The Hydrogeology and Restoration of a Raised Bog

Volume II of II
Appendices

By

Shane Regan

Department of Civil, Structural & Environmental Engineering,
University of Dublin,
Trinity College

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Appendices

Appendix A: Geo-Hydrological Framework

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Appendix A

Geo-Hydrological Framework

Appendix A. Geo-hydrological Framework – till subsoil outcrop

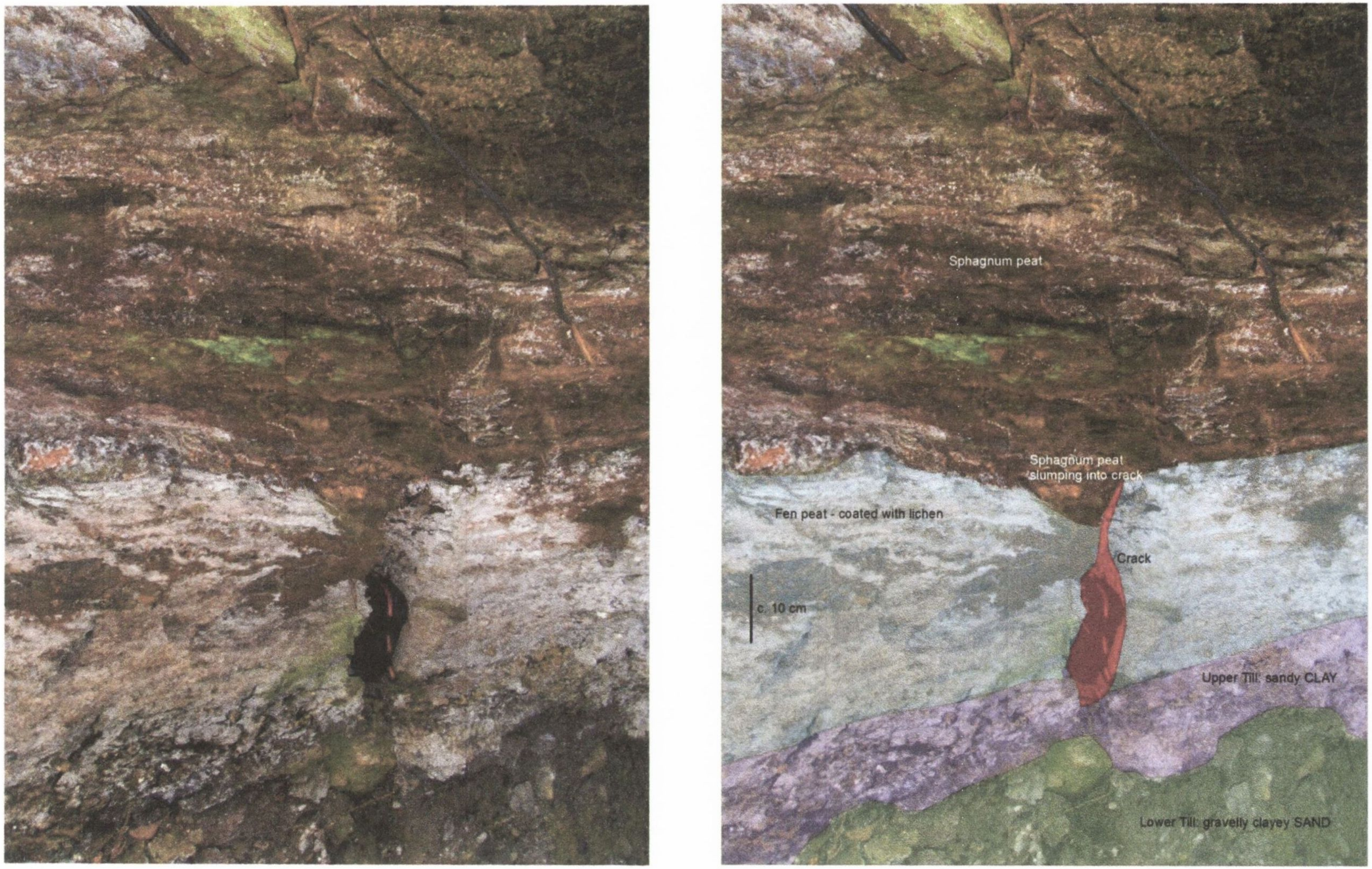


Figure A1. Peat-till outcrop at marginal drain – confluence of drain CT2 and TD2 (see appendix B for location map)

Appendix A. Geo-hydrological Framework: Subsoil and Peat Depth Contour Maps

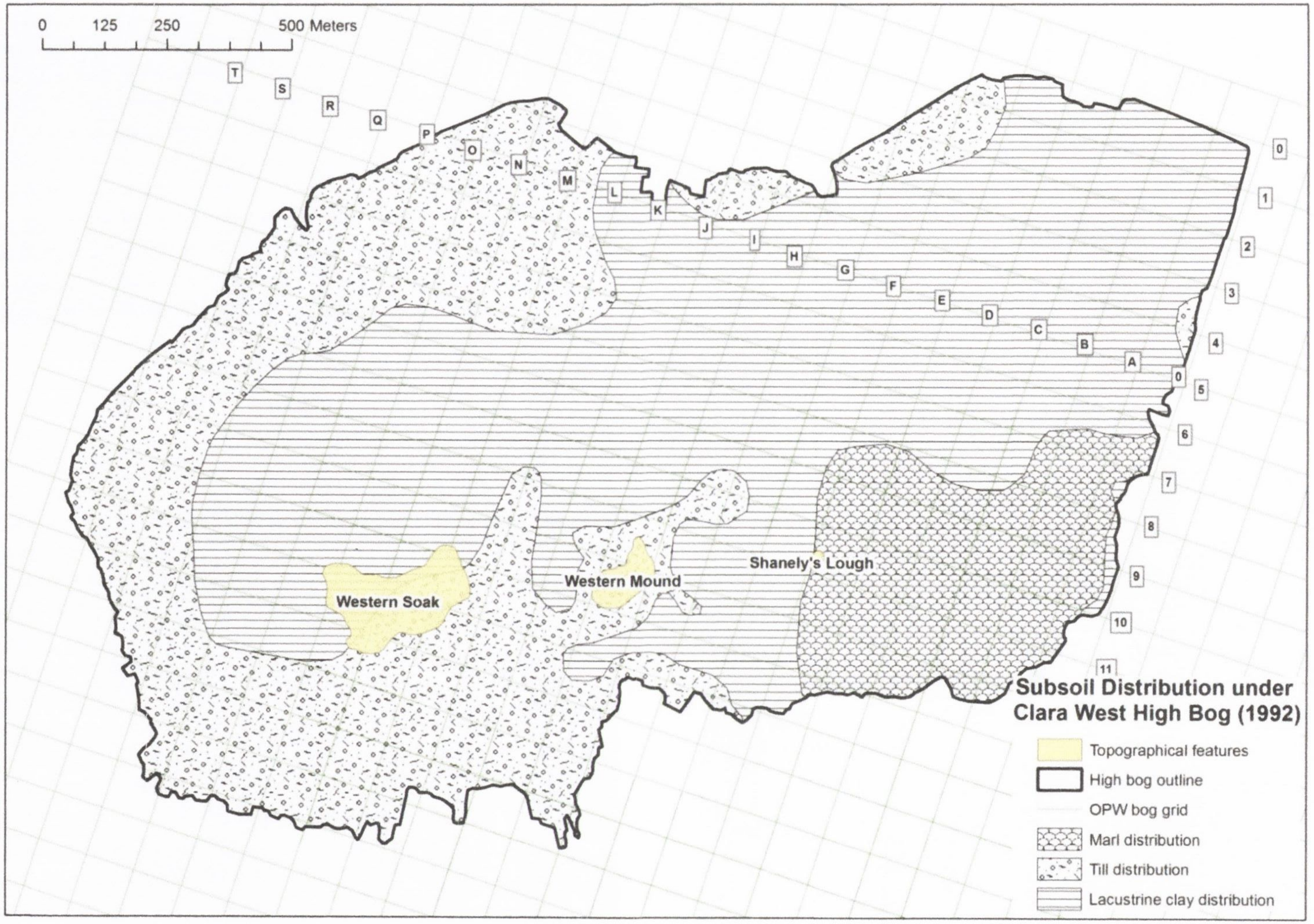


Figure A2. Clara West subsoil distribution map as mapped by Bloejtes (1992) with OPW grid

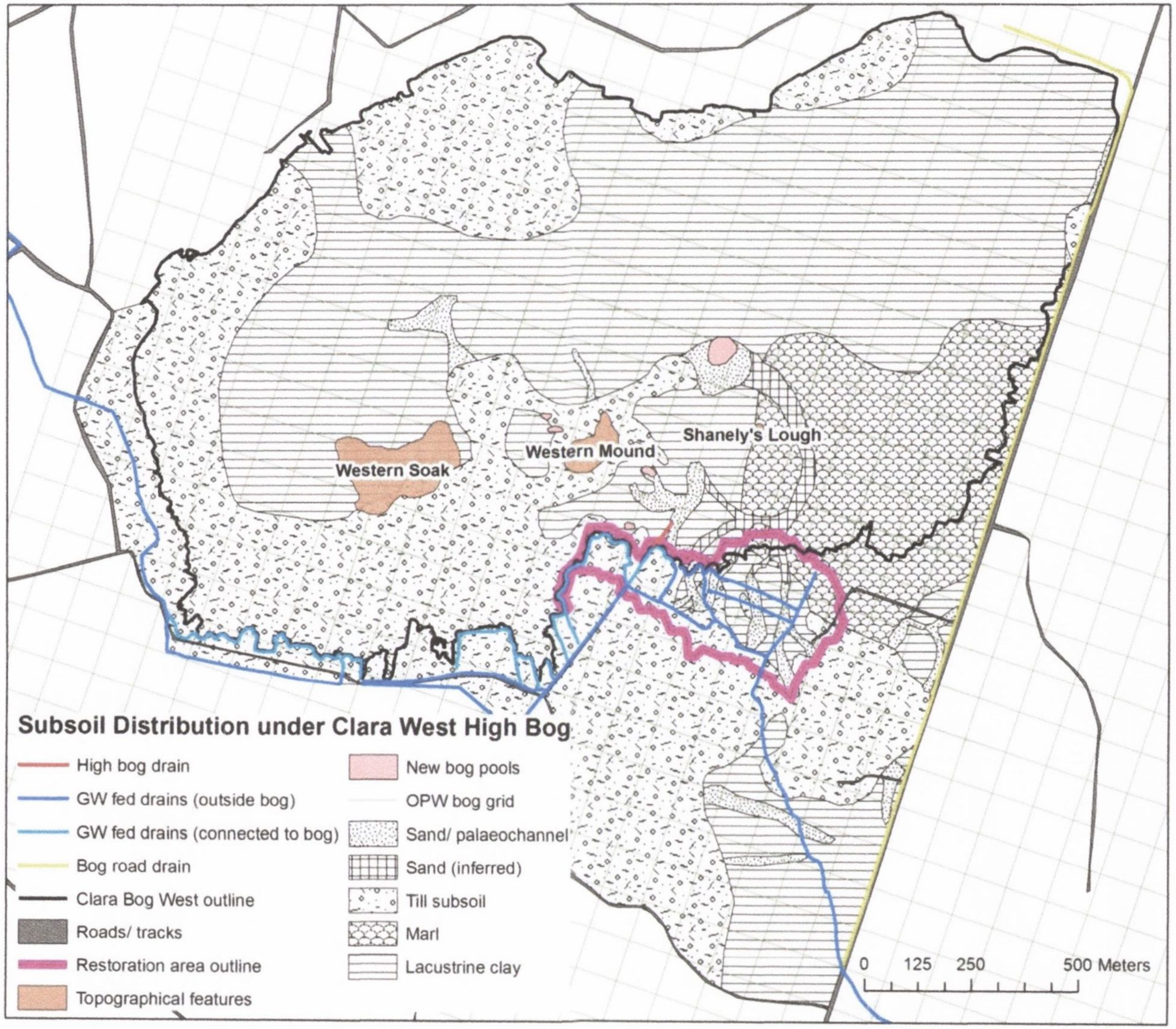


Figure A3. Clara West subsoil distribution map (2010)

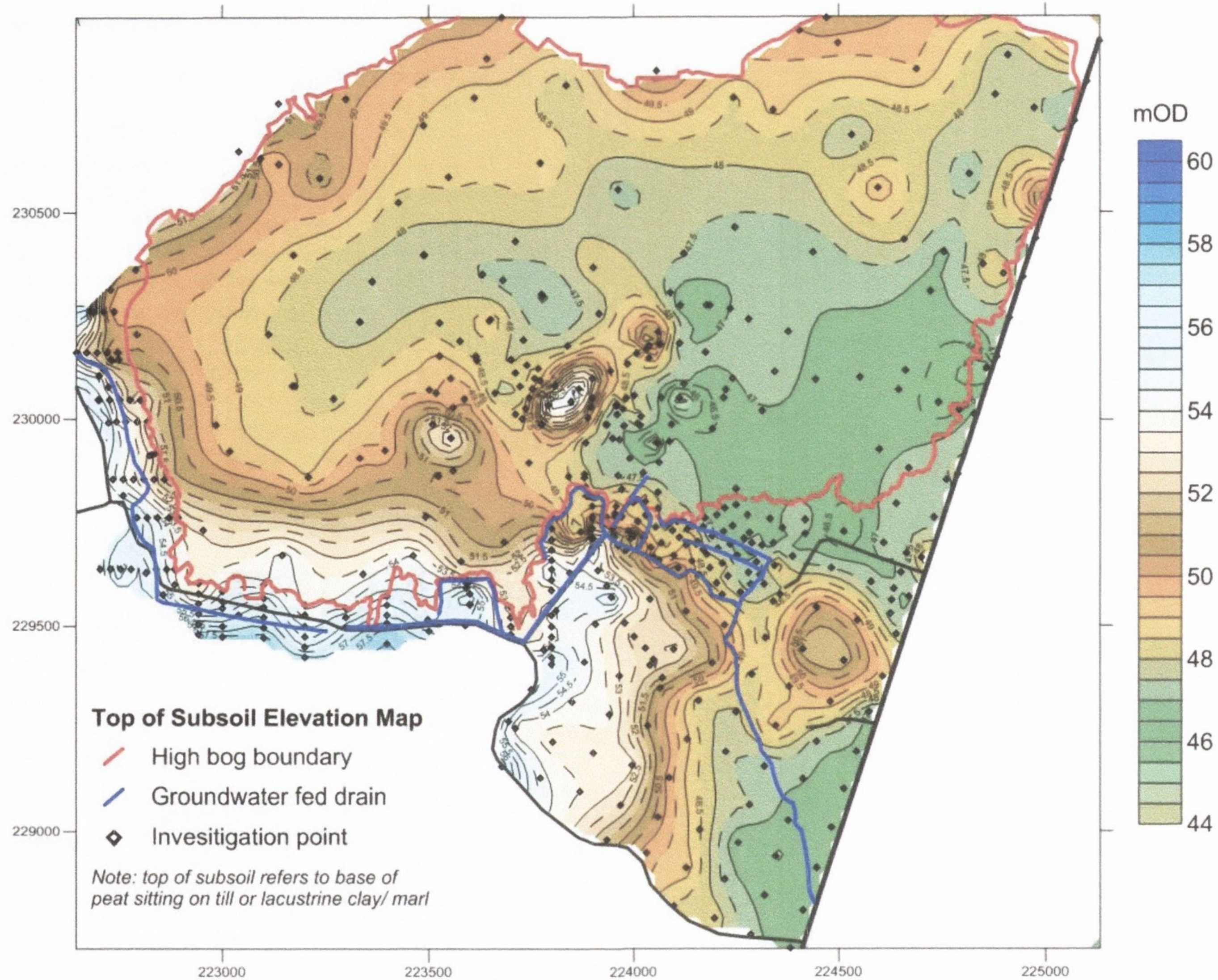


Figure A4. Clara West top of subsoil elevation contour map

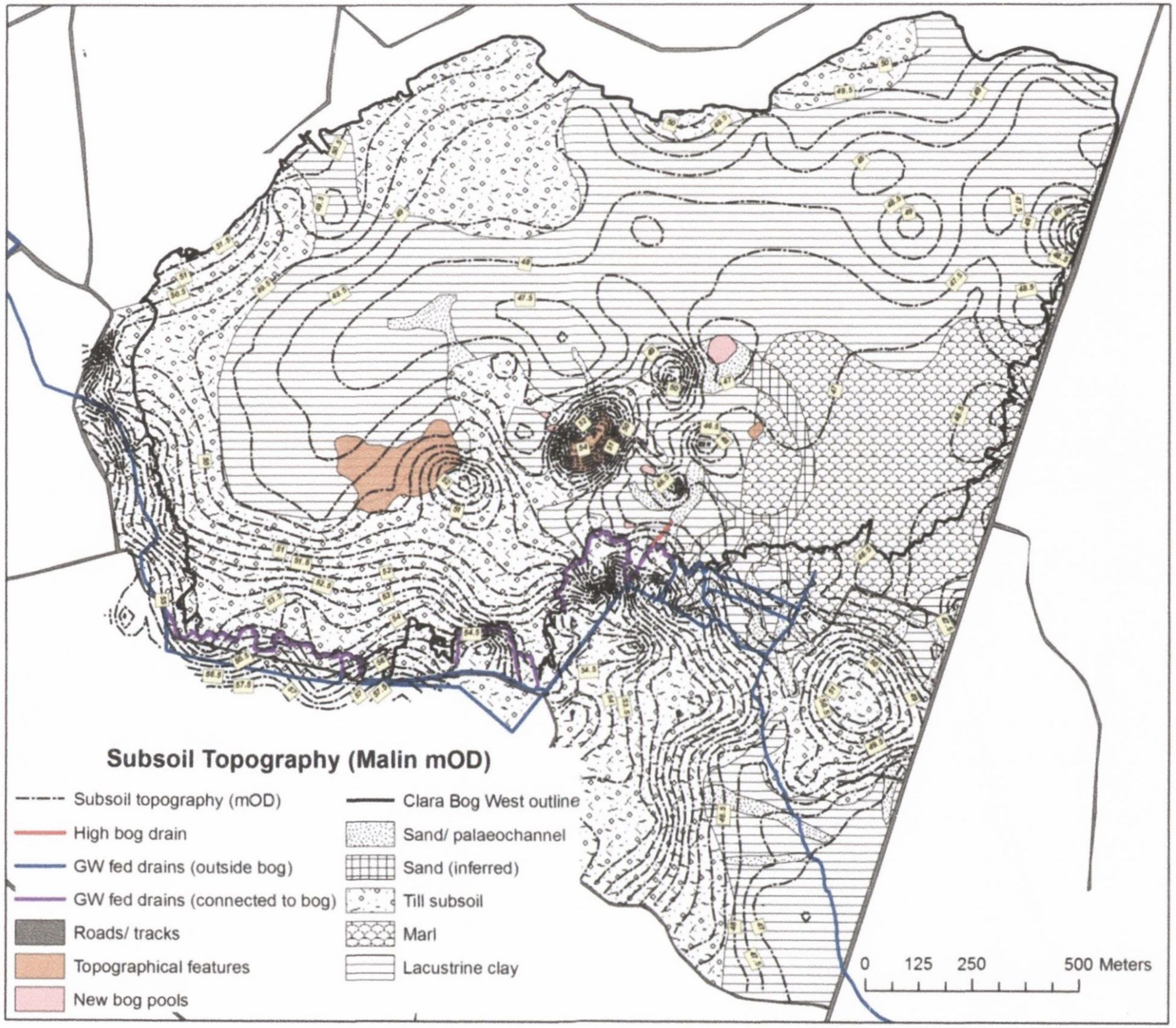


Figure A5. Clara West subsoil distribution and top of subsoil elevation contour map

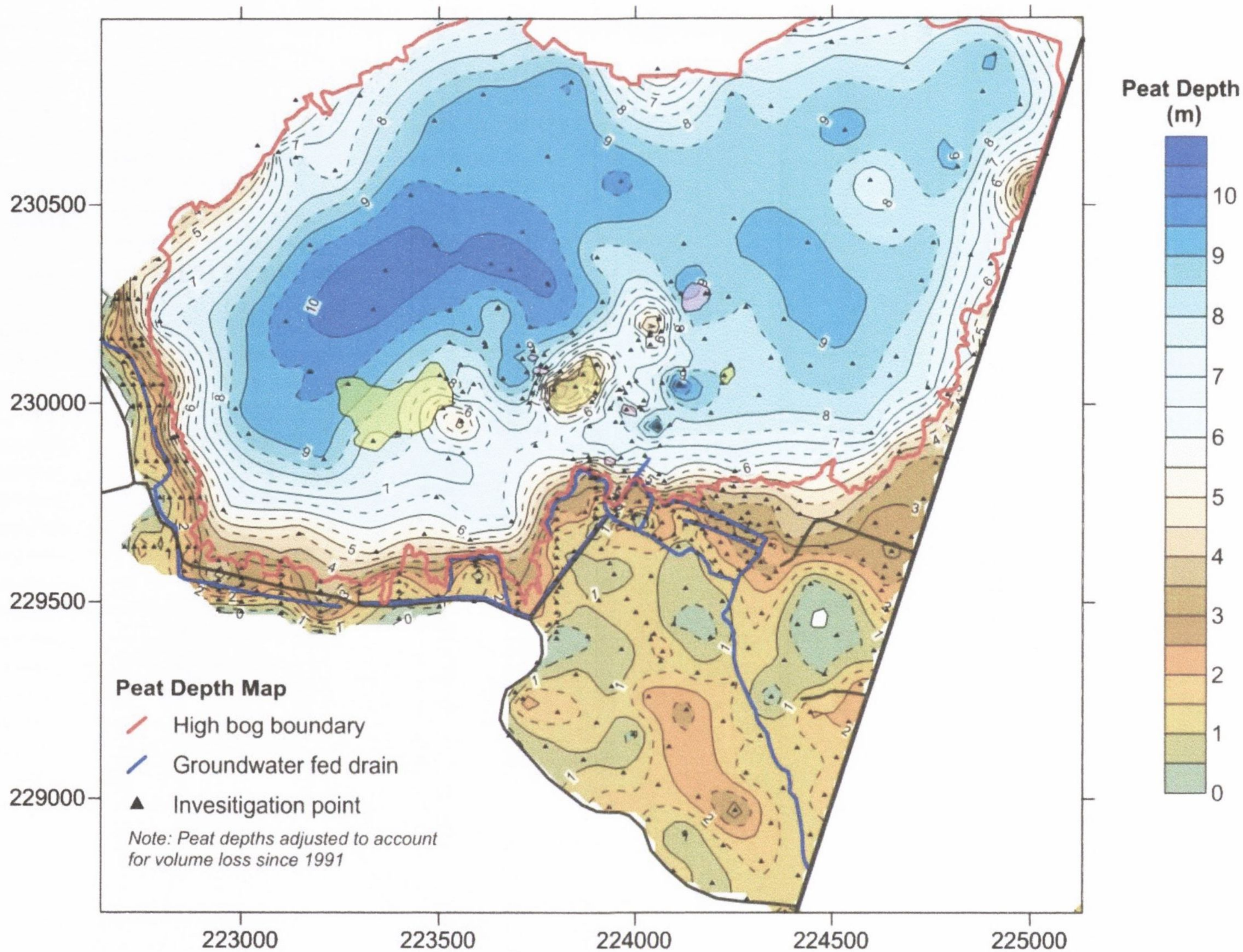


Figure A6. Clara West peat depth contour map (present day situation)

Appendix A. Hydrogeological Investigation: Location of Instrumentation

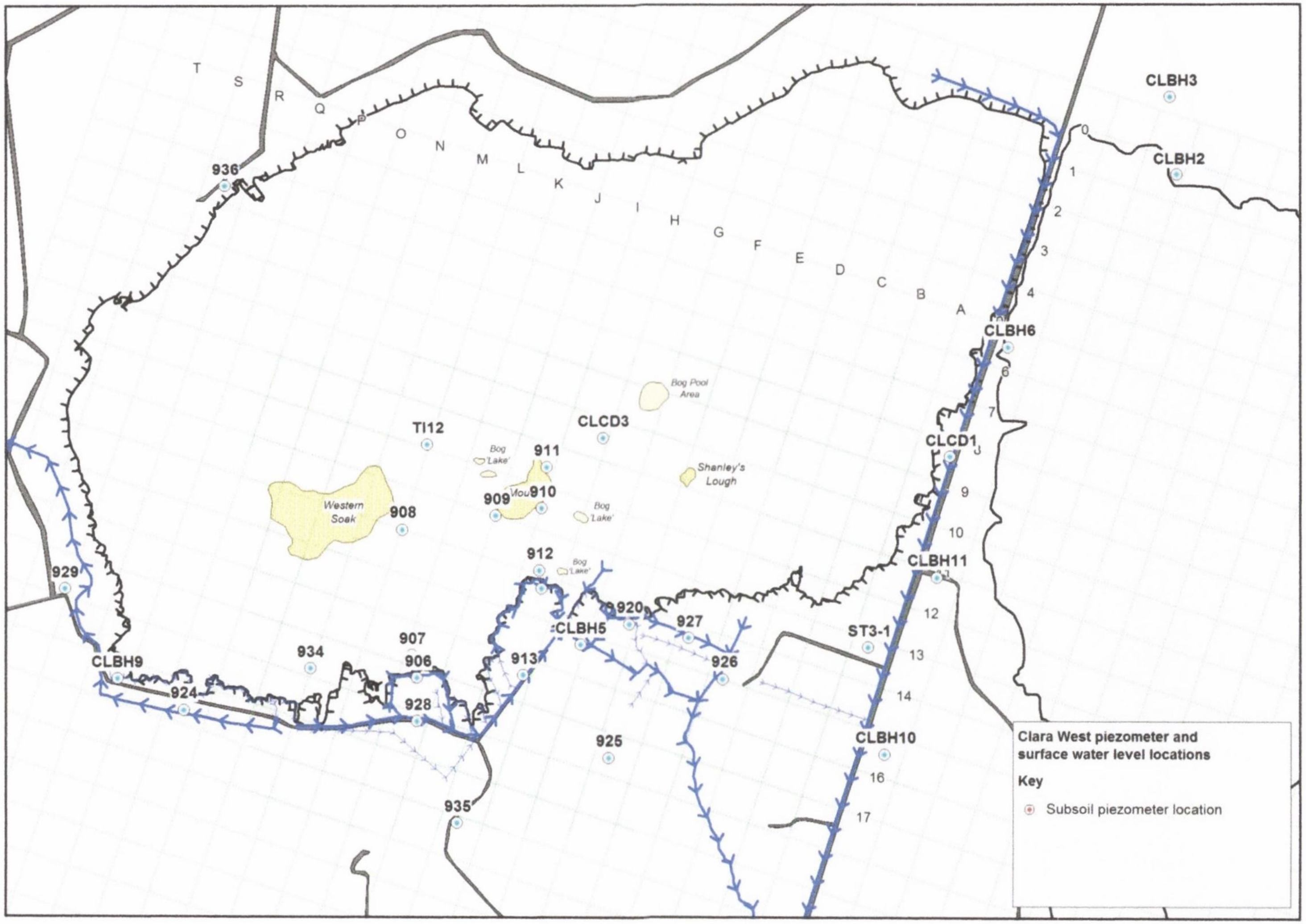


Figure A7. Location of piezometers installed to till subsoil in the Clara region

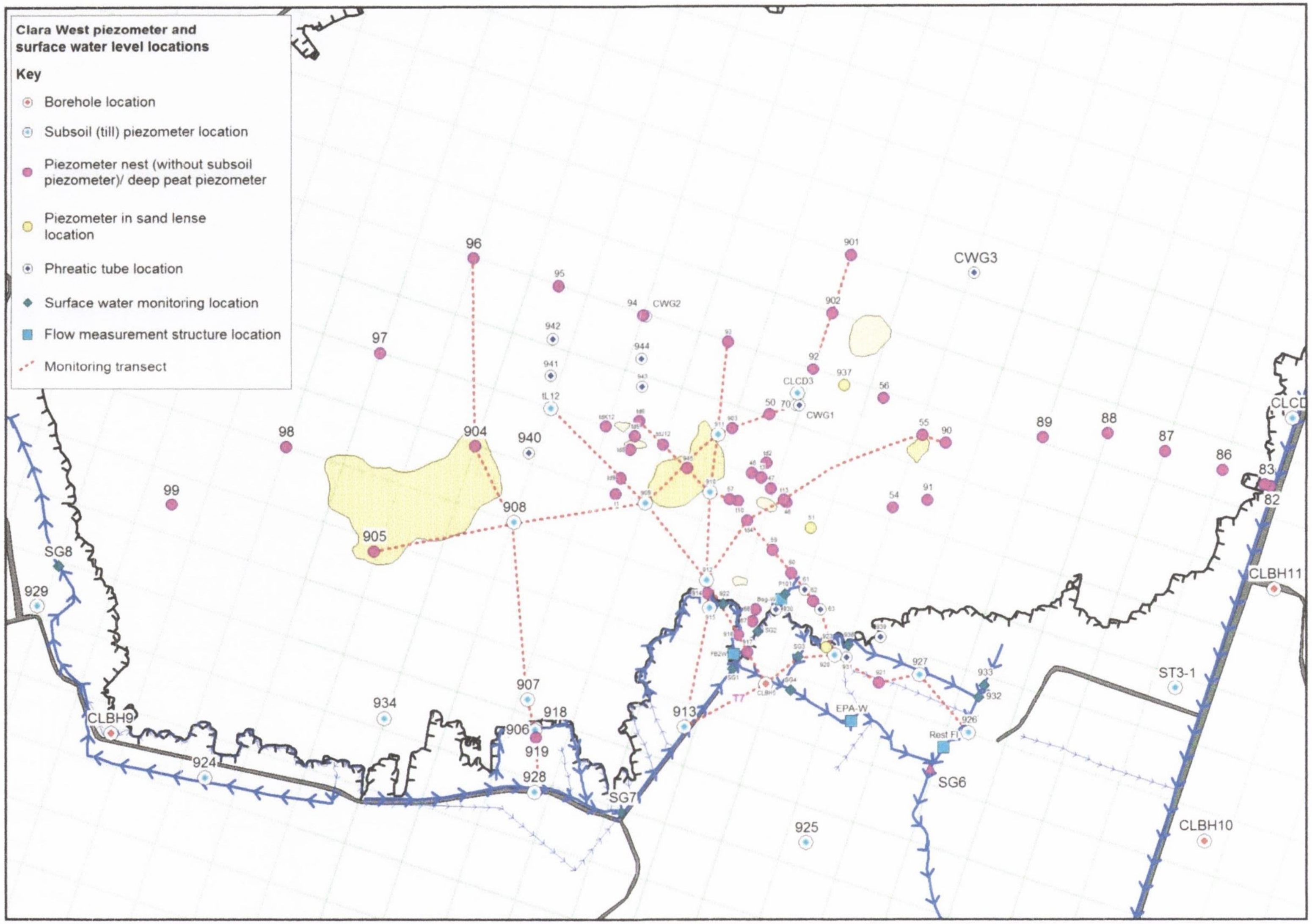


Figure A8. Location of piezometers and surface water monitoring points in Clara West hydrologic system

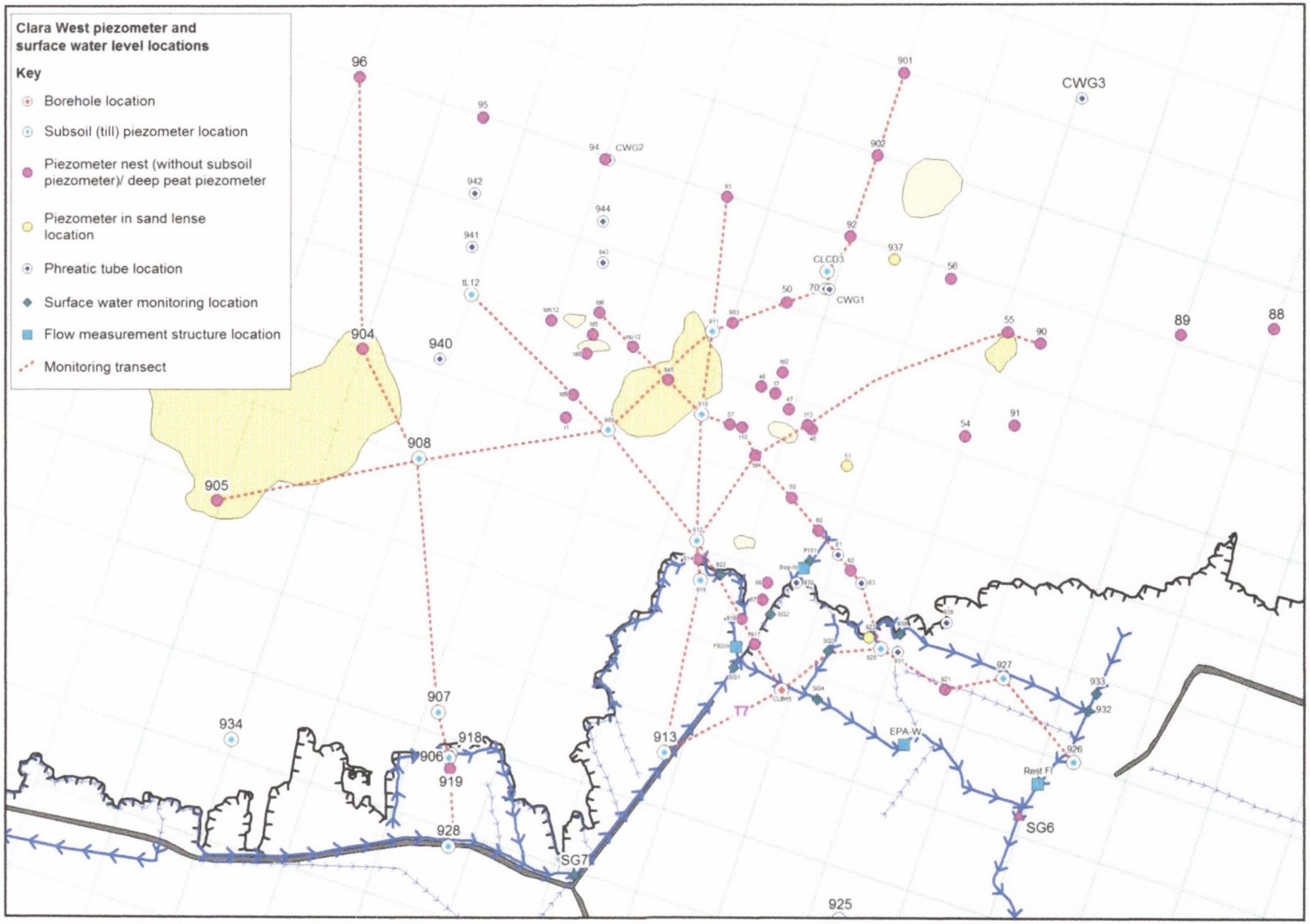


Figure A9. Location of piezometers and surface water monitoring points in Clara West hydrologic system – subsidence analysis area

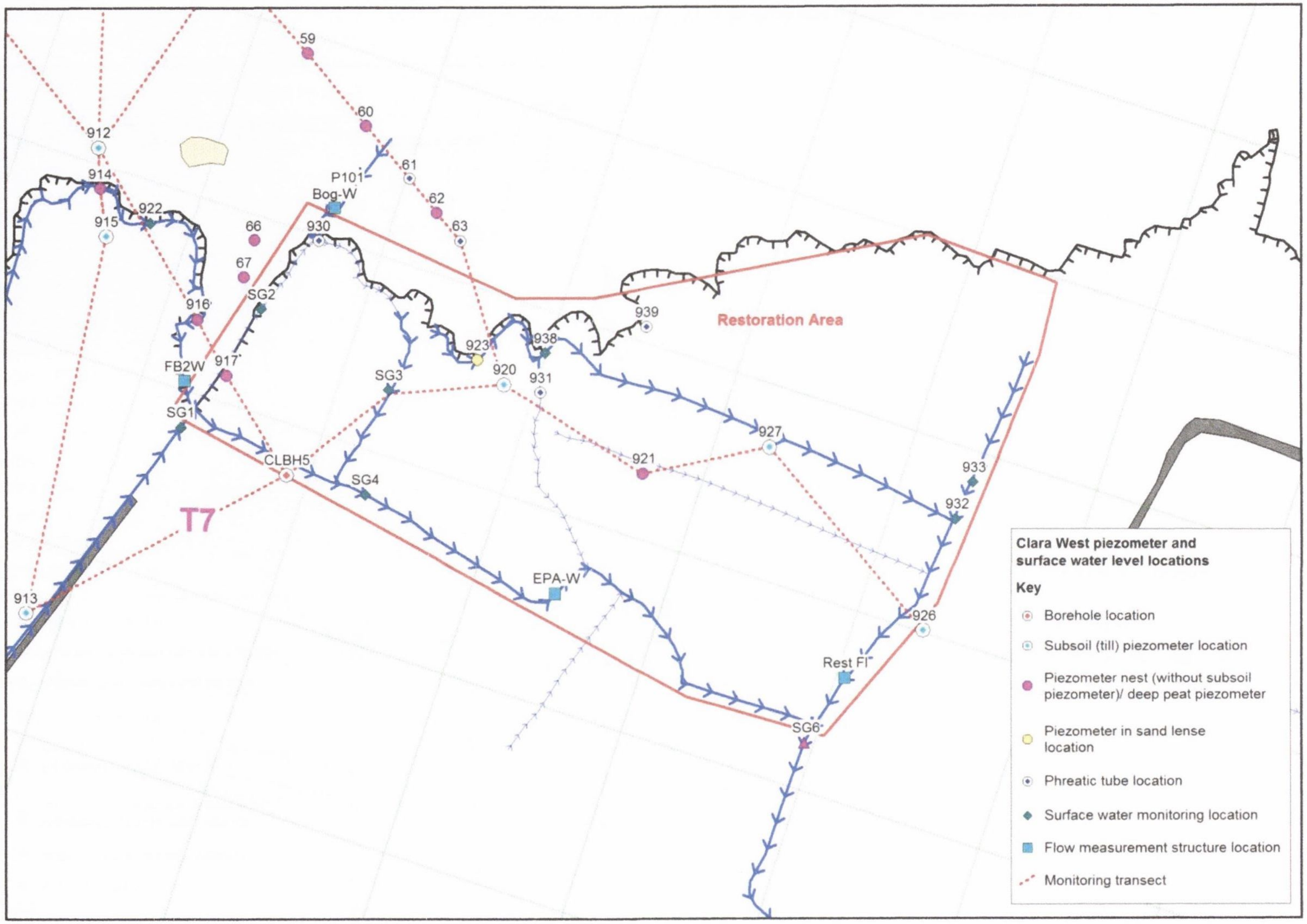


Figure A10. Location of piezometers and surface water monitoring points in Clara West hydrologic system – subsidence analysis area

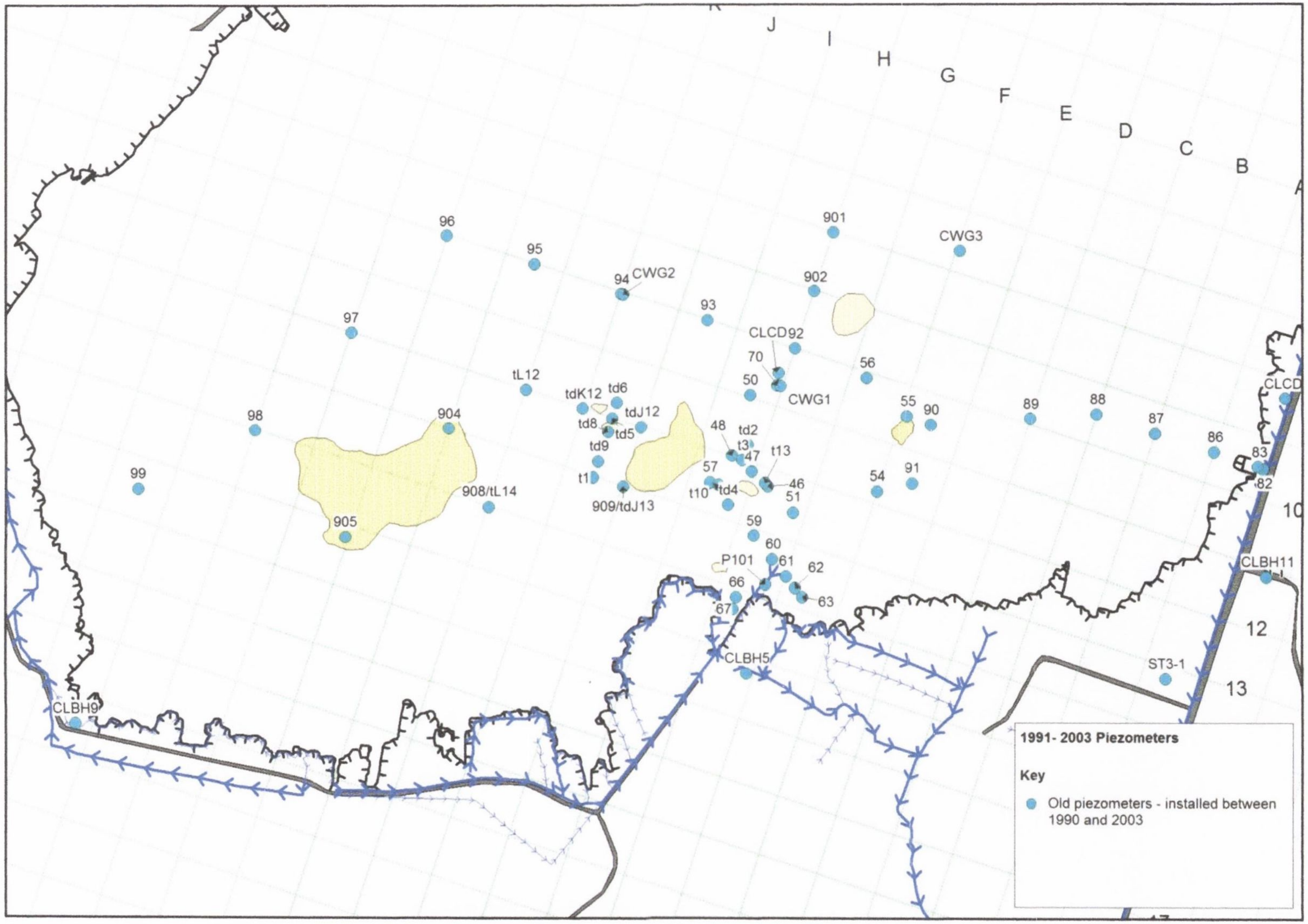


Figure A11. Piezometers installed on high bog between 1990 and 2003

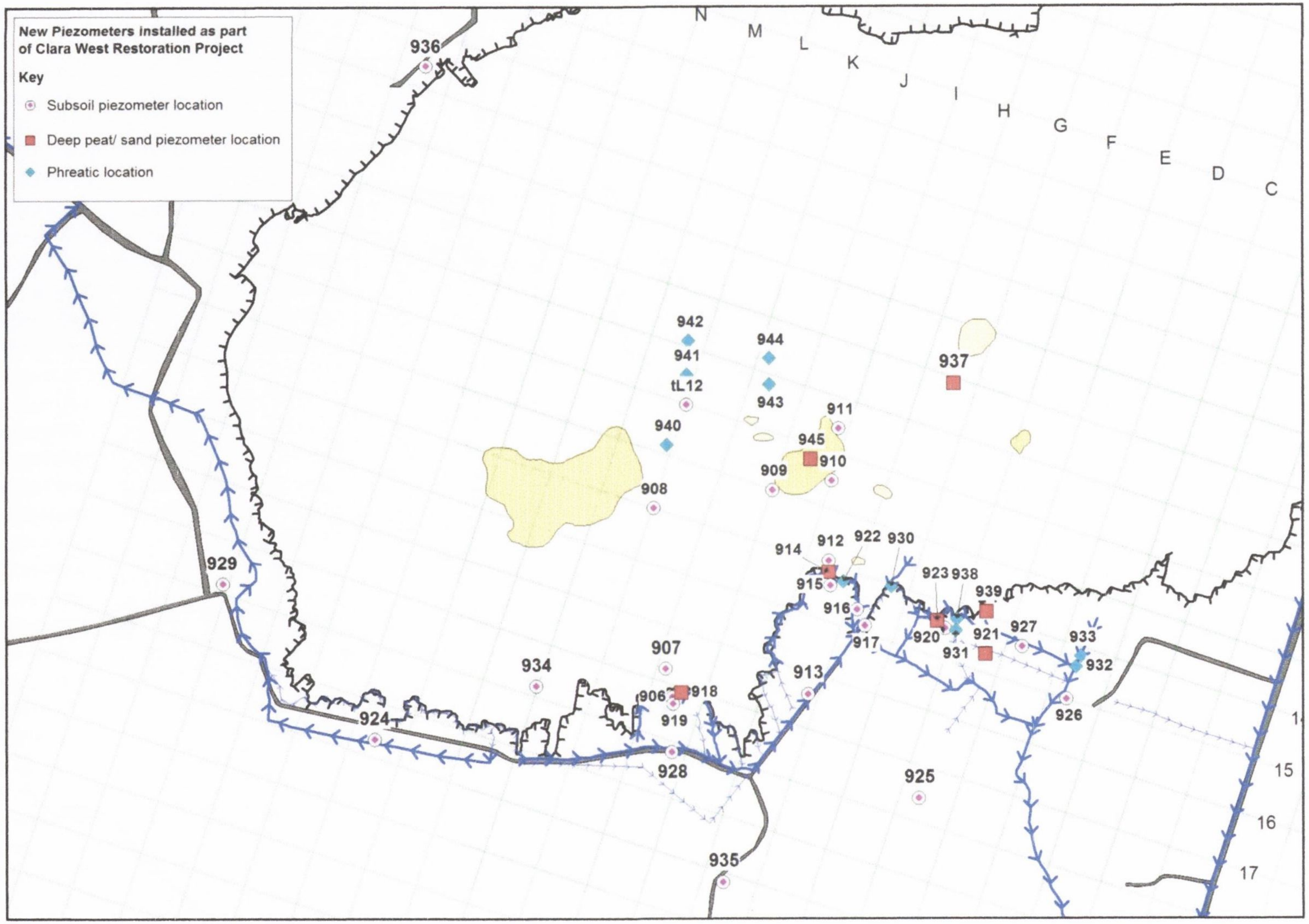


Figure A12. Piezometers installed on high bog between 2009 and 2011

Appendix A. Geo-hydrological Framework

Table A1. Subsoil piezometer/ piezometer nests

ID	Easting	Northing	Elevation (ToP) Malin mOD	Upstand (m)	Substrate	Field Installation Depth (mbGL)
CLCD1	224857.39	230122.38	52.85	1.56	Subsoil	n/t
CLCD3	224032.75	230169.55	55.71	0.48	Subsoil	8.92
CLBH3	225375.06	230974.27	61.50	0.16	Subsoil	12.84
CLBH2A	225391.68	230789.08	55.53	0.62	Rock	12.91
CLBH2B	225391.66	230789.04	55.53	0.62	Subsoil	5.68
CLBH2C	225391.63	230788.95	55.52	0.61	Peat	0.93
CLBH5A	223979.80	229682.87	52.91	0.26	Rock	8.45
CLBH5B	223980.51	229682.70	52.86	0.179	Till	4.25
CLBH6A	224994.48	230381.29	53.92	0.72	Rock	21.41
CLBH6B	224994.54	230381.33	53.80	0.60	Till	12.15
CLBH6C	224994.48	230381.20	53.80	0.60	Peat	7.32
CLBH9A	222883.81	229600.21	56.99	0.18	Rock	11.49
CLBH9B	222883.97	229600.04	57.01	0.20	Till	5.10
CLBH10A	224702.11	229425.74	49.26	0.437	Rock	14.61
CLBH10B	224702.12	229425.65	49.18	0.36	Till	6.94
CLBH11A	224826.66	229839.90	51.03	0.663	Rock	14.23
CLBH11B	224826.57	229839.84	51.09	0.72	Till	6.92
CLBH11C	224826.70	229839.81	51.06	0.691	Peat	3.79
CLBH12A	224706.00	227835.00	47.21	0	Rock	5.27
CLBH12B	224706.00	227835.00	47.21	0	Peat	2.18
ST3-1	224663.00	229676.01	50.41	0.781	Till	9.19
tL12	223617.51	230144.01	57.63	0.378	Peat	8.62
tL12	223617.87	230144.18	57.73	0.521	Peat	0.48
tL12	223620.12	230151.52	58.20	1.164	Subsoil	9.40
906	223591.14	229604.69	56.57	0.122	Subsoil	6.95
906	223591.02	229604.97	56.91	0.414	Peat	2.80
906	223591.33	229604.91	56.99	0.527	Peat	1.50
906	223591.18	229604.98	56.76	0.294	Peat	0.50
907	223579.03	229657.42	57.58	0.115	Subsoil	8.00
907	223578.59	229657.09	57.98	0.451	Peat	5.80
907	223578.45	229656.95	57.92	0.366	Peat	4.00
907	223578.30	229656.74	57.84	0.284	Peat	2.00
907	223578.83	229657.33	57.94	0.411	Peat	0.50
908	223556.41	229953.82	58.12	0.62	Subsoil	9.45
908	223555.46	229954.21	58.00	0.641	Peat	4.27
908	223555.56	229953.63	57.98	0.468	Peat	0.50
909	223777.27	229986.34	57.31	0.893	Subsoil	8.20
909	223777.65	229986.34	56.98	0.558	Peat	5.70
909	223777.41	229986.13	56.95	0.534	Peat	4.00
909	223777.63	229986.09	56.82	0.433	Peat	0.50
910	223886.60	230003.78	55.55	0.296	Subsoil	6.80
910	223886.30	230003.70	55.59	0.312	Peat	5.00
910	223886.34	230003.85	55.59	0.297	Peat	3.20
910	223886.10	230003.81	55.73	0.441	Peat	0.50
911	223899.06	230099.84	56.69	0.115	Subsoil	6.00
911	223899.06	230099.37	57.08	0.471	Peat	4.00
911	223898.94	230099.40	57.05	0.441	Peat	3.00
911	223898.99	230099.21	57.03	0.443	Peat	0.50

912	223880.99	229857.04	54.32	0.365	Subsoil	6.10
912	223880.03	229857.45	54.49	0.446	Peat	5.60
912	223879.88	229857.19	54.56	0.51	Peat	3.00
912	223879.85	229857.39	54.48	0.423	Peat	0.50
913	223842.47	229610.52	55.30	0.096	Subsoil	4.00
915	223885.08	229809.74	52.14	0.331	Peat	3.30
915	223884.97	229809.72	52.53	0.722	Peat	1.50
915	223884.84	229809.74	52.59	0.777	Peat	1.00
915	223886.13	229814.96	52.22	0.457	Subsoil	6.35
920	224095.25	229730.91	50.87	0.119	Peat	2.20
920	224095.14	229731.06	51.03	0.274	Peat	1.20
920	224095.43	229730.71	50.87	0.115	Peat	1.00
920	224095.42	229730.82	51.34	0.516	Subsoil	5.06
924	223040.03	229526.76	58.64	0.251	Subsoil	4.21
925	224046.47	229417.57	54.21	0.91	Subsoil	3.75
926	224318.44	229600.64	50.09	0.07	Subsoil	7.00
927	224236.87	229697.45	50.20	0.32	Subsoil	7.16
927	224236.43	229697.57	50.02	0.15	Sand	2.85
928	223590.48	229502.51	57.11	0.196	Subsoil	2.52
929	222761.03	229813.78	56.63	0.72	Subsoil	4.54
934	223338.67	229625.19	59.06	0.27	Till	6.13
935	223684.77	229263.88	56.34	0.15	Till	1.80
936	223136.00	230766.00	56.32	0.10	Till	5.80

Table A2. High bog piezometer nests (historic)

ID	Easting	Northing	Elevation (ToP) Malin mOD	Upstand (m)	Type	Field Installation Depth (mbGL)
46	224015	229986	54.89	0.29	Piezo D	4.19
46	224015	229986	55.08	0.50	Piezo F	6.53
46	224015	229986	54.90	0.33	Piezo A	0.95
46	224015	229986	55.21	0.30	Phreatic	0.73
47	223988	230010	55.53	0.812	Piezo F	6.19
47	223989	230007	55.04	0.515	Piezo E	5.66
48	223956	230036	54.94	0.140	Piezo F	8.84
51	224057	229943	55.53	0.761	Phreatic	0.26
51	224056	229943	55.18	0.499	Phreatic	0.76
51	224056	229944	55.29	0.568	Piezo E	6.33
51	224057	229943	55.40	0.585	Piezo S	8.90
54	224188	229969	55.21	0.451	Phreatic	0.56
54	224191	229978	55.01	0.258	Piezo F	8.39
54	224192	229978	55.12	0.483	Piezo C	4.06
54	224193	229978	55.00	0.285	Piezo D	4.75
54	224193	229978	55.02	0.386	Piezo E	6.15
54	224193	229978	55.07	0.314	Piezo F	8.25
55	224250	230095	55.79	0.810	Piezo C	3.03
55	224242	230099	55.64	0.442	Phreatic	0.56
55	224242	230099	55.52	0.361	Piezo S	9.41
55	224242	230099	55.33	0.236	Piezo A	1.03
56	224176	230161	55.66	0.486	Phreatic	0.51
56	224177	230161	55.75	0.268	Phreatic	1.00
56	224177	230161	55.99	0.683	Piezo S	9.04
56	224177	230161	55.70	0.410	Piezo D	4.39

56	224177	230162	55.62	0.352	Piezo F		8.13
56	224176	230162	55.59	0.231	Piezo E		6.29
57	223920	229992	55.19	0.466	Piezo C		2.59
57	223920	229992	55.36	0.485	Piezo E		5.30
57	223920	229995	55.07	0.201	Piezo D		4.20
57	223920	229995	55.04	0.178	Piezo C		2.77
57	223920	229995	55.03	0.130	Phreatic		0.25
57	223920	229995	55.05	0.196	Piezo E		5.46
57	223920	229995	54.99	0.090	Piezo A		0.99
57	223920	229995	55.04	0.160	Piezo F		6.14
57	223920	229995	55.02	0.153	Piezo E		4.72
57	223920	229996	54.99	0.129	Piezo D		3.35
59	223991	229907	54.18	0.068	Piezo C		3.19
59	223991	229907	54.54	0.303	Piezo E		5.98
59	223991	229907	54.52	0.053	Piezo D		4.72
59	223990	229917	55.31	0.866	Phreatic		0.39
60	224022	229868	54.14	0.350	Phreatic		0.57
61	224045	229840	53.73	0.176	Piezo D		4.10
61	224045	229840	53.81	0.187	Piezo C		2.75
61	224045	229840	53.73	0.081	Piezo F		5.69
61	224046	229840	53.82	0.249	Phreatic		0.95
62	224060	229822	54.20	0.420	Phreatic	n/t	
63	224072	229807	54.05	0.205	Piezo F		4.20
63	224072	229807	53.97	0.174	Piezo C		2.65
66	223963	229807	53.88	0.238	Phreatic		1.01
67	223958	229788	53.35	0.030	Phreatic		0.87
67	223957	229788	53.38	0.100	Piezo F		4.56
67	223957	229788	53.41	0.130	Piezo B		2.48
67	223957	229788	53.46	0.175	Piezo D		3.83
70	224030	230149	55.40	0.626	Piezo F		5.65
70	224030	230149	55.20	0.488	Piezo C		2.79
70	224030	230149	55.23	0.466	Piezo D		4.31
70	224030	230149	55.20	0.439	Phreatic		0.78
82	224821	230012	51.07	0.10	Piezo F		4.46
82	224821	230012	51.08	0.11	Piezo C		2.69
83	224811	230016	51.50	0.10	Piezo E		4.44
83	224811	230016	51.42	0.02	Piezo F		5.06
83	224811	230016	51.46	0.00	Piezo C		2.88
86	224741	230040	53.75	0.05	Piezo E		6.42
86	224741	230040	53.71	0.06	Piezo F		7.41
86	224740	230039	53.73	0.06	Piezo F		7.42
86	224741	230040	53.72	0.05	Piezo C		2.91
86	224741	230040	53.70	0.03	Piezo D		4.59
87	224645	230070	55.19	0.19	Piezo F		6.36
87	224645	230071	55.32	0.320	Piezo S		8.46
87	224645	230071	55.41	0.410	Piezo E		4.26
87	224645	230071	55.32	0.320	Phreatic		0.14
88	224550	230102	55.59	0.12	Piezo S		9.33
88	224550	230102	55.55	0.07	Piezo D		4.56
88	224551	230103	55.52	0.04	Piezo B		2.88
89	224442	230095	55.65	0.15	Piezo F		8.44
89	224442	230095	55.71	0.19	Piezo S		9.10
89	224442	230095	55.64	0.11	Piezo E		6.43
89	224443	230095	55.79	0.27	Phreatic		0.37

89	224442	230095	55.63	0.10	Piezo E		4.91
90	224281	230086	55.46	0.37	Phreatic		0.03
90	224281	230086	55.48	0.19	Piezo E		4.41
90	224281	230086	55.50	0.30	Piezo C		2.06
90	224280	230086	55.51	0.27	Piezo S	> 10.0	
91	224250	229990	55.35	0.48	Piezo B		2.45
91	224250	229990	55.32	0.365	Piezo D		4.17
91	224250	229990	55.42	0.464	Piezo F		8.74
92	224060	230210	55.91	0.316	Piezo S		5.56
92	224060	230210	55.85	0.289	Piezo S		5.72
92	224060	230211	55.90	0.367	Piezo F		4.91
92	224060	230211	55.90	0.373	Piezo D		4.29
92	224060	230211	55.87	0.37	Piezo B		2.14
92	224060	230211	55.84	0.325	Piezo C		2.68
93	223916	230255	56.95	0.27	Phreatic		0.74
93	223916	230256	57.04	0.355	Piezo S		10.65
93	223916	230256	56.89	0.154	Piezo D		4.62
93	223916	230257	56.68	0.092	Piezo C		3.46
93	223917	230257	56.79	0.201	Piezo F		8.98
93	223916	230257	56.79	0.164	Piezo E		8.40
93	223916	230257	56.82	0.185	Piezo B		2.84
94	223774	230301	57.84	0.699	Piezo F		8.80
94	223774	230301	57.81	0.694	Piezo E		6.81
94	223773	230301	57.66	0.53	Piezo E		5.51
94	223773	230301	57.66	0.534	Piezo D		3.47
94	223772	230302	57.60	0.481	Phreatic		1.02
94	*223774*	*230304*	*57.63*	*0.495*	Piezo B		*1.66*
94	223774	230305	57.37	0.168	Piezo D		4.61
94	223774	230305	57.37	0.152	Piezo S		11.33
94	223774	230305	57.30	0.075	Piezo C		2.95
95	223631	230350	57.81	0.185	Piezo F		10.02
95	*223631*	*230350*	*58.47*	*0.74*	Phreatic		*0.46*
95	223632	230349	58.02	0.361	Piezo S		11.28
95	223631	230350	57.82	0.122	Piezo E		4.66
95	223631	230350	57.79	0.113	Piezo C		2.91
96	223488	230396	58.21	0.714	Piezo S		12.09
96	223488	230396	58.04	0.479	Piezo D		4.28
96	223488	230396	58.01	0.509	Piezo C		2.26
96	223488	230396	57.97	0.459	Piezo C		2.46
96	223488	230396	57.81	0.166	tbc		6.27
96	223488	230396	57.89	0.258	Piezo E		8.21
96	223488	230396	57.99	0.433	Piezo F		10.36
97	223332	230237	58.24	0.261	Piezo S		10.90
97	223332	230238	58.08	0.15	Piezo E		4.63
97	*223332*	*230238*	57.97	0.041	Piezo C		2.96
98	223175	230079	58.32	0.18	Piezo A		1.26
98	223175	230079	58.45	0.32	Piezo S		12.03
98	223175	230079	58.29	0.208	Piezo E		4.56
98	223175	230079	58.22	0.131	Piezo C		2.88
99	222987	229984	58.94	0.571	Phreatic		0.36
99	222986	229983	58.52	0.22	Piezo C		3.73
99	222986	229983	58.46	0.177	Piezo D		4.59
99	222986	229983	58.45	0.135	Piezo S		0.29
99	222985	229983	58.35	0.062	Piezo F		9.26

99	222985	229984	58.42	0.105	Piezo E		7.46
99	222981	229986	58.71	0.318	Piezo A		1.23
901	224122	230399	56.45	0.497	Piezo S		9.26
901	224122	230400	56.35	0.337	Piezo D		4.28
901	224122	230400	56.31	0.232	Piezo B		1.52
901	224122	230400	56.25	0.141	Phreatic		0.16
901	*224122*	*230399*	*56.35*	*0.238*	Piezo F		*8.16*
902	224090	230305	56.04	0.119	Phreatic		0.33
902	224090	230305	56.07	0.18	Phreatic	n/k	
902	224090	230305	56.07	0.121	Piezo B		2.45
902	224090	230305	56.10	0.161	Piezo D		4.45
902	224091	230304	56.19	0.333	Piezo S		8.42
902	224091	230304	56.04	0.129	Piezo D		4.97
902	224091	230304	56.04	0.148	Piezo E		5.38
902	224091	230304	56.07	0.166	Piezo F		8.28
904	223490	230081	57.80	0.508	Piezo F		2.52
904	223490	230081	57.75	0.506	Piezo D		2.25
904	223491	230081	57.72	0.461	Piezo B		4.33
904	223491	230081	57.68	0.349	Piezo C		7.95
904	223491	230081	57.94	0.53	Phreatic		0.47
905	223322	229905	57.82	0.279	Piezo B		2.59
905	223322	229905	57.83	0.289	Piezo D		4.48
905	223322	229905	57.81	0.291	Piezo A		1.23
905	223322	229905	57.94	0.416	Piezo F		7.58
94	223779	230299	57.62	0.506	Phreatic		0.93
94	223778	230299	57.49	0.466	Phreatic		0.53
94	223778	230299	57.49	0.398	Phreatic		1.45
94	223778	230299	57.84	0.78	Piezo F		9.82
94	223778	230299	57.49	0.442	Piezo A		1.06
94	223778	230299	57.49	0.401	Piezo A		1.10
94	223778	230300	57.49	0.363	Phreatic		0.96
CWG1	224036	230149	55.55	0.635	Phreatic		1.42
CWG3	224328	230370	56.43	0.735	Piezo A		1.11
CWG3	224328	230370	56.42	0.646	Phreatic		0.31
CWG3	224328	230370	56.27	0.541	Phreatic		0.77
CWG3	224328	230370	56.46	0.772	Piezo F		7.65
CWG3	224328	230370	56.27	0.546	Phreatic		0.03
P101	224010	229827	54.34	1.059	Phreatic		1.14
ST3-1	224663	229676	50.41	0.781	Piezo S		9.19
t1	223728	230001	56.86	0.38	Piezo S		8.68
t10	223934	229988	55.91	1.086	Piezo F		7.20
t10	223934	229989	55.30	0.477	Phreatic		0.52
t13	224010	229991	55.18	0.489	Piezo S		7.26
t3	223972	230028	54.70	0.405	Piezo		3.65
td2	223981	230052	55.06	0.242	Piezo		5.28
td4	223949	229956	55.09	0.349	Piezo S		7.83
td4	223949	229956	55.25	0.508	Phreatic		0.49
td5	223759	230097	57.25	0.439	Piezo S		8.56
50/ td50	223985	230134	55.44	0.099	Piezo S		7.56
50/ td50	223985	230134	55.34	0.029	Phreatic		1.15
50/ td50	223986	230134	55.39	0.154	Piezo E		6.39
50/ td50	223986	230134	55.28	0.078	Piezo D		4.82
50/ td50	223985	230135	55.73	0.442	Piezo F		6.64
td6	223767	230123	57.51	0.508	Piezo F		8.51

td6	223767	230123	57.40	0.372	Phreatic	0.63
td8	223752	230075	57.75	0.744	Piezo F	8.28
td9	223736	230027	57.83	0.932	Piezo F	8.13
td9	223736	230028	57.38	0.482	Phreatic	0.52
tdJ12	223807	230083	57.53	0.429	Piezo S	6.33
tdJ12	223807	230083	57.60	0.5	Phreatic	0.50
tdK12	223711	230114	57.37	0.849	Piezo S	9.40
914	223882	229835	51.81	0.708	Piezo F	3.00
914	223882	229835	51.88	0.778	Piezo C	1.50
914	223882	229835	52.19	1.089	Phreatic	1.00
916	223933	229764	51.21	0.327	Piezo F	1.40
916	223933	229764	51.21	0.327	Phreatic	1.00
917	223948	229735	52.81	0.34	Piezo F	2.20
917	223949	229736	52.86	0.389	Phreatic	1.70
918	223595	229610	56.66	0.934	Piezo F	2.40
918	223594	229610	56.70	0.973	Phreatic	1.00
919	223593	229593	57.72	0.617	Piezo F	1.35
921	224169	229684	50.43	0.486	Piezo F	2.10
921	224169	229684	50.08	0.136	Piezo C	1.20
921	224169	229684	50.12	0.172	Phreatic	1.00
922	223908	229817	51.50	0.68	Phreatic	0.32
923	224081	229744	50.42	0.44	Piezo B	2.10
923	224081	229744	50.51	0.441	Phreatic	2.10
923	224081	229744	50.24	0.16	Piezo F	2.10
930	223997	229807	50.90	0.80	Phreatic	0.20
931	224115	229727	50.42	0.51	Phreatic	0.49
932	224335	229660	50.07	1.17	Phreatic	-0.17
933	224345	229679	50.07	1.21	Phreatic	-0.21
937	224111	230183	55.96	0.66	Piezo S	8.75
938	224118	229748	50.84	1.06	Phreatic	0.44
939	224171	229761	51.37	1.44	Piezo F	3.00

Table A3. Geological core logs from piezometer installations

ID	Easting	Northing	GL Elevation	Peat Depth	Peat Depth Elevation	Depth	Subsoil Log	Subsoil Type	Comment	Base of screen (mbGL)	Screen length (m)	Date
913	223842.48	229610.52	55.20	0.5	54.7	0.5 - 1.6	Light grey, silty CLAY with gravel and cobbles	Till	Piezometer drilled into gravel	4	1	24-Jun-09
						1.6 - 3.0	Light grey, wet, sandy, gravelly CLAY with gravels and cobbles					
						3.0 - 3.4	Grey, wet, clayey sandy GRAVEL					
						3.4 - 4.2	Grey, wet, clayey sandy GRAVEL with cobbles					
915	223886.07	229815.07	51.76	3	48.761	3.0 - 6.35	Sility clayey GRAVEL with sand	Till	Piezo installed to gravel layer and backfilled with sand & gravel and sealed with peat	5.74	0.3	13-Apr-10
920	224095.37	229730.74	50.74	2.3	48.442	2.3 - 4.1	Blueish gray, stiff, damp CLAY with sand immediately below peat	Lac	Refusal at boulder/rock - piezo installed to gravel layer and backfilled with sand & gravel and sealed with peat	4.7	0.3	13-Apr-10
						4.1 - 4.4	Medium grey, silty, clayey GRAVEL	Till				
						4.4 - 5.2	Medium grey, wet, stiff, silty, sandy GRAVEL with cobbles	Till				
924	224236.99	229697.25	49.86	2.43	47.426	2.43 -2.8	Light brown, stiff, damp, gravelly CLAY	Till	Piezo installed to gravel layer and backfilled with sand & gravel and sealed with peat	4.21	0.3	1-Mar-10
						2.6 - 2.8	Silty gravelly SAND					
						2.8 - 3.6	Gravelly silty CLAY					
						3.6 - 4.4	Silty GRAVEL					
925	224048.00	229419.00	53.48	1.6	51.88	1.6 - 1.95	Grey gravelly CLAY		Piezo installed to gravel layer and backfilled with sand & gravel and sealed with peat	3.75	0.3	1-Mar-10
						> 1.95	Grey silty clayey GRAVEL					
926	224318.50	229600.82	50.04	2.55	47.494	2.55 - 6.35	Blueish great, stiff, damp CLAY with some sand	Lac	Stiff refusal at base of core - piezo installed into silty gravel layer and sealed with sand and bentonite	7	0.3	1-Mar-10
						> 6.35	Grey, stiff, wet silty GRAVEL	Till				
927	224236.99	229697.25	49.86	2.85	47.006	2.85 - 3.0	Medoim grey, well sorted, medium grained SAND	Sand	Piezo installed to gravel layer and backfilled with sand & gravel and sealed with bentonite	2.85	0.3	13-Apr-10
						3.0 - 5.5	Blueish grey, stiff, damp, plastic CLAY	Lac				
						5.5 - 6.35	Blueish grey, stiff, damp, plastic CLAY with sand and gravel	Lac				
						6.35 - 7.0	Grey, silty, clayey GRAVEL with sand	Till				
928	223590.48	229502.56	56.91	1.4	55.511	1.4 - 1.8	Greenish brown/ grey CLAY with sand and gravel	Till	Piezo installed to gravel layer and backfilled with sand & gravel and sealed with bentonite	2.52	0.3	13-Apr-10
						1.8 -2.7	Dark grey, wet, sandy GRAVEL with cobbles					
929	222760.89	229813.59	55.91	1.05	54.861	1.05 - 1.25	Medium brown, sandy CLAY	Till	Piezo installed to gravel layer and backfilled with sand & gravel and sealed with bentonite	3.9	0.3	13-Apr-10
						1.25 - 2.3	Medium grey, sdamp, soft, sandy CLAY with gravels and cobbles					
						2.3 - 2.6	Medium grey, wet, clayey SAND with gravels and cobbles					
						> 2.6	Dark grey, sandy GRAVEL with cobbles					
934	223340.00	229626.00	58.90	5.22	53.68	5.22 - 5.7	Blueish grey, stiff, damp, gravelly CLAY	Till	Gravel encountered at base of core - piezo pushed into this and sealed with sand and bentonite	6.2	0.3	28-Sep-10
						> 5.7	Blueish grey, stiff, wet, clayey GRAVEL					
935	223694.00	229269.00	55.77	0.4	55.37	0.4 - 1.3	Light brown, stiff, dry CLAY with some sand and gravel	Till	Solid refusal at base of core - piezo installed into gravel layer and sealed with sand and bentonite	1.8	0.3	28-Sep-10
						1.3 - 1.8	Light brown, stiff, damp, sandy clayey GRAVEL with cobbles	Till				
936	223136.00	230766.00	56.26	4.6	51.66	4.6 - 5.4	Blueish grey, stiff, damp, plastic CLAY with occasional gravels	Lac	Stiff refusal at base of core - piezo installed into gravelly clay layer and sealed with sand and bentonite	5.8	0.3	28-Sep-10
						5.4 - 5.9	Blueish-light grey, stiff, damp, gravelly CLAY with cobbles	Till				

Table A4. TCD-QUB site investigation information

ID	Easting	Northing	Elevation	Peat Depth	Peat Depth Elevation	Subsoil Type	Subsoil Log	Comment	Date
CG1	224036	230179	55.45	3.05	52.4	Till	Light grey, soft, damp, sandy CLAY with gravel	Elevated area; north of CLCD3	17/06/2010
CG2	224114	230276	55.84	9.35	46.49	Lacustrine clay	Blueish grey, soft, wet, CLAY; sandy in parts with occasional angular gravels	Edge of 'bog pool' area	17/06/2010
CG3	224179	230276	55.8	8.8	47	Lacustrine clay	Blueish grey, sandy CLAY with occasional angular gravels and shell fragments at top	Centre of 'bog pool' area; dry after sustained dry period	17/06/2010
CG4	224236	230268	55.8	8.8	47	Lacustrine clay	Blueish grey, sandy CLAY with occasional angular gravels and mollusc shells 20cm below peat; clay is drier/ stiffer and sandier with depth	Margin of 'bog pool' area; phreatic tubes and $C0_2$ monitoring device in area - researcher unknown	17/06/2010
CG5	223560	230030	57.72	8.4	49.32	Lacustrine clay	Blueish grey, soft, plastic CLAY; very little sand; no gravel or shell fragments	In area of dense 'dry' vegetation; eastern boundary of Western Soak	17/06/2010
CG6	223517	230062	57.7	8.1	49.6	Lacustrine clay	Blueish grey, soft, plastic CLAY; very little sand; no gravel or shell fragments	In area of dense 'dry' vegetation; close to piezometer nest 904	17/06/2010
CG7	223509	229989	57.75	5.55	52.2	Lac/Till	30 cm of blueish grey, soft, plastic CLAY with some sand overlying blueish/ dark grey, gravelly CLAY with sand	South of piezometer nest 908; boundary of till to lacustrine clay; also boundary of Western Soak	17/06/2010
CG8	223393	229925	57.67	8.2	49.47	Till	No subsoil recovered - stiff and grinding/ gravelly refusal felt in gouge core; some sand grains at base of peat recovered	At boundary of the Western Soak	17/06/2010
CG9	223559	229875	55.72	6.9	48.82	Till	No subsoil recovered - stiff and grinding/ gravelly refusal felt in gouge core	Core through tension crack; crack has 'closed in' as a result of dry period	17/06/2010
GC10	223701	230145	57.16	9.25	47.91	Till	No subsoil recovered - solid thump refusal felt in gouge core	Area of dry bog pools	07/07/2010
GC11	223615	230155	57.34	8.95	48.39	Till	Dark grey, wet, silty, sandy CLAY with angular gravels	North of Pz tL12	07/07/2010
GC12	223575	230189	57.42	9.3	48.12	Till	No subsoil recovered - stiff and grinding/ gravelly refusal felt in gouge core		07/07/2010
GC13	223526	230235	57.76	9.5	48.26	Lac/Till	20 cm of blueish grey, soft, wet, plastic CLAY with some sand overlying blueish/ dark grey, stiff, sandy CLAY with gravel	South of piezometer nest 96; boundary of till to lacustrine clay	07/07/2010
GC14	223526	230155	57.58	8.45	49.13	Till	No subsoil recovered - stiff and grinding/ gravelly refusal felt in gouge core	Boundary of 'dry area'; lots of methane 'bubbling' in core hole	07/07/2010
GC15	223553	230098	57.6	8	49.6	Till	No subsoil recovered - stiff and solid thump refusal felt in gouge core; whitish grey sand and gravel at base of peat recovered	East of Pz 904	07/07/2010
GC16	223661	230064	57.29	9.4	47.89	Lacustrine clay	Blueish grey, soft, wet, CLAY; sandy in parts with occasional angular gravels		07/07/2010
GC17	223710	230014	56.88	8.2	48.68	Lacustrine clay	Blueish grey, stiff, wet, CLAY; sandy in parts with occasional angular sand and gravels	Northwest of Pz t1	07/07/2010
GC18	223879.6	229867.7	54.595	6.34	48.255	Till	No subsoil recovered - stiff and grinding/ gravelly refusal felt in gouge core	11m north of Pz912	09/08/2010
GC19	223881.1	229944.9	54.983	7.28	47.703	Lac/Till	35 cm of blueish grey, soft-stiff, wet (drier towards base), plastic CLAY overlying stiff 'grinding' refusal		09/08/2010
GC20	223933.4	229988.8	54.787	7.81	46.977	Lac	Blueish grey, stiff, wet, plastic CLAY	Terminal of geophysics transect; 1.5m east of Pz t10	09/08/2010
GC21	223960	230012	54.9	7.58	47.32	Lac	Blueish grey, stiff, wet, plastic CLAY	Close to bog lake	09/08/2010
GC22	223977	229984	54.81	7.9	46.91	Sand/Lac	6cm of dark grey, silty SAND with angular gravels overlying blueish grey, soft-stiff, wet, plastic CLAY	Close to bog lake	09/08/2010
GC23	223965	229953	54.71	7.62	47.09	Sand/Lac	5cm of dark grey, silty SAND with angular gravels overlying blueish grey, soft-stiff, wet, plastic CLAY	Close to bog lake	09/08/2010
GC24	223959.5	230036	54.767	6.7	48.067	Lac	Blueish grey, stiff, wet, plastic CLAY	Terminal of geophysics transect; close to Pz 48	09/08/2010
GC25	223943.1	230117.1	55.633	6.19	49.443	Lac	Light grey, stiff, wet, plastic CLAY with some sand grains	Terminal of geophysics transect; close to piezo nest	09/08/2010
GC26	224006.1	230159	55.209	7.25	47.959	Lac	2cm light grey CLAY recovered	Beginning of geophysics transect; 28m west of CLCD3	09/08/2010
GC27	224063.8	230181.2	55.317	6	49.317	Lac/Till	20 cm of darkish grey, soft, wet (drier towards base), plastic CLAY overlying stiff 'grinding' refusal	Terminal of geophysics transect; 33m east of CLCD3	09/08/2010
GC28	224112	230185	55.49	8.45	47.04	Sand/Lac	10cm of dark grey, silty CLAY with sand overlying 15cm of dark grey SAND with gravel overlying blueish grey, stiff, damp, plastic CLAY	East of Pz 92	09/08/2010
GC29	223649	230242	57.46	8.58	48.88	Till	No subsoil recovered - stiff and grinding/ gravelly refusal felt in gouge core	Bog grid point L11; peat depth the same as recorded in 1991	09/08/2010
GC30	223730	230192	57.25	9.53	47.72	Lac	Blueish grey, soft-stiff, wet-damp, plastic CLAY (drier with depth)		09/08/2010
GC31	223739	230131	57.14	8.75	48.39	Till	Light grey/ white, wet, stiff, sandy CLAY with gravel	Close to bog pool	09/08/2010
GC32	223771.8	230094.1	56.804	7.88	48.924	Till	Light grey/ white, wet, stiff, sandy CLAY with gravel	Terminal of geophysics transect; close to Pz td5	09/08/2010
GC33	223723	230079	57.25	9.3	47.95	Lac	Blueish grey, soft, wet, plastic CLAY	Close to bog pool	09/08/2010
GC34	224001	230058.5	54.895	7.52	47.375	Lac	Blueish grey, soft, damp, plastic CLAY - no sand grains	In wet area with good *sphagnum* growth	27/08/2010
GC35	224066.3	230052.9	54.915	7.94	46.975	Sand/Lac	15cm of dark grey, silty SAND (fine grained sand well sorted) overlying blueish grey, sfiff, damp, plastic CLAY	In dry area with trees	27/08/2010
GC36	224019.1	230006.7	54.748	6.4	48.348	Sand/Lac	3cm of coarse white sand/gravel overlying 12cm of blueish grey, sfiff, damp, plastic CLAY, overlying 5cm of sandy CLAY, overlying lac clay	Dry area north of new bog lake	27/08/2010
GC37	224059.5	229942	54.752	8.12	46.632	Sand/Lac	45cm of light grey, wet, soft silty CLAY (sandier at top) overlying 35cm of dark grey, soft, wet, sandy CLAY overlying plastic lac clay	Dry area, close to Pz51	27/08/2010
GC38	224074.2	229825	53.901	> 4.3	u/k	u/k	Peat too dry to core > 4.3 mbGL	Dry area, close to Pz63	27/08/2010
GC39	224082.4	229855.8	53.932	> 6.8	u/k	u/k	Peat too dry to core > 6.8 mbGL	Dry area	27/08/2010
GC40	223962.2	229862.7	54.098	7.2	46.898	Lac	Blueish grey, stiff, damp, plastic CLAY - no sand grains	South of bog lake	27/08/2010
GC41	223908.4	229815.7	51.361	3.4	47.961	Lac	Blueish grey, stiff, damp, plastic CLAY - siltier at top	Adjacent to face-bank drain and Pz922	27/08/2010
GC42	223893.8	229815.5	51.438	3.22	48.218	Lac/Till	80cm of blueish grey, stiff, damp, plastic CLAY (siltier at top) overlying Till (grinding/gravelly refusal)	Adjacent to face-bank drain	27/08/2010

Table A5. Restoration Area site investigation information

Core ID	Easting	Northing	Elevation	Peat Depth	Subsoil Elevation	Description/ comment	Subsoil Type
1	223951	229720	52.59	0.60	51.99	Stiff refusal	Till
2	223972	229765	52.05	2.80	49.25	Stiff refusal	Till
3	223999	229797	51.17	2.80	48.37	Lacustrine Clay	Lac
4	224030	229767	51.22	2.80	48.42	Stiff refusal	Till
5	224008	229753	51.61	2.70	48.91	Stiff refusal	Till
6	224026	229714	50.49	0.75	49.74	Stiff refusal in drain	Till
7	223994	229712	52.27	0.10	52.17	Mix peat and clay	Till
8	223999	229720	52.13	0.25	51.88	Mix peat and clay	Till
9	223988	229731	52.27	2.40	49.87	Stiff refusal	Till
10	224042	229688	51.30	1.05	50.25	Stiff refusal	Till
11	224061	229660	51.27	2.20	49.07	Lacustrine Clay	Lac
12	224067	229702	50.86	2.60	48.26	Lacustrine Clay	Lac
13	224055	229740	50.73	2.50	48.23	White/ lght grey, unconsolidated, sandy Clay	Till
14	224081	229744	49.97	2.40	47.57	Medium grey, soft, wet, sandy Clay	*Lac*
15	224107	229754	50.20	2.10	48.10	In drain - bank height c.0.5-0.8 m	Lac
16	224111	229714	50.03	1.40	48.63	In drain - bank height c.0.5-1.0 m	Till
17	224097	229671	51.24	2.40	48.84	Medium grey, soft, wet, sandy Clay	*Lac*
18	224110	229641	51.16	0.20	50.96	Stiff refusal	Till
19	224129	229695	50.44	1.30	49.14	Rock/ boulder refusal	Till
20	224143	229656	50.40	1.30	49.10	Stiff refusal	Till
21	224177	229674	50.13	2.05	48.08	Blueish grey, soft, plastic Clay	Lac
22	224217	229651	50.36	1.80	48.56	Stiff refusal	*Till*
23	224279	229629	50.07	2.60	47.47	Stiff refusal	*Till*
24	224309	229623	50.08	2.90	47.18	Blueish grey, stiff, sandy Clay with shells	Lac
25	224284	229602	49.84	2.70	47.14	Blueish grey, stiff, sandy Clay with shells	Lac
26	224262	229582	49.67	1.90	47.77	Stiff refusal in drain	Till
27	224218	229575	49.99	1.55	48.44	Blueish grey, stiff, sandy Clay; no shells	*Lac*
28	224203	229603	49.96	1.65	48.31	Light grey, stiff, plastic Clay; no shells	*Lac*
29	224159	229622	49.52	1.00	48.52	Light grey, soft, wet, plastic Clay; no shells	Lac
30	224188	229639	50.23	2.20	48.03	Light grey, soft, wet, plastic Clay; no shells	Lac
31	224232	229622	49.85	2.30	47.55	15cm lac overlying sandy Clay (till?)	Lac
32	224419	229723	50.96	3.95	47.01	10cm Marl overling lac clay with shells	Marl
33	224362	229737	50.49	3.45	47.04	10cm Marl overling lac clay with shells	Marl
34	224333	229759	50.43	3.58	46.85	8cm Marl overling lac clay with shells	Marl
35	224276	229768	50.51	3.70	46.81	2cm Marl overling lac clay with shells	Marl
36	224222	229784	50.57	4.00	46.57	Lac clay with shells and organic matter; in drain	Lac
37	224204	229767	50.46	3.70	46.76	Lac clay with few shells	Lac
38	224242	229742	50.08	3.40	46.68	Blueish grey, soft, damp Clay; no shells	Lac
39	224284	229725	49.98	3.20	46.78	Lac clay with few shells	Lac
40	224342	229701	50.37	3.52	46.85	Wet, plastic Clay; with shells	Lac
41	224312	229696	50.34	3.60	46.74	Wet, plastic Clay; with shells	Lac
42	224270	229712	50.01	3.35	46.66	Lac clay with few shells	Lac
43	224220	229728	50.11	3.25	46.86	Blueish grey, wet, stiff clayey SAND; no shells	*Till*
44	224170	229740	50.18	2.80	47.38	Stiff refusal	*Till*
45	224132	229733	50.58	2.05	48.53	Blueish grey, damp, stiff Clay with sand and gravel	*Till*
46	224156	229703	50.26	1.50	48.76	Stiff refusal	Till
47	224152	229697	49.75	1.10	48.65	Stiff refusal	Till
48	224191	229718	50.06	3.10	46.96	Blueish grey, soft, wet, plastic Clay; no shells	Lac
49	224205	229687	50.09	2.70	47.39	Rock/ boulder refusal	Till
50	224237	229697	49.86	2.85	47.01	5cm clay overlying bleish-grey clayey Sand	Till
51	224252	229670	49.90	3.05	46.85	Stiff refusal	*Till*
52	224286	229679	49.95	3.08	46.87	Stiff refusal	*Till*
53	224299	229653	50.08	3.15	46.93	Blueish grey, stiff, sandy Clay; one shell fragment	*Lac*
54	224345	229645	50.63	1.50	49.13	Stiff refusal	*Till*
55	224249	229791	51.12	4.50	46.62	20cm Marl overling lac clay with laminations	Marl
Pz 920	224095	229731	50.74	2.20	48.54	Stiff refusal	*Till*
Pz 921	224169	229684	49.94	2.10	47.84	Lacustrine Clay	Lac
Pz 939	224182	229762	49.94	2.80	47.14	Gritty refusal	Sand/ Lac Clay
Pz 926	224318	229601	50.04	2.55	47.49	Blueish grey, stiff, damp, sandy Clay	Lac
Pz 917	223948	229736	52.47	2.20	50.27	Stiff refusal	Till

Appendix B

Hydrological Characterisation

Appendix B. Hydrological Characterisation: Clara West Drainage System

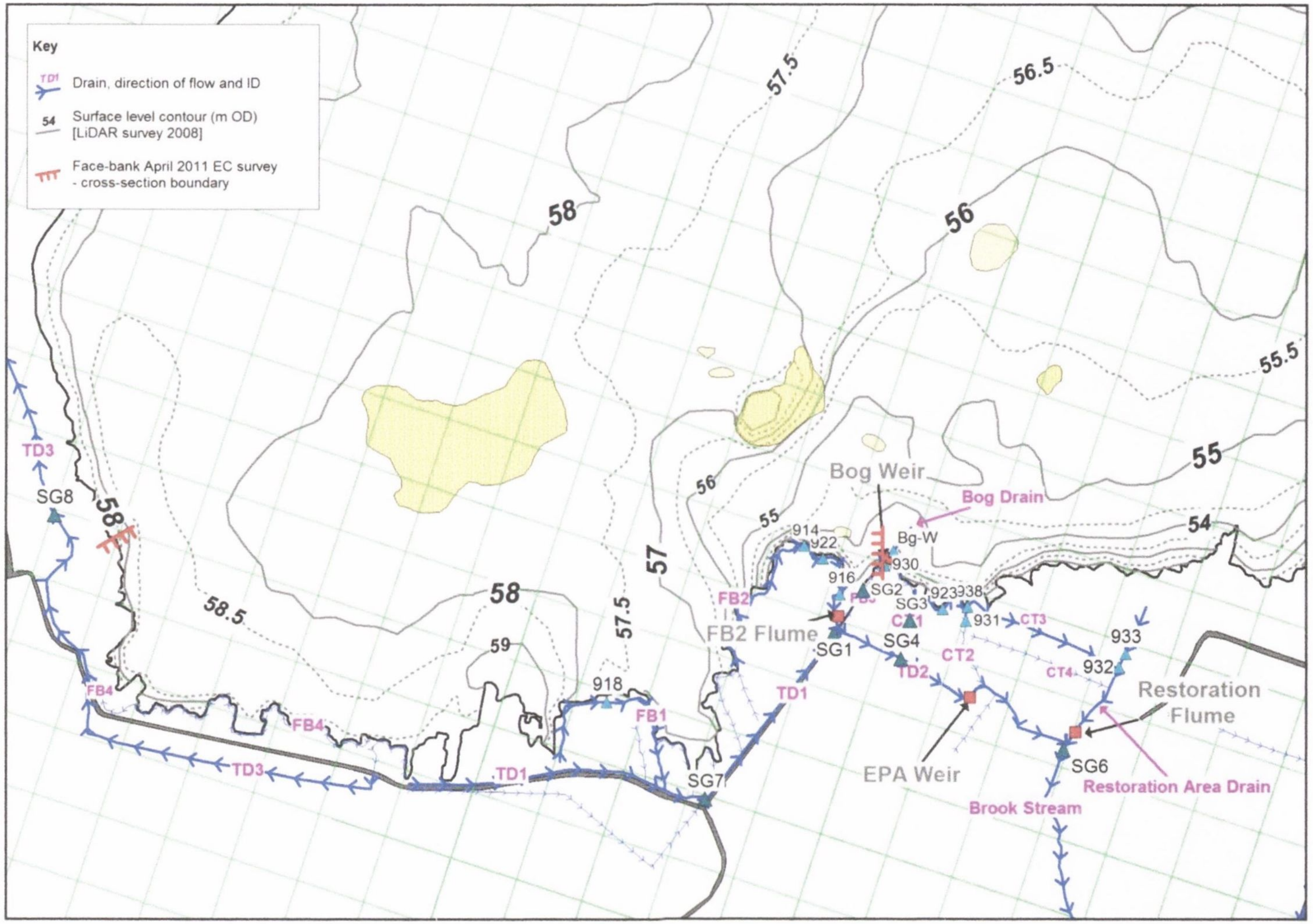


Figure B1. Clara West drainage system and surface water level and flow instrumentation

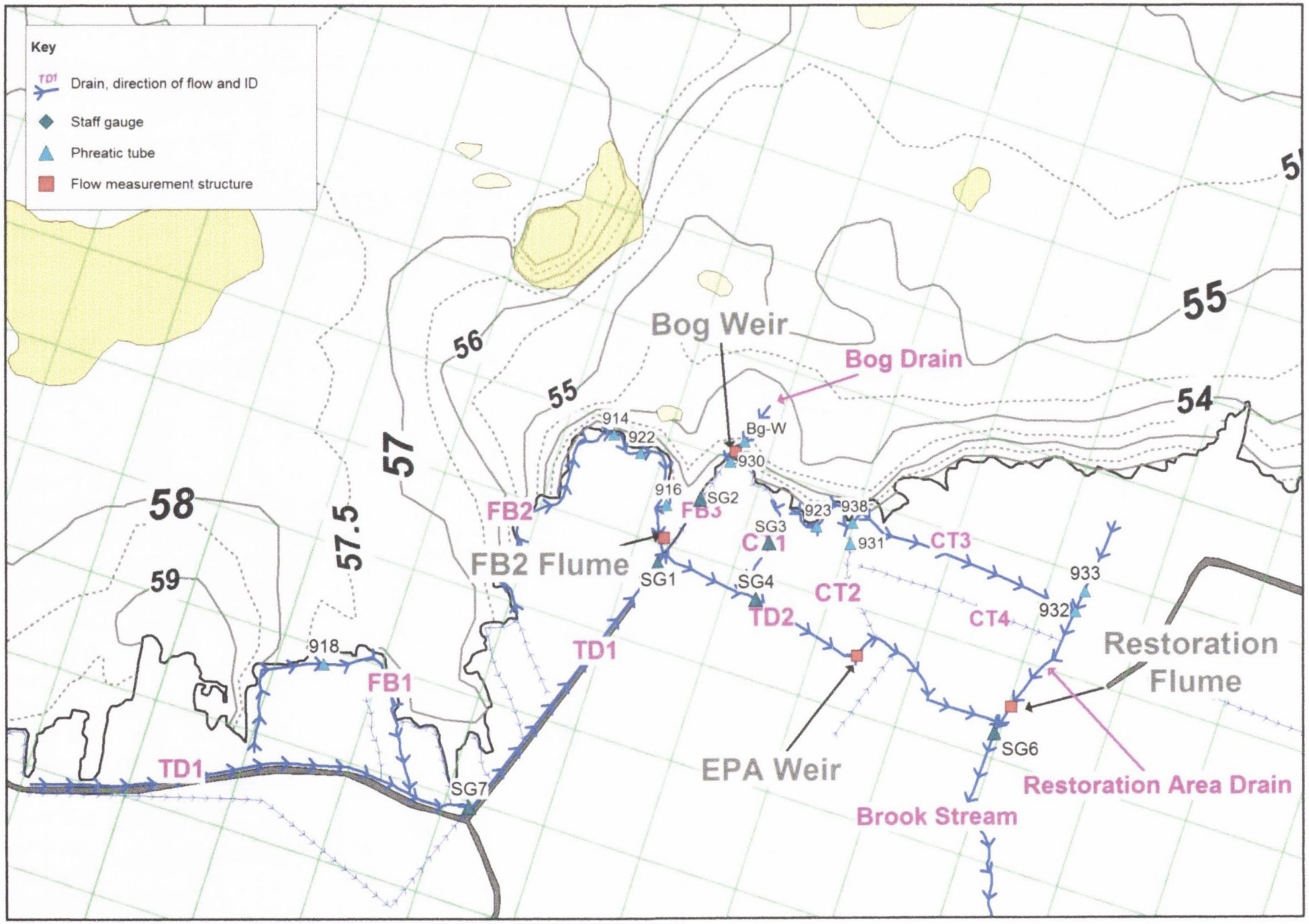


Figure B2. Clara West drainage system and surface water level and flow instrumentation – Restoration Area

Appendix B. Hydrological Characterisation – surface water level hydrographs

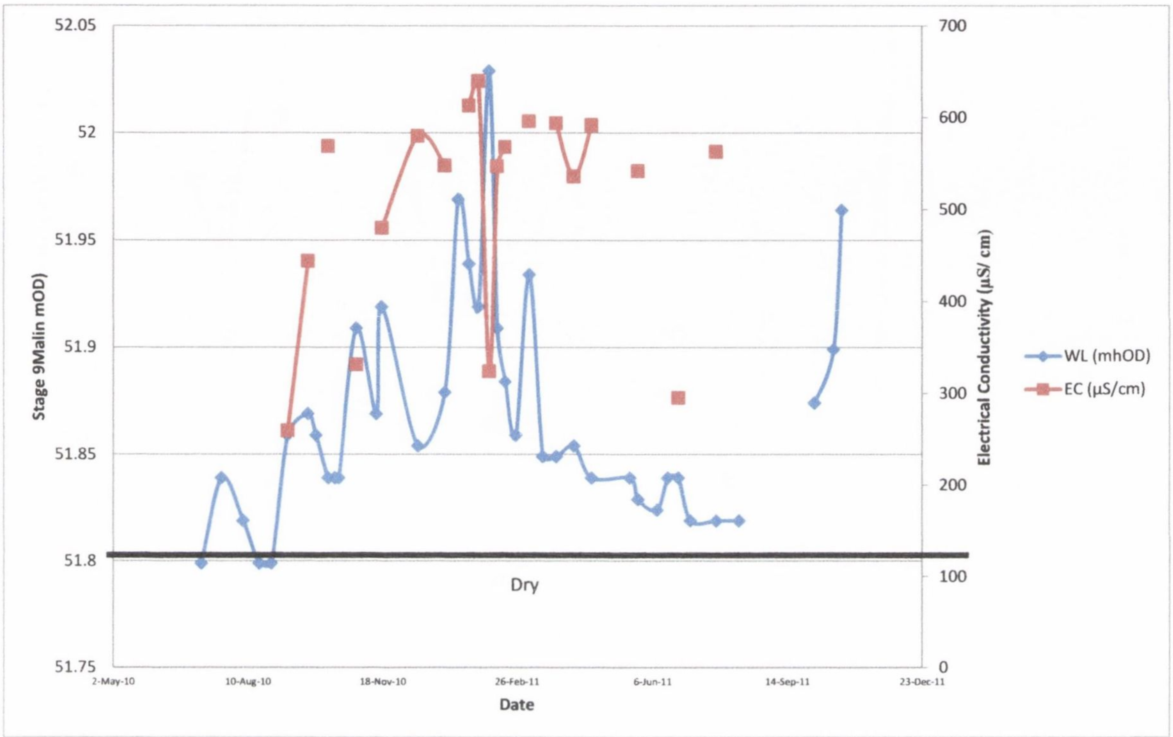


Figure B3. SG1 hydrograph and electrical conductivity measurements (06-06-10 to 24-10-11)

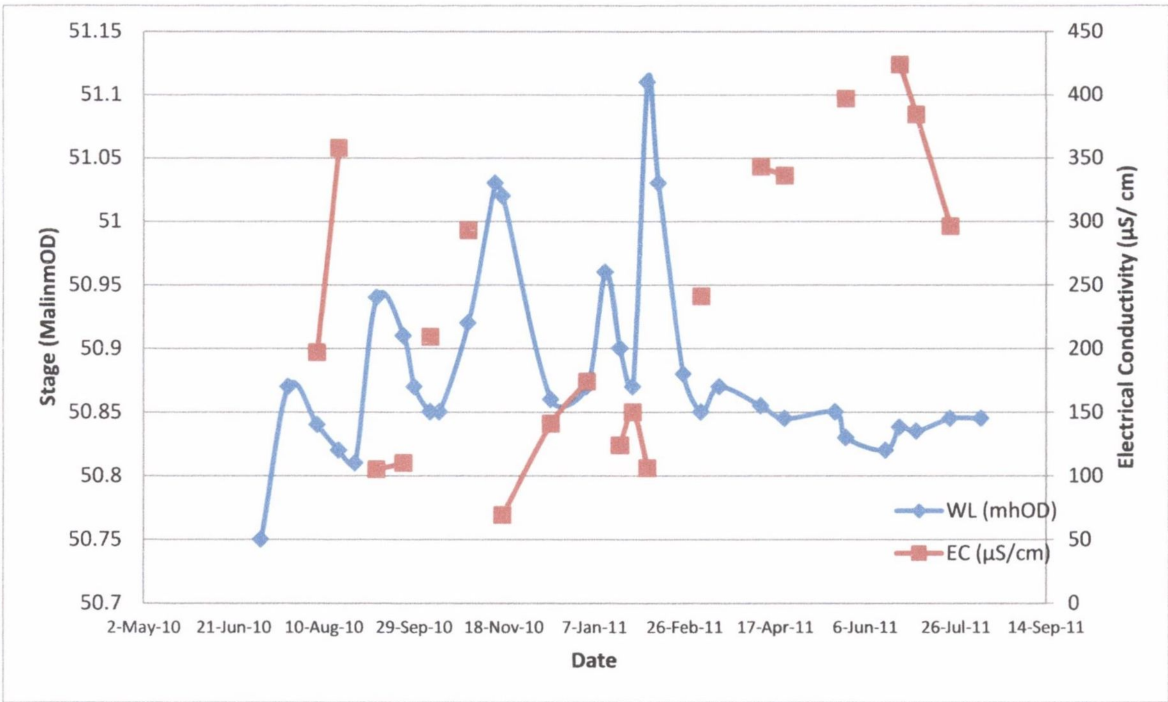


Figure B4. SG2 hydrograph and electrical conductivity measurements (06-06-10 to 09-08-11)

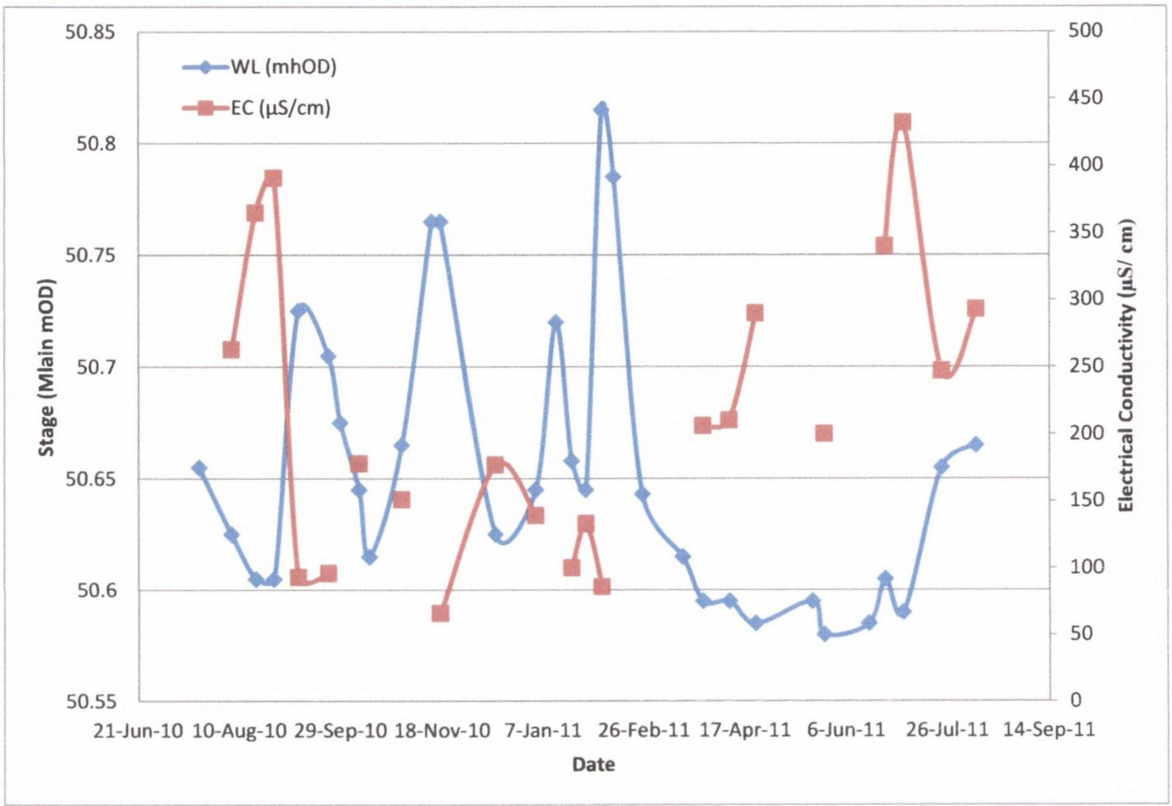


Figure B5. SG3 hydrograph and electrical conductivity measurements (06-06-10 to 09-08-11)

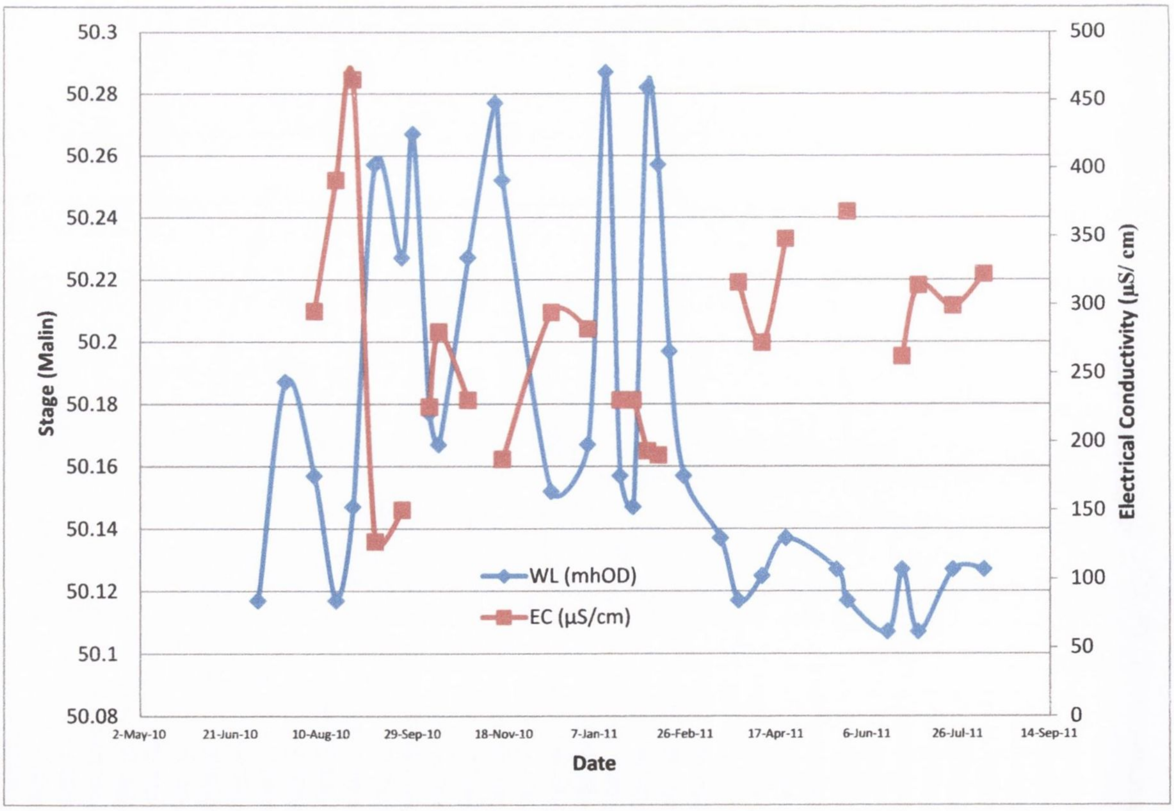


Figure B6. SG4 hydrograph and electrical conductivity measurements (06-06-10 to 09-08-11)

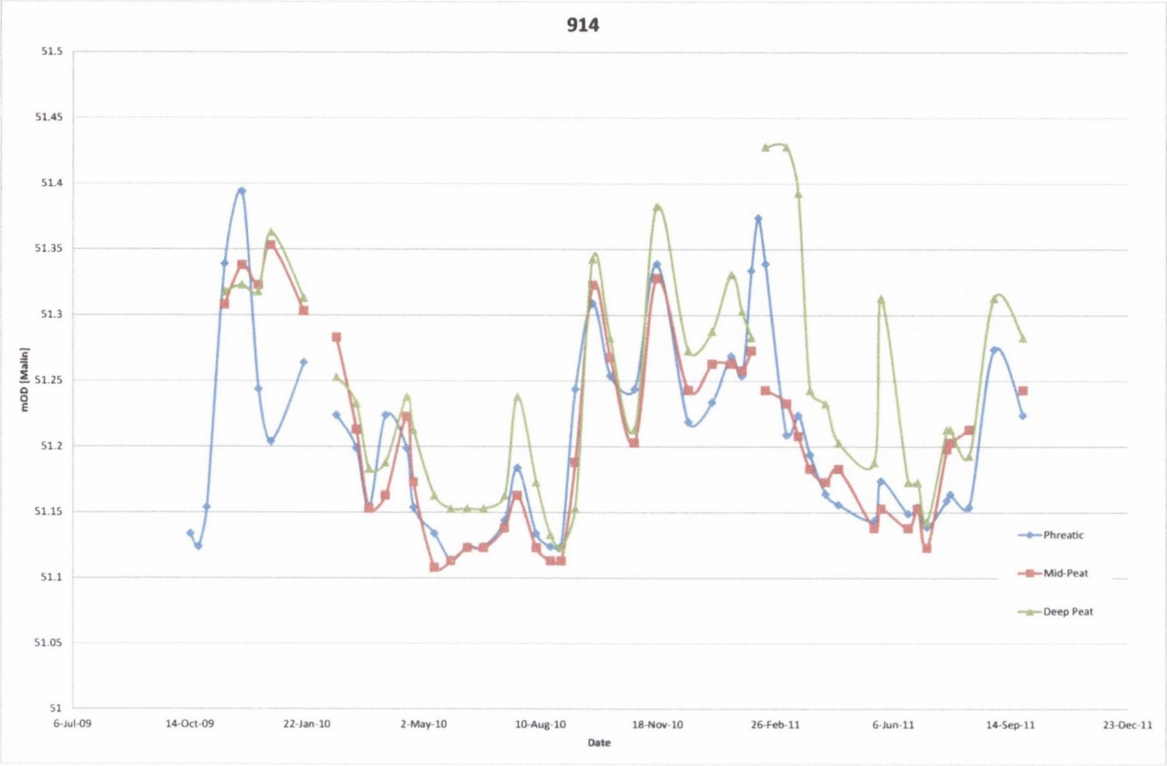


Figure B7. 914 hydrograph (14-10-09 to 24-09-11)

Figure B8. 918 hydrograph (14-10-09 to 24-09-11)

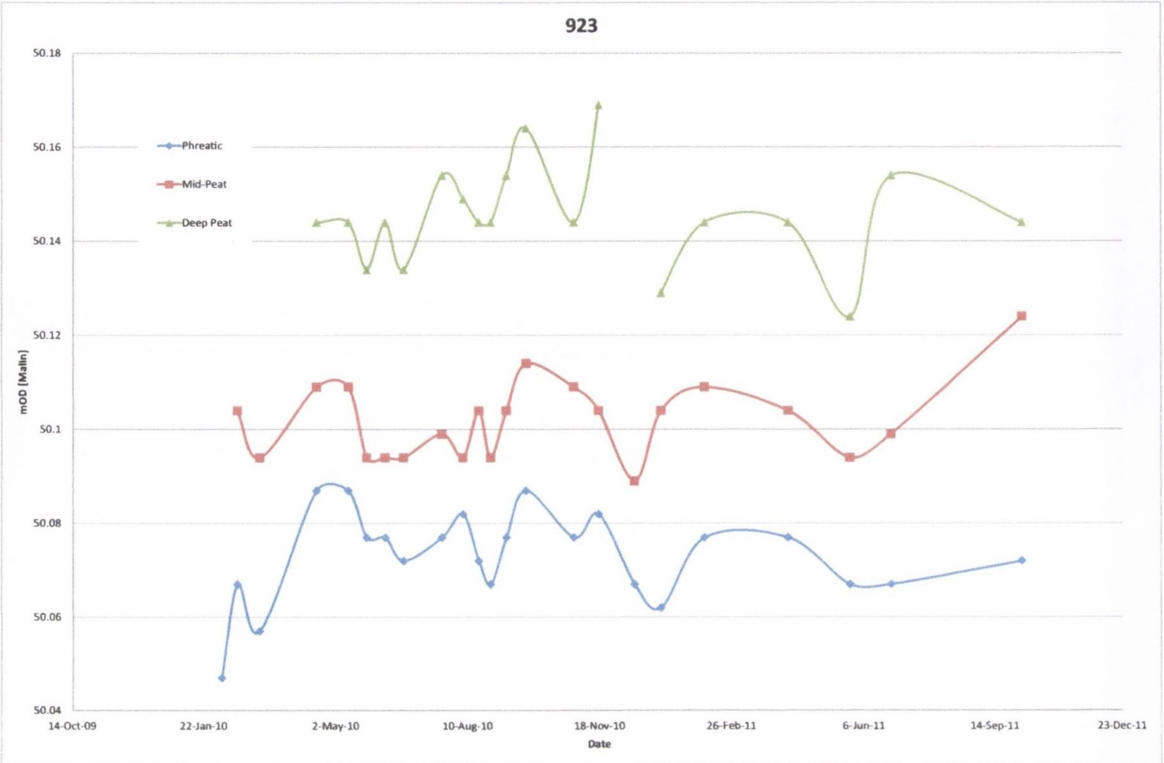


Figure B9. 923hydrograph (14-10-09 to 04-10-11)

Appendix B. Hydrological Characterisation – Rating Curves

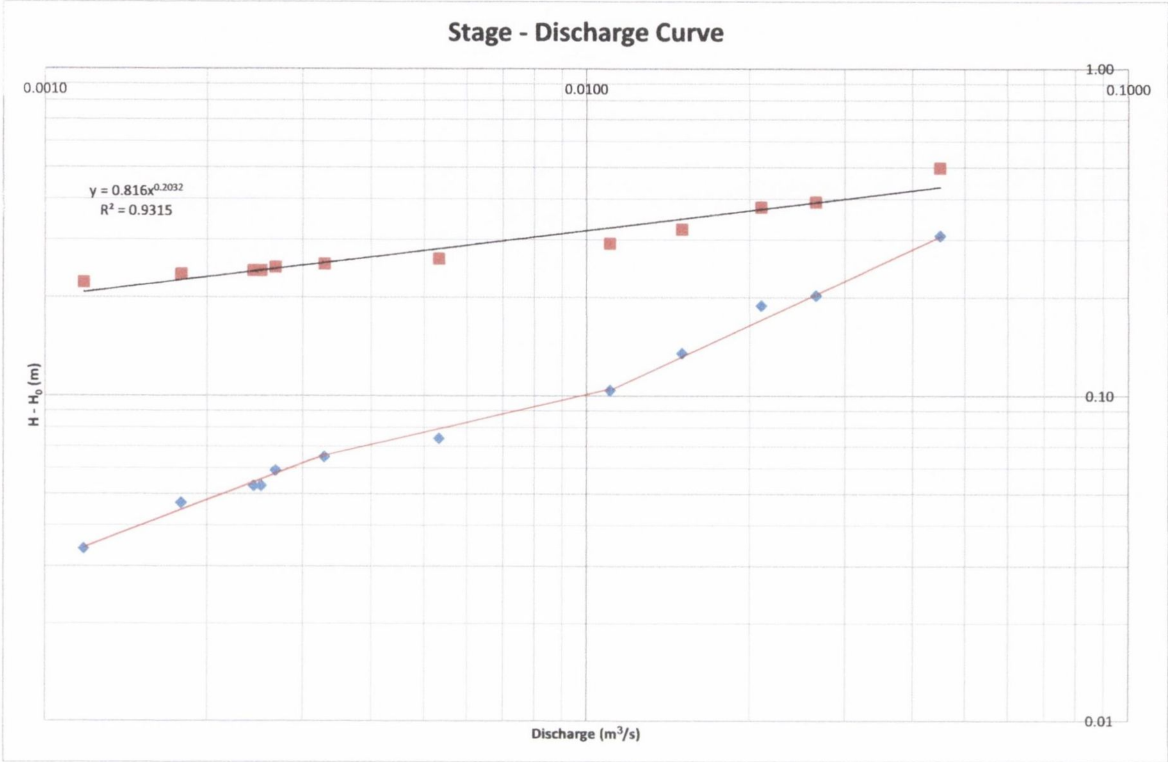


Figure B10. Restoration Flume rating curve

Table B1. Restoration Flume rating equation

Rating Equation				
	$Q = C\,(h - a)^n$	*C*	*a*	*n*
Slope no. 1	$Q = 0.079\,(h\text{-}a)^{1.194}$	0.079	0.188	1.194
Slope no. 2	$Q = 27.994\,(h\text{-}a)^{3.401}$	27.994	0.188	3.401
Slope no. 3	$Q = 0.192\,(h\text{-}a)^{1.237}$	0.192	0.188	1.237
Range				
	Stage level			
Slope no. 1	0 - 0.252			
Slope no. 2	0.252 - 0.292			
Slope no. 3	> 0.292			

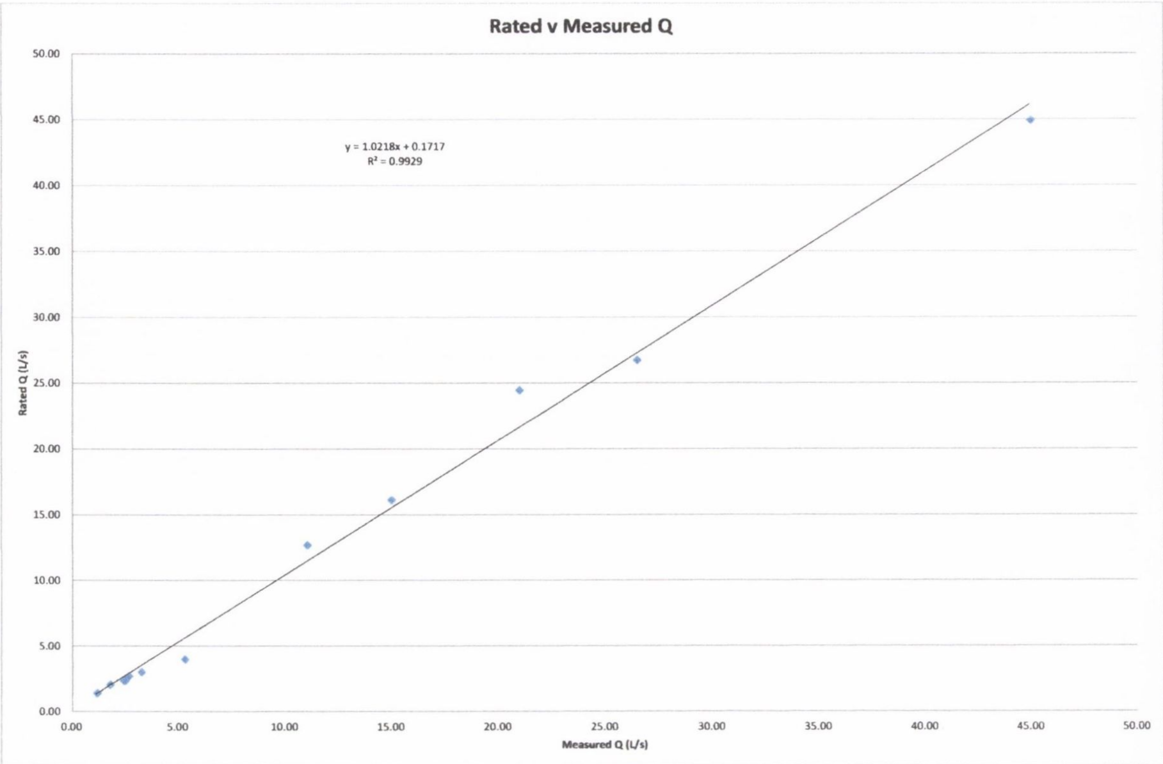


Figure B11. Restoration Flume: measured Q versus rated Q

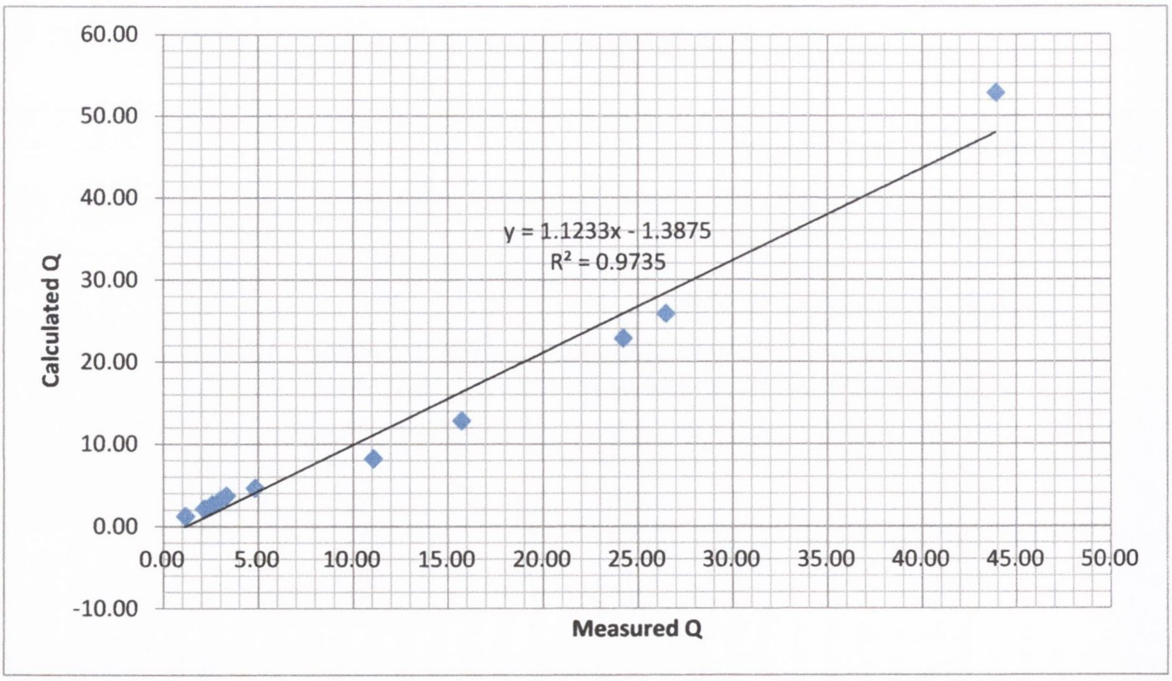


Figure B12. Restoration Flume: measured Q versus flume equation Q

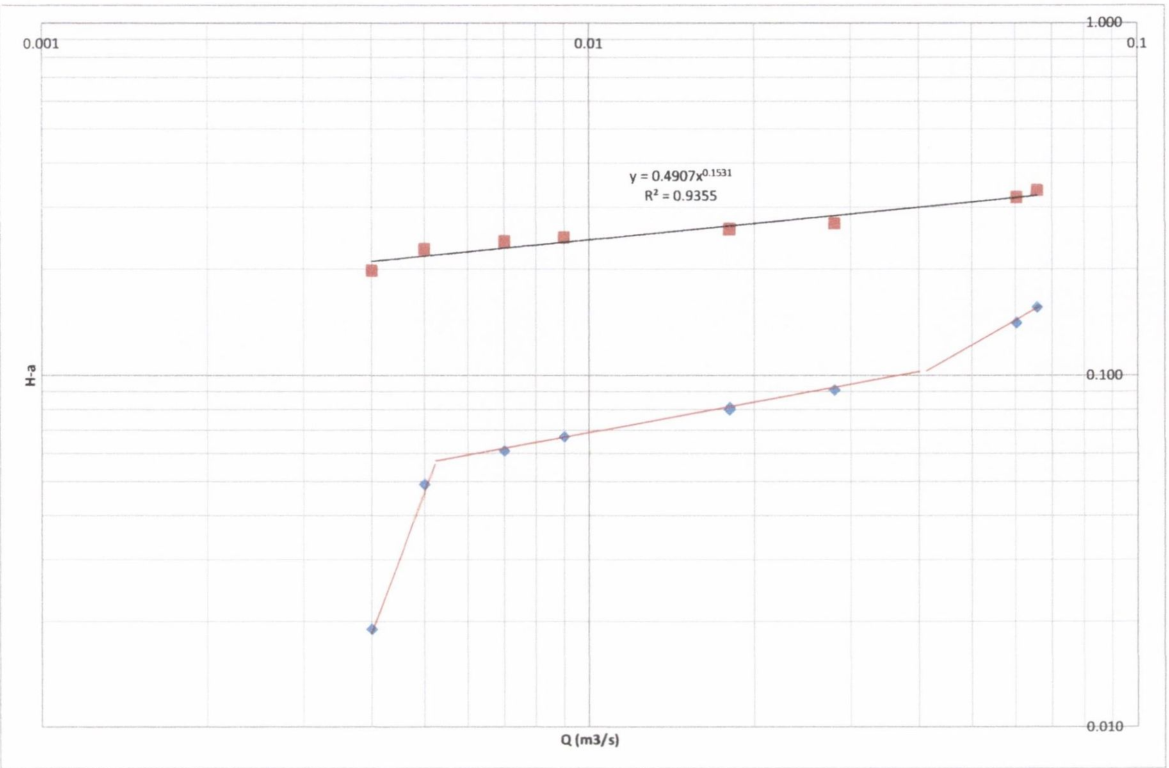


Figure B13. Original EPA Weir rating curve

Table B2. Original EPA Weir rating equation

Rating Equation				
	$Q = C\,(h - a)^n$	*C*	*a*	*n*
Slope no. 1	$Q = 0.0101\,(h\text{-}a)^{0.235}$	0.0101	0.179	0.235
Slope no. 2	$Q = 113.65\,(h\text{-}a)^{3.465}$	113.65	0.179	3.465
Slope no. 3	$Q = 1.115\,(h\text{-}a)^{1.522}$	1.115	0.179	1.522
Range				
	Stage level			
Slope no. 1	0 - 0.236			
Slope no. 2	0.236 - 0.28			
Slope no. 3	> 0.28			

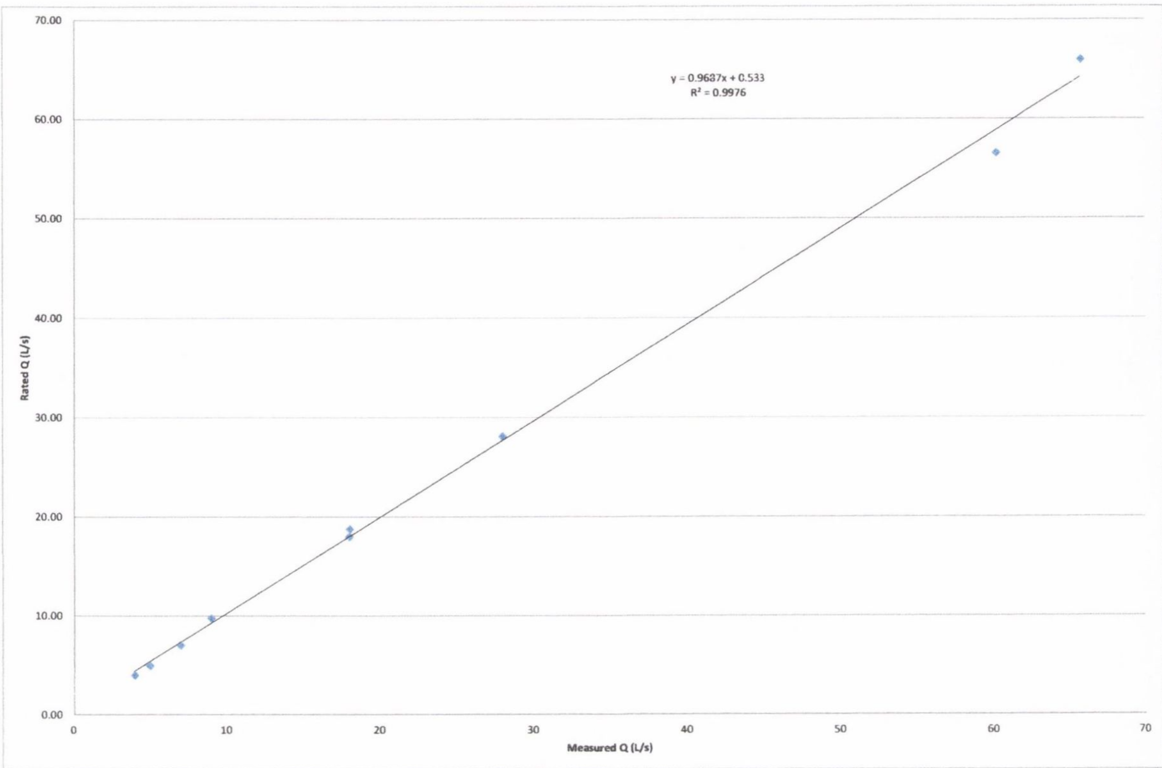


Figure B14. Original EPA Weir: measured Q versus rated Q

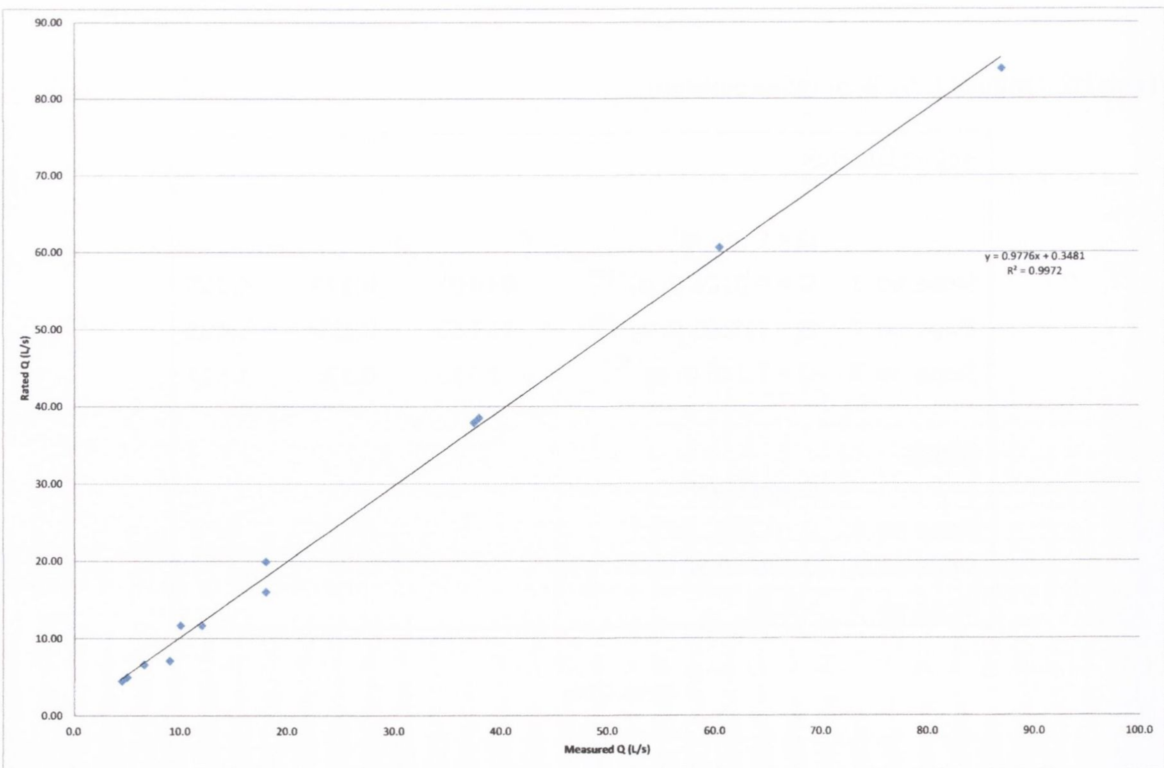


Figure B15. Adjusted EPA Weir: measured Q versus rated Q

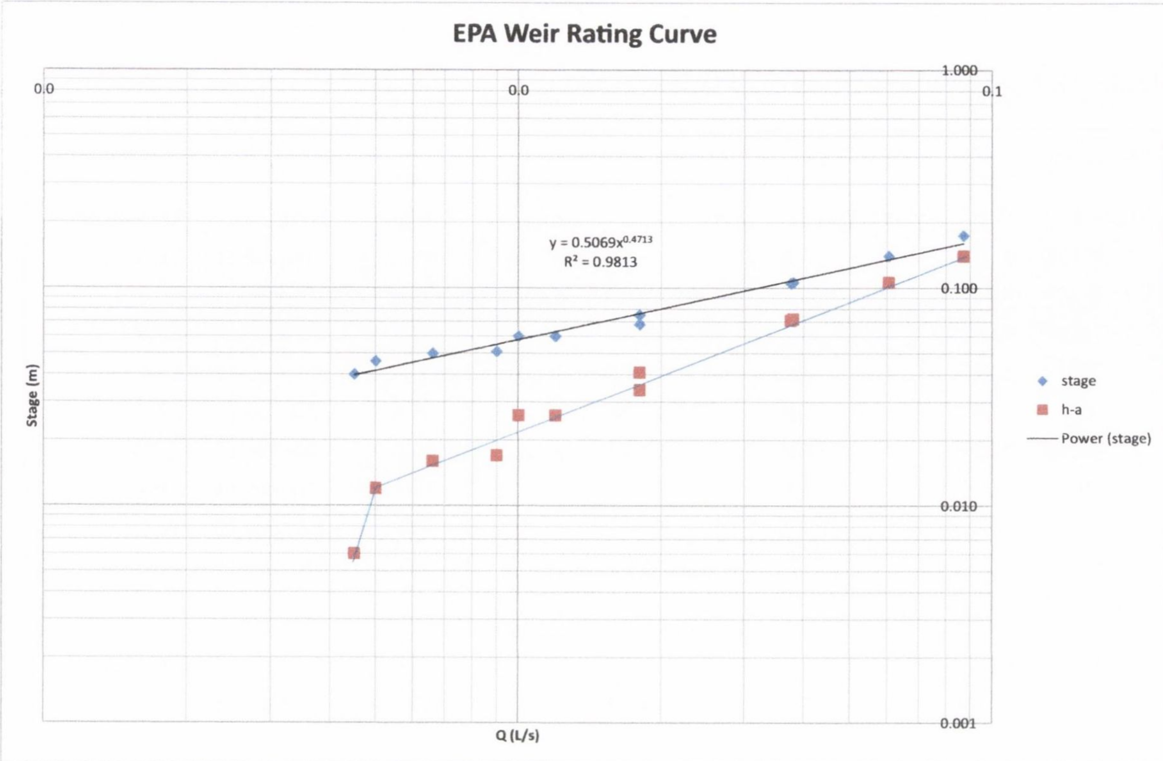


Figure B16. Adjusted EPA Weir rating curve

Table B3. Adjusted EPA Weir rating equation

Rating Equation				
	$Q = C (h - a)^n$	***C***	***a***	***n***
Slope no. 1	$Q = 0.00977 (h\text{-}a)^{0.152}$	0.00977	0.034	0.152
Slope no. 2	$Q = 0.839 (h\text{-}a)^{1.171}$	0.839	0.034	1.171
Range				
	Stage level			
Slope no. 1	0 - 0.046			
Slope no. 2	> 0.046			

Table B4. Field measured Q and rated Q rates

SG WL	H-a	Meas. Q (l/s)	Rated Q (L/s)	Slope (log)	Type	Date	Measured
Original							
0.198	0.019	4	3.98	1	V-A	06-Jul-11	EPA
0.228	0.049	5	4.97	1	V-A	29-Apr-11	EPA
0.24	0.061	7	7.03	2	V-A	30-Mar-11	EPA
0.246	0.067	9	9.73	2	V-A	05-Apr-11	EPA
0.259	0.080	18	17.98	2	V-A	10-Jan-11	EPA
0.260	0.081	18.0	18.77	2	V-A	05-Jan-11	TCD
0.27	0.091	28	28.10	2	V-A	26-Jan-11	EPA
0.32	0.141	60.22	56.54	3	DG	17-Nov-10	TCD
0.335	0.156	65.72	65.95	3	DG	10-Nov-10	TCD
Adjusted							
SG WL	**H-a**	**Meas. Q (l/s)**	**Rated Q (L/s)**	**Slope (log)**	**Type**	**Date**	**Measured**
0.040	0.006	4.5	4.49	1	V-A	09-Aug-11	TCD
0.046	0.012	5.0	4.99	1	V-A	23-Aug-11	EPA
0.050	0.016	6.6	6.62	2	V-A	15-Jul-11	TCD
0.051	0.017	9.0	7.11	2	V-A	29-Sep-11	EPA
0.060	0.026	12.0	11.69	2	Bk-Stp	12-Aug-11	TCD
0.060	0.026	10.0	11.69	2	V-A	11-Aug-11	EPA
0.068	0.034	18.0	16.00	2	V-A	19-Sep-11	EPA
0.075	0.041	18.0	19.92	2	V-A	14-Nov-11	EPA
0.105	0.071	37.5	37.90	2	V-A	11-Jan-12	TCD
0.106	0.072	38.0	38.52	2	V-A	09-Dec-11	EPA
0.140	0.106	60.5	60.59	2	V-A	04-Jan-12	TCD
0.174	0.140	87.0	83.92	2	V-A	03-Jan-12	EPA

Note: V-A is velocity area, DG is dilution gauging and Bk-Stp is bucket and stop watch.

