Tri-County Ground Search and Rescue Group Inc.
Occasional Paper # 3

Magnetic Declination, UTM and Datum

by

Joseph LaBelle
Executive Search Coordinator

This paper has been written to provide background information on cartographic information that may be of interest for Search and Rescue practitioners. The information goes beyond the knowledge elements required for effective field navigation but is required for management positions, particularly the Planning Section Chief and the Operations Section Chief.

Ground search and rescue teams (GSARTs) rely heavily on their ability to navigate effectively. Ground search operations require a good understanding of ground navigation and the associated tools of map and compass. Often, the details of magnetic declination, the worldwide structure of the UTM grid and the difference between geodetic data are not required by the searcher.

There are, however, a number of searchers who will enjoy learning about these topics. There are also circumstances where detailed background knowledge is useful to search management. This paper is for those who would like to further their understanding of these topics.

This document explores three topics relevant to navigation and cartography: magnetic declination, the background of UTM grids and the datum used on different maps.

Magnetic Declination

Magnetic declination is a measure of the difference between the geographic pole and magnetic pole for a given position at a given time.

Since the most widely used personal navigation device remains the magnetic compass, and since its use with a map requires the computation of the magnetic declination for your current location, declination is important to anyone navigating by compass.

Variance between magnetic and geographic poles

The earth's core exists in a liquid state. The molten magma is in constant flux. One result is the movement of the earth's tectonic plates. Another is the changing magnetic field.

Since the earth's magnetic poles are not aligned with the earth's geographic poles, there is always a variation between the direction to the magnetic pole and the direction to the geographic pole. The major variances in the magnetic field are measured as inclination and declination[1].

Inclination

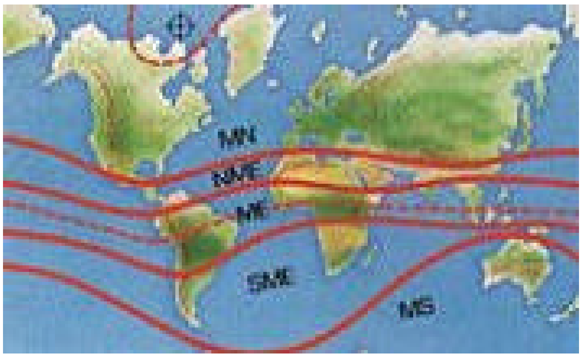
The magnetic pole does not sit on the earth's surface, but is many kilometres deep within the planet. The vertical difference between the location of the pole and the horizontal plane of your location, or the tendency of the compass needle to point downward, is called inclination.

Inclination has little impact on searchers provided you have a compass designed for your specific part of the world. The compass you use has to compensate for the tendency of the magnetic needle to point down and therefore, drag on the housing.

---

[1] The are three measures of the intensity of the magnetic field in addition to the directional inclination and declination measures.

Certain more expensive compasses can compensate for this characteristic. Other compasses will be shipped only to those areas for which they are designed. Inclination compensation only becomes an issue if you travel in central or southern latitudes or if your compass comes from one of these areas.



The attached map illustrates the magnetic zones and shows the type of compass that should be used. The zone for which your compass has been designed is most likely printed somewhere on the bezel. Silva compasses identify the zone on the bezel base plate, next to the needle pin.

Declination

Declination is the measure of the angle between magnetic north and geographic north, and is expressed in degrees west or east. For those of us living in Eastern Canada, the magnetic north pole is west of the geographic North Pole; our declination is a western declination. For Canadians living on the West Coast, the magnetic north pole is east of the geographic North Pole, and the declination is, therefore, an eastern declination.

In South Eastern New Brunswick, declination for 2002 is between 19° West and 21° West. This means that the magnetic north pole is located along a line that is 19° to 21° west of geographic north.[2]

The major sources of declination are seminal and diurnal variances in the location of the poles, and solar magnetic activity and local anomalies.

Seminal Deviation

As the magma in the centre of the earth moves, so do the locations of the magnetic poles. When these changes occur over a long period of time, it is called seminal deviation.[3] This represents about 20° in the Moncton area in 2002.

Diurnal Deviation

In addition to the long-term variance, the magnetic pole changes location on a daily basis. Part of this is due to the internal forces of the earth. These day-to-day variances are called diurnal deviation. Although of interest to geophysicists and people travelling close to the magnetic pole, the diurnal variation represents only 0.1° in our area.

Solar Magnetic Activity

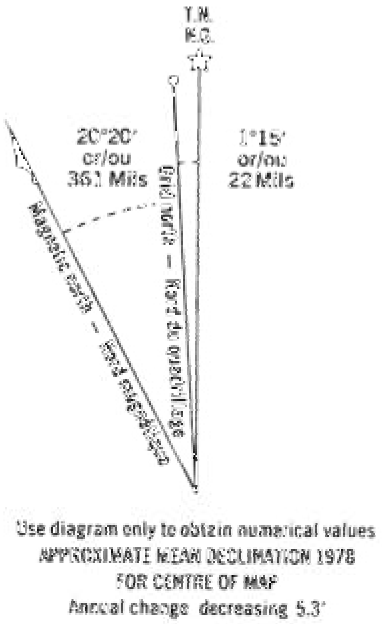


Figure 2-Magnetic Declination Information from a NTS Map

Solar wind, or the magnetic fields generated by the sun, can have an effect on compass performance. It can best be described as a probability, since the sun's magnetic activity varies throughout an 11-year sunspot cycle. The chance that the declination will be deflected by two degrees

---

[2] Detailed declination for various locations in South Eastern New Brunswick for 2002 to 2005 is listed in Appendix 2, page 13.

[3] A table and chart of the changes in magnetic declination for Moncton is attached as Appendix 1 on page 12.

in southern Canada over the entire 11-year cycle is 1% per day[4]. This implies about four days per year, but in practice these days tend to be clustered in years of solar maxima.

Local Anomalies

Magnetic fields are affected by the presence of ferrous metals in the ground. Some geological formations also have their own magnetic charges, i.e., lodestone. Both of these situations can cause variance between the magnetic and geographic poles. No local anomalies have been documented southeastern New Brunswick, although local anecdotes would indicate the possible presence of an anomaly in the Peck's Creek area in Albert County.

