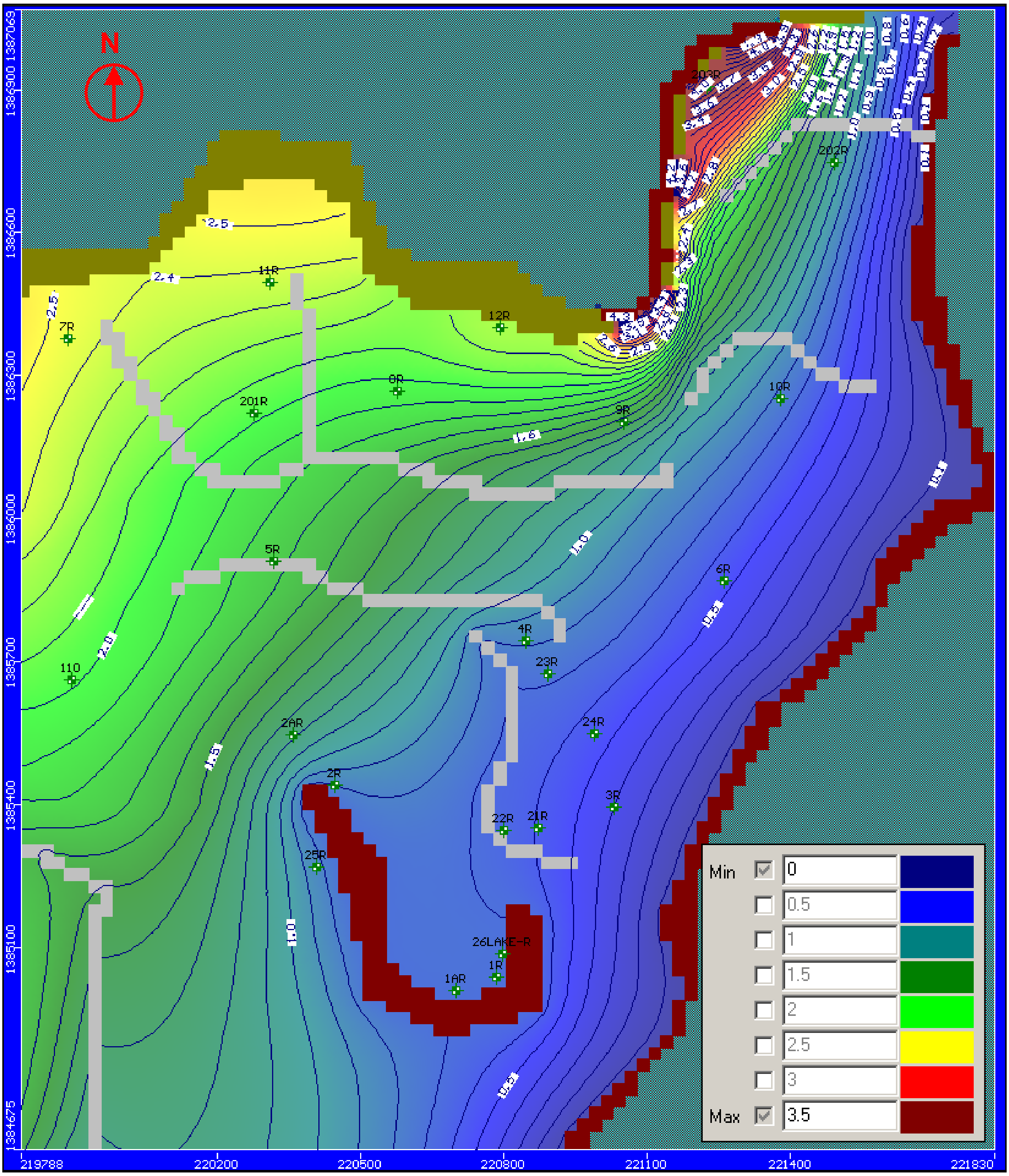
martens

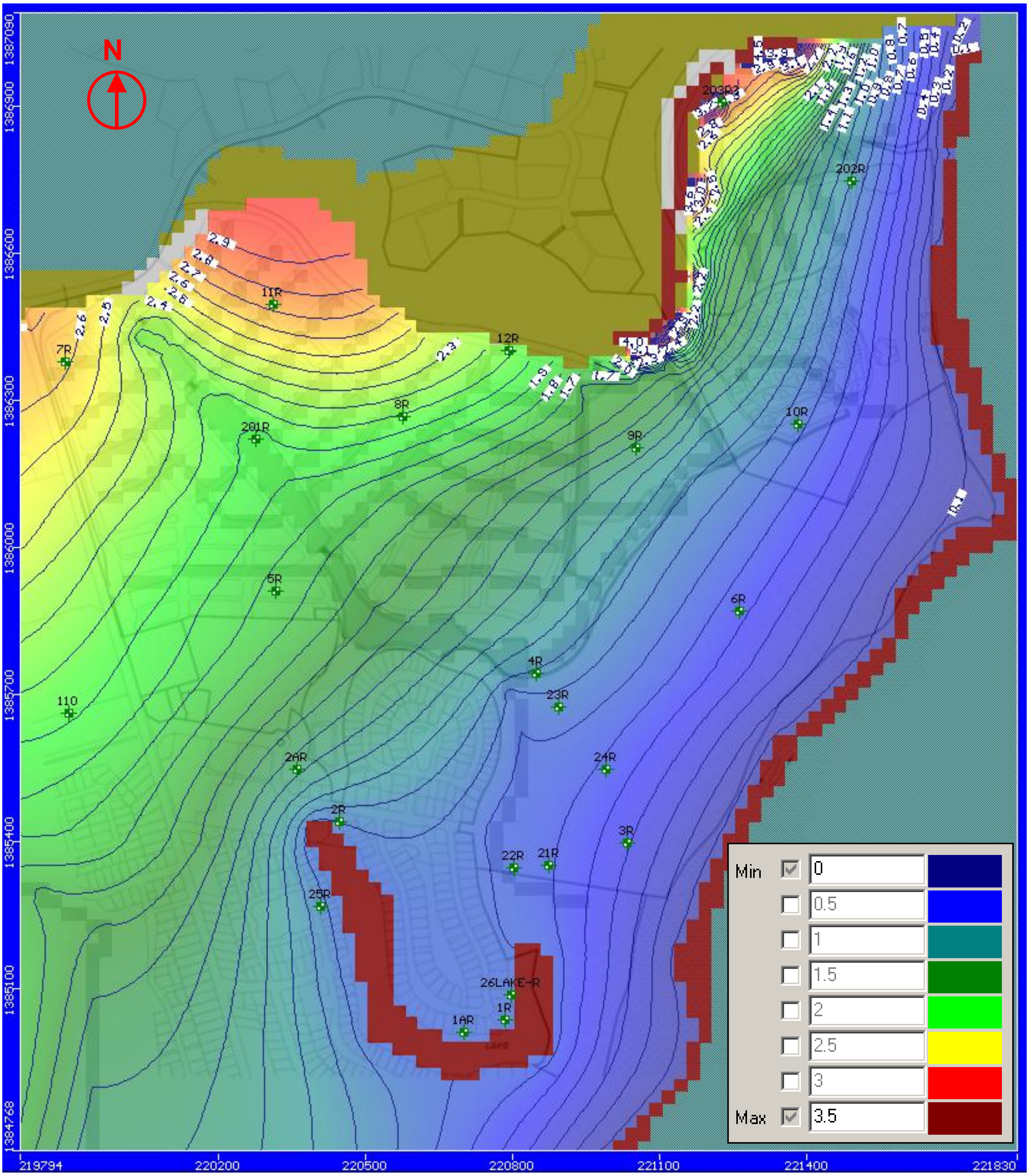


Key

Blue lines - Head Equipotential (0.1 m contour interval)

Martens & Associates Pty Ltd ABN 85 070 240 890		**Environment | Water | Wastewater | Geotechnical | Civil | Management**	
Drawn:	BR	**GROUNDWATER HEAD EQUIPOTENTIAL CONTOURS: M1a- EXISTING SITE, MEAN RAINFALL CONDITIONS**	**Figure 7**
Approved:	DMM		
Date:	22.11.2012		
Scale:	NA		Job No: P0902346

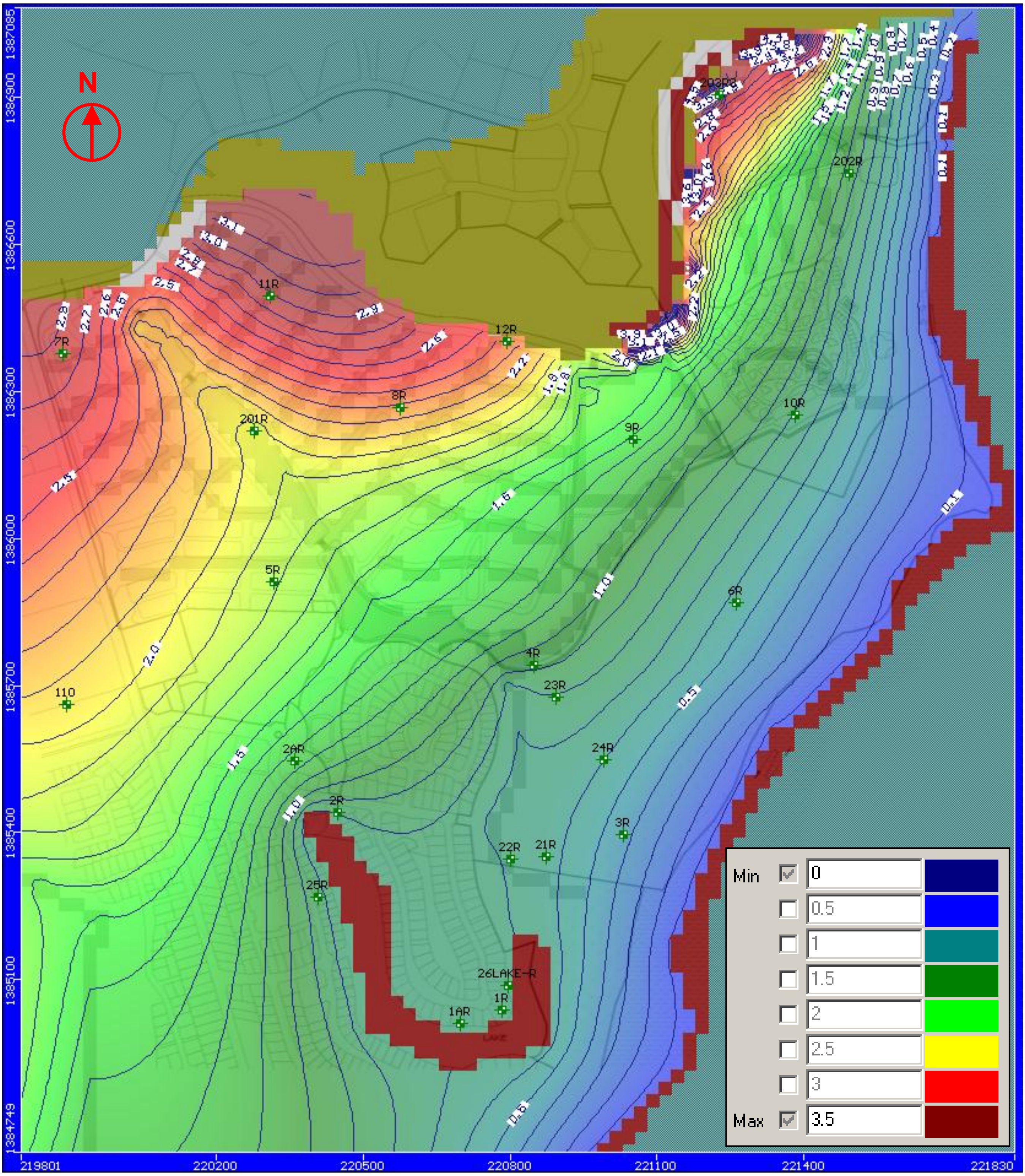
martens



Key

Blue lines - Head Equipotential (0.1 m contour interval)

Martens & Associates Pty Ltd ABN 85 070 240 890		**Environment | Water | Wastewater | Geotechnical | Civil | Management**	
Drawn:	BR	**GROUNDWATER HEAD EQUIPOTENTIAL CONTOURS: M2a- DEVELOPED SITE, MEAN RAINFALL CONDITIONS**	**Figure 8**
Approved:	DMM		
Date:	22.11.2012		
Scale:	NA		Job No: P0902346

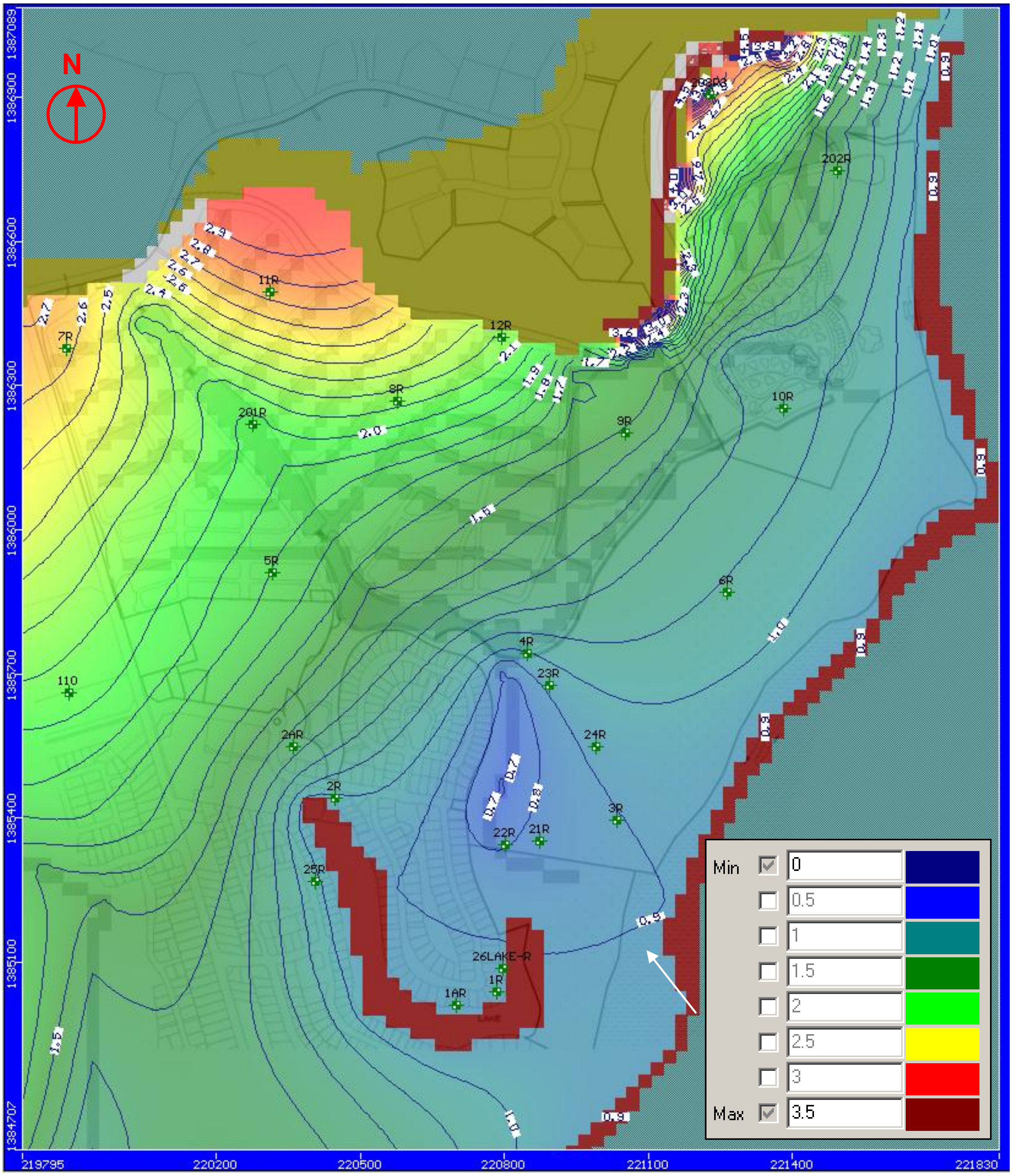


martens

Key

Blue lines - Head Equipotential (0.1 m contour interval)

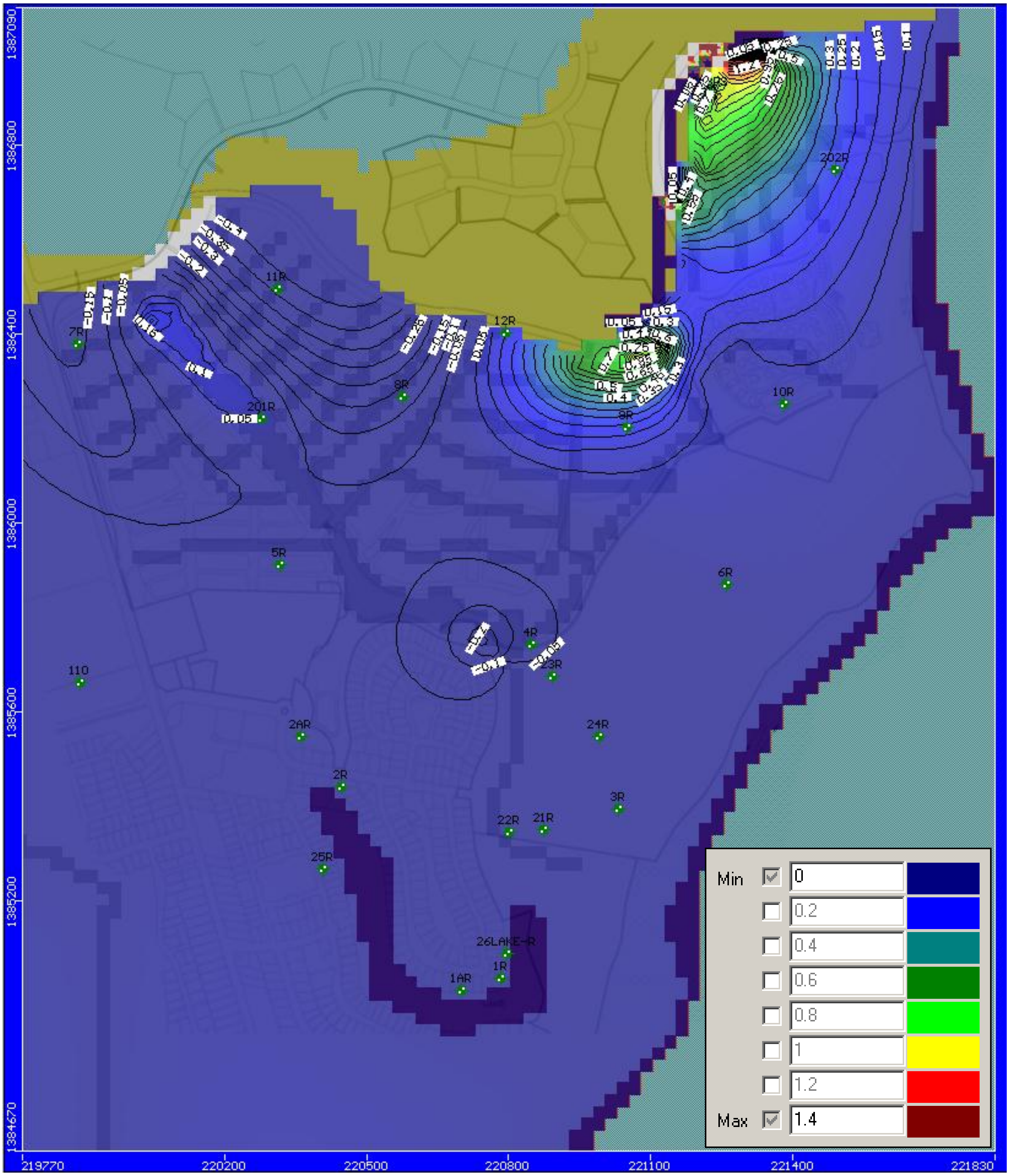
Martens & Associates Pty Ltd ABN 85 070 240 890		**Environment | Water | Wastewater | Geotechnical | Civil | Management**	
Drawn:	BR	**GROUNDWATER HEAD EQUIPOTENTIAL CONTOURS: M2b- DEVELOPED SITE, WET RAINFALL CONDITIONS**	**Figure 9**
Approved:	DMM		
Date:	22.11.2012		
Scale:	NA		Job No: P0902346



Key

Blue lines - Head Equipotential (0.1 m contour interval)

Martens & Associates Pty Ltd ABN 85 070 240 890		Environment | Water | Wastewater | Geotechnical | Civil | Management	
Drawn:	BR	GROUNDWATER HEAD EQUIPOTENTIAL CONTOURS: M2c- DEVELOPED SITE, MEAN RAINFALL CONDITIONS WITH SEA LEVEL RISE	**Figure 10**
Approved:	DMM		
Date:	22.11.2012		
Scale:	NA		Job No: P0902346



Key

Black lines - Drawdown contour (0.05 m contour interval)

Martens & Associates Pty Ltd ABN 85 070 240 890		**Environment | Water | Wastewater | Geotechnical | Civil | Management**	
Drawn:	GMH	**GROUNDWATER HEAD EQUIPOTENTIAL DRAWDOWN PLOT BETWEEN DEVELOPED (M2a) AND EXISTING (M1a) WITH MEAN RAINFALL CONDITIONS**	**Figure 11**
Approved:	DMM		
Date:	26.11.2012		
Scale:	NA		Job No: P0902346

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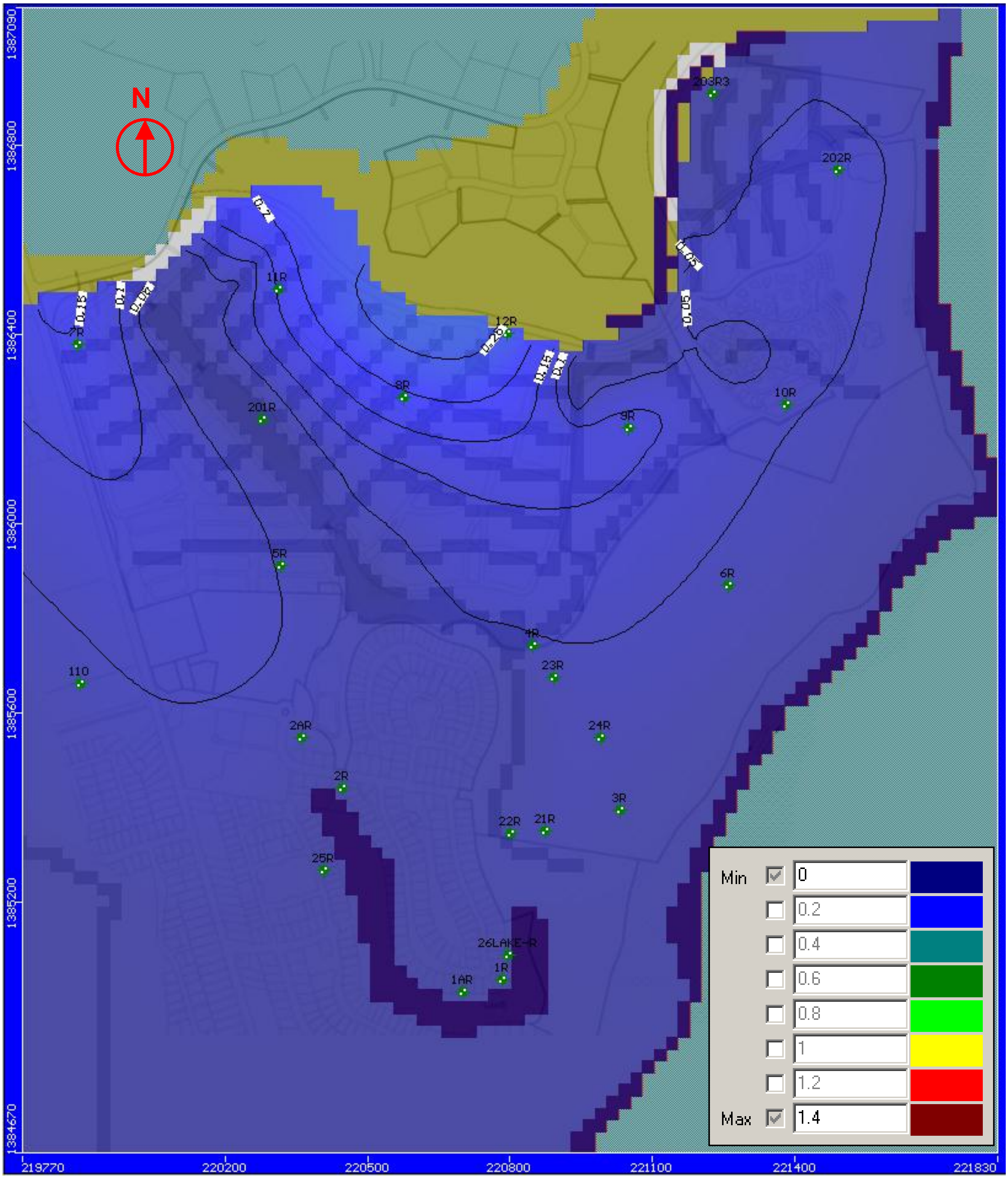
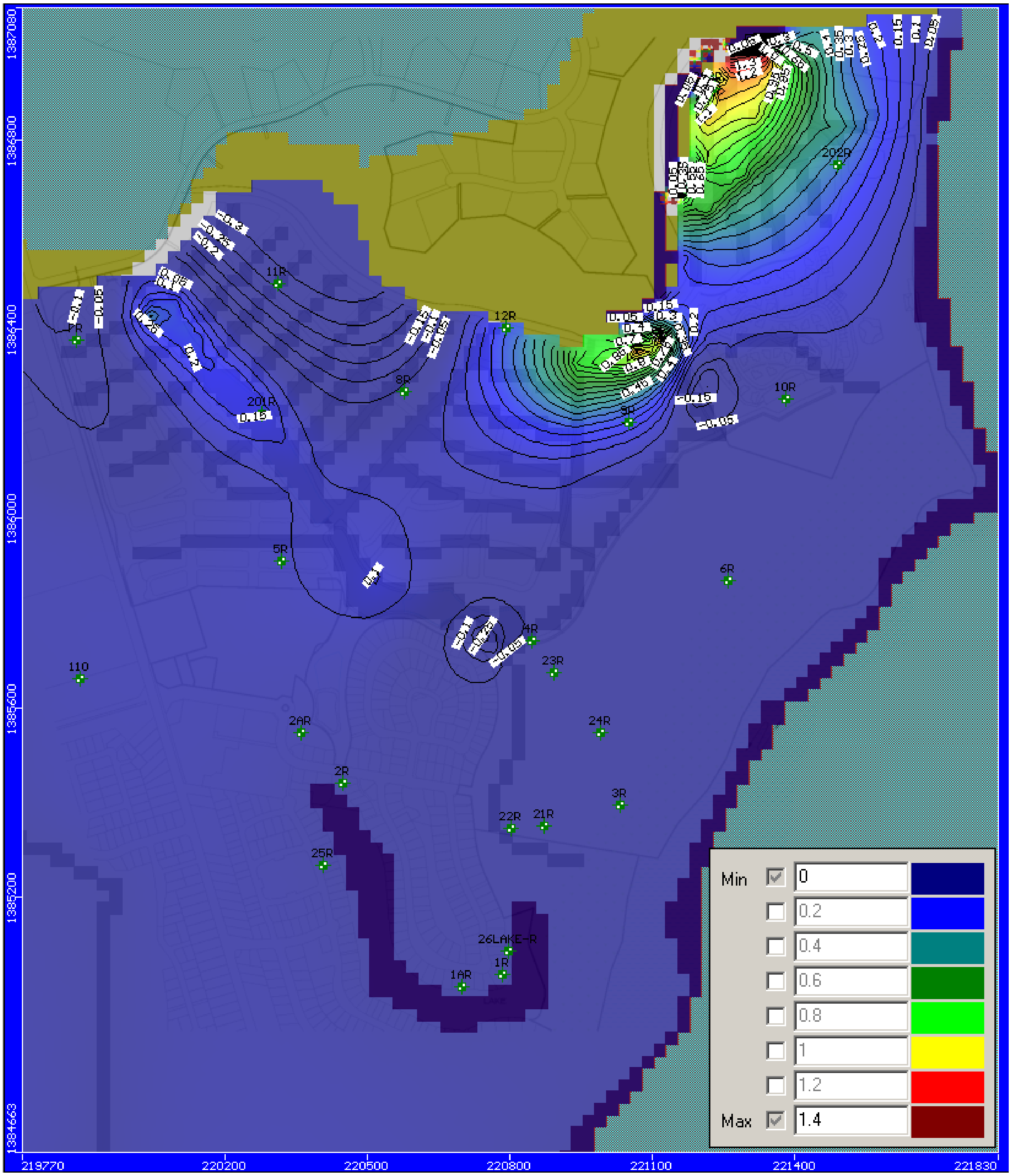


