Nuclear Waste Management Organization

Independent Peer Review of NWMO Draft Study Report "Choosing a Way Forward"

Prepared for
Canadian Association of Nuclear Host Communities

SL-008521
July 2005

Acres-S&L

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Nuclear Waste Management Organization

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CONTENTS

APPENDIXES

A NWMO References

B Activity Flow Charts for the Optional Management Approaches

LIST OF TABLES AND FIGURES

ACRONYMS AND ABBREVIATIONS

Term	Definition or Clarification
AECL	Atomic Energy of Canada Limited
APM	Adaptive Phased Management
ASL	Acres-Sargent & Lundy
CANDU	Canada Deuterium Uranium
CANHC	Canadian Association of Nuclear Host Communities
CEAA	Canadian Environmental Assessment Act
CNSC	Canadian Nuclear Safety Commission
CRL	Chalk River Laboratories
DGR	Deep geological repository (facility)
EA	Environmental Assessment
FCM	Federation of Canadian Municipalities
Golder/Gartner Lee	Golder Associates, Ltd., and Gartner Lee Limited
NFWA	Nuclear Fuel Waste Act
NPV	Net present value
NWMO	Nuclear Waste Management Organization
RFP	Request for proposal
SAR	Safety analysis report

1. EXECUTIVE SUMMARY

1.1 OVERVIEW

Acres-Sargent & Lundy (ASL) was engaged by the Canadian Association of Nuclear Host Communities (CANHC) to assist in its evaluation of Canada's Nuclear Waste Management Organization (NWMO) process for the future management of Canada's used nuclear fuel. Specifically, CANHC requested ASL to review NWMO's Draft Study Report "Choosing a Way Forward: The Future Management of Canada's Used Nuclear Fuel." Accordingly, ASL performed a broad review of the Draft Study Report with the overall objective of identifying issues or questions that CANHC should focus on as the NWMO continues its process.

The NWMO was established in 2002 under the Nuclear Fuel Waste Act (NFWA) to investigate approaches for managing Canada's used nuclear fuel. The Nuclear Fuel Waste Act requires the NWMO to recommend a preferred management approach to the Government of Canada by November 15, 2005. The NWMO will then implement the approach chosen by the Government. As noted in the NWMO's Fact Sheet 9, "The NWMO Study Process," the NWMO has committed to "develop collaboratively with Canadians a management approach that is socially acceptable, technically sound, environmentally responsible, and economically feasible."

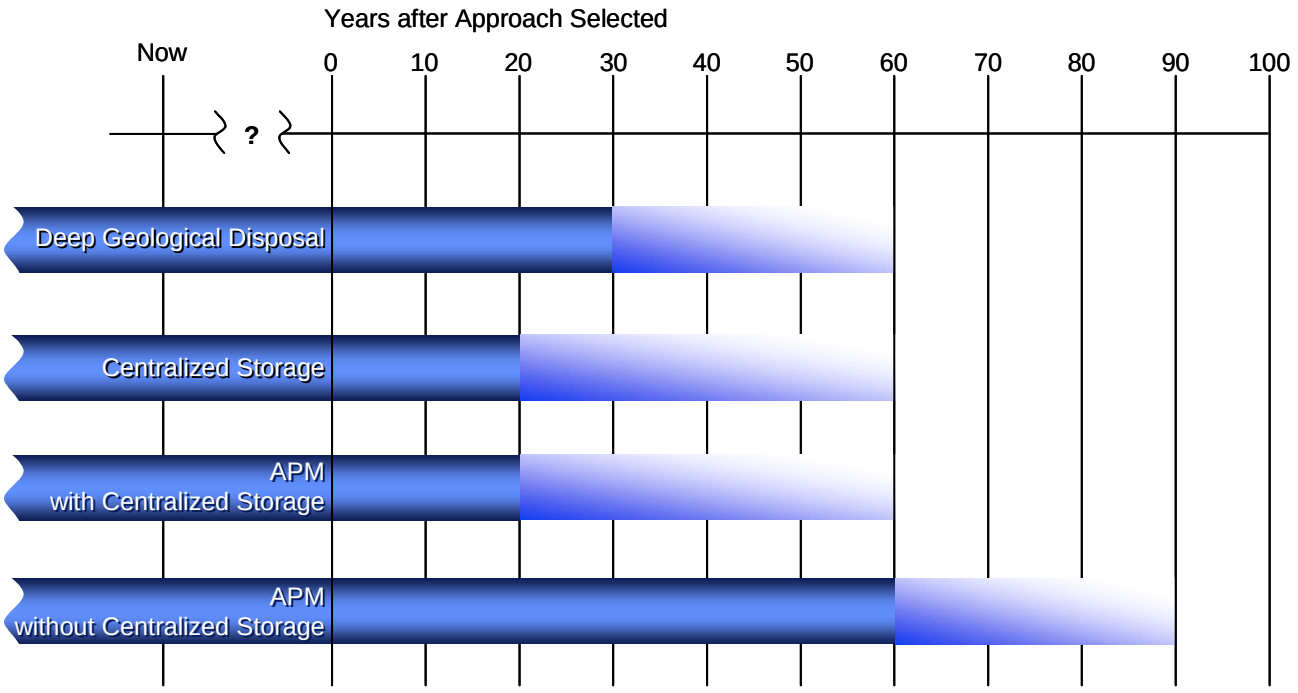
The purpose of the Draft Study Report is to present the NWMO's recommended approach for the long-term management of used nuclear fuel in Canada. The NFWA requires that the following three primary management approaches, as a minimum, be studied: deep geological disposal, storage at nuclear reactor sites, and centralized storage. However, the NFWA also noted that other methods may be considered. Based on its assessment of the three primary approaches, the NWMO decided that there is "considerable merit" in developing and assessing another approach that leverages the strengths of the primary options while minimizing their risks and unfavorable aspects. Accordingly, the NWMO developed a new option called Adaptive Phased Management (APM) that is intended to capture the strengths and mitigate the limitations of the other options. The NWMO has designated APM as the preferred management approach.

APM is essentially the deep geological disposal option, but with an extended schedule that specifically incorporates steps and decision points that provide flexibility and adaptability during implementation. During Phase 1 of the APM scheme, used nuclear fuel would remain at the current nuclear reactor sites under current storage and monitoring conditions. Research would continue into technology improvements for used fuel management. The key activity during this phase is the selection of a preferred site and the decision of whether or

not to construct a shallow central underground storage facility. If the decision is made to not construct the shallow storage facility, then the used fuel would continue to be stored at the reactor sites until it is moved to the deep repository during Phase 3. Phase 2 would begin with the operation of the underground research laboratory. This laboratory would demonstrate the technology to be used and confirm that the selected site is suitable for a deep repository. If the shallow storage facility is constructed, then used fuel would be transported there from the reactor sites during this phase. If it is not constructed, the used fuel would remain at the reactor sites until transported for placement in the deep repository. Phase 3 begins with the receipt of the operating license for the deep repository. Assuming the shallow central storage facility was constructed in Phase 2, fuel transport and repackaging would continue in Phase 3 with the fuel now being placed in the deep repository, and extended in-place monitoring would begin. Access to the repository would be maintained to assess the performance of the repository system and to allow retrieval of the used fuel, if desired. Finally, a decision on when to close and decommission the deep geological repository facility would be made. Although the APM process is flexible, the final disposition is firm, in that the used fuel will be disposed in a deep geological repository.

The following figure illustrates the impact on the duration of interim onsite storage associated with the different management options.

Figure 1-1 — Comparison of Potential Interim Storage Durations



There are two key points illustrated in this figure. The first key issue is that the durations are all impacted by how long it will take before a decision is made to select an approach. The second key issue is that used nuclear fuel could remain in interim storage at the current reactor sites for over 90 years from now. This duration may exceed the storage capacity and licensing parameters for these facilities, and could create technical and security concerns that were not envisioned when these facilities were designed and approved for short-term interim storage.

Overall, ASL believes that the Adaptive Phased Management approach effectively addresses many of the concerns or weaknesses associated with the other options, while building on their strengths. The Adaptive Phased Management approach is technically reasonable and achieves its goal of providing balance relative to the assessment attributes. It should be noted that while there are significant risks and costs, along with benefits, associated with the APM, this approach is considered to be advantageous compared to the three primary alternatives.

1.2 KEY ISSUES AND RECOMMENDATIONS

ASL identified several issues and corresponding recommendations during its independent peer review of the Draft Study Report as summarized in Table 1-1. The issues related to the Draft Study Report are discussed in Section 3; the issues related to Adaptive Phased Management are discussed in Section 4; and the issues related to implementation planning are discussed in Section 5.

Table 1-1 — Issue and Recommendation Summary

Issue	Recommendation
Draft Study Report	
There is a risk associated with an approach that combines quantitative and qualitative assessment factors, in that more weight can be given to quantifiable versus qualitative factors. For example, while the Golder/Gartner Lee analysis acknowledges the potential for significant cost impacts related to social protests, it later notes that “the risks and costs are not significant” for transporting used fuel in a centralized approach.	The NWMO should develop an assessment of the qualitative risks and costs included in its analysis, as well as an assessment of the direct and implicit assumptions, to ensure that appropriate contingency measures have been considered if extreme or unlikely events occur. These assessments should be included in the Final Study Report.

Issue	Recommendation
The Golder/Gartner Lee assessment refers to the impact that could result from opposition groups, such as the potential for social protests that could affect the transportation of used fuel. However, there is no formal discussion or assessment of opposition groups, or a discussion of possible mitigating measures needed to address this issue. This would be relevant or could be a significant concern if these groups are able to stop or change transportation options, which could mean that onsite storage is extended or becomes the long-term approach.	The NWMO should supplement its public engagement strategy as required to assess the concerns, positions, and possible impact of potential opposition groups. This assessment should be performed during implementation planning, and mentioned in the Final Study Report.
In discussions with ASL, the NWMO clarified that certain socio-economic impact mitigation measures, such as compensation for the unavoidable or residual adverse impacts of the management approaches, are not being considered for the current host communities. The NWMO noted that the used fuel owners are responsible for the interim management and storage of the used fuel, including socio-economic effects management and mitigation. Accordingly, the NWMO would not become involved in discussions or actions related to current interim storage arrangements, and the NWMO's obligations would not begin until the used fuel leaves its current locations.	The NWMO should clarify its position towards the current host communities relative to changes in the planned duration of interim storage in the Final Study Report. For example, the NWMO should clearly state whether or not it plans to afford the current host communities the same considerations as new host communities for changes in interim storage plans once a new national policy is decided upon.
Adaptive Phased Management	
The Draft Study Report, in Section 3.3, specifically discusses the advantages and limitations of the three primary management approaches (Deep Geological Disposal in the Canadian Shield, Storage at Nuclear Reactor Sites, and Centralized Storage). However, the report does not include a comparable discussion of the advantages and limitations for Adaptive Phased Management.	The NWMO should develop a specific discussion of Adaptive Phased Management advantages and limitations, comparable to the write-ups for the other options found in Section 3.3. This discussion should be included in the Final Study Report.
There is a potential that some of the decisions that are a critical part of Adaptive Phased Management could be delayed or deferred for longer than expected. Any type of delays would require a continuation of interim storage, with the risk that on-site interim storage would become the de facto long-term management approach. As noted throughout the Draft Study Report, that option has several disadvantages, not the least of which is the lack of fairness to the current host communities.	The NWMO should ensure that the implementation plans for Adaptive Phased Management consider the potential impact of delaying or deferring decisions, and should develop corresponding contingencies and mitigation measures as appropriate. For example, implementing legislation could include requirements that the used fuel will be moved off-site within a defined time-frame, or else certain mitigation measures would go into effect. This issue will have to be addressed during implementation planning, but it should be mentioned in the Final Study Report.

