Making Strides on the Port Hope Area Initiative: Canada's Largest Low-Level Radioactive Waste Clean-up Project

Christine A. Fahey[1], G. Glenn Case[1]
Atomic Energy of Canada Limited, Mississauga, Ontario, Canada

The Port Hope Area Initiative (PHAI) is the largest low-level radioactive waste clean-up project in Canadian history. Approved in 2001 and focused on project definition in its early years, this federally-sponsored project entered a new transition phase in 2008. The transition phase activities include detailed design, construction site preparation, environmental monitoring, and final licensing. In addition, efforts to engage and inform the highly interested project stakeholders will continue. This paper sets out the objective of the PHAI and provides a brief history, a summary of the recent project developments and insight into the upcoming environmental remediation and safe storage phase.

1 Project objective & history

1.1 Project scope

The Port Hope Area Initiative (PHAI) is the largest cleanup of low-level radioactive waste (LLRW) ever undertaken in Canada. It is focused on the excavation of an estimated 1.7 million cubic metres (m^3) of contaminated soil and debris and its consolidation within two new waste management facilities in the form of above-ground, engineered containment mounds. For the most part, the waste is the by-product of uranium and radium ore processing activities of the former crown corporation Eldorado Nuclear Limited and its private sector predecessors. The clean-up is sponsored by the Government of Canada under the federal historic liabilities management program that is the responsibility of Natural Resources Canada (NRCan).

The LLRW is situated within the two adjacent southeast Ontario municipalities: Port Hope and Clarington, which are located about one hour's drive east of Toronto. A Legal Agreement between the federal government and these municipalities [1] was signed in 2001 and defines the scope and terms of the clean-up in each municipality. In addition to the technical parameters of the undertaking, the Agreement also requires the creation of programs to address the social dimensions of carrying out the clean-up within the populated and commercial areas of the communities.

1.2 Waste origin

The vast majority of the waste involved in the Port Hope portion of the clean-up arises from the Eldorado refinery operations between 1933 and 1954. During the early years conventional pitchblende ore processing techniques were modified to increase efficiency of the radium recovery to meet the world's ever increasing need for radium. In the early 1940s, refining operations were expanded to include uranium production to support the demands of The Manhattan Project [2] and Eldorado became a federal crown corporation. Despite improvements

in recovery efficiencies, large quantities of process residues and wastes were produced through the refining processes, which contained residual extraction and leaching chemicals as well as naturally occurring elements such as arsenic, silver, cobalt, and antimony from the original pitchblende ores. Eldorado's waste management practices of that era were typical of the chemical processing industry. The wastes were removed from the plant by the truckload and dumped in locations deemed appropriate at the time. These locations included several ravines in the town of Port Hope, the municipal landfill, an unused sand pit, numerous private properties, and the harbour turning basin.

From the beginning of the Port Hope refining operations in 1932, the potential value of selected process residues was recognized (e.g. silver concentrates, Geiger picker rejects, radium residue) and dedicated residue storage facilities were established within the urban area of Port Hope. However these "in-town" facilities were soon filled and in 1948 Eldorado moved its residue and waste storage operations to a more rural setting near the village of Welcome, within the Township of Hope. The Welcome waste site remained in active use for some six years until 1954, when contaminated runoff from the site prompted the relocation of waste storage operations to a new rural new site on the north shore of Lake Ontario near the village of Port Granby. The year 1954 also marked the closure of the radium refining operation at the plant site and the subsequent shift to new processing operations that would include uranium trioxide refining (1955), metal production (1956), and uranium conversion into products required by nuclear power reactors, such as uranium dioxide (1965) and uranium hexafluoride (1970) [3]. The Port Granby waste storage site, located west of Port Hope in the Municipality of Clarington, remained in use by Eldorado for 33 years, from 1955 until 1988. In that year, Eldorado and the Saskatchewan Mining & Development Company merged to form the private company, Cameco Corporation, and halted further waste placement at the Port Granby site.

