Proceedings

1987

NORMAN WELLS RESEARCH AND MONITORING WORKSHOP

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prepared by

Boreal Ecology Services Ltd.

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FOREWORD

The Environmental Assessment (EA) Panel examining the Norman Wells Oilfield Expansion and Pipeline Project reported its findings to the Minister of the Environment in January 1981. Numerous recommendations were made regarding research and monitoring of the effects of oilfield and pipeline construction and operation. In August of 1981, the oilfield expansion and pipeline projects were granted approval by the Federal Cabinet. Approvals were contingent upon the submission of further information by the proponents, and were subject to a two-year delay to enable preparations by government, native organizations, and the public.

In August of 1982, the Deputy Minister of the Government of the Northwest Territories Department of Renewable Resources, Mr. James Bourque, proposed the development and implementation of an intergovernmental research and monitoring program for the oilfield expansion and pipeline projects. The purpose of this program was to test the validity of impact predictions identified during the environmental assessment and review process, and to test the effectiveness of mitigative measures identified during the regulatory process. Mr. Bourque further proposed four objectives for the program:

1. to determine and quantify environmental impacts and to examine recovery processes;
2. to compare actual and predicted impacts;
3. to evaluate the long-term effectiveness of mitigative measures; and,
4. to prepare environmental recommendations applicable to future northern pipeline and oilfield developments.

In September of 1982, a Working Group was established to develop and implement a research and monitoring program. The Working Group included representatives from:

The Department of Renewable Resources (GNWT)
The Department of the Environment (DOE)
The Department of Indian Affairs and Northern Development (DIAND)
The Department of Fisheries and Oceans (DFO)
The Department of Energy, Mines and Resources (EMR).

Over time, the Working Group has expanded to include:

Esso Resources Canada Limited
Interprovincial Pipe Line (NW) Limited
Dene Nation
Federal Pipeline Coordinator's Office
The Department of Agriculture (DOA)
The University of Alberta (U of A)
The National Research Council (NRC)

The initial task of the Working Group was to identify all environmental issues and concerns related to northern pipeline and oilfield developments. To this end, the reports of the Berger Commission and of the Norman Wells and Alaska Highway Gas Pipeline Environmental Assessment Panels were thoroughly reviewed. The transcripts of the N.W.T. Water Board public hearings and reports resulting from the National Energy Board hearings were also reviewed. In order to make use of the extensive knowledge and experience gained in Alaska from the construction of the Trans-Alaska Pipeline System, a member of the Working Group visited Alaska in January of 1983 and consulted extensively with Federal and State officials who had

been directly involved with environmental regulation and monitoring. In return, two U.S. officials travelled to Yellowknife in March of 1983 and conducted a northern pipelines workshop for interested representatives of government, industry, native organizations, and the public.

Once the available information had been collected and assessed, the members of the Working Group established a set of priority environmental issues. For each priority issue, a research and monitoring project was developed under the sponsorship of one or more of the participating organizations. Over time, the list of priorities for research and monitoring has grown and now includes:

1. revegetation and restoration (including remote sensing)
2. artificial island integrity during Mackenzie River breakup
3. oilfield emissions and air quality
4. terrain performance along the pipeline
5. effects and effectiveness of wood chip insulation
6. thermal regime and ground stability along the pipeline
7. soil temperatures
8. forest ecosystem disturbances
9. contaminants pathways in the Mackenzie River
10. fish quality and physiological condition downstream of the Norman Wells refinery
11. aquatic impacts from the construction of pipeline stream crossings
12. snow geese and their habitat use
13. disturbances to raptors
14. disturbances to terrestrial wildlife
15. renewable resource harvesting

Preliminary field reconnaissance for most of the projects

was carried out during the summer of 1983, and the majority of research and monitoring was well underway by the time pipeline construction began in January 1984.

Now, in March of 1988, seven years following the Environmental Assessment and Review Panel report, the construction period is over and the oilfield and pipeline facilities have been operating for three years.

PROGRAM COORDINATION

The Working Group of the Norman Wells Research and Monitoring Program meets formally at a northern location in the fall of each year. At these meetings, the members of the Working Group discuss the results of individual projects, coordination between studies, requirements for further research and monitoring, and the preparation of environmental recommendations for future northern pipelines and oilfield developments.

