Greater Vancouver GPS Validation Network

October 1997

BRITISH COLUMBIA
Ministry of Environment, Lands and Parks
Geographic Data BC

Natural Resources Canada
Geodetic Survey Division

Greater Vancouver GPS Validation Network

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Foreword

The purpose of this booklet is to provide the basic information required for users to test their GPS equipment and positioning methodology on the Greater Vancouver GPS Validation Network. Please contact Geographic Data BC, Ministry of Environment, Lands and Parks, for information related to this network that is not included in this document.

Table of Contents

1. Introduction to GPS Validation Networks

Background

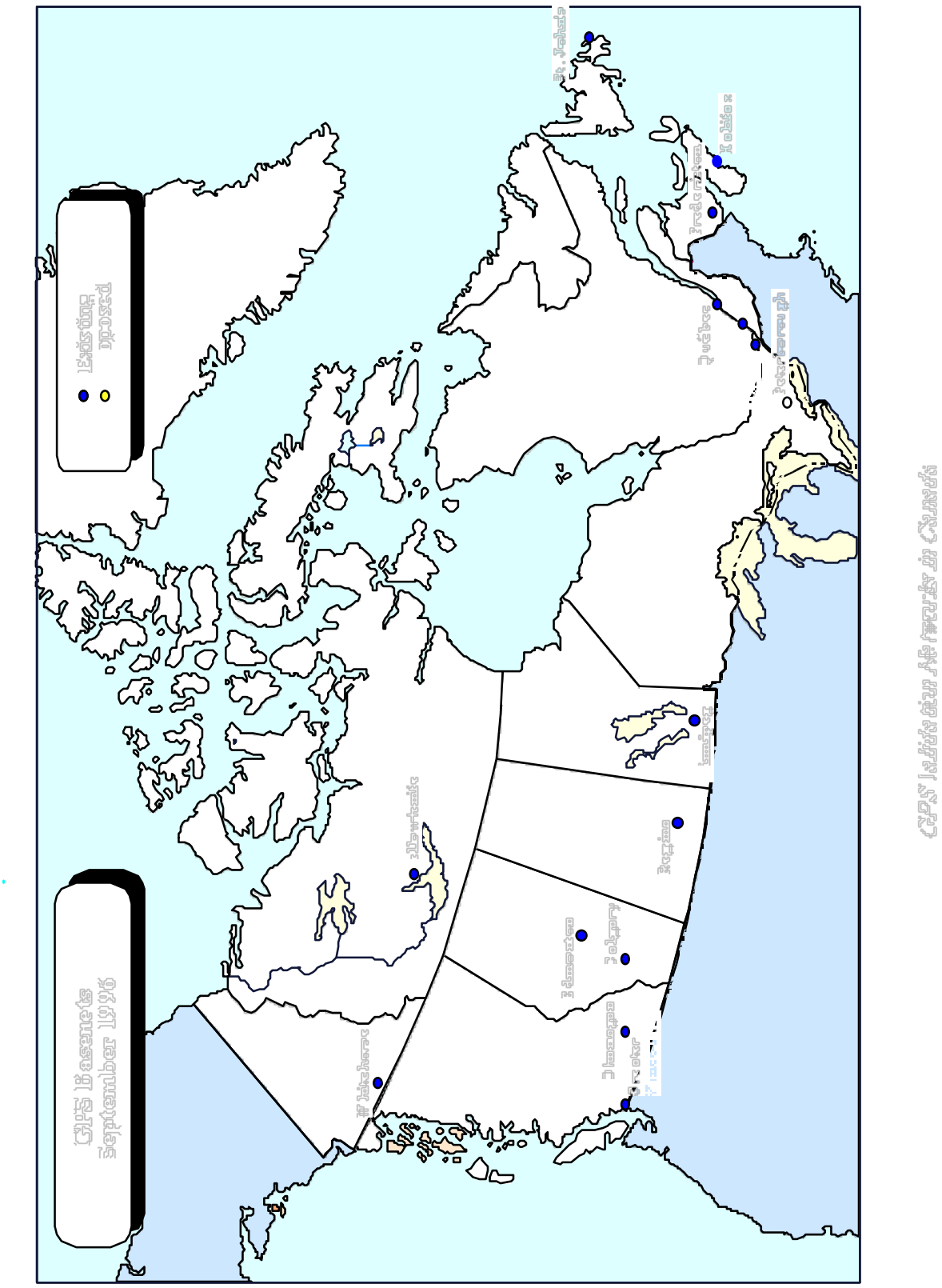
The Global Positioning System (GPS) has dramatically reshaped surveying and navigation in many parts of the world. The use of GPS positioning has become increasingly widespread. The need for a "truth" against which to test GPS positioning accuracy and precision has led to the establishment of GPS validation networks across Canada, also known as basenets, to serve as a physical standard for evaluating GPS equipment, software and positioning methodologies.

The first GPS validation network was established in the Ottawa region in 1988. Since that time other such networks have been established across the country, in collaboration with the provincial agencies responsible for geodetic surveying within their jurisdictions. The map that follows shows the locations of other GPS validation networks in Canada. Geodetic Survey Division (GSD), Natural Resources Canada (NRCan) maintains sole responsibility of the Ottawa network, including site maintenance and dissemination of basenet-related information such as data. For other GPS validation networks, including the Greater Vancouver basenet, this responsibility is shared with the provincial survey agencies.

Geographic Data BC located, designed and installed the Okanagan and Greater Vancouver networks in order to serve the needs of provincial users. GSD, NRCan established the validation coordinates for the network through precise GPS measurements. Each GPS validation network was initially established using at least two separate measurement campaigns in different years. Subsequent measurements may be performed periodically to check on pier movement.

Applications

GPS validation networks are mainly used to evaluate results obtained using a specific combination of GPS equipment, software, and observation procedures. The full range of GPS equipment, from hand-held C/A code receivers to geodetic quality dual frequency receivers, may be checked. Similarly, the accuracies obtainable from different observation procedures such as single point positioning, differential code, kinematic or static positioning techniques may be assessed.


Existing posts
GPS Occupants
September 1997

The validation networks may also be used to evaluate proposals from GPS survey contractors. A "validation survey" on a GPS basenet may be required to assess the proposed GPS positioning system, and determine with confidence whether it can meet contract accuracy requirements. A positioning system in this context includes the equipment and procedures used for data collection as well as the software and procedures used for the data processing and adjustment.

Characteristics

A GPS validation network is typically comprised of between 5 and 10 forced centering pillars or piers. Usually two of these pillars are also part of an Electronic Distance Measurement (EDM) calibration baseline and form the core of the network. The network design provides GPS baselines of varying lengths, usually ranging between 1 and 100 kilometres, and the design and location of pillars is such that:

- forced centering is used to eliminate centering error ;
- sites are easily accessible;
- sites are generally clear of obstructions above 10 degrees from the horizon; and
- for stability and longevity, pillar monumentation is carried out using the same specifications as for EDM calibration baseline pillars. (See Appendix D.)

The following section contains a description and map of the Greater Vancouver GPS validation network, and a brief explanation of the determination of coordinates listed in this document.

