OPG's DEEP GEOLOGIC

REPOSITORY

FOR LOW & INTERMEDIATE LEVEL WASTE

Preliminary Conventional Safety Assessment

March 2011

Prepared by: March Consulting Associates Inc.

NWMO DGR-TR-2011-37

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EXECUTIVE SUMMARY

Ontario Power Generation (OPG) is proposing to build a Deep Geologic Repository (DGR) for Low and Intermediate Level Waste (L&ILW) near the existing Western Waste Management facility (WWMF) at the Bruce nuclear site. The Nuclear Waste Management Organization (NWMO) is managing the development of this facility on behalf of OPG. This report documents the findings of the preliminary conventional health and safety (non-radiological) assessment that was conducted for site preparation, construction and operation of this facility.

The assessment was based on information provided by NWMO for facility design. The DGR consists of facilities to receive L&ILW packages from WWMF and for the transfer of packages from surface to underground for long-term management. A surface storage area is also required to manage the waste rock extracted during development of the underground facility.

The conventional safety implications for site preparation and surface construction determined from this assessment are similar to those for WWMF facilities and other surface construction activities. Underground development and construction methods described in the facility design are standard practice within the mining industry. The conventional safety implications associated with operating the facility are similar to those found in the WWMF, warehousing and freight handling facilities, and underground mining operations.

The assessment was conducted systematically using a Screening Process Hazard Analysis methodology combined with a Job Hazard Analysis approach. Hazards were identified based on the activities that would normally be expected for the various phases of the project. A relational database was used to record and organize the information generated by the assessment. The assessment focussed on identifying potential control/mitigation measures required to manage or avoid the hazards identified. This information was then synthesized into the report and eight recommendations for implementing the control/mitigation measures were developed.

The assessment identified detailed measures to mitigate and control hazards. The general recommendations that were developed are described below.

1. Consider site preparation and construction mitigation and control measures identified in this assessment when developing the Health and Safety Management Plan for design and construction.
2. Verify that the hazards, control and mitigation measures identified in the assessment remain applicable to the project as it progresses and update the assessment, the Health and Safety Management Plan and the standard operating procedures appropriately as the project progresses.
3. Compare the mitigation and control measures developed for operations in this assessment to existing OPG measures and verify that the measures to be adopted are complete and appropriate for the operation of the facility.
4. As site work progresses, identify the safety significance of activities, systems, components and structures, using a risk based safety significance index, to assist in setting safety management and emergency response priorities.
5. Identify standard levels of completion for detailed engineering as an input to risk assessments for construction (for example 50% and 80% completion). Review and update safety assessments on this basis.
6. Validate safety program and systems functionality and routinely verify effectiveness of implementation after site activities commence.

7. Adopt a phased evacuation and safe work shutdown approach commensurate with the level of completion of the project. Test evacuation and emergency shutdown system equipment and procedures on a regular basis.
8. Adopt a Systematic Approach to Training that incorporates a commitment to train project personnel as required.

The DGR facility design is still preliminary at this stage and detailed design engineering work needs to be completed before site construction activity commences. It is therefore expected that the conventional health and safety review will continue to be validated and updated as significant design and engineering milestones are achieved.

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1. INTRODUCTION

Ontario Power Generation (OPG) is proposing to build a Deep Geologic Repository (DGR) for Low and Intermediate Level Waste (L&ILW) near the existing Western Waste Management facility (WWMF) at the Bruce nuclear site. The Nuclear Waste Management Organization (NWMO) is managing the development of this facility on behalf of OPG. This report provides a preliminary conventional (non-radiological) safety assessment of the activities associated with the development and operation of the facility. The assessment was based on the design information from the Preliminary Safety Report (PSR) (OPG 2011a).

The DGR consists of facilities to receive and transfer L&ILW packages from the WWMF on surface to underground, purpose built, long term management facilities. A surface storage area is also required to manage the waste rock extracted during development of the underground facility.

The information in this report is arranged to guide the reader from the background information, such as the introduction, context, and methodology, through a brief description of the DGR site work activities, and then close with assessment results and recommendations.

The work activities summarized in Chapter 4 are those that would normally be expected to occur during the site preparation, construction and operational phases of the DGR facility. The purpose of this chapter is to provide a framework of activities, work conditions and their interactions as a basis for hazard identification.

The assessment focuses on systematically identifying potential hazards, possible consequences, plausible outcomes resulting from the hazards, control measures and recommendations for implementation of the control measures. The plausible outcomes provide a basis for establishing priorities related to mitigation and control measures.

2. ASSESSMENT CONTEXT

2.1 Purpose, Objectives and Scope

The purpose of this assessment is to support the site preparation and construction licence application to the Canadian Nuclear Safety Commission (CNSC) for OPG's DGR for L&ILW.

The following overall objectives have been identified for this assessment:

1. Complete a preliminary conventional safety assessment using standard hazard identification techniques; and
2. Consider applicable Canadian laws, regulations and standards pertaining to health and safety.

The scope of the assessment includes:

1. Identification of hazards associated with the DGR site preparation, construction and operations;
2. Identification of methods at a conceptual level to mitigate these hazards either by design or procedural control; and
3. Documenting the work in a technical report.

The hazard assessment was based on the facility design of the DGR. Qualitative assessment of impacts from potential hazards was used to develop control measures to protect worker safety and not as an absolute measure of worker safety.

Safety impacts considered in this assessment are limited to the conventional safety (non-radiological) impacts associated with occupational hazards related to the development and operation of the DGR facility for L&ILW. The assessment does not address the decommissioning and closure phases of the DGR facility, nor does it consider the following:

1. Abnormal conditions or accident scenarios;
2. Radiological consequences;
3. Radiological accidents;
4. Details of OPG's existing safety system;
5. Effects on the public; and
6. Effects on the environment.

Spatially, the assessment is limited to the surface and underground components of the construction site. The temporal boundaries of the assessment start with the commencement of site preparation for construction and end with the completion of the emplacement operations and prior to decommissioning. This period includes approximately five years for construction of the surface and underground facilities and an estimated 40 years of operations based on current DGR facility planning assumptions.

2.2 Applicable Key Standards, Guidelines, and Regulatory Requirements

The DGR facility is a Class 1B nuclear facility under the Nuclear Safety and Control Act (NSCA), being "a facility for the disposal of a nuclear substance generated at another nuclear facility". Under the NSCA, licences are required from the CNSC to prepare a site, and to construct, operate, decommission and abandon the nuclear facility.

In accordance with Canadian Federal Regulation SOR/98-181, the responsibility for workplace health and safety at all OPG nuclear facilities, including OPG nuclear waste management facilities, has been delegated to the Province of Ontario. Therefore, workplace health and safety during the construction and operation of OPG's proposed DGR will fall under the Ontario Occupational Health and Safety Act (OHSA), and its associated regulations. Labour legislation in the Province of Ontario (including OHSA) is enforced by the Ontario Ministry of Labour (MOL).

The construction of the DGR facility will be regulated under Ontario's Occupational Health and Safety Act. Given the nature of the project, it is expected that the Ontario Ministry of Labour will administer their regulatory supervision of the project primarily under the *Mines and Mining Plants Regulation*, RRO 1990, Reg. 854.

3. ASSESSMENT METHODOLOGY

The assessment was conducted systematically using a Screening Process Hazard Analysis (PHA) methodology combined with a Job Safety Analysis (JSA) approach (Hyatt 2004). Hazards were identified based on the activities that would normally be expected for the various phases of the project. In this assessment, the individual activities that collectively make up the site preparation, construction and operation phases of the DGR facility are identified. The individual activities are then examined and the associated potential hazards listed. Control measures to avoid the potential hazards or mitigate the impact from these hazards are then developed and recommendations for implementing the controls are made, where required. Many of the hazards and control measures identified apply to more than one activity. Therefore, to ensure that these hazards and controls are considered collectively and not in isolation or without context, the approach is to group the common hazards for the activities being considered and then identify the essential control elements that ought to be included in an overall hazard control program for the major project phase. Although this report focuses on the non-nuclear safety aspects and only considers effects within the facility, the hazard control program should consider both the non-radiological and the radiological safety as well as effect on the public and the environment to ensure an effective safety program.