Five-Year Studies of Magnetism

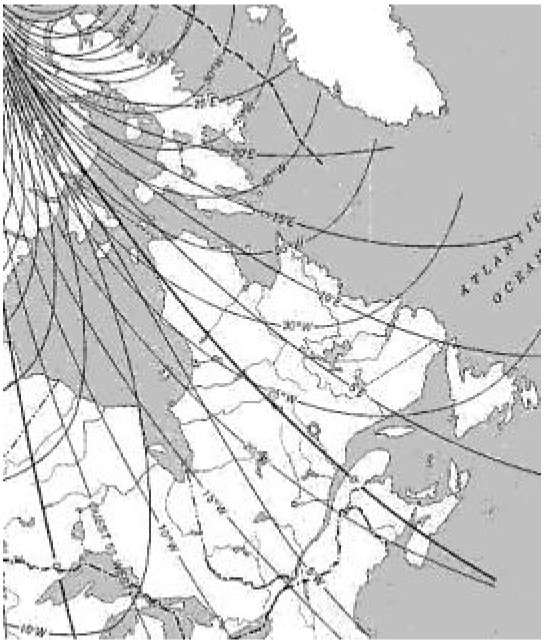


Figure 3-Isogonic Chart Showing Declination and Rate of Change, 1985

The rate and direction of change in the location of the pole is not constant. Every five years, cartographers and geo-physicists make detailed measurements and publish a new "isogonic" chart identifying the declination and rate of change for all locations in the world.

Searcher should therefore be careful of the magnetic declination information published on topographical maps. The information is valid only within five years of publication. In Figure 2, we presented an example of the declination information from a local topographic map.

Even though the example presented here was taken from a 1986 edition of the topo, the declination listed is for 1978. According to this diagram, the declination for the centre of this map in 2002 should be 2° 7' less, or 19°29'. More up-to-date calculations of the declination for 2002, based on the 2000 isogonic chart, reveal that it is actually 19°51', a difference of ½ a degree.

Searchers should never rely on declination information printed on maps unless that information refers to the most recent isogonic study, currently 2000. A new version of the isogonic charts should be completed in 2005 and should be adopted as soon as available.

Search team should maintain detailed charts of magnetic declination for their areas of operations and should ensure the declination to be used for an operation is posted at the search site.

Calculating declination

Declination for a particular point is available from many sources. In addition to Appendix 2, page 13 in this document, declination can be obtained from local airport towers, by using one of many computer programs, by using GPS functions, from an on-line declination calculator at Natural Resources Canada, or by direct calculation.

Whichever method is used must be checked against its underlying information and data. For example, many GPS programs provide declination data or declination calculation functions (e.g., autodec) that assume old isogonic models. Always ensure the underlying isogonic model is the most recent and that your GPS software is updated to the most current version.

The following methods allow you to directly calculate the declination at your current location, provided you have a good compass and a good topographical map.

Method 1 - Daytime

- Set your compass to 0° declination;

---

[4] To put this variance in perspective, consider that the Silva compasses we use in the Team are rated as accurate within 1.8°.

- From a known location, shoot a bearing to a known landmark;
- Measure the bearing from your location to the landmark ON THE TOPO MAP;
- Determine the declination by subtracting the terrain bearing from the map bearing;
- For best results, you should shoot bearings to three landmarks and average the results.

Method 2 - Night-time

- Suspend a plumb line so it describes a line from the pole star to the horizon;
- With the declination of your compass set to 0°, shoot a bearing on the plumb line;

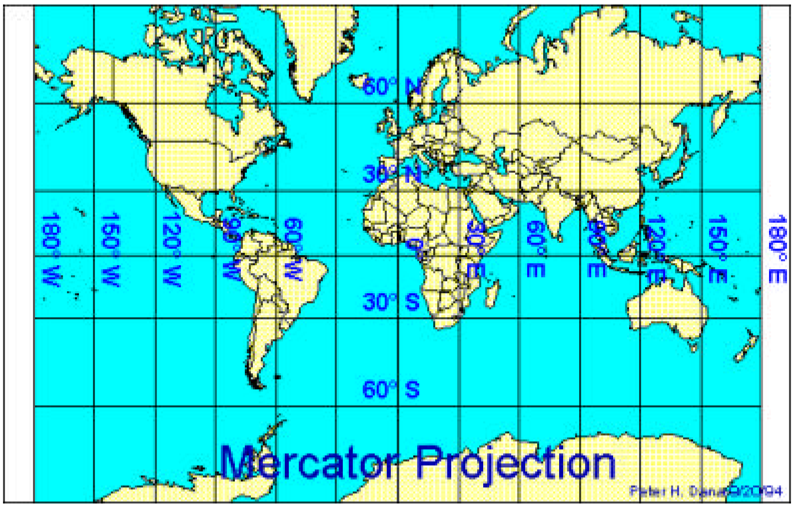


Figure 4-World Map - Mercator Projection

- The bearing of the plumb line will be your declination;
- There is a ¾ degree possible variation in this method, since the earth doesn't rotate on an axis that always points to the polar star. For perfectly accurate results, take the bearing at midnight during the summer solstice.

South Eastern New Brunswick

Declination in the Tri-County Ground Search Area of Operation in southeastern New Brunswick varies from 20.37° to 19.29° in 2002. With minimal changes forecast by the magnetic model for the next two-three years, using a 20° declination during search operations will ensure effective navigation. Even if there were marginal variances between the declination used and the true magnetic declination, it is more important that all team members use the same declination.

For easy reference we have developed a listing of declinations at various locations in our area of operation for the 2002-2005 period[5]. This listing is presented in Appendix 2 on page 13. Once the results of the 2005 magnetic study are available, the Team will recalculate declinations for our area.

Universal Transverse Mercator UTM

Mercator Projection

The earth is slightly pear shaped, while our maps are most often printed on flat sheets of paper. This creates a problem in printing maps that retain their accuracy. The conversion of a "roundish" planet to the flat plane of a piece of paper is called a projection.

In the history of map-making, many projections have been developed, each suited to its own particular purpose. For topographic maps on the scales used in Search and Rescue, a Mercator projection is the most popular. The Mercator projection has the advantage of making everything flat and rectangular and therefore fit printing paper. It has the disadvantage of stretching the southern and northern latitudes, so that they look "wider" than they really are. We will see later that this can have an impact on

---

[5] This table relies on data from the 1995 isogonic model.

how we use maps in search operations. Generally however, the distortions are minimal at the scales involved in search operations.

In Figure 4, the world has been divided into latitude and longitude demarcations. This reflects the historical method of representing co-ordinates. In this system, the equator is the 0° point for latitude. As you move north, the degrees increase until you reach the geographic pole, which is at 90° north. Similarly, as you move south the degrees increase until you reach 90° south.

