ONTARIO
SPECIFICATION FOR
GPS CONTROL SURVEYS

June 2004

Prepared by the:

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SPECIFICATIONS FOR GPS CONTROL SURVEYS

1. INTRODUCTION

This document lays out the minimum requirements that must be met when undertaking a GPS Control Survey for the Province of Ontario. This specification is intended for use in medium scale GPS surveys (e.g. Municipalities, Highways, Pipelines) where typical station spacing is 1 km or greater. It is not intended for providing accurate orthometric elevations in place of levelling.

Unless otherwise stated in the terms of reference for the control survey project, there are two objectives of the survey:

(i) To produce an accurate, high precision GPS network for integration into the Canadian Spatial Reference System – NAD83 (CSRS).

(ii) To produce a homogeneous network, integrated into the existing monumented control, which meets a specified *order of accuracy* for the NAD83 (Original) datum.

Standards for the classification of the *accuracy* of the resulting networks are given in §2.

The network design and monument selection (§ 3, 4) provide the framework for the assessment of the *quality* of the network.

GPS equipment selection, observation and processing (§ 5-7) give measures to provide high *quality* estimated position differences and their error estimates, which must be further assessed in "analysis and adjustment".

Analysis and adjustment provide *objective quality control* for the estimated position differences and error estimates (§ 8, 9). Final *quality* and *accuracy* classifications are only *realistic* if all quality measures and design criteria are followed.

The concluding section (§ 10) outlines the deliverables and is closely aligned with the structure of this document. The appendix covers monumentation, sample network design and field notes.

2. ACCURACY

2.1. NAD83 (CSRS)

The *local accuracy* of the CSRS adjustment is determined by averaging the semi-major axes of the horizontal *relative confidence regions*, at the 95% confidence level, from the weighted constraint adjustment, for all connected stations.

The *network accuracy* of the CSRS network is determined by averaging the semi-major axes of the horizontal *station confidence regions,* at the 95% level, from the weighted constraint adjustment.

Both the relative and station confidence regions are produced by iteratively rescaling the GPS baseline covariance information until the final weighted constraint adjustment has an a posteriori variance factor equal to one (§ 8.5).

The classification of *local* and *network accuracy* for a survey can fall into groups with the following upper boundaries:

- 1 cm;
- 2 cm;
- 5 cm, or;
- 10 cm.

(Natural Resources Canada, 1996. *Accuracy Standards for Positioning Version 1.0*. Geomatics Canada, Geodetic Survey Division, Ottawa, September).

2.2. NAD83 (ORIGINAL)

The *order of accuracy* for the NAD83 (Original) network is determined from the semi-major axis of the horizontal *relative confidence regions*, at the 95% confidence level, from the fully constrained adjustment, for all connected stations. To meet a specified *order of accuracy*, the semi-major axis must be less than or equal to r, as given by the formula:

$$\mathbf{r = c\,(d + 0.2)}$$

Where:

r is in cm
d is the spatial distance between the points in km, and
c is the constant of order as shown below

Order	C
1st	2
2nd	5
3rd	12
4th	30

The assessment of the *order of accuracy* is dependent upon the covariance matrix from which the 95% *relative confidence regions* are determined. The covariance matrix will be scaled by the *a posteriori* variance factor from the minimally constrained adjustment when that value is greater than one.

3. RECONNAISSANCE

3.1. SITE SELECTION

When selecting suitable locations for new control stations, the following must be considered:

- Good Satellite visibility;
- Safe access and permanence;
- Low-multipath environment (50 m radius from station should be free of reflective surfaces);
- Not in close proximity to microwave transmitting stations, radio repeaters, or high voltage power lines.

Once the site has been monumented, a monument position sketch and a station obstruction diagram must be made.

3.2. MONUMENTATION

New control stations will be monumented with:

(a) a tapped brass cap affixed to a died 1.8 metre long, 25 millimetre diameter round iron bar, driven a minimum of 15 centimetres below ground level (monument type B). The station must be marked with a 2” x 2”x 4’ wooden stake when possible;

or
(b) a brass rock post counter sunk and set flush in stable rock or concrete (monument type C). Stations set in rock must be marked with a steel marker, set in the rock, to aid in locating the cap. A measurement from the marker to the monument must be made and recorded in the monument position sketch.

The full eleven-digit COSINE station number (assigned by the issuing agency and conforming to COSINE standards) must be legibly stamped on the cap. Monument standards are given in Appendix A.

3.3. MONUMENT POSITION SKETCHES

Monument position sketches are required for all new control stations. New sketches must also be made for existing stations if the existing sketches are incorrect or deficient.

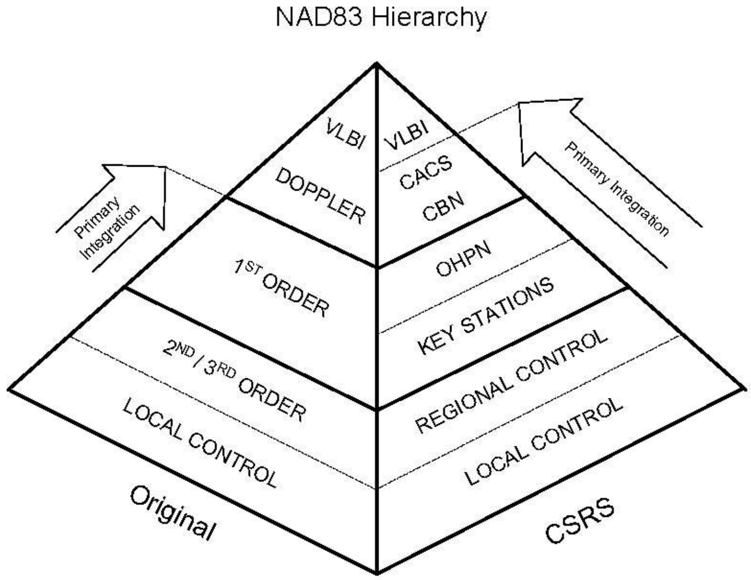
The sketch will indicate the relationship of the monument to the highway or road and show a minimum of three other ties to unambiguous references. Ties should be sufficient to locate the object at the decimeter level and include redundant measurements. Poles and trees used as reference ties must be marked with nail and flagging. Also required are: a north arrow, date of ties, monument type, stamped number, condition, relationship to ground, intervisibility to other stations and a written description referencing the monument in both directions to local features such as roads, rivers, towns, etc. (for rough locating purposes). A sample monument position sketch is given in Appendix B.

4. NETWORK DESIGN

There are three main components of network design:

- The primary integration network;
- The key station network;
- The project network.

Figure 1. The NAD83 control survey hierarchy shown as a pyramid. The areas shown in gray indicate the stations to be produced in the survey. The arrows show which stations can be used for primary integration.



Each component of network design falls under a different control survey hierarchy (Figure 1). The primary integration stations are of greater hierarchy than that of the *project network*. Note that for NAD83 (CSRS), existing *key stations* can be used for primary integration. The *project network* falls under the regional control classification for NAD83 (CSRS) and under the 2^{nd} / 3^{rd} order control classification for NAD83 (Original).

