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PART II STUDY OF THE QUANTITATIVE SOCIAL IMPACTS OF MSAT FINAL REPORT

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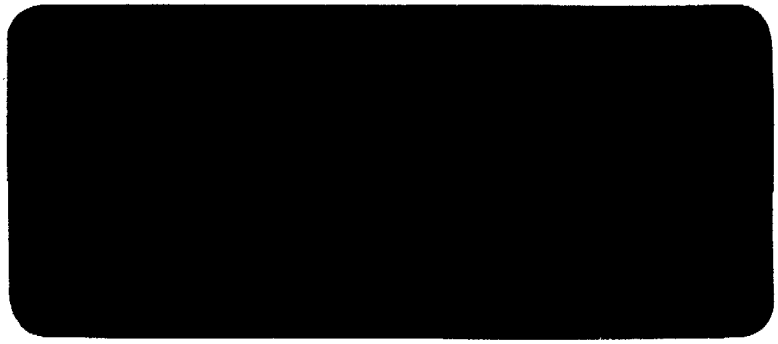

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FOR

DEPARTMENT OF COMMUNICATIONS
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BY

Wescom Communications
Studies and Research Ltd.
Vancouver, B.C.

April 1985

Government of Canada
Department of Communications

Gouvernement du Canada
Ministère des Communications

Your file *Votre référence*

Our file *Notre référence*
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May 25, 1985

Mr. J. Braden
MSAT Manager
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300 Slater Street
Ottawa, Ontario
K1A 0C8

Dear Mr. Braden,

We are pleased to present our final report entitled: The Part II Study of the Quantitative Social Impacts of MSAT. The results for the study have been presented under two separate covers. One is the executive summary and the other is the detailed final report. Readers should refer to the detailed report for the description of the sample, methodology, analytical procedures and indepth findings. The executive summary outlines the purpose, objectives and main findings of the study.

This study represents the second part of our overall appraisal of the social impacts of MSAT. The first Phase A study examined the impacts in a qualitative fashion and was important in identifying the application areas from which social impacts would emerge. These results and the work of other Phase A and Phase B studies were used in this quantitative appraisal of social impacts.

The most essential aspect for this study was the need to define impacts in a dollar quantifiable manner and to link the defined impacts to the uses for MSAT and levels of demand expected to emerge between 1989 to 2002. The approach taken in this study and the model used to quantify the impacts satisfies these requirements to the fullest possible extent.

The results have been presented to illustrate the different types of impacts, their time scale of occurance and their dollar value. These were defined for each of the two system configurations proposed for MSAT and according to the different types of mobile services (MRS, MTS, DACS). The two configurations were the base case US/Can option and the more pessimistic PAM-D option. Overall gross dollar values of social impacts have been defined as well as the yearly expected amounts for the 1989 to 2002 period.

Based on the approach used in this study it is our conclusion that a significant amount of social benefits and social externalities are likely result from the implementation of MSAT. These benefits will accrue to individuals receiving services of all types associated with the primary applications for MSAT. A broader set of impacts have also been identified for society as a whole thereby enhancing the positive benefit that MSAT is likely to have on Canadian society. These social externalities are in addition to the measurable user benefits of an operational and efficiency nature defined in the other Phase B studies.

In general the social benefits of MSAT were expected to derive most significantly from activities affecting safety of employees, response to emergencies, coordination and logistic support to field camps, improved communication infrastructures in northern and remote areas and improved response in disasters and hazardous conditions.

The highest dollar values and amount of externalities were expected to occur in government services, mineral and oil exploration and police services. The lowest number and value were expected in the institutional sector. The majority of the benefits were expected to occur within a five year time frame leading to a gross cumulative value of $150,750,000. Analysis of the application areas indicated that of this amount 31% would result from the use of MSAT by provincial government services, 30% from police services, 11% from forestry services, and 10% from mineral and oil exploration.

Using a derived average per year per mobile value of $1,228 our estimate of the yearly value of all externalities was $40 million leading to a cumulative total of $564 million for the Can/US option over the 1989-2002 period.

When these results were disagregated according to MRS/MTS and DACS for the Can/US option our externality estimate of the yearly benefit for MRS/MTS was $39 million and for DACS $13.8 million. The average yearly estimates for the PAM-D option were $16 million for MRS/MTS and $1 million for DACS. These lead to a cumulative total of $225 million over the 1989-2002 period for MRS/MTS and $2.3 million for DACS.

Based on the results obtained in this study there is very little doubt that the social benefits and externalities deriving from MSAT are likely to be quite significant with most occuring in a reasonably short time frame of five years. These findings add a significant dimension to the overall social and economic evaluation of MSAT and confirm its importance to Canada.

Yours sincerely,

Peter J. Booth
President

PJB:dw

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ACKNOWLEDGEMENTS

The contributions of all companies contacted as part of this survey were greatly appreciated. The MSAT program staff, particularly Mr. J. Braden and E. Staffa, provided valuable insights and direction in the preparation of this report.

1.0 INTRODUCTION

This study was designed to provide a quantitative assessment of the social impacts of MSAT on users and Canadian society. Social impacts were specified as social benefits and externalities which would derive from the development and implementation of the MSAT program. As such, this study represents the second part of an overall assessment of the social impact and social benefits of MSAT.

Part I of this program provided a qualitative assessment of the potential social impacts of MSAT on users and Canadian society. A report, by Wescom "Part I Study of the Qualitative Description of the Social Impacts of MSAT," identified a number of areas which were likely to generate benefits and externalities when the MSAT program was instituted. In addition three background reports were produced which dealt with:

a. a literature review and annotated bibliography of issues relevant to the social impact assessment of MSAT;

b. a methodological framework for measuring impacts;

c. a detailed plan for implementing the quantification procedure for measuring social impacts.

This Part II study is one of a series commissioned by DOC as part of the overall MSAT program. Specifically, the Phase B socio-economic studies were designed to address, the economic and social impacts and benefits of MSAT on industry and Canadian society. Other studies have been conducted examining market demand, impacts on manufacturing, impacts on telephone companies, radio common carriers and the commercial viability of MSAT. The results from all these studies were used as inputs for a report entitled "The Overall Economic Analysis of MSAT" by Econanalysis Inc. of Toronto.

Assessing the overall socio-economic benefits of MSAT required that inputs be supplied which would provide measures of the impacts and benefits to investors (Telesat, service providers and manufacturers), government (in the form of tariffs, income taxes and employment opportunities), user benefits and benefits to society at large. Two major components were identified for the overall evaluation. These were the private sector analysis, which focused on the project's financial attractiveness to private investors, and the socio-economic analysis which concentrated on the economy as a whole.

The major sources of information for the overall socio-economic analysis conducted by Econanalysis Inc. consisted of:

a. the Woods Gordon market definition and user benefit study which provided information on expected demand and expected user benefits of MSAT;

b. a study of the commercial viability of the proposed satellite services by Telesat;

c. a study of the impact of MSAT on telephone companies by Telecom Canada;

d. the study to assess the impact of MSAT on the radio common carriers by KVA Communications and Electronics Ltd.;

e. a manufacturing impact study by Woods Gordon which provided information on the domestic and export markets for MSAT and identified the potential impact on the Canadian manufacturing industry, and the resulting impact of this on the economy as a whole;

f. a study of the quantitative social impacts of MSAT, the subject of this report, which provided an evaluation of the impacts and benefits to Canadian society.

As stated previously, an assessment of the qualitative social impact of MSAT was initially presented in our four reports providing the initial qualitative assessment of social impacts and benefits. The outputs from this Part I study were most important in providing an initial starting point for the calculation of the quantitative social impacts detailed in this study.

Table 1 provides an indication of the range and nature of the qualitative impacts which were defined as a result of the investigations of the Part I study. Social impacts were identified and classified as socio-economic, organizational, sociological, social services or socio-psychological.

The review of social impacts discussed in the Part I qualitative study indicated that only certain subsets of these would be appropriate or possible to quantify. Impacts which were investigated and subsequently quantitatively assessed were drawn from the three areas of socio-economic, sociological and social service impacts.

Areas considered to be the most feasible for further quantification include benefits relating to environmental protection and monitoring, hazard aversion, reduction in renewable resource loss, effectiveness changes in the allocation of government services for law enforcement, fire and ambulance services, reduction in hazardous work, improved work conditions, and improvements in the ability to save lives in emergency situations. Sociological and social service impacts included such things as administration of health care services, better emergency measures and more effective provision of community services.

The specified social benefit areas were derived from an in-depth analysis of past research studies and investigations of mobile communications, satellite services and related systems. Application areas investigated included the way mobile services assist in search and rescue, their role in environmental enhancement and their use in public services. This process not only helped focus the activities for the quantitative study but also verified and substantiated that social effects are

manifest as a result of enhanced mobile services and these can be measured in more than descriptive and anecdotal terms. Substantial use was made of case studies reporting the way social impacts can be measured and the tangible manifestations of such impacts. These could include reductions in loss of life, improved emergency response or enhancements to the overall quality of the work environment.

TABLE 1
Summary of Identified Social Impacts and Issues
Derived from the Part I Study of the Qualitative Social Impacts of MSAT

	Impact Issue	Impacts	Quantitative Characteristics	Qualitative Characteristics
1.	Population/ Demographics	Indirect benefits received by population Improved communications Native populations to be served by new services Quality of life improvements	1988 served population of 9.5 million Current population 6 million Rural growth 1976-81 = 8.9% 200,000 native Indians	Increased rural growth rate Increased need for services Improved access to services Natives groups to be prime users of services
2.	Communication Characteristics of Rural and Remote Areas	Improvements in infrastructure for communications Future requirements in rural areas are likely to grow and MSAT will be important in meeting these needs	1981 - 94,000 households had no phone Estimates for 2002 indicate 35% of all non-metropolitan mobiles in the Prairies, 22% in B.C, 21% in Ontario	Perceived need for improved mobile services, better coverage, higher quality equipment, improved privacy, better service
3.	Human and Social Environment of the North	Accelerated industrial and commercial growth Increased contact with southern culture Increased demand for jobs and the need for retraining Conflicts with native values and patterns of social organization as development proceeds Access to improved employment opportunities from new developments Increased extent and type of commercial operations/diversified economy	Increased welfare dependence in the past as industrial development proceeds Doubling of welfare payments in newly industrialized urban areas historically Increase crime in the NWT as industrialization increased 30% 1969-75	Changing nature of northern and remote areas Accelerated movement from a native majority to white majority Enhanced industrial development Improved employment and altered welfare dependency Social indicators may alter, eg crime, alcoholism
4.	Environmental Monitoring and Forest Fire Protection	Improved protection of the forest and wildlife resources Reduced rate of depletion of natural resources Improved ability to preserve environment Safer fire fighting services Increased capability to work in marginal areas Improved logging operations, eg transport of materials	Forest protection services demand estimated at 1,600 units by 2001 Forest industry ranks 5th in terms of expected number of mobiles by 2009 BC and Ontario account for 30%-40% of total demand	Value attached to the natural environment and wilderness experiences Unique species of plant and animal life Control of forest fire threat Improved organization and safety at work sites Perception by workers of safer, more effective operations Opportunities develop in new areas

TABLE 1
(continued)

	Impact Issue	Impacts	Quantitative Characteristics	Qualitative Characteristics
4.	cont'd	Overall cost savings in expenditure of public funds Retention of the capital stock of forest resources (inventories) Frequency available for use in other disaster-related activities	Fire losses in Canada estimated at $2 billion 1974-83 Loss avoided benefit estimated at $200 million Woods Gordon estimate 1,700 terminals by 2001 for data collection	Increased safety in the operation of fire fighting and better working conditions Safer living environment for remote communities
5.	Rural Agriculture Monitoring	Ability to monitor natural hazards Assist in understanding and reacting to hazardous climatic influences Enhance the data and voice mobile services in rural areas To reduce risk to farmers for crop loss/ property loss	Hail loss was $18 million in Alberta in 1978 Estimated loss avoided benefit for agriculture $20 million per year in Canada	Increased crop values produce higher risk situations for farmers Generally increased use of technologies in farming operations, particularly communications Increased need for climatic information to reduce risk Familiarity with remote data and advanced technology services
6.	Law Enforcement	Reduced expenditures for providing law enforcement Changed requirements for upgrading and updating equipment Social effects: -increased safety -job satisfaction -effectiveness of service provision -efficiency of service operations -improved dispatch services -better service to public in defined areas/rural communities -improved reliability and quality of services to internal and external operations Socio/psychological effects: -over-reliance, better performance -increased autonomy -perceived improvements in job performance -minimal impact on existing behaviours due to technological flexibility	Demand for mobile in government services estimated at 108,000 units by 2009 Estimated communications expenditures $250 million per year (Canada RCMP) Mobile services estimated at $18 million Estimated benefits from MSAT are $18.07 million per year 2001 estimate of 14,000 mobiles in police service RCMP estimates 3,000-15,000 units	Voice and data capabilities enhance MSAT appeal to police Reduce disruption to existing operations Attitudinal and behavioral effects substantiated in field trials of related systems, eg Vancouver No major alterations in voice activity, therefore socially desirable Less reliance on the role of dispatchers and more control by individuals Increased access to remote data sources and other external sources already in place

TABLE 1
(continued)

	Impact Issue	Impacts	Quantitative Characteristics	Qualitative Characteristics
6.	cont'd	More effective use of the system capacity and more efficient use of worker time Organizational effects/mgmt improved	Evidence of quantitative differences in performance of mobile equipped police units	Time utilization improved with increased system flexibility Improved allocation of policing resources and allocation of vehicles
7.	Health Care/ Ambulance and Emergency Services	Improved delivery of emergency health care Assisting in coordinating during field operations Organizational changes in service provision	Ambulance services ranked third in future use Emergency health care expenditure $300 million annually (Canada) Estimate of possible demand for using MSAT 2,500 air calls and 135,000 road calls	Necessity for the speedy delivery of trauma units to a site Increased ability to direct crews to required sites Demonstrated feasibility in rural areas
8.	Emergency Medical Services	Improved delivery of medical services resulting in more effective service Impacts in disaster relief, transport and marine services Better overall management of services Improved access to the public Positive benefits include savings in time, money, lives and property loss	In US, MSAT type services are expected to capture 30% of overall market Expenditures for services in Canada in 1982 were over $8 million Disaster claims in 1982 were $12.7 million Systemhouse estimated cost savings at $172 million and approx 550 lives would be saved each year	Coordination of activities and directing of facilities to accident sites Reactions to MSAT services for hospitals, ambulances and special rescue vehicles have been positive in field tests
9.	Pager Services	More effective health care delivery in low population density areas Improvements in the reaction to emergency situations Coordination of crews and field teams	Total pager units are expected to total between 9,000 and 45,000 by 2001	Staff access to information, messaging, recording, storing and relaying visual information all enhance service performance
10.	Rural Fire Protection	Improved response to rural fire hazards Improved volunteer worker safety Improved allocation of vehicles and services (efficiency) Reduced property loss to the public	Field trials of system reveal in the US a per person cost of $4	Access to data and fire hazard information Mobile data and voice units lead to faster response when alarms are received Reduced property loss can result in lower insurance rates and savings to owners

