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Oxfordshire Highways

Cogges Link Road
River Windrush
Witney, Oxfordshire
Channel Survey

Survey Report

Jacobs Geomatics
Reading School Green
October 2007

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Document control sheet

Client: Oxfordshire Highways
Project: Cogges Link Road Channel Survey Job No: B0834600
Title: Survey Report

	Prepared by	Reviewed by	Approved by
ORIGINAL	NAME **I Coddington**	NAME **J Dutta**	NAME **J Smith**
DATE **08/05/08**	SIGNATURE 	SIGNATURE 	SIGNATURE 

REVISION	NAME	NAME	NAME
DATE	SIGNATURE	SIGNATURE	SIGNATURE

REVISION	NAME	NAME	NAME
DATE	SIGNATURE	SIGNATURE	SIGNATURE

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DATE	SIGNATURE	SIGNATURE	SIGNATURE

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Amendment Record

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Issue	Date	Description of Amendments

Circulation List

Recipient	Company	Position	Date Issued
Ian Coddington	Jacobs	Geomatics Regional Manager	09/05/2008
Jo Dutta	Jacobs	Geomatics Technical Director	09/05/2008
J Mullins	Jacobs	Project Manager	09/05/2008
J Smith	Jacobs	Hydraulic Engineer	09/05/2008

Contents

Contract Title: **Cogges Link Road, Witney**
River Windrush Channel Survey

Client: **Oxfordshire Highways**

Survey Consultant: Jacobs UK Ltd

Date: October 2007

1 Scope

1.1 Oxfordshire Highways commissioned Jacobs UK Ltd to undertake channel survey cross sections on the River Windrush at Witney, Oxfordshire in October 2007.

1.2 The survey required re-observation of previously surveyed cross sections for comparison purposes and survey of new cross sections as identified by Jo Dutta and Julian Smith during a site visit on 30th August 2007. A total of 25 cross sections were required. The existing cross sections were surveyed in 1990 (EA job nos. 1431&1465) and 1997 (EA job no. 4051) for the Environment Agency. Heights for this survey were based upon local Ordnance Survey Benchmarks (OSBM).

1.3 As the survey is required to be submitted to the Environment Agency as part of a flood risk assessment, wherever possible the survey work has been carried out in accordance with the Environment Agency National Standard Contract & Specification for Surveying Services v2.5.

2 Survey Control

2.1 A network of both vertically and horizontally controlled survey stations has been established through the survey area linked to existing Environment Agency GPS stations below.

Station number	Easting (m)	Northing (m)	Height (mODN)
E20610205	435866.079	209944.823	80.145
E20610206	431793.784	211102.137	88.984

Three Leica 500 series GPS receivers were used to observe closed loop baselines to both Environment Agency GPS stations, with occupancy times of at least half an hour at each new network station.

2.2 An unconstrained network adjustment was undertaken holding E20610206 fixed. The following table shows the comparison of computed and published WGS84 heights at other control stations:-

Station number	Computed Height	Published Height	Difference(m)
E20610205	128.007	128.001	+0.006

2.3 Final co-ordinates have been computed using a constrained network adjustment holding all source control stations fixed. WGS84 co-ordinates were transformed to OSGB36 using OSTN02/OSGM02. A list of final OSGB36 co-ordinates is provided in below.

Station number	Easting (m)	Northing (m)	Height (mODN)
STN01	435767.098	210203.038	81.593
STN02	436125.402	209718.685	80.416
STN03	435892.104	210058.781	82.534
STN04	435934.964	209269.917	79.801
STN05	436025.002	209034.766	78.167

A network diagram and network/loop adjustments reports can be found in Appendix C.

2.4 Position and height qualities for established stations are provided below. These have been calculated by the GPS processing software, Leica Geo-Office and can be taken to a 90% confidence level.

Station number	Position Quality (m)	Height Quality (m)
STN01	0.003	0.005
STN02	0.004	0.005
STN03	0.004	0.008
STN04	0.004	0.005
STN05	0.002	0.004

2.5 Level or detail observations were taken from the established control to two local Ordnance Survey Benchmarks (OSBM) and variations between the current OSTN02 datum and the historical OSBM system calculated. These are provided below:

OSBM	Computed Height (m)	Published Height (m)	Difference (m)
SP 3577 1018	82.672	82.724	-0.052
SP 3623 0970	80.807	80.880	-0.073

2.6 A mean of the variations between the historic system and the current OSTN02 datum has been calculated at -0.063m. This has been applied to measurements taken to soffit levels at re-observed structures along the River Windrush to allow comparison between survey observations taken in 1990. A table detailing the comparisons observed can be found in Appendix II.

2.7 Spirit levelling was undertaken as described above. Level misclosures were as follows:

Level run: STN02 to OSBM SP 3623 0970 to STN02
Misclosure = -0.014m

2.8 Survey control for each cross section was provided by establishing temporary survey stations at relevant positions and observing GPS Real Time Kinematic (RTK) observations from the established GPS control stations. A minimum of 5 measurements was taken to each temporary station and the mean taken. Check RTK measurements were also taken to the established GPS control stations to verify accuracy and vertical agreement was within ±30mm.

3 Topography

3.1 The topography has been surveyed using a Leica 1200 series Total Station and a Leica NA2002 digital level. All equipment was calibrated and tested prior to use. All major surface features have been included in the survey but the complexity of detail relates finally to the plotted scales and this must be borne in mind when interpreting the plan.