The *network* must be designed with inherent quality control checks to ensure the reliability of the survey and the methodology used. The checks will include repeat baseline observations, repeat occupations on both existing and new control stations, and other quality control measures.

Sufficient existing control must be used to allow proper orientation and scale of the *project network*. The final configuration must be geometrically strong and result in a fully integrated, homogeneous network. Samples of suitable network designs are given in Appendix C.

A network design proposal must be submitted and approved by the issuing agency before field observations commence. The network design proposal must include:

- A proposed network diagram showing all new and existing stations;
- The baselines to be observed, with session identification;
- The baselines which will be repeated;
- The number and type of GPS receivers and antennae;
- Comments on any element of the proposal that may concern the issuing agency.

4.1. PRIMARY INTEGRATION NETWORK

The *primary integration network* provides both the integration to higher order NAD83 as well as the overall network structure. There are two *primary integration network* components: NAD83 (CSRS) and NAD83 (Original).

4.1.1 NAD83 (CSRS)

Three or more existing NAD83 (CSRS) control stations distributed regularly on the periphery of, and fully encompassing the *project network*, must be used. They are to be directly connected, forming a validation network, to provide both quality control and NAD83 (CSRS) integration for the *key station and project networks*.

These stations should be of greater *hierarchy* than that of the *project network*. For example, *primary integration stations* can be previously established *key stations*, Ontario High Precision Network (OHPN) stations, Canadian Base Network (CBN) stations or Canadian Active Control System (CACS) stations.

4.1.2 NAD83 (Original)

Three or more existing NAD83 (Original) horizontal control stations distributed regularly on the periphery of, and fully encompassing the *project network*, must be used.

These stations should be of a higher *order* than that of the *project network*. Stations of equivalent order to the new stations may be used only when stations of a higher order do not exist or are not suitable for GPS.

4.2. KEY STATION NETWORK

Key stations, when connected to each other and to the *primary integration network*, provide for a homogeneous network with minimal error propagation. They will form part of the OHPN – the provincial densification of the CBN.

The *key station network* must form an independent network when combined with the *primary integration network*.

Key stations are to be set at the periphery of the project area and will form part of the *project network*. Additional *key stations* are required so that the maximum spacing between key stations is 25 kilometres. They are to be high quality stations, preferably set in stable rock or concrete, and with minimal satellite obstructions.

4.3. PROJECT NETWORK

The *project network* is the local densification of NAD83. Connections to the *key station network* provide for primary integration and quality control. The configuration of the *project network* is dependent on the survey requirements as specified by the issuing agency.

4.3.1 Existing Horizontal Control

In addition to the *primary integration stations*, other existing horizontal control must be occupied and properly tied in (if they are suitable for GPS) to ensure a fully integrated, homogeneous *project network.*

For linear projects, at least one existing horizontal control point every 5 kilometres within the *project network* must be occupied and integrated in a homogeneous manner.

For block projects, at least 25% of the existing horizontal control within the *project network* must be occupied and integrated in a homogeneous manner.

Existing horizontal control points should form part of the *project network* where possible.

4.3.2 Vertical Control Integration

A minimum of 3 v*ertical integration stations*, evenly spaced throughout the *project network*, with accurate orthometric elevations are required. Only stations in stable rock or concrete should be used.

These v*ertical integration stations* can be either existing first and second order benchmarks, or stations with elevations transferred from such benchmarks by second order levelling techniques (*see* Surveys and Mapping Branch, 1978. *Specifications and Recommendations for Control Surveys and Survey Markers*. Natural Resources Canada (formerly Energy, Mines and Resources), Ottawa). Lower order vertical control or procedures may be used if approved by the issuing agency.

If elevation transferring is used, it is preferable to transfer elevations to *key stations*. However, elevations can also be transferred to *project network* stations or existing control points.

For linear projects, *vertical integration stations* are required at a maximum spacing of 25 kilometres within the *project network*.

For block projects, *vertical integration stations* are required at a maximum spacing of 10 kilometres within the *project network*.

4.4. STATION INTERCONNECTIONS

The final network must include direct connections between the *primary integration* NAD83 (CSRS) stations.

A direct connection is required from each existing control station in both *primary integration network*s, NAD83 (CSRS) and NAD83 (Original), to the two closest *key stations*. These connections must be observed in separate sessions and under a different satellite constellation.

Key stations are to be tied directly together in addition to ties to the *primary integration networks* and *project network.*

Each station in the *project network* (including *key stations*) must be directly connected to at least two other stations in the *project network* and must have direct connections to all adjacent stations. All intervisible station pairs must be directly connected. (Note: intervisible station pairs are set for azimuth control for conventional survey work).

4.5. REPEATED BASELINES

There must be at least one common baseline between sessions so that in the final network, all sessions are tied together.

For linear *project networks*, all baselines between intervisible station pairs must be repeated.

For block *project networks*, 25% of baselines between intervisible station pairs must be repeated.

4.6. REPEAT OCCUPATIONS

Each station in the GPS survey, including existing control, must have two independent occupations (§ 6.3).

5. EQUIPMENT SELECTION

5.1. RECEIVER

A minimum of three geodetic quality, dual frequency GPS receivers must be used. Regardless of the number of receivers being used, all elements of design must be achieved (e.g. repeat baselines, common sessions baselines, ties to adjacent stations, etc).

The use of one make and model of receiver is highly recommended.

If receivers from different manufacturers are mixed, their compatibility must first be verified and documented by carrying out a GPS validation survey on a provincial GPS basenet.

5.2. ANTENNA

Dual frequency (L1 and L2) geodetic antennae must be used. The use of one make and model of antenna is highly recommended.

If antennae from different manufacturers are mixed, their compatibility must first be verified and documented by carrying out a GPS validation survey on a provincial GPS basenet. The proper application of antenna heights and phase center offsets must be verified in both the baseline processing software and in the RINEX file creation.

6. FIELD OBSERVATIONS

6.1. MONUMENT IDENTIFICATION

For each occupation, it must be verified that the correct station has been occupied.

The receiver operator must record on the field log sheet the inscription appearing on the monument as well as the unique monument number and station name used to officially describe the station.

6.2. ANTENNA SETUP

The centering device (i.e. tribrach) used with each antenna must be checked before and after the survey as well as every week for the duration of the survey.

The antenna type and serial number must be recorded on the field log sheet.

The antenna height must be measured in metric to the nearest millimetre at the beginning and end of each observing session. These measurements must be verified with an independent imperial measurement. If measuring slant antenna heights, measurements must be made to three evenly spaced points around the antenna.

All measured antenna heights must be recorded in field log along with any sketch required to show how the measurements are related to the vertical height from the marker to the antenna phase centre. Any values necessary to convert the measurements to the vertical height from marker to phase centre must be provided.

6.3. INDEPENDENCE OF OBSERVATIONS

Observations (or occupations) can only be considered independent if they have different equipment, observers, and satellite configuration. Although independent observations are preferred, they are not always practical.

When remaining at the same station for consecutive observations, the GPS equipment must be re-set between sessions in order to achieve some level of independence.