In the late 19th century, an international agreement established the central meridian for longitude at Greenwich, in the UK. When moving west, degrees increase until they reach a point half way around the world at 180° west. Similarly, when moving east from Greenwich, degrees increase until they reach the same point, at 180° east.

Each degree is divided into 60 minutes; each minute is further divided into 60 seconds. By using latitude and longitude, the location of the Rotary Lodge in Centennial Park, Moncton, NB, is therefore 46° 05' 03 " North 64° 49' 10" West.

Universal Transverse Mercator (UTM)

Calculating positions in degrees, minutes and seconds presents particular challenges in a world used to dealing with metric systems. During World War I, the French Army, used as it was to working with metric measures, was convinced that there would be a better way to lay out a geographic co-ordinate system using decimal units rather than the degrees, minutes and seconds used up until then. They developed a rectangular grid reference system, to overlay on a map that was much easier to use in calculating the trajectory angles needed to have shells land in the appropriate location. The idea soon caught on and, by the end of World War II, there were over 100 different grid reference systems in use around the world.

In order to bring order to the grid system chaos, NATO established a universal grid system names Universal Transverse Mercator (UTM). This is the system that is over printed in light blue on our topographic maps.

Not only does the UTM grid provide easier math: the unit of measure for the UTM grid is the meter. All references are in a standards unit of length. When using a longitude/latitude reference system, the degrees and minutes are different lengths depending on the distance one is from the equator. Therefore, a single degree of longitude at the equator is much wider than the same single degree of longitude at the tropic or at our latitude at approximately 45° north.

UTM Zones

The UTM grid system divides the earth unto 60 UTM zones, each zone composed of a region defined by the area between two longitudinal lines that are six degrees wide. Figure 5 identifies the zones. The zones can be thought of as segments of an orange peel that has been cut into 60 equal segments, then, peeled and flattened back. Zone 1 begins at 180° west longitude and extends to 174° west longitude. The central meridian of the zone, therefore, runs along the 177° west longitude line. Our area in zone 20 has a central meridian at 63° west.

Each zone is further divided into north south designators ever 8°. The designators are labels by letter, starting at C in the southern hemisphere near the pole, and working up to X in the far north. "I" and "O" are excluded from the system.

Each zone is a rectangular grid, with points in the zone represented by Cartesian (or x,y) reference to an origin at the intersection of the middle longitude line - the central meridian - and the equator.

Grid points are always measured east and north in meters, on a basic x-y co-ordinate system. For the northern hemisphere, grid point values are measured continuously from zero at the equator and increasing the further north you go.

The central meridian, the middle longitude line in the zone, is assigned an east value, called a false easing of 500,000 meters. This assures that there are no negative values in a zone. East-west grid values to the west of the central meridian are less than 500,000 meters and to the east, more than 500,000.

This means that the UTM reference grid for our area identifies the distance from the intersection of the 63° west meridian and the equator. To use our example of the Rotary Lodge again, it is located at 108,000 meters west of the zone's central meridian at 63° west, and 5,104,800 meters (5,104.8 kilometres) north of the equator. The longitude measure is west of the central meridian, which we said was set at an arbitrary 500,000. The 500,000 central meridian, less the 108,000 metres to the proper longitudinal line, equals 392,000. The UTM grid on the map will, therefore, be 392,000 as the "easting" and 5,104,800 "northing" to identify the latitude.

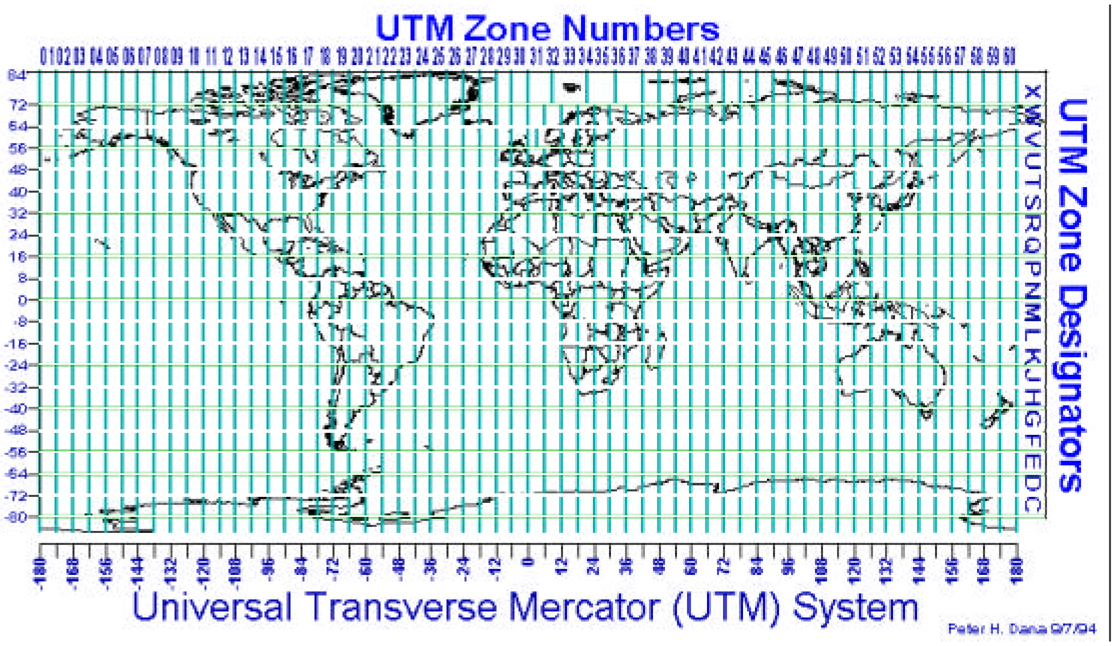


Figure 5-World Distribution of UTM Zones

Grid co-ordinates in the southern hemisphere are somewhat different from their northern counterparts in that the origin continues to be the intersection of the central meridian and the equator, but the origin is given an arbitrary value of 500,000 meters east and 10,000,000 meters north.

UTM Grid Structure

When this system gets over printed in blue on topographic maps, it translates to a grid pattern with each grid square being one kilometre by one kilometre. On a 1:50,000 scale map, the grid squares are 2cm by 2 cm. If you look at a 1:50,000 topo map for Moncton, you will note that the grid is labelled "346000m. E" and "5097000m. N" in the bottom left hand corner of the map. If you follow the grid to the location of the Rotary Lodge, you will arrive at the 392000 meters point for the easting, and 5104800 meters point for the northing.[6]

Grid North and True North

As mentioned above, making a map fit a rectangular piece of paper does present some problems. The most immediate of these is the difference that is created between true north and grid north. We have already seen that our topo maps contain a diagram that illustrates the magnetic declination. The diagram also mentions the grid north declination.

