ASSOCIATION OF
NOVA SCOTIA LAND SURVEYORS

NAD83 User Guide

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LIST OF ACRONYMES

ACS	Active Control Station
ATS77	Average Terrestrial System of 1977
CGVD28	Canadian Geodetic Vertical Datum of 1928
CGVD2013	Canadian Geodetic Vertical Datum of 2013
CSF	Combined Scale Factor
CSRS	Canadian Spatial Referencing System
EDM	Electronic Distance Measurement
GNSS	Global Navigation Satellite System
MTM	Modified Transverse Mercator
NAD27	North American Datum of 1927
NAD83	North American Datum of 1983
NRTK	Network Real Time Kinematic
NSACS	Nova Scotia Active Control Stations
NSCCS	Nova Scotia Coordinate Control System
NSCM	Nova Scotia Control Monument
NSCRS	Nova Scotia Coordinate Referencing Systems
NSHPN	Nova Scotia High Precision Monument
PPP	Precise Point Positioning
RTK	Real Time Kinematic

CHAPTER 1

Introduction

The purpose of this user guide is to help members of the Association of Nova Scotia Land Surveyors (ANSLS) use and integrate the North American Datum of 1983 (NAD83) into their daily work. The NAD83 reference system has been available to surveyors within the province since the late 1990's. The Nova Scotia High Precision Network Monuments (NSHPN) were observed using Global Navigation Satellite Systems (GNSS) and coordinates were made available to users at that time. Until recently the system did not receive much uptake in survey work due to the distance between the monuments (~20 km) and the lack of GNSS users. Many provincial government data layers were migrated from the Average Terrestrial System of 1977 (ATS77) to NAD83 at this time.

Since 2012, the Province of Nova Scotia has began installing permanent Active Control Stations throughout the province, forming the Nova Scotia Active Control Stations (NSACS) network. These stations combined with a denser NSHPN network have reinvigorated the migration of survey work to NAD83 in the province. One of the main purposes of this infrastructure has been to address ongoing accessibility needs to the Nova Scotia Coordinate Referencing System (NSCRS). Surveyors are required to show a control tie to one or more Nova Scotia Control Monuments (NSCMs). Decaying NSCM infrastructure from the Nova Scotia Coordinate Control System (NSCCS) has made it difficult to fulfill the requirement.

The use of GNSS has revolutionized the way land surveyors and other users perform their daily work. The issue with the NSCCS based on ATS77 is that it is not compatible with GNSS.

The NSCCS was established using terrestrial (conventional) based methods. With the widespread use of GNSS, and specifically Real Time Kinematic (RTK) technology, errors have been observed throughout the NSCCS.

As with any industry, the adaptation to new technologies is the key to success and growth. With the NSACS and expanded NSHPN infrastructure in place, the switch from ATS77 to NAD83 has been made possible to surveyors and other users of the system. The purpose of this guide is to provide some direction on how to implement the NSCRS in surveying workflows and to illustrate how making the transition will improve the survey fabric throughout the province.

CHAPTER 2

Why Make the Switch?

This chapter will explain the rationale in switching from ATS77 to NAD83. It is realized that for nearly 35 years, surveyors in the province have been tying their surveys to the NSCCS, based on ATS77. When the NSCCS was rolled out to supersede the North American Datum of 1927 (NAD27) apprehension also existed. At that time, some individuals felt that a compass was the only tool needed to reference a bearing and that using "control monuments" meant more time in the field, more effort and more cost for the client.

No one can disagree that tying a survey to control does require more effort, but the benefits gained by the profession far exceed the added work. Today, all surveys in the province are required to be tied into the Nova Scotia Coordinate Referencing System (NSCRS).

2.1 The ATS77 Based NSCCS

The Average Terrestrial System of 1977 datum is unique to the Maritimes. The ATS77 datum was established by modeling the Earth's size, shape and centre of mass by the use of theodolite and Electronic Distance Measurement (EDM) observations made during the 1960s and 1970s. The specific implementation of ATS77 in Nova Scotia is referred to as the NSCCS. Due to the limitations of this technology over long distances, errors propagated more through the network than they do with GNSS technology. With new GNSS technology, errors and distortions within this datum have become more apparent over the last decade.

