Public Safety and Emergency Preparedness Canada
Critical Infrastructure Protection and Emergency Preparedness

Sécurité publique et Protection civile Canada
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Innovations in GIS
Emergency Response Planning

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Executive Summary

Study Objectives and Research Program

The Office of Critical Infrastructure Protection and Emergency Preparedness (OCIPEP) commissioned this project to determine the scope and evaluate the use of Geographic Information Systems (GIS) by first responders across Canada for emergency response planning. In addition, the research investigated the current degree of integration of spatial datasets between first responders with other stakeholders, such as municipal jurisdictions and the private sector. The objective is to review the extent of the adoption of this technology by first responders and stakeholders to assist in the planning and response to an emergency.

GIS are software programs that store spatially referenced data and allow users to conduct spatial assessments for analytical and decision making purposes. These systems are designed to collect, store, and provide data where geographic location is important. GIS can be used to conduct spatial analyses and evaluate data correlations. Spatial modeling applied to emergency response planning can be used for projecting response times (for example, evacuation route planning), and for evaluating changes to a local environment due to processes such as climate, meteorology, and human development.

In particular, research evaluated the use of GIS by first responders across Canada, identified usage characteristics, principal applications and benefits, and barriers to use. The project focused on GIS applications in rural areas in Canada. The authors also developed the interactive GIS Emergency Planning Training Demonstration on CD which was used to display the utility of GIS. The CD also contained other examples of data used in response to an emergency involving chemical or hazardous material. It was presented to selected audiences of first responders in the provinces of Saskatchewan, Ontario and Quebec.

Summary of Findings

The survey was distributed to over 822 individuals involved in emergency planning across Canada, and included first responders, government and private industry. The response rate was 17%.

Findings of the First Responder Survey

The survey of first responders, municipalities, hazardous good suppliers and transporters, and environmental clean-up service providers regarding their experience with GIS programs found that 72% of respondents were aware of GIS tools, but only 28% used them. A higher level of GIS use exists in those provinces with a strong resource industry base. However, there is a lower level of GIS use in rural (as compared to urban) areas in Canada.

Of the first responders, companies, and municipalities that participated in the survey and use GIS, 45% reported that their GIS software applications are used in emergency response planning (ERP). This equates to 13% of all survey responses. The remainder of applications mentioned in the survey were a variety of planning operations normally undertaken by municipalities. The most frequently mentioned emergency response applications of GIS were risk assessment and planning. Other important uses included response-time planning, tactics, and various location-

based issues. According to survey respondents, the principal benefits derived from GIS usage were improvements in planning, preparedness, responsiveness, and communications.

The gap between GIS awareness (72% of survey respondents) and GIS use (28% of respondents) suggests that there are important barriers for first responders acquiring and learning to use these systems. Based on the survey results, the most important barriers to GIS use are:

1. Ability to demonstrate the benefits of GIS;
2. Ease of acquisition, i.e., having the skills necessary to evaluate and select the best system;
3. Cost of acquisition, including implementation; and
4. Compatibility with other GIS and, therefore, the ability to share data.

Findings from GIS Developers

In order to identify new developments in GIS use for emergency response planning, the activities of current GIS software developers were investigated. The findings indicate that a series of custom applications are being developed, many of which are self-supporting software systems developed for a specific purpose for individual clients. Fewer of these applications are designed for data sharing among a number of users.

Findings from the Interactive Demonstration

Twelve demonstrations of GIS though an interactive CD were conducted for 33 first responders.

The general response from the 33 participants was that the sessions were useful in introducing the merits and use of GIS to non-users, as well as demonstrating how the systems can be used to improve the effectiveness of first responders. The CD format provided a quick and useful means to introduce the use of GIS and the integration of other relevant information in planning for an emergency event. Examples of additional relevant information that could be incorporated into a GIS include climate, time line response, regulatory permit information, and safety material data sheets concerning materials that first responders may encounter in an emergency.

According to the participants in the demonstration sessions, additional information that would have been useful to their needs includes data on residents, landowners; location of water supplies, of specialized fire fighting equipment, of ambulances; call centre (911) coverage areas, health districts, mutual aid zones and large hydro facilities. This additional information is beneficial to responders as it lessens their response time and increases their knowledge of their region. As an example, knowing the location of specialized equipment before and during an event can reduce response time in identifying where and who to call to provide supporting services.

Conclusion

This study demonstrated that the adoption of GIS as applied to ERP is relatively new and the applications were regional and limited in nature. The future adoption of GIS will assist stakeholders involved in ERP, the rate of adoption being a function of the perceived benefits to costs. With further education on the benefits of GIS use for ERP, and lowering of costs as new technologies are developed, greater use across Canada is predicted. This will further enhance

safety, and create synergies between stakeholders in the application of GIS for emergency response planning.

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1.0 Introduction

Geographic Information Systems (GIS) are computer-based software programs that store geographic data and allow users to conduct spatial assessments for analytical and decision-making purposes. Geographic Information Systems are designed to collect, store, and provide data where geographic location is important.

The use of GIS by industry and governments, which includes collecting, and displaying spatial information for planning and functional analysis, has increased significantly over the last five years. This is mainly due to the greater computing power available to users at a much lower cost. New systems, both hardware and software, have been developed that allow for the convenience and flexibility of use on laptop computers.

GIS is a very useful and progressive tool that provides a wide range of capabilities across various user groups. When responding to an incident, first responders can use GIS to identify the various resources required – police, ambulances, fire fighters, tow trucks, cranes, chemicals such as dispersants in order to help respond to an emergency in a timely and efficient manner.

Locations of human-made objects and the characteristics of physical environments can be displayed and quantified. GIS can be used to evaluate the impact of human development on the environment, and is used by different industries and provincial and federal government departments. For example, analytical tools within these systems allow users to assess changes in land use or environment due to human-made or natural causes. GIS has also been applied to measure climate changes or to determine the size of flood plains due to runoff changes. GIS analytical tools can be used to measure the dispersion of air and water pollution. GIS is very beneficial to users as it provides decision-makers with spatial analysis tools, which can assist in understanding cause and effect relationships.

GIS can enhance communication and understanding of data between different organizations involved in emergency response planning (ERP) including first responders, municipal planning departments, and private companies. GIS can also be used for training, providing maps of permit data relative to storage sites of hazardous materials. It can play an important role in assisting first responders to understand their physical, human, and industrial environment.

The primary purpose of this research project was to determine the extent of use of GIS by first responders across Canada and the integration of GIS information with other parties. First responders in Canada were surveyed to evaluate the current adoption of GIS. Survey questionnaires were sent to first responders located in all provinces and territories across Canada.

In addition to first responders, surveys were sent to producers of hazardous chemicals, to transport companies who may transport these products, and to the retail agricultural distributors who may store these products in rural areas. The companies that manufacture and transport these products must have an emergency response plan to respond to an accidental release. Manufacturers and transport companies use these emergency plans with first responders to respond to an event. As regulations change and develop, industry and first responders will be able to use GIS to evaluate changes in their individual applications.

For the purposes of this research, first responders are defined as fire (volunteer or regular), police, and ambulance services. To provide an order of magnitude of the number of first responder agencies in Canada, according to Statistics Canada data[1] there are some 3200 municipal organizations that would have at least one first responder agency. Cities and other larger municipalities within this group, numbering around 400, could have two or more first responder agencies. Based on this count, and after allowing for the common police services provided the Royal Canadian Mounted Police (RCMP) and provincial police agencies, it is estimated that there are up to 4000 first responder organizations in Canada.

2.0 Objectives of Research Project

The specific project objectives were to:

- Determine the use of GIS by first responders across Canada;
- Determine if there were differences in use between rural and urban environments;
- Compare new GIS innovations and their use by first responders;
- Design and develop an interactive CD to demonstrate GIS use to first responders;
- Demonstrate GIS to first responders; and
- Increase the awareness and application of GIS programs to first responders.

In addition to these key objectives, the research team also asked about the types of GIS used, their costs, the types of GIS information layers shared, and the GIS application in terms of either data or function. The team also identified new developments in the use of GIS for emergency response planning.