The Working Group strongly supports the concept of community-based environmental monitoring and welcomes the participation of the public, both at its regular meetings and in its field projects.

THE 1987 WORKSHOP

The working group has addressed the first three objectives originally proposed in 1982. The workshop held in November 1987 focussed on the fourth:

to prepare environmental recommendations applicable to future northern pipeline and oilfield developments.

The workshop format was based on three sequential steps: stating the hypothesis addressed by the research; testing the hypothesis by debating research results; and proposing defendable environmental recommendations supported by the studies.

The workshop was divided into three working groups representing broad subject categories: terrestrial concerns, terrain concerns, and aquatic concerns. Despite a common format as described above, each working group - for valid reasons - pursued a slightly different course to arrive at environmental recommendations. Rather than jeopardize the substance and results of the discussions, each working group report is presented here as provided by the scribe and the facilitator.

GENERAL RECOMMENDATIONS

Several general recommendations emerged from the research and monitoring conducted by members of the working group.

Terrestrial Concerns

1. Existing environmental guidelines for avoiding disturbance of raptor nest sites are adequate.

2. Habitat inventories are not required for impact assessment of terrestrial wildlife for linear facilities and other site specific development activities in the northern boreal forest.

Terrain Concerns

1. The overall design of buried pipelines should accommodate

the prevailing terrain conditions rather than site specific designs for different soil and terrain types.

2. The planning and design for northern pipelines should involve a collaboration of terrain and pipeline specialists from the private and public sectors including staff from the proponent and the regulator(s).

3. An eight-to-ten year monitoring program is required to adequately assess the terrain response to a cleared right-of-way and buried pipeline in permafrost.

Aquatic Concerns

1. Fish and fish habitat at small stream crossings are adequately protected by existing guidelines for winter pipeline construction.

2. Options for constructing river crossings should include tunnelling below the river bed as well as trenching and blasting in the river bed.

3. Baseline data describing the aquatic environment must be collected in advance of any disturbance or contamination resulting from development.

For a more thorough treatment of each subject, the reader is referred to the pertinent section in the report. For summaries of the specific studies, the reader is referred to the fifth annual report of the working group, available from:

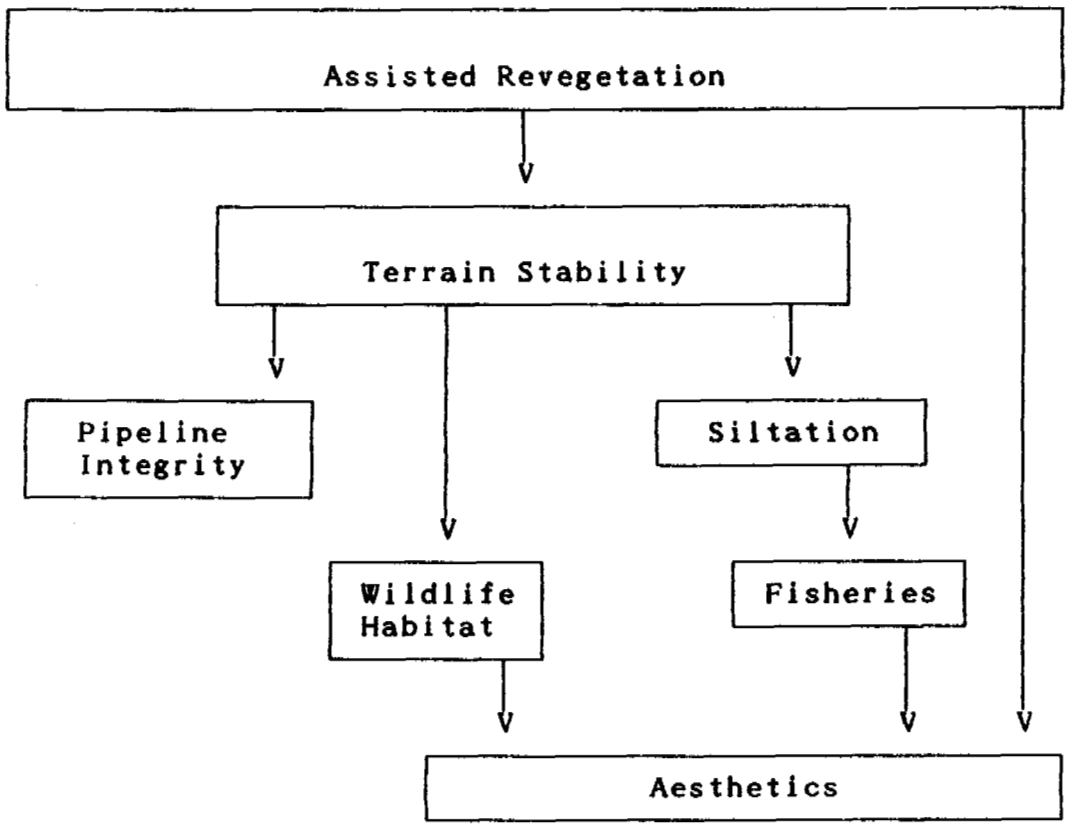
Environmental Protection
Department of the Environment
P.O. Box 370
Yellowknife, N.W.T. X1A 2N3
Telephone (403) 873-3456