2. The Greater Vancouver GPS Validation Network

Description

The Greater Vancouver GPS validation network was constructed in 1993 by the B.C. Ministry of Environment, Lands and Parks, and is comprised of seven concrete forced centering pillars. Two of these pillars, National Geodetic Data Base (NGDB) numbered stations B336131 (Pier 1) and B693275 (Pier 6), are also coincident with the Surrey EDM baseline, and B326595 (Pier 3) is coincident with the West Vancouver EDM baseline. Pillar B192740 (Surrey Nursery) was included in the B.C./Washington State GPS on Benchmarks project. A cross reference list for corresponding provincial Geodetic Control Monument (GCM) numbers is provided in Appendices A and B.

The network, which is centred in Surrey, spans the entire lower Fraser Valley from Mission to West Vancouver. The basic configuration of the network, as shown on the following map, provides baseline lengths ranging from 800 metres to 74 kilometres**.**

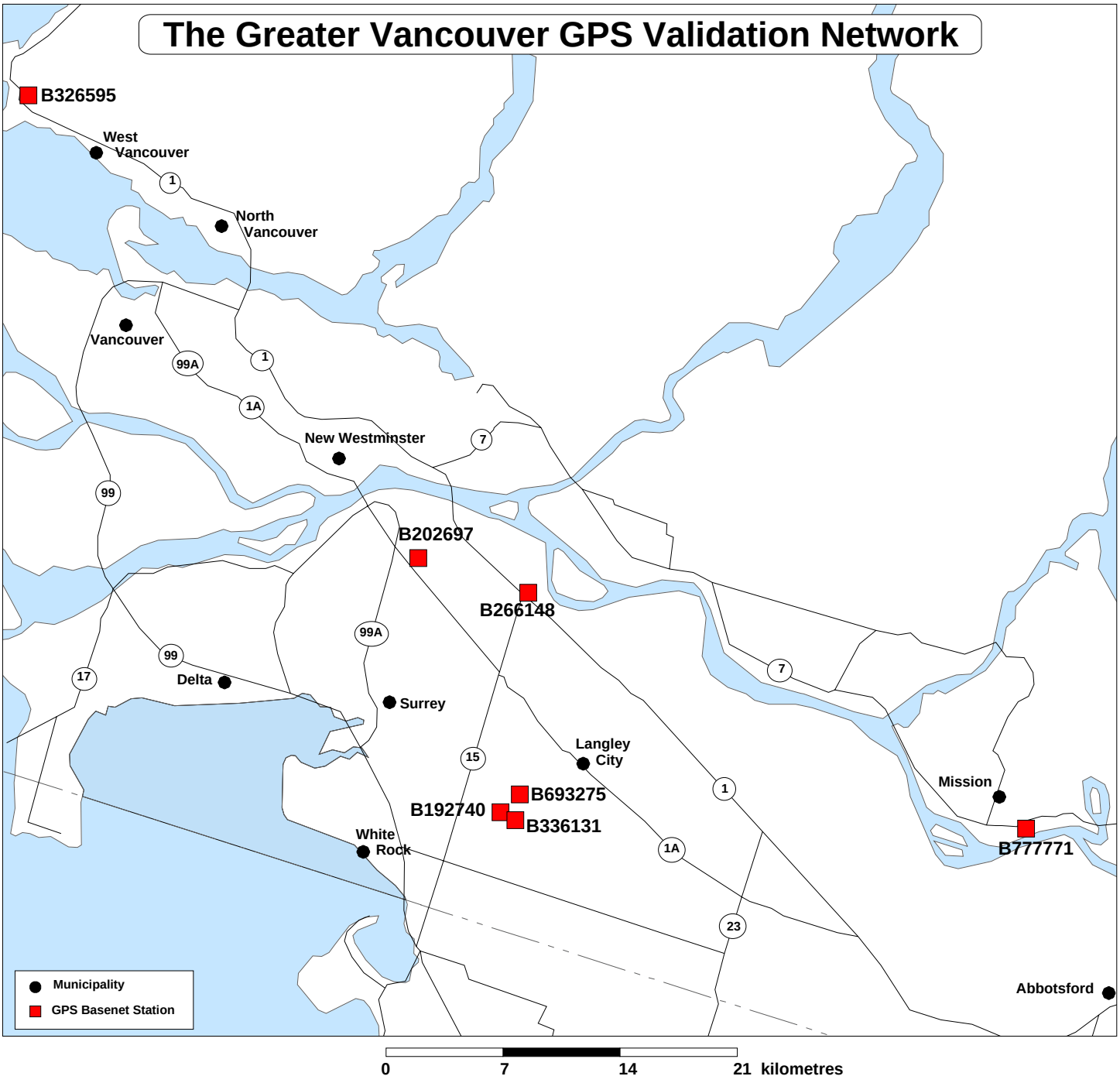
The basenet was first observed with GPS in 1993 by GSD, NRCan, with a second series of measurements carried out in 1994. Ashtech P-12 and Z-12 GPS receivers were used to collect the observations.

In addition to the three-dimensional positions established with GPS, all the pillars in the network have orthometric heights established through first order levelling. Descriptions and site sketches for each of the pillars, as well as a notice to users of this validation network, are provided in Appendix A.

Determination of Network Validation Values

Coordinate values for the Greater Vancouver GPS validation network were determined using data from two complete sets of observations carried out in 1993 and 1994, as shown in the table that follows. For each epoch, or year, the GPS data was processed in session mode using the Bernese GPS processing software.

The network validation coordinates appearing in this document were produced by combining all sessions from the two measurement epochs together in a minimally constrained three-dimensional least squares adjustment. Station B336131 (Pier 1) was constrained to its NAD83 Canadian Spatial Reference System (CSRS) coordinates. In tests carried out, to check for pier movement and statistical compatibility between the epochs, there was no indication of significant pier movement or distortion.



Note: Points on this map have been identified by their NGDB* station number. Corresponding GCM station numbers are provided below:**

NGDB Number	GCM Number
B192740	192740
B202697	202697
B266148	266148
B326595	326595
B336131	336131
B693275	693275
B777771	777771

*** NGDB: National Geodetic Data Base**
**** GCM: Geodetic Control Marker**

Measurement History - Greater Vancouver GPS Validation Network

Year	Receiver Type	Number of Receivers	Session Length (hours)	Number of Sessions	GPS Processing Software
1993	Ashtech P-12	6	5	5	Bernese v3.4
1994	Ashtech Z-12	6	6	3	Bernese v3.4

All coordinate values and error estimates can be found in Appendix B. The ellipsoidal, geocentric Cartesian, and mapping plane coordinates for network piers are given in Tables 1, 2 and 3, respectively. The Cartesian coordinate differences between each of the pillars can be found in Table 4. Absolute 95% confidence regions are provided in Tables 5, 6, and 7, while relative 95% confidence regions are provided in Tables 8, 9, and 10. Note that corresponding covariance data is available, as described in Appendix C.

Separate confidence regions are given for the three-dimensional (3-D), horizontal (2-D) and vertical (1-D) coordinates. This is necessary because the expansion factors used to compute the 95% confidence regions are different for each case. The 3-D confidence ellipsoids should be used when validating 3-D results. Similarly, the horizontal confidence ellipses should be used when validating only horizontal results. The vertical confidence intervals should be used when validating only vertical results. Separate horizontal and vertical validation tests must not be used together as a validation of 3-D results.