Issue	Recommendation
The NWMO's Draft Study assesses the technical aspects of transportation, such as the number of shipments, estimated costs, and statistical accident rates. The Draft Study also notes that there are significant economic benefits associated with transportation, such as the number of jobs created. However, the study does not fully address the negative socio-economic impacts or the potential impact of opposition groups. If these types of events effectively stop implementation of Adaptive Phased Management or another recommended approach, then the status quo option of onsite storage will become the default approach.	The NWMO should ensure that transportation issues are studied and addressed in greater detail as it continues its planning and implementation work. For example, the implementation plan for the recommended approach should include contingency evaluations for selected extreme events or unanticipated delays. This issue will have to be addressed during implementation planning, but it should be mentioned in the Final Study Report.
	Transportation issues should be specifically addressed as the NWMO develops (for the Final Study Report) a recommended assessment of the qualitative risks and costs included in its analysis as discussed earlier in this report.
The potential duration of interim storage is impacted by how long it will take to select a management approach. With the recommended approach, Adaptive Phased Management, used nuclear fuel could potentially remain in interim storage at the current reactor sites for over 90 years from now. This duration may exceed the storage capacity and licensing parameters for the interim storage facilities, and could create technical and security concerns that were not envisioned when these facilities were designed and approved for short-term interim storage. For example, the security risks for locations near heavily populated urban areas and adjacent to the Great Lakes may be significantly increased if the duration of interim storage significantly increases at these locations.	Given the potentially lengthy time frames associated with Adaptive Phased Management, the NWMO should confirm and document that the existing reactor sites have adequate storage capacity for current and future used fuel inventories. The storage capacity should consider both potential facility and site space limitations and constraints. This should be addressed in the Final Study Report.
	The NWMO should address the potential increase in security risks associated with an increase in the duration of interim storage. This should be mentioned in the Final Study Report and addressed in detail during implementation planning. Also, contingencies should be considered if current sites are not able to obtain the licenses required to support expansion based on changes in the duration of interim storage requirements.

Issue	Recommendation
Implementation Planning	
The NWMO has had extensive engagement with Canadian citizens regarding its work as discussed in Appendix 5 of the Draft Study Report. This item was discussed with the NWMO during the CANHC meeting in St. Johns on June 3, 2005, when a question was posed to the NWMO attendees regarding the make-up of the participants in the engagement process (that is, how many private citizens, how many people were representing organizations, etc.). Appendix 5 of the Draft Study Report lists the number of participants and organizations, but does not analyze these data against expectations for participation and the overall quality of the engagement process. This information could provide valuable insight into the effectiveness of the NWMO's engagement process and indicate areas for improvement and lessons learned from their experiences.	It is recommended that the NWMO develop and/or study data characterizing the make-up of engagement participants to verify the quality of the engagement process and to identify areas for improvement during implementation planning. This issue will have to be addressed during implementation planning, but it should be mentioned in the Final Study Report.
There appears to be some confusion or inconsistency regarding the role of the NWMO in working with the current host communities as it develops its recommended management approach and implementation plans. The Draft Study Report notes that "[the NWMO] will be responsible for managing and coordinating the full range of activities related to the long-term management of used nuclear fuel." The NWMO's recommendation and implementation plan will affect the current host communities, and it would seem that the NWMO would take an active role in working with the current host communities to manage and mitigate socio-economic effects before the used fuel leaves interim storage. However, the NWMO stated that it would not be involved with detailed discussions or actions taken relative to mitigating socio-economic effects until the used fuel leaves interim storage.	It is recommended that the NWMO clarify its role regarding current interim storage at reactor sites, so that the current host communities understand the roles and responsibilities of the different organizations involved in developing interim storage policies. This clarification will support effective planning and implementation of current and/or new storage policies. This issue will have to be addressed during implementation planning, but it should be mentioned in the Final Study Report.

Last page of Section 1.

2. METHODOLOGY

ASL's independent review was performed by a core team of consultants that have significant spent-fuel-disposal experience, as well as experience in assessing the impacts of new nuclear facilities and associated development and permitting requirements. Throughout the course of the review, ASL worked collaboratively with CANHC to provide updates via tele-conferences on an as-needed basis.

The review of the NWMO's Draft Study Report *Choosing a Way Forward* was divided into three tasks. The objective of the first task was to identify and perform broad reviews of pertinent background documents in advance of the issuance of the Draft Study Report in order to facilitate the review of NWMO's Draft Study Report. This task was accomplished by comparing the list of NWMO background documents, as posted on the NWMO web site, to the issues identified in ASL's independent peer review of the NWMO's Discussion Document 2 (ref. ASL report SL-008414, December 2004), as well as any additional issues identified by the member municipalities of CANHC in their comments on Discussion Document 2. (Appendix A provides references and links to related documents posted on the NWMO's web site.) ASL performed a general review of the documents with emphasis on the issues identified in the 2004 peer review. The overall outcome of the first task was to expand ASL's working knowledge of the background documents to be applied during further reviews.

The objective of the second task was to perform a preliminary review of the Draft Study Report and share the results, along with pertinent issues and background information identified in ASL's 2004 peer review, with CANHC during the Federation of Canadian Municipalities (FCM) conference in June. This task was accomplished by reviewing NWMO's Draft Study Report while applying the knowledge gained during Task 1 and during the 2004 peer review. The review performed in this task was on a general level due to schedule constraints caused by the fixed date of the FCM conference relative to the issuance of the Draft Study Report. ASL discussed the content of the presentation with CANHC before the meeting in order to identify and resolve their questions and comments during the development of the presentation. The overall outcome of Task 2 was a presentation made by ASL during the FCM conference. ASL included supplemental background information that broadly summarized the overall issue of high level waste management in Canada in its presentation to CANHC at the FCM conference.

The objective of the third phase was to finalize the review of the NWMO's Draft Study Report and develop a report to document this review (similar to the type of report ASL developed for the 2004 independent peer review of NWMO's Discussion Document 2).

ASL used the following questions to guide its review of the Draft Study Report:

- Draft Study Report
  - — Is the Draft Study Report comprehensive and balanced? Are there gaps, and if so, how should they be addressed by the recommendation?
- Adaptive Phased Management
  - — What are the relative strengths and weaknesses of the NWMO's recommended management approach, especially from the perspective of the current host communities?
- Implementation Planning
  - — What are our thoughts regarding the implementation plan? Given that the recommended approach involves relocating the waste, the ability of that approach to be implemented must be addressed, given social and political realities. Otherwise, onsite storage will become, by default, the selected management approach.
  - — Regardless of which management approach is selected, the waste will remain at the existing sites for a number of years. Therefore, the interest of the existing host communities must be considered when developing an implementation plan.

It should be noted that ASL did not perform a detailed review each of the documents referenced in the Draft Study Report, as the level of effort and time required are beyond the scope of our independent peer review. However, the following NWMO background papers are especially relevant and useful to understand the underlying foundation for the Draft Study Report: Technical Report 9.2a, *Assessments of Benefits, Risks and Costs of Management Approaches for Used Nuclear Fuel by Illustrative Economic Region*; Supplemental Report 9.2b, *Assessments of Benefits, Risks and Costs of a Proposed Adaptive Phased Management Approach by Illustrative Economic Region*; and Background Paper 9.3, *A Review of Possible Measures to Avoid or Minimize Significant Socio-Economic Effects on a Community's Way of Life*. These documents provide much of the detailed discussion and analysis supporting the Draft Study Report, and are available on the NWMO's web site.

Last page of Section 2.

3. OVERVIEW OF DRAFT STUDY REPORT

The Draft Study Report is the third major report issued by the NWMO in the course of its work and is the first to present the NWMO's assessment and conclusions of the information it received during the past two years of study and public engagement activities. As stated in the Draft Study Report's foreword, "this report is different in character [from the previous NWMO documents]. It is now time to reflect our synthesis of ideas from the two years of our engagement with citizens and specialists, and to propose a course of action. The NWMO alone is responsible for these conclusions, which we believe to be responsive to the state of current knowledge and our understanding of the values of those who contributed to the dialogue." The overall objective of the draft Study Report is to review and test the NWMO's ideas with interested members of the public in advance of submitting its recommended management approach to the federal government in November.

The NWMO commissioned Golder Associates, Ltd., and Gartner Lee Limited (Golder/Gartner Lee) to evaluate the comparative benefits, risks and costs of the three primary management approaches. The resulting evaluation is described in NWMO background papers 9.2a and 9.2b. Golder/Gartner Lee's evaluation analyzed each management approach relative to the eight key attributes established by the Assessment Team; background paper 9.2a evaluates the three primary approaches, while background paper 9.2b evaluates the Adaptive Phased Management approach. The eight assessment attributes developed by the Assessment Team and utilized by Golder/Gartner Lee are summarized below:

- **Fairness.** Capacity to ensure fairness in the distribution of costs, benefits, and risks: process and substance.
- **Public Health and Safety.** Capacity to ensure public health and safety.
- **Worker Health and Safety.** Capacity to ensure worker health and safety
- **Community Well-being.** Capacity to ensure community well-being
- **Security.** Capacity to ensure security of materials, facilities, and infrastructure
- **Environmental Integrity.** Capacity to ensure environmental integrity
- **Economic Viability.** Capacity to ensure economic viability
- **Adaptability.** Capacity to adapt to changing conditions over time.

The Golder/Gartner Lee approach included identifying measures and indicators for each of the influencing factors related to the eight attributes. These measures and indicators were selected to allow evaluation of the

separate management approaches by using quantitative measures if available, or by developing qualitative discussions where feasible. For example, certain economic benefits were quantified in terms of dollar values, such as estimated construction and transportation costs, while certain risks were evaluated qualitatively, such as the potential for extreme events or unanticipated delays. Quantitative comparisons were made based on transportation costs for making a certain number of shipments for a certain distance on schedule. Qualitatively, the Golder/Gartner Lee analysis notes that if there is social protest against the transportation of used fuel, this could delay the implementation of a selected management approach and have significant cost impacts (ref. Section 7.4.7 of Paper 9.2a). This type of quantitative/qualitative assessment was used in the Golder/Gartner Lee analysis to develop the benefits, risks, and costs associated with each of the eight attributes for the different management approach options.

Overall, the Golder/Gartner Lee assessment determined that all three options are acceptable, in that they could all be implemented safely and securely without adverse effects on people or the environment. The assessment also noted that each option would provide significant economic benefits if implemented at the locations studied. However, the assessment also noted that none of the three primary management approaches perfectly addresses all of the objectives that Canadian citizens indicated were important to address.

The Golder/Gartner Lee analysis noted that within the three primary options, significant advantages were offered by a centralized approach, a single solution implemented with current or near-current generations, deep geological disposal, and an implementation strategy that facilitates stakeholder participation. The analysis noted that a centralized approach, such as deep geological disposal and centralized storage, is more secure as compared to a decentralized approach, such as storage at reactor sites, because fewer locations will limit access to fewer people. Also, the report notes that a new location chosen for a central approach could be selected based on optimum performance criteria and to minimize risks. Although transportation is required, Golder/Gartner Lee noted that “the risks and costs are not significant.”

The assessment notes that a single solution approach, implemented in the near term by current or near-term future generations, is advantageous compared to a solution that requires long-term active management of the used fuel for repackaging and rebuilding facilities. The near-term cost estimates are more robust and certain, according to the Golder/Gartner Lee analysis, and there is greater financial surety for funding a near-term solution. The assessment notes that it would be fair for the current generation, which realized the benefits associated with creating used nuclear fuel, to shoulder the associated costs of long-term management of the used

fuel. The assessment also notes that a single solution is more secure than a solution that requires ongoing repackaging and handling of the used fuel.

The Golder/Gartner Lee study team determined that deep geological disposal offers advantages over surface or near-surface storage. Storage is a method of managing the waste in a manner that allows access under controlled conditions for retrieval or future activities, while disposal is conclusive without any intention or retrieval or future use. According to the Golder/Gartner Lee study team, deep geological disposal is more secure and offers more physical barriers than surface or near-surface storage. Also, they note that the technology for deep geological disposal is currently available and capable of ensuring the isolation required for the used fuel.

The final overall conclusion the Golder/Gartner Lee study team reached after analyzing the three primary options is that an implementation strategy that provides time for all stakeholders to participate in the decision-making process offers many advantages. An extended strategy would also offer opportunity for proof-of-concept testing and adoption of new technologies. The Golder/Gartner Lee assessment notes that it would be fair for near-term generations to be able to participate in decisions (as opposed to having to implement the decisions made by the current generation without having input). The assessment also notes that it would be fair for communities “most affected by the siting and implementation of a solution” to be given an opportunity to participate in the decision-making process. Finally, the assessment noted that it would be fair to demonstrate that issues of concern are being managed equitably.

