Report

HIGHLIGHTS OF THE FIRST ANNUAL FORUM AND WORKSHOP ON THE SCIENCE AND COMMUNITY ENVIRONMENTAL KNOWLEDGE FUND

FORT ST JOHN, BC
MAY 29 – 30, 2003

About this report:

This report summarizes the activities and results of the first annual SCEK Fund Forum and Workshop. As described by the title, the purpose is to convey the highlights of the presentations and discussions that took place and the main conclusions that were reached. Those readers who want further details can access presentations and other supporting information by visiting the OGC web site at **www.ogc. gov.bc.ca/**.

ACKNOWLEDGEMENTS

The OGC would like to thank all those that participated in the Science and Community Environmental Knowledge Fund's First Annual Forum and Workshop. Your time and input is much appreciated.

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STATEMENT FROM THE COMMISSIONER

The Oil and Gas Commission undertakes many activities as part of its broad mandate to build prosperity through unity while regulating for the benefit of all. An important component of our work is the management of the Science and Community Environmental Knowledge (SCEK) Fund, based on an agreement with the Canadian Association of Petroleum Producers (CAPP) and the Small Explorers and Producers Association of Canada (SEPAC).

In May 2003, the OGC held the First Annual Science and Community Environmental Knowledge Fund Forum and Workshop. This report summarizes the proceedings and results of the event, which was attended by over 100 stakeholders and researchers.

The Forum began with an commitment by CAPP and SEPAC to provide funding for another five-year period. I commend them for their foresight and initiative, and welcome the announcement as a vote of confidence in the results achieved to date.

During the Forum, participants were briefed on the findings of 17 research projects and studies supported by the Fund. There was also a series of workshops to discuss and identify future directions for research and funding of projects.

We have now had time to digest the advice of workshop participants and are in the process of establishing a strategy and plan of action for the next fiscal year and beyond. This will be provided to the OGC Advisory Committee for its review and then submitted to the OGC Board for approval.

At the same time, we are working on strengthening and streamlining our procedures for managing the SCEK Fund. Our commitment is to make the application and selection process efficient and effective, in order to maximize value for money from Fund disbursements.

In addition, we are looking for ways to make the Fund accessible and responsive to the concerns and interests of First Nations, local communities and the public of NE British Columbia. This initiative is the rationale for the recent renaming of the Fund and the addition of a new funding envelope focusing on community environmental knowledge.

Finally, we will continue to engage collaboratively with all stakeholders to achieve the objectives of the Fund. I look forward to further interaction on these issues and welcome your views and comments on this report and the directions being taken in research and funding support.

Derek Doyle
Commissioner

FIRST ANNUAL FORUM AND WORKSHOP ON THE SCIENCE AND COMMUNITY ENVIRONMENTAL KNOWLEDGE FUND

Introduction and Background

About the Fund

In 1998, the Environment Fund was established through an agreement between the Government of British Columbia and the Canadian Association of Petroleum Producers (CAPP) and the Small Explorers and Producers Association of Canada (SEPAC). The Fund was originally established for a period of five years with an allocation of $5 million. It facilitates and supports studies concerning environmental issues related to oil and gas activity in British Columbia.

In 2002, CAPP and SEPAC pledged their on-going support to the Fund with another $5 million commitment over five years. Additionally that year, the focus of the Fund was changed to encompass not only science-based research, but also community environmental knowledge. Thus, a new name was developed - the 'Science and Community Environmental Knowledge Fund'. While the current research and funding envelopes will continue, studies of community-based environmental concerns, values and traditional knowledge will be encouraged as well. As before, wherever possible, the results of research projects will be incorporated into: OGC regulatory decision-making; government land use and resource planning; as well as, environmental practices by industry.

Research and Funding Envelopes

At the time of the Forum and Workshop, the Fund was comprised of four knowledge envelopes covering the environmental issues relevant to oil and gas development as follows:

- Health and Safety
- Ecosystem and Cumulative Impact Management
- Engineering and Technology
- Education and Extension

Purpose and Objectives of the Forum and Workshop

The first annual SCEK Fund Forum and Workshop was sponsored by the OGC in collaboration with CAPP and SEPAC. (A copy of the Forum and Workshop Agenda can be found in Annex A.) It provided the partners and stakeholders with a major opportunity to take stock of recent progress with studies initiated through the Fund and to exchange views on future directions for research and funding. As

indicated, the intent is to make this a regular feature of the calendar for those interested in the environmental impacts of oil and gas activities.

The objective of the forum was to provide an opportunity for a broad group of stakeholders and interested parties to gain an understanding of the research projects undertaken through the Fund and learn about the findings and results.

The objectives of the workshops were to identify: problems and issues which could be addressed through the Fund; and, potential research projects and directions that may be considered by the Fund.

The Forum at a Glance

The Forum consisted of a series of presentations on research projects that either had been completed or were still underway with support from the Fund. In total, more than 20 separate presentations were made at the Forum, including keynote and plenary addresses to set the agenda for the two days of sessions. Of these, 17 focused on funded studies and provided participants with a synthesis of the approach and findings of research. These are summarized later in this report.

The roster of research presentations was accommodated in a mix of plenary and parallel sessions, which went into the late evening on the first day of the event. All of the sessions provided opportunities for questions and discussion and there were lively exchanges in some sessions. Well attended by more than 100 participants, the evaluation conducted by OGC indicates the Forum was well received and considered to have been informative and worthwhile by all. The agenda of the Forum 'at a glance' is shown below.

The Workshop in Focus

The workshop component was organized as a series of breakout groups. Each of the four knowledge envelopes previously mentioned was the focus of dialogue to exchange information and views on key issues and options for research to address them. In addition, there was a breakout group on general environmental concerns. An interactive process was followed as far as possible through facilitated discussion and recording of the results.