3.0 Survey Response

3.1 Survey Response From All Group Types

In order to survey first responders, municipalities and manufacturers of hazardous products in Canada regarding Emergency Response Planning and GIS applications, a questionnaire was developed which covered the key information requirements of the study.

The questionnaire that was sent by email and fax to 822 potential respondents is presented in Appendix A.

The purpose of the survey was to determine respondents' level of awareness of GIS for emergency response planning. It prompted respondents to detail their use and applications, types of systems, and costs to develop. The survey asked respondents if GIS was used in their organization and the perceived benefits and constraints associated with using it. The survey also asked in which areas of emergency response planning GIS was used (i.e. was GIS used for mitigation, risk assessment, response or recovery?). Transferability of GIS information between groups was another topic of questioning. Lastly, the survey sought input on additional types of

[1] http://www.statcan.ca/english/census2001/dict/geo012.htm

information that would be beneficial for emergency response planning. Throughout the survey, a primary focus was to quantify the level of GIS adoption by both local and regional agencies, and to discern regional or group variations in the sharing of GIS information. The surveyed groups are summarized in the following subsections.

First Responders

The survey was distributed to volunteer fire, regular fire, police, and ambulance groups across Canada. The Canadian Association of Fire Chiefs, the RCMP, the Ontario Provincial Police, and Sûreté du Québec distributed or provided lists of potential respondents for the survey. In addition, volunteer fire associations in Ontario and Saskatchewan were contacted in order to help solicit involvement by first responders in their respective areas.

A total of 215 surveys were distributed to this group across Canada.

Producers of Hazardous Materials

The suppliers and producers of hazardous industrial chemicals and fertilizers were surveyed, as well as various industry associations who agreed to distribute the questionnaire to their membership. The following associations assisted with the survey:

- Canadian Chemical Producer Association
- Canadian Fertilizer Institute
- Canadian Agriculture Retailers Association

One hundred seventy-nine surveys were distributed to members of these associations.

Rural Municipalities

Four hundred and nine surveys were sent to rural municipalities in Saskatchewan, Manitoba, Alberta, Ontario, Nova Scotia, New Brunswick, and PEI were surveyed. These rural municipalities were surveyed because they perform first responder duties such as firefighting on a volunteer basis.

Transport Carriers

Surveys were sent to major railroads, Canadian National and Canadian Pacific, and a sample of eight trucking companies who are in the business of hauling hazardous materials in both eastern and western Canada.

Environmental Clean-Up Companies

Four environmental clean-up companies were surveyed. All of these companies are based in Ontario and meet regulatory standards to provide environmental clean-up services.

Other

Surveys were sent to the Canadian Red Cross and two government departments: Environment Canada and the Saskatchewan Department of Highways and Transport.

Table 1 identifies the number of surveys sent to each group and the corresponding response rate by group.

Table 1 Survey by Group and Response Rates

Group	Distributed	Replies	% Response
First responders	215	58	29%
Producers of hazardous materials	179	32	18%
Rural municipalities	409	41	10%
Transport carriers	11	4	36%
Environmental clean-up and others	8	8	100%
Total	**822**	**143**	**17%**

A total of 143 replies to the survey were received, which translates to an overall response rate of 17%. Table 2 shows the distribution of survey responses broken down by province. At least one response was received from each of the provinces, and one response from the Yukon.

Table 2 Survey Response by Province

Province	Replies	Percent
British Columbia	8	6%
Alberta	23	16%
Saskatchewan	36	25%
Manitoba	10	7%
Ontario	43	30%
Quebec	12	8%
New Brunswick	4	3%
Nova Scotia	4	3%
Prince Edward Island	1	< 1%
Newfoundland	1	< 1%
Nunavut	0	0%
Northwest Territories	0	0%
Yukon	1	< 1%
Total	**143**	**100%**

3.1.1 Survey Non-Response

A limited amount of follow-up with survey non-respondents was completed in order to increase response rate and to determine the reasons for this non-participation. The most common reasons for non-response were lack of interest and a lack of resources available to complete the questionnaire form.

3.1.2 Survey Responses from Municipalities

Municipal governments across Canada in rural locals may provide volunteer fire services, police, and ambulance services. The research focussed on the differences in the application of GIS between urban and rural jurisdictions. Thus, the survey was sent to various municipalities across Canada that provided both regional government and rural services. Also, most rural areas across Canada are typically resource-based economies, such as agriculture, forestry, mining, oil and gas. These industries have a higher probability of using dangerous materials that are either stored or transported through their jurisdictions.

Table 4 shows the number of surveys distributed, the number of responses received, and the use of GIS by municipalities in Alberta, Saskatchewan, and Manitoba. Due to limited time and financial resources the study focused on municipalities in Western Canada.

Western Canada has more rural municipal jurisdictions than Eastern Canada due to the scope of land surveying and the regions' late development (relative to other parts of the country). For instance, Saskatchewan's larger rural land base was divided into equal areas, as compared to municipal, county and regional government development in Eastern Canada, which created fewer numbers of municipal districts. Another factor affecting GIS use is that Western Canada produces more oil and gas than the rest of Canada, and companies in the oil and gas sectors use GIS for surveying and production monitoring. The fertilizer industry is also concentrated in Western Canada with companies based in Alberta, Saskatchewan and Manitoba producing ammonia and other nitrogen-based products. Therefore, it was expected that in certain areas across Western Canada, there should be greater awareness of the use of GIS by first emergency responders.

Table 4 Completed Questionnaires for Municipalities in Alberta, Saskatchewan and Manitoba (% of completed questionnaires from Western Canada)

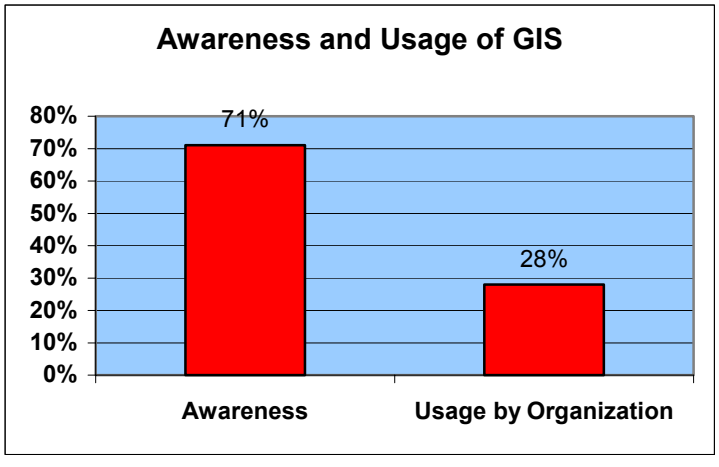
Western Canada Municipalities			
	AB	**SK**	**MB**
Questionnaires sent	30	297	52
# Responses	19	28	4
% Participation	63%	9%	8%
GIS Awareness	19	20	4
# Using GIS	9	5	0
# Not Using GIS	10	23	0
Not Aware of GIS	0	8	0

Municipalities in Alberta had the most experience using GIS for emergency response. As shown in Figure 3, respondents in Alberta and Manitoba showed the highest level of awareness (100%). Of those municipalities currently aware of GIS, those in Alberta were the biggest users (47%), while Manitoba had the smallest proportion with no GIS users. The high degree of GIS use in Alberta is likely attributable to the dominance of the oil and gas industry.

3.2 GIS Awareness and Use Across Canada

The survey participants exhibited a relatively high level of awareness about the application of GIS to emergency response planning (ERP), but had a relatively low level of usage of GIS. Among respondents, 71% were aware that GIS could be applied to ERP, but only 28% reported actually using GIS for this purpose. These results are shown in Figure 1.

Figure 1 GIS Awareness and Usage of All Respondents



The survey responses between urban and rural regions in the application of GIS to emergency response planning were also compared. The number of responses from the survey was almost evenly matched between urban and rural settings; urban represented 53% of the responses while rural represented 47% of total responses.