The distance between longitude meridians at the equator is greater than the distance between the same meridians at the tropics or at our even more northerly latitude. As you move north, the distance between the meridians decreases until they actually merge at the North Pole. Since the mercator projection of a map makes the distance between the longitude meridians the same regardless of latitude, and since the UTM grid is based on a mercator projection, grid north and true north on the topo will diverge whenever you

---

[6] Note the numbers that are printed in slightly larger characters; these are the numbers that are printed directly on the map grid.

move east or west of the central meridian of a zone. The variance between true north and grid north can be as great as 2.2° for maps that are at the extreme east or west of the zone.

When working off a grid to calculate bearings, not only do you have to bear in mind the magnetic declination, but also the grid convergence. In Figure 2, we will assume that the magnetic declination is accurate for the date and location. The declination between magnetic north and true north is 21° 35'. The declination between magnetic north and grid north is only 20° 20', a difference of 1°15".[7] When referring to bearings on NTS topo maps using UTM (or MGRS) grids, care must be taken to account for declination and convergence.

Where magnetic declination changes on a seminal and diurnal basis, the convergence between true north and grid north remains the same over time (provided the same ellipsoid, projection and datum are used).

Users of GPS receivers should also remember that north used for operation can be geographic north, magnetic north with user-defined declination, magnetic north with auto-declination and grid north. In most circumstances, when using UTM grids for managing search operations, the north on the GPS should be set to Grid North.

MGRS

The Military Grid Reference System is an extension of the UTM system. The zone number and zone designators are retained to identify an area 6° east to west and 8° north to south.

MGRS adds a set of alphabetic characters for 100km grid squares. Starting at the 180° meridian, the characters "A" to "Z" (omitting "I" and "O") are used for 18 °, before starting over. From the equator north, the characters "A" to "V (again omitting "I" and "O") are used for 100 km squares, repeating every 2,000km. Northing designators normally begin with 'A' at the equator for odd numbered UTM easting zones. For even numbered easting zones, the northing designators are offset by five characters, starting at the equator with 'F'.

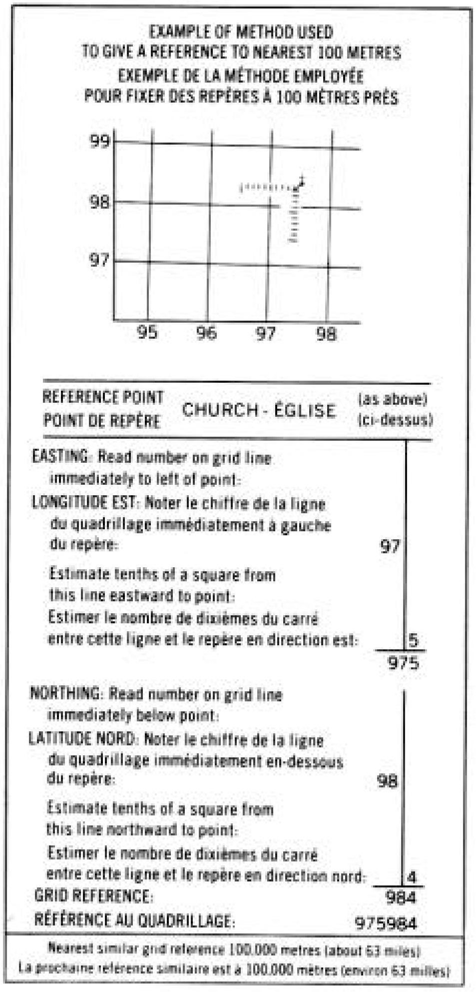
Under MGRS, a UTM reference for Moncton at 392000E and 5104800N becomes 20T LF 92000/04800. Rather than have to worry about the number of digits to drop off the front of the grid reference, positions with the 10 digits (46000/97000) are unique within the nearest 100km.

Reading UTMs

We have already mentioned that the UTM grid on a topo map allows us to reference a particular location. This reference can be made down to a metre-by-metre basis. As it is often difficult to measure to that level of detail, UTM references can be limited to the nearest 100 metres when working from a 1:50,000 scale NTS topo map. However, when using larger scale maps, and particularly when using GPS for source readings, the full 10 digit MGRS position should be reference. If only a 100 metre reference is required you have to use six digits, the first three for the "easting" and the last three are for the "northing". When giving UTM co-ordinates, the easting refers to the distance from the central meridian, while the northing refers to the distance from the equator.

---

[7] We have included the convergence data for the locations in our area of operation in Appendix 2 on page 13.



EXAMPLE OF METHOD USED
TO GIVE A REFERENCE TO NEAREST 100 METRES
EXEMPLE DE LA MÉTHODE EMPLOYÉE
POUR FIXER DES REPÈRES À 100 MÈTRES PRÈS

REFERENCE POINT
POINT DE REPÈRE
CHURCH - ÉGLISE (as above) (ci-dessus)

EASTING: Read number on grid line immediately to left of point:
LONGITUDE EST: Noter le chiffre de la ligne du quadrillage immédiatement à gauche du repère: 97

Estimate tenths of a square from this line eastward to point:
Estimer le nombre de dixièmes du carré entre cette ligne et le repère en direction est: 5

975

NORTHING: Read number on grid line immediately below point:
LATITUDE NORD: Noter le chiffre de la ligne du quadrillage immédiatement en-dessous du repère: 98

Estimate tenths of a square from this line northward to point:
Estimer le nombre de dixièmes du carré entre cette ligne et le repère en direction nord: 4

984

GRID REFERENCE:
RÉFÉRENCE AU QUADRILLAGE: 975984

Nearest similar grid reference 100.000 metres (about 63 miles)
La prochaine référence similaire est à 100.000 mètres (environ 63 milles)

Figure 6-Topo Map Guide to Reading UTM Grid

On a 1:50,000 scale topo map, the grids represent kilometres. The map user has to measure the last 100-metre increment. For greater precision, you should always use the roamer scale on the side of the compass base plate, or make your own scale. The example on Figure 6 demonstrates how to read six digit grid references. (This example is taken directly from a topo map; as long as you have a map handy, you have a ready reference for reading UTM.)

