Prince Albert Validation Network

Prepared by
ISC of Saskatchewan
in cooperation with
Sask Environment

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Regina, Saskatchewan
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Or at www.geosask.ca

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 Prince Albert Validation Network. Please contact the Geomatics Distribution Centre, ISC for information related to this network that is not included in this document.

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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 Regina basenet, this responsibility is shared with the provincial survey agencies. GSD, NRCan is responsible for establishing the validation coordinates for the network through precise GPS measurements. Each GPS validation network is initially established using at least two separate measurement campaigns in different years. Subsequent measurements may be performed periodically to check on pier movement.

The above described basenets are intended to validate results of precise GPS surveys under somewhat ideal field conditions. The forced centering plates eliminate instrument setup errors, and the validation points are chosen with an open sky view. This type of validation network does not meet the needs of the resource sector, where obtaining metre-level accuracy under difficult conditions is more important than obtaining centimetre accuracy under ideal conditions. The Prince Albert Validation Network was established to meet the needs of the resource sector.

The Prince Albert Validation Network was established by ISC of Saskatchewan with assistance from SaskEnvironment. This basenet will be used in a manner similar to the Regina basenet, as well as to test GPS equipment under varying forest cover. This network also supports testing GPS equipment in "kinematic" mode; i.e., continuously recording GPS observations while moving. This network will meet SaskEnvironment and other organizations need to pre-qualify GPS/GIS contractors.

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.

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.

In addition to the above, the Prince Albert Validation Network can be used to test the suitability of GPS receivers under adverse survey conditions – i.e. under forest canopy. The network contains trails which can be used to validate procedures for measuring linear features, and polygons which can be used to validate procedures for measuring and calculating areas.

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 Prince Albert Validation Network does not use piers for the points, since it is primarily intended to validate GPS/GIS equipment, software and procedures. The equipment, etc. usually operates in the 0.5m to 10m. accuracy range. The equipment is usually used in “point-averaging” or “kinematic” mode, and tripods are rarely used , so forced centering is not required as it adds little to the accuracy test, and represents a survey mode not generally used in GPS/GIS applications.

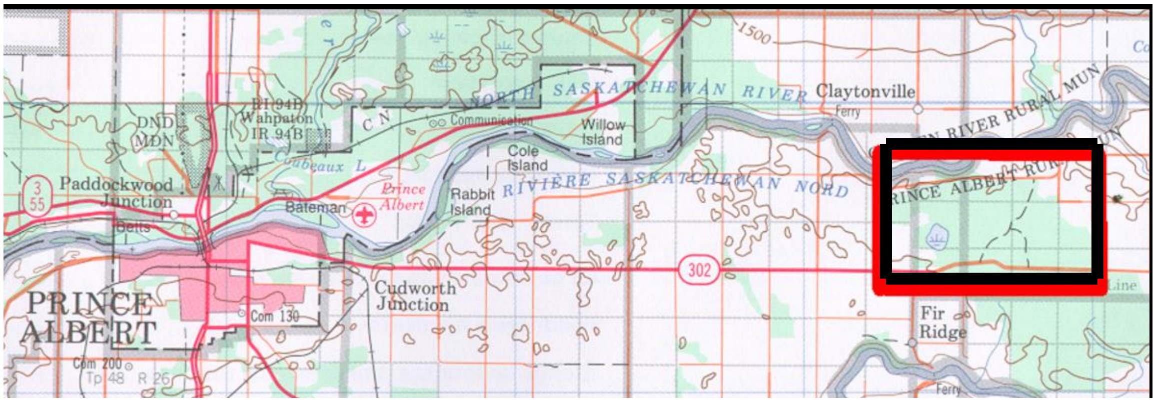
2. The Prince Albert Validation Network

Description

The Prince Albert Validation Network was established in 2002 by ISC and SaskEnvironment. The network is approximately 25 Km. East of Prince Albert on Hwy. 302, and is in the Steep Creek Forest Preserve. The network is comprised of 18 monumented points, 25 kilometres of roads and trails, and 3 polygons. The points are connected to existing geodetic points, including the temporary Active Control Point (ACP) at Prince Albert and Active Control Points at Flin Flon, Churchill, Yellowknife and Priddis. The validation points are marked by a rebar with an orange plastic cap.

The points were selected so that they occur in different types of tree cover, with varying degrees of open canopy. The trails are existing roads and trails, and have varying species and varying degrees of open canopy. The surveyed roads and trails form three polygons.

Site Location



Survey Observations

The Prince Albert validation network was observed with GPS in 2002/2003 by ISC with assistance from SaskEnvironment using five GPS receivers. Two of the receivers were Ashtech Z-XII dual frequency GPS receivers owned by ISC, and the other three were Ashtech Z-Xtreme dual frequency receivers borrowed from Geodetic Survey Division, NRCan.

Three sessions were observed to connect the validation network to the Canadian Active Control System and to existing control points in the area. The validation network points were surveyed over three days. For each point, a minimum one hour static session was observed with two base stations. Some of the points were also re-observed using RTK or terrestrial observations.

The trails were surveyed over four days. On the first two days, portions of the trails and roads were observed using RTK with a single base station and a single rover. A kinematic survey was carried out on the third day with two base stations and two rovers mounted on the survey vehicle. The trails were re-observed in kinematic mode on the last day with a single base station and a single rover.

Descriptions and site sketches for each of the points, as well as a notice to users regarding this validation network, are provided in Appendix A.

Determination of Network Validation Values

Coordinate values for the Prince Albert validation network were determined using data from observations carried out in December 2002 and January 2003. The GPS data for the main control points (775335 and M02V203) and the connections to existing control including the Canadian Active Control Points, was processed in session mode using the PAGES GPS processing software from US National Geodetic Survey. The remaining data, including the static sessions for points and kinematic data for the trails was processed using Ashtech Solutions Version 2.60.

The processing for all static sessions was done using ITRF 2000 datum at epoch 2003 01 01. The processed observations were transformed to NAD83(CSRS) using program TRNOBS prior to the final coordinate calculations.

Program GHOST was used for the final point coordinate calculations. Coordinates of all Active Control Points (ACPs), and the temporary ACP at Prince Albert were held fixed in the adjustment. Coordinates of two “GPS on Benchmark” points (30504 and 87S033) were also held fixed. New coordinates were computed for existing points 775063, 775335, and 86S107.

Final coordinates for the centre-lines of the roads and trails were determined by plotting all sets of trail coordinates and their estimated accuracy class on-screen, and digitizing the “average centre-line” on-screen.

3. Validation Survey Guidelines

Because GPS equipment, observing techniques, applications and software are still evolving rapidly, and what is valid today may change tomorrow, it is almost impossible to establish rigid specifications for GPS surveys at this time without deterring the use of future developments.

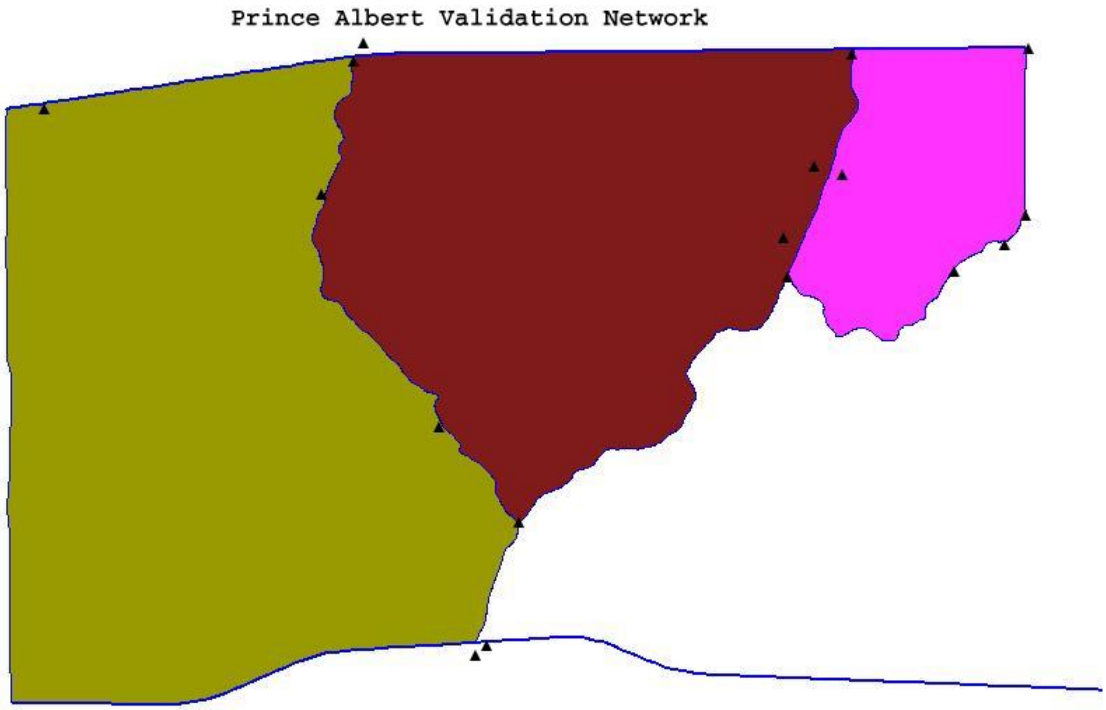
In order to take advantage of the accumulated experience of GPS users and innovations in GPS positioning techniques, the concept of an acceptance test or **validation survey** is advocated to evaluate the mechanics proposed for a particular survey project, instead of a description of specific procedures to be followed. This acceptance test is carried out as a complete survey on a known network to confirm that the proposed procedures are capable of producing the desired results. Once the equipment, procedures and software are validated, they are adopted in their entirety for the conduct of the production survey for which they were proposed.

GPS "Survey System" Validation

The concept behind the validation survey is to evaluate the entire GPS "survey system" that is intended or proposed for use on a production survey, and to determine with confidence whether or not it produces reliable results that meet the accuracy requirement and generate the final products required.

"Survey system" is defined here as the system used from the data collection stage to production of the final results. This includes the equipment and all procedures used for data collection as well as equipment, software and procedures used for data processing and output of the final results. The validation survey is carried out in a manner similar to a production survey. The main difference is that points and primary features have known coordinates which are used for evaluation of the test results by the project authority. The design of the production survey, and the logistics required to execute it are not verified during the validation survey but are addressed in project specifications. Once a GPS "survey system" has been successfully tested during a validation survey, it must be adopted in its entirety for the execution of the production survey for which it was proposed.