Figure 2 illustrates the awareness of GIS in urban settings, at 63%. This amount was slightly lower than the total survey responses; however, there was slightly higher use of GIS. It is also clear that urban GIS uses were not all reserved for emergency response planning. This is attributable to the higher number of responses from private manufactures of chemical companies, whose head offices are located primarily in urban areas.

Figure 2 GIS Awareness and Usage by Urban Respondents

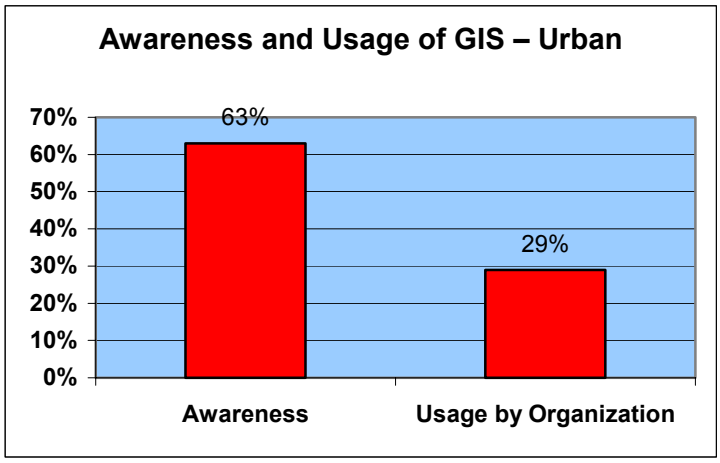
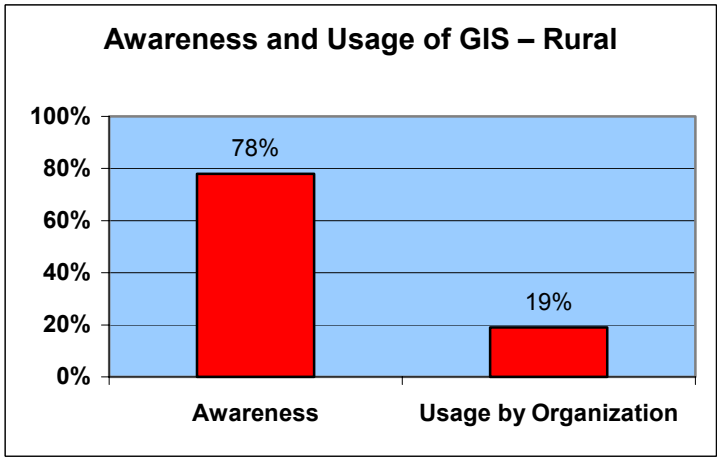


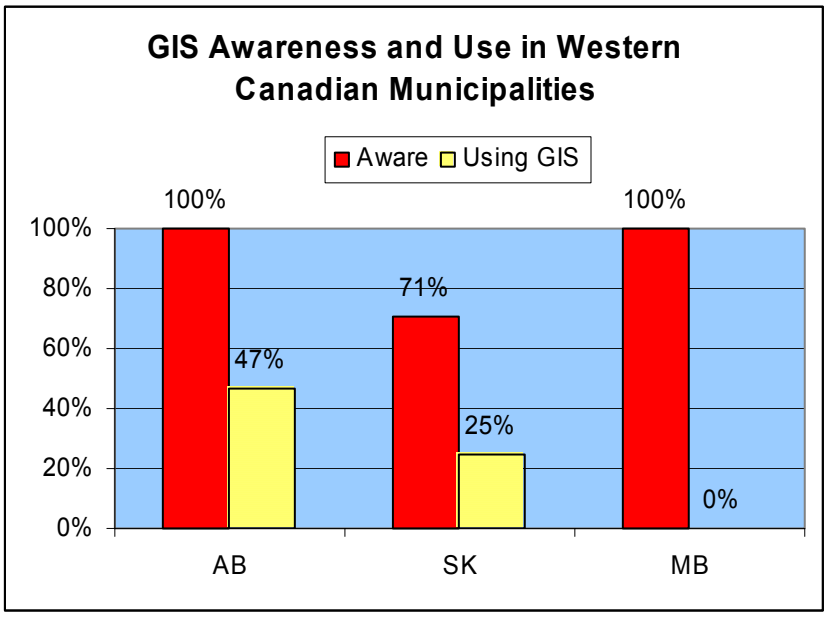
Figure 3 shows that the rural region had a higher level of awareness of GIS and its applications at 78%. However, there was a lower level of GIS use for emergency response planning than the full survey indicated.

Figure 3 GIS Awareness and Usage by Rural Respondents



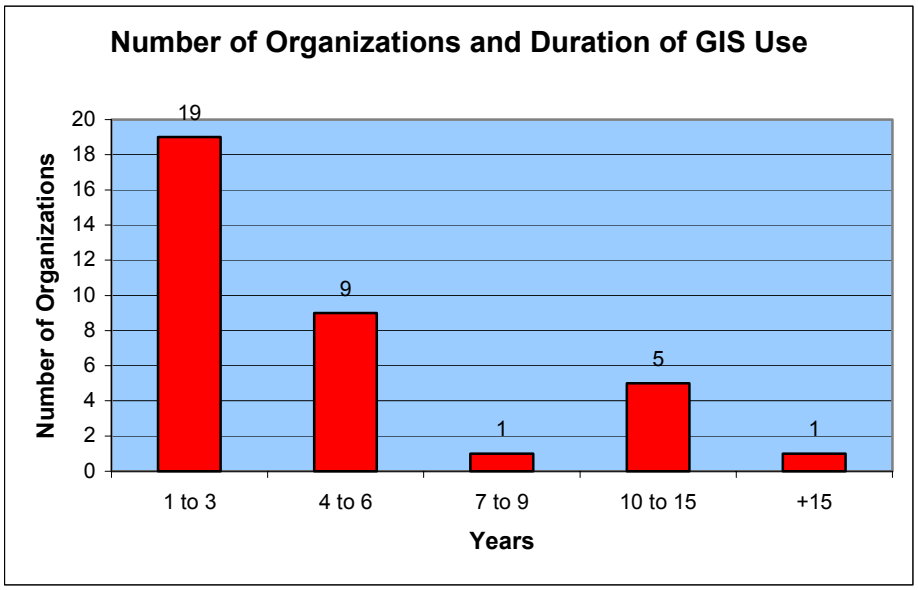
In central Western Canada, the survey results showed a significant difference in awareness and usage between the three western provinces (Figure 4). Alberta has 100% awareness and a 47% usage rate of GIS, whereas in Manitoba the survey results showed an equally high level of awareness but zero use among respondents. The variance of GIS applied in Western Canada is of interest and demonstrates intra-regionally that the province with oil and gas has a higher use than the agricultural based provinces of Saskatchewan and Manitoba.

Figure 4 Survey of Central Western Canadian Municipalities
(% of completed questionnaires from Western Canada)



The research survey also asked participants the length of time they had been using GIS. GIS appears to be relatively new to these organizations, with the majority of respondents using GIS for less than three years. Figure 5 shows the length of time the organizations involved in this study have been using GIS.