TABLE 1
(continued)

	Impact Issue	Impacts	Quantitative Characteristics	Qualitative Characteristics
11.	Worker Safety	Reduction in lives lost Improved work site conditions/rural and remote Lower overall expenditures for compensation claims Reduction in worker isolation Reduction in uncertainty/fear of working in remote areas	Cost of hazardous work estimated from compensation statistics Loss of life value $110,000 Wage loss $1,500 per claim 45% of recorded fatalities in 1982 occurred in rural and remote work sites In Canada over 900 lives lost in industrial activities with compensation $100,000 per life $1.25 billion paid for accident claims	Improvements in communications services will be brought about through MSAT Some proportion of current communications will be shifted Socio/psychological impacts are also likely to occur due to improved communication services
12.	Trucking and Transportation	Improved vehicle and cargo safety Deterrent to hijacking Reductions in property loss Improved driver morale and safety Potentially increased traffic More productive work time Increased employee confidence on the job Indirect benefits likely to accrue in addition to economic benefits Improved travel conditions for the general public by reducing stress Reduction in lost cargo Improved ocean search and rescue	Estimates indicate this industry to be one of the largest users of MSAT - 32% of total use with 18.2% of all voice mobiles by 2001 (44,000 units) 4,000 to 8,000 tractor trailers are estimated users of MSAT by 2001 Terminal demand in 2001 set at 15 for public transportation, 360 for ferry traffic, 180 for commercial aircraft	Trucking requires monitoring dispatch and notification for disasters and emergencies Better coordination and control by drivers Voice channels available for emergency Suitability for bus, train and aircraft have been identified Secondary benefits believed to be the most critical and are psychological in nature Reduction in stress from long haul travel, immediate notification of arrivals and departures, schedule changes Increased incidence of cargo losses due to theft and accidents
13.	Remote Site Monitoring/Oil and Gas Exploration	Reduction in hazardous work conditions Improved reliability and quality of communication services Improved reporting of disasters Safety monitoring Dispatch of aircraft Early warning of weather conditions Data transmission backup to existing services	1981 - 6,900 oil wells being drilled in Canada 6,000 to 8,000 projected over the 1983 period Estimates indicate a demand of 14% of all voice mobiles by 2001 Remote sensing would be one of the top ten commercialusers	Significant activity is related to oil exploration, natural gas extraction and pipelines Offshore and remote area activity will be increasingly important over the next 10-20 years Most uses likely to have more demand for voice rather than data Complementarity for Inmarasat and Anik

2.0 MSAT SYSTEM DESCRIPTION

2.1 Technology

A number of options are under consideration for the implementation of MSAT each of which could ultimately represent the way MSAT will be configured. There could be a Canada only system, a regional Canada-US system or possibly others. The first generation of the system is planned to start in 1990 to be followed by the second generation seven years later.

Coverage will be by a number of ultra high frequency (UHF) 800 MHz band radio beams plus a single superhigh frequency (SHF) back-haul beam. The frequency spectrum allocated to each UHF beam is divided into 5 KHz channels, a small number of which are needed for communications control. Assignment of channels, by DAMA to users, identification of users, record keeping and generation of billing data to the service provider is done by the central control station (CCS).

2.2 Services

A variety of services are planned for the MSAT program. These include mobile radio service (MRS), mobile telephone service (MTS), paging services, mobile data and data acquisition control services (DACS). Mobile radio services are operationally similar to terrestrial mobile radio services but allow a larger coverage area. An MRS user may communicate from anywhere within the MSAT coverage area regardless of which satellite beam he is in, back to his own base station, to any other mobile. An MTS user may communicate via a common carrier gateway station. Optional paging services and videotex may also be available with the mobile radio service. At the present time it is not known whether MRS will be interconnected to the PSTN (Public Switched Telephone Network) since a number of technical, regulatory and institutional issues still need to be resolved.

Mobile telephone service connects mobile users to the public switched telephone network. Operationally, the service is similar to the existing mobile telephone service and the planned cellular mobile telephone services. Calls can be received or transmitted from mobiles virtually anywhere in Canada, including coastal waters, and the service is intended to be reciprocally available in the U.S.

Paging to vehicles and data services will be available to mobile telephone customers. However, direct reception on satellite signals by personal pagers is not considered probable during the first generation of MSAT. Paging services could present one-way message data service via the satellite to a mobile terminal in a users' vehicle or possibly to hand held portables via fixed link operation through the RCC network. This could work in conjunction with an in-vehicle retransmitter for extended range or in conjunction with an existing RCC paging system. Simple beep, alphanumeric and speech paging would be possible with the MSAT system.

Mobile data service may be furnished either as an add-on option to MTS or MRS services to provide voice plus data, or may be furnished as a stand-alone data only service. This service is comprised of a mobile alphanumeric display with keyboard which interconnects to fixed MSAT stations or other mobile terminals. A principal application would be for dispatch type services. Facilities to access computer databases, displays in either alphanumeric or Videotex format would also be available.

Data acquisition and control services, DACS, are one or two-way data services intended to gather small quantities of data at regular intervals from fixed or mobile data collection platforms for remote monitoring applications. Facilities are provided to pass control or command instructions to the platforms. Service may be structured so that a data collection platform can be polled on a predetermined schedule. As well, the data can be transmitted at predetermined time periods for use by a monitoring agency. Control or command instructions are passed from the user's base station or mobile terminal to the control unit where they are stored and then forwarded to the platform.

3.0 OBJECTIVES

The objective of this study was:

- To identify and to quantify social benefits and externalities resulting from the implementation and operation of the proposed MSAT program.

The specific tasks associated with these objectives were:

a. The investigation of information sources and data to serve as inputs for the quantification of social benefits.

b. To develop a methodology for the quantification of the specific areas of social benefits.

c. To analyze the data on social benefits and provide quantitative estimates in dollar values.

The approach developed for this quantitative study stems directly from the results of our Part 1 qualitative social impact study, the Phase A and Phase B market and user benefit study conducted by Woods Gordon and the estimates of potential use derived from the Telesat market forecast.

Many of the impact areas discussed in this report are linked to the special markets identified in the Woods Gordon Phase B study. In particular the attention given to fire fighting, forest fire protection, emergency services, disaster relief, monitoring services and paging is justified on the basis of the assessments made in that study. In many cases the anticipated market size was known to be small and the corresponding economic benefits were considered somewhat restricted. However, it has been assumed that the economic benefits are only one part of the overall assessment. Thus, although the economic and

direct user benefits may be restricted, for the selected special applications the social benefits and externalities are likely to be quite significant. Moreover the special markets which were identified accounted for somewhat less than 20% of the overall projected demand for MSAT.

Another fundamental basis of our approach is the understanding that there are both tangible and intangible impacts in any of the selected application areas and thus, consideration must be given to both. It is important to recognize that the quantitative estimates for the externalities and social benefits should be combined with the more direct and intangible benefits identified in our first qualitative appraisal. Social impacts are considered to be very important when defining the full range of benefits likely to result from the implementation of MSAT.

For the purposes of this study the emphasis has been placed on those social benefits and broader social externalities which are likely to have some tangible manifestation. Dollar values represent the most important tangible manifestation of the social benefits and externalities since these can be used as inputs to the overall socio-economic appraisal of MSAT.

4.0 SOCIO-ECONOMIC STUDY SPECIFICATIONS

Important considerations in our calculations of the social benefits and externalities for this study were the terms of reference defined for the overall socio-economic study. The most important requirements included:

1. Only the quantifiable monetary values of social benefits and externalities would be incorporated.

2. The estimated benefits should where possible, be shown to stem directly from the use of MSAT.

3. The estimates should be linked to the number of mobiles expected in the market place over the 1989-2002 period.

In addition to these requirements, two assumptions were made about the nature of indirect social benefits and externalities.

1. All direct user benefits have been incorporated into the economic evaluations. No quantitative social benefits have been implicity included in the evaluation of user benefits and no allowance was necessary to account for possible double counting.

2. Social externalities and quantitative social benefits are examined by application area. The selected applications have been defined on the basis of our previous qualitative appraisal and the Phase B Woods Gordon market study.

4.1 Defining Social Benefits and Externalities

The assessment of the quantitative value of the social benefits of MSAT considered those benefits of a non-economic nature which would accrue to

individuals and broader non-economic benefits referred to as social externalities, which were thought to accrue to society in general.

One of the important considerations in setting out the requirements for this study was the distinction between user benefits and the social benefits for society at large. These two are quite closely linked since some social benefits may already be incorporated into the calculation of user benefits. At the individual level the distinction is made between those impacts which accrue directly to the user of services and the indirect effects which are likely to accrue to third parties. It is the indirect third party effects which are most relevant to this study.

Making as clear a distinction as possible between user benefits and externalities is important to avoid the possibility of double-counting in the assessment of overall benefits for the program. Social benefits, generally refer to benefits or costs of a market transaction that are neither paid for nor received by those making the transaction. Therefore, they are not incorporated into the market demand or supply curve in most instances. For example, if a service creates pollution within a region and causes residents to subsequently incur some disease, there is a social cost that may not be felt by the firm and will not influence the price or quantity of the good supplied. On the other hand, if through providing a service in a particular area or region individuals are made better off, the service provider does not capture all of the benefits.

We have assumed that user benefits of an economic nature stem from the operational and cost effects of MSAT services. In some cases however operational concerns may overlap with social effects. This would be the case for example where cost savings result from more efficient allocation of vehicles but there is also an improvement in working conditions. The working conditions aspect reflects the social component while the efficient allocation of vehicles reflects the economic component. The concern for this study was to quantify in dollar terms the value of the improved working conditions rather than the direct user benefits resulting from the efficient allocation of vehicles.

The calculation of social benefits required that assumptions be made about the sources of overall benefits and the extent to which they could be considered either social or economic. For the benefits to be social they must be assumed either to accrue to third parties or to society in general in which case we have classified them as social externalities. All internalized benefits are assumed to be included in the User Benefits Study calculations conducted by Econanalysis Inc.

4.2 Examples of Social Benefits and Externalities

Making a clear distinction between internalized and external benefits is a difficult task since there is really no way of knowing the precise point at which such a seperation can be made. For example the savings accruing from reduced forest fires will most likely be partially included into a forestry companies estimate of direct benefits. But the retained stock of trees also has an indirect benefit to society and a long term benefit by preserving the regenerative stock of trees. These constitute social externalities which must be assessed in dollar terms in order to be used as inputs for this study.

Another consideration for this study is whether certain known factors are or are not taken into account by an individual when deciding to use MSAT. As an example consider the case where a mining company operating in remote locations assesses the future value of the lives lost through fatal accidents when making a decision to purchase MSAT. The range of options may include choosing between purchasing and maintaining a helicopter on site for rapid evacuation or to rely on MSAT for rapid access to emergency evacuation services. The ultimate choice would be an economic one in which the relative price of the two options would be evaluated in terms of the assumed value of lives saved. We assume in this study that from a social benefit perspective the value of MSAT is approximated by the value of the lives saved.

The value of other externalities might be approximated in a similar way:

1. **Forest fire protection.** The main benefit of MSAT is quicker spotting and identification of forest fires and consequently faster dispatch of equipment and personnel to deal with the fire. It is possible to imagine the use of other alternative technologies to accomplish the same purpose, e.g. spotter aircraft. In this case, it seems likely that the cost of the alternative technologies would exceed the probablistic cost of the wood destroyed. Hence, the external net benefit of MSAT might be approximated by the economic value of the wood lot saved minus the cost incurred to save the wood since the fires will have to be fought and presumably this would not be possible without MSAT's early warning. The key assumption here is that the forest companies have "not internalized" the benefits of reducing forest fires.

2. **Improved government service in remote areas.** Depending upon the nature of these improved services, some might be handled in a similar fashion to reduce occupational hazards, e.g. ambulance services to remote areas. In this case, the value of the relevant resources saved might be the cost of maintaining fully equipped health care facilities in remote areas or the economic value of lives saved by faster transport of patients to hospitals or health services, depending upon which is the cheapest alternative.

3. **Police services.** Improved policing is somewhat more difficult to deal with. The cost of property crime per se is indirect, not direct. Presumably society would be better off if those committing crimes were engaged in income producing activities. If we impute an economic rationale to crime, criminals on the margin will commit crimes whenever the net revenue per crime exceeds that from honest work. As a first approximation, we might assume that the value of crimes committed approximates the value of honest work that would be done as an alternative. Assuming MSAT improves crime prevention by some quantifiable percentage, it would be effectively

encouraging an equivalent increase in the relative amount of criminal activity that goes into honest labour. Hence, the value of MSAT with respect to this externality might be taken as the monetary value of the expected reduction in crime. However, if a similar reduction could be effected in some other way, e.g. stationing more police in more remote areas, the value of savings might be more appropriately measured as the expenditure on additional police that do not have to be made to realize an equivalent reduction in crime.

4. **Improved morale and general well-being of workers in remote areas.** Again, this is a difficult externality to actually measure. Following the "willingness to pay" approach, the disadvantage of work in remote areas might be approximated by the higher wages that must be paid to workers in remote areas compared to similar workers in more urbanized areas. Equivalently, this difference in wages might be taken as a measure of the non-pecuniary disadvantage of the remote work location. As a first approximation, the benefits of MSAT in this respect might be the sum of these wage differentials.

5.0 APPLICATION AREAS AND IMPACTS

One of the essential requirements for this study was the establishment of clear linkages between an application area, social impacts and MSAT. This involved specifying the way MSAT would be utilized in a given application and what impacts could legitimately be assumed to result from MSAT.

Linkages to MSAT were specified on the basis of our previous Phase I study, reviews of the literature on mobile communications, discussions with industry experts and our in-depth interviews with potential users of MSAT.

The way MSAT could be used to generate social benefits and externalities is quite speculative since no service currently exists. Reliance must be placed therefore on informed and logical assumptions about how enhanced mobile communications would affect a given application area. This aspect has been amply dealt with in the previously presented table of qualitative benefits and is expanded here for selected areas to demonstrate how a given benefit may arise from MSAT.

From a social impact perspective those items deemed most important are usually those dealing directly with people. Thus the extent to which MSAT will help save lives enhances its value to society. The value of MSAT services to an individual operator will also vary in terms of the economic gains to be achieved through its use and the benefits derived from reducing fatal accidents and the associated compensation payments. The following table provides a summary of some of the ways MSAT can be considered linked to specific social benefits and externalities.

