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Natural Resources Canada's Role
in
Arctic Science Activities

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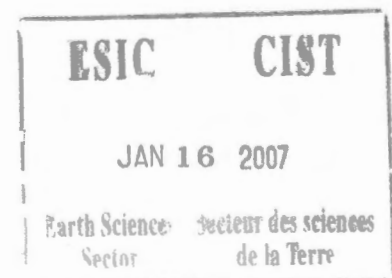
Natural Resources
Canada

Ressources naturelles
Canada

Canada

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1.0. Introduction

1.1. NRCan Science & Technology

Science and technology (S&T) activities within NRCan are vital to the sustainable development of Canada's natural resources. These activities underpin Canada's competitiveness through assisting in the discovery, development, management and most effective use of Canada's forest, mineral and energy resources. In addition, some NRCan research examines natural and anthropogenic hazards and global climate change, and as well is directed towards enhancing the health and safety of all Canadians. This research results in cost-effective methods of ameliorating any deleterious effects of resource extraction. NRCan also provides broad geographic and geologic information on the architecture of the Canadian landmass and its offshore areas. This information is increasingly available in electronic form. NRCan has developed a critical mass of advanced facilities, scientific expertise and information databases that are not duplicated in the private sector, by provincial research organizations, other federal laboratories or at universities. Much of NRCan science is undertaken by using a "centres of excellence" approach, involving key researchers from government, industry and universities.

1.2. Mandate and Business Lines

NRCan deals primarily with Canada's landmass and geomatics, and the sustainable development and responsible use of the country's energy, mineral and forest resources.

Forestry, mining and energy contribute \$86 billion a year to the economy, or 13 percent of the Gross Domestic Product. These sectors employ one in seven workers and are the primary source of income for some 500 communities. In 1993, net trade in energy, mineral and forest products reached \$ 4.4 billion. These products contributed \$17.4 billion to Canada's trade surplus. Long-term forecasts project continued growth.

Natural resources are a rich Canadian heritage. The Government of Canada's responsibilities regarding these resources involve science and technology, policy & regulation, market access, international trade and other matters of broad national interest, such as sustainable development.

NRCan is a leading S&T organization. Four of its five sectors are science based. The Canadian Forest Service, the Energy Sector, and the Minerals and Metals Sector promote the sustainable development and use of Canada's energy, forest and mineral resources and the competitiveness of those industries. The Earth Sciences Sector, comprising the Geological Survey of Canada and Geomatics Canada, provides geoscientific and geographic knowledge of Canada's landmass.

Following the Program Review results, the department confirmed its two core competencies - science and technology (75 per cent of resources) and policy (combined with administration, 25 per cent). These activities are integrated - policies are based on sound science and scientific activities are directed by policy priorities. The science and technology aspect of the department's work cover four business lines: minerals and metals, energy, forests and earth sciences. The S&T budget for the department for 1995-96 was approximate \$422 million.

2.0. Scope of the Report

Under the leadership of DIAND and DOE, an Interdepartmental Working Group was formed in order to develop a strategy to allow the federal government to identify and coordinate its northern science needs. This strategy involves the preparation of a document, which will describe current and planned federal departments research in the Arctic, coordination mechanisms employed, improvements in coordination, a strategy for improving northern science and a plan for implementing and communicating. This report, as well as the reports of the other participating departments, will be used as a basis from which the overall strategy will be developed.

3.0. NRCan Activities in the Arctic

3.1. Introduction

NRCan has been conducting natural resources research in the Arctic for many decades. Its earliest efforts, initiated in the middle of the last century, resulted in modern-day exploration of the Arctic landmass, and provided the first data on the resource potential of the region. Since these early mapping efforts, the need for natural resource science information has grown. Today it remains economically important to understand the details of the wide variety of natural resources held in the Arctic, but it is also important to ensure that the information gathered and the research conducted is useful to policy makers and the public in their responsibilities for making wise use of finite resources, in an area of Canada that is sensitive particularly environmentally. To this end,

greater emphasis has been placed on the study of risk reduction, terrain sensitivity, natural hazards, global change issues, and production of scientific data and research for the increasingly sophisticated needs of the country.

NRCan's earth science research is a critical component of the broader Arctic research efforts particularly, in environmental studies. As with other federal agencies doing focused Arctic research, NRCan's work fills a particular niche - specialized research that reflects a unique expertise. This research probably could be better linked to that of other organizations to form a network of integrated scientific programs and projects designed to observe, understand, evaluate Arctic natural resources, and to develop an improved understanding of the effects of a changing climate on the Arctic. This latter research mission is a cooperative effort among NRCan, DFO, Environment Canada, and various international environmental and land management agencies.

3.2. NRCan Northern S&T Program Reporting and Delivery

NRCan's broad northern science activities supported 26 projects totaling \$ 12.5 million in FY 95. The Program supports research in a wide variety of fields of earth sciences, remote sensing, energy, and forestry (detailed in Appendix-1). Many projects receive support through split-funding agreements with several agencies. Some projects involve collaboration with national and foreign research programs.

The Current NRCan's Approach

- I. Jobs & growth: geoscience supports economic development; regional studies underpinning exploration.*
- II. Sustainable development in the North.*
- III. Understanding natural processes within the North, e.g. permafrost, rates of uplift and coastal erosion, etc.*
- IV. Arctic processes of relevance to global systems, e.g. question on effects of global warming on melting of permafrost and gas hydrates, etc.*

NRCan's broad S&T activities in the North are grouped together into five deliverables. A description of the principal deliverable for each follows:

3.2.1. **Minerals:** Geological Survey of Canada (GSC) and CANMET

3.2.1.a. Introduction

The scientific and technical data and expertise provided to the minerals resource industry by NRCan are fundamental to strengthening new base metal, gold, and diamond exploration and developments in the North (detailed in Appendix 1).

*** Northern** is apply to the Yukon and NWT.

GSC:

- I. provides sound science input to the policy development process (for example, land use planning);
- II. provides scientific expertise to industry and the Territorial governments on the exploration for, and mining and production of, all types of mineral deposits; and
- III. helps industry to develop new value-added products, new processes, new engineering services and equipment, and environmental monitoring and improvement systems.