The coordinates given in this document are to be used **for validation purposes only.** If needed, adopted NAD83 survey control values are available from the Geo-Spatial Reference Unit, Geographic Data BC (see Appendix C).

The descriptions, sketches and coordinate values provided in this booklet are intended to provide all the basic information needed to use the Greater Vancouver GPS validation network as a physical standard for testing and validating GPS positioning systems to suit specific applications. Details on obtaining further information, data or documents are given in Appendix C.

Appendix A

Station Descriptions and Site Sketches

GCM Number	NGDB Number	Station Name
192740	B192740	Surrey Nursery
202697	B202697	Green Timbers Nursery
266148	B266148	Tynehead Park
326595	B326595	Pier 3 West Vancouver Baseline
336131	B336131	Pier 1 Surrey Baseline
693275	B693275	Pier 6 Surrey Baseline
777771	B777771	Fraser River Heritage Park

Notice to Users

- The Greater Vancouver GPS validation network is located on public property. Any damage to private or public property which may occur during the use of the network is the responsibility of the user.
- Users must obey normal traffic safety laws.
- The network was installed with the cooperation of local residents and common courtesy should be observed during occupations.
- Some of the adjacent roads are not paved; please try to keep dust levels at a minimum by driving at a moderate rate of speed.
- Users may reserve the basenet, for validation purposes only, by contacting the agency specified on the station diagrams.
- Users are also asked to assist in the preservation of the network pillars. Please report any damage or potential dangers to:

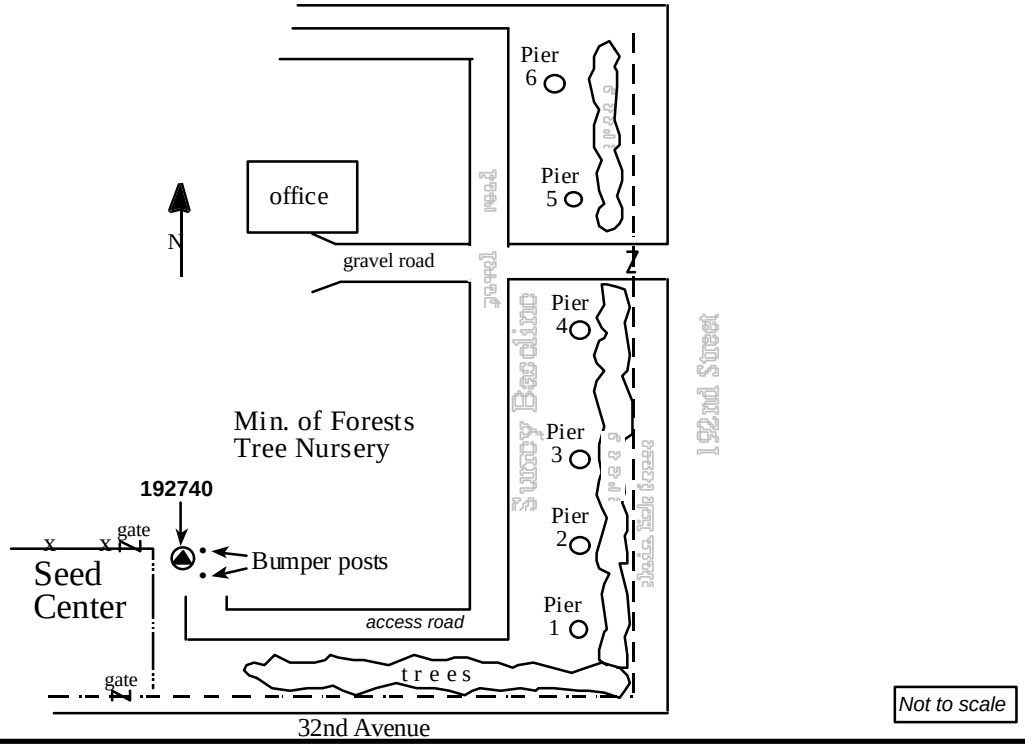
Ministry of Environment, Lands and Parks
Geographic Data BC
Geo-Spatial Reference Unit
4th Floor, 1802 Douglas Street
Victoria, British Columbia
V8T 4K6
Tel: (250) 387-3164
Fax: (250) 356-7831

Station 192740 Surrey Nursery ***(NGDB B192740)***

GREATER VANCOUVER GPS VALIDATION NETWORK

STATION NAME - SURREY NURSERY
GCM NO. 192740 *(NGDB B192740)*

SCALED COORDINATES
LAT: 49°13'40"
LON: 122°42'7"
ELEV: 47 m



DESCRIPTION: Marked by a cylindrical concrete pillar with a stainless steel forced centering baseplate set in the top.

ACCESS: Surrey. From the intersection of 200th Street and 32nd Avenue, proceed East 1.7 km along 32nd Avenue to 192nd Street. Proceed North 0.9 km along 192nd Street to the gate at the "Surrey Nursery and Seed Orchards Land". Pass through the gate and turn South along access road past the Surrey Baseline to the other side of the nursery. Station is located 10.5 m South and 1.5 m East of gate and fence corner to Seed Centre.

NOTE: Centering pins and wrench must be obtained from Peter Mueller, BCLS District of Surrey (14245-56th Avenue, Surrey, B.C., V3X 3A2, 604-591-4260)

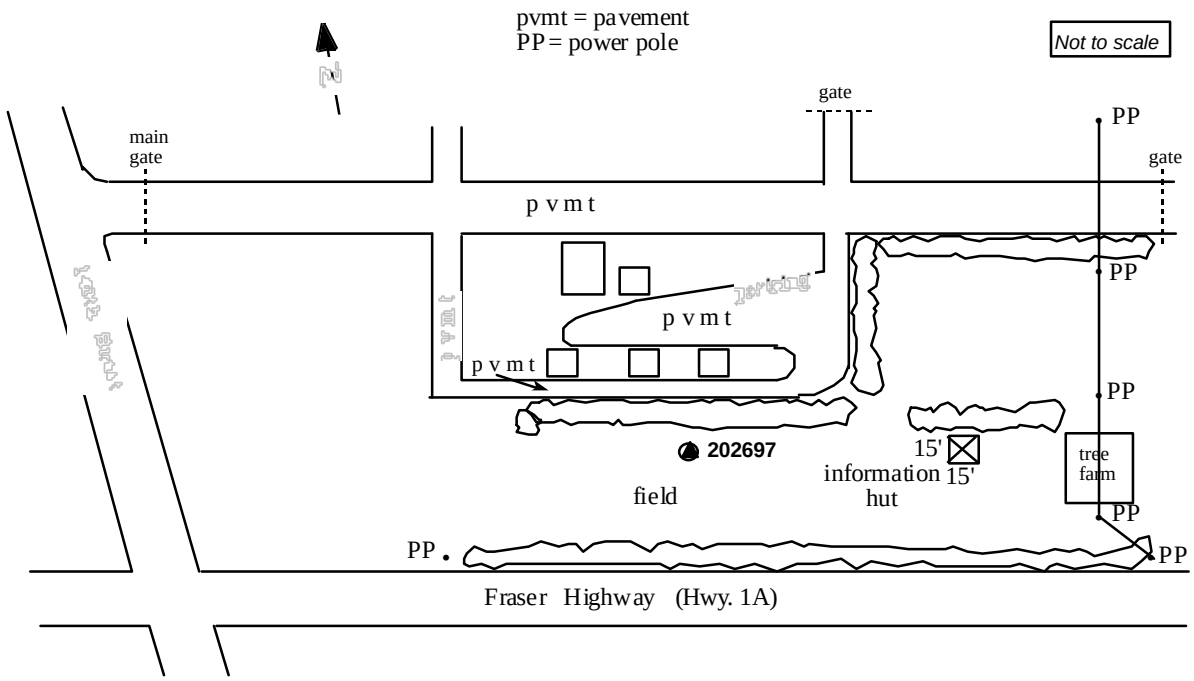
OWNER: Ministry of Forests. Surrey Nursery. Hours of operation: Monday-Friday 08:00-16:00. Any access outside of operating hours please make arrangements with Nursery Superintendent, phone 604-576-9161.