Specific tasks for the breakout groups were to:

- identify the most important problems in health and safety, ecosystem and cumulative impact management, environment in general, engineering and technology and education and extension;
- suggest the types of research and development projects that best address these issues; and,
- give a relative ranking of these suggestions in terms of their priority.

Breakout group sessions began with an initial 'brainstorming' in which all ideas and concerns were listed on whiteboards as having equal value. Relative priorities were established through 'preferential voting' against the issues and research options listed. The results of the deliberations of the five breakout groups were reported to the final plenary of the forum and workshop. These are summarized later.

Announcement of Continuation of the Fund

On behalf of CAPP and SEPAC, David Pryce, Vice President of Western Canada Operations announced the continuation of the Fund for another five years. In making this announcement, Mr. Pryce recalled the history of the Environment Fund, noted the changes that were taking place in the scope and orientation of the Fund and emphasized the benefits that accrue from the Fund.

Environment Fund Coverage to Date

The early focus of Fund research concerned linear disturbance, cumulative effects, air emissions soil and groundwater remediation and reclamation. From the perspective of CAPP and SEPAC, projects on these topics have proven successful in their convergence on a BC focus, broad applicability and immediate deliverables. Moreover, many projects have lowered costs through co-funding while yielding high benefits. Also notable has been the range of those engaged in research including: governments; industry; consulting and contracting companies; universities and colleges; environmental and community groups; and, First Nations.

Shift of SCEK Orientation

The SCEK Fund will continue to focus on environmental research, but it will also broaden its scope to promote the integration of science with First Nations' traditional knowledge and community environmental knowledge. CAPP and SEPAC commit to multi-party consultation on needs and priorities of this nature. A cornerstone of this commitment will be the annual conference on the SCEK Fund to share results and consider ways forward. The extension of funding for another five years will help to provide certainty to planning and confidence in consultation.

Benefits of the Fund

Several current and anticipated benefits are derived from the Fund, notably:

- enhanced understanding of potential impacts on the environment;
- identification of potential mitigation measures;
- promotion of responsible oil and gas development;
- improved local, regional and BC research capabilities; and,
- enhanced community and First Nations' contribution to research.

PRESENTATIONS MADE AT THE FORUM

Health and Safety Research

Flare Management Strategy for British Columbia

Presentation by Dave Krezanoski, Oil and Gas Commission

This overview of flare reduction trends and issues in northeast BC provided a general background for other studies reported below. It focused on: past and present flaring practices; reduction drivers and challenges; and, the targets set and strategies being followed by the Commission, noting the differences among different regimes. For example, well test and non-routine flaring typically are short term (few days to weeks in latter case) with potentially large volumes. By contrast, routine and emergency flaring are both low volume, although the former is continuous and the latter usually only lasts a few hours.

Significant flare reductions were achieved under informal policy between 1997 and 2001 (e.g., 48% reduction). Further demands to reduce flaring are imposed by: public health and safety concerns; proposed limitations on greenhouse gas emissions; and, Alberta's success in meeting new guidelines. A flare reduction project has been underway for the past two years. This is based on: an evaluation of flaring data; review of guidance and experience in Alberta; and, cooperation with operators and government agencies. New targets for flare reduction are proposed using 1997 as the baseline volume (with a 55% reduction by 2005) volume.

The OGC is committed to implementing a four part strategy consistent with the Province's 'results-based' regulatory system:

- application of the Alberta Energy Utility Board flare management hierarchy to eliminate, reduce and improve efficiency;
- economic assessment of conservation of all solution gas flares;
- limiting non-routine flaring during facility outages; and,
- stakeholder consultation and input to take advantage of 'Alberta momentum'.

Western Canada Animal Health Study

Presentation by Michael O'Connell, Western Interprovincial Scientific Studies Association (WISSA)

This is a five-year, $17 million study to determine if there impacts on animal health from exposure to emissions from oil and natural gas field facilities, and if so, under what conditions. It is funded jointly by industry and government (with a $600,000 contribution from the SCEK Fund). The geographic scope of the study

is Alberta, BC and Saskatchewan, and encompasses some 33,000 animals distributed in 200 herds.

Key study components focus on:

- beef cattle productivity to examine whether animals exposed to emissions from oil and gas facilities are at greater risk of mortality, disease and related losses compared to non-exposed cattle;
- beef cattle immunotoxicology to examine exposure, nutritional and infectious disease factors of yearling heifers and their association with immune system structure and function;
- wildlife health/immunotoxicology to examine the relationship of reproductive, nesting and fledgling success and immune function;
- exposure assessment using passive sampling of H_2S, SO_2 and VOCs and particulate matter sampling ($PM_{1.0}$);
- water quality sampling to analyze the hydrocarbons, metals and contaminants in deep wells, particulate matter sites and selected passive monitoring sites; and,
- feed analysis to be used together with nutritional status and toxicology data to assess possible interactions with histological data on tissue structure.

The data collection phase of the study has been completed. Data verification and entry is scheduled to be completed in February 2004, with the integration of databases and analyses to be completed in fall of 2004. A public report is scheduled for release in the summer of 2005.

While a comprehensive overview of the study approach was given, the investigators were not in a position to release preliminary findings; however, given its scope, the WISSA study promises to provide an authoritative assessment of the impact of exposure to H_2S and other emissions from oil and gas facilities on animal health.

Determination of Sour Gas and H_2S Thresholds on the Mammalian Brain

Presentation by Sheldon Roth (Faculty of Medicine, University of Calgary)

This is a study in progress that is scheduled for completion in 2005. Objectives are:

- to determine threshold levels of H_2S, sour gas and H_2S/organic compound mixtures at the lowest observable adverse effect levels (LOAEL) and the no observable adverse effect level (NOAEL); and,
- to evaluate the differences of effects between H_2S alone as a component of sour gas on *in vivo* and *in vitro* mammalian central nervous systems (the brain).