Figure 5 Number of Organizations and Duration of GIS Use



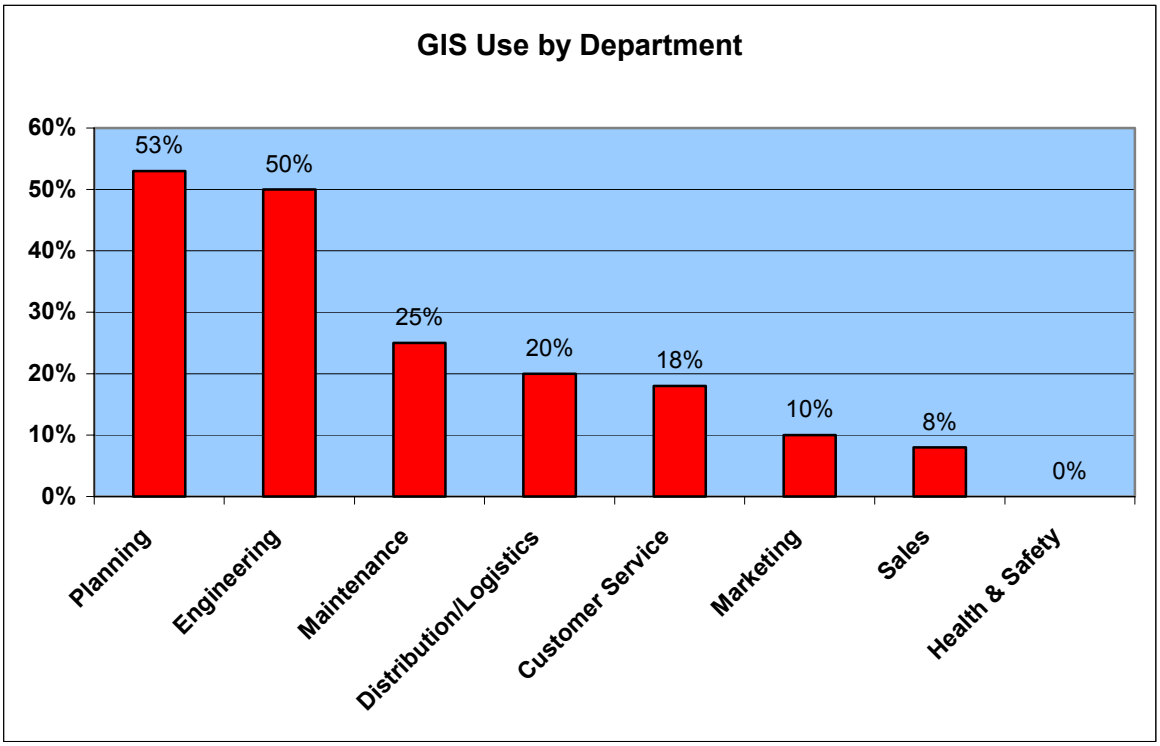
Of those organizations reporting use of GIS, the top three applications were planning operations, emergency response planning, and global positioning**.** Specific findings on GIS applications are shown in Table 6.

Table 6 GIS Applications
(% of total number of applications mentioned)

Applications of GIS	
Planning Operations	55%
Emergency Response Planning	45%
Global Positioning	40%
Structure Inventory (roads, bridges)	35%
Land Inventory	30%
Environmental	25%
Risk Assessment	25%
Monitor Vehicles	20%
Event Simulation	20%
Time Response	18%
Network Assessment	15%
Sales Assessments	5%
Climate Data	3%

The survey also indicated that among organizations and municipalities actually using GIS, it is the planning and engineering departments that are the most likely to use it. Thus, an organization or municipality may use GIS for regular planning and maintenance and apply the technology to emergency response planning. For example, data regarding structures, age, size, and last inspection date can be shown using GIS. Most of the private sector organizations surveyed either produce or transport hazardous material. These organizations have safety directors, transportation and logistic personnel involved in the handling, transporting, or storing of hazardous materials. These individuals may be directly involved in the event of an incident or provide support services to first responders. Thus, a private company may use GIS in one application which could then be used to develop an emergency response system, incorporating safety and training of private and first responders. These findings are shown in Figure 6.

Figure 6 GIS Usage by Department
(% of total responding using GIS)



The majority of GIS applications are used in planning and engineering; these functional areas can assist in the development of emergency planning systems in the company or in collaboration between a company's safety personnel and its first responders.

There were 40 responding organizations which used GIS, and within this group only 18 (45%) used GIS for ERP. Almost all of these organizations used GIS for risk assessment and planning, and nearly seven out of 10 organizations used it for mitigation and response. The complete breakdown of GIS applications for emergency response planning and GIS-specific tasks are

shown in Table 7. For the purpose of this report, the GIS applications listed (response, mitigation, preparedness, and recovery) refer specifically to emergency response applications.

Table 7 GIS Applications Used in Emergency Response Planning
(% of total responding using GIS, N=18)

GIS Applications Used in Emergency Response Planning	
Risk Assessment and Planning	92%
Response	77%
Mitigation	69%
Preparedness	31%
Recovery	15%
Specific GIS Tasks	
Tactical	54%
GIS –Location of Interest	54%
Buffer Zones	46%
Risk Route Planning	38%
Minimize Mitigation	38%
GIS – Infrastructures	38%
Inventory – Hazard	31%
Strategic	23%
Notification	15%
Weather	8%
Pre Routing	8%

Cost of GIS

In the survey, respondents were asked to identify GIS-related expenditures incurred within the last year. Of the 29 organizations that reported their level of GIS spending, the majority spent between $1,000 and $10,000. The full distribution of expenditures is shown below:

Expenditures on GIS

$1,000–10,000	45%
$10,000–25,000	10%
$25,000–50,000	7%
Greater than $50,000	21%
Confidential	17%

The fact that the most common level of expenditure was less than $10,000, combined with the results shown in Figure 5, suggests that reporting organizations are only just starting to invest in basic GIS software programs. A greater proportion of expenditures exceeding $10,000 would suggest a much higher level of use and on-going investments in other spatial GIS applications and database development.

3.2.1 Benefits and Barriers to Using GIS

For those organizations using GIS, the major benefits realized through the use of this type of software were improved planning, preparedness, and responsiveness. Table 8 contains a basic breakdown of the benefits.

Table 8 Benefits of Using GIS
(% of total responding using GIS)

Benefits of GIS	
Improved planning	83%
Improved preparedness	58%
Improved responsiveness	53%
Improved communications	50%
Lowering costs	25%
Increased competitiveness	10%
Lower insurance costs	3%

The major barrier to the use of GIS for the purpose of sharing information was the overall lack of awareness among relevant organizations that these types of systems even existed. Compared to other results, it is interesting to note that confidentiality and lack of cooperation/trust ranked the lowest in terms of the listed barriers to use. Table 9 shows the complete set of barriers identified by respondents.

Other barriers cited in the survey included a lack of local expertise in GIS, and the accuracy of topographical maps due to the age of data for roads and structures.

Table 9 Barriers to GIS Use
(% of total responding using GIS)

Barriers to GIS Use	
Lack of knowledge of systems	58%
Cost to develop systems	53%
Time to develop	45%
Lack of compatibility of systems	40%
Other	18%
Confidentiality	13%
Lack of Cooperation	5%

Lack of knowledge about GIS is a significant barrier to its application as a tool to assist in the development of emergency response plans by first responders. With increased knowledge and awareness, it is speculated that the use of GIS would increase by first responders, industry, and municipalities in applying GIS to emergency response planning. The cost of developing and gaining expertise in GIS varies from the type of GIS employed to the types of data collected. The time required to develop useful systems in support of ERP varies depending on the availability of data. In addition, first responders have not been developing and using GIS technology because little to no work has been done to quantify the benefits of using it in emergency management. Given the massive academic and government investment in GIS expertise in related fields, the benefits of GIS need to be further quantified and qualified on a wider scale to ensure that new users like ERP are cognizant of the tangible savings that GIS can provide.

The incompatibility between various Geographic Information Systems with respect to information sharing and display of this information is a concern. However, with the development of new Open GIS®[2] this barrier should be significantly reduced in the near future.

[2] The Open GIS Consortium registered this trademark worldwide "to assert the importance of open standards in geoprocessing and to protect these standards with a legal brand" (Open GIS Consortium. Resources – Glossary of Terms. http://www.opengis.org/resources/?page=glossary [21 Nov 2003]).

3.3 Current Applications of GIS in Canada for Emergency Response Planning

The following sections present findings taken from the first responder survey on the different types of spatial information systems. The different phases of emergency management applications, which are typically part of GIS emergency planning, are also specified.

3.3.1 Applications in Emergency Management

The survey sought current applications of GIS used in emergency response planning. This section reviews examples of such applications across Canada.

Before an Emergency

- An Automatic Vehicle Locating system installed in the emergency response vehicles from which addresses may be located on the way to an incident.
- A set of pre-fire plans for high-risk industrial and residential occupancies.
- Developed more than 80 data sets in a central repository concerning storage sites of hazardous materials. These datasets can be replicated and moved onto a mobile computer platform and taken into the field.