A robust assessment leading to effective control measures demands consistent hazard identification and thorough assessment of the consequence that may result from the hazard. Accurately identifying potential hazards requires that the activities, the working environment and interaction between various activities be considered in the assessment. PHA Pro 7, a relational data base developed by Dyadem International, was used to record and organize the assessment and facilitate consistent application of the assessment methodology. The assessment was divided into four areas, namely site preparation, construction, operations and safety management. Under each of these areas the major work packages or elements are listed. Comments are then added if required for clarification. Work activities that would normally be expected to occur are listed for each major work package. These work activities, the expected working environment and potential interactions among these elements are then considered to assist in identifying the potential hazards. Plausible outcomes that may result from potential hazards are recorded on worksheets and may include personal injury, death, property damage, or loss of critical safety function. These outcomes provide a basis for establishing priorities related to mitigation and control measures and recommendations; they assist in determining the safety significance of the hazards associated with certain activities.

4. DGR FACILITY - PHYSICAL DESCRIPTION AND WORK ACTIVITIES

4.1 General Description of Facility

The DGR facility consists of surface infrastructure to receive waste packages and transfer them underground via the main shaft to the repository horizon approximately 680 m below the shaft collar. The downcast main shaft will have a concrete headframe equipped with a personnel hoist and a separate large six-rope Koepe friction hoist to raise and lower a suitably sized conveyance and payload capacity to accommodate the waste packages, transfer carts, pallets and rigging. The ventilation shaft will be an up-cast shaft with main exhaust fans on the surface to pull the spent air out of the repository. During repository construction, this shaft will be used to remove the excavated rock from underground. Figure 4.1 shows the DGR surface layout (Chapter 4, OPG 2011b).

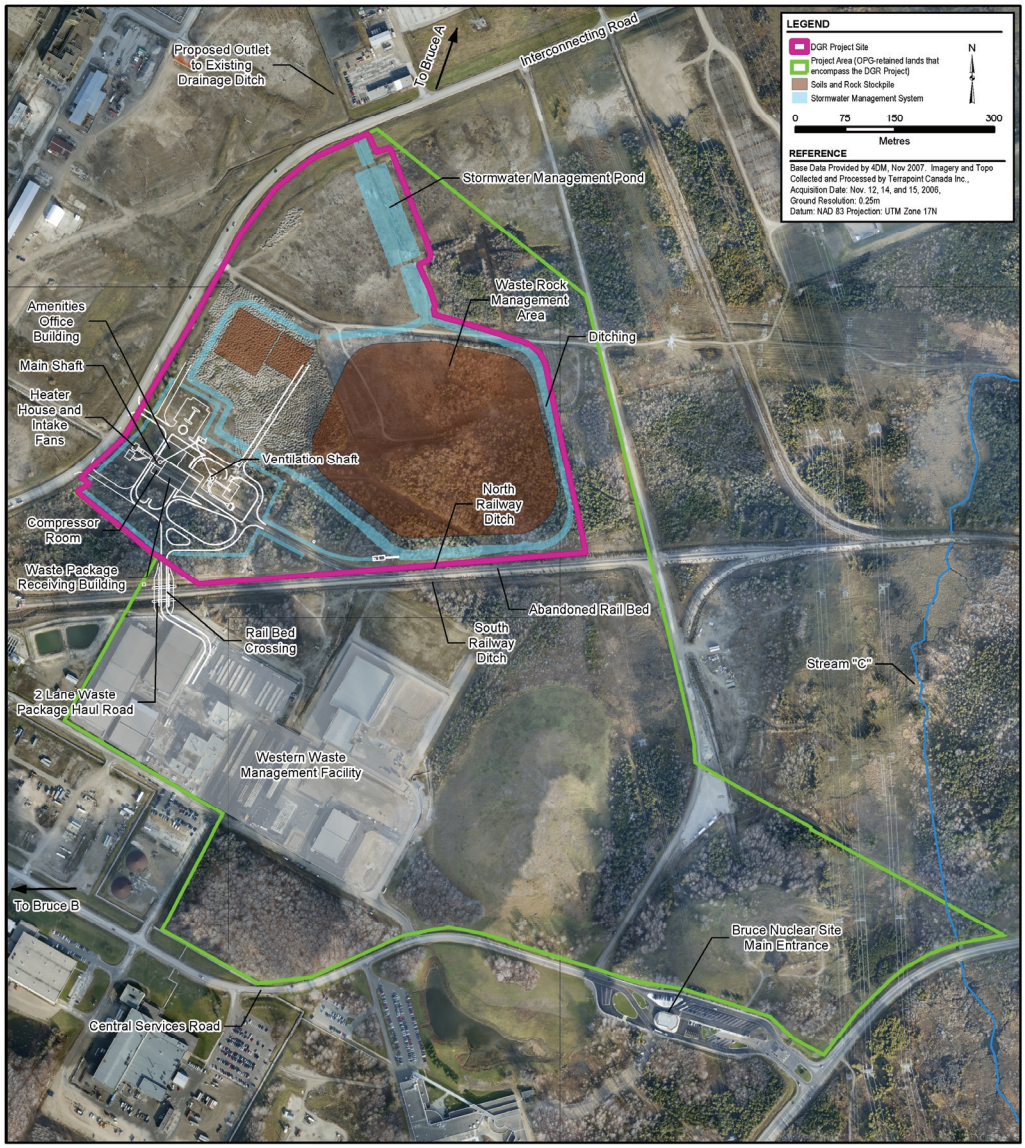

Figure 4.1: DGR Surface Layout

Shafts will be excavated by controlled drill and blast methods. A waste rock pile for the excavated rock will be accommodated to the northeast of the two shafts in a Waste Rock Management Area. A storm water run-off management system of ditches and a storm water management pond will be provided to control the outflow of discharge water from the site before release. Berms and vegetation will be used to limit the aesthetic impact of the rock pile and control dust and suppress noise.

The underground facilities will be fully developed during initial construction, so that once waste emplacement operations commence, no mining activities, other than inspection and maintenance of rock support, concrete linings, concrete floors and ventilation systems will need to occur.

The underground layout of the repository has the two vertical shafts with a shaft services area, in which offices, a workshop, wash bay, refuge stations, lunch rooms and geotechnical laboratory are provided. A main access tunnel will be driven from the main shaft station to the east, passing the ventilation shaft and then proceeding towards the emplacement room panels. The overall underground arrangement enables the entire underground infrastructure to be kept in close proximity to the shaft, while keeping the emplacement areas away from normally occupied areas.

There will be two panels of emplacement rooms. The main shaft access tunnel continues straight into the Panel 1 access tunnel, while a branch tunnel to the south leads to the Panel 2 access tunnel. A ventilation tunnel connects the east end of the emplacement rooms in Panel 2 and Panel 1 to the ventilation shaft (OPG 2011a). Figure 4.2 shows the general layout of the underground DGR.

4.2 Site Preparation Activities

Site preparation activities will focus on site clearing and grading, fencing, establishing a water management system, creating material laydown areas and general preparation for construction activities. Power for the initial site preparation activities may be supplied from an existing Hydro One substation, in close proximity to the DGR site or from temporary diesel generators on site.

The construction site will be arranged to form a “construction island”, in which all facilities will be grouped in relatively close proximity around the construction site. This arrangement will be fenced off from the rest of the Bruce nuclear site and will allow for controlled access and security at the site. Access will be primarily from the Interconnecting Road on the western side of the DGR site, with an alternative gate on the southeast leading to the road running along the eastern boundary of the project site via the abandoned railway bed (OPG 2011a). A more detailed description of site preparation activities is contained in Chapter 9 of the PSR.