TABLE 2

Social Benefits For Selected Applications Likely to be Generated by MSAT

	Application Area	MSAT Services	Specified Social Impact
1.	Remote Work Sites Exploration Camps in Remote Areas	Emergency Response, Monitoring Hazard Situations, Families Social Interaction	Improved response to accidents and likely reduction in fatalities Between 150 - 200 lives lost each year could be avoided through better communication. SARSAT is attributed to have saved 26 lives in six months of operation.
2.	Highway Monitoring	Coverage in previously unserved areas Maintenance of Highways for safe conditions	Aid to stranded motorists Coordination in disaster situations. Improved quality of transportation services.
3.	Forestry	Monitoring using DACS for fire conditions. Coordination in firefighting situations. Fire control improvements.	Avoidance of loss due to anticipation of potential fires. Improved safety of personnel fighting fires. Reduced need for expensive aircraft.
4.	Construction Sites in Remote Areas	Coordination of activities over large geographic areas Reporting of work conditions and safety.	Reduce isolation. Reduced travel to home sites for workers. Improved safety of personnel on jobsites.
5.	Renewable Resources	DCP monitoring of streams and water quality. Hazardous waste monitoring. Coordination in very remote areas for protection from poachers.	Maintenance of fresh water sources. Improved response to water quality deterioration. Maintenance of unique species in national/provincial parks.
6.	Police Services (RCMP)	Provide services in most remote locations not served by terrestrial systems. Replacement of poor quality VHF and HF radio low speed data linkages	Search and rescue in very remote areas. Improved saftey for personnel. Improved liason with other services and agencies - health care, transportation and social services.

6.0 DATA SOURCES FOR MEASURING EXTERNALITIES

It has already been noted that assessing externalities and measuring them in a quantitative fashion is quite difficult since while it is possible to assume their existence and ample evidence is given to support the fact that such social externalities occur, sources of information for actually measuring them are difficult to specify, particularly in terms of identifying their size, dollar value and occurrence over time.

For the purposes of this study, two sources of information were proposed to serve as the basis for inputs to the calculation of externalities. One was comprised of secondary research sources which included information on the activities of agencies and companies likely to purchase and use MSAT. Of particular interest were those activities for which MSAT was likely to have a significant social impact and services to the public where indirect effects would result from enhancing communication services through the adoption of MSAT. Data was obtained by examining published reports on police services, Workers Compensation statistics, ambulance and emergency services, fire statistics and forest fire occurrence.

In some cases these reports provided information about the perceived value of benefits accruing from the operation of a service, while in others the statistics provided a base to evaluate the relative costs for the provision of communication services. In some cases MSAT-type services represented additional expenditures for new services or as a full or partial replacement cost for existing services.

The second source of data for this study, was a survey of potential users of MSAT. The survey was conducted with representatives from companies, agencies and government departments who had expressed an interest in the future of MSAT services to the DOC and who had also expressed the likelihood of the occurrence of indirect benefits accruing from the use and implementation of MSAT. This information was gleened from a previous market survey conducted

by Woods Gordon and submissions made to DOC as part of their Post Launch Communications Program (PLCP).

The second area of data collection for this study was the most important since one of the critical concerns was the need to validate the nature, type, extent and time frame over which externalities would occur. This represented a particularly difficult task since there are no specific or easily identifiable individuals for whom these benefits can actually be measured. A reliance was therefore placed on the potential providers and users of MSAT to give evidence of the type, scale, nature, time frame and dollar value of social benefits and externalities.

7.0 DATA COLLECTION PROCEDURE AND SAMPLE SOURCES

The sources used to generate the imputs for this study were:

1. A selection of the Woods Gordon market survey respondents who indicated potential impacts to society would result from MSAT.
2. The responses to the field trial activities received as part of the Post Launch Communications Program (PLCP) conducted by the MSAT staff of DOC.
3. Documents and reports collected for application areas such as police services, forestry services, national and provincial parks services, wildlife services, industry and social services.
4. Background data such as, fire statistics, wilderness perception surveys, workers compensation statistics, etc. (a detailed list of specific sources is provided in the appendix to this report).

The Woods Gordon market survey sample and PLCP proposals were used because they constituted a ready and available sample source for this study. Also through examining each of these sources our survey could be targeted to those individuals most likely to use MSAT in the future and who consequently were most likely to generate social benefits and externalities. Admittedly this represents a restricted sample which cannot be generalized beyond the MSAT user population but, none the less, it is considered the best available source for obtaining the detailed and specific inputs needed for our estimates.

The Woods Gordon and PLCP samples were also useful for providing background information, such as the number of mobile units, whether companies own or lease mobiles they operate, the use of the UHF or VHF band, the distribution of mobiles by province and the uses of mobiles.

PLCP responses were proposals made by potential users wishing to conduct or participate in field trials of the MSAT services. The Department of Communi-

cations conducted a series of on-going meetings with the public and private sector over a two year period and as part of that program, interested parties were asked to submit proposals for their participation in field trial activity during the post-launch phase. Proposals were received at DOC four or five months prior to a deadline of August 31, 1984. Each proposal was required to include some indication of expected economic and social benefits. Fifty organizations were selected on the basis of these submissions to participate in this social impact study.

Final proposals for our study were obtained from the following organization categories:

a. forestry companies;
b. university and science organizations;
c. natural resource services;
d. parks and renewable resources;
e. transportation and communications companies;
f. labour organizations;
g. health service organizations;
h. community and social service organizations;
i. correctional services;
j. environmental protection services;
k. educational institutions;
l. agricultural and food co-operatives;
m. police departments (Surete du Quebec and the RCMP);
n. the Department of Energy Mines and Resources;
o. territorial governments;
p. aviation companies;
q. trucking companies.

The Woods Gordon Phase B study consisted of a selection of 426 candidate systems originally identified in their Phase A study. Completed questionnaires

from their market survey were examined to reveal any potential social benefits or externalities stemming from questions which dealt with specialized uses such as emergency fire fighting, medical, law enforcement or disaster relief applications.

Respondents were also asked whether they could foresee benefits which could not easily be put into monetary terms, such as response to emergencies, lives saved, improved working conditions and elimination of dead spots in communications. If answers were given for these questions the respondents were included in the Wescom social impact sample database. A total of 75 questionnaires were selected and incorporated along with the PLCP group to provide the overall sample for our survey.

The following tables provide the proportional representation of different user categories in the combined Post Launch Communications Program (PLCP) and Woods Gordon Sample (WG).

TABLE 3

Woods Gordon and PLCP Proposals Used in the Social Impact Survey

Category	PLCP	WG	Total
Academic Institutes	6	1	7
Chemical Companies	1	0	1
Communication/Phone Companies	6	1	7
Construction Companies	0	4	4
Forestry Companies	1	8	9
Oil/Mineral Exploration & Development	7	13	20
Police Forces	1	7	8
Power/Hydro Companies	4	5	9
Transportation/Aviation Companies	10	9	19
Other	2	6	8
Provincial Government Departments:			
Transportation	0	8	8
Renewable/Natural Resources	3	7	10
Health and Energy Services	0	2	2
Energy	1	0	1
Fisheries	0	2	2
Education	0	1	1
Wildlife	0	1	1
Federal Government Departments:			
Communications/Regional Offices	4	0	4
Environment	1	0	1
Indian Affairs	1	0	1
Transportation	1	0	1
Fisheries and Oceans	1	0	1
	50	75	125

8.0 SURVEY APPLICATION

8.1 Questionnaire Development and Data Collection

Data for this study, in addition to the secondary sources which were reviewed, was collected by means of questionnaires mailed out to all respondents included in the sample. The questionnaire was composed of the following sections: An introductory section collected detailed information with respect to organizational name, mobile type, telephone number and contact name. Instructions for completing the survey were also provided along with an indication of the study's purpose which emphasized this was part of the ongoing MSAT program. Respondents were told the questionnaire dealt with the measurement of the impacts and benefits of a social nature which may emerge as a result of the introduction and implementation of MSAT services. A short description of the meaning of social benefits and the types of benefits which may occur was provided.

Part I of the questionnaire dealt with current and future uses of mobiles. Individuals were asked to provide a description of mobile services currently used by their organization or agency, and to indicate what groups, organizations or individuals would be considered most affected by the mobiles currently in operation, i.e. where the secondary or indirect benefits were likely to occur. Next, individuals were asked to provide a description of the nature and way mobile telephone and/or regular services may be used in the future. The final question in this section asked individuals to state what impact MSAT would have on the quality of their services, and what would be the nature of this impact. Individuals were asked whether it would have no impact, some impact or a significant level of impact for the future.

The second part of the questionnaire was the most important and was divided into three parts: First, a list of applications for MSAT services were defined. This was composed of 18 categories and included such things as lives saved,

emergency response, environmental and wilderness monitoring, co-ordination in disasters, crime prevention, environmental protection, transportation of hazardous materials, fighting forest fires, rural fire protection, monitoring of oil spills, marine safety, agricultural monitoring and delivery of remote medical services. Individuals were also provided with a category of "other" to include any additional types of benefits which they thought might accrue from the use of MSAT.

For each of the 18 application areas, three questions were asked. The first dealt with the likelihood certain applications and their associated externalities would occur. This utilized a four point scale where 1 represented very likely, 2 likely, 3 not likely and 4 not very likely.

The second part of the question asked individuals to provide a time scale for the occurrence of the impact or externality, i.e. over what time period did they feel the penetration of MSAT would be such, that an observable and tangible social benefit would begin to emerge. Four time periods were specified. These were 1) one year, 2) two to five years, 3) six to ten years and 4) eleven years or more.

The final part of this question was one of the most important and at the same time one of the most difficult to answer. This required individuals to indicate in tangible dollar terms the value that they would attach to the indirect social benefits and externalities associated with each application or service area. Individuals were asked to express their answers in gross dollars per year where possible, and to consider their responses with respect to both immediate and long term effects of the particular application.

The next set of questions probed respondents about additional social benefits which they felt might emerge due to its implementation in the future. The final sets of questions probed respondents about both positive and negative non-economic impacts which they felt may occur in Canada as a result of the implementation of MSAT. Respondents were also given the opportunity in this section to provide their comments about MSAT.

8.2 Survey Procedures

The survey was administered in the following manner: First, a package of material was compiled for each of the survey respondents, containing the questionnaire, a letter of introduction from the Department of Communications and a return envelope so that those individuals wishing to fill the questionnaire out would have the option of mailing the information back to the Wescom offices in Vancouver. Copies of the questionnaire and the introductory letter are provided in the appendix to this report.

Questionnaires were mailed out to respondents in the early part of October 1984. Two weeks were allowed before an interviewer from Wescom contacted each respondent to arrange an appropriate time for the administration of the questionnaire over the telephone. Interviewers were instructed to make the initial contact with the organization and the person specified as the prime contact. These individuals were then asked to indicate an appropriate time that the survey could be conducted in depth, and this time was recorded by the interviewers and used to make follow-up calls.

The results of this procedure indicated that in many cases respondents would be quite willing to discuss specific questions on the telephone and to fill out the questionnaire in detail and mail in back to Wescom, rather than simply filling out all of the questions over the telephone as originally planned.

8.3 Survey Response Rate

In general, the results of the survey activity were quite good with a total of 54 usable questionnaires, representing a 49% response rate, being received. The 49% response rate is based on a total number of usable surveys of 110. This varies slightly from the original mail-out of 125 questionnaires, but 14 of the questionnaires were returned as undeliverable or as having no person at the designated address to receive the questionnaire.

For the 54 usable responses, approximately 30% of the questionnaires were completed over the telephone with the remaining 70% preferring to discuss questions on the phone and then to mail their questionnaire responses. Responses received in this manner were examined by the research team at Wescom and assessed for the need to provide a follow-up interview. In approximately 90% of the cases, this procedure was necessary particularly for clarifying questions related to the estimation of the dollar value of social benefits.

It was anticipated that the measurement of externalities and social benefits would prove difficult and thus having the ability to discuss questions in depth with the respondents provided a more reliable set of information for the calculation of externalities. In some cases, respondents requested further clarification of the meaning of externalities or social benefits, and in other cases they would ask for clarification of the type of value that was expected. Providing these explanations was critical in assisting respondents to specify the required inputs for the study and improved the quality of responses to our questions.

8.4 Reliability of Survey Results

Important concerns for any survey are the questions of reliability and confidence of the results. These two issues have relevance to this study since one of the important outputs is the estimation of some quantifiable measure of social benefits. Survey reliability can usually be assessed in terms of the sample size relative to a known population and can also be examined with respect to the response rate for the survey as a whole or the response rate by individual questions. In a typical survey the number of respondents providing an answer to a question will vary depending on the nature of the issue being investigated.

In terms of the first criteria, it becomes very difficult to set confidence limits on the results achieved in this study since our sample is merely a subset of other samples. However, it is important to remember this sample was drawn from a

set of known MSAT users with a very high likelihood of being in the prime user market when MSAT is available. The results are therefore assumed to be representative of a sample of known users. However, it is not possible to place precise statistical confidence limits around the results of this survey since the actual population from which the sample was drawn is not known. This sample simply represents a subset of the Woods Gordon survey and a collection of PLCP applications. Its characteristics were determined on the basis of the presence or absence of the likelihood of external or indirect social benefits being achieved in the operation of MSAT services. Thus, the sample accurately reflects a subset of potential MSAT users who are likely to generate a significant amount of the overall indirect social benefits and externalities.

8.5 Survey Analysis

The data obtained in the survey provided quantitative dollar estimates of expected social benefits and a qualitative description of a host of factors relating to the use of MSAT, expected impacts on services and possible applications. We have divided our analysis therefore into two parts. One which deals with the descriptive information and a second which uses the quantitative data.

In the first case, the results were aggregated to provide a descriptive analysis. But in the second case a much more detailed analytical procedure and methodology was defined, which is outlined in the following section. For that analysis, an important criteria was the linking of the survey data which specifies the impact areas with the projected demand for MSAT.

The demand estimates were based on the baseline forecast provided by Telesat presented in the October 1984 DOC socio-economic assumptions for MSAT. All of the assumptions included in that document were incorporated into the calculations provided in this quantitative social impact assessment (ref: Department of Communications "The Socio Economic Input Study Assumptions" MSAT Program Office, Ottawa, 1984).

9.0 METHODOLOGY AND ASSUMPTIONS FOR THE CALCULATIONS OF THE DOLLAR VALUE OF BENEFITS TO SOCIETY AT LARGE

Identification and calculation of the social benefits and externalities of MSAT were made by application area. A selected set of applications were defined based on previous studies, the main source of which were the Phase A and B Woods Gordon market and user benefit studies, the Phase A Systemhouse benefits study and the Wescom Qualitative Assessment of Social Impacts Study. Each of these studies identified different applications areas for MSAT and suggested in a qualitative manner what associated benefits would occur from the implementation and use of MSAT. In some cases these benefits were strictly operational or economic, while in other cases they were more indirect and supported our assumption that not all benefits had been accounted. This supported the estimation of other external non-economic benefits additional to those benefits already calculated.

An in-depth investigation of secondary data was also carried out which contained published reports relating to several impact areas. This involved government, private industry and agency reports dealing with fire services, forestry services, wildlife preservation, environmental protection, worker safety, government services, social services, northern development and emergency services. (A detailed list of these sources is provided in the attached appendix.)