To re-set the GPS equipment the receiver logging must be stopped, antenna and tripod reset, new antenna heights measured and a new log sheet started.

6.4. LENGTH OF OBSERVATION SESSION

Static and rapid static GPS techniques may be used. Kinematic methods may <u>not</u> be used.

The length of observation session is a function of the GPS method used, the number of satellites observed and the length of line measured. The length of observation session must:

- Meet the receiver manufacturer's minimum recommendations;
- Be sufficient to resolve integer ambiguities for baselines < 30 km;
- Be sufficient to ensure a high accuracy float solution, when fixed ambiguity solutions are not achieved, for baselines > 30 kilometres;
- Have a minimum of 20 minutes of common GPS observations.

6.5. MEASUREMENT RATE

For static observations, data may be recorded at 30-second intervals, or less.

For rapid-static observations, data may be recorded at 10-second intervals, or less.

The measurement rate must be recorded on field log sheet.

6.6. MEASUREMENT TYPES

All possible measurements, including carrier phase measurements on L1 and L2, must be observed and recorded.

6.7. ELEVATION MASK ANGLE

The elevation mask angle must be 15° or greater. The elevation mask angle must be recorded on the field log sheet.

6.8. FIELD NOTES

A detailed field log must be recorded for each occupation. At minimum the following information must be included:

- Observer;
- Date of observations (year, month, day and Julian day number);
- Session identification;
- Station identification (unique monument number, station name, monument inscription);
- Receiver and antenna type and models;
- Serial number of receiver, antenna and data logger;
- All measurements taken to derive and check antenna height (a sketch depicting the procedure is also recommended);
- Starting and ending time of observations (with offset from UTC noted);
- Data recording rate;
- Elevation mask angle;
- General weather conditions and changes, if any during the session (especially the occurrence of electrical storms);
- All problems or unusual behavior with equipment or satellite tracking.

A sample log sheet is given in Appendix D.

6.9. OBSTRUCTION DIAGRAM

An obstruction diagram is required for all new and existing stations. The diagram must show all obstructions at elevation angles greater than 15° as seen from the antenna location. If there are no obstructions then it must be noted on the diagram. A sample obstruction diagram is given in Appendix E.

7. GPS DATA PROCESSING

7.1. SOFTWARE AND PROCESSING PROCEDURES

The same software must be used for all GPS data processing. The name and version of software must be documented. The software must calculate a covariance matrix for all estimated coordinate differences, which can be used as input to a rigorous three-dimensional network adjustment program.
Precise orbits must be used for processing baselines over 50 kilometres in length

Single baseline processing techniques must be used. All baseline combinations (not just independent baselines) must be processed and used in the adjustment. Fixed integer ambiguity solutions must be obtained for all baselines less than 30 km in length.

Dual frequency data must be processed for all baselines. L1-fixed solutions may be accepted for short baselines (less than 10 km in length) if they provide better solutions than the combined L1/L2-fixed solutions. All processing controls and options used must be clearly identified in the report.

Published NAD83 (CSRS) or NAD83 (Original) coordinates must be used for the first station of baseline processing for coordinate seeding. Subsequent baseline processing should be set up to propagate these initial values to the rest of the network throughout the processing.

7.2. DIFFERENCES BETWEEN REPEATED BASELINES

Differences between repeated baselines must be computed to check for blunders and to check for internal consistency of the GPS network. The maximum differences in repeated baseline lengths must not exceed (3 cm + 1 ppm). Repeat baselines that do not meet this requirement must be investigated and re-processed or re-observed if needed to meet all requirements of this specification.

8. ANALYSIS AND ADJUSTMENT

To allow for a complete analysis of the control network, both minimally constrained and fixed constraint least squares adjustments must be provided.

8.1. LEAST SQUARES ADJUSTMENT SOFTWARE

Rigorous 3D least squares adjustment software must be used. It must calculate and use the full formal covariance matrix of all the estimated coordinate differences and provide observation residuals. Regardless of software used, GeoLab input files are required for delivery (§ 10.5)

8.2. SCALING OF BASELINES AND COVARIANCE MATRIX INFORMATION

The scaling of individual *baselines* or baselines within a session is not permitted. Also, the scaling of the *covariance information* from individual baselines or from individual sessions is not permitted.

8.3. MINIMALLY CONSTRAINED ADJUSTMENT

A minimally constrained adjustment must be provided where one horizontal and one vertical station are held fixed to assess the quality and internal strength of the observations.

The latitude and longitude of one primary integration station (§ 4.1) will be fixed to its published NAD83 (CSRS) or NAD83 (Original) values along with the orthometric elevation of one of the stations defined in section 4.3.2. The geoid model must be applied to the adjustment (§ 9).

The baseline component (x, y, z) residuals derived from the adjustment must not exceed:

- 2 cm + 3 ppm of the baseline length, for baselines less than 20 km, and;
- 4 cm + 2 ppm of the baseline length, for baselines greater than 20 km.

Common trends in residuals must be investigated and analyzed.

The full covariance matrix will be scaled by the *a posteriori* variance factor when that value is greater than one.

The semi-major axis of the 95% horizontal *relative confidence region* between all connected stations must not exceed 2 cm. These *confidence regions* must be derived from the covariance matrix, which has been scaled by the *a posteriori* variance factor.

8.3.1 Baseline Rejection

The rejection of any baseline must be justified. The entire session containing the rejected baseline must be rejected unless the problem baseline can be isolated. Any baseline rejection must be documented with valid reasoning.

The network must continue to satisfy all specifications after the rejection of any baseline.

8.3.2 Verification of Control

The adjusted values from the minimally constrained adjustment must be compared to the published values of the existing horizontal and vertical control to assess the accuracy, compatibility and reliability of the existing control.

If any of the existing control is not compatible and therefore should not be held fixed in the final constrained adjustment, or used in the weighted constraint adjustment, valid detailed reasoning must be provided. In any event, the minimum number and accuracy of existing control must be met (§ 4.1.1, 4.1.2, 4.3.1, and 4.3.2).

8.4. FIXED CONSTRAINT ADJUSTMENT

8.4.1 NAD83 (CSRS)

A fixed constraint adjustment must be provided in which the existing NAD83 (CSRS) control stations in the network are held fixed to their NAD83 (CSRS) 3-D ellipsoidal coordinates.

Every effort must be made to meet the specified *local* and *network accuracy* throughout the network. However if it is not possible to achieve this level of accuracy for every station due to distortions in the existing network, a lower *local* or *network accuracy* classification may be deemed acceptable by the issuing agency.

8.4.2 NAD83 (Original)

A fixed constraint adjustment must be provided in which the existing horizontal and vertical (orthometric) control stations in the network are fixed to their published NAD83 (Original) values. The geoid model must be applied to the adjustment (§ 9).

Every effort must be made to meet the specified *order of accuracy* throughout the network. However if it is not possible to achieve this level of accuracy for every station due to distortions in the existing network, a lower *order of accuracy* may be deemed acceptable by the issuing agency.