Appendix A. Map and Point Sketches



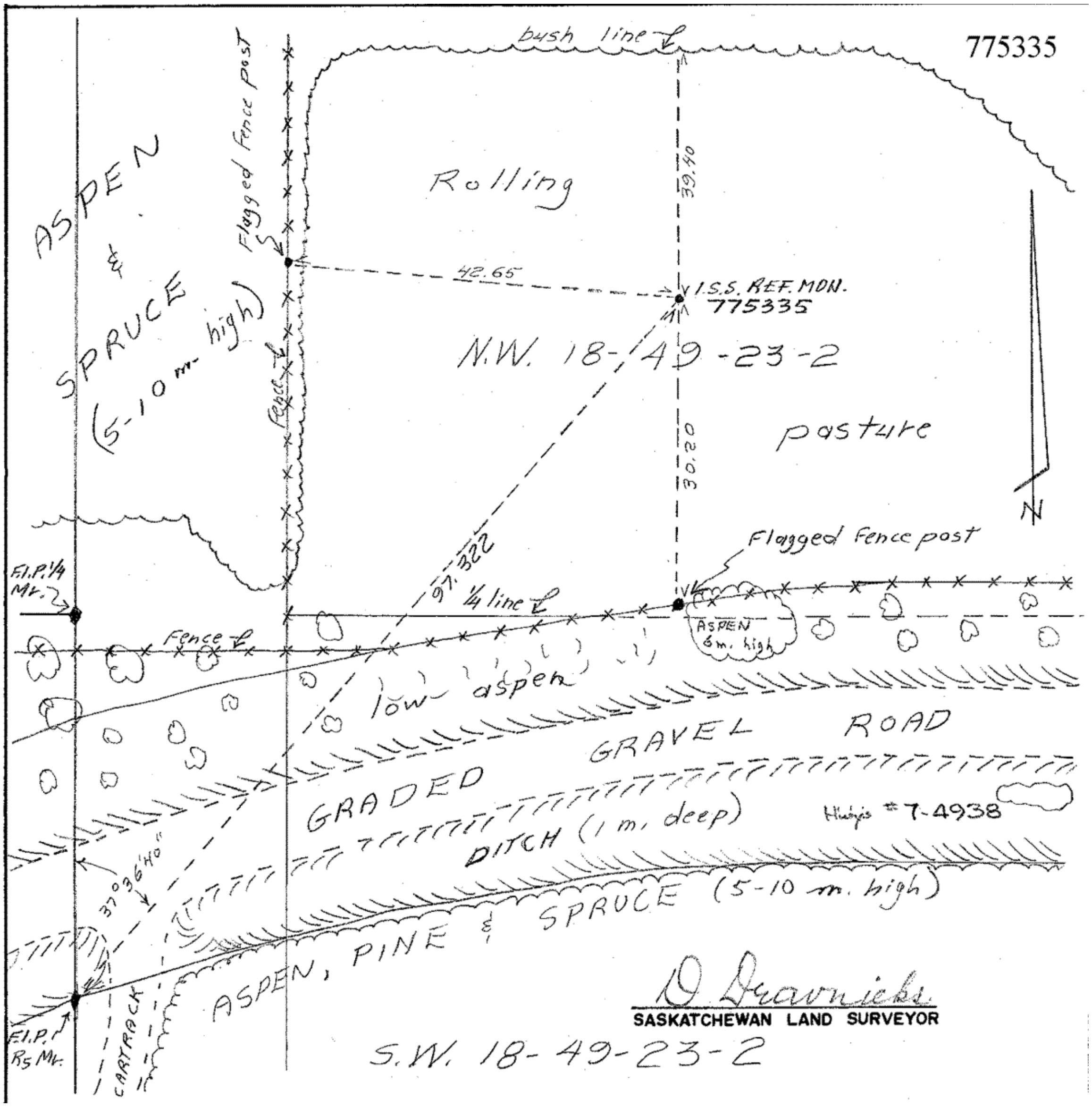
Notice to Users

• The Prince Albert 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.
• The adjacent roads are not paved; please try to keep dust levels at a minimum by driving at a moderate rate of speed.
• Users are also asked to assist in the preservation of the network points. Please report any damage or potential dangers to:

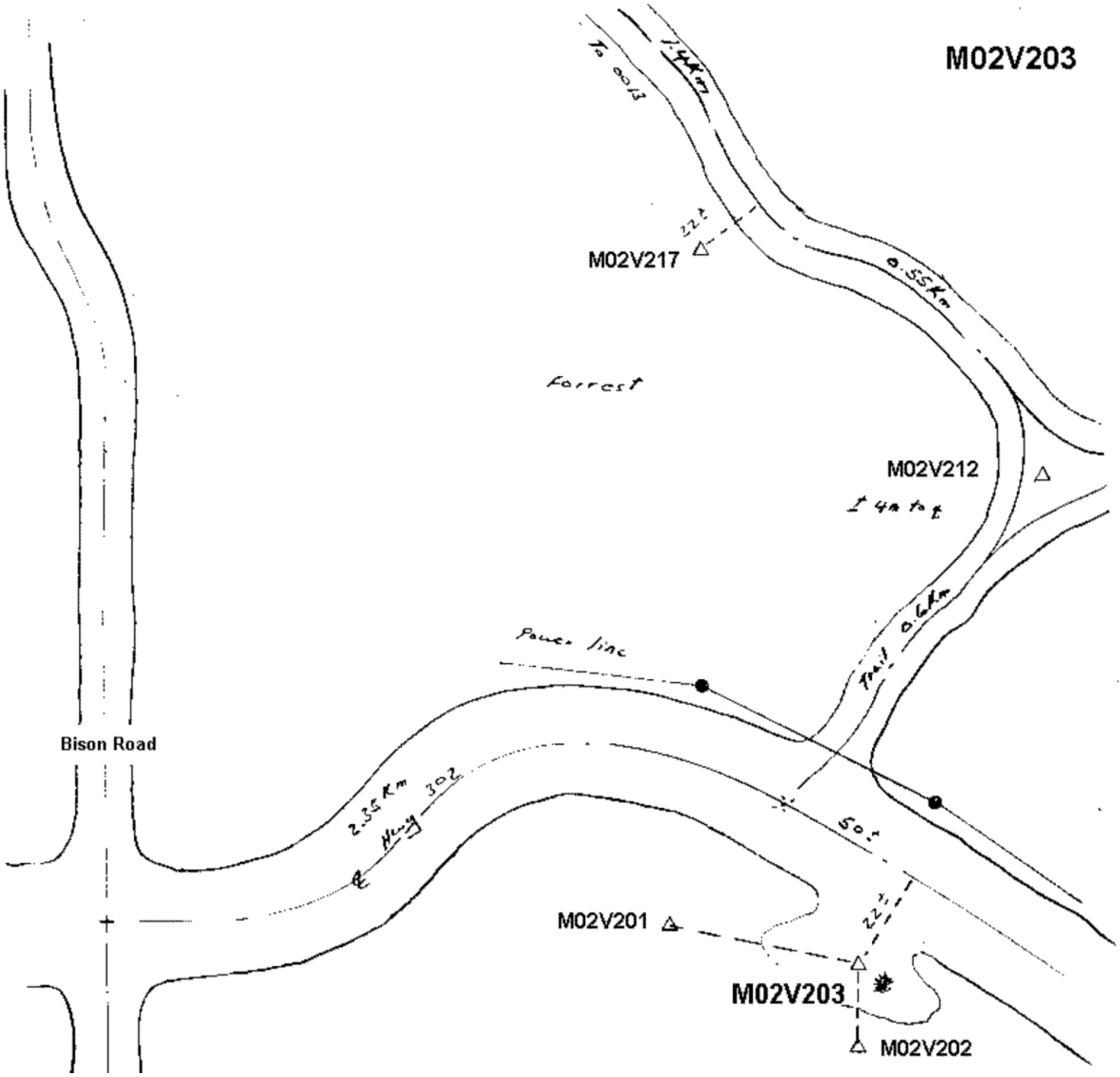
ISC of Saskatchewan
Surveys
1301 1st Avenue
Regina, Saskatchewan
S4R 8H2