The most important source of information was the survey of potential users of the MSAT service.

Social impacts and estimates of externalities were first assessed in this study by generating a list of the expected application areas known to be closely associated with the use of existing mobiles, and which were expected to lend themselves in the future to the use of MSAT. These were presented to the sample respondents in the questionnaire. MSAT was considered to be both a replacement of current mobiles and a new service for applications which might not be possible with current technologies. A good example of this latter use

would be in the far north where remoteness, geophysical anomalies and ionic disturbances restrict the use of VHF, UHF and FM radios to such an extent that only shortwave is possible for use by field parties and exploration crews. In this study, MSAT was found to offer significant opportunities to parties engaged in such activities. Externalities would be expected to emerge from the use of mobile voice services in search and rescue, emergency situations and for providing an important social function in reducing isolation over the twelve to fourteen week field season.

9.1 Descriptive Qualitative Analysis of the Social Impacts and Benefits of MSAT

The results in this section were derived from the findings of the Part I study and the survey conducted as part of this Part II study.

The main purpose of this study was the analysis, interpretation and calculation of the dollar value of social benefits and externalities. While that constitutes the main focus of this report a significant amount of information was obtained of a more qualitative nature detailing uses, effects and impressions our survey respondents had of the proposed MSAT services. The results of the analysis of that information is contained in the following section.

The results contained in the following tables reveal the character and type of benefits and externalities identified by users for each application group. Recurring themes in many of the affected areas involve safety of personnel, enhanced access to and quality of communications, as well as improvements in providing services to the public by government agencies. The main areas where impacts were anticipated to occur were:

a. Safety of employees and the general public when in remote and rural areas.
b. More effective response capabilities and improved coordination in emergencies.

c. Improved transmission quality to and from remote field camps.

d. Expansion of communications to areas previously unserved.

e. Improved overall communications infrastructure allowing more extensive coverage to the indigenous population.

This brief summary of impact areas was derived mainly from the results of the survey and takes into consideration a number of the more detailed descriptions presented earlier. The social implications of these items are quite obvious inferring better quality of the living and working environment, safety for people travelling, working or recreating in the service territory and improved provision of government services to the public. Enhanced coordination of firefighting services leads to lower risk for the loss of valuable forest resources, wildlife and fresh water. All of these constitute part of the "social equity" which the public entrusts to the government for preservation.

The anticipated negative impacts of MSAT, were few, but those mentioned included: competition with the telephone companies' existing services; surveillance by any level of government (resulting in "Big Brother" style control) and the possibility for over dependence on technology by individuals. Implicit in this latter statement is the threat to traditional ways of life in rural and remote areas.

TABLE 4

Descriptive Analysis of Social Benefits Derived From MSAT (Survey Questions 1 - 4)

	Application Group	Current No. of Mobiles (Q. 1)	How Used (Q. 1)	Who Affected (Q. 2)	Expected Impact (Q. 3, 4)
1.	Academic Institutes	2 mobiles	Student Training on new services	Students	Better training of students
2.	Chemical Companies	5 mobiles	Coordinating in spills, disasters.	Chemical emergency response team, fire crew	Better communications in chemical emergencies and disasters.
3.	Communication/Phone companies	2700 mobiles	Public mobile telephone services, communication for remote areas not previously serviced.	Employees, (salesmen & engineers, etc.) remote crews assisting the public.	Stengthen communication, services to the public.
4.	Construction Companies	200 mobiles	Communication between vehicles and bases in emergencies and for social purposes.	Field service personnel; jobsite stations and local populations.	Broader coverage resulting in better overall quality of services.
5.	Forestry Companies	150 mobiles	Communication between vehicles and bases for monitoring fire conditions, prevention and coordination.	Logging contractors, trucking contractors Recipients of services	Improved efficiency and productivity. Improved communication in rough terrain. Lower accidents and fatal accidents.
6.	Federal Government Agencies:				
a.	Communication	68 mobiles	Day to day operation of Departments mandate Providing and improving services to the public.	Mainly affects employees communicating with their respective offices or with the home.	Improved communication between mobile offices particularly in remote areas. Quicker identification of sources of interference and arrangements for remedial action

TABLE 4 (Continued)

	Application Group	Current No. of Mobiles (Q. 1)	How Used (Q. 1)	Who Affected (Q. 2)	Expected Impact (Q. 3, 4)
b.	Energy	72 mobiles	Logistics, support, field exploration for saftey and social contact.	Field workers and other individuals in the field Flight crews and support staff.	Improved voice services communication directly to field offices & parties. Social communications disaster monitoring.
7.	Provincial Goverment Departments				
a.	Renewable/Natural Resources	3274 mobiles	Used for safety of employees and patrons of park sites i.e. forest fires, law enforcement Remote data monitoring, Base Field camp communications	General public, rangers warden staff, field workers, law breakers (poachers, etc)	Expansion to remote mountainous sites. Data transfer from field to central computer Improved availability of contact
b.	Emergency Services	300 mobiles	Monitoring services used by public agencies	Hunters, hikers, tourists, children	Coordination of search operations.
c.	Telecommunication	1092 mobiles	Not specified	Highways, Natural Resources, Security Personnel.	Minor impact due to present efficiency of terrestrial services.
d.	Transportation	6850 mobiles	Internal use province-wide dispatch for maintenance,emergencies, disasters and accidents.	Motoring public, highway employees, tourists, transportation companies	Improved northern region communication. Quicker voice data transmission, improved employee safety.

TABLE 4 (Continued)

	Application Group	Current No. of Mobiles (Q. 1)	How Used (Q. 1)	Who Affected (Q. 2)	Expected Impact (Q. 3, 4)
8.	Power/Hydro Companies	5783 mobiles	Maintenance and repair, load control, data collection, construction activities, station operations, weather monitoring, hazardous conditions monitoring. Assistance to the general public.	People who work daily on the power system (linemen, maintenance) customers, general public	Quicker restoration after power failures; Expansion of services in the north. Maintenance improved as well as safety for work crews.
9.	Oil/Mineral Exploration and Development	1232 mobiles	Communication to drilling and construction sites/remote sites. Emergency, social advisory.	Field personnel, drill ships and support vessels, geological exploration crews, dispatching maintenance groups	Data transmission growth Expansion in remote areas. Reduced risk to workers. Faster response to emergencies.
10.	Police Forces	7339 mobiles	Dispatch, communication between vehicles, public services and other agencies.	General public, all Police personnel support services.	Availability of services presently not provided, automatic vehicle location, coverage of remote areas, voice services where home now available.
11.	Transportation/Aviation	574 mobiles	Airline dispatch and control network, reservations and operations, land and water based transportation operations	Air travellers, various provincial departments	Assured communication over vast areas; safety, location of aircraft, search activities, firefighting service improved.
12.	Other Agencies and Services	307 mobiles	Enhanced ommunication between parties vessels, camps) public service functions.	Employees (managers maintenance), field service personnel general public, tourists vehicle operators.	Improved communication between operating centers, privacy of communication, improved sense of security. Lower personnel risk in hazardous areas.

TABLE 5

Summary of Survey Qualitative Data (Q. 6 - 12)

	Application Group	Main Social Impact of MSAT (Q. 6)	Social Benefits of Present Company Activities (Q. 7)	Anticipated Negative Social Impacts (Q. 10)	Effect of MSAT on Company Services (Q. 12)
1.	Academic Institutes	Safety - due to reliable communication links	N/A	None anticipated	None anticipated
2.	Chemical Companies	Reliable emergency response capabilities; Having the right information quickly for proper decision making.	Reduction of hazards due to chemical spills Faster response ability to relay information in response to problems.	None anticipated	Lower hazard risk to the public.
3.	Communication/ Phone Companies	Open up remote areas. Serve populations not already served.	Providing communication service to those areas that cannot support the cost without subsidy.	Service not self - sustaining and requires subsidization. Degrade present telephone networks. Restrict service to remote locations. Will create a competitive communication network.	Alleviate air time used for message services Quicker emergency response. Some present customers will break away to try MSAT. This may erode revenue to lead to increased fees. Provide basic lifeline services to the public.
4.	Construction Companies	Enhanced coverage to remote camps	Contact with employees in remote areas	None anticipated	Better quality and more reliable emergency services.
5.	Forestry Companies	Overcoming obstacles due to limited technology currently available.		None anticipated	Expanded and improved service. Better quality communication for personnel. Overall benefit in managing resources and hence preservation of the natural environment.

TABLE 5 (Continued)

	Application Group	Main Social Impact of MSAT (Q. 6)	Social Benefits of Present Company Activities (Q. 7)	Anticipated Negative Social Impacts (Q. 10)	Effect of MSAT Company Services (Q. 12)
6.	Federal Government Agencies:				
a.	Communications	1) Improved safety for personnel working in remote/isolated areas 2) Improved effectiveness of field operations	Radio services for safety purposes i.e. fire and police. Effective departmental programs and resources	Competition with telephone companies. Immediacy of contact lessens "sober second thought"; Further alienation of remote areas not having MSAT; Inability of participants to afford the technology.	Identifying and eliminating interference to radio services. Increased feeling of security for employees.
b.	Energy	Quicker transmission of information in cases of emergencies.	Preservation	Cost relative to existing services.	Direct communication for quick field decision making - faster voice/ data transmission.
7.	Provincial Government Departments:				
a.	Renewable/Natural Resources	Improved communications for effective implementation of dept. programs. Better communication in mountainous areas where parks are responsible for rescue operations and wildlife management. The provision of reliable, cost effective communications to remote areas.	Recreational values for the general public; Resource management i.e. responsibility for: Protection of valuable timber.	None anticipated	Improved program delivery in remote areas; Better communication in mountainous areas. Improved coordination in forest fires.

TABLE 5 (Continued)

	Application Group	Main Social Impact of MSAT (Q. 6)	Social Benefits of Present Company Activities (Q. 7)	Anticipated Negative Social Impacts (Q. 10)	Effect of MSAT Company Services (Q. 12)
b.	Health/Emergency	Time saving in emergency situations due to immediate voice connection and generally improved communications.	Saving lives, safety in remote areas; Improved access to recreation.	None anticipated	Improved coordination in disasters; Task effectiveness, back-up services in disasters, extended services.
c.	Telecommunications	None specified	None specified	None anticipated	Expansion of services to unsearched areas.
d.	Transportation	Safety of motoring public, maintenance crews, tourists.	Maintenance, safety and service of highways, etc. for secure travelling.	Control and abuse of system - Illegitimate calls; Competition.	Better road services. Increased operational effectiveness would advance supervisory control over maintenance and construction projects. Maintains the "public" equity in highways. Maintains the quality of transportation infrastructure for all services, particularly emergency and disaster.
8.	Power/Hydro Companies	Open up services to the North; increased live - ability. Quicker power restoration in emergencies; Improvement in speed of information transfer.	The provision of reliable electrical power to the consuming public and industries. Improving quality of life and standard of living.	Over exposure of media analysis; "Big Brother" control over population. Dependance on technology; Competition with existing services.	Coordination internally amongst team members and supervisors; Quicker restoration of interrupted service; More reliable electrical power supply to consumers.

TABLE 5 (Continued)

	Application Group	Main Social Impact of MSAT (Q. 6)	Social Benefits of Present Company Activities (Q. 7)	Anticipated Negative Social Impacts (Q. 10)	Effect of MSAT Company Services (Q. 12)
9.	Oil/Mineral Exploration Development	Safety and security of remote personnel; quality of reception for emergency/distress calls; Outside contact to families for employees in remote areas.	Canadian energy self-sufficiency through domestic exploration; Employment for local people during summer season. Expansion of Canadian sovereignty in northern areas.	Over dependance on technology under hazardous conditions; More surveillance on individuals by government.	Expansion of exploration areas; Employee safety; Faster turn around to client; Expedited analysis of results obtained in remote areas; Improved communication between field crews/camps and head office; Better control over supply and personnel.
10.	Police Forces	Emergency applications in remote areas; Improved time response in disasters reducing damage and saving lives.	Public service and safety	Too many carrier supply services of similar nature resulting in competition.	Greater access to remote areas; Automatic vehicle location; Public safety and service in northern areas.
11.	Transportation/ Aviation	Improved coordination of airline services i.e. efficiency of operation. Disaster, relief and transportation of patients; fire patrols	Employment of a large labour force; Coordination for firefighting; Air ambulance; link for food, freight and passenger service to remote areas.	Penetration of system by unauthorized users; tampering.	More efficient airline dispatch and control; Control of operations outside the range of terrestrial repeaters. Less hazard to northern and remote operators.
12.	Other	Communication within remote and isolated areas.	Soliciting medical and ambulance assistance. Provision of public services.	Abrupt changes to culture and way of life in remote areas. Individual privacy may be breached.	Ability to communicate rapidly and more reliably. Better quality services. Overall improvements in quality of life factors to existent and future populations.

10.0 QUANTITATIVE ASSESSMENT OF THE SOCIAL IMPACTS

10.1 Current and Expected Demand for MSAT by Sample Respondents

The first step in the quantitative evaluation was the calculation of the demand for MSAT as expressed by the survey respondents. This was then compared, for descriptive purposes, to the existing number of conventional mobiles. The results of this calculation are provided in Table 6.

The expected demand for MSAT varied between the different categories of users but generally showed a relationship with the existing mobile population. A correlation of .67 was achieved between the number of existing mobiles and the number of expected MSAT mobiles. The correlation coefficient is a standard statistical measure indicating how well two variables are linearly related. If the value of the calculation were 1, the two variable have a perfect linear relationship. In this case the value of .67 indicates a strong relationship between the two measures being examined.

The sample response revealed the highest demand for MSAT will most likely emerge in the government, mineral and oil exploration and police services sectors. The lowest expected demand for MSAT was observed in the institutional sector and communication companies, i.e. telephone companies. It should be realized that for many companies and organizations, there may be a significant market demand expected for MSAT but in most cases, the benefits will accrue in terms of economic and operational gains. These results represent only one sector of the overall market for MSAT and should not be viewed as indicative of the overall demand for the proposed services. The demand for services or the portion of total demand directly related to the provision of services which have an indirect of external benefit is as illustrated in this sample only a small portion of total demand.

In Table 6 the number of mobiles was provided by the respondents or, in the case of the Woods Gordon samples, was taken directly from the original questionnaire. The column designated MSAT represents the expected demand for MSAT,

expressed in terms of the number of mobiles, for each of the sample categories. This represents initial demand and has been assumed to be a five year average estimate.

