Submission to the EPA Oral Hearing on a Proposed Landfill at Nevitt by Patrick Boyle, BE.

Hydrogeology

Introduction

This brief submission highlights the obstacle to the proposed landfill at Nevitt posed by the presence of horticultural wells operated by Thomas Kerrigan, Tim Bergin, John Thorn and Thomas Moore - all significant horticultural processors in the vicinity of the landfill, and the risk posed by surface water discharge to the Courtlough River local irrigation system.

Source Protection Zones

The GSI Groundwater Protection Schemes specifies that the distance from a source of pollution to a Groundwater Source is measured from the point at which the contaminant comes in contact with the groundwater. In the case of a landfill with low vulnerability subsoil the Response Matrix gives R4 for the SI (Inner Source Protection Zone, TOT < 100days) and R3 for the SO (Outer Source Protection Zone, i.e. within the Zone of Contribution which normally extends to the up-gradient water divide). The point of contact with the groundwater in this case therefore lies directly below the landfill at a depth of some 10m or more.

Groundwater flow patterns in gravel and rock faults.

The Groundwater flow patterns in the gravels and rock faults below and in the vicinity of the landfill are unknown. Dr Paul Ashley has indicated that due to the complexity of the site a computer model analysis would be required, and that the normal UK programme, LandSim, cannot be of use because the liner is below the water table. We cannot therefore hope to come to any immediate conclusions based on the EIS regarding the potential contribution of these features in the determination of either Inner or Outer Source Protection Zones, except to say that the geophysical and borehole data to date, and the evidence of Dr Ashley, Mr. Kevin Cullen and Mr Tim Begin clearly indicates that they are significant.

Bog of Ring public water supply

The GSI have indicated that there is insufficient borehole data in a critical area north of the Five Roads to allow for an accurate determination of the position of a water divide. The applicant's assertion that they have done so cannot therefore be relied upon.

The calculation is further complicated by the fact that the valley is of very low relief and the bedrock is overlain by a continuous layer of gravel constituting a distinct separate layer saturated with groundwater and stretching from below the landfill all t5he way to the Bog of Ring wellfield. This gravel layer has been comprehensively illustrated by Mr. Kevin Cullen at the Oral Hearing. This aquifer is confined and would in places deliver water to the surface without pumping, as at borehole BGB1. There is hardly any doubt then that all indications at present then are that it would b capable of delivering water through the gravels to the Bog of Ring.

The EIS and the applicant's replies to the EPA have failed to address the issue of the possible contribution of these gravels below the landfill to the Bog of Ring Zone of Contribution and in particular whether or not the landfill would lie within the SO of the public water supply with a corresponding R3 response.

John Thorn's horticultural well

This well has an estimated yield of 750,000 l/day and supplies water principally to a vegetable washing plant at Thorn's farm which is situated some 400 m to the immediate North east of the landfill footprint. Mr Kevin Cullen's interpretation of the gravel depth at that location indicates a figure of between 0m and 5m ad a continuous connection with the gravels below the footprint.

The EIS fails to attempt an analysis of the possible contribution of the gravels beneath the proposed landfill to either the SI or So of this adjacent well, but given the conditions as outlined, the response may well be R4 or R3.

Thomas Kerrigan's horticultural well

This well has an estimated yield of 1,900,000l/day and a working pump capable of delivering circa 600,000 l/day. It supplies water to a medium sized vegetable processing plant supplying supermarket chains and institutions.

Again no attempt has been made within the EIS to ascertain whether the extensive and deep grave deposits beneath the southern landfill footprint area could form part of the Zone of Contribution of this well.

The well is located some 900m directly to the south of the footprint and within the Annsbrook landfill site section study area. Selected borehole and Geophysical data from this study is attached, along with relevant data from the EIS for the Nevitt site.

During this Oral Hearing I questioned the applicant regarding the evidence contained in the EIS geophysics to the probable presence of a Fault Line running North South below the landfill footprint – a feature also mentioned by Mr Cullen. If it is a fault line and given that it points directly towards Kerrigan's well, it may well be responsible for the very high yield. The probable connectivity between the landfill and Kerrigan's and consequential imput to the Zone of Contribution of this well has not been established in the EIS but again the resultant outcome of such a study might well yield an R4 or R3 response.

Similarly the geophysics or the southern end of the landfill site and the northern end of he Annsbrook site would indicate a possible contribution by the gravels below the footprint to the Zone of Contribution of Kerigan's well.

Thomas Moore's and Tim Bergin's wells – Important water sources

These wells fulfil extremely prominent roles in the local horticultural industry- Moore's because of its long established reputation and Bergin's because of its pivotal role in the local irrigation system as outlined below.

The EIS fails to recognize their value in its risk assessments as with all other horticultural wells mentioned above.

Landfill surface water runoff and the Courtlough River horticultural irrigation system

An important, locally devised, crop irrigation system has been in use on the lower reaches of the Courtlough River for some time - the details of which were outlined to the hearing by Mr Tim Bergin. Crops irrigated include "the largest lettuce production facility in Ireland" a "high risk" crop requiring only the purest of potable water. Unless this level of purity of surface runoff can be guaranteed, taking into account the cumulative effect of operations at the proposed Nevitt landfill, including the clean-up of an illegal landfill, together with runoff from Murphy's Environmental existing landfill, produce from this entire area will be at risk and/or the entire horticultural enterprise may have to cease.

Conclusion

The risk to the horticultural industry presented by landfill surface water runoff into the Courtlough River has not been adequately assessed in the EIS.

The risk to the horticultural industry through the contamination of local wells has not been adequately assessed in the EIS.

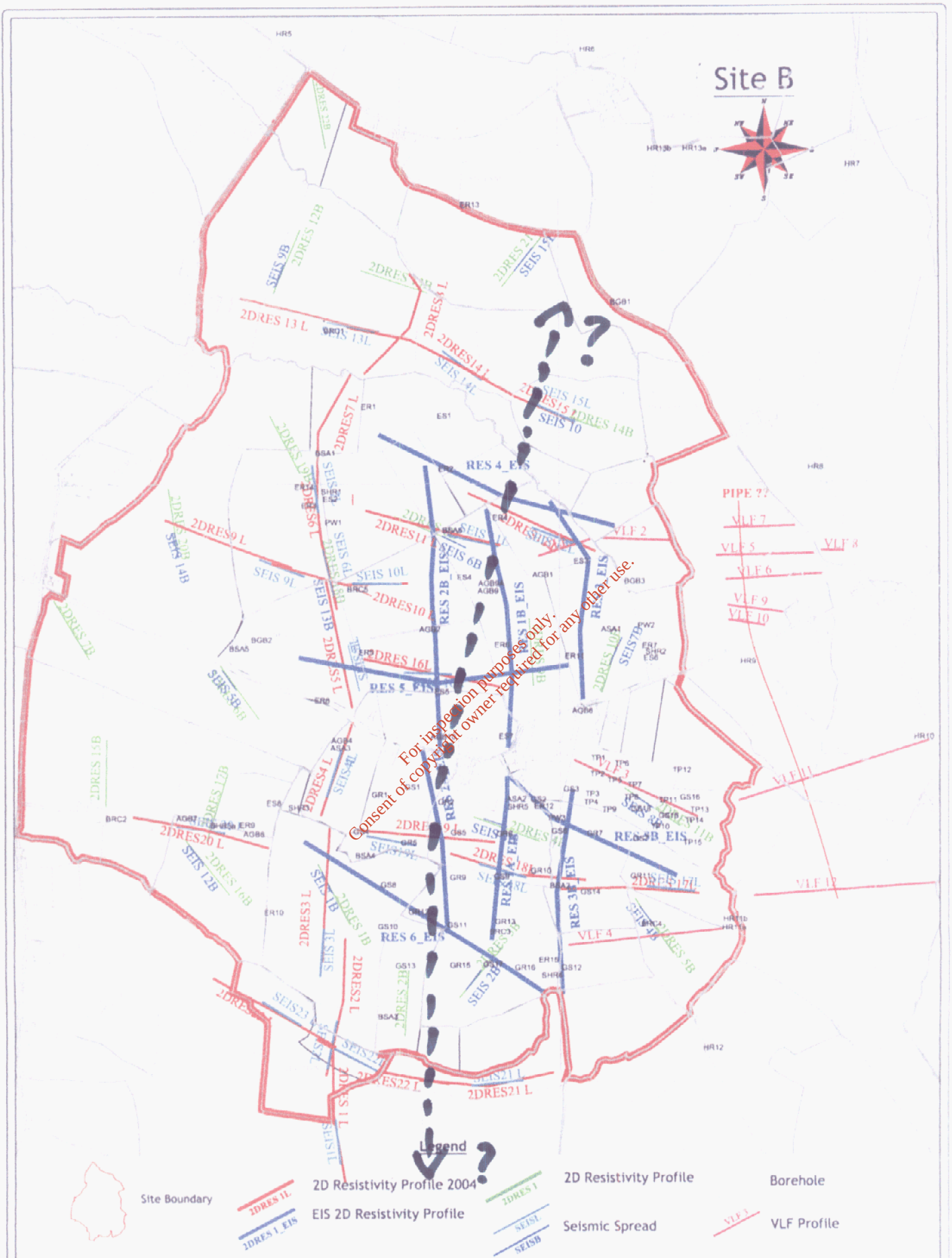
The contribution of gravels and rock faults to the Zones of Contribution of water sources in the vicinity of the proposed landfill has not been assessed in the EIS. Such an assessment, as stated by Dr Ashley, would require computer modelling of some complexity. The outcome of such a study might well be an R4or R3 categorization for this site, and the project could therefore not proceed.

In the absence of this vital computer modelling and the level of risk present, and having regard to the Precautionary Principle, I cannot see how the EPA can allow this project to proceed.

References

Marked maps, and selected borehole and geophysical data from the Fingal County Council Landfill Site Selection Study, July 2004 and the EIS in relation to Kerrigan's well are attached.

NEVITT REF 22 FAULT. 5



KERRIGANS WELL

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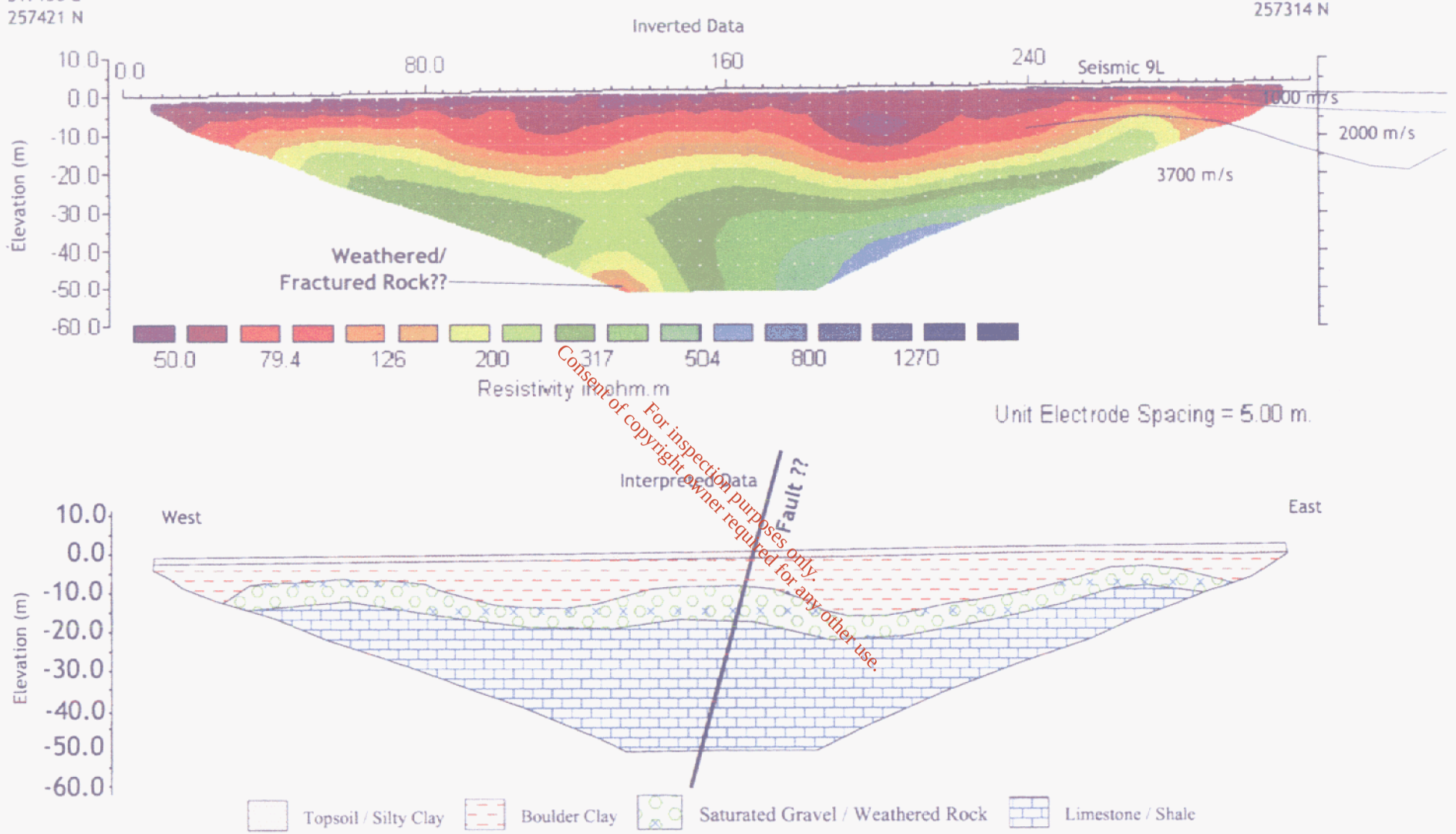
257421 N

317410 E
257314 N



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RMS ERROR
1.4 %

SECTION 9 LONG
INTERPRETATION
2D-RESISTIVITY PROFILE 9
LONG

FINGAL LANDFILL SITING
STUDY (SITE B)

RPS-MCOS

Dwg No 1492/19

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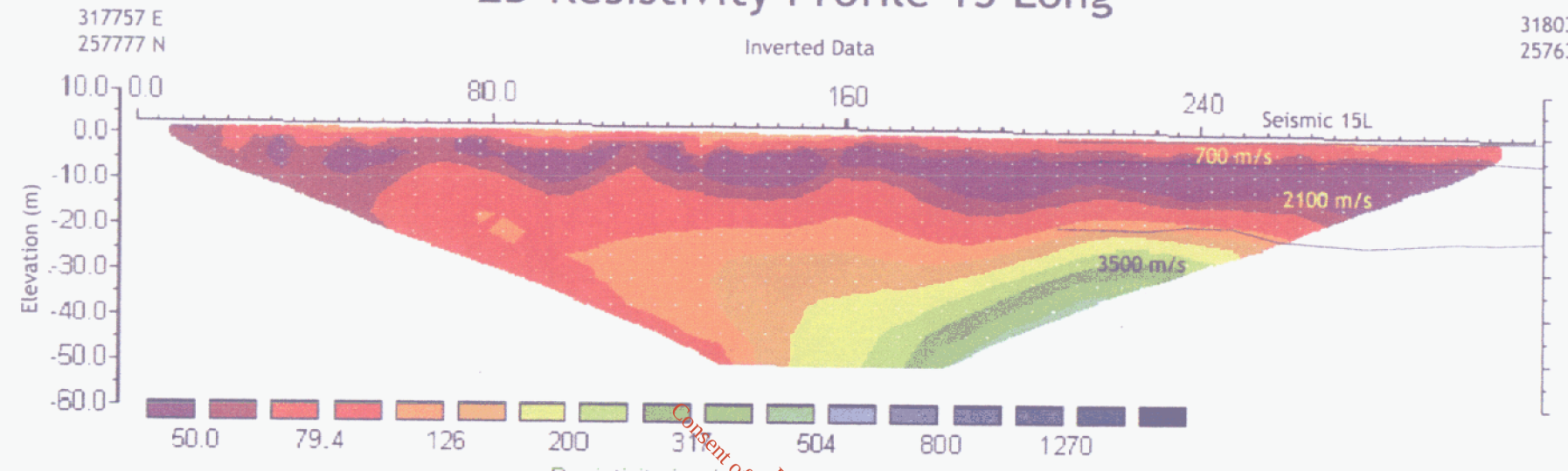