Overall, ASL considers the Golder/Gartner Lee evaluation and quantitative/qualitative approach to be reasonable and practical given the timeframe under consideration (longer than recorded history) and inherent uncertainties related to some of the influencing variables, such as the public acceptance and political climate. However, there is a risk associated with this approach, in that more weight can be given to quantifiable versus qualitative factors. For example, while the Golder/Gartner Lee analysis acknowledges the potential for material cost impacts related to social protests of transporting used fuel, it later notes that “the risks and costs are not significant” for transporting used fuel in a centralized approach (i.e., deep geological disposal or centralized storage), and subsequently recommends a centralized approach. While the assessment of transportation risks and costs may be valid based on assumed shipment requirements and statistical data regarding transportation mishaps, it implicitly relies on an assumption that potential unanticipated delays either will not happen or will not be significant.

ASL recommends that the NWMO develop a specific assessment of the qualitative risks and costs included in its analysis, as well as an assessment of the direct and implicit assumptions, to ensure that appropriate contingency measures have been considered if extreme or unlikely events occur. These assessments should be included in the Final Study Report. The current process is one of making a choice between several alternatives, and so the relevant parameters and issues are those that help differentiate the alternatives. If the different alternatives all have similar qualitative risks and assumptions, with comparable impacts, then these risks would not affect the decision of which alternative to choose as much as affect the implementation and risk management of the selected approach. Accordingly, once a determination is made about how these issues would affect the decision for which approach is recommended, the assessment of qualitative risks and costs can be developed and used to support implementation planning.

The Draft Study Report addresses many of the issues identified in ASL's independent peer review of the NWMO's Discussion Document 2. For example, ASL's comments regarding the need to address adaptability and the capability of retrieving used fuel are directly discussed in the Draft Study Report. However, there are a few recommendations that are not clearly addressed in the Draft Study Report. The ASL report included a recommendation that the NWMO assess the position of groups that focus or represent public opinion, such as nuclear awareness groups or environmental advocate organizations. We recommended that "the NWMO should develop an assessment of the positions of these groups, the influence they may exert on the process, the impact this influence could have on the recommended management approach, and what can be done to gain their input or otherwise address their positions." The Draft Study Report does not address this issue or otherwise refer to this kind of assessment. The Golder/Gartner Lee assessment refers to the impact that could result from these groups, such as the potential for social protests that could affect the transportation of used fuel. However, there is no formal discussion or assessment of groups that may have specific agendas that are counter to the NWMO's ultimate objectives (opposition groups), or a discussion of possible mitigating measures needed to address this issue. This assessment would be relevant or could be a significant concern if these groups are able to stop or change transportation options, which could mean that onsite storage is extended or becomes the long-term approach. Accordingly, ASL recommends that the NWMO supplements its public engagement strategy as required to assess the position and possible impact of potential opposition groups. This assessment should be included in the Final Study Report.

Another issue that is not clearly addressed in the Draft Study Report is related to ASL's recommendation that "the ongoing comparative analysis should specifically assess the overall impact of the selected management

approach on the current host communities to ensure that they are afforded the same considerations and potential benefits as new host communities." This issue appears to be addressed in the Draft Study Report's discussion related to implementation. The Draft Study Report clearly notes that the NWMO will work collaboratively with affected communities to develop and implement the recommended management approach, and it clearly identifies current reactor site communities as implicated communities of interest for each of the management approach options under consideration. For example, in Table 4-11 of the Draft Study Report, "Describing Implicated Communities for the Four Management Approaches," the reactor site communities are specifically identified as communities of interest until all used nuclear fuel is relocated. Accordingly, it appeared that the NWMO was planning to include the current host communities in considerations for managing and mitigating the socio-economic effects related to the adoption of Canada's new long-term used fuel management policy. The adoption of a new policy may include extending the duration of on-site storage as part of the transition from current interim storage programs to the long-term management program.

However, in discussions with ASL during our independent review of the Draft Study Report, the NWMO offered clarification that certain socio-economic impact mitigation measures, such as compensation for the unavoidable or residual adverse impacts of the management approaches, are not being considered for the current host communities. The NWMO noted that the used fuel owners are currently responsible for the interim management and storage of the used fuel, including socio-economic impact management and mitigation. Accordingly, the NWMO would not become involved in discussions or actions related to current interim storage arrangements, and the NWMO's obligations would not begin until the used fuel leaves its current locations. The current host communities would need to pursue the issue of socio-economic impact mitigation with the current fuel owners as opposed to the NWMO. ASL recommends that the NWMO should confirm that it does not plan to afford the current host communities the same considerations as for new host communities for changes in interim storage plans once a new national policy is decided upon. This information should be included in the Final Study Report.

Last page of Section 3.

4. ADAPTIVE PHASED MANAGEMENT

4.1 OVERVIEW

Based on the analysis and conclusions of the initial assessment for the three primary options, the NWMO requested Golder/Gartner Lee to develop a comparative assessment of a fourth option, Adaptive Phased Management (APM). APM is intended to capture the strengths and mitigate the limitations of the other options. As noted by the NWMO in the Draft Study Report, "this approach builds on the best features of the three approaches outlined in the NFWA, and implements them in a staged or phased manner over time." APM is essentially the deep geological disposal option, but with an extended schedule that specifically incorporates steps and decision points that provide flexibility and adaptability during implementation. The three phases of this approach are as follows:

- **Phase 1: Preparing for Central Used Fuel Management.** During Phase 1 of the APM scheme, used nuclear fuel would remain at the current nuclear reactor sites under current storage and monitoring conditions. Research would continue into technology improvements for used fuel management. The key activity during this phase is the selection of a preferred site (to start in process year 10) "that has rock formations suitable for underground storage, an underground research laboratory and a deep geologic repository." Corresponding pre-licensing and licensing activities would be conducted as well as the development of transportation containers. In year 20 or shortly afterwards, a decision would be made whether or not to construct an interim central shallow storage facility. Construction licenses would be obtained for the underground laboratory and shallow storage facility at the central site. If the decision is made to construct the shallow storage facility, the facility would be constructed and an operating license would be obtained by the end of Phase 1. If the decision is made to not construct the shallow storage facility, then the used fuel would continue to be stored at the reactor sites until it is moved to the deep repository during Phase 3 of the APM scheme.

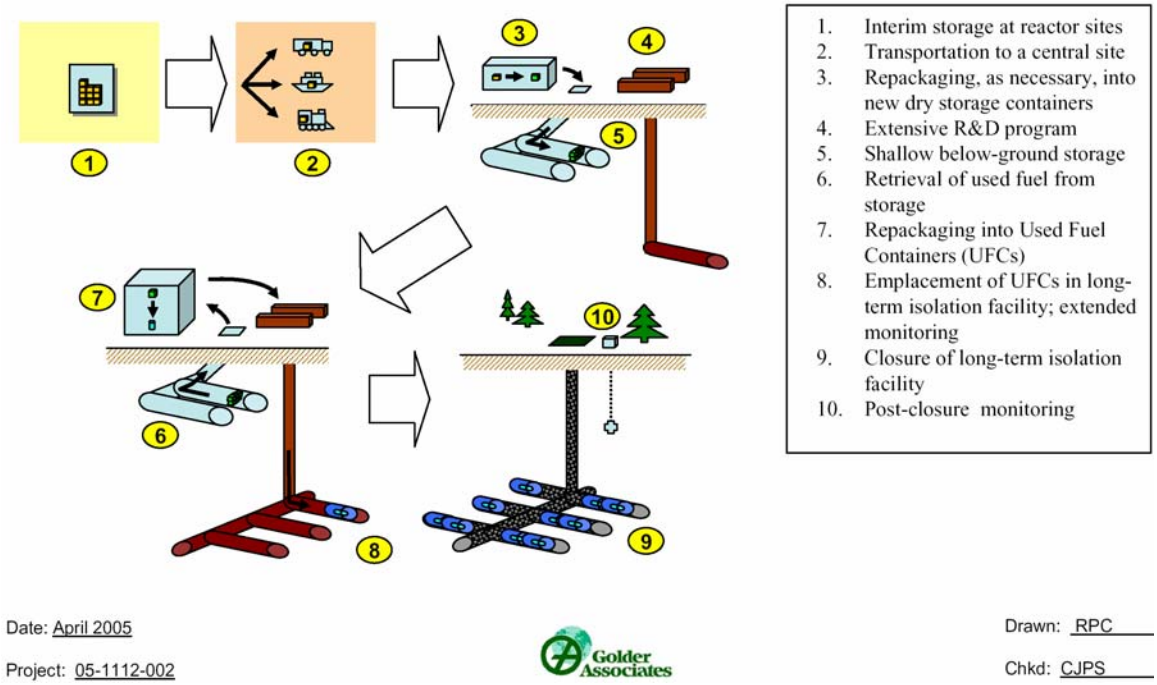
- **Phase 2: Central Storage and Technology Demonstration.** Phase 2 would begin in process year 30 with the operation of the underground research laboratory. This laboratory would demonstrate the technology to be used and confirm that the selected site is suitable for a deep repository. If the shallow storage facility was selected in Phase 1, used fuel would be transported there, to be repackaged as necessary and stored. If the shallow storage facility was not selected in Phase 1, used fuel would remain at the reactor sites during this phase. In approximately year 50, the decision would be made as to when to construct the deep repository and ancillary facilities. The construction license would be obtained for the deep repository.

- **Phase 3: Long-Term Containment, Isolation, and Monitoring.** Phase 3 of the APM scheme would begin with the receipt of the operating license for the deep repository, anticipated in year 60. Fuel transport and repackaging would continue (or start, if the shallow storage facility was not constructed during Phase 2) with the fuel being placed in the deep repository, and extended in-situ monitoring would begin. It is anticipated that by year 90 all used fuel would be fully

placed in the deep repository. Access to the repository would be maintained to assess the performance of the repository system and to allow retrieval of the used fuel, if desired. Finally, some time after year 90, a decision on when to close and decommission the deep geological repository facility would be made.

The steps involved in APM are detailed and illustrated in Figure 4-1 below.

Figure 4-1 — Adaptive Phased Management Approach



Source: From Figure 2-1 of Appendix A of NWMO Background Paper 9-2b, "Assessment of Benefits, Risks and Costs of a Proposed Adaptive Phased Management Approach by Illustrative Economic Region."

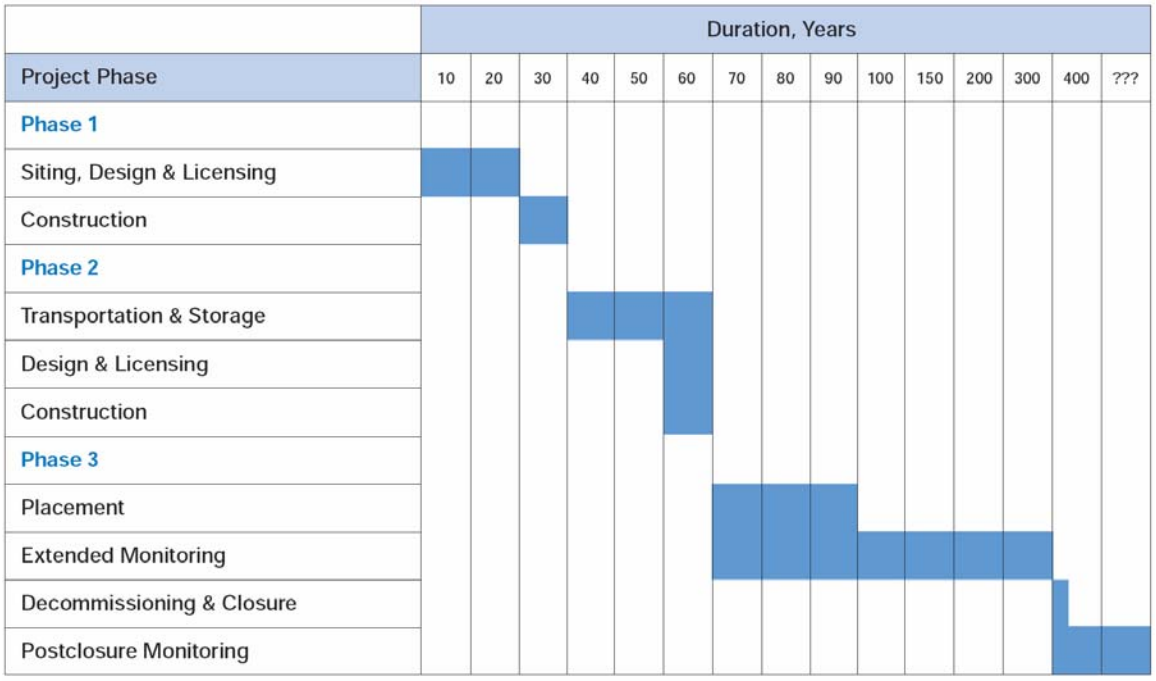
The NWMO notes the following key features of the adaptive phased management approach:

- Centralized containment and isolation of the used fuel in a deep geologic repository in suitable rock formations, such as the crystalline rock of the Canadian Shield or Ordovician sedimentary rock
- Flexibility in the pace and manner of implementation through a phased decision-making process, supported by a program of continuous learning, research, and development
- Provision for an interim step in the implementation process in the form of shallow underground storage of used fuel at the central site, before final placement in a deep repository
- Continuous monitoring of the used fuel to support data collection and confirmation of the safety and performance of the repository

- Potential for retrievability of the used fuel for an extended period, until such time as a future society makes a determination on the final closure, and the appropriate form and duration of postclosure monitoring

Although the Adaptive Phased Management process is flexible, the final disposition is firm, in that the used fuel will be disposed in a deep geological repository. A significant change from the mandated deep geological disposal option is the inclusion of potential sites in regions beyond the Canadian Shield, "in other geotechnically suitable rock formations, such as the Ordovician sedimentary rock basins." Also, used fuel could remain at reactor sites for a longer period of time compared to the other options. If the decision is made to not build a centralized storage facility as part of Adaptive Phased Management, then the used fuel could remain at the reactor sites for up to 90 years, as indicated by the end of the placement activity shown in Figure 4-2.