martens

Key

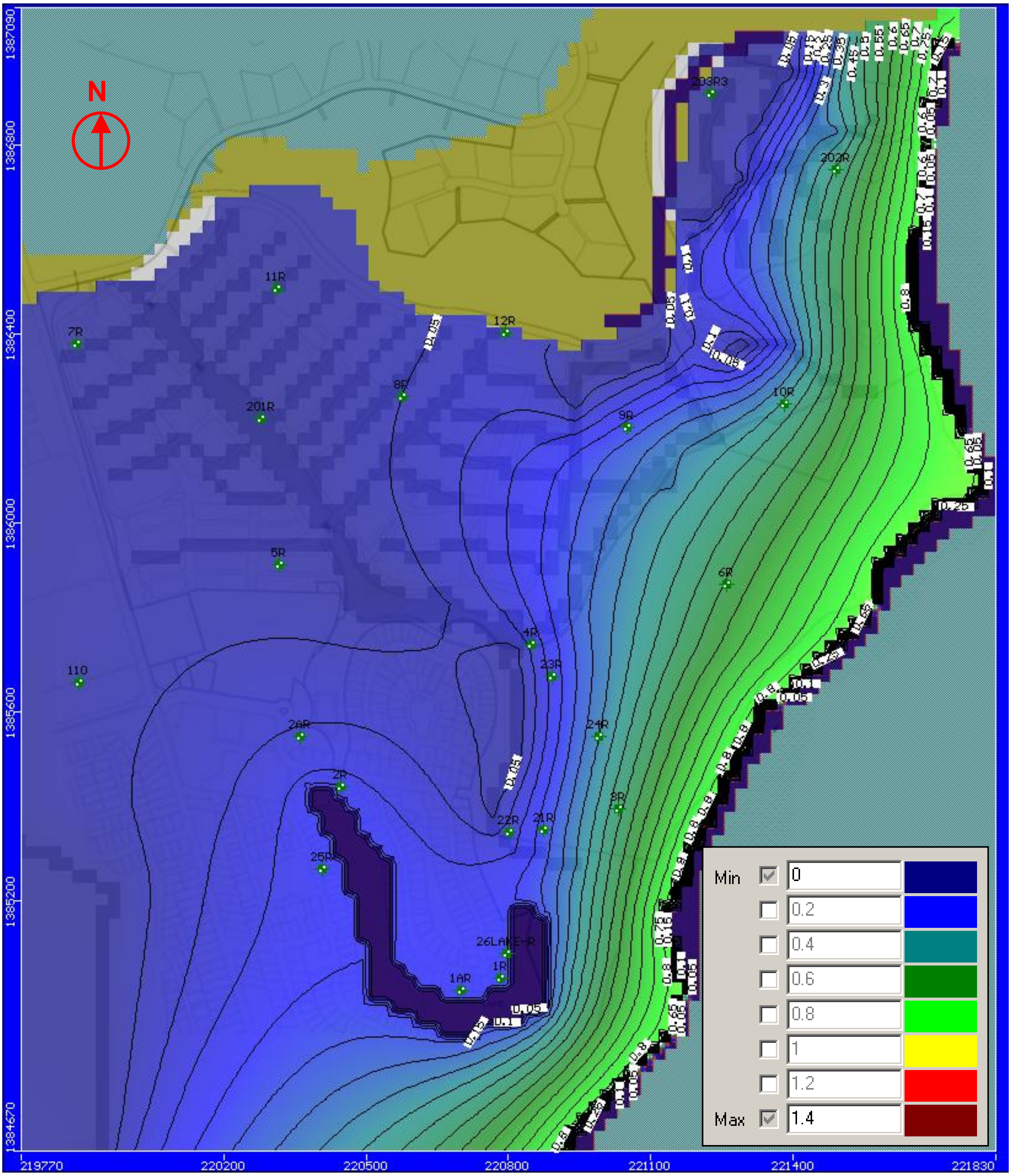
Black lines - Drawdown contour (0.1 m contour interval)

Martens & Associates Pty Ltd ABN 85 070 240 890		**Environment | Water | Wastewater | Geotechnical | Civil | Management**	
Drawn:	GMH	**GROUNDWATER HEAD EQUIPOTENTIAL DRAWDOWN PLOT BETWEEN DEVELOPED MEAN RAINFALL (M2a) &WET RAINFALL CONDITIONS (M2b)**	**Figure 12**
Approved:	DMM		
Date:	26.11.2012		
Scale:	NA		Job No: P0902346



Key
Black lines - Drawdown contour (0.1 m contour interval)

Martens & Associates Pty Ltd ABN 85 070 240 890		Environment | Water | Wastewater | Geotechnical | Civil | Management	
Drawn:	GMH	GROUNDWATER HEAD EQUIPOTENTIAL DRAWDOWN PLOT BETWEEN DEVELOPED (M2c) & EXISTING (M1c) WITH MEAN RAINFALL CONDITIONS & SEA LEVEL RISE	Figure 13
Approved:	DMM		
Date:	26.11.2012		
Scale:	NA		Job No: P0902346

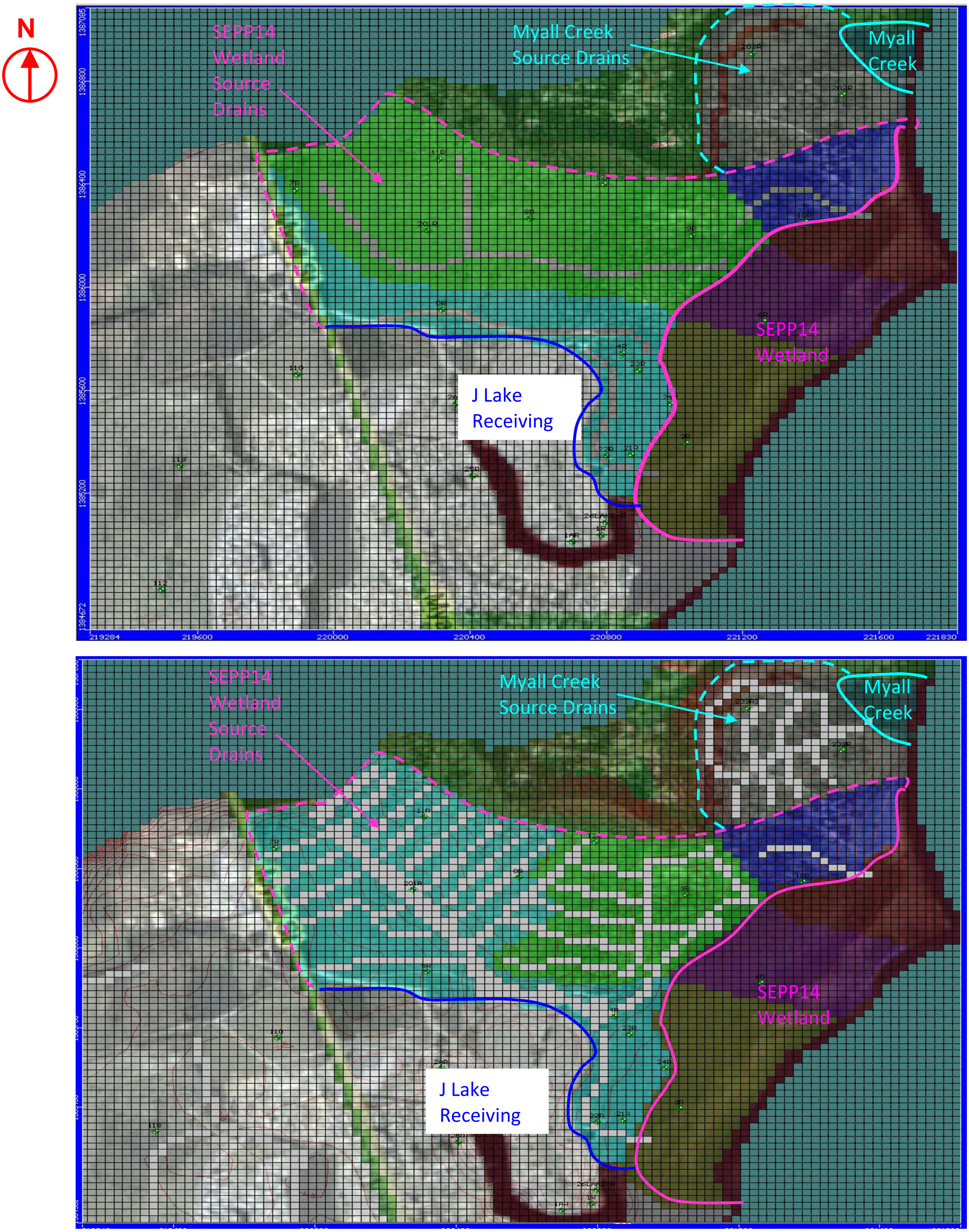


martens

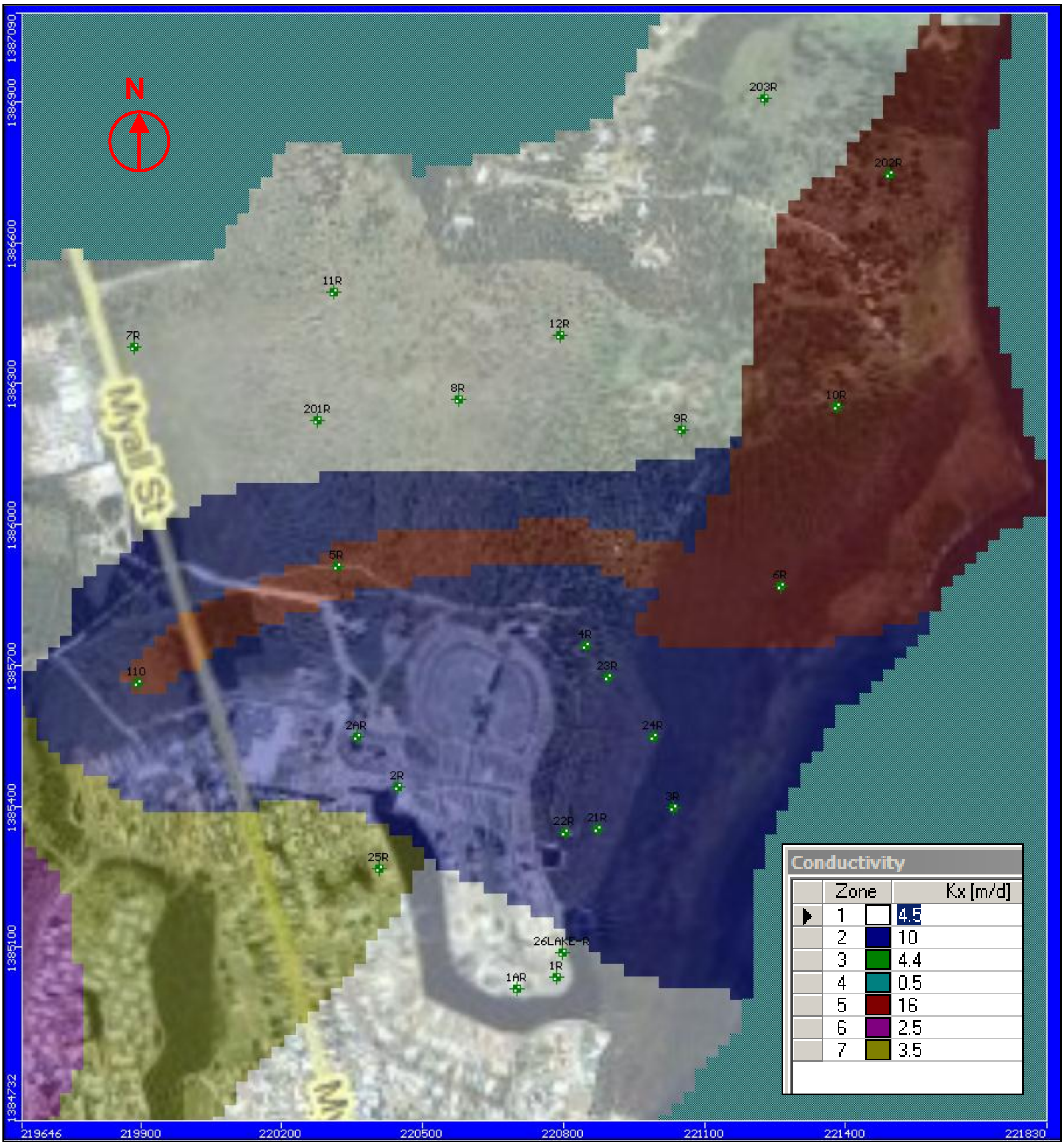
Key

Black lines - Drawdown contour (0.1 m contour interval)

Martens & Associates Pty Ltd ABN 85 070 240 890		Environment | Water | Wastewater | Geotechnical | Civil | Management	
Drawn:	GMH	GROUNDWATER HEAD EQUIPOTENTIAL DRAWDOWN PLOT BETWEEN DEVELOPED MEAN RAINFALL WITH (M2c) & WITHOUT (M2a) SEA LEVEL RISE	Figure 14
Approved:	DMM		
Date:	26.11.2012		
Scale:	NA		Job No: P0902346



Martens & Associates Pty Ltd ABN 85 070 240 890		Environment | Water | Wastewater | Geotechnical | Civil | Management	
Drawn:	GMH	GROUNDWATER MODEL WATER BALANCE ZONES AND DRAINS	Figure 15
Approved:	DMM		
Date:	26.11.2012		
Scale:	NA		Job No: P0902346



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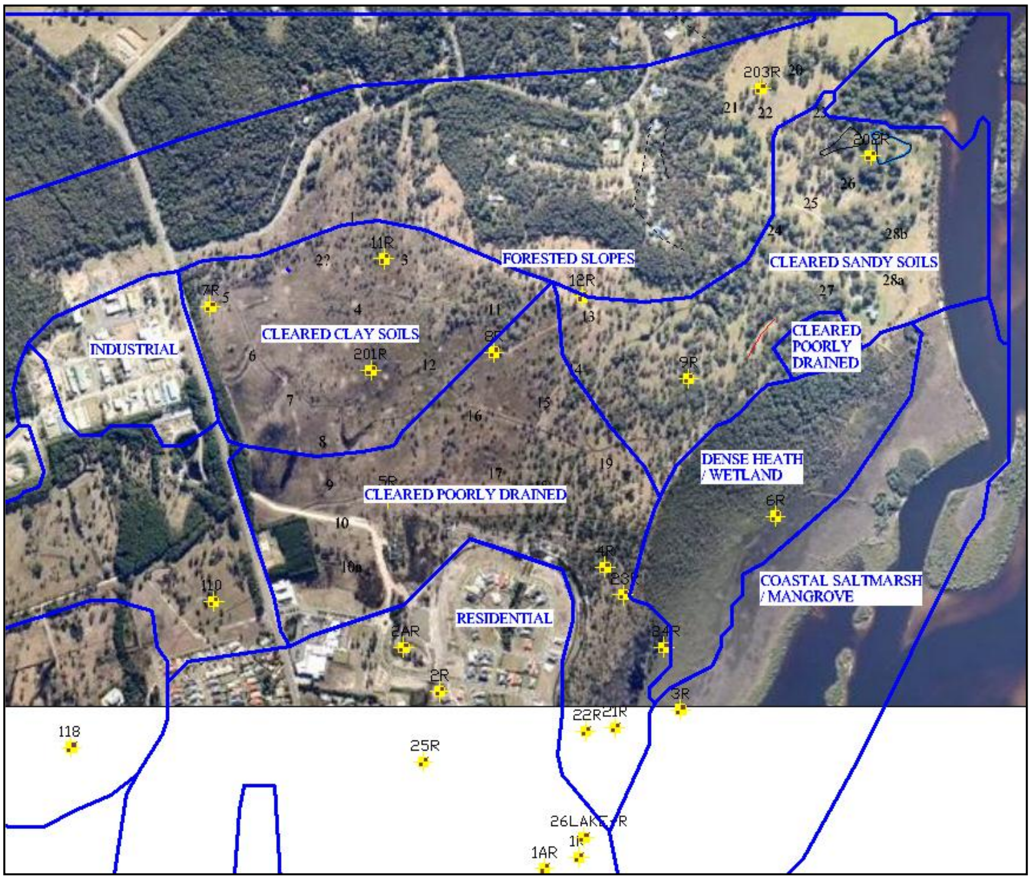
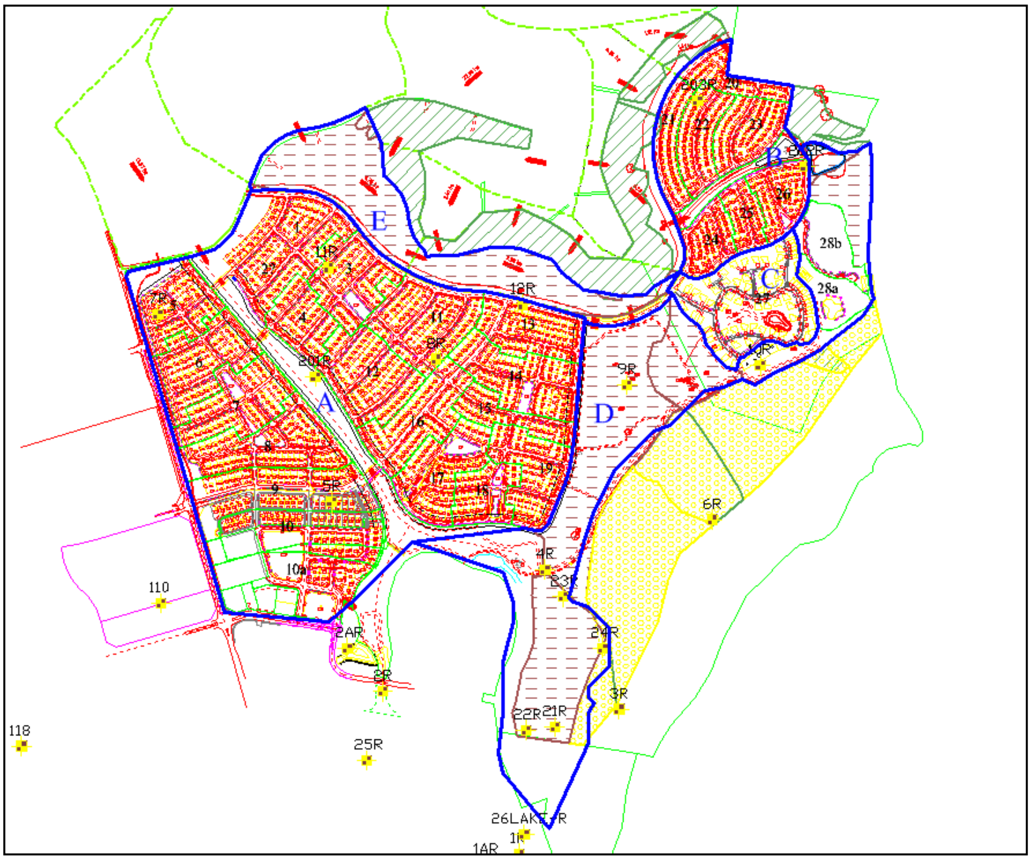
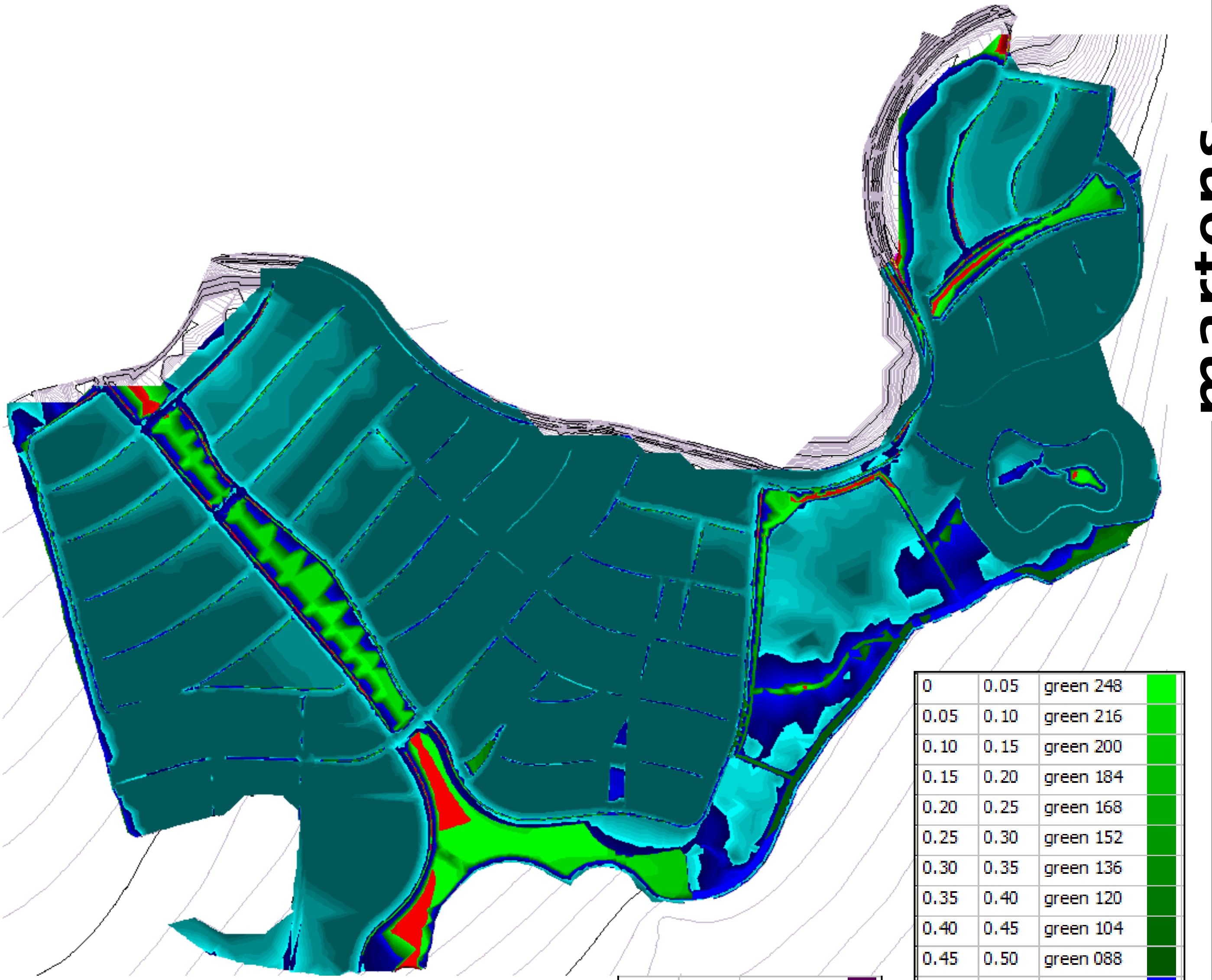
Martens & Associates Pty Ltd ABN 85 070 240 890		Environment | Water | Wastewater | Geotechnical | Civil | Management	
Drawn:	GMH	GROUNDWATER MODEL HYDRAULIC CONDUCTIVITY ZONES	Figure 16
Approved:	DMM		
Date:	26.11.2012		
Scale:	NA		Job No: P0902346





Martens & Associates Pty Ltd ABN 85 070 240 890		Environment | Water | Wastewater | Geotechnical | Civil | Management	
Drawn:	GMH	**GROUNDWATER MODEL RECHARGE ZONES – EXISTING AND DEVELOPED CONDITIONS**	**Figure 17**
Approved:	DMM		
Date:	26.11.2012		
Scale:	NA		Job No: P0902346



-1.00	-0.95	magenta 088	
-0.95	-0.90	magenta 104	
-0.90	-0.85	magenta 120	
-0.85	-0.80	magenta 136	
-0.80	-0.75	magenta 152	
-0.75	-0.70	magenta 168	
-0.70	-0.65	magenta 184	
-0.65	-0.60	magenta 200	
-0.60	-0.55	magenta 216	
-0.55	-0.50	magenta 248	
-0.50	-0.45	red 088	
-0.45	-0.40	red 104	
-0.40	-0.35	red 120	
-0.35	-0.30	red 136	
-0.30	-0.25	red 152	
-0.25	-0.20	red 168	
-0.20	-0.15	red 184	
-0.15	-0.10	red 200	
-0.10	-0.05	red 216	
-0.05	0	red 248	

0	0.05	green 248	
0.05	0.10	green 216	
0.10	0.15	green 200	
0.15	0.20	green 184	
0.20	0.25	green 168	
0.25	0.30	green 152	
0.30	0.35	green 136	
0.35	0.40	green 120	
0.40	0.45	green 104	
0.45	0.50	green 088	
0.50	0.55	blue 248	
0.55	0.60	blue 216	
0.60	0.65	blue 200	
0.65	0.70	blue 184	
0.70	0.75	blue 168	
0.75	0.80	blue 152	
0.80	0.85	blue 136	
0.85	0.90	blue 120	
0.90	0.95	blue 104	
0.95	1.00	blue 088	
1.00	1.05	cyan 248	
1.05	1.10	cyan 216	
1.10	1.15	cyan 200	
1.15	1.20	cyan 184	
1.20	1.25	cyan 168	
1.25	1.30	cyan 152	
1.30	1.45	cyan 136	
1.45	1.50	cyan 120	
1.50	1.55	cyan 104	
1.55	300	cyan 088	

Martens & Associates Pty Ltd ABN 85 070 240 890		**Environment | Water | Wastewater | Geotechnical | Civil | Management**	
Drawn:	GMH	**GROUNDWATER MODELING DESIGN SURFACE DEM Vs DESIGN GROUNDWATER MEAN CONDITIONS (M2a) DEM**	**Figure 18**
Approved:	DMM		
Date:	26.11.2012		
Scale:	NA		Job No: P0902346

