Public Interest Benefit Evaluation of the Enbridge Northern Gateway Pipeline Project: Update and Reply Evidence

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Background

Enbridge Northern Gateway Pipelines (Northern Gateway or NGP) is proposing to construct and operate a pipeline project to provide tidewater access to new markets for Canadian oil sands production. This consists of a line from near Edmonton, Alberta to a marine terminal at Kitimat, British Columbia to transport synthetic crude oil (SCO) and diluted bitumen and a line to transport condensate from Kitimat to Edmonton. At full capacity these lines could move an average of 525,000 barrels per day (bpd) (or 83,500 m^3 per day) of oil and 193,000 bpd (or 30,700 m^3/d) of condensate. The anticipated in-service date for the project is August 2018 but for analytical purposes we have assumed it to be January 1, 2019.

Northern Gateway has filed an application with the National Energy Board (NEB or 'the Board') for approval to construct and operate the Northern Gateway project. In its evaluation the Board must consider, among other things, the need for the project and whether it is in the Canadian public interest.

Objective

The objective of this report is to update the previous (2010) impact study and present reply evidence in relation to intervenors' submissions dealing with the report, including a detailed Cost Benefit Analysis (CBA) of the Northern Gateway project.

In evaluating the public interest aspects of a project such as the NGP it is useful to recall Section 52 of the NEB Act. It reads as follows:

"The Board may, subject to the approval of the Governor in Council, issue a certificate in respect of a pipeline if the Board is satisfied that the pipeline is and will be required by the present and future public convenience and necessity and, in considering an application for a certificate, the Board shall have regard to all considerations that appear to it to be relevant, and may have regard to the following:

a) the availability of oil or gas to the pipeline;
b) the existence of markets, actual or potential;
c) the economic feasibility of the pipeline;
d) the financial responsibility and financial structure of the applicant, the methods of financing the pipeline and the extent to which Canadians will have an opportunity of participating in the financing, engineering and construction of the pipeline; and
e) any public interest that in the Board's opinion may be affected by the granting or the refusing of the application."[1]

These criteria taken together and interpreted by the NEB have been likened by the NEB Chairman as equivalent to requiring that a project contribute to sustainability of the Canadian economy generally and of the energy sector specifically.[2] For decades, the NEB has acknowledged that the social, environmental, financial and economic dimensions of projects are to be assessed in its decision making.

Clearly the NEB must balance the private interest with the public interest which is a hallmark of sustainability. One would also expect the resilience of a project to be a consideration.

This report informs the issue of sustainability through its use of the best available tools of economic analysis: the Economic Impact Analysis and the social Cost Benefit Analysis (CBA). The former provides information relating to the macroeconomic impacts on Canadians such as GDP, incomes and jobs, and their distribution over time and geographically. The social cost benefit analysis provides an assessment of the net economic benefits or economic welfare stemming from the NGP. It measures the efficiency of deploying economic resources such as labour and capital in order to earn a series of benefits. Importantly, the CBA considers explicitly those "externalities" or other effects which may not be considered by a private investor, such as certain benefits (e.g. reduction of unemployment or oil price uplifts for producers) and the cost expectations that may occur from environmental impacts.

[1] NEB Act, Section 52
[2] "The National Energy Board's Contribution to Canada's Pursuit of a Sustainable Energy Future." Speech by NEB Chairman Caron to Alberta Chamber of Commerce, 2012

Context

The underlying economic, policy and energy market environment within which the project is evaluated includes the following:

- The Canadian petroleum industry fits the classic definition of a basic, key or motor industry that forms the base of economic growth, development and prosperity. It has been and remains a key driver of the Canadian economy and numerous regional economies in the nation. Estimated contributions of this sector over the next 25 years include $3.6 trillion in GDP, 25 million person years of employment and over $1.1 trillion in net revenues for the federal and provincial governments. The net wealth[3] associated with just the oil sands component of the industry is estimated at almost $1.5 trillion, equivalent to about $44,000 for each Canadian or roughly 18 per cent of Canada's entire tangible wealth.

- Growth in global energy demand is expected to be substantial, with Asian markets accounting for over half of this growth. The Northern Gateway project provides critical tidewater access to the fastest growing markets and provides important market and trade diversification benefits for Canada. The Canadian petroleum sector is quite unique in that at present virtually all of its exports go to just one foreign market. The market diversification associated with the Northern Gateway project can significantly contribute to a higher and more stable value for Canadian resources and their contributions to long term prosperity.

- The petroleum sector represents a major component of Canada's comparative advantage in an increasingly competitive global economy. The very large contributions of the petroleum sector to Canadian output, employment, incomes and government revenues are clearly important to sustaining national prosperity.

- A number of related issues raised by intervenors are addressed at the outset. Of particular note are the allegations that the Northern Gateway project would, through various mechanisms embodied in

[3] Net wealth is the present value of the expected market value of production less production costs and costs associated with Green House Gas emissions.

the Dutch Disease theory, result in a permanent decline in Canadian output, incomes, employment and government revenues. As a single project aimed at diversifying markets for Western Canadian oil it is not credible that it would or could drive growth of the entire resource sector to a degree required to create Dutch Disease.

- The empirical studies provide inconclusive evidence of the existence and significance of Dutch Disease in Canada. While some suggest rising commodity prices in the period 2004-2007 played a partial role in appreciation of the Canadian dollar thereby negatively impacting employment in a subset of the manufacturing sector, this has not been a significant issue in earlier or later periods. Further, the Dutch Disease studies for Canada are flawed by the inability to show that there has been any permanent change in manufacturing employment or that in terms of positive externalities such as through technological innovation, that those are greater for manufacturing than for the resource sector, including oil and gas. It is useful to note that the majority (over three quarters) of employment in Canada and the provinces is in the services sectors, compared to about 10% in manufacturing. Finally, as noted by the Governor of the Bank of Canada and various empirical studies, the increases in commodity prices have increased total value added (or GDP), per capita disposable income and purchasing power, investment, and government revenues.

IMPACT ANALYSIS

Methodology

Important consequences of the Northern Gateway project include the economic impacts on Canadian and regional investment, labour income, overall value added (or Gross Domestic Product), employment and government revenues. These are associated with the direct, indirect and induced effects arising from the construction and operation of the pipelines, from the increase in prices received by Canadian oil producers as a result of the reduction in discounts in the U.S. market for Canadian oil, from the reinvestment arising from these increased revenues and from the price and stabilization effects of market diversification.

- The approach used in this report includes the modelling of Canadian energy balances, the use of results from modelling Canadian crude oil market allocation and oil price/netbacks associated with Northern Gateway, and a macro-economic impact analysis using an input output framework. The newest Statistics Canada Interprovincial Input Output model is employed, along with updated oil price uplift estimates and project investment costs, to produce updated estimates of the macro-economic impacts associated with the Northern Gateway project.

- Certain methodological objections in intervenors' evidence are addressed. It is demonstrated that these objections are not sustained but rather are the result of a combination of errors in fact, logic and theory. One intervenor's claim is that reducing the price discount on Western Canadian oil sold in export markets (and thereby increasing the price these producers receive by 2-3%) will cause significantly and continuously higher inflation rates, higher interest rates, and a decline in output, incomes, employment and government revenues. If one were to accept this flawed logic, the non-credible conclusion is that for a small, open economy such as Canada's, the country would gain output, incomes, employment and government revenues if it simply discounted the price it receives for its commodities sold in export markets.

- There are considerable uncertainties, particularly in relation to market shifts and policies in the single (US) export market that Western Canadian oil producers can generally access. These give rise to significant diversification, stabilization, and option values associated with the project. These benefits are difficult to quantify but they are nonetheless real and important, and they are in addition to the measurable direct and indirect contributions to Canadian incomes, production, employment and government revenues.

- The approach used to estimate the quantified economic impacts in Canada of Northern Gateway involves the comparison of results for two cases: a Benchmark case that does not include the project and a case that assumes the construction and operation of Northern Gateway.

- This Northern Gateway Case assumes that total Canadian oil sands production remains the same as in a benchmark forecast but some oil exports that would otherwise go to U.S. markets are sent via the Northern Gateway project to Asian markets. While Canadian crude oil production volumes are unchanged, there is an increase in the value of this production which would benefit all Western Canadian oil producers. The incremental net revenues from this would in part be reinvested in the economy and generate further gains to output, employment, incomes and government revenues in Canada.

Estimated Impacts

Based on this analysis, the total (direct, indirect and induced) estimated economic impacts for the main case over the construction and operating period (to 2048) are summarized below (in millions of year 2012 Cdn$; employment in person years), along with the corresponding annual averages.

TOTAL IMPACTS - Sum to 2048	**BC**	**Alberta**	**Ontario**	**Quebec**	**Sask**	**Other**	**Canada**
Direct, Indirect and Induced							
Investment/Revenues	52841	208047			30006	10483	301376
Labour Income	18302	36394	6778	1904	4697	1872	69948
GDP	55163	207501	10774	3063	24544	10468	311514
Federal Government Revenue	6627	30962	2016	404	3277	1027	44314
Provincial Government Revenue	8623	36884	1302	557	5179	1459	54005
Total Government Revenue	15251	67846	3319	960	8457	2486	98319
Employment	263037	401147	104069	34099	72320	32395	907067

TOTAL IMPACTS - Annual Averages							
Direct, Indirect and Induced							
Investment/Revenues	1554	6119			883	308	8864
Labour Income	538	1070	199	56	138	55	2057
GDP	1622	6103	317	90	722	308	9162
Federal Government Revenue	195	911	59	12	96	30	1303
Provincial Government Revenue	254	1085	38	16	152	43	1588
Total Government Revenue	449	1995	98	28	249	73	2892
Employment	7736	11798	3061	1003	2127	953	26678

Detailed estimates of each of the impact components associated with the project are also provided.

These widely-distributed impacts of Northern Gateway include:

- A gain of about $312 billion in Canadian GDP (Gross Domestic Product), equivalent to about 2 months of output for the entire Canadian economy. Alternatively, this amounts to an average annual gain of $9.2 billion, equivalent to an increase of about a 0.5

percentage points in the growth rate for Canadian GDP at current levels.

- The total employment impact is estimated to be 907 thousand person years over the construction and operations period. Expressed differently, the average annual increase in employment as a result of Northern Gateway would be equal to approximately 6 per cent of the average annual increase in total Canadian employment over the years 2005 to 2008, a period of strong growth.

- The $98 billion increase in government revenue over the entire operating period would be equivalent on an annual basis to over 0.5 of a per cent annual increase in total federal plus provincial government revenues.

These impacts are widely distributed across the country. For example, the approximate geographical distribution of this incremental employment would be: 263,000 person years in B.C.; 401,000 in Alberta; 72,000 in Saskatchewan; 104,000 in Ontario; 34,000 in Quebec and 32,000 distributed among the remaining regions.

These estimates of impacts are conservative for a number of reasons:

- The Muse, Stancil & Co. (Muse Stancil) estimates of oil price uplifts that are used in the analysis are reasonable and balanced, as argued by Muse Stancil, and are consistent with some conservative assumptions outlined in the report.[4] Given this, and the fact that no shut in oil production due to lack of market access is assumed, the actual gains to the Canadian and regional economies are more likely to be underestimated than overestimated.

- Northern Gateway generates important diversification and option values but these have not been quantified and therefore are not included as estimated benefits. Nevertheless, these values are real, substantial and likely growing in importance given the uncertainties with respect to future policies affecting traditional markets for Canadian oil, the growing differences among key oil markets in

[4] See Muse, Stancil & Co., *Market Prospects And Benefits Analysis For The Northern Gateway Project, July 2012*, page 4.

terms of growth rates, and generally the potential arbitrage opportunities and the gains in stability through market diversification.

- It could be argued that the estimated economic gains resulting from the project will prove to be overestimates if in the future the economy was operating at or near full capacity. However, in general, conditions of excess capacity and unemployment rates above the 'full employment' or 'non-accelerating inflation' level prevail, with only occasional and usually short periods of time when the economy is operating at or near capacity. Under these usual conditions, the impacts estimated here are well within the normal and growing absorptive capacity of the economy. As such, significant dislocations would not be expected.

- In summary, the analysis undertaken in this study indicates that Northern Gateway would be a catalyst for the generation of substantial and widely-distributed economic impacts in Canada and a significant contributor to sustaining Canadian growth and prosperity for many years into the future.

COST BENEFIT ANALYSIS (CBA)

Methodology

The objective in the social CBA undertaken is to determine whether the Northern Gateway project can be expected to produce a net gain in total welfare of Canada. In essence, it amounts to a determination whether all private and social benefits directly attributable to the project are sufficient to generate a net gain after deducting all private and social costs directly attributable to the project.

Key elements in this analysis, including sensitivity tests, are noted below:

- *Direct Cash Flows from Project*: investment and operating costs, and tolls paid by the shippers generate cash flow costs and benefits to the private sector debt and equity owners of NGP, along with property taxes for local governments and income taxes for provincial and federal governments.

- *Adjustment for Reducing Unemployment*: for taking into account the fact that some portion of the direct employees of NGP would otherwise be unemployed. Therefore their costs should not be counted as a resource cost for the project.

- *Costs from Excess Capacity on Main Oil Pipelines to US*: the switching of 500,000 barrels per day from US markets towards shipment to Asia as a result of NGP will likely induce costs or lost revenues for the main oil export pipeline for a few years.

- *NGP "Needed" or Not, before certain year*: if the NGP is viewed as not being necessary (from point of view of Canada's overall pipeline capacity) then the revenues paid by the shippers of oil may be viewed as not being benefits and should therefore be deducted.

- *Canadian Oil Price Uplift*: generates additional revenues for private sector individuals and companies and for the public sector in the form of incremental taxes and royalties. However the price uplift will increase the costs incurred by Canadian refineries using Western Canadian Sedimentary Basin (WCSB) oil.

- *Environmental Impacts*: the cost expectation of all environmental impacts, including the expected social value associated with loss of ecological services and the social costs associated with GHGs from project activities.

- *Oil or Condensate Spills:* the risk and expected cost of spill impacts, including those associated with the offshore related to tanker traffic in Canadian waters, the Marine Terminal and the onshore pipelines and other terminals.

Along with a 'most likely' or base case, the net social benefits are calculated for a number of sensitivity cases used to capture and evaluate the main uncertainties.

Results

- Using the social discount rate of 8% and in terms of real or constant dollars, the Base Case shows a social net benefit of $23.5 billion, equivalent to a social rate of return of almost 33%. The results from the many sensitivity cases show that this net benefit value is generally robust even when subjected to wide variations in the parameters affecting its components, including the doubling of costs and halving of benefits.

- The oil price uplift is important to making the project robust and yielding high net social benefits. In a sensitivity case with only half of the oil price uplift, assumed to be realized for only five years, the overall net benefit remains positive $3.65 billion at 8% discount rate. The social rate of return is 17.6%.

- Without any oil price uplift, the social rate of return is 7.6% and the project would be viewed as marginally acceptable.

- In another sensitivity case, with the oil price uplift reduced by 50% and only continuing for 5 years, along with all the cost components doubled and other benefit components halved, the overall net benefit is positive $2.58 billion, at 8% discount rate.[5] It can be argued that this sensitivity case (more than) covers the issues raised by intervenors of possible increases in cost expectations from oil spills resulting from a potential increase in oil volumes shipped through the project.

- In the analysis we have attempted to err on the side of caution in all of the estimates of externality costs associated with possible environmental impacts and oil spills. Thus, another sensitivity test of the project included increasing the oil spill cost expectations to the point that the Base Case net benefit would become zero. It was found that the estimated oil spill cost expectations would have to be increased by more than 280 times. This indicates a substantial cushion in support of the social net benefit of the project.

- The bottom line of the CBA analysis is that the economics of the project from the national Canadian perspective are very favourable:

[5] Sensitivity Case 3, in Appendix C

the estimated net benefits are expected to be both large and highly likely.

- An over-riding factor in determining a successful project, not only in rather narrow CBA terms, but in relation to the broad public interest, is that the probabilities of upsets should be controlled so as to be negligible in the context of the entire project. It is expected that this will be a continuing pre-occupation of any responsible project proponent and of its regulator, presently and through the life of the project. Both for the Offshore and the Onshore, the project proponents have indicated that they are committed to mitigation measures to minimize risks.

- The recent historical trend of a continuing reduction in externality costs, such as from oil spill risks, is noteworthy and it can be expected to continue as a result of practical experience and technological improvements over the thirty or more years of the project.

Conclusion

The analysis undertaken in this study indicates that Northern Gateway would be a catalyst for the generation of substantial and widely-distributed economic stimulus for Canada and a significant contributor to sustaining Canadian growth and prosperity for many years into the future. While the benefits of greater flexibility, adaptability and opportunity for the Canadian petroleum sector, through market expansion and diversification, have not been quantified, they are also real and important.

Further, the cost benefit analysis indicates that, taking into account all benefits and costs, including cost expectations from oil spills, there is a large and robust net social benefit associated with the project from a national Canadian perspective.

1. Introduction

1.1 Background

Northern Gateway Pipelines Limited Partnership (Northern Gateway) is proposing to construct and operate a pipeline project (the Project) to provide tidewater access to important new markets for Canadian oil and condensate supply for Western Canada. In summary, the Project consists of:

- a 914mm (36") OD line stretching 1,172 km from near Edmonton, Alberta to a marine terminal at Kitimat, British Columbia with the capacity to transport an average of 525,000 barrels per day (525Mb/d) or 83,500 m^3 per day (m^3/d) of oil.
- a 508 mm (20") OD line to transport condensate from Kitimat to a terminal near Edmonton with a capacity to transport an average of 193,000 barrels per day (193 Mb/d) or 30,700 m^3 per day (m^3/d) of condensate.
- 10 pump stations for oil and condensate.
- 2 permanent berths at Kitimat, along with 14 tanks and infrastructure to support potentially two additional tanks at the Kitimat terminal.
- Ancillary marine services equipment, including tugs, first response equipment and equipment for navigational aids.

The estimated capital cost of the Project, incurred 2010 to 2019, is $6.393 billion (in year 2012 Cdn$)[6] and direct annual operating expenditures are estimated to average $341 million (2012$) over the operating period.[7] About 90% of the capital spending would take place over the period 2015 to 2018, with full operation planned to begin in August of 2018.

Northern Gateway has filed an application with the National Energy Board (NEB or 'the Board') for approval to construct and operate the Project. As previously mentioned, Section 52 of the *National Energy Board Act* provides guidance as to the considerations the Board must generally take into account in determining whether a pipeline project is approved. Two of

[6] See Table 2.1 for a breakdown.
[7] These costs rise from $298 million (2012$) at the start of operations to $392 million at the end of the operating period. They include property taxes (which increase over time) but exclude corporate income taxes. They also include $68 million for operating costs of associated facilities which remain constant in real terms over the period.

these considerations relate to the need for the project and whether it is in the public interest.

1.2 Study Objective

In 2009, Fraser Milner Casgrain (FMC), acting for Northern Gateway, requested Wright Mansell Research Ltd. (WMR) to undertake an evaluation of the Canadian benefits of the Northern Gateway project with respect to need and public interest considerations. In response, WMR prepared a report which was submitted as part of the Northern Gateway application to the Board.[8] Henceforth, this will be referred to at the WMR 2010 report.

The objectives in the present report (henceforth referred to as the WMR 2012 report) are:

- **to provide an update of the impact analysis presented in the WMR 2010 report, and**
- **to present reply evidence in relation to intervenors' comments on that report, including a detailed Cost Benefit Analysis (CBA) of the project.**

In the interest of providing continuity, some sections of the earlier report are repeated here.

1.3 Context

It is important at the outset to note some basic realities with regard to the overall economic and energy environment within which the Northern Gateway project is to be evaluated. These are outlined below.

Small Open Economy

In terms of its structure and functioning, Canada's economy is classified as a 'small, open economy'. In essence this means the primary driver is its exporting sectors and, in general, it is a 'price taker' (rather than a 'price setter') in its export markets. As such, while other elements of national

[8] See B1-4, Vol 2, Gateway Application, Economics, Commercial and Financing (Part 1 of 1), A1S9X7, May 2010, Appendix B – *Public Interest Benefits of the Enbridge Northern Gateway Pipeline Project,* Wright Mansell Research Ltd., March 2010.

output (Gross Domestic Product or GDP) such as consumer and government expenditures on goods and services (and related investment expenditures and imports) are important, they are mainly endogenously determined. That is, they are primarily driven by Canadian incomes that are, in turn, directly or indirectly reliant on the revenues and economic activity generated by basic or exporting sectors. Put differently, in the absence of strong and vibrant export sectors, there are no sustainable mechanisms through which sufficient revenues can be generated to pay for the large imports of goods and services that cannot be competitively supplied by domestic firms serving a relatively small domestic market. Similarly, Canada's regional and local economies are also classified and modelled as 'small, open economies'.

For Canada the dominant net exports (that is, the difference between exports and imports) are those from the resource sector - agriculture and fishing, energy products and forestry products. For example, in 2009, the net contribution of these resource-based sectors to Canada's trade balance was +$89 billion (52% of which was contributed by energy) compared to -$79 billion for the other exporting sectors.[9]

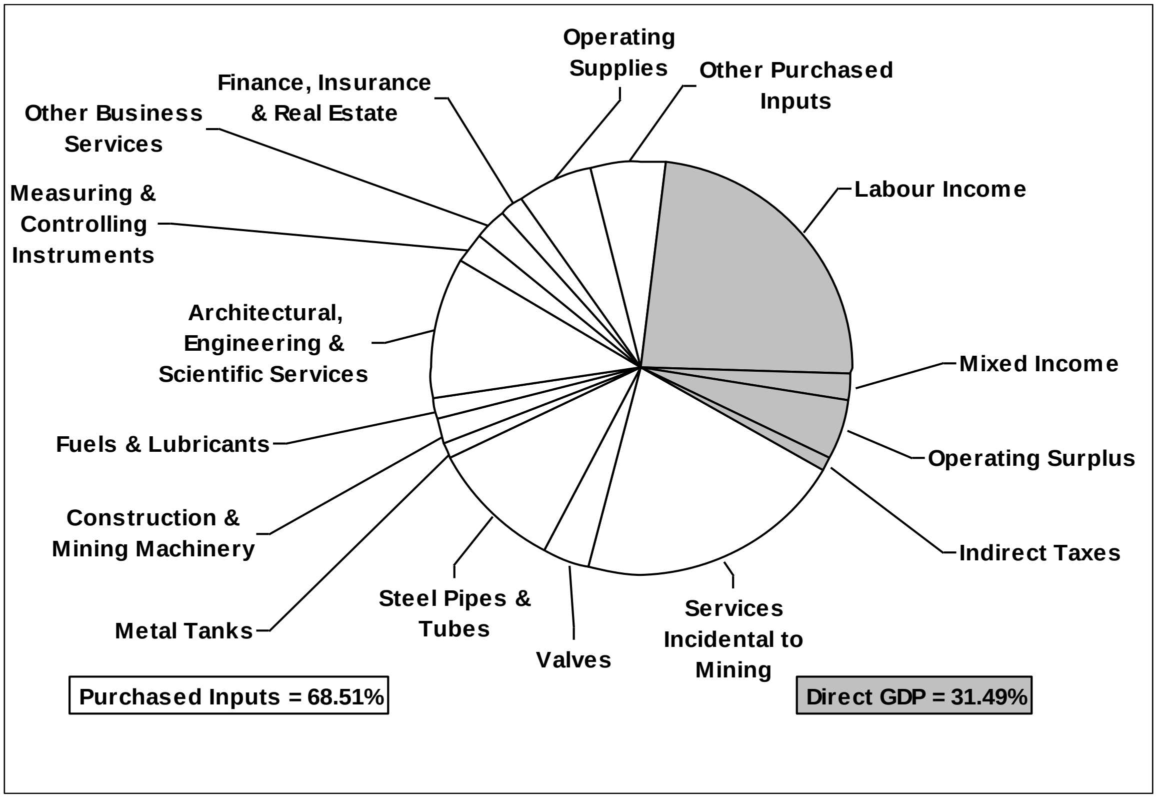
Contributions of the Petroleum Sector to the Canadian and Regional Economies

The petroleum industry in Canada fits the classical definition of a basic, key or motor industry. Such industries form the base of economic development, growth and prosperity.[10] In general, they exhibit a strong comparative advantage in international markets, they involve massive amounts of capital, they generate large export revenues, and they have strong forward and backward linkages. The result is large inter-industry multiplier impacts. As indicated in Figure 1.1 for representative oil and gas engineering projects, roughly two thirds of the investment expenditures involve inputs from a wide range of manufacturing and service sectors.

[9] Source: Data from Statistics Canada. www40.statcan.gc.ca/101/cst01/gblec04-eng.htm and www40.statcan.gc.ca/101/cst01/gblec05-eng.htm

[10] A summary of the relevant concepts and theory can be found in any standard text on economic growth and development, such as E.M. Hoover and F. Giarratani, *An Introduction to Regional Economics*, Third Edition, Knopf: New York, pp. 314-330.

Figure 1.1: Distribution of Investment Impacts for Canada Associated with Oil and Gas Engineering Construction



Note: Operating Surplus includes interest, depreciation, income taxes and after-tax profits.
Source: Statistics Canada, Industry Accounts Division

In the case of the petroleum sector, these inter-industry impacts are further enhanced by the high output per worker and highly skilled labour requirements that translate into high average wage and income levels. Further enhancement arises from the substantial contributions to government revenues that are also cycled through the economy.

Given these characteristics it is not surprising that the petroleum sector has been and remains a major driver of economic growth and prosperity in Canada and in many of its regions. For example, it directly or indirectly accounts for about 8% of national Gross Domestic Product (GDP), it represents the largest single private sector investor in the country and it is the largest net contributor to Canada's positive trade balance.[11] Further, it is

[11] For example, in 2008 oil and gas exports amounted to $94 billion or just under 20% of total Canadian exports. For the same year, total capital expenditures by this sector on construction and machinery and equipment was about $61 billion or equal to approximately 28% of all such capital expenditures in Canada,

a major component of Canada's total wealth. For example, an analysis by the Canadian Centre for the Study of Living Standards estimated that in 2008 the wealth in Canada's oil sands, even after reducing the value by the costs of GHG emissions, amounts to almost $1.5 trillion. This is equivalent to about $44,000 for every Canadian and represents 18% of Canada's entire tangible wealth.[12]

These contributions of the resource sector (of which oil and gas is the dominant component) have been emphasized by the Governor of the Bank of Canada.

> "Although natural resources as a whole represent only 6 per cent of direct employment and 12 per cent of GDP, the sector has an important influence on Canadian economic activity through a number of channels. Resources account for roughly one-third of all business investment and about 45 per cent of our exports. As such, the benefits of the current commodity boom can be felt across Canada – not just in resource-heavy sectors and regions.
>
> Above all, rising commodity prices have made Canada wealthier as a nation. Since 2002, rising commodity prices have fuelled a 25 per cent improvement in our terms of trade, which alone has been responsible for roughly two-thirds of the 15 per cent gain in real per capita disposable income recorded over that period. These income gains have helped reduce corporate leverage to its lowest level in a quarter of a century and have helped our governments to record consistent fiscal surpluses. Higher commodity prices bring increased investment, which entails direct and indirect benefits not only for the sectors in question, but also for the service sectors that support them. As well, many individual Canadians – and their pension funds – have benefited greatly from the gains in the value of their own investments in commodity-producing firms. Finally, the rise in our terms of trade has brought with it an associated appreciation of our currency that has benefited everyone by lowering the cost of imported goods and services. With this downward pressure on import prices, productivity-enhancing machinery and equipment – much of which is imported – has become less expensive for all firms, not just commodity producers."[13]

excluding those on housing and by government (or equal to 18% if all capital expenditures on construction and machinery and equipment are included). Statistics Canada [CANSIM 228-0003 and 029-0005]

[12] Tangible wealth includes, for Canada, the total net Capital Stock, the stock of Research and Development, the net international investment position, the stock of natural resources (net of costs, including life cycle GHG costs) and the total stock of Human Capital (i.e. the sum of all investment in education). See CSLS (Centre for the Study of Living Standards), *The Valuation of Alberta Oil Sands*, CSLS Research Report No. 2008-7, November 2008.

[13] http://www.bankofcanada.ca/2008/06/speeches/capitalizing-commodity-boom-role-monetary-policy/

In the context of these remarks by the Governor of the Bank of Canada it is important to note that, contrary to the view expressed by Robyn Allan that an increase in export prices for oil is simply inflation that damages the domestic economy,[14] such an increase improves Canada's terms of trade[15] and, particularly for a small, open economy, generates significant gains in levels of economic activity and in real (or inflation adjusted) per capita income. Additional evidence supporting this standard conclusion is provided in a later section.

The potential remains for the oil and gas sector to continue to be a key driver of the economy for many years into the future. In its base case, assuming adequate infrastructure such as pipelines, the Canadian Energy Research Institute (CERI) estimates that over the 25 year period 2009-2033, the upstream oil and gas sector will invest $1.09 trillion (2008Cdn$) in Canada and the direct plus indirect contributions of this sector to the economy will amount to:

- $3.6 trillion in GDP,
- $409 billion in net federal taxes,
- $429 billion in royalties,
- $282 billion in net provincial taxes and,
- almost 25 million person years of employment.[16]

These contributions are roughly split between the conventional and unconventional oil and gas sector and are fairly widely spread across the country with Alberta, British Columbia, Saskatchewan and Ontario being the largest beneficiaries of the direct impacts.

The sustainability of Canadian living standards requires development and expansion of basic or propulsive industries. Other sectors such as manufacturing that historically have also been important drivers for the

[14] See *An Economic Assessment of Northern Gateway*, Robyn Allan, January 2012, A2L7D1, p.5. As indicated there, it is alleged that the increase in export prices for Western Canadian oil producers arising from Northern Gateway is "...an inflationary price shock" and "The inflation Northern Gateway represents will lead to higher interest rates, a permanent and long term decline in GDP, a loss of existing jobs, decline in labour income and standard of living for many Canadians, as well as a deterioration of government revenues."

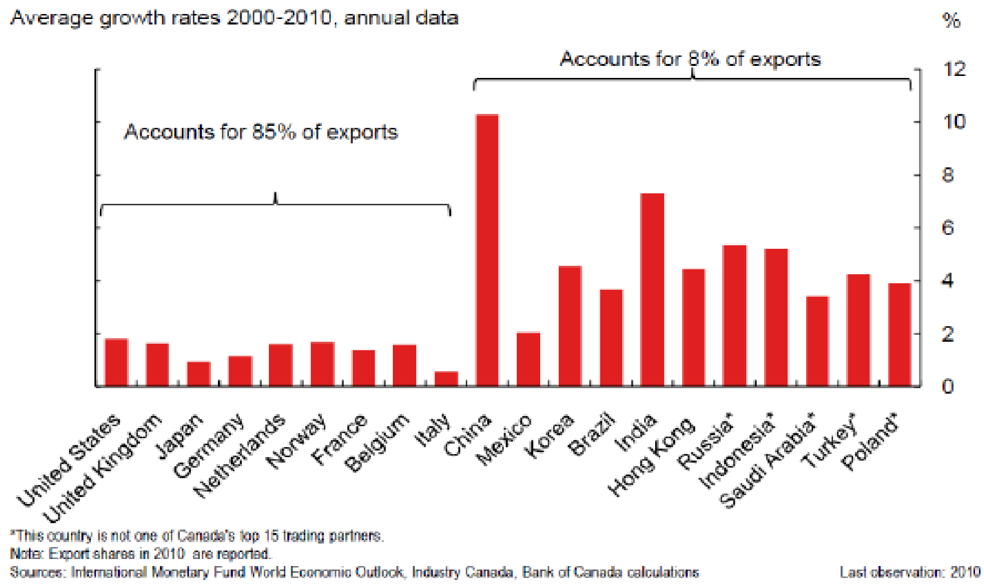
[15] The terms of trade is the ratio of the prices for exports to the prices for imports.

[16] See Canadian Energy Research Institute, *Economic Impacts of the Petroleum Industry in Canada,* Summary Report, July 2009, pp. 5-12. Estimates include some impacts associated with other oil and gas related projects with a total capital investment of $24 billion. All dollar figures are expressed in terms of 2008Cdn$.

national economy are expected to continue to face increasing competition from lower-wage, developing countries. In this context the continued development of the petroleum sector takes on added importance. Quite simply, it is difficult to identify any other sectors of comparable size, contributions, potential and comparative advantage that can maintain and enhance Canadian prosperity. Further, these prosperity benefits are spread widely across the country through indirect linkages (for example, through the purchases of inputs produced in regions other than where petroleum is produced) and through fiscal linkages (for example, as one of the largest industrial contributors to federal revenues, the petroleum sector significantly supports programs such as fiscal equalization that transfer substantial benefits to the provinces east of Alberta and to the northern territories).

In a recent (April 2, 2012) speech, the Governor of the Bank of Canada also highlighted the concern that for the long term, Canada must improve its export performance, particularly through development of export markets in the faster growing markets. He has suggested that the single biggest factor in Canada's declining export performance and consequent drag on the economy is the absence of adequate export market diversification. Specifically, he has noted that 85% of the nation's exports are to the slowest growing economic regions (including the U.S. and Europe) while only 8% go to regions (including Asia and the BRIC countries) that are growing at high rates (see Figure 1.2 below). Further, he notes that expanding penetration of Canada's exports into these fast growing markets will be key to achieving growth and prosperity in the years ahead. The Northern Gateway project is aimed at that goal.

Figure 1.2: Canada's Trade Directed Toward Slow-Growth Economies



Source: BIS Central Bankers' Speeches, Mark Carney, *Exporting in a post-crisis world*, Chart 5, p.6, www.bis.org/review/r120403e.pdf, accessed June 1, 2012

Growth and Changes in Oil Markets

So long as there is global population and economic growth, energy demand will continue to increase. Although some of this growing demand is expected to be met by increasing production of alternative and renewable energy, further expansion of petroleum production will be required. For example, recent studies by the International Energy Agency (IEA) suggest that world oil demand will continue to increase at about 1% per year, with all of this growth occurring outside of OECD Pacific, Europe and North America regions and with China expected to contribute about 40% to this growth. In general, the growth in oil imports by Asia is projected to be much greater than the growth in total oil demand.[17]

Given this growth in demand outside of North America and the large expected geographical shifts in oil markets, Northern Gateway provides considerable advantages. Along with tidewater access to reach the fastest growing markets, it provides an important element of market diversification in an environment of shifting markets.

[17] See International Energy Association, *World Energy Outlook* (2009, 2010 and 2011 outlooks consulted).

Impacts on other Sectors: Crowding Out Theory and Evidence

Clearly the many backward and forward linkages associated with the oil and gas sector means that growth in these sectors translates into substantial activity and growth in other sectors. However, based on the concept of ‘Dutch Disease’, it has been suggested that, particularly by raising the value of the Canadian dollar in international markets and creating inflationary pressures, a strong oil and gas sector may ‘crowd out’ growth in the manufacturing sector such that overall economic performance is negatively affected. As emphasized later, the Northern Gateway project could not even theoretically create Dutch Disease in Canada on its own. Quite simply, as a single project aimed at diversifying markets for Western Canadian oil it is not credible that it would or could drive growth of the entire resource sector to a degree required to create Dutch Disease. Nevertheless, given the current political debates around Dutch Disease, it is useful to provide a summary of the key issues.

The Dutch Disease

The genesis of the Dutch Disease concept was the natural gas resource boom in the Netherlands in the early 1970s and a later theoretical model associated with Cordon and Neary.[18] According to the theory, the resource boom could, by producing an appreciation of the exchange rate and driving up the cost of inputs, cause a permanent shrinkage of the manufacturing sector. Given its exposure to international competition for markets, the increased costs could not be absorbed by the manufacturing sector, thereby causing it to decline. Further, on the assumption that there are important positive externalities associated with the manufacturing sector (such as, assumed larger contributions to research and development and technological innovation compared to the resource sector), declines in manufacturing would have negative implications for the overall economy.

There is a large literature on the empirical testing of this theory. It is perhaps ironic that there has not been any conclusive evidence of Dutch Disease even in the Netherlands economy. Within approximately five years of the onset of the resource boom, the manufacturing sector had recovered.

[18] Corden WM, Neary JP (1982). "Booming Sector and De-industrialisation in a Small Open Economy". *The Economic Journal* 92 (December): 825–848.

Further, as suggested by Corden[19], the temporary decline in Dutch manufacturing appears to have been mainly the result of large increases in spending on social services by the government in response to the increase in revenues and not a result of the exchange rate or input cost impacts that are the focus in the Dutch Disease theory.

In response to the growing strength of the resource sector in Canada, there have been allegations of Dutch Disease and renewed interest in testing the Dutch Disease theory for Canada. Prior to summarizing the evidence, the requirements to demonstrate the existence and significance of Dutch Disease include the following.

1. The first requirement is that a boom in the resource sector has caused a significant appreciation of the exchange rate (the Cdn - US dollar exchange rate in the case of Canada) over a prolonged period and that this appreciation is not the result of other key factors, including monetary policy, relative rates of inflation, differences in Debt/GDP ratios, overall strength of the national economy relative to the economies of other trading partners, differences in productivity growth, or shifts in foreign direct investment patterns.
2. The second requirement is that there are significant positive externalities (such as technological innovation) generated by the manufacturing sector but not by the resource sector, including the oil and gas sector.
3. The third requirement is that there is a <u>permanent</u> decline in the manufacturing sector relative to that of the trading nation (primarily the United States in the case of Canada) purchasing most domestic manufactured products.
4. Finally, from 2) and 3), there must be evidence that the level and growth rate of national per capita output and income has been reduced from what it would otherwise be in the absence of a resource sector boom.

The most recent studies by Shakeri, Gray and Leonard[20] and by Beine, Bos and Coulombe[21] that are noted in the following discussion provide a good

[19] Corden WM (1984). "Boom Sector and Dutch Disease Economics: Survey and Consolidation". *Oxford Economic Papers* **36**: 362.
[20] Mohammad Shakeri, Richard S. Gray and Jeremy Leonard, *Dutch Disease or Failure to Compete: A Diagnosis of Canada's Manufacturing Woes,* IRPP Study, No.30, May 2012.

bibliography of other studies on the topic for the interested reader. A brief summary of this literature is provided below.

1. Given the many factors that determine the value of a nation's currency, combined with the fact that effects often show up with variable lags, exchange rate trends and fluctuations are extremely difficult to model empirically. In this context there have been many studies that have attempted to link the international value of the Canadian dollar to resource prices such as oil. A fundamental problem is that one can find periods when oil prices and the value of the Canadian dollar moved in the same directions and periods when they moved in opposite directions. Further, one can find situations where, with rising oil prices, the Canadian dollar appreciated against currencies of some oil importing nations (for example, the US$) but depreciated against other oil importing nations such as those in the Euro area.

   In general, studies of the relationship between commodity prices (mainly oil prices) received by Canadian producers and the value of the Canadian $ (vis-a-vis the US$) have generated widely varying conclusions ranging from oil prices having no long run impact on the exchange rate to evidence of a statistically significant relationship, particularly in some sub periods over the 1970s to 2007.[22] In one of the most recent studies, Beine, Bos and Coulumbe[23] suggest that 42% of the appreciation of the Canadian dollar relative to the US dollar over the period 2002-2007 can be explained by Canadian economic strengths, including higher energy and commodity prices, while 58% can be explained by US economic weaknesses contributing to a general decline in the international value of its currency. In another recent study using data from 1992-2007, Shakeri, Gray and Leonard[24],

[21] Michel Beine, Charles S. Bos and Serge Coulombe, *Does the Canadian Economy Suffer from Dutch Disease?*, forthcoming in Resource and Energy Economics (accessed at: http://aix1.uottawa.ca/~scoulomb/pages/dutchdiseaserev_forthcoming.pdf)

[22] For example, Amano and Norden conclude that there is a negative relationship between energy prices and the strength of the Canadian dollar against the US dollar. Amano, R., and S. van Norden, "Terms of Trade and Real Exchange Rates: The Canadian Experience", *Journal of International Money and Finance* 14 (1), 1995.