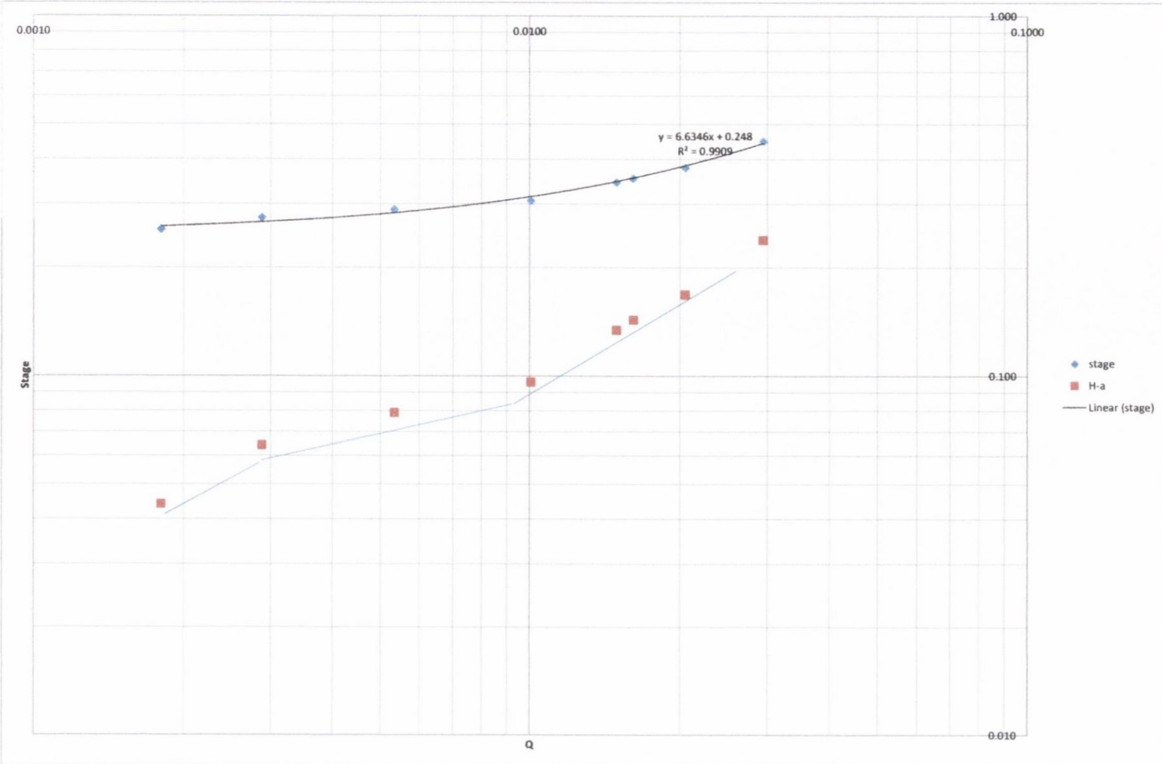


Figure B17. FB2 Flume Weir rating curve

Table B5. FB2 Flume rating equation

Rating Equation				
	$Q = C (h - a)^n$	***C***	***a***	***n***
Slope no. 1	$Q = 0.0948 (h-a)^{1.27}$	0.0948	0.211	1.27
Slope no. 2	$Q = 13.73 (h-a)^{3.077}$	13.73	0.211	3.077
Slope no. 3	$Q = 0.159 (h-a)^{1.177}$	0.159	0.211	1.177
Range				
	Stage level			
Slope no. 1	< 0.275			
Slope no. 2	0.275 - 0.308			
Slope no. 3	> 0.308			

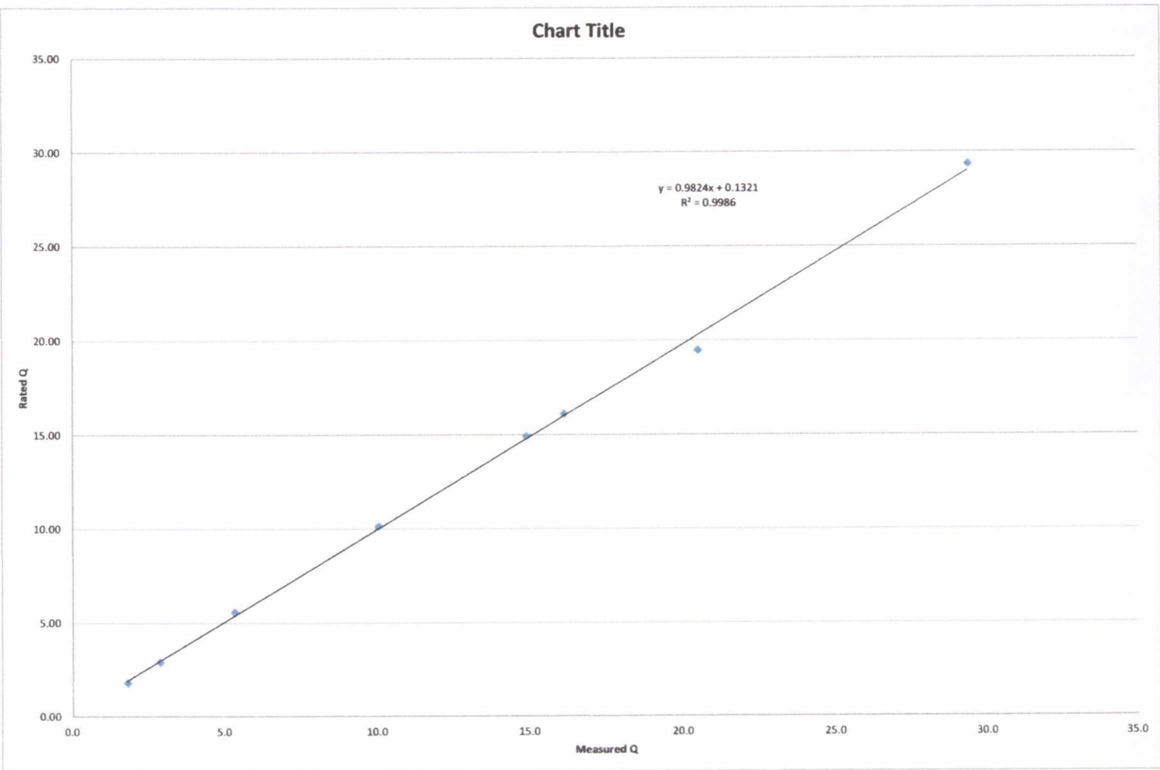


Figure B18. FB2 Flume: measured Q versus rated Q

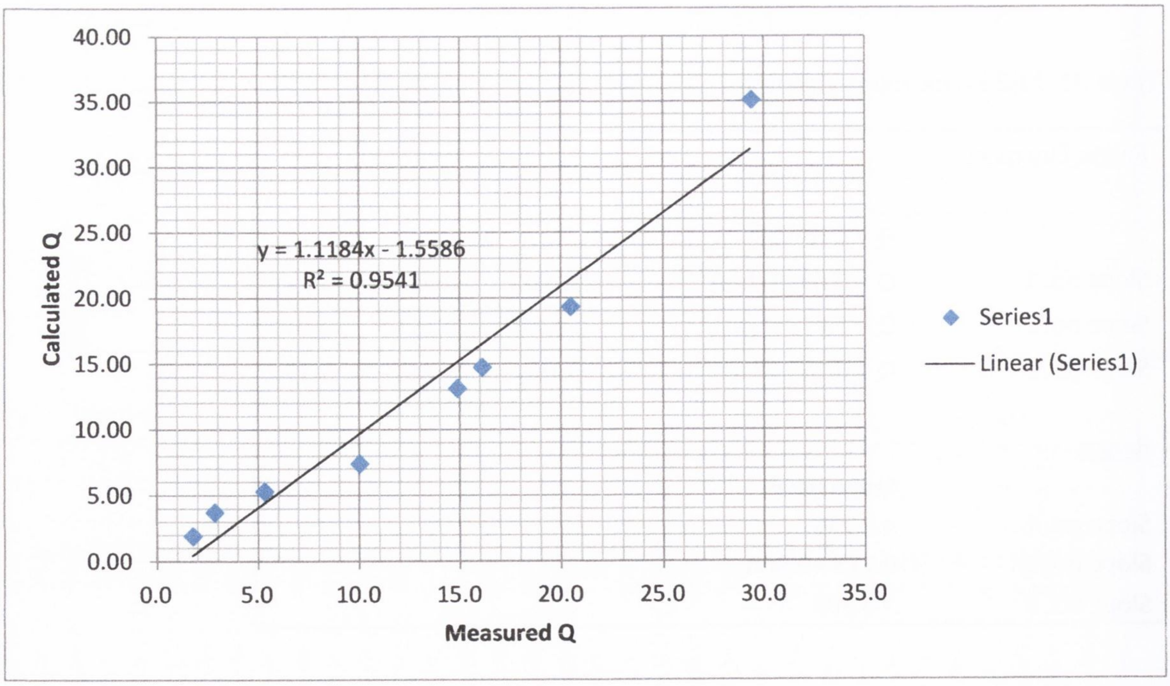


Figure B19. FB2 Flume: measured Q versus flume equation Q

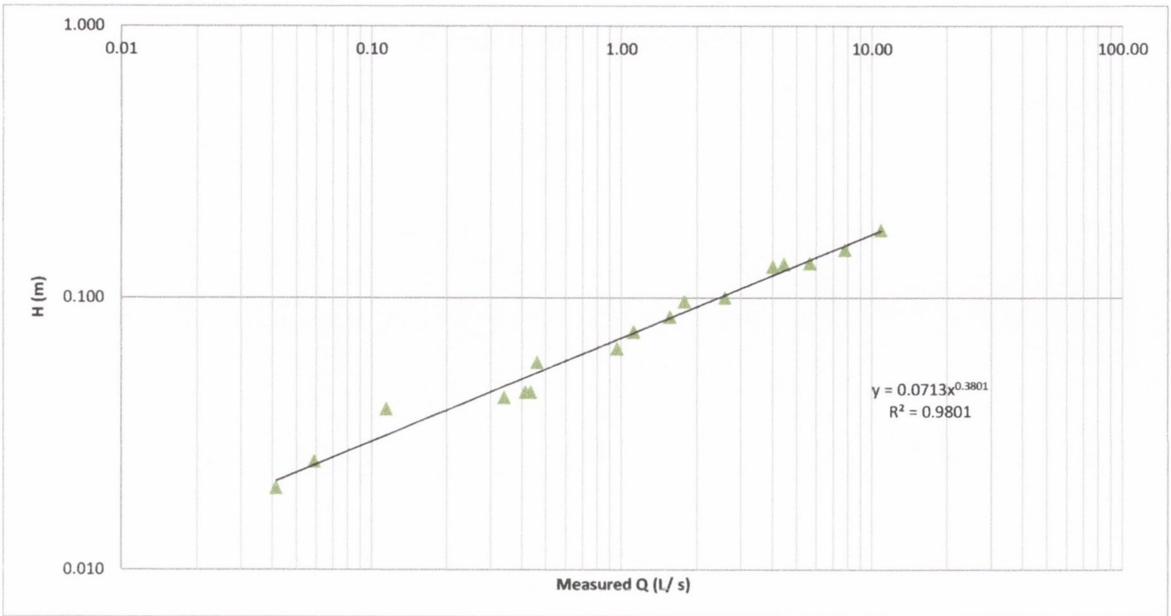


Figure B20. BG Weir rating: measured Q versus H (head above weir notch)

Table B6. Bog Weir rating table

Date	BW Level (m)	Measured Discharge (m^3/s)	H (estimate)	Calculated Discharge (m^3/s)	Difference
11-Feb-11	0.333	0.0108	0.177	0.01061	0.0002
5-Feb-11	0.360	0.0078	0.150	0.00701	0.0008
17-Feb-11	0.376	0.0056	0.134	0.00529	0.0004
25-Feb-11	0.410	0.0026	0.100	0.00254	0.0000
7-Mar-11	0.435	0.0011	0.075	0.00124	-0.0001
27-Mar-11	0.452	0.0005	0.058	0.00065	-0.0002
22-Apr-11	0.471	0.0001	0.039	0.00024	-0.0001
17-Jun-11	0.490	0.00004	0.020	0.00005	0.0000
25-Jun-11	0.480	0.00041	0.045	0.00035	0.0001
4-Jul-11	0.500	0.00006	0.025	0.00008	0.0000
17-Jul-11	0.460	0.00096	0.065	0.00087	0.0001
23-Jul-11	0.480	0.00043	0.045	0.00035	0.0001
9-Aug-11	0.482	0.00034	0.043	0.00031	0.0000
24-Sep-11	0.440	0.00156	0.085	0.00169	-0.0001
24-Oct-11	0.392	0.00444	0.133	0.00519	-0.0008
13-Nov-11	0.428	0.00178	0.097	0.00236	-0.0006
11-Jan-12	0.395	0.00401	0.130	0.00490	-0.0009

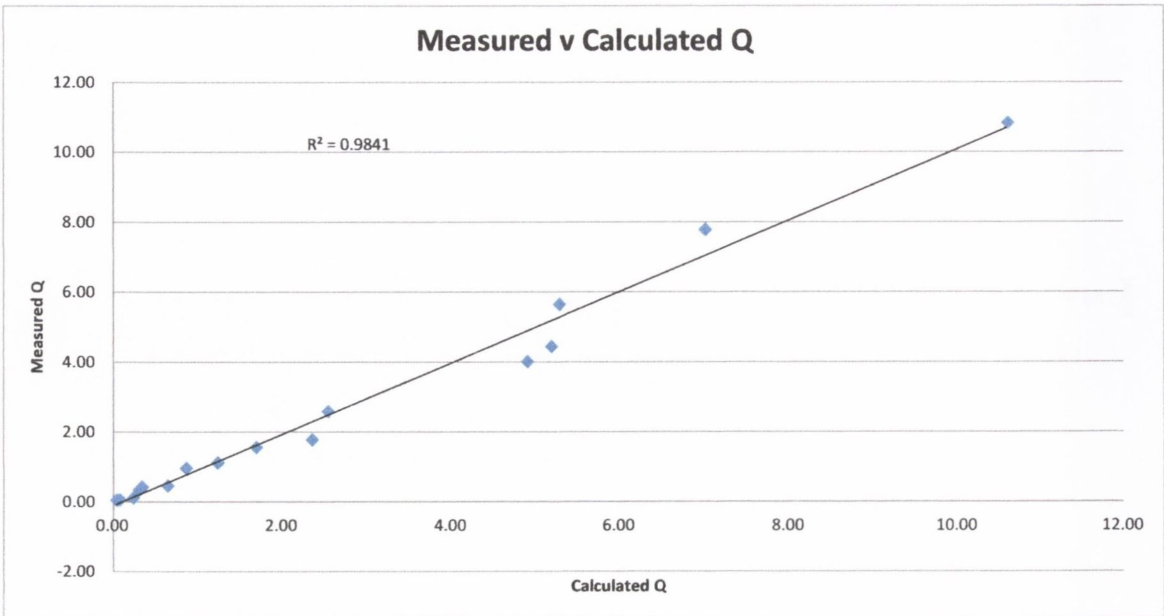


Figure B21. BG Weir: measured Q versus rated Q

Appendix B. Hydrological Characterisation – hydraulic structure hydrographs

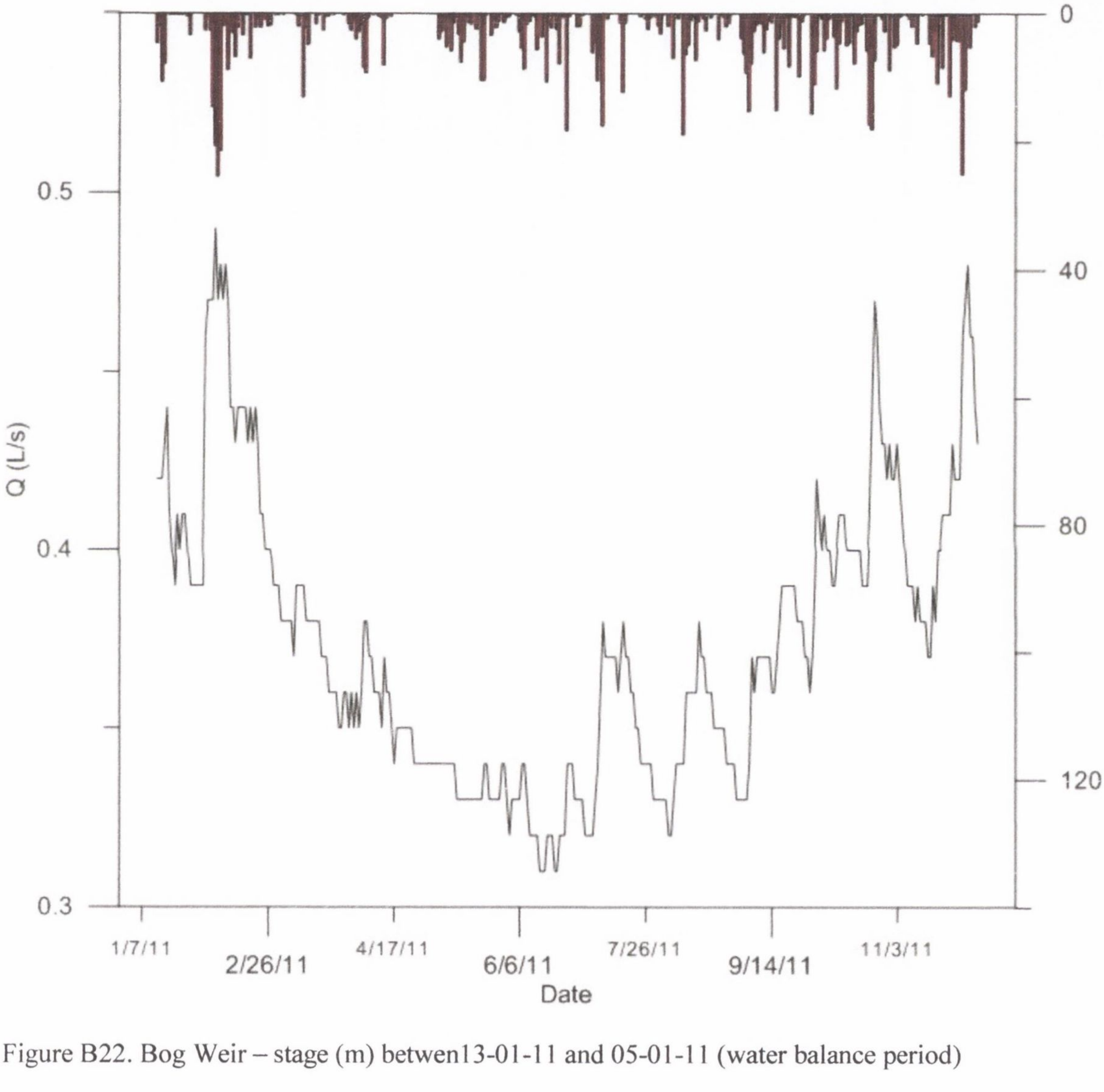


Figure B22. Bog Weir – stage (m) betwen13-01-11 and 05-01-11 (water balance period)

)

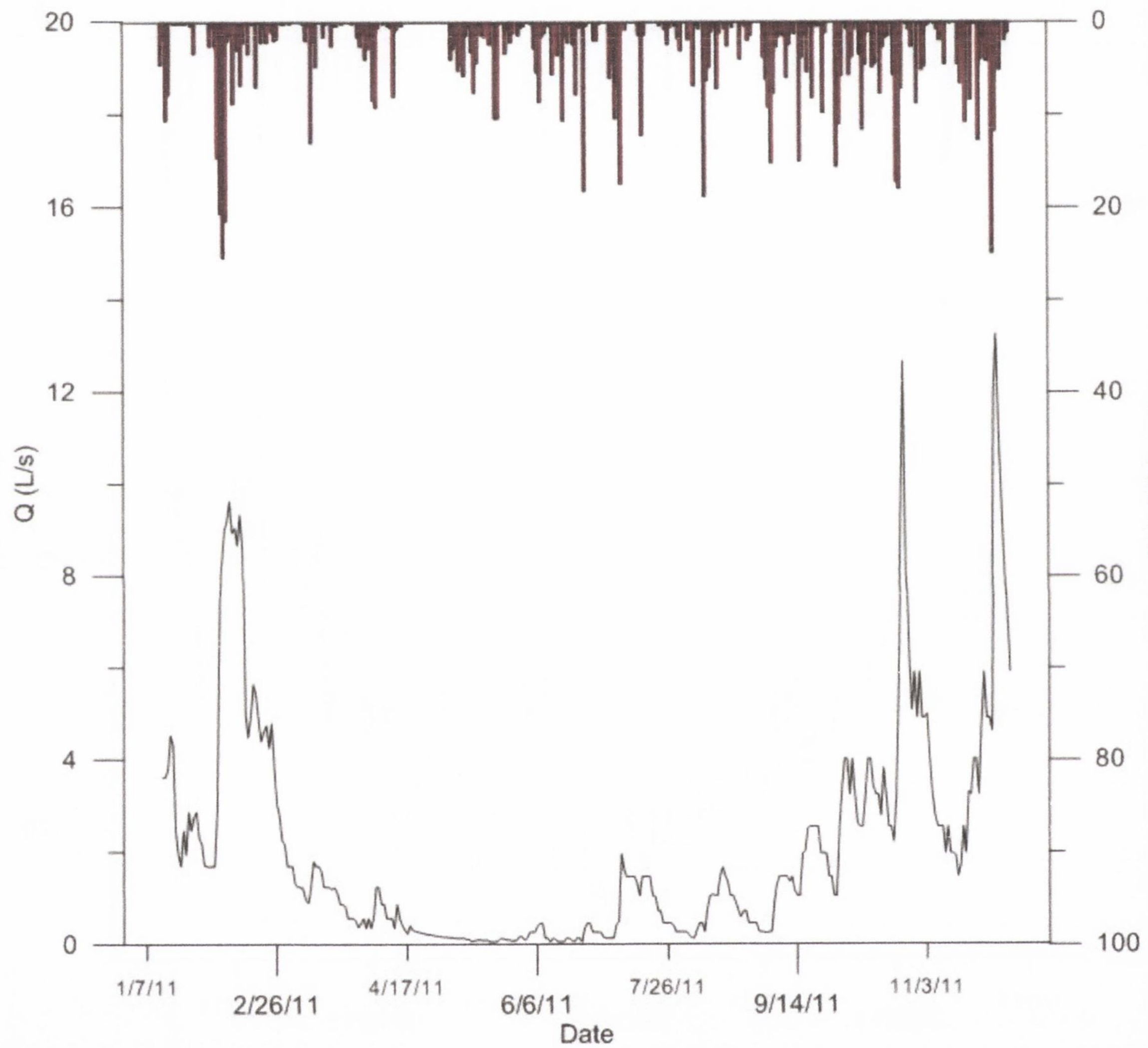


Figure B23. Bog Weir – discharge (L/ s) betwen13-01-11 and 05-01-11 (water balance period)

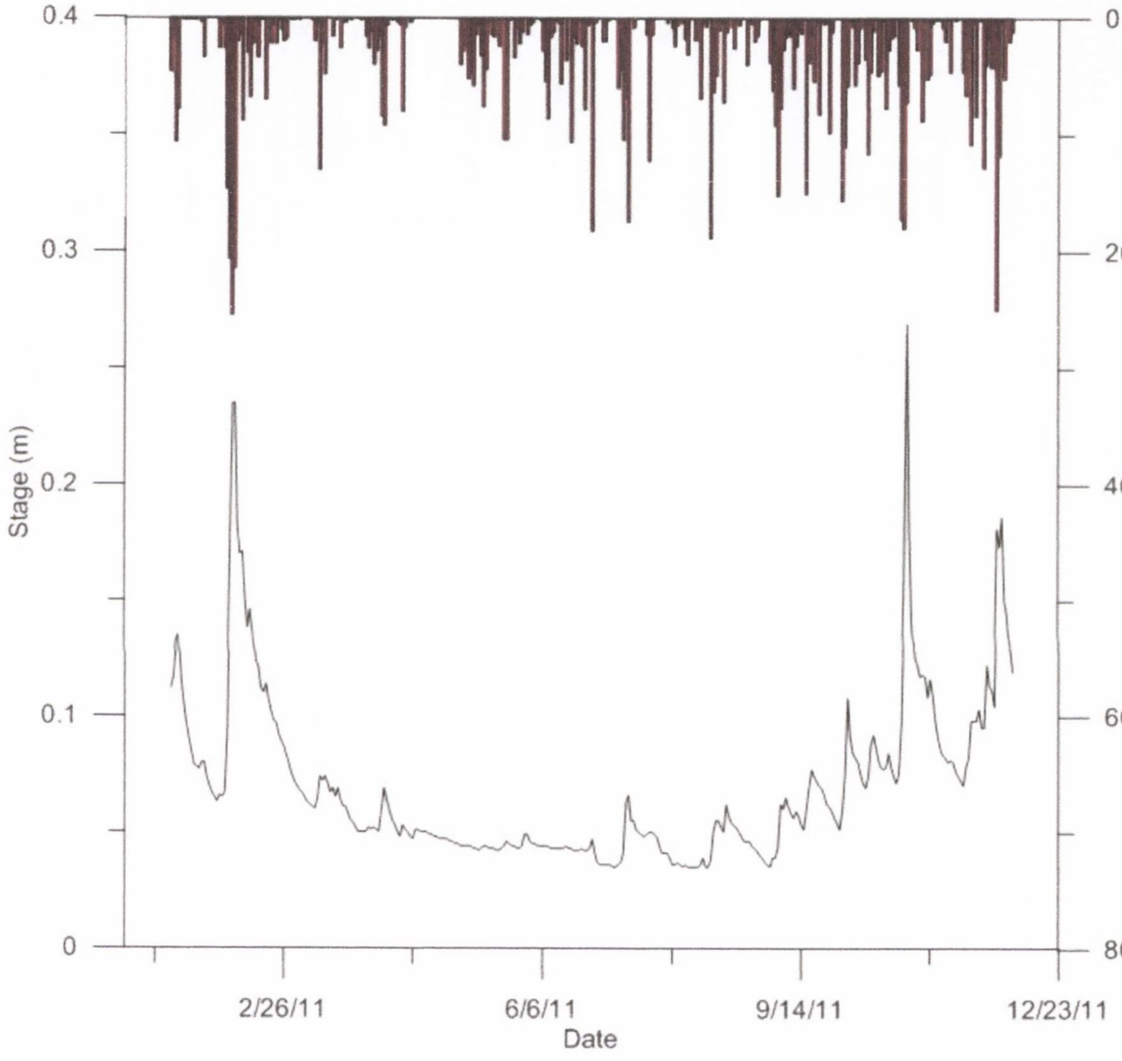


Figure B24. EPA Weir – stage (m) betwen13-01-11 and 05-01-11 (water balance period)

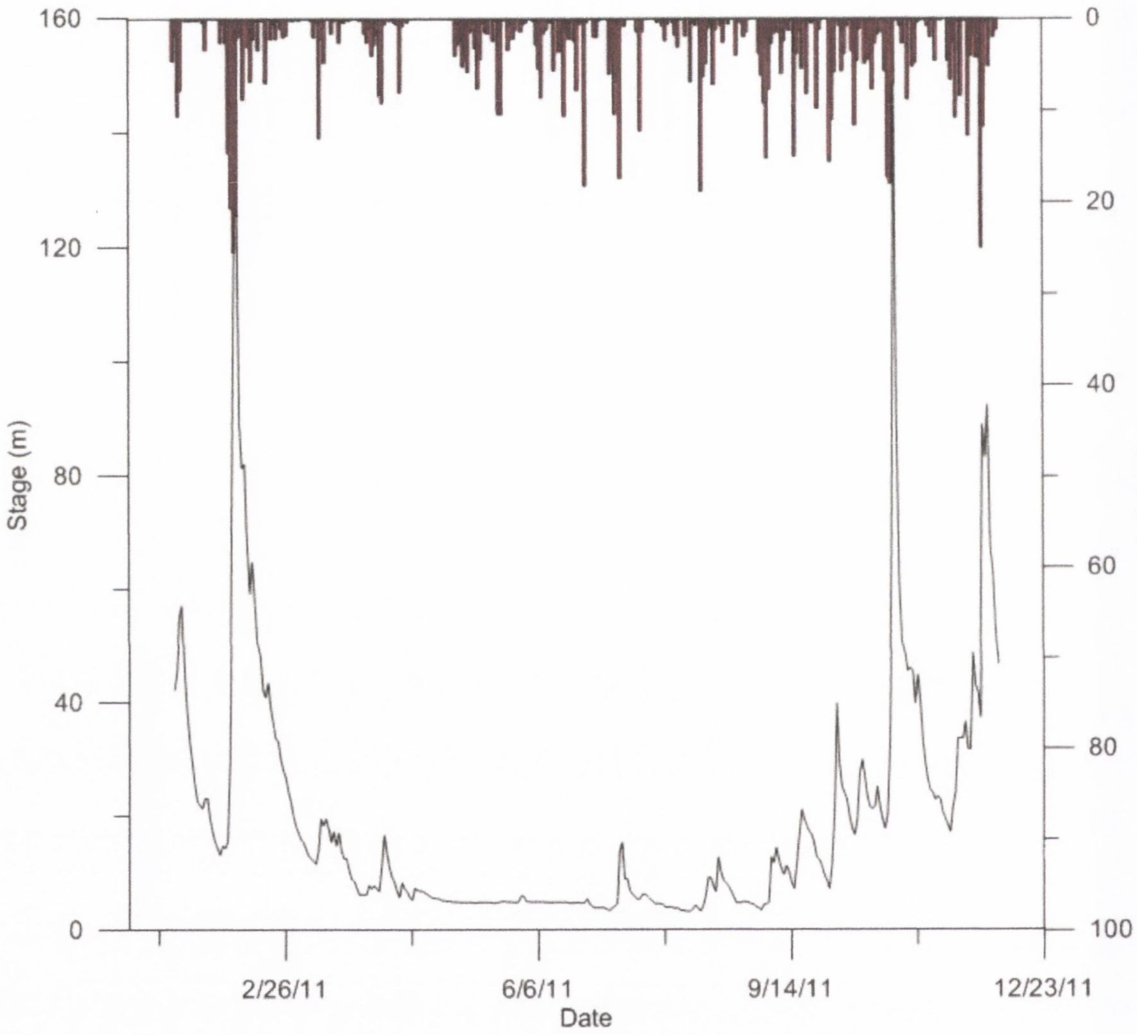


Figure B25. EPA Weir – discharge (L/ s) between 13-01-11 and 05-01-11 (water balance period)

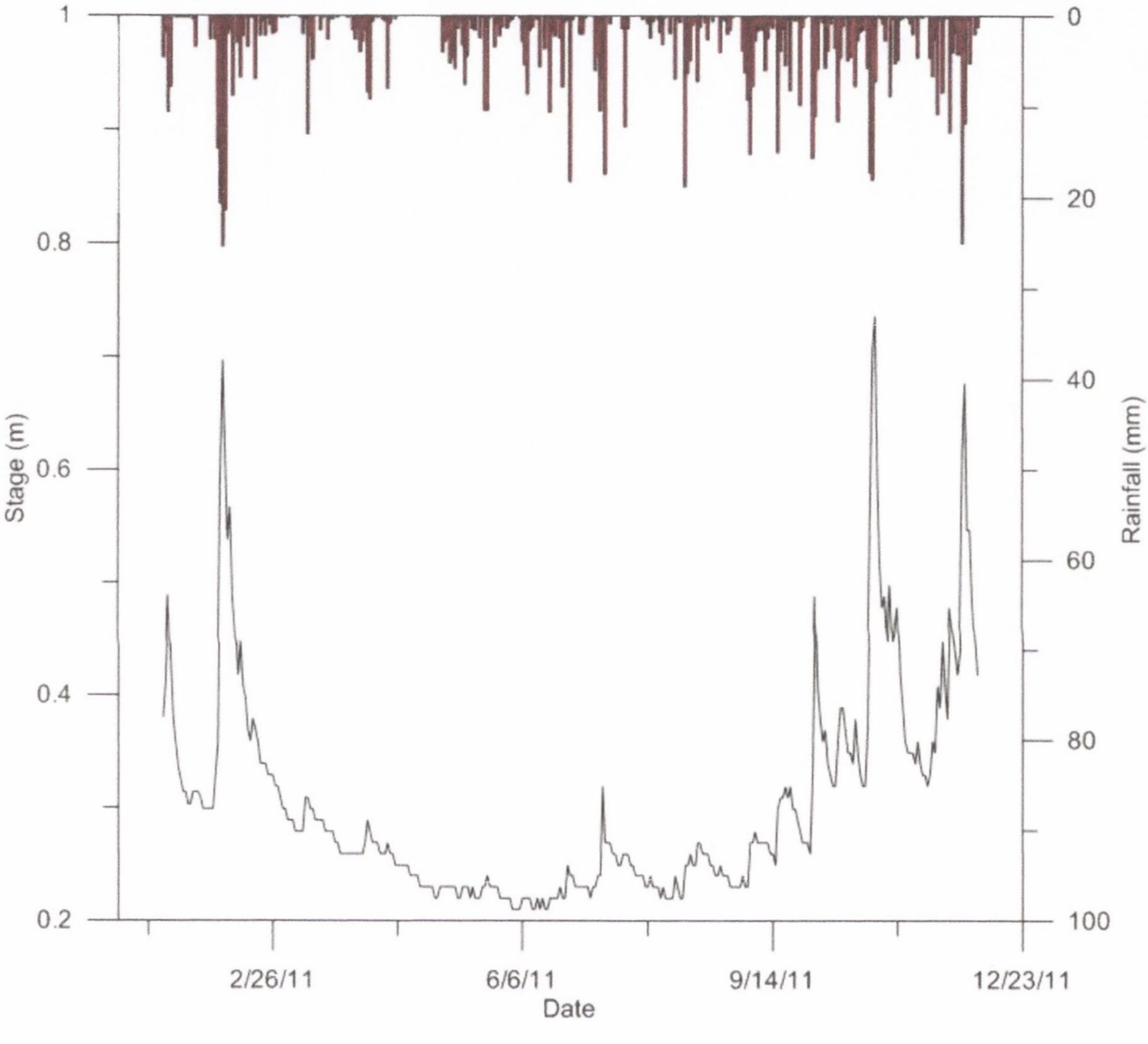


Figure B26. Restoration Flume – stage (m) betwen13-01-11 and 05-01-11 (water balance period)

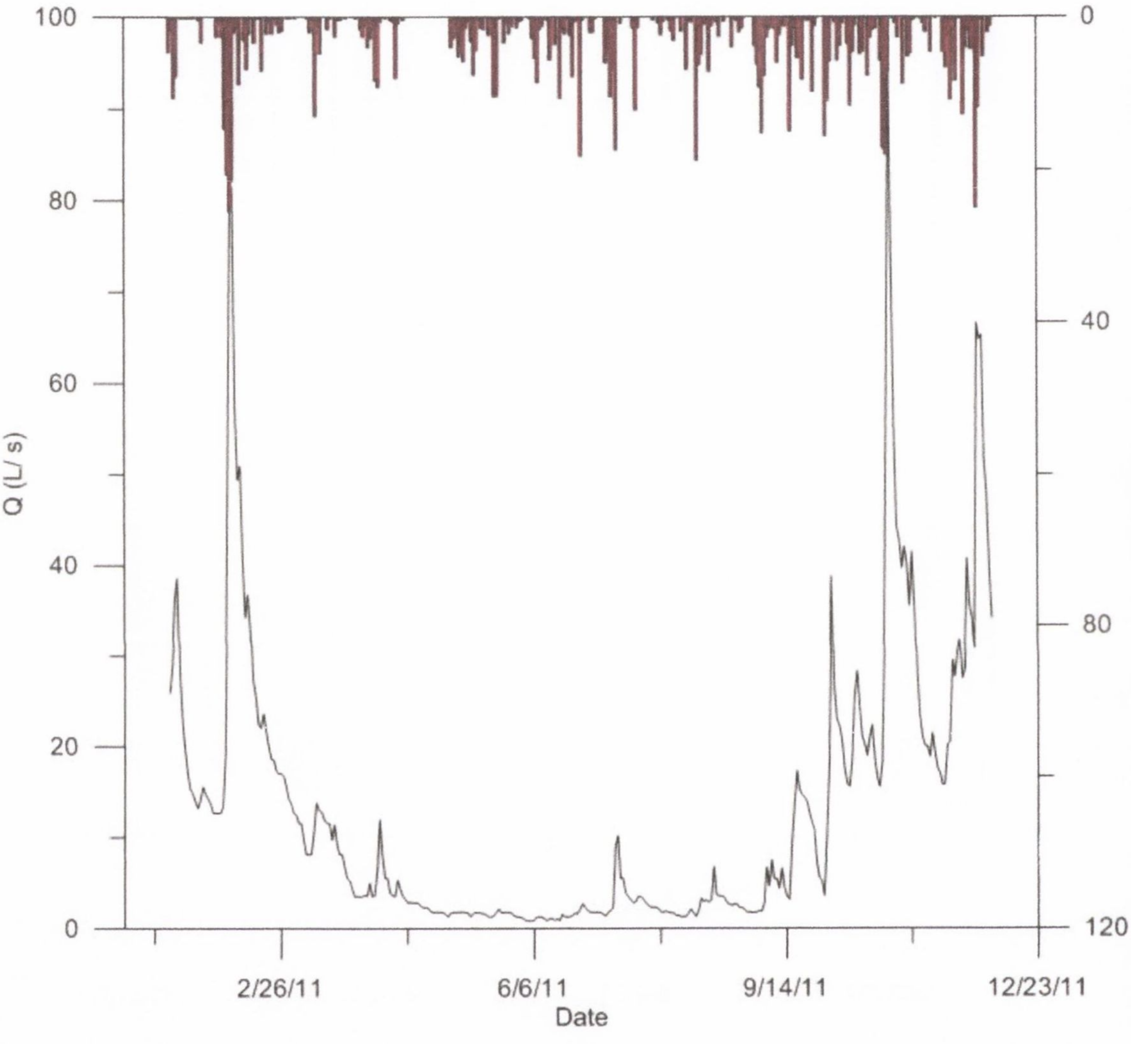


Figure B27. Restoration Flume – discharge (L/ s) between 13-01-11 and 05-01-11 (water balance period)

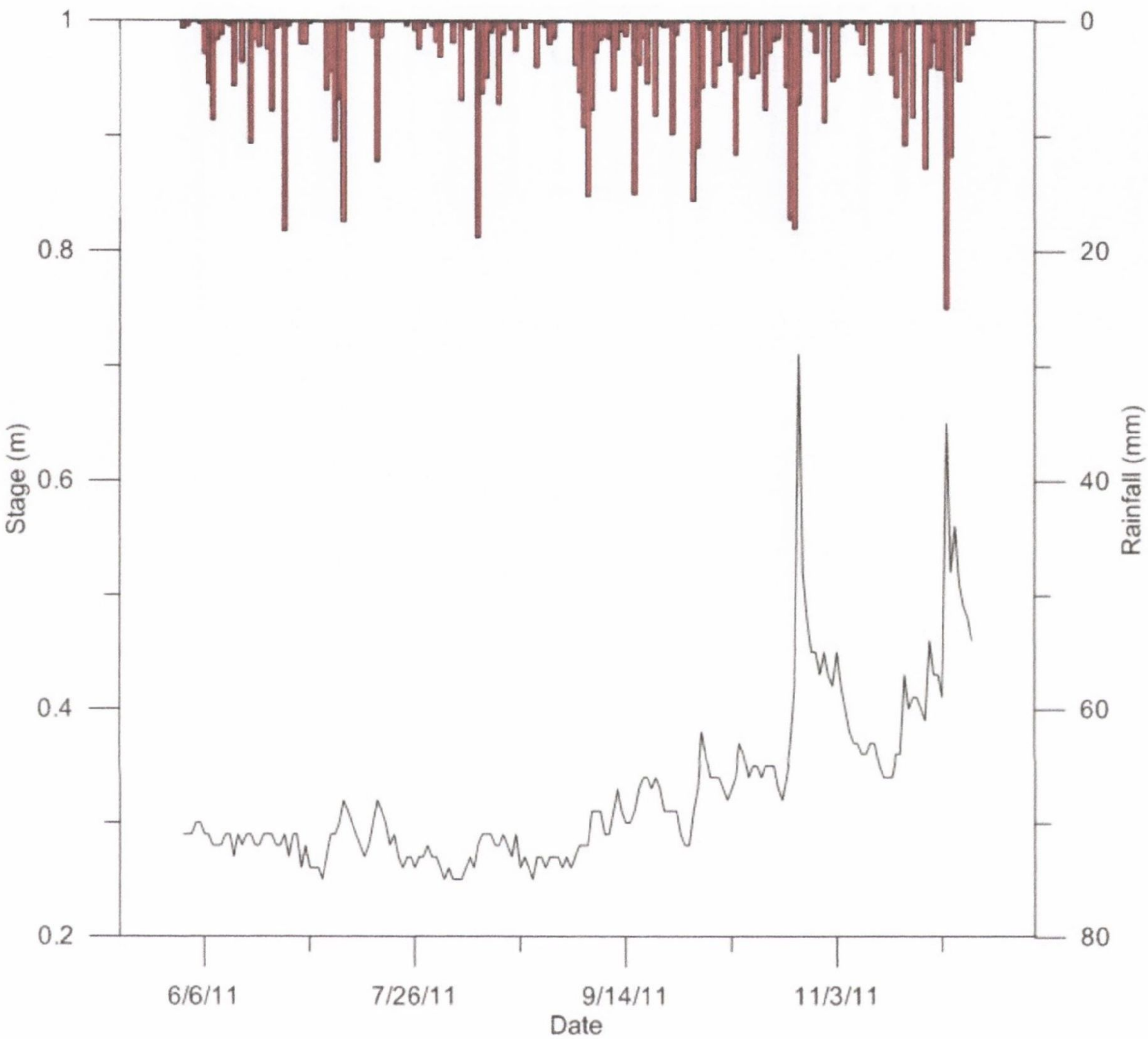


Figure B28. FB2 Flume – stage (m) between 01-06-11 and 05-01-11 (water balance period)

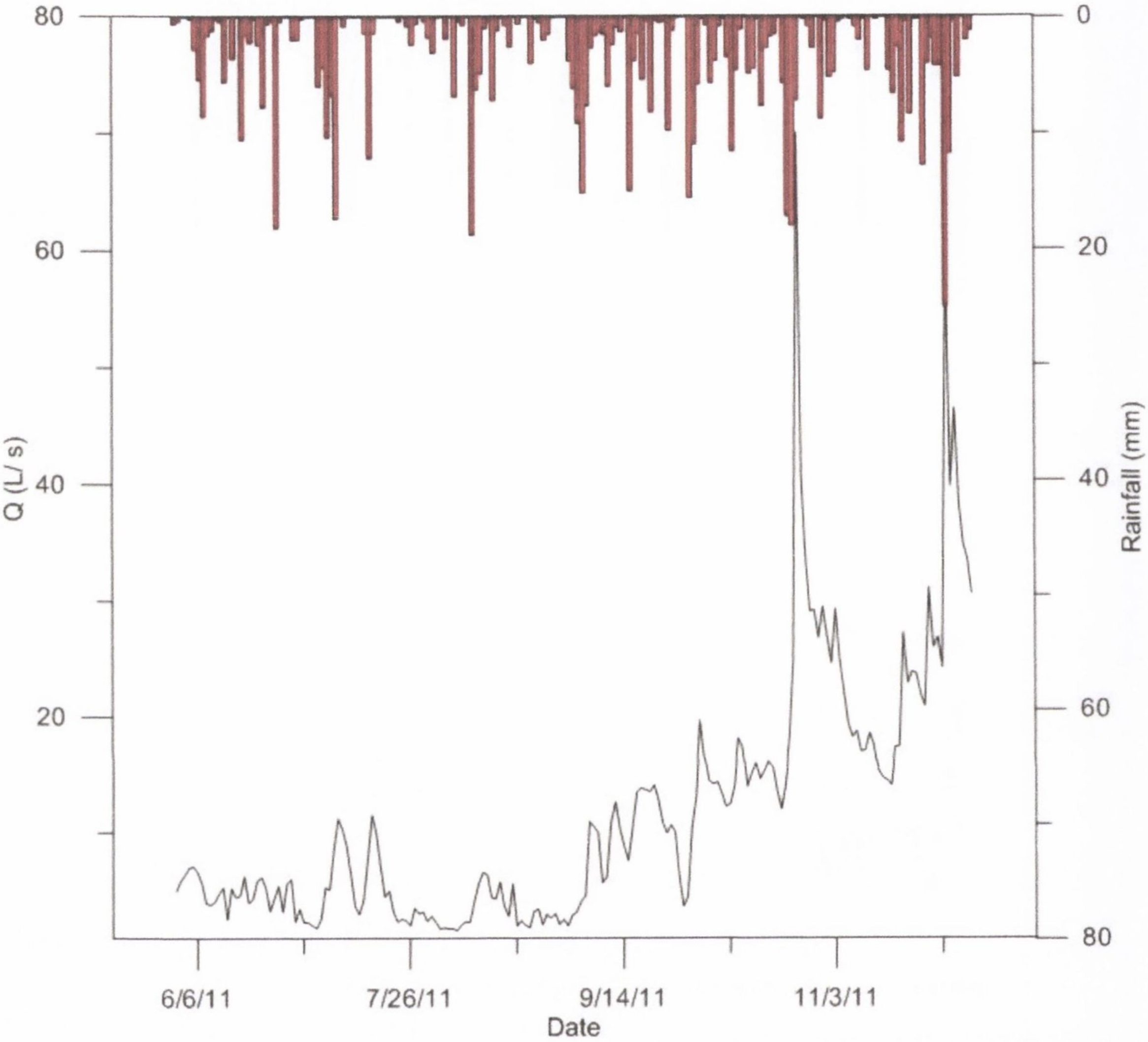


Figure B29. FB2 Flume – discharge (L/ s) between 01-06-11 and 05-01-11 (water balance period)

Appendix B. Hydrological Characterisation – Flume Design

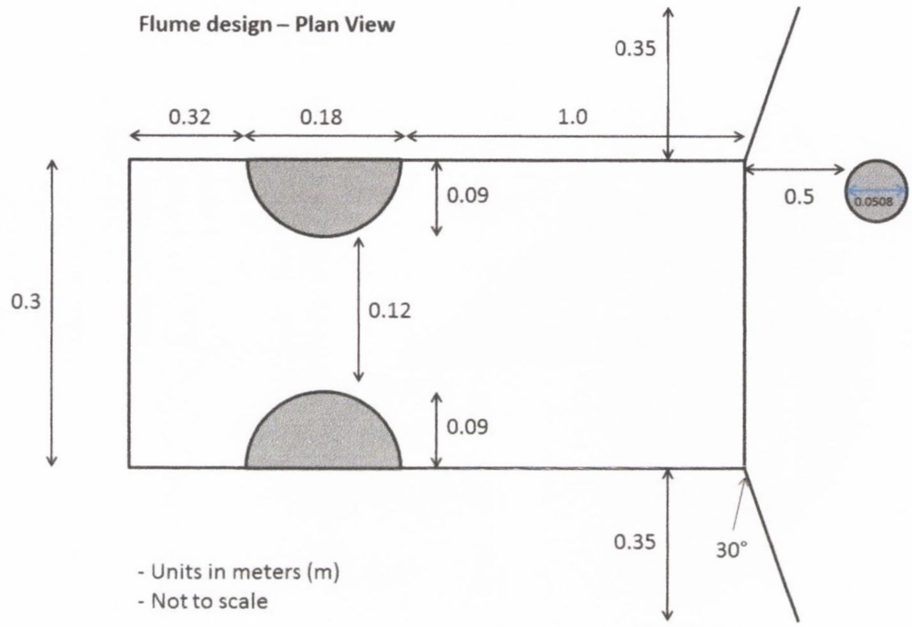


Figure B30. Plan view of flume design (not to scale)

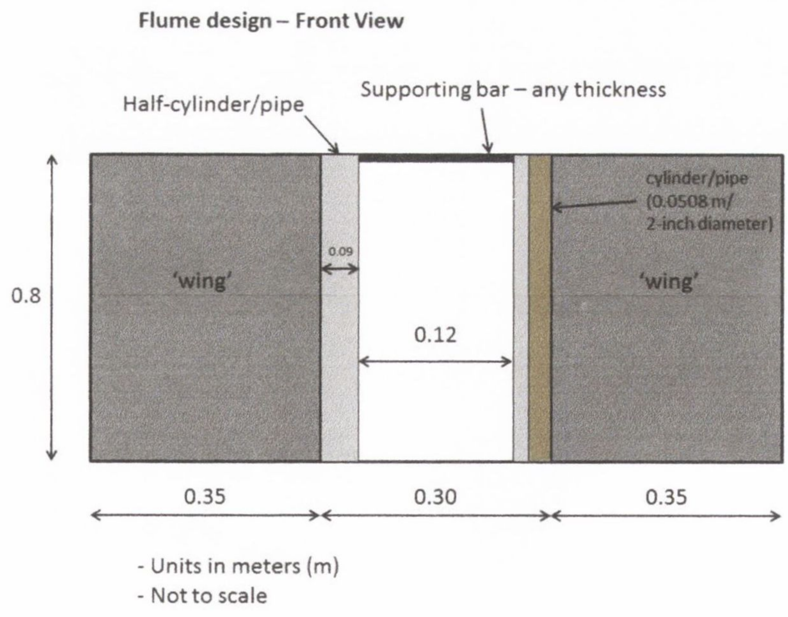


Figure B31. Profile view of flume design (not to scale)

Appendix B. Hydrological Characterisation: High bog drainage system

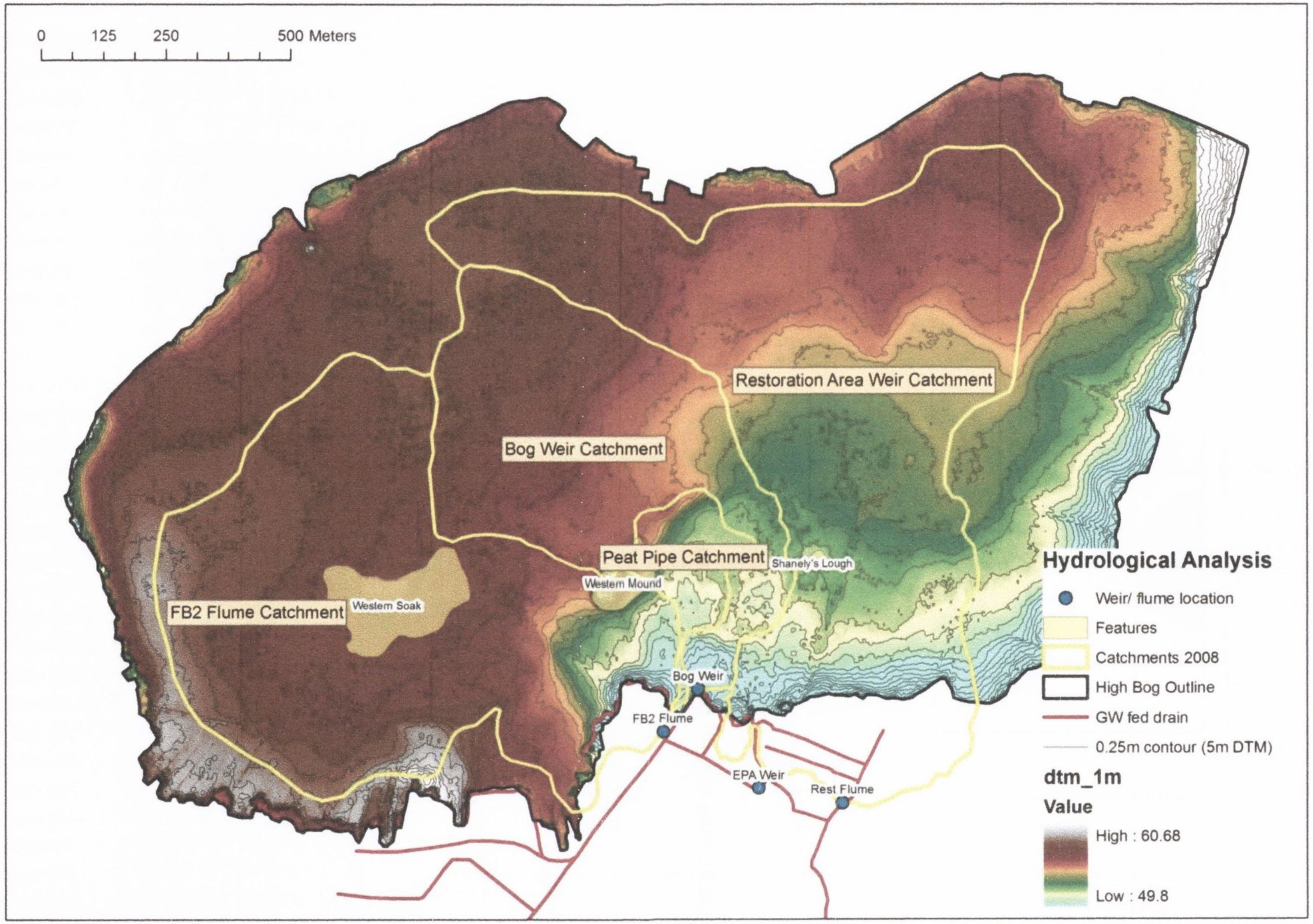


Figure B32. DTM of Clara West high bog and location of high bog catchment areas

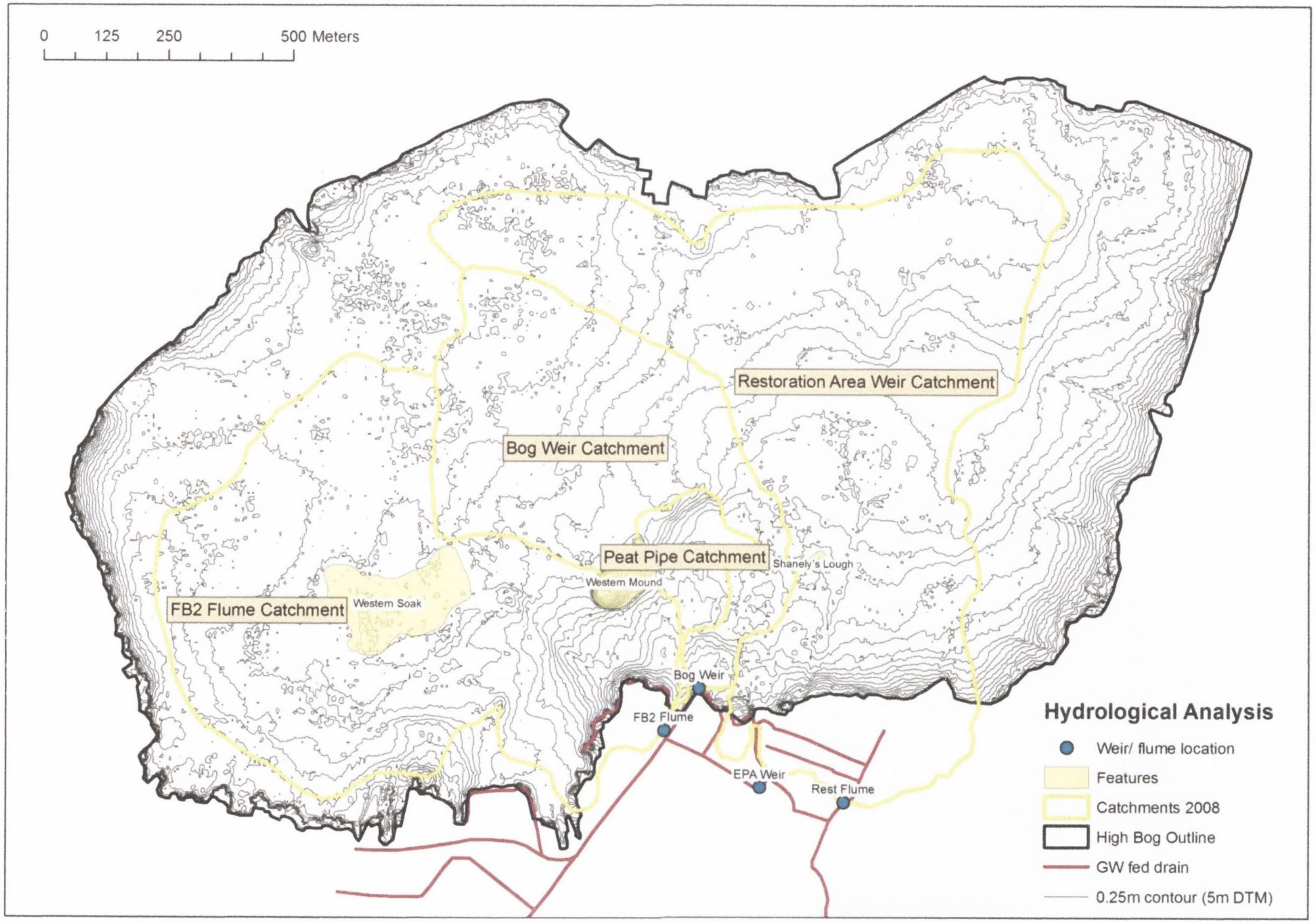


Figure B33. High bog catchment areas and high bog topography

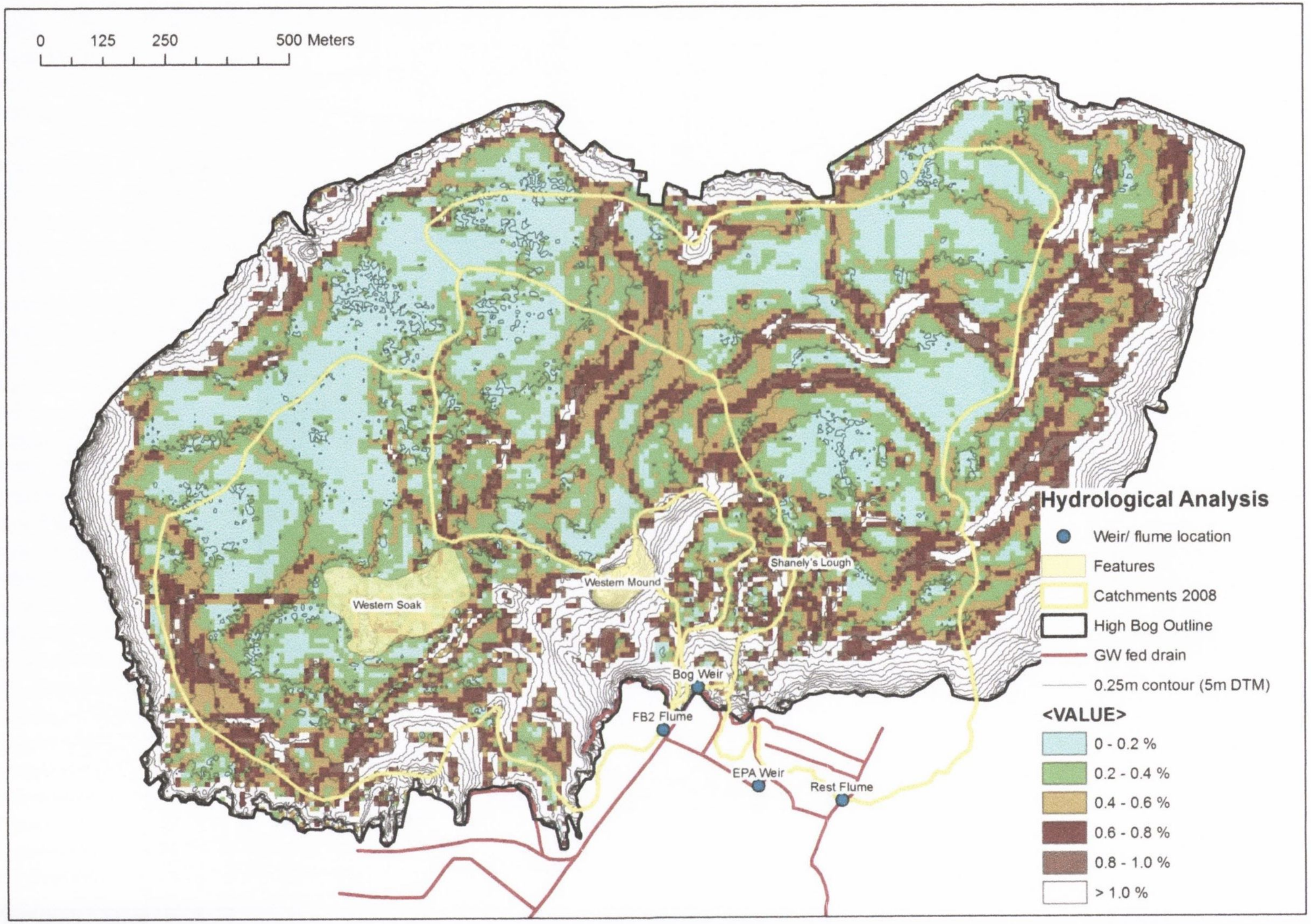


Figure B24. Slope gradients (%) on Clara West high bog

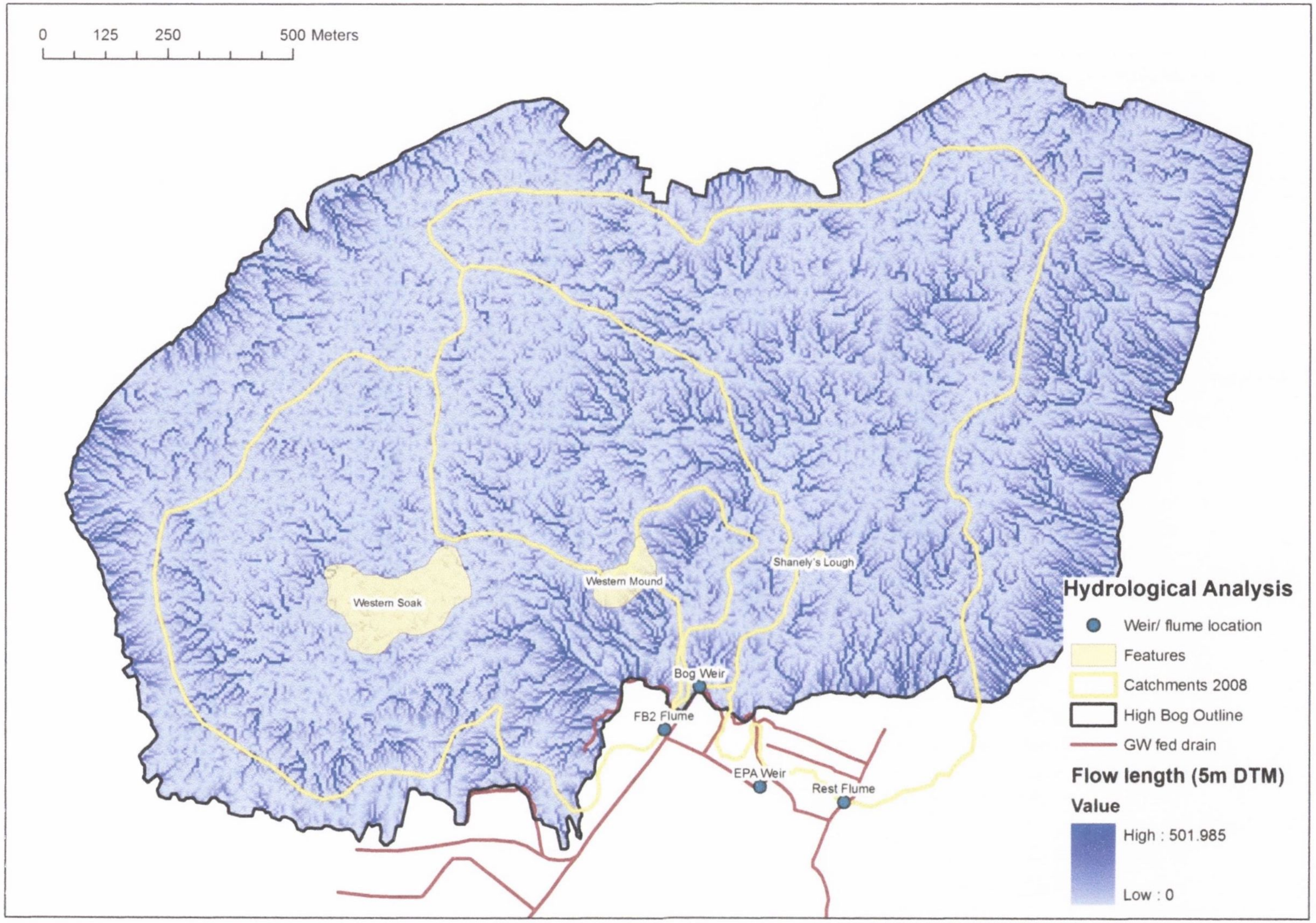


Figure B35. Flow path length distribution

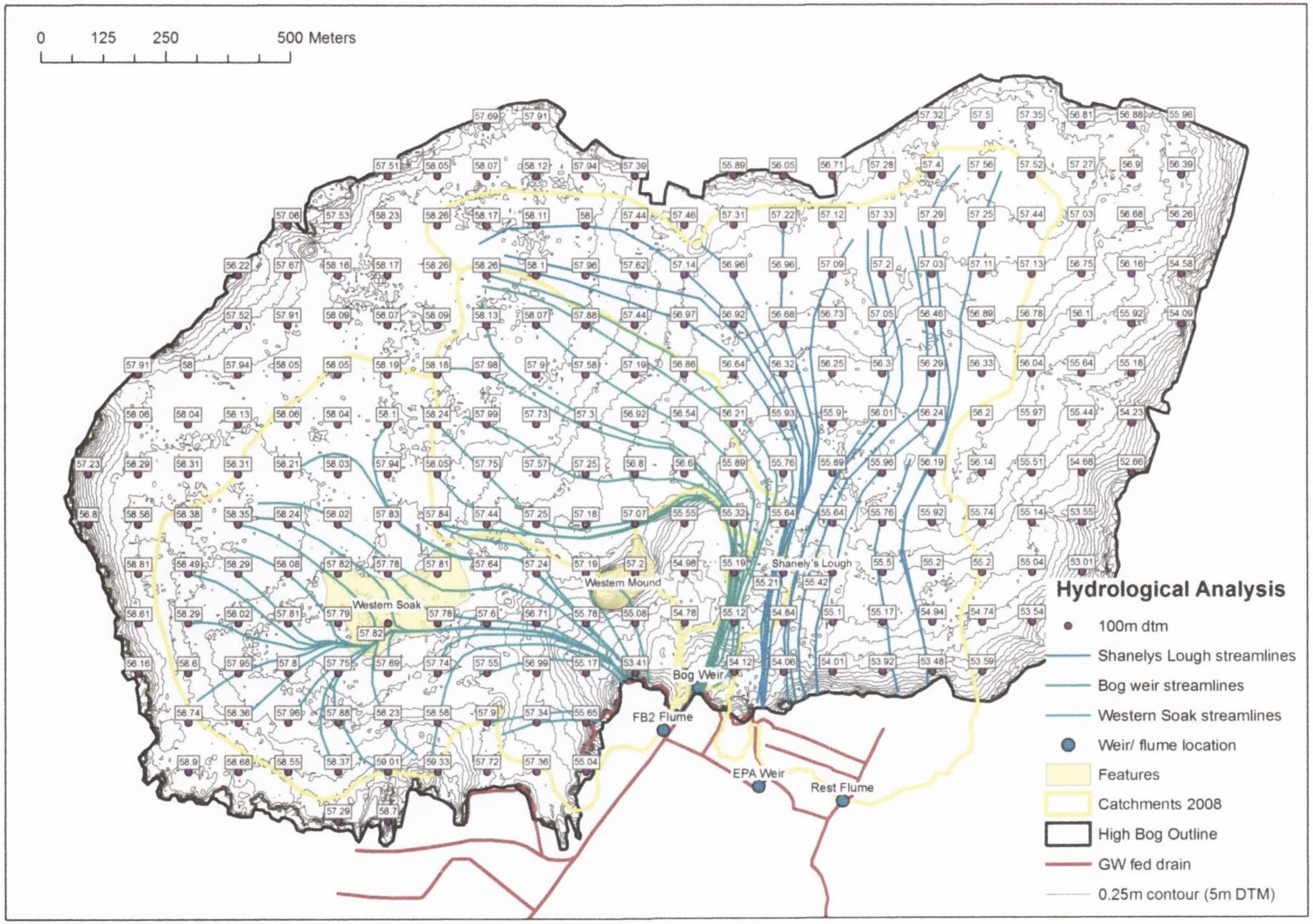


Figure B36. Flowlines and 100m DTM grid

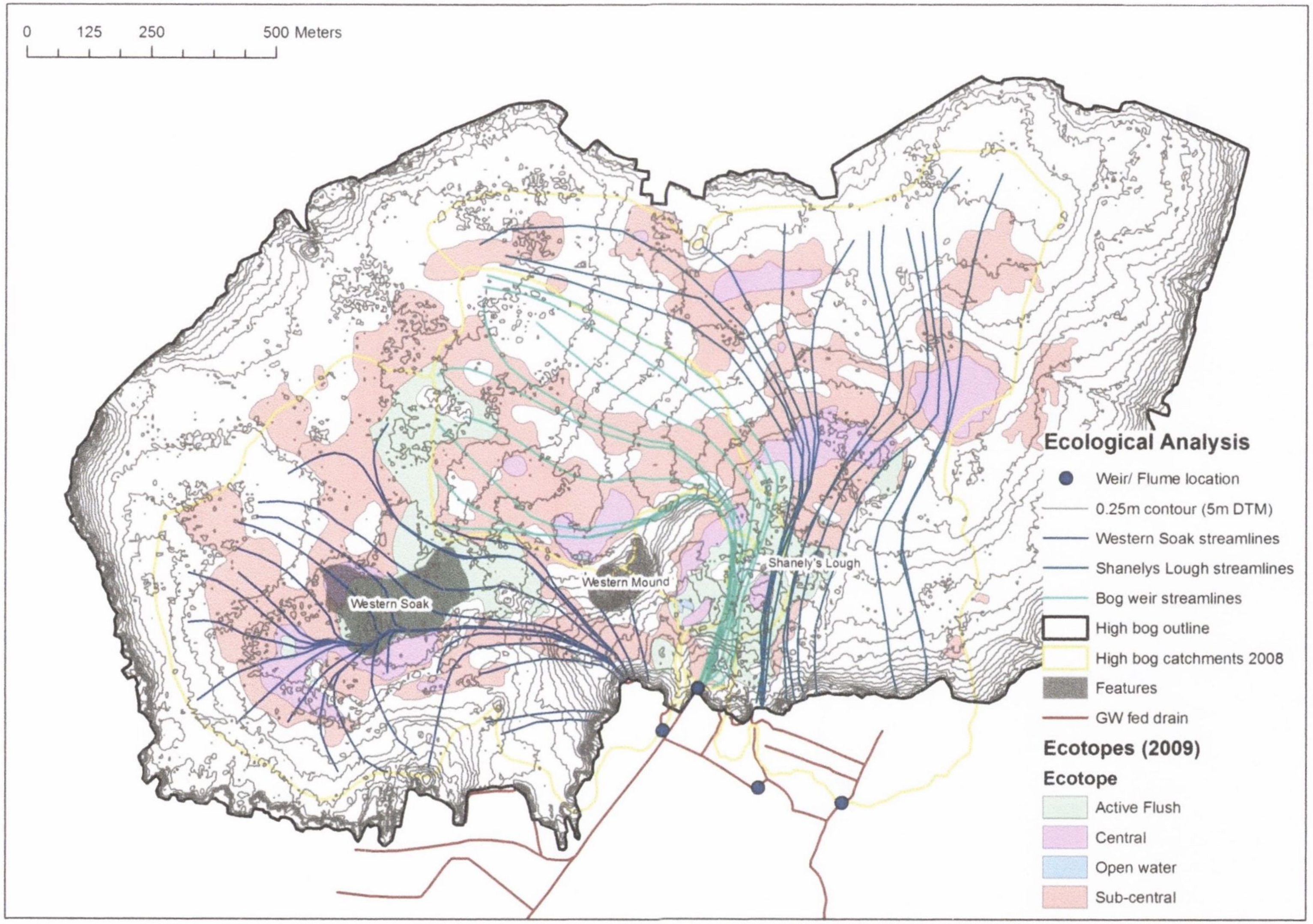


Figure B37. Flow path lengths in high bog catchment areas and distribution of 'wet' ecotopes

Appendix C

Hydrogeological Analysis

Appendix C: Hydrogeological Analysis: Borehole hydrographs

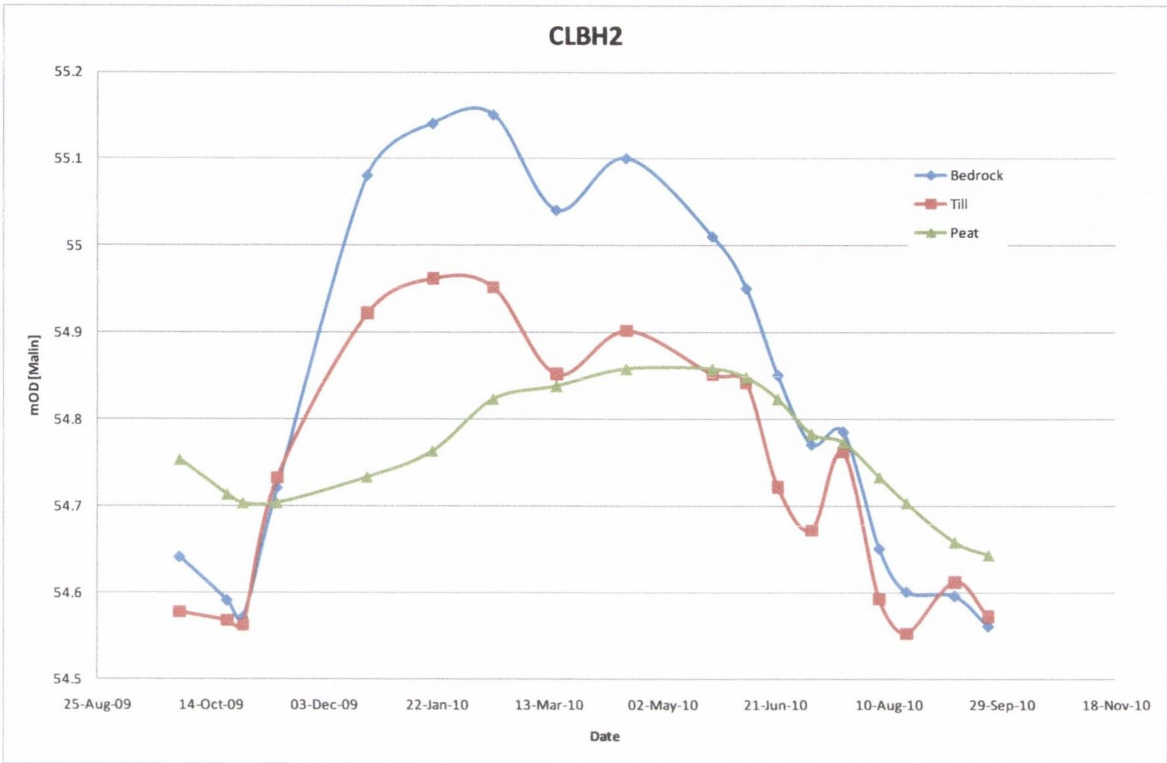


Figure C1. CLBH2 hydrograph from hydrological year 2009-2010

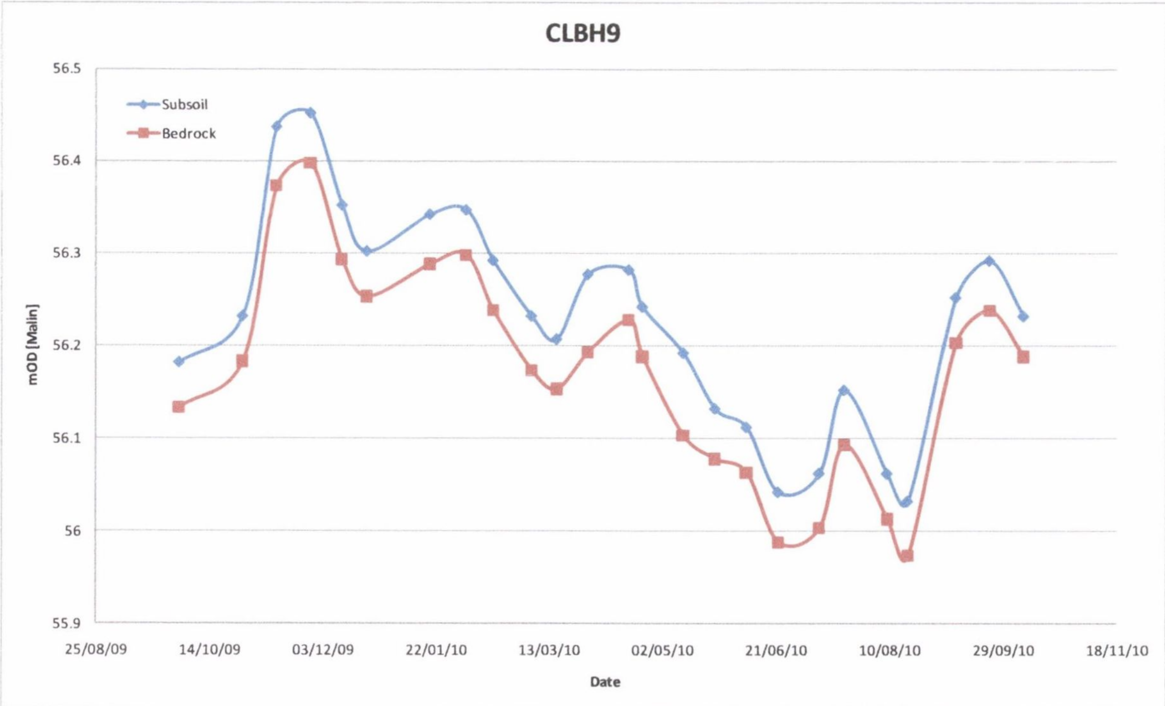


Figure C2. CLB92 hydrograph from hydrological year 2009-2010

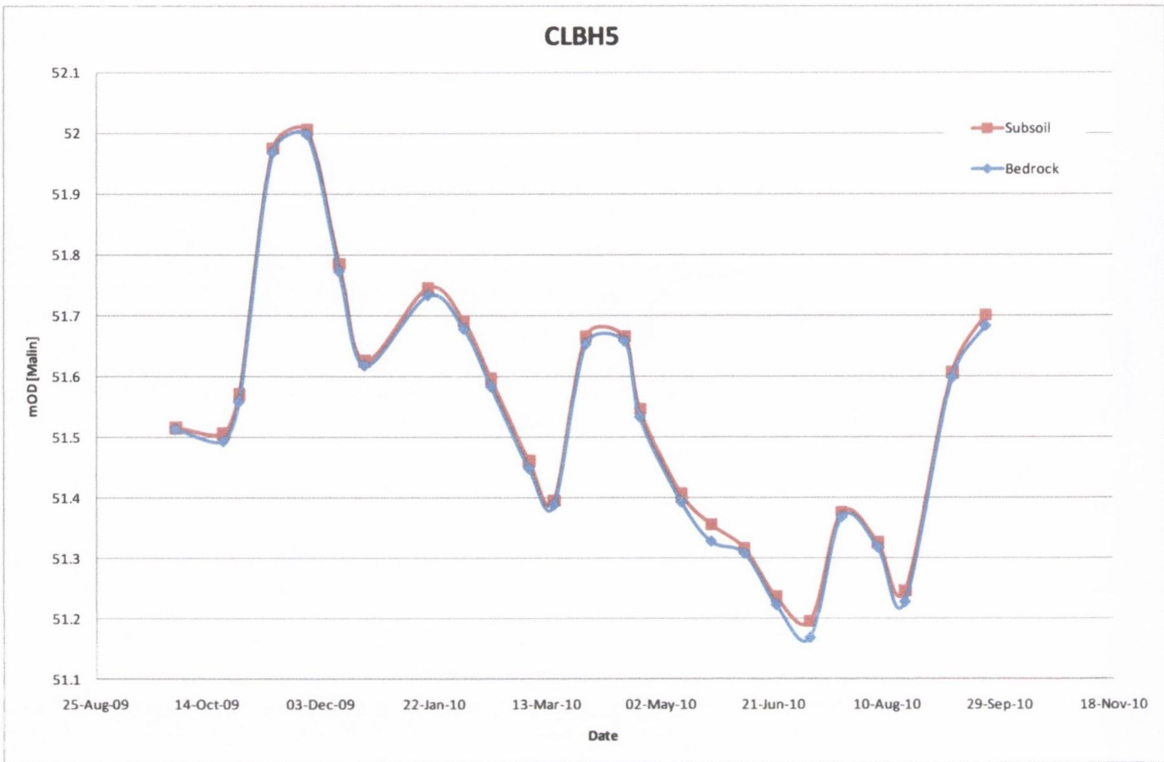


Figure C3. CLBH5 hydrograph from hydrological year 2009-2010

Appendix C: Hydrogeological Analysis: High bog hydrographs

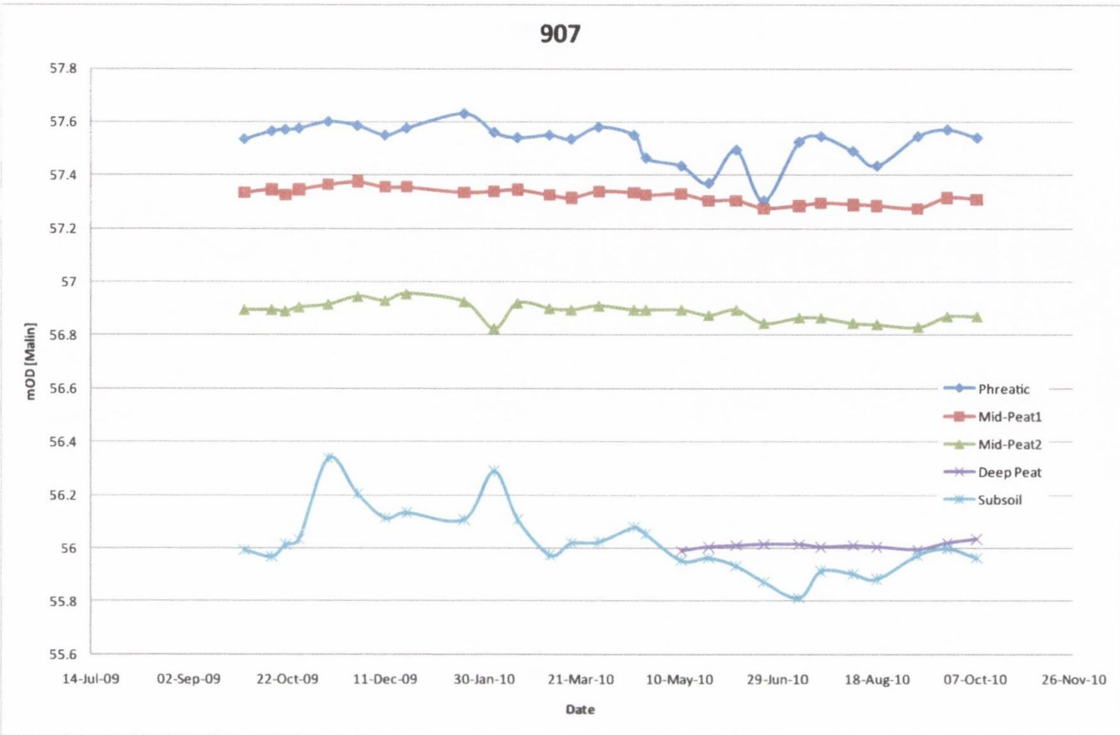


Figure C4. Hydrograph for high bog subsoil piezometer nest 907 for hydrological year 2009-2010

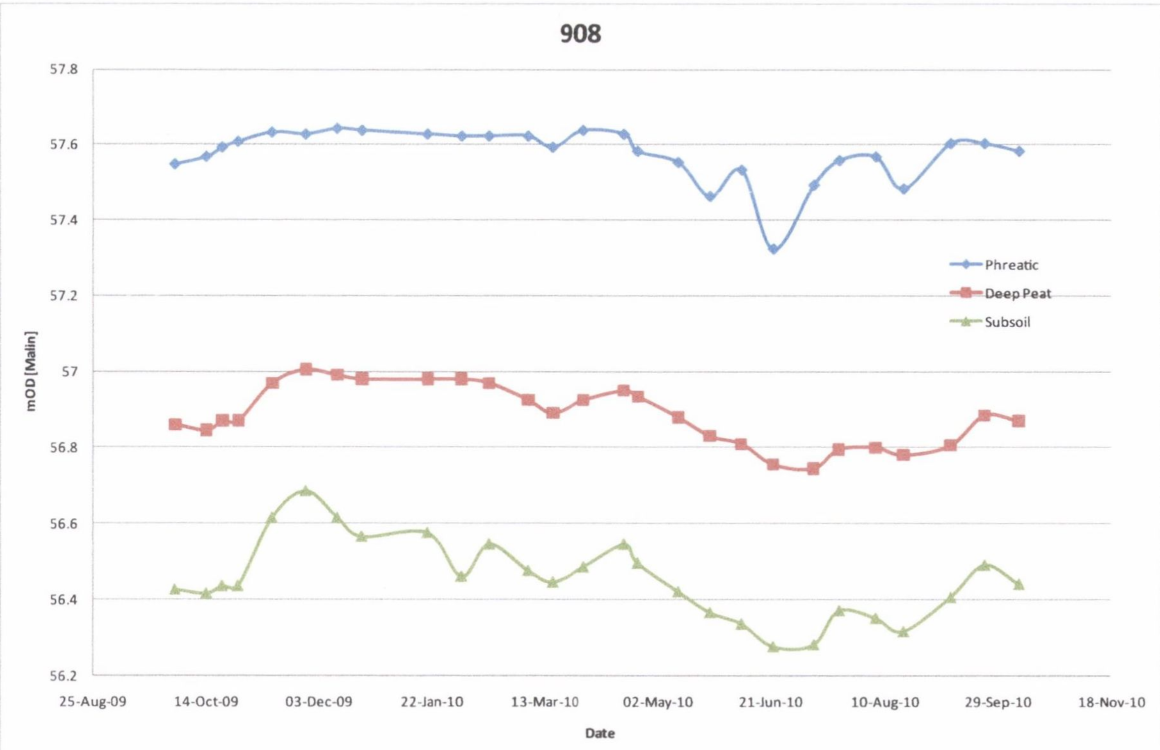


Figure C4. Hydrograph for high bog subsoil piezometer nest 908 for hydrological year 2009-2010

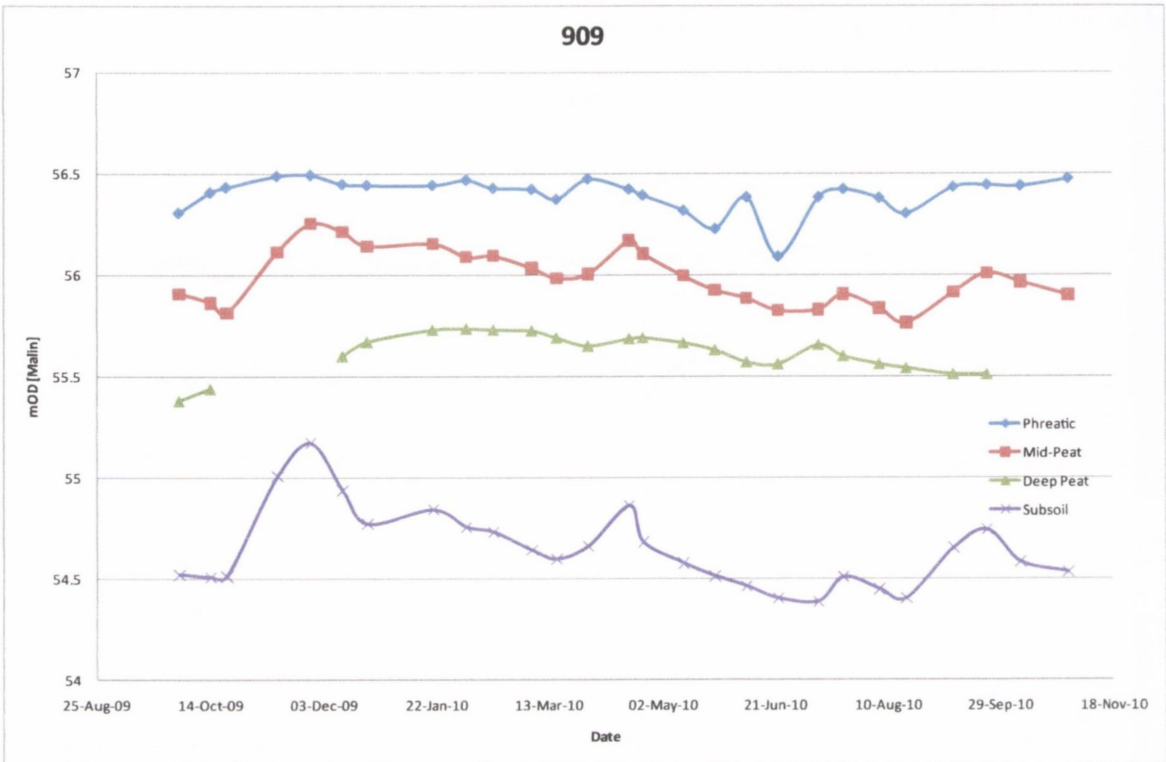


Figure C6. Hydrograph for high bog subsoil piezometer nest 909 for hydrological year 2009-2010

Figure C7. Hydrograph for high bog subsoil piezometer nest 910 for hydrological year 2009-2010

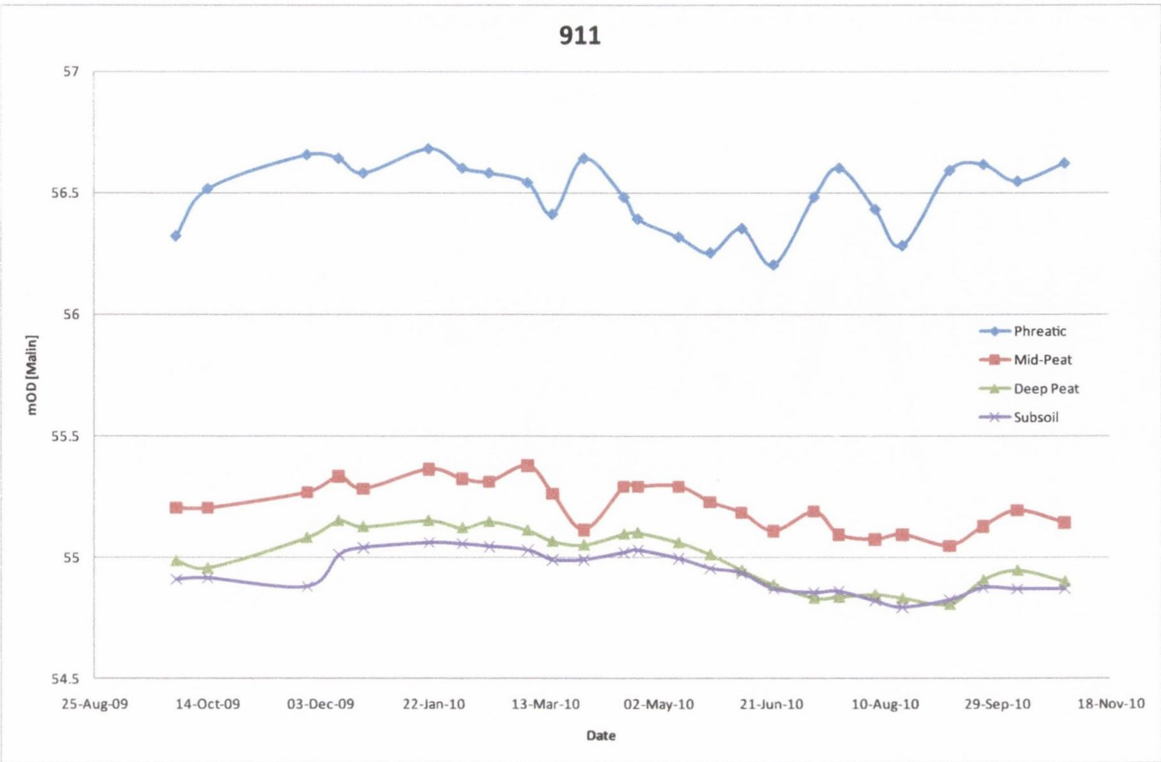


Figure C8. Hydrograph for high bog subsoil piezometer nest 911 for hydrological year 2009-2010

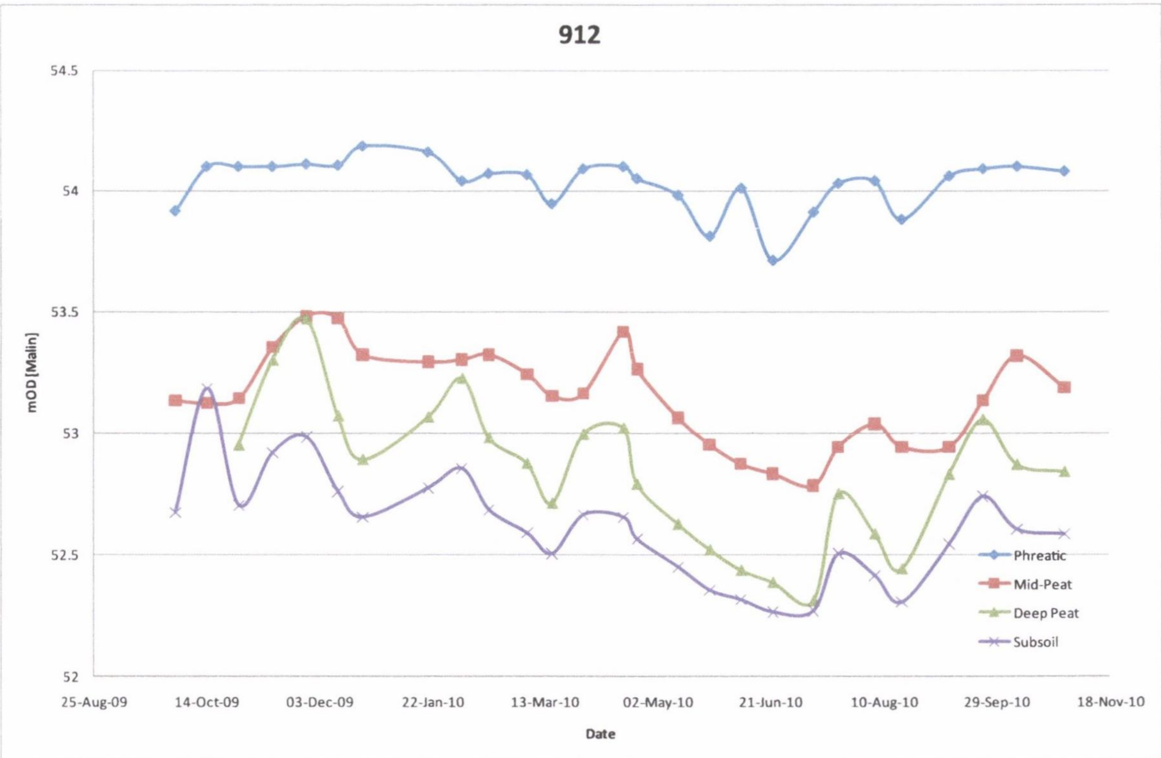


Figure C9. Hydrograph for high bog subsoil piezometer nest 912 for hydrological year 2009-2010

Appendix C: Hydrogeological Analysis: Cutover bog hydrographs

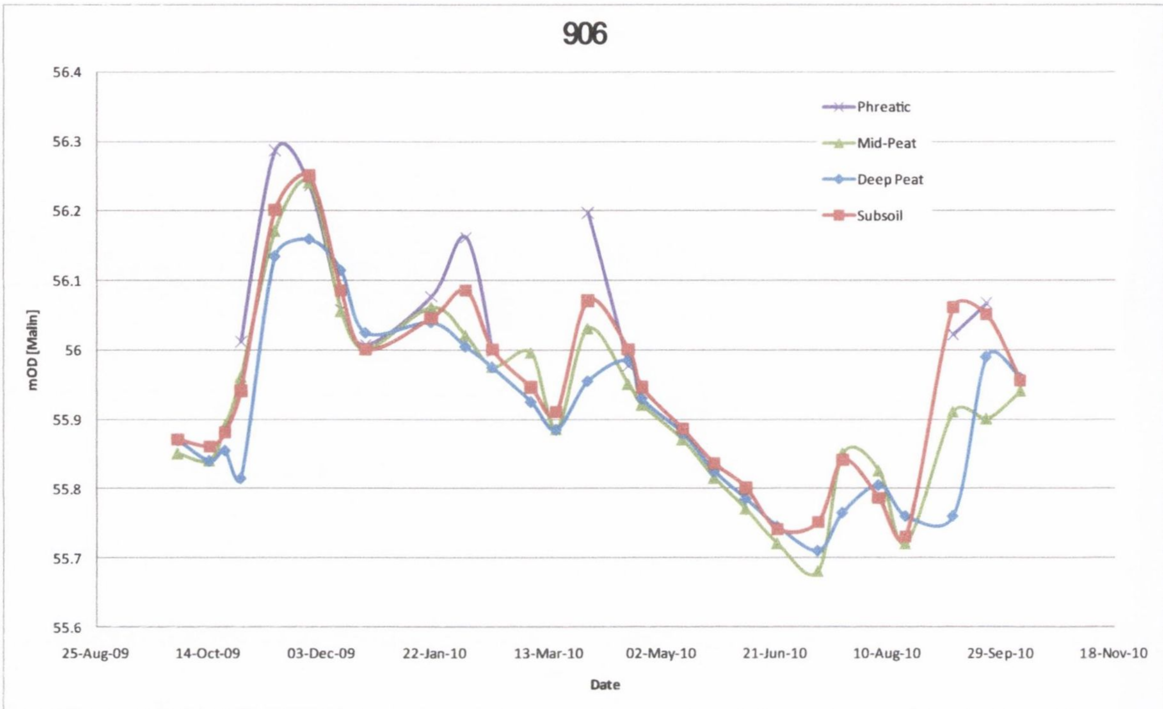


Figure C10. Hydrograph for high bog subsoil piezometer nest 906 from hydrological year 2009-2010

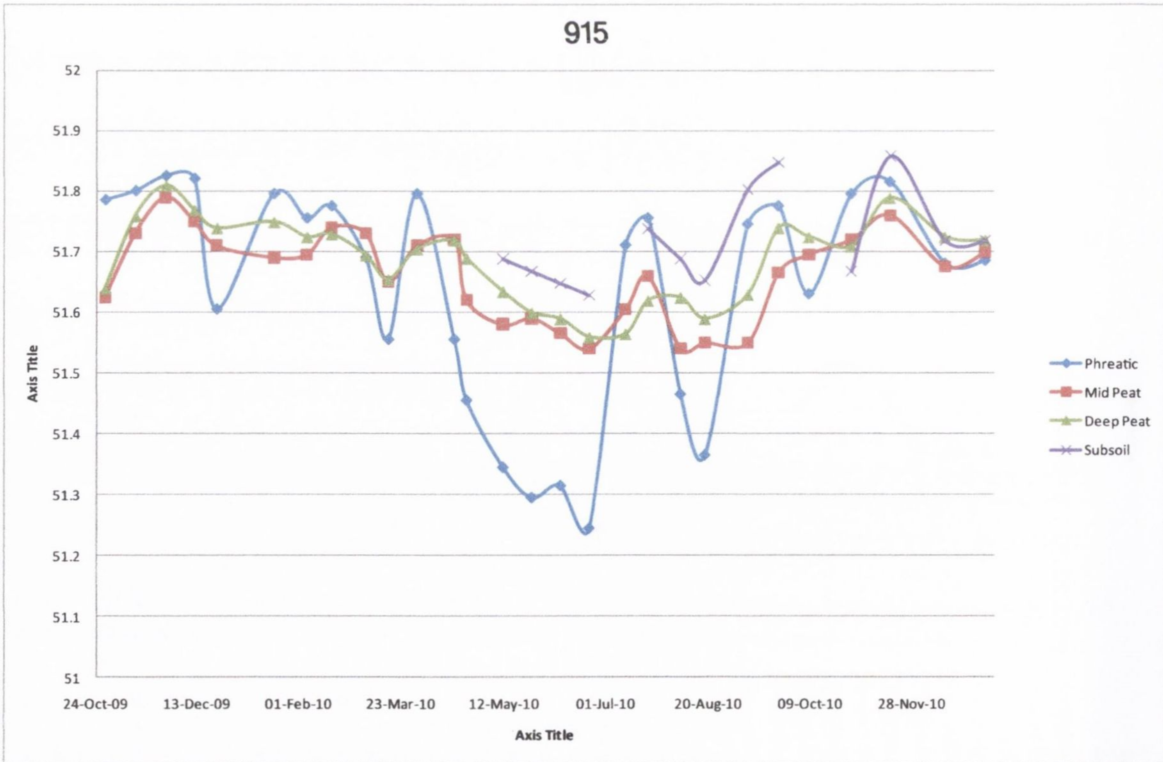


Figure C11. Hydrograph for high bog subsoil piezometer nest 915 from October 2010 to January 2011

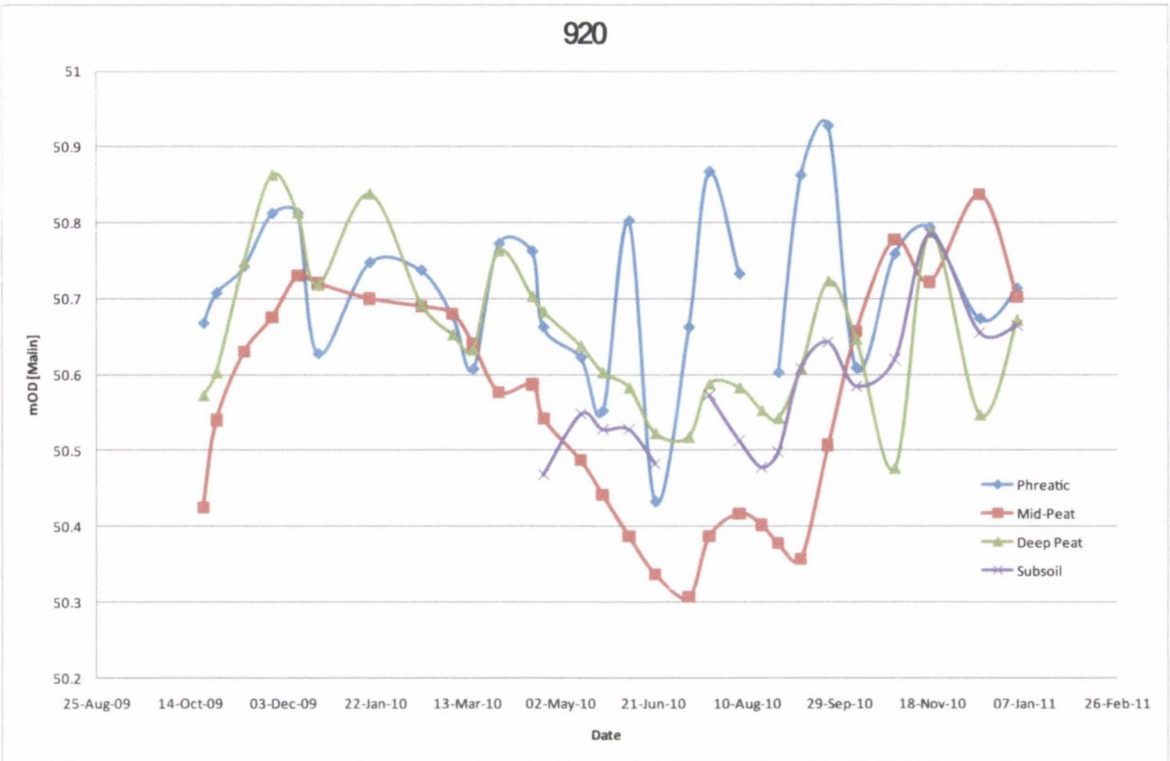


Figure C12. Hydrograph for high bog subsoil piezometer nest 920 from October 2010 to January 2011