19 Attachment 4B – Groundwater Level Data

1 - lost or destroyed sometime between 2004 and 2007.
2 - installed by BR. 3 - ground elevations taken from Martens (july, 2009)

Source	GMB	GMB1	GMB2	GMB3	GMB4	GMB5	GMB6	GMB7	GMB8	GMB9	GMB10	GMB11	GMB12
		1	1	1									
	Ground level (mAHD)	1.020	2.370	0.845	2.045	2.608	0.861	2.963	2.598	2.859	1.490	3.395	3.261
	Concrete cap level (mAHD)	1.020	2.375	0.840	2.131	2.638	1.020	3.163	2.598	2.909	1.310	3.547	3.311
Source	Date												
Coffey (feb, 1996)	8/11/1994	0.570	0.850			1.488			1.388	1.459	0.700	1.837	1.951
	24/11/1994	0.410	0.785	0.260		1.338		1.713	1.268	1.319		1.657	1.761
	6/12/1994	0.300	0.735	0.300		1.268		1.593	1.188	1.319		1.597	1.621
	22/12/1994	0.250	0.685	0.060		1.188		1.553	1.108	1.229	0.390	1.457	1.481
	6/01/1995	0.650	0.835	0.720		1.298		1.733	1.258	1.449	0.620	1.437	1.591
	21/02/1995	0.570	0.765	0.550		1.138		1.563	1.078	1.329	0.480	1.347	1.371
	8/03/1995	0.240	1.525	0.550		1.658		2.568	0.728	1.159	0.760	2.047	2.332
	14/03/1995	0.855	1.295	0.780		2.278		2.593	2.098	1.749	0.800	2.127	2.421
	31/03/1995	0.595	1.020	0.660		1.713		2.243	1.578	1.549	0.615	1.952	1.921
	19/04/1995	0.440	0.985	0.525		1.433		1.938	1.328	1.399	0.485	1.717	1.646
	2/05/1995	0.370	0.800	0.250		1.363		1.803	1.218	1.329	0.395	1.562	1.486
	17/05/1995	0.910	0.995	0.760		1.823		2.133	1.628	1.429	0.830	1.697	1.831
	18/05/1995	0.930	1.375	0.760		2.328		2.403	2.258	1.699	0.910	2.237	1.601
	19/05/1995	0.900	1.365	0.760		2.358		2.443	2.208	1.699	0.890	2.067	1.681
	22/05/1995	0.925	1.795	0.790				2.703	2.458	1.859	1.110	2.257	2.761
	23/05/1995	0.920	1.825	0.780		2.558		2.723	2.408	1.899	1.070	2.337	2.971
	24/05/1995	0.920	1.715	0.780		2.538		2.733	2.368	1.859	1.030	2.337	3.051
	25/05/1995	0.910	1.685	0.780		2.548		2.763	2.348	1.839	1.020	2.477	2.931
	26/05/1995	0.920	1.695	0.770		2.548		2.743	2.368	1.829	1.050	2.447	2.951
	21/06/1995	0.880	2.015	0.785				2.803	2.428	1.969	1.210	2.777	3.041
	13/07/1995	0.710	1.965	0.760		2.228		2.713	2.188	1.939	1.230	2.747	2.721
	26/07/1995	0.640	0.925	0.740		1.898		2.413	1.958	1.749	1.030	3.007	2.521
	11/08/1995	0.580	0.825	0.720	1.071	1.608	0.670	2.183	1.778	1.719	0.970	1.967	2.261
	28/08/1995	0.510		0.460	0.821	1.478	0.280	1.953	1.528	1.559	0.760	1.837	2.071
	19/09/1995	0.600		0.740		2.328		2.423	2.328	1.869	1.160	2.377	2.491
	20/09/1995	0.620		0.750	1.301	1.598	0.750	2.603	2.278	1.929	1.140		2.641
	Late July 1994 - mid Nov 1994						0.500						
	Late July 1994 - late Sept 1994				1.100								
Coffey (Oct, 2007)	7/04/2004			0.298	1.144	2.043	0.768	2.816	2.314	2.111	1.101	2.562	2.708
	11/05/2004			0.232	0.928	1.451		2.081	1.774	1.880	0.836	1.939	2.120
	29/03/2007				0.823	1.303			1.534	1.657	0.541	1.689	1.655
Martens & Associates (July, 2009)	04/06/2009 - 6/7/2009							2.891		2.375			
Martens & Associates (Early Sept 2012)	03/09/2012 or 04/09/2012			0.745	0.985	1.928	0.743	2.383	2.268	2.059	0.975	2.495	2.541
Martens & Associates (Late Sept 2012)	25/09/2012 & 26/09/2012				0.905	1.748	0.563	2.233	2.098	1.959	0.890	2.295	
Tattersall Lander (Oct 2012)	11/10/2012												
	Minimum Level (mAHD)	0.24	0.69	0.06	0.82	1.14	0.28	1.55	0.73	1.16	0.39	1.35	1.37
	Median Level (mAHD)	0.63	1.02	0.74	0.99	1.71	0.67	2.41	1.96	1.73	0.89	2.06	2.19
	Mean Level (mAHD)	0.66	1.24	0.61	1.01	1.81	0.61	2.31	1.83	1.69	0.86	2.08	2.20
	Maximum Level (mAHD)	0.93	2.02	0.79	1.30	2.56	0.77	2.89	2.46	2.38	1.23	3.01	3.05
	Min Depth (m) to GW	0.09	0.36	0.06	0.74	0.05	0.09	0.07	0.14	0.48	0.26	0.39	0.21
	Depth range	0.69	1.33	0.73	0.48	1.42	0.49	1.34	1.73	1.22	0.84	1.66	1.68
	Mean Depth (m) below Ground level	0.36	1.13	0.24	1.04	0.80	0.25	0.65	0.77	1.17	0.63	1.32	1.06

Source	GMB	GMB21	GMB22	GMB23	GMB24	GMB1A	GMB2A	GMB25	Lake 26	GMB201	GMB202	GMB203
						2	2	2	2			
	Ground level (mAHD)	1.026	1.095	1.111	0.834	1.708	2.479	1.798	0.492	2.740	3.690	5.140
	Concrete cap level (mAHD)											
Coffey (Oct, 2007)	11/05/2004	0.778	0.876	0.930	0.681							
	29/03/2007	0.813	0.826	0.760	0.628							
Martens & Associates (July, 2009)	04/06/2009 - 6/7/2009			1.270		0.838	1.198	0.872	0.708			
Martens & Associates (Early Sept 2012)	03/09/2012 or 04/09/2012	0.803	0.766	0.831	0.834	0.738		0.753				
Martens & Associates (Late Sept 2012)	25/09/2012 & 26/09/2012									2.08	1.00	4.11
Tattersall Lander (Oct 2012)	11/10/2012									1.90	0.90	3.82
	Minimum Level (mAHD)	0.78	0.77	0.76	0.63	0.74	1.20	0.75	0.71	1.90	0.90	3.82
	Median Level (mAHD)	0.80	0.83	0.88	0.68	0.79	1.20	0.81	0.71	1.99	0.95	3.97
	Mean Level (mAHD)	0.80	0.82	0.95	0.71	0.79	1.20	0.81	0.71	1.99	0.95	3.97
	Maximum Level (mAHD)	0.81	0.88	1.27	0.83	0.84	1.20	0.87	0.71	2.08	1.00	4.11
	Min Depth (m) to GW	0.21	0.22	-0.16	0.00	0.87	1.28	0.93	-0.22	0.66	2.69	1.03
	Depth range	0.03	0.11	0.51	0.21	0.10	0.00	0.12	0.00	0.18	0.10	0.29
	Mean Depth (m) below Ground level	0.23	0.27	0.16	0.12	0.92	1.28	0.99	-0.22	0.75	2.74	1.18

(yellow) estimated **median** based on visual observation of plot

(green) **mean** from martens diver monitoring

20 Attachment 4C – Groundwater Quality Data

Source	Sample date		GMB1	GMB2	GMB3	GMB4	GMB5	GMB6	GMB7	GMB8	GMB9	GMB10	GMB11	GMB12	GMB13	GMB21	GMB22	GMB23	GMB24	GMB1A	GMB2A	GMB25	Lake 26	Lake	GMB201	GMB202	GMB203
Coffey (Feb, 1996)	Average result 13/12/94 to 29/8/1995	pH	6.40	5.30	6.20			6.00				5.60	6.00	5.30													
		TDS (mg/L)	490.00	190.00	13900.00			1900.00				420.00	2300.00	220.00													
		Chloride (mg/L)	220.00	82.00	7600.00			1100.00				150.00	1200.00	60.00													
		Sulphate (mg/L)	33.00	16.00	1200.00			170.00				**5.00**	170.00	25.00													
		Magnesium (mg/L)	36.00	6.00	540.00			76.00				8.40	85.00	5.20													
		Calcium (mgLL)	9.00	1.20	160.00			33.00				7.20	22.00	2.20													
Coffey (Oct, 2007)	29/03/2007	pH				5.32								5.02		5.62	6.05	5.60	5.46								
		TDS (mg/L)				155.00								1210.00		11500.00	1350.00	212.00	2250.00								
		Chloride (mg/L)				50.40								64.60		5300.00	430.00	58.70	800.00								
		Sulphate (mg/L)				10.00								22.00		702.00	39.00	6.00	344.00								
		Magnesium (mg/L)				4.00								6.00		420.00	23.00	7.00	54.00								
		Calcium (mgLL)				2.00								2.00		126.00	11.00	3.00	31.00								
		EC (us/cm)				202.00								268.00		15500.00	1610.00	234.00	2730.00								
		TN (mg/L)				0.93								3.07		12.13	7.24	2.51	9.33								
		TP (mg/L)				0.14								0.76		1.38	0.79	0.32	1.12								
Coffey (Oct, 2007)	30/03/2007	pH									3.99													5.83			
		TDS (mg/L)									200.00													129.00			
		Chloride (mg/L)									34.40													37.40			
		Sulphate (mg/L)									13.00													12.00			
		Magnesium (mg/L)									3.00													3.00			
		Calcium (mgLL)									**1.00**													8.00			
		EC (us/cm)									178.00													182.00			
		TN (mg/L)									2.53													0.72			
		TP (mg/L)									1.00													0.08			
Martens and Associates (July, 2009)	6/07/2009	pH									4.30							5.70		6.20	5.10	5.60	6.30				
		TDS (mg/L)									96.00							180.00		170.00	120.00	160.00	11000.00				
		Chloride (mg/L)									37.00							65.00		30.00	50.00	25.00	5800.00				
		Sulphate (mg/L)									**5.00**							**5.00**		39.00	**5.00**	5.00	850.00				
		Magnesium (mg/L)									2.90							7.80		8.20	3.40	4.40	360.00				
		Calcium (mgLL)									0.30							3.60		5.60	1.20	3.60	110.00				
		EC (us/cm)									160.00							280.00		280.00	200.00	260.00	14000.00				
		TN (mg/L)									1.00							**0.60**		7.10	3.80	30.00	**0.60**				
		TP (mg/L)									1.90							**0.05**		6.10	2.80	1.20	**0.05**				
Martens and Associates (Sept, 2012)	4/09/2012	pH			6.7	6.20	6.30	6.40		5.80	4.00		6.10									6.30	7.30				
		TDS (mg/L)			7300	120.00	200.00	3500.00		200.00	160.00		2800.00									130.00	10000.00				
		Chloride (mg/L)			5500	75.00	49.00	1700.00		62.00	27.00		1300.00									36.00	4900.00				
		Sulphate (mg/L)			760	4.00	10.00	210.00		20.00	**1.00**		170.00									1.00	600.00				
		Magnesium (mg/L)			370	6.10	2.10	130.00		4.80	3.10		77.00									4.20	300.00				
		Calcium (mgLL)			110	2.40	0.90	49.00		2.80	0.50		18.00									4.20	97.00				
		EC (us/cm)			18000	320.00	260.00	6400.00		310.00	170.00		4700.00									240.00	16000.00				
		TN (mg/L)			2.2	1.90	1.90	0.90		1.90	2.80		0.70									5.30	0.90				
		TP (mg/L)			**0.05**	**0.05**	0.09	**0.05**		0.10	1.30		0.50									0.20	**0.05**				
Martens and Associates (Sept, 2012)	27/09/2012	pH					5.80	5.70	5.50	5.20	4.10	6.00	5.60												5.30	5.40	5.30
		TDS (mg/L)					180.00	4900.00	120.00	160.00	150.00	160.00	2700.00												65.00	1200.00	110.00
		Chloride (mg/L)					44.00	2900.00	38.00	71.00	29.00	53.00	1400.00												640.00	18.00	43.00
		Sulphate (mg/L)					10.00	360.00	7.00	24.00	**1.00**	3.00	180.00												26.00	5.00	5.00
		Magnesium (mg/L)					1.50	170.00	3.70	5.00	3.10	10.00	87.00												42.00	1.90	4.00
		Calcium (mgLL)					0.60	67.00	3.60	3.10	**0.50**	6.20	21.00												13.00	1.70	1.10
		EC (us/cm)					230.00	8400.00	200.00	320.00	170.00	300.00	4600.00												2000.00	110.00	190.00
		TN (mg/L)					1.10	1.20	3.00	1.60	1.90	1.60	0.70												9.90	3.30	4.10
		TP (mg/L)					**0.05**	**0.05**	0.20	0.30	1.30	0.10	0.07												1.20	0.30	0.60

Value is less than laboratory PQL

21 Attachment 4D – Hydraulic Conductivity Test Results

Single Bore Slug Test (Rising or Falling)

Method ST-13 Revised 7.3.2007

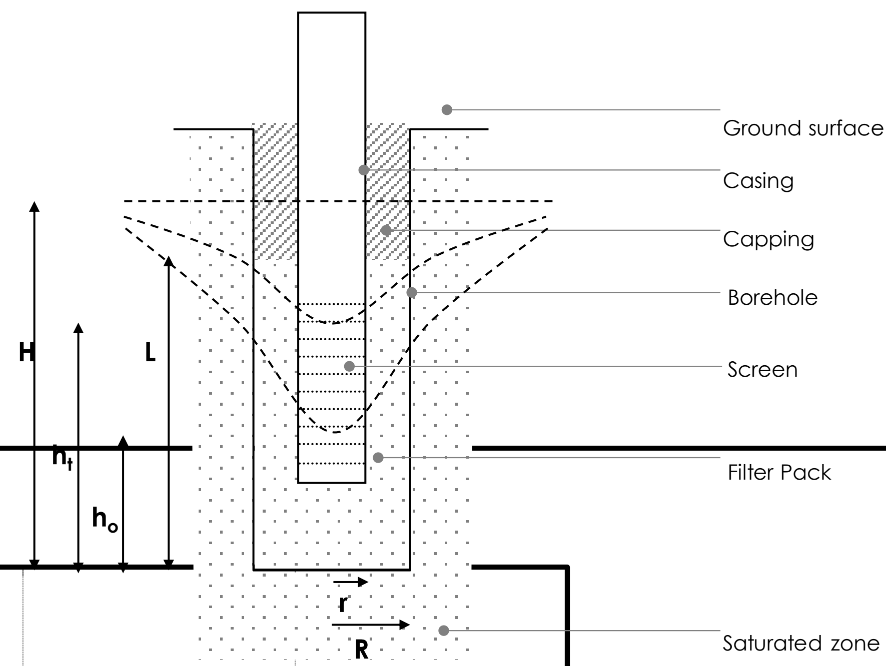
PROJECT DETAILS

Project	P902346 - Riverside	Test Date	04.09.12
Project Ref	P902346JS31V01	Field Testing	B. Rose and G. Harlow
Borehole Ref	GMB1a	Data Analysis	B. Rose
Method	Hvorslev (1981)	Reviewed	Dr D. Martens

FIELD TEST DATA

Screened material - clay

FACTOR	Enter Data	Unit
H - Initial water level reading (mH2O pressure)	11.13	mH2O
h_o - Water level reading at time = 0 (mH2O pressure)	12.48	mH2O
r - Casing radius	0.030	m
R - Bore radius	0.030	m
L - Length of open screen	1.00	m
T_o - Length of characteristic time	0.35	minutes
K_{sat} - Saturated hydraulic conductivity	6.50	m/d



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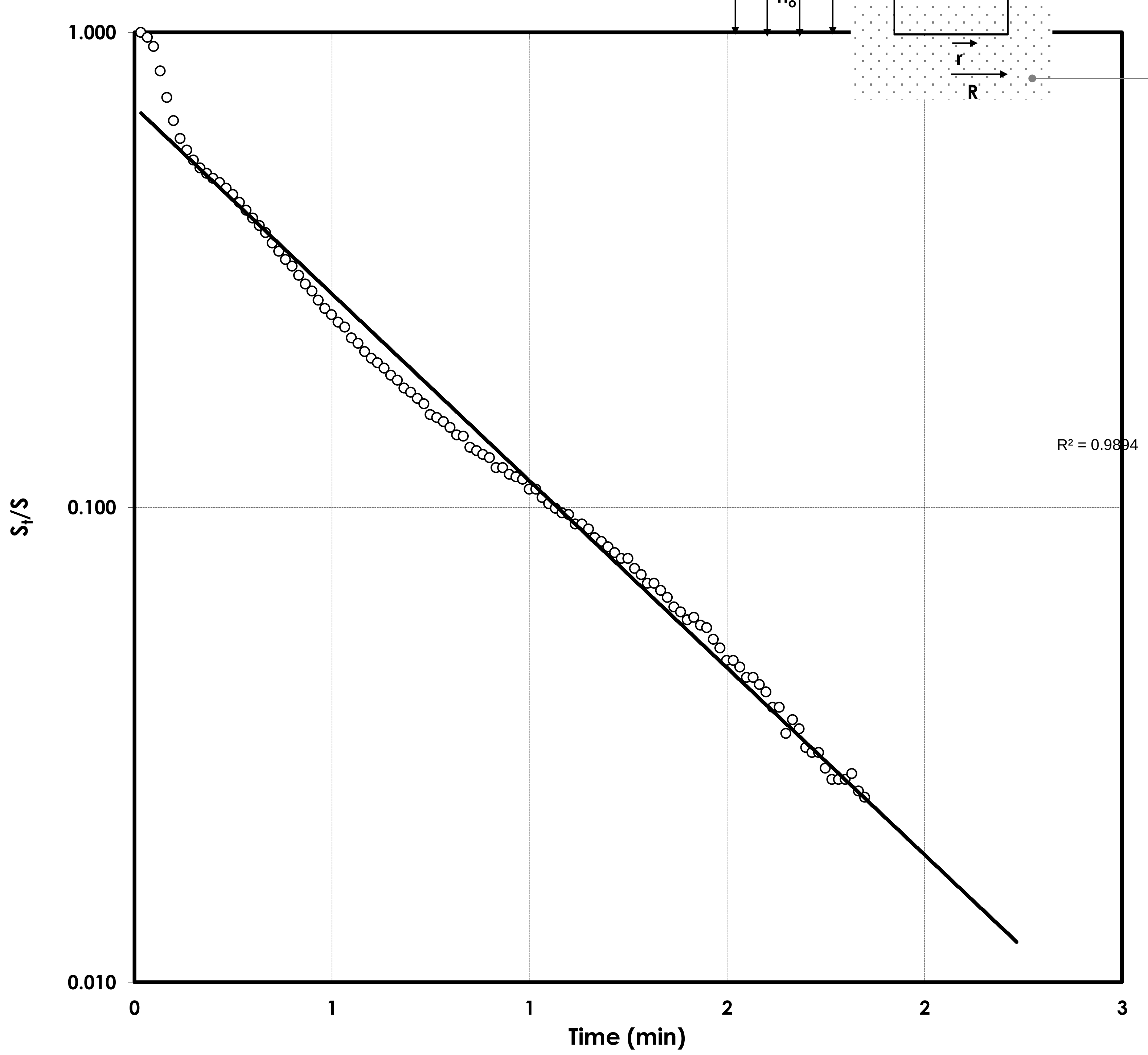

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Single Bore Slug Test (Rising or Falling)

Method ST-13 Revised 7.3.2007

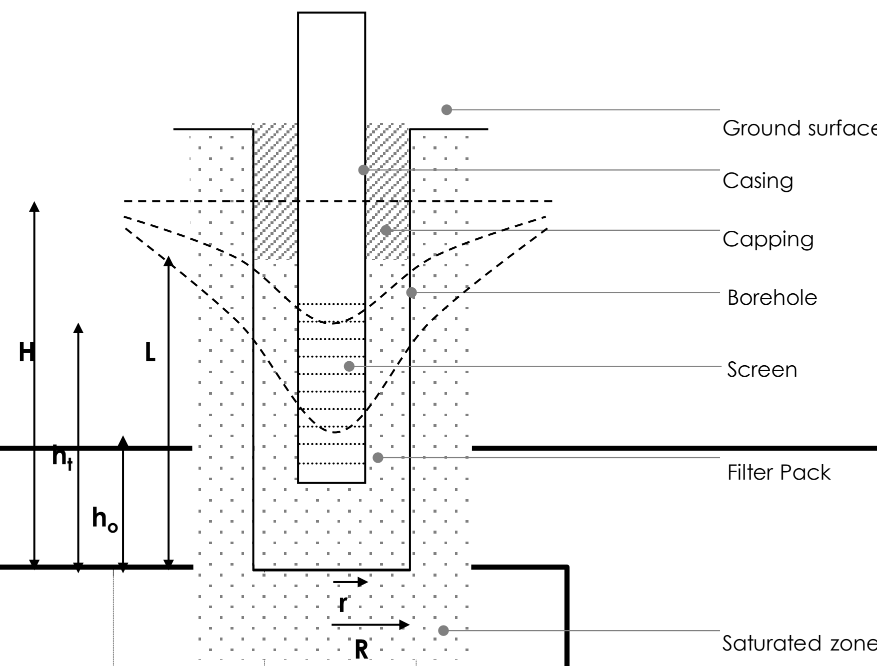
PROJECT DETAILS

Project	P902346 - Riverside	Test Date	04.09.12
Project Ref	P902346JS31V01	Field Testing	B. Rose and G. Harlow
Borehole Ref	GMB3	Data Analysis	B. Rose
Method	Hvorslev (1981)	Reviewed	Dr D. Martens

FIELD TEST DATA

Screened material - clay

FACTOR	Enter Data	Unit
H - Initial water level reading (mH2O pressure)	15.00	mH2O
h_o - Water level reading at time = 0 (mH2O pressure)	15.55	mH2O
r - Casing radius	0.030	m
R - Bore radius	0.030	m
L - Length of open screen	2.00	m
T_o - Length of characteristic time	0.12	minutes
K_{sat} - Saturated hydraulic conductivity	11.71	m/d



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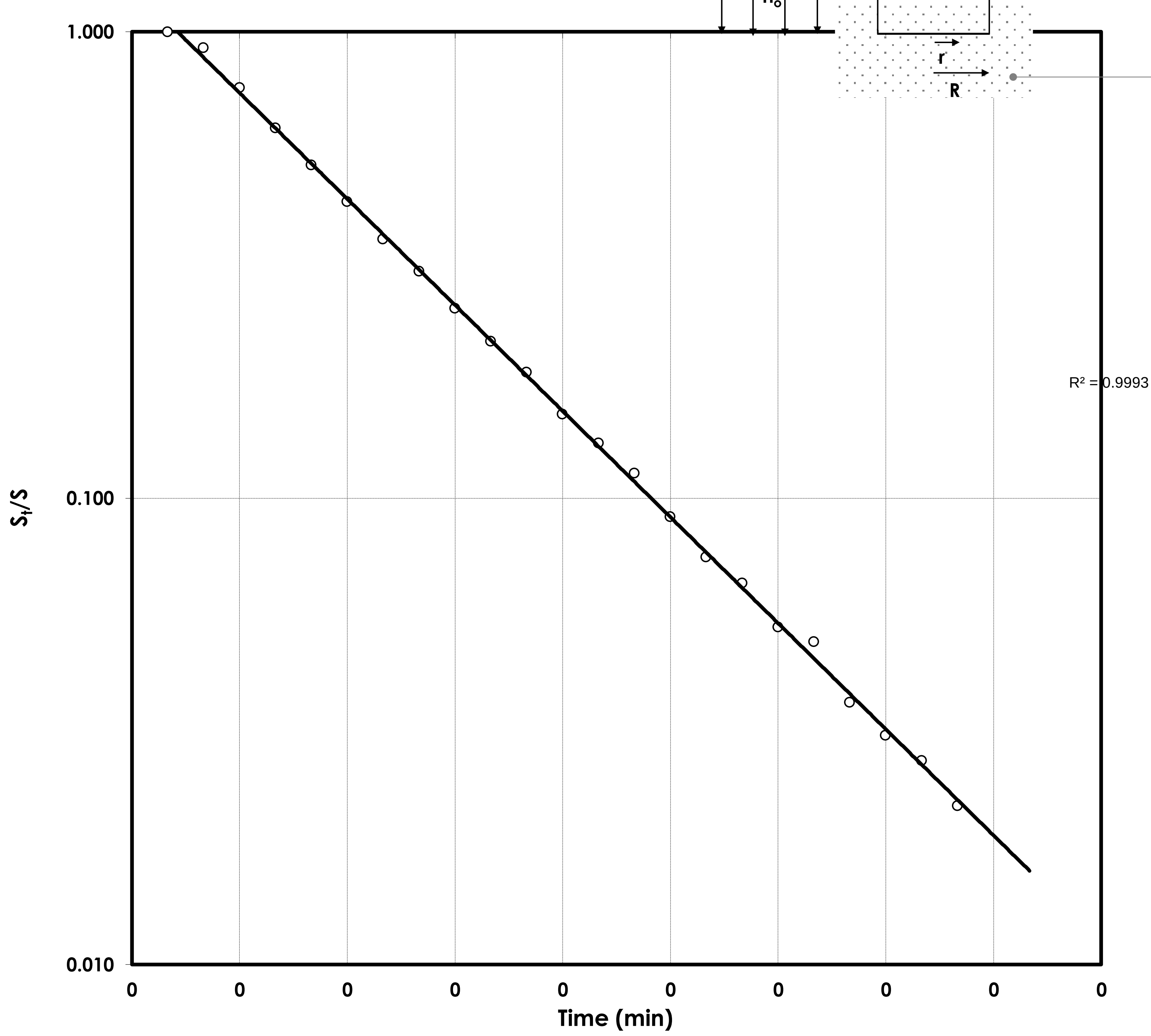

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Single Bore Slug Test (Rising or Falling)