3.2 All mapped features have been heighted and these relate to Ordnance Datum Newlyn. The precision of heights on hard surfaces may be taken, to a 95% confidence level, to be within ±20mm relative to the control station height.

3.3 For re-observation of structure cross sections, the soffit level has been observed and in addition, where possible a profile of the channel has been surveyed.

3.4 The survey as a whole has been quality checked by Martyn Walker and Ian Coddington MRICS.

4 Presentation

4.1 The survey is presented as 2D AutoCAD R14 DXF & DWG files, from which the following drawings have been produced:-

Drawing No.	Contents	Scale	CAD filename
B0834600/01-03	Surveyed cross sections	1:100	*B0834600_xsec.dwg*
B0834600/04	Cross section location plan	1:2500	*B0834600_plan.dwg*

5 Comments

5.1 Site photography is included in Appendix A.

5.2 A table detailing the structure soffit level comparisons observed can be found in Appendix B.

5.3 The survey was undertaken by Ian Coddington and James Beattie of Jacobs UK Ltd between the 12th and 19th October 2007.

5.4 Comparisons with soffit level observed in 1990 and 1997 are generally good (all within ±45mm and generally ±25mm). The only exceptions are those taken at Structures B and G. Both of these structures are disused dilapidated railway bridges which may have been subject to settlement since they were surveyed. Both a negative difference in level since they were survey in 1990.

5.5 All new sections have been surveyed so that they are viewed looking downstream.

Signed: Date: 9th May 2008……

Ian Coddington
Principal Land Surveyor

Appendix A - Site Photography

Photograph 1 Structure ST01 Sluice Gate

Photograph 2 Structure ST02 upstream face of culvert

Photograph 3 Structure ST03 upstream face of footbridge

Photograph 4 Structure ST04 upstream face of road bridge

Photograph 5 Structure A upstream face of A40 road bridge

Photograph 6 Structure B upstream face of disused railway bridge

Photograph 7 Structure C upstream face of footbridge

Photograph 8 Structure D Bridge Street road bridge

Photograph 9 Structure E upstream face of A40 road bridge

Photograph 10 Structure F upstream face of disused railway bridge

Photograph 11 Structure G upstream face of disused railway bridge

Photograph 12 Structure H upstream face of Farm Mill

Photograph 13 Structure I upstream face of footbridge

Photograph 14 Structure J upstream face of culvert

Photograph 15 Cross Section CS1

Photograph 16 Cross Section CS2

Photograph 17 Cross Section CS3

Photograph 18 Cross Section CS4

Photograph 19 Cross Section CS5 and downstream face of Farm Mill

Photograph 20 Cross Section CS6

Photograph 21 Cross Section CS7

Photograph 22 Cross Section CS8

Photograph 23 Cross Section CS9

Photograph 24 Cross Section CS10

Photograph 25 Cross Section CS11

Photograph 26 Cross Section CS12

Photograph 27 Cross Section CS13

Appendix B - Structure Soffit Comparisons

Cogges Link Road, Witney Topographic Survey
Jacobs Geomatics

Structure Soffit Level Comparison

Structure	2007 Level (m)	1990 Level (m)	Diff (m)	Difference less variation between OSGM02 and OSBM system
A	79.580	79.629	0.049	-0.013
B	78.680	78.662	-0.018	-0.081
C	79.970	80.010	0.040	-0.022
D (US1)	80.825	80.863	0.038	-0.025
D (US2)	80.823	80.863	0.040	-0.022
D (DS1)	80.766	80.836	0.070	0.007
D (DS2)	80.828	80.908	0.080	0.017
E	79.110	79.170	0.060	-0.002
F	78.470	78.520	0.050	-0.013
G	78.680	78.680	0.000	-0.063
H (US1)	79.241	79.270	0.029	-0.034
H (DS1)	78.663	78.680	0.017	-0.045
H (DS2)	78.652	78.710	0.058	-0.005
I	80.040	80.060	0.020	-0.043
J	78.800	78.840	0.040	-0.022

Note: Levels for 1990 are based on heights obtained by measuring from local Ordnance Survey Benchmarks and are taken from supplied drawings A01S 1431/6, 1431/8, 1431/9, 1465/5, 1465/6 and SURV 4051/4. Level for Structure J was observed in 1997
Levels for 2007 are based on OSGB36 using the OSGM02 transformation

Difference between OSGM02 and OSBM system calculated as mean difference observed betweeb two local Ordnance Survey Benchmarks as below:

OSBM SP3577 1018

Published height	82.724
Observed OSGM02 height	82.672
Difference (m)	0.052

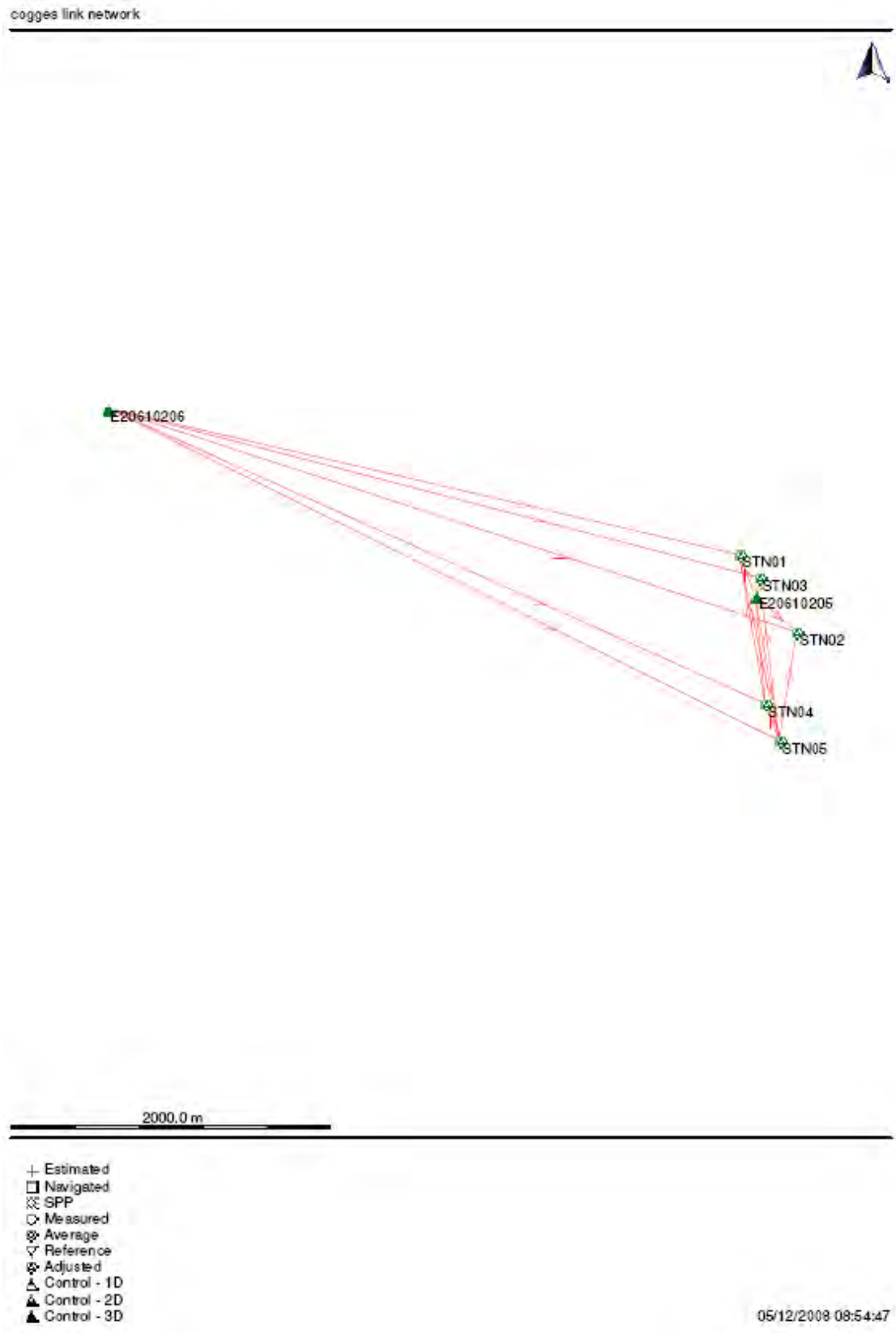
OSBM SP3623 0970

Published height	80.880
Observed OSGM02 height	80.807
Difference (m)	0.073

Mean difference = 0.063

Appendix C - GPS Network Reports

Constrained Network Diagram



Leica Geosystems

Network Adjustment

www.MOVE3.com

Created: 05/12/2008 08:55:08

Project Information

Project name:	cogges link network
Date created:	05/08/2008 16:49:43
Time zone:	0h 00'
Coordinate system name:	OSGB36(02)
Application software:	LEICA Geo Office 6.0
Processing kernel:	MOVE3 3.4

General Information

Adjustment

Type:	Constrained	
Dimension:	3D	
Coordinate system:	WGS 1984	
Height mode:	Ellipsoidal	
Number of iterations:	1	
Maximum coord correction in last iteration:	0.0000 m	✓ (tolerance is met)

Stations

Number of (partly) known stations:	2
Number of unknown stations:	5
Total:	7

Observations

GPS coordinate differences:	45 (15 baselines)
Known coordinates:	6
Total:	51

Unknowns

Coordinates:	21
Total:	21
Degrees of freedom:	30

Testing

Alfa (multi dimensional):	0.4836
Alfa 0 (one dimensional):	5.0 %
Beta:	80.0 %
Sigma a-priori (GPS):	10.0
Critical value W-test:	1.96
Critical value T-test (2-dimensional):	2.42

Critical value T-test (3-dimensional):	1.89	
Critical value F-test:	0.99	
F-test:	1.80	⚠ (rejected)