1.3 The first clean-up project

The need to clean-up the LLRW dates back to the mid-1970s when elevated levels of radon gas, a product of the natural decay of radium, were first measured within the basements of several hundred Port Hope homes. In addition to elevated radon gas levels, radioactively contaminated soils and building materials were discovered on many properties. To address this matter, a Federal-Provincial Task Force on Radioactivity was created with the (then) Atomic Energy Control Board as the lead federal agency. From 1976-1981, the Task Force conducted radiological investigations on some 3500 properties within Port Hope. These investigations included interior radon gas sampling, exterior and interior gamma measurements and interior contamination surveys. Based upon the results of these investigations, remedial clean-up action was conducted at approximately 450 residential and commercial properties in Port Hope. During this first wave of remedial clean-up activities, some 100,000 m^3 of soil was excavated and safely trucked for storage at Atomic Energy of Canada Limited's (AECL's) Chalk River Laboratories.

The 1976 to 1981 investigations identified over 500,000 m^3 of Eldorado process wastes in the Port Hope; however, the storage capacity at the Chalk River Site was limited to 100,000 m^3. From 1982 to1997 several initiatives involving the federal government, Eldorado and the local municipalities were pursued with the goal of finding an acceptable long-term waste management solution for the remaining wastes in Port Hope, as well as the wastes at the Welcome and Port

Granby waste management sites. The solution currently being implemented, the Port Hope Area Initiative arose from three proposals advanced in 1998 by Port Hope, Hope Township and Clarington to build LLRW storage facilities within the individual municipalities where the waste was situated. A Memorandum of Understanding was brokered in 1999 to formalize the federal and municipal governments' acceptance of the proposals and the Legal Agreement for the clean up project was developed and signed in 2001 March.

1.4 The current clean-up project & phase I progress

The Legal Agreement initially required the development of three waste management facilities: one each in the Town of Port Hope and the Township of Hope (which later amalgamated to form the Municipality of Port Hope) and one in the Municipality of Clarington. A recommendation from the alternative means evaluation conducted as part of the environmental assessment, recommended that the proposed Port Hope and Hope Township facilities be combined and thus the PHAI now consists of two distinct but linked remediation efforts: the Port Hope Project and the Port Granby Project. The two proposed long-term waste management facilities will be separated by a distance of approximately 10 kilometres. Figure 1 shows the locations of the proposed new waste facilities and illustrates their relative geographical proximity.

Figure 1: Relative proximity of the Port Hope and Port Granby Projects

The PHAI is being implemented in the following three main phases, with Phases 1 and 2 estimated to span a 20 year period:

- Phase 1 – Project definition and regulatory approvals
- Phase 2 – Implementation of the remediation project and construction of new facilities
- Phase 3 – Long-term monitoring and maintenance of the completed facilities

Phase 1 was initiated in 2001 upon the approval of the federal funds to proceed. It focused on the definition of the project, the establishment of the programs set out in the Legal Agreement, and the review of the projects under the Canadian Environmental Assessment Act. At the start of Phase 1, AECL's Low-Level Radioactive Waste Management Office (LLRWMO) was appointed by the Government of Canada to carry out many of its Legal Agreement responsibilities, including managing the Phase I project activities, and designated as the project proponent. This appointment was consistent with the LLRWMO's mandate to directly assist NRCan in the management of federal historic radioactive waste liabilities.

In the early days of Phase 1, an extensive waste characterization program was undertaken to confirm data previously collected and to further define the scope and composition of the waste materials. This work built on the results of over twenty-five years of previous investigations and entailed the analysis of hundreds of new samples taken from dozens of new boreholes. A major activity for the PHAI was the development of project-specific clean-up criteria. Developed in conjunction with the municipalities of Port Hope and Clarington, and federal and provincial regulatory agencies, these criteria represent the radiological and non-radiological contaminant concentrations that must be removed from the waste sites to meet current and foreseeable unrestricted future uses of the sites as prescribed in the Legal Agreement. Based upon the application of these cleanup criteria, it was estimated that the capacity of wastes to be emplaced in the new facilities was 1.2 million m^3 for Port Hope and 500,000 m^3 for Port Granby. From there, the preliminary excavation plans and the designs of the mounds were established. Although the mound designs for the individual projects reflect local geologic and topographic site conditions, both engineered facilities feature multi-layer base liner and cover systems comprising geo-synthetic and natural materials to fully encapsulate the consolidated wastes. The concept and cross-sections for the Port Hope Project above-ground mound are provided in Figures 2 and 3 to illustrate the preliminary design features. Each mound incorporates a leachate collection system to collect moisture runoff from within the consolidated wastes and route it to a water treatment system for processing.

