



METHODS FOR EVALUATING INDUCED DEVELOPMENT IMPACTS

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DEFINITIONS AND ABBREVIATIONS

%	Percent
Agent-Based Modelling and Simulation	A type of simulation modelling that predicts interactions of components within the environment
BCFD	Billion cubic feet per day
CARC	Canadian Arctic Resources Committee
CCME	Canadian Council of Ministers of the Environment
Cumulative effects	The combined effects that human activities and natural processes have on the environment
Cumulative effects assessment	An evaluation conducted as part of an Environmental Assessment to evaluate a project's potential impacts in relation to other projects and developments that overlap spatially and temporally
Delphi analysis	Systematic process for collecting informed judgments, usually from experts, regarding a set of variables to reach a consensus
Discrete-Event Modelling and Simulation	A type of simulation modelling that represents a sequence of events in a complex system
Drivers of change	Processes that result in different outcomes for the scenarios
EA	Environmental assessment: a regulatory process used in Canada to evaluate the potential impacts of development projects and decide whether they should proceed
Focal issue	The main concern identified for a scenario analysis
GIS	Geographic Information System
GNWT	Government of Northwest Territories
Induced development	Any physical activity required for a project to proceed or a physical activity that is facilitated by the development or completion of another project
km	kilometres
MVEIRB	Mackenzie Valley Environmental Impact Review Board
NU	Nunavut

NWT	Northwest Territories
Qualitative data	Non-numerical information
Qualitative method	A method that uses non-numerical information, narrative descriptions to evaluate induced development
Qualitative trend analysis	Using non-numerical information about past or present conditions to understand potential future conditions
Quantitative data	Numerical information
Quantitative method	A method that uses numerical information to evaluate and quantify induced development impacts
Quantitative trend extrapolation	Evaluation of past or present numerical data using simple techniques to project future conditions
Regional-strategic environmental assessment	Defined by the CCME as "a process designed to systematically assess the potential environmental effects, including cumulative effects, of alternative strategic initiatives, policies, plans, or programs for a particular region." (CCME, 2009)
Scenario	Description of possible images of the future
Scenario Analysis	The structured and rigorous process for developing and evaluating scenarios
Scenario implications	The consequences of the scenarios, either described quantitatively using numerical information or qualitatively using words and/or images
Scenario logics	Factors that influence the scenarios, including drivers of change and uncertainties
SEA	Strategic environmental assessment
Simulation modelling	Development of a tool to forecast environmental conditions and impacts based on the characteristics and behaviours of a system using numerical information
Stakeholder	Parties interested in or impacted by a project or with legal obligation related to a project
System Dynamics Modelling and Simulation	A type of simulation modelling that describes continuous changes in variables over time
Terms of Reference	A document that specifies the information to be included during the EA process in NWT, such as temporal and spatial scope of the EA.
Traditional knowledge	Knowledge and values, which have been acquired through experience, observation, from the land or from spiritual teachings, and handed down from one generation to another

Uncertainties	Unknown aspects about the drivers of change and future conditions
Valued component	Defined by the Impact Assessment Agency as "components that are of particular concern or value to participants and that may be affected by the project" (Impact Assessment Agency of Canada, 2022)
YK	Yukon

1.0 INTRODUCTION

The Government of the Northwest Territories (GNWT) Cumulative Impact Monitoring Program has contracted ARKTIS Solutions Inc. (ARKTIS) to conduct research regarding methods for evaluating the effects of induced development. Induced development is any physical activity required for a project to proceed (e.g., a rail to allow transport of ore as part of a mining project) or a physical activity that is facilitated by the development or completion of another project (e.g., building new communities in previously inaccessible areas following the development of new roads) (Impact Assessment Agency of Canada, 2018). In northern Canada, induced development may have differing impacts from southern regions that are more developed. For example, construction of new all-season roads may facilitate access to remote areas that were formerly inaccessible, allowing for increased hunting and trapping activities. Assessment of induced development impacts has become increasingly important in northern Canada with the increasing development of roads (e.g., Tibbitt to Contwoyto Winter Road), seaports (e.g., Milne Inlet and Steensby Inlet at the Mary River Mine), oil and gas projects (e.g., Inuvialuit Energy Security Project), and mining projects (e.g., NICO Cobalt-Gold-Bismuth-Copper Project) in the Canadian territories.

Within this scope of work, ARKTIS has completed a review of academic literature, guidance documents, and case studies to identify and evaluate the methods for considering impacts of induced development during the Environmental Assessment (EA) or similar processes such as regional-strategic environmental assessments that consider a broader spatial scale. EA is a regulatory process used in Canada to evaluate the potential impacts of development projects and decide whether they should proceed (Impact Assessment Agency of Canada, 2023a).

Cumulative effects assessments are conducted as part of the EA process to evaluate a project's potential impacts in relation to other projects and developments that overlap spatially and temporally (Impact Assessment Agency of Canada, 2018; Mackenzie Valley Environmental Impact Review Board (MVEIRB), 2004). The cumulative effects assessment for an EA is described by the *Operational Policy Statement on Assessing Cumulative Environmental Effects under the Canadian Environmental Assessment Act, 2012* and includes five key steps: scoping, analysis, mitigation, significance, and follow up (Impact Assessment Agency of Canada, 2015). Guidance is available for assessing cumulative effects (e.g., *Technical Guidance for Assessing Cumulative Environmental Effects under the Canadian Environmental Assessment Act, 2012*); however, the guidelines allow for and suggest different methods to be applied given the project and impacts (Impact Assessment Agency of Canada, 2018).

Evaluation of induced development impacts are incorporated into cumulative effects assessments as part of the EA process and can be considered during the stages of scoping, analysis, mitigation, significance, and follow-up (AXYS Environmental Consulting Ltd., 1999; Impact Assessment Agency of Canada, 2018). However, existing guidance documents do not define a method to identify and evaluate the induced development activities that may occur for a project. Evaluation of induced development impacts is further complicated by the limited data available to understand the impacts of future activities that may be induced by the project. For example, in the case of increased hunting and trapping in a previously inaccessible region following road development, the number of future hunters and trappers accessing the land would need to be estimated or assumed to evaluate potential environmental and social impacts. Identified herein are best practices for evaluating induced development impacts in EA through review of guidance documents, literature, and case studies.

The purpose of this report is to document the outcomes of the review and evaluation of methods for evaluating induced development impacts. The objectives of this research are to:

1. Identify and describe the methods for evaluating induced development impacts from review of guidance documents and literature with a focus on quantitative methods (i.e., methods that use numerical information to evaluate and quantify induced development impacts).
2. Identify case studies in northern Canada that evaluated induced development as part of the EA process and evaluate the methods used to consider induced development impacts and the merit of these methods.
3. Provide recommendations regarding the applicability and use of methods for evaluating induced development impacts.

This report is structured as follows:

- Section 1: Introduction – description of scope of work, objectives, and report structure.
- Section 2: Methodology – description of steps that were completed to identify and evaluate methods and case studies that evaluate induced development impacts.
- Section 3: Results – summary of the outcomes of the research, including methods for evaluating induced development impacts and case studies that evaluated induced development.
- Section 4: Conclusions and Recommendations – identification of recommendations as an outcome of the method and case study evaluation.

2.0 METHODOLOGY

This section describes the methodology that was used to identify and evaluate methods for considering induced development impacts in an EA. The methodology consists of three main steps:

1. Review of guidance documents and literature to identify methods for evaluating induced development impacts (Section 2.1).
2. Identification of northern case studies that evaluate induced development impacts for detailed review and evaluation (Section 2.2).
3. Detailed review and evaluation of case studies to evaluate the merit of methods used to evaluate induced development impacts (Section 2.2).

2.1 Review of Guidance Documents and Literature

Guidance documents and literature describing the evaluation of induced development impacts were reviewed to identify the methods for evaluating induced development impacts. The resources that were reviewed are listed in Section 6.0 and can be generally categorized as follows:

- Canadian guidance documents pertaining to EA and cumulative effects assessment.
- Other guidance and reference documents not specific to Canada.
- Academic papers identified from an online literature search.

Future scenarios¹ were identified early as a common tool for evaluating induced development. For this reason, scenario analysis, the structured process for developing and evaluating scenarios, was the focus of the guidance and literature review. The purpose of focusing on scenario analysis was to provide further guidance to the GNWT regarding how this commonly used method can be used to evaluate induced

¹ Literature speaks to scenarios, future developments, future projects, future conditions, image of the future, or some mix of those terms. As all the terms could be classified as a scenario, and to simplify understanding and limit the number of terms with minor nuances, we have considered all under the same term: scenario.

development impacts. Guidance for using scenario analysis was provided by answering the following three questions:

1. How are scenarios developed?
2. What is a “good” scenario?
3. How many scenarios are needed?

The information collected from the review was consolidated into a table to summarize the methods for evaluating induced development and how they are used, including:

- Whether the method was quantitative (i.e., uses numerical or measurable information to evaluate induced development) or qualitative (i.e., uses non-numerical information and descriptions to evaluate induced development).
- The information needed to apply the method.
- The applicability of the method.
- The pros and cons of using the method.

2.2 Identification, Review, and Evaluation of Case Studies

The purpose of the case study review was to identify northern case studies that evaluated induced development as part of the EA. Project EA documents available on the Northwest Territories (NWT), Nunavut (NU), and Yukon (YK) public registries were identified.

Projects were selected for detailed review if they evaluated induced development impacts and there was sufficient information available online to understand the method of evaluation. Projects with linear infrastructure such as a road, pipeline, or ports were prioritized as these align with the anticipated induced development in the NWT.

A total of four case studies were selected for detailed review and further evaluation of the efficacy of the methods and their applicability for other EAs, particularly those in the NWT. The cumulative effects assessments and other relevant materials (e.g., supplemental reports describing methodology) for these case studies were reviewed in detail to summarize the methods used to evaluate induced development impacts. The methods identified in the case studies were evaluated to identify:

1. Pros and cons of the method.
2. Information required to use the method.
3. How scientific, social, and Traditional Knowledge² was incorporated into the evaluation of induced development.
4. If and how the case study incorporated the guidance for scenario analysis (i.e., the three questions for scenario analysis in Section 2.1).

² Traditional Knowledge is knowledge and values, which have been acquired through experience, observation, from the land or from spiritual teachings, and handed down from one generation to another (Government of the Northwest Territories Traditional Knowledge Policy Implementation Framework, 1997). Traditional Knowledge has been and is currently being created by Indigenous peoples, groups, and organizations, and is inclusive of all knowledge holders. Where possible knowledge will be referred to using the preferred terminology of the knowledge holder or community.

3.0 RESULTS

The results of the review are presented in this section. This section is separated into two subsections:

- Section 3.1 summarizes the outcomes of the guidance document and literature review and illustrates the common process of developing scenario(s) for evaluating induced development, including the considerations that make a 'good' scenario, and how many scenarios should be developed. Alternative methods that can be used to evaluate induced development and how they relate to scenarios are also discussed.
- Section 3.2 expands into a detailed review of selected case studies that evaluated induced development impacts, applying the literature review outcomes from Section 3.1. Key learnings for each case study are presented in this section.

3.1 Outcomes of the Guidance and Literature Review

Canadian guidance documents do not require a specific method for evaluating induced development impacts in an EA and/or cumulative effects assessment (Impact Assessment Agency of Canada, 2018; MVEIRB, 2004). The Impact Assessment Agency of Canada and MVEIRB provide some guidance on how induced development may be considered in an EA and/or cumulative effects assessment but this guidance is not prescriptive (AXYS Environmental Consulting Ltd., 1999; MVEIRB, 2004). Federally, induced development activities can be identified during the scoping stage of a cumulative effects assessment based on the certain or most likely future scenario (AXYS Environmental Consulting Ltd., 1999). The MVEIRB guidelines suggest looking at “comparable developments in areas with similar characteristics” to identify potential impacts from induced development activities (MVEIRB, 2004). Both identify that the most likely future scenario and comparable developments in areas with similar characteristics should be considered standard when evaluating induced development.

Regional-strategic environmental assessments may also be used to identify and evaluate future impacts of a project (AXYS Environmental Consulting Ltd., 1999; CCME, 2009); however, they are not specific to induced development. The Canadian Council of Ministers of the Environment (CCME) defines regional-strategic environmental assessments as “a process designed to systematically assess the potential environmental effects, including cumulative effects, of alternative strategic initiatives, policies, plans, or programs for a particular region” (CCME, 2009). Thus, regional-strategic environmental assessments are implemented to evaluate multiple developments that could occur in a geographic region, including induced development, rather than an individual project.