Exposure to H_2S has a broad spectrum of toxic effects on the nervous and respiratory systems. These effects are dependent on concentration, duration and rate of exposure. Some of the known effects of H_2S on the nervous system include: mental depression; irritability; loss of memory; loss of appetite; lethargy; fatigue; and, headaches.

Key conclusions reached to date:

- long-lasting synaptic enhancement occurs following exposure to low levels of H_2S;
- effects appear to be concentration-dependent;
- inhibition of respiratory enzymes confirmed; and,
- effects may account for symptoms such as anxiety and cognitive impairment.

Future experiments are planned in the coming year. These include experiments on the brain slice (invitro model system) designed to determine threshold levels of hydrogen sulphide and sour gas and development of the whole animal (in vivo) studies. Collaboration is in progress to extended the studies on respiratory enzymes.

Prophet River Moose Study

Presentation by Claudia Houwers (Wildland Resources)

This study responded to concerns of the Prophet River Indian Band about the health and edibility of the moose population and their safety for human consumption. It was designed to determine the nature of cysts and green fluids observed in the body cavities of harvested moose and to establish a possible correlation with ingestion of open sump water or licking mud solids as observed by elders of the Prophet River First Nation. Study methodology was based on a combination of traditional knowledge and scientific analysis.

Tissue samples were collected from the lungs, liver and kidneys of three moose (cow, bull and calf) culled by a hunting party and sent for laboratory analysis. External and internal conditions of the moose were also documented. Laboratory analysis confirmed that the cysts were those of common parasites (e.g., tapeworm) or the result of bacterial infection that was not 'out of the ordinary'. The green fluid is suspected to be bile or possibly algae.

Ten well sites were surveyed to determine if open sumps, flare pits or drilling mud solids were present and to track which species were present at these sites. A majority had one or a combination of the features described. It was not possible to determine a connection between these features and unhealthy moose, although the study concluded that companies should be held responsible for securing, monitoring and cleaning up open well sites.

Ecosystem and Cumulative Impact Management Research

Cumulative Impact Management: A Framework for Northeast BC

Presentation by Jeff Green (AXYS Environmental Consulting Ltd.)

This study was part of a comprehensive project on cumulative impact management (CIM). The framework described here is integrated with a study of indicators and thresholds and their pilot testing in candidate areas. Cumulative impacts in Northeast BC have occurred due to the rapid expansion and relatively high concentration of resource-based industries on the land base, combined with a wide range of other land uses (e.g., recreational use, hunting). Given the high wilderness and traditional use values in the region, concerns have arisen about the capability of the landscape to sustain all of these different land uses during the same time period. A 'regional' approach is critical to provide a coherent framework within which management actions can be related to: resource values and uses; other proposals; and, individual decisions.

The proposed framework developed by AXYS and Salmo Consulting consists of five major elements:

- a *regional assessment* to establish baseline conditions and identify valued ecosystem components (VEC) and areas of concern for cumulative impacts ('hotspots');
- identification of preferred *indicators* for measurement of cumulative effects, as well as *thresholds* for these indicators against which potential changes can be compared relative to regional land us objectives (i.e., *'limits of acceptable change*)';
- development of a *screening approach* for oil and gas applications to inform regulatory and policy decision-making relative to assessment of potential project-specific and cumulative effects and potential changes in indicators relative to regional thresholds;
- *impact management* to avoid, reduce or offset the aggregate or total impact; and,
- *research and monitoring* to check that mitigation measures are working as intended and to track progress against objectives and thresholds.

Such an approach can provide the basis for a sustainable resource management strategy, consistent with BC Government policy directions; however, it is recognized that the above elements are insufficiently developed for this purpose and that further work is necessary to fill information and knowledge gaps. Examples include: the assembly of a regional database; and, refining and testing of indicators, thresholds and screening procedures especially in respect of single project applications to the OGC. In addition, the implementation of this approach will have implications for government ministries, industry, First Nations and other stakeholders and will require extensive consultation.

Cumulative Impact Indicators and Thresholds

Presentation by Terry Antoniuk (Salmo Consulting Inc.)

This study was an integral part of the CIM project described above. It was designed to develop a suite of cumulative impact indicators and thresholds for application specifically to northeast BC. Four key land use and habitat indicators were selected, comprising respectively of: access density; stream crossing index; core area; and, patch and corridor size. 'Science-based' thresholds were developed for these indicators to reflect levels of 'acceptable change'. Similar approaches are already used in BC and once agreed upon, will provide a tool to evaluate the significance and acceptability of project-specific and regional cumulative impacts.

In this case, the proposal is for a three tier framework, comprising:

- *cautionary thresholds*, which give early warning of possible cumulative impacts and signal the need for standard protection measures and monitoring;
- *target thresholds*, which indicate the acceptable range of loss or change that, if approached, signals the need for enhanced protection measures; and,
- *critical thresholds*, which indicate the maximum acceptable damage permitted, that, if approached, signals the need for intensive protection measures or restrictions.

The proposed CIM indicators and thresholds reflected case studies completed for the Blueberry and Sukunka areas. Limits of acceptable change were related to the different types of resource management zones (RMZ's) established by government plans in northeast BC (e.g., protected areas, special management, general resource management and enhanced resource development zones). For example, protected areas and special management zones are to be relatively undisturbed as they are: a primary source of habitat for all species; managed to protect wildlife and wilderness values; and, their candidate thresholds were established below the lowest detected effect for the most sensitive species. By contrast, enhanced resource development zones were considered to represent neutral or sink habitat for most species and candidate thresholds were established to sustain most species.

Cumulative Effects Case Studies

Presentation by Terry Antoniuk (Salmo Consulting Inc.)

This study involved testing the CIM indicators and thresholds described above. It provides more detailed documentation on baseline trends and their implications for application of a 'thresholds approach' to the Blueberry and Sukunka areas. The Blueberry area is 2690 km^2, encompassing boreal plains and the Beatton River watershed, and overlapping four RMZ's in the Fort St John Land and Resource Management Plan (LRMP). The Sukunka area is 1200 km^2, located in the Rocky Mountains foothills and overlapping six RMZ's in the Dawson Creek LRMP.