A bit of geometry

If you have two UTM references, you can easily calculate the distance between the two points. For example, if there is a school at 955972 on the map segment portrayed in Figure 6, simple geometry will allow you to calculate the distance from the school to the church listed at 975984.

The grid reference for the school is 2.0 kilometres west (955 versus 975), and 1.2 kilometres south (972 versus 984) of the church. They are therefore 2.3 kilometres apart. The distance between the two (d) is equal to the square root of the sum of the difference in the eastings (e) squared and the difference in the northing (n) squared.

$$d = \sqrt{\Delta e^{2} + \Delta n^{2}}$$

Datum

What is a datum?

In our review of maps, we said that one of the pieces of information along the bottom margin of topo maps is the datum, in the case of topo maps - NAD27 or NAD83. This, therefore, begs the question: “What is a datum?” A datum is simply a starting point for a co-ordinate system. Every map has to have one location on (or in) the earth that acts as point zero for all references. Over time, various cartographers have developed different datum, meaning that the same co-ordinates on maps of different datum will be located at different places.

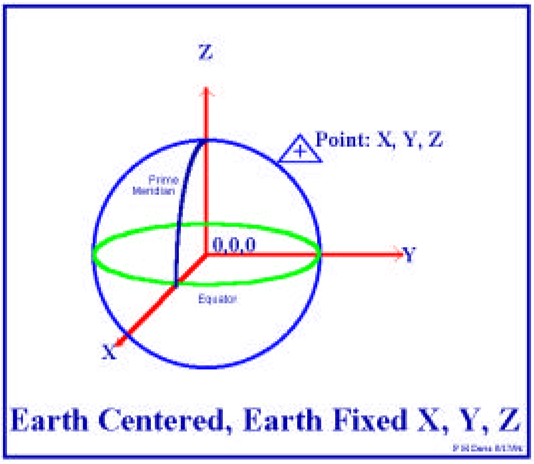


Figure 7-General Format of Ellipsoid Models

Ellipsoids

An "ellipsoid" is a model of the earth that explains the real shape of the planet. This allows for corrections from the absolute round conception we might have of the globe to the slightly pear-shaped planet we actually live on. Figure 7 demonstrates the components of an ellipsoid. As with most things, the geo-physicists have varying opinions about the most realistic ellipsoids, meaning there are quite a few different ones in the world. We have reproduced information on various ellipsoids in Appendix 4 on page 15.

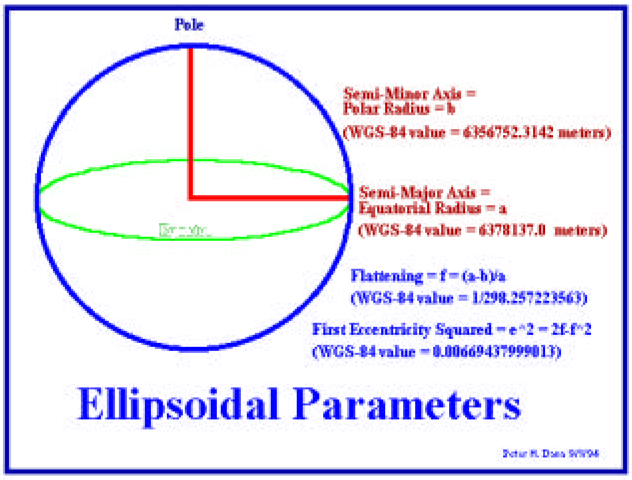


Figure 8-WGS-84 Ellipsoid

WGS-84 Ellipsoid

The ellipsoid that is currently enjoying the most favour is the WGS-84 ellipsoid[8]. For reference we have attached the diagram that also contains the major values for this ellipsoid.

Datum

The details of the ellipsoids aren't in themselves relevant to Search and Rescue, but datum are. Datum are the point on the earth that a particular ellipsoid uses for its point zero. As you can see from the diagram in Figure 8, the semi-major axis has to come out somewhere. This location is called the prime meridian. The location of the prime meridian is the starting point of the whole geographic co-ordinate system.

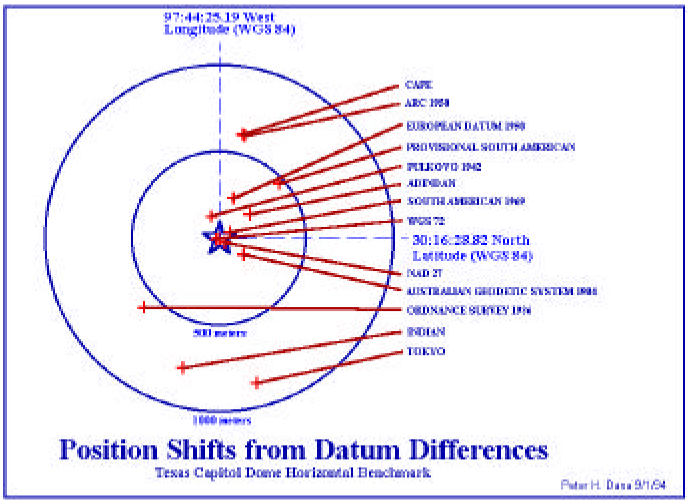


Figure 9-Physical Difference Between Datum

NAD27

Most North American datum of the past have used the Clarke 1866 ellipsoid as their description of the earth. In this ellipsoid, the basic reference point is the triangulation station at Meades Ranch in Kansas. The system based on the location of this triangulation station became the official US datum point in 1901. In 1913, Canada and Mexico adopted the same system and the name was changed to North American Datum. Between 1927 and 1932, most available data was changed to accommodate the new datum. It became known officially as the North American Datum of 1927, more often abbreviated as "NAD27".

NAD83

Further adjustments of the system were made in 1980 and 1982 and the new system became known as North American Datum 1983, or NAD83. The ellipsoid used was named GRS-80. With the popularity of the system, and the promotion of the WGS84 (very close to GRS-80) ellipsoid, the new NAD83-WGS84 datum is gaining popularity.

Provincial Department of Natural Resources and Energy Forestry Development Survey Maps are charted using a datum very close to NAD83. Topographical maps from the Federal Depart-

---

[8] The "WGS" part stands for World Geodetic System" and the 84 represent 1984; the year the ellipsoid was popularized.

ment of Energy, Mines and Resources are charted using NAD27 and NAD83 depending on the date of publication of the map.[9]. Appendix 6, on page **Error! Bookmark not defined.** identifies the datum used on the various NTS maps for the South Eastern part of New Brunswick.