Figure 4-2 — Overall Implementation Schedule for Adaptive Phased Management



Source: Figure 4-20 from NWMO's Draft Study Report "Choosing a Way Forward: The Future Management of Canada's Used Nuclear Fuel."

It is important to note that the duration of interim storage at reactor sites is impacted by how long it will take to select a management approach. Furthermore, used nuclear fuel could remain in interim storage at the current reactor sites for over 90 years from now.

4.2 STRENGTHS AND WEAKNESSES

The Draft Study Report notes that several critical factors have to be balanced when deciding on a management approach. The assessment considered the need to balance security with accessibility. Deep geological disposal was considered the most secure approach due to the isolation of the waste from people and the environment. However, this isolation hinders accessibility of the used fuel, making it difficult to implement new technologies for the management of the used fuel or to retrieve the fuel if new uses for it are developed. There is a need to balance the minimization of transportation with the removal of used fuel from population centers. The NWMO also discussed the need to balance the current generation's taking responsibility for a decision today against providing flexibility for future generations by deferring some decisions for future generations. Finally, the NWMO discussed balancing fairness to the current host communities with fairness to future host communities.

Based on the need to strike a reasonable balance, ASL believes that the Adaptive Phased Management approach effectively addresses many of the concerns or weaknesses of the other options while building on their strengths. Overall, this approach is technically reasonable and achieves its goal of providing balance for these critical areas. It should be noted that while there are significant risks and costs, along with benefits, associated with the APM, this approach is advantageous compared to the three primary alternatives. The Golder/Gartner Lee assessment emphasizes this as shown in Background Paper 9.2b. Tables 3-1 through 3-9 in the Draft Study Report provide a more detailed summary of the benefits, risks, and uncertainties associated with each alternative, and these tables also indicate that APM is advantageous.

The Draft Study Report, in Section 3.3, specifically discusses the advantages and limitations of the three primary management approaches (Deep Geological Disposal in the Canadian Shield, Storage a Nuclear Reactor Sites, and Centralized Storage). However, the report does not include a comparable discussion of the advantages and limitations for APM. Although there is a detailed summary of the assessment for APM against the eight objectives, ASL recommends that the NWMO develops a specific discussion of APM's advantages and limitations comparable to the write-ups for the other options in Section 3.3. This discussion should be included in the Final Study Report.

There are certain aspects of APM that deserve further consideration. The first is the potential that some of the decisions that are a critical part of APM will be delayed or deferred for longer than expected. Any type of delay would require a continuation of interim storage, with the risk that onsite interim storage would become the de facto long-term management approach. As noted throughout the Draft Study Report, that option has several

disadvantages, not the least of which is the lack of fairness to the current host communities. The NWMO should ensure that the implementation plans for APM consider the potential impact of delaying or deferring decisions, and develop corresponding contingencies and mitigation measures as appropriate. For example, implementing legislation could include requirements that the used fuel will be moved off site within a defined time-frame, or else certain mitigation measures would go into effect. This issue will have to be addressed during implementation planning, but it should be mentioned in the Final Study Report.

The second issue that should be considered further is one that would affect all the centralized options, namely the adequacy of the assessment of transportation risks and costs. The NWMO's Draft Study Report assesses the technical aspects of transportation, such as the number of shipments, estimated costs, and statistical accident rates. The Draft Study Report also notes that there are significant economic benefits associated with transportation, such as the number of jobs created. However, the study does not fully address the negative socio-economic impacts or the potential impact of opposition groups. As noted above, these issues are identified in the assessment, but on a qualitative level. It should be noted that communities along the transportation corridors are identified as being communities of interest relative to the NWMO's engagement and implementation strategies. The NWMO should ensure that transportation issues are studied and addressed in greater detail as it continues its planning and implementation work. For example, the implementation plan for the recommended approach should include contingency evaluations for selected extreme events or unanticipated delays. These plans should recognize that if these types of events effectively stop implementation of the recommended approach, then the status quo option of onsite storage will become the default approach. Transportation issues should also be specifically addressed as the NWMO develops a recommended assessment of the qualitative risks and costs included in its analysis as discussed earlier in this report. Transportation issues will have to be addressed during implementation planning, but they should be mentioned in the Final Study Report.

The third issue that deserves further attention is the potential impact on the duration of interim storage. The potential duration of interim storage is impacted by how long it takes to select a management approach. For example, if it takes the government over 10 years to select a management approach after receiving the NWMO's recommendation, it is possible that used nuclear fuel could remain in interim storage at the current reactor sites for over 100 years from now (in the case of Adaptive Phased Management without a centralized storage facility). This duration may exceed the storage capacity and licensing parameters for the interim storage facilities, and could create technical and security concerns that were not envisioned when these facilities were designed and approved for short-term interim storage. For example, the security risks for locations near heavily

populated urban areas and adjacent to the Great Lakes may be significantly increased if the duration of interim storage significantly increases at these facilities.

Given the potentially lengthy time frames associated with Adaptive Phased Management, the NWMO should ensure that the existing reactor sites have adequate storage capacity for current and future used fuel inventories. The storage capacity should consider both potential facility and site space limitations and constraints. This should be addressed in the Final Study Report. The NWMO should address the potential increase in security risks associated with an increase in the duration of interim storage. This should be mentioned in the Final Study Report and addressed in detail during implementation planning. Also, contingencies should be considered in case current sites are not able to obtain the licenses required to support expansion based on changes in the duration of interim storage requirements.

Last page of Section 4.

5. IMPLEMENTATION PLANNING

5.1 NWMO APPROACH

The NWMO notes that some issues are not fully addressed through selection of a management approach itself. For example, the design of a fair siting process and the determination of safety thresholds apply to more than one option, and should be considered as part of a collaborative decision making process. Also, the NWMO noted that implementation can only be addresses in general terms at this time based on the status of the long-term management approach selection process: certain specifics cannot be addressed because the approach and affected communities have not been identified. However, the NWMO has established the foundation for its intended implementation planning process in the Draft Study Report and has developed Activity Flow Charts for each of the management approach options (which are provided in Appendix B of this report for reference).

The foundation for the NWMO's implementation planning includes an emphasis on process and collaborative decision making. As noted in the Draft Study Report, the NWMO stated that "the process by which a management approach is implemented will be an important determinant of the overall effectiveness of the approach and the extent to which it is, and continues to be, responsive to societal needs and concerns and in so doing, builds the confidence of Canadians." The Draft Study Report notes that implementation plans must be discussed with the many communities of interest, and that the plans will not be static and must continue to evolve. To date, the NWMO has had extensive engagement with Canadian citizens regarding its work. This item was discussed with the NWMO during the CANHC meeting in St. Johns on June 3, 2005, when a question was posed to the NWMO regarding the make-up of the participants in the engagement process (that is, how many private citizens, how many people were representing organizations, etc.). This information could provide valuable insight into the effectiveness of the NWMO's engagement process, and indicate areas for improvement and lessons learned from their experiences. Accordingly, ASL recommends that the NWMO develop and/or study data characterizing the make-up of engagement participants to verify the quality of the engagement process and to identify areas for improvement during implementation planning. This issue will have to be addressed during implementation planning, but it should be mentioned in the Final Study Report.

Overall, the foundation described by the NWMO is reasonable. However, there appears to be some confusion or inconsistency regarding the role of the NWMO and its corresponding interaction with the current host communities as it develops its recommendation for a management approach and implementation plans. The

Draft Study Report notes that "[the NWMO] will be responsible for managing and coordinating the full range of activities related to the long-term management of used nuclear fuel." The NWMO's implementation planning process, and subsequent implementation, will affect the current host communities. For example, delays in implementation will mean that the planned duration of interim storage will be extended. In an extreme case, failure to implement a centralized management approach (if selected) would cause the management approach to default to reactor site storage. Accordingly, it would seem that the NWMO's intention of working collaboratively with communities of interest implies that the NWMO would take an active role in working with the current host communities to manage and mitigate socio-economic effects before the used fuel leaves interim storage. However, as discussed earlier in this report, the NWMO stated that it would not be involved with discussions or actions taken relative to mitigating socio-economic effects until the used fuel leaves interim storage. It is recommended that the NWMO clarify its role regarding current interim storage at reactor sites, so that the current host communities understand the roles and responsibilities of the different organizations involved in developing interim storage policies. This clarification will support effective planning and implementation of current and/or new policies. This issue will have to be addressed during implementation planning, but it should be mentioned in the Final Study Report.

5.2 SOCIO-ECONOMIC EFFECTS MANAGEMENT

The Draft Study Report notes that the NFWA requires the NWMO to address significant socio-economic effects (or changes in to socio-economic conditions) as part of implementation planning. Further, the NWMO notes that "the socio-economic dimension is the key to the success of our strategy for managing used nuclear fuel." The purposes of socio-effects management, as defined in the Draft Study Report, is to ensure that people and communities affected by the implementation of the selected management approach have the capacity to cope with the associated changes, and to ensure that good relationships are fostered between the proponent of change, the affected communities, and others involved in the process.

The Draft Study Report identifies five potential means to manage socio-economic effects: mitigation, enhancement, compensation, monitoring and contingency measures, and community liaison measures. Mitigation refers to actions taken avoid or reduce the severity of negative effects. Enhancement refers to actions taken to maximize potential positive effects. Compensation refers to actions or measures taken to redress or offset negative consequences of the management approach. Monitoring and contingency measures are policies or programs intended to ensure timely and appropriate response to problems and unanticipated impacts.

Community liaison measures are policies, programs, or procedures established to maintain cooperative, non-adversarial relationships among the different participants involved in the project.

The issue of compensation has been discussed by the current host communities relative to the transition from interim storage to becoming an integral phase of a comprehensive long-term management approach. Two of the background papers commissioned by the NWMO provide insight into the application of socio-economic effects management related to the long-term management of used nuclear fuel. Golder/Gartner Lee prepared Background Paper 9.3, *A Review of Possible Measures to Avoid or Minimize Significant Socio-Economic Effects on a Community's Way of Life*. This paper considers the possible impacts that could arise from implementing one of the four management approaches, and provides examples of the types of mechanisms that exit to address the impacts. Background Paper 2.6, *A Review of Waste Facility Siting Case Studies Applicable to Spent Nuclear Fuel Management*, is a review of several waste facility siting cases intended to identify and assess the experience gained in other projects in order to develop lessons that can be applied by the NWMO. Both of these papers include discussions and examples of how compensation can be used as part of socio-economic effects management programs.

The NWMO confirmed to ASL that the cost estimates for the different management approaches include the costs for socio-economic mitigation measures such as compensation. However, the NWMO noted that these cost estimates are applicable for new host communities, as opposed to current host communities. The potential applicability for current host communities could be based on the change from considering onsite storage an interim measure intended for a limited duration while a long-term management approach is selected, to considering it a component of a broader long-term management approach. For example, there could be an increase in the duration of onsite storage to 90 years in the case of APM if a centralized storage facility is not constructed. Based on the NWMO's roles and responsibilities related to interim storage, and how the current host communities may be affected by potential changes in the duration of onsite storage, the applicability of potential compensation for the current host communities may need to be reconsidered. This issue will have to be addressed during implementation planning, but it should be mentioned in the Final Study Report.