TABLE 6
Current Mobiles* and Expected MSAT Demand by User Category

Category	No. of Respondents	Current Mobiles	Expected MSAT
Institutes	2	2	2
Chemical	1	5	3
Comm. Co.'s	3	2,700	5
Const. Co.'s	2	200	75
Forestry	3	150	50
Fed. Govt. 1	2	68	6
Fed. Govt. 2	1	72	60
Prov. Govt. 1	6	3,274	150
Prov. Govt. 2	1	300	100
Prov. Govt. 3	1	1,092	10
Prov. Govt. 4	3	6,850	620
Hydro	5	5,783	100
Min/oil	10	1,232	600
Police/RCMP	4	7,339	612
Transportation	8	574	144
**Other	2	307	30
TOTAL	54	29,948	2,567

Fed. Govt.
1 = Dept. of Communications/Regions
2 = Energy Mine and Resources/Others

Prov. Govt.
1 = Resource Agencies
2 = Emergency Service Organizations
3 = Telecommunications Agencies
4 = Highways and Transportation

* No. of mobiles reported currently in operation by the sample respondents.

** Other - represents non-specific industry class of operation.

10.2 Quantification of Social Benefits and the Justification for Adjusting Data

The most important use of the survey and related data was for the calculation of the dollar value of the social benefits. The data for this section was drawn from three questions contained in our survey:

Q.5A Considering the following list of possible social benefits and applications please indicate the likelihood that MSAT will have an impact on each of the specified areas. Use the scale provided where:

1. Very Likely
2. Likely
3. Not Likely
4. Not Very Likely

Q.5B For each of the specified areas where impacts are expected, what time scale should be anticipated before a significant level of impacts would occur? Use the scale to record your answers.

1. 1 year
2. 2 - 5 years
3. 6 - 10 years
4. 11+ years

Q.5C In many cases social benefits may be expressed in terms of dollar values, such that the value of lives saved in a year or loss avoided due to the application of services such as MSAT may be quantified. What in general is the value or magnitude of impacts you would consider likely for each of the defined areas. (Express your answers in $'s per year, where possible, for different impact areas).

Appraisal of the results of this section first considered the categorization of the specified impacts according to the two principal criteria of the likelihood an event would occur and the time frame over which it would emerge. Table 7 presents the classification of the impacts on two criteria, likelihood of occurrence and time frame of occurrence.

This resulted in the following classification:

1. Impacts with the highest likelihood of occurrence within a one to two year period include: lives saved, emergency response, co-ordination in disasters, support for search and rescue.

2. Impacts with the second highest likelihood of occurrence but only after about two years include: forest fire protection and provision of public services.

3. Impacts with a medium likelihood of occurrence within five years but not less than two years include: marine safety operations, remote medical services, improved local communications.

4. Impacts with a medium to low likelihood of occurrence between two and five years include: monitoring of wilderness areas and wildlife, crime prevention and law enforcement, environmental protection, travel safety, transportation of hazardous materials, rural fire protection and monitoring oil spills.

5. The impact which had only a very low likelihood of occurrence over a long time frame beyond five years was: agricultural monitoring. (This was deemed to have a very low likelihood of being adapted by MSAT).

TABLE 7

Indirect Benefits and Externalities
Likelihood of Occurrence and Time Frame

	Occurrence and Time Frame
Group I	
a. Lives saved b. Emergency Response c. Capabilities d. Coordination in Disasters e. Support for Search and Rescue	Very high likelihood of occurrence within one to two years.
Group II	
a. Forest Fire Protection b. Public Service Provision	High likelihood of occurrence slightly over two years to maximum of five years.
Group III	
a. Marine Safety Operations b. Delivery of Remote Medical Services c. Improved Local Communications	Medium likelihood of occurrence within five years but not less than two years.
Group IV	
a. Monitoring Wilderness Areas b. Crime Prevention and Law Enforcement c. Environmental Protection d. Travel Safety e. Transportation of Hazardous Material f. Rural Fire Protection g. Monitoring Oil Spills	Medium to low likelihood of occurrence minimum of five years.
Group V	
a. Agricultural Monitoring	Very low likelihood of occurrence beyond five years and up to ten years.

This assessment was useful for providing an indication of the types of externalities which have a reasonable likelihood of occurring as well as the time of their occurrence. The classification was also useful for identifying those externalities which were considered by potential users to accrue to society as a result of the provision of MSAT-based mobile services and for which tangible dollar values could be provided. It was assumed at this stage these impacts would occur from all the possible uses of MSAT; mobile radio, mobile telephone and data acquisition systems. Very little evidence emerged in our study about the use of paging and consequently this has not been assumed to be part of our estimates.

The results from this part of the analysis were also used in the calculation of the tangible values of the externalities. Each group of impacts were combined with the defined application categories. In this way, impacts with a high likelihood of occurrence over a short time frame were matched with the appropriate user groups. This procedure was the first step in the formulation of a set of impact matrices detailing the gross externality estimates for each application area.

10.3 Gross Externality Estimates

A series of matrices were developed each composed of a number of cells representing the estimated gross value of an externality in association with an application category. While initially we had assumed a three stage time frame of occurrence of one, five and ten years, the results from our classification procedure suggest all tangible impacts would occur within a five year period. The time frames finally used were one to two years and two to five years.

The following sample matrix is provided as an example of the approach used to calculate benefits.

Sample Category	Lives	Externality Public Service	Monitoring	Emergency etc.
Institutes	X1.1	X2.1	X3.1	X4.1
Chemical Co.'s	X1.2	X2.2	X3.2	X4.2
Construction Co.'s	X1.3	X2.3	X3.3	X4.3
Forestry Co.'s	X1.4	X2.4	X3.4	X4.4
Fed. Govt.	X1.5	X2.5	X3.5	X4.5
Prov. Govt.	X1.6	X2.6	X3.6	X4.6
Hydro/Power Co.'s	X1.7	X2.7	X3.7	X4.7
Oil/Mineral	X1.8	X2.8	X3.8	X4.8
Police Services	X1.9	X2.9	X3.9	X4.9
Transportation	X1.10	X2.10	X3.10	X4.10
Other	X1.11	X2.11	X3.11	X4.11

The quantitative estimates provided in the survey were entered into the defined matrix according to the category, time scale of occurrence and type of impact. The rows of each matrix were then summed to provide the estimated total impact for the one to five year period for each sample category. The columns of the matrix were also summed to provide the total impact by application across all sample categories. This procedure provided the total gross dollar impact for the sample by category and over the defined time frames. Table 8 provides the summary of the gross dollar estimates for the application areas and externalities.

It will be recalled from the previous sections that the majority of impacts were assumed to occur within a five year period. When respondents provided their estimates of the dollar values and when secondary sources were used to provide inputs, these most often were set within a five year perspective. Individuals had difficulty in providing a one, two, or three year estimate and would in most cases indicate a somewhat more general five year perspective.

Table 8 summaries the raw unweighted gross estimates of the social benefits for the sample. The values in the "total" category represent cumulative totals for the full five years over which individuals were able to make estimates.

TABLE 8

Sample Respondent Unweighted Dollar Estimates of Gross Social Externalities by Application Area

Application Group	1 - 2 Years Short Term Immediate Cumulative	2 - 5 Years Medium Term Cumulative	Cumulative Total
1. Institutes	2,500,000	1,500,000	4,000,000
2. Chemical Co.'s	2,000,000	-	2,000,000
3. Communication Co.'s	-	-	-
4. Construction Co.'s	-	1,400,000	1,400,000
5. Forestry Co.'s	10,900,000	7,300,000	18,200,000
6. *Fed. Govt. 1	2,460,000	-	2,460,000
7. *Fed. Govt. 2	-	3,800,000	3,800,000
8. *Provincial Govt. 1	17,000,000	16,574,000	33,700,000
9. Provincial Govt. 2	4,000,000	10,000,000	10,400,000
10. Provincial Govt. 3	4,000,000	-	4,000,000
11. Provincial Govt. 4	-	1,650,000	1,650,000
12. Hydro/Power Co.'s	2,400,000	1,620,000	4,020,000
13. Mineral/Oil Exploration	1,000,000	13,550,000	14,550,000
14. Police Services	12,000,000	33,000,000	45,000,000
15. Transportation	600,000	4,700,000	5,300,000
16. Other	-	-	-
Total	$52,400,000	$98,350,000	$150,750,000
Average	$ 5,822,222	$ 6,556,667	$ 9,421,875

Fed. Govt.
1 = Dept. of Communications/Regions
2 = Energy Mine and Resources/Others

Prov. Govt.
1 = Resource Agencies
2 = Emergency Service Organizations
3 = Telecommunications Agencies
4 = Highways and Transportation

Note:
1. No values were provided by communication company representatives and thus are not included in this table.
2. No suggestions were provided for estimates in the other categories.
3. These values were derived from the sample of potential users and related secondary sources.

10.4 Scaling of Impacts

The next step in these calculations involved the scaling of the externality values to account for the limited sample size and the bias inherent in the sample structure. This involved weighting the results according to a known value reflecting the characteristics of the population from which the sample was drawn. Sampling from a known population generally allows one to assume that the sample parameters are reasonable approximations of the population parameters. In other cases one might know that a sample does not represent a given population or strata of the population and adjustments can be made through a weighting procedure. In this study no population characteristics are actually known since the sample was drawn from two sources, neither of which can be assumed to represent the actual population of MSAT users.

To help account for these problems a weight was defined which adjusted the estimated impacts to reflect the relative importance of a particular sample segment. The assumption has been made for this study that a significant relationship exists between the current number of mobiles in service and the expected number of MSAT units. The actual numbers were provided in our survey or were extracted from the original sample sources.

The externality estimates were adjusted by applying a weight, calculated as the ratio of the sample proportion of actual mobiles and the estimated number of MSAT mobiles for each sub-group. This is expressed in the following simple formula:

$$wi = \frac{ai / \sum_{i}^{n} ai}{bi / \sum_{i}^{n} bi}$$

where wi = the sample weight

i = index i = i ··· n corresponding to application groups tested in Table 8

n = total number of application areas = 16

ai = expected MSAT demand for any given application segment

$\sum_{n}^{i} ai$ = the total of the expected demand for all segments

bi = current number of mobiles for a given segment

$\sum_{n}^{i} bi$ = the total of existing mobiles for all segments

Following the calculation of the proportional weight (wi), the values were scaled to provide a relative weighting. This procedure is expressed in the following formula:

$$Wi^* = \frac{wi}{\sum wi}$$

where Wi^* = scaled weight

wi = original unscaled weight

$\sum wi$ = total of the weights for each sector

The following table provides the values for the scaled and unscaled weights by each of the application categories.

TABLE 9
Weights Used for Adjusting Gross Externalities

		wi	Wi*
1.	Institutions	.08	.0011
2.	Chemical Co.'s	.14	.0019
3.	Comm. Co.'s	.46	.6158
4.	Const. Co.'s	.002	.0003
5.	Forestry	.25	.003
6.	Fed. Govt. 1	.97	.013
7.	Feb. Govt. 2	.10	.001
8.	Prov. Govt. 1	9.36	.124
9.	Prov. Govt. 2	.26	.003
10.	Prov. Govt. 3	9.36	.124
11.	Prov. Govt. 4	.94	.012
12.	Hydro	4.95	.066
13.	Min/Oil	.17	.002
14.	Police/RCMP	1.02	.014
15.	Transportation	.34	.005
16.	Other	.87	.012
	TOTAL	15.15	1.00

Where wi = raw weight
Wi* = scaled weight

(See page 50 for weight specification)

The cumulative dollar totals outlined in Table 8 were weighted and then converted to per year and per mobile values on the basis of the estimated number of MSAT mobiles expected to generate impacts in the first or base year. This was determined from the estimates provided in the survey and totalled 2,567 MSAT mobiles.

TABLE 10

Weighted Externality Dollar Estimates Per Year/Per Mobile

Index	Total/ Category (unweighted)	Total/ Year	5 Year	Total/ Weight (weighted)	Avg/Yr/ Year	Mobile (weighted)
1.	Institutes	$ 800,000	$ 4,000,000	.0011	$ 912.44	$ 456.22
2.	Chemical	400,000	2,000,000	.0019	760.36	253.45
3.*	Comm. Co.'s	-	-	.6158	-	-
4.	Const. Co.'s	280,000	1,400,000	.0003	8.51	.11
5.	Forestry	3,640,000	18,200,000	.003	12,454.81	249.10
6.	Fed. Govt.1	492,000	2,460,000	.013	6,359.71	1,059.95
7.	Fed. Govt.2	760,000	3,800,000	.001	1,040.18	17.34
8.	Prov. Govt.1	6,714,000	33,700,000	.124	836,216.00	5,574.77
9.	Prov. Govt.2	2,160,000	10,400,000	.003	7,390.76	73.90
10.	Prov. Govt.3	800,000	4,000,000	.124	99,638.48	9,963.84
11.	Prov. Govt.4	330,000	1,650,000	.012	4,158.41	6.70
12.	Hydro	804,000	4,020,000	.066	53,030.26	530.30
13.	Min/Oil	2,910,000	14,550,000	.002	6,815.01	11.35
14.	Police	9,000,000	45,000,000	.014	123,095.60	201.13
15.	Transportation	1,060,000	5,300,000	.005	4,819.14	33.46
16.*	Other	-	-	-	-	-
	Total	$30,150,000	$150,750,000		$1,156,700.00	
	Average	$ 2,153,571	$ 9,421,875		$ 82,621.40	$ 1,228.78

Avg/Mobile/Weighted = $1,228

Fed. Govt.
1 = Dept. of Communications/Regions
2 = Energy Mine and Resources/Others

Prov. Govt.
1 = Resource Agencies
2 = Emergency Service Organizations
3 = Telecommunications Agencies
4 = Highways and Transportation

* No realistic dollar values were defined in these sectors.

Using the results from our survey data and complementing that somewhat, although to a limited extent, with secondary sources, the total estimated externalities for the cumulative five year period (the time frame over which most quantifiable externalities were assumed to occur) are provided in Table 10. For each of the application areas, the five year total has been adjusted to reveal the per year externality, the weighted per year externality value and finally the average externality per year per mobile. Thus we are able to denote an average externality for each of the mobiles assumed to be operated by the sample respondents.

Inspection of this table reveals the wide variation in the average/year/mobile values. These range from a low of $.11 to a high of $9,963.84. In general this reveals the strong effect public service applications have in generating social benefits since the higher average values tend to be associated with government and quasi government applications. The lowest average value is associated with the construction sector while the communications group were unable to identify any benefit values.

The estimates provided in the survey and the adjustments made by extrapolating these over a five year time horizon introduce, quite clearly, some uncertainty into our estimates. Furthermore the sampling base of the study was not considered representative of a broader population and therefore would be subject to significant variation (in a statistical sense). Consideration of all of these factors supports the choice of the <u>average per mobile value</u> as the base from which to extrapolate future benefits derived from the population of all mobiles.

Thus the average value per mobile calculated from our sample was assumed to be a good approximation of the population parameter for all mobiles. The calculations provided in the next sections rest on the assumption this average value can be assumed constant for all mobiles.

Our calculations have lead to the following values:

a.	Total cumulative five year value of social externalities	$150,750,000
b.	Total per year value of social externalities	$ 30,150,000
c.	Average weighted per mobile value per year	$ 1,228.78

10.5 Estimating the Future Value of Externalities

The next step in the estimation of externalities was to link the average benefit value to the population of all mobiles.