Most literature reviewed points to the development of scenarios to evaluate the impacts of induced development (e.g., Ash et al., 2010; Cardinale & Greig, 2013; Duinker & Greig, 2007). Scenario analysis was commonly regarded as a best practice for evaluating future development in an EA context as it considers multiple alternative futures that can aid in understanding uncertainty in future impacts and management strategies (Blakley & Franks, 2021; Strömmer & Ormiston, 2022). Scenario analysis was commonly used in case studies in literature (e.g. Russell et al., 2021) and in cumulative effects assessments for projects in northern Canada (see Section 3.2). An example of scenario analysis for evaluating induced development is provided in Figure 3-1, based on the scenario analysis performed for the Mackenzie Gas Project in NWT (Cizek, 2005) and adapted from the method described by Zhu et al. (2011).

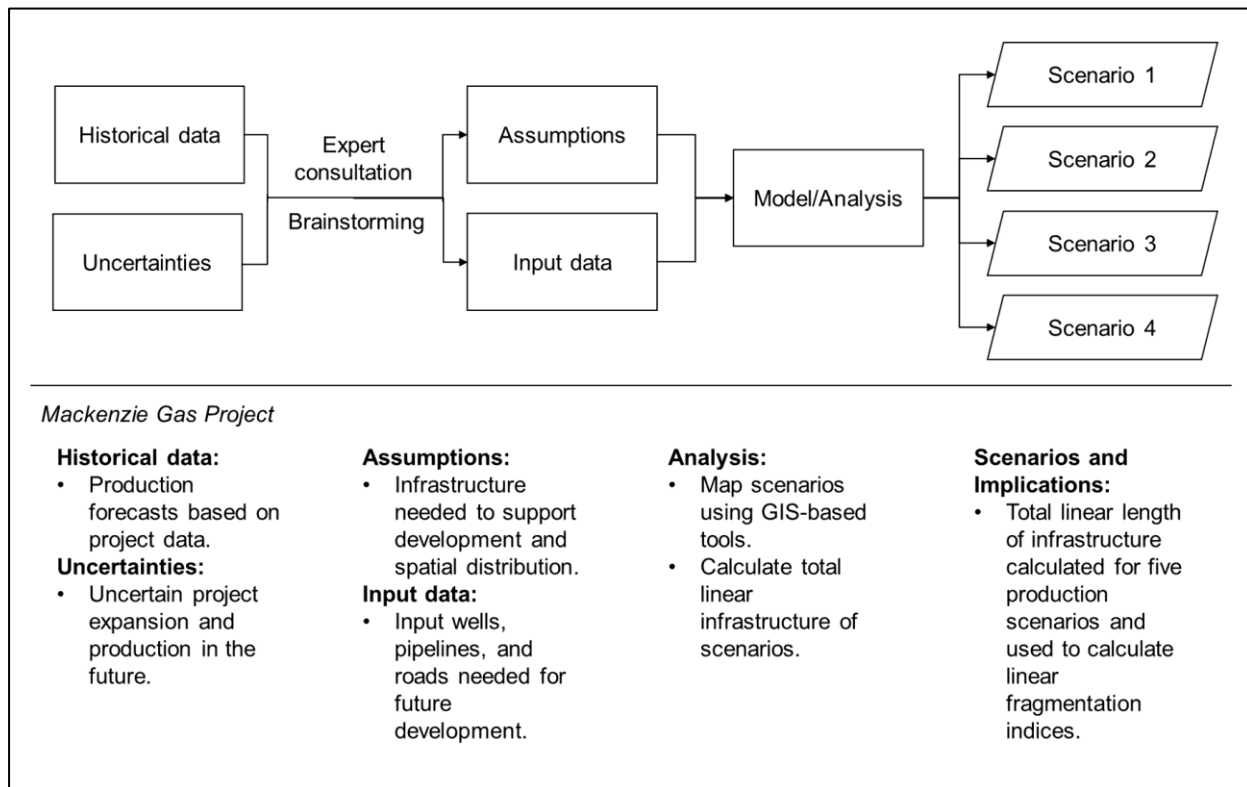


Figure 3-1. Scenario analysis for the Mackenzie Gas Project (Cizek, 2005), adapted from Zhu et al. (2011) and references therein.

Although alternative methods for evaluating induced development impacts have been identified from the guidance and literature review, these methods relate to scenarios as they result in the development of one or more scenarios (see Section 3.1.3 for more information on these methods). Therefore, the focus of this section is on using scenarios to describe and evaluate induced development, which can then be evaluated in the cumulative effects assessment. How the scenarios are developed and how many scenarios are needed to evaluate induced development varies based on the information available, the scale or context of the project (i.e., is it a federal initiative or a small oil and gas well), and the outcomes of engagement with stakeholders (e.g., Indigenous communities impacted by the project), to name but a few. The following sections summarize answers to those questions, then describe some of the different methods that can be used for evaluating impacts of induced development.

3.1.1 How are good scenarios developed?

There is no prescriptive or common approach to developing scenarios (Tourki et al., 2013). The process to develop scenarios is dependent on the specific project (e.g., development type, location, etc.) and information available (e.g., availability of quantitative data to incorporate into scenarios). For this reason, various types of scenarios may be developed to evaluate induced development, such as quantitative scenarios that use numerical information to describe future conditions and qualitative scenarios that involve non-numerical, narrative descriptions of future conditions (Alcamo et al., 2008).

Scenario analysis is the structured process for developing and evaluating scenarios and has been considered in this section to provide guidance for using scenarios to evaluate induced development impacts. Although scenario analysis is described as a standalone method in the literature, it has been used as the example for developing and evaluating scenarios given that many of the other methods identified in literature (see Section 3.1.3) are either used within a scenario analysis or result in development of one or more scenarios by following similar steps. Although scenario analysis can be applied for a variety of reasons, such as identifying project alternatives in the regulatory process, this section focuses on how scenario analysis can be applied to evaluate induced development.

What makes a scenario good?

Evaluation of induced development impacts is only as good as the scenarios that describe the induced development. Several resources speak to the factors and components that should be considered or included when developing scenarios to ensure they are effective at evaluating induced development impacts. Common components of good scenarios, include:

1. Development of multiple scenarios that are plausible (i.e., it is possible that they occur in the future) (Ash et al., 2010; Duinker & Greig, 2007).
2. Development of scenarios that are informed by looking to similar projects to identify potential induced development activities (AXYS Environmental Consulting Ltd., 1999; MVEIRB, 2004).
3. Scenario descriptions that focus on precision rather than accuracy to avoid ambiguity and provide detailed, meaningful scenarios (Blakley & Franks, 2021).
4. Stakeholder input and expert judgement inform the scenarios (Blakley & Franks, 2021; Guaita García et al., 2020; Liu et al., 2008).
5. Scenario analysis that begins early in the cumulative effects assessment process (i.e., during scoping) to ensure the scenario analysis is not limited by constraints of the EA (Blakley & Franks, 2021).
6. A scenario analysis that is transparent and communicated well to account for uncertainty and the judgement made to develop the scenarios (Ash et al., 2010).

These components of a good scenario should be considered to identify how they can be included in the scenario analysis and to what extent. Although it may not be possible to achieve all these components perfectly, effort should be made to maximize the number of these components included in the scenario analysis to an extent that is reasonably achievable. Transparency and communication will be a key component to achieve to explain and justify how these components have been reasonably achieved. At minimum, scenario analysis should involve multiple, precise scenarios that are well described. Details for how to develop good scenarios are provided throughout Section 3.1.1.

The common steps of scenario analysis that have been identified from the literature review are consolidated in Figure 3-2 (Ash et al., 2010; Blakley & Franks, 2021; Duinker & Greig, 2007; Tourki et al., 2013). The remainder of this section provides details for how the main steps of scenario analysis (Figure 3-2) can be applied to evaluate induced development and how good scenarios are developed.

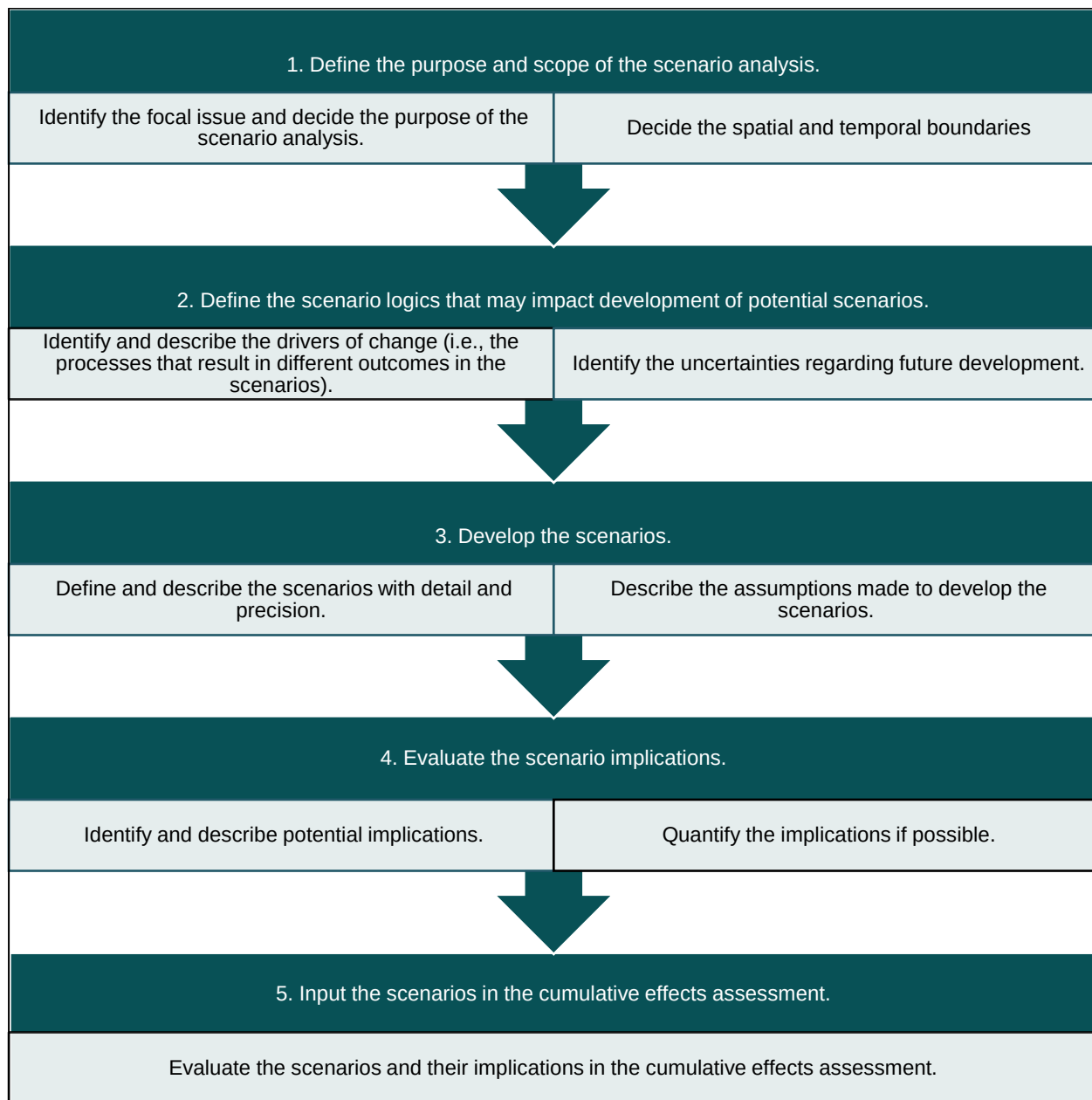


Figure 3-2. General steps of scenario analysis.

Step 1: Define the purpose and scope of the scenario analysis

The first step of scenario analysis involves identifying the focal issue that describes the reason why the scenario analysis is needed and defining the purpose of the scenario analysis. In this step, identify the main concerns for the future with respect to the project and describe the focal issue clearly and objectively (Ash et al., 2010). For an induced development scenario, the main concern could be related to the potential impacts of future developments that may occur as a result of the proposed project or to support the proposed project. For example, Rempel et al. (2021) used five scenarios to characterize the impacts to caribou, wolves, and moose from climate change and development in Ontario; the focal issue that guided this study was the potential for adverse impacts to caribou, wolf, and moose populations that could result from environmental changes from climate change and development (Rempel et al., 2021).

