# A G.I.S. APPLICATION FOR THE MANAGEMENT OF LEGAL SURVEY INFORMATION FOR CANADA LANDS

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**ABSTRACT**

Legal Surveys Division (LSD) has developed a GIS application for the management of legal survey information pertaining to Canada Lands. The Property Fabric Information System (PFIS) is the GIS component of an Automated Canada Lands Information Systems (ACLIS) and provides the ability to access all survey documents/information upon identification of any area, line or node. The PFIS also provides a basis for the property rights system by expressing the current property fabric in terms of the cadastral survey framework. The data management methodology chosen was a boundary management system using coordinate geometry. This presentation discusses the PFIS as a tool for the management of survey records within Legal Surveys Division. Also, the data capture techniques and contract potential for the private sector are discussed.

## 1. INTRODUCTION

The Legal Surveys Division of EMR's Surveys, Mapping & Remote Sensing Sector has developed a geographical information system (GIS) for retrieving and managing boundary and parcel information pertaining to Crown Canada Lands. This Property Fabric Information System (PFIS) is a component subsystem of a proposed multipurpose information system now being designed and implemented by the Division designated as the Automated Canada Lands Information System (ACLIS) (Figure 1). The ACLIS will improve information management in all operational areas of the Division, including survey records, survey standards and other technical and administrative data areas. This information is used by the Division, the surveying industry, and the land administration community who deal with lands under federal jurisdiction.

The Surveyor General of Canada Lands has the legislated responsibility for managing legal surveys, and records of those surveys, for approximately 2300 Indian Reserves across Canada, National Parks, public and private lands in the Yukon and Northwest Territories, and for oil and gas leases within Canada's offshore jurisdictional boundaries. Efficient access is necessary to the more than 70,000 survey records and numerous volumes of support material that the division has accumulated in more than 100 years of operation as the main federal legal surveys organization in the country.

Conventional methods of accessing and managing records can no longer meet the daily information needs of internal users, and the various other outside agencies and individuals in the public and private sector. This problem becomes even more apparent with the current task of surveying large expanses of recent native land claims, comprising thousands of parcels across vast stretches of the Yukon, Northwest Territories and various provinces. The division has chosen to use modern GIS (CARIS) and relational data base management technology (INGRES) to resolve the problem of information management.

The PFIS will use this technology as a tool for survey records management. Before the PFIS can become useful, the immense task of data capture by coordinate geometry, must be completed. Most of this data capture will be contracted to the private sector and will require the expertise and experience of the survey industry, in dealing with cadastral systems and solving problems that occur during the input of legal survey plans using coordinate geometry.

## 2. THE PROPERTY FABRIC INFORMATION SYSTEM (PFIS)

In order to improve legal survey records access and management, the Division chose to use modern GIS and relational data base management technology. The "Property Fabric Information System" was the GIS application developed for this purpose. The design of the PFIS incorporates a topologically structured survey fabric layer of information to which other layers of information are related as well as associated textual attributes. The primary purpose of the PFIS is to manage boundary survey information, provide a basis for property rights parcel information management, to give access to all Canada Lands documents in Legal Surveys Division archives, and to provide for fast, simple, and robust data capture.

The PFIS contains a direct link to a Survey Records Information System

(SRIS), for textual information on the survey document. The SRIS is a relational database application, currently in use by Legal Survey Division and contains textual information (ie. surveyor, date of survey, etc.) for each survey and mapping product.

As indicated in Figure 2, the six primary information layers are: survey, land registry, leases, easements, topography, and miscellaneous annotation. The survey layer comprises a survey framework level and a reference network level and is supported by a control network level. To accommodate the requirements of Legal Surveys Division clients, other information layers can be incorporated as needed.

## 2.1 PFIS and the Management of Survey Records:

A number of unique features have been incorporated into the PFIS to provide an intelligent means to manage and access boundary survey data and parcel based property rights data. Topologically structured graphics linked to a relational data base manager are the cornerstone to the PFIS application.