[23] Beine, Michel., Charles S. Bos and Serge Coulombe, *Does the Canadian Economy Suffer from Dutch Disease?*, forthcoming in Resource and Energy Economics (accessed at: http://aix1.uottawa.ca/~scoulomb/pages/dutchdiseaserev_forthcoming.pdf)

[24] Mohammad Shakeri, Richard S. Gray and Jeremy Leonard, *Dutch Disease or Failure to Compete: A Diagnosis of Canada's Manufacturing Woes,* IRPP Study, No. 30, May 2012.

suggest a positive relationship between energy and non-energy commodity prices and the value of the Canadian dollar (vis-a-vis the US dollar) but only a weak relationship for most of the period (1992-2003). Over the four years (2004-2007), they suggest that rising energy and non-energy commodity prices contributed to the appreciation of the Canadian currency. However in more recent periods, particularly since 2008, the evidence is less clear. For example, over the period since 2007, the value of the Canadian dollar vis-a-vis the US dollar has increased from an average of 93 cents in 2008 to approximate parity in 2011. Over this same period oil prices received by Western Canadian oil producers fell sharply from levels in 2008 and remain well below those levels and, similarly, natural gas prices have declined sharply and remain at very low levels.

2. The empirical studies on Dutch Disease applicable to a developed country such as Canada are typically silent on the issue of the special growth enhancing properties of the manufacturing sector. For example, it is not at all clear that technological innovations in manufacturing are any more significant or more broadly transferable to the economy than are those in the resource sector and particularly the oil and gas sector. In fact, oil and gas is typically one of the most capital, technology and knowledge intensive sectors in the economy. Further, it leads all other sectors by a wide margin in terms of value added per worker and leads in skill and education levels of the workforce and in wages and salaries per worker.[25] Indeed, any 'special' characteristics and place of the manufacturing sector relative to other sectors of the economy are much less apparent today than four decades ago when the Dutch Disease theory was developed.

   It is also useful to note in this context that manufacturing employment has, with just a couple of exceptions, continuously declined as a share of total employment in the developed economies while the share of employment in the services sector has grown. This reflects both productivity increases in manufacturing and the shift of labour intensive industries to low wage, developing countries. In the case of Canada, employment in services-producing sectors accounts for 78% of total Canadian employment and the proportions in the regions are

[25] See Ch.3, of ACR Task Force on Resource Development and the Economy. This can be accessed at: http://www.acr-alberta.com/Publications/tabid/205/Default.aspx

similar. In comparison, the goods-producing sector represents 22% of total employment, with manufacturing accounting for 10%.[26] Again, this is a much different picture than the situation envisaged in the Dutch Disease theory when manufacturing employment provided a major component of total national employment.

3. The existing empirical studies on Dutch Disease are notable in that they focus on short term rather than permanent declines in manufacturing employment, whereas evidence of Dutch Disease requires demonstration of the latter. Since employment in all sectors is subject to some cyclical elements, the lack of evidence on permanent declines casts considerable doubt on any conclusions that shorter term reductions in manufacturing employment is evidence of Dutch Disease. Further, as noted by Mintz in a recent article,[27] there is no evidence that longer term trends in Canadian manufacturing are any different than those in other developed countries. For example, it is shown that Ontario's share of employment in manufacturing has actually gained relative to that in the US and in directly competing states such as Michigan and Ohio. If Dutch Disease was a significant factor, one would expect the opposite to have occurred as the Canadian dollar appreciated against the US currency.

   The recent study by Shakeri, Gray and Leonard indicates that of the 80 manufacturing industries studied, only 25 showed evidence of being negatively affected by an appreciation of the Canadian dollar (due to a variety of factors including increasing energy and non-energy commodity prices), while 52 showed evidence of a positive effect (for 28 of these the effect was not statistically significant).[28] The other recent study by Beine, Bos and Coulumbe suggests that between 33 and 39 percent of the manufacturing job losses in the period 2002-2007 was related to appreciation of the Canadian dollar. However, as noted earlier, neither of these studies show that any such losses were permanent. Nor do they explain how the appreciation of

[26] Data for April 2012 from Statistics Canada (www.statcan.gc.ca/daily-quotidien/120511/t120511a003-eng.htm , accessed June 1, 2012.
[27] Jack Mintz: *No Dutch disease here. http://opinion.financialpost.com/2012/03/02/jack-mintz-no-dutch-disease-here/, accessed June 1, 2012.*
[28] Shakeri, Mohammad, Richard S. Gray and Jeremy Leonard, *Dutch Disease or Failure to Compete: A Diagnosis of Canada's Manufacturing Woes,* IRPP Study, No. 30, May 2012, p. 14.

the Canadian dollar since 2007 is reconciled with the dramatic drops in both oil and gas prices after mid 2008.

4. For the reasons noted above, notions of the existence and importance of Dutch Disease in the case of Canada are mainly conjecture. Dutch Disease is more of a theoretical possibility than a real and substantial policy issue in the case of Canada. Quite simply, the empirical evidence is far from complete and often subject to conflicting results. Much more clear from the studies is that, overall, the expansion of the oil and gas sector has been and remains a very important driver of the Canadian economy. For example, studies by Alexeev and Conrad, Brunnschweiler and Bulte, Cotet and Tsui[29], all demonstrate the positive and substantial contributions of the oil and gas sector to a small, open and developed economy such as Canada's, including during rapid growth or 'boom' periods. Indeed, as noted in the exhaustive analysis undertaken by Keay:[30]

- Based on indicators such as relative profitability, productivity and capital intensity, throughout the period since the 1970s, the contributions of the resource sector (of which oil and gas is the dominant component) to per capita economic performance in Canada were large, positive and growing.

- Over this period, resource-intensive production lead increases in the output produced by 'new economy' industries and other 'non-resource-intensive' industries.

- The resource industries appear to have maintained their role as a leading or propulsive sector through the operation of forward, backward and final demand linkages.

- There does not appear to have been a statistically significant relationship between increases in output from Canada's energy,

[29] Alexeev, M., and R. Conrad., "The Elusive Curse of Oil", *Review of Economics and Statistics*, 91 (3), 2009; Brunnschweiler, C. N. and E.H. Bulte. "The Resource Curse Revisited and Revised: A Tale of Paradoxes and Red Herrings. *Journal of Environmental Economics and Management* 55(3), 2008; Cotet, A., and K. Tsui., *Resource curse or Malthusian trap? Evidence from oil discoveries and extractions*. Working Paper 201001, Department of Economics, Ball State University, 2010.

[30] Keay, Ian, "Resource Specialization and Economic Performance: A Canadian Case Study, 1970-2005", *Canadian Public Policy, Vol.XXXV, No.3, 2009.*

fishing, forestry and mining industries and subsequent increases in non-resource-intensive labour or capital costs or the value of the Canadian dollar relative to the US dollar.

- The natural resource sector produced positive spillover effects driving down domestic raw material prices and generating demand for non-resource-intensive production.

- In general, since 1970 resource specialization has directly and indirectly contributed to the improvement of Canada's living standards and per capita economic performance.[31]

The existence of a strong energy and resource sector is a large net positive for the country. Through the extensive linkages to other sectors across Canada, including the services sector that accounts for over three-quarters of total employment, and through the large contributions to net export revenues, investment and government revenues, the energy sector is major driver of Canadian growth and prosperity. One cannot reasonably argue that Canada would have higher incomes or generally a higher standard of living if it did not have its oil and gas wealth and as a result had a much lower international value of the Canadian dollar.[32]

Regional Economic Well Being

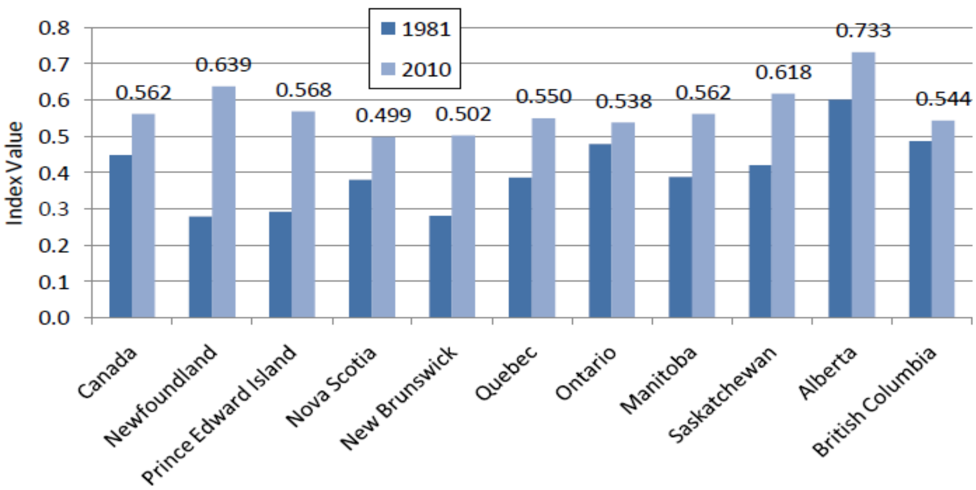
Given part of the focus in this study is on macroeconomic variables such as Gross Domestic Product (GDP), labour income and employment, it is useful to put these measures in the context of overall economic well-being. Specifically, it is sometimes argued that, especially with an economy reliant on the prosperity of the resource sector, these variables do not necessarily translate into overall well-being of Canadians across the major regions.

Indexes of economic well-being have been prepared by the Centre for the Study of Living Standards (CSLS). These take into account four main domains of well-being: per-capita consumption; per capita wealth; economic equality and economic security. In turn, these domains capture many individual measures such as private consumption, public goods

[31] See ibid, p. 310-311 for more detailed conclusions.
[32] See for example, T.Bayoumi and M.Muhleisen, *Energy, the Exchange Rate and the Economy: Macroeconomic Benefits of Canada's Oil Sands Production,* IMF Working Paper WP/06/07, March 2006.

consumption, physical, human and R&D capital, natural resources, environmental degradation, income inequality, poverty, risks from unemployment and illness, risks of poverty in old age and numerous others. The overall index values for Canada and the provinces are shown in Figure 1.3 for 1981 and 2010.

Figure 1.3: Overall Index of Economic Well-being, Canada and the Provinces, 1981 and 2010



Source: Chart 3, p.9 of *Beyond GDP: Measuring Economic Well-Being In Canada And The Provinces, 1981-2010*, Lars Osberg and Andrew Sharpe, Centre for the Study of Living Standards, CSLS Research Report 2011-11, September 2011.

As indicated, based on the CSLS index, there have been substantial gains in economic well-being over this period for Canada and each of the provinces. It is noteworthy that the largest gains occurred between 2000 and 2008, a period of rapid growth of the energy sector.[33] Also important is the fact that over that period and, indeed since 1981, there has been a significant narrowing in the differences across regions in the overall level of economic well-being.

[33] See p.IV, *Beyond GDP: Measuring Economic Well-Being In Canada And The Provinces, 1981-2010*, Lars Osberg and Andrew Sharpe, Centre for the Study of Living Standards, CSLS Research Report 2011-11, September 2011.

Environmental and Other Policy Uncertainty

Canada's oil sands have been recognized in the dominant U.S. market as providing considerable security of supply. Given this, along with the environmental concerns, it has been argued that U.S. policies should "provide incentives to cut emissions generated in producing each barrel of crude from the oil sands, but in a way that is careful to avoid directly discouraging increased production."[34] However, some groups have been very successful in painting the oil sands as an environmental villain, particularly in terms of GHG emissions and this appears to be having some effect on U.S. policymakers. For example, in addition to the opposition to the Keystone XL pipeline, approximately half of the U.S. states now have or are planning the implementation of Low Carbon Fuel Standards which in some cases have been aimed fairly directly at imports of crude oil produced from the Canadian oil sands.[35] This is in spite of the fact that GHG emissions from oil sands production are relatively small, being approximately equal to 6.5% of total Canadian emissions and 0.5% of total U.S. emissions. Further, responsible and credible analyses indicate that on a well to wheels or life cycle basis (with the burning of gasoline or diesel in vehicles accounting for 70% to 80% of the life cycle GHG emissions associated with oil), the life cycle GHG emissions from oil sands production are often in the same range as those for other crudes refined in the U.S.[36] Figures 1.4 and 1.5 below show total or life cycle emissions for various crude oils used by the US and for oil derived from the oil sands using various production approaches.

The results in Figure 1.4 show the comparative life cycle emissions for cases where oil sands production does not incorporate cogeneration facilities while those in Figure 1.5 show the emissions for those operations that incorporate cogeneration.[37]

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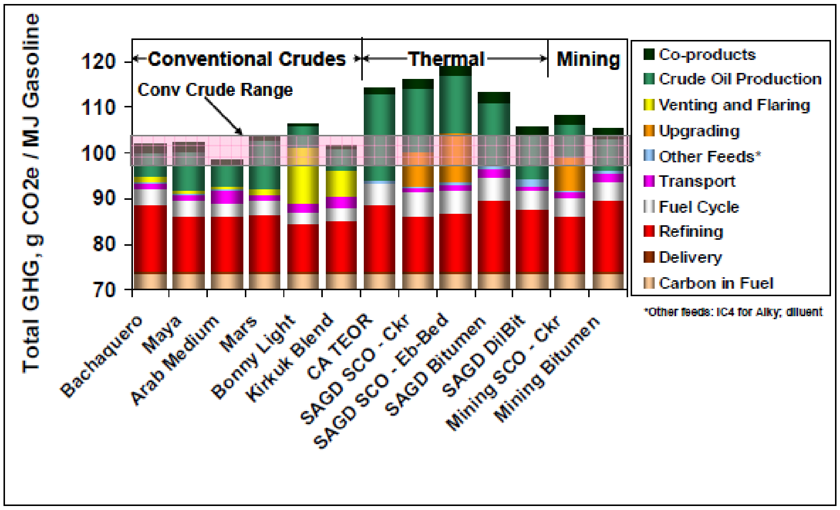
[34] For example, see Michael A. Levi, *The Canadian Oil Sands: Energy Security vs. Climate Change*, Council on Foreign Relations, Special Report No. 47, May 2009. (p. vii)

[35] Implementation of Low Carbon Fuel Standards is not certain in all cases. For example, California's LCFS has been blocked by a Court decision based on the discriminatory nature of its proposed standard.

[36] See Jacobs Consultancy, Life Cycle Associates, *Life Cycle Assessment Comparison of North American and Imported Crudes,* July 2009. This report can be found at: http://www.eipa.alberta.ca/media/39640/life%20cycle%20analysis%20jacobs%20final%20report.pdf For a summary of recent analyses see Eddy Isaacs, *Life Cycle Analysis – Exploring the Facts on Oil Sands Development*, Alberta Energy Research Institute, presentation available at www.aeri.gov.ab.ca

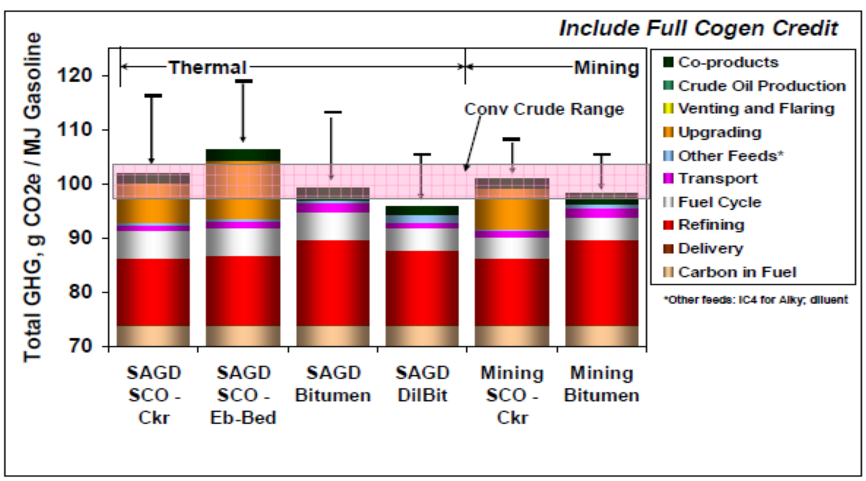
[37] Thermal refers to in situ production typically using steam assisted gravity drainage (SAGD) and covers cases of SAGD production plus upgrading to synthetic crude oil (SCO), SAGD production to bitumen and

Figure 1.4: Life Cycle Assessment of Well to Wheels GHG Emissions for Various Conventional and Unconventional Crude Oils to Low Vapour Pressure Gasoline Blend (No Cogeneration with Production)



Note: Life cycle emissions, represented herein as WTW, include WTT emissions plus fuel carbon as CO_2, plus vehicle methane and N_2O. For identical vehicles, the gCO_2e/MJ representation above is the same as a traditional WTW representation in gCO_2e/mile.

Figure 1.5: Life Cycle Assessment of Well to Wheels GHG Emissions for Various Conventional and Unconventional Crude Oils to Low Vapour Pressure Gasoline Blend (Cogeneration with Production)



Source: Tables E-6 and E-7, Jacobs Consultancy, Life Cycle Associates, *Life Cycle Assessment Comparison of North American and Imported Crudes*, July 2009.

SAGD production to DilBit (a mixture of diluents and bitumen). Mining refers to production by mining and the two cases are (i) combined mining of bitumen and upgrading to SCO and, (ii) mining of bitumen.

It is expected that there will continue to be substantial progress in reducing net GHG emissions per barrel of crude oil from oil sands production and it should be noted that oil sands production gives far less GHG emissions than other non-conventional sources of oil such as shale oil and liquids from coal.

An important long run goal is to increase the amount of upgrading in Canada. For example, the Province of Alberta has focused its attention on the development and implementation of next generation upgrading technologies to further reduce water, natural gas and diluent requirements as well as reduce GHG emissions.[38] This includes the application of gasification technologies, novel hydrotreating processes and integrated carbon capture and storage.

There remains considerable uncertainty about the levels of upgrading in the future. However, it can be noted that a significant advantage of the Northern Gateway project is its flexibility. Specifically, it provides the physical capability of transporting a wide range of types of oil, including conventional crude, SCO (synthetic crude oil), DilBit (a combination of diluent and bitumen), SynBit (a combination of SCO and bitumen), intermediate refinery feedstocks and, potentially, refined products. In the event that government policies and/or market conditions warrant higher levels of upgrading prior to export than would otherwise be the case, the resulting shift in the composition of crude oil flows could be accommodated by the NGP.

The U.S. is anticipated to remain the dominant market for Canadian conventional and unconventional oil production over the long term. Nevertheless, the politics of perception, whether at the Federal or State level, may result in U.S. policies that penalize oil sands production or otherwise reduce access to U.S. markets for growing oil sands production.[39] This, in turn, could materially and negatively impact Canadian conventional and unconventional oil exports to the U.S.

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[38] See Alberta Energy Research Institute, Research Priorities (www.aeri.ab.ca) for details. This goal is also prominent in the Government of Alberta Energy Strategy. See *Launching Alberta's Energy Future – Provincial Energy Strategy*, 2008, available at www.energy.gov.ab.ca

[39] It is interesting to note that in the April 30, 2009 edition of the NY Times, the Chair of CARB stated that " the most important value of a low carbon fuel standard is to discourage these investments" [i.e. referring to "oil from the hard to reach tar sands"]

In the light of foregoing policy uncertainties, and in the context of the substantial geographical shifts underway in oil markets, the Northern Gateway project can produce major benefits for Canada.

1.4 Summary

The unfolding policy and market developments, noted above, are very important in assessing the public interest aspects of the Northern Gateway project. The overall economic impacts will be particularly important in the expected environment where the petroleum sector remains a key driver of the Canadian economy and where Canada's comparative advantage remains largely resource-based. The project does provide access to the growth markets. This market diversification and expansion can produce higher and more stable values for Canadian resources. And, it can provide very significant diversification and option values in a situation of policy uncertainty.

A number of related issues raised by intervenors are addressed. Of particular note are the allegations that the Northern Gateway project would, through various mechanisms embodied in the Dutch Disease theory, result in a permanent decline in Canadian output, incomes, employment and government revenues. As a single project aimed at diversifying markets for Western Canadian oil it is not credible that it would or could drive growth of the entire resource sector to a degree required to create Dutch Disease.

Further, the empirical studies provide inconclusive evidence of the existence and significance of Dutch Disease in Canada. While some suggest rising commodity prices in the period 2004-2007 played a partial role in the appreciation of the Canadian dollar thereby negatively impacting employment in a subset of the manufacturing sector, this was not a significant issue in earlier or later periods. Further, the Dutch Disease studies for Canada are flawed by their inability to show that there has been any causal permanent change in manufacturing employment, or that positive externalities, such as those induced by technological innovation, are greater for manufacturing than for the resource sector, including oil and gas. Finally, as noted by the Governor of the Bank of Canada and various empirical studies, the recent increases in commodity prices have increased total value added (or GDP), per capita disposable income and purchasing power, investment, and government revenues.

2. METHODOLOGY

2.1 Measuring Public Interest Benefits

Important components of the total benefits of the Northern Gateway project include the positive economic impacts on Canadian and regional investment, labour income, overall value added (or Gross Domestic Product), employment and government revenues. These are associated with the direct, indirect and induced effects arising from the construction and operation of the pipeline, from the effects of market diversification and expansion in the value of oil exports and from reinvestment of some portion of the gains in producer revenues.

It is important to note that other public interest aspects are addressed in Section 4. Specifically, it includes a cost benefit analysis (CBA) of the project. Unlike the impact analysis presented in this section which focuses on the changes in macroeconomic variables at the national and regional level, the CBA is focused on estimating the net social benefit (or net economic welfare gain) to Canada, taking into account the direct benefits and costs associated with the Northern Gateway project.

The approach used in Section 3 of the report includes the modelling of Canadian energy balances, the use of results from modelling Canadian crude oil market allocation and oil price/netbacks associated with Northern Gateway, and a macroeconomic impact analysis using an input output framework.

The energy balances modelling tracks the flows of synthetic crude oil (SCO), bitumen, DilBit and other oil, along with associated monetary values, to various export and domestic markets.

Updated modelling of Canadian crude oil market allocation and price/netback impacts associated with the introduction of Northern Gateway has been undertaken by Muse, Stancil & Co. The details can be found in the report hereafter referred to as the 'Muse Stancil' report.[40] The economic impact modelling outlined below uses these estimates of oil price uplifts to

[40] Muse, Stancil & Co., *Market Prospects And Benefits Analysis For The Northern Gateway Project, July 2012*.

calculate the national and regional macroeconomic impacts associated with Northern Gateway.

Methodological Issues

The modelling of the macro-economic impacts associated with Northern Gateway focuses on estimates of selected economic measures, such as investment, labour income, output (GDP), employment and government revenues, taking into account the 'multiplier' or direct, indirect and induced effects. To illustrate, a given expenditure on construction in Canada will involve an increase in purchases of labour, steel, concrete and so on. The increases in GDP, labour income, employment and government revenues directly arising from these expenditures are referred to as ***Direct*** impacts. However, this expenditure will also cause those industries or sectors providing the increased inputs to the construction project to increase their purchases from other industries or sectors. The associated impacts on GDP, labour income, employment and government revenues are referred to as ***Indirect*** impacts. These will be more significant the greater the backward and forward linkages in the economy.[41] Finally, the expansion in consumer expenditures associated with the increases in labour incomes give rise to ***Induced*** impacts as production expands to meet these demands.[42] While there may also be increased government expenditures arising from the expansion in government revenues (or increased consumer expenditures in the case where the increased revenues translate into tax reductions), these are not incorporated in the analysis.

These direct, indirect and induced impacts are typically estimated using an Input-Output Model.[43] The latest (2008) Statistics Canada Interprovincial Input Output Model (the I/O Model) is the primary tool used for the macro-economic analysis in this section. Note that the WMR 2010 study employed

[41] Backward linkages for industry 'x' refer to the extent of purchases by industry 'x' from the industries providing inputs to industry 'x'. Forward linkages refer to the sales of output from industry 'x' to other industries, typically for upgrading, marketing or other value added activities.
[42] Using standard input output terminology, these are estimated by closing the model with respect to labour income.
[43] The standard method of measuring the net impacts after all complex actions and reactions are complete involves the use of an interregional input-output model. An input-output model simulates the effect on the economy when overall output of an industry changes in a specific region or when final demand for a particular commodity changes in a specific region (these changes are referred to as shocks). It can be noted there will also be *Induced* impacts as the larger labour income translates into increases in consumer expenditures and as additional government revenues translate into increased expenditures by government on goods and services.

the 2005 Statistics Canada I/O model. An additional difference is that induced impacts were not estimated in the earlier study.

Initially, a detailed modelling of the project components is used to estimate the annual requirements and sourcing for all goods and services associated with the construction and operation of the Northern Gateway facilities. This step also includes estimation of reinvestment expenditures and associated energy production resulting from the increased producer revenues arising from the oil price uplifts generated by Northern Gateway. The model is then run over the construction period and a 30-year operations period to estimate the overall national and regional economic impacts.

The development of I/O models of national and regional economies dates back to the early 1930s with the publication of Wassily Leontief's "Quantitative Input-Output Relations in the Economic System of the United States".[44] Since then they have been refined and widely used in most industrialized countries, where they are the standard used to estimate project impacts.

Issues raised by Intervenors

In an intervenor report by Robyn Allan it is alleged that "...by undertaking an IO analysis, Enbridge has used a misrepresentative methodology..." and that "A general equilibrium framework ... suggests that the impact of Northern Gateway would likely be negative".[45] Further, she claims that "The inflation that Northern Gateway represents will lead to higher interest rates, a permanent and long term decline in GDP, a loss of existing jobs, a decline in labour income and standard of living for many Canadians, as well as a deterioration of government revenues."[46] However these allegations are not valid for the following reasons.

1. Ms. Allan starts with the erroneous notion that Northern Gateway will dominate the macro economy and create a resource boom, so much so

[44] For a detailed history and explanation of Input Output methodology see: William H. Miernyk. 2008. *Elements of Input-Output Analysis.* www.rri.wvu.edu/WebBook/Miernykweb/new/index.htm An introductory summary can also be found in William Schaffer. 2010. *Regional Impact Models.* www.rri.wvu.edu/WebBook/Schaffer/index.html

[45] Robyn Allan, An Economic Assessment of Northern Gateway, January 2012. A2L7D1, p.21.

[46] Ibid, p.5.

that this single project could significantly increase the inflation rate, would cause increases in interest rates and various types of crowding out associated with Dutch Disease theory.

a. In reality, the impact on oil prices in Canada is relatively small, representing an uplift of $2 to $3 per barrel, and well within the price swings in crude oil prices one can often observe week to week. Further, contrary to Ms. Allan's assumption, the Northern Gateway project cannot affect the world price of oil and therefore cannot affect the prices paid for crude oil by Eastern refiners serving approximately one half of the Canadian markets for refined products. In the case of the Western Canadian refineries, the impact of Northern Gateway would, at most, be a one-time increase of about 1.5 cents per litre in the price of gasoline. Indeed, under conditions such as those prevailing in recent periods, there would be no increase in refined product prices.[47] In any event, an increase of between zero and 1.5 cents per litre in the price of gasoline is well within the range of regular short term price movements. Further, to the extent that it affects the Consumer Price Index, the impact is negligible and short term. Contrary to Ms. Allan's allegation, a one-time price increase does not cause higher rates of inflation in every future year thereafter.
b. Contrary to the claim by Ms. Allan, the Central Bank does not base its monetary policy simply on short term movements in the CPI, and certainly not any minor changes associated with a zero to 1.5 cent per litre increase in fuel prices in the Western part of the country. In fact, the key measure used is core inflation which excludes food and energy prices.
c. Contrary to the notion advanced by Ms. Allan that the NGP will set off a case of Dutch Disease, it is simply not credible that a reduction of $2 or $3 per barrel in the present price discount being received by Western Canadian producers would constitute a resource boom of the type envisaged in the Dutch Disease theory. Moreover, as outlined in Section 1.3, the evidence of Dutch Disease in Canada even during periods of

[47] Western Canadian refined product prices appear to be notionally established on an import parity basis rather than on a cost-plus basis. For example, Edmonton crude oil prices are below Chicago crude oil prices but Alberta product prices are generally above those in Chicago.

very large and sustained oil and other resource price increases is tenuous and at best inconclusive.

d. Ms. Allan makes large errors in her calculations and wrongly concludes that the revenue increase from the price uplift for Western Canadian oil (that is, the reduction in the price discount) is only $0.6 billion (Cdn$)[48] for a representative year when in fact, as properly estimated by Muse Stancil, is $2.5 billion (US$) or over $2.6 billion in Cdn$ (using a 95 cent Canadian dollar). Even after allowing for the cost to pipelines of offloading from the main export pipes to the US in the first few years of the NGP, the revenue increase is over $2.2 billion in Cdn$.

2. The argument advanced by Ms. Allan that a general equilibrium model must be used to properly measure the impacts of Northern Gateway is not sustainable for the following reasons.

   a. I/O is the only widely accepted model for measuring project impacts, particularly when the project is small relative to the total economy and it is necessary to capture the interregional and inter-industry impacts. It might be noted that, even with all direct, indirect and induced investment impacts associated with Northern Gateway, the average annual total investment represents about 2% of that for Canada in 2010. The average annual direct, indirect and induced GDP impacts are equivalent to about 0.5 of a percent of current total GDP for Canada.
   b. While there are numerous computable general equilibrium models used by researchers, they are typically not validated and are generally small and, as such, lack the detail required to assess complex projects such as Northern Gateway. At the macro level they are typically used to assess policy shifts that have relatively large implications for the macro-economy.
   c. Detailed and large general equilibrium models such as the 2000 equation model developed by R. Mansell and colleagues (which also includes an input/output component) and operated for

[48] *An Economic Assessment of Northern Gateway*, Robyn Allan, January 2012, A2L7D1, Table 2, p.13.

many years have not demonstrated to more accurately capture overall impacts for a project than a carefully applied and qualified I/O model. In general this is because many key economic variables that the results are sensitive to (such as exchange rates, interest rates, or economic conditions in export markets) cannot be accurately forecasted far into the future.

3. In general, under any standard, accepted models for a small, open economy, an increase in the terms of trade (the ratio of export to import prices) must generate a positive net impact for the economy in terms of both output and income. By reducing the discount on Western Canadian oil going to U.S. markets, and particularly in light of the large net trade surplus generated by the oil and gas sector, the NGP will improve Canada's terms of trade. As such, one would expect a significant net gain to the economy. If one were to accept the claims of Ms. Allan, then in order to improve the economic well-being of Canadians, Canada would require a policy of voluntarily discounting the prices of its key export commodities sold in foreign markets. The benefits of the current and projected discounts on Western Canadian oil mostly flow to U.S. refiners and it is hard to imagine how even larger discounts in the absence of the NGP could be a benefit to Canada or Canadians.

2.2 Diversification and Option Values

Diversification

Diversification is an approach to reduce the variation in outcomes. In general, all other things being equal, economic stability and predictability have a significant value in economies (and sectors within) because the costs of adjustments to economic variations are often substantial. In the context of economic diversification aimed at increased stability and predictability, the goal might be diversification in terms of industries, products, markets[49] or upgrading.[50] For instance, greater stability may be obtained simply by diversification of markets with no additional diversification of industries or products or increased value added.

[49] See R. Mansell and M. Percy, *Strength in Adversity: A Study of the Alberta Economy.* University of Alberta Press and C.D. Howe Institute, 1990, pp 115-118.
[50] Upgrading can provide greater stability if markets and prices for upgraded products tend to be less variable than for raw materials or non-upgraded products.

It is important to note that Canada is quite unique among the significant crude oil exporting nations in that all but a small portion of Canada's exports go to just one foreign jurisdiction. In this context the NGP is particularly important in terms of gaining economic stability through market diversification. To use a simple example, if there is one market (A) the variation in, say, revenues from that market is given by Var (A).[51] If a second market (B) of equal size and with variance equal to Var (B) is added, the variance of the combined markets (or market 'portfolio') will be given by:[52]

Var (A + B) = Var (A) + Var (B) +2 Cov (A,B).

If the prices and / or sales in the two markets tend to move together, there is positive covariance; if they tend to vary in opposite directions there is negative covariance. It can be observed that the variance of the combined markets is very heavily determined by the covariance given that it is double weighted. In other words, overall variability will be substantially reduced if there is negative covariance (i.e., the values and opportunities in the two markets tend to move in opposite directions). And, if Var (B) is less than that of (A), then selling more product into market B would also tend to reduce overall variance.

While there is a tendency for prices in the various crude oil markets to move together, there can be a significant negative covariance in terms of the profitability of sales in different markets. Differential movements in U.S and Asian crude oil markets produce significant swings in the potential profitability of sales. Further, as noted in Section 1.3 (Growth and Changes in Oil Markets), it is expected that there will be significantly different growth rates between U.S. and Asian petroleum markets. Indeed, it may well be that over the long term or in certain time periods there will be declines in U.S. oil demand while at the same time there is substantial growth in Asian oil demand.

These elements of negative covariance in profitability and possibly in growth can add substantial value to Northern Gateway by reducing the

[51] Variance or Var is a statistical measure of how narrowly or widely the values for a variable are spread around its mean.
[52] Covariance or Cov is a statistical measure of how closely the values for two variables tend to move together.

variability of industry net revenues compared to the variability that would otherwise exist. Such value would be additional to that arising from the price uplifts for Canadian oil production and the economic activity associated with the construction and operation of the pipelines and related facilities, including those associated with the reinvestment of incremental producer revenues.

Option Values

The traditional approach to evaluating investment projects has relied heavily on Discounted Cash Flow (DCF) analysis in one form or another. One form is Cost Benefit Analysis (CBA) which is used to evaluate projects from a broad social perspective. However, in situations where there is considerable uncertainty (versus risk), it has been recognized that proper application of these evaluation methods should include "an option value". That is, under conditions of uncertainty, flexibility and adaptability are critical to capitalizing on favourable market and investment opportunities and essential for limiting losses under unfavourable conditions. Flexibility and adaptability have a value, and as argued in the literature on real options,[53] this value should be reflected in the evaluation.

In general there are many dimensions to real options value.[54] However, in the context of Northern Gateway there are three particularly important elements from a Canadian public interest perspective.

First, in the event that U.S. Federal or State energy policies or U.S. regulatory changes, intentionally or unintentionally, impair access to some or all U.S. markets for Canadian heavy or light oil, Northern Gateway could provide somewhat of a counterbalance by adding flexibility through oil shipments to other markets. Further, it would provide some protection from short-term pipeline and refinery outages in the U.S.

Second, the existence of the Northern Gateway option would provide important leverage in achieving changes to such limiting policies or regulations to reduce the negative impacts on the Canadian oil and gas sector. Indeed, this option may also allow the exertion of leverage in

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[53] A good summary of real option theory and applications can be found in Lenos Trigeorgis, *Real Options: Managerial Flexibility and Strategy in Resource Allocation.* MIT Press, 1996.
[54] For example, see Trigeorgis, ibid, Table 1.1.

obtaining exemptions or changes to protectionist US policies or regulations that might affect Canadian industrial sectors other than crude oil.

Third, these policy and regulatory issues aside, most of the expected growth in oil demand will be in markets not currently accessible to a significant degree by Canadian producers. This, combined with an expected increase in netback prices arising from access to the new markets, would provide both an incentive for increased oil production from existing reserves and an attraction for investment capital to facilitate increased production.

In general, by reducing the uncertainties faced by Canadian oil producers in maintaining or gaining access to markets at prices based on competitive international oil trading, the Northern Gateway project will add substantial diversification and option value to the Canadian economy. This value may be difficult to quantify but it is nonetheless real and important.

2.3 Cases Evaluated

The approach used here to evaluate the economic impact of the construction and operation of Northern Gateway involves the use of two cases or scenarios modelled by Muse Stancil and presented in the 2012 Muse Stancil report.[55]

The Benchmark Case, which assumes no Northern Gateway, simply serves as a benchmark against which the incremental impacts associated with Northern Gateway are measured.

The Northern Gateway Case assumes that Canadian crude oil supply is the same as in the Benchmark Case, but up to 525 Mbpd (83.4 $10^3 m^3/d$**)** of Canadian oil exports that would otherwise have to go to U.S. markets are sent via Northern Gateway to Asian markets. This is expected to generate price increases for all Western Canadian oil production, particularly heavy oil, bitumen and DilBit. Oil exports through Northern Gateway are assessed to go primarily to Northeast Asia (Japan, Northern China, Southern China, South Korea and Taiwan).[56] In addition, the project's import pipeline would

[55] Muse, Stancil & Co., *Market Prospects And Benefits Analysis For The Northern Gateway Project, July 2012*.

[56] As noted in the Muse Stancil report there could also be exports to the U.S. West Coast market, in which case the potential oil price increases and resultant benefits could be higher than those indicated in the report. Further, there could be some opportunistic flows to S.E. Asia and India.

increase the availability of condensate to be used primarily as diluent in Canada (or, equivalently, reduce other condensate imports to Canada).

Although there would be some year-to-year variations in the export flows with the NGP, an average throughput of 500 Mbpd (79.5 $10^3 m^3/d$) of crude oil and 175 Mbpd (27.8 $10^3 m^3/d$) of condensate is assumed.

The difference between the results for the Northern Gateway case and the Benchmark Case represent the expected economic impacts associated with the project. These impacts are measured in terms of incremental GDP (Gross Domestic Product) or value added, incremental labour income, incremental employment and incremental government revenues. Further, these impacts are broken down into the following components.

- The impacts arising from the construction expenditures associated with the Northern Gateway pipelines and related facilities.

- The impacts arising from the annual revenues and operating expenditures associated with the operation of the pipelines and related facilities. It is assumed that full operation begins in 2019 and continues for 30 years.[57] This includes an adjustment to take account of the anticipated offloading in the early years of Northern Gateway operations from the other pipelines moving oil out of the Western Canadian Sedimentary Basin (WCSB). A net offloading of 405 Mbpd (thousand barrels per day) is estimated in 2019 and decreasing to 35 Mbpd in 2025.[58] It is estimated that the additional cost associated with lost revenues on other pipelines will sum to $857 million.[59]

- The impacts arising from the expected increase in revenues to oil producers associated with gains in the netback prices on Western Canadian oil production, after deducting all increases in transportation costs and after deducting the increased feedstock costs for Canadian refineries as a result of the higher oil prices. These values are taken from the 2012 Muse Stancil study.

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[57] Although the pipeline is scheduled to begin operations in August of 2018, in this and the later cost benefit analysis it is assumed that full operations begin at the start of 2019.
[58] The average annual offloading over the period 2019-2025 is 165 kbpd.
[59] This estimate is made using, as a proxy, the lost toll revenue if all offloading occurred on Enbridge pipelines carrying oil to the U.S.

- The impacts arising from reinvestment of a portion of the incremental oil revenues in the energy sector (based on historical patterns) and from the associated gains in production. Allocation of investment by province was based on the average over the 2007-2010 period. Modelling of the production revenues assumed both conventional oil and gas development.