8.5. WEIGHTED CONSTRAINT ADJUSTMENT

For the NAD83 (CSRS) weighted constraint adjustment, all NAD83 (CSRS) stations must be constrained to their published ellipsoidal coordinates and error estimates (covariance matrix) as provided from the CBN and OHPN adjustments.

The GPS baseline covariance matrix (not the coordinate covariance matrix) must be iteratively rescaled until the *a posteriori* variance factor is equal to one when adjusted with the coordinate constraints. This ensures that the final position error estimates fit the error estimates of the CBN.

Unless stated otherwise, the issuing agency will be responsible for performing the weighted constraint adjustment.

9. GEOID MODEL

The latest available Canadian geoid model, with appropriate corrector surface if applicable, must be used.

10. REPORTS AND RETURNS

The final report of a GPS survey project shall provide all the information necessary to evaluate the satisfactory completion of the project objective. Sufficient information must be provided in the report to enable reprocessing of the raw data, if required. The report items identified below are the minimum requirements for a project. Depending on the instrumentation or methodology used, additional information may be required.

10.1. PROJECT DESCRIPTION

A short description of the objectives of the project, location of the survey and number of stations positioned must be presented.

A detailed description of the project quality control plan and the measures taken to ensure the plan was followed must be included.

A description of any problems encountered, and how they were resolved, must be given.

A final network diagram showing all stations occupied must be submitted. It shall be to scale and must show:

- All existing control stations in the project area
- All new control stations;
- The baselines observed, complete with session identification, and;
- All repeat baselines.

10.2. SURVEY PROCEDURES

The returns submitted must be accompanied by a clear description of the survey procedures used in the field. The following information must be provided:

- A summary of the equipment used;
- Information related to specific procedures used in the field such as values and methods necessary to convert antenna height measurement to vertical height from marker to phase centre, and;
- A summary indicating for each session the stations occupied, their respective start and end time of data collection, and raw data file names.

10.3. GPS DATA PROCESSING PROCEDURES

A detailed description of the procedures used for processing and verifying the GPS data in the field or office must be presented. The following information must be provided:

- Computer software (version number and date) used in the data processing;
- A detailed description of the processing controls and options used;
- A description of the ephemerides used, their source and datum;
- A list of the fixed stations used for coordinate seeding during processing;

- Information and explanations about data editing performed;
- The ionospheric and tropospheric models used;
- Information and evaluation of the differences between repeat baselines.

10.4. ADJUSTMENT PROCEDURE AND ANALYSIS

A detailed description of the procedures used for adjustment and analysis of the network must be presented. The following information must be provided:

- Computer software (version number and date) used in the adjustments;
- The value used for scaling the covariance matrix in the minimally constrained adjustment to account for overly optimistic error estimates;
- A justification for any baselines rejected;
- An analysis of the residuals, residual outliers and the semi-major axes of the 2-D and 1-D 95% *relative confidence regions* between all connected stations from the minimally constrained adjustment;
- An analysis of the accuracy, compatibility and reliability of the existing control;
- An analysis of the residuals, residual outliers and the semi-major axes of the 2-D and 1-D 95% *relative confidence regions* between all connected stations from the fixed constraint adjustment;
- The *local* and *network accuracy* classification of the NAD83 (CSRS) network and the *order of accuracy* of the NAD83 (Original) network from the constrained adjustments.