During an Emergency

- The type of service provided, determined by the time it takes for other response vehicles to arrive.
- Standard GIS output, including:
  - dispersion assessment of a spill involving hazardous materials
  - evaluation of toxic plume direction in relation to population densities
  - location of road blocks
  - information to phone companies for automated dialling systems to deliver warnings

After an Emergency

- GIS can be used to analyze all information gathered during the response to an incident. Types of information collected included travel speed, road conditions, and type of response and weather conditions. GIS is a useful tool for mitigation, and the collection of past emergency information can be used in preplanning for mitigation assessments.

3.3.2 Information Shared with Other Parties in Emergency Response

Respondents were asked about the type of information typically shared with other parties involved in emergency response. Examples of information that can be shared are as follows:

- Basic emergency information (e.g. key contacts, responder capability, and critical product movements within the area)
- Emergency response plans
- Material safety data sheets
- Maps and key facility site floor plans
- Emergency equipment availability

- Address and phone numbers of public agencies and responders

Responders were asked about the information they share with other first responders in order to determine a common base of information that can be used in developing emergency response GIS. The information listed here could be placed in a common database that would be shared between all responders in an area. More importantly, this information can be developed into GIS layers to be used by responders in each area to develop their own base systems. Furthermore, the collaboration between both federal and provincial emergency services planning agencies would provide common dataset development of information to be used as building blocks in the development of GIS to be used by first responders.

3.3.3 Detailed examples of Information Sharing

Below are more detailed examples of the type of information, as supplied by survey participants, which must be shared between parties involved in responding to emergencies. The information which is shared can be developed into collaborative datasets that can be used in developing GIS emergency response plans.

- In one regional emergency response system that was surveyed, there are three fire departments, one ambulance service, one RCMP detachment, five municipalities, five public works departments, varied social services agencies, schools, industry, and a variety of other interested players. All organizations in the region are encouraged to participate in the emergency planning process as all resources may be used during an incident.

- All information contained in the emergency plan, with the exception of FOIP[3] protected information, is taken into the field and shared with all participants. With a high level of oil and gas drilling underway in Prairie rural regions, some first responders have taken a proactive approach, including participating in the ERP meetings prior to drilling. At these meetings, emergency response information is transferred. Where required, any incorrect information gathered by outside agencies charged with compiling the ERP is corrected.

- A detailed emergency plan has been created to co-ordinate response teams from two rural municipalities, two villages, two ambulance services, the RCMP, Saskatchewan Parks, and the area Mutual Aid program. This particular plan defines those supplies and services that will be shared in case of an emergency.

- A dialogue process is in place in this community where plant risk data (i.e., worst case scenarios), prevention efforts, and emergency preparedness are discussed openly with local first responders and other community stakeholders.

- Information is shared with local fire departments and police departments on hazardous products and how to handle them in response to various situations. In

[3] Alberta's Freedom of Information and Protection of Privacy Program

particular, information about chemicals transported to and from sites within the region is shared. In Ontario, this information is also shared with local authorities.

- First responders are provided with maps of the municipality, indicating locations of residences, regional parks, sources of water, etc.

- In several regions route risk analysis is performed. This consists of assessing and identifying the location of: population centres, road networks, key buildings, waterways, etc., and other information used in developing emergency evacuation plans.

3.3.4 Other Types of Information that should be Incorporated into a GIS

Respondents were asked about additional types of information that would be beneficial to emergency response and could be incorporated into a GIS. Answers included the following:

- Identification of industrial manufacturing sites in a given region.
- Provide a listing of requirements for Customs clearance during an emergency at a border crossing.
- Ranking of capabilities in terms of level of training of other responders within a geographic area; locations of equipment supplies; location of carriers and their equipment.
- Real-time tracking and optimal routing of emergency vehicles.
- Information regarding hazardous materials in the region (it would be beneficial to know the locations of all storage facilities and information on movements of these materials at all times via rail and truck routes).
- Floor plans for key buildings.
- Weather/wind direction in real-time.
- Access route alternatives; type of roadways (gravel, paved); data on existing infrastructure in the vicinity and at the response location (water, sewer, gas, power, type and number of buildings in an area).
- The minimum and maximum number of personnel able to respond to a given threat; fast assessment of the chain of command for a given emergency response.
- A Canadian equivalent to the U.S. PSAP (Public Safety Answering Points) would be useful and would eliminate the task of trying to keep emergency responders' databases up-to-date.
- List of local ER members/contractors capable of shorter response time.

Many of these suggestions are costly, but all are certainly well within the capability of the existing technology and software.

These survey results indicate that there is little integration or coordination of GIS data and information sharing between first responders and other stakeholders. An example of an area where such integration was reported to be difficult was the sharing of phone contacts between responders. By having the phone contact information of private companies, transport carriers, and environmental clean-up companies, first responders can contact persons to assist in the

response, or gain knowledge of product characteristics. In addition, first responders also need to know whom to contact in order to secure extra services from a neighbouring community in the event of fire.

If properly used, GIS integration could allow for individual systems to be linked to other mapping programs, providing additional information such as: elevation and topographic maps; automatic phone alert systems; material safety sheets given storage sites; information on Transport Canada Permit Databases; and climate and wind dispersion models. First responders who share borders may be able to share common information datasets, which can be used in each responder's development of a GIS application. Common information sets may include road and water networks, and locations of industries, schools, hospitals and other health care sites. Only 30% of respondents that use GIS have integrated their systems with another organization. The three most frequently mentioned parties with whom first responders have integrated their systems are major industries in the community, and other first responder groups. A lack of GIS integration and coordination increases the cost of database development and can likely result in inadequate or ineffective emergency response planning.

There is little commitment across Canada to share GIS platforms and data, a problem in part due to the software licensing agreements that exist for many of these systems, and copyright issues with Canadian data. These include data developed by both federal and provincial jurisdictions for distinguishing base boundary files such as census districts and road network datasets. There are also liability issues regarding land ownership and disclosure. As evidence of the impact of these issues, of the organizations using GIS, only 38% in the survey share information or plan to share GIS platforms with industrial organizations or with police, fire, and ambulance services. Notwithstanding the limitations resulting from the software licences, the survey has revealed that there is a clear need for a greater sharing of information and coordination between relevant agencies. Sharing data information and developing datasets at a regional to municipal level would assist in the development of systems between stakeholders.

4.0 New GIS Applications for Emergency Response Planning

4.1 New GIS Development for ERP

To identify new developments using GIS in emergency response planning, the following activities were also conducted: a telephone survey, a literature review, patent search, and an extensive Web search of current GIS software suppliers. In this regard, the following associations and their member Websites for new applications of GIS were investigated:

- Geomatics Industry Association of Canada
- Canadian Institute of Geomatics
- GeoConnections Canada
- Open GIS Consortium

Geomatics Industry Association of Canada

This association represents companies that provide consulting and software services associated with Geomatics or GIS mapping services. Geomatics is the term for the technology and service sector that provides service in the acquisition, storage, analysis, management and dissemination of geographic referenced information. There are over 90 companies that are members of this association. The association provides information on the Canadian Geomatics sector in Canada. The association also provides informational and seminar information concerning new GIS developments in Canada, and a Web portal to link to member company services: www.giac.ca.

Canadian Institute of Geomatics

The Institute is a non-profit scientific technical association and its primary purpose is to advance the development of the Geomatics sector in Canada. It provides a forum for networking, publications, a scholarship in Geomatics, and annual seminars, and also ensures that international standards are upheld. The Institute promotes cooperation between companies and organizations within the Geomatics sector. It also provides a certificate course to members, which provides official recognition in Geomatics disciplines such as remote sensing, GIS, and cartography. For further information regarding the Institute, visit their Web site at www.cig-acsg.ca.

