A COORDINATE REFERENCING POLICY

FOR THE PROVINCE OF NOVA SCOTIA

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TABLE OF CONTENTS

A Coordinate Referencing Policy for the Province of Nova Scotia

Purpose

The purpose of this document is to recommend policy regarding the establishment of a Nova Scotia Coordinate Referencing System (NSCRS); as the reference for all provincial land survey measurement, and as the foundation upon which all subsequent geo-spatial, primary and thematic databases are built.

Note: Definitions of technical terms and acronyms used in this document are included in Appendix A

Summary Goal And Policy Statements

GOAL

To provide a Coordinate Referencing System for the Province of Nova Scotia as the foundation for all positional geographic information uses to be known as the Nova Scotia Coordinate Referencing System (NSCRS).

POLICY STATEMENTS

1. **To adopt the Nova Scotia High Precision Network (NSHPN) as the new coordinate referencing framework for use by geographic information users in the Province;**

2. **To maintain the existing network as a reference framework during the transition to the NSHPN;**

3. **To adopt a horizontal datum for the NSCRS;**

4. **To adopt a vertical datum for the NSCRS;**

5. **To adopt a projection system for the Province;**

6. **To establish standards and specifications for the NSCRS;**

7. **To employ appropriate technology to maintain the integrity of the NSCRS;**

8. **To facilitate and encourage the use of the NSCRS; and**

9. **To adopt legislation governing use of the NSCRS.**

A Coordinate Referencing Policy for the Province of Nova Scotia

BACKGROUND

1.0 Introduction

The precision with which places, objects and features can be located on the ground or depicted on maps, historically, has been dependent on a network of physical control points, the exact locations of which have been determined by established survey methods. In Nova Scotia this network has been known as the Nova Scotia Coordinate Control System (NSCCS). The system provides a framework to which land surveyors reference their work. The system also provides a foundation for base and topographic mapping, property mapping and all other thematic mapping programs. Users of the system include: the federal, provincial and municipal governments; engineers, planners, surveyors, mappers, foresters, hydrographers, geologists, GIS managers, consultants and others. Some use the system daily; others use it only on individual projects as the need arises.

The system has served Nova Scotia well. It has been a "cost-effective societal investment" to quote the "Report of the Task Force on Control Surveys in the Maritime Provinces" (Angus Hamilton and James Doig, March 1993).[1] However, improved technology, coupled with impending changes to the datums of the coordinate referencing network upon which the NSCCS is currently based, signals the need for change. There is a requirement to implement a new network: the Nova Scotia High Precision Network (NSHPN), based on the recently established Canadian Base Network (CBN) high precision control points.

The NSCCS, the new NSHPN and all of their component parts (databases, control points, products, etc.) collectively will be known as the Nova Scotia Coordinate Referencing System (NSCRS).

1.1 Coordinate Referencing Control Points

The Nova Scotia Coordinate Control System (NSCCS), referred to in this document, includes a network of coordinate referencing control points on the ground, each of which have precisely determined positional locations. This network forms part of national and international coordinate referencing networks. The positions of the control points are determined with reference to an established point of origin. The positional values are recorded as x (Easting) and y (Northing) coordinates. Control Points also have a "H" (Height) coordinate. The H coordinate provides the elevation of the point above an established surface (e.g. mean sea level). By establishing x, y and H values for a point on the ground, a very precise geo-spatial location can be determined for each

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[1] This report was funded jointly by the three Maritime Provinces; Nova Scotia, New Brunswick and Prince Edward Island. See Appendix B for recommendations from the report.

point. When connected by survey, these control points create a precise grid or network to which features on the ground (e.g. location of individual points, property boundaries, road intersections, structures, etc.) can be accurately referenced.

1.2 Use of Coordinate Referencing Control Points

The NSCCS presently serves as the primary network for all land related measurements for the location of geographic information.

Such measurements or locations can be determined either directly or indirectly, i.e.:

- Directly
  - Land Surveyors use the NSCCS as the reference for detailed surveys to accurately establish and define positions of features on the ground.

- Indirectly
  - Aerial photography depicting ground cover can be referenced to the NSCCS and used to create accurate maps.

  - Maps are created based on the NSCCS, and indirectly all geographic features or themes plotted on the maps are geo-referenced (related to the NSCCS on the ground).

The integrity of surveying, mapping and many Geographic Information System (GIS) projects rests on the integrity of the NSCCS. The NSCCS is, therefore, a critical component of the provincial land information management system.