Figure 2: Proposed mound design for the Port Hope Project

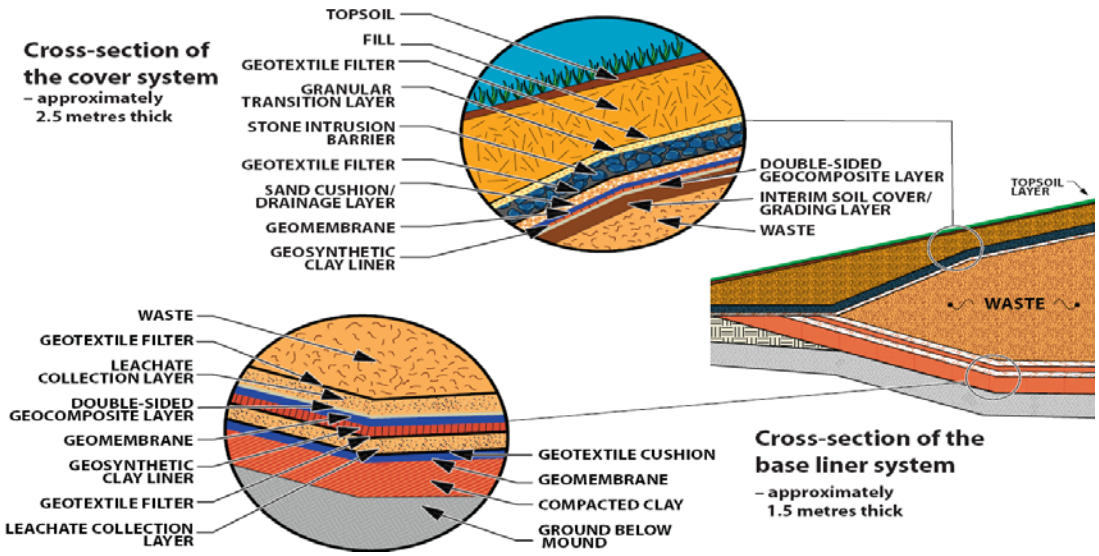

Figure 3: Cross section of base liner and cover systems proposed for the Port Hope mound

In parallel with the evolution of the preliminary mound designs, comprehensive Screening Level Environmental Assessment (EA) Studies for each project were completed and accepted by each municipality. Each of the 17-volume studies considered the potential socio-economic and biophysical impacts and concluded that neither project would have a significant long-term environmental effect, so long as mitigation actions were taken into consideration. In early 2007, the EA Screening Report for the Port Hope Project was finished and accepted by the Responsible Authorities (NRCan, the Canadian Nuclear Safety Commission (CNSC) and the Department of Fisheries & Oceans). The Port Granby Project Screening Report was, however, delayed pending the resolution of Municipal concerns (related to the proposed mound design and waste transportation route), and eventually accepted by the Responsible Authorities (NRCan and CNSC) in 2009 August.

A public communication and stakeholder outreach program was also established during the project's first stage. Early on, the value of an information exchange portal was recognized and both a main-street Project Information Exchange and a Web site were created to make information available to the public and to answer questions. Further, as part of the EA process, some twenty facilitated meetings were arranged with stakeholders to gather their ideas and obtain feedback on evolving project matters. It was during this first stage that the practice of mailing newsletters to the homes of residents in the communities was initiated. The Property Value Protection (PVP) program, which protects property owners from project effects, was also implemented in Phase 1.

