no matter how intensively a property or facility is used after the cleanup.

uranium - the heaviest naturally occurring (metal) element in the earth's crust, exists as three isotopes in the following percentages by weight: U-238, 99.283%; U-234, 0.0054%; and U-235, 0.711%; by radioactivity: U-238, 48%; U-234, 50%; and U-235, 2%

waste dangerous good - means a substance with the characteristics described in subsection 4(4) of E10.2 Hazardous Substance and Waste Dangerous Good Regulation (e.g. waste oil, is in a quantity greater than 0.01% by mass including in Division 2 of Class 9 as defined in the Dangerous Goods Transportation Regulations).

1. Introduction

1.1 Overview

The Saskatchewan Research Council (SRC), on behalf of the Governments of Canada and Saskatchewan, has been asked to manage the rehabilitation of the former Gunnar Mine site, located on the north shore of Lake Athabasca in northern Saskatchewan.

The proposed project involves demolition of existing buildings, facilities and structures; appropriate disposal of materials resulting from demolition; installation of an appropriate cover on all or a portion of the exposed mill tailings; rehabilitation of existing waste rock piles; rehabilitation of additional risk(s), as warranted; general site clean-up and revegetation, as required; and appropriate monitoring during and after rehabilitation.

This Demolition Plan has been developed to meet the requirement to *'submit to Mr. Don Howard, the Director, Wastes and Decommissioning Division, of the Canadian Nuclear Safety Commission, by no later than October 15, 2010, a plan for demolishing, during the year 2011, buildings and structures that fail the structural safety assessment'* for the Gunnar Mine Site, in compliance with Commission Order 10-1 issued by the Canadian Nuclear Safety Commission (CNSC) on July 23, 2010.

A structural safety assessment was conducted on the Gunnar Mine site to determine which buildings and structures will be taken down as part of the Order (AECOM 2010a). Buildings and structures were deemed to fail the structural assessment if there is the potential for structural failure of either the external building shell or some component of the internal structure. Specifically, this would include situations where:

- There is risk of collapse of the structure itself, such as but not limited to the exterior walls or the roof (a 'primary' deficiency) or the structures within, such as but not limited to the interior walls or the floor (a 'secondary' deficiency); or
- There is risk of a person falling through the floor or falling due to internal structural deficiencies if a structure is entered (also, 'secondary' deficiencies).

Based on this assessment, two buildings (the mall and the dock warehouse) passed the structural assessment, along with two types of other structures (the acid tanks and the freshwater storage tank) (Table 4-1). All remaining buildings and structures failed the structural assessment and must be taken down no later than October 31, 2011, in compliance with Action Item 11 of the Order.

1.2 Report Objectives

The focus of the current report is to develop a demolition plan for the buildings and structures that have failed the structural assessment. In doing so, consideration was taken of the inventory of hazardous substances and materials (AECOM 2010b), along with the appropriate occupational health and safety measures to be taken during the demolition of each building and structure (AECOM 2010c).

This Demolition Plan is a subset of the decommissioning work the former Gunnar Mine site and includes all work to demolish buildings, clean up debris and temporarily store demolition debris and wastes generated during the process.

2. Schedule and Planning Envelopes for Demolition Work

Decommissioning can be defined as those actions taken, in the interest of health, safety, security and protection of the environment, to retire a licensed activity or facility permanently from service and render it to a predetermined end-state condition (CNSC 2000). The end-state (final or interim) is the proposed physical, chemical and radiological condition of the facility at the end of the decommissioning program. Where a decommissioning program is to take place in discrete phases, the interim end-state objectives for each phase should be defined.

In the case of the demolition of buildings and structures at the Gunnar Mine site, depending upon the type of material being disposed of, in some cases, it is likely the end-state will be interim, whereas in other cases, it will be final. For example, hazardous substances, such as PCBs, that will not be disposed of on the Gunnar site will likely be shipped off-site to approved disposal facilities for final disposal under the Order, whereas debris generated during demolition will likely be sorted, to the extent possible, and piled on an interim basis until disposal in an approved landfill on-site, following approval of the Gunnar EIS.

The end state will be to demolish the unsafe buildings and structures and to dispose of or to temporarily store waste/debris into two waste streams. In some cases, it may be preferable to conduct work, such that some materials can be stored or disposed of in their final state, for example, in cases where a large volume of material is being generated and there may not be adequate space for safe, temporary storage. Such situations would need to be discussed with regulatory agencies and approved, as appropriate, on a case-by-case basis. In other cases, it may be possible to conduct work, such that material is placed into the final end-state.

The demolition work can be organized in the context of planning envelopes, which represent a definable part or area of a facility that is sufficiently removed from, or otherwise independent of, other parts or areas so that the strategic approach to decommissioning that part or area may be planned in a relatively independent manner (CNSC 2000). With respect to the demolition of buildings on the Gunnar Mine site and the corresponding schedule, the work is being planned depending on the potential hazards associated with a given structure or set of similar structures, as defined in the structural safety assessment (AECOM 2010a). Buildings that have failed the structural assessment will be taken down no later than October 31, 2011, in compliance with Action Item 11 of the CNSC Order, whereas those that pass will be taken down following approval of the Gunnar EIS. Demolition work under the Order is being further sub-divided into work scopes that have been carried out in 2010 and that will be carried out in 2011, as described in the sections that follow.

2.1 2010 Demolition Work

The 2010 work on the Gunnar Mine site was focused on demolition of non-production buildings, which included the:

- large, wooden structures that are unsafe for human entry, including the bunkhouses, the Mine Manager’s Residence and the Married Quarters;
- small, wooden structures, including the fishing shacks and cabins;
- beached barge and the second barge located on the shoreline of Lake Athabasca;
- collapsed curling rink; and
- the school.

Low- and moderate-risk abatement of asbestos in the Mall (also called the Community Centre) was also carried out.

Demolition of the large, wooden structures involved compacting the buildings with an excavator, covering the resultant asbestos-containing material (ACM) with local cover, taking GPS coordinates around the perimeter of the cover, installing high visibility fencing and posting signage to indicate an asbestos hazard. During demolition, amended water was sprayed on the structure throughout
demolition to reduce asbestos in the air and air was monitored using filters on the workers to quantify asbestos exposure. Fit-tested respirators, safety glasses, gloves and full Tyvec suits were worn during this work to prevent asbestos exposure.

Small wooden structures, along with the two barges, that did not contain asbestos were taken down with equipment and segregated into a pile of wooden debris. The curling rink was also piled for short-term disposal.

SRC provided all content in this report relating to the 2010 demolition work.

2.2 2011 Demolition Work

The remaining buildings and structures that have failed the structural safety assessment (as listed in Table 4-1) will be taken down or made safe in 2011. A number of the structures are production buildings or are otherwise hazardous (e.g., utilidors containing friable asbestos). Due to the complexity of the process buildings, building-specific plans are being developed to carry out demolition work for each in a safe manner. Demolition plans for these structures are detailed in the sections that follow and building-specific safety procedures will be developed for each by the contractor prior to starting work.

3. Mine Facilities and Development

3.1 Summary of Buildings and Structures

The Gunnar Mining site is located at 59° 23' N, 108° 53' W, midway along the north shore of Lake Athabasca in the northwest corner of Saskatchewan (Figure 1). The site is located on the southern tip of the Crackingstone Peninsula, approximately 25 km southwest of Uranium City (Figure 1 & 2).

For the purposes of this report, the buildings and structures on the Gunnar Mine site have been categorized as non-production-related, production-related and other facilities and structures, as listed in the sections that follow.

Non-Production Buildings:
Large Wooden Structures
- Married Quarters (demolished 2010)
- Bunkhouses (including debris from the Girls' Dormitory) - (demolished 2010)
- Mine Manager's Residence (demolished 2010)

Small Wooden Structures
- Cabins (west of marina) (demolished 2010)
- Cabins (east of head-frame) (demolished 2010)
- Cafeteria (demolished 2010)
- Community Centre
- Curling Rink (demolished 2010)
- Pumphouse
- School (demolished 2010)
- Sewage Treatment Plant (STP)

These buildings and structures have been assessed as part of this Structural Assessment and include the following:

Production Buildings:
- Acid Plants (No.1 and No.2)
- Dock Warehouse
- Geology/Mine Dry
- Head-frame
- Maintenance Shops/Warehouse
- Mill Building Complex
- Powerhouse

Other Site Facilities and Structures:
- Two Acid Storage Tanks
- Barge adjacent to shoreline of Lake Athabasca
- Beached Barge
- Docks
- Freshwater Storage Tank
- Tailings Line
- Tank at the Tank Farm
- Utilidors
- Wooden Storage Shacks (interspersed across the Gunnar Mine site)
- Sulphur Storage
- Concrete Mixing Plant
- Mine Ventilation and Air Heating Unit

- Gas and Diesel Service Pumps
- Lube Storage Pad
- Office Building
- Guest House
- Cap and Oil House
- Hoist House Foundation and related Outbuilding

The general arrangement of the buildings on-site is shown in Figure 2. Details showing the site facilities are shown in the aerial photo mosaics included in Figures 3 and 4.

3.2 Buildings and other Structures

Head Frame
The head frame covers an area of 120 ft by 76 ft (36.5 m by 23.2 m) and is on a reinforced-concrete foundation wall pinned to bedrock. It has a total height of 157 ft (48 m) and is sheeted with asbestos siding. The entire interior was insulated with spray on (“limpet”) asbestos fibre. A 76 ft by 48 ft (23 m by 15 m) bin house is incorporated in the head frame and contains two 1,000-ton storage bins. There is no residual ore in either of the bins and very little scrap material scattered on the floor in this area. No chemicals were found. The shaft house is 76 ft by 67 ft (23 m by 20 m) and was built within the structural "A” of the head frame.

Currently, the shaft covered by the head frame has a concrete cap of undetermined thickness, and it is suspected that the cap has a high potential for failure. Three, 4-inch vents are visible in the cap.

The floor of the head frame and shaft house is covered with old wooden crates and various steel objects, including engine parts. There were no chemicals located in the head frame. The stairwell, which ascends to the top of the head frame, appeared to be in a relatively safe condition. However, the top level of the head frame is a safety hazard, because the siding has been damaged and there are no railings of any sort. As a result, 2003 site safety activities cut the stairway to prevent any access to the upper levels of the head frame, and the head frame and shaft house itself were wrapped with 8 ft high chain link fence to prevent unauthorized entry.

A short distance to the west is a concrete foundation and various pieces scrap steel. This would appear to have been the location of the hoist.

Mill Building Complex
The mill is of structural steel construction and is 550 ft long by 160 ft wide (168 m by 29 m). The roof ranges between 40 and 80 ft (12 and 24 m) in height. The mill building was sheeted with asbestos. The main building was not insulated. The laboratory areas, which are on the south side of the main building, were insulated with spray-on limpet asbestos that was then painted. At some time in the past, perhaps to facilitate previous salvage operations, portions of the mill roof were removed to allow light to enter.

In total, the mill building houses (i) ore bins, (ii) the crushing plant, (iii) milling circuits and (iv) laboratories. Each of these is described below:

(i) There are two annex buildings that house a 1,000 tonne and a 200 tonne ore bin and which were fed by and discharged to the mill building proper by conveyers. Both of these buildings are asbestos sheeted. In the 1,000 tonne Bin Annex, there is a man-way connected to the mill along the conveyor.
(ii) In the crushing plant, the crushers have been removed from the crushing plant as have the Marc ball mills. In both areas, large volumes of reinforced concrete remain. Five 1,000 tonne ore bins are in place, as is the supporting steel for the conveyers under the ore bins. Some salvage has taken place in all of these areas and the stairways are in various stages of disrepair.

(iii) In the milling circuit there are four, 50 ft (15 m) diameter by 23 ft (7 m) deep thickener tanks supported on steel "I" beam legs approximately 2 m off the floor. All the tanks have been previously emptied and hatchways have been left open. The roof to the northeast of the thickeners has collapsed to some extent; however, the reason is not obvious. In one area, there is a block of concrete approximately 1 cubic meter in size that has fallen to the floor. There is also evidence of other material dropping on the stairwells in the same area. The majority of the leaching circuit has been salvaged at some point in the past and all that remains are three of the original fourteen leach tanks. The three remaining tanks (6 m diameter by 6 m high) are complete. All that remains of the others are the steel "I" beams which were used as supports. Fifteen string filter units are located on the upper level at the eastern end of the mill building. There are also four wood-stave clarithickeners, two Whitco Leaf clarifiers and an Eimco precoat filter. The floor level below the string filters consists of a single wood-stave tank contained within a concrete berm approximately 7 ft deep. There is evidence that water has accumulated within this berm. There are two 5 m by 5 m wood-stave surge tanks intact and empty. The milling circuit then flowed to the south side of the mill building where the ion exchange and precipitation circuits are located. There are 2 brine tanks (6 m by 6 m), two recycle tanks (5 m x 6 m) and six ion-exchange columns 2 m in diameter and 7.3 m high. In addition, there are three ~1 m by 1 m filter presses, two 2 m diameter 3.5 m^3 hoppers, two 3 m. diameter dryers and a drum packer. In the product packaging area, there appeared to be a small amount of residue fines.

(iv) In the laboratory area, the concrete floor and the main structural walls appear to have shifted 23 to 25 cm.

The mill also has a cold storage annex on the south east side. A substantial number of salvaged doors and windows are being stored in this area. Within the building, there are also 15 pallets of magnesium oxide in 25 kg bags and 5 pallets of calcium hydroxide also in bags. Both stacks are well under roof, within the confines of the walls and well protected from weather and the environment. They are stacked in a stable manner. In addition, there is a small amount of scrap steel in this cold storage building. The generating plant (power house), which was a separate building in front of the mill, has been dismantled, and the generating units and building steel have been transported off-site. However, the area remains littered with all of the siding and other material discarded during the salvage operation. As well, the building's concrete floor, with 1 m deep concrete trenches in which piping and wiring was run, remains. As a result, the building has a substantial amount of concrete remaining.

Acid Plant
The acid plant is composed of two separate buildings with piping, associated with cooling, occupying the area between the two buildings. Based on the available records, these pipes have not been evaluated for presence of residual liquids or other materials. Within the acid plant buildings, there is an accumulation of more than 265 barrels that were used to store the spent vanadium pentoxide pellets used as a catalyst in the process. Many of the barrels have corroded over time and the pellets have spilled onto the floor. The buildings are constructed of steel with asbestos siding. All of the metal work in the acid plant has corroded to a large extent. There is a substantial volume of elemental sulphur remaining in an uncovered outdoor storage area to the east of the acid plant. There is evidence that, at some time in the past, the pile started on fire. There are two 12 m diameter by 9 m high insulated acid storage tanks located behind and slightly to the west of the acid plant on an adjacent elevated rock outcropping. The tanks are empty and most of the conduit piping has rusted away.

Geology/Mine Dry
The geology/mine dry building is a 46 m by 12 m, two-storey building of structural steel and block construction with fibrous filler used to increase the insulation. The walls are, however, further insulated with what appears to be asbestos that was then painted over. The roof appears to have a spray-on asbestos insulation with no covering. The entire building is sheeted with asbestos siding. All rooms were checked and no chemicals were found. There are floor drains and sumps in the concrete ground floor. The possible presence of residual materials in the sumps apparently has not been evaluated to date. There is a large (approx. 1.4 m^3) asbestos-wrapped hot water heater located in the mine dry area.

Mine Engineering
This building is attached to the maintenance shop with access between the two. It is roughly the same size as the Geology/Mine Dry and is also constructed of structural steel and fibrous blocks, insulation and siding. Partitions for offices were constructed of 2" by 4" lumber and gyproc, in most cases. All rooms were investigated and no chemicals were found. The building has concrete floors.

Maintenance Shops
This is a very large building constructed of steel with exterior sheeting of asbestos siding and 14 equipment access doors. The central area of the building houses a large overhead crane that has been removed and sits on the ground between the building and the flooded pit. There are 15 pallets of Portland Cement in the central area and eleven 10- gallon barrels of what appears to be caustic soda in crystal form. Inside the various bays, the area is littered with a wide array of scrap materials. There is a 45-gallon drum containing an unidentified liquid in this area. At some point in the past, it appears the barrel had been moved to its present location in an area well-protected from the elements and where, in the unlikely event of spillage, all volumes would be contained within the building.

Dock Warehouse
Approximately 60 m by 9 m in size, this steel frame building has corrugated tin sheet siding. During the 1970s, a fish processing plant was located in this building. The east end of the building was used for processing while the west end housed the compressors of which a number are still in place. The floor of most of this building is covered with unused cardboard boxes that were originally used to pack fish. At the west end, there is a storage yard with a large refrigeration plant, which is intact and, in all likelihood, contains freon. It appears this area was also used as an oil storage area as there are a number of used oil drums scattered about and evidence of spillage. This spillage is approximately 25 m in-shore and appears to have occurred a number of years ago.

Utilidors
Throughout the site, remnants can be found of above-ground utilidors which appear to have connected all of the buildings on the site. During operations, these would have carried the water, sewage and steam used for heating. A typical utilidor contains two 1" steel piping, one 2" steel piping, –and one 4" steel piping - all enclosed in a wooden frame insulated with fibreglass insulation and located atop a trestle when required. There is very little underground piping on the site. However, there is an area on the west side of the pit between the mill mechanical shop and the head frame where there is evidence of buried piping, the total extent of which is unknown.

Freshwater Pump House
The freshwater pump house is located west of the head frame on a bedrock outcrop. On one side, it is constructed on the bedrock with log supports on the other side (the lakeside). The pump house is of cinderblock construction and has concrete flooring. While the pumps have been removed, there is a quantity of scrap steel, including intake lines that still extend into Lake Athabasca. In the same area, there is evidence of a propane storage tank building, which, at some point in the past, was entirely dismantled. One propane tank remains and was found to be empty. North of, and slightly elevated above, the propane tank is a 4,500 L (estimated) steel storage tank. The tank is of bolted plate construction and is empty, but appears to have been used for bulk oil storage. Chlorine-based disinfectants would not be expected within the pump house since only a portion of the intake water (that intended for domestic use) was chlorinated, and this would have been after storage in the water tower.

Bunkhouses (Staff Housing)
These are two-storey, asbestos tile clad housing units approximately 90 ft. x 36 ft. (27 m x 11 m) in dimension. One is located immediately west of the mill; the rest are grouped further to the west. These buildings contained a number of single-room apartments with a common bathroom on each floor. There is an asbestos-wrapped hot water heater (approximately 100 gallons) located in each bathroom. The buildings are primarily of 2 x 4 construction with gyproced interior walls. It appears the roofs are constructed of plywood sheeting with 1 ft x 1 ft (0.3 m x 0.3 m) tin tiles for roofing. All hot water pipes are

asbestos-wrapped. There were approximately 28 apartments per unit. Entrance and exit ways and exterior stairwells are decayed. One building appears to be constructed on a concrete basement. The other buildings are constructed on concrete piles that result in 2 ft (0.6 m) high crawl spaces under the lower floors.

Cold Storage
Located slightly west and south of the apartment buildings, all that remains of this facility is its original concrete piles and various scrap materials.

Community Centre
This is the largest of the non-production buildings on site. It contained a full-sized auditorium, a four-lane bowling alley, a Hudson's Bay Store, bakery and commissary, numerous walk-in coolers, a bank, post office, billiards room and numerous other club rooms. Built of structural steel and cinder block construction, all ceilings are open and show spray-on asbestos insulation. In many areas, the asbestos is falling from the ceiling and accumulating on the floor. The building is relatively clear of any type of scrap wood or steel. In what were the former ‘photography club’ rooms, there are five, partially-used, 1-gallon bottles of ethyl acetate and ammonia hydroxide. Within the area of the walk-in coolers, there is a large refrigeration unit, possibly containing freon.

Curling Rink
Most of the curling rink has been dismantled and salvaged. What remains is a 20 ft (6.1 m) section of quonset which was not part of the ice surface. This is of wood construction and nothing was identified of environmental concern.

School
The school is a one-storey building of cinderblock construction with interior walls also of cinder blocks. A central corridor divides the building, with 4 or 5 regular-sized classrooms on either side. The building has a flat roof and its own furnace for steam heat.

Sewage Treatment
This cinderblock building is approximately 30 ft by 10 ft (9 m x 3 m) in dimension and consists of a pump room in the front and what appears to be a holding tank in the rear. The building is located on the road leading to the ‘Married Quarters’ housing at the far west end of the site. Very little historical information is available regarding the type of sewage treatment or disposition of final effluent. The configuration suggests, however, that the building was simply a reservoir and lift station, which may have served to convey the sewage to higher elevations for co-disposal with tailings. If raw sewage was left in piping or reservoir areas within the station or collection lines, there is a slight possibility that biodegradation within confined spaces during the approximate 45 years since the cessation of operations could have resulted in the entrapment of biogases such as methane or H_2S. Although there may be pathogen risks associated with exposures to raw sewage, the biodegradation over the last ~45 years would likely reduce the levels of any human pathogens introduced during site operations to negligible levels. Overall, any risks associated with trapped gases or pathogens will require assessment prior to demolition.

Married Quarters
These are two-storey family accommodations built of fibrous blocks forming some of the main structural walls. The buildings are covered with asbestos siding and sit on concrete piles that support the floor. Each contains an asbestos-wrapped hot water heater and piping. There is evidence that the roofs are leaking, which has caused a partial collapse of the ceilings in some rooms.

Pump Shed
This a small shed, typical of those used in the utilidor works. A number of these types of sheds exist around the property. It appears some may have been used to house firefighting equipment, based on valve take-offs from an 8-inch high pressure line. As well, they also contain valve assemblies for the various piping systems in the utilidors.

Concrete Basement
Salvage of this building took place previously and all that remains are the basement walls and a relatively small amount of scrap material.

