



**Mackenzie Valley** Environmental Impact Review Board

June 30, 2003

Kenneth Vollman  
Chairman  
National Energy Board  
444 Seventh Avenue S.W.  
Calgary Alberta

*Ken*  
Dear Mr. Vollman:

Re: **WesternGeco Mackenzie Delta and Mackenzie River 2-D Seismic Projects – 2003 Report of Environmental Assessment**

The Review Board is pleased to submit the attached Report of Environmental Assessment on the WesternGeco Mackenzie and Liard Rivers 2D Seismic Program.

This report concludes the Review Board's Environmental Assessment of this development and has been completed on schedule and in keeping with the original work plan and terms of reference developed by the Board for this assessment.

Sincerely,

*T. Burlingame*  
Todd Burlingame  
Chairman

Cc: The Honourable Robert D. Nault, P.C. M.P.  
Minister, Indian and Northern Affairs Canada

Robert Hornal, Chairman  
Environmental Impact Review Board  
Inuvialuit Settlement Region

Attachment



**Mackenzie Valley** Environmental Impact Review Board

June 30, 2003

The Honourable Robert D. Nault, P.C. M.P.  
Minister, Indian and Northern Affairs Canada  
10 Wellington Street, North Tower  
Hull, P.Q., K1A 0H4

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A handwritten signature in black ink, appearing to read "T. Burlingame".

Todd Burlingame  
Chairman

Cc: Ken Vollman, Chairman  
National Energy Board

Robert Hornal, Chairman  
Environmental Impact Review Board  
Inuvialuit Settlement Region

Attachment

Mackenzie Valley Environmental Impact Review Board  
Report of Environmental Assessment  
On the  
WesternGeco  
Mackenzie and Liard Rivers 2D Seismic Program

June 30<sup>th</sup>, 2003

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*Report of Environmental Assessment  
WesternGeco Mackenzie and Liard Rivers 2D Seismic Program  
June 30th, 2003*

## Executive Summary

The Mackenzie Valley Environmental Impact Review Board (Review Board) has been guided by the principles outlined in s. 114 and s. 115 of the *Mackenzie Valley Resource Management Act* (MVRMA or Act) throughout this environmental assessment. These principles are to protect the environment from significant adverse impacts, and to protect the social, cultural and economic well being of residents and communities in the Mackenzie Valley.

Having considered the views and concerns of the participants in this process, and the evidence on the Public Registry, the Review Board made its decisions according to s. 128 of the MVRMA.

The developer, WesternGeco Ltd., proposes to conduct a river seismic survey using 1500 in.<sup>3</sup> for a length of approximately 1500km along the Mackenzie and Liard Rivers. This development will be conducted entirely on the water.

The NEB and DFO referred the development to the Review Board because information gaps about the impacts of air guns led them to conclude that the project might cause significant adverse environmental impacts. To fill some of these gaps, WesternGeco conducted field studies on what the noise will do in the river, the physical effects of air guns on fish, the effects of air guns on fish movements, and the effects of air guns on wildlife. Some of the impacts of the proposed development were assessed as follows:

- WesternGeco conducted a literature review on the effects of air guns on fish, and original field research. It concluded that the project would not cause physical harm to fish or affect their movements. Various parties to the environmental assessment and the expert advisor to the Review Board identified several problems with the research that was conducted on fish. The studies are insufficient to determine whether or not the air guns will harm fish. However, the Review Board notes that the exposure to air guns from this development will be brief and intermittent. The Review Board finds that this project may have a significant impact on fish, but that this impact can be prevented with certain mitigation measures. These include a program for monitoring, evaluation and management, designed cooperatively with, and supervised by, the Department of Fisheries and Oceans. The Review Board also recommends that WesternGeco submit a mitigation plan for the approval of the Department of Fisheries and Oceans. This plan will include unconditional shutdown or the air guns within one kilometer of sensitive areas.
- WesternGeco's acoustic studies have helped to clarify how sound from the air guns will behave in the river.
- WesternGeco predicts no significant impacts on birds, terrestrial mammals or semi-aquatic furbearers (such as beaver, muskrat, mink and otter). The wildlife study also showed, to the Review Board's satisfaction, that the project will not have a serious impact on wildlife if certain mitigation measures are used. WesternGeco will have a

scout boat ahead of the survey, and if any mammals are spotted in the river, the air guns will shut down within one kilometer.

- WesternGeco has proposed to avoid disrupting harvesting and damaging fishing equipment. If they do cause these problems, processes in the Gwich'in and Sahtu land claims will be followed to compensate residents. The Review Board recommends that harvesters in the Deh Cho receive the same mitigative measure. If the project causes reductions in fish catch levels, then WesternGeco will compensate harvesters in the manner described in the land claims for the Sahtu and Gwichin areas, and in a similar manner for Deh Cho harvesters.
- WesternGeco and the Review Board agree that the socio-economic benefits of this development are of low significance. The development offers few employment opportunities, and these occur only over a relatively short period.
- The Deh Cho First Nations have stated that the Mackenzie River is of great spiritual significance, and that this development will cause significant impacts to the spiritual well being of the Dene and Metis people of the Deh Cho region. The Review Board suggests that Deh Cho First Nations produce a protocol regarding spiritually acceptable activities on the Mackenzie River, to inform land use plans and decision makers in the future.

Based on the evidence on the public record, the Review Board finds there may be significant adverse environmental impact on fish, wildlife, and harvesting as a result of this development. The Review Board has therefore made recommendations to mitigate these impacts.

# Table of Contents

<b>1</b>	<b>INTRODUCTION</b> .....	<b>1</b>
<b>2</b>	<b>DEVELOPMENT DESCRIPTION</b> .....	<b>2</b>
<b>3</b>	<b>SETTING OF THE PROPOSED DEVELOPMENT</b> .....	<b>4</b>
<b>4</b>	<b>REGULATORY HISTORY OF THE PROPOSED DEVELOPMENT</b> .....	<b>5</b>
<b>5</b>	<b>ENVIRONMENTAL ASSESSMENT PROCESS TO DATE</b> .....	<b>6</b>
5.1	SCOPING PROCESS .....	6
5.2	ADJOURNMENT OF EA .....	8
5.3	WORK PLAN AND TERMS OF REFERENCE .....	8
5.4	CONFORMITY REVIEW .....	9
5.5	TECHNICAL REVIEW .....	9
5.6	DEVELOPMENT IMPACT BOUNDARIES .....	10
5.7	DETERMINING SIGNIFICANCE .....	10
<b>6</b>	<b>PREAMBLE TO ASSESSMENT OF IMPACTS</b> .....	<b>12</b>
<b>7</b>	<b>NOISE ATTENUATION</b> .....	<b>13</b>
7.1	WESTERNGECO'S SUBMISSIONS .....	13
7.2	CONCLUSIONS OF THE REVIEW BOARD .....	14
<b>8</b>	<b>IMPACTS ON WILDLIFE</b> .....	<b>15</b>
8.1	WESTERNGECO'S SUBMISSIONS .....	15
8.2	OTHER SUBMISSIONS .....	17
8.3	CONCLUSIONS .....	17
8.4	SUGGESTIONS .....	17
<b>9</b>	<b>IMPACTS ON FISH</b> .....	<b>19</b>
9.1	WESTERNGECO'S SUBMISSIONS ON PHYSICAL IMPACTS TO FISH .....	20
9.2	OTHER SUBMISSIONS ON PHYSICAL IMPACTS TO FISH .....	22
9.3	WESTERNGECO'S SUBMISSIONS ON IMPACTS ON FISH EGGS, LARVAE AND JUVENILES .....	25
9.4	OTHER SUBMISSIONS ON IMPACTS ON FISH EGGS, LARVAE AND JUVENILES .....	26
9.5	EFFECTS ON FISH MOVEMENTS .....	27
9.6	WESTERNGECO'S SUBMISIONS ON IMPACTS TO FISH MOVEMENTS .....	28
9.7	OTHER SUBMISSIONS ON IMPACTS TO FISH MOVEMENTS .....	30
9.8	OTHER SUBMISSIONS ON IMPACTS TO FISH (GENERAL) .....	32
9.9	CONCLUSIONS OF THE REVIEW BOARD .....	34
9.10	RECOMMENDATIONS AND SUGGESTIONS .....	36
<b>10</b>	<b>IMPACTS ON HARVESTING</b> .....	<b>38</b>
10.1	WESTERNGECO'S SUBMISSION .....	38
10.2	OTHER SUBMISSIONS .....	40
10.3	CONCLUSIONS OF THE REVIEW BOARD .....	40
10.4	RECOMMENDATIONS .....	41
<b>11</b>	<b>SOCIO-ECONOMIC IMPACTS</b> .....	<b>42</b>

11.1	WESTERNGECO'S SUBMISSION.....	42
11.2	CONCLUSIONS OF THE REVIEW BOARD.....	42
<b>12</b>	<b>SPIRITUAL IMPACTS IN THE DEH CHO REGION.....</b>	<b>43</b>
12.1	WESTERNGECO'S SUBMISSION.....	43
12.2	OTHER SUBMISSIONS.....	43
12.3	CONCLUSIONS OF THE REVIEW BOARD.....	45
12.4	SUGGESTIONS.....	45
<b>13</b>	<b>CUMULATIVE IMPACTS.....</b>	<b>46</b>
13.1	WESTERNGECO'S SUBMISSION.....	46
13.2	CONCLUSIONS OF THE REVIEW BOARD.....	47
<b>14</b>	<b>PUBLIC CONSULTATION.....</b>	<b>48</b>
14.1	WESTERNGECO'S SUBMISSION.....	48
14.2	OTHER SUBMISSIONS.....	48
14.3	CONCLUSIONS OF THE REVIEW BOARD.....	49
<b>15</b>	<b>FINAL CONCLUSIONS.....</b>	<b>50</b>
	<b>APPENDIX 1.....</b>	<b>51</b>
	<b>APPENDIX 2.....</b>	<b>52</b>
	<b>APPENDIX 3.....</b>	<b>53</b>
	<b>APPENDIX 4.....</b>	<b>55</b>
	<b>APPENDIX 5.....</b>	<b>60</b>

# 1 Introduction

This document is the Mackenzie Valleys Environmental Impact Review Board's *Report of Environmental Assessment*, produced for the WesternGeco Mackenzie and Liard Rivers 2D Seismic Program 2004 (originally 2003). This report is produced as per s.128(2)(b) of the Mackenzie Valley Resource Management Act.

This document briefly describes the proposed development and its environmental setting. It summarizes the development's regulatory history and environmental assessment process to date. Individual impacts are then assessed based on the information on the public record, and the Review Board's conclusions are described. Where appropriate, the Review Board makes recommendations and suggestions.



## 2 Development Description

A regional 2D seismic development in the Mackenzie and Liard Rivers in the summer of 2003 is proposed by WesternGeco. WesternGeco is a joint venture of Schlumberger and Baker Hughes based in Calgary, Alberta. The seismic program will encompass the Mackenzie River from the Gwich'in Settlement Area/Inuvialuit Settlement Region boundary to the confluence of the Liard River and from the confluence with the Mackenzie River to the British Columbia border. The proposed undertaking is continuous with a 2D seismic program extending north along the Mackenzie River to Shallow Bay in the Inuvialuit Settlement Region. The total length of the proposed development in the Mackenzie Valley is approximately 1500 km.

This development will look for gas deposits below the Mackenzie River by sending powerful sound signals downwards through the river and the ground beneath, and recording how they are reflected back. The acoustic energy generated by the air guns radiates into the subsurface, and part of the energy will be reflected back from the subsurface to the recording devices. The sound energy reflected back from the subsurface is recorded using streamers towed behind the source vessel.

The proposed development is ship-based, using the vessel Henry C. with a barge. Northwest Transportation Company Limited (NTCL) will provide the seismic vessels and crews. Although originally proposed with two main vessels, the results of the field testing showed a seismic data problem related to signal interference that was resolved by using only one main seismic vessel.

The Henry C will tow an air gun array and a streamer cable with hydrophones. The 1500 in<sup>3</sup> sleeve gun array consists of two 750 in<sup>3</sup> subarrays, 12m apart, operating at a pressure of 2000 psi. Each subarray is comprised of two gun clusters of two guns, and four single guns. Based on the project description, the Review Board estimates that WesternGeco proposed to fire the air guns approximately 72,500 times, about once every 20 m, or every nine to ten seconds during the survey operation.

The Henry C will also tow one streamer approximately 100 m behind the vessel to record seismic data. The hydrophones that record the reflected energy occur in groups within the streamer. There are 14 hydrophones per group with a group length of 17.7 m. A total of 160 hydrophone groups are at 12.5 m intervals along the streamer. Depth transducers maintain streamers at depth.

Each time the array is put into operation, WesternGeco proposes to "ramp-up", by slowly increasing the volume from a low setting to the operational level instead of starting out at full intensity. This is intended as a mitigation to provide fish and wildlife time to move away from the air guns.

The program will be conducted on the Liard River first, moving upstream from its mouth to the British Columbia border. Then the ship will relocate to the Inuvialuit Settlement Region boundary and conduct the program again upstream on the Mackenzie River moving north to south. The projected schedule has WesternGeco mobilizing the boats in Hay River from June 9<sup>th</sup> to June 14<sup>th</sup>, conducting the Liard River seismic work from June 14<sup>th</sup> to June 21<sup>st</sup>,

then moving down to the Inuvialuit Settlement Region border by the 24<sup>th</sup>, and heading upstream on the Mackenzie until August 9<sup>th</sup>. Upon completion of the proposed development, the Henry C will proceed to the Mackenzie Delta to complete a similar project there. The development is currently planned for 2004.

Clean-up, reclamation, disposal and abandonment will not be required for this water based program. Prevention of spills and leaks will be the principle form of mitigation and the Emergency Response Plan will be implemented, if required. Waste disposal from the vessels would be conducted in accordance with NTCL approved procedures or WesternGeco operating standards, whichever is more stringent.

### 3 Setting of the Proposed Development

The proposed development for this environmental assessment includes the length of the Mackenzie River from the southern boundary of the Inuvialuit Settlement Region to the confluence with the Liard River near Fort Simpson. There are twelve communities along the Mackenzie and Liard Rivers within the development area. These are Inuvik, Aklavik, Fort McPherson, Tsiigehtchic, Fort Good Hope, Norman Wells, Tulita, Wrigley, Fort Simpson, Jean Marie River, Nahanni Butte and Fort Liard.

The Mackenzie River runs approximately 1,700 km from Great Slave Lake into the Beaufort Sea. Its watershed covers roughly 1.8 million km<sup>2</sup>, draining one fifth of Canada. With the exception of the Sans Sault and the Ramparts rapids between Norman Wells and Fort Good Hope the Mackenzie is a flat water river. It averages about 2 km in width but narrows to less than 0.5 km below the Ramparts at Fort Good Hope and widens to over 4 km at other places. The river generally carries a high sediment load and sand bars limit barges and large boats to a shipping channel marked by the Canadian Coast Guard. The Mackenzie River usually freezes up in November, starting that the arctic coast. Break up occurs around mid May at the southern end and in early June in the north. The barge operating season extends from mid to late June until October.

The Mackenzie River is an important migration route for several fish species. Anadromous species including arctic cisco, broad whitefish, chum salmon, and inconnu begin to migrate in late summer and fall. Some resident species spawn in spring or early summer, including emerald shiner, northern pike, and walleye (pickerel). Spawning generally occurs in tributaries, not the Mackenzie River itself. The Mackenzie Valley is an important migration route for birds, particularly waterfowl. The spring migration generally coincides with break up. Only the fall migration overlaps with the shipping season. There are various staging and feeding areas for migratory birds along the river. Mammals commonly seen along the river include black bear, moose, beaver, and muskrat.

The Liard River's headwaters are in the southern Yukon from where the river flows through northern British Columbia and back north into the Mackenzie River in the NWT. The South Nahanni River is a major tributary to the Liard. The Liard empties a high sediment load into the Mackenzie; in spring or after rainstorms it also adds large amounts of woody debris. Compared to the Mackenzie River the Liard is shallow and only a portion of it is navigable by barge. Like the Mackenzie, it provides habitat for a number of fish species, mammals and migratory birds. The proposed seismic program involves the Liard from its mouth at Fort Simpson to the British Columbia border.

## 4 Regulatory History of the Proposed Development

On May 2<sup>nd</sup>, 2002, WesternGeco applied to the National Energy Board (NEB) for a Geophysical Operation Authorization for a river seismic program in the Mackenzie and Liard Rivers for June to August 2002. The proposed undertaking included river seismic for the Mackenzie River from south of the Inuvialuit Settlement Region / Gwich'in Settlement Area border to Fort Simpson and for the Liard River from the confluence with the Mackenzie River to the Northwest Territories/British Columbia border, a distance totaling approximately 1,800 km in length.

A preliminary screening of the proposed development was initiated on May 2, 2002 in accordance with the MVRMA. On June 24, 2002 the NEB and the Department of Fisheries and Oceans (DFO) jointly referred the development proposal to the Review Board<sup>1</sup>, in accordance with ss.125(1) of the MVRMA, citing the following reasons for the referral:

*The development might have significant adverse impact on the environment.*

The potential for a significant adverse impact was based upon the magnitude of the development and information gaps regarding:

- *acoustic output and attenuation of the seismic energy source;*
- *behavioral impacts of the seismic energy source on fish and freshwater mammals;*
- *physiological impacts of the seismic energy source on fish and freshwater mammals;*  
*and*
- *effectiveness of proposed mitigation measures.*

In the letter of referral, NEB and DFO noted that the company had proposed to do a test study to address information gaps.