2.2 NAD83

The North American Datum of 1983 is not unique to Nova Scotia. All provinces and territories in Canada have adopted NAD83. The current version of NAD83 in Nova Scotia is specifically known as NAD83(CSRS) Epoch 2010.0. Previous versions of the datum like NAD83(Original) were again based on terrestrial observations, much like ATS77. The Canadian Spatial Referencing System (CSRS) is based on GNSS observations which provides the most accurate model of the Earth to date. NAD83(CSRS) is endorsed by the Canadian Council of Geomatics and is the best choice when conducting GNSS surveying.

The epoch of the datum is also important. Due to the fact that a GNSS receiver provides positions based on a global scale, tectonic plate movements can now be quantified. As the plates move over time, monuments set in the ground also move with them. The global coordinates of these monuments will change as time passes. The purpose of noting the epoch provides a time stamp on a monument as where is was positioned on the Earth's surface at a particular time. Currently the NSACS broadcasts coordinates in Epoch 2010.0. For more details regarding NAD83 please visit NSCRS Tech Support at: http://geonova.novascotia.ca/coordinate-referencing-technical-support.

2.3 Modified Transverse Mercator (MTM) Mapping Projection

The most common surveying mapping projection used in Nova Scotia is the 3º Modified Transverse Mercator Projection (MTM). Throughout Nova Scotia, this projection is divided into 2 zones which cover the majority of the province (Zone 4 & Zone 5). The mapping projection dictates bearings illustrated on survey plans. The MTM projection has been in use in

Nova Scotia since the implementation of the NSCCS. With the transition to NAD83, the MTM mapping projection can still be used and is recommended for survey work. This will enable a direct comparison of bearings shown on ATS77 plans versus new NAD83 plans. For more details regarding mapping projections used in the province please visit NSCRS Tech Support at: http://geonova.novascotia.ca/coordinate-referencing-technical-support.

2.4 Vertical Reference Systems

A vertical reference system is simply the height reference used when illustrating elevations on an engineering or survey plan. The typical vertical reference system used throughout the province is the Canadian Geodetic Vertical Datum of 1928 (CGVD28). This vertical datum was established in 1935 as the official height referencing system in Canada. NSCCS heights were based upon CGVD28 derived from levelling and trigonometric heighting. Since the implementation of the NSCCS, elevations used in engineering and surveying plans were usually derived from a specific NSCM's published elevation.

In 2013, the Canadian Geodetic Vertical Datum of 2013 (CGVD2013) was adopted as the official height referencing system in Canada. The difference between CGVD28 and CGVD2013 is approximately 0.60 metres throughout the majority of the Province, but is dependant on your geographic location. CGVD2013 is based on satellite gravimetric observations whereas CGVD28 was based on leveling techniques as noted above. CGVD2013 works seamlessly with the new Nova Scotia High Precision Network (NSHPN).

All new work completed in the province is recommended to be conducted using the new CGVD2013 vertical datum. For more details vertical reference systems used in the province please visit NSCRS Tech Support at:

http://geonova.novascotia.ca/coordinate-referencing-technical-support.

2.5 Advantages and Disadvantages

There are many advantages to making the switch to NAD83. Simply put, once a survey is conducted in NAD83, it can be transformed into virtually any other coordinate system. This is an important point, as ATS77 surveys can not. The NSCCS was established using terrestrial observations and subsequent surveys were tied into these monuments. Since the implementation of GNSS over the past 20 years, discrepancies in the NSCCS monuments have become apparent.

Surveys tied to the NSCCS run the risk of suffering from so much distortion as to be inconsistent with coordinate values across the rest of the province. In this scenario, the survey is tied into a brass plug set in a pillar of concrete that has a published coordinate value from 30+ years ago. If you were to traverse a kilometre or more between these monuments, you will eventually see discrepancies between measured values and the published values for surrounding monuments. This is in part due to the methodology used to establish these monuments and the fact that some of these monuments have moved or have been disturbed over time. In order to re-establish a survey that was conducted using the NSCCS, you would be required to use the same monument as the previous survey. If that NSCM is destroyed, the connection to historic survey work is lost.