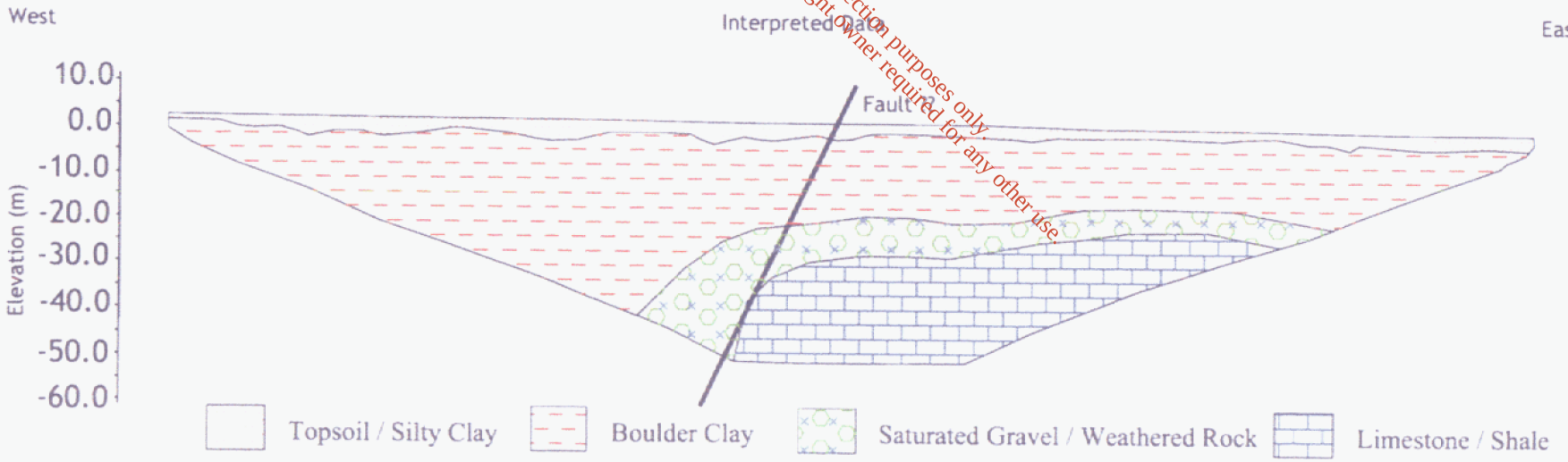

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SECTION 15 LONG
INTERPRETATION
2D-RESISTIVITY PROFILE 15
LONG

FINGAL LANDFILL SITING
STUDY (SITE B)

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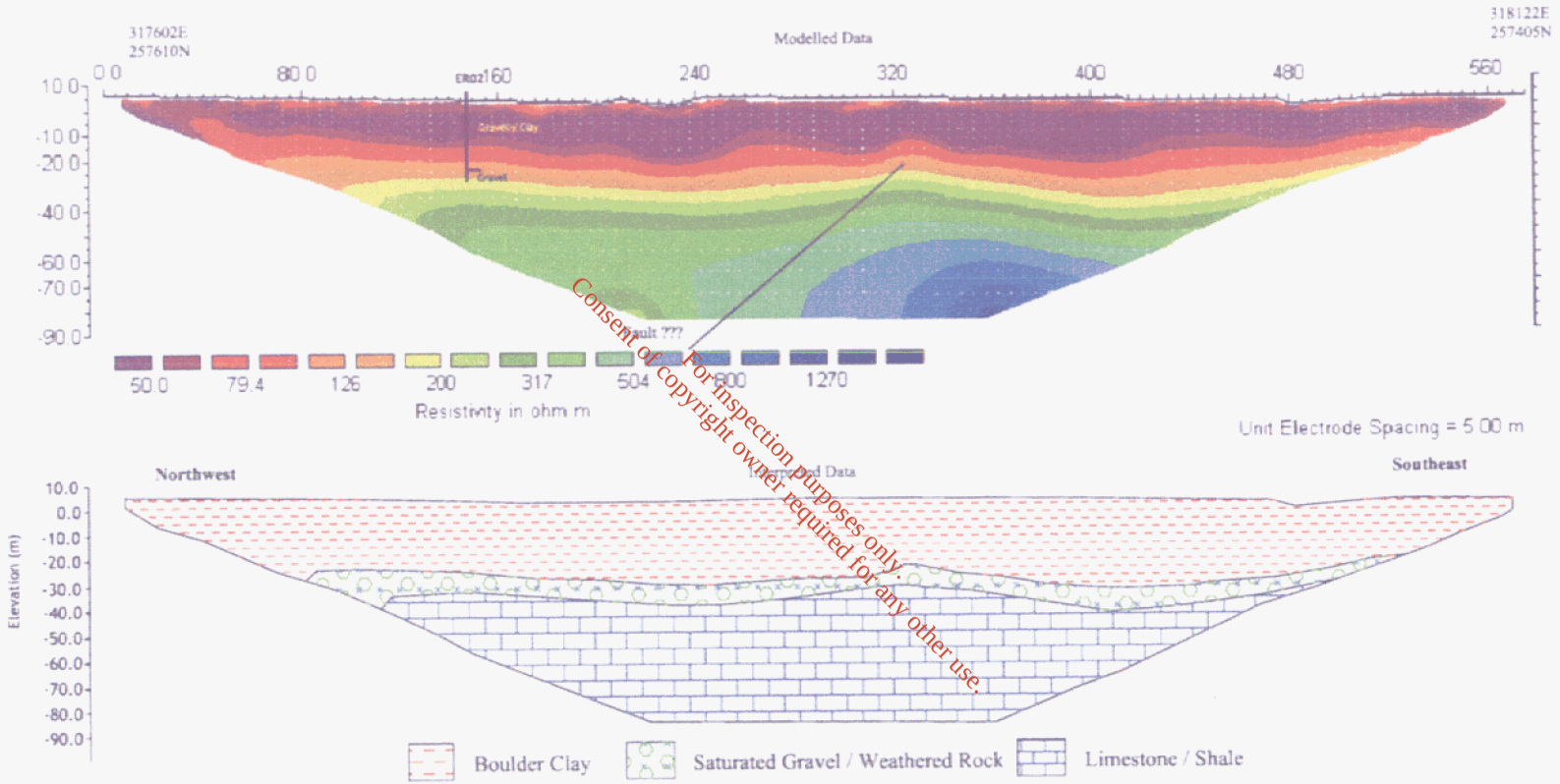
2D-Resistivity Profile 4 (EIS_2005)



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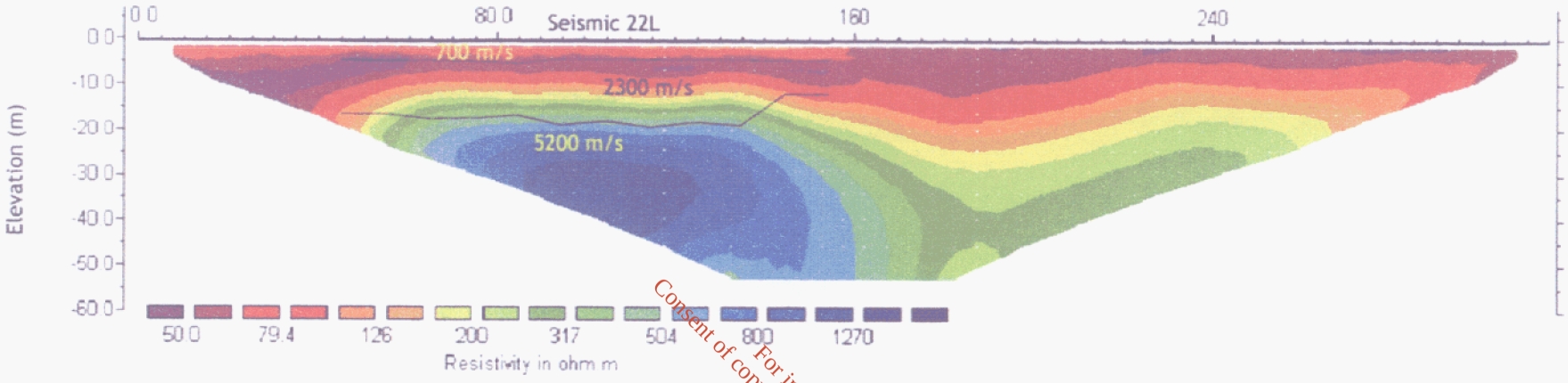
2D-Resistivity Profile 22 Long

317462 E
256258 N

317754 E
256157 N

Inverted Data



West

East

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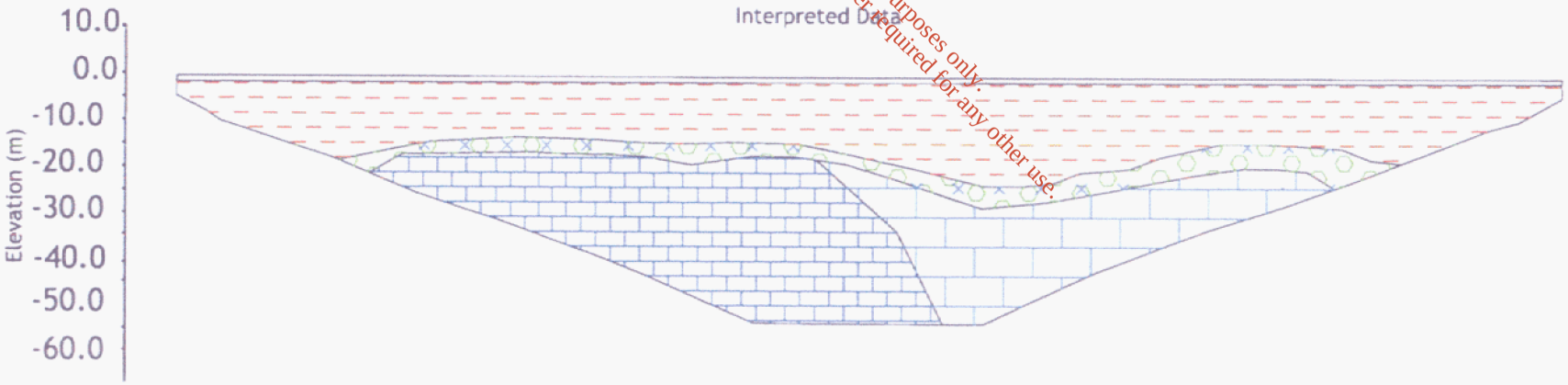

Topsoil / Silty Clay

Boulder Clay

Saturated Gravel / Weathered Rock

Limestone / Shale

Weathered Limestone / Change in Lithology?

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Notes
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0.71 %

Drawn: Kamila Dutkiewicz
Checked: Joannes Hodgson
Date: July 2004

Title
SECTION 22 LONG
INTERPRETATION
2D-RESISTIVITY PROFILE 22
LONG

Job
FINGAL LANDFILL SITING
STUDY (SITE B)

Client
RPS-MCOS

Dwg No: 1492/22

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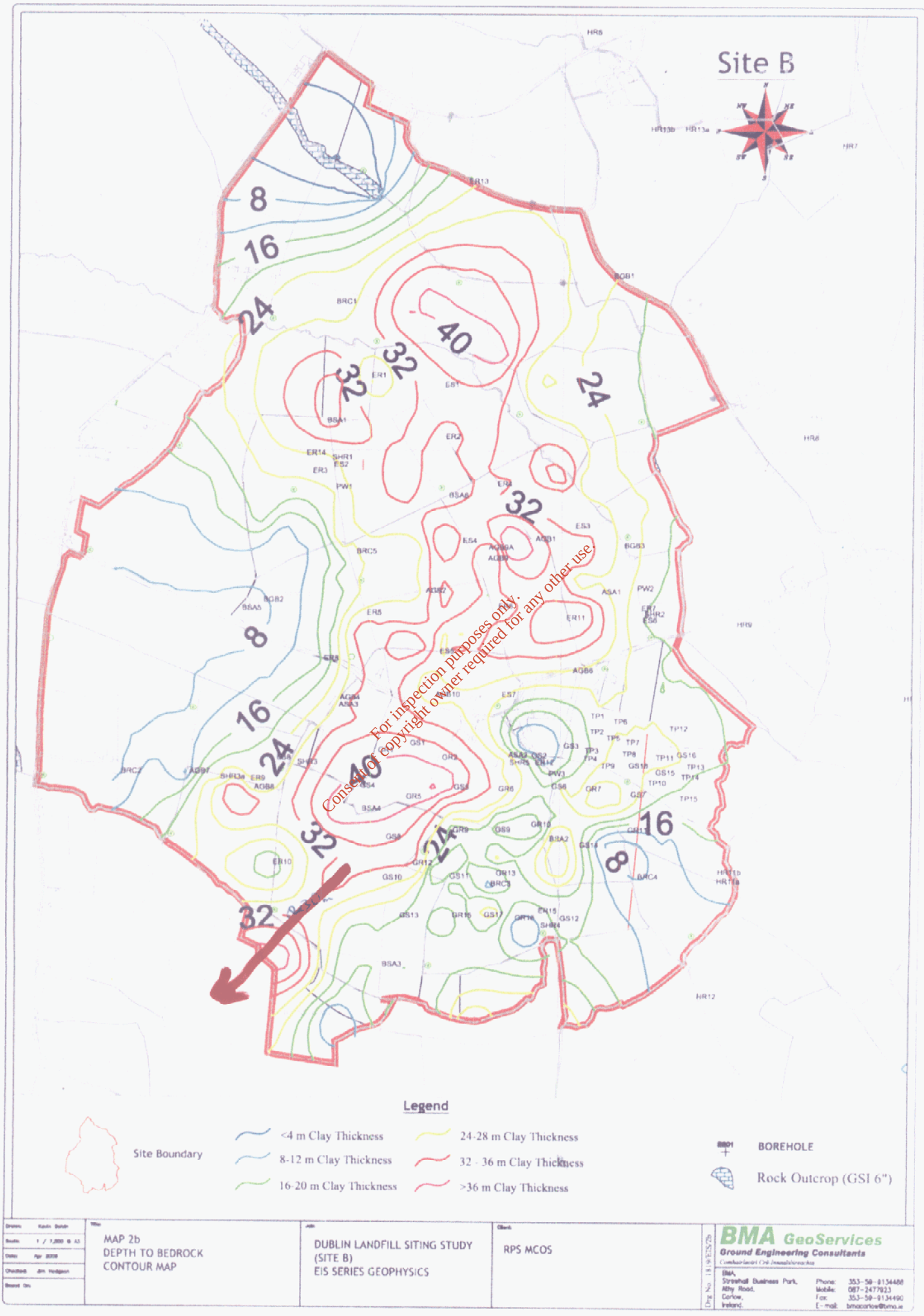
NEVITT. ~~REF24~~ SW BEDROCK GAP. 10