Background Papers 9.3 and 2.6 provide insight into possible future steps that can be taken to address the issue of compensation. The papers describe how the practice of negotiating various municipal agreements has been used in Canada for some time, especially to facilitate the resolution of complex, politically-charged issues such as those related to used nuclear fuel management. For example, Paper 9.3 notes that Ontario Power Generation recently negotiated a compensation agreement to facilitate development of a low-and-intermediate radioactive

waste disposal facility at its Western Waste Management Facility at the Bruce Nuclear Facility. However, Paper 9.3 notes that these agreements are typically done in advance of facility approval. Because the interim storage facilities have already been established, the current host communities are not able to negotiate these types of agreements "in advance." Accordingly, the current host communities must work with the NWMO and the current used nuclear fuel owners to determine the applicability of the socio-economic impact management measures for existing facilities.

Last page of Section 5.

6. BACKGROUND INFORMATION

6.1 CANADIAN ASSOCIATION OF NUCLEAR HOST COMMUNITIES

The Canadian Association of Nuclear Host Communities (CANHC) consists of those communities in Canada that are hosts to nuclear generating stations or other nuclear facilities, as follows:

- The Municipality of Kincardine, Ontario (Bruce Nuclear Generating Station)
- The City of Pickering, Ontario (Pickering Nuclear Generating Station)
- The Municipality of Clarington, Ontario (Darlington Nuclear Generating Station)
- The City of Becancour, Quebec (Gentilly 2 Nuclear Generating Station)
- The Town of Deep River, Ontario (AECL Chalk River Laboratories)
- The Town of Pinawa, Manitoba (AECL Whiteshell Laboratories)
- The Region of Durham, Ontario (Darlington and Pickering Nuclear Generating Stations)

CANHC has noted that, as Canada's nuclear host communities, they will be substantially affected by the NWMO's process and the recommended management approach, regardless of which approach is recommended. Accordingly, CANHC requested ASL's support to evaluate the NWMO's work by performing independent peer reviews of key NWMO documents.

6.2 THE NWMO AND USED NUCLEAR FUEL IN CANADA

The NWMO was established under the Nuclear Fuel Waste Act (NFWA) in 2002 to investigate approaches for managing Canada's used nuclear fuel. Used nuclear fuel is a by-product of the generation of electricity in a nuclear power plant. If not managed properly, used nuclear fuel is hazardous to people and the environment for a very long time. The NWMO has published the following vision, mission, and values:

- Vision: Our vision is the long-term management of Canada's nuclear waste in a manner that safeguards people and respects the environment, now and in the future.
- Mission: The purpose of the NWMO is to develop collaboratively with Canadians a management approach for the long-term care of Canada's used nuclear fuel that is socially acceptable, technically sound, environmentally responsible and economically feasible.
- Values: The fundamental beliefs that will guide us in our work include:
  - Integrity: We will conduct ourselves with openness, honesty and respect for all persons and organizations with whom we deal.

— Excellence: We will pursue the best knowledge, understanding and innovative thinking in our analysis, engagement processes and decision-making.

— Engagement: We will seek the participation of all communities of interest and be responsive to a diversity of views and perspectives. We will communicate and consult actively, promoting thoughtful reflection and facilitating a constructive dialogue.

— Accountability: We will be fully responsible for the wise, prudent and efficient management of resources and be accountable for all our actions.

Currently, nuclear power plants are operating in Ontario, Quebec, and New Brunswick. The following table summarizes the location and quantities of used fuel bundles in Canada as of December 31, 2001:

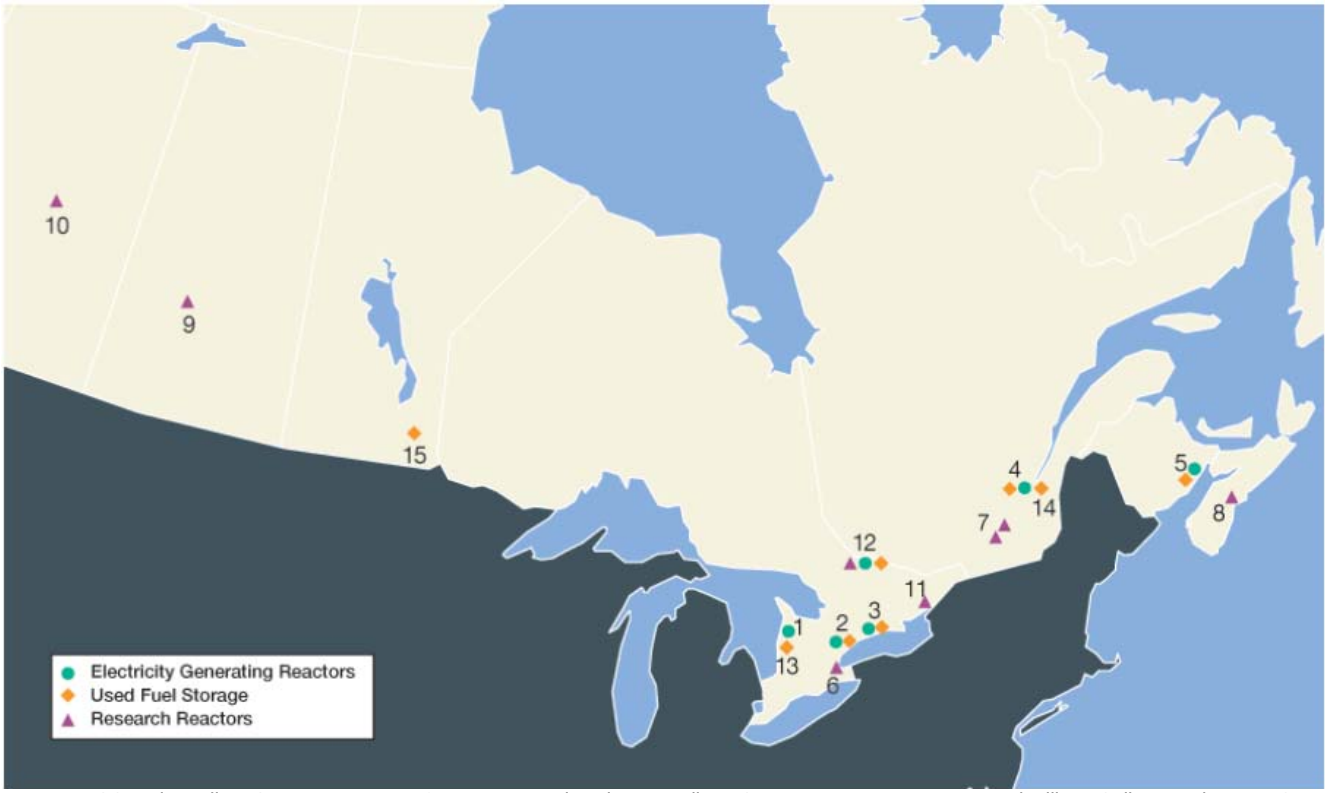
Table 6-1 — Used Fuel Bundles at Canadian Nuclear Facilities as of December 31, 2004

Nuclear Facility – Owner	Province	Number in Reactor	Number in Wet Storage	Number in Dry Storage	Total
Bruce A – Bruce Power	Ontario	12,480	361,271		373,751
Bruce B – Bruce Power	Ontario	24,575	369,344	29,184	423,103
Pickering – OPG	Ontario	36,744	382,332	135,927	555,003
Darlington – OPG	Ontario	24,960	256,068		281,028
Douglas Point – AECL	Ontario			22,256	22,256
Chalk River – AECL	Ontario			4,853	4,853
Gentilly 1 – AECL	Quebec			3,213	3,213
Gentilly 2 – HQ	Quebec	4,560	33,814	60,000	98,374
Point Lepreau – AECL	New Brunswick	4,560	39,482	63,180	111,562
Whiteshell – AECL	Manitoba			360	360
Total		107,879	1,442,311	318,973	1,873,503

Source: Table A7-1, NWMO Draft Study Report

These locations, along with the locations of other nuclear reactor sites, are shown on the following figure:

Figure 6-1 — Locations of Nuclear Reactor Sites in Canada



1. Bruce NGS – Kincardine, ON
2. Pickering NGS – Pickering, ON
3. Darlington NGS – Clarington, ON
4. Gentilly 2 NGS – Bécancour, PQ
5. Point Lepreau NGS – Musquash, NB
6. McMaster University – Hamilton, ON
7. École Polytechnique – Montréal, PQ
8. Dalhousie University – Halifax, NS
9. Saskatchewan Research Council – Saskatoon, SK
10. University of Alberta – Edmonton, AB
11. Royal Military College – Kingston, ON
12. AECL CRL – Chalk River, ON
13. AECL Douglas Point – Kincardine, ON
14. AECL Gentilly 1 – Montréal PQ
15. AECL Whiteshell Labs – Pinawa, MB

Source: Figure A7-1, NWMO Draft Study Report.

Table 6-2 — Current Projected Fuel Bundles and Percentages by Waste Owner

Company	No. of bundles	Percentage of bundles
Ontario Power Generation Inc.	1,746,410	88.21
NB Power Nuclear	103,436	5.22
Hydro-Québec	99,245	5.01
Atomic Energy of Canada Limited	30,682	1.55
Total	**1,979,773**	**100.0**

Source: Table 4-13, NWMO Draft Study Report.

Notes:

Number of fuel bundles based on 2005 year-end predictions. Expected totals are through 2005.

Used fuel inventory is expected to be 3.6 million used fuel bundles based on a 40-year reactor operating life. Sensitivity analyses were performed for 30-year and 50-year lifetimes.

The NFWA requires electricity generating companies that produce used nuclear fuel to—

- Establish a waste management organization to provide recommendations to the Government of Canada on the long-term management of used nuclear fuel and
- Establish segregated trust funds to finance the long-term management of the used fuel.

The NFWA requires the waste management organization to—

- Establish an Advisory Council whose comments on the waste management organization's study and reports will be made public and
- Within three years of the legislation coming into force, submit to the Minister of Natural Resources proposed approaches for the management of used nuclear fuel, along with comments of the Advisory Council, and a recommended approach.

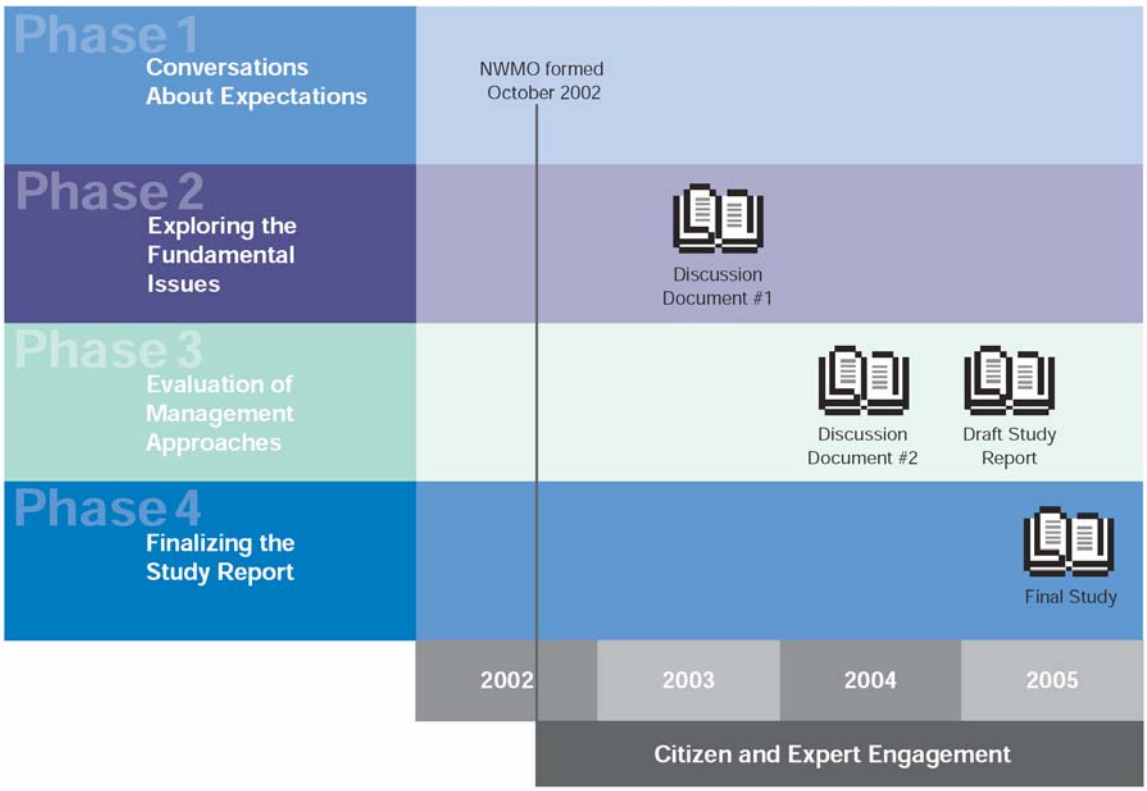
The legislation authorizes the Government of Canada to decide on the approach. The government's choice will then be implemented by the NWMO, subject to all of the necessary regulatory approvals. The Nuclear Fuel Waste Act is the most recent milestone in a 25-year program to identify and implement a long-term management approach for used nuclear fuel in Canada. The legislation represents, in part, the Government of Canada's response to the Nuclear Fuel Waste Management and Disposal Concept Environmental Assessment Panel, which was chaired by Mr. Blair Seaborn and which reported in March 1998. The law entered into force on November 15, 2002.