Results based on a-posteriori variance factor

Adjustment Results

Coordinates

Station		Coordinate	Corr	Sd	
E20610205	Latitude	51°47' 13.28489" N	0.0000 m	-	fixed
	Longitude	1°28' 53.11187" W	0.0000 m	-	fixed
	Height	128.0010 m	0.0000 m	-	fixed
E20610206	Latitude	51°47' 51.63031" N	0.0000 m	-	fixed
	Longitude	1°32' 25.26300" W	0.0000 m	-	fixed
	Height	136.9660 m	0.0000 m	-	fixed
STN01	Latitude	51°47' 21.66535" N	-0.0011 m	0.0030 m	
	Longitude	1°28' 58.18206" W	-0.0016 m	0.0019 m	
	Height	129.4560 m	-0.0004 m	0.0047 m	
STN02	Latitude	51°47' 05.90539" N	0.0008 m	0.0032 m	
	Longitude	1°28' 39.66253" W	-0.0003 m	0.0020 m	
	Height	128.2606 m	0.0013 m	0.0053 m	
STN03	Latitude	51°47' 16.96736" N	0.0014 m	0.0029 m	
	Longitude	1°28' 51.71133" W	-0.0008 m	0.0020 m	
	Height	130.3914 m	-0.0024 m	0.0076 m	
STN04	Latitude	51°46' 51.42416" N	0.0018 m	0.0030 m	
	Longitude	1°28' 49.76770" W	-0.0004 m	0.0019 m	
	Height	127.6419 m	-0.0031 m	0.0049 m	
STN05	Latitude	51°46' 43.79215" N	0.0013 m	0.0019 m	
	Longitude	1°28' 45.15690" W	-0.0006 m	0.0012 m	
	Height	126.0025 m	0.0043 m	0.0038 m	

Observations and Residuals

	Station	Target	Adj obs	Resid	Resid (ENH)	Sd
DX	STN04	STN01	-737.1679 m	0.0137 m	0.0081 m	0.0049 m
DY			-142.2799 m	0.0077 m	0.0007 m	0.0021 m
DZ			579.6217 m	0.0184 m	0.0228 m	0.0046 m
DX	STN05	STN04	-186.5261 m	-0.0085 m	-0.0006 m	0.0046 m
DY			-83.6045 m	-0.0004 m	0.0061 m	0.0018 m
DZ			147.2251 m	-0.0010 m	-0.0060 m	0.0038 m
DX	STN05	STN03	-805.8565 m	0.0058 m	0.0011 m	0.0055 m
DY			-104.8649 m	0.0009 m	-0.0026 m	0.0019 m
DZ			637.7655 m	0.0031 m	0.0060 m	0.0061 m
DX	STN05	STN02	-532.6718 m	0.0058 m	-0.0025 m	0.0047 m
DY			119.1112 m	-0.0026 m	-0.0034 m	0.0020 m
DZ			424.5984 m	0.0019 m	0.0051 m	0.0044 m
DX	STN05	STN01	-923.6940 m	-0.0056 m	0.0009 m	0.0037 m
DY			-225.8843 m	0.0011 m	0.0033 m	0.0017 m
DZ			726.8468 m	-0.0017 m	-0.0048 m	0.0038 m
DX	E20610205	STN05	718.6319 m	-0.0070 m	0.0013 m	0.0028 m
DY			133.9746 m	0.0015 m	0.0017 m	0.0012 m
DZ			-565.4840 m	-0.0061 m	-0.0092 m	0.0032 m
DX	E20610205	STN04	532.1058 m	0.0049 m	0.0002 m	0.0044 m
DY			50.3701 m	0.0001 m	0.0027 m	0.0018 m

DZ			-418.2590 m	0.0106 m	0.0113 m	0.0037 m
DX	E20610205	STN03	-87.2246 m	-0.0081 m	-0.0006 m	0.0053 m
DY			29.1097 m	-0.0004 m	0.0059 m	0.0020 m
DZ			72.2815 m	-0.0007 m	-0.0055 m	0.0062 m
DX	E20610205	STN02	185.9601 m	-0.0028 m	0.0027 m	0.0045 m
DY			253.0858 m	0.0027 m	0.0042 m	0.0020 m
DZ			-140.8857 m	0.0032 m	0.0007 m	0.0043 m
DX	E20610205	STN01	-205.0621 m	-0.0130 m	0.0013 m	0.0035 m
DY			-91.9097 m	0.0016 m	-0.0128 m	0.0019 m
DZ			161.3627 m	-0.0372 m	-0.0373 m	0.0043 m
DX	E20610206	STN05	1751.2321 m	0.0032 m	-0.0001 m	0.0028 m
DY			4174.1916 m	-0.0002 m	-0.0040 m	0.0012 m
DZ			-1305.5579 m	-0.0023 m	0.0002 m	0.0032 m
DX	E20610206	STN04	1564.7060 m	0.0132 m	0.0010 m	0.0044 m
DY			4090.5871 m	0.0007 m	-0.0090 m	0.0018 m
DZ			-1158.3329 m	0.0023 m	0.0100 m	0.0037 m
DX	E20610206	STN03	945.3756 m	0.0020 m	-0.0015 m	0.0053 m
DY			4069.3267 m	-0.0015 m	0.0048 m	0.0020 m
DZ			-667.7925 m	0.0102 m	0.0093 m	0.0062 m
DX	E20610206	STN02	1218.5603 m	-0.0083 m	0.0046 m	0.0045 m
DY			4293.3028 m	0.0048 m	0.0031 m	0.0020 m
DZ			-880.9596 m	-0.0056 m	-0.0096 m	0.0043 m
DX	E20610206	STN01	827.5380 m	0.0050 m	-0.0065 m	0.0035 m
DY			3948.3073 m	-0.0066 m	0.0059 m	0.0019 m
DZ			-578.7112 m	0.0160 m	0.0158 m	0.0043 m