Next, define the spatial and temporal boundaries to constrain the scenario analysis based on the focal issue and purpose (Liu et al., 2008). Refer to the Terms of Reference³ for the EA to identify any requirements for temporal and spatial scope; at minimum the spatial and temporal scope of the scenario analysis should achieve requirements of the Terms of Reference. Consider the main concerns identified for the future and why the scenario analysis is needed to help decide what geographical area and timescale should be included. Spatial scope could be selected based on the proximity of nearby communities or Critical Habitat for priority wildlife, such as the Bathurst Inlet Port and Road case study that used the annual range of barren-ground caribou to guide spatial extents of a scenario (Bathurst Inlet Port and Road Joint Venture Ltd., 2008c; Section 3.2.3).

Select the temporal scope based on the expected time needed for the focal issue to be managed (Ash et al., 2010). Ensure the temporal boundaries of the induced development scenario extend far enough into the future to include the cumulative effects that may occur, consistent with Canadian guidance for cumulative effects scoping for a project (Impact Assessment Agency of Canada, 2018). This will vary based on the project and an evaluation may be needed to understand when the most meaningful impacts are expected to occur for the scenarios. Ensuring that the Terms of Reference are achieved, the minimum temporal scope should include the active phase of the project (e.g., construction and operation).

Consider extending the temporal scope until impacts from the project and its induced development have obtained steady state conditions (no further changes to impacts are expected), if reasonable to do so. For example, a permanent road is an example of a project that may not have a clearly defined project timeline due to the ongoing use and maintenance of roads; in this case, evaluating when steady state conditions are expected for impacts from the road could be used to select the temporal scope of the scenarios.

However, caution should be taken with this approach as the further the scenarios are extended into the future, the greater the uncertainty is associated with the scenarios, which may present challenges for developing and evaluating the scenarios. Use the outcomes of engagement with stakeholders to inform the temporal scope and ensure local and Traditional knowledge is incorporated in the scope development.

To aid selection of temporal and spatial boundaries, scoping of the induced development scenario can be incorporated with early scoping in an EA process to ensure the EA scope is inclusive of potential induced development and does not limit the spatial and temporal boundaries considered for the scenario analysis (Blakley & Franks, 2021). Consider integrating the induced development scenario analysis with the EA and cumulative effects assessment to ensure the cumulative effects assessment and evaluation of induced development is comprehensive and effective for identifying induced development impacts.

Stakeholder Participation in Scenario Analysis

Stakeholder engagement can and should be included in the scenario analysis to incorporate local and Traditional knowledge. Outcomes of stakeholder engagement can inform the purpose, scenario logics, development of scenarios, and evaluation of implications (Reed et al., 2013) and can be used to add context to the results of the scenario analysis (Hallberg-Sramek et al., 2023). Stakeholder engagement can be conducted through workshops and surveys (e.g., Hallberg-Sramek et al., 2023). Delphi analysis, the structured method for collecting information from individuals, can also be used to obtain information from stakeholders (Tourki et al., 2013). Reed et al. (2013) identified several specific participatory methods that can be incorporated into the scenario analysis, such as Soft Systems Analysis that uses informal discussions and structured surveys to understand the scale and scope of issues for a community.

³ Terms of Reference is a document that specifies the information to be included the EA process in NWT, such as temporal and spatial scope of the EA (MVEIRB, 2004).

Consider implementing participatory methods (e.g., workshops) in Step 1 to incorporate stakeholder input into developing the purpose and scope of the scenario analysis, including through identifying the focal issue, defining the purpose of the scenario analysis, and selecting appropriate spatial and temporal boundaries to address stakeholders' concerns (Tourki et al., 2013). It is critical that in this step, and all steps of the scenario analysis, that all decisions and justifications are clearly described to support the scenario analysis.

Before proceeding to Step 2, ensure the following key questions are answered:

1. Has the focal issue been identified?
2. Has the purpose of the scenario analysis been clearly described?
3. Have the temporal and spatial boundaries of the scenario analysis been clearly defined and justified?
4. Has scoping been incorporated early in the EA to ensure the temporal and spatial scope is not limited by that of the EA?
5. Has stakeholder input been considered and/or incorporated into this step?

Step 2: Define the scenario logics that may impact development of potential scenarios.

Scenario logics can be thought of as the framework for which the scenarios are built upon; they are the factors that influence the scenarios, including the drivers of change (i.e., processes that result in different outcomes for the scenarios) and uncertainties (Khosravi & Jha-Thakur, 2019). In Step 2, identify and describe the drivers of change and uncertainties that should be incorporated in the scenarios (Khosravi & Jha-Thakur, 2019), as well as the possible magnitude and trajectories for the drivers of change and how they may impact the resulting scenarios considered (Ash et al., 2010). Use the scenario logics to decide the number of scenarios to develop (Ash et al., 2010). Section 3.1.2 provides detailed guidance regarding the number of scenarios. It is good practice to develop multiple scenarios to avoid focusing on what is most likely to occur as the future is uncertain and alternative outcomes are possible (Ash et al., 2010).

Drivers of change are processes that result in different future outcomes such as regulatory processes, direct and indirect impacts of climate change, economic development, and human behaviours. For induced development scenarios, consider drivers of change that impact whether induced development occurs and the extent to which it occurs. For example, the Environmental Impact Assessment process in the NWT decides whether a project may proceed or not, such as additional road development or mine development following development of a road in the area. In this case, regulatory process is a driver of change that may impact the induced development for a project.

Uncertainties include what is unknown about these drivers of change, such as whether proposed developments will receive approval or which climate change projection will come to pass. Consider the uncertainties for the induced development itself, such as where it may occur, how many will be developed, and to what spatial and temporal extent. For example, in the Mackenzie Gas Project scenario analysis (see Section 3.2.2), a key uncertainty that was identified was the location of future wells for different production scenarios. This uncertainty was used to inform how the scenario analysis was performed as assumptions were needed to decide the location of future wells to evaluate potential impacts of the induced development.

Decide whether climate change is a key driver of change that should be considered in the induced development scenarios. This will depend on project specific details, such as the type of activities that are expected to occur and whether their impacts are influenced by, or sensitive to, climate change. Consult the Terms of Reference for the EA to identify whether consideration of climate change is required for the EA and/or cumulative effects assessment and whether climate change is expected to influence future impacts of the project. For example, the Terms of Reference for the Prairie Creek Mine indicated that the EA should consider how the project will be affected by climate change. The Terms of Reference specifically indicated a sensitivity to climate change for water management and geotechnical stability (MVEIRB, 2009). In this case, if the induced development scenario involved water management and geotechnical stability, climate change impacts could be considered in the scenario analysis to better evaluate induced development impacts. An evaluation by a knowledgeable person may be needed to identify whether the impacts of a

project and its induced development are sensitive to climate change. Use the outcomes of this evaluation to decide whether climate change should be considered in the induced development scenarios.

A good scenario will incorporate stakeholder input and expert opinion to inform the drivers of change and uncertainties. For example, stakeholder input can be used to identify the most important drivers of change that should be considered in the scenarios. Expert-based methods may be helpful to select scenario logics when there is uncertainty or disagreement regarding the scenario logics that should be considered to develop the scenarios. Before proceeding to Step 3, ensure the following key questions are answered:

1. Have the uncertainties for future development been identified?
2. What are the drivers of change for future development?
3. Have the possible trends and trajectories for drivers of change been identified?
4. Has the project's sensitivity to climate change been considered to inform the scenario logics that are selected?
5. Has stakeholder input been considered and/or incorporated into this step?
6. How many scenarios are needed to sufficiently capture the scenario logics?

Step 3: Develop the scenarios.

In Step 3, develop the detailed descriptions of the scenarios. These can be thought of as the “storylines” for each scenario (Ash et al., 2010). Ensure the scenarios are plausible, meaning that the scenarios are grounded in the basis of reality and it is possible for them to occur in the future (Blakley & Franks, 2021; Duinker & Greig, 2007). For induced development scenarios, this may involve looking to similar projects to identify induced development that is known to occur (AXYS Environmental Consulting Ltd., 1999; MVEIRB, 2004). Review relevant documentation and/or consult with relevant agencies and organizations to identify potential plans or projects that may impact the scenarios (Blakley & Franks, 2021). Referring to existing information about similar projects and future plans can support and strengthen the descriptions of the scenarios by making them more plausible.

Focus on developing precise scenarios rather than accurate scenarios as well-described and detailed scenarios can be more meaningfully evaluated and interpreted (Blakley & Franks, 2021). Precise scenarios include detailed descriptions of future conditions, such as the Mackenzie Gas Project case study that quantified future gas production for specific years (Cizek, 2005; Gilbert Laustsen Jung Associates Ltd., 2004; Section 3.2.2). Although these predictions may not come to be true (i.e., they may not be accurate), they provide for detailed future conditions that can be used to evaluate future impacts. Alternatively, scenarios that focus on accuracy strive to capture the most likely or true future conditions, which is likely not possible or challenging to achieve given the uncertainty of the future.

The scenarios may be described quantitatively via numerical information or qualitatively via non-numerical, narrative information (see Section 3.1.3 for quantitative and qualitative methods for scenario analysis). Qualitatively, the Baffin Bay and Davis Strait strategic environmental assessment (SEA) in NU used a literature review and expert opinion to identify the equipment and infrastructure needs for four exploration and development scenarios (Nunami Stantec Ltd., 2018a; Section 3.2.4). Whereas quantitative methods were used to estimate future gas production for the Mackenzie Gas Project (Gilbert Laustsen Jung Associates Ltd., 2004) and map future production scenarios using spatial analysis (Cizek, 2005). Regardless of the methods used to describe the scenarios, all assumptions used to develop the scenarios must be identified and clearly stated (Ash et al., 2010). Before proceeding to Step 4, ensure the following key questions are answered:

1. Have the scenarios been described precisely and with detail?
2. Have all assumptions been described for the scenarios?
3. Is it possible to quantify the scenarios?
4. Has stakeholder input been considered and/or incorporated into this step?

Step 4: Evaluate the scenario implications.

In Step 4, conduct an evaluation to identify and describe the outcomes/consequences of the scenarios (i.e., the implications). The scenario implications are the output of the scenario analysis; these implications are then input into the cumulative effects assessment and evaluated using the standard methods for cumulative effects assessments (Blakley & Franks, 2021). For example, in the Baffin Bay and Davis Strait SEA (Section 3.2.4), qualitative implications were identified such as air emissions and noise; the scenarios and their implications were evaluated with other past, present, and future projects to identify cumulative effects for valued components, such as changes to air quality.

The evaluation of scenario implications may be qualitative or quantitative (Ash et al., 2010). Choose between qualitative or quantitative methods to evaluate the scenario implications based on the information available for the scenarios. If numerical information for the scenario is available, then quantitative analysis may be applied. However, if quantitative data is not available or would require unreasonable assumptions to use, then qualitative analysis may be more appropriate for evaluating scenario implications.

Qualitative vs Quantitative Evaluation of Implications

Qualitative

- **What it is:** non-numerical evaluation of scenario implications.
- **When to use:** when numerical information is not available or requires unreasonable assumptions to use.
- **Data needed:** qualitative information about cause and effect, processes, and trends obtained through literature search, expert opinion, and/or engagement.
- **Example:** expert opinion is used to identify that increased noise and dust generation is expected for induced development that may occur for a project, such as development of new deposits for a mine (e.g., Mary River Mine; see Section 3.2.1).

Quantitative

- **What it is:** numerical evaluation of scenario implications obtained through a numerical evaluation (e.g., data extrapolation).
- **When to use:** when reliable numerical information is available.
- **Data needed:** numerical data that is relevant to the induced development, such as historical data and trends for the region or data from comparable projects.
- **Example:** The percent of vegetation impacted by dust for a mine is used to estimate the percent of vegetation impacted by dust for a similar project (e.g., Mary River Mine; see Section 3.2.1).

Qualitative evaluations result in descriptions of the scenario consequences using words (e.g., descriptions of the cause and effect). For example, the implications for the Baffin Bay and Davis Strait SEA involved a qualitative evaluation of scenario implications that described the consequences of the four scenarios, such as noise pollution and dust generation (Nunami Stantec Ltd., 2018b; Section 3.2.4). Qualitative evaluations can be strengthened by incorporating stakeholder input and expert opinion to identify and describe potential outcomes of the scenarios. The benefit of a qualitative approach is capturing multiple stakeholder perspectives and extreme events that may influence the scenario implications (Ash et al., 2010).