MAP 2b
DEPTH TO BEDROCK
CONTOUR MAP

DUBLIN LANDFILL SITING STUDY
(SITE B)
EIS SERIES GEOPHYSICS

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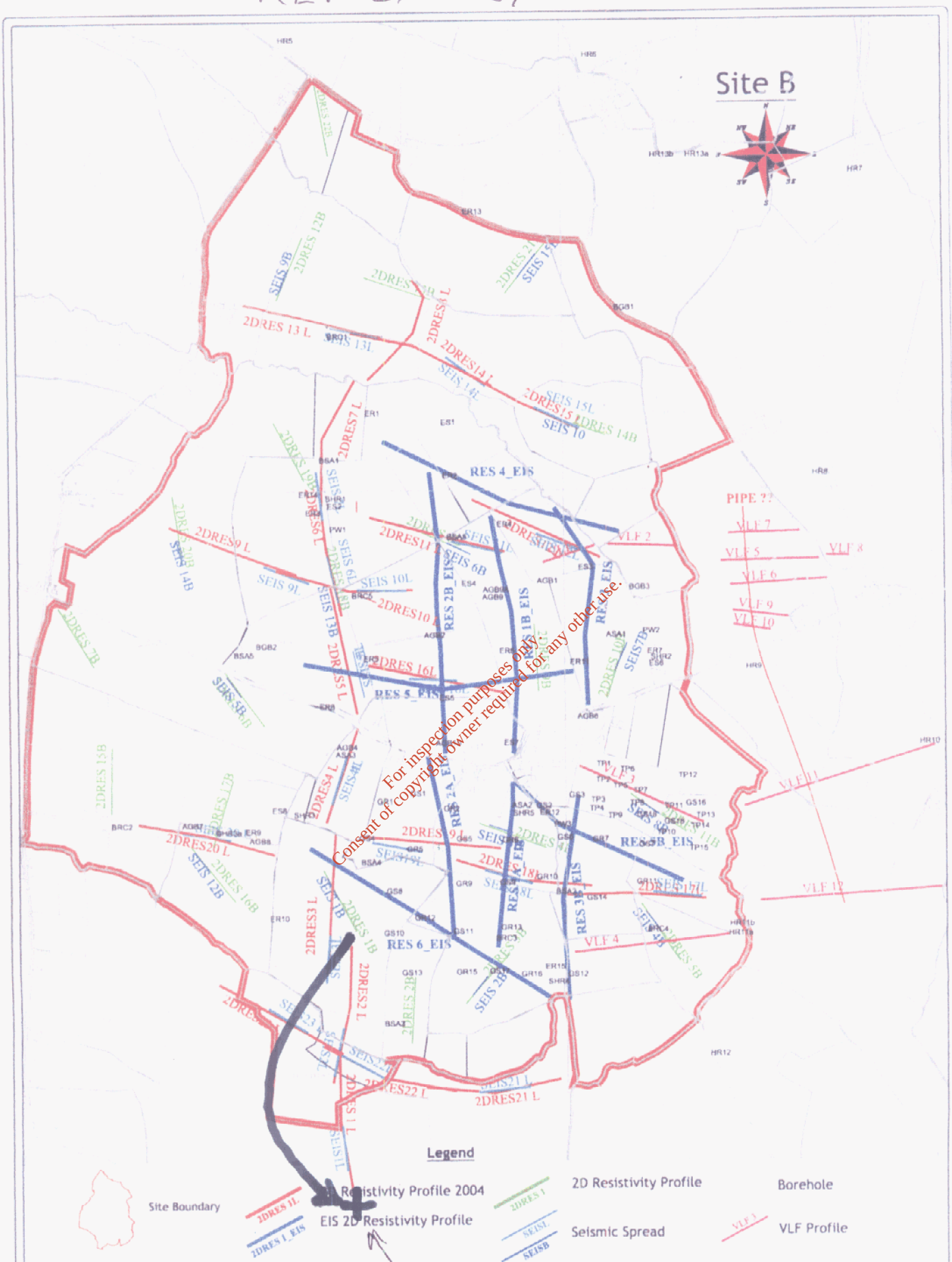
REF 23 S/W BEDROCK GAP. 11



MAP 1b
LOCATION OF GEOPHYSICAL & VLF PROFILES

DUBLIN LANDFILL SITING STUDY
(SITE B)
EIS SERIES GEOPHYSICS

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+ KERRIGANS

See GOOGLE EARTH MAP.
~~REF 6.~~

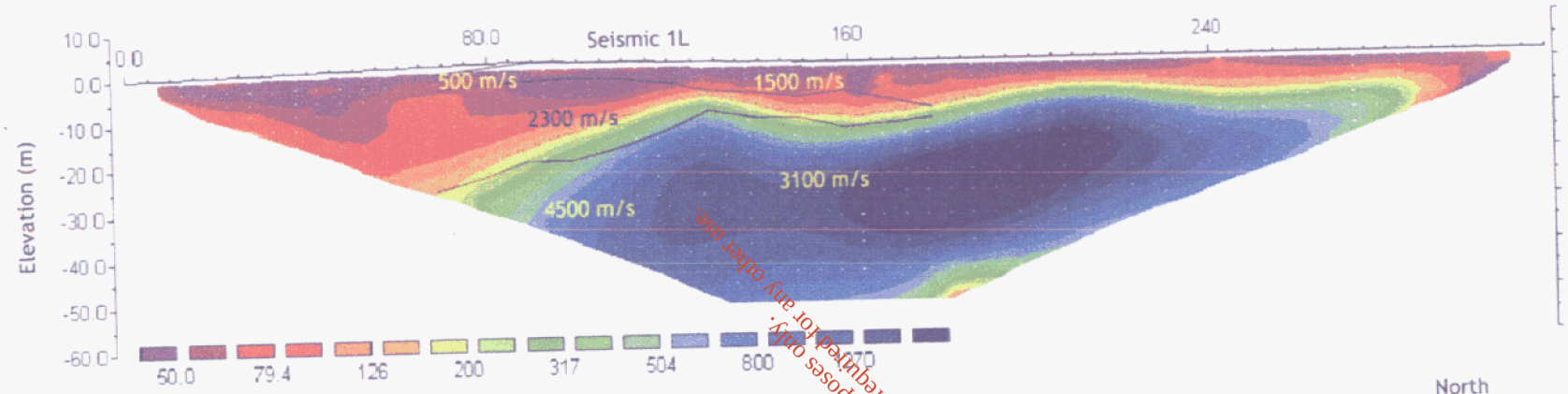
12

2D-Resistivity Profile 1 Long

317524 E
255938 N

317497 E
256242 N

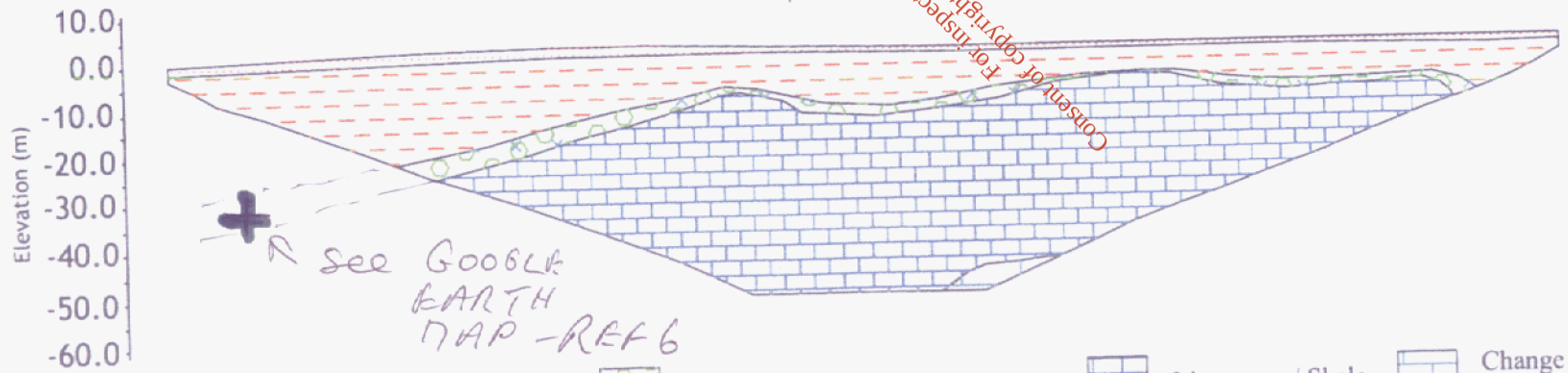
Inverted Data



South

North

Interpreted Data



Topsoil / Silty Clay

Boulder Clay

Saturated Gravel / Weathered Rock

Limestone / Shale

Change in Lithology / Weathered Limestone?

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RMS ERROR
1.3 %

SECTION 1 LONG
INTERPRETATION
2D-RESISTIVITY PROFILE 1
LONG

FINGAL LANDFILL SITING
STUDY (SITE B)

RPS-MCOS

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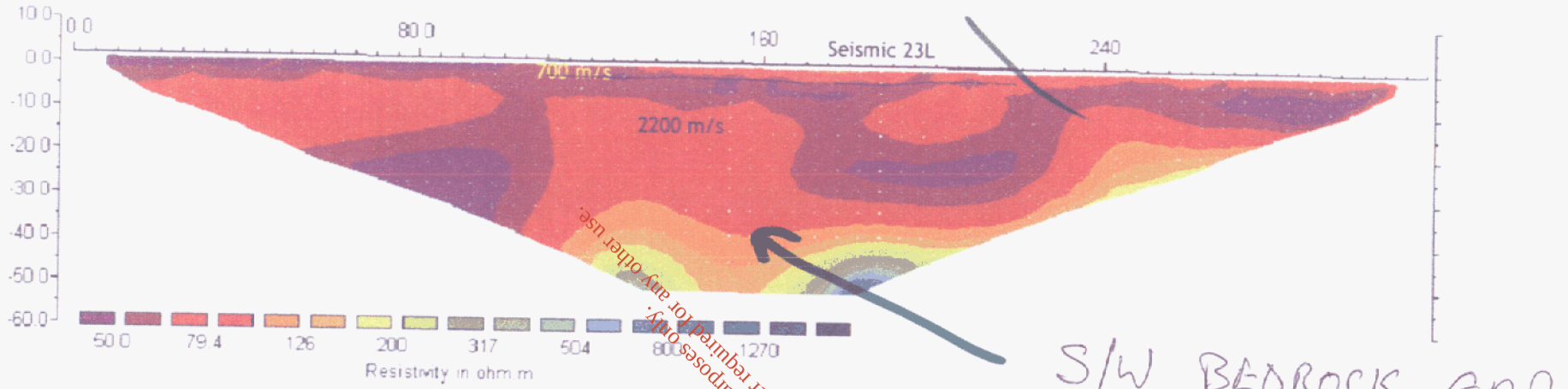
2D-Resistivity Profile 23 Long

317233 E
256396 N

317504 E
256241 N

Inverted Data

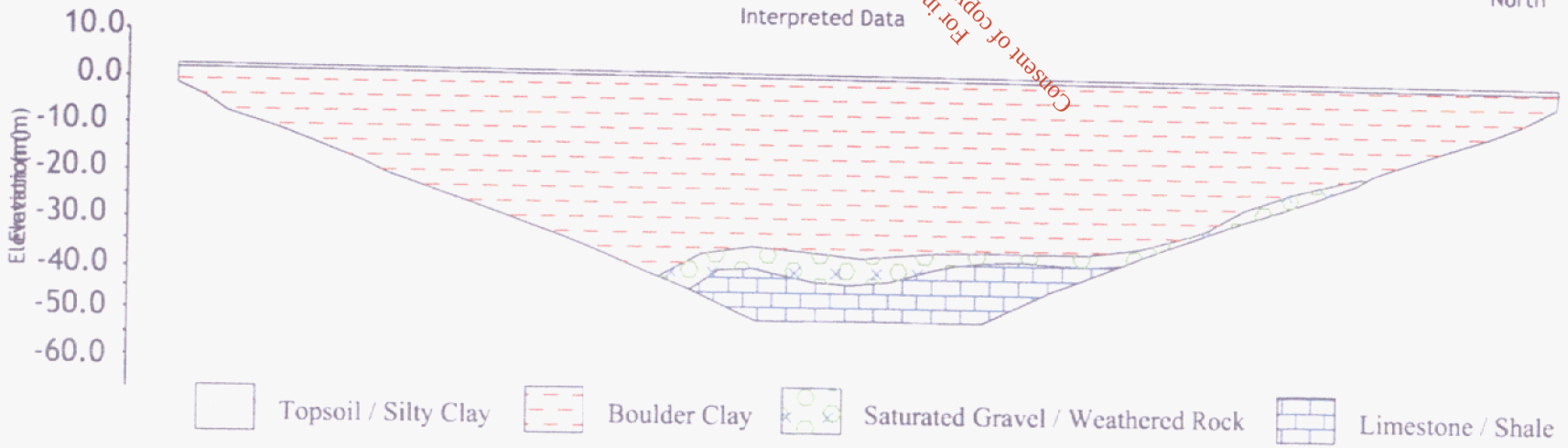


S/W BEDROCK GAP

South

Interpreted Data

North



Topsoil / Silty Clay

Boulder Clay

Saturated Gravel / Weathered Rock

Limestone / Shale

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14

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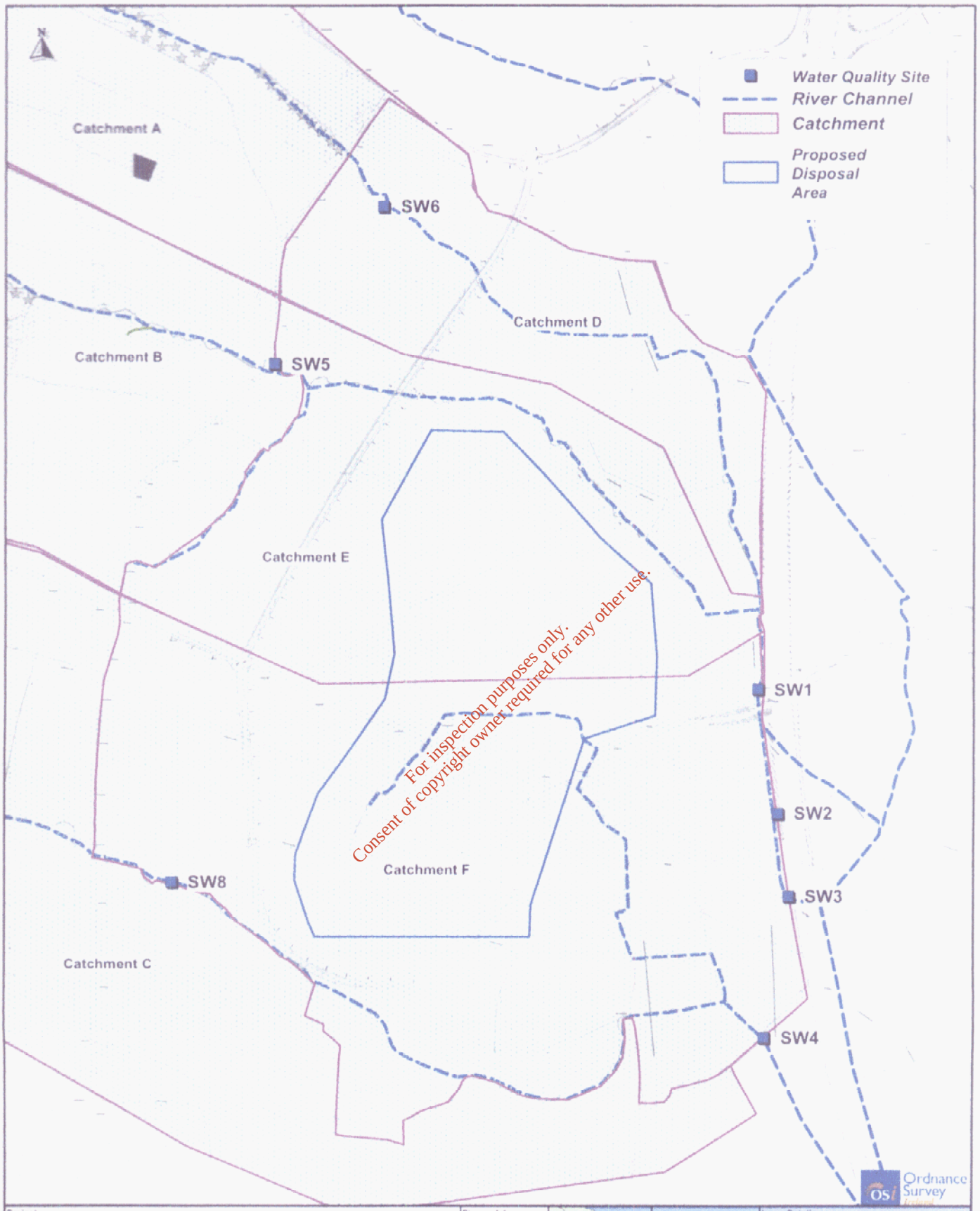

Project: *Fingal Landfill Project*

Figure 1.1

Title: Monitoring Locations, River Channels and Catchments

Fingal County Council

RPS Consulting Engineers

Issue Details

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Checked: WS | File Ref:

Approved: KW | MDR0901M0010

Scale: N.T.S. | Drawing No: | Rev:

Date: 04/13/06 | M0010 | 1101

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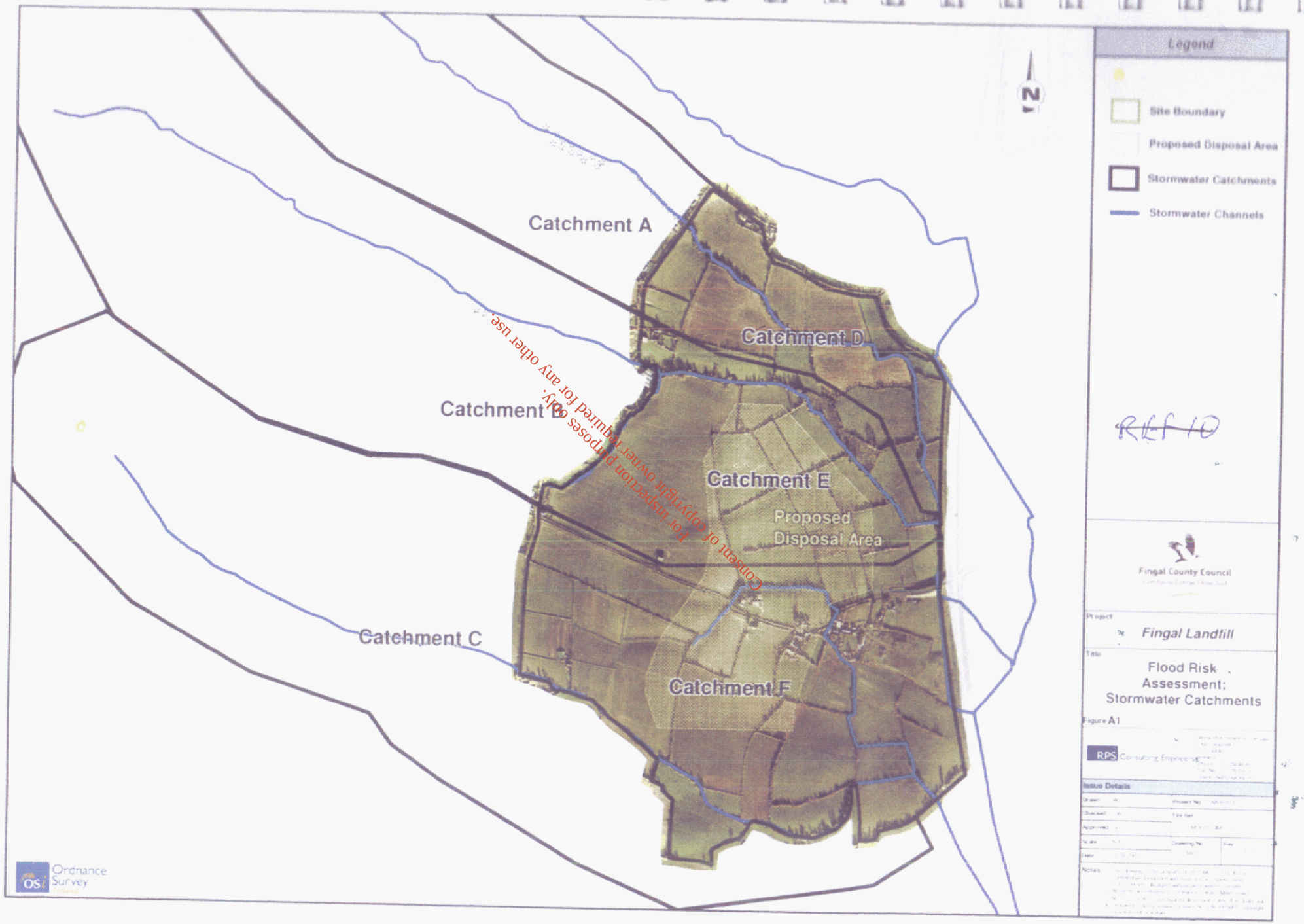

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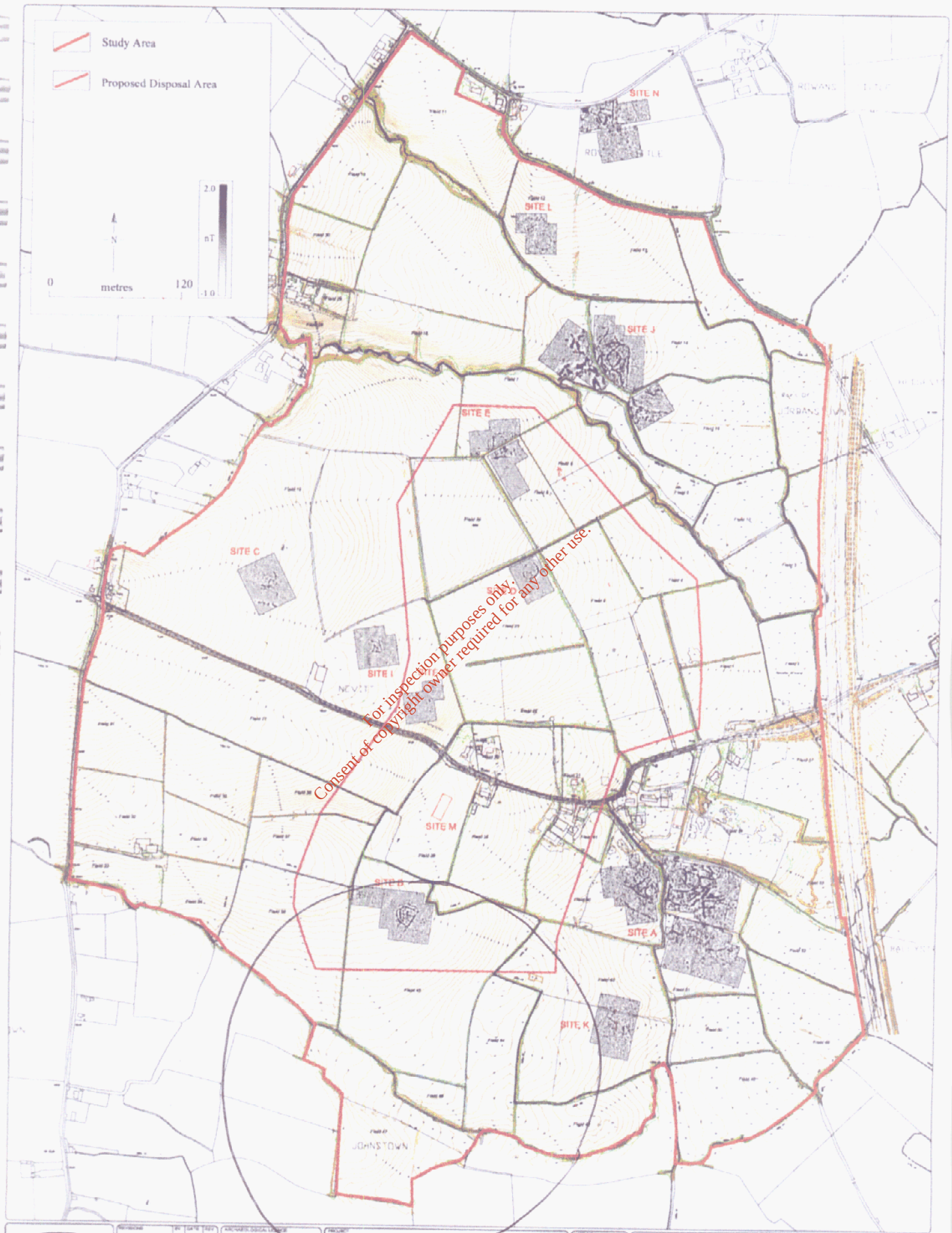

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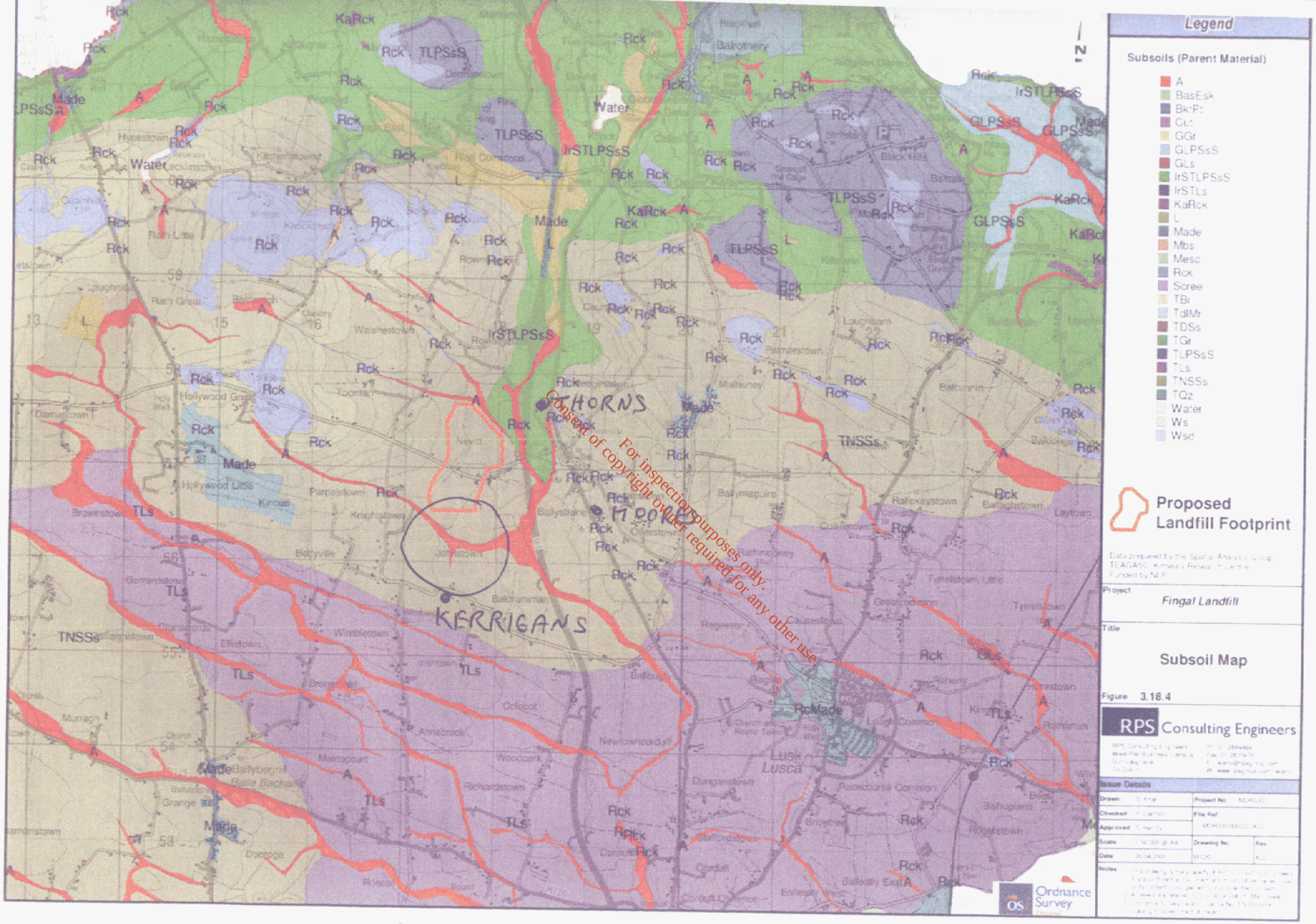

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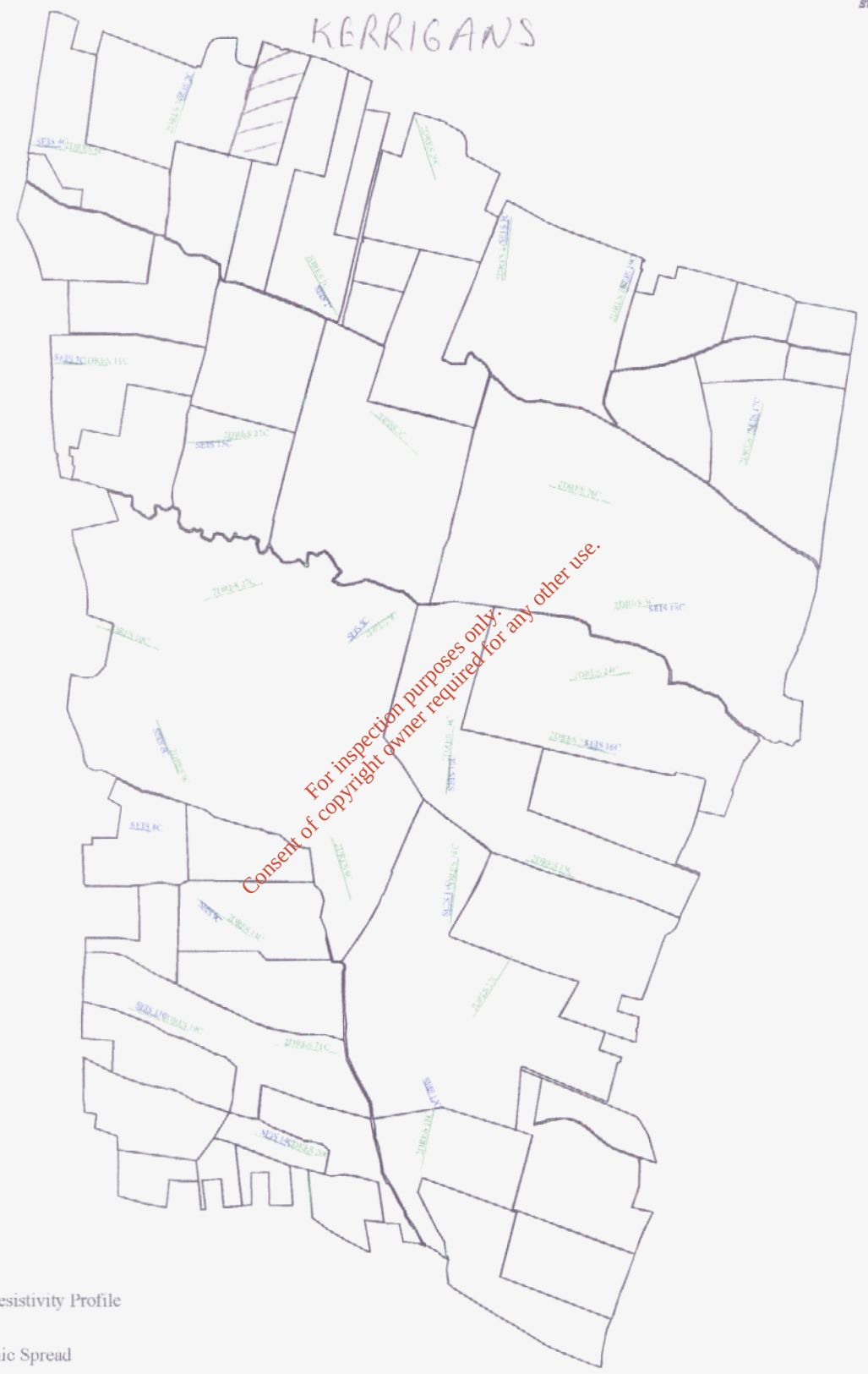