Group of Cabins West of Marina
A group of four or five cabins are clustered in the trees near the Environment Canada Water Level Station on the shore of the lake, west of the marina, but it does not appear they have been used during the past number of years. They appear to have been constructed of various types of wood salvaged from other facilities on site. While nothing was identified which would be of environmental concern, the area is however littered with debris.

Group of Cabins East of Headframe
This is a group of approximately 19 wood frame cabins likely constructed as support housing when the fish processing plant was operational. Some have been sheeted with salvaged aluminum siding. All are constructed with materials that appear to have been salvaged from the site.

3.3 Mine Development

The overall mine site operations are described in two publications produced by the then active mining company (Gunnar Mines Ltd.) entitled *The Gunnar Story, September 1957* and *The Gunnar Story, 1962.* A concise history of mine development and operations is provided in Table 3-1.

Table 3-1 Development of the Gunnar Mine Site

Date	Development
1933 - Oct. 27	Gunnar Mines Ltd. originally incorporated as Gunnar Gold Mines Ltd.
1952 - July	Discovery and staking of the Gunnar Uranium deposit.
1952 - Oct.	Eleven short inclined diamond drill holes (“E” core) advanced.
1953 - 1954	Completion of an additional 179 drill holes, indicating reserves of 4 million tons of ore with about 0.2% U_8O_3. The last 9,000 ft. of drilling was through lake ice.
1955 - Aug 23	Commencement of mill site operations.
1955 - Sept. 9	First drum of concentrate (yellow cake) produced.
1957 - March	Installation of additional equipment in mill building facilitated expansion of capacity to 1,650 tons/d.
1955 - 1959	Mill supplied primarily from open pit.
1957	First ore from underground workings delivered to mill.
1959 - April	Mill installed cyclone plant with four sand storage tanks for production of sand from tailings, subsequently used as backfill in the underground mine.
1961	Open pit production exhausted. Underground ore thereafter accounted for the entire mill feed.
1963 - October	Underground mining ceased (maximum depth of 580 m from the surface). Ore depleted.
1964	Commencement of pit flooding, by blasting of channel in bedrock ridge separating pit from Lake Athabasca.
1966	Blasted channel (above) filled with waste rock.
1971 - 1981	Fish processing plant operating on site, using dock warehouse and miscellaneous other buildings for accommodation. Fish offal was disposed in the flooded pit.

Figure 5 and 6 show the process flowcharts for the mill and leaching system respectively. These two figures provide information on the number and sizes of various process components within the Mill building.

The Gunnar Mine site was not decommissioned to any appreciable degree once operations ceased in October of 1963. As a consequence, the major mine site and mill site infrastructure remains on site. The only major structures removed since 1963 include (i) all tanks located within the fuel tank farm except one tank that was reportedly used in support of fish processing plant operations between 1971 and 1981; (ii) the power house and generators; and (iii) miscellaneous tanks, crusher mills and other equipment within the mill building. The condition of several structures has deteriorated appreciably, as would be expected over a period of nearly five decades.

3.4 Proposed Demolition Phases

It is intended to commence demolition in the 2011. The detailed phasing of the work will be controlled by the remediation contractor (to be appointed); however, the main phases of work are summarized as follows:

- Mobilization of staff and equipment. Preparation of the Site for the demolition project will include mobilization of supplies, equipment (where not available locally) and personnel to the Site, and set up of temporary camp facilities, including supply of water and wastewater treatment systems.
- The areas of the Site accessible by the general public and which are included either in the abatement and demolition project or used for laydown or storage will be cleared, leveled and secured.
- Preparation of decontamination facilities, access, set-up of site offices, first aid room, communications and establishment of site security;
- Preparation of abatement work areas to facilitate access (e.g., ground clearing wooden structures);
- Preparation of temporary storage cells and hazardous materials staging and packaging areas, including crushing of intermediate cover materials;
- Commencement of asbestos abatement activity associated waste disposal and monitoring work. This will be combined with building demolition.
- Hazardous Wastes (other than ACM and inert demolition debris and concrete) will be segregated for transport off-site;
- Storage Cell closure activities;
- Demobilization of demolition staff and equipment; and,
- Inspections of Site status during demolition operations and subsequent to closure.

The previous environmental site assessment reports have identified Areas of Potential Environmental Concern (APECs) in addition to ACM; however, these issues are beyond the scope of the current phase of work. SRC has identified the first priority at the Site is to address the potential asbestos exposure risk.

3.5 Site Operations

The Site operations will include the asbestos abatement and demolition of buildings and structures on site. Depending on the structural and access issues associated with each building, the following are the general procedure for abatement and demolition of the buildings:

- Seal the area scheduled for abatement (using negative pressure units fitted with HEPA filters if required);
- Remove and bag asbestos containing materials;
- Deposit ACM in temporary storage cells;
- Remove hazardous wastes and segregate (excluding ACMs);
- Demolish building following appropriate protocols;
- Deposit demolition and debris waste in temporary storage cells; and,
- Temporary close storage cells prior to decommissioning activities.

3.6 Site Closure

When the demolition project is completed, the Site will be cleared of debris and voids identified during the demolition work will be in filled using suitable materials. The final Site area will be substantially levelled and left in a safe condition. The temporary storage cells utilized during the abatement and demolition program will be closed and the option is available for these to become the permanent storage site as part of final decommissioning.

4. Background Information

4.1 Structural Safety Assessment

Buildings and structures have been deemed to fail the structural assessment if there is the potential for structural failure of either the external building shell or some component of the internal structure. Specifically, this would include situations where:

- There is risk of collapse of the structure itself, such as but limited to the exterior walls or the roof (a 'primary' deficiency) or the structures within, such as but not limited to the interior walls or the floor (a 'secondary' deficiency); or
- There is risk of a person falling through the floor or falling due to internal structural deficiencies if a structure is entered (also, 'secondary' deficiencies).

Photographs of the buildings are found in Appendix A.

Primary Deficiencies:

Based on the detailed evaluation of primary deficiencies of the buildings and structures on the Gunnar Mine site, the following conclusions were drawn:

- Steel-framed structures that are structurally deficient due to primary deficiencies are the Acid Plant No. 1, Fine-Crushed Waste Bin Transfer Tower, and the remains of the Powerhouse.
-
- Wood-framed structures, the majority of which are non-production buildings, have primary deficiencies in structure and are at risk of collapse. On this basis, these structures must be demolished, in compliance with Item 2 of the Order and include:
  - Bunkhouses
  - Cabins (West of Marina)
  - Cabins (East of Headframe)
  - Married Quarters (Apartment Blocks 1 & 2)
  - Mine Manager Residence
  - Tailings Line Substructure
  - Utilidors Substructure
  - Vestibule Adjoining the Acid Storage Tanks

- Of the masonry buildings on the Gunnar Mine site, the pumphouse has primary deficiencies and will need to be taken down as part of the Order.

- Other structures that fail the structural assessment due to primary deficiencies include the beached barge and the interconnecting timber-framed pumproom between the acid storage tanks.

Secondary Deficiencies:

- The building shells of the following steel-framed buildings do not have primary deficiencies ,but have numerous secondary deficiencies, and therefore, fail the structural assessment and must be demolished:
  - Acid Plant No.2
  - Geology/Mine Dry
  - Head-frame
  - Maintenance Shops/Warehouse
  - Mill Building
  - Surge Bin Transfer Tower

- School

Such secondary deficiencies would include, but not be limited to damaged masonry walls, water-damaged ceilings and instances of roof system failures.

The following Table 4-1 provides a summary of the buildings/structures their primary and secondary deficiencies and whether or not they required demolition as part of the Structural Safety Assessment.

Table 4-1 Structural Assessment

Type of Structure	Building/Structure	Risk Level		Require Demolition (Yes/No)
		Primary Deficiency (Yes/No)	Secondary Deficiency (Yes/No)	
Steel Structure	Acid Plant No.1	Yes	Yes	Yes
	Acid Plant No.2	No	Yes	Yes
	Community Center	No	No	No
	Dock Warehouse	No	No	No
	Fine Crushed Waste Bin Transfer Tower	Yes	Yes	Yes
	Geology/Mine Dry	No	Yes	Yes
	Head-frame	No	Yes	Yes
	Maintenance Shop/Warehouse	No	Yes	Yes
	Mill Building	No	Yes	Yes
	Powerhouse	Yes	Yes	Yes
	Surge Bin Transfer Tower	No	Yes	Yes
Wood-framed Structure	Bunkhouses	Yes	Yes	Yes
	Cabin (West of Marina)	Yes	Yes	Yes
	Cabins (East of Head-frame)	Yes	Yes	Yes
	Married Quarters (Apartment Blocks 1 & 2)	Yes	Yes	Yes
	Mine Manager ‘s Residence	Yes	Yes	Yes
	Tailings Line Substructure	Yes	Yes	Yes
	Utilidors Substructure	Yes	Yes	Yes
	Vestibule Adjoining the Acid Storage Tanks	Yes	Yes	Yes
Masonry Building	Pumphouse	Yes	Yes	Yes
	School	Yes	Yes	Yes
Other Structures	Acid Tanks	No	No	No
	Beached Barge	Yes	Yes	Yes
	Interconnecting Timber-framed Pump Room between Acid Tanks	Yes	Yes	Yes
	Freshwater Storage Tank	No	No	No

The community center and dock warehouse do not show any evidence of primary deficiencies. The dock warehouse contains some secondary deficiencies that must be addressed to render the building safe for entry. Both these buildings are not a risk of immediate structural collapse and both buildings are secured from casual entry. These structures do require abatement of hazardous materials present within the buildings and are thus unsafe for public entry in their current state.

4.2 Hazardous Materials

4.2.1 Inventory of Hazardous Substances and Materials

Almost all buildings and structures are either painted, clad or contain materials that require separation and management prior to or during demolition. Management of hazardous materials and substances is further described in this report for short-term and anticipated long-term disposal of materials. Training, controls, personnel protection equipment, hazard analysis, and specific job procedures developed under these regulations pertaining to Hazardous Substances and Materials will be detailed in the site Health and Safety Plan (HASP), Radiation Protection Plan (RPP) and included in the detailed technical specifications included as part of drawings and specifications developed during the tender process.

An inspection of the majority of vessels in the Mill Building Complex and Acid Plants suggest that all vessels have been emptied of process wastes and materials except for some minor mineral deposits in some of the heat exchangers in the Acid Plants.

All hazardous substances will be handled and disposed of according to Provincial and Federal Regulations. Some chemical solutions and reagents (e.g., catalysts and sulphur) may be safety neutralized on-site or disposed of in a temporary storage cell without adversely impacting the area or generating leachate. Proper disposal of PCBs, mercury and selected chemicals will involve packaging and transport off-site to a permitted disposal facility.

4.2.2 Recommendations for Asbestos

ACMs are pervasive across the Gunnar Mine site in many forms, including in rigid building cladding panels, roof deck panels, and as spray-on insulation in the roof and walls of buildings. The form of spray-on friable insulation represents a known carcinogenic health risk. The interior spray-on, friable asbestos insulation is separating from the cladding, and in many instances has fallen to the walkways and floors below. In some locations, the asbestos pipe insulation has also deteriorated and fallen. Therefore, the ACM needs to be carefully managed, removed or encapsulated as part of the demolition process.

Table 5 in the SKOHSA, 1996 defines asbestos removal processes for high, moderate and low risk abatement. The presence of rigid ACM will require low-hazard asbestos-abatement procedures, while the limited quantities of friable ACM could be handled using moderate asbestos-abatement procedures prior to demolition. The presence of all spray-applied insulation (Crocidolite and Amosite) and large quantities of friable mechanical insulation will require high-risk asbestos abatement procedures prior to demolition.

Asbestos materials must be removed prior to demolition activities in accordance with Saskatchewan Health and Safety Regulations or as specified under the conditions provide in permits from regulatory authorities and disposed of in accordance with Saskatchewan Environment regulations in an approved storage cell. This includes all friable materials such as spray-applied insulation, pipe insulation, and mechanical insulation on various vessels, boilers, boiler breeching, and tanks. Non-friable materials, such as drywall joint compound, vinyl floor tiles, and roofing materials, can be left in the building; however, cement cladding materials (transite) should be removed prior demolition due to the large quantity and content of asbestos. Air monitoring and inspection services should be conducted to verify proper worker protection and appropriate work procedures.

4.3 Radiological

This section describes estimated extent of radiological contamination and potential radiological exposure for workers and members of the public in and around the various buildings and structures on-site.

4.3.1 Non-Production Buildings

Canadian Radiation Protection Regulations (SOR-2000-203) require that an area be posted as radiological hazard areas with the warning "RAYONNEMENT-DANGER-RADIATION" if there is a reasonable probability that a person in the area, room or enclosure will be exposed to an effective dose rate greater than 25 µSv/hr. In general, there were no gamma radiation fields exceeding 1 µSv/hr inside the non-production buildings. However, while dose rates are low in the non-production buildings, some non-production buildings have total surface contamination levels exceeding the generally accepted free release criteria for residual uranium of 83 Bq/100 cm^2 (5,000 dpm/100 cm^2): these include the married quarters, bunkhouses, mine manager's house and community centre. Radiological worker protection and exposure controls will need to be in place during demolition of these structures.

4.3.2 Outside Areas Surrounding the Mine Facilities

In general, gamma radiation fields range from 1 to 3 µSv/hr outside the production and non-production buildings with some areas exceeding 6 µSv/hr. Off-site background gamma radiation fields are approximately 0.2 µSv/hr. As such, occupational exposures in these areas could exceed 1.5 mSv per 500-hour work quarter or 3.0 mSv per year (mSv/yr), assuming 1,000 hours for the on-site construction season and an average exposure rate of 3 µSv/hr.

For many other sites in Ontario and Saskatchewan, a dose from casual access has been estimated for a person who is assumed to spend 200 hours per year on site. In the present context, it would seem reasonable to assume that an individual who might access the Gunnar Mine site for the purpose of hiking, snowmobiling, or hunting, could spend an aggregate total of 100 hours per year on the property given the relative remoteness, resulting in an exposure of about 200 µSv/yr, which is well below the annual dose limit of 1,000 µSv/yr (1 mSv/yr) for non-Nuclear Energy Workers.

The following table, based on the 1993, 2003 and 2004 gamma radiation measurements collected by Saskatchewan Environment (Table 4-2), the Canadian Nuclear Safety Commission, and the SRC, Respectively, provides a summary of the length of time an individual would have to spend at different locations on the Gunnar Mine property in order to receive a dose equal to the limit of 1 mSv/yr prescribed for members of the public in the General Nuclear Safety and Control Regulations issued pursuant to the Canadian Nuclear Safety and Control Act.

Table 4-2 Residence Time Required to Exceed Dose Limit

Areas of the Site	Average Gamma (µSv/h)	Residence Time Required to Acquire 1 mSv/yr[a]
Haul Road	1.5	667 hr
Yard in Front of Mill	2.0	500 hr
Fines Piles (ore Conveyor)	5.16	193 hr
Gunnar Main Tailings	4.21	37 hr
Gunnar Central Tailings	3.90	256 hr
Langley Bay Tailings	4.30	232 hr
Gunnar Waste Rock	1.49	934 hr
AVERAGE	**3.2**	**312 hr**

a – Does not consider contributions from radon (see Section 7.4).

4.3.3 Production Buildings

There were measurable levels of surface contamination and measurable gamma radiation fields in the mill, mill lean-to, and the head-frame that would exceed action levels during demolition.

Gamma radiation exposure rates in the packaging area of the Mill exceeded 10 µSv/hr, while total surface contamination levels exceeded 20,000 Bq/100 cm^2. The remaining areas of the Mill did not have any elevated gamma exposure rates. However, surface radiation contamination was widespread throughout the Mill building ranging from 170 Bq/100 cm^2 to 21,000 Bq/100 cm^2.

During the August 2010 radiological assessment, the AECOM survey technician observed what appears to be “yellowcake” on the floor and wall in the Mill and Mill Lean-To. This identification is based on visual observations and radiation measurements.

The head-frame contained several large ore bins. Surface contamination levels under these tanks exceeded the free-release criteria ranging from 160 Bq/100 cm^2 to 2,900 Bq/100 cm^2

Appropriate contamination control and radiological exposure controls should be used when handling these ore hoppers, support features, and when working with interior areas of the Headframe, mill lean to and packaging area in the mill near the mill lean to. Such controls would include surveillance monitoring of personnel involved in the dismantlement or demolition of structures in these areas and surveillance of waste materials generated from the area. Continuous air sampling for airborne radioactivity should be conducted, while working in this area, and appropriate PPE should be worn.

4.3.4 Waste Rock Piles

The 2004 SRC investigation also included a survey of the two major waste rock piles at the former Gunnar Mine site. This waste rock area was surveyed on a two-metre grid with a total of approximately 3000 separate measurements being taken. The 2004 investigation revealed an average gamma radiation level at 1 m above surface of 0.98 µSv/hr, with a maximum of 4.88 µSv/hr. In total, 42 of the measurements exceeded a 2.50 µSv/hr benchmark established as the maximum for post decommissioning. It must be noted than in virtually all instances, those areas with fields exceeding 2.5 µSv/hr were areas that did not consist of waste rock, but were materials that had been hauled to the waste rock pile and end-dumped from the back of a truck. These materials may have been sludges etc. from tanks that were emptied at the time the mill was shut down. Notwithstanding this observation, the areas in which fields exceeded 2.5 µSv/hr were neither contiguous nor near to one another in the waste rock piles. In total, there 19 distinct areas were identified, each of approximately 2 m^2, in which fields exceed 2.5 μSv/h.

Based on these results, for an assumed 1,000 hours per year of exposure to the waste rock piles by a casual visitor to the Gunnar site, the dose to a member of the public would amount to approximately 980 μSv/yr, which is just below the annual dose limit of 1,000 μSv/yr (1 mSv/yr) for non-Nuclear Energy Workers.

4.3.5 Radiation Protection Plans

Both the radiological assessment performed in August 2010 and previous radiological assessments have identified radioactive materials and contamination on the Gunnar Mine site. Demolition work will result in personnel entering radiological controlled areas, and, therefore, all future work at the Gunnar Mine site will be conducted under a site-specific Radiation Protection Plan (RPP).

- The RPP will be a stand-alone document that is administered in parallel with the site health and safety plan.
- The RPP will be reviewed and approved by a Certified Health Physicist (CHP).
- The RPP will address all radiological hazards associated with the project, including external gamma radiation, loose contamination, dispersible radioactive materials, and radon.

For each identified radiological hazard, the RPP will provide appropriate monitoring procedures, dosimetry requirements, training requirements, protective equipment requirements, and operational safety procedures and limitations, and so forth. The RPP will also identify specific minimization procedures consistent with SRC's ALARA requirements.

5. Technical Approach

5.1 General Demolition Approaches

The general demolition approach will consist of a variety of methods as described below:

- Systematic Demolition – means methodical dismantling of the structure piece by piece. It is usually carried out in the reverse order of construction
- Hand Demolition – means the systematic demolition of structures by workers using hand-held tools. This could include using of hydraulic splitters and thermic lances.
- Mechanical Demolition – means the systematic demolition of structures using powered equipment.

Other approaches were considered and not carried forward due to concerns regarding abatement of hazardous materials. However, if contractors can demonstrate worker protection using these methods then they can be revisited.

- Balling – means raising the ball with a crane and releasing the brakes allowing the ball to fall on that part of the structure to be demolished. Could also include stationary boom balling or swing balling.
- Rapid Progressive Failure - means a method of demolition in which key structure elements are removed or destroyed, casing rapid complete collapse of the whole or a segregated part of the structure being demolished (often associated with explosives).

The process of demolition at the Gunnar site would be a mix of hand and mechanical processes to separate the structures into safe workable components. The use of a large excavator to perform most of the demolition is expected. Use of explosives is not an option at this time (refer to discussion above). The contractor (to be appointed) will determine the appropriate methodology to be employed.

The work must be performed safely, while minimizing the potential for effects to the environment. Other considerations during demolition are salvage/recovery, recycling of steel, equipment/skilled labour availability, access, training and schedule.

5.1.1 Production Buildings

The following sections describe appropriate demolition approaches for each of the major facilities and structures.

Head Frame

The head frame is approximately 49 m (160 ft) high and demolition using typical heavy equipment is therefore not possible. Two options are considered, they are outlined below:

- Weaken the base and topple the structure, then either cut with a torch or use hydraulic shears to cut the steel beams into manageable size pieces for disposal.
- Cut it down in pieces using a crane and cutting torches.

Either option would work; the first option would probably be more efficient since all work would be on the ground but it would require demolition experts to determine where to cut to topple the structure in a safe manner. The impact associated with toppling the head frame would cause dusting of the spray-on asbestos and asbestos siding. Cutting down the headframe in pieces is not as desirable as toppling the structure as workers are exposed to additional risks working at heights. The approach that is typically used would be to remove whatever transite panels that can be safely accessed then to wet down remaining panels and set up misters or hoses over the fall zone and topple the head frame. If accessible the spray on asbestos could be stabilized with the use of encapsulation products prior to fall and then dealt with on the ground.

Demolition using crane operations will require care and attention to determine the safe loads and thus the size of pieces that could be taken down. Large 120 to 160 ton boom cranes are common in the construction industry. Several head frames elsewhere in Canada have been removed using a crane. A crane may also be used to remove the 1,000 ton ore bins in the head frame (although the bin could be toppled and sheared up on the ground). It is assumed these will need to be cut up so that they can be handled and taken to the temporary storage cell. A crane will also be required for some of the demolition in the mill.

Cutting the steel with a torch or hydraulic shears are both possible. Hydraulic shears large enough to cut 30 mm thick steel are available and can cut most of the structural steel on site. Use of shears has the added advantage of reducing worker exposure to asbestos and lead based paint.

The cap on the main shaft and the vent raise will be inspected and made safe as required to meet accepted decommissioning standards.