D. REVEGETATION

Results of revegetation studies done on the pipeline right-of-way were presented by Kaye MacInnes of Indian and Northern Affairs Canada, Yellowknife.

Hypothesis

Assisted revegetation will promote terrain stability.



Research and Monitoring Results

1. Application of fertilizer and a broad species composition

TERRESTRIAL WORKING GROUP

Facilitator:

Peter McNamee	Environmental & Social Systems Analysts Ltd.	Toronto

Technical Expert:

Tony Yarranton	Yarranton Holdings Ltd.	Calgary

Reporter:

Tom Nesbitt	T.H.D. Nesbitt and Associates	Yellowknife

Investigators:

Peter Boothroyd	Dept. of the Environment	Winnipeg
Ed Collins	Dept. of the Environment	Yellowknife
Kaye MacInnes	Indian and Northern Affairs	Yellowknife
Steve Matthews	Govt. of the Northwest Territories	Yellowknife
Cal Sikstrom	Esso Resources	Calgary
Don Wishart	Interprovincial Pipe Line	Edmonton
Steve Zoltai	Dept. of Agriculture	Edmonton

Discussion Participants:

Terry Antoniuk	Gulf Canada	Calgary
Jamie Bastedo	Govt. of the Northwest Territories	Yellowknife
Evan Birchard	Esso Resources	Calgary
John Gorjup	National Energy Board	Ottawa
Rick Hurst	MEMP/Indian and Northern Affairs	Yellowknife
Allison Jumbo	Community representative	Trout Lake
George McCormick	Canada Oil & Gas Lands Administration	Yellowknife
Fred McFarland	MEMP/Indian and Northern Affairs	Ottawa
Ted Spearing	Chevron Canada	Calgary
Jim Umpherson	Indian and Northern Affairs	Yellowknife

II. TERRAIN WORKING GROUP

A. INTRODUCTION

Following a brief discussion, the suggested workshop format was abandoned by the Terrain Working Group. The following sixteen issues were identified as requiring attention.

1. Scour of submarine pipelines
2. Alignment
3. Thaw Subsidence
4. Slope Stability
5. Surface Disturbance of Vegetative Mat
6. Permafrost Stability (at all phases)
7. Prediction and Control of Surface Erosion
8. Baseline Data including Soil Temperatures
9. Ditch Backfill
10. Consumption of Non-Renewable Resources
11. Remedial Measures and Effectiveness of Same
12. Timing and Extent of Monitoring
13. Naturally Occurring Extreme Events
14. Research Structure and Funding
15. Water Crossings
16. Corridor Effects

There was a short discussion of socio-economic aspects and it was concluded that this was not really an issue for this group. The list of sixteen issues was subsequently consolidated to nine, as follows:

1. Stability of Permafrost Slopes
2. Thaw Settlement
3. Frost Heave

4. Drainage and Erosion
5. Route Selection
6. Artificial Islands
7. River Crossings
8. Resource Consumption
9. Monitoring Issues including Database

It was emphasized at several points during the two days of discussion on terrain issues that we are still at a very early stage of evaluation and firm recommendations of value to future projects cannot yet be made. It is therefore important to continue monitoring. The results of this working group discussion were more in the form of observations, comments, and conclusions than firm recommendations for future projects in the Mackenzie Valley.