Method ST-13 Revised 7.3.2007

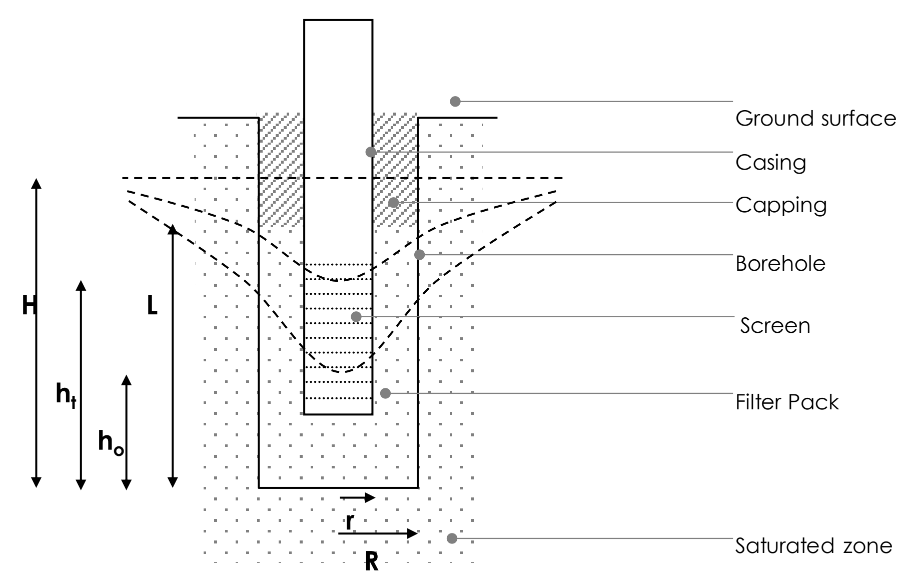
PROJECT DETAILS

Project	P902346 - Riverside	Test Date	04.09.12
Project Ref	P902346JS31V01	Field Testing	B. Rose and G. Harlow
Borehole Ref	GMB4	Data Analysis	B. Rose
Method	Hvorslev (1981)	Reviewed	Dr D. Martens

FIELD TEST DATA

Screened material - clay

FACTOR	Enter Data	Unit
H - Initial water level reading (mH2O pressure)	13.60	mH2O
h_o - Water level reading at time = 0 (mH2O pressure)	15.00	mH2O
r - Casing radius	0.030	m
R - Bore radius	0.030	m
L - Length of open screen	2.00	m
T_o - Length of characteristic time	0.10	minutes
K_{sat} - Saturated hydraulic conductivity	13.12	m/d



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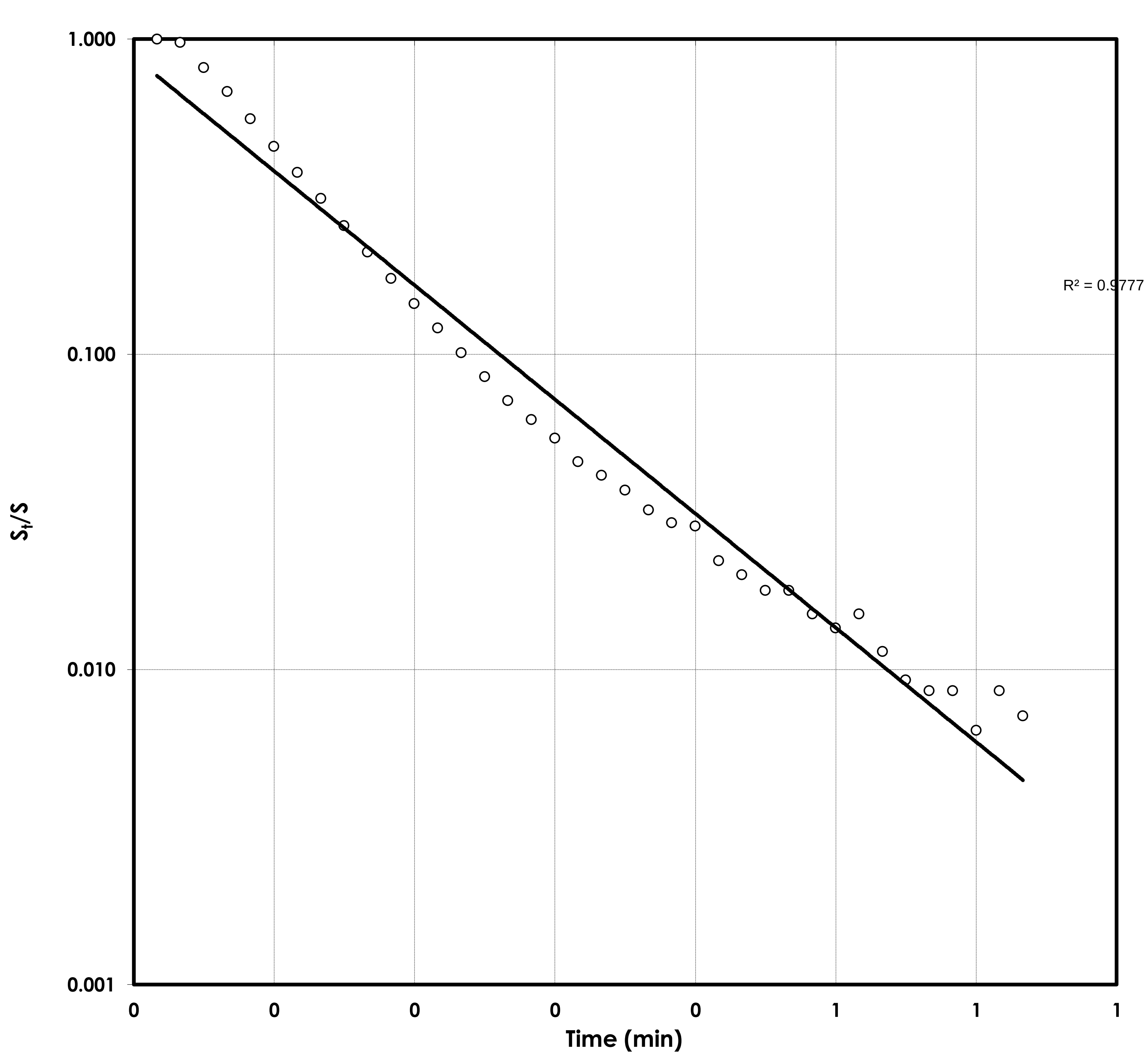

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Single Bore Slug Test (Rising or Falling)

Method ST-13 Revised 7.3.2007

Note - logger not used. Data quality poor. Permeability probbaly higher than test indicates

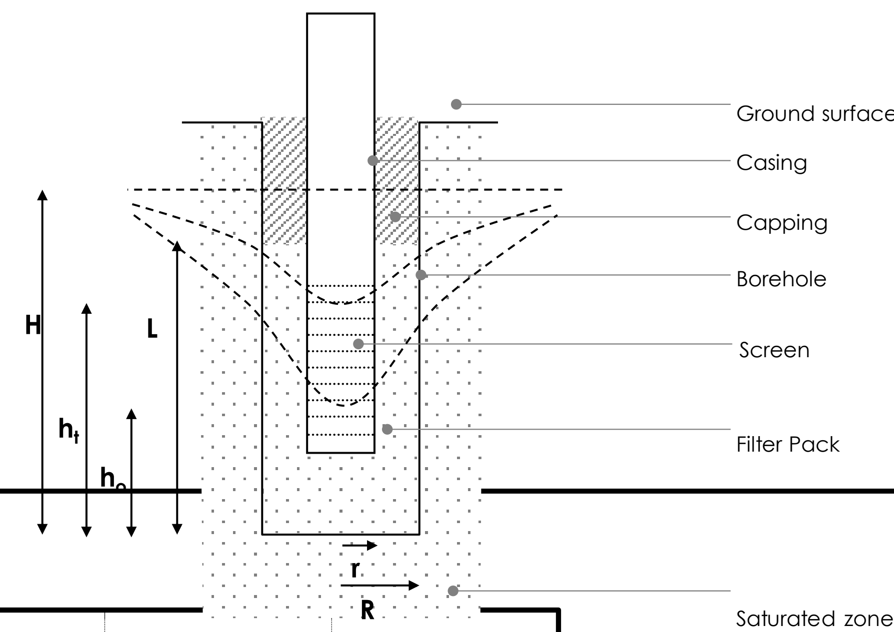
PROJECT DETAILS

Project	P902346 - Riverside	Test Date	25.09.12
Project Ref	P902346JS31V01	Field Testing	G. Harlow
Borehole Ref	GMB5 (2)	Data Analysis	G. Harlow
Method	Hvorslev (1981)	Reviewed	Dr D. Martens

FIELD TEST DATA

Screened material - clay

FACTOR	Enter Data	Unit
H - Initial water level reading (mH2O pressure)	13.17	mBTOP
h_o - Water level reading at time = 0 (mH2O pressure)	14.34	mBTOP
r - Casing radius	0.030	m
R - Bore radius	0.030	m
L - Length of open screen	2.00	m
T_o - Length of characteristic time	0.07	minutes
K_{sat} - Saturated hydraulic conductivity	18.42	m/d



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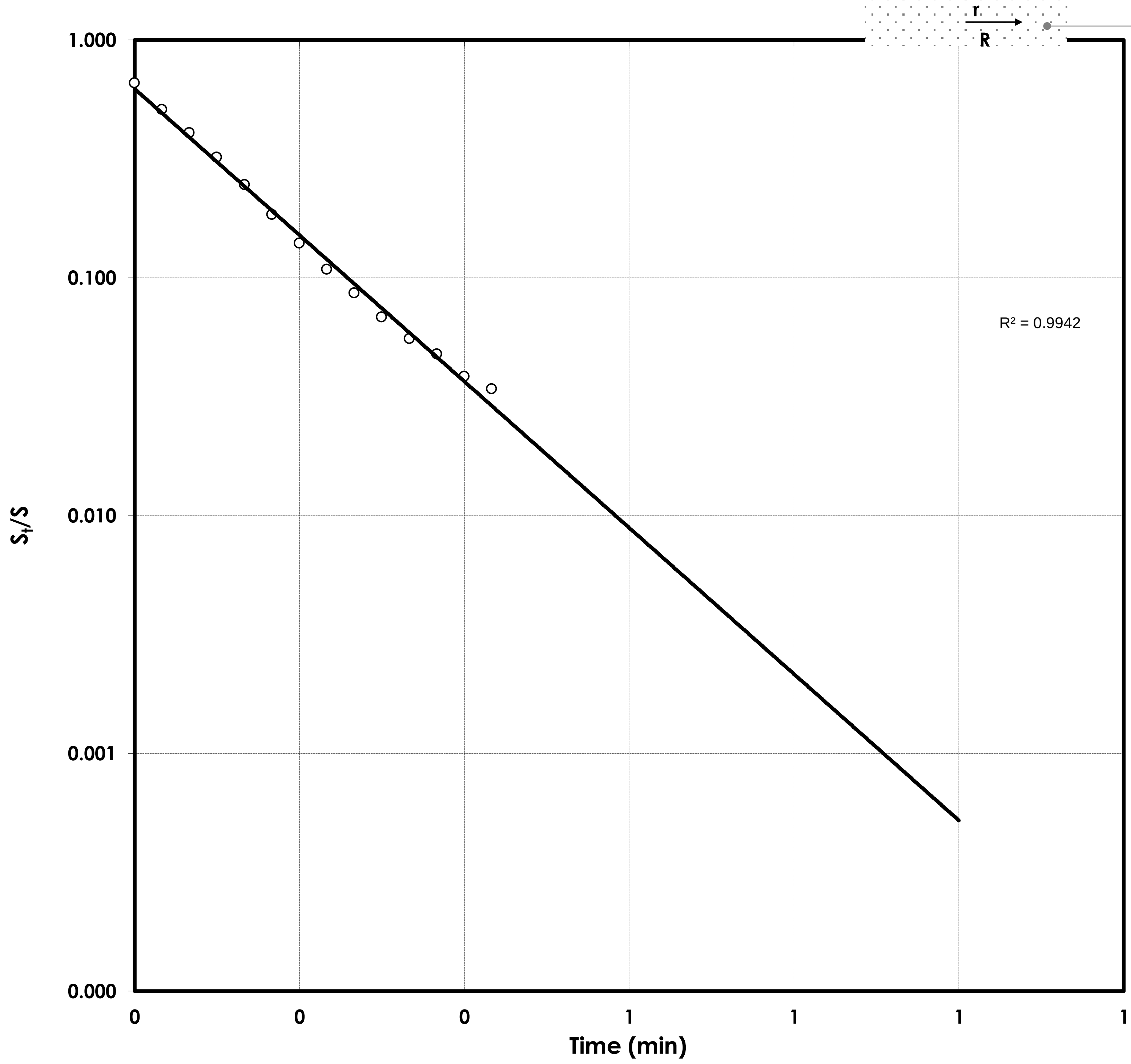

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Single Bore Slug Test (Rising or Falling)

Method ST-13 Revised 7.3.2007

Note - logger not used. Data quality poor. Permeability probbaly higher than test indicates

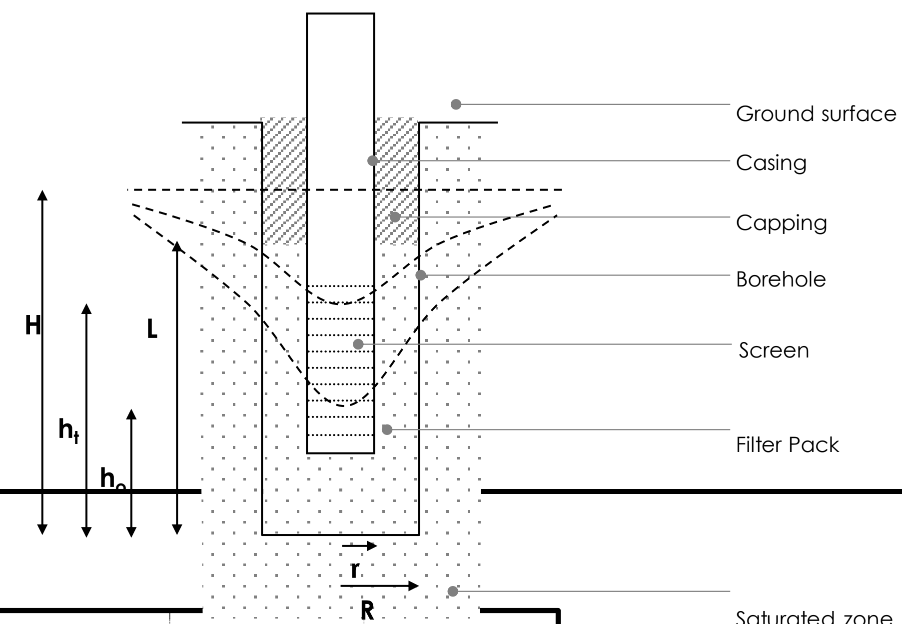
PROJECT DETAILS

Project	P902346 - Riverside	Test Date	25.09.12
Project Ref	P902346JS31V01	Field Testing	G. Harlow
Borehole Ref	GMB6 (2)	Data Analysis	B. Rose & G. Harlow
Method	Hvorslev (1981)	Reviewed	Dr D. Martens

FIELD TEST DATA

Screened material - clay

FACTOR	Enter Data	Unit
H - Initial water level reading (mH2O pressure)	14.47	mBTOP
h_o - Water level reading at time = 0 (mH2O pressure)	15.17	mBTOP
r - Casing radius	0.030	m
R - Bore radius	0.030	m
L - Length of open screen	2.00	m
T_o - Length of characteristic time	0.08	minutes
K_{sat} - Saturated hydraulic conductivity	16.99	m/d



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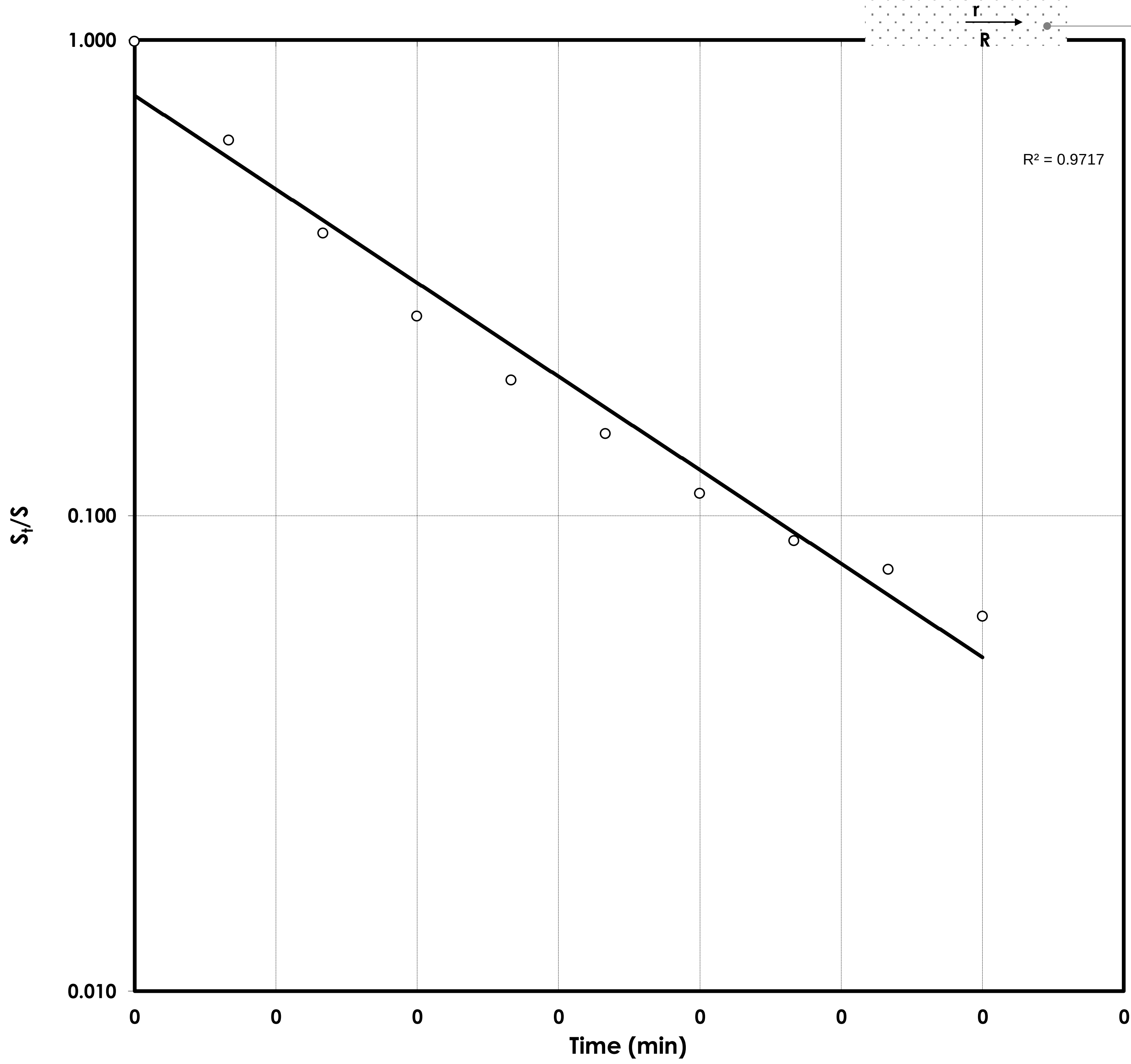

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Single Bore Slug Test (Rising or Falling)

Method ST-13 Revised 7.3.2007

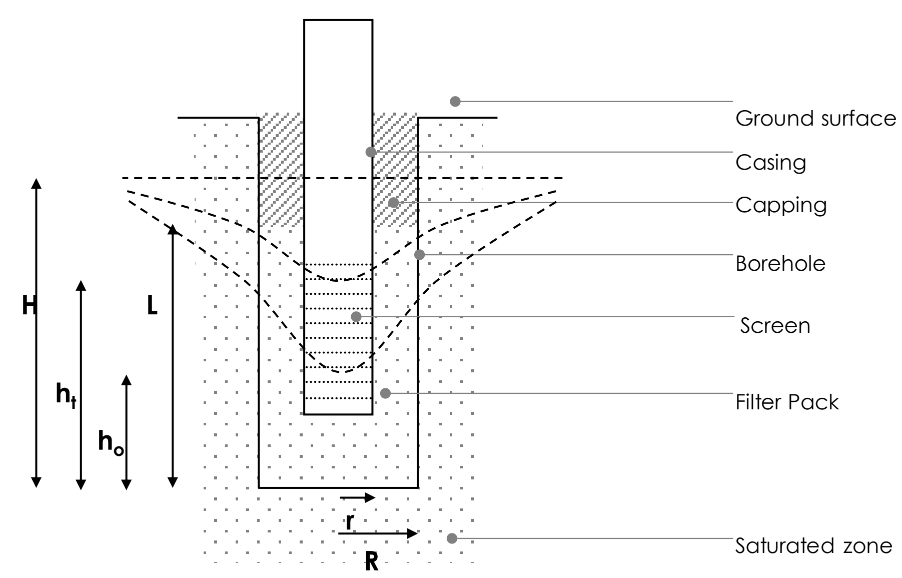
PROJECT DETAILS

Project	P902346 - Riverside	Test Date	03.09.12
Project Ref	P902346JS31V01	Field Testing	B. Rose and G. Harlow
Borehole Ref	GMB7	Data Analysis	B. Rose
Method	Hvorslev (1981)	Reviewed	Dr D. Martens

FIELD TEST DATA

Screened material - clay

FACTOR	Enter Data	Unit
H - Initial water level reading (mH2O pressure)	14.24	mH2O
h_o - Water level reading at time = 0 (mH2O pressure)	15.45	mH2O
r - Casing radius	0.030	m
R - Bore radius	0.030	m
L - Length of open screen	2.00	m
T_o - Length of characteristic time	0.31	minutes
K_{sat} - Saturated hydraulic conductivity	4.38	m/d



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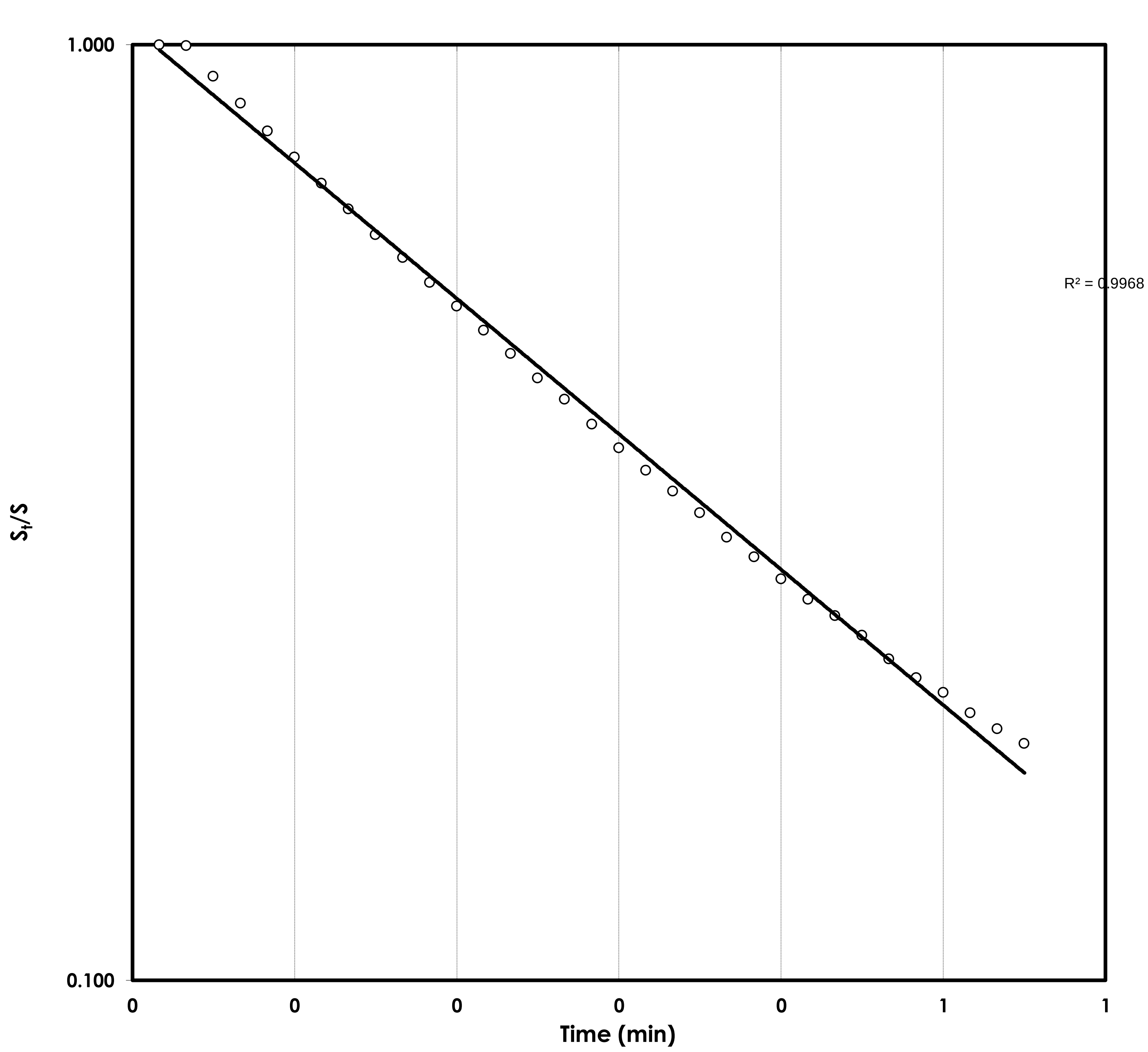

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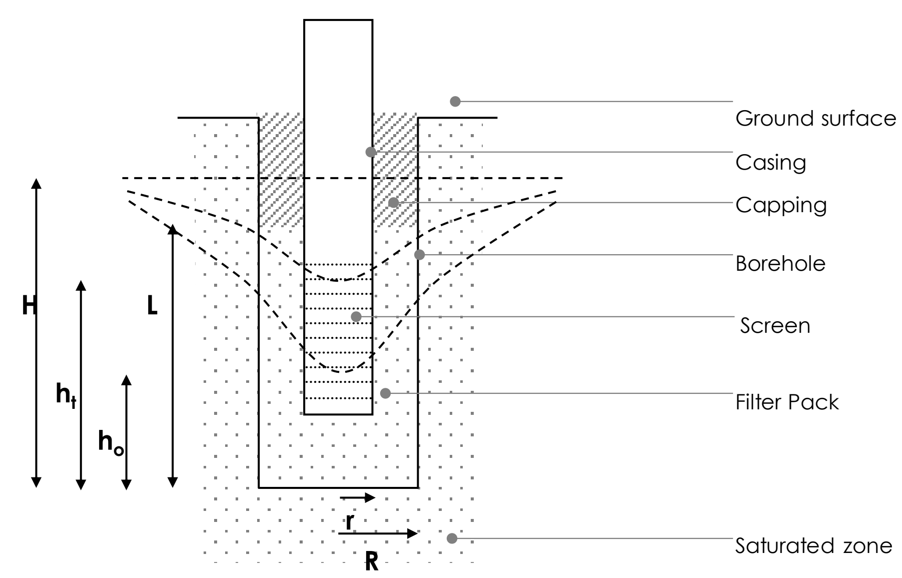
PROJECT DETAILS

Project	P902346 - Riverside	Test Date	03.09.12
Project Ref	P902346JS31V01	Field Testing	B. Rose and G. Harlow
Borehole Ref	GMB8	Data Analysis	B. Rose
Method	Hvorslev (1981)	Reviewed	Dr D. Martens

FIELD TEST DATA

Screened material - clay

FACTOR	Enter Data	Unit
H - Initial water level reading (mH2O pressure)	13.19	mH2O
h_o - Water level reading at time = 0 (mH2O pressure)	12.96	mH2O
r - Casing radius	0.030	m
R - Bore radius	0.030	m
L - Length of open screen	2.00	m
T_o - Length of characteristic time	0.39	minutes
K_{sat} - Saturated hydraulic conductivity	3.49	m/d



