INTERNATIONAL ASSOCIATION OF HYDROGEOLOGISTS

Australian National Chapter

NSW Branch

2009 Seminar Series

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Department of Water & Energy

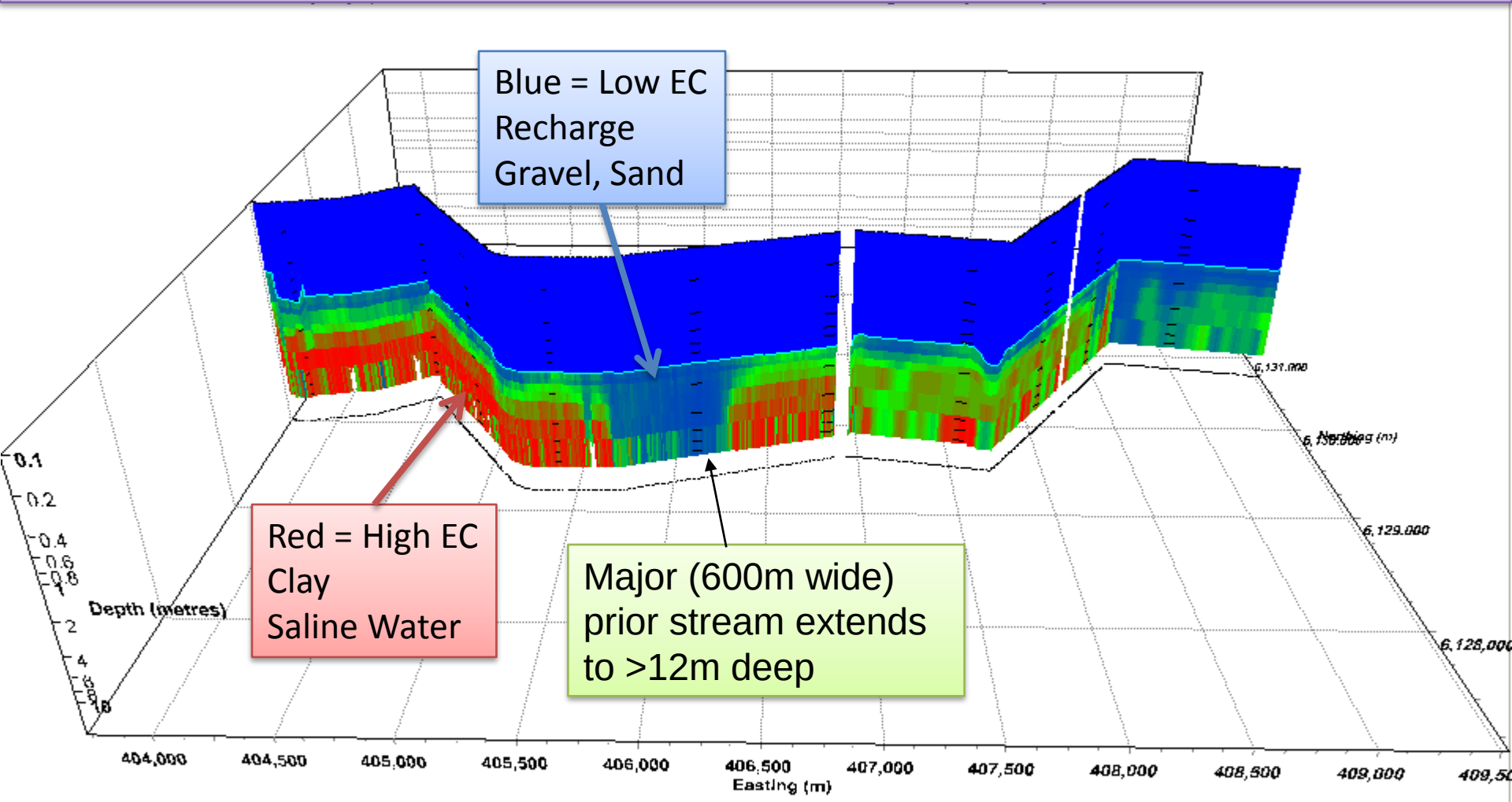
Australian Government
National Water Commission

Geophysical Imaging for aquifer recharge investigation in Western NSW.

GROUNDWATER IMAGING

By: Dr David Allen
Groundwater Imaging Pty. Ltd.
PhD - National Centre for Groundwater Management, UTS.
David@GroundwaterImaging.com
279 Fitzroy St, DUBBO, NSW 2830
Ph 02 6882 7465 Mob 0418 964097

A palaeochannel beneath an irrigation canal



Log10 Depth Scale 0.1 to 12m

Coleambally IRRIGATION

Why use Electrical Conductivity Imaging for Recharge Investigation

- reveal spatial details not observable by any more economically viable means
- EC responds clearly and conclusively to recharge pathways

LOW EC

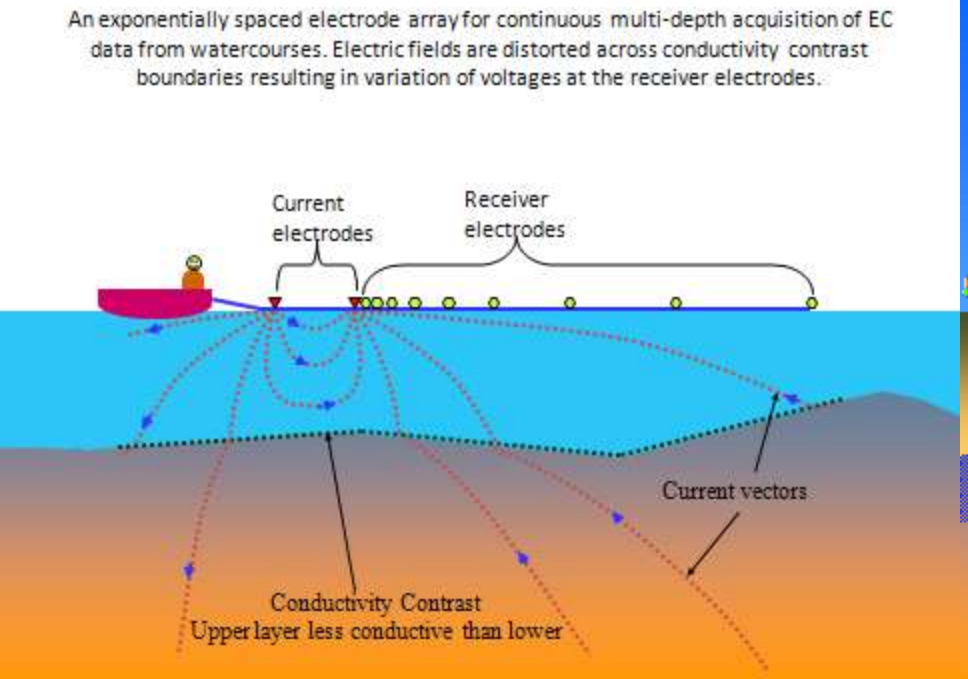
- Lack of Clays
- Low Saturation
- Fresh pore water
- Impervious fresh rock

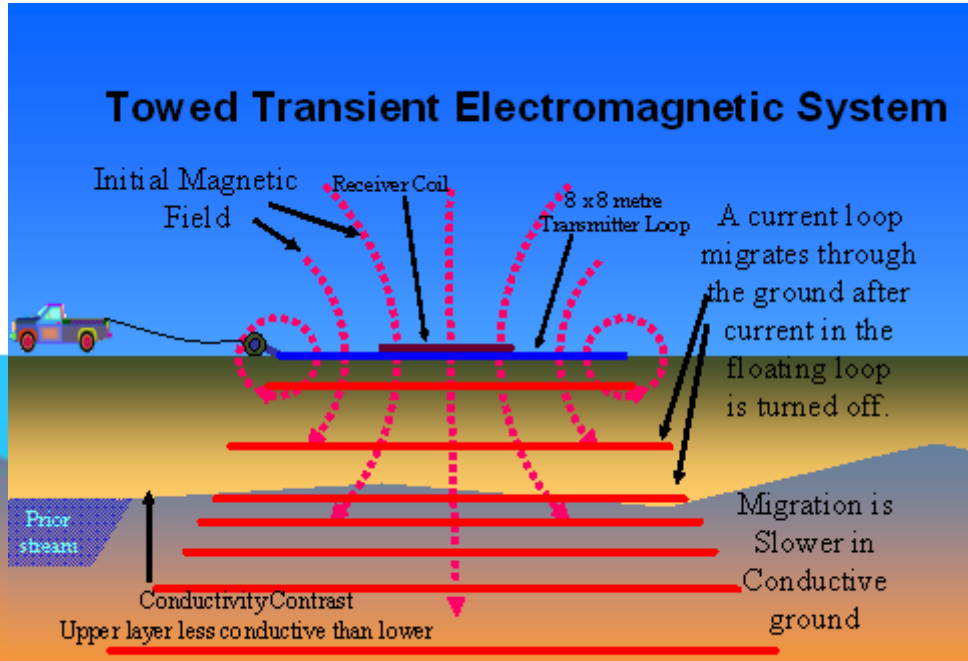
HIGH EC

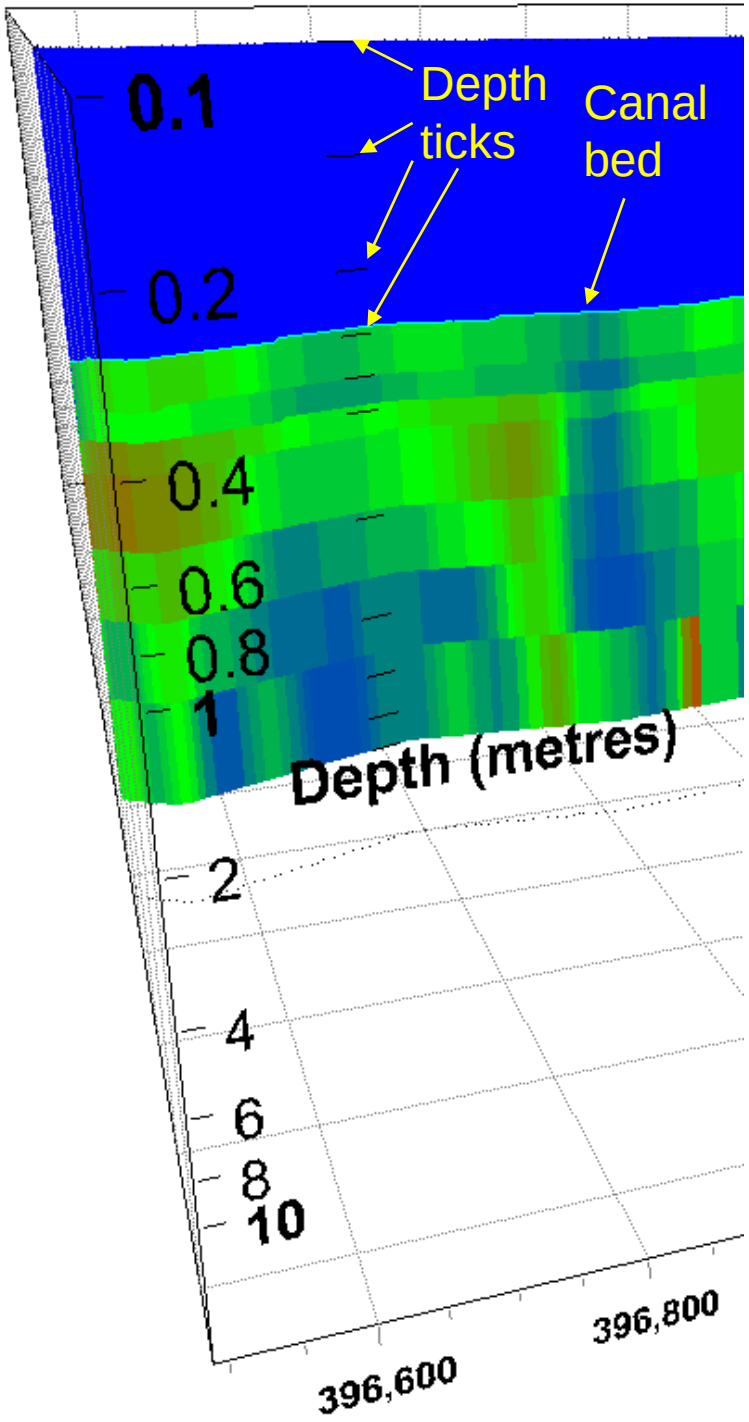
- Clays
- High Saturation
- Saline pore water
- Weathered rock

At depths significant to groundwater investigation, EC imaging may be conducted

- on water, using geo-electric streamers
- on land, using Transient Electromagnetics (TEM)

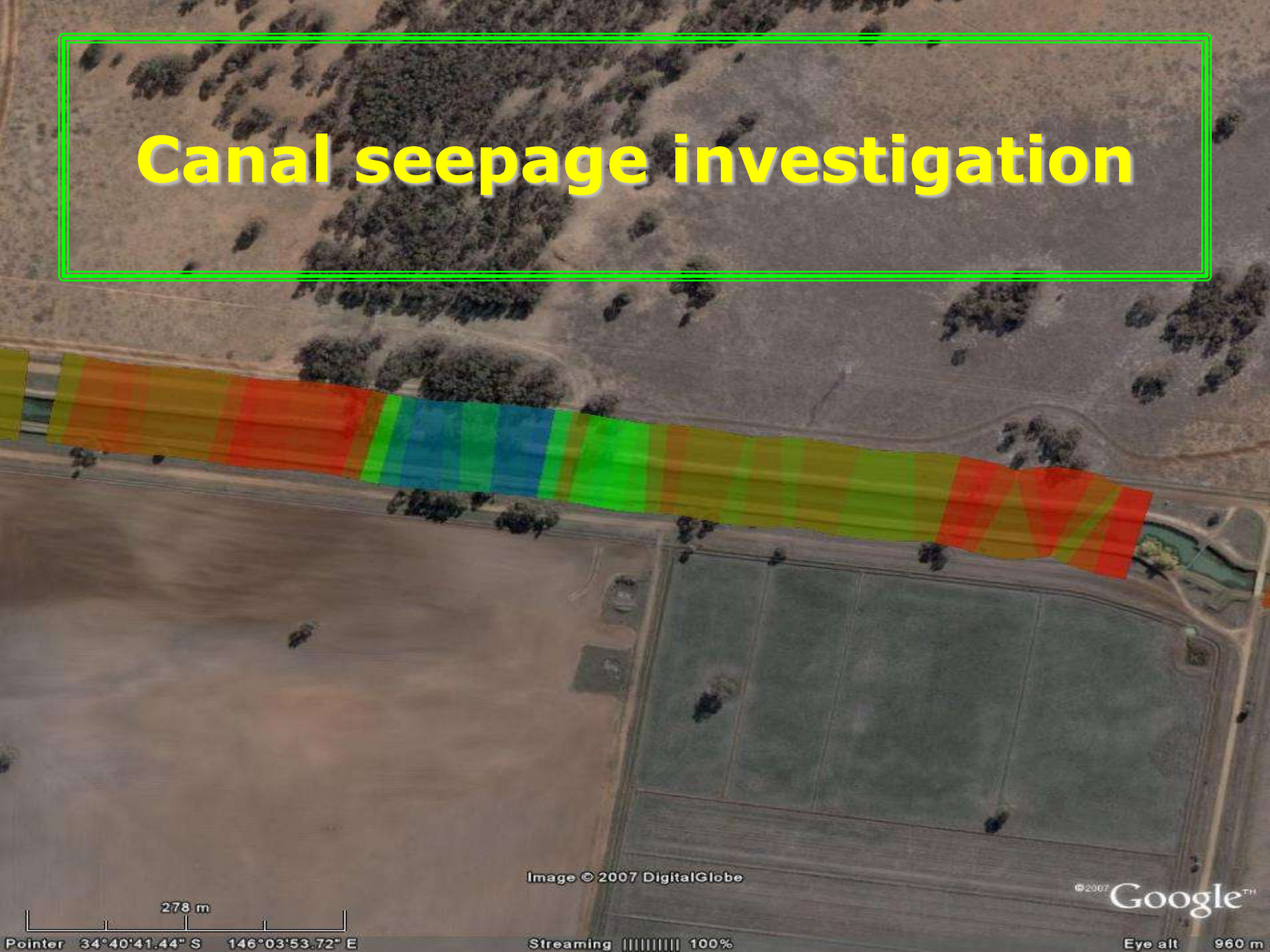






Identifying depths on 3D EC curtain images

Canal seepage investigation



Seepage Conduits interpreted beneath the CIA using submerged streamer geo-electric data