The first four issues were suggested by Bill Slusarchuk, who spoke to each in turn. He noted that, geotechnically, the Norman Wells pipeline could be divided into three regions:

1. North of Fort Norman (Kp 0 to Kp 78);

2. Fort Norman to Willow Lake River (Kp 78 to Kp 380); and

3. South of the Willow Lake River, where permafrost is only significant in association with organic terrain.

The following general observations were made:

1. the right-of-way and buried pipe have not yet reached thermal equilibrium with the surrounding terrain, and so

2. the need for monitoring will continue for several years to come;

3. the thaw depth was determined by the clearing of the right-of-way and construction disturbance, rather than by oilflow in the pipe;

4. good predictions were made of the thaw settlement during the design of the pipeline, and;

5. conservative design was the strategy from the outset.

B. THAWING OF PERMAFROST SLOPES

This subject was addressed by Bill Slusarchuk. The design approach used for the Norman Wells pipeline was discussed at some length. Slopes were categorized by soil type and subjected to "infinite slope analyses". This approach predicts the permissible thaw depth as a function of soil type, which in turn leads to the required depth of wood chips on the slope as an insulative cover. It was noted that, in general, the wood chips were a very stable medium; however, there has been a gradual warming beneath them and their ultimate equilibrium remains uncertain. The following observations were made:

1. all efforts should be made to minimize surface disturbance on slopes (hand clearing was recommended but not used);

2. the width of the right-of-way should be reduced from that normally required (13 m instead of 25 m);

3. the design process must include field data and post construction monitoring, (it was noted that one half of the

slopes are instrumented and this appears to be a reasonable level of instrumentation);

4. an external review consultant should be employed;

5. the frequency of inspections should depend on slope conditions and performance;

6. the build-up of heat within the wood chip blankets was predicted and monitored. (Some unexpected hotspots have occurred within the wood chip cover, probably due to biological activity);

7. future research and monitoring is recommended to determine the best tree species to be used for chips in order to reduce heating in the wood chip cover;

8. the slopes are performing well, with the exception of Table Mountain;

9. design and construction for drainage control at slope crests needs more attention;

10. more attention must be paid to cross drainage which can be hard to spot at certain times of year except from the air;

11. there is a need for more robust drainage control features on slopes.

Recommendations

The overall recommendations with respect to this issue were as follows:

1. Research into wood chip performance should be undertaken to increase information available for future designs.

2. There should be a final design check list for items which require fine tuning in the field during construction.

3. Monitoring needs to be an extension of final design. In the present state of the science we have all the required elements for design and show a good safety factor. Field observations and experience for design engineers, however, can still improve future designs and performance.

C. THAW SETTLEMENT

This subject was presented by Bill Slusarchuck. A generalized thaw settlement design was employed and predictions of settlement were made for specific terrain units. While predicted settlements in several units exceeded the criteria adopted for the project, this was considered acceptable in view of the available database for monitoring and the limited extent of these terrain units. The present strategy is to monitor and repair when and where necessary. Several (5-8) years of monitoring are required in order to establish whether or not predicted thaw settlement will occur.

There was some discussion with regard to the state of backfill (whether better-processed backfill would be a superior approach). The conclusion was that it was less expensive to restore backfill than to engineer a better backfill or to improve the process of backfill during construction.

Observations indicated that the geotechnical program for the Norman Wells Pipeline had been effective. The results to date are good, but not yet conclusive.

Finally, the designer, owners, and regulatory authorities must coordinate their review activities to facilitate efficient design and construction. Adversarial positions between the proponent and regulator should be avoided. It was suggested that the Norman Wells model should be used for future projects, unless proven by time to be inadequate.

D. FROST HEAVE

This subject was presented by Bill Slusarchuk. The working group generally agreed that, for this project, frost heave was not an issue south of Norman Wells . The insulation on the pipe appeared to be performing well. There were problems with the installation of the insulation on the pipe, but this was a construction issue. Ensuring the integrity of the insulation could be improved by a better insulation product and improved application procedures, especially on pipe bends.

Frost heave could be an issue north of Norman Wells where a chilled oil pipeline may need greater insulation in stretches of unfrozen soils.