2.4 Assumptions and Inputs

In estimating the impacts of the Northern Gateway project there are a number of common assumptions concerning items such as the exchange rates, overall rates of inflation etc. These are noted below.

- To convert current dollar values to real (or inflation adjusted values) an average rate of inflation of 2% per year is assumed for both the US and Canada. Real values are expressed in terms of mid-2012 dollars.

- To convert amounts denominated in U.S. dollars to Canadian dollars, an exchange rate of $1Cdn = $1US is assumed for 2012, falling to $0.98 in 2013, $0.96 in 2014, $0.95 in 2015 and then remaining at $1Cdn = $0.95US in all subsequent years. Although, based on long term productivity differences, the long run exchange rate should be around $1Cdn=$0.85US. However, to err on the conservative side, a higher value for the Canadian dollar is used.

- The incremental impacts are estimated over an operating period of 30 years from the first quarter of 2019 to 2048. Flows on Northern Gateway are expected to begin in August of 2018 but for analytical simplicity (and to provide a conservative bias) it is assumed that flows begin in Q1 of 2019. Although the pipeline would be expected to operate beyond 2048, the impacts are presented for only the first 30 years of operations.

- To estimate the impact of the oil price uplift for the period 2036 to 2048 the average price increase estimated for 2035 by Muse Stancil in their 2012 report is assumed to prevail over the 2036-2048 period.

- There are many environmental regulations applicable to the development and operations of pipelines, oil sands facilities and other upstream oil and gas facilities. The anticipated costs of meeting these regulatory requirements are generally included in the capital and operating costs used in the analysis. An exception is the treatment of future prices or penalties related to CO_2 emissions. While there is now a price of $15/tonne for CO_2 emitted in Alberta[60], there remains considerable uncertainty as to future provincial and federal policies and regulations that will affect these prices / costs / penalties. Therefore it is assumed in the Economic Impact Analysis that whatever the future carbon price, the revenue impact for governments will be neutral. That is, it is assumed that any incremental government revenue as a result of CO_2 emissions policies will be used to reduce other taxes or charges. However, in the Cost Benefit Analysis we have assumed a cost of $20/tonne for CO_2 equivalent.

2.5 Incremental Construction and Operating Costs

The construction costs associated with the Northern Gateway project used in the analysis are summarized in Table 2.1 below. It is expected that about 90 per cent of these capital expenditures would take place in the period 2015 to 2018.

The annual operations and maintenance expenditures for the pipelines and related facilities average $341 million per year (including property taxes but excluding other taxes)[61].

Table 2.1: Estimates of Construction Costs, 2013-2019
(in millions of year 2012 Cdn $)

Component	
Pipelines	$4,009
Initiating and Pumping Stations	595
Terminals and Marine Facilities	1,258
Other	531
Total	$6,393

[60] Under current Alberta policy, any large carbon emitter unable to meet a 12 per cent reduction in emissions intensity is required to pay into a technology fund an amount equal to $15/tonne for every tonne exceeding the emissions reduction target.
[61] These start at $298 million and rise, in nominal terms, to $392 million by the end of the operating period.

2.6 Price Impacts, Incremental Revenues and Reinvestment

An important impact associated with Northern Gateway is the effect of the project on netback oil prices[62] received by Western Canadian producers. Given that about 75 per cent of Canadian oil production is exported (with an even larger percentage for Western Canadian oil), this price increase would provide a very significant stimulus to the energy sector and the Canadian national and regional economies.

The price impacts have been estimated by Muse and are used in the analysis in this report to estimate the overall impacts associated with Northern Gateway. Specifically, these price increases are applied to forecast Western Canadian oil production (by type and year) benefiting from the price uplift to arrive at an estimate of total incremental producer revenues. They are also applied to the amounts of oil production (by type and year) subject to this price uplift that is used by Canadian refiners. The latter provides an estimate of the increased costs to Canadian refiners. The net incremental revenues for Canada are then calculated as the total incremental revenues to Canadian producers minus the incremental costs to Canadian refineries/consumers.

Table 2.2 provides the projected benchmark prices for selected types of oil used in the analysis. These prices are before the expected price increases associated with Northern Gateway.

Table 2.2: Selected Base Prices without Northern Gateway (selected years in 2012US$)

	SCO at Edm	DilBit at Edm	WTI at Cushing
Year	**US$/Bbl**	**US$/Bbl**	**US$/Bbl**
2018	97.74	79.59	97.68
2019	96.87	78.15	97.10
2020	97.53	78.69	97.86
2025	100.40	79.95	101.53
2030	104.68	82.40	105.54
2035	109.45	84.70	109.71

Source: Table A - 16, Muse, Stancil & Co., *Market Prospects And Benefits Analysis For The Northern Gateway Project, July 2012*.

[62] Net back prices refer to the prices received by the producer after deducting the costs of transporting the oil to the ultimate market destination.

The estimated price uplifts attributable to Northern Gateway are applied to other WCSB production as well as sales through the NGP. The average uplifts for selected oil types and years are summarized in Table 2.3. The price uplifts for the period 2036 to 2048 are assumed to remain at the values for 2035.

Table 2.3: Estimated Average Price Uplifts for Selected Oil Types (selected years, in 2012US$)

	Conventional	Synthetic	Heavy
Year	**US$/Bbl**	**US$/Bbl**	**US$/Bbl**
2018	1.20	1.10	1.86
2019	2.81	3.15	3.35
2020	2.60	2.55	3.30
2025	1.52	1.45	2.28
2030	0.88	1.01	2.13
2035	0.43	0.34	2.35

Source: Table A - 18, Muse, Stancil & Co., *Market Prospects And Benefits Analysis For The Northern Gateway Project, July 2012*.

A summary of net additional revenues for selected years from the price uplifts with Northern Gateway is shown in Table 2.4. The Gross Revenue Uplift is the Gross Aggregate Netback, Table A-18 of the 2012 Muse Stancil report, converted to Canadian dollars using an exchange rate of 1Cdn$=0.95US$. The increased feedstock costs for Canadian refineries served by Western Canadian suppliers is from Canadian Refinery Impact, Table A-20 in the Muse Stancil report and converted to Canadian dollars.

These estimates indicate that Northern Gateway results in an incremental revenue gain of $114.8 billion over the period to 2048, or an annual average of $3.8 billion, after deducting the higher costs imposed on Canadian refineries.

Table 2.4: Summary of Incremental Revenues For WCSB Crude Oil Production and Sales Resulting from Northern Gateway (in millions of year 2012 Cdn$)

	Gross Revenue Uplift	Increased Costs to Refineries	Net Revenue Uplift
Year	**C$million**	**C$million**	**C$million**
2019	5,260	999	4,261
2020	5,193	931	4,262
2025	4,111	596	3,514
2030	3,996	440	3,556
2035	4,555	296	4,259
Annual from 2035 to 2048	4,555	296	4,260
Total for 2019 to 2048			114,804

Source: Tables 15-17, Muse, Stancil & Co., *Market Prospects And Benefits Analysis For The Northern Gateway Project,July 2012*.

Based on historical reinvestment patterns it is expected that a significant portion of the net cash flow derived from these incremental revenues will be reinvested in some combination of energy projects across the country. This will generate further increases in national income, employment and government revenues.

Over the period 2000 to 2010, investment expenditures by the conventional oil and gas sector have averaged about 47 per cent of net income (that is, the value of producer sales minus royalties).[63] For the analysis here it is assumed that this average ratio, along with the associated debt to equity ratios used to finance these investments, will be maintained into the future.

It is more difficult to predict the specific types and locations of energy projects that would receive those investments. Given the inability to

[63] Based on data from Canadian Association of Petroleum Producers, *Statistical Handbook.*

accurately predict what these reinvestment patterns might be and, in addition, given the considerable added complexity in modelling the many possible variations in these future patterns, a simplified approach is used here. Specifically, it is assumed that the geographical distribution across Canadian regions and the types of investments in the future will be similar to those observed between 2007 and 2010.[64] While significant departures from this pattern would obviously change the regional distribution of the impacts, the overall national impacts would be subject to much less variation.

2.7 Summary

Important consequences of the Northern Gateway project include the positive economic impacts on Canadian and regional investment, labour income, overall value added (or Gross Domestic Product), employment and government revenues. These are associated with the direct, indirect and induced effects arising from the construction and operation of the pipeline, from the market diversification, added stability, and option value, from the increased value received for Canadian resources and from the reinvestment arising from increased producer revenues.

- The approach used in this report includes the modelling of Canadian energy balances, the use of results from modelling Canadian crude oil market allocation and oil price/netbacks associated with Northern Gateway, and a macro-economic impact analysis using an input output framework. The newest Statistics Canada Interprovincial Input Output model is employed, along with updated oil price uplift estimates and project investment costs, to produce updated estimates of the macro-economic impacts associated with the Northern Gateway project.

- Certain methodological objections to the analysis have been outlined in intervenor evidence and these are addressed. It is demonstrated that these objections are not sustained but rather are the result of a combination of errors in fact, logic and theory. One intervenor claim is that, by reducing the price discount on Western Canadian oil and thereby increasing the price these producers receive by 2-3%, this will

[64] This assumed distribution of future investments is based on the geographical investment pattern for the oil and gas industry as reflected by the 2007-2010 capital expenditures provided in the Canadian Association of Petroleum Producers *Statistical Handbook*.

cause continuously higher inflation rates, higher interest rates, a decline in output, incomes, employment and government revenues. If one were to accept this flawed logic, the non-credible conclusion is that for a small, open economy such as Canada's, the country would gain output, incomes, employment and government revenues if it simply discounted the price it receives for commodities produced and sold by the resource sector primarily to export markets.

- There are considerable uncertainties, especially with respect to various energy and environmental policies, shifts in oil markets, future oil prices, and oil production that are important in the context of evaluating the public interest benefits of the Northern Gateway project. These uncertainties give rise to significant diversification, stabilization and "real option" values associated with the project. These benefits are difficult to quantify but they are nonetheless real and important, and they are in addition to the measurable direct and indirect contributions to Canadian incomes, production, employment and government revenues.

- The approach used to estimate the quantified economic impacts in Canada of Northern Gateway involves the comparison of results for two cases: a Benchmark Case that does not include the project and a case that assumes the construction and operation of Northern Gateway.

- This Northern Gateway Case assumes that total Canadian crude supply remains the same as in a benchmark forecast (the CAPP Growth forecast) but some oil exports that would otherwise go to U.S. markets are sent to Asian markets. While Canadian crude supply volumes are unchanged, there is an increase in the value of this supply which would benefit all Western Canadian oil producers. The incremental net revenues from this would in part be reinvested in the economy and generate further gains to output, employment, incomes and government revenues in Canada.

3. ESTIMATES OF ECONOMIC IMPACTS

Given the methodology and inputs described in the previous section, the direct, indirect, induced and total impacts of the Northern Gateway project on a number of economic variables are estimated for the period to 2048. Results are given for Canada and for its regions. The overall results are outlined below.

3.1 Overall Impacts

The direct, indirect and induced economic impacts over the period to 2048 expected from the construction and operating expenditures associated with the Northern Gateway facilities are summarized in Table 3.1. The upper part of the table shows the direct plus indirect impacts and the lower part shows the direct, indirect plus induced impacts, as described in Section 2.1. The corresponding annual averages are shown in Table 3.2.

Table 3.1: Total Sum of Macro Impacts of Northern Gateway Construction and Operations

(Sum 2015 to 2048, in millions of year 2012 Cdn $, and employment in person years)

TOTAL IMPACTS	BC	Alberta	Ontario	Quebec	Sask	Other	Canada
Direct and Indirect Only							
Investment/Revenues	52841	208047			30006	10483	301376
Labour Income	13477	29872	4039	1072	3875	1320	53655
GDP	46215	194248	5856	1575	22717	9400	280011
Federal Government Revenue	4882	28108	1040	193	2789	835	37847
Provincial Government Revenue	7391	35403	606	263	5010	1294	49967
Total Government Revenue	12273	63510	1646	456	7799	2128	87814
Employment	183445	312081	60072	18429	57064	21363	652455
TOTAL IMPACTS	**BC**	**Alberta**	**Ontario**	**Quebec**	**Sask**	**Other**	**Canada**
Direct, Indirect and Induced							
Investment/Revenues	52841	208047			30006	10483	301376
Labour Income	18302	36394	6778	1904	4697	1872	69948
GDP	55163	207501	10774	3063	24544	10468	311514
Federal Government Revenue	6627	30962	2016	404	3277	1027	44314
Provincial Government Revenue	8623	36884	1302	557	5179	1459	54005
Total Government Revenue	15251	67846	3319	960	8457	2486	98319
Employment	263037	401147	104069	34099	72320	32395	907067

Table 3.2: Total Annual Average Macro Impacts of Northern Gateway Construction and Operations

(Annual averages over 34 years from 2015 to 2048, in millions of year 2012 Cdn $, and employment in person years)

TOTAL IMPACTS	BC	Alberta	Ontario	Quebec	Sask	Other	Canada
Direct and Indirect Only							
Investment/Revenues	1554	6119			883	308	8864
Labour Income	396	879	119	32	114	39	1578
GDP	1359	5713	172	46	668	276	8236
Federal Government Revenue	144	827	31	6	82	25	1113
Provincial Government Revenue	217	1041	18	8	147	38	1470
Total Government Revenue	361	1868	48	13	229	63	2583
Employment	5395	9179	1767	542	1678	628	19190
TOTAL IMPACTS							
Direct, Indirect and Induced							
Investment/Revenues	1554	6119			883	308	8864
Labour Income	538	1070	199	56	138	55	2057
GDP	1622	6103	317	90	722	308	9162
Federal Government Revenue	195	911	59	12	96	30	1303
Provincial Government Revenue	254	1085	38	16	152	43	1588
Total Government Revenue	449	1995	98	28	249	73	2892
Employment	7736	11798	3061	1003	2127	953	26678

These widely-distributed impacts of Northern Gateway for the case including direct, indirect and induced effects are summarized below:

- A gain of almost $312 billion in Canadian GDP, or an average annual gain of $9.2 billion. The overall gain includes $55 billion for B.C., $208 billion for Alberta, $25 billion for Saskatchewan, about$14 billion for Ontario and Quebec and over $10 billion for the remaining regions.

- An increase of $70 billion in Canadian labour income or an average annual increase of $2.1 billion.

- A gain of $98 billion in government revenues, or an average annual increase of $2.9 billion. Of this amount, roughly $44 billion will accrue to the Federal Government and $54 billion will accrue to provincial / territorial governments. The additional federal revenues will ultimately be widely distributed across the country.

- An increase of 907 thousand person years of employment or an average annual increase of over 27,000 person years of employment. The approximate geographical distribution of this incremental employment would be: 263,000 person years in B.C.; 401,000 in Alberta; 72,000 in Saskatchewan; 104,000 in Ontario; 34,000 in Quebec and 32,000 distributed among the remaining regions.

To put these numbers into perspective it can be noted that $312 billion in GDP is equivalent to about 2 months of output of the entire Canadian economy at current levels or the annual impact is equivalent to an increase of 0.5 percentage points in the growth rate for Canadian GDP at current levels. The average annual increase in employment as a result of Northern Gateway is equal to approximately 6 per cent of the average annual increase in total Canadian employment over the years 2005 to 2008, a period of strong growth. And, the $98 billion in government revenue would be equivalent on an annual basis to more than 0.5 of one per cent increase in total annual federal plus provincial government revenues.

These impacts are widely distributed across the country even though virtually all of the initial Northern Gateway construction expenditures are in B.C. and Alberta.[65] For example, of the total employment generated, roughly 29 per cent is in B.C., 44 per cent is in Alberta, 8 per cent is in Saskatchewan, 11 per cent is in Ontario, 4 per cent is in Quebec, and 4 per cent is distributed in the remaining regions. The breadth in the distribution of these impacts occurs as a result of the extensive linkages associated with the project. These linkages, as captured by the modelling, include the effects arising from purchases of goods and services associated with the construction and operation of Northern Gateway, the distribution of the gains in resource revenues and government taxes and the gains arising from the reinvestment activities of the energy sector.

Qualifications

In general, these estimates of positive outcomes benefiting Canadians are likely to be conservative. In particular, as discussed in Section 2.2, there are important diversification and option values associated with the Northern Gateway project. While these have not been quantified and included in the tables, one should not conclude that their benefits would be small. Indeed, there are many plausible and perhaps high-probability scenarios where the value of such benefits would be very large. For example, given protectionist tendencies that would adversely affect any number of Canadian export

[65] About 72 per cent of these occur in B.C., with 28 per cent in Alberta.

industries, the ability of the project to provide some leverage in avoiding or minimizing such tendencies could prove extremely valuable. Similar substantial values would arise from the flexibility to adjust oil export portfolios to take advantage of shifts in pricing differentials.

Another important factor is future conditions in the Canadian economy. In general, conditions of excess capacity and unemployment rates above the 'full employment' or 'non-accelerating inflation' level prevail, with only occasional and usually short periods of time when the economy is operating at or near capacity. Under these usual conditions, the impacts shown above are well within the normal and growing absorptive capacity of the economy. As such, significant dislocations would not be expected. For example, in comparison to the estimated average annual increase of about 27 thousand person years of employment associated with the Northern Gateway project, the total number unemployed in April 2012 (with a national unemployment rate of 7.3%) was 1,370 thousand. Similarly in the regions, the average increase in employment due to the project is much lower than the total number unemployed. For example, in B.C., the increase in employment of 7.7 thousand compares to current unemployment of 154 thousand and for Alberta the increase in employment of 11.8 thousand compares to current unemployment of 112 thousand.[66] Of course, it should be recognized that some shortages of particular skills, particularly related to the construction sector, might normally be expected.

As noted, the odds are against the Canadian economy operating at or near full capacity over significant periods during the construction and operation of the Northern Gateway project. However, to the extent that this did occur the estimated gains presented in Tables 3.1 and 3.2 would be reduced. In that event, the reductions would occur first and most to the estimated induced impacts.

Given that the estimated impacts are substantially influenced by the extent of the price uplifts, the actual impacts will depend to a considerable degree on the size of the price uplifts that ultimately materialize. It is believed that the estimates, prepared by Muse Stancil and used here, are reasonable and have a somewhat conservative bias. Given this, the actual gains to the Canadian

[66] Labour force statistics are from Statistics Canada, *Labour Force Survey*, April 2012. See www.statcan.gc.ca/daily-quotidien/120511/t120511a002-eng.htm

and regional economies are more likely to be underestimated than overestimated.

3.2 Disaggregation of the Impacts

The overall impacts associated with Northern Gateway as outlined in the previous section can be disaggregated to provide a sense of the relative contributions of the various aspects of the project. These components are: the construction of the pipeline and related facilities; the operation of the pipeline; the price uplift for Western Canadian producers, net of increased refiner costs; and the reinvestment of a portion of the increase in net producer income and the associated production. For each of the sources of impact the summary tables show the results at two levels: one including only the direct and indirect impacts and the other including direct, indirect and induced impacts. The one exception is Table 3.5 in the case of the price uplift where only the direct effect is shown, which would be a direct increase in GDP (or value added) and government revenues.

The impacts associated just with the construction phase of the NGP are shown in Table 3.3.

Table 3.3: Impacts from Northern Gateway Construction

(Sum to the year 2018, in millions of year 2012 Cdn $,
and employment in person years)

PIPELINE CONSTRUCTION IMPACTS	BC	Alberta	Ontario	Quebec	Sask	Other	Canada
Direct and Indirect Only							
Investment	4730	1663					6393
Labour Income	1847	783	283	85	40	43	3081
GDP	2866	1335	427	125	68	70	4890
Federal Government Revenue	487	235	74	15	10	11	832
Provincial Government Revenue	330	76	44	21	6	6	483
Total Government Revenue	817	311	118	36	16	17	1315
Employment	18982	7839	3925	1394	577	714	33432
PIPELINE CONSTRUCTION IMPACTS	**BC**	**Alberta**	**Ontario**	**Quebec**	**Sask**	**Other**	**Canada**
Direct, Indirect and Induced							
Investment	4730	1663					6393
Labour Income	2326	971	453	138	55	67	4009
GDP	3710	1683	718	217	99	113	6539
Federal Government Revenue	645	307	129	28	15	18	1141
Provincial Government Revenue	456	106	81	38	10	11	702
Total Government Revenue	1101	412	210	66	25	29	1843
Employment	26148	10608	6478	2192	826	1161	47413

(Annual averages over 4 years to the year 2018, in millions of year 2012 Cdn $, and employment in person years)

PIPELINE CONSTRUCTION IMPACTS	BC	Alberta	Ontario	Quebec	Sask	Other	Canada
Direct and Indirect Only							
Investment	1183	416					1598
Labour Income	462	196	71	21	10	11	770
GDP	717	334	107	31	17	17	1223
Federal Government Revenue	122	59	18	4	2	3	208
Provincial Government Revenue	82	19	11	5	2	2	121
Total Government Revenue	204	78	29	9	4	4	329
Employment	4746	1960	981	349	144	178	8358
PIPELINE CONSTRUCTION IMPACTS	**BC**	**Alberta**	**Ontario**	**Quebec**	**Sask**	**Other**	**Canada**
Direct, Indirect and Induced							
Investment	1183	416					1598
Labour Income	582	243	113	34	14	17	1002
GDP	927	421	179	54	25	28	1635
Federal Government Revenue	161	77	32	7	4	4	285
Provincial Government Revenue	114	26	20	10	2	3	176
Total Government Revenue	275	103	53	17	6	7	461
Employment	6537	2652	1619	548	206	290	11853

It can be observed that the largest gains during the construction phase are in B.C., where the bulk of the construction activity takes place. These gains are followed by those in Alberta, Ontario and Quebec. The gains to the latter two provinces primarily flow from the large purchases of manufactured and service inputs associated with the construction of the project and, subsequently, from the purchases by workers and businesses directly or indirectly benefiting from the construction of the project.

Table 3.4: Impacts from Northern Gateway Operations

(Sum 2019 to 2048, in millions of year 2012 Cdn $, and employment in person years)

PIPELINE OPERATIONS IMPACTS	BC	Alberta	Ontario	Quebec	Sask	Other	Canada
Direct and Indirect Only							
Pipeline Revenues	19081	5851					24932
Labour Income	2770	472	267	78	10	27	3623
GDP	18853	4549	390	113	31	44	23981
Federal Government Revenue	1188	218	70	14	3	7	1499
Provincial Government Revenue	2556	379	43	19	2	4	3003
Total Government Revenue	3744	597	113	33	5	11	4502
Employment	38407	5007	4077	1303	158	468	49420
PIPELINE OPERATIONS IMPACTS	**BC**	**Alberta**	**Ontario**	**Quebec**	**Sask**	**Other**	**Canada**
Direct, Indirect and Induced							
Pipeline Revenues	19081	5851					24932
Labour Income	4287	624	472	147	20	53	5603
GDP	21423	4980	728	213	46	81	27470
Federal Government Revenue	1650	283	138	30	6	14	2122
Provincial Government Revenue	2926	410	95	43	5	10	3489
Total Government Revenue	4576	693	233	73	11	25	5611
Employment	63077	7069	7356	2601	347	979	81428

(Annual averages over 30 years to the year 2048, in millions of year 2012 Cdn $, and employment in person years)

PIPELINE OPERATIONS IMPACTS	BC	Alberta	Ontario	Quebec	Sask	Other	Canada
Direct and Indirect Only							
Pipeline Revenues	636	195					831
Labour Income	92	16	9	3	0	1	121
GDP	628	152	13	4	1	1	799
Federal Government Revenue	40	7	2	0	0	0	50
Provincial Government Revenue	85	13	1	1	0	0	100
Total Government Revenue	125	20	4	1	0	0	150
Employment	1280	167	136	43	5	16	1647
PIPELINE OPERATIONS IMPACTS	**BC**	**Alberta**	**Ontario**	**Quebec**	**Sask**	**Other**	**Canada**
Direct, Indirect and Induced							
Pipeline Revenues	636	195					831
Labour Income	143	21	16	5	1	2	187
GDP	714	166	24	7	2	3	916
Federal Government Revenue	55	9	5	1	0	0	71
Provincial Government Revenue	98	14	3	1	0	0	116
Total Government Revenue	153	23	8	2	0	1	187
Employment	2103	236	245	87	12	33	2714

Table 3.4 shows the impacts strictly associated with the operation of the NGP. As indicated, the majority of the impacts during the operations period are also centered in B.C. When the direct, indirect and induced impacts in operations are taken into account the employment gains in BC are just over 2100 jobs.

Table 3.5: Direct Impacts from Price Uplift

(Sum 2019 to 2048, in millions of year 2012 Cdn $, and employment in person years)

PRICE UPLIFT IMPACTS	BC	Alberta	Ontario	Quebec	Sask	Other	Canada
Direct Only (no Indirect or Induced)							
Producer Revenue Uplift	82	111392			3165	165	114804
Labour Income	0	0			0	0	0
GDP	82	111392			3165	165	114804
Federal Government Revenue	12	16709			475	25	17221
Provincial Government Revenue	19	21566			671	34	22290
Total Government Revenue	31	38275			1146	59	39511
Employment	0	0			0	0	0

Note: **T**he O**ther category covers production in Manitoba and the Territories.**

The initial impact of the price uplift, shown in Table 3.5, is to increase revenues to western Canadian oil producers. Expressed differently, this gain represents a reduction of the price discount on Western Canadian oil in U.S. markets. The increased revenue will immediately show up as an increase in GDP and government revenues (in the form of taxes and royalties), with these amounts distributed across the provinces in line with the proportion of oil production within each province.

The price uplift would not translate immediately into employment and labour income. The proximate effect would be to improve the cash flow and balance sheets of companies. The main employment impact is estimated as a result of the indirect and induced effects arising from reinvestment, stimulated by increased company cash flow and the improved value of Canadian resources.

Table 3.6 shows the direct effects from reinvestment. The oil and gas sector typically accounts for a large part of all non-residential, non-government investment in Canada. As noted in Section 2.6, there is a highly stable relationship between oil and gas sector net income and reinvestment in oil and gas exploration and development (and, increasingly in other energy projects). It is assumed that these historical relationships will be maintained into the future. Further, it is assumed that geographical investment patterns by the conventional oil and gas industry observed over the period 2007-2010 will be reasonable indicators of future patterns. This is chosen as a representative period in that, unlike the current situation, there was more of a balance between oil and gas exploration and development.

These assumptions lead to an estimated incremental increase in reinvestment of $48 billion in Canada over the period 2019-2048 as a result of the oil price uplift associated with Northern Gateway. This is equal to an increase of about $1.6 billion annually. Including Induced impacts, these capital expenditures would generate $53 billion in incremental GDP over the 30 year operating period, as shown in the bottom half of Table 3.6.

Table 3.6: Impacts from Price Uplift Reinvestment

(Sum 2019 to 2048, in millions of year 2012 Cdn $,
and employment in person years)

PRICE UPLIFT REINVESTMENT IMPACTS	BC	Alberta	Ontario	Quebec	Sask	Other	Canada
Direct and Indirect Only							
Investment	10652	29051			6294	2421	48419
Labour Income	6004	16473	1967	493	1905	763	27605
GDP	7865	22249	2819	718	3107	1272	38030
Federal Government Revenue	1397	4094	495	87	452	197	6722
Provincial Government Revenue	820	1490	275	119	484	113	3302
Total Government Revenue	2218	5584	770	206	936	310	10023
Employment	87035	190754	29139	8523	27969	12095	355515

PRICE UPLIFT REINVESTMENT IMPACTS	BC	Alberta	Ontario	Quebec	Sask	Other	Canada
Direct, Indirect and Induced							
Investment	10652	29051			6294	2421	48419
Labour Income	7803	19980	3296	887	2286	1054	35306
GDP	11393	29256	5221	1434	3958	1850	53112
Federal Government Revenue	2099	5600	965	186	624	300	9774
Provincial Government Revenue	1300	2263	619	258	609	204	5253
Total Government Revenue	3398	7864	1584	444	1232	504	15027
Employment	117114	237165	50486	15974	34691	17833	473263

Table 3.7: Impacts of Production from Reinvestment

(Sum 2019 to 2048, in millions of year 2012 Cdn $,
and employment in person years)

PRODUCTION from REINVESTMENT IMPACTS	BC	Alberta	Ontario	Quebec	Sask	Other	Canada
Direct and Indirect							
Investment	18296	60090			20546	7897	106829
Labour Income	2857	12144	1523	416	1919	488	19346
GDP	16549	54723	2220	618	16346	7849	98305
Federal Government Revenue	1797	6852	401	77	1849	595	11573
Provincial Government Revenue	3666	11892	244	105	3847	1137	20890
Total Government Revenue	5463	18744	645	182	5696	1733	32463
Employment	39022	108480	22930	7209	28360	8087	214088

PRODUCTION from REINVESTMENT IMPACTS	BC	Alberta	Ontario	Quebec	Sask	Other	Canada
Direct, Indirect and Induced							
Pipeline Revenues	18296	60090			20546	7897	106829
Labour Income	3886	14819	2558	733	2336	698	25030
GDP	18556	60190	4108	1199	17276	8260	109589
Federal Government Revenue	2221	8063	784	160	2158	670	14056
Provincial Government Revenue	3923	12539	507	217	3885	1199	22271
Total Government Revenue	6144	20601	1291	378	6043	1869	36327
Employment	56698	146306	39750	13333	36456	12421	304964

The reinvestment and subsequent production associated with the uplift in the price received by oil producers is forecast to be a significant stimulus to economic growth, regionally and nationally.

3.3 Overall Results and Conclusions

Northern Gateway can be expected to generate large and widely-distributed positive economic impacts in Canada. These arise from the construction and operation of the project, and through the associated oil price uplifts, the increased value of Canadian oil production and the reinvestment of a portion of those gains. These have been estimated using a model of Canadian energy balances, a model to capture Canadian crude oil market allocation and oil price/netbacks associated with Northern Gateway, and an Input-Output model to capture the total (direct, indirect and induced) impacts associated with Northern Gateway.

These overall impacts include an expected gain of about $312 billion in Canadian GDP over the construction and operations period (to 2048). On an average annual basis this amounts to roughly $9.2 billion or equivalent to approximately a 0.5 of a percentage point gain in the growth rate for Canadian GDP at current levels. The total employment impact is estimated to be 907 thousand person years over the construction and operations period. The average annual increase in employment as a result of Northern Gateway would be equal to approximately 6 per cent of the average annual increase in total Canadian employment over the years 2005 to 2008, a period of strong growth. The $98 billion increase in government revenue would be equivalent on an annual basis to over 0.5 of a per cent annual increase in total federal plus provincial government revenues.

These impacts are widely distributed across the country. For example, the approximate geographical distribution of this incremental employment would be: 263,000 person years in B.C.; 401,000 in Alberta; 72,000 in Saskatchewan;104,000 in Ontario; 34,000 in Quebec and 32,000 distributed among the remaining regions.

The level of estimated impacts may be understated for a number of reasons:

- The Muse, Stancil & Co. (Muse Stancil) estimates of oil price uplifts that are used in the analysis are reasonable and balanced, as argued by Muse Stancil, with some conservative assumptions.[67] Further, in maintaining a conservative estimation bias, there is a

[67] See Muse Stancil &Co., *Market Prospects And Benefits Analysis For The Northern Gateway Project, July 2012*, page 4.

diversion of oil from U.S. markets with no incremental oil sands production. In a case where, without the NGP, some Western Canadian oil would be shut in, the gains to the Canadian and regional economies arising from the project will be much larger than indicated by the estimates noted above.

- Northern Gateway generates important diversification and option values but these have not been quantified and therefore not included in the estimated benefits. Nevertheless, these values are real, substantial and likely growing in importance given the uncertainties with respect to future policies affecting traditional markets for Canadian oil, the growing differences among key oil markets in terms of growth rates, and generally the potential arbitrage opportunities and the gains in stability through market diversification.

- It could be argued that the estimated economic gains resulting from the project will prove to be too high, if in the future the economy was operating at or near full capacity. In general, conditions of excess capacity and unemployment rates above the 'full employment' or 'non-accelerating inflation' level prevail in Canada, with only occasional and usually short periods of time when the economy is operating at or near capacity. Under these usual conditions, the impacts estimated here are well within the normal and growing absorptive capacity of the economy. As such, any significant dislocations would not be expected.

- In summary, the analysis undertaken in this study indicates that Northern Gateway would be a catalyst for the generation of substantial and widely-distributed positive economic impacts for Canada and a significant contributor to sustaining Canadian growth and prosperity for many years into the future.

4. COST BENEFIT ANALYSIS

4.1 Introduction

Cost Benefit Analysis (CBA) is a well-established approach commonly used to evaluate the efficiency or effectiveness of a project or policy. It represents a systematic attempt to quantify all direct, incremental benefits and costs to determine whether there is a net benefit and, as such, whether the project or policy is wealth or well-being enhancing. When used in private decision making (where it is properly called a private CBA but most commonly referred to as Discounted Cash Flow analysis), the objective is to determine whether a particular investment will generate a return in excess of the cost of capital (and therefore be profitable) or equivalently, whether there is a positive net benefit when all relevant private benefits and costs into the future are properly discounted by the cost of capital.

A social CBA, on the other hand, is used when it is important to take a 'long' view (where repercussions extend well into the future) and a 'wide' view (where social costs and benefits rather than just private costs and benefits) must be considered. The objective is to determine whether a particular project, policy or action can be expected to produce a net gain in total welfare of a given constituency (usually a nation, region or other well defined group).[68] The contrast with an impact study such as that presented earlier might be usefully noted. Unlike an impact study, where the objective is to capture all direct, indirect and induced effects on selected measures such as output, income and employment, a social CBA considers only the direct benefits generated and the direct costs incurred.

Since the early 1990s, the NEB has not generally requested a CBA of projects under its purview. In the case of the Northern Gateway application, however, a number of intervenors have suggested that a social CBA of the project should be undertaken and have submitted their own social cost benefit analysis.[69] In this context, WMR was asked by Fraser Milner Casgrain LLP (FMC), acting for Northern Gateway, to provide such a study

[68] In the context of project evaluation, it could also be used to compare the efficiency or effectiveness of alternative or competing projects or to determine the optimal timing of a project.
[69] *A Public Interest Assessment of the Enbridge Northern Gateway Project*, by Dr. Thomas Gunton and Sean Broadbent, prepared for Coastal First Nations, January 2012.

in reply to this intervenor evidence. The social CBA, outlined in this and subsequent sections, is the response to that request.

It should be emphasized at the outset that the CBA undertaken here uses a national perspective. That is, the objective is to determine whether the Northern Gateway project is in the national interest as measured by the net benefits to the collective within Canada's national borders. As such, the view is that all individuals, businesses and governments within those borders have 'equal standing' within the analysis.

It must be noted that the single "bottom line" of a CBA will be an estimate of the Net Present Value (NPV) of a stream of benefits and costs. However, our approach is along the lines of what Marvin Shaffer calls "Multiple Account Benefit-Cost Analysis.[70] By showing the component accounts that make up the analysis, the user is provided much more information than just having the one NPV result. Decision making should be improved because the trade-offs and sensitivities can readily be seen in the component NPVs for each element of the analysis.

The analysis does not purport to consider all possible alternative ways to produce, refine, blend, or transport oil production from Western Canada. That is not the objective. Rather, the focus is on an evaluation of the economic merits of the proposed Northern Gateway project for Canada. Nor is it the objective to speculate about other projects that might come into play in the future, as for example the proposed Kinder Morgan expansion or other projects in BC. Those projects will have their turn to appear before regulatory boards. In addition it is not reasonable to speculate about the effects of increased volumes through NGP. The NEB may condition any certificate to restrict volumes if that were a real concern of the regulator.[71] However, the CBA sensitivity cases, described below, can indicate the possible influence of other projects.

As far as possible the analysis is quantitative, but some features of the project are not easily amenable to quantification. One of these is a notable benefit which stems from the "diversification or option value" of opening a new major market for Canadian crude oil other than the United States. Another non-quantifiable feature, but with possible negative overtones is the

[70] *Multiple Account Benefit-Cost Analysis*, Marvin Shaffer, U of T Press 2010
[71] Some intervenors (e.g. Ms. Allan) have suggested NGP should consider other projects and higher volumes. We note that with higher volumes there would be higher benefits as well as potential costs.

divergent distribution of benefits and costs amongst Canadians. While it is clear from the Impact Analysis that the people of all provinces are forecast to benefit, as well as the federal government, it is equally clear that residents of the various provinces do not benefit equally. In general, there is no claim that the 'market' produces equal or equitable outcomes. Rather, subject to policies and regulations to ensure a well-functioning market, the market objective is to achieve efficient outcomes or, expressed differently, to maximize the size of the 'economic pie'. With this maximization it is then the role of elected governments to implement various tax, expenditure and transfer policies to ensure the outcomes meet distributional objectives. In the case of the CBA, these issues of appropriate distribution or redistribution are outside the scope of analysis. However, this does not diminish the potential role for provincial or federal governments to change the distribution of some of the benefits of a project found to be in the national interest through any number of policy mechanisms.

As outlined in Section 3, the 2012 Muse Stancil report provides an updated first order estimate of the net benefit from the project, showing the annual gross revenue increase from the forecast oil price uplift, less the annual tolling cost on the NGP oil pipeline.[72] However, that analysis was not (and was not intended to be) a social CBA. As such, it did not incorporate a number of elements considered here. For example, it did not incorporate the cost of any underutilized pipeline capacity in Canada (costs or resulting losses of revenue for pipeline companies) when Northern Gateway diverts oil away from the United States to Asia, and it did not include the possibility of induced externalities (benefits or costs), such as those related to ecological or environmental impacts.

The CBA presented here attempts to fill in the details and to address the main complexities and externalities that hitherto were not coordinated within the framework of an economic appraisal of the project.

4.2 Methodology

Overview

Cost Benefit Analysis is essentially cash flow analysis, writ large in the social context. Here it is conducted from a national (Canadian) perspective.

[72] Muse Stancil & Co., 2012 Report, Table A-21

The approach includes the use of either forecast dollar flows or expected values that take into account probability distributions as a means of measuring costs and benefits. These are calculated on an annual basis and discounted by selected discount rates to obtain Net Present Values (NPVs) for each component and to generate an overall net benefit result. The CBA matrices in Appendix C show the detailed results, component by component, and the overall net benefit, using four discount rates: 0%, 5%, 8% and 10%. The approach is summarized in Figure 4.1 and in the following text.

Direct Cash Flows from Project: investment and operating costs, and tolls paid by the shippers generate cash flow costs and benefits to the private sector debt and equity owners of NGP, and property taxes for local governments, and income taxes for provincial and federal governments.

Adjustment for Reducing Unemployment: for taking into account the fact that some of the direct employees of NGP would otherwise be unemployed. Therefore their costs should not be counted as a resource cost for the project.

Costs from Excess Capacity on Main Oil Pipelines to US: it is estimated that the switching of 500,000 barrels per day from US markets towards shipment to Asia, as a result of NGP, will likely induce costs or lost revenues for the main oil export pipelines for a few years.

NGP "Needed" or Not, before certain year: if NGP is viewed as not being necessary (from point of view of Canada's overall pipeline capacity) then the revenues paid by the shippers of oil may be viewed as not being benefits, and should therefore be deducted.[73]

Canadian Oil Price Uplift: generates additional revenues for private sector individuals and companies and for the public sector in the form of incremental taxes and royalties. However the price uplift will increase the costs incurred by Canadian refineries using Western Canadian Sedimentary Basin (WCSB) oil.