It is apparent that the shaft opening has been capped by some undetermined means. As Photo 6 indicates, the top of the cap is situated approximately 2 m below grade and is presently obscured by debris. The 1993 conditions report prepared by Saskatchewan Mineral Industry Environmental Protection Branch states that *'the shaft has a concrete cap of undetermined thickness'*. Prior to demolition, an evaluation of the existing cap will need to be carried out. The design thickness of the cap will be a function of the amount of backfill that is expected to be placed over it.

Mill

The mill will be the single largest part of the demolition effort. After the removal of the hazardous substances and materials including asbestos demolition of the external segments would commence (surge tower, conveyor gallery's, mill lead to etc.). Consideration of the radiological issues in the Mill leads to what would be an integral part of the deconstruction of this segment.

The sequence would be to start at one end of the building and systematically demolish the structure using a hydraulic shear. As the major process items, ore bins, thickener, leach tanks, etc. were encountered they would be cut up and removed. A conventional method would be to cut wide vertical strips of steel out of the tank. The on-site mobile crane would be required to support the steel strips. A man-lift would be required to gain access to top of the tanks, and a skilled cutter would need to work with the excavator, weakening critical parts of the structures. The steel beams that form the walls and roof will require at least partial removal before the larger pieces inside the mill such as the ore bins can be handled. Beams can be torch cut or cut with hydraulic shears and pulled down with a tracked excavator and crane. All the large pieces such as ore bins, leach tanks and thickener tanks should be partially dismantled or cut up because over the long term rusting and rotting of tanks could cause surface collapses and safety issues. In order to cut up the tanks, they may have to be removed or laid on their sides with a crane. If ex-situ disposal is required, then these pieces may have to be loaded onto rock trucks with a crane. Smaller equipment and structures within the mill can be handled with tracked excavators, grapple loaders, loaders and rock trucks. The foundation for the mill is a massive concrete structure would be best left in place.

Once the leaching and precipitation building structures are the only remaining items, critical and backup pull cables would be affixed to the structural columns and critical cuts would be made to structural members. Care would have to be made to ensure the adjacent column line does not come down inadvertently. At one point, the end frame of the structure will fail and the roof would collapse.

As the building is taken down the fallen debris must be removed to a temporary storage cell, in order to gain safe access to the remaining part of the building. Once completed, the next section would be pulled down, and so on along the full length of the mill building. Once the building has been demolished, the shear and grapple will process the material into pieces for transportation to the storage cell.

Any lower concrete sub-levels or floors would be broken by hydraulic hammer. Any utility tunnels would be collapsed and refilled.

Acid Plant

After the removal of the hazardous substances and materials including asbestos demolition of the external segments would commence (utilidors, piping headers, vestibules etc.). The acid plant demolition would be similar to that in the Mill building. It would require torch or hydraulic cutting of some of the posts and beams to dismantle the enclosure. An excavator and crane would be required to take the members down. Much of the steel in the acid plant may be considerably weakened by corrosion especially in the area around the sulphur pit. There are two 12.2 m (40 foot) diameter acid storage tanks located behind the plant. These tanks may also be considerably weakened by corrosion. The tank foundations may also be weakened by the acidic environment. The tanks could be toppled and sheared up on the ground.

Maintenance Shops

The shops consist of 12 attached buildings. The buildings are 5 to 8 m high and can probably be demolished with excavators, dozers and loaders. Hazardous materials and substances would be removed from the building. Then the column bases would be cut or weakened, and the grapple / shear would be used to drop the structure frame by frame. The building materials would be progressively broken up and hauled to the temporary storage cell on the waste rock dump. A crane would assist with roof beams. The foundation is concrete slab, with an internal oil filled slab heating system. Care would have to be taken to ensure oil has been purged from the piping network. The slab is proposed to be covered and left in place.

Mine Engineering and Geology/Dry Buildings

These buildings are close to the maintenance shops (Mine Engineering and Geology/Dry Buildings are attached) and they could be demolished using the same methods as for the maintenance shops.

5.1.2 Non Production Buildings

After the removal of the hazardous substances and materials including asbestos demolition of the non-production buildings would commence. Some demolition efforts of the wooden apartments and bunkhouses were conducted in 2010. Demolition debris from this effort would be loaded into rock trucks and transported to the temporary storage cell.

The wood frame and concrete block non-production buildings can be demolished with tracked excavators to pull down and compact the materials, dozers to push the material into piles, and skidders with logging grapples or loaders to load the material onto rock trucks to the temporary storage cell. The foundations on these buildings are light and can be ripped up and disposed of along with the other building materials. Each building site could then be graded to natural slopes and reclaimed to natural conditions.

Dock Warehouse

This building is also close to the maintenance shops and could be demolished during the same phase. It is close to the lake and care must be taken to avoid shoreline alteration during demolition.

Water Tank

The water tank is 5 m in diameter and 19.5 m high. It could either be removed in pieces by crane or toppled and cut up. Access to the water tower is not good at present. Either option would require construction of a temporary access road and possibly a pad.

5.1.3 General Site Debris

There are numerous other small buildings, utilidors, tailings lines and miscellaneous scrap (including 8,000 empty barrels) that can be dozed into piles and removed to the temporary storage cell on the waste rock pile.

5.1.4 Equipment and Personnel Decontamination

The contractor shall set up an exclusion zone, decontamination zone and support zone for all high hazard abatement work. All personnel, equipment and trucks that come in contact with building materials within the ‘Exclusion Zone’ may be contaminated with Asbestos. As such, there is a potential to track contamination which may adhere to clothing, truck tires and tracks during offsite transport into the ‘Support Zone’. Details regarding decontamination will be outlined in the HASP.

5.2 Special Procedures

5.2.1 Asbestos Abatement

When considering the practical work to be performed at Gunnar the abatement of the asbestos hazard is the largest element to address. The site has substantial amounts of both friable and non friable asbestos. The friable material will require the full implementation of the Part A removal procedure. (Refer to the Saskatchewan Occupational Health and Safety Regulations (SKOHSA) Table 5 [Subsections 7(2) and 343(1) and section 344] Asbestos Processes); this table defines asbestos removal processes for high, moderate and low risk abatement. The presence of rigid ACM will require low-hazard asbestos-abatement procedures, while the limited quantities of friable ACM could be handled using moderate asbestos-abatement procedures prior to demolition. The presence of all spray-applied insulation (Crocidolite and Amosite) and large quantities of friable mechanical insulation will require high-risk asbestos abatement procedures prior to demolition.

When planning to perform asbestos work companies must complete an Asbestos Work Notification form and submit it to the Senior Occupational Hygienist at Saskatchewan Labour no later than 14 days before the work is to proceed.

For the purposes of this project, until all friable asbestos has been removed and disposed of properly, the entire site should be declared an asbestos removal site. During asbestos removal anywhere on the site, regardless of what they are doing, workers must wear the minimum personal protective equipment (PPE).

The asbestos removal program will include an air monitoring program. The site monitoring will be important to establish which activities may take place concurrent with the asbestos removal activities. Monitoring stations will be established at the four compass points in addition to specific locations such as the air strip, the proposed Camp and the dock areas. Individual workers may also be monitored.

The removal process will be complicated by the fact that the site has been traditionally used by local lodge owners and the general public; lodge owners use the local air strip, north of the mine, to transport customers through the site to the dock area adjacent to the Cold Storage building. The transport vehicles, including a bus and a van, are parked either at the Dock or at the air strip.

The philosophy of the removal work is to balance the risk from the exposure to asbestos with the physical risk of working at heights and the potential risk to the local environment post closure. For the least hazardous ACM types such as cemented tiles, floor tiles, corrugated siding (that is free of sprayed on ACM) and other transite wall boards simple air quality precautions are typically sufficient to protect workers in well ventilated areas. These precautions may include;

- Properly fitted filtration masks with P100 or equivalent replaceable cartridges,
- Disposable work suits with elasticized wrist, ankle and hood openings,
- Work Gloves, mono-goggles and all other essential safety apparel.
- The friable or Part A Asbestos removal will require additional protection measures to be implemented such as;
- Power assisted air filtration,
- Showers and clean changing rooms that are constructed away from the contaminated area but not as part of the camp infrastructure.

Many asbestos materials, including all friable asbestos and transite, must be removed prior to demolition activities, in accordance with Saskatchewan Health and Safety Regulations, or as specified under the conditions provide in permits from regulatory authorities.

Friable asbestos materials include spray-applied insulation, pipe insulation, and mechanical insulation on various vessels, boilers, boiler breeching, and tanks. Transite is a cement cladding material and this should also be removed prior to demolition, due to the large quantity and content of asbestos. Non-friable materials, such as drywall joint compound, vinyl floor tiles, and roofing materials, can be left in the building prior to demolition.

The removal procedures can be site specific but there are several basic principals that guide the removal and handling of ACM that apply to Gunnar. The ACM should be secured at the end of each shift either by cover or burial at the designated landfill site. Any personnel entering the work area must have the full complement of protective gear that is used by the workers. When transporting ACM, the contractor must follow the provincial standards by sufficiently securing the material to prevent friable material from dispersing.

Final disposal of asbestos must be done in accordance with Saskatchewan Environment regulations. ACM may only be disposed of in an approved location. This may require that the owner investigate and make application for the permitting of an onsite landfill with the additional classification to allow the deposition of ACM. The disposal of ACM in an approved site will require careful monitoring to assure that the daily cover is performed and that the volumes are monitored, estimated and recorded. Due to the scope 'of the ACM issue at the Gunnar site it is recommended to begin the decommissioning by making all reasonable attempts to remove as much ACM as possible to minimize the exposure to workers during demolition.

5.2.2 Sulphur

Sulphur is present in small quantities in places around the Gunnar site. The main hazard associated with sulphur is the possibility of fire, or in extreme cases explosion, where sulphur is dispersed in fine powdered form. The successful contractor for the demolition work will develop site-specific procedures for the handling, transport, and fire-fighting of sulphur. The contractor will also have the equipment on site that is required to fight such a fire and have trained their staff in the hazards and how to respond to such a fire. Industrial guidelines, emphasizing the minimization of risk due to fire that can be initiated by sparks (from machinery or static electricity), flame, or oxidizing agents, are given in Appendix B, along with fire-fighting methods and an MSDS.

5.3 Site Access and Transportation Methods

Off site activities in support of this project will be in the form of transportation associated with the transport of materials, equipment and personnel to the site. These activities are described below:

- Air Transport - Most personnel transportation by air is expected to utilize a combination of existing commercial services and charter services in and out of the site.
- Land Transport - It is anticipated that overland transport will be required between the end of the winter road in Uranium City and the project site via winter CAT Train for mobilization of materials and equipment. The scope of the project will include the winter road from Uranium City to the project site.
- Barge Transport - It is anticipated that contractors will utilize barge to transport hazardous materials southbound; some fuel and equipment re-supply during the summer and the majority of equipment would be demobilized via barge services. Selected equipment may remain on-site beyond October 1st, 2011 and be demob via the winter road or summer barge operations in 2012. Barge transport would be to/from Fort McMurray, Alberta.

Figure 7 illustrates the approximate routing of a winter road extension from Uranium City to the site. It is expected that the winter road to Uranium City from Fond du Lac would be built by others.

5.4 Salvage and Recovery

SRC has previously reviewed the potential for salvage of equipment, materials and steel from the site (Watermark 2004). It appears that some of the major process units (e.g. ball crushers), and power generation equipment has previously been removed from the site. The condition of all remaining structures and materials has deteriorated and therefore none of the materials left on site are considered salvageable. Options for steel recovery and reuse were examined with shipment south to end markets (mostly in Asia) and found to be not cost effective. Demolition and disposal on-site is, therefore, the recommended option for clean up.

5.5 Contractor Support Activities

The following activities will occur on-site to support the remediation work:

- Use of existing dock area, airstrip and roads for equipment transport, movement and access to work areas.
- Set-up of the site for camp and equipment storage. Demobilization and clean up of the camp following project completion.
- Sewage from the camp will be handled with, at minimum, primary treatment (settling tank and lagoon) and discharged to ground surface.
- Domestic waste to be disposed (as is, or incinerated as specified by the Land Use Permit) in the new temporary storage cells.
- Duration of work is anticipated to be approximately six months; although the time line from mobilization to complete de-mobilization will be more than one year considering winter road and summer barge access.
- The contractor will provide Emergency Response and Fire Control Equipment during demolition activities
- The contractor will provide suitable spill cleanup equipment and supplies

6. Waste Management

6.1 Temporary Storage of Waste Material

We have explored two alternatives for the interim storage of demolition wastes.

- A single storage cell concept in which all waste is transported to a common area; or
- A multiple storage cell concept in which waste transport distances are minimized and wastes are segregated according to origin or potential contaminants.

The locations of the proposed storage cells are illustrated in Figure 8. Each concept is discussed below.

Single Temporary Storage Cell Concept

Cell 1, a single storage cell on the east waste rock pile is estimated to have adequate capacity for all of the wastes.

A preliminary estimate of the total capacity of a single storage cell would need to be 110,000 m^3 based on a 4:1 average slope extending from 239 m elevation contour down to the toe shown on Figures 9 and 10. An average cover thickness of 2 m is recommended since the waste surface will be highly irregular with many voids to be filled. For estimating purposes, 80% of the total capacity is assumed to be waste and 20% is waste rock cover material.

All of the potentially radioactive materials would be placed in this storage cell. No hazardous wastes or bulk chemicals would be placed in this storage cell.

Multiple Temporary Storage Cell Concepts

Three isolated storage cells, one the waste rock dump (Cell 1), and two at the footprints of the mill and acid plant buildings (Cells 2 and 3 respectively), would minimize haul distances, eliminate the need to remove the foundation and backfill the vertical rock cuts. Figure 8 shows the footprints of the three storage cells. Each storage cell takes advantage of the steepest portion of the slope and natural drainage runs divert drainage around each storage cell. This is desirable from an environmental protection perspective to minimize infiltration and groundwater mounding beneath the sites. Conceptual design and rough estimates of the capacity of each configuration and the quantities of cover material required at each storage cell are presented below.

Cell 2 Temporary Storage Cell – Mill Foundation

The mill storage cell would occupy the area along the toe of the bedrock ridge north of the mill and would encompass the mill site. The roof and walls of the mill would be dismantled and placed around the structure. Likewise, the ore bins and tanks would be dismantled and stacked in and around the mill. The following structures/items would be placed in the Mill Storage cell:

- Mill and contents
- Ore bins, crusher area and conveyors
- Remains of the Powerhouse
- Tailings line
- Empty concentrate drums
- Any utilidors in the immediate vicinity of the mill

The total capacity in the footprint is estimated to be 49,000 m^3; the cover is estimated to require approximately 23,400 m^3 of waste rock and there is estimated be less than 48,000 m^3 of waste from the above listed structures. A slope of 4:1 extends from the 231 m elevation contour down to the toe shown on Figure 11. The materials placed in this storage cell would require little to no haul, lessening effort and cost. It would be more or less in situ disposal with the structures being dismantled and flattened as much as necessary to ensure minimal collapse or subsidence with time.

Cell 3 Temporary Storage Cell – Acid Plant Foundation

The acid plant storage cell would occupy the area along the toe of the bedrock ridge north of the acid plant. It is essentially on the site of the acid plant. The roof and walls of the acid plant would be dismantled and placed around the structure. Likewise, the internal contents would be dismantled and stacked in and around the plant. The following structures/items would be placed in the Acid Plant Storage cell:

- Plant buildings
- Condensor block
- 2 Acid tanks
- Water Tower
- Any utilidors in the immediate vicinity of the plant

The waste capacity in the footprint of the Acid Plant Storage cell is estimated to be 11,600 m^3 and the cover is estimated to require 6,000 m^3 of waste rock. A slope of 4:1 extends from the 230 m elevation contour down to the toe shown on Figure 13. The haul of materials to this storage cell would be minimal. It would be more or less in situ disposal with the structures being dismantled and flattened as much as necessary to ensure minimal collapse or subsidence with time. All hazardous substances and materials would be removed from prior to storage.

Recommended Option

A multiple storage cell concept is recommended. The multiple storage cell concept provides several advantages over the single storage cell option. It maintains the advantage of having Gunnar Pit as a point of control and containment should contaminant migration become an issue from the mill or acid plant storage cells. It provides for isolation of different types of waste, allows for the reuse of the concrete foundation and mitigates the vertical rock cut behind the mill building.

Additional on the major waste components and temporary storage option onsite or disposal offsite is provided in Table B in Appendix B.

7. Project Management

7.1 Oversight of Demolition Process

Full time inspection of the activities will be provided during demolition. The responsibilities of the full time inspector(s) include:

- Confirmation and documentation that the segregation and removal of the various hazardous and non-hazardous waste streams has been conducted in accordance with the demolition plan;
- Providing testing services for ambient air monitoring for asbestos and potential radiological exposures;
- Document that the demolition is compliant with the technical specifications and advise the demolition team to implement corrective actions if required;
- Confirm and document that trucks and equipment have been decontaminated prior to exiting the site;
- Monitor and audit the Health and Safety processes implemented by the demolition contractor; and
- Report to the project manager at a minimum of daily basis.

Air Monitoring

The ambient air monitoring system will include instrumentation at one fixed sampling location (downwind of the site) and two portable asbestos monitoring stations in high hazard areas. SRC will develop a site specific air monitoring plan (AMP). The AMP will contain provisions to: monitor asbestos and lead in particulates. Wind speed and wind direction (WS/WD) data will be obtained and logged from the nearest regional meteorological station.

Photo Documentation

The onsite field inspector will take digital photographs of decontamination and demolition activities. The photographs will be compiled as an appendix to the Final Completion Report in a CD format.

Inspection Logs

Inspection log forms will be prepared prior to Day 1 of the demolition activities. The inspection logs will be submitted to SRC for comment prior to implementation to ensure the expectation of SRC are met. The forms may also be modified as demolition progresses. The proposed inspection log forms include:

- Content of daily health and safety tailgate meeting;
- Location of air/dust monitoring equipment;
- Activity at various times of the day;
- Photo number and description of photos taken during the day;
- Tracking of transport trucks entering and leaving the site with a check box indicating the equipment has been decontaminated;
- Documentation demolition equipment has been decontaminated prior to leaving the site; and
- Samples submitted for analysis including sample numbers and description

Loading, Transport and Demolition of Waste Streams

Provide oversight of the loading, manifesting, transport and disposition of the non-hazardous and hazardous waste. Manifests, Certificates of Destruction, and Bills of Lading will be provided as an appendix to the completion report.

Onsite Placement of Fill

Oversight will be provided for onsite placement of fill. Imported fill will be sampled and analyzed to ensure it meets requirements in the technical specifications.

Completion Report

A Completion Report will be prepared upon completion of the demolition and include the following sections:

- Introduction
- Methodologies and deviations from demolition plan
- Environmental Monitoring Results
- Summary of waste streams including tonnages, disposal details
- Appendices:
  - Health and Safety
  - Manifests, Certificates of Destruction, and Bills of Lading for Waste materials
  - Air Monitoring Data, Certificates of Analyses
  - Certificates of Analyses for Confirmatory Sampling
  - Daily Activity Log
  - Photo Log

The Completion Report will be submitted to the SRC along with a letter signed by a Professional Engineer certifying the accuracy of the Report.

7.2 Quality Assurance and Quality Control

Project QA/QC (an aspect of quality management) addresses both the management of the project and the product of the project. QA includes the documented processes required to ensure that the project will satisfy the needs for which it was undertaken and will meet the project specifications and data quality objectives. It also includes all activities of the overall management function that are required in meeting the objectives of the project including planning, QC elements, and any scope changes. The overall QA/QC program of the project will be the foundation upon which the professional member is to assure that the work is being, and has been, adequately performed and upon which to base his or her decision that the desired end results have been met.

The following are examples of QA/QC measures commonly employed in a project:

- A project management strategy (such as ISO).
- Advance training of professional members and competent practitioners and use of appropriate specialists.
- Peer support, consultation, technical advice and/or peer review by someone more qualified.
- Task-observed competency evaluations by someone more qualified.
- Project task supervision and performance audits.
- Performance audit by government regulators and/or supervisors.
- Use of standard field tests and assessment protocols, standard operating guidelines and procedures.
- Documentation and detailed record keeping of field work, sampling, testing, ongoing monitoring and decommissioning, sample storage and delivery, etc.
- Laboratory management and accreditation systems.

7.3 Schedule

The OHS, Structural Safety and Hazardous Materials assessments were conducted at the Gunnar site in 2010. The CNSC Order specifies all buildings that fail the Structural assessment must be demolished by October 31, 2011. To meet this deadline the contractor will mobilize to the site via winter road (CAT train) during March 2011. Clean up activities are expected to begin in April or May and continue through to the summer of 2011, depending on the contractors' approach and weather conditions. It is expected a minimum of 50% of the contractors' workforce and accessory personnel will mobilize to and from the site from nearby northern communities. Equipment will be demobilized from the site via winter road or barge during 2012.

The preliminary schedule suggests a one year time-frame to demolish the facilities. This may be difficult to achieve given the extensive nature of asbestos abatement required. To mitigate against the possibility that abatement of hazardous materials and demolition of the un-safe buildings and structures cannot be completed by October 31, 2011 the following is proposed:

- Those buildings and structures that do not fail the structural assessment would be left until 2012. These include:
  - Community centre/mall
  - The dock warehouse
  - Water tank
  - Acid tanks

- If additional time is required for abatement and demolition then two buildings that failed the structural safety assessment would be made safe and then those buildings deferred until 2012. These include:
  - Mine Dry
  - Maintenance Shops

This approach will ensure that worker and public safety is held paramount and sufficient contingency is built into the program to ensure a realistic schedule for execution of the work.