By a letter dated June 28, 2002, the Review Board formally notified regulatory bodies of the referral and initiated work planning for the environmental assessment. Because the proposed activity by WesternGeco crosses from the Mackenzie Valley into the Inuvialuit Settlement Region, it had been evaluated by the Inuvialuit Environmental Impact Screening Committee and referred to the Inuvialuit Environmental Impact Review Board for a Public Review as per the Inuvialuit Final Agreement. WesternGeco originally proposed the Inuvialuit and Mackenzie Valley portions as a single project. Both the MVEIRB and the Inuvialuit Environmental Impact Review Board recognized certain advantages to collaboration, since this was one developer proposing to do the same work on the same river in the same season. Procedural difficulties in combining the processes resulted in the two boards conducting separate reviews on the portions of the development in their respective settlement areas.

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<sup>1</sup> The Review Board is responsible for the assessment of the environmental, socio-economic and cultural impacts of the proposed development according to Part 5 of the *Mackenzie Valley Resource Management Act*. The Review Board is required by s.126 of the MVRMA to conduct an EA of the development proposal and must conduct the EA in accordance with ss. 117(2). The Review Board is also required to prepare and submit its report of environmental assessment in accordance with ss.128(2), a decision under ss.128(1), and written reasons, required by s.121, to the Federal Minister of Indian and Northern Affairs Canada (INAC) and the Designated Regulatory Agency (the National Energy Board).

## 5 Environmental Assessment Process to Date

### 5.1 SCOPING PROCESS

The Review Board must determine the scope of the development pursuant to s.117(1) of the Mackenzie Valley Resource Management Act. The Board must also determine the scope of the environmental assessment. The Review Board made these determinations on the basis of comments submitted during the development of the Work Plan and Terms of Reference for the EA.

#### 5.1.1 *Scope of Development*

The scope of the development includes those components of the proposed development that will be included for consideration in the environmental assessment. The scope of development takes into account the principal and accessory development activities.

The Review Board identified the principal development activities to be:

- Operations on land will be limited to existing docking and re-fueling stations;
- Two push boats will be used as the source and source/recording vessels;
- Both push boats will be pushing barges to house equipment and crew;
- The source vessel will travel approximately 2 km ahead of the source/recording vessel;
- A 1,500 in<sup>3</sup> sleevegun array will be towed behind each vessel at a depth of 2.5 m.;
- Each sleevegun array will be consists of two 750 in<sup>3</sup> subarrays that operate at an air pressure of 2000 PSI;
- Each subarray is comprised of two two-gun clusters and four single guns;
- Each sub-array is separated by 12 m;
- A computer-based system will be used to control firing of the air guns;
- Air guns will be fired at linear intervals of 15 to 20 m, alternating from the source vessel to the source/recording vessel, or approximately every 8 seconds;
- A solid, 600 to 2,000 m long streamer that houses hydrophones for measuring acoustic pressure;
- There will be up to 160 hydrophone groups (14 hydrophones per group) placed at 12.5 m long intervals along the streamer;
- The streamer will be used in water that is 2 m or deeper;
- Surveying will occur in an upstream direction; and
- Surveying speed is approximately 4.5 to 5 knots in the water or 0.5 to 2 knots over river bottom.

Accessory development activities include:

- Marine services (provided by contractor Northern Transportation Company Limited (NTCL));
- Collection of domestic waste (source/recorder vessel is equipped with crew accommodation, a galley, and a mess hall);
- Sewage and gray water (handled as per regulations for other NTCL vessels); and
- Fuel supply and refueling procedures.

WesternGeco reduced the scale of their program from two push boats operating as a source vessel and a source/recording vessel to a single push boat as a source/recording vessel.

### *5.1.2 Scope of Assessment*

Scope of assessment covers the components of the environment that will be evaluated for impacts from the proposed development. In determining the scope of assessment, the Review Board was conscious of its obligation under ss.117(2) of the MVRMA to consider:

- the impact of the development on the environment including the impacts of malfunctions or accidents,
- any cumulative effects that are likely to result from the development in combination with other developments, and
- comments submitted by members of the public.

After considering the information placed on the public registry, the Review Board decided on the following scope of assessment:

#### ***Physical and Biological Environment***

- Water Quality
- Aquatic Resources and Habitat
- Wildlife and Wildlife Habitat
- Noise

#### ***Human Environment***

- Cultural and Heritage Resources
- Social and Economic Matters
- Land and Resource Use

#### ***Cumulative Impacts***

- Natural Environment
- Social, Economic and Cultural Environment

#### ***Other Relevant Matters***

- Description of the Development
- Developer Identification and Performance Record
- Regulatory Regime
- Environmental Assessment Methodology
- Public Consultation
- Effects of the Environment on the Development
- Accidents and Malfunctions

- Alternatives to Parts of the Development
- Abandonment and Restoration
- Environmental Protection Plan

## **5.2 ADJOURNMENT OF EA**

On July 26, 2002, WesternGeco requested that the EA for the Mackenzie River 2D Seismic Development be adjourned subject to completion of the 2002 Test Program. The Review Board formally adjourned the EA on August 23<sup>rd</sup>, 2002. In July and August of 2002, WesternGeco consulted on, designed and implemented the 2002 Test Program to address key information gaps in consultation with NEB and DFO. WesternGeco conducted tests on characteristics of air gun noise in a river setting and on the effects of air guns on fish. It also monitored wildlife, looking at encounter rates and changes in behaviour. Upon completion of the study, the results were provided to the Review Board.

## **5.3 WORK PLAN AND TERMS OF REFERENCE**

The Review Board issued a draft Work Plan and draft Terms of Reference for the environmental assessment for public comment on the timeline, scope of development, scope of assessment and directions to WesternGeco on December 19, 2002. The documents were placed on the Review Board's public registry and web site. They were also circulated to the Review Board's distribution list for this environmental assessment.<sup>2</sup>

The consultation period on the draft documents was from December 19, 2002 to January 23, 2003. WesternGeco, Fisheries and Oceans Canada, Indian and Northern Affairs Canada, Deh Cho First Nations and Dr. Aurthur Popper (expert advisor to the Review Board) provided comments on the draft Terms of Reference and Workplan.

Fisheries and Oceans Canada and Dr. Aurthur Popper submitted critiques of the *Behavioural and Physical Response of Fish to Air guns* report submitted from the 2002 Test Program. The Review Board considered all comments received and available information before issuing the final Work Plan and final Terms of Reference on January 27, 2003. The Work Plan

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<sup>2</sup> The distribution list for this environmental assessment included WesternGeco, Golder Associates, the Dene Nation, the Deh Cho First Nations, the Acho Dene Koe, the Fort Liard Métis Local #67, the Hamlet of Fort Liard, the Nahanni Butte First Nations, the Jean Marie River First Nation, the Liidlii Kue First Nation, the Fort Simpson Metis Local #52, the Village of Fort Simpson, the Pehdzeh Ki First Nation, the Sahtu Secretariat Inc., the Sahtu Dene Council, the Tulita Dene Band, the Fort Norman Metis Land Corporation, the Tulita Land and Financial Corporation, the Hamlet of Tulita, the Sahtu Renewable Resources Board, the Ernie MacDonald Land Corporation, the Town of Norman Wells, the K'ahsho Got'ine Community Council, Fort Good Hope Metis Land Corporation, Xahweguweh Yamoga Corporation, Sahtu Land and Water Board, Gwich'in Tribal Council, Gwichya Gwich'in Council/Charter Community of Tsiigehtchic, Tetlit Gwich'in Council, Hamlet of Fort MacPherson, Aklavik Indian Band, Hamlet of Aklavik, Nihtat Gwich'in Council Town of Inuvik, Gwich'in Renewable Resource Board, Environmental Impact Screening Committee, Environmental Impact Review Board, Government of the Northwest Territories, Environment Canada, Fisheries and Oceans Canada, Natural Resources Canada, Indian and Northern Affairs Canada, National Energy Board, Transport Canada, Canadian Parks and Wilderness Society, World Wildlife Fund, and Lornel Consultants.

established the milestone dates and identified the Review Board's expectations for the completion of the environmental assessment. The Terms of Reference described the scope of development and scope of assessment and provided directions to WesternGeco and others regarding their roles, responsibilities and deliverables in the remaining EA process.

#### **5.4 CONFORMITY REVIEW**

WesternGeco completed its developer's assessment report on the basis of the final ToR and filed the report with the Review Board on February 17, 2003. The Review Board undertook a conformity review to ensure that WesternGeco had provided the information requested in the Terms of Reference. March 4, 2003, the Review Board issued a deficiency statement citing lack of information about:

- expected channel depths;
- types and amounts of hazardous materials stored on the barge;
- acoustic field studies undertaken during 2002 and the importance of substrate type;
- potential impacts of air guns on eggs and larvae of fish species that are likely to be present in the Liard and Mackenzie Rivers;
- potential short and long-term effects of air guns on invertebrates that are, directly or indirectly, ecologically linked to fish;
- mitigation measures (e.g., ramping up procedures) and all uncertainties in mitigation measures;
- general hearing information (bandwidth and thresholds) on Mackenzie River fish or related species (at all life stages) for which data are available in the literature;
- potential impacts of air guns on anatomy and physiology of fish exposed to air guns (including effects on ear, lateral line, swim bladder and any other stress indicators); and
- long-term impacts over days, weeks and months, and implications for survival of exposed fish.

WesternGeco submitted its response to the deficiency statement on March 17, 2003. The Review Board ruled that WesternGeco's EAR conformed to the requirements of the Terms of Reference and closed the conformity review on March 26, 2003.

#### **5.5 TECHNICAL REVIEW**

A technical review of WesternGeco's EAR was initiated concurrent with the conformity review. This was done through the Review Board's Information Request (IR) process<sup>3</sup>. The IRs helped to facilitate the technical analysis of the proposed development. The Review Board's staff co-ordinated the analysis of the EA. The analysis included opportunities for regulatory authorities (RA's), expert advisors, First Nations, communities, the public and other interested parties to present their information to the Review Board. The result of this step was to find and focus on unresolved or unclear issues, and to provide the Review Board with the additional information that would contribute to its decision.

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<sup>3</sup> Information Requests are an interrogatory in the form of written questions and answers.



## **5.6 DEVELOPMENT IMPACT BOUNDARIES**

WesternGeco cited the difficulty in scoping the development due to the lack of a permanent footprint on the land and waterscape. The temporal and spatial dimensions of the zone of influence were defined by sound transmission and attenuation. The spatial extent of the riverine portions was defined to include the river in which the program was operating, the shores of that river and portions of tributaries to the river. Although there were no land based activities proposed beyond docking, above ground noise from the vessels and air guns served as the basis for expanding the scope to include an additional 1 km on either side of the river. This expansion accounted for semi-aquatic mammals as opposed to terrestrial mammals given that terrestrial mammals would be largely habituated to existing river traffic. The 2002 Test Program was used to verify the scoping based on an understanding sound transmission and attenuation in a river environment.

## **5.7 DETERMINING SIGNIFICANCE**

Section 128 of the MVRMA requires the Review Board to decide whether or not a development will have a significant adverse impact or significant public concern based on the evidence provided and report their conclusion to the Responsible Minister. Where a secondary source of evidence is provided, the sources should be appropriately referenced. In this process, the Review Board has no objection to the proponent or others applying professional judgement and the use of previously completed reports. In fact, it is encouraged as long as the basis for the conclusion is documented, the expertise applied is identified and, if possible, the person and/or source of information responsible for the conclusion is also identified.

For the Review Board to make the decision required by Section 128, there must be a clear explanation of the effect that the mitigation measure will have on the impact that it is meant to ameliorate. In other words, it is the Review Board's view that it must, under ss.117(2) of the MVRMA, be advised of the significance of an impact without mitigation and then receive a careful explanation of the effect mitigation will have in reducing that impact.

In determining significance, the Review Board considered the impact of the proposed development on each component of the scope of assessment. When potential impacts were identified, the factors considered included:

- Direction;
- Geographic extent;
- Duration;
- Magnitude;
- Frequency;
- Confidence; and
- reversibility.

The Review Board considered the benefits of the proposed development to the residents of the Mackenzie Valley and Canada in light of the possible environmental impacts of the development and the public concerns expressed during the environmental assessment process. (A complete list of the contents of the Public Registries of June 20<sup>th</sup>, 2003, is included in Appendix Five of this document). The remainder of this document summarizes material on

the public record, the conclusions of the Review Board, and the recommendations and suggestions that it reached.

## 6 Preamble to Assessment of Impacts

This section of the Report of Environmental Assessment considers specific issues related to impacts that arose during the Environmental Assessment. All information is based on material from the Public Record. For each impact, the Review Board describes:

- WesternGeco's submissions and predictions (based on the document *Environmental Assessment for the WesternGeco Mackenzie and Liard Rivers 2D Seismic Program 2003* [referred to herein as the developer's assessment report of Feb. 2003] and other items on the public record) and the WesternGeco's original research on which predictions were based;
- Other relevant items on the public record (such as submissions from parties to the Environmental Assessment<sup>4</sup> and from the Review Board's technical expert);
- The conclusions of the Review Board pertaining to each issue; and,
- The recommendations or suggestions of the Review Board (if any).

This section is intended to provide a summary of selected items on the public registry. It does not include every item. (see Appendix Five for a full listing of documents on the public registry).

The Review Board has considered all issues raised in this Environmental Assessment, as per the requirements of MVRMA s.117. Issues that the Review Board finds to be evidently and adequately addressed by the material on the public record are not discussed in this report. The only issues discussed in detail in this *Report of Environmental Assessment* are those which the Review Board decided warranted further detailed consideration.

The conclusions reached in this document are based on the assumption that WesternGeco will fulfill its commitments made during the environmental assessment. These include the commitments listed in WesternGeco's report of Feb. 2003 (see Appendix Three for the list of commitments) plus any commitments made after that submission. If WesternGeco fails to fulfill these commitments, the Review Board's determinations regarding significance described here may change accordingly.

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<sup>4</sup> This includes, but is not limited to, Aboriginal organizations and government departments.

## 7 Noise Attenuation

The Government of NWT Department of Resources, Wildlife and Economic Development (RWED) (May 24, 2002) voiced concern at the lack of understanding of noise levels associated with this project.

Uncertainties about acoustic output and attenuation of sound from the air guns were cited in the referral from the NEB and DFO. An understanding of this is necessary for both the prediction of environmental impacts and for seismic data acquisition.

With respect to noise, the Review Board included the following item in section 4.8 of the Terms of Reference that were issued to WesternGeco:

*WesternGeco to report results from acoustic field studies undertaken during 2002, including:*

- *objectives and methods;*
- *sound levels necessary for the development;*
- *pressure changes as they relate to development noise;*
- *attenuation of noise over distance; and*
- *ambient noise levels in the Mackenzie River;*

*This discussion should also evaluate the importance of substrate type, water depth, and channel width to the impacts of reflected energy in the water column. The above information is required with respect to the size air guns to be used during the proposed development. Any reference to additional information on noise from smaller air guns should be clearly identified as such.*

### 7.1 WESTERNGECO'S SUBMISSIONS

In response, WesternGeco conducted acoustic monitoring during the 2002 test program before re-submitting its report to the Review Board. Jasco Research Ltd. conducted this research for WesternGeco. This study and the results are described in the (Feb. 2003) report by WesternGeco<sup>5</sup>.

This acoustic monitoring involved taking measurements using hydrophone cables at different depths, distances and directions from the air guns to quantify the amplitudes and frequencies of sounds. This enabled WesternGeco to measure ambient (background) river noise, noise from vessels, noises near and far from the air gun array, noises from a cross section of the river, in a variety of conditions, over different substrates, in different directions, up tributaries, during ramp-up and at fish cages (for use in fish studies- see Section Eight).

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<sup>5</sup> (s.8.1, pp.51-53 and Appendix 2)

The studies identified sound levels at different frequencies, with a maximum of 224dB  $\mu$ Pa at 4 m range. The study found that bottom depth had a strong effect on long-range sound propagation, and that sand bars strongly attenuated air-gun noise. The study also found that the high frequency noise was detectable 10km away, and that low frequency noise propagated through the ground and was measurable one kilometer up tributaries.

The study make a distinction between near-field and far field noise. Noise spreads out as sound travels away from the air guns, and the noise of individual air guns (near-field noise, close to the source) is replaced with combined overlapping noise from multiple air guns (far-field noise). The transition from near-field to far-field occurs at a distance of 10-25m.

WesternGeco states that the noise heard from above the water is relatively quiet (92dB), and is hard to separate from vessel noise as heard from close by.

## **7.2 CONCLUSIONS OF THE REVIEW BOARD**

The Board reviewed the results of the acoustic testing with interest, as it is necessary to understand the sound levels and attenuation of the proposed activities to evaluate the geographical extent of the initial effect of each air gun blast, and resulting impacts on other valued ecosystem components such as fish.

The Review Board accepts that the noise of the air guns as heard above water is relatively quiet. (This is further considered in Section Eight of this report, in terms of potential disturbance to wildlife). The Board also notes that the noise underwater is much louder.

The Review Board notes that WesternGeco underestimated the geographical extent of the underwater sound in its initial (April 2002) assessment. The company predicted that the sound of the air guns is “predicted to drop... to the ambient noise in the river at 250 to 400m” from the source (s.1.2.2.4, p.11). In other words, 400 m from the air guns, WesternGeco predicted that the noise from the air guns would be indistinguishable from the background noise of the river. In a letter of June 28<sup>th</sup> to DFO, WesternGeco stated that “WesternGeco has at best given ‘worst case’ (higher than expected) values to sound propagation calculation in the range and amplitude”. However, the acoustic monitoring in the field established that the high frequency noise was actually detectable 10 km away from the source. WesternGeco’s “worst case” predictions were underestimations by over an order of magnitude. The field test has greatly improved these predictions.

The Review Board notes that the evidence on the public record does not indicate any disagreement with the findings of the acoustic testing.

The Review Board finds that the acoustic field study by WesternGeco has provided a good basis for understanding the noise produced by the proposed development, and how noise will attenuate in the river setting of this development.