Environmental Impacts*:* the cost expectation of environmental impacts, including GHG from project activities, is counted as a social cost.

[73] This assumption appears to be made in the report: *A Public Interest Assessment of the Enbridge Northern Gateway Project*, by Dr. Thomas Gunton and Sean Broadbent, prepared for Coastal First Nations, January 2012.

Included here are cleanup and damage costs associated with any spill impacts arising from offshore spills related to tanker traffic in Canadian waters, the Marine terminal or from the onshore pipelines.

Figure 4.1: Summary of Cost Benefit Components

Components of Cost Benefit Analysis		
Direct Cash Flows from Project		
	Investments	Cost to debt & Equity of NGP
	Operating Cost	Cost to debt & Equity of NGP
	Revenues	Benefit to Debt and Equity of NGP
	Property Taxes	Benefit to local governments
	Income Taxes	Benefit to Fed & Prov governments
Adjustment for reducing unemployment		Benefit to Canadians generally
Cost from excess capacity on main oil pipelines to US		Cost to Equity of Canadian Pipeline Cos
NGP "Needed" or not, before certain year		minus NGP Oil Toll Revenues if not needed
		Cost Expectation to Canadians generally
Canadian Oil Price Uplift		
	to Private Sector	Benefit to Canadian Private sector
	to Governments	Benefit to Canadian governments
	Cost to Cdn refineries	Cost to Refineries or Canadian consumers
Environmental Impacts: possible Cleanup and Damages		
	Other	Cost Expectation to Canadians generally
	GHG	Cost Expectation to Canadians generally
Oil & Condensate Spills: possible Cleanup & Damages		
	Offshore	Cost Expectation to Canadians generally
	Marine Terminal	Cost Expectation to Canadians generally
	Onshore	Cost Expectation to Canadians generally

Risks

With regard to possible risks, the approach is to introduce Cost Expectations, defined by the annual frequency or probability of occurrence of an event, the size or extent of the event and the remedial cost of rectifying the event. As an example, for the offshore component Det Norske Veritas (DNV) has estimated that the probability of a spill of any size in any year is 0.004 (250 year return period), the average spill size is approximately 9,000 m3 and we have made estimates of the cost per m3 (and per barrel) for cleanup and the cost per m3 (and per barrel) for rectifying the situation.

The Cost Expectations approach is applied to possible offshore and onshore environmental impacts, including GHG emissions and the possible cost impacts of oil spills. Since the precise location or size of any spills cannot be predicted, the Cost Expectations approach relies on the estimated mean (average) values of volumes, areas at risk, damage to such areas, cleanup costs, and recovery periods.

Lest a reader think we are mixing proverbial apples and oranges by combining the predicted costs and benefits of the other components in the CBA with the cost expectations related to risks, we have allowed for sensitivity tests on the size of all the components. This covers the issue of uncertainty in the estimates of components where probability distributions are not available, such as in some Northern Gateway investment and cost components and in the estimates of the oil price uplift. A sensitivity factor is attached to each component and set at 100% for the Base Case. In addition, the modeling allows any of the components to be completely switched off, or in some cases to be operational only for a selected number of years.

The Base Case and Sensitivity Cases are described in more detail in subsequent sections of this report.

Insurance

The insurance coverage for offshore oil spills is approximately $1.3 billion and for offshore condensate spills is some $157 million. NGP is not responsible for insurance against offshore spills. The coverage for condensate is far less than for crude oil. This reflects the fact that condensate spills are less damaging than oil spills.

The externalities in the oil tanker trade have been recognized for many years and have led to the creation of various government-sponsored Funds for cleanup and remediation of offshore oil spills. Canada contributes to the international funds and also has its own fund (SOPF). The insurance coverage for spills is extensive.

Key elements of insurance coverage for clean up and compensation are summarized in Figure 4.2.

Figure 4.2: Summary of Insurance Coverage for Clean Up and Compensation

Insurance Coverage for Clean Up and Compensation			
	Acronym	Max Payable for Single Incident Million Cdn$	
For Offshore, for Oil Tankers			in Canadian waters
Private Insurance			
Oil Tanker max liability under private insurance, Ship owners/insurers Protection & Indemnity Club	P & I Club	137	if negligence, then unlimited
Government Sponsored Insurance			
International Oil Pollution Compensation Fund	IOPCF	309	
IOPCF Supplementary	IOPCF	833	Canada is one of 27 sponsor countries. USA absent
Canada's Ship-Source Oil Pollution Fund	SOPF	157	under Canadian Marine Liability Act
Maximum Payable: Total less Private Insurance		1,299	
For Offshore, for Condensate Tankers			in Canadian waters
Tanker private insurance			no legislated maximum
Canada's Ship-Source Oil Pollution Fund	SOPF	157	
Maximum Payable: Total less Private Insurance		157	
For Onshore, Oil or Condensate			
Enbridge existing maximum coverage		575	Note: Marine Terminal may need additional insurance
NGP to be determined, but Enbridge has committed to cover any and all costs			response to JRP IR # 9, page 12
Source: NGP Responses to various IR s			

For the onshore, Enbridge has stated that its existing insurance coverage of $575 million may be extended in order to cover separately the Marine Terminal. Northern Gateway has acknowledged that it would be responsible to pay for any costs attributable to pipeline spills beyond its insurance maximums.[74] We note that the expected (or probability weighted) condensate spill sizes from the NGP pipelines are smaller than oil spills, partly because some types of spills are proportional to volumes.

We turn now to the issue of insurance premiums (or government levies and payments into the government-sponsored funds). Assuming that all parties are properly insured and there are well-functioning insurance markets, it could be argued that annual insurance premiums would be equivalent in

[74] Response to JRP IR # 9 page 12

amount to slightly more than the amount of annual cost expectations from environmental impacts and possible oil spills. Conceptually, such annual premiums should be included in the costs of the parties involved in the project. Therefore, if incremental insurance premiums (e.g. against cost of oil spills) were included in the CBA as costs, then we should either reduce or fully offset the corresponding cost expectations. However, we have no information about incremental insurance premiums that would be induced by the project.[75] As such, we have used the expected values associated with spill cleanup and compensation as costs in the context of the CBA, as detailed in subsequent sections of the report. This is a conservative approach and could over-estimate social costs if insurance premiums or levies are already included in the costs of the project or in the assumed ocean shipping tariffs.

Incremental Effects

The criterion for measuring costs and benefits in a CBA is to identify and measure the incremental real resource costs imposed by the project and the incremental real benefits. The incremental effects are assessed against a benchmark forecast of factors such as forecast Canadian inflation rate, the foreign exchange rate, Canadian oil production, oil exports and Canadian and international oil prices. The benchmark forecasts are the same as for the Impact Analysis and key factors are summarized in Appendix A.

We assume that the NGP investment costs are entirely real costs to the economy, but that a portion of the labour costs may be for persons who would otherwise be unemployed. In such cases, the real cost to society of using that labour would be less than the normal wage cost. A small positive allowance is included for this in the CBA (described in the Data section below) and is primarily intended to show the relative size of the effects of using a lower 'shadow' price for labour rather than the going wage rates. This adjustment demonstrates that as the amount of otherwise unemployed labour absorbed by the project increases, the net benefit of the project rises.

[75] The contributions to Canada's SOPF have already been made or will be made through yet-to-be defined levies on shipping in Canadian waters and Canada's contributions to the international funds are being made irrespective of NGP. For the onshore, Enbridge already has general coverage for the consequences of any spills and may or may not augment its insurance for NGP.

As in the NGP application to the NEB, it is assumed that the oil exported through the project would otherwise be exported to the United States. The benefits to the oil producers (and governments) are solely a result of the oil price uplift. There are no costs (or benefits) associated with any increases in Canadian oil production over the benchmark level.

In relation to cost expectations from environmental incidents, including oil spills in the onshore, it could be argued that the incremental reduction of oil volumes on the export pipelines to the United States will reduce the risks and possible costs of spill events on those pipelines (or rail shipments) and that we should include this effect as a positive component in the CBA. We have not done this but it deserves consideration. Our approach is to be conservative, as with several other possible but difficult to define benefits.

4.3 Data

NGP Pipeline Investments, Operating Costs and Revenues

The starting points for the CBA are the forecast Cost of Service (COS) financial statements of the NGP. We have combined the investments, operating costs and revenues for both the oil pipe and the condensate pipe, and all the connecting facilities such as the terminals, into a single simplified COS model. The COS model can then calculate tolls essentially the same as the weighted sum of those that have been filed by NGP, using a much more complicated proprietary COS model. This provides us with a means of estimating very accurately the annual cash flows to equity and debt in the combined NGP and items such as property taxes and income taxes derived directly from the NGP. The direct NGP annual cash flows can be seen in the first column of the CBA matrices in Appendix C. The advantage of our approach is that we can do sensitivity analyses on the NGP cash flows as well as on the other components in the CBA matrix and we can also show the contribution of each component.

Labour Market Adjustments

While it is likely much higher, the Base Case assumption is that 5% of the labour input in NGP construction and operations would otherwise be unemployed. The labour content has been estimated by NGP as 14.55% in investment and 20.50% in operations. Overall in the Base Case the weighted average labour content in investment plus operating costs is

16.93%. For simplicity, we assume that the opportunity cost of unemployed persons would be zero. This leads to a small offset to the labour costs embedded in the NGP investment and operating costs, shown in the 4th column of the CBA matrix.

"Need" for NGP

The 2012 Muse Stancil forecasts of oil prices and the oil price uplift provide estimates of the volume impacts on pipelines moving oil to the US as a result of temporary offloading caused by shipments being redirected from U.S. markets to the NGP. Consequently it was necessary to develop an estimate of this offloading cost to be included in the CBA. This was based on data provided by Enbridge, and reflects the costs or lost revenues from the short term mainline "underutilized capacity" in the first few years of NGP operations (these are shown in column 5 of the CBA matrices).

As previously noted, some intervenors have asserted that the NGP will not be "needed" either wholly or partially until around 2024 and that the NGP is designed with excess capacity and consequently its tolling revenues for oil shipments would not fully be a benefit even after 2024.[76] This assertion may stem from a misinterpretation of sections of the NEB Act[77] and a misunderstanding of pipeline economics. However, as a sensitivity alternative, we have included a component in the CBA that can switch off the NGP annual revenues from oil shipments for a designated number of years. This is shown in the 6th column of the CBA matrices.

It should also be pointed out that, as a general rule, all new major pipelines are built with a maximum capacity well above the immediate requirements of the shippers. In part this is because pipelines exhibit substantial economies of scale. Once the pipe is in the ground, it is much more economic to add pump stations to increase capacity than it is to loop the pipeline.

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[76] A Public Interest Assessment of the Enbridge Northern Gateway Project, by Dr. Thomas Gunton and Sean Broadbent, prepared for Coastal First Nations, January 2012.
[77] NEB Act, Section 52 sets out various criteria which must be taken together in judging the merits of a project.

Oil Price Uplift

The oil price uplift is taken from the 2012 Muse Stancil report which estimates these uplifts for the period from 2018 to 2035. We have extended the analysis to a full 30 year operating period (that is, to 2048).[78] The US dollar uplifts are converted to Canadian dollars using our foreign exchange series.[79] The CBA matrix shows the gross revenue uplift split 65.6/34.4 between the two direct recipients: the private sector oil producers and governments (income taxes and royalties). However, part of the uplift revenue imparts higher costs on Canadian refineries that use Western Canadian crude oil. This was also estimated in the 2012 Muse Stancil report through detailed analysis of oil volumes and refinery use of WCSB crude oil. If this uplift were passed along to consumers it is estimated that the result would be an impact of about 1.5 cents per litre for gasoline in the western regions.[80] However, as noted in section 2.1, given that Western Canadian product prices appear more tied to imported product prices than to feedstock costs, there may be no impact on product prices. As such the impact would be borne by refiners using Western Canadian crude supplies, rather than consumers. In either case, the higher feedstock costs are considered a cost within the CBA.

The estimated oil price uplift is primarily on heavy crude oil, including bitumen and DilBit, which have limited refining opportunities in North America, rather than on conventional light oil.[81] The uplift is in the order of $2 to $3 per barrel on an oil price of about $100 per barrel. Thus the uplift is only some 2% to 3% over the benchmark oil price trajectory. It would be a one-time shift upwards in the profile of future Canadian oil prices measured at Edmonton, with this uplift assumed to begin in 2019 in the CBA Base Case. It is not a continuous increase in oil prices year after year, as has been implied by one intervenor, but simply a one-time shift in the expected future price schedule.[82] The price uplift becomes significant when it is applied to the revenues received by all volumes of supply from the WCSB (including those going through the NGP). Most of the increased revenues are from oil

[78] Muse Stancil & Co., *Market Prospects And Benefits Analysis For The Northern Gateway Project,* July 2012, Tables A-18, A-20 and A-21
[79] Exchange rate and other key assumptions are set out in Section 2.4 of this report and repeated in Appendix A.
[80] NGP Response to Wier IR No. 5, Question 5-49
[81] See Appendix A where example price uplifts are shown.
[82] See An Economic Assessment of Northern Gateway, by Robyn Allan, January 2012.

exports to the United States, which remains by far the largest single market for Canadian crude oil through the forecast period.

Condensate Supply & Prices

A part of the project is the condensate import pipeline and its facilities. The investment costs and operating costs are included in the Direct Cash Flows from the Project (column 1 of CBA matrices). Condensate prices tend to track light crude oil prices, subject to swings depending on short term supply and demand pressures. Generally, forecasts of condensate supplies have shown the possibility of an emerging deficit in availability compared to the demand for this product as a diluent for Canadian heavy crude oils and oil sands bitumen. The NGP condensate volumes will tend to fill that deficit and on balance Canadian condensate prices may not be significantly affected by the project. No costs or benefits associated with condensate prices have been incorporated in the CBA.

4.4 Environmental Impacts and Oil Spill Risks

Introduction

The CBA treats two varieties of environmental externalities: (i) cost expectations associated with loss of ecosystem goods and services (EGS) from direct project activities; and, (ii) cost expectations related to the cleanup and remediation of possible oil spill risks from incidents associated with offshore, the marine terminal, and the onshore pipeline operations.[83]

The cost expectations of an oil spill in any given future year are calculated as follows:

Annual Cost expectation = (Annual Probability of Spill) X (Size of Spill) X (Oil Spill Cost), where: Oil Spill Cost = Cleanup Costs + Environmental Costs (per barrel or per hectare)

Generally, cleanup costs and costs of environmental damage can be expressed as $/bbl or $/ha and they depend on spill size and impact location. For ease of presentation and comparison, we have normally expressed all

[83] The cost expectation of spills does not include the value of lost oil or disruptions to operations.

final costs on a $/bbl basis. A summary of the various parameters for different spills is shown in Table 4.1. The assumptions and rationale for these costs are discussed further below. Detailed background information is provided in Appendix B.

Table 4.1: Summary of Representative Parameters for Oil Spill Cost Calculations *

	Tanker Spill	Marine Terminal Spill	Pipeline Full Bore Rupture	Pipeline Other Spills
Mean Size	56,700 bbl	1,575 bbl	14,100 bbl	600 bbl
Return Period	250 years	61 years	240 years	4 years
Annual Probability	0.004	0.0164	0.00417	0.25
Cleanup Costs	$15,000/bbl	$11,000/bbl	$4,000/bbl	$9,000/bbl
Damage Costs	$22,500/bbl	$9,000/bbl	$10,000/bbl	$800/bbl

*Note: Estimates for Tanker and Marine Terminal Spills include condensate handling. Estimates for Pipeline are for oil pipeline. Condensate pipeline parameters are similar except mean rupture size is 5,200 bbl with 273 year return period and cleanup costs for other small spills is $5,000/bbl.

The analysis treats any direct loss of ecosystem goods and services as a project cost expectation. We have tried to err on the cautious side by tending to overstate some of these costs in the Base Case. Sensitivity cases have been used in the CBA as a further measure of assessment in view of their inherent uncertainty. Consistent with the environmental assessments undertaken in support of the application, probable impacts will be mitigated to required regulatory standards or better, but the CBA nonetheless conservatively includes the full resource values at risk. [84]

[84] Cumulative effects, for example, are internalized within the project operational and capital costs to the extent that necessary mitigating measures were identified in Volume 6C: environmental and Socio-Economic Assessment (ESA) Human Environment, Enbridge Northern Gateway Project (Sec 52 Application).

Terrestrial Impacts. No losses of Ecosystem Goods and Services (EGS) were identified as part of routine project operation, but project construction will result in land degradation along the 1,172 km of the Project Development Area (PDA). Mean values of EGS along this corridor were computed to be $180/ha/yr commencing in the year of degradation. Normally this area would recover naturally over some period and the lost EGS would thus diminish in value. For the base case of the CBA, we assume that the 50m wide PDA corridor does not recover after initial construction impact. This results in a project cost of $1.39 million annually for the 7,700 ha of PDA.

We note that one implication of assuming that the PDA loses EGS is that any future spills affecting only this area will have zero additional damage costs; this permits us to discount any damages from small leaks and spills contained within the PDA. The result is that these spills have a damage cost expectation of $800/bbl. [85]

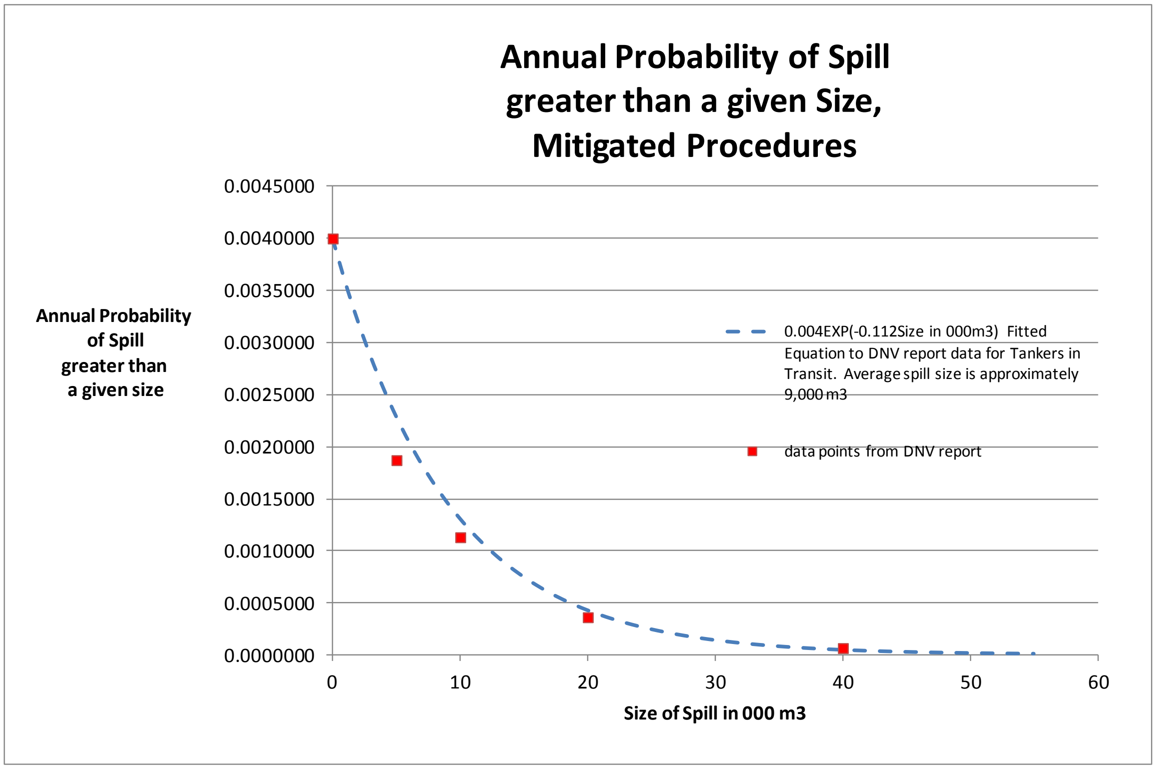
Greenhouse Gas (GHG) Emissions. Incremental GHG emissions associated with the project are assigned a cost to Canadians of $20/tCO2e.[86] The incremental emissions are associated with fuel use during construction, pipeline operations, marine terminal operations, and tanker operations within Canadian waters. An estimated 100,000 tCO2e per year are forecast during construction and 200,000 tCO2e during operations.

Offshore Oil Spills

Offshore Oil Spill Probability and Size. An extensive study of the probability of oil spills in offshore Canadian waters was undertaken by Det Norske Veritas (DNV). The principal results relating to oil and condensate tankers in transit are summarized in Figure 4.3 below.

[85] The weighted average total cost for cleanup and damages across all “other” spills including both pipelines is $7,815/bbl.
[86] Note that the present market price in BC is $25/tCO2e as per Pacific Carbon Trust, but the price in Alberta is $15/tCO2e. .

Figure 4.3: Offshore Annual Spill Probabilities[87]



We have fitted an equation - the dashed line - to the data points (above as red squares) shown in the DNV report. The chart shows that the estimated annual probability of a spill of any size is 0.004 for tankers in transit in the waters from Kitimat to the open ocean and it can be calculated that the average size of a spill would be approximately 9,000 m3. The annual probability of a major spill of 41,000 m3 or more is in the order of 0.000041 – a highly unlikely but large event (roughly the same size as the Exxon Valdes spill: a “Black Swan” event).[88] We acknowledge that most persons' fears of a spill are related to the possibility of such an event. However, for purposes of the CBA the average event expectation and consequent cost expectation is what is relevant.

Even if we would assume that the per barrel costs for cleanup and remediation were the same for a major spill as for the smaller average spill, the cost expectation of a major spill would be considerably less than for the average spill, because of its very low probability of occurrence. A major spill is so unlikely that it does not significantly impact upon the normal

[87] Termpol Study No. 3.15, Table 4-10 and Figure 4.3, pages 4-17 and 4-18.
[88] See The Black Swan, Taleb, 2010 for discussion of unlikely but large events.

economic analysis. Notwithstanding, Sensitivity Case # 5, shown below, is provided as a test of the degree to which spill frequencies and consequences could be increased without undoing the economic viability of the project.

It is important to understand that the probability of any offshore spill during the entire operating period of the project is very low. Another way to view the annual probabilities is to consider the probability of a spill over the 30 year operating period. It can be calculated that the annual probability of 0.004 implies that the probability of a spill over a 30 year period is 0.113, as shown in the following table.[89]

Table 4.2: Lifetime Spill Probabilities

Lifetime Probability of a Spill, given Annual Probability of any Spill					
Return Period Yrs		250	110	78	30
Annual Prob		0.004	0.009	0.013	0.033
Lifetime Yrs		Lifetime Probability of a Spill			
30		0.113	0.240	0.321	0.638
50		0.182	0.367	0.475	0.816
78		0.268	0.510	0.634	0.929
90		0.303	0.560	0.687	0.953
110		0.357	0.634	0.758	0.976
250		0.633	0.898	0.960	0.9998

Based on the DNV estimates, there is approximately an 89% chance that no spills of any size will occur during the 30 year period. The lifetime spill probabilities in Table 4.2 are derived from a range of annual probabilities (reciprocal of return periods) that have been considered in the DNV reports. For example, if mitigation measures to avoid spills are not taken, DNV

[89] The calculation is 1 - ((1 – annual probability)^Yrs)

estimates an annual probability of any spill as 0.013 (78 year return period).[90]

Note that the assessed probability of a spill is higher for the tankers carrying oil than those carrying condensate. [91] The consequences of an oil spill, especially DilBit, are almost always greater than for a condensate spill. The data include the operations of both the oil and the condensate tankers.

Offshore Oil Spill Costs. For cleanup costs and damages we conservatively use costs applicable to a crude oil or DilBit spill rather than a condensate spill. For the Base Case, offshore cleanup costs of $15,000/bbl are used. These are at the high end of the range of costs shown by a literature review associated with IOPCF oil spill cost data over the period 1979-2006. Regression analyses over the period 1979-2006 showed an average value of US$4,118/tonne (2009) [approximately Cdn$800/bbl (2012)] over the entire period, with lowest unit costs for the largest spills.[92] Our cost estimates are also higher than those in studies of spills in the offshore of Atlantic Canada, conducted for Transport Canada (2007). They placed cleanup costs in a range of $820/bbl to $5,960/bbl (2012$) for 'high-persistence' oil. The lowest costs per barrel were associated with the largest spills.[93] Our assumptions reflect the literature (e.g. Psarros 2009) that higher unit costs should be used in cost benefit analyses where public safety and risk concerns are being evaluated for a hypothetical event. [94]
As explained in Appendix B, offshore environmental damage estimates are taken as $22,500/bbl based on IOPCF analysis (Kontovas et al., 2010) using adjustment factors over the basic spill costs at the various reference scales. At the average spill volume the adjustment factor would be about 1.5, but it

[90] Termpol Study No. 3.15 Table 4-10, page 4.15
[91] Termpol Study No. 3.15 Table 4-11, page 4.15
[92] Kontovas et al. 2010. An empirical analysis of IOPCF oil spill cost data. Marine Pollution Bulletin. Total costs included clean up costs and social and environment costs. The equation of fitted model of cleanup cost is LOG10 (Cleanup)=4.64773 + 0.643615 LOG10(V); V=volume in tonnes , i.e., Cleanup cost = 44,435*(V^0.644). For total costs the result is TC=51,432*(V^0.728). These show the declining unit costs to size. Note also that this paper provides a comprehensive critique of Psarros et al (2009) who argues that for risk assessment costing a value of about $80,000/tonne ($12,700/bbl) should be used.
[93] Transport Canada. 2007. Synopsis Report – Environmental Oil Spill Risk Assessment for the South Coast of Newfoundland, Edition 1 September 2007, Revised 11/2007. Report TP14740E.
[94] Psarros G, Skjong R, Enderson O, Vanem E. 2009. A Perspective on the Development of Environmental Risk Assessment Criteria related to Oil Spills. Annex to International Maritime Organization document MEPC 59/INF.21, submitted by Norway.

varies with the spill volume. Again, we regard this as a conservative estimate (that is, one which errs on the side of overestimating costs).[95]

Various intervenors have proposed that "passive use values" should be considered in assessing project costs. Passive use values reflect how much somebody would be willing to pay (WTP) to avoid ecosystem damage by a high-risk event, even if they are not directly affected by the events or its impacts (see Appendix B). Such values were first measured in detail for American oil spills by Carson (1992, 2003, 2004), and have been proposed as a point of departure for estimating passive use values in Canada. Carson used surveys of hypothetical events in Alaska and California coastal waters, using questionnaires that poll the WTP for moving from a "high risk situation" (e.g. single hulled tankers with no escorts) to a "low risk situation" (double hulled tankers with escorts and other mitigation measures). As the project configuration and the mitigation measures which will be taken by the NGP are as good as or better than Carson's "low risk situation", Carson's results are not applicable in this case. Moreover, recent published reports have found that transferring results of that type of assessment to other jurisdictions or countries can be extremely unreliable.[96]

Marine Terminal Oil Spills

Marine Terminal Oil Spill Probability and Size. DNV made separate estimates for spills at the Marine Terminal. Any spills are expected to be much smaller than in the offshore but more frequent. They estimate an annual probability of any spill as 0.0164 (61 years return period) and a "maximum credible spill size" of 250 m3 (1,575 bbl). DNV doesn't give enough data to establish the average size spill and therefore, again as a conservative measure, we use the maximum credible size in the Base Case.

Marine Terminal Oil Spill Costs. For the CBA Base Case we have assumed cleanup costs of $11,000/bbl and environmental costs of $9,000/bbl. This cost is consistent with those in the literature. For example, Etkin (2004) examined cleanup costs in North America and suggested modifier factors in

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[95] We note that a median value of 1.287 may be more appropriate for factoring point estimates. Moreover, the Transport Canada study, which also addressed onshore and near-shore damages to fisheries, aquaculture and tourism, had implied factors of 0.85 for spills under 10,000 bbls and approximately 0.6 for larger spills.
[96] Brander L, Ghermandi A, Kuik O, Markandya A, Nunes PALD, Schaafsma M, Wagtendonk A. 2010. Scaling up ecosystem values: Methodology, Applicability and a Case Study. Sustainable Development Series, Carlo Carraro, (ed.), Fondazione Eni Enrico Mattei, Milano.

order to estimate costs in various environments.[97] As detailed in Appendix B, her factors included consideration for location, remoteness, size of spill, extent of shoreline oiling and degree of manual cleanup required. The range of cleanup costs for a spill of 250m3 was estimated as being between US $7,640 and US $14,440/bbl, depending on the degree of manual cleanup required. Our estimate is at the approximate midpoint of this range ($11,000/bbl), even though shoreline oiling should be limited, as spill mitigation equipment is readily available and deployable onsite. Note also that regression analyses conducted by Restrepo et al. (2009) confirm that leak costs associated with onshore pumping facilities included in such terminals tend to be lower than system average costs of the type addressed by Etkin; we thus regard our estimate as conservative.[98] For environmental costs we again rely on the IOPCF factored cost data and apply a multiplier of 0.85, which corresponds to a medium cost spill of 250m3, giving a cost of $9,000/bbl.

Onshore Oil Spills

Onshore Pipeline Oil Spill Probability and Size. Northern Gateway has undertaken extensive studies of the proposed onshore pipeline facilities and has concluded that the annual probability of the largest spill (a “full bore rupture”) is 0.00417 (240 year return period) and the expected average size of a spill from such a rupture is 2,238 m3 (14,099 bbl).[99] The annual probability of a similar spill from the condensate pipeline is 0.00366 (273 year return period) with a corresponding expected average spill size of 823 m3 (5,183 bbl). These spills could be caused by threats that include manufacturing defaults, third party strikes (assumed for modeling as a backhoe blade strike), and geohazards. The full bore rupture may occur at any point of the 1172 km pipeline right of way.

Apart from the full bore rupture, all other spills are classified as leaks. The overall range of spill threats contain several subcategories in addition to the above: pipe corrosion, construction faults, operational faults, and equipment failure. Within this range, the smallest include spills through pinholes

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[97] Etkin DS. 2004. Modeling Oil Spill Response and Damage Costs. USEPA.

[98] Restrepo CE, Simonoff JS, Zimmermann R. 2009. Causes, cost consequences, and risk implications of accidents in US hazardous liquid pipeline infrastructure. International Journal of Critical Infrastructure Protection 2:38-50.

[99] Enbridge SQRA Spill Studies and communication with study authors. Worley Parsons. 2012. Northern Gateway Pipelines Limited Partnership, Enbridge Northern Gateway Project, Semi-Quantitative Risk Assessment (SQRA); Submitted in Response to Joint Review Panel Information Request Number 8.1(B).

(<1.8mm holes in the pipe) having negligible probabilities and these can be ignored in the overall analyses. The leak associated with the highest expected (probability adjusted) release is a 568bbl (90 m3) spill with a 5 year return period (annual probability 0.198) occurring at a pumping station due to equipment failure. Although this is a relatively frequent spill, mitigation and containment measures associated with the pumping stations would limit the potential impacts, damages, and cleanup costs associated with such an event. Oil leaks in general (combining all sizes) have a probability weighted volume release of 150 bbl, corresponding to an average spill size of about 600 bbl at a return period of 4 years.

<u>Onshore Pipeline Oil Spill Costs</u>. We have assessed the scope of possible cleanup costs and damages from oil spills from the pipeline by considering two general categories of spill: full-bore rupture; and, leaks. The expected average spill size for a full bore rupture is 2,238 m3 which is about 15,000 barrels and based on Etkin and others we estimate a cleanup cost of around $4,000/bbl. Even leaks, however, can be quite costly: on average, oil leaks have an expected cleanup cost of $9,000/bbl and condensate leaks have a cost in the order of $5,000/bbl.

Each spill also has a damage cost associated with an event risk, to which an appropriate probability is applied. The environmental costs of most leaks are small, averaging $800/bbl, in comparison to cleanup costs. This is a consequence of their small size and containment possibilities within the PDA or, for equipment failures, near the pumping station sites. The full-bore rupture is the spill which could cause significant environmental costs and we estimate it at $10,000/bbl.[100]

[100] This reflects a worst case and not necessarily expected value because additional mitigation is still likely to be put in place as NGP defines some of the mitigation measures for Kitimat River. For example, a cost expectations approach, which is not based on the worst case, could yield an impact less than this because pipeline assessments indicate that only 292 (about 25%) of the 1,196 pipeline segments are considered moderate or high risk.

Summary of Environmental and Oil Spill Cost Expectations

The resultant annual lost environmental service values and oil spill cost expectations are summarized in Table 4.3 and the following figures.

Table 4.3: Summary of Environmental and Oil Spill Costs Expectations (2012 Cdn$)

	Period	Cost Expectations $million/year
Terrestrial Ecosystem Goods and Services	2019-2048	$1.40
Greenhouse Gas Emissions (Construction) Greenhouse Gas Emissions (Operation)	2015-2018 2019-2048	$2.00 $4.00
Tanker Spill (Cleanup) Tanker Spill (Environmental Damages)	2019-2048	$3.40 $5.10
Marine Oil Terminal Spill (Cleanup) Marine Oil Terminal Spill (Environmental Damages)	2019-2048	$0.28 $0.23
Pipeline Spill (Cleanup) Pipeline Spill (Environmental Damages)	2019-2048	$2.38 $1.03

Figure 4.4: Pipeline Annual Oil and Condensate Spill Cost Expectations

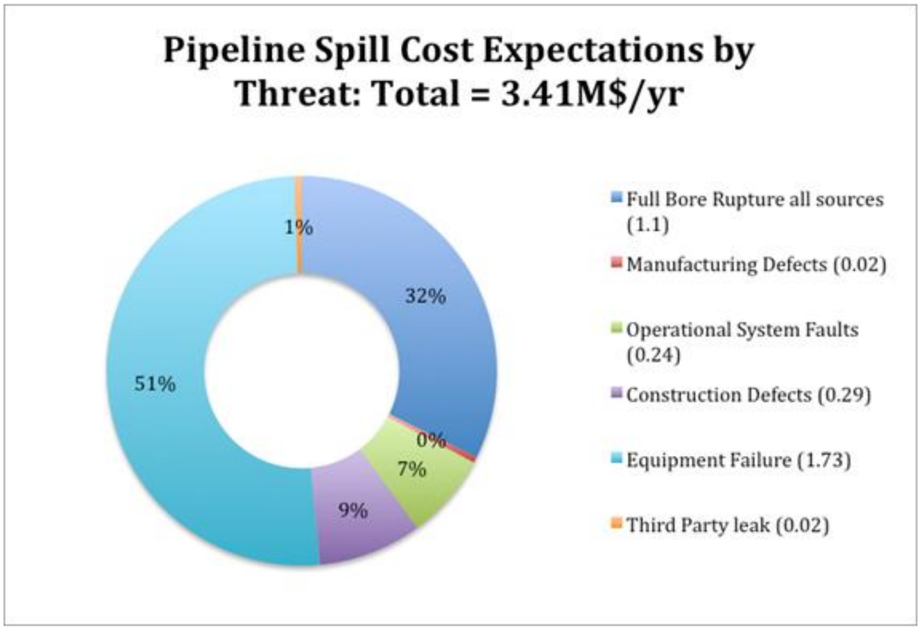
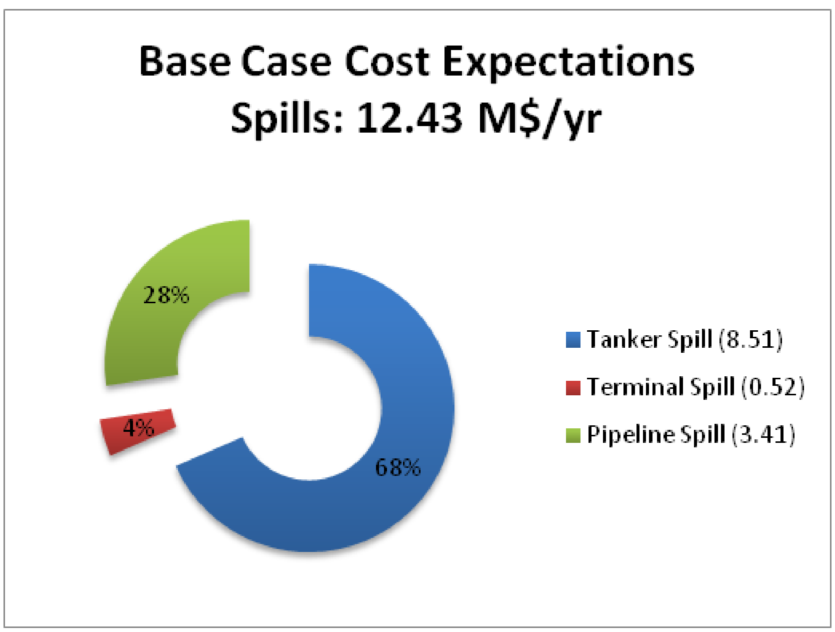


Figure 4.5: All Annual Oil and Condensate Spill Cost Expectations



5. Cost Benefit Results

5.1 Introduction

To help explain the process, we show below the Control Panel within the CBA spreadsheets. Figure 5.1 shows the setup for the Base Case. The 'best-estimate' of expected costs and benefits are included at 100%. Three possible components are switched off: 1) a possible allowance for the NGP being assumed not to be "needed" for oil shipments; 2) possible benefits from the "option value" derived from NGP; and 3) any price uplift (through operation of oil futures markets) in 2018.

Figure 5.1: Settings for Cost Benefit Analysis in Various Cases

CASE CONTROL PANEL, FOR BASE CASE AND SENSITIVITY CASES						
					%	
				% or	switch or	
To include in TOTAL Cash Flow		yes=1	sensitivity	Limit yr	Limit yr	
Investment		1	100.0%			
Property Taxes		1	100.0%			
Income Taxes		1	100.0%			
Labor Mkt Adjustments		1	100.0%			
Cost from reduced vol on ENB Mainline		1	100.0%			in Col R
"Need for Oil Pipe" Adjust'nt, before yr		0	100.0%	0		between 2020 and 2049
Price Uplift		1	100.0%	2048	1	Muse=1
	Include 2018 in anticipation				0	= 0, no anticipation in 2018
	Latest year of price uplift				2048	between 2018 and 2048
	Refinery Impact	1	100.0%		Caution: usually depends on Price Uplift	
	Split to Private sector/Govt			65.6%	34.4%	in Cols U and V
Benefits from Option Value		0	100.0%			in Col Y not used
Other Environmental Costs		1	100.0%			
GHG impact		1	100.0%			
Oil Spills	Onshore & Upland Terminal	1	100.0%			
	Marine Terminal	1	100.0%			
	Offshore	1	100.0%			

Although the operational phase of the NGP is scheduled for the 3rd quarter of 2018, in the analysis presented here the start of operations and the oil price uplift are assumed to begin at January 1, 2019 and continue through the period to 2048.[101]

[101] The forecast NGP operational startup date is August 1, 2018. Therefore in the CBA the net operating benefits and the oil price uplift are delayed five months, as are the various cost components. On balance there would be a net benefit in 2018, which we do not count to maintain conservative bias. We also include the investment costs in 2010 and 2011 which are sunk costs and would normally be excluded in a CBA except in this case they influence the level of the pipeline tolls.

The detailed CBA matrices, showing annual costs and benefits for the Base Case and Sensitivity Cases, are shown in Appendix C, with the Net Present Value results, using 0%, 5%, 8% and 10% discount rates. The calculations are made in constant (or inflation adjusted) Canadian dollars ($2012) and the results are summarized in the following sections.