The case studies included the development of a GIS database of forest cover and land use and the documentation of key trends and future scenarios. Land use trends, covering access corridors and clearings for oil and gas, forest cut blocks, agriculture, mining and settlement, were used to derive CIM indicators of access density and a stream crossing index. Forest inventories were used to derive habitat suitability ratings for four focus species (moose, woodland caribou, elk and grizzly bear). These habitat models were then related to CIM core area and patch size indicators. A landscape cumulative effects simulator (ALCES) model was used to simulate historical and future trends for the period 1950 to 2050. Forecasts of future changes were based on natural disturbance regime and scenarios extrapolated from past change.

Analysis was limited by a lack of readily available data; however, CIM indicators for access density and core area were statistically related to moose and elk population indices, and permitted predictions equivalent to more detailed and costly habitat indicators. The case studies also suggested that access density relationships identified in the scientific literature might not apply directly in northeast British Columbia, for example, because of comparatively low population and human activity. More research is needed on these relationships.

Foothills Model Forest Grizzly Bear Research Program

Presentation by Gordon Stenhouse (Foothills Model Forest)

This multi-phase, five-year study is designed to provide resource managers with the necessary knowledge and planning tools to ensure the long-term conservation of grizzly bears. Now entering the last year of field data collection, the study area is 9762 km^2, extending from Jasper National Park to the Rocky Mountain foothills that are managed for multiple uses. Partial support for the project has been provided by the SCEK Fund as the project will contribute information related to the cumulative impact management of oil and gas activities in relation to bear habitat, movement and population dynamics.

A range of study methods and tools are used including:

- deployment of radio collars to track bear movement (over 60,000 GPS data points have been collected during this study);
- remote sensing technologies to map bear habitat at a landscape scale;
- GIS tools to measure and quantify landscape and land use change from drilling activities, linear disturbance, etc.; and,
- DNA tools and procedures to inventory the status of bear populations.

Existing cumulative effects assessment models are reported to have poor capability to predict bear occurrence and movement through their home ranges. New approaches and tools for this purpose are being tested and validated to better reflect the boreal landscape; for example, resource selection function models are used to predict the relative probability of bear occurrence based on habitat and land use features. Graph theory models have also been used to identify common grizzly bear movement corridors on the landscape and maps

have been produced showing predicted level of use in these corridors. Habitat selection maps have been used by the oil and gas industry for road and pipeline alignment as well as access control. This is important since preliminary findings indicate a strong correlation between population level survival rates and open road densities. Program researchers are also looking at the relationships between grizzly bear health parameters and environmental conditions.

Habitat Use and Ecology of Boreal Caribou in the Snake/Sahtaneh Watershed

Presentation by Brad Culling (Diversified Environmental Services)

This five-year study was initiated in 1999/2000 as a partnership between BC Environment and Slocan Forest Products, for which the SCEK Fund has provided partial funding. It addresses issues related to survival of the Boreal Caribou, which is 'blue-listed' in BC and is classed as a 'threatened' species under Canadian criteria. Little is known about the impact of development activities and landscape change on the species in the study area, which covers 465,960 ha of boreal ecotype in the northeastern corner of the province. Specific concerns focus on possible alteration of predator-prey relationships as a result of enhanced resource development, human access and intrusion.

Study objectives include: describing seasonal movements and habitat use of Boreal Caribou; monitoring population dynamics (pregnancy rates, spring calf survival and recruitment and adult mortality); and, determining the role of wolf and bear predation. Data for the study are collected by capture, collaring and tracking of caribou, bears and wolves (by telemetry flights). On capture, basic morphometric measurements of caribou are taken. Wolf collaring provides location data on breeding, denning and rearing periods as well as seasonal movements - particularly during the June caribou calving and neonatal period. Scat analysis is also undertaken to determine food habits**.**

Overview Fish and Fish Habitat Inventory of the Milligan and Wapiti Watershed Groups

Presentation by Ted Euchner (Diversified Environmental Services)

This study is designed to collect baseline information on fish distribution and critical habitats for spawning, rearing and overwintering at a watershed scale (1:50,000). In the Milligan and Chinchaga watersheds, 43 sites were assessed. Aquatic habitats were grouped into two morphological types, namely riffle pool and large channel.

Riffle pool characteristics comprise 1-2% gradient, with some degree of confinement, occurring in well drained, mixed wood upland habitats and with instream fish cover provided by boulder, woody debris and undercut banks. Large channel characteristics are less than 0.5% gradient, meandering and unconfined, often discontinuous in their upper reaches with muskeg seepage and instream fish cover provided by deep pools and vegetation.

Significant features and fisheries observations for the Milligan watershed:

- relatively low quality fish habitat on a regional scale;
- localized populations of Arctic grayling;
- widespread, low density incidence of Northern pike;
- few lakes have the capability to overwinter fish; and,
- low species diversity.

Significant features and fisheries observations for the Wapiti watershed:

- some distinct, isolated populations of bull trout and mountain whitefish in two sub-basins;
- suitable and accessible summer feeding habitat for Arctic grayling in three sub-basins but species present only in low densities; and,
- survey of critical bull trout spawning habitat to be completed in September 2003.

Soil Productivity and Forest Regeneration Success on Reclaimed Oil and Gas Sites in the Dawson Creek Forest District

Presentation by Chuck Bulmer (BC Ministry of Forests)

This study is designed to evaluate the effectiveness of previous efforts to restore forests on abandoned well sites near Dawson Creek. It documents the soil and ecological factors that affect success and the reclamation and operational practices that contribute to reforestation. Practices are well established for restoring the working forest to a productive state, but to date there is limited experience in the context of oil and gas reclamation. Substantial land disturbance occurs as a result of oil and gas activities in northeast BC; for example, 3000 ha per year, which is equal to 3% of the annual allowable cut in the Dawson Creek and Fort St John forest base.