## 8 Impacts on Wildlife

RWED has expressed concerns that it is unclear how the proposed noise will affect the hearing and behaviour of aquatic mammals (May 24, 2002). It has suggested to the NEB that "...it would be an appropriate condition of this project approval for the proponent to institute a study to determine the effects of overpressure and noise on freshwater aquatic mammals".

One of the reasons for referral was the need to fill information gaps related to the physiological and behavioural impacts of the seismic energy source on freshwater mammals.

With respect to impacts on wildlife, the Review Board included the following instructions in section 4.10 (Wildlife and Wildlife Habitat) of the Terms or Reference that were issued to WesternGeco:

*WesternGeco shall describe potential impacts on wildlife and wildlife habitat, and discuss mitigation methods and predicted residual impacts. To facilitate this discussion, WG shall provide details of methods and results of wildlife monitoring during 2002 field studies.*

*This section should include, but not be limited to, a discussion of the following, with respect to the size air gun proposed to be used during the development:*

- *Short and long-term impacts, (anatomical, physiological and behavioral) of the air gun array on semi-aquatic furbearers and water birds...*

### 8.1 WESTERNGECO'S SUBMISSIONS

WesternGeco hired IMG-Golder to conduct the wildlife monitoring survey. This study was intended to estimate encounter rates, halting vessels if necessary, and to observe effects on behaviour, monitoring for harm where possible. Wildlife monitors from communities were trained. Wildlife observations were made from two boats in front of and behind the seismic survey.

#### 8.1.1 *Semi-Aquatic Furbearers*

In their assessment report (Feb. 2003 s.8.3.1), WesternGeco predicted that the effects on wildlife would be minimal based on low encounter rates. The assessment identified beaver, muskrat, river otter and mink as the semi-aquatic furbearers most likely to be found in the project area. The project area was not the preferred habitat of these semi-aquatic furbearers. This was supported by the field study, in which no semi-aquatic furbearers were observed while air guns were firing.

Please see Appendix Four of this document for a summary of WesternGeco's proposed mitigation measures related to semi-aquatic mammals.

WesternGeco predicts, with medium confidence, that although an encounter with a semi-aquatic furbearer is possible, the impacts will be low in magnitude because of the low likelihood of an encounter, localized in geographical extent, and of an immediate duration.

### *8.1.2 Terrestrial Wildlife*

WesternGeco (Feb. 2003, s.8.3.2) identifies several ungulate and carnivore species in the area surrounding the development, including woodland caribou, moose, wood bison, grizzly and black bear, gray wolf, Canada lynx, wolverine, marten and red fox. During the field study, five bears were observed, and one moose was seen swimming.

WesternGeco reported that river islands in the Liard were important feeding areas for moose, and are used by pregnant cows to calve in spring. WesternGeco also reported that wood bison have been observed to take over 30 minutes in the Liard River while crossing.

In its report (Feb. 2003 s.9.2.4), WesternGeco predicts that impacts on terrestrial wildlife are likely to be of low significance, because of the low probability of occurrence, the low magnitude of the effect and the short-term nature of the impact.

WesternGeco proposes to shut down its air guns if a semi-aquatic mammal or swimming terrestrial mammal is seen within one kilometer, as a precautionary mitigation. A monitor will scan in front of the source vessel for wildlife, using a laser range-finder to establish distance. Scout boats will precede the seismic vessel by up to two kilometers. Although not looking specifically for wildlife, they will complete wildlife sighting observation forms whenever wildlife is seen in the river while air guns are being fired.

Please see Appendix Four of this document for a summary of WesternGeco's proposed mitigation measures related to terrestrial wildlife.

### *8.1.3 Birds*

WesternGeco provided a summary of raptors, upland birds and waterfowl found along the proposed route. Its report identified the Lower Mackenzie River Islands (in the Gwich'in and Sahtu Settlement Areas), the Middle Mackenzie River Islands (in the Sahtu Settlement Area) and the Southeastern Mackenzie Mountains (Deh Cho) as being particularly important for waterfowl. WesternGeco noted waterfowl are expected to move through the first two of these important areas before July, and before the proposed development reaches the area. The Southeastern Mackenzie Mountains are important to tundra swan, but these nest on small inland water bodies. As a result, tundra swans are not expected to be exposed to the project.

WesternGeco's wildlife field study included birds. The study looked at whether birds behave differently near and far from the project. The analysis found no detectable difference in behaviour with distance from the seismic vessels.

Please see Appendix Four of this document for a summary of WesternGeco's proposed mitigation measures related to birds.

## 8.2 OTHER SUBMISSIONS

Deh Cho First Nations has stated that “Deh Cho First Nations firmly believe that the WesternGeco 2-D River Program may have significant adverse effects on wildlife, specifically fish and aquatic furbearers in the Mackenzie River”.

RWED has not voiced any additional concerns since receiving the results of the field study.

Deh Cho First Nations requested that “further studies be conducted to determine the long-term effects of seismic air guns on the anatomy, physiology, breeding, stress levels and behaviour of semi-aquatic furbearers, mammals and birds of the Mackenzie River” (Jan. 15<sup>th</sup>, 2003).

## 8.3 CONCLUSIONS

The Board notes the low likelihood of encounters with semi-aquatic furbearers in the river, and little interaction with terrestrial mammals on the shore. The seismic barge is not expected to be operating close to shore. For wildlife that is not in the river, such as mammals on land and nesting birds, the Board finds that low volume of the above-water noise of the air guns is not likely to cause a significant adverse impact.

The Board recognizes that little is known about the effects of seismic air guns on mammals and birds. However, it notes that although WesternGeco’s predictions were made with only medium confidence, the company has committed to shutdown the air guns at a distance of 1 km from any beaver, muskrat, mink, river otter, or larger mammals in the river. This makes the uncertainty regarding the physiological effects of air guns on mammals less relevant.

If wildlife can be spotted, the Review Board accepts shutdowns as an adequate precautionary measure to prevent significant adverse impacts on mammals in the river. With the mitigations proposed by WesternGeco in its report of Feb. 2003, and the additional commitments on the public record, the Review Board does not find that the single pass of the seismic array as proposed will be likely to cause significant adverse impacts on wildlife. However, in order to spot mammals in the river at least one kilometer before the source boat, the scout boats should actively look for swimming mammals no less than one kilometer in advance of the source vessel. At present, the staff on scout boats fill out wildlife reports if they see any wildlife, but look only for people, boats, nets and camps on shore.

## 8.4 SUGGESTIONS

**The Review Board suggests** that scout boats look for mammals in the river more than one kilometre before the source vessel, and coordinate with the wildlife monitor on the source vessel for shutdowns as needed.



**The Review Board suggests** that WesternGeco talk to RWED about the known crossing points for wood bison before the operation, and notify local RWED personnel when these areas are being approached.

**The Review Board suggests** that scout vessels record all wildlife observations, rather than only record wildlife observations when air guns are firing. Wildlife observation records should be shared with the Sahtu and Gwich'in Renewable Resources Boards, Deh Cho First Nations and RWED.

## 9 Impacts on Fish

The most numerous issues raised and explored in this environmental assessment relate to the effects of the proposed development on fish anatomy, physiology and behaviour. Concerns regarding these subjects were expressed by RWED (May 24<sup>th</sup>, 2002). DFO also described many concerns and questions relating to various impacts including potential for fish herding, long term impacts and behavioural reactions (May 30<sup>th</sup>, 02). The Sahtu Renewable Resources Board agreed with DFO's list of unanswered questions. These concerns were shared by the Gwich'in Renewable Resources Board (June 25<sup>th</sup>, 2002).

In referring this development to environmental assessment, the NEB and DFO cited issues related to information gaps regarding impacts on fish physiology and behaviour.

With respect to noise, the Review Board included the following instructions to WesternGeco in section 4.9 (Aquatic resources) of the Terms of Reference:

*WG shall provide information on aquatic resources, mitigation measures and predicted residual impacts. To facilitate this discussion, WG shall provide details of methods and results of fieldwork during 2002 that evaluated effects of air guns on fish. This section shall include, but not be limited to, a discussion of the following:*

- *general environmental setting of the Mackenzie and Liard Rivers;*
- *species of fish present at the time of the seismic survey and their life stages, movement, migration patterns and habitat use;*
- *general hearing information (bandwidth and thresholds) on Mackenzie River fish or related species (at all life stages) for which data are available in the literature;*
- *potential impacts of air guns on all life stages, including eggs and larvae, of fish species that are likely to be present in the Liard and Mackenzie Rivers at the time of the proposed seismic survey. Include consideration of behavioural effects and effects on anatomy and physiology of fish exposed to air guns (including effects on ear, lateral line, swim bladder and any other stress indicators);*
- *potential short and long-term effects of air guns on invertebrates and aquatic plants that are, directly or indirectly, ecologically linked to fish or otherwise ecologically important;*
- *long-term impacts over days, weeks and months, and implications for survival of exposed fish;*
- *details of mitigation measures to prevent immediate and long-term mortality, injury or adverse behavioural changes to fish, including, but not limited to, ramping up procedures;*
- *effects on subsistence and recreational fisheries in the development area;*
- *shut-down protocol in the event that fish mortality or stress is detected;*
- *details of work timing in relation to fish species' distributions and movements; and,*

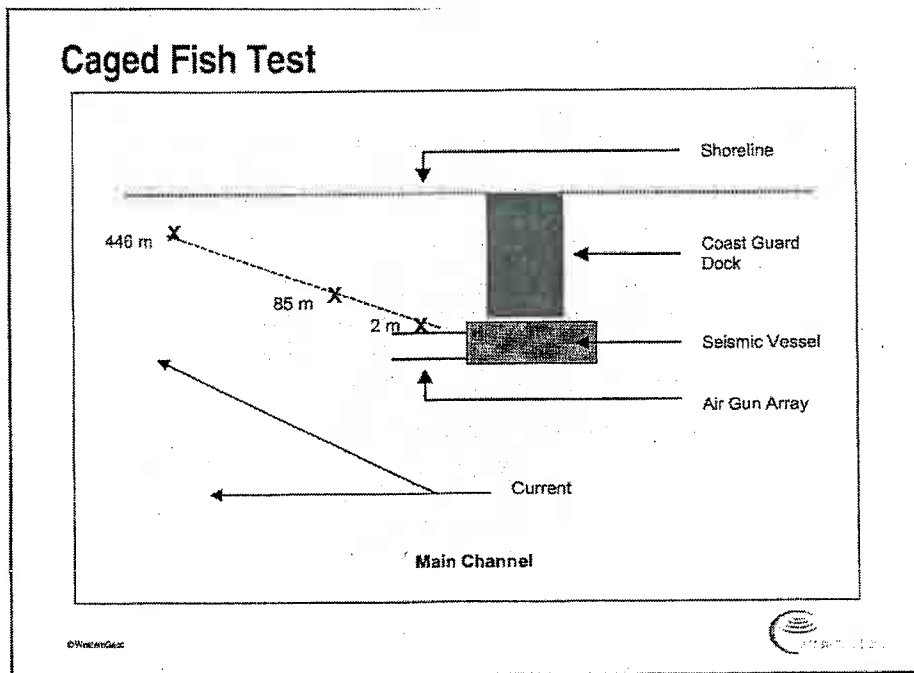
- details of proposed monitoring programs related to aquatic resources.

*This discussion is also to include a description of all uncertainties related to the above. The above information is required with respect to the size air guns to be used during the proposed development. Any reference to additional information on impacts from smaller air guns should be clearly identified as such.*

To address these questions, WesternGeco hired Golder Associates to conduct field studies on fish in July and August of 2002. The results of these studies serve as major considerations in WesternGeco's predictions regarding impacts on fish. In this section, the Review Board summarizes WesternGeco's research and results, and its impact predictions. This section also considers comments on the public registry relating to the research, results, and impact predictions.

### **9.1 WESTERNGECO'S SUBMISSIONS ON PHYSICAL IMPACTS TO FISH**

To test for anatomical effects on fish from air gun noise, WesternGeco exposed fish in cages to air gun noise at different distances<sup>6</sup>. Afterward, fish were examined to identify possible impacts. This study was conducted at the Coast Guard dock in Norman Wells. In this study, fish were caged 2 m (at 230dB), 85 m (at 193dB), and 446 m (at 169dB) from the air guns (see Figure 1). The inclusion of a cage at 2 m by WesternGeco was designed to evaluate a "worst-case scenario". Air guns were ramped-up for five minutes, and then fired for one minute.



<sup>6</sup> This research is described in the WesternGeco's Feb. 2003 report.

## Figure 1: Overhead View of the Caged Fish Test Setup<sup>7</sup>

In the first trial, Golder Associates put pearl dace in the 2 m and 446 m cages. A mixed assemblage of large fish (flathead chub, longnose sucker, northern pike, burbot and walleye) were placed in the cage at 85 m. In the second trial, only small bodied fish were used.

After the trial, the fish were observed after a half an hour, and then at intervals of 2, 4, 8 and 48 hours. Four fish died during the 48 hours interval, but this was attributed to handling stress. Three fish from each cage at each trial were also sacrificed and preserved in formalin, for histopathological analysis. Swim bladders were found to be intact. These fish were cut into sections. The abnormalities found were considered to be artifacts of preservation, natural abnormalities, and results of sectioning. From this, WesternGeco concluded that there were no impacts in the fish due to air gun exposure. (The field study is summarized in WesternGeco's 2003 report, s.8.2.1).

WesternGeco's report (Feb. 2003 s.8.2) describes the fish of the Mackenzie and Liard Rivers, and provides details about their life histories. The report notes that both rivers are important for fish migration, spawning, rearing young, and for other reasons. Fish using the rivers include broad whitefish, lake whitefish, burbot, lake trout, bull trout, northern pike, walleye, inconnu, white sucker and pearl dace, among many others.

WesternGeco, based on field study results and a review of the available literature, provides conclusions on the physical effects of the proposed development on fish. The physical effects on fish are seen to arise from a combination of noise frequencies, intensities, peak pressure, the rate of change in these factors, and the distance from the source. These variables may affect the internal organs of fish, the hearing of fish, and fish eggs, larvae and juveniles.

The literature indicates that pressure pulses from air guns are less damaging to fish than the pressure pulses from dynamite, due to different physical characteristics. However, air guns have been known to cause damage to the internal organs, including hemorrhaging of the liver, kidney and gonads. The swim bladder of fish, which contains gas, is also pressure sensitive and can rupture in response to air gun exposure.

WesternGeco also notes that past research indicates that air gun exposure can harm sensory hairs (part of the fish hearing mechanism), and that damage takes time to become visible. However, WesternGeco points out, this research was conducted on different fish species with a different air gun stimulus.

WesternGeco notes that past studies are not directly comparable, because the response is dictated by the particular combination of variables to which the fish are subjected.

WesternGeco cites in its field studies that "[n]o significant abnormalities, no signs of injury to the hearing organs of fish... Therefore, considering the ... information related to exposure and effect, impacts on fish hearing... are predicted to be negligible". WesternGeco states that

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<sup>7</sup> From Dec. 12, 2002 presentation "Behavioural and Physical Response of Riverine Fish to Air guns" by Golder Associates. Used with permission of WesternGeco.

it will have an occasional short term low-magnitude physical impact on fish, and the occurrence rate is considered “unlikely”. It reports a high degree of confidence in this prediction.

Please see Appendix Four of this document for a summary of WesternGeco’s proposed mitigation measures related to fish.

## **9.2 OTHER SUBMISSIONS ON PHYSICAL IMPACTS TO FISH**

The Review Board received two technical reports dealing with WesternGeco’s research and impact conclusions relating to physical impacts on fish. These were from the Gwich’in Renewable Resources Board (June 2<sup>nd</sup>, 2003) and from Dr. Arthur Popper, expert advisor to the Review Board. The Review Board also notes DFO’s comments regarding the research, as described in its Jan. 7<sup>th</sup>, 2003 letter to WesternGeco. The Gwich’in Renewable Resource Board, found that the research performed by WesternGeco was fundamentally flawed and could not provide a reasonable basis for WesternGeco’s conclusions.

The Gwich’in Renewable Resources Board, in its technical review (June 2, 2003), stated that “The GRRB believes that the impact of air gun operations on fish hearing in the Mackenzie and Liard Rivers cannot be predicted based on the study and literature review completed”. The Gwich’in Renewable Resource Board states that damage or impairment of fish hearing is important. Damage to or impairment of fish hearing may leave fish vulnerable to predators, or unable to find mates.

### *9.2.1 Choice of Species Studied*

One of the issues discussed in the technical reports involved the choice of species tested. The Gwich’in Renewable Resource Board points out that no coregonid (whitefish family) species were used in the test. This family of fish, which includes broad whitefish, lake whitefish, least cisco, arctic cisco, and inconnu, are the most important subsistence fish species in the area. The Gwich’in Renewable Resource Board submits that “there is virtually no scientific information about the sensitivity of local fish species coregonid species (sic) to loud noises and recent work by McCauley et al (2003) demonstrates that long term damage to fish hearing can occur from air gun operation”. The Gwich’in Renewable Resource Board concludes that negative impacts could have a significant impact on coregonid populations.

Before the test study, in a letter of July 15<sup>th</sup> to WesternGeco, DFO advised that the test study should not proceed without including at least 10 to 20 whitefish.

DFO, in a letter of Jan. 7<sup>th</sup>, 2003, states that coregonids are extremely important to the subsistence fishery in the lower Mackenzie River and Delta. The department further said that “the species that were used (in the tests) were considered ‘hardy’ relative to the whitefishes. Therefore, the potential impact of the seismic air guns on the subsistence fishery is still unclear”.

### 9.2.2 Timing of Specimen Preservation

The Gwich'in Renewable Resource Board found that fish were sacrificed too early for damage to be apparent, because the literature shows significantly greater impacts that require more time to become visible. It notes that caged fish were sacrificed 48 hours after exposure, and state that "research results suggest that the damage is unlikely to be detected 48 hours after air gun exposure".