Station 202697 Green Timbers Nursery ***(NGDB B202697)***

GREATER VANCOUVER GPS VALIDATION NETWORK

STATION NAME - GREEN TIMBERS NURSERY
GCM NO. 202697 *(NGDB B202697)*

SCALED COORDINATES
LAT: 49Þ10'41"
LON: 122Þ49'48"
ELEV: 85 m



DESCRIPTION: Marked by a cylindrical concrete pillar with a stainless steel forced centering baseplate set in the top.

ACCESS: Surrey. From the intersection of Fraser Highway and King George Highway, take the Fraser Highway East 2 blocks to 140th Street, go North on 140th for approximately 1 km and take the first turn off to the East. There is a gate. A key can be borrowed to open the gate. Proceed through the first intersection and make a right at the next intersection. There should be 5 buildings around a paved court. Go straight so that you take the road which goes behind the furthest building from the intersection. Once at the end, you must make a right. The monument is 15 m Southwest from the corner.

NOTE: The centering pins and wrench must be obtained from Peter Mueller, BCLS District of Surrey (14245-56thAvenue, Surrey, B.C., V3X 3A2, 604-591-4260).

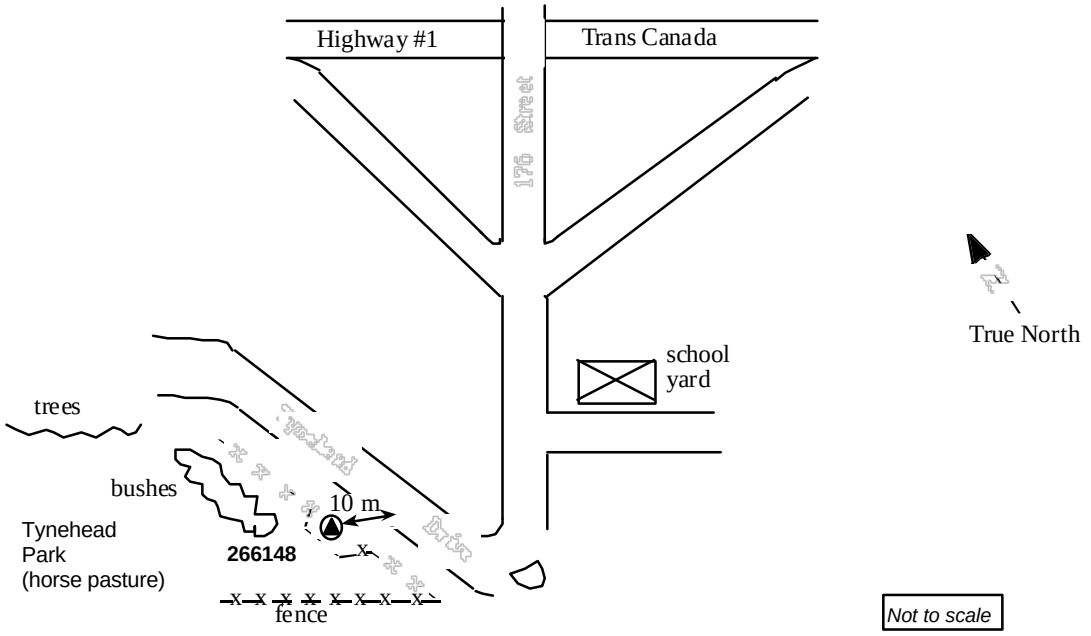
OWNER: Ministry of Forests. Surrey Nursery . Hours of operation: Monday-Friday 08:00-16:00. Any access outside of operating hours please make arrangements with Nursery Superintendent, phone 604-930-3325.

Station 266148 Tynehead Park ***(NGDB B266148)***

GREATER VANCOUVER GPS VALIDATION NETWORK

STATION NAME - TYNEHEAD PARK
GCM NO. 266148 *(NGDB B266148)*

SCALED COORDINATES
LAT: 49Þ10'41"
LON: 122Þ44'6"
ELEV: 68 m



DESCRIPTION: Marked by a cylindrical concrete pillar with a stainless steel forced centering baseplate set in the top.

ACCESS: Surrey. From the intersection of Highway #1 (T rans Canada) and 176 Street overpass proceed South on 176 Street 250 m, turn right (West) onto Tynehead Drive. Proceed Northwest on Tynehead Drive 50 m. Monument is located on the West side of road marked by a forced centering steel plate set in the top of a concrete pier.

NOTE: The centering pins and wrench must be obtained from Peter Mueller, BCLS District of Surrey (14245-56thAvenue, Surrey, B.C., V3X 3A2, 604-591-4260).

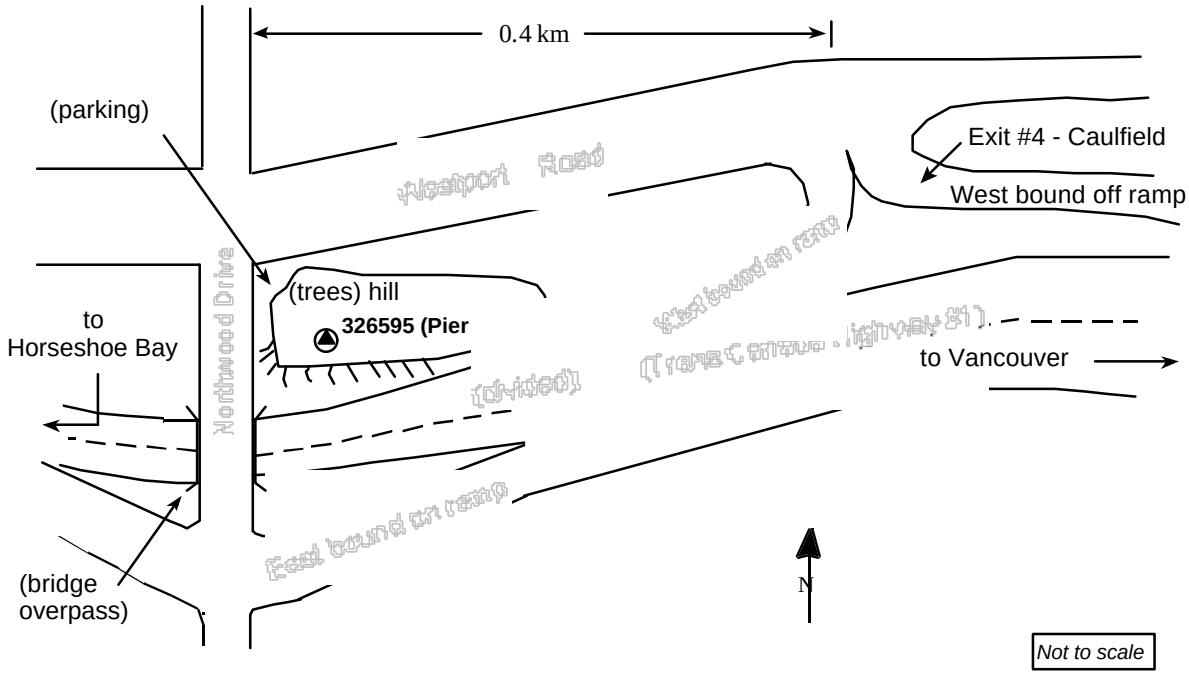
OWNER: Tynehead Park - Greater Vancouver Regional District