Estimating the future value of the externalities was based on the following assumptions:

1. Not all MSAT mobiles can legitimately be assumed to generate social benefits or externalities. Thus applying our average value to all mobiles would lead to severe over estimation of the externalities. To acount for this concern we have used the number of MSAT mobiles estimated from our sample as a baseline and applied the growth factor derived from the market demand forecasts to obtain yearly estimates of mobiles generating social impacts.

2. In almost all cases in this study, mobile radio was the preferred form for MSAT. Also the majority of respondents indicated most of the benefits would accrue from the use of MSAT for voice rather than for data. For example, in the police sector, while there was a significant amount of interest in the voice and data capabilities of MSAT, the main external benefits were usually associated with the voice capabilities.

3. No estimates of the growth in either airtime use or in the requirements for base stations were available and thus were not included in our estimates.

4. While most of the tangible externalities were expected to accrue from voice applications a significant amount of use, was also expected to emerge from the data collection and transmission capabilities of MSAT, particularly in the environmental, hazard monitoring and wildlife assessment functions.

5. Forecasting the future value of social benefits was made by first using the sample baseline estimate of 2,567 mobiles and calculating the overall population growth rates on a per year basis. The expected yearly number of mobiles was then combined with the average per mobile externality value to produce our yearly externality estimates for the 1989 to 2002 period.

10.6 Extrapolating the Survey Results

Telesat produced estimates (based on cost estimates contained in the MSAT Program Office, October 1984, Socio-Economic Input Study Assumptions, CAN/US Option) of the expected sales and number of users for the MSAT services over a 15 year period. In the following section of this report the most recent (October 1984) figures were used to provide the mobile population estimates for calculating the externalities.

In this initial estimation procedure mobile radio, mobile telephone and data acquisition have been aggregated with no adjustment made for the relative weight that each would contribute to externalities. This is due to the fact there was no indication in the survey of the relative effect each would have in generating benefits or externalities.

10.7 Forecast Value of Externalities and Social Benefits

The future value of known and estimated social benefits were measured by applying the known weighted average per mobile externality value to the

expected population of mobiles in each year over the project life cycle. For this calculation the following assumptions are made:

1. Values are in 1984 dollars.

2. The weighted average is used since it reflects the impact of different sectors in the market likely to use MSAT in such a way that externalities can be assumed to result.

3. The externalities accrue each year equally for existing (previous year mobiles) and new additional mobiles.

4. The average per mobile externality is constant.

Under these assumptions, the following dollar value of externalities is estimated for the combined MRS/MTS and DACS applications for the CAN/US option.

TABLE 11

Forecast Gross Dollar Value of Social Benefits for the Baseline Scenario

Year	Population MRS/MTS/ DACS CAN/US	Growth Rate (Based on Market Forecast	Estimated Mobiles Generating Externalities	$ Value of Social Benefits $'s
1989	4,300		2,567	$ 3,152,276
1990	12,650	1.94	7,546	9,265,488
1991	24,000	.89	14,261	17,572,508
1992	36,100	.50	21,391	26,268,148
1993	45,501	.26	26,952	33,097,056
1994	47,301	.03	27,760	34,089,280
1995	49,001	.03	28,592	35,110,976
1996	60,703	.23	35,168	43,186,304
1997	71,717	.18	41,498	50,959,544
1998	81,326	.12	46,477	57,073,756
1999	88,927	.09	50,659	62,209,252
2000	94,368	.06	53,698	65,941,144
2001	97,300	.03	55,308	67,916,224
2002	98,700	.01	55,861	68,597,308

Based on the Average Externality (value) = $1,228

Total $564,610,000
Avg/Year $ 40,329,520

10.8 Disaggregate Benefit Calculation CAN/US Option

The next stage in the calculation of the forecast externalities considered the separation of the MRS/MTS and DACS applications. In this calculation the population of users for each of the two segments was derived from the October 1984 socio-economic input study assumptions for MSAT. The following tables provide the estimates of externalities for MRS/MTS and DACS assuming the Canada/US option for the years 1989 to 2002. The growth factors for each sector and the corresponding estimated number of mobiles likely to contribute some form of externality are also provided.

The assumptions for this calculation are similar to those mentioned in the previous section with one major exception. The expected number of MRS/MTS mobiles and the number of DACS mobiles were disaggregated thereby leading to a change in the growth rate for each sector. Our baseline sample estimate was divided to yield 2,000 MRS/MTS mobiles and 560 DACS mobiles. These served as the starting points for the calculation of the expected growth in the number of mobiles over the project term of 1989 to 2002. Growth rates were derived from the market estimates of each type of mobile.

Once the number of mobiles was defined the actual expected value of all externalities for MRS/MTS and DACS could be specified. This required the separation of those externalities which would accrue from each type of mobile. We have already indicated most individuals in our survey were not able to make a clear distinction when identifying impacts accruing from voice and those from data, as a result the task of separating them was based on our secondary research and related background reports. These provided an indication of the applications which would be more likely to use either data services or mobile radio and telephone in ways that would generate social impacts. However it must be emphasized that while this provided some indication of likely use it did not provide a clear separation of the estimates by application. We have therefore used considerable judgement and assumed an allocation of estimated

dollar benefits corresponding to the number of mobiles in each sector. This resulted in approximately a 30% allocation for data with the remainder accruing from voice services.

The calculation of the value of the social externalities for the baseline forecast was achieved by combining the expected value of the benefits on a per mobile basis with the number of mobiles estimated each year. The average value of externalities on a per mobile basis was derived from the cumulative five year amounts obtained from the survey and separated by mobile type. The application areas generating impacts included: police services, mining, transportation, government, emergency services, hydro, forestry, institutes and chemical companies (see Table 12). The gross externalities were adjusted by the same weighting procedure outlined in the first section of this report but in this case the weights were applied separately for the MRS/MTS and DACS mobiles. These were applied to the estimates of the dollar value of externalities for each of the sample strata (applications) to yield the adjusted total impact values. Then the average per mobile value was calculated for either MRS/MTS or DACS.

TABLE 12

Baseline Forecast
Gross Dollar Estimates of Social Benefits Disaggregated by MRS/MTS/DACS
Cumulative Five Year Total

Sector	MRS/MTS	DACS
Institutes	$ 4,000,000	$ -
Chemical Companies	2,000,000	-
Construction Companies	1,400,000	-
Forestry Companies	13,877,000	4,323,000
Federal Government 1	1,833,000	627,000
Federal Government 2	3,800,000	-
Provincial Government 1	23,670,000	9,900,000
Provincial Government 2	10,800,000	-
Provincial Government 3	4,000,000	-
Provincial Government 4	1,650,000	-
Hydro Companies	3,624,000	396,000
Mineral/Oil Exploration	13,857,000	693,000
Police	38,400,000	6,600,000
Transportation	977,000	4,323,000
Total	$123,890,000	$26,862,000
Avg/Mobile (weighted)	$ 1,141	$ 530.00

Fed. Govt.
1 = Dept. of Communications/Regions
2 = Energy Mine and Resources/Others

Prov. Govt.
1 = Resource Agencies
2 = Emergency Service Organizations
3 = Telecommunications Agencies
4 = Highways and Transportation

TABLE 13

Disaggregated Demand Projections
Number of MRS/MTS and DACS Users
Baseline Forecast 1989-2002

Year	MRS/MTS* Mobiles Sample Estimate	Growth Factor	DACS Sample Estimate	Growth Factor
1989	2,000	-	560	-
1990	7,000	2.5	1,209	1.16
1991	14,000	1	2,006	.66
1992	21,980	.57	2,648	.32
1993	27,914	.27	3,230	.22
1994	27,914	-	3,779	.17
1995	27,914	-	4,270	.13
1996	36,000	.29	4,782	.12
1997	43,561	.21	5,260	.10
1998	50,095	.15	5,733	.09
1999	55,104	.10	6,191	.08
2000	55,401	.06	6,624	.07
2001	62,498	.07	7,021	.06
2002	66,872	-	7,442	.06

* Note: The sample estimate of mobiles was adjusted by the overall market forecast growth estimates to derive these yearly figures.

The yearly totals represent only a portion of the expected market demand for MSAT in each sector.

The total gross value of externalities for the MRS/MTS segment was $123,890,000 resulting in an average (weighted) per mobile per year externality of $1,141. The total gross value of externalities calculated for the DACS applications was $26,862,000. This resulted in an average (weighted) per year per mobile (DACS) externality of $530. This was slightly less than one-half of the MRS/MTS value. Approximately 30% of all externalities were expected to occur from data service applications.

Combining the estimates for the number of mobiles in each category (i.e. MRS/MTS and DACS) (Table 13) with the average externality per mobile yields the 1989-2002 forecast of the total value of externalities. Table 14 details this calculation on a per year basis and indicates an overall MRS/MTS estimate of $554,090,000 and for DACS $32,200,150. The average yearly impact is $39,577,623 and $2,300,011 respectively.

TABLE 14

Disaggregated Baseline Forecast
Dollar Value of Social Benefits

Year	MRS/MTS	DACS	Total
1989	$ 2,282,000	$ 296,800	$ 2,578,800
1990	7,987,000	640,770	8,627,770
1991	15,974,000	1,063,180	17,037,180
1992	25,079,180	1,403,440	26,482,620
1993	31,849,874	1,711,900	33,561,774
1994	31,849,874	2,002,870	33,852,744
1995	31,849,874	2,263,100	34,112,974
1996	31,849,874	2,534,460	34,384,334
1997	41,076,000	2,787,800	43,863,800
1998	57,158,395	3,038,490	60,196,885
1999	62,873,664	3,281,230	66,154,894
2000	66,645,810	3,510,720	70,156,530
2001	71,310,218	3,721,130	75,031,348
2002	76,300,952	3,944,260	80,245,212
Total	$554,090,000	$32,200,150	$586,290,000
Avg.	$ 39,577,623	$ 2,300,011	$ 41,877,633

Avg/Yr/Mobile = $1,141 MRS/MTS DACS = $530

11.0 PESSIMISTIC FORECAST FOR MSAT

The values used in this forecast are based on estimates provided by Telesat using inputs from the RCC and Telephone Company study contractors.

The estimation of the dollar value of social impacts in this case was based on a PAM-D configuration using two small satellites rather than the original concept which considered a small and large satellite. The estimation proceeded in similar fashion to the previous section with one exception. Since the overall demand for MSAT in this pessimistic forecast is lower the base case estimates from our survey must therefore be lowered somewhat. Since our original study did not make any allowance for such a situation we have relied on our judgement to reduce the expected number of MRS/MTS or DACS mobiles in the base year case. We have maintained the number of MRS/MTS mobiles at 2000 and only slightly reduced the number of data (DACS) mobiles to 520 from our original number of 560.

Using the estimates for the gross value of externalities and the average value per mobile, which were defined previously the per year externality estimates can be calculated. We have assumed for these calculations the total amount of externalities over the cumulative five year period will remain the same and that the average value per mobile was $1,141 for MRS/MTS and $530 for DACS. The main differentiating factor for the two estimates is the growth rate for the expected population of MRS/MTS and DACS mobiles. It is this factor more than any other which leads to the significant difference in the estimated value of externalities over the 1989-2002 period. The final estimates for this forecast are presented in Table 16. The cumulative estimate of the value of externalities for MRS/MTS was $225,310,000 and for DACS $13,863,015. The total value was determined to be $239,180,000. The average yearly externality for MRS/MTS was $16,093,887 and for DACS $990,215.

TABLE 15

Pessimistic Forecast 1989-2002
Number of MRS/MTS and DACS Users

Year	MRS/MTS* Mobiles Sample Estimate	Growth Factor	DACS Sample Estimate	Growth Factor
1989	2,000	-	520	-
1990	4,600	1.3	764	.47
1991	7,935	.72	863	.13
1992	9,323	.17	1,062	.23
1993	11,001	.18	1,285	.21
1994	11,210	.19	1,478	.15
1995	13,003	.16	1,699	.15
1996	14,954	.15	1,954	.15
1997	16,898	.13	2,228	.14
1998	18,926	.12	2,384	.07
1999	21,007	.11	2,670	.13
2000	22,058	.05	2,857	.07
2001	22,278	.01	3,085	.09
2002	22,278	-	3,301	.07

* Note: The sample estimate of mobiles was adjusted by the overall market forecast growth estimates to derive these yearly figures.

TABLE 16

Pessimistic Forecast
Dollar Value of Estimated Social
Benefits and Externalities

Year	MRS/MTS	DACS	Total
1989	$ 2,282,000	$ 275,600	$ 2,557,600
1990	5,248,600	405,132	5,653,732
1991	9,053,835	457,771	9,511,607
1992	10,637,543	563,059	11,200,602
1993	12,552,141	681,293	13,233,434
1994	12,790,610	783,450	13,574,061
1995	14,836,423	900,951	15,737,375
1996	17,062,514	1,036,022	18,098,536
1997	19,280,618	1,181,009	20,461,627
1998	21,594,566	1,263,668	22,858,234
1999	23,968,987	1,411,290	25,384,277
2000	25,168,178	1,514,347	26,682,525
2001	25,419,198	1,635,484	27,054,682
2002	25,417,198	1,749,937	27,169,135
Total	$225,310,000	$13,863,015	$239,180,000
Avg/Yr	$ 16,093,887	$ 990,215	$ 17,084,102

12.0 SUMMARY OF RESULTS AND CONCLUSIONS

12.1 Results

The results from this study indicated a significant amount of social benefits and externalities could result from the implementation of MSAT. These externalities are in addition to the measurable user benefits of an operational and efficiency nature.

The findings from this study support the likely occurrence of a wide range of social benefits occuring within most of the user segments identified for the study. They are represented, where appropriate, as dollar values over the 1989-2002 time frame. The quantifiable benefits analysed for this study resulted from the use of MSAT in each of the following applications.

a) Saving Lives
b) Police Services
c) Emergency Services
d) Forest Fire Protection
e) Health Care Services/Ambulance
f) Trucking and Transportation
g) Mineral and Oil Exploration
h) Disaster Relief
i) Public Service Provision
j) Monitoring

Recurring themes in this study and the Phase 1 qualitative analysis include safety of personnel, enhanced access to and quality of communications, and improvements in providing services to the public. The effects of MSAT were expected to be greatest for:

a) Safety of employees
b) Response to emergencies

c. Coordination and logistic support for field camps
d. Improved comunications infrastructure in nothern and remote areas
e. Improved response to disasters and monitoring of hazard conditions.

Negative impacts were generally not expected but those mentioned included; competition with the telephone companies existing services, surveillance possibilities, lack of privacy, and a tendency for too much reliance on technology.

The main purpose of this study was to provide quantitative, tangible and dollar values of the expected social benefits and externalities of MSAT. The estimates which we have provided are derived from using as a baseline the number of mobiles estimated in our social impact survey which was 2,567 MRS, MTS, and DACS terminals. In general impacts were associated more often with mobile voice services than with mobile data services. The flexibility of MSAT to offer both voice and data was viewed quite positively particularly where search, rescue and safety were mentioned.