GeoConnections Canada

GeoConnections is a national initiative to provide Canadians with geospatial information on the Internet. Led by Natural Resources Canada, GeoConnections has two main roles: first, it is helping create the Canadian Geospatial Data Infrastructure (CGDI), which will make Canada's geospatial databases available on-line. Second, by coordinating the efforts and investments of its government, private, and public sector partners, GeoConnections is establishing technologies and polices to access the collection of geospatial data across Canada. Geospatial data defines the locations of things – settlements, schools, hotels, roadways, administrative boundaries – just about anything that can be described in terms of space. However, geospatial data does more than merely pinpoint a bridge on a map; it describes information or attributes about features. CGDI will assist in the sharing and exchanging of relevant information for emergency managers and all Canadians. Government agencies and business can better manage emergency response, protect critical infrastructure, and safeguard our communities by using geospatial tools and technologies

available through GeoConnections. More information may be discovered by visiting the GeoConnections Web site: www.geoconnections.ca

Open GIS Consortium

The purpose of this organization is to advance the development and use of open operable GIS technology between industry, government and the public. At present, it participates in developing Open GIS® protocols and applications to provide Web-based GIS solutions for emergency and disaster planning. The consortium has conducted demonstration projects with the U.S. Federal Emergency Management Agency (FEMA). It claims some 250 members and is international in scope, including private companies, government agencies, and universities. Approximately half of the Open GIS Consortium members are based outside the United States. GeoConnections Canada also participates in this consortium.

4.1.1 Results

From the review of the various associations across Canada, 185 companies were identified which provide GIS services in Canada. The majority of these companies provide services associated with land surveying, forestry and environmental sectors applying and developing GIS. From the assessment of these companies, suppliers who were developing new computer software applications which could be applied to Emergency Response Planning were identified. These companies were also contacted, including eight software developers and 25 consulting firms.

From the discussions with these suppliers, it is clear that new programs are being developed for emergency response planning. These are, for the most part, self-supporting software systems for individual company applications**.** Self-supporting systems are internal to one organization where information is only available to employees through an intranet. As such, these systems are principally standalone; a minority of them were data-shared programs. On the other hand, shared data systems can be made interactive through the Web and provide multiple users the same common information sets that are used to generate maps.

Integrating and sharing information is a key concern to emergency first responders and to local industry. The costs of data collection and data maintenance, as well as several legal concerns, all inhibit the development of collaborative systems. The legal concerns mentioned by the respondents were of two types: first, concerns regarding the protection of proprietary software and data and, second, legal liability issues in mutual aid agreements.

There is, however, a move towards Web-based data sharing sites that can be accessed through Open GIS® applications. These sites provide a clearing centre for data sets to be used between multiple users. These data sharing sites were set up to address barriers to establishing collaborative systems.

The team also completed a literature and Web review to identify the types of GIS applications that are available. The following is a non-exhaustive overview of the characteristics of recent GIS software applications for emergency first responders:

- Event and task management applications, including related documentation systems, have been developed. These systems allow users to build pre-event capability and trace events and communications prior to and during an emergency. These systems can be used for event pre-planning and simulation assessments in addition to training.

- Infrastructure site database systems have been developed which use GIS to show inventory of infrastructure locations.

- Risk assessment software has been developed by several software companies for both vehicle routing assessments and for urban municipal services such as water distribution.

- Disaster management plan software has been developed for use by municipalities.

- Evacuation route planning software has been designed for first responders.

- Dispatch systems that can show the location of 911 callers have been developed. They also allow the user to compare different routings, infrastructure types, and property sites. Most of these systems have been designed for large urban area applications.

- New geo-based systems that would allow multiple users to compile geo-data through a Web-based browser. This allows different parties to share data and create new multi-layered maps through a specific Web site.

- Several new emergency management software systems target mainly large urban centres.

- There are several software developments for floodplain mapping. These systems show locations of residential and industrial sites located in a floodplain with different water levels and rainfall scenarios.

- New software designed for search and rescue has been developed. It uses grid-based location systems to assist first responders in search and rescue activities.

5.0 Demonstration of GIS to First Responders

5.1 Purpose of the Demonstration

An important objective of the research project was to design an interactive CD demonstrating the use of GIS and spatial information to first responders. The demonstration CD was designed to show potential users GIS capability for planning, training or responding to an emergency in their area, and to determine what GIS information and functionality was of use to them. The CD approach also demonstrated how GIS applications could be developed on an open source GIS platform that would allow users with no GIS training to view GIS map layers. The output of the GIS maps could be coded onto an interactive CD that a responder could use without prior GIS training.

In total, the demonstration CD contained: a set of interactive maps for GIS first responders; timeline maps and routes; a database of response times by first responders to locations of hazardous material storage sites; a database example of hazardous material sites across one province, Saskatchewan; a database example of material safety datasheets; picture images of various hazardous material sites showing approaches and condition; climate wind data shown as wind rosettes for various communities (with a focus on Saskatchewan); Internet links to Environment Canada, Transport Canada; and links to other emergency response planning organizations.

The CD also contained many applications of GIS that first responders could use to assist in their decision making process in planning, training or responding to an emergency event. These applications include the following:

- Proximity of dispatch sites to known storage sites of chemical products;
- Proximity to other first responders;
- Response time comparing travel speeds to road conditions;
- Route plans from know dispatch sites to storage sites;
- Location of hazardous material storage sites by type;
- Location of critical infrastructure; and
- Route models for heavy equipment.

5.2 Demonstrating the CD

The interactive Emergency Response CD was used as an educational tool to promote the use of GIS to first responders, and to determine what GIS information and functionality was of use to them. In the first step of the demonstration, background information was provided on geographic information systems and how geospatial information can be stored and displayed on maps as points, areas or themes. Specific reference was made to information that should be of value to first responders.

The demonstration CD prototype was designed to show how GIS information could be used to assist first responders with other information to plan for an emergency in their respective areas. The CD features drop-down menus for easier navigation, which allow users to easily navigate

between layers and maps. The CD also demonstrated how Open Source GIS tools could be used to create interactive GIS maps, combined with other informational sets that could be disseminated on a need-to- know basis to a region or local area of coverage for first responders.

The CD was shown to 33 individuals. These were first responders located in Saskatchewan, Ontario, and Quebec. The individuals represented included fire chiefs, deputy fire chiefs, volunteer firefighters, ambulance personnel, and police personnel from chiefs to officers.

A breakdown of the participants who attended the CD demonstration is shown below:

Group	Number
Police	5
Fire	21
Municipal: Other	2
Ambulance	5

Roughly half of the participants were already familiar with GIS applications applied to emergency response planning. However, only three of the participants were presently using GIS.

The CD contains two demonstrations of GIS, showing interactive maps and route-time distance maps between first responders and storage sites of hazardous materials in the province of Saskatchewan.

The demonstration of the interactive maps allowed users to view different information and compare their locations. The datasets included the locations of fire, police, and ambulance services relative to hospitals and to various hazardous material sites. Also, users could view road and rail networks in their region, and identify the roads that have weight or seasonal restrictions in the event that heavy equipment would be required. Users were shown how to view all of the selected map layers or, alternatively, select one or two different layers individually. Next, a discussion was undertaken with participants about what other data map layers could be developed for their region. Not surprisingly, location of public water wells was important to some. Other participants sought to identify those fire stations possessing equipment to respond to incidents involving anhydrous ammonia.

The next part of the demonstration showed how GIS could be used to develop timeline route maps that could be used to compare routes from a location to the emergency site. These maps displayed the routes that could be integrated for use by various responders. A critical element in response planning in which participants expressed interest both in the demonstration discussions as well as in the survey, was the need to know when other responders would arrive at an emergency site. By using GIS and network optimization models, travel distances for various emergency response service centres were determined using different routes. From this exercise, additional time lines were developed for other first responder locations to the locations of storage sites (across Saskatchewan) using different travel times. This demonstration illustrated that maps created in this manner can be sent as an image file via the Internet and displayed on a personal digital assistant. Ultimately, the time line maps can be integrated as a tool to show directions to emergency personnel in real time.