Station 326595 Pier 3 West Vancouver Baseline ***(NGDB B326595)***

GREATER VANCOUVER GPS VALIDATION NETWORK

STATION NAME - Pier 3 West Vancouver Baseline
GCM NO. 326595 *(NGDB B326595)*

SCALED COORDINATES
LAT: 49H 21'6"
LON: 123H 15'4"
ELEV: 180 m



DESCRIPTION: Marked by a cylindrical concrete pillar with a stainless steel forced centering baseplate set in the top.

ACCESS: West Vancouver. Concrete monument anchored in, and on South side of, bedrock knob on East side of Northwood Drive between Trans-Canada Highway (Highway #1) and Westport Road. 34.1 m South of centre line of Westport Road, 30.2 m North of centre line of westbound lane of Trans-Canada Highway, 26.3 m East of centre line of Northwood Drive, 6 m above road level.

NOTE: Centering pins and wrench must be obtained from Peter Mueller , District of Surrey , phone 604-591-4260. In addition, please also make reservations with the Vancouver City Surveyor, Noel Peters, phone 604-873-7328.

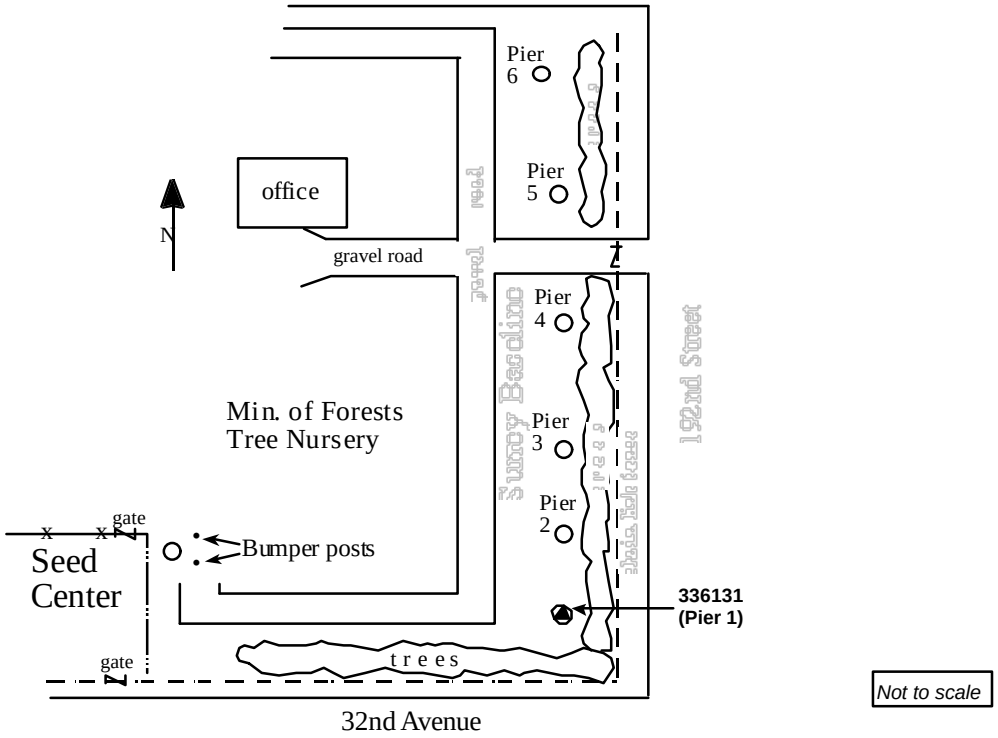
OWNER: Ministry of Transportation and Highways - Right-of-Way.

Station 336131 Pier 1 Surrey Baseline ***(NGDB B336131)***

GREATER VANCOUVER GPS VALIDATION NETWORK

STATION NAME - PIER 1 SURREY BASELINE
GCM NO. 336131 *(NGDB B336131)*

SCALED COORDINATES
LAT: 49Þ8'36"
LON: 122Þ41'28"
ELEV: 48 m



DESCRIPTION: Marked by a cylindrical concrete pillar with a stainless steel forced centering baseplate set in the top.

ACCESS: Surrey. From intersection of 200th Street and 32ndAvenue proceed East 1.7 km along 32nd Avenue to 192nd Street. Proceed North 0.9 km along 192nd Street to the gate at the "Surrey Nursery and Seed Orchards Land". Pass through gate and turn South. The station is 800 m South of the gate. The monument is Pier #1 of the Surrey Baseline and is painted white with a black #1 on the West side of it. Marked by a forced centering steel plate on top of a concrete pier.

NOTE: The centering pins and wrench must be obtained from Peter Mueller, BCLS District of Surrey (14245-56thAvenue, Surrey, B.C., V3X 3A2, 604-591-4260).

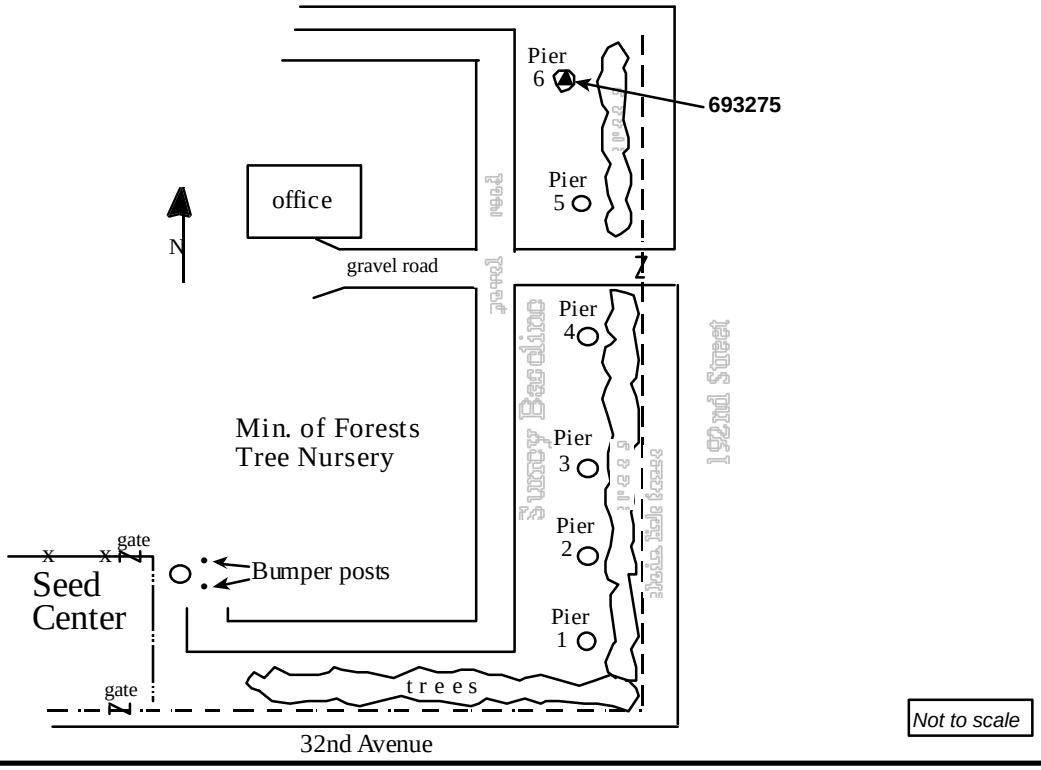
OWNER: Ministry of Forests. Surrey Nursery. Hours of operation:
Monday-Friday 08:00-16:00. Any access outside of operating hours please make arrangements with Nursery Superintendent, phone 604-576-9161.