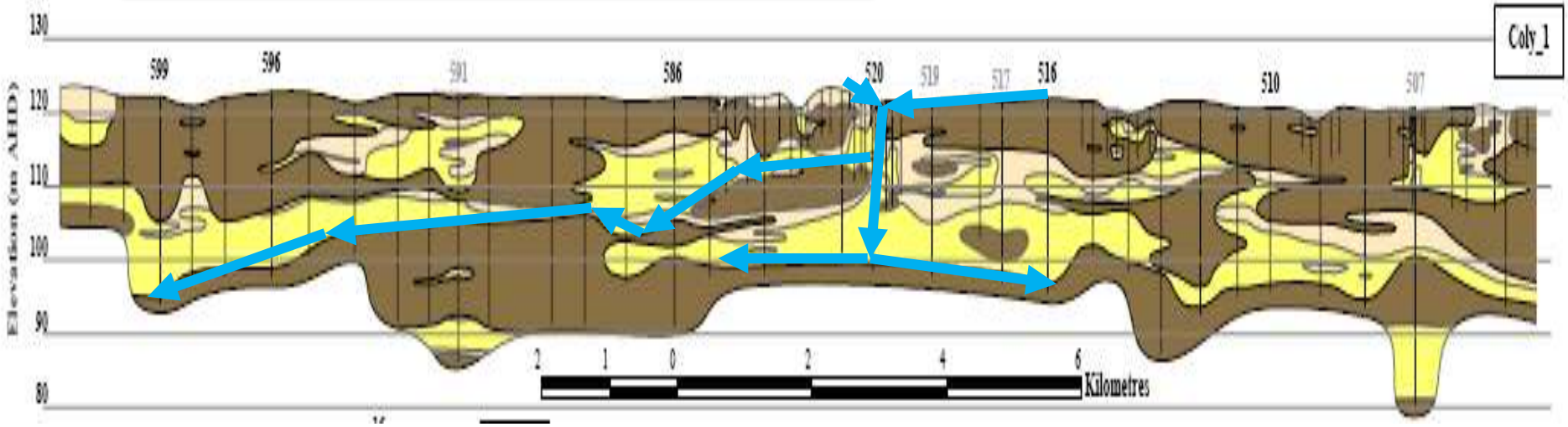
- Seepage slides from CIA have been removed from the distributed version of this talk for confidentiality reasons

Submerged geo-electric streamers are ideal for canal seepage investigation because they exhibit:

- Good depth resolution under canal beds
- Negligible artifacts from canal depth
- Negligible artifacts from bank proximity

Vertical Section through Murray Basin sediments - Coleambally

Percolation pathways

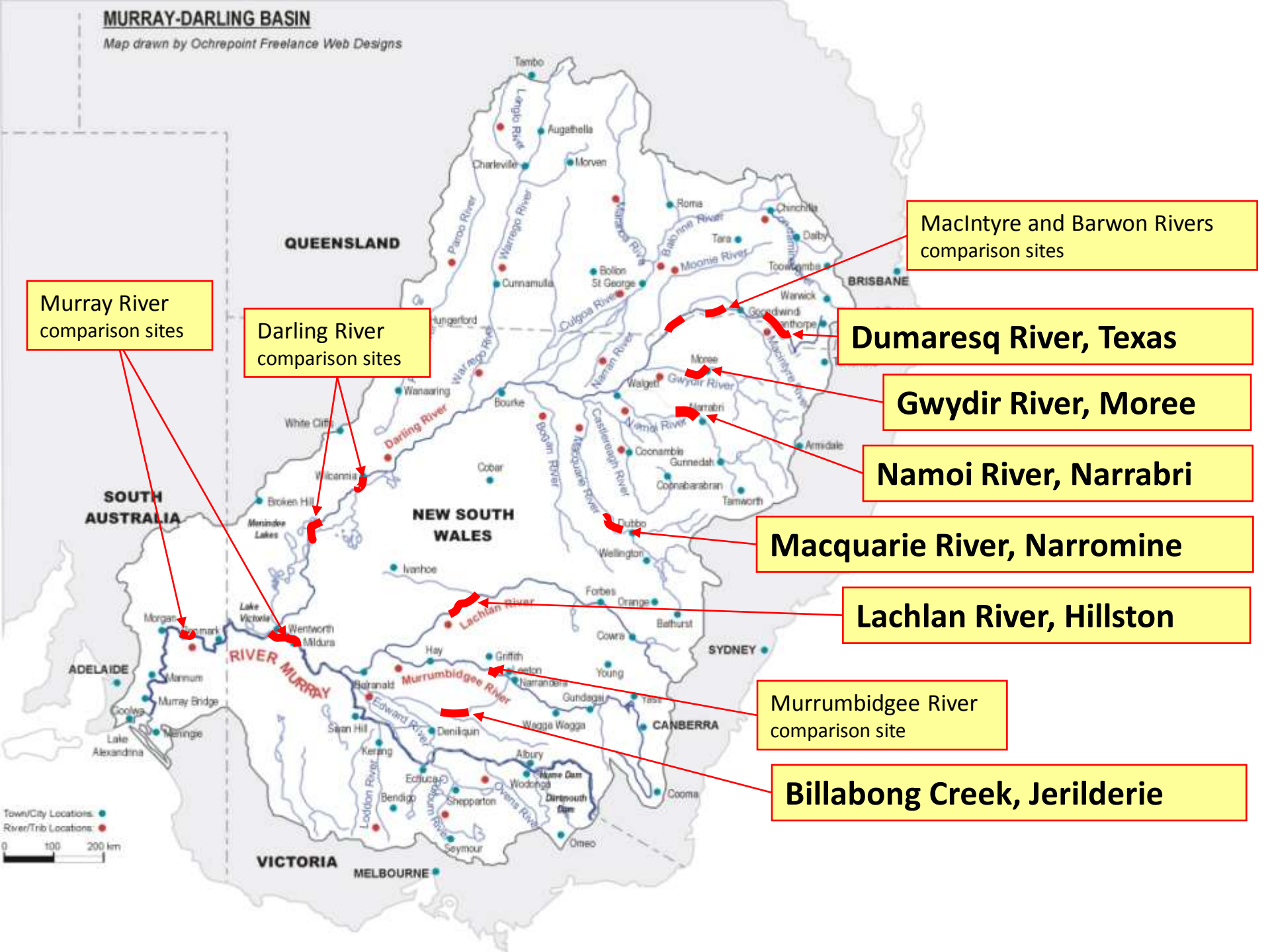


Modified from **Pucillo, K.** (2005) QUATERNARY PALAEOCHANNEL EVOLUTION AND GROUNDWATER MOVEMENT IN THE COLEAMBALLY IRRIGATION DISTRICT OF NEW SOUTH WALES, PhD Dissertation, University of Wollongong.

Rivers

A comparison of sediment electrical conductivity beneath inland rivers of the Murray Darling Basin, Australia

All plotted with a Murray Darling Basin Composite colour stretch


MURRAY-DARLING BASIN
Map drawn by Ochrepoint Freelance Web Designs
QUEENSLAND
NEW SOUTH WALES
VICTORIA
SOUTH AUSTRALIA
BRISBANE
SYDNEY
CANBERRA
MELBOURNE
ADELAIDE
RIVER MURRAY
Darling River
Lachlan River
Murrumbidgee River
Macintyre River
Gwydir River
Namoi River
Macquarie River
Tambo
Augathella
Charleville
Morven
Roma
Tara
Chinchilla
Dalby
Toowoomba
Warwick
Goondiwindi
Cunnamulla
Bollon
St George
Hungerford
Moree
Walgett
Narrabri
Wee Waa
Armidale
Coonamble
Gunnedah
Coonabarabran
Tamworth
Dubbo
Wellington
Bourke
White Cliffs
Wanaaring
Cobar
Broken Hill
Wilcannia
Menindee Lakes
Ivanhoe
Forbes
Orange
Bathurst
Cowra
Young
Griffith
Hay
Narrandera
Gundagai
Tumut
Wagga Wagga
Deniliquin
Balranald
Swan Hill
Kerang
Albury
Wodonga
Echuca
Bendigo
Shepparton
Seymour
Omeo
Cooma
Wentworth
Mildura
Lake Victoria
Morgan
Renmark
Mannum
Murray Bridge
Coolwa
Meningie
Lake Alexandrina
Town/City Locations
River/Trib Locations
0
100
200 km
MacIntyre and Barwon Rivers comparison sites
Dumaresq River, Texas
Gwydir River, Moree
Namoi River, Narrabri
Macquarie River, Narromine
Lachlan River, Hillston
Murrumbidgee River comparison site
Billabong Creek, Jerilderie
Murray River comparison sites
Darling River comparison sites

Dumaresq River

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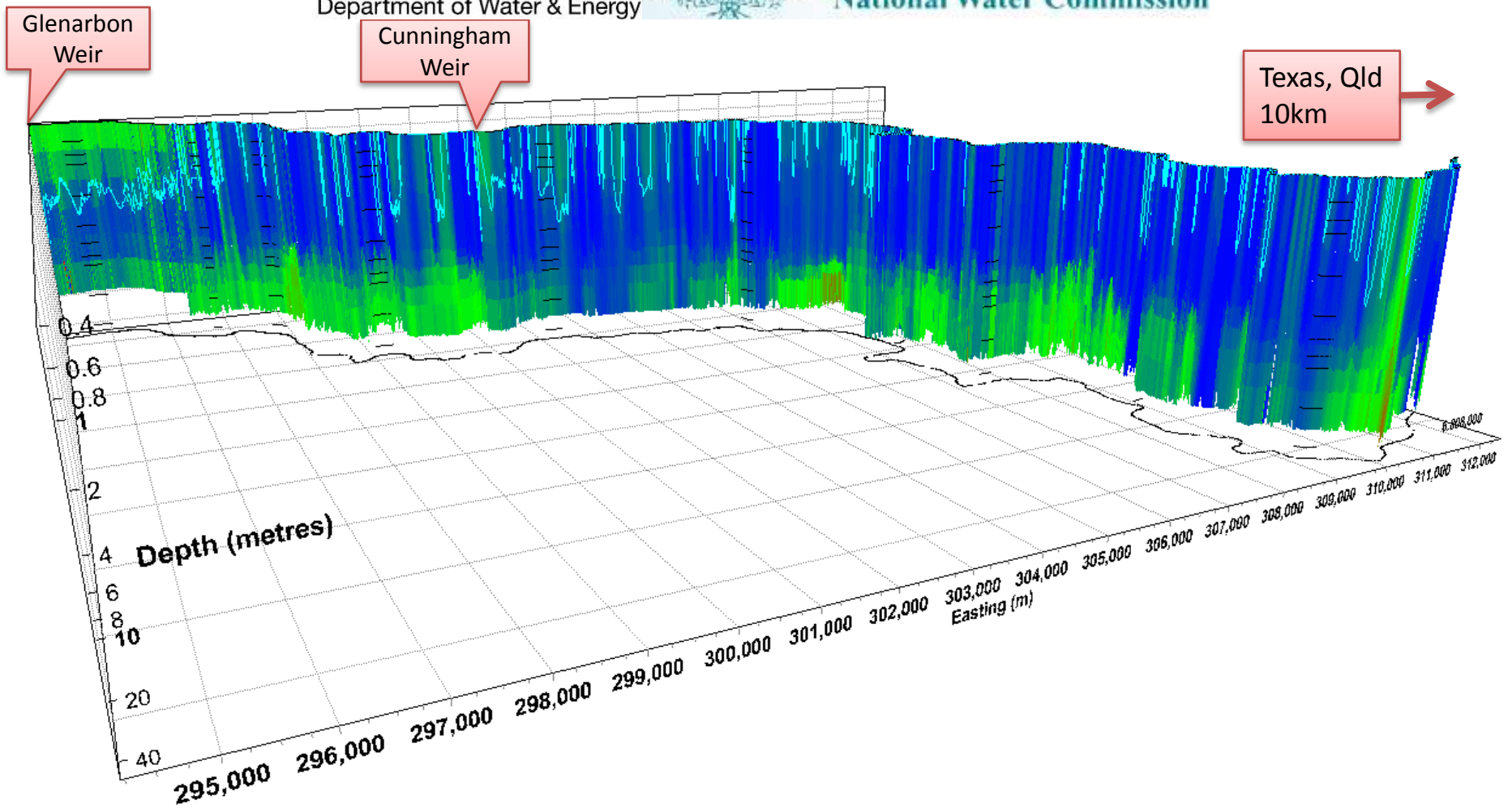
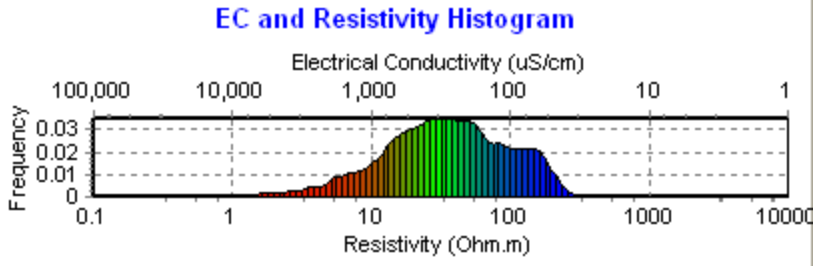
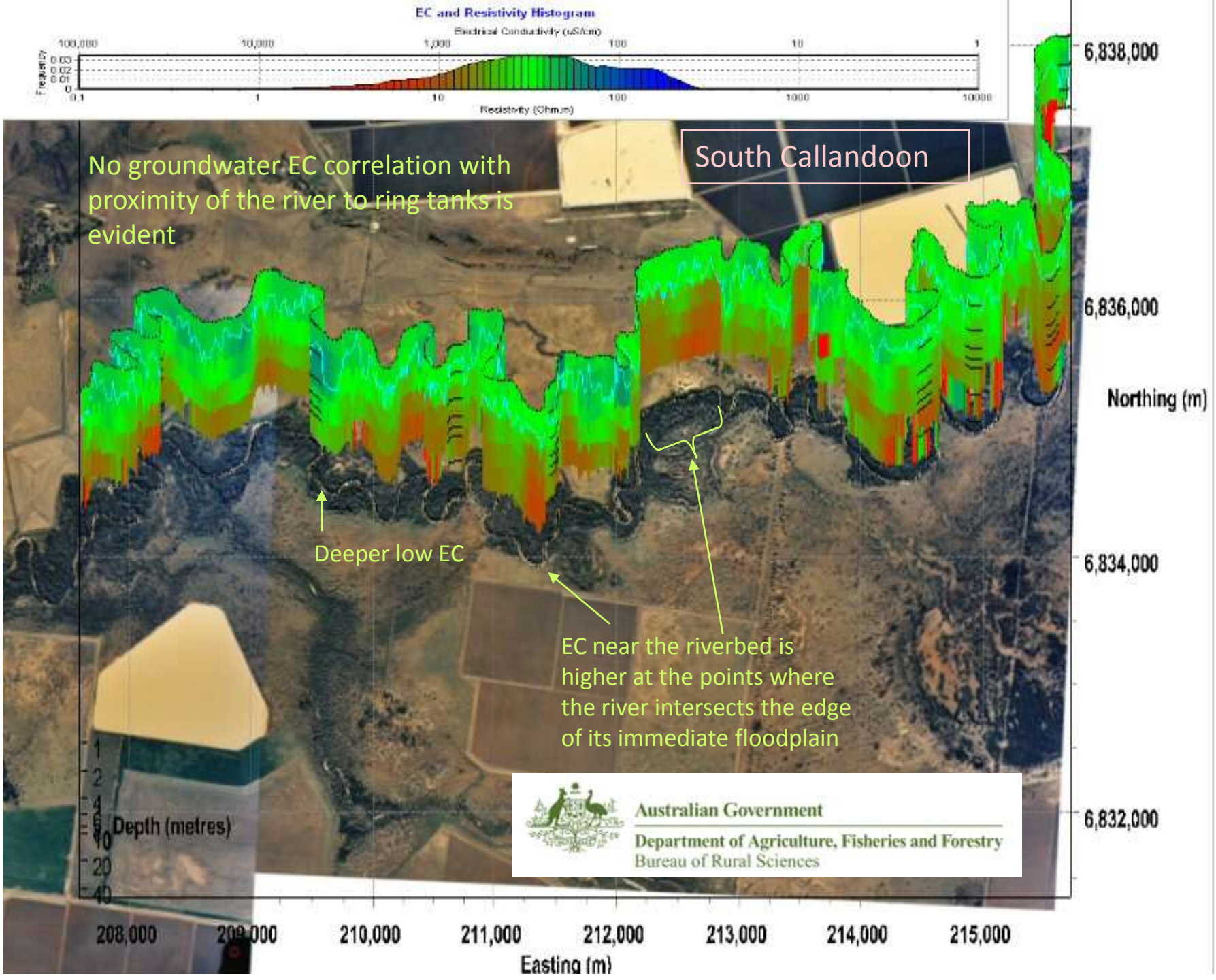