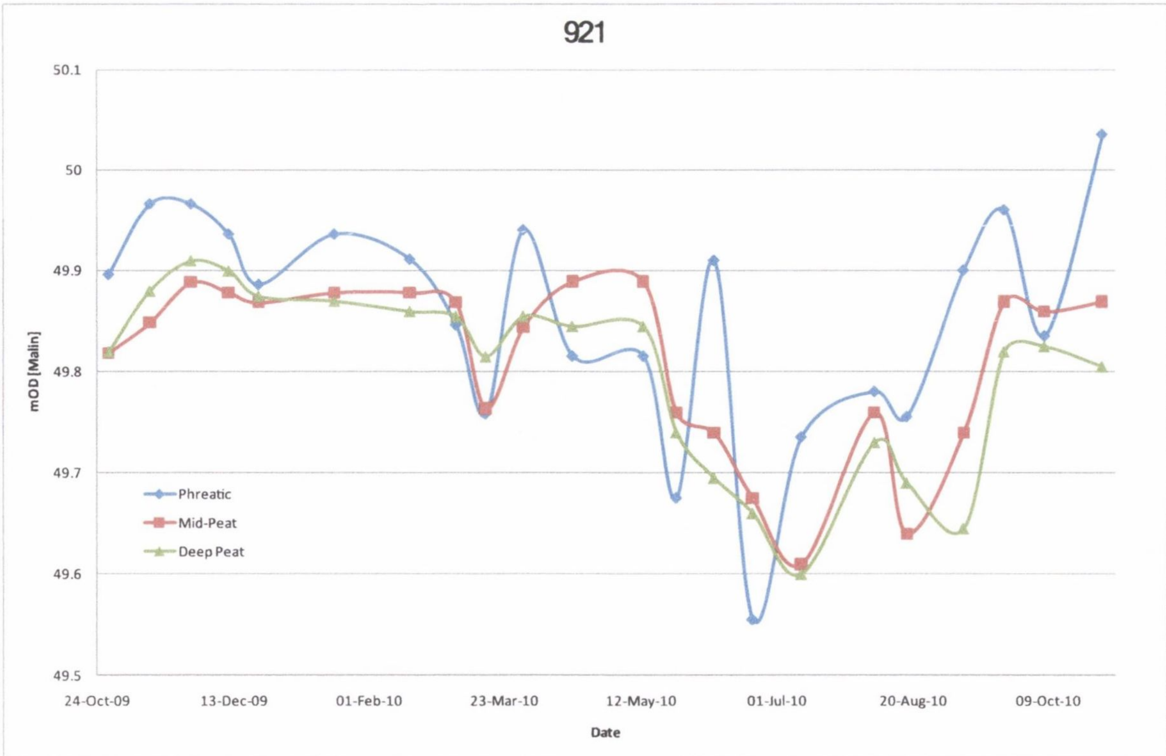


Figure C13. Hydrograph for high bog subsoil piezometer nest 921from hydrological year 2009-2010

Appendix C. Hydrogeological Analysis: Potentiometric Surface Contour Maps

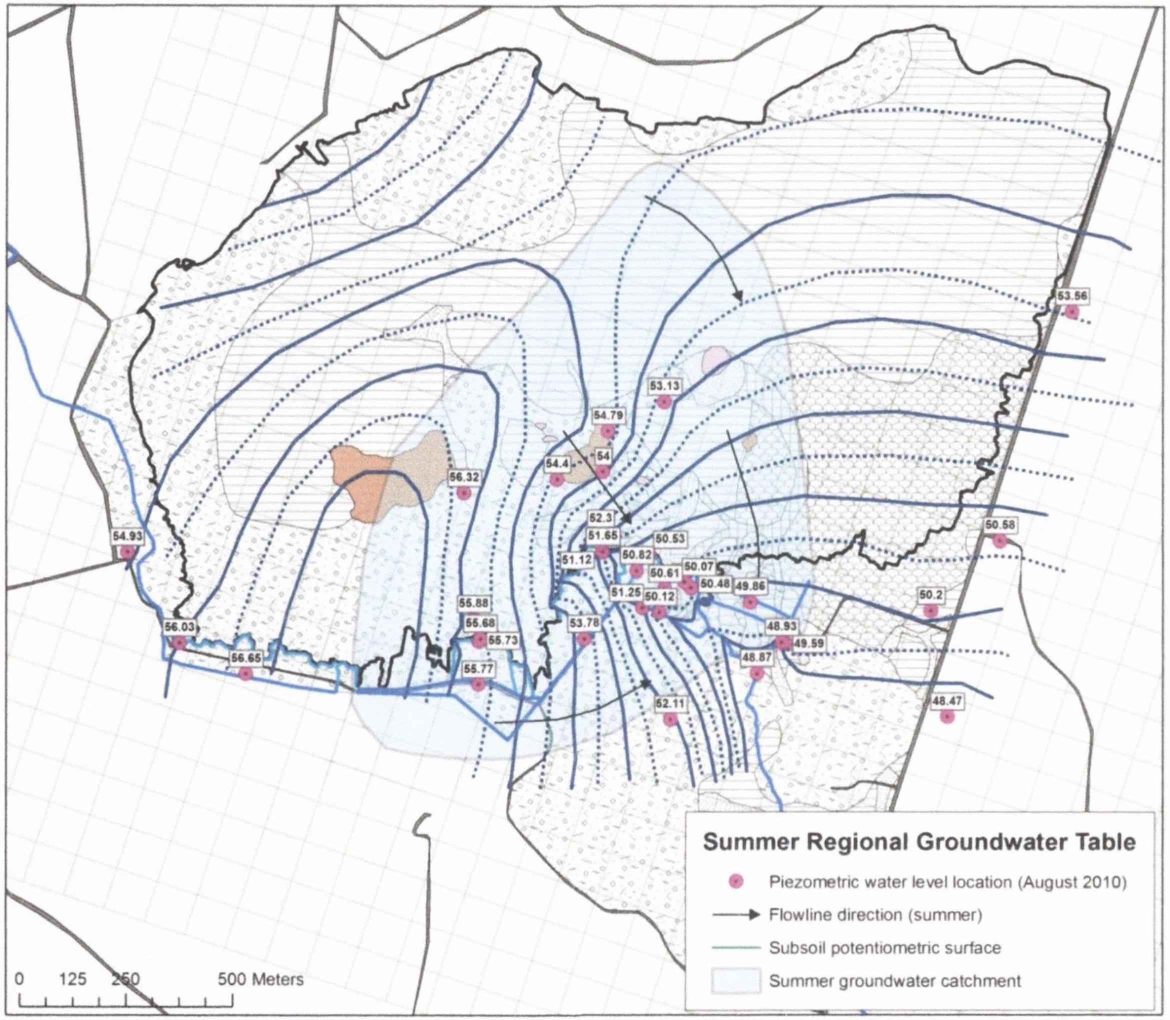


Figure C14. August 2010 potentiometric surface contour map – till groundwater body

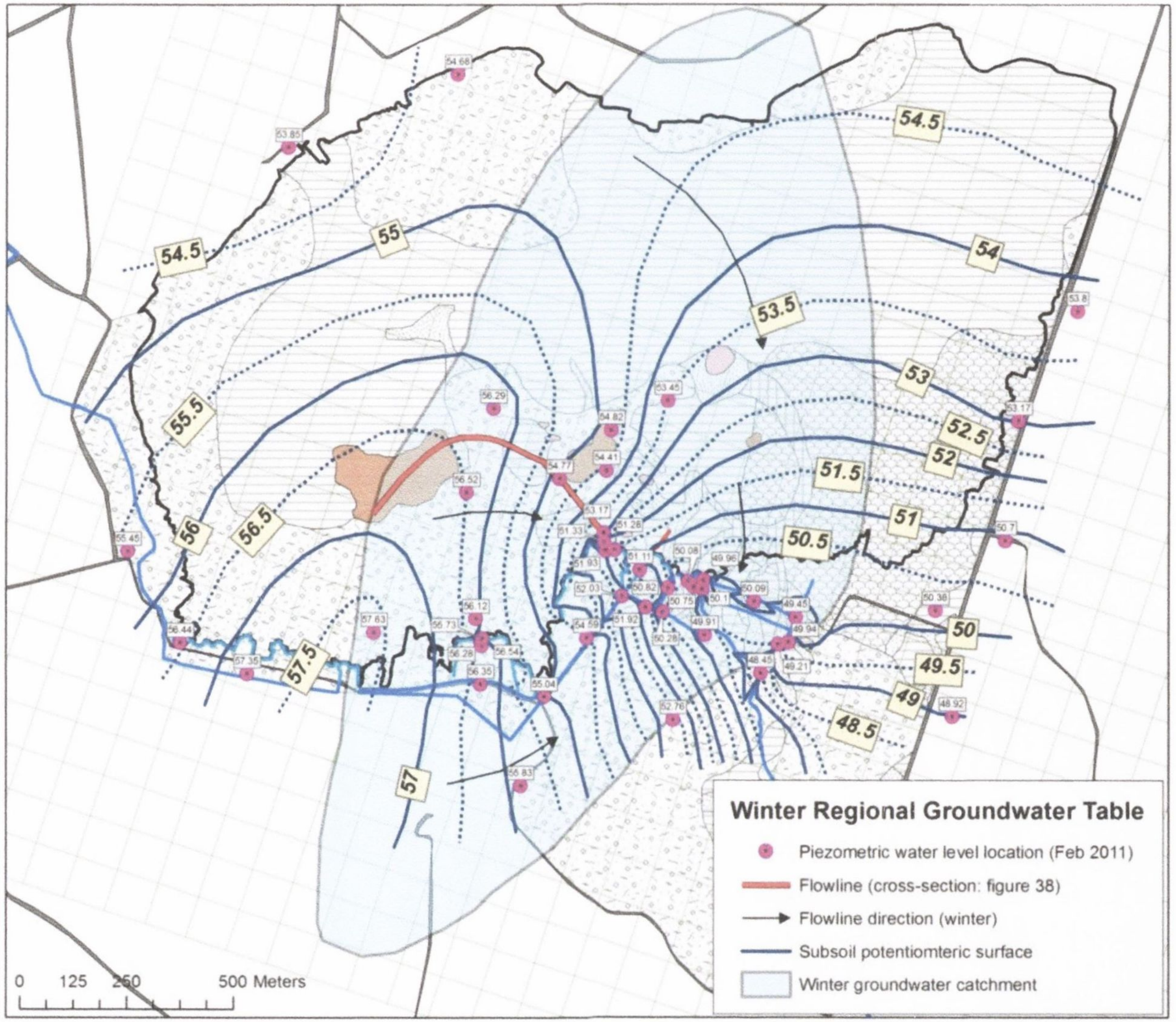


Figure C15. January 2011 potentiometric surface contour map – till groundwater body

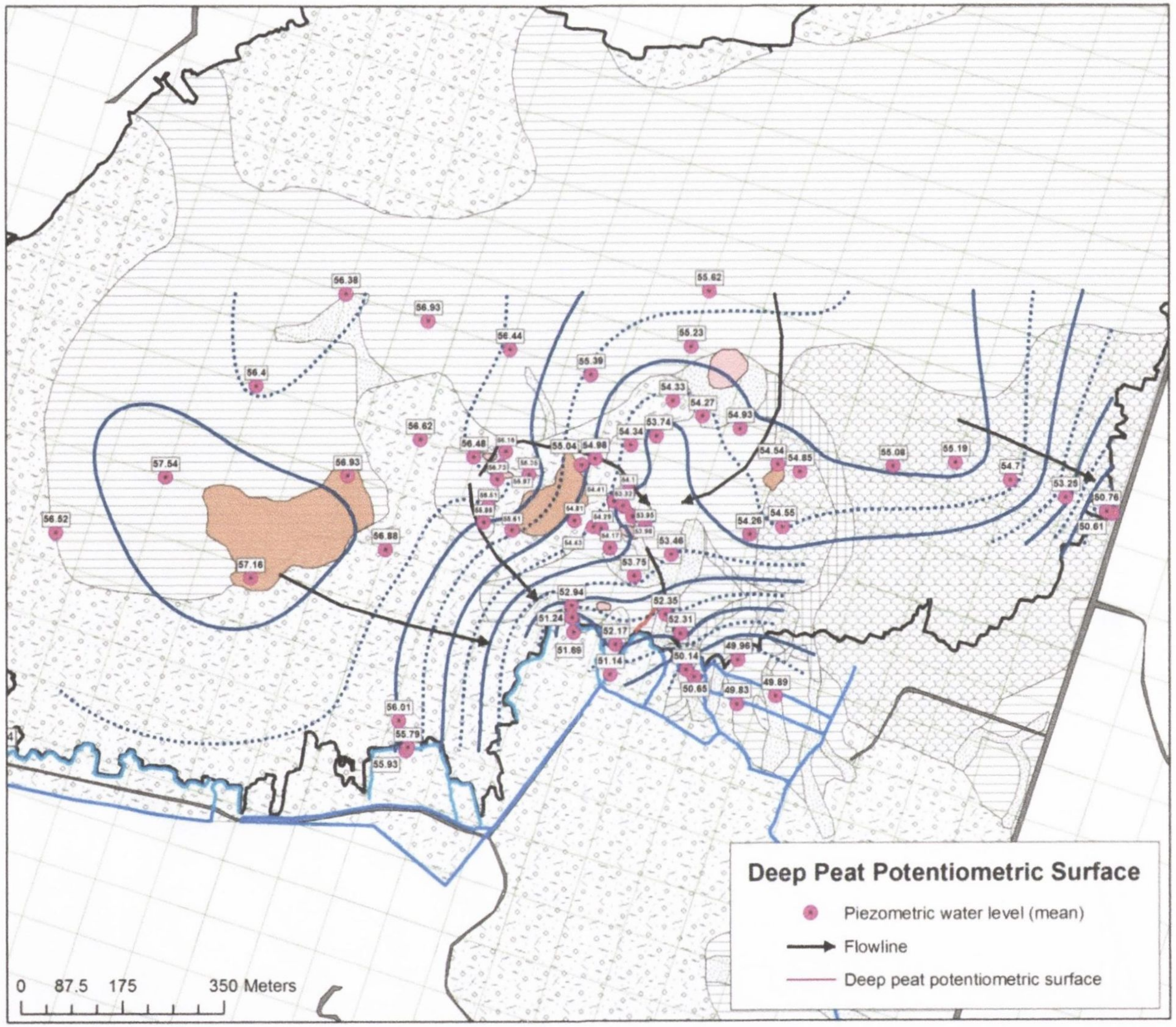


Figure C16. Mean deep peat potentiometric surface contour map

Hydrogeological Cross Section through Transect 1
August 2011

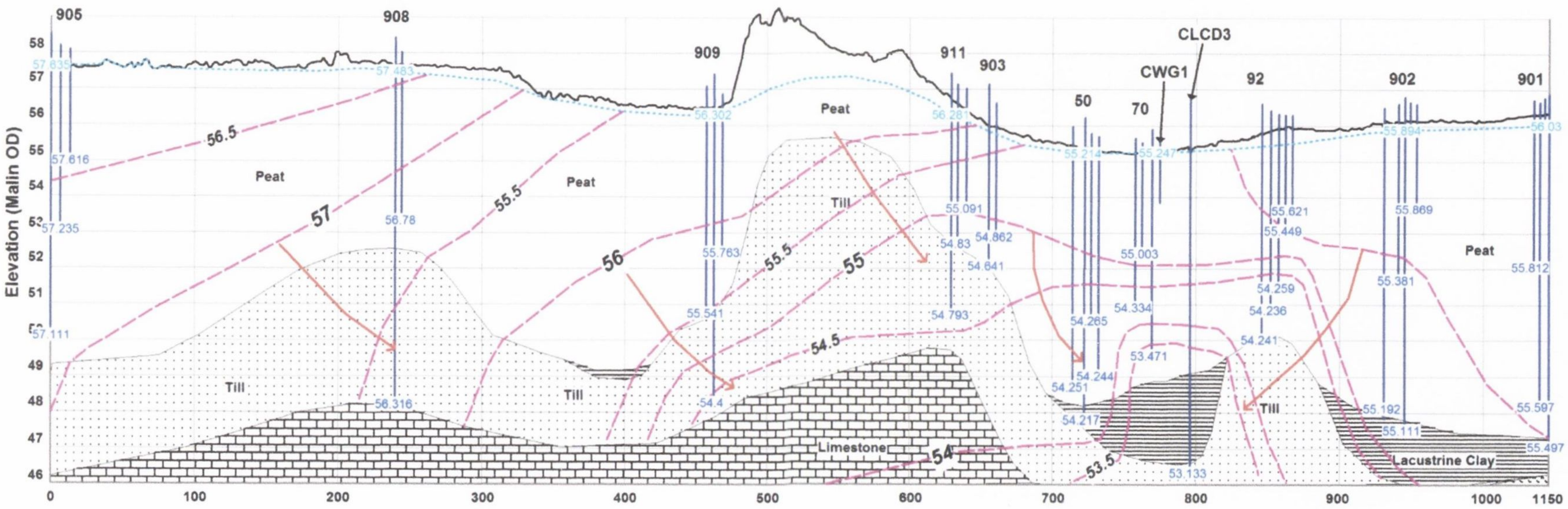


Figure C17. Hydrogeological cross-section through monitoring Transect 1

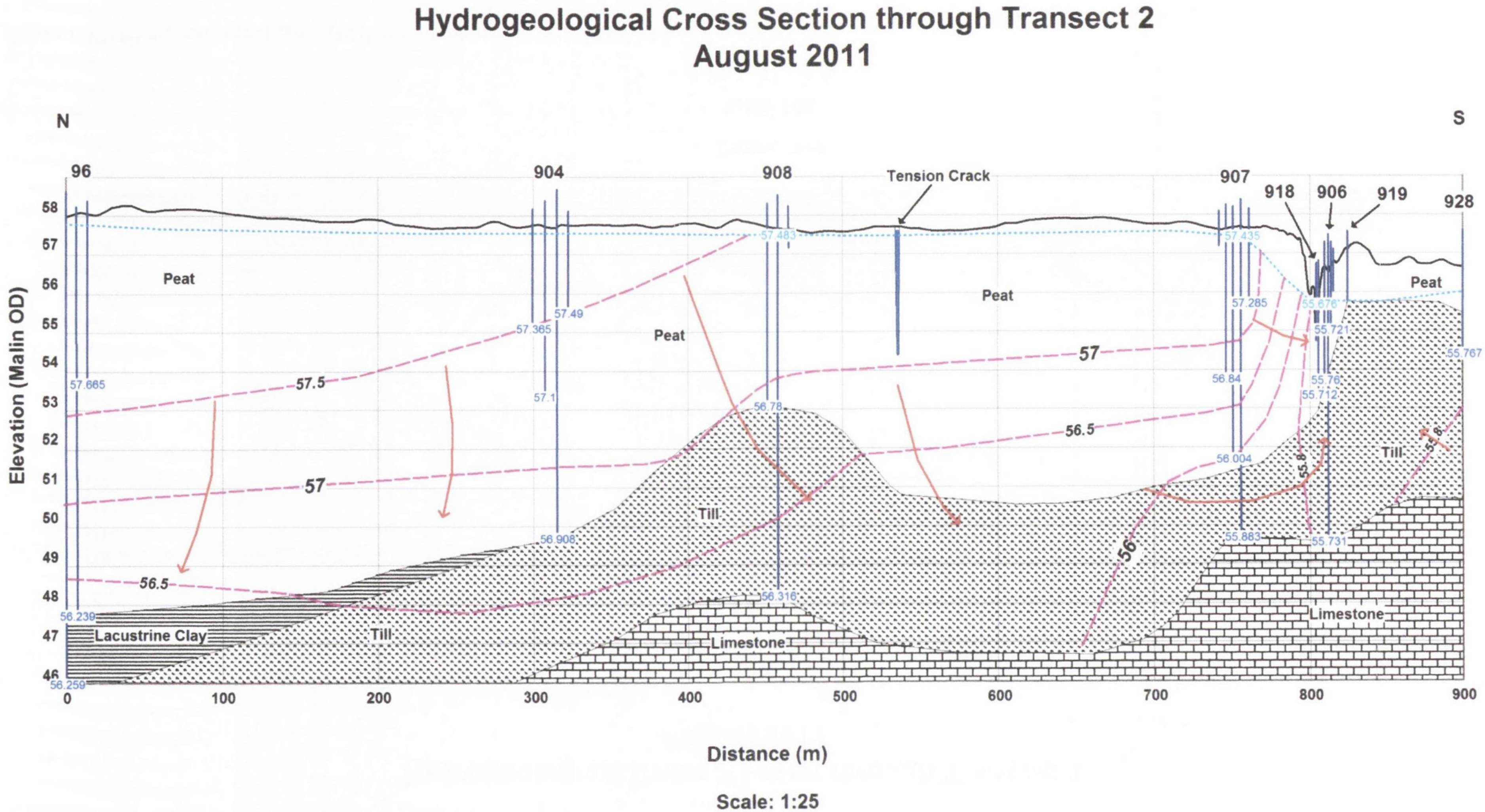


Figure C18. Hydrogeological cross-section through monitoring Transect 2

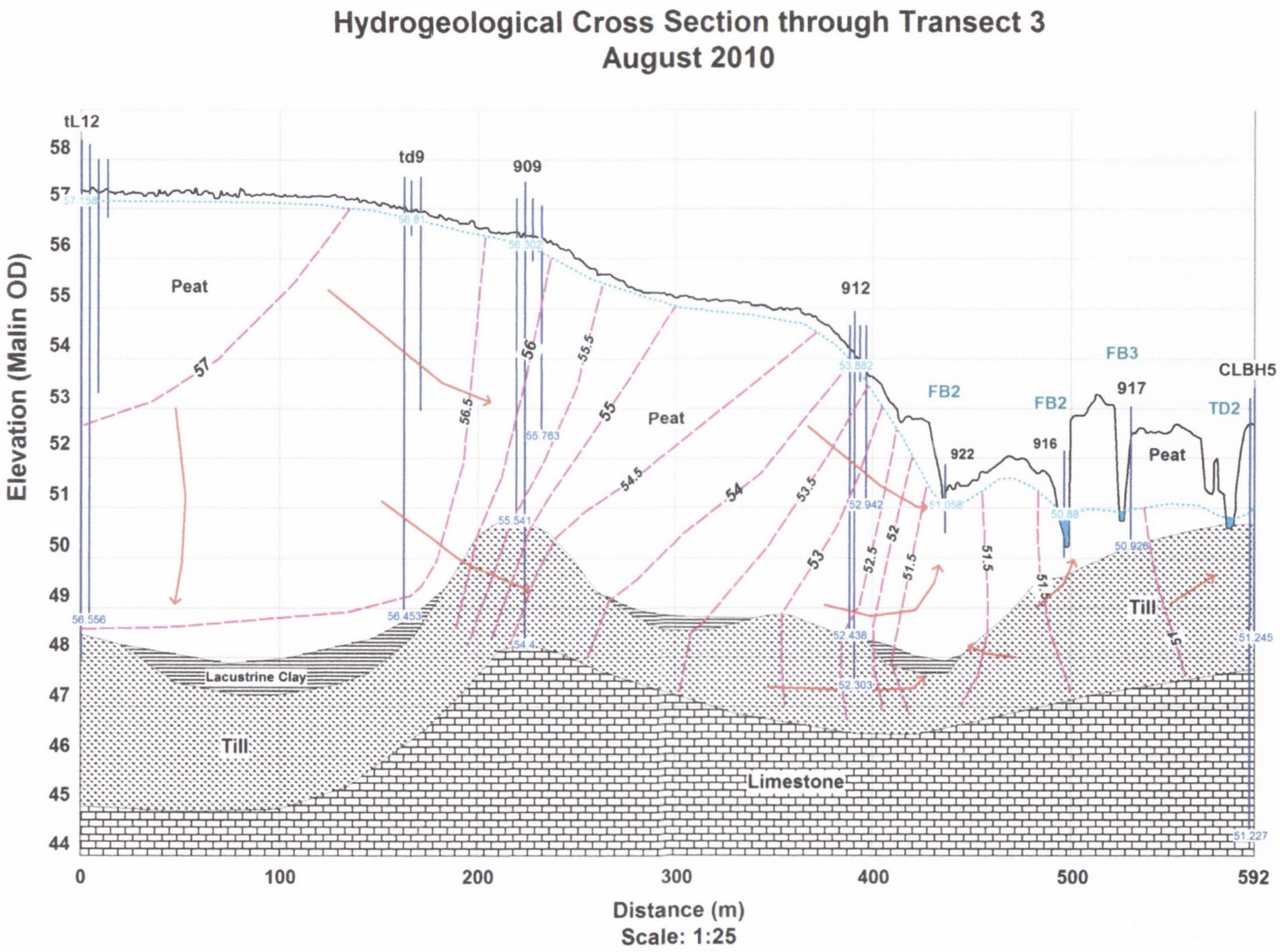


Figure C19. Hydrogeological cross-section through monitoring Transect 3

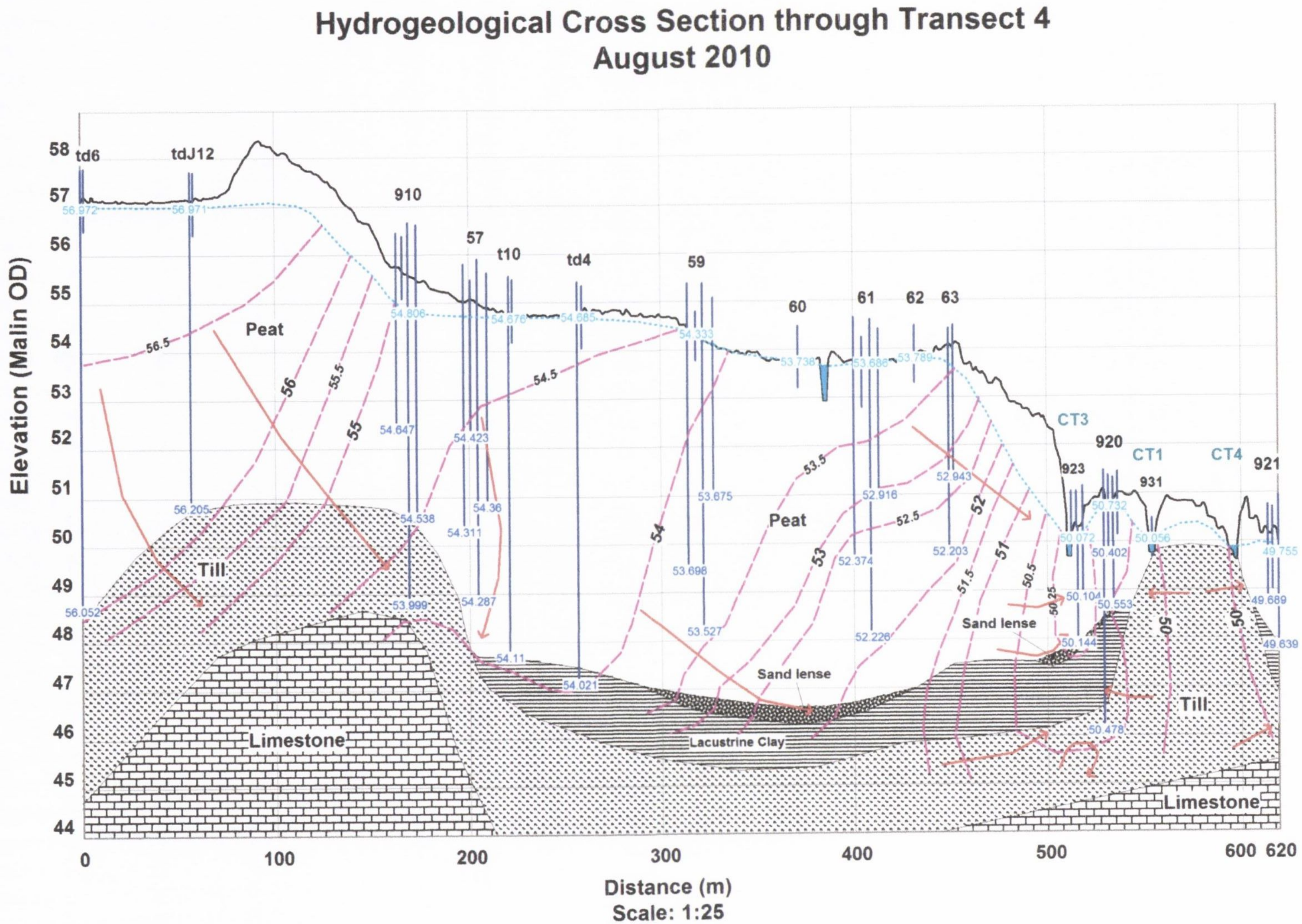


Figure C20. Hydrogeological cross-section through monitoring Transect 4

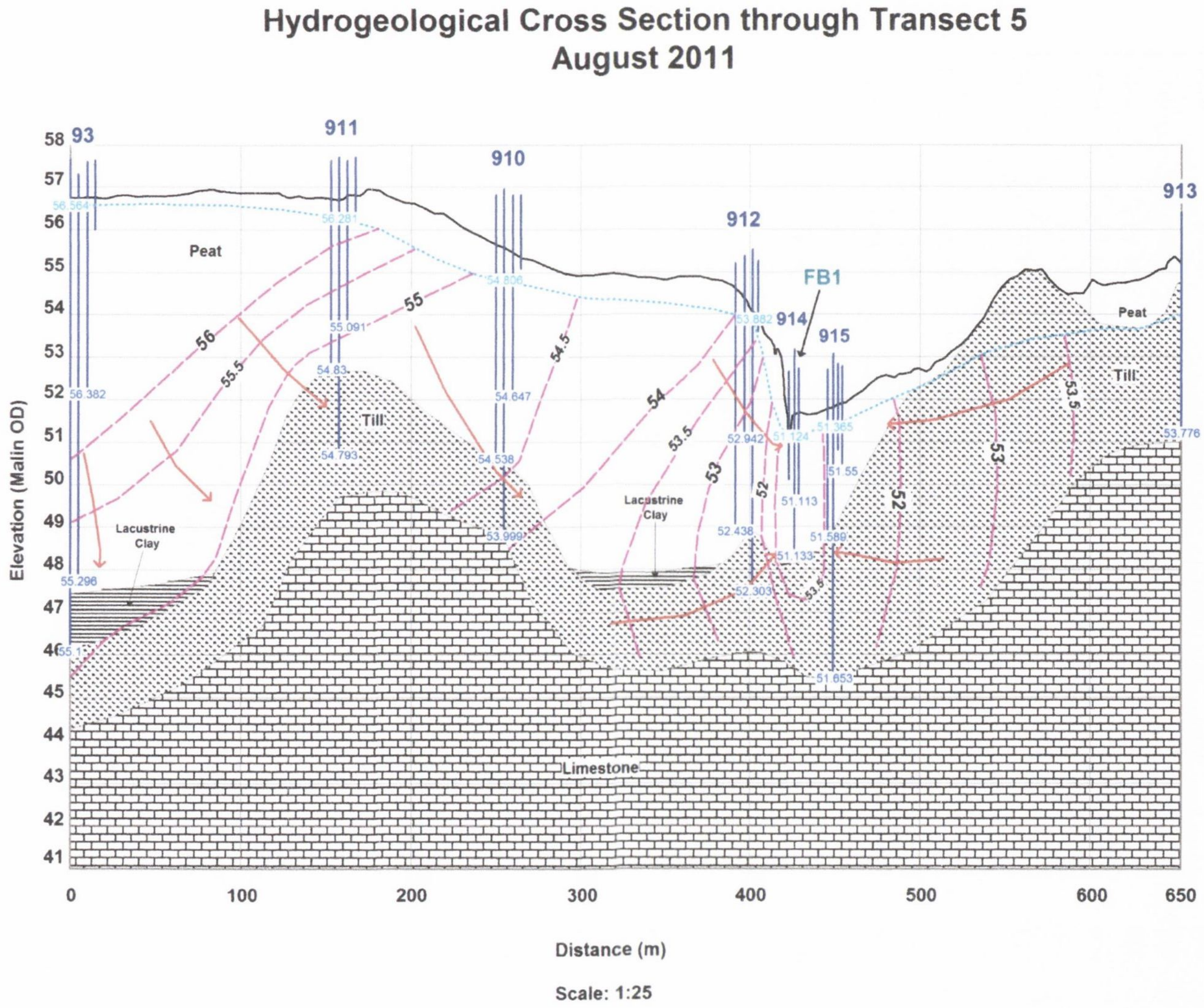


Figure C21. Hydrogeological cross-section through monitoring Transect 5

Appendix C. Hydrogeological Analysis: Water level data

Table C1. Max, min and mean water levels from piezometers installed in till subsoil (August 2009 to April 2012)

ID	No. measurements	Max WL (Malin mOD)	Min WL (Malin mOD)	Mean WL (Malin mOD)	Fluctuation (m)
906	56	56.28	55.72	55.96	0.56
907	55	56.34	55.81	56.02	0.53
908	56	56.69	56.27	56.45	0.42
909	58	55.17	54.39	54.60	0.78
910	59	54.60	53.98	54.25	0.63
911	47	55.06	54.70	54.91	0.36
912	20	53.35	52.48	52.66	0.87
tL12	15	56.42	56.12	56.26	0.30
913	55	54.59	53.78	54.26	0.81
915	30	51.95	51.62	51.69	0.34
920	34	50.79	50.47	50.59	0.32
924	30	57.35	56.62	56.91	0.73
925	27	52.76	52.07	52.52	0.69
926	31	49.94	49.56	49.76	0.38
927	37	50.19	49.90	50.02	0.29
928	32	56.35	55.72	56.09	0.63
929	31	55.53	54.91	55.16	0.62
934	13	57.86	57.18	57.36	0.67
935	11	55.50	55.18	55.34	0.32
CLCD1	9	52.79	52.57	52.73	0.23
CLCD3	54	53.55	53.10	53.32	0.45
ST3-1	36	50.38	50.17	50.29	0.20

Table C2. Max, min and mean water levels from piezometers installed in till subsoil in GSI boreholes (August 2009 to April 2012)

ID	No. measurements	Max WL (Malin mOD)	Min WL (Malin mOD)	Mean WL (Malin mOD)	Fluctuation (m)
CLBH2	20	54.96	54.55	54.70	0.41
CLBH5	47	52.01	51.20	51.59	0.81
CLBH6	30	53.80	53.56	53.67	0.24
CLBH9	33	56.45	56.03	56.25	0.42
CLBH10	13	48.85	48.45	48.62	0.40
CLBH11	28	50.70	50.57	50.64	0.13

Table C3. Max, min and mean water levels from piezometers installed into the sand lense (August 2009 to April 2012)

ID	No. measurements	Max WL (Malin mOD)	Min WL (Malin mOD)	Mean WL (Malin mOD)	Fluctuation (m)
927	10	49.77	49.48	49.68	0.29
937	9	54.078	53.858	53.958	0.22

Table C4. Max, min and mean water levels from piezometers installed at the base of peat in the 1990s (August 2009 to April 2012)

ID	N	Max WL (Malin mOD)	Min WL (Malin mOD)	Mean WL (Malin mOD)	Fluctuation (m)	Underlying subsoil
54	7	54.31	54.18	54.26	0.13	Lac
56	6	54.96	54.92	54.93	0.05	Lac
67	5	52.29	51.77	52.17	0.52	Till
82	4	50.66	50.58	50.61	0.08	Lac
83	3	50.81	50.73	50.76	0.07	Lac
86	4	53.38	53.12	53.25	0.26	Lac
87	4	54.74	54.64	54.70	0.10	Lac
88	4	55.22	55.14	55.19	0.08	Lac
89	3	55.16	54.97	55.08	0.19	Lac
91	5	54.59	54.52	54.55	0.07	Lac
94	4	56.46	56.39	56.44	0.06	Lac
95	5	56.98	56.90	56.93	0.08	Lac
97	5	56.46	56.35	56.40	0.11	Lac
98	5	57.57	57.48	57.54	0.09	Lac
99	6	56.58	56.43	56.52	0.15	Lac
47	12	54.03	53.85	53.96	0.19	Lac
48	13	54.46	54.27	54.41	0.19	Lac
50	16	54.38	54.25	54.34	0.13	Lac
55	17	54.62	54.45	54.54	0.17	Lac
57	18	54.52	54.27	54.43	0.26	Lac
59	17	53.97	53.50	53.75	0.47	Sand/ lac
61	14	52.46	52.17	52.35	0.30	Sand/ lac
63	13	52.49	52.20	52.31	0.29	Sand/ lac
70	28	53.87	53.61	53.74	0.25	Lac
90	13	54.90	54.78	54.85	0.12	Lac
92	18	54.46	54.24	54.33	0.22	Till
93	14	55.48	55.29	55.39	0.19	Lac
96	14	56.52	56.20	56.38	0.33	Lac
901	15	55.67	55.58	55.62	0.09	Lac
902	16	55.29	55.16	55.23	0.13	Lac
903	15	55.08	54.86	54.98	0.21	Lac
904	19	57.04	56.91	56.93	0.13	Lac
905	19	57.26	57.06	57.16	0.20	Till

Table C5. Max, min and mean water levels from piezometers installed at the base of peat by ten Hegglar et al (2003) (August 2009 to April 2012)

ID	N	Max WL (Malin mOD)	Min WL (Malin mOD)	Mean WL (Malin mOD)	Fluctuation (m)	Underlying subsoil
t1	12	55.96	55.78	55.86	0.18	Lac
t2	13	54.16	53.98	54.10	0.18	Till
t3	11	53.38	53.17	53.32	0.21	Lac
t4	19	54.25	54.01	54.17	0.24	Sand/ lac
t5	13	56.18	55.87	55.97	0.31	Till
t6	21	56.28	56.03	56.16	0.25	Till
t8	11	56.82	56.63	56.73	0.19	Lac
t9	30	56.59	56.41	56.51	0.18	Lac
t10	21	54.37	54.11	54.29	0.26	Lac
t13	17	54.04	53.77	53.95	0.27	Lac
tdj12	22	56.52	56.21	56.35	0.31	Till
tdk12	13	56.58	56.38	56.48	0.20	Lac
tdL12	31	56.75	56.51	56.62	0.24	Till

Table C6. Max, min and mean water levels from piezometers installed at the base of peat in high bog as part of PhD study (August 2009 to April 2012)

ID	N	Max WL (Malin mOD)	Min WL (Malin mOD)	Mean WL (Malin mOD)	Fluctuation (m)	Underlying subsoil
914	48	51.43	51.12	51.24	0.31	Lac
915	45	51.81	51.51	51.69	0.30	Till
916	18	51.16	50.94	51.01	0.22	Till
917	7	51.38	50.91	51.14	0.47	Till
918	42	55.95	55.70	55.79	0.26	Till
920	47	50.86	50.48	50.65	0.39	Lac
921	26	49.91	49.60	49.83	0.31	Lac
923	19	50.17	50.12	50.14	0.04	Sand/ lac
927	9	50.01	49.80	49.89	0.21	Sand/ lac
939	9	50.02	49.73	49.96	0.29	Sand/ lac

Table C7. Max, min and mean water levels from piezometers installed at the base of peat in high bog as part of PhD study (August 2009 to April 2012)

ID	N	Max WL (Malin mOD)	Min WL (Malin mOD)	Mean WL (Malin mOD)	Fluctuation (m)	Underlying subsoil
906	51	56.16	55.71	55.93	0.45	Till
907	20	56.18	55.98	56.01	0.20	Till
908	54	57.01	56.75	56.88	0.26	Till
909	48	55.83	55.22	55.61	0.61	Till
910	54	55.03	54.17	54.81	0.86	Till
911	46	55.15	54.81	55.04	0.35	Till
912	53	53.56	52.31	52.94	1.25	Lac/ till
937	3	54.33	54.13	54.27	0.21	Sand/ lac

Appendix D

Groundwater-Surface-Water Interactions

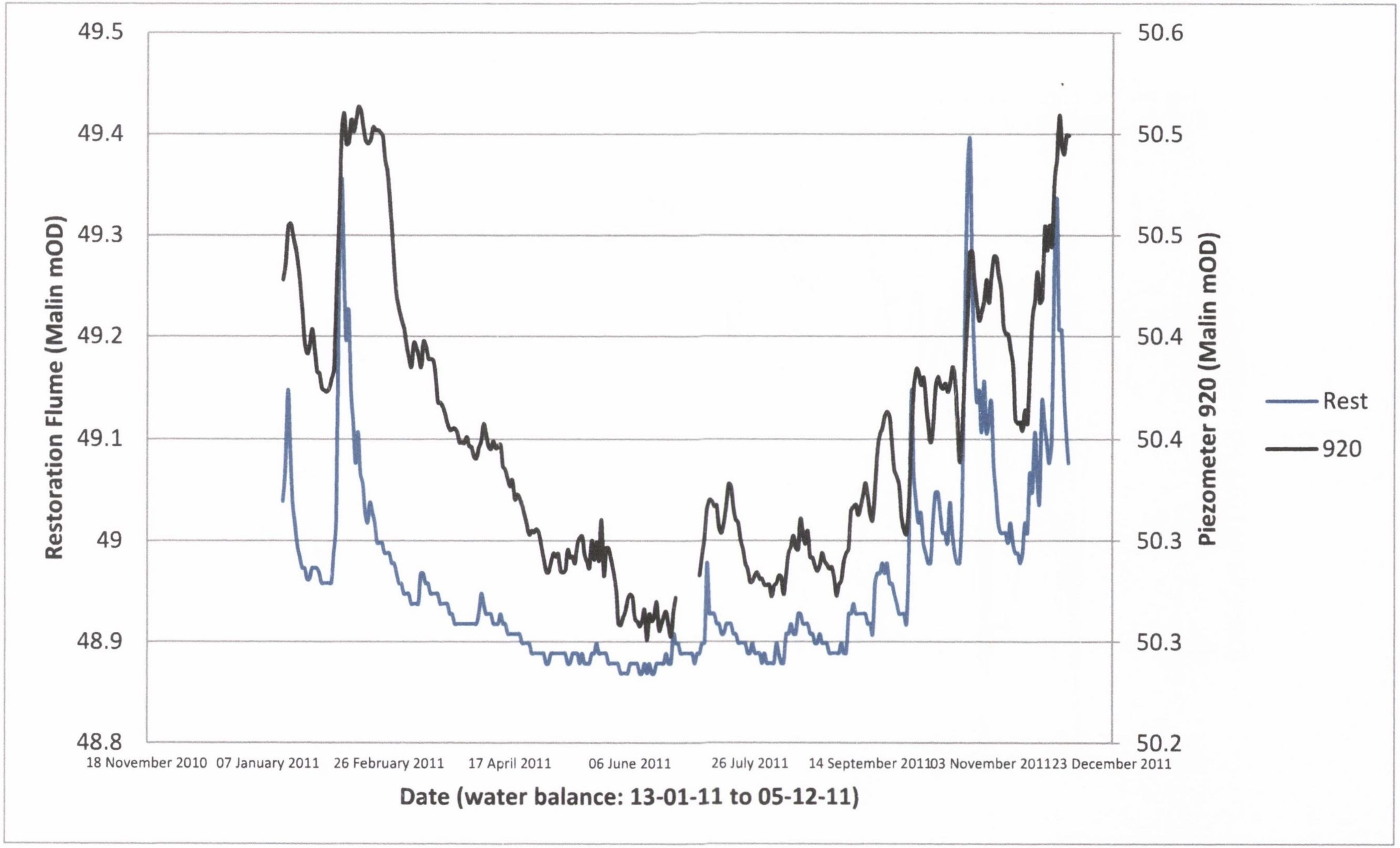


Figure D1. Restoration Area Flume: Stage level in drain and groundwater level in till subsoil piezometer 920 in cutover bog (water balance period)

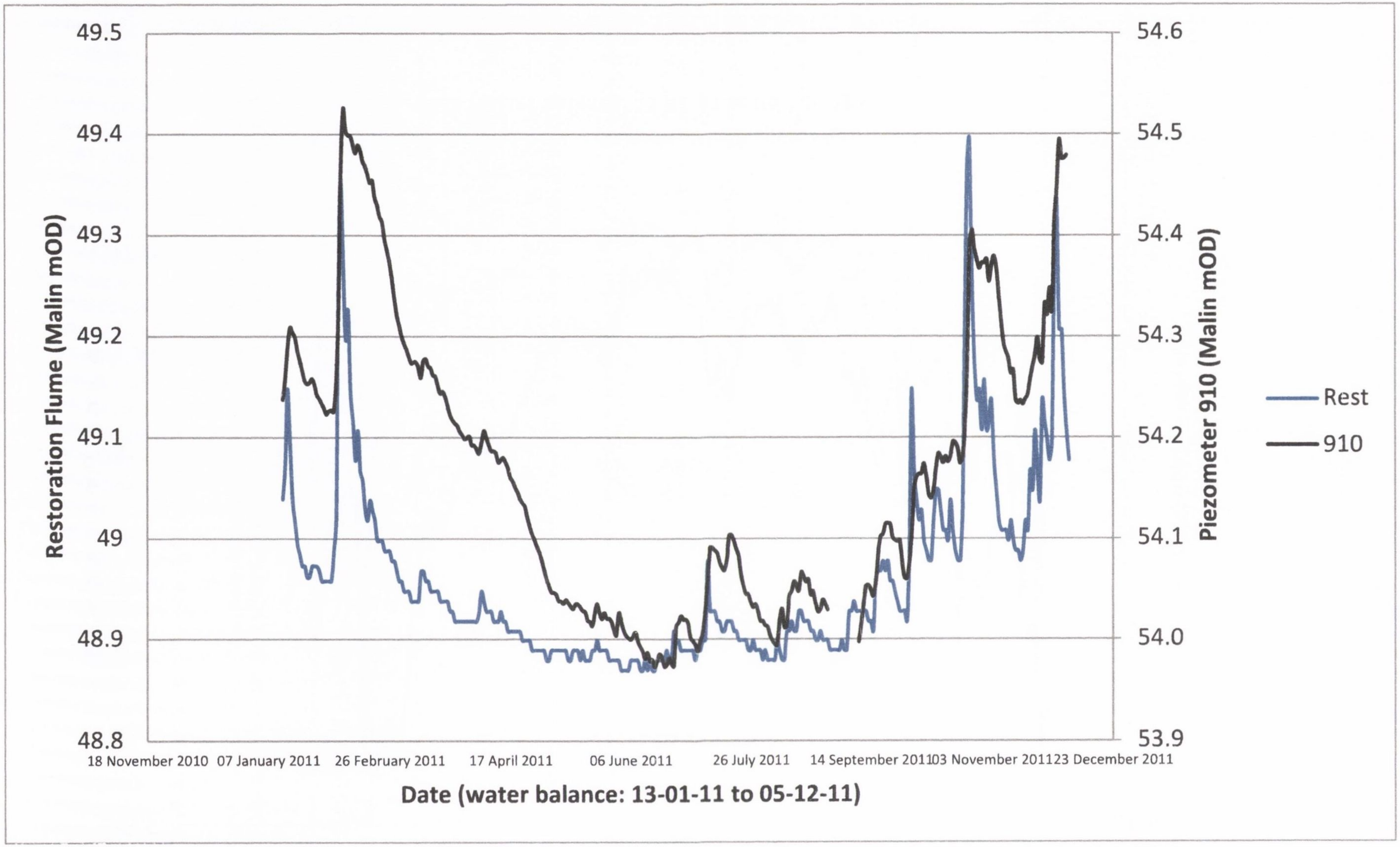


Figure D2. Restoration Area Flume: Stage level in drain and groundwater level in till subsoil piezometer 910 on high bog (water balance period)

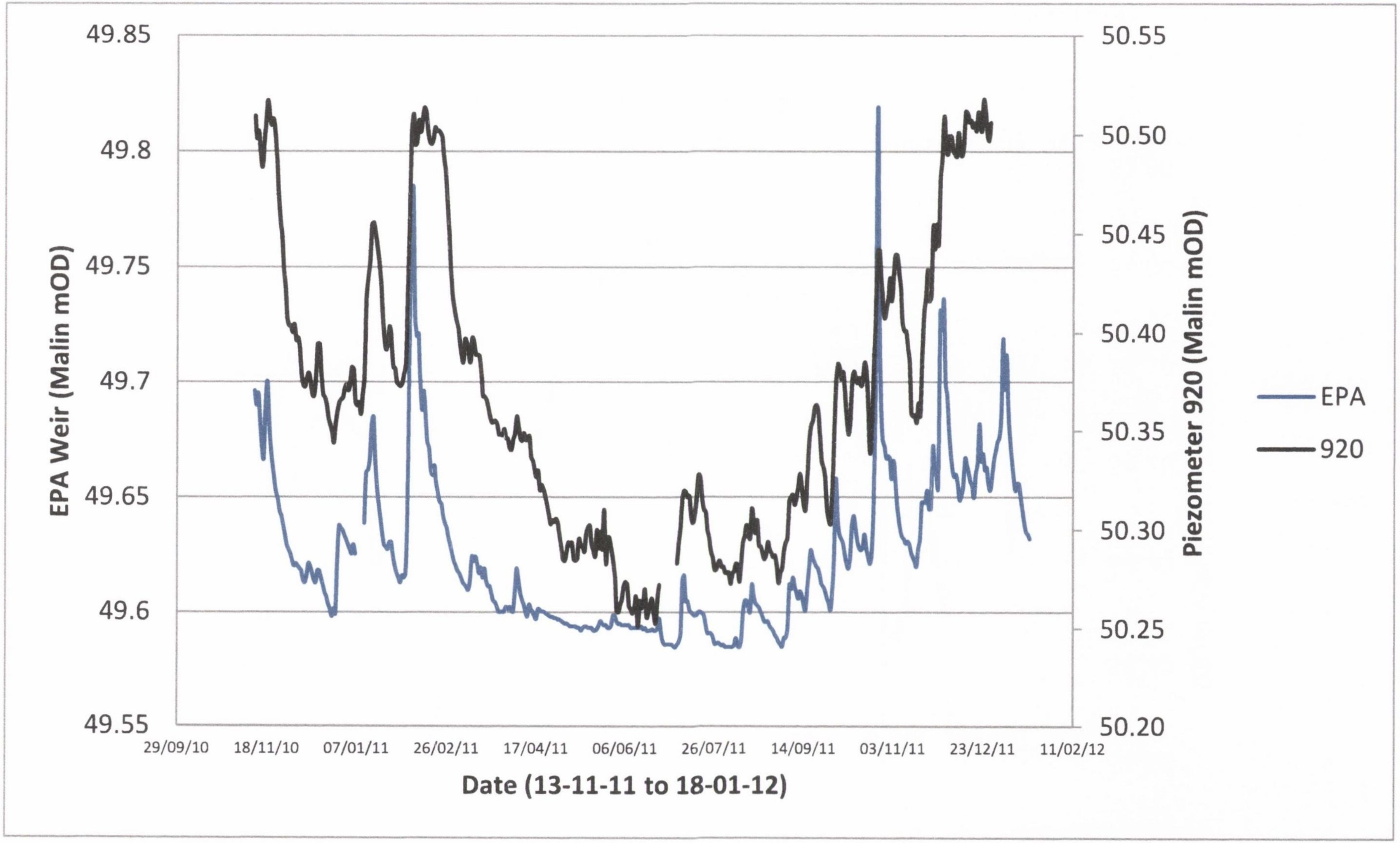


Figure D3. EPA Weir: Stage level in drain and groundwater level in till subsoil piezometer 920 in cutover bog (water balance period)

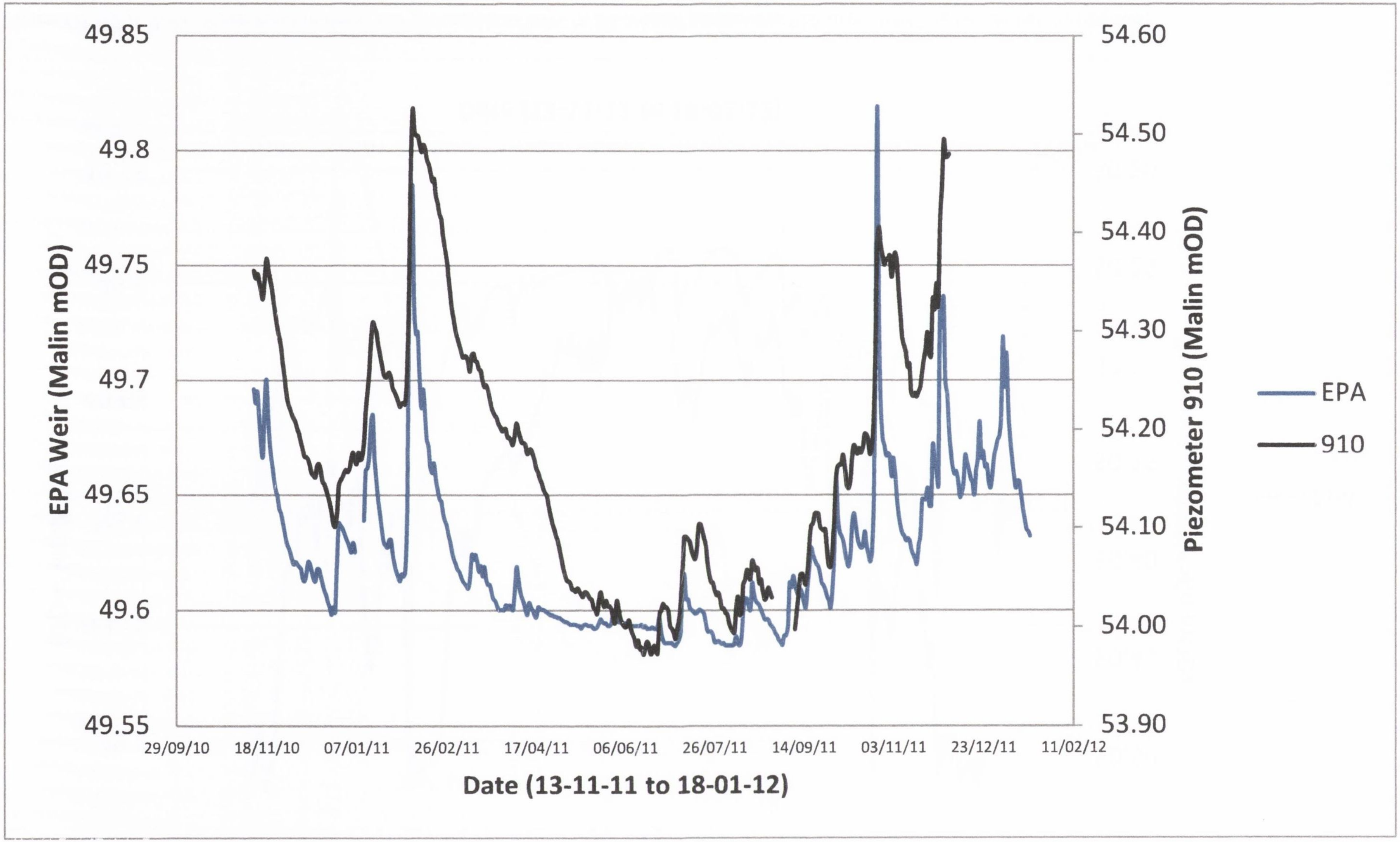


Figure D4. EPA Weir: Stage level in drain and groundwater level in till subsoil piezometer 910 on high bog (water balance period)

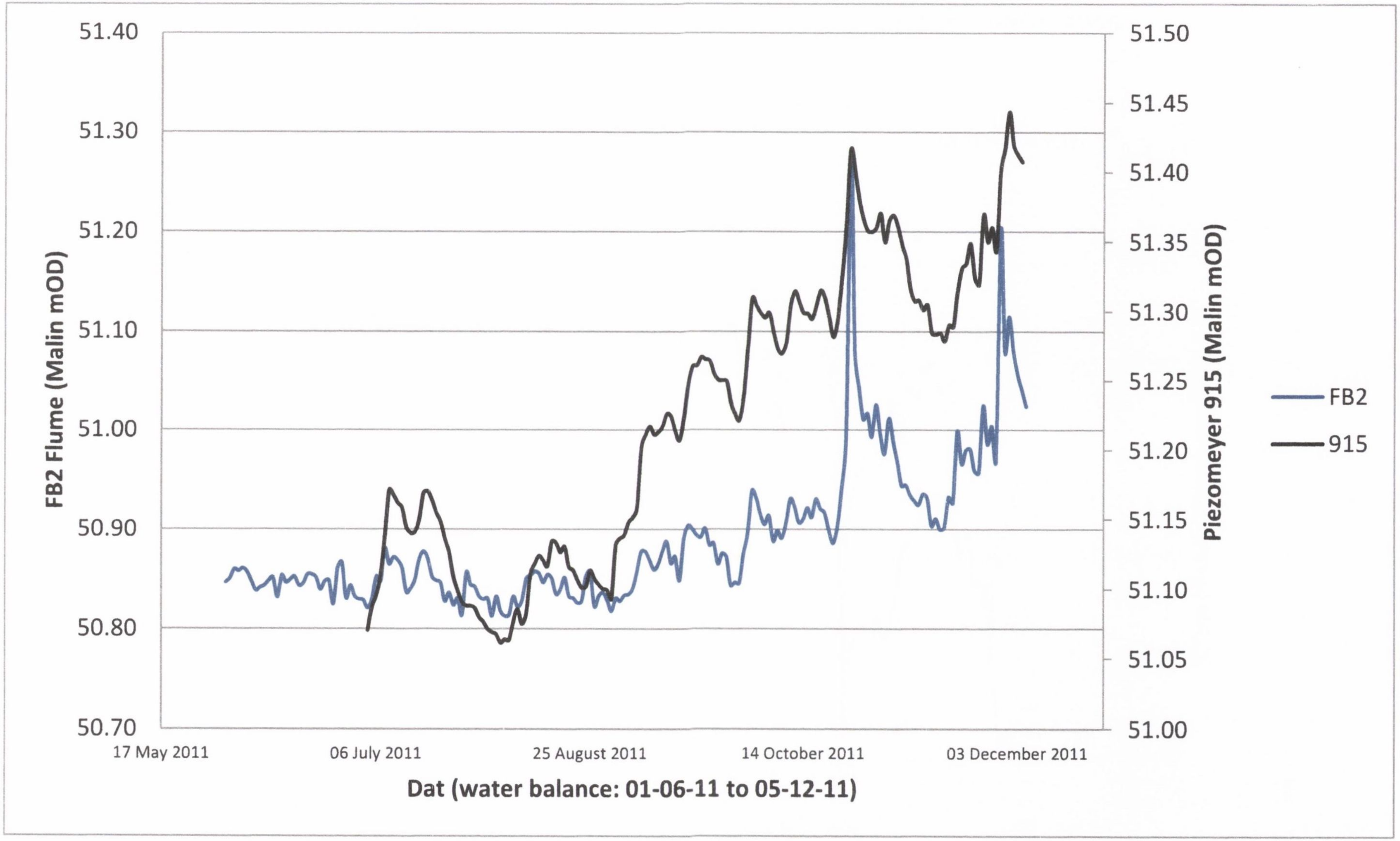


Figure D5. FB2 Flume: Stage level in drain and groundwater level in till subsoil piezometer 915 in cutover bog (water balance period)

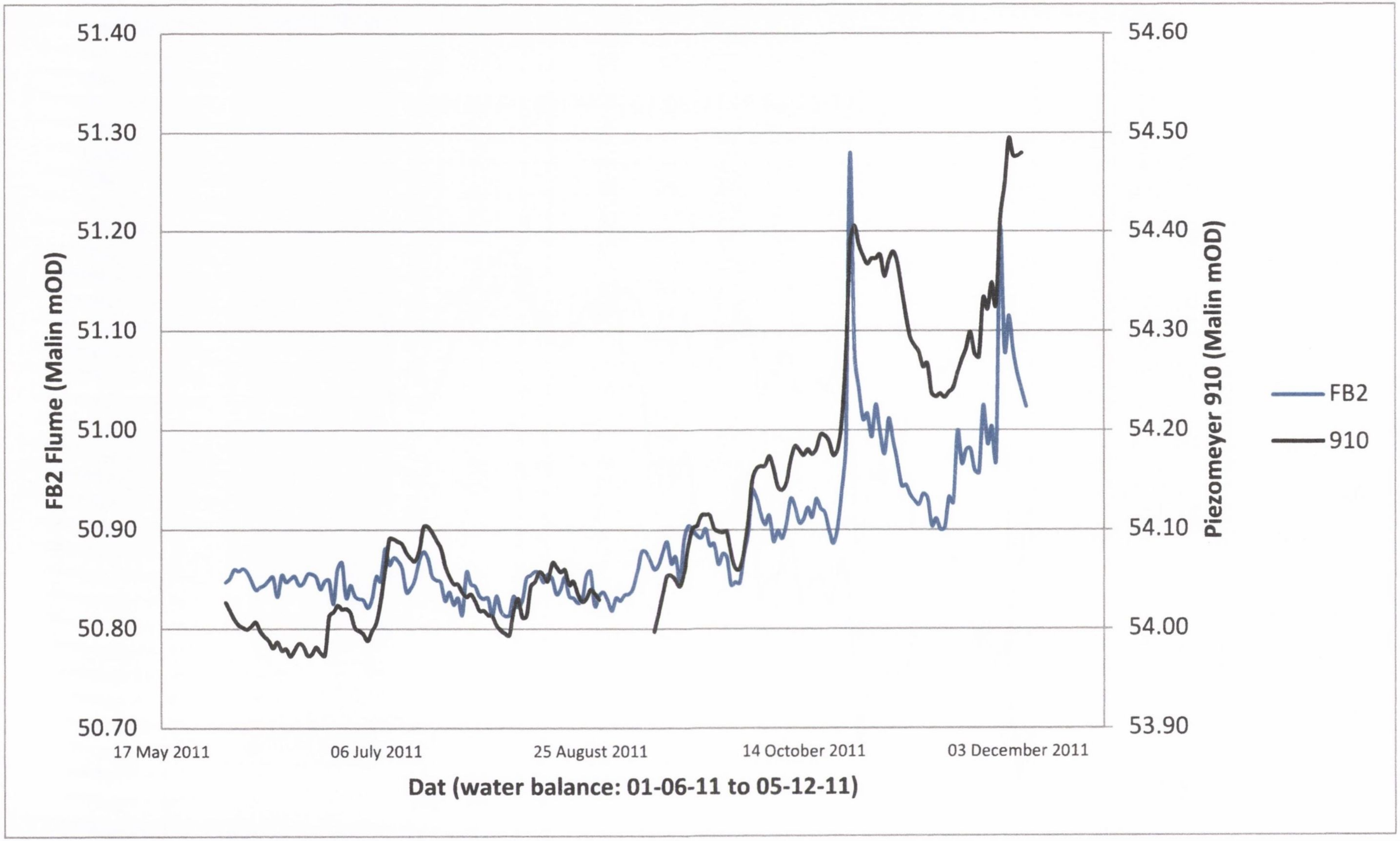


Figure D6. EPA Weir: Stage level in drain and groundwater level in till subsoil piezometer 910 on high bog (water balance period)

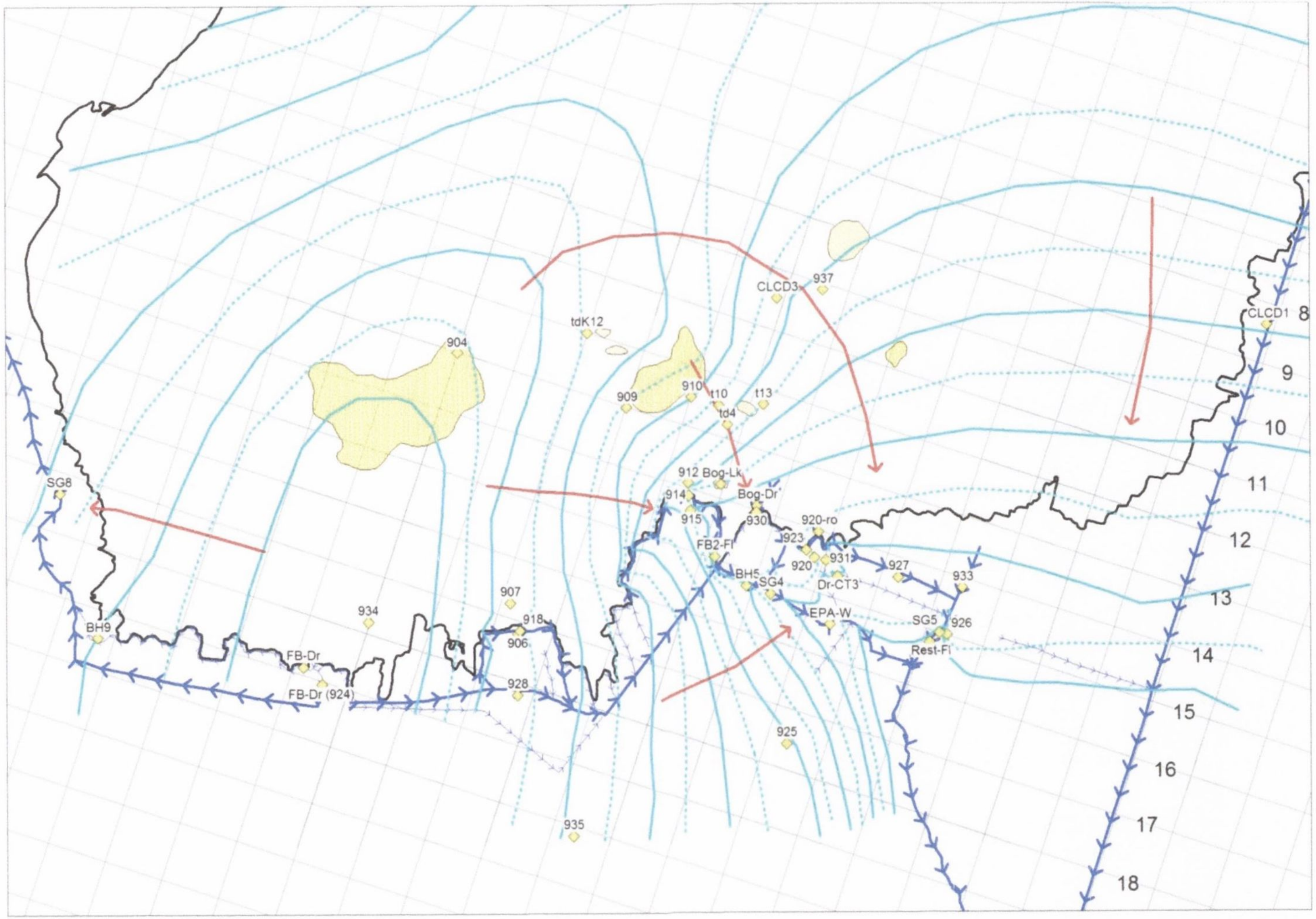


Figure D7. Hydrochemical investigation points

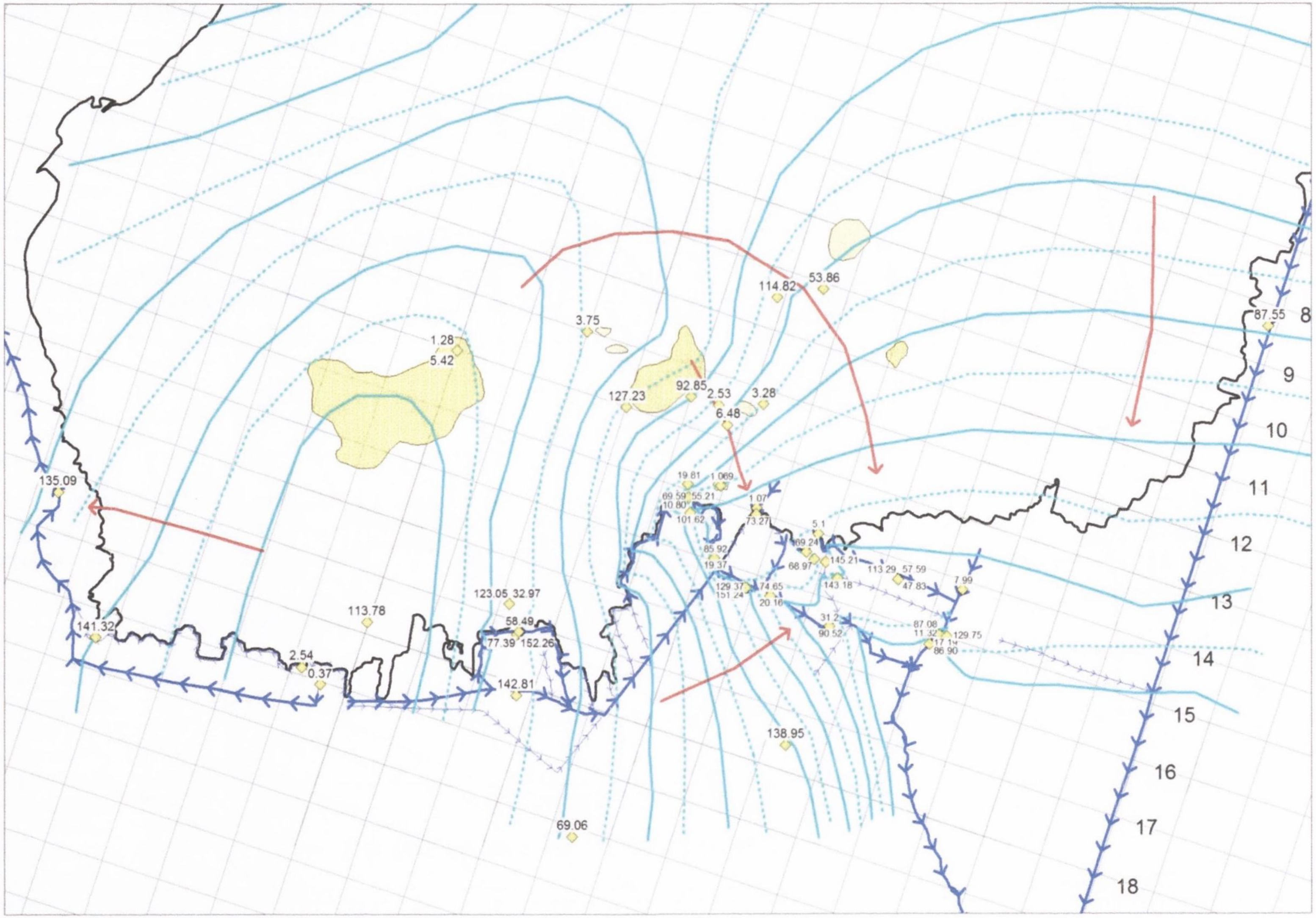


Figure D8. Calcium concentrations (mg/ L) - see table D1 – D4

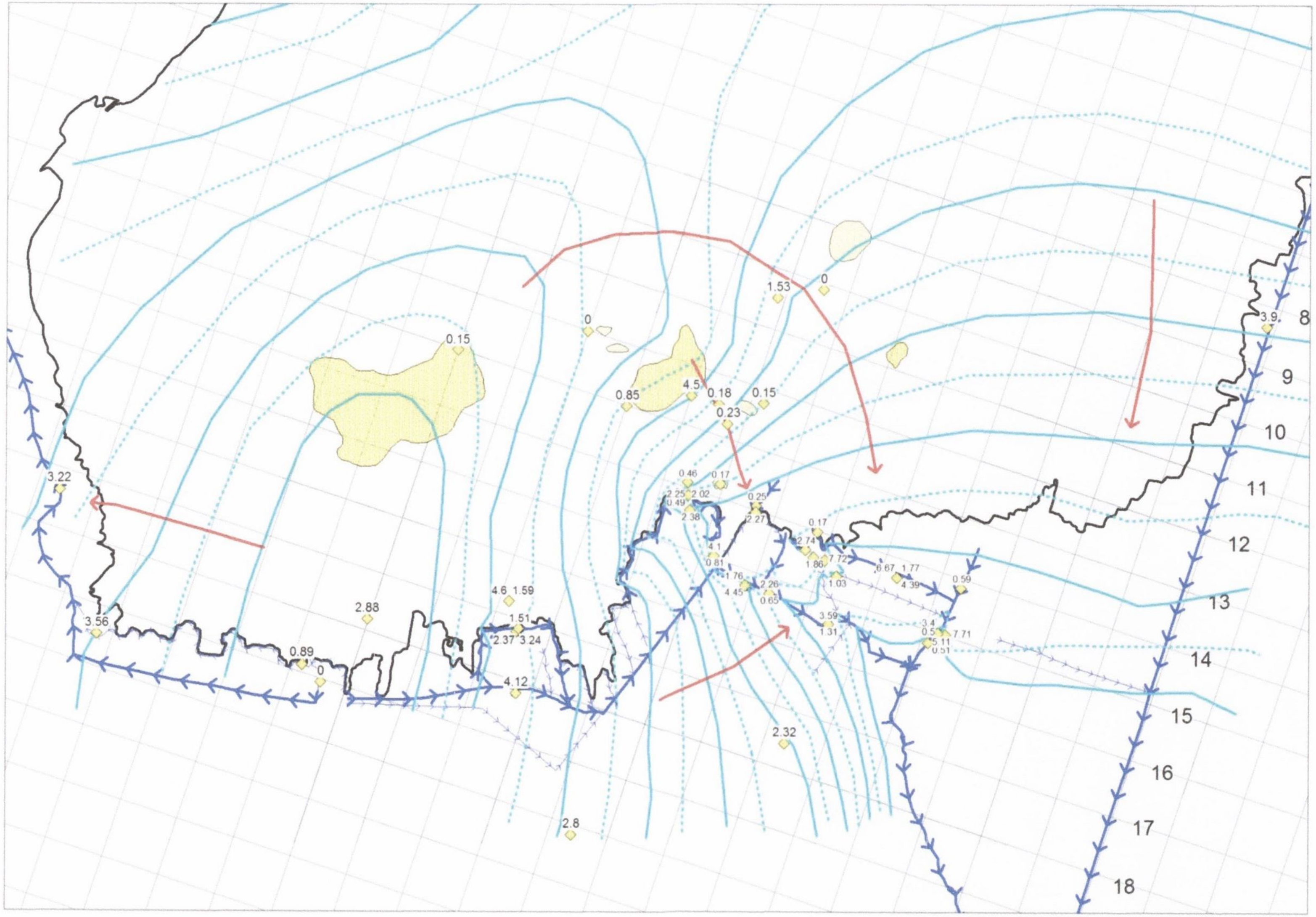


Figure D9. Silica concentrations (mg/ L) - see table D5 – D8

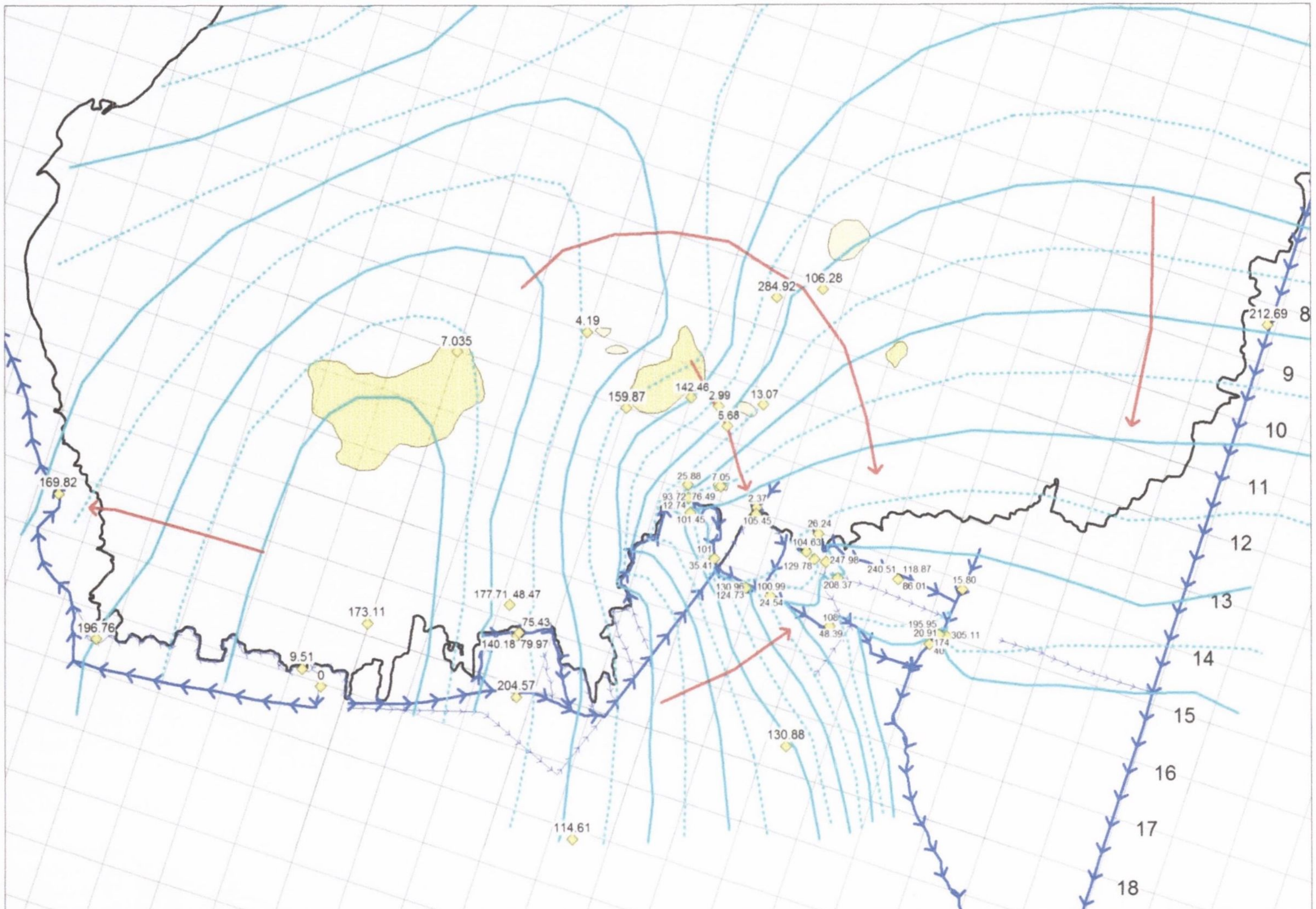


Figure D10. Strontium concentrations (µg/ L) - see table D9 – D12

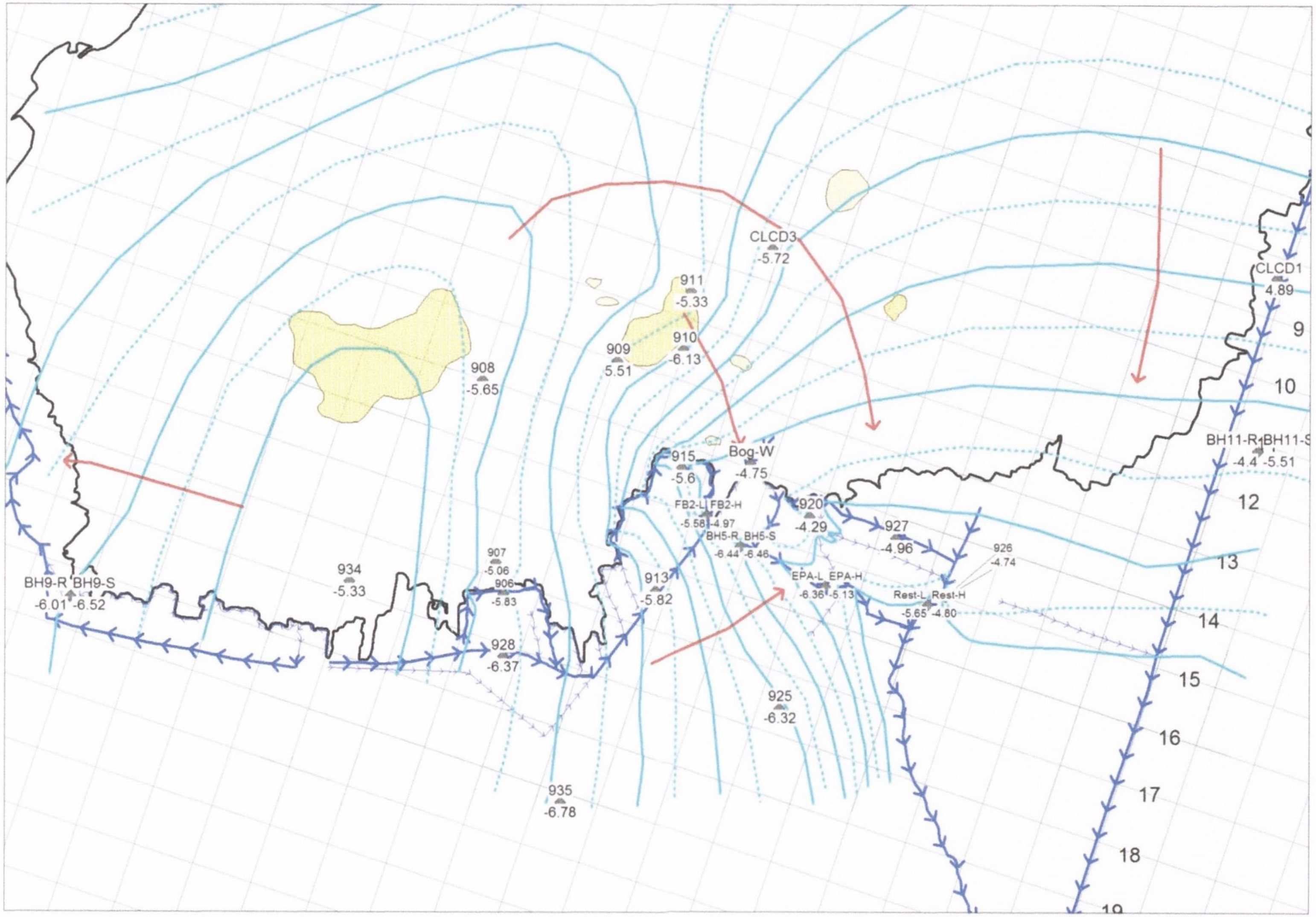


Figure D11. Oxygen 18 (‰) in groundwater (till and bedrock) - see table D13 – D16

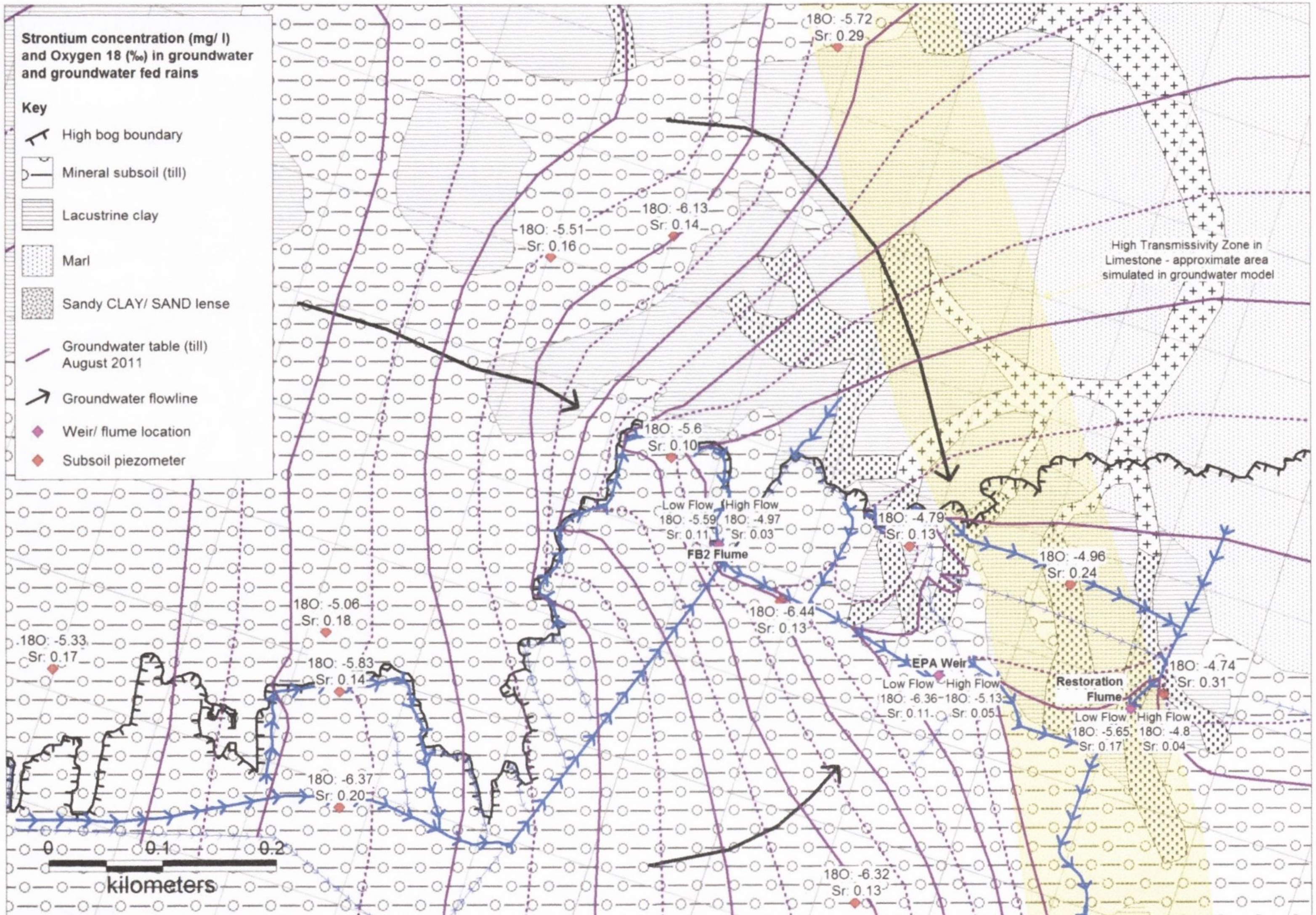


Figure D12. Strontium concentrations (μg/ L) and oxygen 18 (‰) in groundwater (till and bedrock)

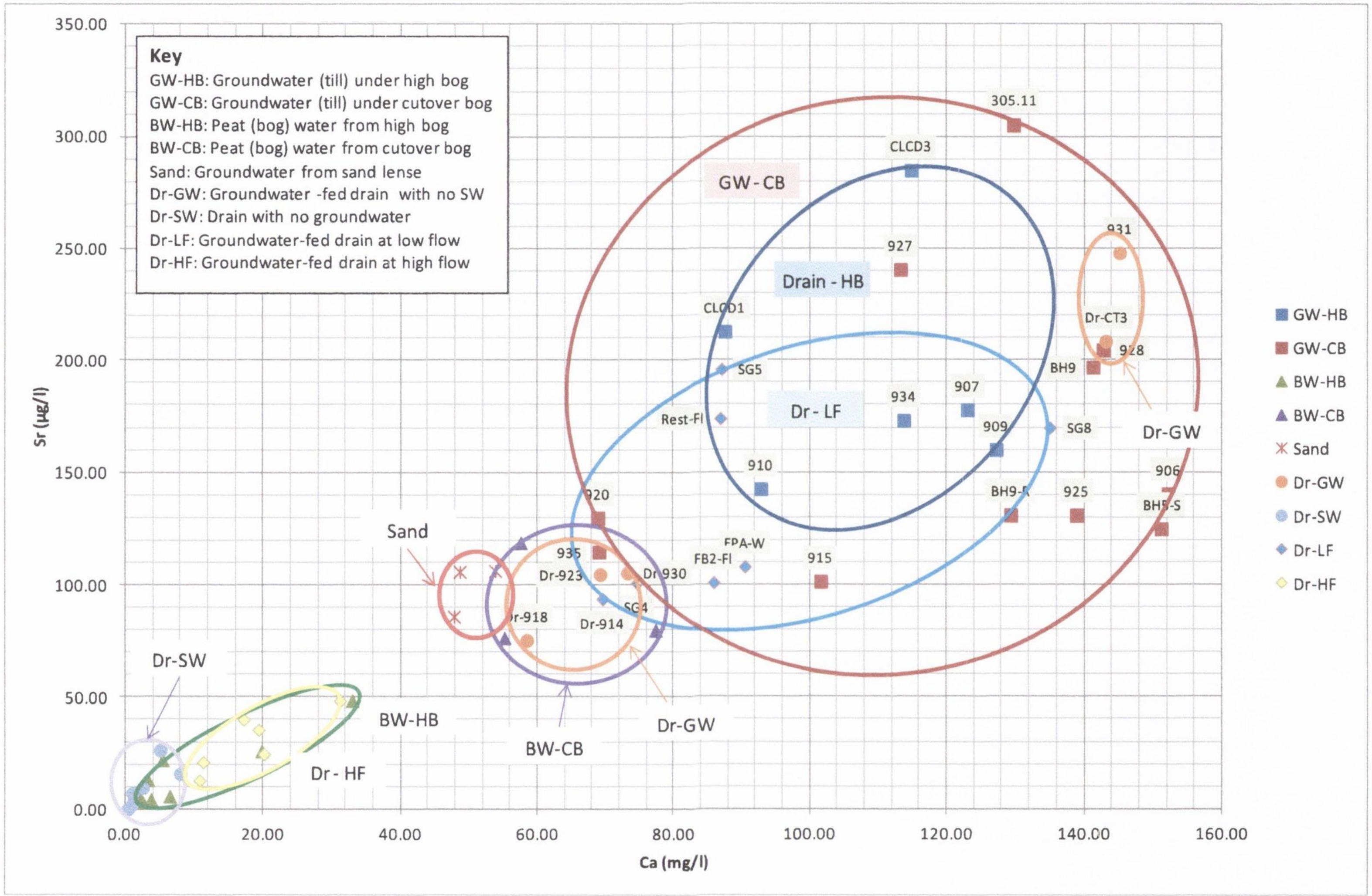


Figure D13. Strontium (Sr) and calcium (Ca) water source analysis

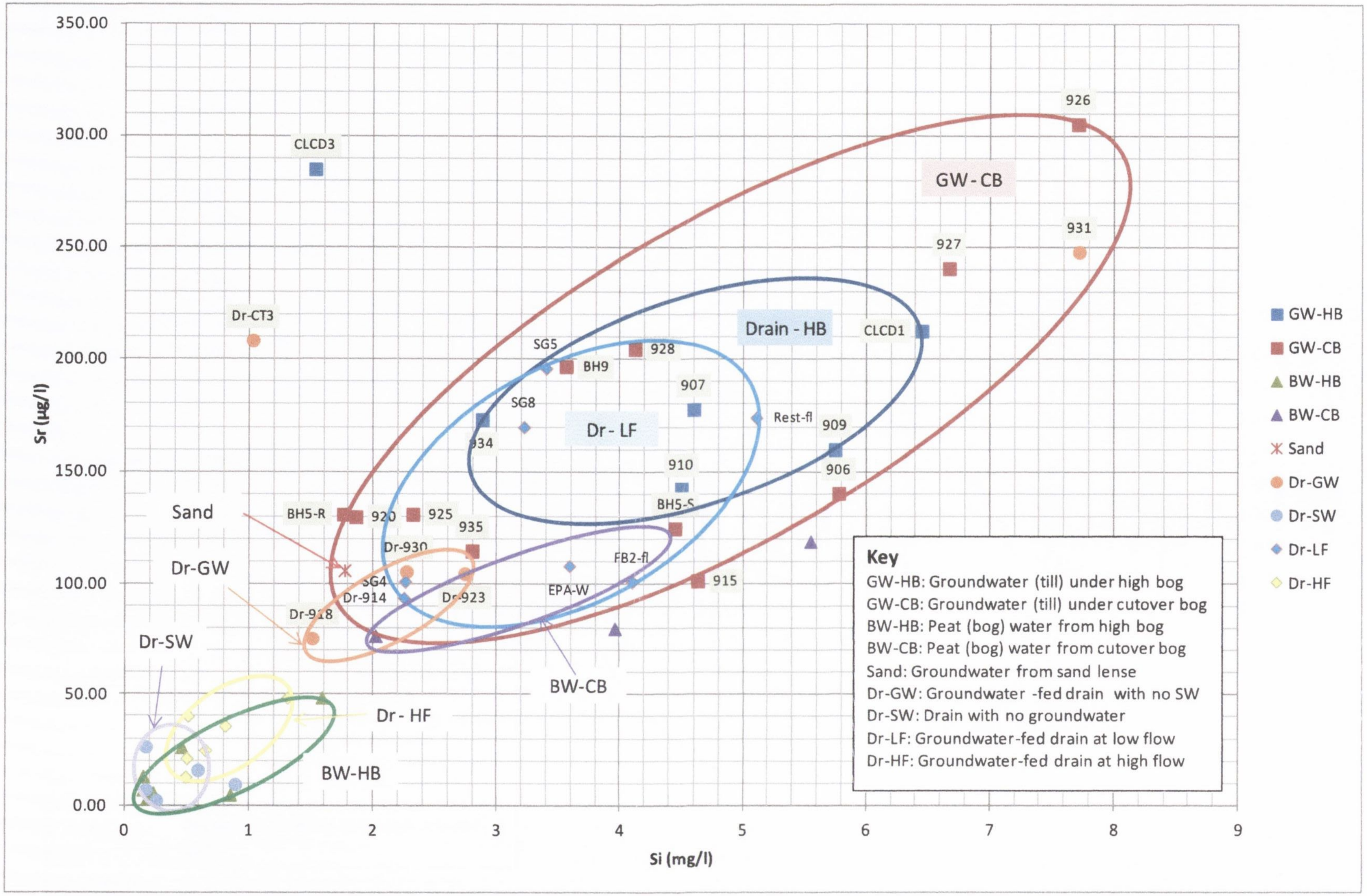


Figure D14. Strontium (Sr) and Silica (SiO_2) water source analysis

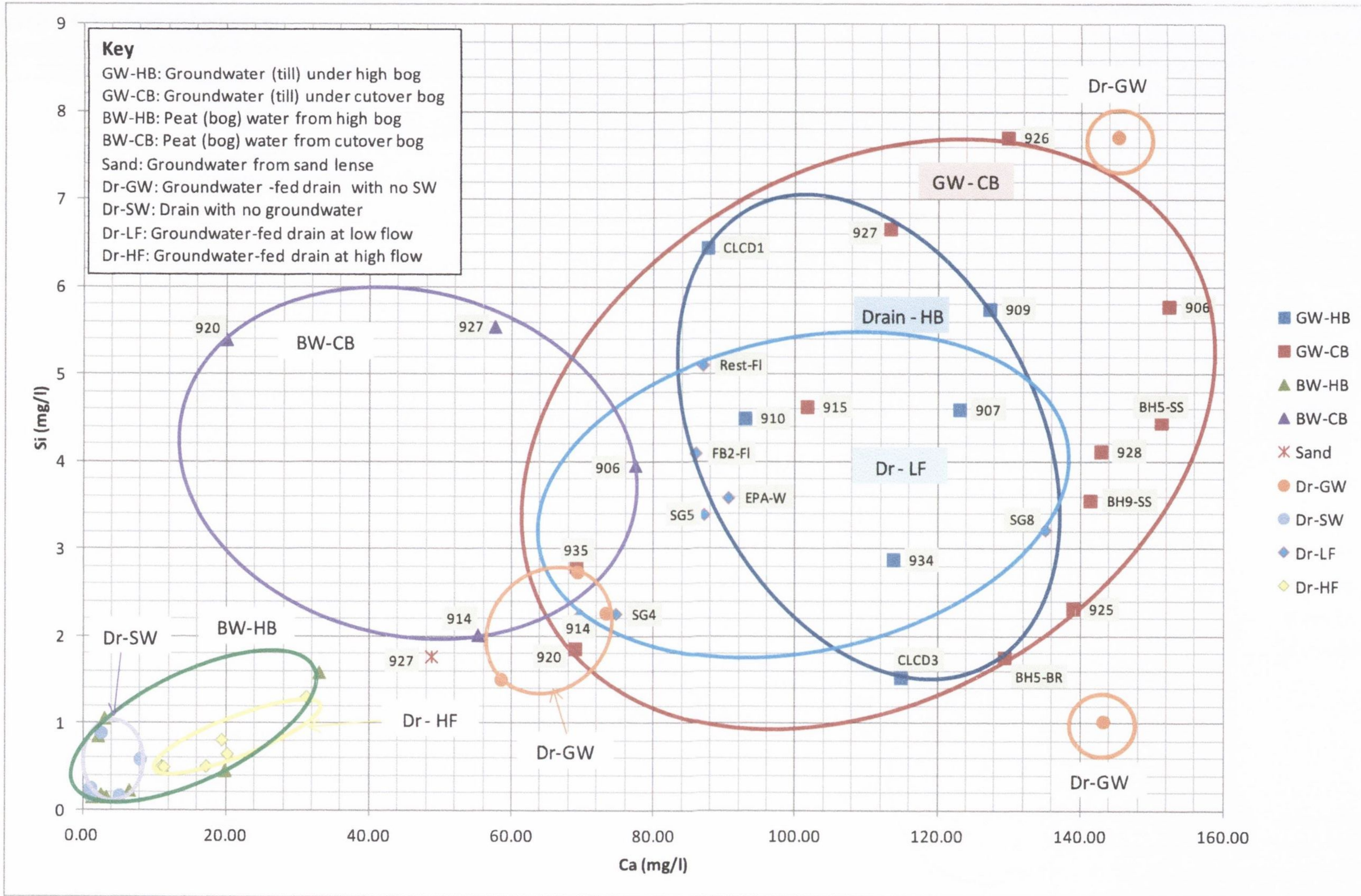


Figure D15. Silica (SiO_2) and calcium (Ca) water source analysis

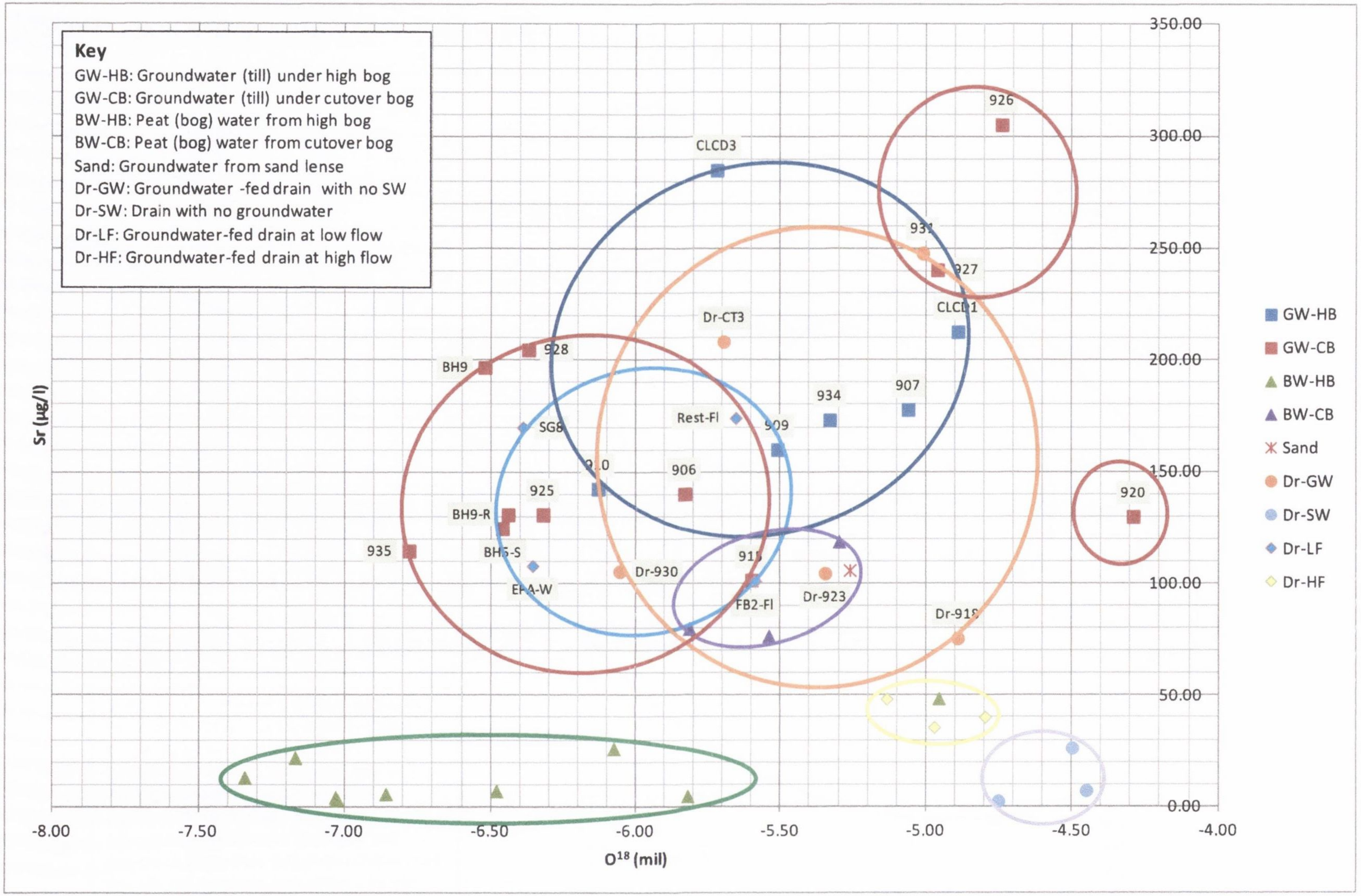


Figure D16. Strontium (Sr) and stable oxygen isotope (O^{18}) water source analysis

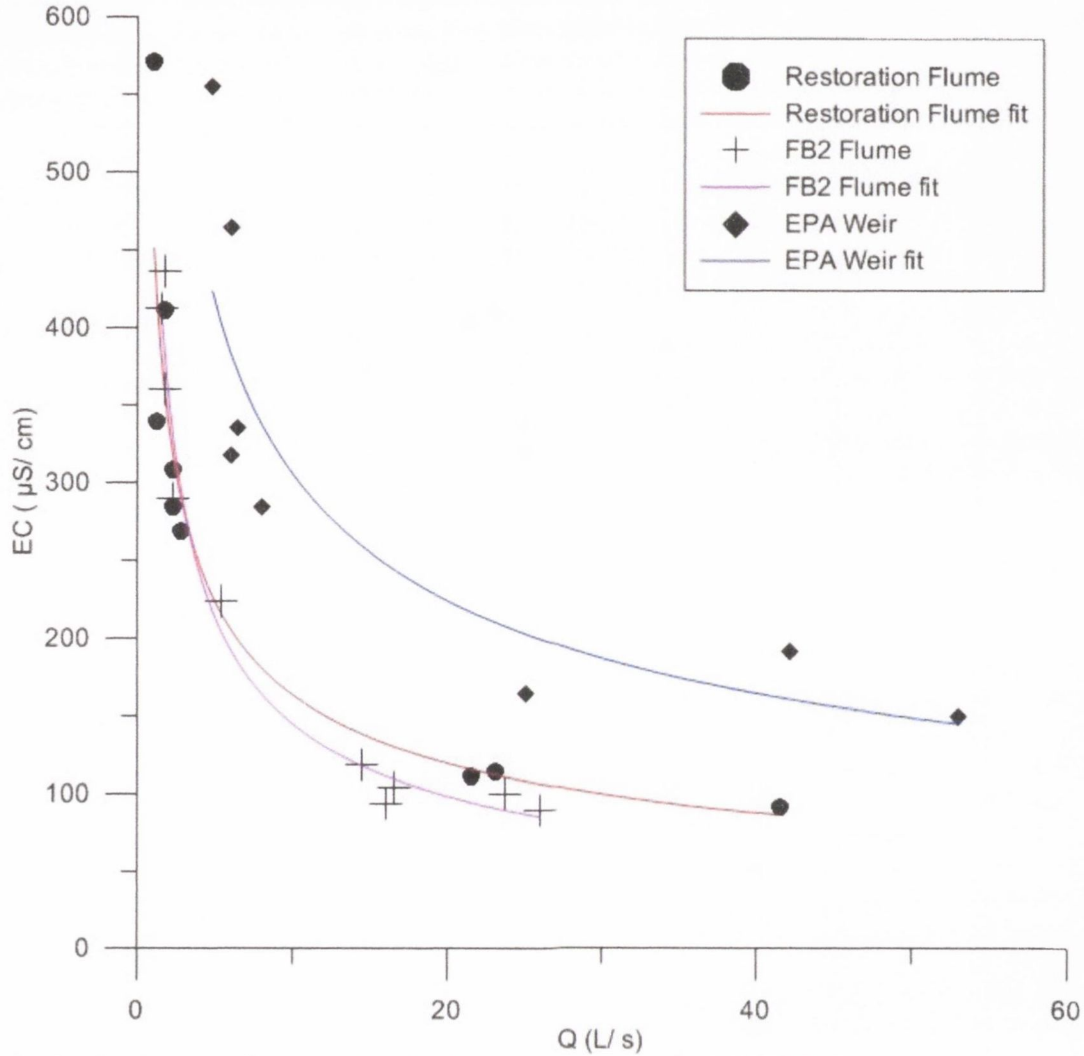


Figure D17. Electrical conductivity (µS/ cm) versus flow rate (L/ s) in instrumented groundwater-fed drains

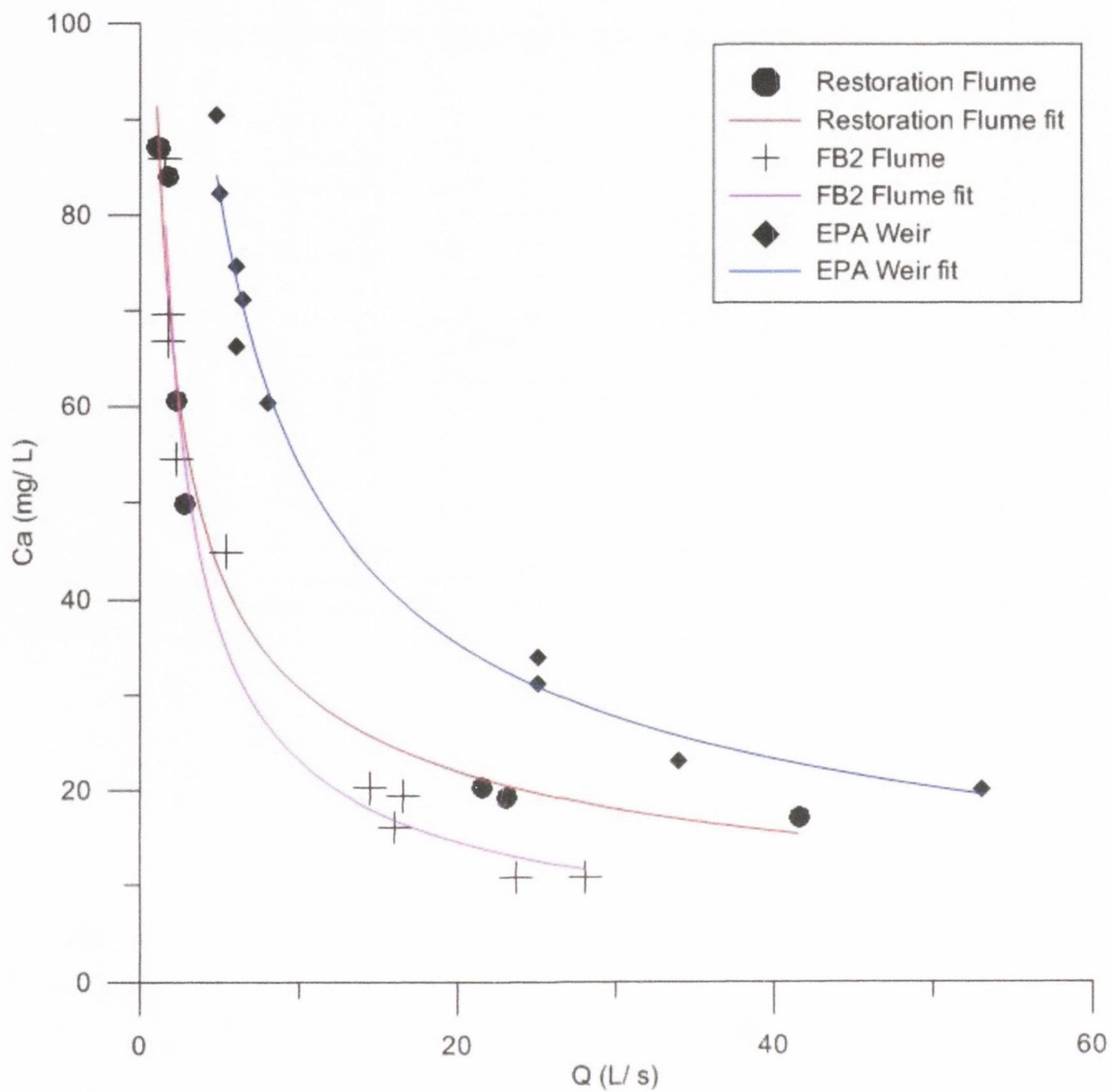


Figure D18. Calcium (mg/ L) versus flow rate (L/ s) in instrumented groundwater-fed drains

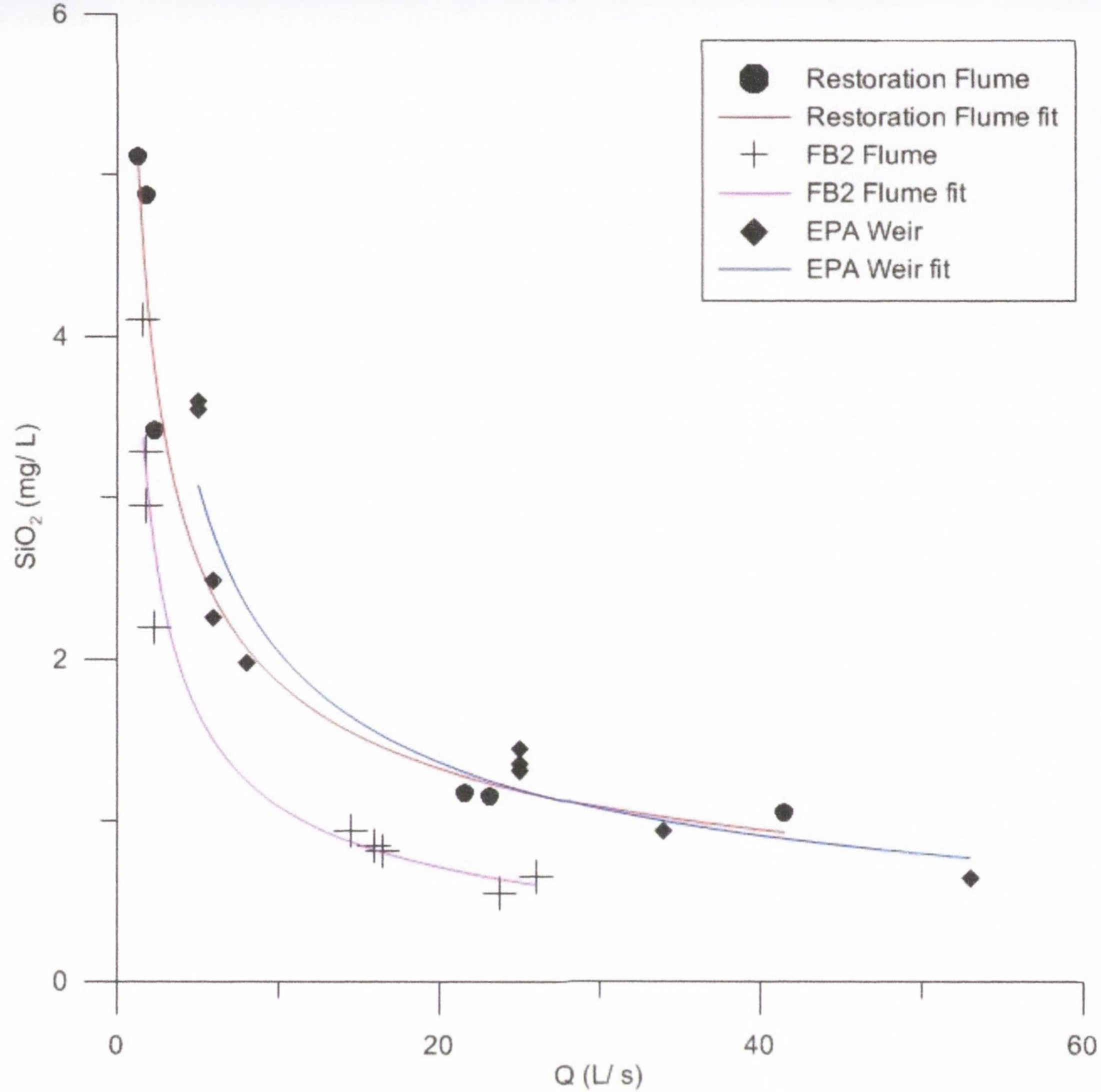


Figure D19. Silica (mg/ L) versus flow rate (L/ s) in instrumented groundwater-fed drains

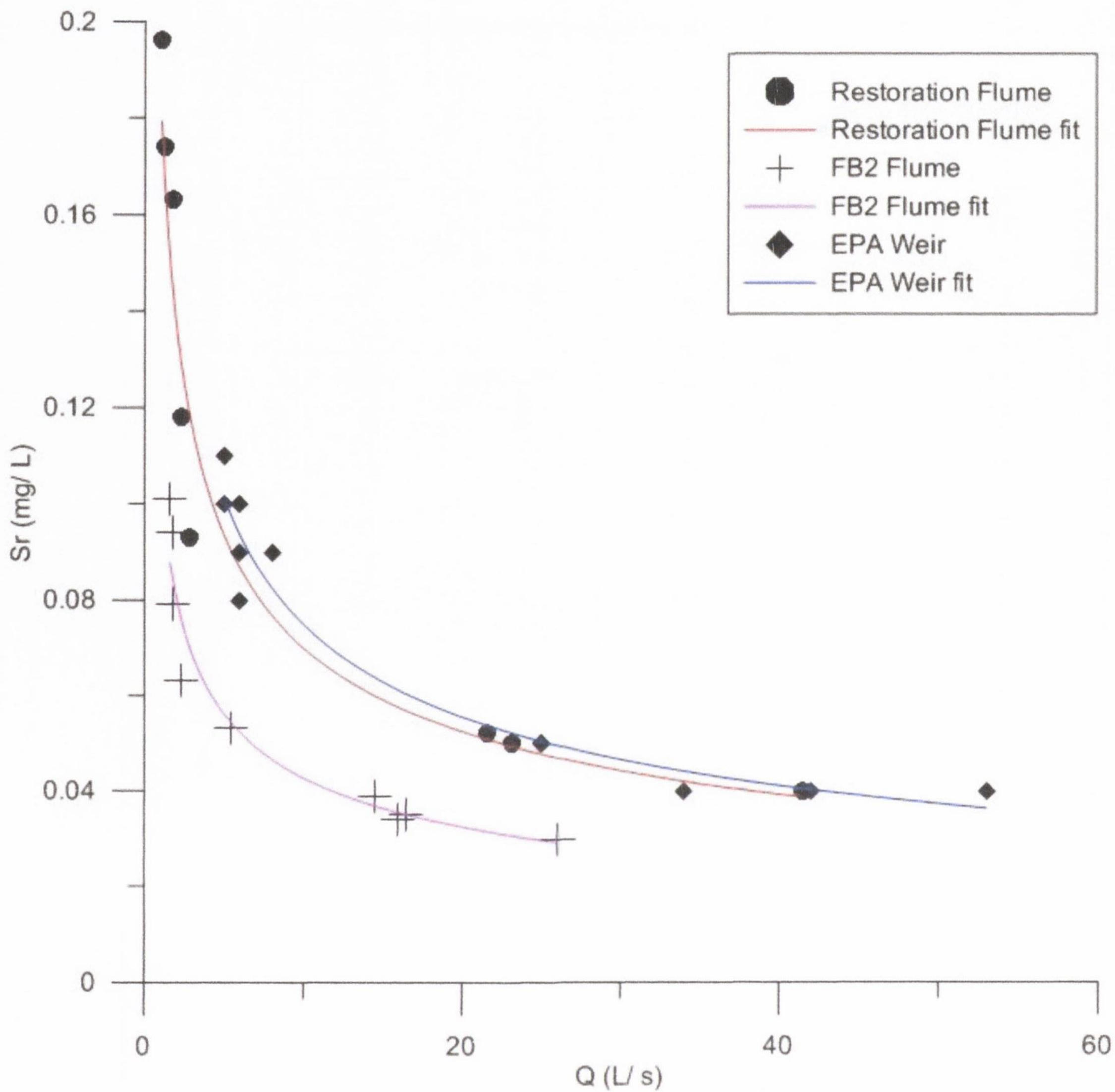


Figure D20. Strontium (mg/ L) versus flow rate (L/ s) in instrumented groundwater-fed drains

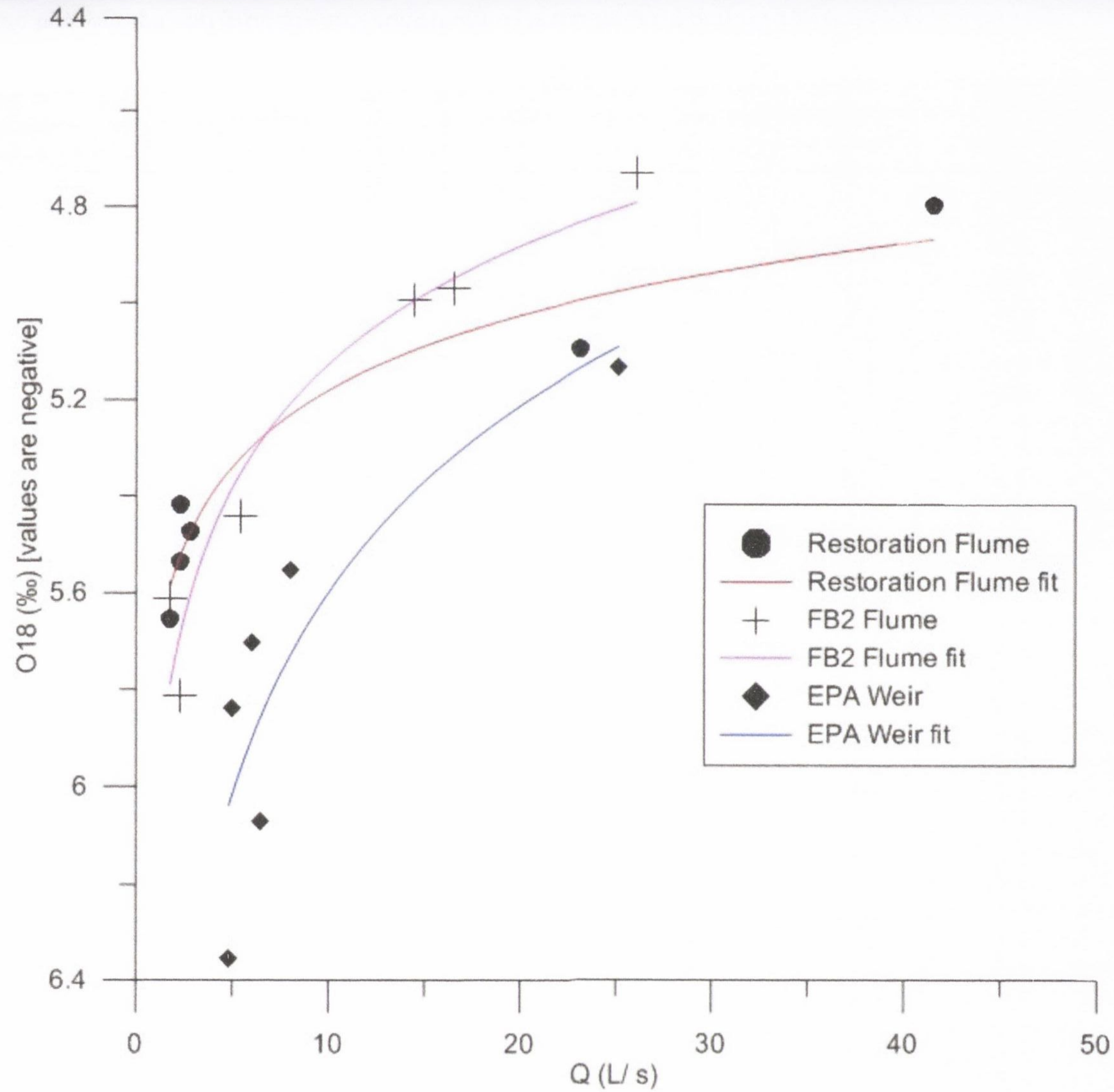


Figure D21. Oxygen 18 (‰) versus flow rate (L/ s) in instrumented groundwater-fed drains

Appendix D: Groundwater-Surface-Water Interaction – Hydrograph Base Flow Separation