Quantitative methods can be used to estimate numerical information about the outcomes of the scenarios, which can then be input into the cumulative effect assessment (Ash et al., 2010; Blakley & Franks, 2021). Various quantitative methods can be used to evaluate scenario implications, such as environmental modelling methods (e.g., Strömmer & Ormiston, 2022). Tailor the quantitative evaluations towards the information that is available for the scenario. For example, one approach to quantitative evaluation of implications was demonstrated by the Mackenzie Gas Project; in this case study, the scenario implications were calculated as the total linear length of infrastructure for five gas production scenarios using quantitative information from the scenarios regarding expected pipelines, winter roads, and seismic lines (Cizek, 2005). The Mary River Mine demonstrated an alternative approach to quantitative evaluation of implications using

existing data for the mine (e.g., percentage of vegetation impacted by dust) to estimate implications for induced development in the scenario (Baffinland Iron Mines Corporation, 2012).

The methods identified in literature can be used to aid quantitative and qualitative evaluation of scenario implications; these methods are described in greater detail in Section 3.1.3. Key questions that should be answered by concluding this step, include:

1. Is there numerical information that can be used to quantify the implications of the scenarios?
2. Is expert opinion needed to analyze the scenario implications?
3. What are the implications of the scenarios?
4. Has stakeholder input been considered and/or incorporated in this step?

Step 5: Input the scenarios in the cumulative effects assessment.

In the final step, use the scenarios and their implications as the inputs for the cumulative effects assessment (Blakley & Franks, 2021). Conduct the cumulative effects assessment according to the usual steps: scoping, analysis of effects, identification of mitigation, evaluation of significance, and follow-up (Impact Assessment Agency of Canada, 2023b) with the scenarios used as the situations being assessed by these steps. The typical methods for evaluating effects should be used, such as impact models, spatial analysis, or numerical modelling (AXYS Environmental Consulting Ltd., 1999). Detailed guidance is available for executing the cumulative effects assessment (e.g., AXYS Environmental Consulting Ltd., 1999; Blakley & Franks, 2021; Impact Assessment Agency of Canada, 2023b, 2023a) and is outside the scope of this report.

3.1.2 How many scenarios are needed?

There is no standard or guideline for how many scenarios should be developed to evaluate induced development impacts. Although the Canadian guidance suggests choosing one scenario that is most likely to occur (AXYS Environmental Consulting Ltd., 1999), literature suggests that developing one scenario may be inadequate as humans are a poor judge of probability for future scenarios (Blakley & Franks, 2021). Further, scenario analysis is most useful when multiple, contrasting scenarios are considered (Duinker & Greig, 2007). The recommended number of scenarios varies in literature. For example, Duinker and Greig (2007) suggest choosing two to five scenarios, whereas Blakley and Franks (2021) suggest developing two to four scenarios for a cumulative effects assessment. However, Ash et al. (2010) caution against developing too many scenarios as this will cause difficulty understanding and evaluating the scenarios. Therefore, careful consideration and judgement is needed to select the number of scenarios.

For example, Joseph et al. (2023) suggest developing a minimum of two scenarios that consider changes in the environment from the different key drivers of change, such as a strong versus modest influence of climate change. A minimum of two scenarios is recommended to ensure the scenarios are not biased to what is believed to be “most likely” to occur and to allow better understanding of uncertainty for future induced development (Cardinale & Greig, 2013). A maximum of five scenarios is recommended to avoid the challenges associated with developing too many scenarios, as described by Duinker and Greig (2007) and Ash et al. (2010). Situations where up to five scenarios are needed could include those with several uncertainties and/or drivers of change that impact induced development and should be considered in the scenario analysis (e.g., varying climate change and economic growth drivers; Figure 3-3).

The number of scenarios selected should reflect the purpose of the scenario analysis. Various approaches to selecting the number of scenarios and their themes have been described in literature (Ash et al., 2010;

Choosing the Number of Scenarios

Two to five scenarios

are expected to contrast key drivers of change while not having too many scenarios to overcomplicate and lessen the impact of the scenario analysis. Developing two to five scenarios with consideration of the purpose of the scenario analysis, the scenario logics, and outcomes of engagement aligns with literature that describes the various approaches to developing scenarios.

Duinker & Greig, 2007; Khosravi & Jha-Thakur, 2019). For example, Duinker and Greig (2007) describe one approach that involves selecting five scenarios: a surprise-free or continuation scenario, an optimistic scenario, a transformation scenario, a pessimistic scenario, and a disastrous scenario. This approach may be useful in understanding the potential management needs for the future; however, the scenarios are subjective to the perspective of people or person developing the scenarios and engagement is needed to ensure the scenarios capture what stakeholders consider “pessimistic” or “optimistic”. Another approach is to select two main uncertainties and plot these on axes to develop a matrix that defines four scenarios (Ash et al., 2010; Khosravi & Jha-Thakur, 2019). This approach would require agreement among those developing the scenarios regarding the most important or influential uncertainties. Other approaches involve developing two scenarios that describe the best-case and worst-case scenarios (Ash et al., 2010). This approach may be useful when there are a limited number of uncertainties and drivers that are sufficiently captured by the two scenarios and/or to minimize time and effort of the scenario analysis when these resources are limited.

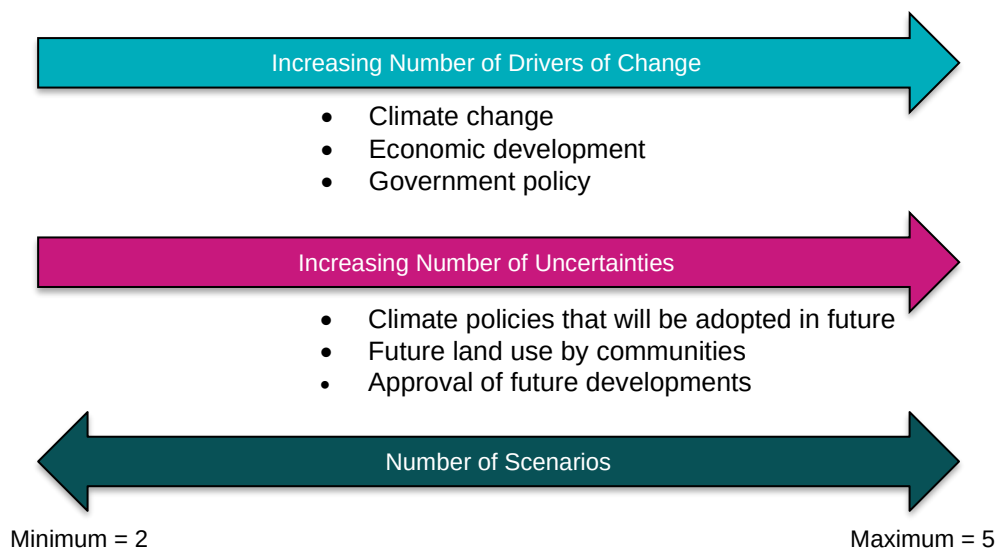


Figure 3-3. Guidance for selecting number of scenarios.

3.1.3 Methods to Develop and Evaluate Scenarios

Scenario analysis has been identified in literature as a method for evaluating the impacts of future developments (e.g., induced development), along with other methods such as qualitative trend analysis (e.g., scanning and monitoring), quantitative trend extrapolation, simulation modelling, and Delphi analysis (Duinker & Greig, 2007). Strömmer and Ormiston (2022) categorized the methods for evaluating future development impacts as follows: scenario-based methods, algorithmic methods, expert-based methods, environmental monitoring, and participatory methods. Examples of these methods can be found in literature, such as the study by Adams et al. (2023) that used participatory methods (e.g., workshops with communities) and scenario-based methods (e.g., scenario analysis) to evaluate cumulative effects of future development along the Central Coast of British Columbia.

The methods for evaluating induced development impacts that were identified from the guidance and literature review can be incorporated in Step 3 and 4 of the scenario analysis to aid in developing and evaluating the scenarios. Table 3-1 summarizes these methods identified from the guidance and literature review. The methods included in Table 3-1 were selected for summary as they were identified by Duinker and Greig (2007) for evaluating future development in an environmental impact assessment context and were also described in relation to scenario analysis by Ash et al (2010).



Table 3-1. Methods for evaluating induced development impacts within scenario analysis.

Method	Description	Quantitative or Qualitative	Applicable Situations	Information Requirements	Pros	Cons
Qualitative Trend Analysis	Identifying past or present developments to understand potential future development.	Qualitative.	Applicable in a wide range of situations but may be most beneficial when quantitative data is unavailable or uncertain.	Descriptive, non-numerical information about past or current trends that relate to the project. For example, qualitative description of development and activities that occurred following construction of a road can be used to inform potential induced development from building a new road in a similar region.	1. Can be used regardless of availability of quantitative data.	1. May be limited by the occurrence of similar projects that can be used to understand potential future development. 2. May be limited in the ability to incorporate scientific, social, and Traditional knowledge on its own.
Quantitative Trend Extrapolation	Evaluation of past or present numerical data using simple techniques (e.g., statistical analysis) to project future conditions.	Quantitative.	Applicable when quantitative data is available and assessing short-term future development (e.g., one to five years).	Information required could include various types of quantitative data depending on the goals of using the method. For example, historical data quantifying the rates of change for land use following development of a past road development could be used to project how the land use might change following development of a new road in a similar region.	1. May be advantageous in incorporating scientific knowledge through use of quantitative data. 2. Uses simple equations and calculations that may allow for a simpler evaluation to predict future conditions compared to other quantitative methods, such as Simulation Modelling.	1. May be limited by data availability, particularly data that is relevant and comparable to northern projects. 2. May be limited in the ability to incorporate social and Traditional knowledge on its own.
Simulation Modelling	Development of a tool to forecast environmental conditions and impacts based on the characteristics and behaviours of a system using numerical information.	Quantitative.	Applicable when quantitative data is available and applicable for a variable timeframe (short- to long-term).	Information required includes several sources of numerical information that could vary depending on the goals of using the method. This numerical information would be input into the simulation model.	1. Can provide insight into induced development occurring over a longer time frame compared to other quantitative methods (e.g., quantitative trend extrapolation). 2. More complex evaluation allows for understanding of behaviours in a system and how they change future conditions. 3. May be advantageous in incorporating scientific knowledge through use of quantitative data.	1. Process of simulation modelling can be complex and time-consuming resulting in high effort and cost to use this method. 2. The complex nature of simulation modelling requires the person conducting the simulation to be trained and familiar with simulation modelling, making the method not easily accessible. 3. May be limited in the ability to incorporate social and Traditional knowledge on its own.
Delphi Analysis	Systematic process for collecting informed judgments, usually from experts, regarding a set of variables to reach a consensus.	Qualitative.	Assessing short-term future development (e.g., one to five years).	Participation of experts and their feedback regarding the potential induced development activities and their impact.	1. Can incorporate scientific, social, and Traditional knowledge from experts in those fields.	1. May be limited by willingness and availability of experts to participate.

3.1.3.1 Qualitative Trend Analysis

Qualitative trend analysis involves looking to past trends to understand what might happen in the future. The underlying concept of qualitative trend analysis is that the future will be an extension of the past (Duinker & Greig, 2007). This method differs from scenario analysis as it does not include the rigorous, structured approach to developing scenarios and it is constrained to qualitative evaluations, whereas scenario analysis may be qualitative or quantitative.

Qualitative trend analysis can be used to develop and evaluate scenarios in Step 3 and 4 of the scenario analysis. Qualitative trends could be identified for similar projects to identify induced development activities that occur from a particular project type that should be included in the scenarios. This concept aligns with the guidance from MVEIRB to look to similar projects to identify induced development activities (MVEIRB, 2004). For example, when conducting scenario analysis for a new road development, a proponent could look to other roads in the region to identify qualitative trends regarding induced development activities that occurred following road construction (e.g., development of additional roads, increased timber harvest, or increased hunting activities). These qualitative trends could be used to identify potential induced development activities that should be included in the scenarios during Step 3 of the scenario analysis. In this same example, qualitative trend analysis could be used in Step 4 of scenario analysis to identify trends of the impacts from these induced development activities (e.g., increased dust generation or decreased wildlife sightings). Qualitative trend analysis may be used with scenario analysis when:

1. Qualitative information for similar projects and their induced development and impacts are readily available.
2. Quantitative data for the project and potential induced development is not available.

3.1.3.2 Quantitative Trend Extrapolation

Quantitative trend extrapolation involves projecting current or past numerical trends into the future using simple calculations, usually for a short timeframe (i.e., one to five years) (Duinker & Greig, 2007). This method differs from scenario analysis as it does not include a rigorous and structured method and it is more applicable over a short time horizon, whereas scenario analysis is applicable to a wide range of timeframes. Further quantitative trend extrapolation results in a single fixed prediction of future conditions (i.e., one scenario), whereas scenario analysis considers multiple pathways and outcomes for the future (Zhu et al., 2011).