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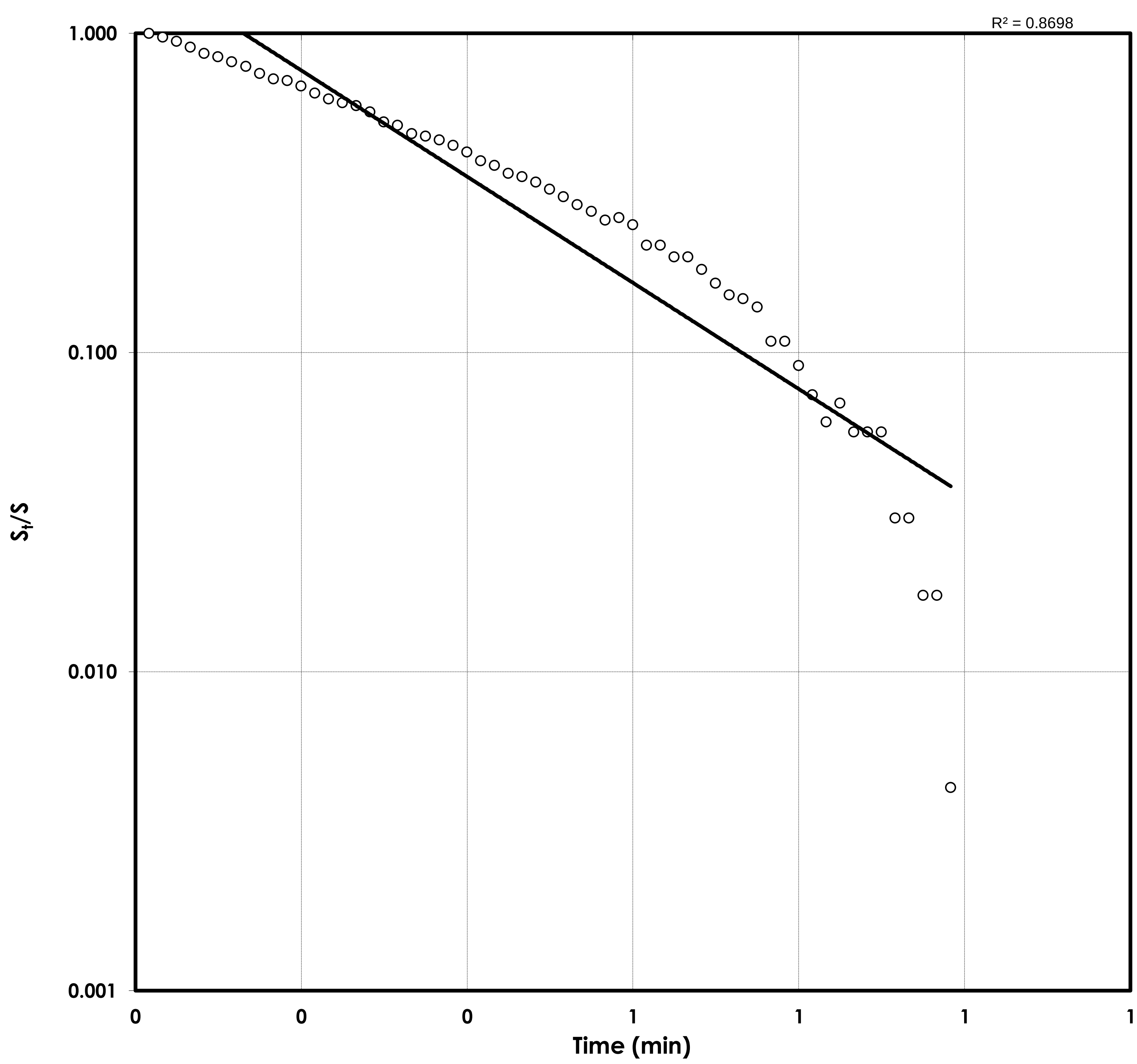

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Single Bore Slug Test (Rising or Falling)

Method ST-13 Revised 7.3.2007

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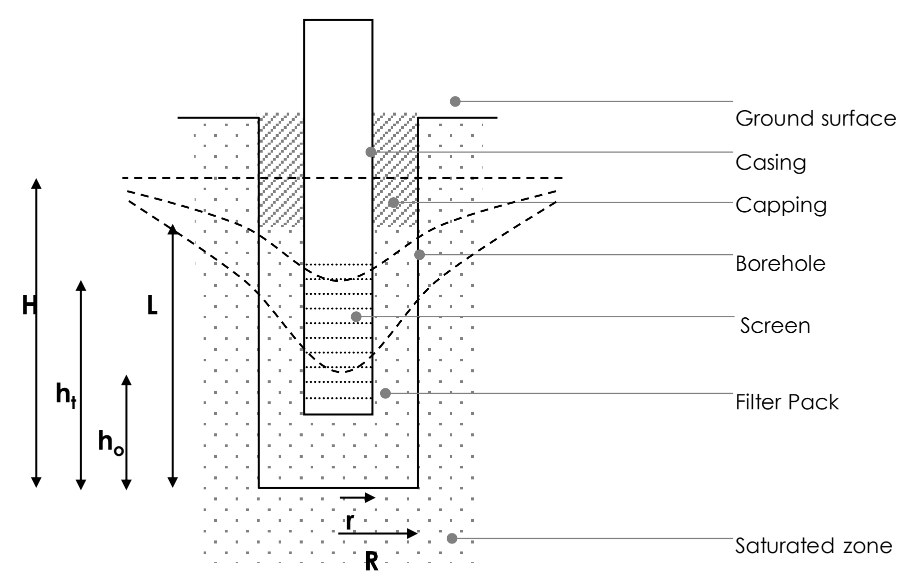
PROJECT DETAILS

Project	P902346 - Riverside	Test Date	04.09.12
Project Ref	P902346JS31V01	Field Testing	B. Rose and G. Harlow
Borehole Ref	GMB9	Data Analysis	B. Rose
Method	Hvorslev (1981)	Reviewed	Dr D. Martens

FIELD TEST DATA

Screened material - clay

FACTOR	Enter Data	Unit
H - Initial water level reading (mH2O pressure)	15.37	mH2O
h_o - Water level reading at time = 0 (mH2O pressure)	16.07	mH2O
r - Casing radius	0.030	m
R - Bore radius	0.030	m
L - Length of open screen	2.00	m
T_o - Length of characteristic time	0.30	minutes
K_{sat} - Saturated hydraulic conductivity	4.54	m/d



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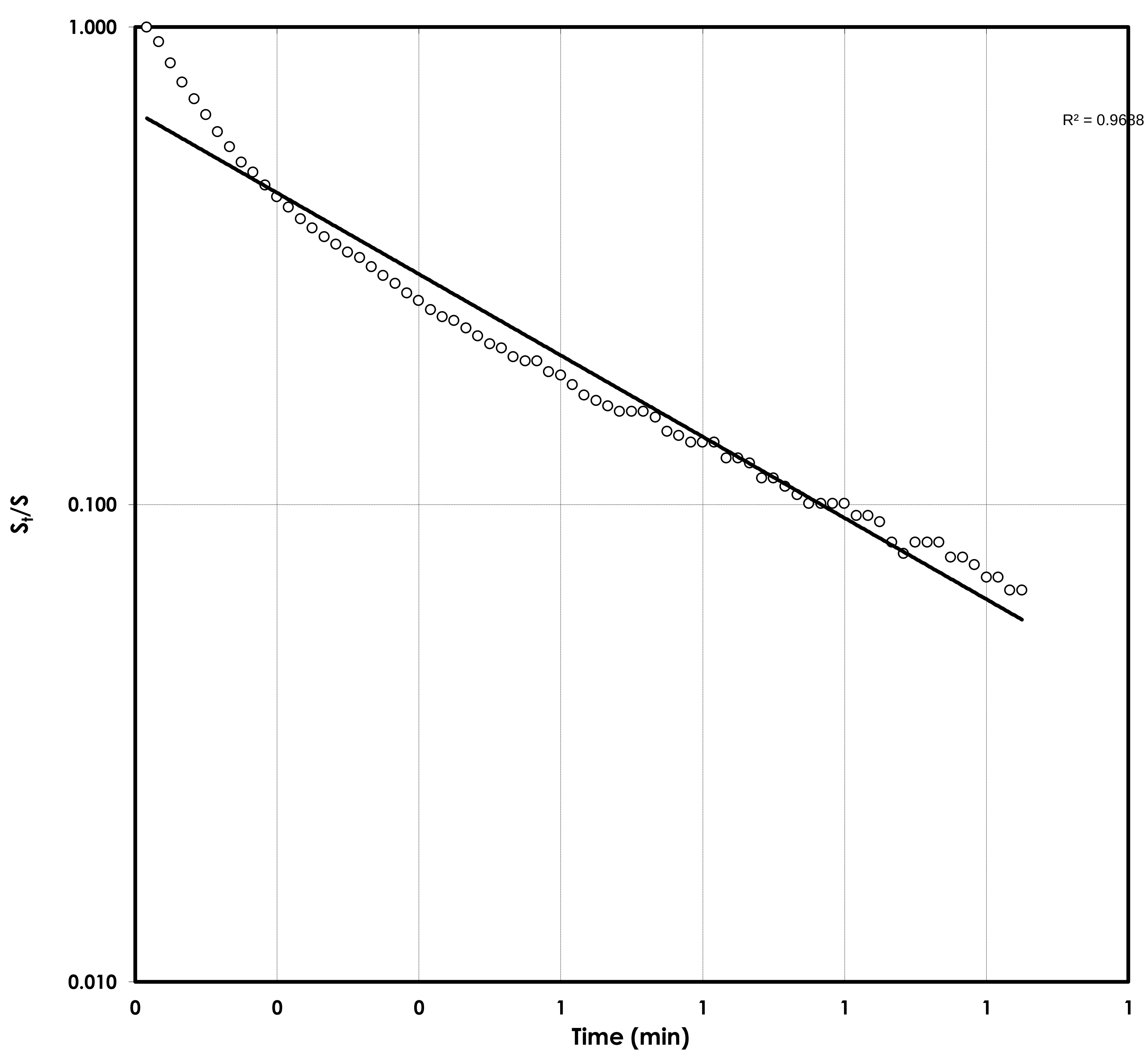

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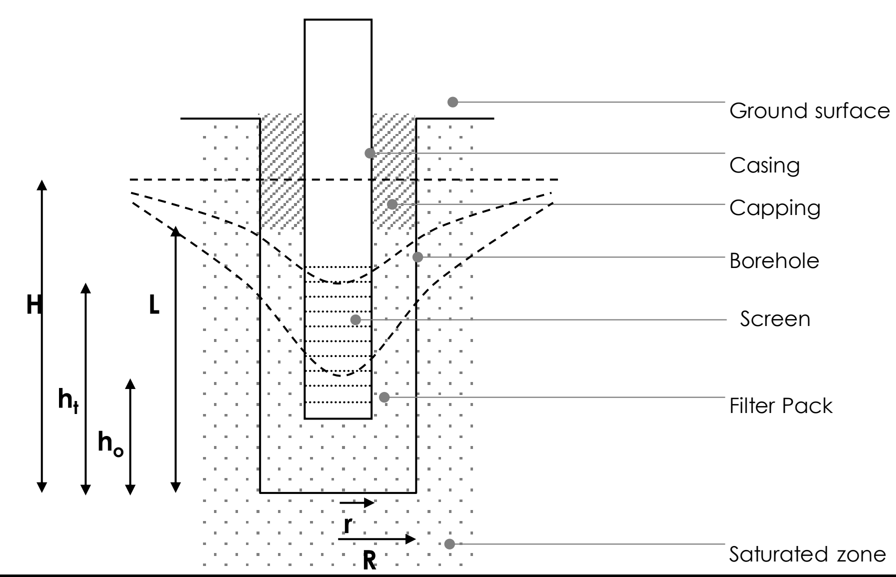
PROJECT DETAILS

Project	P902346 - Riverside	Test Date	04.09.12
Project Ref	P902346JS31V01	Field Testing	B. Rose and G. Harlow
Borehole Ref	GMB10	Data Analysis	B. Rose
Method	Hvorslev (1981)	Reviewed	Dr D. Martens

FIELD TEST DATA

Screened material - clay

FACTOR	Enter Data	Unit
H - Initial water level reading (mH2O pressure)	11.22	mH2O
h_o - Water level reading at time = 0 (mH2O pressure)	11.90	mH2O
r - Casing radius	0.030	m
R - Bore radius	0.030	m
L - Length of open screen	2.00	m
T_o - Length of characteristic time	0.08	minutes
K_{sat} - Saturated hydraulic conductivity	16.62	m/d



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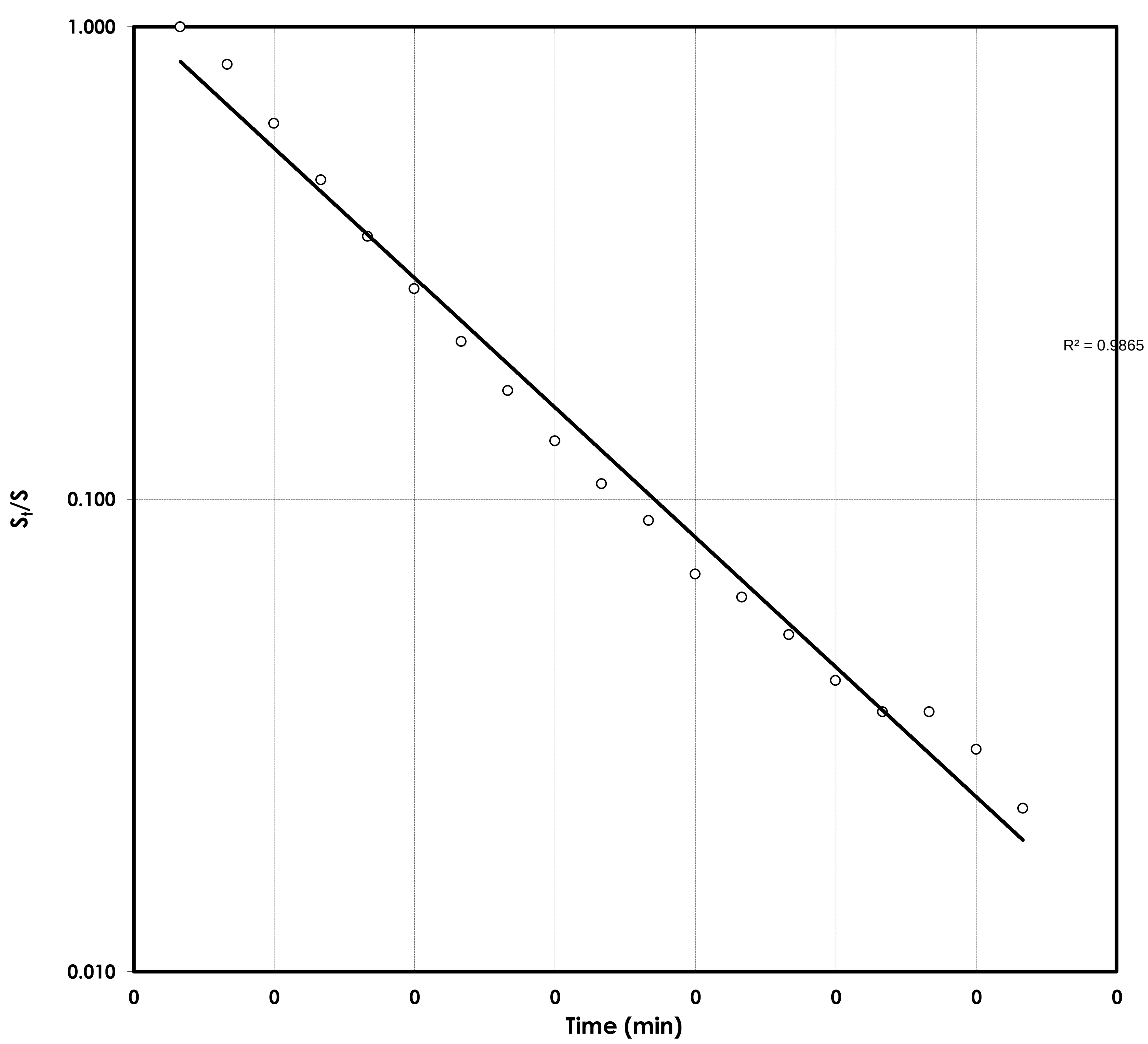

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Single Bore Slug Test (Rising or Falling)

Method ST-13 Revised 7.3.2007

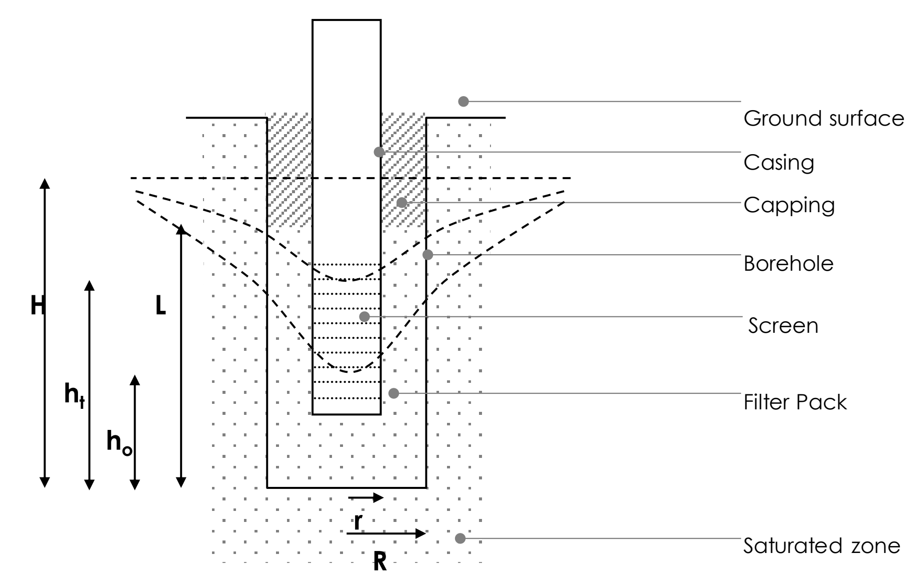
PROJECT DETAILS

Project	P902346 - Riverside	Test Date	04.09.12
Project Ref	P902346JS31V01	Field Testing	B. Rose and G. Harlow
Borehole Ref	GMB11	Data Analysis	B. Rose
Method	Hvorslev (1981)	Reviewed	Dr D. Martens

FIELD TEST DATA

Screened material - clay

FACTOR	Enter Data	Unit
H - Initial water level reading (mH2O pressure)	13.90	mH2O
h_o - Water level reading at time = 0 (mH2O pressure)	14.71	mH2O
r - Casing radius	0.030	m
R - Bore radius	0.030	m
L - Length of open screen	2.00	m
T_o - Length of characteristic time	0.44	minutes
K_{sat} - Saturated hydraulic conductivity	3.10	m/d



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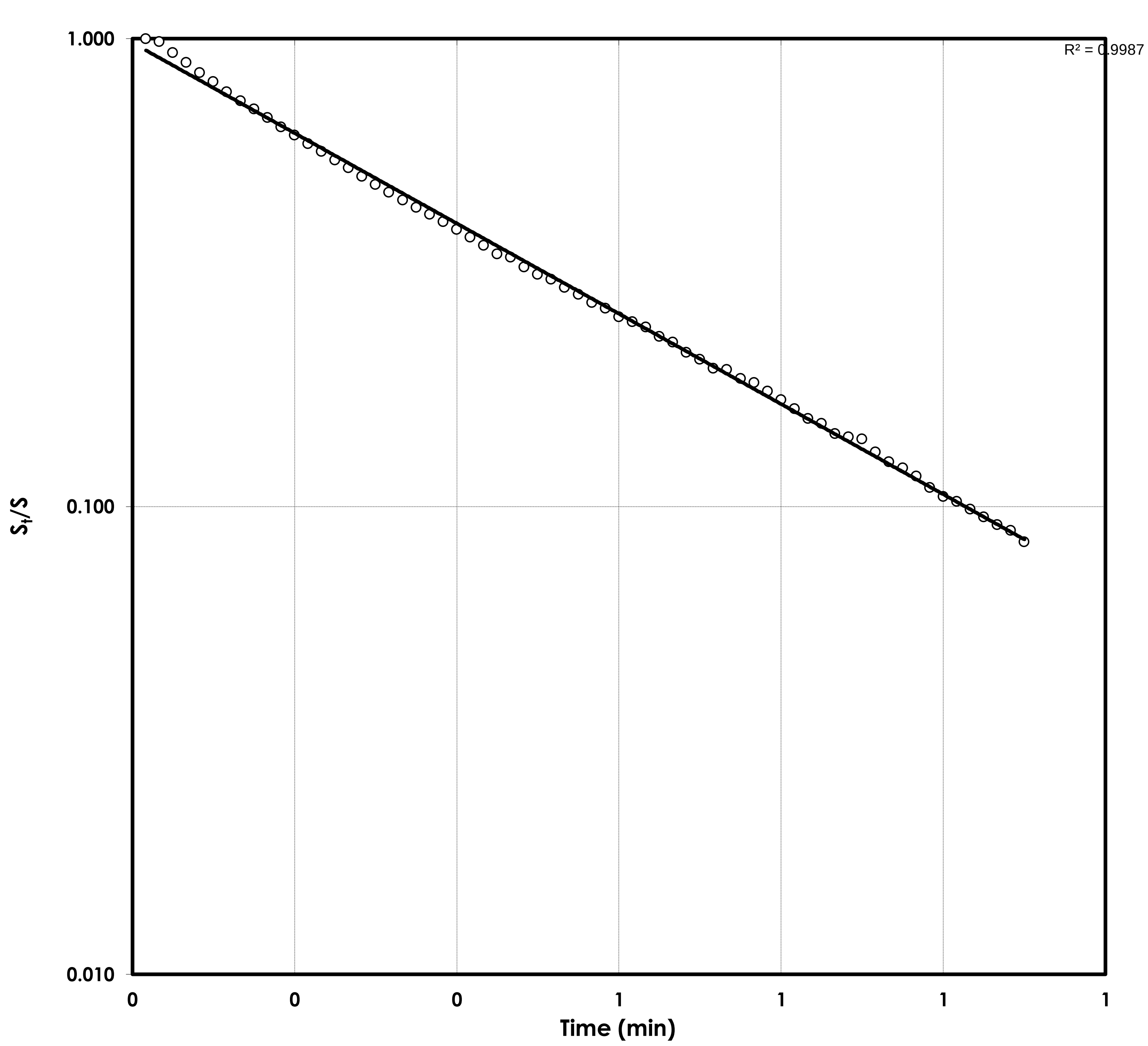

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Single Bore Slug Test (Rising or Falling)

Method ST-13 Revised 7.3.2007

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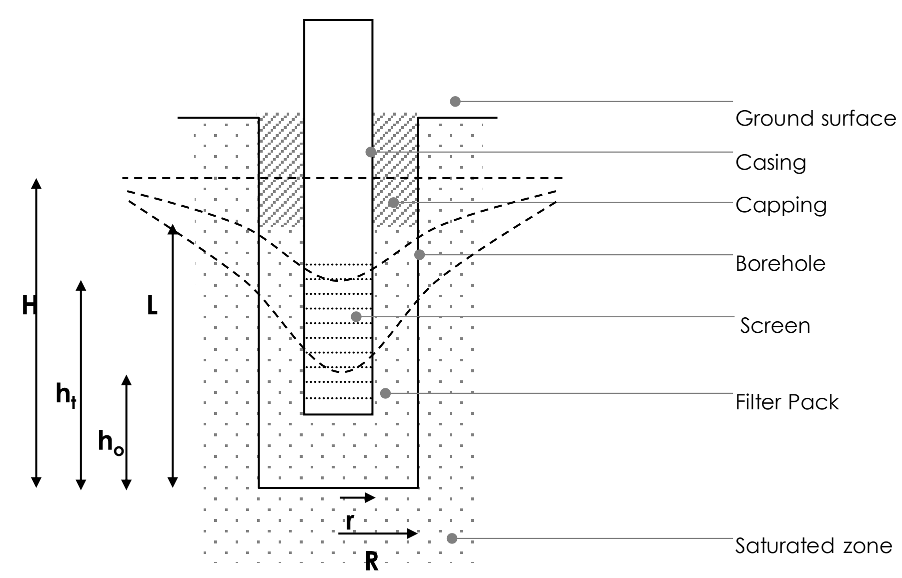
PROJECT DETAILS

Project	P902346 - Riverside	Test Date	04.09.12
Project Ref	P902346JS31V01	Field Testing	B. Rose and G. Harlow
Borehole Ref	GMB12	Data Analysis	B. Rose
Method	Hvorslev (1981)	Reviewed	Dr D. Martens

FIELD TEST DATA

Screened material - clay

FACTOR	Enter Data	Unit
H - Initial water level reading (mH2O pressure)	12.00	mH2O
h_o - Water level reading at time = 0 (mH2O pressure)	13.07	mH2O
r - Casing radius	0.030	m
R - Bore radius	0.030	m
L - Length of open screen	2.00	m
T_o - Length of characteristic time	0.29	minutes
K_{sat} - Saturated hydraulic conductivity	4.77	m/d



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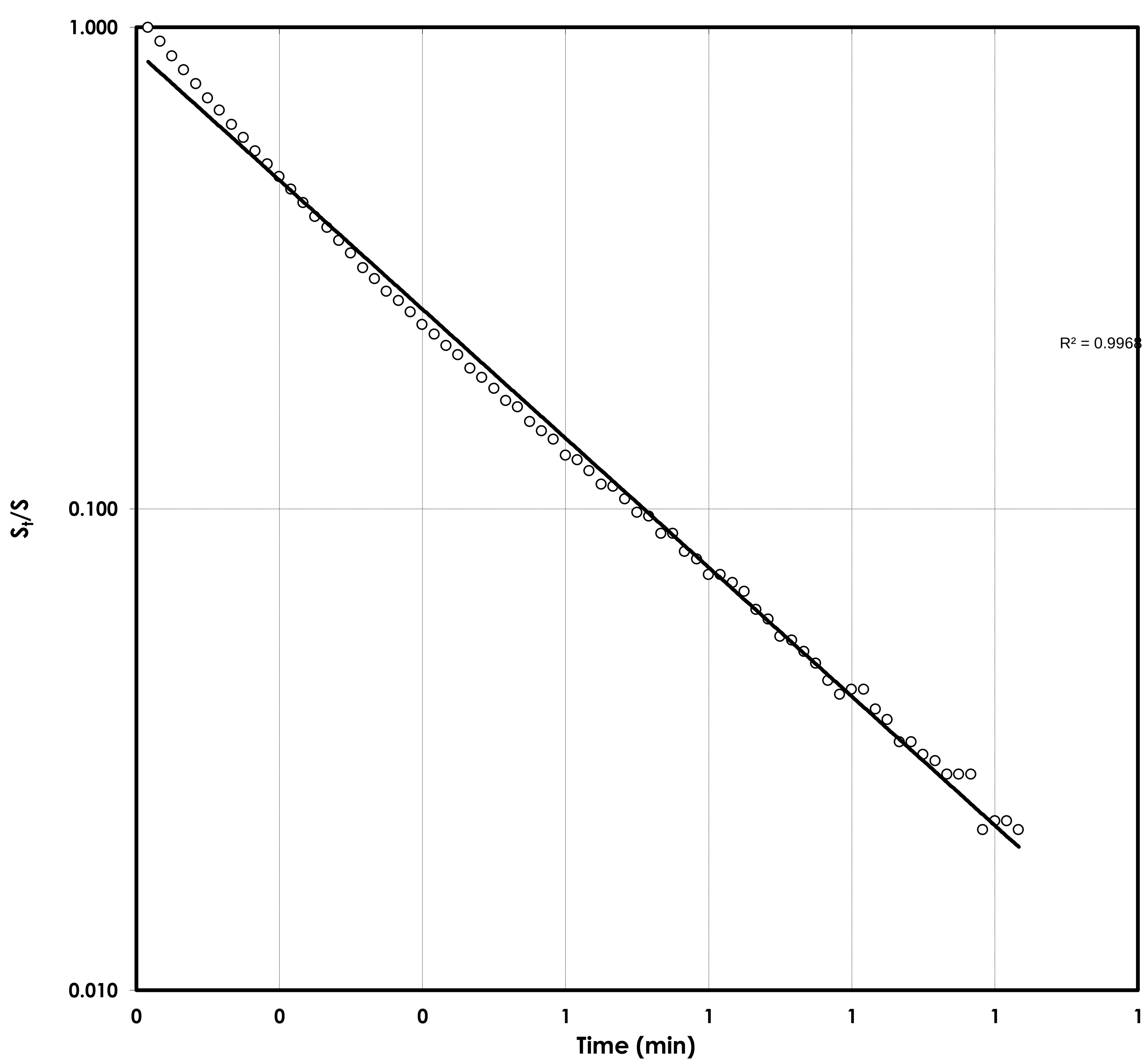