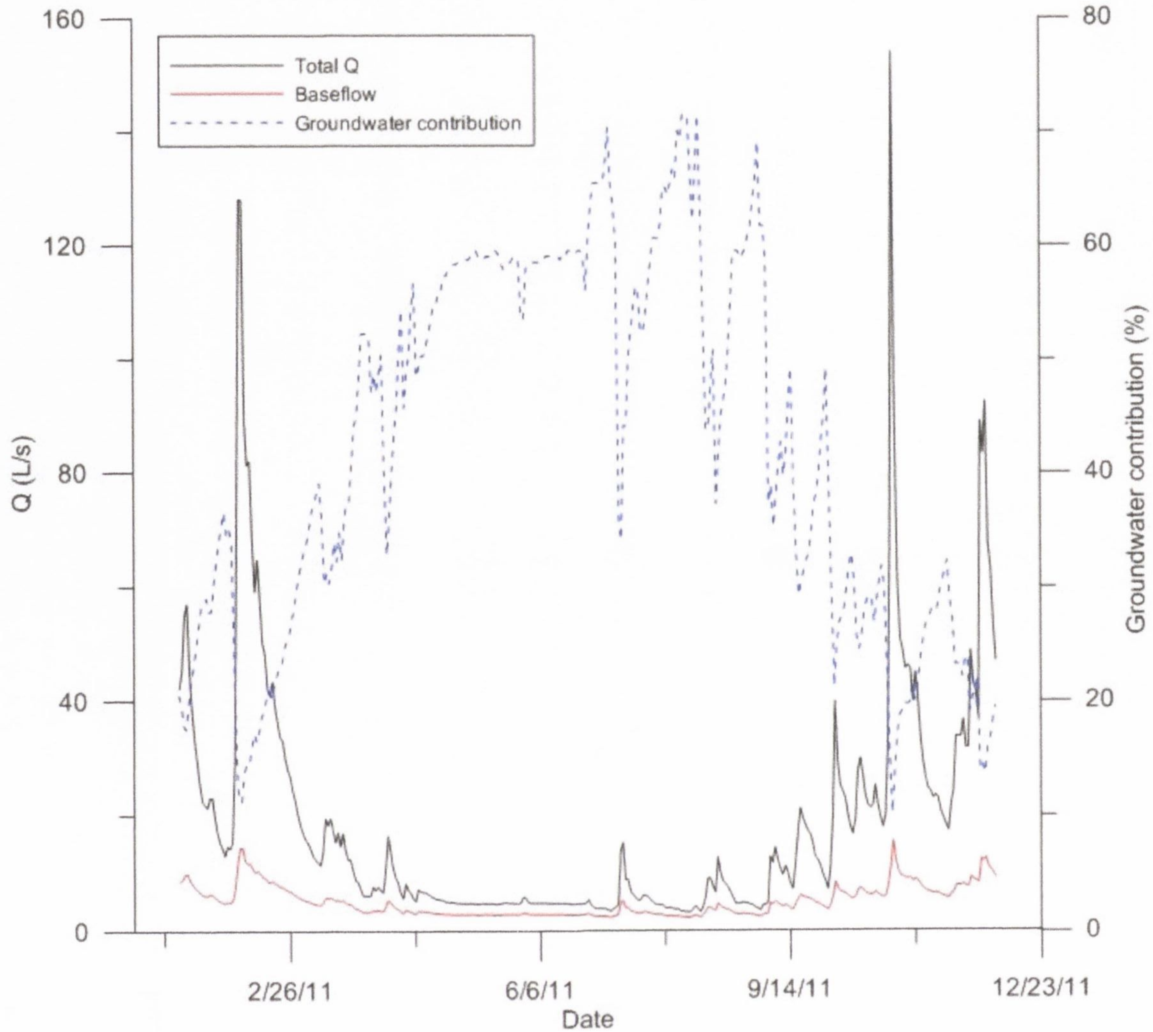


Figure D22. EPA Weir flow rate hydrograph and groundwater contribution (water balance period: 13-01-11 to 05-12-11)

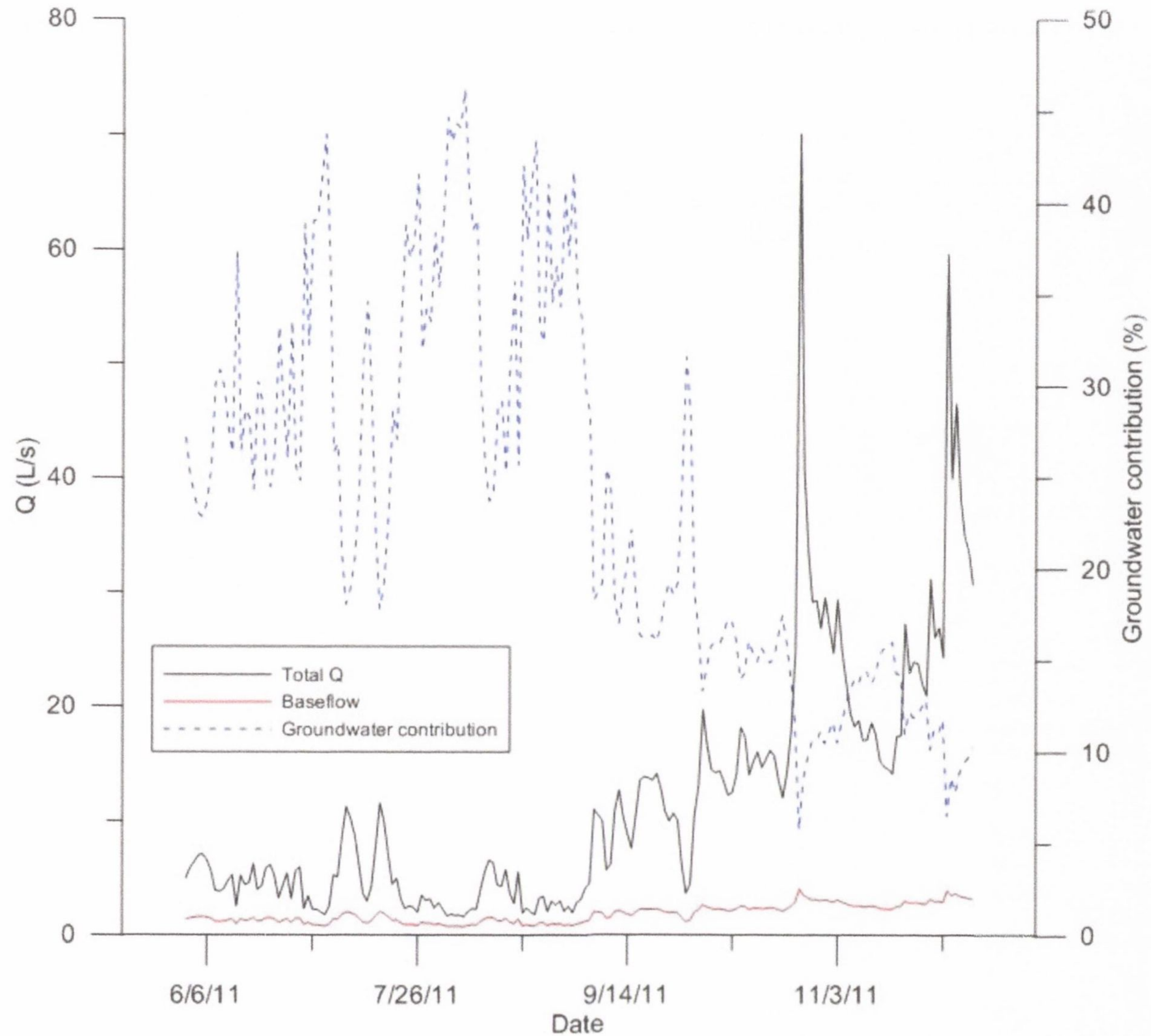


Figure D23. FB2 Flume flow rate hydrograph and groundwater contribution (water balance period: 01-06-11 to 05-12-11)

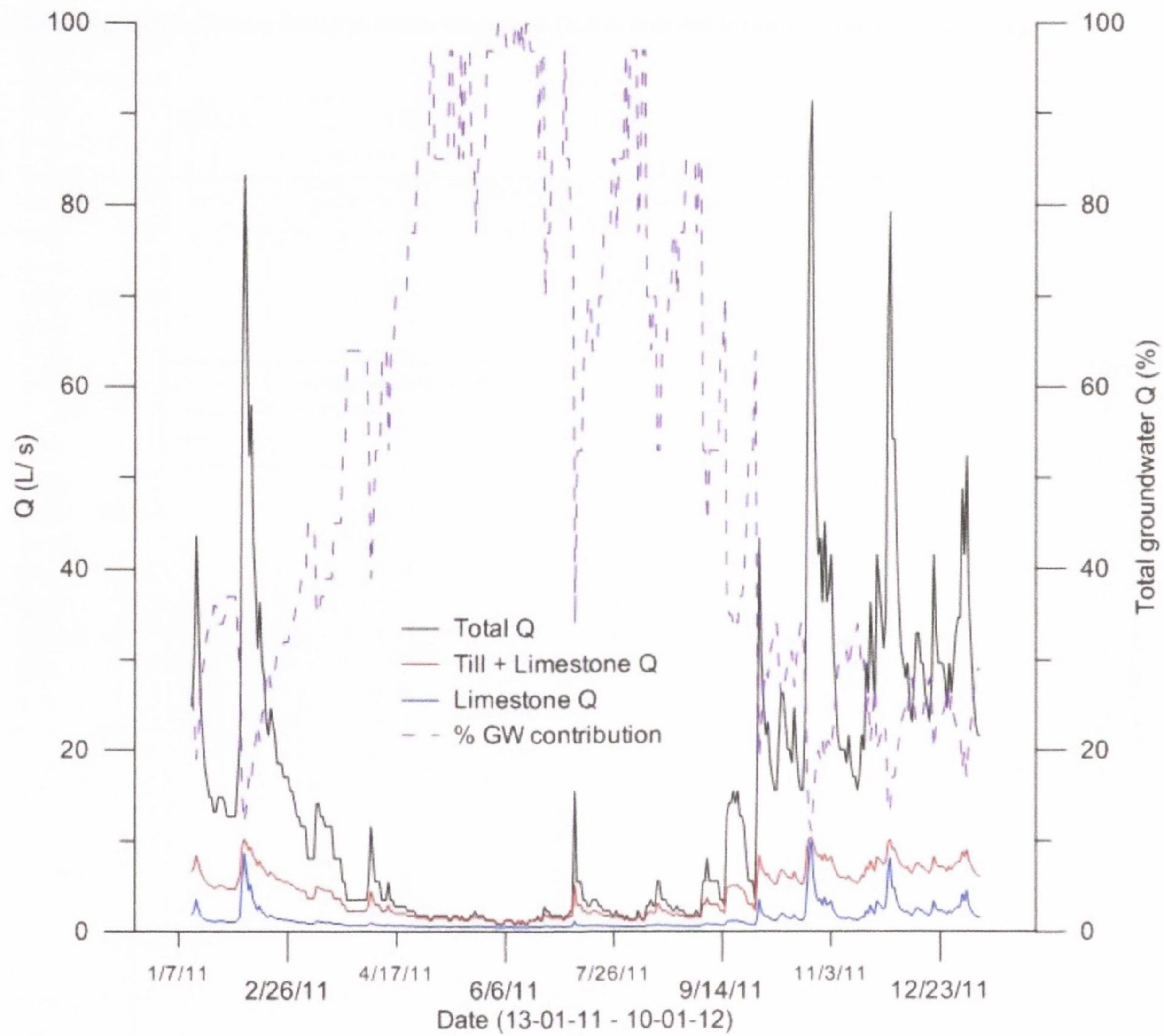


Figure D24. Restoration Flume flow rate hydrograph and groundwater contribution (Water balance period: 10-01-11 to 05-12-11)

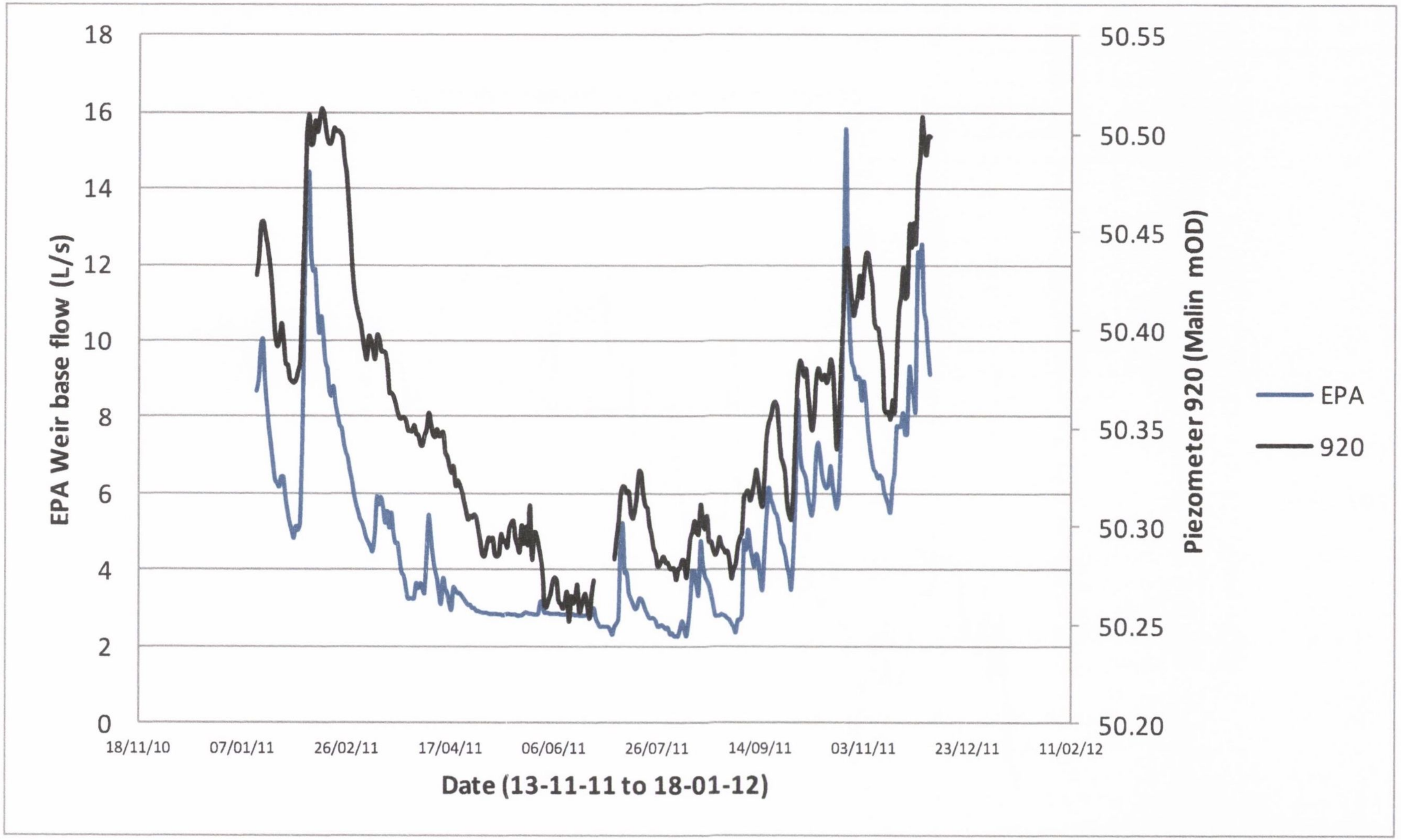


Figure D25. EPA Weir base flow hydrograph and groundwater level in subsoil piezometer 920 (water balance period: 13-01-11 to 05-12-11)

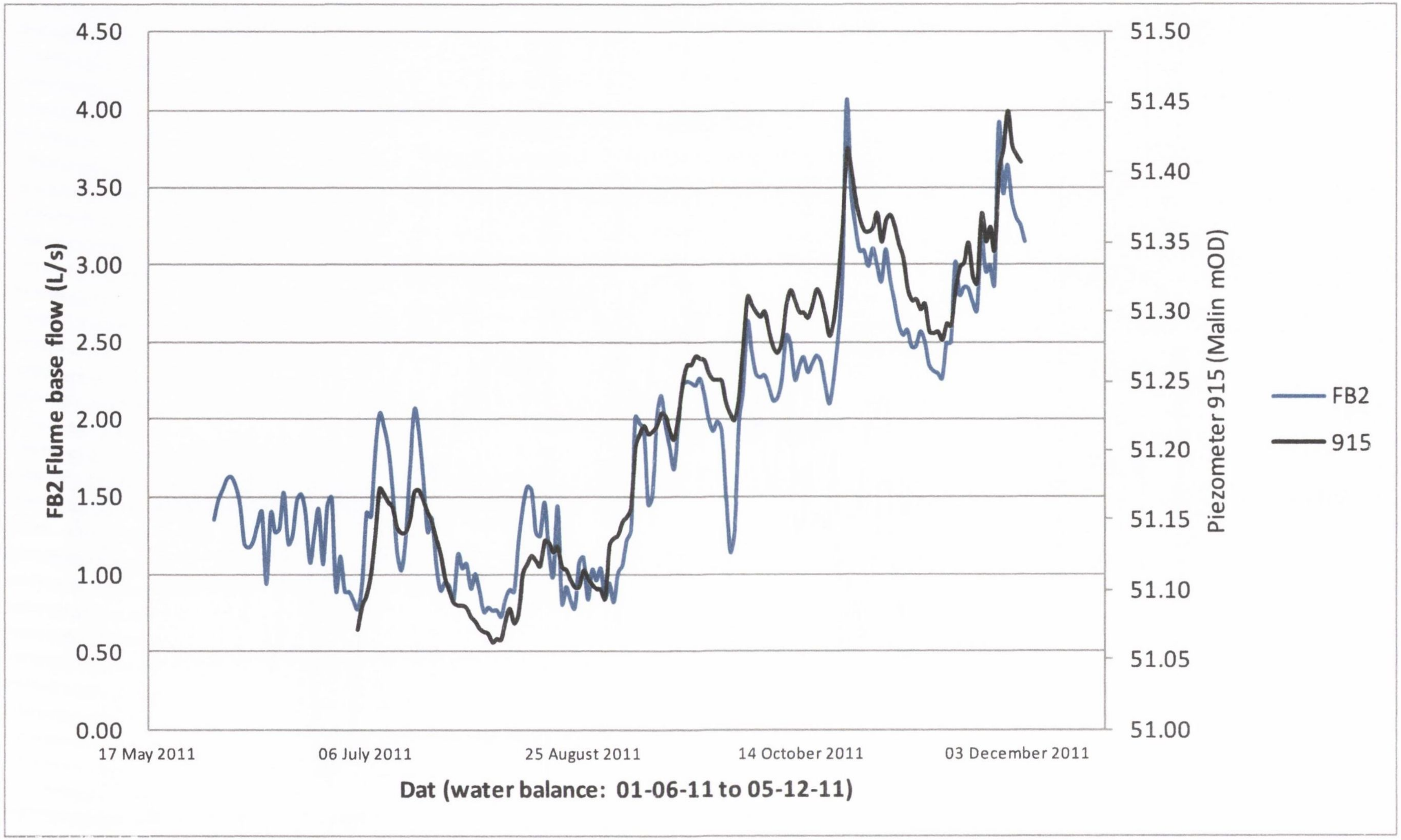


Figure D26. FB2 Flume base flow hydrograph and groundwater level in subsoil piezometer 915 (water balance period: 01-06-11 to 05-12-11)

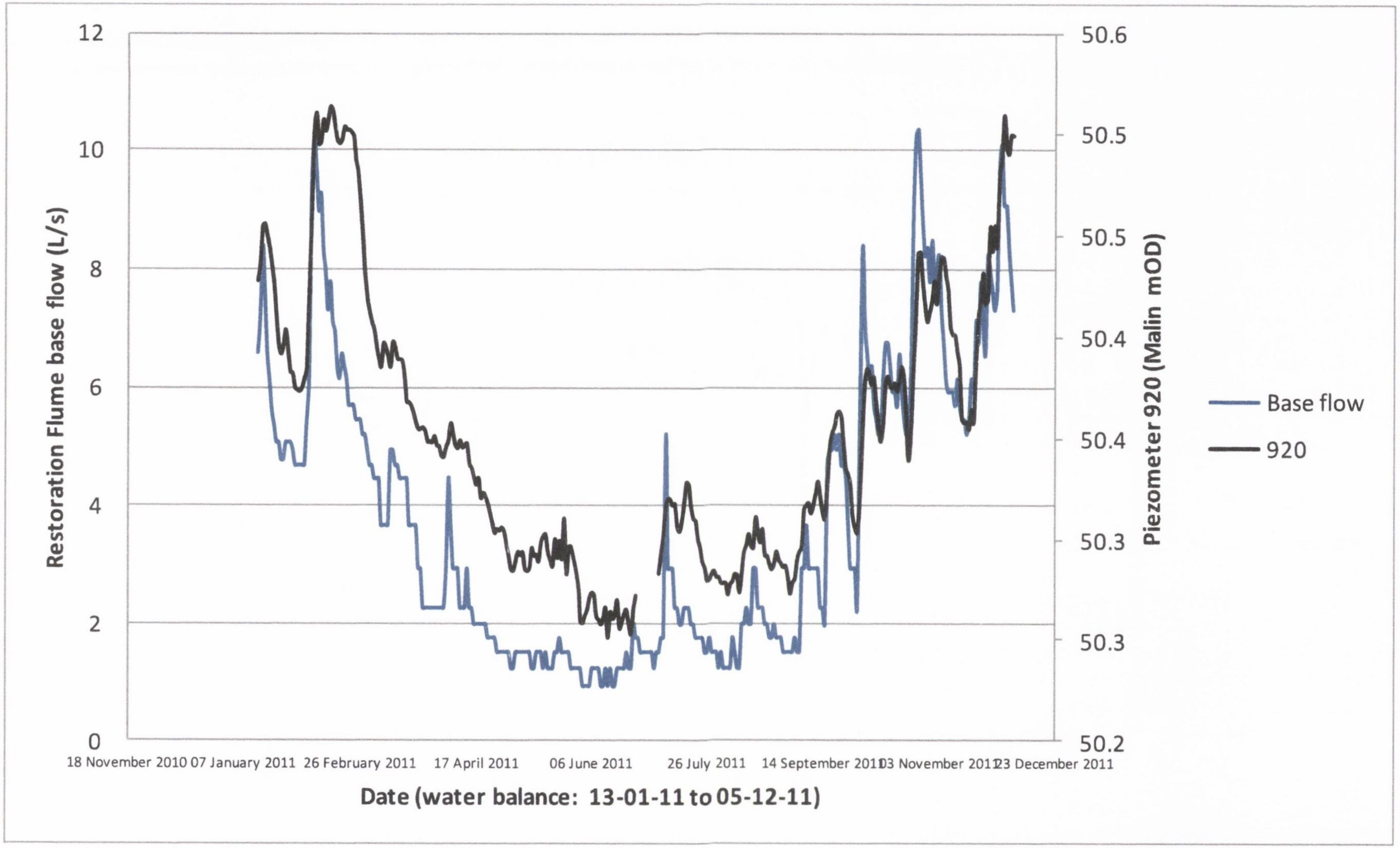


Figure D27. Restoration AreaFlume base flow hydrograph and groundwater level in subsoil piezometer 920 (water balance period: 10-01-11 to 05-12-11)

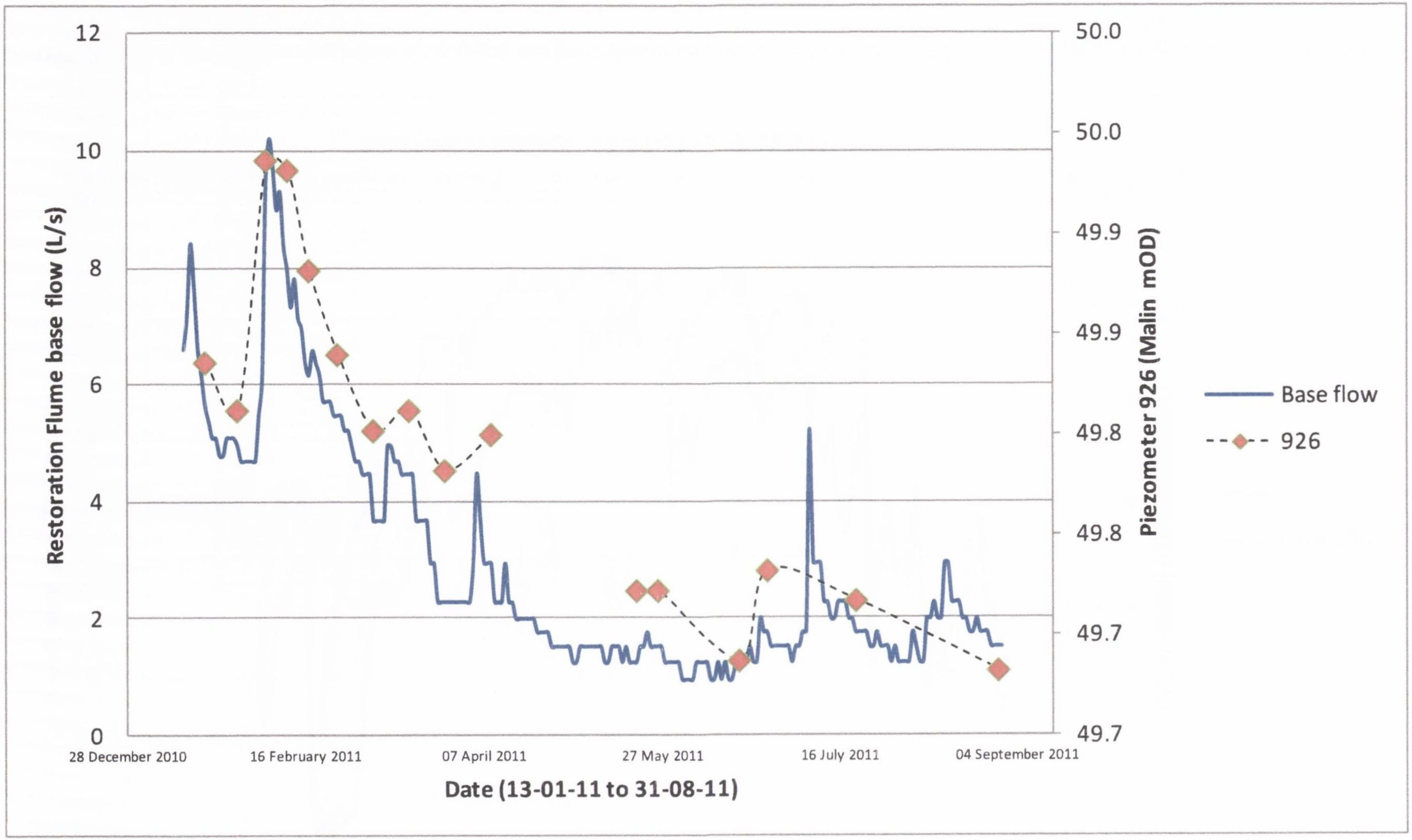


Figure D28. Restoration Area Flume base flow hydrograph and groundwater level in subsoil piezometer 926 (13-01-11 to 31-08-11)

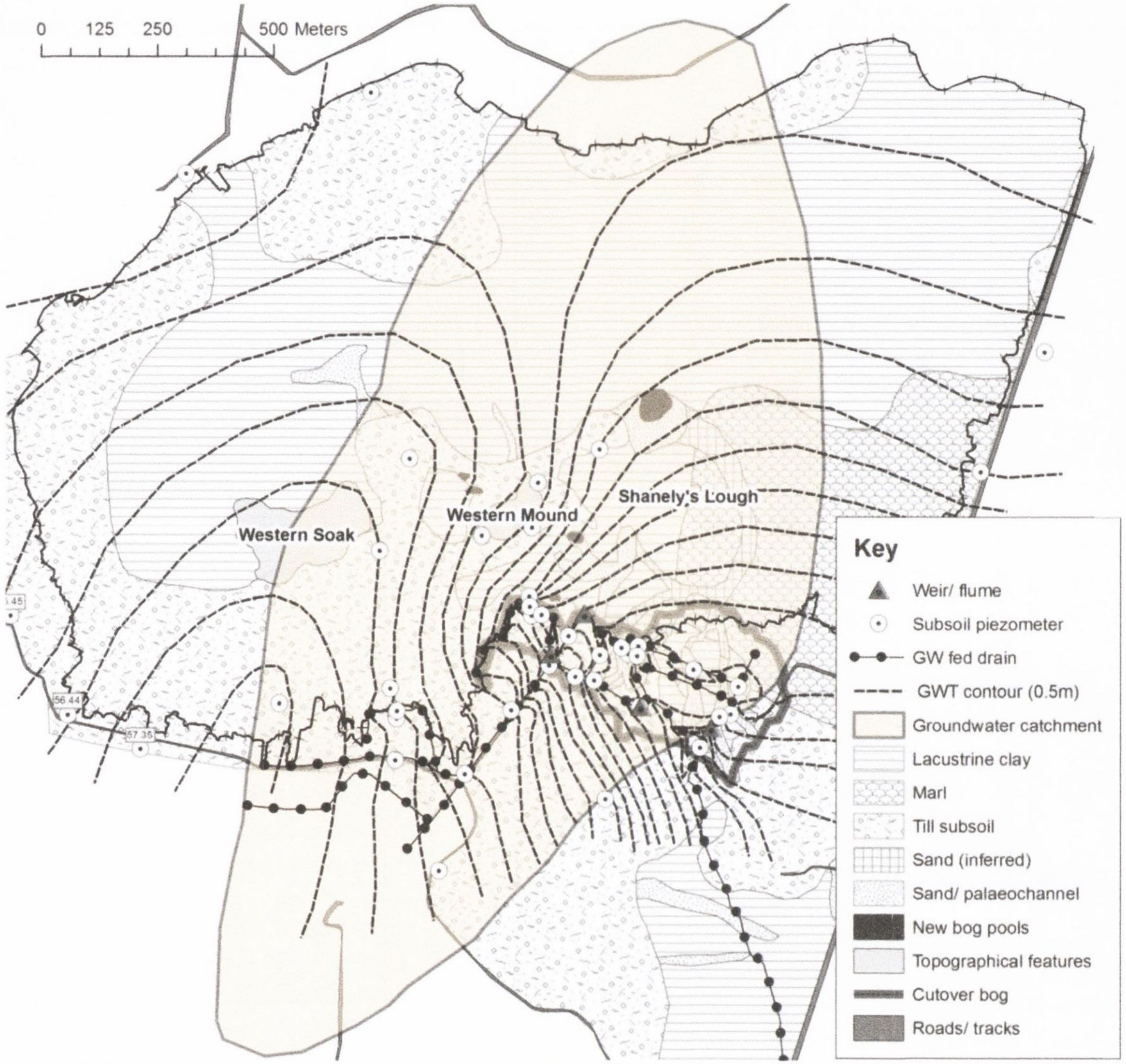


Figure D29. Recharge catchment – delineated based on groundwater flow to EPA Weir and Restoration Flume catchment

Appendix D: Groundwater-Surface-Water Interaction – Chemical Analysis Results

Table D1. Calcium concentrations from piezometers installed to till subsoil and date of water sampling

Groundwater (under cut bog)				Groundwater (under high bog)		
ID	**Date**	**mg / L**		**ID**	**Date**	**mg / L**
925	16/10/2010	138.95		934	16/10/2010	88.95
926	16/10/2010	88.94		934	04/10/2011	113.78
926	24/10/2011	129.75		907	16/10/2010	94.25
926	17/02/2012	104		907	17/02/2011	105.14
927	16/10/2010	85.85		909	23/09/2010	97.7
927	24/10/2011	113.29		909	17/02/2011	114.34
928	04/10/2011	142.81		910	21/07/2010	71.89
935	24/10/2011	69.06		910	17/02/2011	82.77
906	16/10/2010	109.31		CLCD1	16/10/2010	87.55
906	17/02/2011	133.49		CLCD3	21/07/2010	114.82
915	23/09/2010	101.6				
920	23/09/2010	68.9				
920	17/02/2012	54				
927	17/02/2012	87				
BH5-BR	21/07/2010	129.37	(Lst)			
BH5	21/07/2010	125.11				
BH5	17/02/2011	151.24				
BH9	17/02/2011	141.32				

Table D2. Calcium concentrations from piezometers installed in peat, sand and date of water sampling

Peat Water (high bog)			Peat Water (cutover bog)		
ID	**Date**	**mg / L**	**ID**	**Date**	**mg / L**
904-mp	04/10/2011	1.28	906-dp	16/10/2010	77.39
904-dp	04/10/2011	5.42	914-dp	23/09/2010	55.2
907-dp	16/10/2010	32.97	920-dp	17/02/2012	20
908-dp	17/02/2012	3	927-dp	24/10/2011	57.59
909-dp	23/09/2010	2.1	927-dp	17/02/2012	54
912-dp	23/09/2010	19.8			
937-dp	17/02/2012	8		**Sand lense**	
t10	16/10/2010	2.53	**ID**	**Date**	**mg / L**
t13	04-Oct-11	3.28	927	09-Aug-11	47.83
td4	16/10/2010	6.48	927	24-Oct-11	48.70
td4	04-Oct-11	10.27	937	09-Aug-11	53.87
td6-dp	17/02/2012	11			
tdK12	24-Oct-11	3.75			

Table D3. Calcium concentrations from drains (1) where there is a perched groundwater table and (2) where there is no groundwater contribution

GW seepage drains			Surface water (no GW influence)		
ID	**Date**	**mg / L**	**ID**	**Date**	**mg / L**
931	24/10/2011	145.21	Bog-Dr	avergae	1.07
Dr-918	27/08/2010	58.49	FB-Dr	21/07/2010	2.54
Dr-930	27/08/2010	73.27	Bog-Lk	27/08/2010	1.07
Dr-923	27/08/2010	69.24	920-ro	24/10/2011	5.10
Dr-CT3	16/10/2010	143.18	FB-Dr (924)	27/08/2010	0.37
			Pz-933	16/10/2010	7.99

Table D4. Calcium concentrations from drains at (1) low flow and (2) high flow. Note: Minimum and maximum values.

Surface Water (low flow)			Surface Water (high flow)		
ID	**Date**	**mg / L**	**ID**	**Date**	**mg / L**
Dr-914	27/08/2010	69.59	Dr-914	17/02/2010	10.80
SG5	27/08/2010	87.09	SG5	17/02/2010	11.32
SG4	27/08/2010	74.65	SG4	23/09/2010	20.16
SG8	22-Apr-11	135.09	Rest-Fl	24-Oct-11	17.19
EPA-W	17-Jun-11	90.52	FB2-Fl	18-Oct-11	19.37
FB2-Fl	17-Jun-11	85.92	EPA-W	04-Oct-11	31.20
Rest-Fl	04-Jul-11	86.90			

Table D5. Silica concentrations from piezometers installed to till subsoil and date of water sampling

Groundwater (under cut bog)				Groundwater (under high bog)		
ID	**Date**	**mg / L**		**ID**	**Date**	**mg / L**
913	17/02/2012	3.25		934	16/10/2010	2.24
925	16/10/2010	2.32		934	04/10/2011	2.88
925	24/10/2011	0.75		907	16/10/2010	3.69
926	16/10/2010	4.37		907	17/02/2011	4.6
926	24/10/2011	7.71		908	21/07/2010	2.42
926	17/02/2012	7.13		909	17/02/2011	5.75
927	16/10/2010	4.08		910	21/07/2010	2.81
927	24/10/2011	6.67		910	17/02/2011	4.5
928	04/10/2011	4.12		910	17/02/2012	4.95
935	24/10/2011	2.80		CLCD1	16/10/2010	3.90
906	16/10/2010	2.79		CLCD1	17/02/2012	6.45
906	17/02/2011	4.45		CLCD3	21/07/2010	1.53
906	17/02/2012	5.78		Tl12	17/02/2012	1.31
915	23/09/2010	3.2				
915	17/02/2012	4.63				
920	23/09/2010	2.4				
920	17/02/2012	2.03				
927	17/02/2012	6.22				
BH10-R	17/02/2012	5.76	(Lst)			
BH10	17/02/2012	2.01				
BH11-R	17/02/2012	4.43	(Lst)			
BH11-ss	17/02/2012	5.73				
BH5-R	21/07/2010	1.86	(Lst)			
BH5	21/07/2010	1.76				
BH5	17/02/2011	2.43				
BH5	17/02/2011	3.56				

Table D6. Silica concentrations from drains (1) where there is a perched groundwater table and (2) where there is no groundwater contribution

GW seepage drains			Surface water (no GW influence)		
ID	**Date**	**mg / L**	**ID**	**Date**	**mg / L**
931	24/10/2011	7.72	Bog-Dr	avergae	0.26
Dr-918	27/08/2010	1.51	FB-Dr	21/07/2010	0.89
Dr-930	27/08/2010	2.27	Bog-Lk	27/08/2010	0.17
Dr-923	27/08/2010	2.74	920-ro	24/10/2011	0.17
Dr-CT3	16/10/2010	1.03	FB-Dr (924)	27/08/2010	1.81
Dr-918	17/02/2012	3.39	Pz-933	16/10/2010	0.59
			905-sw	17/02/2012	0

Table D7. Silica concentrations from piezometers installed in peat, sand and date of water sampling

Peat Water (high bog)			Peat Water (cutover bog)		
ID	**Date**	**mg / L**	**ID**	**Date**	**mg / L**
909-DP	23/09/2010	0.9	914-DP	23/09/2010	2.0
912-DP	23/09/2010	0.5	906-DP	16/10/2010	2.37
td4	16/10/2010	0.23	927-DP	24/10/2011	4.39
t10	16/10/2010	0.18	927-dp	17/02/2012	5.55
907-DP	16/10/2010	1.59	920-dp	17/02/2012	5.4
904-E	04/10/2011	<0.21	906-dp	17/02/2012	3.96
t13	04-Oct-11	< 0.21			
92-dp	17/02/2012	1.01		**Sand lense**	
937-dp	17/02/2012	2.62	**ID**	**Date**	**mg / L**
904-dp	17/02/2012	0	927-sd	09-Aug-11	<0.21
tl12-dp	17/02/2012	0.52	927-sd	24-Oct-11	1.77
td6-dp	17/02/2012	0.51	937-sd	09-Aug-11	<0.21
908-dp	17/02/2012	1.06			
94-dp	17/02/2012	0			
910-dp	17/02/2012	0.44			
td9-dp	17/02/2012	0.46			
tl12-mp	17/02/2012	2.32			

Table D8. Silica concentrations from drains at (1) low flow and (2) high flow. Note: Minimum and maximum values.

Surface Water (low flow)			Surface Water (high flow)		
ID	**Date**	**mg / L**	**ID**	**Date**	**mg / L**
Dr-914	27/08/2010	2.25	Dr-914	23/09/2010	0.49
SG5	27/08/2010	3.40	SG5	23/09/2010	0.50
SG4	27/08/2010	2.26	SG4	23/09/2010	0.65
SG8	22-Apr-11	3.22	Rest-Fl	24-Oct-11	0.51
EPA-W	17-Jun-11	3.59	FB2-Fl	18-Oct-11	0.81
FB2-Fl	17-Jun-11	4.10	EPA-W	04-Oct-11	1.31
Rest-Fl	04-Jul-11	5.11			

Table D9. Strontium concentrations from piezometers installed to till subsoil and date of water sampling

Groundwater (under cut bog)			Groundwater (under high bog)		
ID	Date	µg / L	ID	Date	µg / L
925	16/10/2010	130.88	934	16/10/2010	105.19
925	24/10/2011	55.251	934	04/10/2011	173.11
926	16/10/2010	206.23	907-SS	16/10/2010	129.84
926	24/10/2011	305.11	908-SS	21/07/2010	
927	16/10/2010	168.53	909-SS	23/09/2010	127.7
927	24/10/2011	240.51	910-SS	21/07/2010	144.4
928	04/10/2011	204.57	CLCD1	16/10/2010	212.69
935	24-Oct-11	114.6	CLCD3	21/07/2010	284.9
906-SS	16/10/2010	147.86	907-SS	17/02/2011	160.47
915-SS	23/09/2010	140.2	908-SS	17/02/2011	46.49
920-SS	23/09/2010	101.4	909-SS	17/02/2011	151.78
BH5-BR	21/07/2010	129.8	910-SS	17/02/2011	138.30
BH5-SS	21/07/2010	131.0			
906-SS	17/02/2011	189.89			
BH5-SS	17/02/2011	121.51			
BH9-SS	17/02/2011	196.76			

Table D10. Strontium concentrations from piezometers installed in peat, sand and date of water sampling

Peat Water (high bog)			Peat Water (cutover bog)		
ID	Date	µg / L	ID	Date	µg / L
909-DP	23/09/2010	4.7	914-DP	23/09/2010	76.5
912-DP	23/09/2010	25.9	906-DP	16/10/2010	79.91
td4	16/10/2010	5.68	927-DP	24/10/2011	118.87
t10	16/10/2010	2.99			
907-DP	16/10/2010	48.47			
904-E	04/10/2011	7.04			
904-F	04/10/2011	21.87			
t13	04-Oct-11	13.07			
td4	04-Oct-11	20.353			
tdK12	24-Oct-11	4.19			

Table D11. Strontium concentrations from drains (1) where there is a perched groundwater table and (2) where there is no groundwater contribution

GW seepage drains			Surface water (no GW influence)		
ID	Date	µg / L	ID	Date	µg / L
931	24/10/2011	247.98	Bog-Dr	average	2.37
Dr-918	27/08/2010	75.44	FB-Dr	21/07/2010	9.51
Dr-930	27/08/2010	105.45	Bog-Lk	27/08/2010	7.05
Dr-923	27/08/2010	104.63	920-ro	24/10/2011	26.24
Dr-CT3	16/10/2010	208.37	FB-Dr (924)	27/08/2010	0.00
			Pz-933	16/10/2010	15.80

Table D12. Strontium concentrations from drains at (1) low flow and (2) high flow. Note: Minimum and maximum values.

Surface Water (low flow)			Surface Water (high flow)		
ID	Date	µg / L	ID	Date	µg / L
Dr-914	27/08/2010	93.71	Dr-914	17/02/2010	12.74
SG5	27/08/2010	195.95	SG5	17/02/2010	20.91
SG4	27/08/2010	100.99	SG4	23/09/2010	24.54
SG8	22-Apr-11	169.82	Rest-Fl	24-Oct-11	40.00
EPA-W	17-Jun-11	108.00	FB2-Fl	18-Oct-11	35.41
FB2-Fl	17-Jun-11	101.00	EPA-W	04-Oct-11	48.39
Rest-Fl	04-Jul-11	174.00			

Table D13. $\delta^{18}O$ values (‰) from piezometers installed to till subsoil, limestone bedrock and date of water sampling

Groundwater (under cut bog)

ID	Date	d^{18O} (‰)
913	14/10/2009	-5.82
925	16/10/2010	-6.45
925	24/10/2011	-6.18
926	16/10/2010	-4.72
926	24/10/2011	-4.76
927	16/10/2010	-4.98
927	24/10/2011	-4.94
928	16/10/2010	-6.61
928	04/10/2011	-6.58
935	16/10/2010	-7.03
935	24-Oct-11	-6.53
906	14/10/2009	-5.71
906	16/10/2010	-6.02
906	17/02/2011	-5.77
915	23/09/2010	-5.60
920	23/09/2010	-4.29
BH11	30/09/2009	-5.51
BH2	30/09/2009	-6.50
BH3	30/09/2009	-6.78
BH5	30/09/2009	-6.53
BH5	21/07/2010	-6.60
BH5	17/02/2011	-6.26
BH9	30/09/2009	-6.55
BH9	17/02/2011	-6.48

Groundwater (under high bog)

ID	Date	d^{18O} (‰)
934	16/10/2010	-5.01
934	04/10/2011	-5.65
907	14/10/2009	-5.15
907	16/10/2010	-4.93
907	17/02/2011	-5.09
908	14/10/2009	-5.90
908	21/07/2010	-5.54
908	17/02/2011	-5.52
909	14/10/2009	-5.28
909	23/09/2010	-5.66
909	17/02/2011	-5.59
910	14/10/2009	-6.09
910	21/07/2010	-5.90
910	17/02/2011	-6.40
911	14/10/2009	-5.33
CLCD1	30/09/2009	-4.82
CLCD1	16/10/2010	-4.95
CLCD3	14/10/2009	-5.91
CLCD3	16/10/2011	-5.52

Groundwater (bedrock)

ID	Date	d^{18O} (‰)
BH11	30/09/2009	-4.4
BH12	30/09/2009	-5.79
BH2	30/09/2009	-4.52
BH5	30/09/2009	-6.44
BH5	21/07/2010	-6.29
BH9	30/09/2009	-6.01

Table D14. $\delta^{18}O$ values (‰) from piezometers installed in peat, lacustrine clay, sand and date of water sampling

Peat Water (high bog)

ID	Date	d^{18O} (‰)
70	14/10/2009	-6.83
902	14/10/2009	-5.57
904-dp	14/10/2009	-7.07
904-mp	04/10/2011	-6.48
904-dp	04/10/2011	-7.41
904-mp	14/10/2009	-5.78
905-dp	14/10/2009	-6.93
907-dp	14/10/2009	-4.88
907-dp	16/10/2010	-5.03
907-mp	14/10/2009	-5.28
908-dp	14/10/2009	-5.84
909-dp	14/10/2009	-6.00
909-dp	23/09/2010	-5.64
909-mp	14/10/2009	-5.46
910-dp	14/10/2009	-6.13
910-mp	14/10/2009	-6.16
911-dp	14/10/2009	-5.68
912-dp	14/10/2009	-5.65
912-dp	23/09/2010	-6.50
912-mp	14/10/2009	-5.62
93-dp	14/10/2009	-5.91
96-dp	14/10/2009	-6.76
96-mp	14/10/2009	-5.87
t10	16/10/2010	-7.03
t13	04-Oct-11	-7.34
td4	14/10/2009	-6.77
td4	16/10/2010	-6.78
td4	04-Oct-11	-7.03
td6	14/10/2009	-6.43
td9	14/10/2009	-6.74
tdJ12	14/10/2009	-6.17
tdK12	24-Oct-11	-7.03

Peat Water (cutover bog)

ID	Date	d^{18O} (‰)
906-dp	14/10/2009	-5.75
906-dp	16/10/2010	-5.88
914-dp	14/10/2009	-5.49
914-dp	23/09/2010	-5.59
927-dp	24/10/2011	-5.30

Lacustrine clay

ID	Date	d^{18O} (‰)
93	14/10/2009	-6.93
96	14/10/2009	-6.91
902	14/10/2009	-6.73

Sand lense

ID	Date	d^{18O} (‰)
927	24-Oct-11	-5.26

Table D15. $\delta\ ^{18}O$ values (‰) from drains (1) where there is a perched groundwater table and (2) where there is no groundwater contribution

GW seepage drains			Surface water (no GW influence)		
ID	**Date**	**d180 (‰)**	**ID**	**Date**	**d180 (‰)**
931	24/10/2011	-5.01	905-PH	14/10/2009	-4.59
Dr-918	30/09/2009	-5.10	905-sw	14/10/2009	-4.33
Dr-918	27/08/2010	-4.68	907-PH	14/10/2009	-4.75
Dr-923	27/08/2010	-5.35	907-ph	16/10/2010	-6.00
Dr-930	27/08/2010	-6.06	908-Ph	14/10/2009	-5.35
Dr-CT3	16/10/2010	-5.70	911-ph	14/10/2009	-4.85
			920-ro	24/10/2011	-4.50
			93-ph	14/10/2009	-6.17
			Bog-Dr	30/09/2009	-4.99
			Bog-Dr	24/10/2011	-4.75
			Bog-Lk	14/10/2009	-4.45
			Bog-Lk	27/08/2010	-5.80
			CWG1	14/10/2009	-4.47
			FB-Dr	21/07/2010	-5.49
			FB-Dr	27/08/2010	-3.13
			Pz-933	16/10/2010	-5.99

Table D16. $\delta\ ^{18}O$ values (‰) from drains at (1) low flow and (2) high flow. Note: Minimum and maximum values.

Surface Water (low flow)			Surface Water (high flow)		
ID	**Date**	**d180 (‰)**	**ID**	**Date**	**d180 (‰)**
EPA-W	17-Jun-11	-6.36	EPA-W	04-Oct-11	-5.13
FB2-Fl	17-Jun-11	-5.59	FB2-Fl	18-Oct-11	-4.97
Rest-Fl	17-Jun-11	-5.65	Rest-Fl	24-Oct-11	-4.80
SG8	22-Apr-11	-6.39			

Appendix E

Subsidence

Appendix E. Subsidence: Subsidence Analysis Area

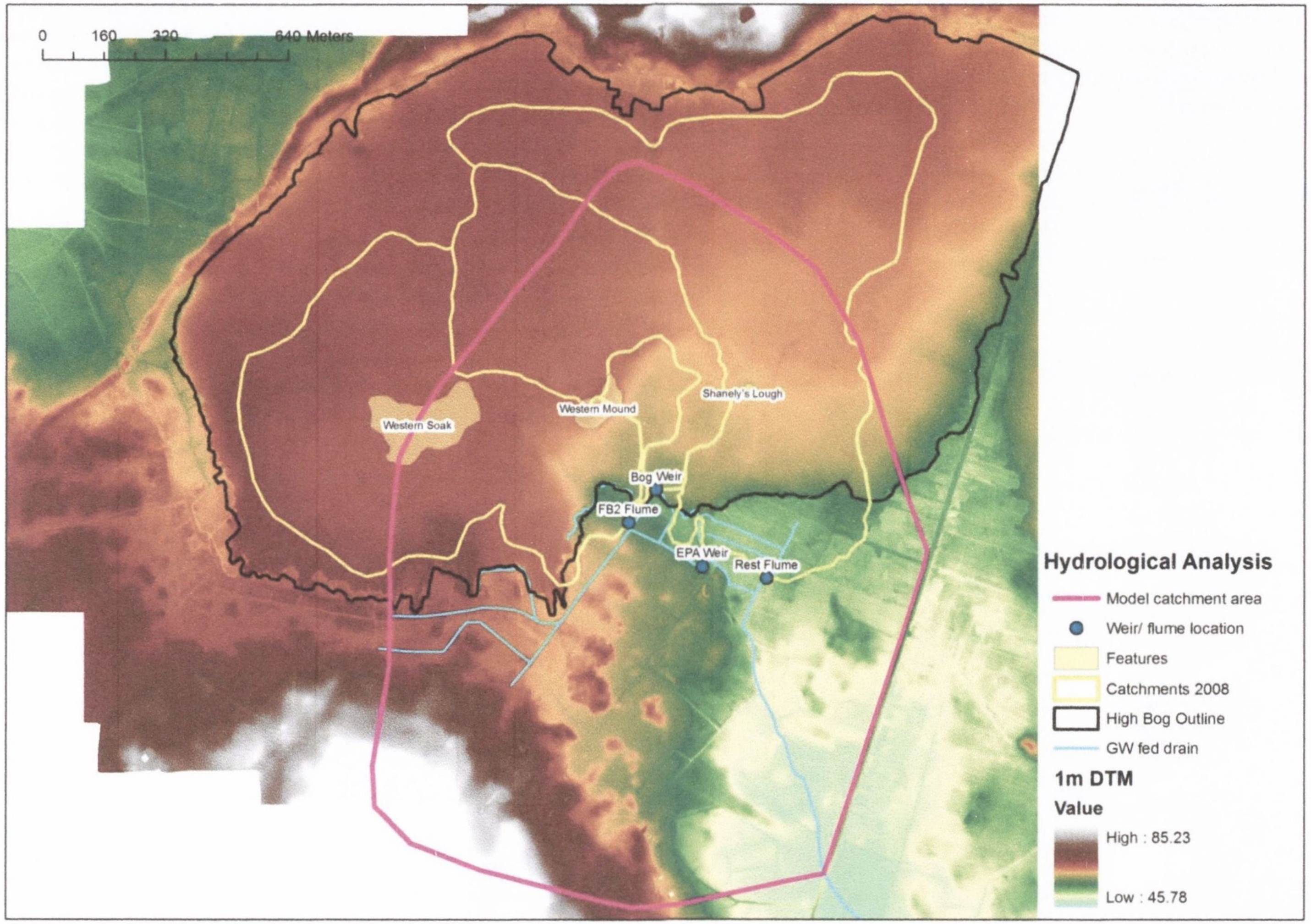


Figure E1. Subsidence analysis area and underlying topographic catchment areas

Appendix E. Subsidence: Topographic changes between 1992 and 2011

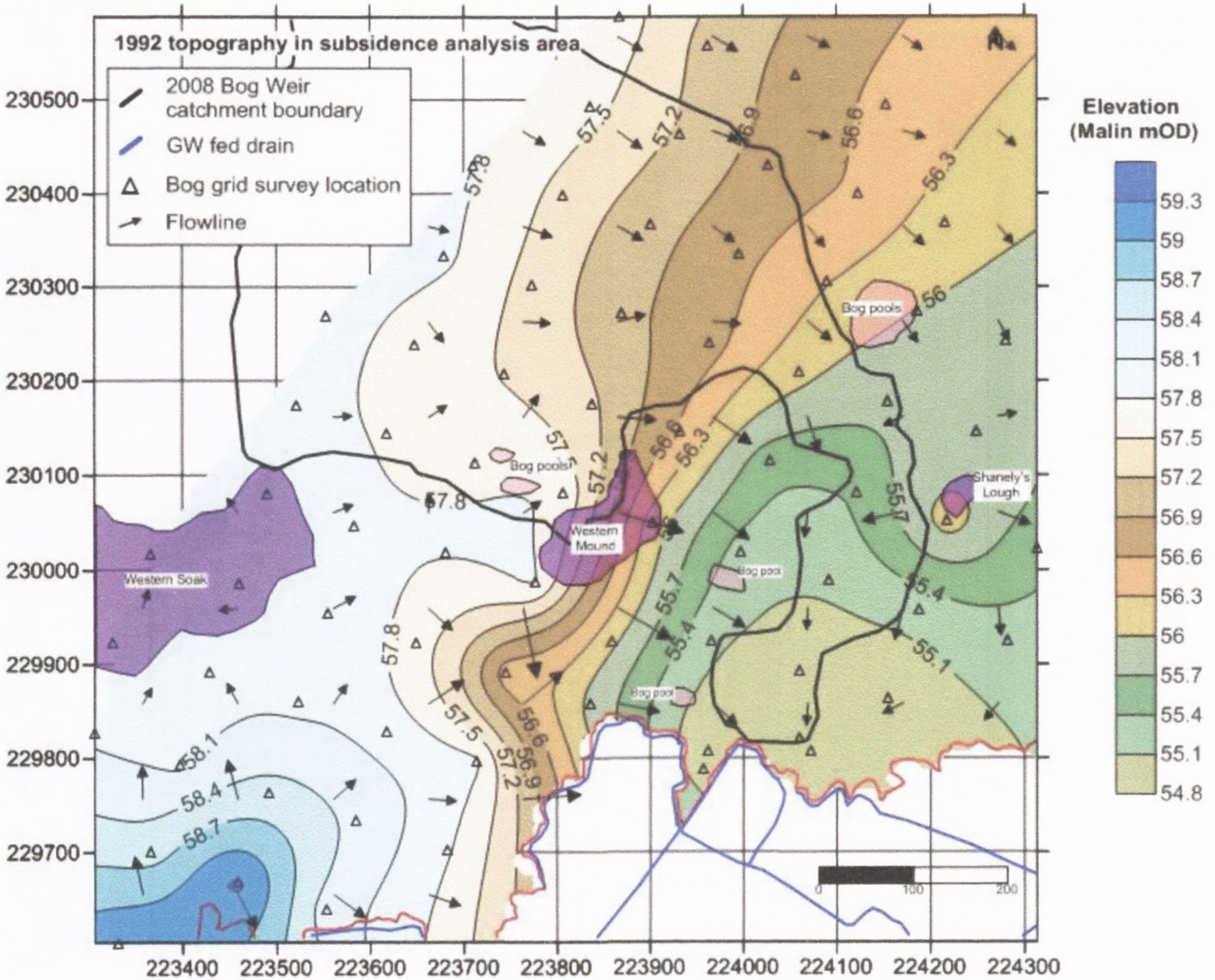


Figure E2. High bog topography in subsidence analysis area in 1992 (100m grid)

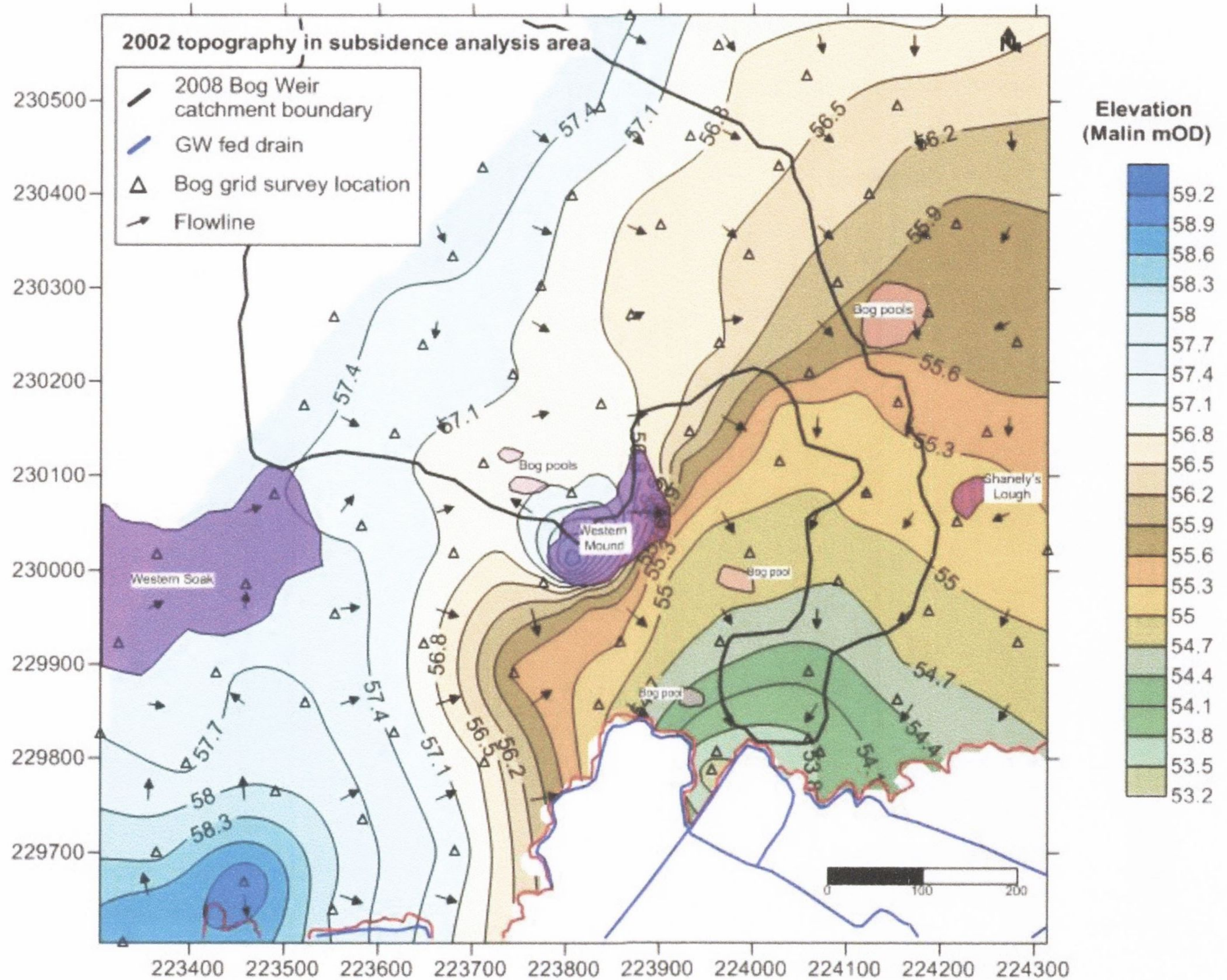


Figure E3. High bog topography in subsidence analysis area in 2002 (100m grid)

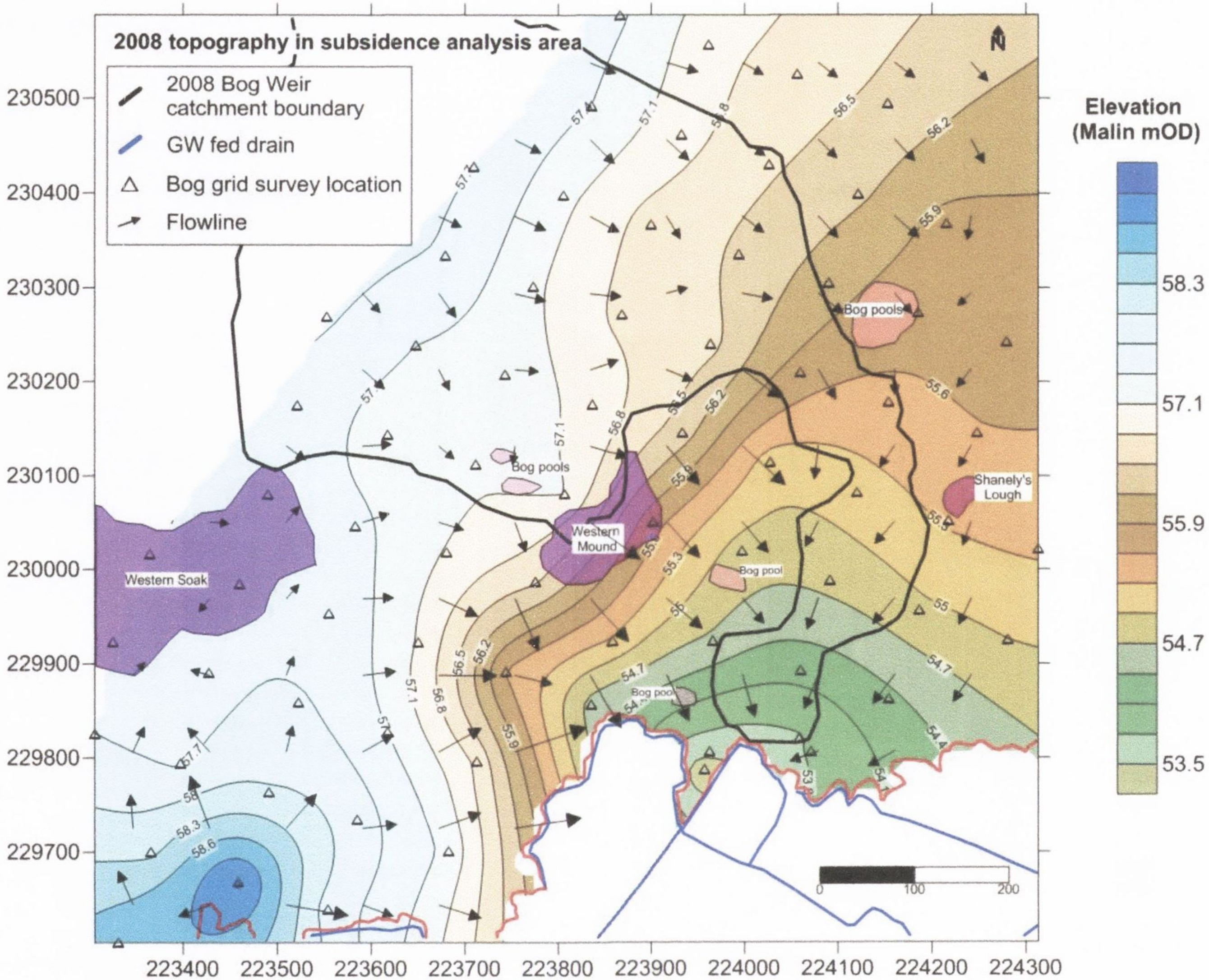


Figure E4. High bog topography in subsidence analysis area in 2008 (100m grid: LiDAR elevations)

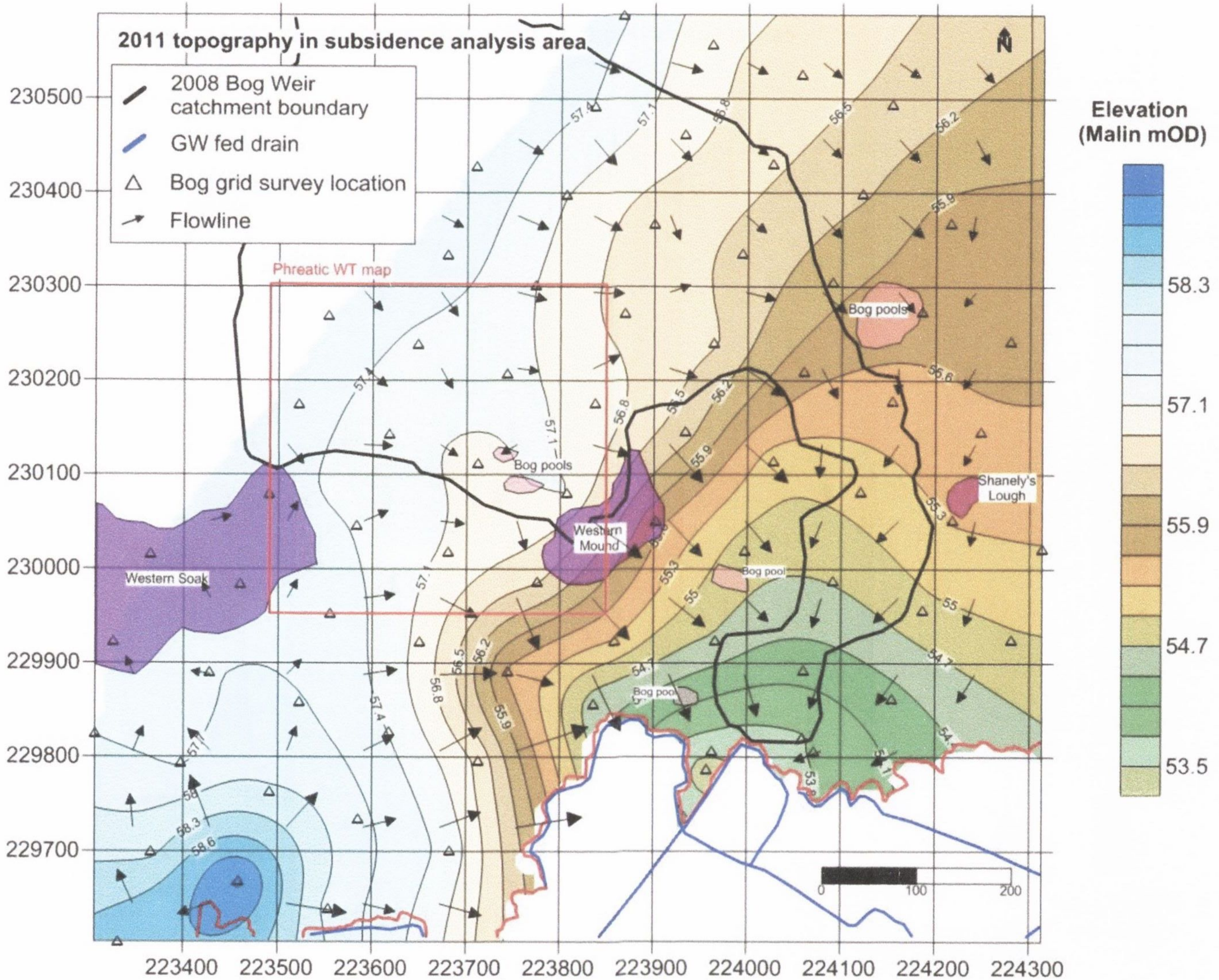


Figure E5. High bog topography in subsidence analysis area in 2011 (100m grid: Trimble GPS survey)

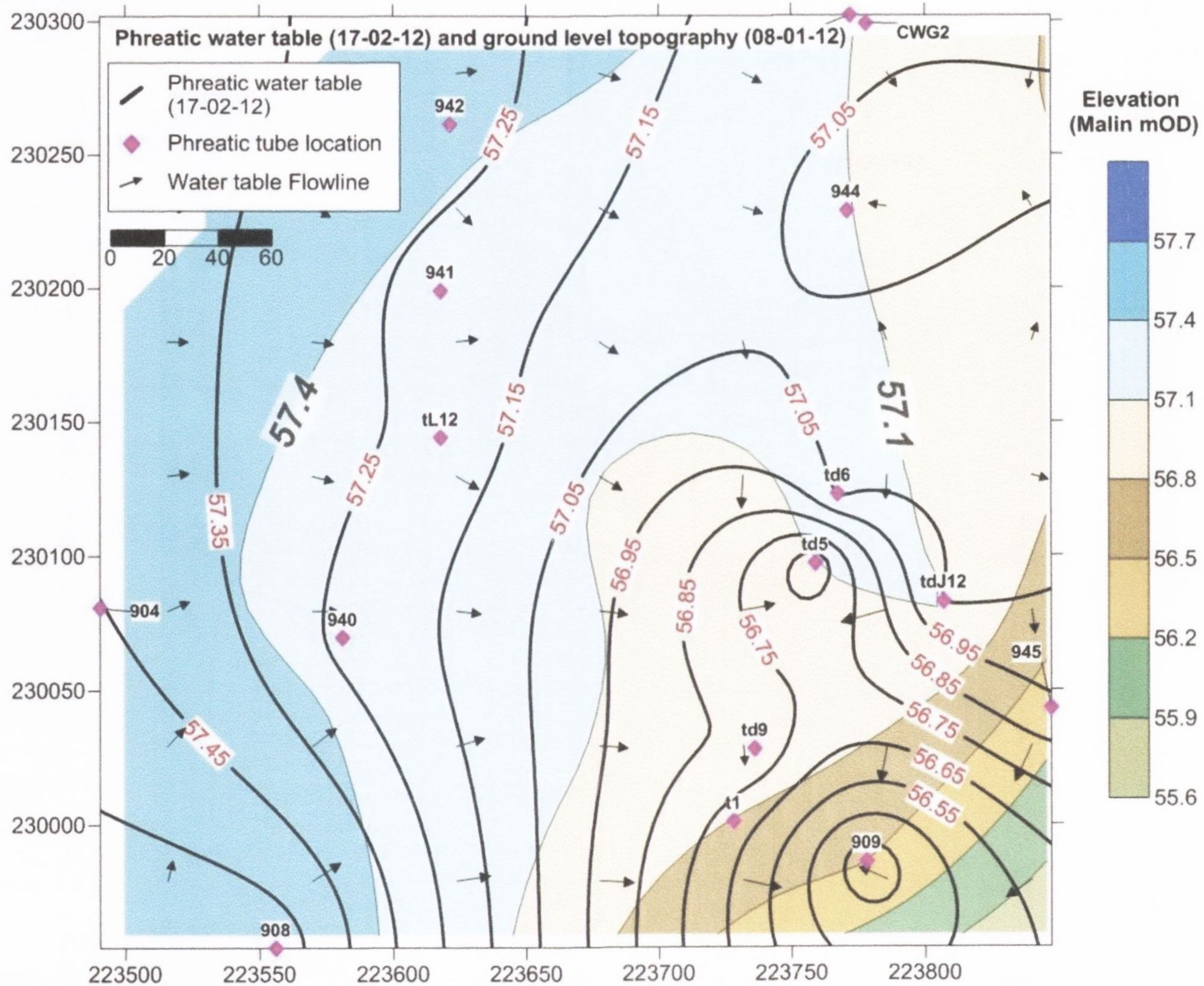


Figure E6. High bog topography and February 2012 phreatic water table in catchment divide area

Appendix E: Subsidence – Ground Level Decrease

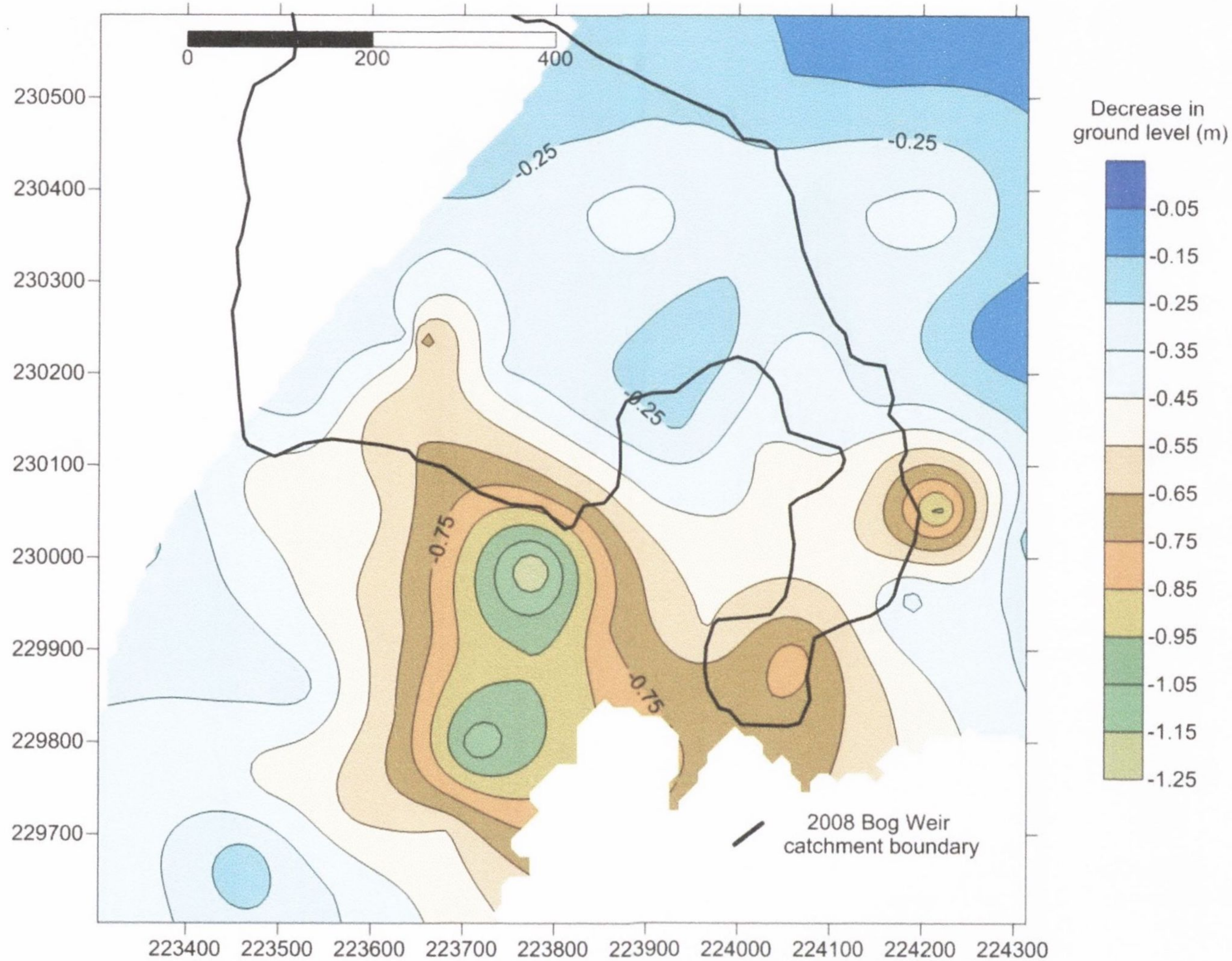


Figure E7. Decrease in surface ground level (m) between 1991 and 2011

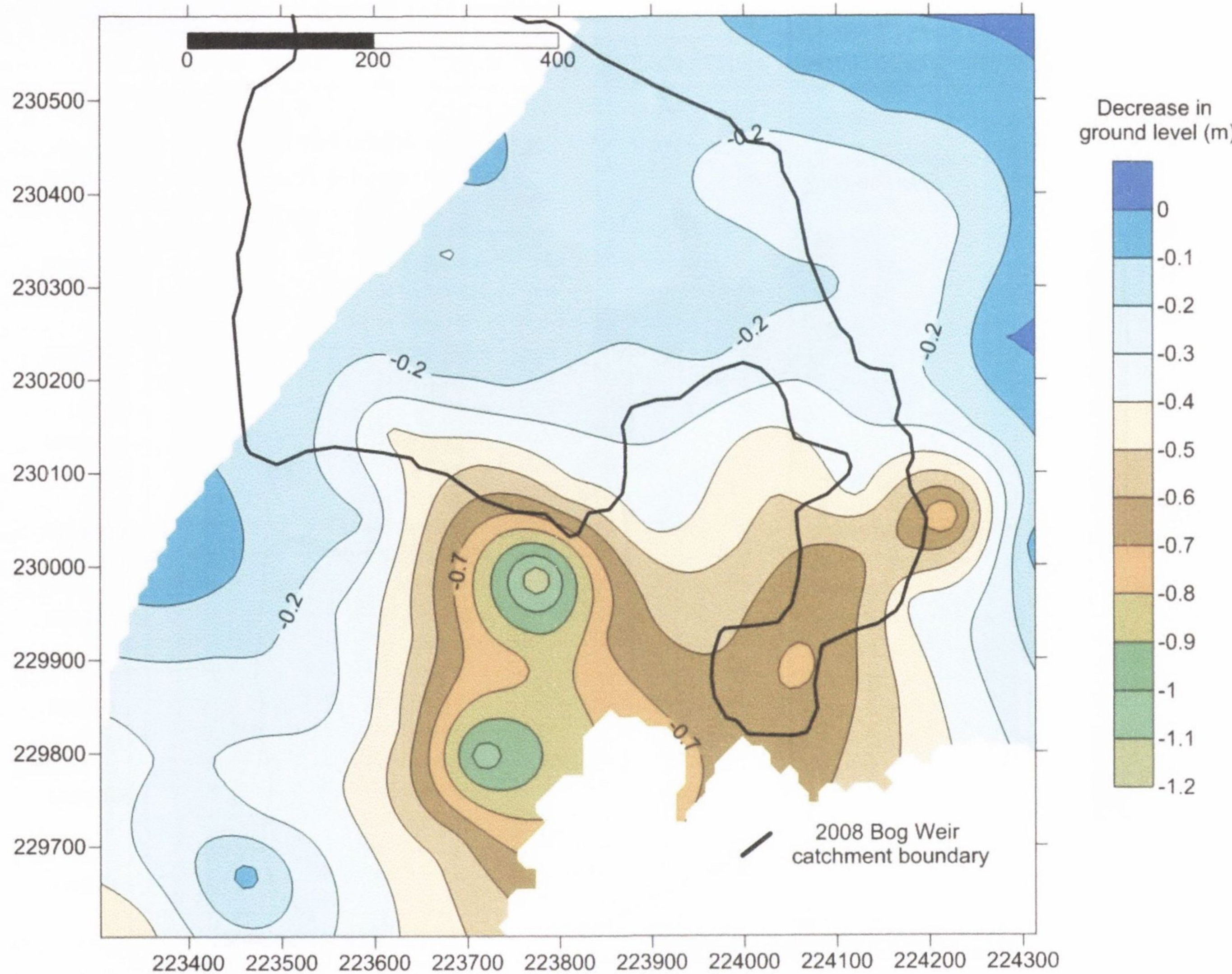


Figure E8. Decrease in surface ground level (m) between 1991 and 2002

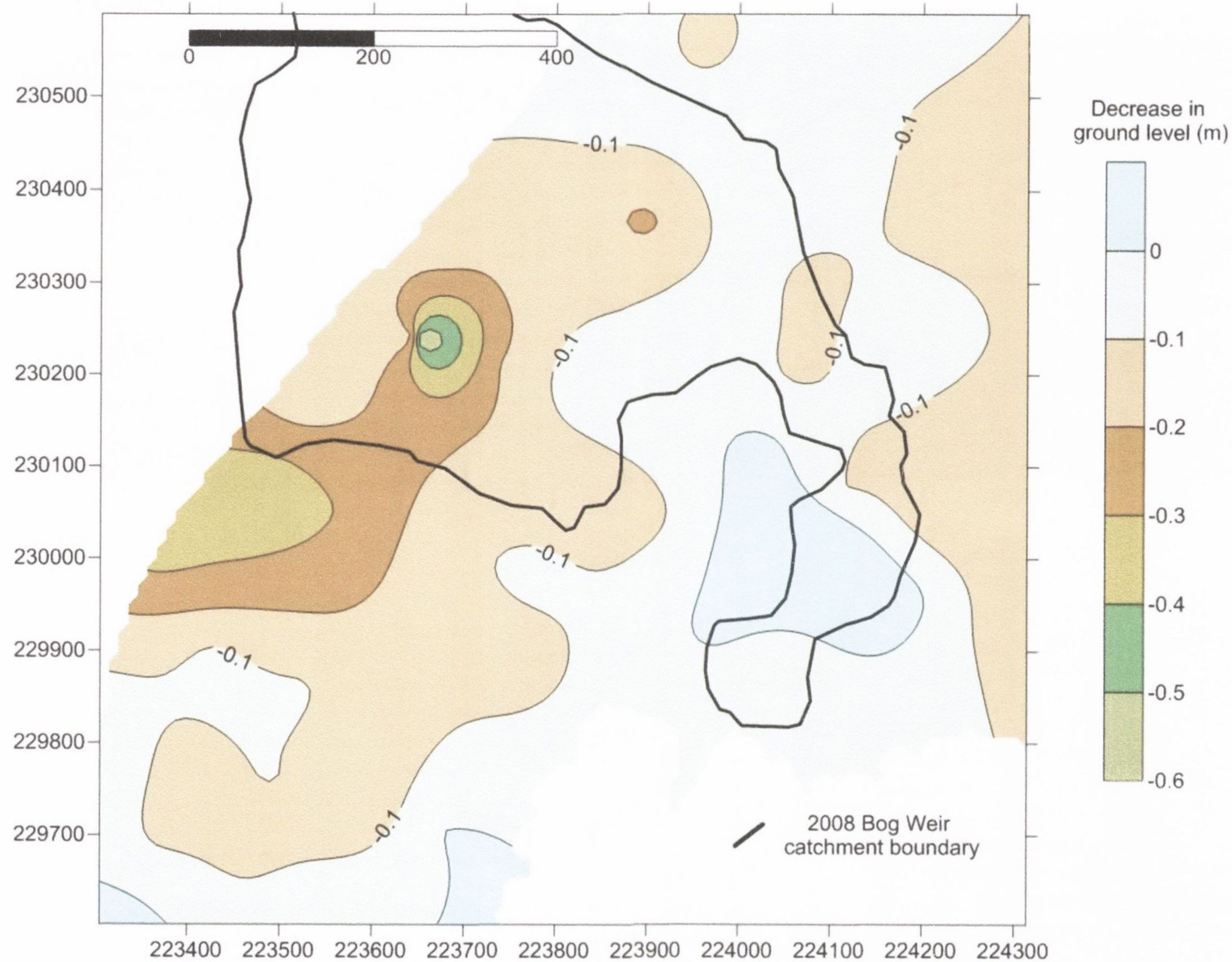


Figure E9. Decrease in surface ground level (m) between 2002 and 2011

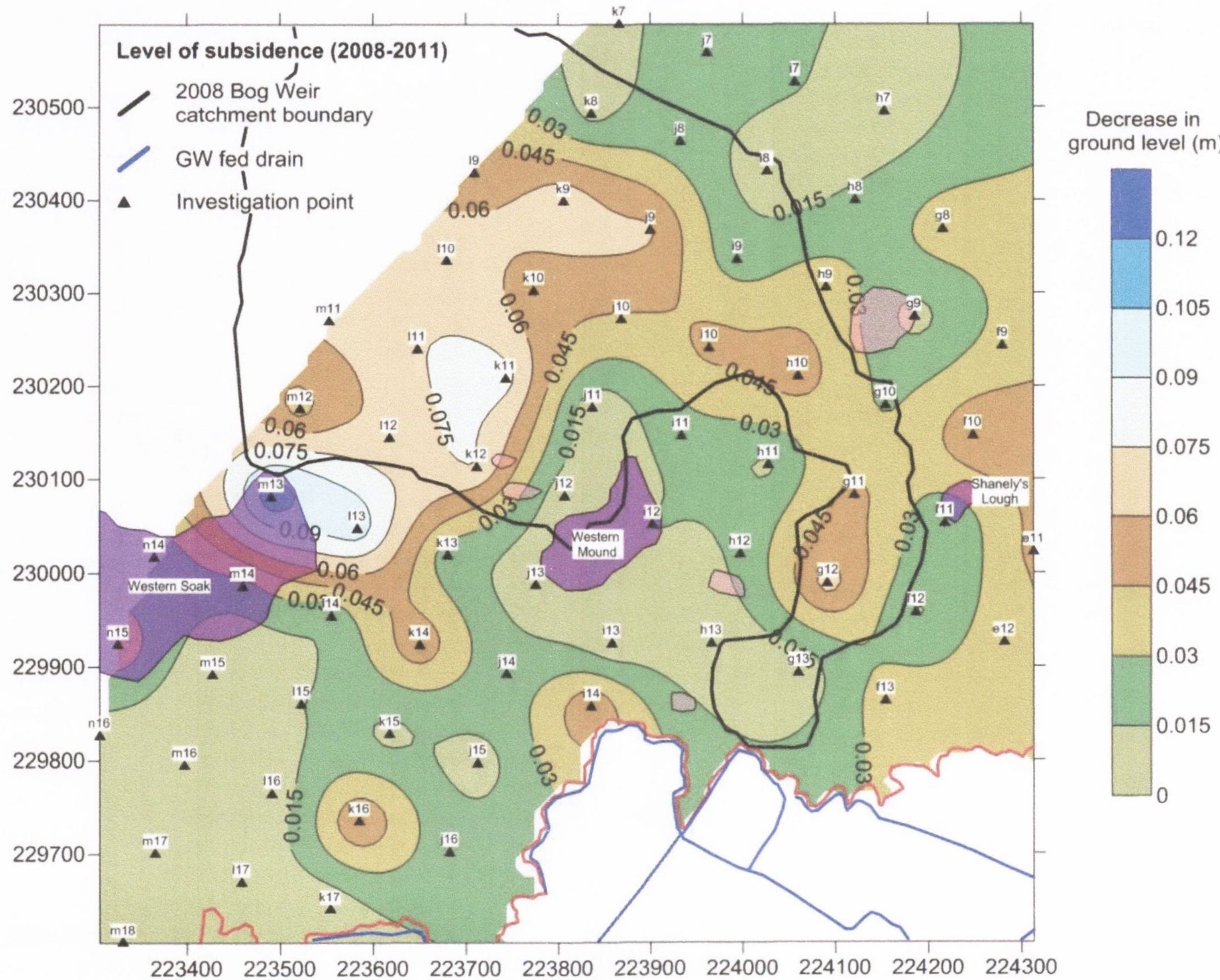


Figure E10. Decrease in surface ground level (m) between 2008 and 2011

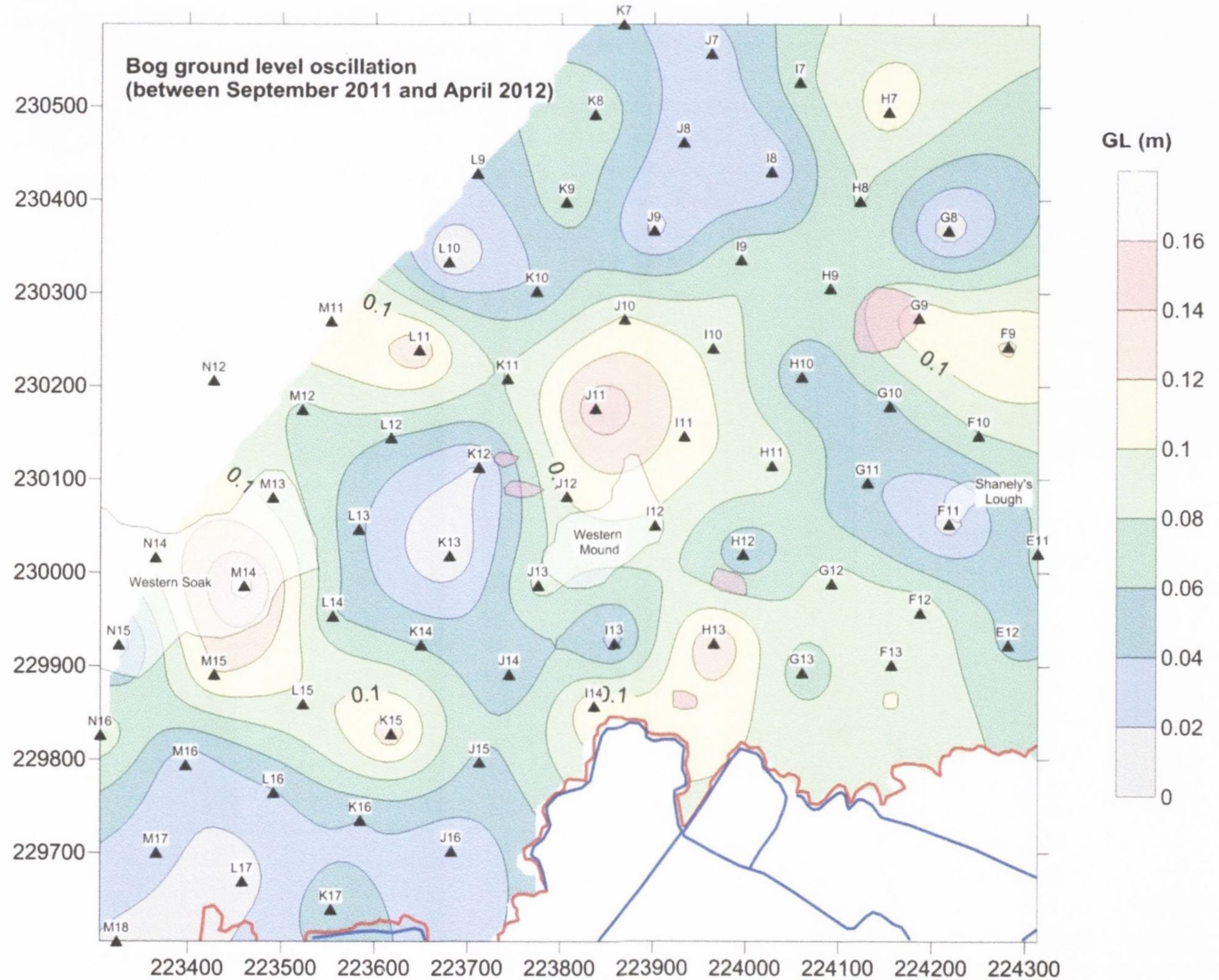


Figure E11. Ground level oscillation: September to April 2011

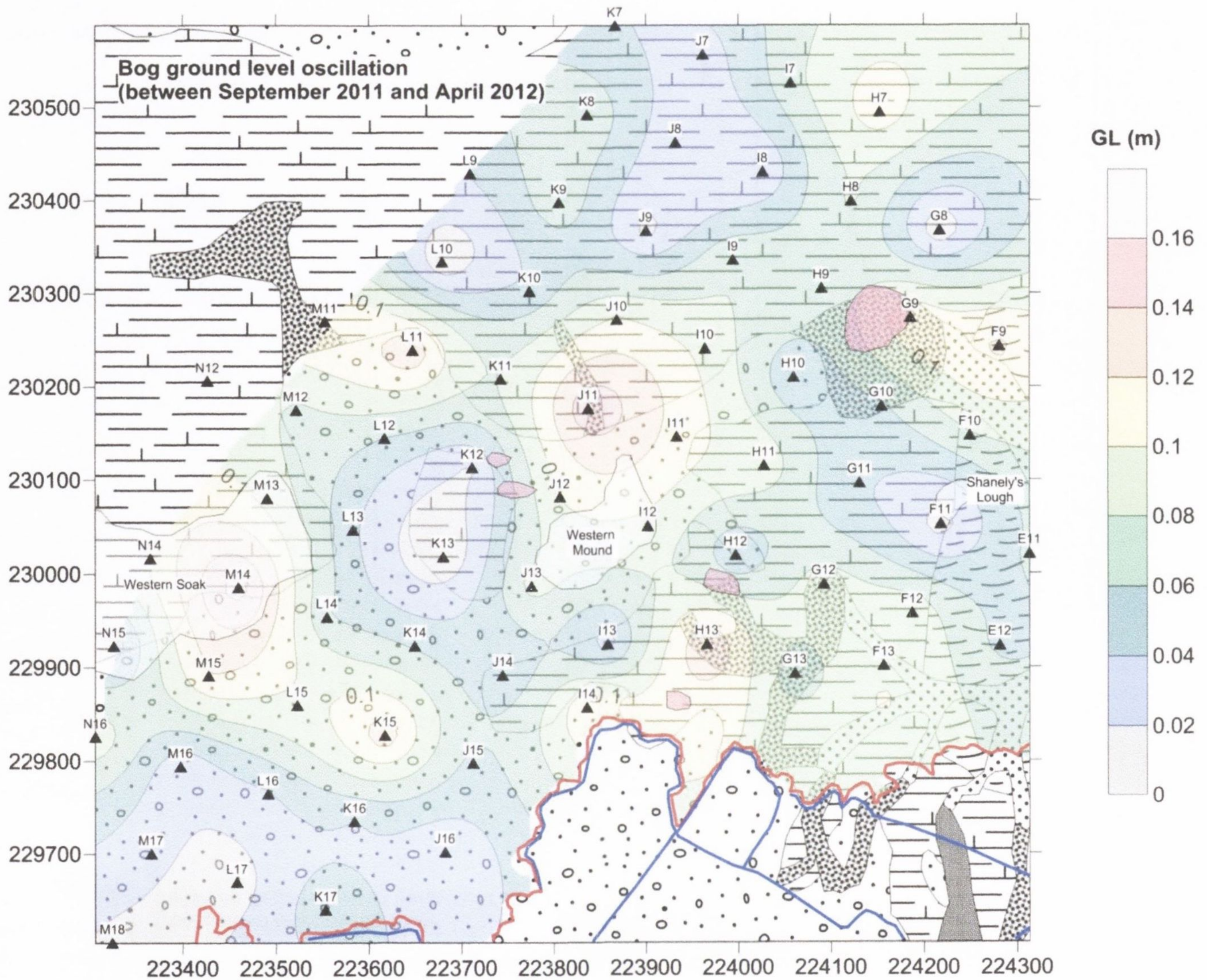


Figure E12. Ground level oscillation with underlying subsoil geology: September to April 2011

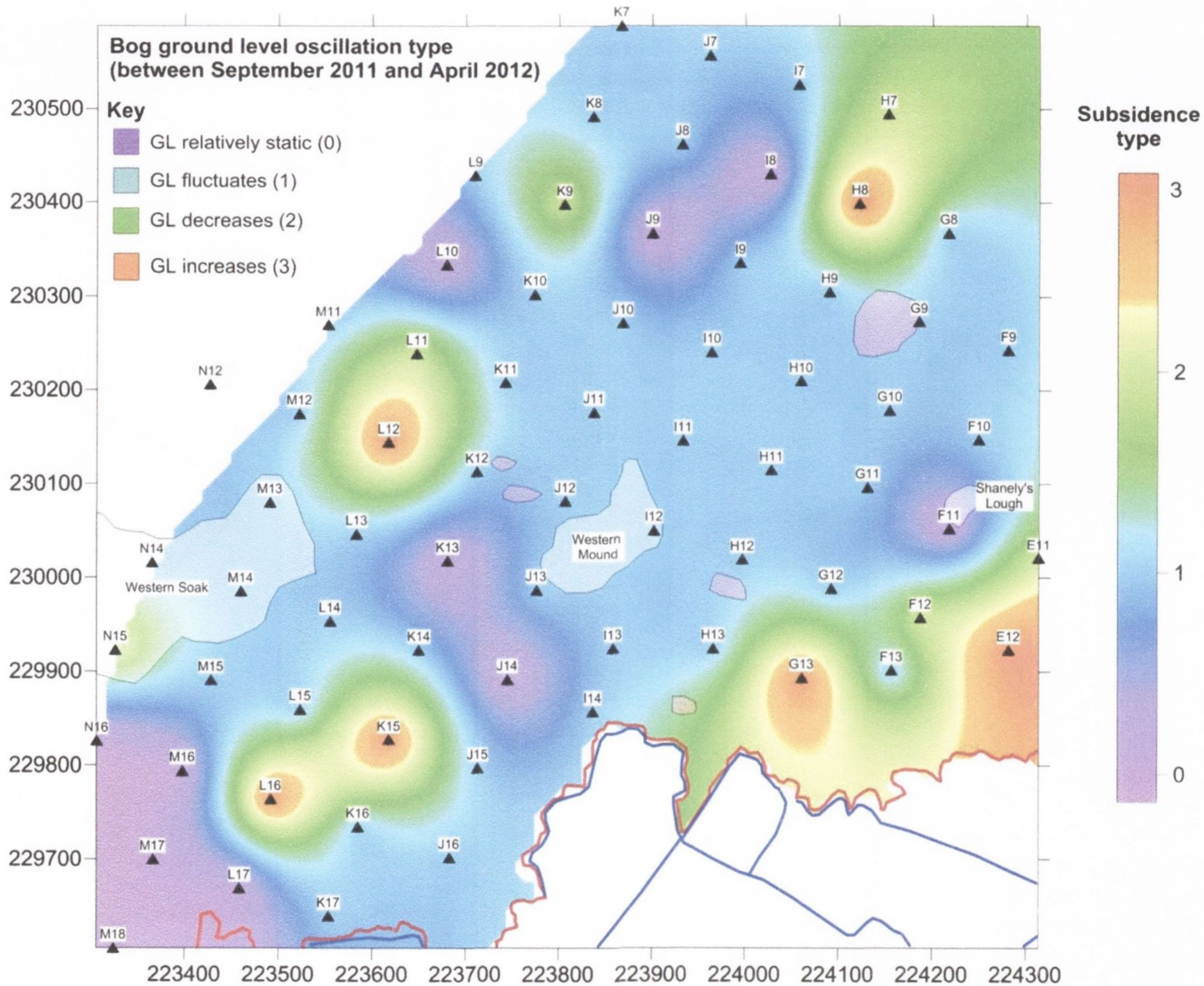


Figure E13. Ground level oscillation type

Appendix E. Subsidence: Fitted Cosine Curves to Ground Level Oscillation

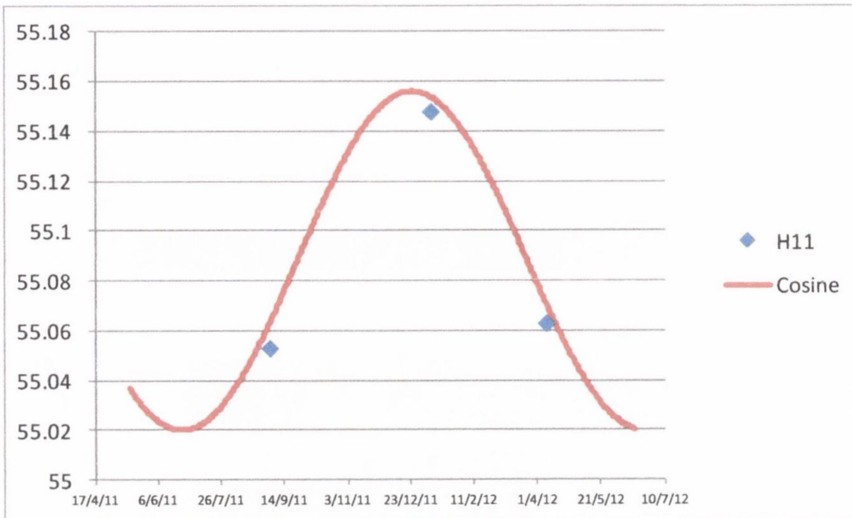


Figure E14. Measured surface level elevation at grid point H11 and fitted cosine transformation curve.

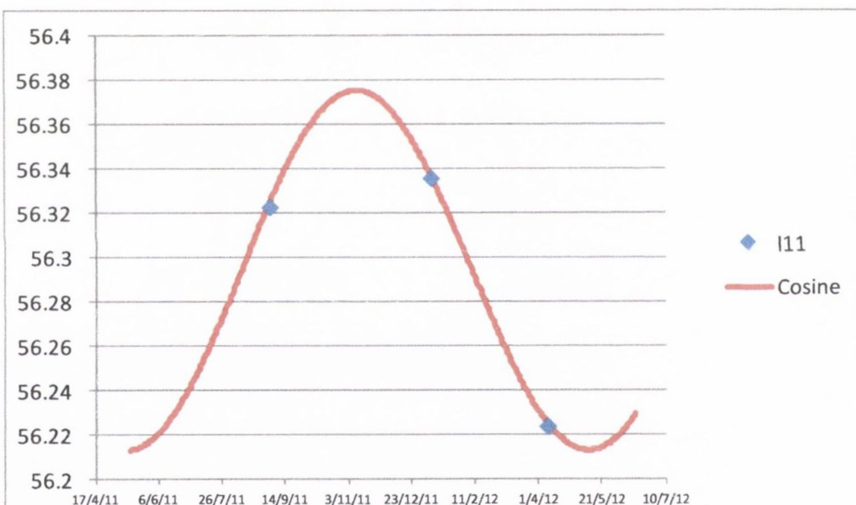


Figure E15. Measured surface level elevation at grid point I11 and fitted cosine transformation curve.

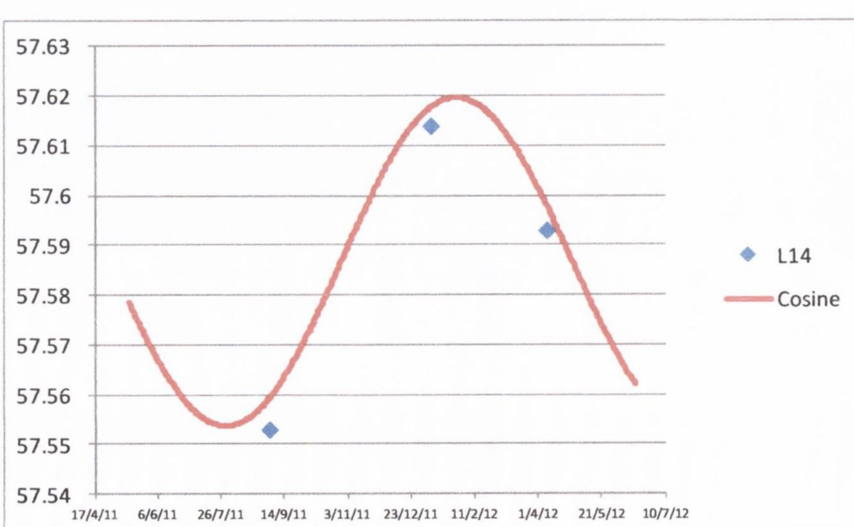


Figure E16. Measured surface level elevation at grid point L14 and fitted cosine transformation curve.

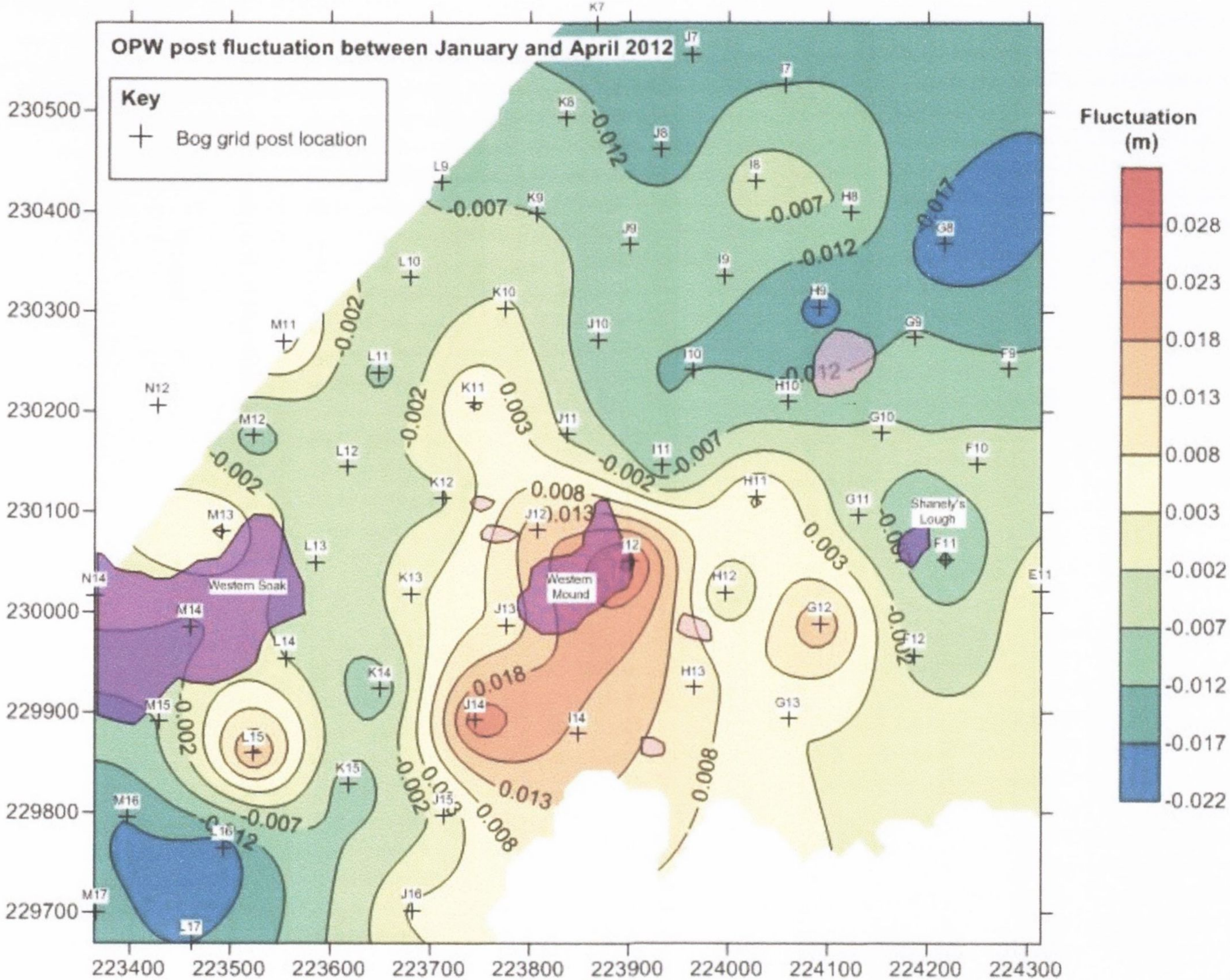


Figure E17. Peat Column oscillation between 2nd September 2011 and the 8th April 2012

Appendix E: Subsidence – Ground Level versus Water Level

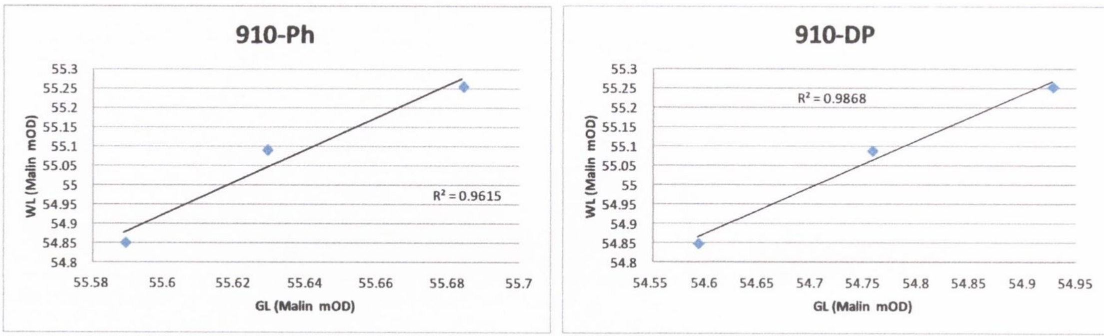


Figure E18. Bog ground level elevation versus (a) phreatic water level and (b) deep peat water level at piezometer nest 910 (note: bog grid point I10 is located c. 50m north of piezometer nest).

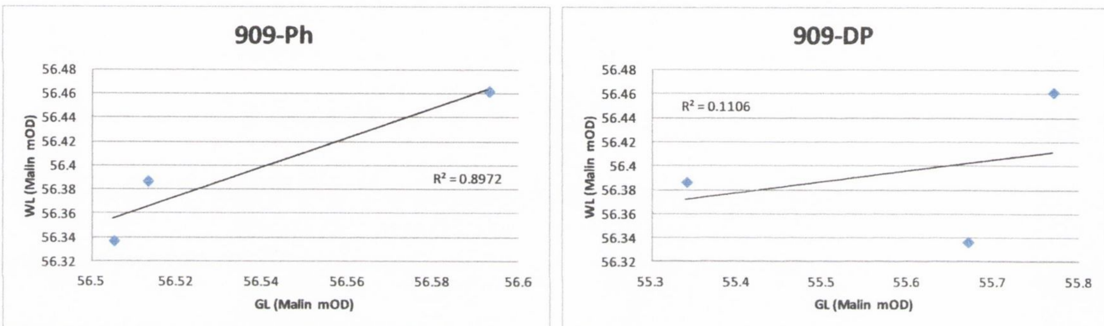


Figure E19. Bog ground level elevation versus (a) phreatic water level and (b) deep peat water level at piezometer nest 909 (note: bog grid point J13 is located adjacent to the piezometer nest).

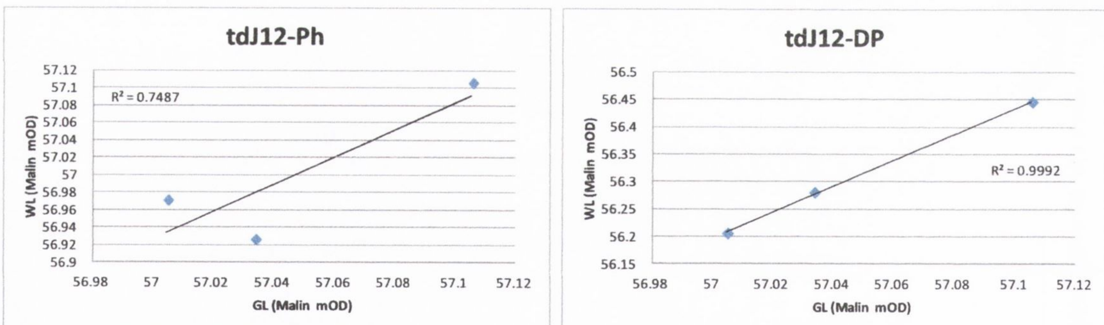


Figure E20. Bog ground level elevation versus (a) phreatic water level and (b) deep peat water level at piezometer nest tdJ12 (note: bog grid point J12 is located adjacent to the piezometer nest).

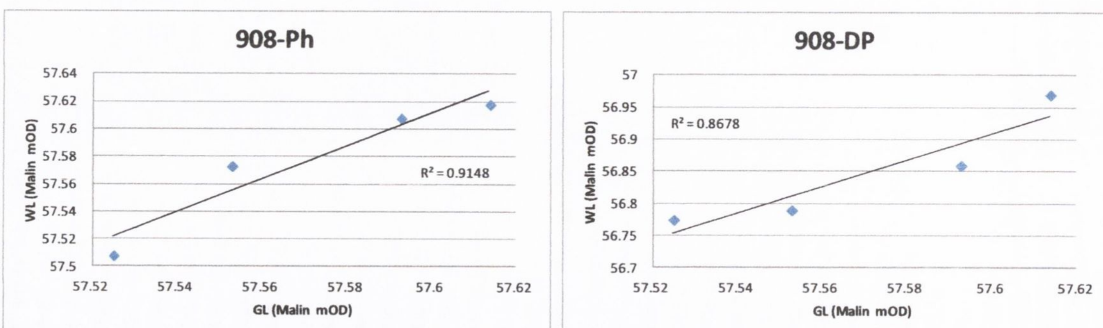


Figure E21. Bog ground level elevation versus (a) phreatic water level and (b) deep peat water level at piezometer nest 908 (note: bog grid point L12 is located adjacent to the piezometer nest).

Appendix E: Subsidence – Ground Level Subsidence Trend

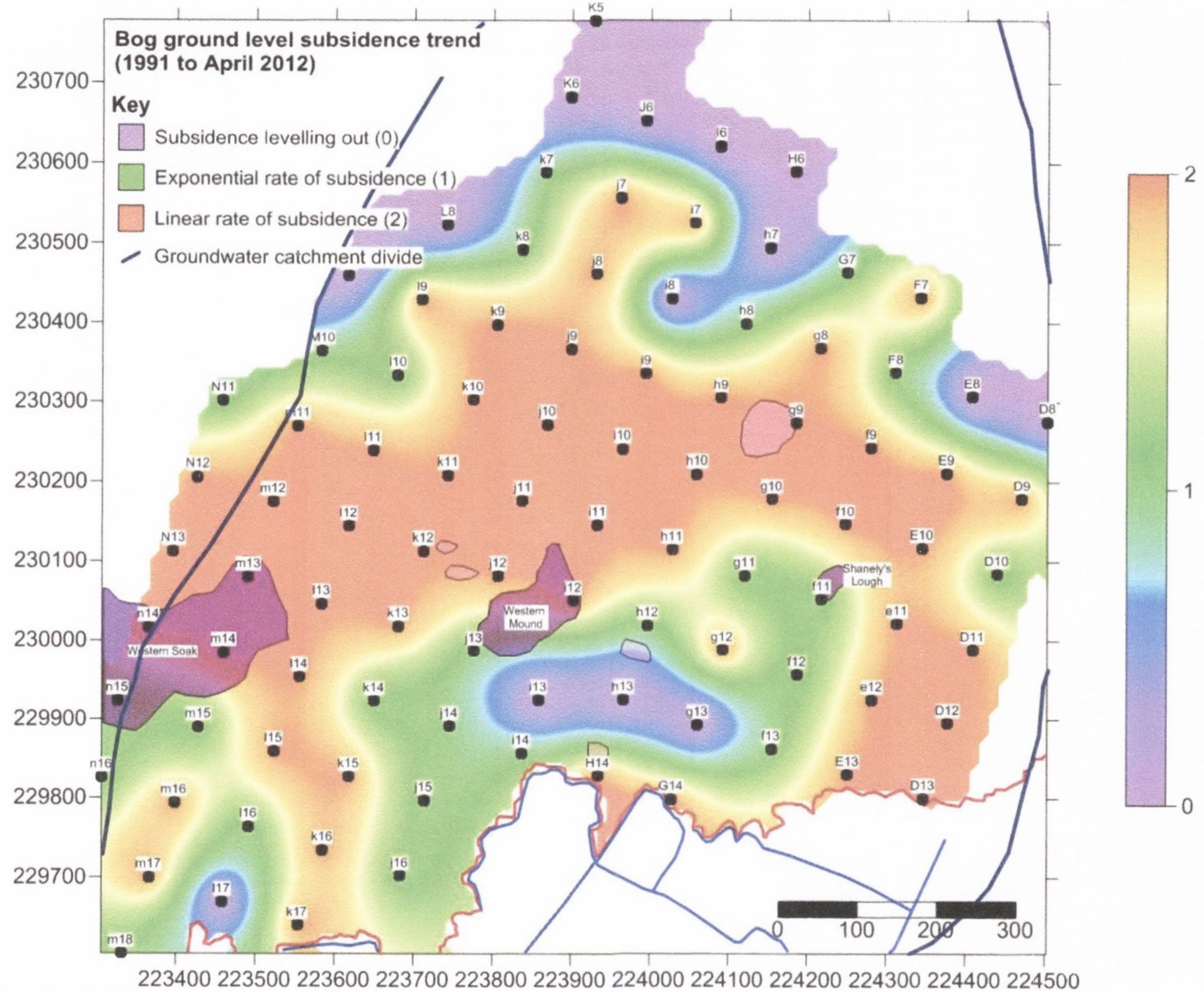
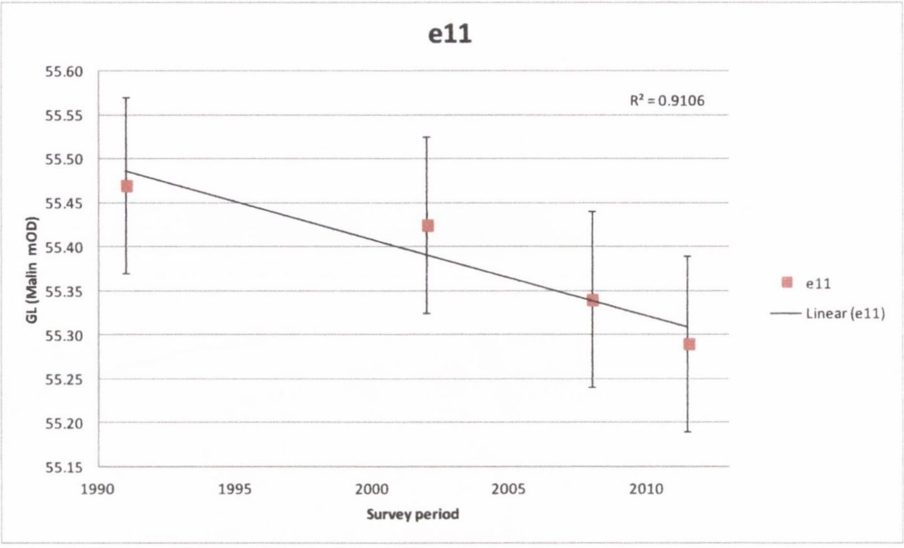
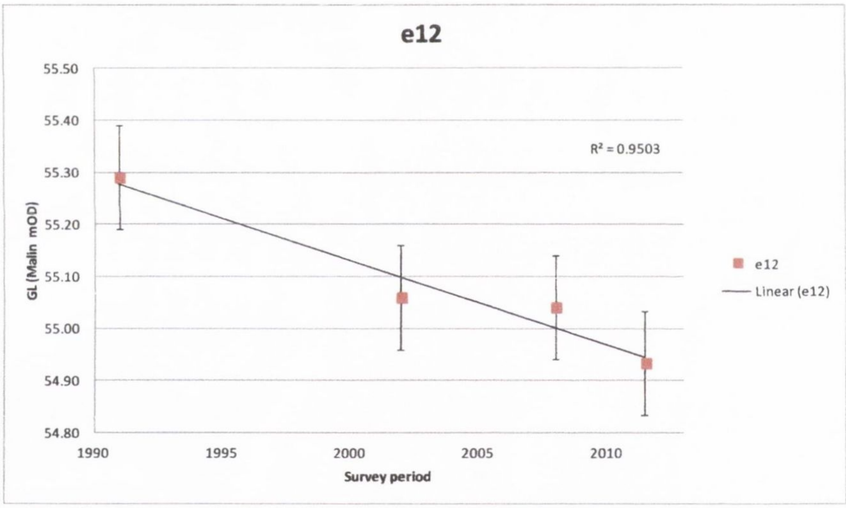


Figure E22. Ground level subsidence trend between 1991 and 2011

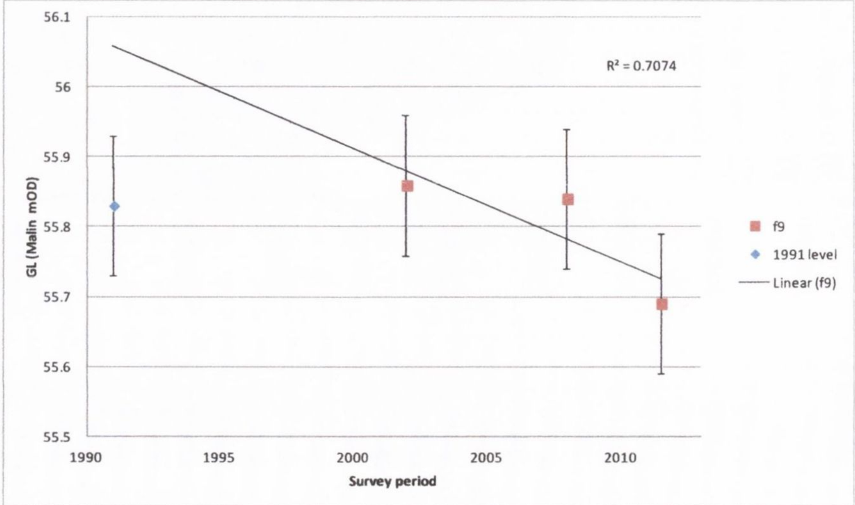
Appendix E23: Subsidence: Decrease in Ground Level Trend



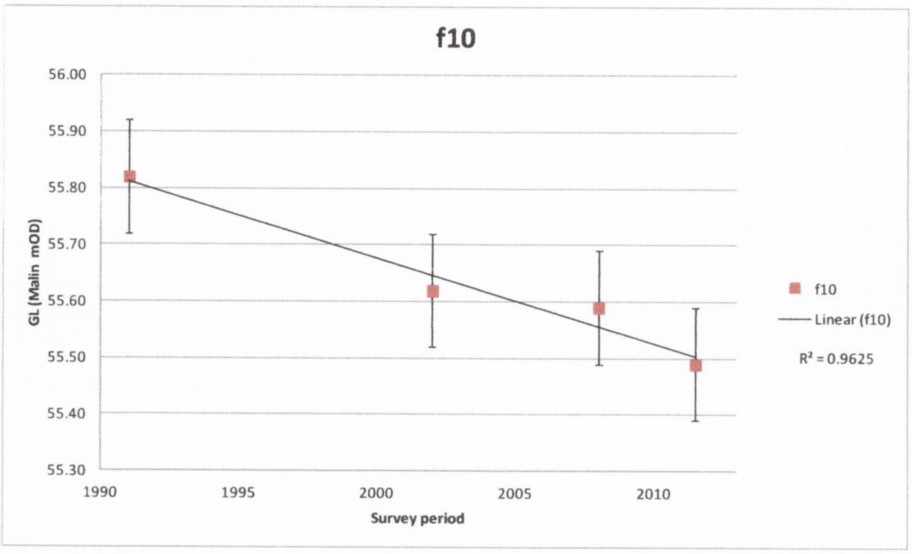
Subsidence trend at bog grid point E11. Note: Mean 2011-2012 elevation used.