From an oversight standpoint, it was early in Phase 1 that the Agreement Monitoring Group (AMG), involving the signatories to the Legal Agreement and the project proponent, was formed to guide and review the efforts of the project. Through 2009 more than 60 AMG meetings have been held. Various subcommittees of the AMG were also formed to champion specific facets, such as communication and technical coordination. In composite, the AMG's oversight provides

a mechanism to ensure the obligations of the Legal Agreement continue to be fulfilled and a forum for the PHAI's senior stakeholders to discuss progress, plans, and issues; both vital requirements for the success of this large and complex undertaking.

2 New framework for project execution

A new project execution framework was introduced by the federal government in 2008, in its capacity as project sponsor, and pursuant to an internal NRCan review undertaken at the end of 2007. This framework was targeted to be introduced over a three-four year transition period and dubbed Phase 1A. The purpose of the transition phase is to effectively bridge the conclusion of Phase 1 and the start of the Phase 2 fieldwork activities.

2.1 Federal government requirements

The federal government's requirements for the new framework included many of the original project implementation expectations, as well as new requirements. Ongoing from Phase 1 was the need to implement community-based communication, property value protection, and interim waste management programs; to provide AMG oversight and locally-based project management; and to complete licensing applications. New for Phase 1A was the requirement to advance work packages, such as property resurveys, land acquisitions, and detailed design and site preparation, all to enable the start of construction when the funding for Phase 2 is approved. In addition, to accelerate the project's completion, the federal government directed that a fully-dedicated project organization be formed to exclusively focus on the completion of the PHAI and to implement industry-best project management practices. In recognition of the forthcoming large-scale procurement and changes in federal policies, the government also instructed that Public Works & Government Services Canada (PWGSC) become involved in the project to manage the major contracts. Lastly, the government stipulated that a senior level steering committee be established to oversee the implementation of the project from the federal perspective.

2.2 Project delivery team & PHAI steering committee

Since 2008, substantial progress has been made on the Transition Phase 1A objectives. Perhaps most importantly, a project delivery team comprised of experienced, full-time, multi-disciplinary resources from AECL, PWGSC and NRCan has been formed to implement the project. United by a Project Charter and a Memorandum of Understanding, these three federal entities have joined together as partners in the PHAI Management Office to plan and implement the remainder of the remediation project. In addition, the Management Office has been designated as the Federal Operating Agency, as set out in the Legal Agreement, to lead the execution of the PHAI project.

The PHAI steering committee was formed shortly after the start of the Transition Phase in 2008. With recently approved Terms of Reference, this project oversight committee meets quarterly to review project performance and plans, risk management, and relationships with key municipal and community stakeholders. The committee is comprised of one senior-level representative from each of the project delivery team organizations and is chaired by NRCan.

2.3 Transition phase accomplishments to date

The PHAI Management Office has already achieved several of the defined Transition Phase objectives. Among the Phase 1A milestones met to date are:

- The approval of the EA Screening Report for the Port Granby Project; the federal Responsible Authorities declared in 2009 August that the project was unlikely to cause significant environmental effects, mitigation actions considered.
- The granting of a Waste Nuclear Substances Licence for the Port Hope Project; the CNSC granted the licence in 2009 October, following a two-day public hearing and consideration of one hundred interventions.
- The public tendering of the detailed design consulting services work for both the Port Hope and Port Granby Projects; fixed price proposals were received from multiple engineering firms and evaluated. Federal approvals to award the two multi-million dollar contracts are pending.
- The completion of several construction pre-requisites at the designated entrance to the new Port Hope waste facility including the archaeological assessment, the establishment of visual barriers through a substantial tree-planting campaign, and the demolition of obsolete structures to establish the new intersection on Toronto Road.

In concert with the above accomplishments, the well-established project communications and PVP programs have continued and evolved to meet project requirements. The Project Information Exchange has seen a high-level of traffic with the recent EA and licensing activities and a dedicated and refreshed project Web site has been launched to align with the new project execution framework. Knowledge of the PVP program among local developers, real estate agents and property owners has grown through seminars and other communication efforts of the Management Office. This increased knowledge and the sense of the approaching field remediation work has led to an increase in PVP activity and the number of claims and awards for project-related effects, particularly the value of properties upon sale.