3.2.1.b. Key Northern Strategies

- I. GSC's intensive regional geological studies of both bedrock and surficial materials, refined mineral deposit models, and new exploration concepts and technologies will enhance the knowledge infrastructure for discovery.
- II. New geological maps will provide the fundamental information for identification of areas of best potential for new mineral resources at the detail required by industry. This research will be conducted with the GNWT & DIAND (National Mapping Program);
- III. New exploration technology will enable industry to "see through" the surficial materials that cover most of the Arctic, as well as "see deeper", particularly in established mining districts; and
- IV. Research to increase the efficiency of mineral production will focus on recovery of metal from uneconomic sources, and optimized mining processes and practices (CANMET).

Selected Activities

- ◆ *GSC Regional Geoscience Surveys have stimulated and guided gold and diamond exploration in the Keewatin (eastern N.W.T.); the Mayo map sheet in the Yukon led to industry staking and exploration and was used in the settlement of native land claims; work in northern Quebec and Labrador and southern Baffin Island has fundamentally revised geological maps and concepts on mineral potential. The National Geochemical Reconnaissance Program has covered significant portion of Northern Canada, providing baseline geochemical data as well as indicators of potentially economic mineralization.*
- ◆ *Through Minerals Resource Assessments (MERA): 8 national parks established and 2 boundaries decided; high mineral and/or energy potential excluded from all but 3 MERA cases; significant areas of high mineral potential included in 5 cases; and high mineral potential is defined at west end of Wager Bay proposed park.*



Natural Resources Canada
Ressources naturelles Canada

GEOLOGICAL SURVEY OF CANADA



COMMISSION GÉOLOGIQUE DU CANADA

NORTHERN GEOSCIENCE PROGRAM

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Northern Geoscience Activities

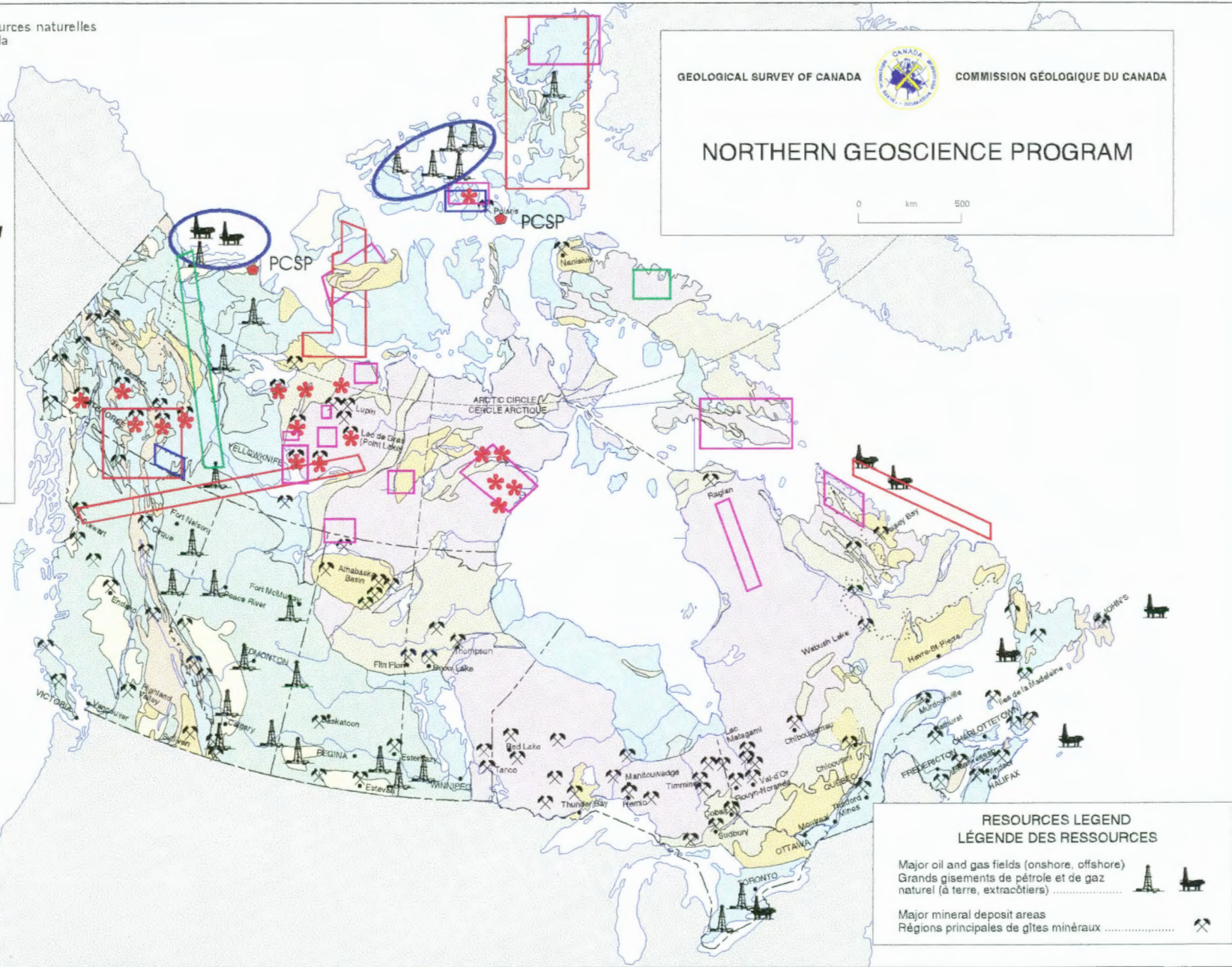
-  **Bedrock and Surficial Mapping**
-  **Geophysical Mapping**
-  **Geochemical Mapping**
-  **Global Change**
-  **Minerals Research**
-  **Energy Research**

GEOLOGY LEGEND LÉGENDE GÉOLOGIQUE

-  Cenozoic
Cénozoïque
-  Mesozoic
Mésozoïque
-  Paleozoic
Paléozoïque
-  Late Proterozoic
Protérozoïque tardif
-  Middle Proterozoic
Protérozoïque moyen
-  Early Proterozoic
Protérozoïque précocé
-  Archean
Archéen

RESOURCES LEGEND LÉGENDE DES RESSOURCES

- Major oil and gas fields (onshore, offshore)
Grands gisements de pétrole et de gaz naturel (à terre, extracôtiers)  
- Major mineral deposit areas
Régions principales de gîtes minéraux 



3.2.2. Energy (CANMET and GSC)

3.2.2.a. Introduction

Conducting sedimentary basin analysis & petroleum systems, and research into alternate forms of energy and energy efficiency are significant elements of NRCan's Arctic research program. (detailed in Appendix 1).