Log10 Depth scale from 0.4 to 50 m


EC and Resistivity Histogram
Electrical Conductivity (uS/cm)
100,000
10,000
1,000
100
10
1
Frequency
0
0.1
1
10
100
1000
10000
Resistivity (Ohm.m)
South Callandoon
No groundwater EC correlation with proximity of the river to ring tanks is evident
Deeper low EC
EC near the riverbed is higher at the points where the river intersects the edge of its immediate floodplain
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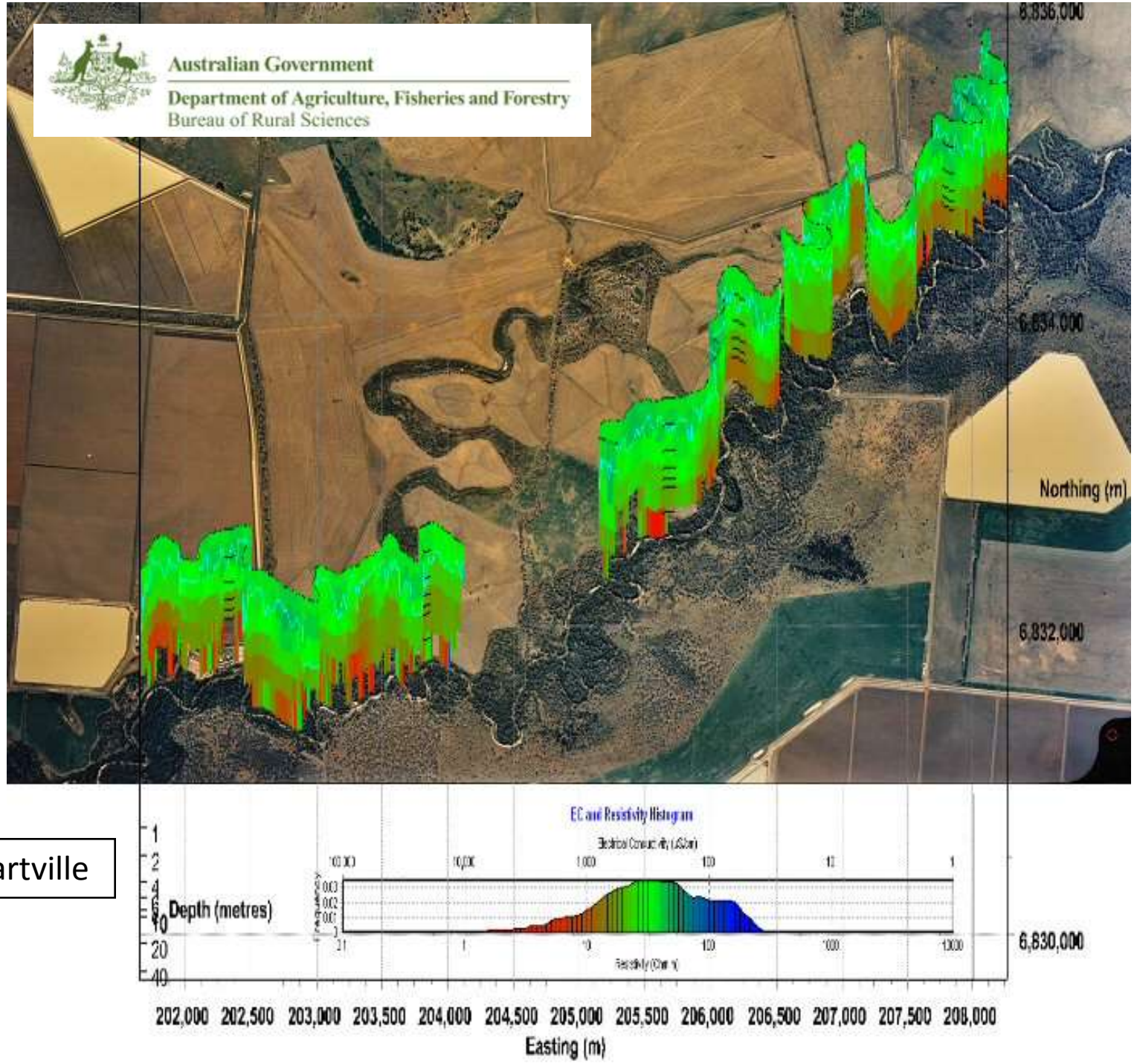
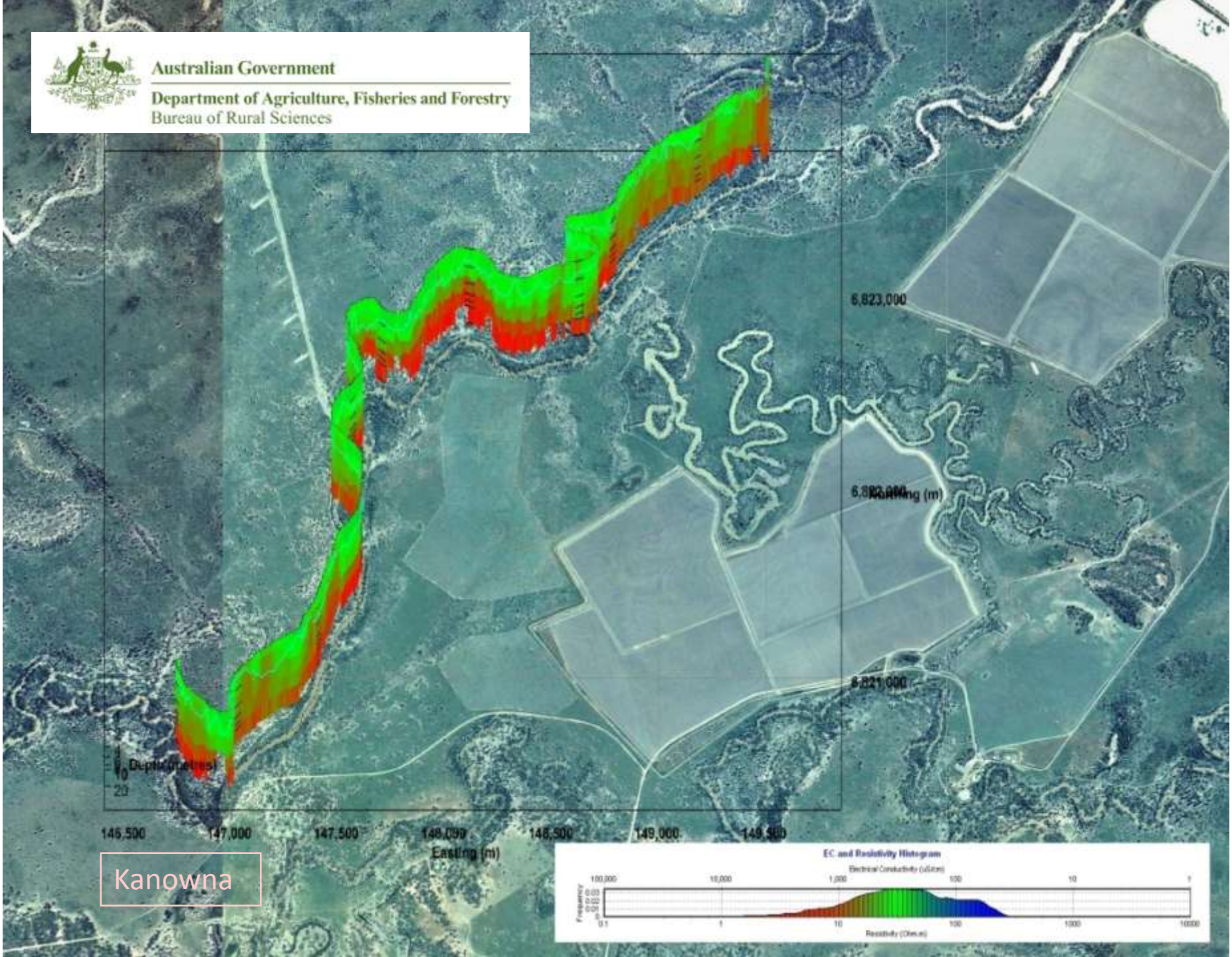
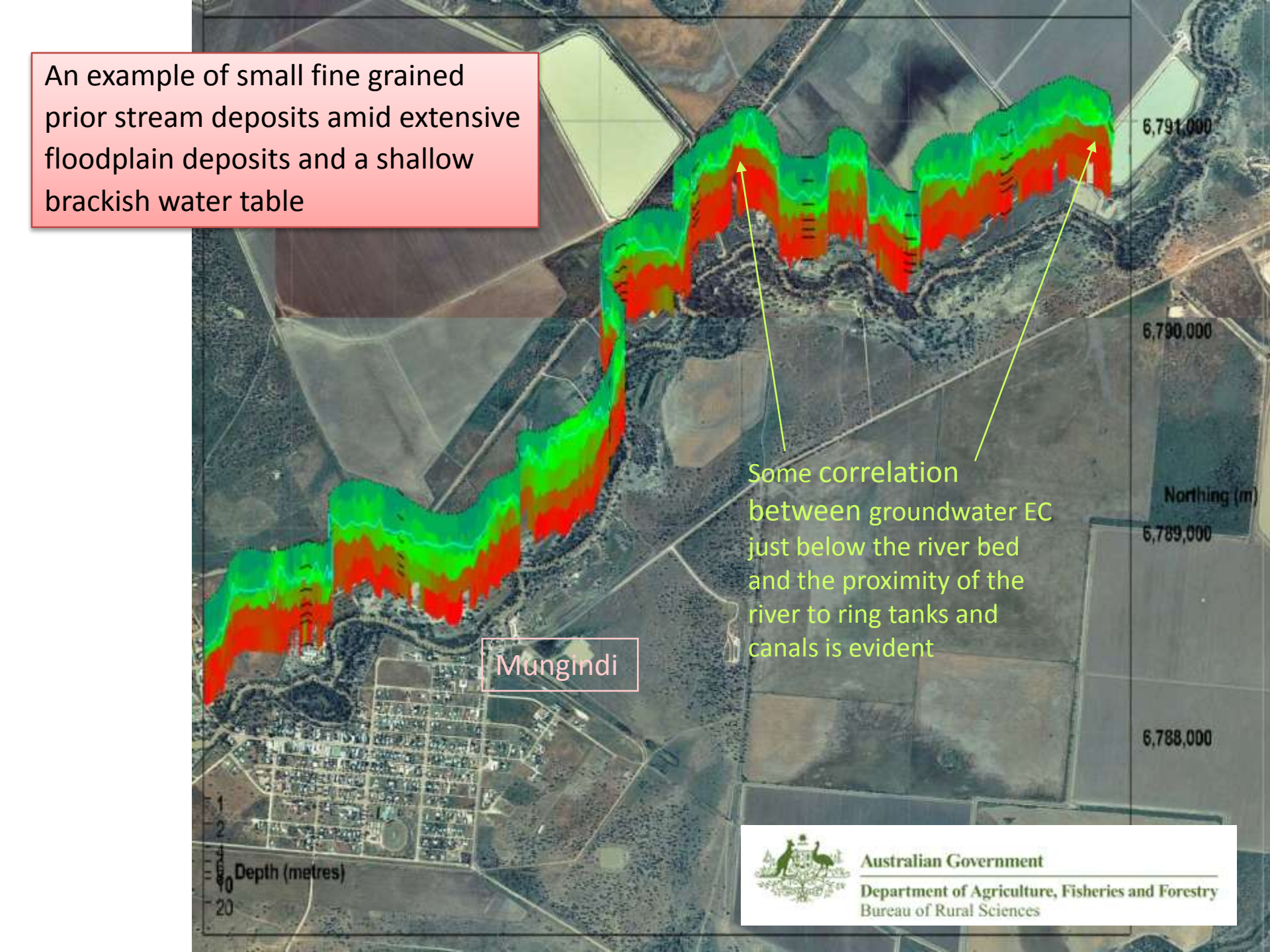
Bureau of Rural Sciences
Depth (metres)
1
2
4
6
10
20
40
208,000
209,000
210,000
211,000
212,000
213,000
214,000
215,000
Easting (m)
6,838,000
6,836,000
6,834,000
6,832,000
Northing (m)



Stuartville


Australian Government
Department of Agriculture, Fisheries and Forestry
Bureau of Rural Sciences
6,823,000
6,822,000
6,821,000
Depth (metres)
0
20
146,500
147,000
147,500
148,000
148,500
149,000
149,500
Easting (m)
Kanowna
EC and Resistivity Histogram
Electrical Conductivity (uS/cm)
100,000
10,000
1,000
100
10
1
Frequency
0.03
0.02
0.01
0
0.1
1
10
100
1000
10000
Resistivity (Ohm.m)


An example of small fine grained prior stream deposits amid extensive floodplain deposits and a shallow brackish water table
6,791,000
6,790,000
Northing (m)
6,789,000
6,788,000
Some correlation between groundwater EC just below the river bed and the proximity of the river to ring tanks and canals is evident
Mungindi
Depth (metres)
1
2
10
20
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Department of Agriculture, Fisheries and Forestry
Bureau of Rural Sciences

Gwydir River EC image with Murray Darling Basin Composite colour stretch

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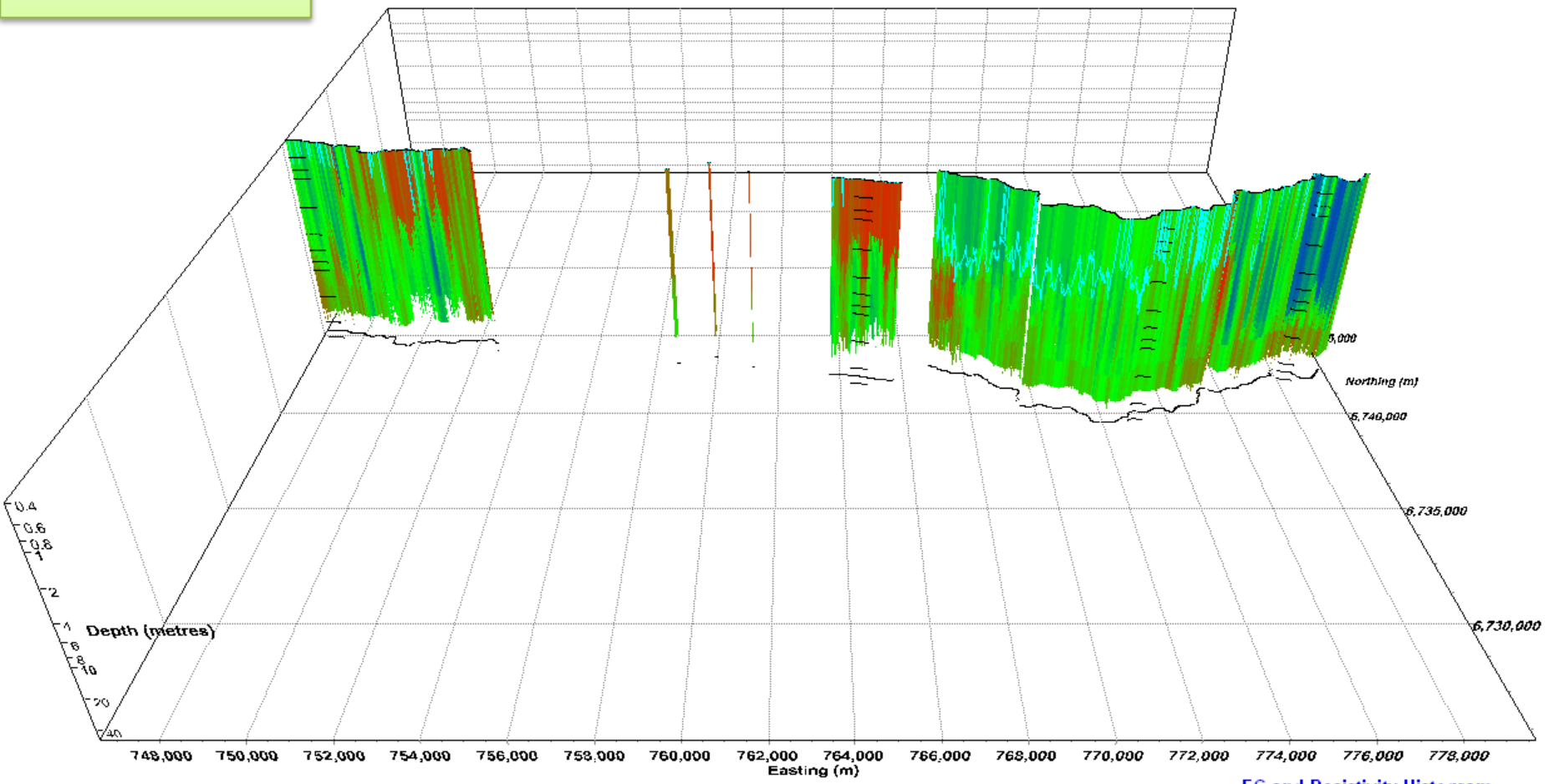
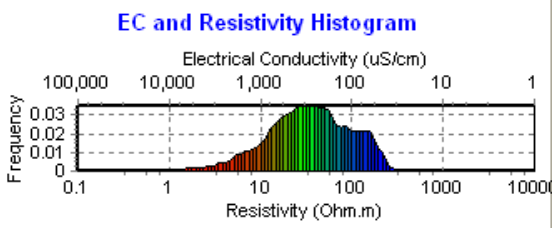
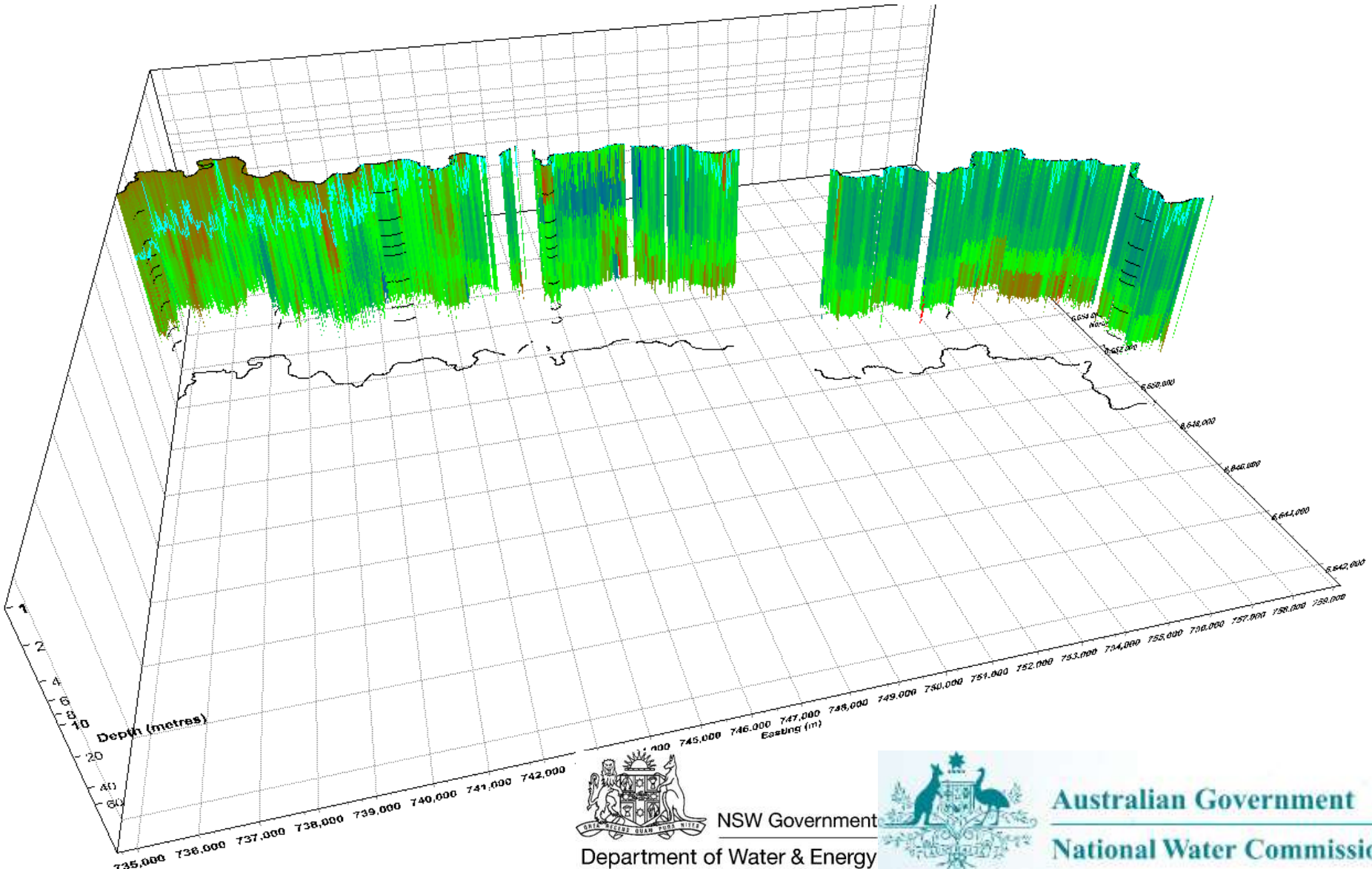
Australian Government
National Water Commission