The PFIS provides users with an access to the most recent legal measurements for a specified boundary. The system contains no derived data or adjusted data. The database retains only data which is shown on official plans. Through associated survey data management application software, all computations are executed and managed. This leaves little for the operator to do beyond identifying parcel corners, entering measurements and correcting errors identified by the PFIS. The PFIS allows for the addition of new survey data to improve the accuracy of any existing survey layer file. The survey layer is automatically updated with this new data and all affected geometry is upgraded through the software.

The PFIS provides a basis for property rights parcel information management. This property rights information resides on the land registry layer, the lease layer, and the easement layer, and is linked directly to the survey layer. Both current and historical data is managed. The historical perspective is achieved by expressing property rights in terms of the survey fabric which incorporates both the current and underlying historical survey data into one layer. Although the survey layer displays only the current survey fabric, all underlying historical surveys are related explicitly to this current fabric through the data base structure. For example, an old parcel is expressed in terms of the present parcels into which it has been subdivided. This provides an historical query capability to cadastral information by expressing property rights in terms of their perspective older survey parcels.

The PFIS gives users the ability to access all documents in the custody of Legal Surveys Division (LSD). This access provides a means to retrieve not only survey plans, but also other related documents (air photos, maps, survey project extent, etc). Upon identification of:

i) any area (parcel, plan extent, arbitrary polygon);
ii) any line (surveyed line, natural boundary, etc.);or,
iii) any node (monument, survey control, etc.); the PFIS retrieves all related data sharing the same physical space or linked to that same graphic feature.

The data entry is efficient, complete and simple. It allows the capture of all required survey information in one operation. The plan information (surveyor's name, date surveyed, purpose of plan, etc.), the boundary metric data, the parcel data (lot number, active status, legal area, etc.) and the monument data (type of monument, inscription, etc.) can be entered in one pass.

Through a unique relational data base structure linked to the associated graphic file, queries to the records can be done graphically or textually through the relational data base. If for example a plan number is provided as the search criteria, the extent of that plan will be highlighted in the graphic display. If a grantee's name is identified as the search criteria the parcel(s) held by that grantee will be highlighted. Conversely if a parcel is pointed to in the graphic display, the associated information for that parcel (plans, grantee, etc.) will be listed in the textual data base query report. A broad variety of queries can be undertaken as specified by the user. The combination of attributes for the search criteria are virtually unlimited. Polygon overlay of the various graphic layers for spatial query is also virtually unlimited. This is handled in a windows graphical user interface environment which allows both the graphics and attributes to be viewed on the same output device. This will also allow the direct access to other property rights data bases, both Federal and Provincial to be accessed through the same windows interface.

Other theme layers of information such as property mapping and infrastructure are established in reference to the survey layer thus eventually the basis for a multipurpose GIS can be accommodated within the PFIS application.

## 3. DATA CAPTURE AND CONTRACT POTENTIAL

The method chosen for data capture is a boundary management system using coordinate geometry to input bearings and distances from survey documents. This method will require the expertise of land surveyors who are experienced in analyzing the conflicts and errors existing on the survey documents. Most of the data capture will be contracted to the private sector, from each of the Legal Surveys Division regional offices across Canada. In Ontario, contracts will be managed by:

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606 - 55 St. Clair Avenue East
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### 3.1 Co-ordinate Geometry vs. Digitizing

This paper summarizes the reasons a boundary management system using coordinate geometry was chosen over digitizing, as the preferred method of data capture. A more detailed reasoning may be found in the paper entitled "A Database Approach to GIS Implementation" (see references).

Perhaps the most important reason for accepting the coordinate geometry method is that the resultant accuracy of the database is greatly increased over that of digitizing. The more accurate database allows users requiring additional layers (ie. utilities layer, sewer layer, etc.) to utilize the cadastral data with confidence. Other systems using digitizing, find the accumulation of errors in the cadastral layer make the use of subsequent layers unreliable.

The digitizing method requires the links between the geometric and the attribute (descriptive) elements to be created manually. All points and lines found on a survey plan must be digitized, resulting in a spaghetti file forming a graphic representation of the points, lines and text data. These lines must be properly joined, without undershoots or overshoots so that topology can be built. The attribute information for lines (ie. bearing, distance, etc.), monuments (ie. type, status, etc.) and parcels (ie. lot number, area, etc.) must be performed manually. This results in a plan being used twice to build the graphic file, then populate the database. With the boundary management system using coordinate geometry, the geometric information is derived from the description information (ie. bearing, distance,a etc.), thereby reducing the steps in creating the geometric information.