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Method ST-13 Revised 7.3.2007

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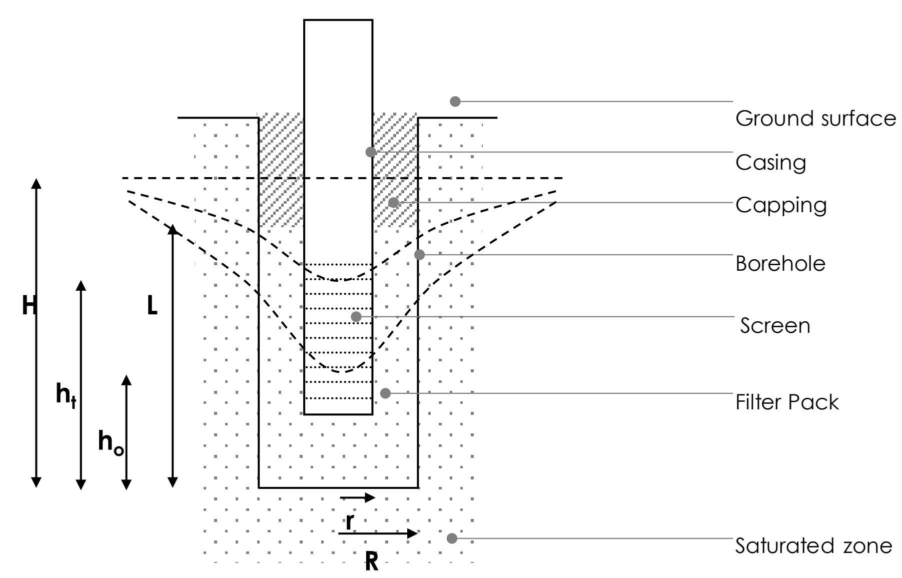
PROJECT DETAILS

Project	P902346 - Riverside	Test Date	04.09.12
Project Ref	P902346JS31V01	Field Testing	B. Rose and G. Harlow
Borehole Ref	GMB21	Data Analysis	B. Rose
Method	Hvorslev (1981)	Reviewed	Dr D. Martens

FIELD TEST DATA

Screened material - clay

FACTOR	Enter Data	Unit
H - Initial water level reading (mH2O pressure)	12.11	mH2O
h_o - Water level reading at time = 0 (mH2O pressure)	13.27	mH2O
r - Casing radius	0.030	m
R - Bore radius	0.030	m
L - Length of open screen	2.00	m
T_o - Length of characteristic time	0.14	minutes
K_{sat} - Saturated hydraulic conductivity	9.78	m/d



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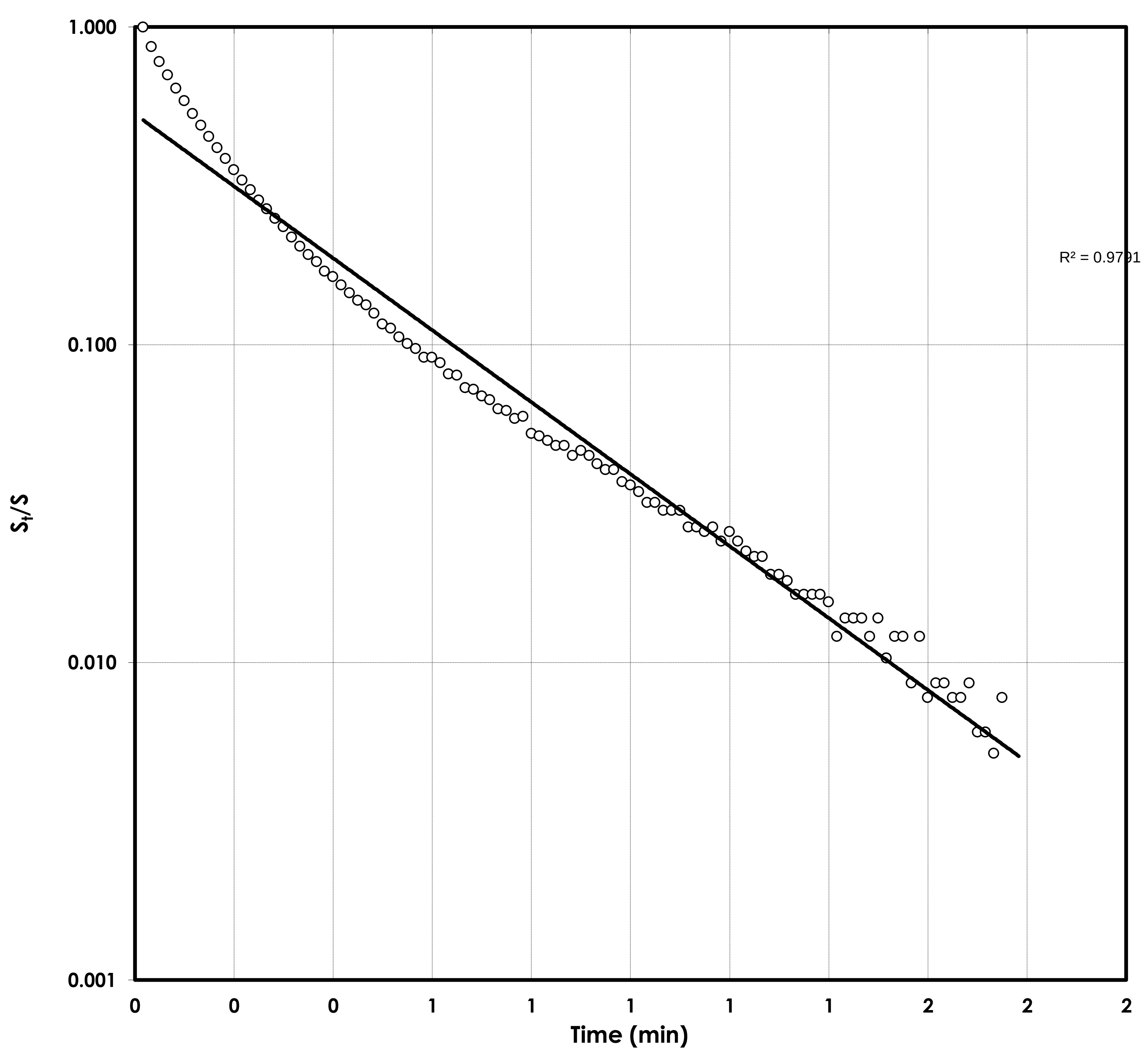

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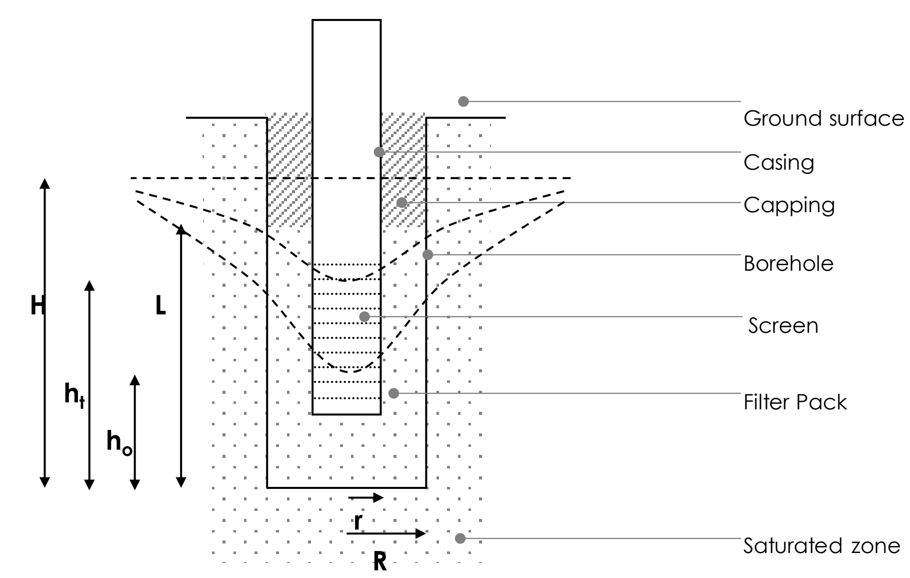
PROJECT DETAILS

Project	P902346 - Riverside	Test Date	04.09.12
Project Ref	P902346JS31V01	Field Testing	B. Rose and G. Harlow
Borehole Ref	GMB22	Data Analysis	B. Rose
Method	Hvorslev (1981)	Reviewed	Dr D. Martens

FIELD TEST DATA

Screened material - clay

FACTOR	Enter Data	Unit
H - Initial water level reading (mH2O pressure)	12.04	mH2O
h_o - Water level reading at time = 0 (mH2O pressure)	13.20	mH2O
r - Casing radius	0.030	m
R - Bore radius	0.030	m
L - Length of open screen	2.00	m
T_o - Length of characteristic time	0.20	minutes
K_{sat} - Saturated hydraulic conductivity	6.70	m/d



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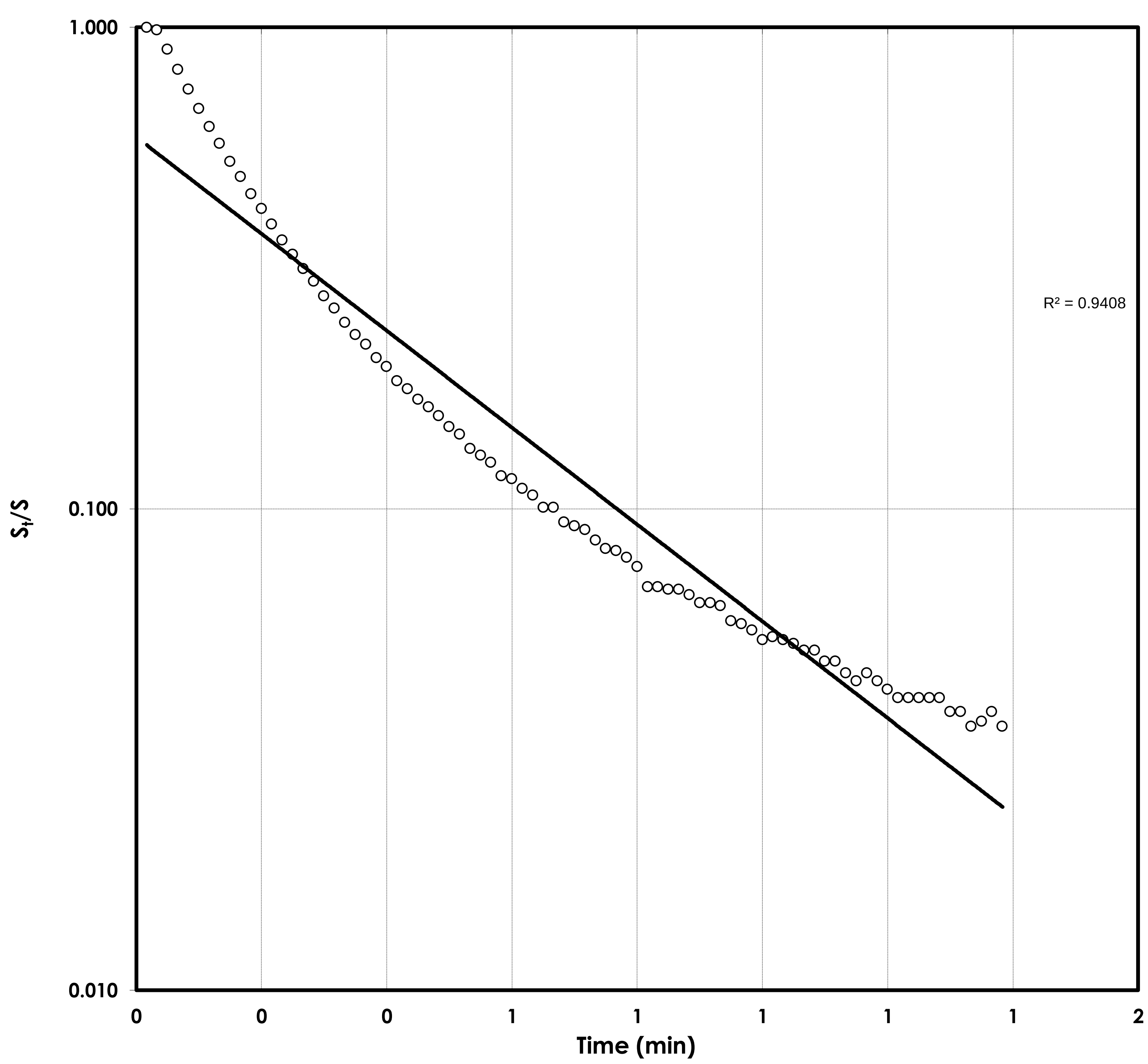

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Single Bore Slug Test (Rising or Falling)

Method ST-13 Revised 7.3.2007

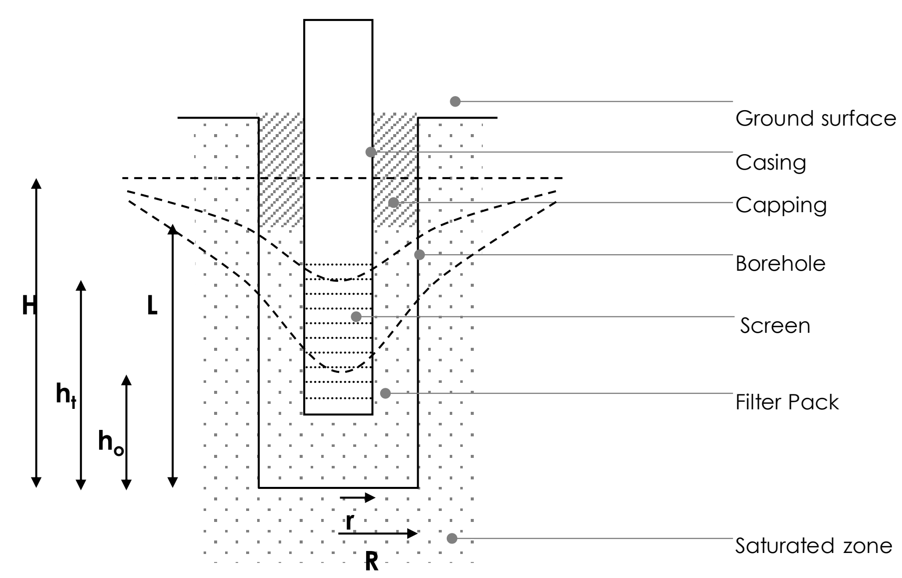
PROJECT DETAILS

Project	P902346 - Riverside	Test Date	04.09.12
Project Ref	P902346JS31V01	Field Testing	B. Rose and G. Harlow
Borehole Ref	GMB23	Data Analysis	B. Rose
Method	Hvorslev (1981)	Reviewed	Dr D. Martens

FIELD TEST DATA

Screened material - clay

FACTOR	Enter Data	Unit
H - Initial water level reading (mH2O pressure)	12.14	mH2O
h_o - Water level reading at time = 0 (mH2O pressure)	13.04	mH2O
r - Casing radius	0.030	m
R - Bore radius	0.030	m
L - Length of open screen	2.00	m
T_o - Length of characteristic time	0.16	minutes
K_{sat} - Saturated hydraulic conductivity	8.60	m/d



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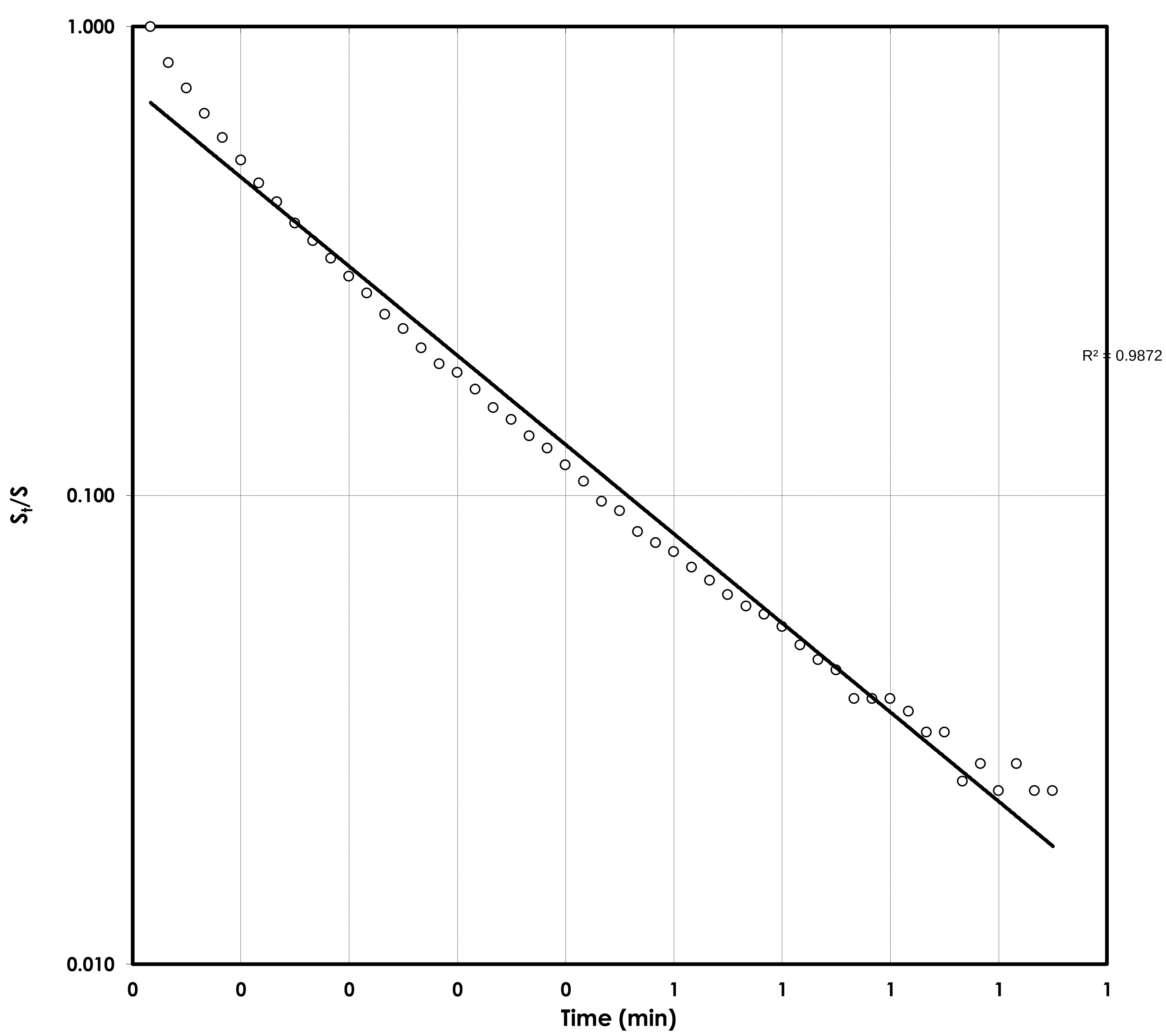

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Method ST-13 Revised 7.3.2007

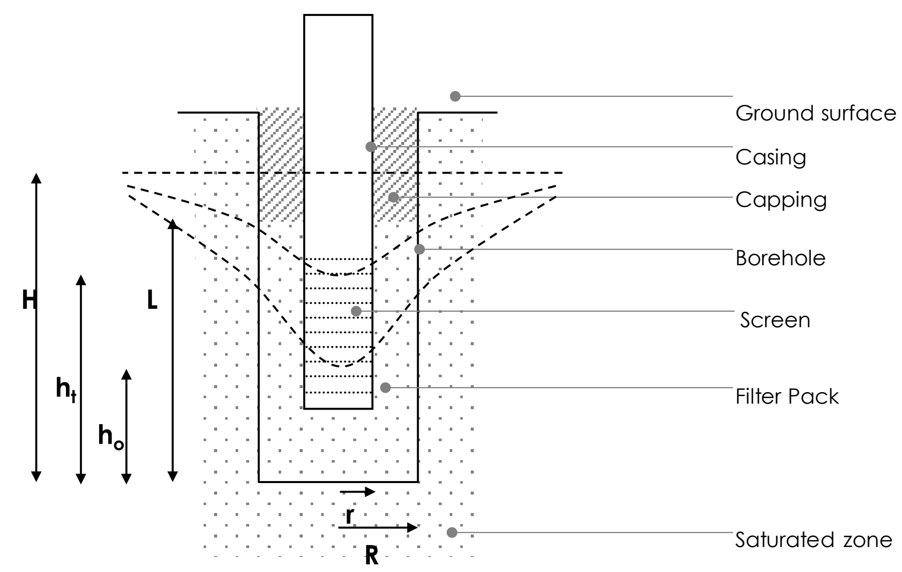
PROJECT DETAILS

Project	P902346 - Riverside	Test Date	04.09.12
Project Ref	P902346JS31V01	Field Testing	B. Rose and G. Harlow
Borehole Ref	GMB24	Data Analysis	B. Rose
Method	Hvorslev (1981)	Reviewed	Dr D. Martens

FIELD TEST DATA

Screened material - clay

FACTOR	Enter Data	Unit
H - Initial water level reading (mH2O pressure)	11.84	mH2O
h_o - Water level reading at time = 0 (mH2O pressure)	13.01	mH2O
r - Casing radius	0.030	m
R - Bore radius	0.030	m
L - Length of open screen	2.00	m
T_o - Length of characteristic time	0.15	minutes
K_{sat} - Saturated hydraulic conductivity	8.94	m/d



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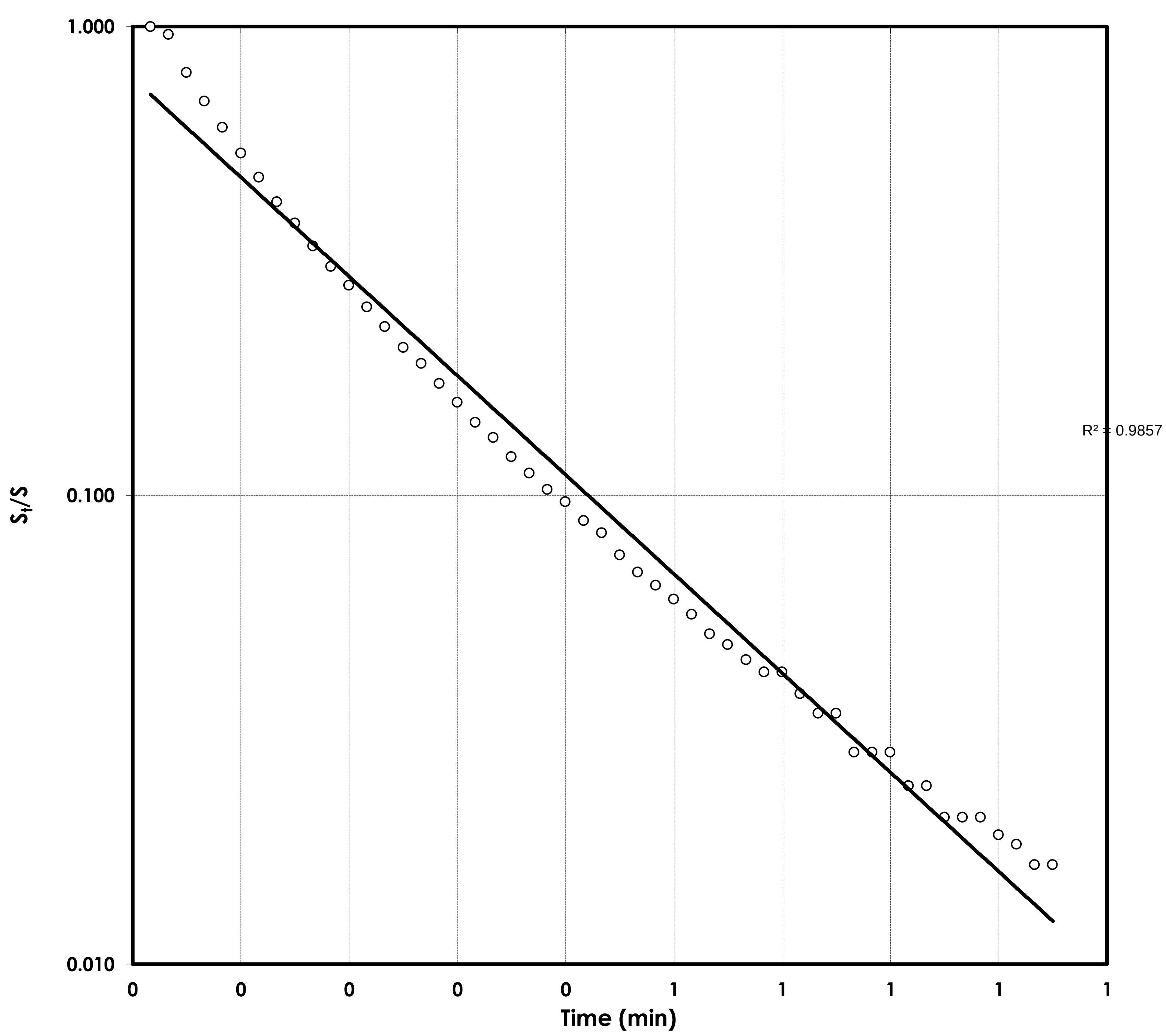

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Single Bore Slug Test (Rising or Falling)