GPS Baseline Vector Residuals

	Station	Target	Adj vector [m]	Resid [m]	Resid [ppm]
DV	STN04	STN01	948.4838	0.0242	25.5
DV	STN05	STN04	251.9066	0.0085	33.9
DV	STN05	STN03	1033.0276	0.0066	6.4
DV	STN05	STN02	691.5276	0.0066	9.5
DV	STN05	STN01	1196.8879	0.0059	4.9
DV	E20610205	STN05	924.2041	0.0094	10.2
DV	E20610205	STN04	678.6857	0.0117	17.2
DV	E20610205	STN03	116.9620	0.0081	69.5
DV	E20610205	STN02	344.2127	0.0050	14.6
DV	E20610205	STN01	276.6511	0.0395	142.7
DV	E20610206	STN05	4711.1751	0.0040	0.8
DV	E20610206	STN04	4530.2255	0.0134	3.0
DV	E20610206	STN03	4230.7329	0.0105	2.5
DV	E20610206	STN02	4549.0029	0.0111	2.4
DV	E20610206	STN01	4075.3964	0.0180	4.4

Absolute Error Ellipses (2D - 39.4% 1D - 68.3%)

Station	A [m]	B [m]	A/B	Phi	Sd Hgt [m]
E20610205	0.0000	0.0000	1.0	-9°	0.0000
E20610206	0.0000	0.0000	1.0	-9°	0.0000
STN01	0.0030	0.0019	1.6	-2°	0.0047
STN02	0.0032	0.0019	1.7	16°	0.0053
STN03	0.0029	0.0020	1.5	-2°	0.0076
STN04	0.0030	0.0018	1.6	-7°	0.0049
STN05	0.0019	0.0012	1.6	-8°	0.0038

Testing and Estimated Errors

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Coordinate Tests

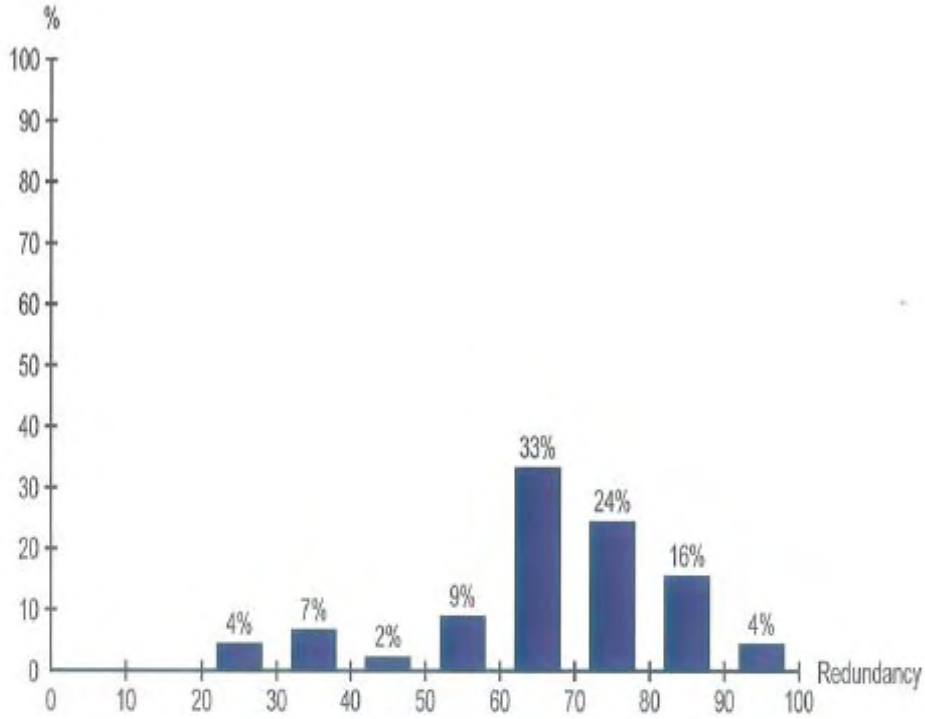
Station		MDB	BNR	W-Test	T-Test
E20610205	Latitude	0.0084 m	999.9	0.00	0.00
	Longitude	0.0058 m	999.9	0.00	
	Height	0.0165 m	999.9	0.00	
E20610206	Latitude	0.0084 m	999.9	0.00	0.00
	Longitude	0.0058 m	999.9	0.00	
	Height	0.0165 m	999.9	0.00	