Digitizing does not provide the ability to check measurements on the plan, resulting in the perpetuation of errors shown on the plan. The coordinate geometry approach calculates a series of closed traverses onto known points, to help identify blunders. After all errors are corrected, a least squares adjustment is performed to calculate adjusted coordinates for each point.

With the digitizing method, new surveys are forced to fit the existing data, but the coordinate geometry method will allow the database to be updated and improved with new more accurate data.

### 3.2 Data Capture Procedures Using Coordinate Geometry

A commercial software package, Cadastral Data Management System (CDMS), has been chosen by Legal Surveys as the boundary management system which provides the functionality required. The coordinate geometry method of data capture will result in a series of steps for the data input of each Canada Land (ie. Indian Reserve):

1. The Canada Land must be analyzed using all survey plans, for the areas of strongest survey data. As shown in figure, 3, the PFIS will contain a number of survey network levels, with the survey framework level depending on the reference network level, which in turn depends on the control network level. As a result the control network level will contain fixed control points, linked by the reference network level. The reference network should be geometrically sound and should contain data from an accurate source (often, but not necessarily, more recent surveys).

2. After a decision has been made as to which control points will be accepted, these points are entered and fixed into the system with the known coordinates and code to identify the monument type. The entire survey structure of the Canada Land will be adjusted around these fixed control points.

3. The chosen reference network is then entered using coordinate geometry, through a series of closed traverses connecting the control points. A closure is performed to identify blunders and, when the error level is acceptable, a compass rule adjustment is performed. Because the survey framework level will depend on the reference network level, the reference network should consist of strong survey data with a geometrically sound structure. This level usually consists of exterior boundaries of the Canada Land and the interior road network.

4. The survey framework level is then entered using coordinate geometry (ie. closed traverses, bearing-bearing intersections, distance-distance intersections, etc.) from reference network points or control points. As these traverses are entered, line codes (ie. exterior boundary, natural boundary, etc.), and monument codes (ie. iron bar, wooden post, etc.), are entered as descriptive information. Also, the source plan number is entered, so the bearing correction along with the distance multiplier, may be applied for correction to UTM coordinates. Upon completion of the traverses, a least squares adjustment may be performed to adjust the entire project.

5. The graphic representation of the database must be generated either interactively or in batch. This process creates the graphics and links the geometric information with the corresponding descriptive information in the database. The network and polygon topology is then created using the GIS software (CARIS). Parcels can then be created interactively with parcel key (unique identifier) and display text (ie. lot number) added in CARIS. The points, lines and polygons created in the survey layer can then be used in the other layers (ie. land registry layer), with updates automatically reflected in each pertinent layer.

Throughout the data input process, blunders of an unacceptable level will be found on survey documents. These areas will be flagged, so that Legal Surveys Division is notified of these areas, and field checks may be carried out in the future. Because the system stores all original data in the database,

# G.I.S. APPLICATION cont'd

the corrected measurements may be entered, and an adjustment performed to adjust all those points affected.

## CONCLUSION

The primary function of the PFIS is to improve the access and management of survey records. The system has also been designed to accommodate the requirements of other potential users by providing the cadastral basis for a multipurpose GIS.

The boundary management approach using coordinate geometry has been chosen as the best method of data capture. The result is fast, simple data capture producing a more accurate database which allows updates and adjustments to be reflected on all layers, and manages links between the geometric and descriptive information.

The data capture will be contracted to the private sector and will require the expertise and experience of the survey industry, in using coordinate geometry to input data from legal survey plans.

## REFERENCES


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CARIS - is a registered trademark of Universal Systems Limited, Fredericton, New Brunswick.
CDMS - is a registered trademark of Alpha Information Systems, Winnipeg, Manitoba.
INGRES - is a registered trademark of Ingres Corporation.