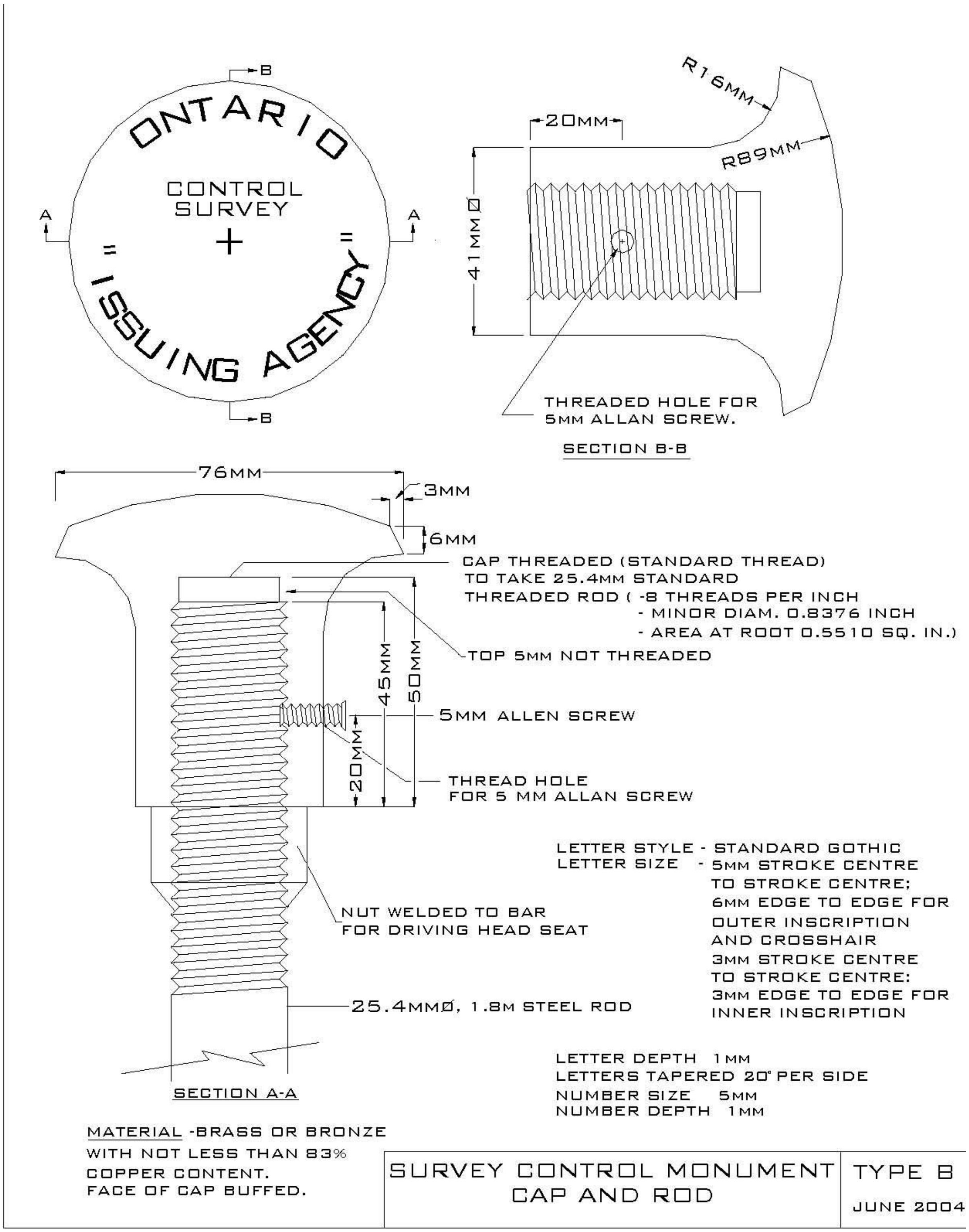
10.5. PROJECT DELIVERABLES

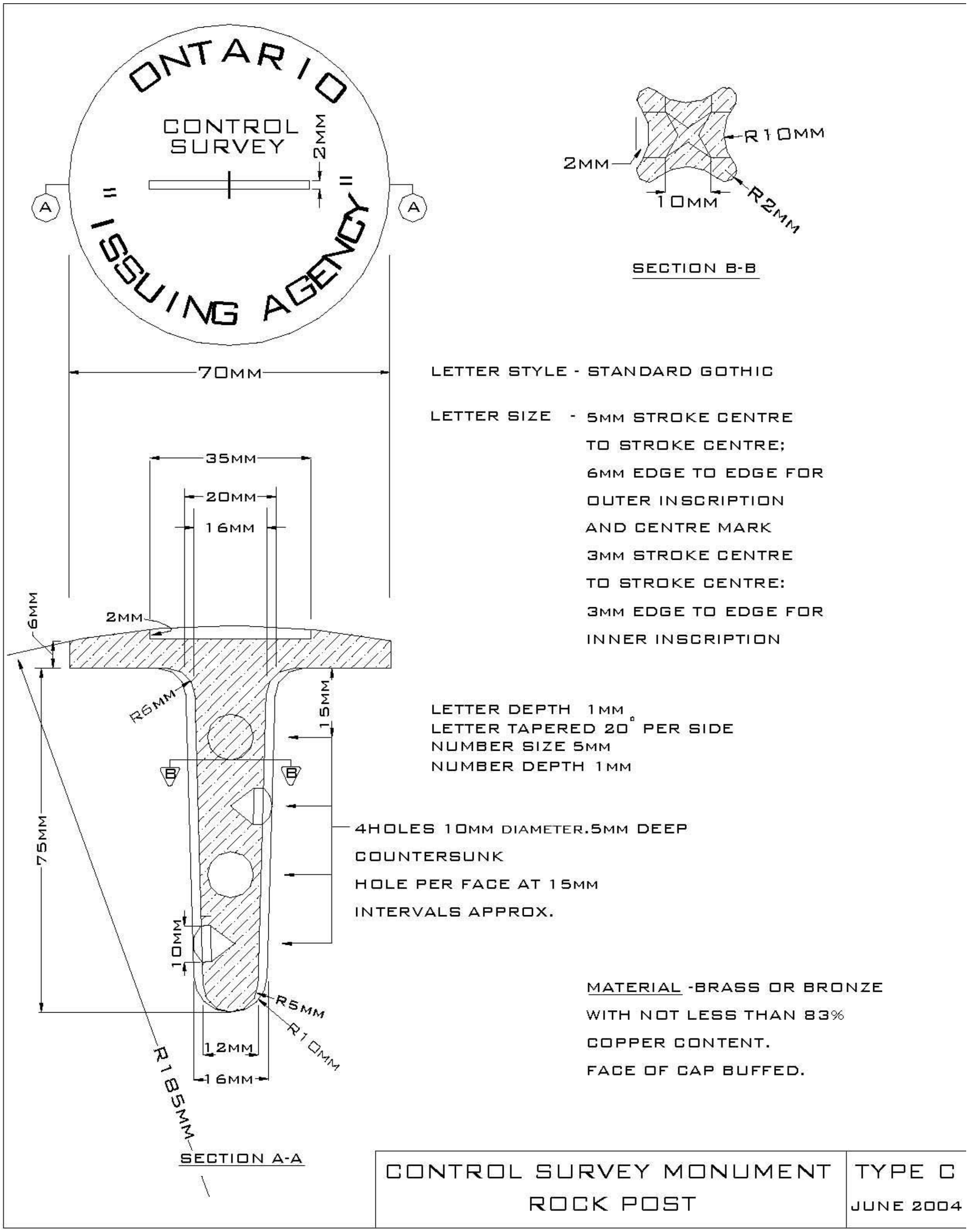
All digital data must be submitted on compact disc.

The deliverables shall include:

- All original measurement data (raw data) collected during the project, clearly labeled and described. Data must also be provided in RINEX (Receiver INdependent EXchange) Format, Version 2 or later;
- All original field notes, field logs, obstruction diagrams, levelling notes, etc.;
- New monument location sketches for both new and existing monuments (where required);
- All GPS baseline solution files in digital format with an index referencing the file to the session and baseline;
- A summary of the baseline solutions in digital (ASCII) format clearly indicating whether the ambiguities have been resolved and an indication of their quality;
- Minimally constrained and fixed constraint adjustment input files in digital format;
- Minimally constrained and fixed constraint adjustment output files in digital format;
- Minimally constrained and fixed constraint adjustment input files (digital) in GeoLab input file format (version 3 or greater);
- Final geographic (latitude, longitude orthometric elevation and ellipsoidal height), UTM and MTM coordinates in digital (ASCII) format, and;
- The final report.

APPENDIX A – MONUMENTATION




ONTARIO
CONTROL SURVEY
"ISSUING AGENCY"
2MM
A
A
R10MM
2MM
10MM
R2MM
SECTION B-B
70MM
LETTER STYLE - STANDARD GOTHIC
LETTER SIZE - 5MM STROKE CENTRE TO STROKE CENTRE; 6MM EDGE TO EDGE FOR OUTER INSCRIPTION AND CENTRE MARK
3MM STROKE CENTRE TO STROKE CENTRE: 3MM EDGE TO EDGE FOR INNER INSCRIPTION
35MM
20MM
16MM
6MM
2MM
R6MM
15MM
LETTER DEPTH 1MM
LETTER TAPERED 20° PER SIDE
NUMBER SIZE 5MM
NUMBER DEPTH 1MM
B
B
75MM
4HOLES 10MM DIAMETER.5MM DEEP COUNTERSUNK
HOLE PER FACE AT 15MM INTERVALS APPROX.
10MM
MATERIAL -BRASS OR BRONZE WITH NOT LESS THAN 83% COPPER CONTENT.
FACE OF CAP BUFFED.
R5MM
R10MM
12MM
16MM
R185MM
SECTION A-A
CONTROL SURVEY MONUMENT
ROCK POST
TYPE C
JUNE 2004