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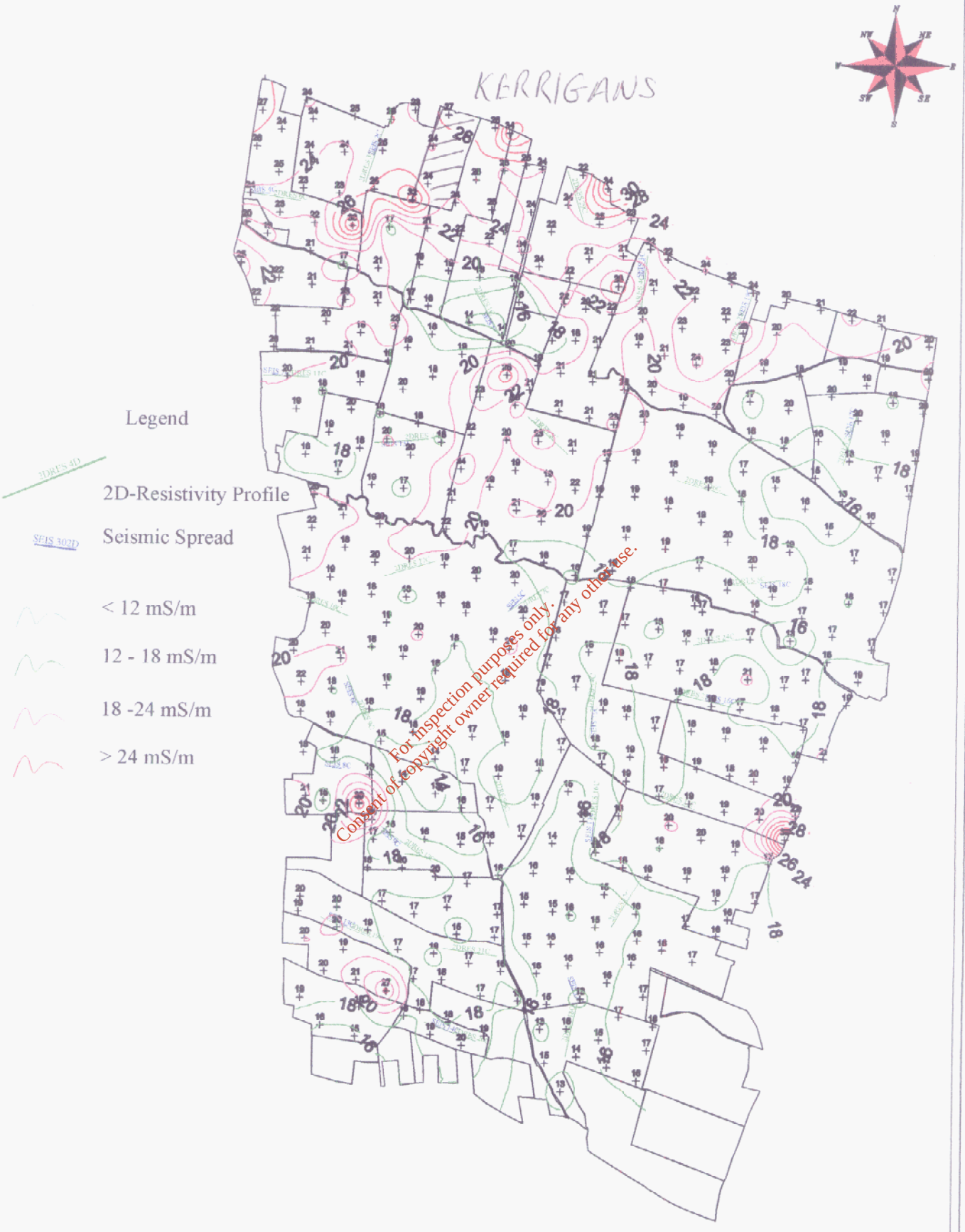
KERRIGANS



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Dwg No. 1796/IC2

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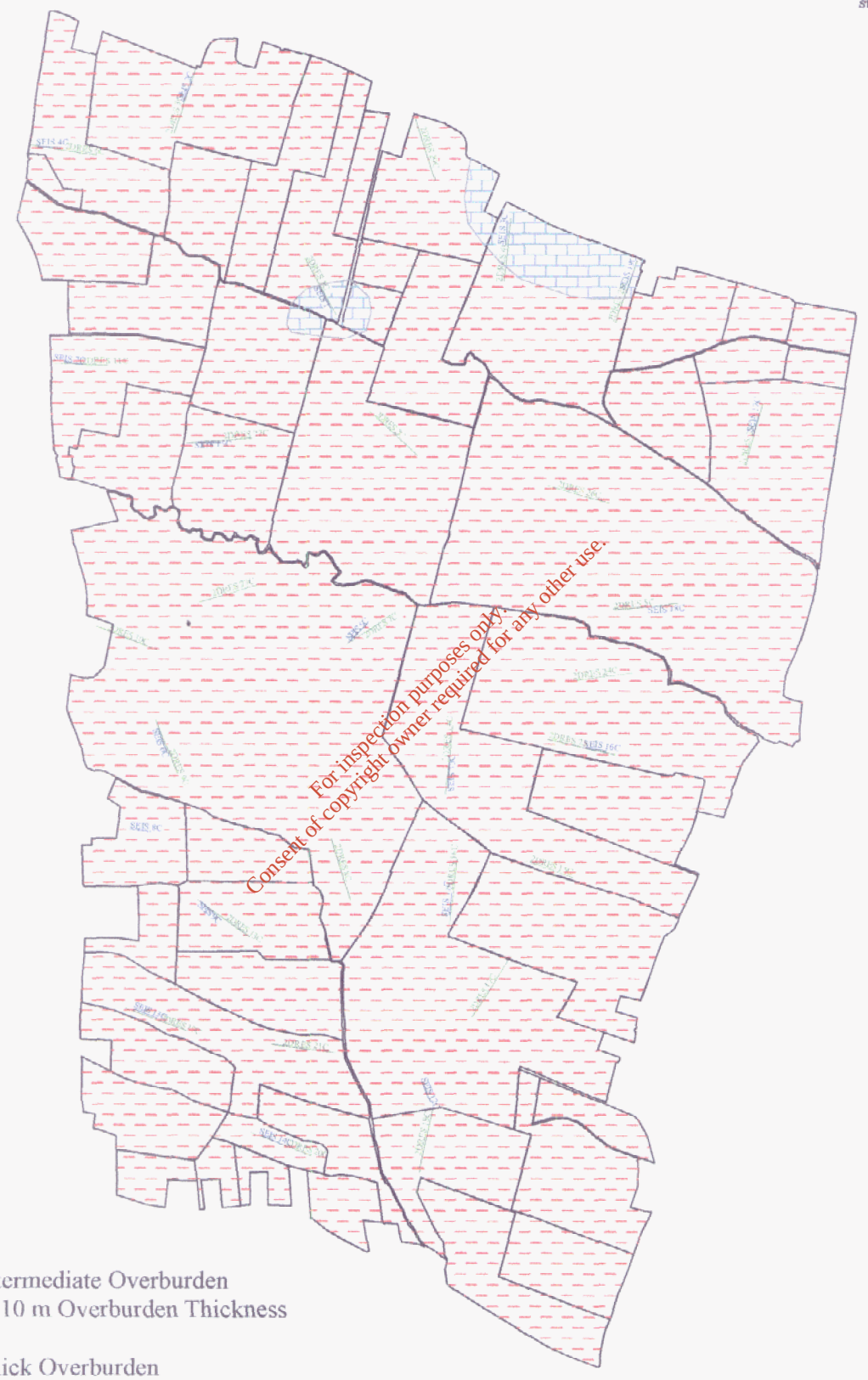

Intermediate Overburden
5 -10 m Overburden Thickness

Thick Overburden
> 10 m Overburden Thickness

Drawn: Kevin Gabbe Scale: 1 / 10,000 Date: April 2004 Checked: Jim Hodgson Board No:	Title: MAP 3C SUMMARY MAP FOR SITE C	Job: DUBLIN LANDFILL SITING STUDY	Client: RPS MCOS	Drg No: 1492/1C/3

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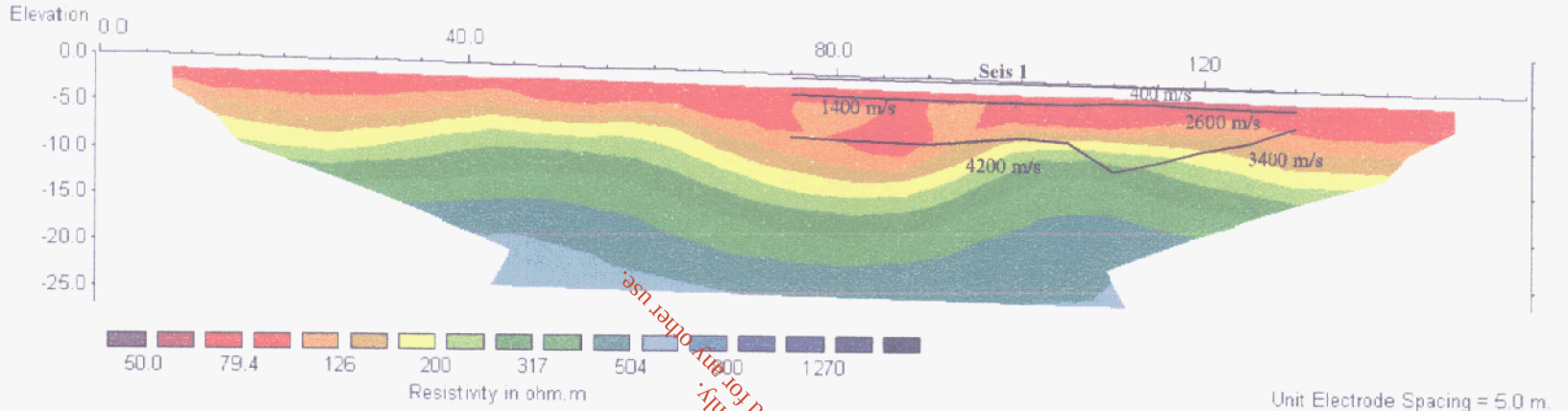
2D-Resistivity Profile 1 (Site C)

317586 E
255193 N

Modelled Data

317662 E
255057 N



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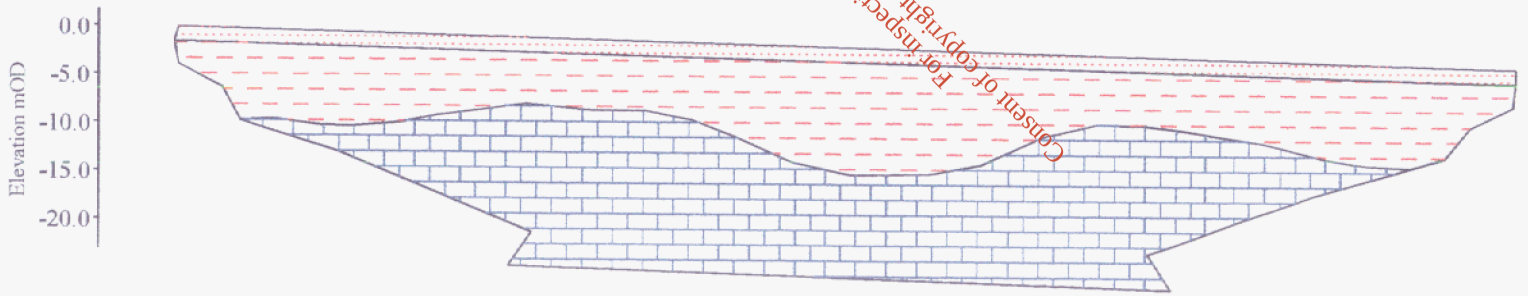
Northwest

Southeast



Topsoil / Silty Clay

Boulder Clay

Gravelly Clay / Clayey Gravel

Limestone / Shale

Notes: Notes	Drawn: Donal Crean Scale: 1 / 750 Date: Mar 2004 Checked: James Hodgson Based On:	Title: SECTION 1 INTERPRETATION 2D-RESISTIVITY PROFILE 1	Job: FINGAL LANDFILL SITING STUDY (SITE C)	Client: RPSMCOS	Drg No: 1492/C/R1

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2D-Resistivity Profile 2 (Site C)

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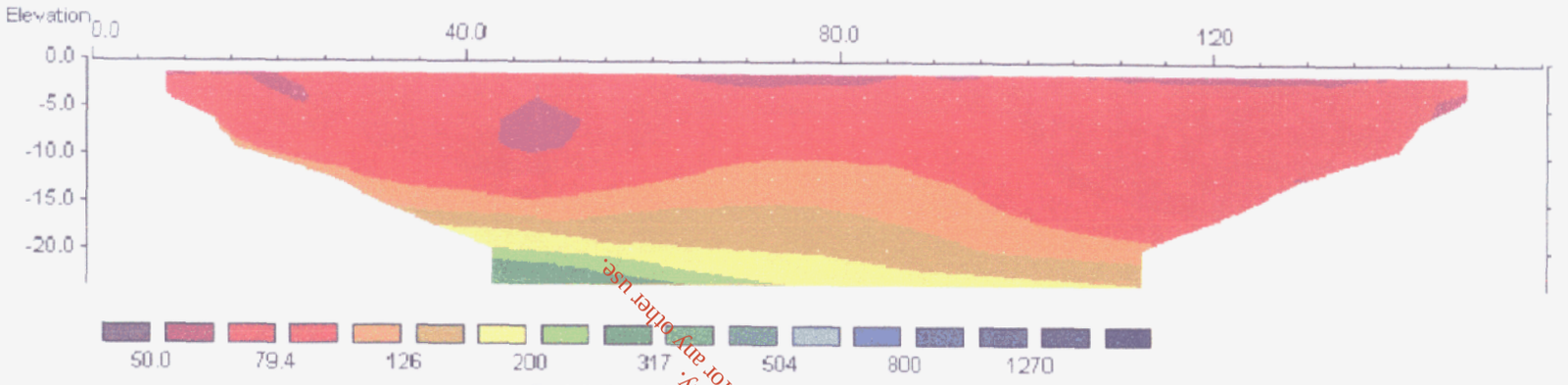
254833 N

Modelled Data

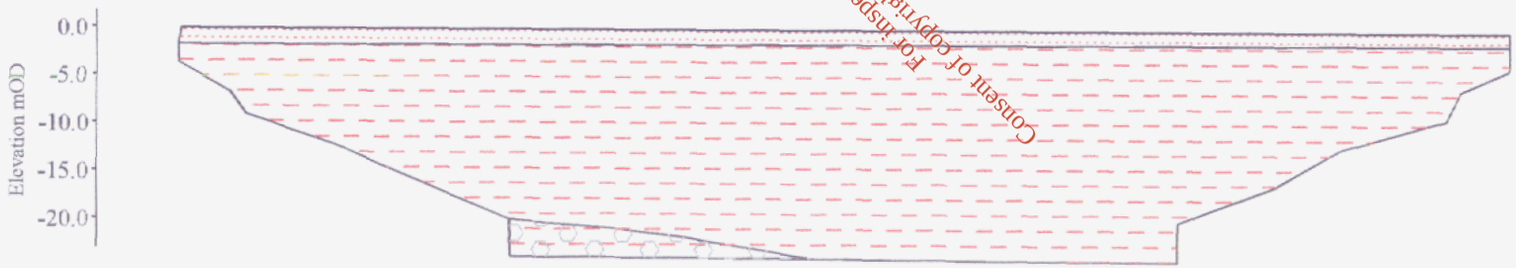
317853 E
254729 N



Unit Electrode Spacing = 5.0 m.