Datum in SAR

NAD27 and NAD83 are probably the only datum you will encounter in Search and Rescue activities in New Brunswick. There are, however, many more, some of which we have added to Appendix 5, page 16, for you reference.

When you provide references to other members of the SAR community, you must ensure both parties are using the same datum. Otherwise, you and whomever you are corresponding with will understand different locations from the same co-ordinates.

In the Tri-County area, conversions[10] can be made as follows:

To Convert NAD27 to NAD83			
LL	Lat	Add	0.3”
	Long	Subtract	2.2”
Grid	Easting	Add	52m
	Northing	Add	225m

To Convert NAS83 to NAD27			
LL	Lat	Subtract	0.3”
	Long	Add	2.2”
Grid	Easting	Subtract	52m
	Northing	Subtract	225m

In addition to the maps used, you must exercise caution in setting the GPS units, so that you are using the proper datum. If you are using DNR&E maps, set the GPS to NAD83. If you are using topo maps, set the datum to NAD27.

The DNR&E maps are based on a New Brunswick datum. Although not exactly NAD83, the datum is close enough for no material difference to exist between the two sets of data.

Relevance to GSAR

Magnetic Declination

Although GPS accuracy and detail of position has improved remarkably, a person travelling on foot does not move quickly enough to use GPS headings. Compasses remain the most effective method of determining the direction of travel for searchers on foot.

When searches are managed and executed from maps, and searchers operate with magnetic compasses, there must be a common understanding and acceptance of the divergence between true north, grid north and magnetic north. Although an approximate declination commonly accepted by all participants in a search operation will yield generally acceptable levels of precision, the most accurate declination setting possible will provide the most detail when plotting search directions, sound bearings, etc. Every effort should therefore be made to use as precise a declination correction as possible.

The actual declination used at a search operation should be posted and provided to all field teams as part of their briefing. Managers must ensure proper declination calculations, including the convergence adjustment.

UTM

Part of the declination briefing must also be direction on which “north” to use for bearings. Most often, when using MGRS location descriptions, GPS should be set to “Grid North”.

As GPS receivers have improved in accuracy and affordability, they have become accessible and useful for field searchers. Field searchers can provide precise location data. Geo-referenced waypoints can be issued as part of search assignment briefings. Clear and concise position data easily charted on operational maps is required to effectively use the new geopositioning tools.

MGRS positions provide simple decimal based position reporting that eliminates the more complex math associated with geographical co-ordinate systems. MGRS also provides a stan-

---

[9] More recent printings of topo maps show conversion information to allow calculation of NAD83 data to NAD27 data and vice versa.

[10] For easy reference we have reproduced this conversion table for NAD27/NAD83 transformation in Appendix 3 on page 14.

dard reference system where east/west and north/south units of measure are the same length. Finally, MGRS positions, displayed from a GPS are standard format, and eliminate the extraneous information provided by the full scale UTM coordinate reference.

Datum

The significance of the datum used is obvious when we consider the difference between the two systems (225 meters north/south and 52m east/west). Although for many applications, the difference between NAD27 and NAD83 is immaterial, SAR requires a common datum for management of operations.

All new National Topographic System maps are being upgraded to NAD83 as the newer versions of the maps are published. In addition to a revision in datum, the new versions are being published with metric contour lines.

A final word on GPSs

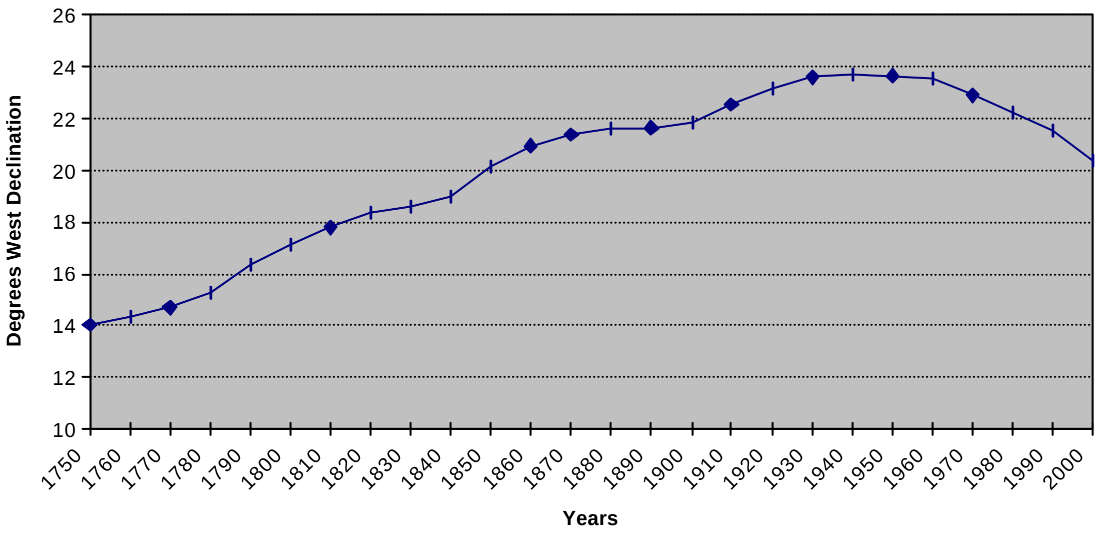
With the elimination of selective Availability, GPSs have come into their own in ground search and rescue. But, as with all technology, SAR manager must have a strong underlying understanding of geography, cartography and geophysics to put the technology to use.

To effectively use the GPS, managers must clearly identify the declination to be used, the grid from which everyone is to work, and the datum being referenced. Finally, managers must clearly communicate the location reference system to be used by field teams.

October 15 2002.