Study methods were based on rehabilitation treatment in the field. Between 1994 and 1999, twenty-seven well sites were reclaimed and reforested. The sites were decompacted, seeded for cover, fertilized and planted with lodgepole pine. Four to eight years later, a review found that 3 sites were reused, five sites had no trees and 18 sites had trees established. These sites exhibited differential rates of restocking and growth. Using random subplots, vegetation cover, ecological conditions and soil texture, density and conditions were sampled.

Key factors affecting success included:

- moisture regime (wetter sites often had poor establishment success);
- soil texture (some of the best early results were in coarse textured soils);
- competition from seeded cover (dense grass cover appeared to reduce seedling establishment); and,

- species selection in relation to site conditions (pine trees were inhibited on spruce bog).

Building on this information, relatively minor adjustments would likely improve success in reforestation of oil and gas well sites to a standard comparable to forest landings with similar soil and ecological conditions.

Impact of Sour Gas Well Production Test Flares on Vegetation

Presentation by Katherine Enns (Golder Associates Ltd.)

This study compared pre-flare and post-flare data to determine the area of potential impact of this activity for 16 well test sites (and 8 additional post-flare test sites) in the Sukunka-Grizzly and Buick gas fields. Passive monitoring stations were set up before the test and baseline vegetation information was collected for each site, noting insect damage and disease symptoms. Well tests were conducted during the period October to March (winter) and from April to September (summer) from 1999 to 2003. Data on flare dispersal was modeled by Levelton Engineering Ltd.

Acute injury from sulphur dioxide was noted in pine up to approximately 150 metres from the wells. Injury was more predominant at wells flared in the spring. Generally, passive monitoring and chemical analysis of vegetation tissues indicate sulphur levels are slightly elevated after flaring in areas closest to or downwind from the pad. At distances from the wells, the concentrations were not significant enough to cause substantial damage to vegetation and there was no visible injury. Summer flare tests had lower concentrations of sulphur dioxide, but still caused some injury to trees. In conclusion, the study indicates that short duration winter flaring had few adverse impacts on surrounding vegetation or forest health. Except for lichens, which do not exhibit dormancy, vegetation is in a dormant or near-dormant state in this period. Lichen absorption of sulphur was the best indicator of impacts from the well flare tests.

Wildlife Monitoring Project – Partnership of Pioneer Natural Resources Canada and Ernst Environmental Services

Presentation by Todd Dillabough (Pioneer) and Jonathan Wright (Ernst)

This study addresses knowledge gaps related to oil and gas development and cumulative effects in the Chinchaga sweet-gas field. It uses low invasive technology to establish baseline information on a range of species. What began as a snow-tracking exercise to assess the status of furbearers (martin, fisher and wolverine), now includes the use of other techniques, such as remote camera monitoring, and has broadened to a range of wildlife. For example, analysis of

glucocorticoid (stress hormone) levels in caribou, moose and wolf feces has been added to the study.

Now entering its seventh winter-field season, the specific component for which SCEK funding has been made available, the study was presented as a non-reductionist approach to cumulative effects assessment. It incorporates both observation and analysis to evaluate the response and level of habituation of an array of species to oil and gas activities and other types of disturbances, such as linear corridors and expansion into formerly remote areas.

Engineering and Technology Research

Acid Gas Sorption by BC Coal: Implications for Permanent Disposal of Acid Gas in Deep Coal Seams with Possible Co-Production of Methane

Laxminarayana Chikatamarla (University of British Columbia)

This study was undertaken to determine the sequestration potential of acid gas using coal as a medium. It addresses a number of highly technical questions relating to the capacity of coal to sorb H_2S and SO_2, the effect on coal (volumetric change, fracture porosity, etc.) and the effects of moisture, mineral matter and other factors on sorption of H_2S, SO_2 and CO_2 gases. Sorption analysis was carried out for these and other gases (H_2, N_2, CH_4) using a specially designed apparatus.

For all coals, sorption capacity to SO_2 and H_2S is markedly greater than other gases. Moisture has no affect on the adsorption capacity of SO_2 and H_2S, which is contrary to other gases. Strain studies indicated that volumetric swelling is proportional to the quantities of gas adsorbed and increases with the coal rank (vitrinite reflectance).

Some of the implications of the findings draw from the composition of natural gas containing substantial quantities of H_2S, which must be scrubbed prior to marketing. Also, use of high sulphur coals generates CO_2, SO_2, NO_2 and H_2S and disposing of them could enable many coals to be exploited as an energy resource. The experiments carried out in this project are close to providing a quantitative evaluation of the technical questions cited above.

Use of High Resolution Microscale Model Fields with the CALPUFF Dispersion Modeling System in Prince George, BC

Presentation by Bryan McEwan (University of Northern British Columbia)

This study was undertaken to determine if meteorological simulation can be used in lieu of observed conditions to estimate SO_2 dispersion in an area of complex terrain. Specific objectives were to assess the use of the Regional Atmosphere Misoscale Model (RAMS) in producing high quality California Meteorological Model (CALMET) meteorological fields of wind, temperature and other variables

in combination with the California Puff Model (CALPUFF) pollutant dispersion estimates.

RAMS is a meso-scale forecasting model that is able to 'telescope down' from upper atmosphere circulation patterns to predict local scale fluctuations by taking account of the influence of topography, vegetation cover, water bodies, etc. CALMET is a deterministic model that simulates a three-dimensional meteorological field based upon upper air and surface data (from at least one station). CALPUFF is a probabilistic dispersion model that predicts pollution concentration based on CALMET fields and an inventory of pollution sources and emission rates.