1.3 History of the Nova Scotia Coordinate Control System (NSCCS)

A coordinate control network for the Province of Nova Scotia was initiated in March 1968 under the Atlantic Provinces Surveying and Mapping Program (APSAMP). APSAMP was administered on behalf of the Province by the (then) Department of Lands and Forests, under a federal/provincial agreement signed between the Province and the federal Atlantic Development Board, subsequently taken over by the federal Department of Regional Economic Expansion in April 1969.

The program to establish a coordinate control network throughout the Province was initiated in 1968 by the Nova Scotia Department of Lands and Forests through its Control Surveys Section, Surveys and Mapping Division. During the first five years of operation, the department placed a total of 8,000 control points throughout the developed areas of the Province.

On April 1st, 1973, responsibility for implementation of a coordinate control network in the

Maritime Provinces was transferred from the individual provinces to the newly formed Land Registration and Information Service (LRIS): an inter-provincial agency under the Council of Maritime Premiers. The network was completed by LRIS in 1981 with the establishment of approximately 23,000 control points, installed at a total cost of over $10,000,000. The network had previously been referred to by various titles, but was commonly known in the Province as the Nova Scotia Coordinate Control System (NSCCS). By 1981 the System was considered to be completed, apart from on-going maintenance and densification. It was considered the envy of many provinces and states throughout North America.

The NSCCS, created by building upon the federal Geodetic Survey of Canada's (GSC) control base as a foundation, is a network of accurately measured control points marked on the ground by metal "plugs" set in concrete monuments, bedrock or on metal rods or pipes driven into the ground. These control points are used as the point of reference for survey work, carried out in the Province. They permit the results of surveys to be referenced to the provincial NSCCS and, indeed, into national and international systems. The NSCCS is extensively used and relied upon by both government and the private sector. Today, the major effort is focussed on maintenance and improvement of the existing network, including the mathematical adjustments of the survey data.

The technology that enabled the building of the network was the electronic distance meter (EDM). The traversing methodology used required visibility between adjacent control points, making it necessary to place most of them along provincial road rights-of-way. This technology is now being superseded by newer technology associated with Global Positioning Systems (GPS), based on signals received from earth orbiting satellites.

Even as the network was being established, control points were being destroyed through various activities, such as necessary maintenance and improvement activities carried out by the Department of Transportation and Communications (DoT&C) within their rights-of-way; as well as projects initiated by other users and developers (utilities, forestry, subdivisions, etc...). The need for a maintenance program to replace destroyed control points was identified and initiated in 1981, to ensure continued access by the many users of the network. The maintenance program involved: field inspection of each control point on a regular cycle; an analysis of new and ongoing requirements; replacement of destroyed control points; the establishment of new control points (densification of the network); and mathematical adjustment to integrate new and revised positional information into the existing network. This maintenance work (to replace a control point) required funding estimated to cost $600 per control point.

A Monument Trust Fund was set up in 1982 as a mechanism through which payment for destroyed control points could be received. Since the Monument Trust Fund was established, more than 425 control points have been replaced using these funds. Only DoT&C has reported destroyed control points, consequently all contributions to the fund have been made by that department. Since 1980, a total of approximately 2,500 control points have been added to the network, either as replacements or as additions to the initial network.

In 1992, through a cooperative project led by the Province of New Brunswick, the three Maritime Provinces contracted for a study concerning future developments with regard to coordinate referencing in the region. The results of that study were presented in March 1993, as the **Report of the Task Force on Control Surveys in the Maritime Provinces** by Angus Hamilton and James Doig (see Appendix B for recommendations from the report). The recommendations contained in that report form the basis for many of the recommendations and policy statements contained herein.

As a result of a decision taken in November, 1993 by the Council of Maritime Premiers, the agency, LRIS, was closed on March 31, 1994. With the closure of LRIS, the NSCCS became the responsibility of the Province. It is currently administered by the Nova Scotia Geomatics Centre (NSGC), Land Information Management Services Division, Department of Municipal Affairs.

The overall quality of the NSCCS has been considered to be good, however, ongoing maintenance of the System and mathematical adjustment of positional values of the control points continue to present costly challenges. An estimated $2.25 million was reported in a 1989 proposal to undertake a single cycle to inspect and densify the conventional coordinate control system in a five year maintenance rotation plan. The proposal was rejected as too costly. The cost of establishing the new Nova Scotia High Precision Network on the other hand is estimated at $750,000.