In addition to the time database, two other databases were also developed and demonstrated. The first provided information on the numbers and types of hazardous material sites for each municipality. The second database provide more detailed information on the owner (or owner's representative) of each hazardous site, with key contact names and phone numbers for use in an emergency.

Additional information can be integrated with a GIS. Examples include material safety data sheets, pictures of hazardous material storage sites, climate information, links to other useful Web sites, and the Transportation of Dangerous Goods Handbook. The Transportation of Hazardous Material Handbook is critical to first responders. It assists them in identifying material identification placards displayed on a truck or rail car, or on a storage site door. The Handbook gives the meaning of various hazardous materials symbols, as well as related materials and procedures to be followed during an emergency.

In summary, there appeared to be a high level of interest for all aspects of emergency response information management using GIS tools as illustrated on the demonstration CD. The participants in the demonstration session responded positively to the high level of functionality and recognized the benefit of these systems as well as their applicability to emergency first responder work. The most frequently mentioned benefit was functionality, which assured the availability of updated information that would maintain the quality and timeliness of emergency responses.

5.3 Participant Feedback on the GIS Demonstration

GIS functionality was demonstrated to a selection of first responders who participated in the survey. The objective was to obtain their input about the potential benefits of this technology. Participants completed questionnaires to gather opinions on this tool, which assisted the researchers in quantifying responses from participants about the demonstration project. Twelve demonstrations were conducted for 33 participants.

Participants' views were solicited on the ability of the CD to assist them in carrying out pre-planning exercises**.** Most participants found the CD easy to use and navigate. Participants agreed that the scope of the CD showing the range of GIS applications was informative. Participants also agreed that contents and format assisted in their understanding of how GIS can be applied to emergency response planning. One comment from a participant was "within two to three clicks I have information, instead of conducting queries and waiting for responses."

The CD provided an easy format for participants to access a wide range of emergency response information that could be used in training and pre-planning with other responders. More importantly, the CD can also be customized to local needs and be designed to provide more detail about local concerns. For instance, grid roads and public water well locations could easily be added.

To identify which layers contained on the CD were the most beneficial to first responders, participants were asked to rank the layers in terms of their importance. This ranking is shown in Table 10.

Table 10 Ranking of GIS Information Layers

More Important	Important	Less Important
Fire	Hospitals	Ammonia
Police	Roads	Fuel
Ambulance	Farm Chemicals	Fertilizer
		Rail

The group ranked fire departments as most important, indicating that their location was the most important. During the ranking, some respondents ranked all layers as equally important.

Data for each first responder location could be collected and displayed using GIS. This includes information on the number of employees, average level of training, and type of equipment. Other information, such as container or tank size, amount of storage, and demand period are also important data elements.

The farm chemical storage sites were the most important of all hazardous material sites. Some respondents also concluded that ammonia location was very important. It was suggested that other products such as chlorine sites be added.

Participants were asked what information they felt should be added to the CD in order to increase its value and benefits to them as first responders. The most frequently cited items were:

- ¼ section of land owner (land survey)
- number of individuals in a house
- location of water supplies, wells
- location of specialized equipment by fire unit
- training levels of fire, ambulance units
- road conditions
- number of ambulance units at each locale
- map of health districts
- map of 911 call centre coverage
- map of mutual aid zones
- map of large hydro facilities
- map of fire by level of training
- map of equipment available within a region – including ambulances and chemical suits

Much of this information could be easily customized on a local level.

All of the respondents agreed that the site picture images were of value to the overall utility of the CD. Some respondents commented that other pictures could be added, such as those of large

industry sites (mines, pulp mills), warehouses, adjacent building structures, types of rail tank cars, aerial views, and other manufacturing sites. Close-up images of tank sites with access showing rail or road crossings could also be added.

5.4 Perceived Benefits of GIS

During the presentation and discussions, it was evident that the CD approach increased knowledge about the application of GIS to emergency response. The presentations and discussions also identified the types of information that was of value to build different GIS data layers to be used by first responders. The general feeling among the respondents was that using GIS as a preplanning tool for first responders is quite beneficial. It can quickly provide a base level of information to a wide audience at low expense.

GIS could also be customized for a defined area, which would allow users to view their own region in more detail. There appears to be a need for information that is consistent and that can be shared amongst many of the participants in emergency response.

A Geographic Information System of the type described here could be shared between police, fire, industry, and ambulance services in order to provide a knowledge base of a region and its storage sites. It would enhance the awareness of GIS and its application in rural areas. It is well understood that emergency response departments in rural areas may not have the budget and labour skills to develop their own system. Widespread use of GIS in the manner suggested here will eventually lower the costs of acquiring the technology.

A GIS could be developed to manipulate interactive layers in order to plan for a series of different emergency response situations. For example, floods, fire and rail hazardous material incidents could all be included. CD's can be updated and password protected for security reasons.

Once the participants were shown the demonstration CD, they concluded that GIS applications could be extremely beneficial in their endeavours. The major benefits of the CD included the ease of use, the capability for expansion, the ability to customize and collaborate relatively low cost, and quick access.

6.0 Summary of Findings

6.1 Summary of Findings from Survey

The key findings of this study were:

1. The survey regarding the GIS experience of first responders, municipalities, hazardous good suppliers and transporters, and environmental clean-up service providers demonstrated that 72% of respondents were aware of GIS tools but only 28% had used them.

1. A higher level of GIS use was found in those provinces with a strong resource industry base, and a lower level of GIS in rural as compared to urban areas in Canada.

2. Fifty percent of respondents reported that use of GIS software was for applications used in emergency response planning.

3. As expected, the organizations that have planning departments account for 53% of GIS use. However, there is a broad cross-section of other functional areas presently using GIS tools, principally Engineering, Maintenance, Logistics, and Customer Service.

4. Within emergency response applications, risk assessment and planning was the most frequently mentioned use of GIS. Other important uses included response time planning, mitigation, tactics and various spatial or location based issues.

5. The primary benefits that the survey respondents said were provided by GIS included improvements in planning, preparedness, responsiveness, and communications.

6. The most important barriers to greater use of GIS were lack of knowledge of the systems and the perceived high cost, both in terms of money and time, to acquire and set up such systems. Lack of compatibility between various GIS software was also mentioned as a significant barrier to use.

7. The current use of GIS was less relatively new amongst respondents, with most users indicating less than four years.

The gap between GIS awareness and GIS use suggests that there are important barriers to acquiring these systems among first responders. Based on the survey results, the following are the most important barriers indicated by first responders:

- Ability to demonstrate the cost/benefit of GIS in order to show first responder decision makers; an important consideration is having the information available so that the costs and benefits can be easily shown.

- Ease of acquisition, in terms of having the skills to evaluate alternative solutions and select the one most suitable for the needs of that particular first responder.

- Cost of acquisition, including the direct cost of acquisition, the cost of installation, and of loading the various data sets required to make the system operational.

- Compatibility with other Geographic Information Systems. Most importantly, those that are installed in sister first responder agencies such that data sharing and collaborative systems can be put in place as soon as practical.

6.2 Summary of Findings from Interactive CD Demonstration

Twelve demonstrations of the interactive CD were conducted for 33 first responders in order to demonstrate the potential of GIS. The feedback from these demonstrations is summarized below.

- Eighty-five percent of participants found the demonstration CD easy to use and navigate. Participants agreed that the scope of the range of GIS applications was informative, and that the format assisted in their understanding of how GIS can be applied to emergency response planning.

- The demonstration provided an easy format for participants to access a wide range of emergency response information that could be used in training and pre-planning with other responders. The most important information layers were for the locations of fire, police, and ambulance services. The farm chemical storage sites were the most important of all hazardous materials.

- Participants cited additional information that would be useful: information on residents and land owners; location of water supplies, specialized firefighting equipment, ambulances; maps of call centre (911) coverage areas, health districts, mutual aid zones, and large hydro facilities.

- All of those persons interviewed agreed that the timeline database and time-maps were beneficial information to be contained on the CD developed through use of a GIS.

- All of the respondents said that the picture images were of value to the overall context of a GIS and that additional pictures would be useful.

- Overall benefits of the demonstration included the ease of use, the capability for expansion, customization and collaboration, low cost, and quick access.