Namoi River, Gunidgera Weir (Wee Waa) to Mollee Weir (Narrabri) with Murray Darling Basin Composite Colour stretch



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Macquarie River sub-river EC

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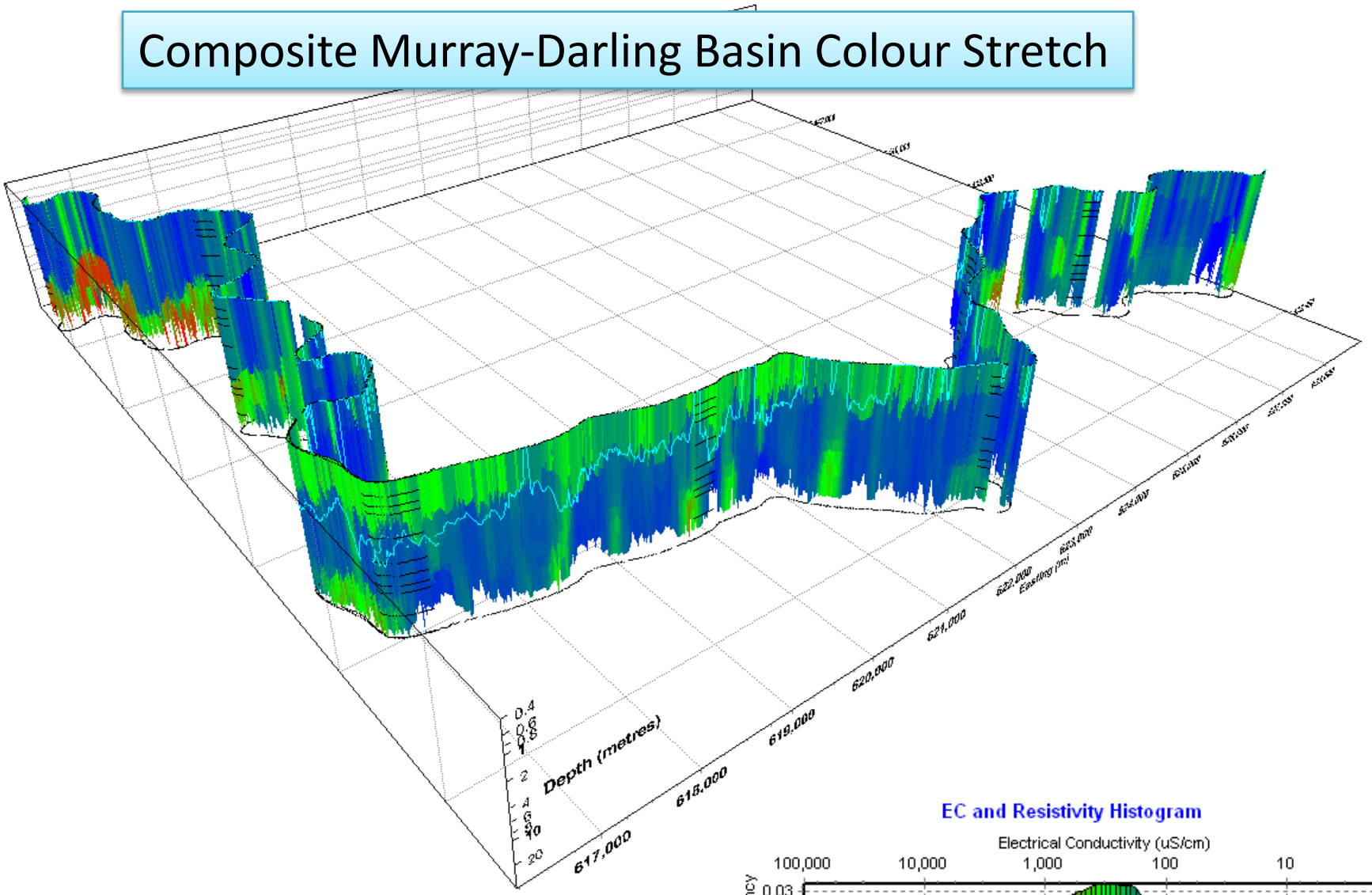
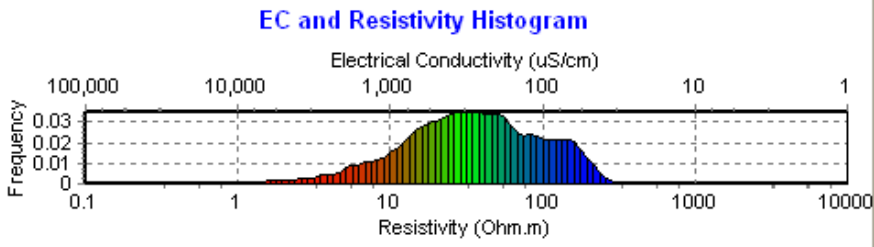
National Water Commission

Composite Murray-Darling Basin Colour Stretch





Log10 Depth Scale

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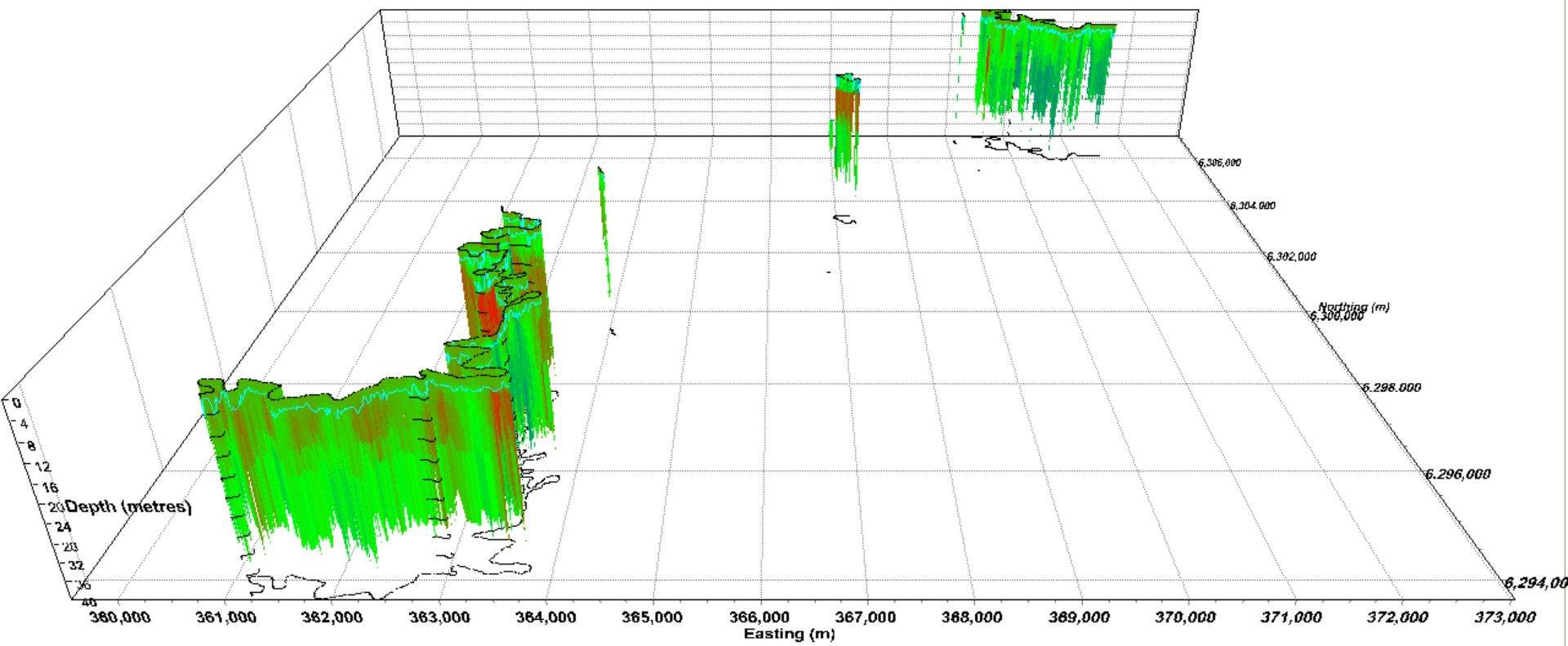
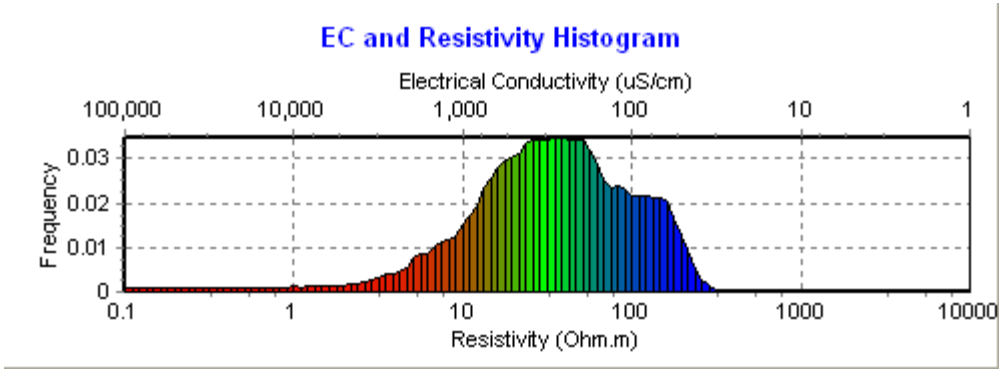
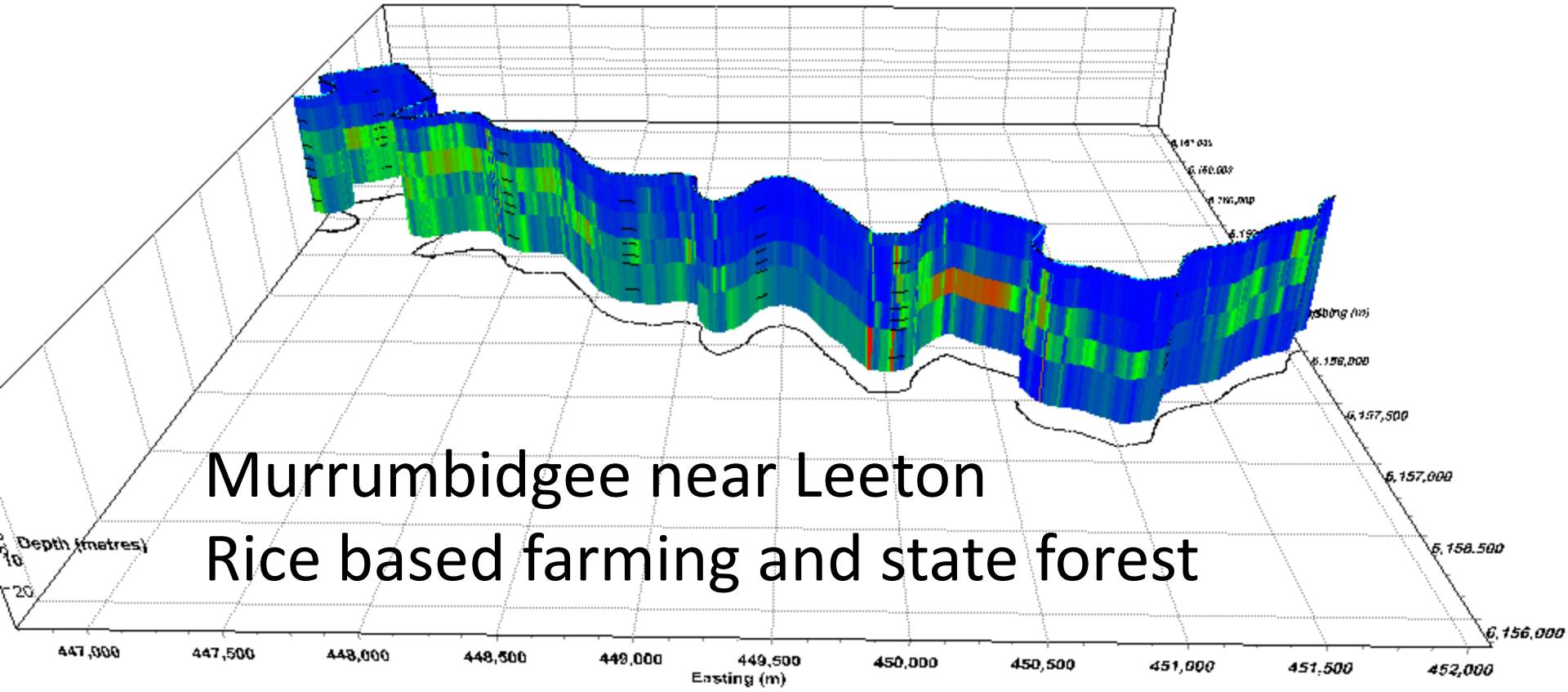