With the increased use of new technology, such as GPS and the introduction of redefined datums upon which the network is based, a review of the overall system is in order. The use of new technology significantly increases the precision with which the positions of control points can be measured. These two developments have prompted the Province to consider establishing a new network (the NSHPN) upon which the Nova Scotia Coordinate Referencing System will be based. In the long run, the new network is expected to result in significant cost savings over maintenance of the old system.

Components of the total system will be referred to collectively as the Nova Scotia Coordinate Referencing System (NSCRS).

2.0 Policy Goal

To provide a Coordinate Referencing System for the Province of Nova Scotia as the foundation for all positional geographic information uses

The Province of Nova Scotia has developed a comprehensive network of control points for use in referencing geographic features to a specific location on the ground. The network, commonly referred to as the Nova Scotia Coordinate Control System (NSCCS), does not meet current state of the art accuracy standards. Developments in survey technology that provide greater accuracy, together with redefinition of the datums which underpin the network, dictate a need for change and

the requirement to implement a new network which embraces this new technology. This new network is referred to as the Nova Scotia High Precision Network (NSHPN) to differentiate between the two networks. Both networks (the new NSHPN and the existing NSCCS) together with their databases, products, etc. will be referred to as the Nova Scotia Coordinate Referencing System (NSCRS).

3.0 Implementation of Policy Statements

3.1 To adopt the Nova Scotia High Precision Network (NSHPN) as the new coordinate referencing network for use by geographic information users in the Province

The existing coordinate referencing network, commonly referred to as the Nova Scotia Coordinate Control System (NSCCS), was developed between 1968 and 1981, and consists of a network of more than 23,000 control points. The network has been used and has served its users well over the years, but it had not been formally adopted as the official coordinate referencing network by the Province. In the years since the completion of the NSCCS, developments in survey technology accuracy, in combination with improvements to vertical and horizontal datums and other developments, suggest the requirement for modifications to the network.

In the "Report of the Task Force on Control Surveys in the Maritime Provinces," it is recommended that the Province implement a new referencing network on which to base its coordinate referencing system. This recommendation is based on the improved survey capability and the accuracy possible through the use of new technology, associated with Global Positioning Systems (GPS), as well as redefinition of the datums which form the base for the existing referencing network. GPS technology permits determination of accurate geographical positioning quickly and economically over relatively long distances. It is anticipated that most jurisdictions in North America, and internationally, will be adopting the new datums. For Nova Scotia not to adopt and use the new technology and datums would leave it out of step with the rest of North America and the world.

The Province has participated in establishing a new coordinate referencing network which will permit it to use GPS technology. In cooperation with the federal government and the other two maritime provinces, the Province has established four high precision control points forming part of the Canadian Base Network (CBN). These control points form part of national and international networks. In conjunction with this work, the Province established fourteen additional "secondary" (provincial) control points evenly distributed throughout the Province. These control points together with the four CBN control points, can be considered the Nova Scotia component of the CBN. With the establishment of this new network, the new vertical and horizontal datums, and the use of new technology; there is a requirement to implement a new coordinate referencing network for the Province. The Province should adopt an incremental approach to the establishment of the

new coordinate referencing network to be known as the Nova Scotia High Precision Network (NSHPN).

The transition to a new network will require that two networks (the new NSHPN and existing NSCCS) be maintained in parallel until the new network is fully operational. In addition, numerous actions will be required to facilitate the transition. Some of these include:

- densification of NSHPN (the Nova Scotia component of the CBN) from the current 18 control points, to perhaps 150, in order to provide easy access to the network from all areas in the Province;

- development and maintenance of a database of transformation vectors, between the new coordinate referencing network and the existing network. The transformation vectors will be obtained through observations using the new network, and used to facilitate conversion of coordinate values between the two networks;

- encouragement of training for government survey staff and others, in the use and application of the new technology, the networks, the system, etc.

RECOMMENDATIONS:

It is recommended that:

- *the Province adopt a new coordinate referencing network; and*

- *the network be named the Nova Scotia High Precision Network (NSHPN).*

3.2 To maintain the existing network as a reference network during the transition to the NSHPN

During the transition from the NSCCS to the NSHPN, it is imperative that the two networks be operated in parallel. This implies that the NSCCS will not be allowed to deteriorate during that time, but will be maintained as at present, until such time as the NSHPN is in place and operational; and until appropriate technology is in general use among practicing land surveyors.