8. Worker and Environmental Protection

8.1 Health and Safety Plan

A detailed and specific Health and Safety Plan (HASP) will be prepared by the contractor prior to commencement of demolition work. The information in the plan will supplement SRC's OH&S program. as described in the CLEANS Occupational Health and Safety Handbook. The purpose of the HASP is to address the specific onsite roles, responsibilities and requirements at the Gunnar Mine Site for the demolition work as they pertain to the health and safety of all employees, and visitors as well as the potential environmental impact of the demolition work.

The HASP provides a general description of the levels of personal protection and safe operating guidelines expected of each employee or subcontractor at the Gunnar Site. The HASP also identifies hazards and control measures to be implemented prior to and during work activity. HASP Supplements will be generated as necessary to address any additional activities or changes in site conditions, which may occur during field operations.

The provisions of this HASP are mandatory for all SRC staff and contractor personnel engaged in work associated at the site. A copy of this HASP, any applicable HASP Supplements and the SRC CLEANS Occupational Health and Safety handbook shall be maintained on site and available for review at all times. Record keeping will be maintained in accordance with this HASP and the applicable Standard

Operating Procedures (SOPs). In the event of a conflict between this HASP, the SOPs and federal, provincial, and local regulations, workers shall follow the most stringent/protective requirements.

The OH&S hazard assessment report has identified hazards on the site. A hazard and risk assessment will be conducted prior to work to identify any new hazards on site. Primary physical hazards to which the employees will be exposed are the instability of the buildings, the debris associated with the mine site and the demolition activities. The health hazards which may be encountered include asbestos (in old building insulation) and radiation (from tailings), as well as any uncovered deposits of petroleum or other chemicals..

All SRC staff, visitors and contractors, will participate in a pre-trip project safety meeting which will orientate them to the hazards and onsite controls, including emergency response procedures, personal protective equipment, site control, and monitoring requirements. Daily toolbox meetings will be held to discuss the results of the daily informal inspections and to identify any new hazards and controls, as well as any lessons learned or concerns from the previous day.

The practices and procedures presented in this HASP and any supplemental documents associated with this HASP are binding on all SRC employees and contractors while engaged in the subject work. In addition, all site visitors shall abide by these procedures as the minimum acceptable standard for the work site. Operational changes to this HASP and supplements that could affect the health or safety of personnel, the community, or the environment will not be made without prior approval of the SRC Project Manager and the assigned SRC Safety Professional.

Protocols

This HASP is a supplemental to existing SH&E protocols already established for the site and for SRC employees and Contractors. As such, all employees on this project must also comply with:

- SRC OH&S Program and OHS management system(including incident reporting, safety rules, roles and responsibilities and all standard operating procedures)
- CLEANS (Clean up of Abandoned Northern Sites) Project Safety Handbook
- OHS Assessment (AECOM report, August 2010)
- Structural Safety Assessment (AECOM report, September 2010)
- Inventory of Hazardous Substances and Materials (AECOM report, September 2010)

8.2 ALARA Program

Even though current occupational exposures provide a very low risk of acute or chronic health impacts, it is prudent to avoid unnecessary exposure to radiation with an objective to ensure that occupational exposures are as low as reasonably achievable (ALARA). This will be achieved by means of good planning (preparation of a detailed and useful Radiation Protection Plan) and practice, as well as commitment to policies that foster vigilance against departures from good practice.

In addition to minimizing doses to individuals, the sum of the doses received by all exposed individuals should also be maintained at the lowest practicable level. It would not be desirable, for example, to hold the highest doses to individuals to some fraction of the applicable limit if this involved exposing additional people and significantly increasing the sum of radiation doses received by all involved individuals.

During project planning, ALARA (dose) goals shall be established for individuals who may be involved in operations that could result in exposures greater than 100 mrem (1 mSv) from site operations in a calendar year. The ALARA goals should be:

- Based on historical values for this type of work or on estimations of dose and should be modified either up or down depending upon the nature of the work involved.
- Approved by the Project Manager and exposed individual's supervisor.
- Periodically evaluated relative to accrued dose received by the worker.

If it is observed during operations that an individual is approaching 100 mrem (1 mSv) for the year and no ALARA goal has been established, then a goal should be established.

The Radiation Protection ALARA Program is implemented by:

- Reviewing radiological operations and analyze the hazards.
- Developing and implementing controls that reduce or eliminate unnecessary dose and keep the necessary doses low and document the controls in the RPP.
- Documenting areas surveyed for radioactive material and retain the records according to
- Establishing ALARA goals for individuals or work groups.
- Providing feedback to workers and managers by tracking an individual's dose relative to his/her ALARA goal.
- Re-evaluating the situation if it appears an individual is likely to exceed his/her ALARA goal.
- Being aware that implementation of a radiation safety control may introduce unintended consequences that may negatively impact the overall safety of the operation and take appropriate corrective action. For example:
  - Excessive protective clothing or equipment used to control personnel contamination events may have deleterious consequences, such as heat stress and ergonomic impacts.
  - Respirators used to reduce intakes of radionuclides may impair visual acuity and communications capabilities among workers.
  - Protective clothing and equipment used to protect workers from chemical hazards may slow down work, leading to increased worker dose.

8.3 Occupational Exposure Estimates

In general, external gamma radiation dose rates range from 1 to 3 μSv/hr outside the production and non-production buildings with some areas exceeding 6 μSv/hr. Exposure rates inside structures are generally lower than outside but can exceed 10 μSv/hr in some localized areas. Off-site background gamma radiation fields are approximately 0.2 μSv/hr.

Occupational dose (effective dose above background levels) at the Gunnar Mine site areas could exceed 1.5 mSv per 500-hour work quarter or 3.0 mSv per year (mSv/yr) assuming 1000 hours for the on-site construction season and an average external dose rate of 3 μSv/hr. These estimates do not, however, include contributions from radon daughters or internal exposures. Internal exposures will be controlled using engineering controls and/or respiratory protection. Radon emanation rates at the site have not been determined and cannot be estimated at this time. The effective dose shall be calculated using the following formula and expressed in mSv [SOR-2000/203 Sections 12(1) and 13(2)]:

$$\text{Effective Dose} = E + 5RnP + 20\ \Sigma\ I/ALI$$

where:

"E" is the portion of the effective dose, in mSv: (a) received by a person from sources outside the body; and (b) received by and committed to the person from sources inside the body, measured directly or from excreta.

"I" is the activity, in Becquerel (Bq), of any radionuclide that is taken into the body, excluding the radon progeny and the activity of other radionuclides accounted for in the determination of E.

"RnP" is the exposure to radon progeny in working level months.

"Σ I/ALI" is the sum of the ratios of "I" to the corresponding annual limit on intake (ALI).

To receive occupational doses on this level (greater than 1 mSv/yr), Canadian Radiation Protection Regulations (SOR-2000/203) require that personnel be trained as "Nuclear Energy Workers." As such, all personnel working on site full-time shall be required to be appropriately trained and participate in a radiation dose monitoring program that will be defined in the site RPP. Depending on the location of their work assignment, temporary workers that are not expected to be on site for more than 200 hours would not necessarily need to be trained "Nuclear Energy workers" as their dose would not likely exceed 1 mSv. Regulatory occupational dose limits are provided in Table 8-1.

Table 8-1 Regulatory Dose Limits

Person	Period	Effective Dose (mSv)
Nuclear Energy Worker, including a pregnant nuclear energy worker	(a) One-year dosimetry period (b) Five-year dosimetry period	(a) 50 (b) 100
Pregnant Nuclear Energy worker	Balance of the pregnancy	4
A person who is not a nuclear energy worker	One calendar year	1

External doses will be monitored for all site personnel using external dosimetry such as a thermoluminescent dosimeter (TLD) or optically-stimulated luminescent (OSL) dosimeter in accordance with the RPP. The wear period of the dosimeters will be established so that cumulative doses trends are identified with sufficient time to respond with additional training or dose control measures before ALARA goals and/or exposure limits are exceeded.

SRC will implement appropriate internal dose/toxicity monitoring for the uranium compounds of interest. Contamination exists at the site in several forms such as uranium mill tailings, yellowcake, and waste rock. SRC will plan to collect baseline and exit urine samples of site personnel, typical practice for uranium mining and milling operations. Samples will be "spot" samples, samples from an 8-hour collection time.

SRC will also collect urine samples following a possible intake of radioactive materials. Potential intakes will also be assessed using nasal swabs or hair samples. It has been shown that the record of exposure will remain registered in the hair for weeks or even months following an exposure incident.

Personal and Work Zone air samplers will also be used to monitor exposures to airborne contaminants during certain work activities. These will provide an assessment of the work environment and can provide an estimate of worker intake and dose if respiratory protection is not in use. These samples will also be used to verify that appropriate respiratory protection measures are in place. However, early analysis of air samples can only estimate air concentrations. Samples will require about 3 days for radon daughters to completely decay before an accurate assessment of the uranium air concentrations can be performed.

8.4 Regulatory Requirements

Regulatory considerations are described in detail in the OHS, Inventory of Hazardous Substances and Materials and Structural Safety Reports (AECOM 2010). Those requirements specific to demolition are provided in the following table and we refer the reader to the other documents for additional information.

A summary of the various regulatory applications, permits and plans that are required are shown in Table 8-2.

Table 8-2 Regulatory Applications, Permits and Plans Required

Governing Regulation(s)	Application, Permit or Plan Required	Comment
• National Building Code of Canada 2005, Div B, Part 8 'Safety Measures at Construction and Demolition Sites	• Demolition Plan Amendment	• The amendment will specify the specific job hazards and work procedures that will be utilized during demolition.
• Section 5.6 of the National Fire Code of Canada 2005	• Fire Safety Plan	• The plan will specify fire control measures to be utilized during demolition.
• Occupational Health and Safety Act, 1993 (SKOHSA), and the Occupational Health and Safety Regulations, 1996 (SKOHSR) • Policy on the Disposal of Friable Waste Asbestos (EPB 269) • Saskatchewan's Environmental Management and Protection Act, 2002 (EMPA,2002)	• Notification of High Risk Asbestos Abatement • Demolition Plan Amendment • Biological Monitoring Plan • HAZWOPER Health and Safety Plan	• The notification form will be submitted at least 14 days before work is to commence • Develop Health and Safety Plan to ensure obligations are covered under the Act and regulations. • Develop training on policies, procedures, hazard assessments, hazardous materials handling (HAZWOPER), asbestos abatement/safety and radiation safety as required. • Conduct biological monitoring for asbestos and lead.
• Saskatchewan's Environmental Management and Protection Act, 2002 (EMPA,2002) • Construction/Demolition Waste Recycling and Disposal (EPB172/1M/03) • Sections 130 and 250 of The Urban Municipality Act • Section 97.1 (Untidy or unsightly lands or buildings) of The Northern Municipalities Act • Section 3 of the Litter Control Act • Chapter E-10.2 Reg 4 The Municipal Refuse Management Regulations	• Building Permit or Demolition Permit or Permission to Demolish • Permit to Establish a Waste Disposal Ground • Permit to Construct and/or Operate a Sewage Works • Permit to Construct and operate a Winter Road • Permit to Operate an Industrial Effluent Works • Permit to Construct and/or Operate a Waterworks	• Applies to effluent works regulated by the Ministry of Environment, for the collection, containment, storage, transmission, treatment or disposal of industrial waste. • Applies to the construction and operation of sewage works regulated by the Ministry of Environment, with a treatment capacity of greater than 18 cubic metres per day • Applies to waterworks regulated by the Ministry of Environment, including most municipal waterworks
• PCB Waste Storage Regulation E-10.2 Reg 6 21/89	• Storage of PCB materials	• Ensure safe temporary storage of PCB waste materials
• SOR/2000-203, Radiation Protection Regulations • Sections 84 and 85 of Part VI of the SKOHSR, which covers	• Radiation Protection Plan	• Develop safe work practices and procedures to handle, use, store and dispose of radioactive substances

Governing Regulation(s)	Application, Permit or Plan Required	Comment
General Health Requirements • Radiation Health and Safety Act (1985) and the Radiation Health and Safety Regulations		• Ensure that these procedures are implemented • Conduct biological monitoring for radiation
• E-10.2 Reg 3 - The Hazardous Substances and Waste Dangerous Goods Regulations	• Permit to construct and operate a temporary storage site for hazardous materials and substances	• Approval to temporally store site hazardous materials and substances
• C-12.1 Reg 1 - The Clean Air Regulations	• Burning Permit	• Permit to burn combustible paper and abated wood materials recovered during demolition
• Transportation of Dangerous Goods Act, 1992 (1992, c. 34) • Transportation of Dangerous Goods Regulations have been consolidated to include SOR/2008-34 (Amendment 6).	• Hazardous waste manifests	• manifesting under Dangerous Goods Transportation legislation, treatment or disposal at approved sites using approved methods only
• Bill C-45 OH&S Criminal Code Legislation	• All the above	• Ensure provisions are in place for awareness of hazardous materials, informing workers of the nature and degree of the effects to their health or safety of any chemical substance or biological substance to which the workers are exposed in the course of their work; provide the workers with adequate training with respect to work procedures and processes; and instruct in the proper use of any personal protective equipment required by these regulations

9. Summary and Recommendations

This Demolition Plan has been developed to meet the requirement *to 'submit to Mr. Don Howard, the Director, Wastes and Decommissioning Division, of the Canadian Nuclear Safety Commission, by no later than October 15, 2010, a plan for demolishing, during the year 2011, buildings and structures that fail the structural safety assessment'* by no later than October 15, 2010 for the Gunnar Mine Site, as specified in Commission Order 10-1 issued by the Canadian Nuclear Safety Commission (CNSC) on July 23, 2010. A detailed and specific 'demolition plan' will be prepared by the contractor prior to commencement of work. This will include Occupational Health and Safety (OH&S) plan for the work being conducted.

9.1 Phasing

It is intended to commence demolition in the 2011. The detailed phasing of the work will be controlled by the demolition contractor (to be appointed); however, the main phases of work are summarized as follows:

1. Preparation of OH&S plan, Radiation Protection Plan (RPP), Asbestos Control Plan (ACP), Health and Safety Plan and Emergency Response Plan;
2. Mobilization of staff and equipment for routine and emergency situations (for response and monitoring);
3. Preparation of the Site for the demolition project will include mobilization of supplies, equipment (where not available locally) and personnel to the Site, and set up of temporary camp facilities, including supply of water and wastewater treatment systems;
4. Preparation of temporary storage cells;
5. The areas of the Site accessible by the general public and which are included either in the abatement and demolition project or used for laydown or storage will be cleared, leveled and secured;
6. Preparation of decontamination facilities, access, set-up of site offices, first aid room, communications and establishment of site security;
7. Preparation of abatement work areas to facilitate access (e.g., ground clearing wooden structures).
8. Preparation of temporary storage cells and hazardous materials staging and packaging areas including crushing of intermediate cover materials;
9. Commencement of asbestos abatement activity associated waste disposal and monitoring work. This will be combined with building demolition;
10. Hazardous Wastes (other than ACM and inert demolition debris and concrete) will be segregated for transport off-site;
11. Storage Cell closure activities;
12. Demobilization of demolition staff and equipment; and,
13. Inspections of Site status during demolition operations and subsequent to closure.

9.2 Temporary Storage Cells

Two alternatives for the interim storage of demolition wastes have been considered.

- A single storage cell concept in which all waste is transported to a common area; or
- A multiple storage cell concept in which waste transport distances are minimized and wastes are segregated according to origin or potential contaminants.

A multiple storage cell concept in which waste transport distances are minimized and wastes are segregated according to origin or potential contaminants is recommended.

A preliminary estimate of the total capacity is 110,000 m^3. An average cover thickness of 2 m is recommended since the waste surface will be highly irregular with many voids to be filled. For estimating purposes, 80% of the total capacity is assumed to be waste and 20% is waste rock cover material. The 90,000 m^3 of capacity available for waste is essentially the same as the waste volume estimated.

Three isolated storage cells, one on the waste rock dump (Cell 1), two at the footprints of the mill and acid plant buildings (Cells 2 and 3 respectively), would minimize haul distances, eliminate the need to remove the foundation and backfill the vertical rock cuts. Each storage cell takes advantage of the steepest portion of the slope and natural drainage runs divert drainage around each storage cell. This is desirable from an environmental protection perspective to minimize infiltration and groundwater mounding beneath the sites.

All of the potentially radioactive materials would be placed in the Mill Cell 2 storage cell to provide segregation. No hazardous wastes or bulk chemicals would be placed in the storage cells. Crushed waste rock or other suitable borrow material is required for the temporary storage cells and use as grading material. An estimate 81,000 m^3 is required.

The demolition debris from 2010 has been secured. Further consideration of the long term storage for the 2010 debris to remain in place will be included in the Waste Management Plan.

9.3 Waste Management

All ACM products would be co-disposed on site in the temporary storage cell on the waste rock dump. All hazardous wastes would be taken off-site to a licensed disposal facility. Selected bulk chemicals and substances may be neutralized on-site for disposal as inert debris. Where bulk chemicals cannot be neutralized onsite they will be shipped offsite as non-hazardous wastes.

Waste transport and disposal will be conducted in accordance with applicable federal and provincial regulations.

9.4 Schedule

The preliminary schedule suggests a one year time-frame to demolish the facilities. This may be difficult to achieve given the extensive nature of asbestos abatement required. To mitigate against the possibility that abatement of hazardous materials and demolition of the unsafe buildings and structures cannot be completed by October 31, 2011 the following is proposed:

- Those buildings and structures that do not fail the structural assessment would be left until approval of the Gunnar Environmental Impact Statement (EIS). These include:
    - Community centre/mall
    - The dock warehouse
    - Water tank
    - Acid tanks
- If additional time is required for abatement and demolition, then two buildings that failed the structural safety assessment could be made safe by removing secondary deficiencies and then taken down in 2012. These include:
    - Mine Dry
    - Maintenance Shops

This approach will ensure that worker and public safety is held paramount and sufficient contingency is built into the program to ensure a realistic schedule for execution of the work.

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Figures

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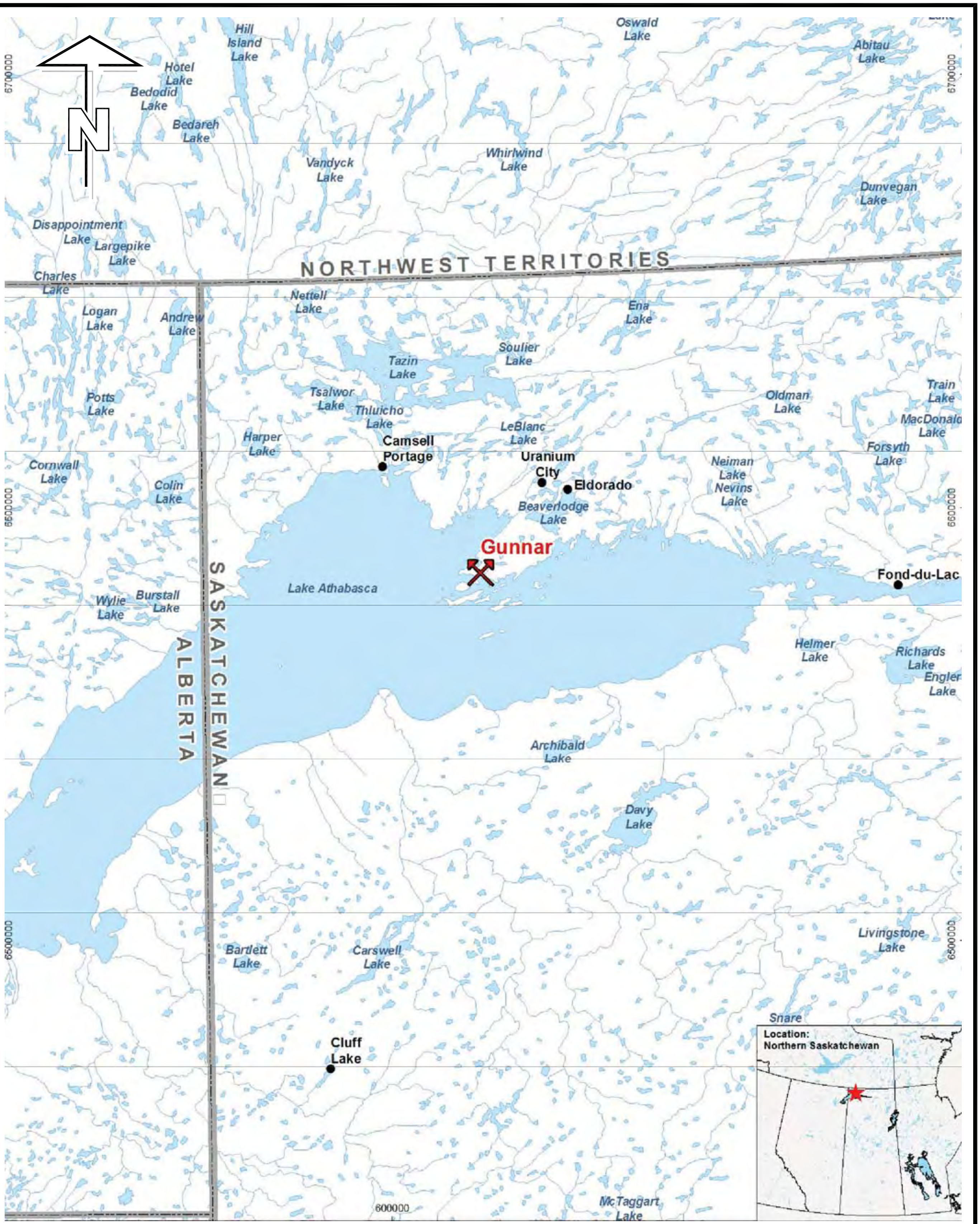
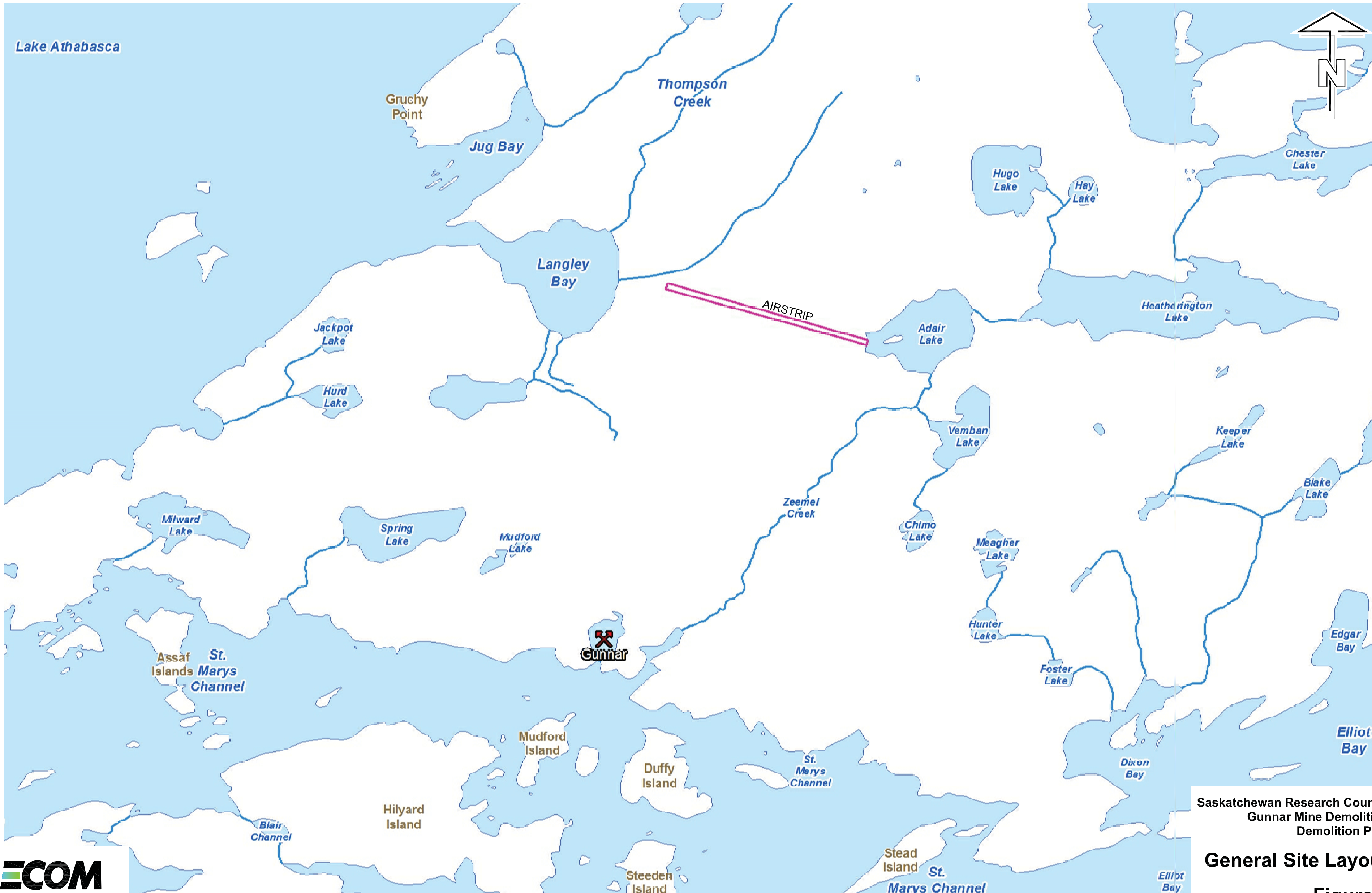