The NWMO's process to determine a recommended management approach includes the release of the following documents:

- **Discussion Document 1 – Asking the Right Questions** (November 2003) initiated the dialogue with Canadians about the long-term management of used nuclear fuel.
- **Discussion Document 2 – Understanding the Choices** (September 2004) provided an initial assessment of the three management options being considered.
- **Draft Study Report – Choosing a Way Forward** (Early 2005) provided a more detailed assessment of management options, proposed implementation strategies, and provided draft recommendations.
- **Final Study Report – Choosing a Way Forward** (November 2005) will provide the final assessment of the management options and recommend an approach for the long term management of Canada's used nuclear fuel.

The process and phases used by the NWMO are summarized in the Draft Study Report:

Figure 6-2 — NWMO Study Plan



Source: Figure 2-1, NWMO Draft Study Report.

In addition to these papers, the NWMO has developed and posted many other documents as part of their current work to arrive at a recommended approach. These additional documents include a series of background papers that present concepts and contextual information about the state of knowledge on important topics related to the management of radioactive waste. The intent of these background papers is to provide input to defining possible approaches for the long-term management of used nuclear fuel and to contribute to an informed dialogue with the public and other stakeholders. The papers currently available are posted on the NWMO's web site (http://www.nwmo.ca).

The current assessment framework is derived from the original 10 questions discussed in the NWMO's Discussion Document 1, *Asking the Right Questions*:

1. Does the management approach have a foundation of rules, incentives, programs, and capacities that ensure all operational consequences will be addressed for many years to come?

2. Does the management approach provide for deliberate and full public engagement through different phases of the implementation?
3. Have aboriginal perspectives and insights informed the direction and influenced the development of the management approach?
4. Is the process for selecting, assessing, and implementing the management approach one that is fair and equitable to our generation and future generations?
5. When considered together, do the different components of the assessment suggest that the management approach will contribute to an overall improvement in human and ecosystem well-being over the long-term?
6. Does the management approach ensure that people's health, safety, and well-being are maintained (or improved) now and over the long-term?
7. Does the management approach contribute adequately to human security? Will it result in reduced access to nuclear materials by terrorists or other unauthorized agents?
8. Does the management approach ensure the long-term integrity of the environment?
9. Is the economic viability of the management approach assured and will the economy of the community (and future communities) be maintained or improved as a result?
10. Is the technical adequacy of the management approach assured and are design, construction and implementation of the method(s) used by it based on the best available technical and scientific insight?

To help with the comparative analysis of alternate approaches, the NWMO put together a multi-disciplinary Assessment Team and asked them to develop an assessment framework based on these ten questions. The NWMO Assessment Team issued its report in June 2004.

Based on the NWMO's engagement with Canadians and its research and analysis activities, the Assessment Team converted the original ten questions into eight objectives and associated guiding principles and influences, which comprise the assessment framework. These are summarized below:

- **Fairness.** Capacity to ensure fairness in the distribution of costs, benefits, and risks: process and substance.
- **Public Health and Safety.** Capacity to ensure public health and safety.
- **Worker Health and Safety.** Capacity to ensure worker health and safety.
- **Community Well-being.** Capacity to ensure community well-being.
- **Security.** Capacity to ensure security of materials, facilities, and infrastructure.
- **Environmental Integrity.** Capacity to ensure environmental integrity.

- **Economic Viability.** Capacity to ensure economic viability.
- **Adaptability.** Capacity to adapt to changing conditions over time.

6.3 PRIMARY LONG-TERM MANAGEMENT OPTIONS

Three primary long-term management options were originally evaluated:

- **Deep Geological Disposal.** After a monitoring period, the central facility is closed with no intent to retrieve fuel.
- **Storage at Nuclear Reactor Sites.** Facilities are maintained, rebuilt, and operated in perpetuity at reactor sites.
- **Centralized Storage.** Facilities are maintained, rebuilt, and operated in perpetuity at a central location.

In the discussion of these different long-term management options, note the difference between "storage" and "disposal." Storage refers to managing the waste in a manner that allows access under controlled conditions for retrieval or future activities, while disposal is conclusive without any intention of retrieval or further use.

These three options are discussed individually below.

6.3.1 Option 1: Deep Geological Disposal

The deep geological repository option relies on natural and engineered barriers to isolate the used fuel from the surface environment over its hazardous lifetime. Key steps in this option are the following:

- Used nuclear fuel is transported from the nuclear reactor sites to a central location for long-term management.
- Used nuclear fuel is managed over the long term through containment and isolation in a deep geologic repository in the crystalline rock of the Canadian Shield.
- The deep geologic repository is based on the concept described by Atomic Energy of Canada Limited in the Environmental Impact Statement on the Concept for Disposal of Canada's Nuclear Fuel Waste, and modified to take into account the views of the environmental assessment panel as reported in February 1998.
- Following an interim period of monitoring, the repository is closed, without the intent to retrieve the used fuel.

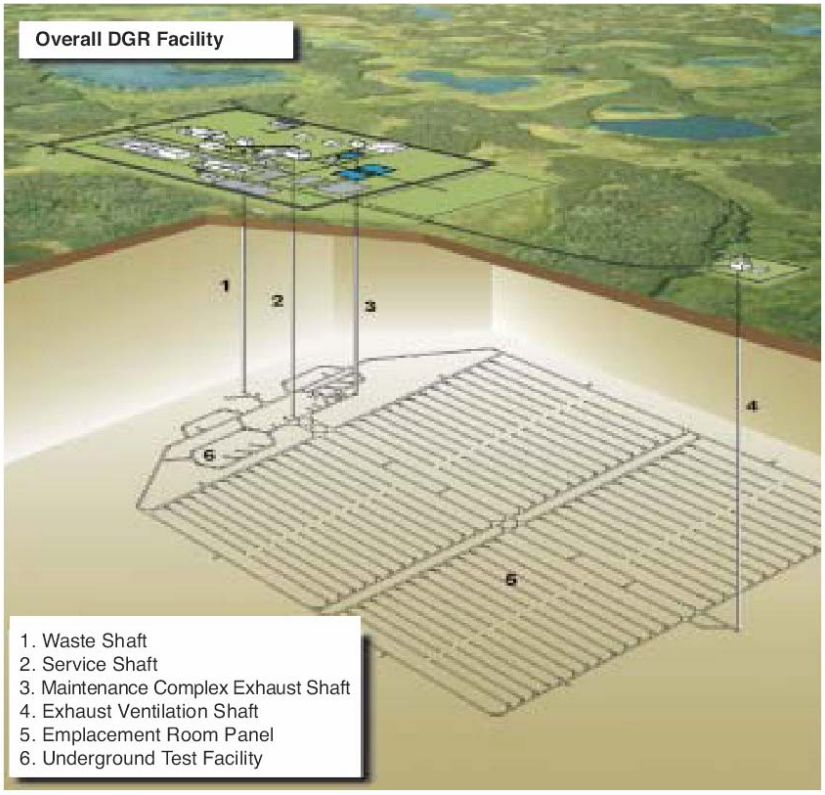
The facility would be monitored for an extended period of time to confirm the performance and safety of the system before final sealing, decommissioning, and closure of the repository. Extended monitoring of the used

fuel containers, sealing systems, rock around the repository, underground water flows, and the natural environment would be conducted to confirm the long-term safety and performance of the system.

Closure activities include removal and sealing of monitoring instruments and returning the site to greenfield conditions. There is the option of continued post-closure monitoring, should society at the time require this provision. Following closure of the deep repository, maintenance, inspection, and security-related operations would be minimal. Such a facility would be designed to be passively safe over the long term and not rely on institutional controls to ensure safety.

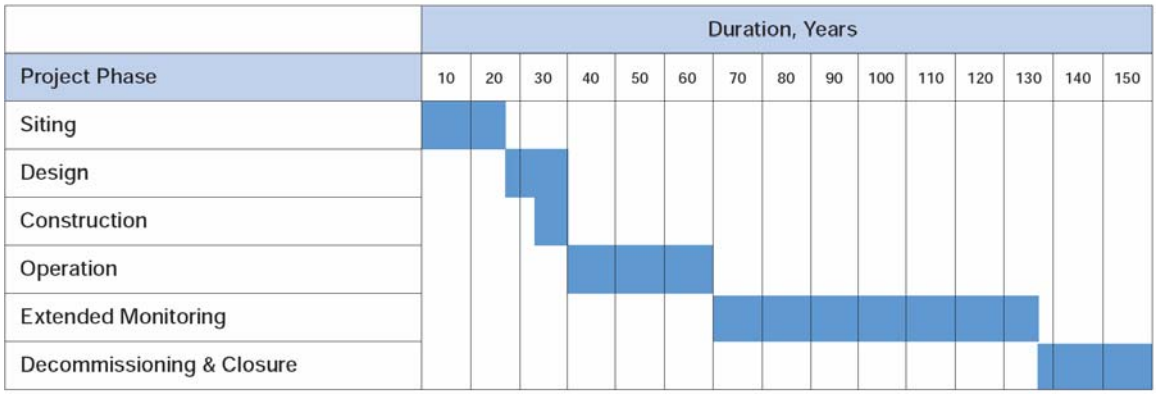
This option is shown schematically in Figure 6-3; the anticipated schedule is shown in Figure 6-4.

Figure 6-3 — Deep Geological Disposal in the Canadian Shield



Source: Figure 4-1, NWMO Draft Study Report

Figure 6-4 — Overall Work Schedule for Deep Geological Disposal in the Canadian Shield



Source: Figure 4-14, NWMO Draft Study Report

6.3.2 Option 2: Storage at Nuclear Reactor Sites

This storage option elects long-term management of used nuclear fuel in storage facilities, at or just below surface, at each nuclear reactor site in Canada. The storage facilities would be maintained, rebuilt, and operated in perpetuity at each reactor site.

Long-term storage at existing reactor sites would involve the expansion of existing dry storage facilities or the establishment of new, long-term dry storage facilities at each of the seven used fuel storage sites in Canada.

No off-site transportation of used fuel is required for extended storage at nuclear reactor sites.

Once all the used fuel from the reactor site was placed in the long-term storage facility, it would require ongoing monitoring to ensure that the facility was being safely maintained and to ensure preventive maintenance and repair. Eventually the storage containers and buildings would need to be replaced. This would involve construction of new storage buildings, transfer of the used fuel from the long-term storage containers to new packages, and transfer of the containers to the new buildings. The old buildings and waste storage containers would need to be refurbished or demolished. These activities would take approximately 30 years, and repackaging of the fuel is assumed to be repeated every 100 years.

Examples of the facilities are shown in Figure 6-5; the anticipated schedule is shown in Figure 6-6.