Appendix 1 - Historical Declinations at Moncton - 1750-2000

Year	Mag Dec	Year	Mag Dec
1750	14.0°	1900	21.8°
1760	14.3°	1910	22.5°
1770	14.7°	1920	23.2°
1780	15.3°	1930	23.6°
1790	16.4°	1940	23.7°
1800	17.1°	1950	23.7°
1810	17.8°	1960	23.5°
1820	18.4°	1970	22.9°
1830	18.6°	1980	22.2°
1840	19.0°	1990	21.5°
1850	20.1°	1995	20.7°
1860	21.0°	2000	20.4
1870	21.4°	2005	19.6
1880	21.6°		
1890	21.6°		


Magnetic Declination at Moncton

Appendix 2 - Magnetic Declination 2002-2005 - Tri-County Area

Place	Location[11]	Conv.[12]	2002[13]	2003	2004	2005
Pt. Escuminac	64.80°W-47.07°N	1.32°	20.37	20.26	20.14	20.02
Kouchibouguac	65.50°W-46.77°N	1.82°	20.03	19.92	19.81	19.70
Kent Jct.	65.34°W-46.58°N	1.70°	19.98	19.87	19.76	19.66
Cap Lumiere	64.71°W-46.66°N	1.24°	20.20	20.09	19.97	19.86
Coal Branch	65.15°W-46.36°N	1.56°	19.93	19.82	19.72	19.61
Cocagne	64.62°W-46.37°N	1.17°	20.09	19.97	19.86	19.75
Harewood	65.25°W-46.07°N	1.62°	19.77	19.66	19.56	19.46
Moncton	64.77°W-46.09°N	1.28°	19.91	19.81	19.70	19.59
Anderson Settle.	64.25°W-46.12°N	0.90°	20.07	19.95	19.84	19.73
Cape Tormintine	63.77°W-46.14°N	0.56°	20.19	20.08	19.96	19.85
Elgin	65.10°W-45.78°N	1.51°	19.68	19.57	19.47	19.37
Caledonia Mtn.	64.80°W-45.85°N	1.29°	19.79	19.69	19.58	19.48
Sackville	64.37°W-45.87°N	0.98°	19.92	19.81	19.70	19.60
Pt. Wolfe	65.02°W-45.54°N	1.44°	19.59	19.49	19.39	19.29
Cape Enrage	64.78°W-45.58°N	1.27°	19.68	19.58	19.47	19.37

---

[11] NAD83

[12] UTM convergence, i.e., variation between grid north and true north.

[13] On January 01 of year indicated

Appendix 3 - NAD27 - NAD83 Conversions for Tri-County Area

NAD27 ➡ NAD83

Geographic:	**Latitude**	**add**	**0.3”**
	Longitude	**subtract**	**2.2”**

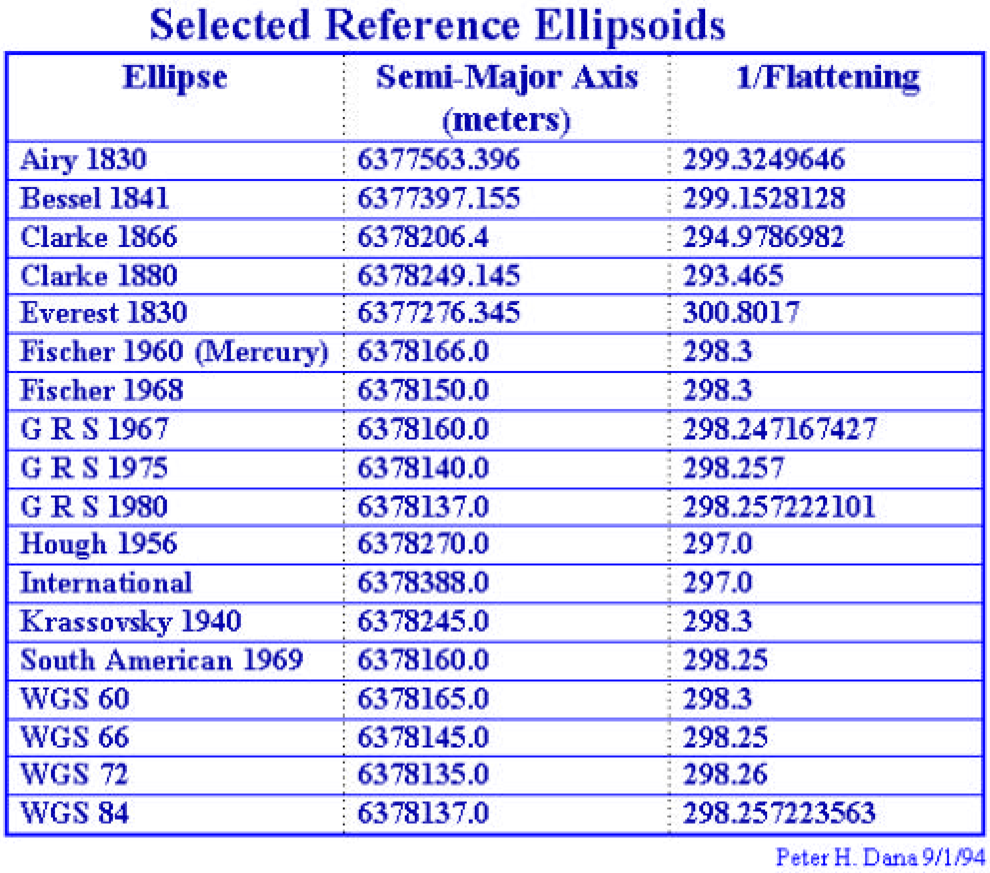
Grid:	**Easting**	**add**	**52m**
	Northing	**add**	**225m**