Saskatchewan Research Council
Gunnar Mine Demolition
Demolition Plan

Site Location Plan

Figure 1



Saskatchewan Research Council
Gunnar Mine Demolition
Demolition Plan

General Site Layout

Figure 2

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Saskatchewan Research Council
Gunnar Mine Demolition
Demolition Plan

Central Site

Figure 3

Saskatchewan Research Council
Gunnar Mine Demolition
Demolition Plan

West Side of Site

Figure 4

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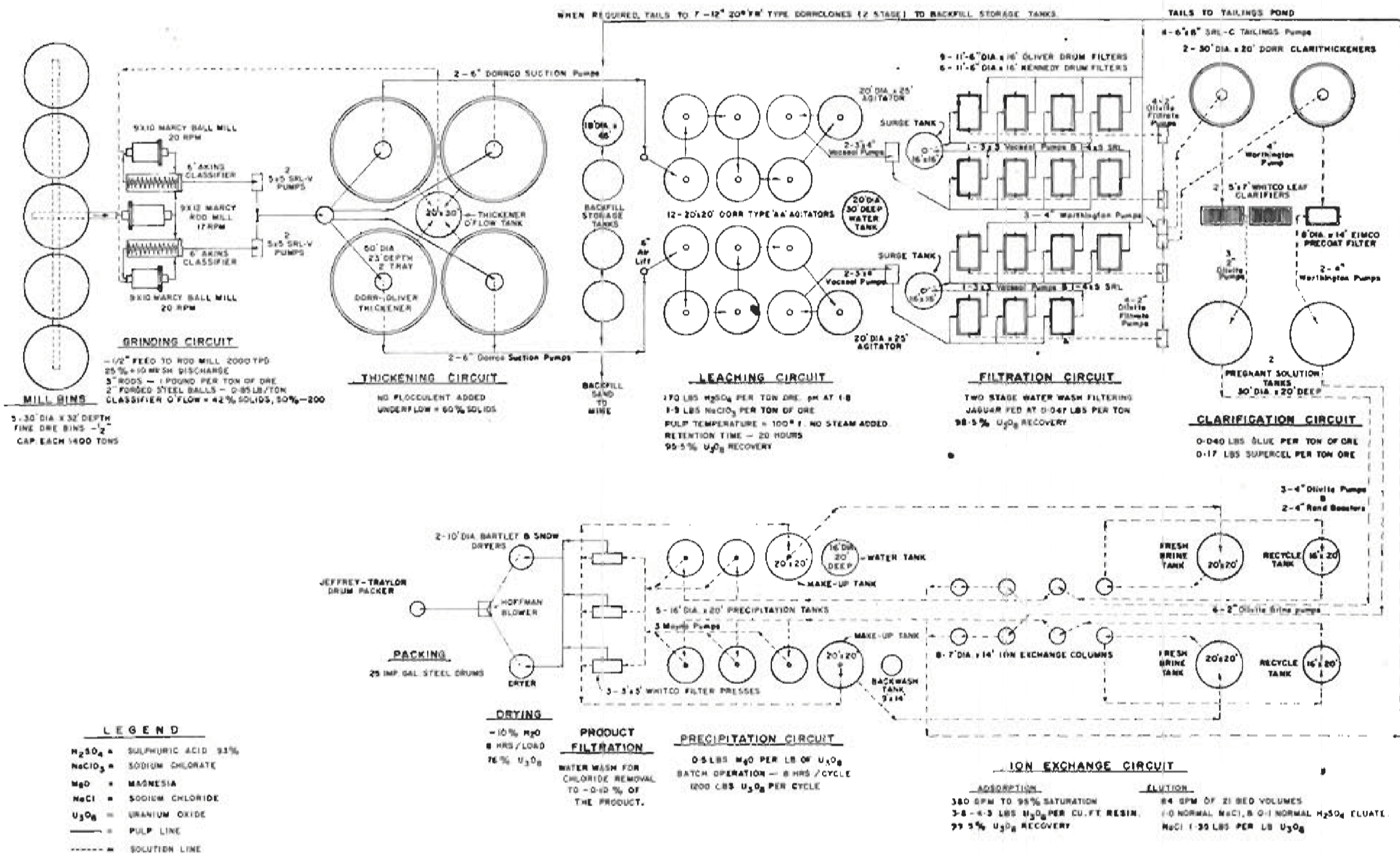

Uranium mill flowsheet.

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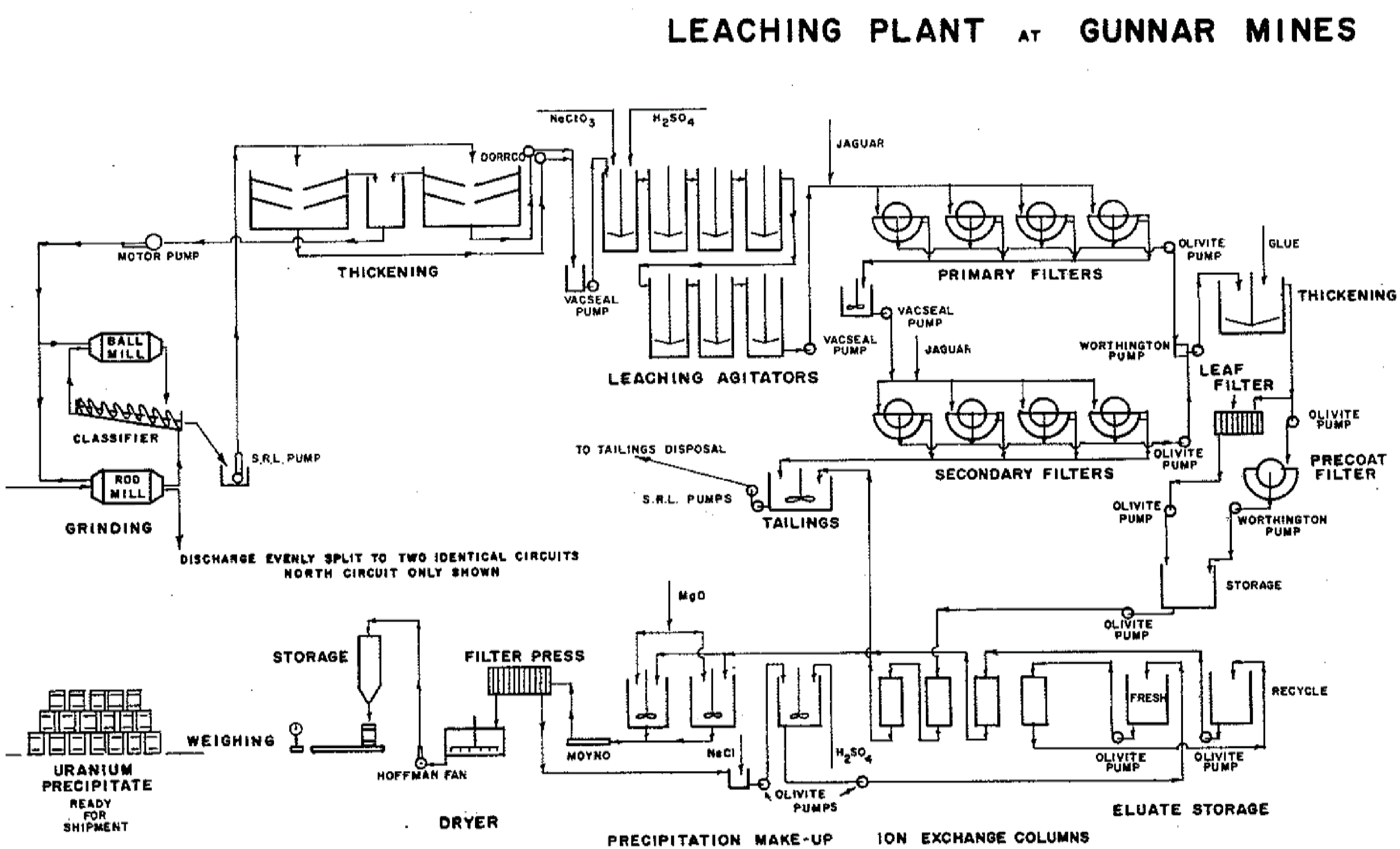
Gunnar Mine Demolition
Demolition Plan

Mill Process Flowchart

Figure 5

AECOM



Saskatchewan Research Council
Gunnar Mine Demolition
Demolition Plan

Leaching System Flowchart

Figure 6

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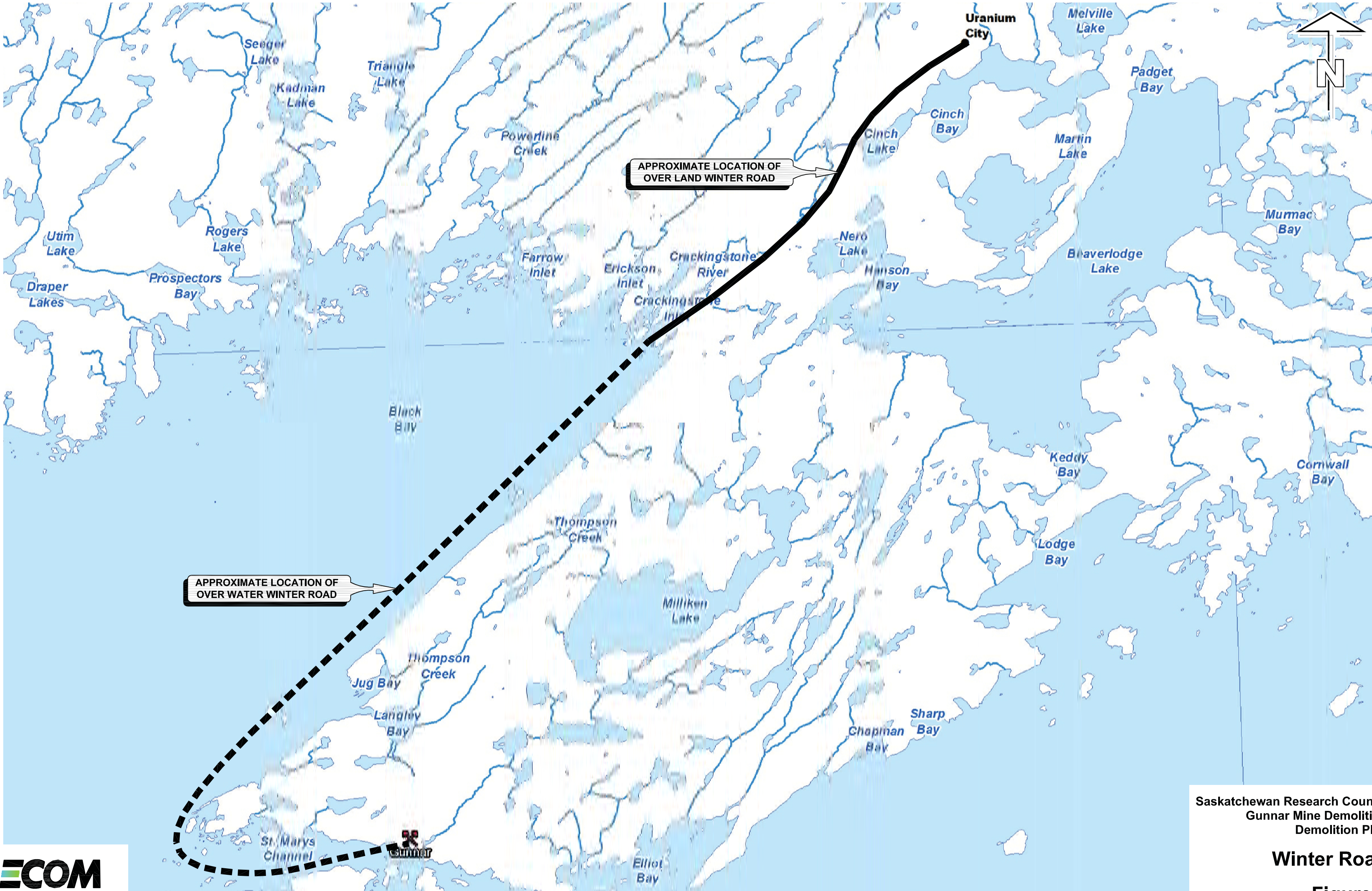

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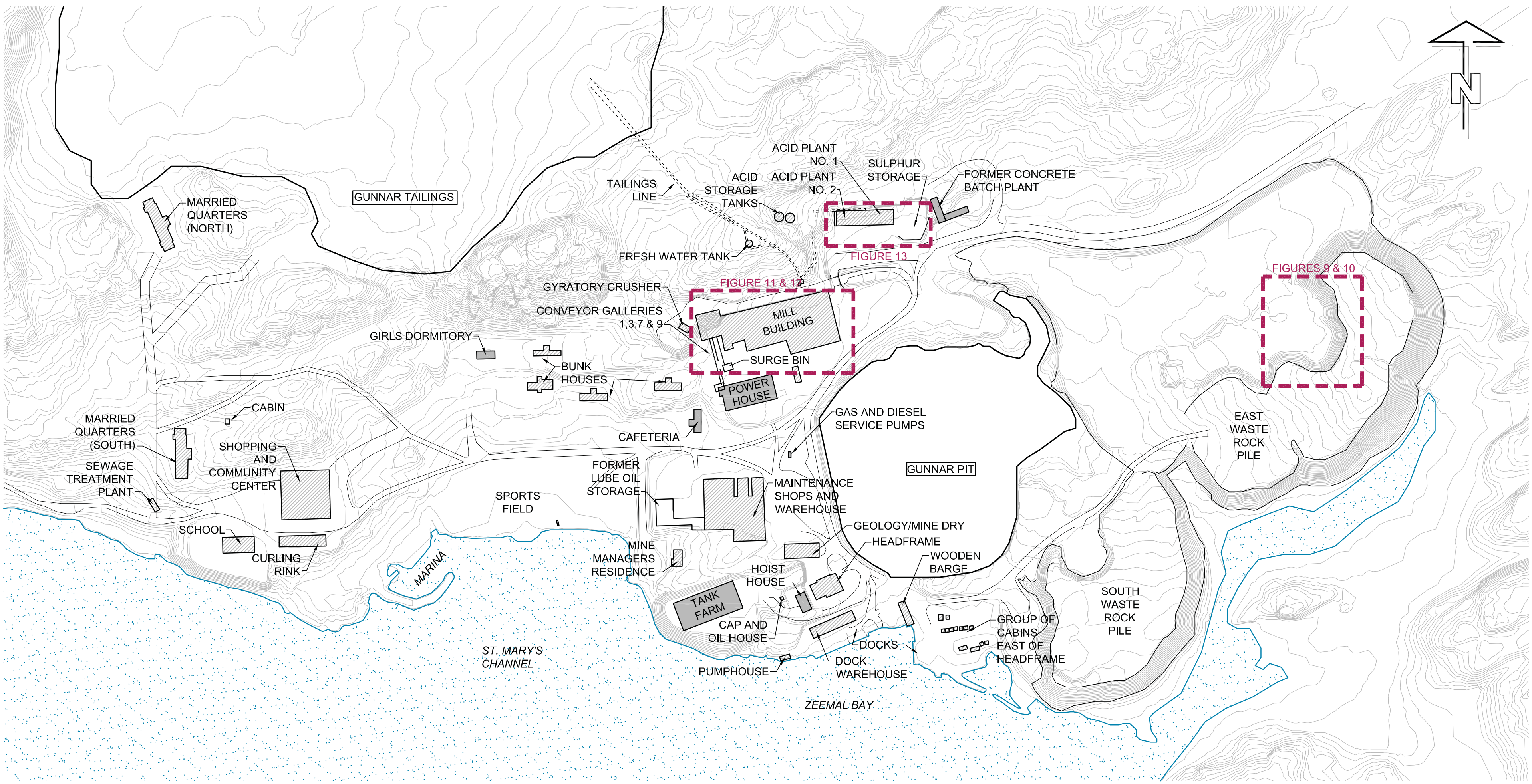
Gunnar Mine Demolition
Demolition Plan

Winter Road

Figure 7



LEGEND

EXISTING STRUCTURE

PREVIOUSLY DEMOLISHED STRUCTURE

Saskatchewan Research Council
Gunnar Mine Demolition
Demolition Plan

Site Plan

Figure 8

AECOM

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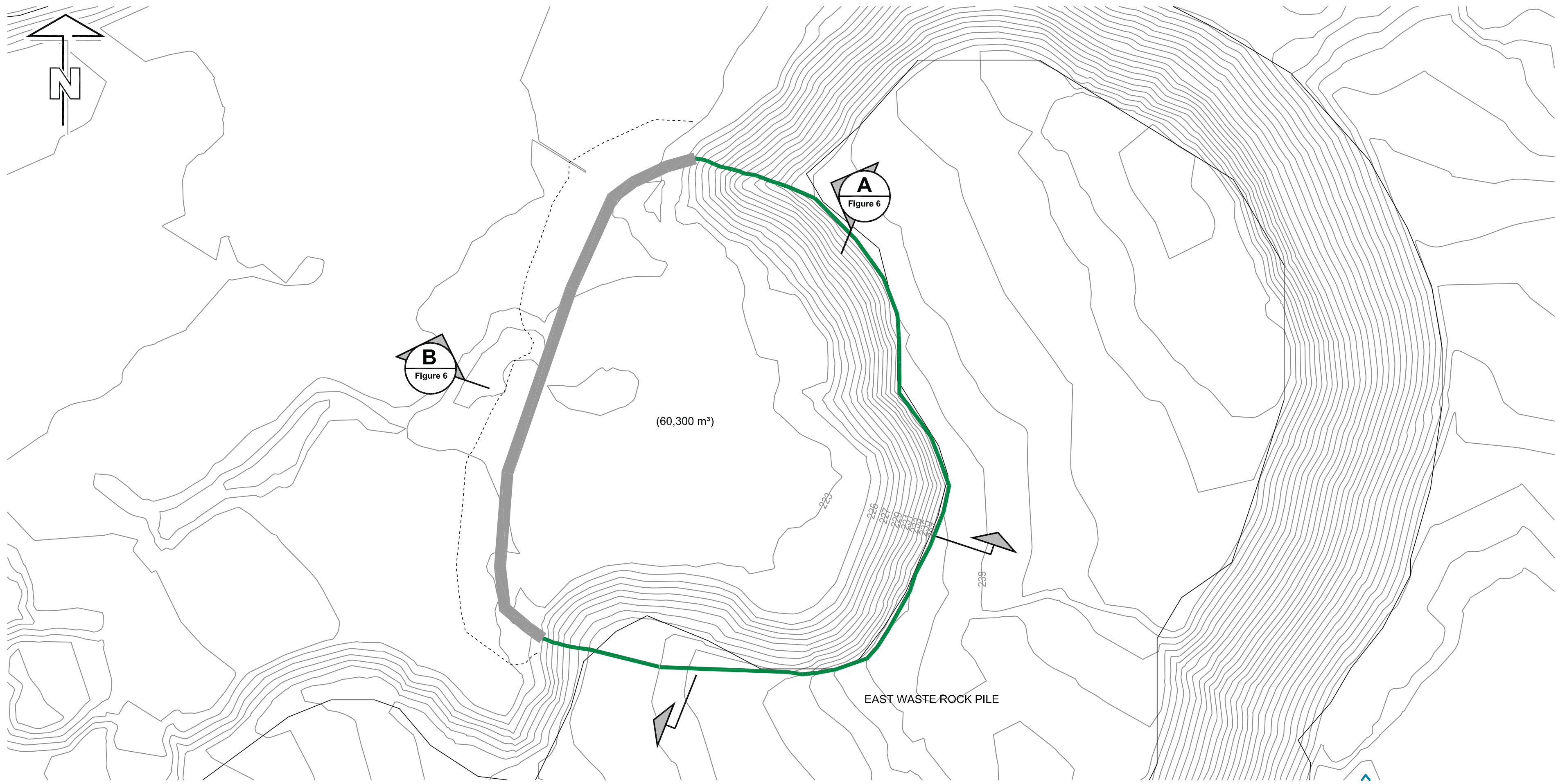

