



NUCLEAR WASTE MANAGEMENT ORGANIZATION SOCIÉTÉ DE GESTION DES DÉCHETS NUCLÉAIRES

Economic Modelling Report for the APM Project Located in the Area Near Ignace, Ontario



APM-REP-06145-0201 R000

AUGUST 2015

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Nuclear Waste Management Organization (NWMO)

**Economic Modelling Report
for the APM Project Located in the
Area Near Ignace, Ontario**

Report

Nuclear Waste Management Organization (NWMO)

Economic Modelling Report for the APM Project Located in the Area Near Ignace, Ontario

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Executive Summary

The NWMO is committed to implementing the APM Project in a location which meets robust safety requirements and where the well-being of the community and area is fostered. Economic effects are one aspect of well-being explored collaboratively with interested communities, and those in the area, as part of the dialogue and assessment process. To support discussions to explore potential economic effects associated with the APM Project with communities and areas identified as having strong potential to meet APM site selection requirements, the NWMO retained AECOM to update generic modelling completed in 2010 (http://www.nwmo.ca/uploads_managed/MediaFiles/1497_nwmosr-2010-09_preliminary_ass.pdf).

This report describes the economic model uses of financial and economic data to generate estimates of employment, income and gross domestic product associated with project spending. The model is constructed in a series of modules to predict impacts at the provincial, economic region and area level. Benefits are predicted for each of the six phases of the APM Project: siting, initial licensing, construction, operations, extended monitoring and decommissioning. The economic model design and programming was done to provide the economic models with the various flexibilities needed to accommodate future changes to budgets and schedule initiated by the NWMO and other assumptions as conversations continue with communities.

The job projections presented in this report are based on a preliminary cost estimate of approximately \$20 billion (excluding transportation costs) for the APM Project and assumptions regarding allocation of expenditures within Ontario and between economic regions based on informed judgement. These projections should be interpreted with caution keeping in mind that assumptions used in the modelling reflect current business conditions which may change, and thus they provide “order of magnitude” estimates at this point in time.

As shown in Table ES-1, the economic modelling results indicate that the APM Project has the potential to result in significant economic benefits to the Province of Ontario, the economic region in which the project is situated, the interested community, First Nation and Métis communities and surrounding communities in the area in which it is located, particularly during the construction and operations phases, which are expected to last for approximately 10 and 38 years respectively.

NWMO is committed to working with communities in the area near Ignace to foster well-being in the communities and to assist to capture benefits that align with the vision for the area among those living there.

Table ES-1. Estimated Average Annual Employment in Ontario, the Northwest Economic Region and the Area near Ignace during Construction and Operations Phases

| APM Project Phase | Jobs per year | | | |
|----------------------------|---------------|---------|---------------------------|------------------|
| | | Ontario | Northwest Economic Region | Area near Ignace |
| Site Selection | Total | 1000 | 50 | 50 |
| | Direct | 210 | 10 | 10 |
| | Indirect | 590 | 30 | 30 |
| | Induced | 200 | 10 | 10 |
| Initial Licensing | Total | 860 | 45 | 40 |
| | Direct | 220 | 10 | 10 |
| | Indirect | 460 | 25 | 20 |
| | Induced | 180 | 10 | 10 |
| Construction | Total | 2,800 | 1,295 | 1,165 |
| | Direct | 795 | 405 | 365 |
| | Indirect | 1,430 | 625 | 560 |
| | Induced | 575 | 265 | 240 |
| Operations | Total | 2,420 | 1,410 | 1,340 |
| | Direct | 720 | 520 | 490 |
| | Indirect | 1,205 | 600 | 575 |
| | Induced | 495 | 290 | 275 |
| Extended Monitoring | Total | 305 | 290 | 275 |
| | Direct | 135 | 130 | 125 |
| | Indirect | 100 | 95 | 90 |
| | Induced | 70 | 65 | 60 |
| Decommissioning | Total | 505 | 425 | 380 |
| | Direct | 290 | 250 | 220 |
| | Indirect | 115 | 90 | 80 |
| | Induced | 100 | 85 | 80 |

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1. Introduction

The Nuclear Waste Management Organization (NWMO) is implementing Adaptive Phased Management (APM), Canada's plan for the long-term management of its used nuclear fuel, and referred to as the APM Project in this report. Since 2010, the NWMO has been implementing a process, developed with Canadians, for selecting a site for Canada's Deep Geological Repository for used nuclear fuel. Assessments conducted to date have identified several communities and areas as having strong potential to meet APM site selection requirements.

The NWMO is committed to implementing the project in a location which meets robust safety requirements and where the well-being of the community and area is fostered. One aspect of well-being is economics, and community interest includes understanding the economic impact and benefits (e.g., funds spent and direct, indirect and induced jobs created) which come with the project.

To support conversations with communities to explore potential economic effects associated with the project, AECOM was retained by the NWMO to update the generic benefits assessment completed in 2010 which used illustrative and generic communities for the assessment. This updated economic assessment instead is designed to reflect the areas surrounding the specific interested communities which entered the siting process which are now the focus of Step 3, Phase 2 preliminary assessments. This report updates the generic 2010 economic benefit information and extends the analysis to specific siting areas.

The NWMO has committed to working with communities in the siting area to plan the implementation of the project in order to optimize benefits and well-being effects in light of priorities and objectives of communities identified through discussions with those in the area. However, the information presented in this report assumes no particular effort is made by the NWMO or by communities to capture, redirect or expand the economic benefits associated with the project, or to customize the implementation of the project to better meet the needs of the communities in the area to further harness the economic drivers associated with the project. The economic benefit analysis is intended to provide a starting point for more detailed discussion with communities about how the project might be implemented to foster well-being in the interested community, First Nation and Métis communities in the area and surrounding communities. Based on discussions with communities, planning and area capacity building could be used to align economic benefits with community aspirations and could result in greater benefits than those presented in this report.

The economic benefit analysis and results presented in this report are illustrative for a number of reasons:

1. The selection of a preferred site for the APM Project is several years away following more detailed technical studies, field investigations, and learning and exploration of the potential to foster well-being;
2. Communities are in the early stages of learning more about the APM Project and what it might mean economically for the interested community, First Nation and Métis communities in the area and surrounding communities;
3. The specific plan for how the APM Project might be implemented is designed to be flexible so that the project itself can be designed and implemented in a manner that is in keeping with the aspirations of the communities; and
4. The cost estimates are preliminary and will be updated as the APM Project proceeds.

The economic modelling study presented in this report is intended to provide an "order of magnitude" estimate of the possible range of economic benefits likely to occur in a host Province, an economic region, and the local communities in an area should the APM Project be sited in that area, absent of shared planning with communities in

the area to direct and capitalize on the project. Consequently, analysis and discussion of economic benefits in this report should be interpreted with caution and considered as illustrative since they are necessarily based on a set of assumptions which could evolve over time or which could change as a result of efforts by the NWMO and the communities to work together to enhance their benefits.

The economic model uses financial and economic data to generate estimates of employment, income, and gross domestic product (GDP) associated with project spending. The model uses a commodity-based approach and economic multiplier information derived from Statistic Canada's Interprovincial Input-Output Model of the Canadian economy. The economic model design and programming was done to provide the economic models with the various flexibilities needed to accommodate future changes to budgets and schedule initiated by the NWMO and other assumptions as conversations continue with communities.

2. Economic Model

The model was developed to provide the capability to calculate annual economic benefits to the host province, the Statistics Canada economic region in which the APM Project may be located, and the siting area (or “the area”), including direct, indirect and induced effects. The results presented in this report are illustrative of the economic benefits that could occur from implementation of the APM Project if no effort is made to direct the project to optimize benefits and if conditions, for example population centres, local industry and retail, were similar to those of the current day.

2.1 Framework and Method

Any major new development in or near a community would be expected to generate economic benefits for the community, its surrounding region, its province, and the country. The size and distribution of such potential benefits (in terms of employment, GDP, income, and tax revenues) depends on a number of factors such as:

- a) size of the project in terms of expenditure;
- b) the location of the project relative to population centres; and
- c) the nature/type of the project.