Lachlan River EC with Composite Murray Darling Basin Colour Stretch

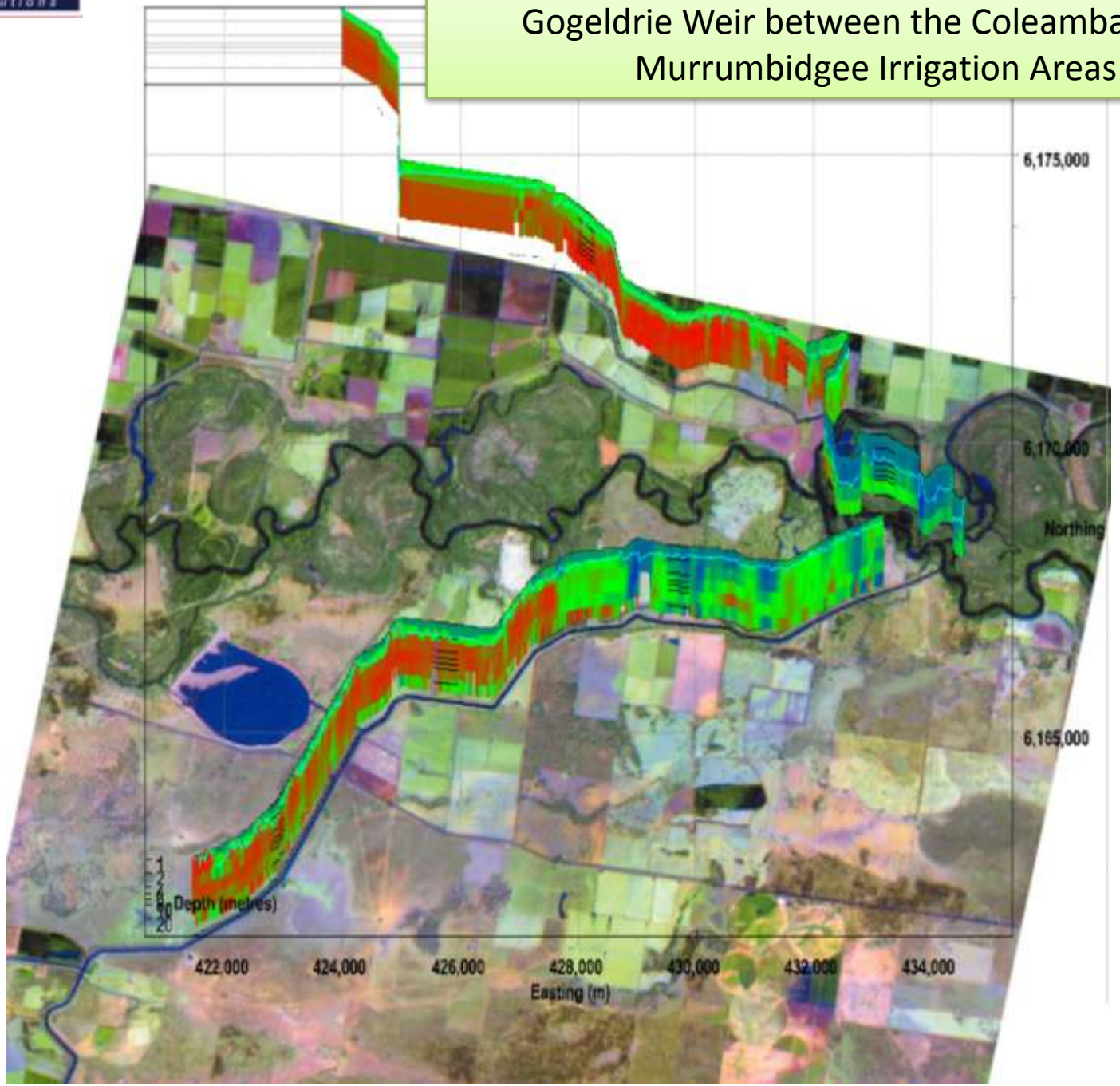


Project: Murrumbidgee River, CIA and MIA Ground/Surface Water Interaction Survey.
Site: Murrumbidgee River upstream of Yanco Wier Client: RiceCRC
Data Provider: Allen Hydrogeophysics JobNum: 1
Survey Equipment: Zonge GDP32, 144m array Survey Date: 19/02/2003



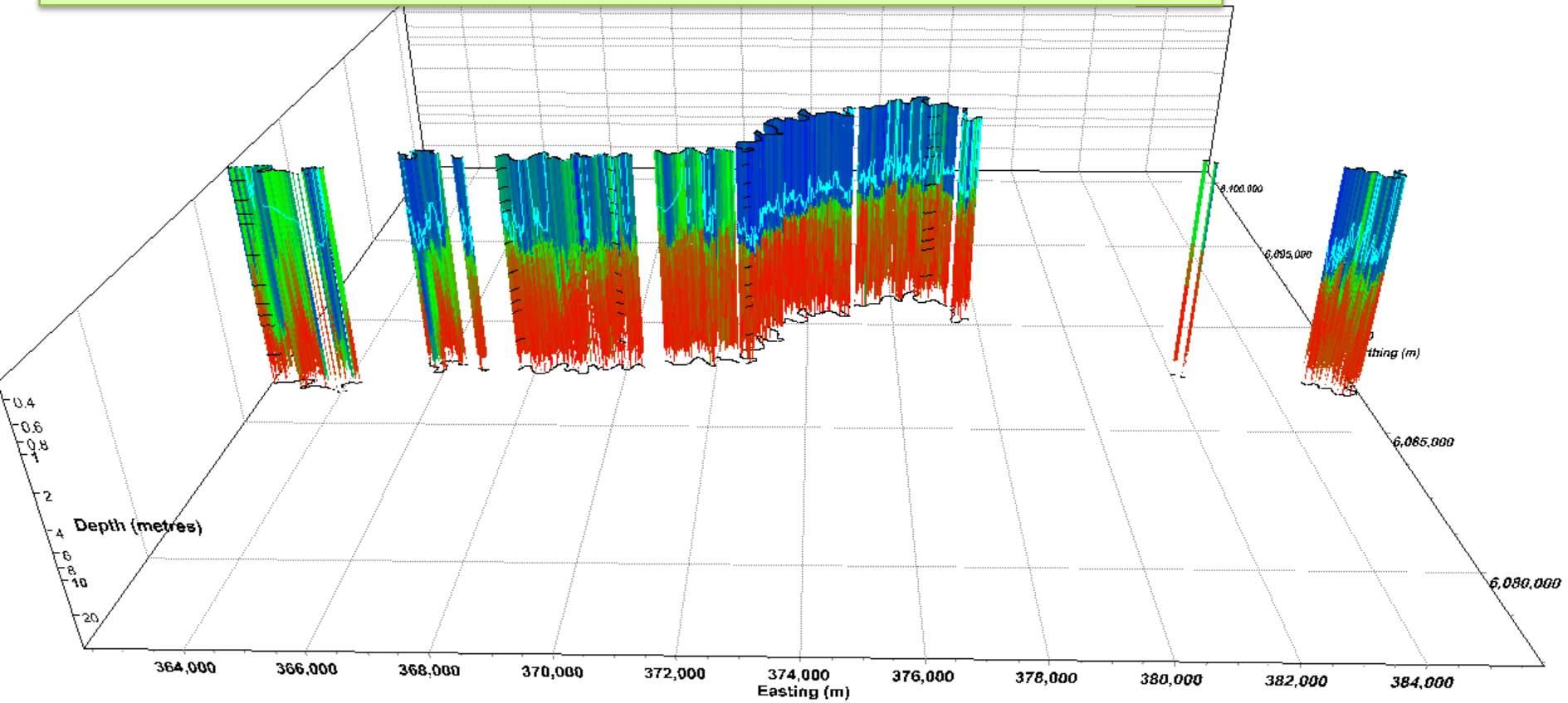
Murrumbidgee near Leeton
Rice based farming and state forest

Cross and long section of the Murrumbidgee River at Gogeldrie Weir between the Coleambally and Murrumbidgee Irrigation Areas

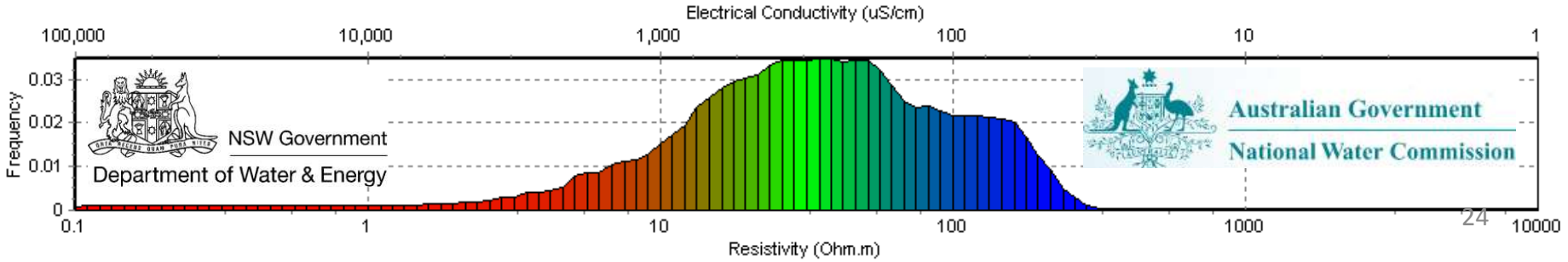


Project: NSW Losing/Disconnected Rivers
Site: Billabong Creek - Kurraroo - to Jerilderie Client: NSW DWE
Data Provider: Groundwater Imaging Pty Ltd JobNum: 1
Survey Equipment: TerraohmRIP924b,ABEM_SAS2000,Sonar,100mSchlumb,Argo Survey Date: 26/07/2008

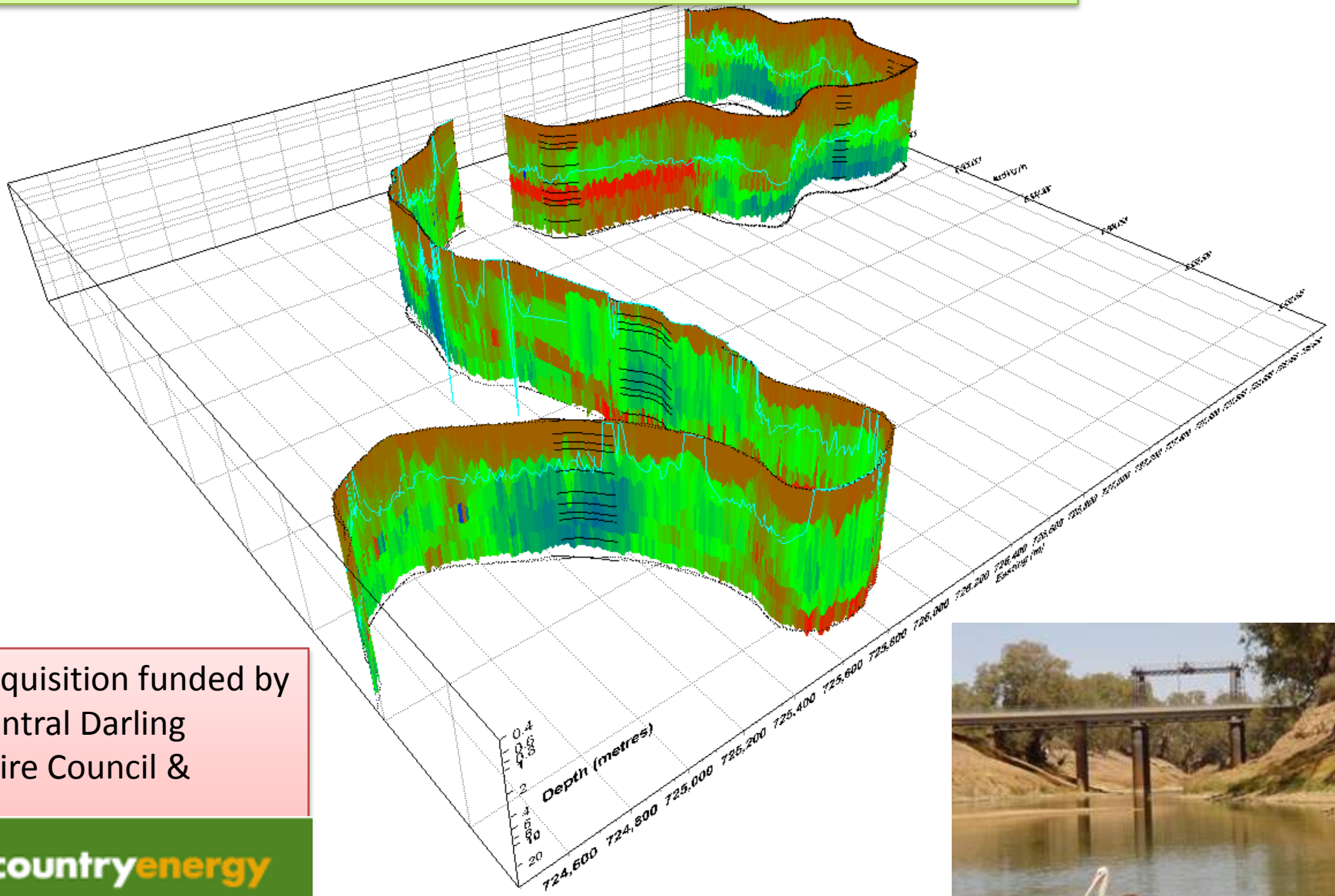
Billabong Creek Geo-electric survey with Murray Darling Basin Composite Colour Stretch and Log10 Depth Scale



EC and Resistivity Histogram



Darling River at Wilcannia Geo-electric survey with
Murray Darling Basin Composite Colour Stretch and Log10 Depth Scale

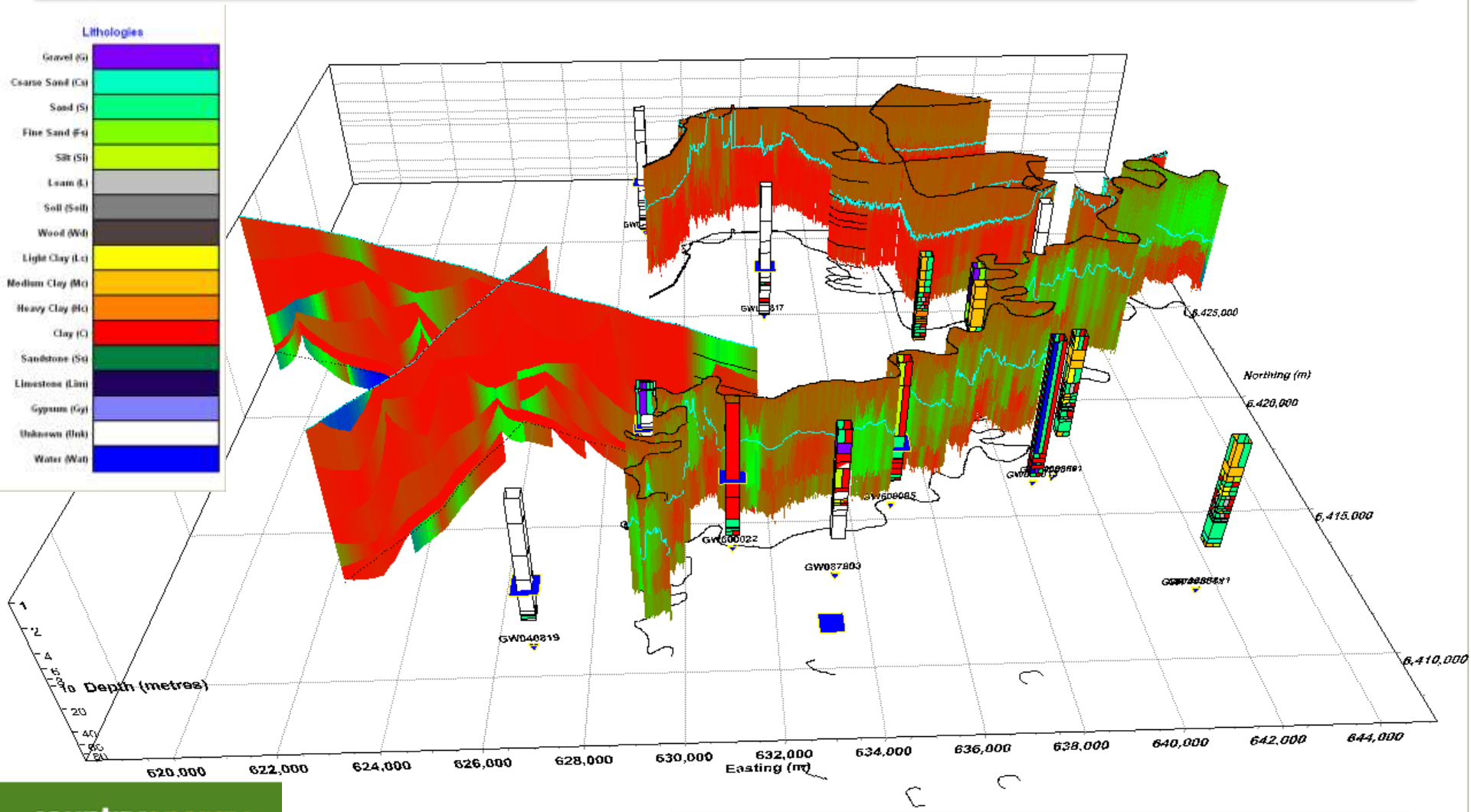


Acquisition funded by
Central Darling
Shire Council &

countryenergy

We live here too.