LEGEND

- LANDFILL BOUNDARY
- 3.0 m WIDE CONTAINMENT BERM
- TOE OF BERM
- 220 1.0 m CONTOUR

0 10 20 m SCALE 1:1000

Saskatchewan Research Council
Gunnar Mine Demolition
Demolition Plan

Temporary Storage Cell 1
Waste Rock - Plan
Figure 9

AECOM

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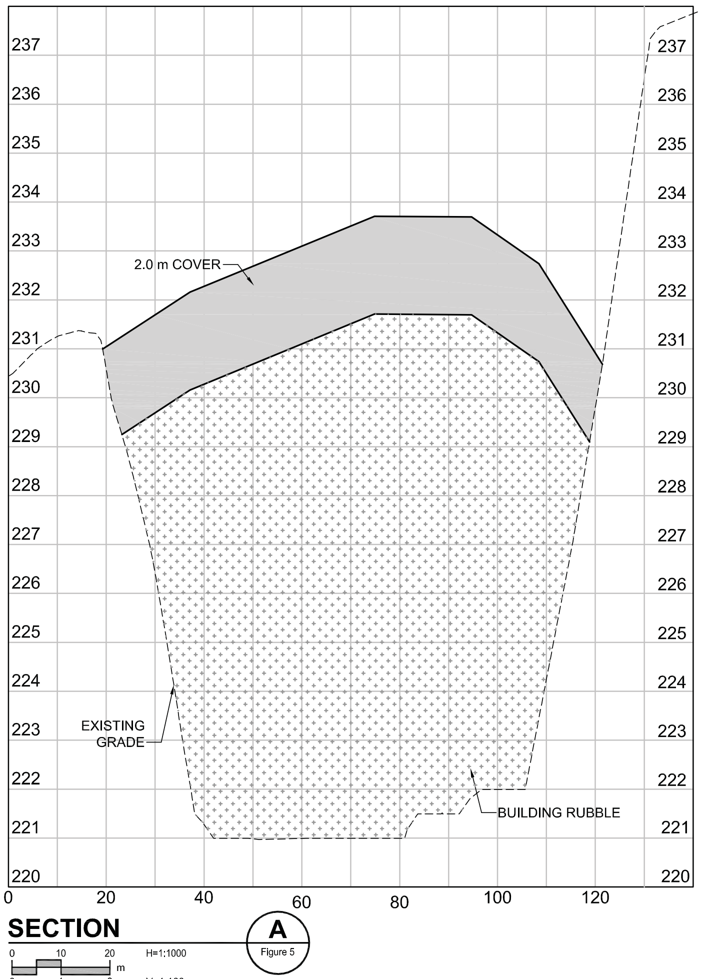

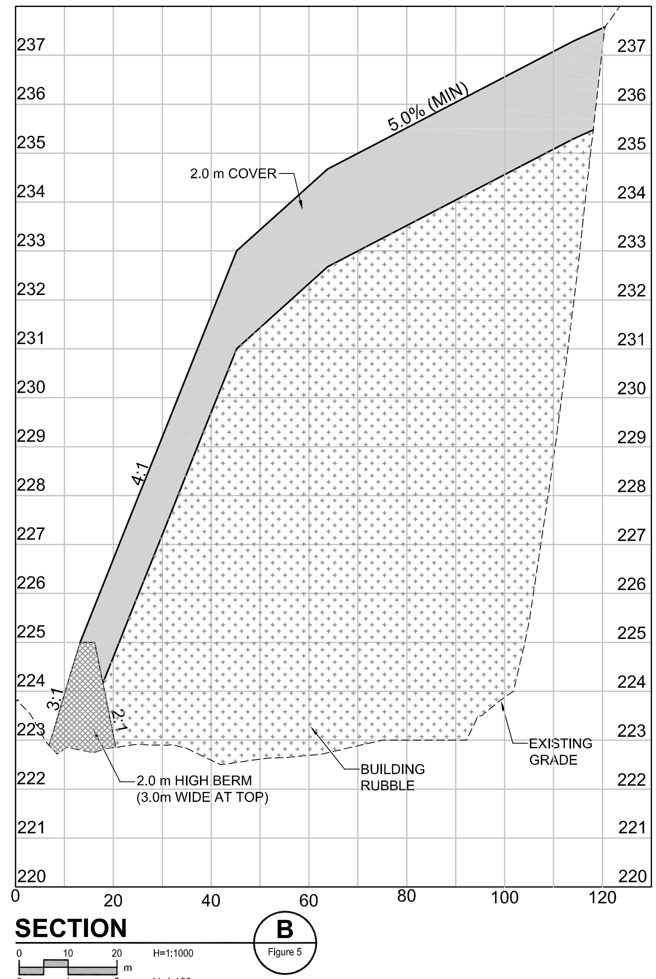

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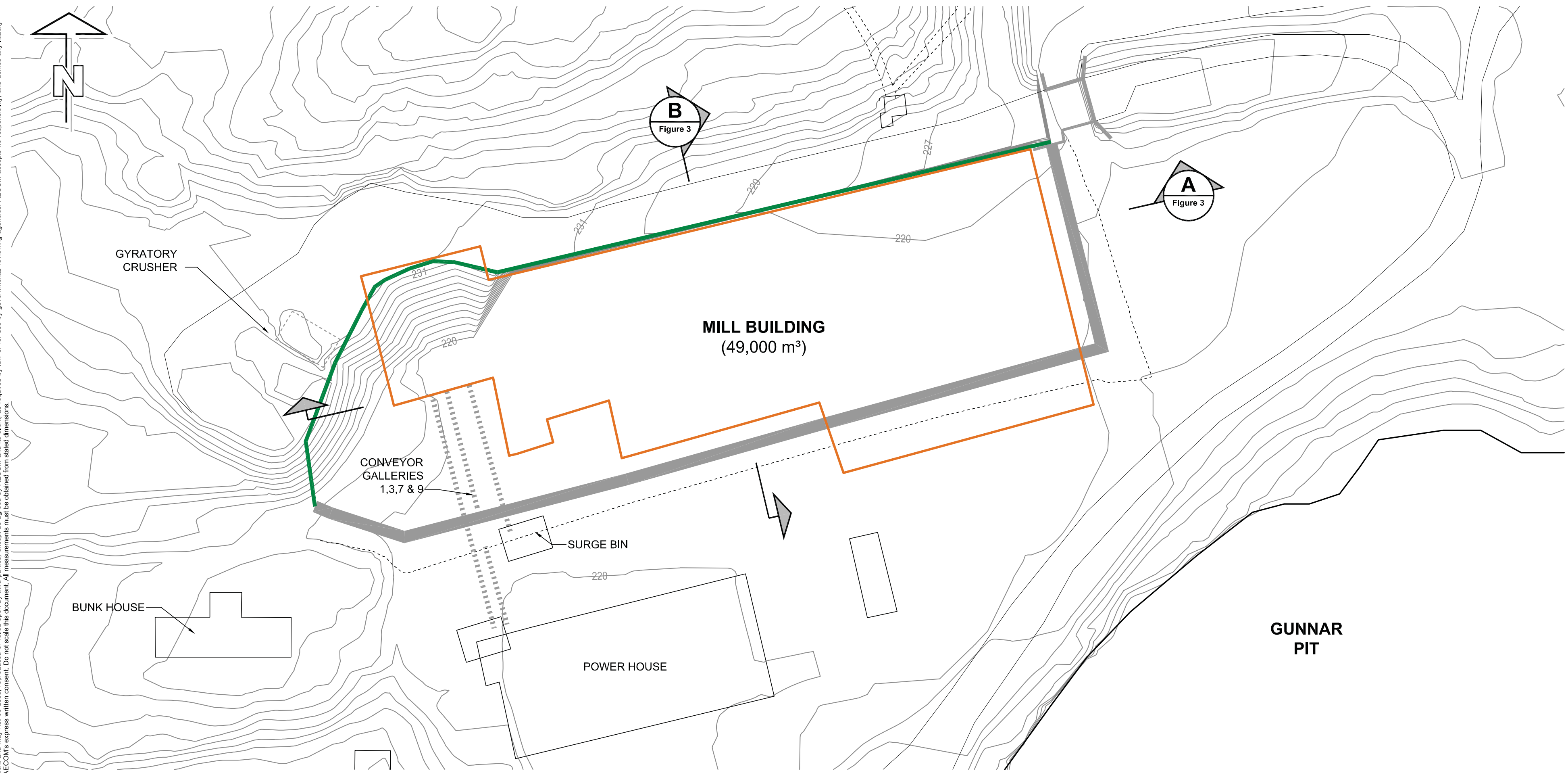
Saskatchewan Research Council
Gunnar Mine Demolition
Demolition Plan

Temporary Storage Cell 1
Waste Rock - Sections

Figure 10



LEGEND

- LANDFILL BOUNDARY
- 3.0 m WIDE CONTAINMENT BERM
- TOE OF BERM
- BUILDING FOUNDATION
- 220 — 1.0 m CONTOUR

Saskatchewan Research Council
Gunnar Mine Demolition
Demolition Plan

Temporary Storage Cell 2
Mill - Plan

Figure 11

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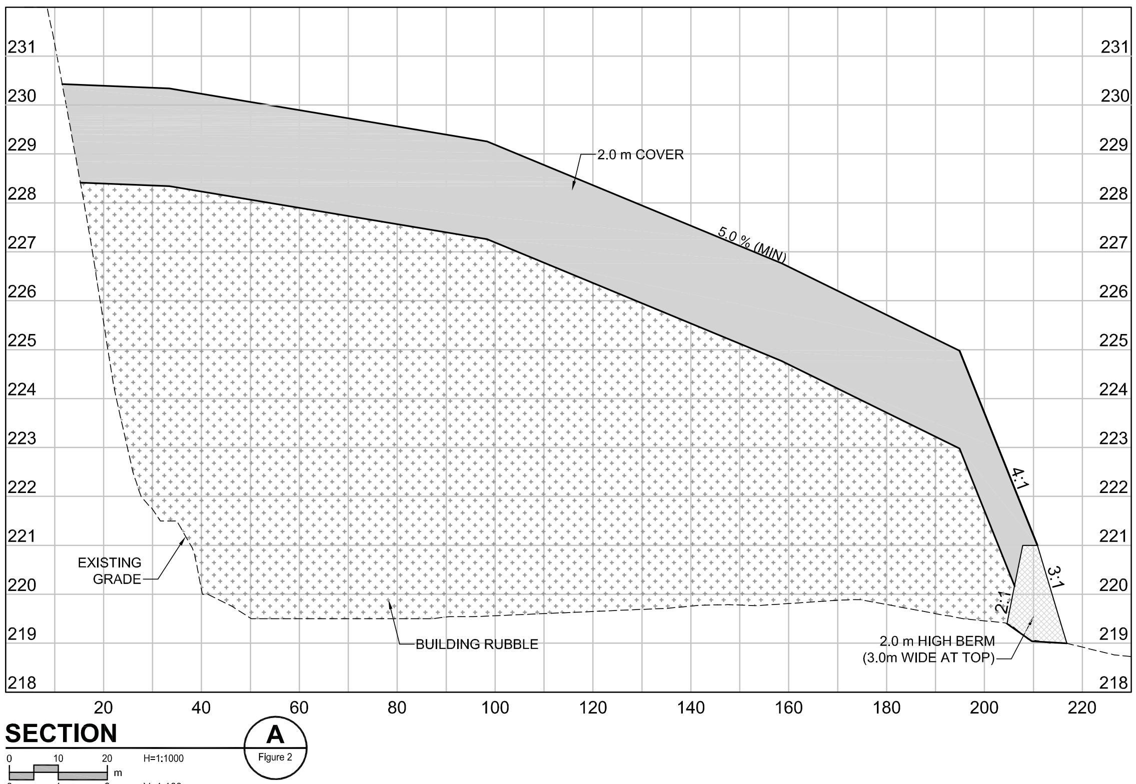

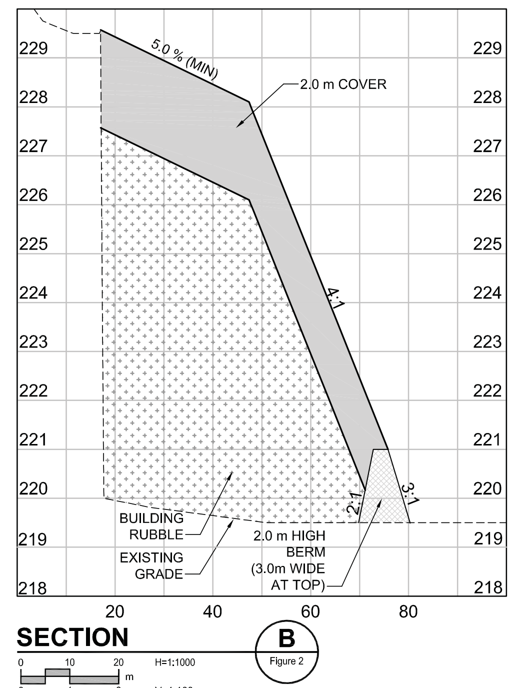

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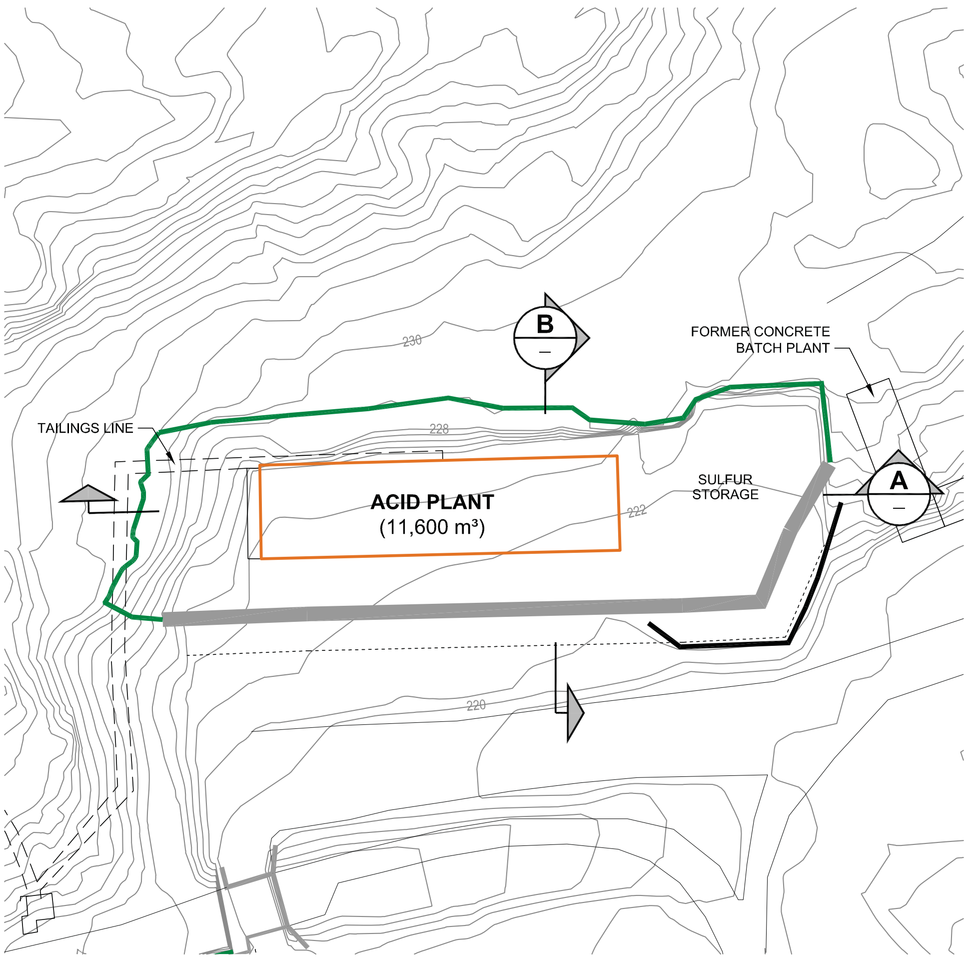
AECOM

Saskatchewan Research Council
Gunnar Mine Demolition
Demolition Plan

Temporary Storage Cell 2
Mill - Sections

Figure 12



LEGEND

- LANDFILL BOUNDARY
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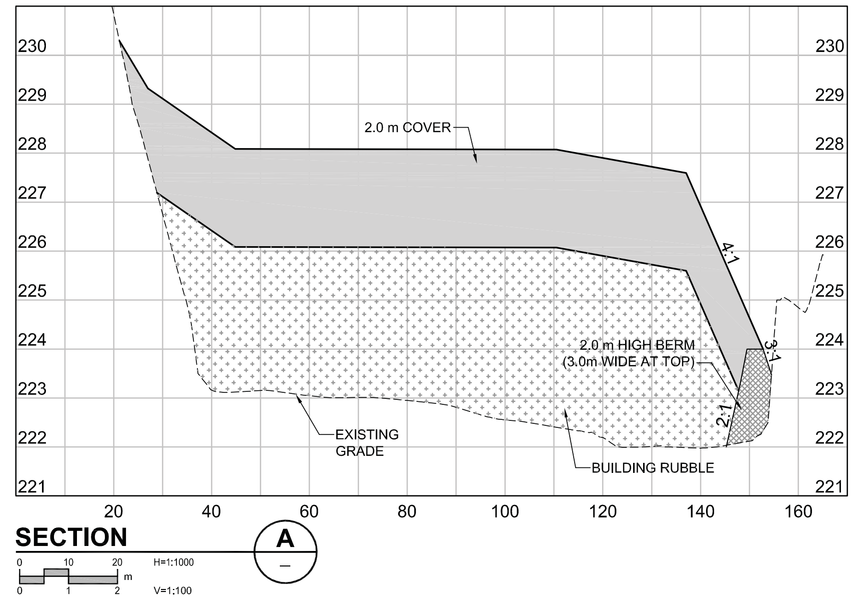
- TOE OF BERM
- BUILDING FOUNDATION
- 220 1.0 m CONTOUR

0 10 20 m SCALE 1:1000



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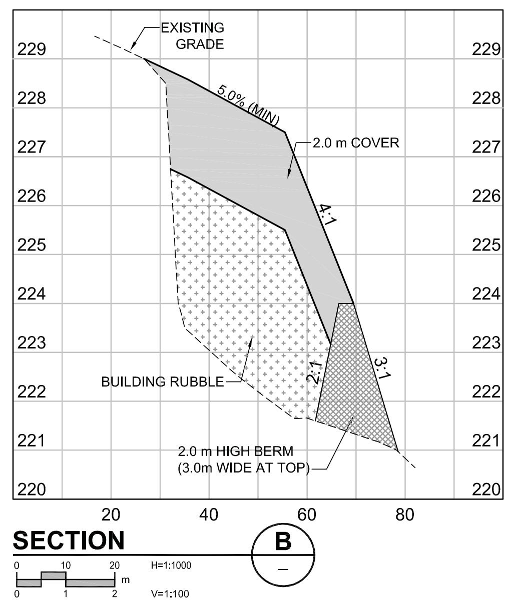

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Saskatchewan Research Council
Gunnar Mine Demolition
Demolition Plan