APPENDIX B – MONUMENT POSITION SKETCH

MONUMENT POSITION SKETCH

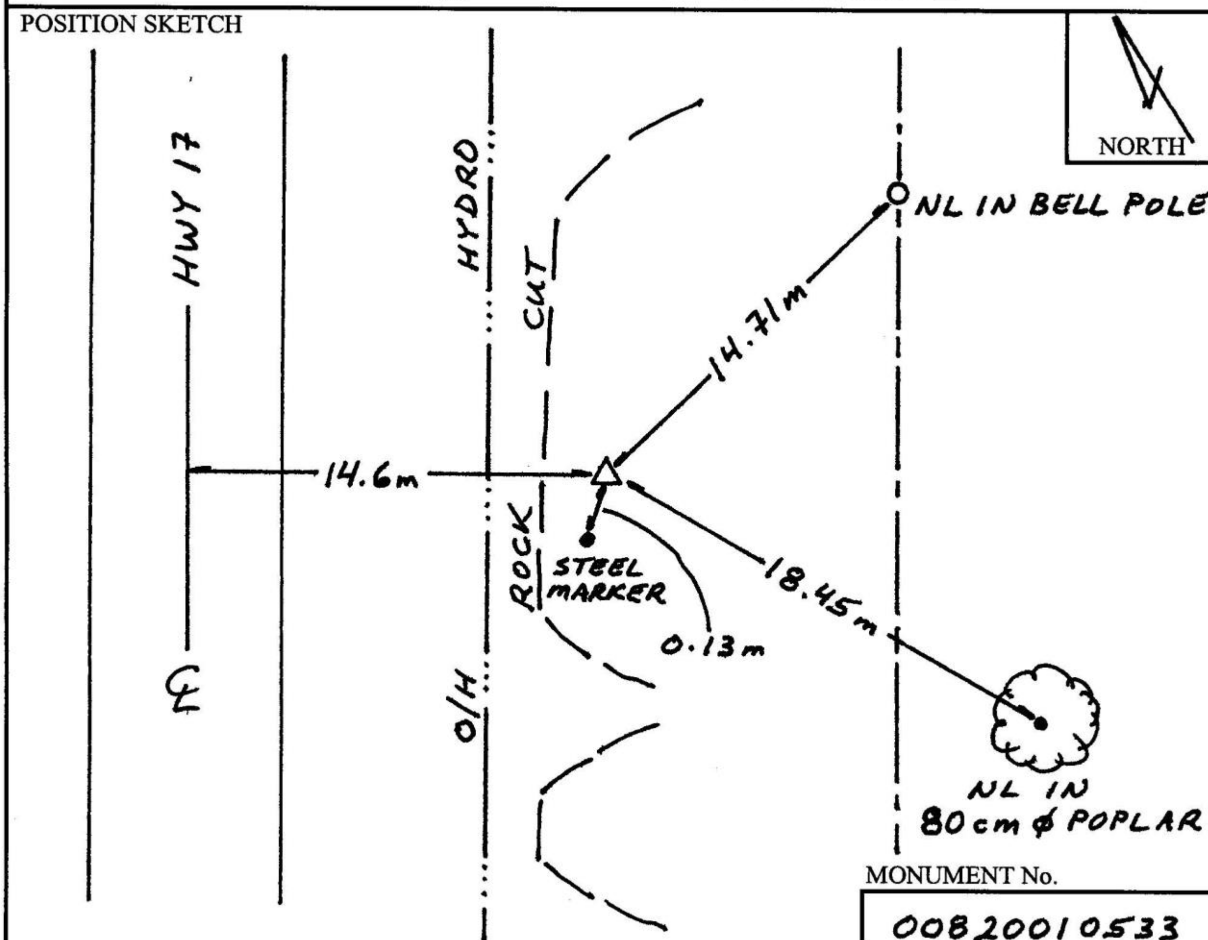
DATE: OCT. 15, 2001	UPDATED:	JOB FILE: 2001-109
TYPE OF MONUMENT: CAP IN ROCK	RELATIONSHIP TO GROUND: FLUSH	CONDITION NEW

INTERVISIBLE WITH:
00820010532

LOCATION:
POINT IS LOCATED 15.1 KM SOUTH OF A SCENIC LOOKOUT, 2.4 KM NORTH OF MAMAINSE HARBOUR RD., ON THE EAST SIDE OF HWY. 17.