Dr. Poppers' review supports this, stating:

*Data from Hastings et al. (1996) and McCauley et al. (2003) clearly show that sound-induced inner ear damage does not show up, even at the electron microscope level, until several days after exposure to the stimulus. The longest time that fish were held by WesternGeco before sacrifice was 48 hours, and it is questionable whether this was sufficient time to show damage. Without data from longer time intervals, it is not possible, at least with respect to inner ears, to conclude that no damage occurred as a result of sound exposure<sup>8</sup>.*

Deh Cho First Nations, in a Jan. 15<sup>th</sup> letter to the Review Board, expressed this concern also. It said:

*It is our opinion that the studies were limited in duration and scope, and therefore do not provide solid evidence that air guns do not pose long-term damage to Mackenzie River fish... As noted in Arthur N. Popper's comments regarding this study, WesternGeco's study was insufficient in length to determine the long-term effects of air guns on fish. Popper also noted that the long-term effects of sound on fish may not show up right away, thus rendering WesternGeco's results premature and tenuous.*

DFO also expressed concerns with the 48 hour observation time after exposure, concluding that the long-term effects are unknown.

### 9.2.3 Lab Analysis / Histopathology

Samples from the caged fish were preserved and sent to a laboratory for histopathological analysis. The Gwich'in Renewable Resource Board states that the methods used for analysis were inadequate to detect hearing damage. This requires the use of a scanning electron microscope, which was not done. The Gwich'in Renewable Resource Board says that "the

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<sup>8</sup> The McCauley et al. paper cited above is referenced by the Gwich'in Renewable Resource Board. Deh Cho First Nations referenced this paper as support that impacts require several days to appear. Popper notes that this was not published when WesternGeco was drafting the EIS, but that the same point is made in Hastings et. al., (1996), which was part of the literature reviewed by WesternGeco.

particularly alarming conclusion from McCauley *et al.*'s study is that damage can only be detected by scanning electron microscopy”.

The McCauley *et al.* paper, from the Journal of the Acoustical Society of America (Jan. 2003) states:

*...the ears of fish exposed to an operating air-gun that was moved towards and away from the animals sustained extensive damage to their sensory epithelia which was apparent as ablated hair cells. The damage was regionally severe and there was no evidence of repair or replacement of damaged sensory cells up to 58 days after exposure.*

Dr. Popper notes in his Technical Review of June 9th, 2003, that the samples for the lab were preserved in formalin. This fixative makes analysis of sensory hair cells impossible. The lab analysis consisted of only light microscopy, not electron microscopy. He states that “analysis of inner ear tissue with light microscopy in tissue fixed... with formalin is not sufficient to reveal damage to sensory hair cells... The major damage encountered in earlier work is only visible with much higher levels of magnification”.

Dr. Popper raises an additional issue related to the specimen preservation and lab analysis. Ear tissue is not adequately preserved by the fixation methods used in the study. WesternGeco opened the abdomen of small fish and sectioned larger fish so that formalin would reach internal tissues. Because heads were not opened, the ear tissue was likely slowly and inadequately preserved. The poor method of tissue fixation should have resulted in some artifacts, such as missing cells, and poor membranes. The fact that none was reported is cause for concern, Popper states.

The Review Board issued an Information Request to clarify what was meant by the phrase “no significant abnormalities” in the lab results. The response from WesternGeco was that “Abnormalities associated with hearing structures were assumed by Dr. Lumsden to be the result of the preservation method or sectioning”.

Regarding this, Dr. Popper submits the following:

*This implies that there were abnormalities present in the ear tissue, and that these were discounted as being artifacts. If this was the case, how could the pathologist identify damage since it too would have looked like abnormalities? In effect, this... strongly suggests that the pathologists analysis of the tissue could not discriminate between damage and fixation problems, and thus any statement of no damage to the ears (or other organs, for that matter) is totally meaningless.*

Popper cites numerous other criticisms of the research methods and lab analysis pertaining to the physical impacts of the air guns:

- The cages were not exposed to the maximum output of the air guns (which would be 25m from the array, where sound signals from the different guns overlap), and do not represent a worst-case scenario.

- No larger fish were tested at the closest cage.
- Fish were not observed during at the time of exposure, so no record of their immediate behavioural response could be studied.
- Some fish were described as “temporarily stunned”, but there is no way to verify with certainty if these fish were among those sent for lab analysis.
- Most of the fish sent for lab analysis were from species that are not representative of most fish in the Mackenzie River, and even if these were not damaged, it is not possible to extrapolate to other species. The ear mechanism in most Mackenzie fish is different from that of most fish sent for lab analysis by WesternGeco.
- Too few fish were sampled to provide statistically adequate results on the effects, or lack of effects, or air guns on various tissues.
- Very little can be learned by comparing the effects of one species at one distance to effects on other species at different distances.

WesternGeco’s e-mail of June 13<sup>th</sup> indicates that it disagrees with some of Dr. Popper’s points. It states that WesternGeco did test at an appropriately high volume and position for a worst-case scenario, saying the fish were at the point of highest calculated amplitude. WesternGeco also disagrees that the cages should have tested walleye, northern pike and lake fish.

The Gwich’in Renewable Resource Board also noted that no large bodied fish were tested in the closest cage with the highest level of sound exposure, and because of this doubts that WesternGeco’s conclusions apply to all sizes of fish.

In response to Information Request 1.2.7(e), when asked if research results could be extended to the whitefish family, WesternGeco stated that it is reluctant to extrapolate results to other species. Also, the notes from a meeting on Dec. 5<sup>th</sup>, 2002, indicate that WesternGeco did not study effects on the whitefish family because the whitefish on hand were too small, and they were concerned about possible impacts of handling them. The same notes state that “First Nations groups didn’t want game species used in any studies”. During the same meeting, DFO pointed out that WesternGeco was permitted to capture whitefish for the study, but WesternGeco did not do so.

### **9.3 WESTERNGECO’S SUBMISSIONS ON IMPACTS ON FISH EGGS, LARVAE AND JUVENILES**

WesternGeco predicted (s. 9.2.2.1) impacts on eggs, larvae and juvenile fish. It stated that “no information about hearing in the early life stages of fish is available”. WesternGeco reviewed past work showing that a lethal radius for eggs from an air gun was from zero to three meters at over 230dB. It also cited a 1973 study indicating that egg survival increased with distance from air guns and that survival at 5m was approximately 100%. A more recent (1991) study shows that air guns have led to a 35% reduction of survival in four day old fish larvae, exposed to 40 air guns of 120-300 cubic inches. A 1996 study in Norway concluded that larval fish have a natural mortality of 5-15%, and that the small mortality measures from marine seismic could not be differentiated from natural mortality. More recent work (Davis *et*



al. 1998) suggests that small changes on the survival rates of fish larvae could have “large effects on the recruitment to the adult population”.

WesternGeco did not include any eggs or larvae in their research, but conclude from the results of their horizontal study that fish are not in the top 5 m of the water column, and that exposure time for any life stage would be brief because “seismic vessels travel against the current and small organisms would be carried rapidly... past the air guns. Therefore, it is predicted that few larvae or fish would be exposed at close range, or for an extended period of time, to active air guns during the Project”.

Please see Appendix Four of this document for a summary of WesternGeco’s proposed mitigation measures related to eggs, larvae and young fish.

Spawning and rearing occurs in tributaries, lakes or shallow parts of mainstream rivers. These are far removed from the path of the seismic vessels. Noise monitoring showed that noise in mouth of Fat Rabbit Creek, a tributary of the Mackenzie River included in the acoustic tests did not exceed 160dB, below the level of harm. WesternGeco did not conduct any field tests on fish eggs, larvae or juveniles, but concludes, in consideration of the above, that the proposed development will have negligible impacts on fish eggs, larvae and juveniles. It states that the occurrence is possible, and that there is a medium degree of confidence in their predictions.

#### **9.4 OTHER SUBMISSIONS ON IMPACTS ON FISH EGGS, LARVAE AND JUVENILES**

WesternGeco states (3.3.4) that young-of-the-year of some species are probably quickly displaced downstream by the spring flood, reaching the delta in late May or early June. Because the program will not begin until mid-June, the peak passive drift of young fish will have passed before the program begins.

In its January 8<sup>th</sup> 2003 letter to WesternGeco, DFO raises concerns regarding juvenile fish:

*... (T)he potential impact of the seismic air guns on the subsistence fishery is still unclear. Of particular concern is the impact on the large number of young-of-the-year that are carried out of their natal streams and into the Mackenzie River in the spring. In my opinion, this is a critical issue. We do not fully understand how this migration takes place and these small fish do not have the swimming capability to avoid the seismic survey ship.*

In Information Request 1.1.3 (April 7, 2003), it was noted that the 1973 study on air gun damage to eggs was conducted on marine species unrelated to Mackenzie River fish, and that none of the eggs were allowed to survive and develop to observe damage that could appear later. WesternGeco clarified in its response of May 1, 2003 that the study illustrated that eggs had to be close to the seismic source and exposed for an extended period for mortality to occur.

In Dr. Popper's technical review, he comments:

*If... there are eggs and larvae present, it will be imperative to do a well-designed parametric study of the effects of air guns on both. Since these do not move except with currents, any exposure to air guns could be for the whole time the ship moves by. Most importantly, the data available to date (cited in the Environmental Assessment) are minimal, and there have been no studies that have examined both the immediate effects of air gun stimulation on eggs and larvae, and long-term effects on continued development.*

## **9.5 EFFECTS ON FISH MOVEMENTS**

Some of the predictions in WesternGeco's report relate to movements of fish in response to the air guns. There are four main issues of interest regarding fish movements.

- The actual exposure of fish to air guns may be decreased if fish move away from the source, because the volume of the air guns decreases with distance. Understanding how fish will move in response to air guns is important in determining likely exposure, which relates to ultimate impact.
- Because the Mackenzie River is an important fish migration route for spawning migrations, there was interest in whether the seismic vessel would pose a barrier to fish movements.
- There may be a potential for the vessel to herd fish. The concern is that if fish do move away from the air guns, and are unable to or do not pass beside the seismic vessel, the seismic survey could herd fish in front of the advancing boat as it goes up river for several hours at a time. This is a concern because it could exhaust and harm the fish in front of the vessel. It may also disrupt normal fish movements within the river, and because it could expose fish to air gun noise over a prolonged period as long as they are in front of the boat.
- There is uncertainty regarding the effectiveness of ramping-up as a mitigation. WesternGeco's impact predictions include consideration of the potential mitigation by ramping up. Ramping-up refers to starting the air guns at low levels and slowly increasing to peak operation over five minutes. This is intended to allow fish time to move away before noise levels are very high. In the April 2002 report submitted before the field tests had been conducted, WesternGeco stated that "...ramping up procedures and the approaching noise will likely frighten fish away from the immediate vicinity of the air guns, lessening the likelihood of injury" (p.94).

These issues are raised by DFO, the Gwich'in Renewable Resource Board, the Sahtu Renewable Resource Board, and Deh Cho First Nations in several items on the public registry<sup>9</sup>, and were the subject of Information Requests by the Review Board. Information

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<sup>9</sup> These include DFO's letter of May 30, 02, DFO's letter of June 19<sup>th</sup>, 2002, DFO's letter of Jan 7, 2003, the Gwich'in Renewable Resource Board submission of June 25, 2002, the Sahtu Renewable Resource Board submission of July 12, 2002, the Deh Cho First Nations letter of Jan 15<sup>th</sup>, 2003, and the Deh Cho First Nations submission of April 11, 2003.

gaps related to behaviour and mitigation were identified in the June 24, 2002, referral from NEB and DFO.

## 9.6 WESTERNGECO'S SUBMISIONS ON IMPACTS TO FISH MOVEMENTS

In evaluating whether fish will avoid the air guns, WesternGeco presented a review of literature indicating that seismic exploration may cause changes in fish abundance and distribution, but that these changes are generally temporary and local. Catch rates may vary before, during and after air gun firing. The response to sound of fish species is species specific, and the influence of air gun noise on behaviour and catch rates is also expected to be species specific.

To test the behavioural responses of fish to air guns in the Mackenzie, WesternGeco conducted field studies. Two different types of investigations were conducted- vertical acoustic monitoring and horizontal scanning. The vertical acoustic monitoring looked for evidence of herding, while the horizontal scanning looked for changes in the direction of fish movements on exposure to air guns during ramp-up and operations.

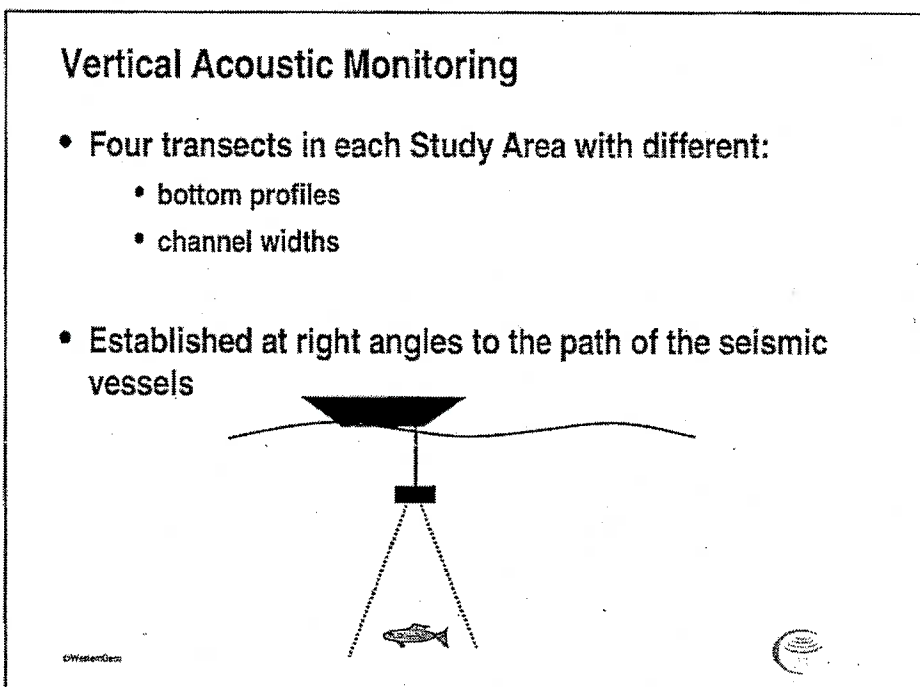


Figure 2: Illustration of Vertical Acoustic Monitoring<sup>10</sup>

The vertical acoustic monitoring involved researchers in a research vessel studying a transect crossing the river to see how many fish were along the transect before, during and after the pass of the seismic vessel as it surveyed upriver. From the research boat, a 120kHz split beam

<sup>10</sup> From Dec. 12, 2002 presentation "Behavioural and Physical Response of Riverine Fish to Air guns" by Golder Associates. Used with permission of WesternGeco.

transducer transmitted sound downward to detect fish by finding the echo they produce. This research boat crossed the river in the same place five times: once before ramp up, once after ramp-up but before the seismic vessel passed, once immediately in front of the seismic vessel, once immediately behind the second seismic vessel (which was still proposed as part of the development at that time) and once well behind the vessels. This was repeated at each of three test areas, in the Sahtu, in the Gwich'in, and in the Inuvialuit areas.

The vertical acoustic monitoring found that most of the fish were less than 15 cm long, and were in the deepest parts of the channel. Researches found that although fish abundance was different between passes at transects, there were no consistent differences among the transects. Researchers found no detectable herding, and no consistent change in vertical distribution of fish.

In addition to the vertical acoustic monitoring, WesternGeco conducted horizontal scanning to monitor fish movements in response to ramping-up (see Figure 3). For this, the transducer was suspended off the research boat 2.5 m below the surface, and aimed parallel to the surface. This technique studied changes in the direction of fish swimming next to the air guns while the air guns ramped-up for five minutes, and fired for one minute at full capacity. Changes in the direction of fish movements were categorized as moving towards or away from the array, or no change in direction.

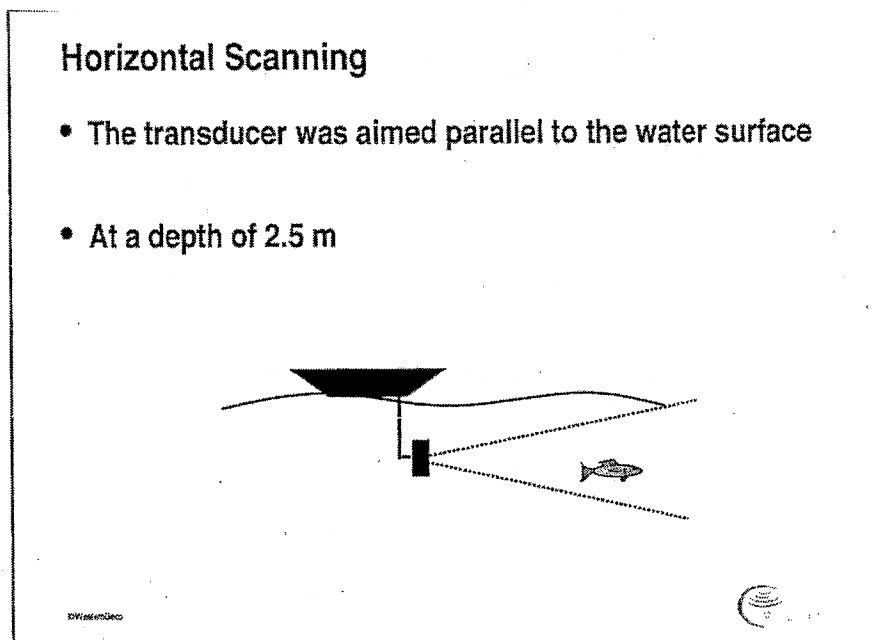


Figure 3: Illustration of Horizontal Scanning Study<sup>11</sup>

The horizontal scanning observed 36 fish, most of which were small. The only change observed was one fish changing its path away from the air gun. From this, WesternGeco

<sup>11</sup> From Dec. 12, 2002 presentation "Behavioural and Physical Response of Riverine Fish to Air guns" by Golder Associates. Used with permission of WesternGeco.

concluded that “The 2002 test program results indicate... there was no apparent effect of air gun operation... upon the fish population measured by hydroacoustic methods” (p.116).