GSC and CANMET conduct energy-related S&T programs that:

- I. provide sound science input to policy development regarding frontier energy sources;
- II. help industry to locate and evaluate new reserves of oil and gas;
- III. help industry to enhance the cost-effectiveness of production and use of conventional, renewable and alternative energy supplies;
- IV. help energy producers and consumers to reduce the environmental impact of energy production and use;
- V. help industry to develop new value-added products and services, adopt new processes and acquire knowledge that will enable them to capture markets in Canada and abroad.

3.2.2.b. Key Northern Strategies

- I. A precise three-dimensional picture of the Northern Canada Sedimentary Basins will aid in new discoveries and in assessing hydrocarbon resource potential. Marine geoscience surveys and engineering studies will provide information for offshore oil and gas well-siting, environmental impact assessment, and pipeline and loading /shipping facilities.

Selected Success Story

Exploration following GSC studies in four major Arctic basins revealed 17 oil & gas fields in Sverdrup Basin with excellent potential; 1 oil pool in Franklin Basin with moderate potential; 53 oil & gas fields in the Beaufort-Mackenzie Basin with excellent potential; 20 oil & gas fields with excellent potential in the Northern Plains Basin have been defined.
- II. Cost-effective alternative and renewable energy sources that have minimal environmental impact will be developed (e.g., alternative motor fuels, community heating and cooling systems, bioenergy, solar thermal energy, wind energy and small hydro energy);
- III. Environmental impacts from production and combustion of hydrocarbons and biomass-based fuels will be alleviated.

3.2.3. **Forestry** (Canadian Forest Service)

3.2.3.a. Introduction

The Canadian Forest Service (CFS), through its national network of science-based establishments, delivers a research program that focuses on the two key issues of promoting the sustainable management of Canada's forests and competitiveness of the Canadian forest sector. It leads and coordinates the country's national and international forestry S&T activities, and undertakes a research program that is based on the principle of partnership with governments, industry and other stakeholders.

Ecosystem-based forest management is the key means to both sustainable forest management and forest sector competitiveness. A major part of the program will be the development of new forest protection technologies that are both cost-effective and environmentally acceptable. Better protection of forests from losses due to fire, insects and pathogens will offset timber supply reductions related to environmental constraints on industry.

In addition to providing support for industrial forest research agencies and fostering enhanced research at Canadian universities, the CFS will place greater emphasis on intellectual property management and commercialization initiatives, and will strengthen the international dimension of its S&T program over the next five years.

3.2.3.b. Key Northern Strategies

- I. understanding the fundamental processes and dynamics of Canada's forest ecosystems (e.g., fire ecology, dynamics of insects and diseases, impacts of forestry practices);
- II. providing leadership in forest ecosystem monitoring and analysis (e.g., carbon budget models for assessment of climate change, BOREAS, development of bio-indicators);
- III. developing and promoting better ways of protecting and enhancing the health, diversity and productivity of forest ecosystems (e.g., forest fire management, etc.);
- IV. developing the integrated knowledge, tools and techniques needed for sustainable management of forest ecosystems (e.g., national / international Model Forests, ecological land classification, criteria and indicators); and

- V. contributing to the future viability and competitiveness of Canada's forest-based economies through research and funding support, scientific and technical advice, and assistance in the application and commercialization of environmentally sound systems and technologies (e.g., wood products research, biotechnology, development of new biological pest controls, decision-support systems).

3.2.4. **Geomatics** (Geomatics Canada)

3.2.4.a. Introduction

“Geomatics” is one of Canada’s newest and fastest growing high-technology industry sectors. Geomatics companies provide geographically- reference information, used widely in planning for new industrial developments, for assessing commercial opportunities, and for the orderly use of our landmass. Geomatics information underpins economic development. A national agency must be in place to collect and archive this information, and to provide it to industry for geographic information systems (GIS). Geomatics Canada fulfills this role.

The S&T programs of Geomatics Canada (GC) are grouped in three main activity areas. The first consists of Legal Surveys and Geodetic Surveys, which are fundamental to establishing international and national boundaries, and in providing accurate elevation and coordinate points for all surveying and mapping activities in Canada. Secondly, GC provides the national topographic data base, produces topographic maps and aeronautical charts and air information. These all map Canada’s land surface and are essential to national defence, sovereignty, resource exploitation and infrastructure development. Thirdly, remote sensing research and satellite data acquisition are the principal S&T activities the Canada Centre for Remote Sensing (CCRS).

3.2.4.b. Key Northern Strategies

- I. Every native land claim settlement has a requirement for a survey to demarcate the boundaries of the native lands. Legal Surveys will continue to regulate and manage location of boundaries of Canada Lands and is also responsible for the delineation of the international boundary with the United States.
- II. Geodetic surveys will maintain the spatial reference system for Canada at very high precision, using radio-telescopes and global positioning satellites.

** Geomatics: acquisition, use and manipulation of geographically referenced data.

- III. Developing and maintaining the national topographic data base, and topographic mapping are core functions of Geomatics Canada. These maps, which provide geographic information about Canada's landmass, will be in computer-accessible format, an important new direction for topographic mapping. The development of computerized aeronautical charts, and computer accessible information to aviators will become an even more efficient service than at present.
- IV. The Canada Centre for Remote Sensing (CCRS) will lead in collecting and analyzing satellite data. This Centre is developing new remote sensing technology, such as in the Canadian RADARSAT satellite, and for aircraft-based remote sensing. Projects with private-sector partners will be used for determining forest health, ice conditions, transportation planning, and for geological mapping in the Arctic.

3.2.5. Health, Safety, Environment and other Public Good Activities

3.2.5.a. Introduction

Aside from the obvious benefits for wealth creation of the S&T activities described above, NRCan's science sectors conduct various programs that relate to environmental protection and the health and safety of Canadians.

3.2.5.b. Key Northern Strategies

- I. The end-users of the maps and satellite data from Geomatics Canada will monitor ice movement, and fire damage. Military and commercial pilots use aeronautical charts and publications to ensure flight safety.