Typically, economic impact studies use financial and economic data to generate estimates of employment, income and GDP benefits associated with changes in the level of economic activity resulting from the project or industry being analyzed. Since every industry or proposed project relies on a diverse range of inputs (such as many types of materials and labour) it affects a broad spectrum of other industries and activities like a “ripple effect” throughout the whole economy. To capture the full impact of this economic “ripple effect” economists rely on economic modelling, with most relying on Input-Output (I-O) models. The most complete and robust I-O model in Canada is that developed and maintained by Statistics Canada, commonly referred to as the Inter-Provincial Input-Output Model of the Canadian economy.

The use of I-O modelling to estimate economic benefits of a project has been accepted by the Canadian Nuclear Safety Commission (CNSC) and many other federal and provincial agencies as a reasonable and accurate predicting tool and method for this purpose. For example, the Statistics Canada I-O model was successfully used in economic impact studies for the Environmental Assessment (EA) studies for large nuclear projects which were subjected to extensive peer and CNSC review.

2.1.1 Terminology

For the purpose of this report, the total economic impact is the sum of three subsets of impact:

1. **Direct Impacts** are the associated changes in business activity (i.e., output, jobs and income) occurring as a direct consequence of business decisions. Typically direct effects result from “front end” expenditures associated with constructing and operating a project, such as labour, materials, supplies, and capital.

Direct job impacts would result from NWMO expenditures for labour, for example, labour hired to manage the project. Another example is the activities directly attributable to the project such as labour wages paid during operations and expenditures to firms for transporting inputs (e.g., construction materials) to the project site. Direct jobs are expected to be located predominantly at or near the project site. They would include skilled and semi-skilled employment on-site during construction and operations, for example, geology, engineering, safety assessment and engagement jobs.

According to Statistics Canada, a direct impact measures the initial requirements for an extra dollar's worth of output of a given industry. The direct impact on the output of an industry is a one

dollar change in output to meet the change of one dollar in final demand. Associated with this change, there will also be direct impacts on GDP, jobs, and imports.

2. **Indirect Impacts** result from project expenditures which include inter-industry purchases in the supply chain. These second-round impacts would not occur but for the project. For example, an indirect impact is expenditures made to a transportation firm(s) for its purchase of new vehicles, which in turn creates demand and expenditures for vehicle manufacturers, who in turn purchase steel from steel fabricators, etc. This indirect impact is what “ripples” through the economy, which at each iteration creates more employment with each round of spending in the supply chain. In all cases, this rippling of expenditures is linked to the direct expenditures of the project.

Indirect jobs would be those providing support, products and services, for example, food catering, accommodation, transportation and equipment.

According to Statistics Canada, indirect impacts measure changes due to inter-industry purchases as they respond to the new demands of the directly affected industries. This includes all the chain reaction of output up the production stream since each of the products purchased will require, in turn, the production of various inputs.

3. **Induced Impacts** result from the direct and indirect employees of the directly and indirectly affected businesses purchasing goods and services at the household level. According to Statistics Canada, induced impacts measure changes in the production of goods and services in response to consumer expenditures induced by households' incomes (i.e., wages) generated by the production of the direct and indirect requirements. For example, household expenditures on food, accommodation, insurance, etc. are all considered induced impacts.

Induced jobs include those associated with household expenditures such as doctors, lawyers, and retail.

The Interprovincial Input-Output model is updated annually based on annual surveys of industry expenditure patterns. The economic modelling conducted in this study is running with the 2010 data¹.

2.2 Model Structure

The economic model for the APM Project located in the area near the Corporation of the Township of Ignace, Ontario (Ignace) is constructed in a series of modules that respectively address impacts at three geographic levels:

- a) province;
- b) economic regions within the Province; and
- c) “the area” which includes the interested community, First Nation and Métis communities in the area and surrounding communities.

During Phase 2 studies, economic modelling at a fourth geographic level, that is, the “community-specific” level, will be possible through discussions with communities.

Economic regions are those defined by Statistics Canada, which tend to be large geographic areas, while “the area” in this analysis refers to a smaller group of communities within the economic region that, based on geography, community size and economic activity, are likely to benefit from implementing the APM Project in “the area”. The modules address each of the six project phases:

1. *Economic modelling in this report is based on the APM cost estimate prepared in 2011 which used 2010 dollars. This data was used because the NWMO cost estimates are presented in 2010 cost dollars.*

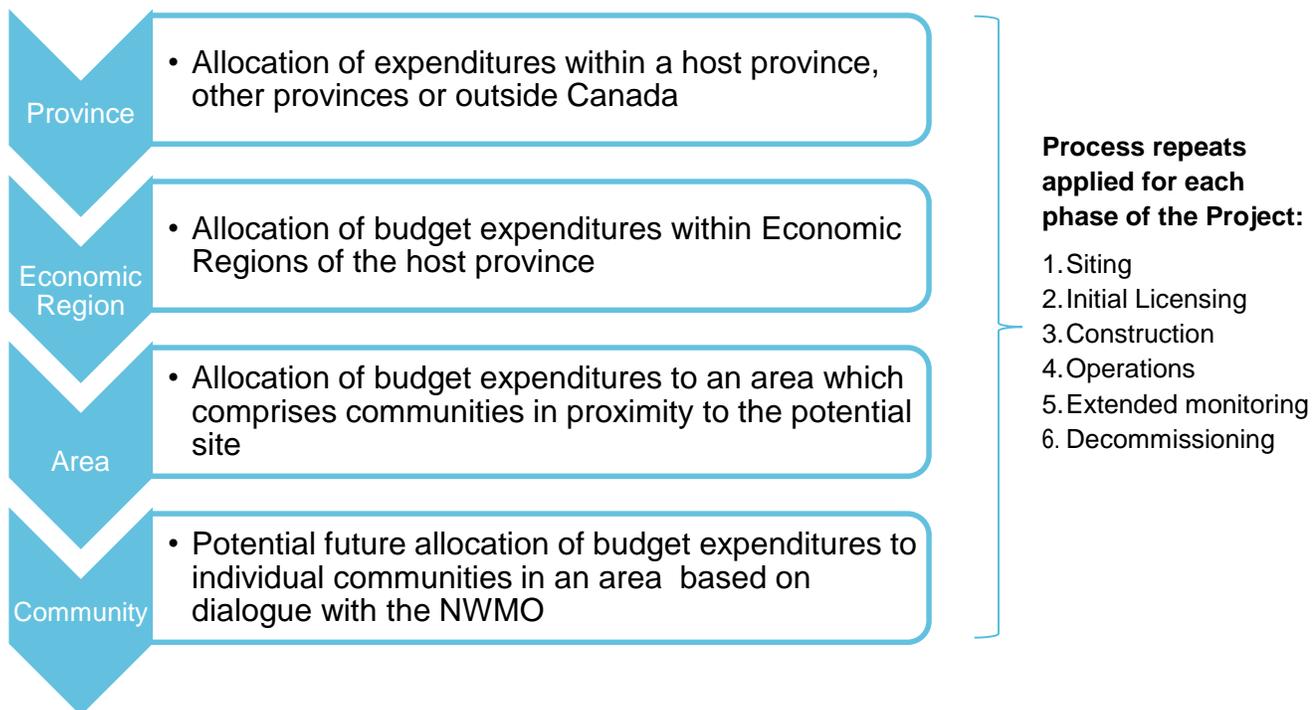
- | | |
|-----------------------|-----------------------------|
| 1. Siting; | 4. Operations; |
| 2. Initial Licensing; | 5. Extended monitoring; and |
| 3. Construction; | 6. Decommissioning. |

The general functioning of the economic model for implementing the APM Project in the area near Ignace is represented in Figure 1. The model framework used for the area near Ignace is identical to that used for all other communities in Phase 2.

The economic model (broken down by phase of Project activity) calculates direct, indirect and induced impacts for each of the geographic levels and the model also generates summary graphs and tables. The model has been designed to be fully integrated from top to bottom so any changes are automatically rippled throughout the entire structure. The model has been fully calibrated with project cost information and schedule. The model has also been populated with economic multiplier information derived from commodity runs using the Statistics Canada’s Interprovincial Input-Output model of the Canadian economy. Additionally, 2010 industry sector employment information has been incorporated in the model for economic regions and areas.