When a survey is tied into the NAD83 based NSHPN, it is tied into a provincially controlled and updated system. This means any survey that has been tied into this system can be coordinated using any of the High Precision Network Monuments located throughout the province. NAD83 is completely GNSS compatible and as such the survey could be independently verified using local base/rover, network RTK or absolute GNSS techniques with millimetre level accuracy.

A common practice when conducting a GNSS survey using a NSCCS Monument is localization (site calibration). This simply forces the GNSS receiver to hold a published value on the brass plug that you are setup over. In reality, you have degraded your GNSS solution to a system that is not GNSS compatible. Localization (site calibration) is not required when conducting a NAD83 survey.

The bearings on a historical survey tied into the NSCCS are based on the published values for the monument that the surveyor was setup over and the other monument as their back sight. As noted earlier, the actual bearing between these monuments may differ if you were to observe them using a GNSS receiver (i.e. terrestrial observations vs. GNSS observations). Most surveyors conducting a GNSS survey using the NSCCS carry out a site calibration on one monument and usually check into another. When control is set at the site of survey, it is no longer based on the published bearing between these 2 NSCCS monuments, rather by the mapping projection set in your GNSS controller. With that being said, you have fixed your position to only one specific NSCCS monument and your bearings are then derived from GNSS observations. When using NAD83, your GNSS is completely compatible with any Nova Scotia

High Precision Monument. You are not required to use a specific monument as the system is uniform throughout the province and works seamlessly with NSACS derived positions.

CHAPTER 3

NAD83 Project Preparation

This chapter will explain how to setup up your project before heading out to the field. There are a multitude of variations on how surveyors can do this. This chapter will focus on GNSS controller setup, coordinating an ATS77 plan (worksheet) and NSHPN monument reconnaissance using the NSCRS Viewer.

3.1 Controller Setup

One of the most important factors in completing a NAD83 survey is to have your GNSS controller setup properly. There are many brands of controllers and receivers, all having specific data inputs regarding datums, mapping projections and vertical reference frames. If the user feels confident setting up their own templates for NAD83 within their controller, it is recommended to conduct a field test ensuring the results are favourable. This would simply be an observations on 2 or more existing NSHPN Monuments with favourable results. If a user does not feel confident, it is recommended to contact your service provider or distributor to have them prepare a template for you.

3.2 Coordinating an ATS77 plan

As with all surveyors, the first step is often reviewing your subject property within Nova Scotia Property Online. This on-line tool provides property details including deeds, burdens, benefits as well as previous recorded survey plans. The majority of these survey plans are referenced to the NSCCS monuments. As there is no absolute translation between ATS77 and

NAD83, the provincial grid shift file provides surveyors with a tool to approximate this translation.

3.2.1 Using GeoNova's Coordinate Transformation Web Service

Since the previous survey plan was tied into the NSCCS monuments, the mapping projection used is the 3º Modified Transverse Mercator (MTM) by default. This mapping projection can be used in conjunction with the NAD83 datum so the bearings illustrated on the plan will be referenced to the same North. Since the bearings are relatively the same, the only translation is the starting point, which in this case is the NSCCS monument.

Using GeoNova's Coordinate Transformation Web Service, the user can transform between ATS77 coordinates and NAD83 coordinates (metric only) using the provincial grid shift file. Simply input the ATS77 published value for the NSCM used into the tool and transform the value to a NAD83 coordinate. This service can be found at http://gis1.nsgc.gov.ns.ca/sns_webclient/.

The output from the online tool will provide the user with an approximated NAD83(CSRS) coordinate in Epoch 1997.0. As noted earlier in this guide, the epoch used in the current NSACS is NAD83(CSRS) Epoch 2010.0. The difference between these 2 epochs is generally 0.03 metres across the province. If the user requires another shift between epochs (1997 to 2010), this can be done using Natural Resources Canada online tool TRX, which can be found at http://webapp.geod.nrcan.gc.ca/geod/tools-outils/trx.php?locale=en.