Based on the results of the acoustic study, the zone of impact on fish behaviour was expected to extend up to 3,600 m from the air guns, based on noise levels indicated in the literature (above 160dB). (p.117). The vertical acoustic monitoring began at a distance greater than this, and changes at this distance would have appeared in the research. However, fish showed no sign of herding, nor of changing their positions.

Please see Appendix Four of this document for a summary of WesternGeco’s proposed mitigation measures related to fish behaviour.

WesternGeco points out that the periodic shutdown of the air guns will provide additional mitigation against herding fish, because fish have an opportunity to re-distribute themselves. Based on the mitigation and the research, WesternGeco concludes that the project will not result in the herding of fish.

In WesternGeco’s e-mail of June 13<sup>th</sup>, WesternGeco reaffirmed its assumption that the fish observed by sonar represented the full range of species present at the time.

## **9.7 OTHER SUBMISSIONS ON IMPACTS TO FISH MOVEMENTS**

Deh Cho First Nations, the Department of Fisheries and Oceans, and Dr. Popper (expert advisor to the Review Board) all submitted comments relating to the field studies and WesternGeco’s findings regarding changes to fish behaviour and movements.

Deh Cho First Nations, in its submission of Apr. 11, 2003, notes that WesternGeco concludes, in its Feb. 2003 report (s.3.2.4), that ramping up has no effect and does not result in fish avoiding the air guns. In this report, WesternGeco states its intention to use ramping up anyways as precautionary measure. Based on this, the Review Board issued an Information Request (IR 1.2.4) at Deh Cho First Nations’ request to ask for other alternatives to ramping-up. WesternGeco’s response (May 15, 2003) is that, although it is mitigating the project in other ways, no beneficial alternatives to ramping-up are known.

Deh Cho First Nations also noted in its Apr. 11<sup>th</sup> submission that, in the horizontal scanning study, the bottom 1 m of data was generally removed from analysis. Based on this, the Review Board issued an Information Request (IR 1.2.9) at Deh Cho First Nations’ request to ask for comment on this. WesternGeco’s response (May 15, 2003) stated that the horizontal scanning measured location of all fish but not the changes in movement of fish near the bottom, it assumed fish at bottom would move as much as fish in middle of water column.

In reviewing the horizontal scanning research to look for changes in fish movements, DFO (Jan. 7, 2003) points out that the research “seems to assume that the only possible swimming vector that would demonstrate a reaction to the air gun is a horizontal one away from the air gun. Other vectors are possible, and, in fact, the fish may react in a chaotic manner if they were stunned or partially stunned as was demonstrated in the cage experiment”. DFO also

notes that no information is available on the species of fish being exposed to noise, and that the fish measured could have all been one species. "Certainly the fish insonified are not representative of all the fish in the Mackenzie River".

Regarding the vertical acoustic test to look for fish herding, DFO identifies three points that may have had a significant impact on interpretation of results. It notes:

- 1) Golder Associates assumed no natural variability in fish distribution over the course of a day. If changes in fish number over the transect are what is being measured, it is necessary to be able to compare this to how much this would change on its own over the day. (This point was also raised by Deh Cho First Nations in its Apr. 11, 2003 submission).
- 2) The transect traveled by the survey boat in a fast flowing river is unlikely to be exactly the same with each crossing, and any variation on the route could influence the results.
- 3) The presence of the research boat could have affected density and distribution of fish. Such vessel avoidance "has been well documented for many species, including the coregonids".

DFO states that it is unclear how these were accounted for in the research and analysis, stating that "a violation of any of these assumptions could result in a bias in measurement... that could mask the true behaviour of the fish to the seismic survey ship".

DFO identifies other deficiencies in the field study. It notes that the survey saw very few large fish, and states: "In other large rivers (ex. Fraser), migrating fish stay very close to the bottom and near shore because that is where the current is lowest... If this is the case in the Mackenzie, then many fish would be missed". (WesternGeco was not able to test in shallow areas, nor monitor changes in fish movements close to the bottom). In an earlier (June 19, 2002) letter to WesternGeco, DFO identified this problem before the test was conducted, suggesting a different type of transducer. DFO pointed out that "fish typically move down and away from sound sources. This puts most fish close to the bottom where they are most difficult to detect."

(The Review Board notes that in a letter of June 25<sup>th</sup>, 2002 to the NEB, RWED specified that "the use of the transducer ... should be adequately tested to ensure that it is effective in recording the location of fish throughout the river environment".)

In addition to these problems, DFO notes in its Jan. 2003 letter that the sample size studied is small, and also that no validated software was used to track sonar pings. Researchers looked at target locations and assumed they were the same fish.

Regarding the field studies of fish movements in response to WesternGeco's air guns, DFO concludes that "(t)he conclusions imply that we now have a very clear understanding of the behaviour of fish... in the river with respect to the seismic survey and that the seismic survey will have no impact on fish. Regardless of whether this proves to be ultimately true or not, the evidence from this study clearly does not support this conclusion".

In its technical report of June 9<sup>th</sup>, 2003, DFO states that “DFO does not believe that the conclusions on fish behaviour are conclusive enough to make (WesternGeco’s) predictions”, and that it believes that a precautionary approach should be taken. It suggests shutdowns of the seismic program at sensitive areas.

Dr. Popper notes that the field studies do not differentiate between the responses of different species, but that it is necessary to do so because fish behaviour is highly species specific. “Thus, while the species encountered by the sonar may generally not show behavioural changes in response to the air guns, individual species may have done so. In effect, this was a very crude and potentially meaningless set of results”. Dr. Popper further notes that Golder Associates’ studies did not include fish on or near the bottom, and points out that if hearing specialists such as dace and sucker liver close to the bottom, their movements would not have been determined. Fish species living close to the bottom may behave differently from fishes within the water column. Their behaviour may have been affected without being detected by sonar. “...The sonar data are insufficiently precise to give any but the broadest view on the response of fish *populations* to air guns, and do not resolve species differences” (p.17).

## **9.8 OTHER SUBMISSIONS ON IMPACTS TO FISH (GENERAL)**

In its June 9<sup>th</sup>, 2003 technical report, DFO states that although it does not believe some of WesternGeco’s conclusions, it feels that shutdown areas would provide a sufficient precautionary approach. It provided a list of recommended mitigation measures, including:

1. Ramping-up every time seismic operations resume to allow fish time to leave the area;
2. Shutdown of the air gun array for a minimum of one hour of every six to avoid potential herding of fish for prolonged periods;
3. Fish monitoring by monitors on board the vessel and in the small boats in front of and behind the vessel;
4. If injured or dead fish are observed, preserving them appropriately, ceasing operations, contacting DFO immediately; and,
5. Shutting down air guns around areas of known sensitivity (including zones around the mouths of tributaries listed by DFO).

In the same report, DFO recommends that shutdown zones extend one kilometre around sensitive areas. This contrasts with the shutdown buffer recommended by DFO on July 15<sup>th</sup>, 2002, which stated “Due to the sensitive nature of fishery resources in certain locations, air guns should not be operated within 5 km upstream and 5 km downstream...” of identified sensitive areas.

In response to DFO’s recommended shutdown zones around sensitive areas of fish congregation and spawning, WesternGeco stating in an e-mail of June 13<sup>th</sup> that it suggests instead to have an advance boat with a fish finder to detect congregations of fish, and shut down for one kilometre on either side when they are detected. WesternGeco proposes to develop guidelines for this. Alternatively, WesternGeco proposes that DFO study the river a year before the program, to study fish densities at areas identified as sensitive. WesternGeco is willing to use the results in the design of “future initiatives”.

In a letter of May 30<sup>th</sup>, 2002, DFO states that "...bull trout (*Salvelinus confluentus*) is a species of special concern in the Northwest Territories and occurs throughout the project area".

The Gwich'in Renewable Resource Board (Technical Report- June 2, 2003) believes that air gun operation will damage fish hearing, and that WesternGeco's studies failed to show that the development will not hurt native fish species in general, and those important to subsistence harvesting in particular. It recommends that more testing, including testing on whitefish, be conducted before the development is approved.

The Gwich'in Renewable Resource Board accepts that the scheduling of activity will mitigate many impacts on spawning runs, but notes that the development is likely to conflict with the inconnu spawning run. Inconnu harvest peaks in the Gwich'in Settlement Area in early July and that Mackenzie River inconnu are believed to congregate and spawn near the Ramparts Rapids at Fort Good Hope. The inconnu is an important subsistence species. The Gwich'in Renewable Resource Board recommends:

1. Further studies are needed to determine the impacts of air gun operation on the whitefish family. It offers specific suggestions for study design.
2. Possible spawning areas of Mackenzie River inconnu be identified using scientific and community knowledge, and that the program should shut down within one kilometer of these areas.

Deh Cho First Nations believes that the program may have significant adverse effects on fish, and point out that "the whole of the Mackenzie River in the Deh Cho is a traditional fishing river that provides crucial subsistence fishing". It requests the following:

1. The precautionary principle should be exercised with respect to this seismic program.
2. Further study should be conducted "to determine the long-term effects of seismic air guns on the anatomy, physiology, spawning, stress levels and behaviour of Mackenzie River fish of all species and at all lifestages. These studies should use the exact air gun size that is proposed for the seismic survey".
3. WesternGeco provide detailed evidence that 'ramping up' procedures will be an effective means to prevent negative impacts of air guns on fish.

Dr. Popper submits two overall conclusions:

*First, the attempts by WesternGeco to document the effects of exposure to air guns on fishes in the Mackenzie were totally inadequate. **Based upon the data provided, no conclusions can be reached as to whether the air gun exposure does or does not damage fish, or whether there is any short or long-term potential for harming fish or fish populations (bold added).** I reach this conclusion because I find that the specific experimental methods and data analysis used by WesternGeco were inadequate for proper determination of short or long-term effects... It is important to note that had WesternGeco conducted the experiments correctly, the data could have provided the seismic and scientific communities with invaluable information to help understand the effects of air guns on fishes.*



*Second, despite the lack of data from WesternGeco, other (albeit limited) data in the literature leads to the conclusion that the approach being taken by WesternGeco in their survey work may not have a substantial negative effect on fishes (bold added). Because the seismic vessels used by WesternGeco will only be making a single pass at any one point, the likely exposure to maximum signals from air guns for individual fishes (or, for that matter, invertebrates, fish eggs, larvae, etc.) will be no more than for a few minutes, and this exposure will be intermittent since the air guns are not fired continuously.*

## **9.9 CONCLUSIONS OF THE REVIEW BOARD**

The Review Board notes that WesternGeco went to considerable expense to conduct complex field research to improve its impact predictions, and made a genuine effort to determine its likely environmental impacts on fish. This may not have been necessary, had there been extensive documentation of the effects of similar undertakings in similar settings. However, none were available, and the developer has therefore relied on original field research to augment a literature review. The Board agreed with WesternGeco that an *in-situ* field study of the proposed air guns in the proposed setting had the potential to address key information gaps relating to the effects of air guns on fish.

In considering the impact on fish, the Review Board reviewed the predicted effects of air gun firing in the context and scale of the whole development. It notes that the air guns are proposed to fire many thousands of times along the length of the Mackenzie and Liard rivers, and that the total impacts on fish in those rivers may be greater than any single firing. The Review Board also notes that individual fish are only likely to be exposed to the air guns for a small portion of the survey.

Because there is little published literature on the effects of air guns on fish in rivers, WesternGeco cited air gun research with different size air guns, in different settings and on different species than those likely to be found in the Mackenzie and Liard Rivers. The developer has also indicated that results are likely to be species specific, and that the size and arrangement of air guns can influence their effects. Even if the results of past studies were comparable, the published material presented by WesternGeco is not consistent in its findings. The Board accepts, based on the material on the record, that seismic air guns can harm fish, but finds little in the research cited that is directly applicable to the proposed developments potential impact on fish.

The Review Board notes that the acoustic field study appears to have added substantially to the all parties' understanding of the characteristics and attenuation of air gun noise in the setting of the Mackenzie River. The results of this research is largely uncontested by any other material on the public record. In terms of impacts on fish, the Review Board accepts the results as a useful description of an impact stimulus.

The Review Board accepts the views of DFO, Gwich'in Renewable Resource Board, Deh Cho First Nations, and Dr. Popper that the research conducted by WesternGeco did not

conclusively provide the needed information on the impacts of the proposed river seismic development on fish. Regarding cage tests, deficiencies are noted in study design, a lack of control subjects, the use of species that are not representative of important species in the area, problems with preservation of samples for histopathology (including timing of preservation), issues related to the histopathological analysis methods, and other problems. Particularly problematic is the exclusion of coregonids (whitefish family) in the research, considering their importance to harvesters in communities. Regarding the tests relating to fish movement, this is due to the inability to differentiate species specific responses and to detect fish near the bottom, where larger fish may be, and other problems. Responses by WesternGeco have not satisfactorily addressed these issues.

The Board notes that this is regrettable, because better research may have served to clearly resolve the issues in this Environmental Assessment relating to fish. The Review Board further notes that the potential of these studies to improve impact prediction was considerable.

The Review Board notes that WesternGeco produced little consistent literature regarding the effects of their proposed development on fish eggs, larvae and juveniles, and that these were not included in the field tests. The Review Board also notes that one study related to air guns found that survival rates of young are very important to the adult fish population. However, as the timing of the development avoids the spring freshet, the key period of sensitivity for fish eggs, larvae and juveniles, the Review Board does not anticipate significant adverse impacts on these, despite the lack of information provided. It notes, however, that this serves to increase the overall importance of the scheduling of the development as a mitigation.

The Review Board further notes that the tests do not clarify the effectiveness of ramping up as mitigation. WesternGeco's predictions in its initial environmental assessment document (submitted before the tests) stated that ramping up would frighten fish away from the air guns, lessening the likelihood of injury. This was contradicted by the field tests, which showed no response. (However, due to the aforementioned flaws in the tests, this may not be a reliable finding). The tests do not provide an adequate basis to determine the effectiveness of ramping up as a mitigation measure.

The MVEIRB accepts the conclusion that the timing of the project avoids peak migration of most anadromous fish species, and of the spring movement of fish eggs, larvae and juveniles. However, this conclusion cannot be drawn with any certainty for inconnu. In consideration of the Gwich'in Renewable Resource Board points regarding inconnu, and publicly available relevant information<sup>12</sup>, the Review Board notes that inconnu congregate around the Ramparts at Fort Good Hope and are believed to spawn there and/or in nearby tributaries. Although peak migration in the lower Mackenzie River occurs in early July, substantial numbers of inconnu are caught at Fort Good Hope in early to mid July. While the seismic survey will

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<sup>12</sup> Specifically, *Integrated Fisheries Management Plan for Coney (Stenodus leucichthys) in the Gwich'in Settlement Area, Inuvialuit Settlement Region, and the Sahtu Settlement Area, Northwest Territories. Fisheries and Oceans Canada, December 2000*; *Mackenzie River Inconnu. DFO Science Stock Status Report D5-04 (1998)*; *Life History Characteristics of Freshwater Fishes Occurring in the Northwest Territories and Nunavut, with Major Emphasis on Riverine Habitat Requirements. C.L. Evans, J.D. Reist and C.K. Minns. Canadian Manuscript Report of Fisheries and Aquatic Sciences 2614, Fisheries and Oceans Canada, October 2002*; and *Biological Data from Experimental Fisheries at Special Harvesting Areas in the Sahtu Dene and Metis Settlement Area, NWT: Volume 1. The Upper Ramparts and Little Chicago Areas of the Mackenzie River.*

avoid the peak migration, there is potential for considerable overlap between the survey and inconnu migration from the Inuvialuit Settlement Region boundary to the Fort Good Hope area. The Review Board further notes that there is a potential for disturbance of inconnu at or near their spawning grounds, although not during spawning. However, the Review Board finds that the proposed shutdown areas, in combination with proposed periodic shutdowns of the shutdowns of the air guns, are expected to mitigate potential impacts specific to inconnu.

The Review Board does not accept WesternGeco's proposed alternative to DFO's recommendation of shutdowns around sensitive areas. WesternGeco's alternative mitigation is based on their successfully identifying congregations of fish using a transducer. The evidence on the public record for this environmental assessment indicates that even in the controlled setting of field tests, various problems limit the effectiveness of the transducers in the river setting. In light of this, the Review Board finds that it is not an adequately reliable mitigation in comparison to the shutdown areas suggested by DFO.

The Review Board further notes that the proposed shut down areas are a small proportion of the proposed development route.

The Review Board therefore finds that the development as proposed is likely to cause significant adverse impacts to fish, but that these impacts are preventable with the use of appropriate mitigation measures.

## **9.10 RECOMMENDATIONS AND SUGGESTIONS**

**The Review Board recommends** that WesternGeco submit a mitigation plan for DFO's approval, in order to prevent significant adverse environmental effects on fish by air guns. This will include unconditional shutdown in all areas of known sensitivity as identified by DFO in its Technical Report of June 9<sup>th</sup>, 2003, and the submission of June 13<sup>th</sup>, 2003. This mitigation plan shall be approved by DFO before the NEB issues an authorization for this development.