- II. GSC will provide information on the response of the land, coasts and the seafloor to earthquake shaking, land disturbance including permafrost studies, and slope stability and landslide problems.

Selected Success Story

- a *A major GSC study over the last 30 years has established the distribution of permafrost and ground ice data. This work is now directed at assessing the impact of climate change in the Mackenzie Valley.*
- b *Compilation of magnetic & refraction seismic data in the Arctic Ocean and adjacent land areas were completed under GSC Marine Geoscience Program.*

- III. GSC will study nature's contributions to global change, including indirect measurement of the changes in rainfall, temperature, wind, and sea level over the past 10,000 years.

- IV. Geochemical surveys, combined with research on coastal, lake and river sediments, will determine the distribution of potentially toxic naturally occurring compounds, and the potential for their release as a result of future development strategies.
- V. CFS programs in ecosystem research, climate change, surveys of forest health and Model Forests are parts of the government strategy for sustainable resource management. The Model Forest program addresses the use of our forest lands as for recreation, forest products, and water.
- VI. CFS conducts research into the basic functioning of forest ecosystems, and how forests contribute to the maintenance of global ecological cycles (carbon, water, air, etc) that support life.

3.2.6. Research Logistics (Polar Continental Shelf Project)

3.2.6.a. Introduction

For almost four decades, Polar Continental Shelf Project (PCSP) has served to help Canada establish and maintain its sovereignty in the Arctic by helping thousands of scientists work in otherwise inaccessible locations in the North and learn about a region covering more than one-third of Canada's landmass and offshore.

3.2.6.b. Key Northern Strategies

Scientists working with PCSP assistance have helped to define Canada's offshore limits and to establish Canada's claims to offshore hydrocarbon and mineral resources; to identify and develop renewable and non-renewable resources in support of national and local economies; to assess the environmental impact of development in the North and the impact of the northern ecosystems on infrastructure development; and to help governments develop land management programs and determine sustainable development methods in order to protect the northern environment.

By providing one-stop shopping for logistics, PCSP offers an efficiency and cost-effectiveness in provision of services to its government and university clients.

Most of the programs supported by PCSP are carried out on a cost-shared basis; research conducted by non-Canadian and private sector groups receive support on a full cost-recovery basis.

In 1995, PCSP recovered a total of 44 percent of the monies it spent on provision of logistics services to clients. With its diminishing resources, PCSP is increasing cost recoveries from other governments departments.

Selected Support Activities

- a PCSP has supported research leading to establishment of National Wildlife Areas and Migratory Bird Sanctuaries in the Arctic to protect and conserve wildlife habitats.*
- b Among the many government and university biology programs supported by PCSP have been those examining peary caribou conservation, polar bear populations, Canada geese migration and nesting areas, Arctic char distribution, wildlife habitat mapping in the Inuvialuit Settlement Region, and beluga and narwhal movements and behavior.*
- c Canadian scientists have been collaborating with their circumpolar colleagues to map air- and water-borne contaminants, including PCBs, DDTs and acid rain, in the Arctic. Studies conducted in a "toxic corridor" beginning in Russia and extending over the North Pole into North America, have resulted in the discovery of high levels of PCBs in the breast milk of Inuit in northern Quebec.*
- d With PCSP support, government hydrographers conducted a three-year survey of the Coronation Gulf to help identify safe shipping routes in support of the mining industry and Government of the Northwest Territories. Past surveys have determined safe sealift supply routes into communities, allowing government to save up to \$1 million a year on air cargo expenses.*
- e Industry and government have joined forces to study the geothermal, geological and geotechnical conditions of frozen sediments in the Mackenzie Delta area. These ongoing studies contribute to the knowledge of the properties of permafrost, an issue vital to the future development of oil and gas in the area.*
- f Extensive experimental oil spill studies have been undertaken to monitor the effects of spills on regional ecosystems over the long term.*
- g A variety of archaeological, anthropological and traditional knowledge studies have been supported, contributing to the knowledge of past cultures and environments. In 1996, PCSP is supporting traditional knowledge studies involving elders from six northern communities.*

4.0. Potential Research/Program Gap

The level of activity in the Arctic has been scaled down, as have its other programs in the Department. However, a number of outstanding scientific issues offer opportunities for new projects:

4.1. Metals in the Environment

As part of a larger GSC study to evaluate natural vs. anthropogenic inputs of metal into the environment in the various terrain of Canada, work needs to be done on the trace element content of Arctic lake sediments. Study must be able to discriminate natural from anthropogenic sources.

4.2. Hydrogeology of Permafrost

Relatively little work on hydrogeology in northern regions has been carried out by GSC or other research institutions in Canada. Yet, in the discontinuous permafrost zone, groundwater is a major source of water for many settlements (63% of the population in the Yukon relies on groundwater for its source of water). Apart from the water availability issue, other concerns revolve around contaminant movement in frozen ground (e.g. from tailings ponds, sumps, associated with mining and hydrocarbon development). Fundamental research

is needed on the processes of water and solute movement through frozen and seasonally frozen ground, and the role of the freezing process in concentrating chemicals. Field studies of contaminated sites and detailed laboratory modeling are required.

4.3. Settlement Maps/Permafrost Evaluation Studies

Towns in Canada's Arctic face a unique set of geotechnical and landuse problems related to the existence of permafrost. A multidisciplinary and multiagencies program on the geology and environmental/geotechnical setting of Arctic town sites would provide information to facilitate planning and development in northern settlements. The work would involve several parts of the GSC plus DIAND, GNWT, settlement councils, and the Nunavut government.

4.4. Remote Sensing and Predictive Permafrost Mapping

Mapping the presence or absence of permafrost, gas hydrates and ice conditions is a major challenge faced by engineers responsible for the placement and construction of roads, pipelines, and other infrastructure in the north. In many areas preliminary alignments must be made without detailed data available. GSC has had some success in predictive mapping using GIS technology and satellite data. Though it would be a very major undertaking, this work should be expanded, as the development of "expert systems" would be an invaluable contribution to future development in Canada's north.