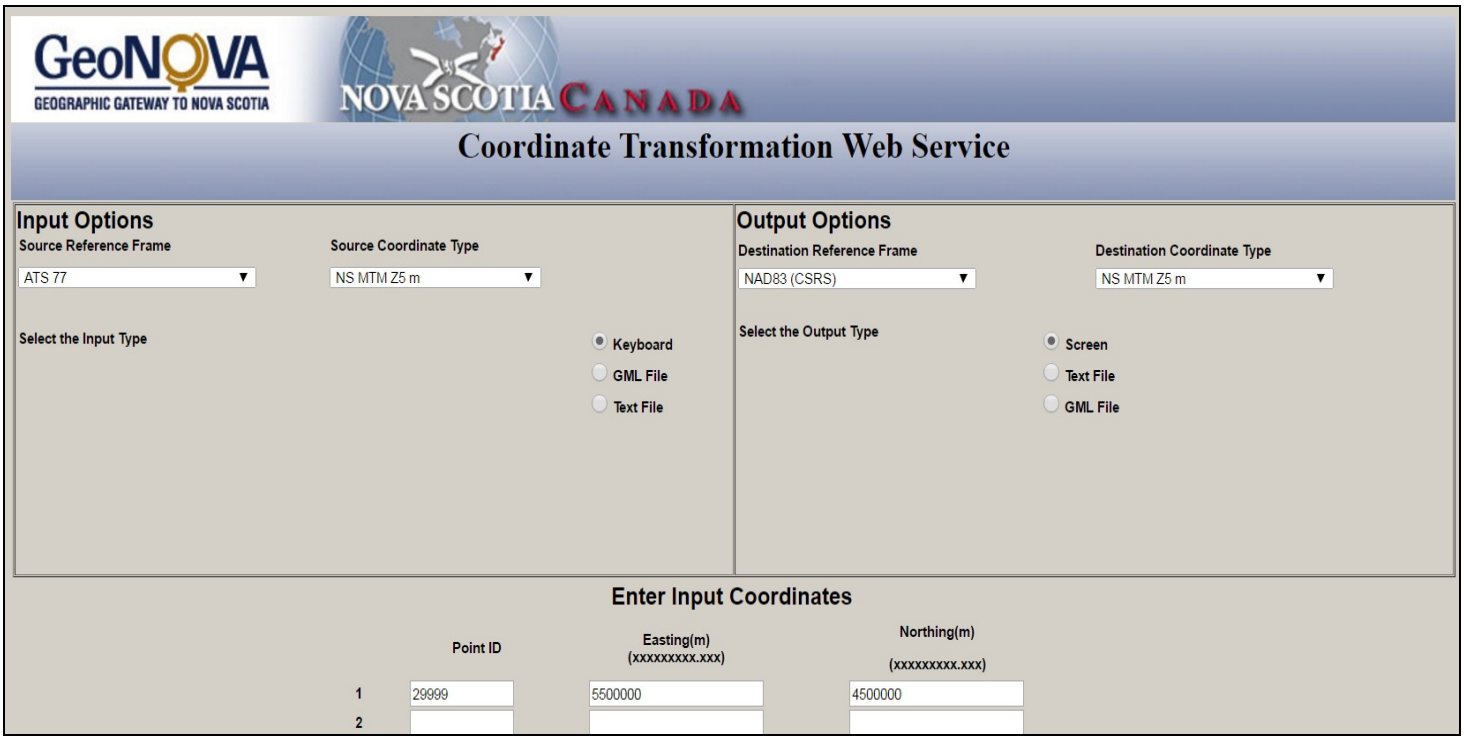

Figure 3.1 - GeoNova's Coordinate Transformation Web Service

While using the grid shift file is the only way to approximate between ATS77 and NAD83, it is not absolute. The current grid shift file will provide the user with coordinates within 0.30 metres, more or less, of the actual location. This means that if you were to input the approximated NAD83 value for the NSCCS monument in your GNSS controller (project is NAD83), you would find the monument to be within 0.30 metres, more or less. Now that the user has a NAD83 coordinate for the NSCCS monument, simply coordinate the plan from the approximated NAD83 value of the NSCCS monument using the MTM bearings and distances illustrated on the plan. As noted earlier in this guide, our NAD83 survey is also intended to use the MTM projection, so the bearings are virtually the same.