**The Review Board recommends** that WesternGeco proceed with the development with the addition of a program for monitoring, evaluation and management, in order to prevent significant adverse environmental impacts on fish. The Review Board makes this recommendation notwithstanding the inconclusive nature of the recent study, because the evidence on the record suggests that a single pass will result in brief and intermittent exposure to air gun noise, resulting in a risk that is acceptable if well-managed. This monitoring program should allow for adaptive management, and be designed cooperatively between the developer and DFO. If this monitoring identifies acute adverse impacts on fish, the seismic program is to immediately shutdown until DFO has approved its re-starting. The program must include monitoring and related research to develop an understanding of the acute and long-term effects of the development on fish, and should be conducted in conjunction with the development. DFO should provide quality assurance and control, as well as supervise the implementation of the program. DFO and WesternGeco must ensure that the study considers comments raised in this environmental assessment regarding research design and methodology.

**The Review Board suggests** that WesternGeco and DFO consult the Sahtu and Gwich'in Renewable Resources Boards and consider Traditional Knowledge when designing the fish impact monitoring program.

**The Review Board suggests** that the research methodology and analysis issues raised by the parties to the EA and Dr. Popper be considered carefully in the design of future research on the effects of air guns on fish.

## 10 Impacts on Harvesting

Two types of issues arose on the public registry with respect to the potential cultural impact of effects on harvesting. These were concerns over physical interactions between the project and fish nets, fish camps and related river traffic, and effects on catch.

With respect to harvesting, the Review Board included the following instructions in section 4.9 (Land and Resource Use) of the Terms or Reference that were issued to WesternGeco:

*(WesternGeco) shall discuss the potential impacts of the proposed development on land and resource use along with potential mitigation methods and residual impacts. This discussion shall include, but not be limited to, the following:*

- *traditional land use and occupation;*
- *existing land use and occupation;*
- *availability, abundance and quality of wildlife and fish for subsistence, recreational and/or commercial harvesting; ...*

*In this discussion, WG shall include a detailed description of how it will respond to all other river traffic, (including small boats). WG shall also include a description of planned mitigations related to potential infringement on Aboriginal harvesting rights, including disruption to materials (such as nets) and activities.*

### 10.1 WESTERNGECO'S SUBMISSION

#### 10.1.1 *Physical Interactions with River Users and Nets*

WesternGeco said in its report of Feb. 2003 that community-based monitors stated "fishermen on the river and in camps did not feel inconvenienced or affected by the Test Program... (During the survey) wildlife monitors in the scout boat will precede the seismic vessels to check for potential problems. WesternGeco wrote that "during the development, community-based monitors will act as point of contact before, during and after the Project.... Any damaged nets could be replaced quickly". WesternGeco also cites its "extensive efforts to avoid areas containing nets".

In response to Information Request 1.2.20, proposed by DFO and issued by the Review Board on April 24<sup>th</sup>, 2003, WesternGeco further states that no nets were observed during the field tests. It also responded that nets are likely to be in places with less current than the deepest navigation route (the river's thalweg), the development's proposed course. If fishing nets interfere with safe navigation, the vessel will change course or request net removal.

WesternGeco concludes, with medium certainty, that their impacts from conflicts with fish harvesting are possible, but likely to be rare, of low magnitude and localized, and therefore have a low significance.

To avoid conflicts with other river users and to provide advance notice of the seismic survey, WesternGeco (Feb. 2003, s.11) proposes to have scout boats notify other river users of the advancing program. These same boats will notify the seismic vessel captain of oncoming river traffic. Please see Appendix Four of this document for a summary of WesternGeco's proposed mitigation measures related to local river traffic and fish harvesting.

WesternGeco finds, with medium certainty, that it will probably occasionally encounter other river users, but that any impacts are likely to be short term with low magnitude.

#### *10.1.2 Impaired Fishing Success*

WesternGeco (Feb. 2003, s. 9.2.2.2 pp.118-119) reviews the literature of effects of air guns on fish harvesting. It points out that most, if not all, studies have been conducted in the ocean environment, and states that "the studies cited generally indicated that catch rates return to normal within hours after disturbance". Some of the studies, however, did show reductions in catch, one showing lasting effects over a large area.

During the WesternGeco field tests in 2002, community monitors talked with people on the river and at fishing camps. No changes in fishing success were recorded after the seismic program.

In the preamble to Information Request 1.1.5. (April 7<sup>th</sup>, 2001), the Review Board notes that WesternGeco's report indicates "that there was more interest than concern in the proposed seismic river program. Content analysis of all the community-based monitoring reports does not support this generalization. Monitoring reports indicate concerns regarding potential effects on fish, fish harvesting and concerns for the preparation of the monitoring reports". The monitoring reports lack detailed information on observed changes in fish catch.

In its Feb. 2003 report, WesternGeco concluded, as a result of the literature, the community monitoring and the results of the field research on fish movements, that adverse effects on fishing success are unlikely. In its May 1, 2003, response to IR 1.1.5 (e), WesternGeco states that confidence in the prediction is only 'medium' and that "The assessment of medium confidence was based on a limited understanding of the cause-effect relationships using data pertinent to the study area".

## **10.2 OTHER SUBMISSIONS**

In its submission of June 25, 2002, the Gwich'in Renewable Resource Board describes concerns regarding interactions with harvesters and proposed mitigation to limit their disturbance. It also describes concerns over conflicts with river traffic, and specifically whether traditional harvesters on the river will be asked to move. On July 12<sup>th</sup>, 2002, the Sahtu Renewable Resource Board voiced concern over the avoidance of fish camps and fish nets during the test study.

On January 15<sup>th</sup>, 2002, Deh Cho First Nations wrote that “for the Dene and Metis of the Deh Cho, the whole of the Mackenzie River in the Deh Cho is a traditional fishing river that provides crucial subsistence fishing... Therefore, any proposed activity on the Mackenzie River affects all Deh Cho communities...”. They requested that the Terms of Reference for this environmental assessment include “an in-depth explanation on how (WesternGeco) will respond to all other river traffic, including fishing vessels and small fishing boats, canoes and kayaks, and other river traffic” and “a detailed explanation on how (WesternGeco) will mitigate any infringement on Aboriginal harvest rights, including but not limited to Right of Way, damage or disruption to harvesting activities, and damage or disruption to harvesting gear and nets”.

## **10.3 CONCLUSIONS OF THE REVIEW BOARD**

The Review Board notes that the Gwich'in and Sahtu land claim agreements contain provisions to compensate renewable resource harvesters for any loss or damage of property or equipment related to harvesting which result from development activities. Bearing these in mind, the Review Board accepts the proposed mitigation related to physical interactions with river users and fishing nets as adequate for the parts of the development in the Sahtu and Gwich'in settlement areas. Given these provisions and the proposed mitigation measures including use of scout boats and net avoidance, the Board does not find that the development is likely to cause significant adverse impacts on harvesters due to loss or damage of equipment in the Sahtu and Gwich'in Settlement Areas. No such provisions apply to loss or damage of harvesting property or equipment in the Deh Cho region.

The Review Board notes that WesternGeco's proposed use of scout boats is expected to prevent some conflicts with river users and nets.

With respect to impacts on fishing success, the Review Board finds the following:

- The literature is not conclusive, and is based on different species from those in the development area, in a different setting from the development, with different air gun activity.
- Although no changes in fishing success were noted, the interviews did not appear to consistently look for this information. The Board does note that WesternGeco proposes to use a more standardized interview format during the actual project.

- The field study results regarding fish movements with respect to the development are inconclusive.
- All mitigations that minimize impacts on fish are also mitigations that minimize long term impacts on fishing success.
- The Board is aware that the Mackenzie River is a complex ecosystem, and that fishing success may be influenced by natural variations as well as those caused by human activities.

The Review Board notes that there are provisions in the Gwich'in and Sahtu land claims that protect renewable resource harvesting and harvests, and that the land claims include a system for arbitration applicable if compensation claims cannot be resolved.

In the Review Board's view, these land claims based systems are sufficient to address any impacts of this development on harvesting in the settlement areas. There is, however, no legally binding compensation system in place for the Deh Cho region and harvesters in the Deh Cho could be exposed to impacts on their harvesting activities which would otherwise be mitigated in the Gwich'in and Sahtu settlement areas.

The Review Board therefore finds that this development is likely to cause significant adverse impacts on harvesting activities in the Deh Cho unless the following mitigation measures are implemented.

#### **10.4 RECOMMENDATIONS**

**The Review Board recommends** that in order to prevent significant adverse impacts on Deh Cho Dene and Metis harvesters the NEB include provisions in its authorizations that provide protection measures similar to those outlined in Section 17.1.2 of the Gwich'in Comprehensive Land Claim Agreement, and Section 18.1.2 of the Sahtu Dene and Metis Comprehensive Land Claim Agreement, to be applied to the Deh Cho portion of the development.



# 11 Socio-Economic Impacts

This section considers socio-economic impacts excluding those related to impacts on harvesting, which are discussed in Section 10.

With respect to socio-economic impacts, the Review Board instructed WesternGeco as follows in the Terms of Reference:

*WG shall provide details on the existing socio-economic environment and discuss potential development impacts. This should include information such as identifying the local businesses that will be involved in the development, the likely increase in local employment, implications for community quality of life impacts as well as the documentation and details related to any other predicted social and economic impacts and mitigation measures.*

## 11.1 WESTERNGECO'S SUBMISSION

In its report of Feb. 2003, WesternGeco states that it is committed to develop a "mutually beneficial relationship with residents in the vicinity of the Project, and First Nation leaderships". It goes on to state that there are less employment opportunities on a ship-based seismic program compared to a land-based seismic program.

It lists a total of 8 to 17 positions that would be open to people who reside in the Inuvialuit Settlement Area, Gwich'in Settlement Area, Sahtu Settlement Area and the Deh Cho region. WesternGeco intends to have one crew for both this and the Mackenzie Delta portion of its activity.

In addition to ship crew, WesternGeco says that a number of community-based monitoring positions will be available, and that NTCL will use local businesses for resupply.

WesternGeco described overall residual economic impacts to be positive and regional, but of low magnitude and of low significance.

## 11.2 CONCLUSIONS OF THE REVIEW BOARD

The Review Board agrees with WesternGeco's prediction that positive economic impacts will be of low significance, due to the small number of positions available and the short duration of the work. The Review Board recognizes that this appears to be a characteristic of this type of activity.

## 12 Spiritual Impacts in the Deh Cho Region

With respect to the subset of impacts on culture described as “spiritual impacts”, the Review Board included the following instructions in section 4.12 (Cultural and Heritage Resources) of the Terms or Reference that were issued to WesternGeco:

*(WesternGeco) shall discuss the potential impacts of the proposed development on cultural and heritage resources along with potential mitigation methods and residual impacts. This discussion is to include, but not be limited to, a discussion of the significant areas of the Mackenzie River as designated by the Gwich'in, Sahtu and Deh Cho organizations, as well as the mitigation required to maintain the values that resulted in the identification of these areas. WG shall describe the spiritual significance of the Mackenzie River, and describe related cultural impacts and any proposed mitigations.*

### 12.1 WESTERNGECO'S SUBMISSION

In WesternGeco's report of Feb. 2003, (s.8.6.4), it states that “As there are no land-based activities associated with the project, no residual impact to cultural... resources is predicted... Thus description of surrounding cultural and historic resources has not been needed.”

### 12.2 OTHER SUBMISSIONS

The Deh Cho First Nations stated, in a submission of Jan. 15, 2003, that the Mackenzie River holds spiritual and cultural importance for all communities in the Deh Cho region. It further notes that Deh Cho First Nations has agreed that the Mackenzie River waters and riverbed have been included in the areas selected for Interim Land Withdrawals.

Regarding the above prediction in WesternGeco's (Feb. 2003) report, Deh Cho First Nations wrote to the Review Board on April 11<sup>th</sup>, 2003, that the conclusion considered only specific artifacts and sites, and failed to consider the Mackenzie River itself as a cultural resource.

The Review Board issued an Information Request (IR 1.1.1) to Deh Cho First Nations requesting its assistance in understanding the importance of its spiritual sites, asking specifically “1) What portion of the river is important to the spiritual well-being of the DCFN? 2) Is the spiritual value of the Mackenzie River diminished or altered by river seismic exploration in a manner different from existing river traffic? If so, how has the spiritual value changed?”.

Deh Cho First Nations responded that the entire river is integral to the culture and to spiritual well-being of the Dene and Metis in the Deh Cho region, and states that “the whole river is the lifeblood of our culture”. Deh Cho First Nations states that altering or tampering with the river will be perceived as sacrilegious, that it is the core of the identity of the people of the Deh Cho, and that “the Deh Cho holds immense spiritual and cultural importance for the

Dene and Metis ... The Deh Cho waters have spiritual significance in that the waters have the power to heal, to purify and cleanse oneself?.

In response to the second question, regarding how river seismic spiritual impacts are different from existing river traffic, Deh Cho First Nations states:

*Existing river traffic is predominantly for subsistence fishing and for the transportation of people and goods. Seismic exploration differs in its intent, as it is using waters of the Dene in an intrusive way. The intent of seismic is also to take information about the subsurface lands, for monetary gain... Many Dene have also expressed that the purification and healing powers of the water will be made unusable and that seismic on the Deh Cho offends Dene values and may destroy the lifeblood of the river. We have also expressed that Dene values are more important than money; values are a way of life and we must look towards the future generations, not today.*

On receipt of the IR response from Deh Cho First Nations, the Review Board issued an IR to WesternGeco asking if, in recognition of the above, it wished to amend its predictions regarding cultural impacts. WesternGeco replied that it did not wish to.

Following this, the Village of Fort Simpson (May 21, 2003) noted that the above response from Deh Cho First Nations was not signed, and pointed out that it may or may not represent the Deh Cho First Nations in its entirety. The Village of Fort Simpson Council said it realizes the importance of the Mackenzie River with regards to the spiritual well being of the Deh Cho First Nations.

Following an inquiry by the Review Board, Deh Cho First Nations specified that the response to IR 1.1.1 was drafted as follows: The contributors were Grand Chief Michael Nadli and Deputy Grand Chief Michael Cazon, with input from Deh Cho First Nations Executive Director Alison DePelham. The response was reviewed and approved as culturally appropriate by Pehdzeh Ki First Nation Chief Tim Lennie.

### **12.3 CONCLUSIONS OF THE REVIEW BOARD**

The Review Board notes that WesternGeco has not disagreed with any of the points raised by the Deh Cho First Nations with respect to cultural significance of the Mackenzie River. The Review Board further notes that The Village of Fort Simpson acknowledged the importance of the Mackenzie River to the spiritual well-being of the Deh Cho First Nations, and that Deh Cho First Nations has specified who collaborated on the Information Request response.

It also notes that no issues directly related to spiritual impacts have been raised in the Sahtu or Gwich'in settlement areas, although cultural issues related to harvesting have been raised in both.

The Review Board recognizes that the Mackenzie River is of spiritual and cultural importance for the Dene and Metis of the Northwest Territories.

The Review Board finds that developments in the Mackenzie River may cause impacts to the spiritual well-being of the people of the Deh Cho region. However, the Review Board further notes that the development involves a single pass up the Mackenzie River, with no constructed structures or resource extraction proposed. The Review Board finds that lasting residual significant impacts related to spirituality from this development as proposed are not likely.

### **12.4 SUGGESTIONS**

**The Review Board suggests** that Deh Cho First Nations develop a protocol regarding spiritually acceptable activities on the Mackenzie River, to inform land use planners, developers, and environmental impact assessment decision makers in the future.

## 13 Cumulative Impacts

In the Terms of Reference, the Review Board instructed WesternGeco as follows:

*WG shall Analyze and report on the cumulative impacts that might result from the development impacts in combination with those of other past, present or reasonably foreseeable developments or activities. WG should:*

- a) Identify the valued components that may be affected by the proposed development in combination with other human activities.*
- b) Identify the other past, present and reasonably foreseeable human activities and developments that may affect the same valued components.*
- c) Predict the combined impact of the proposed development in combination with the past, present and reasonably foreseeable future activities and developments (b) on the valued components identified (a).*
- d) Describe ways to avoid, mitigate or manage those impacts.*

### 13.1 WESTERNGECO'S SUBMISSION

In Section 10 of its report of Feb. 2003, WesternGeco stated that it included the Mackenzie Delta and riparian habitat within one kilometer of shore, as a "conservative approach to ensure that the CESA (cumulative effects study area) is large enough to address all potential cumulative effects. Temporally, it included "only approved or known, man-made projects or activities" (s.10.1, p.131).

WesternGeco also states that "Since the proposed Project has no permanent footprint, only those projects or activities occurring while it is in operation will be considered". It points out that the majority of existing disturbance along the Mackenzie and Liard Rivers is land-based, and that there is no potential for cumulative effects in conjunction with land-based development. WesternGeco considers other traffic on the river, its own program proposed for the Mackenzie Delta, and the proposed Northern River Surveys Ltd. river seismic program for the Liard River.

WesternGeco committed to liaise closely with Northern River Surveys Ltd. to ensure the two programs do not operate within five kilometers of each other. WesternGeco identified the potential for low magnitude, short term adverse cumulative effects on fish, semi-aquatic mammals, terrestrial wildlife, traditional land use, other land use (i.e. other vessels). Of these, the cumulative effect on fish was expected to be regional, and local for all others. All are predicted to have low or negligible significance.

WesternGeco predicted a positive regional short-term socio-economic impact, based on local employment and purchase of supplies.

## **13.2 CONCLUSIONS OF THE REVIEW BOARD**

The Review Board notes that WesternGeco looked at the cumulative effects of its development in combination with other projects or activities that will occur during the seismic survey. However, the Review Board instructed WesternGeco to consider its impacts in combination with those of other past, present and reasonably foreseeable developments. WesternGeco failed to consider effects of past or reasonably foreseeable developments, and did not examine the effects of developments occurring along the shores or surrounding land adjacent to the Mackenzie or Liard rivers.

Despite the quality of the developer's submission, there is no evidence on the public record that indicates that there will be a significant adverse cumulative impact, nor significant concern regarding this issue. Therefore, the Review Board finds that the proposed development is not likely to cause a significant adverse cumulative impact.