2.4 Moving from planning to digging

As a result of the CNSC licensing decision for the Port Hope Project, the desire to get “shovels in the ground” is increasing among local stakeholders, eager to see the long-standing community concern with waste resolved as quickly as possible. It is challenging from a public relations perspective to communicate the progress that is being made and sustain confidence, while tempering expectations that backhoes and dump trucks will imminently be shuttling back and forth between waste storage sites and the new mounds. This challenge will continue for the next 12-18 months as the project completes the final detailed documentation that supports the cases for federal funding and regulatory approvals for the PHAI’s Phase 2 field implementation.

To overcome these final hurdles to construction, the Management Office is now embarking on several key deliverables including engineering contracts, EA monitoring programs, licensing submissions and land acquisition.

First and foremost, based on competitive bids already evaluated, design consulting firms will soon be engaged to produce the detailed plans and specifications for the new waste facilities and major waste site excavations. These firms will also produce the construction tender documents and the substantial cost estimates for the field work. Currently, this engineering work is scheduled to be completed early in 2011.

Technologies to treat the leachate from the completed waste facilities and the contaminated runoff while they are under construction are now under development. Bench top trials using water samples from the existing Welcome and Port Granby waste management facilities were completed in 2009 December and the results will inform the specification of pilot-scale testing planned for the spring of 2010. Thereafter, detailed process designs will be prepared and incorporated within the overall plans for the new waste facilities. The effluent water quality to be met by the designs is prescribed in the recently issued licence for the Port Hope Project.

Assessments of existing municipal infrastructure (e.g. roads, bridges, culverts) that is on the designated transportation routes for either waste movement or the import of clean construction materials will be launched in early 2010. Scopes of work have been prepared for consultants to review the conditions of the current public works in both Port Hope and Port Granby and to recommend what, if any, upgrades are required to these works prior to the movement of heavy transportation vehicles. Where repairs, remediation or reconstruction is required, engineering work will be specified to make the infrastructure ready for the main project.

Contracts to develop the methodology for conducting resurveys of small-scale contaminated sites and techniques for verifying the results are now underway. In the spring of 2010, pilot-scale resurveys will be conducted in Port Hope to “test drive” the procedures and demonstrate the communication programs needed for work in residential neighbourhoods.

Monitoring Plans are one of the Follow-up Program activities being undertaken to fulfill the requirements of the final Screening Reports. These plans establish the specific parameters and methodologies for measuring the socio-economic and biophysical effects of the project on the people and the natural surroundings in the local area. Potential socio-economic effects include increases in traffic volume and noise and dust levels, and decreases in property value and business revenues. Potential biophysical effects include a reduction in air and water quality due to particulate and suspended solids. The Monitoring Plans for the Port Hope socio-economic effects, as well as the Port Hope and Port Granby biophysical effects, are currently under development. By the end of 2010, all Monitoring Plans are scheduled to be completed and submitted to the Responsible Authorities for acceptance. As the plans are completed, sample collection and analysis will commence and continue for up to one year to re-establish the baselines used in the environmental assessment studies to predict the projects’ effects. In addition, the mitigation measures to offset the confirmed project effects will be fully developed for implementation, in conjunction with the detailed design.

When all of the aforementioned documents are completed, the Management Office will apply for the regulatory approvals necessary to commence construction. For the Port Hope Project, the CNSC approval is anticipated upon acceptance of the documents set out in the licence issued in

2009 October and the outcome of a public meeting or hearing to be convened in 2011. For Port Granby, the Management Office's strategy is to defer the application for the licence until all of the pre-requisite documentation is available from the detailed design and EA Follow-up Program development and the Port Hope Project's construction approval is in hand. Thus, the current plan is to pursue the Port Granby licence in mid to late 2011. For both projects, regulatory protocols have been signed by the CNSC, NRCan and AECL. These protocols serve to raise the PHAI's priority within these organizations and promote the timely completion, review and revision of submissions that support EA and licensing decisions.