There are two types of maintenance required to support the NSCCS: physical and mathematical.

Physical maintenance includes analysis of the network to ensure that it continues to meet the needs of its users; field inspection; and if required, placement / replacement of new/ disturbed or destroyed control points.

Mathematical maintenance includes mathematical adjustment to the coordinate values of individual control points to integrate them into the network; maintenance and upkeep of the associated databases; distribution of data to users, and remaining current with developing technology.

The mathematical maintenance can be done only at the central office responsible for maintenance of the database: at present the Nova Scotia Geomatics Centre, Land Information Management Services Division, Department of Municipal Affairs, Amherst. The physical maintenance is usually done by regional survey staff within the Land Information Centres (LIC's). Recently, however, regional survey staff of the Departments of Natural Resources; and Transportation and Communications as well as staff from some municipalities, have cooperated with regional survey staff of the LIC's to inspect and report on the status of control points within their regions. This cooperation has greatly assisted with the maintenance of the network. Continued cooperation should be encouraged, and LIC survey staff should consult with their regional peers during the planning and priority setting process while establishing annual, regional work plans.

It will be necessary at some point to establish a target date for the complete transition from the NSCCS to the NSHPN. At that time, the NSCCS will not be "shut down," but its maintenance will be discontinued following which the network will degenerate. The target date cannot be firmly established at this time, but will be set in consultation with the survey community, so that users will be fully aware of developments within the system. Many factors will determine when this transition will take place such as: economics, efficiency, cost, and acceptance of the new technology by the survey community. This transition should be completed before the year 2005.

RECOMMENDATIONS:

It is recommended that:

- *the NSCCS and NSHPN be operated and maintained in parallel, until the formal transition to the NSHPN;*

- *the cooperation of all users of the system be encouraged to maintain the system and to plan for annual maintenance work; and*

- *liaison with the user community be maintained on a continuous basis.*

3.3 To adopt a horizontal datum for the NSCRS

With a more accurate definition of the shape of the ellipsoid of the earth, geodesists recognized the need to improve the horizontal reference datum, and have implemented a new datum. The North

American Datum 1927 (NAD27), was used initially to compute the coordinate values of the majority of the control points included in the NSCCS. In the Maritime Provinces, this datum was replaced in 1979 by the newer and much more positionally correct Average Terrestrial System 1977 (ATS77). The observations for all control points in the NSCCS were adjusted and coordinate values determined based on the ATS77 Datum. To further improve on ATS77 and to be compatible with the federal government and other provinces, Nova Scotia must now consider adoption of a revised datum.

Many of the Canadian Provinces and the federal governments of Canada and the U S A have already adopted a new datum: the North American Datum 1983 (NAD83). The Geodetic Survey Division, Natural Resources Canada has recently (1995) committed to "concentrate on the establishment and maintenance of the Canadian Spatial Referencing System (CSRS) and related standards, through international collaboration." A current realization of NAD83 (NAD83 CSRS95) is seen as an integral component of that commitment. At a meeting of staff between the Maritime Provinces and the Geodetic Survey Division in Fredericton, May 25 and 26, 1995, it was agreed that the three Maritime Provinces would adopt NAD83(CSRS95) as the new horizontal datum, subject to a commitment by the Geodetic Survey Division to support this realization of NAD83.

RECOMMENDATIONS:

It is recommended that:

- *Subject to a commitment of support from the Geodetic Survey Division, Nova Scotia will adopt NAD83(CSRS95) as the provincial horizontal datum; and*

- *the new coordinate referencing network (NSHPN) be based on the NAD83(CSRS95) datum.*

3.4 To adopt a vertical datum for the NSCRS

In addition to redefining the horizontal datum, the federal government is adjusting the vertical datum. This process is underway, but may not be sufficiently advanced for adoption for several years. In the interim, the Province should adopt the present Canadian Geodetic Vertical Datum as the provincial standard and be prepared to consider implementation of a readjusted federal vertical datum such as the North American Vertical Datum 1988 (NAVD88) upon its completion. It is not essential that the horizontal datum and vertical datum be implemented at the same time.