It was also noted that a better method of applying strain gauges or monitoring for pipe deformation is highly desirable.

E. DRAINAGE AND EROSION CONTROL

This subject was presented by Bill Slusarchuk. It was observed that the erosion control features have generally

performed well and berm breaks are probably not needed on overland segments of the pipeline for slopes less that four degrees. Erosion control is a regular part of the normal pipeline maintenance program.

Other observations included the following:

. Erosion control on long low-angle peat slopes performed poorly because peat becomes highly erodible when broken up, as occurred during the construction process.

. Mound breaks were not particularly useful.

. It is questionable if additional fill is necessary to restore the sunken ditch backfill.

. Minor winter grading at points along the right-of-way (eg. at cross slopes) was necessary and has not been harmful to the environment.

Recommendations

The recommendations with respect to terrain issues A through E were:

1. Don't over-design for drainage and erosion control on gentle slopes.

2. Spend more design time identifying drainages on shallow slopes by air photo interpretation and staking during the spring freshet to ensure proper design, location, and direction of the erosion control measures.

3. Solve low slope erosion with stick plugs and a regular and frequent monitoring program for corrective and preventive maintenance.

4. Continue monitoring for the life of the pipeline.

5. Review the regulatory requirement for burning slash, since this material could be used on the right-of-way as mulch to reduce erosion.

F. ROUTE SELECTION AND ALIGNMENT

This discussion was led by Bernie Gauthier. There was some discussion of a corridor concept, but the consensus was that it was not possible to make appropriate recommendations at the present time, given the uncertainty of future project types and locations.

Recommendation

There was a consensus that forethought should be directed to specific locations such as Gibson's Gap north of Norman Wells and the Swimming Point Crossing of East Channel in the Delta. Both sites were identified as "the bottle necks" in a corridor concept.

G. ARTIFICIAL ISLANDS

Cal Sikstrom of Esso Resources Canada Ltd. described the survey and monitoring program which had been carried out over the past several years to meet reporting requirements for the artificial islands in the Mackenzie River. This monitoring included bathymetric surveys to identify scour holes and

patterns in the river bed adjacent to the islands. Two aspects of the original working hypothesis were:

a. the stream flow and ice will affect the islands, and
b. the islands will have an impact on the channel.

The data indicated some deepening of the channel, thereby increasing the conveyance. This is considered a positive result. There has not been a measurable effect of the islands on the ice breakup pattern.

Recommendations

Recommendations for future projects are:

1. Adopt a similar process to that used for this project at all phases including planning, design, construction and monitoring. The islands and oil production systems have performed well. The level of planning, design, and assessment was adequate for conditions experienced to date. There is a need for monitoring to continue for the functional life of these structures.

2. The consultative approach involving both the proponent and the regulators during planning, design, assessment, and construction seemed to work well and should be repeated.

H. RIVER CROSSINGS

Archie Pick led the discussion with respect to river crossings. IPL designed crossings for more than 150 streams including the Great Bear and Mackenzie Rivers. These two major

crossings were installed as summer construction projects, whereas the remainder were constructed during winter. The general consensus was that all crossings have performed well and there were no substantive recommendations which could be put forth at this workshop.

Recommendation

The present design and construction procedures were considered to be adequate.

I. RESOURCE CONSUMPTION

This issue related to the use of granular materials as fill, and to the use of trees for making wood chips.

Recommendation

The proponent should lay out a range of options early during the project planning phase to facilitate flexible permit conditions and so ensure more latitude during construction.

J. MONITORING AND RESEARCH

There was some general discussion with regard to the present monitoring and research program. There is a need for a faster start-up when a proponent comes forward with the next major project. This response will require the combined support of government and industry for a cooperative research and monitoring effort. There should also be a limited and project-specific program to record meteorological data, ground thermal data, and ground ice distribution.

Recommendation

Collection of baseline data should be initiated up to two years prior to right-of-way clearing and monitoring should continue for eight years following completion of the construction phase.

TERRAIN WORKING GROUP

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Reporter:

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David Harry	Energy Mines & Resources	Ottawa
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Paul Trudel	National Energy Board	Ottawa
Frank T'sele	Chevron Canada	Ft.Good Hope
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