The acquisition of the lands on which the current waste storage facilities (established by Eldorado and operated currently by Cameco) are situated and where the new waste facilities will be constructed is linked contractually with the issuance of the new project licences. In Port Hope, the real estate transaction between the federal government and the current land owner is well advanced and is expected to be completed early in 2010. The Port Granby land purchase is planned for 2011.

Finally, in support of the federal funding application for Phase 2 Implementation, the Management Office will prepare a comprehensive plan for the remediation and construction work. Building on the outputs of the various contributing consulting firms and the work led and/or managed by the Office itself, a full-scope proposal including a detailed work plan, schedule and cost estimate for Phase 2 will be prepared in the spring of 2011.

3 Preliminary plan for field clean-up & mound construction

3.1 Port Hope Project

As noted previously, the Port Hope Project will involve the excavation and transportation of some 1.2 million m^3 of waste located in a variety of urban community settings, ranging from the bottom of the Port Hope harbour turning basin, from within the municipal landfill site, from within various ravines, from under municipal roadways, to the front and backyards of some 200 to 300 private properties. These major sites are shown in Figure 4. It will be necessary to use public roadways to transport the wastes from current locations to the site of the new long-term waste management facility. The wastes will be transported using conventional dump trucks (tandem, tri-axle, dump trailers) that will have their dump boxes completely covered with tarpaulins during haulage operations to prevent wind scouring of the wastes. Each truck will also be suitably signed to indicate its involvement in the project, and issued with individual trip tickets for each load to track the initial and final disposition of all excavated waste.

In the assessment of potential environmental effects that might occur during waste handling and placement operations at the new long-term management facility, it was determined that the maximum daily receipt volume should be in the order of 2,000 m^3. Based upon this prescribed maximum daily delivery limit, it will be necessary to develop and maintain a comprehensive delivery schedule that can accurately track waste volume deliveries in real time and can maintain

the flexibility to address delivery problems due to inclement weather conditions or waste site-specific upset conditions due to equipment failures or unforeseen excavation problems.