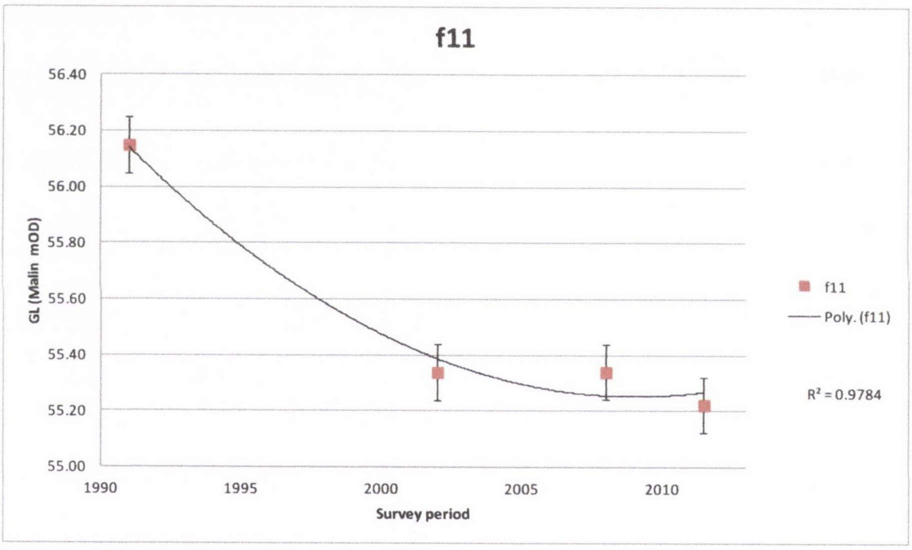
Subsidence trend at bog grid point E12. Note: Mean 2011-2012 elevation used.



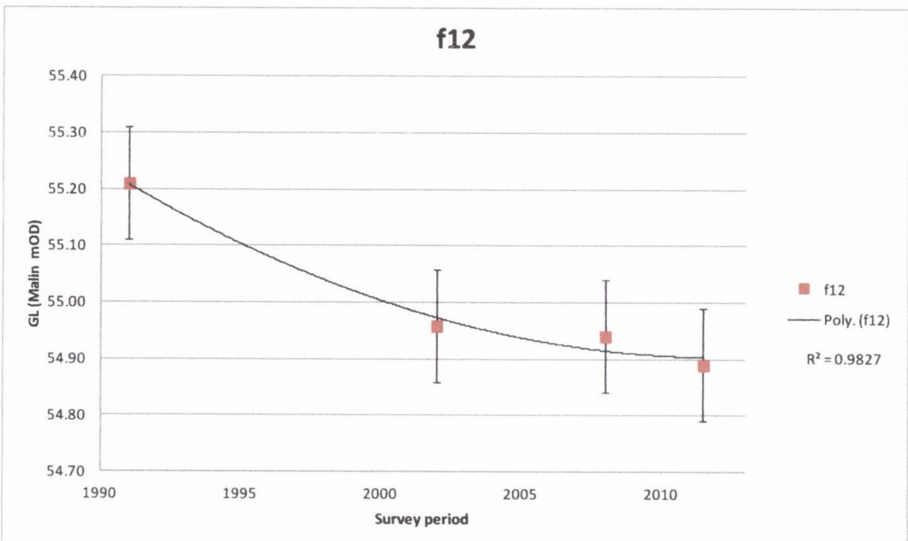
Subsidence trend at bog grid point F9. Note: Mean 2011-2012 elevation used.



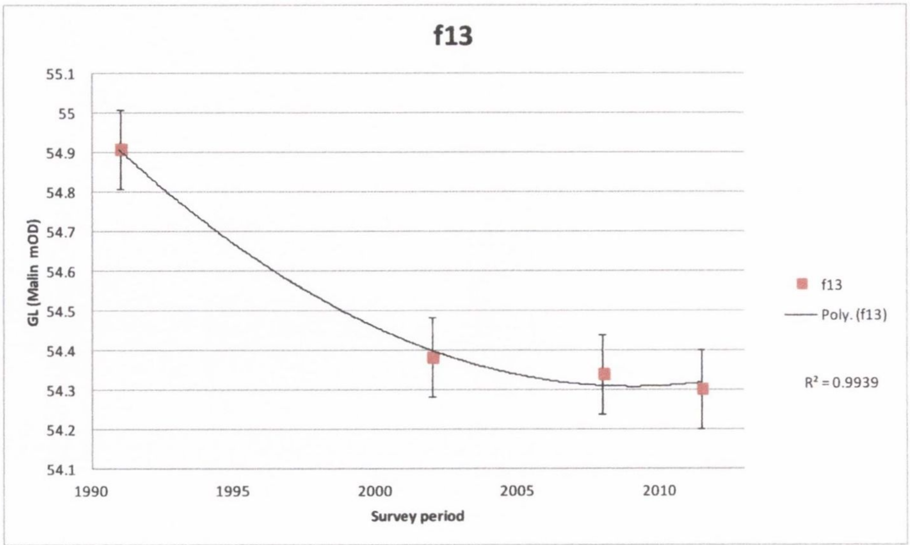
Subsidence trend at bog grid point F10. Note: Mean 2011-2012 elevation used.



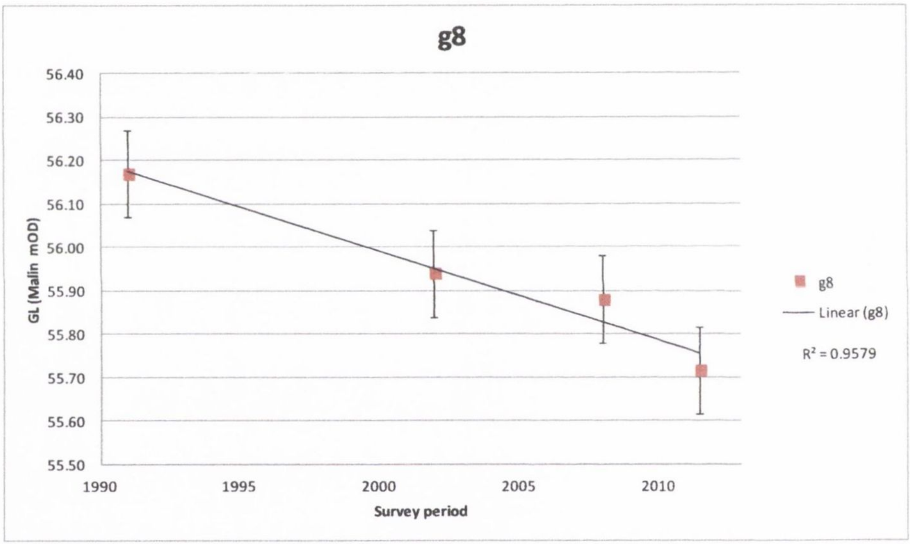
Subsidence trend at bog grid point F11. Note: Mean 2011-2012 elevation used.



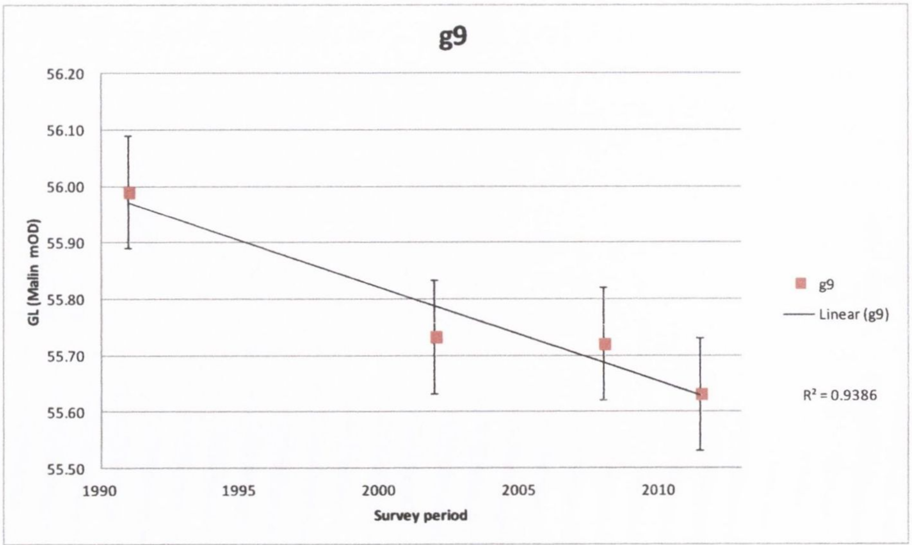
Subsidence trend at bog grid point F12. Note: Mean 2011-2012 elevation used.



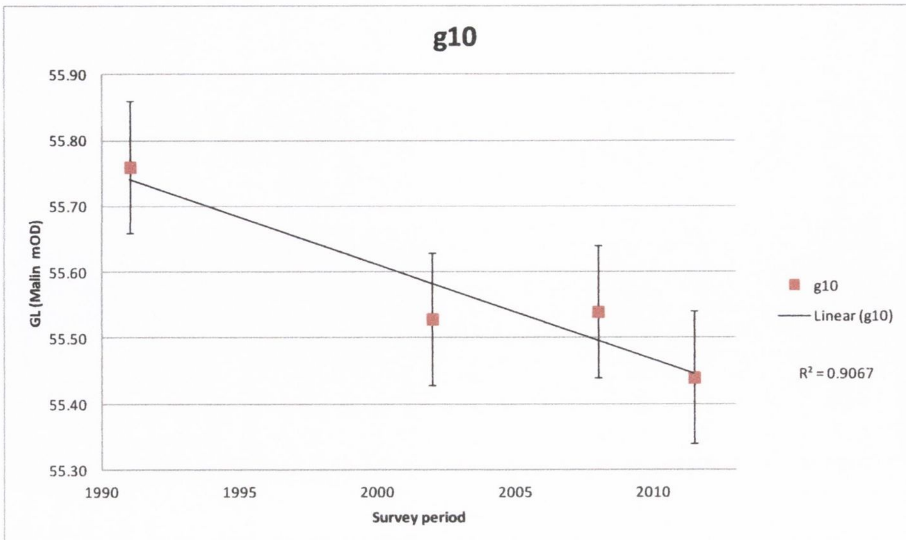
Subsidence trend at bog grid point F13. Note: Mean 2011-2012 elevation used.



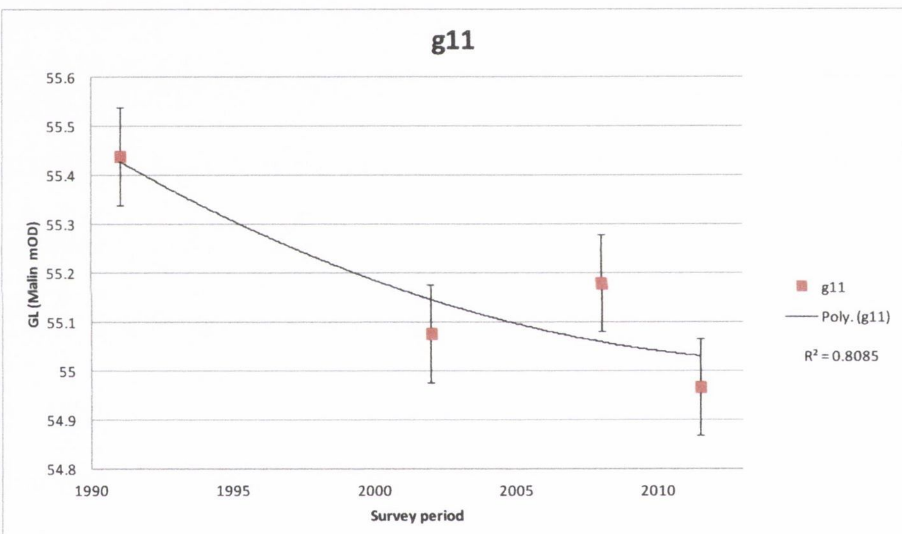
Subsidence trend at bog grid point G8. Note: Mean 2011-2012 elevation used.



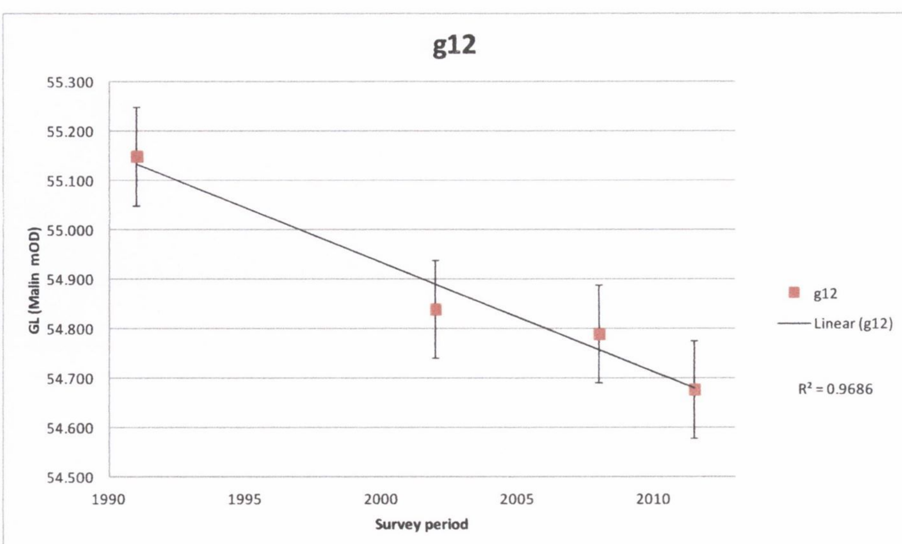
Subsidence trend at bog grid point G9. Note: Mean 2011-2012 elevation used.



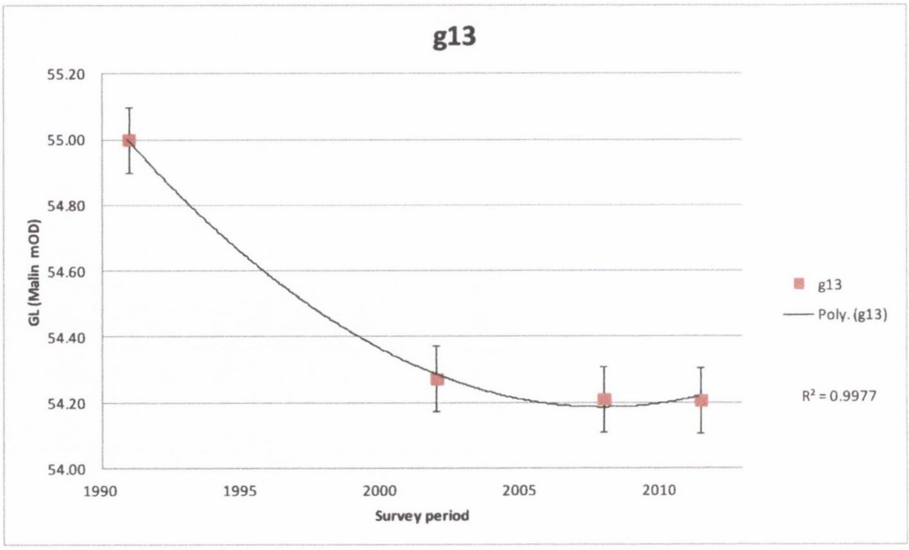
Subsidence trend at bog grid point G10. Note: Mean 2011-2012 elevation used.



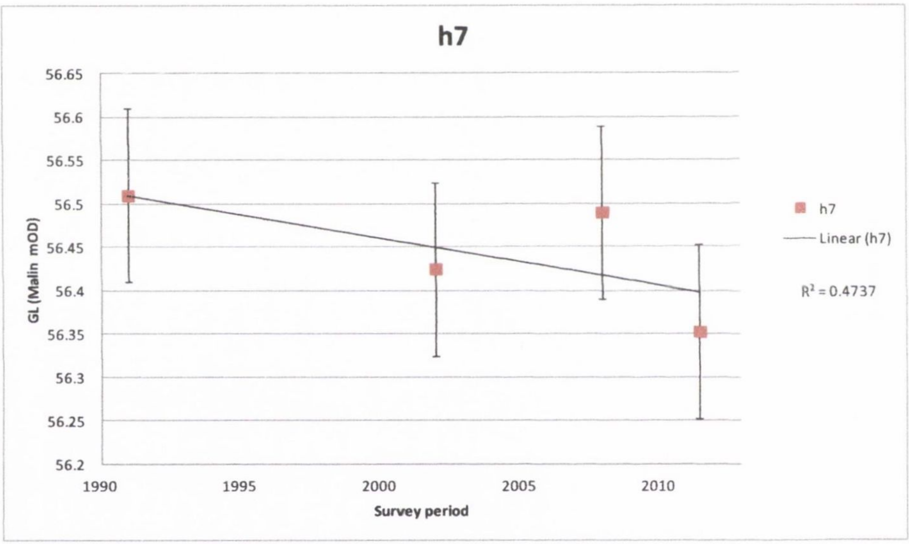
Subsidence trend at bog grid point G11. Note: Mean September 2011 elevation used.



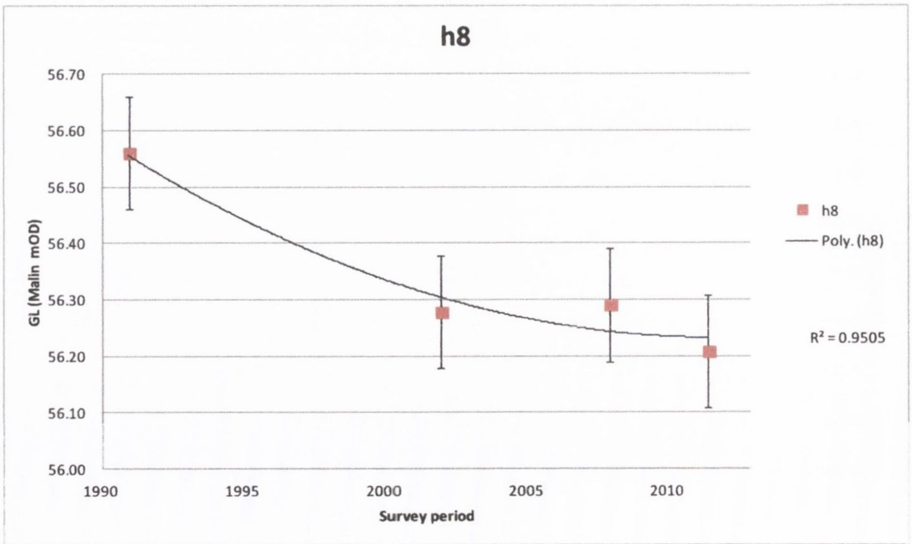
Subsidence trend at bog grid point G12. Note: Mean 2011-2012 elevation used.



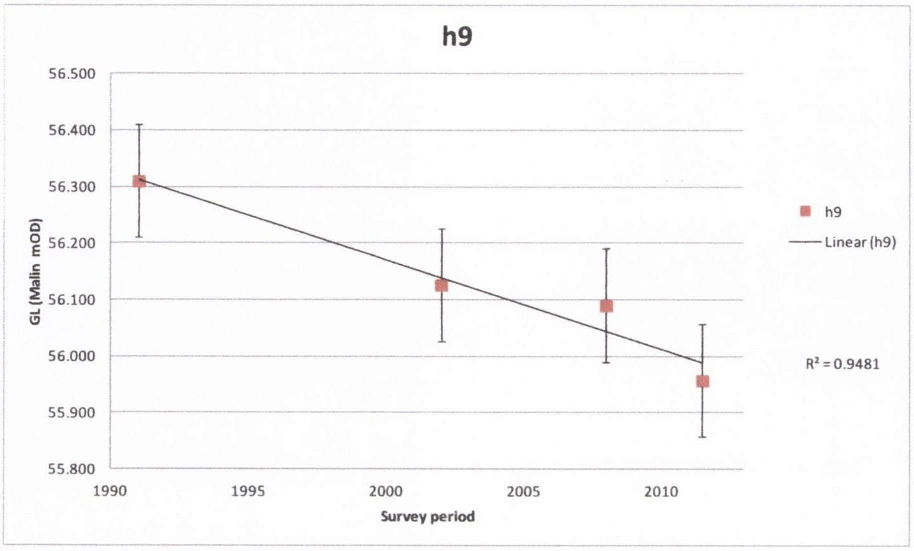
Subsidence trend at bog grid point G13. Note: Mean 2011-2012 elevation used.



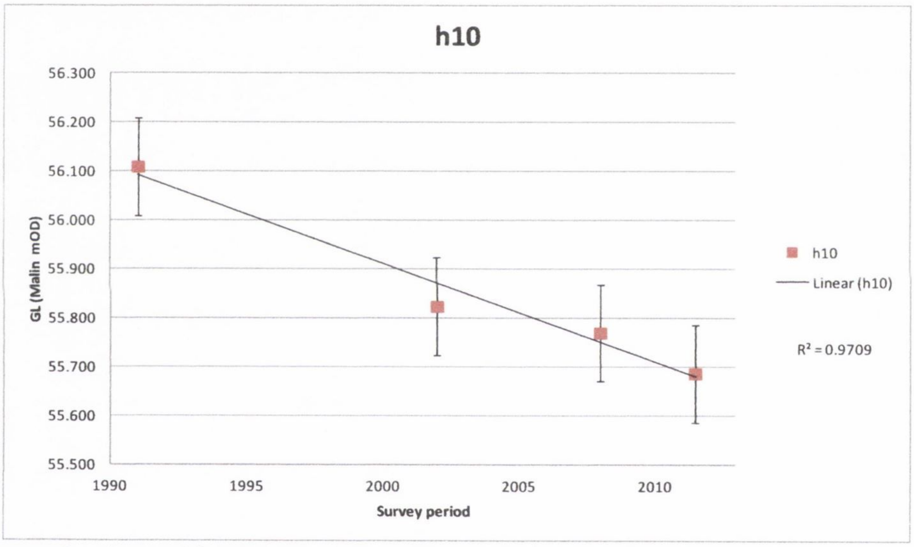
Subsidence trend at bog grid point H7. Note: Mean 2011-2012 elevation used.



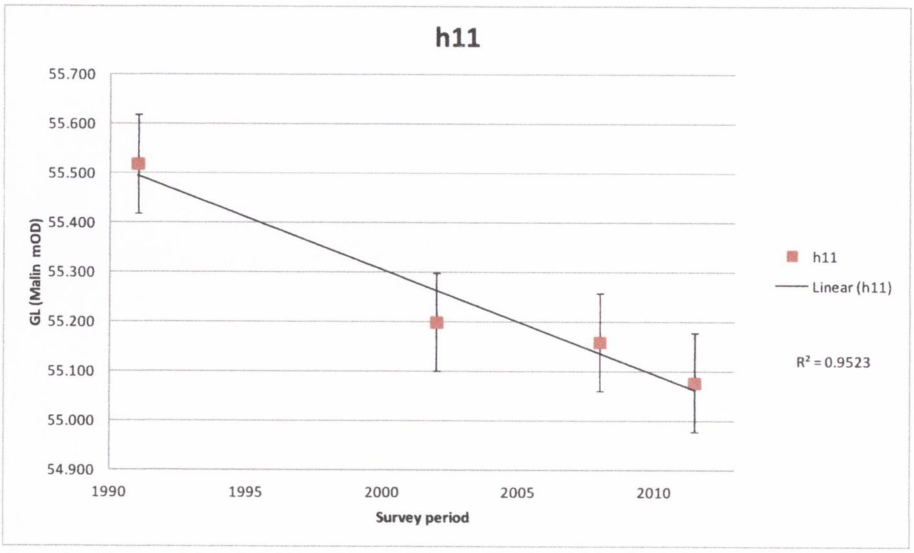
Subsidence trend at bog grid point H8. Note: Mean 2011-2012 elevation used.



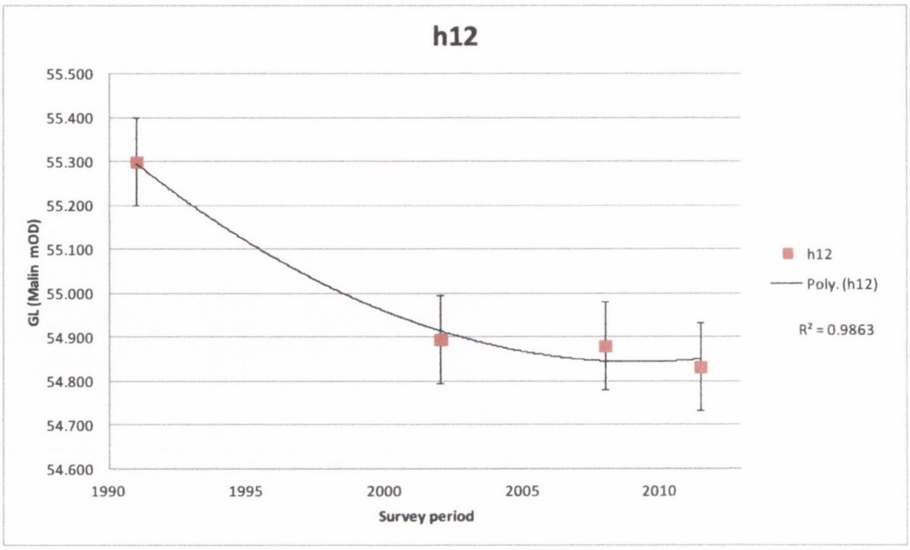
Subsidence trend at bog grid point H9. Note: Mean 2011-2012 elevation used.



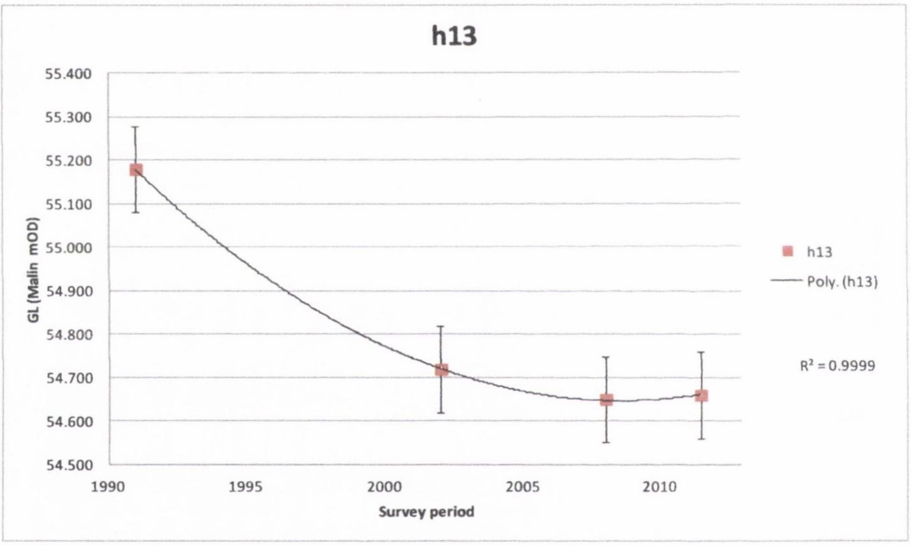
Subsidence trend at bog grid point H10. Note: Mean 2011-2012 elevation used.



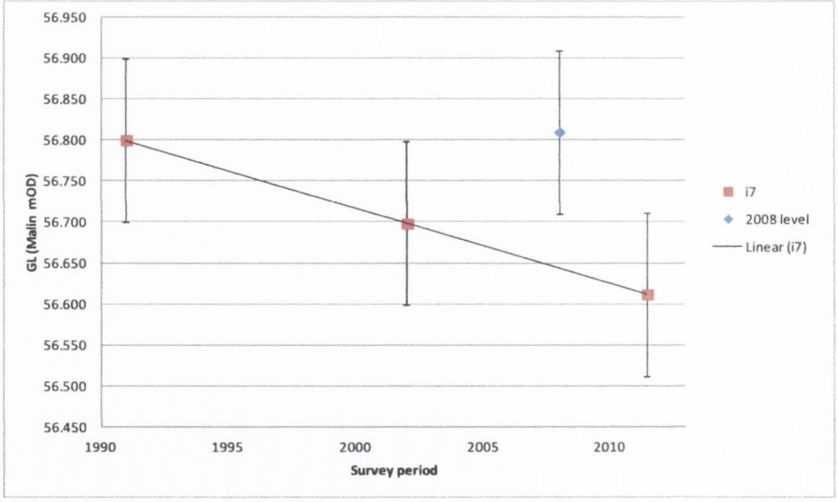
Subsidence trend at bog grid point H11. Note: Mean 2011-2012 elevation used.



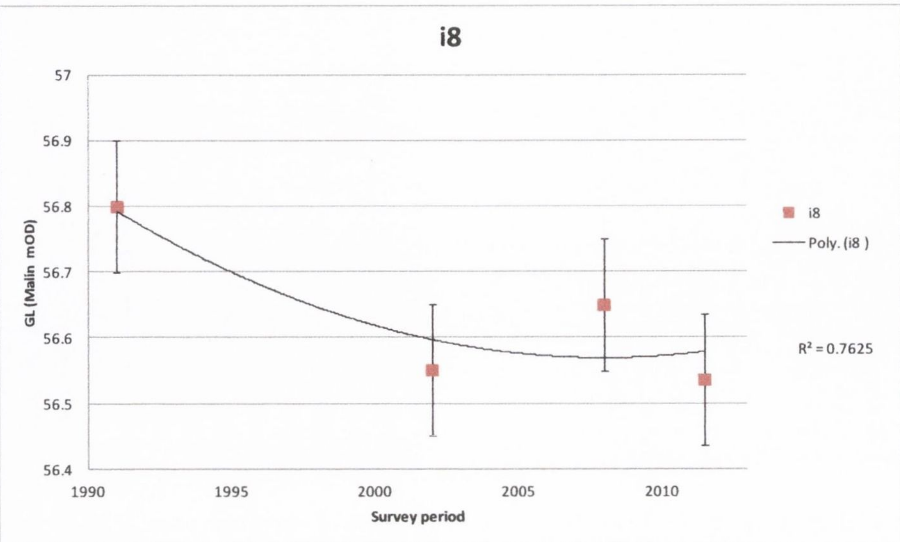
Subsidence trend at bog grid point H12. Note: Mean 2011-2012 elevation used.



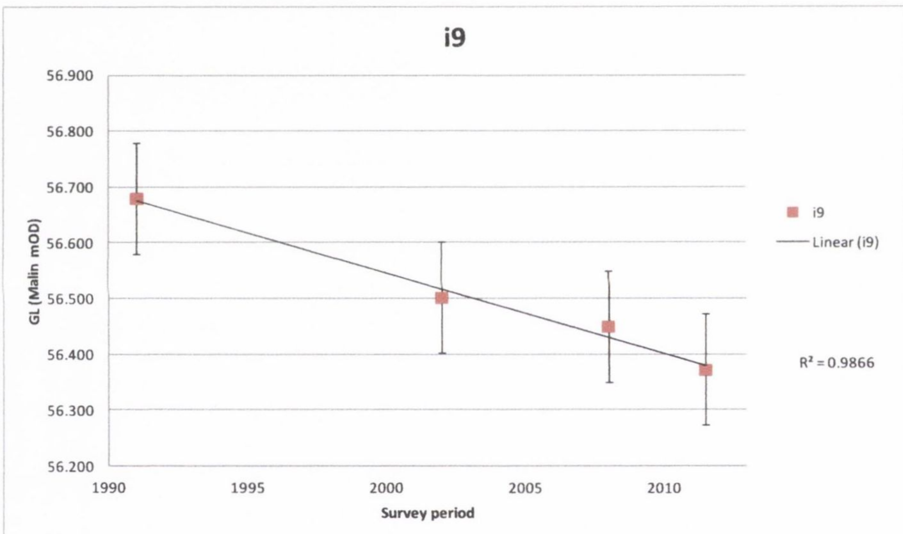
Subsidence trend at bog grid point H13. Note: Mean 2011-2012 elevation used.



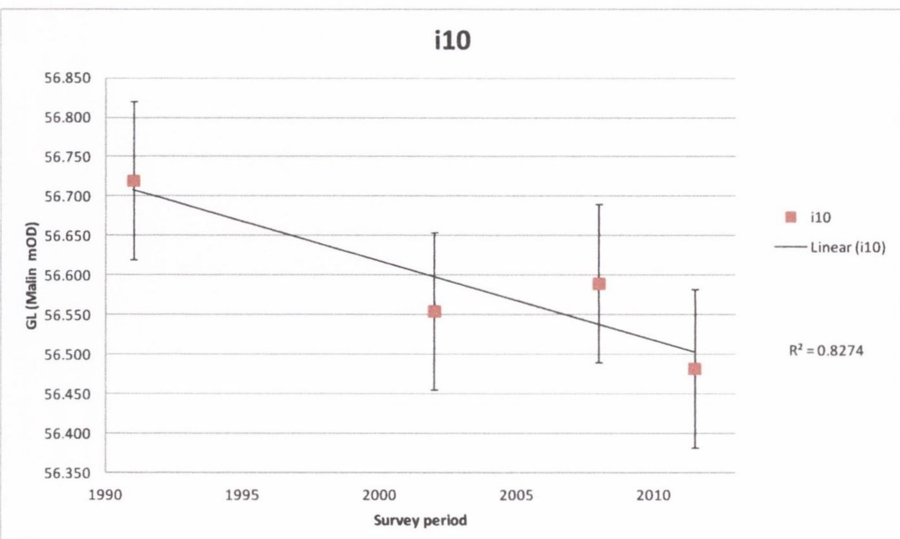
Subsidence trend at bog grid point I7. Note: Mean 2011-2012 elevation used. 2008 LiDAR elevation appears unusually large – omitted from trend.



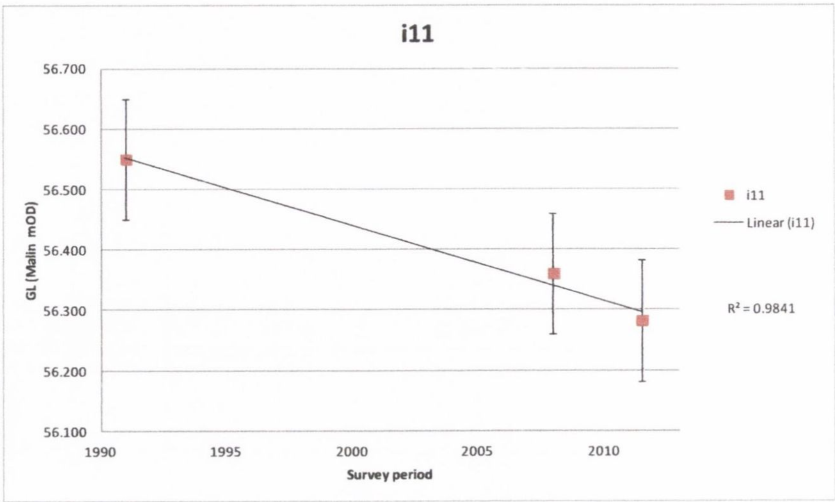
Subsidence trend at bog grid point I8. Note: Mean 2011-2012 elevation used.



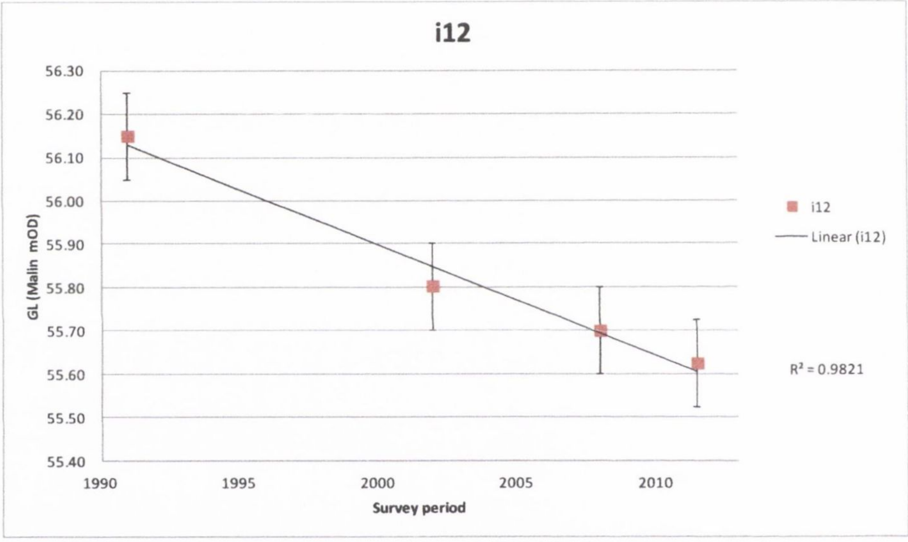
Subsidence trend at bog grid point I9. Note: Mean 2011-2012 elevation used.



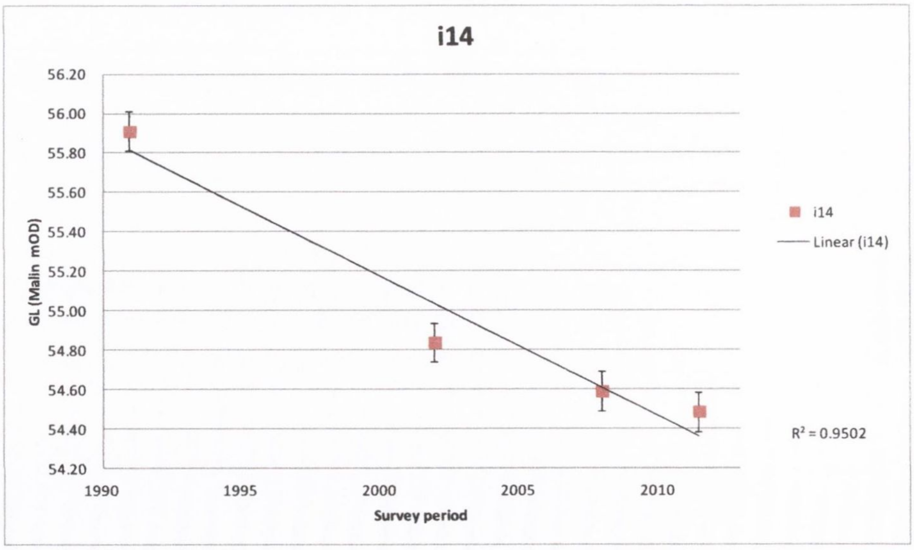
Subsidence trend at bog grid point I10. Note: Mean 2011-2012 elevation used.



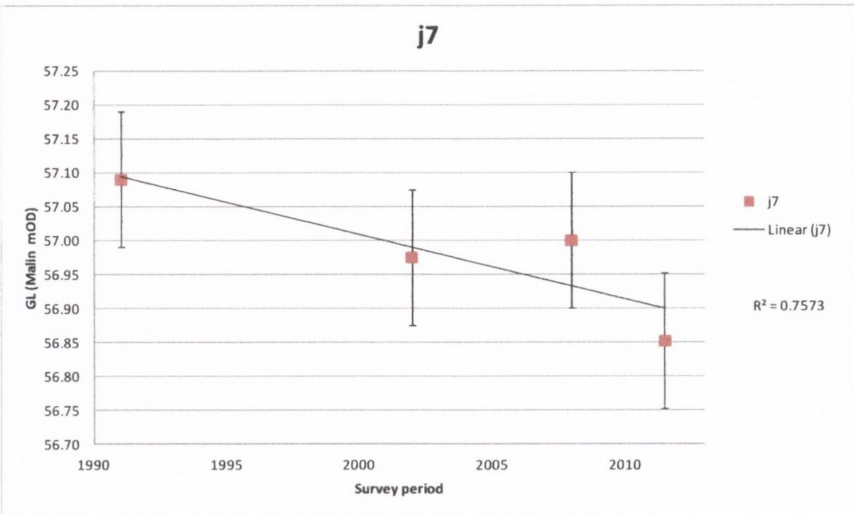
Subsidence trend at bog grid point I11. Note: Mean 2011-2012 elevation used. 2002 level absent.



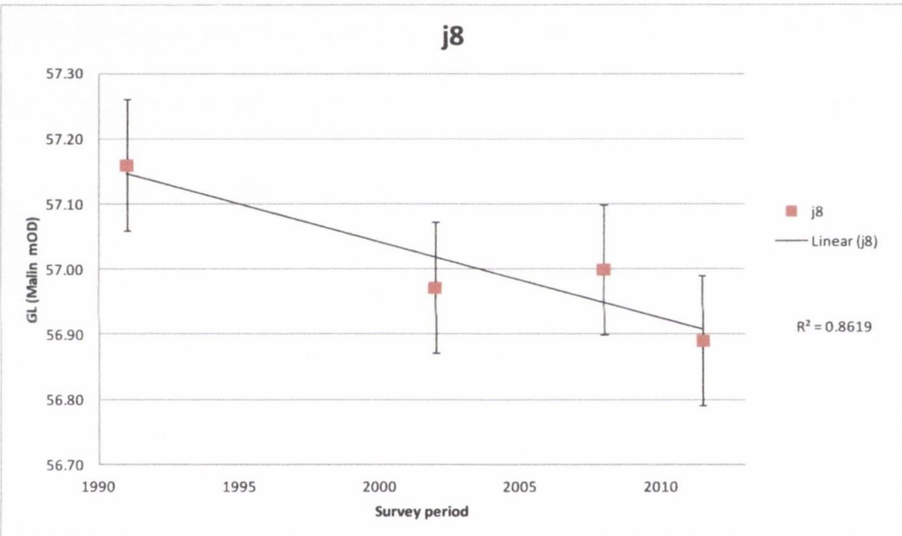
Subsidence trend at bog grid point I12. Note: Mean 2011-2012 elevation used.



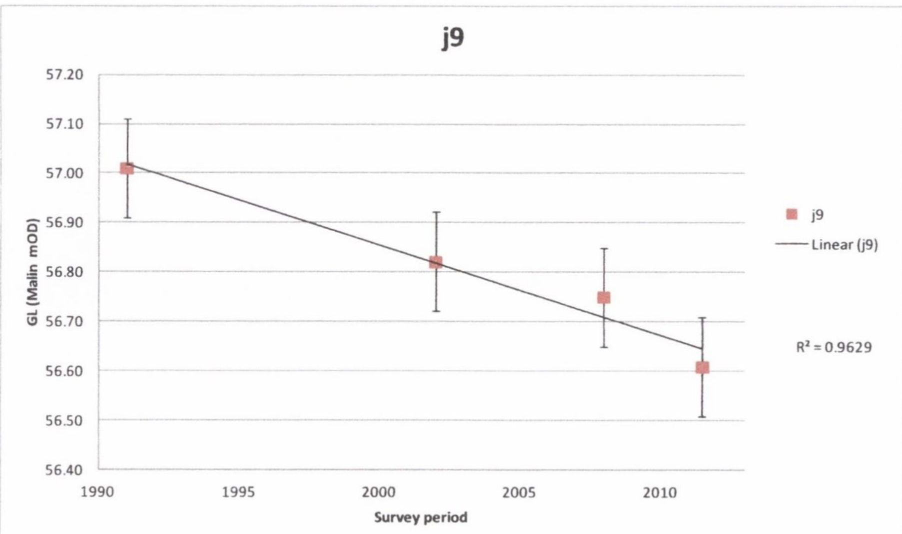
Subsidence trend at bog grid point I14. Note: Mean 2011-2012 elevation used.



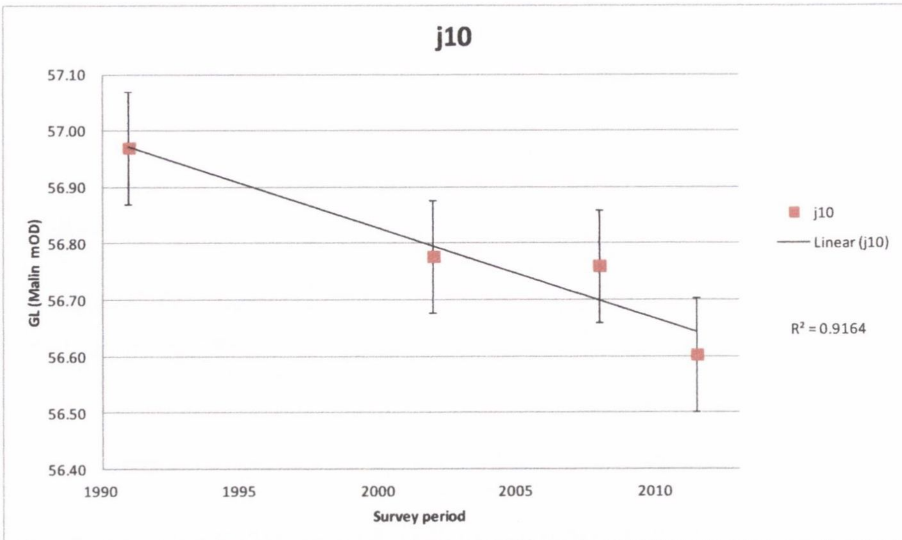
Subsidence trend at bog grid point J7. Note: Mean 2011-2012 elevation used.



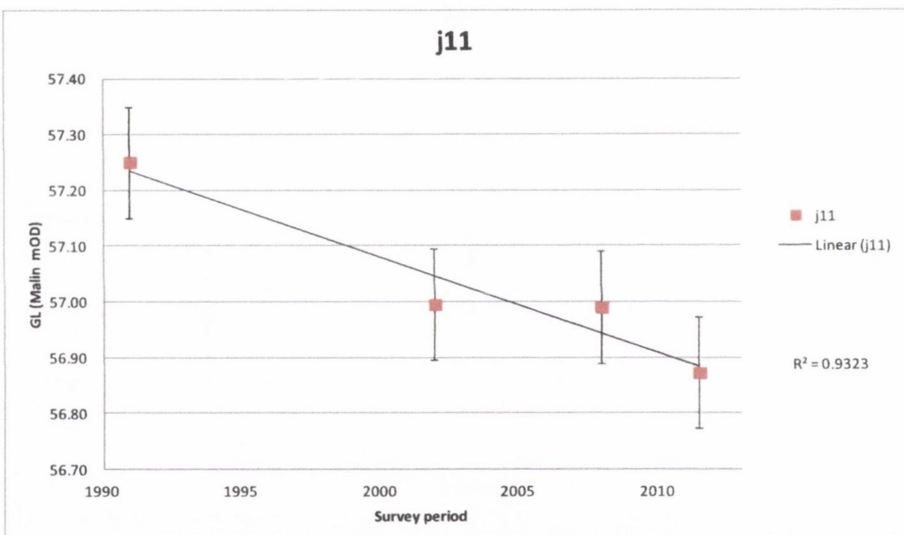
Subsidence trend at bog grid point J8. Note: Mean 2011-2012 elevation used.



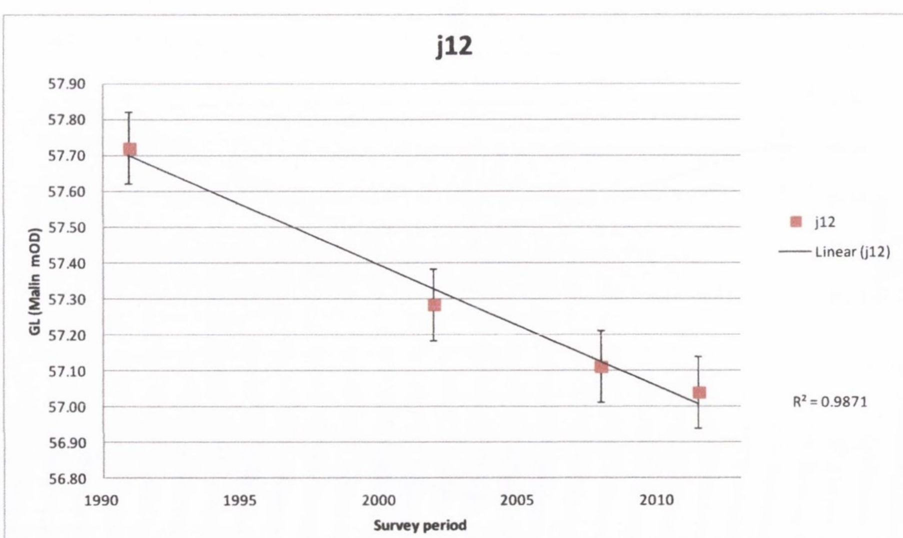
Subsidence trend at bog grid point J9. Note: Mean 2011-2012 elevation used.



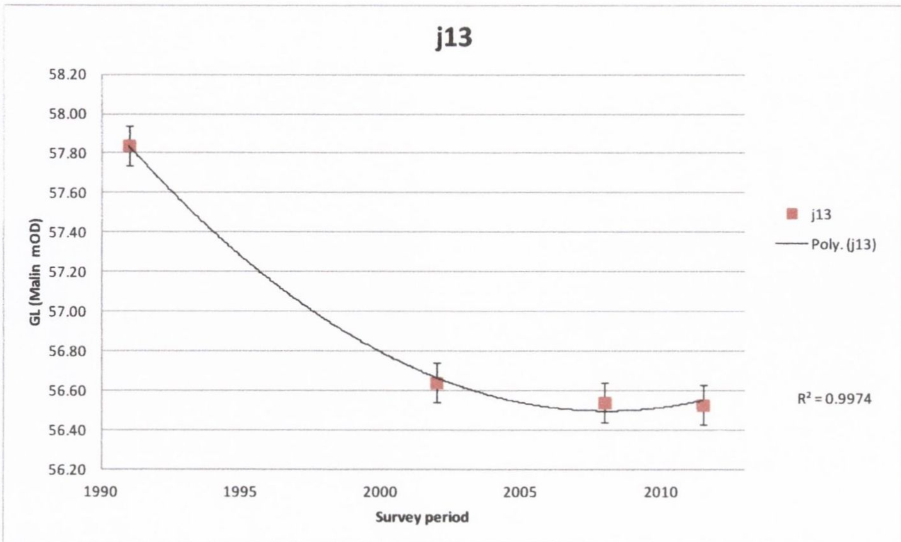
Subsidence trend at bog grid point J10. Note: Mean 2011-2012 elevation used.



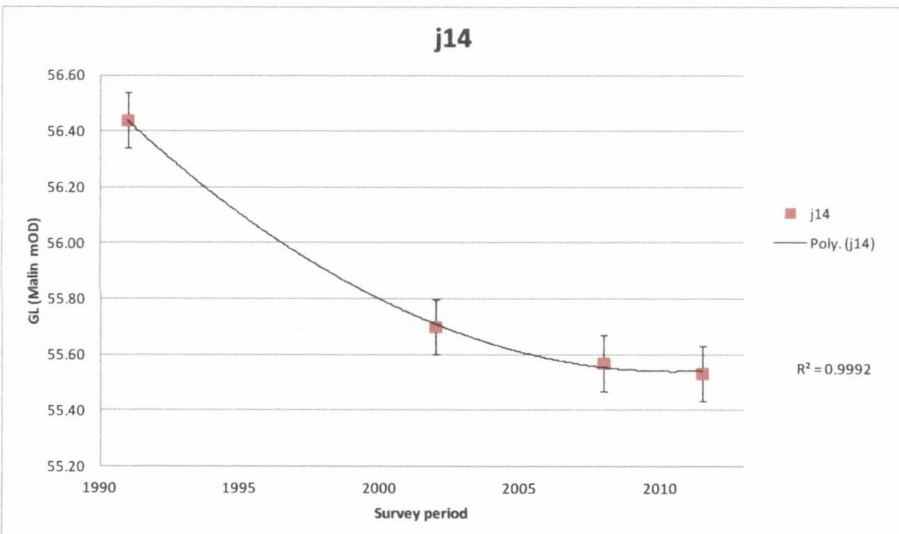
Subsidence trend at bog grid point J11. Note: Mean 2011-2012 elevation used.



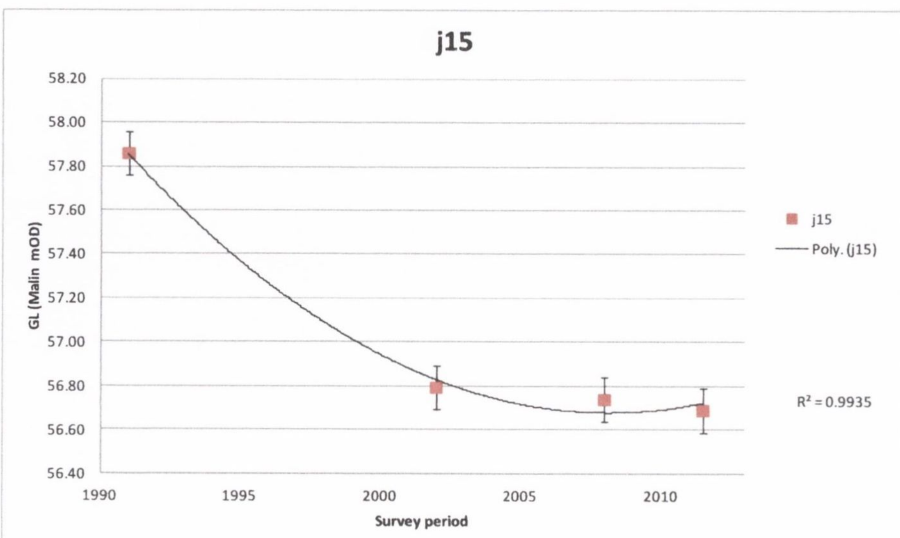
Subsidence trend at bog grid point J12. Note: Mean 2011-2012 elevation used.



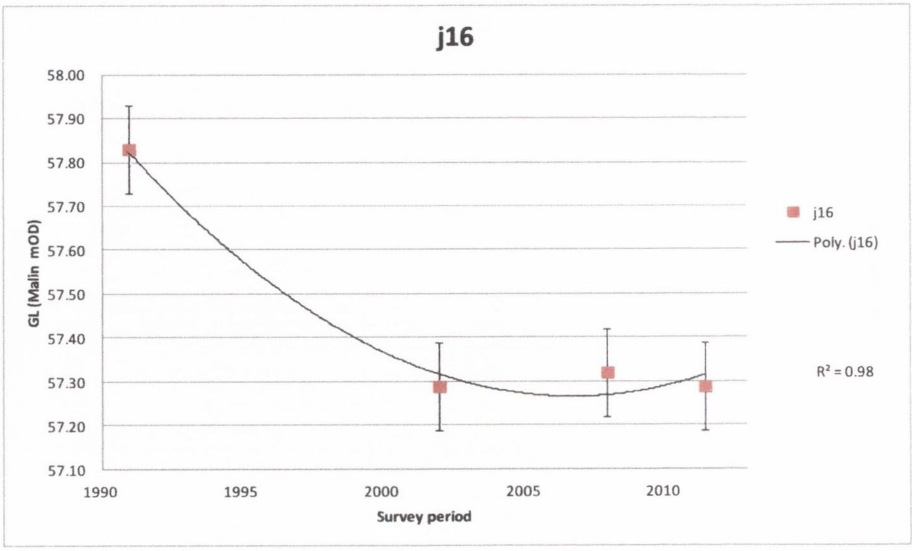
Subsidence trend at bog grid point J13. Note: Mean 2011-2012 elevation used.



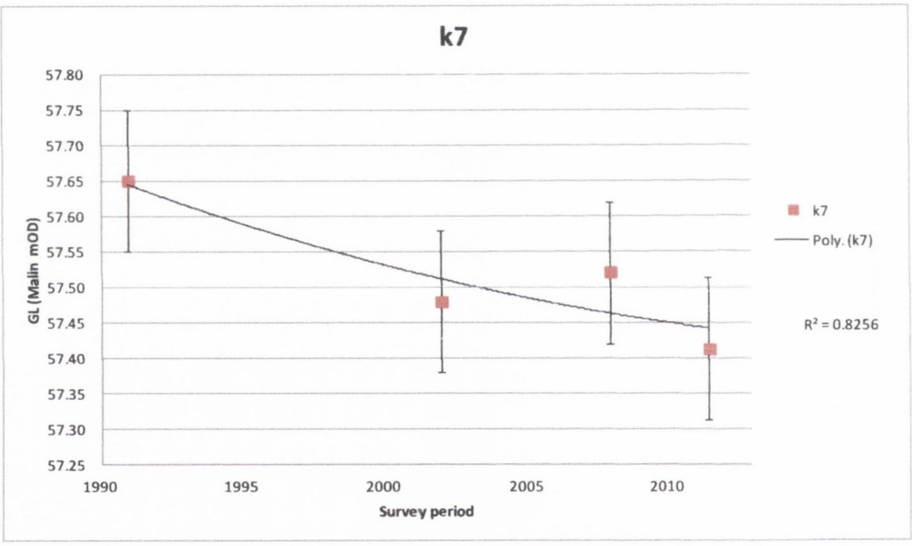
Subsidence trend at bog grid point J14. Note: Mean 2011-2012 elevation used.



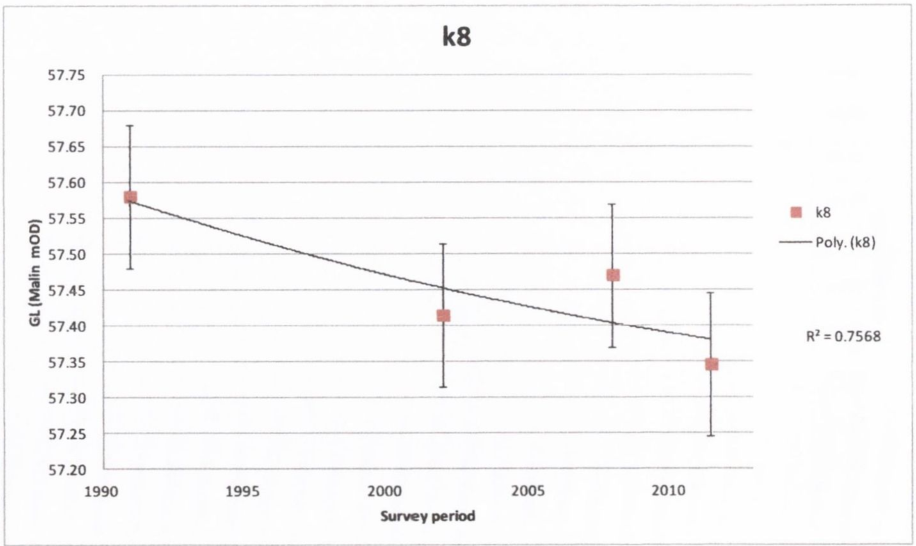
Subsidence trend at bog grid point J15. Note: Mean 2011-2012 elevation used.



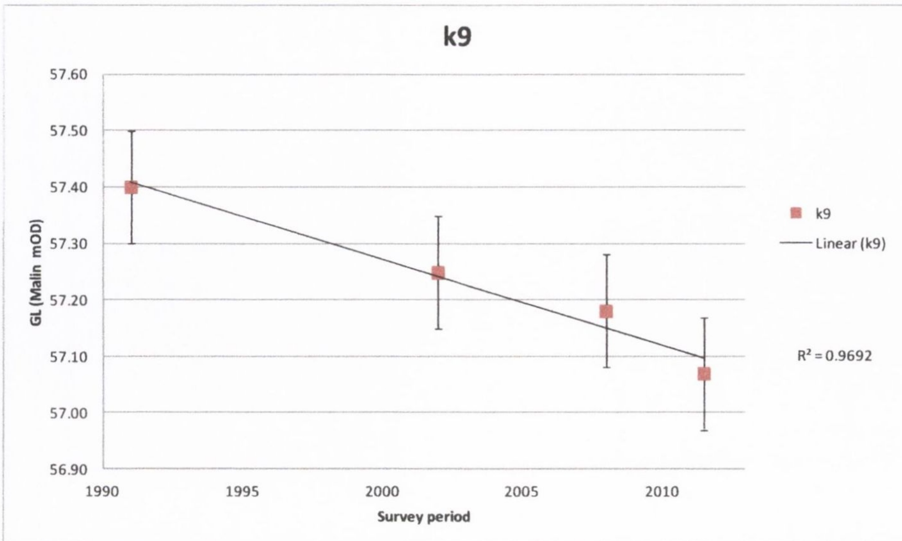
Subsidence trend at bog grid point J16. Note: Mean 2011-2012 elevation used.



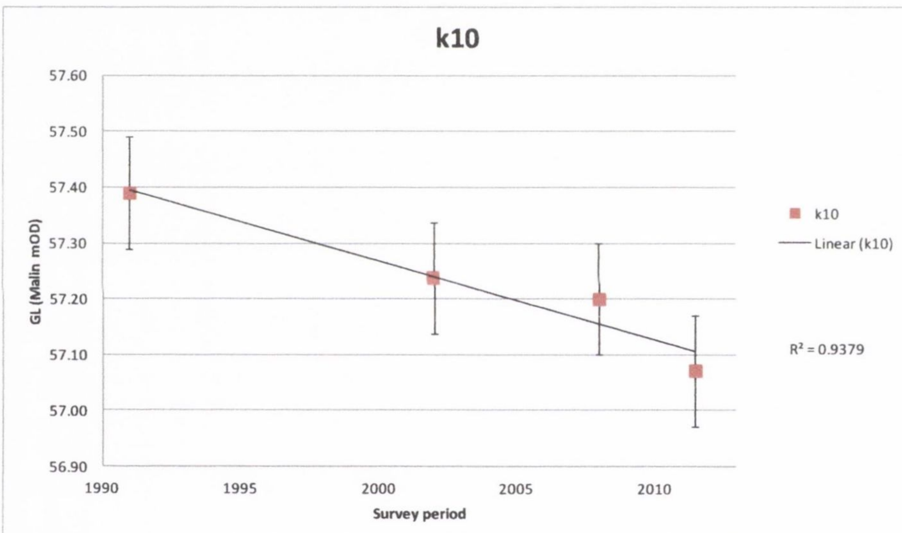
Subsidence trend at bog grid point K7. Note: Mean 2011-2012 elevation used.



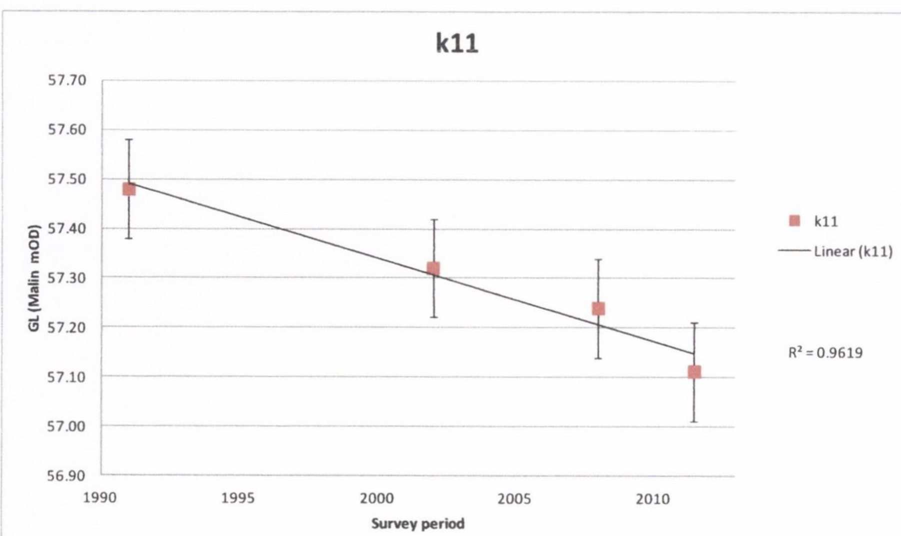
Subsidence trend at bog grid point K8. Note: Mean 2011-2012 elevation used.



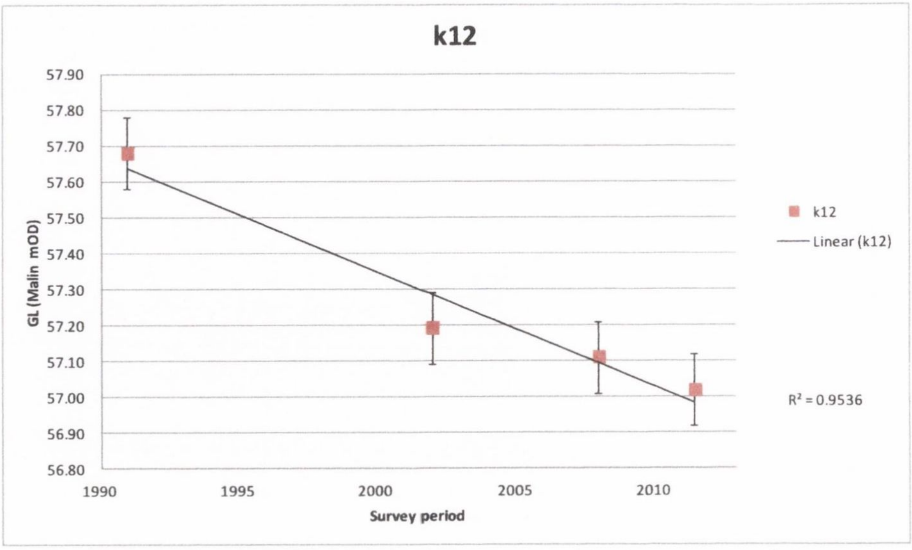
Subsidence trend at bog grid point K9. Note: Mean 2011-2012 elevation used.



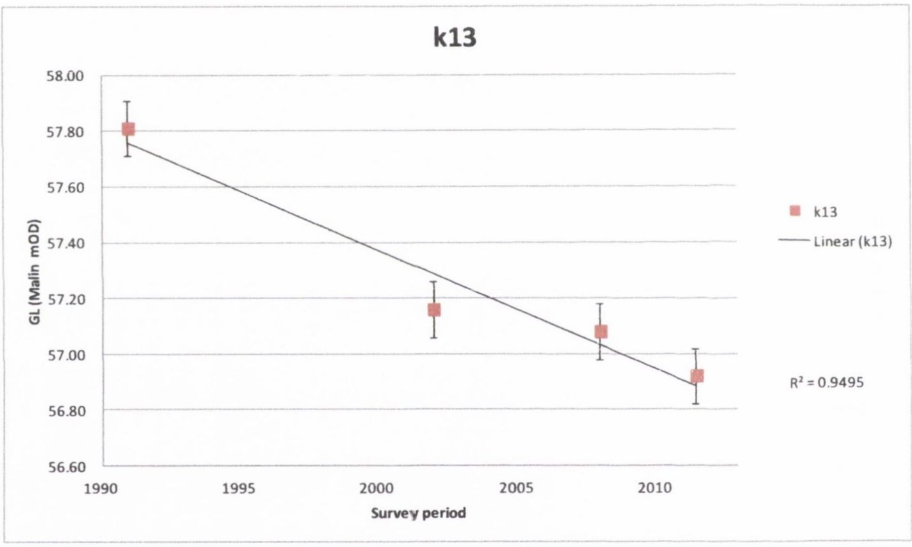
Subsidence trend at bog grid point K10. Note: Mean 2011-2012 elevation used.



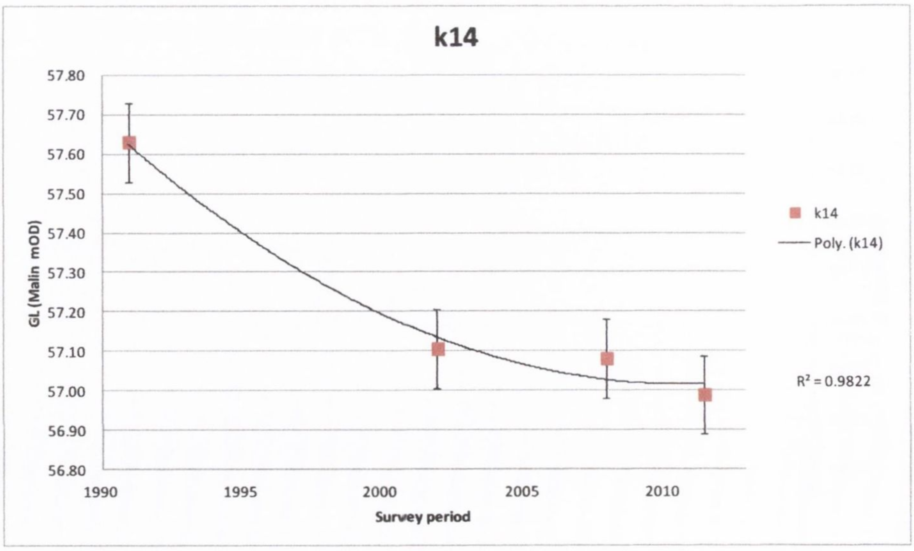
Subsidence trend at bog grid point K11. Note: Mean 2011-2012 elevation used.



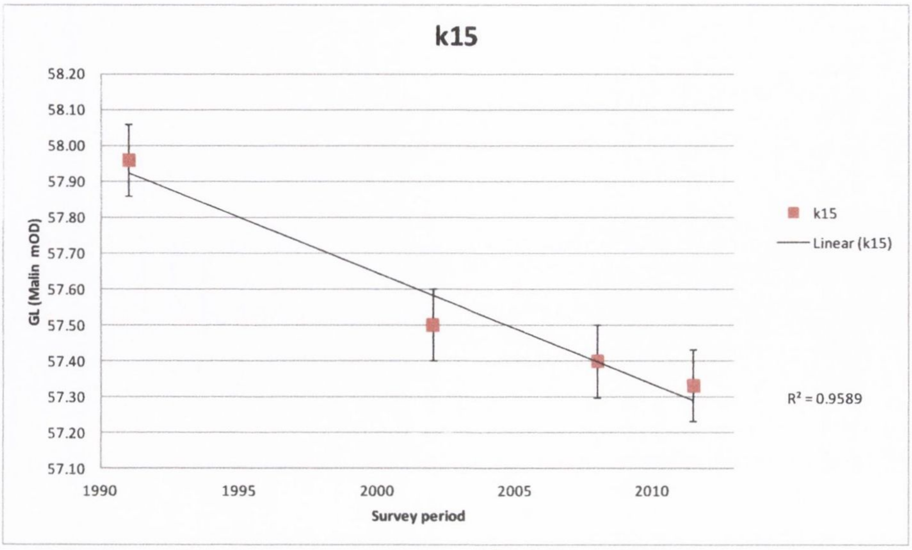
Subsidence trend at bog grid point K12. Note: Mean 2011-2012 elevation used.



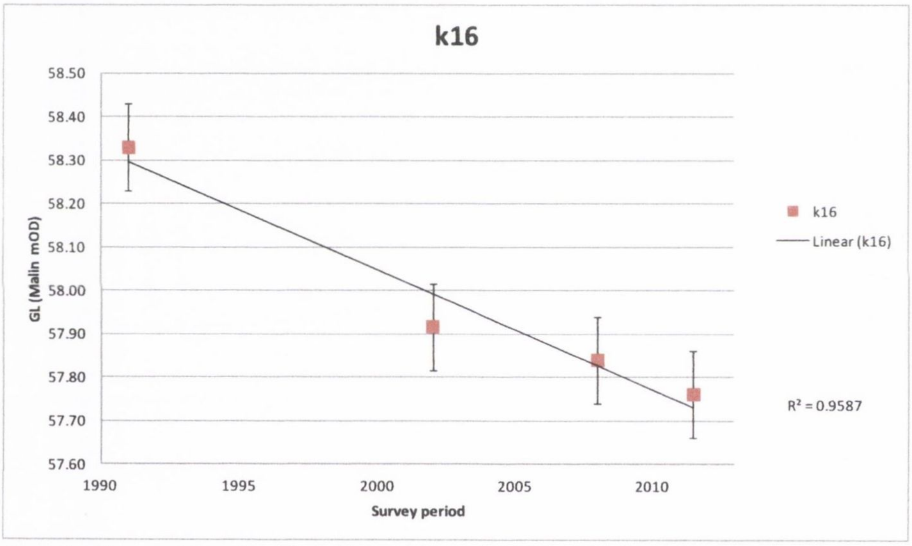
Subsidence trend at bog grid point K13. Note: Mean 2011-2012 elevation used.



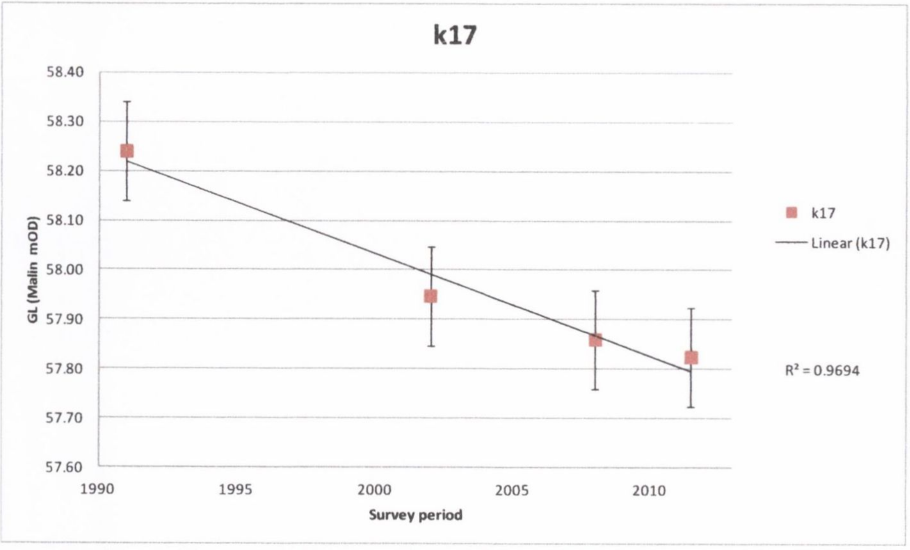
Subsidence trend at bog grid point K14. Note: Mean 2011-2012 elevation used.



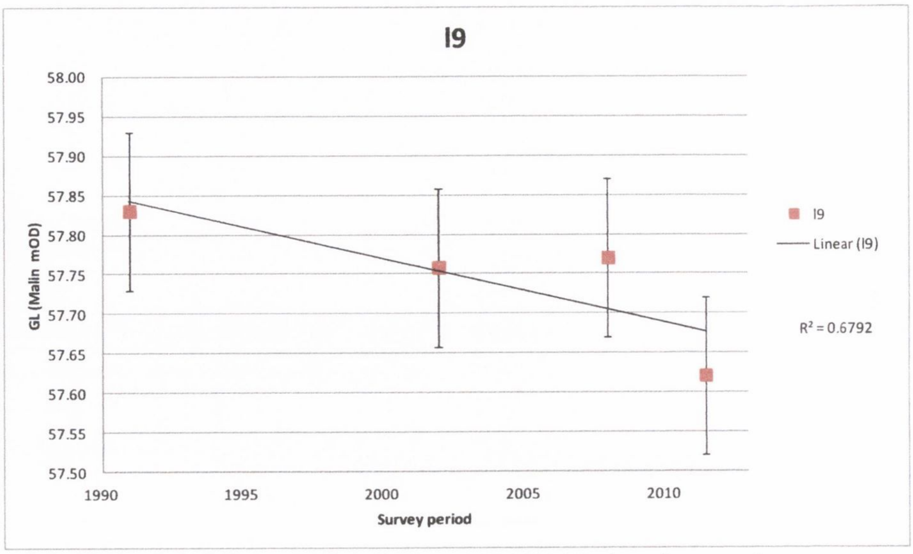
Subsidence trend at bog grid point K15. Note: Mean 2011-2012 elevation used.



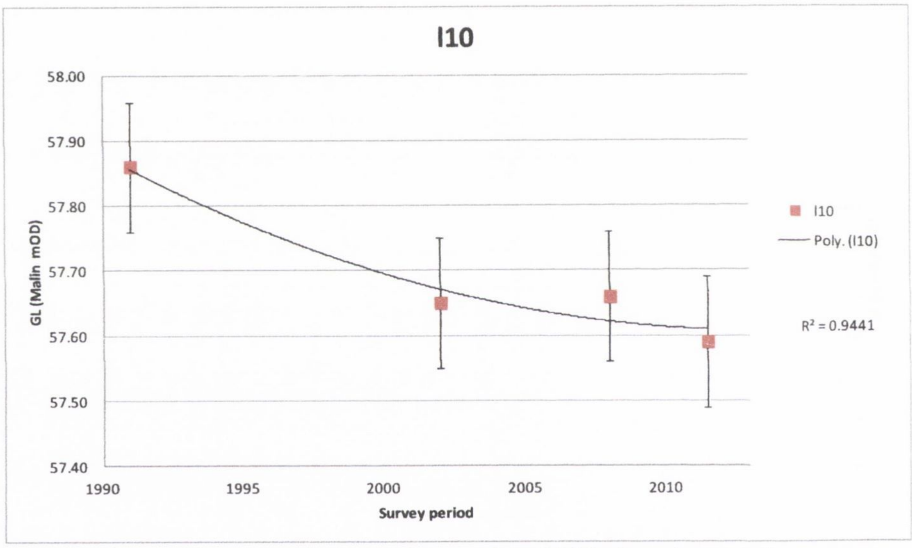
Subsidence trend at bog grid point K16. Note: Mean 2011-2012 elevation used.



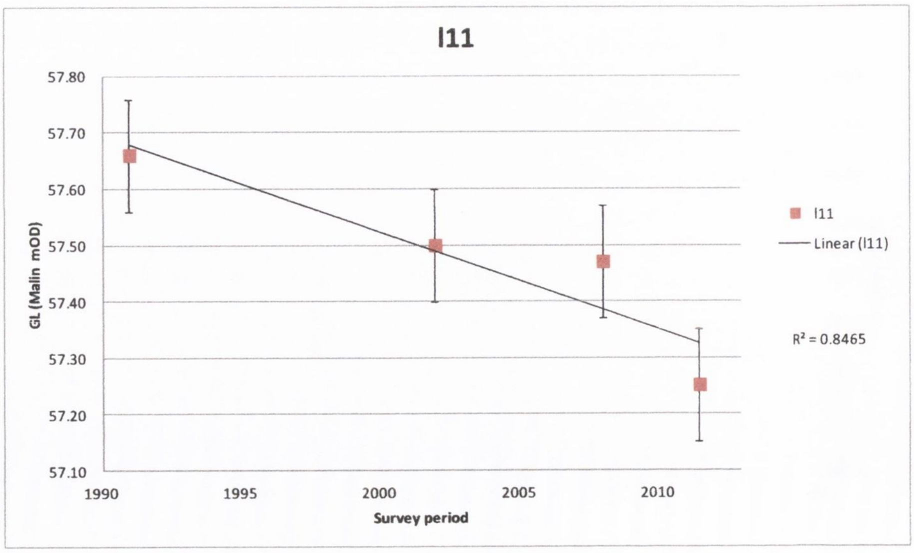
Subsidence trend at bog grid point K17. Note: Mean 2011-2012 elevation used.



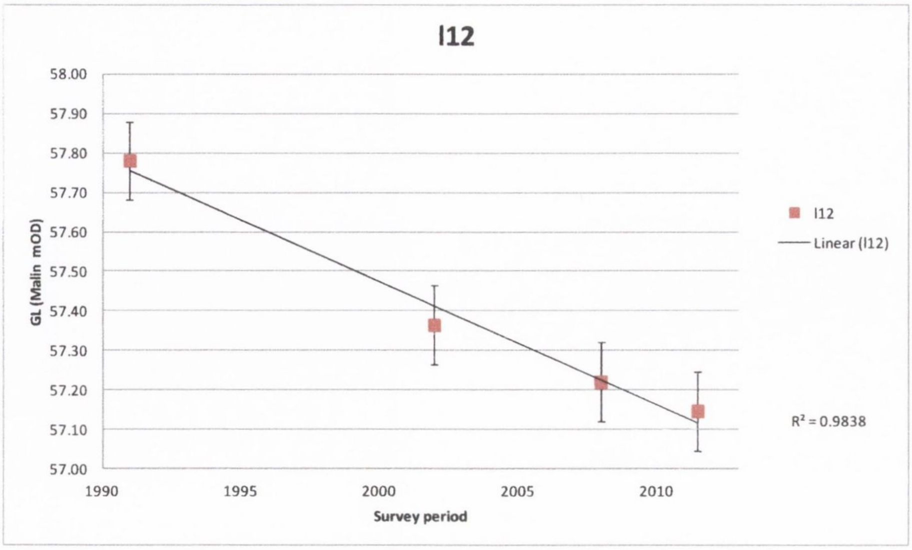
Subsidence trend at bog grid point L9. Note: Mean 2011-2012 elevation used.



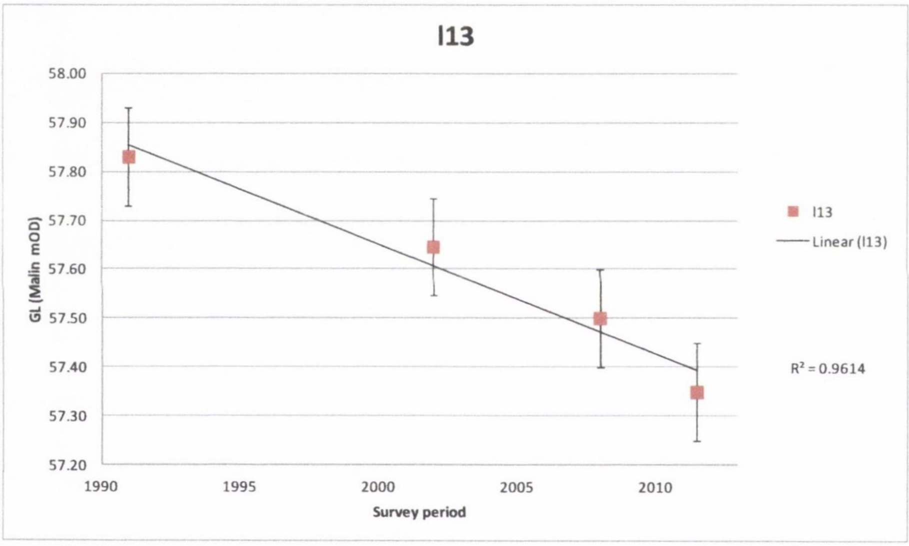
Subsidence trend at bog grid point L10. Note: September 2011 elevation used.



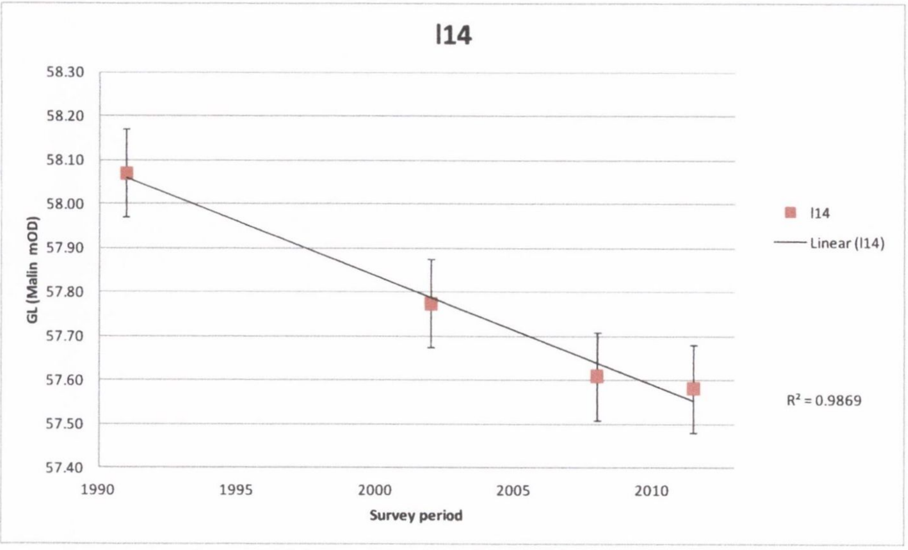
Subsidence trend at bog grid point L11. Note: Mean 2011-2012 elevation used.



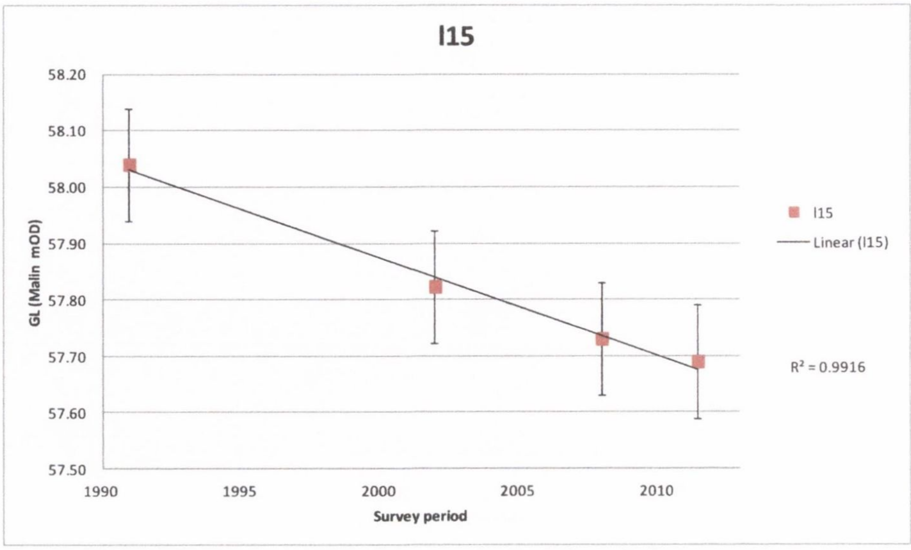
Subsidence trend at bog grid point L12. Note: Mean 2011-2012 elevation used.



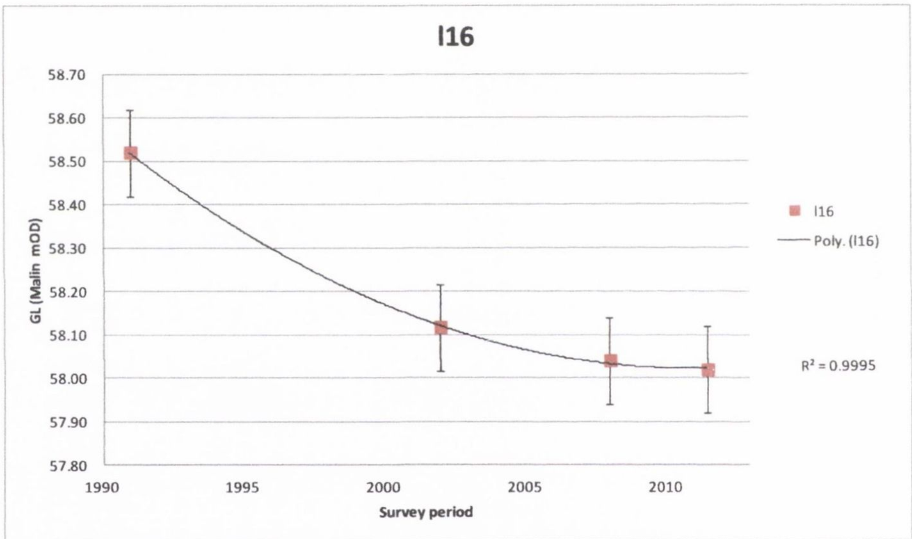
Subsidence trend at bog grid point L13. Note: Mean 2011-2012 elevation used.



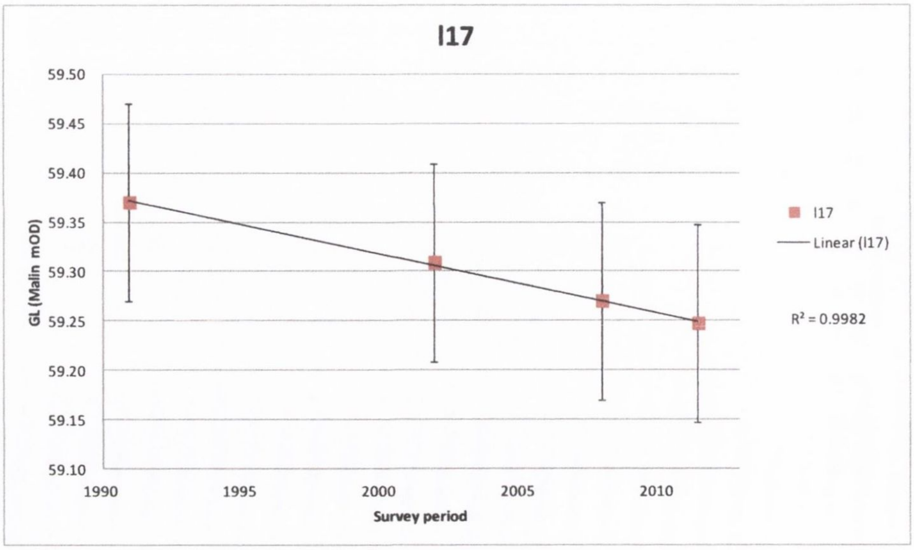
Subsidence trend at bog grid point L14. Note: Mean 2011-2012 elevation used.



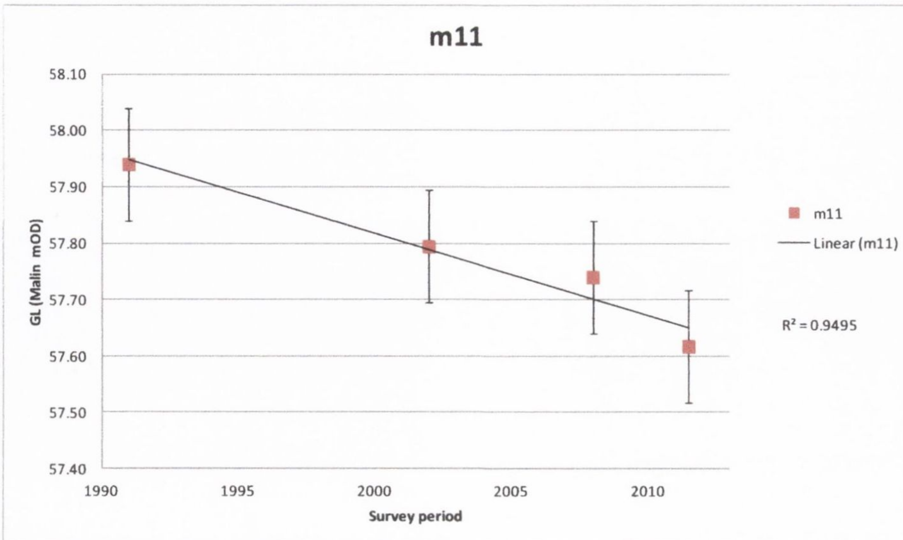
Subsidence trend at bog grid point L15. Note: Mean 2011-2012 elevation used.



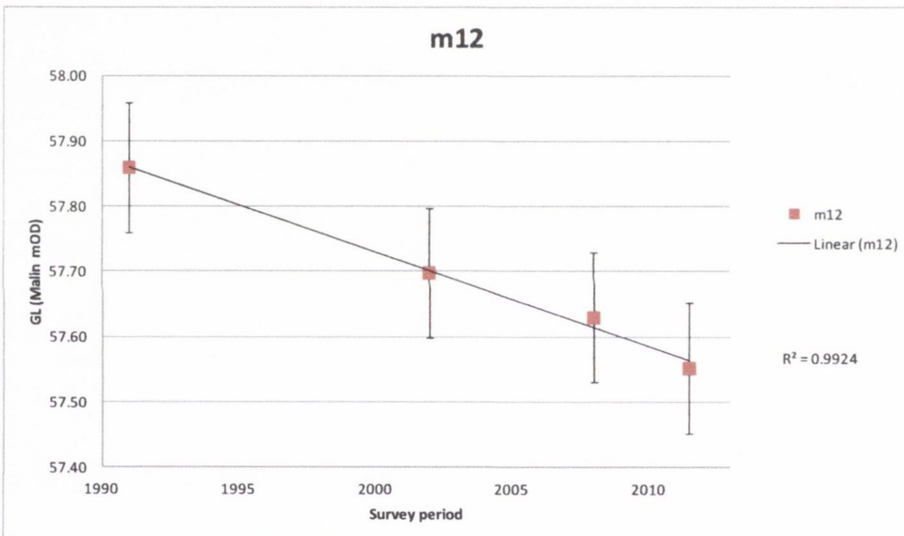
Subsidence trend at bog grid point L16. Note: Mean 2011-2012 elevation used.



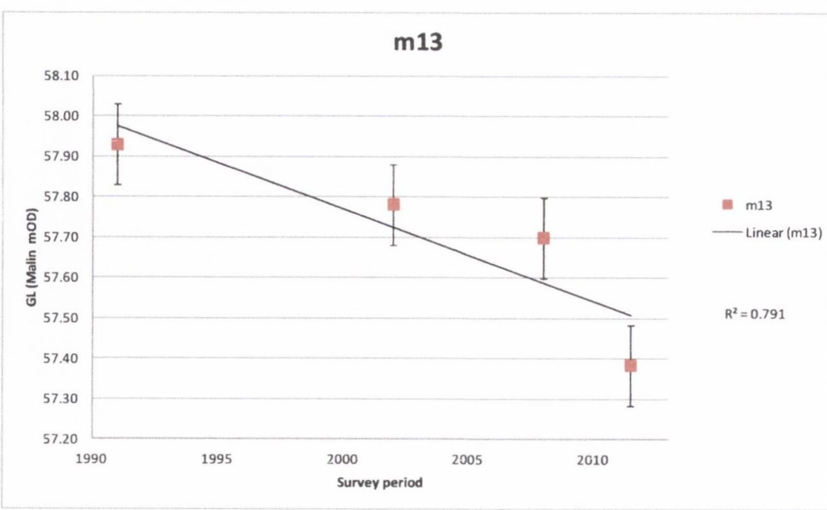
Subsidence trend at bog grid point L17. Note: Mean 2011-2012 elevation used.



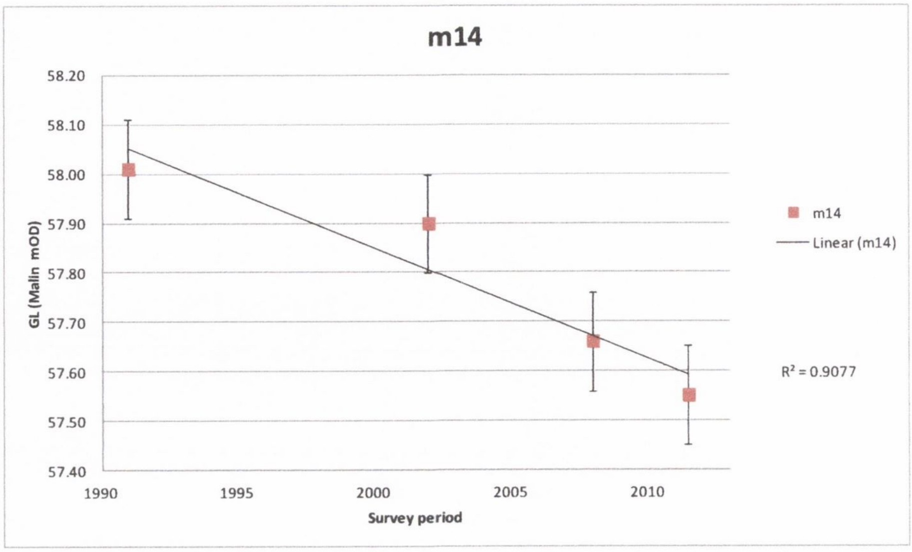
Subsidence trend at bog grid point M11. Note: Mean 2011-2012 elevation used.



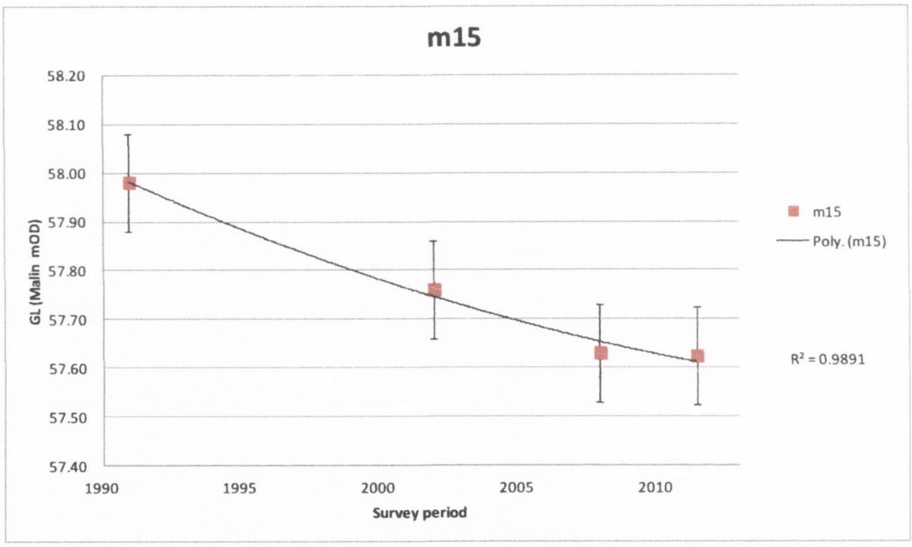
Subsidence trend at bog grid point M12. Note: Mean 2011-2012 elevation used.



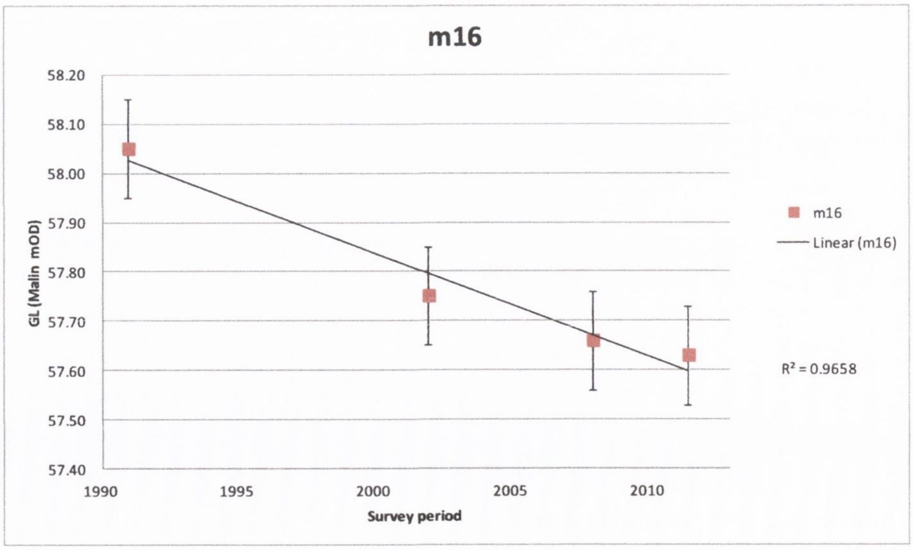
Subsidence trend at bog grid point M13. Note: Mean 2011-2012 elevation used. Mound area – LiDAR may not measure ground surface accurately.



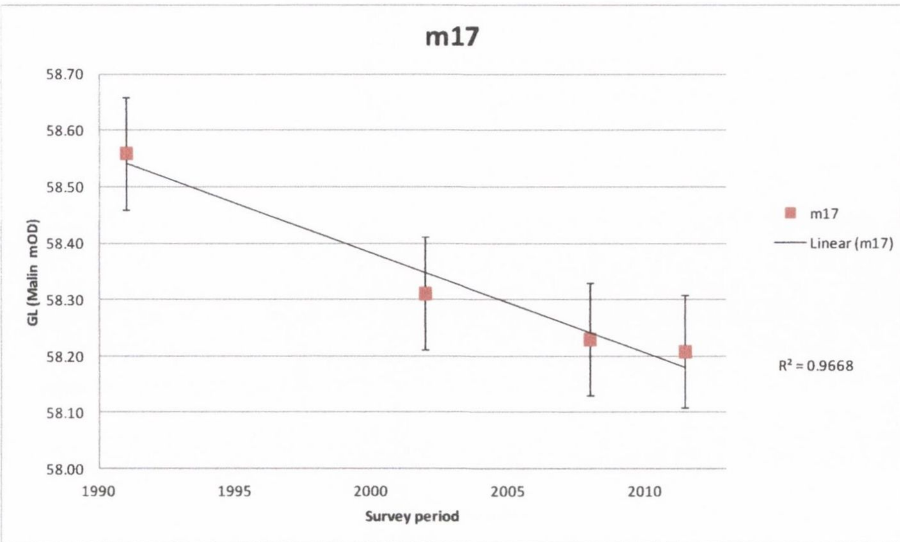
Subsidence trend at bog grid point M14. Note: Mean 2011-2012 elevation used.



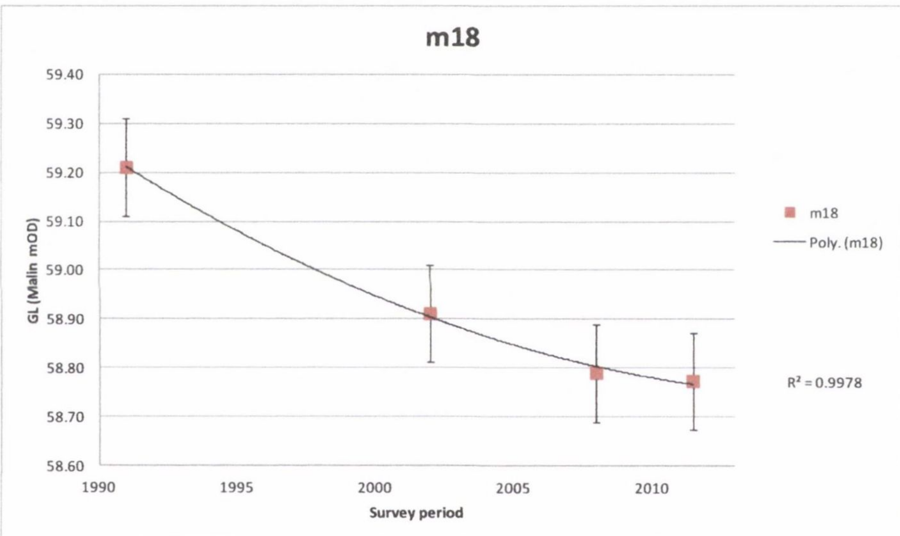
Subsidence trend at bog grid point M15. Note: Mean 2011-2012 elevation used.



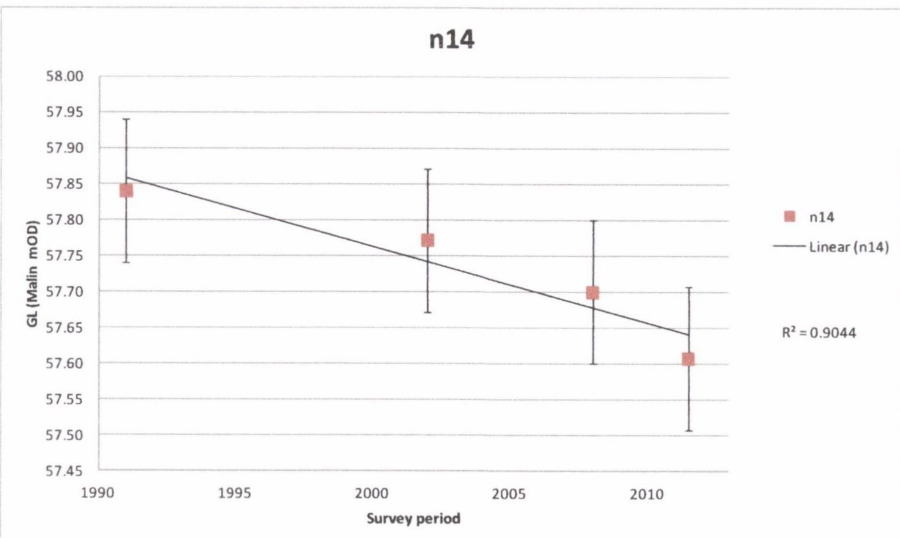
Subsidence trend at bog grid point M16. Note: Mean 2011-2012 elevation used.



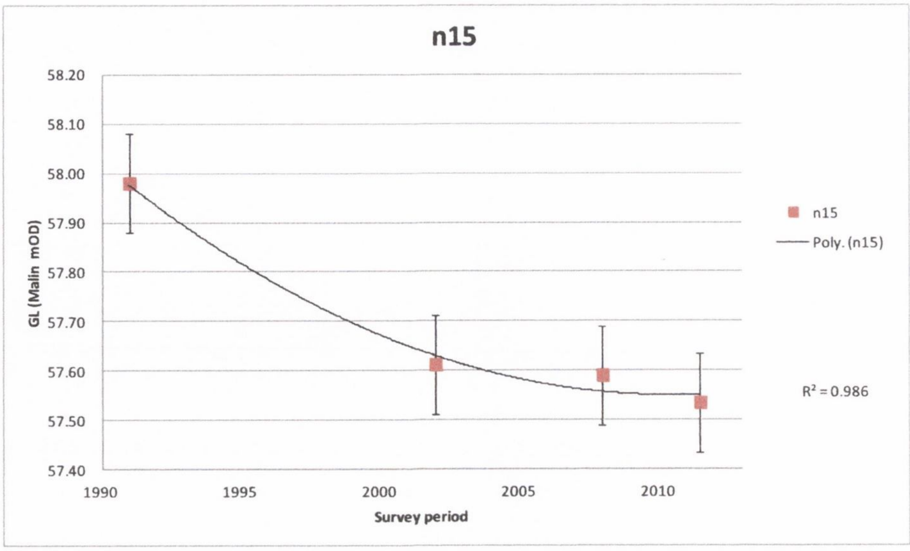
Subsidence trend at bog grid point M17. Note: Mean 2011-2012 elevation used.



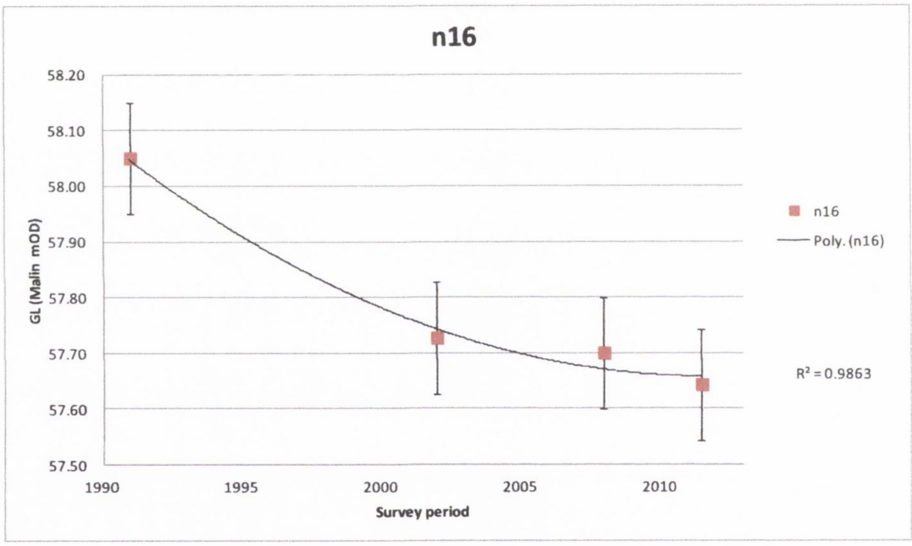
Subsidence trend at bog grid point M18. Note: Mean 2011-2012 elevation used.



Subsidence trend at bog grid point N14. Note: Mean 2011-2012 elevation used.



Subsidence trend at bog grid point N15. Note: Mean 2011-2012 elevation used.



Subsidence trend at bog grid point N16. Note: Mean 2011-2012 elevation used.