Government, mineral and oil exploration and the police sectors were expected to generate the greatest amount of externalities. The lowest amount of tangible externalities were specified for the institutional sector and communication companies.

Externalities were measured in terms of the likelihood of occurrence, time frame over which they would occur and their dollar value. Considering the likelihood and time scale measures resulted in the following classification of impacts:

1. Impacts which were very likely to occur with a one or two year period include:

- lives saved
- emergency response
- coordination in disaster
- support for search and rescue

2. Impacts which have a good likelihood of occuring but not sooner than two years include:

- public service provision
- forest fire prevention and fighting

3. Impacts with a medium likelihood of occuring within five years but not less than two included:

- marine safety
- improved local communications
- delivery of remote medical services

4. Impacts with a medium to low likelihood of occurrence between two and five years include:

- monitoring of wilderness areas and wildlife
- crime prevention and law enforcement
- environmental protection
- travel safety
- transport of hazardous materials
- rural fire protection
- monitoring oil spills

5. Impacts with a very low likelihood of occurrence even over a long time frame of five to ten years included:

- agricultural monitoring

Dollar Value of Externalities and Social Benefits

Estimating the dollar value of social impacts, benefits or externalities is admittedly a very difficult task. This was made more onerous in this study because there is no operational MSAT service which can be observed or monitored to reveal externalities. Finally we have been extremely narrow in dealing only with those externalities which could be considered in dollar terms. To obtain estimates we have relied very heavily on a survey of individuals with a very high likelihood of using MSAT in the future. The limitations of this approach have been compensated somewhat by the use of secondary sources which served to verify the findings of our survey. Despite the limitations of our approach we have defined a number of feasible impact areas and quantified those having the greatest likelihood of occurrence within a five year time frame.

The calculation of social benefits was made first using the estimates derived from the survey and our secondary sources. These served as "raw" or "gross" values. These estimates were then used to define an average per mobile externality value which was used in conjunction with the population of mobiles expected over the 1989-2002 period. The estimates were provided for two forecasts; a baseline CAN/US option and a pessimistic forecast referred to as the PAM-D configuration. An overall baseline calculation was provided for the CAN/US option and then a disaggregated forecast was made. This was carried out for both of the service options.

The majority of benefits were expected to occur within a 5 year time frame leading to a gross cumulative value of $150,750,000. Analysis of the dollar value of externalities by application area indicated the highest amounts were

expected to result in provincial government services (31%), forestry (11%), police services (30%), mineral and oil exploration activities (10%).

Weighting the externalities in the baseline estimate led to an average per year/per mobile value of $1,228. This was used to recalculate the expected externality values for each year of the MSAT project for the combined MRS, MTS and DACS users. This initial calculation provided yearly externality estimates averaging $40 million dollars with a cumulative total of $564 million dollars for the CAN/US option over the 1989-2002 period.

The final stage in the calculations required the disaggregation of the social benefits according to MRS/MTS and DACS using the Telesat baseline and pessimistic forecasts. In the base case, estimates of the yearly benefits for MRS and MTS were $39 million. The average yearly benefits were $2.3 million for DACS. The overall cumulative social benefits for the fourteen year period were value at $586 million or $41.8 million per year.

The estimates for Telesat's pessimistic forecast revealed an average yearly benefit value of $16 million for MRS/MTS and approximately $1 million for DACS. The respective 1989-2002 cumulative totals were $225 million for MRS/MTS and $13.8 million for DACS. The 1989-2002 total was $240 million averaging approximately $17 million per year.

12.2 Conclusions

Social benefits and externalities resulting from MSAT are likely to be quite significant and to be generated over the short and longer term of the program. They will however begin to emerge within a reasonably short time frame, according to the evidence presented in this study. Most of the tangible benefits were expected to emerge within a five year period. Support for the emergence of a range of benefits affecting individuals, groups and society in general emerged in the qualitative assessments and was given further support in these

detailed quantitative measurements. These additional benefits therefore represent important additions to the more traditional economic and operational benefits defined in the other background studies.

The importance of such indirect social effects has been emphasized in this and numerous studies attempting social benefit cost analysis. In many cases the efforts are directed only to income distribution effects and while these are important we have attempted to expand the scope of such analysis by including measures such as "loss avoided" or "potential lives saved". This we believe adds another critical dimension to undertaking and valuing the equity and efficiency consequences of MSAT. Admittedly the "estimate" can be questioned on statistical and purely economic criteria. The sample frame was not rigidly specified and has not been assumed to be a truly accurate reflection of the population of all possible user of MSAT.

The nature of our survey questions can also be critized as being to general and for allowing to much reliance on judgement in interpreting the meaning of the dollar values. At the same time the procedures we have employed to deal with these known limitations lend support to our estimate and help restrict whatever variance actually exists in our final calculations. These results are therefore considered an accurate and reasonable reflection of the way special user groups will generate social benefits and externalities. In many cases the users are oriented to social services and non-commercial operations. Thus the results are assumed to provide a valid assessment of the type of externalities most likely to evolve from the use of MSAT along with their dollar value. Since these estimates derive from only a few of the expected applications of MSAT it is reasonable to assume that the derived values under estimate the total amount of social benefits and externalities likely to result from the implementation of MSAT.

13.0 TECHNICAL GLOSSARY

ACSSB	Amplitude Compandored Single Sideband (a type of modulation which is more power and frequency efficient than Narrow Band FM)
bps	Bits per second
DACS	Data Aquisition and Control
DAMA	Demand Assigned Multiple Access (automatically assigns open channels, producing far more efficient channel usage than manual channel selection)
DCP	Data Collection Platform (also called Data Return Platform (DRP); which are remotely located, self-contained installations that monitor rainfall, water quality, snow cover, pipeline flows, etc.)
Gigahertz or GHz	1,000,000,000 Hertz or 1,000 megahertz
Hertz or Hz	A unit of frequency equal to one cycle per second
kbps	Kilobits per second
Kilohertz or KHz	1,000 Hertz
LPC	Linear Predictive Coding (a type of modulation which is more power-and frequency-efficient than NBFM)
mbps	Megabits per second
MDS	Mobile Data Service
Megahertz or MHz	1,000,000 Hertz or 1,000 kilohertz
MPS	Mobile Paging Service
MRS	Mobile Radio Service
MTS	Mobile Telephone Service
NBFM	Narrow Band Frequency Modulation

PSTN	Public Switched Telephone Network
RF	Radio Frequency
SHF	Super High Frequency
UHF	Ultrahigh Frequency
VHF	Very High Frequency

14.0 REFERENCES

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Canada, Department of Communications, "MSAT Service Description", MSAT Program Office, Ottawa, Ontario, 1983.

Canada, Department of Communications, "Report on the Results of the Post Launch Communications Program", Ottawa, Ontario, 1984.

Canada, Department of Communications, "The Socio-Economic Input Study Assumptions", MSAT Program Office, Ottawa, Ontario, 1984.

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Gramlich, E., "Benefit Cost Analysis of Government Programs", Prentice Hall-Englewood, New Jersey, 1981.

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Woods Gordon. "DOC MSAT Marketing Report, Section 1", Department of Communications, Ottawa, Ontario. 1984.

Woods Gordon. "The Market for MSAT Services", Part I, II and III, Toronto, Ontario. 1984.

APPENDICES

APPENDIX A

Social Benefit Calculations For Sample Data

	Total 5 Year Value	No. MSAT Mobiles	5 Year Per Mobile	Value Per Mobile/ Year	WT	Externality WT/Per Year/Mobile
1.	4,000,000	2	2,000,000	400,000	.0011	456
2.	2,000,000	(3)	666,666.7	133,333	.0019	253
3.	1,400,000	(75)	18,666.67	3,733	.0003	.11
4.	18,200,000	(50)	364,000	72,800	.003	249
5.	2,460,000	(6)	410,000	82,000	.013	1,059
6.	3,800,000	(60)	63,333	12,666	.001	17.33
7.	33,570,000	(150)	223,800	44,760	.124	5,574
8.	10,800,000	(100)	108,000	21,600	.003	93.90
9.	4,000,000	(10)	400,000	80,000	.124	9,963.84
10.	1,650,000	(620)	2,661	532	.012	6.70
11.	4,020,000	(100)	40,200	8,040	.066	530.3
12.	14,550,000	(600)	24,250	4,850	.002	11.35
13.	45,000,000	(612)	73,529	14,705	.014	201.13
14.	5,300,000	(144)	36,805	7,361	.005	33.46

Overall average weighted value = $ 1,228.78

APPENDIX B

List of Respondent Companies

The following is a list of the respondent companies:

- Academic Institutions - included both St. Mary's University and Saskatchewan Continuing Education.

- Chemical Companies - included only DuPont Canada Ltd.

- Communication/Phone Companies - included Bell Canada Ltd., Trans-Quebec & Maritimes Ltd. and Native Communications.

- Construction Companies - included Flint Engineering and Construction and Maritime Builders.

- Forestry Companies - included Manitoba Forestry Resources, MacLaren Forest Products and Canadian Forest Products.

- Federal Government Agencies: Energy - included Energy, Mines and Resources Canada.

- Federal Government Agencies: Communications - included the Pacific and Central Regions' Department of Communications.

- Provincial Government Agencies: Resources - included Saskatchewan Department of Parks and Renewable Resources, B.C. Ministry of Forests, Government of Newfoundland and Labrador Department of Wildlife, Manitoba Natural Resources, New Brunswick Department of Natural Resources, and Alberta Parks and Recreation.

- Provincial Government Agencies: Transportation - included Saskatchewan Department of Highways and Transportation, B.C. Highways and Transportation, and Alberta Department of Transportation.

- Provincial Government Agencies: Emergency - included the B.C. Provincial Emergency Department.

- Provincial Government Agencies: Telecommunications - included Government of Manitoba: Telecommunications.

- Oil/Mineral Exploration and Development - included Longyear Canada Inc., Riocanex Inc., Inco Field Exploration Office, Dome Petroleum, Monopros Ltd., J.S. Redpath Ltd., Urangesellschaft Ltd., Mobil Oil and Boreal Projects Ltd.

- Police Forces - included the Royal Canadian Mounted Police, Peel Regional Police Force, Niagara Regional Police and Montreal Urban Police (CUM).

- Power/Hydro Companies - included B.C. Hydro, Nova Scotia Power Corporation, Ontario Hydro, Alberta Power and Manitoba Hydro.

- Transportation/Aviation Companies - included Ontario Northland (Nor-Ontario), J.D. Irving Ltd., Vancouver Island Helicopter, Seaspan, Bearskin Airlines, J.A. MacKay Trucking, Air Northwest Ltd. and Northern Mountain Helicopters.

- Other - included B.C. Packers and Regional District of Fraser-Pt. George.

APPENDIX C

Secondary Data Sources

This file contains a catalogue of government sources listed alphabetically by Ministry.

Canadian Federal Government

1. AGRICULTURE CANADA:

1.1 "Annual Report of the Minister Under the Crop Insurance Act," 1981/82, Cat. No. A1-3/1982.

- Legislation
- Crop insurance agreements
- Federal services
- Crop insurance plans.

2. DEPARTMENT OF COMMUNICATIONS:

2.1 "The Socio-Economic Input Study Assumptions," John Braden (MSAT Green Book), MSAT Program Office, DOC.

- Summary of key assumptions on prices, costs, supply and demand for MSAT equipment and air time (for contractors).

2.2 "Telecommunications Policy Proposals for Mobile Satellite Services," DOC, 1984, Appendix - Notice No. DGTP-007-84.

- MSAT description, service considerations, providers, opportunities, etc.

3. ENERGY, MINES AND RESOURCES CANADA:

3.1 "The Canadian Oil and Gas Lands Administration - Annual Report," 1983, Cat. No. M97-1983E, 2 copies.

- Exploration
- Development
- Occupational/environmental safety
- Regional statistics.

3.2 "Earth Sciences Sector," 1983-1984, Cat. No. M2-4/1984.

- Geoscience studies
- Economic studies
- Technology development.

4. ENVIRONMENT CANADA:

4.1 "Socio-Economic Impacts of Climate," Northern Forest Research Centre, Info Report No. NOR-X-217.

- Proceedings of the workshop and annual meeting of the Alberta Climatological Asociation, March 1979.

4.2 "Only on Earth," Environmental Conservation Service, Hewson, Bridge and Smith Ltd.

- Exposition of development and conservation issues in Canada.

5. HEALTH AND WELFARE CANADA:

5.1 "Statistical Bulletin: Canada Pension Plan," December 1983 - Vol. 15, No. 4, March 1984 - Vol. 16, No. 1, June 1984 - Vol. 16, No. 2, ISSN 0382-3334.

- Selected statistical information on the operation of the Canada Pension Plan.

6. INDIAN AND NORTHERN AFFAIRS CANADA:

6.1 "Current and Recent Research and Studies Relating to Northern Social Concerns," 1981 - Vol. IV, Part 1, Cat. No. R/2-154/5-1F.

- Information on research in progress on northern social concerns.

6.2 "Economic Accounts: Northwest Territories," 1967-1974, Cat. No. R/1-25/1974.

- Data on the economic accounts of the NWT
- Government, business, household, etc.

6.3 "Forest Fire Management in the Northwest Territories," April 1980, Cat. No. R/2-161/1980E.

- A review of the 1979 forest fire operations and management policy.

6.4 "Government Activities in the North - Annual Northern Expenditure Plan," 1981-82 - Cat. No. R/1-7/1982E, 1982-83 - Cat. No. R/1/11983E, 1983-84 - Cat. No. R/1/11983E.

- Consolidation of both federal and territorial government activities and related expenditures in Yukon and NWT.

6.5 "Innuit Land Use and Occupancy Project," Vol. 2 - Supporting Studies, Cat. No. R2-46/19/62.

- Part 1 - background to study
- Part 2 - prehistoric occupation
- Part 3 - cultural adaptation
- Part 4 - photos.

6.6 "Mines and Mineral Activities," 1982, Cat. No. R/1-5/1982E.

- Technical and statistical information
- Economic and policy analysis.

6.7 "North/Nord," January 1983, Spring 1983, Cat. No. ISSN 0029-236.

- Magazine:
- January 1983 - Northern Transportation
- Spring 1983 - Satellites.

6.8 "Population Projections of the Northwest Territories to 1981," November 1973, Cat. No. QS-8245-000-EE-A1.

- Demographic study of population in the Northwest Territories.

6.9 "Review of the 1980 Beafort Sea Drilling Program," Ottawa, 1981, Cat. No. QS-8277-000-EE-A1.

- Review of social, economic and cultural matters and technical aspects of Dome's 1980 operations.

6.10 "Executive Summary: Socio-Economic Impacts of the Nomisivik Mine on North Battin Region Communities," Ottawa, 1980, Cat. No. QS-8266-000-EE-A1.