4.5. Transarctic Pollution Studies

There is need to coordinate an international effort to collect and analyze core from circumpolar ice caps and snow and ice samples from across the Arctic to document the timing and impact of transarctic pollution. Such studies help to identify the sources of the pollution and provide the baseline data required for curbing this global problem. Soot and sulphates are thought to be causing regional changes in Arctic climate, and the data provided by these studies are required for a quantitative assessment of this hypothesis, as well as the monitoring of the effectiveness of remedial actions.

5.0. Suggestion for Better Coordination of Canada's Northern Research Effort

In an era of budget contraction greater effectiveness and return on research funds should be a shared aspiration among federal Arctic programs. Better coordination and integration among all departments that support Arctic research

are needed to achieve the most efficient use of PCSP resources and to facilitate cooperation.

5.1. What we need among federal departments :

1. *Determine which Arctic S&T requirements have a common interdepartmental focus;*
2. *Establish a common understanding of the need to develop a science knowledge infrastructure of the Arctic region;*
3. *Develop, and coordinate where appropriate, joint projects; these might have common information and facilities requirements; and*
4. *Agree on common protocol or standards for data collection, transmission and archiving.*

5.2. What coordination functions does the federal government need?

Three Key areas where an effective coordination can best support federal government need:

1. *Common data bases and scientific protocols.*
2. *A northern economic development strategy.*
3. *Efficient uses of PCSP & ships.*

5.3. Suggested Synergies and Opportunities of Scientific Cooperation

Common areas of interest are :

1. *Common development of S&T strategy or framework for the Arctic in the areas of economic development, land use and ecosystem processes.*
2. *Understanding Global Climate Change.*
3. *Protecting the Arctic environment e.g. Metals in the Environment.*
4. *Land use sensitivity: reduction of risk through permafrost degradation, coastal zone management, etc.*
5. *Common geoscience information base for all Arctic research..*

"Virtual Institute" proposal for discussion in Appendix 2.

Appendices

NRCan Research Programs in the Arctic

Major Programs/Initiatives	Objectives	Resources	Mechanism	Future Plans
GEOLOGICAL SURVEY OF CANADA				
Precambrian Bedrock Mapping	<i>To improve knowledge and understanding of the bedrock geology of the North through regional mapping and thematic studies, and thereby provide a geoscience knowledge infrastructure for sustainable mineral resource development and land use decision-making.</i>	Program budget : ~ \$1.0m/yr	Joint program design and delivery with Provinces/Territories, OGDs, universities, industry (e.g., NATMAP, IPP). Many Projects receive support through split-funding agreements, and others involve collaboration.	Release of maps and reports stemming from the NWT MDA and the Slave Province NATMAP Project; Initiate LITHOPROBE SNORCLE transect; Initiate work for Western Churchill geoscience studies and release maps and reports; Complete southern Baffin Island integrated mapping Project; Complete Minto greenstone belts project and release of maps and Bulletin
Regional Tectonics of the Arctic Ocean Basin and its Margins	<i>To improve understanding of the tectonic evolution of Canada's high Arctic as a fundamental tool for resource assessment. To provide baseline information for environmental studies, and evaluate the impact of the Law of the Sea regulations.</i>	NRCan Cont. : ~ \$20k/year. * US Naval Research Laboratory (provided over \$2 million in potential field data),	Through Polar Margin Aeromagnetic Program (PMAP), a cooperative effort between Defence Research Establishment, NRC and NRCan. Projects receive support through split-funding agreements, and others involve collaboration.	PMAP data acquisition in Lincoln Sea area will be integrated with field studies in northern Greenland; Complete Canadian Ice Island seismic study; Participate in aerogravity and aeromagnetic data collection in the Arctic Basin with the US Naval Research Laboratory; Integrate available ERS-1 derived satellite gravity data with airborne and surface gravity observations; Participate in updating magnetic coverage as data from other agencies/industry become available; Refine the plate tectonic framework.
Arctic Islands Mapping	<i>To provide the basic knowledge necessary for resource evaluation and environmental assessments of new land claims areas, exercise of sovereignty.</i>	Program budget : ~ \$ 580k/yr.	Projects are developed in consultation with other government geoscience agencies (GNWT, DIAND, USGS, etc.) as well as local stakeholders. Projects receive support through split-funding agreements, and others involve collaboration.	Complete mapping projects- Bathurst Island and Hvitland-North Axel; Initiate new program for east-central Ellesmere; Concentrate Northern Mainland mapping sheets immediately north of 60° and on selected areas of the Northern Yukon.
Regional Surficial Geology Studies	<i>To determine of the Quaternary history of northern Canada and the provision of maps and data that will assist in sustainable development, land use planning, and environmental protection.</i>	Program budget : ~ 588k/yr.	Program design in consultation with other government geoscience agencies (GNWT, DIAND) as well as local stakeholders. Some projects involve collaboration and split funding agreements.	Maintain a low level of surficial mapping activity in Slave Province, the Yukon, Bathurst Island, and southern Baffin Island; Release data on Victoria Island, Fosheim Peninsula, Devon Island, and Melville Peninsula; Research into drift prospecting methods and the results of the analysis of archived samples for kimberlitic indicator minerals; Testing of cosmogenic dating methods will continue on an opportunity basis.
Geophysical Surveys	<i>To acquire aeromagnetic and gravity data for regions of the Canadian landmass and offshore..</i>	Ellesmere Island gravity survey: (NRCan -\$100K & US Defense Mapping Agency (\$500K-\$1M)). Queen Maud Gulf on-ice survey (logistics shared with Canadian Hydrographic Service) Aeromagnetic TF Survey - In Victoria Island: (\$600K NRCan; \$400K from industry) - In B. C./Yukon/NWT: (1.15M NRCan & \$150 K from industry)	On-ice gravity measurements, conducted in cooperation with the Canadian Hydrographic Service. Gravity measurements were also taken on-ice over Nares Strait and on the adjacent terrain of Ellesmere Island in partnership with the U.S. Defense Mapping Agency. A high resolution aeromagnetic survey over part of Victoria Island was jointly funded by industry partners.	Arctic Channels project will continue at a much reduced rate due to diminished funding for the Canadian Hydrographic Service; Complete aeromagnetic coverage in the eastern Arctic; Initiate next phase of PMAP in the area north-west of Ellesmere Island.
Geochemical Surveys	<i>To provide and interpret regional geochemical data as a basis for mineral exploration and environmental protection National Geochemical Reconnaissance - NGR).</i>	Program budget : ~ 100k/yr. These survey have been funded almost entirely with external request	Geochemical survey was carried out at the request of the Yukon/Territorial Government.	Complete geochemical Atlas of Yukon; Release results of Victoria and Bathurst Island surveys
Mineral Deposits Research & Regional Metallogeny	<i>To develop models for mineral deposit types of current and potential significance in Canada as an underpinning for mineral exploration and resource assessment. To identify prospective terranes for significant mineral deposit types, as a basis for sustained exploration activities.</i>	Program budget : ~ \$360k/yr	Program design and delivery in consultation with other government geoscience agencies (GNWT, DIAND, etc.), industry as well as local stakeholders.	Complete research on application of Noril'sk model to Victoria Island; Complete metallogenic studies under Slave NATMAP project; Begin studies under new Churchill NATMAP projects; Report new showings and exploration models north of 60