Station 693275 Pier 6 Surrey Baseline ***(NGDB B693275)***

GREATER VANCOUVER GPS VALIDATION NETWORK

STATION NAME - PIER 6 SURREY BASELINE
GCM NO. 693275 *(NGDB B693275)*

SCALED COORDINATES
LAT: 49Þ4'26"
LON: 122Þ41'28"
ELEV: 44 m



DESCRIPTION: Marked by a cylindrical concrete pillar with a stainless steel forced centering baseplate set in the top.

ACCESS: Surrey. From intersection of 200th Street and 32nd Avenue, proceed East 1.7 km along 32nd Avenue to 192nd Street. Proceed North 0.9 km along 192nd Street to the gate at the "Surrey Nursery and Seed Orchards Land". Pass through gate and turn right. The station is approximately 700 m North of the gate. The monument is Pier #6 of the Surrey Baseline and is painted white with a black "6" on the W est side of it. Marked by a forced centering steel plate set in a concrete pier .

NOTE: The centering pins and wrench must be obtained from Peter Mueller, BCLS District of Surrey (14245-56th Avenue, Surrey, B.C., V3X 3A2, 604-591-4260).

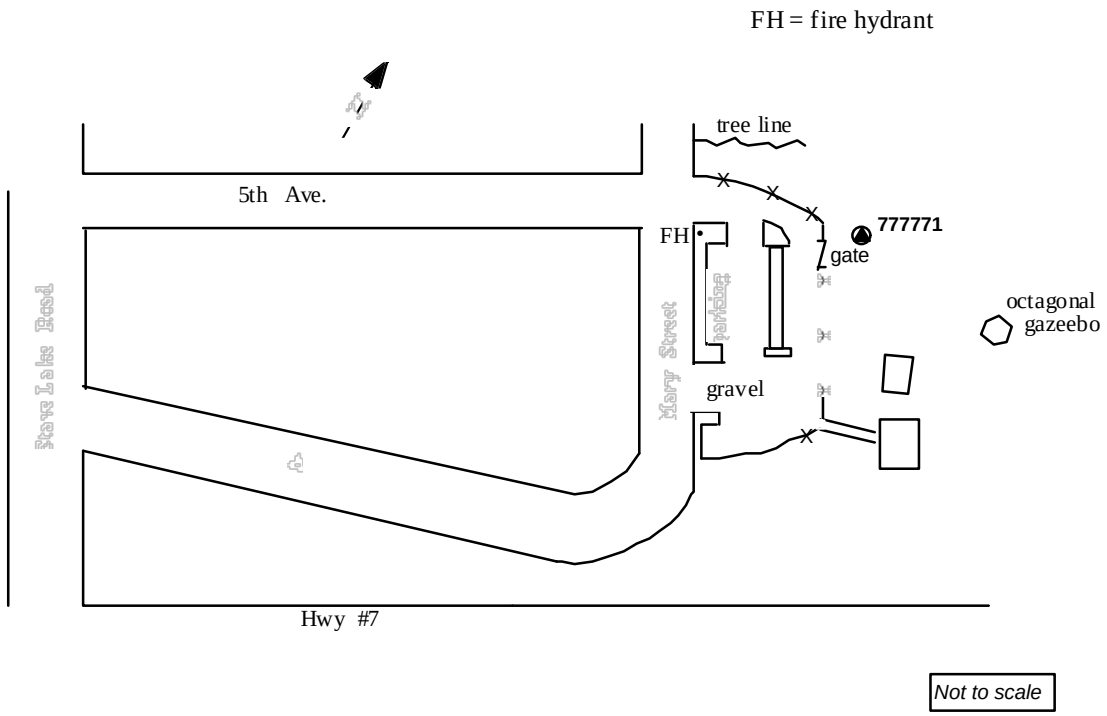
OWNER: Ministry of Forests. Surrey Nursery . Hours of operation:
Monday-Friday 08:00-16:00. Any access outside of operating hours please make arrangements with Nursery Superintendent, phone 604-576-9161.

Station 777771 Fraser River Heritage Park ***(NGDB B777771)***

GREATER VANCOUVER GPS VALIDATION NETWORK

STATION NAME - FRASER RIVER HERIT AGE PARK
GCM NO. 777771 *(NGDB B777771)*

SCALED COORDINATES
LAT: 49Þ3'17"
LON: 122Þ17'13"
ELEV: 49 m



DESCRIPTION: Marked by a cylindrical concrete pillar with a stainless steel forced centering baseplate set in the top.

ACCESS: Mission. From Mission by the Fraser River , go East on Highway #7 for about 2 km to Stave Lake Road, go North on Stave Lake Road about 300 m to 5th Avenue go East on 5th Avenue about 300 m to Mary Street. Fraser River Heritage Park is on the West side of Mary Street at its South end. The monument is beside this park's parking lot (North side). There are three 4" x 4" wooden posts evenly spaced around the monument (approximately 70 cm away).

NOTE: The centering pins and wrench must be obtained from Peter Mueller, BCLS District of Surrey (14245-56th Avenue, Surrey, B.C., V3X 3A2, 604-591-4260).

OWNER: Fraser River Heritage park - Dewdney-Alouette Regional District

Appendix B

Tables of Values

(Greater Vancouver GPS Validation Network - 1993 & 1994 epochs combined)

Warning to Users: These coordinates are to be used for validation only, and are not to be considered survey control values. Control coordinates may be obtained from the Geo-Spatial Reference Unit as described in Appendix C. Note that station B336131 was constrained to its NAD83(CSRS) value in the adjustment that produced these coordinates.