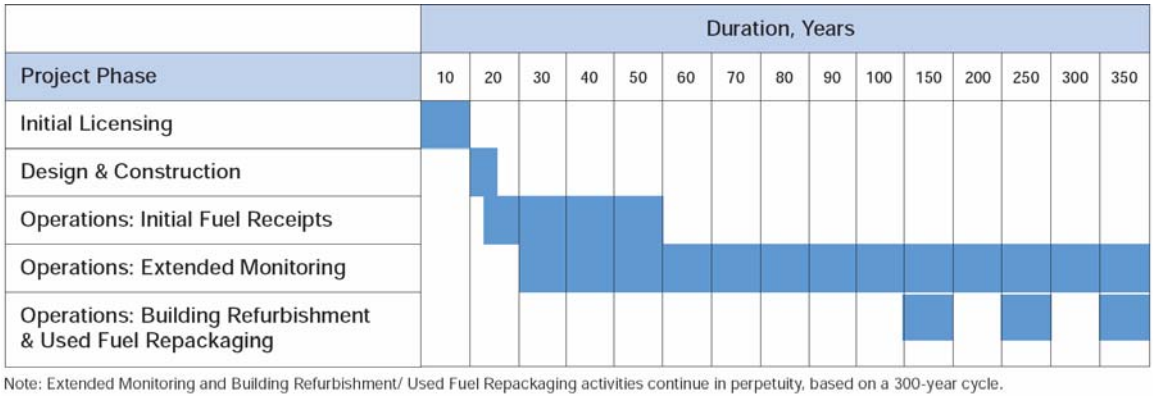
Figure 6-5 — Examples of Used Fuel in Dry Storage at Reactor Sites

Surface Storage Building

Dry Storage Containers

Source: Figures 4-3 and 4-4, NWMO Draft Study Report.

Figure 6-6 — Overall Work Schedule for the Storage at Nuclear Reactor Sites



Note: Extended Monitoring and Building Refurbishment/ Used Fuel Repackaging activities continue in perpetuity, based on a 300-year cycle.

Source: Figure 4-16, NWMO Draft Study Report.

6.3.3 Option 3: Centralized Storage

The centralized storage option envisions long-term management of used nuclear fuel in a storage facility, above or just below ground, at a central site in Canada. The used nuclear fuel would be transported from the nuclear

reactor sites to this central location for long-term management, and then the storage facility would be maintained, rebuilt, and operated in perpetuity at this central site.

New, long-term storage facilities would need to be created at a central location. This newly designed facility would receive used fuel from the seven interim storage sites in Canada. Once all the used fuel is transferred to the long-term storage facilities, ongoing maintenance, inspections, and security systems would be required.

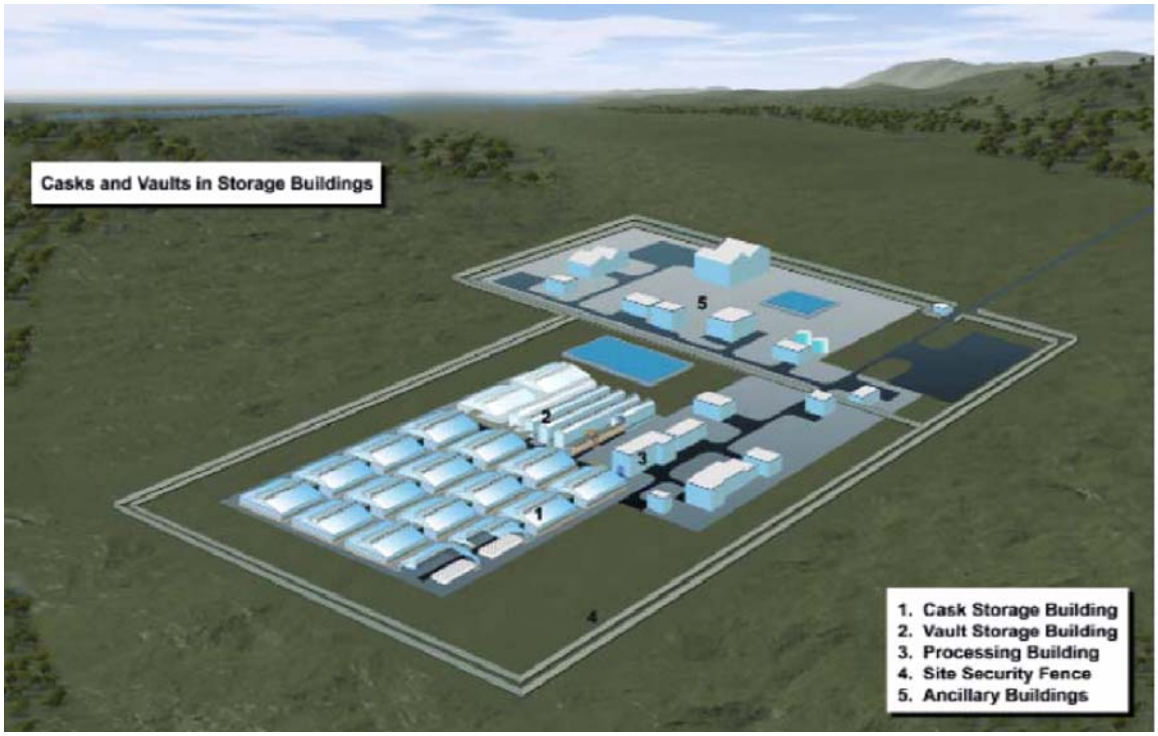
Storage would require an ongoing program of regular replacement and refurbishing activities, as facilities would be renewed and expanded indefinitely. The operation would require ongoing preventive maintenance and repair, as well as continuous monitoring to ensure that facility safety was being maintained.

The storage containers and storage facilities are designed to last at least 100 years. Based on current design assumptions, complete refurbishment of all components and repackaging of the entire fuel storage system is assumed to be repeated every 300 years.

The long-term storage facilities would be designed to allow safe retrieval of used nuclear fuel at any point during the service life of the facility. If the storage systems did not perform as expected, they could be repaired, or the fuel could be transferred to a new storage facility.

This option is shown schematically in Figure 6-7; the anticipated schedule is shown in Figure 6-8.

Figure 6-7 — Centralized Storage – Above Ground



Source: Figure 4-5, NWMO Draft Study Report.

Figure 6-8 — Overall Work Schedule for Centralized Storage

	Duration, Years														
Project Phase	10	20	30	40	50	60	70	80	90	100	150	200	250	300	350
Siting & Licensing	■	■													
Design & Construction		■													
Operations: Fuel Receipts			■	■	■										
Operations: Extended Monitoring						■	■	■	■	■	■	■	■	■	■
Operations: Building Refurbishment Repackaging											■		■		■

Note: Extended monitoring and building refurbishment/ repackaging activities continue in perpetuity, based on a 300-year cycle.

Source: Figure 4-18, NWMO Draft Study Report.

Last page of Section 6.

Appendix A
NWMO References

NWMO Background Papers

2.6 *A Review of Waste Facility Siting Case Studies Applicable to Spent Nuclear Fuel Management Facilities and Associated Infrastructure*. DPRA Inc. March 2005. [http://www.nwmo.ca/Default.aspx?DN=1173,207,199,20,1,Documents]

9.1 *Assessing the Options: Future Management of Used Nuclear Fuel in Canada*. Assessment Team Report. June 2004. [http://www.nwmo.ca/default.aspx?DN=1091,1090,199,20,1,Documents]

9.2a *Assessment of Benefits, Risks and Costs of Management Approaches for used Nuclear Fuel by Illustrative Economic Region: Technical Report*. Golder Associates Ltd., Gartner Lee Limited. February 2005. [http://www.nwmo.ca/default.aspx?DN=1231,1090,199,20,1,Documents]

9.2b *Assessment of Benefits, Risks and Costs of a Proposed Adaptive Phased Management Approach by Illustrative Economic Region: Supplemental Report*. Golder Associates Ltd., Gartner Lee Limited. April 2005. [http://www.nwmo.ca/default.aspx?DN=1231,1090,199,20,1,Documents]

9.3 *A Review of Possible Measures to Avoid or Minimize Significant Socio-Economic Effects on a Community's Way of Life*. Golder Associates Ltd., Gartner Lee Limited. April 2005. [http://www.nwmo.ca/default.aspx?DN=1232,1090,199,20,1,Documents]

NWMO Discussion Documents

Discussion Document 1. *Asking the Right Questions? The Future Management of Canada's Used Nuclear Fuel*. [http://www.nwmo.ca/default.aspx?DN=1027,1026,20,1,Documents]

Discussion Document 2. *Understanding the Choices: The Future Management of Canada's Used Nuclear Fuel*. [http://www.nwmo.ca/default.aspx?DN=1067,1026,20,1,Documents]

Draft Study Report. *Choosing a Way Forward: The Future Management of Canada's Used Nuclear Fuel*. [http://www.nwmo.ca/Default.aspx?DN=1224,1026,20,1,Documents]

Executive Summary Draft Study Report. *Choosing a Way Forward: The Future Management of Canada's Used Nuclear Fuel*. [http://www.nwmo.ca/adx/asp/adxGetMedia.asp?DocID=1224,1026,20,1,Documents&MediaID=2342&Filename=NWMO_DSR_Exec_Summary_E.pdf]

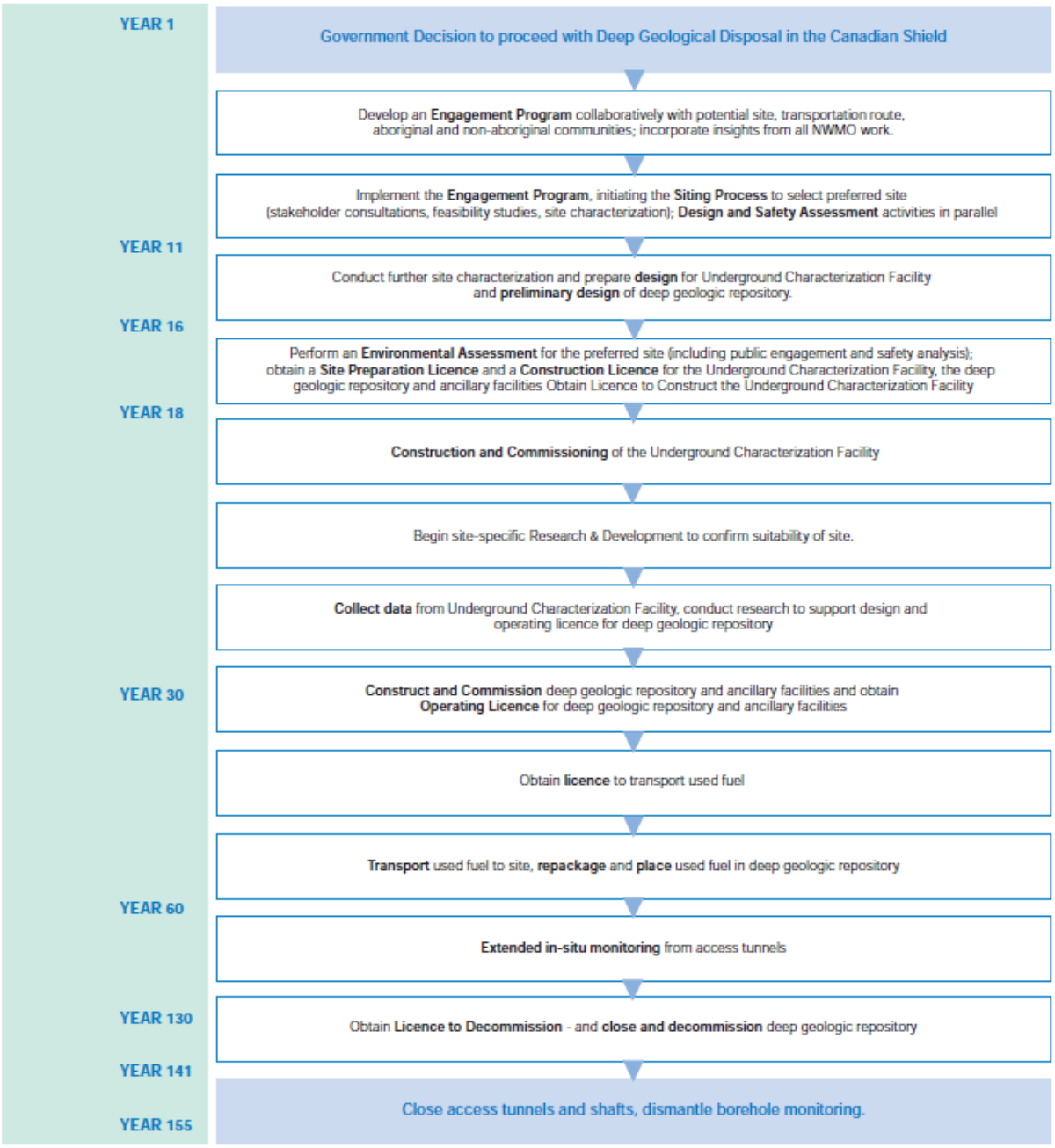
Other

Independent Peer Review of NWMO Discussion Document 2, "Understanding the Choices". Prepared for Canadian Association of Nuclear Host Communities by Acres–Sargent & Lundy (ASL), Report SL-008414, December 2004. [http://www.nwmo.ca/default.aspx?DN=1199,349,86,21,1,Documents]