In the case of the area near Ignace, Ontario there are a number of communities which are more likely to benefit from the project should no special effort be made to direct the benefits associated with the project, based on their proximity to the area being explored in Step 3, Phase 2 preliminary assessments. They include the interested community, First Nation and Métis communities in the area and other surrounding communities. However, at this early stage of the APM siting process, further analysis, studies and discussions with these potentially affected communities would be required to prepare more detailed economic modelling of the APM Project and benefits down to the individual community level.

Figure 1. Economic Model for Area near Ignace, Ontario – Cascading Analysis



The model looks at project expenditures in each of the geographic levels across four categories:

- a) labour;
- b) materials and equipment;
- c) other; and
- d) contingency.

Labour costs include costs for NWMO labour and, where possible, for labour associated with services purchased from others. The majority of jobs created through direct labour expenditure are expected to be located at or near the project site.

Materials and equipment costs typically relate to experimental or prototyping equipment required to demonstrate technology or processes as well as equipment required to operate the repository.

In cases where it was not possible to define the unique material and equipment, the costs were included as “other” and are a blend of labour and materials and equipment costs.

Contingency funding is a monetary provision to cover uncertainties or unforeseeable elements of time and cost in the estimate associated with the normal execution of a project, for example, labour rates and design development, and to cover the costs associated with the occurrence of one or more specific risks.

Direct, indirect and induced levels of impact are calculated for each of these expenditure categories. For the province and economic regions, four types of impact can be determined:

- a) gross output;
- b) GDP;
- c) labour income; and
- d) full time equivalent (FTE) jobs.

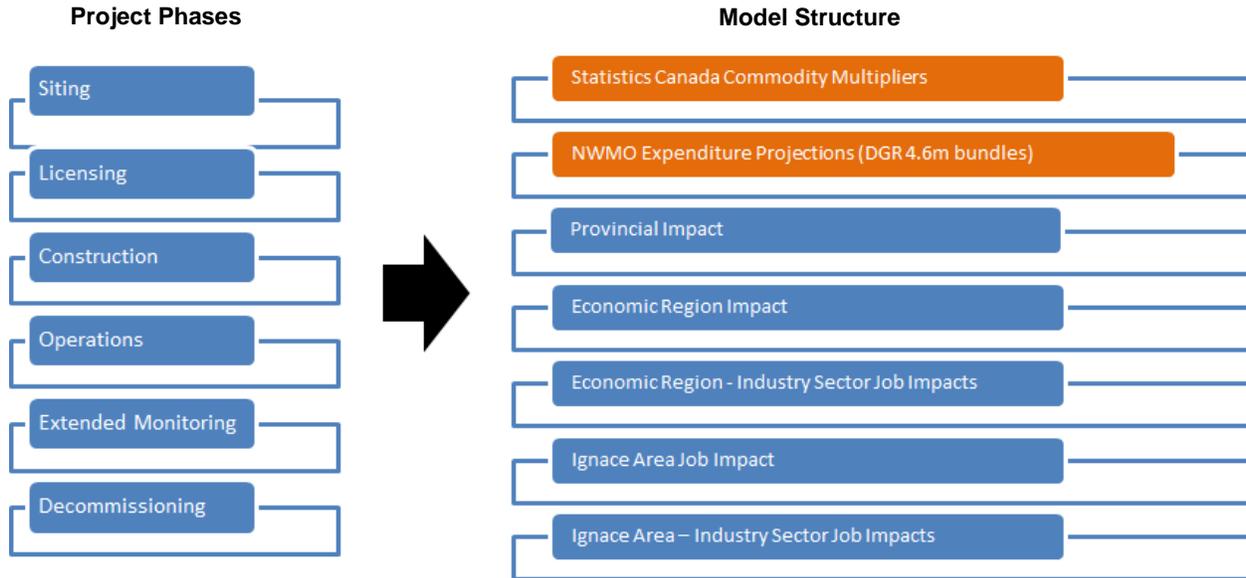
For the area, the model calculates FTE jobs and average annual jobs by phase of project. For the area, the model has the ability to compare labour force demand and current labour force supply by industry sector.

User input in all models is accommodated through a set of allocation matrices that respectively apportion the project budget at each of the three geography levels previously mentioned, namely – province, economic region, and the area. A set of presentation matrices at the bottom of each model accept user allocation inputs and automatically calculate and graph results.

The model allows close examination of the potential economic benefits during any phase of the project. The model itself viewed from the perspective of calculating power is quite large.

For each phase of the APM Project, the model utilizes similar data and generates similar results and reports as illustrated in Figure 2. This means that a user could focus on one project phase at a time, or the sum of all phases.

Figure 2. Similar Information and Result Outputs for Each Project Phase



2.3 Implementation of the Model

Inputs to the model include commodity groups, which are used to develop multipliers, and cost information.

2.3.1 Commodity Groups

AECOM consulted with Statistics Canada to select commodity groups most appropriate for each phase of the APM Project. Statistics Canada developed specific production functions for each commodity by cost category and carried out a series of runs using their Interprovincial Input-Output (I-O) model to generate appropriate multipliers. Table 1 identifies the commodity groups employed in the modelling, their assignment to cost categories, and the number of runs done using the Statistics Canada I-O model.

Economic impacts in Ontario-based communities are derived from Ontario commodity multipliers. Communities in other provinces would use commodity multipliers specific to their province. In all cases these multipliers are derived from custom runs of the Inter-Provincial I-O Model by Statistics Canada.

Model runs were done on each commodity group for the host province. For each commodity group and specified cost category one run was done for expenditures within the host province and a second run was done to capture the economic spin back to the host province from project expenditures made in other provinces. The total economic impact of the undertaking in a host province is the sum of outputs created by direct expenditures made in a host province plus those outputs that rebound back from direct expenditures made in other provinces.

Table 1. Commodity Groups, Expenditure Category Application and Runs

| Phase | Description | Cost Category Application |
|---|--|--|
| Siting, Initial Licensing, Extended Monitoring | Architectural, engineering and related services | <ul style="list-style-type: none"> ▪ Labour, ▪ Materials and Equipment ▪ Other ▪ Contingency |
| | Management, scientific and technical consulting services | <ul style="list-style-type: none"> ▪ Labour, ▪ Materials and Equipment ▪ Other ▪ Contingency |
| Construction and Decommissioning | Other Engineering Construction | <ul style="list-style-type: none"> ▪ Labour ▪ Contingency ▪ Other |
| | Mining and Quarrying (except oil and gas) | <ul style="list-style-type: none"> ▪ Materials and Equipment |
| Operations | Other Metal Ore Mining | <ul style="list-style-type: none"> ▪ Labour, ▪ Materials and Equipment ▪ Other ▪ Contingency |

In Table 1 the rows for siting (including initial licensing and extended monitoring), construction (including decommissioning), and operations (including parallel excavation of placement rooms) identify the commodities used in the area Model Suites.

2.3.2 APM Facility Expenditures and Schedule

The expenditures for the APM Project and the schedules that have been used to calibrate and test the model reflect the cost estimate provided by NWMO for the long-term management of 4.6 million used CANDU fuel bundles which is the reference used fuel inventory assumed for this economic analysis. These APM facility costs exclude the cost associated with transporting the used fuel to the repository (estimated at approximately \$1 billion (2010\$)) which will vary depending on location of the facility.

Table 2 summarizes the planned expenditure for the APM Project by project phase in dollars of 2010. These costs were used to drive the economic assessment.