Tel: 1-866-275-4721

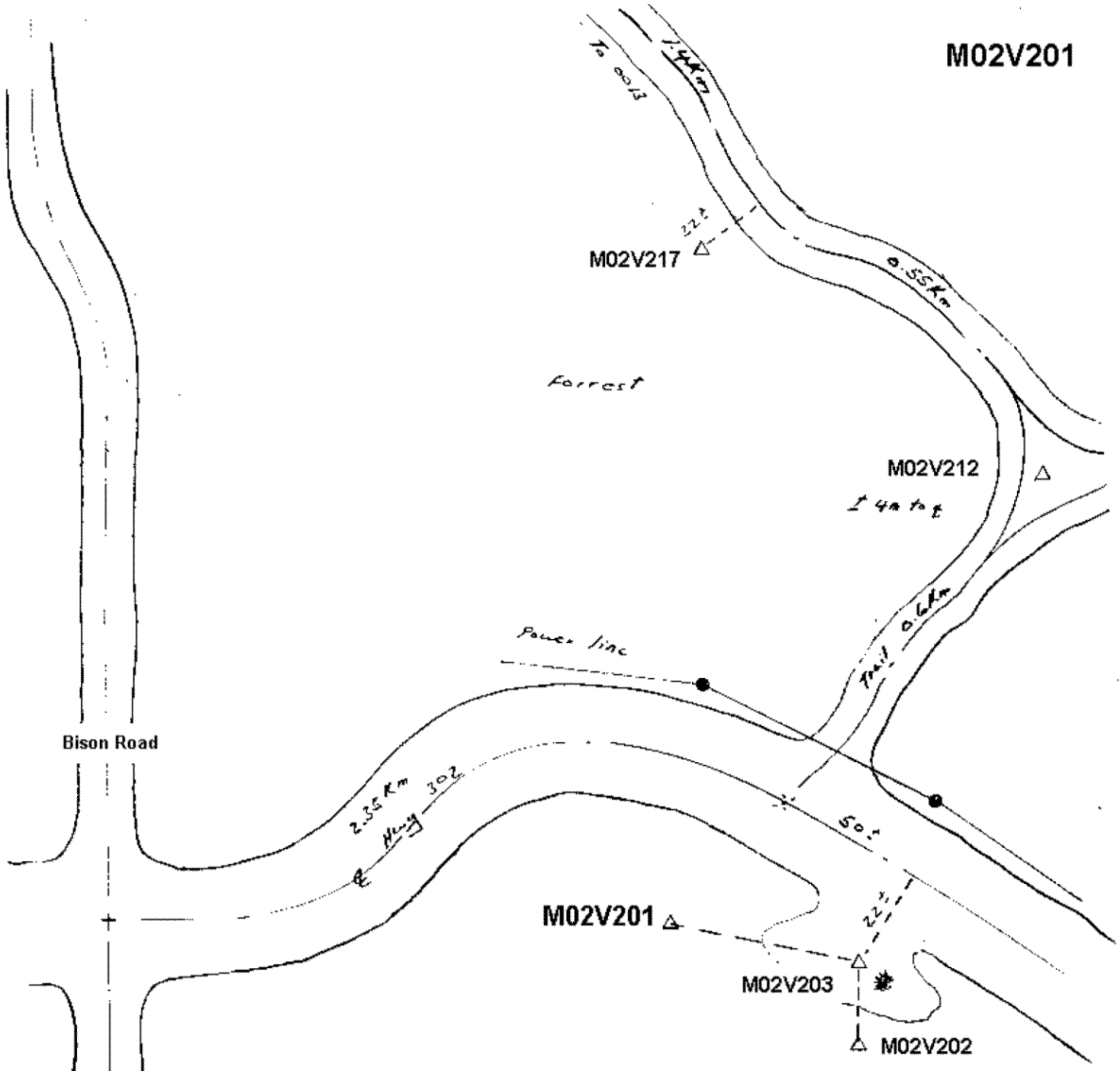
Base Point 775335



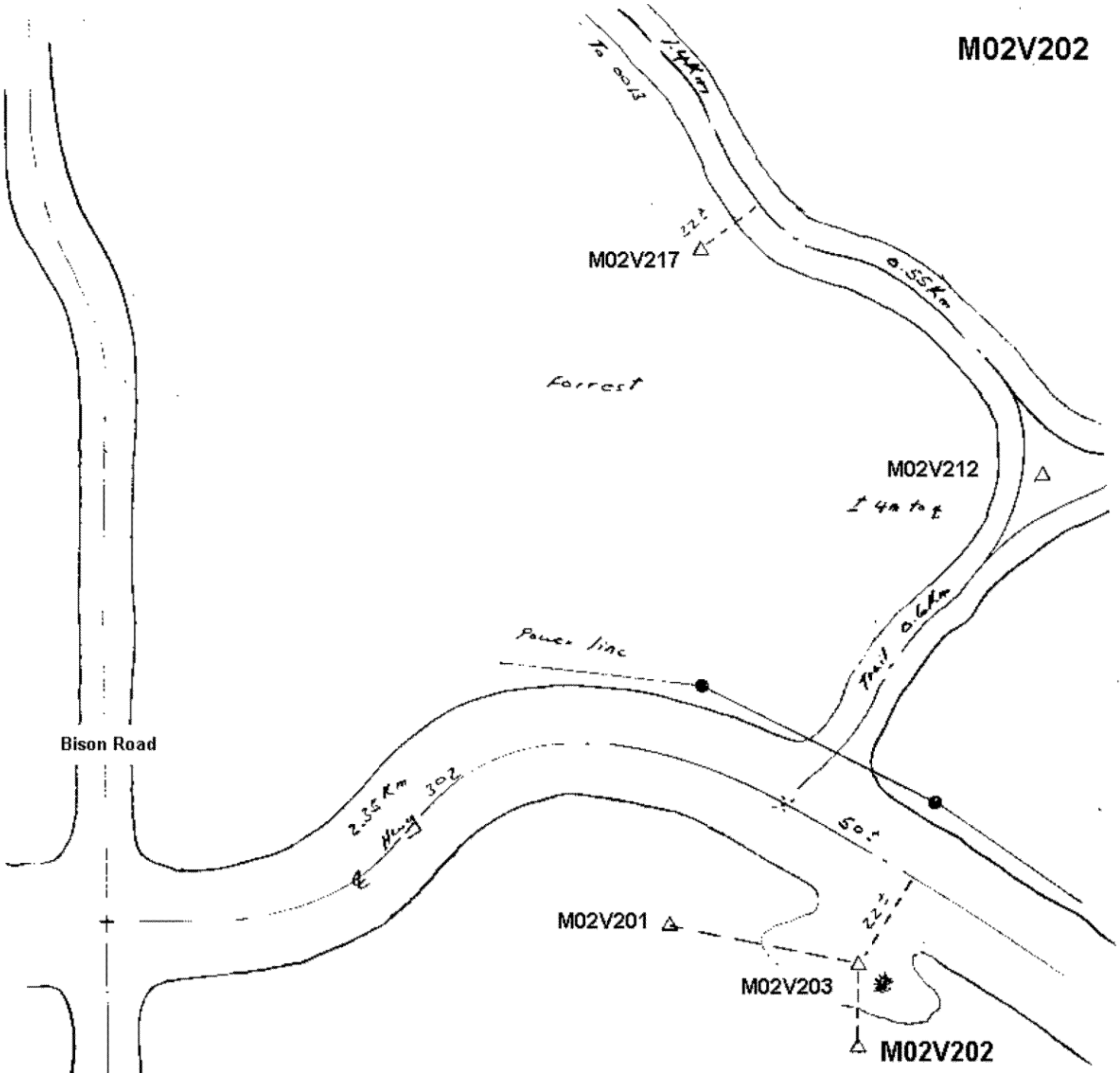
Base Point M02V203



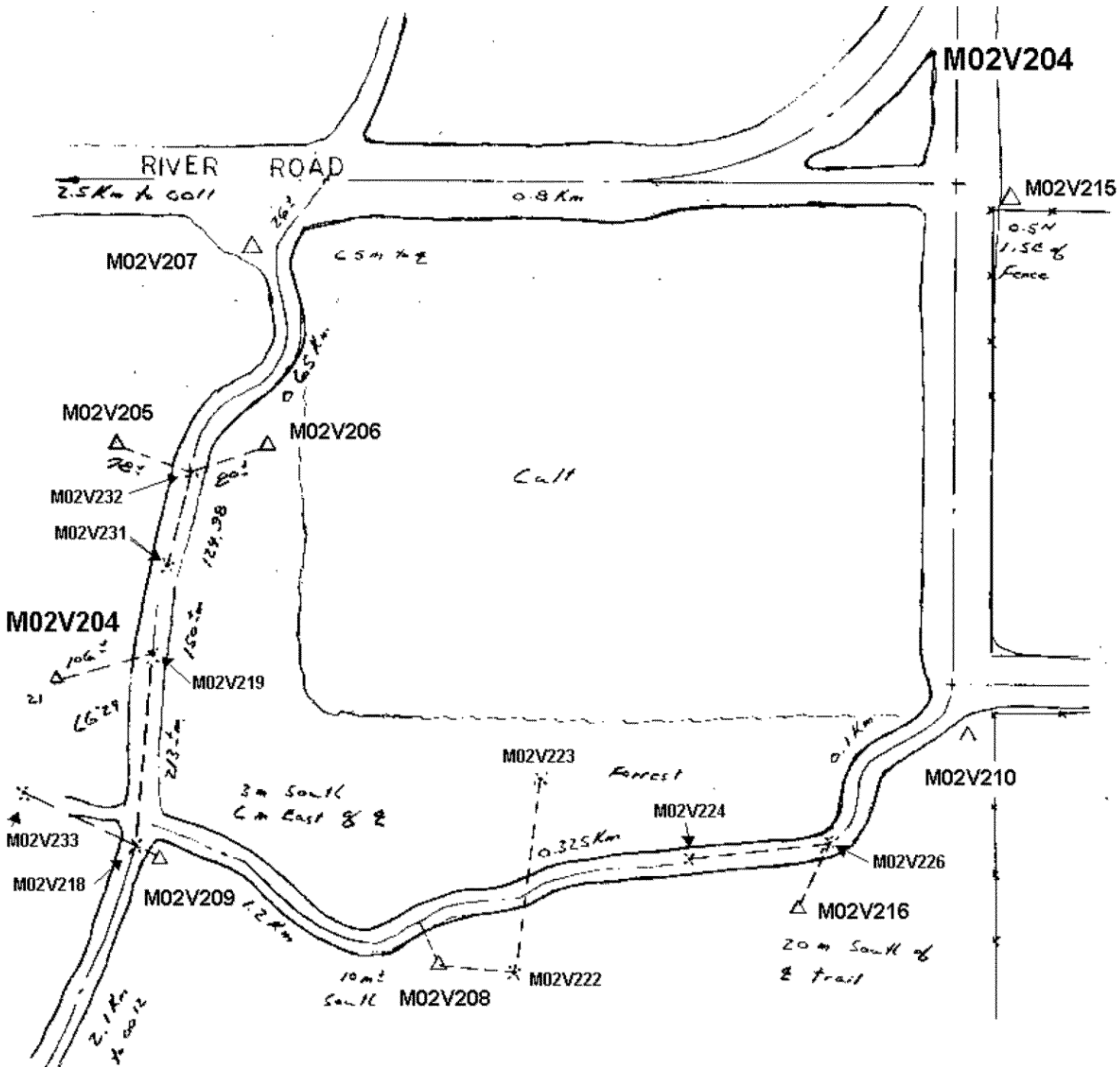
Point M02V201



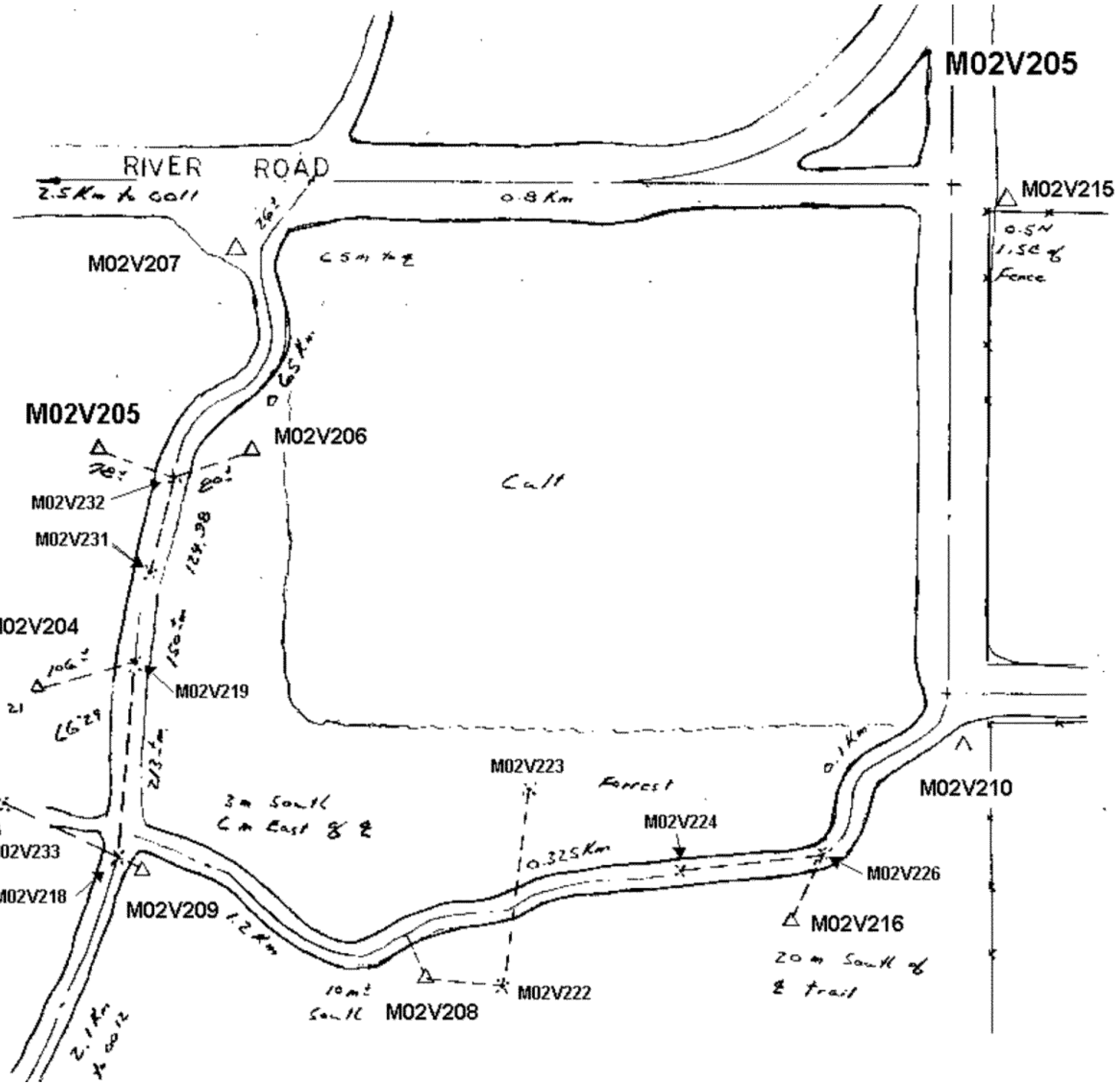
Point M02V202



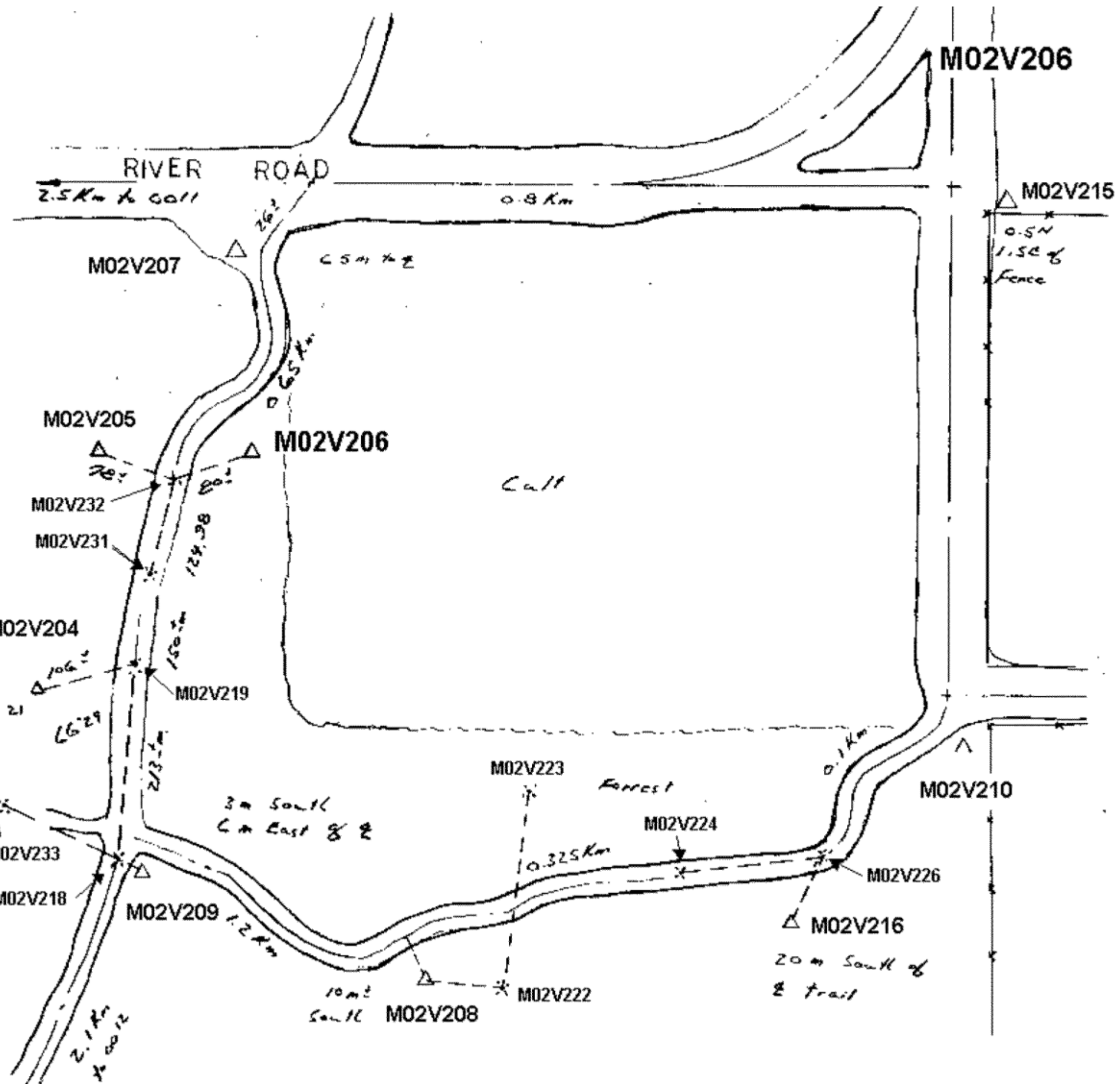
Point M02V204



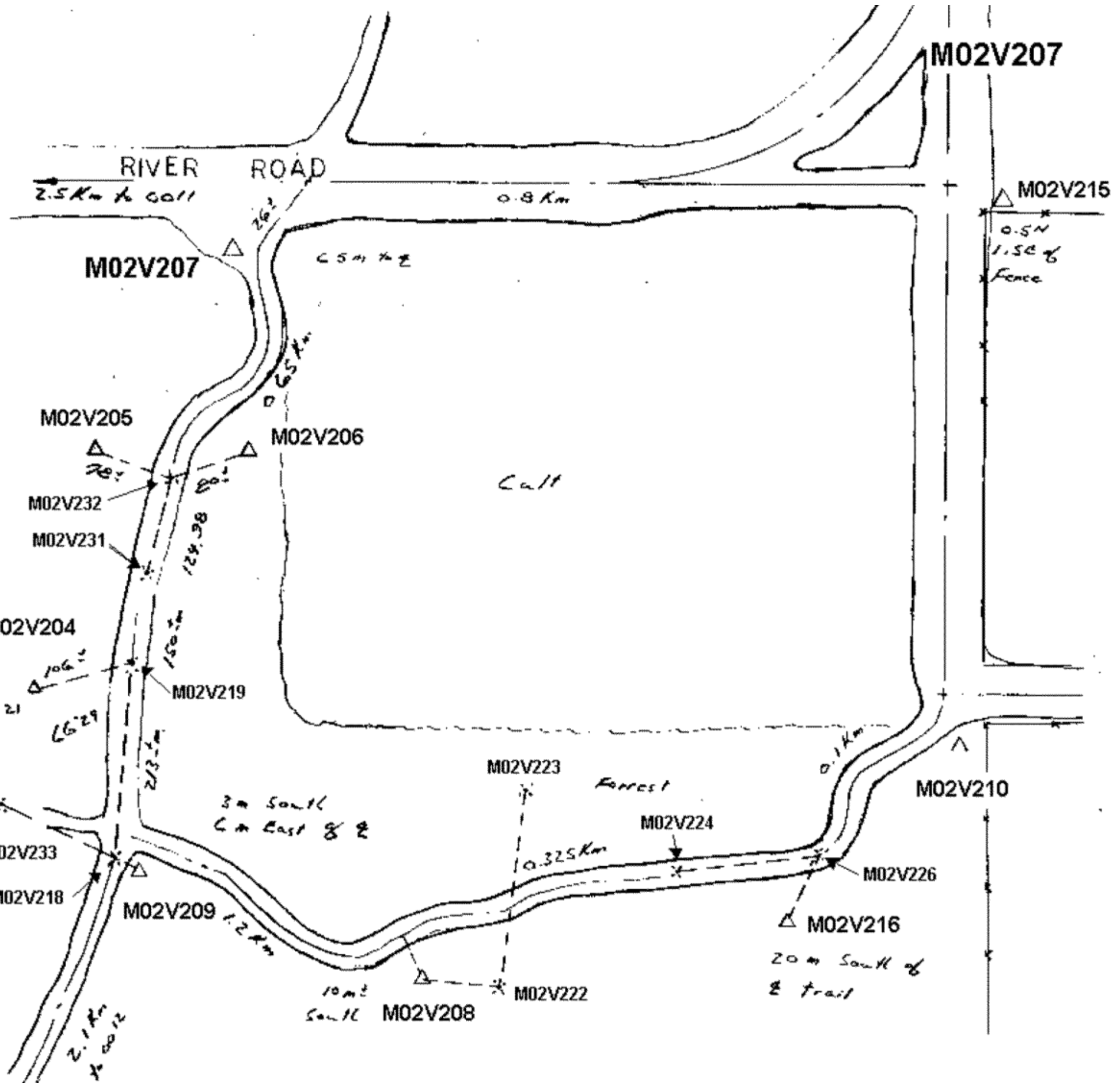
Point M02V205



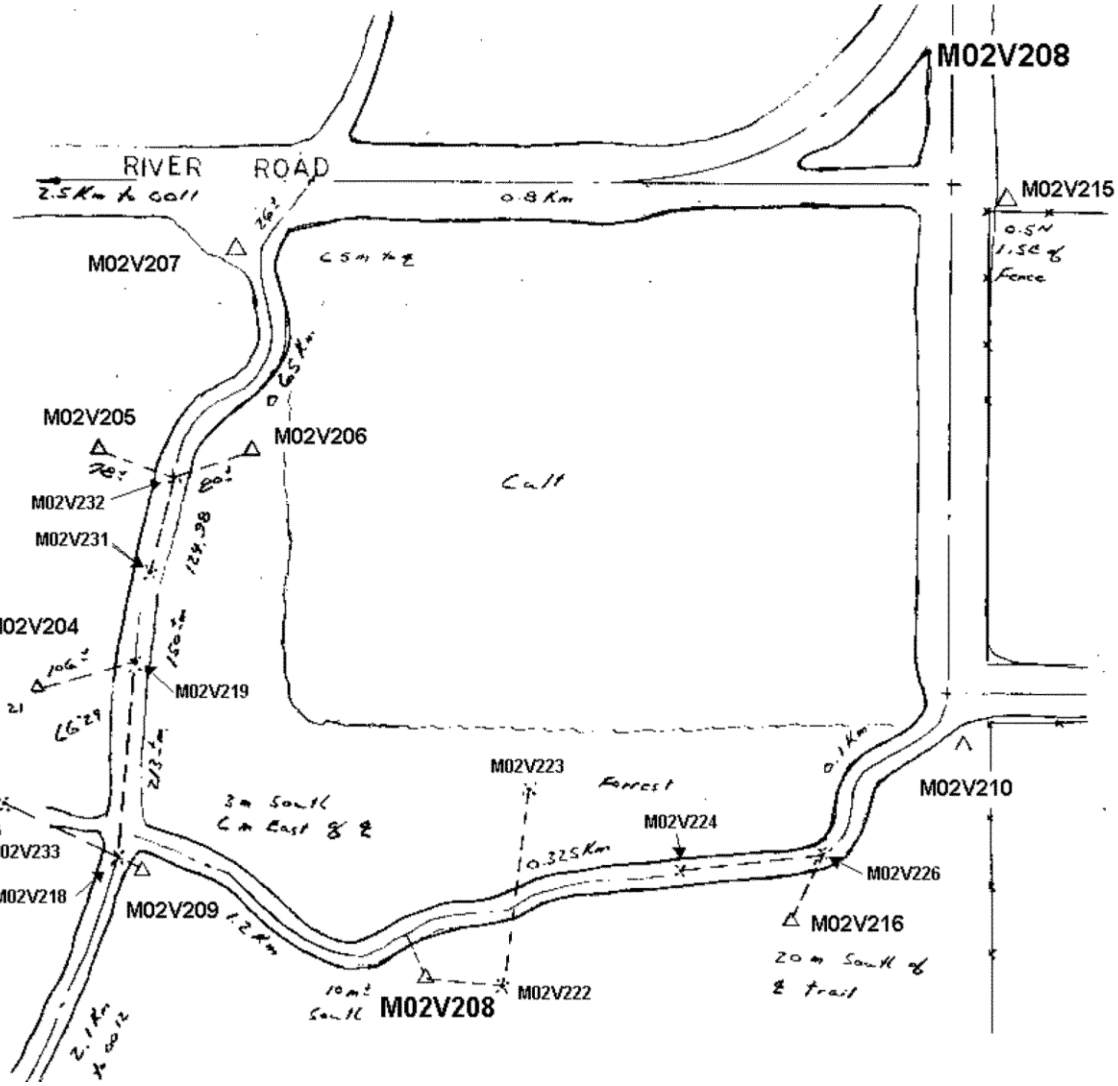
Point M02V206



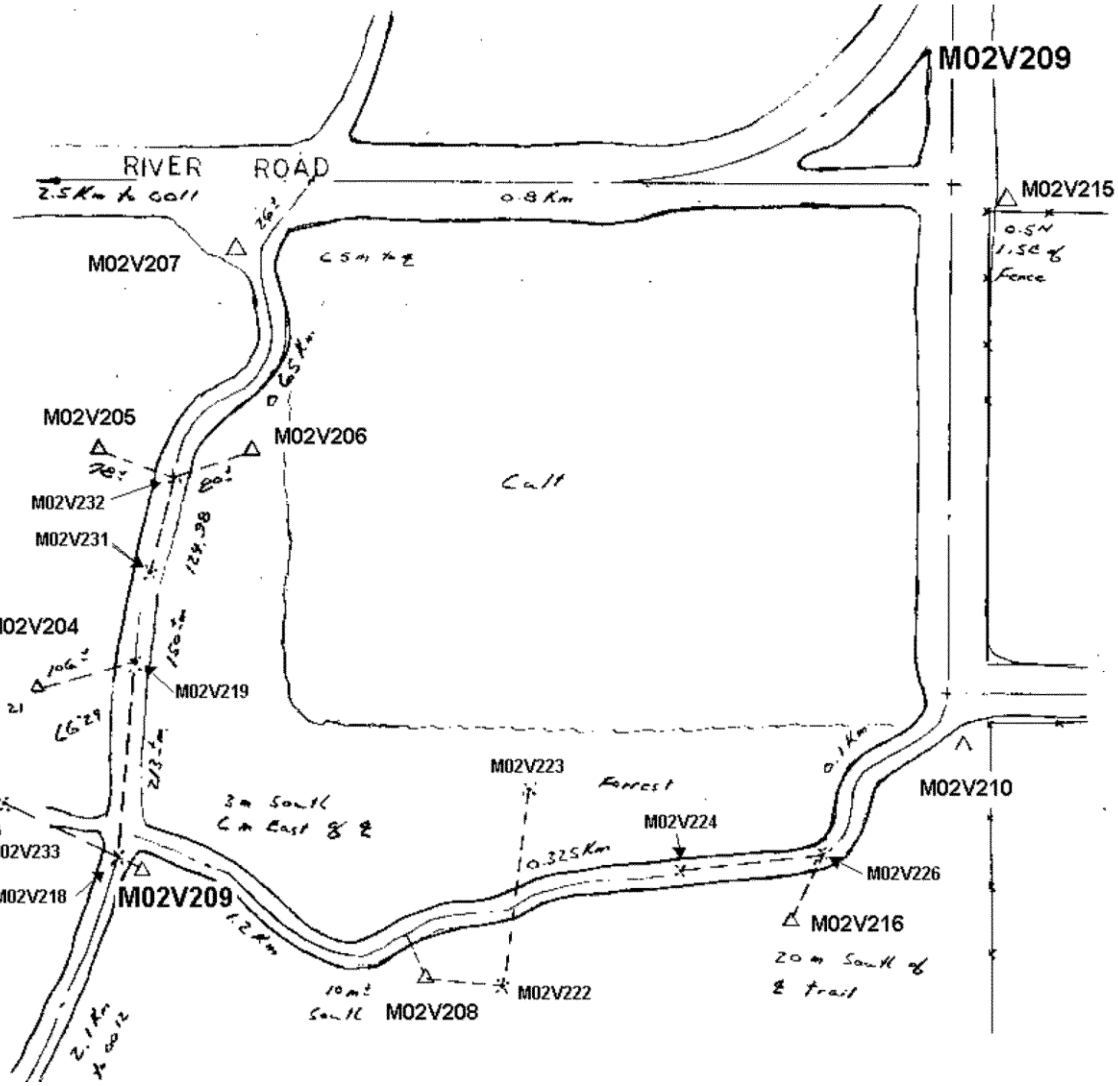
Point M02V207



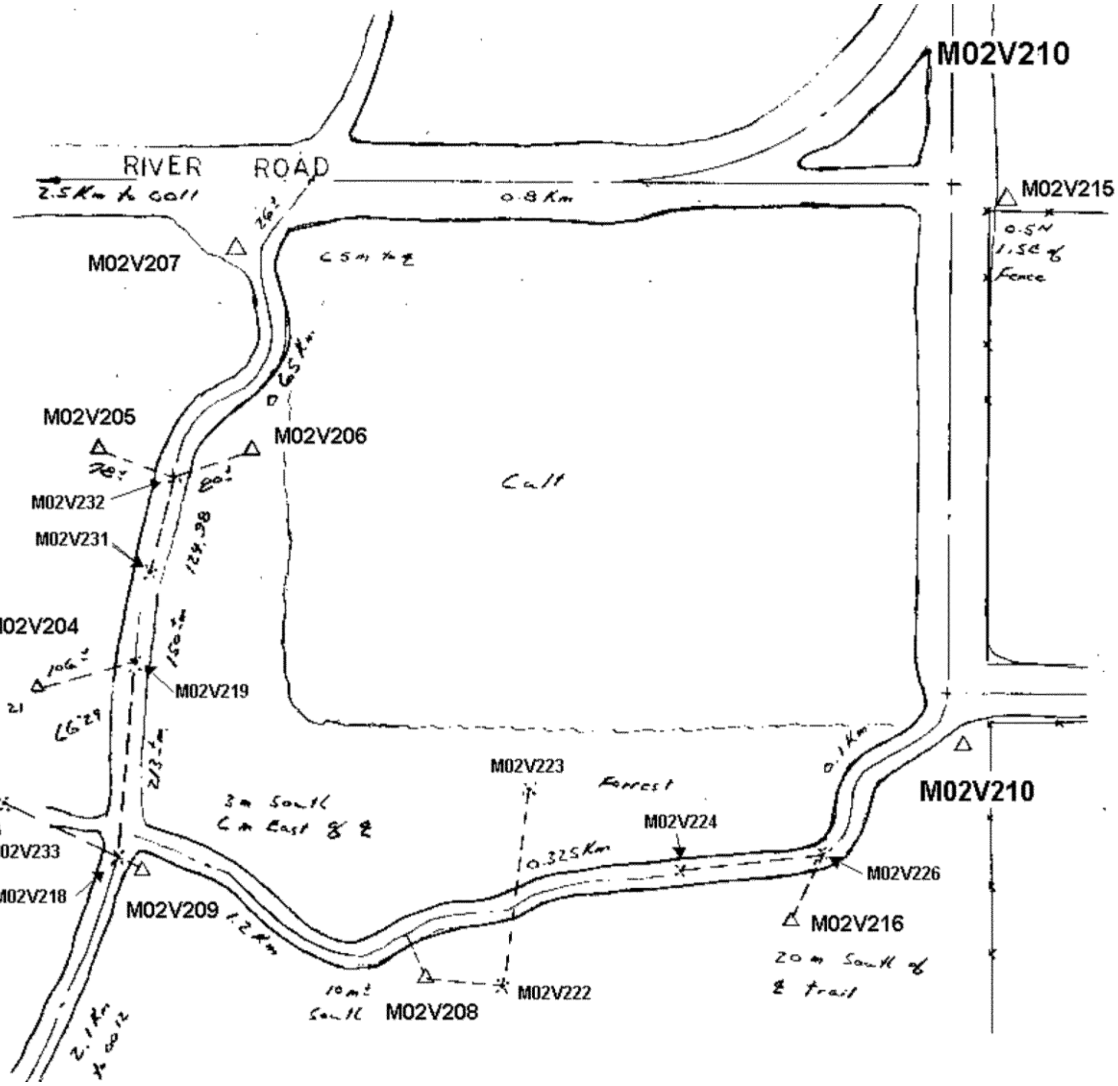
Point M02V208



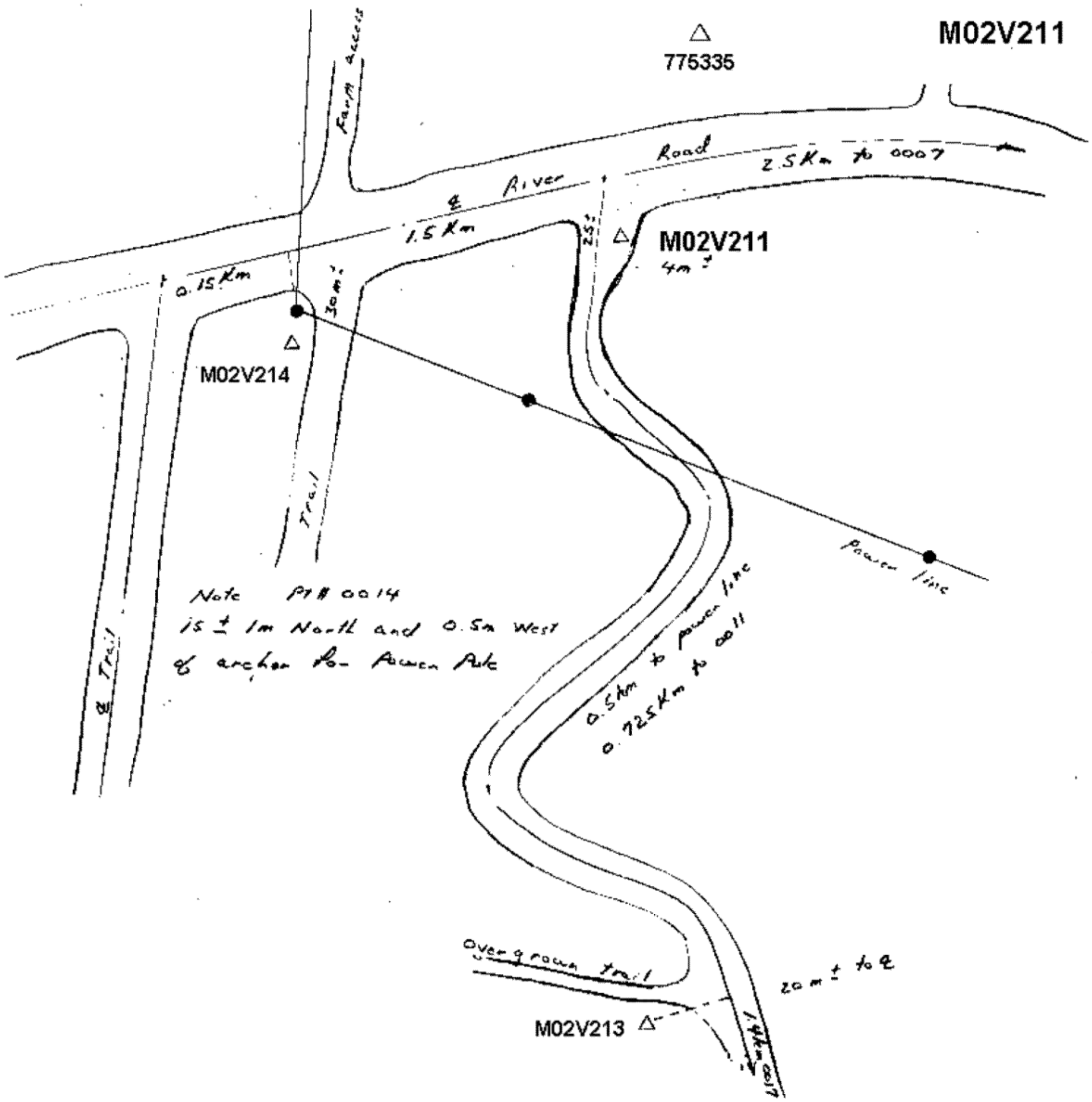
Point M02V209



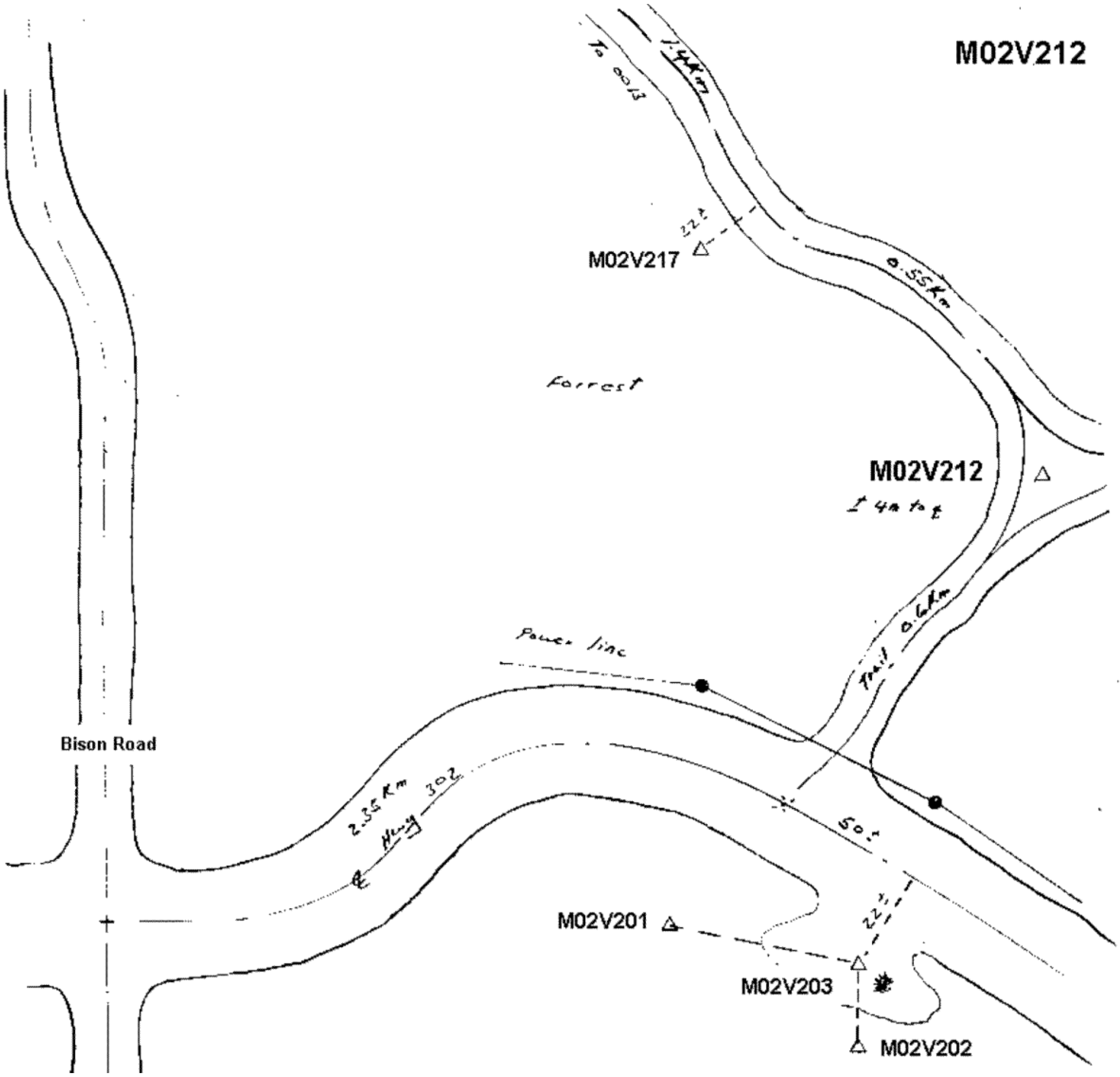
Point M02V210



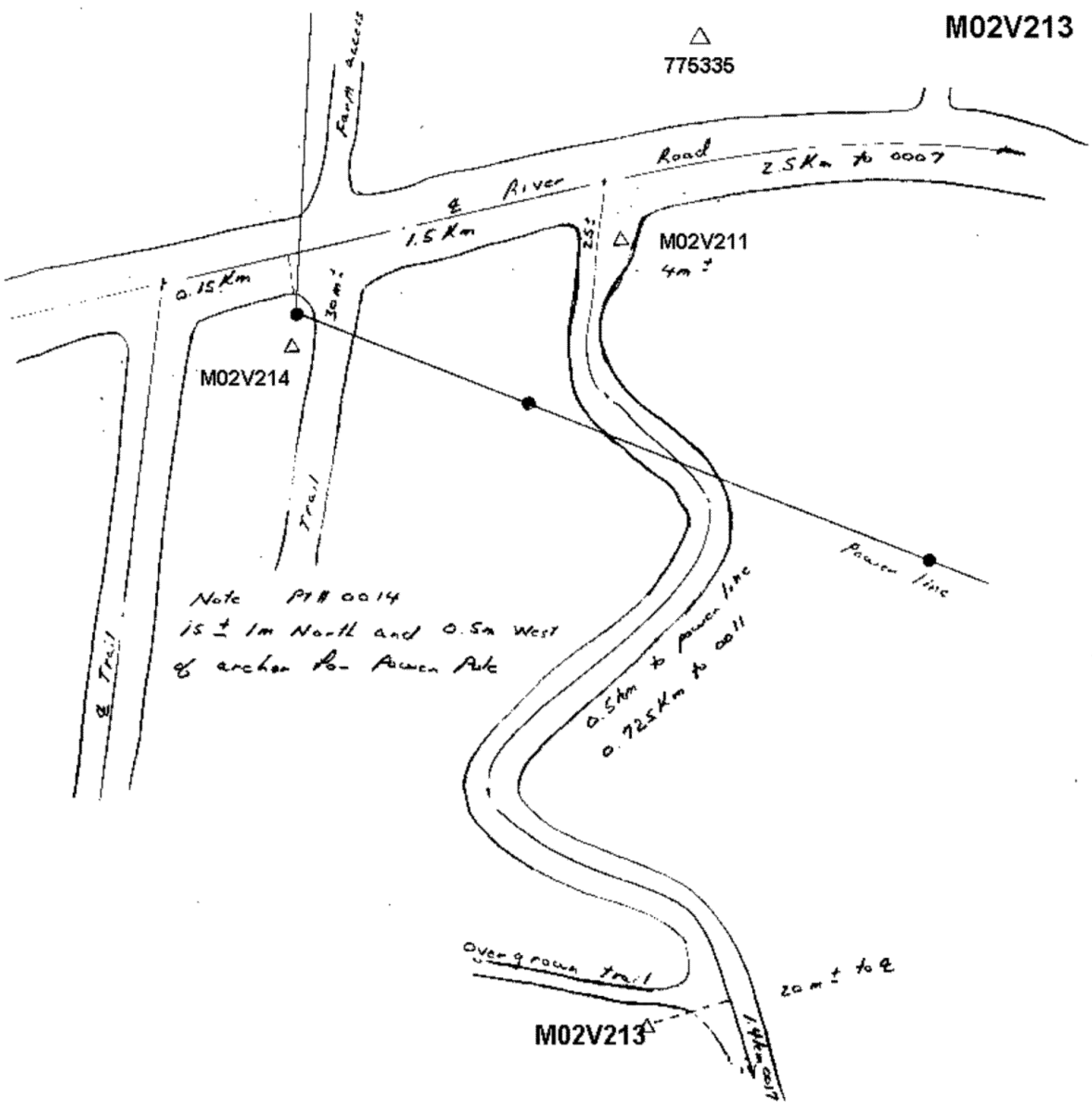
Point M02V211



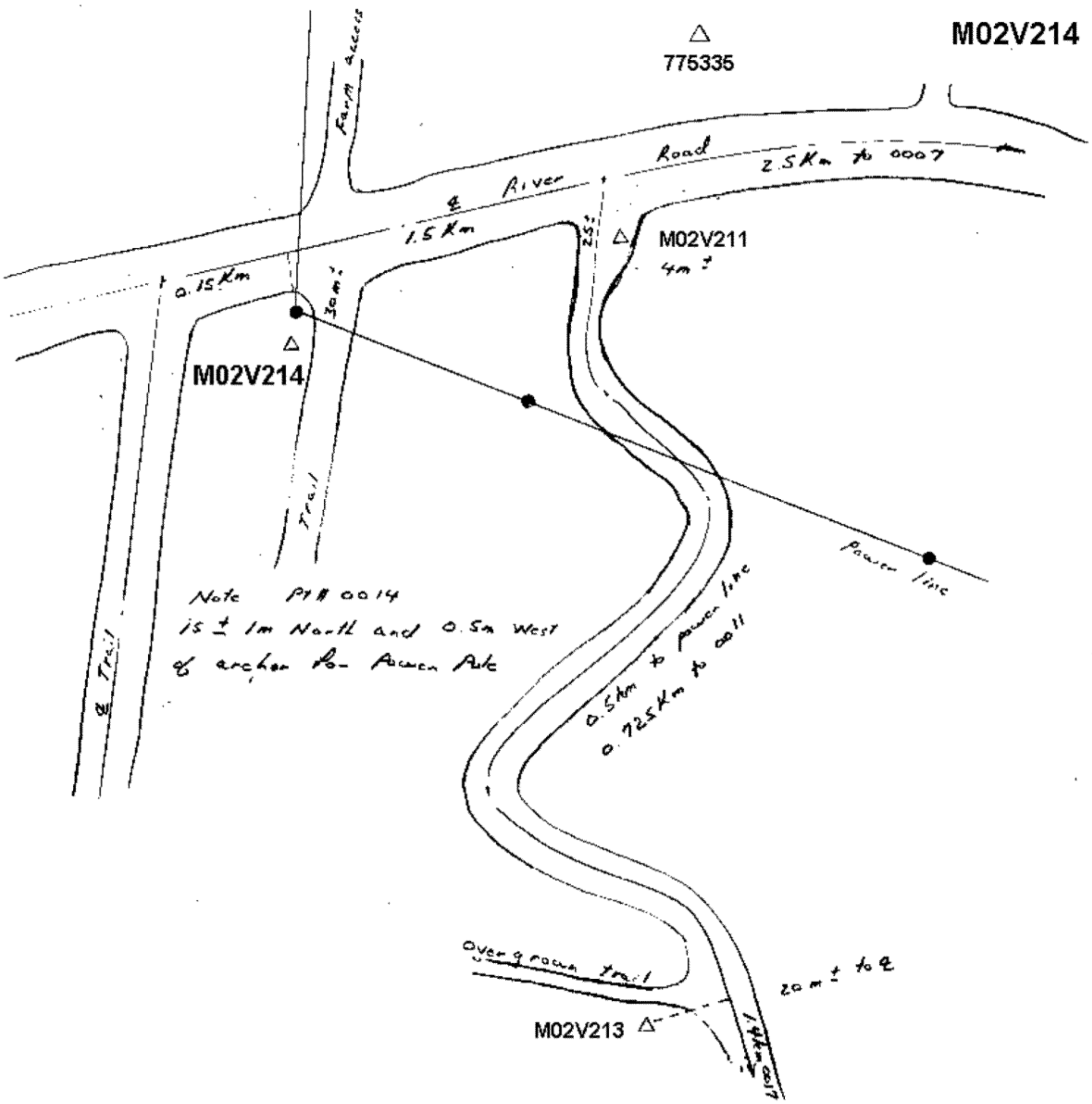
Point M02V212



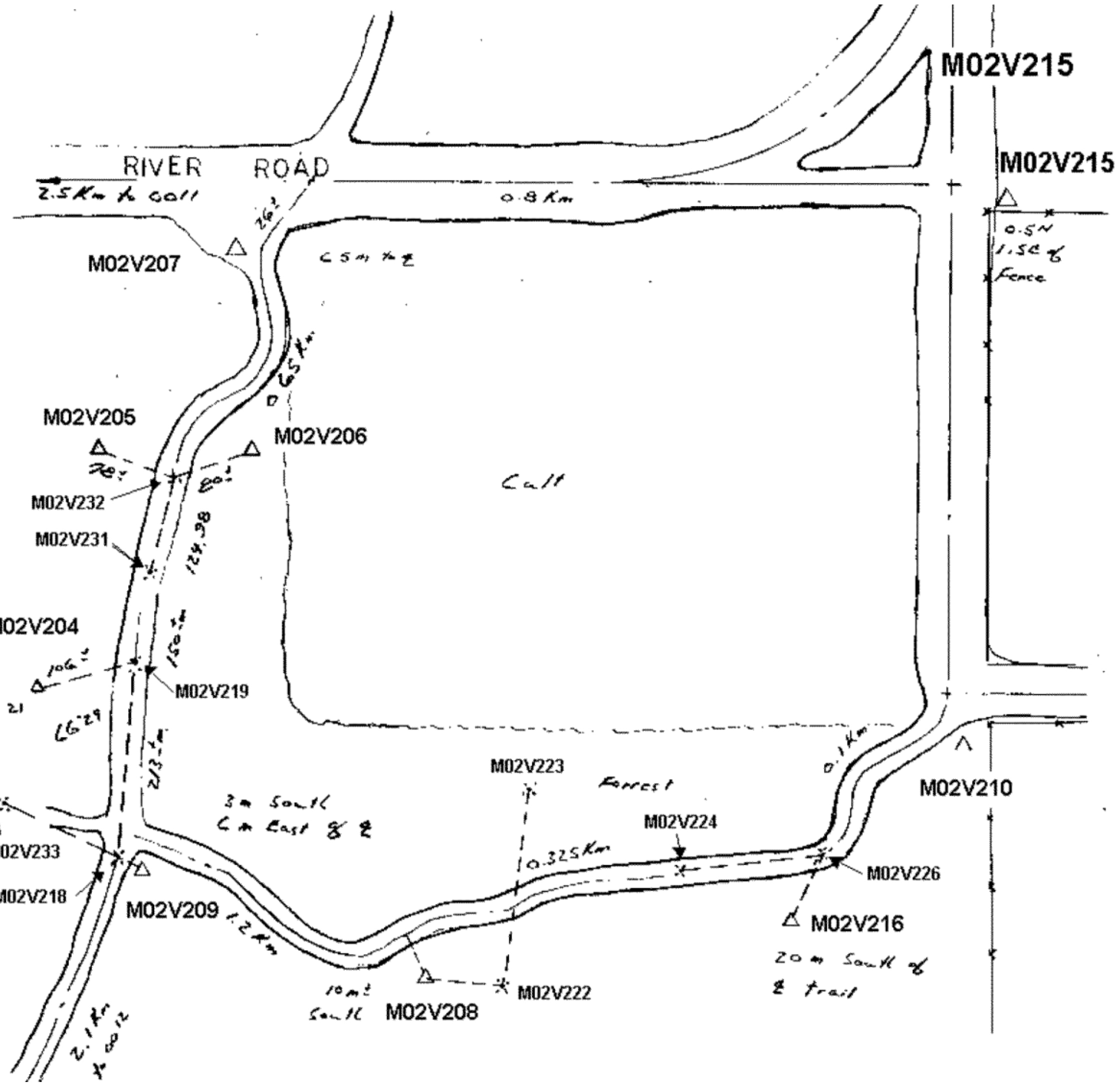
Point M02V213



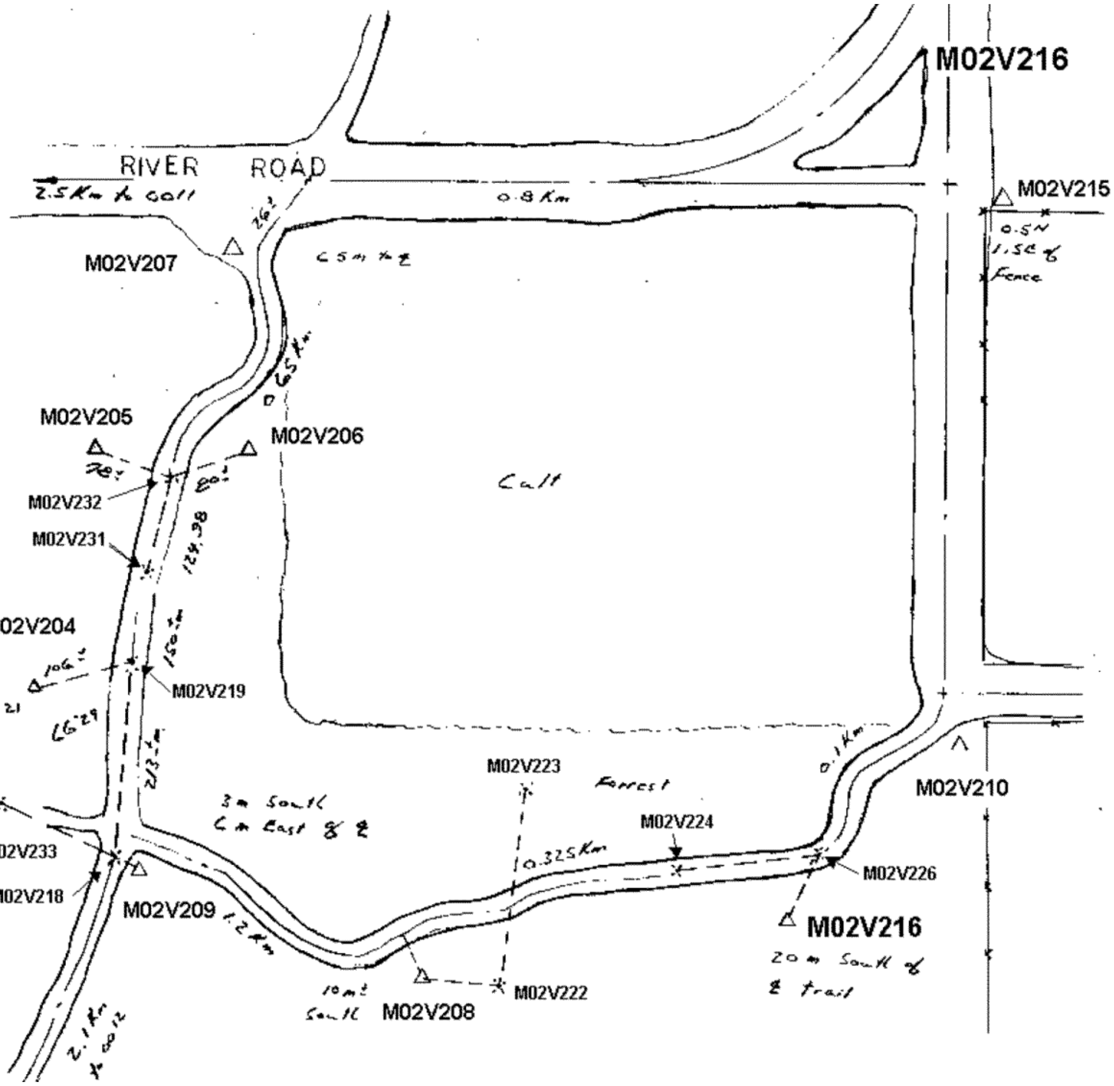
Point M02V214