Major Programs/Initiatives	Objectives	Resources	Mechanism	Future Plans
GEOLOGICAL SURVEY OF CANADA- Contd.				
Mineral and Energy Resource Assessments (MERA)	<i>To develop and promote national standards for resource assessment in land use planning, and to provide Mineral and Energy Resource Assessments (MERA) of proposed National Park as required by DIAND and Parks Canada.</i>	Program Budget: ~ \$295k/yr	NRCan conducts field and laboratory research, and publishes MERA reports containing NRCan's professionals and opinions on mineral and energy resources potential in the proposed park areas. Cost shared by Parks Canada, DIAND, and NRCan.	Publish MERA Terms of Reference with synopsis of underlying geoscience; adapt MERA methods to National Marine Conservation areas; Complete fieldwork for MERA in Region 38 (Arctic Islands); Participate in community consultations to assist promote understanding of MERA results; Develop, apply and publish consistent techniques for generating mineral potential maps
Basin Analysis and Petroleum Systems	<i>To develop quantitative process models for analyzing the dynamic evolution of sedimentary basins, including the origin, movement and geofluids for sedimentary basin resources; supports for assessment of Canada's energy resource and environmental issues.</i>	Program budget: ~ \$625k/yr	Program design in consultation with industry & other government geoscience agencies (GNWT, DIAND, etc.) as well as local stakeholders.	Complete Basin Atlas; Initiate a study of southern half of the Northern Plains basin; Work in the Sverdrup Basin will consist of a completion of field studies, a synthesis of subsurface and surface data, a resource assessment; Studies in the central Ellesmere area where there is good mineral potential in the succession.
Permafrost Research	<i>To determine regional controls on permafrost distribution and its characteristics including thermal properties, ice contents, chemistry, and permafrost stability in the face of natural and anthropogenic changes. To determine the applicability of various geophysical techniques for permafrost characterization and delineation.</i>	Program budget: ~ \$724k/yr	Research during the past funded and design largely through PERD, NOGAP, ESRF, DIAND, and other mechanisms.	Reports on configuration and variability of permafrost in the Mackenzie Delta; Final report on Grande Baleine permafrost and geological processes research; Synthesis report on thermal regime and slope stability over the past 10 years associated with the Norman Wells Pipeline; Reports on thermal regime in and around lakes and eskers systems Slave Province; Reports evaluating the capacity coupled resistivity unit.
Global Change	<i>To document how climate change will affect the physical environment in Arctic regions.</i>	Program budget: ~ \$435k/yr.	Project is developed in consultation with other government agencies as well as local stakeholders.	Reports describing environmental conditions in Canada at 1000 year intervals through the Holocene
Glaciology and the Study of Arctic Ice Caps	<i>To study past environmental changes by analyzing surface-to-bedrock ice core variations in ion, microparticle, pollen concentrations, stable isotopes, and ice layer variations.</i>	Program budget: ~ \$520k/yr.	Continuing work is proceeding with strong inter-agency and international cooperation	Complete an international ice coring program on Baffin Island
Marine Geoscience	<i>To provide basic geoscience information for sustainable development of Canada's coastal and nearshore regions, through understanding, assessing, predicting or mitigating coastal and seabed erosion and deposition problems, transport of contaminants, and other related hazards. To develop new, innovative technology to meet the requirements of the Marine Geoscience Program and to transfer this technology, where appropriate, to Canadian industry in order to enhance Canada's international competitiveness.</i>	Program budget: ~ \$500k/yr	Continuing work is proceeding with strong inter-agency and international cooperation	Evaluate existing data in Arctic ocean, share and research common data with other Arctic nations; Develop, with OGDs and Provinces, a framework for marine geoscience input to Integrated Coastal Zone Management strategies; Assess historic ocean dumping practices in Cambridge Bay, N.W.T.; Upgrade and improve field and laboratory instrumentation and transfer to Canadian industry where appropriate; Assess the engineering implications of subsea permafrost, Beaufort Sea
GEOMATICS CANADA				
Remote Sensing and global change	<i>develops remote sensing technology and applications of earth observation aimed at the knowledge and effective management of Canada's natural resources and environment.</i>	Program budget: ~ \$80k/yr	Coordination of global change Program, within the limits of the resources made available, and in cooperation with the industry, OGD, international research institutions.	Develop and demonstrate methods for using RADARSAT and future earth observation satellites for the assessment of land cover types and properties in the Arctic (e.g. tundra); Develop datasets for obtaining synergetic information on sea ice, clouds and surface radiation budget in the Arctic basin from RADARSAT and other satellites; In collaboration with Canadian Climate Centre improvement of the performance of the Canadian global climate model in the Arctic using satellite-based data products.