Regulatory modeling uses a past meteorological period to assess the dispersion of pollution concentrations, such as SO_2, which are associated with oil and gas operations. In this case, RAMS is used to make a 'hindcast' of atmospheric conditions using 'nearby' observations to establish boundary conditions and large scale, coarse grid data sets to initialize and 'fine tune' forecasts. The use of RAMS fields with CALMET, although containing errors, produced meteorological fields as good or better than CALMET using input from 1 to 3 surface stations. Using the same comparison, CALPUFF dispersion estimates of SO_2 made with RAMS input were more representative of observed conditions.

Modeled Meteorology – Applicability to Well Test Flaring Assessments

Alex Schutte (Levelton Engineering)

This study compared a meteorological model with independent site measurements to assess the accuracy of the model outputs and the feasibility of using modeled data in lieu of site observations, with particular reference to assessing the potential impacts of flaring. It is generally accepted that measured data are better for estimating such impacts. Current government and industry practice uses meteorological data from a single point that is often far from the emission source and assumes a uniform wind field or straight line dispersion of pollutants. Use of a surrogate location can lead to predictions that may be misleading, especially when topography, wind speed, and direction are different, as in mountainous terrain.

Against this background, a three-stage approach was followed. First, the MM5 mesoscale prognostic meteorological model was reviewed to establish the data resolution of wind fields (on a 20 km grid). Second, the output from this model was coupled with the CALMET model (see above) and the meteorological fields similarly assessed. Third, case comparisons were made of modeled versus observed measurements.

Key findings were that CALMET/CALPUFF is a viable approach that can act as a substitute for collecting long-term meteorological data in the region.

CALMET fields are more realistic than assumed uniform wind fields but still limited by the degree of data resolution available from the MM5 prognostic model. Future research is needed, for example, to refine the input data sets and make more robust comparisons for a variety of averaging periods, before a CALMET/CALPUFF model is viable for all locations in addition to the study area.

Muskwa-Kechika Management Area Heliportable Drilling Feasibility Study

Presentation by Randal Glaholt (TERA Environmental Consultants)

This study comprised a regulatory, environmental, technical and economic analysis of the feasibility of helicopter-based drilling technology in the Muskwa-Kechika Management Area (M-KMA). A number of previous evaluations of this approach have been undertaken. Industry has typically rejected the application of heliportable drilling in the past due to concerns over costs and or safety. Government has been reluctant to endorse or promote heliportable drilling because of uncertainty about its capability to meet emergency response and worker safety requirements for management of sour gas and blowout risk.

Key findings from the TERA analysis of heliportable drilling feasibility under each of the four key areas of investigation were as follows:

- no regulatory or policy constraints which would explicitly exclude the application of heliportable drilling;
- heliportable exploration drilling will have substantially less environmental impact than conventional road-based drilling programs although noise and disturbance of wildlife and recreationalists from this activity need to be addressed;
- 3400m depth-rated heliportable rigs and service equipment are readily available in Canada while rigs capable of drilling in excess of 5000m are available internationally. Helicopters with lift capability adequate for heliportable rig mobilization and routine support are also readily available in North America;
- worker safety and sour gas well control concerns are manageable with existing technology and appropriate levels of planning; and
- current economic analysis suggest that for sites requiring relatively short, simple access, moderate-depth heliportable drilling will be slightly more expensive than conventional road-based drilling operations and substantially more expensive for deep wells. For sites requiring long, complex access, moderate-depth heliportable drilling may be substantially cheaper than conventional road-based drilling and deeper heliportable wells may slightly to moderately cheaper than conventional road-based drilling.

Major recommendations from the study:

- heliportable drilling should be part of the M-KMA technology tool box;
- policy and best practice guidance should be developed further;
- opportunities should be sought to pilot test this technology to facilitate its implementation and refine guidelines and procedures; and,
- financial incentives for industry should be considered where there are commitments to use heliportable drilling.

DIGEST OF DISCUSSION AT THE WORKSHOPS

The discussion at the workshops on the issues that the SCEK Fund should address resulted in a large body of information being recorded on whiteboards and reported to the final plenary session.

A digest of this information is presented in this section. It is organized in accordance with the four knowledge envelopes identified previously, comprising: health and safety; ecosystem and cumulative impact management; engineering and technology; and, education and extension. The inputs of workshop participants have been aggregated to reflect research topics and priorities based on their relative frequency of interest and mention.

Research Topics and Priorities for

Health and Safety Envelope

Issues and Research Topics	Relative Frequency of Mention/ Degree of Interest/ Concern
Air quality - Impacts on communities - Odours - Concentrations - Charlie Lake/communities/regions - Long term assessment of cumulative impact of air quality - Monitor areas with diffuse sources - Replicate WISSA cattle study for wildlife (e.g. caribou) - Implications for human consumption	High, strong interest
General concerns related to OG industry emissions (mainly concerning air but not always specified) - Inventory - Analysis - Best practices - Effects on birds (decreasing population) - Effects on productivity/health of wildlife - Long terms viability of wildlife population - Sources of existing levels of air contaminants - Reduction strategies - Effects on humans - Track exposure limits - Trace metals - How to mitigate	High, wide ranging interest across a number of issues
Specific issues related to OG industry emissions (Health & Safety) - Impact of flaring from human health and safety - Impact on wildlife (monitor for adverse health effects) - Pollutant variability (should be studied over short periods of time) - Impact of sumps on wildlife and water quality - Water quality issues and impacts on humans, wildlife, livestock, fish - Contaminated wastes (left on leases in proximity to human habitation)	Medium-high, strong interest when combined with inputs on same topic from envelope II
Enforcement of health and safety issues related to: - Industrial practices and public health and safety - Impact on First Nations need particular consideration by OGC - Truck (odor) condensate - Truck spillage of liquids - Noise, fumes, traffic	Medium, moderate interest

Research Topics and Priorities for

Ecosystem and Cumulative Impact Management Envelope (includes environment impacts in general)