Method ST-13 Revised 7.3.2007

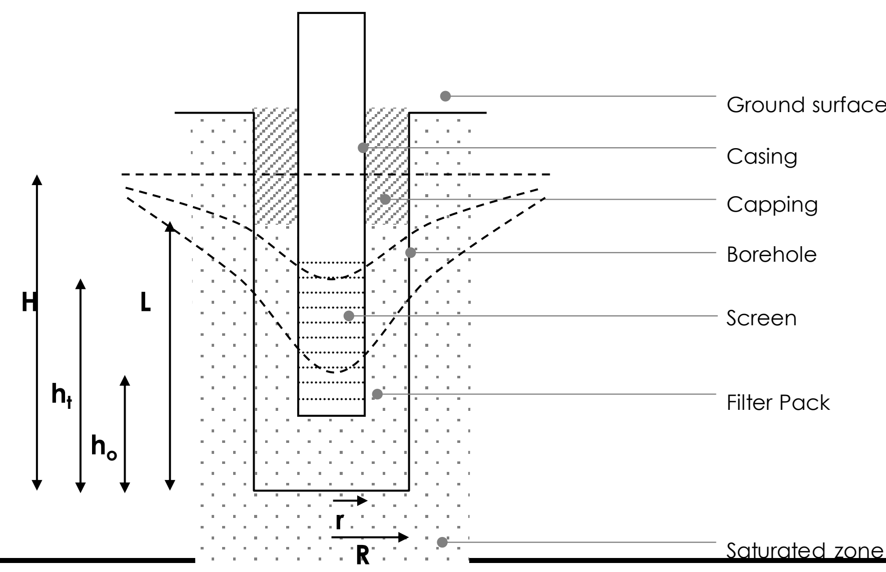
PROJECT DETAILS

Project	P902346 - Riverside	Test Date	04.09.12
Project Ref	P902346JS31V01	Field Testing	B. Rose and G. Harlow
Borehole Ref	GMB25	Data Analysis	B. Rose
Method	Hvorslev (1981)	Reviewed	Dr D. Martens

FIELD TEST DATA

Screened material - clay

FACTOR	Enter Data	Unit
H - Initial water level reading (mH2O pressure)	11.65	mH2O
h_o - Water level reading at time = 0 (mH2O pressure)	13.42	mH2O
r - Casing radius	0.030	m
R - Bore radius	0.030	m
L - Length of open screen	1.00	m
T_o - Length of characteristic time	0.64	minutes
K_{sat} - Saturated hydraulic conductivity	3.55	m/d



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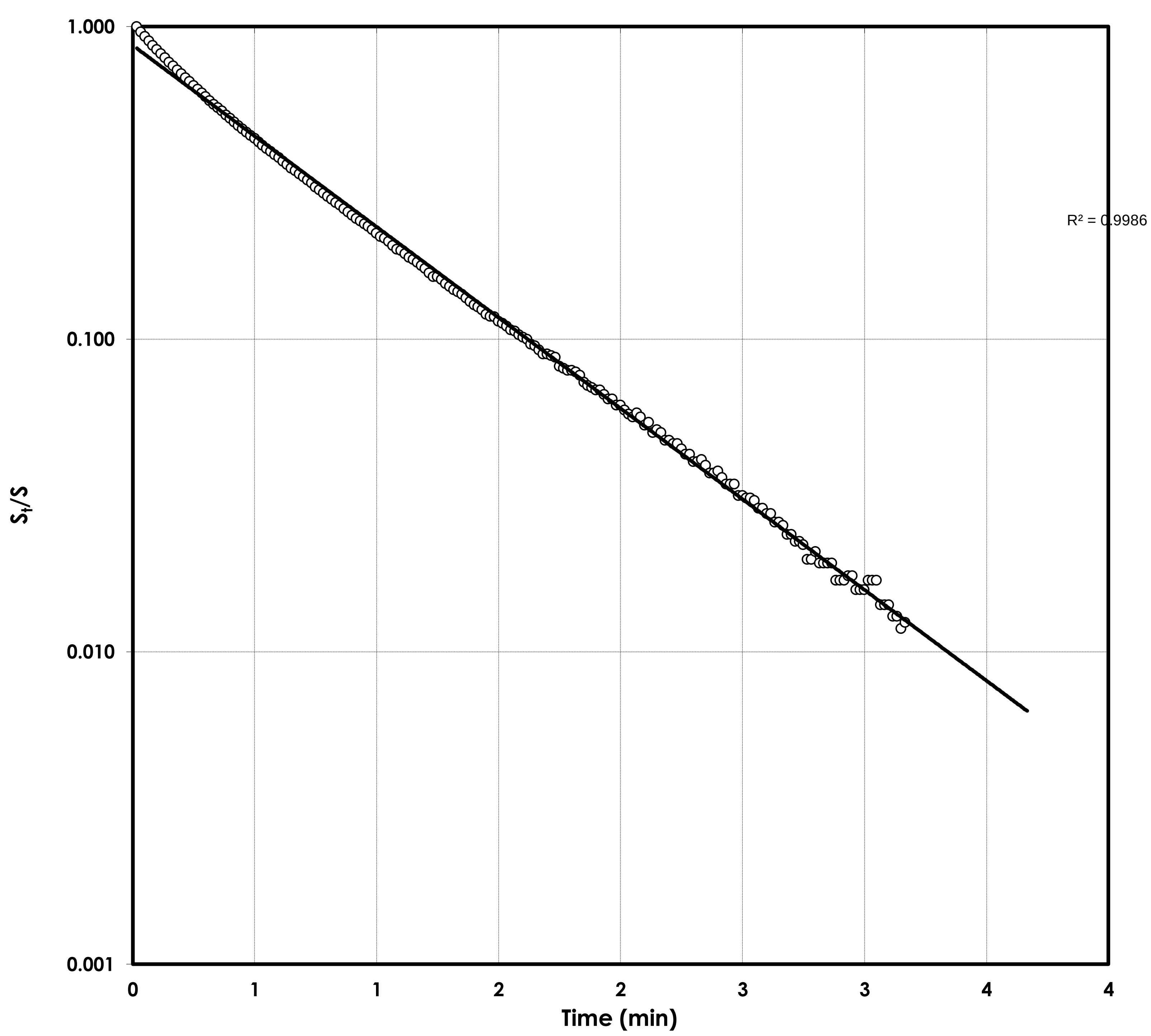

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Single Bore Slug Test (Rising or Falling)

Method ST-13 Revised 7.3.2007

Note - logger not used. Data quality poor. Permeability probbaly higher than test indicates

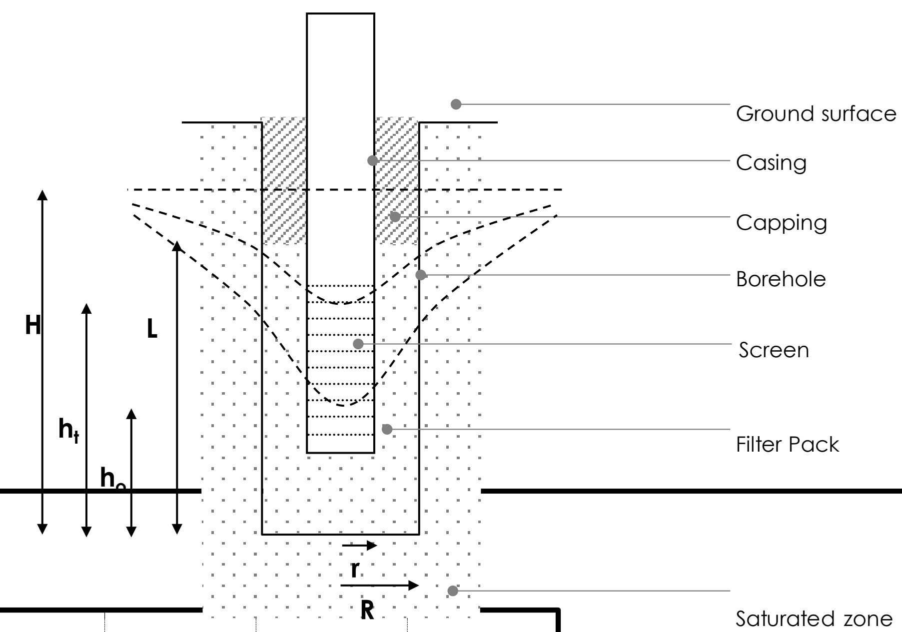
PROJECT DETAILS

Project	P902346 - Riverside	Test Date	26.09.12
Project Ref	P902346JS31V01	Field Testing	G. Harlow
Borehole Ref	GMB201 (2)	Data Analysis	G. Harlow
Method	Hvorslev (1981)	Reviewed	Dr D. Martens

FIELD TEST DATA

Screened material - clay

FACTOR	Enter Data	Unit
H - Initial water level reading (mH2O pressure)	13.91	mBTOP
h_o - Water level reading at time = 0 (mH2O pressure)	14.84	mBTOP
r - Casing radius	0.030	m
R - Bore radius	0.030	m
L - Length of open screen	3.00	m
T_o - Length of characteristic time	0.21	minutes
K_{sat} - Saturated hydraulic conductivity	4.81	m/d



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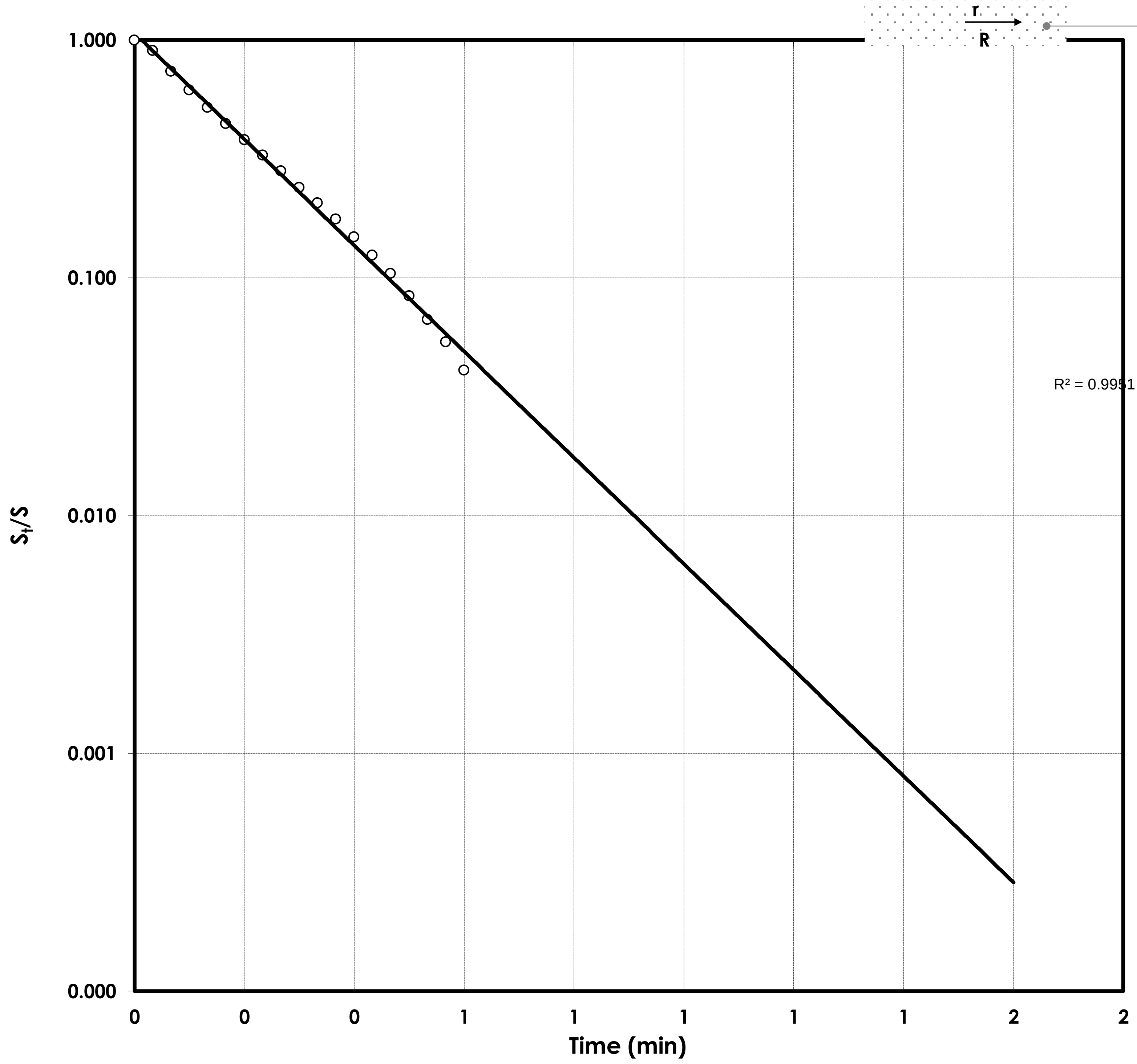

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Note - logger not used. Data quality poor. Permeability probbaly higher than test indicates

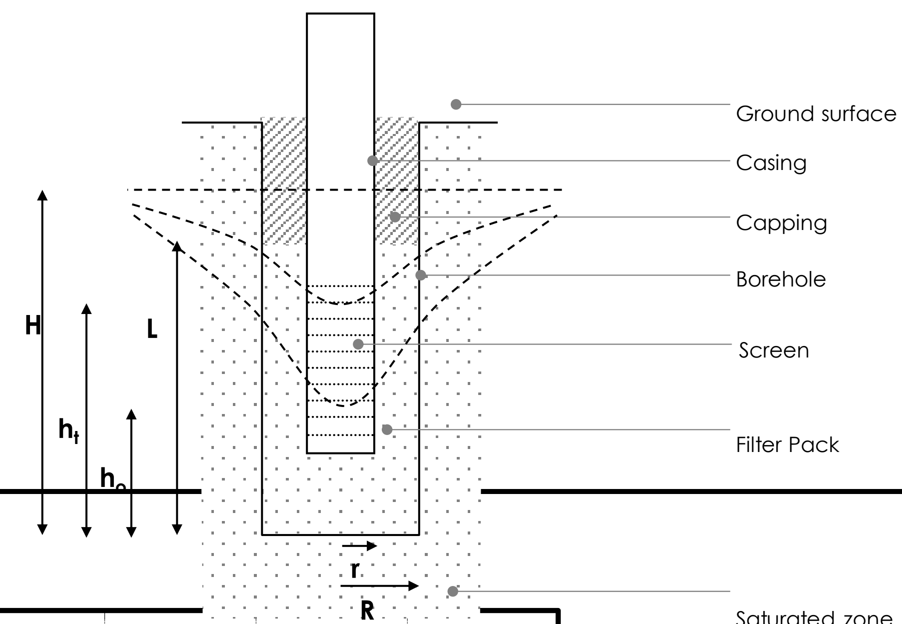
PROJECT DETAILS

Project	P902346 - Riverside	Test Date	26.09.12
Project Ref	P902346JS31V01	Field Testing	G. Harlow
Borehole Ref	GMB202 (2)	Data Analysis	G. Harlow
Method	Hvorslev (1981)	Reviewed	Dr D. Martens

FIELD TEST DATA

Screened material - clay

FACTOR	Enter Data	Unit
H - Initial water level reading (mH2O pressure)	13.07	mBTOP
h_o - Water level reading at time = 0 (mH2O pressure)	13.59	mBTOP
r - Casing radius	0.030	m
R - Bore radius	0.030	m
L - Length of open screen	3.00	m
T_o - Length of characteristic time	0.06	minutes
K_{sat} - Saturated hydraulic conductivity	16.33	m/d



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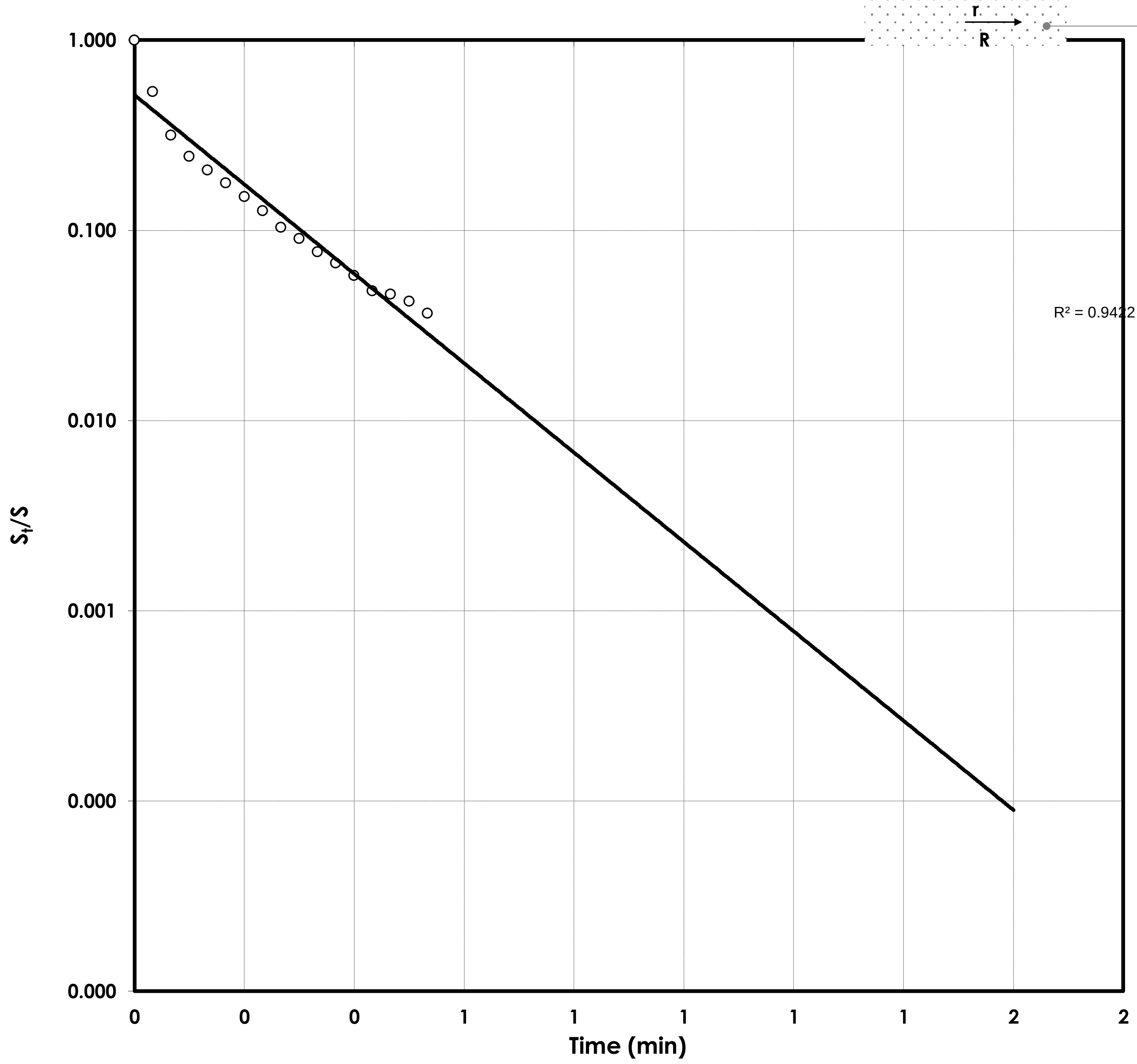

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Note - logger not used. Data quality poor. Permeability probbaly higher than test indicates

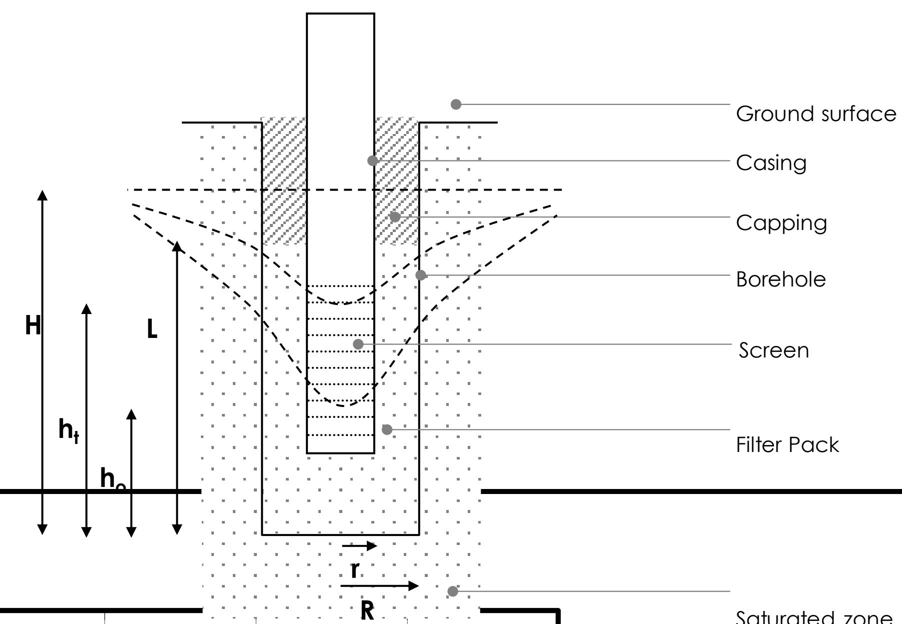
PROJECT DETAILS

Project	P902346 - Riverside	Test Date	26.09.12
Project Ref	P902346JS31V01	Field Testing	G. Harlow
Borehole Ref	GMB203	Data Analysis	G. Harlow
Method	Hvorslev (1981)	Reviewed	Dr D. Martens

FIELD TEST DATA

Screened material - clay

FACTOR	Enter Data	Unit
H - Initial water level reading (mH2O pressure)	13.76	mBTOP
h_o - Water level reading at time = 0 (mH2O pressure)	15.14	mBTOP
r - Casing radius	0.030	m
R - Bore radius	0.030	m
L - Length of open screen	3.00	m
T_o - Length of characteristic time	0.25	minutes
K_{sat} - Saturated hydraulic conductivity	3.97	m/d



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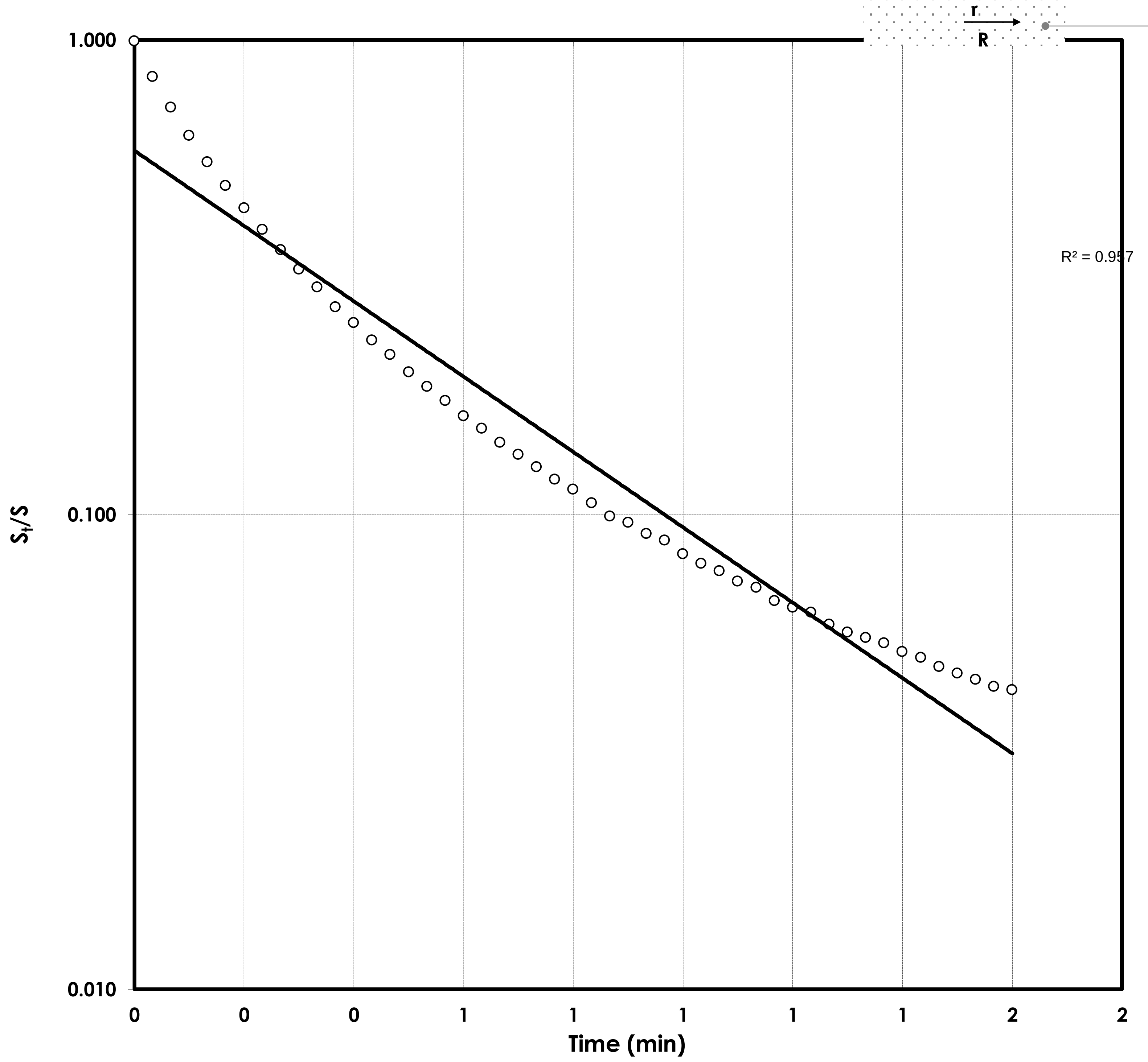

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22 Attachment 5 – Concept Drainage Layout Design and Flood Assessment (Tattersall Lander Pty Ltd)

STORMWATER MANAGEMENT REPORT
for
CONCEPT PLAN APPLICATION

RIVERSIDE ESTATE
TEA GARDENS

PREPARED BY

TATTERSALL LANDER PTY LTD

DEVELOPMENT CONSULTANTS

January 2013

DEVELOPMENT CONSULTANTS IN ENGINEERING, SURVEYING, PLANNING & ENVIRONMENTAL
Tattersall Lander Pty Limited ABN 41 003 509 215
2 Bourke Street, RAYMOND TERRACE 2324 **All mail to**: PO Box 580
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1.0 INTRODUCTION

1.1 PROJECT DESCRIPTION

The Riverside Estate proposal seeks to gain approval for a multi-staged Community Title subdivision on residentially zoned land at Tea Gardens. This would be made up of 13 residential stages, and one stage containing a small tourist facility. Ultimately the proposal would see land and services produced to cater for approximately 945 dwellings on the site.

Large portions of the site will remain undeveloped and set aside for various purposes, including environmental conservation, water management, public open space and recreation.

The site is bounded by Shearwater rural-residential estate to the north, Myall Street to the west, Myall Quays residential estate to the south, and the Myall River to the east.

Figure 1 – Locality Sketch

1.2 SITE DESCRIPTION

Previously part of a large pine plantation, the site is currently predominately clear and currently used for cattle grazing. The majority of the site has sandy soils and is extensively flat, with a slight fall to the south and to the east. Several existing drains assist in draining water east towards an existing SEPP14 wetland and beyond to the Myall River.

Due to their small size, and being near-level, these drains do not have a large capacity, and during extended wet periods or large rainfall events, surface water can pond on the site before draining away or infiltrating.