Station Number Cross Reference List

GCM Number	NGDB Number	Station Name
192740	B192740	Surrey Nursery
202697	B202697	Green Timbers Nursery
266148	B266148	Tynehead Park
326595	B326595	Pier 3 West Vancouver Baseline
336131	B336131	Pier 1 Surrey Baseline
693275	B693275	Pier 6 Surrey Baseline
777771	B777771	Fraser River Heritage Park

Table 1: Ellipsoidal Coordinates

NGDB #	Latitude North (d m s)	Longitude West (d m s)	Ellipsoidal Height (m)
B266148	49 10 44.29305	122 44 06.86721	49.262
B336131	49 03 39.46757	122 41 30.28191	28.976
B202697	49 10 42.77284	122 49 48.48202	65.873
B693275	49 04 27.05088	122 41 30.79476	25.107
B192740	49 03 42.13248	122 42 08.88031	27.248
B326595	49 21 06.17499	123 15 03.72812	161.860
B777771	49 08 16.81459	122 17 15.56325	31.111

Table 2: Geocentric Cartesian Coordinates

NGDB #	X (m)	Y (m)	Z (m)
B266148	-2258975.379	-3513959.729	4803630.448
B336131	-2261659.401	-3524013.294	4795025.822
B202697	-2264817.236	-3510252.594	4803612.318
B693275	-2261066.979	-3523070.938	4795985.963
B192740	-2262284.600	-3523536.723	4795078.460
B326595	-2282575.322	-3481368.720	4816252.770
B777771	-2233291.093	-3534402.780	4800637.234

Table 3: UTM Mapping Plane Coordinates

NGDB #	Northing (m)	Easting (m)	Zone
B266148	5447385.107	519295.661	10
B336131	5434278.569	522519.005	10
B202697	5447318.312	512379.962	10
B693275	5435747.877	522502.629	10
B192740	5434357.732	521735.424	10
B326595	5466585.800	481768.267	10
B777771	5443041.502	551958.313	10

Warning to Users: Distances derived from UTM coordinates are distorted. They cannot be compared to spatial distances derived from Cartesian or ellipsoidal coordinates without applying the proper scale factors. UTM coordinates and distances should only be compared to other UTM coordinates and distances. For more information, please contact Geodetic Survey as described in Appendix C.

Table 4: Interstation Cartesian Coordinate Differences

From NGDB #	To NGDB #	Δ X (m)	Δ Y (m)	Δ Z (m)	Spatial Distance (m)
B266148	B336131	-2684.023	-10053.565	-8604.625	13502.508
B266148	B202697	-5841.858	3707.134	-18.130	6918.849
B266148	B693275	-2091.600	-9111.209	-7644.485	12075.888
B266148	B192740	-3309.222	-9576.994	-8551.988	13259.196
B266148	B326595	-23599.943	32591.009	12622.322	42171.723
B266148	B777771	25684.285	-20443.051	-2993.213	32963.012
B336131	B202697	-3157.835	13760.700	8586.496	16524.427
B336131	B693275	592.423	942.356	960.140	1469.990
B336131	B192740	-625.199	476.571	52.638	787.886
B336131	B326595	-20915.920	42644.575	21226.948	52025.174
B336131	B777771	28368.308	-10389.486	5611.412	30727.679
B202697	B693275	3750.258	-12818.343	-7626.355	15379.716
B202697	B192740	2532.636	-13284.129	-8533.858	15990.905
B202697	B326595	-17758.085	28883.875	12640.452	36185.755
B202697	B777771	31526.143	-24150.185	-2975.084	39824.368
B693275	B192740	-1217.622	-465.785	-907.503	1588.433
B693275	B326595	-21508.343	41702.218	20266.807	51111.910
B693275	B777771	27775.885	-11331.842	4651.272	30356.956
B192740	B326595	-20290.721	42168.004	21174.310	51363.463
B192740	B777771	28993.507	-10866.057	5558.774	31457.823
B326595	B777771	49284.228	-53034.060	-15615.536	74063.430

Table 5: Absolute 95% 3-D Confidence Ellipsoids

NGDB #	Major Semi-axis			Medium Semi-axis			Minor Semi-axis		
	length (m)	az. (deg)	inc. (deg)	length (m)	az. (deg)	inc. (deg)	length (m)	az. (deg)	inc. (deg)
B266148	0.03	187	89	0.01	38	1	0.01	128	0
B336131	0.03	196	89	0.01	24	1	0.01	114	0
B202697	0.03	186	89	0.01	27	1	0.01	117	0
B693275	0.03	192	89	0.01	23	1	0.01	113	0
B192740	0.03	201	89	0.02	23	1	0.01	113	0
B326595	0.03	174	89	0.01	22	1	0.01	112	0
B777771	0.04	215	89	0.01	30	1	0.01	120	0

Table 6: Absolute 95% Horizontal Confidence Ellipses

NGDB #	Major Semi-axis		Minor Semi-axis	
	length (m)	az. (deg)	length (m)	az. (deg)
B266148	0.01	38	0.01	128
B336131	0.01	24	0.01	114
B202697	0.01	27	0.01	117
B693275	0.01	23	0.01	113
B192740	0.01	23	0.01	113
B326595	0.01	21	0.01	111
B777771	0.01	30	0.01	120

Table 7: Absolute 95% Vertical Confidence Intervals

NGDB #	+/- length (m)
B266148	0.02
B336131	0.02
B202697	0.02
B693275	0.02
B192740	0.02
B326595	0.02
B777771	0.02

Note: The semi-axes of the absolute confidence regions are shown to the nearest centimetre (rather than millimetre), because absolute accuracy with respect to the reference system NAD83(CSRS) is known only at the centimetre level.

Table 8: Relative 95% 3-D Confidence Ellipsoids

From NGDB #	To NGDB #	Major Semi-axis			Medium Semi-axis			Minor Semi-axis		
		length (m)	az. (deg)	inc. (deg)	length (m)	az. (deg)	inc. (deg)	length (m)	az. (deg)	inc. (deg)
B266148	B336131	0.015	200	89	0.003	6	1	0.002	96	0
B266148	B202697	0.016	192	89	0.003	13	1	0.002	103	0
B266148	B693275	0.015	192	89	0.003	7	1	0.002	97	0
B266148	B192740	0.017	209	89	0.003	8	1	0.002	98	0
B266148	B326595	0.018	191	89	0.003	347	1	0.003	77	1
B266148	B777771	0.019	216	89	0.003	14	1	0.003	104	1
B336131	B202697	0.015	198	89	0.003	0	1	0.002	90	0
B336131	B693275	0.015	198	89	0.003	12	1	0.002	102	0
B336131	B192740	0.015	216	89	0.003	13	1	0.002	103	0
B336131	B326595	0.017	200	89	0.003	332	1	0.003	62	1
B336131	B777771	0.017	215	89	0.003	30	1	0.002	120	0
B202697	B693275	0.016	189	89	0.003	2	1	0.003	92	0
B202697	B192740	0.016	207	89	0.003	2	1	0.002	92	1
B202697	B326595	0.018	202	89	0.003	349	1	0.003	79	1
B202697	B777771	0.018	211	89	0.003	15	1	0.003	105	0
B693275	B192740	0.017	207	89	0.003	13	1	0.002	103	0
B693275	B326595	0.018	196	89	0.004	338	1	0.003	68	1
B693275	B777771	0.018	211	89	0.003	23	1	0.003	113	0
B192740	B326595	0.018	206	89	0.004	338	1	0.003	68	1
B192740	B777771	0.019	217	89	0.003	26	1	0.003	116	0
B326595	B777771	0.019	215	89	0.004	114	0	0.003	24	1