Appendix B

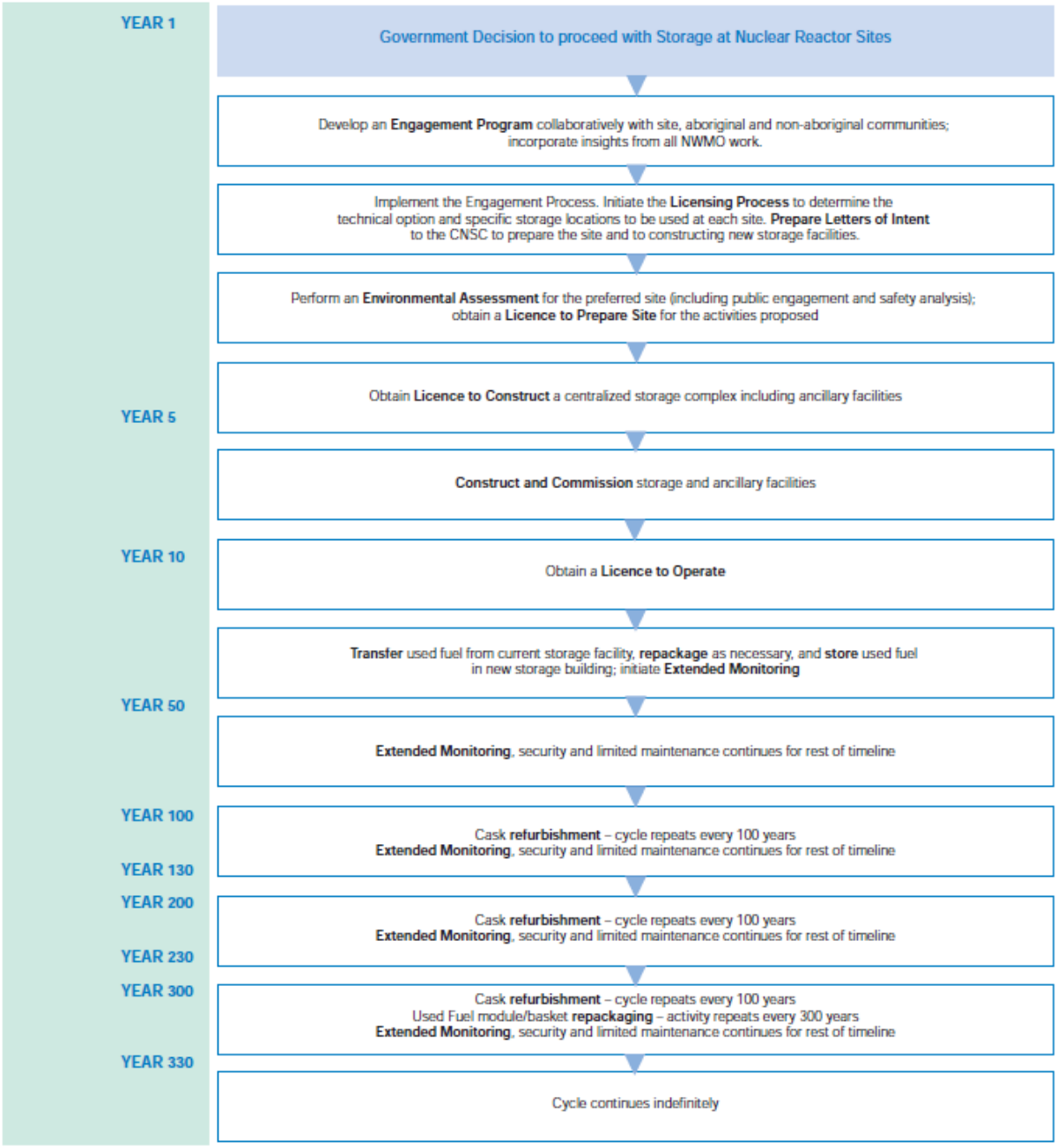
Activity Flow Charts for the Optional Management Approaches

Figure 4-15 Activity Flowchart for Deep Geological Disposal in the Canadian Shield



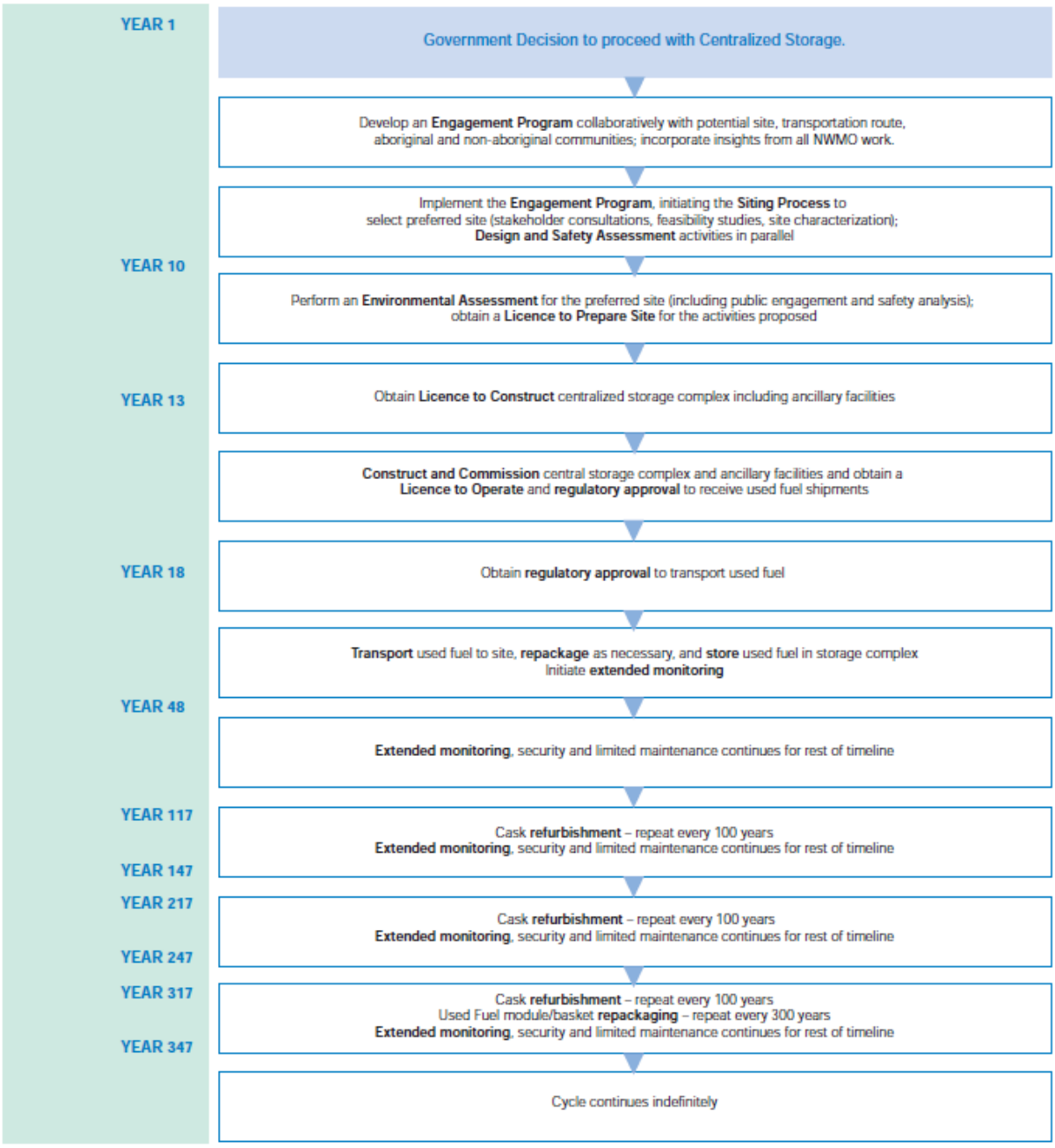
Source: NWMO Draft Study Report

Figure 4-17 Activity Flowchart for Storage at Nuclear Reactor Sites



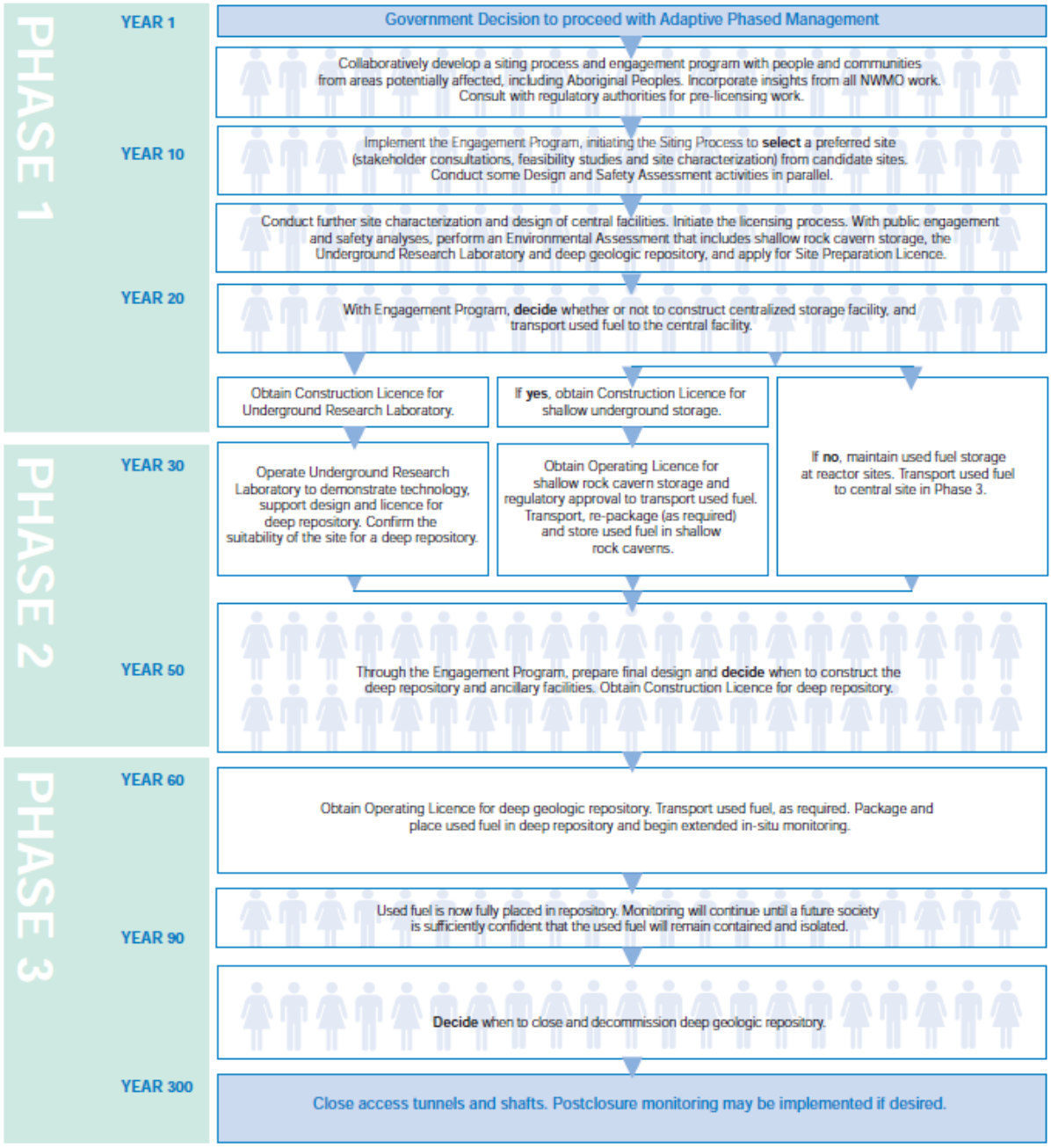
Source: NWMO Draft Study Report

Figure 4-19 Activity Flowchart for Centralized Storage



Source: NWMO Draft Study Report

Figure 4-21 Activity Flow Chart for Adaptive Phased Management



Source: NWMO Draft Study Report