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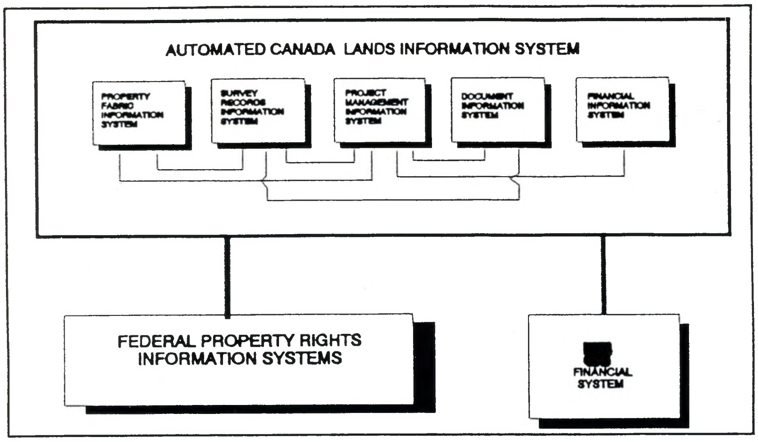


**Figure 1**
Automated Canada Land Information System

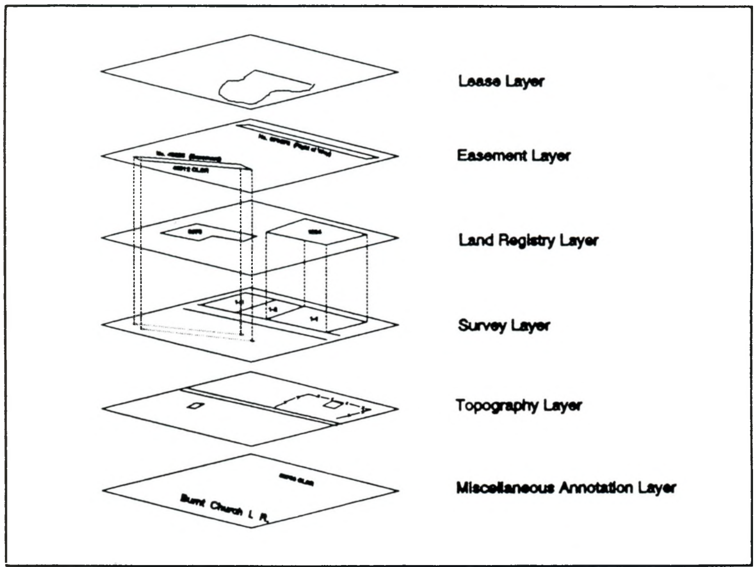


**Figure 2**
Property Fabric Information System Schematic

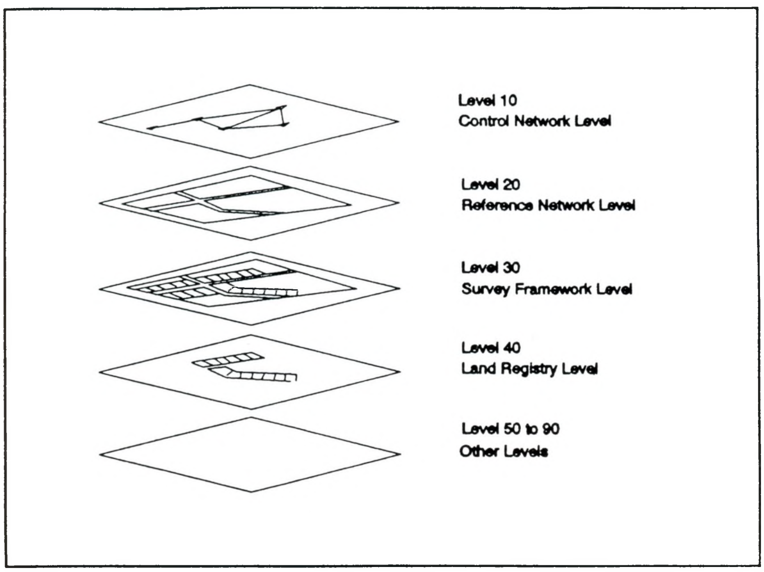


**Figure 3**
Property Fabric Information System Levels