Quantitative trend extrapolation can be used to help define the conditions of the scenarios in a scenario analysis (Step 3). For example, quantitative trend extrapolation could be used to project future carbon dioxide emissions for a region to better understand and define the conditions of the future scenarios. This example would require numerical data for past and present carbon dioxide emissions for the region to define a quantitative trend and forecast it forward to the future. In the Mackenzie Gas Project scenario analysis, forecasts of future gas production were used to define five scenarios; this involved two detailed forecasting studies to predict gas production based on known and anticipated gas resources in the project area (Joint Review Panel for the Mackenzie Gas Project, 2009). Quantitative trend extrapolation may be used for scenario analysis when:

1. Quantitative data is available for the project or spatial boundaries that could be used to better understand future conditions.

3.1.3.3 Simulation Modelling

Simulation modelling is a group of methods that can be used to predict behaviors of a system (reviewed by Moon, 2017). Simulation modelling is a predictive tool that captures the characteristics and behaviours of a system based on assumptions and using quantitative information. Quantitative information is input into the simulation model to quantitatively predict and describe the outcomes. Simulation modelling can be used to predict interactions within the environment (Agent-Based Modelling and Simulation), represent a sequence of events in a complex system (Discrete-Event Modelling and Simulation), or describe continuous changes in variables over time (System Dynamics Modelling and Simulation). Simulation modelling differs from quantitative trend extrapolation in that it considers the behaviours and processes of a system and

uses complex equations and algorithms to project future conditions based on these behaviours and processes.

For example, Fullman et al. (2021) demonstrated the use of simulation modelling to quantify impacts of five future development scenarios. The scenarios were developed to represent different levels of future development and management then input into the model to simulate the infrastructure for the five scenarios, such as roads and oil production pads (Fullman et al., 2021). Infrastructure was simulated using estimates of undiscovered oil in the study area with consideration of development restrictions and spatial restrictions from water bodies; these infrastructure features were mapped using GIS-based tools. The impacts on caribou, shorebirds, and brant (geese) were evaluated using the simulation model by simulating habitat displacement that occurred for the five scenarios. To do this, geospatial data for caribou calving habitat, shorebird habitat, and brant molting habitat was compared to the location of the simulated infrastructure to identify overlapping areas where habitat displacement would occur in the scenarios. This study demonstrated the high information requirements and technical knowledge needed for simulation modelling as the method required several types of quantitative information, including geospatial data for waterbodies and wildlife habitat and quantitative data for undiscovered oil and land use.

Simulation modelling relates to scenario analysis as the scenarios that are developed are the inputs for the model and the output of the model are the quantified implications of the scenario. In this way, simulation modelling could be incorporated during Step 4 of the scenario analysis to evaluate scenario implications. This method differs from scenario analysis in that it requires the use of quantitative data, whereas scenario analysis could use either quantitative or qualitative information to evaluate scenarios. Although simulation modelling focuses on evaluating the scenario implications, it can also be used to expand on scenarios or identify/develop new scenarios (Moon, 2017), such as the example from Fullman et al. (2021) that simulated infrastructure for the five development scenarios. Thus, simulation modelling could also be incorporated as part of Step 3 (develop the scenarios) of the scenario analysis. Simulation modelling may be used with scenario analysis when:

1. Several types of numerical data are available for the scenario (e.g., land use, wildlife population, etc.).
2. The behaviours of the system (e.g., changes in land use) can be modelled.
3. The goal of the evaluation is to better understand how features of the environment interact or change sequentially or continuously over time to characterize impacts.
4. Trained experts in simulation modelling are able to perform the method.

3.1.3.4 Delphi Analysis

Delphi analysis is a qualitative method that involves systematically collecting expert input to forecast future conditions or impact (Strömmer & Ormiston, 2022). This method typically involves sequential questionnaires to obtain and refine information from experts and can be used to gain both social and technical information (Duinker & Greig, 2007). The main steps of Delphi analysis involve defining the study objective, conducting an overview of relevant information (e.g., problems and trends, conducting multiple rounds of information gathering, and providing a recommendation to inform scenarios (Calleo & Pilla, 2023). Although both Delphi analysis and scenario analysis involve rigorous, structured steps, Delphi analysis differs from scenario analysis in that it does not result in development of one or more scenarios on its own; rather, Delphi analysis provides a set of information that could be used to construct or evaluate the scenarios. Delphi analysis is limited to qualitative analysis, whereas scenario analysis may be qualitative or quantitative in nature.

Delphi analysis can be used with scenario analysis to incorporate expert opinion into the scenario analysis and support or validate decisions made to develop and evaluate the scenarios. Delphi analysis can be used to identify drivers of change and uncertainties for future scenarios, aid in the development of scenarios, and evaluate the scenario implications (i.e., Steps 2, 3, and 4 of scenario analysis). For example, Delphi analysis could be used to obtain expert opinion regarding the main drivers of change and uncertainties for future development in a region; this could involve surveying experts of regulatory processes, climate change, and land use/urban planning, to name a few. Delphi analysis could also be used to identify likely induced development to occur for a project in a region, thereby aiding development and description of the scenarios

in Step 3. Finally, in Step 3 of the scenario analysis, Delphi analysis might be used to qualitatively evaluate the implications of the scenarios by obtaining expert opinion of the consequences of the scenarios.

Although Delphi analysis may be helpful in supporting and validating the scenario analysis, it is a formal process that requires time, effort, and willingness of participants. Informal approaches to obtaining and incorporating expert opinion may also be suitable for scenario analysis. Delphi analysis may be used with scenario analysis when:

1. There is a high degree of uncertainty or disagreement regarding the scenario logics, scenario descriptions, or scenario implications for which expert opinion may be valuable to justify and support decisions of the scenario analysis.
2. There are time and resources available to systematically survey experts and consolidate the information to inform the scenario analysis.
3. There are willing participants of relevant expertise to the project that may be surveyed to inform the scenario analysis.

3.2 Detailed Review of Case Studies

A total of 15 case studies were reviewed and are summarized in Appendix A. Four case studies were selected for detailed review as they directly evaluated induced development impacts in the project cumulative effects assessment and demonstrated different ways of evaluating induced development. Scenario analysis was used to evaluate induced development impacts for all four of these projects. However, the methods used to develop and analyze scenarios varied between the projects demonstrating the different ways scenario analysis can be applied to evaluate induced development impacts. These four case studies are described and evaluated in Sections 3.2.1 to 3.2.4. A summary and comparison of the four case studies is provided in Section 3.2.5. Figure 3-4 identifies the locations of each case study project.

In all case studies, engagement was conducted to inform the EA; however, the extent to which the proponent engaged stakeholders or used engagement outcomes to develop induced development scenarios is limited to non-existent. How engagement was used to inform the scenarios was not well described in any of the case studies. Therefore, engagement was likely used to support the induced development scenarios as it was conducted for the EA, but to what degree engagement was used is not well understood.

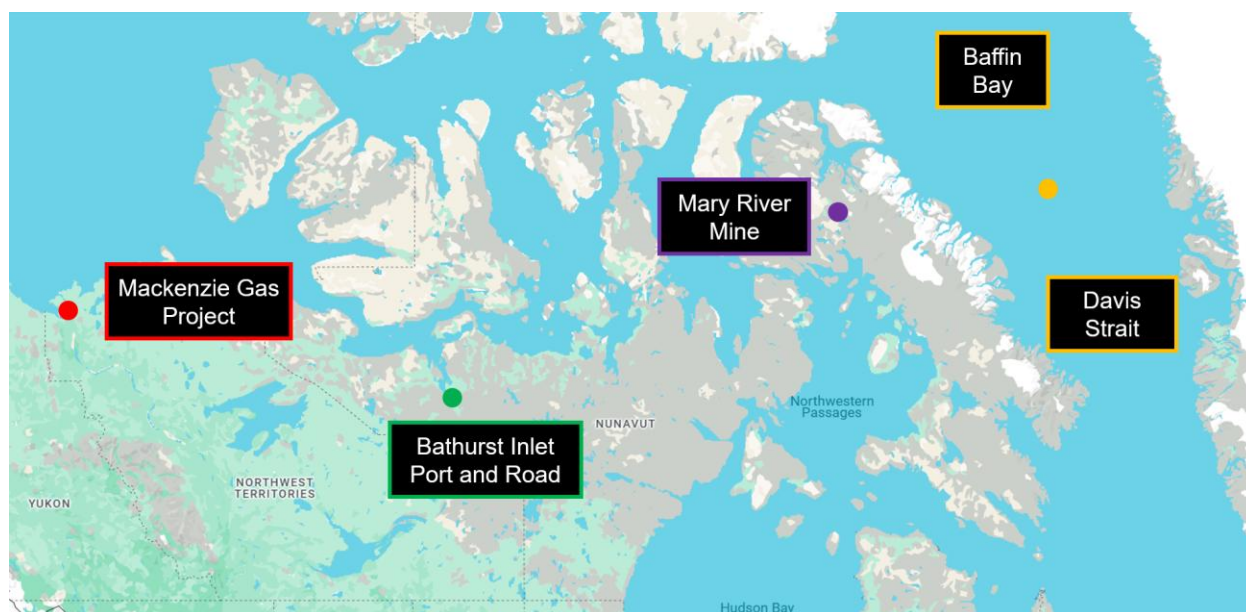


Figure 3-4. Overview of case study project locations.

The Mary River Mine is an iron mine located on Baffin Island, NU Baffinland Iron Mines Corporation, 2012). The main development is an open pit mine with a road linking the deposit with tidewater on the north end of Baffin Island and a proposed railway connecting to the south coast of Baffin Island (Figure 3-5). The mine is currently active and underwent an EA three times (2012, 2014, and 2018) for initial and then expanded project scopes. Induced development impacts were evaluated as part of the cumulative effects assessment for the first EA (Baffinland Iron Mines Corporation, 2012) and not evaluated thereafter. This section summarizes the scenario used in the Mary River Mine's cumulative effect assessment with information obtained from review of the project's EA (Baffinland Iron Mines Corporation, 2012).



The proponent used quantitative and qualitative methods for scenario analysis. A single scenario was developed qualitatively by identifying past, present, and future developments within Nunavut. Past projects included mines and ports that have been abandoned, present projects included resource development projects, and future projects included those that may be developed given the project moving forward, such as expansion of the Mary River Mine. The proponent selected each of these developments to include in one scenario for evaluation of cumulative effect. The implications of that scenario were quantified and then included within the cumulative effects assessment. Including other known developments is a common method for evaluating cumulative effects of a project; however, this project differs from most other projects

identified in Appendix A as it included induced development in the scenario: expansion of the project by mining additional iron deposits. The structured process described in Section 3.1.1 was not described for the Mary River Mine scenario; rather, descriptions of the scenario were interspersed throughout the cumulative effects assessment for the project making it challenging to follow along with the scenario analysis process.

Purpose and scope: The purpose of the scenario analysis was not clearly stated. The temporal and spatial scopes of the scenario were the same as that of the cumulative effects assessment; temporal scope included the lifespan of the mine (42 years) and spatial scope included the NU settlement boundary (4,025,445 km²) as it was considered representative of local and regional projects that may interact with the Mary River Mine.

Scenario logics: The scenario logics were not clearly stated; however, it is understood from the scenario that was developed that the key driver of change was development activities in the region, including confirmed and reasonably foreseeable projects that intersect spatially and temporally with the project. Uncertainties included whether or not these developments would proceed or continue on their planned schedule.

Scenarios: One scenario was developed describing past, current, and future development to evaluate cumulative effects. Induced development in the scenario was described semi-quantitatively as an expansion of the current project resulting in a doubling of production, disturbed land, marine traffic, water use, and 100 km of linear development to support the expansion. The proponent did not indicate why only one scenario was developed; however, this is the common method applied for cumulative effects assessments based on Canadian guidance to consider impacts of past, present, and future projects.

Implications: The implications of this scenario were generally described qualitatively using the judgement of the proponent. Quantitative implications were described when numerical information was available. For example, the proponent assumed the scenario would result in doubling the vegetation impacted by dust (i.e., from 0.14% to 0.28%) as the land disturbance was expected to double. As there was only one scenario developed, the implications were also limited to the one scenario, thereby limiting the understanding of induced development impacts and potential future management requirements to only one future scenario that may or may not occur.

Cumulative Effects Assessment: The scenario and its implications were considered in the cumulative effects assessment by identifying the cumulative effects for the valued components for all projects and developments considered in the scenario, including the induced development. Examples of cumulative effects that were identified for the scenario included greenhouse gas emissions, increased noise, reduction of vegetation abundance, among others. A matrix was used to identify mitigation measures for each cumulative effect and qualitatively evaluate the magnitude, duration, frequency, extent and reversibility of the effect. Based on this evaluation, the proponent rated the significance of the residual effects.