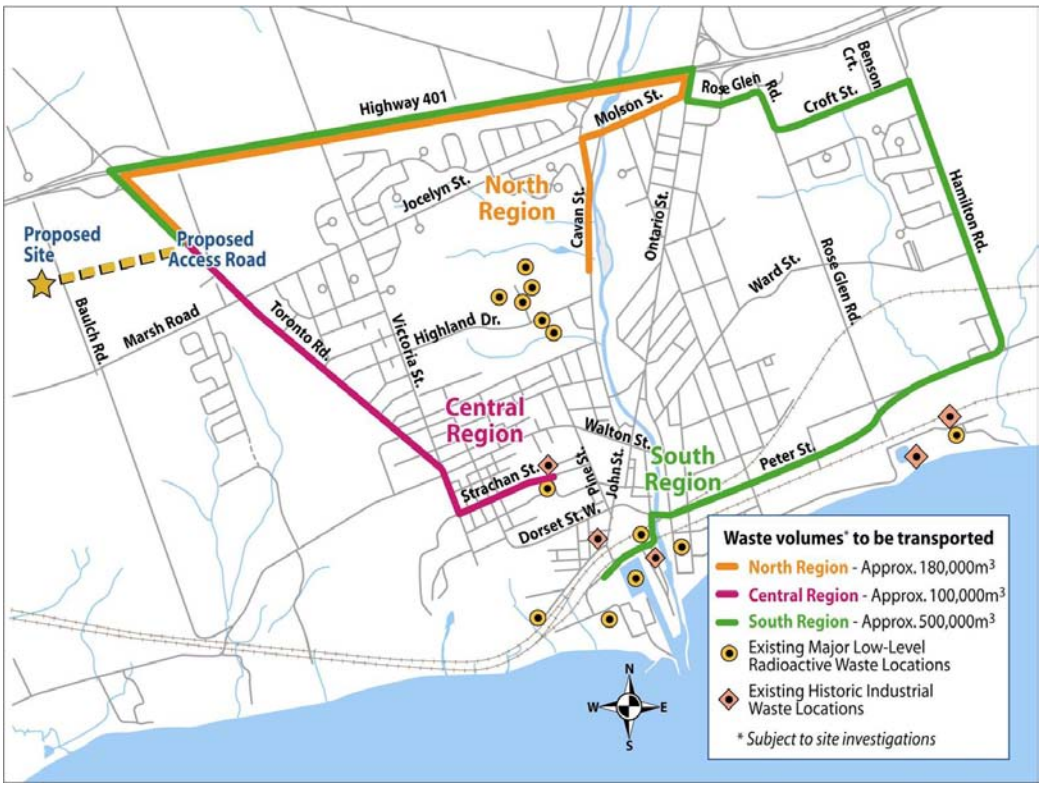

Figure 4: Urban setting and transportation routes for the Port Hope Project

The schedule will also need to consider the various waste source locations and associated volumes in conjunction with predicted rates of removal based on the complexity and type of excavations. To put the complexity of this schedule into perspective, the estimated amount of off-site waste to be delivered to the site is 760,000 m^3, with an additional 450,000 m^3 already on the site. The individual estimated off-site volumes range from highs of 120,000 m^3 in the Highland Drive landfill area and 110,000 m^3 of contaminated sediment in the harbour, to lows of 3,000 m^3 from the Strachan Street Ravine and "tens" of cubic metres from individual private properties. This waste delivery schedule is further complicated by the requirement to coordinate the excavation and placement of the 450,000 m^3 of the on-site waste into the new waste facility with the delivery of the off-site wastes to the site.

The process of building the new engineered mound in Port Hope will take an estimated seven years to complete. In the first two years, the site will be cleared and grubbed and excavation of the waste at the existing Welcome waste storage facility will commence. In years 2-6, the base liner system (Figure 3) will be installed and the waste from the multitude of locations in Port Hope systematically delivered and emplaced in the new facility. In year 7, the cover system will be installed and the mound closed. A long-term monitoring and maintenance program will then be initiated to verify the performance of the facility in accordance with regulatory requirements.

3.2 Port Granby Project

The Port Granby Project will involve the excavation and transportation of approximately 500,000 m^3 of waste located within the existing Port Granby waste storage facility, some 700 metres north to the site of the new engineered mound. The current plan for the project is based upon the construction of an inter-site waste transportation road, as shown in Figure 5. This haulage route incorporates the construction of double-arch underpass under Lakeshore Road so that there will be no requirement to use public roadways to transport the wastes from the current storage location to the new waste facility. The only use for public roadways will be for the transportation of construction materials to the site of the new mound (e.g., aggregate, sand, synthetic liner materials, etc.), as indicated in Figure 6.