RECOMMENDATIONS:

It is recommended that:

- *the Province of Nova Scotia officially adopt the present Canadian Geodetic Vertical Datum as the provincial vertical datum; and*

- *when and if the federal government establishes NAVD88 or another new vertical datum, at that time consideration be given to adopting that datum.*

3.5 To adopt a projection system for the Province

Nova Scotia has produced its mapping using a 3E Modified Transverse Mercator projection (3EMTM). The projection system adopted by the federal government for national coverage is the 6E Universal Transverse Mercator projection (6EUTM). Conversion is necessary if data is to be exchanged between the two systems.

There continues to be an increase in the amount of data exchanged between federal and provincial governments. Recent reductions to federal budgets indicate that this data exchange will increase even more as both levels of government seek to reduce costs and avoid duplication of effort. Because more data can now be exchanged more easily, and because of the increasing use of GIS technology, the data conversion problem encountered with the use and transformations of different projections has become more widespread.

A number of options were considered by the Task Group to remedy this problem, including adoption of an oblique transverse mercator projection. Due to issues of compatibility, convention and general user experience these options were discarded. To facilitate exchanges of data and to accommodate the problem presently encountered in displaying complete provincial datasets using the present 3°MTM projection; it is recommended that the Province adopt the 6°UTM projection as its official map projection.

When the new projection system is adopted, it should be implemented at the same time as a new horizontal datum to minimize inconvenience and disruption to users of geographic information.

RECOMMENDATIONS:

It is recommended that:

- *the Province of Nova Scotia adopt the 6EUniversal Transverse Mercator projection as the official map projection system for use in the Province; and*

- *the adoption of the new projection system and the horizontal datum be implemented at one time, so that major users are inconvenienced as little as possible.*

3.6 To establish standards and specifications for the NSCRS

All systems and databases require standards and specifications to ensure that the data and other products generated are of consistent quality and accuracy, and are uniform across the Province. The standards and specifications must be established, documented, implemented and used to ensure that a consistent coordinate referencing system is available. The NSCRS serves the public of the Province, therefore, government must accept responsibility for the quality of its standards and specifications, and for their consistent and continuous application. Some of the areas for which standards, specifications, procedures and guidelines must be established and documented include:

Data: Data must be collected, processed, analyzed, stored, maintained and disseminated. Transformation vectors must be calculated, verified and recorded for future use. Data values must be converted between the networks; from the existing network NSCCS, to the new network NSHPN, and vice versa.

Global Positioning Systems: GPS technology, its use, data processing, analysis, adjustment and archiving must meet established provincial standards. Field survey procedures, applications for use: e.g. use on property surveys, and other issues, must be specified.

Field Procedures: The control points which form the foundation of the networks must be established to exacting specifications in terms of site selection, their construction and the determination of their precise position. The same will be true for control points established to densify the NSHPN or for Active Control Points, if established. A standard set of field procedures must be established for maintenance of the NSHPN.

RECOMMENDATIONS:

It is recommended that:

- *the Nova Scotia Geomatics Centre, in cooperation with the Nova Scotia Committee on Standards for Geographic Information; establish, document and maintain standards and specifications for the NSCRS; and*

- *as a cost saving measure, and since many of the standards and specifications required by Nova Scotia will be similar to those required by the other Maritime Provinces, cooperative efforts should be undertaken to develop them jointly with New Brunswick and Prince Edward Island .*

3.7 To employ appropriate technology to maintain the integrity of the NSCRS

Continued development of the NSCRS will be required: densification of the NSHPN; observations

to obtain and record transformation vectors between the new and existing networks; the possible establishment of a validation network to test equipment and procedures; and development of transformation software packages to facilitate use of the system.

Development and maintenance of the NSHPN will require the use of new technologies. These technologies will improve upon conventional procedures for surveying. One of these is Global Positioning Systems (GPS) technology. GPS can provide greater positional accuracy than can now be attained using conventional survey procedures, and it can be more efficient and possibly less costly to use over the long term.

The Global Positioning System includes a constellation of approximately two dozen earth orbiting satellites, maintained by the US Government, which transmit locational signals on a continuous basis. To determine new positions using GPS technology, receivers read locational signals transmitted from four or more of the satellites. With these signals and measurements from the high precision control points established through the CBN, it is possible to determine very accurate locations for the position of any feature on the ground. GPS technology requires a less dense network of accurately measured control points to support a coordinate referencing system (1,000 or fewer control points as compared with the more than 23,000 required to support the present NSCCS). A GPS supported system should, therefore, be less costly to maintain and can provide accurate measurements for ground features over relatively long distances.