Table 9: Relative 95% Horizontal Confidence Ellipses

From NGDB #	To NGDB #	Major Semi-axis length (m)	Major Semi-axis az. (deg)	Minor Semi-axis length (m)	Minor Semi-axis az. (deg)
B266148	B336131	0.003	7	0.002	97
B266148	B202697	0.003	13	0.002	103
B266148	B693275	0.003	7	0.002	97
B266148	B192740	0.003	8	0.002	98
B266148	B326595	0.003	348	0.003	78
B266148	B777771	0.003	15	0.003	105
B336131	B202697	0.003	0	0.002	90
B336131	B693275	0.003	12	0.002	102
B336131	B192740	0.002	14	0.002	104
B336131	B326595	0.003	333	0.002	63
B336131	B777771	0.003	30	0.002	120
B202697	B693275	0.003	2	0.002	92
B202697	B192740	0.003	3	0.002	93
B202697	B326595	0.003	350	0.003	80
B202697	B777771	0.003	16	0.003	106
B693275	B192740	0.003	13	0.002	103
B693275	B326595	0.003	339	0.003	69
B693275	B777771	0.003	24	0.002	114
B192740	B326595	0.003	339	0.003	69
B192740	B777771	0.003	26	0.002	116
B326595	B777771	0.004	114	0.003	24

Table 10: Relative 95% Vertical Confidence Intervals

From NGDB #	To NGDB #	+/- length (m)
B266148	B336131	.010
B266148	B202697	.011
B266148	B693275	.011
B266148	B192740	.012
B266148	B326595	.012
B266148	B777771	.013
B336131	B202697	.010
B336131	B693275	.010
B336131	B192740	.011
B336131	B326595	.012
B336131	B777771	.012
B202697	B693275	.011
B202697	B192740	.012
B202697	B326595	.013
B202697	B777771	.013
B693275	B192740	.012
B693275	B326595	.013
B693275	B777771	.013
B192740	B326595	.013
B192740	B777771	.013
B326595	B777771	.013

Appendix C

Contacts for Additional Information

The following information is available in various formats and on different media, including computer diskette, from the Geo-Spatial Reference Unit (see below):

- Adopted NAD83 survey control values for network piers
- Official validation coordinates (in ellipsoidal, mapping plane or Cartesian format) as they appear in this document
- Coordinates and associated covariance matrix for network piers

Ministry of Environment, Lands and Parks
Geographic Data BC
Geo-Spatial Reference Unit
4th Floor, 1802 Douglas Street
Victoria, British Columbia
V8T 4K6

Tel: (250) 387-3164
Fax: (250) 356-7831
WWW: http://www.env.gov.bc.ca/gdbc/

For more information on the Surrey EDM calibration baseline, please contact the above address.

For more information on the Greater Vancouver GPS validation network analysis, and determination of coordinate values contained in this guide, contact:

Client Services Section
Geodetic Survey Division
Natural Resources Canada
615 Booth Street
Ottawa, Ontario
K1A 0E9

Tel. (613) 995-4410 or 992-2061
Fax. (613) 995-3215
Email: information@geod.nrcan.gc.ca

Appendix D

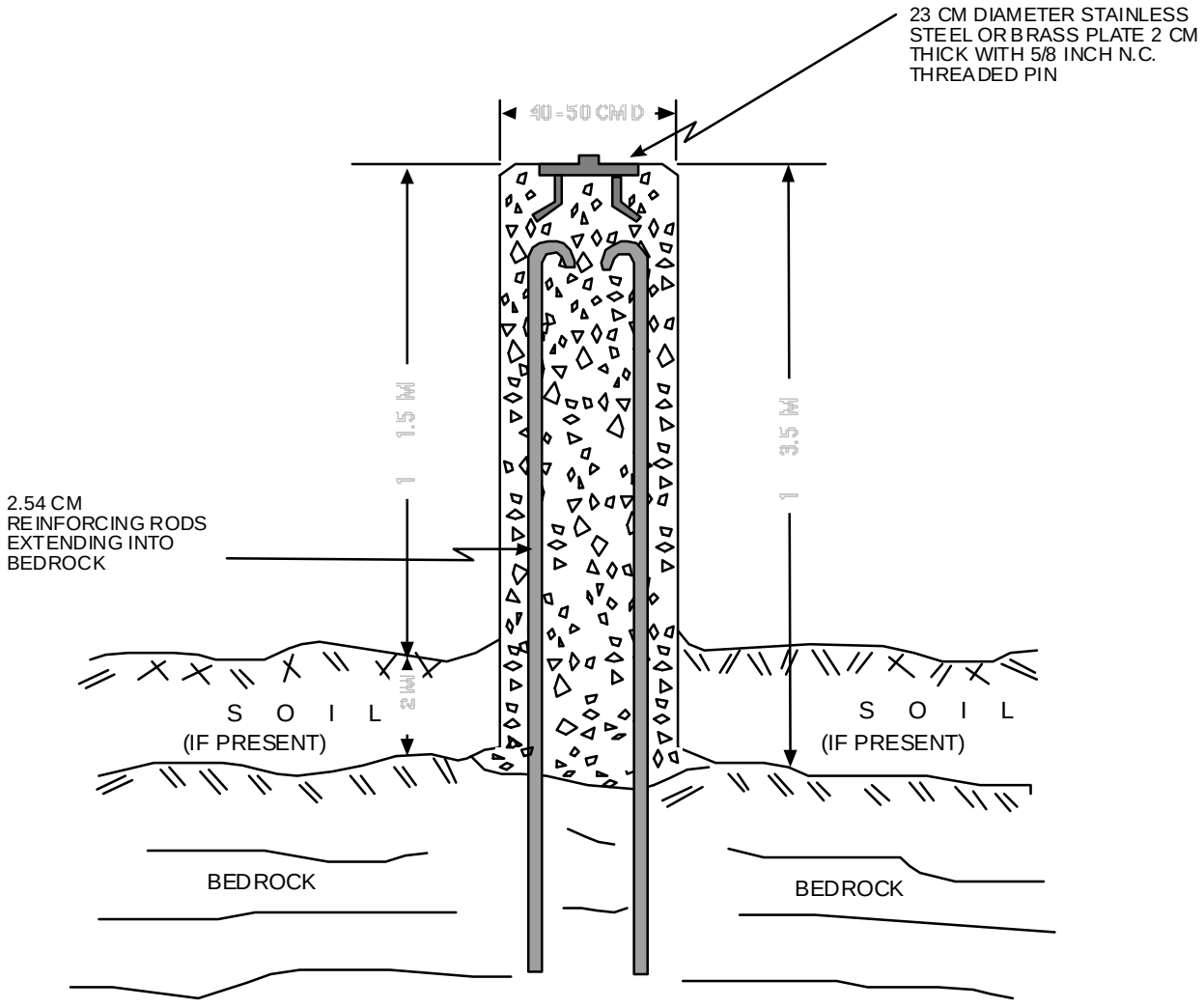
Ministry of Environment, Lands and Parks

Geographic Data BC

Pier Design - Greater Vancouver GPS Validation Network

Forced Centering Pillars

D.1 Cross Section



D-2 Forced Centering Plate