The Mary River Mine scenario analysis included aspects of a good scenario that were described in Section 3.1.1, including development of a plausible scenario that was informed by relevant documents and information for projects in the region. The scenario was also precise in that it described the expected production, land disturbance, marine traffic, water use, and linear development to support induced development. However, the scenario could be improved by clearly defining the conditions of the scenario at the start of the cumulative effects assessment and describing how stakeholder input had been incorporated into the scenario analysis. Only one scenario was developed, which constrained the understanding of potential future impacts and management requirements for the project and region.

The following lessons can be taken from this case study to better understand how scenario analysis can be applied in the NWT:

- The proponent used a simple approach to quantifying scenario implications, which could be easily applied to other projects in the NWT with low effort when time and resources are limited to do the scenario analysis.
- The case study demonstrated the importance of transparency and a well-described scenario analysis, as the description of the scenario analysis (i.e., interspersed description throughout the cumulative effects assessment) made it challenging to follow along with the scenario analysis, including the decisions made and justifications. Future evaluations may benefit from a clear description of the scenario analysis prior to the cumulative effects assessment or supplemental information that can be provided with the cumulative effects assessment to convey the process of the scenario analysis and how it relates to the cumulative effects assessment.
- This case study demonstrated the importance of developing multiple scenarios as only one scenario was developed and thus, the management of potential future impacts was limited to the assumptions of the one scenario. Multiple scenarios could have been developed to demonstrate the different management needs for different possible induced development activities and future outcomes.

3.2.2 Mackenzie Gas Project (NWT)

The Mackenzie Gas Project was a proposed oil and gas project that involved the development of three onshore natural gas fields in the Mackenzie Delta, gathering pipelines that connect the natural gas fields to the a processing facility and existing pipelines, and a 1,200 km pipeline to transport 1.2 billion cubic feet per day (BCFD) of natural gas to Alberta (Figure 3-6; Joint Review Panel for the Mackenzie Gas Project, 2009). The project was intended to support future development of oil and gas in the region, including potential expansion to 1.8 BCFD, thereby facilitating induced development.

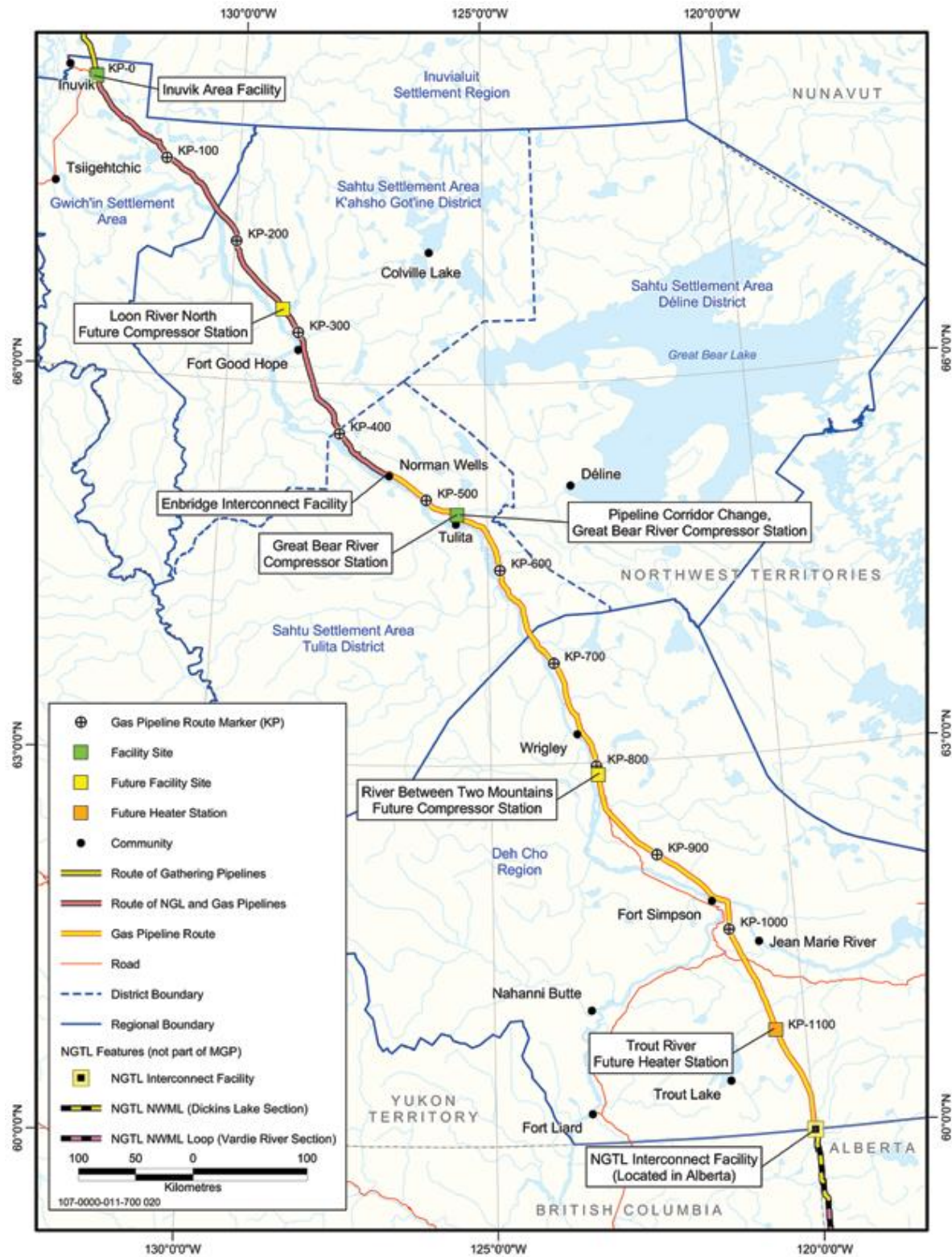


Figure 3-6. Overview of the proposed pipeline for the Mackenzie Gas Project (Joint Review Panel for the Mackenzie Gas Project, 2009).

In 2004, the project was recommended for an Environmental Impact Review by the MVEIRB and a Joint Review Panel was established for the project. Although the project was intended to support future oil and gas development in northern Canada, the initial cumulative effects assessment did not evaluate induced development impacts. The proponent was later required to conduct a scenario analysis that considered potential project expansion and induced development impacts. The proponent developed a hypothetical expansion scenario based on a study that forecasted future gas production for the project (Gilbert Laustsen Jung Associates Ltd., 2004), but the proponent did not quantify the implications of the scenario (Joint Review Panel for the Mackenzie Gas Project, 2009). In response, the Canadian Arctic Resources Committee (CARC) conducted a scenario analysis to quantify the implications of the project expansion scenario (Cizek, 2005). The CARC scenario analysis is the focus of this section herein as it provides an example of quantitative scenario analysis and the proponent's scenario analysis is not readily available for detailed review; information summarized herein was obtained from the report of the CARC scenario analysis (Cizek, 2005).

Purpose and scope: The purpose of the CARC scenario analysis was to understand and quantify the cumulative impacts from future developments of the Mackenzie Gas Project. The scope and scenario logics were informed by two studies that forecasted gas production. Based on these studies, the spatial scope was selected to be consistent with maps showing future production and the temporal scope was selected to be 2053 and 2059, consistent with the production forecasts. The reason for selecting this scope is not clearly articulated by CARC; however, it is understood that these scenarios were developed to quantify the impacts of potential future production that was forecasted by these studies.

Scenario logics: Project expansion and pipeline capacity were the drivers of change in the scenarios and five potential pipeline capacities were selected to define the scenarios: 0.8 BCFD, 1.2 BCFD, 1.8 BCFD, 2.5-3.0 BCFD, and 4.0 BCFD. The reason for selecting these logics was not clearly described by CARC; however, scenario pipeline capacities were based on the outcomes of the two studies that forecasted natural gas production and provided insight into possibilities for future development.

Scenarios: Five scenarios were developed and described quantitatively using Geographic Information System (GIS) tools to map the production fields, exploration wells, pipelines, seismic lines, and winter roads for the five pipeline capacity scenarios. The information from the forecasting studies used to quantify the scenarios included the number of undiscovered fields, undiscovered marketable gas, historical discovery rate, and historic seismic cost per well. This information was used to calculate the expected number of producing fields, the expected number of exploration wells, and the total linear kilometers of seismic lines. This information was mapped using GIS-based tools and assumptions to decide where the exploration wells, pipelines, seismic lines, and winter roads will be located and how they will be spatially related. For example, the exploration wells were randomly distributed, and it was assumed that all onshore wells would be accessed by a winter road. The CARC did not indicate the reason for selecting five scenarios; however, the five scenarios demonstrated the varied induced development activities and impacts for different gas production quantities in the future.

Implications: Quantitative analysis using GIS-based tools was used to evaluate the implications of the scenarios by calculating the total length of linear features induced by the project (i.e., pipelines, seismic lines, and winter roads). Evaluation of multiple scenarios allowed for comparison of implications for different future production values. For example, the total length of linear features in the Mackenzie Delta was 102,482 km for the lowest production scenario compared to 191,093 km for the highest production scenario.

Cumulative Effects Assessment: The induced development scenario was developed after the cumulative effects assessment was completed and in response to reviewer comments that indicated the cumulative effects assessment did not sufficiently address the potential for induced development. Therefore, the scenario was not used in the cumulative effects assessment. However, within the scenario analysis, an evaluation of cumulative effects was conducted by calculating linear fragmentation indicators (i.e., linear length divided by area) and comparing them to acceptable threshold values in literature.

The scenario analysis included components of a good scenario that were identified in Section 3.1.1, including development of multiple, plausible scenarios and inclusion of expert opinion by means of using the two forecasting studies to inform the scenario development. The scenario analysis was also detailed and precise by visually describing future conditions using GIS-based tool. However, the scenario analysis

could have been improved by directly incorporated stakeholder input or better describing this if it was done. The scenario analysis was also conducted after the initial cumulative effects assessment; thus, it was not incorporated early in the EA process.

The following lessons can be taken from this case study to better understand how scenario analysis can be applied in the NWT:

- The case study demonstrated how quantitative methods, specifically GIS-based tools, can be applied in scenario analysis, particularly for understanding the impacts of oil and gas development and linear disturbances. This method can be used for other oil and gas developments and linear infrastructure (e.g., roads) in NWT.
- The case study demonstrated the level of information needed to use quantitative methods for evaluating induced development, which included results of two forecasting studies and numerous assumptions to quantify the linear length of disturbance resulting from the scenarios. The effort and resources needed to conduct this method should be considered when deciding whether the method is feasible to use for similar developments in the NWT.
- The case study demonstrated the value of developing multiple scenarios to evaluate induced development impacts. These scenarios demonstrated that the scale of induced development and its impacts varied greatly based on the production of the project. These differences in impacts could be used to inform the potential management needs in the future.

3.2.3 Bathurst Inlet Port and Road (NU)

Bathurst Inlet Port and Road is a proposed port on Bathurst Inlet and a 211 km all weather road to Contwoyto Lake in the Kitikmeot region, NU (Figure 3-7; Bathurst Inlet Port and Road Joint Venture Ltd., 2008a). The project is intended to support current and future mining activities in NU, as well as create employment and business opportunities for communities in the region.



Figure 3-7. Overview of project location and components for the Bathurst Inlet Port and Road (Bathurst Inlet Port and Road Joint Venture Ltd., 2008a).

A draft Environmental Impact Statement for the project was submitted by the proponent in 2008 with the review paused later that year and not completed to date. Scenario analysis was used to evaluate induced development impacts in the proponent's cumulative effects assessment in the draft Environmental Impact Statement (Bathurst Inlet Port and Road Joint Venture Ltd., 2008c). One scenario was developed for the cumulative effects assessment that described the past, current, and future development, including induced development activities. This scenario was integrated in the cumulative effects assessment and did not distinguish between impacts from proposed and induced development. The induced development identified for the scenario was focused on projects that had existing project descriptions or information online, including two base metal mines (Izok Lake and Hackett River) (Bathurst Inlet Port and Road Joint Venture Ltd., 2008c). Potential expansion of the proposed project was also considered as an induced development activity.

Purpose and scope: The scenario was developed to evaluate cumulative effects for past, present, and future development; however, the purpose of the scenario analysis is not clearly stated. The spatial and temporal scope of the cumulative effects assessment was used as the scope of the scenario analysis (Bathurst Inlet Port and Road Joint Venture Ltd., 2008c). The temporal scope was selected to be the lifespan of all current and future projects identified in the cumulative effects assessment, including from the onset of the project in 2009 until 2031 (22 years). The spatial scope was selected to include current and future mines in the region as well as the annual range of the Bathurst caribou herd.