Darling River at Menindee plus Lakes Pamamaroo and Menindee Geo-electric survey with Murray Darling Basin Composite Colour Stretch and Log10 Depth Scale



countryenergy

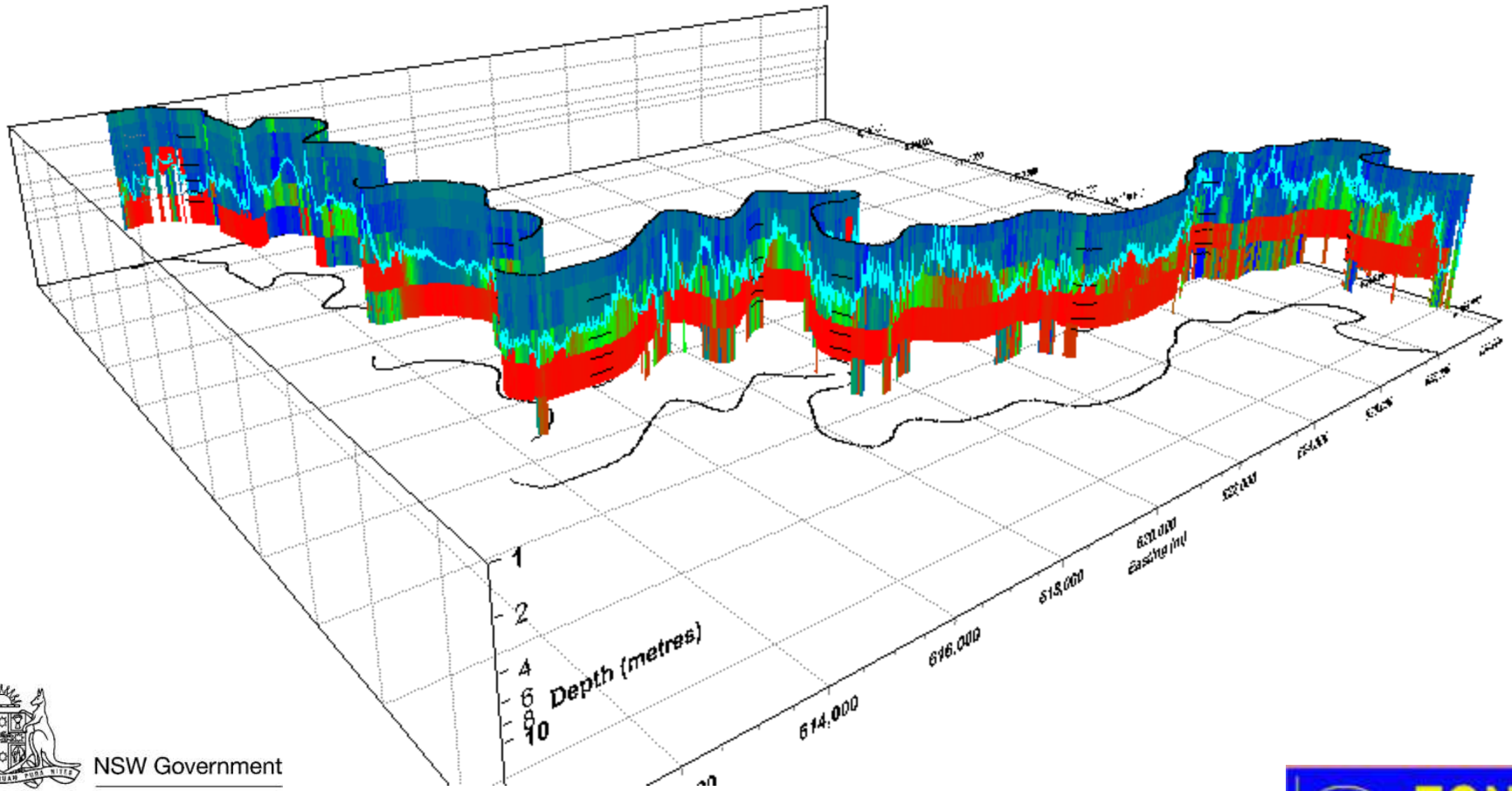
countrywater

We live here too.

Menindee Lake data – 1994 from O'Neill - WRC

All other data – 2006 from Allen – funded by Country Energy

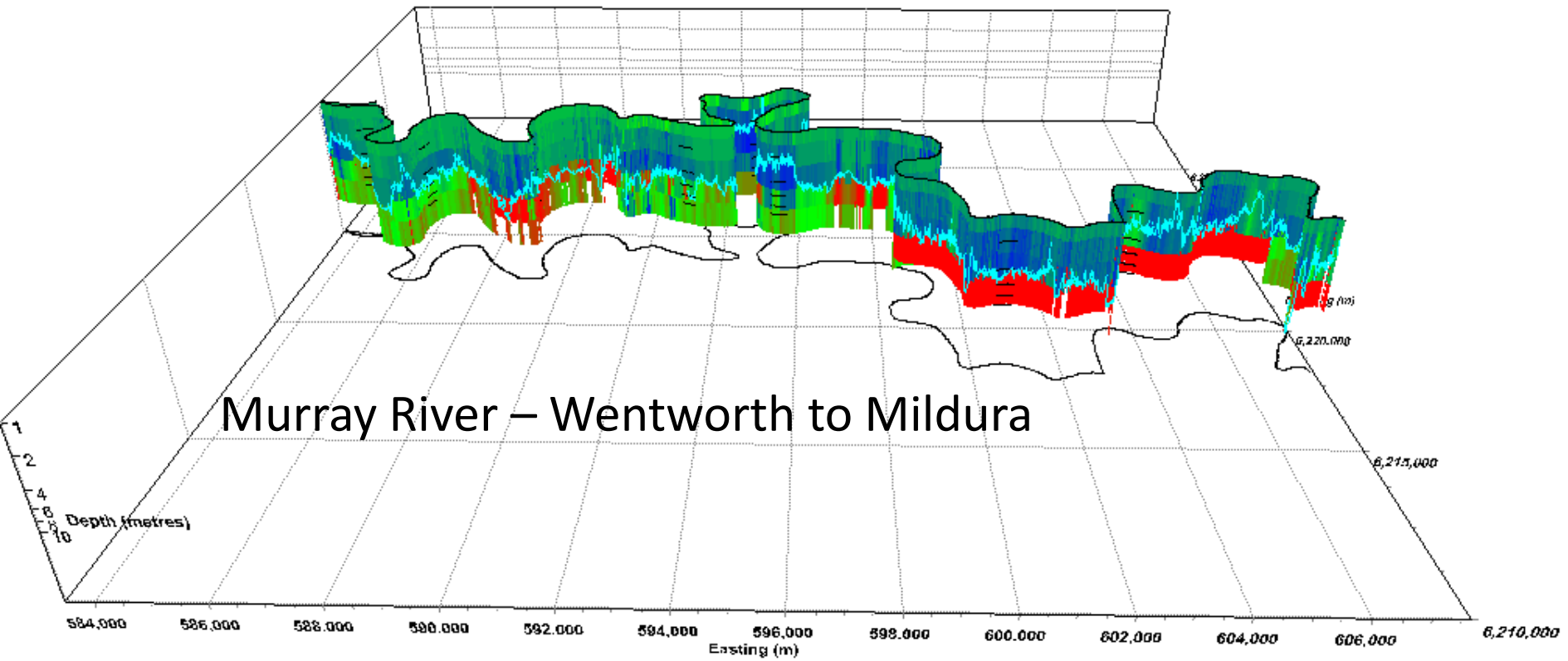
Murray River - 0-60 km upstream of Mildura.
Viticulture and uncleared land above fossil hypersaline groundwater discharge deposits



NSW Government
Department of Water & Energy

ZONGE

Project: Mildura,Buronga and Mallee Cliffs EC Monitoring Trials
Site: Wentworth to Mildura Client: DIPNR
Data Provider: Zonge supplied to National Centre For Groundwater Management JobNum: NCGM2004/4
Survey Equipment: Zonge GDP32 with 160V Tx Survey Date: 12/11/2003

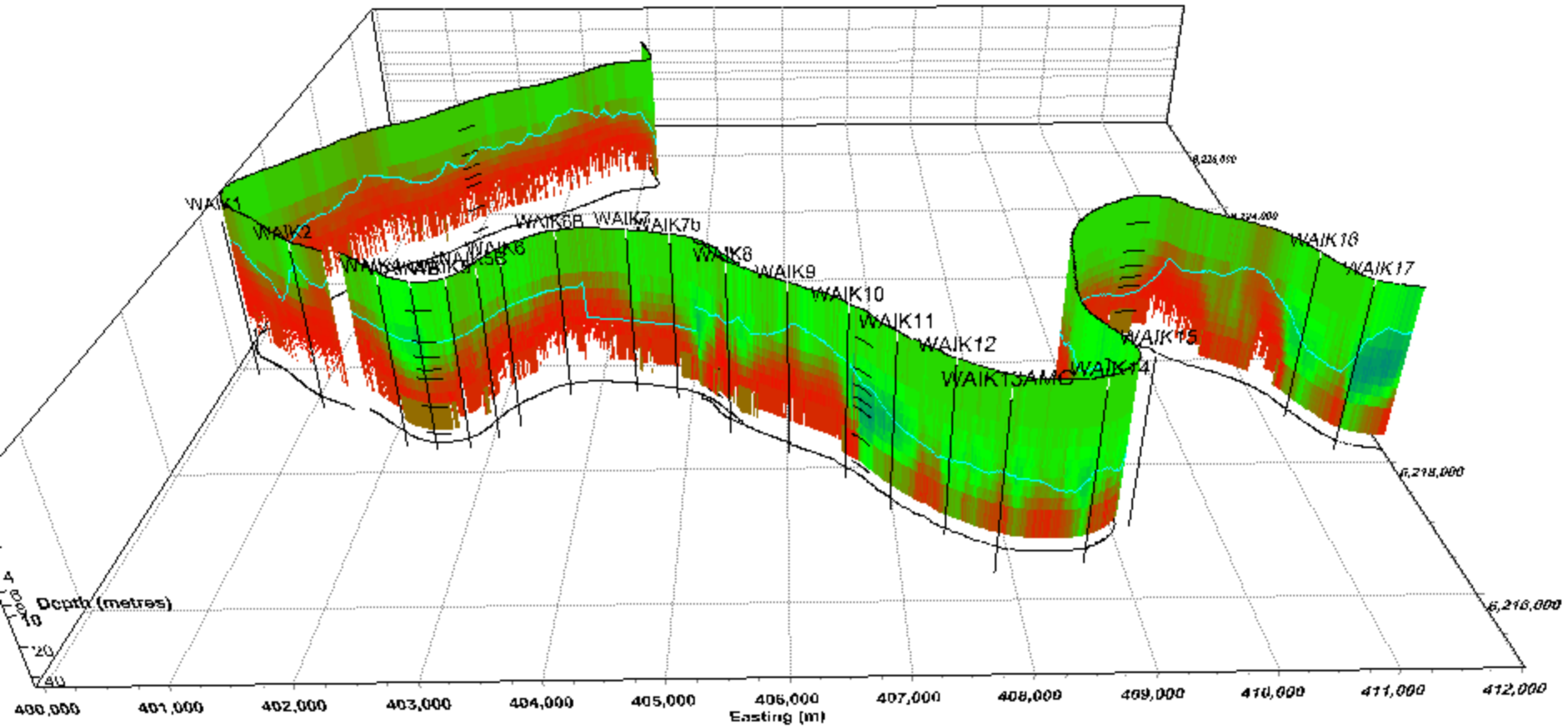


Murray River – Wentworth to Mildura

NSW Government
Department of Water & Energy

ZONGE

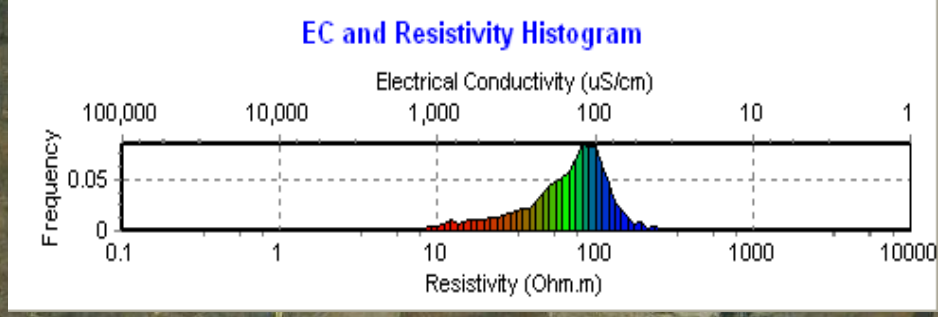
Murray River – Waikerie 1 and 2a salt water interception schemes – South Australia
Vitculture and citrus



End of constant colour scheme river comparison.


Macquarie River
Geo-electric and associated run-of-river data

Macquarie River EC 8m below the river bed



Inferred Aquiclude with holes

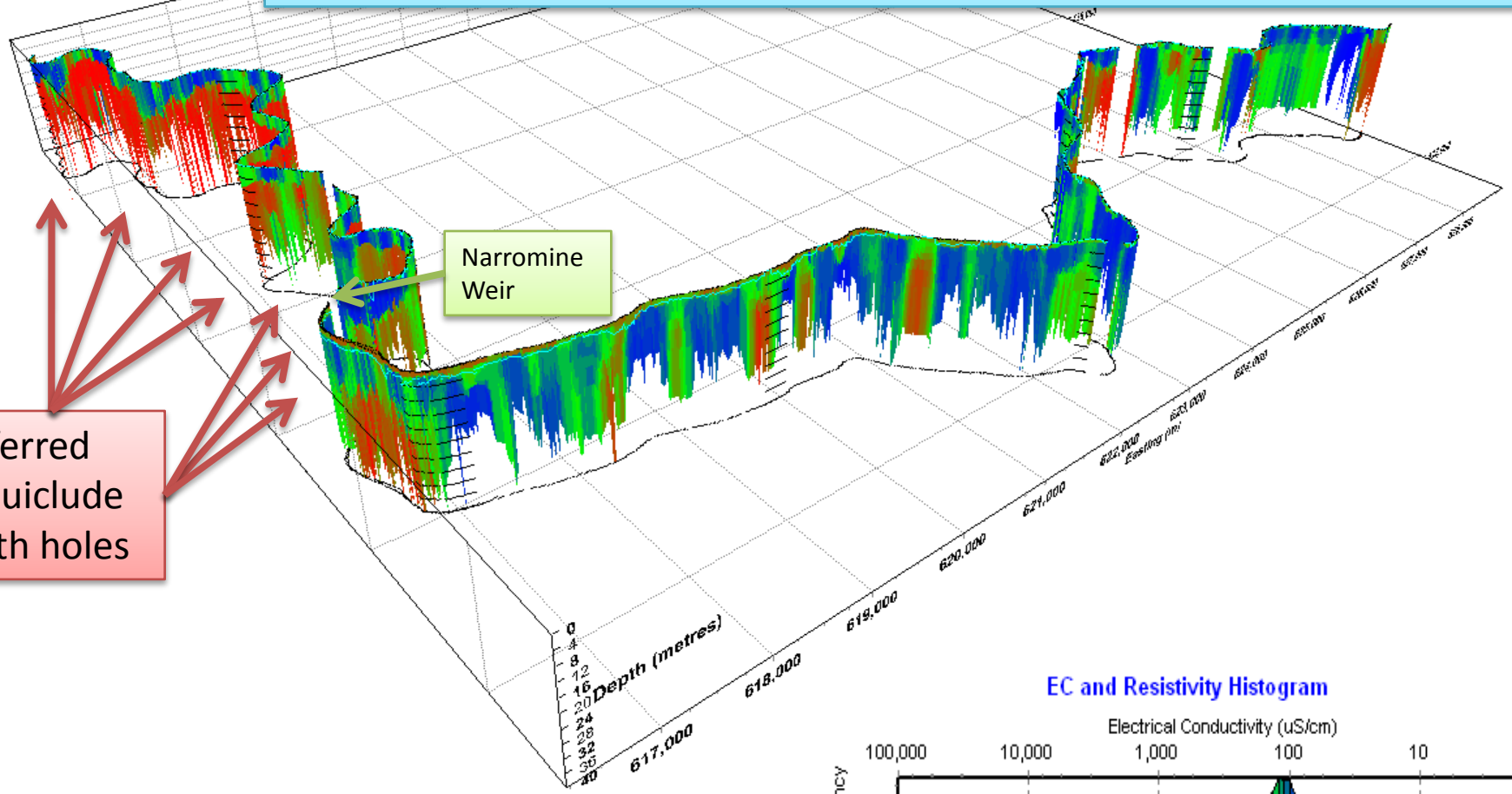
Inferred predominantly losing/disconnected river overlying highly permeable unconsolidated deep valley fill infringing on folded basement rock with saline fracture zones and granite plutons

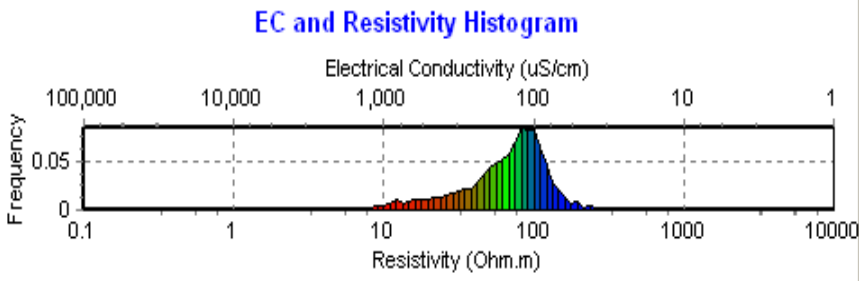
Gilgandra Rd
Warren Rd
Narromine
Dandaloo St
Peak Hill Rd
Algalah St
Tullamore Narromine Rd
Mitchell Hwy
© 2008 Cnes/Spot Image
© 2008 MapData Sciences PtyLtd, PSMA
5.00 km
Google
lat -32.136820° lon 148.240287°
elev 234 m
Eye alt 17.99 km