Use of GPS technology can be based on either "active" or "passive" control points. "Active" control points require placement of GPS receivers at strategically located control points throughout the Province. These receivers operate continuously, or on request, and constantly receive signals from the satellite and transmit signals from a known position (preferably from one of the established CBN control points). Use of "active" control points reduces the time and cost to individual users to determine a required position. There are, however, considerable cost and other liabilities associated with the establishment of "active" control points. At this time it is suggested that the Province's use of the GPS technology be restricted to "passive" control points only, and that the establishment of active control points may provide a business opportunity for the private sector.

Appropriate technology and professional staff are essential to support and implement any high technology system. Not only must today's appropriate technology be used, but also staff must be aware of, or participate in the current research and development of tomorrow's technology. Training, through participation in workshops, conferences and development projects will ensure that staff, and the system, remain current with technological development; and that plans can be made to employ these innovations in a timely manner.

Such expertise can be maintained in-house or contracted through the private sector or academia. Having acquired this expertise there is an obligation on government to share it with its client users to ensure that its benefits accrue to the general public of the Province. This can be accomplished through workshops by and for the user community, to ensure that they are fully aware of the

complete range of services and products available through the NSCRS.

RECOMMENDATIONS:

It is recommended that:

- *GPS technology be used to develop and maintain the NSCRS;*
- *at present, "passive" control points be used to support the NSCRS:*
- *the private sector and academic community be utilized whenever possible to improve the NSCRS.*

3.8 To facilitate and encourage the use of the NSCRS

The NSCRS must be well maintained, documented and easily accessed by its users. The system must be robust; its databases accurate, current and easy to use. Users must be encouraged to use it and to report perceived weaknesses or shortcomings.

Government can set an example for the survey community by requiring that cadastral survey work carried out or contracted by government is referenced to the NSCRS. The agency responsible for the NSCRS must liaise with the survey community on a continuous basis to promote use of the system and to require that survey work be referenced to the System. In this way the major users of the system will be involved in its maintenance to the mutual benefit of all.

Appropriate education and training services should be made available to users to facilitate and encourage use of the new system.

RECOMMENDATIONS:

It is recommended that:

- *cadastral surveys carried out or contracted by government be required to be referenced to the NSCRS.*

3.9 To adopt legislation governing use of the NSCRS.

The current system, the NSCCS, had not been formally adopted as the official coordinate referencing system for the Province. Although most land surveyors in the Province have accepted

and used the system, there was no requirement to do so. Indeed in many instances it would have been difficult and expensive to reference some surveys to the system. With the adoption of the new system, the NSCRS, it must be mandatory to reference cadastral surveys to the system, otherwise the Province will be required to support two or more coordinate referencing systems. It is recommended, therefore, that legislation be enacted to ensure that the NSCRS is the official coordinate referencing system for the Province, and that it be so recognized by the user community.

RECOMMENDATIONS:

It is recommended that:

- *the NSCRS be adopted as the "official" coordinate referencing system for the Province through legislation such as "An Act Respecting the Establishment of a Coordinate Referencing System for the Province."*[2]

[2] A similar act "An Act Respecting the Establishment of a Survey System for the Province" was introduced in 1971, but has not been proclaimed by the Province.

APPENDIX A

A Coordinate Referencing Policy for the Province of Nova Scotia

DEFINITIONS

Active Control Point Active control points require placement of GPS receivers at strategically located control points throughout the Province. These receivers operate continuously, or on request, and constantly receive signals from the satellite and transmit signals from a known position (preferably from one of the established CBN control points).

Canadian Spatial Referencing System (CSRS) A term used to define the Canadian federal government's coordinate referencing system.

Control Point A permanently fixed point on the ground with mathematically adjusted 3 dimensional positional values used to accurately reference information to the earth. Physical characteristics of a control point may vary from a metal stake in the ground to a marker set in concrete or bedrock to a brass plate embedded in a pillar. Also referred to as a grid monument or Nova Scotia Control Monument (NSCM) or Survey Control Point.

Densification refers to the establishment of additional control to improve the network due to an insufficient number of control points to meet the needs of users.

Destroyed refers to control points, which have been either physically "destroyed" or disturbed in such a manner as to render their coordinate values unreliable: and the control points no longer useful to the system.

Geographic Information System(GIS) An organized collection of computer hardware, software and procedures designed to support the capture, management, manipulation, analysis, modelling and display of spatially referenced data for solving complex planning and management problems.