Observation Tests

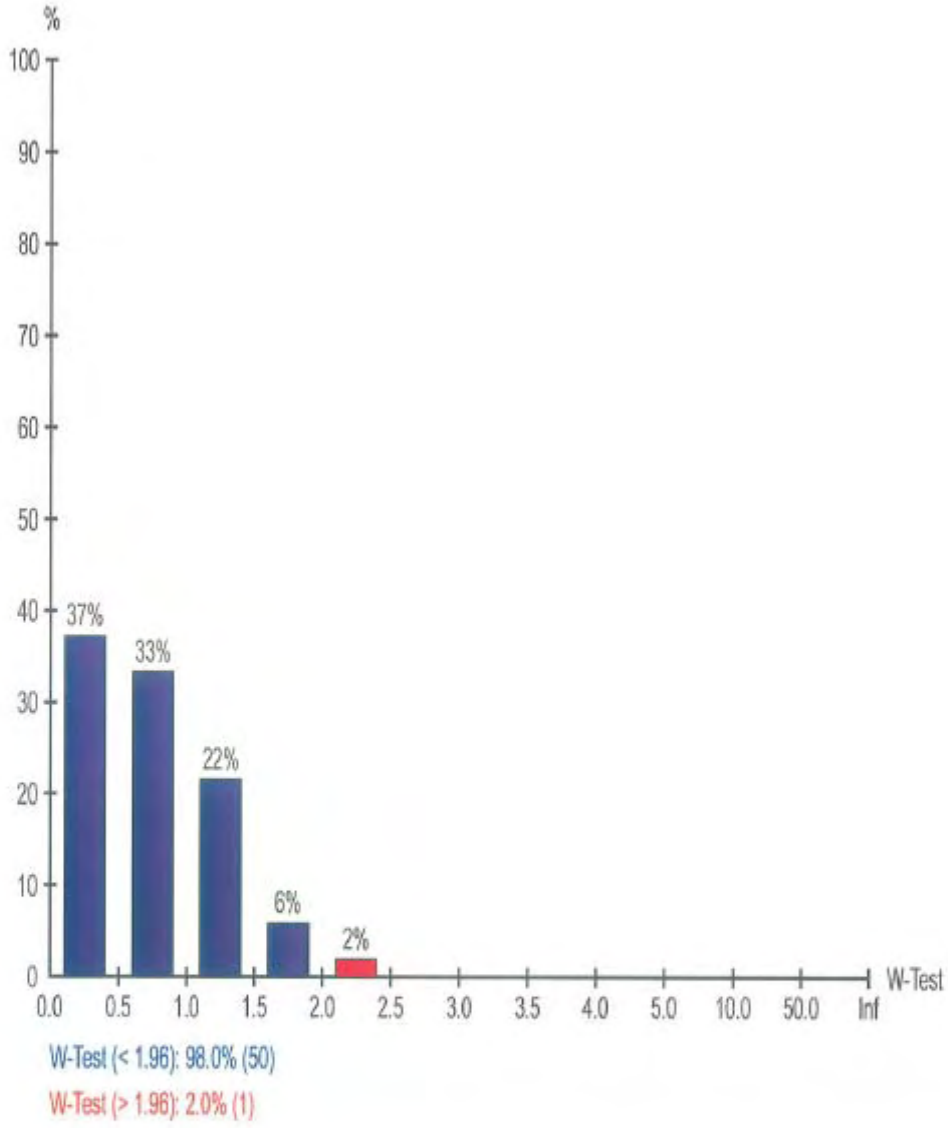
	Station	Target	MDB	Red	BNR	W-Test	T-Test
DX	STN04	STN01	0.0298 m	73	1.7	1.05	2.07 ⚠
DY			0.0120 m	65	2.5	0.71	
DZ			0.0257 m	68	2.3	1.11	
DX	STN05	STN04	0.0288 m	75	1.6	-1.06	0.40
DY			0.0103 m	61	3.0	0.09	
DZ			0.0216 m	64	2.8	-0.03	
DX	STN05	STN03	0.0227 m	57	5.0	1.34	0.70
DY			0.0115 m	27	4.7	0.65	
DZ			0.0263 m	25	6.0	-1.00	
DX	STN05	STN02	0.0210 m	53	3.1	0.85	1.16
DY			0.0110 m	38	3.5	-1.29	
DZ			0.0207 m	39	3.6	-0.34	
DX	STN05	STN01	0.0210 m	65	2.2	-0.88	0.55
DY			0.0098 m	43	3.5	0.60	
DZ			0.0207 m	38	3.6	-0.41	
DX	E20610205	STN05	0.0134 m	68	1.9	-1.28	0.96
DY			0.0074 m	71	1.8	0.60	
DZ			0.0162 m	76	1.8	0.14	
DX	E20610205	STN04	0.0217 m	67	2.1	-0.63	1.41
DY			0.0116 m	71	1.9	0.52	
DZ			0.0187 m	66	2.2	1.94	
DX	E20610205	STN03	0.0261 m	74	1.6	-1.14	0.46
DY			0.0137 m	82	1.5	-0.57	
DZ			0.0353 m	84	1.1	0.44	
DX	E20610205	STN02	0.0209 m	60	2.3	-0.45	0.42
DY			0.0115 m	67	2.1	0.58	
DZ			0.0208 m	57	2.3	0.75	
DX	E20610205	STN01	0.0234 m	81	1.3	-0.45	1.83
DY			0.0188 m	91	1.0	-1.23	
DZ			0.0413 m	93	1.0	-1.80	
DX	E20610206	STN05	0.0130 m	64	2.1	1.51	0.87
DY			0.0071 m	67	2.0	-0.51	
DZ			0.0158 m	73	2.0	-1.34	
DX	E20610206	STN04	0.0220 m	69	2.1	2.22 ⚠	1.68
DY			0.0117 m	71	1.9	0.06	
DZ			0.0187 m	65	2.2	-1.11	
DX	E20610206	STN03	0.0239 m	61	2.0	-0.37	0.29
DY			0.0131 m	80	1.7	-0.19	
DZ			0.0329 m	82	1.2	0.84	
DX	E20610206	STN02	0.0258 m	77	1.4	-0.48	0.70
DY			0.0144 m	82	1.3	0.96	
DZ			0.0292 m	85	1.2	-0.56	
DX	E20610206	STN01	0.0179 m	50	2.8	0.47	0.87
DY			0.0129 m	76	2.0	-0.70	