What the user should find in the field is the survey makers noted on the survey plan to be within 0.30 metres, more or less, of the coordinated value. This is dependant on the original survey's control tie and accuracies. The difference in using NAD83 compared to ATS77 in this example is that no effort is required locating the NSCCs monuments. Once a survey marker is located, the user simply observes the survey marker and provides new NAD83 coordinates for it.

3.2.2 Using provincial grid shift file in survey software

Depending on the type of surveying software a particular firm uses, often the provincial grid shift file can be implemented directly into a software package. Most survey controllers and survey grade desktop software can use the provincial grid shift file to implement approximate transformations between ATS77 and NAD83. It is recommended that a user contact their software supplier for details about integrating the grid shift file. For more details regarding Grid Shift Files please visit NSCRS Tech Support at:
http://geonova.novascotia.ca/coordinate-referencing-technical-support.

3.4 Using the NSCRS Viewer

The Nova Scotia Coordinate Referencing System Viewer is the only certified source for acquiring coordinate values for NSCCS and NSCRS monuments throughout the province. The NSCRS viewer can be found at https://gis8.nsgc.gov.ns.ca/NSCRS/. This tool enables the user to view NSHPN coordinate values, heights, sketches, photos and notes pertaining to each specific monument. This tool also provides users with historical data regarding the NSCCS monuments.