Issues and Research Topics	Relative Frequency of Mention/ Degree of Concern/ Interest
Herbicides - Use on ROW - Need unbiased review of information - Impacts on users – trappers, hunter, and FN's - Impacts on wildlife	Medium, clear interest
Background monitoring of air/water/soil - Prior to operational approvals - Retrospective research with historical data - Interview medical professionals in communities affected - Effects on cereal and other crops - Effects of wild game/berries on humans when consumed	High, strong, widespread interest; also becomes major priority when combined with baseline data (see below)
Baseline data and inventory studies - Integrated data base required to measure indicators – should be shared - Establish reference sites (integrated field study on reference sites) - Sensitive wetlands site assessment for wildlife - Stream classification/ inventory of NE BC - Fish supply inventory required - Fish habitat inventory required	High, strong and widespread interest; when aspects combined, becomes major priority when combined with background monitoring (see above)
Water quality concerns - Concerns re livestock, fish and wildlife consumption - Examine depth/size of aquifers in NE BC - Determine if there is movement/leaching of water underground (e.g., potential to enter human water supply) - How industry is addressing water issues during re-injection - Study of water quality around oil and gas facilities - Cumulative effects from water crossings - Impacts from sumps - Water turbidity (e.g. Kiskatinaw watershed) - Effects of spills on wetlands	High, strong, widespread interest; also becomes major priority when combined with inputs on same subject from health and safety envelope
Impact of emissions and effluent - Inventory - Analysis - Best practices - Long term study of impacts from emissions on forest cover - Site restoration of hydrocarbon spills - Remediation of salt spills	Moderate, some concern/interest

Research Topics and Priorities for

Ecosystem and Cumulative Impact Management Envelope (includes environment impacts in general) (cont'd.)

Issues and Research Topics	Relative Frequency of Mention/ Degree of Concern/ Interest
Monitoring and assessment of cumulative effects - Develop standards, need definition - Need for consistent approach - Framework of goals and guidelines - Establishing thresholds and indicators (AXYS/Salmo Report) - Also study other thresholds/ avoid over-dependence on indicator species - Link thresholds to values - Acceptable social limits on losses due to industrial activity - Importance of pre-impact data - Identify aggregate footprint of oil and gas activity - Corridor and connectivity research - Implement corridor design plan - Big picture/population density/fragmentation analysis - Identification of critical areas - Pilot studies - ERP planning and modeling - Particularly mountainous terrain	Very high priority when inputs are combined
Cumulative effect of roads - Concerns related to number, status, safety, km of development - Impact levels annually - Effects on wildlife populations - Frequency of people/access management of unused roads - Need to coordinate access with all parties - Better restoration standards	Moderate to high
Cumulative effects on wildlife and habitat - On wildlife populations generally - Increased habitat fragmentation - Specific impacts of seismic activity - On wildlife habitat - On wildlife based uses – trapping and guiding - Specific impact of H_2S emissions ingestion & inhalation - Caribou as an endangered species – need for recovery plan	High concern, especially regarding habitat loss and fragmentation
Other cumulative effects concerns - On private land - On annual allowable cut of timber - Bio-accumulation from deposition of waste – effects on air/water/soil - Environmental impacts of coal bed methane - Environmental impacts of offshore exploration	Moderate

Research Topics and Priorities for

Ecosystem and Cumulative Impact Management Envelope (includes environment impacts in general) (cont'd.)

Issues and Research Topics	Relative Frequency of Mention/ Degree of Concern/ Interest
Regional analysis, system approach and environmental strategy - Snapshot of northeast BC - Review conflicting policies - Conduct gap analysis - Need large RFP - Identify components for immediate action (e.g., water, reclamation) and long-term action items - Conduct workshop with residents (public) to i.d. issues - Address environmental systems - Identify gaps and solutions in one succinct document - Validate Sustainable Resource Management Plan	High, particular interest in ecosystem approach to strategic planning

Research Topics and Priorities for

Engineering and Technology Envelope

Issues and Research Topics	Relative Frequency of Mention/ Degree of Concern/ Interest
Reclamation of lands disturbed by oil and gas activities - Abandoned oil and gas sites - No legislation – need regulations and enforcement - Better management of reclamation guidelines - No timeframe to complete - Enforcement - Evaluation of public health in relation to abandoned wells - Impacts on wildlife after well abandoned - Rehabilitate abandoned wells - Need FN and other stakeholder participation - Bring back to original state - Private land – no incentive to reclaim - FN monitoring of sites (training required) - Develop best management practices - Reclamation of seismic sites - Restoration of culturally sensitive sites - Seed mix for reclamation - Range, Taylor mixed to env. native species	Extremely High interest – Full Support of E&T group
Support small fabricators - Until able to get funding elsewhere - Small entrepreneurs in technology to take concept to commercialization - Call for proposals for innovative technologies	Full support of E&T group
Landslides - Need to understand why large landslides are increasing - What processes are at work? - Future predictions - Forest pilot and MK forest structures - Regarding roads and pipelines	Full support of E&T group
Portable scrubber flare systems - Sour well flow testing - Reduce environmental impact	Full support of E&T group
Environmental Modeling - Promote advancement of - Air quality - Climatology - Areas that don't have a lot of data - Reduction in Canadian data	Full support of E&T group
Alternative Energy in NE BC - Remote power supply - Remote communication - Wind capacity - Geothermal capacity	Full support of E&T group