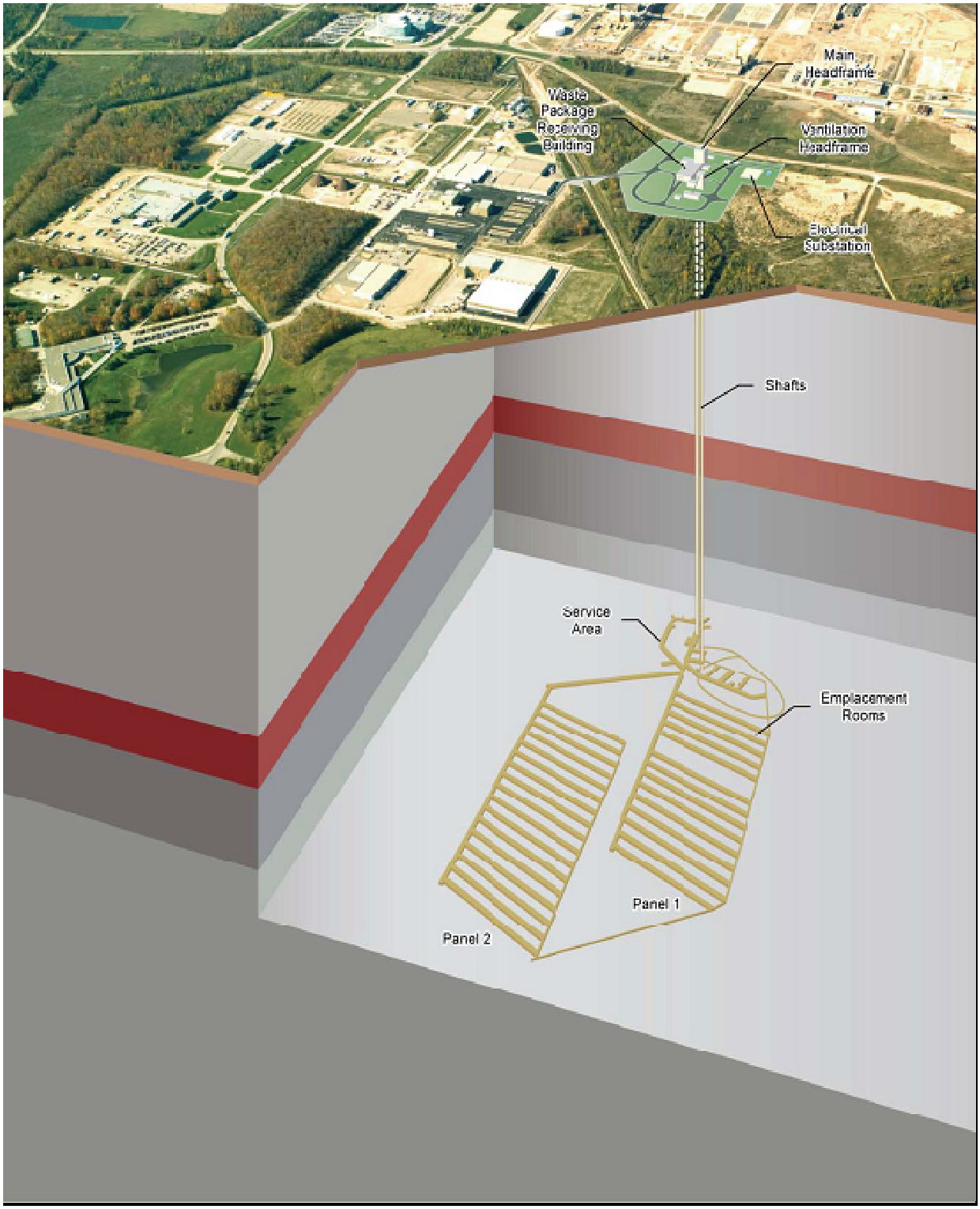

Figure 4.2: Schematic of the DGR

4.3 Construction Activities

The construction phase will include preparation activities for shaft sinking such as constructing the shaft collars for both shafts, erecting headframes, ground treatment to facilitate shaft sinking, installing a sinking hoist on the main shaft and both sets of sinking winches (main and ventilation shafts). A temporary hoist house for the main shaft sinking hoist will also be installed. Additionally, a temporary heating and fan house will be installed and equipped to provide controlled air temperatures to the shaft sinking crew. The shafts will be sunk simultaneously to the DGR horizon where lateral development will commence followed by construction of the services area and the emplacement rooms.

The waste rock generated during the repository construction will be hoisted up the ventilation shaft using two skips. The discharge from the skips will be diverted to a muck bay located outside of the headframe via a chute.

The surface facilities to be constructed include the permanent surface buildings, main site electrical substation, permanent ventilation shaft hoist house, exhaust fan building and waste bin for waste rock dumping.

Unpaved construction roads to accommodate heavy construction traffic and access construction laydown areas and a concrete batch plant will be constructed. For the construction period of the project, main access will be via the existing Interconnecting Road on the west side of the construction site.

Commissioning of the DGR facility will occur throughout construction and will be required for the permanent facilities and also for temporary facilities installed to support construction activities (OPG 2011a). A more detailed description of construction activities is contained in Chapter 9 of the PSR.

4.4 Operations Activities

The description of operational activities is taken from Chapter 6 of the PSR (OPG 2011a). All waste packages delivered to the DGR facility will be required to meet waste acceptance criteria for the DGR. Waste packages will be transferred into and out of the main shaft conveyance by means of a self-propelled, rail-based transfer cart. Diesel-powered forklifts or an overhead crane will load packages onto empty carts in the waste package loading area of the Waste Package Receiving Building (WPRB). The packages will be secured on the cart as required to ensure that the load will remain stable while being transported.

The underground layout of the DGR is shown in Figure 4.3. This layout provides secondary egress via the return air drifts. Underground, the majority of the waste packages will be transferred from the staging area at the main shaft station on the repository level to the emplacement rooms by diesel-powered forklifts. However, the heat exchangers and shield plug containers will not be off-loaded at the staging area, but will be taken to their emplacement room on the rail carts, where they will be off-loaded by a gantry crane.

Panel 2 will be filled first with the majority of the backlog of waste packages that will be in storage at the WWMF at the time emplacement operations commence. Both Panel 1 and Panel 2 will contain LLW and ILW rooms. In general, LLW and ILW packages will not be stored in the same room. Three rooms in Panel 1 will be equipped with rail tracks and will be used to emplace the packages that cannot be handled by forklift due to their mass and/or size.