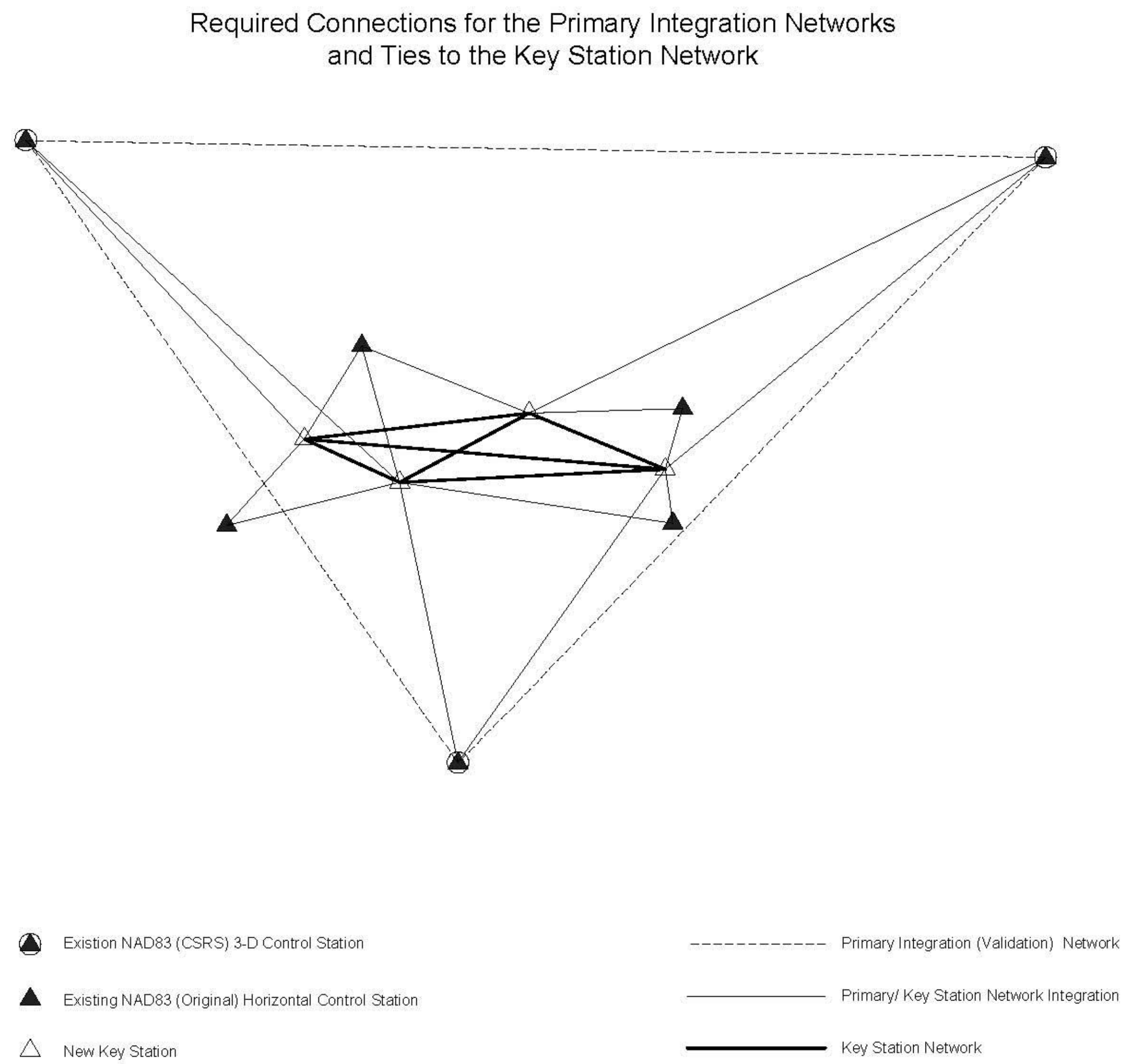
PURPOSE: LOCATE ✓ PRECISE REFERENCE __

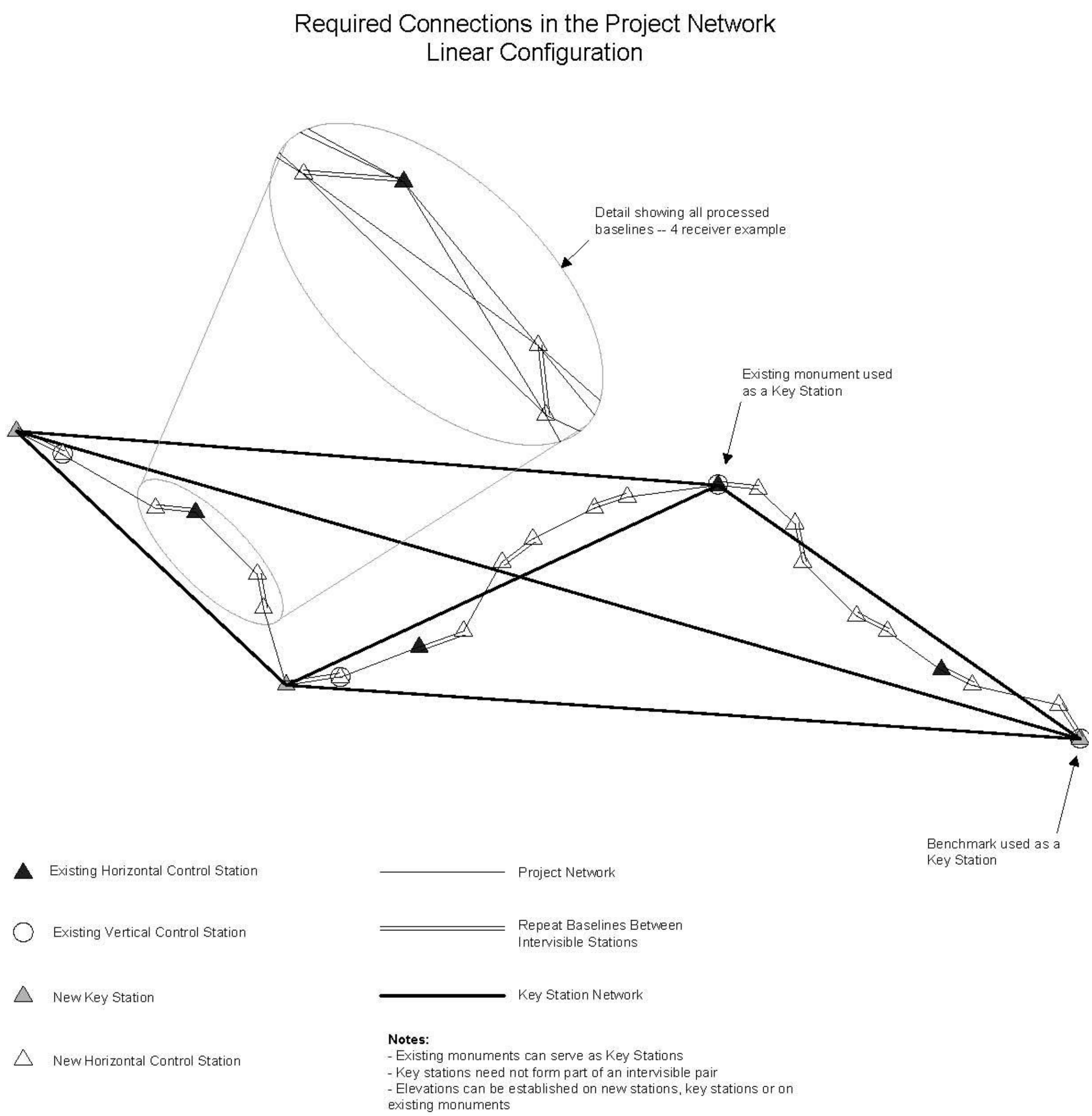
POSITION SKETCH



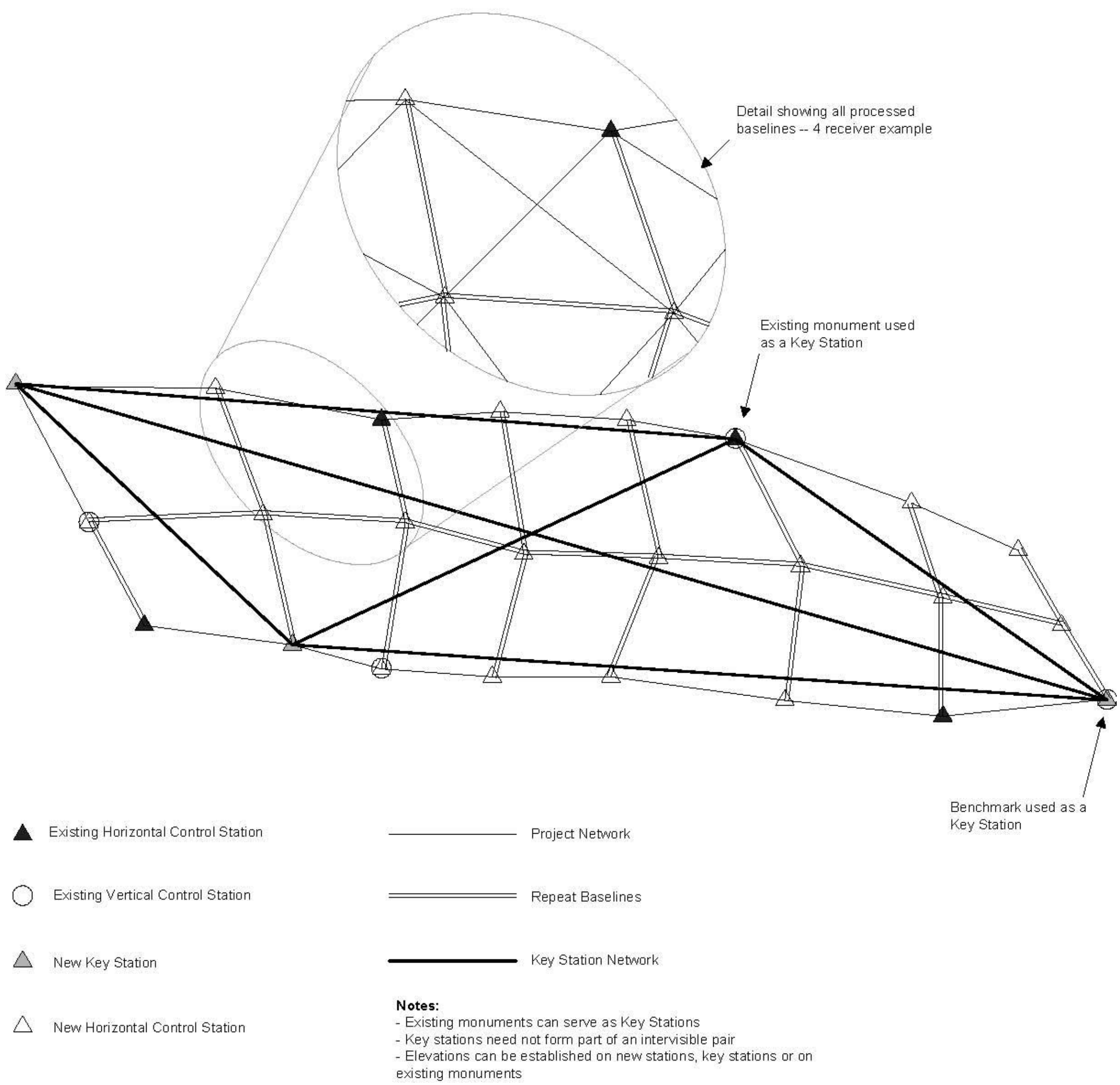
MONUMENT No.
00820010533

APPENDIX C – NETWORK DESIGN




Required Connections in the Project Network
Linear Configuration
Detail showing all processed baselines -- 4 receiver example
Existing monument used as a Key Station
Benchmark used as a Key Station
Existing Horizontal Control Station
Existing Vertical Control Station
New Key Station
New Horizontal Control Station
Project Network
Repeat Baselines Between Intervisible Stations
Key Station Network
Notes:
- Existing monuments can serve as Key Stations
- Key stations need not form part of an intervisible pair
- Elevations can be established on new stations, key stations or on existing monuments

Required Connections in the Project Network