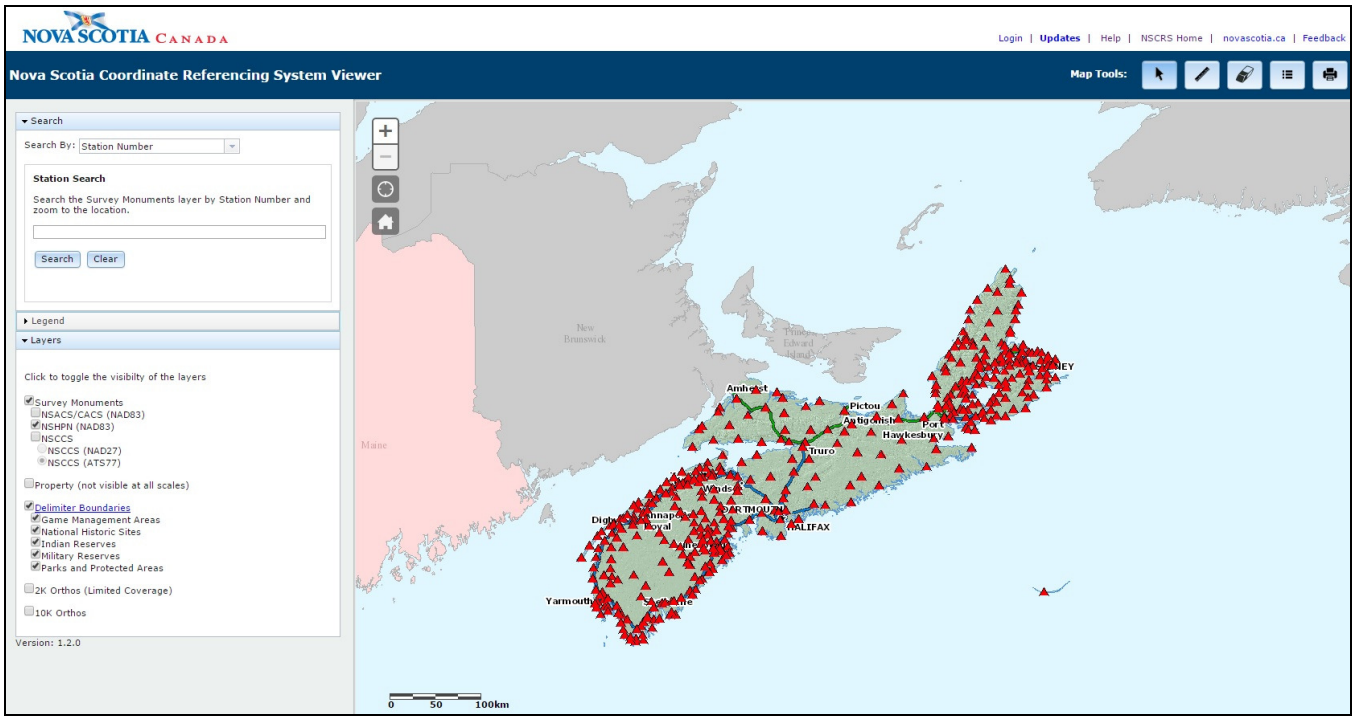

Figure 3.2 - Nova Scotia Coordinate Referencing System Viewer

This tool should be used every time a surveyor is conducting a survey in NAD83. Once the surveyor is prepared to enter the field, this tool should be used to locate the nearest NSHPN monument to their site of survey. Prior to the surveyor setting control at a site, it is recommended to perform a check measure observation on the nearest NSHPN monument. This observation will ensure that the user's GNSS controller is setup properly. Regardless of the type of GNSS system being used (Static, RTK, NRTK), the NSHPN monument is your direct physical correlation to the provincial system.

CHAPTER 4

NAD83 GNSS Surveying Types

This chapter will detail the main variations of GNSS surveying types and how to implement NAD83 while conducting a survey in the province. Depending on the land surveyor or firm, field techniques can vary widely from one end of the province to the other. This chapter is not intended to detail best practices with regards to fieldwork, rather how to implement NSHPN monuments and the NSACS network when conducting a NAD83 based survey.

4.1 NSACS Network

The 40 GNSS stations comprising the NSACS network were completely installed in Nova Scotia in 2015. Since that time, users have been able to access a sub-centimeter GNSS network with only the use of one GNSS receiver, survey controller and a mobile network signal (cell phone signal). This system, unlike any other, provides the user with real time coordinates without the limitation of a radio link or base station setup.

This system is based on NAD83(CSRS) Epoch 2010.0. In order for a surveyor to use the system to complete a survey in NAD83, the first step is to ensure that their survey controller is setup correctly. With the project open, the user simply connects to the NSACS Network through their service provider. Once connected, the user should begin receiving corrections from the NSACS Network. With the project running, it is recommended for the user to perform a check measure observation on the nearest NSHPN monument to their site of survey. Results may vary, but a residual of 0.02 metres (horizontal and vertical), more or less, should be expected.

At this point the user is receiving corrections from the NSACS network and they have ensured that the project is set up correctly on their survey controller as the observation on the NSHPN returned favorable results. At this time, the user can continue to the site to begin to survey. As the corrections received are based on the NSACS Network, there is no need for localization (site calibration). It is recommended that control at the site of survey is set so that checks can be made at the site in subsequent visits, without the need to return to the NSHPN monument.

It is recommended that the user conduct periodic observations on their control set at the site of survey to ensure the NSACS Network is providing adequate results throughout the day. If high confidence is required in vertical measurements (i.e. inverts, pipelines, etc.), the user should complete a repeat pass on the same topographic points to confirm the results (check-measure). After conducting a survey, visiting the GNSS Service Provider's website will enable the user to verify the uptime of the nearest ACS during the time of survey. This is useful as it indicates whether the nearest ACS to the site of survey was functioning properly. If the nearest ACS was not operating during the survey period, results may vary (i.e. longer baseline to next ACS).

When using the NSACS Network, it is important to remember that the NSHPN monument is your only physical link to the NSCRS. Once you have confirmed the system is working and you are receiving real time corrections from the network, you can provide real time coordinates in NAD83 to features located in the field.

4.2 Base/Rover RTK

The majority of RTK users are familiar with a Base/Rover RTK setup. To conduct a survey in NAD83(CSRS) Epoch 2010.0, a user needs only to locate a NSHPN monument near their site of survey. These monuments are generally spaced 10 kilometres apart, more or less, providing a NSHPN monument within 5 kilometres, more or less, of any site of survey.