5.2 Base Case and Summary of Results

The results for the Base Case and five Sensitivity Cases using an 8% discount rate are summarized in Table 5.1.

Table 5.1: Summary of Cost Benefit Results for Base Case and Sensitivity Cases

Components of Cost Benefit Analysis, Net Present Values at 8% (million 2012 Cdn$)		Base Case	Sens # 1	Sens # 2	Sens # 3	Sens # 4	Sens # 5
Direct Cash Flows from Project							
	Revenues less Investment & Operating Costs before interest payments & after taxes	(527)	(527)	(527)	(1,053)	(1,053)	(527)
	Property Taxes	427	427	427	427	427	427
	Income Taxes	387	387	387	387	387	387
Adjustment for reducing unemployment		41	41	41	37	37	41
Cost from reduced volume on Mainlines		(416)	(416)	(416)	(831)	(831)	(416)
NGP "Needed" or not		0	0	0	0	(2,611)	0
Canadian Oil Price Uplift							
	to Private Sector	17,851	0	3,090	3,090	3,090	17,851
	to Governments	9,367	0	1,622	1,622	1,622	9,367
	Cost to Cdn refineries	(3,476)	0	(851)	(851)	(851)	(3,476)
Environmental Impacts: possible Cleanup and Damages							
	Other	(9)	(9)	(9)	(18)	(18)	(9)
	GHG	(32)	(32)	(32)	(63)	(63)	(32)
Oil Spills: possible Cleanup & Damages							
	Onshore	(22)	(22)	(22)	(45)	(45)	(6,485)
	Marine Terminal	(3)	(3)	(3)	(7)	(7)	(981)
	Offshore	(56)	(56)	(56)	(112)	(112)	(16,149)
TOTAL NET BENEFIT		23,533	(209)	3,651	2,582	(29)	(0)
Overall Social Rate of Return (IRR)		32.8%	7.6%	17.6%	11.4%	8.0%	8.0%

Base Case
Sensitivity Case # 1 Without Oil Price Uplift
Sensitivity Case # 2: Oil Price Uplift halved & only for 5 Years
Sensitivity Case # 3: Double Costs and Halve Benefits, & only 5 years of Oil Price Uplift
Sensitivity Case # 4: Double Costs and Halve Benefits, & only 5 years of Oil Price Uplift & NGP not Needed for Oil Transport until 2024
Sensitivity Case # 5: Oil Spill Costs set high enough to offset all other benefits in Base Case (NPV8=0)

It is widely accepted that an appropriate social discount rate in Canada is in the range of 5% to 8%.[102] Generally, a higher discount rate tends to make the Net Benefits (Net Present Values) smaller as future values for net benefits are discounted more heavily. This can be seen from the CBA matrices in Appendix C.

Table 5.1 shows the components which make up the total net benefit. For example it can be seen that the Oil Price Uplift is the major contributor to net benefits in the Base Case. Glancing across the table it can be seen how each component is altered in the sensitivity cases, which are discussed in more detail below. In the first sensitivity case, the Price Uplift is entirely excluded. In the second sensitivity case it is included at a lesser level. In the third sensitivity case, costs are increased and other benefits are decreased. In the fourth sensitivity case, costs are increased and other benefits are decreased and in addition the NGP oil pipeline is considered not needed until 2024. The fifth sensitivity case is grounded in the Base Case but it includes increases in the oil spill cost expectations such that the net benefit becomes zero, at the 8% discount rate.

Base Case

The Base Case shows an overall net benefit of $23.5 billion in constant 2012Cdn$). Note that the negative NPV of $527 million for Direct Cash Flows from Project, which go to NGP debt and equity, does not mean that the project is uneconomic, but simply means that the internal rate of return is less than 8%.[103]

Given the 'best-estimate' assumptions, it is clear that the Base Case demonstrates a very significant positive net benefit for Canada. It may be asked however, whether the benefits take a long time to be realized, implying that the result may be uncertain. We can measure this uncertainty by showing the results in the form of a "Payout Chart" similar to the charts often used by industry for evaluating projects, as in Figure 5.2 below.[104]

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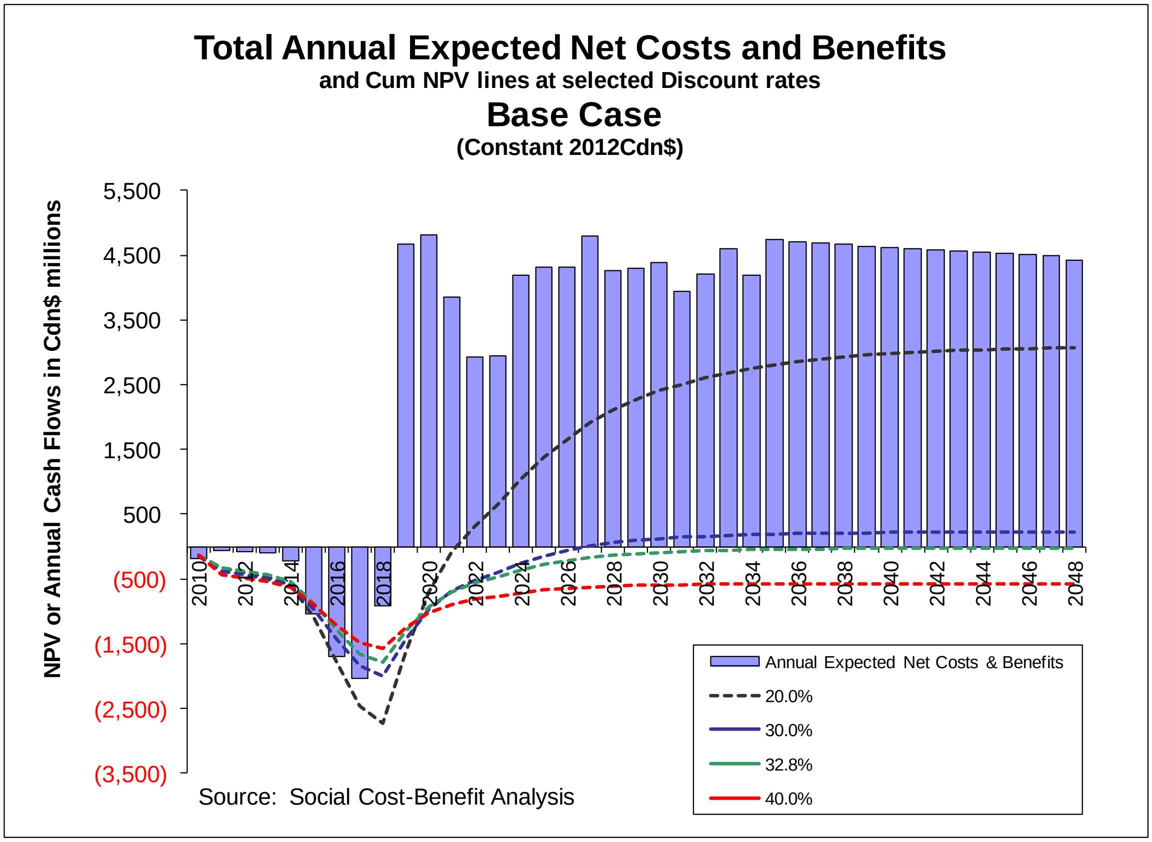
[102] A huge literature exists on the subject of discount rates. The present thinking is that a discount rate of approximately 8% is appropriate for Canada, as recommended in "The Economic Opportunity Cost of Capital for Canada –An Empirical Update" by G. Jenkins and C. Kuo, Queen's Economics Department Working Paper No 1133, July 2007. It can be argued that a higher discount rate tends to under-weight long term environmental costs, but at the same time it gives less weight to long term benefits.

[103] See Base Case, in Appendix C: The IRR for NGP debt and equity, before interest payments and after taxes, is 6.8%.

[104] The chart might be called a Social Payout Chart.

Figure 5.2: Payout Chart for Base Case



The chart shows that a social rate of return of 20% is achieved in the year 2021 – just 3 years after commencement of the project. A rate of return of 30% is realized by 2027 and 32.8% by 2048. These payout periods are extremely rapid and indicate a robust project from the point of view of economic analysis and the Canadian public interest.

As shown in Table 5.1, the cost expectations from oil spills or other environmental impacts are relatively small compared to the other components. On the other hand, the net benefit from the oil price uplift (after Canadian refinery costs) is obviously a major component of the overall net benefit. This raises the question whether the overall results would still be positive if the oil price uplift were ignored (or didn't occur). The first sensitivity case addresses this issue.

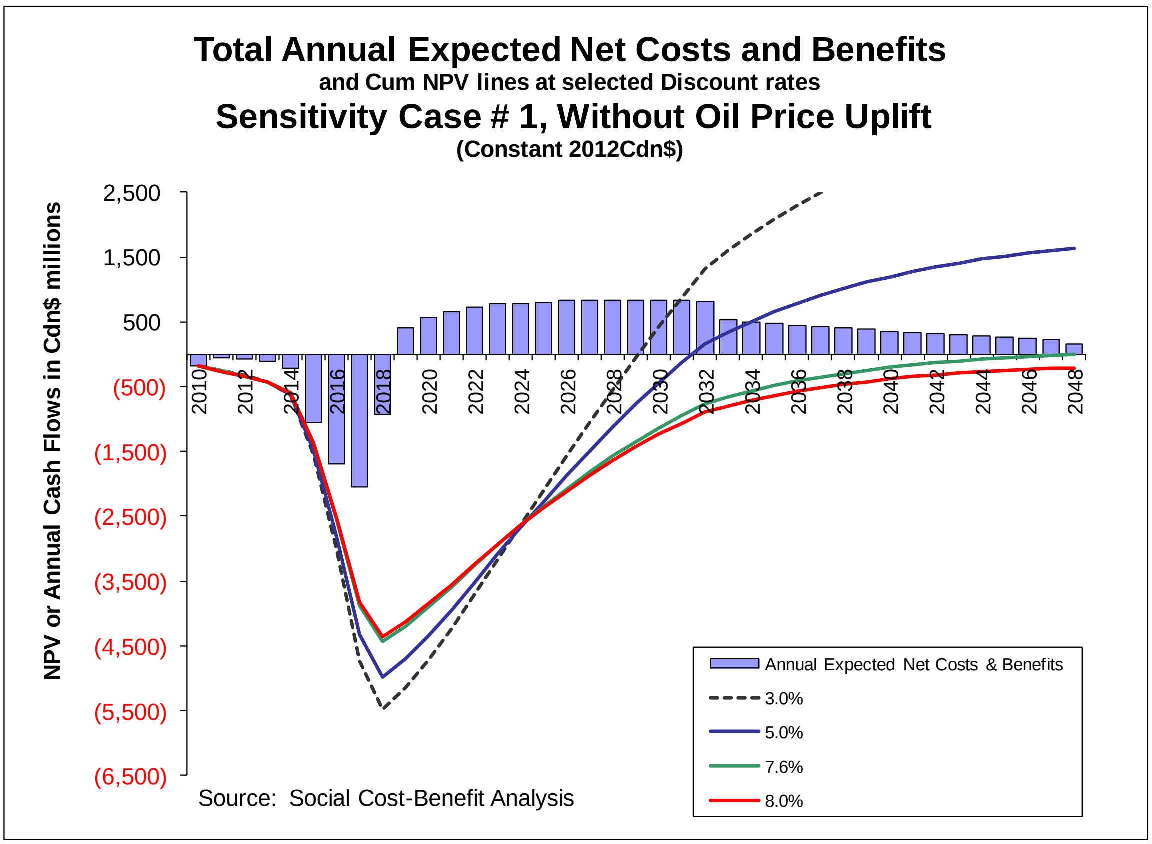
5.3 Sensitivity Cases

Sensitivity Case 1

The first sensitivity case shows the project and contingent costs and benefits, but without the important oil price uplift. The overall net benefit is negative $209 million at 8% discount rate. The social rate of return (IRR) is calculated as 7.6%. [105]

The payout chart in Figure 5.3 for this extreme sensitivity case demonstrates the long time period that it takes for a social rate of return to be achieved. A rate of return of 5% is achieved by 2032, after 13 years of operations. The amount and the duration of the oil price uplift are critical factors underpinning the robustness of the social net benefits.

Figure 5.3: Payout Chart for Sensitivity Case 1

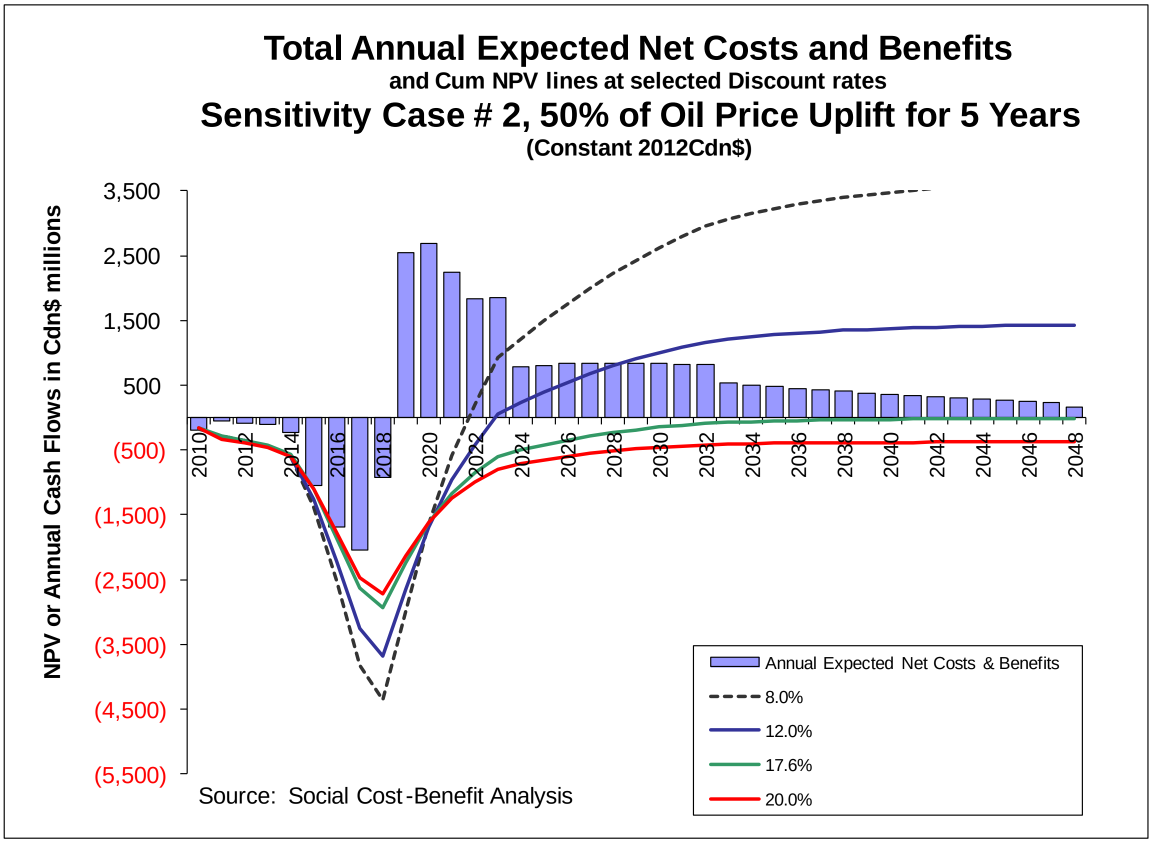


[105] Sensitivity Case 1, in Appendix C

Sensitivity Case 2

A second adverse situation would be where the oil price uplift is smaller and over a shorter term than expected. The second sensitivity case cuts the oil price uplift by 50% and only provides for it to last over a five year period. The overall net benefit is positive $3.65 billion, the social rate of return is 17.6%, and the threshold rate of return payout of 8% occurs in 2022. These results suggest that the NGP would generate a large net benefit even under these unfavourable conditions. The payout chart is shown in Figure 5.4

Figure 5.4: Payout Chart for Sensitivity Case 2



Sensitivity Case 3

A number of additional sensitivity cases have included a doubling of all costs (except property and income taxes which are costs to NGP but revenues to respective governments: i.e. merely 'transfers') and halving of other benefit components, plus other negative features. Sensitivity Case 3 assumes, as in Sensitivity Case 2, that the oil price uplift is reduced by 50% and only continues for 5 years and also that all other cost components are doubled and other benefit components are halved. The overall net benefit is positive $2.58 billion, at 8% discount rate.[106]

It can be argued that this sensitivity case (more than) covers the issue raised by intervenors of possible increases in cost expectations from oil spills resulting from an increase in oil volumes shipped through the project.[107]

Sensitivity Case 4

Sensitivity Case 4 is the same as Case 3, but in addition the pipelines are considered "not needed" until 2024. The resulting net benefit is negative $29 million at 8%. With these extreme assumptions, the social (internal) rate of return is 8%. [108] Summary results, highlighting the penalty from assumed excess capacity in this case, for 5% discount rate as well as 8% are shown in the Table 5.2.

Table 5.2: Adverse Conditions under Sensitivity Case 4

Cost Benefit Analysis Sensitivity Case 4		
	NPV @ 8%	NPV @ 5%
(million $)		
Project	(203)	3,392
Excess Capacity	(3,442)	(4,532)
Net Price Uplift	3,860	5,045
Externalities:		
Cost Expectation	(244)	(401)
TOTAL	(29)	3,503

Clearly the extreme assumptions of doubling costs and halving benefits, and limiting the duration of the price uplift, as well as in effect double-counting any costs from excess pipeline capacity – i.e. on the Enbridge mainline as well as on the NGP oil line itself, negate the very high values inherent in the project. However, the social rate of return of 8.0% that is achieved would

[106] Sensitivity Case 3, in Appendix C
[107] *An Economic Assessment of Northern Gateway*, Robyn Allan, January 2012
[108] Sensitivity Case 4, in Appendix C

normally still be considered acceptable in concluding that the net benefits are consistent with overall economic efficiency.

Sensitivity Case 5

Other sensitivity cases have been undertaken that deal with the question of how high various expected costs would have to be for the overall net social benefits to become zero. These are not really sensitivity cases but rather test cases. In Case 5, we have tested how much the cost expectations from oil spills would have to be increased for the project to just break even from a social perspective (i.e. to result in zero net social benefits using an 8% discount rate). The conclusion is that our Base Case calculation of the cost expectations from oil spills (NPV $82 million) would have to be increased by 289 times for the net social benefit to become equal zero.

Given the other Base Case assumptions, this sensitivity case implies a significant level of confidence that the expected outcome is a large and robust positive net social benefit for the Northern Gateway project.[109]

5.4 Summary and Conclusions

Using the social discount rate of 8% and in terms of real dollars, the Base Case shows a net benefit of $23.5 billion. [110]

Many sensitivity cases have been run and five of the more extreme cases are reported above.

They have shown that the project is generally robust even when subject to unusually wide and adverse variations in the parameters affecting its components, including the doubling of costs and halving of benefits.

Clearly, the oil price uplift is the key to making the project robust and yielding high net benefits. An instructive case is Sensitivity # 2 with half of the oil price uplift and only for five years. The overall net benefit is positive $3.65 billion at 8% discount rate. The social internal rate of return (IRR) is

[109] The exact increase is 289.52 times. Each of the three elements of the oil spill cost calculations (Probability, size of spill and Costs of Spill) could be increased by a factor of 6.61 times over those estimated for the Base Case (i.e. 6.61 X 6.61 X 6.61 = 289)
[110] See Base Case, in Appendix C

calculated as 17.6%. Without any oil price uplift, the social rate of return is 7.6% and would be viewed as marginal, but probably acceptable.

Given the assumptions of the Base Case, including the price uplift, further tests can be made of the robustness of the project from an economic point of view. In order for the Base Case overall net benefit (NPV8) to become zero, the oil spill cost expectations would have to be increased by more than 280 times, which indicates a substantial cushion in support of the economics of the project.

The main conclusions reached from the analysis are:

1. The bottom line of the CBA analysis is that the economics of the project from a national Canadian perspective are very favourable in the Base Case: the estimated net benefits are expected to be both large and highly likely. The Base Case uses 'best estimates' for many of the parameters, or purposefully it errs on the side of being conservative.

2. Moreover, the project remains robust when tested against sensitivity cases of higher social discount rates, lower oil price uplift and greater possible ecological or oil spill damages than in the Base Case.

3. One key to a successful project not only in CBA terms, but in relation to the broad public interest, is that the probabilities of upsets should be controlled so as to be negligible in the context of the entire project. This is of course a continuing preoccupation of any responsible project proponent and of its regulator, presently and through the life of the project.

4. Both for the Offshore and the Onshore, the project proponents are committed to extensive mitigation measures to reduce risks and these are included in the parameters of the CBA. In addition, the recent historical trend of a continuing reduction in spill risks is noteworthy and it can be expected to continue as a result of practical experience and technological improvements over the 30 or more years of the project.

APPENDIX A- SELECTED DATA INPUTS FOR CBA

Data Table

				Example Oil Price Uplifts				
	Inflation Index	Foreign Exchange Rate	WTI Oil Price without NGP	WTI Oil Price Uplift	Athabasca DilBit Price Uplift	NGP Investment 2012Cdn$	NGP Fixed Op Cost 2012Cdn$	Offloading Barrels/day from ENB Mainline with NGP
			2012US$	2012US$	2012US$	2012Cdn$	2012Cdn$	
		Cnd/US	US$/bbl	US$/bbl	US$/bbl	$mill	$mill	bbl/day
2010	1.00	0.91				186	0	0
2011	1.03	0.90				54	0	0
2012	1.05	1.00				79	0	0
2013	1.07	0.98				103	0	0
2014	1.10	0.96				222	0	0
2015	1.12	0.95				1,051	0	0
2016	1.14	0.95				1,706	0	0
2017	1.16	0.95				2,056	0	0
2018	1.19	0.95	97.68	0.24	1.84	927	0	457,423
2019	1.21	0.95	97.10	1.51	3.40	10	142	404,882
2020	1.23	0.95	97.86	1.51	3.28	0	142	310,174
2021	1.26	0.95	98.62	1.31	2.32	0	142	203,793
2022	1.28	0.95	99.39	0.41	1.49	0	142	105,211
2023	1.31	0.95	99.97	0.19	1.51	0	142	50,000
2024	1.34	0.95	100.75	0.19	2.16	0	142	52,586
2025	1.36	0.95	101.53	0.19	2.14	0	142	35,214
2026	1.39	0.95	102.32	0.19	2.12	0	142	0
2027	1.42	0.95	103.12	0.19	2.39	0	142	0
2028	1.45	0.95	103.92	0.19	1.97	0	142	0
2029	1.47	0.95	104.73	0.19	1.89	0	142	0
2030	1.50	0.95	105.54	0.20	1.90	0	142	0
2031	1.53	0.95	106.36	0.00	1.59	0	142	0
2032	1.56	0.95	107.19	0.00	1.79	0	142	0
2033	1.60	0.95	108.03	0.00	2.23	0	142	0
2034	1.63	0.95	108.87	0.00	1.96	0	142	0
2035	1.66	0.95	109.71	0.00	2.20	0	142	0

Notes: Oil prices and selected examples of oil price uplifts are from Tables V and VI, Muse, Stancil & Co., *Market Prospects And Benefits Analysis For The Northern Gateway Project, July 2012*.

NGP export volumes are 500,000 bbl/day and condensate volumes are 175,000 bbl/day.

APPENDIX B-VALUATION OF ENVIRONMENTAL EXTERNALITIES

This Appendix addresses issues relating to the economic valuation of environmental externalities as incorporated in the CBA.

The objectives of the Appendix are:

- **to present reply evidence in relation to intervenors' findings pertaining to the economic valuation of environmental externalities, and**
- **to elaborate details relating to the treatment – in the CBA – of direct project impacts on ecosystem goods and services (EGS), as well as of conditional impacts associated with oil spill events.[111]**

The Appendix is organized into the following sections:

B1: Summary of intervenor findings and reply
B2: Introduction to environmental valuation and externalities
B3: Benefit transfer and its role in valuation
B4: Passive use values and the Carson studies
B5: Oil spill costs
B6: Closing note on estimators

B1. Summary of intervenor findings and reply

This Appendix presents reply evidence to portions of the five following interventions relating to the economic valuation of environmental externalities:

- "Gregory et al (Economic Impacts)" – Gregory R, Failing L, Joseph C. December 16, 2011. *Economic Impacts of the ENGP on the Gitga'at First Nation*. 88 pp.

[111] This Appendix also relied specifically on: (i) Anielski M. July 2012. *Evaluation of Natural Capital and Ecological Goods and Services at Risk Associated with the Proposed Enbridge Northern Gateway Pipeline*. Anielski Management Inc., Edmonton; (ii) Enbridge SQRA Spill Studies and pers. comm. with study authors. Worley Parsons. 2012. Northern Gateway Pipelines Limited Partnership, Enbridge Northern Gateway Project, Semi-Quantitative Risk Assessment (SQRA); Submitted in Response to Joint Review Panel Information Request Number 8.1(B).

- "Gregory et al (Spill Risks)" – Gregory R, Failing L, Joseph C. December 16, 2011. *Making Informed Decisions about the ENGP: Evaluating the Anticipated Costs, Benefits, and Risks of Marine Oil Transportation on the Gitga'at Nation and Canada's Public Interest*. Compass Resource Management. 38 pp.
- "Gunton & Broadbent (Spill Risks)" – Gunton T, Broadbent S. January 2012. *A Review of Potential Impacts to Coastal First Nations (CFN) from an Oil Tanker Spill associated with the Northern Gateway Project*. Prepared for Coastal First Nations. 136 pp.
- "Gunton & Broadbent (Public Interest)" – Gunton T, Broadbent S. January 2012. *A Public Interest Assessment of the Enbridge Gateway Project*. Prepared for Coastal First Nations. 37 pp
- "Ruth & Gasper" – Ruth M, Gasper R. December 2011. *Ecological Costs Associated with the Proposed Northern Gateway Pipeline*. Prepared for Haisla Nation Council. 53 pp.

The above interventions contain findings of three general varieties:

(i) those asserting that some attempt can and should be made to place an economic value on changes in environmental goods and services brought about by the project through direct impacts (for example, oil spills) or through possible impacts under a defined probability;

(ii) those providing their own assessments of the value of such goods and services, often relying on transfers of values from studies undertaken elsewhere; and,

(iii) those further arguing that if the loss of such values were properly considered, then the economic costs of the project would be considerably higher and that the project might not be in the public interest. A common tipping point relates to the loss of "passive use values" associated with a study done by Carson relating to the amount of money that American households would be willing to pay to avoid a spill similar to the Exxon Valdez Oil Spill (EVOS).

The general thrust of all of these interventions is that environmental goods and services have a high economic value, and that the project would potentially result in the complete or partial loss of these services to some stakeholders, which would cause them to suffer uncompensated costs. The values at risk cited by intervenors are excessively high: Appendix B shows the conceptual, methodological and arithmetic flaws underlying the high estimates of values and it provides a basis for treating correctly the potential costs and evaluation of environmental externalities in the context of a CBA.

Gregory et al (Economic Impacts)

This intervention argues for greater attention being given to the distribution of economic impacts on the Gitga'at population, including potential impacts on the non-use values associated with the Great Bear Rainforest. The intervention makes its own calculations of environmental impacts in a "Total Economic Value" (TEV) framework and adds various estimates based on transferring values from other studies. In addition, the intervention notes that "it's important to recognize that not just Canadians but also other citizens of the world hold non-use values for Gitga'at territory." As part of its estimate of potential environmental impacts, the authors also rely on two Carson oil spill studies in Alaska and California to argue that some values of potential environmental costs within the Gitga'at territory approach $2.8 billion in present value terms.

<u>Reply</u>: The suggestion that environmental costs might be in the order of $2.8 billion is far higher than can be considered as reasonable. The estimated present value of all environmental and oil spill cost expectations over the life time of the project, shown in Table 5.1 above, is $122 million (at an 8% discount rate, in the Base Case). The intervention uses benefit transfer techniques that do not respect the guidelines of such analyses: specifically to transfer like values to like systems of similar scales and attributes. Also, incorporation of values to non-Canadians is not relevant in the context of a CBA.

Appendix B describes in detail why transfer of the Carson study estimates is flawed and not relevant to the NGP Application.

Gregory et al (Spill Risks)

The intervention asserts that economic analyses should reflect (inter alia) the value of environmental goods and services and the expectations of losses from oil spills. Various arguments about economic impacts are summarized. The intervention then makes its own assessment of the risks of oil spills and provides assumptions about spill probabilities. In addition, it argues that the perception of risk by local people and risk aversion should play an important part in the cost calculus of economic impacts. It argues that the risk perceptions of local communities, associated with "Stigma Events" such as spills, should in effect add substantially to potential project costs. The intervenors' calculations reflect the Carson studies and other estimates for offshore spill risks, as well as the results from other contingent valuation studies through benefit transfer, in order to assign high passive use values to local resources.

Reply: This report in Section 5 provides its CBA results which: (i) incorporate expected costs of environmental impacts and (ii) provide estimates of probabilities for spill type and associated costs. Appendix B, below, describes the derivation and proper role of such estimates within a social CBA. The CBA should assume that all Canadians are to be treated equally and it does not pretend to differentially evaluate individual or group preferences. The evidence also shows that Canadians have been living with offshore oil spill risks of similar orders of magnitude for many years in Atlantic Canada: this revealed behaviour over a prolonged period shows that from a societal perspective such risks, when low, are acceptable.

Gunton & Broadbent (Spill Risks)
This intervention can be described in four parts: (i) an estimate of the value of ecosystem services at stake; (ii) a criticism that NGP did not properly assess consequences of a spill; (iii) the use of EVOS data and transfer of values to a hypothetical major spill in Coastal First Nations (CFN) territory; and, (iv) reference to the regulatory criteria for determining whether a project is likely to cause significant environmental damage: magnitude, geographic extent, duration and frequency, permanency of effects and ecological context. Notably, the authors conclude that NGP has not shown properly the probability of spills and that, in the event of a spill, adequate compensation is not assured. Within the context of Appendix B, the primary issues of concern are those dealing with the ecosystem valuations and the interpretation of non-use values derived from EVOS studies.

The intervention summarizes the activities of the CFN and the degree to which these activities depend on marine resources. A valuation framework that considers the market values of current economic uses is applied but then is augmented by non-market use values including modest domestic salmon harvests and very large ecosystem service values (the latter based on benefit transfer from global studies from Costanza et al, 1997).[112] Non-use values

[112] Originally published in Costanza R, d'Arge R, de Groot R, Farber S, Grasso M, Hannon B, Limburg K, Naeem S, O'Neill RV, Paruelo J, Raskin RG, Sutton P, van den Belt M. 1997. The value of the world's ecosystem services and natural capital. *Nature*, 387:253.

based on the Carson EVOS study are applied to the entire Canadian population and are incorporated within the analysis.

The intervention calls for greater attention to be paid to the importance of small spills and for the need to address explicitly oil spill occurrence estimates. One of the assessments finds that the value of ecosystem goods and services at risk are $28.5 billion per year over an area of 88,000 km2 of the Pacific North Coast Integrated Management Area (PNCIMA); inclusion of other direct uses (about $0.4 billion per year) and non-use values (up to $1.0 billion per year) augments total values at risk to be close to $30 billion annually. The interpretation of EVOS information places oil spill costs for a similar disaster in CFN territory to be in the range of a present value of $5.2 to $22.7 billion; this includes an upper bound non-use value of $17.2 billion. The authors suggest that this non-use value is a "conservative" (low) estimate and note that a more relevant survey instrument using "Willingness-to-Accept (WTA)" instead of WTP models could increase this value by a factor of 10.4.

Reply: Appendix B shows the flaws in applying selected global values (such as those from Costanza which include some high value densely populated areas and include a mix of biomes) to the large target area of the PNCIMA, 43,000 km^2 of which is open ocean. For example, the transferred values associated with disturbance prevention services (comprising $611 million annually in their calculations) are largely based on storm protection and flood control functions in protecting populated areas from hurricanes.

Also, for correct valuation within a CBA context, the framework requires one to consider the value of *marginal impacts* on the system as a whole. For large systems, unless the character of the system is entirely lost, the losses at the margin are likely to be very small and more typically will be close to zero.[113] Of the $28.5 billion calculated by Gunton & Broadbent, for example, over $25 billion of this is associated with "nutrient storage, cycling, processing and acquisition (e.g., nitrogen fixation)". These services are unlikely to be lost over the entire PNCIMA and if they are lost over a small part of the area, then the marginal impact is expected to be small.

[113] This point is also made by Anielski (2012) for the case of terrestrial landscapes: even though some trees may be lost, the functional services of the forest are not affected if the impact footprint is small compared to the scale of the forest.

Also, as noted in Appendix B, the use of a “Total Economic Value” framework is prone to double counting when ecosystem services and economic production are intertwined. The estimates by Gunton & Broadbent suffer from this problem: ecosystem services related to food production, raw materials and recreation approach $1.25 billion annually but the authors also include direct uses of commercial fishery, seafood processing, aquaculture, marine tourism, and salmon harvests of about $0.35 billion annually in their calculus.

Finally, Appendix B describes why reliance on the non-use values as reflected in the Carson study is generally flawed and not relevant to this Application. Moreover, the use of multiplicative factors to the Carson estimates to arrive at expected WTA/WTP ratios of 10.4 cannot be generalized to this type of situation.

Gunton & Broadbent (Public Interest)

This intervention summarizes the environmental costs (in their Table 7) based on many of the arguments in Gunton & Broadbent (Spill Risks), stressing again the importance of “adjust[ing] for probability of occurrence to estimate an expected value for inclusion in the BCA [Benefit Cost Analysis].” A cost of up to $5.5 billion, excluding non-use costs estimates is shown ,along with a cost of $22.7 billion including non-use cost estimates.

Reply: As noted above, Appendix B describes the flaws in applying global values from high value highly populated prime sites such as those reflected in Costanza to areas of open ocean or sparsely populated coastal areas. Further, the non-use values as estimated in the Carson study are irrelevant to the NGP. Finally, while the authors call for the calculations to reflect the “probability of occurrence”, their own presentations fail to include any such consideration or calculus. The CBA results properly include oil spill probabilities [based on DNV and SQRA assessments] and show that the present value of environmental externalities over the lifetime of the project would conservatively increase project cost expectations by $122 million (at an 8% discount rate, in the Base Case).

Ruth & Gasper

The intervention argues for comprehensive inclusion of all identifiable environmental values at risk, directly from project operations or through their potential loss from oil spill incidents. They also include environmental impacts from presumed incremental oil sands production associated with the project, as well as GHG impacts from tanker voyages anywhere between Canada and Asia, and impacts from end-user demand for petroleum products in final markets in Asia. Within Canada generally and the Haisla territory specifically, they treat both terrestrial and marine resources. Drawing on various methods (including benefit transfer from other sources), they derive final values for the cost of environmental impacts in excess of $200 billion under some circumstances. They qualify their valuations by noting that "some potential impacts (e.g., cultural impacts) … could not be captured in a defensible cost estimate…."

Reply: Appendix B reveals a number of fundamental methodological flaws in the Ruth & Gasper findings; these flaws result in estimates that are orders of magnitude higher than if best practices are applied. First, within the context of a CBA, only incremental costs are relevant and such costs must be costs to Canadians. The project Application is evaluated on the basis of a diversion of oil shipments from the U.S. market with no incremental oil sands production. Second, Canadians or the NGP should not be penalized with the cost of GHG impacts from the tankers when on the high seas or in port in Asia because such costs would not be costs to Canadians. Third, Canadians or NGP do not bear the environmental impact costs from the use of oil in Asian refineries, nor indeed would such costs be incremental since alternatively the oil would be refined in the U.S. As a result, more than 85% of the environmental costs described in the Ruth & Gasper Tables 17 to 20 are not relevant to the NGP Application.

The remaining item in those Tables deals with the environmental impact costs from pipeline construction, purported to range from a present value of US$1.7 billion to US$2.6 billion, depending on a discount rate of either 7% or 3%. Those estimates are orders of magnitude higher than a best estimate in the foregoing CBA analysis in Section 5 of this report (in the order of 30 or more times higher). The reason for the Ruth & Gasper gross over-estimate stems from flaws in the use of benefit transfer of the value of externalities: these are attributable to factors such as incorrect verification of functional value, inappropriate application of scale, failure to reflect dynamic responses and recovery, excess inflation of values to those well beyond opportunity costs (for carbon) and failure to consider human population attributes within the area of interest.[114]

[114] Anielski (2012) estimates these to be over-estimated by a factor of 115 for construction impacts and by at least 1000 for operational impacts.

The Ruth & Gasper estimates for Haisla lands (Table 23) also suffer from simple arithmetic incongruencies. For example, the impacts on forests, wetlands, salmon fishing and tourism in the Haisla area are greater than or almost equal to those for the project area as a whole, even though the Haisla territory is a subset of the total project area (for example, Haisla territory accounts for 17% of total forest lands and 5% of total wetland area).[115]

In dealing with oil spills, Ruth and Gasper use estimates of social and ecological costs for a selection of hypothetical spills with various durations of impact (Table 22) and they conclude that the ex post costs could range from US$28 million up to US$13 billion (US$2011).[116] However, the critical issue in this respect is the probability of such spills. No probability estimates are shown. Nevertheless the report states: "Our highest estimates of social and ecological costs should not be considered remote possibilities or examples of an extreme case." However, as set out in Sections 4 and 5 of this report, the range of probabilities of spills is a necessary and critical component of any foresighted evaluation of the project. In Section 4 it was mentioned that the probability of any offshore spill during the life of the project is small and that the probability of a large spill in any year is extremely small (estimated as 0.00004), based on the best estimates prepared by DNV.

B2. Introduction to environmental valuation and externalities

Context

We are all familiar with the prices of goods and services that are routinely traded in the economy. Markets for labour, apples, cars, building supplies, or consumer electronic goods – to name just a few – are all well-developed and most of us have a general feel for whether we might be getting a good deal or a bad deal if we are ever faced with a specific purchasing decision. Even if we have no direct experience with such purchases, our friends, family, and manufacturers themselves are usually more than willing to provide their

[115] The authors revise their estimates for forestry and wetlands in Haisla Nation Reply to Northern Gateway IR No 1, Request 1.16, June 29, 2012. However, wetland services impacts in Haisla territory (revised to $335-$632 million) remain disproportionately large relative to the total wetland services impacts ($341-$641 million).

[116] The authors confirm there were no adjustments for likelihood of the spills occurring (Haisla Nation Reply to Northern Gateway IR No 1, Request 1.12, June 29, 2012.)

opinions of what something is worth. Even if dollar values are not always obvious, the explicit tradeoffs we make when we decide to take the bus instead of the car, buy the DVD instead of going to the theatre, or spend time with our friends instead of getting a part-time job, are all examples of decisions that implicitly value the choices before us. In short, as individuals or households, we are constantly explicitly or implicitly doing valuations. The valuations are so common that we may not even realize it; nor do we realize (or necessarily care) what the basis is for such valuations.

Apart from these familiar situations, there is also a large class of goods and services that never enter familiar markets. Birds and insects pollinate fruit-bearing trees. Trees keep our urban areas cool, sequester carbon and prevent erosion. Wetlands process and convert harmful wastes. Such goods and services are sometimes called environmental services, or ecological functions. But a commonality is that market prices typically do *not* exist, or where they do exist such pricing does not reflect its end-use value. Water is an excellent example: we are accustomed to paying next to nothing for it, but it is arguably one of the most valuable goods on the planet. Without water we would not be alive. The distinction between price and value is thus important.