Macquarie River Interpretation Summary

Project: NSW Losing/Disconnected Rivers Investigation
Site: Macquarie River - Turkey Farm Reserve to Brummagen Creek Client: NSW DWE
Data Provider: Groundwater Imaging Pty Ltd JobNum: 1
Survey Equipment: RIP924, 100m streamer, sonar and water pH, Temp and EC loggers Survey Date: 1/07/2008

From the weir upstream - Inferred predominantly losing/disconnected river overlies highly permeable unconsolidated deep valley fill infringing on folded basement rock with saline fracture zones and granite plutons

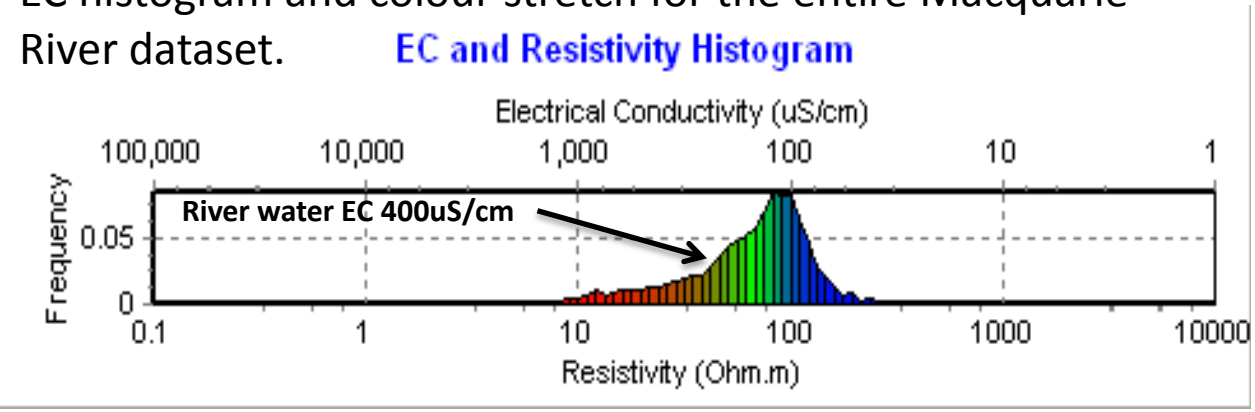




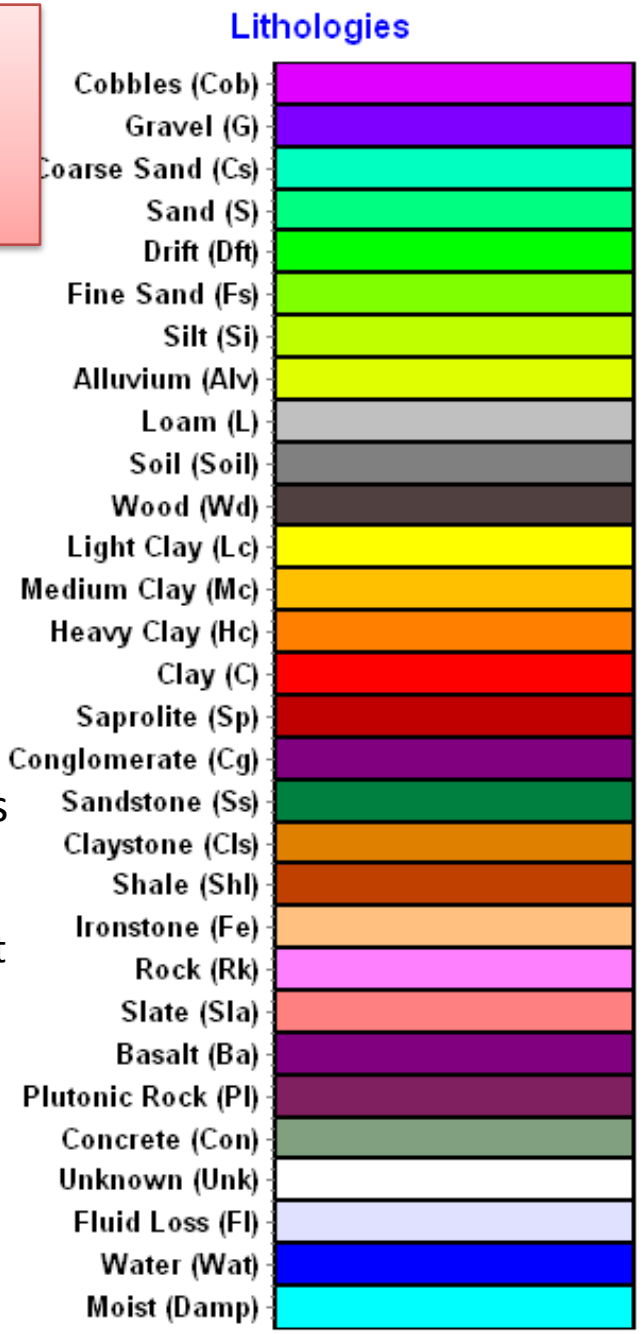
Linear Depth Scale

Macquarie Modelled Resistivity Images - Key

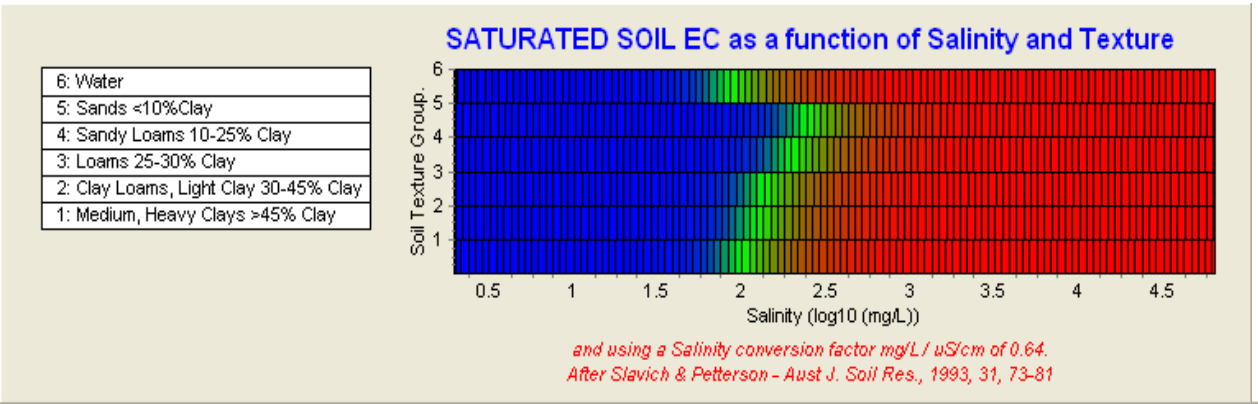
EC histogram and colour stretch for the entire Macquarie River dataset.



Lithologies encountered in drillers logs near the Macquarie River



EC, Salinity, and Soil Texture relationship for the Macquarie River dataset

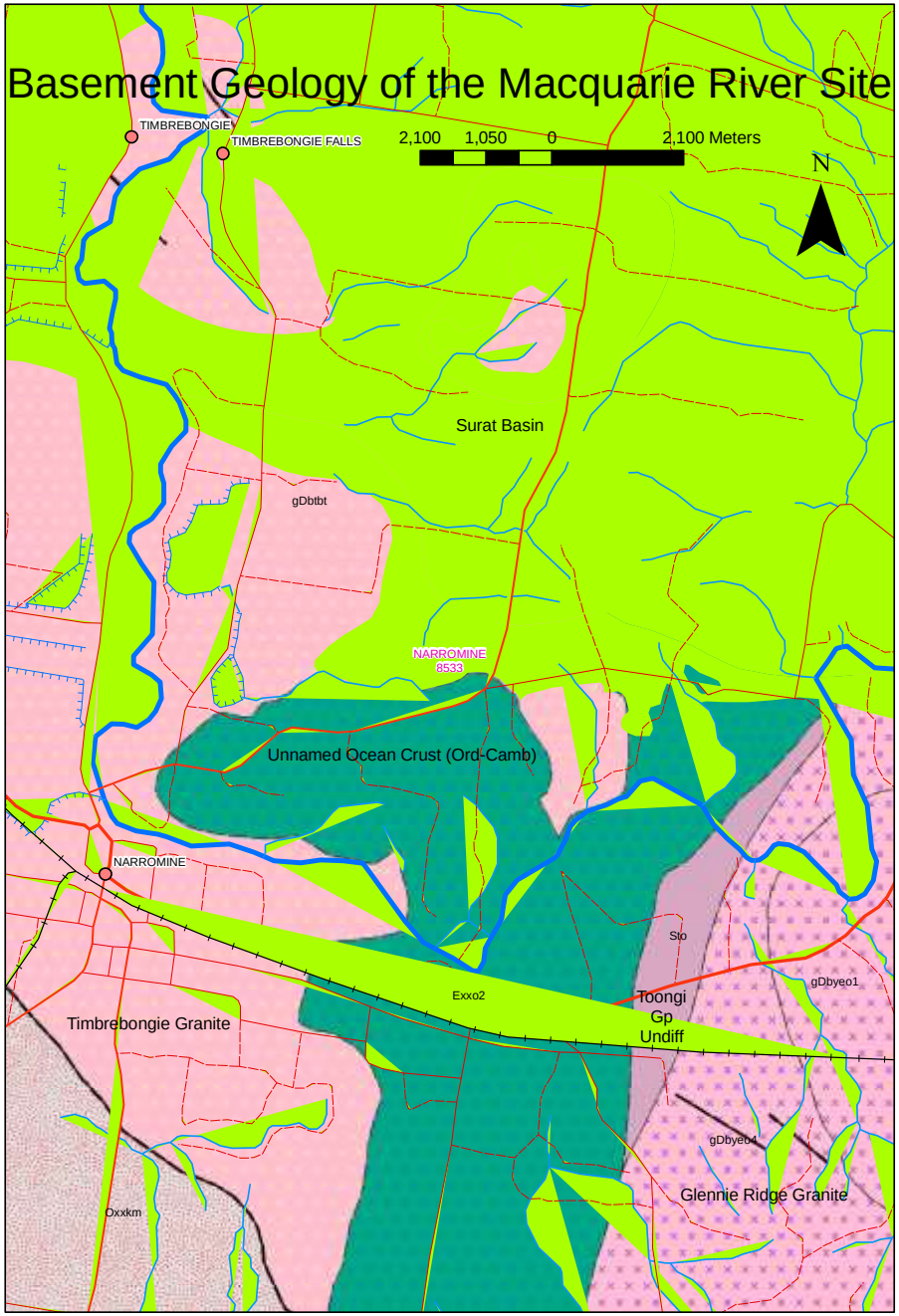


Comparison with Tempest data and Geological Maps

Photo sourced from http://www.fugroairborne.com/service/tempest.php

The 8m deep geo-electric depth slice has been superimposed over various datasets. Due to river incision, direct comparison of Tempest depths and Geo-electric depths is not appropriate. Due to river incision, the 8m geo-electric depth slice should correspond most directly to the 15-20m Tempest depth interval.

Lachlan Fold Belt and GAB Geology beneath the Macquarie River Palaeovalleys

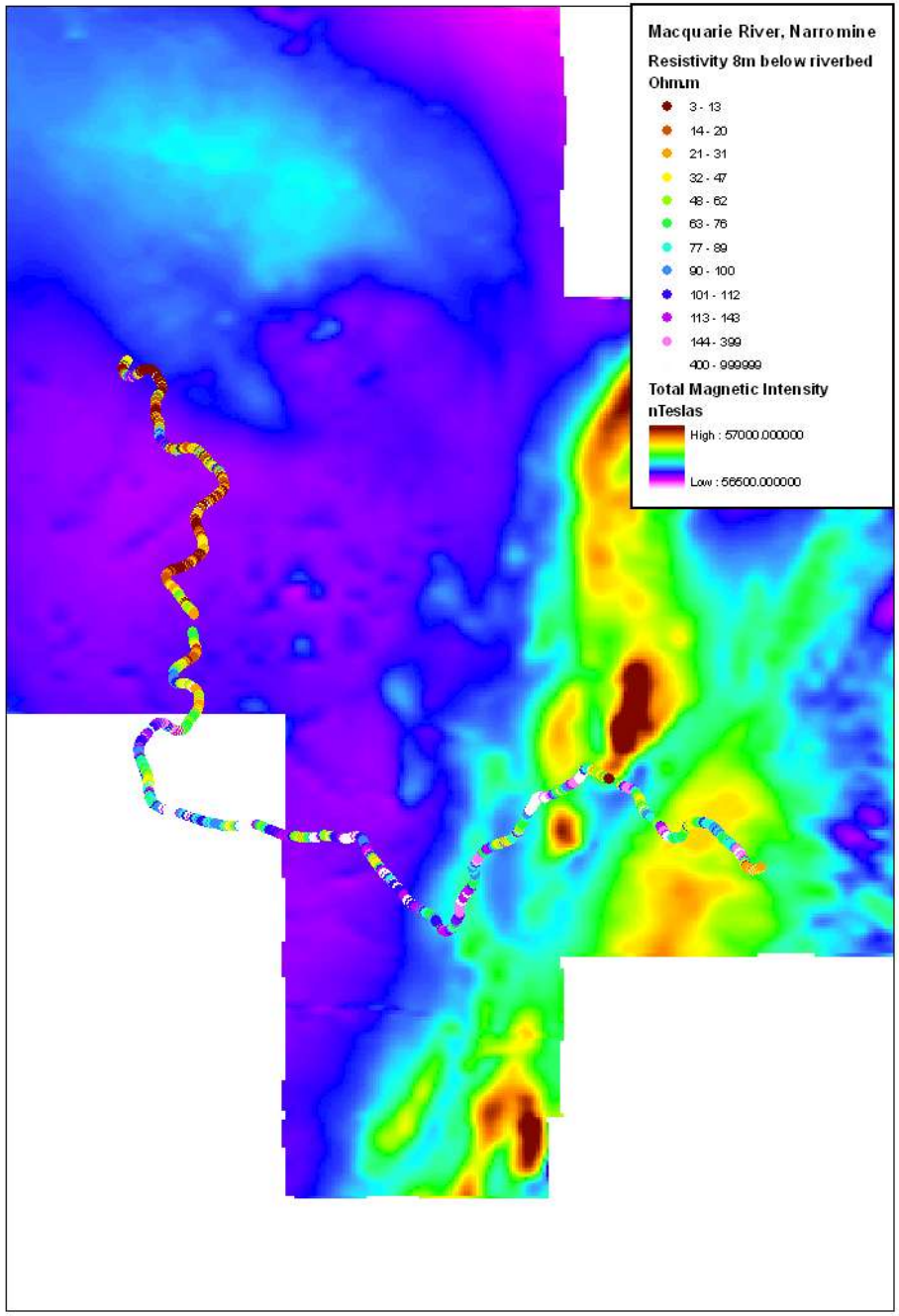


Source: Eastern Lachlan Orogen Geosciences Database Version 2. Sept 2006.
NSW Dept. of Primary Industries.

Beware – the level of detail presented here smoothes over features detected under the river. In places, it can be assumed that the new information presented in the Tempest survey and this report will result in modification of this map.