Scenario logics: The scenario logics were primarily focused on development activities in the region and the proponent select pasted, present, and future developments to include in the scenario. Future developments, including induced development, were selected for the scenario if they were considered "reasonably foreseeable" (Bathurst Inlet Port and Road Joint Venture Ltd., 2008c). The proponent provided criteria to define what was considered "reasonably foreseeable", which constrained the evaluation of induced development to projects that were in the EA process, were an expansion of a project in the EA process or were publicly announced to be entering the EA process in the future.

Scenarios: One scenario was developed, which quantitatively described the annual average imports and exports, truck traffic, and barge traffic for the past, present, and future developments using available information (e.g., project descriptions and transportation data) (Bathurst Inlet Port and Road Joint Venture Ltd., 2008c). The annual average material to be imported and exported for each project was obtained using transportation data from mining companies, transportation companies, and winter road operators (Bathurst Inlet Port and Road Joint Venture Ltd., 2008b). The total annual imports and exports for the scenario were obtained as the sum of the annual average quantities for each project (Bathurst Inlet Port and Road Joint Venture Ltd., 2008c). Barge traffic and truck traffic for the scenario were estimated using the total annual imports/exports. The proponent assumed that the barge capacity would be 1,700 tonnes of fuel per barge and 1,000 tonnes of cargo per barge with three barges per sailing, resulting in 52 one-way trips per year. The rationale for these assumptions was not described by the proponent, but they may be based off of typical barge capacities. The annual truckloads were estimated by assuming truck capacities for ore (90 tonnes), cargo (45 tonnes), and fuel (35 tonnes), resulting in 40,950 one-way trips per year. The reason for developing only one scenario was not described by the proponent.

Implications: The implications of this scenario were qualitatively described throughout the cumulative effects assessment using the proponent's judgement (i.e., the implications identified were the cumulative effects) (Nunami Stantec Ltd., 2018b). For example, increased sedimentation and increased dust deposition were identified as the implications of the scenario. The reason for conducting a qualitative evaluation of implications was not described and it is unclear if quantitative data could have been used to evaluate the scenario implications.

Cumulative Effects Assessment: The scenario implications were considered in the cumulative effects assessment to qualitatively evaluate the significance of cumulative effects (Nunami Stantec Ltd., 2018b). The implications of the scenario were directly used as the cumulative effects for this evaluation. The significance of each cumulative effect was qualitatively evaluated with respect to the valued components based on the magnitude, geographic extent, duration, frequency, reversibility, probability, and biophysical/social context of each cumulative effect.

Aspects of the scenario analysis that made it good, included development of a precise and plausible scenario that was informed by documentation and information for developments in the region. The scenario analysis was generally well-described and transparent; however, it was unclear if and how stakeholder input was incorporated into the scenario analysis and expert judgement could have been used to better support the qualitative evaluation of the scenario implications. Further, the scenario analysis could have included development of more than one scenario to better demonstrate the breadth of potential impacts and inform future management needs.

The following lessons can be taken from the Bathurst Inlet Port and Road induced development analysis to better understand how scenario analysis can be applied in the NWT:

- Existing documentation on future and induced development can be used to inform quantitative scenario development (e.g., using project descriptions to obtain information about production for a project). This method requires moderate time and effort to find, review, and synthesize existing and available data; however, it may be beneficial as it does not require studies to generate new data.
- Although this method considered induced development, it was limited to projects that were undergoing an EA or publicly announced to be submitted for an EA. Thus, this method may fail to consider future induced development that is not explicitly stated or advanced to the planning stages.
- Similar to the Mary River Mine, this case study demonstrated the importance of developing multiple scenarios. Only one scenario was developed in this case study, which limited the understanding of future impacts and management needs. Multiple scenarios can better inform the different possibilities for future induced development impacts and management.

3.2.4 Baffin Bay and Davis Strait (NU)

This case study involved a SEA of offshore oil and gas development at the Baffin Bay and Davis Strait, NU (Nunami Stantec Ltd., 2018b). The SEA was conducted to evaluate the impacts of different offshore oil and gas development scenarios in the region and was not specific to one project (Figure 3-8). The SEA was conducted by Nunavut Impact Review Board and the methodology was similar to that of a typical EA, but with an expanded scope that considered multiple projects and development possibilities instead of only one project. Prior to the effects assessment, four future development scenarios were developed to be evaluated in the SEA (Nunami Stantec Ltd., 2018a). The scenarios were informed by literature and expert opinion of typical offshore oil and gas development activities and timelines (Nunami Stantec Ltd., 2018a). These four scenarios were considered in an effects assessment to consider potential effects, mitigations, and planning considerations for different future development outcomes in the Baffin Bay and Davis Strait (Nunami Stantec Ltd., 2018b).

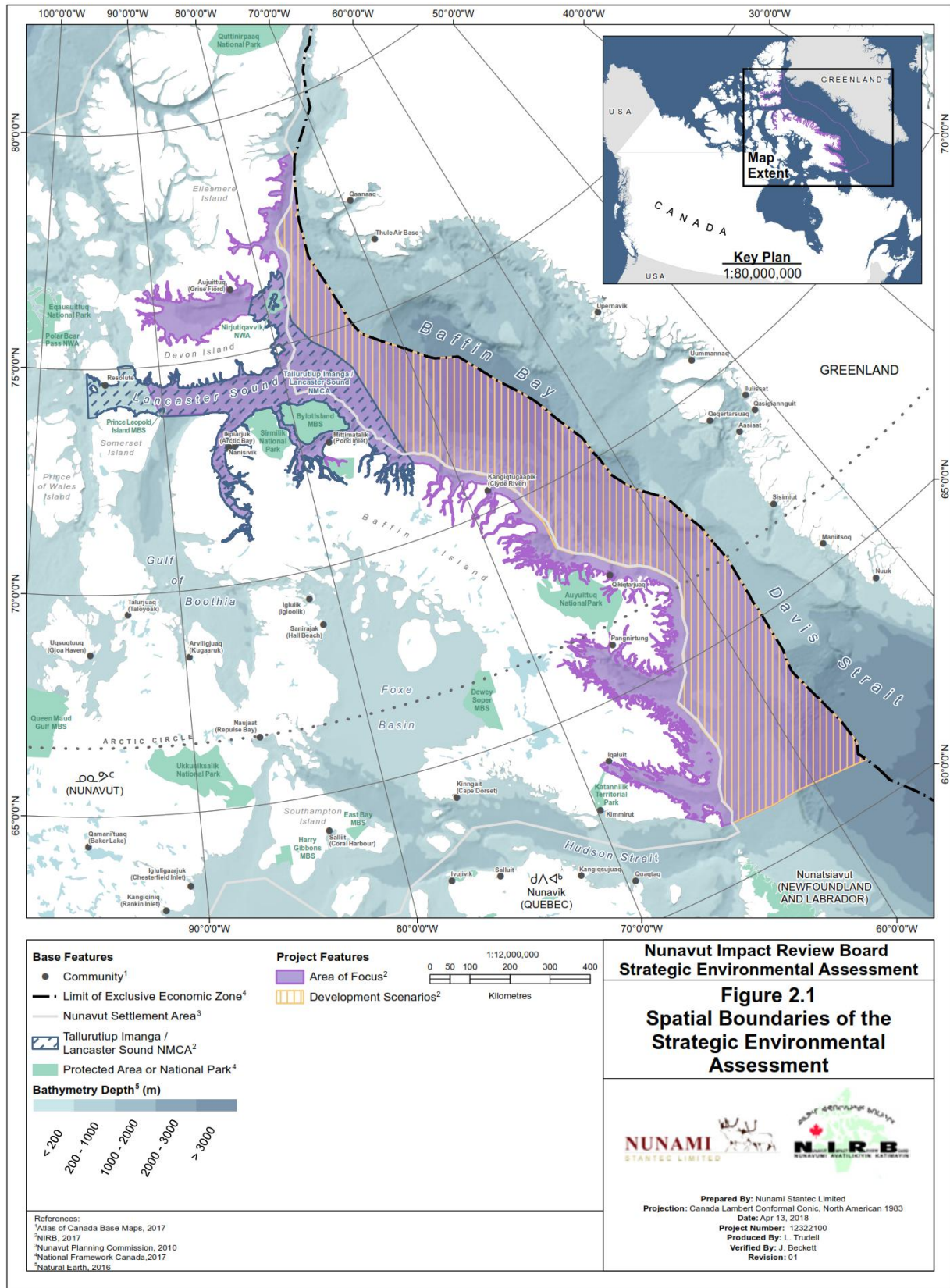


Figure 3-8. Spatial boundaries of the Baffin Bay and Davis Strait SEA (Nunami Stantec Ltd., 2018b).

Purpose and scope: The purpose of the scenario analysis was to develop a baseline understanding of the potential impacts and effects pathways if offshore oil and gas development occurred in the Baffin Bay and Davis Strait (Nunami Stantec Ltd., 2018a). The spatial scope was decided based on the geological potential of oil and gas in the Baffin Bay and Davis Strait area. The temporal scope was decided based on the timelines for oil and gas exploration and development activities, which was assumed to be 15 to 20 years for exploration and 30 to 60 years for development (Nunami Stantec Ltd., 2018b). The rationale was not provided for this assumption but it can be inferred that it was based on typical industry timelines. As the exploration and development activities varied for the four scenarios, it is understood that the temporal scope also varied for each scenario. For example, the scenario that involved exploration only would have a temporal scope up to 20 years, whereas a scenario that involved exploration and development could have a temporal scope up to 80 years.

Scenario logics: The scenario logics considered processes that could impact future oil and gas development, including geological potential for oil and gas resources, project expansion and new discoveries, new technology, cost, operational challenges, and external events (e.g., political changes) (Nunami Stantec Ltd., 2018a). These logics were informed by expert opinion and literature review and described in detail prior to developing the scenarios.

Scenarios: Four scenarios were developed: 1) exploration with offshore seismic surveys, 2) exploration drilling, 3) field development and production drilling, 4) no offshore oil and gas activity (Nunami Stantec Ltd., 2018a). Four scenarios were developed as they were considered to sufficiently address the possibilities of future oil and gas development in the region. Scenario development involved qualitative descriptions of the potential capital expenditure, equipment and infrastructure needs, and potential accidents and malfunctions that could occur with quantitative estimates provided when available (e.g., estimates of capital expenditure). These qualitative descriptions were informed by the expert opinion and literature search that was obtained when identifying and selecting scenario logics. Activities associated with each scenario (e.g., drilling, transportation, etc.) were identified in the effects assessment and further defined the conditions of the scenario (Nunami Stantec Ltd., 2018b).

Implications: Scenario implications were qualitatively assessed as part of effects assessment completed for the SEA (Nunami Stantec Ltd., 2018b). A summary table identified the potential impacts⁴ (e.g., air emissions, noise, etc.) of the activities that were described for each scenario; these impacts are the implications of the scenario. The impacts of the activities were identified using the proponent's judgement; it is unclear if quantitative data could have been used to support the evaluation of scenario implications.

Cumulative Effects Assessment: The scenario implications were considered in the cumulative effects assessment to identify potential cumulative effects and screen the valued components that interact with these potential cumulative effects (Nunami Stantec Ltd., 2018b). A qualitative evaluation was completed to identify the potential cumulative effects of the scenarios, such as changes in air quality or changes in water quality. The cumulative effects assessment considered the effects of the scenarios along with other past, present, and future projects.

Aspects of this scenario analysis that made it good according to Section 3.1.1, included development of multiple, plausible scenarios and use of relevant documents and information for similar projects to inform scenario descriptions. The scenarios were precise in that they each qualitatively described the infrastructure, activities, capital expenditures, and potential accidents/malfunctions in detail. Scenario analysis was incorporated early in the effects assessment as the outcomes were used as the inputs for the effects assessment. The scenario analysis also involved the development of multiple scenarios, which demonstrated the benefit of this decision as the potential impacts for regional development could better be identified compared to a single future scenario. Overall, the scenario analysis was transparent and well communicated; however, improvements could be made by clearly describing how stakeholder input was incorporated into the scenario analysis.

⁴ In the Baffin Bay and Davis Strait SEA, impacts are defined as "the influence that an activity has on the environment" and effects are defined as "the consequence of an impact on a specific receptor in the environment" (Nunami Stantec Ltd., 2018b).