Over the past three decades, serious efforts and work have been conducted world-wide in placing monetary values on such environmental services. There exists an extensive literature on the topic.[117] Some may feel that such valuation is either impossible because of the general uncertainties surrounding environmental issues, or that – even if it were possible – there are certain subjects that we simply should not attempt to value.[118] Those positions are not debated here. It should be noted, however, that there is growing use of such valuation techniques both in raising awareness (where

[117] For example, the Journal of Environmental Economics and Management is devoted to the publication of theoretical and empirical papers concerned with the linkage between economic systems and environmental and natural resources systems. Major international initiatives such as "The Economics of Ecosystems and Biodiversity (TEEB)" have produced compendiums of literature and case studies of interest to policymakers, businesses, and citizens worldwide (see: http://www.teebweb.org/). Canada itself has been a repository for maintaining an extensive database of literature through an internationally financed initiative: Environmental Valuation Reference Inventory (EVRI) maintained by Environment Canada and containing over 3000 records.

[118] Many argue convincingly, for example, that it is often politically unacceptable to try to put an economic value to human health or a human life. See: "Priceless: On Knowing the Price of Everything and the Value of Nothing" by Frank Ankerman and Lisa Heinzerling, 2004, New Press. Also see John Podesta's related and now seminal lecture on 25 February 2004 entitled "Putting a Price on Human Life: The Costs and Benefits of Cost Benefit Analysis".

the striking of values seeks to draw attention to the idea that environmental goods and services have an economic value in the context of human production or consumption) and in other applications. The Canadian Food and Inspection Agency (2005) for example, in adopting norms for organic agriculture and labelling, noted that valuation of environmental and social benefits of organic food certification showed present value net benefits of $767 million.[119] Statistics Canada has for some time maintained environmental accounts entitled the Canadian System of Environmental and Resource Accounts (CSERA). Canada was in fact one of the early adopters of so-called 'green accounting' methods and spearheaded much of the international research in this area. In 2011, Statistics Canada initiated a three year project – Measuring Ecosystem Goods and Services (MEGS) – as an experimental project that would systematize more formally how valuation information would be gathered and presented in a statistical framework, for use within public decision-making. It is important to note that one reason the MEGS Project remains experimental is because the methods of accounting remain less well developed than those associated with more familiar traded goods and services.

The objective of this section is to provide adequate background to the current state-of-the-art such that the reader can understand the uses and limits of environmental valuation within the context of the NGP Application.

The following topics are treated.

- Total Economic Value (TEV)
- Valuation Methods
- Marginal and Average Values
- Valuation and the Social Welfare Function

Topic 1: valuation and types of values (TEV)

Environmental economic valuation attempts to estimate the value of environmental goods and services. The values that it estimates are the values

[119] Canadian Food and Inspection Agency. 2005. Cost-Benefit Analysis of the Effects of Federal Regulation for Organic Products (Prepared by TDV Global, 27 May 2005).

to people *of* nature or *of* nature's component species or natural functions. The values are not the values *to* nature itself, nor *to* the species; there are no methods available for quantifying such concepts. Put simply, the economic value of an environmental good or service is the contribution it makes to persons' social welfare, expressed in monetary terms. The good or service can make contributions to social welfare through different avenues: through its direct use or consumption, as well as through non-consumption uses. The complete collection of all of these contributions is often referred to as the Total Economic Value (TEV). The actual TEV is often decomposed into "use" *versus* "non-use" values, or to "active use" *versus* "passive use" values. One characterization of TEV is represented in Figure B1. The diagram shows that TEV can be regarded as a composite of reasonably well-defined direct uses (such as recreation) and indirect uses (including physical processes such as erosion control), as well as less well-defined concepts such as option value, bequest value, and existence value. These latter three are less tangible, but generally relate to the idea that environmental goods and services may have some future (perhaps unknown) uses or that they may have some intrinsic importance to individuals now or in the future that is independent of their direct usefulness or being consumed. Parts of these latter three are at times called "passive use" values.

The actual meaning of TEV should not be taken too literally. A diagram such as Figure B1 implies that TEV is the sum of these parts and some analysts in fact make the error of adding these without giving too much thought to whether the different categories can, in fact, be summed. Strictly, the assumption of linear additivity is in most cases incorrect for a number of reasons:

- Use values are at times mutually exclusive. A fish may be eaten, or may be caught and released by an angler, or may simply be watched by a nature enthusiast. All of these events have a bearing on social welfare, and thus have some imputed value. But they cannot be added because (for a single fish in a single period) not all three uses can be accommodated concurrently.
- Values contribute in a non-linear fashion. Non-linearities are common in complex systems, especially if such systems are close to thresholds or if the system being valued is narrowly defined. The non-linearities may exist in an environmental system (that provides the good or

service). One hundred hectares of wetlands in one spot will likely have different functional attributes (and thus a different value) than ten smaller wetlands that add up to the same area.

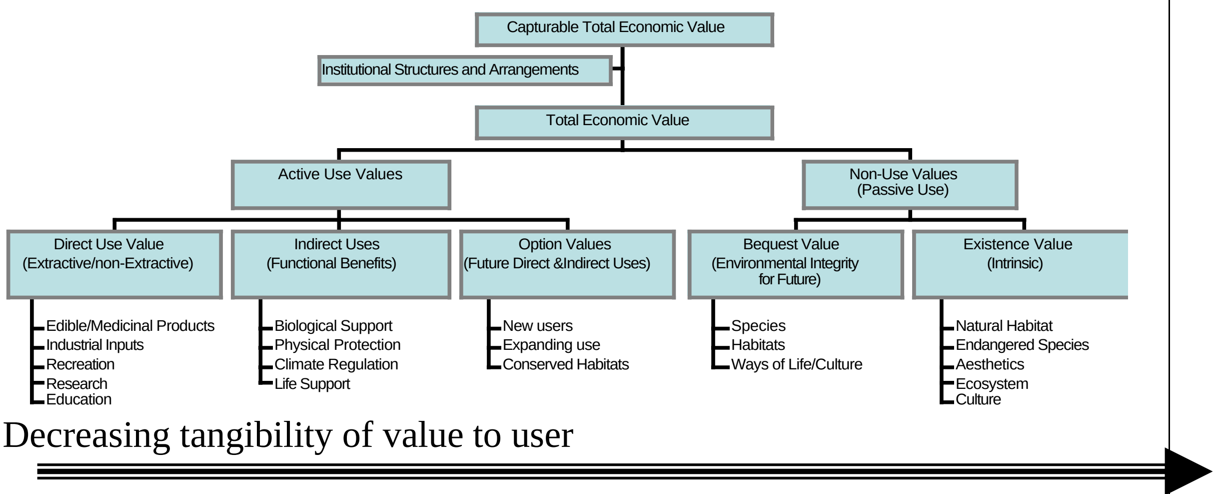
- <u>Environmental values are not readily assessable or 'captured', by any mechanisms</u>. The actual value that is of policy relevance in decision-making is that associated with the reference society. Although those living in Europe may value Canadian forests, unless there is a mechanism in place to capture this value, such a contribution to welfare may be of little relevance in Canadian decision-making. Adding it into the overall social calculus may or may not have a bearing on what the actual tradeoffs might be. This aspect of "value capture" is especially critical in cases where the ecosystem itself overlaps international boundaries (such as watersheds).

An important lesson is that TEV is most useful as a pedagogical and conceptual tool for organizing the assessment of a range of values. With respect to the appraisal of the NGP, effective environmental valuation involves: (i) ensuring that values (or costs) are not double counted; (ii) ensuring that the system impacted is relatively homogeneous if unit values are applied to its valuation; and, (iii) ensuring that values can in fact be potentially captured or "crystallized" through some implementable mechanism. If one or more of these conditions are not met, the resultant values may still be of interest, but they should be used more qualitatively than quantitatively and using qualitative multi-criteria analysis (MCA) of the sort that is commonly used in policy decisions.[120]

[120] A comprehensive MCA assesses impacts thematically and geographically. An ambitious example of such a framework was developed by the Coast Information team in 2004 as a basis for BC's Land Use Planning processes. The framework was provided to the three sub-regional Land and Resource Management Planning tables and several First Nations Land Use Planning tables to assist them in developing practical recommendations to resolve land use and natural resource management issues. "The analytical element involves assessing the benefits and trade-offs among alternative planning solutions; the goal being to reduce conflict and achieve multiple ecological, cultural, social and economic objectives." The framework includes both non-monetary attributes (e.g., for culture) as well as monetized elements within an "Economic Gain Spatial Analysis". Source: Coast Information Team. 2004. EBM Planning Handbook. P 23. (http://www.citbc.org/index.html)

Figure B1: Concept of TEV

The concept of TEV is often used to characterize the contribution that environmental goods and services make to society's general well-being.



Topic 2: valuation methods

Environmental valuation is largely based on the assumption that individuals are willing to pay (WTP) for improvements in environmental quality and, conversely, are willing to accept compensation (WTAC) in exchange for suffering environmental losses. Individuals are said to demonstrate preferences, which, in turn, place values on environmental resources. Although this approach to valuation through preferences is well known, quantifying it (e.g., expressing it in money equivalents) can be complicated and may draw inspiration from many different lines of argument.[121] These include market-based, surrogate market-based and non-market-based approaches. Figure B2 shows a simple diagram of the valuation approaches available and routinely used in the literature.

Market-based approaches rely on direct, observable market interactions to place monetary values on goods and services. The existence of explicit

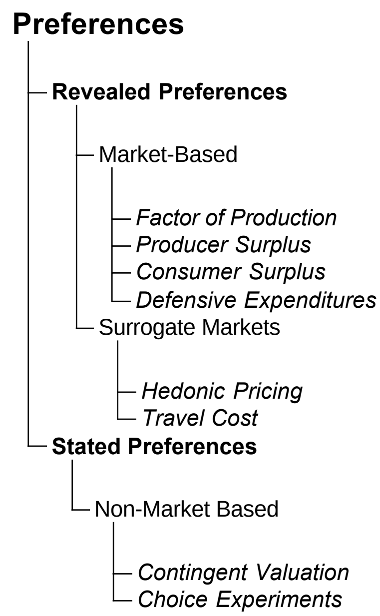
[121] Valuation is usually done in money equivalents to a standard base year so that a like comparison to other goods and services in the economy can be made.

markets enables economists to measure an individual's willingness to pay to acquire or preserve environmental services. In turn, individuals reveal their preferences through the choices they make in allocating their scarce resources among competing alternatives. They make real spending decisions using their own time and/or money, foregoing other alternatives in the process. An obvious advantage to this approach is that it is based on observed behaviour for which a value can be directly observed or readily inferred. A problem is that it has limited applications because no existing market may exist for the environmental resource in question.

In the absence of a clearly defined market, the value of an environmental resource can be derived from information acquired through surrogate markets. In other words, in situations where the environmental resource is not directly bought and sold in an existing market, there may be other markets indirectly associated with the use of the resource in question. This information may serve as a proxy in order to infer environmental values. A strength of this approach is that it is based on observed behaviour, while a major weakness is the technical difficulty that can be encountered in linking appropriate market indicators with environmental qualities.

Figure B2: Valuation Methods.

(valuation methods to inform individual or social preference.)



Non-market based approaches attempt to gather relevant information concerning preferences from individuals through the use of surveys, questionnaires, or interviews. Individuals are presented with constructed scenarios or hypothetical markets involving a change in environmental quality. This approach is necessary to elicit non-use values (e.g., existence value) associated with a resource. The usefulness and strength of this approach is its ability to estimate the value of goods and services not transacted in the market. A major weakness is the possibility of introducing a number of different types of bias, causing significant errors in any results especially because of the difficulties of obtaining reliable and valid information when hypothetical or constructed markets are used. The non-market approaches are also frequently designed to capture "consumer surplus" values, which are amounts above and beyond what the market would normally pay for a good as reflected in its market price. While such values are of policy interest they are difficult to translate into conventional accounting measures (specifically, most goods and services in national accounting frameworks reflect the values at the margin and do not seek to capture the entire consumer surplus.[122])

Non-market valuation methods generally follow one of two approaches 1) of Revealed Preferences, which are based on real world conditions that may resemble market-based prices, and 2) Stated Preference (SP) methods, which are based on hypothetical situations. Both approaches can be useful, but those using stated preferences about hypothetical situations are generally subject to greater uncertainty in their application.

Indeed, we can learn some lessons from Professor Dale Whittington of the University of North Carolina, who has spent his entire career conducting hypothetical contingent valuation and similar SP studies worldwide. His work is among the most frequently cited, and he has also overseen hundreds of such studies as part of the IDRC (Canada) sponsored efforts in Southeast Asia, South Asia and Latin America. In a recent 2010 article[123] he notes the difficulties and problems underlying situations with hypothetical multiple uncertainties about baselines or impacts. First, they are cognitively more difficult for respondents. Second, they are equally difficult for enumerators who find it difficult to explain differences consistently from one respondent to the next. Third, the hypothetical baselines and impacts may raise ethical issues if they are interpreted as potentially harmful to the respondent. In brief, extreme caution must be exercised by surveyors and analysts in both the execution and interpretation of SP methods.

SP methods may also be misapplied if inadequate or one-sided information is made available to respondents. The case of the spotted owl's struggle against the US forest industry is a case in point. The conservation community took on forestry companies and eventually succeeded in securing the protection of thousands of hectares of old growth forest on the strength of the Endangered Species Act. Forestry communities lost income and jobs

[122] There are some exceptions in national accounts where surplus values are implicitly included. Military and defense expenditures fall into this category.

[123] Whittington D. 2010. What have we learned from 20 years of stated preference research in less developed countries? *Annual Review of Resource Economics* 2:209-236.

as a consequence, but the valued species and valued forest functions were saved. The opportunity costs were argued to be a relatively small price to pay.

Economists rose to the occasion and were eager to show the various values at stake should the spotted owl come to its demise. Rubin *et al*. in 1987 initiated a CVM survey showing an aggregate WTP (willingness to pay) for the spotted owl of almost $1.5 billion in the US. This exceeded the opportunity costs by a factor of three and therefore protection seemed to make economic sense.[124] In 1991 Doug White wrote a 300 page textbook entitled "An assessment of methods for economic valuation of the northern spotted owl" (MIT, Sloan School of Management), which went into deep detail showing the various techniques and how they could be applied to this particular policy issue. Loomis and Gonzalez-Caban (1998) showed that households in the local vicinity were typically willing to pay $56 each to protect some 2570 acres (10.4 km^2) of "critical habitat of the Northern and California Spotted Owl."[125] Indeed, even 1998 Economics Nobel Laureate Amartya Sen recently (2004) argued the case for preserving the spotted owl.[126] There is little doubt that valuation and conservation policy remained linked for some time in this instance. But hindsight now tells us a different story. Despite the unprecedented protection, spotted owl numbers have declined. The intense interest in the spotted owl spurred considerable research and we now know that:[127] (i) the spotted owl adapts quite readily to habitats other than old growth forests; and, (ii) major contributors to the decline of the (western) spotted owl are that the (eastern) barred owl is taking over its turf. Protection of old growth habitat has arguably had little to do with saving the spotted owl. Multi-billion dollar values elicited through CV certainly appeared to have merit at the time in the decision making

[124] Rubin J, Helfand G, Loomis J. 1991 (December). A benefit-cost analysis of the northern spotted owl: results from a contingent valuation survey. *Journal of Forestry*, pp 25-30.

[125] Loomis JB, González-Cabán A. 1998. A willingness-to-pay function for protecting acres of spotted owl habitat from fire. *Ecological Economics* 25:315-322.

[126] Sen A. 2004 (Feb). Why We Should Preserve the Spotted Owl. *London Review of Books* (26)3:10f. Specifically, Sen argued the moral point (as an entry to public policy) rather than making any strict economic case: "To illustrate, consider our sense of responsibility towards the future of other species, not merely because – nor only to the extent that – their presence enhances our own living standards. For example, a person may judge that we ought to do what we can to ensure the preservation of some threatened animal species, say, spotted owls. There would be no contradiction if that person were to say: 'Our living standards are largely – or completely – unaffected by the presence or absence of spotted owls, but I strongly believe that we should not let them become extinct, for reasons that have nothing much to do with human living standards.'"

[127] US Fish and Wildlife Service. 2004 (November*). Northern Spotted Owl Five-Year Review: Summary and Evaluation*. Portland, Oregon.

process, but under conditions of uncertain or incomplete information they may be innately flawed and must always be used with caution.

A final concern in practice with the CV and similar SP studies is the separation of passive use from direct use values. SP work frequently inadvertently or knowingly captures such direct use value and care must be taken to remove these to isolate “passive use”. Recent studies in Europe show how this can affect values. Many of these studies have trouble unravelling fishery and tourism values from non-use values. Ahtiainen (2007) attempted to evaluate oil spill avoidance in Finnish coastal waters but could not find a suitable instrument due to local perceptions of lack of regulatory reliability, causing very low WTP in initial responses; the eventual CV study concentrated on valuing recreational uses.[128] Liu et al. (2009) conducted an experimental CV pilot study on Germany’s coast to determine household willingness to pay to reduce the harm from oil spill pollution. The survey was administered to 122 tourists while they were on the coast, and the mean WTP was subsequently applied to all 39 million residents of Germany to derive a total presumed value of just over 1 billion euros. The validity of aggregating in this manner is doubtful. And apart from the obvious ambiguity from having potentially included direct use values as well as passive values in the calculation, the authors themselves point to “methodological difficulties based on the primary problem of deriving a monetary value for non-market goods from asking consumers.”[129]

To summarize, valuation can be applied to use and non-use values, involving either produced goods and services or ecological functions. Other values associated with future uses or existence values are less tangible, but techniques are available to address these.

With respect to the NGP, best practice in evaluating environmental impacts involves using revealed preference methods wherever possible, preferably relying on existing markets. Historical damages associated with lost resources, or actual costs of remediation measures (such as cleanup costs

[128] Ahtiainen H. 2007. The willingness to pay for reducing the harm from future oil spills in the Gulf of Finland – an application of the contingent valuation method. Discussion Paper 18. University of Helsinki Department of Economics and Management, Helsinki. 29 pp.
[129] Liu X, Wirtz KW, Kannen A, Kraft D. 2009. Willingness to pay among households to prevent coastal resource from polluting by oil spills: A pilot survey. *Marine Pollution Bulletin* 58:1514-1521. (Cited p 1520)

after a spill) are both examples of robust estimates under the standards of the literature.

Topic 3: marginal and average values

In competitive markets with many producers and consumers, a market equilibrium is established when the price of a good or service equals that which an existing (or additional) consumer is willing to purchase one more unit of a good or service from an existing (or additional) producer. We take this market clearing price as the marginal value of a good; every consumer pays that price and every producer receives that price. It is important to note that some consumers are willing to pay more than this price (but do not need to) while some producers are willing to provide the good or service for less money (but do not need to). These surpluses are reflected in measures of what are commonly called consumer surplus and producer surplus respectively; producer surplus is also referred to as super normal profits or economic rents depending on the circumstances and commodity. In the case where no free markets exist, or the commodities are segregated in a way that multiple markets exist at different locations, numerous "prices" can emerge for similar goods.

From a planning perspective we are usually concerned with marginal changes and marginal values, to the extent that these reflect the addition or withdrawal of a good (or a problem in the case of pollution) from the economic system. The same idea applies to EGS: we are normally interested in the marginal values, rather than average values. But markets for EGS don't exist and therefore numerous values or estimates can arise and we need to be clear which (if any) are the marginal values, or if a mean of these values can in fact be taken as a fair approximation of marginal value.

The distinction is relevant in three common contexts:

- <u>Different values of the same good or service within an ecosystem</u>. This arises when different components of the ecosystem can have different values for similar goods and services. Fishery values may differ depending on location. Parts of a wetland may be more critical for erosion control, thus having higher values for this function. A natural wetland may have been zoned in a way to limit access to some parts while permitting access to others; production values will then also differ. In all such cases, some judgment is required on how to treat values. Normally, if the ecosystem as a whole is being valued, the average values of these elements would constitute a legitimate marginal value of the ecosystem in its entirety. This is the convention normally followed in the literature.[130]

- Different ecosystems having similar and potentially substitutable values. The issue becomes more significant at larger scales or comparisons among ecosystems. Recall that economics is commonly defined as the science of scarcity: if something is not scarce, it is not of interest to economics, and would have no economic value. Value is thus linked to scarcity. If some commodity has a readily and freely available close substitute, then its value in a broad system may be very low. We run into this on numerous occasions. In the tropics, turtle nesting beaches are frequently regarded as high value commodities providing an important ecosystem service. One such beach was destroyed by a port in Orissa State in India some years ago, resulting in a huge backlash from environmental lobbies because the 200,000 turtles normally frequenting that stretch in February had lost important nesting grounds (and local residents lost a source of tourist income and some subsistence harvesting of eggs). But the following year the turtles simply found a different beach some distance away, and there was no disruption in the "services" available to the turtles (although one community lost an asset while a different community gained one). This substitution effect occurs frequently and is even recognized within the ecological sciences as a normal adaptation; the accepted use of offsets as a way to mitigate impacts of ecosystem loss is a key example. In some cases, explicit offsets are not even needed: if a duck cannot find its habitual staging ground it may find a suitable substitute nearby. In such cases, it is possible that some ecosystem functions will be overstated. In this circumstance, the value of one

[130] For a review and recent example applied to a major European wetland see: Bouscasse H; Defrance P; Duprez C; Strosser P; Beley Y; Morardet S. 2011 (September). Evaluation économique des services rendus par les zones humides - Enseignements méthodologiques de monétarisation. Ministere de l'Ecologie, du Developpement durable et de l'Energie (France), Commissariat general au developpement durable.

ecosystem may not be representative of an average value for other systems, or may overstate its marginal value to the system as a whole.

- Translation of TEV into a unit measure. This concern follows on from the previous example: an ecosystem value is routinely translated into some common measurement unit (numéraire) usually based on area. This average value is then represented as a price that can be applied to other goods and services in similar systems. This price may or may not be close to the marginal value (and typically the marginal value is lower than this if there are many substitutes available). Interpretation of any such normalized "price" must again be done in the context of the overall system.

Within valuation work, it is common to use "average" values when in fact marginal values may in fact be lower because of ecosystem adaptation, or because loss of a small part of an ecosystem may in fact have no real impact on its scarcity value to people.

Regarding the NGP, best practice involves: (i) using local value estimates wherever possible as these are more likely to reflect marginal values; (ii) applying average values within a context of informed understanding of the ecosystem in a way that permits acknowledgment of cases where values may be (conservatively) over-estimated; and, (iii) where systems are not homogeneous, attempts should be made to value different subsystems (e.g., forest and grassland) before aggregating to a weighted average value.

Topic 4: valuation and the social welfare function

Economic valuation has its theoretical basis in welfare economics, which is occupied with the general idea of improvements in societal welfare. As societies are made up of many individuals, cultures and institutions, the topic of welfare economics is potentially quite broad. Indeed, the literature includes issues as apparently diverse as treatment of environmental externalities, income and asset inequality, and the socially efficient and equitable use of direct or indirect taxes to meet budgetary requirements. Underlying this wide range of potential policy considerations is a mathematical construct broadly called the social welfare function (SWF). Many students of economics are familiar with the concept of the "indifference curve" of an individual; it defines the choices and tradeoffs that any individual is purported to make as an economic entity. Those choices manifest themselves through preference orderings, demand functions, and even what may be regarded as a "fair" distribution of income and wealth. Motivations to purchase, work, recreate, donate to charity, and vote may all be reflected in the indifference curve. The SWF can be regarded as the social equivalent of this individual indifference function. Abram Bergson (1938) first introduced the idea of the indifference curve and SWF as a pure mathematical construct, but with real dollar values and well-behaved differentiability. The economist, Arrow (1951/1963) generalized it for more complex choices that did not necessarily include differentiability. Sen (1970) used the concept of SWF in its modern sense as a descriptor of collective choice in circumstances of broad policy choices. He also proposed its equivalence to valuation in the context of cost benefit analysis of projects, or in any public policy choice. Drèze and Stern (1987) showed the mathematical equivalence of project and policy valuation to the valuations made in the SWF. They also showed the necessity of the "marginal value" *ceteris paribus* assumptions within the context of the SWF construct. [131]

The SWF can be regarded as the "domain" for valuation, to the extent that it reflects social trade-offs and preferences. The function is a multi-dimensional preference map, to the extent that any income/quantity tradeoffs are reflected in it, as well as preferences and tolerances for various types of income distribution. As a generalization, it can reflect something as simple as the price of an apple, through the change in the value of the SWF in response to adding an additional apple to the consumption possibilities, or as complex as reflecting an environment. It can also reflect something as complex as society's implicit judgments on income inequality as implied in its tax structure.

Perhaps the most important take-away idea from the SWF is that any set of policies reflects a value function for the economy as a whole. For example, if a set of well informed policies, laws, and regulations determine that remediation of an ecosystem to a given standard is adequate to protect the

[131] See: (i) Bergson A. 1938 (February). A reformulation of certain aspects of welfare economics. *Quarterly Journal of Economics* 52(2):310-34. (ii) Arrow K. 1951, 2nd ed., 1963. *Social Choice and Individual Values*, Yale University Press. (iii) Sen A. 1970. "Collective rationality," Chapter 3 in *Collective Choice and Social Welfare*. North-Holland, Amsterdam. (iv) Drèze J, Stern NH. 1987. The theory of cost benefit analysis. Chapter 14 in Auerbach AJ, Feldstein M (eds). *Handbook of Public Economics* Volume 2. Elsevier. Pp 909-89.

public good, it follows that any remediation beyond the standard is not necessary and may in fact be of negative net benefit. A point of "optimal" cleanup is well recognized in the literature.

In the absence of readily identifiable values for public goods, the "will of the people" may often be adequately captured by existing regulatory or precautionary policies. The costs that firms or individuals incur in complying with such regulations can be regarded as a reflection of the costs (or compensation) that society regards as adequate precaution, remediation or compensation.

With respect to the NGP, this argument could be applied to environmental regulation that will set standards and contain environmental impacts, under the regulatory framework of the NEB and other environmental legislation. Assuming that all the costs of meeting such standards are explicit and are included in evaluating the project, such costs could be regarded as a proxy for the social value of the lost EGS. In many instances this must already be the case, such as in routine operational costs that would include the cleanup of small oil leaks. The challenge in assessing environmental cost expectations is to avoid double counting. Clearly, if such costs are explicit in the capital and operating costs of the project, they should serve as indicators of environmental impact mitigation. Therefore, if there is a risk of double counting, documentation should note that conservative procedures may have caused overestimation of environmental impact costs.

Examples in the application of best practice

In closing, one example of best practice is that by Anielski (2012, in support of this Application) of pipeline ROW impact values leading to average values of about $180/ha/yr of EGS lost in event of disruption. This is calculated from current LULC mapping, and it also reflects estimates of net biomass productivity to capture carbon sequestration impacts. If this were lost in perpetuity for the corridor, it would have a PV at 8% of about $17 million lost EGS flows for the project. This is the maximum lost in event of a disruption; ecosystem recovery would reduce this over time so that the PV of losses would be less. It is also noted that some parts of the system are in a continually degrading state because of mountain pine beetle attack. Reflecting this, the PV of losses would be lower still. The input to the CBA reflects the highest of these losses, in effect conservatively assuming that there is no recovery.

Comment on Cumulative Effects and Incrementality

The general idea of environmental impact valuation is always in relation to a change versus a benchmark. The benchmark, or status quo, includes many factors, including the potential impacts of other projects and activities that are assumed to occur in any event. If an ecosystem is degrading because of pests or fires, then the impact of a project should be measured relative to a degraded baseline. In other circumstances, regulations may accept that some degree of pollution is acceptable at a given location; area zoning for heavy industry is a case in point.

In the assessment of many of the environmental externalities related to the NGP, the valuation follows a conservative approach, relying also on assessments of cumulative effects undertaken in the environmental assessment of the project (Volume 6C). [132] Many of the relevant costs associated with mitigation of environmental externalities have already been reflected in the project costs (for land disturbance during ROW clear, for example). In some instances, such as loss of ecosystem services for which there are no markets, incremental values are additionally assessed.

B3. Benefit transfer and its role in valuation

Benefit transfer in effect involves transferring values from a site where detailed existing studies have been conducted (the “study site”) to a new site with similar attributes but where no primary valuation research has been conducted.[133] This new site or target site is typically called the “policy site”, reflecting the idea that a new policy or plan is being considered for application to this new site. Benefit transfer is not a “method” in its own right, as it must rely on the transfer of numbers based on one of the revealed or stated preference methods described previously.

[132] Volume 6C: Environmental and socio-Economic Assessment (ESA) Human Environment, Enbridge Northern Gateway Project (Sec. 52 Application).
[133] The term “benefit transfer” was first used by Desvousges, Naughton and Parsons (1992) to describe the transfer of monetary valuations determined by research applicable to the site studied, to a different site. The term has stuck, although many analysts more correctly refer to it as value transfer as it can involve transfer of either benefits or costs.

The benefit transfer procedure is of interest to analysts and policy-makers because the process is less costly and faster than conducting primary research. Typically valuation is done as a two-stage process: (i) the values are transferred based on specific targets (such as areas of ecosystems, numbers of species, or the number of dependent people); (ii) the values are then further adjusted for various parameters relating to resource quality, income, timing or other characteristics that are considered to be significant in the determination of value. The first step, of transferring the unadjusted values, requires similarity in project sites, environmental services, and local populations. Adjustments undertaken in the second step may be able to accommodate some site differences.

The policy interest in benefit transfer work has turned what was originally a simple ad hoc procedure with low levels of confidence, into a more sophisticated science that now may be subject to standard statistical tests of significance and consequently it is now regarded with somewhat more confidence. A recent stock-taking of the science appeared in a special issue of Ecological Economics, edited by Wilson and Hoehn (December 2006) in which 32 international experts and practitioners addressed some of the opportunities and remaining limitations of the benefit transfer techniques.[134]

Some lessons of relevance to NGP include:

- Site similarity is normally a prerequisite. This similarity requires comparability of the ecosystem commodity, market context and formulated welfare measure.[135] In practical terms this means paying attention to the distribution of benefits among individuals. Consistency checks are difficult to verify, however, because the original published studies often do not contain that detail due to space or publication restrictions.
- Meta-analysis of multiple studies can produce a valid basis for transferred values, but consistency requirements among sites still

[134] Wilson MA, Hoehn JP. 2006. Valuing environmental goods and services using benefit transfer: the state-of-the-art and science. *Ecological Economics* 60:335-342.
[135] Loomis JB, Rosenberger RS. 2006. Reducing barriers in future benefit transfers: Needed improvements in primary study design and reporting. *Ecological Economics* 60:343-350.

hold.[136] Estimates will be improved through making adjustments for core demographic and related variables.

- Values typically need to be adjusted for geographic proximity of the respondents to the policy site. There exists a distinct value "drop-off" for both use values and non-use values as respondents are further away from a site; individuals' valuations are more stable for non-use values, but both values decline because of non-responses or lexicographic preferences.[137] Using mean value transfers under such circumstances will generally generate higher values than those that are spatially sensitive.

An important observation, of course, is that benefit transfer techniques remain a complement to good primary research and should only be applied with caution. Recent work has focused on ongoing assessments as the most appropriate way to conduct benefit transfer. Two methods are emerging, which can be broadly characterized as:

- Unit transfer. This involves transferring unit values from one site to a second site. The literature in fact distinguishes among three sub-types: simple (or naïve) unit value transfer using average values per household or unit area; adjusted unit value transfer, commonly incorporating income or price differences; and, value or demand function transfer that incorporates a larger range of explanatory variables. The complexity and levels of ecosystem quality adjustment between sites can also vary, taking into account the various characteristics of the two sites as described above, but the essence remains a site-to-site transfer with varying degrees of complexity.

- Meta-analysis transfer. This method involves consolidating a large number of different site studies and determining through statistical or other analyses the values of underlying causal or correlated characteristics, which are then translated to the new study site through a value function transfer. In economic jargon: the approach attempts

[136] Bergstrom JC, Taylor LO. 2006. Using meta-analysis for benefits transfer: Theory and practice. *Ecological Economics* 60:351-360.
[137] Bateman I, Day B H, Georgiou S, Lake I. 2006. The aggregation of environmental benefit values: Welfare measures, distance decay and total WTP. *Ecological Economics* 60:450-460.

to assign values to different attributes of the value function, and transfer those attributed values. The reliability of this approach hinges on accurate starting values from the range of study sites in the meta-analysis, and some stability and consistency in the value function over time and space.

A rigorous discussion of these approaches is provided by Luke Brander and his team at the Institute for Environmental Studies at Amsterdam,[138] who has reviewed and conducted extensive "side-casting" analyses to other sites to determine the robustness of various techniques; his team in fact recommends that the meta-analytical approach be used as a means for transferring values among European wetland sites. The results show that the errors involved in the different approaches do not generally lend preferential weight to one approach or the other. A review of meta-analytic function transfers showed errors of a range of 29%-433%. For simple and advanced unit value transfers, errors ranged from 0% to 577%; for complex functions, transfer errors were also typically in the 0% to 500% range. The received view is that, in early stages, it is best to commence with approaches relying on unit transfer where those units are themselves adequately disaggregated; this improves transparency and reduces scope for initial errors. Moreover, this will be required in any event even if a meta-analytical approach is adopted at a later date.

The current state of the science is that benefit transfer methods are appropriate for raising awareness and identifying initial priorities, but not necessarily for complex resource management decisions unless the study site and the policy site are in close proximity and virtually identical in demographic characteristics.

For the NGP, best practice involves the use of benefit transfer only if: (i) it is clear that the study site and NGP project site have similar characteristics; (ii) the methodology used at the study site was reasonably transparent and robust, permitting separation of unit values that could be transferred to the NGP project site; and, (iii) they are used as a screening tool to provide "order of magnitude" estimates against which other values may be compared.

[138] Brander L, Ghermandi A, Kuik O, Markandya A, Nunes PALD, Schaafsma M, Wagtendonk A. 2010. Scaling up ecosystem values: Methodology, Applicability and a Case Study. *Sustainable Development Series*, Carlo Carraro, (ed.), Fondazione Eni Enrico Mattei, Milano. Figures quoted in this paragraph are summarized from Table 2.1 and 2.2 of that report.

Examples in the application of best practice

A number of the intervenors did not exercise best practice in reflecting the above lessons. Notable examples include:

- Inconsistent use of benefit transfer for salmon and tourism impacts between Haisla Territory and other territory with result that Haisla value (as a subset) is greater than the total value (A37905 – Ecological Costs Associated with the Proposed Northern Gateway Pipeline by Ruth and Gasper (December 2011). Sections 4.3 p 29, 5.1 p 41, and section 5.3 pp 43-44.)
- Incorrect transfer of 2001 study site values in Woodward and Wui (2001) to NGP site for wetlands due to incorrect inflators[139] and non-commensurable characteristics of sites. A37905 – Ecological Costs Associated with the Proposed Northern Gateway Pipeline by Ruth and Gasper (December 2011). Section 4.1 p27, section 4.2 p29, and Appendix B.
- Non-commensurability of study site in Costanza's original meta-analysis with selected "policy site" deemed to be the 80,000 km^2 PNCIMA for NGP. A37835 – Gunton & Broadbent: A Review of Potential Impacts to Coastal First Nations (CFN) from an Oil Tanker Spill associated with the Northern Gateway Project. January 2012. Section 4.5, p 36
- Non-commensurability of study site in Costanza's original meta-analysis (1997) with NGP site. The study site was based on global services provided by tropical rainforests. A37905 – Ecological Costs Associated with the Proposed Northern Gateway Pipeline by Ruth and Gasper (December 2011). Table 8. Page 28

[139] The authors corrected the inflation factors in a subsequent update (Haisla Nation Reply to Northern Gateway IR No 1, Request 1.17, June 29, 2012).

Summary

When transferring values, there are different types of errors that are commonly made in the discipline, and were repeated by some intervenors. The first is treatment of a present value in the original study site as an annual value at the new site; this overstates the value at the new site.[140] The second is an inconsistency of scale between the original and new sites: the average value of a landscape cannot be readily transferred to a smaller site where some incremental small service is lost. Neither can values reflecting a small high value site (that serves as a critical watershed, for example) be transferred to a large landscape or a different landscape (such as open ocean). Neither can pooled values from different CV studies on nature conservation (such as proposed by Gregory et al in assessing spill risks) be used reliably to inform passive use values associated with low probability spill risks. The third relates to standardizing values to a base year; Ruth & Gasper (Section 4.1, Table 7) appears to have deflated past year values drawn from Woodward and Wui (2001)[141] to the current year instead of legitimately inflating them (this causes an underestimate of values).[142] A fourth error involves failing to adjust adequately for the presence of local populations; most high value sites in the world simply reflect high local population densities with many beneficiaries. Failure to consider the low population densities along the area of interest will tend to overstate values; for example, Ruth & Gasper incorrectly rely on values from Costanza's "high" estimates that include values relating to protection from hurricane damages across heavily populated US coastlines. Finally, double counting of goods and services is common both in new studies and in existing studies hence validation of the original study must be done before it can be reliably used; part of the validation for double counting requires that a transferred value has a separable, additive, and statistically significant value. In their estimates for wetland values, Ruth & Gasper transferred their low value

[140] Ruth & Gasper make this error in their analysis of a large hypothetical spill of 36,000 m^3 in Wright Sound. Using EPA total cost estimates ($210/gal from their Table 14), this equates to a total spill cost of about $2.0 billion. They then incorrectly decline this total value on an annual basis by 10% and calculate present values ranging from $3 billion to $13 billion as shown in Table 22; the precise value depends on recovery scenario and discount rate. This procedure overstates costs by an order of magnitude. (Cash flow tables are provided in Haisla Nation Reply to Northern Gateway IR No 1, Request 1.15, June 29, 2012).
[141] Woodward R, Wui Y. 2001. The economic value of wetland services: a meta-analysis. *Ecological Economics* 37:257-270.
[142] The authors correct this in Haisla Nation Reply to Northern Gateway IR No 1, Request 1.17, June 29, 2012.

from a meta-analysis by Woodward and Wui (2001) for which the only statistically significant value related to “bird-watching”; their high estimate for inland wetlands had no statistically significant variables.

B4. Passive use values and the Carson studies

The valuation of passive uses is potentially relevant to Northern Gateway to the extent that some Canadians may hold ‘existence’ or similar non-use values for some of the coastal ecosystems at risk in the project area. Because of the nature of such non-use values, we note that many of these values are considered to last for all time – not being limited in time. Existence, for example, is normally an “on” or “off” state that implies certain ecosystems or their values will be available for “future” generations, and most existence value surveys in fact are worded in this manner. Given that any project impacts are expected to be temporary, because all will be mitigated and in any event ecosystems will in due course recover from any project impact, the passive use values for relatively small sites such as for NGP are expected to be low. In any event, no specific study has been done for them, and – as described previously – transferring values from other sites is problematic.
Specifically, however, many intervenors have drawn parallels between the impacts of the Exxon Valdez Oil Spill (EVOS) in Alaska in 1989 and the potential impacts of oil spills caused by the NGP. The intervenors typically refer to a study undertaken by Richard Carson and his colleagues in 1992 as a Report to the Attorney General of the State of Alaska; results were republished in a peer reviewed journal in 2003. The headline result of that study was that American households on average would be willing to pay $53.60/household to avoid a similar such incident. The intervenors[143] have then used simple benefit transfer methods to transfer these results to Canada in the current period, with various adjustments for population and inflation.