DZ	0.0273 m	77	2.1	0.55

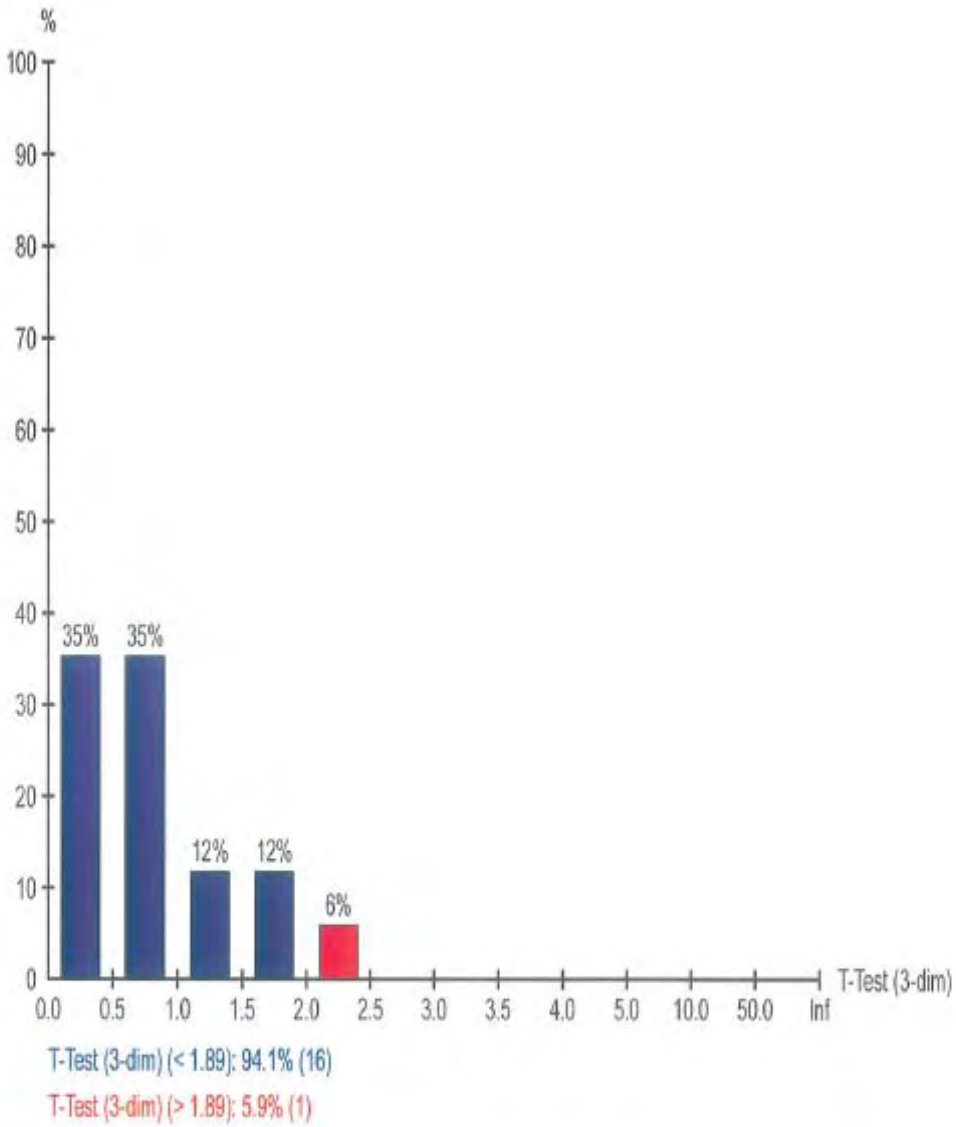
Redundancy:



W-Test:



T-Test (3-dimensional):



Estimated Errors (Observations)

Estimated Errors For Observations With Rejected W-Tests (max 10)

	Station	Target	W-Test	Fact	Est err
DX	E20610206	STN04	2.22	1.1	0.0175 m

Estimated Errors For Observations With Rejected T-Tests (max 10)

	Station	Target	T-Test	Fact	Est err
DX	STN04	STN01	2.07	1.0	0.0189 m
DY					0.0092 m
DZ					0.0236 m

Loops and Misclosures

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Created: 05/12/2008 08:55:34

Project Information

Project name:	cogges link network
Date created:	05/08/2008 16:49:43
Time zone:	0h 00'
Coordinate system name:	OSGB36(02)
Application software:	LEICA Geo Office 6.0
Processing kernel:	MOVE3 3.4
Critical value W-test is:	1.96
Dimension:	3D

GPS Baseline Loops

Loop 1

From	To	dX[m]	dY[m]	dZ[m]
STN05	STN04	-186.5346	-83.6049	147.2241
STN04	E20610206	-1564.7192	-4090.5678	1158.3306
E20610206	STN05	1751.2353	4174.1914	-1305.5609
X:	-0.0185 m	W-Test:	-1.87	
Y:	-0.0013 m		-0.30	
Z:	-0.0056 m		-0.60	
Easting:	-0.0017 m	W-Test:	-0.42	
Northing:	0.0111 m		1.14	
Height:	-0.0158 m		-1.65	
Closing error:	0.0193 m	(2.0 ppm)	Ratio:(1:490762)	
Length:	9493.3192 m			