The user needs only to setup a GNSS base receiver directly over the NSHPN monument. If radio range to the site of survey can not be maintained, the "leap frog" method can be utilized. It is also possible to deploy a base and radio link anywhere near the job site, and post process using freely available NSACS data.

4.3 Static

Surveyors in the province have been performing static surveys since the implementation of GNSS in the surveying industry. A static survey by today's standards would typically be used in remote locations, where no mobile network service is available or radio link range is limited. The methodology is no different than before, with the exception of having GNSS receivers located at NSHPN monuments rather than ATS77 LRIS monuments.

Users of the NSACS network have an advantage as they do not require their own multiple GNSS receivers running at one time during a static survey. The user would need to only setup their GNSS receiver at the site of survey for approximately 20 to 30 minutes to acquire centimeter level accuracy. This is due to the fact that there are multiple Nova Scotia Active Control Stations running throughout the province 24 hours a day. The user can simply download

from their service provider a RINEX file (GNSS raw data) during their observation time period from multiple stations or a virtual reference station near their site of survey. Using their GNSS software, a user can post process a static network using this supplied data to position NAD83 control at their site of survey.

Precise Point Positioning (PPP) is provided to the public through Natural Resources Canada and also enables surveyors to set NAD83 control at their site. PPP is simply a standalone system (Absolute GNSS – no reference station require) that enables users to submit a raw GNSS RINEX file and receive post processed results of their data within 24 hours. The only draw back from this system is that it can require lengthy observations in order to provide centimeter level accuracy. (Generally 3 hours = 3 cm, 12 hours = 1 cm, but is site dependent).

CHAPTER 5

Plan Preparation

This chapter will provide suggestions regarding the making of surveys using NAD83. As no one survey plan is the same, variations of information regarding datum and mapping projections can differ from one surveyor to another. The purpose of this chapter is to provide some input as to a suggested minimum standard of what should be shown on a plan.

5.1 Grid vs. Ground

Grid distances and ground distances are a common concern when conducting GNSS surveys. Regardless of datum, the differences between grid and ground distances in the province are often substantial. The majority of GNSS receivers measure along the grid, while total stations (terrestrial observations) measure along the ground. The important point is to understand what you are measuring and how it may influence your survey.

Most surveys completed in the province illustrate measurements as being ground distances. This is usually due to the fact that total stations have been used to measure around a site of survey. If a GNSS system was used to set control at a site, grid measurements would have been used to establish a control tie from a base point, typically a monument within the NSCRS.

As many surveyors are using both GNSS observations and terrestrial observations, the combined scale factor at the site must be implemented. The combined scale factor at the site of survey should be used to reduce or enlarge (depending on location) grid measurements (GNSS) to ground measurements (terrestrial). In most cases, the only grid distance shown on a survey

plan is the control tie from the NSCRS monument used. All other measurements, typically the boundary dimensions, are illustrated as ground measurements. Grid distances are determined by multiplying the combined scale factor at a site by the ground distance (i.e. Grid = Ground x CSF). Ground distances derived from GNSS measurements are determined by multiplying the reciprocal of the combined scale factor (1/CSF) at a site by the grid distance (i.e. Ground = Grid x 1/CSF).

5.2 Control Tie

The control tie has been the standard method of coordinating survey plans since the implementation of the NSCCS. The control tie typically illustrated a calculated (published) bearing and distance between 2 monuments and a measured bearing and distance from one of the monuments into the site of survey. Up until the late 1990's, it was apparent that all control ties were ground distances. Since the implementation of GNSS, control ties can be either ground or grid as noted earlier.

The control tie still has a relevant place in a NAD83 survey. The control tie should be from a NSHPN monument. In the case of a Base/Rover RTK or Static survey, the control tie should be illustrated from the NSHPN observed and held fixed during the course of the survey. In the case of a NSACS Network survey, the tie can be shown from the published values of the NSHPN monument checked into during the initial phase of the project. This will enable other surveyors that review your plan the opportunity to duplicate your control tie if necessary. This control tie should always be illustrated as a grid distance, as the distance from the NSHPN to the site may be in excess of 5 kilometres. The NSHPN tie also helps to verify that the NSACS

network is functioning properly in the survey area. It is not sufficient to observe a NSHPN near the survey office (away from the site of survey) as it may not reflect NSACS conditions at the site of survey. If a control tie is to be illustrated on the plan, published coordinates of the NSHPN used should be shown, its horizontal reference frame, published coordinate date and its epoch of adjustment.