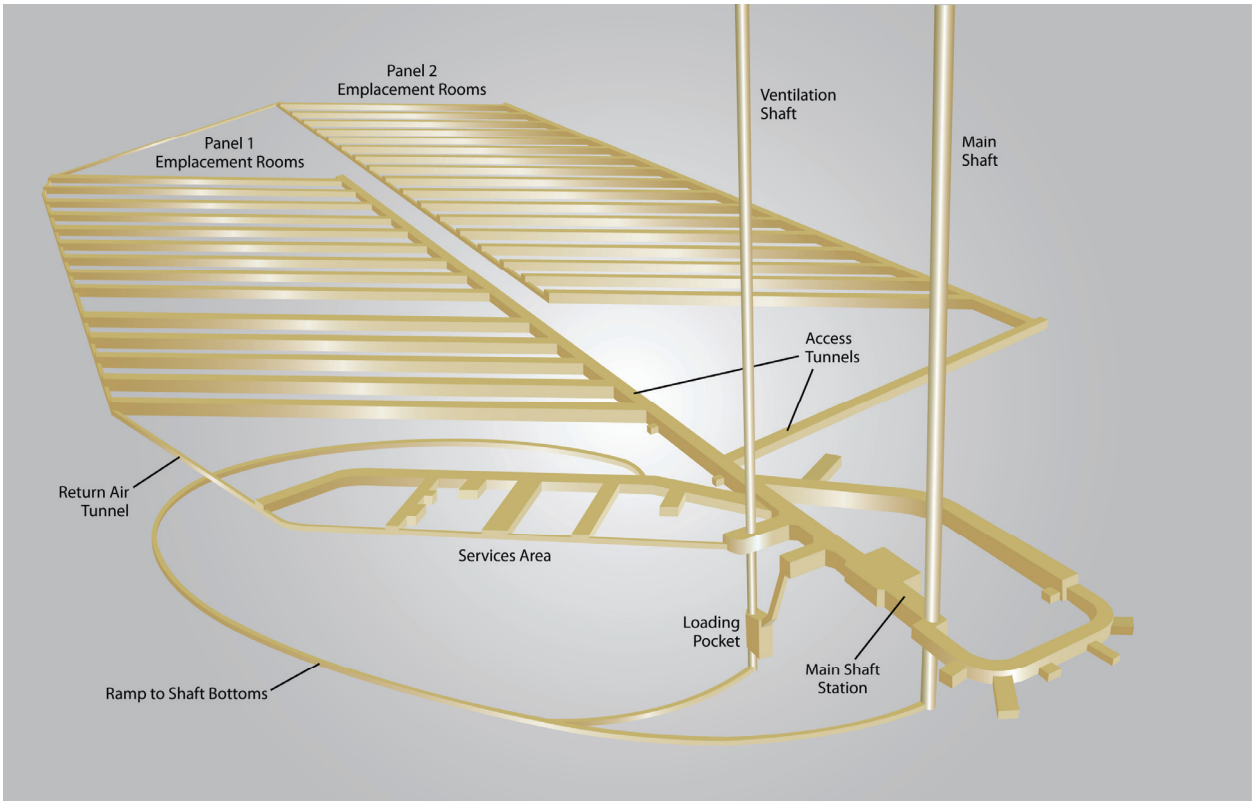

Figure 4.3: Underground Layout of the DGR

The repository's underground ventilation system has been designed so that fresh air flows from the main shaft through the emplacement rooms to the return air drifts and then exhausts through the ventilation shaft to surface (Figure 4.3). Therefore, under normal conditions, workers are on the fresh air side of each workplace, with potentially contaminated air being exhausted from the workplace.

Filled emplacement rooms will have a wall at each end. The primary purpose of these end walls will be to isolate the waste-filled room to prevent access, control ventilation, and if necessary protect workers in the access tunnels from radiation in waste-filled rooms. Monitoring of gas emissions and contaminant levels will be undertaken using instrumentation installed in the return air drifts.

Closure walls will eventually be constructed in the access tunnels to isolate a group of waste-filled rooms. Since ventilation and all other services to those rooms would then be suspended, explosive gases could build-up in the closed-off section of the panel. These walls will be designed to withstand the blast pressure waves that could be generated in the unlikely event of ignition of those gases.

After a further approximately 15 years, the first nine rooms of Panel 1 will be full of packages and will then be closed. The remaining waste packages in the inventory will be emplaced in the final open rooms over the next approximately 15 years. At the end of waste emplacement operations the remaining open rooms in Panel 1 will also be isolated by closure walls. After a

period of monitoring, an application would be made to the regulator to decommission the facility, which would include constructing engineered seals in each shaft.

During the operational phase, regular scheduled inspection and maintenance of various underground installations and equipment (e.g., ventilation system, pumps, electrical substation and dust control equipment) will occur. Shaft inspections which are primarily visual in scope will be conducted on a routine basis. In addition, a detailed structural condition survey should be performed annually to supplement these weekly shaft observations. If required, appropriate repairs will be performed to maintain the integrity of the shaft liner.

Maintenance requirements for rock support elements and the concrete floors are expected to be minimal during the initial operating life of the repository. However, some limited repair and installation of rock bolts and shotcrete may be required periodically. Over time the concrete running surface in portions of the access tunnels and some rock support elements may require more extensive repair.

5. ASSESSMENT

The assessment focuses on conventional safety associated with expected work activities described in Chapter 4. The results of the assessment are presented as they relate to site preparation, construction, operations and general safety management. A short discussion (Section 5.4) on safety management in general follows the safety assessment of work activities. This discussion deals with the elements of safety management that are not limited to a specific phase of the project but are essential to all project phases.

The safety implications of the project will be similar to those experienced in other industries where similar work is performed. Effectively managing the safety on this type of project requires early recognition of the hazards and the development of clearly documented control measures. These documented measures must then be implemented when appropriate with the necessary understanding and foresight to effectively support the work but avoid becoming an unnecessary barrier to the work.

The conventional safety implications for site preparation and surface construction determined from this assessment are similar to those for WWMF facilities and other surface construction activities. Underground development and construction methods described in the facility design are standard practice within the mining industry. The conventional safety implications associated with operating the facility are also similar to those found in WWMF, warehousing and freight handling facilities, and underground mining operations.

5.1 Site Preparation

Site preparation involves preparing the site for construction and includes clearing and grubbing, grading, surveying, site layout, fencing and security, drainage control and water management and other activities required for construction. Some of the “other activities” required for construction are shown in this section as “Mobilization” as they are closely associated with site preparation. Others are listed in Section 5.2 under Construction activities. Table 5.1 provides a list of the site preparation jobs/aspects and the associated activities that make up the site preparation phase of the project.

Table 5.2 summarizes the hazards associated with the site preparation activities. The table also provides control/mitigation measures and other information related to the identified hazards.

Table 5.1: Site Preparation Activities

Job/Aspect	Activities
Site clearing and grubbing	• Vegetation clearing • Chipping, pilling and burning
Site grading	• Site surveying • Grading • Material stockpiling • Ditching • Storm water management
Fencing and security	• Post-hole digging • Fence erection • Establish construction security, access control systems

Job/Aspect	Activities
Mobilization	• Set up temporary construction offices and admin buildings • Receive and unload construction equipment supplies and materials • Set up lay down areas for receiving and storing construction materials • Set up areas for equipment storage and maintenance • Install construction utilities
Site characteristics that may affect safety	• Old construction landfill south east of WWMF • Freezing temperatures in winter
Site survey and layout	• Staking, line and grade, aggregate inventory/consumption measurements

Table 5.2: Summary of Site Preparation Conventional Safety Assessment

Hazardous Activity or Condition	Potential Consequences	Plausible Outcomes	Control/Mitigation Measures
Dust	• Worker exposure • Poor visibility	• Occupational disease • Personal injury • Property damage	• Vehicular speed control standard • Application of water or other dust allaying substance • Worker awareness • Work permits • Personal protective equipment
Electrical	• Electric shock • Fire	• Property damage • Reportable dangerous occurrence • Personal injury or death • Potential loss of critical safety function	• Live electrical line work procedures • Lock-out/tag out procedure • Use only qualified workers • Work permits • Emergency response capability
Fire	• Brush fire • Construction material fire • Temporary facility or equipment fire • Worker burns	• Property damage • Personal injury or death	• Emergency response capability • Fire extinguishers • Fuel dispensing procedure • Emergency equipment in mobile equipment