NAD83 ➡ NAD27

Geographic:	**Latitude**	**subtract**	**0.3”**
	Longitude	**add**	**2.2”**

Grid:	**Easting**	**subtract**	**52m**
	Northing	**subtract**	**225m**

Appendix 4 - Ellipsoids Around the World

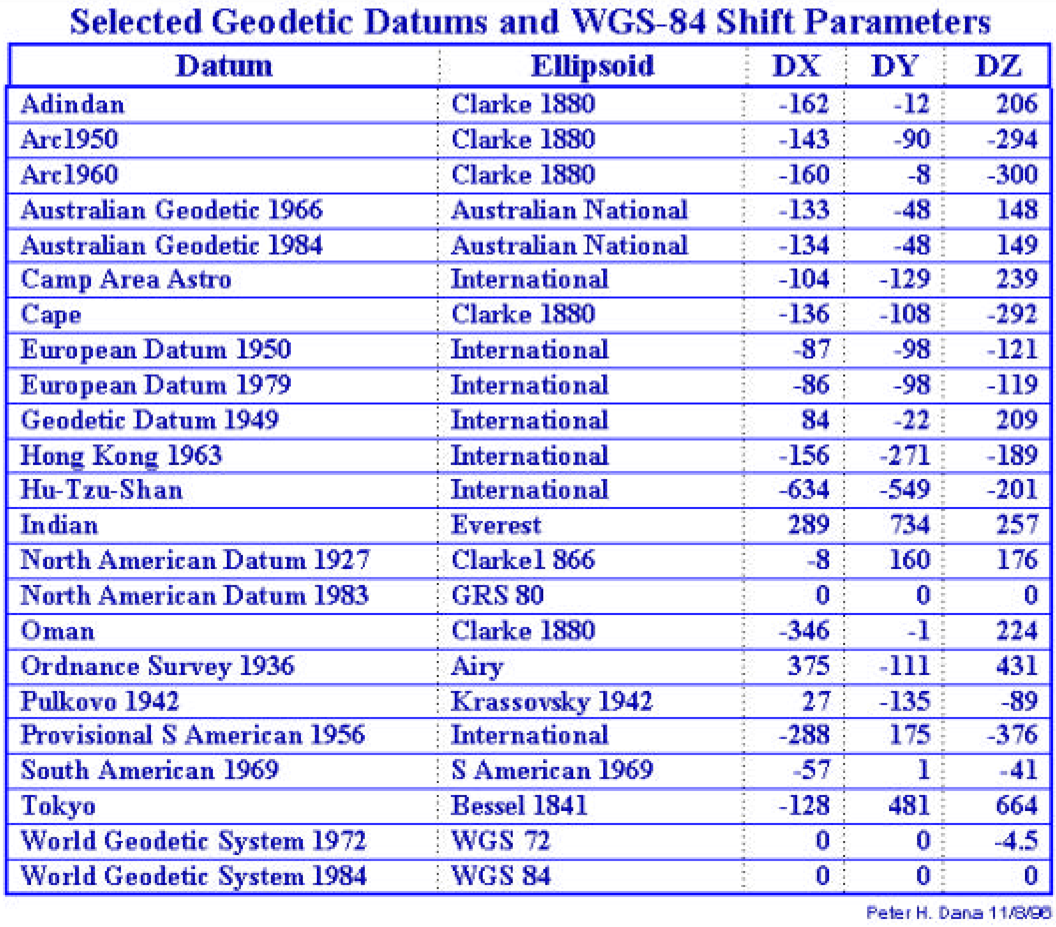


Selected Reference Ellipsoids

Ellipse	Semi-Major Axis (meters)	1/Flattening
Airy 1830	6377563.396	299.3249646
Bessel 1841	6377397.155	299.1528128
Clarke 1866	6378206.4	294.9786982
Clarke 1880	6378249.145	293.465
Everest 1830	6377276.345	300.8017
Fischer 1960 (Mercury)	6378166.0	298.3
Fischer 1968	6378150.0	298.3
G R S 1967	6378160.0	298.247167427
G R S 1975	6378140.0	298.257
G R S 1980	6378137.0	298.257222101
Hough 1956	6378270.0	297.0
International	6378388.0	297.0
Krassovsky 1940	6378245.0	298.3
South American 1969	6378160.0	298.25
WGS 60	6378165.0	298.3
WGS 66	6378145.0	298.25
WGS 72	6378135.0	298.26
WGS 84	6378137.0	298.257223563

Peter H. Dana 9/1/94

Appendix 5 - Datum Around The World



Selected Geodetic Datums and WGS-84 Shift Parameters

Datum	Ellipsoid	DX	DY	DZ
Adindan	Clarke 1880	-162	-12	206
Arc1950	Clarke 1880	-143	-90	-294
Arc1960	Clarke 1880	-160	-8	-300
Australian Geodetic 1966	Australian National	-133	-48	148
Australian Geodetic 1984	Australian National	-134	-48	149
Camp Area Astro	International	-104	-129	239
Cape	Clarke 1880	-136	-108	-292
European Datum 1950	International	-87	-98	-121
European Datum 1979	International	-86	-98	-119
Geodetic Datum 1949	International	84	-22	209
Hong Kong 1963	International	-156	-271	-189
Hu-Tzu-Shan	International	-634	-549	-201
Indian	Everest	289	734	257
North American Datum 1927	Clarke1 866	-8	160	176
North American Datum 1983	GRS 80	0	0	0
Oman	Clarke 1880	-346	-1	224
Ordnance Survey 1936	Airy	375	-111	431
Pulkovo 1942	Krassovsky 1942	27	-135	-89
Provisional S American 1956	International	-288	175	-376
South American 1969	S American 1969	-57	1	-41
Tokyo	Bessel 1841	-128	481	664
World Geodetic System 1972	WGS 72	0	0	-4.5
World Geodetic System 1984	WGS 84	0	0	0

Peter H. Dana 11/8/96

Appendix 6-

Map	Edition	Name	Year Valid	Contour Interval	Datum	Accuracy	NB Atlas Page
11L/4	4	CAPE TORMINTINE	1987	25FT	NAD27	C-2	67
21I/1	03	PORT ELGIN	1980	25FT	NAD27	D-2	66
21I/2	04	MONCTON	1977	50FT	NAD27	D-3	65
21I/3	03	SALISBURY	1980	25FT	NAD27	D-2	64
21I/4	03	CHIPMAN	1980	25FT	NAD27	D-2	63
21I/5	02*	SALMON RIVER ROAD	1975	50FT	NAD27	D-3	56
21I/6	02	HARCOURT	1975	50FT	NAD27	D-3	57
21I/7	02	BUCTOUCHE	1975	25FT	NAD27	D-2	58
21I/10	02	RICHIBOUCTO	1975	25FT	NAD27	D-2	51
21I/11	02	ROGERSVILLE	1975	50FT	NAD27	D-3	50
21I/12	02	BLACKVILLE	1975	50FT	NAD27	D-3	49
21I/14	03	KOUCHIBOUGUAC	1986	10M	NAD83	A-0	43
21I/15	03	POINTE-SAPIN	1987	10M	NAD83	A-0	44
21H/5	04*	LOCH LOMAND	1987	50FT	NAD27	A-1	87
21H/6	04*	SALMON RIVER	1994	10M	NAD83	C-1	88
21H10	04	ALMA	1994	10M	NAD83	C-1	82
21H/11	04*	WATERFORD	1994	10M	NAD83	C-3	81
21H/12	04*	SUSSEX	1980	50FT	NAD27	B-2	80
21H/13	03*	CODYS	1980	50FT	NAD27	C-2	72
21H/14	04	PETITCODIAC	1994	10M	NAD83	C-1	73
21H/15	04	HILLSBOROUGH	1994	10M	NAD83	C-2	75
21H/16	04*	AMHERST	1980	10M	NAD83	C-2	75

HORIZONTAL ACCURACY

Rating	1:50,000	Distance at Map Scale
A	25m	0.5mm
B	50m	1.0mm
C	100m	2.0mm
D	>100m	
E	Not determined	

Vertical Accuracy

Rating	1:50,000
0	5m
1	10m
2	20m
3	>20m
4	Not determined