The unanimous response from the 33 participants in the demonstration sessions was indicative and showed how GIS can be used to improve the effectiveness of emergency first responders. It provided the important first step in building awareness and confidence in these systems on the part of newcomers, particularly given its ease of use and its relatively low cost.

7.0 Observations

Although there was a relatively high level of awareness amongst first responders and industry of GIS in general, its actual use is relatively limited. The survey provided a window to examine if there are differences between regions regarding GIS use across Canada. The survey also gathered information in order to evaluate what GIS information was most beneficial to emergency responders and industry. It identified such factors as differences among GIS data sets, the type of information that is currently shared, along with future informational requirements that need to be integrated into an ERP GIS.

The survey provided perceptions of GIS use and benefits by first responders. It identified the scope of GIS use and levels of expenditures on GIS by first responders and private industry. It also identified some of the barriers for GIS development and use by first responders, governments and industry. Ultimately, this survey provides a benchmark by which future surveys can measure the rate of adoption of GIS technology and can review the changes in regional variations in GIS use by emergency first responders across the country. The current use of GIS across Canada by first responders is limited as to its development and integration.

The research also reviewed some of the current differences in GIS technology and system development among software companies in Canada and the United States. There are differences in the GIS developments underway, and patents are in place in the two countries. However, the GIS industry under development in Canada is growing as new technology and research is completed. In many cases, Canadian companies have developed international expertise in the use of GIS and remote sensing technologies, technologies that can be used by emergency first responders and industry.

Results of this study indicate that few first responders are using GIS. The CD provided an example of how GIS information can be operated and used by individuals without prior GIS training. The interactive CD demonstrated its potential as a useful tool in training, and increasing the awareness of GIS use by the target group.

Finally, the emergency first responder survey and the demonstration CD sessions both highlighted the high level of interest in GIS tools to increase the efficiency of emergency response systems. The first responders who participated in the study spoke frequently of the important benefit of having the type of information readily available that would improve the effectiveness of their responses.

Appendix A – Survey Regarding GIS Applications to Emergency Response

Introduction

Logistic Marketing Services is conducting a research project on behalf of the federal Department of public works and Government Services for the Office of Critical Infrastructure Protection and Emergency Preparedness (OCIPEP). We are reviewing current applications of Geographic Information Systems (GIS) by stakeholders involved in emergency management. Our objective is to review the adoption of this technology by first responders and companies to assist in the planning and response to an emergency.

Are you familiar with the term Geographic Information Systems or GIS?

If No:

Geographic Information Systems, or GIS, are computer mapping software systems that allow users to quantify and analyze data and then produce maps. Data can include information on a point, area, or line basis. These systems are associated with land inventory management; climate, economic, network, infrastructure and inventory assessments; and maintenance planning. GIS applications can be used in planning, mitigation, preparedness, response and recovery to help in decision making. An example of how a GIS can be used is to evaluate and quantify infrastructure that may create a hazardous situation, such as an ammonia tank or a bridge that is subject to flooding. Both the public and private sector use GIS.

In order to gather information about the adoption of GIS and its application we have prepared a survey, which will take about ten minutes. Can you take a few minutes at this time to respond to the survey?

If No:

Arrange a more convenient time or medium (i.e. fax or email back) or note refusal.

Please indicate with an X or yes after each question, and add other any comments that are relevant to your adaptation of GIS in your organization.

Lastly, once completed save as a new file with your affiliate name and province abbreviation at end and email to _____.

Thanks for your cooperation.

Name: _____

Organization: _____

Phone Number: _____

Email: _____

Date: _____

A. What type is your organization?

- ☐ Company:
  - ☐ Chemical manufacturer
  - ☐ Fertilizer manufacturer
  - ☐ Mining
  - ☐ Forestry
  - ☐ Trucking
  - ☐ Railway
  - ☐ Environmental Service
- ☐ First Responder:
  - ☐ Police Service
  - ☐ Ambulance Service
  - ☐ Fire Service Regular
  - ☐ Fire Service Volunteer
- ☐ Municipality

B. In what province(s) are you located? _____

C. Are you aware of GIS and its application to emergency response planning?

☐ Yes ☐ No

1. Does your organization use GIS?

   ☐ Yes (if **yes**, go to question 2)
   ☐ No (if **no**, go to question 15)

   If **no**, are you planning to adopt GIS? ☐ Yes ☐ No

2. If **yes**, when and for what purpose?

   If **no**, close interview (provide explanation if there are barriers preventing use of GIS, such as cost, or lack of human resources).

3. What applications of GIS do you use?

- ☐ Planning Operations
- ☐ Inventory of Structure
- ☐ Monitoring Vehicles
- ☐ Event Simulation
- ☐ Network Assessments
- ☐ Global Positioning
- ☐ Environmental
- ☐ Land Inventory
- ☐ Sales Assessments
- ☐ Climate Data
- ☐ Risk Assessment Planning
- ☐ Time Response
- ☐ Recovery Assessment
- ☐ Emergency Response Planning

4. Which departments in your organization use GIS?

- ☐ Engineering
- ☐ Maintenance
- ☐ Planning
- ☐ Sales
- ☐ Marketing
- ☐ Health/Safety
- ☐ Distribution or Logistics
- ☐ Customer Service

5. GIS has been used in emergency response planning. Has your organization applied GIS to emergency response planning?

- ☐ Yes
- ☐ No (if **no**, go to question 7)

6. If **yes**, in which areas has your company applied GIS?

- ☐ Risk assessment and planning
- ☐ Strategic planning: responding routing to an incident
- ☐ Tactical planning: information regarding risks, hazards, infrastructure planning
- ☐ Risk route planning hazardous materials
- ☐ Mitigation
- ☐ Prioritize needs to minimize mitigation
- ☐ GIS used to inventory current infrastructures at site
- ☐ GIS used to show other locations of interest (i.e. schools)
- ☐ Buffer zones
- ☐ Inventory of hazardous material storage sites
- ☐ Preparedness (activities that prepare for the consequences of an emergency but which you cannot mitigate)
- ☐ Weather
- ☐ Pre Routing Assessments
- ☐ Notification systems
- ☐ Response
- ☐ Recovery

7. What Geographical Information Systems are you using?

☐ ESRI ArcView
☐ MapInfo
☐ CARIS
☐ GeoMedia
☐ ER Mapper
☐ Maptitude
☐ Toshiba
☐ Other (Please specify)

8. How long have you been using GIS? _____

9. Have you integrated GIS with others' systems?

☐ Yes
  ☐ Suppliers
  ☐ Transport companies
  ☐ Customers
  ☐ Third party
  ☐ Government
  ☐ Other
☐ No

10. Do you share or plan to share GIS platforms?

☐ Yes ☐ No

11. How much have you spent on GIS development in the last year?

☐ $1,000–10,000
☐ $10,000–25,000
☐ $25,000–50,000
☐ Greater than $50,000
☐ Confidential

12. What benefits do you see in applying GIS?

☐ Improved communications
☐ Improved planning
☐ Improved preparedness
☐ Improved responsiveness
☐ Lowering costs
☐ Less insurance costs
☐ Increased competitiveness

13. What do you see as issues or barriers to GIS development for emergency response in sharing of information?

- ☐ Lack of cooperation or trust
- ☐ Lack of knowledge of systems
- ☐ Time to develop
- ☐ Lack of compatibility of systems
- ☐ Cost to develop systems
- ☐ Confidentiality
- ☐ Other

14. Emergency response planning crosses many areas because there are a variety of interested parties who require information, such as public sector personnel, private citizens, private companies (manufacturers or transporters), and researchers. Information is required before, during and after an incident. What spatial information systems have you developed as part of your GIS emergency planning?

    Before:

    During:

    After:

15. Does your organization share information regarding Emergency Response with other parties involved in Emergency Response (i.e. first responders, private companies) and if so what kind of information is this?

    What information regarding Emergency Response do other organizations share with you?

    What other kinds of Emergency Response information would be beneficial for you to have?

Thank you.