Hazardous Activity or Condition	Potential Consequences	Plausible Outcomes	Control/Mitigation Measures
Ground disturbance	• Contacting electrical conductor • Damaged communications cables • Damaged water line	• Personal injury or death • Potential loss of critical safety function • Property damage	• Work permits • Ground disturbance permits • Exposing utility lines by hand or other suitable means • Sub-surface survey
Hand tools	• Amputation injury • Cuts, bruises and scrapes	• Personal injury	• Safe work code of practice • Personal protective equipment • Maintenance and Inspection program
Hazardous materials handling	• Worker exposure to toxic designated or controlled substance	• Occupational disease • Personal injury	• Personal protective equipment • Worker awareness • Workplace Hazardous Materials Information System (WHMIS)
Inclement weather, cold or icy conditions	• Frostbite • Heat exhaustion/stroke • Loss of control of mobile equipment • Slips, trips and falls	• Personal injury	• Personal protective equipment • Worker awareness • Routine sanding/salting of the site • Defensive driving practice
Moving/rotating machinery	• Crush or amputation injury	• Personal injury or death	• Machine guarding • Worker awareness • Personal protective equipment • Maintenance and inspection program
Noise	• Worker exposure - industrial hearing loss • Hampered communication	• Occupational disease • Personal injury • Potential loss of critical safety communication	• Engineered noise abatement - barriers, encapsulation, shielding • Personal protective equipment • Equipment planned/preventative maintenance

Hazardous Activity or Condition	Potential Consequences	Plausible Outcomes	Control/Mitigation Measures
Power line relocation	• Electric shock • Falling from scaffold, ladder or elevated work location	• Personal injury or death • Property damage	• Lock-out procedure • Live electrical line work procedures • Work permits • Use only qualified workers
Pressurized cylinder/tank leak	• Serious fire, explosion • Oxygen deficiency	• Personal injury or death • Property damage	• Safe work code of practice • Worker awareness • Inspection protocol • Emergency response capability • Flash back arrestors
Scaffold, elevated platform and ladder	• Structural collapse • Falling from scaffold, ladder or elevated platform • Dropping material from scaffold or elevated platform	• Property damage • Personal injury or death • Reportable incident/dangerous occurrence	• Scaffolding, elevated work platform and ladder procedures • Safe work code of practice • Personal protective equipment • Worker awareness • Use only qualified workers • Work permits
Static electricity ignition source	• Serious fire	• Personal injury or death • Property damage	• Fire suppression system • Static electricity grounding • Fuel dispensing procedure
Traffic/excavation equipment	• Traffic accident • Heavy equipment collision • Personnel collision	• Personal injury or death • Property damage • Reportable incident/dangerous occurrence	• Defensive driving practice • Worker awareness • Vehicular speed control standard • Operator training • Defensive driving practice • Site driving plan for construction • Signage
Trenching	• Caving/trench wall collapse	• Personal injury or death	• Trenching code of practice

Hazardous Activity or Condition	Potential Consequences	Plausible Outcomes	Control/Mitigation Measures
			• Work permits • Worker awareness • Excavation permits
Uneven walking surface/poor footing	• Slips trips and falls	• Personal injury	• Housekeeping • Personal protective equipment • Worker awareness • Alternative routes • Barricades • Signage
Unstable stacking and storage of material	• Toppling of pile • Collapse or rolling of stacked pipes	• Personal injury or death	• Safe work code of practice • Worker awareness • Pipe handling work instruction • Housekeeping

5.2 Construction

The construction of the DGR facility will be completed using a phased approach; once the site preparation and other activities required for the start of construction are complete, the pre-sink phase will commence followed by the sinking phase and the commissioning phase. Some of the activities required to prepare for construction are listed in site preparation activities (Section 5.1) and others listed in this section. The major construction activities include the following:

- Establishing construction services including:
  - Temporary diesel generators and electrical substation;
  - Permanent roads;
  - Concrete batch plant;
  - Fire water connections;
  - Fuel storage and dispensing station;
  - Communications links; and
  - Emergency response and mine rescue;
- Water management system construction including a temporary water treatment facility (if required);
- Establishing a waste rock management area;
- Ground improvement around the shafts using grouting or ground freezing as an alternative;
- Shaft collar preparation and foundations for both headframes;
- Erection of main shaft and ventilation shaft headframes;
- Installation of hoisting equipment;
- Shaft sinking;
- Shaft equipping and permanent hoisting equipment installation;
- Development and construction of underground facilities;

- Construction of surface buildings ;
- Construction of surface roadways;
- Construction of crossing to WWMF;
- Connection of services; and
- Commissioning including:
    - Testing, adjusting and calibrating systems in preparation for use; and
    - Handover to OPG.

Table 5.3 provides a list of the construction jobs/aspects and the specific activities associated with these elements that make up the construction phase of the project.

All tasks will be planned and the associated risk analysis and safety planning will be conducted and completed prior to work commencing.

Detailed assessment work sheets were used to identify hazards on an activity by activity basis. This information is summarized in Table 5.4.

Table 5.3: Construction Activities

Job/Aspect	Activities
Install electrical substation	• Excavation, crush rock placement, concrete foundations • Steel erection • Duct banks • Security fencing around substation • Install grounding grid, high and low voltage electrical power and controls • Quality assurance / quality control (QA/QC) • Commissioning
Establish permanent roads	• Operate large earth moving and road construction equipment such as haul trucks, graders, loaders and excavators • Construction services (surveying, compaction testing, dust control, and water management) • QA/QC • Commissioning
Install concrete batch plant	• Surveying • Excavation • Foundations • Steel and equipment erection • Utilities hook-up • Create feedstock receiving area • Cleaning area • QA/QC • Commissioning
Install utilities	• Surveying • Trenching • Utility hook-up

Job/Aspect	Activities
	• Backfill and compaction • QA/QC • Commissioning
Establish waste rock area	• Surveying • Grading • Ditching and berms • QA/QC • Commissioning
Construct water management facilities	• Surveying • Excavation of water management ditches • Excavation of storm water receiving pond • Temporary water treatment plant installation if required • Utility hook-up • Establish water treatment reagent storage and handling area • Process piping installation • Monitoring equipment installation and connection • QA/QC • Commissioning
Ground improvement	• Surveying • Drilling • Curtain grouting and/or freezing • Pressure injection of grout • Grout equipment preparation • Freeze equipment preparation if required • QA/QC
Collar preparations and headframe foundations	• Surveying • Excavations • Forming, rebar installation, concrete work and form stripping • Concrete batching • QA/QC
Erect reinforced concrete headframe and conventional steel structure headframe	• Surveying • Crane operations • Steel erection • Slip form work • Rebar installation • Conventional headframe envelope installation • QA/QC • Commissioning
Install temporary hoisting equipment for shaft sinking	• Surveying • Crane operations • Foundation installation

Job/Aspect	Activities
	• Steel erection • Electrical connecting • Mechanical adjustment • QA/QC • Commissioning
Shaft sinking	• Surveying • Setting up Galloway stage • Drilling and blasting • Mucking • Ground support • Stage operations • Sinking bucket use • Hoisting • Concrete liner installation • Install services (pumping, ventilation, compressed air, power) • QA/QC
Shaft equipping and permanent hoisting equipment installation	• Surveying • Crane operations and hoisting • Dismantling temporary hoisting equipment • Steel erection • Electrical connecting • Mechanical mounting and equipment alignment • Welding and flame cutting • Grinding • QA/QC • Shaft commissioning
Develop and construct underground facilities	• Surveying • Drilling • Blasting • Mucking and hauling • Ground support • Excavations, rebar installation, concrete batching and concrete placement • Shotcrete application • Equipment installation • QA/QC • Commissioning
Construct surface buildings	• Surveying • Excavation • Foundations • Steel and equipment erection • Install building envelope • Utility hook-ups

Job/Aspect	Activities
	• QA/QC • Commissioning
Connect services	• Surveying • Site services interruption planning • Hook-ups to existing utilities (power, water, sewer, communications) • QA/QC • Commissioning
Overall commissioning	• Bump tests • Spin tests • Inspection • Observation/monitoring • Mechanical adjustment • Electrical adjustment • QA/QC