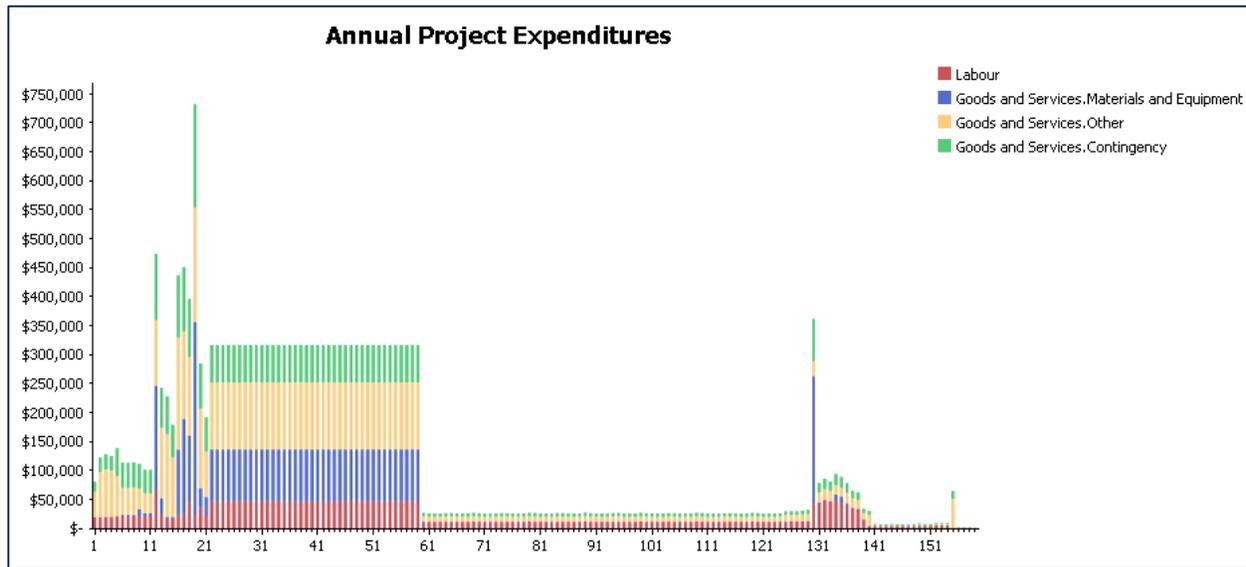
Table 2. Estimated APM Facility Expenditures by Project Phase (\$M 2010)

| Phase | Timing (Years) | Budget | | | | Total ¹ |
|----------------------------|----------------|----------------|-------------------------|----------------|----------------|--------------------|
| | | Labour | Materials and Equipment | Other | Contingency | |
| Siting | 1 to 7 | \$141 | \$3 | \$450 | \$223 | \$817 |
| Initial Licensing | 8 to 11 | \$83 | \$25 | \$153 | \$165 | \$426 |
| Construction | 12 to 21 | \$297 | \$1,003 | \$1,378 | \$934 | \$3,611 |
| Operations | 22 to 59 | \$1,793 | \$3,373 | \$4,393 | \$2,465 | \$12,023 |
| Extended Monitoring | 60 to 129 | \$766 | \$23 | \$650 | \$365 | \$1,804 |
| Decommissioning | 130 to 159 | \$457 | \$251 | \$269 | \$246 | \$1,224 |
| Total¹ | | \$3,537 | \$4,677 | \$7,294 | \$4,938 | \$19,905 |

Note: 1. Column and row totals are subject to rounding errors

Figure 3 presents the annual cash flow for the APM Project. It is understood that APM Project phasing schedules and project cost estimates will evolve during project implementation. When new information is available, the current models can be readily updated with this information since the model architecture is such that new information can be easily plugged in, recalibrated and run to create new economic benefit projections.

Figure 3. Estimated Annual Project Expenditures (\$M 2010) by Expenditure Category



2.3.3 Allocation Assumptions

NWMO expenditure data combined with the multipliers generated by Statistics Canada production functions for the different commodity groups are used to generate project specific outputs. For illustration purposes and for an APM interested community in Ontario, the total job output (direct + indirect + induced) per \$1 million of direct project expenditure in the province by cost category is presented in Table 3.

Table 3. Total FTE Jobs per \$1 Million of APM Project Expenditure (2010)

| | Total FTE Jobs / \$1 million of APM Project Expenditures (2010) | | | |
|----------------------------|---|----------------------|-------|-------------|
| | Labour | Material & Equipment | Other | Contingency |
| Siting | 16.79 | 8.02 | 8.02 | 8.02 |
| Initial Licensing | 16.79 | 8.02 | 8.02 | 8.02 |
| Construction | 20.35 | 9.16 | 6.86 | 6.86 |
| Operations | 19.11 | 6.36 | 6.36 | 6.36 |
| Extended Monitoring | 16.79 | 8.02 | 8.02 | 8.02 |
| Decommissioning | 20.35 | 9.16 | 6.86 | 6.86 |

Once the project Phase Models have been appropriately calibrated with multipliers, budget and schedule information, the remaining user input requirements involve allocating expenditures by geography.

Currently, there are three levels of geographic allocation required for each model. Allocation of expenditures by geography is done for each of the project phases.

A – National/Provincial Allocation

The national/provincial allocation of expenditures for the siting and initial licensing phases of the APM Project is based on NWMO input from engineering, geoscience, and safety assessment specialists. Each specialist used informed judgement and knowledge of the planned work, those organizations currently conducting similar work, the

location of specialized technical experts and research institutions, along with recent NWMO experience on the distribution of costs during the feasibility studies. For the construction and operations phases, the allocations reflect knowledge of current conditions relating to these industries and the nuclear and mining support industries, which are subject to change. For these phases, between 75 and 100 per cent of labour expenditures, and 85 per cent of materials and services expenditures were assumed to remain in Ontario. The long time-frames associated with the project are expected to provide opportunities for training and capacity-building in the area which would increase the ability to source needed skills and labour more locally.

B – Economic Region Allocation within Ontario

There are 11 economic regions within the province of Ontario. Ignace is located in the Northwest economic region of Ontario, which is very large, covering half of northern Ontario. Once the Provincial allocation has been determined Ontario spending by cost category is allocated across the complement of economic regions by the user.

The allocation used in this modelling is based on AECOM's informed judgment² drawing on our experience and knowledge of the economic regions and the location of manufacturing and service hubs. For example, although construction labour might be sourced largely from within the region (e.g., 60% in the Northwest economic region), many materials and "other" expenditures are likely to be derived from manufacturing or "source" centres in southern Ontario, such as the economic regions of Toronto, Hamilton, and the Northeast (Sault Ste. Marie/Sudbury). As indicated earlier, the long time-frames associated with the project are expected to provide opportunities for training and capacity-building in the area which would increase the ability to source needed skills and labour more locally. The models will automatically interpolate the percentage allocations for project years between the input dates, which are also user defined in the model.

It is likely some portion of labour supply might also come from the Northeast economic region which includes Sudbury, Sault Ste. Marie, and Timmins, all communities with experience and expertise in the mining sector and energy sectors. The allowance for some growth in sourcing labour is possible given the relatively long construction phase.

With respect to the operations phase a similar allocation of project expenditures is observed across economic regions in Ontario.

During the operations phase (which extends over multiple decades) it is expected that an increasing number of labour resources will be sourced from within the Northwest economic region. This is typical of projects of this nature which are located in relatively remote regions of the province.

C – Allocation of Expenditures to "the Area" within the Northwest Economic Region of Ontario

The Northwest economic region comprises a number of diverse and widespread communities. However, there will likely be a subset of communities that are most likely to benefit from the project if no further effort was made to direct the project. These communities represent a sub-region of the economic region, referred to as "the area" in this study. The area includes the interested community, First Nation and Metis communities in the area and surrounding communities that may benefit from implementation of the APM Project. The area is assumed to capture between 90% and 95% of the economic benefit accruing to the entire economic region² depending on the project phase. In the construction phase, it is assumed that the area near Ignace captures 90% of the benefit in the Northwest

² *It is expected that many current residents will now have an incentive to stay in the region and many who out-migrated will have reason to return. Also, many new people and families might in-migrate to the area with the prospect of long-term career and business opportunities linked to the project.*

economic region. It is possible that a small proportion of workers (in this case 10%³) might come from outside this area and wish to commute for family reasons rather than relocate to the surrounding area communities during the construction phase. During the longer operations phase it is assumed that the area will capture 95% of the economic benefit.

D – Allocation of Expenditures to Individual Communities in “the Area”

Note the model also has flexibility to allow changes to the area and to model benefits to specific communities most likely to benefit from the project. In this case for an APM facility located in the area near Ignace, knowledge of which communities are most likely to benefit from the project and are therefore in “the area” is based on information derived from a combination of sources:

- a) Information contained in the Community Profile and the Assessment Report (SENES 2013; NWMO 2013); and
- b) Personal communication (AECOM conversations with the Ignace and area community leaders).