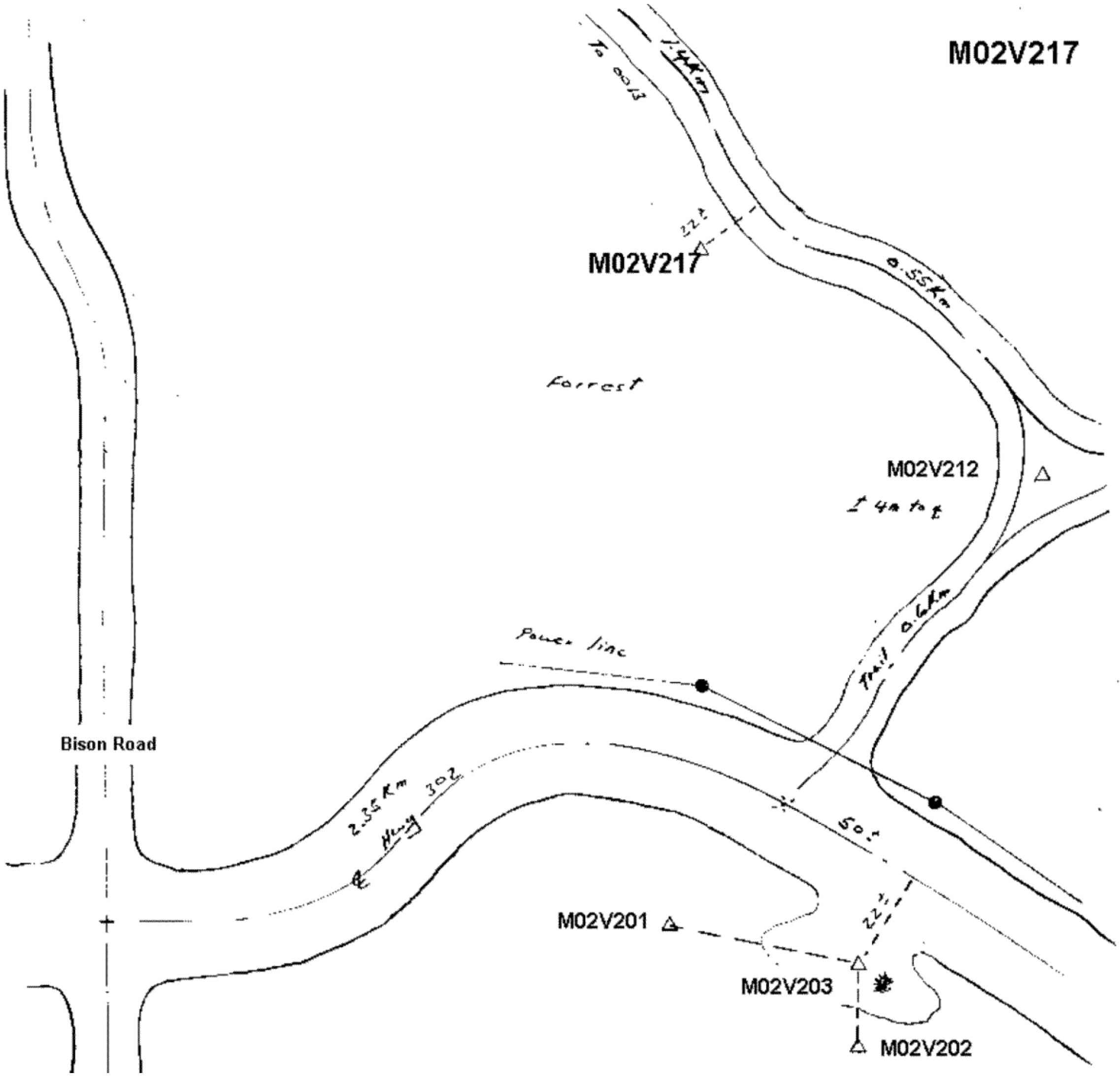
Point M02V215



Point M02V216



Point M02V217



Appendix B. Point Coordinates

All coordinates are referenced to the NAD83(CSRS) datum. Accuracies are 95% confidence circle with respect to the fixed points of the adjustment. Coordinates for other datums such as IGS00 or WGS84 may be available on request from ISC.

Canadian Active Control Points Used for the Coordinate Computation

Point #	Latitude	W. Longitude	Accuracy	Ellipsoid Height	Orthometric Height
756047 PRDS	50 52 16.845	114 17 36.532	Fixed	1248.336	1263.685
889201 YELL	62 28 51.195	114 28 50.447	Fixed	180.959	207.883
924001 CHUR	58 45 32.647	94 05 19.371	Fixed	-18.964	28.926
965000 FLIN	54 43 32.075	101 58 40.870	Fixed	312.001	342.477

Existing Points Held Fixed for the Coordinate Computation

Point #	Latitude	W. Longitude	Accuracy	Ellipsoid Height	Orthometric Height