Table 5.4: Summary of Construction Conventional Safety Assessment

Hazardous Activity or Condition	Potential Consequences	Plausible Outcomes	Control/Mitigation Measures
Underground ventilation failure	• Exposure to noxious fumes, dust and gasses	• Occupational disease • Personal injury	• Install visual and audible alarms on ventilation system • Inspect ventilation system prior to entering the underground workplace • Routine monitoring of ventilation flows • Refuge station
Underground blasting	• Exposure to blasting dust and fumes • Unexpected detonation • Exposure to blast concussion and flying debris	• Personal injury or death • Occupational disease • Property damage	• Central blasting control • Controlled re-entry • Adequate ventilation • Blasting procedures • Controlled blasting times • Use only qualified workers
Noxious fumes, gases and dust underground	• Hazardous atmosphere	• Occupational disease • Personal injury or death	• Ventilation flow through the work place

Hazardous Activity or Condition	Potential Consequences	Plausible Outcomes	Control/Mitigation Measures
Cranes and hoisting	• Dropped load • Crane failure • Uncontrolled load impacting equipment or personnel	• Personal injury or death • Property damage • Reportable dangerous occurrence • Potential loss of critical safety function	• Critical lift procedure • Lift planning • Use only qualified workers • Work permits • Worker awareness • Hoisting log books/records • Equipment planned/preventative maintenance • Safe work code of practice
Dusty conditions on surface	• Worker exposure	• Occupational disease	• Vehicular speed control • Application of water or other dust control method • Worker awareness • Work permits • Personal protective equipment
Electrical	• Electric shock	• Personal injury or death • Property damage • Reportable dangerous occurrence	• Lock-out/Tag-out procedure • Use only qualified workers • Work permits • Signage
Shaft flooding from unexpected groundwater source	• Drowning • Flooded shaft	• Personal injury or death • Project delay	• Probe-hole drilling and grout procedure • Worker awareness • Underground water management system • Hydrostatic shaft liner • Very tight rock – water ingress not expected • See Chapter 7 (preclosure safety assessment) of the PSR for more information (OPG 2011a)
Ground disturbance	• Contacting electrical conductor • Damaged utility (water,	• Personal injury or death • Property damage • Potential loss of critical safety function	• Ground disturbance permits • Work permits • Worker awareness • Manually expose utilities

Hazardous Activity or Condition	Potential Consequences	Plausible Outcomes	Control/Mitigation Measures
	communication)		• Pre-excavation ground surveys. • Drawings
Hand tools	• Amputation injury • Cuts, bruises and scrapes	• Personal injury or death • Property damage • Reportable dangerous occurrence	• Personal protective equipment • Worker awareness • Maintenance and inspection programs
Hazardous materials handling	• Worker exposure to toxic, designated or controlled substance	• Occupational disease • Personal injury	• Personal protective equipment • Worker awareness • WHMIS
Mobile/heavy equipment congestion	• Equipment collision • Personnel collision	• Property damage • Personal injury or death	• Defensive driving practice • Operator training • Worker awareness • Work permits • Traffic plan • Signage
Underground diesel equipment exhaust	• Worker exposure to toxic, designated or hazardous substance	• Occupational disease • Personal injury	• Ventilation • Underground diesel control code of practice to avoid exceeding the ventilation system capacity to safely support diesel equipment operation • Working environment monitoring • Maintenance • Worker awareness
Hoisting using a shaft sinking bucket	• Hoisting equipment failure • Crush or amputation injury • Cuts, bruises and scrapes • Uncontrolled load impacting equipment or personnel	• Personal injury or death • Property damage	• Equipment planned/preventative maintenance • Equipment design, installation and operation to meet shaft/hoist safety standards • Hoisting log books/records • Inspection protocol • Personal protective

Hazardous Activity or Condition	Potential Consequences	Plausible Outcomes	Control/Mitigation Measures
			equipment • Worker awareness • Operator training • Use only qualified workers • Shaft sinking safe work practices • Worker orientation
Loose ground/rock burst	• Rock falling from roof or walls (rock bust, fall of ground)	• Personal injury or death • Property damage	• Worker awareness • Ground control standards • Loose rock scaling work instruction • Inspection protocol • Engineered ground support
Moving/rotating machinery	• Crush or amputation injury	• Personal injury or death	• Worker orientation • Worker awareness • Machine guarding • Safe work practices • Spotters for mobile equipment • Barricading off of work areas • Controlled access
Mucking shaft bottom during sinking	• Falling from scaffold, ladder or elevated platform	• Personal injury or death	• Fall protection program • Personal protective equipment • Operator training • Shaft sinking procedures
Noise	• Worker exposure • Industrial hearing loss	• Occupational disease	• Personal protective equipment • Equipment planned/preventative maintenance • Engineered noise abatement - barriers, encapsulation, shielding • Worker awareness
Pressurized containers	• Serious fire, explosion	• Personal injury or death • Property damage	• Fire suppression system at container recharging locations • Worker awareness • Emergency response

Hazardous Activity or Condition	Potential Consequences	Plausible Outcomes	Control/Mitigation Measures
			capability • Procedures • WHMIS
Scaffold, elevated platform and ladder (including shaft sinking stage)	• Structural collapse • Falling material from scaffold or elevated platform • Falling from scaffold, ladder or elevated platform	• Personal injury or death • Property damage • Reportable dangerous occurrence	• Scaffolding, elevated work platform and ladder procedures • Fall protection program • Use only qualified workers • Shaft sinking safe work practices • Hoisting log books/records Inspection protocol • Safe work code of practice • Personal protective equipment • Worker awareness • Work permits
Traffic	• Heavy equipment collision • Personnel collision • Traffic accident	• Personal injury or death • Property damage	• Vehicular speed control • Operator training • Defensive driving practice • Traffic plan • Signage
Trenching	• Caving/trench wall collapse • Accumulation of hazardous aerosols ("heavier than air" gases and vapours)	• Personal injury or death	• Trenching code of practice • Worker awareness • Work permits • Excavation permit
Uneven walking surface/poor footing	• Slip trips and falls	• Personal injury	• Personal protective equipment • Worker awareness • Alternative routes • House keeping • Barricades • Signage
Unstable stacking and storage of	• Toppling of pile • Collapse or rolling of stacked pipes	• Personal injury or death	• Safe work code of practice • Worker awareness

Hazardous Activity or Condition	Potential Consequences	Plausible Outcomes	Control/Mitigation Measures
material			• Pipe handling work instruction
Welding and cutting	• Burns • Fire • Worker exposure to welding flash • Worker exposure to toxic or designated substance • Electrocution	• Personal injury or death • Property damage • Occupational disease	• Worker awareness • Personal protective equipment • Hot work permit • Maintenance and inspection program
Shaft inspection	• Hoisting equipment failure • Falling from height	• Personal injury or death • Property damage	• Equipment planned/preventative maintenance • Hoisting log books/records • Personal protective equipment • Worker awareness • Shaft inspection • Safe work practices • Worker orientation
Working on the shaft bottom	• Crush or amputation injury • Cuts, bruises and scrapes • Fall of ground • Falling objects • Hazardous atmosphere • Slip trips and falls • Uncontrolled load impacting equipment or personnel	• Personal injury or death • Property damage	• Worker awareness • Personal protective equipment • Ground control standards • Safe work code of practice • Loose rock scaling work instruction • Controlled re-entry after blasting • Housekeeping • Operator training • Worker orientation

5.3 Operations

Operations involves waste package handling, transfer and emplacement, inspection and maintenance, end wall and closure wall erection and the operation and maintenance of fire and life safety systems.

Table 5.5 lists the jobs/aspects associated with operating the facility and the activities associated with these elements.

Table 5.6 summarizes the hazards from major operational activities and the control/mitigation measures that have been identified.