However at this early stage of the APM siting process, economic modelling at the individual community level has not been undertaken since further analysis, studies and discussions with these communities would be required to prepare a regional economic development strategy and more detailed economic modelling of the APM Project and benefits at that level.

³ *Not all labour will choose to live and work in the same area. This experience is typical of projects of this nature. In some cases, specialized labour may only be required for short or intermittent periods and thus not require them moving into the area.*

3. Output: Economic Benefits for APM Project in the Area near Ignace, Ontario

Calibration of the preceding allocation tables enables the model to generate a wide variety of output tables and graphs. The analytical results for Ontario, the Northwest economic region, and the area near Ignace are highlighted in this section. The key focus of this report is on potential job creation. Information on GDP, income, and gross output is also generated from the model and available to users. The economic benefit projections presented in this report should be interpreted with some caution keeping in mind that these estimates are reasonable if understood as “order of magnitude” estimates only. As well, the long time-frames associated with the project are expected to provide opportunity to optimize benefits within the area.

3.1 Economic Benefits to the Province of Ontario

Within Ontario, the potential annual average employment (direct, indirect, and induced jobs per year) for each phase of the APM project is presented in Table 4. In the period prior to construction (i.e., siting and initial licensing) the number of direct, indirect and induced jobs the project generates in Ontario is predicted to average about 1,000 jobs per year for the siting phase and 860 jobs per year for the initial licensing phase. During construction, lasting about 10 years, the average annual number of direct, indirect and induced jobs created in Ontario is predicted to be about 2,800 jobs per year.

Table 4. Estimated Average Annual Employment in Ontario by Phase of Project

| Project Phase | Direct Jobs per year | Indirect Jobs per year | Induced Jobs per year | Total Jobs per year |
|--------------------------------|----------------------|------------------------|-----------------------|---------------------|
| Siting (7 years) | 210 | 590 | 200 | 1,000 |
| Initial Licensing (4 years) | 220 | 460 | 180 | 860 |
| Construction (10 years) | 795 | 1,430 | 575 | 2,800 |
| Operations (38 years) | 720 | 1,205 | 495 | 2,420 |
| Extended Monitoring (70 years) | 135 | 100 | 70 | 305 |
| Decommissioning (30 years) | 290 | 115 | 100 | 505 |

During the operations phase the level of direct, indirect and induced employment is relatively consistent with a predicted average of approximately 2,420 jobs per year in all of Ontario. Over the longer extended monitoring period an annual average of about 305 potential direct, indirect and induced jobs per year is predicted to be created in the province. Decommissioning, which would occur once closure of the site repository was deemed safe and appropriate, would generate predicted average annual employment of about 505 new direct, indirect and induced jobs per year.

The above range of Ontario-wide employment opportunity predicted to result from the APM project in each phase translates into significant GDP for Ontario. For example the average annual GDP is estimated at about \$270 million during construction and at about \$220 million annually during operations.

3.2 Economic Benefits to the Northwest Economic Region

Within the Northwest economic region of Ontario, which includes the Ignace area, the same distribution of potential employment (direct, indirect, and induced) would occur (Table 5) but with less employment per project phase, since many jobs would also be created in other economic regions. Specifically, during the siting and initial licensing phase it is estimated that only a small fraction of total jobs will occur in the Northwest economic region given the short and highly technical requirement of the work to be done in these pre-construction activities. However, during the

remaining phases of the project a larger portion of the available jobs fall within this economic region. As the project planning progresses over the coming years, there may be opportunities to alter the local region employment projection through investments in infrastructure and training to the benefit of the host region.

Table 5. Estimated Average Annual Employment in the Northwest Economic Region by Phase of Project

| Project Phase | Direct Jobs per year | Indirect Jobs per year | Induced Jobs per year | Total Jobs per year |
|----------------------------|----------------------|------------------------|-----------------------|---------------------|
| Siting | 10 | 30 | 10 | 50 |
| Initial Licensing | 10 | 25 | 10 | 45 |
| Construction | 405 | 625 | 265 | 1,295 |
| Operations | 520 | 600 | 290 | 1,410 |
| Extended Monitoring | 130 | 95 | 65 | 290 |
| Decommissioning | 250 | 90 | 85 | 425 |

During construction, it is predicted that an annual average of approximately 1,295 jobs per year (total of direct, indirect, and induced) could be created in the Northwest economic region, followed by an increase in average annual employment to about 1,410 jobs per year during the operations phase. In this case it is assumed that as the operations phase gets underway, more of the workforce would locate in the region during early stages of this phase until it plateaus sometime later in the operations phase. It is assumed that given the long lead time prior to operations, the NWMO and the First Nation and Métis communities and communities in the area and economic region would work together in planning and preparation to ensure the increase in local employment in the first part of this phase is managed. It is expected that a certain amount of goods and services would continue to be procured outside the region throughout operations, hence the possible plateau effect.

During the extended monitoring phase a predicted annual average of about 290 jobs per year would likely stay within the Northwest economic region, increasing to an annual average of about 425 jobs per year during decommissioning many years later.

The above range of predicted employment in the Northwest economic region translates into an average of about \$120 million in GDP annually during construction and about \$125 million annually during the operations phase.

The economic model also generates an estimate of the employment impact by industry sector for each phase of the project. For example, during a sample year in the mid-point of the construction phase of the project, the potential estimated job distribution (total of direct, indirect, and induced) by sector is illustrated in Figure 4. The greatest employment impacts to the Northwest economic region during construction would fall to the following industry sectors:

- Manufacturing
- Construction
- Wholesale and retail trades
- Professional, scientific and technical services, finance, insurance, and real estate services
- Mining and quarrying
- Transportation and warehousing
- Administrative and support, waste management and remediation services

The distribution of labour needs (direct, indirect, and induced) would fluctuate from year to year as construction activities progress, which is typical of projects of this nature.

Potential employment (total of direct, indirect, and induced) by industry sector during the operations phase is presented in Figure 5 for a sample year at the mid-point of operations. It shows that different job types would be required during operations compared with construction. Excavation would continue throughout most of the operations phase of the project, hence the industry sector most impacted in this phase is the mining and quarrying sector. This industry sector has been active in this region for many decades.

Figure 4. Total Job Impact in the Northwest Economic Region by Industry Sector during Construction Phase (sample year mid-phase)