Research Topics and Priorities for

Education and Extension Envelope

Issues and Research Topics	Relative Frequency of Mention/ Degree of Concern/ Interest
Disseminate information on the SCEK Fund - Encourage interdisciplinary work - Local vs. non-local issues - Define parameters - Bring researchers together (farmers, animals, local involvement, residents)	Low
Project information dissemination - Develop a system where information from SCEK projects is gathered and distributed - Suggest obligation of project proponent to educate/communicate findings of the project - Laymen friendly - Honesty, transparency - Avoid missed information	Moderate
Better information and understanding - Air quality (perception of information being hidden) - Public access is needed - Health effects - Coal bed methane	Low
Education - On the process, laws of conservation - Of industry, government, First Nations - Educate in schools re oil and gas - OGC to develop a strategy on how to communicate – hire a communications officer - Public information on industry practices (re water) (possible PRFA involvement in project)	High, interest of E&E group
Lack of communication among researchers - Newsletters	Low
Traditional ecological knowledge - Particularly as part of CIM baseline data	Moderate

Other Issues Emerging from Discussions

Topic	Frequency
Inability of rural residents to access natural gas - For heating homes and shops	N/A
Fund Management - Use 'top down' approach (rather than 'bottom up') - Solicit for proposals - Generate ideas/proposals to support cumulative impact management - Encourage interdisciplinary work - Make known other funding sources	N/A
Road/Driver Safety - Researchers should call out kilometers - Workers should have driver training - Drinking and driving a problem - Unclear authority over road maintenance/safety	N/A

APPENDIX 1

Forum and Workshop Agenda 'At a Glance'

Day 1: Thursday, May 29th, 2003			
Time	**Item**	*Details*	*Responsibility*
7:30-8:00	Registration and Continental Breakfast		All Participants
8:00-8:20	Welcome and Introduction		Ben Mitchell-Banks, OGC
8:20-8:40	• Purpose of the forum • Purpose of workshops • Envelopes • Review agenda • Review handout binder • Review breakout group format		Andrea Morison, OGC
8:40-9:10	• History of the fund • Announcement of funding for another 5 years		David Pryce, CAPP (also representing SEPAC)
9:10-9:55	Health and Safety Presentations	• Flaring reduction in BC & AB *(15 mins)* • Western Canada Animal Health Study (WISSA) *(30 mins)*	• Dave Krezanoski, OGC • Michael O'Connell, (Western Interprovincial Scientific Studies Assoc.)
9:55 – 10:25		**COFFEE BREAK**	
10:25-12:00	Health and Safety Breakout Groups		All Participants
12:00-1:15	**LUNCH**		
1:15-3:15	Ecosystem and Cumulative Impact Management Presentations	• Introduction • The science of cumulative impact management (CIM) (AXYS - Vol 2) *(30 mins)* • Proposed CIM approach to res. mgt. & project level (45 mins) • CEI case study – Blueberry (45 mins)	• Howard Madill, Muskwa-Kechika Mgt. Area (MKMA) • Barry Sadler • Jeff Green (Axys Env. Consulting Ltd.) • Terry Antoniuk (Salmo Consulting Inc.)
3:15-3:30	**COFFEE BREAK**		
3:30-5:00	Ecosystem and CIM Breakout Groups		All Participants

Forum and Workshop Agenda 'At a Glance' *(cont'd.)*

Day 1: Thursday, May 29th, 2003	
Evening Presentations (Room #1)	
7:00-7:20	*Improved Methods of Air Quality Modeling* *(Brian McEwan, UNBC)*
7:20-7:40	Applicability of Modelled Site-Specific Meteorological Data to Well-Test Flaring Assessments in BC *(Alex Shutte, Levelton Engineering)*
7:40-8:00	*Impacts of Sour Gas Flaring on Vegetation in Northeastern BC* *(Katherine Enns, Golder Associates Ltd.)*
8:00-8:20	*Determination of Sour Gas and H2S Threshold Levels on the Mammalian Brain* *(Sheldon Roth, University of Calgary)*
8:20-8:40	*Northeastern BC Boreal Caribou Study* *(Brad Culling, Diversified Environmental Services)*
8:40-9:00	*Cumulative Impact Assessment Project – Sukunka Case Study* *(Terry Antoniuk, Salmo Consulting Inc.)*

Evening Presentations (Room #2)	
7:00-7:30	*Helicopter Drilling* *(Randall Glaholt, TERA Environmental Consultants)*
7:30-7:50	OGC & MKMA Response to Helicopter Drilling Review *(Howard Madill, Muskwa-Kechika Management Area & OGC)*
7:50-8:10	Acid Gas Sorption by BC Coal: Implications for Permanent Disposal of Acid Gas in Deep Coal Seams with Possible Co-Production of Methane *(Laxmi Chikatamarla, University of British Columbia)*
8:10-8:30	*Prophet River Moose Study* *(Claudia Houwers, Wildland Resources)*
8:30-8:50	*Foothills Model Forest Grizzly Bear Research Project* *(Gordon Stenhouse, Foothills Model Forest)*

Forum and Workshop Agenda 'At a Glance' *(cont'd.)*

Day 2: Friday May 30th, 2003			
7:30-8:00	Registration and Continental Breakfast		All Participants
8:00-8:15	• Welcome Back • Housekeeping • Recap Yesterday's Session • Review Objectives for today		Ben Mitchell-Banks, OGC
8:15-9:15	Environmental Study Presentations	• Soil Productivity and Forest Regeneration Success on Reclaimed Oil and Gas Sites *(20 mins)* • Overview Fish and Fish Habitat Inventory *(20 mins)* • Pioneer Natural Resources Canada Inc. Wildlife Studies: Working Towards an Understanding of Cumulative Effects Associated with Oil and Gas Development in the Chinchaga Area of BC and AB *(20 mins)*	• Chuck Bulmer, MoF • Brad Culling, Diversified Environmental Services • Todd Dillabough, Pioneer Nat. Res. Can. • Jonathan Wright, Ernst Env. Services
9:15-10:45	Breakout Groups • Environment (general) • Engineering & Technology • Education & Extension		All Participants
10:45-11:15	**COFFEE BREAK**		
11:15-12:00	• Breakout Group Summaries • Next Steps		• Ben Mitchell-Banks OGC • Derek Doyle, OGC
12:00-1:00	**LUNCH**		