Table 5.5: Operations Activities

Job/Aspect	Activities
Waste package receipts	• Waste package arrives at the WPRB from WWMF • Inspect package • Fork lift operation • Crane operation • Move loaded carts • Load/unload onto cart into or from conveyance • Load /unload carts
Waste package emplacement	• Hoisting (cage operation) • Routine personnel travel in the shaft • Transport with forklift or with self propelled cart to emplacement room underground • Crane operation • Fork lift operation • Stack packages as appropriate
Inspection and maintenance	• Monitoring • Routine inspection of facilities • Preventative maintenance of mechanical, electrical, ventilation, monitoring and control systems • Repair or replace equipment as required

Table 5.6: Summary of Operations Conventional Safety Assessment

Hazardous Activity or Condition	Potential Consequences	Plausible Outcomes	Control/Mitigation Measures
Underground ventilation failure	• Exposure to noxious fumes, dust and gasses	• Occupational disease • Personal injury	• Install visual and audible alarms on ventilation system • Inspect ventilation system prior to entering the underground workplace • Routine monitoring of

Hazardous Activity or Condition	Potential Consequences	Plausible Outcomes	Control/Mitigation Measures
			ventilation flows • Refuge station • Evacuation procedure • Back-up power • Safety stations with personal protective equipment
Mobile/heavy equipment congestion	• Equipment collision • Personnel collision	• Property damage • Personal injury or death	• Defensive driving practice • Operator training • Worker awareness • Work permits • Traffic plan • Use of spotters • Signage
Working around water	• Drowning	• Property damage • Personal injury or death	• Procedures for working around water (sumps) • Inspection and maintenance program (sump pumps, service water lines) • Anti backflow devices in water lines
Buildup of explosive gasses underground	• Explosive atmosphere • Fire • Oxygen deficiency	• Property damage • Personal injury or death	• Expected slow rates of gas generation or in-seepage • Ventilation • Monitoring • Closure walls
Confined space entry	• Hazardous atmosphere	• Occupational disease • Personal injury or death	• Confined space entry program
Crane and shaft hoisting	• Crane failure • Dropped load • Structural collapse • Uncontrolled load impacting equipment or personnel • Shaft damage • Hoist failure	• Personal injury or death • Property damage • Reportable incident/dangerous occurrence	• Critical lift procedure • Lift planning • Safe work code of practice • Equipment design installation and operation to meet established crane and hoisting safety standard • Work permits • Operator training • Worker awareness • Equipment

Hazardous Activity or Condition	Potential Consequences	Plausible Outcomes	Control/Mitigation Measures
			planned/preventative maintenance • Inspection protocol • Hoisting log books/records
Dust underground	• Worker exposure	• Occupational disease	• Vehicular speed control standard • Concrete floors underground • Shotcreted walls underground • Housekeeping • Ventilation
Electrical	• Electric shock	• Personal injury or death • Property damage • Reportable dangerous occurrence	• Lock-out/tag-out procedure • Use only qualified workers • Work permits
Fire	• Worker burns • Temporary facility or equipment fire • Emergency response initiation • Hazardous atmosphere	• Personal injury or death • Property damage • Reportable dangerous occurrence	• Housekeeping • Hot work permit • Worker awareness • Refuge stations • Fire suppression system • Emergency response capability • Safe work code of practice • Inspection and maintenance program
Hand tools	• Amputation injury • Cuts, bruises and scrapes	• Personal injury	• Safe work code of practice • Personal protective equipment • Worker awareness • Inspection and maintenance program
Hazardous materials handling	• Worker exposure to toxic, designated or controlled substance	• Occupational disease • Personal injury	• Personal protective equipment • Worker awareness (WHMIS)
Heavy equipment congestion	• Smaller vehicle collision/heavy equipment collision	• Property damage • Personal injury or death	• Defensive driving practice • Operator training • Worker awareness • Spotters

Hazardous Activity or Condition	Potential Consequences	Plausible Outcomes	Control/Mitigation Measures
	• Personnel collision		• Traffic plans • Signage
Diesel exhaust from equipment operation underground	• Worker exposure to toxic, designated or hazardous substance	• Occupational disease • Personal injury	• Ventilation • Underground diesel control code of practice to avoid overloading ventilation capacity to support diesel equipment operations • Working environment monitoring • Worker awareness • Inspection and maintenance program
Moving/rotating machinery	• Crush or amputation injury	• Personal injury or death	• Machine guarding • Worker awareness • Barricading • Controlled entry • Signage
Loose ground	• Rock falling from roof or walls (fall of ground)	• Personal injury or death • Property damage	• Worker awareness • Ground control standards • Scaling work instruction • Inspection protocol • Ground support
Noise	• Worker exposure - industrial hearing loss	• Occupational disease • Personal injury	• Engineered noise abatement - barriers, encapsulation, shielding • Equipment planned/preventative maintenance • Personal protective equipment • Signage
Scaffold, elevated platform and ladder	• Structural collapse • Falling material from scaffold of elevated platform • Falling from scaffold, ladder or elevated platform	• Personal injury or death • Property damage • Reportable dangerous occurrence	• Inspection protocol • Worker awareness • Work permits • Personal protective equipment • Fall protection program

Hazardous Activity or Condition	Potential Consequences	Plausible Outcomes	Control/Mitigation Measures
Shaft inspection	• Hoisting equipment failure • Falling from height	• Personal injury or death • Property damage	• Equipment planned/preventative maintenance • Hoisting log books/records • Personal protective equipment • Worker awareness • Shaft inspection safe work practices • Worker orientation
Uneven walking surface	• Slip trips and falls	• Personal injury	• Worker awareness • Personal protective equipment • Housekeeping • Alternative routes • Barricades • Signage
Welding and cutting	• Burns • Fire • Worker exposure to welding flash • Worker exposure to toxic or designated substance • Electrocution	• Personal injury or death • Property damage • Occupational disease	• Worker awareness • Personal protective equipment • Hot work permit • Inspection and maintenance program

5.4 General Safety Management

Safety systems have common management elements that influence all areas of safety. These elements focus mainly on the development, coordination, implementation and verification of the safety system.

Site preparation and construction activities involve numerous activities often occurring simultaneously. A Health and Safety Management Plan will be developed prior to commencing construction to provide clear and documented guidance to construction management and supervisory personnel (Section 4.2.7.2, NWMO 2011). The plan will clearly describe the planning, coordination, control, monitoring, emergency response, reporting and communication processes to be followed by various parties involved in construction. The plan will also clearly define the responsibilities and accountability of the parties related to construction.

The major aspects of safety management include leadership, bilateral communications from and between management and the workers, quality management of the safety function, training of the workforce including supervisors, safety review and assessment of engineering and design

work, and general safety implementation practices such as developing a risk based safety plan, anticipation of potential safety issues, recognition of hazards and the authority to trigger control measures where required. Table 5.7 lists the common elements and the safety related activities that generally occur within these areas.

Control measures implemented within a carefully thought out management system lead to the creation of a safety climate that encourages the development of a strong safety culture where the precursors to safety incidents are identified and controlled or avoided.

Table 5.8 provides a detailed breakdown of the hazards, consequences, outcomes and control/mitigation measures to manage the hazards and mitigate potential impact of a breakdown within the management elements. Table 5.8 provides results of the conventional safety management assessment, grouped by management element.