30504 Kinistino	52 56 12.232	104 58 35.818	Fixed	433.617	457.399
87S033 Meacham	53 25 02.314	104 29 10.930	Fixed	394.182	419.300
925000 PRAL	53 12 46.224	105 55 51.462	Fixed	455.057	478.806

Existing Points NOT Held Fixed for the Coordinate Computation

Point #	Latitude	W. Longitude	Accuracy	Ellipsoid Height	Orthometric Height
775063 Shipman	53 28 01.472	104 57 13.759	0.01	450.804	475.895
775335	53 13 39.282	105 22 00.343	0.01	434.346	458.596
86S107 Birch Hills	52 59 15.468	105 16 15.711	0.01	433.012	456.659

Validation Network Points

Point #	Latitude	W. Longitude	Accuracy	Ellipsoid Height	Orthometric Height
775335	53 13 39.282	105 22 00.343	0.01	434.35	458.60
M02V201	53 12 01.826	105 21 29.860	0.02	437.97	462.15
M02V202					
M02V203	53 12 03.255	105 21 26.816	0.01	438.36	462.54
M02V204	53 13 08.451	105 20 08.687	0.21	437.25	461.51
M02V205	53 13 18.659	105 19 53.003	0.14	434.98	459.25
M02V206	53 13 19.981	105 20 00.392	0.15	435.87	460.14