Appendix E: Subsidence: Ground Level Oscillations

Table E1. Ground level elevations from 1991, 2002, 2008 and 2012

id	2011	2008	2002	1991	id	2011	2008	2002	1991
e11	55.38	55.34	55.43	55.47	l9	57.65	57.77	57.76	57.83
e12	54.92	55.04	55.06	55.29	l10	57.59	57.66	57.65	57.86
f9		55.84	55.86	55.83	l11	57.33	57.47	57.50	57.66
f10		55.59	55.62	55.82	l12	57.14	57.22	57.36	57.78
f11		55.34	55.34	56.15	l13	57.36	57.50	57.65	57.83
f12		54.94	54.96	55.21	l14	57.55	57.61	57.77	58.07
f13		54.34	54.38	54.91	l15	57.64	57.73	57.82	58.04
g8		55.88	55.94	56.17	l16	58.00	58.04	58.12	58.52
g9		55.72	55.73	55.99	l17	59.26	59.27	59.31	59.37
g10		55.54	55.53	55.76	m11	57.66	57.74	57.79	57.94
g11		55.18	55.08	55.44	m12	57.58	57.63	57.70	57.86
g12		54.79	54.84	55.15	m13	57.42	57.70	57.78	57.93
g13	54.20	54.21	54.27	55.00	m14	57.62	57.66	57.90	58.01
h7	56.42	56.49	56.43	56.51	m15	57.57	57.63	57.76	57.98
h8	56.22	56.29	56.28	56.56	m16	57.60	57.66	57.75	58.05
h9	55.93	56.09	56.13	56.31	m17	58.19	58.23	58.31	58.56
h10	55.69	55.77	55.82	56.11	m18	58.76	58.79	58.91	59.21
h11	55.13	55.16	55.20	55.52	n14	57.68	57.70	57.77	57.84
h12	54.84	54.88	54.90	55.30	n15	57.55	57.59	57.61	57.98
h13	54.64	54.65	54.72	55.18	n16	57.69	57.70	57.73	58.05
i7	56.65	56.81	56.70	56.80					
i8	56.54	56.65	56.55	56.80					
i9	56.43	56.45	56.50	56.68	**EXTRA Points - April 2012**				
i10	56.54	56.59	56.56	56.72	D8		56.18	56.13	56.10
i11	56.32	56.36		56.55	D9		55.95	56.04	56.09
i12	55.67	55.70	55.80	56.15	D10		55.49	55.52	55.67
i13	*FILL*	*55.18*	*55.40*	*56.07*	D11		55.18	55.20	55.36
i14	54.49	54.59	54.84	55.91	D12		54.81	54.85	54.98
j7	56.84	57.00	56.98	57.09	D13		52.08	52.11	52.15
j8	56.91	57.00	56.97	57.16	E8		56.00	55.82	56.06
j9	56.62	56.75	56.82	57.01	E9		55.93	55.96	56.12
j10	56.68	56.76	56.78	56.97	E10		55.65	55.69	55.86
j11	56.97	56.99	57.00	57.25	E13		53.00	53.08	53.54
j12	57.01	57.11	57.28	57.72	F7		56.16	56.18	56.22
j13	56.51	56.54	56.64	57.84	F8		55.86	55.80	55.86
j14	55.53	55.57	55.70	56.44	G7		56.25	56.21	56.37
j15	56.68	56.74	56.79	57.86	G14		53.68	53.88	54.69
j16	57.29	57.32	57.29	57.83	H6		56.93	56.94	56.93
k7	57.39	57.52	57.48	57.65	H14		53.45	53.69	54.85
k8	57.39	57.47	57.41	57.58	I6		56.91	56.80	56.90
k9	57.11	57.18	57.25	57.40	J6		57.11	57.17	57.13
k10	57.10	57.20	57.24	57.39	K5		57.41	57.45	57.35

k11	57.14	57.24	57.32	57.48	K6		57.43	57.39	57.45
k12	57.02	57.11	57.19	57.68	L8		57.86	57.73	57.92
k13	57.04	57.08	57.16	57.81	M9		57.93	57.92	58.04
k14	57.02	57.08	57.11	57.63	M10		57.79	57.81	57.92
k15	57.35	57.40	57.50	57.96	N11		58.06	57.91	57.99
k16	57.77	57.84	57.92	58.33	N12		57.91	57.92	58.08
k17	57.73	57.86	57.95	58.24	N13		57.73	57.79	57.97

Table E2. Ground level oscillations between September 2011 and April 2012

ID	02-Sep-11	08-Jan-12	08-Apr-12	Range (m)	ID	02-Sep-11	08-Jan-12	08-Apr-12	Range (m)
E11	55.378	55.28	55.216	0.16	J14	55.505	55.548	55.546	0.04
E12	54.904	54.937	54.959	0.05	J15	56.678	56.733	56.68	0.06
F9	55.698	55.755	55.631	0.12	J16	57.293	57.299	57.278	0.02
F10	55.444	55.502	55.522	0.08	K7	57.388	57.429	57.42	0.04
F11	55.325	55.166	55.176	0.16	K8	57.313	57.39	57.353	0.08
F12	54.927	54.911	54.83	0.10	K9	57.109	57.064	57.035	0.07
F13	54.353		54.251	0.10	K10	57.058	57.101	57.069	0.04
G8	55.619	55.771	55.768	0.15	K11	57.078	57.158	57.121	0.08
G9	55.595	55.712	55.622	0.12	K12	57.018	57.034	57.016	0.02
G10	55.452	55.472	55.415	0.06	K13	56.85	57.061	56.852	0.21
G11		55.131	55.087	0.04	K14	57.023	56.965	56.976	0.06
G12	54.631	54.722	54.699	0.09	K15	57.256	57.349	57.39	0.13
G13	54.169	54.214	54.236	0.07	K16	57.766	57.739	57.778	0.04
H7	56.417	56.338	56.304	0.11	K17	57.733	57.898	57.843	0.17
H8	56.159	56.221	56.242	0.08	L9	57.621	57.648	57.607	0.04
H9	55.929	55.999	55.961	0.07	L10	57.592	57.508	57.51	0.08
H10	55.683	55.717	55.674	0.04	L11	57.326	57.24	57.189	0.14
H11	55.053	55.148	55.063	0.10	L12	57.111	57.158	57.17	0.06
H12	54.827	54.862	54.821	0.04	L13	57.335	57.378	57.346	0.04
H13	54.796	54.655	54.666	0.14	L14	57.553	57.614	57.593	0.06
I7	56.579	56.653	56.622	0.07	L15	57.638	57.734	57.715	0.10
I8	56.544	56.54	56.524	0.02	L16	57.998	58.023	58.036	0.04
I9	56.364	56.43	56.35	0.08	L17	59.269	59.192	59.281	0.09
I10	56.447	56.541	56.485	0.09	M11	57.658	57.675	57.557	0.12
I11	56.323	56.336	56.224	0.11	M12	57.575	57.591	57.515	0.08
I12	55.589	55.684	55.629	0.09	M13	57.339	57.433	57.403	0.09
I13	55.309	55.339	55.33	0.03	M14	57.606	57.637	57.466	0.17
I14		55.138	55.018	0.12	M15	57.572	57.692	57.638	0.12
J7	56.839	56.847	56.87	0.03	M16	57.601	57.625	57.664	0.06
J8	56.885	56.907	56.88	0.03	M17	58.301	58.195	58.221	0.11
J9	56.617	56.603	56.606	0.01	M18	58.858	58.765	58.781	0.09
J10	56.591	56.677	56.574	0.10	N12		57.736	57.642	0.09
J11	56.853	56.987	56.83	0.16	N14	57.683	57.622	57.518	0.17
J12	57.005	57.106	57.034	0.10	N15	57.548		57.521	0.03
J13	56.513	56.593	56.505	0.09	N16	57.597	57.693	57.64	0.10

Appendix E: Rate of Subsidence – Ground Level Oscillations

Table E3. Borehole levels used to control bog surface level elevations

id	02-Sep-11	08-Jan-12	11-Jan-12	08-Apr-12
915	52.218	52.200	52.217	52.212
CLBH5	52.869	52.848	52.868	52.863
906			56.585	56.587
909	57.342			57.336
Offset (m):		0.018	0.001	0.006

Table E4. OPW bog grid post oscillation in Clara West subsidence analysis area

Post	08-Jan-12	08-Apr-12	Fluctuation (m)	Post	08-Jan-12	08-Apr-12	Fluctuation (m)
E11	55.952	55.949	0.003	J14	56.237	56.21	0.027
F9	56.319	56.33	-0.011	J15	57.298	57.299	-0.001
F10	56.205	56.21	-0.005	J16	57.849	57.845	0.004
F11	55.989	56.002	-0.013	K7	57.944	57.961	-0.017
F12	55.353	55.357	-0.004	K8	57.978	57.987	-0.009
G8	56.412	56.433	-0.021	K9	57.592	57.599	-0.007
G9	56.152	56.163	-0.011	K10	57.588	57.589	-0.001
G10	56.042	56.048	-0.006	K11	57.716	57.707	0.009
G11	55.516	55.522	-0.006	K12	57.482	57.485	-0.003
G12	55.33	55.312	0.018	K13	57.487	57.485	0.002
G13	54.915	54.912	0.003	K14	57.605	57.616	-0.011
H8	56.949	56.956	-0.007	K15	57.966	57.976	-0.010
H9	56.731	56.75	-0.019	L9	58.321	58.329	-0.008
H10	56.492	56.502	-0.010	L10	58.176	58.182	-0.006
H11	55.729	55.72	0.009	L11	57.843	57.852	-0.009
H12	55.215	55.218	-0.003	L12	57.746	57.748	-0.002
H13	55.319	55.309	0.010	L13	57.921	57.928	-0.007
I7	57.148	57.16	-0.012	L14	58.273	58.275	-0.002
I8	57.095	57.099	-0.004	L15	58.269	58.249	0.020
I9	56.853	56.863	-0.010	L16	58.575	58.595	-0.020
I10	56.954	56.966	-0.012	L17	59.486	59.503	-0.017
I11	56.743	56.755	-0.012	M11	58.198	58.187	0.011
I12	56.338	56.308	0.030	M12	58.117	58.127	-0.010
I14	55.659	55.642	0.017	M13	58.11	58.101	0.009
J7	57.372	57.387	-0.015	M14	58.032	58.035	-0.003
J8	57.462	57.478	-0.016	M15	58.023	58.03	-0.007
J9	57.138	57.146	-0.008	M16	58.274	58.291	-0.017
J10	57.197	57.208	-0.011	M17	58.796	58.811	-0.015
J11	57.254	57.257	-0.003	N12	58.362	58.361	0.001
J12	57.421	57.405	0.016	N14	58.424	58.423	0.001
J13	56.94	56.931	0.009				

Table E5. Surface level oscillation in Clara West subsidence analysis area

ID	02-Sep-11	08-Jan-12	08-Apr-12	Range (m)	ID	02-Sep-11	08-Jan-12	08-Apr-12	Range (m)
E11	55.378	55.28	55.216	0.16	J14	55.505	55.548	55.546	0.04
E12	54.904	54.937	54.959	0.05	J15	56.678	56.733	56.68	0.06
F9	55.698	55.755	55.631	0.12	J16	57.293	57.299	57.278	0.02
F10	55.444	55.502	55.522	0.08	K7	57.388	57.429	57.42	0.04
F11	55.325	55.166	55.176	0.16	K8	57.313	57.39	57.353	0.08
F12	54.927	54.911	54.83	0.10	K9	57.109	57.064	57.035	0.07
F13	54.353		54.251	0.10	K10	57.058	57.101	57.069	0.04
G8	55.619	55.771	55.768	0.15	K11	57.078	57.158	57.121	0.08
G9	55.595	55.712	55.622	0.12	K12	57.018	57.034	57.016	0.02
G10	55.452	55.472	55.415	0.06	K13	56.85	57.061	56.852	0.21
G11		55.131	55.087	0.04	K14	57.023	56.965	56.976	0.06
G12	54.631	54.722	54.699	0.09	K15	57.256	57.349	57.39	0.13
G13	54.169	54.214	54.236	0.07	K16	57.766	57.739	57.778	0.04
H7	56.417	56.338	56.304	0.11	K17	57.733	57.898	57.843	0.17
H8	56.159	56.221	56.242	0.08	L9	57.621	57.648	57.607	0.04
H9	55.929	55.999	55.961	0.07	L10	57.592	57.508	57.51	0.08
H10	55.683	55.717	55.674	0.04	L11	57.326	57.24	57.189	0.14
H11	55.053	55.148	55.063	0.10	L12	57.111	57.158	57.17	0.06
H12	54.827	54.862	54.821	0.04	L13	57.335	57.378	57.346	0.04
H13	54.796	54.655	54.666	0.14	L14	57.553	57.614	57.593	0.06
I7	56.579	56.653	56.622	0.07	L15	57.638	57.734	57.715	0.10
I8	56.544	56.54	56.524	0.02	L16	57.998	58.023	58.036	0.04
I9	56.364	56.43	56.35	0.08	L17	59.269	59.192	59.281	0.09
I10	56.447	56.541	56.485	0.09	M11	57.658	57.675	57.557	0.12
I11	56.323	56.336	56.224	0.11	M12	57.575	57.591	57.515	0.08
I12	55.589	55.684	55.629	0.09	M13	57.339	57.433	57.403	0.09
I13	55.309	55.339	55.33	0.03	M14	57.606	57.637	57.466	0.17
I14		55.138	55.018	0.12	M15	57.572	57.692	57.638	0.12
J7	56.839	56.847	56.87	0.03	M16	57.601	57.625	57.664	0.06
J8	56.885	56.907	56.88	0.03	M17	58.301	58.195	58.221	0.11
J9	56.617	56.603	56.606	0.01	M18	58.858	58.765	58.781	0.09
J10	56.591	56.677	56.574	0.10	N12		57.736	57.642	0.09
J11	56.853	56.987	56.83	0.16	N14	57.683	57.622	57.518	0.17
J12	57.005	57.106	57.034	0.10	N15	57.548		57.521	0.03
J13	56.513	56.593	56.505	0.09	N16	57.597	57.693	57.64	0.10

Appendix E: Rate of Subsidence: Measured and Estimated Peat Thickness Change

Table E6. Measured and estimated peat thickness at grid points in subsidence analysis area

ID	Peat depth (m)				Peat Depth
	1991	2002	2008	2012	
e11	8.5	8.455	8.37	8.321	Measured
e12	7.831	7.6	7.541	7.5	Estimated
f9	8.5	8.49	8.46	8.425	Measured
f10	8.548	8.347	8.308	8.25	Estimated
f11	8.5	7.688	7.68	7.675	Measured
f12	8.283	8.031	8.013	8	Estimated
f13	6.858	6.33	6.288	6.25	Estimated
g8	9.149	8.919	8.789	8.75	Estimated
g9	9.2	8.943	8.93	8.922	Measured
g10	8.688	8.457	8.428	8.4	Estimated
g11	8.4	8.18	8.14	8.091	Measured
g12	8.3	7.99	7.94	7.872	Measured
g13	7.75	7.022	6.97	6.964	Measured
h7	9.043	8.958	8.953	8.95	Estimated
h8	9	8.717	8.7	8.682	Measured
h9	9.15	8.966	8.88	8.839	Measured
h10	5.2	4.914	4.86	4.807	Measured
h11	6.872	6.552	6.512	6.5	Estimated
h12	7.688	7.283	7.268	7.25	Estimated
h13	7.775	7.314	7.255	7.25	Estimated
i7	9.247	9.145	9.117	9.1	Estimated
i8	9.056	8.807	8.804	8.8	Estimated
i9	8.55	8.372	8.32	8.3	Estimated
i10	6.679	6.514	6.509	6.5	Estimated
i11	7.714		7.524	7.5	Estimated
i12	5.2	4.853	4.75	4.734	Measured
i14	7.43	6.358	6.11	6.05	Estimated
j7	9.8	9.685	9.61	9.58	Measured
j8	9.553	9.365	9.323	9.3	Estimated
j9	8.6	8.411	8.27	8.207	Measured
j10	9.293	9.1	9.043	9	Estimated
j11	9.4	9.145	9.07	9.022	Measured
j12	6.4	5.963	5.79	5.718	Measured
j13	6.15	4.95	4.85	4.847	Measured
j14	7.3	6.56	6.43	6.408	Measured
j15	7.227	6.161	6.107	6.1	Estimated
j16	7.1	6.6	6.59	6.569	Measured
k7	9.471	9.3	9.261	9.25	Estimated
k8	9.54	9.374	9.36	9.35	Estimated
k9	9.641	9.489	9.401	9.35	Estimated

k10	10.5	10.348	10.26	10.211	Measured
k11	10.072	9.913	9.832	9.75	Estimated
k12	8.75	8.262	8.18	8.104	Measured
k13	9.949	9.298	9.219	9.2	Estimated
k14	7.907	7.382	7.357	7.3	Estimated
k15	7.22	6.761	6.66	6.65	Estimated
k16	7.402	6.989	6.912	6.85	Estimated
k17	6.397	6.105	6.017	6	Estimated
l9	10	9.928	9.87	9.818	Measured
l10	10.5	10.29	10.27	10.25	Measured
l11	8.6	8.439	8.34	8.266	Measured
l12	9.3	8.884	8.74	8.678	Measured
l13	7.5	7.316	7.15	7.05	Measured
l14	4.8	4.504	4.34	4.323	Measured
l15	7.8	7.583	7.49	7.475	Measured
l16	6.9	6.497	6.42	6.416	Measured
l17	5.3	5.239	5.2	5.199	Measured
m11	10.115	9.969	9.915	9.85	Estimated
m12	9.619	9.457	9.389	9.35	Estimated
m13	8.897	8.749	8.517	8.4	Estimated
m14	7.773	7.662	7.423	7.4	Estimated
m15	7.456	7.236	7.106	7.1	Estimated
m16	7.725	7.426	7.335	7.3	Estimated
m17	6.839	6.59	6.509	6.5	Estimated
m18	5.929	5.63	5.509	5.5	Estimated
n14	8.857	8.789	8.717	8.7	Estimated
n15	8.732	8.364	8.342	8.3	Estimated
n16	8.157	7.834	7.807	7.8	Estimated

Appendix F

Subsurface drainage

Appendix F. Comparison of Piezometer Levels in Till

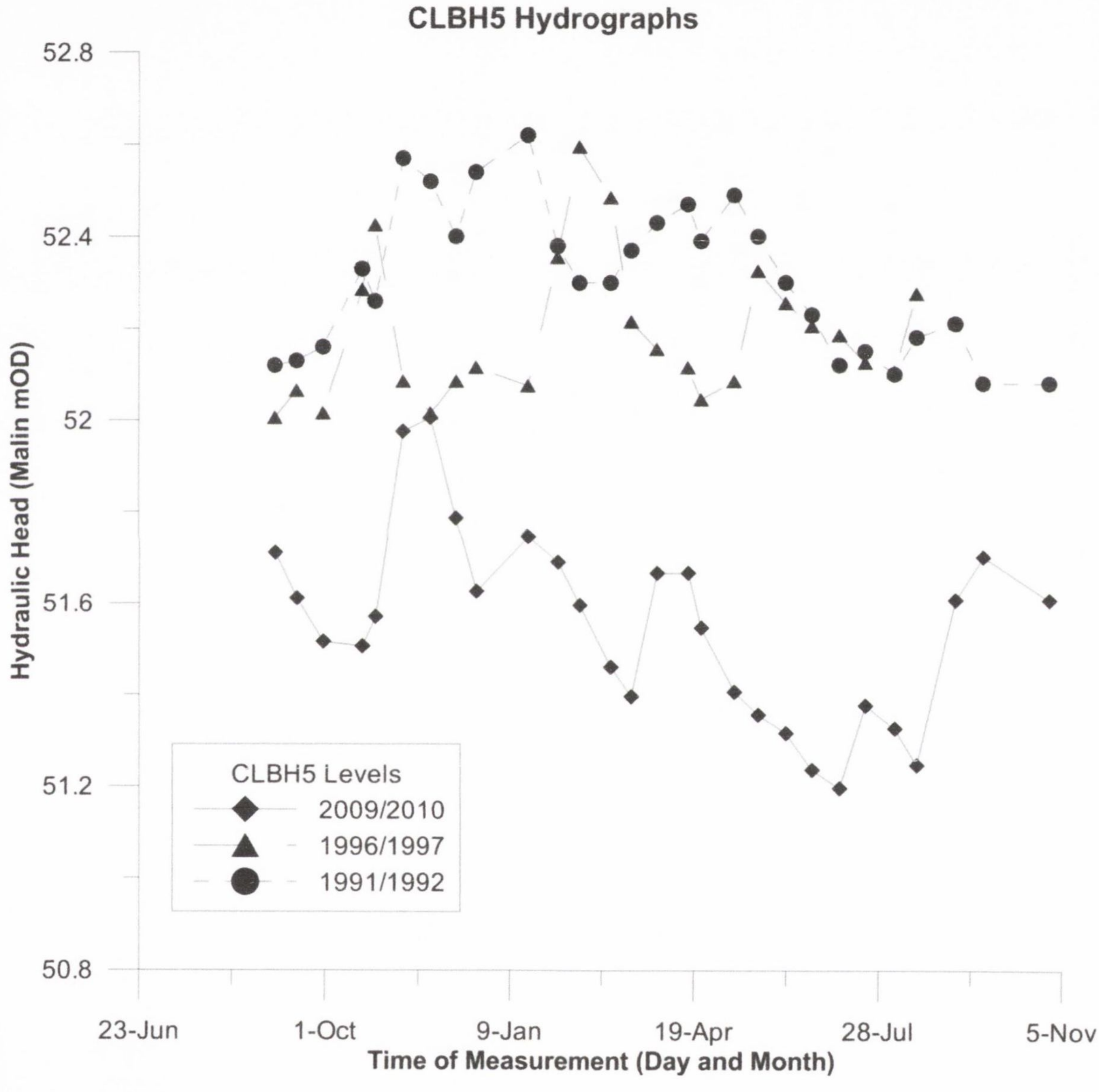


Figure F1. CLBH5 Hydrograph: 1990/1992, 1996/1997 and 2009/2010

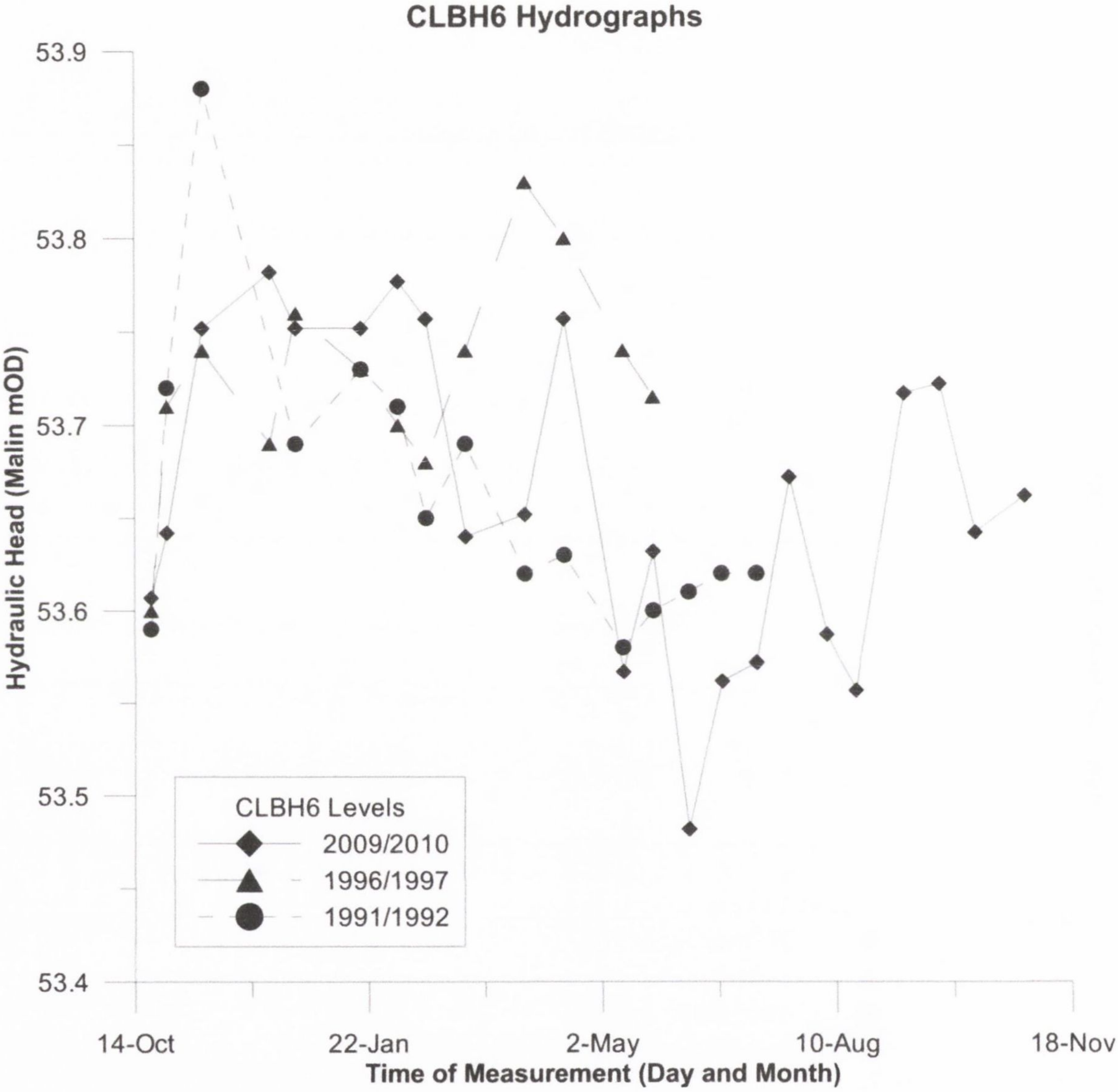


Figure F2. CLBH6 Hydrograph: 1990/1992, 1996/1997 and 2009/2010

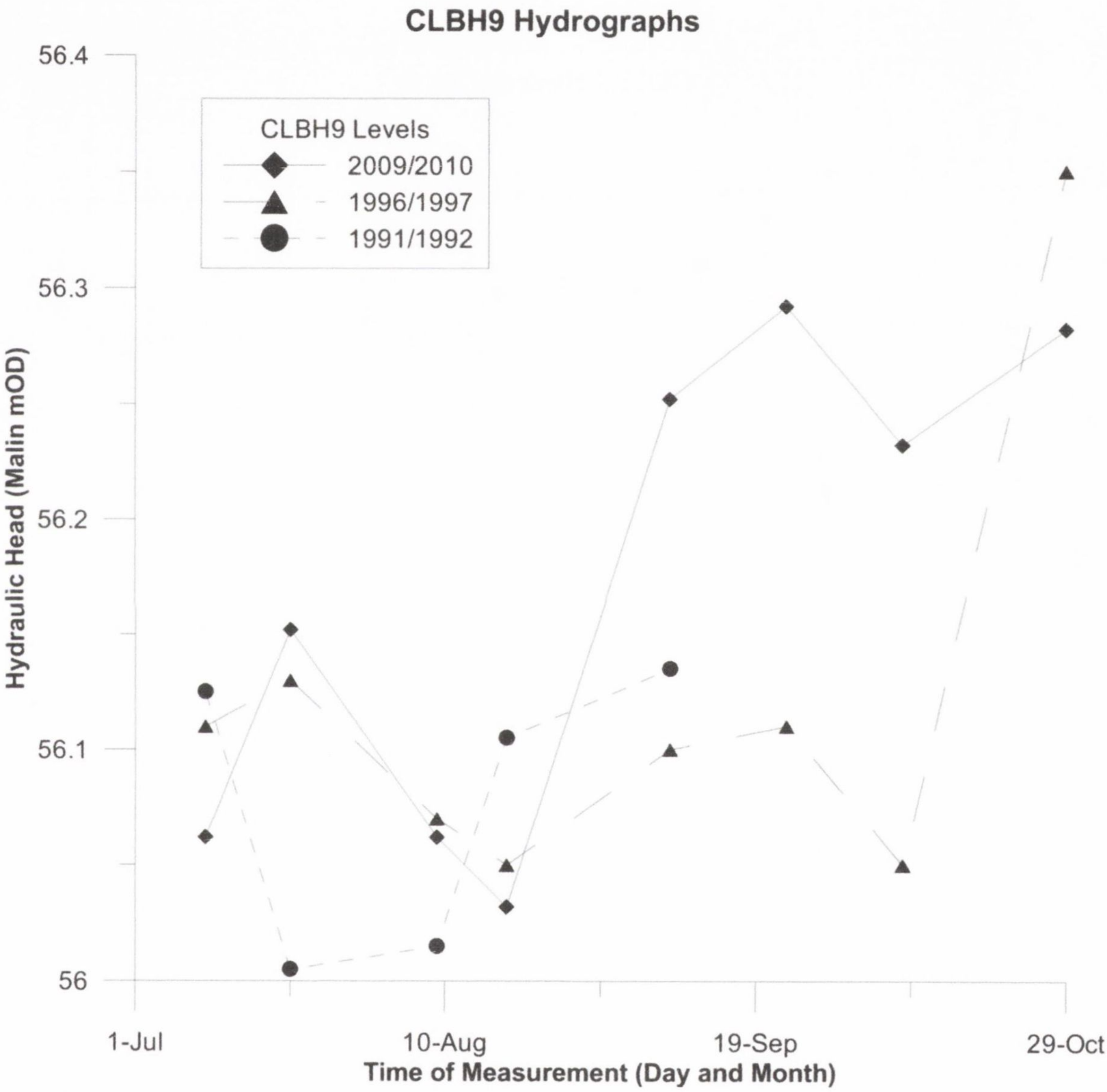


Figure F3. CLBH9 Hydrograph: 1990/1992, 1996/1997 and 2009/2010

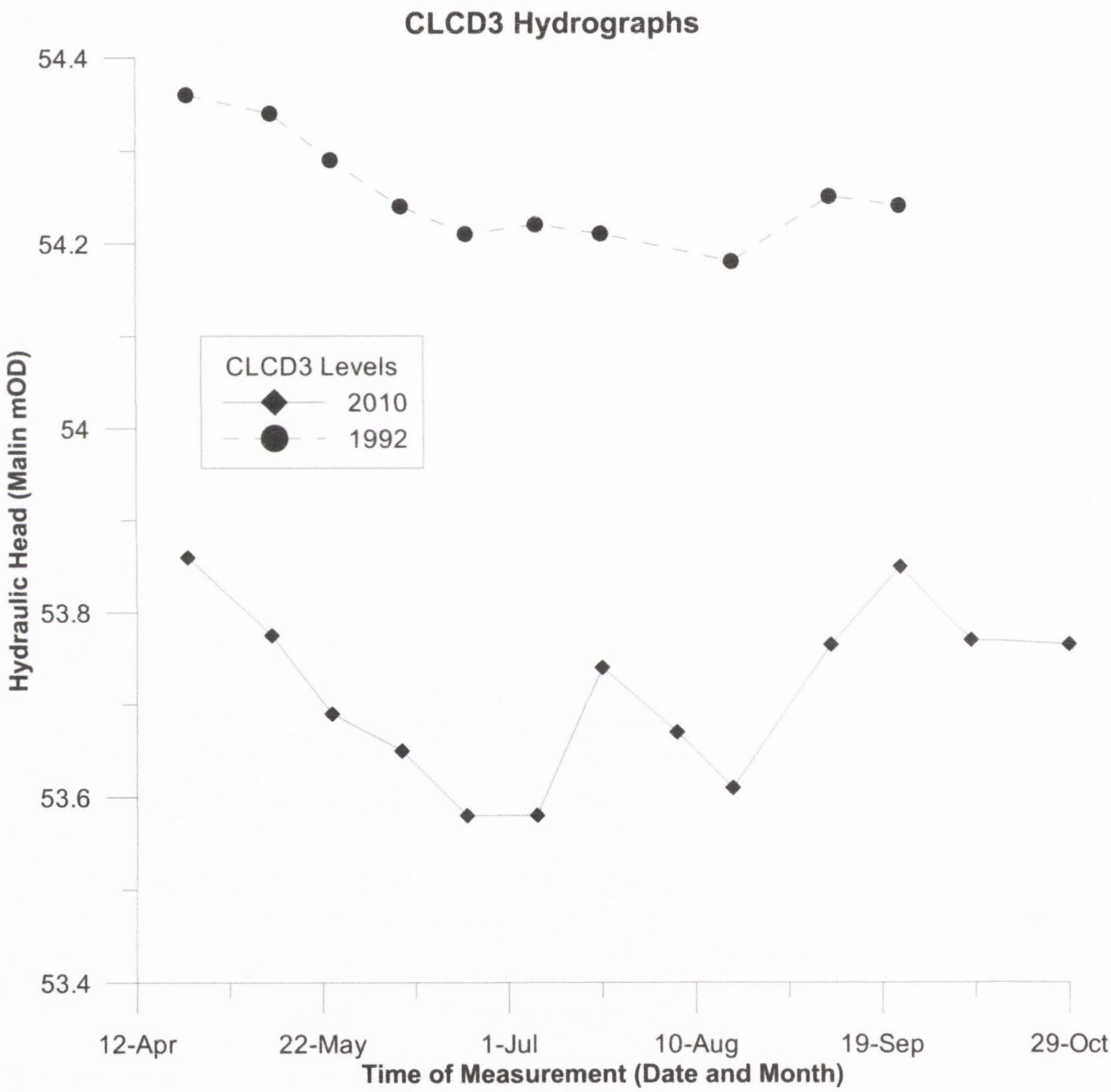


Figure F4. CLCD3 Hydrograph: 1990/1992 and 2009/2010

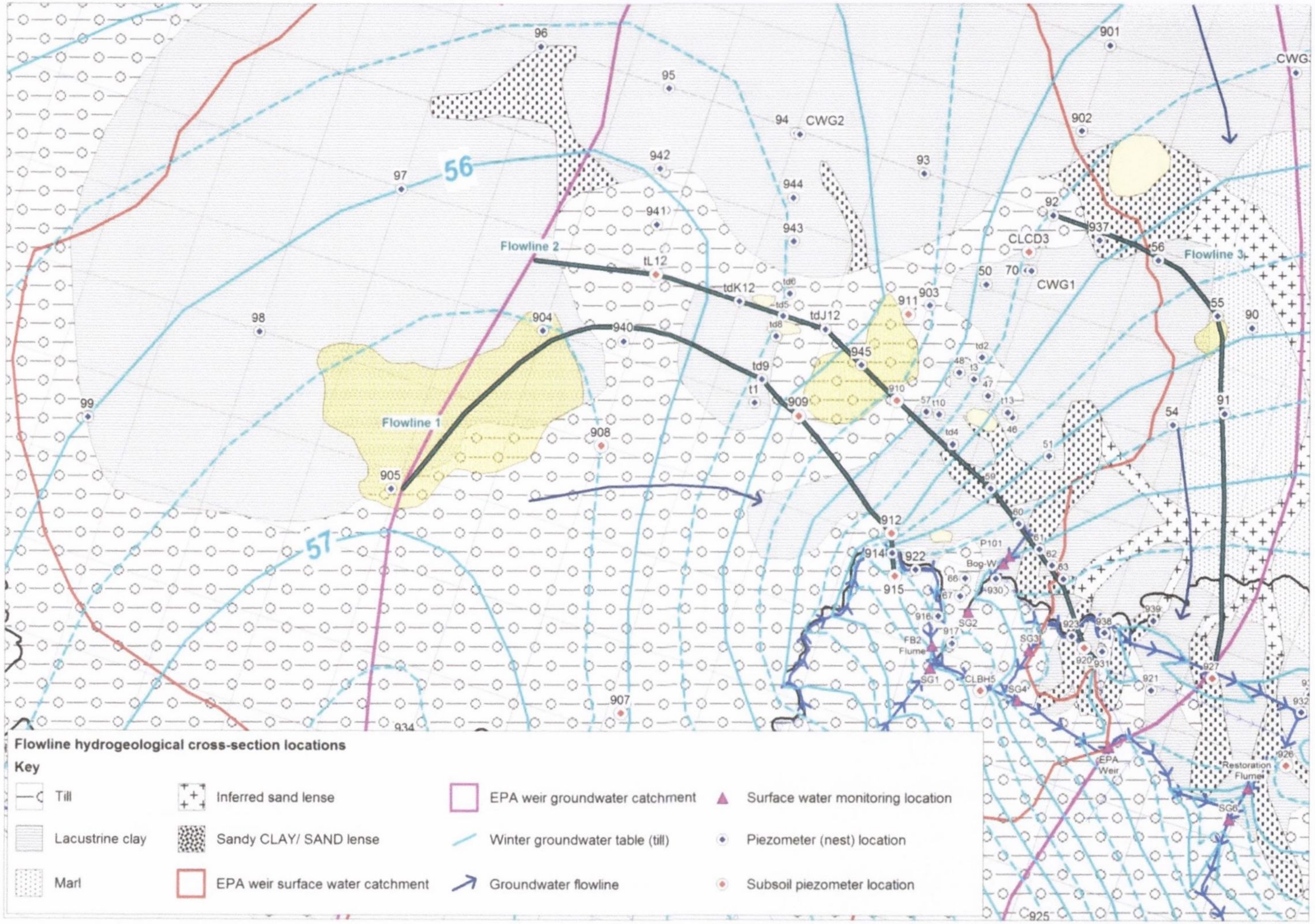


Figure F5. Flow line locations and underlying subsoil geology, groundwater catchment and potentiometric surface in till

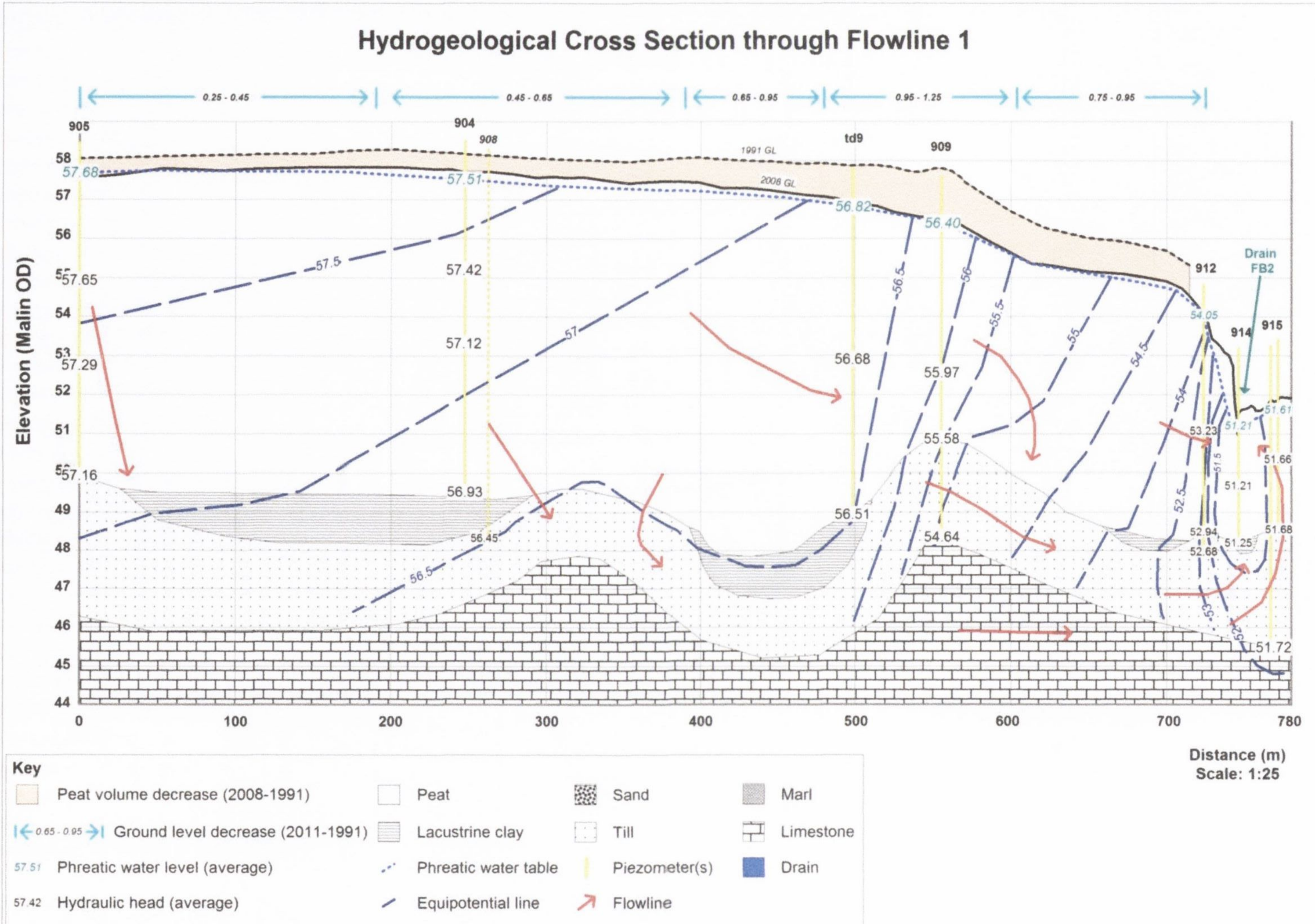


Figure F6. Hydrogeological cross-section through flow line 1

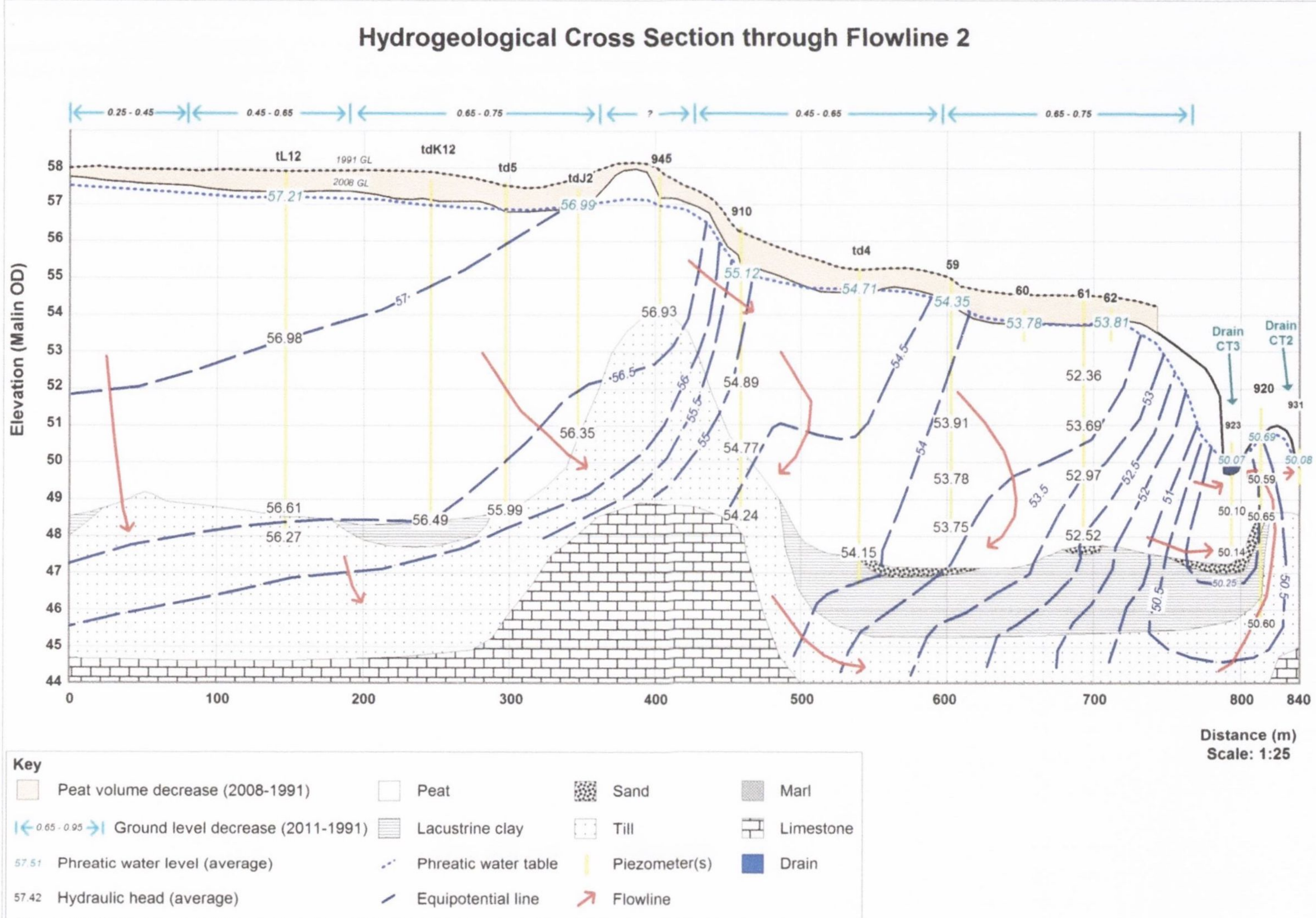


Figure F7. Hydrogeological cross-section through flow line 2

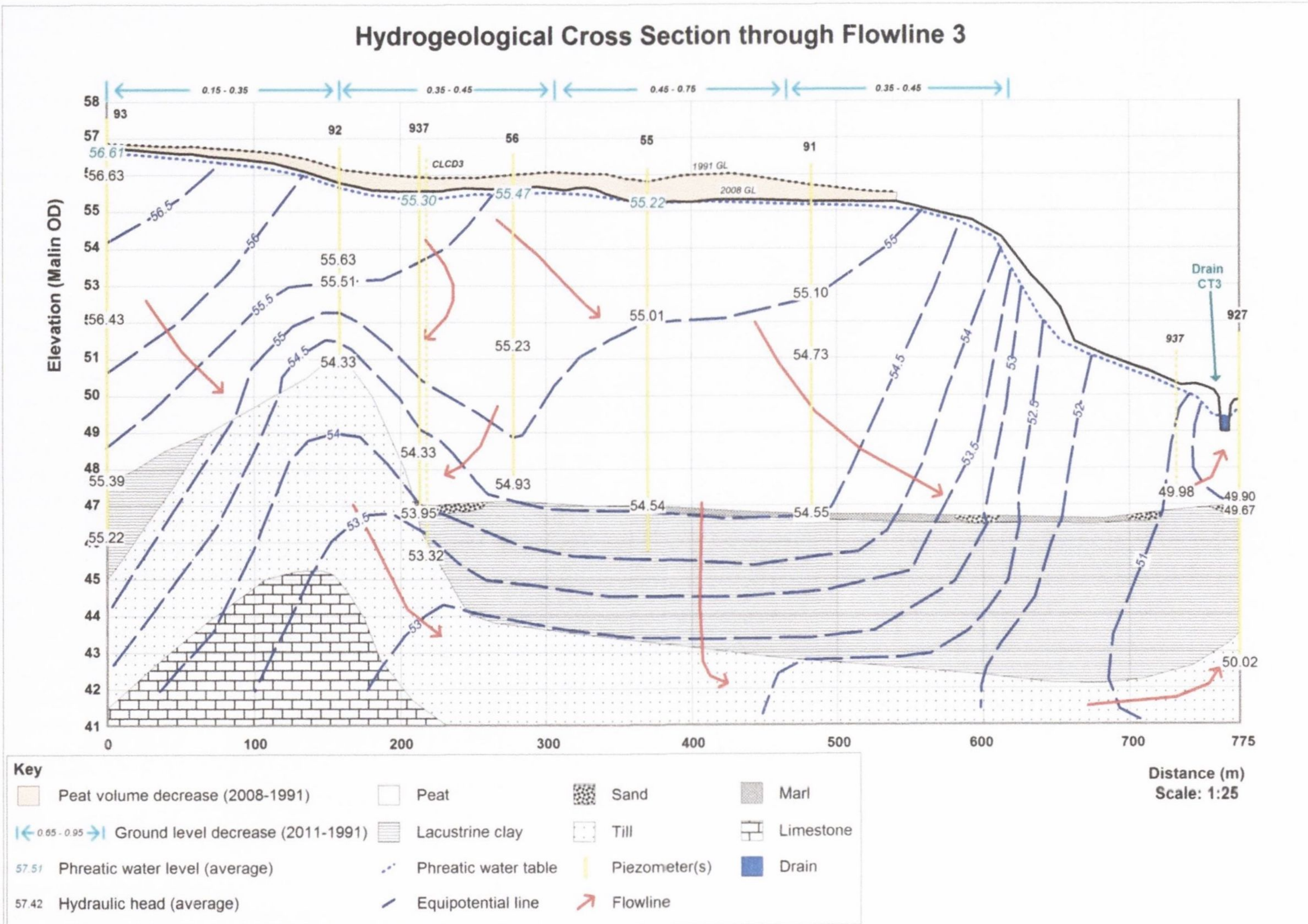


Figure F8. Hydrogeological cross-section through flow line 3

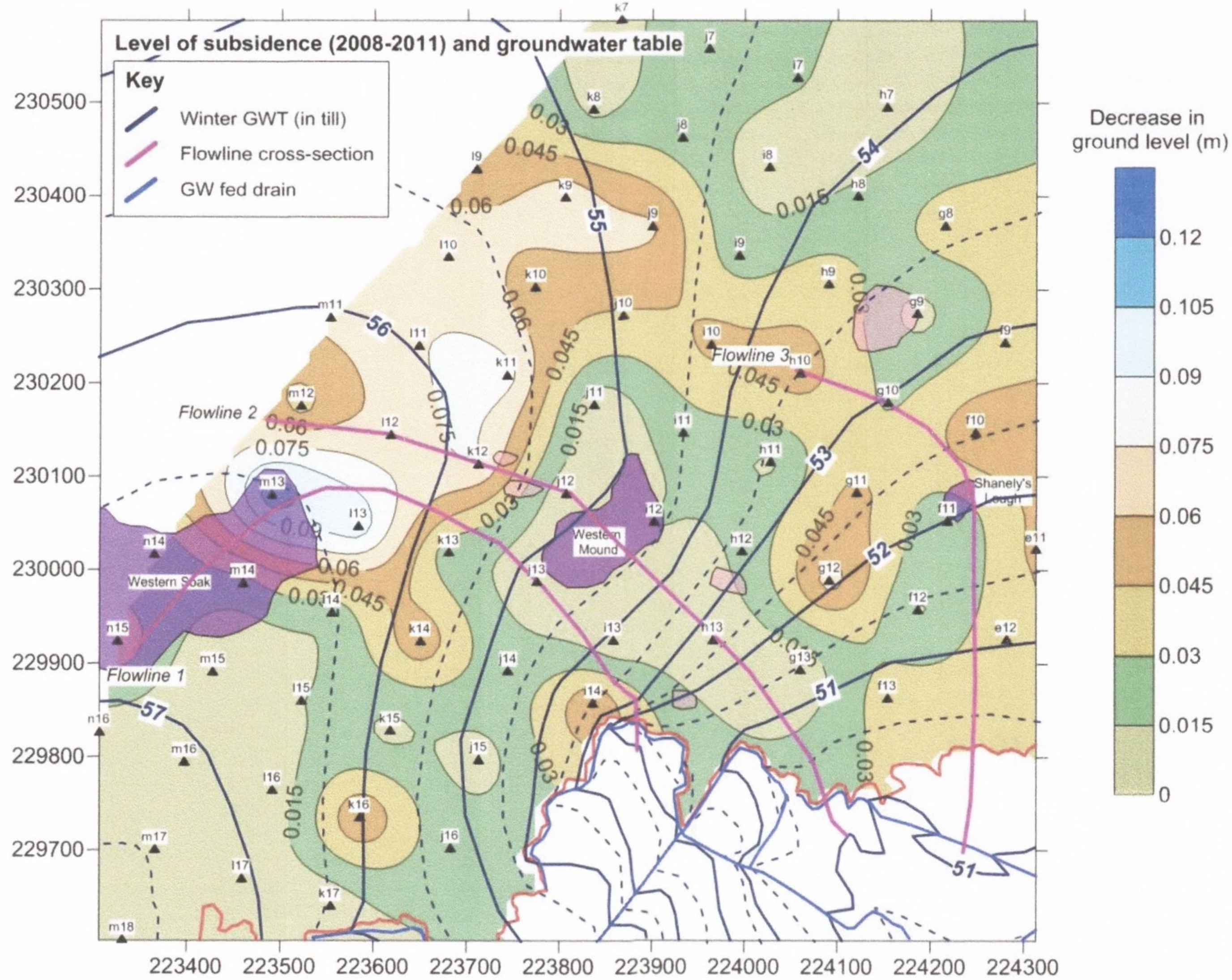


Figure F9. Flow line locations, high level potentiometric surface in till and 2008-2011 ground level

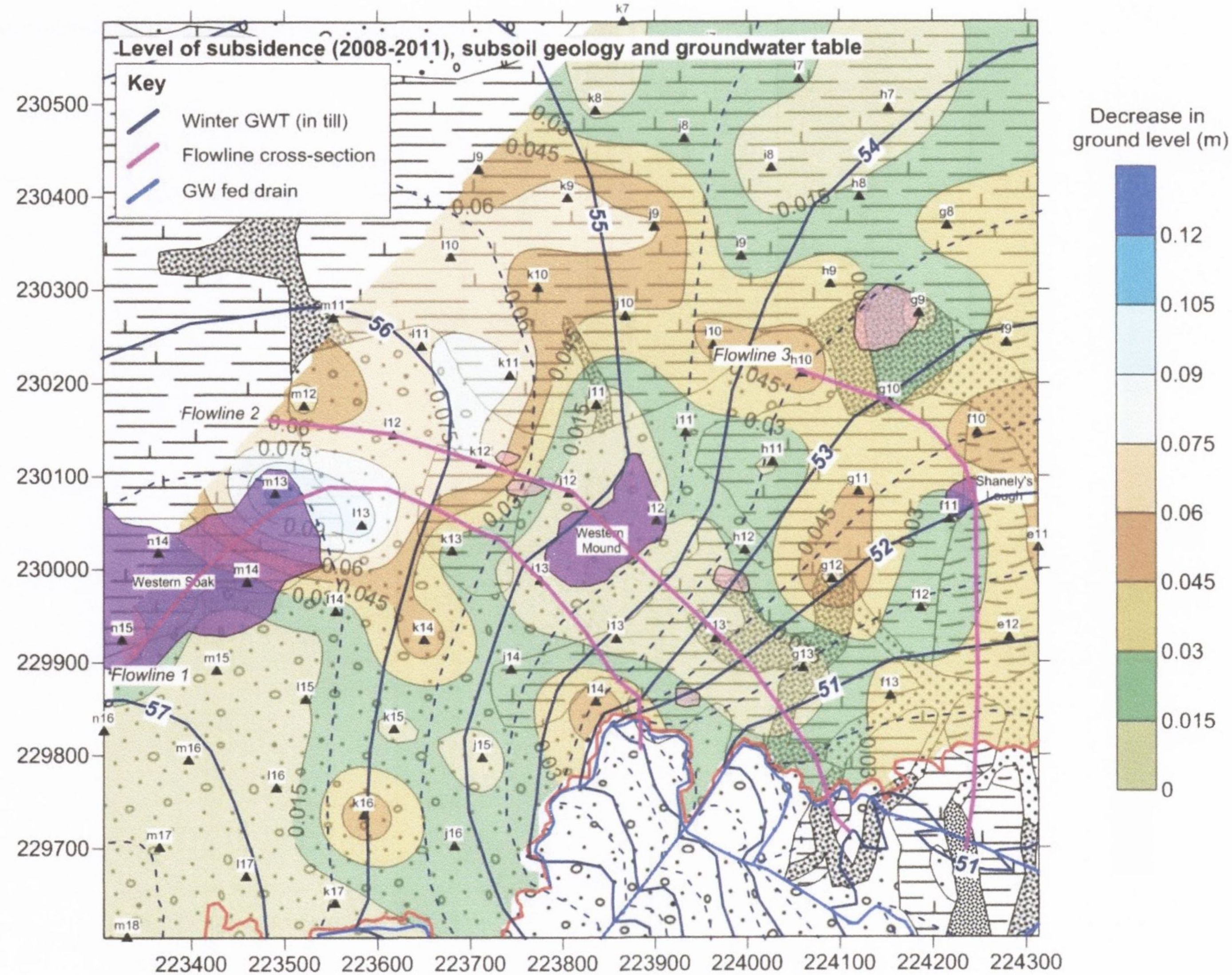


Figure F10. Flow line locations, subsoil geology, high level potentiometric surface in till and 2008-2011 ground level

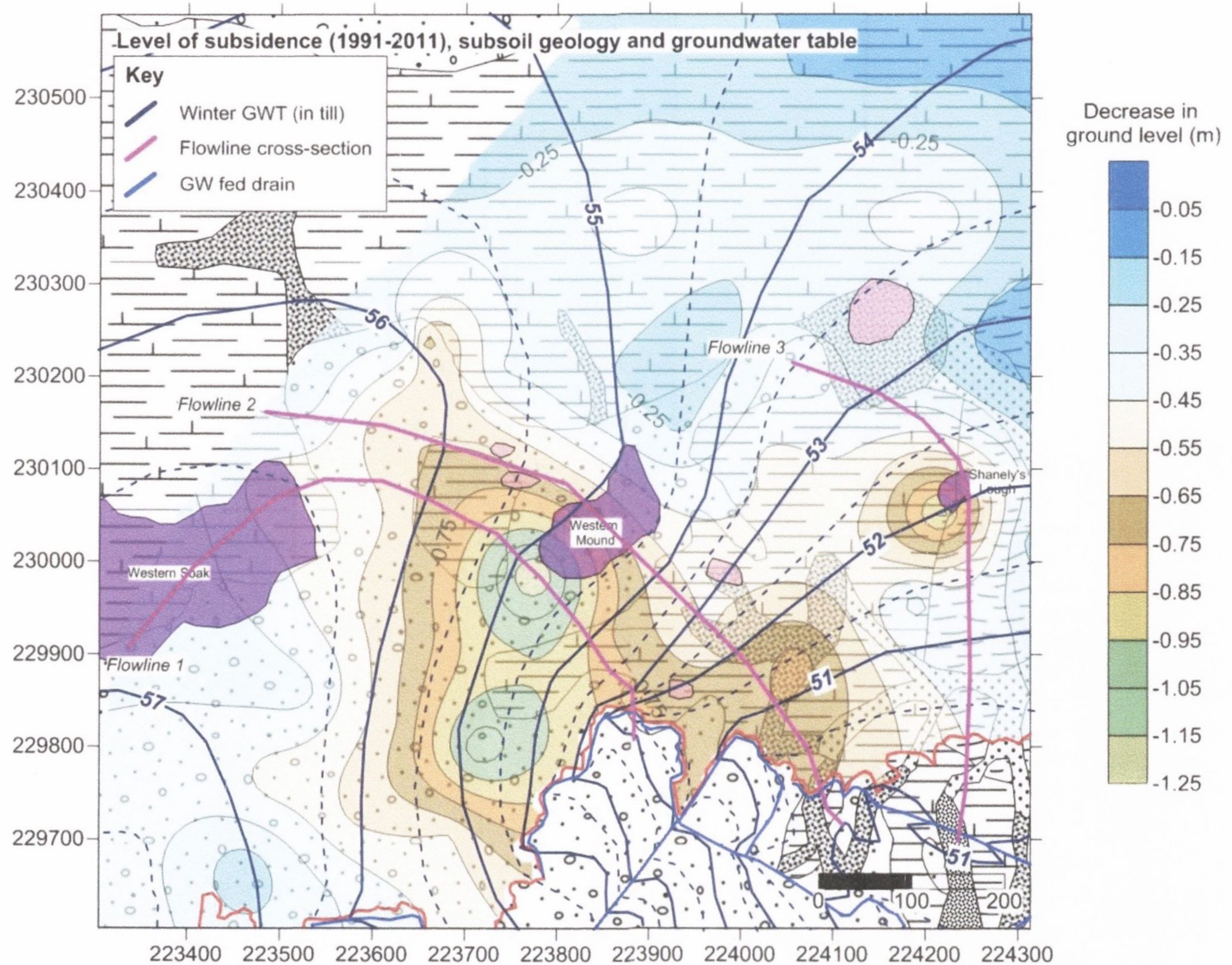


Figure F11. Flow line locations, subsoil geology, high level potentiometric surface in till and 1991-2011 ground level

Appendix G

The Water Balance

Appendix G: The Water Balance: Catchment Area

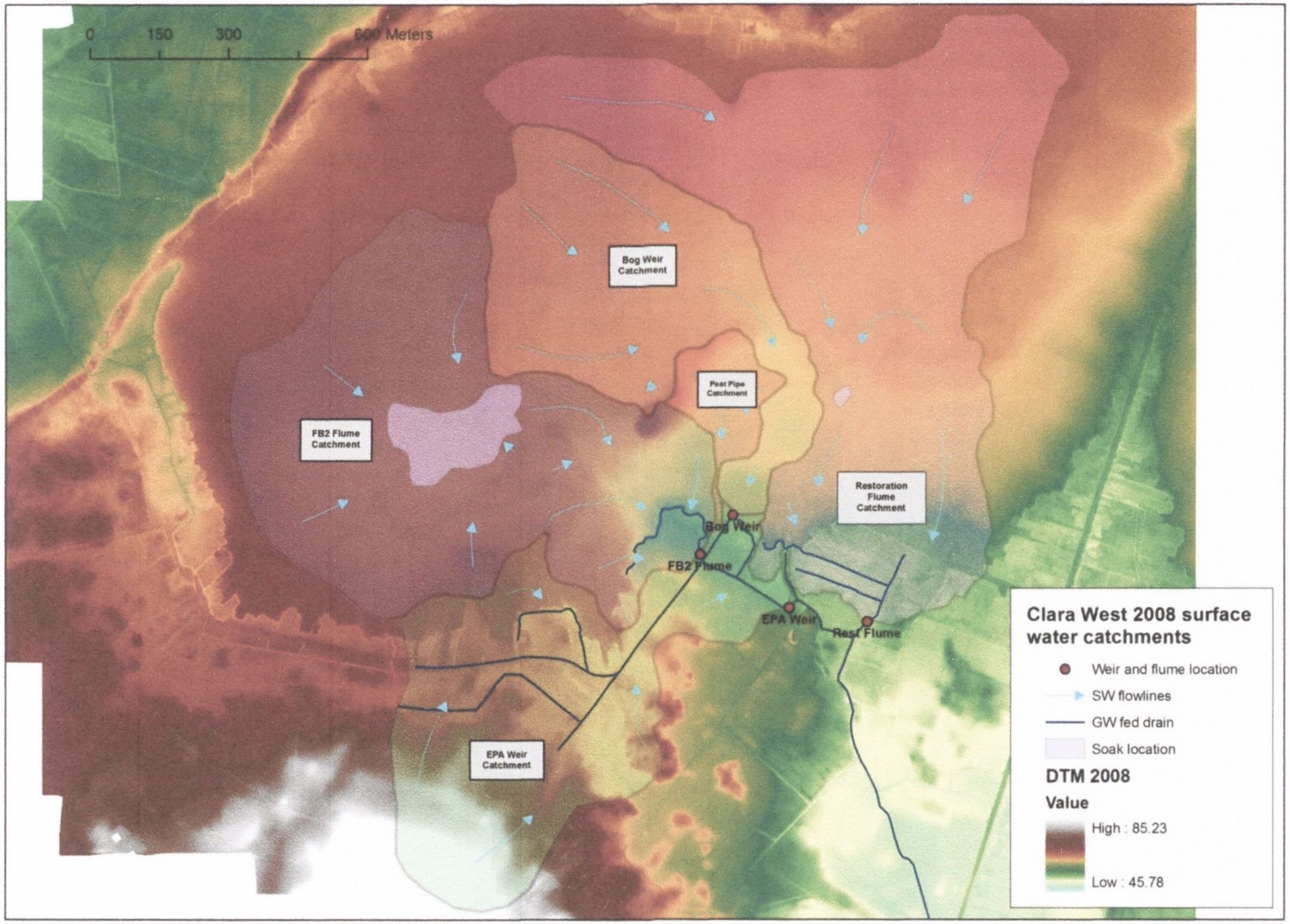


Figure G1. Clara Bog drainage system: surface water catchment areas

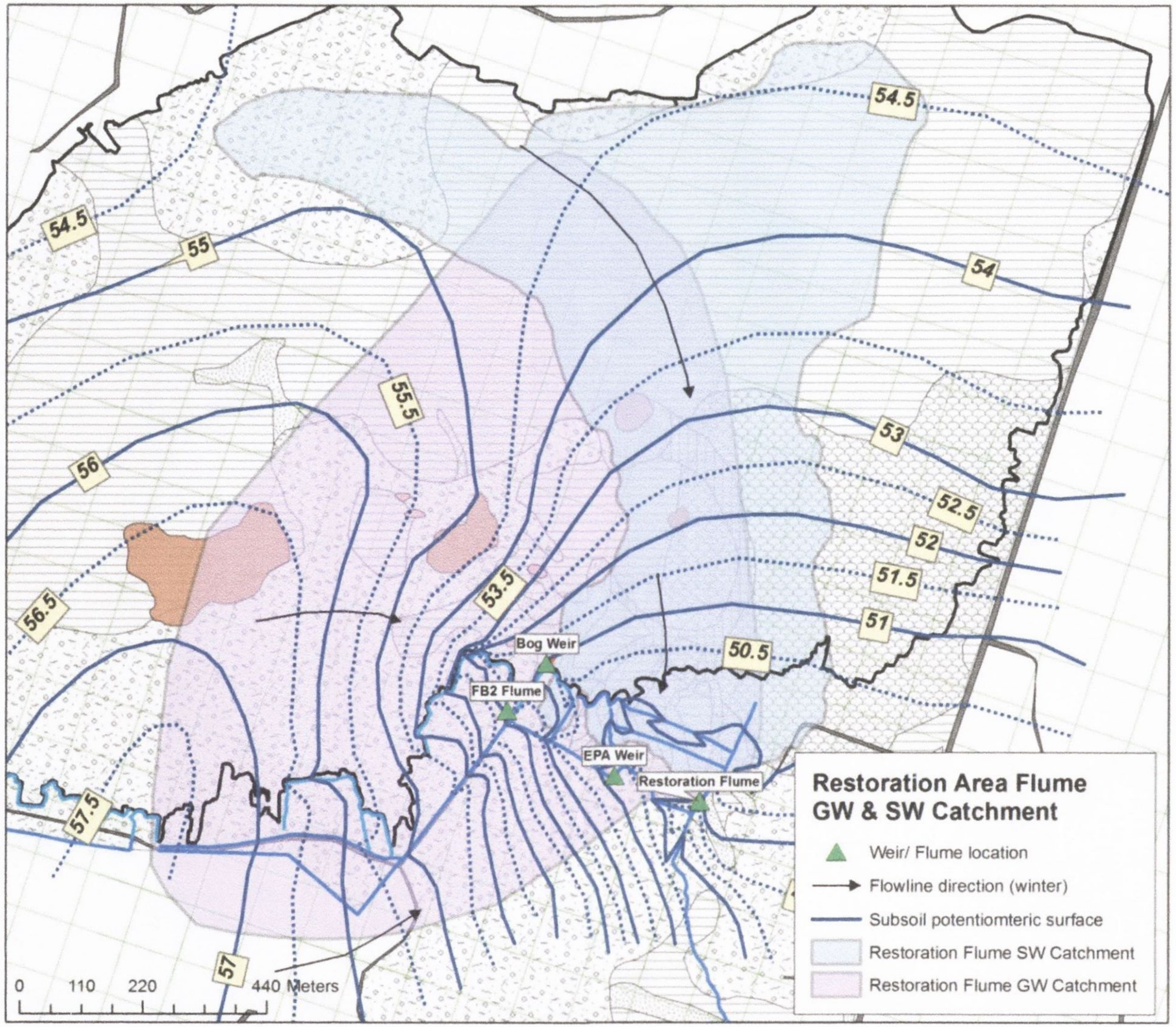


Figure G2.Groundwater and surface water catchment area to Restoration Flume

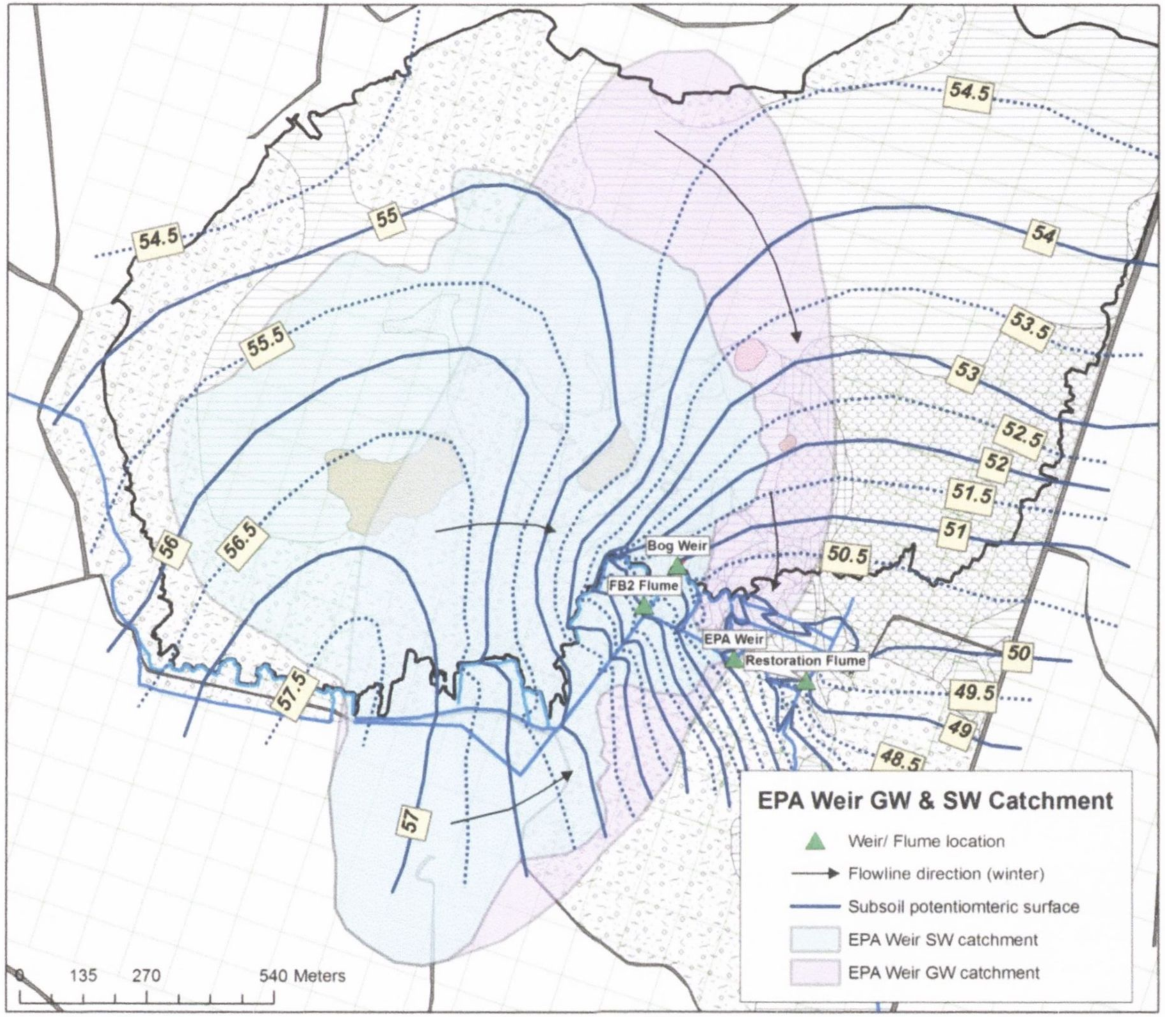


Figure G3.Groundwater and surface water catchment area to EPA Weir

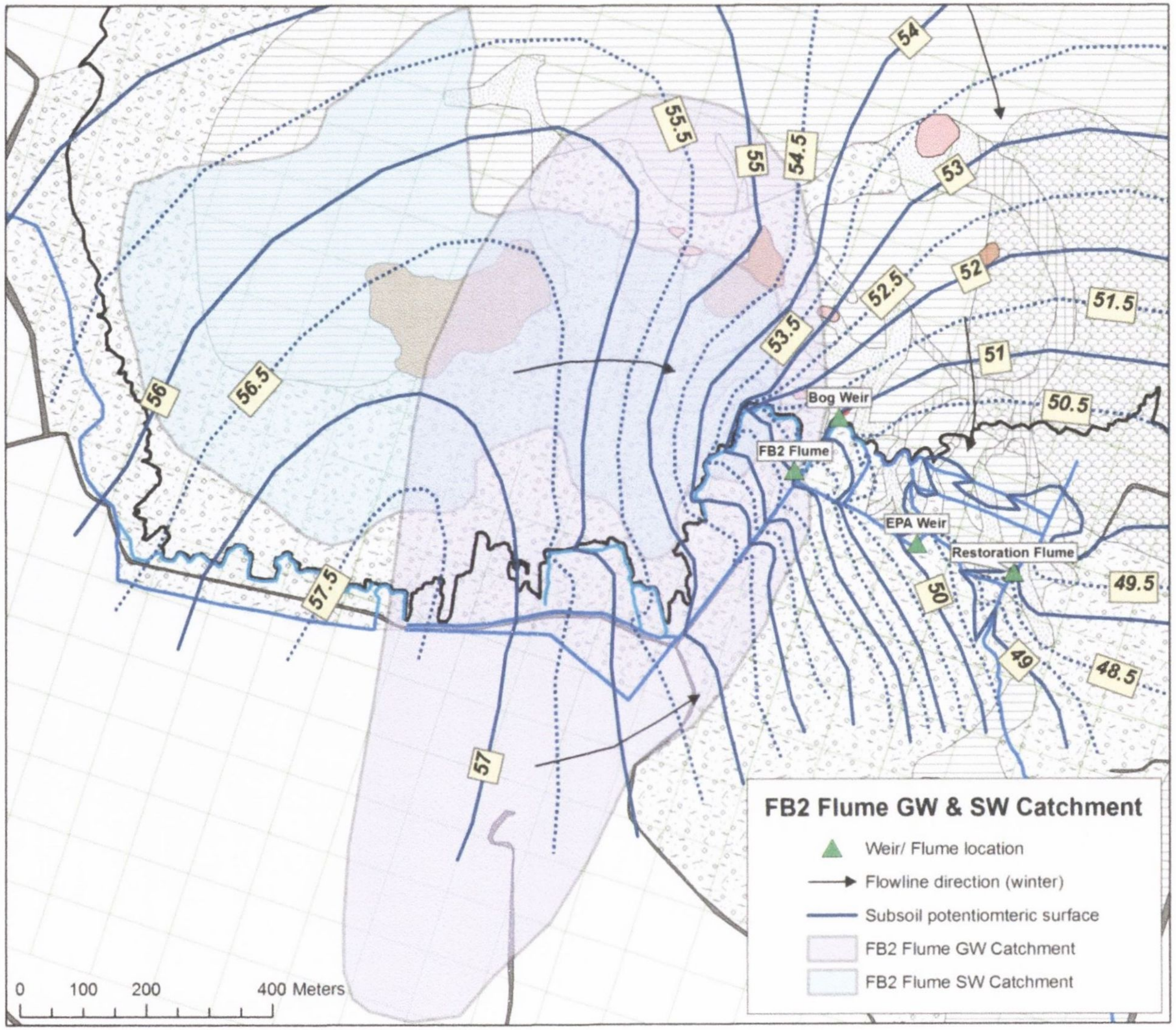


Figure G4.Groundwater and surface water catchment area to FB2 Flume

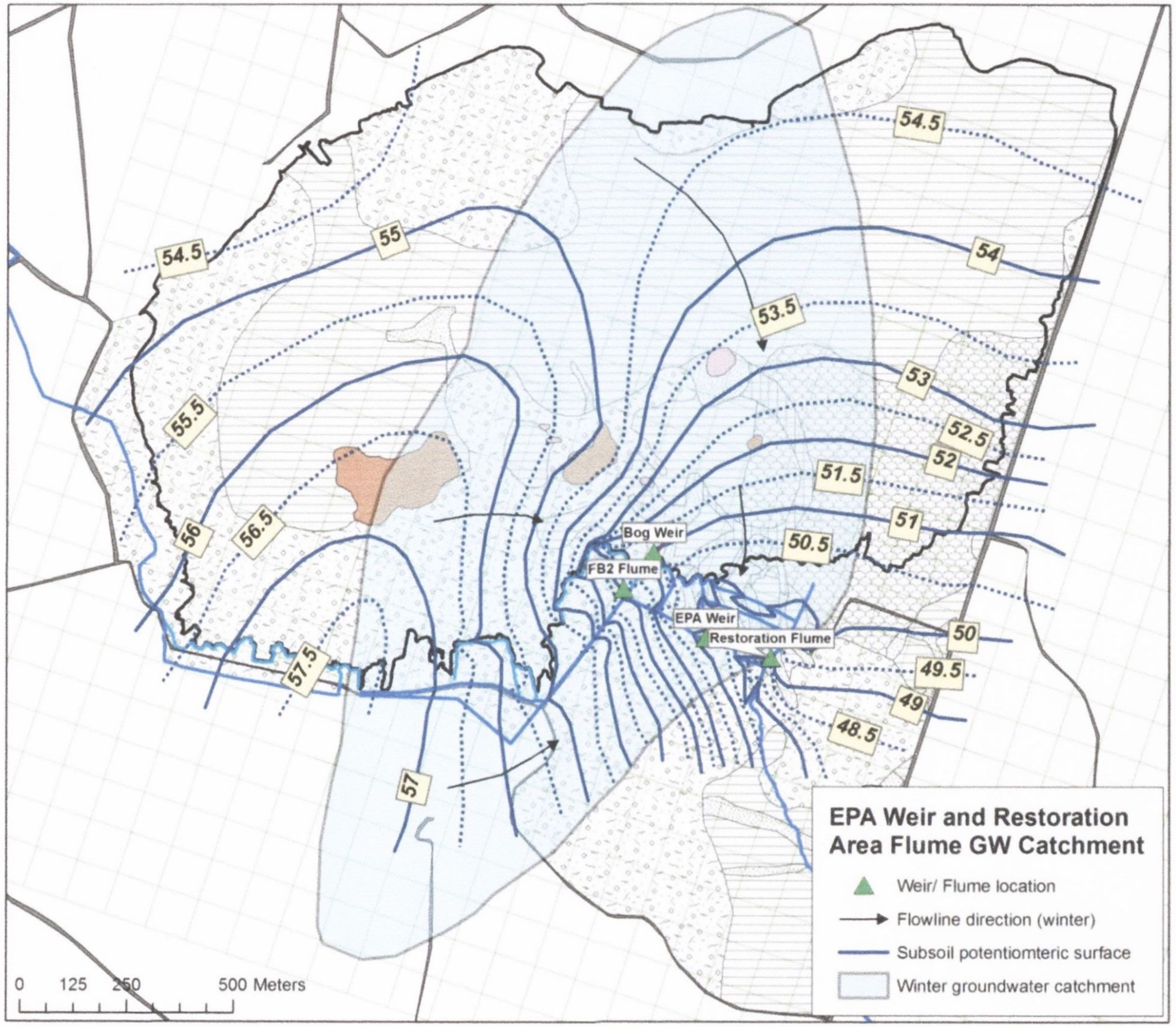


Figure G5.Groundwater catchment area to EPA Weir and Restoration Flume

Appendix H

Conceptual Model
and
Model Design

Appendix H: Conceptual Hydrological Model

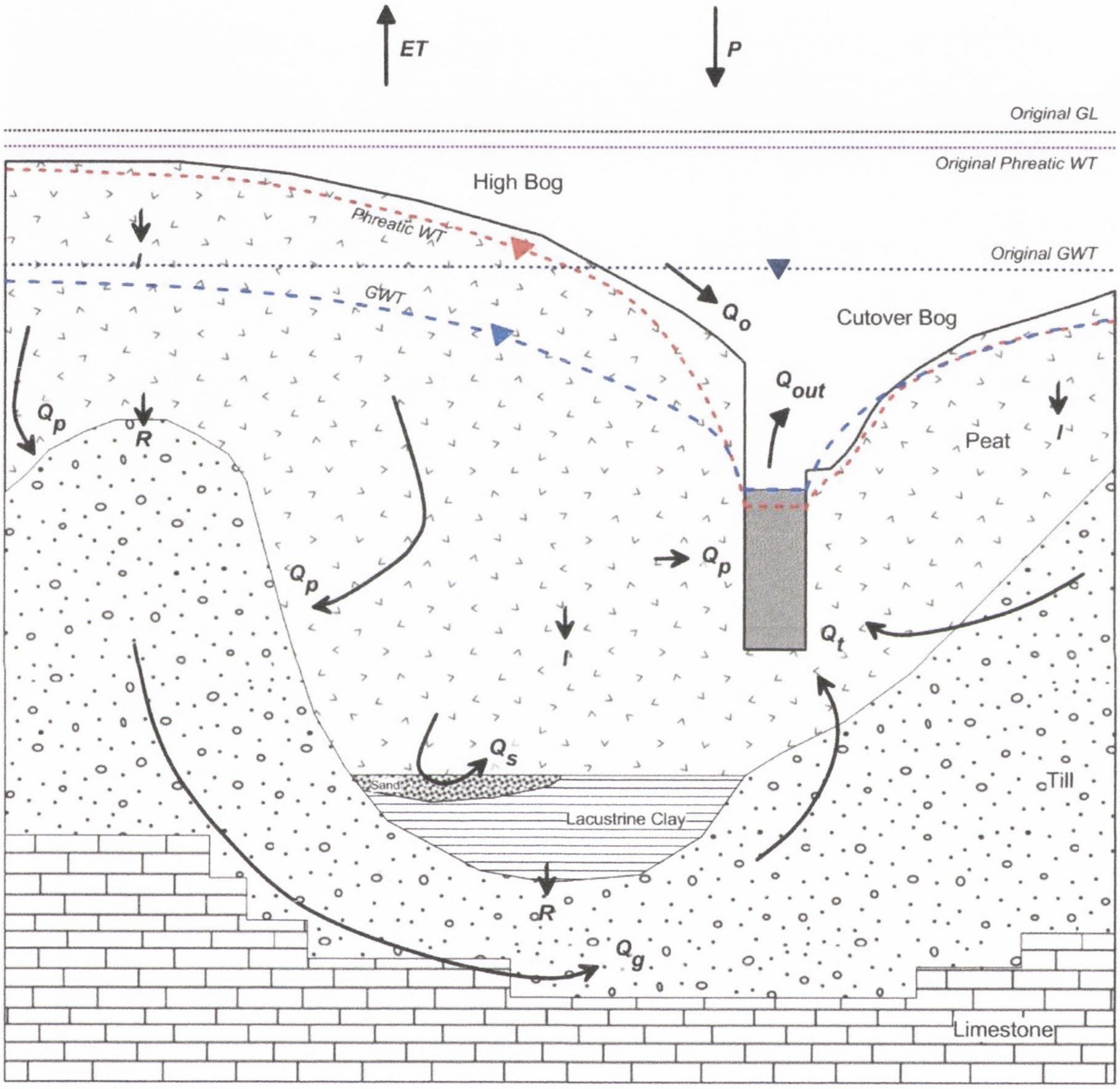


Figure H1. Conceptual Clara West hydrological model (not to scale). Note: P is precipitation, ET is evapotranspiration, Q_o is overland flow, Q_{out} is runoff outflow, Q_t is the total subsurface inflow to the drain, Q_p is flow through peat, Q_s is flow through sand, Q_g is groundwater flow through till and limestone, I is infiltration and R is recharge to the till groundwater body.

Appendix H: Model Design: Grid Generation

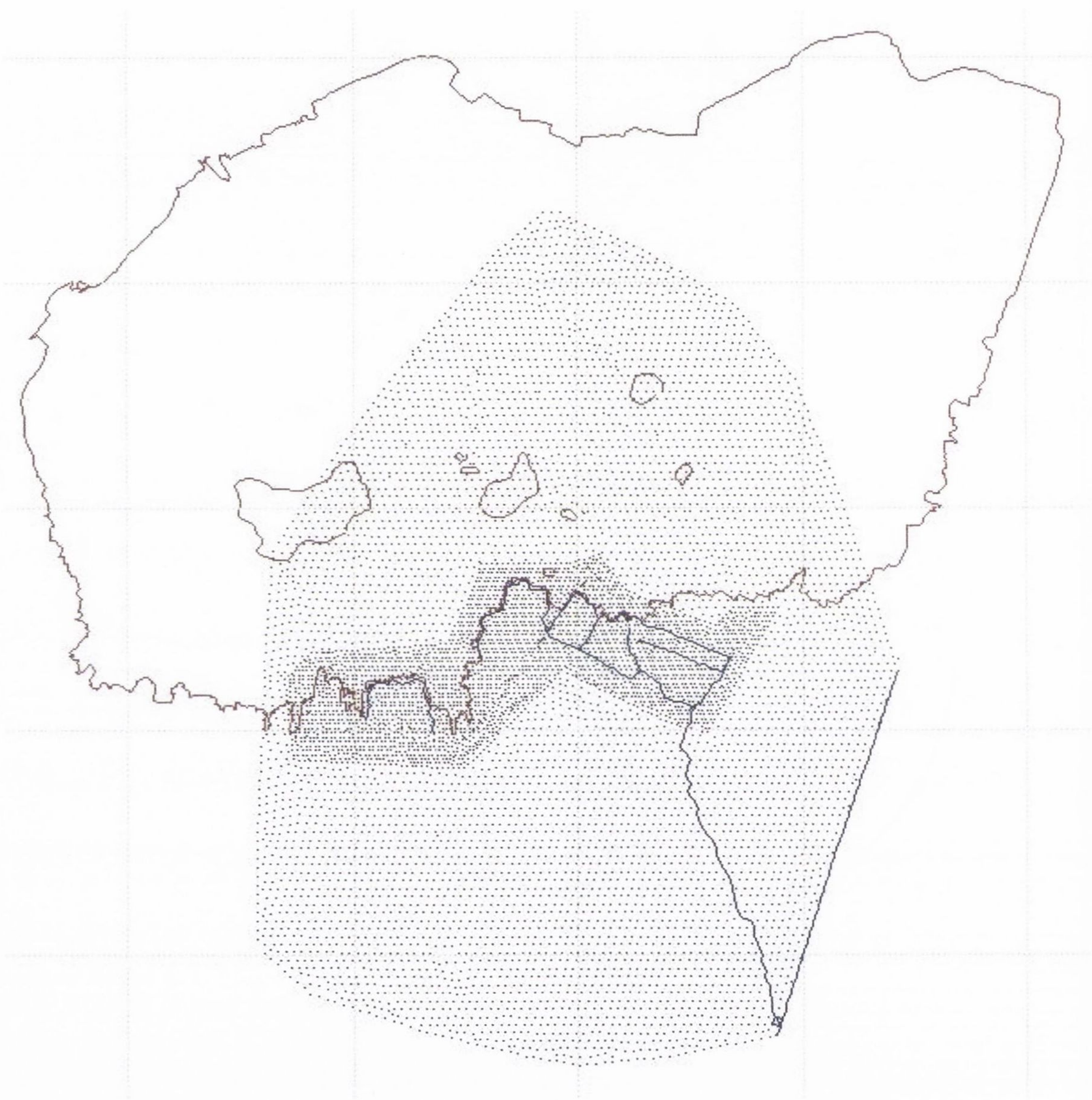


Figure H2. Model domain with position of Clara West high bog and distinguishing Clara West high bog features (highlighted in red). Note: black dotes are model nodes and blue lines are drains with fixed-head boundary conditions.

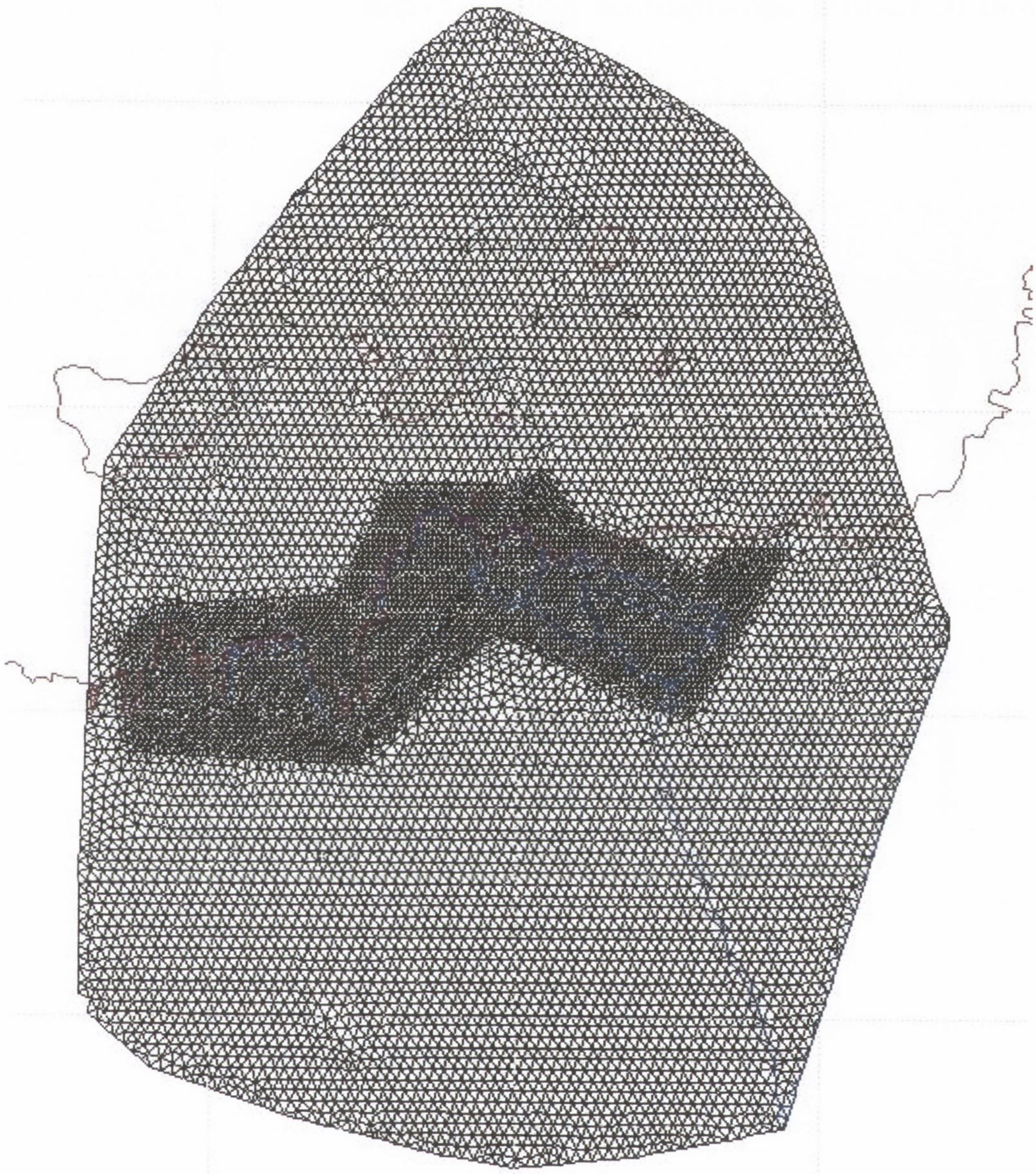


Figure H3. Finite element grid design of model area

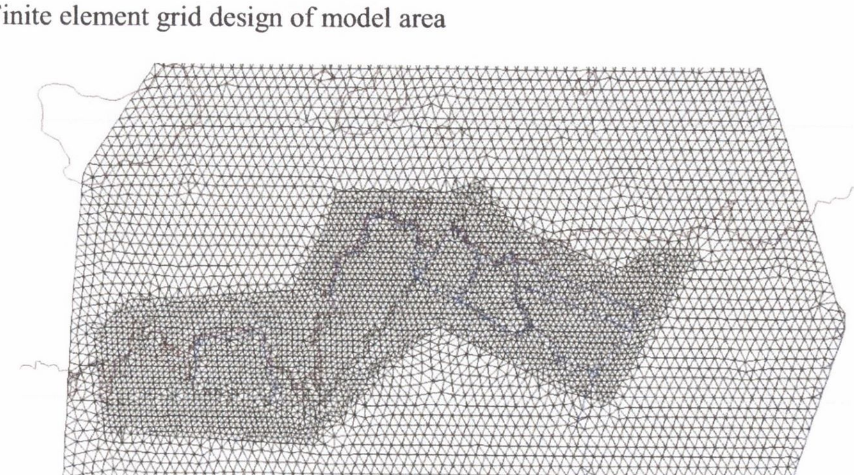


Figure H4. Finite element grid design of model area – finer node spacing in drainage system area

Appendix H: Model Design – hydraulic parameter input

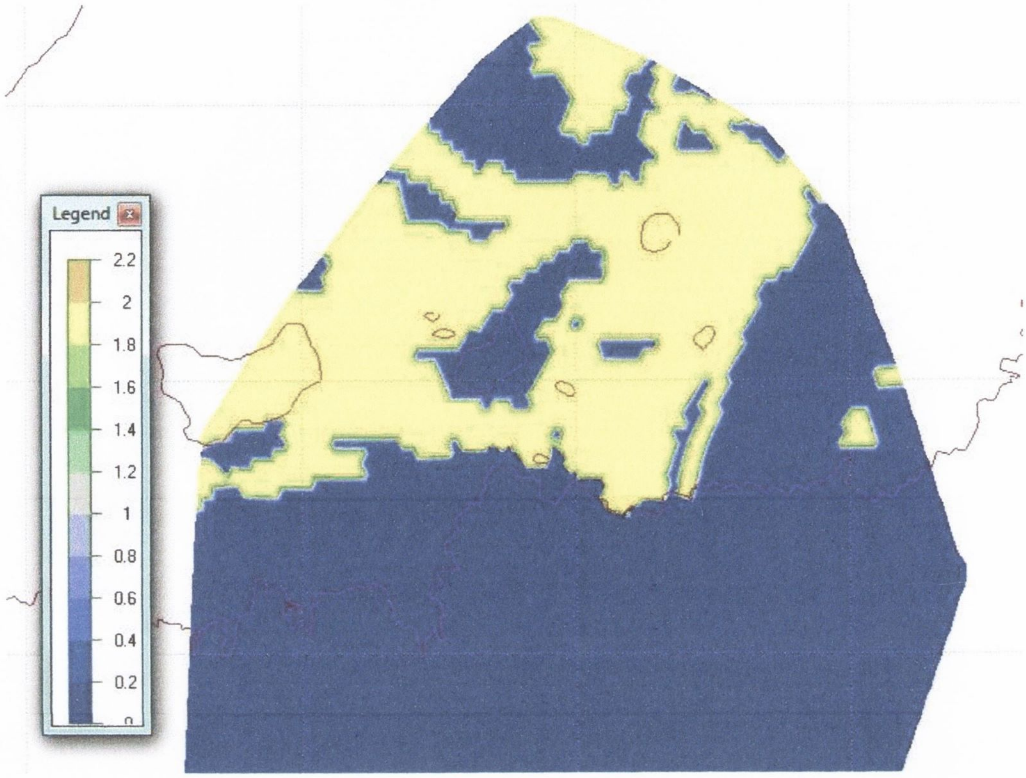


Figure H5. Layer 1 (acrotelm) transmissivity distribution in model domain

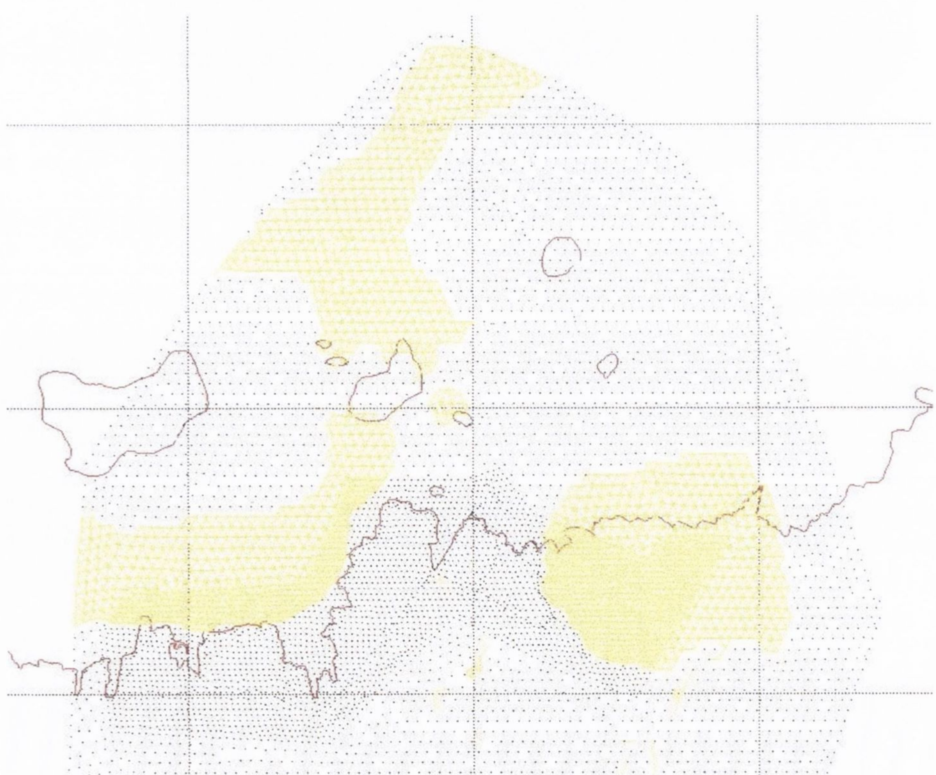


Figure H6. Layer 2 (peat) transmissivity < 0.001 m^2/ day distribution in model domain

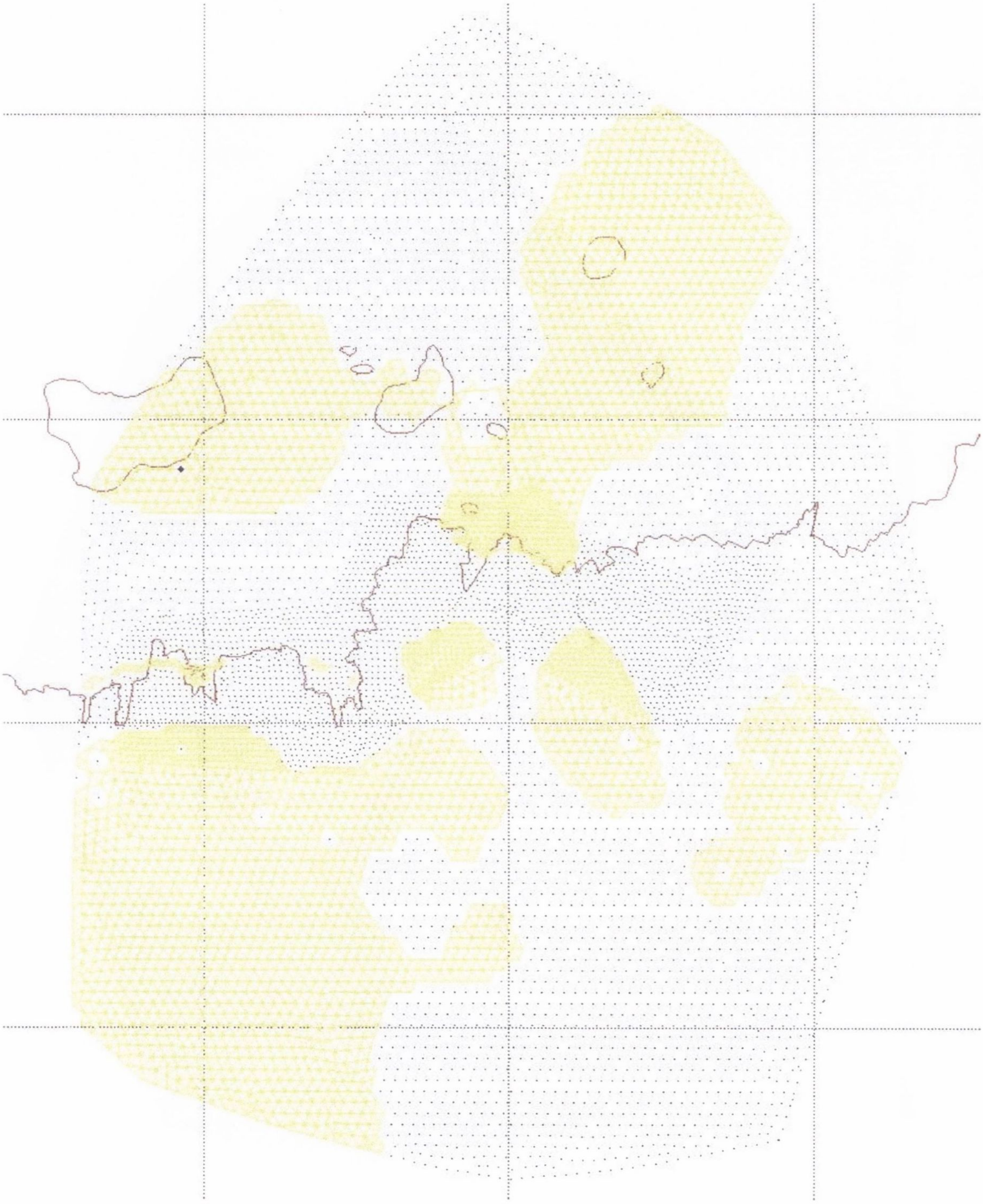


Figure H7. Layer 2 (peat) transmissivity > 0.01 m^2/ day distribution in model domain

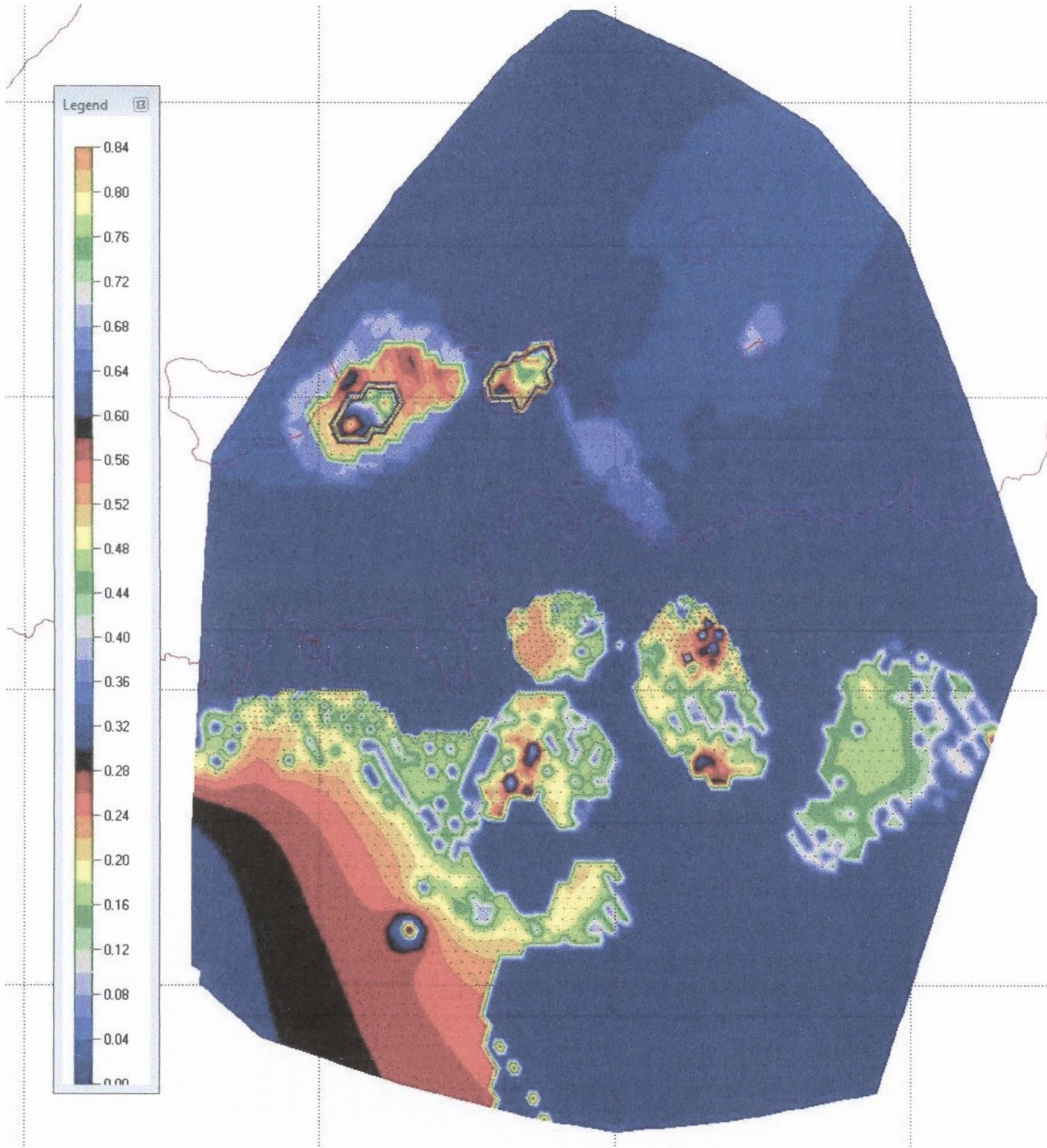


Figure H8. Layer 2 (peat) transmissivity distribution in model domain

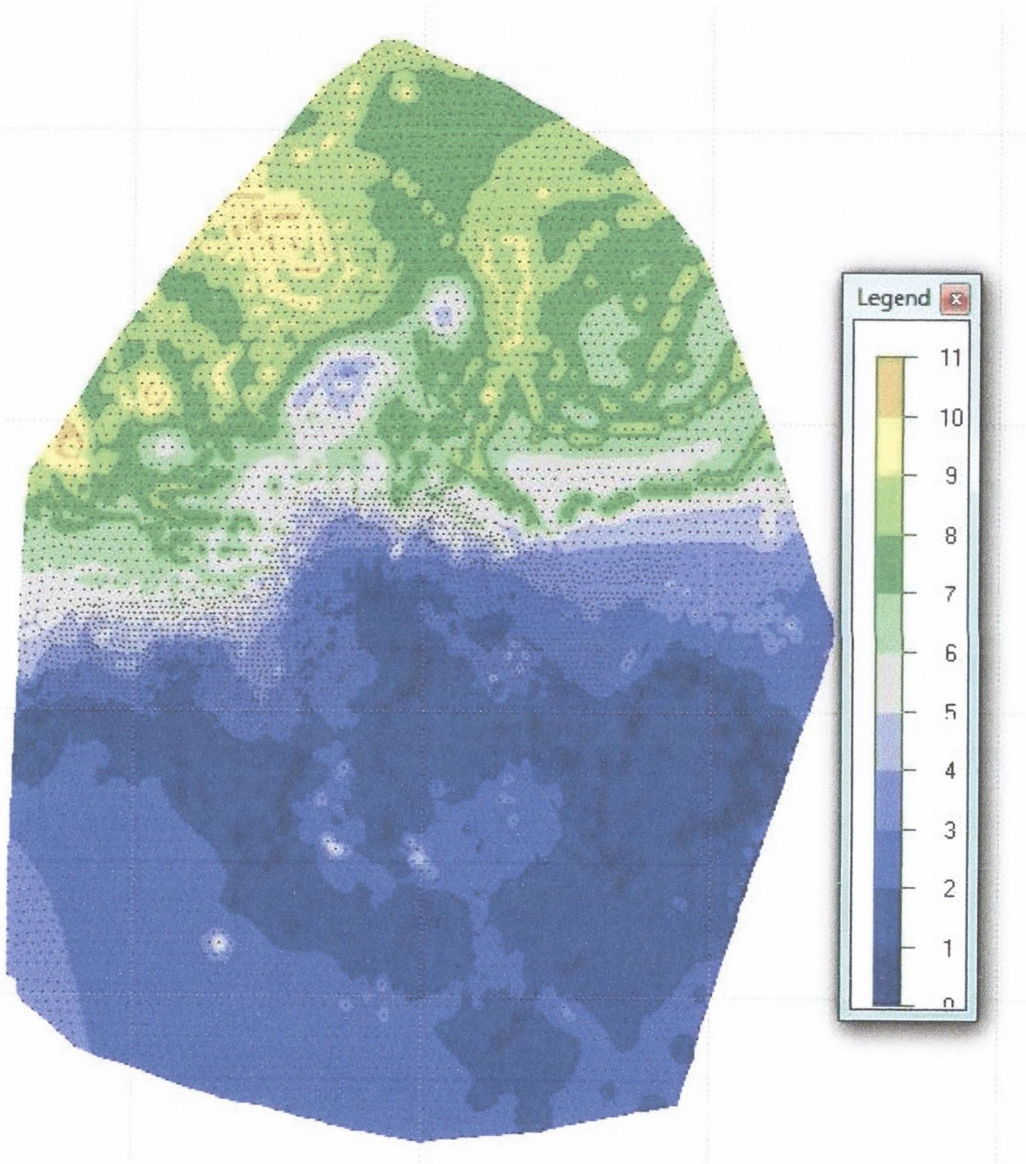


Figure H9. Layer 2 (peat) aquifer thickness distribution in model domain

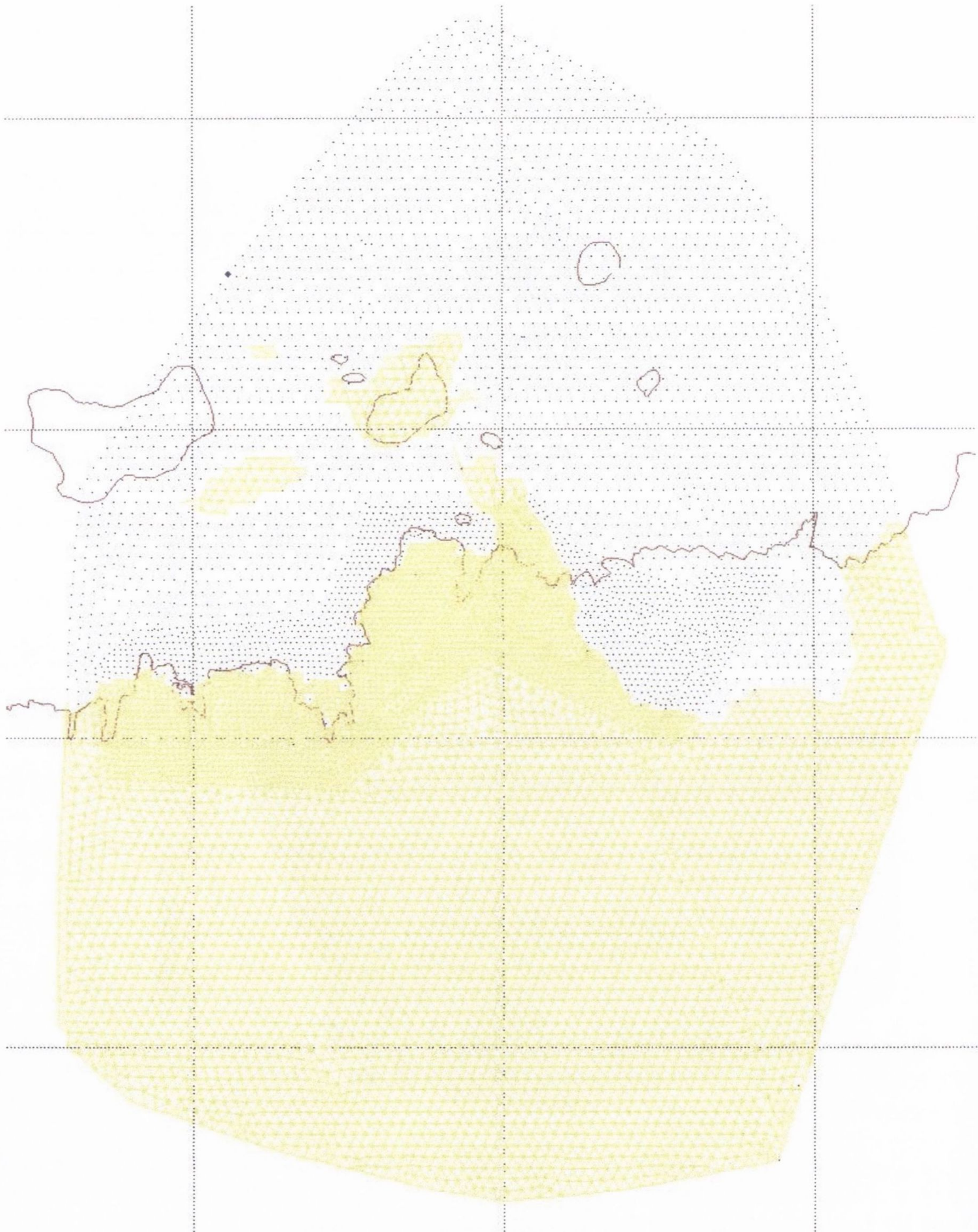


Figure H10. Layer 2 (peat) resistance < 1500 days distribution in model domain

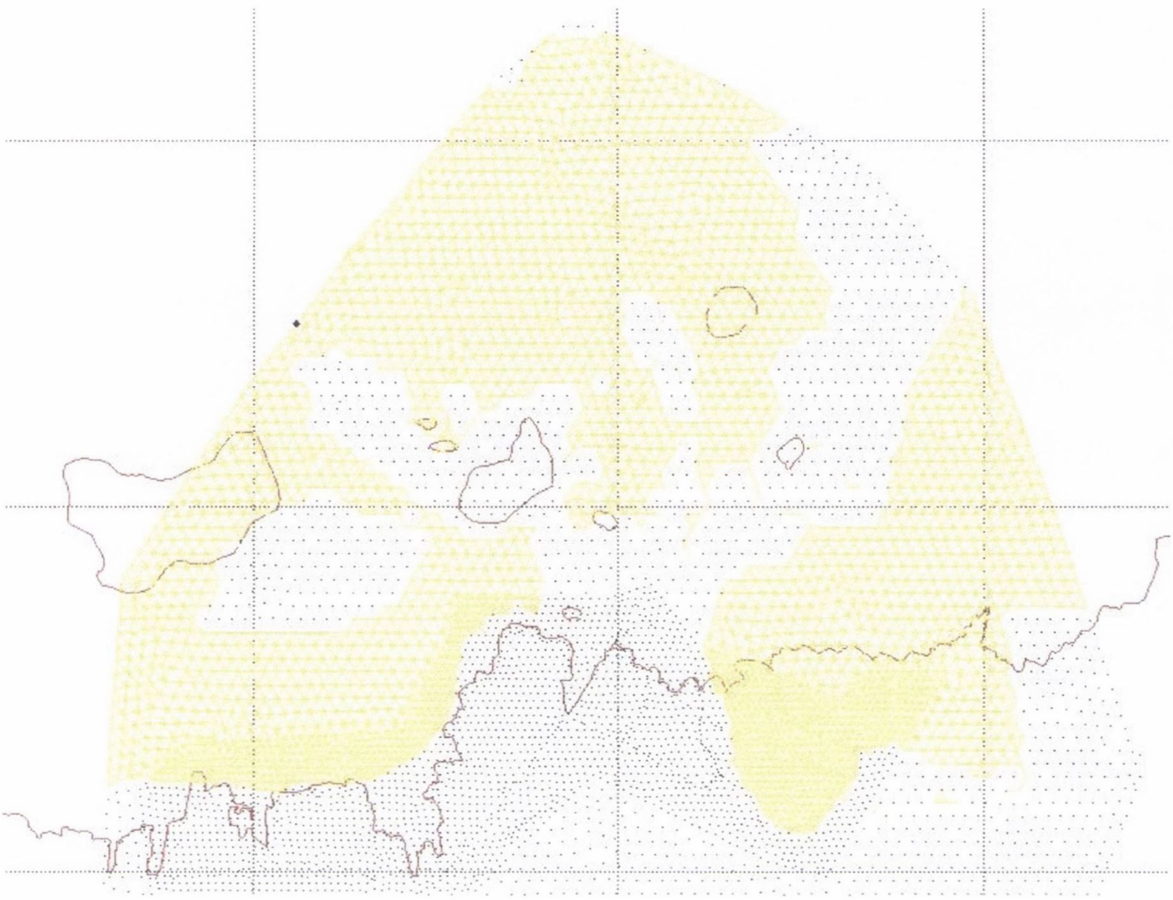


Figure H11. Layer 2 (peat) resistance > 3000 days distribution in model domain

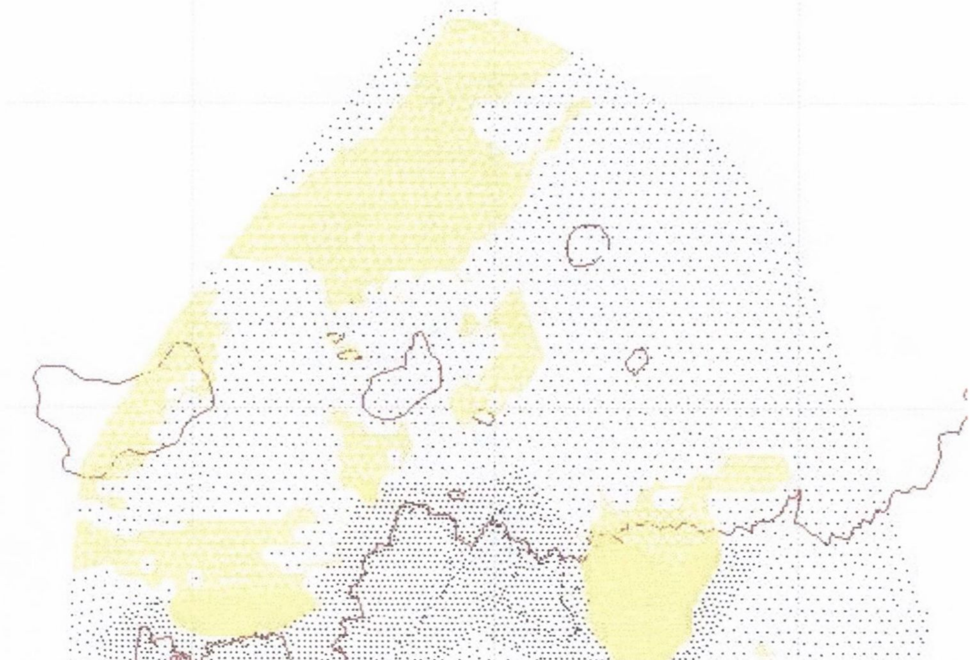


Figure H12. Layer 2 (peat) resistance > 6000 days distribution in model domain

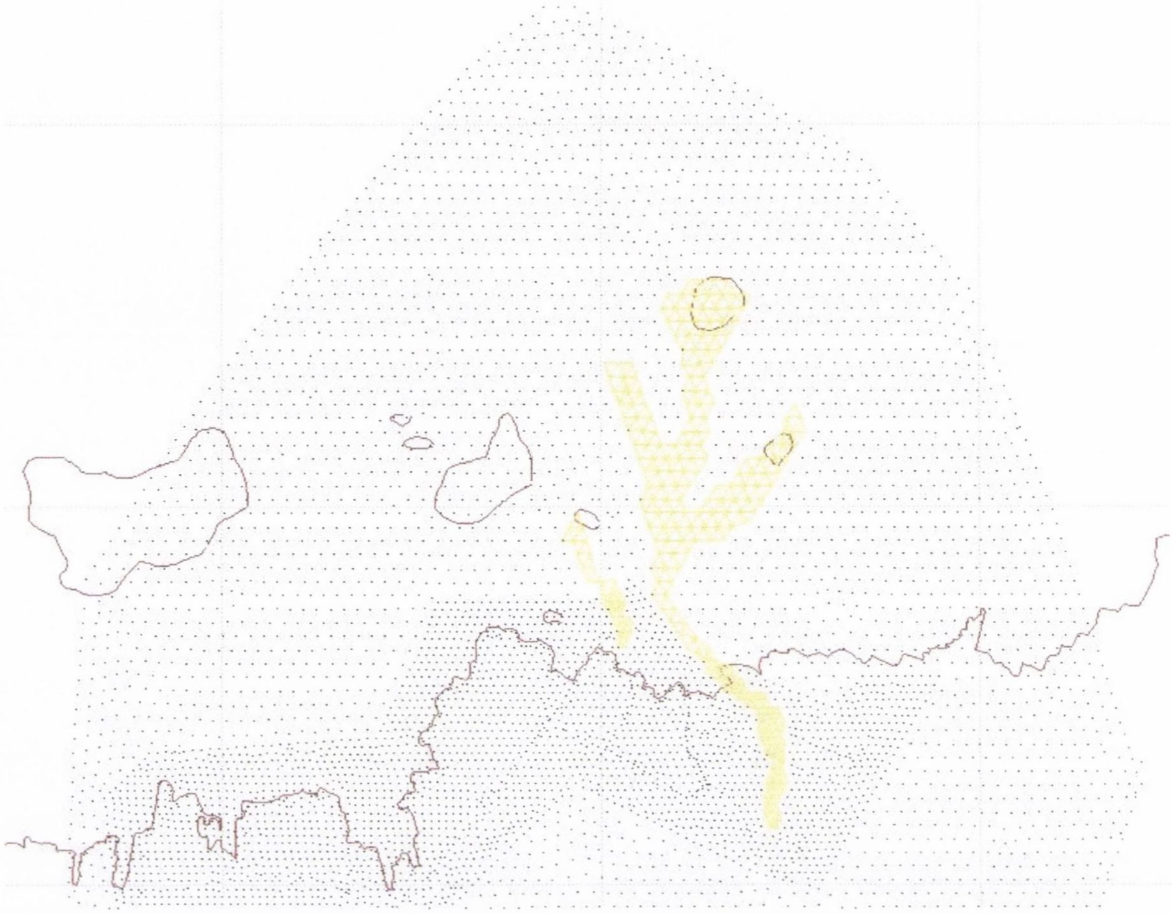


Figure H9. Layer 3 (sand) – location of transmissivity zones

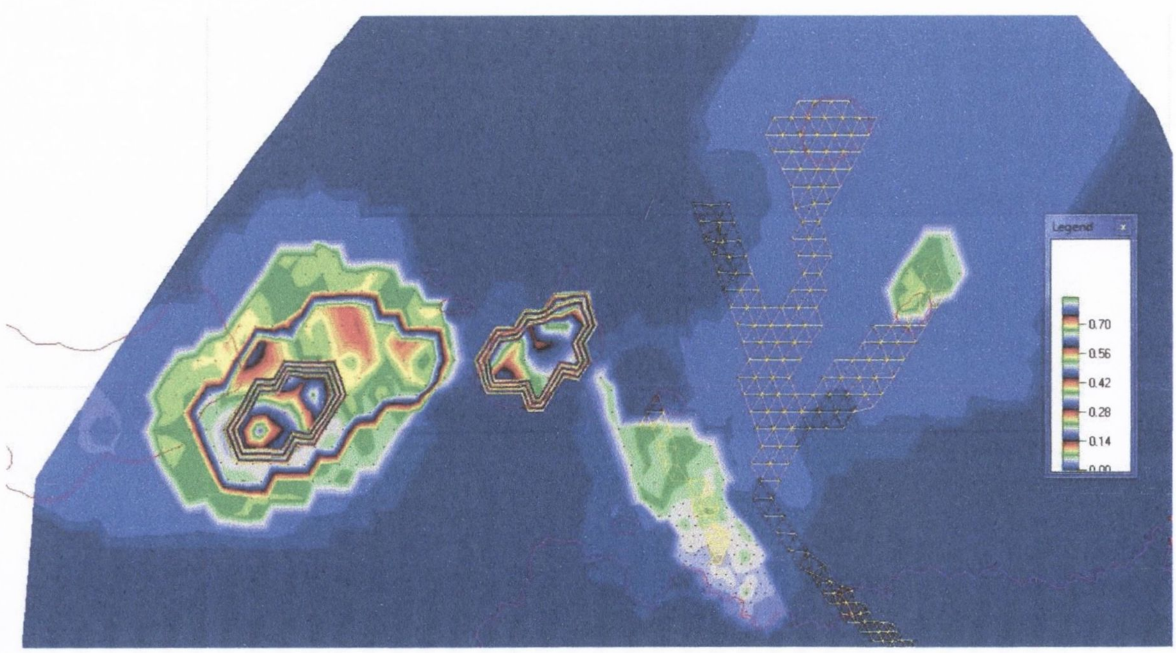


Figure H13. Layer 2 (peat) transmissivity and location of transmissive sand zoe in layer 3