Major Programs/Initiatives	Objectives	Resources	Mechanism	Future Plans
GEOMATICS CANADA- Contd.				
Arctic Remote Sensing (Sea Ice Applications Development)	<i>develops technology and applications of earth observation aimed at the knowledge and effective management of Canada's natural resources and environment.</i>	Program budget: ~ \$160k/yr	Coordination of Canadian sea ice remote sensing community in strong cooperation with Ice Services Environment Canada and Value-Adding Industry. Funding of industry to establish Canadian commercial capability in automated interpretation algorithms. Liaison with international polar remote sensing community for RADARSAT planning and algorithm development.	Strong emphasis on early validation and demonstration of RADARSAT capabilities for sea ice monitoring with OGD and industry, followed by reduced levels of effort on coordination and algorithm development.
Arctic Remote Sensing (Geological Data Integration)	<i>develops technology and applications of earth observation aimed at the knowledge and effective management of Canada's natural resources and environment</i>	Program budget: ~ \$80k/yr	Coordination of geological activities within NRCan, with University of Ottawa through ADRO proposal for work on Ellesmere Island, with mining and value-added Industry. Funding of industry to establish Canadian commercial capability in automated integrated products and systems. Liaison with international geological remote sensing community for research and application development using RADARSAT data.	Strong emphasis on early validation and demonstration of RADARSAT unique capabilities; Increased level of effort required in technology transfer to OGD and industry.
CANMET- ENERGY				
PV (Photo Voltic) for the North	<i>to help the Canadian PV industry develop technologies appropriate for the severe northern climate; to initiate technology transfer which will lead to the successful implementation of PV in the North; and to strengthen Canada's commitment to sustainable energy development.</i>	Five year project initiated in 1993. Program budget: ~ \$ 1.0 m/yr	Partner with Science Institute of the Northwest Territories	At the core of the PV for the North program is a sustainable market development effort. It is expected that this program will give the Canadian PV industry the opportunity to earn a reputation as a leader in the field of PV system design and implementation in harsh environments, both within North America and abroad.
Renewable Energy for Remote Communities	<i>promote the use of renewable energy (RE) technologies in Canada's remote regions where the cost of electricity is very high and where REs are often cost-effective options</i>	Project will be started in 1996. \$600k/year (estimate) NRCan and matching funds from partners.	Potential new partners for the "Renewable Energy in Remote Communities" program include electric utilities with an active interest in RE technologies, such as N.W.T. Power Corporation, Ontario Hydro, B.C. Hydro and Hydro Quebec, first nations, other territorial/provincial/municipal governments, other federal departments and the RE technology industry.	Report findings of project to all stakeholders.
CANADIAN FOREST SERVICE				
Forestry Research and Development	<i>To solve problems identified by Northwest Territories clients and various research advisory processes particular to the Northwest Territories.</i>	Program Budget : ~ \$86k/yr.	Canada-Northwest Territories Cooperation Agreement in Forestry	Not applicable due to termination agreement and downsizing.
Management Planning and Resource Data	<i>To support the development of a forest management policy for Northwest Territories forecasts and a long term management plan for the Lower Liard Forest Management Unit.</i>	Program Budget : ~ \$200k/yr.	Canada-Northwest Territories Cooperation Agreement in Forestry	Not applicable due to termination agreement and downsizing.

Major Programs/Initiatives	Objectives	Resources	Mechanism	Future Plans
CANADIAN FOREST SERVICE- Contd.				
Technology Transfer Projects	<i>To provide prompt, accurate and appropriate transmission and transfer from scientists to practicing field foresters and other forest users.</i>	Program Budget : ~ \$46k/yr.	Canada-Northwest Territories Cooperation Agreement in Forestry	Not applicable due to termination of agreement and downsizing.
Forest Insect and Disease Management Systems and	<i>To obtain and maintain and updated surveys of forest insect and diseases. To develop technologies to assess pest caused losses, to understand and predict the nature and causes of this damage and develop techniques to mitigate e effects of these agents on the productive forest resource.</i>	Program Budget : ~ \$74k/yr	Regional Insect and Disease Technical Advisory Committee	A small number of forest health benchmark and monitoring plots (PSPs) will be set up and maintained in the Northwest Territories; Annual survey work will e discontinued due to downsizing, however, some information will e collected on the forest heal PSPs; Research on pests, e.g., spruce budworm, which is applicable to the Northwest Territories will be done in northern boreal forests of the prairie provinces.
Fire Research	<i>To research aspects of wildland fire occurrences behavior and environmental impact to develop and improve fire management policies and programs.</i>	A-base and Green Plan	Canadian Committee on Forest Fire Management Western Regional Fire Weather Committee Central Region Fire Weather Committee Interior West Fire Council Regional Fire Research Technical Advisory Committee	Cooperative international (Canada, Russia, U.S.A, and German) scientific expert on crown fire phenomena and modeling at Ft. Providence, Northwest Territories.
Boreal Mixedwood Silviculture Forest Ecosystem Classification	<i>To research and develop Silviculture systems for the management of northern boreal mixedwood and hardwood stands. To research and develop ecological site classification and evaluate the impact of forest practices on the northern boreal forest, ecological processes and productivity.</i>	A-base and Green Plan	Regional Regeneration Technical advisory Committee	Nothing specifically planned for the Northwest Territories.
Climate Change Peatland Ecology	<i>To research aspects of the role of forests in storing atmospheric carbon as well as the effect of climate change on forest biology. To determine the ecology of wetland development.</i>	A-base and Green Plan	Boreal Ecosystem Atmospheric Study Group (BOREAS);Northern Biosphere Observation and modeling Experiment (BIOME); Global Water and energy Exchange Experiment (GEWEX) Mackenzie Basin Impact Study (MIS); National Climate Change Action Plan (NCCAP); International Boreal Forest Research Association (IFBRA);Carbon Budge model of the Canadian Forest Sector (CBI)	Nothing specifically planned for the Northwest Territories
POLAR CONTINENTAL SHELF PROJECT (PCSP)				
Polar Continental Shelf Project	<i>providing cost-effective co-ordinated logistics support to Canadian government, independent and university groups, and on a cost-recoverybasis, to private sector and non-Canadian groups that conduct scientific research programs in the Arctic; and providing information about scientific operations in the Arctic to clients, northern inhabitants, and the general public.</i>	Program Budget:: ~ 4.0m/yr	The costs of undertaking Arctic research are shared by PCSP and its user groups. Mechanisms for cost sharing and cost recovery vary from group to group and from year to year depending upon a number of variables, including a client group's funding sources, its overall budget levels, PCSP's ability to supply services within the context of overall demand, cost-effectiveness and logistics feasibility. During the 1995 field season, PCSP spent a total of \$6.0 million in providing logistics support to its user groups; of that total, \$2.6 million (44 per cent) was recovered.	PCSP will maintain logistics support levels for Canadian university clients annually at 1995 levels (\$800K per annum in total). Federal departments will be required to cover a greater portion of logistics expenses than in the past. The largest federal user departments are Natural Resources, Fisheries & Oceans and Environment. Non-Canadian user groups will continue to cover the costs of all services provided by PCSP.