Loop 2

From	To	dX[m]	dY[m]	dZ[m]
STN05	STN04	-186.5346	-83.6049	147.2241
STN04	E20610205	-532.1107	-50.3702	418.2484
E20610205	STN05	719.6249	133.9761	-565.4902
X:	-0.0204 m	W-Test:	-2.07	⚠
Y:	0.0010 m		0.24	
Z:	-0.0177 m		-1.89	
Easting:	0.0005 m	W-Test:	0.11	
Northing:	0.0051 m		0.52	
Height:	-0.0265 m		-2.78	⚠

Closing error:	0.0270 m	(14.5 ppm)	Ratio:(1:68757)
Length:	1854.7981 m		

Loop 3

From	To	dX[m]	dY[m]	dZ[m]
STN05	E20610206	-1751.2353	-4174.1914	1305.5603
E20610206	STN01	827.5430	3948.3007	-578.6952
STN01	STN05	923.6996	225.8833	-726.8450

X:	0.0073 m	W-Test:	1.02	
Y:	-0.0075 m		-1.67	
Z:	0.0201 m		1.88	
Easting:	-0.0073 m	W-Test:	-1.62	
Northing:	0.0065 m		0.75	
Height:	0.0204 m		2.15	⚠
Closing error:	0.0226 m	(2.3 ppm)	Ratio:(1:441522)	
Length:	9983.4564 m			

Loop 4

From	To	dX[m]	dY[m]	dZ[m]
STN05	E20610205	-718.6249	-133.9761	565.4902
E20610205	STN02	185.9573	253.0885	-140.8825
STN02	STN05	532.6660	-119.1086	-424.6003

X:	-0.0016 m	W-Test:	-0.19	
Y:	0.0038 m		1.01	
Z:	0.0074 m		0.89	
Easting:	0.0038 m	W-Test:	1.00	
Northing:	0.0059 m		0.70	
Height:	0.0048 m		0.57	
Closing error:	0.0085 m	(4.3 ppm)	Ratio:(1:231077)	
Length:	1959.9384 m			

Loop 5

From	To	dX[m]	dY[m]	dZ[m]
STN05	E20610205	-718.6249	-133.9761	565.4902
E20610205	STN03	-87.2327	29.1093	72.2808
STN03	STN05	805.8507	104.8640	-637.7686

X:	-0.0069 m	W-Test:	-0.61	
Y:	-0.0028 m		-0.63	
Z:	0.0023 m		0.17	
Easting:	-0.0030 m	W-Test:	-0.66	
Northing:	0.0068 m		0.55	
Height:	-0.0024 m		-0.19	
Closing error:	0.0078 m	(3.8 ppm)	Ratio:(1:266215)	
Length:	2074.1951 m			

Loop 6

From	To	dX[m]	dY[m]	dZ[m]
E20610205	STN05	718.6249	133.9761	-565.4902
STN05	STN01	-923.6996	-225.8833	726.8450
STN01	E20610205	205.0751	91.9081	-161.3255

X:	0.0004 m	W-Test:	0.05
Y:	0.0009 m		0.14
Z:	0.0294 m		1.78
Easting:	0.0009 m	W-Test:	0.14
Northing:	0.0178 m		1.43
Height:	0.0233 m		1.65
Closing error:	0.0294 m	(12.3 ppm)	Ratio:(1:81615)
Length:	2397.7320 m		

Loop 7

From	To	dX[m]	dY[m]	dZ[m]
E20610206	STN05	1751.2353	4174.1914	-1305.5603
STN05	STN03	-805.8507	-104.8640	637.7686
STN03	E20610206	-945.3776	-4069.3251	667.7823

X:	0.0070 m	W-Test:	0.68
Y:	0.0023 m		0.54
Z:	-0.0094 m		-0.74
Easting:	0.0025 m	W-Test:	0.58
Northing:	-0.0113 m		-1.00
Height:	-0.0031 m		-0.26
Closing error:	0.0120 m	(1.2 ppm)	Ratio:(1:833106)
Length:	9974.9320 m		

Loop 8

From	To	dX[m]	dY[m]	dZ[m]
E20610206	STN05	1751.2353	4174.1914	-1305.5603
STN05	STN02	-532.6660	119.1086	424.6003
STN02	E20610206	-1218.5520	-4293.3076	880.9652

X:	0.0172 m	W-Test:	1.84
Y:	-0.0076 m		-1.67
Z:	0.0052 m		0.50
Easting:	-0.0071 m	W-Test:	-1.57
Northing:	-0.0105 m		-1.07
Height:	0.0149 m		1.49
Closing error:	0.0195 m	(2.0 ppm)	Ratio:(1:509497)
Length:	9951.7070 m		

Loop 9

From	To	dX[m]	dY[m]	dZ[m]
STN04	STN05	186.5346	83.6049	-147.2241
STN05	STN01	-923.6996	-225.8833	726.8450
STN01	STN04	737.1542	142.2721	-579.6401

X:	-0.0108 m	W-Test:	-0.99	
Y:	-0.0063 m		-1.35	
Z:	-0.0192 m		-1.91	
Easting:	-0.0065 m	W-Test:	-1.41	
Northing:	-0.0035 m		-0.33	
Height:	-0.0216 m		-2.08	⚠
Closing error:	0.0229 m	(9.5 ppm)	Ratio:(1:104812)	

Length: 2397.2865 m