Temporary Storage Cell 3
Acid Plant

Figure 13

AECOM

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Appendix A

Site Photographs

Photograph 1 ↑
Acid Plants

Photograph 2 ↑
Acid Plants

Photograph 3 ↑
Acid Plants

Photograph 4 ↑
Acid Plants

Photograph 5 ↑
Acid Plants

Photograph 6 ↑
Acid Plants

Photograph 7 ↑
Acid Plants

Photograph 8 ↑
Acid Plants

Photograph 9 ↑
Apartments 1 and 2-01

Photograph 10 ↑
Apartments 1 and 2-02

Photograph 11 ↑
Apartments 1 and 2-03

Photograph 12 ↑
Apartments 1 and 2-04

Photograph 13 ↑
Apartments 1 and 2-05

Photograph 14 ↑
Apartments 1 and 2-06

Photograph 15 ↑
Apartments 1 and 2-07

Photograph 16 ↑
Apartments 1 and 2-08

Photograph 17 ↑
Barge-01

Photograph 18 ↑
Barge-02

Photograph 19 ↑
Barge-03

Photograph 20 ↑
Barge-04

Photograph 21 ↑
Bunkhouses-01

Photograph 22 ↑
Bunkhouses-02

Photograph 23 ↑
Bunkhouses-03

Photograph 24 ↑
Bunkhouses-04

Photograph 25 ↑
Bunkhouses-05

Photograph 26 ↑
Bunkhouses-06

Photograph 27 ↑
Bunkhouses-07

Photograph 28 ↑
Bunkhouses-08

Photograph 29 ↑
Cabins East of Mine-01

Photograph 30↑
Cabins East of Mine-02

Photograph 31 ↑
Curling Rink-01

Photograph 32 ↑
Curling Rink-02

Photograph 33 ↑
Curling Rink-03

Photograph 34 ↑
Curling Rink-04

Photograph 35 ↑
Headframe-01

Photograph 36 ↑
Headframe-02

Photograph 37 ↑
Headframe-03

Photograph 38 ↑
Headframe-04

Photograph 39 ↑
Headframe-05

Photograph 40 ↑
Headframe-06

Photograph 41 ↑
Headframe-07

Photograph 42 ↑
Headframe-08

Photograph 43 ↑
Maint. Bldg.-01

Photograph 44 ↑
Maint. Bldg.-02

Photograph 45 ↑
Maint. Bldg.-03

Photograph 46 ↑
Maint. Bldg.-04

Photograph 47 ↑
Maint. Bldg.-05

Photograph 48 ↑
Maint. Bldg.-06

Photograph 49 ↑
Maint. Bldg.-07

Photograph 50 ↑
Maint. Bldg.-08

Photograph 51 ↑
Maint. Bldg.-09

Photograph 52 ↑
Maint. Bldg.-10

Photograph 53 ↑
Maint. Bldg.-11

Photograph 54 ↑
Maint. Bldg.-12

Photograph 55 ↑
Maint. Bldg.-13

Photograph 56 ↑
Maint. Bldg.-14

Photograph 57 ↑
Mill-01

Photograph 58 ↑
Mill-02

Photograph 59 ↑
Mill-03

Photograph 60 ↑
Mill-04

Photograph 61 ↑
Mill-05

Photograph 62 ↑
Mill-06

Photograph 63 ↑
Mill-07

Photograph 64 ↑
Mill-08

Photograph 65 ↑
Mill-09

Photograph 66 ↑
Mill-10

Photograph 67 ↑
Mill-11

Photograph 68 ↑
Mill-12

Photograph 69 ↑
Mill-13

Photograph 70 ↑
Mill-14

Photograph 71 ↑
Mill-15

Photograph 72 ↑
Mill-16

Photograph 73 ↑
Mine Dry-01

Photograph 74 ↑
Mine Dry-02

Photograph 75 ↑
Mine Dry-03

Photograph 76 ↑
Mine Dry-04

Photograph 77 ↑
Power Plant-01

Photograph 78 ↑
Power Plant-02

Photograph 79 ↑
Power Plant-03

Photograph 80 ↑
Power Plant-04

Photograph 81 ↑
Power Plant-05

Photograph 82 ↑
Power Plant-06

Photograph 83 ↑
Power Plant-07

Photograph 84 ↑
Power Plant-08

Photograph 85 ↑
Rec Centre-01

Photograph 86 ↑
Rec Centre-02

Photograph 87 ↑
Rec Centre-03

Photograph 88 ↑
Rec Centre-04

Photograph 89 ↑
Rec Centre-05

Photograph 90 ↑
Rec Centre-06

Photograph 91 ↑
Rec Centre-07

Photograph 92 ↑
Rec Centre-08

Photograph 93 ↑
School-01

Photograph 94 ↑
School-02

Photograph 95 ↑
School-03

Photograph 96 ↑
School-04

Photograph 97 ↑
School-05

Photograph 98 ↑
School-06

Photograph 99 ↑
Misc-01

Photograph 100 ↑
Misc-02

Photograph 101 ↑
Misc-03

Photograph 102 ↑
Misc-04

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Misc-05

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Misc-06

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Misc-09

Photograph 108 ↑
Misc-10

Photograph 109 ↑
Misc-11

Photograph 110 ↑
Misc-12

Photograph 111 ↑
Tailings and Utilidors-01

Photograph 112 ↑
Tailings and Utilidors-02

Photograph 113 🡹
Tailings and Utilidors-03

Photograph 114 🡹
Tailings and Utilidors-04

Photograph 115 🡹
Tailings and Utilidors-05

Photograph 116 🡹
Tailings and Utilidors-06

Photograph 117 ↑
Tailings and Utilidors-07

Photograph 118 ↑
Tailings and Utilidors-08

Photograph 119 ↑
Warehouse-01

Photograph 120 ↑
Warehouse-02

Photograph 121 🡅
Warehouse-03

Photograph 122 🡅
Warehouse-04

Photograph 123 🡅
Warehouse-05

Photograph 124 🡅
Warehouse-06

Photograph 125 ↑
Warehouse-07

Photograph 126 ↑
Warehouse-08

Demolition of Wooden Buildings – Before and After, October 15, 2010.

1099 – Demolition of the east cabins.

1344 – Debris covered with clean waste rock.

1104 – Demolition of the Barge.

1203 – Debris removed to the waste rock dump.

1108 – Demolition of bunk house #2

1229 – Debris covered with clean waste rock.

Demolition of Wooden Buildings – Before and After, October 15, 2010.

1144 – Demolition of bunk house #1.

1235 – Debris covered with clean waste rock.

1152 – Demolition of bunk house #4.

1290 – Debris covered with clean waste rock.

1156 – Demolition of the mine manager's residence.

1254 – Debris covered with clean waste rock.

Demolition of Wooden Buildings – Before and After, October 15, 2010.

1161 – Demolition of apartment building #1.

1222 – Debris covered with clean waste.

1165 – Demolition of apartment building #4.

1248 – Debris covered with clean waste rock.

1181 – Demolition of apartment building #2.

1266 – Debris covered with clean waste rock.

Demolition of Wooden Buildings – Before and After, October 15, 2010.

1182 – Demolition of west cabin from the marina.

1295 – Removal of debris.

1376 – Demolition of the school.

1394 – Debris covered with clean waste rock.

Appendix B

Sulphur Handling Hazards

Precautions for Handling, Moving, and the Prevention and Fighting of Sulphur Fires

1. Fire Prevention

The advice on precautions of handling and working around sulphur is taken from NEW ZEALAND HEALTH AND SAFETY IN EMPLOYMENT ACT 1992 APPROVED CODE OF PRACTICE FOR THE PREVENTION OF SULPHUR FIRES AND EXPLOSIONS (http:// www.osh.dol.govt.nz/order/catalogue/pdf/sulphur.pdf).

1.1 Handling Sulphur

Sulphur dust suspended in air ignites easily, and can cause an explosion in confined areas. Sulphur may be ignited by friction, static electricity, heat, sparks, or flames Solid sulphur is a poor conductor of electricity, and when in motion under conditions of low humidity can easily develop a sufficient static charge to cause sparking and ignition. For this reason, fine, dry sulphur dust must not be allowed to fall freely in air.

1.1.1 Minimization of Dust

To prevent dust formation during the storage and handling of sulphur, enclosures should be constructed with a minimum number of horizontal surfaces where dust can accumulate. Scattering of dust where solid sulphur is transferred from one point to another should be avoided. Where feasible, dust-tight housings or extraction hoods should be provided.

Compressed air to remove dust from any surface, vigorous sweeping or any other method of cleaning which may raise a dust cloud is prohibited.

Every care must be taken to prevent static electricity accumulation in areas where solid sulphur is handled. If the relative humidity of the air is above 60%, the possibility of static build-up is reduced.

1.1.2 Moving Powdered Sulphur

Long sulphur drops from overhead gantries into the store should be avoided by discharging near the top of the existing sulphur pile. Alternatively, dust formation can be reduced using a telescoping spout, preferably made from aluminum. Where this is not possible or practical, the sulphur shall be dampened to minimize dust cloud formation.

Bulk accumulations of fine sulphur may also be removed using soft push brooms, having natural bristles and non-sparking scoops or shovels before vacuum cleaning equipment is used.

Aluminum is the best all-round material for fabricating bins containing sulphur, because it is non-sparking and resistant to corrosion. Where interior structures have horizontal surfaces on which sulphur dust may collect, these should be roofed with steeply sloping upper surfaces of at least 60º.

1.1.2.1 FRONT-END LOADERS

Unmodified front-end loaders powered by diesel or other fossil fuels are a source of ignition. They must be equipped with spark arrestors and protected muffler and exhaust systems, when used in areas where the sulphur contains

10% or more fines. The temperature rating of the engine and exhaust system shall be T5, which allows for a maximum surface temperature of 100ºC.

The buckets of front-end loaders are generally manufactured from hardened alloy steels, which in contact with concrete can produce incendiary sparks and ignition of sulphur. There is no firm evidence, however, that the so called “non sparking” metals such as bronzes are any safer in this respect, as these can also generate sparks in contact with concrete which are hotter than those produced by steel. (The non-sparking metals generally do not spark in contact with steel but there are also exceptions, e.g. when the steel is rusty.) This means that when working with front-end loaders care must be exercised to avoid raising dust clouds as far as possible and to prevent the bucket from scraping along the concrete.

1.2 PPE for Solid Sulphur

1.2.1 Eye Protection

Dust-tight safety goggles shall be available to workers.

1.2.2 Respiratory Protection

Although sulphur is essentially non toxic, dust respirators should be worn for greater employee comfort. Breathing apparatus suitable for use in atmospheres containing sulphur dioxide shall be available for emergency use, in case of sulphur fires.

1.2.3 Body Protection

The use of fire-retardant overalls is recommended. As the ignition of sulphur impregnated clothing could result in serious burns, overalls should be kept as free of dust as possible. Impregnated clothing must not be worn. Workers whose skin may be sensitive to sulphur dust should wear PVC or rubber gloves.

1.3 No Smoking, No Open Fires, No Sources of Ignition

Smoking and the use of matches shall be prohibited in all areas where sulphur dust is likely to be present. Prominent NO SMOKING signs shall be placed around such areas.

Naked flames or lights and the use of gas cutting or welding equipment is prohibited during the normal operation of the plant. Repairs involving the use of flames, heat, or hand or power tools in areas where sulphur may be present shall be made only after all sulphur-handling machinery and operations are shut down, and a hot work permit of the type illustrated in Appendix 3 completed. Where practical, all sulphur shall be removed. Where this is not possible the sulphur shall be wetted down, and workers provided with an assured supply of fresh air and a hose line with spray nozzle to extinguish fires.

1.3.1 Avoid Oxidizing Agents

Solid sulphur is capable of forming explosive mixtures when mixed with chlorates, nitrates or other oxidizing agents. Where practical, it is recommended that nitrates or other oxidizing materials are stored in completely separate buildings from sulphur with their own loading facilities. If this is not possible, bins for these products need to be separated from the sulphur by at least 30 meters.

1.4 Burns and First Aid

First-degree burns can result from splashes of liquid sulphur on skin and clothing. The sulphur will rapidly solidify. Do not attempt to remove it. Immerse affected area in cold water, treat the patient for shock and obtain medical attention.

If larger amounts of liquid sulphur are in contact with the body, e.g. when someone gets a boot full of sulphur, deep third-degree burns will result. Immerse the burned area in cold water for at least 20 minutes. Do not attempt to remove affected clothing. Hospital treatment is essential

2. Fighting a Sulphur Fire

This information is taken from advice from the Georgia Sulfur Company http://www.georgiagulfsulfur.com/fires.htm.

2.1 Fire and Explosion Data

- Flashpoint: 207.2 °C
- Explosive Limits of Dust in Air: LEL 35 g/m^3 UEL 1400 g/m^3
- Auto-ignition Temperature: 248-266 °C
- Extinguishing Media: Water fog, spray, or regular foam. DO NOT use a direct water stream.

Burning Sulphur decomposes into TOXIC sulphur oxide gases such as: Sulphur dioxide (SO_2) and Hydrogen sulfide (H_2S).

2.2 Primary Hazard:

- Sulphur dust suspended in air ignites easily, and can cause an explosion in confined areas.
- May be ignited by friction, static electricity, heat, sparks, or flames.
- Toxic gases will form upon combustion.
- Bulk/solid forms burn only at moderate rate, whereas dust burns with explosive violence.

2.3 Fire:

- Wear full-faced, self-contained breathing apparatus and full protective clothing.
- Use a water fog to extinguish fire.
- DO NOT use solid streams of water; which could create sulphur dust clouds and cause an explosion or move burning sulphur to adjacent areas.
- Fire will rekindle until mass is cooled below 154 °C. Cool surrounding areas with water fog to prevent re-igniting. Cool containers, tank cars, or trailer loads with flooding quantities of water until well after fire is out.
- Evacuate nonessential personnel from the fire area. If large fire, evacuate people downwind from fire. Isolate for ½ mile in all directions; consider evacuation for ½ mile in all directions. Prevent human exposure to smoke, fumes, or products of combustion (sulphur oxide gases).
- Firemen exposed to contaminated smoke should be immediately relieved and checked for symptoms of exposure to toxic gasses. Seek medical attention immediately! This should not be mistaken for heat exhaustion or smoke inhalation. These are extremely irritating to the respiratory tract and may cause breathing difficulty and pulmonary edema. Symptoms may be delayed several hours or longer depending upon exposure.

2.4 Additional Information:

- Incipient fires in sulphur storage piles can be frequently smothered by gently shovelling more sulphur, sand, or fine earth on them to exclude all air.
- For larger fires, water applied as a fine mist is the most useful agent.
- High pressure water sprays disperse the dust into the air and should not be used. Coarser water sprays are permissible on deposits containing only a small proportion of extreme sulphur fines.

Steam or inert gases are excellent extinguishers for use in containers that can be closed tightly. Care should be taken that the sulphur dust is not scattered into the air. If a container is closed tightly and the volume of oxygen enclosed is not too large, a fire will be put out by the sulphur dioxide formed. Sulphur dioxide is a toxic gas.

Firefighters handling larger fires should be equipped with breathing apparatus with a self contained air supply. Gas masks approved for acid gases would not provide adequate protection in a serious sulphur fire. In all cases, it should be certain that the fire is fully extinguished before disturbing the dust and that the sulphur has cooled sufficiently so that it will not re-ignite.

Workplace Health and Safety

Bulletin

WORK SAFE ALBERTA

Handling Sulphur

Recommended procedures for the safe handling and processing of solid sulphur in new facilities

General

- The latest revision of the National Fire Protection Association's Standard on the Prevention of Sulphur Fires and Explosions (NFPA No. 655) should be used as a reference.
- These procedures are intended to establish standards of practice in the design, construction, operation and maintenance of sulphur facilities in Alberta.
- New facility means any facility presently under design or any modification to an existing facility.

Buildings

- Buildings housing any equipment in which sulphur is handled or processed should be constructed with fire resistant materials.
- Where practical, dust producing processes should be confined and isolated.

Government of Alberta
Employment and Immigration

- Where possible, to prevent accumulation of dust, the design of the building should be such and the structural members so sloped and assembled or protected as to present the least possible surface (other than floor) on which the dust can lodge.

- Floor drains or troughs or gutters should be provided to carry off water from any area where cleaning is accomplished by flushing with hose streams.

- It is recommended that during the design stage and operating phase every effort be made to minimize the possibility of rusty metal components scraping or striking objects that may cause sparking inside the building during normal operations and/or failure, collapsing or falling situations. Metal surfaces of carbon steel, structural steel, hoppers, equipment, tools, etc. should be protected from iron oxide formation at all times by painting, covering or use of other types of metals where practical.

Explosion vents

- All parts of any building where sulphur dust may be present or handled should have adequate explosion proof vents.

- Building vents should be distributed as uniformly as possible to provide adequate ventilation consistent with good engineering practices.

- All parts of the building in which dust may be raised should be vented to the outside air.

- The design and installation of explosion proof vents should be assigned to a competent person who is familiar with their operation and effectiveness.

Bins

- All interior bins handling sulphur dust should be provided with facilities to prevent blowing or dust dispersion inside the building due to the displacement of air during filling.

- Sulphur bins should be filled and emptied through dust tight spouts or chutes.

Dust collection

- Dust should not be allowed to accumulate in any part of any building or structure. Dust should be carefully removed from the walls, floors, and machinery of the plant at regular intervals.

- Blowing down of any surface by compressed air or other gases in a confined space should not be allowed.

- Where floor drains or troughs or gutters are provided for the removal of dust, the dust may be washed down the drain, trough or gutter using water hoses. Where drains, troughs or gutters are not provided, the dust should be carefully collected and removed.

- Where there is a provision for the collection of dust by vacuum systems, the systems should be designed such that the build up of static electricity is prevented. Non-conducting ducts or hoses should not be used unless effectively bonded.

- Vacuum cleaners or other electrical devices for cleaning are required to be certified for use in the appropriate class and group of the Canadian Standards Association (CSA) Electrical Code Standards.

Hand tools, power tools, welding

- Before any repair or maintenance work including any welding, burning and cutting is undertaken on any machinery or equipment, the area within which it is to be undertaken plus an additional space of 2 metres all around, should first be carefully cleaned so that there is no sulphur dust present. If impractical, other acceptable prevention measures should be taken, i.e. covering, wetting, steam blanketing, etc.

- On completion of any burning, cutting or welding, the surrounding area should be carefully examined to ensure that no residual fragments or particles of burned or heated materials are left.

- Electrical power tools or any other piece of electrical equipment are required to be approved for use according to the appropriate class and group of the Canadian Electrical Code.

Ventilation

- Relative humidity should be maintained as high as practical inside enclosed area where dust is expected to be in suspension.

Electrical

- The electrical installation and electrical equipment are required to be constructed and installed in accordance with regulations adopted under the provisions of the *Safety Codes Act* of Alberta.

- Portable battery powered devices are required to be approved for use in the appropriate hazardous area.

Conveyor and V-Belts

- Where practical, conveyor belts should be of a type that are both fire resistant and anti-static. Provision for static discharge devices should be installed where it is impractical to use such type of conveyor belts.

- V-belts that drive machinery in an enclosed area should be fire resistant and anti-static.

Hydraulic oils in equipment in enclosed areas

- Oils used in enclosed areas for hydraulic circuits should be of fire resistant grade. Similar oils should also be used for any traction purposes, where practical.

Gasoline and diesel equipment

- Gasoline and diesel powered equipment should not be used in enclosed hazardous areas without special precautions such as a hot work permit.

Smoking

- Smoking is not allowed in any building in which sulphur is handled or processed.
- Local municipality and plant company regulations apply.

Developed jointly (April 1991) by:

- Industrial Task Force Hazards of Sulphur Handling Committee
- Alberta Human Resources and Employment

Industry endorsement from:

- Canterra Energy Ltd.
- Petrogas Processing Ltd.
- Chevron Standards Ltd.
- Shell Canada Resources Ltd.
- Procor Limited Sulphur Services Division
- Amoco Canada Petroleum Company Ltd.

Labour endorsement in principal from:

- Energy and Chemical Workers Union

Reviewed and minor revisions by Alberta Employment and Immigration, January 2010.

Contact us:

Province-Wide Contact Centre

Edmonton & surrounding area:
780-415-8690

Throughout Alberta:
1-866-415-8690

Deaf or hearing impaired
- In Edmonton: **780-427-9999**

or
- **1-800-232-7215** throughout Alberta

Web Site

www.worksafe.alberta.ca

Getting copies of OHS Act, Regulation & Code:

Queen's Printer

www.qp.gov.ab.ca

Edmonton 780-427-4952

Workplace Health and Safety

http://employment.alberta.ca/whs-ohs

Call any Government of Alberta office toll-free
Dial 310-0000, then the area code and telephone number you want to reach

Keyera Energy Ltd

Material Safety Data Sheet

SULPHUR

1. MATERIAL INFORMATION:

Material Identifier – Sulphur (Liquid and Solid)

Manufacturer:	Keyera Energy Ltd
Emergency Tel:	1-866-377-7110
Address:	Suite 600 Sun Life Plaza West Tower 144 - 4th Avenue SW Calgary, Alberta T2P 3N4
Fax Number:	1-403-205-7664

Description: Molten or liquid elemental sulphur. In liquid form liquid sulphur is a light-yellow to amber liquid with a temperature of at least 127 C/ 260 F, which may contain small amounts of hydrogen sulphide and sulphur dioxide. Solid sulphur is a bright yellow.

Chemical Identity: Sulphur

Formula: S

Synonyms/Trade Names: Elemental sulphur, S8, brimstone, molten sulphur, and solid sulphur.

Material Use: Sulphur is used as a raw material in the manufacture of sulphuric acid, as a soil conditioner, in pesticides, in rubber vulcanizing and other chemical processes.

2. HAZARDOUS INGREDIENTS:

Ingredients	Conc (%)	CAS No.	TLV-TWA 8hr.	STEL	Ceiling
Sulphur	100	7704-34-9	10 mg/m3 (Alberta)	None	None
Sulphur Dioxide	Varies	7446-09-5	2ppm (ACGIH) 2ppm (Alberta)	5ppm (ACGIH) 5ppm (Alberta)	None
Hydrogen Sulphide	Varies	7783-06-4	10ppm (ACGIH) 10ppm (Alberta)	15ppm (ACGIH) 15ppm (Alberta)	None (ACGIH) 15ppm (Alberta)

Sulphur dust may be produced in areas or equipment where molten material is permitted to solidify. Sulphur dioxide and hydrogen sulphide may be released from hot, molten sulphur in varying concentrations depending on source. Hydrogen sulphide may cause irritation, breathing failure, coma & death, without necessarily any warning odour being sensed.

3. REGULATORY CLASSIFICATION:

WHMIS: Class B, Division 4 – Flammable Solid
Class D, Division 1A - Very Toxic Material
Class D, Division 2B - Toxic Material Skin or Eye irritant.