5.3 Coordinate Table

A coordinate table is recommended when preparing a survey plan using NAD83. The coordinate table allows another surveyor to quickly differentiate the grid coordinates of a survey marker versus the ground distances illustrated on the plan. As noted in section 5.1, the control tie is typically illustrated showing a grid distance, while boundary dimensions are illustrated using ground distances.

The coordinate table should list the grid coordinates of a main corner(s) of a property or terminal point(s) along a boundary. This enables another surveyor using a GNSS receiver to observe the actual grid coordinates of a survey marker in real time, rather then computing the grid coordinates from the plan. A minimum of at least one survey marker at the site of survey will also eliminate rounding errors from a long control tie (i.e. 1" over 20km = 0.097m).

Grid Coordinate Table (metric)				
Point	Northing	Easting	Elevation	Description
A	4526365.215	2565231.214	30.256	S.M. (pl.)
B	4526456.263	2565592.325	41.568	S.M. (pl.)
C	4526299.692	2565219.589	32.635	S.M. (fd.) #378
225879	4527125.632	2565917.532	29.645	NSHPN (used)

Figure 5.1 - Example Grid Coordinate Table

5.4 Notes on Plan

The notes on a NAD83 survey plan should reflect what was done during the course of the survey and how coordinates were attained. As noted earlier in this guide, there are many different types of GNSS survey methods that can provide NAD83 coordinate values. For these reasons, a table is recommended to be shown on the plan to identify the GNSS survey type, the horizontal and vertical datum used, their corresponding epoch, and the mapping projection used. Shown below are examples of tables that are recommended.

GNSS Survey type:	NRTK	Source:	CanNet
Coordinate System information			
Horizontal Datum:	NAD83 (CSRS)	Epoch	2010.0
Vertical Datum:	CGVD2013	Calculated Offset Between CGVD28 to CGVD2013:	-0.64m
Projection:	3° MTM	Zone:	5
Combined Scale Factor at the Site of Survey: *1.00002354*			

Figure 5.2 - Example of NAD83 MTM survey using NSACS Network

GNSS Survey type:	PPP	Source:	NRCan
Coordinate System information			
Horizontal Datum:	NAD83 (CSRS)	Epoch	2010.0
Vertical Datum:	CGVD2013	Calculated Offset Between CGVD28 to CGVD2013:	-0.64m
Projection:	6° UTM	Zone:	20N
Combined Scale Factor at the Site of Survey: *0.999961235*			

Figure 5.3 - Example of NAD83 UTM survey using PPP

GNSS Survey type:	Static	Source:	NSCRS
Coordinate System information			
Horizontal Datum:	NAD83 (CSRS)	Epoch	2010.0
Vertical Datum:	CGVD2013	Calculated Offset Between CGVD28 to CGVD2013:	-0.64m
Projection:	3° MTM	Zone:	4
Combined Scale Factor at the Site of Survey: 0.*999995632*			

Figure 5.4- Example of NAD83 MTM survey using Static

Survey plans should always indicate whether ground or grid distances are being illustrated and how they are obtained (i.e. GNSS or Total Station). The combined scale factor at the site of survey should always be noted on the plan and also how it was applied. Examples of notes regarding the use of a combined scale factor could resemble:

"Distances shown on this plan are grid distances as derived from GNSS observations."

"Distances shown on this plan are ground distances derived from grid distances using the indicated combined scale factor."

"Distances shown on the plan are ground distances measured using a total station."

"Distances shown on the plan are ground distances using a combination of total station measurements and derived GNSS ground distances."

The former use of "scale factors applied" or "scale factors not applied" is no longer sufficient with the multitude of surveying methods available today. It is important for the surveyor to realize the values their equipment is providing and how to illustrate those values clearly on a plan of survey. This will enable the next surveyor with a clear understanding of how the measurements illustrated on a plan were derived.