## 14 Public Consultation

With respect to public consultations, the Review Board included the following instructions in section 4.7 (Public Consultations) of the Terms of Reference that were issued to WesternGeco:

*WG shall summarize consultations undertaken with federal and territorial government departments, municipal governments, aboriginal groups and non-governmental organizations, listing dates, and participants. WG shall describe any concerns that were raised and detailing the responses to the concerns. Any unresolved concerns shall be highlighted along with a description of the intended course of action to resolve the concerns. In addition to the summaries, WG shall provide full minutes of all community meetings in an appendix to the Developer's Assessment Report.*

### 14.1 WESTERNGECO'S SUBMISSION

In the report of Feb. 2003, WesternGeco identified twelve communities along the Mackenzie and Liard Rivers within the development area. These are Inuvik, Aklavik, Fort MacPherson, Tsiigehtchic, Fort Good Hope, Norman Wells, Tulita, Wrigley, Fort Simpson, Jean Marie River, Nahanni Butte and Fort Liard. Between March 4<sup>th</sup> and 7<sup>th</sup>, 2002, community consultation sessions were held. A total of 27 meetings with communities and organizations were met with, between March 3-19<sup>th</sup>, 2002, May 6-10, 2002, and Jan. 15-29, 2003. These are listed in section seven of WesternGeco's report<sup>13</sup>.

### 14.2 OTHER SUBMISSIONS

On April 16, 2002, during preliminary screening, Nola Benwell of the Deh Cho First Nations contacted the Review Board to inquire about standards for consultation, indicating that only one resident attended one community meeting and other First Nations had not been consulted. The project referral to the MVEIRB on June 25, 2003 coincided with further correspondence from the Gwich'in Renewable Resources Board expressing concerns about a failure to meet with the Renewable Resource Council or the Gwich'in Renewable Resource Board during WesternGeco's public consultation. The Sahtu Renewable Resources Board, in correspondence dated July 12, 2002, similarly highlighted the lack of consultation with the Renewable Resource Councils and the Sahtu Renewable Resources Board that are mandated to manage, protect and conserve all fish and wildlife in the Sahtu Settlement Area.

Comments on the draft Terms of Reference and Workplan from INAC, in a letter dated January 9, 2003, specifically requested that the developer provide dates and participants for each consultation. January 15, 2003, the Laura Pitkanen submitted a letter on behalf of Deh

<sup>13</sup> Consultation by monitors during the test study is described in s.10.1 of this document, as it pertained more directly to potential impacts on harvesting.

Cho First Nations stating they were “wholly unsatisfied with the consultation process undertaken by WesternGeco for this 2-D River Seismic Program”. Specifically, the letter noted the lack of consultation information on the public record, indicating that the consultation with the communities was not representative of all Deh Cho communities in failing to encompass the Deh Cho Leadership. The Deh Cho First Nations asked that the Draft Terms of Reference require details of all consultation “including minutes, lists of people in attendance, and WesternGeco’s response to community concerns” rather than summaries that interpret as opposed to provide evidence of community input.

In response, WesternGeco agreed, in an e-mail dated January 23, 2003, to:

- participate in a meeting with the Deh Cho First Nations Group Leadership Meeting to present results of the 2002 Test Program;
- contact the Band Councils in Fort Liard, Nahanni Butte, Fort Simpson, Jean Marie River and Wrigley to offer to provide continuing updates on the project
- hold for the Deh Cho First Nations a workshop similar to the workshops held in Calgary December 5, 2003 and Yellowknife, December 12, 2003.

In a letter date stamped January 23, 2003, WesternGeco expressed concern and surprise at the number of issues raised by the Deh Cho First Nations, given the meetings with Deh Cho Chiefs and support staff and public in the communities during May and June 2002.

### **14.3 CONCLUSIONS OF THE REVIEW BOARD**

The Review Board notes that WesternGeco has compiled detailed information regarding public consultation. The records of consultation provided in WesternGeco’s submission vary between interpretive summaries and detailed transcripts. This inconsistency makes it difficult to draw conclusions about the quality of information provided to the parties.

WesternGeco did make a commendable effort to reconfigure public consultation to better respond to the changing capacity and information needs of communities throughout the Mackenzie Valley. This is particularly noted in consultation with the Deh Cho First Nations.

The Review Board notes that WesternGeco did not provide any direct response to all public concerns relative to the cultural value of the Mackenzie River. This issue is described in section eleven of this report.

The Review Board finds that the concerns voiced in public consultation will be adequately addressed by its recommendations or suggestions. The Board does not find that there will be outstanding significant public concern related to this project with the successful implementation of these recommendations and suggestions.



## 15 Final Conclusions

Based on the evidence on the public record, the Review Board finds the proposed development may have a significant adverse environmental impact on fish and fish harvesting. The Review Board has concluded that mitigation measures are required. The mitigation measures recommended herein will ensure that significant adverse environmental impacts will not occur.

If the recommendations are not followed, the Review Board's conclusions regarding impact significance may change.

The Review Board notes that the conclusions related to air gun impacts described in this Report of Environmental Assessment are specific to WesternGeco's proposed development. Impacts may be different for air guns with different configurations, sizes and settings.

In addition to the three recommendations, the Board has made six suggestions concerning wildlife, the monitoring of impact on fish, and spiritual well-being of the Dene and Metis of the Deh Cho. These are intended to be advisory in nature.

## Appendix 1

### List of Recommendations

Based on a consideration the information on the Public Registry, makes the following recommendations, as per MVRMA s.128(1)(b)(ii):

1. **The Review Board recommends** that WesternGeco submit a mitigation plan for DFO's approval, in order to prevent significant adverse environmental effects on fish by air guns. This will include unconditional shutdown in all areas of known sensitivity as identified by DFO in its Technical Report of June 9<sup>th</sup>, 2003, and the submission of June 13<sup>th</sup>, 2003. This mitigation plan shall be approved by DFO before the NEB issues an authorization for this development.
2. **The Review Board recommends** that WesternGeco proceed with the development with the addition of a program for monitoring, evaluation and management, in order to prevent significant adverse environmental impacts on fish. The Review Board makes this recommendation notwithstanding the inconclusive nature of the recent study, because the evidence on the record suggests that a single pass will result in brief and intermittent exposure to air gun noise, resulting in a risk that is acceptable if well-managed. This monitoring program should allow for adaptive management, and be designed cooperatively between the developer and DFO. If this monitoring identifies acute adverse impacts on fish, the seismic program is to immediately shutdown until DFO has approved its re-starting. The program must include monitoring and related research to develop an understanding of the acute and long-term effects of the development on fish, and should be conducted in conjunction with the development. DFO should provide quality assurance and control, as well as supervise the implementation of the program. DFO and WesternGeco must ensure that the study considers comments raised in this environmental assessment regarding research design and methodology.
3. **The Review Board recommends** that in order to prevent significant adverse impacts on Deh Cho Dene and Metis harvesters the NEB include provisions in its authorizations that provide protection measures similar to those outlined in Section 17 of the Gwich'in Comprehensive Land Claim Agreement, and Section 18 of the Sahtu Dene and Metis Comprehensive Land Claim Agreement, to be applied to the Deh Cho portion of the development.

## Appendix 2

### List of Suggestions

1. **The Review Board suggests** that scout boats look for mammals in the river more than one kilometere before the source vessel, and coordinate with the wildlife monitor on the source vessel for shutdowns as needed.
2. **The Review Board suggests** that WesternGeco talk to RWED about the known crossing points for wood bison before the operation, and notify local RWED personnel when these areas are being approached.
3. **The Review Board suggests** that scout vessels record all wildlife observations, rather than only record wildlife observations when air guns are firing. Wildlife observation records should be shared with the Sahtu and Gwich'in Renewable Resources Boards, Deh Cho First Nations and RWED.
4. **The Review Board suggests** that WesternGeco and DFO consult the Sahtu and Gwich'in Renewable Resources Boards and consider Traditional Knowledge when designing the fish impact monitoring program.
5. **The Review Board suggests** that the research methodology and analysis issues raised by the parties to the EA and Dr. Popper be considered carefully in the design of future research on the effects of air guns on fish.
6. **The Review Board suggests** that Deh Cho First Nations develop a protocol regarding spiritually acceptable activities on the Mackenzie River, to inform land use planners, developers, and environmental impact assessment decision makers in the future.

## Appendix 3

### Summary of Commitments by WesternGeco

The following commitments were made by WesternGeco in their environmental assessment report (EAR) of Feb. 2003.

Source	Description of Commitment
EAR 8.1; 8.3; 9.2.2; 9.2.3; 9.2.9; 10.2; 10.3; 11.0; Appendix IV; Appendix V	Ship-based monitors will be employed to scout ahead of boat 2 km to look for people swimming, boats, nets, camps, on shore activity to avoid conflict. Complete wildlife observation form for wildlife observed in water while air guns fire. Check wildlife distances using laser range finder. Notification of Captain if terrestrial, semi-aquatic or aquatic wildlife within 1 km.
EAR 8.1; 8.3; 9.2.2; 9.2.3; 9.2.9; 10.3.1; 11.0; Appendix III; Appendix IV	Community-based monitors will be employed to directly identify impacts from boat or anecdotal evidence from fishers and hunters. Monitors 2 km behind the boat will scout for injured or dead wildlife. Report to RWED if injured or dead semi-aquatic or terrestrial wildlife are found. Report to DFO if injured or dead marine mammals are found. Dead or stunned fish will be reported to DFO. Program suspended subject to discussion with RWED/DFO if dead or injured wildlife are found. Program suspended if more than 10 stunned fish are encountered within 1 hr or if dead fish are found pending discussion with DFO.
EAR 8.5.1.1; Appendix IV	Ongoing discussions with RWED to avoid disturbance to terrestrial wildlife, raptors and nesting waterbirds
EAR 3.3.3; 5.1.4	Program will avoid most sensitive nesting period
EAR 3.3.1; 3.3.3; 9.1.1; Appendix IV	Vessels will not operate near shore
EAR; 3.2.4; 8.2.1.1; 9.2.3; Appendix III; Appendix IV	Ramp up procedures will be used.
EAR 3.2.11; 4.0; 5.1.4; 9.1.1; 9.2.4; Appendix IV	Program timing and schedule
EAR 9.2.3; 9.2.4; Appendix IV	Shutdown will occur if wildlife (aquatic, semi-aquatic or marine) is observed in water within 1 km.
EAR 8.6.2; 8.6.3, 9.6.2; 8.6.3; 9.2.10; 10.3.2; Appendix IV	Communication with other river traffic
EAR; 3.3.1; 4.0; 5.1.2; 8.11.2; 9.2.5; 9.2.6.2	Vessels will stay in the deepest part of the channel to avoid disturbance of the river bed. Following scout boat will monitor the position of end of cable.
EAR 5.1.2; 8.2; 9.2.2.1; 10.3.1; Appendix III	Project routed through deepest part of the river to avoid typical spawning and rearing habitat.
EAR 3.3.4; 5.1.4; 8.2; 10.3.1	Scheduling of project so that most dispersal predicted to occur before the project starts.
EAR 3.3.4; 5.1.4; 8.2; 9.2.2.1; 10.3.1	Scheduling of project to avoid most fish migration

EAR 9.2.2; Appendix III	Limit exposure; sounds will be pulsed not continuous; array size to be used has been shown not to kill fish
EAR 5.1.2	Use of optimum array depth to minimize exposure with depth monitoring by WG
EAR 9.2.2.2	There will be periodic shutdowns of air guns.
EAR 7.2; 10.3.3	Ongoing community consultation will be undertaken regarding fish harvesting.
EAR 8.5; 9.2.2.2; 9.2.9; 10.3.3; 11.0; Appendix III; Appendix V	Community based monitors will advise local HTC's of the project schedule and check for any issues before and after boat passes.
EAR 6.6.2; 9.2.10	Communication between project vessels and ferry captains will avoid conflicts.
EAR 9.2.8; 11.0	Water quality will be monitored by environmental monitors.
EAR 8.6.1; 9.2.10.1; 10.3.4	NTCL push-boats and crews will be used to facilitate integration.
EAR 3.1	WG will work closely with all interested parties in an open process to ensure planned activities are understood and activities result in minimal impact.
EAR 3.2.3; 3.3.1	Air guns will be operated greater than 1 m above the river bottom to avoid kicking up silt and sand particles.
EAR 3.2.5.2	Streamers equipped will be used in water depths that are 2 m or greater. Streamers will be equipped with depth transducers to prevent them from touching bottom. GPS floats at the end of the streamer will provide end of streamer position information.
EAR 3.2.8	The seismic crew will work during daylight hours for effective environmental monitoring.
EAR 3.2.8	Environmental monitors will be employed
EAR 3.2.8	Each non-marine personnel joining the vessel for the first time will be given a full safety orientation.
EAR 3.3.1	Shelter will be sought in the event of extreme flood conditions that may pose a hazard to the vessel and crews.
EAR 3.3.2	Damaged equipment will be repaired or replaced immediately.
EAR 3.3.2	Any equipment torn loose would be picked up by support vessels.
EAR 3.3.5	If a slide is of sufficient magnitude to impede the program, the vessels would anchor in a safe location or proceed to the nearest downstream docking facilities.
EAR 3.3.6	In poor weather, air gun shooting will halt.
EAR 3.3.6	In severe storm with high waves and lightening, the vessels will seek shelter at an appropriate location and anchor to wait for safe conditions.
EAR 3.3.8	When noise from other barge traffic interferes with data quality, recording will be suspended, reducing cumulative effects.

## Appendix 4

# WesternGeco's Summary of Proposed Mitigations

The following table was submitted to the Review Board on May 15<sup>th</sup>, 2003 in response to Information Request 1.2.24. It is provided as a reference. Note that some cross-references to sections of WesternGeco's Feb. 2003 report may be inaccurate.

Potential Impact	Proposed Mitigation	Proposed Monitoring	Responsibility	Section of EA
Effect of noise on traditional and commercial fishing	Use of environmental monitors <sup>1</sup>	<p>Ship based monitors will work up to 2 km ahead of boat, to look out for people swimming, boats, nets, camps on shore, etc. Ensure no conflicts occur. Complete wildlife sighting form for each observation of wildlife in water while airguns are firing. Watch for debris in river. Communicate observations to Captain.</p> <p>Community based monitors will make daily boat trips before, during and after the seismic vessels pass, searching for sign of impacts that could be associated with the Project. They also liaise with local fishers and hunters to see if any concerns have been raised.</p>	WesternGeco Project Manager is responsible for seeing that monitors are hired	8.1; 9.2.2; 9.2.9; 11.0
Terrestrial mammal disturbance	On-going discussions with RWED		WesternGeco Project Manager	8.5.1.1; Appendix
	Vessels will not operate near shore		NTCL Captain	3.3.1; 3.3.3; 9.1.1; Appendix IV
	Use of ramp up procedures		WesternGeco Marine Advisor	3.2.4; 9.2.3; Appendix
	Location and timing of Project		WesternGeco Project Manager	3.2.11; 4.0; 9.1.1; 9.2 Appendix IV
	Shutdown if wildlife observed in water within 1 km		NTCL Captain	9.2.3; 9.2.4; Appendix

Potential Impact	Proposed Mitigation	Proposed Monitoring	Responsibility	Section of EA
	Communication with other river traffic		NTCL Captain	8.6.2; 8.6.3; 9.2.10; 10.3.2; Appendix IV
	Use of environmental monitors	Environmental monitor duties as above.	WesternGeco Project Manager	11.0; Appendix IV
Nesting raptor disturbance	On-going discussions with RWED		WesternGeco Project Manager	8.5.1.1; Appendix IV
	Use of environmental monitors	Environmental monitor duties as above.	WesternGeco Project Manager	11.0; Appendix IV
Nesting waterfowl disturbance	Project to occur after most sensitive nesting period		WesternGeco Project Manager	3.2.11; 3.3.3; 5.1.4
	Use of ramp up procedures		WesternGeco Marine Advisor	3.2.4
	Use of environmental monitors	Environmental monitor duties as above.	WesternGeco Project Manager	11.0; Appendix IV
Semi-aquatic mammal disturbance	Use of ramp up procedure		WesternGeco Marine Advisor	3.2.4; 9.2.3; Appendix IV
	Shutdown if wildlife observed within 1 km		NTCL Captain	9.2.3; Appendix IV
	Communication with other river traffic		NTCL Captain	8.6.2; 8.6.3; 9.2.10; 10.3.2; Appendix IV
	Use of environmental monitors	Environmental monitor duties as above, plus: On the vessel, monitors will check wildlife distances to vessels using laser range finder. Communicate to Captain if any semi aquatic mammals and marine mammals are within 1 km. Captain to halt operations if this threshold approached.  Monitors 2 km behind boat will search for injured or dead wildlife. Report to RWED (or DFO for marine mammals) if any found, and Project to be suspended pending further discussion with RWED/DFO.	WesternGeco Project Manager	8.3; 9.2.3; 11.0; Appendix IV