West

East



Topsoil / Silty Clay

Boulder Clay

Gravelly Clay / Clayey Gravel

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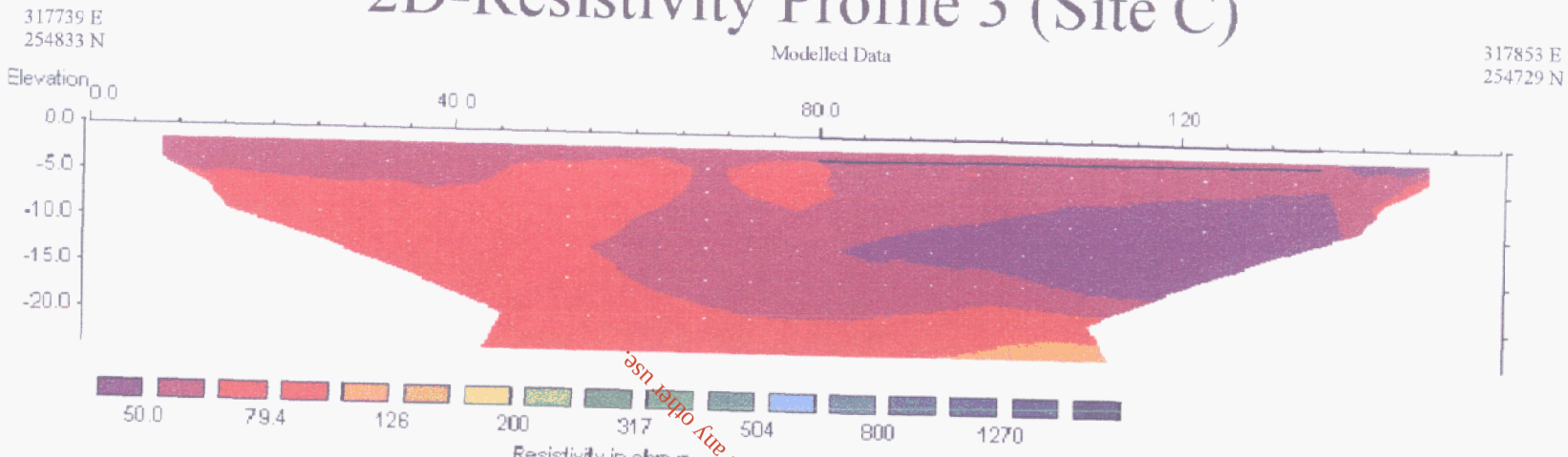
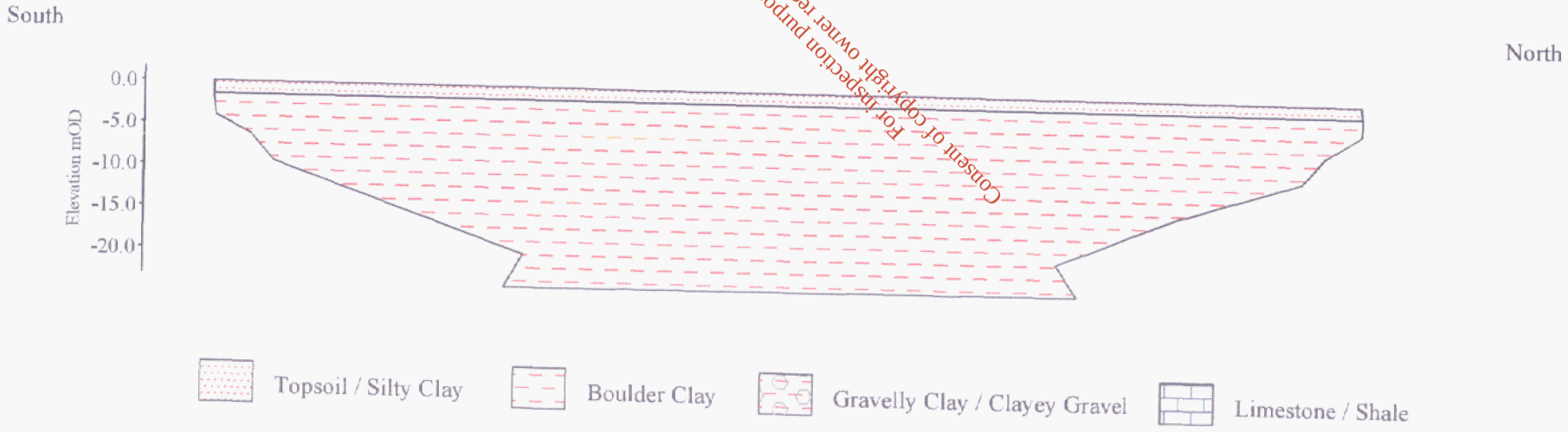
2D-Resistivity Profile 3 (Site C)





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Notes

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Date: Mar 2004
Checked: James Hodgson
Issued On:

Title:
SECTION 1
INTERPRETATION
2D-RESISTIVITY PROFILE 3

Job:
FINGAL LANDFILL SITING STUDY
(SITE C)

Client:
RPSMCOS

Drg No: 1492/C/R3

BMA GeoServices
Ground Engineering Consultants
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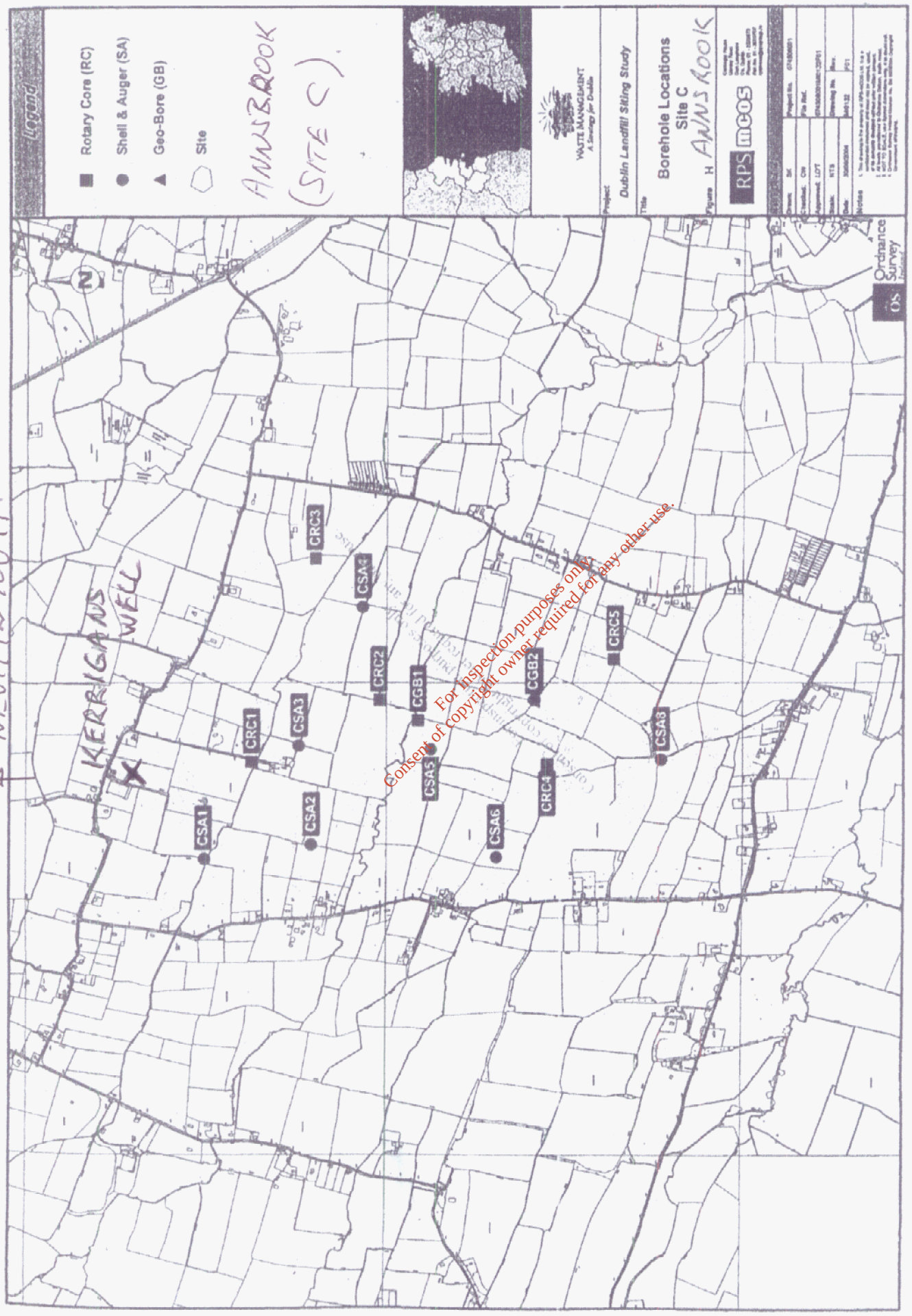
BOREHOLE LOGS + GROUNDWATER MONITORING
ANNSBROOK.



GROUNDWATER MONITORING DATA

IGSL

Contract: Dublin Landfill Sitting Scheme
Number: 9716
Client: Fingal County Council
Engineer: RPS-MCOS Ltd.

Borehole/ Drillhole	Standpipe Response Zone	Water Level (m bgl) (30.7.04)
ARC1	11 to 20	4
ARC4	12 to 20.85	2.62
ASA2	3.9 to 7.7m	1.42
ASA3	2.7 to 3.7m	1.52
ASA4	3.6 to 5.6m	2.51
	12 to 13m	3.18
ASA5A	3.6 to 5.6m	1.46
	8 to 14m	1.4
BRC1	27 to 34	4.67
BRC2	9.7 to 18.7	3.64
BRC3	11 to 18.4	3.84
		4.03
BRC4	7.6 to 11.3	0.41
BGB1	22 to 24m	artesian
BGB2	8.5 to 17.6	7.57
	2 to 6.5	6.19
BGB3	14 to 24m	3.84
	2 to 12m	4.03
BSA1	16.5 to 17.5m	2.18
BSA2	5.4 to 7.4m	2.85
BSA3A	16 to 17m	9.29
BSA4	2 to 12.3m	2.51
BSA5	6.4 to 6.9m	4.13
CRC1	6.75 to 14.75	1.05
CRC2	13.35 to 23.35	5.68
CRC3	11.5 to 24.2	2.2
CRC4	23 to 32.05	11.27
CRC5	23.4 to 32.4	14.2
CSA1	2 to 6m	2.2
CSA2	2 to 7.4m	1.75
CSA4	1.7 to 7.7m	1.73
	23 to 32.05	1.75
CSA6	10.4 to 15m	3.5
CSA8	10.2 to 13.5	9.16
	14.5 to 16.5m	9.16
CGB2	2 to 10	2.85
	15.2 to 18.2	4.49
CGB1	2 to 5.5m	8.4
	7 to 10.5m	14.12
DGB1	16.5 to 24m	1
	2 to 10m	0.65
DRC2	2 to 17.6	Artesian
DRC3	12.5 to 21.5m	0.51
DRC4	6.7 to 9.0m	1.79
		8.84
DRC5	4 to 40m	5.6
DRC6	6.3 to 15.3m	0.49
DGB2	2 to 10m	2.03
	13 to 22m	4.99
DSA1	10.5 to 14.7m	Artesian
DSA2	1 to 2m	1.31
DSA3	7.7 to 10.9	Artesian
DSA4	5 to 9.95m	4.25
DSA5A	1.5 to 5.8m	1.87
DSA6	4 to 10m	Artesian
DSA7	3 to 11.5m	10

Notes:

AS BUILT SURVEY DUBLIN LANDFILL SITTING SCHEME 24/8/04

BH NO.	EASTING	NORTHING	RL
ARC1	259636.177	320839.326	78.662
ARC4	258466.580	322120.622	70.008
ASA2	259507.278	321152.801	76.786
ASA3	258792.845	321268.993	82.280
ASA4	258036.207	321750.532	74.563
ASA6	321751.589	258031.700	73.523
ASA5	258591.153	322181.447	67.734
ASA7	258364.467	322060.692	73.487
ASA7A	258358.654	322061.344	73.367
BGB1	257899.744	318109.860	43.919
BGB2	257277.005	318138.248	40.053
BGB3	257144.704	317314.900	62.184
BRC1	257838.276	317476.680	59.340
BRC2	256749.851	316994.349	56.151
BRC3	256495.916	317838.752	38.224
BRC4	256513.260	318174.240	30.056
BRC5	257260.770	317526.491	56.889
BSA1	257564.181	317457.546	59.186
BSA2	256666.825	317542.890	48.760
BSA3	256309.515	317589.259	41.704
BSA4	256616.663	317972.022	34.171
BSA5	257143.291	317309.718	62.251
BSA6	257391.254	317736.974	49.926
CGB1	254358.537	317841.967	30.222
CGB2	254358.547	317841.833	30.208
CRC1	255056.667	317663.026	34.021
CRC2	254525.782	317933.560	31.852
CRC3	254784.153	318527.493	27.870
CRC4	253823.821	317592.859	27.641
CRC5	253553.997	318092.919	28.661
CSA1	255251.755	317249.481	37.074
CSA2	254725.700	317302.946	37.610
CSA2A	254731.246	317304.944	37.499
CSA3	254853.839	317726.595	33.705
CSA3A	254854.900	317731.600	33.800
CSA4	254598.486	318333.526	28.093
CSA5	254301.113	317662.862	32.165
CSA5A	254294.073	317663.839	32.079
CSA6	254110.491	317226.118	34.513
CSA7	253904.790	317913.804	28.742
CSA7A	253910.872	317917.265	28.784
CSA8	253344.783	317666.766	23.537
DGB1	258091.782	313479.683	98.715
DGB2	256022.598	312817.939	77.290
DRC2	257009.653	313547.747	77.982
DRC3	257997.726	313027.103	99.885
DRC4	256241.373	313687.302	75.040
DRC5	256228.790	312776.950	81.081
DRC6	256604.649	312492.390	81.328
DSA1	258825.773	313060.321	109.372
DSA2	258931.268	313709.188	99.029
DSA3	255925.300	312155.402	78.461
DSA4	255925.268	312155.384	78.468
DSA5	256914.292	312794.852	84.650
DSA6	256402.978	313219.620	75.946
DSA7	256298.635	314141.319	68.225
DSA8	258310.811	312874.250	113.449

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REPORT NO: 9716	GEOTECHNICAL BORING RECORD	IGSL Ltd.

CONTRACT : Dublin Landfill Siting Study

BOREHOLE NO: CSA1
Sheet 1 of 1

CLIENT : Fingal County Council
ENGINEER : RPS-MCOS

CO-ORDINATES : E 255251:76
N 317249.48

GROUND LEVEL (mOD) 37.07
BOREHOLE DIAMETER (mm) 200
BOREHOLE DEPTH (m) 6.10
CASING DEPTH (m) 4.50

DATE STARTED: 01/06/2004
DATE COMPLETED: 02/06/2004

BORED BY: G Roberts

DEPTH (M)	DESCRIPTION	LEGEND	ELEVATION (mOD)	DEPTH (m)	SAMPLES: REF. NUMBER	SAMPLES: SAMPLE TYPE	SAMPLES: DEPTH (m)	FIELD TEST RESULTS	BLOWS / RECOVERY	STAND PIPE DETAILS
0	TOPSOIL		36.87	0.20	L1462	B	0.20			
	Brown slightly sandy gravelly CLAY				L1463					
1					L1464	B	1.00			
					L1465					
2	Stiff grey sandy gravelly CLAY		35.07	2.00	L1466	B	2.00	C=19		
3	Very stiff grey slightly sandy gravelly CLAY with some cobbles		34.07	3.00	L1467	B	3.00			
					L1468	B	3.50			
4					L1469	B	4.00			
					L1470			C=51/ 255mm		
5					L1471	B	5.00			
6	End of Borehole at 6.10 m		30.97	6.10				C=25/ 35mm		
7										
8										
9										
10										

ANNSBROOK

Hard Strata Boring / Chiselling

From (m)	To (m)	Hours	Comments
2.60	3.00	1.50	
3.50	3.90	1.00	
4.60	5.00	1.50	
5.00	5.40	1.25	
5.90	6.10	1.75	

Water Strike Details

Water Strike	Casing Depth	Sealed At	Rise To	Time	Comments

Standpipe Installation Details

Date	Tip Depth	RZ Top	RZ Base	Type
02/06/2004	6.10	2.00	6.10	SP

Groundwater Observations

Date	Hole Depth	Casing Depth	Depth to Water	Comments
01/06/2004	0.00	-	-	Damp at end of day

Remarks:

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GEOTECHNICAL BORING RECORD

REPORT NO: 9716 | IGSL Ltd.