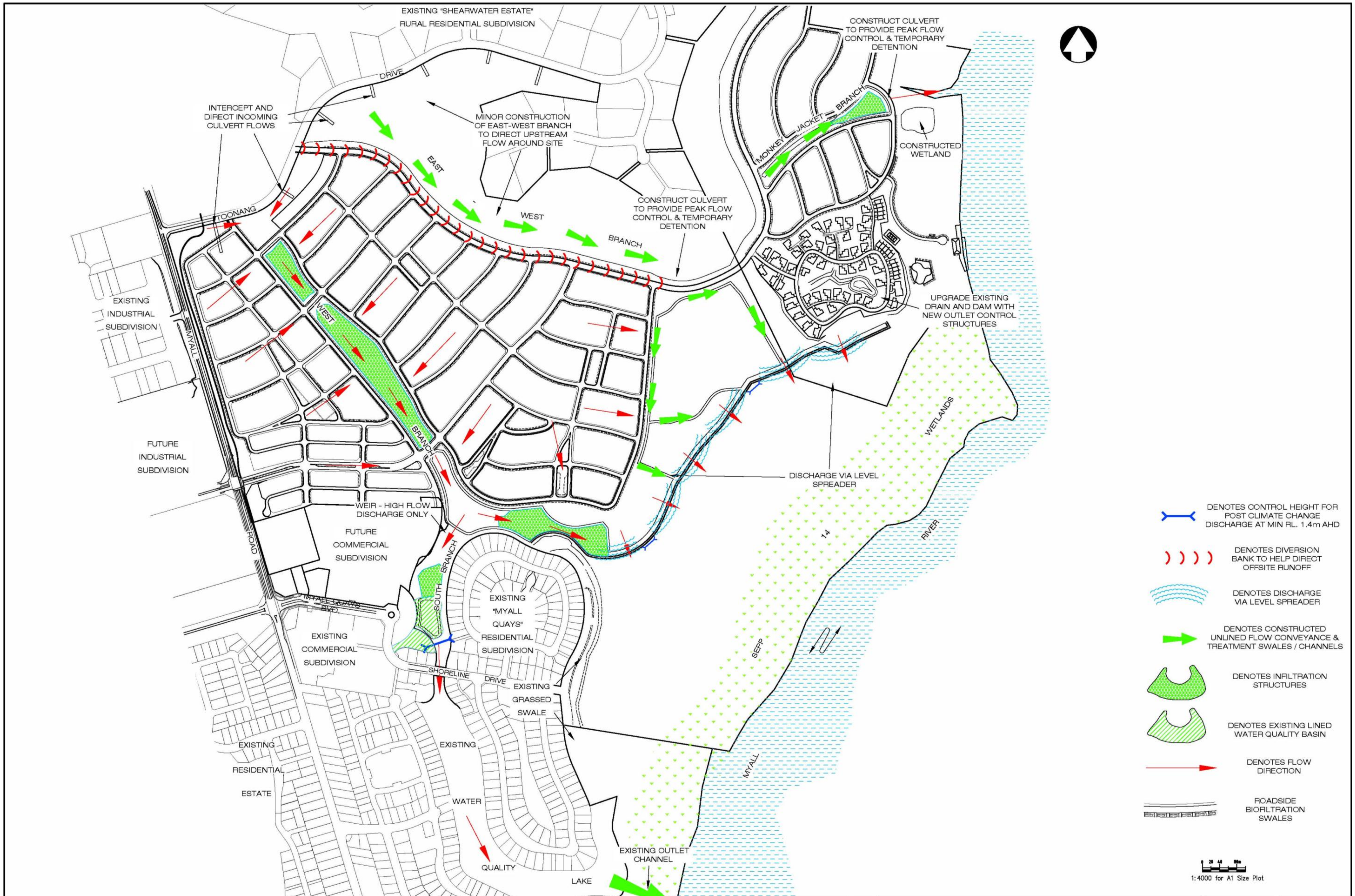
Photograph 1 – Existing Site Conditions

2.0 DRAINAGE DESIGN

The Riverside proposal has been modified from the previous submission to address the issues raised during public exhibition. Modifications from the previous proposal include;

- Revised development layout, relocating the main development footprint further away from the SEPP14 wetlands, and an overall reduction in developable area
- Removal of the 'East Branch' floodway and reserve
- Removal of several basins, wetlands and lake structures
- Inclusion of bio-filtration swales for 'at source' water quality treatment, including necessary site regrading works required for successful installation
- Inclusion of additional constructed wetland in the northern 'Monkey Jacket' precinct
- Redesign of the East-West Branch floodway to limit disturbance of vegetation in the wildlife corridor

The drainage regime proposed for the Riverside Development is illustrated in the Drainage Concept Plan in Figure 2. The following summary describes the main drainage features in detail. Further specific technical details (modelled structure sizes, levels etc.) can also be seen in Appendix A.



REV	DETAILS OF AMENDMENT	DESIGNED	DRAWN	CHECKED	APPROVED	DATE
E	Revised Layout - August 2012	AV	AV			29/06/12
D	Revised Development Footprint	AV	AV	DWK*	BL*	2/12/11*
C	Revised per Cardno Comment	AV	AV	DWK*	BL*	2/11/10*
B	Revised East-West Branch Corridor	AV	AV	-	BL*	03/02/11*

* Denote the original signature and date when revision was issued.

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FIGURE 2 - DRAINAGE CONCEPT PLAN

PROPOSED RESIDENTIAL DEVELOPMENT
RIVERSIDE ESTATE, TEA GARDENS

COUNCIL: GREAT LAKES	REFERENCE: 21000166
PARISH:	SHEET SIZE: A1
SCALE: 1:4000	SHEET No.: 1 of 3
DATE:	Plotted 09:26 02/07/12

CLIENT: CRIGHTON PROPERTIES | JOB No.: 201479 | COMPUTER FILE : S:\projects\Myall Quays\dwg\STG9\Riverside DA Inundation Plans.dwg

Specific features of the proposed drainage network are described in more detail below;

2.1 Minimum Discharge Level

The design philosophy to date for drainage works in Tea Gardens has been to have drainage structure outlet levels at or above Mean High Water Mark, adopted at 0.5m AHD. Discussions with Great Lakes Council have determined that approach should continue, but this minimum should now be adjusted by 0.9m to 1.4m AHD to account for the worst case 2100 sea level rise due to climate change. As such, low flow discharges from behind the level spreader will be set at a minimum 1.4m AHD.

2.2 Interception of Upstream Flows – The East-West Branch Floodway

The majority of upstream flows from the existing Shearwater Estate enter the Riverside site via a series of seven culverts under Toonang Drive. To limit the impact of this water on the proposed development, the East-West Branch will intercept flows from the five most easterly incoming culverts and divert these flows along the floodway and around the main development footprint. Doubling as a wildlife corridor, minimal disturbance will be allowed in this floodway. Instead of invert excavation, the design will instead form the floodway over the existing surface by construction of the adjacent perimeter road, with the incorporation of a raised flood mound. Grades will be substantially flat, and will result in an effective floodway of between 50-100m wide within the wildlife corridor of between 90-200m width.

2.3 Main Trunk Drainage Line – The West Branch Floodway

The remaining two (most westerly) Toonang Drive culverts are not able to be diverted around the site, and are instead directed to the top of the West Branch floodway. Running through the centre of the main portion of the development site, the West Branch has multiple functions which also includes acting to collect, detain, and infiltrate regular low flow discharges from the majority of the site, and convey high flow discharges to the downstream discharge structures, as well as providing areas of reforestation and public open space.

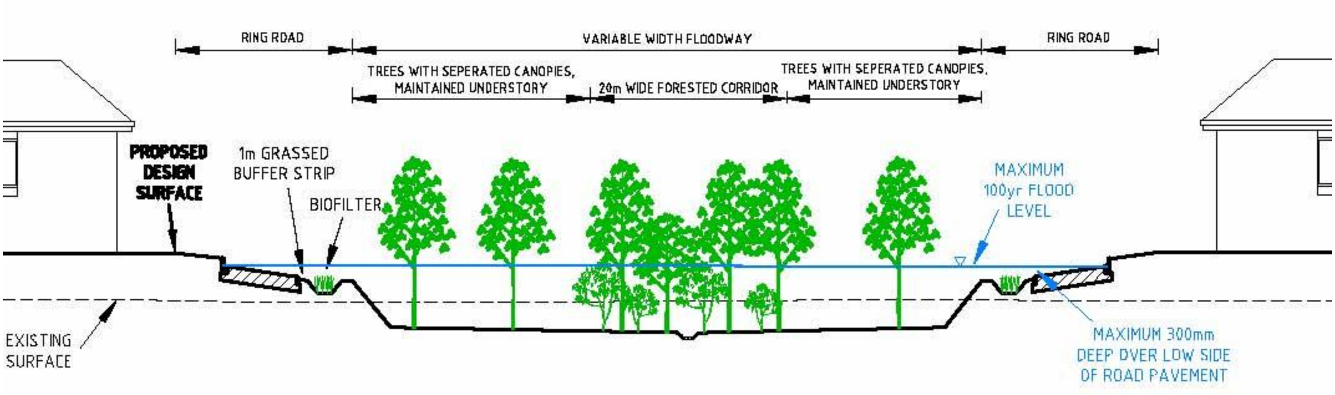

Figure 3 – West Branch/Monkey Jacket Branch Floodway Preliminary Cross Section

2.4 Distributing Site Discharges Along the Full Wetland Frontage

One of the main objectives for the design of the Riverside Estate is to minimise the impact on the adjacent downstream wetlands. The current proposal has further relocated the development footprint so that the main body of the development is now over 350m from the SEPP14 wetlands.

Post development, it will be important to both maintain the flow regime during regular rainfall events, and ensure that large events are not concentrated to the point that they result in scouring, high velocity flows. An important feature of the proposed development is a low level weir and level spreader along the full frontage between the development and the wetland buffer. Much of the low flow discharge from the existing site is via infiltration. In order to replicate this, post development low flows would be contained behind the proposed weir and allowed to infiltrate.

Larger storm events would top over this weir along the full frontage of the wetland buffer and distribute low velocity flows into the wetland buffer and on towards the wetland as would currently occur. In order for this arrangement to also provide peak flow attenuation, two low-flow outlets will be positioned where the existing surface drains currently deliver point source discharges into the wetland buffer area. It should be noted that the level spreader and low flow outlets are outside the wetland buffer area, and generally around 250m from the SEPP14 wetlands. An assessment of the effectiveness of this arrangement to replicate existing flows into the wetland buffer can be seen in Section 3.9.1.

The preliminary design modelled for this spreader includes a 2.5m wide weir crest at RL1.9m AHD, with the two low-flow discharge culverts at RL.1.4m. While it is expected that this design may be further refined during the detail design stage, modelling of this arrangement is intended to show that this approach will be suitable to replicate existing flow conditions in the wetlands.

2.5 South Branch Floodway

Primarily required to drain the future commercial area precinct (not part of this application) and draining south under the existing ‘Bebo’ bridge into the existing saline lake via a recently constructed basin structure, the South Branch is also connected to the West Branch via a high level overflow weir. Regular flows from the Riverside site will not enter the South Branch, but in rarer events peak flow will top the weir and the South Branch will provide an additional floodway discharge path, replicating existing flow conditions.

The South Branch has been designed and modelled in its finished configuration, despite its upstream development proposal requiring a separate application. This will ensure the current modelling will still be relevant and compatible with the future proposal. Construction of this floodway area will include the removal of an existing temporary flood interception berm and haul road. It will also provide storage and infiltration capacity, and areas for reforestation and public open space.

2.6 Monkey Jacket Branch Floodway

In the eastern 'Monkey Jacket Precinct', upstream flows from Shearwater Estate will be intercepted by a collection drain above the development ring-road, and directed towards the Monkey Jacket Branch floodway that is central to this precinct. As with the West Branch, the Monkey Jacket Branch also has multiple functions which include acting to collect, detain, infiltrate and convey the development runoff.

Discharges from this branch will be initially into a downstream constructed wetland for water quality treatment before flowing into to the existing river inlet just as the existing drains do in this area of the site. This area will also provide areas for reforestation.

2.7 Bio-filtration Swales

Detailed discussions were held with Council engineers to develop a preferred approach to incorporating bio-filtration swales into the streetscape. A recent addition to the Riverside proposal to assist with urban pollutant removal, bio-filtration swales are a favoured treatment device of Great Lakes Council as they provide 'at source' water quality treatment. They are, however, a relatively new addition to the urban stormwater landscape, and are yet to be widely implemented in the GLC area. Council's Engineering Department had not yet developed standards for the implementation of bio-filtration swales until approached in regard to the Riverside development.

Significant efforts were made in conjunction with Council and local service authorities to adapt available bio-retention guidelines to the specific requirements of the Riverside site and Great lakes Council. Required modifications from previous Council standards include a single road crossfall, modified kerb types, relocation of the footpath and rearrangement of service locations and road verge widths. Figures 4 and 5 detail the proposed arrangements.

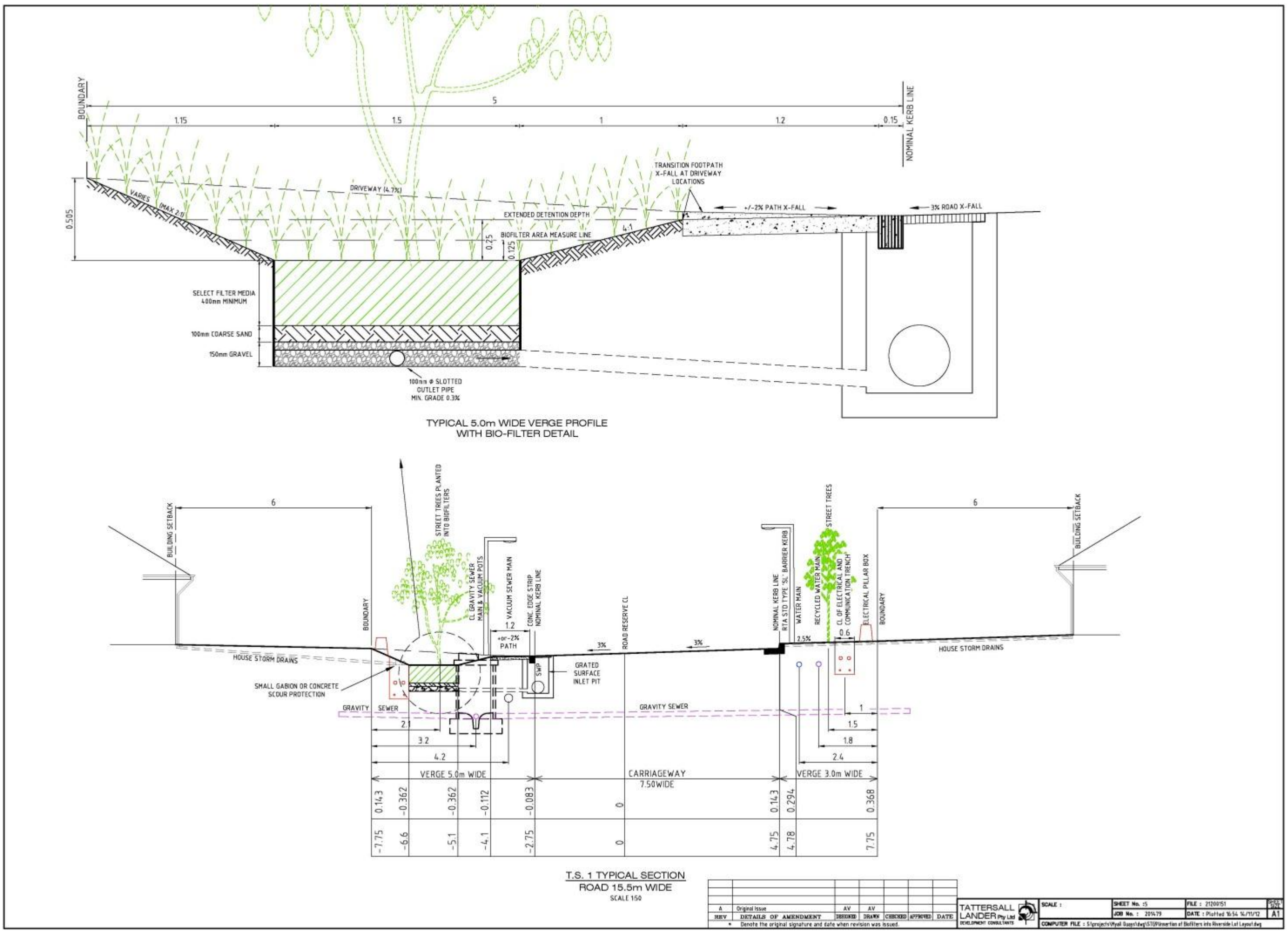

Figure 4 – Typical Residential Street Profile including all Services and Bio-filtration Swales

Figure 5 – Typical Residential Street Detail including all Services and Bio-filtration Swales

2.8 Site Filling/Road and Street Drainage Design

In order to produce residential land suitable for future housing, the development footprint area of the site will be filled with imported material. Levels on all lots have been set to be free from the worst case 100yr flood levels. Minor roads adjoining floodways have been designed to be covered by a maximum of 0.3m of water by the worst case 100yr flood (see Figure 3).

Intersecting roads perpendicular to the floodway rise away at a minimum grade of 0.3%, the level controlled by the Great Lakes Council minimum stormwater pipe grade. The normal 0.5% minimum road grade is not relevant in this development as this is a kerb self-cleansing grade, and at Riverside the low side kerbs have now been replaced with bio-filtration swales.

Details regarding the extent of filling within the floodplain, and impact on flood behaviour are addressed in more detail in Section 3.8.

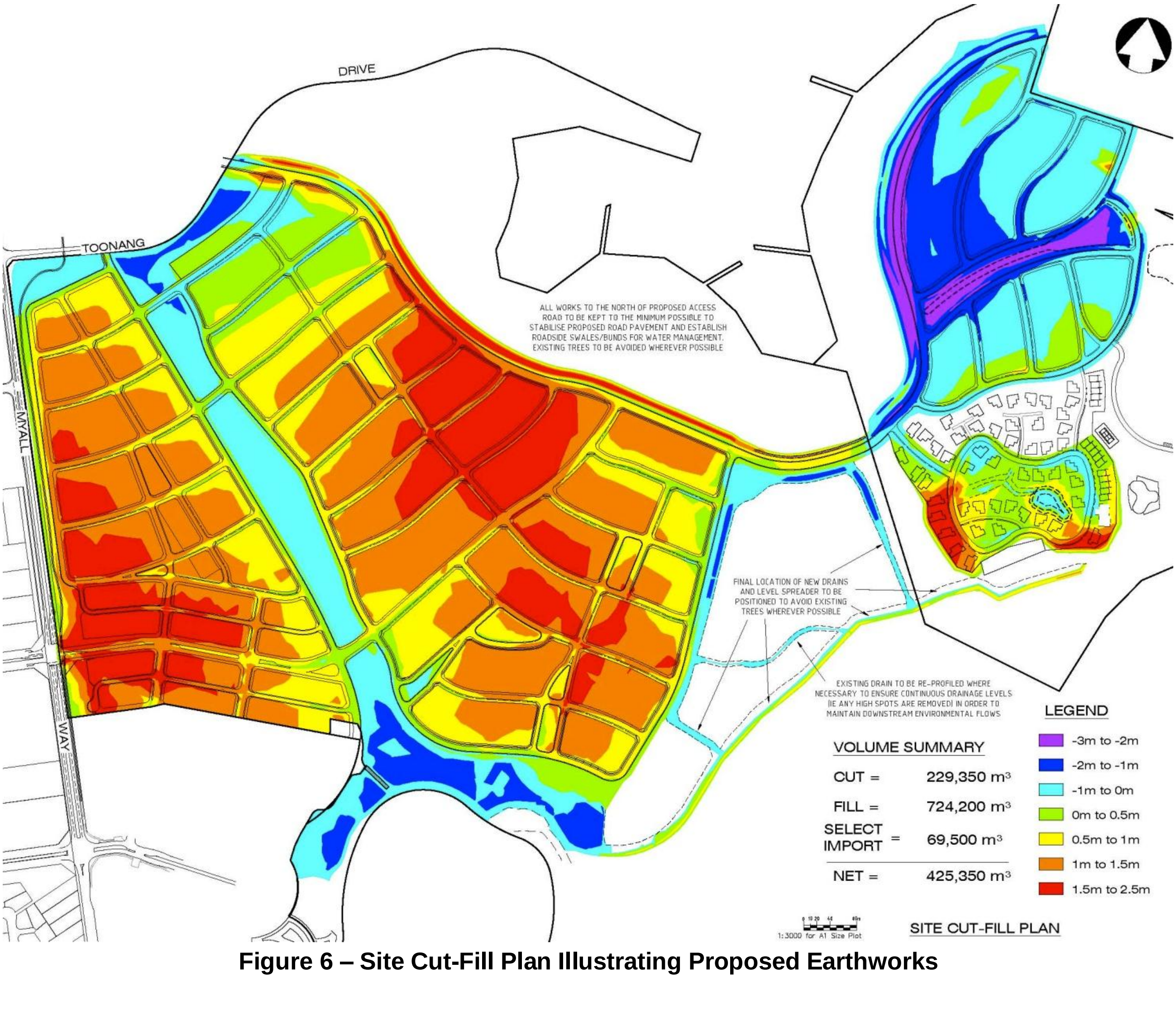

Figure 6 – Site Cut-Fill Plan Illustrating Proposed Earthworks

3.0 FLOODING AND DRAINAGE ASSESSMENT

3.1 BACKGROUND

The aims of this flood study include;

- determine appropriate floodway designs, and required fill levels within the proposed development,
- design a drainage system to mitigate post development impacts on receiving downstream environment,
- address the impact of the proposed development (including filling) on flood behaviour of the site and adjacent lands,
- determine the flood hazard within the proposed development, including egress and safety in extreme flood events

A hydrological model of the Riverside development and surrounding areas has been prepared utilising the XP-Storm 2D computer modelling software. Both existing and developed DTM scenarios were modelled with numerous storm events covering the full range of exceedance probabilities and durations.

3.2 PREVIOUS STUDIES

Several previous reports have been prepared for Crighton Properties by Cardno to support previous iterations of the Riverside proposal, the most recent of which was December 2011. Review of this report by various government agencies following public exhibition in April 2012 highlighted a number of issues that required further addressing, including Hydraulic Category mapping, Flood Hazard mapping, Probable Maximum Flood assessment, Flood Planning Level assessment, analysis of public safety and evacuation requirements and the inclusion of the Monkey Jacket precinct within the flood study.

Following further modification to the proposed development footprint and drainage strategy, this study is intended to provide similar analysis to the previous studies, incorporating the updated development proposal, data from more recent adjacent studies, utilising more detailed 2D modelling procedures and addressing the areas highlighted as deficient in the previous report.

While proposed flood control regime and modelling techniques vary significantly from Cardno's previous work, the results in this report have been compared with results seen in the previous studies where applicable (i.e. incoming upstream flows), and have been observed to be in general agreement.

3.3 CATCHMENTS

Previous studies on the site had utilised a 1D xprafts 'node and links' flood model, which requires the catchment to be broken up smaller sub-catchments and allocating indicative areas, widths, slopes, routing parameters etc. to attempt to replicate flow conditions. With the advent of 2D modelling, this approach is now unnecessary. In the models prepared for this report, rainfall was applied directly to the grid, which then flows across the model as directed by the underlying DTM.

The extent of the model stretches from the top of the watershed along Viney Creek Road above Shearwater Estate to the north, west to Myall Street, east across the SEPP14 wetlands to the Myall River, and south to Coupland Avenue. The extent of the 2D model is shown below in Figure 7. It can be seen the modelled catchment includes all upstream lands to the top of the catchment, the Riverside site and all adjoining downstream land potentially affected by flows from the site.

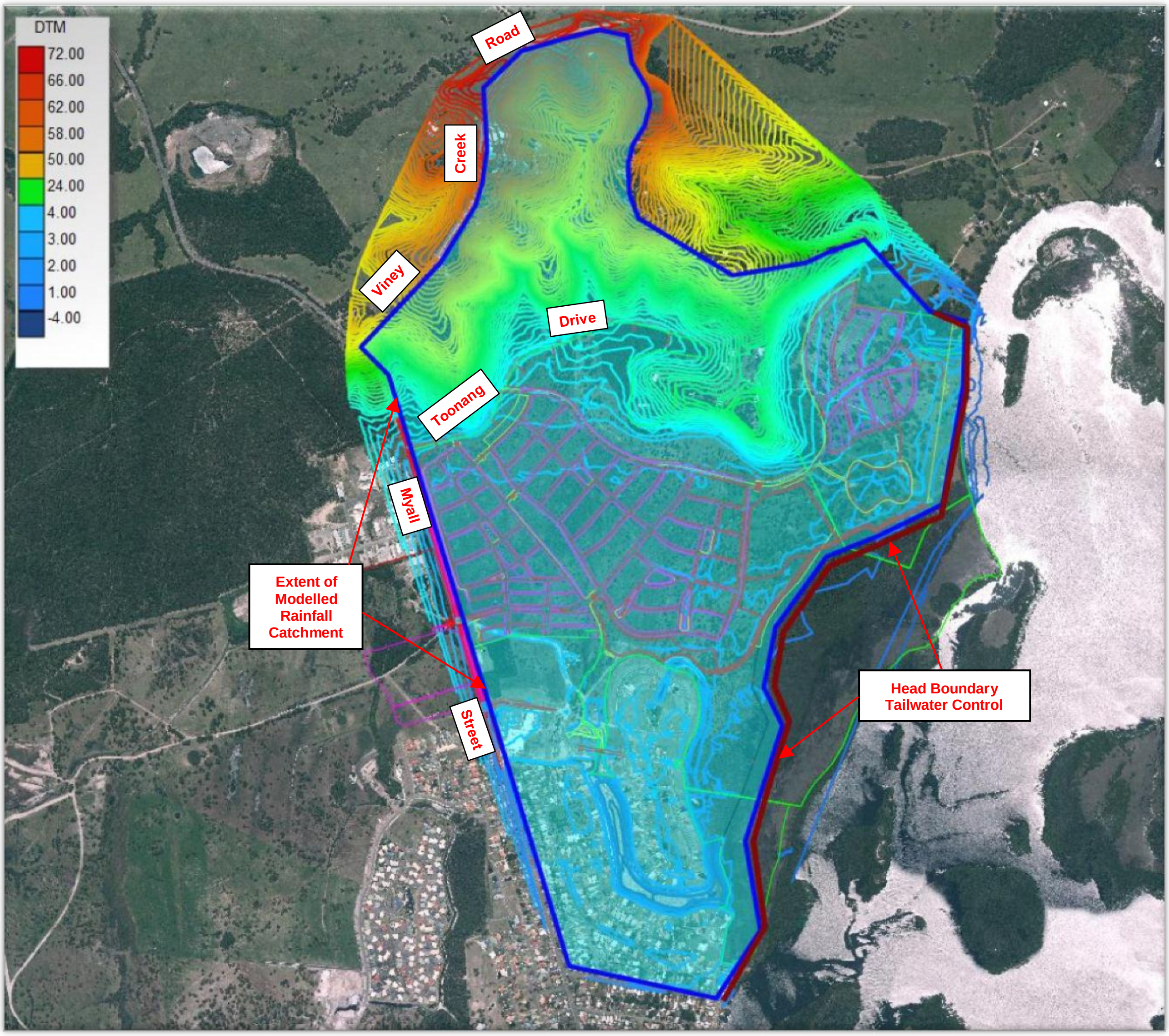

Figure 7 – DTM and Modelled Catchment Extent