In Brief: NRCan supports 26 major initiatives (GSC- 13; GC-3; CANMET Energy- 2; CFS-7; & PCSP-1) totalling \$ ~ 12.5 millions/yr.

Canada can ill afford to waste research dollars of any kind...the absence of general awareness of what research is **not** being done or what expertise the country is losing through lack of adequate support...affects the quality of what research is being done."
 [excerpt from Canada and Polar Science, March 1987]

Coordinating Canada's Northern Research Effort

Introduction

In its review of federal S&T, *Science and Technology for the New Century: A Federal Strategy*, the government emphasizes its commitment to adopting a strategy with "real priorities, real direction, and a real review of results". It notes the need for "...a coherent set of goals to which our S&T resources should be directed...goals for building a strong, forward-looking, dynamic Canadian innovation system: sustainable job creation and economic growth, improved quality of life and advancement of knowledge."

The report goes on to say that with smaller budgets, it is essential that the government invests its resources strategically, that it focusses on core activities, that it finds more efficient and effective ways to deliver them, that it reduces overlap, and that it maximizes synergies from activities performed at all levels and across all sectors.

The federal strategy, in identifying the need for better management of the government's \$5.5 billion annual investment in S&T, proposes creation of an Advisory Council on Science and Technology, an annual report on S&T performance, and creation of a special Cabinet committee to establish S&T priorities.

Northern Research - Where is it Heading

In 1993/94, federal departments expected to spend approximately \$900 million in delivering programs north of 60°; the territorial governments projected expenditures of an additional \$1.6 billion [*Annual Northern Expenditure Plan, 1993-94, DIAND*]. How much of this total is dedicated to S&T activities, how or whether government-wide northern S&T priorities are established in a coordinated manner, to what degree efforts are overlapping or being duplicated, whether well informed, adequate and appropriate science/policy linkages have been established - it is not possible, today, to provide meaningful, well informed, accurate responses to these questions, nor would the northern S&T community be able to identify precisely how its activities contribute to economic growth, to the health and well-being of northern societies, or to development of a knowledge-based, innovation-driven society.

Activities carried out in support of northern S&T by universities, the private sector, and funding and coordination organizations further cloud the picture.

If the northern S&T community expects to contribute effectively to the requirements outlined in the S&T strategy, it must identify

- what has been done
- what needs to be done
- who is doing what
- why northern S&T is important
- how northern S&T contributes to national priorities
- how existing resources can be put to best advantage
- what success is being achieved in coordinating activities through partnerships.

5Ws: The Need for a "Virtual Institute"

Why: Canada has an opportunity to become a leader among circumpolar nations.

Canadian northern technology and expertise is greatly valued, for example, among Antarctic nations. The Canadian

northern scientific research community is highly regarded internationally. However, while Canada is reducing funding for northern research, many other circumpolar nations are increasing funding. Canada does not have a way of coordinating its northern S&T, or of providing strategic direction to related national and international commitments and activities.

Other, much smaller, Arctic nations came to grips with this challenge years ago. The Danish Polar Center was established in 1989 "...to consider ways of preserving the continuity of Danish arctic research and a long-term...research effort in the Arctic...to coordinate Danish scientific, administrative and commercial interests in relation to international research and to focus particularly on any opportunities for a closer Nordic cooperation in this field".

In a recent letter to a Canadian colleague, a research scientist from Norsk Polarinstitutt (Norwegian Polar Institute) wrote: "There are piles of money for Arctic research in this part of the world, but not enough time to apply for it all..."

Canada stands to lose any competitive advantage it may now enjoy if it cannot grasp the imminent opportunity presented by the government's S&T strategy to get its collective house in order.

As the 1987 report *Canada and Polar Science* noted, it is neither desirable nor advisable or necessary to create any new organizations or bureaucracies to drive the effort to better coordinate this country's northern S&T.

What is needed is a way to bring those organizations which are involved in the North together - to exchange information, to share resources, to strategically align activities to meet national and international commitments, and to provide credible, focussed and proactive advice to Cabinet via the proposed Advisory Council on S&T in order to ensure northern S&T does not fall out of sight and out of mind of the country's decision-makers.

What: An umbrella Northern S&T Advisory Board, serving as a subset of the proposed Advisory Council on S&T. The Board could meet annually to discuss and determine short- and medium-term priorities and directions based upon policy imperatives and direction from the Advisory Council on S&T. Chair/vice-chair to rotate every 2 years among members to reflect diversity of agencies represented. Vice-chair is chair-elect to ensure continuity.

A small, centralized secretariat to help coordinate the advisory group's work and annual meetings could be housed within an existing agency. Funding should not exceed \$150 000 per annum (salaries for a coordinator and secretarial support, administrative costs.)

Who: Membership to include federal government departments and agencies, territorial and northern peoples representatives, funding and support agencies, university research community. (Suggested representation from Environment, DIAND, DFO, Health, Industry, NRCan, NRC, Transport, museums, FAIT, CPC, Aboriginal peoples' representatives, Science Institute of NWT - East and West, Yukon Northern Research Institute, funding and support agencies [NSERC, SSHERC, PCSP], Association of Canadian Universities for Northern Studies)

When:

- 1) Spring 96 - ADMs' Committee on Northern S&T considers proposal for Advisory Board on Northern S&T and membership.
- 2) Summer 96 - Consultations within the northern S&T community to solicit support for creation of an Advisory Board, exchange information on activities and priorities, determine areas for potential cooperation and cost savings, and identify general strategic directions. Final determination of Board membership made.
- 3) Fall/Winter 1996/97 - Draft terms of reference and discussion document outlining strategic program and policy directions circulated among designated members.
- 4) March/April 1997 - Inaugural meeting of new Advisory Board on Northern S&T held in the North. Strategic directions document to be finalized for submission to Cabinet science committee and/or the federal Advisory Council on S&T.

Where: Possible venues: Resolute Bay or Eureka, NWT. Meeting could be linked to the 50th anniversary celebrations marking establishment of the High Arctic Weather Stations; two of the original stations, established as joint operations with the U.S., were located at Resolute and Eureka.