Key takeaways from the Baffin Bay and Davis Strait SEA are:

- This study demonstrated the importance of a structured and well-communicated scenario analysis. The line of reasoning and steps for this scenario analysis were easy to follow as the scenario analysis was described in detail prior to using the scenarios in the effects assessment.
- This case study demonstrated how expert-based methods can be used to inform scenario analysis. Expert opinions and a literature search were used to inform the possibilities for the future by identifying uncertainties and drivers of change to develop the scenarios. They were also used to evaluate the implications of the scenarios, resulting in qualitative descriptions of the scenario implications.
- This case study demonstrated the benefit of using multiple scenarios to better understand possibilities of future development. The four scenarios involved different activities that resulted in different implications that could be evaluated in the effects assessment. This approach allowed for better understanding of the potential future impacts of offshore oil and gas development and associated management needs.

3.2.5 Summary of Case Studies

Overall, the detailed review of case studies revealed that in practice, the methodological steps of scenario analysis described in Section 3.1.1 are not strictly followed or clearly communicated in an EA. This may be due to the complex nature of scenario analysis and lack of detailed or prescriptive methodology available in guidance and literature. The proponent's judgement is often used to develop scenarios; however, little detail is provided regarding the rationale for the choices and how scientific, social, and Traditional knowledge is incorporated into the scenario analysis (e.g., via participatory and expert-based methods). Although engagement is conducted for an EA, the case studies generally did not describe how stakeholder input was incorporated into the scenario analysis. The outcomes of the detailed review of case studies are summarized in Table 3-2, including an evaluation of the pros and cons of the methods used and the applicability to the NWT.

Table 3-2. Summary and evaluation of selected case studies.

Case Study	Method of Evaluating Induced Development	Qualitative or Quantitative	Incorporation of Scientific, Social, and Traditional Knowledge	Information Requirements	Applicable Situations	Pros	Cons	Applicability to NWT Context
Mary River Mine	Informal scenario analysis – description of one potential future development scenario that assumes expansion of the project results in doubling of production and resource use.	Semi-quantitative.	Stakeholder input was not described for the scenario analysis; uncertain if and how social and Traditional knowledge was incorporated. Scientific knowledge was incorporated using quantitative data collected at the site (e.g., vegetation abundance, percentage of vegetation impacted by dust).	General understanding of qualitative and quantitative changes that result from project expansion.	Widely applicable to common project types, particularly for induced development that is expanding upon current and well-understood activities.	Simple and quick evaluation of induced development (low effort, did not require collection of new data).	- Informal approach that did not articulate the steps of scenario analysis, including a precise description of the scenario. - Scenario analysis did not include stakeholder collaboration or incorporation of social and Traditional knowledge.	This method could be applied to most projects in NWT, particularly those that involve potential expansion of current project activities (e.g., mines, oil and gas, roads, etc.).
Mackenzie Gas Project	Scenario analysis using GIS software – mapping and quantification of induced development for five oil and gas production scenarios.	Quantitative.	Scientific knowledge was incorporated through quantification and mapping of future pipelines, seismic lines, and winter roads induced by the project for five production scenarios. Stakeholder input was not described for the scenario analysis; uncertain if and how social and Traditional knowledge was incorporated.	Production forecasts, number of production and exploration wells	Projects that result in spatial disturbance from linear features (e.g., roads, pipelines, railway, etc.).	- Evaluated more than one scenario without focusing on what was “most likely” to occur, providing insight into multiple potential outcomes to inform future management. - Scenarios were detailed and precise, allowing for meaningful evaluation in the scenario analysis.	- Scenario analysis did not include stakeholder collaboration or incorporation of social and Traditional knowledge. - Scenario was developed after initial cumulative effects assessment.	This method could be applied to projects in the NWT that induce linear features of disturbance (e.g., roads, pipelines).
Bathurst Inlet Port and Road	Scenario analysis – development of one future scenario that describes past, current, and future development and estimation of resulting material imports/exports and traffic.	Semi-quantitative.	Scientific knowledge was incorporated through estimation of import/export quantities and resulting truck and barge traffic using information available for confirmed and potential projects. Stakeholder input was not described for the scenario analysis; uncertain if and how social and Traditional knowledge was incorporated.	Project descriptions for past, current, and future projects, including induced development projects.	Widely applicable to common project types for which the induced development has been identified and described.	Simple and quick evaluation of induced development (low effort, did not require collection of new data).	- The scenario did not consider potential induced development activities that are not documented and described (e.g., increased access for hunting and trapping). - Scenario analysis did not involve stakeholder collaboration or incorporation of social and Traditional knowledge.	This method is widely applicable to the various project types in the NWT.
Baffin Bay and Davis Strait SEA	Scenario analysis – development of four scenarios that describe oil and gas exploration and development activities.	Qualitative.	Scientific, social, and Traditional knowledge was collected during the SEA, but it is unclear how that information was used to inform development of the four scenarios.	High level understanding of potential exploration and development methods for oil and gas and the resulting costs, infrastructure, and malfunctions.	Applicable to oil and gas development but could be extended to other project types using expert-based methods to identify drivers of change.	Evaluated multiple scenarios to understand different outcomes and future management needs.	Scenario analysis did not involve stakeholder collaboration or incorporation of social and Traditional knowledge.	This method could be applied to understanding regional oil and gas development in NWT when quantitative information about potential impacts is not needed or available. The general approach could be extended to other project types (e.g., roads, mines).

Notes: NWT = Northwest Territories; SEA = strategic environmental assessment.

4.0 RECOMMENDATIONS AND CONCLUSIONS

This report has:

1. Identified and described the methods for evaluating induced development impacts from review of guidance documents and literature with a focus on quantitative methods.
2. Identified case studies in northern Canada that evaluated induced development as part of the EA process and selected case studies for detailed review and evaluation based on the information available for these case studies.
3. For the case studies selected for detailed review, evaluated the methods used to consider induced development impacts and the merit of these methods.
4. Provided recommendations regarding the applicability and use of methods for evaluating induced development impacts.

The key findings from the review include:

- Scenario analysis is a commonly recommended method for evaluating induced development impacts; the other methods identified from the literature review (e.g., qualitative trend analysis) relate to scenario analysis as they either result in development of a scenario or can be used to develop or evaluate scenarios within the scenario analysis.
- Scenario analysis is a structured process for developing scenarios (i.e., plausible descriptions of future conditions) and evaluating their implications; however, there is no standard method or prescriptive process for conducting scenario analysis.
- Scenario analysis was a common method used to evaluate induced development impacts for Canadian case studies; however, in practice, scenario analysis lacks aspects that are needed for a “good” scenario analysis (e.g., stakeholder engagement, transparency, and development of multiple scenarios).

The following are recommended to aid evaluation of induced development impacts using scenario analysis:

1. Scenario analysis should follow a structured process that includes, at least, the following steps:
 - a. Define the purpose and scope of the scenario analysis.
 - b. Define the scenario logics that influence the future development.
 - c. Describe the scenarios.
 - d. Evaluate the implications of the scenarios.
 - e. Input the scenarios in the cumulative effects assessment.
2. Scenario analysis should aim to include the following components to ensure the scenario sufficiently addresses and evaluates induced development impacts:
 - a. Development of two to five plausible scenarios that are precise and detailed.
 - b. Use of existing information and reference to similar developments to support qualitative and/or quantitative description of scenarios (e.g., project descriptions for similar projects).
 - c. Stakeholder collaboration and incorporation of scientific, social, and Traditional knowledge.
 - d. Transparent and well-communicated scenario analysis.
 - e. Early incorporation of scenario analysis in the EA process, if possible.
3. Develop between two to five scenarios to evaluate induced development with consideration of the purpose of the scenario analysis, processes that influence future development, and stakeholder input. Multiple scenarios are needed to better understand the breadth of potential future impacts and their management needs; thus, it is not necessary to evaluate the likelihood of the scenarios and select the most likely scenario as this may limit the understanding of potential impacts.

5.0 CLOSING

This report has been prepared exclusively for the use of the GNWT for the specific application described within this report. The details provided in this report are for general information purposes only. The information and recommendations contained in this report should not be used for any other purpose, at another location, or by any other parties. Any use of, or reliance on this report by any third party is at that party's sole risk. ARKTIS assumes no responsibility for inappropriate use of the contents of this report, and disclaims all liability arising from negligence or otherwise. General terms and conditions are provided in Appendix B.

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APPENDIX A: CASE STUDIES REVIEWED

All projects that were reviewed to identify case studies that evaluated induced development impacts are summarized in Table A-1. Table A-1. Projects that were selected for detailed case study review are bolded.

Table A-1. Summary of projects reviewed to identify case studies for detailed review.

Project ^a	Location	Were Induced Development Impacts Evaluated in the Project EA?	Method of Evaluation
Prairie Creek All Season Road	NWT	No	N/A
Mackenzie Valley Highway	NWT	No	N/A
Mackenzie Gas Project	NWT	Yes	Scenario analysis
Grays Bay Port and Road	NWT	No – project not progressed to effects assessment	N/A
Mary River Mine	NU	Yes	Scenario analysis (informal)
Taltson Hydroelectric Expansion Project	NWT	No	N/A
Jay Project	NWT	No	N/A
Bathurst Inlet Port and Road	NU	Yes	Scenario analysis
Lockhart All Season Road	NWT	No - project not progressed to effects assessment	N/A
Baffin Bay and Davis Strait (SEA)	NU	Yes	Scenario analysis
Beaufort Regional Environmental Assessment (REA)	NU	No	N/A
Tlicho All Season Road	NWT	No	N/A
Dehcho Bridge	NWT	No	N/A
Casino-Rude Road Construction Project	YK	No - project not progressed to effects assessment	N/A
Inuvik-Tuktoyaktuk All Season Road	NWT	No	N/A

Notes: N/A = not applicable, EA = Environmental Assessment, NWT = Northwest Territories, NU = Nunavut, YK = Yukon.

^a Bolded projects were selected as case studies for detailed review.

APPENDIX B: GENERAL TERMS AND CONDITIONS

USE OF REPORT

This report pertains to a specific site, a specific development, and a specific scope of work. It is not applicable to any other sites, nor should it be relied upon for types of development other than those to which it refers. Any variation from the site or proposed development would necessitate a supplementary investigation and assessment.

This report and the assessments and recommendations contained in it are intended for the sole use of ARKTIS Solutions Inc.'s (ARKTIS) client. ARKTIS does not accept any responsibility for the accuracy of any of the data, the analysis or the recommendations contained or referenced in the report when the report is used or relied upon by any party other than ARKTIS' client unless otherwise authorized in writing by ARKTIS. Any unauthorized use of the report is at the sole risk of the user.

LIMITATIONS OF REPORT

This report is based solely on the conditions which existed on site at the time of ARKTIS' investigation. The client, and any other parties using this report with the express written consent of the clients and ARKTIS, acknowledge that conditions affecting the environmental assessment of the site can vary with time and that the conclusions and recommendations set out in this report are time sensitive.

The client, and any other party using this report with the express written consent of the client and ARKTIS, also acknowledge that the conclusions and recommendations set out in this report are based on limited observations and testing on the subject site and that conditions may vary across the site which, in turn, could affect the conclusions and recommendations made.

The client acknowledges that ARKTIS is neither qualified to, nor is it making, any recommendations with respect to the purchase, sale, investment or development of the property, the decisions on which are the sole responsibility of the client.

During the performance of the work and the preparation of this report, ARKTIS may have relied on the information provided by persons other than the client. While ARKTIS endeavors to verify the accuracy of such information when instructed to do so by the client, ARKTIS accepts no responsibility for the accuracy or the reliability of such information which may affect the report.

STANDARD OF CARE

Services performed by ARKTIS for this report have been conducted in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions in the jurisdiction in which the services are provided, subject to the time limits and financial and physical constraints applicable to the services. Professional judgment has been applied in developing the conclusions and/or recommendations provided in this report. No warranty or guarantee, express or implied, is made concerning the test results, comments, recommendations, or any other portion of this report.

ALTERNATE REPORT FORMAT

Where ARKTIS submits both electronic file and hard copy versions of reports, drawings and other project related documents and deliverables (collectively termed instruments of professional service), the Client agrees that only the signed and sealed hard copy versions shall be considered final and legally binding. The hard copy versions submitted by ARKTIS shall be the original documents for record and working purposes, and, in the event of a dispute or discrepancies, the hard copy versions shall govern over the electronic versions. Furthermore, the Client agrees and waives all future right of dispute that the original hard copy signed version archived by ARKTIS shall be deemed to be the overall original for the Project.

The Client agrees that both electronic file and hard copy versions of instruments of professional services shall not, under any circumstances, no matter who owns or uses them, be altered by any party except ARKTIS. The Client warrants that instruments of professional services will be used only and exactly as submitted by ARKTIS.