Potential Impact	Proposed Mitigation	Proposed Monitoring	Responsibility	Section of E
Physical effects to semi-aquatic mammals	Use of ramp up procedure		WesternGeco Marine Advisor	3.2.3; 9.2.3
	Shutdown if wildlife observed within 1 km		NTCL Captain	9.2.3
	Communication with other river traffic		NTCL Captain	8.6.2; 8.6.3; 9.2.10
	Use of environmental monitors	Environmental monitor duties as above, plus: On the vessel, monitors will check wildlife distances to vessels using laser range finder. Communicate to Captain if any semi aquatic mammals and marine mammals are within 1 km. Captain to halt operations if this threshold approached.  Monitors 2 km behind boat will search for injured or dead wildlife. Report to RWED (or DFO for marine mammals) if any found, and Project to be suspended pending further discussion with RWED/DFO.	WesternGeco Project Manager	8.3; 9.2.3; 11.0; Ap IV
Important species involvement (listed species)	Covered in other sections of this table. See Question 2-6 for more details.			8.3; 9.2.4
Grounding of equipment on the river bed	Vessels will stay in deepest part of river channels	Following scout boat will monitor position of end of cable.	NTCL Captain	3.3.1; 3.2.5.2; 5.1.2
Physical effect to eggs and larvae	Project routed in deepest part of river channel, thereby avoiding typical spawning and rearing habitat		NTCL Captain	5.1.2; 8.2; 9.2.2.1; Appendix III
Physical effect to young of year and adult fish	Scheduling the Project so that most dispersal predicted to occur before Project starts		WesternGeco Project Manager	3.2.11; 3.3.4; 8.1
	Scheduling Project to avoid most fish migration		WesternGeco Project Manager	3.2.11; 3.3.4; 5.1.4; 9.2.2.1; 10.3.1
	Limit exposure; sounds will be pulsed, not continuous; array size to be used has been shown not to kill fish		WesternGeco Marine Advisor	9.2.2; Appendix III



Potential Impact	Proposed Mitigation	Proposed Monitoring	Responsibility	Section of EA
	Use of optimum array depth to minimize exposure	Depth monitored by WesternGeco.	WesternGeco Marine Advisor	5.1.2
	Use of environmental monitors	Environmental monitor duties as above plus: Monitors 2 km behind boat will search for and collect any dead fish. Stunned fish will be reported to DFO. If more than 10 stunned fish observed within 1 hr, or any dead fish, Project will be suspended pending further discussion with DFO.	WesternGeco Project Manager	10.3.1; 11.0; Appendix
Behavioral response by fish	Use of ramp up procedure		WesternGeco Marine Advisor	3.2.4; 8.2.1.1; 10.3.1; Appendix III
	Periodic shutdown of airguns		WesternGeco Marine Advisor	9.2.2.2
Disturbance to invertebrates and their habitat from grounded equipment	Vessels will stay in deepest part of river channels	Following scout boat will monitor position of end of cable.	NTCL Captain	3.2.2; 4.0; 8.11.2; 9.2.9.2.6.2
Conflicts with fish harvesting	Ongoing community consultation		WesternGeco Project Manager	7.2; 10.3.3
	Use of community based monitors	Community based monitors will discuss with local HTC's to advise of Project schedule and check for any issues before and after boat passes.	WesternGeco Project Manager	8.5; 9.2.2.2; 9.2.9; 10.11.0; Appendix III; Appendix V
Conflict with local river traffic	Communication between Project vessels and ferry captains		NTCL Captain	6.6.2; 9.2.10
	Use of environmental monitors	Environmental monitor duties as above.	WesternGeco Project Manager	9.2.9; 10.2; 10.3; 11.0 Appendix V
Increased employment	n/a			9.2.11; 10.3.5
Reduction in water quality	Use of community monitors	Environmental monitor duties as above.	WesternGeco Project Manager	9.2.8; 11.0
	Vessels will stay in deepest part of river channel; avoid disturbance of river bed	Following scout boat will monitor position of end of cable.	NTCL Captain	4.0; 5.1.2

Potential Impact	Proposed Mitigation	Proposed Monitoring	Responsibility	Section of EA
Conflicts with regular barge traffic	Use of NTCL push-boats and crew facilitates integration		NTCL Captain	8.6.1; 9.2.10.1;
	Communication between Project vessel and ferry captains		NTCL Captain	9.2.10
	Use of environmental monitors	Environmental monitor duties as above.	WesternGeco Project Manager	10.3; 11.0; Appendix

<sup>1</sup> Both ship-based and community-based environmental monitors will be employed.

## Appendix 5

### Public Registry Items

The following items were considered by the Review Board during the course of this Environmental Assessment. All of these items are available to the public.

Title/Subject	Date rec'd/sent
Presentation made by WesternGeco in Yellowknife to various government departments and regulators.	22-Feb-02
WG's community consultation schedule for March.	27-Feb-02
Note to File by Vern Christensen on a phone call from Nola Benwell of the Deh Cho First Nations. Nola was wondering about standards for consultation given WesternGeco's claim that adequate consultation had occurred for this development.	16-Apr-02
WesternGeco report: Environmental Impact Assessment for the WesternGeco Mackenzie River 2D Seismic Program 2002. Submitted to the MVLWB with one copy provided for forwarding to the Review Board.	22-Apr-02
NEB's notification that they have received an application from WesternGeco for the development, are initiating the preliminary screening and are inviting review and comments.	2-May-02
Letter from the Fisheries Joint Management Committee to the EISC providing the FJMC's comments on the Mackenzie Delta development.	13-May-02
Letter from the Inuvialuit EISC to WesternGeco. The EISC determined that WesternGeco's application for the Mackenzie Delta program had deficiencies of a nature that warranted a termination of its consideration and the submission of another project description.	16-May-02
NEB's Information Request No.1 to WesternGeco for WG's Mackenzie Delta application.	21-May-02
GNWT comments on the proposed development in a letter to the NEB.	24-May-02
Fax from the NEB containing the comments it had received on WG's Mackenzie River application. Comments were submitted by the Sahtu Land and Water Board, the Prince of Wales Northern Heritage Centre, INAC-Water Resources Division, Transport Canada, Liidlii Kue First Nation and the GNWT-RWED.	27-May-02
Letter from DFO to the NEB providing comments on the development.	30-May-02
Fax from the NEB containing more comments it had received on WG's Mackenzie River application. Comments were submitted by the Town of Norman Wells, Environment Canada and DFO (same ones as Item #8).	31-May-02
NEB Information Request No. 1 to WG on the Mackenzie River development.	31-May-02
E-mail from Golder Associates providing details on a June 13 meeting in YK about the development.	5-Jun-02

WG's response to NEB IR No. 1. Submitted directly to the Review Board by WG.	10-Jun-02
Fax from the NEB requesting comments on WG's response to IR No.1.	11-Jun-02
E-mail from Golder Associates providing the agenda for the June 13th meeting.	12-Jun-02
WG's presentation from the meeting in the Copper Room of the Yellowknife Inn. Includes WG's draft proposed acoustic and biological assessment program.	13-Jun-02
DFO's comments on WG's draft proposed acoustic and biological assessment program.	19-Jun-02
Letter from the EISC to WG to advise that the Mackenzie Delta development has been referred to the EIRB for review.	19-Jun-02
Draft referral letter from the NEB for the Mackenzie River development.	24-Jun-02
EA referral letter from the NEB for the Mackenzie River development. Referral is being made jointly by the NEB and DFO.	25-Jun-02
Additional GNWT comments on the proposed development in a letter to the NEB.	25-Jun-02
Letter from DFO confirming that they agree with the NEB's referral letter.	25-Jun-02
Notice of Referral to Environmental Assessment sent from the Review Board to WG.	27-Jun-02
NEB letter to the GNWT acknowledging the GNWT's June 25th letter.	27-Jun-02
IMG-Golder's response, on behalf of WG, to DFO's comments on the proposed acoustic and fish monitoring program.	28-Jun-02
Notice of Referral to Environmental Assessment sent from the Review Board to the EA fax distribution list.	28-Jun-02
The Gwich'in Renewable Resource Board's comments on the proposed development.	28-Jun-02
Newspaper notice of the referral of the Mackenzie Delta development to the EIRB for a review.	8-Jul-02
The GRRB's letter (Item #29) faxed to the distribution list.	8-Jul-02
GNWT letter to WG providing comments on the proposed test program.	11-Jul-02
Letter from the Sahtu Renewable Resources Board to the Review Board providing comments on the proposed development.	12-Jul-02
The SRRB's letter (Item #33) faxed to the distribution list.	12-Jul-02
Three Northern News Services articles on the development: "Protecting a Lifeline", "Mackenzie Seismic on Hold" and Running Upstream".	12-Jul-02
E-mail from the NEB that contains the NEB's notification that they received WG's application for the test program and that the application is exempt from preliminary screening by Section 15 of the Exemption List Regulations. The e-mail also contains WG's detailed plan for the test program.	12-Jul-02
Faxed version of item #36. One additional document is a letter from WG to the NEB that describes that consultation undertaken by WG for the test program.	15-Jul-02

DFO Letter of Advice to WG for the test program.	15-Jul-02
E-mail exchange between the GNWT and the NEB regarding consultation for the test program.	15-Jul-02
E-mail request from the NEB to WG to have WG provide a response to the SRRB letter (Item #33).	15-Jul-02
E-mail request from the NEB to WG to have WG provide a response to the DFO Letter of Advice (Item #38).	15-Jul-02
Another e-mail request from the NEB to WG to have WG provide a response to the SRRB letter (Item #33).	18-Jul-02
Letter from the EIRB inviting the Review Board to apply for designation as a Registered Participant in the EIRB's review of the Mackenzie Delta development.	18-Jul-02
Letter from WG requesting that the EIRB put its review of the Mackenzie Delta development on hold.	26-Jul-02
Letter from the EIRB to its distribution list advising that its review of the Mackenzie Delta development has been placed on hold.	30-Jul-02
Letter from the NEB to WG advising that the NEB's review of the Mackenzie River development is suspended until the EA is completed and the question of an INAC-approved Benefits Plan is resolved.	8-Aug-02
Letter from the Review Board to WesternGeco and the distribution list advising that the EA is on hold until the test program is completed.	23-Aug-02
fax dist list - change of contact information for EA.	8-Jul-02
faxed letter of Aug. 19/02 from Lornel Consultants for NRS - response to WesternGeco's Aug. 13/02 letter: concerns with overlap between NRS' application and one from WesternGeco.	26-Aug-02
News clipping - re results of seismic tests on Mackenzie River.	26-Aug-02
email to WesternGeco - detailing phone conversation with Marty Swagar - EA on hold pending test program report.	4-Sep-02
email acknowledgement of above.	9-Sep-02
letter to Robert Moore, NRS: acknowledgement of request for intervenor status in WesternGeco EA.	19-Sep-02
faxed letter from NEB - copy of May 22/02 letter from Nahanni National Park re impacts being mitigated by communication strategy outlined in EIA report.	19-Sep-02
news clipping - Liidlii Kue First Nation may support seismic program on the Liard and Mackenzie rivers.	26-Sep-02
news brief - comments from Chief Rita Cli re seismic testing in region.	2-Oct-02
news brief - interview with Herb Norwegian, chief negotiator, Deh Cho FN re seismic testing on the Mackenzie River.	2-Oct-02
email to WesternGeco requesting 40 copies and 10 CD's of assessment report.	11-Oct-02
collection of media stories re seismic testing on the Mackenzie River. Sent to WesternGeco.	23-Oct-02

email to Marty Swagar re confidentiality of test program report.	23-Oct-02
Note to file - phone discussion with Keith Rosindell re presenting test program results in a workshop.	24-Oct-02
Bound copy of draft report prepared for WesternGeco- Wildlife Monitoring Survey for the WesternGeco Mackenzie River Seismic Test Study.	2-Nov-02
Bound copy of draft report prepared for WesternGeco- Acoustic Monitoring of WesternGeco 2002 Mackenzie River Seismic Project.	19-Nov-02
loose copy of above-noted document.	19-Nov-02
letter of Nov. 20/02 to RB summarizing phone discussions to facilitate the restarting of the EIA process.	2-Dec-02
Bound copy of draft report prepared for WesternGeco - Behavioural and Physical Response of Riverine Fish to Air guns.	1-Nov-02
loose copy of above-noted document.	1-Nov-02
loose copy of document in item #62.	1-Nov-02
copy of presentation - Behavioural and Physical Response of Riverine Fish to Air guns.	1-Nov-02
copy of presentation - Acoustic Monitoring Goals.	1-Nov-02
email to Keith Rosindell with attachments - Fish Behavioural Report.	27-Nov-02
fax dist list - letter to WesternGeco notifying that the EA has been re-activated, with <b>draft copy of Terms of Reference and Workplan</b> for the EA.	19-Dec-02
email to Keith Rosindell with attachment - meeting notes from the December 5/02 WesternGeco technical workshop in Calgary on acoustic/fish/wildlife report.	23-Dec-02
email to Keith Rosindell with attachment - meeting notes from the December 12/02 WesternGeco technical workshop in Yellowknife on acoustic/fish/wildlife report.	23-Dec-02
faxed letter to RB - comments from DFO on the 'Behavioural and Physical Response to Riverine Fish to Air guns' report.	8-Jan-03
fax dist list - meetings notes from the Dec. 5 and Dec. 12/02 workshops on acoustic/fish/wildlife report.	19-Dec-02
email cover sheet from EIRB - notice of receipt of WesterGeco's draft Environmental Impact Statement - <i>copy was supposed to be attached?</i>	8-Jan-03
email dist list - copies of draft field results are available upon request. Note - final field results will be reviewed as part of the developer's Assessment Report.	9-Jan-03
fax from INAC to RB - comments re the draft ToR and Workplan.	9-Jan-03
fax to RB from DFO - comments on draft ToR.	9-Jan-03

fax dist list - circulation of comments from INAC and DFO re draft Terms of Reference, and DFO's comments re WesternGeco's research results.	13-Jan-03
fax dist list - comments from Dr. Aurthur Popper re technical advice on the effects of sound on fish.	14-Jan-03
request from Lornel Consultants to re fax document of Jan. 9/03.	16-Jan-03
RB fax with above-noted missing pages.	17-Jan-03
email from DFO enclosing article: "WesternGeco kills seismic work".	28-Oct-02
additional comments to those provided by DFO re draft ToR. document forwarded to Deh Cho FN as requested.	13-Jan-03
	15-Jan-03
Note to file: phone conversation with DFO - they support Arthur Popper's comments re draft ToR and workplan.	15-Jan-03
fax dist list - comments forwarded by Deh Cho FN re draft ToR and Workplan.	16-Jan-03
actual comments from Deh Cho FN re draft ToR and Workplan.	16-Jan-03
<b>actual copy of ToR and Workplan for the WesternGeco EA.</b>	27-Jan-03
fax dist list - final ToR and Workplan	21-Jan-03
above document re-sent to Gwich'in Land Tribal Council as requested to alternate fax number.	30-Jan-02
email cc'd to Review Board - to Deh Cho FN summarizing steps that WesternGeco has committed to follow (i.e. workshops).	23-Jan-03
comments to Review Brd. re draft ToR and Workplan.	23-Jan-03
fax dist list - copies of items 94 and 95 above.	25-Jan-03
Email from WesternGeCo	31-Jan-03
Receipt of Developer's Assessment Report; EA Self-ID Forms	21-Feb-03
Deficiency Statement	21-Feb-03
EA Reports - 11 hard copies	5-Mar-03
RE: Identification of Environmental Assessment Roles	21-Feb-03
RE: Identification of Environmental Assessment Roles	24-Feb-03
RE: Identification of Environmental Assessment Roles	24-Feb-03
RE: Identification of Environmental Assessment Roles	25-Feb-03

RE: Identification of Environmental Assessment Roles	25-Feb-03
RE: Identification of Environmental Assessment Roles	27-Feb-03
RE: Identification of Environmental Assessment Roles	28-Feb-03
Alternative Source Configuration. Mackenzie River 2-D	5-Mar-03
Correspondence from WesternGeco faxed to Parties (Refer to Item # 108)	10-Mar-03
Correspondence from DFO RE: WesternGeco faxed to Parties (Refer to Item # 86)	14-Mar-03
RE: Identification of Environmental Assessment Roles	17-Mar-03
RE: WesternGeco - Deficiency Statement	17-Mar-03
RE: WesternGeco - Deficiency Statement faxed to Parties (Refer to Item # 112)	17-Mar-03
WesternGeco EA Information Request Guidance Note faxed to Parties	28-Mar-03
Information Requests from MVEIRB	7-Apr-03
Information Requests from MVEIRB faxed to Parties (Refer to Item # 115)	7-Apr-03
Information Request No. 1 - NEB review of the WesternGeco EA	10-Apr-03
Information Requests: Introduction, Regulatory Approvals and Induced Development	14-Apr-03
Information Requests (Refer to 117, 118)	24-Apr-03
Response to the Information Request No. 1	7-May-03
Re: Response to Information Request Issued to Deh Cho First Nation	12-May-03
Distribution of Deh Cho First Nation response to Information Request	14-May-03
Responses to MVEIRB Information Request No. 2, dated April 24, 2003	15-May-03
Reason for delay of Mackenzie Delta and Mackenzie River 2-D Seismic Projects - 2003	11-May-03
Distribution of WesternGeco letter and IR Responses No. 2 (Refer to 123, 124)	15-May-03
response to the reason for delay (to James C. White, WesternGeco)	20-May-03
response to the reason for delay (to James C. White, WesternGeco) - sent out to the Distribution List	20-May-03
WesternGeco letter and IR Responses - Format for Technical Reports	22-May-03



Re: Information Request response from Deh Cho First Nation - May 1st, 2003 letter	28-May-03
Distribution of letter from Villiage of Fort Simpson (Refer to 129)	28-May-03
Change in Deadline for Technical Reports	29-May-03
WesternGeco May 30th, 2003 letter regarding the EA	30-May-03
"High intensity anthropogenic sound damage fish ears" - from the Journal of Acoustical Society of America	01-Jan-03
Technical Reports for WesternGeco EA	28-May-03
Technical Reports for WesternGeco EA	2-Jun-03
Executive Summary - Technical Review of the EA for WesternGeco	8-Jun-03
WesternGeco EA - DFO Technical Report	9-Jun-03
DCFN Letter and Technical Reports (Refer to 134, 135, 136, 137)	10-Jun-03
Technical Review of the WesternGeco EA	9-Jun-03
Re: Popper's tech report - full text	13-Jun-03
WesternGeco EA technical report clarification	13-Jun-03
Public Registry Submissions	16-Jun-03