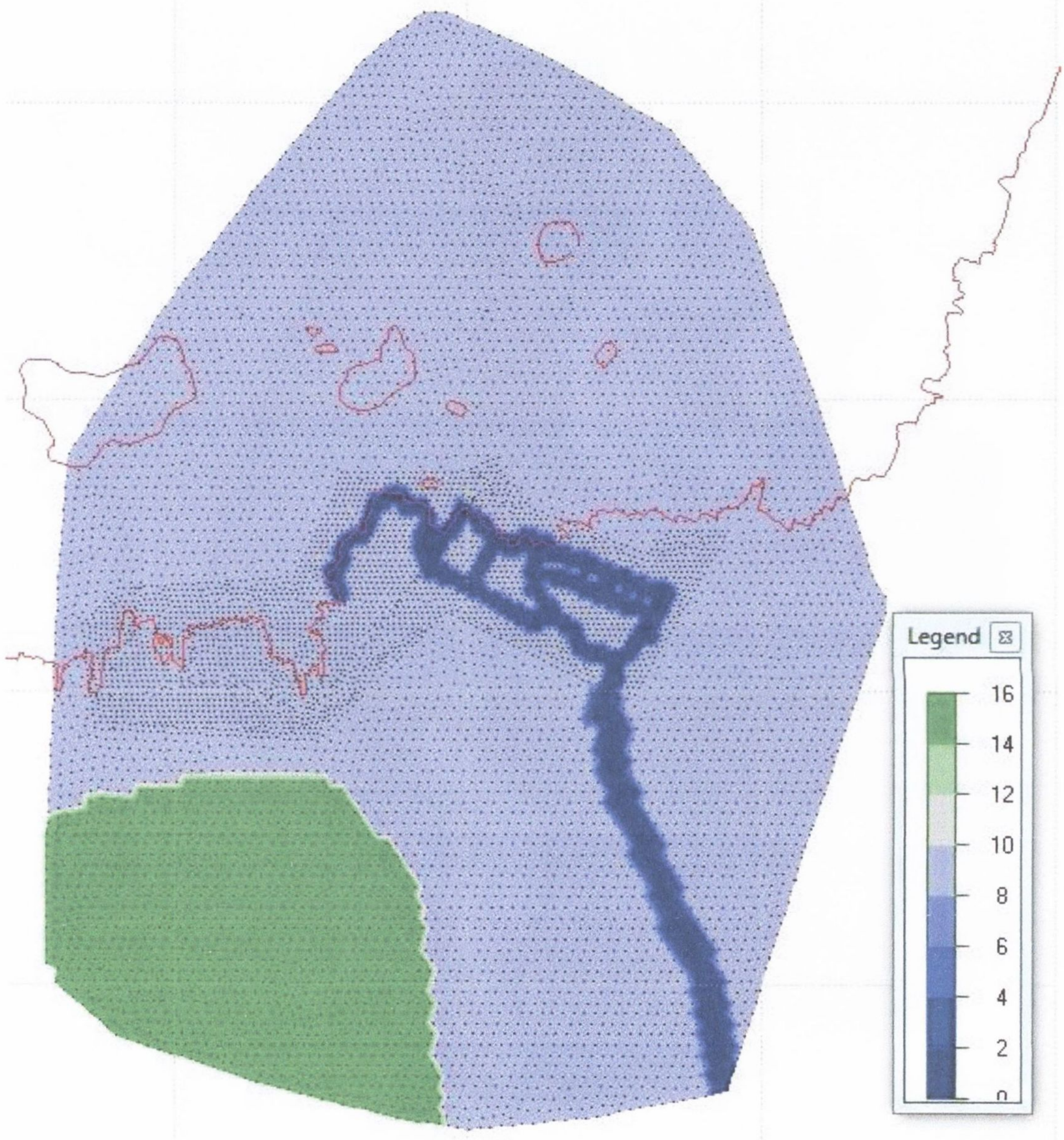


Figure H14. Layer 4 (till) – location of transmissivity zones

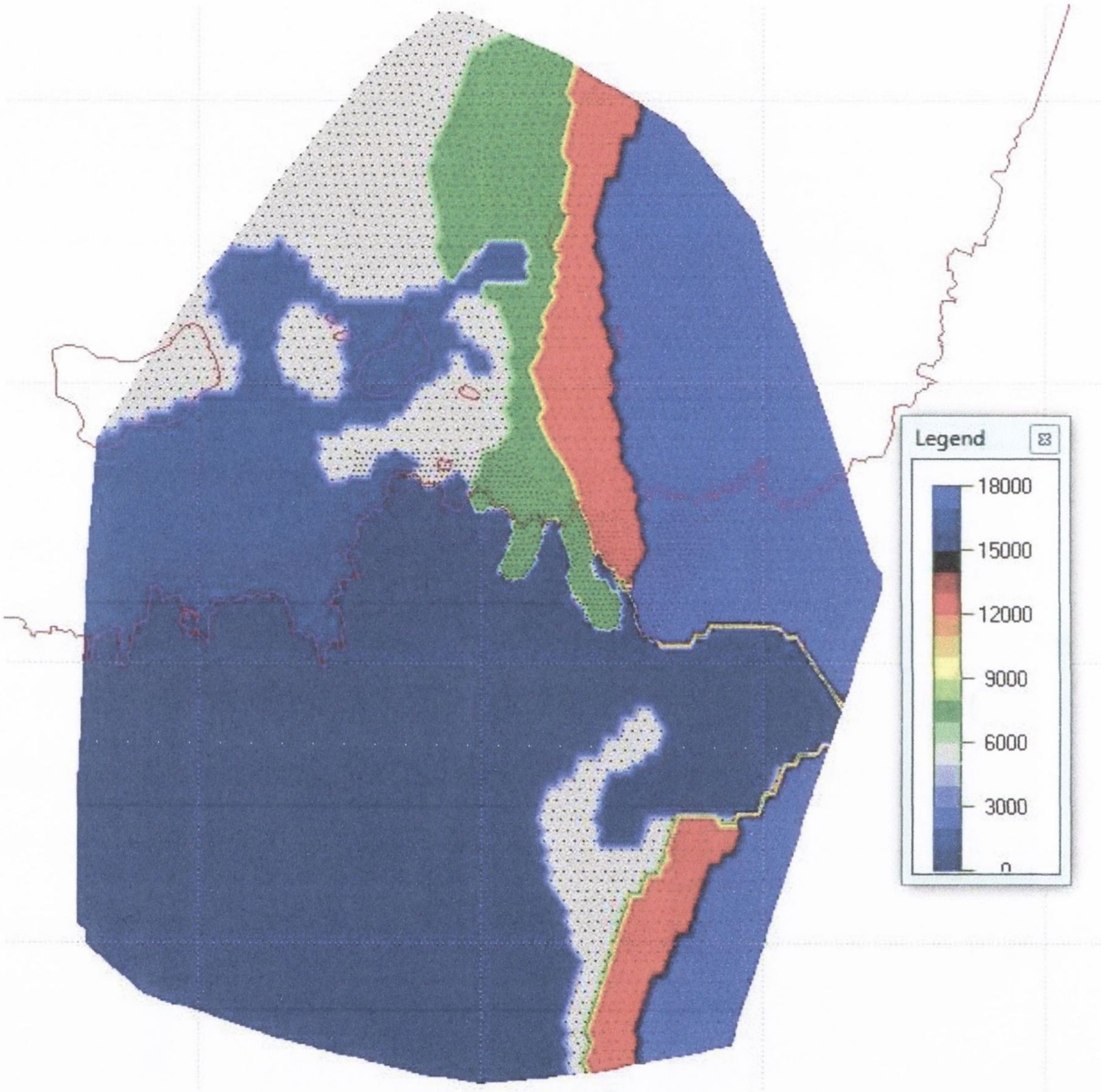


Figure H15. Layer 4 (till) – location of resistance (c3) zones

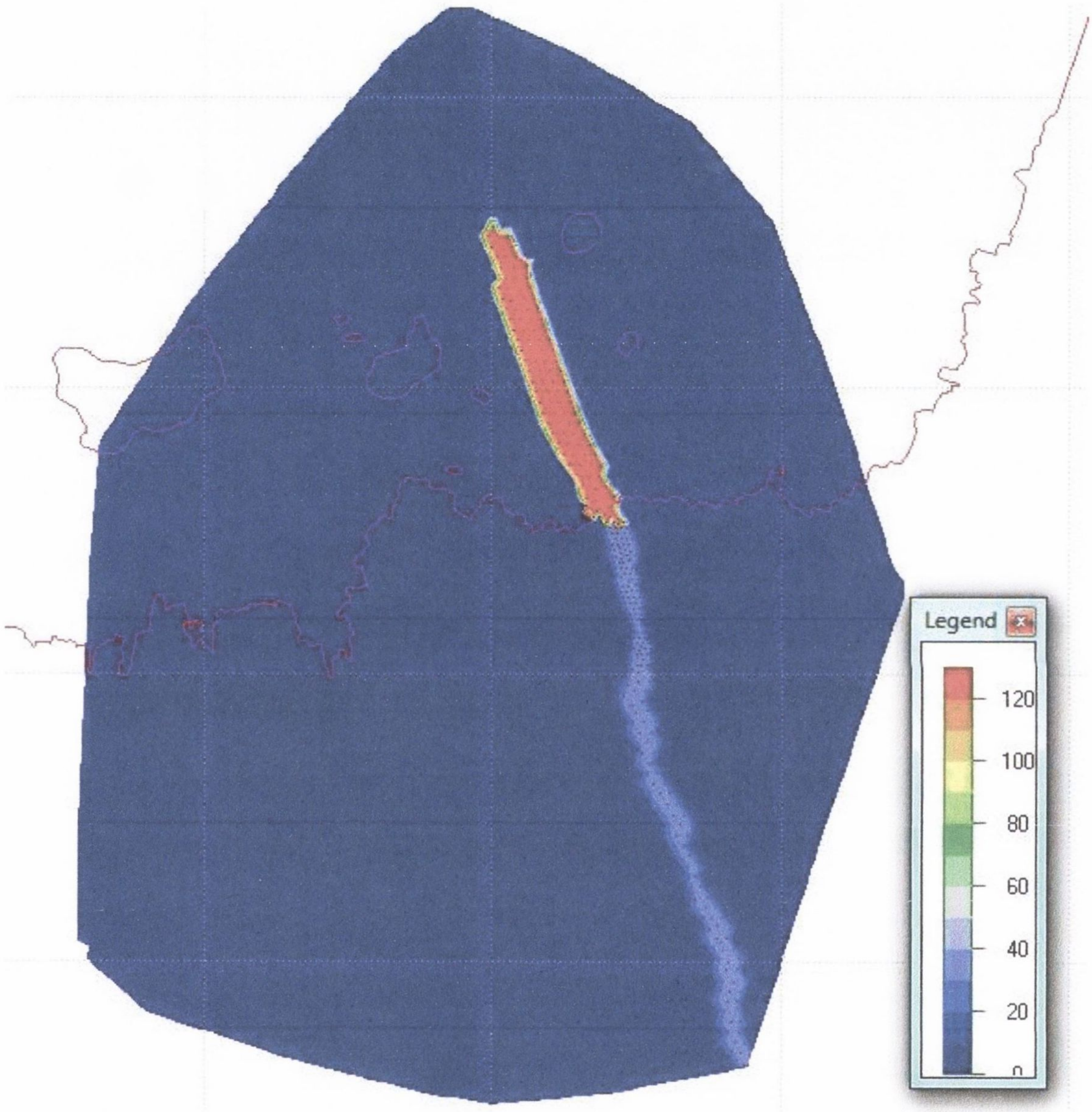


Figure H16. Layer 5 (limestone) – location of high transmissivity zones

Appendix H: Model Design – calibration

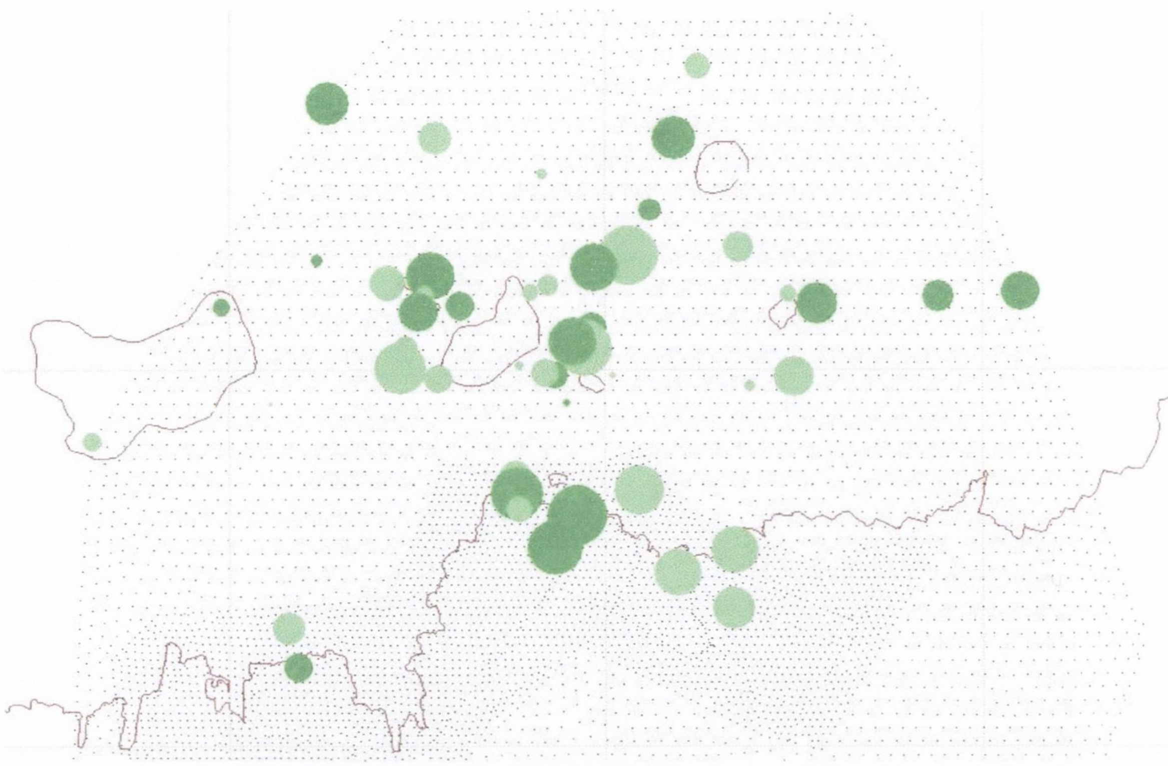


Figure H17. Layer 2 distribution of residuals (size of disc is relative to the size of the residual)

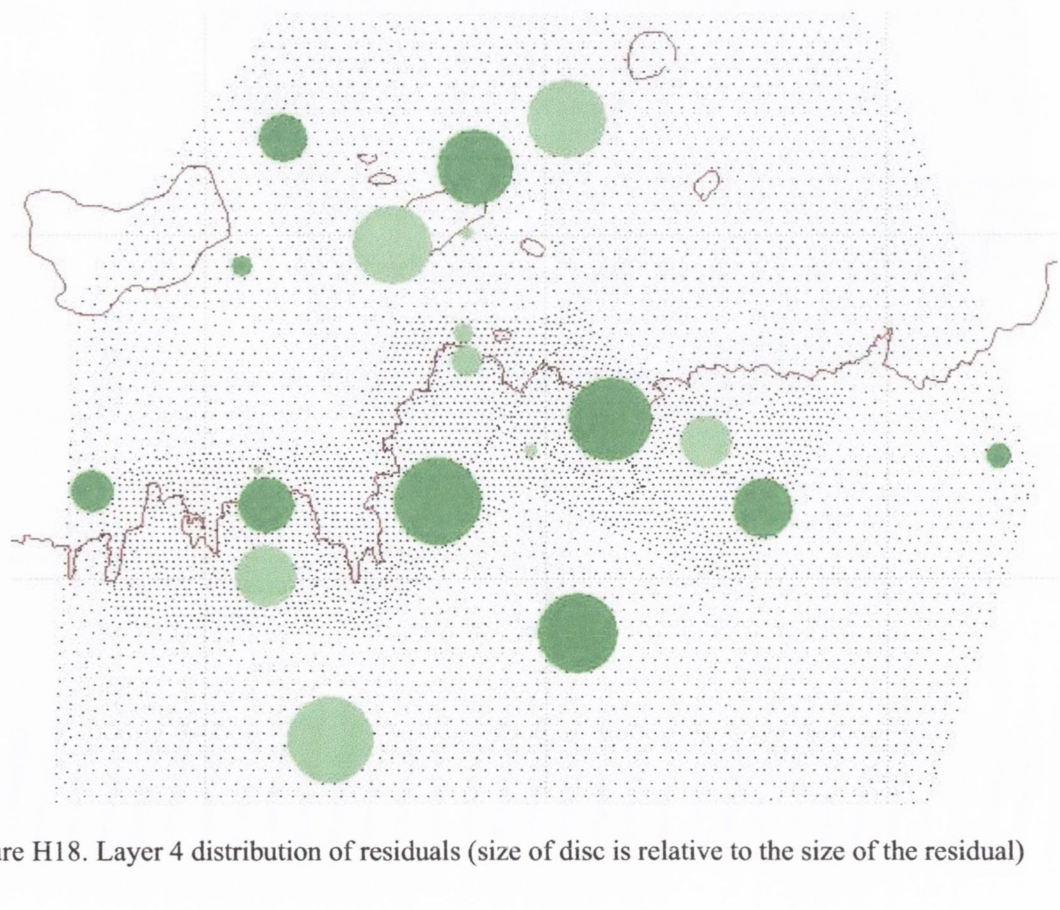


Figure H18. Layer 4 distribution of residuals (size of disc is relative to the size of the residual)

Table H1. Calculated model heads, field-measured heads (mean) and residuals from layer 2 (peat aquifer) calibration

ID	Calculated	Observed	Residuals	ID	Calculated	Observed	Residuals
88	54.98	55.2	-0.22	907	55.981	56.01	-0.029
89	55.018	55.16	-0.142	td8	56.508	56.72	-0.212
901	55.721	55.62	0.101	tdj12	56.209	56.34	-0.131
905	57.203	57.16	0.043	td9	56.598	56.51	0.088
95	56.657	56.93	-0.273	t1	56.286	55.87	0.416
90	54.59	54.84	-0.25	td2	53.935	54.08	-0.145
904	56.886	56.93	-0.044	921	49.855	49.79	0.065
55	54.575	54.54	0.035	t13	53.938	53.93	0.008
902	54.949	55.23	-0.281	t3	53.769	53.28	0.489
94	55.8	55.64	0.16	47	53.974	53.96	0.014
91	54.787	54.55	0.237	48	54.053	54.39	-0.337
56	55.074	54.93	0.144	61	52.735	52.35	0.385
93	55.403	55.38	0.023	920	50.952	50.62	0.332
Tl12	56.588	56.61	-0.022	909	55.755	55.63	0.125
54	54.272	54.25	0.022	910	54.782	54.77	0.012
92	54.247	54.32	-0.073	t10	54.146	54.25	-0.104
908	56.853	56.86	-0.007	57	54.551	54.43	0.121
tdk12	56.67	56.48	0.19	906	55.791	55.91	-0.119
70	54.253	53.73	0.523	td4	54.141	54.15	-0.009
939	50.29	49.98	0.31	66	51.773	52.3	-0.527
50	54.011	54.34	-0.329	912	53.104	52.95	0.154
903	54.847	54.78	0.067	916	50.557	51.01	-0.453
td6	55.807	56.15	-0.343	914	50.85	51.24	-0.39
td5	56.037	55.99	0.047	915	51.779	51.67	0.109
911	55.045	55.01	0.035				

Table H2. Calculated model heads, field-measured heads (mean) and residuals from layer 5 (till aquifer) calibration

ID	Calculated	Observed	Residuals	ID	Calculated	Observed	Residuals
ST3-1	50.248	50.28	-0.032	907	55.979	56.02	-0.041
934	57.176	57.3	-0.124	928	56.28	56.05	0.23
926	49.547	49.77	-0.223	920	50.203	50.61	-0.407
Tl12	56.14	56.29	-0.15	909	55.018	54.63	0.388
935	55.817	55.36	0.457	910	54.24	54.23	0.01
925	52.072	52.47	-0.398	906	55.772	55.95	-0.178
908	56.386	56.43	-0.044	CLBH5	51.567	51.56	0.007
CLCD3	53.701	53.32	0.381	913	53.774	54.23	-0.456
927	50.174	50.02	0.154	912	52.86	52.84	0.02
911	54.574	54.93	-0.356	915	51.796	51.74	0.056

Table H3. Residuals from measured head and calculated head in layer 4 aquifer for three different transmissivity input hydraulic parameters

ID	**T = 4**	**T = 8**	**T = 12**
906	-0.16	-0.18	-0.18
907	0.15	-0.03	-0.07
908	0.42	0.07	-0.30
909	0.73	0.32	0.22
910	0.28	-0.08	-0.10
911	-0.04	-0.50	-0.50
912	-0.14	-0.02	0.14
913	-0.25	-0.50	-0.55
915	-0.08	0.02	0.16
920	-0.43	-0.42	-0.39
925	-0.27	-0.47	-0.52
926	-0.32	-0.31	-0.16
927	0.12	0.15	0.19
928	0.86	0.28	0.18
934	0.37	-0.02	-0.32
CLCD3	0.38	0.41	0.39
ST3-1	0.03	-0.06	-0.05
tl12	0.33	-0.09	-0.43
BH5	-0.24	-0.14	0.17
Av.	0.09	-0.08	-0.11
Std Dev.	0.35	0.26	0.28

Note: T = 4 implies residuals are from analysis when transmissivity was set to 4 m^2/ day

Appendix I

Clara West Groundwater Flow Model
Steady State

Appendix I: Steady State Model - 2D Cross-Sections

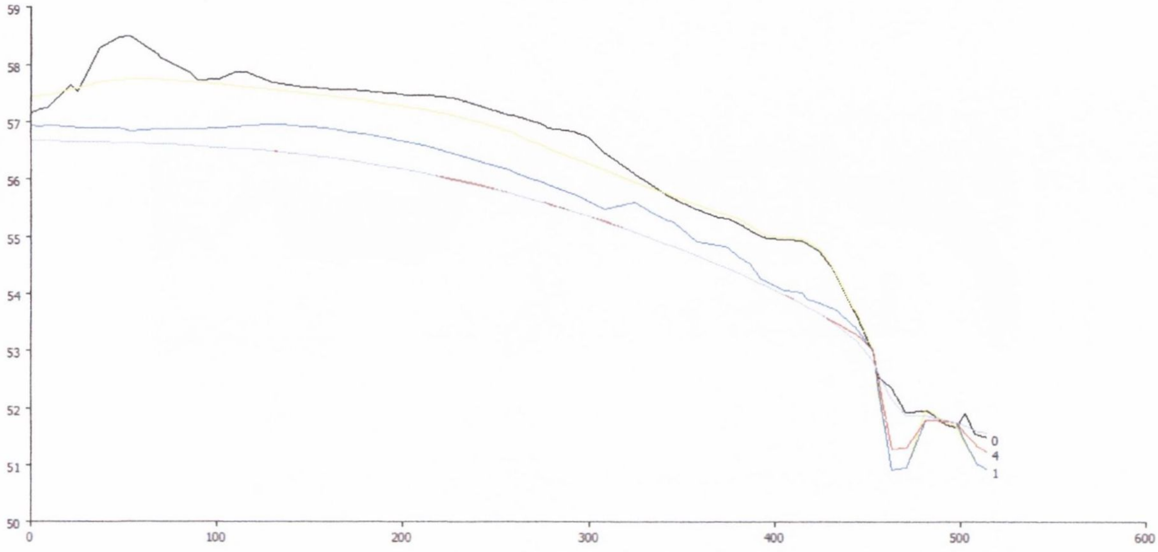


Figure I1. Topographic profile and modelled potentiometric surfaces through flow line1

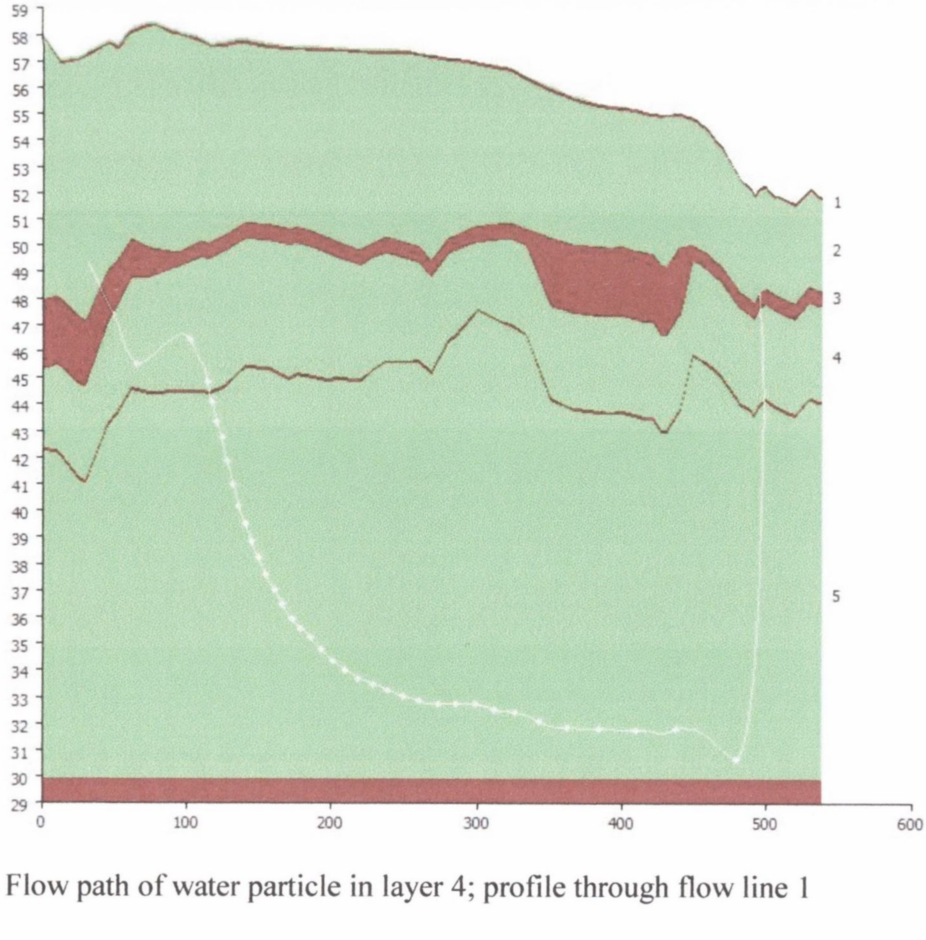


Figure I2. Flow path of water particle in layer 4; profile through flow line 1

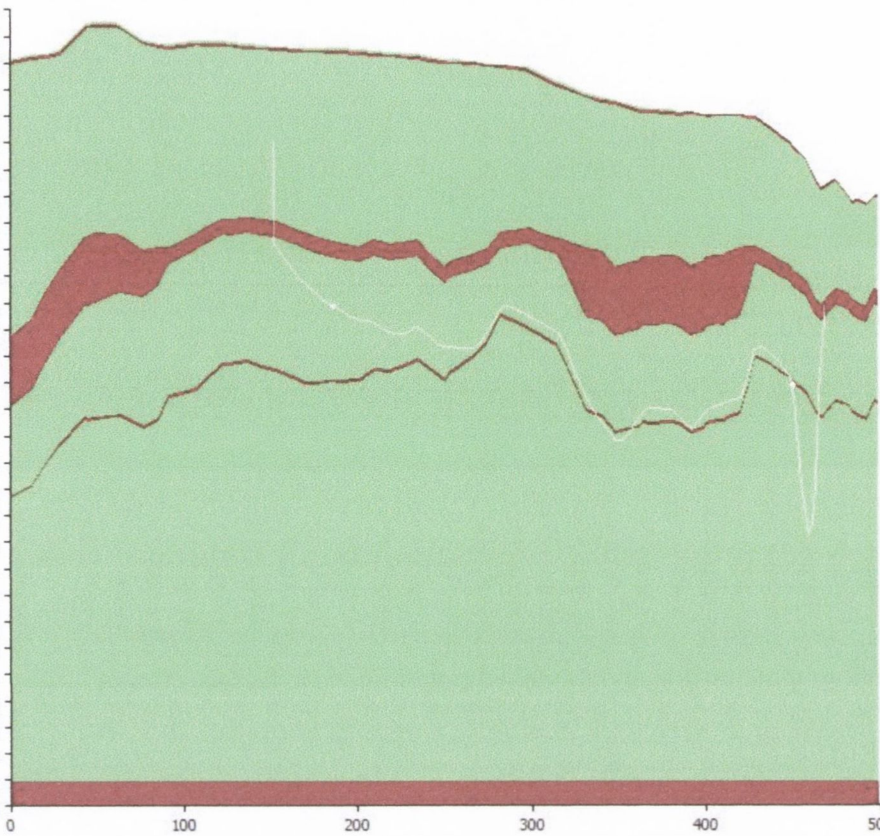


Figure I3. Flow path of water particle in layer 2; profile through flow line 1

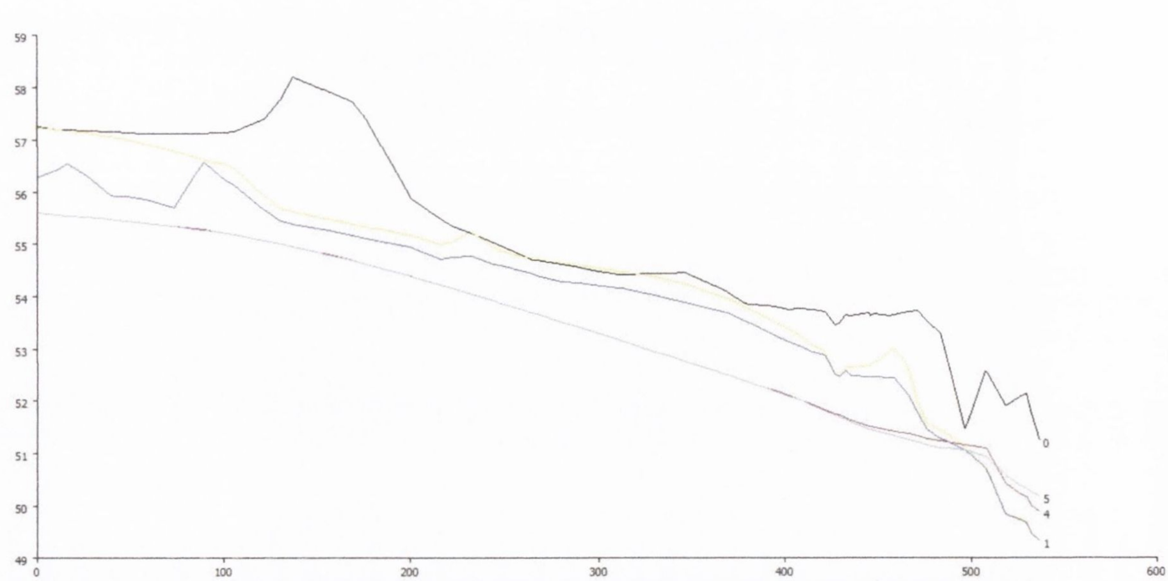


Figure I4. Topographic profile and modelled potentiometric surfaces through flow line 2

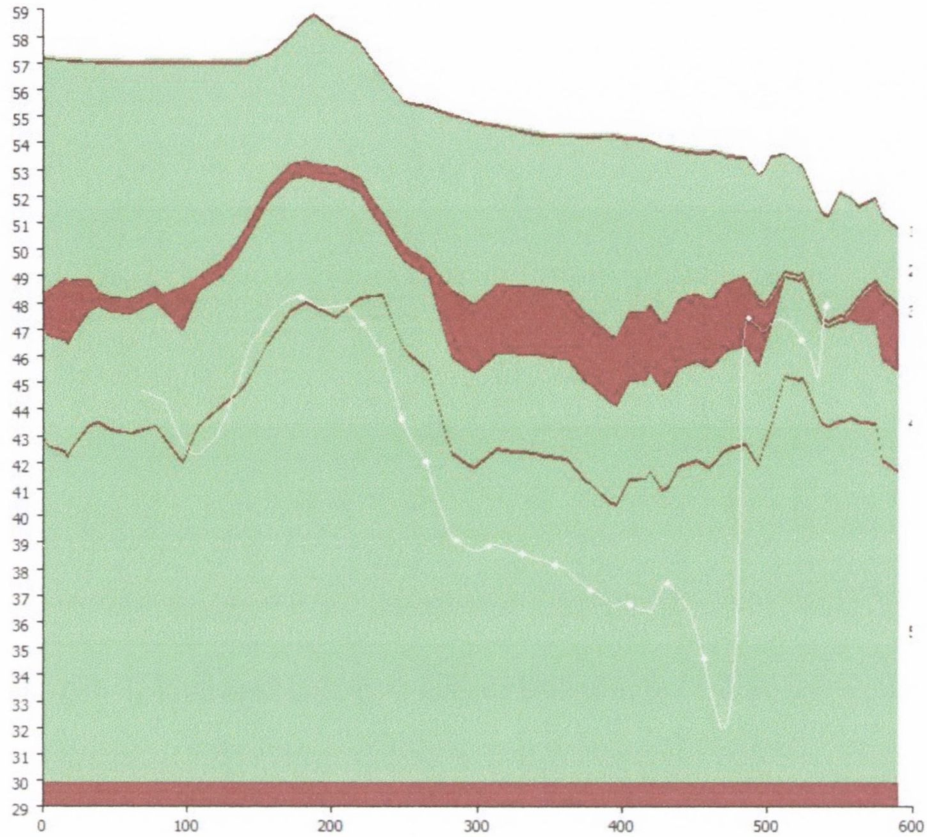


Figure I5. Flow path of water particle in layer 4; profile through flow line 2

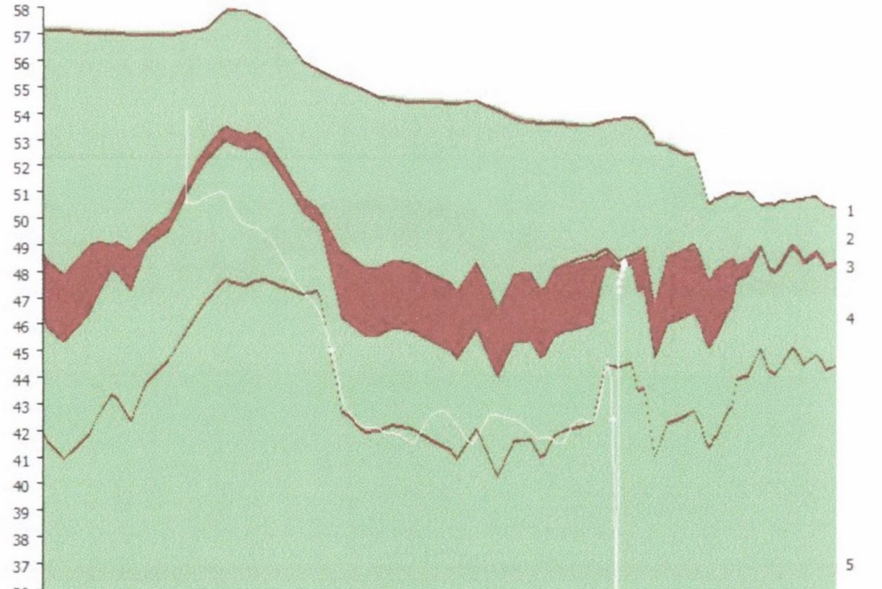


Figure I6. Flow path of water particle in layer 2; profile through flow line 2

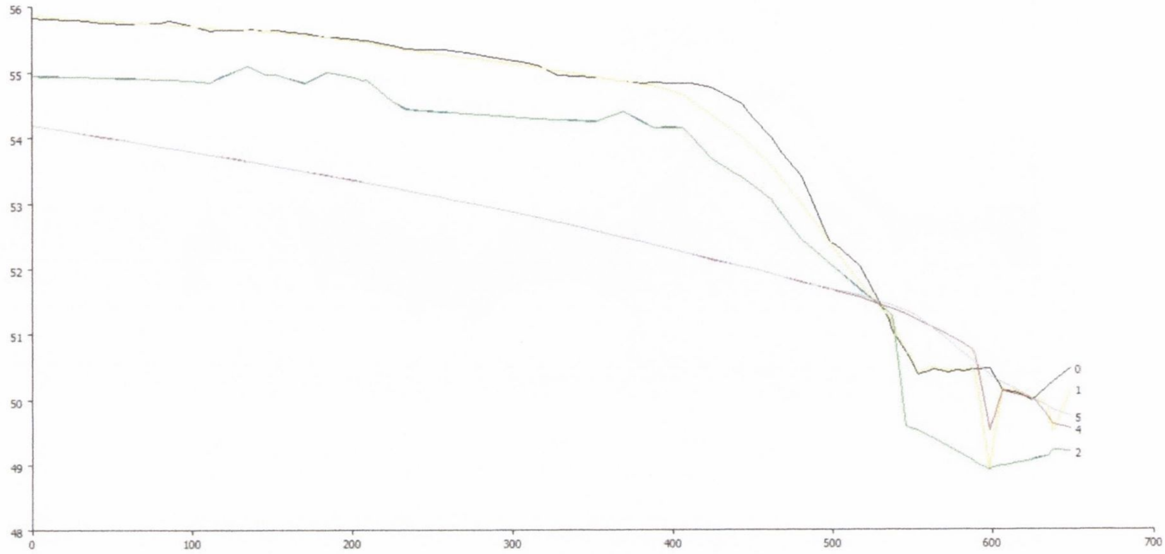


Figure I7. Topographic profile and modelled potentiometric surfaces through flow line 3

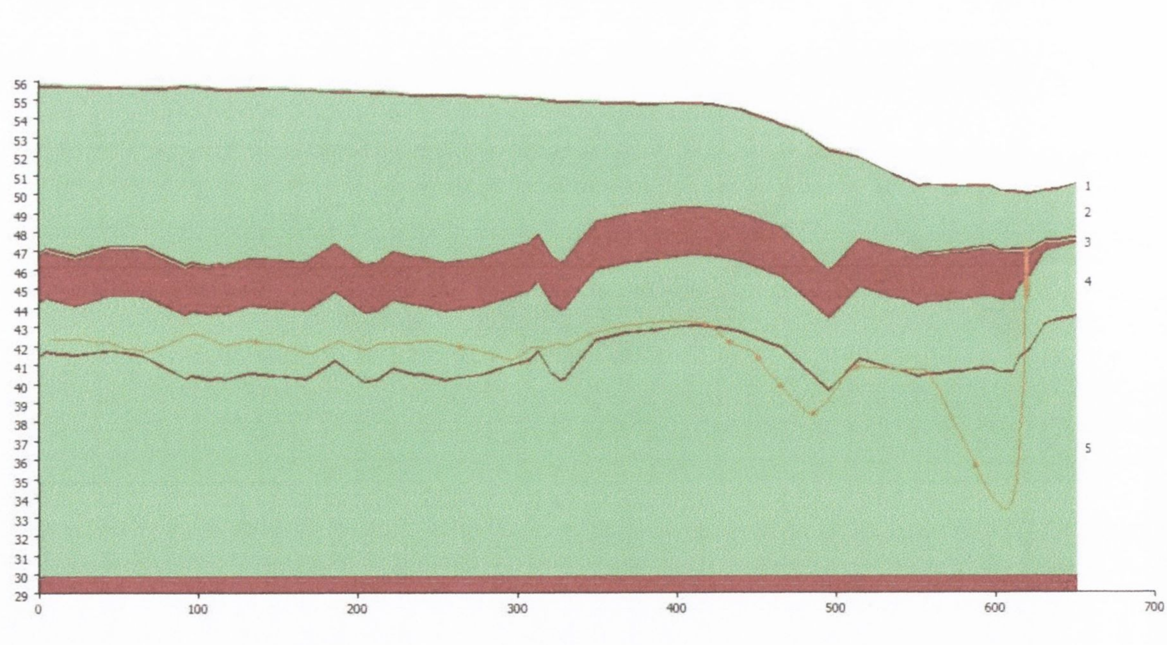


Figure I8. Flow path of water particle in layer 4; profile through flow line 3

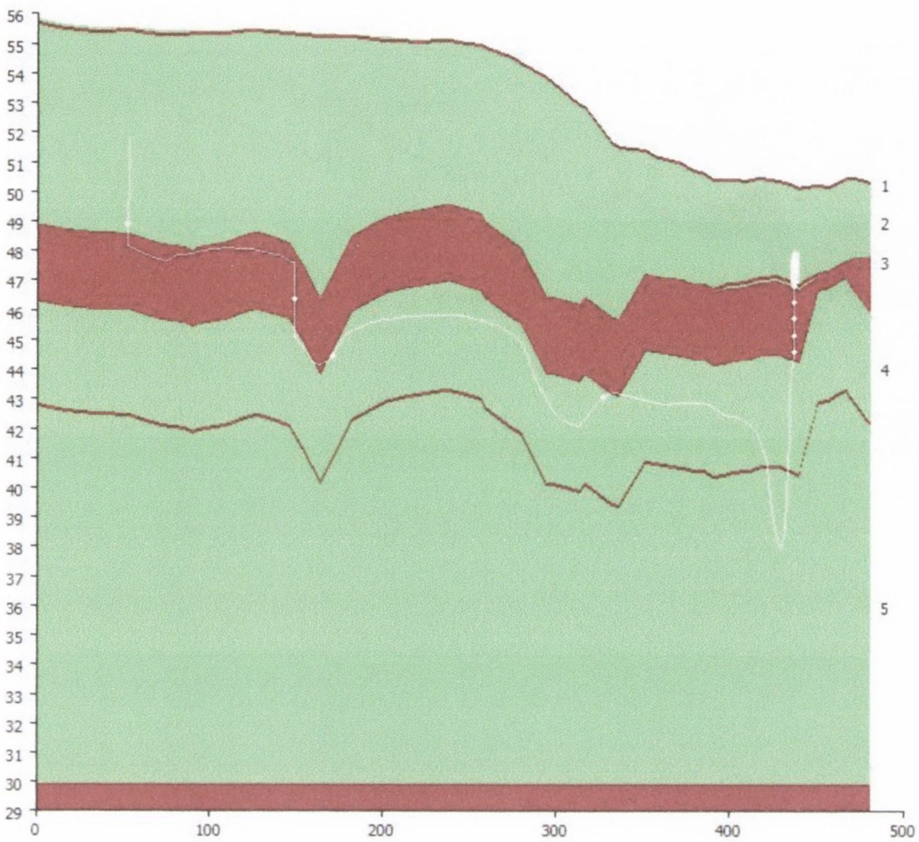


Figure I9. Flow path of water particle in layer 2; profile through flow line 3

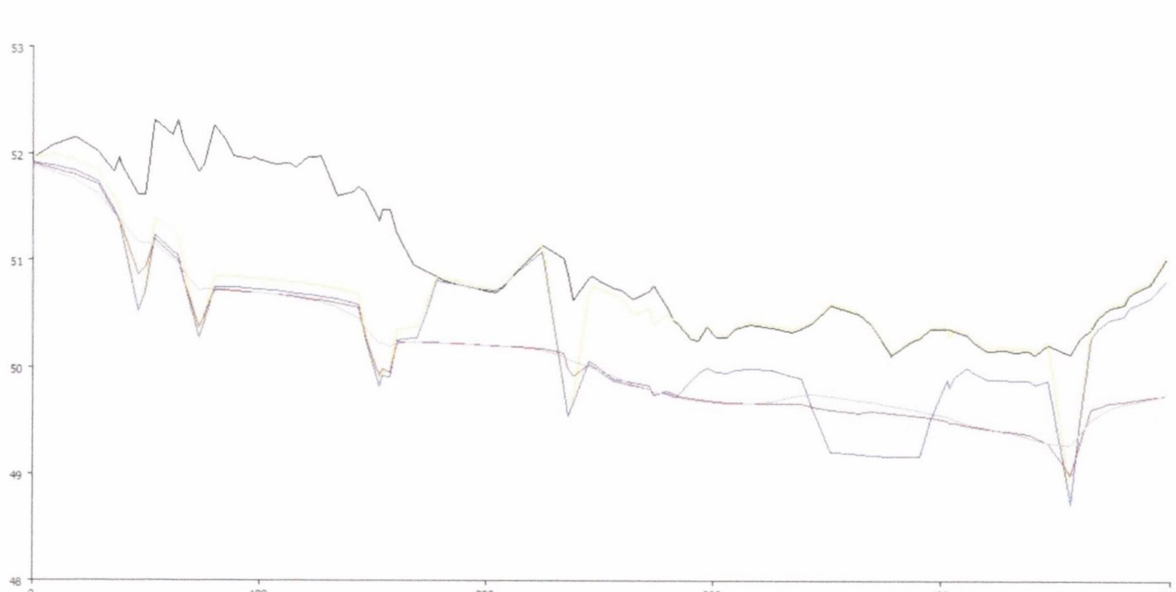


Figure I10. Topographic profile and modelled potentiometric surfaces through flow line 4

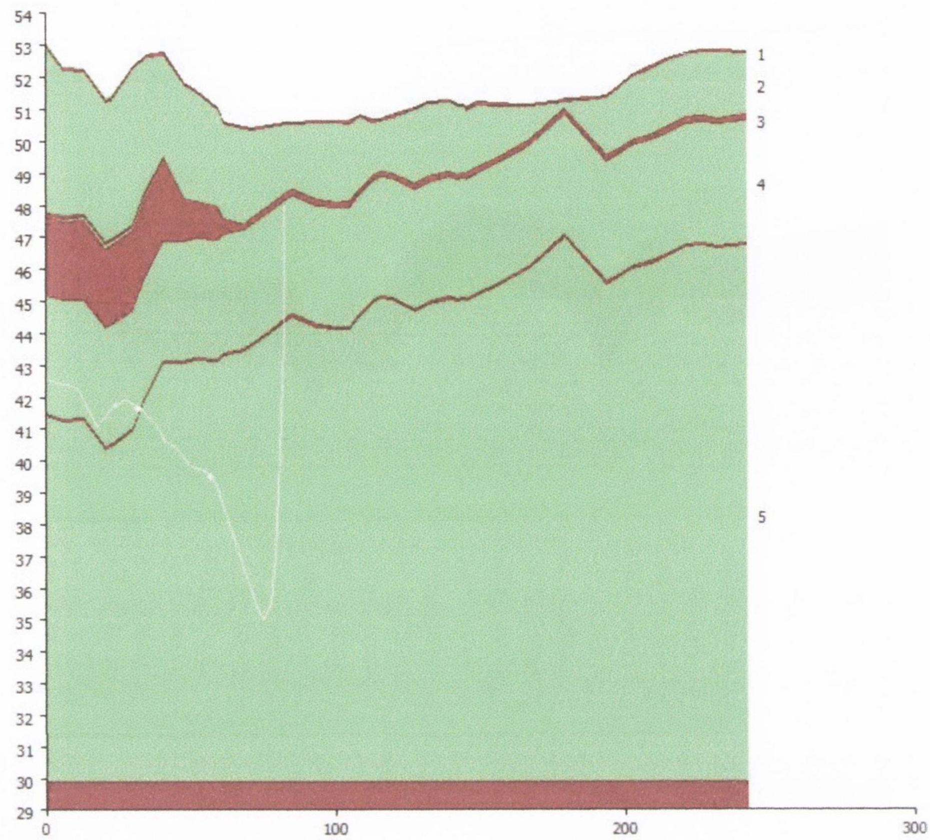


Figure I11. Flow path of water particle in layer 4; profile through flow line 4

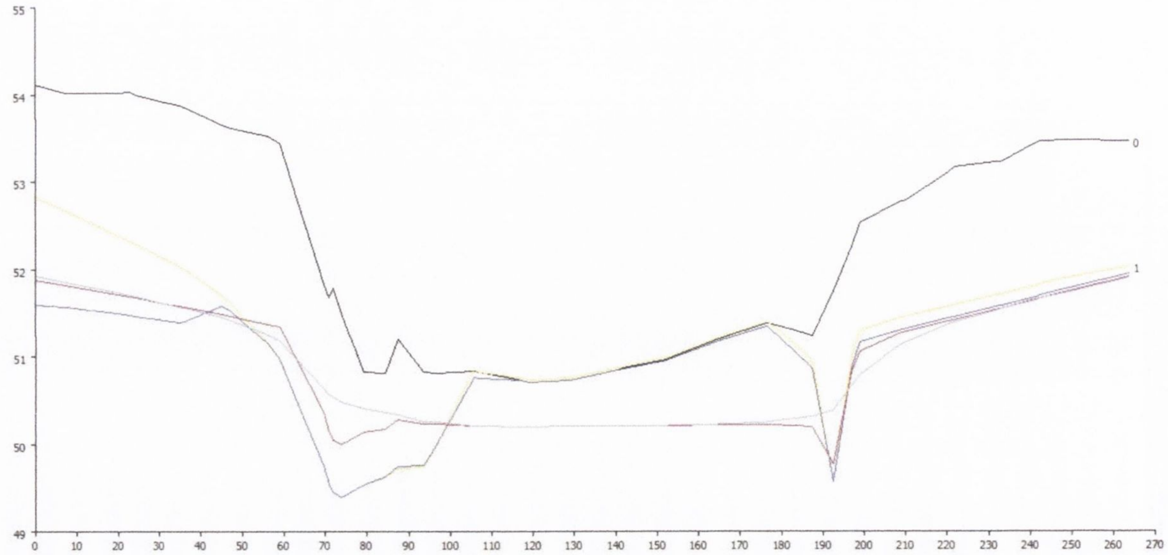


Figure I12. Topographic profile and modelled potentiometric surfaces through flow line 5

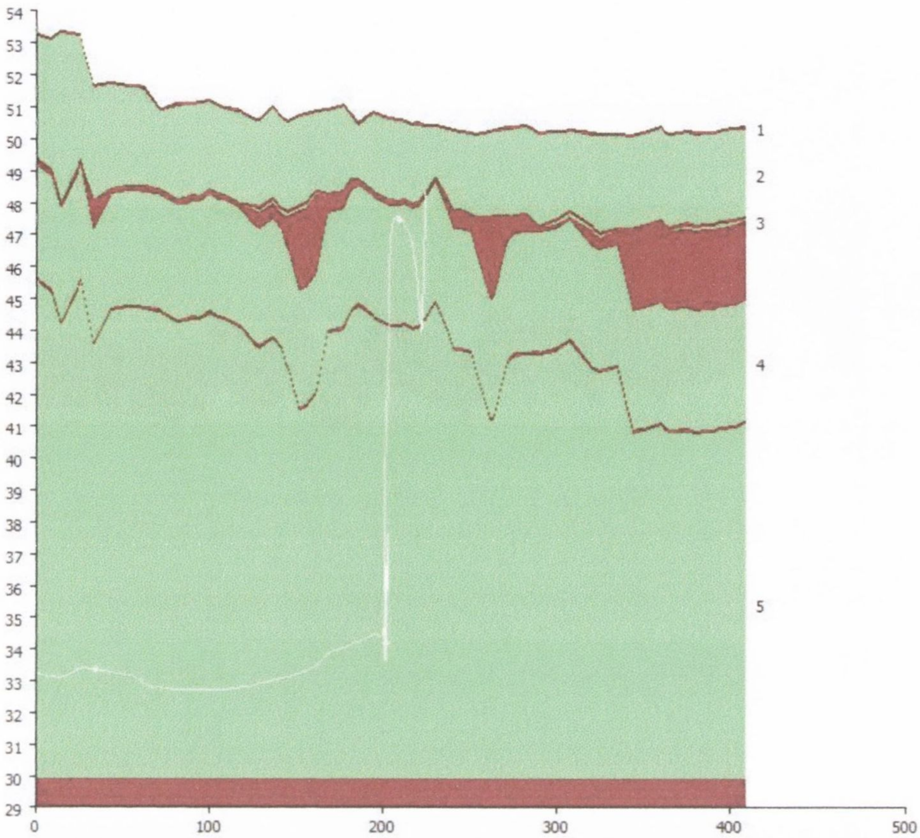


Figure I13. Flow path of water particle in layer 4; profile through flow line 5

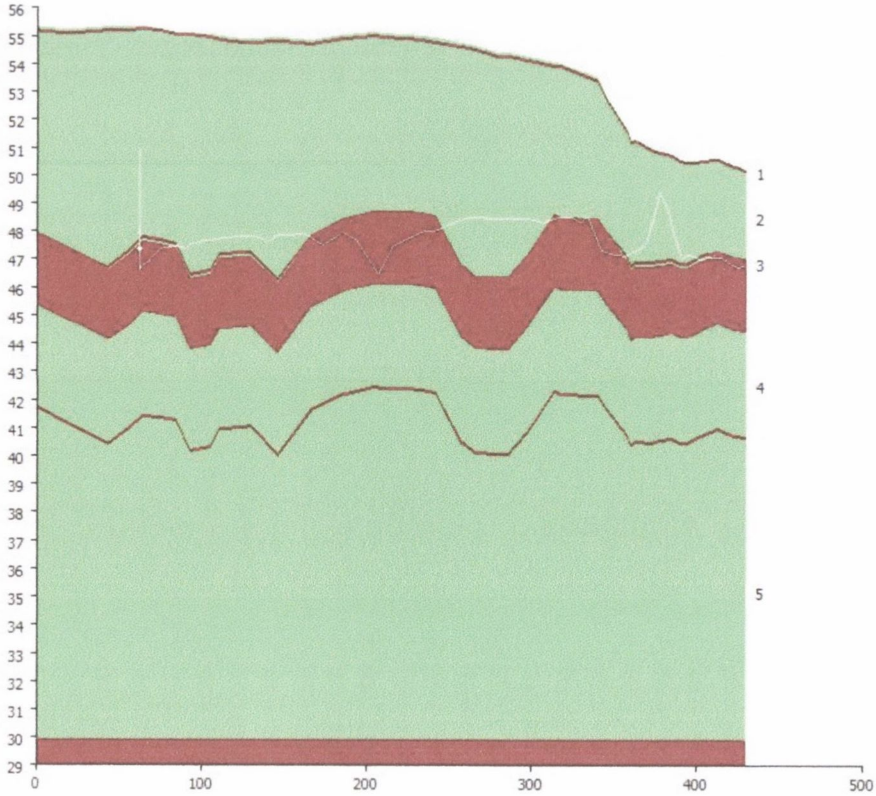


Figure I14. Flow path of water particle in layer 2; sand lense area (N-S orientation)

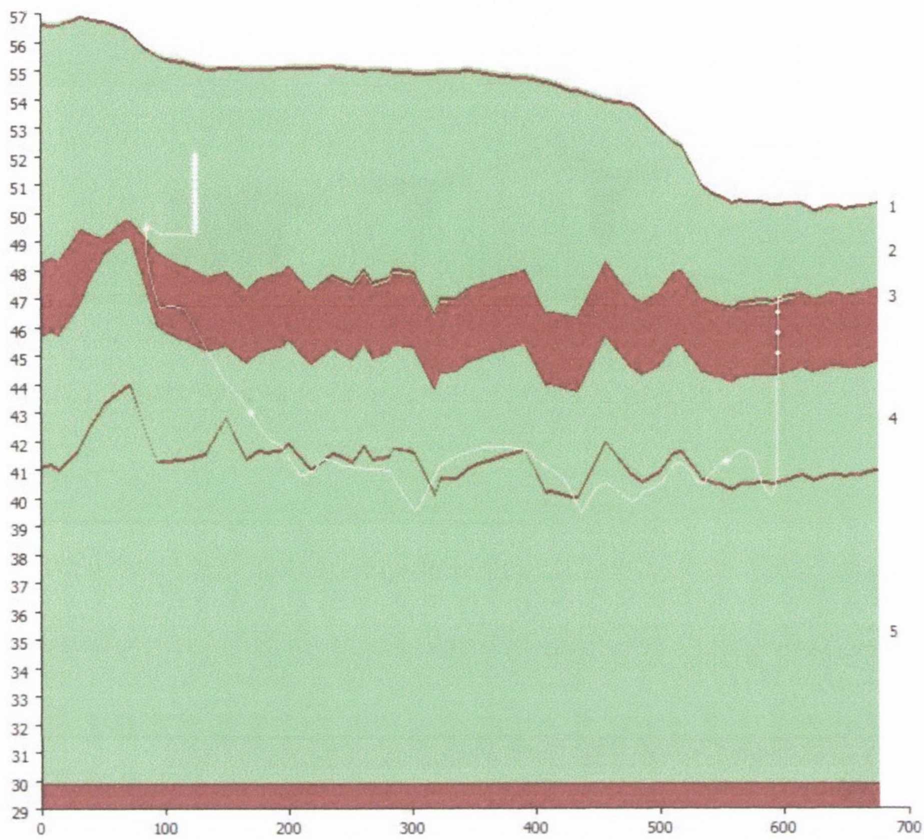


Figure I15. Flow path of water particle in layer 4; Western Mound area (N-S orientation)

Appendix I: Steady State Model - 3D Cross-Sections

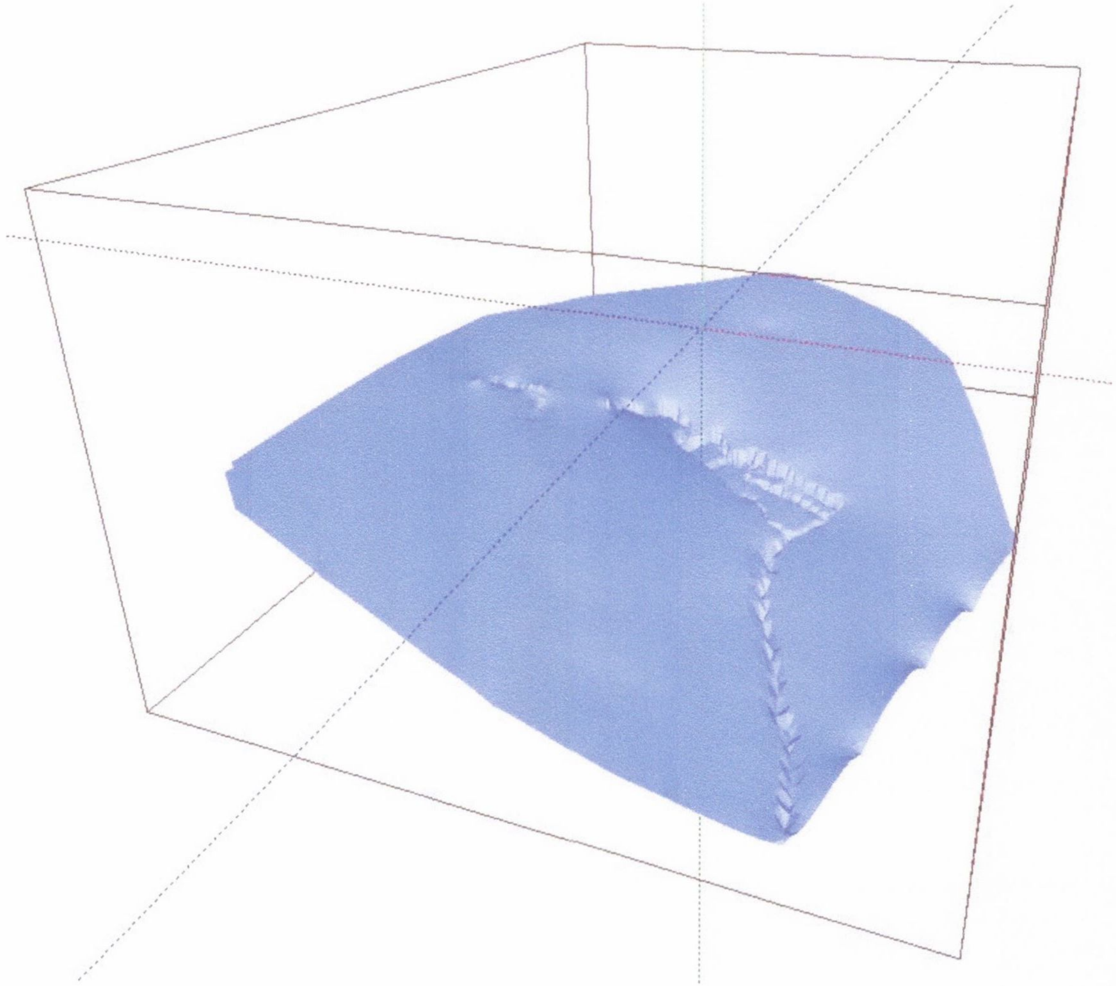


Figure I16. 3D image of layer 4 potentiometric surface – view looking northwest

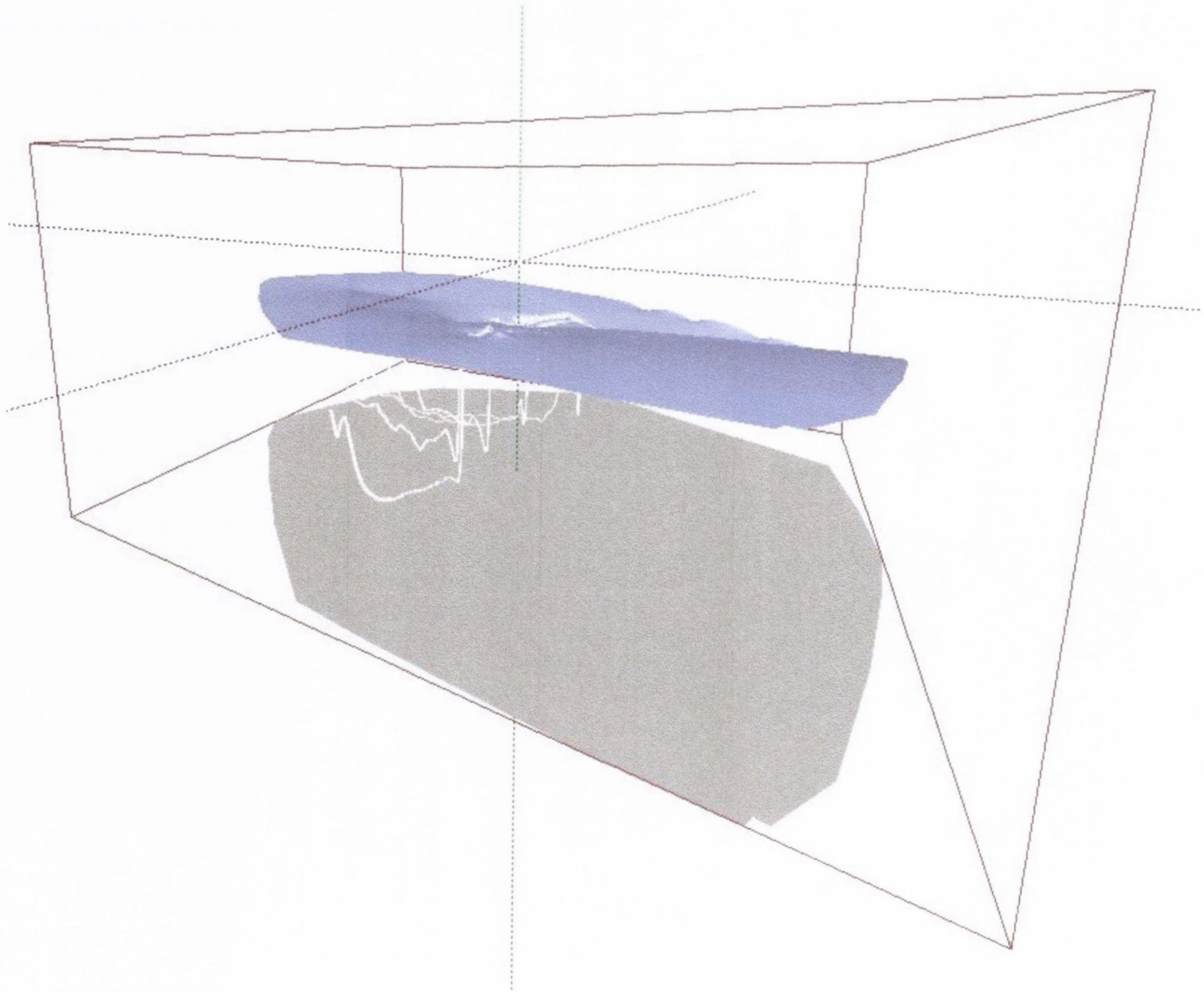


Figure I17. 3D image of layer 4 potentiometric surface with flow lines – view looking southeast

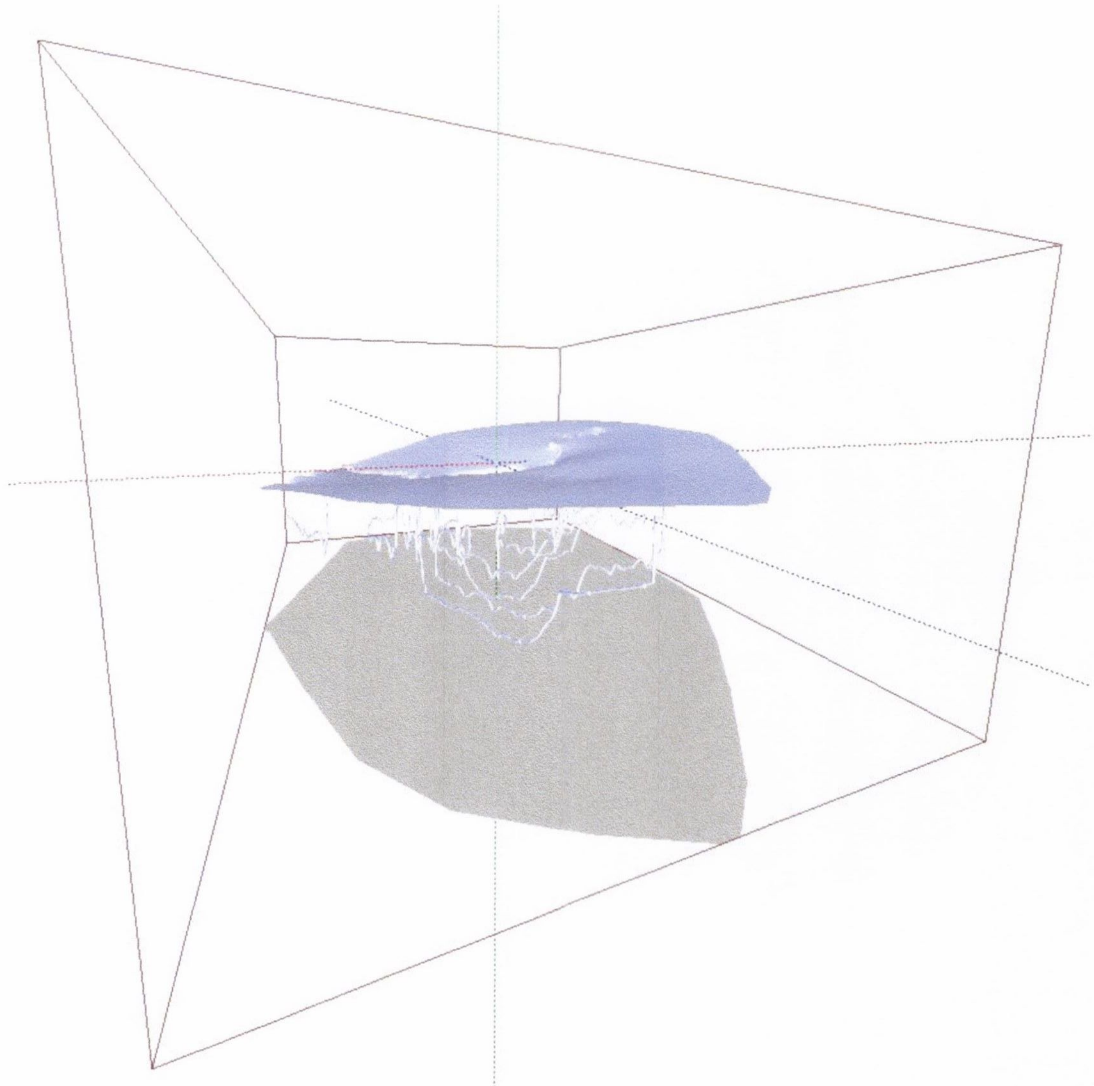


Figure I18. 3D image of layer 4 potentiometric surface with flow lines – view looking westwards

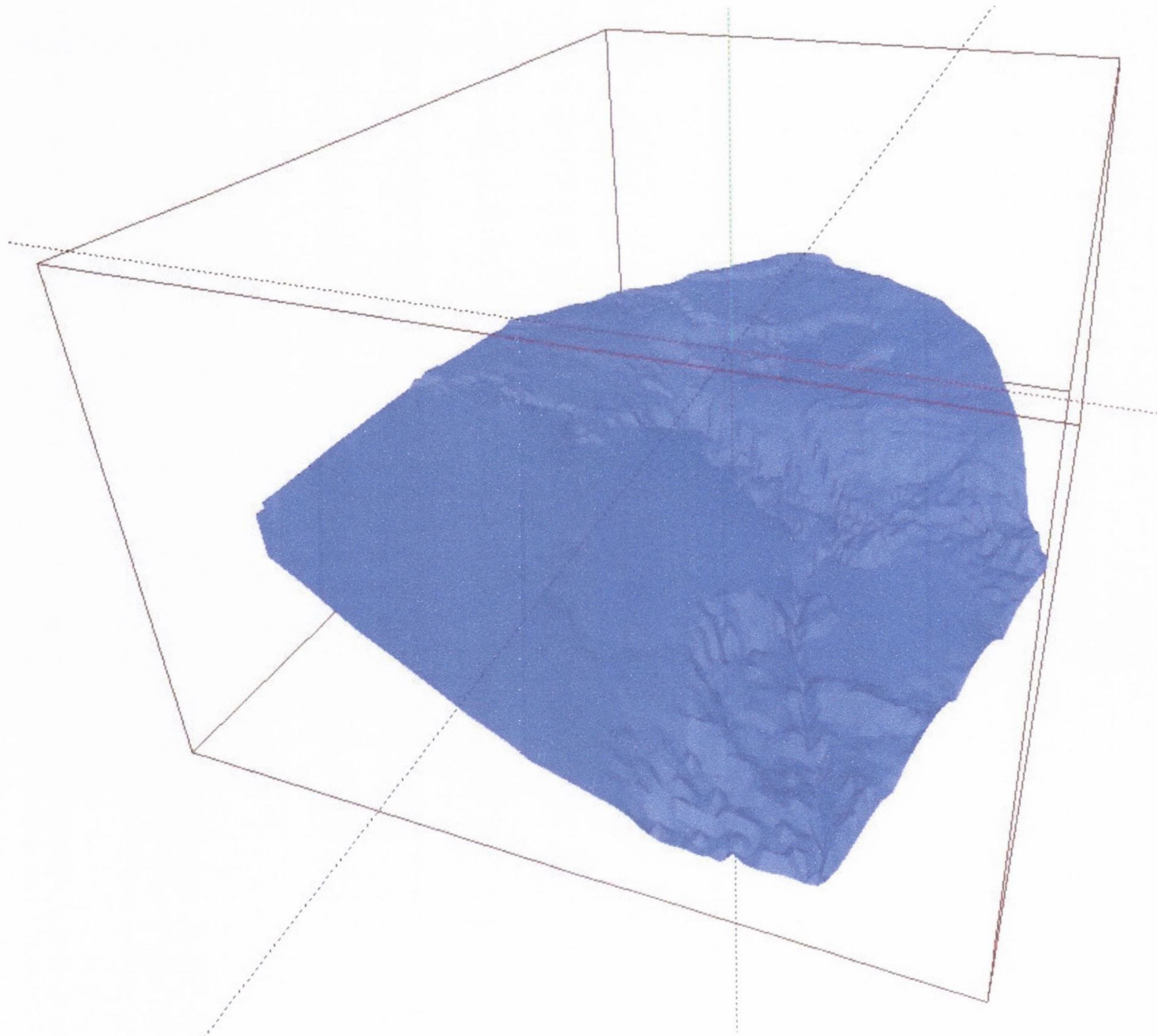


Figure I19. 3D image of layer 4 potentiometric surface – view looking northwest

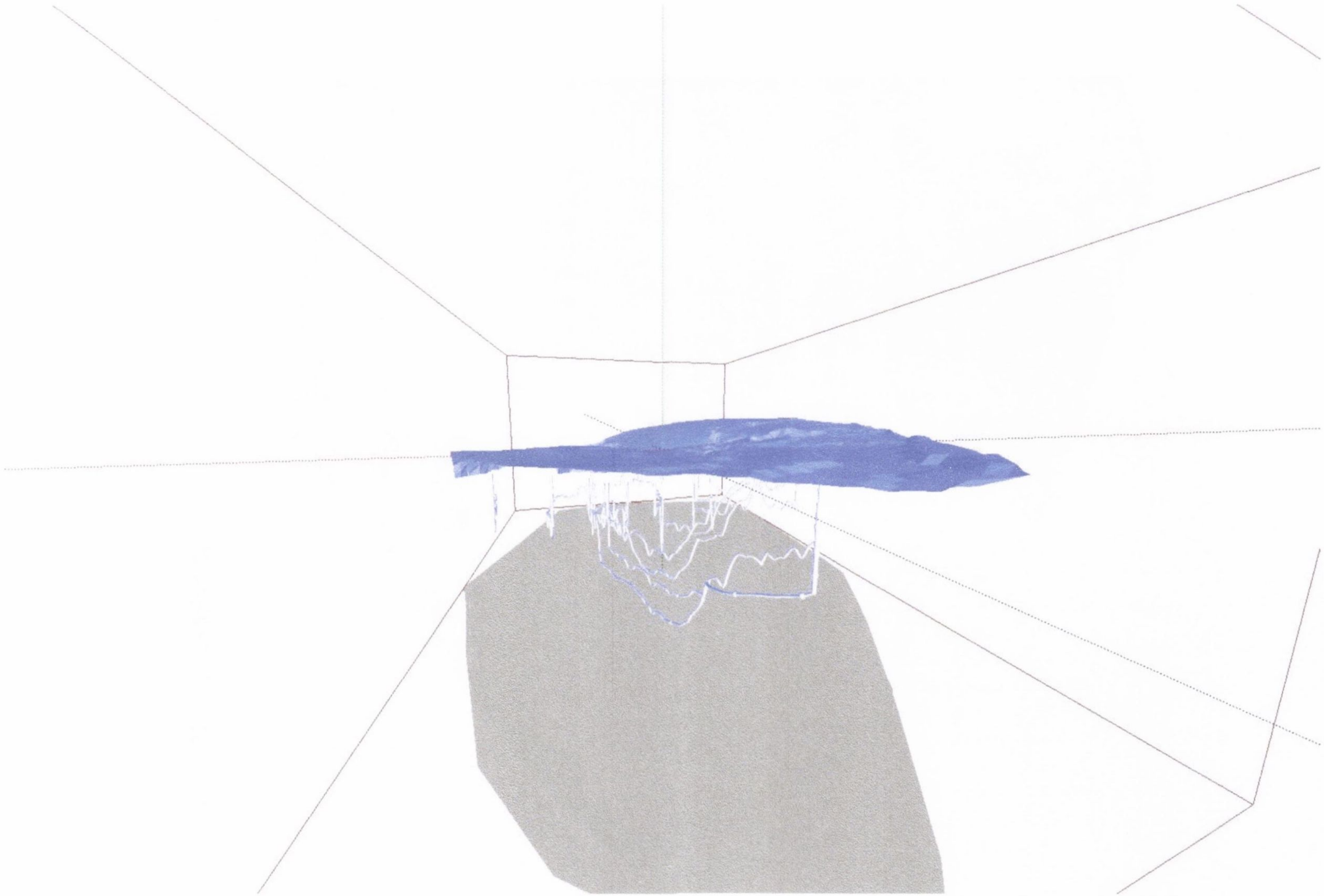


Figure I20. 3D image of layer 4 potentiometric surface with flow lines – view looking southwest

Appendix I: Steady State Model – layer 2 and layer 4 potentiometric surface maps

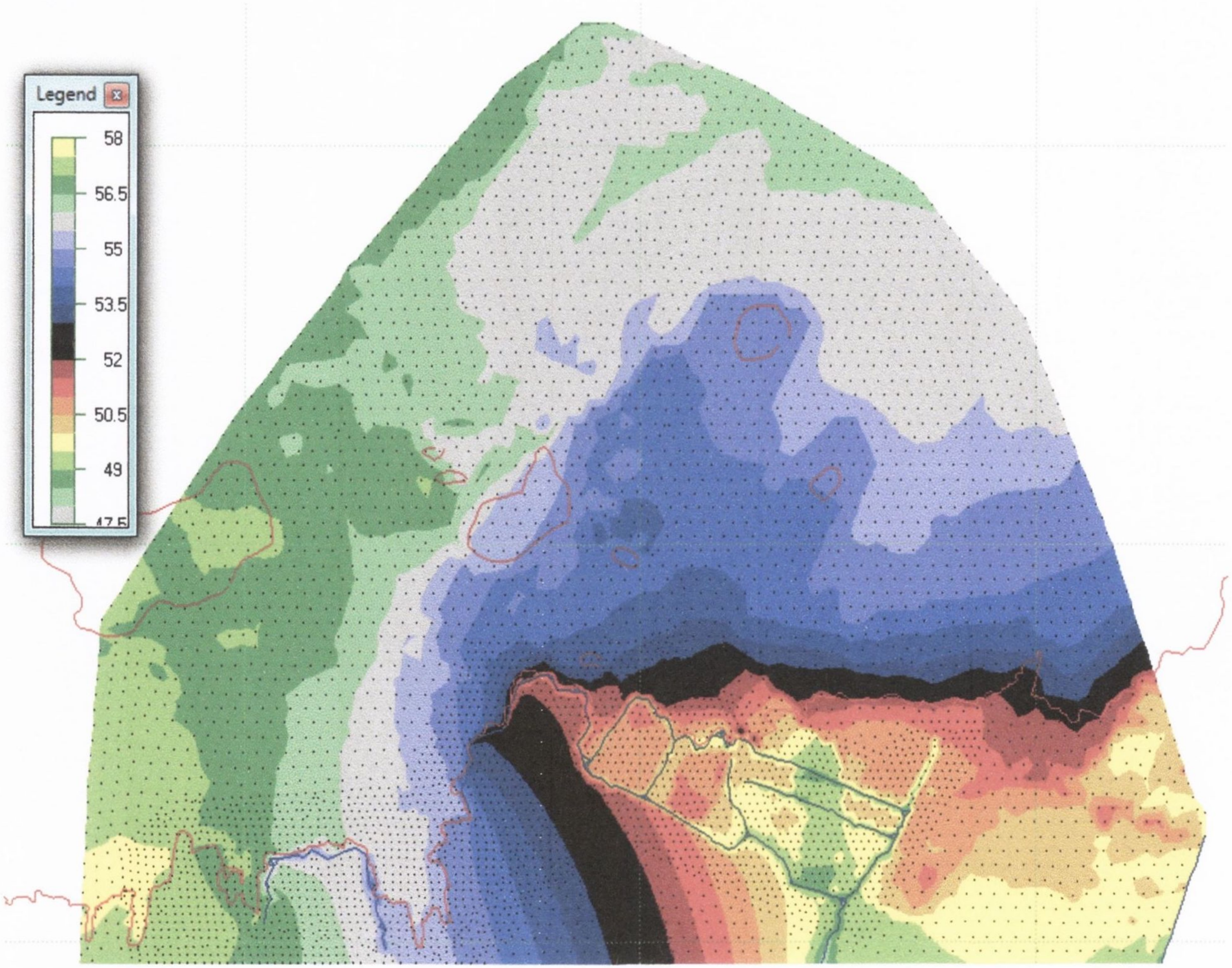


Figure i21. Potentiometric surface contours in layer 2 (peat aquifer). Contour interval is 0.5 m.

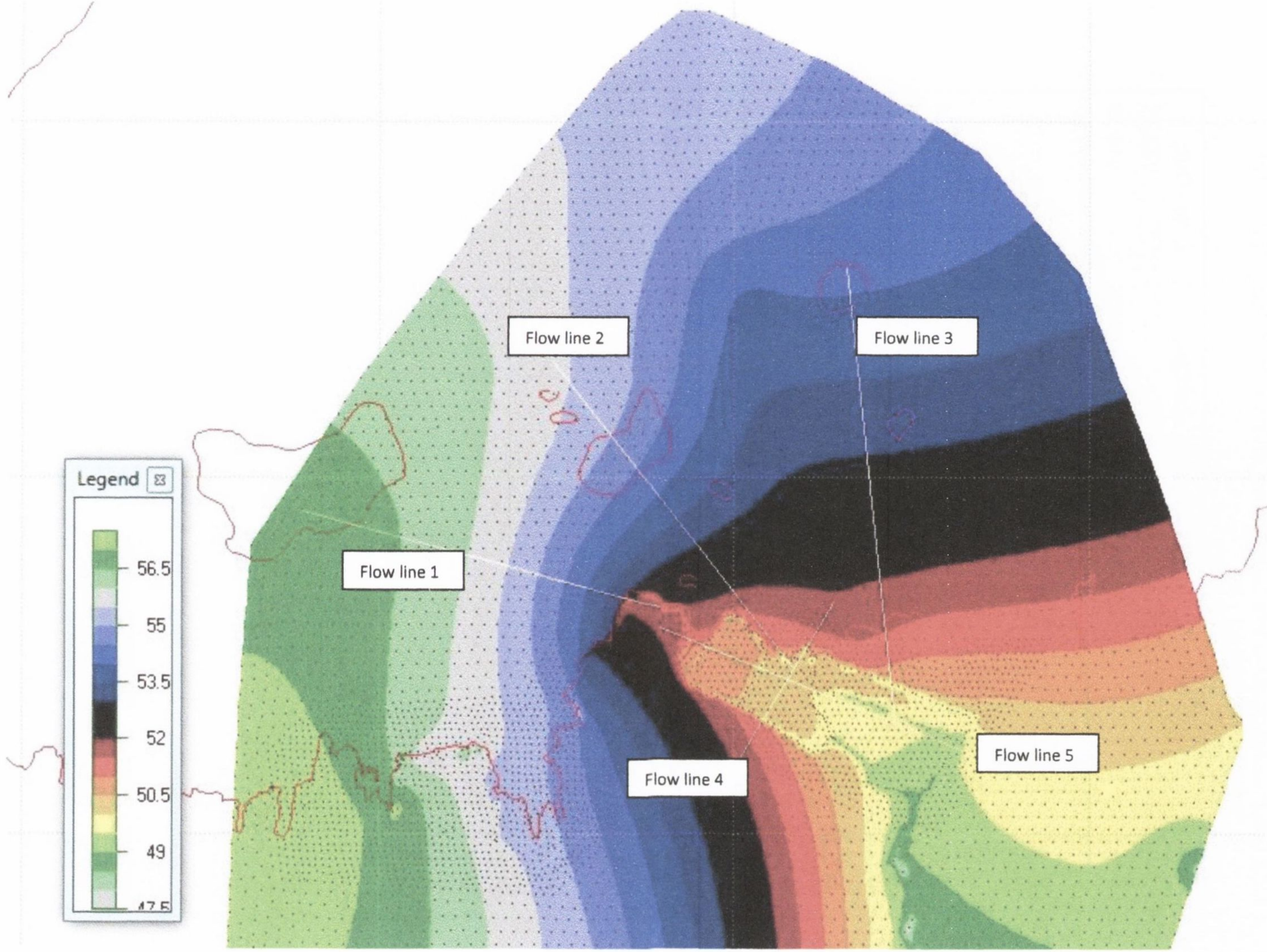


Figure i22. Potentiometric surface contours in layer 4 (till aquifer). Contour interval is 0.5 m. White lines are flow line locations.

Appendix I: Steady State Water Balance Computations

1. Entire model domain

Table I1. Clara West steady state water balance for entire model area (flow rate)

		Inflow	Outflow	In - Out
Precipitation		742.21		742.21
Drain system 1			348.35	-348.35
Sum topsystems		742.21	348.35	393.87
	Leakage			
1	**Lateral flow**			
	Boundary flow	8.38	29.14	-20.76
	Total (error)	784.02	784.02	0
	Leakage	406.53	33.43	373.1
2	**Lateral flow**			
	Boundary flow	0.33	11.04	-10.71
	Total (error)	442.9	442.74	0.17
	Leakage	398.27	36.04	362.23
3	**Lateral flow**			
	Boundary flow	12.15	86	-73.86
	Total (error)	506.08	506.09	0
	Leakage	384.04	95.67	288.38
4	**Lateral flow**			
	Boundary flow	136.53	424.67	-288.14
	Total (error)	872.71	872.54	0.17
	Leakage	352.2	352.13	0.07
5	**Lateral flow**			
	Boundary flow			
	Total (error)	352.2	352.13	0.07
Units:		m^3/ day		
Model area:		2034644 m^2		

Table I2. Clara West steady state water balance for entire model area (flux)

		Inflow	Outflow	In - Out
Precipitation		0.36		0.36
Drain system 1			0.17	-0.17
Sum topsystems		0.36	0.17	0.19
	Leakage			
1	**Lateral flow**			
	Boundary flow	0.00	0.01	-0.01
	Total (error)	0.39	0.39	0.00
	Leakage	0.20	0.02	0.18
2	**Lateral flow**			
	Boundary flow	0.00	0.01	-0.01
	Total (error)	0.22	0.22	0.00
	Leakage	0.20	0.02	0.18
3	**Lateral flow**			
	Boundary flow	0.01	0.04	-0.04
	Total (error)	0.25	0.25	0.00
	Leakage	0.19	0.05	0.14
4	**Lateral flow**			
	Boundary flow	0.07	0.21	-0.14
	Total (error)	0.43	0.43	0.00
	Leakage	0.17	0.17	0.00
5	**Lateral flow**			
	Boundary flow			
	Total (error)	0.17	0.17	0.00
Units: mm/ day				

2. Groundwater catchment areas as measured by Clara West flow measurement structures

Table I3. Steady state water balance for groundwater catchment area measured at FB2 Flume (flow rate)

		Inflow	Outflow	In - Out
Precipitation		196.21		196.21
Drain system 1			71.63	-71.63
Sum topsystems		196.21	71.63	124.58
	Leakage			
1	**Lateral flow**	1.67	5.05	-3.38
	Boundary flow	4.43	6.61	-2.18
	Total (error)	202.45	202.45	0
	Leakage	119.16	0.15	119.01
2	**Lateral flow**	0.11	0.27	-0.16
	Boundary flow	0.24	1.42	-1.18
	Total (error)	119.72	119.65	0.07
	Leakage	117.82	0.21	117.61
3	**Lateral flow**	0.15	1.46	-1.32
	Boundary flow	0.67	31.88	-31.21
	Total (error)	150.73	150.73	0
	Leakage	117.18	32.09	85.08
4	**Lateral flow**	6.65	40.75	-34.1
	Boundary flow	95.38	137.44	-42.06
	Total (error)	275.81	275.74	0.07
	Leakage	65.47	56.61	8.86
5	**Lateral flow**	2.51	11.35	-8.84
	Boundary flow			
	Total (error)	67.98	67.96	0.01
Units:		m^3/ day		
Model area:		459599 m^2		

Table I4. Steady state water balance for groundwater catchment area measured at FB2 Flume (flux)

		Inflow	Outflow	In - Out
Precipitation		0.43		0.43
Drain system 1			0.16	-0.16
Sum topsystems		0.43	0.16	0.27
	Leakage			
1	**Lateral flow**	0.00	0.01	-0.01
	Boundary flow	0.01	0.01	0.00
	Total (error)	0.44	0.44	0.00
	Leakage	0.26	0.00	0.26
2	**Lateral flow**	0.00	0.00	0.00
	Boundary flow	0.00	0.00	0.00
	Total (error)	0.26	0.26	0.00
	Leakage	0.26	0.00	0.26
3	**Lateral flow**			
	Boundary flow	0.00	0.07	-0.07
	Total (error)	0.33	0.33	0.00
	Leakage	0.25	0.07	0.19
4	**Lateral flow**	0.01	0.09	-0.07
	Boundary flow	0.21	0.30	-0.09
	Total (error)	0.60	0.60	0.00
	Leakage	0.14	0.12	0.02
5	**Lateral flow**	0.01	0.02	-0.02
	Boundary flow			
	Total (error)	0.15	0.15	0.00

Units: mm/ day

Table I5. Steady state water balance for groundwater catchment area measured at Restoration Area Flume (flow rate)

		Inflow	Outflow	In - Out
Precipitation		396.55		396.55
Drain system 1			175.99	-175.99
Sum topsystems		396.55	175.99	220.56
	Leakage			
1	**Lateral flow**	0.88	0.28	0.61
	Boundary flow	8.38	29.14	-20.76
	Total (error)	406.12	406.12	0
	Leakage	200.71	0.3	200.4
2	**Lateral flow**	3.48	0.13	3.36
	Boundary flow	0.33	11.04	-10.71
	Total (error)	207.98	207.85	0.13
	Leakage	196.38	3.46	192.93
3	**Lateral flow**			
	Boundary flow	12.15	86	-73.86
	Total (error)	271.61	271.61	0
	Leakage	182.15	63.08	119.07
4	**Lateral flow**	55.45	44.55	10.91
	Boundary flow	136.53	424.67	-288.14
	Total (error)	719.73	719.62	0.11
	Leakage	187.32	345.59	-158.28
5	**Lateral flow**	173.32	14.99	158.33
	Boundary flow			
	Total (error)	360.64	360.58	0.06
Units:		m^3/ day		
Model area:		459599 m^2		

Table I6. Steady state water balance for groundwater catchment area measured at Restoration Area Flume (flux)

		Inflow	Outflow	In - Out
Precipitation		0.42		0.42
Drain system 1			0.18	-0.18
Sum topsystems		0.42	0.18	0.23
	Leakage			
1	**Lateral flow**	0.00	0.00	0.00
	Boundary flow	0.01	0.03	-0.02
	Total (error)	0.43	0.43	0.00
	Leakage	0.21	0.00	0.21
2	**Lateral flow**	0.00	0.00	0.00
	Boundary flow	0.00	0.01	-0.01
	Total (error)	0.22	0.22	0.00
	Leakage	0.21	0.00	0.20
3	**Lateral flow**			
	Boundary flow	0.01	0.09	-0.08
	Total (error)	0.29	0.29	0.00
	Leakage	0.19	0.07	0.13
4	**Lateral flow**	0.06	0.05	0.01
	Boundary flow	0.14	0.45	-0.30
	Total (error)	0.76	0.76	0.00
	Leakage	0.20	0.36	-0.17
5	**Lateral flow**	0.18	0.02	0.17
	Boundary flow			
	Total (error)	0.38	0.38	0.00

Units: mm/ day

Table I7. Steady state water balance for groundwater catchment area measured at EPA Weir (flow rate)

		Inflow	Outflow	In - Out
Precipitation		304.76		304.76
Drain system 1			105.6	-105.6
Sum topsystems		304.76	105.6	199.16
	Leakage			
1	**Lateral flow**	3.09	1.23	1.86
	Boundary flow	5.47	21.85	-16.38
	Total (error)	313.58	313.58	0
	Leakage	184.89	0.25	184.64
2	**Lateral flow**	0.26	0.42	-0.16
	Boundary flow	0.31	5.45	-5.14
	Total (error)	187.54	187.45	0.09
	Leakage	181.32	2.08	179.24
3	**Lateral flow**	8.13	12.96	-4.83
	Boundary flow	2.25	45.29	-43.03
	Total (error)	236.58	236.58	0
	Leakage	176.25	44.87	131.38
4	**Lateral flow**	17.03	26.98	-9.95
	Boundary flow	99.19	187.31	-88.12
	Total (error)	411.22	411.12	0.1
	Leakage	151.96	118.75	33.2
5	**Lateral flow**	10.53	43.69	-33.16
	Boundary flow			
	Total (error)	162.49	162.44	0.05
Units:		m^3/ day		
Model area:		459599 m^2		

Table I8. Steady state water balance for groundwater catchment area measured at EPA Weir (flux)

		Inflow	Outflow	In - Out
Precipitation		0.41		0.41
Drain system 1			0.14	-0.14
Sum topsystems		0.41	0.14	0.27
	Leakage			
1	**Lateral flow**	0.00	0.00	0.00
	Boundary flow	0.01	0.03	-0.02
	Total (error)	0.42	0.42	0.00
	Leakage	0.25	0.00	0.25
2	**Lateral flow**	0.00	0.00	0.00
	Boundary flow	0.00	0.01	-0.01
	Total (error)	0.25	0.25	0.00
	Leakage	0.24	0.00	0.24
3	**Lateral flow**			
	Boundary flow	0.00	0.06	-0.06
	Total (error)	0.32	0.32	0.00
	Leakage	0.24	0.06	0.18
4	**Lateral flow**	0.02	0.04	-0.01
	Boundary flow	0.13	0.25	-0.12
	Total (error)	0.55	0.55	0.00
	Leakage	0.20	0.16	0.04
5	**Lateral flow**	0.01	0.06	-0.04
	Boundary flow			
	Total (error)	0.22	0.22	0.00

Units: mm/ day

3. Steady state water balances for areas of high bog underlain by till, sand/ lacustrine clay and lacustrine clay

Table I9. Steady state water balance for groundwater catchment area under high bog underlain by till (flow rate)

		Inflow	Outflow	In - Out
Precipitation		135.65		135.65
Drain system 1			46.58	-46.58
Sum topsystems		135.65	46.58	89.07
	Leakage			
1	**Lateral flow**	9.1	8.76	0.35
	Boundary flow		0.63	-0.63
	Total (error)	144.79	144.79	0
	Leakage	88.81	0.03	88.78
2	**Lateral flow**	0.64	0.3	0.33
	Boundary flow	0.01	0.16	-0.16
	Total (error)	89.51	89.46	0.05
	Leakage	88.97	0.05	88.91
3	**Lateral flow**	1.34	0.87	0.47
	Boundary flow		6.83	-6.83
	Total (error)	97.19	97.19	0
	Leakage	89.44	6.88	82.55
4	**Lateral flow**	72.15	111.76	-39.61
	Boundary flow	23.31	26.35	-3.03
	Total (error)	194.49	194.44	0.05
	Leakage	49.45	9.59	39.86
5	**Lateral flow**	27.65	67.5	-39.85
	Boundary flow			
	Total (error)	77.1	77.09	0.02
Units:		m^3/ day		
Model area:		302246 m^2		

Table I10. Steady state water balance for groundwater catchment area under high bog underlain by till (flux)

		Inflow	Outflow	In - Out
Precipitation		0.45		0.45
Drain system 1			0.15	-0.15
Sum topsystems		0.45	0.15	0.29
	Leakage			
1	**Lateral flow**	0.030	0.029	0.001
	Boundary flow		0.002	-0.002
	Total (error)	0.479	0.479	0.000
	Leakage	0.294	0.000	0.294
2	**Lateral flow**	0.002	0.001	0.001
	Boundary flow	0.000	0.001	-0.001
	Total (error)	0.296	0.296	0.000
	Leakage	0.294	0.000	0.294
3	**Lateral flow**	0.004	0.003	0.002
	Boundary flow		0.023	-0.023
	Total (error)	0.322	0.322	0.000
	Leakage	0.296	0.023	0.273
4	**Lateral flow**	0.239	0.370	-0.131
	Boundary flow	0.077	0.087	-0.010
	Total (error)	0.643	0.643	0.000
	Leakage	0.164	0.032	0.132
5	**Lateral flow**	0.091	0.223	-0.132
	Boundary flow			
	Total (error)	0.255	0.255	0.000

Units: mm/ day

Table I11. Steady state water balance for groundwater catchment area under high bog underlain by lacustrine clay (flow rate)

		Inflow	Outflow	In - Out
Precipitation		271.53		271.53
Drain system 1			167.29	-167.29
Sum topsystems		271.53	167.29	104.24
	Leakage			
1	**Lateral flow**	9.47	19.21	-9.74
	Boundary flow	5.38	9.81	-4.43
	Total (error)	286.42	286.41	0
	Leakage	90.1	0.04	90.07
2	**Lateral flow**	0.09	1.49	-1.4
	Boundary flow	0.28	0.39	-0.11
	Total (error)	90.66	90.58	0.09
	Leakage	88.65	0.19	88.46
3	**Lateral flow**	0.04	13.56	-13.53
	Boundary flow	2.25	2.82	-0.56
	Total (error)	91.3	91.31	-0.01
	Leakage	74.74	0.35	74.38
4	**Lateral flow**	64.28	82.22	-17.95
	Boundary flow		8.72	-8.72
	Total (error)	148.87	148.8	0.07
	Leakage	57.51	9.86	47.65
5	**Lateral flow**	40.41	88.02	-47.61
	Boundary flow			
	Total (error)	97.92	97.88	0.04
Units:		m^3/ day		
Model area:		603894 m^2		

Table I12. Steady state water balance for groundwater catchment area under high bog underlain by lacustrine clay (flux)

		Inflow	Outflow	In - Out
Precipitation		0.45		0.45
Drain system 1			0.28	-0.28
Sum topsystems		0.45	0.28	0.17
	Leakage			
1	**Lateral flow**	0.016	0.032	-0.016
	Boundary flow		0.016	-0.007
	Total (error)	0.474	0.474	0.000
	Leakage	0.149	0.000	0.149
2	**Lateral flow**	0.000	0.002	-0.002
	Boundary flow	0.000	0.001	0.000
	Total (error)	0.150	0.150	0.000
	Leakage	0.147	0.000	0.146
3	**Lateral flow**	0.000	0.022	-0.022
	Boundary flow		0.005	-0.001
	Total (error)	0.151	0.151	0.000
	Leakage	0.124	0.001	0.123
4	**Lateral flow**	0.106	0.136	-0.030
	Boundary flow		0.014	-0.014
	Total (error)	0.247	0.246	0.000
	Leakage	0.095	0.016	0.079
5	**Lateral flow**	0.067	0.146	-0.079
	Boundary flow			
	Total (error)	0.162	0.162	0.000

Units: mm/ day

Table I13. Steady state water balance for groundwater catchment area under high bog underlain by lacustrine clay and no sand (flow rate)

		Inflow	Outflow	In - Out
Precipitation		63.13		63.13
Drain system 1			45.38	-45.38
Sum topsystems		63.13	45.38	17.75
	Leakage			
1	Lateral flow	0.19	1.1	-0.91
	Boundary flow			
	Total (error)	63.32	63.32	0
	Leakage	16.84		16.84
2	Lateral flow	0.02	0.05	-0.03
	Boundary flow			
	Total (error)	16.86	16.83	0.03
	Leakage	16.78		16.78
3	Lateral flow		0.59	-0.59
	Boundary flow			
	Total (error)	16.78	16.8	-0.02
	Leakage	16.2		16.2
4	Lateral flow	9.78	22.76	-12.97
	Boundary flow			
	Total (error)	25.99	25.97	0.01
	Leakage	3.22		3.22
5	Lateral flow	2.43	5.65	-3.22
	Boundary flow			
	Total (error)	5.65	5.65	0
Units:		m^3/ day		
Model area:		141346 m^2		

Table I14. Steady state water balance for groundwater catchment area under high bog underlain by lacustrine clay and no sand (flux)

		Inflow	Outflow	In - Out
Precipitation		0.45		0.45
Drain system 1			0.32	-0.32
Sum topsystems		0.45	0.32	0.13
	Leakage			
1	Lateral flow	0.001	0.008	-0.006
	Boundary flow			
	Total (error)	0.448	0.448	0.000
	Leakage	0.119		0.119
2	Lateral flow	0.000	0.000	0.000
	Boundary flow			
	Total (error)	0.119	0.119	0.000
	Leakage	0.119		0.119
3	Lateral flow		0.004	-0.004
	Boundary flow			
	Total (error)	0.119	0.119	0.000
	Leakage	0.115		0.115
4	Lateral flow	0.069	0.161	-0.092
	Boundary flow			
	Total (error)	0.184	0.184	0.000
	Leakage	0.023		0.023
5	Lateral flow	0.017	0.040	-0.023
	Boundary flow			
	Total (error)	0.040	0.040	0.000

Units: mm/ day

Appendix J

Clara West Groundwater Flow Model Prediction

Appendix J: Prediction Model - 2D Cross-Sections

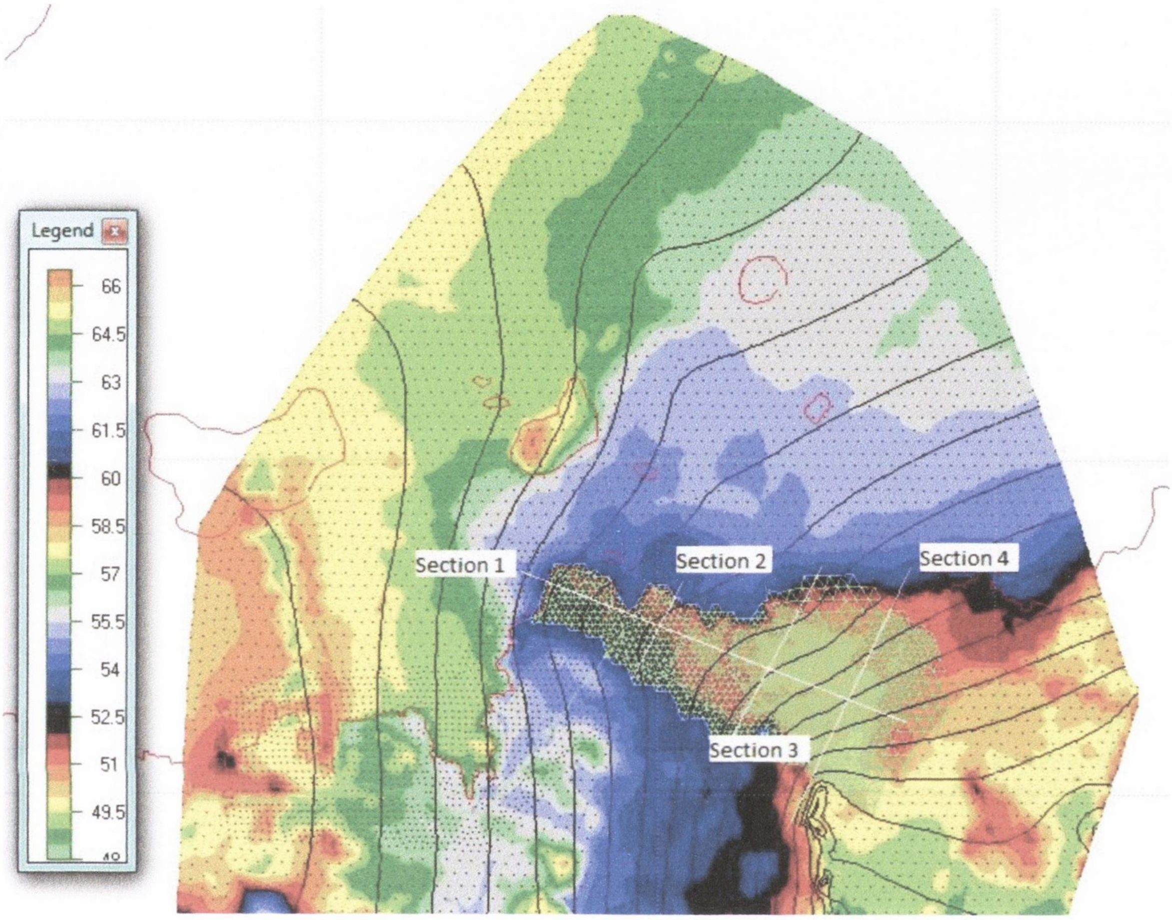


Figure j1. Dam/ peat infill location (green shaded area), cross-section locations, 0.5 m layer 4 potentiometric surface after restoration works and underlying topography elevation

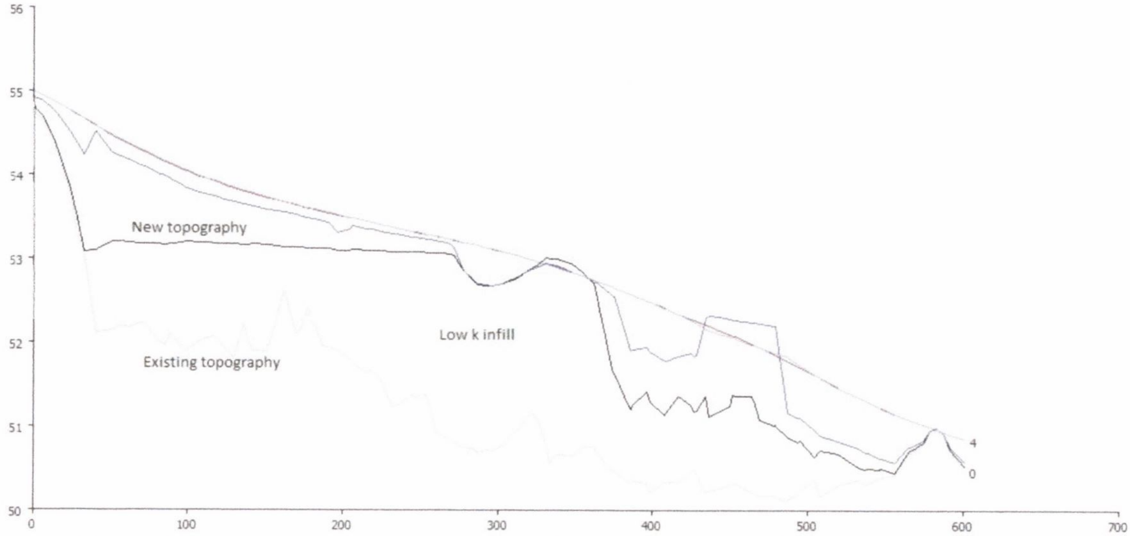


Figure j2. Cross secction1 through infill area with model potentiometric surface

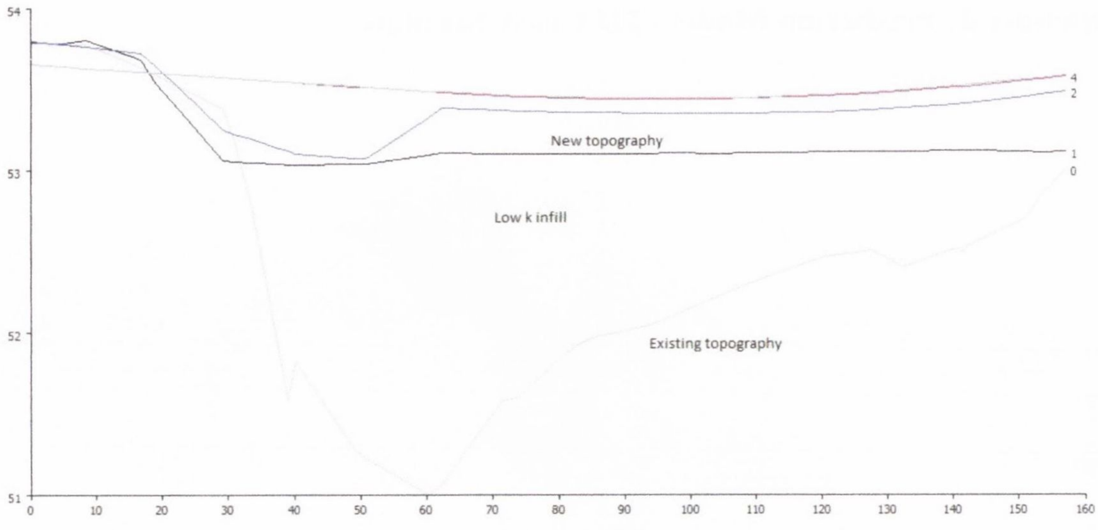


Figure j3. Cross section 2 through infill area with model potentiometric surface

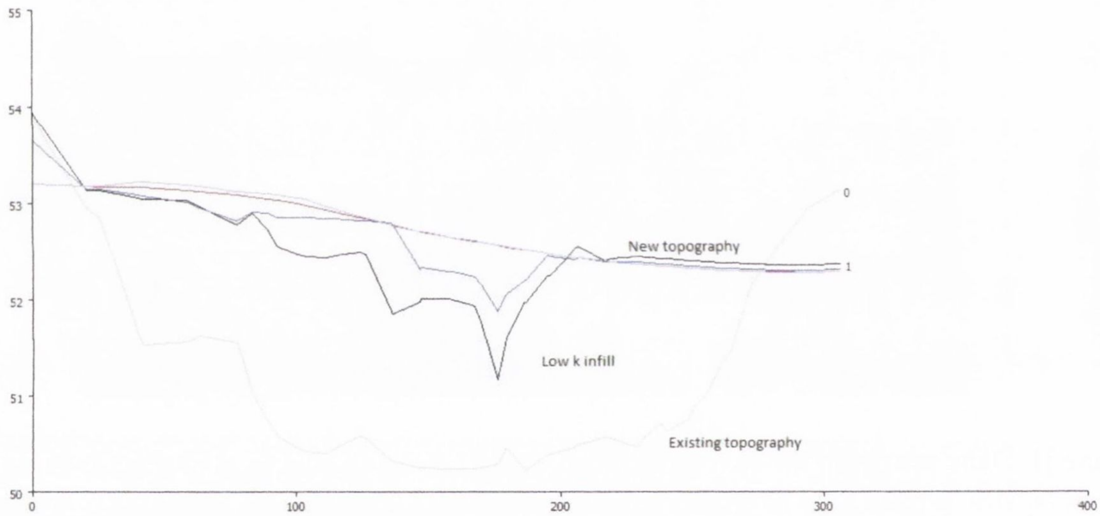


Figure j4. Cross section 3 through infill area with model potentiometric surface

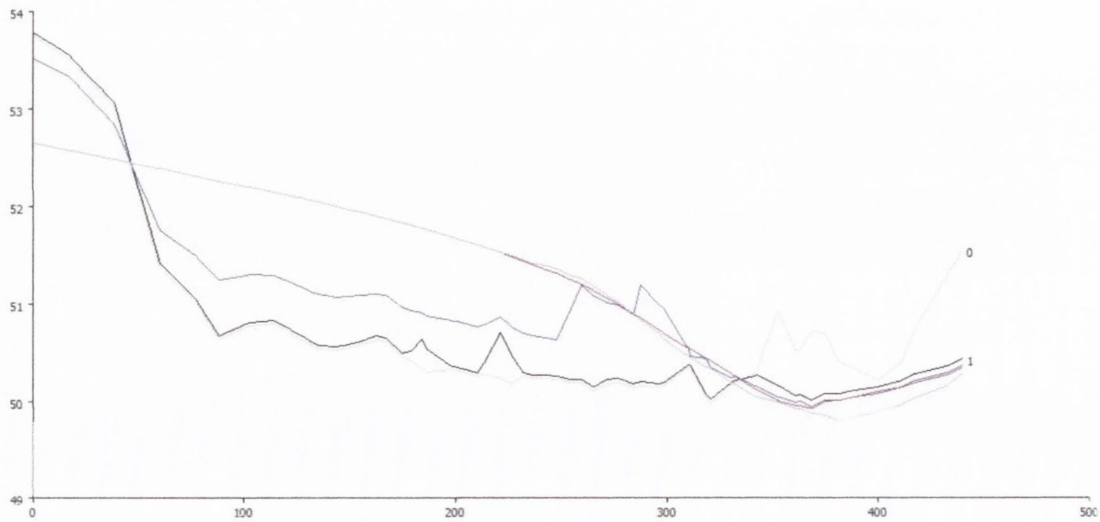


Figure j5. Cross section 4 through infill area with model potentiometric surface

Appendix J: PredictionModel Model - 2D Cross-Sections

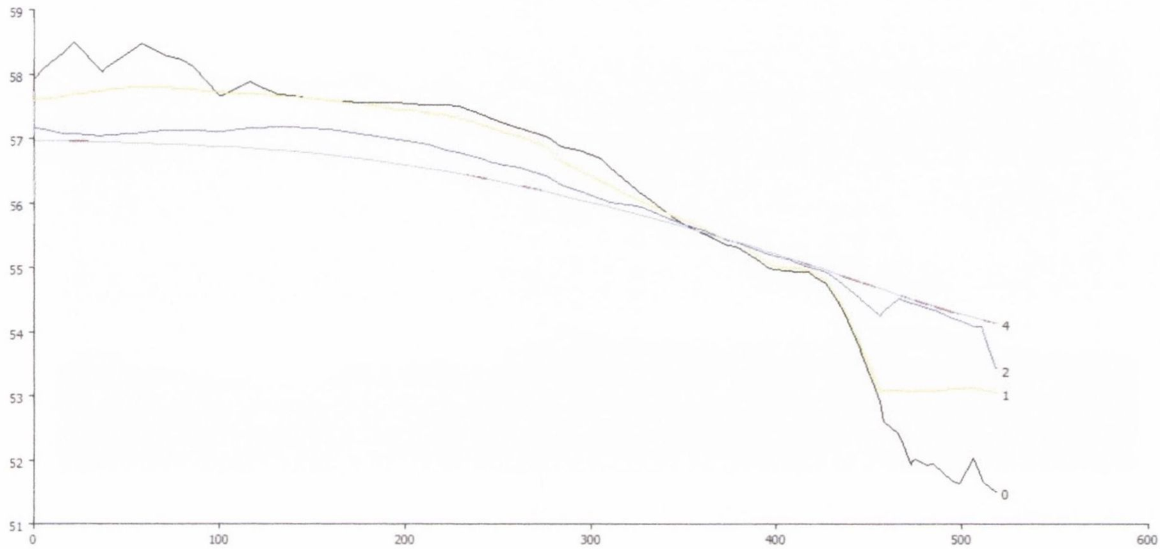


Figure J6. Topographic profile and modelled potentiometric surfaces following restoration works through flow line1

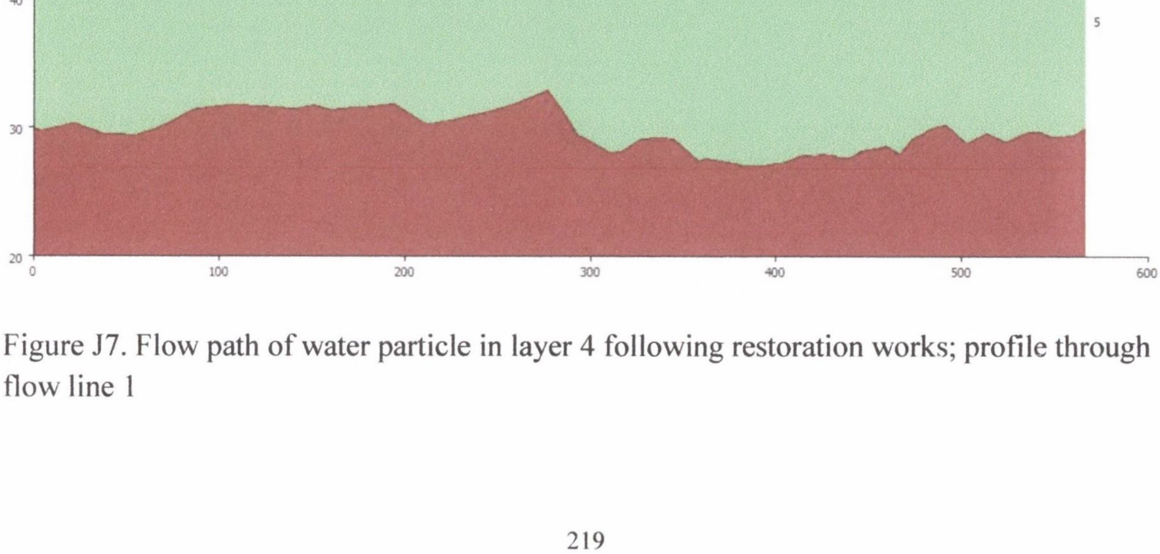


Figure J7. Flow path of water particle in layer 4 following restoration works; profile through flow line 1

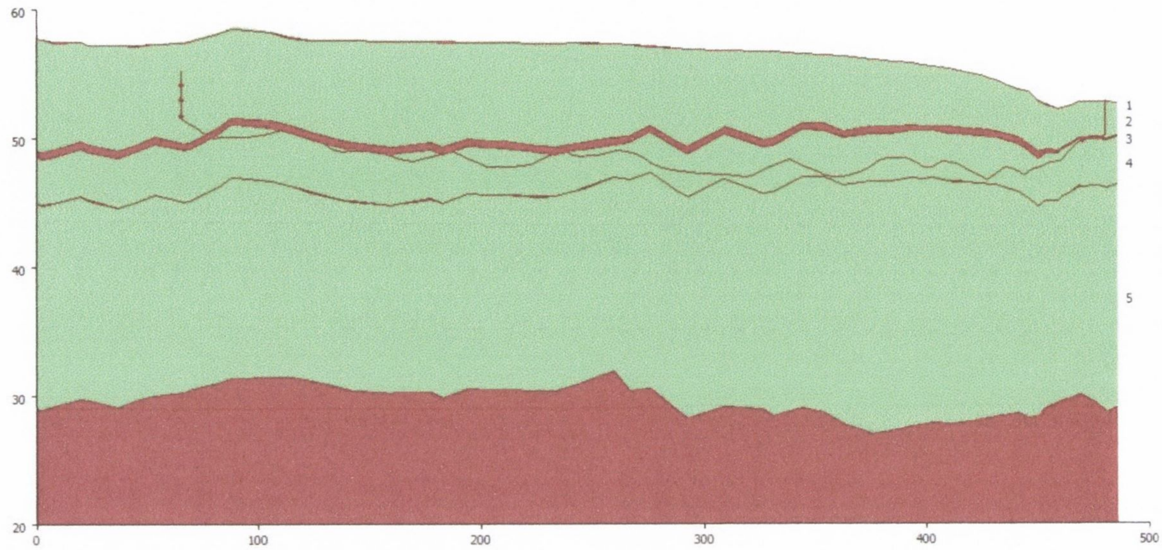


Figure J8. Flow path of water particle in layer 2 following restoration works; profile through flow line 1

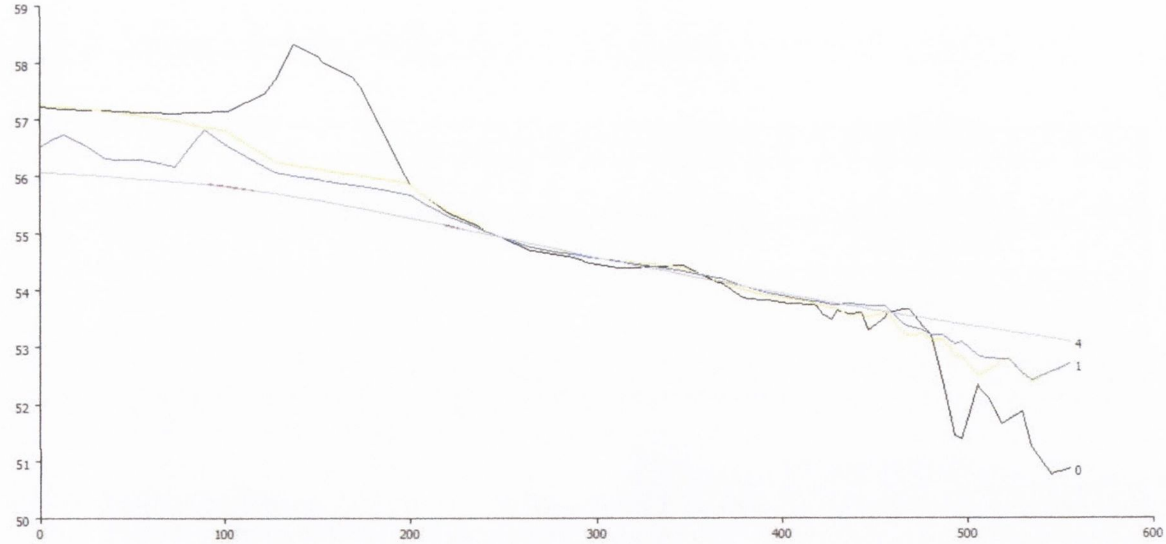


Figure J9. Topographic profile and modelled potentiometric surfaces following restoration works through flow line 2

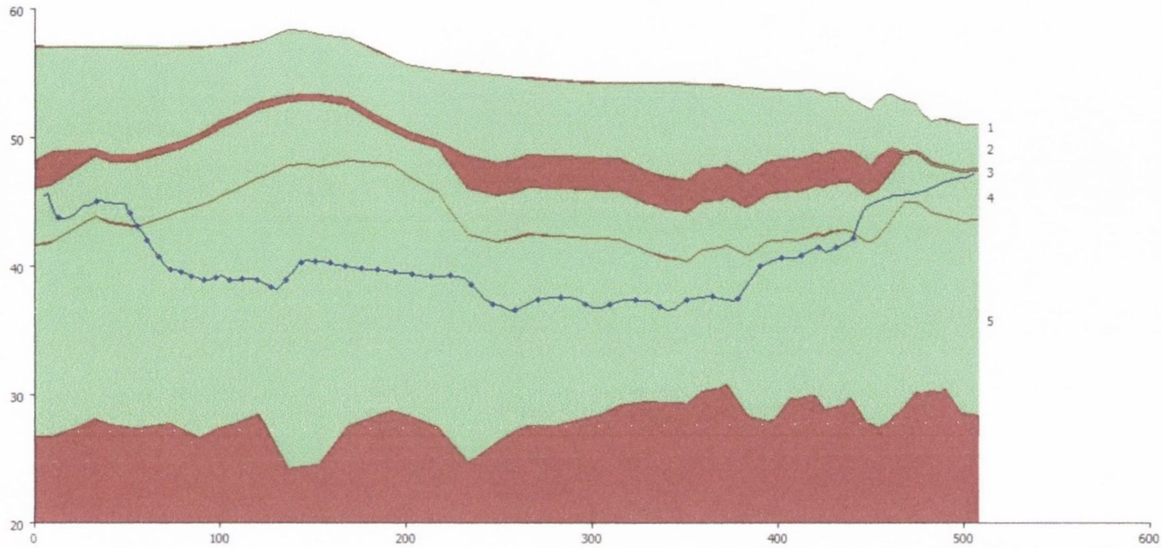


Figure J10. Flow path of water particle in layer 4 following restoration works; profile through flow line 2

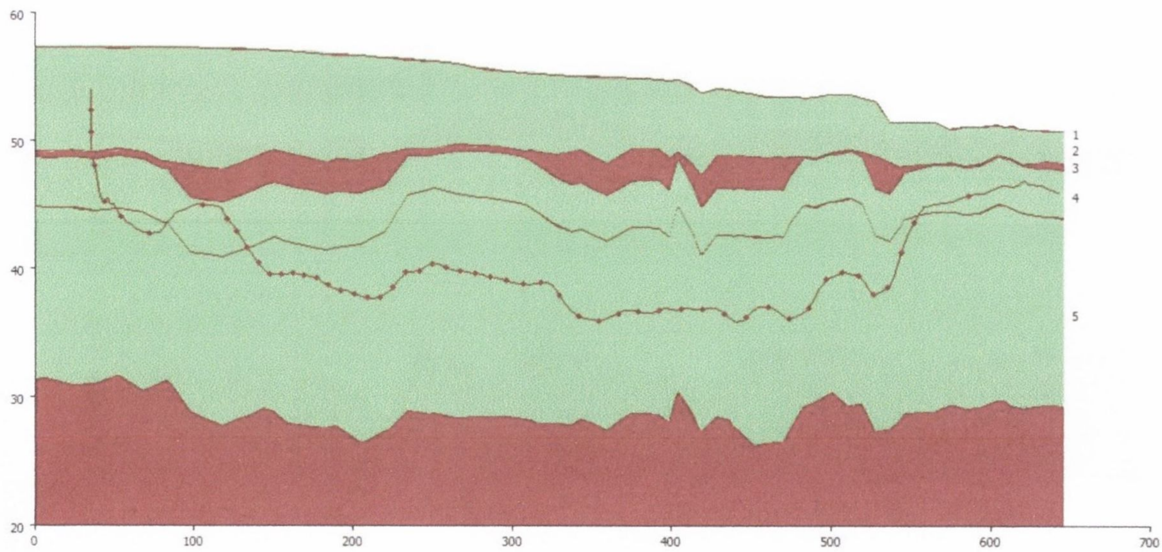


Figure J11. Flow path of water particle in layer 2 following restoration works; profile through flow line 2

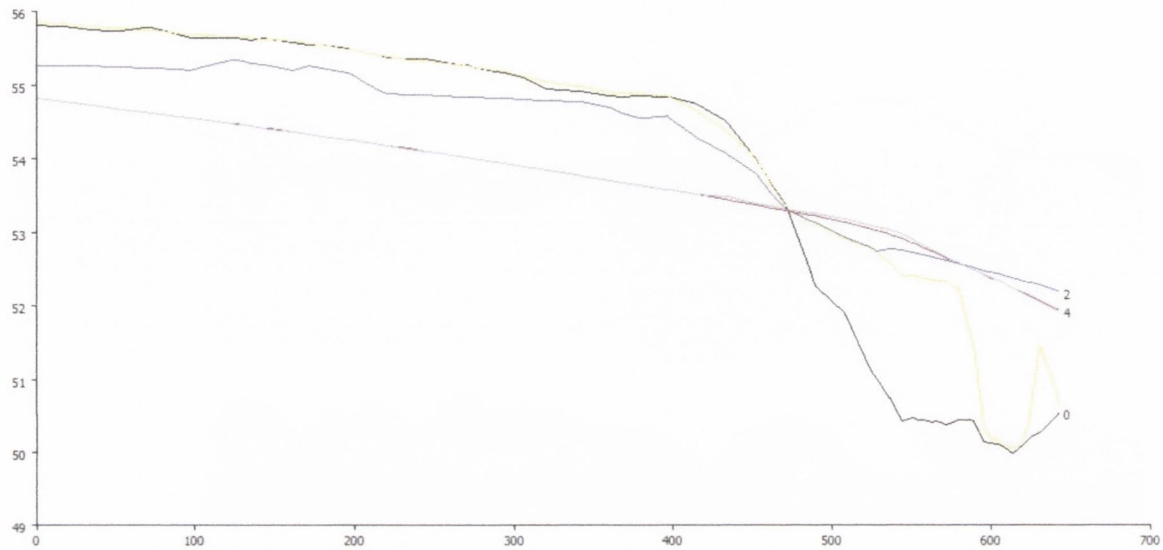


Figure J12. Topographic profile and modelled potentiometric surfaces following restoration works through flow line 3