Block Configuration



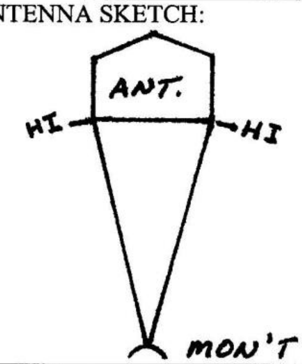
APPENDIX D – FIELD LOG SHEET

GPS FIELD LOG SHEET			
DATE: NOV. 3, 2001	JULIAN DAY: 307	JOB FILE: 2001-109	
RECEIVER MODEL: TRIMBLE 4700		ANTENNA MODEL: INTERNAL	
RECEIVER SN: 53904		ANTENNA SN: 21128	
WEATHER: SUNNY		OBSERVER: JOE B.	
	TIME: UTC OFFSET -5	HEIGHT:	TRUE __ SLANT ✓
START	12:25	1.289 1.289 = 1.289 M 1.288	4.22 F
STOP	14:55	1.289 1.288 = 1.288 M 1.288 1.288	4.22 F

TIME:	REMARK:
START	6 SV's GDOP = 4.1
12:31	SV 13 LOSS OF LOCK
12:38	SV 13 RE-LOCK
STOP	6 SV's GDOP = 3.8

NOTES:

ANTENNA SKETCH:

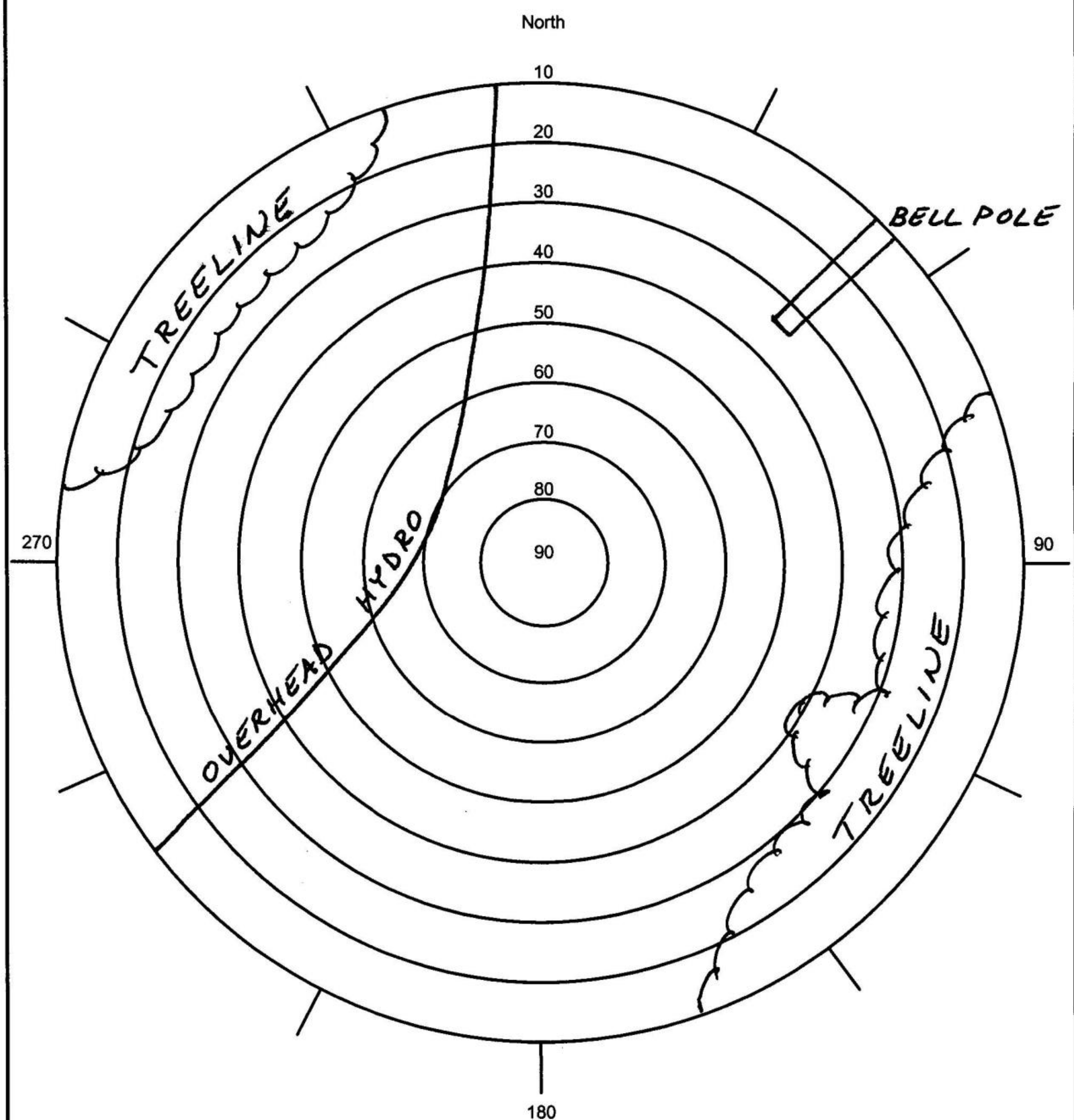


DATA RATE:	ELEVATION MASK:	SESSION ID:	MONUMENT No.:
10 SEC.	15°	3	00820010533

APPENDIX E – OBSTRUCTION DIAGRAM

MONUMENT OBSTRUCTION DIAGRAM

DATE: OCT. 15, 2001	UPDATED:	JOB FILE: 2001-109



MONUMENT No.

00820010533