TDG: Shipping Name – Sulphur, Molten
Class 4.1, Flammable Solid
P.I.N. – UN 2448 (Molten)
P.I.N. – UN 1350 (Solid Sulphur)
Packing Group – III

4. HEALTH HAZARD INFORMATION:

NATURE OF HAZARD

Inhalation: Sulphur fumes or dust may be generated if molten material cools and can cause irritation to mucous membranes of the nose, throat and upper respiratory tract. Small amounts of sulphur dioxide and hydrogen sulphide may be released from hot, molten sulphur. Vapour space of container may contain TOXIC concentrations of Hydrogen Sulphide, which could be fatal if inhaled. Hydrogen Sulphide is very flammable and even explosive under certain conditions. Sulphur dioxide is a strong respiratory irritant. Symptoms of exposure to sulphur dust or sulphur dioxide include: burning sensation or sore throat, coughing, wheezing, shortness of breath, headache, nausea and vomiting.

Eye Contact: Contact with molten sulphur will cause severe burns and permanent damage to eye tissue. Sulphur dust will cause eye irritation.

Skin Contact: Contact with molten sulphur will severely burn unprotected skin. Dust can cause skin irritation especially when in contact with hot, perspiring skin.

Ingestion: Sulphur itself is practically non-toxic. Liquid sulphur will cause thermal burns to the mouth, throat, and stomach.

TOXICOLOGICAL SUMMARY:

ACUTE TOXICITY DATA:

ROUTES OF ENTRY: Inhalation

TOXICITY TO HUMANS: Molten sulphur

LD50 >8437 mg/kg (oral, rat)

ACUTE EFFECTS ON HUMANS:

EYES: Dust is an eye irritant. Liquid may cause thermal burns

SKIN: Moderate irritant. Liquid may cause thermal burns

INHALATION: Sulphur fumes or dust may be generated if molten material cools and can cause irritation to mucous membranes of the nose, throat and upper respiratory tract. Small amounts of sulphur dioxide and hydrogen sulphide may be released from hot, molten sulphur. Vapour space of container may contain TOXIC concentrations of hydrogen sulphide, which could be fatal if inhaled. Hydrogen sulphide is very flammable and even explosive under certain conditions. Sulphur dioxide is a strong respiratory irritant. Symptoms of exposure to sulphur dust or sulphur dioxide include: burning sensation or sore throat, coughing, wheezing, shortness of breath, headache, nausea and vomiting.

INGESTION: Vomiting, diarrhea.

OTHER TOXICITY DATA: No Known effects.

CARCINOGENICITY: Sulphur and hydrogen sulphide are not classified by NTP (National Toxicology Program), not regulated as carcinogenic by OSHA (Occupational Safety and Health Administration), and have not been evaluated by IARC (International Agency for Research on Cancer) or ACGIH (American Conference of Governmental Industrial Hygienists).

EFFECTS OF CHRONIC EXPOSURE TO THE PRODUCT: No Known effects.

IRRITANCY: Irritant of the skin.

SENSITIZATION: No Known effects.

REPRODUCTIVE TOXICITY: No Known effects.

TERATOGENICITY: No Known effects.

MUTAGENICITY: No Known effects.

TOXICOLOGICALLY SYNERGISTIC PRODUCTS: None

5. FIRE HAZARD:

Flash Pt (°C): 207°C. (C.C.)

Auto-ignition Temp (°C): 257°C. (as liquid); 190°C. (as fine dust)

Flammable Limits (% volume): Note: Fine sulphur dust is explosive in the range of 35-1400 g/m3

General Hazards: Transported as hot liquid and may be ignited by heat, sparks or flames. May burn fiercely. Accumulations of dust in and around process equipment may explode or burn with explosive violence. May reignite after fire is extinguished. Sulphur burns with a pale blue flame that may be difficult to see in daylight.

Means of extinction: Evacuate all unnecessary personnel to upwind positions. Full-face, positive-pressure, self-contained breathing apparatus and appropriate protective clothing (chemical and heat-resistant) must be worn by all individuals required to enter hazardous areas. Avoid straight streams of water, which will scatter molten sulphur and dust. Move containing vessels from fire area if it can be done without risk. Cool containing vessels with flooding quantities of water until well after fire is out.

6. PHYSICAL DATA:

Physical State: Liquid or solid

Odour: Sulphur odour. (Hydrogen sulphide has a rotten egg odour)

Odour Threshold: N.A.

Appearance: Liquid sulphur is light-yellow to amber in colour, solid sulphur is bright yellow.

Vapour Pressure: 1mm Hg

Melting Pt (°C): 113 to122°C.

Relative Density (Specific Gravity water =1): approx 1.8

Vapour Density (Air=l): approx 3.64

pH: N.A.

Boiling Pt (°C): 444.6°C

Coeff Water/Oil Distribution: Insoluble in water.

7. PREVENTATIVE MEASURES:

Respiratory Protection: Air-purifying respirators suitable for dusts and SO2 for routine work, provided air concentrations within respirator protection limits. Full-face, positive-pressure, self-contained breathing apparatus for non-routine, emergency work or when limits are likely to exceed the OEL or TLV. Respiratory devices should be NIOSH-approved.

Skin Protection: Heat-resistant gloves, clothing and boots when in vicinity or during handling of molten sulphur or hot equipment.

Eye Protection: Full-face shields when in vicinity or during handling of molten material.

Exposure Control: Local and general ventilation to maintain dust and vapour concentrations below exposure limits and explosive levels. Use only explosion proof mechanical ventilation. Environmental controls may be required for exhaust air.

Waste Disposal: Steps to be taken if material is released or spilled: Evacuate area. Eliminate all ignition sources. Personnel required to work in hazard areas must wear full-face, positive-pressure, self-contained breathing apparatus or air-line devices and appropriate protective clothing. Stop discharge if safe. Prevent entry into waterways. Contain spill by dike or damming. Use water spray to reduce vapours. Cover with wet earth, sand or other non-combustible material. Cleanup and dispose of in accordance with federal, provincial, and municipal requirements.

Handling/Storage: Combustible. Store away from ignition sources. Prevent accumulation and suspension of sulphur dust, which may be generated from handling of solid sulphur. Equipment and conveying lines in potentially dusty areas must be grounded to prevent any build-up of static electricity. Exercise caution around hot equipment. Use protective equipment when opening tank cars (SCBA) in the event of any release of accumulated sulphur dioxide or hydrogen sulphide.

8. REACTIVITY DATA:

Hazard: Sulphur dust is explosive in air.

Stability: This material is stable. Under normal handling and storage conditions.

Incompatibility Oxidizing agents such as chlorine and fluorine and alkalis. May react explosively with ammonia, ammonium nitrate, chlorine dioxide (bromates, chlorates, and iodates of barium, calcium, magnesium, potassium, sodium or zinc), chromic anhydride, silver bromate, lead dioxide, mercuric nitrate, all inorganic perchlorates, phosphorus trioxide, sodium nitrate, and zinc. Hydrocarbons in contact with molten sulphur may generate hydrogen sulphide and carbon disulphide, which may accumulate in explosive concentrations.

Hazardous Polymerization: Will not occur under normal conditions.

Decomposition Products: May release SOx and smoke.

9. FIRST AID MEASURES:

Inhalation: Don breathing apparatus. Remove victim to fresh air. Only trained personnel should administer supplemental oxygen and/or cardio-pulmonary resuscitation if necessary, summon medical aid immediately. Victim must be observed for at least 48 hours to monitor for the development of pulmonary edema.

Eye Contact: Sulphur Dust: Flush eyes with clean, cool running water for at least 30 minutes, occasionally lifting eyelids. Obtain medical attention if irritation persists.

Skin Contact: Molten Sulphur: Cool burn area immediately with cool, clean, running water until no heat is emitted from burn area. Do not try to pull solidified sulphur away from skin. Cover with light, dry dressing. Do not apply ointments or puncture blisters. Obtain medical attention immediately.

Sulphur dust on skin: Wash with soap and water.

Ingestion: DO NOT INDUCE VOMITING. If victim is alert and not convulsing, rinse mouth and give ½ to 1 glass of water to dilute material. If spontaneous vomiting occurs, have victim lean forward with head down to avoid breathing in of vomitus, rinse mouth and administer more water. IMMEDIATELY contact local poison control centre. Vomiting may need to be induced but should be directed by a physician or a poison control centre. IMMEDIATELY transport victim to an emergency facility.

10. MSDS PREPARATION:

Prepared by: PHH ARC Environmental Ltd. 1-780-347-0713

Contact: Murray Selle, Manager of Health and Safety, Keyera Energy
Phone Number: (403) 843-7162
Date Issued: November 21, 2007
Validity Expires: November 21, 2010

References:
American Conference of Governmental Industrial Hygienist Documentation of Threshold Limit Values, 6 Edition, 2004.

American Conference of Governmental Industrial Hygienist Threshold Limit Values and Biological Exposure Indices, 2004.

Alberta Occupational Health and Safety Act, Regulation and Code.

Oil and Hazardous Materials/Technical Assistance Data System

Glossary:
ACGIH - American Conference of Governmental Industrial Hygienist
ANSI - American National Standards Institute
CAS - Chemical Abstract Service
DSL - Domestic Substances List
IARC - International Agency for Research on Cancer
IRIS - Integrated Risk Information System
LD50/LC50 - Lethal Dose/Lethal Concentration Kill 50%
NTP - National Toxicology Program
OSHA - Occupational Safety and Health Administration (USA)
SCBA - Self Contained Breathing Apparatus
STEL – Short Term Exposure Limit (15 Minute)
TLV - TWA - Threshold Limit Value - Time Weighted Average.
TSCA- Toxic Substance Control Act.

Appendix C

Tables

Table A
Building Volume Estimates

Building	Height (m)	Building Footprint (m^2)	Exterior Wall/Roof Area (m^2)	Wall/Roof/Concrete Thickness (m)[1]	Building Volume (m^3)	Internal Volume (% of Total) [2]	Internal Volume (m^3)
2010 Demolition							
Bunkhouses							
Bunkhouse (Northwest)							
Building	7	246	610	0.15	1,599	0.20	320
Gable Roof			246	0.30			
Foundation				0.30			
Bunkhouse (Southwest)							
Building	7	431	716	0.15	2,802	0.20	560
Gable Roof			431	0.30			
Foundation				0.30			
Bunkhouse (Central)							
Building	7	338	642	0.15	2,197	0.20	439
Gable Roof			338	0.30			
Foundation				0.30			
Bunkhouse (East)							
Foundation	1	412		0.30	412	0.20	82
Cabins East of Head-frame							
Buildings	3	361		0.15	1,083	0.20	217
Curling Rink							
Building	1	837		0.30	837	0.10	84
Married Quarters							
Married Quarters (North)							
Building	7	1,115	1,131	0.15	7,248	0.25	1,812
Flat Roof			1,115	0.25			
Foundation				0.30			
Married Quarters (South)							
Building	7	1,079	1,153	0.15	7,014	0.25	1,753
Flat Roof			1,079	0.25			
Foundation				0.30			
Mine Manager's Residence							
Building	7	261	468	0.20	1,697	0.20	339
Roof			261	0.20			
Foundation				0.30			
School							
Building	7	871	809	0.25	5,662	0.25	1,415
Roof			871	0.20			
Foundation				0.30			
2010 TOTAL					**30,549**		**7,000**

Table A
Building Volume Estimates

Building	Height (m)	Building Footprint (m^2)	Exterior Wall/Roof Area (m^2)	Wall/Roof/Concrete Thickness (m)[1]	Building Volume (m^3)	Internal Volume (% of Total) [2]	Internal Volume (m^3)
2011 Demolition							
Acid Plant							
Acid Plant No.1							
Building	12	612	1,006	0.20	7,344	0.30	2,203
Roof			612	0.20			
Foundation				0.30			
Acid Plant No.2							
Building	12	637	1,237	0.20	7,644	0.30	2,293
Roof			637	0.20			
Foundation				0.30			
Dock Warehouse							
Building	7	951	1,065	0.15	6,182	0.20	1,236
Roof			1,124	0.15			
Foundation				0.30			
Geology/Mine Dry							
Building	6	892	2,450	0.25	5,349	0.20	1,070
Roof			967	0.20			
Foundation				0.30			
Head-frame							
Building	24	825	4,006	0.20	19,800	0.35	6,930
Roof			1,227	0.20			
Foundation				0.30			
Maintenance Shop and Warehouses							
Building	9	5,254	3,885	0.20	44,659	0.15	6,699
Roof			5,676	0.20			
Foundation				0.30			
Mill							
Building	15	9,130	27,610	0.20	136,950	0.35	47,933
Building Roof			9,355	0.20			
Conveyor Galleries	2		1,539	0.20	3,078	0.20	616
Foundation				0.30			
Powerhouse							
Building	1	2,160		0.30	2,160	0.20	432
Surge Bin and Fine Crush Waste Bin							
Surge Bin and Fine Crush Waste Bin	39	126	2,489	0.20	4,914	0.15	737
Surge Bin and Fine Crush Waste Bin Roofs			126	0.20			
Foundation				0.30			
Former Girl's Dormitory							
Building	1	233		0.30	233	0.20	47
Cafeteria							
Building	1	323		0.30	323	0.20	65

Table A

Building Volume Estimates

Building	Height (m)	Building Footprint (m^2)	Exterior Wall/Roof Area (m^2)	Wall/Roof/Concrete Thickness (m)[1]	Building Volume (m^3)	Internal Volume (% of Total) [2]	Internal Volume (m^3)
Community Center							
Building	9	3,836	2,479	0.18	34,524	0.20	6,905
Gable Roof			3,960	0.50			
Foundation				0.30			
Pumphouse							
Building	2	71		0.20	142	0.20	28
Sewage Treatment Plant							
Building	7	127	331	0.15	826	0.15	124
Roof			127	0.25			
Other Structures							
Acid Storage Tanks	10	229			2,290	0.25	573
Beached Barge	2	334			668	0.80	534
Former Concrete Mixing Plant	1	551		0.30	551		
Freshwater Tank	20	75			1,490	0.25	373
Tailings Line	1	537			269	0.75	201
Tanks at the Tank Farm	17	1,601			27,217	0.10	2,722
Utilidors	0.50	5,000			2,500	0.75	1,875
Mine Ventilation and Air Heating Unit	8	155			1,159	0.20	232
2011 TOTAL					**309,112**		**84,000**
PROJECT TOTAL					**339,660**		**91,000**

NOTES:

[1] - Assumptions used for wall and roof thicknesses were obtained from WaterMark Consulting Ltd - Gunnar Demolition Strategy, 2005. Concrete thickness was assumed to be 0.30m.

[2] - Assumptions used for internal volume percentages were obtained from WaterMark Consulting Ltd - Gunnar Demolition Strategy, 2005

Table B
Temporary Disposal Requirements
for Major Components

Structure	Major Components[1]	Demolition Waste Temporary Disposal			
		Temporary Storage Cell 1 – Waste Rock Pile	Temporary Storage Cell 2 - Mill	Temporary Storage Cell 3 – Acid Plant	Process and Incinerate or Containerize for off-site disposal
Acid Plant	Structural steel members			X	
	Steel, concrete, plastics, treated or painted wood			X	
	Paper, untreated/ unpainted cardboard and Combustible Wooden Waste				X
	Asbestos			X	
	Hazardous Waste Material including elemental sulphur, approximately 300 barrels of vanadium pentoxide pellets				X
Dock Warehouse	Structural steel members	X			
	Steel, concrete, plastics, treated or painted wood	X			
	Paper, untreated/ unpainted cardboard and Combustible Wooden Waste				X
	Asbestos	X			
	Hazardous Waste Material including PCB containing fluorescent light ballasts, refrigeration units may contain freon				X
Geology/Mine Dry	Structural steel members	X			
	Steel, concrete, plastics, treated or painted wood	X			
	Paper, untreated/ unpainted cardboard and Combustible Wooden Waste				X
	Asbestos	X			
	Hazardous Waste Material including PCB containing fluorescent light ballasts				X
Head-frame	Structural steel members	X			
	Steel, concrete, plastics, treated or painted wood	X			
	Paper, untreated/ unpainted cardboard and				X

Table B
Temporary Disposal Requirements
for Major Components

Structure	Major Components[1]	Demolition Waste Temporary Disposal			
		Temporary Storage Cell 1 – Waste Rock Pile	Temporary Storage Cell 2 - Mill	Temporary Storage Cell 3 – Acid Plant	Process and Incinerate or Containerize for off-site disposal
	Combustible Wooden Waste				
	Asbestos	X			
Maintenance Building and Warehouse	Structural steel members	X			
	Steel, concrete, plastics, treated or painted wood	X			
	Paper, untreated/ unpainted cardboard and Combustible Wooden Waste				X
	Asbestos	X			
	Hazardous Waste Material including PCB containing fluorescent light ballasts, 6 – 100 lb bags of colored concrete, 11 – 40 L barrels of sodium hydroxide, 30 L of carbon tetrachloride				X
	20 pallets of Portland cement	X			
Mill Building including Conveyor galleries	Structural steel members		X		
	Steel, concrete, plastics, treated or painted wood		X		
	Paper, untreated/ unpainted cardboard and Combustible Wooden Waste				X
	Asbestos		X		
	Hazardous Waste Materials including 15 pallets of magnesium oxide, 5 pallets of calcium hydroxide				X
	Yellowcake				X
Powerhouse	Steel, concrete, plastics, treated or painted wood		X		
	Paper, untreated/ unpainted cardboard and Combustible Wooden Waste				X
	Asbestos		X		
Surge Bin and	Structural steel members	X			

Table B
Temporary Disposal Requirements
for Major Components

Structure	Major Components[1]	Demolition Waste Temporary Disposal			
		Temporary Storage Cell 1 – Waste Rock Pile	Temporary Storage Cell 2 - Mill	Temporary Storage Cell 3 – Acid Plant	Process and Incinerate or Containerize for off-site disposal
Fine Crush Waste Bin	Steel, concrete, plastics, treated or painted wood	X			
	Asbestos	X			
Bunkhouses (including debris from the Girls Dormitory)	Steel, concrete, plastics, treated or painted wood	X			
	Paper, untreated/ unpainted cardboard and Combustible Wooden Waste				X
	Asbestos	X			
Cabins (East of head-frame)	Paper, untreated/ unpainted cardboard and Combustible Wooden Waste				X
	Asbestos	X			
Cabins (west of marina)	Paper, untreated/ unpainted cardboard and Combustible Wooden Waste				X
Cafeteria	Steel, concrete, plastics, treated or painted wood	X			
	Paper, untreated/ unpainted cardboard and Combustible Wooden Waste				X
	Asbestos	X			
Community Center	Structural steel members	X			
	Steel, concrete, plastics, treated or painted wood	X			
	Paper, untreated/ unpainted cardboard and Combustible Wooden Waste				X
	Asbestos	X			
	Hazardous Waste Material including PCB containing fluorescent light ballasts, ammonia hydroxide, ethyl acetate				X
Curling Rink	Steel, concrete, plastics, treated or painted wood	X			
	Paper, untreated/ unpainted cardboard and Combustible Wooden Waste				X
	Asbestos	X			

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Temporary Disposal Requirements
for Major Components

Structure	Major Components[1]	Demolition Waste Temporary Disposal			
		Temporary Storage Cell 1 – Waste Rock Pile	Temporary Storage Cell 2 - Mill	Temporary Storage Cell 3 – Acid Plant	Process and Incinerate or Containerize for off-site disposal
Married Quarters	Steel, concrete, plastics, treated or painted wood	X			
	Paper, untreated/ unpainted cardboard and Combustible Wooden Waste				X
	Asbestos	X			
Mine Manager's Residence	Steel, concrete, plastics, treated or painted wood	X			
	Paper, untreated/ unpainted cardboard and Combustible Wooden Waste				X
	Asbestos	X			
Pumphouse	Steel, concrete, plastics, treated or painted wood	X			
	Paper, untreated/ unpainted cardboard and Combustible Wooden Waste				X
	Asbestos	X			
School	Structural steel members	X			
	Steel, concrete, plastics, treated or painted wood	X			
	Paper, untreated/ unpainted cardboard and Combustible Wooden Waste				X
	Asbestos	X			
	Hazardous Waste Material including PCB containing fluorescent light ballasts				X
Sewage Treatment Plant	Steel, concrete, plastics, treated or painted wood	X			
	Paper, untreated/ unpainted cardboard and Combustible Wooden Waste				X
	Asbestos	X			
Acid Storage Tanks	Steel, concrete, plastics, treated or painted wood			X	
Beached Barge	Steel, concrete, plastics, treated or painted wood	X			

Table B
Temporary Disposal Requirements
for Major Components

Structure	Major Components[1]	Demolition Waste Temporary Disposal			
		Temporary Storage Cell 1 – Waste Rock Pile	Temporary Storage Cell 2 - Mill	Temporary Storage Cell 3 – Acid Plant	Process and Incinerate or Containerize for off-site disposal
	Paper, untreated/ unpainted cardboard and Combustible Wooden Waste				X
	Hazardous Waste Material including PCB containing fluorescent light ballasts and white paint on window frames with lead concentrations of 12 mg/L.				X
Concrete Mixing Plant	Steel, concrete, plastics, treated or painted wood	X			
	Asbestos	X			
Docks	Paper, untreated/ unpainted cardboard and Combustible Wooden Waste				X
Freshwater Storage Tank	Steel, concrete, plastics, treated or painted wood			X	
Tailings Line	Paper, untreated/ unpainted cardboard and Combustible Wooden Waste		X		X
Tank at the Tank Farm	Steel, concrete, plastics, treated or painted wood	X			
Utilidors	Paper, untreated/ unpainted cardboard and Combustible Wooden Waste		X	X	
	Asbestos		X		
Other Demolition items	Barrels	X			
	Transformers				X
	Lead Plated Telephone Lines				X
	Other miscellaneous debris piles scattered over the site	X			