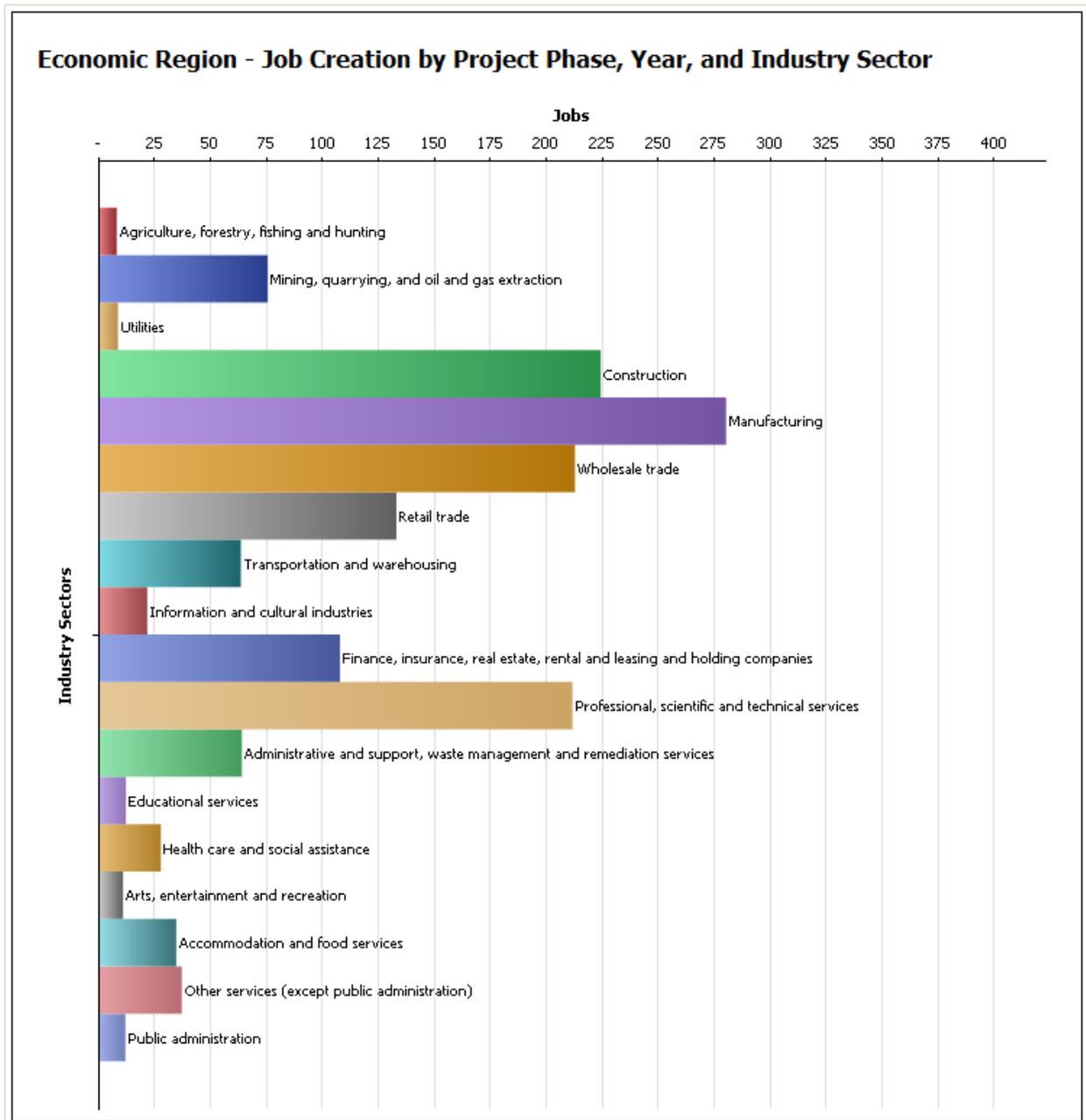
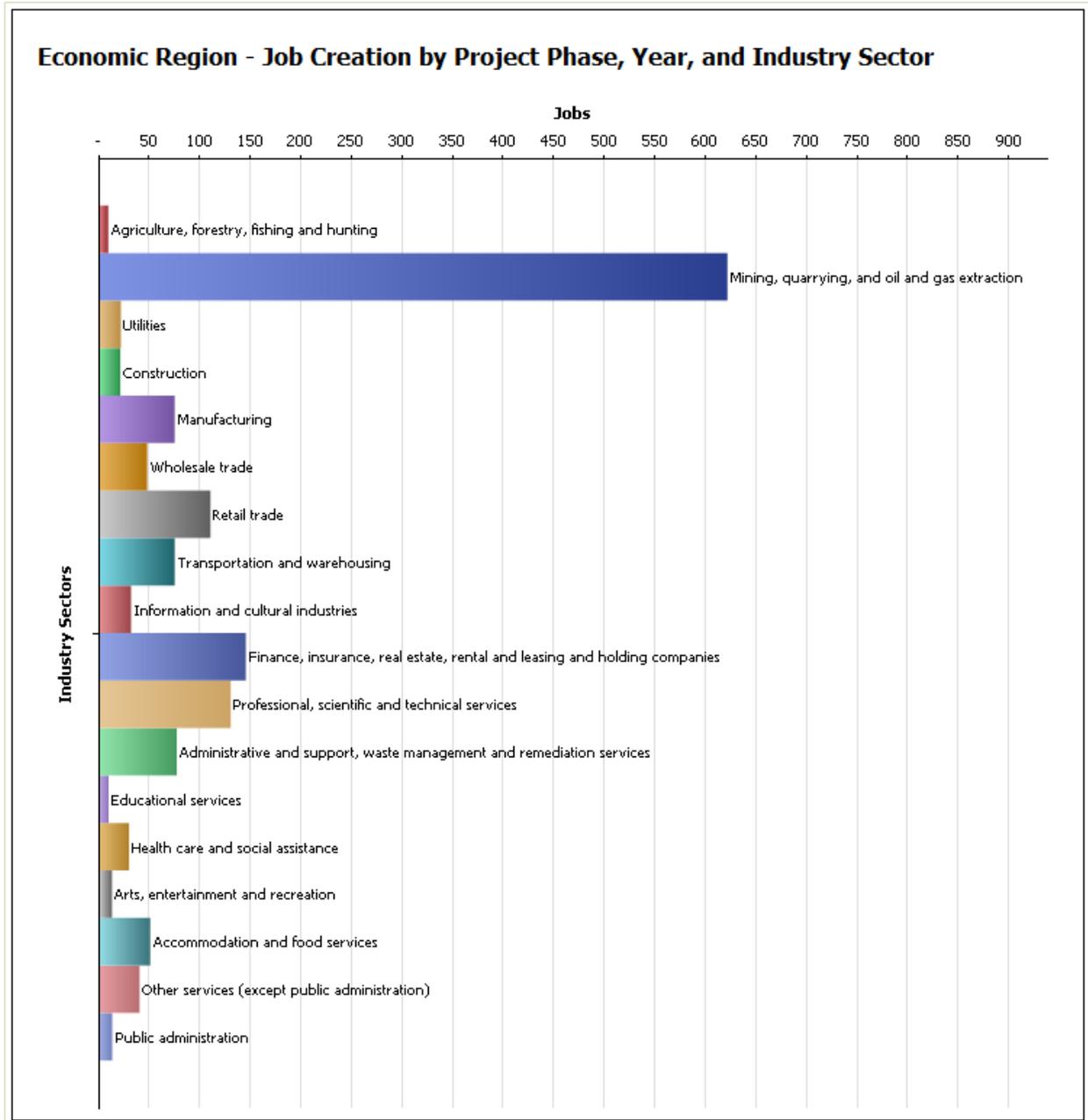


Figure 5. Total Job Impact in the Northwest Economic Region by Industry Sector during Operations in Ontario (sample year mid-phase)



3.3 Employment Benefits in the Area near Ignace

Finally, within the area near Ignace the potential impact on employment (direct, indirect and induced) across all project phases would be significant to the communities in the area. There would be a predicted annual average of about 50 jobs per year during the initial siting and initial licensing phases. However, employment opportunities are

predicted to quickly increase to an annual average of approximately 1,165 jobs per year during the 10 year construction period (Table 6).

During the longer operations phase, annual average employment within the area near Ignace may see a relocation of employees and goods and service providers to the area near Ignace, to a predicted 1,340 jobs per year. Following this, during extended monitoring, a predicted annual average of 275 jobs per year linked to this phase of activity would be located within the area near Ignace. When decommissioning activities begin, the predicted annual average employment opportunities would be about 380 jobs per year.

Table 6. Estimated Annual Average Employment in the Area near Ignace by Phase of Project

| Project Phase | Direct Jobs per year | Indirect Jobs per year | Induced Jobs per year | Total Jobs per year |
|----------------------------|----------------------|------------------------|-----------------------|---------------------|
| Siting | 10 | 30 | 10 | 50 |
| Initial Licensing | 10 | 20 | 10 | 40 |
| Construction | 365 | 560 | 240 | 1165 |
| Operations | 490 | 575 | 275 | 1340 |
| Extended Monitoring | 125 | 90 | 60 | 275 |
| Decommissioning | 220 | 80 | 80 | 380 |