M02V207	53 13 37.944	105 19 50.612	0.08	434.42	458.71
M02V208	53 13 03.314	105 19 23.160	0.15	435.86	460.13
M02V209	53 13 02.207	105 20 07.335	0.09	437.74	462.00
M02V210	53 13 12.339	105 19 04.270	0.08	434.38	458.65
M02V211	53 13 36.421	105 22 03.100	0.07	436.73	460.98
M02V212	53 12 22.964	105 21 18.537	0.13	439.19	463.40
M02V213	53 13 15.170	105 22 11.609	0.16	437.46	461.68
M02V214	53 13 28.491	105 23 25.309	0.09	435.86	460.07
M02V215	53 13 38.917	105 19 03.775	0.09	437.75	462.05
M02V216	53 13 07.581	105 19 09.911	0.09	435.58	459.85
M02V217	53 12 38.065	105 21 40.000	0.14	442.01	466.21

Validation Network Points – UTM Coordinates

Point #	Northing	Easting	Zone	Ellipsoid Height	Orthometric Height
775335	5897650.00	475516.14	13	434.35	458.60
M02V201	5894635.61	476066.31	13	437.97	462.15
M02V202					
M02V203	5894679.49	476123.01	13	438.36	462.54
M02V204	5896687.11	477582.16	13	437.25	461.51