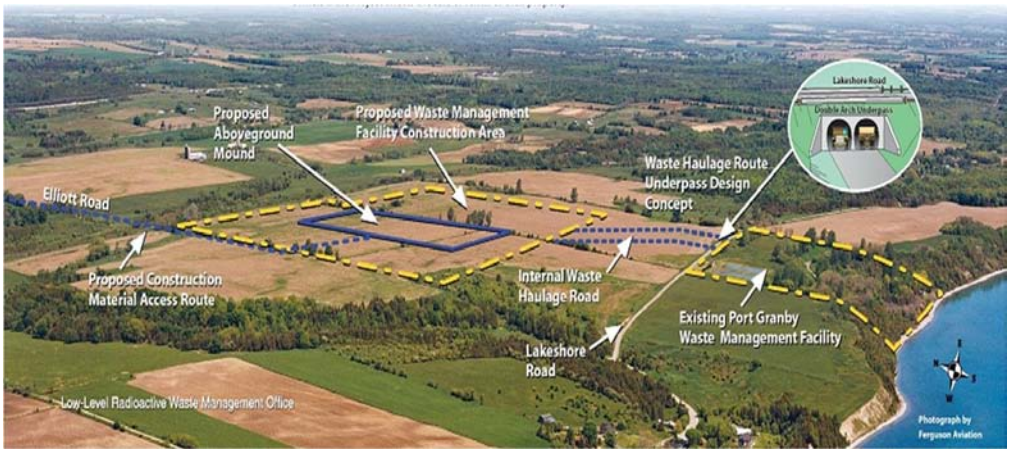

Figure 5: Rural Port Granby Project site location and layout

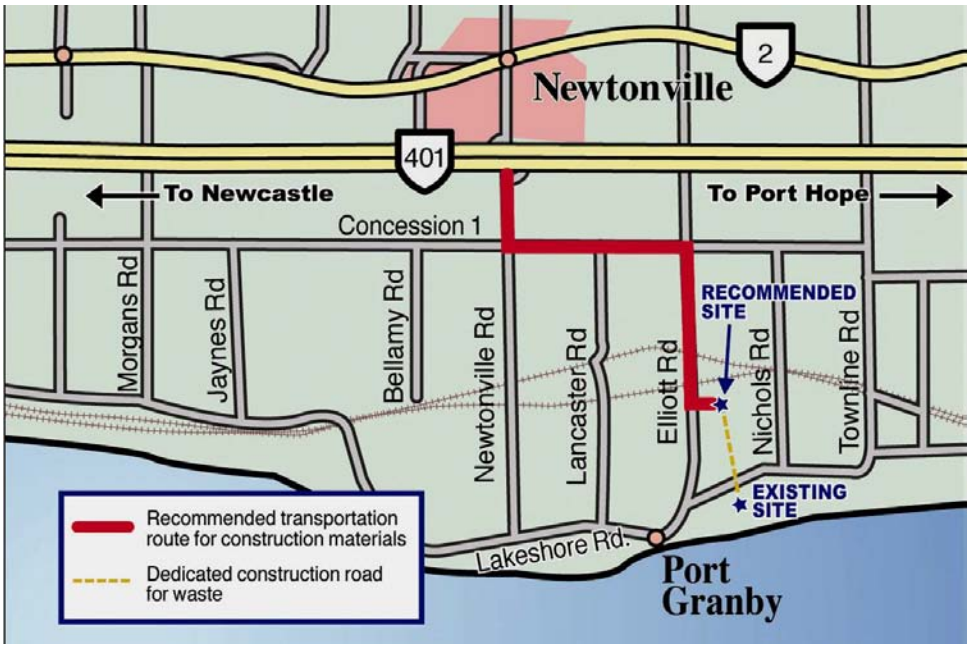

Figure 6: Public routes for delivery of (clean) construction materials

As with the Port Hope Project, the Port Granby mound will be constructed based on a maximum daily waste delivery volume of 2,000 m^3. The mound is envisaged to take six years to construct. The site will be developed in the first year; the base liners for each of the two mound cells installed in years 2 and 3, and the waste emplaced in years 2-5. The mound will be closed and capped with the cover system in year 6. Following this, a long-term maintenance and monitoring program will be commenced to verify the performance of the waste facility in accordance with the regulatory requirements.

4 Summary and conclusions

The PHAI is Canada's largest waste clean-up project. It was initiated in 2001 with the signing of a Legal Agreement between the federal government and the Municipalities of Port Hope and Clarington. Comprised of two separate and related undertakings, the Port Hope and Port Granby Project, the PHAI endeavours to excavate some 1.7 million m^3 of LLRW and consolidate it in two above-ground engineered mounds, situated in the two communities where the waste now is stored.

Following seven years of essential assessments and reviews, great strides are now being made on the activities that will serve to transition the project from planning to digging. The detailed design work for the new mounds and the remediation of waste sites is about to start and the environmental monitoring programs required by the EA Screening Reports will shortly be launched. An experienced management team is in place to lead the project through the current Transition Phase and to prepare for the forthcoming construction. More than thirty years after the LLRW problem was first discovered, the final solution is now visible on the horizon.

5 References

[1] *An Agreement for the Cleanup and the Long-term Safe Management of Low-Level Radioactive Waste Situate in the Town of Port Hope, the Township of Hope and the Municipality of Clarington*, 2001 March (Amended 2009 December).

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