- Purpose: Study a) effectiveness of the native employment program and b) impacts of mine employment on Inuit workers and their families.

6.11 "A Survey of Public Review Hearings in Northern Canada," August 1981, Cat. No. R/2-171-1981.

- General guide to PRH in northern Canada with attention to any developing trends.

7. PUBLIC WORKS CANADA:

7.1 "Fire Losses in Canada: Annual Reports," 1975, 1976, 1977, 1978, 1979, 1980, 1981, Cat. No. W51-1975 (etc.).

- Statistics on fire losses, deaths, causes, locations, etc.

7.2 "Report of Fire Losses in Government of Canada Property," 1975, 1976, 1977, 1978, 1979, 1980, 1981

- Statistics of losses calculation by department, monetary loss, property type, value, transmission of alarm, action taken.

8. SECRETARY OF STATE:

8.1 "Sources of Government of Canada Support to Voluntary Organizations," MSS 1984, Cat. No. S2-130/1984.

- Potential sources of support for certain organizations.

9. SOLICITOR GENERAL CANADA:

9.1 "Solicitor General Annual Report," 1982/83, Cat. No. JSI-1983.

- Operational elements in Criminal Justice System: Secretariat, RCMP, correctional services.

10. STATISTICS CANADA:

10.1 Health Division

a) Institutional Statistics Secretariate, "Hospital Statistics Preliminary Annual Report," 1980/81, 1981/82, 1982/83, Cat. No. 83-232.

- Admissions in reporting hospitals classified by type and size - Canada and provinces.
- Distribution of operating expense by service, % of emergency units.

b) "Workmen's/Workers Compensation," April 1980, Cat. No. 86-501.

- Amounts on death claism, burial expenses.
- Total number of claims, 1975-77.

10.2 Manufacturing and Primary Industries Division

a) Machinery, Wood and Metal Products Secretariate, "Canadian Forestry Statistics," April 1984, Cat. No. 25-202.

- Forest fire statistics.

10.3 "Provincial Government Finance: Summary of Revenue and Expenditure, Canada, Provinces and Territories," From Year Ending March 31, 1975 to Year Ending March 31, 1984.

- Summary by province.

11. TRANSPORT CANADA:

11.1 Canadian Transportation Commission: Research Branch, "Transport Review: Trends and Selected Issues," 1983, Cat. No. TT12-5/1983.

Provincial Governments and Commissions

1. QUEBEC:

1.1 Gouvernement du Quebec - Ministere de la Justice, "Justice Information Report: Police Services in Canada," 1978/79, 1979/80, Cat. No. ?

- Services provided by Canada's three levels of government: federal, provincial and municipal.
- Statistical data on law enforcement - strengths and expenditures.

APPENDIX D

Questionnaire and Survey Material

Government of Canada
Department of Communications
300 Slater Street
Ottawa, Ontario
K1A 0C8

Gouvernement du Canada
Ministère des Communications

Your file Votre référence

Our file Notre référence
6977-6-12

October 5, 1984

PARTICIPANTS IN THE STUDY OF THE SOCIAL IMPACTS OF MSAT

Wescom Communications Studies and Research of Vancouver has been awarded a contract by the Department of Communications to study the social impacts of MSAT on society at large. This contract is one of a series of studies being performed as a part of the Project Definition Phase of the MSAT Program.

As you are probably aware, MSAT is a new satellite system planned to provide mobile communications services to land vehicles, ships, aircraft and field parties operating in rural and remote areas of Canada.

Mobile communications users, the telecommunications service industry, and the manufacturing industry have joined DOC in studies and discussions on MSAT planning in order to provide the greatest benefits to Canada.

The study by Wescom is an attempt to quantify the social impacts and benefits that such services will bring to individuals and Canadian society. The identification of these benefits is important to the final decision regarding possible future government support for the development of satellite mobile services in Canada. While the study will collect information from a variety of sources, one of the most important is this survey of possible future MSAT users such as yourselves.

.../2

Canada

You are therefore encouraged to work closely with Wescom to ensure the success of this study. Soon you will be contacted by telephone by Wescom and asked to provide your views and opinions about the social benefits likely to result from the proposed MSAT services. The enclosed questionnaire is to familiarize you with the questions you will be asked so that you can be better prepared to answer their questions. Your help is very much appreciated.

Yours sincerely,

R.W. Breithaupt
Director, MSAT Program

DESCRIPTION OF MSAT SERVICE CAPABILITIES AND SYSTEM CONCEPTS

Introduction

MSAT is a way of providing mobile communications services to users over a wide area using a geostationary satellite system. The program plan calls for a satellite to provide mobile services starting in 1989. The MSAT system would comprise two satellites in geostationary orbit communicating with mobile users in the 806-890 MGz band, either via base stations or, in the case of mobile telephone service, by means of a number of gateway earth stations which interfere with the public switched telephone network.

The demand assigned multiple access (DAMA) and the overall satellite and communications system control, comprising the satellite positioning and other control functions, would be integrated within one central control station. The backhaul communications facility between the satellite, the central control station, the base stations and the gateway stations will operate on different frequency assignments in the 14/11 GHz band.

System Concepts

The MSAT satellite communicates to users in the 806-890 MHz band by dividing the country into segments and illuminating each segment with a separate beam. The spectrum allocated within each beam is divided into channels which are allocated on a dynamic demand assignment basis under the control of a single central control station (CCS).

The satellite is linked to the ground elements of the system via UHF (ultra high frequency) and SHF (super high frequency). The type of linkage employed is fixed for each type of ground equipment. All links between the satellite and the subscriber's mobile terminal equipment are UHF. All links between the gateways and the satellite are SHF. Base stations can be linked to the satellite via UHF or SHF in order to accommodate base stations of varying degrees of sophistication and applications. The satellite does not possess any control intelligence. It simply performs reception, frequency conversion and transmission.

The central control station will perform all switching functions required for all types of calls as well as the frequency translation and necessary channel allocation and modulation conversions. In addition, it will perform the control functions required for call processing and billing as well as some diagnostic functions.

Communications Architecture

The system employs a number of UHF beams, each focused over a given geographical area and employing a portion of the total available UHF frequency

spectrum. The same portion of the spectrum may be allocated to widely separated beams, thus re-using the spectrum. The spectrum in each beam is divided into a number of UHF channels.

The overall system control would be managed by one CCS. Communications between the CCS and the remainder of the system are on SHF. All interbeam traffic is cross-connected at SHF by the CCS. The gateway and base stations are capable of routing any SHF channel onto an appropriate terrestrial channel.

The CCS controls and updates the channel connection map. The basic mode of operation of the system is one in which terminals are dynamically assigned (DAMA operation) by the system intelligence to an available channel or a pair of channels.

Coverage

Coverage is fixed by the positioning of the satellite and spacecraft antenna design. Longitudinally there exists a fair amount of freedom in the placement, the only limiting factor being the interference with other geostationary spacecraft operating at SHF.

The present target is that all points located within the 10^{o} elevation contour will sustain reliable communications. For points located within the 0^{o} and 10^{o} ring, it is expected that special antennas will have to be employed offering gains and hence higher multipath resolution. These special antennas will allow all forms of mobile, transportable or fixed point communications.

Description of Service Capabilities

The following is a list of service capabilities available using the MSAT system. The variety of terminals available is expected to be large because of differing bandwidth and modulation requirements, differences in call processing, protocols between MTS and MRS, the stringent requirements for frequency spectrum conservation and power conservation, and the variety of packaging requirements.

1. Mobile Telephone Service (MTS):

   This service connects users to the public switched telephone network (PSTN) and is operationally similar to a normal telephone. Calls can be placed or received using a full duplex telephone in a manner essentially identical to the cellular system.

   Channel allocations is on a dynamic demand assignment basis (DAMA) under the control of a single central control station which will control all MSAT traffic, including MTS. Several SHF gateways may operate with the central control station, and these may carry only MTS or a combination of MTS plus other services.

The question of compatibility between MSAT and cellular service is being examined. Whereas cellular mobile systems are ideally suited to urban application and have the advantage of full duplex communications and universal access to the telephone network, the concept becomes less and less viable economically as the distance from urban centres increases. The MSAT offering provides countrywide mobile communications, which is particularly suited to those segments of the country with low population density.

The MTS service on MSAT would have the following characteristics:

a. Two-way, full-duplex voice and data communications.
b. Nationwide coverage and compatibility.
c. Interconnection to the terrestrial telephone networks.
d. Interoperability with terrestrial cellular applications.
e. Fixed access protocol.
f. Total channel bandwidth including guardband of 5 KHz. The 5 KHz bandwidth will be contingent upon the use of customer terminals operating in one of two modes:
   - Pitch Excited Linear Predictive Coding (PELPC) with differential minimum shift keying (DMSK).
   - Amplitude Companded Single Sideband (ACSSB).
g. Specialized paging and data services (described in later sections).
h. MSAT system standard grade of service.

2. Mobile Radio Service (MRS):

This would be technically similar to MTS, channel assignments being controlled by the same central control station. UHF or SHF base stations would typically be needed for each MRS network, although it may be cost effective in some cases for several networks to operate through the same base station.

This service will be similar in operation to the mobile radio service as presently offered terrestrially by the radio common carriers or owned by private entities. The service will have the following characteristics:

a. Two-way, half-duplex voice and data communications.
b. Nationwide coverage.
c. Access to private and public networks by special arrangements.
d. Fixed access protocol.
e. Transparency to message format and protocols.
f. Total channel bandwidth (including guardbands) of 5 KHz.
g. MSAT system standard grade of service.
h. Other services (e.g. specialized paging or data service).

3. Mobile Data Service (MDS):

Mobile data service is planned as a general-use two-way service to all classes of mobile and base station terminals. It would normally be offered in

combination with voice mobile radio (MRS) or voice mobile telephone (MTS) services.

The service will be organized with respect to switching and DAMA assignments in a manner similar to MRS and MTS. The advantage of this class of service is that it can be carried in a very cost effective manner, allowing a large user population to be carried on a relatively small portion of the satellite. Dispatch types of operation, where data is transmitted and then stored within the receive terminal, is an ideal application for the service.

This service has the following characteristics:

a. Two-way service.
b. Nationwide coverage.
c. Error rates controlled by forward error correction techniques to suit the users' requirements.
d. 2.4 kbps data rate.
e. Any message format, dependent on user requirements.
f. Interface with terrestrial data systems (e.g. dial access to the PSTN for voice bank ASCII data; TWX/TWLLEX and packet switching, etc., for medium to higher speed data applications).
g. Fixed access protocol.

4. Data Acquisition and Control (DACS):

Data acquisition and control service would be similar to that provided by the existing GOES and ARGOS satellite systems operated in the 400 MHz band. These systems relay meteorological and geographical data from various Data Collection Platforms to a central station for processing. The service, however, will have an expanded scope extending to other remote data collection applications and will include control functions.

Data acquisition and control will be used primarily for unmaned non-mobile applications, e.g. the control and monitoring of pipelines or pumping stations. Mobile applications could be used for monitoring the status of cargos in transit.

5. Mobile Paging Service (MPS):

Mobile Paging Service is a one-way data service to vehicles which will be similar to existing advanced data paging systems. Service sophistication ranging from a simple "beeper" up to the transfer of a number of pages of alpha-numerics will be available. The wide area coverage provided by MSAT paging means it will be possible to provide companies and institutions using the service access to their personnel hitherto impossible.

The characteristics of the service are as follows:

a. One-way data communications only.
b. Specialized access from terrestrial data processing stations.
c. Data rate less than 2.4 kbps.
d. Subject to limited message length.

MSAT QUESTIONNAIRE
Social Impacts and Benefits

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Vancouver, B.C.
(604) 669-7175

Office Use

Organization Name: _____

Mobile Type: MRS _____ MTS _____

Phone Number: _____

Contact Name: _____

Result of Call: _____ Complete
_____ Incomplete

Introduction

This survey is being conducted on behalf of the Department of Communications as part of the ongoing MSAT program.

As the attached letter illustrates, this questionnaire deals with the measurement of the impacts and benefits of a social nature which may emerge as a result of the introduction and implementation of MSAT services. Social benefits are generally considered to represent impacts which occur as a result of the use and implementation of MSAT. For example, MSAT may assist in saving lives in remote areas. The number of lives assisted and the costs of such activity can be used to estimate the value of the social benefits for MSAT.

This questionnaire will be administered over the telephone. However, taking a few minutes to examine the attached material, these questions and to think about your answers, will assist us in completing it in the shortest possible time.

A. Current and Future Uses of Mobiles

1. Please provide a description of the mobile services currently used by your organization or agency.

_____
_____
_____
_____

2. What groups, organizations or individuals are most affected by the mobiles you currently operate and the services you provide?

3. Could you provide a description of the nature and way mobile telephone and/or radio services may be used by your organization in the future? What new requirements are you anticipating for the 5-10 year time frame? What aspects of your services or operations do you expect will be most affected by the possible use and adoption of MSAT?

4. Do you think that the type of mobile communications offered by MSAT will have an impact on the quality of services you provide to the public or other organizations and businesses?

			Why?
a.	_____	Will have no significant impact	
b.	_____	Will have some impact	
c.	_____	Will have a significant impact	

5b. Another important consideration in assessing the social impacts is the time scale over which they will occur. Some are expected to emerge immediately even though the penetration of MSAT would be low, while others will occur as the penetration increases to medium levels and still other much later when penetration is high.

For each of the specified areas where impacts are expected, what time scale should be anticipated before a significant level of impacts would occur? Use the following scale to record your answers:

1 = 1 year (on introduction)
2 = 2-5 years
3 = 6-10 years
4 = 11+ years

(Please refer back to column 5b to record your answer.)

5c. In many cases social benefits may be expressed in terms of a dollar value, such that the value of lives saved in a year or loss avoided due to the application of services such as MSAT may be quantified. What in general is the value or magnitude of impacts which you would consider likely for each of the defined areas?

(Please use column 5c to express your answers in $s per year, where possible, for the different impact areas.)

6. How would you expect MSAT to affect each of the areas you have identified? (Please describe the way these impacts may emerge and the specific contribution or role that MSAT-based communications will play.)

7. What do you consider the main benefits of a social nature which stem from the activities of your company or agency at the present time?

8. Indicate and describe experiences, if any, you and your organization may have had in using mobile communications to deliver public services providing the social benefits mentioned previously.

9. Considering your experiences with the applications which have been identified in the previous questions, what would you estimate to be the associated costs of using conventional mobile services for these activities over a typical year for the particular activity?

10. What, in general, do you expect to be some of the negative social and non-economic impacts which could emerge in Canada as a result of the development of MSAT services?

11. What costs, if any, could you attach to these negative effects on Canadian society, and over what time period would you expect them to occur?

C. Impact of MSAT on Operations and Activities

12. What aspects of your company's services or operations do you expect will be most affected by the use and adoption of MSAT? (Consider the services provided, rather than internal operational benefits.)

13. Comments - Any additional comments you would like to make about these services and their expected benefits?

Thank you.