Table 5.7: Safety Management Activities

Job/Aspect	Activities
Communication	• Safety communications (toolbox talks, pre-job safety instruction, training, posters, post incident briefing, routine on the job interaction) • Safety meetings • Job observation • Active listening
Quality Management	• Identification of quality requirements • Documentation of programs, procedures and work instructions • Monitoring and verification of health and safety program implementation effectiveness • Validation of safety systems, services, and program functionality • Auditing
Leadership	• Safety culture development • Communicating and enforcing expectations. • Problem solving • Risk analysis • Lead through example • On the job visibility
Training	• Employee orientation • Systematic approach to training (needs assessment, training development, presentation, testing, monitoring effectiveness of training, improve training) • Skills training • Safety related training • Practical skills demonstration
Design and engineering review	• Hazard assessment and safety risk management

Job/Aspect	Activities
General	• Implementation of a risk based safety plan • Anticipation of potential safety issues • Recognition of hazards • Trigger control measures • Peer reviews • Open discussion and feedback

Table 5.8: Summary of Safety Management Assessment

Hazardous Activity or Condition	Potential Consequences	Plausible Outcomes	Control/Mitigation Measures
Inadequate communications	• Potential hazards not identified • Disruption of important safety related communications • Workers not fully engaged in safety awareness • Perception that management is not committed to safety	• Degradation or lack of safety culture • Missed opportunity to avoid safety incidents • Accumulation of poor safety conditions leading to a major safety incident • Inappropriate work planning • Potentially unsafe conditions/acts go unchecked	• Communication mechanism that fosters and encourages the free flow of constructive safety information and concerns between workers, management and the client • Recognition of the importance of a positive safety culture throughout the workforce, management and client • Active visible participation in the development and improvement of a safety culture that meets the unique needs of the project
Inadequate risk management	• Unidentified “risk creep" • Risk assessment does not recognize relevant hazards • Inadequate safety factors in the design and engineering • Insufficient detailed	• Inappropriate acceptance of safety risk • Unrecognized safety risk factors • Unknown exposure of workers to unacceptable safety risk	• Standard level of completion for detailed engineering as input for risk assessments (for example 50% and 80% complete) • Control and manage deviations from the original design that was assessed for safety

Hazardous Activity or Condition	Potential Consequences	Plausible Outcomes	Control/Mitigation Measures
	design available effective risk assessment of project design • Design failure • Engineering liability		• Review and periodically update safety assessments as the design and/or construction progresses • Safe work planning for all activities • Appropriate work procedures
Inadequate leadership	• Lack of clear direction • Culture of blame • Lack of accountability for safety function • Unclear roles, responsibilities and accountabilities related to safety • Reactive leadership based on lagging indicators rather than proactive leadership based on leading indicators	• Ineffective safety systems and services • Inappropriate safety culture • Lack of confidence by the workforce in the project leadership • Inadequate responsiveness to safety issues for optimal safe project execution	• Provide clearly documented roles responsibilities • Validate safety program and systems functionality and routinely verify effectiveness of implementation • Visible management and safety personnel in day to day health and safety issues • Publish safety performance data • Set reasonable but challenging safety performance targets • Be seen to be involved – attend safety and toolbox meetings • Regular safety walks on the site to interact with all workers • Set the example and standard through own behaviour
Inadequate quality management	• Errors and omissions going unchecked • Unnoticed degradation of safety performance • Poor quality project safety management	• Inability to accurately assess the adequacy of safety systems/services • Ineffective safety systems and services	• Use a system of metrics to monitor and record key performance indicators (KPIs) • Benchmarking and external review of safety systems and

Hazardous Activity or Condition	Potential Consequences	Plausible Outcomes	Control/Mitigation Measures
	• Inconsistent approach to work	• No basis for continual improvement	services • Audits • Include auditing in KPIs
Cumbersome project organizational structure	• Too many reporting layers with a poor interface between project management and contractor organizations	• Inadequate responsiveness to safety issues for optimal safe project execution	• Avoid unnecessary management and supervisory levels that may create cumbersome and inflexible bureaucracy within the project
Compliance that does not develop beyond the minimum regulatory expectations	• Inability to advance the safety awareness • Wasted resources of dealing with immediate safety issues	• Reactive leadership based on lagging indicators rather than proactive leadership based on leading indicators	• Educate through conversation, clear expression of expectations and passion for the importance of safety
Inadequate training	• Lack of knowledge of health and safety expectations • Inadequate skills inventory	• Persistent unsafe workplace conditions • Acceptance of unsafe conditions in the workplace	• Identify applicable lessons learned and disseminate these between contractors, owners and owners representative organizations • Include applicable lessons learned into project training and orientation • Adopt Systematic Approach to Training (SAT) • Develop a training matrix
Inappropriate allocation of resources	• Cost overruns • Underfunding of necessary safety efforts	• Insufficient resources allocated to managing safety aspects that have higher negative impact potential than others	• Assign a safety significance index to activities, systems, components or structures to facilitate priority setting

Hazardous Activity or Condition	Potential Consequences	Plausible Outcomes	Control/Mitigation Measures
Inadequate chemical physical and biological hazards control	• Unhealthy workplaces	• Occupational disease • Personal injury • Reportable occurrence	• Assign a safety significance index to activities, systems, components or structures • Training • Procedures
Failure of backup systems that may impact health and safety	• Imminent danger to health and safety and property	• Emergency shutdown of activities and operations and evacuation of personnel	• Routine testing and inspection of backup systems • Evacuation procedures • Refuge stations

6. RECOMMENDATIONS

Based on the analysis presented in Chapter 5, the following recommendations for the implementation of control measures were developed.

1. Consider site preparation and construction mitigation and control measures identified in this assessment when developing the Health and Safety Management Plan for design and construction.
2. Verify that the hazards, control and mitigation measures identified in the assessment remain applicable to the project as it progresses and update the assessment, the Health and Safety Management Plan and the standard operating procedures appropriately as the project progresses.
3. Compare the mitigation and control measures developed for operations in this assessment to existing OPG measures and verify that the measures to be adopted are complete and appropriate for the operation of the facility.
4. As site work progresses, identify the safety significance of activities, systems, components and structures, using a risk based safety significance index, to assist in setting safety management and emergency response priorities.
5. Identify standard levels of completion for detailed engineering as an input to risk assessments for construction (for example 50% and 80% completion). Review and update safety assessments on this basis.
6. Validate safety program and systems functionality and routinely verify effectiveness of implementation after site activities commence.
7. Adopt a phased evacuation and safe work shutdown approach commensurate with the level of completion of the project. Test evacuation and emergency shutdown system equipment and procedures on a regular basis.
8. Adopt a Systematic Approach to Training that incorporates a commitment to train project personnel as required.

7. CONCLUSIONS

This report provides a preliminary conventional (non-radiological) safety assessment of the activities associated with the development and operation of this facility based on facility design. The assessment identified specific measures to control potential hazards and mitigate possible impacts from these hazards for site preparation, construction and operations.

General safety management is addressed in Section 5.4, recognition and proper implementation of the safety management elements listed in this section will facilitate the successful completion of the project. NWMO has developed a document entitled “Design and Construction Phase Management System (OPG’s L&ILW DGR)” that addresses many of the findings of this assessment specific to safety management during site preparation and construction. This document also includes a framework for implementation of a Health and Safety Management Plan that will be based on conventional industry safety practice as identified in this assessment.

A mature management system and a good safety culture already exist within OPG. The benefits of this system and the safety culture are fully expected to extend to the DGR facility as operations commence.

The DGR facility design is still preliminary at this stage and detailed design engineering work needs to be completed before site activity commences. It is therefore expected that the conventional health and safety review will continue to be validated and updated as significant design, engineering and construction milestones are achieved.

This preliminary assessment has not identified any reason why the facility could not be constructed and operated in a safe manner.

8. REFERENCES

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9. ABBREVIATIONS AND ACRONYMS

CNSC	Canadian Nuclear Safety Commission
DGR	Deep Geologic Repository
JSA	Job Safety Analysis
KPI	Key Performance Indicator
L&ILW	Low and Intermediate Level Waste
MOL	Ontario Ministry of Labour
NSCA	Nuclear Safety and Control Act
NWMO	Nuclear Waste Management Organization
OHSA	Occupational Health and Safety Act
OPG	Ontario Power Generation
PHA	Process Hazard Analysis
PSR	Preliminary Safety Report
QA	Quality Assurance
QC	Quality Control
SAT	Systematic Approach to Training
WHMIS	Workplace Hazardous Materials Information System
WPRB	Waste Package Receiving Building
WWMF	Western Waste Management Facility