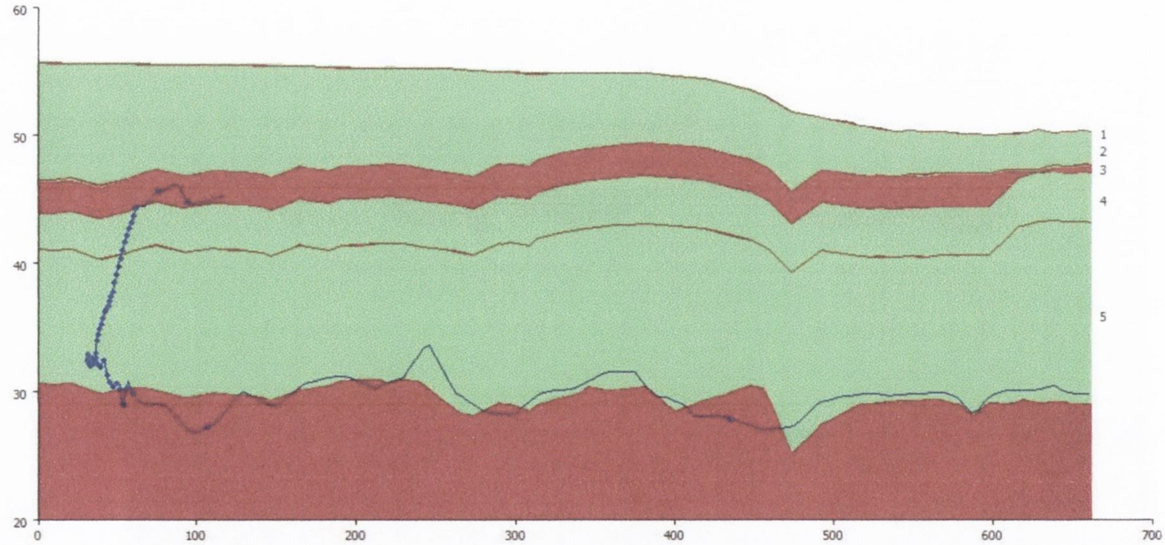


Figure J13. Flow path of water particle in layer 4 following restoration works; profile through flow line 3

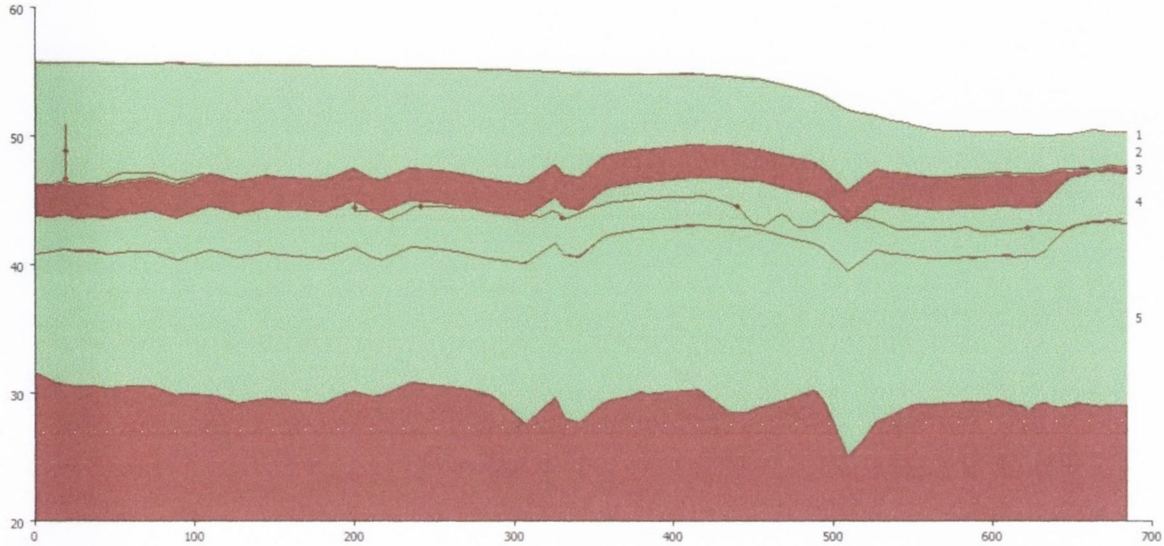


Figure J15. Flow path of water particle in layer 2 following restoration works; profile through flow line 3

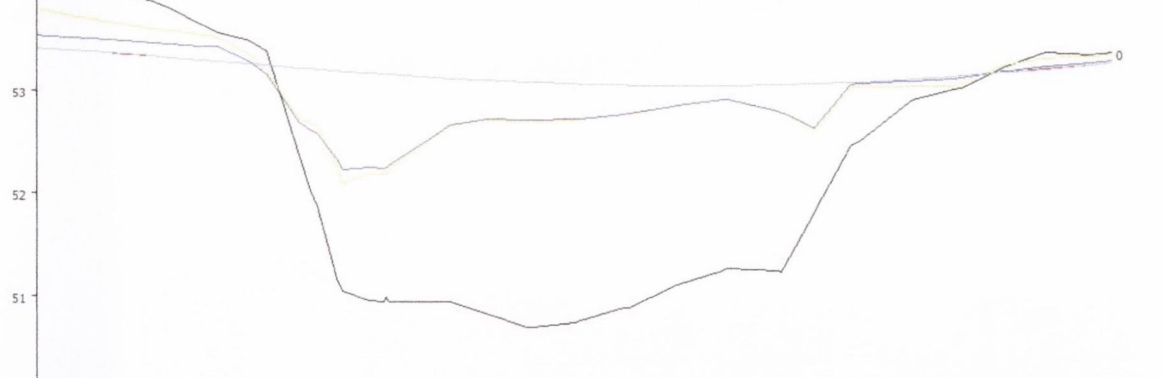


Figure J16. Topographic profile and modelled potentiometric surfaces following restoration works through flow line 4

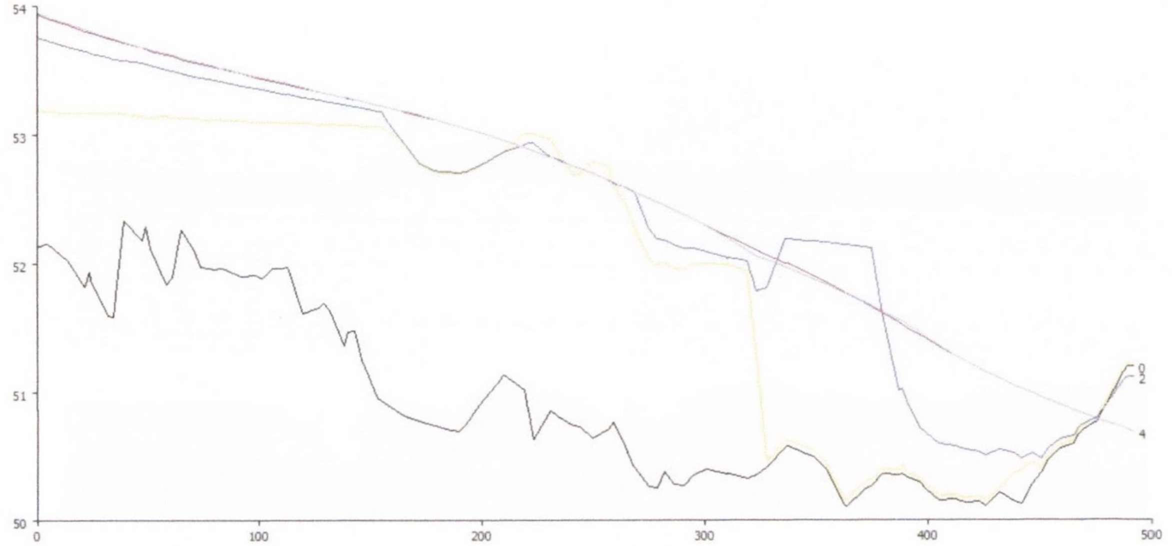


Figure J17. Topographic profile and modelled potentiometric surfaces following restoration works through flow line 5

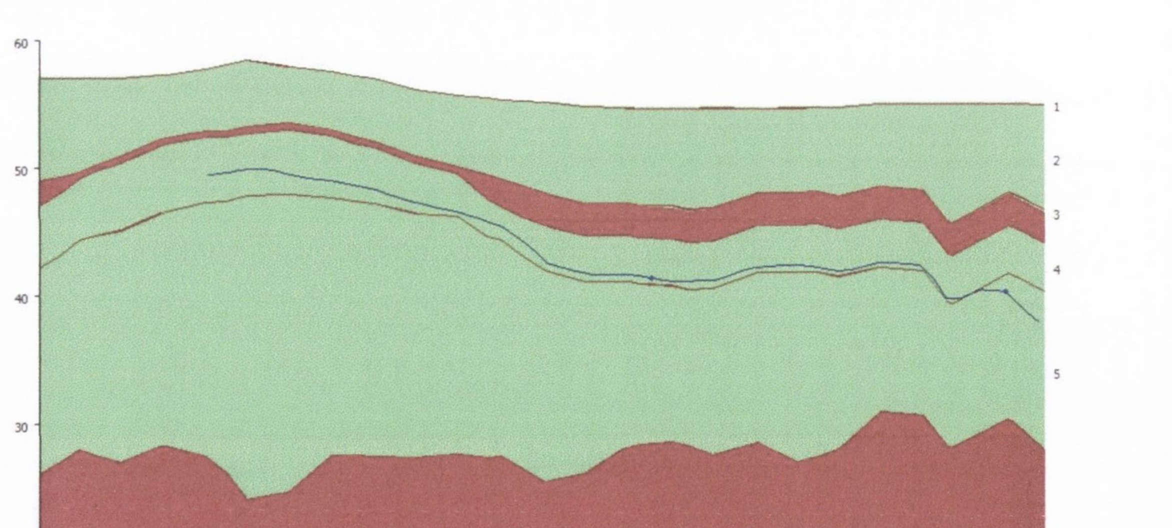


Figure J18. Flow path of water particle in layer 4 following restoration works; profile through Western Mound from West to East

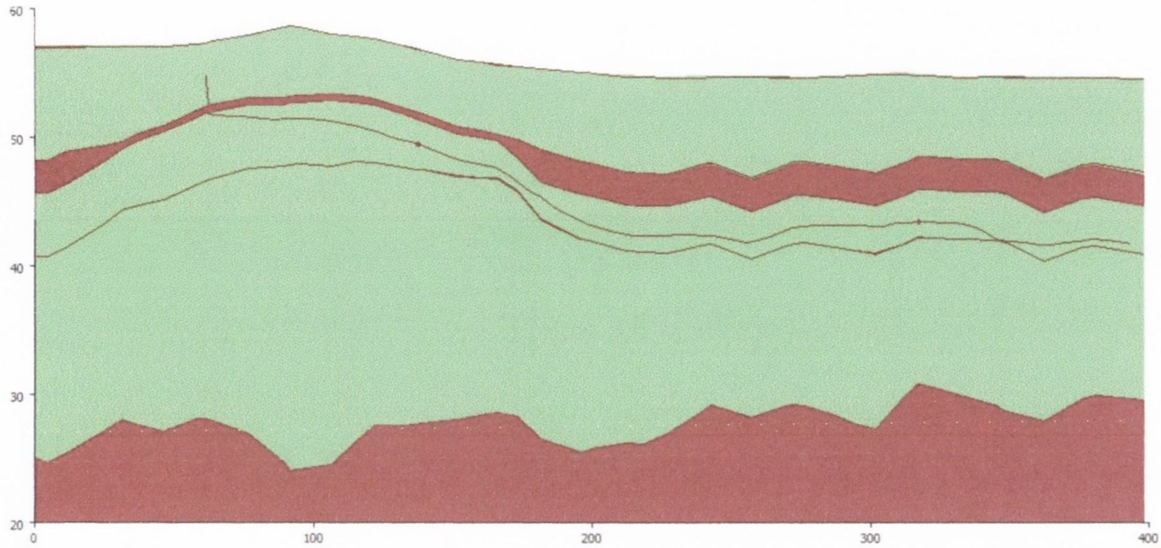


Figure J19. Flow path of water particle in layer 2 following restoration works; profile through Western Mound from West to East

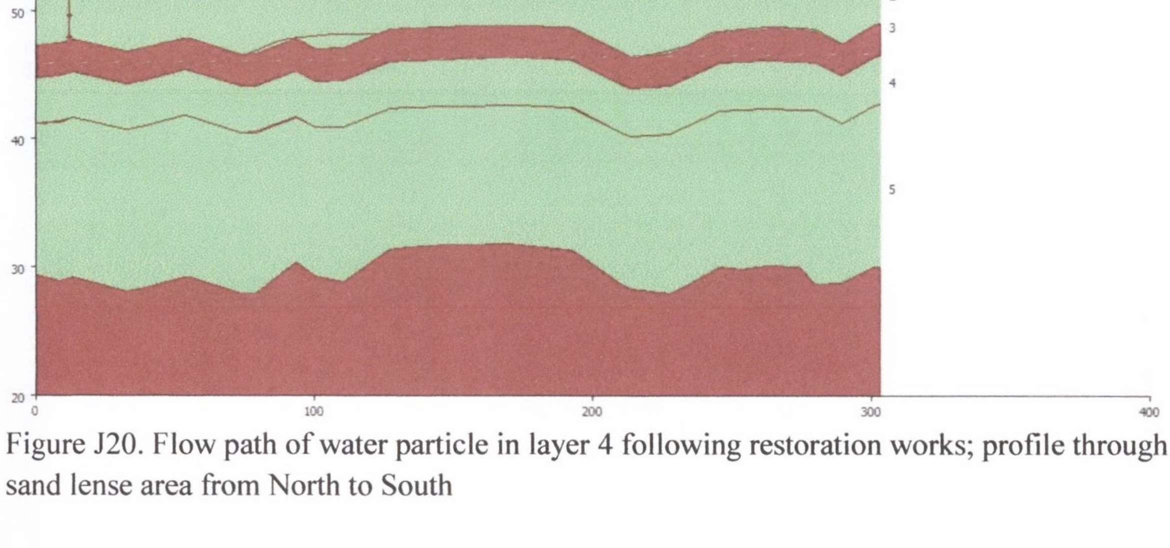


Figure J20. Flow path of water particle in layer 4 following restoration works; profile through sand lense area from North to South

Appendix J: Prediction Model - 3D Cross-Sections

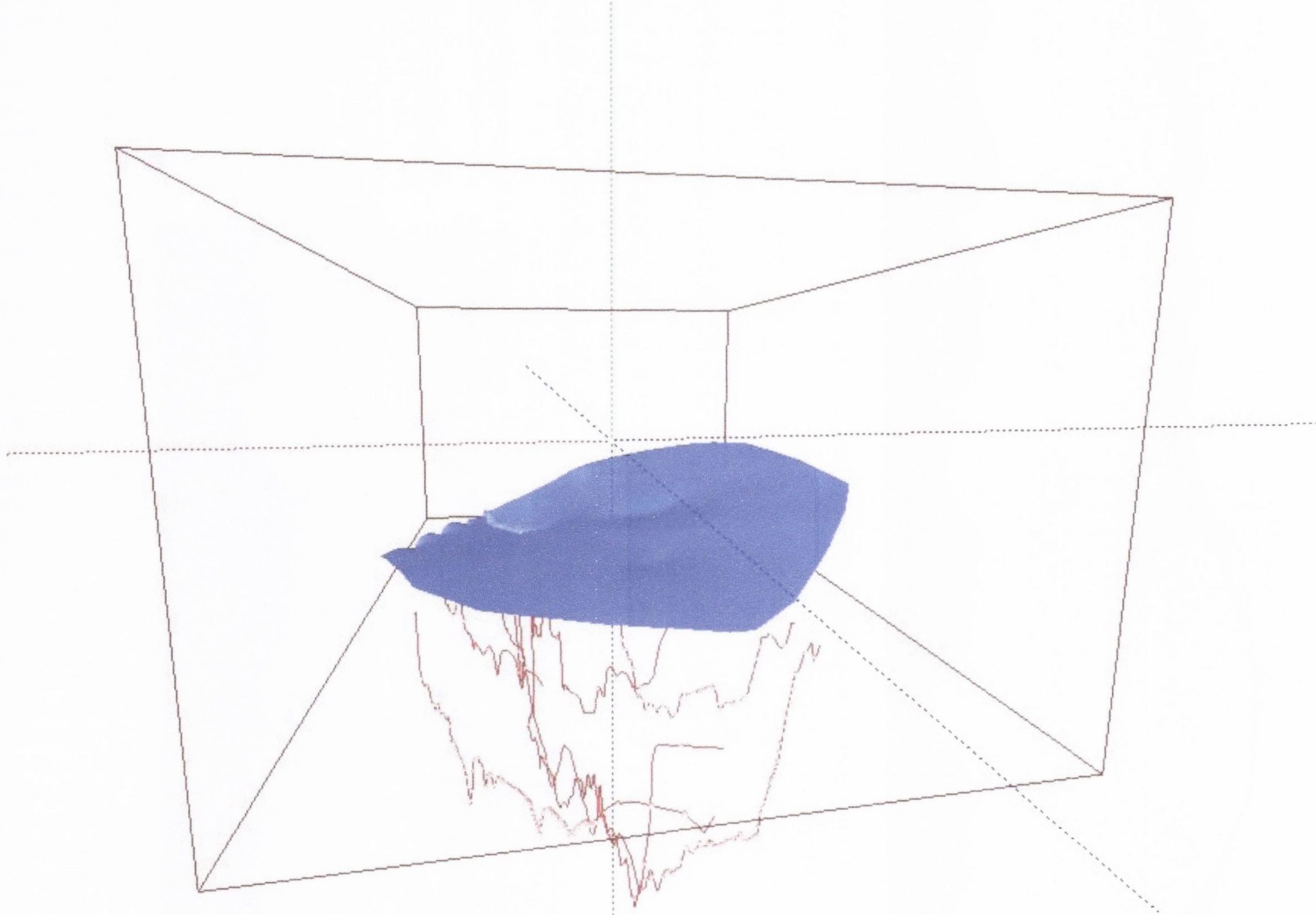


Figure J21. 3D image of layer 4 potentiometric surface following restoration works – view looking southwards

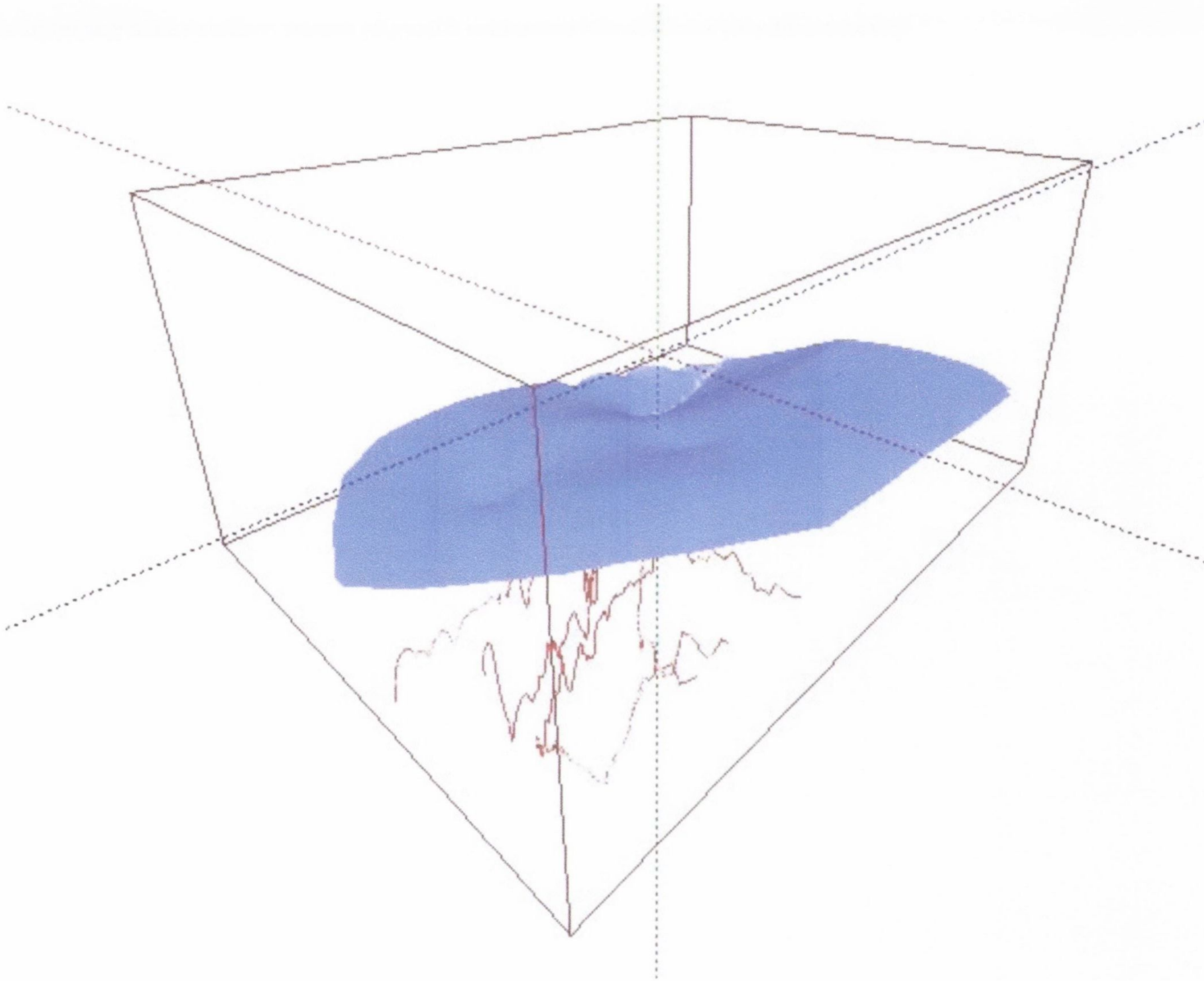


Figure J22. 3D image of layer 4 potentiometric surface following restoration works – view looking southeast

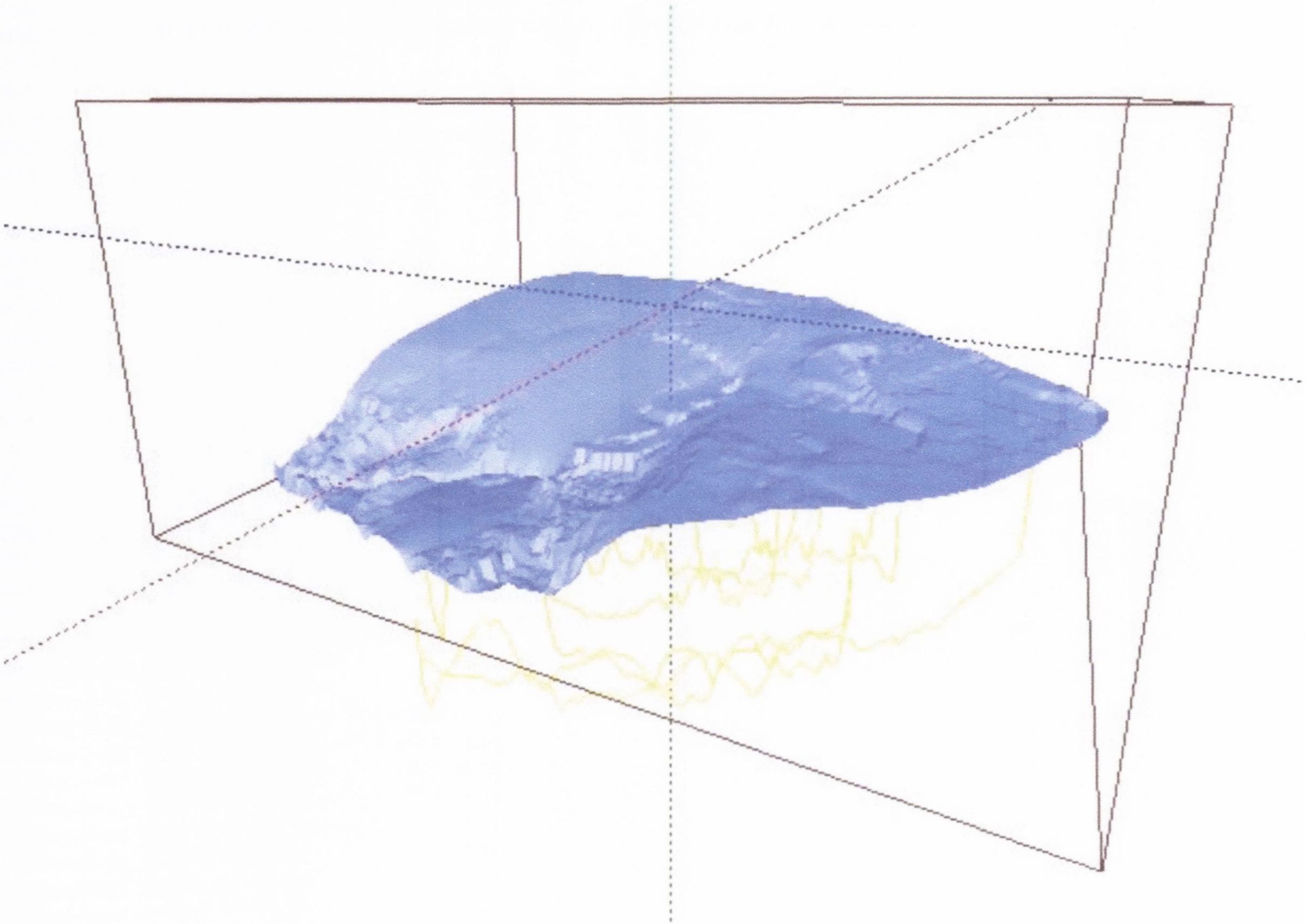


Figure J23. 3D image of layer 2 potentiometric surface following restoration works – view looking westwards

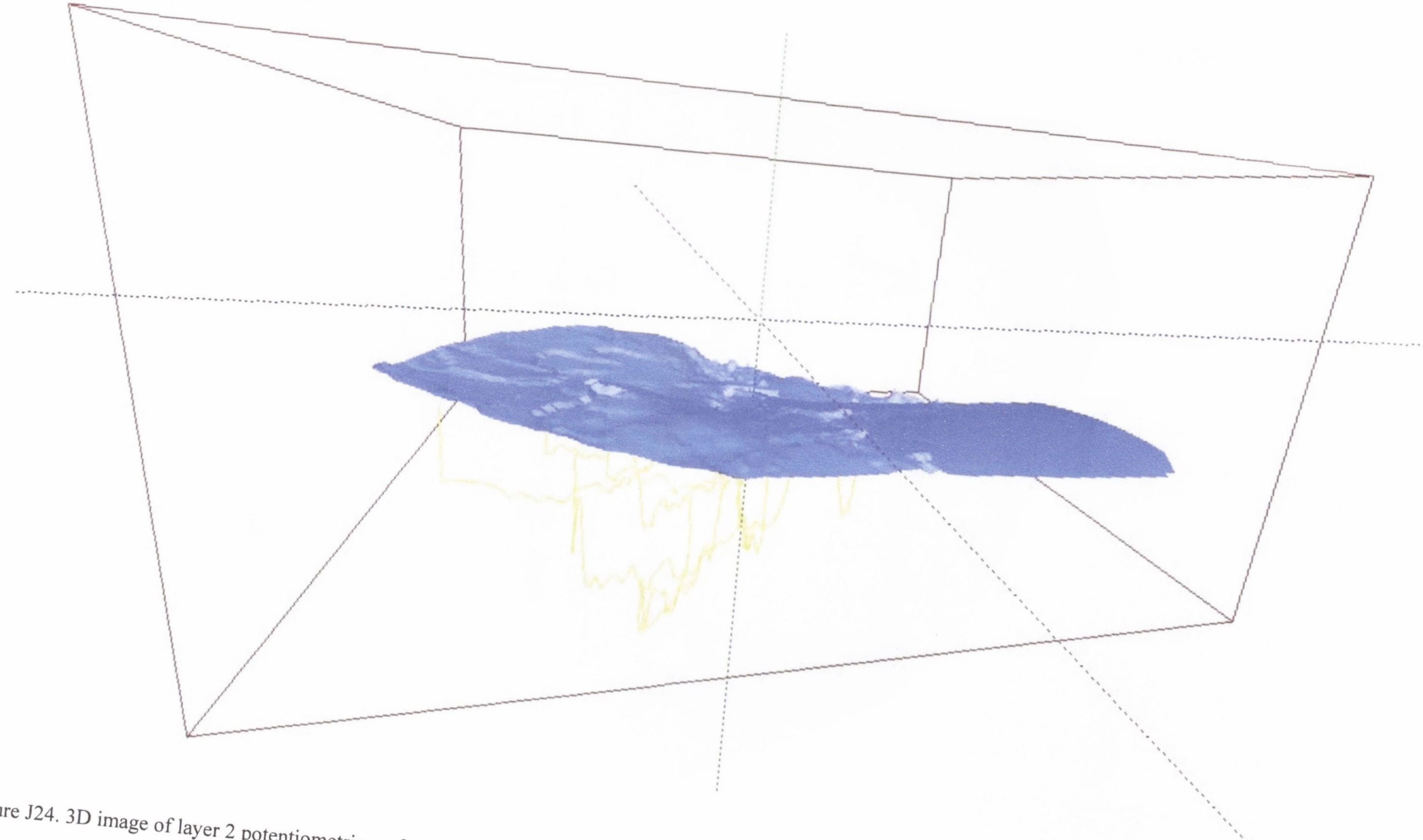


Figure J24. 3D image of layer 2 potentiometric surface following restoration works – view looking southeast

Appendix J: Prediction Model – alternative management scenarios

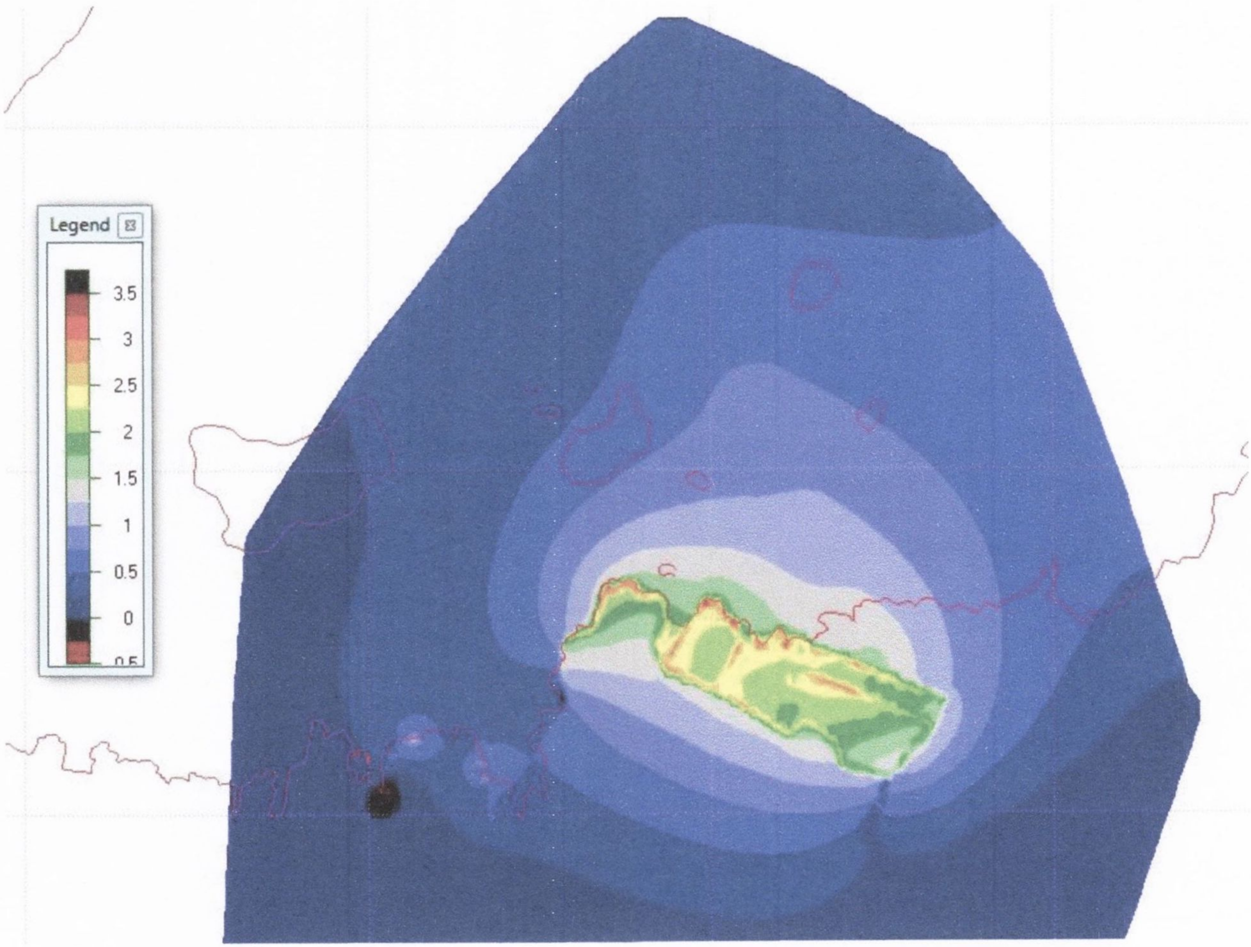


Figure J25. Rise of potentiometric surface in layer 4 following blocking of marginal drains.

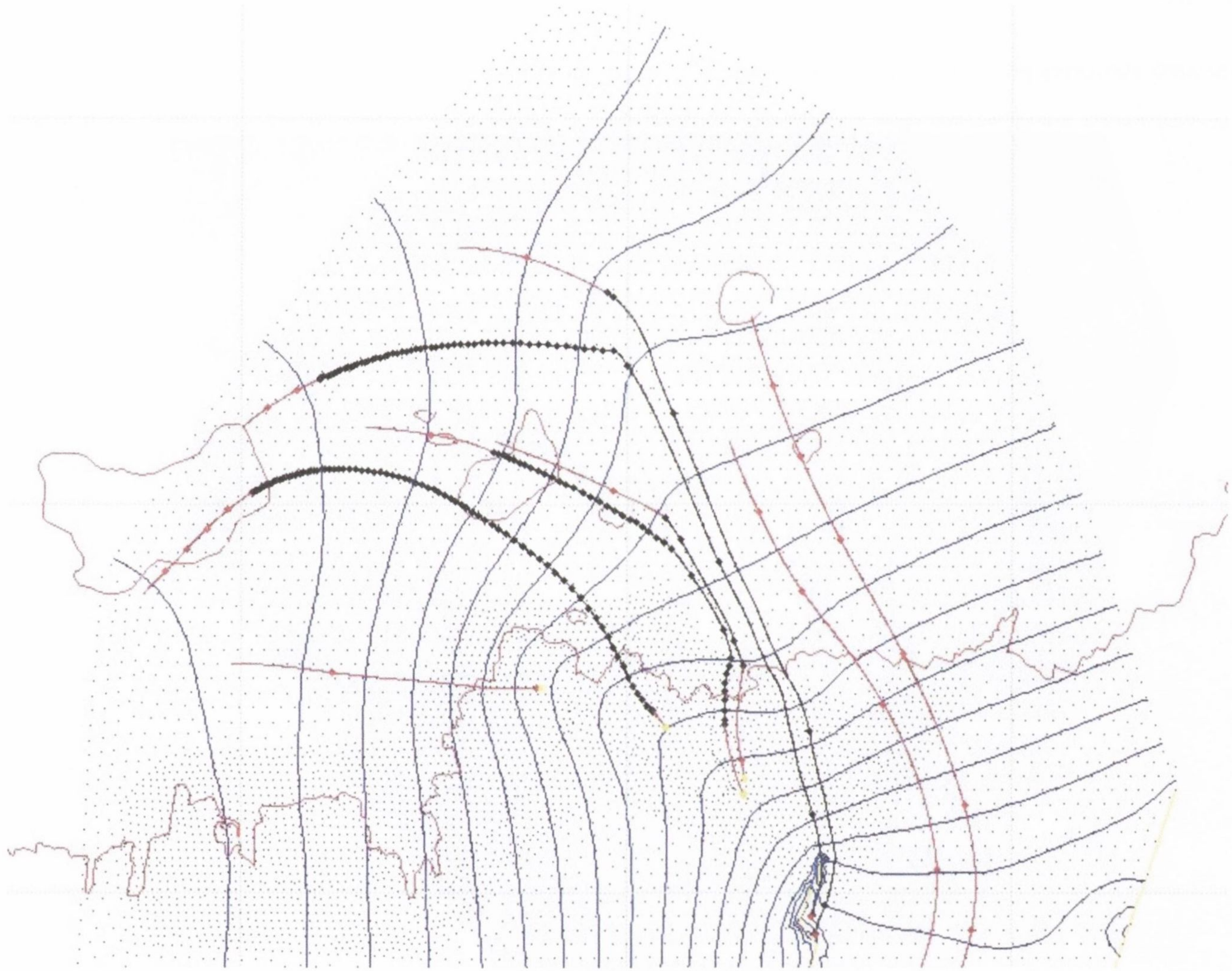


Figure J26. Potentiometric surface and flow lines in layer 4 following blocking of marginal drains. Note: red flow line indicates quick transport rate of water particle and yellow line is fixed-head boundary applied to Brook Stream and Bog Road Drain

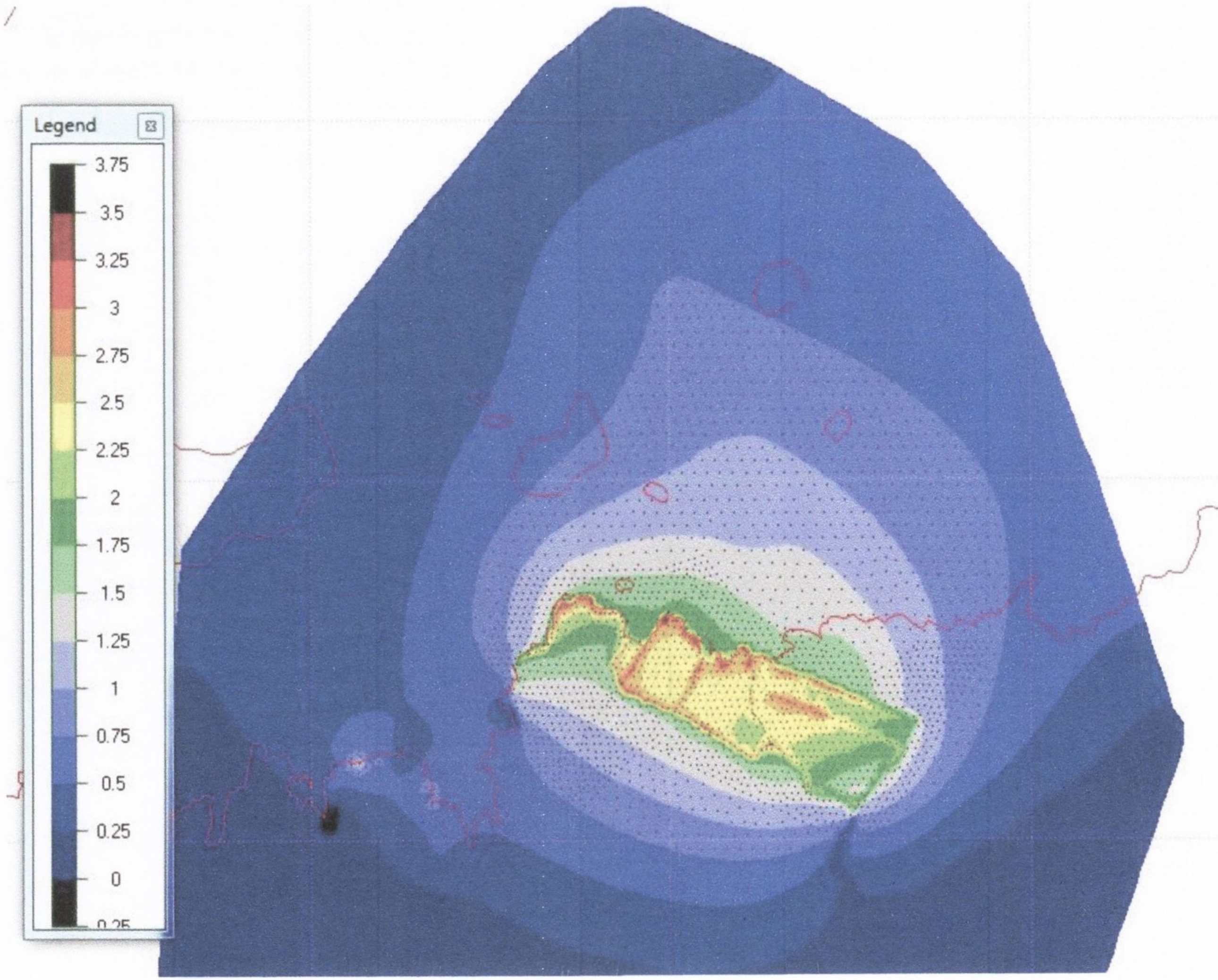


Figure J27 Rise of potentiometric surface in layer 4 following blocking of marginal drains and installation of facebank dam and dam in restoration area

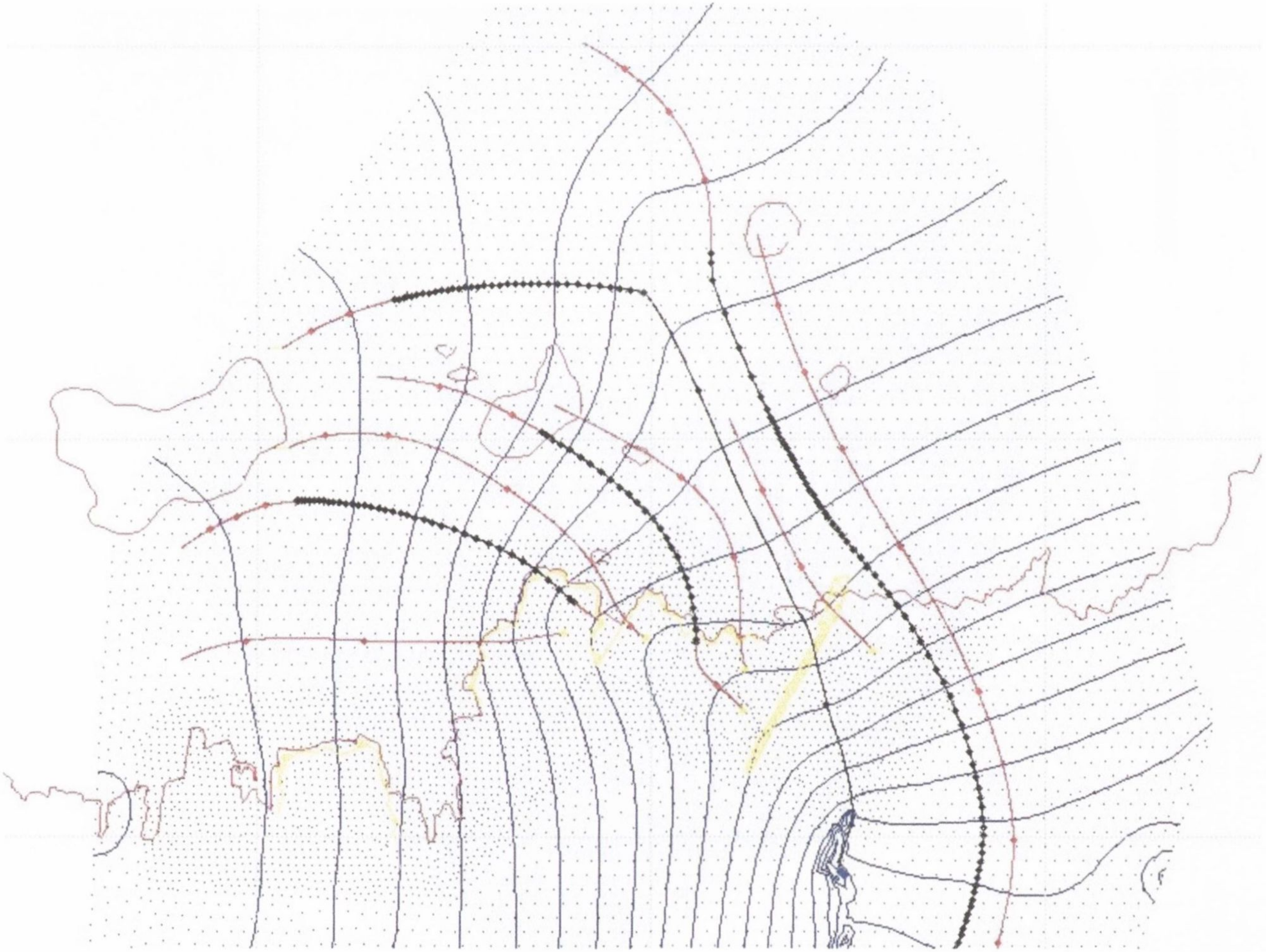


Figure J28 Potentiometric surface and flow lines in layer 4 following blocking of installation of dams. Note: red flow line indicates quick transport rate of water particle and yellow line is dam location.

Appendix J: Prediction Model – rise in groundwater table

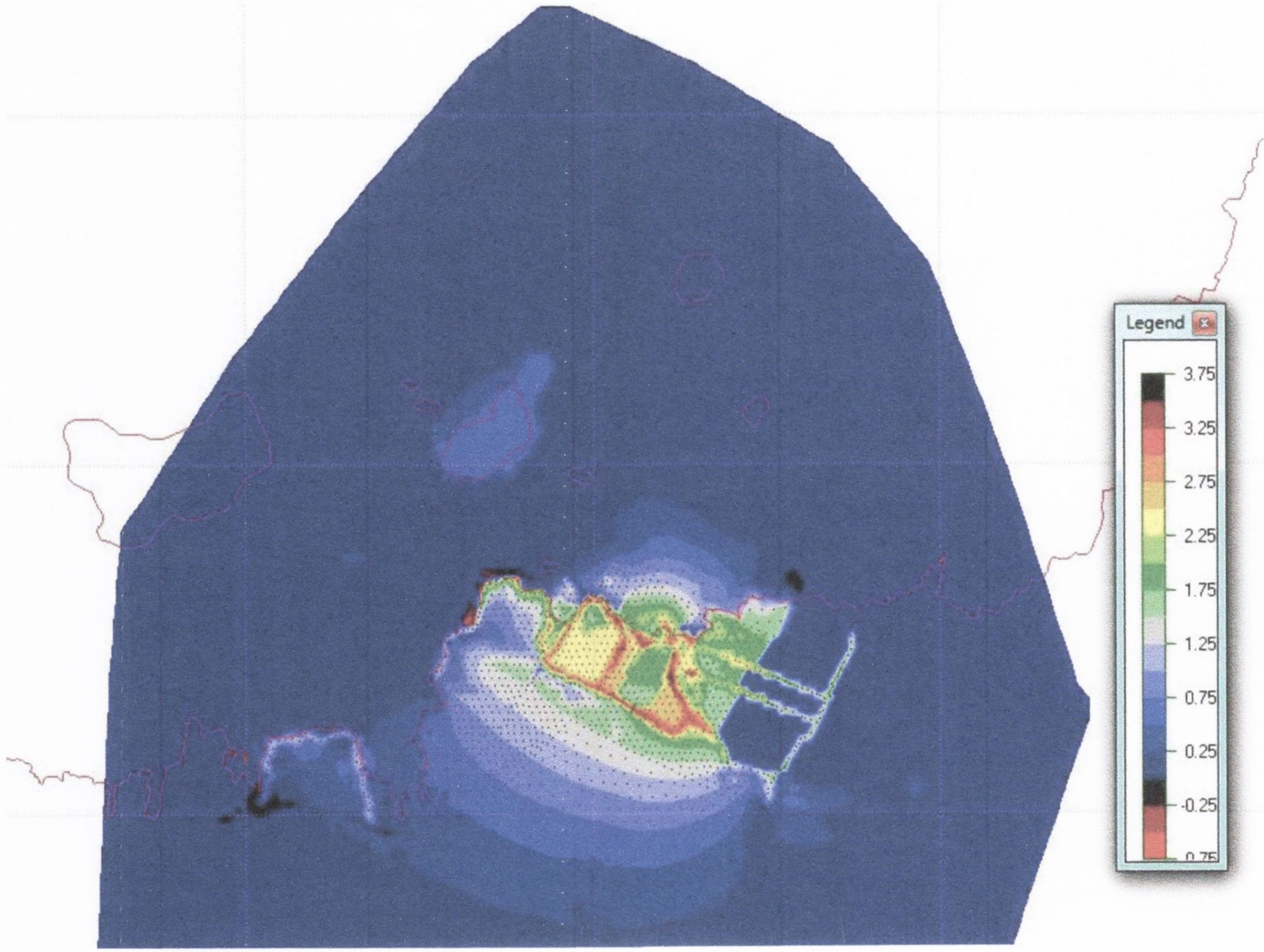


Figure J29. Rise in potentiometric surface contours in layer 1 (acotelm aquifer) following restoration works. Contour interval is 0.25 m.

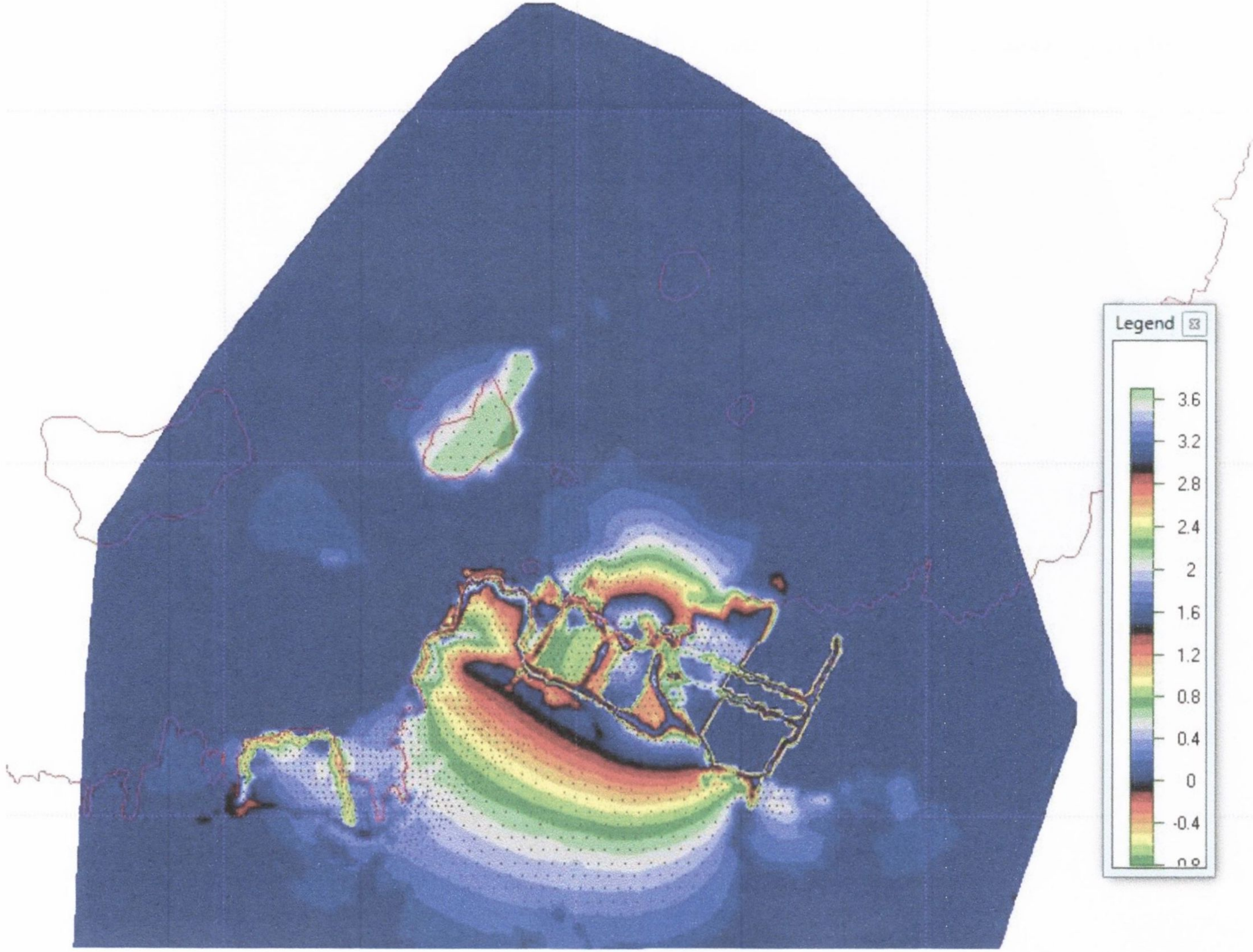


Figure J30. Rise in potentiometric surface contours in layer 2 (acrotelm aquifer) following restoration works. Contour interval is 0.1 m.

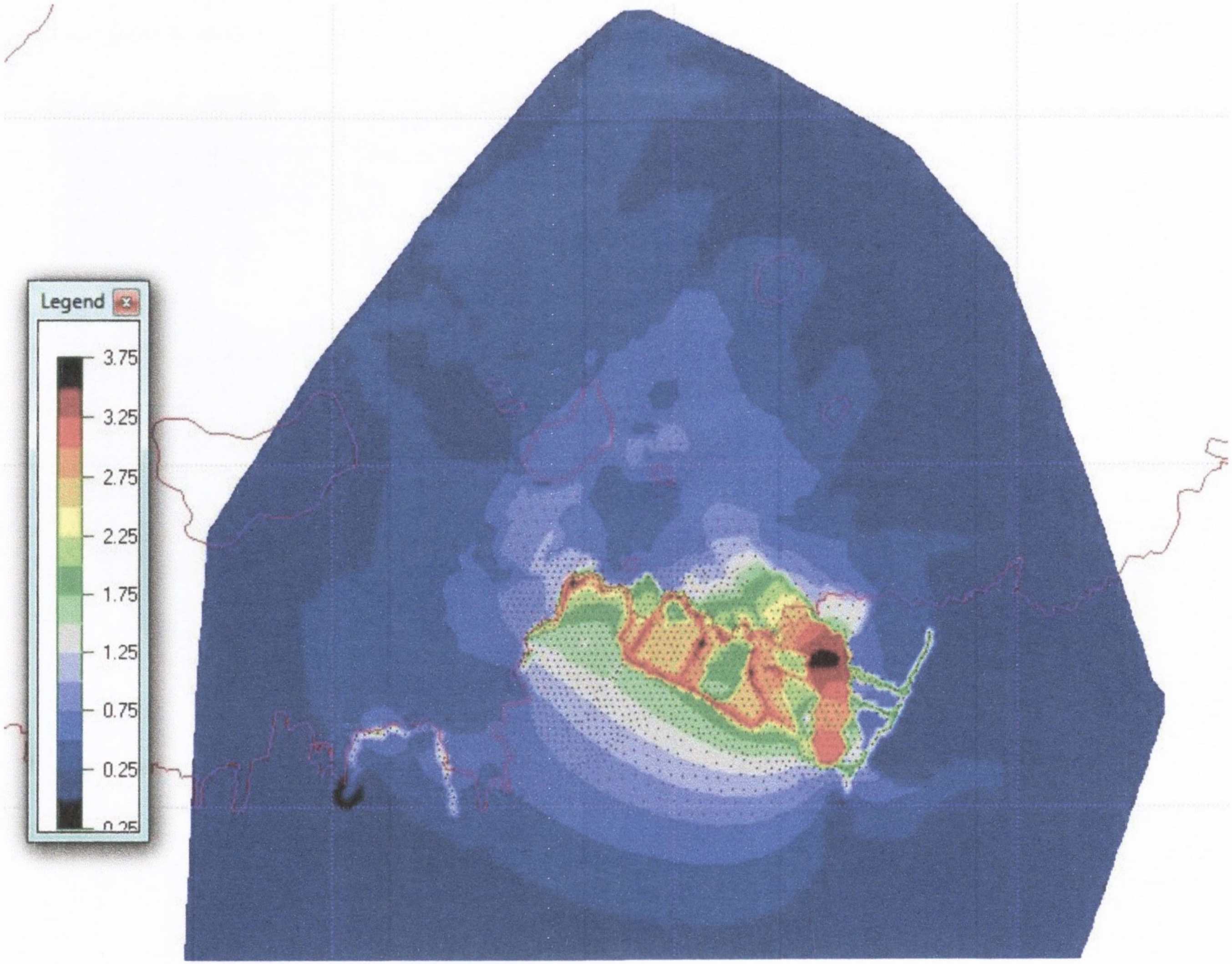


Figure J31. Rise in potentiometric contours in layer 2 (peat aquifer) following restoration works. Contour interval is 0.5 m.

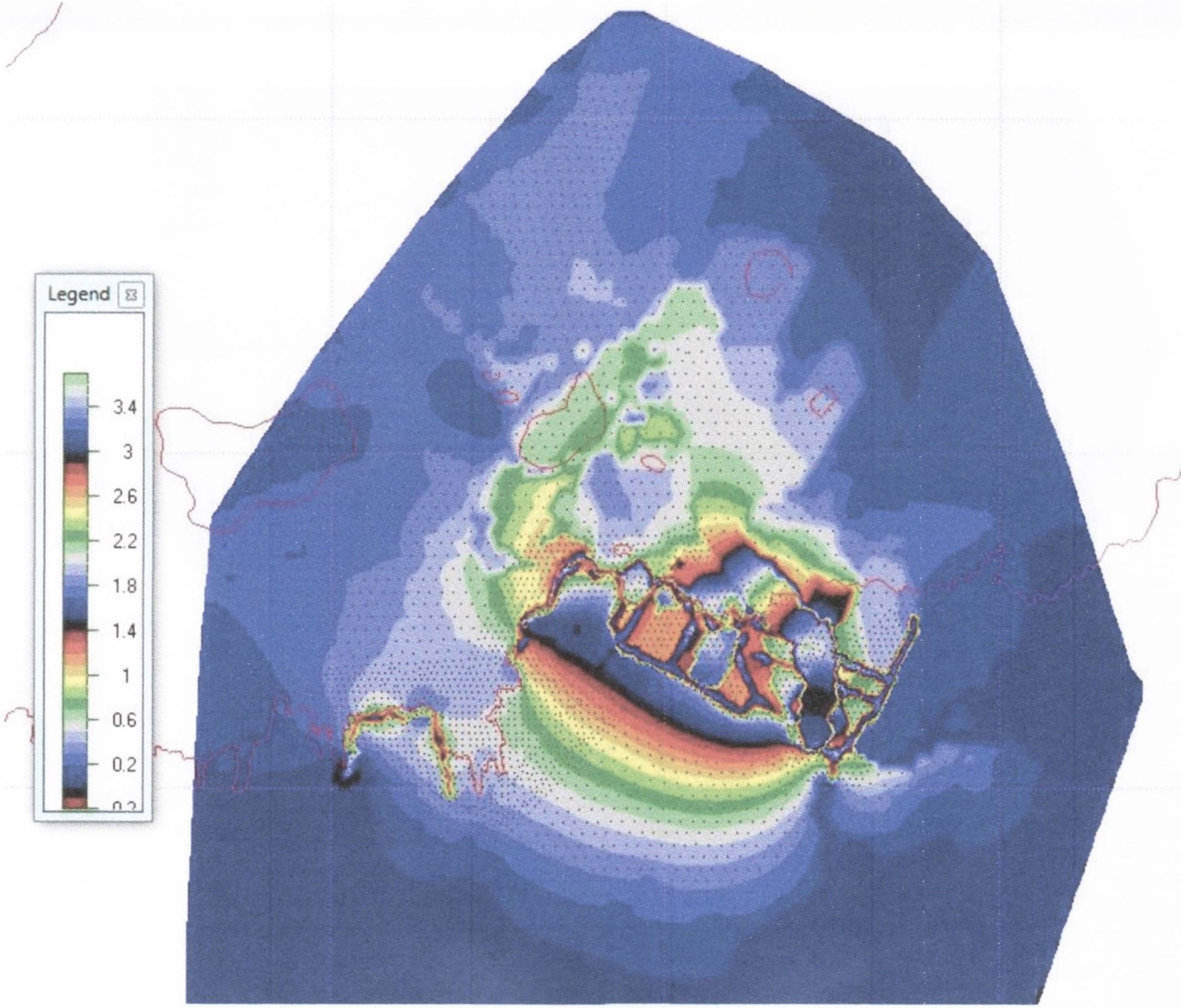


Figure J32. Rise in potentiometric surface contours in layer 2 (peat aquifer) following restoration works. Contour interval is 0.25 m.

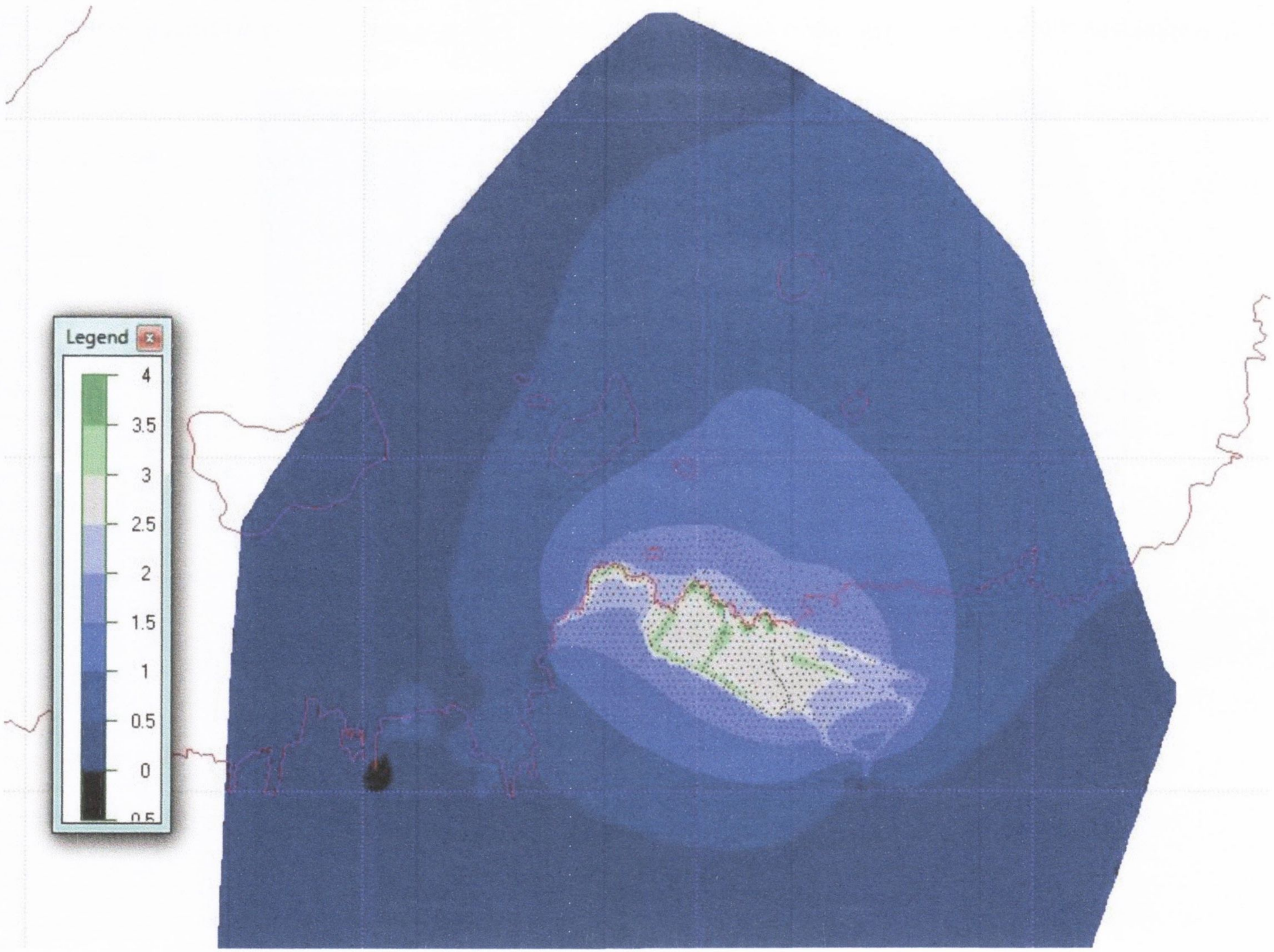


Figure J33. Rise in potentiometric surface contours in layer 4 (till aquifer) following restoration works. Contour interval is 0.5 m.

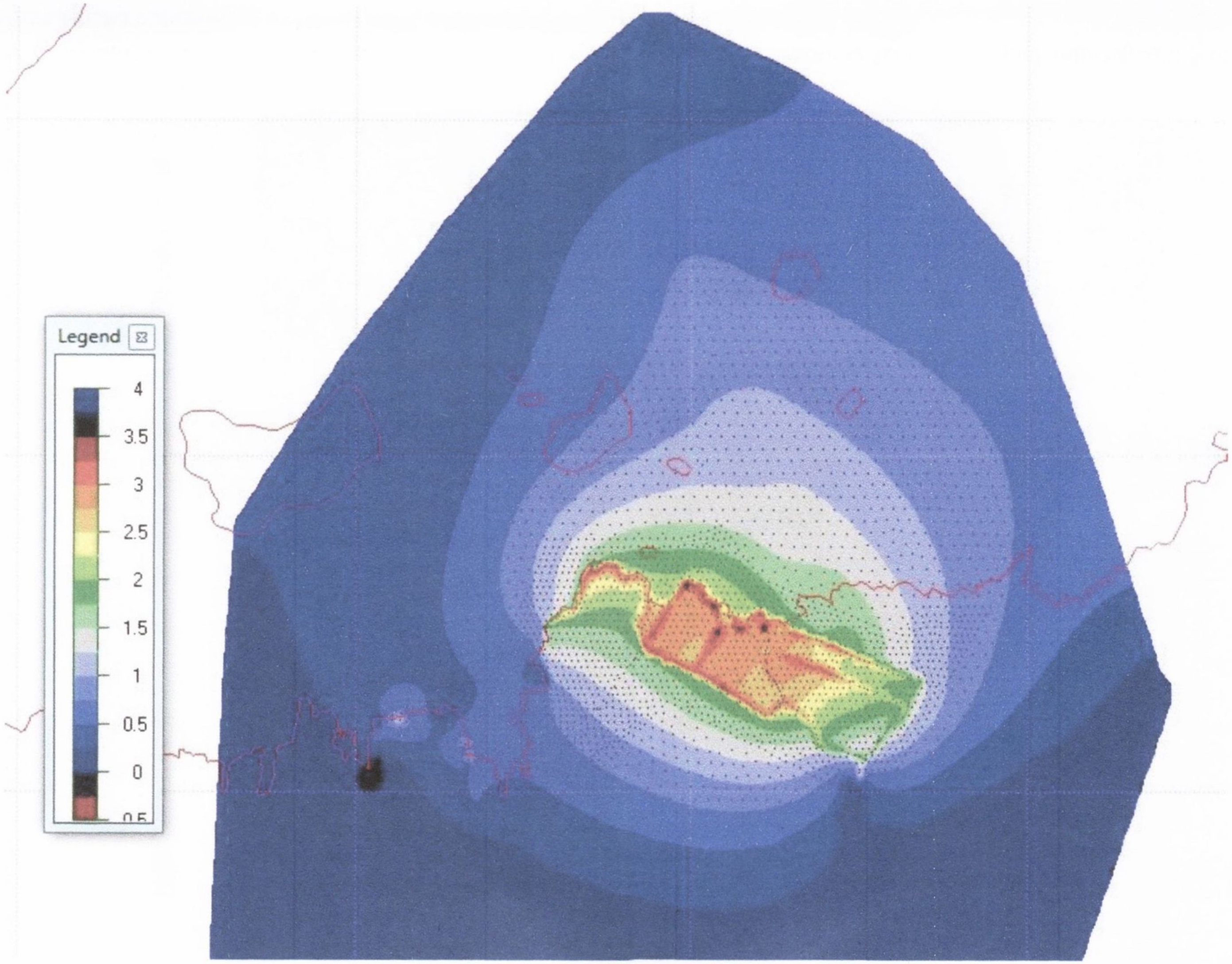


Figure J34. Rise in potentiometric surface contours in layer 4 (till aquifer) following restoration works. Contour interval is 0.25 m.

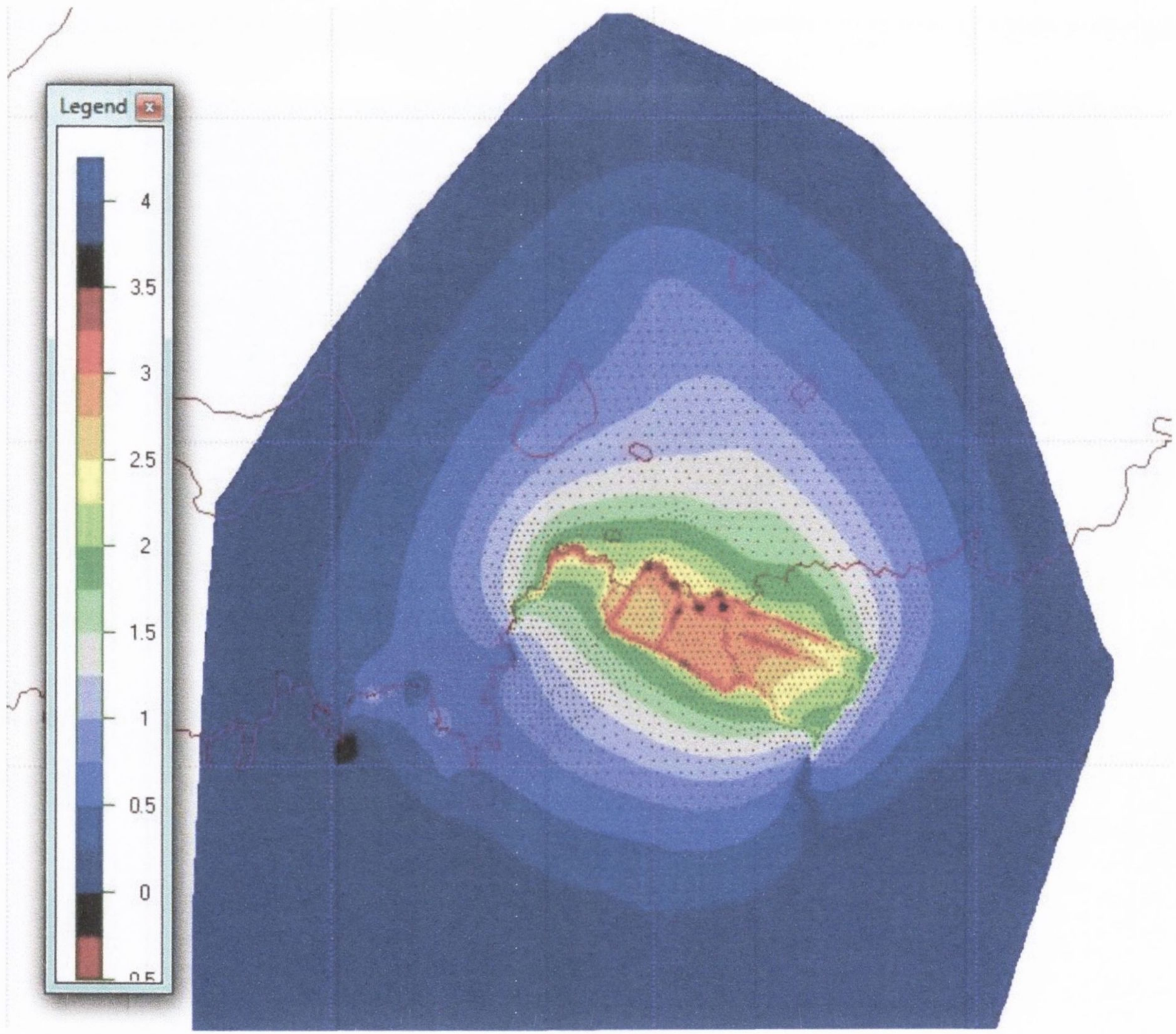


Figure J35. Rise in potentiometric surface contours in layer 4 (till aquifer) following restoration works. Contour interval is 0.5 m. Model boundaries set to fixed-head conditions.

Appendix J: Prediction Model – layer 2 and layer 4 potentiometric surface maps

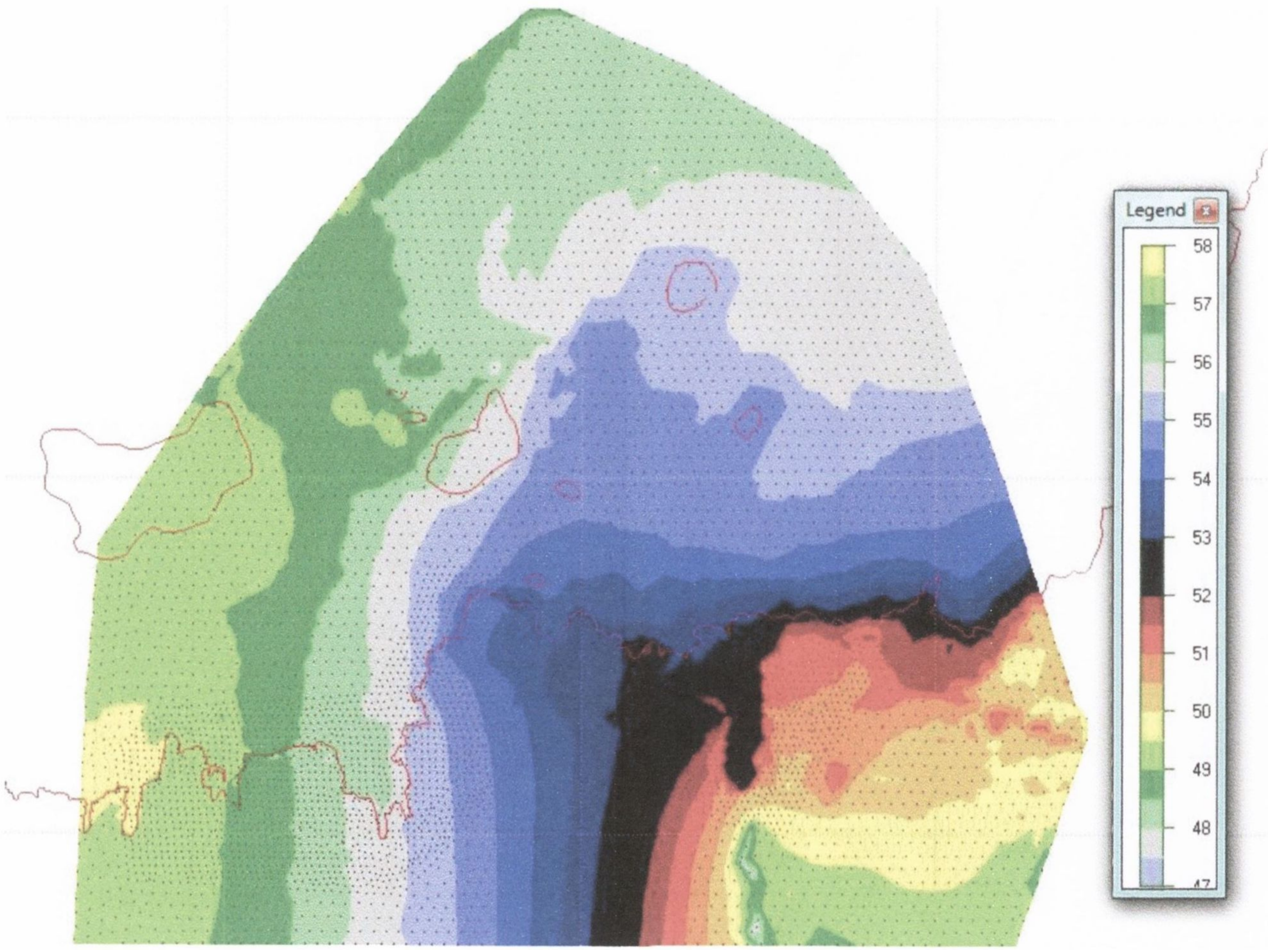


Figure J36. Potentiometric surface contours in layer 2 (peat aquifer) following restoration works. Contour interval is 0.5 m.

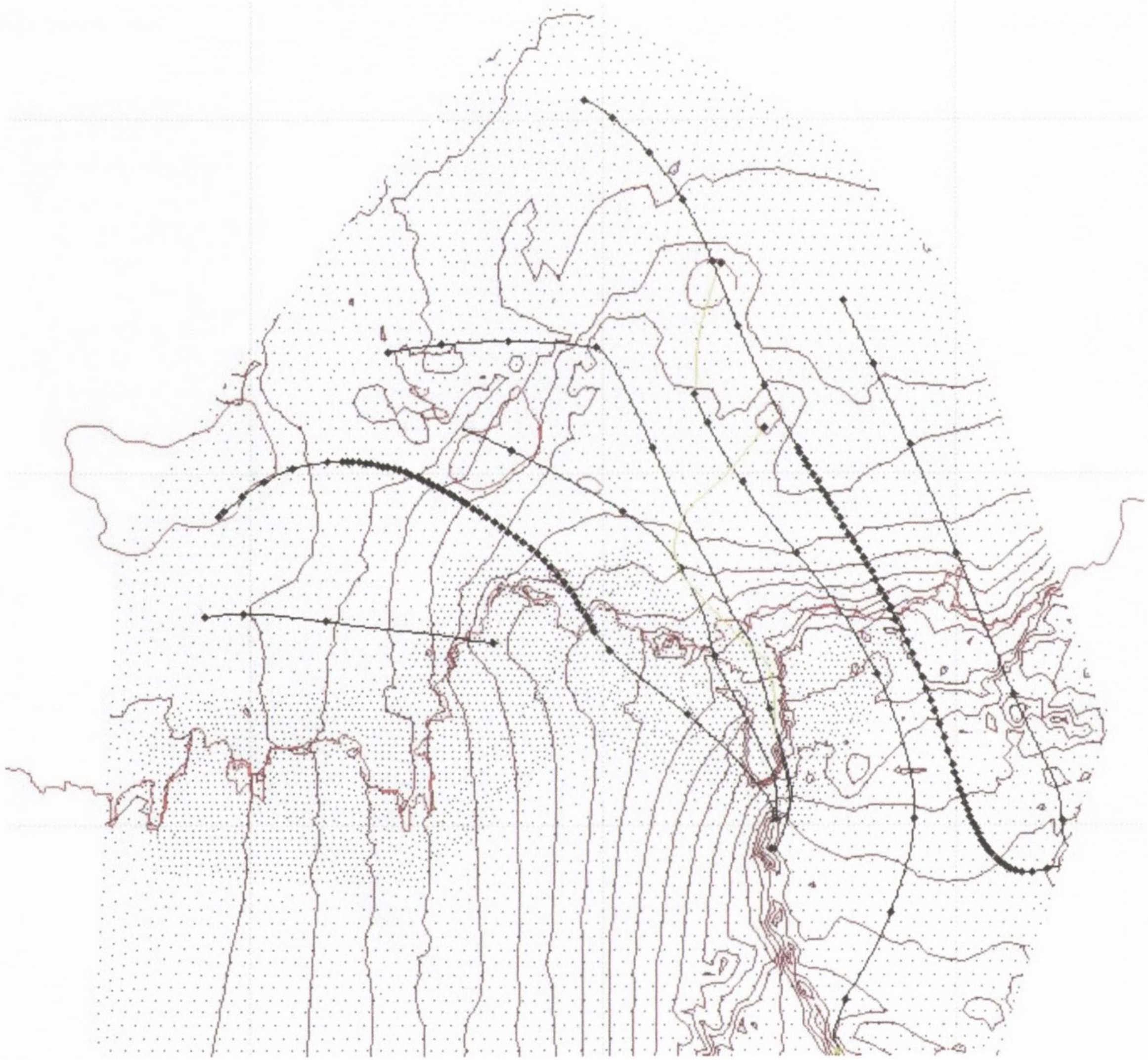


Figure J37. Potentiometric surface and flow lines in layer 2 (peat aquifer) following restoration works. Contours are at 0.5 m intervals.

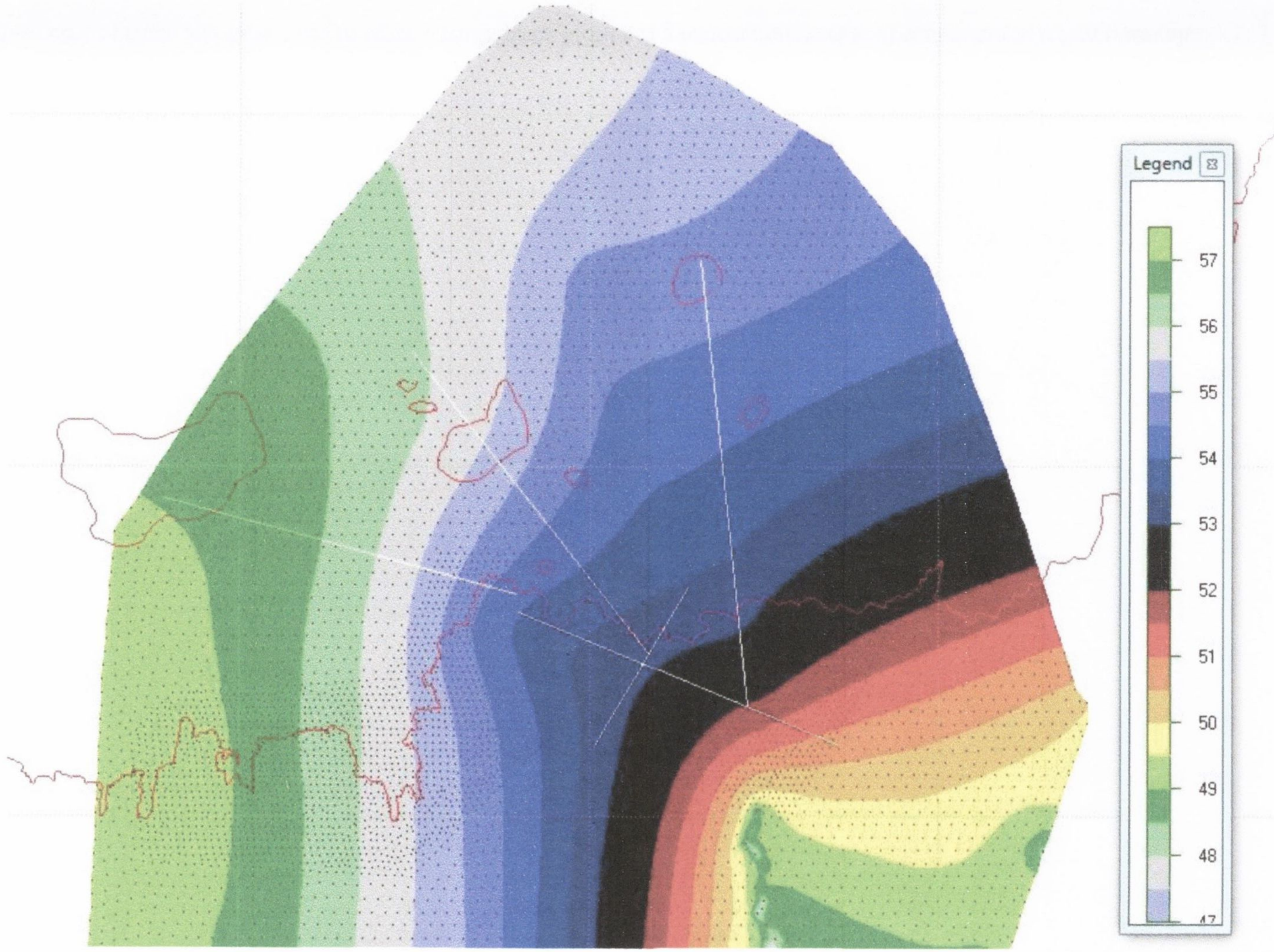


Figure J38. Potentiometric surface contours in layer 4 (till aquifer) following restoration works. Contour interval is 0.5 m. White lines are flow line locations.

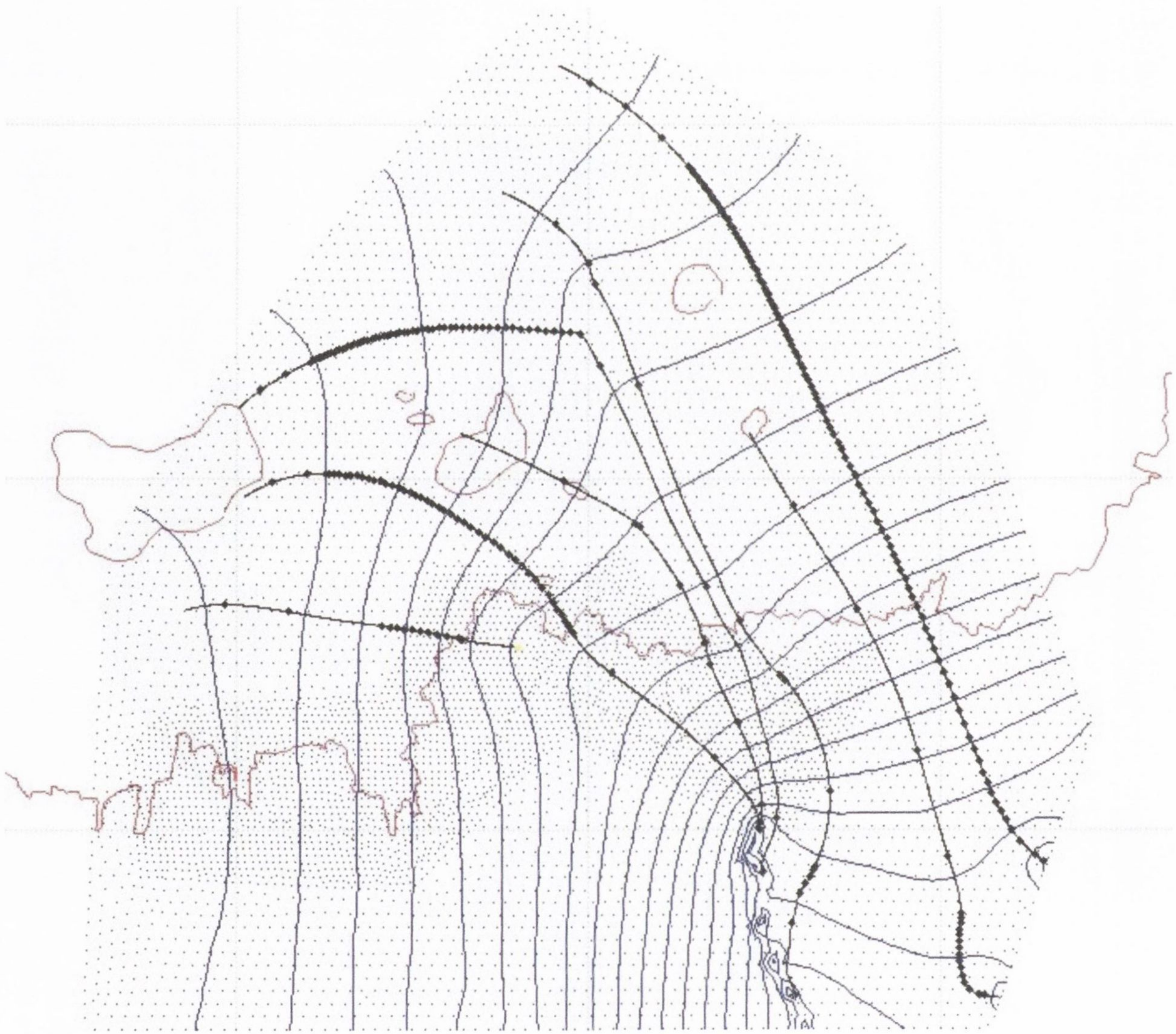


Figure J39. Potentiometric surface and flow lines in layer 4 (till aquifer) following restoration works. Contours are at 0.5 m intervals.

Appendix J: Prediction Model - timelines

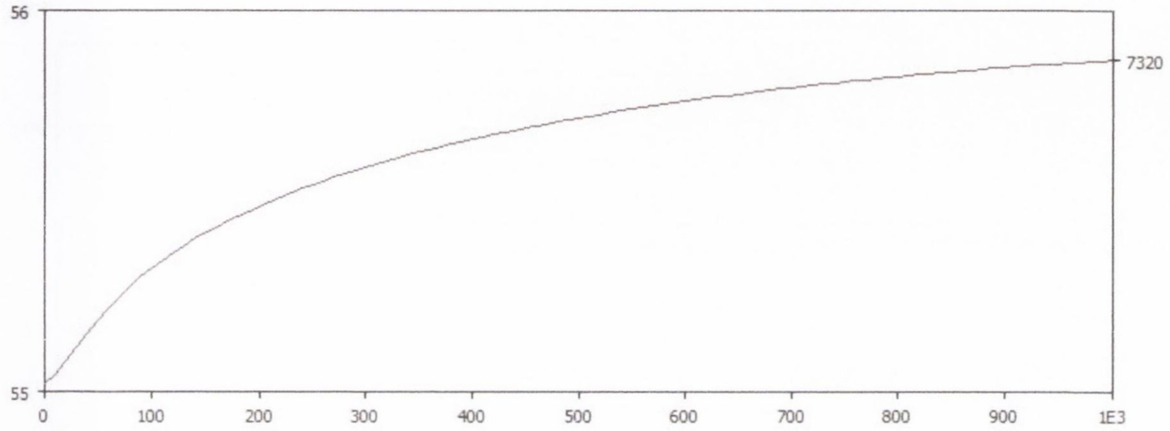


Figure 40. Rise in GWT (layer 4) at piezometer location 909 following Restoration Area infill. Period is 1000 days.

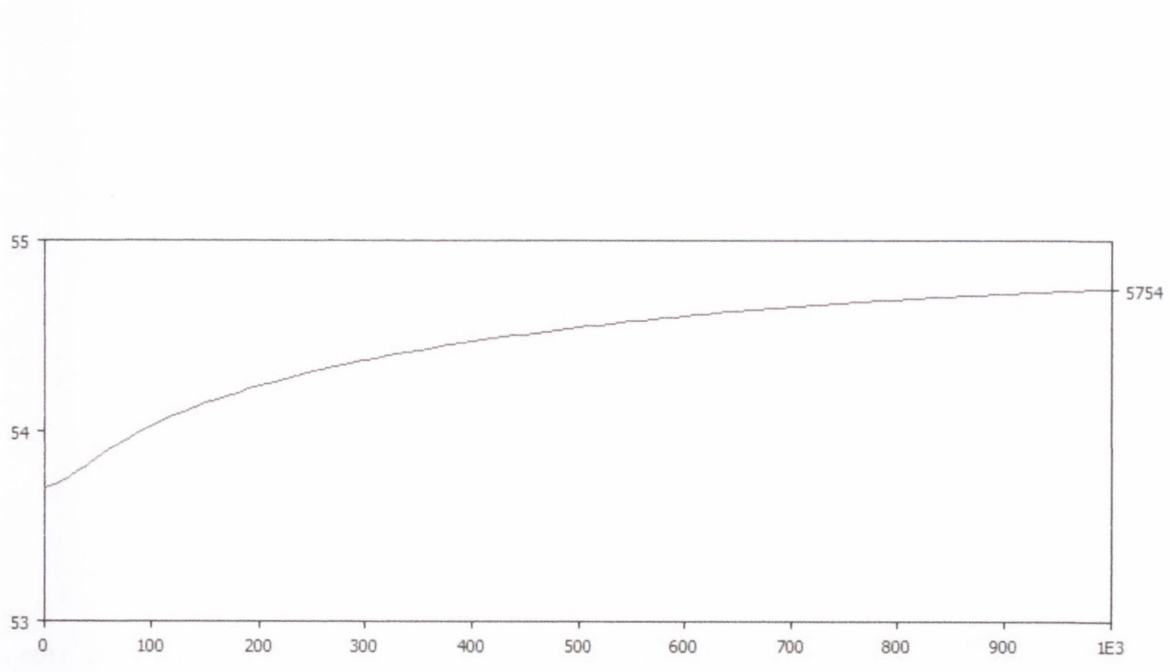


Figure 41. Rise in GWT (layer 4) at piezometer location CLCD3 following Restoration Area infill. Period is 1000 days.

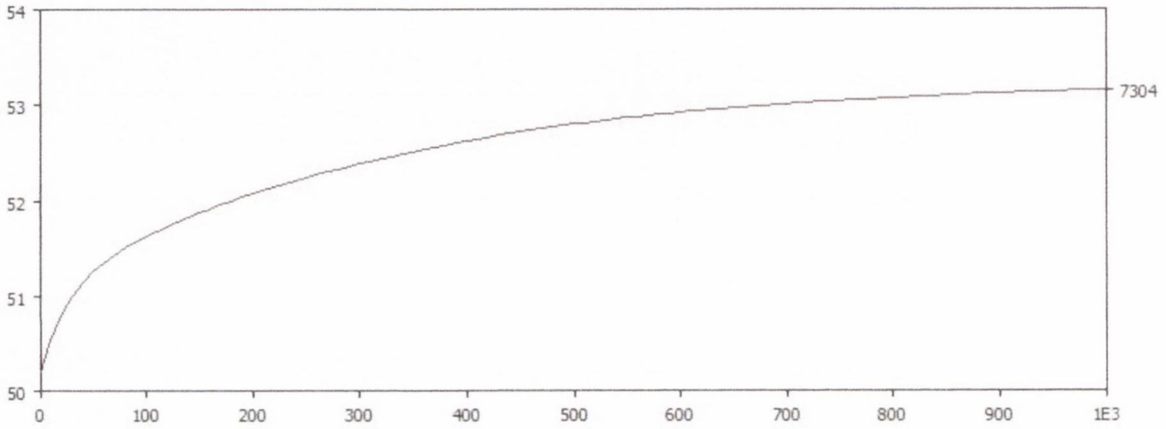


Figure 42. Rise in GWT (layer 4) at piezometer location 920 following Restoration Area infill. Period is 1000 days.

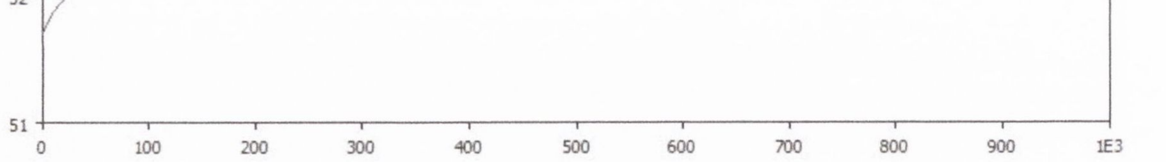


Figure 43. Rise in GWT (layer 4) at piezometer location CLBH5 following Restoration Area infill. Period is 1000 days.

Appendix J: Model Water Balance Analysis Area

1. Steady state model

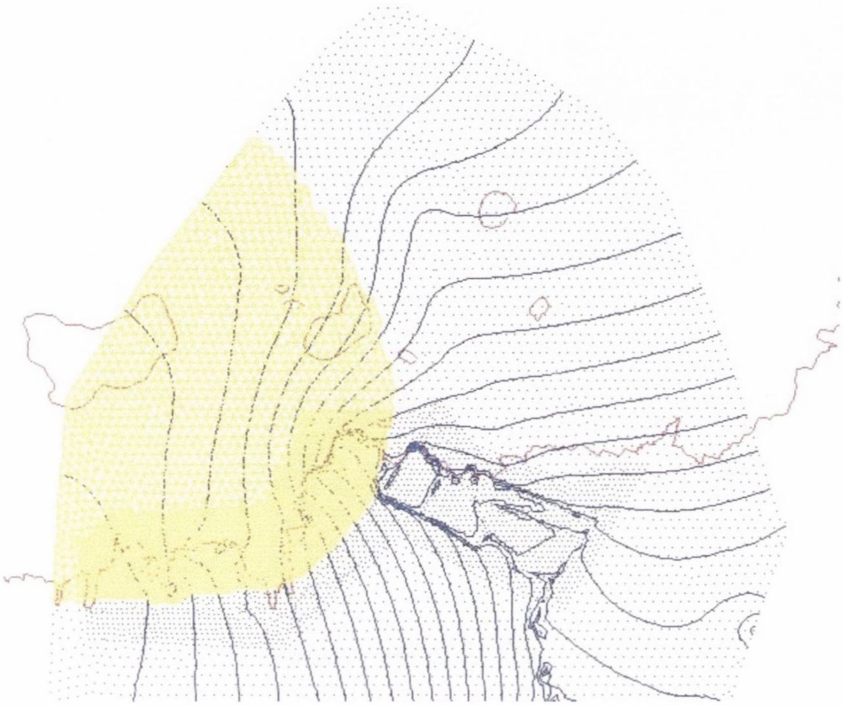


Figure J44. FB2 groundwater catchment analysis area

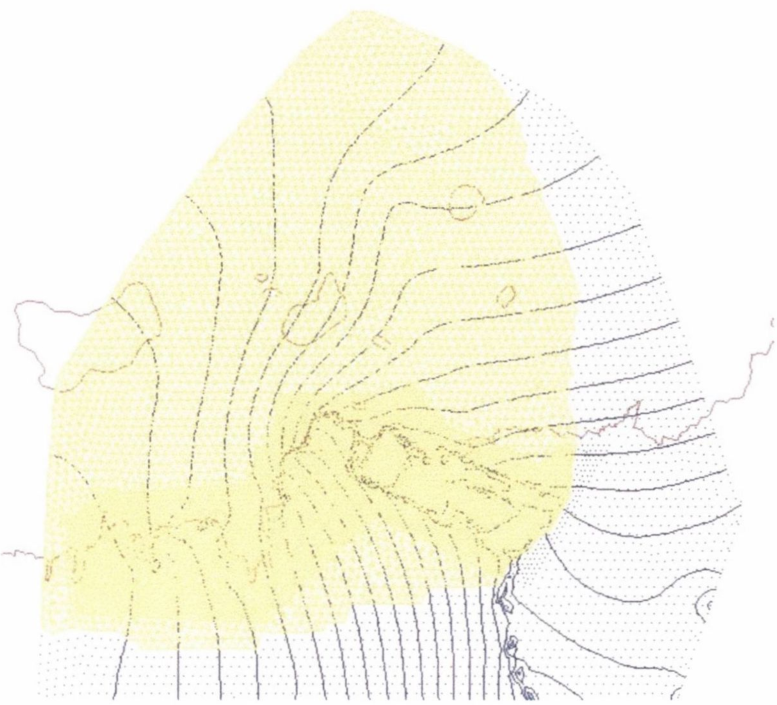


Figure J45. Restoration Area Flume groundwater catchment analysis area

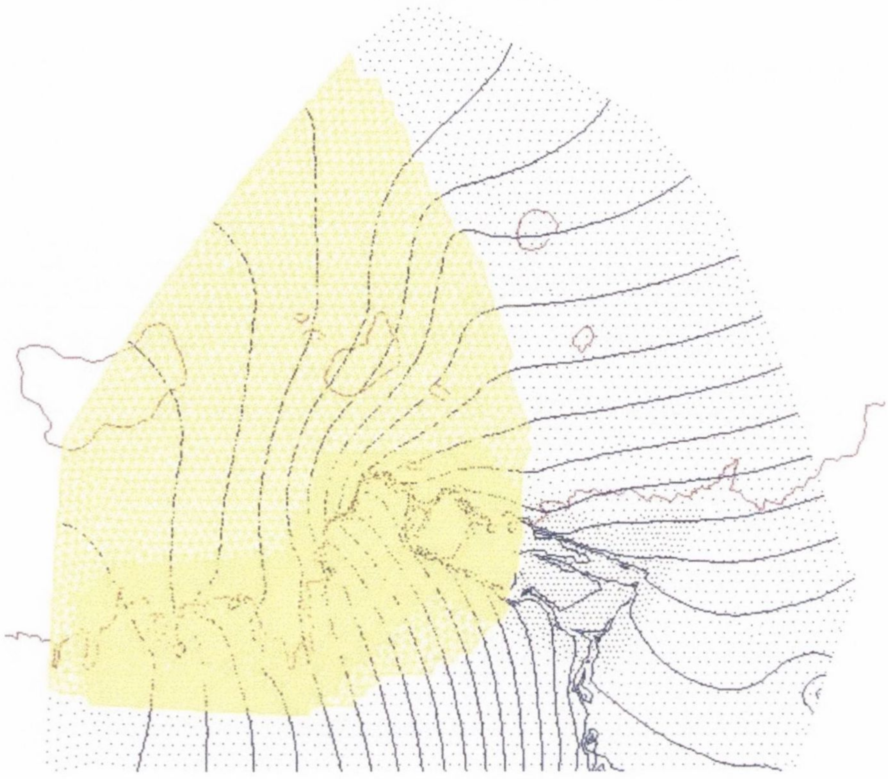


Figure J46. EPA Weir groundwater catchment analysis area

2. Prediction model

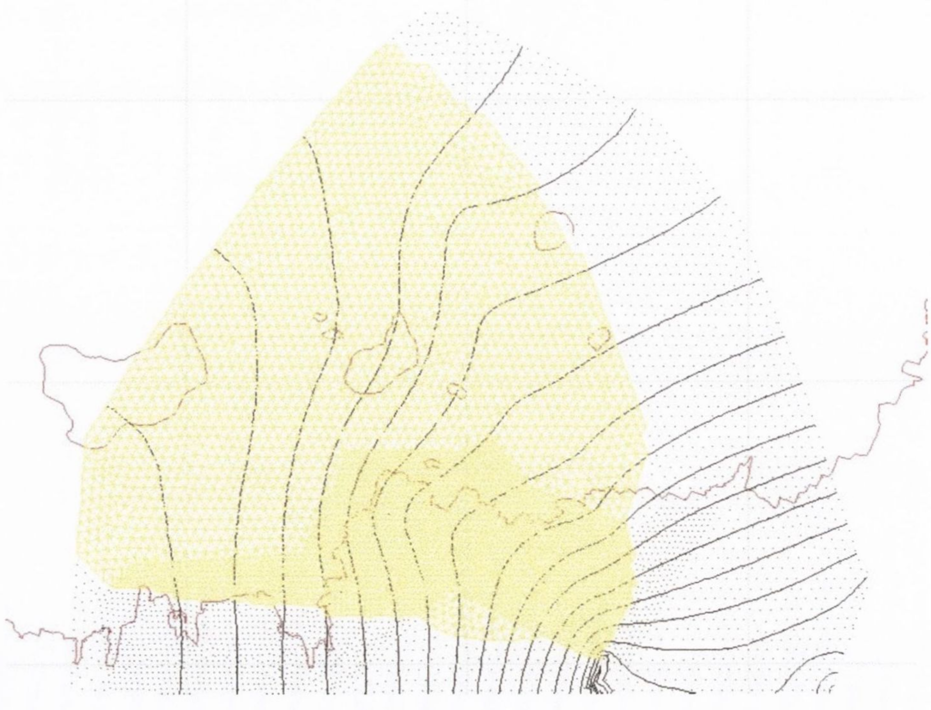


Figure J47. Groundwater catchment to Brook Stream (no-flow model boundary condition)

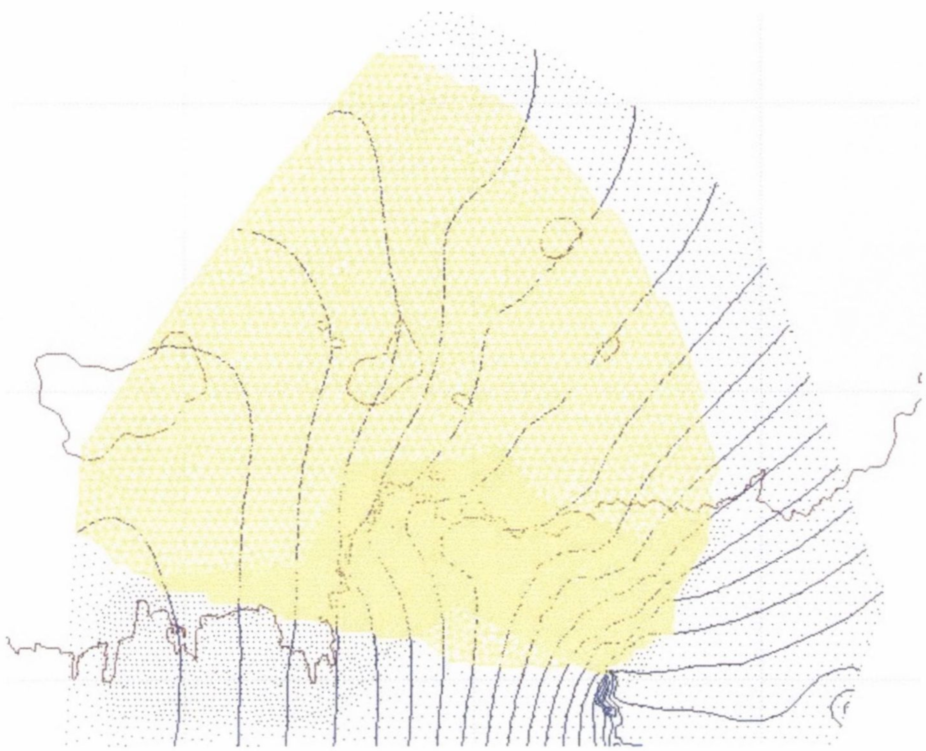


Figure J48. Groundwater catchment to Brook Stream (fixe-flow model boundary condition)

Figure J49. Water balance area underlain by till subsoil (no-flow model boundary condition)

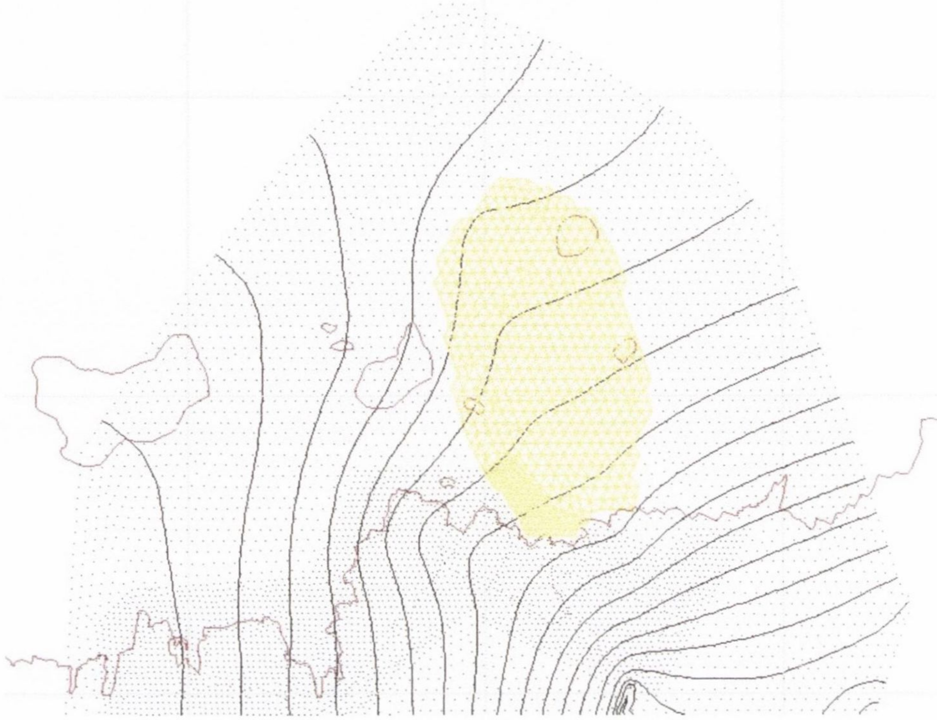


Figure J50. Water balance area underlain by sand subsoil (no-flow model boundary condition)

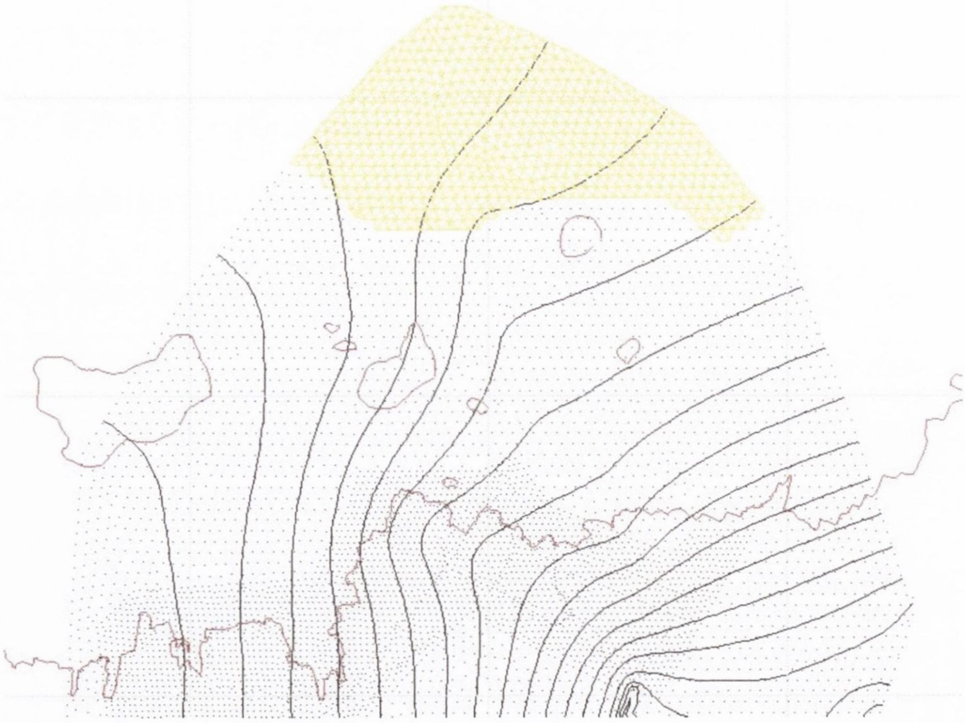


Figure J51. Water balance area underlain by lacustrine subsoil (no-flow model boundary condition)

Appendix J: Prediction Water Balance Computations

Table J1. Prediction model water balance to Brook Stream outlet (flow rate)

		Inflow	Outflow	In - Out
Precipitation		312.49		312.49
Drain system 1			235.05	-235.05
Sum topsystems		312.49	235.05	77.44
	Leakage			
1	**Lateral flow**	2.1	0.25	1.85
	Boundary flow		0.07	-0.07
	Total (error)	352.17	332.45	19.72
	Leakage	97.08	37.58	59.5
2	**Lateral flow**	0.21	0.17	0.03
	Boundary flow		0.12	-0.12
	Total (error)	134.41	133.22	1.19
	Leakage	95.34	37.12	58.22
3	**Lateral flow**	1.3		1.3
	Boundary flow		0.48	-0.48
	Total (error)	132.28	130.92	1.36
	Leakage	93.32	35.64	57.68
4	**Lateral flow**	24.61	33.03	-8.43
	Boundary flow		27.62	-27.62
	Total (error)	145.76	143.44	2.32
	Leakage	47.15	27.83	19.32
5	**Lateral flow**	6.62	23.71	-17.09
	Boundary flow			
	Total (error)	53.76	51.54	2.23
Units:		m^3/ day		
Model area:		735933 m^2		

Table J2. Prediction model water balance to Brook Stream outlet (flux)

		Inflow	Outflow	In - Out
Precipitation		0.42		0.42
Drain system 1			0.32	-0.32
Sum topsystems		0.42	0.32	0.11
	Leakage			
1	**Lateral flow**	0.003	0.000	0.003
	Boundary flow		0.000	0.000
	Total (error)	0.479	0.452	0.027
	Leakage	0.132	0.051	0.081
2	**Lateral flow**	0.000	0.000	0.000
	Boundary flow		0.000	0.000
	Total (error)	0.183	0.181	0.002
	Leakage	0.130	0.050	0.079
3	**Lateral flow**	0.002		0.002
	Boundary flow		0.001	-0.001
	Total (error)	0.180	0.178	0.002
	Leakage	0.127	0.048	0.078
4	**Lateral flow**	0.033	0.045	-0.011
	Boundary flow		0.038	-0.038
	Total (error)	0.198	0.195	0.003
	Leakage	0.064	0.038	0.026
5	**Lateral flow**	0.009	0.032	-0.023
	Boundary flow			
	Total (error)	0.073	0.070	0.003
Units: mm/ day				

Table J3. Prediction model water balance for area underlain by till (flow rate)

		Inflow	Outflow	In - Out
Precipitation		143.88		143.88
Drain system 1			89.57	-89.57
Sum topsystems		143.88	89.57	54.32
	Leakage			
1	**Lateral flow**	0.76	2.51	-1.75
	Boundary flow			
	Total (error)	150.38	146.47	3.91
	Leakage	54.39	5.74	48.66
2	**Lateral flow**	0.02	0.05	-0.03
	Boundary flow			
	Total (error)	60.12	59.76	0.36
	Leakage	53.97	5.71	48.26
3	**Lateral flow**	0.02	0.32	-0.3
	Boundary flow			
	Total (error)	59.72	59.35	0.37
	Leakage	53.32	5.73	47.59
4	**Lateral flow**	6.63	43.89	-37.26
	Boundary flow			
	Total (error)	61.06	60.38	0.69
	Leakage	10.76	1.11	9.65
5	**Lateral flow**	1.66	10.82	-9.17
	Boundary flow			
	Total (error)	12.42	11.94	0.48
Units:		m^3/ day		
Model area:		321517 m^2		

Table J4. Prediction model water balance for area underlain by till (flux)

		Inflow	Outflow	In - Out
Precipitation		0.45		0.45
Drain system 1			0.28	-0.28
Sum topsystems		0.45	0.28	0.17
	Leakage			
1	**Lateral flow**	0.002	0.008	-0.005
	Boundary flow			
	Total (error)	0.468	0.456	0.012
	Leakage	0.169	0.018	0.151
2	**Lateral flow**	0.000	0.000	0.000
	Boundary flow			
	Total (error)	0.187	0.186	0.001
	Leakage	0.168	0.018	0.150
3	**Lateral flow**	0.000		-0.001
	Boundary flow			
	Total (error)	0.186	0.185	0.001
	Leakage	0.166	0.018	0.148
4	**Lateral flow**	0.021	0.137	-0.116
	Boundary flow			
	Total (error)	0.190	0.188	0.002
	Leakage	0.033	0.003	0.030
5	**Lateral flow**	0.005	0.034	-0.029
	Boundary flow			
	Total (error)	0.039	0.037	0.001

Units: mm/ day

Table J5. Prediction model water balance for area underlain by sand/ lacustrine clay (flow rate)

		Inflow	Outflow	In - Out
Precipitation		75.38		75.38
Drain system 1			56.65	-56.65
Sum topsystems		75.38	56.65	18.73
	Leakage			
1	**Lateral flow**	3.79	1.1	2.69
	Boundary flow			
	Total (error)	79.62	75	4.62
	Leakage	17.25	0.45	16.8
2	**Lateral flow**	0.09	0.09	0
	Boundary flow			
	Total (error)	17.77	17.5	0.27
	Leakage	16.96	0.42	16.53
3	**Lateral flow**	0.96	5.04	-4.07
	Boundary flow			
	Total (error)	18.04	17.71	0.32
	Leakage	12.25	0.12	12.14
4	**Lateral flow**	27.53	17.1	10.43
	Boundary flow			
	Total (error)	43.46	42.87	0.6
	Leakage	25.65	3.68	21.97
5	**Lateral flow**	6.9	27.92	-21.02
	Boundary flow			
	Total (error)	32.55	31.59	0.95
Units:		m^3/ day		
Model area:		167515 m^2		

Table J6. Prediction model water balance for area underlain by sand/ lacustrine clay (flux)

		Inflow	Outflow	In - Out
Precipitation		0.45		0.45
Drain system 1			0.34	-0.34
Sum topsystems		0.45	0.34	0.11
	Leakage			
1	**Lateral flow**	0.023	0.007	0.016
	Boundary flow			
	Total (error)	0.475	0.448	0.028
	Leakage	0.103	0.003	0.100
2	**Lateral flow**	0.001	0.001	0.000
	Boundary flow			
	Total (error)	0.106	0.104	0.002
	Leakage	0.101	0.003	0.099
3	**Lateral flow**	0.006		-0.024
	Boundary flow			
	Total (error)	0.108	0.106	0.002
	Leakage	0.073	0.001	0.072
4	**Lateral flow**	0.164	0.102	0.062
	Boundary flow			
	Total (error)	0.259	0.256	0.004
	Leakage	0.153	0.022	0.131
5	**Lateral flow**	0.041	0.167	-0.125
	Boundary flow			
	Total (error)	0.194	0.189	0.006

Units: mm/ day

Table J7. Prediction model water balance for area underlain by lacustrine clay (flow rate)

		Inflow	Outflow	In - Out
Precipitation		82.68		82.68
Drain system 1			63.1	-63.1
Sum topsystems		82.68	63.1	19.58
	Leakage			
1	**Lateral flow**	0.52	2.06	-1.54
	Boundary flow			
	Total (error)	83.2	83.08	0.13
	Leakage	17.91		17.91
2	**Lateral flow**	0.01	0.09	-0.08
	Boundary flow			
	Total (error)	17.92	17.74	0.18
	Leakage	17.65		17.65
3	**Lateral flow**			
	Boundary flow			
	Total (error)	17.65	17.48	0.17
	Leakage	17.48		17.48
4	**Lateral flow**	3.01	13.4	-10.4
	Boundary flow			
	Total (error)	20.49	20	0.49
	Leakage	6.6		6.6
5	**Lateral flow**	0.77	7	-6.24
	Boundary flow			
	Total (error)	7.36	7	0.36
Units:		m^3/ day		
Model area:		183740 m^2		

Table J8. Prediction model water balance for area underlain by lacustrine clay (flux)

		Inflow	Outflow	In - Out
Precipitation		0.45		0.45
Drain system 1			0.34	-0.34
Sum topsystems		0.45	0.34	0.11
	Leakage			
1	**Lateral flow**	0.003	0.011	-0.008
	Boundary flow			
	Total (error)	0.453	0.452	0.001
	Leakage	0.097		0.097
2	**Lateral flow**	0.000	0.000	0.000
	Boundary flow			
	Total (error)	0.098	0.097	0.001
	Leakage	0.096		0.096
3	**Lateral flow**			
	Boundary flow			
	Total (error)	0.096	0.095	0.001
	Leakage	0.095		0.095
4	**Lateral flow**	0.016	0.073	-0.057
	Boundary flow			
	Total (error)	0.112	0.109	0.003
	Leakage	0.036		0.036
5	**Lateral flow**	0.004	0.038	-0.034
	Boundary flow			
	Total (error)	0.040	0.038	0.002

Units: mm/ day

Table J9. Prediction model water balance to Brook Stream outlet (flow rate) – fixed-head model boundary conditions

		Inflow	Outflow	In - Out
Precipitation		344.25		344.25
Drain system 1			272.34	-272.34
Sum topsystems		344.25	272.34	71.9
	Leakage			
1	**Lateral flow**	1.37	0.2	1.17
	Boundary flow	0	0.13	-0.13
	Total (error)	382.1	382.1	0
	Leakage	109.43	36.49	72.95
2	**Lateral flow**	0.18	0.2	-0.02
	Boundary flow	0.01	0.21	-0.2
	Total (error)	145.76	145.76	0
	Leakage	108.87	36.14	72.73
3	**Lateral flow**			
	Boundary flow	0.01	0.41	-0.4
	Total (error)	143.92	143.92	0
	Leakage	107.37	35.04	72.33
4	**Lateral flow**	14.45	42.59	-28.14
	Boundary flow		19.47	-19.47
	Total (error)	175.41	175.41	0
	Leakage	78.3	53.59	24.72
5	**Lateral flow**	10.1	34.82	-24.72
	Boundary flow			
	Total (error)	88.41	88.41	0
Units:		m^3/ day		
Model area:		814588 m^2		

Table J10. Prediction model water balance to Brook Stream outlet (flux) – fixed-head model boundary conditions

		Inflow	Outflow	In - Out
Precipitation		0.42		0.42
Drain system 1			0.33	-0.33
Sum topsystems		0.42	0.33	0.09
	Leakage			
1	**Lateral flow**	0.002	0.000	0.001
	Boundary flow		0.000	0.000
	Total (error)	0.469	0.469	0.000
	Leakage	0.134	0.045	0.090
2	**Lateral flow**	0.000	0.000	0.000
	Boundary flow	0.000	0.000	0.000
	Total (error)	0.179	0.179	0.000
	Leakage	0.134	0.044	0.089
3	**Lateral flow**			
	Boundary flow		0.001	0.000
	Total (error)	0.177	0.177	0.000
	Leakage	0.132	0.043	0.089
4	**Lateral flow**	0.018	0.052	-0.035
	Boundary flow		0.024	-0.024
	Total (error)	0.215	0.215	0.000
	Leakage	0.096	0.066	0.030
5	**Lateral flow**	0.012	0.043	-0.030
	Boundary flow			
	Total (error)	0.109	0.109	0.000

Units: mm/ day