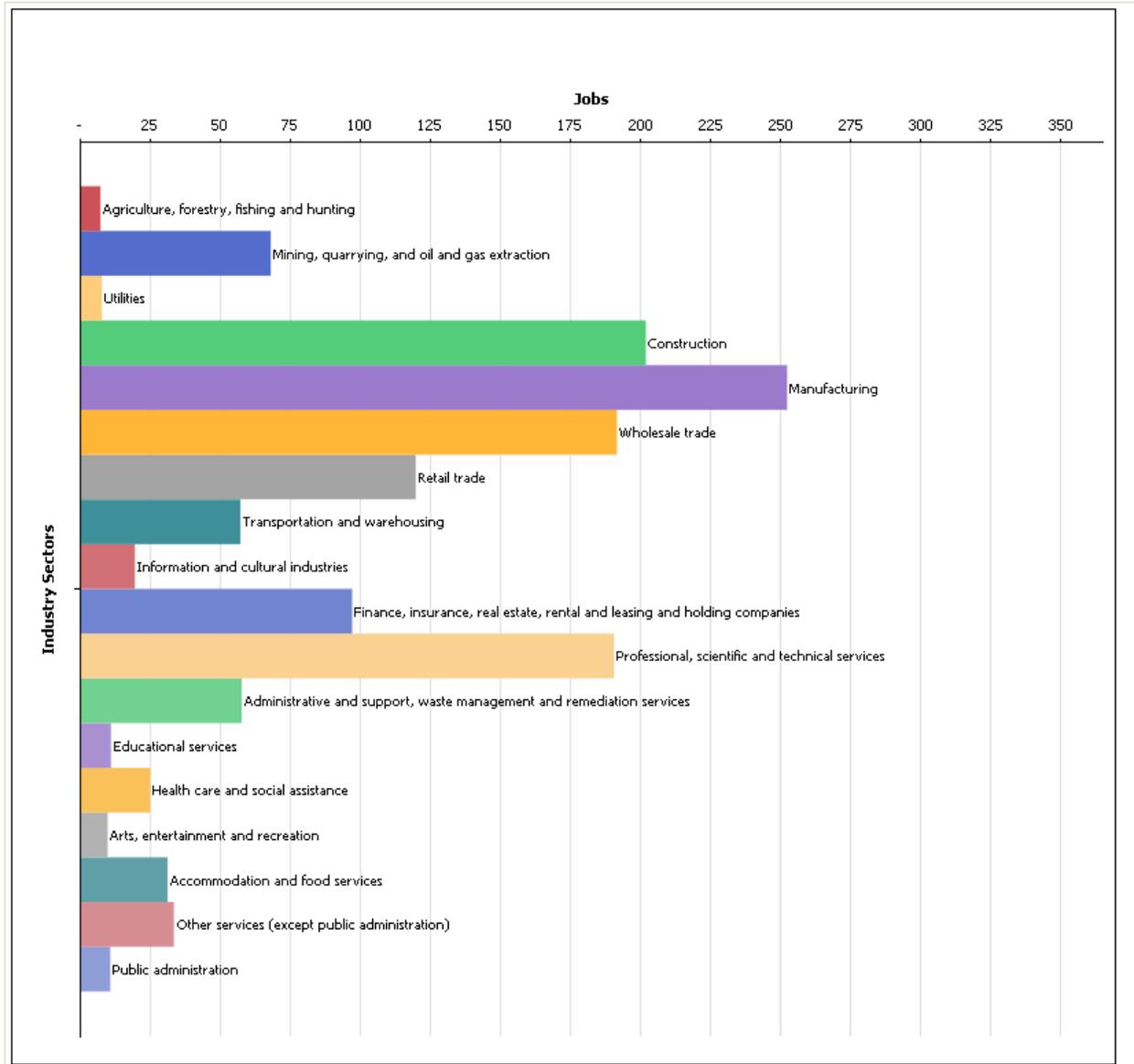
The above range of employment in the area near Ignace generates about \$109 million in GDP annually during the construction phase and about \$120 million annually during the operations phase.

The APM project is unlike many northern mining operations. Most mining operations typically have a 15 to 20-year life span so surrounding communities tend to not develop significant supporting services. In these cases, it is common to see “fly-in / fly-out” behaviour of mining staff. In other words, many workers do not move their families into the local community(s) for such a short time period. However, in the case of the APM project, many construction jobs (mining, rock excavation of placement rooms) will extend into operations and operations is expected to be as long as 38 years followed by a long extended monitoring phase. Hence, given the extended time frame for the APM project, it is more likely to expect increasing numbers of new families making the area near Ignace their permanent home.

During a sample year mid-point in the construction phase, the possible distribution of employment (total of direct, indirect, and induced) that would be needed by sector in the area near Ignace alone is illustrated in Figure 6 and presented in more detail in Table 7. Similar to the regional impact, the most affected industry sectors in sequence are:

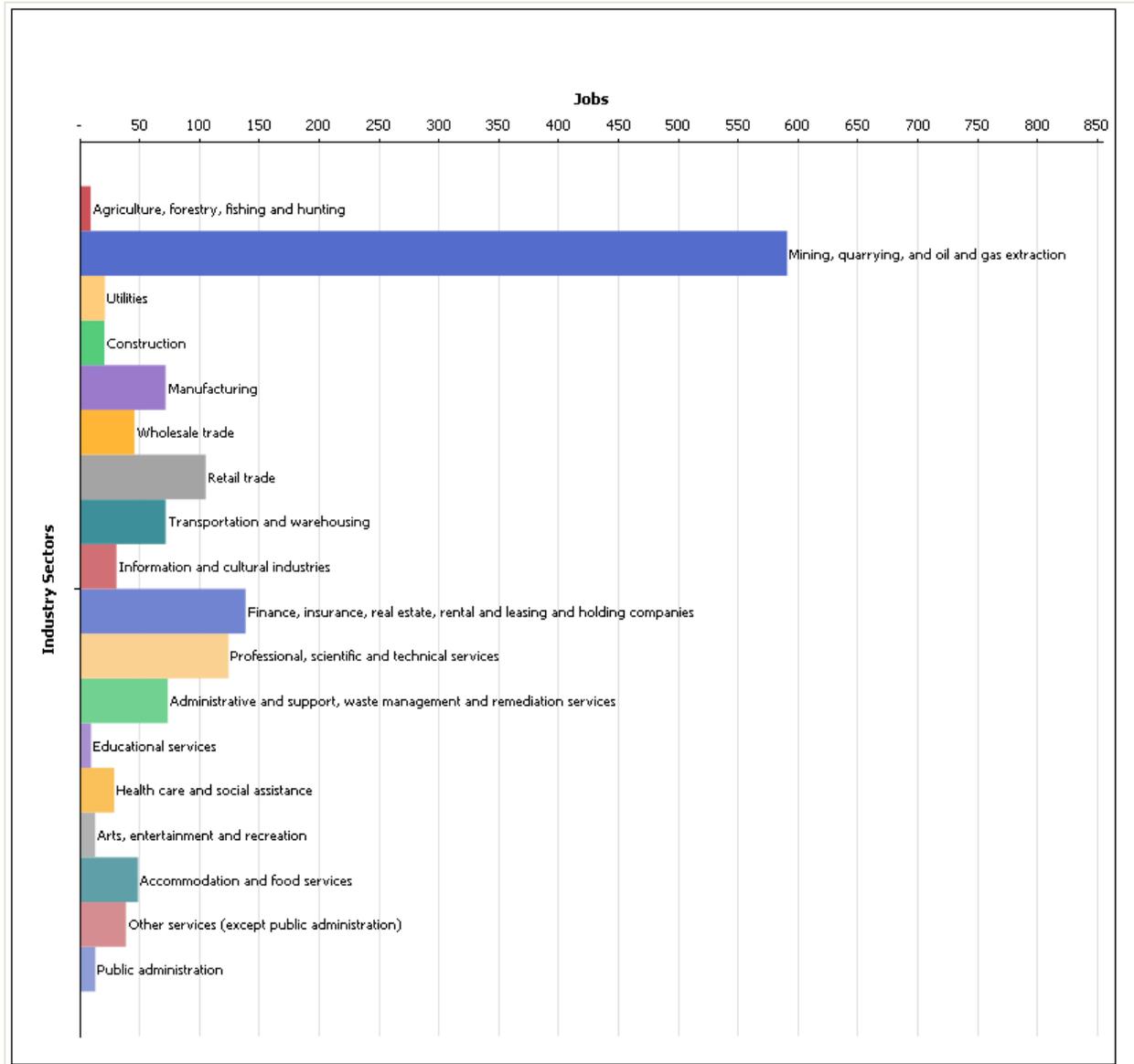
- Manufacturing
- Construction
- Wholesale and retail trades
- Professional, scientific and technical services, finance, insurance, and real estate services

Figure 6. Distribution of Employment by Industry Sector in the Area near Ignace during the Construction Phase (sample year mid-phase)



During a sample year in the mid-point of operations of the project, the possible distribution of employment by sector is presented in Figure 7 and in Table 8.