Geo-Spatial as used in this context, refers to geographic data or information which is areal in extent, and is geographically referenced to a specific point on the ground through a network of control points.

Global Positioning Systems (GPS) A Global Positioning System includes a constellation of approximately two dozen earth orbiting satellites, maintained by the US Government, which transmit locational signals on a continuous basis. To determine new positions using GPS technology, receivers read locational signals transmitted from four or more of the satellites. With these signals and measurements from known high precision control points, it is possible to determine very accurate locations for the position of any feature on the ground.

Nova Scotia Coordinate Control System (NSCCS) A term used to describe the network of Nova Scotia coordinate control points referenced to the NAD27 datum and those referenced to or subsequently converted to the ATS77 datum and their associated databases.

Nova Scotia Coordinate Referencing System (NSCRS) A term used to describe the coordinate referencing system proposed for the Province of Nova Scotia, in its entirety, including the NSCCS, the NSHPN and the associated databases and products.

Nova Scotia High Precision Network (NSHPN) A term used to describe the network of Nova Scotia coordinate control points referenced to positional values determined from the new Canadian Base Network (CBN) (this may include some control points included in the former NSCCS, if their new CBN positional coordinates have been determined to an appropriate standard) and its associated databases.

Passive Control Point A passive control point is one that has had its precise coordinate values previously measured using GPS technology. This control point can be used as a reference while utilizing the GPS technology.

Projection Because the earth is ellipsoidal, it is impossible to portray it on a flat surface (a paper map) in a manner which does not distort either shape, distance or direction. To overcome this problem a projection system must be selected which best meets the needs of the shape of the Province and the intended use of the mapping.

Replace refers to the placement of a new control point where one has been "destroyed" and/or its survey to establish positional values for its location.

Survey means a survey to define an accurate geographic position for a land feature, property boundary, etc.

Definition of Acronyms:

ATS77 - Average Terrestrial System 1977: a horizontal datum upon which calculations were based to determine the value of coordinates of control points.

CBN - Canadian Base Network: A High Precision Network 1995 (see also HPN).

GPS - Global Positioning System: is a constellation of approximately two dozen earth orbiting satellites which transmit locational signals. GPS is a technology through which accurate positional control point coordinates can be determined through readings received from the network of satellites, and related to other control points with known values.

GSD - Geodetic Survey Division of the Geodetic Survey of Canada: a sub unit of Natural Resources Canada (formerly the Department of Energy, Mines and Resources Canada).

HPN - High Precision Network 1995 (see also CBN).

MTM - Modified Transverse Mercator: a 3E mapping projection used by the Province of Nova Scotia.

NAD27 - North American Datum 1927: a horizontal datum upon which calculations were based to determine the value of coordinates of control points.

NAD83 - North American Datum 1983: a horizontal datum upon which calculations are based to determine the value of coordinates of control points.

NAVD88 - North American Vertical Datum 1988: the datum upon which calculations of vertical "H" values (elevations) may be based.

UTM - Universal Transverse Mercator Projection: a 6° mapping projection used in federal mapping (e.g. for National Topographic System maps at scale 1:50,000)

APPENDIX B

A Coordinate Referencing Policy for the Province of Nova Scotia

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RECOMMENDATIONS FROM "REPORT OF THE TASK FORCE ON CONTROL SURVEYS IN THE MARITIME PROVINCES"

Note:

In the Fall of 1992 the New Brunswick Geographic Information Corporation (NBGIC), Nova Scotia Department of Municipal Affairs and the Prince Edward Island Department of Finance co-sponsored a Task Force Study on Control Surveys in the Maritime Provinces. The completed task force report made recommendations focusing on the need to establish a new coordinate referencing system to meet the needs of the 21st century.

The Task Force recommendations have not yet been formally considered and adopted as policy by Nova Scotia and Prince Edward Island, but New Brunswick has formally accepted the recommendations. There is widespread agreement, however, that Global Positioning Systems technology will be the technology of choice in the near future.

A key statement in the Report advised that the Geodetic Survey of Canada has proposed to have a High Precision Network (HPN) completed across Canada by 1995. The HPN is intended to improve the horizontal accuracy of the system and to facilitate the use of the new Global Positioning System (GPS) technology. The federal government is prepared to do the observation on 10-12 Primary HPN points in the Maritimes Provinces if the provinces are prepared to do the site selection and construction of the primary HPN points within their individual provinces. The federal timetable requiring that the HPN points within Nova Scotia be constructed by the fall of 1993 was met by the Province, and preparations are currently underway for a 1994 observation campaign.