For a number of reasons, such a procedure is fundamentally flawed. This can best be revealed through a review of Carson’s own work for the EVOS study and a subsequent California Oil Spill Study (COSS) which he did while conducting a household survey relating to the avoidance of a hypothetical **future** oil spill on the California coast. Table B1 provides a summary comparison of the studies and their results. It is important to note that we do

[143] For example, Gunton et al (2012) in their intervention regarding CFN Traditional territories Non-Use cite an “upper end of $79.20/hh.

not take issue with the manner in which these two studies were undertaken, although we do note that there remains a broad literature dating formally to 1996 that still debates whether the results of either study have any merit in their own right.[144] The position taken here is that the study results and methods are not relevant to the NGP in any event.

It is also important to note that many of the critiques of Carson's work come from Carson himself: his subsequent work in COSS was meant to address some weaknesses in the approach taken in the EVOS study and he notes that the COSS *results* are applicable only to California because of the survey design, but that the *survey methods* may be used elsewhere.

The main reasons why the valuation results of EVOS and COSS cannot be applied to NGP either directly through simple transfer or through any other means of value transfer are the following:

1. The EVOS study was done after a spill event, which places respondents in a different cognitive space than a hypothetical pre-spill scenario. Carson notes (COSS page 4, 191) that surveys undertaken post-event of an additional hypothetical event place respondents in a different cognitive space (essentially believing that a spill is highly likely) than pre-event surveys. For this reason, any results of the EVOS work are not indicative of results normally used for planning and decision-making (which requires expected values before an event happens without any bias). EVOS involves a post-event survey, which is not relevant to NGP which requires a pre-event survey for decision making.

2. Scenarios at different locations involving different populations are fundamentally not comparable. Specifically through comparing COSS and EVOS, he states (COSS p. 191) "… neither the populations sampled, the location of the injuries, the relationship between the location of the injuries and the population sampled, or the nature of the injuries avoided are directly comparable. In particular, the differences between the two studies in relationships between the residents and the respondents and the locations of the injuries is striking: the COSS estimates the value to *California*

[144] Dunford RW, Gable AR, Hudson SP, Desvousges WH, Johnson FR. 1996. A review of the 1996 contingent valuation study on the value of preventing oil spills along California's central coast. Triangle Economic Research, Durham NC. http://bama.ua.edu/~issr/cosbook.html.

households of preventing spills along the *California Coast*, and the EVOS study estimates the value to *US households outside Alaska* of preventing a spill on the *Alaskan Coast*. [Carson's emphasis]". NGP would require a survey relevant to a BC location and Canadian residents (including BC), which has not been done, and for which COSS and EVOS cannot act as substitutes.

3. Carson regards the COSS survey as state of the art responding to NOAA panel and other critiques of EVOS survey. He acknowledges problems (COSS Pages 191-196) with transferring numbers from EVOS to anywhere else based on the Turnbull statistical distribution. This is because the distribution does not provide covariances on separate characteristics of the population surveyed and it is thus statistically not possible to transfer results and make appropriate standard adjustments. The statistical construct of the EVOS study is not amenable to transfer anywhere else, and is thus not applicable to NGP.

4. COSS survey results for mean WTP are same as EVOS, but Carson notes that the estimates "are not comparable" (COSS, p. 191): this is coincidental and the underlying preference functions are not the same (COSS has more probing). He supports the idea of using Benefit Transfer of COSS inside the State of California to other populations, but not outside California. In that instance he supports using the survey instrument redesigned and tested on the new sample frame. The statistical construct of the COSS is amenable to transfer only within the state of California, and is thus not applicable to NGP.

5. COSS survey finds that proximity to a hypothetical spill is relevant in determining WTP while the EVOS work does not capture this (COSS, pp 100f, 197). We note this is also consistent with general benefit transfer findings noted above (Bateman et al. 2006). Any attempt at estimating passive use values for NGP should take into account that, all other things equal, the values and reliability of responses decline as distance from hypothetical spill site increases.

6. Both surveys define a specific high risk and low risk scenario and measure the WTP for a ten year bridge period that in effect brings the high risk baseline levels to those of the low risk hypothetical

> case. The low risk case is defined as mandated use of double hull tankers, with various other mitigation measures such as escorts that: (i) reduce likelihood of oil spill; (ii) reduce size and impact of spill if one does occur. The "low risk" scenario is already the starting point for Northern Gateway: hence transferring either the EVOS or COSS numbers would be meaningless in the NGP context.

This last point is perhaps the most critical, and it warrants a note on the specific "low risk measures" taken as endpoints (after making the payment) in the EVOS and COSS scenarios, in comparison to those that will be in place in the NGP project. In both the EVOS and COSS, respondents were made aware of the fact that ten years hence (from the date of survey) legislation would be in place that required all tankers to be double hulled. The payment scenarios were to put in place a system for the intervening decade that would reduce oil spill risks equivalent to that of a double hull tanker. The operational scenario was that of using escort boats for all single-hulled tankers in the meantime, coupled with changes in tanker speed and availability of spill impact mitigation measures in event of a spill. The NGP, by contrast, already includes commitment to double hulled tankers, reduced tanker speeds, use of double escort boats, use of pilots, and best practices required by Transport Canada.

Table B1: Comparison of Carson et al Study Attributes and Results		
Study Feature	EVOS	COSS
Object of Choice	Program that would prevent another Exxon Valdez-type spill sometime over the next 10 years. Program operates for 10 years, after which defined provisions (double hull) will be in place consistent with low spill risk.	Program that would prevent cumulative harm from oil spills along California's Central Coast over the next 10 years Program operates for 10 years, after which defined provisions (double hull) will be in place consistent with low spill risk.
Injury Description	1000 miles of shoreline oiled – few years to recover; 22,600 dead birds found with estimated bird deaths of 75000 to 150000 – 3 to 5 years to recover; 580 otters and 100 seals killed – couple of years to recover	Many small animals and plants along 10 miles of shoreline killed – 5 years to recover; 12000 birds killed and 1000 injured – 10 years to recover
Payment Vehicle	One-time increase in federal taxes; money goes into Prince William Sound Fund	One time increase in State income taxes; money pays to set up response centers
Location	South Central Alaska Coast	Central California Coast
Sampling Frame	US residents outside of Alaska	California residents
Summary Statistics	Double-bounded Weibull Median WTP of $30.91 (1991) Carson et al., 2003, version that was published included a Turnbull lower bound mean of $53.60 (Note: this and its upper end $79.20 were used by Gunton et al. 2012, Table 21 Non-use Values in CFN Traditional Territories)	Turnbull estimate of lower bound of sample mean of $76.45 (1995)
Choice question (paraphrased)	Choice question + follow-up question depending on response to first question: Question1: For or against this program at a one-time cost of $x? Question 2: If yes, would you pay $x + $y?; if no, would you pay $x - $y?	Choice question (exclusive of reconsideration questions later in survey) Question: For or against this program at a one-time cost of $x?
Design Points ($x)	$10, $30, $60, or $120	$5, $25, $65, $120, or $220

Based on: Carson, Richard T., Michael B. Conaway, W. Michael Hanemann, Jon A. Krosnick, Robert C. Mitchell, and Stanley Presser (2004). *Valuing Oil Spill Prevention: A Case Study of California's Central Coast*, Kluwer. 257 pp & D.

B5. Oil spill costs

In this section we describe how environmental valuation methods enter into the calculation of oil spill costs. It should be recognized at the outset that different methodologies are available, but selection of an appropriate methodology is largely contextual. The literature typically summarizes spill costs in terms of US$/bbl, and that convention is followed here, although the derivation of this summary metric can be much more complicated. It is in effect a shorthand for a rather complex series of calculations, reflecting events and circumstances, many of which may be highly uncertain. It is a convenient metric because it looks like a unit cost, and valuation often places costs or values in scalable terms such as $/ha of forest for forest production, or $/tCO2 for valuation of carbon dioxide sequestration.

In principle, what we are interested in for valuation purposes is the total expected cost of a given size spill at a given location under given "circumstances". These "circumstances" can cover a broad range of parameters: oil type, time of year, mitigation measures available, and characteristics of the location, to name but a few. *No two situations are the same*. From a valuation perspective, we thus need to focus on *expected values*. An "expected value" is in fact a statistical or probabilistic concept. In simple terms, it represents the average or mean value of a distribution of possible outcomes. While we all may be aware of a worst possible outcome, or a best possible outcome, we do not make our decisions solely on the extremes.

An oil spill is thus an event with an associated probability of occurrence. Large spills may be rare but have impacts with high total costs. Small spills may be more frequent but have impacts with lower total costs. The literature on oil spill costs typically separates two elements, which can be added: (i) cleanup costs; and, (ii) damage costs. The total cost, is the sum of these two items:

Total Conditional Cost = Total Conditional Cleanup Cost + Total Conditional Damage Cost

The term "conditional" in the above is usually implicit and we include it here just as a reminder that it can be understood to mean, "assuming a spill occurs". A spill of any given size will have some probability of occurrence P in a given year, such that the expectation becomes:

Expected Total Cost/yr = P/yr x Total Conditional Cost

or

Expected Total Cost/yr = P/yr x Total Cost = P/yr x (Cleanup Cost + Damage Cost)

Introducing the spill size, we have the annual cost expectation, applying to every future year in which a spill might occur:

Expected Total Cost/yr = P/yr x Expected Spill Size x (Cleanup Cost per bbl + Damage Cost per bbl)

Again, it is important to note that more generally the costs per barrel can vary according to many factors. Indeed, spill costs and damages tend to exhibit economies of scale such that larger spills have lower unit cleanup cost and damage costs.

Some statistical concepts

In looking at values, one needs to consider the "expected" levels of costs. Two attributes of oil spill distribution are worthy of note, as they relate to an understanding of how these "expected values" are used. As discussed, valuation should include incremental impacts, which are often for practical purposes taken as the average values of a number of observations or possibilities. With oil spills also we are concerned with the average values to the extent that they reflect expected costs. But two factors are relevant in calculating this:

- Using averages over different spill sizes. If different spill sizes are possible with different clean up costs, then the average cost of the distribution is not necessarily the same as the cost of the average spill. Event trees need to be adjusted accordingly.[145]

[145] Consider an example, of say three spills of [5,7.5,10] barrels with costs per barrel of [10,9,8] and probability of [0.25, 0.5, 0.25]. The mean spill size (expected spill size) is 7.5 bbl and the expected cost of the distribution can be shown to be 66.25 hence the average cost of the spill at the mean is 66.25/7.5= $8.83/bbl whereas the expected cost of the average spill is, as noted, $9/bbl. Although in this case the arithmetical difference is less than 2%, the variation can become more significant with other spill profiles. We therefore preferentially rely on making separate spill calculations for different spill types and sizes if there is a large distribution of possible outcomes (as with the pipeline).

- Spill statistics frequently contain extreme outliers which can disproportionately affect the means. Treatment of these outliers is relevant to what is reported as an expected outcome. Some authors advocate using median values for spill costs or release volumes, on the grounds that they ignore anomalous outliers. [146] We have taken the approach of staying with mean values, although they tend to increase final spill costs.

An example using the method of "statistical loss" on Canada's east coast

In 2007 Transport Canada reviewed shipping operations to estimate the costs (cleanup and indirect environmental) of ship operations along the South Coast of Newfoundland. In its assessment, it looked at expected future losses from existing and potentially new activities that might have a bearing on oil spill risks in Canadian coastal waters.[147] It noted, "risk includes two main elements: probability and consequence. An overall estimation of risk must combine these two elements. The combination of probability and consequence is termed the 'statistical loss'. It is calculated by simply multiplying of the estimated economic loss if the event were to occur by the probability of the event occurring." This is equivalent to the expected value of losses, or cost expectations, used in valuations.

Relative to NGP, Section 4.4 of this report shows that the cost expectations associated with marine spill risks (including tankers and terminal) are somewhat under $10 million a year. Also, recall that the total volume of condensate and oil handled through NGP are 675,000 bpd or 255.5 Mbbl annually. To place this in perspective, the cost expectations study conducted for Transport Canada (2007) on Atlantic Canada operations showed that "statistical losses" associated with tanker spills involved with expanded crude oil and refined product movements were in the range of $12 - $17 million a year. This was associated with a total projected volume of 411 Mbbl annual movements of crude and product, of which 78% (322 Mbbl/yr) was linked to operations at North Atlantic (Come by Chance)

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[146] This argument is made by Kontovas et al (2010) indicating such a median approach may be useful in the context of Formal Safety Assessment (FSA) often conducted using IOPCF statistics. Kontovas CA, Psaraftis HN, Ventikos NP. 2010. An empirical analysis of IOPCF oil spill cost data. *Marine Pollution Bulletin* 60(9):1455-1466.

[147] Transport Canada. 2007. *Synopsis Report – Environmental Oil Spill Risk Assessment for the South Coast of Newfoundland*, Edition 1 September 2007, Revised 11/2007. Report TP14740E.

refinery and Whiffen Head terminal (both in Placentia Bay, Newfoundland)[148].

Although the Atlantic study was undertaken to look at impacts of existing and expanded operations, it showed that even existing operations unrelated to shore-bound tanker traffic represented a risk of the order of $10 million annually (this is for tankers crossing the Area of Interest to or from St. Lawrence Seaway, Great Lakes or Holyrood power plant.)

The foregoing demonstrates that the offshore cost expectations and volumes associated with NGP are of the same order of magnitude as existing operations in Atlantic Canada; moreover, Canadians have obviously been living with such cost expectations for some time in Atlantic Canada. While the risks are present – and at times obvious, such as the May 2012 accidental but contained release of oil at the North Atlantic refinery – the economic impacts and benefits to Canadians are also present. While the locations are different, shorelines in Newfoundland are as important to Canadians as the shores of British Columbia.

Oil spill probability and costs – Tanker operations

Oil spill probability from tankers in Canadian waters was studied in detail by DNV. [149] Their work showed that the expected spill size was about 9,000 m^3 with an expected return period of 250 years (P=0.004).

The costs of offshore spills were studied in detail by Kontovas et al (2010) based on a study of oil spill cost data from the period 1979 to 2006.[150]

[148] We note further that about 82% of projected expected costs (which included clean up and environmental damage) were in near-coastal waters associated with these facilities. Also, it is relevant to note that an additional $8 million of statistical losses from fuel spills were attributable annually to non-tanker operations (cargo and other shipping). Transport Canada. 2007. *Synopsis Report – Environmental Oil Spill Risk Assessment for the South Coast of Newfoundland*, Edition 1 September 2007, Revised 11/2007. Report TP14740E.

[149] Termpol Study No. 3.15, Table 4-10 and Figure 4.3, pages 4-17 and 4-18

[150] Kontovas et al. 2010. An empirical analysis of IOPCF oil spill cost data. *Marine Pollution Bulletin*. Total costs included clean up costs and social and environment costs. The equation of fitted model of cleanup cost is LOG10 (Cleanup)=4.64773 + 0.643615 LOG10(V); V=volume in tonnes , i.e., Cleanup cost = 44,435*(V^0.644). For total costs the result is TC=51,432*(V^0.728). These show the declining unit costs to size. Note also that this paper provides a comprehensive critique of Psarros et al (2009) who argue that for risk assessment costing a value of about $80,000/tonne ($12,700/bbl) should be used. (Psarros G, Skjong R, Endersen O, Vanem E. 2009. A perspective on the development of Environmental Risk Acceptance Criteria related to oil spills, Annex to International Maritime Organization document MEPC 59/INF.21, submitted by Norway).

Regression analyses over the period 1979-2006 showed an average value of US$4,118/tonne (2009) [approximately C$800/bbl (2012)] over the entire period with lowest unit costs for the largest spills. Many analysts, including Psarros et al (2009) assert that higher costs should be used to reflect additional contingencies and safety factors. A two-fold factor would yield cleanup costs of the order of about $1,600/bbl in 2012 terms. Other studies reviewed by Kontovas place the upper range estimate for cleanup costs at close to $15,000/bbl.[151] Using a conservative approach to estimating cleanup costs of this order of magnitude spill size, would give a cost of $15,000/bbl as an upper bound. This cost estimate is higher than those in studies of spills in the offshore of Atlantic Canada, conducted for Transport Canada (2007), which placed cleanup costs in a range of $820/bbl to $5,960/bbl (2012$) for ‘high-persistence' oil.

The same study by Kontovas et al (2010) estimated a regression for damage costs, which were collected separately for the data set of all spills. The costs were also found to be a function of spill size and could be estimated with a statistical form similar to the cleanup costs. The authors indicate that many analysts would use a "ratio" estimate to factor the damage costs from the cleanup costs; at the mean spill size they estimate a figure of 1.5 as being representative of the mean, but note that that a median value of 1.287 may be more appropriate for factoring point estimates. Moreover, the Transport Canada study, which also addressed onshore and near-shore damages to fisheries, aquaculture and tourism, had implied factors of 0.85 for spills under 10,000 bbls and approximately 0.6 for larger spills. A conservative estimate implies a 1.5 factor on the high level of cleanup costs to arrive at an expected damage cost of $22,500/bbl for a marine oil spill. We note that these two figures together yield a total conditional cost of $37,500/bbl (or about $236,000/t) or $2.1 billion for the mean spill size. With a 0.004 annual probability this corresponds to an annual cost expectation of about $8.5 million/year once operations commence.

Oil spill probability and costs –Marine terminal operations

DNV made separate estimates for spills at the Marine Terminal. Spills are expected to be much smaller than in the offshore but more frequent. They

[151] We note also that Professor Gunton places costs in the range of $14,000/bbl to $21,000/bbl for "hard costs." Gunton & Broadbent: A Review of Potential Impacts to Coastal First Nations (CFN) from an Oil Tanker Spill associated with the Northern Gateway Project. January 2012.

estimate an annual probability of a spill as 0.0164 (61 years return period) and a "maximum credible spill size" of 250 m3.

For the base case under the CBA, cleanup costs of $11,000/bbl and environmental costs of $9,000/bbl are estimated. This cost is consistent with those in the literature. For example, Etkin (2004) examined cleanup costs in North America and suggested modifier factors in order to estimate costs in various environments.[152] Her factors included consideration for location, remoteness, size of spill, extent of shoreline oiling and degree of manual cleanup required. The range of cleanup costs for a remote heavy oil spill of 250m^3 would yield a result of $7,640-14,440/bbl depending on the degree of manual cleanup required (Table B3). Our cost estimate is at the approximate midpoint of this range ($11,000/bbl), even though shoreline oiling will be limited and spill mitigation equipment is readily available and deployable onsite. Note also that regression analyses conducted by Restrepo et al. (2009) confirm that leak costs associated with onshore pumping facilities included in such terminals tend to be lower than system average costs of the type addressed by Etkin.[153] Also, we note that cleanup of condensate spills would have lower costs within this environment; the Transport Canada (2007) study showed spills of medium persistence liquids to be about two-thirds the cost of a high persistence spill. Our estimate is thus conservative. For environmental costs we again rely on the IOPCF factored cost data and apply a multiplier of 0.85, which corresponds to a modest spill of 250m^3.

Oil spill probability and costs – Onshore pipeline

Enbridge has undertaken extensive studies of the proposed onshore facilities and have concluded that the annual probability of a large spill is 0.00417 (240 year return period) and the expected average size of a spill is 2,238 m3 (14,099 bbl).[154] The annual probability of a spill from the condensate pipeline is 0.00366 (273 year return period) with a corresponding expected average spill size of 823 m3 (5,183 bbl). These spills could be caused by

[152] Etkin DS. 2004. Modeling Oil Spill Response and Damage Costs. USEPA.
[153] Restrepo CE, Simonoff JS, Zimmermann R. 2009. Causes, cost consequences, and risk implications of accidents in US hazardous liquid pipeline infrastructure. *International Journal of Critical Infrastructure Protection* 2:38-50.
[154] Enbridge SQRA Spill Studies. Note that this spill is greater than the average of all spills modeled. The entire pipeline was divided into one kilometer segments which in turn were each modeled as 20 separate 50 meter long elements, resulting in a model of over 23,000 elements and spills for each of these. The "expected rupture" within any one kilometer segment was taken as the largest rupture of the 20 elements. The mean expected rupture for the pipeline as a whole was taken as the mean of the 1172 maximum values.

threats that include manufacturing defaults, third party strikes (assumed for modelling as a backhoe blade strike), and geohazards such as landslides. The full bore rupture may occur at any point of the 1,172 km pipeline right of way.

Apart from the full bore rupture, all other spills are classified as leaks. The overall range of spill threats contain several subcategories in addition to the above: pipe corrosion, construction faults, operational faults, and equipment failure. Within this range, the smallest include spills through pinholes (<1.8mm holes in the pipe) having negligible probabilities and these can be ignored in the overall analyses. The leak associated with the highest expected (probability adjusted) release is a 568bbl (90 m3) spill with a 5 year return period (annual probability 0.198) occurring at a pumping station due to equipment failure. Although this is a relatively frequent spill, mitigation and containment measures associated with the pumping stations would limit the potential impacts, damages, and cleanup costs associated with such an event. Other leaks are different in terms of expected volume and return period: pipe corrosion leaks are negligible; leaks from construction defects, operational faults, or material effects are expected to release about 700 bbls of oil and have return frequencies ranging from 38 years for construction faults to 652 years for manufacturing defects.[155] Oil leaks in general (combining all sizes) have a probability weighted volume release of 150 bbl, corresponding to an average spill size of about 600 bbl at a return period of 4 years. All leak probabilities and sizes are summarized in Table B4.

We have assessed the scope of possible cleanup costs and damages from oil spills from the pipeline by considering two general categories of spill: full-bore rupture; and, leaks. The expected average spill size for a full bore rupture is 2,238 m3 which is about 15,000 barrels: for this size, we estimate a cleanup cost of around $4,000/bbl. Etkin's estimating methods present a range of $1,870 to $3,530 for this size spill depending on cleanup methods (Table B3). Condensate line rupture costs are also estimated to be $4,000/bbl: the expected rupture is smaller (823 m3 or 5,183 bbl), which increases unit costs; but condensate has off-setting lower cleanup costs as it is less persistent. Even leaks, however, can be quite costly: on average, we estimate DilBit leaks to have an expected cleanup cost of $9,000/bbl and

[155] Leaks are based on information provided in the SQRA studies, with leak volumes taken as the historical information based on industry data sets. The leaks were screened for pipelines of 20" and greater, with the same leak volumes used for condensate and DilBit.

condensate leaks to have a cost in the order of $5,000/bbl. The rupture cost estimates reflect higher costs relating to remoteness, need for manual cleanup, and an assumption that all of them will affect water bodies and involve some shoreline cleanup. For leaks we assume that one-quarter will have water exposure. This tends to over-estimate costs for ruptures and leaks, as the SQRA estimates that 83% of ruptures will affect a water body; for leaks contained inside the Project Effects Assessment Area (PEAA) only 11% will affect water bodies.

Each spill has a damage cost associated with an event risk, to which an appropriate probability is applied. The damage functions reflect average ecosystem service values in the PEAA of $180/ha/year (based on Anielski, 2012). The damage functions correspond primarily to impacts from the full bore rupture. Other leaks – which have a mean spill size of 600 bbl – are assumed to be contained within the PDA or a mean area inside the PEAA not greater than 5 km2. The full-bore rupture leak (with 240 year return period) has the largest potential damage of about $140,000,000 (affecting a 30km x 30km area of the Regional Effects Assessment Area (REAA) and corresponding to a unit cost of $10,000/bbl spilled.

The resultant costs on a per barrel basis remain conservative. Large DilBit spills have a total cost of approximately $14,000/bbl while the leaks have a cost of $10,000/bbl or less. To place these in perspective, the Pine River 6,200 bbl spill in 2000 had a cost including third party settlements of about $6,500/bbl (C$2012); the 2011 Plains rainbow spill of 28,000 bbl had cleanup costs of about $2,500/bbl.[156] Enbridge's experience with eight oil spill incidents over the period 2001-2011 suggests costs of the order of $10,000/bbl for all spills and about $2,500/bbl for six spills excluding two outliers.[157] We note moreover that at least one of these spills (Marshall) was in a high risk/high consequence area; the SQRA estimates that only 6% of the pipeline right of way is in a high risk area and additional mitigation measures will be put in place in these areas.

A summary of the cost expectations for pipelines is provided in Table B5. It demonstrates an annual statistical loss (cost expectation) of $3.41 million. Of this, about two-thirds of the costs are associated with the oil line. It is also notable that $2.07 million are cost expectations associated entirely with

[156] Communication from John Thompson 12 June 2012.
[157] Personal communication with Greg Milne, Enbridge 20 June 2012.

leaks (mean size 600 bbl and return period of 2 years across both lines), some of which may be covered already in operational costs yet are nevertheless treated here as incremental costs.

B6. Closing note on estimators

Given the inherent uncertainty in the estimation of environmental costs, we have chosen to err on the side of over-estimation. Examples of this conservative approach are provided in Table B2.

Table B2: Conservative Estimates and Assumptions
a/ counting EGS loss in PDA with zero recovery
b/ ignoring the potential credit for EGS services lost if this DilBit went by rail to the US - this credit would reflect both expected spill cleanup costs and damages, and potentially higher GHGs from fuel emission on rail transport than there are for pipeline pumping via Gateway
c/ ignoring the potential delayed credit due to possible forestry policy in BC which would likely have placed some this area into accelerated cut in any event within the next 10 years due to mountain pine beetle losses.
d/ when assessing spill costs on the ROW, we take all spill cleanup costs and damages into account (even for spills with short return periods) although some allowance for these costs may already be reflected in company operating costs
e/ valuations used are typically average values even though marginal value in BC may be closer to zero for small scale impacts of this nature because of available substitute landscapes.
f/ we use spill cleanup and damage costs which essentially reflect an order of magnitude (10x) margin over recent evidence from three decades of spill costs based on international insurance fund data
g/ we use a "high side multiplier" damage:cleanup costs from the database of 1.5 instead of a lower figure at the median (1.2) which would be statistically defensible. Also, values in similar studies in Atlantic Canada show multipliers of less than one, which could be defensible for BC.
h/ we give no credit to any insurance premiums already in NGP costs
i/ we give no credit for implicit insurance premiums in the tanker tariffs and sovereign funds because most such payments in any event need to cover non-tanker spills (which are the majority of spills in size and cost

Table B3: Typical Clean Up Costs

		Nearshore Terminal Spill Size				Pipeline (DilBit) Spill Size		Pipeline (Condensate) Spill Size	
Mean Spill Size in NGP Study				1,575		14,099 Rupture	594 Leak	5,183 Rupture	593 Leak
Spill Size (Etkin)		Larger	Average	Modest	Small	Larger	Modest	Average	Modest
Spill Size Upper Value in Range	bbl	23,800	11,900	2,380	238	23,800	2,380	11,900	2,380
Spill Size Lower Value in Range	bbl	11,900	2,400	238	-	11,900	238	2,400	238
North American Average Clean Up Costs	US$/tonne ($1999)	19,815	19,815	19,815	19,815	19,815	19,815	19,815	19,815
Inflation factor 1999-2012		1.302	1.302	1.302	1.302	1.302	1.302	1.302	1.302
North American Average Clean Up Costs	US$/tonne ($2012)	25,799	25,799	25,799	25,799	25,799	25,799	25,799	25,799
	$/bbl (C$2012)	3,686	3,686	3,686	3,686	3,686	3,686	3,686	3,686
Spill Size Multiplier reflecting Scale effects	(per Etkin)	0.15	0.27	0.65	2.00	0.15	0.65	0.27	0.65
Expected Clean Up Cost Reflecting Scale	$/bbl (C$2012)	553	995	2,396	7,372	553	2,396	995	2,396
Spill-specific Multiplicative Factors:									
Remoteness Factor	(per Etkin: Max 1.2)	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20
Nearshore Water Exposure	(per Etkin: Max 1.46)	1.46	1.46	1.46	1.46	1.46	1.12	1.46	1.12
Oil Type (DilBit assumed like Heavy Oil)	(per Etkin: Max 1.82)	1.82	1.82	1.82	1.82	1.82	1.82	1.00	1.00
Shoreline Impacts - 100 km	(per Etkin: Max 1.06)	1.06	1.06	1.00	1.00	1.06	1.00	1.06	1.00
Cumulative Multiplicative Factors		3.38	3.38	3.19	3.19	3.38	2.44	1.86	1.34
Expected Clean Up Costs (Lower Bound)	$/bbl (C$2012)	1,869	3,364	7,640	23,507	1,869	5,834	1,848	3,206
Multiplier for Manual Cleanup	(per Etkin: Max 1.89)	1.89	1.89	1.89	1.89	1.89	1.89	1.89	1.89
Expected Clean Up Costs (Upper Bound)	$/bbl (C$2012)	3,532	6,358	14,439	44,428	3,532	11,027	3,493	6,059
Expected Clean Up Costs (Mid-point)	$/bbl (C$2012)	2,700	4,861	11,039	33,967	2,700	8,431	2,671	4,632
Assumed in NGP Study	$/bbl (C$2012)			11,000		4,000	9,000	4,000	5,000

Note: ignores foreign exchange rate differences.

Source: Based on Etkin (2004).

<u>Associated Assumptions:</u>

Inflation 1999-2010	1.24
Inflation 2010-2012	1.05
bbl/tonne	7.00
Water exposure of pipeline leaks (modest)	25%

Table B4: DilBit and Condensate Pipeline Spill Likelihood

Pipeline Spill Risk Assessment Summary

Threat - Dilbit 36" - Rupture	Prob (/y)	Return (y)	Size bbl	Source/Notes regarding Frequency/probability/Size
Manufacturing Defects per SQRA	1.535E-03	651.6		DRAS FLA* Section 2.6 (50% 2.619E-06)
Third Party (Fault Hit Model) rupture mean	7.643E-04	1,308.5		DRAS em 6 June/12
Geohazard	1.887E-03	530.0		DRAS em 6 June/12
All Threats	4.186E-03	238.9	14,099	(2238m3) FLOC model
Threat - Dilbit 36" - Leak	**Prob (/y)**	**Return (y)**	**Size bbl**	**Source/Notes**
External Corrosion per SQRA	0.00E+00	n.a.	-	All frequencies per km per year SQRA - original report unless
Internal Corrosion per SQRA	0.00E+00	n.a.	-	otherwise noted; spills PHMSA Database
Manufacturing Defects per SQRA	1.53E-03	651.6	692	MOC23**; DRAS FLA* Section 2.6 (50% 2.619E-06)
Construction Faults per SQRA	2.58E-02	38.7	692	MOC23; DRAS FLA* Section 2.7
Third Party (Fault Hit Model) leak mean	2.29E-03	436.2	758	THIRD8; DRAS em 6 June/12
Operational System Faults	2.14E-02	46.7	692	MOC23; DRAS FLA* Section 2.5
Equipment Failure	1.98E-01	5.0	568	EQ21; DRAS FLA* Section 2.4
All Threats	2.49E-01	4.0	594	
Threat - Condensate 20" - Rupture	**Prob (/y)**	**Return (y)**	**Size bbl**	**Source/Notes**
Manufacturing Defects per SQRA	1.535E-03	651.6		DRAS em 7 June/12
Third Party (Fault Hit Model) rupture mean	2.410E-04	4,149.4		DRAS em 7 June/12 & 11 June/12
Geohazard	1.887E-03	530.0		DRAS em 7 June/12
All Threats	3.663E-03	273.0	5,183	(823 m3) FLOC model {Worley Parsons em 12 June/12}
Threat - Condensate 20" - Leak	**Prob (/y)**	**Return (y)**	**Size bbl**	**Source/Notes**
External Corrosion per SQRA	0.00E+00	n.a.	-	All condensate spill size for leaks same as Dilbit line
Internal Corrosion per SQRA	0.00E+00	n.a.	-	
Manufacturing Defects per SQRA	1.53E-03	651.6	692	DRAS em 7 June/12
Construction Faults per SQRA	2.59E-02	38.7	692	DRAS em 7 June/12
Third Party (Fault Hit Model) leak mean	7.22E-04	1,385.0	758	DRAS em 7 June/12 & 11 June/12
Operational System Faults	2.14E-02	46.7	692	DRAS em 7 June/12
Equipment Failure	1.98E-01	5.0	568	Taken same as Dilbit as per DRAS em 11 June/12
All Threats	2.48E-01	4.0	593	

* DRAS FLA: SQRA report by Dynamic Risk Assessment Systems Inc, 30 April 2012 "Failure Likelihood Assessment"
** PHMSA Incident Database 2002-2009 filtered for large (>=20") hazardous liquids pipelines install year>=1990
MOC23: Additional filter for: materials defects, incorrect operations, construction damage (23 incidents)
THIRD8: Additional filter for: 3rd Party damage (8 incidents)
EQ21: Additional filter for: Equipment failure (21 incidents)
FLOC: Susceptibility to Loss of Containment (per SQRA)
Rupture: SQRA modeling results; mean of maxima within each segment (dilbit and condensate done separately)

HJ Ruitenbeek 3-July-2012

Table B5: Oil Spill Cost Expectations - Results (Cleanup and Damage costs in Cdn$ millions)

Losses Summary (annual expected lost M$/year)	Total	Cleanup	Damage
Both Lines All Risks	**3.41**	**2.38**	**1.03**
Dilbit Line All Risks	2.28	1.57	0.72
Condensate Line All Risks	1.12	0.81	0.31
All Risks Both Lines	**3.41**	**2.38**	**1.03**
Rupture Both Lines	1.10	0.31	0.79
Leaks Both Lines	2.31	2.07	0.24

Mean Spill Attributes	Size (bbl)	return (yr)	Cleanup $/b	Damage $/b	Total $/b
Dilbit Ruptures	14,099	240.0	4000	10170	14170
Condensate Ruptures	5,183	273.0	4000	10170	14170
Dilbit Leaks	594	4.0	9000	808	9808
Condensate Leaks	593	4.0	5000	806	5806

Base Case Cost Expectations All Spills: 12.43 M$/yr	Annual Cost
Tanker Spill	8.51
Terminal Spill	0.52
Pipeline Spill	3.41

APPENDIX C-COST BENEFIT ANALYSIS MATRICES

Base Case

Sensitivity Case 1: **Without Oil Price Uplift**

Sensitivity Case 2: **Oil Price Uplift Halved and only for 5 Years**

Sensitivity Case 3: **Double Costs and Halve Benefits & Oil Price Uplift only for 5 Years**

Sensitivity Case 4: **Double Costs and Halve Benefits & Oil Price Uplift only for 5 Years & NGP considered "not needed" for oil transmission until 2024**

Sensitivity Case 5: **Oil Spill Cost Expectations set high enough to offset all other Benefits in Base Case (NPV8=0)**

Base Case

Cost/Benefit Analysis for NGP (including Oil and Condensate Pipes & Kitimat Terminals) Real Cdn $2012, Update 2012

Base Case

								Muse Est.											
Included		yes	yes	yes	yes	yes		yes		yes	yes	yes	yes	yes	yes	yes	yes	yes	
Sensiivity Factor		100.0%	100.0%	100.0%	100.0%	100.0%		100.0%		100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	
		of Investment						until											
								2048											
											Cost Expectation of		**Cost Expectation of Oil Spills**						
		Direct Cash Flows from Project			**Labor Mkt**	**Cost from**	**NGP**	**Oil Price Uplift**			**Environmental Impacts**		**Onshore Pipes**				**Offshore**		
		NGP	**Local Gov't**	**Fed+Prov Gov't**	**Adjustments**	**Reduced Vol**	**always**	**Gross Revenue Increase**		**Cost to Cdn**			**& Upland Terminal**		**Marine Terminal**		**in Canadian Waters**		**TOTAL**
Year		**before Interest**	**Property**	**Income**	**labor in**	**on ENB**	**Needed**	**to Private**	**to Gov'ts**	**Refineries or**	**Other**	**GHG**	**Clean Up**	**Envir'nt**	**Clean Up**	**Envir'nt**	**Clean Up**	**Envir'nt**	**Costs/**
		after Taxes	**Tax**	**Tax**	**invest + Op costs**	**Mainline**		**Sector**	**tax + royalties**	**Consumers**		**(CO2e)**		**Damage**		**Damage**		**Damage**	**Benefits**
		$mill	$mill	$mill	$mill	$mill	$mill	$mill	$mill	$mill	$mill	$mill	$mill	$mill	$mill	$mill	$mill	$mill	$mill
2010		(186)	0	0	1.4	0	0	0	0	0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	(185)
2011		(54)	0	0	0.4	0	0	0	0	0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	(53)
2012		(79)	0	0	0.6	0	0	0	0	0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	(78)
2013		(103)	0	0	0.7	0	0	0	0	0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	(102)
2014		(222)	0	0	1.6	0	0	0	0	0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	(221)
2015		(1,051)	0	0	7.6	0	0	0	0	0	0.00	(2.0)	0.0	0.0	0.0	0.0	0.0	0.0	(1,045)
2016		(1,706)	0	0	12.4	0	0	0	0	0	0.00	(2.0)	0.0	0.0	0.0	0.0	0.0	0.0	(1,695)
2017		(2,056)	0	0	15.0	0	0	0	0	0	0.00	(2.0)	0.0	0.0	0.0	0.0	0.0	0.0	(2,043)
2018		(927)	0	0	6.7	0	0	0	0	0	0.00	(2.0)	0.0	0.0	0.0	0.0	0.0	0.0	(922)
2019		571	59	96	1.5	(294)	0	3,450	1,810	(999)	(1.39)	(4.0)	(2.4)	(1.0)	(0.3)	(0.2)	(3.4)	(5.1)	4,677
2020		656	60	92	1.5	(231)	0	3,405	1,787	(931)	(1.39)	(4.0)	(2.4)	(1.0)	(0.3)	(0.2)	(3.4)	(5.1)	4,822
2021		667	60	88	1.5	(150)	0	2,578	1,353	(728)	(1.39)	(4.0)	(2.4)	(1.0)	(0.3)	(0.2)	(3.4)	(5.1)	3,853
2022		677	61	84	1.5	(75)	0	1,749	918	(466)	(1.39)	(4.0)	(2.4)	(1.0)	(0.3)	(0.2)	(3.4)	(5.1)	2,932
2023		687	62	80	1.5	(37)	0	1,683	883	(403)	(1.39)	(4.0)	(2.4)	(1.0)	(0.3)	(0.2)	(3.4)	(5.1)	2,939
2024		697	62	76	1.5	(40)	0	2,648	1,389	(628)	(1.39)	(4.0)	(2.4)	(1.0)	(0.3)	(0.2)	(3.4)	(5.1)	4,188
2025		707	63	72	1.5	(29)	0	2,696	1,415	(596)	(1.39)	(4.0)	(2.4)	(1.0)	(0.3)	(0.2)	(3.4)	(5.1)	4,310
2026		717	63	67	1.5	0	0	2,659	1,395	(560)	(1.39)	(4.0)	(2.4)	(1.0)	(0.3)	(0.2)	(3.4)	(5.1)	4,324
2027		727	64	62	1.5	0	0	2,958	1,552	(550)	(1.39)	(4.0)	(2.4)	(1.0)	(0.3)	(0.2)	(3.4)	(5.1)	4,795
2028		733	65	57	1.5	0	0	2,556	1,341	(469)	(1.39)	(4.0)	(2.4)	(1.0)	(0.3)	(0.2)	(3.4)	(5.1)	4,266
2047		169	78	3	1.5	0	0	2,988	1,568	(295)	(1.39)	(4.0)	(2.4)	(1.0)	(0.3)	(0.2)	(3.4)	(5.1)	4,493
2048		98	79	1	1.5	0	0	2,988	1,568	(295)	(1.39)	(4.0)	(2.4)	(1.0)	(0.3)	(0.2)	(3.4)	(5.1)	4,421
SUM		7,927	2,054	1,201	90.2	(857)	0	83,574	43,856	(12,626)	(41.6)	(128.0)	(71.4)	(30.9)	(8.5)	(7.0)	(101.9)	(152.8)	124,678
NPV at 2012 at	**5.00%**	1,027	722	572	52	(541)	0	29,878	15,679	(5,342)	(15)	(50)	(26)	(11)	(3)	(3)	(37)	(56)	41,848
NPV at 2012 at	**8.00%**	(527)	427	387	41	(416)	0	17,851	9,367	(3,476)	(9)	(32)	(16)	(7)	(2)	(2)	(22)	(33)	23,533
NPV at 2012 at	**10.00%**	(1,097)	311	303	36	(350)	0	13,118	6,884	(2,681)	(7)	(24)	(12)	(5)	(1)	(1)	(16)	(25)	16,432
	IRR	6.8%																**IRR**	32.8%
		Note	**Note**	**Note**	**Inputs**	**Inputs**	**Inputs**	**Note**	**Note**	**Note**	**Inputs**	**Inputs**	**Inputs**		**Inputs**		**Inputs**		
		from/to equity	revenues	revenues	Labor as % Costs.	Revenue		to Private	to Fed	to Cdn oil	Prob/yr	Prob/yr	Estimated from		Prob Oil Spill/yr		Prob Oil Spill/yr		
		& Debt of NGP.	to local	to Fed	% Labor would be	Loss		Sector	& Prov	products	hectares	t mill after 2018	Enbridge SQRA		Avge Spill m3		Avge Spill m3		
			Gov'ts	& Prov	unemployed.	on mainline			Gov'ts		Cost $/htare	Cost $/t	Studies		Cost/Spill $/bbl		Cost/Spill $/bbl		
		Cum Net		Gov'ts	16.93%	per ENB		% total	% total		1.00000	1.00000			0.01639	0.01639	0.00400	0.00400	
		Investment			5.00%			65.6%	34.4%		7,700	0.200			250	250	9,000	9,000	
		-6,383									180	20			11,000	9,000	15,000	22,500	
Other notes:																			
Deflated to Constant Dollars of year				2012															
In COS calculation, general inlfation is				2.00%															
Power costs and Property Taxes escalated separately at				4.00%	and	3.00%													
smoothed income taxes and tilted depreciation per NGP																			
DCF Avge Toll, at NGP money cost, both pipes				3.98	2012Cdn$/bbl														
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Sensitivity Case 1