M02V205	5897001.20	477874.52	13	434.98	459.25
M02V206	5897042.67	477737.66	13	435.87	460.14
M02V207	5897596.92	477921.61	13	434.42	458.71
M02V208	5896524.46	478425.83	13	435.86	460.13
M02V209	5896494.05	477606.33	13	437.74	462.00
M02V210	5896801.80	478777.45	13	434.38	458.65
M02V211	5897561.85	475464.55	13	436.73	460.98
M02V212	5895287.75	476279.65	13	439.19	463.40
M02V213	5896905.97	475303.38	13	437.46	461.68
M02V214	5897324.88	473938.75	13	435.86	460.07
M02V215	5897623.07	478790.27	13	437.75	462.05
M02V216	5896655.23	478672.17	13	435.58	459.85
M02V217	5895756.39	475883.84	13	442.01	466.21

Earth-centered Cartesian Coordinates

Point #	**X**	**Y**	**Z**
30504	-995597.539	-3721695.629	5066649.086
756047	-1659602.277	-3676726.917	4925493.421
775063	-981923.202	-3676436.940	5102019.203
86S107	-1013517.204	-3712168.174	5070060.680
87S033	-953000.884	-3688600.767	5098674.477
889201	-1224451.912	-2689217.201	5633638.001
924001	-236438.143	-3307617.972	5430049.029
925000	-1050707.603	-3680987.000	5085127.720
965000	-766173.856	-3611376.487	5184056.121
775335	-1014058.60	-3689876.02	5086093.28
M02V201	-1014152.95	-3692354.77	5084291.94
M02V202			
M02V203	-1014089.16	-3692335.84	5084318.72
M02V204	-1012263.42	-3691162.37	5085524.94
M02V205	-1011915.54	-3690994.24	5085712.08
M02V206	-1012039.27	-3690926.94	5085737.26
M02V207	-1011746.42	-3690545.09	5086068.57
M02V208	-1011482.08	-3691507.59	5085428.72
M02V209	-1012280.18	-3691318.39	5085409.76
M02V210	-1011084.72	-3691383.81	5085594.61
M02V211	-1014127.09	-3689932.16	5086042.24
M02V212	-1013811.89	-3691906.52	5084684.36
M02V213	1014418.89	-3690398.17	5085649.48
M02V214	-1015649.64	-3689716.50	5085894.77
M02V215	-1010902.53	-3690753.40	5086089.25
M02V216	-1011216.99	-3691470.49	5085507.50
M02V217	-1014097.42	-3691442.12	5084966.21