The following recommendations concerning the Nova Scotia Coordinate Referencing System are quoted directly from the **Report of the Task Force on Control Surveys in the Maritime Provinces**:

1. The Value of a Survey Control Framework

Recommendation

The government in each province must continue to maintain an effective survey control framework.

2. Maintenance

Recommendations

Physical maintenance. Recognizing that the importance of conventional survey control markers will be diminishing as the new technology is phased in, the cooperation of the user community in reporting the condition of control points and in establishing *"interim"* control should be encouraged.

Mathematical maintenance. Recognizing that the existing database is the foundation for the transformation vector database, it is recommended that support for the mathematical maintenance programs be continued.

3. Design an Implementation Plan for a Survey Control Framework for the Twenty-first Century

Recommendations

Start preparations immediately on the design of a completely new GPS-based reference framework tied to the GSD's High Precision Network. It is suggested that this be called NAD 83 (HPN95).

Retain and maintain the ATS 77 reference framework until the new NAD83 (HPN95) framework is in place and until geodetic quality GPS receivers are in general use among practicing land surveyors. It is expected this would occur about the year 2000.

Request that the GSD establish a primary High Precision Network of 10 or 12 points in the Maritimes. The Provinces should cooperate with the GSD on this project. These points would be the foundation for NAD83 (HPN95), the horizontal survey control framework for the twenty-first century.

Prepare to establish and maintain a regional High Precision Network. Initially some 20 to 30 regional HPN points would be established, and the resources would be made available to add points as required. The objective of the regional HPN program should be to have at least one point in every sizeable population centre. Ultimately, there are likely to be more than 100 HPN points in the region.

Build a database of observed transformation vectors for converting NAD27 and/or ATS 77 coordinates to NAD83 (HPN95) coordinates. This database must be supported by observations and computation. It is estimated that it will take at least five years to build a transformation vector database, and it is likely that it will be needed for at least ten years after that.

Define a *"transition period"* during which survey plans could be submitted either in the ATS 77 framework or the NAD83 (HPN95) framework. This period could start a few months after the HPN is in place, hopefully early in 1995, and continue until the year 2000 ± 2 years when the new framework would become the official framework.

Train or recruit a GPS specialist for the long term. For the short term, it is suggested that the provinces contract for expertise as required.

Develop standards and guidelines for the use of GPS on property surveys. It is suggested that the provinces collaborate on this task.

4. Related Technical Issues

Recommendations

Maps at the scale of 1:10,000 and smaller be compiled on the UTM projection with the UTM grid the dominant grid and the MTM grid the secondary grid; and

Maps at the scales larger than 1:10,000 be compiled on the MTM projection with the MTM grid the dominant grid and the UTM grid the secondary grid.

5. The Vertical Datum

Conclusion and Recommendation

It is apparent that, at least for the next two or three years, New Brunswick and Nova Scotia can consider NAVD 88 as a *"scientific analysis"*. If the Geodetic Division does decide to make NAVD 88 the *"official"* datum, then the situation should be reviewed again.

6. Integrated Surveys (Note: Applies to New Brunswick only)

APPENDIX C

A Coordinate Referencing Policy for the Province of Nova Scotia

CONTROL SURVEYS TASK GROUP

Membership

A Control Surveys Task Group was established under the Land Information Systems Advisory Committee of the Nova Scotia Land Use Committee, to recommend a draft policy on this topic. Members of the Task Group are listed below:

- K. AuCoin, Department of Natural Resources
- M. Banks, Department of Natural Resources
- K. Caines, Department of Transportation and Communications (part)
- G. Clarke, Department of Natural Resources (retired)
- B. Fay, Nova Scotia Land Use Committee (Secretary)
- A. Flemming, Department of Municipal Affairs (part)
- W. Franklyn, Department of Transportation and Communications (part)
- P. Kittilsen, Department of Municipal Affairs (Chair)
- B. Robertson, Department of Municipal Affairs
- D. Rushton, Department of Transportation and Communications (part)
- D. Rice Smith, Department of Transportation and Communications (part)
- R. Snair, Department of Transportation and Communications (part)
- W. Thompson, Department of Municipal Affairs