Figure 7. Distribution of Employment by Industry Sector in the Area near Ignace during Operations Phase (sample year mid-phase)



Mining and quarrying would be the dominant industry sector for employment during the operations phase in the area near Ignace.

Table 7. Project Demand for Industry Sector Jobs in the Area near Ignace during Construction (sample year mid-phase)

| | APM Job Demand |
|--|----------------|
| Agriculture, forestry, fishing and hunting | 7 |
| Mining, quarrying, and oil and gas extraction | 68 |
| Utilities | 8 |

| | |
|---|-----|
| Construction | 202 |
| Manufacturing | 252 |
| Wholesale Trade | 192 |
| Retail Trade | 120 |
| Transportation and Warehousing | 57 |
| Information and Cultural industries | 20 |
| Finance, insurance, real estate, rental and leasing and holding companies | 97 |
| Professional, scientific and technical services | 191 |
| Administrative and support, waste management and remediation services | 58 |
| Educational services | 11 |
| Health care and social assistance | 25 |
| Arts , entertainment and recreation | 10 |
| Accommodation and food services | 31 |
| Other services (except public administration) | 34 |
| Public administration | 11 |

APM Job Demand is generated by the economic impact model. Using Statistics Canada’s Interprovincial I-O Model and their Industry Sector Profile tables, a labour profile by industry sector is generated based on the specifications described earlier relating to modelling assumptions and calibrations. Essentially, the model generates industry labour profiles for the province, regions and communities of Ontario based on the allocations within the model. The presence of the APM project creates new demand for more labour by industry sector.

Table 8. Project Demand for Industry Sector Jobs in the Area near Ignace Today during Operations (sample year mid-phase)

| | APM Job Demand |
|---|----------------|
| Agriculture, forestry, fishing and hunting | 9 |
| Mining, quarrying, and oil and gas extraction | 591 |
| Utilities | 21 |
| Construction | 21 |
| Manufacturing | 72 |
| Wholesale Trade | 46 |
| Retail Trade | 105 |
| Transportation and Warehousing | 72 |
| Information and Cultural industries | 31 |
| Finance, insurance, real estate, rental and leasing and holding companies | 138 |
| Professional, scientific and technical services | 124 |
| Administrative and support, waste management and remediation services | 74 |
| Educational services | 10 |
| Health care and social assistance | 29 |
| Arts , entertainment and recreation | 13 |
| Accommodation and food services | 49 |
| Other services (except public administration) | 39 |
| Public administration | 13 |

3.4 Potential Employment Benefits in Individual Communities in the Area

The previous section indicates that during the construction and operations phases an annual average of approximately 1,165 and 1,340 jobs (direct, indirect and induced) respectively are predicted to result in the area near Ignace. As discussed earlier in the report, although it is possible to model the distribution of the economic benefits associated with these jobs to individual municipalities within the area it is premature to conduct such modelling at this point in time. It is important to note that the proportion of labour demand which will be drawn from any of the First Nation or Métis communities or other communities in the area is driven by a number of different factors including economic interactions between the communities, population, skills availability, employment conditions, and service availability in each of the communities.

As an example of potential benefits to an individual community, if a community in the area near Ignace was able to capture 40 per cent of benefits during the operations phase of the APM Project, this would represent approximately 536 additional households in the community to accommodate the employees. With an average family size in Canada of 2.9 persons (Statistics Canada 2013), the population increase associated with these households would be about 1,554. A population increase of this magnitude would also result in a need for increased infrastructure and social services and could attract additional retail and services to the community. The NWMO will work with the community to develop the needed infrastructure to support the project.

Like any of the economic benefits described in this report, the communities within the area, including First Nation and Métis communities, in consultation with the NWMO, can plan a regional economic development strategy that coordinates developments in the area to best meet goals and aspirations of the communities. For example, individual communities may choose to limit their growth and development to a certain population level which would essentially translate into a “plateauing” of employment in the community to match this growth aspiration. In this development scenario, the operations phase employment would display a plateau effect (flat or even level) in its employment projection. Similarly, other communities may choose to jointly plan their developments to leverage existing services and local strengths that might in turn alter the nature of employment profiles in each community.

4. Summary

If the APM Project were to be sited near the Town of Ignace, the potential job benefit to Ontario and area communities would be significant (Table 9). Starting with the province of Ontario, predicted potential average annual job creation (total of direct, indirect and induced) would be about 2,800 jobs per year during construction, and would average about 2,420 jobs per year during operations. The Northwest economic region (as defined by Statistics Canada) could experience a predicted average of approximately 1,295 jobs per year during construction and about 1,410 jobs per year during operations, through the combination of all direct, indirect and induced effects.

Table 9. Estimated Average Annual Employment in Ontario, the Northwest Economic Region and the Area near Ignace during Construction and Operations Phases

| APM Project Phase | Jobs per year | Ontario | Northwest Economic Region | Area near Ignace |
|---------------------|---------------|---------|---------------------------|------------------|
| Construction | Total | 2,800 | 1,295 | 1,165 |
| | Direct | 795 | 405 | 365 |
| | Indirect | 1,430 | 625 | 560 |
| | Induced | 575 | 265 | 240 |
| Operations | Total | 2,420 | 1,410 | 1,340 |
| | Direct | 720 | 520 | 490 |
| | Indirect | 1,205 | 600 | 575 |
| | Induced | 495 | 290 | 275 |

Within the area communities, the total annual average direct, indirect, and induced job creation benefits are predicted to be about 1,165 jobs per year during construction and 1,340 jobs per year during operations assuming no effort is made to further direct the implementation of the project in the area.

Direct jobs are expected to be predominantly located at or near the project site. An annual average of approximately 800 direct jobs is expected to be required during the construction phase and approximately 700 during operations. In addition, as opportunities are identified over the long life of the project, it is expected that employers in the supply chain would move closer, resulting in an increasing number of indirect jobs moving to or near the project site over time.

It is important to note that these job projections are based on a preliminary project cost estimate which will be refined over time. Also, the assumptions regarding allocation of expenditures within Ontario and between economic regions are based on informed judgement and the current location of industry and services which may change in the future. The economy is dynamic. Firms and industry concentrations change and as such labour and expenditure patterns change in turn. Thus, the economic benefit projections presented in this report should be interpreted with some caution keeping in mind that these estimates are reasonable if understood as “order of magnitude” estimates. As well, the long time-frames associated with the project are expected to provide opportunity to optimize benefits within the area.

As the job projections for the largest phases of the APM Project (construction and operations) are some years in the future, it affords NWMO time to work with communities in the area near Ignace to create a common economic development strategy that would affect the nature and scale of benefits to individual communities in the area. This could be accomplished by a combination of actions such as:

- training targeted to local and regional residents well in advance of construction;
- development of procurement policies that are preferential to local or regional content; and
- support from government or the NWMO to foster new businesses, and the development of infrastructure to serve the project locally.

NWMO is committed to working with communities in the area to foster well-being and to assist to capture benefits that align with the vision for the area among those living there. Planning and area capacity building could be used to align economic benefits with community aspirations and could result in greater benefits than those presented in this report.

5. References

Nuclear Waste Management Organization, 2013:

Preliminary Assessment for Siting a Deep Geological Repository for Canada's Used Nuclear Fuel, The Corporation of the Township of Ignace, Ontario, Findings from Phase One Studies. NWMO Report ASPM-REP-06144-0009. Toronto, Canada.

Senes, 2013:

Draft Community Profile: Township of Ignace, Ontario. Report prepared for Nuclear Waste Management Organization. NWMO Report APR-REP-06144-0015. Toronto, Canada.

Statistics Canada, 2013:

Fifty Years of Families in Canada 1961 to 2011. Accessed on June 25, 2015 at

https://www12.statcan.gc.ca/census-recensement/2011/as-sa/98-312-x/98-312-x2011003_1-eng.cfm