CONTRACT : Dublin Landfill Siting Study

BOREHOLE NO: CSA2
Sheet 1 of 1

CLIENT : Fingal County Council
ENGINEER : RPS-MCOS

CO-ORDINATES : E 254725.70
N 317302.95

GROUND LEVEL (mOD) 37.61
BOREHOLE DIAMETER (mm) 200
BOREHOLE DEPTH (m) 6.00
CASING DEPTH (m) 4.50

DATE STARTED: 26/05/2004
DATE COMPLETED: 26/05/2004

BORED BY: G Roberts

DEPTH (M)	DESCRIPTION	LEGEND	ELEVATION (mOD)	DEPTH (m)	SAMPLES REF. NUMBER	SAMPLE TYPE	SAMPLES DEPTH (m)	FIELD TEST RESULTS	BLOWS / RECOVERY	STAND PIPE DETAILS
0	TOPSOIL									
			37.11	0.50	L1447	B	0.50			
	Brown/grey sandy gravelly CLAY									
1			36.61	1.00	L1448	B	1.00			
	Stiff grey slightly sandy slightly gravelly CLAY with occasional cobbles and boulders				L1450					
					L1451					
					L1449	U	1.55		100%	
2					L1452	B	2.00	C=19	NR	
					L1453	U				
					L1451					
3					L1454	B	3.00	C=26		
					L1455					
4					L1456	B	4.00	C=26		
					L1457					
5					L1458	B	5.00	C=25		
					L1459					
	OBSTRUCTION - possible boulder		32.11	5.50						
6			31.61	6.00				C=22		
	End of Borehole at 6.00 m									
7										
8										
9										
10										

Hard Strata Boring / Chiselling

From (m)	To (m)	Hours	Comments
5.50	6.00	1.00	

Water Strike Details

Water Strike	Casing Depth	Sealed At	Rise To	Time	Comments

Standpipe Installation Details

Date	Tip Depth	RZ Top	RZ Base	Type

Groundwater Observations

Date	Hole Depth	Casing Depth	Depth to Water	Comments
26/05/2004	6.00	4.50	-	Dry at end of day

CONTRACT : Dublin Landfill Siting Study

BOREHOLE NO: CSA3A
Sheet 1 of 1

CLIENT : Fingal County Council
ENGINEER : RPS-MCOS

GROUND LEVEL (mOD) 33.80
BOREHOLE DIAMETER (mm) 200
BOREHOLE DEPTH (m) 4.30
CASING DEPTH (m) 4.30

DATE STARTED: 21/06/2004
DATE COMPLETED: 21/06/2004

CO-ORDINATES : E 254854.90
N 317731.60

BORED BY: P Thomas

DEPTH (M)	DESCRIPTION	LEGEND	ELEVATION (mOD)	DEPTH (m)	SAMPLES REF. NUMBER	SAMPLES SAMPLE TYPE	SAMPLES DEPTH (m)	FIELD TEST RESULTS	BLOWS / RECOVERY	STAND PIPE DETAILS
0	TOPSOIL		33.60	0.20						
1	Stiff brown slightly sandy gravelly CLAY with cobbles				K7833	U	1.00		60/100%	
	Dense brown grey fine to coarse GRAVEL		32.30	1.50						
2					K7834	D	2.00			
	Stiff brown sandy gravelly CLAY		31.30	2.50						
3					K7835	U	3.00		68/100%	
					K7836	D	3.50			
4					K7837	D	4.00			
	End of Borehole at 4.30 m		29.50	4.30						
5										
6										
7										
8										
9										
10										

Hard Strata Boring / Chiselling

From (m)	To (m)	Hours	Comments
2.10	2.20	0.33	
4.20	4.30	1.50	

Water Strike Details

Water Strike	Casing Depth	Sealed At	Rise To	Time	Comments

Standpipe Installation Details

Date	Tip Depth	RZ Top	RZ Base	Type

Groundwater Observations

Date	Hole Depth	Casing Depth	Depth to Water	Comments

Remarks:

GEOTECHNICAL BORING RECORD

REPORT NO: 9716 | **IGSL Ltd.**

BOREHOLE NO: CSA4 Sheet 1 of 1

CONTRACT : Dublin Landfill Siting Study

CLIENT : Fingal County Council
ENGINEER : RPS-MCOS

CO-ORDINATES : E 254598.49 N 318333.53

GROUND LEVEL (mOD) 28.09
BOREHOLE DIAMETER (mm) 200
BOREHOLE DEPTH (m) 9.30
CASING DEPTH (m) 9.30

DATE STARTED: 09/06/2004
DATE COMPLETED: 11/06/2004

BORED BY: M Collins

DEPTH (M)	DESCRIPTION	LEGEND	ELEVATION (mOD)	DEPTH (m)	SAMPLES REF. NUMBER	SAMPLES SAMPLE TYPE	SAMPLES DEPTH (m)	FIELD TEST RESULTS	BLOWS / RECOVERY	STAND PIPE DETAILS
0	TOPSOIL		27.69	0.40						
	Brown sandy CLAY		27.29	0.80						
1	Stiff brown sandy gravelly CLAY with occasional cobbles				324 325	B	1.00			
2					326 327	B	2.00	C=28		
	Hard black sandy gravelly CLAY with occasional cobbles		25.69	2.40						
3					329 330 331	B U	3.00		80%	
4								C=60/ 195mm		
5					334 335	B	5.00	C=58/ 85mm		
6					337 338 342	B U	6.00		100%	
7					339 340	B	7.00	C=29/ 45mm		
8					341 342	B	8.00	C=43/ 120mm		
9			18.79	9.30						
	End of Borehole at 9.30 m									
10										

Hard Strata Boring / Chiselling

From (m)	To (m)	Hours	Comments
4.30	4.70	1.00	
8.80	9.00	1.50	
9.00	9.30	0.75	

Water Strike Details

Water Strike	Casing Depth	Sealed At	Rise To	Time	Comments

Standpipe Installation Details

Date	Tip Depth	RZ Top	RZ Base	Type
11/06/2004	7.70	1.70	7.90	SP
11/06/2004	9.30	9.00	9.30	SP

Groundwater Observations

Date	Hole Depth	Casing Depth	Depth to Water	Comments

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GEOTECHNICAL BORING RECORD

IGSL Ltd.

REPORT NO: 9716

BOREHOLE NO: CSA5A
Sheet 1 of 1

CONTRACT : Dublin Landfill Siting Study

CLIENT : Fingal County Council
ENGINEER : RPS-MCOS

CO-ORDINATES : E 254294.07
N 317663.84

GROUND LEVEL (mOD) 32.08
BOREHOLE DIAMETER (mm) 200
BOREHOLE DEPTH (m) 7.20
CASING DEPTH (m) 6.50

DATE STARTED: 10/06/2004
DATE COMPLETED: 14/06/2004

BORED BY: J O'Toole

DEPTH (M)	DESCRIPTION	LEGEND	ELEVATION (mOD)	DEPTH (m)	SAMPLES: REF. NUMBER	SAMPLES: SAMPLE TYPE	SAMPLES: DEPTH (m)	FIELD TEST RESULTS	BLOWS / RECOVERY	STAND PIPE DETAILS
0	TOPSOIL		31.88	0.20						
	Very stiff brown sandy gravelly CLAY									
2	Hard black sandy gravelly CLAY with occasional boulders		29.88	2.20						
7					7317	D	6.80	C=R		
	End of Borehole at 7.20 m		24.88	7.20						

Hard Strata Boring / Chiselling

From (m)	To (m)	Hours	Comments
2.40	3.50	2.00	
3.50	5.80	1.00	
6.30	6.40	1.00	
6.80	7.20	2.50	

Water Strike Details

Water Strike	Casing Depth	Sealed At	Rise To	Time	Comments

Standpipe Installation Details

Date	Tip Depth	RZ Top	RZ Base	Type

Groundwater Observations

Date	Hole Depth	Casing Depth	Depth to Water	Comments

GEOTECHNICAL BORING RECORD

IGSL Ltd.

REPORT NO: 9716

BOREHOLE NO: CSA6
Sheet 2 of 2

CONTRACT : Dublin Landfill Siting Study

CLIENT : Fingal County Council
ENGINEER : RPS-MCOS

CO-ORDINATES : E 254110.49
N 317226.12

GROUND LEVEL (mOD) 34.51
BOREHOLE DIAMETER (mm) 200
BOREHOLE DEPTH (m) 15.00
CASING DEPTH (m) 13.50

DATE STARTED: 28/05/2004
DATE COMPLETED: 04/06/2004

BORED BY: M Collins

DEPTH (M)	DESCRIPTION	LEGEND	ELEVATION (mOD)	DEPTH (m)	SAMPLES REF. NUMBER	SAMPLES SAMPLE TYPE	SAMPLES DEPTH (m)	FIELD TEST RESULTS	BLOWS / RECOVERY	STAND PIPE DETAILS
10	Very stiff dark brown slightly sandy slightly gravelly CLAY with cobbles and boulders				M0308			C=63		
11					M0309 M0310 M0311	B U	11.00			
			23.01	11.50						
	Brown silty SAND									
			22.51	12.00	M0313 M0314	B	12.00	C=60/ 160mm		
12	Hard grey slightly sandy slightly gravelly CLAY with pockets of silt, cobbles and boulders									
13					M0315 M0316	B	13.00			
14					M0317 M0318	B	14.00	C=24/ 10mm		
			19.51	15.00						
15	End of Borehole at 15.00 m									
16										
17										
18										
19										
20										

Hard Strata Boring / Chiselling

From (m)	To (m)	Hours	Comments
2.50	3.00	0.50	
10.00	12.00	2.00	
12.00	14.00	3.00	
14.00	15.00	3.50	

Water Strike Details

Water Strike	Casing Depth	Sealed At	Rise To	Time	Comments

Standpipe Installation Details

Date	Tip Depth	RZ Top	RZ Base	Type
04/06/2004	15.00	10.40	15.00	SP

Groundwater Observations

Date	Hole Depth	Casing Depth	Depth to Water	Comments
01/06/2004	10.00	-	4.50	Start of day
03/06/2004	14.00	-	6.80	Start of day
31/05/2004	6.00	3.00	4.50	Start of day

REPORT NO.	9716	GEOTECHNICAL CORE LOG RECORD J4	IGSL Ltd.

CONTRACT: Dublin Landfill Siting Study

DRILLHOLE NO : CGB1
SHEET: Sheet 2 of 3

CLIENT: Fingal County Council
ENGINEER: RPS-MCOS

CORE DIAMETER (mm): 102
GROUND LEVEL (mOD): 30.22

DATE STARTED: 17/06/2004
DATE COMPLETED: 18/06/2004

CO-ORDINATES: 254358.54
317841.97

INCLINATION (Degrees): 90
FLUSH: Polymer Gel

DRILLED BY: MILLENIUM
LOGGED BY: DO'S

DOWNHOLE DEPTH (m)	CORE RUN DEPTH (m)	T.C.R.%	S.C.R.%	R.Q.D.%	Fracture Spacing (mm) 0 250 500	UCS (MPa)	POINT LOAD Is(50) MPa	SYMBOLIC LOG	ELEVATION (mOD)	DEPTH (m)	SPT (N value)	STANDPIPE DETAILS	GEOTECHNICAL DESCRIPTION
10		67	0	0									Firm to stiff, brown/black, sandy, locally very gravelly CLAY with occasional cobbles.
	10.00	100	0	0									
	10.50								19.72	10.50			
11		80	56	22									Strong to very strong (to locally moderately strong), grey/blue to locally dark grey, fine-grained, LIMESTONE (Moderately strong, dark grey, argillaceous layers at 12.75-13.3m, 15.54-15.57m, 18.16-18.24m, 18.47-18.54m & 19.67-19.78m), fresh to locally slightly weathered intersected by smootht to locally rough, planar, tight to open, locally clay-smeared, slightly iron-oxide stained fractures of sub-horizontal & locally 45° dip.
	11.50	80	80	62									
12	12.00												
		100	84	58									
13	13.50												
		93	80	37									
14	15.00												
		100	91	71									
15	16.50												
		62	48	38									
16													

Continued next sheet

REMARKS: Second standpipe installed at 10.5m : Gravel 10.5-7.0m, seal 20.0-10.5m & 7.0-5.5m.

INSTALLATION DETAILS
Installation Type : SP
Depth to Response Zone top (m) : 2.00
Depth to Response Zone bottom (m) : 5.50
Comments : Gravel 5.5-2.0m, seal 2.0-0.0m, headworks.

REPORT NO.	9716	GEOTECHNICAL CORE LOG RECORD	IGSL Ltd.

CONTRACT: Dublin Landfill Siting Study

DRILLHOLE NO : CRC1
SHEET: Sheet 1 of 2

CLIENT: Fingal County Council
ENGINEER: RPS-MCOS

CORE DIAMETER (mm): 74
GROUND LEVEL (mOD): 34.02

DATE STARTED: 03/06/2004
DATE COMPLETED: 05/06/2004

CO-ORDINATES: 255056.67
317663.03

INCLINATION (Degrees): 90
FLUSH: Air/Mist

DRILLED BY: IGSL
LOGGED BY: DO'S

DOWNHOLE DEPTH (m)	CORE RUN DEPTH (m)	T.C.R.%	S.C.R.%	R.Q.D.%	Fracture Spacing (mm) 0–250–500	UCS (MPa)	POINT LOAD Is(50) MPa	SYMBOLIC LOG	ELEVATION (mOD)	DEPTH (m)	SPT (N value)	STANDPIPE DETAILS	GEOTECHNICAL DESCRIPTION
													OPEN HOLE DRILLING: No recovery, observed by driller as returns of brown sandy gravelly clay with occasional cobbles.
		0	0	0					31.52	2.50			OPEN HOLE DRILLING: No recovery, observed by driller as returns of gravel.
									29.32	4.70			OPEN HOLE DRILLING: No recovery, observed by driller as returns of weathered rock
	5.25								28.77	5.25			Strong to locally weak, medium to thinly bedded to locally thinly laminated, grey/blue/black, fine-grained, LIMESTONE (Argillaceous layers at 7.77-7.83m, 7.92-8.06m, 8.95-9.06m, 9.38-9.56m, 9.8-10.0m, 10.25-10.7m, 10.94-11.14m, 11.28-11.34m, 11.6-11.77m, 12.07-12.14m, 12.2-12.3m, 12.67-12.8m, 13.04-13.16m, 13.56-13.75m, 13.94-13.99m, 14.06-14.12m & 14.47-14.63m) fresh to locally moderately/highly weathered (at 7.77-7.83m, 9.38-9.56m, 10.25-10.7m & 11.28-11.34m), intersected by smooth to locally rough, planar, tight to narrow, locally clay-smeared, locally calcite-filled, locally slightly iron-oxide stained fractures of 45° & locally irregular dip.
	5.60	100	46	29									
	5.90	67	37	0									
	6.30	75	0	0									
	7.00	71	30	0									
	8.30	85	50	35									
	8.50	100	70	0									

Continued next sheet

REMARKS: Water encountered at 2.5m, water at 1.02m at end of drilling. Packer tests carried out - see packer result sheet. 1hr extra over move.

INSTALLATION DETAILS
Installation Type : SP
Depth to Response Zone top (m) : 6.75
Depth to Response Zone bottom (m) : 14.75
Comments : Gravel 14.75-6.75m, seal 6.75-0.4m, headworks.

REPORT NO.	9716	GEOTECHNICAL CORE LOG RECORD 3 6	IGSL Ltd.

CONTRACT: Dublin Landfill Siting Study

DRILLHOLE NO : CRC2
SHEET: Sheet 2 of 3

CLIENT: Fingal County Council
ENGINEER: RPS-MCOS

CORE DIAMETER (mm): 74
GROUND LEVEL (mOD): 31.85

DATE STARTED: 14/06/2004
DATE COMPLETED: 16/06/2004

CO-ORDINATES: 254525.78
317933.56

INCLINATION (Degrees): 90
FLUSH: Air/Mist

DRILLED BY: IGSL
LOGGED BY: DO'S

DOWNHOLE DEPTH (m)	CORE RUN DEPTH (m)	T.C.R.%	S.C.R.%	R.Q.D.%	Fracture Spacing (mm) 0 250 500	UCS (MPa)	POINT LOAD Is(50) MPa	SYMBOLIC LOG	ELEVATION (mOD)	DEPTH (m)	SPT (N value)	STANDPIPE DETAILS	GEOTECHNICAL DESCRIPTION
10									22.15	9.70			OPEN HOLE DRILLING: No recovery, observed by driller as returns of sandy gravelly clay with occasional cobbles..
									21.65	10.20			OPEN HOLE DRILLING: No recovery, observed by driller as returns of gravel.
11									21.20	10.65			OPEN HOLE DRILLING: No recovery, observed by driller as returns of sandy gravelly clay with occasional cobbles..
													OPEN HOLE DRILLING: No recovery, observed by driller as returns of gravel.
12									19.85	12.00			OPEN HOLE DRILLING: No recovery, observed by driller as returns of weathered rock
13	12.75								19.10	12.75			Strong to very strong (to locally moderately strong), medium to thinly bedded to locally thinly laminated, grey/blue to locally black, fine-grained, LIMESTONE, (Argillaceous layers at 15.13-15.5m, 16.3-6.4m, 16.55-16.7m, 17.73-17.86m, 18.39-18.46m, 18.92-18.99m, 20.39-20.53m, 20.75-21.0m & 22.21-22.35m)fresh to locally slightly/moderately weathered (see argillaceous layers above) intersected by smooth to locally rough, planar, tight to narrow, locally calcite-filled fractures of 45° & very locally sub-vertical dip.
14		97	89	43									
	14.25												
15		100	71	16									
16	15.75												
		97	63	0									
	17.25												

Continued next sheet

REMARKS: Water encountered at 9.7m, water at 5.45m at end of drilling. Packer tests carried out - see packer result sheet. 1hr extra over move.