Cost/Benefit Analysis for NGP (including Oil and Condensate Pipes & Kitimat Terminals) Real Cdn $2012, Update 2012
Sensitivity Case # 1 Without Oil Price Uplift

Included		yes	yes	yes	yes	yes		no		no	yes	yes	yes	yes	yes	yes	yes	yes	
Sensiivity Factor		100.0%	100.0%	100.0%	100.0%	100.0%					100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	
		of Investment																	
											Cost Expectation of Environmental Impacts		**Cost Expectation of Oil Spills**						
		Direct Cash Flows from Project			**Labor Mkt Adjustments**	**Cost from Reduced Vol on ENB Mainline**	**NGP always Needed**	**Oil Price Uplift**					**Onshore Pipes & Upland Terminal**		**Marine Terminal**		**Offshore in Canadian Waters**		**TOTAL Costs/ Benefits**
		NGP before Interest after Taxes	**Local Gov't Property Tax**	**Fed+Prov Gov't Income Tax**	**labor in invest + Op costs**			**Gross Revenue Increase to Private Sector**	**to Gov'ts tax + royalties**	**Cost to Cdn Refineries or Consumers**									
Year											**Other**	**GHG (CO2e)**	**Clean Up**	**Envir'nt Damage**	**Clean Up**	**Envir'nt Damage**	**Clean Up**	**Envir'nt Damage**	
		$mill	$mill	$mill	$mill	$mill	$mill	$mill	$mill	$mill	$mill	$mill	$mill	$mill	$mill	$mill	$mill	$mill	$mill
2010		(186)	0	0	1.4	0	0	0	0	0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	(185)
2011		(54)	0	0	0.4	0	0	0	0	0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	(53)
2012		(79)	0	0	0.6	0	0	0	0	0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	(78)
2013		(103)	0	0	0.7	0	0	0	0	0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	(102)
2014		(222)	0	0	1.6	0	0	0	0	0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	(221)
2015		(1,051)	0	0	7.6	0	0	0	0	0	0.00	(2.0)	0.0	0.0	0.0	0.0	0.0	0.0	(1,045)
2016		(1,706)	0	0	12.4	0	0	0	0	0	0.00	(2.0)	0.0	0.0	0.0	0.0	0.0	0.0	(1,695)
2017		(2,056)	0	0	15.0	0	0	0	0	0	0.00	(2.0)	0.0	0.0	0.0	0.0	0.0	0.0	(2,043)
2018		(927)	0	0	6.7	0	0	0	0	0	0.00	(2.0)	0.0	0.0	0.0	0.0	0.0	0.0	(922)
2019		571	59	96	1.5	(294)	0	0	0	0	(1.39)	(4.0)	(2.4)	(1.0)	(0.3)	(0.2)	(3.4)	(5.1)	415
2020		656	60	92	1.5	(231)	0	0	0	0	(1.39)	(4.0)	(2.4)	(1.0)	(0.3)	(0.2)	(3.4)	(5.1)	560
2021		667	60	88	1.5	(150)	0	0	0	0	(1.39)	(4.0)	(2.4)	(1.0)	(0.3)	(0.2)	(3.4)	(5.1)	649
2022		677	61	84	1.5	(75)	0	0	0	0	(1.39)	(4.0)	(2.4)	(1.0)	(0.3)	(0.2)	(3.4)	(5.1)	731
2023		687	62	80	1.5	(37)	0	0	0	0	(1.39)	(4.0)	(2.4)	(1.0)	(0.3)	(0.2)	(3.4)	(5.1)	776
2024		697	62	76	1.5	(40)	0	0	0	0	(1.39)	(4.0)	(2.4)	(1.0)	(0.3)	(0.2)	(3.4)	(5.1)	779
2025		707	63	72	1.5	(29)	0	0	0	0	(1.39)	(4.0)	(2.4)	(1.0)	(0.3)	(0.2)	(3.4)	(5.1)	796
2026		717	63	67	1.5	0	0	0	0	0	(1.39)	(4.0)	(2.4)	(1.0)	(0.3)	(0.2)	(3.4)	(5.1)	831
2027		727	64	62	1.5	0	0	0	0	0	(1.39)	(4.0)	(2.4)	(1.0)	(0.3)	(0.2)	(3.4)	(5.1)	836
2028		733	65	57	1.5	0	0	0	0	0	(1.39)	(4.0)	(2.4)	(1.0)	(0.3)	(0.2)	(3.4)	(5.1)	838
2047		169	78	3	1.5	0	0	0	0	0	(1.39)	(4.0)	(2.4)	(1.0)	(0.3)	(0.2)	(3.4)	(5.1)	233
2048		98	79	1	1.5	0	0	0	0	0	(1.39)	(4.0)	(2.4)	(1.0)	(0.3)	(0.2)	(3.4)	(5.1)	161
SUM		7,927	2,054	1,201	90.2	(857)	0	0	0	0	(41.6)	(128.0)	(71.4)	(30.9)	(8.5)	(7.0)	(101.9)	(152.8)	9,874
NPV at 2012 at	5.00%	1,027	722	572	52	(541)	0	0	0	0	(15)	(50)	(26)	(11)	(3)	(3)	(37)	(56)	1,632
NPV at 2012 at	8.00%	(527)	427	387	41	(416)	0	0	0	0	(9)	(32)	(16)	(7)	(2)	(2)	(22)	(33)	(209)
NPV at 2012 at	10.00%	(1,097)	311	303	36	(350)	0	0	0	0	(7)	(24)	(12)	(5)	(1)	(1)	(16)	(25)	(888)
	IRR	6.8%																**IRR**	7.6%
		Note	**Note**	**Note**	**Inputs**	**Inputs**	**Inputs**	**Note**	**Note**	**Note**	**Inputs**	**Inputs**	**Inputs**		**Inputs**		**Inputs**		
		from/to equity	revenues	revenues	Labor as % Costs.	Revenue		to Private	to Fed	to Cdn oil	Prob/yr	Prob/yr	Estimated from		Prob Oil Spill/yr		Prob Oil Spill/yr		
		& Debt of NGP.	to local	to Fed	% Labor would be	Loss		Sector	& Prov	products	hectares	t mill after 2018	Enbridge SQRA		Avge Spill m3		Avge Spill m3		
			Gov'ts	& Prov	unemployed.	on mainline			Gov'ts		Cost $/htare	Cost $/t	Studies		Cost/Spill $/bbl		Cost/Spill $/bbl		
		Cum Net		Gov'ts	16.93%	per ENB		% total	% total		1.00000	1.00000			0.01639	0.01639	0.00400	0.00400	
		Investment			5.00%			65.6%	34.4%		7,700	0.200			250	250	9,000	9,000	
		-6,383									180	20			11,000	9,000	15,000	22,500	
Other notes:																			
Deflated to Constant Dollars of year				2012															
In COS calculation, general inlfation is				2.00%															
Power costs and Property Taxes escalated separately at				4.00%	and	3.00%													
smoothed income taxes and tilted depreciation per NGP																			
DCF Avge Toll, at NGP money cost, both pipes				3.98	2012Cdn$/bbl														
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Sensitivity Case 2

Cost/Benefit Analysis for NGP (including Oil and Condensate Pipes & Kitimat Terminals) Real Cdn $2012, Update 2012
Sensitivity Case # 2: Oil Price Uplift halved & only for 5 Years

								Muse Est.											
Included		yes	yes	yes	yes	yes		yes		yes	yes	yes	yes	yes	yes	yes	yes	yes	
Sensiivity Factor		100.0%	100.0%	100.0%	100.0%	100.0%		50.0%		50.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	
		of Investment						until											
								2023											
											Cost Expectation of Environmental Impacts		**Cost Expectation of Oil Spills**						
		Direct Cash Flows from Project			**Labor Mkt Adjustments**	**Cost from Reduced Vol on ENB Mainline**	**NGP always Needed**	**Oil Price Uplift**					**Onshore Pipes & Upland Terminal**		**Marine Terminal**		**Offshore in Canadian Waters**		**TOTAL**
		NGP	**Local Gov't**	**Fed+Prov Gov't**				**Gross Revenue Increase**		**Cost to Cdn**									
Year		**before Interest after Taxes**	**Property Tax**	**Income Tax**	**labor in invest + Op costs**			**to Private Sector**	**to Gov'ts tax + royalties**	**Refineries or Consumers**	**Other**	**GHG (CO2e)**	**Clean Up**	**Envir'nt Damage**	**Clean Up**	**Envir'nt Damage**	**Clean Up**	**Envir'nt Damage**	**Costs/ Benefits**
		$mill	$mill	$mill	$mill	$mill	$mill	$mill	$mill	$mill	$mill	$mill	$mill	$mill	$mill	$mill	$mill	$mill	$mill
2010		(186)	0	0	1.4	0	0	0	0	0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	(185)
2011		(54)	0	0	0.4	0	0	0	0	0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	(53)
2012		(79)	0	0	0.6	0	0	0	0	0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	(78)
2013		(103)	0	0	0.7	0	0	0	0	0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	(102)
2014		(222)	0	0	1.6	0	0	0	0	0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	(221)
2015		(1,051)	0	0	7.6	0	0	0	0	0	0.00	(2.0)	0.0	0.0	0.0	0.0	0.0	0.0	(1,045)
2016		(1,706)	0	0	12.4	0	0	0	0	0	0.00	(2.0)	0.0	0.0	0.0	0.0	0.0	0.0	(1,695)
2017		(2,056)	0	0	15.0	0	0	0	0	0	0.00	(2.0)	0.0	0.0	0.0	0.0	0.0	0.0	(2,043)
2018		(927)	0	0	6.7	0	0	0	0	0	0.00	(2.0)	0.0	0.0	0.0	0.0	0.0	0.0	(922)
2019		571	59	96	1.5	(294)	0	1,725	905	(499)	(1.39)	(4.0)	(2.4)	(1.0)	(0.3)	(0.2)	(3.4)	(5.1)	2,546
2020		656	60	92	1.5	(231)	0	1,703	894	(466)	(1.39)	(4.0)	(2.4)	(1.0)	(0.3)	(0.2)	(3.4)	(5.1)	2,691
2021		667	60	88	1.5	(150)	0	1,289	676	(364)	(1.39)	(4.0)	(2.4)	(1.0)	(0.3)	(0.2)	(3.4)	(5.1)	2,251
2022		677	61	84	1.5	(75)	0	875	459	(233)	(1.39)	(4.0)	(2.4)	(1.0)	(0.3)	(0.2)	(3.4)	(5.1)	1,832
2023		687	62	80	1.5	(37)	0	841	442	(201)	(1.39)	(4.0)	(2.4)	(1.0)	(0.3)	(0.2)	(3.4)	(5.1)	1,857
2024		697	62	76	1.5	(40)	0	0	0	0	(1.39)	(4.0)	(2.4)	(1.0)	(0.3)	(0.2)	(3.4)	(5.1)	779
2025		707	63	72	1.5	(29)	0	0	0	0	(1.39)	(4.0)	(2.4)	(1.0)	(0.3)	(0.2)	(3.4)	(5.1)	796
2026		717	63	67	1.5	0	0	0	0	0	(1.39)	(4.0)	(2.4)	(1.0)	(0.3)	(0.2)	(3.4)	(5.1)	831
2027		727	64	62	1.5	0	0	0	0	0	(1.39)	(4.0)	(2.4)	(1.0)	(0.3)	(0.2)	(3.4)	(5.1)	836
2046		185	77	5	1.5	0	0	0	0	0	(1.39)	(4.0)	(2.4)	(1.0)	(0.3)	(0.2)	(3.4)	(5.1)	250
2047		169	78	3	1.5	0	0	0	0	0	(1.39)	(4.0)	(2.4)	(1.0)	(0.3)	(0.2)	(3.4)	(5.1)	233
2048		98	79	1	1.5	0	0	0	0	0	(1.39)	(4.0)	(2.4)	(1.0)	(0.3)	(0.2)	(3.4)	(5.1)	161
SUM		7,927	2,054	1,201	90.2	(857)	0	6,433	3,376	(1,763)	(41.6)	(128.0)	(71.4)	(30.9)	(8.5)	(7.0)	(101.9)	(152.8)	17,919
NPV at 2012 at	5.00%	1,027	722	572	52	(541)	0	4,036	2,118	(1,110)	(15)	(50)	(26)	(11)	(3)	(3)	(37)	(56)	6,677
NPV at 2012 at	8.00%	(527)	427	387	41	(416)	0	3,090	1,622	(851)	(9)	(32)	(16)	(7)	(2)	(2)	(22)	(33)	3,651
NPV at 2012 at	10.00%	(1,097)	311	303	36	(350)	0	2,598	1,364	(717)	(7)	(24)	(12)	(5)	(1)	(1)	(16)	(25)	2,358
	IRR	6.8%																**IRR**	17.6%
		Note	**Note**	**Note**	**Inputs**	**Inputs**	**Inputs**	**Note**	**Note**	**Note**	**Inputs**	**Inputs**	**Inputs**		**Inputs**		**Inputs**		
		from/to equity	revenues	revenues	Labor as % Costs.	Revenue		to Private	to Fed	to Cdn oil	Prob/yr	Prob/yr	Estimated from		Prob Oil Spill/yr		Prob Oil Spill/yr		
		& Debt of NGP.	to local	to Fed	% Labor would be	Loss		Sector	& Prov	products	hectares	t mill after 2018	Enbridge SQRA		Avge Spill m3		Avge Spill m3		
			Govts	& Prov	unemployed.	on mainline			Govts		Cost $/htare	Cost $/t	Studies		Cost/Spill $/bbl		Cost/Spill $/bbl		
		Cum Net		Govts	16.93%	per ENB		% total	% total		1.00000	1.00000			0.01639	0.01639	0.00400	0.00400	
		Investment			5.00%			65.6%	34.4%		7,700	0.200			250	250	9,000	9,000	
		-6,383									180	20			11,000	9,000	15,000	22,500	
Other notes:																			
Deflated to Constant Dollars of year				2012															
In COS calculation, general inlfation is				2.00%															
Power costs and Property Taxes escalated separately at				4.00%	and	3.00%													
smoothed income taxes and tilted depreciation per NGP																			
DCF Avge Toll, at NGP money cost, both pipes				3.98	2012Cdn$/bbl														
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Sensitivity Case 3

Cost/Benefit Analysis for NGP (including Oil and Condensate Pipes & Kitimat Terminals) Real Cdn $2012, Update 2012
Sensitivity Case # 3: Double Costs and Halve Benefits, & only 5 years of Oil Price Uplift

								Muse Est.											
Included		yes	yes	yes	yes	yes		yes		yes	yes	yes	yes	yes	yes	yes	yes	yes	
Sensiivity Factor		200.0%	100.0%	100.0%	50.0%	200.0%		50.0%		50.0%	200.0%	200.0%	200.0%	200.0%	200.0%	200.0%	200.0%	200.0%	
		of Investment						until											
								2023											
											Cost Expectation of Environmental Impacts		**Cost Expectation of Oil Spills**						
		Direct Cash Flows from Project			**Labor Mkt Adjustments**	**Cost from Reduced Vol on ENB Mainline**	**NGP always Needed**	**Oil Price Uplift**					**Onshore Pipes & Upland Terminal**		**Marine Terminal**		**Offshore in Canadian Waters**		**TOTAL Costs/ Benefits**
		NGP before Interest after Taxes	**Local Gov't** Property Tax	**Fed+Prov Gov't** Income Tax	labor in invest + Op costs			**Gross Revenue Increase** to Private Sector	to Gov'ts tax + royalties	**Cost to Cdn** Refineries or Consumers									
Year											**Other**	**GHG (CO2e)**	**Clean Up**	**Envir'nt Damage**	**Clean Up**	**Envir'nt Damage**	**Clean Up**	**Envir'nt Damage**	
		$mill	$mill	$mill	$mill	$mill	$mill	$mill	$mill	$mill	$mill	$mill	$mill	$mill	$mill	$mill	$mill	$mill	$mill
2010		(373)	0	0	1.4	0	0	0	0	0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	(371)
2011		(107)	0	0	0.4	0	0	0	0	0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	(107)
2012		(158)	0	0	0.6	0	0	0	0	0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	(157)
2013		(206)	0	0	0.7	0	0	0	0	0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	(205)
2014		(444)	0	0	1.6	0	0	0	0	0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	(443)
2015		(2,101)	0	0	7.6	0	0	0	0	0	0.00	(4.0)	0.0	0.0	0.0	0.0	0.0	0.0	(2,098)
2016		(3,412)	0	0	12.4	0	0	0	0	0	0.00	(4.0)	0.0	0.0	0.0	0.0	0.0	0.0	(3,403)
2017		(4,112)	0	0	15.0	0	0	0	0	0	0.00	(4.0)	0.0	0.0	0.0	0.0	0.0	0.0	(4,101)
2018		(1,853)	0	0	6.7	0	0	0	0	0	0.00	(4.0)	0.0	0.0	0.0	0.0	0.0	0.0	(1,851)
2019		1,149	59	96	0.8	(588)	0	1,725	905	(499)	(2.77)	(8.0)	(4.8)	(2.1)	(0.6)	(0.5)	(6.8)	(10.2)	2,811
2020		1,312	60	92	0.7	(462)	0	1,703	894	(466)	(2.77)	(8.0)	(4.8)	(2.1)	(0.6)	(0.5)	(6.8)	(10.2)	3,097
2021		1,333	60	88	0.7	(300)	0	1,289	676	(364)	(2.77)	(8.0)	(4.8)	(2.1)	(0.6)	(0.5)	(6.8)	(10.2)	2,749
2022		1,354	61	84	0.7	(150)	0	875	459	(233)	(2.77)	(8.0)	(4.8)	(2.1)	(0.6)	(0.5)	(6.8)	(10.2)	2,414
2023		1,374	62	80	0.7	(74)	0	841	442	(201)	(2.77)	(8.0)	(4.8)	(2.1)	(0.6)	(0.5)	(6.8)	(10.2)	2,488
2024		1,394	62	76	0.7	(80)	0	0	0	0	(2.77)	(8.0)	(4.8)	(2.1)	(0.6)	(0.5)	(6.8)	(10.2)	1,417
2025		1,413	63	72	0.7	(58)	0	0	0	0	(2.77)	(8.0)	(4.8)	(2.1)	(0.6)	(0.5)	(6.8)	(10.2)	1,455
2026		1,433	63	67	0.7	0	0	0	0	0	(2.77)	(8.0)	(4.8)	(2.1)	(0.6)	(0.5)	(6.8)	(10.2)	1,528
2027		1,452	64	62	0.7	0	0	0	0	0	(2.77)	(8.0)	(4.8)	(2.1)	(0.6)	(0.5)	(6.8)	(10.2)	1,543
2028		1,466	65	57	0.7	0	0	0	0	0	(2.77)	(8.0)	(4.8)	(2.1)	(0.6)	(0.5)	(6.8)	(10.2)	1,552
2047		337	78	3	0.7	0	0	0	0	0	(2.77)	(8.0)	(4.8)	(2.1)	(0.6)	(0.5)	(6.8)	(10.2)	383
2048		196	79	1	0.7	0	0	0	0	0	(2.77)	(8.0)	(4.8)	(2.1)	(0.6)	(0.5)	(6.8)	(10.2)	241
SUM		15,849	2,054	1,201	68.4	(1,713)	0	6,433	3,376	(1,763)	(83.2)	(256.0)	(142.8)	(61.8)	(17.0)	(13.9)	(203.8)	(305.7)	24,420
NPV at 2012 at	5.00%	2,052	722	572	44	(1,081)	0	4,036	2,118	(1,110)	(30)	(100)	(52)	(23)	(6)	(5)	(74)	(111)	6,954
NPV at 2012 at	8.00%	(1,053)	427	387	37	(831)	0	3,090	1,622	(851)	(18)	(63)	(31)	(14)	(4)	(3)	(45)	(67)	2,582
NPV at 2012 at	10.00%	(2,194)	311	303	33	(701)	0	2,598	1,364	(717)	(13)	(48)	(23)	(10)	(3)	(2)	(33)	(49)	816
	IRR	6.8%																**IRR**	11.4%
		Note	**Note**	**Note**	**Inputs**	**Inputs**	**Inputs**	**Note**	**Note**	**Note**	**Inputs**	**Inputs**	**Inputs**		**Inputs**		**Inputs**		
		from/to equity	revenues	revenues	Labor as % Costs.	Revenue		to Private	to Fed	to Cdn oil	Prob/yr	Prob/yr	Estimated from		Prob Oil Spill/yr		Prob Oil Spill/yr		
		& Debt of NGP.	to local	to Fed	% Labor would be	Loss		Sector	& Prov	products	hectares	t mill after 2018	Enbridge SQRA		Avge Spill m3		Avge Spill m3		
			Govts	& Prov	unemployed.	on mainline			Govts		Cost $/htare	Cost $/t	Studies		Cost/Spill $/bbl		Cost/Spill $/bbl		
		Cum Net		Govts	16.04%	per ENB		% total	% total		1.00000	1.00000			0.01639	0.01639	0.00400	0.00400	
		Investment			5.00%			65.6%	34.4%		7,700	0.200			250	250	9,000	9,000	
		-12,766									180	20			11,000	9,000	15,000	22,500	

Other notes:

Deflated to Constant Dollars of year		2012		
In COS calculation, general inlfation is		2.00%		
Power costs and Property Taxes escalated separately at		4.00%	and	3.00%
smoothed income taxes and tilted depreciation per NGP				
DCF Avge Toll, at NGP money cost, both pipes		6.40	2012Cdn$/bbl	
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Sensitivity Case 4

Cost/Benefit Analysis for NGP (including Oil and Condensate Pipes & Kitimat Terminals) Real Cdn $2012, Update 2012

Sensitivity Case # 4: Double Costs and Halve Benefits, & only 5 years of Oil Price Uplift & NGP not Needed for Oil Transport until 2024

								Muse Est.												
Included		yes	yes	yes	yes	yes	yes	yes		yes	yes	yes	yes	yes	yes	yes	yes	yes		
Sensiivity Factor		200.0%	100.0%	100.0%	50.0%	200.0%	100.0%	50.0%		50.0%	200.0%	200.0%	200.0%	200.0%	200.0%	200.0%	200.0%	200.0%		
		of Investment						until												
								2023												
											Cost Expectation of		**Cost Expectation of Oil Spills**							
		Direct Cash Flows from Project			**Labor Mkt**	**Cost from**	**No Need**	**Oil Price Uplift**			**Environmental Impacts**		**Onshore Pipes**				**Offshore**			
		NGP	**Local Gov't**	**Fed+Prov Gov't**	**Adjustments**	**Reduced Vol**	**for NGP**	**Gross Revenue Increase**		**Cost to Cdn**			**& Upland Terminal**		**Marine Terminal**		**in Canadian Waters**		**TOTAL**	
Year		**before Interest**	**Property**	**Income**	**labor in**	**on ENB**	**before**	**to Private**	**to Gov'ts**	**Refineries or**	**Other**	**GHG**	**Clean Up**	**Envir'nt**	**Clean Up**	**Envir'nt**	**Clean Up**	**Envir'nt**	**Costs/**	
		after Taxes	**Tax**	**Tax**	**invest + Op costs**	**Mainline**	**2024**	**Sector**	**tax + royalties**	**Consumers**		**(CO2e)**		**Damage**		**Damage**		**Damage**	**Benefits**	
		$mill	$mill	$mill	$mill	$mill	$mill	$mill	$mill	$mill	$mill	$mill	$mill	$mill	$mill	$mill	$mill	$mill	$mill	
2010		(373)	0	0	1.4	0	0	0	0	0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	(371)	
2011		(107)	0	0	0.4	0	0	0	0	0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	(107)	
2012		(158)	0	0	0.6	0	0	0	0	0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	(157)	
2013		(206)	0	0	0.7	0	0	0	0	0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	(205)	
2014		(444)	0	0	1.6	0	0	0	0	0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	(443)	
2015		(2,101)	0	0	7.6	0	0	0	0	0	0.00	(4.0)	0.0	0.0	0.0	0.0	0.0	0.0	(2,098)	
2016		(3,412)	0	0	12.4	0	0	0	0	0	0.00	(4.0)	0.0	0.0	0.0	0.0	0.0	0.0	(3,403)	
2017		(4,112)	0	0	15.0	0	0	0	0	0	0.00	(4.0)	0.0	0.0	0.0	0.0	0.0	0.0	(4,101)	
2018		(1,853)	0	0	6.7	0	0	0	0	0	0.00	(4.0)	0.0	0.0	0.0	0.0	0.0	0.0	(1,851)	
2019		1,149	59	96	0.8	(588)	(1,091)	1,725	905	(499)	(2.77)	(8.0)	(4.8)	(2.1)	(0.6)	(0.5)	(6.8)	(10.2)	1,721	
2020		1,312	60	92	0.7	(462)	(1,111)	1,703	894	(466)	(2.77)	(8.0)	(4.8)	(2.1)	(0.6)	(0.5)	(6.8)	(10.2)	1,985	
2021		1,333	60	88	0.7	(300)	(1,125)	1,289	676	(364)	(2.77)	(8.0)	(4.8)	(2.1)	(0.6)	(0.5)	(6.8)	(10.2)	1,624	
2022		1,354	61	84	0.7	(150)	(1,138)	875	459	(233)	(2.77)	(8.0)	(4.8)	(2.1)	(0.6)	(0.5)	(6.8)	(10.2)	1,277	
2023		1,374	62	80	0.7	(74)	(1,150)	841	442	(201)	(2.77)	(8.0)	(4.8)	(2.1)	(0.6)	(0.5)	(6.8)	(10.2)	1,337	
2024		1,394	62	76	0.7	(80)	0	0	0	0	(2.77)	(8.0)	(4.8)	(2.1)	(0.6)	(0.5)	(6.8)	(10.2)	1,417	
2025		1,413	63	72	0.7	(58)	0	0	0	0	(2.77)	(8.0)	(4.8)	(2.1)	(0.6)	(0.5)	(6.8)	(10.2)	1,455	
2026		1,433	63	67	0.7	0	0	0	0	0	(2.77)	(8.0)	(4.8)	(2.1)	(0.6)	(0.5)	(6.8)	(10.2)	1,528	
2027		1,452	64	62	0.7	0	0	0	0	0	(2.77)	(8.0)	(4.8)	(2.1)	(0.6)	(0.5)	(6.8)	(10.2)	1,543	
2028		1,466	65	57	0.7	0	0	0	0	0	(2.77)	(8.0)	(4.8)	(2.1)	(0.6)	(0.5)	(6.8)	(10.2)	1,552	
2047		337	78	3	0.7	0	0	0	0	0	(2.77)	(8.0)	(4.8)	(2.1)	(0.6)	(0.5)	(6.8)	(10.2)	383	
2048		196	79	1	0.7	0	0	0	0	0	(2.77)	(8.0)	(4.8)	(2.1)	(0.6)	(0.5)	(6.8)	(10.2)	241	
SUM		15,849	2,054	1,201	68.4	(1,713)	(5,615)	6,433	3,376	(1,763)	(83.2)	(256.0)	(142.8)	(61.8)	(17.0)	(13.9)	(203.8)	(305.7)	18,805	
NPV at 2012 at	5.00%	2,052	722	572	44	(1,081)	(3,451)	4,036	2,118	(1,110)	(30)	(100)	(52)	(23)	(6)	(5)	(74)	(111)	3,503	
NPV at 2012 at	8.00%	(1,053)	427	387	37	(831)	(2,611)	3,090	1,622	(851)	(18)	(63)	(31)	(14)	(4)	(3)	(45)	(67)	(29)	
NPV at 2012 at	10.00%	(2,194)	311	303	33	(701)	(2,179)	2,598	1,364	(717)	(13)	(48)	(23)	(10)	(3)	(2)	(33)	(49)	(1,363)	
	IRR	6.8%																**IRR**	8.0%	
		Note	**Note**	**Note**	**Inputs**	**Inputs**	**Inputs**	**Note**	**Note**	**Note**	**Inputs**	**Inputs**	**Inputs**		**Inputs**		**Inputs**			
		from/to equity	revenues	revenues	Labor as % Costs.	Revenue	Minus NGP	to Private	to Fed	to Cdn oil	Prob/yr	Prob/yr	Estimated from		Prob Oil Spill/yr		Prob Oil Spill/yr			
		& Debt of NGP.	to local	to Fed	% Labor would be	Loss	oil revs	Sector	& Prov	products	hectares	t mill after 2018	Enbridge SQRA		Avge Spill m3		Avge Spill m3			
			Gov'ts	& Prov	unemployed.	on mainline	before		Gov'ts		Cost $/htare	Cost $/t	Studies		Cost/Spill $/bbl		Cost/Spill $/bbl			
		Cum Net		Gov'ts	16.04%	per ENB	2024	% total	% total		1.00000	1.00000			0.01639	0.01639	0.00400	0.00400		
		Investment			5.00%			65.6%	34.4%		7,700	0.200			250	250	9,000	9,000		
		-12,766									180	20			11,000	9,000	15,000	22,500		
Other notes:																				
Deflated to Constant Dollars of year				2012																
In COS calculation, general inlfation is				2.00%																
Power costs and Property Taxes escalated separately at				4.00%	and	3.00%														
smoothed income taxes and tilted depreciation per NGP																				
DCF Avge Toll, at NGP money cost, both pipes				6.40	2012Cdn$/bbl															
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Sensitivity Case 5

Cost/Benefit Analysis for NGP (including Oil and Condensate Pipes & Kitimat Terminals) Real Cdn $2012, Update 2012

Sensitivity Case # 5: Oil Spill Costs set high enough to offset all other benefits in Base Case (NPV8=0)

								Muse Est.											
Included		yes	yes	yes	yes	yes		yes		yes	yes	yes	yes	yes	yes	yes	yes	yes	
Sensiivity Factor		100.0%	100.0%	100.0%	100.0%	100.0%		100.0%		100.0%	100.0%	100.0%	28952.0%	28952.0%	28952.0%	28952.0%	28952.0%	28952.0%	
		of Investment						until											
								2048											
											Cost Expectation of Environmental Impacts		**Cost Expectation of Oil Spills**						
		Direct Cash Flows from Project			**Labor Mkt Adjustments**	**Cost from Reduced Vol on ENB Mainline**	**NGP always Needed**	**Oil Price Uplift**					**Onshore Pipes & Upland Terminal**		**Marine Terminal**		**Offshore in Canadian Waters**		**TOTAL Costs/ Benefits**
		NGP before Interest after Taxes	**Local Gov't** Property Tax	**Fed+Prov Gov't** Income Tax	labor in invest + Op costs			**Gross Revenue Increase** to Private Sector	to Gov'ts tax + royalties	**Cost to Cdn** Refineries or Consumers									
Year											**Other**	**GHG (CO2e)**	**Clean Up**	**Envir'nt Damage**	**Clean Up**	**Envir'nt Damage**	**Clean Up**	**Envir'nt Damage**	
		$mill	$mill	$mill	$mill	$mill	$mill	$mill	$mill	$mill	$mill	$mill	$mill	$mill	$mill	$mill	$mill	$mill	$mill
2010		(186)	0	0	1.4	0	0	0	0	0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	(185)
2011		(54)	0	0	0.4	0	0	0	0	0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	(53)
2012		(79)	0	0	0.6	0	0	0	0	0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	(78)
2013		(103)	0	0	0.7	0	0	0	0	0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	(102)
2014		(222)	0	0	1.6	0	0	0	0	0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	(221)
2015		(1,051)	0	0	7.6	0	0	0	0	0	0.00	(2.0)	0.0	0.0	0.0	0.0	0.0	0.0	(1,045)
2016		(1,706)	0	0	12.4	0	0	0	0	0	0.00	(2.0)	0.0	0.0	0.0	0.0	0.0	0.0	(1,695)
2017		(2,056)	0	0	15.0	0	0	0	0	0	0.00	(2.0)	0.0	0.0	0.0	0.0	0.0	0.0	(2,043)
2018		(927)	0	0	6.7	0	0	0	0	0	0.00	(2.0)	0.0	0.0	0.0	0.0	0.0	0.0	(922)
2019		571	59	96	1.5	(294)	0	3,450	1,810	(999)	(1.39)	(4.0)	(689.1)	(298.2)	(82.1)	(67.2)	(983.4)	(1,475.1)	1,094
2020		656	60	92	1.5	(231)	0	3,405	1,787	(931)	(1.39)	(4.0)	(689.1)	(298.2)	(82.1)	(67.2)	(983.4)	(1,475.1)	1,239
2021		667	60	88	1.5	(150)	0	2,578	1,353	(728)	(1.39)	(4.0)	(689.1)	(298.2)	(82.1)	(67.2)	(983.4)	(1,475.1)	270
2022		677	61	84	1.5	(75)	0	1,749	918	(466)	(1.39)	(4.0)	(689.1)	(298.2)	(82.1)	(67.2)	(983.4)	(1,475.1)	(650)
2023		687	62	80	1.5	(37)	0	1,683	883	(403)	(1.39)	(4.0)	(689.1)	(298.2)	(82.1)	(67.2)	(983.4)	(1,475.1)	(644)
2024		697	62	76	1.5	(40)	0	2,648	1,389	(628)	(1.39)	(4.0)	(689.1)	(298.2)	(82.1)	(67.2)	(983.4)	(1,475.1)	605
2025		707	63	72	1.5	(29)	0	2,696	1,415	(596)	(1.39)	(4.0)	(689.1)	(298.2)	(82.1)	(67.2)	(983.4)	(1,475.1)	728
2026		717	63	67	1.5	0	0	2,659	1,395	(560)	(1.39)	(4.0)	(689.1)	(298.2)	(82.1)	(67.2)	(983.4)	(1,475.1)	742
2027		727	64	62	1.5	0	0	2,958	1,552	(550)	(1.39)	(4.0)	(689.1)	(298.2)	(82.1)	(67.2)	(983.4)	(1,475.1)	1,213
2028		733	65	57	1.5	0	0	2,556	1,341	(469)	(1.39)	(4.0)	(689.1)	(298.2)	(82.1)	(67.2)	(983.4)	(1,475.1)	683
2047		169	78	3	1.5	0	0	2,988	1,568	(295)	(1.39)	(4.0)	(689.1)	(298.2)	(82.1)	(67.2)	(983.4)	(1,475.1)	911
2048		98	79	1	1.5	0	0	2,988	1,568	(295)	(1.39)	(4.0)	(689.1)	(298.2)	(82.1)	(67.2)	(983.4)	(1,475.1)	839
SUM		7,927	2,054	1,201	90.2	(857)	0	83,574	43,856	(12,626)	(41.6)	(128.0)	(20,671.7)	(8,946.2)	(2,462.9)	(2,015.1)	(29,501.5)	(44,252.3)	17,201
NPV at 2012 at	5.00%	1,027	722	572	52	(541)	0	29,878	15,679	(5,342)	(15)	(50)	(7,528)	(3,258)	(897)	(734)	(10,743)	(16,115)	2,708
NPV at 2012 at	8.00%	(527)	427	387	41	(416)	0	17,851	9,367	(3,476)	(9)	(32)	(4,526)	(1,959)	(539)	(441)	(6,460)	(9,689)	(0)
NPV at 2012 at	10.00%	(1,097)	311	303	36	(350)	0	13,118	6,884	(2,681)	(7)	(24)	(3,333)	(1,443)	(397)	(325)	(4,757)	(7,136)	(898)
	IRR	6.8%																**IRR**	8.0%
		Note	**Note**	**Note**	**Inputs**	**Inputs**	**Inputs**	**Note**	**Note**	**Note**	**Inputs**	**Inputs**	**Inputs**		**Inputs**		**Inputs**		
		from/to equity	revenues	revenues	Labor as % Costs.	Revenue		to Private	to Fed	to Cdn oil	Prob/yr	Prob/yr	Estimated from		Prob Oil Spill/yr		Prob Oil Spill/yr		
		& Debt of NGP.	to local	to Fed	% Labor would be	Loss		Sector	& Prov	products	hectares	t mill after 2018	Enbridge SQRA		Avge Spill m3		Avge Spill m3		
			Gov'ts	& Prov	unemployed.	on mainline			Gov'ts		Cost $/htare	Cost $/t	Studies		Cost/Spill $/bbl		Cost/Spill $/bbl		
		Cum Net		Gov'ts	16.93%	per ENB		% total	% total		1.00000	1.00000			0.01639	0.01639	0.00400	0.00400	
		Investment			5.00%			65.6%	34.4%		7,700	0.200			250	250	9,000	9,000	
		-6,383									180	20			11,000	9,000	15,000	22,500	
Other notes:																			
Deflated to Constant Dollars of year				2012															
In COS calculation, general inlfation is				2.00%															
Power costs and Property Taxes escalated separately at				4.00%	and	3.00%													
smoothed income taxes and tilted depreciation per NGP																			
DCF Avge Toll, at NGP money cost, both pipes				3.98	2012Cdn$/bbl														
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