INSTALLATION DETAILS
Installation Type : SP
Depth to Response Zone top (m) : 13.35
Depth to Response Zone bottom (m) : 22.35
Comments : Gravel 22.35-13.35m, seal 13.35-11.0m, headworks.

REPORT NO.	9716	GEOTECHNICAL CORE LOG RECORD	IGSL Ltd.

CONTRACT: Dublin Landfill Siting Study

DRILLHOLE NO: CRC3
SHEET: Sheet 2 of 3

CLIENT: Fingal County Council
ENGINEER: RPS-MCOS

CORE DIAMETER (mm): 74
GROUND LEVEL (mOD): 27.87

DATE STARTED: 08/06/2004
DATE COMPLETED: 08/06/2004

CO-ORDINATES: 254784.15
318527.49

INCLINATION (Degrees): 90
FLUSH: Air/Mist

DRILLED BY: IGSL
LOGGED BY: DO'S

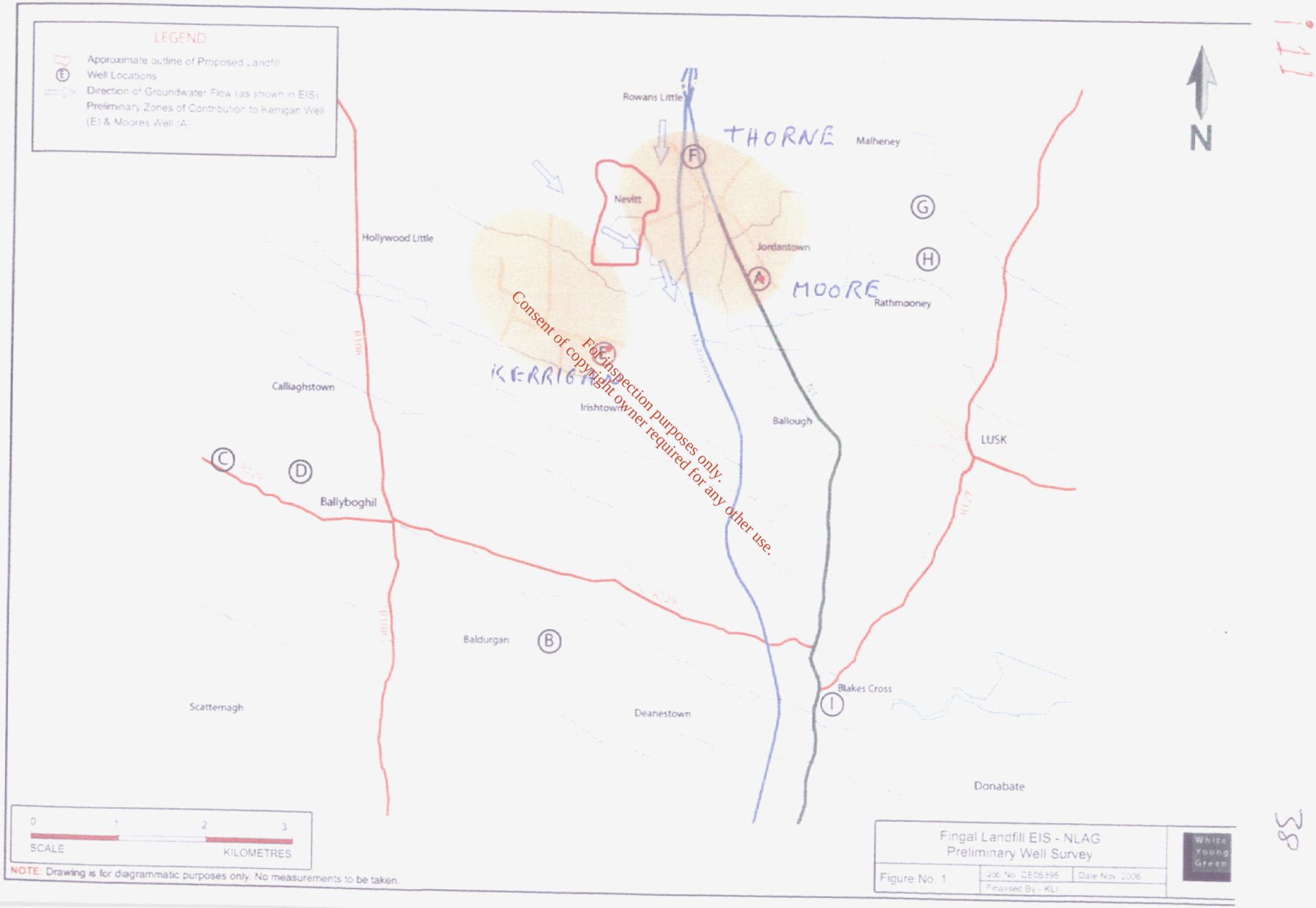
DOWNHOLE DEPTH (m)	CORE RUN DEPTH (m)	T.C.R.%	S.C.R.%	R.Q.D.%	Fracture Spacing (mm) 0 250 500	UCS (MPa)	POINT LOAD Is(50) MPa	SYMBOLIC LOG	ELEVATION (mOD)	DEPTH (m)	SPT (N value)	STANDPIPE DETAILS	GEOTECHNICAL DESCRIPTION
10									18.07	9.80			OPEN HOLE DRILLING: No recovery, observed by driller as returns of brown sandy gravelly clay with occasional cobbles.
													OPEN HOLE DRILLING: No recovery, observed by driller as returns of gravel.
11									17.37	10.50			OPEN HOLE DRILLING: No recovery, observed by driller as returns of weathered rock
	11.20								16.67	11.20			Moderately strong to moderately weak, thinly bedded to thinly laminated, grey/black, fine-grained, LIMESTONE (predominantly argillaceous), moderately to locally highly weathered intersected by closely spaced, irregular, clay-smeared fractures of irregular dip.
12		36	0	0									
	12.60												
13		31	0	0									
14	14.20												
15		47	0	0									
	15.70												
16		50	0	0									
	17.20												

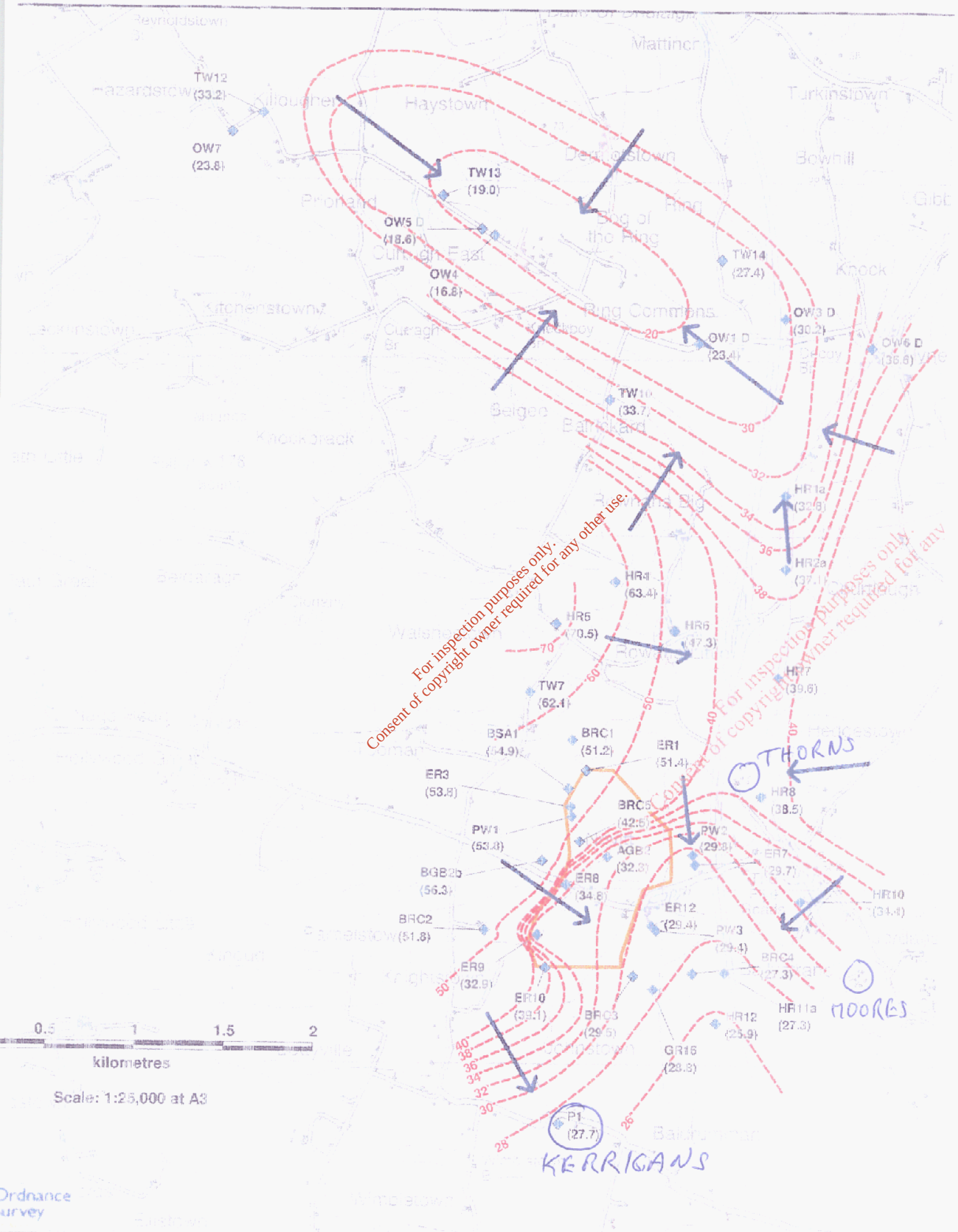
Continued next sheet

REMARKS: Water encountered in rock, water at 15.4m at end of drilling. 0.5hr extra over move.

INSTALLATION DETAILS
Installation Type : SP
Depth to Response Zone top (m) : 11.50
Depth to Response Zone bottom (m) : 24.20
Comments : Gravel 24.7-11.5m, seal 11.5-9.0m, headworks.

REF 5.





~~RBK 8~~ BEDROCK CONTOURS GROUNDWATER

Site C

ANNSBROOK

Site Description & Geological Setting (Site C)

Site C centred on the townland of Annsbrook encompasses an area of approximately 4,15,000 m^2 (415 ha) and is located approximately 10 km southwest of Skerries and 4 km west of Lusk. There is little change in elevation across the site, with a slight rise from southeast to northwest from about 20 mOD to a high of 40 mOD. The new M1 motorway is located close to the eastern margin of the site approaching within approximately 100 m. The ground is typically grass and agricultural fields. A number of small streams run northwest - southeast through the site.

The geological map for the area 'Geology of Meath, 2001' indicates that the area is underlain predominantly by 'Calp' limestone of the Lucan Formation. Calcarenites and calcisiltites of the Naul Formation are also present towards the northeastern corner of the site.

The following section integrates the geophysical results with the available geological data. The interpretation is based on the available factual information, typical geophysical responses of known materials and the experience of the author. The interpreted 2D-Resistivity and seismic sections are shown at the end of this report.

Locations for the geophysical readings are shown on Maps 1C-3C. Maps were provided by RPSMCOS.

EM31 Ground Conductivity Data (Site C)

An EM31 ground conductivity survey was carried out across the site with readings taken at approximately 100 m centres. An average conductivity contour map is shown on Map 2C. Across most of the site little variation is seen with values typically ranging between 15 and 20 mS/m, indicating relatively thick clay rich overburden across the site. No significant areas of low or very high conductivity values are recorded across the site indicating relatively uniform overburden thickness in the top 6 m of the subsurface.

2D Resistivity Data (Site C)

A total of 29 2D resistivity profiles have been carried out across the survey area and show little variation with low resistivities (< 200 ohm-m) across the whole site indicating thick clay overburden, some zones of intermediate resistivity (200 - 300 ohm-m) have been interpreted as gravely clay / clayey gravel or in some cases shaley bedrock. These layers may also represent an increase in the boulder/cobble content of the boulder clay. Bedrock is interpreted by high resistivities (> 300 ohm-m) along some of the profiles. Towards the east of the site bedrock is interpreted to lie at between 10 and 15 m depth b.g.l. To small areas to the north have been interpreted as indicating bedrock at 5 to 10 m depth. Across the rest of the site particularly in

the west, central and southern sections overburden is interpreted to be extremely thick at about > 20 m.

Seismic Data (Site C)

A total of 19 seismic spreads were undertaken across site C and are shown to agree well with the resistivity data. Two or three layers have been modelled for the seismic data with typically a low velocity (400 - 800 m/s) layer of topsoil / silty clay overlying an intermediate velocity layer (1400 - 2200 m/s) of stiff glacial till (boulder clay) overlying high velocity (> 3000 m/s) competent bedrock. Across most of the site high velocity bedrock is interpreted at > 10 m depth b.g.l. or is not detected by the seismic data indicating that bedrock is at a depth greater than approximately 15 m. Along seismic spreads 3 and 18 bedrock is interpreted to lie at about 5 to 10 m depth b.g.l. This area represents the area of shallowest bedrock within the site. High recorded velocities (> 4000 m/s) for the bedrock across mush of the site indicate the relatively competent nature of the bedrock.

The higher the velocity measured for overburden / rock the greater the stiffness / competency of the material.

Integrated Geophysical Data (Site C)

EM31 ground conductivity readings measure the bulk conductivity from the upper 6 m of the subsurface, therefore in an area of generally thick overburden little variation in ground conductivity values is seen. Within site C thick clay rich overburden is interpreted within the top 6 m across the site.

Generally the seismic and resistivity data correlate well indicating generally thick boulder clay overburden overlying limestone / shale bedrock across most of the site. There is no area interpreted where bedrock shallows to less than 5 m depth b.g.l. Within the western, central and southern areas bedrock is interpreted at about 20+ m b.g.l. Within the western portion of the site bedrock shallows slightly and is interpreted at about 10 - 5 m b.g.l. Two small zones in the north of the site have been interpreted as indicating bedrock, which lies between 5 and 10 m b.g.l.

Typically bedrock has been interpreted by high resistivities (> 300 ohm-m) and high seismic velocities (>3000 m/s), however, in a few instances high seismic velocities (> 3000 m/s) correlate with intermediate resistivity values (150 - 300 ohm-m), which may indicate more shalely or weathered bedrock.

The combined geophysical properties can be summarised as follows:

Table 1c: Combined Geophysical Data for Site C

Interpretation	Thickness (m)	Velocity (m/s)	Resistivity (ohm-m)	Estimated Stiffness/ Rock Quality*	Rippability
SUBSOIL / Silty CLAY	0 - 2	300 - 600	< 100	Soft - Firm	Diggable
Gravelly CLAY / Clayey GRAVEL	0 - 4	1200 -2600	150 - 300	Firm - Stiff	Diggable
Boulder CLAY	5 - 20+	1200 -2600	< 200	Stiff - V. Stiff	Break/Blast
SHALE / LIMESTONE Bedrock	-	>3000	> 300	Strong	Break/Blast

*Estimates of soil stiffness and rock quality are based on the measured geophysical properties.

Conclusions & Recommendations (Site C)

Subject to direct investigation and further geotechnical testing the presence of thick boulder clay deposits across most of the site would indicate that this site would be generally suitable, in respect to ground conditions, for the siting of a landfill. The stiffness of the overburden and the presence of a clay matrix indicate that the permeabilities are likely to be low. Areas to the west, centre and south would be most suitable due to the very thick clay deposits.

The presence of two streams running through the centre of the site, however, would decrease the suitability of the site unless adequately engineered for.

Trial pitting and drilling is recommended across the site to confirm the findings of this report, to determine the thickness of the boulder clay deposits and undertake geotechnical and permeability testing of the overburden and rock. As well as noting the presence of any gravel concentrations or boulder beds within the overburden.

Following the further selection of a preferred/suitable area within the site detailed drilling should be undertaken. The method used should allow detailed logging and undisturbed sampling of the soil materials to allow strength and permeability testing and identification of any potential leakage paths. It should also allow for follow on rotary core drilling to prove bedrock and bedrock conditions.

Maps and Interpreted Sections (Site C)