Macquarie River Geo-electric Resistivity at 8m below the river bed superimposed over Fugro-Tempest Total Magnetic Intensity

TMI colour stretch is linear

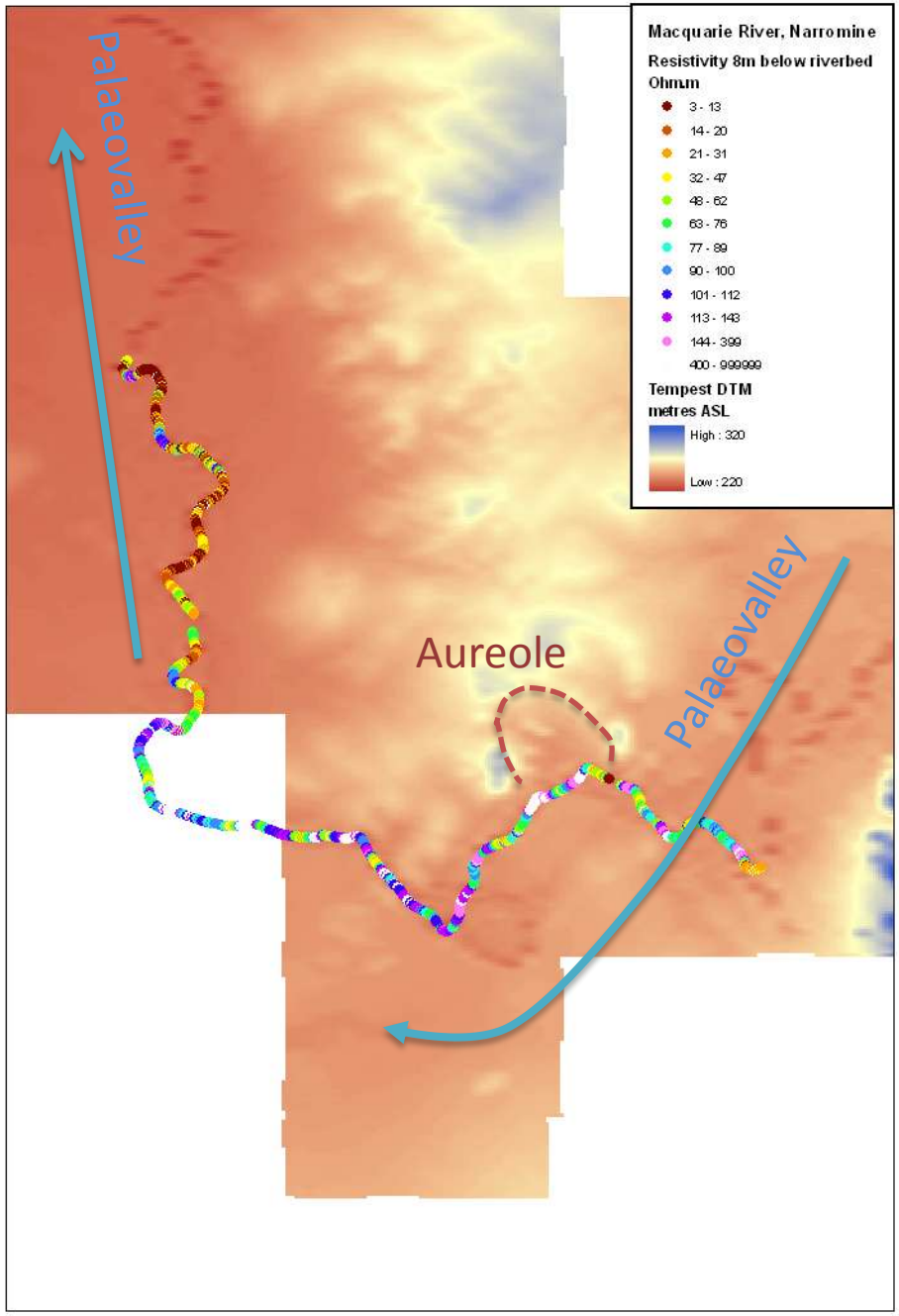


Tempest data sourced from:
Noteboom, M., and Stenning, L., 2007, Lower Macquarie River TEMPEST AEM Survey, NSW, Final Data (P1140), Geoscience Australia
GeoCat # 67211
ISBN 978-1-921498-17-6

The TMI data principally indicates deep structures of the basement rock. The significance of these will be explained using the other datasets. The level of smoothing of this TMI data precludes identification of the depth of features evident.

Macquarie River Geo-electric Resistivity at 8m below the river bed superimposed over Fugro-Tempest Digital Terrain Model

DTM colour stretch is linear



Tempest data sourced from:
Noteboom, M., and Stenning, L., 2007, Lower Macquarie River TEMPEST AEM Survey, NSW, Final Data (P1140), Geoscience Australia GeoCat # 67211
ISBN 978-1-921498-17-6

Subsurface valleys are indicated by slight broad topographic lows (ie. transition from peneplain to depositional plain). An aureole around a small granite north of the river is evident as a sharp topographic high.

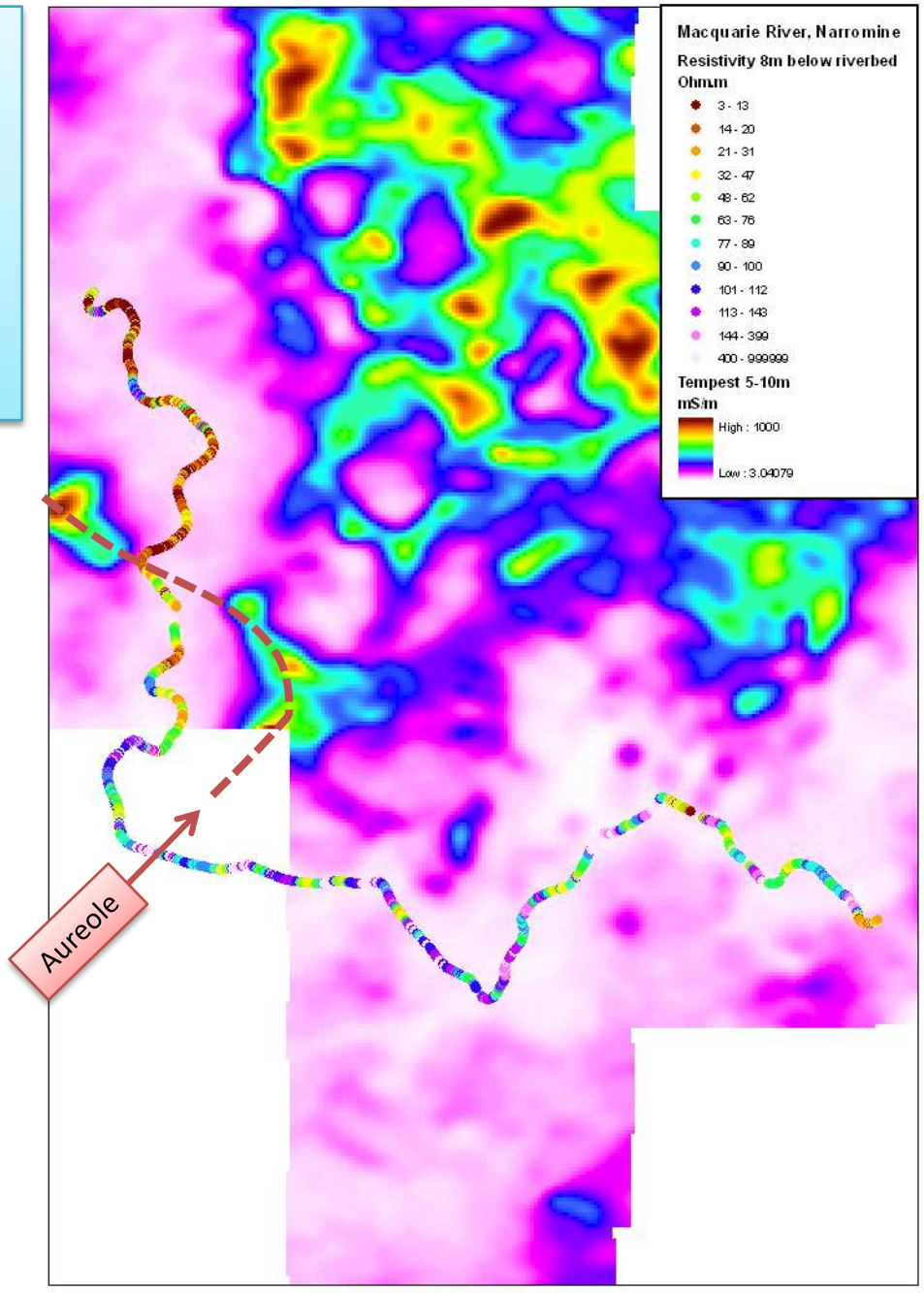
Macquarie River Geo-electric Resistivity at 8m below the river bed superimposed over Fugro-Tempest EC at 5-10m depth

Tempest colour stretch is equal area.

No attempt to standardize the Tempest and Geo-electric colour scales has been made because they are drastically different.

When comparing depths beware that the river is incised sharply 6 to 12 metres deep.

Horizontal smoothing of the Tempest data has blurred most of the details evident in the geo-electric data.

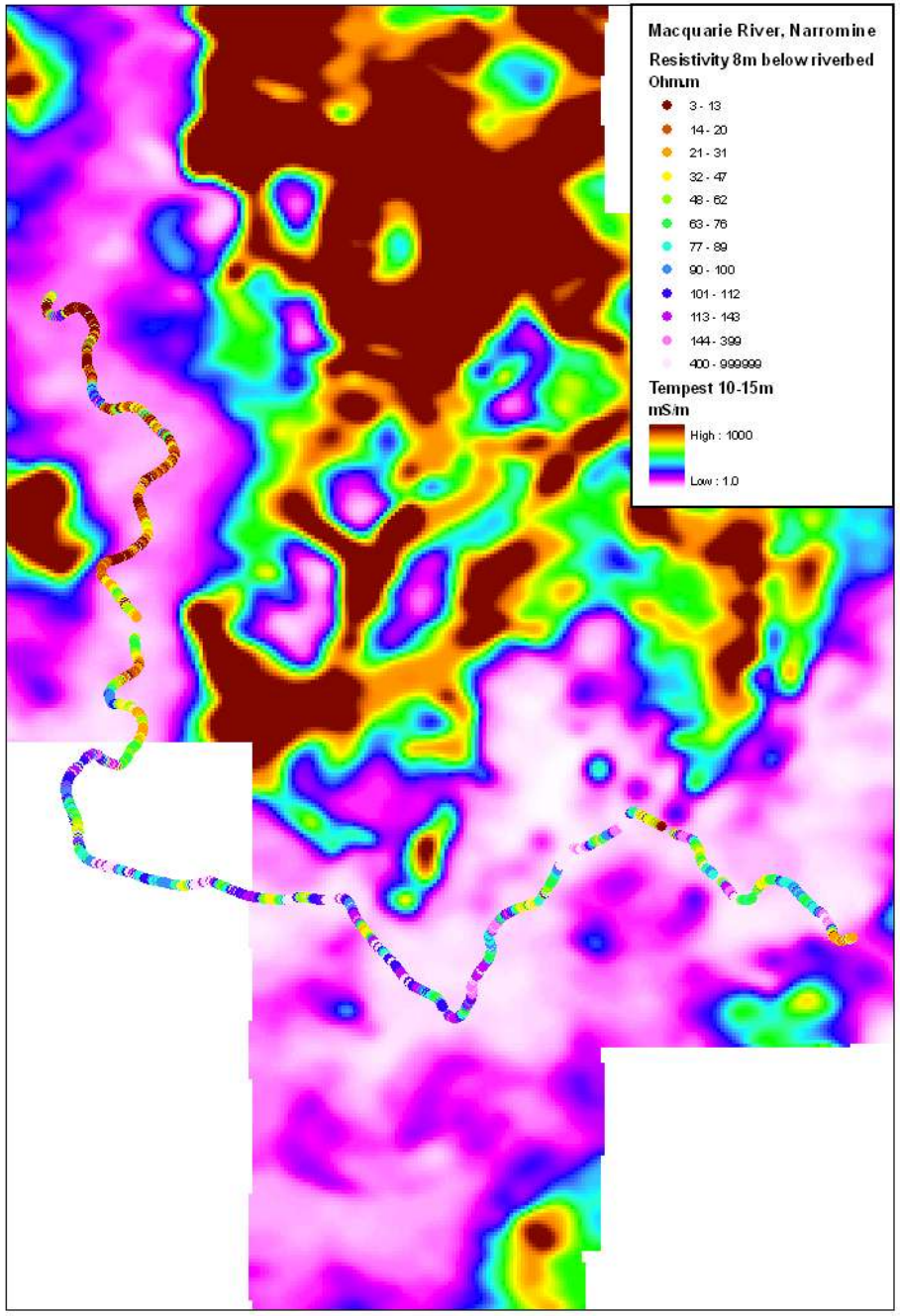


Tempest data sourced from:
Noteboom, M., and Stenning, L., 2007,
Lower Macquarie River TEMPEST AEM Survey, NSW, Final Data (P1140),
Geoscience Australia
GeoCat # 67211
ISBN 978-1-921498-17-6

The River at Narromine turns north and crosses over the aureole of a granite (shown). This is a very shallow feature indicating that the buried northern valley is relatively shallow and confined at this point.

The 0-5m deep Tempest data is not shown because its altitude correction and horizontal smoothing is badly affected by river incision.

Macquarie River Geo-electric Resistivity at 8m below the river bed superimposed over Fugro-Tempest EC at 10-15m depth



Tempest colour stretch is equal area.

No attempt to standardize the Tempest and Geo-electric colour scales has been made because they are drastically different.

When comparing depths beware that the river is incised sharply 6 to 12 metres deep.

Horizontal smoothing of the Tempest data has blurred most of the details evident in the geo-electric data.

Tempest data sourced from:
Noteboom, M., and Stenning, L., 2007, Lower Macquarie River TEMPEST AEM Survey, NSW, Final Data (P1140), Geoscience Australia GeoCat # 67211
ISBN 978-1-921498-17-6

Tempest reveals Lachlan Fold Belt regolith weathering and wider shear zones. Resistive poorly weathered fold belt rocks and more recent freshwater and gravel filled palaeovalleys are represented by low conductivity but can only be differentiated by their geometry.

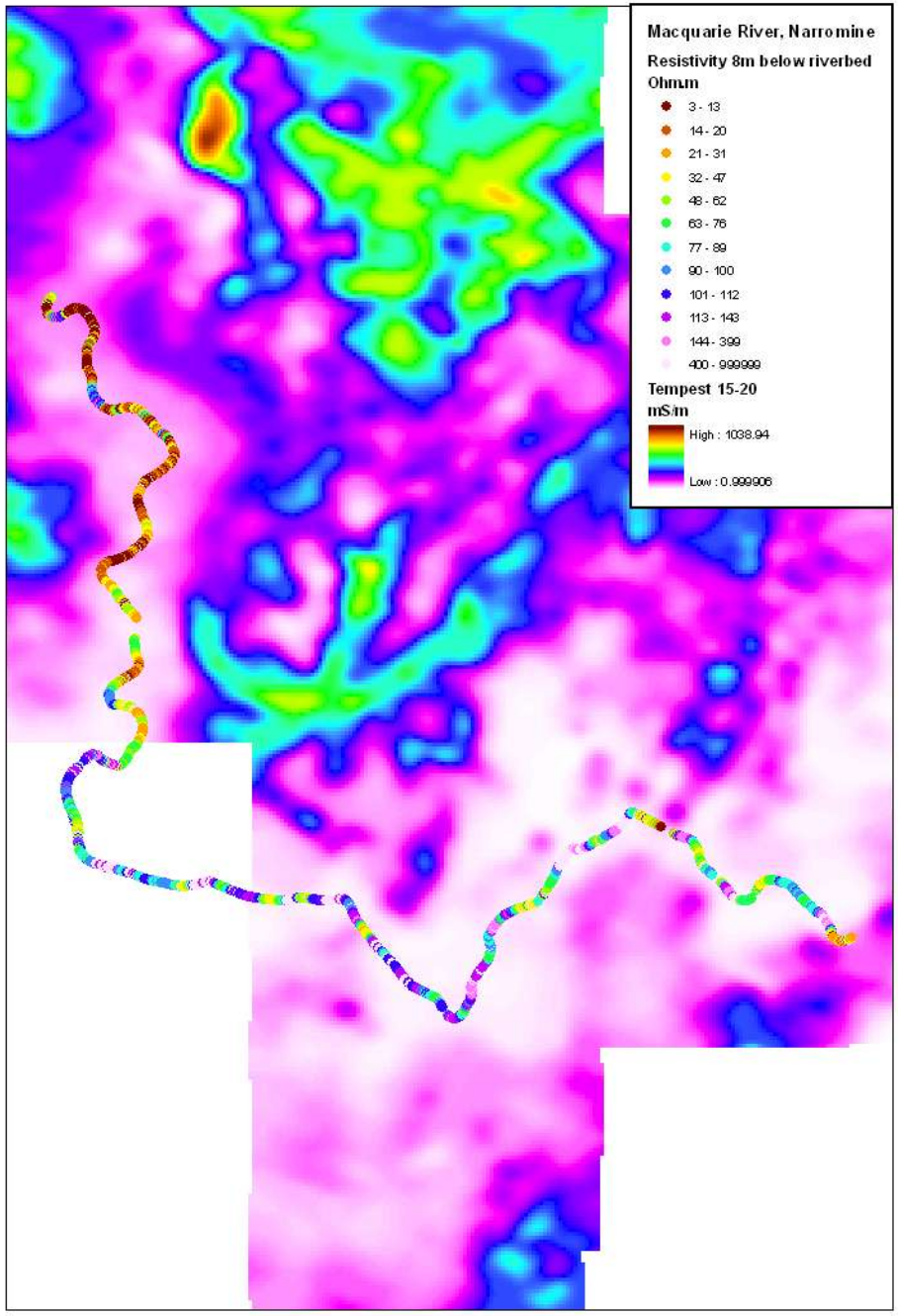
Macquarie River Geo-electric Resistivity at 8m below the river bed superimposed over Fugro-Tempest EC at 15-20m depth

Tempest colour stretch is equal area.

No attempt to standardize the Tempest and Geo-electric colour scales has been made because they are drastically different.

When comparing depths beware that the river is incised sharply 6 to 12 metres deep.

Horizontal smoothing of the Tempest data has blurred most of the details evident in the geo-electric data.



Tempest data sourced from:
Noteboom, M., and Stenning, L., 2007,
Lower Macquarie River TEMPEST AEM Survey, NSW, Final Data (P1140),
Geoscience Australia
GeoCat # 67211
ISBN 978-1-921498-17-6

The discontinuous aquiclude evident in geo-electric data north of Narromine Weir is presented in the Tempest data as a slight increase in the valley conductivity.

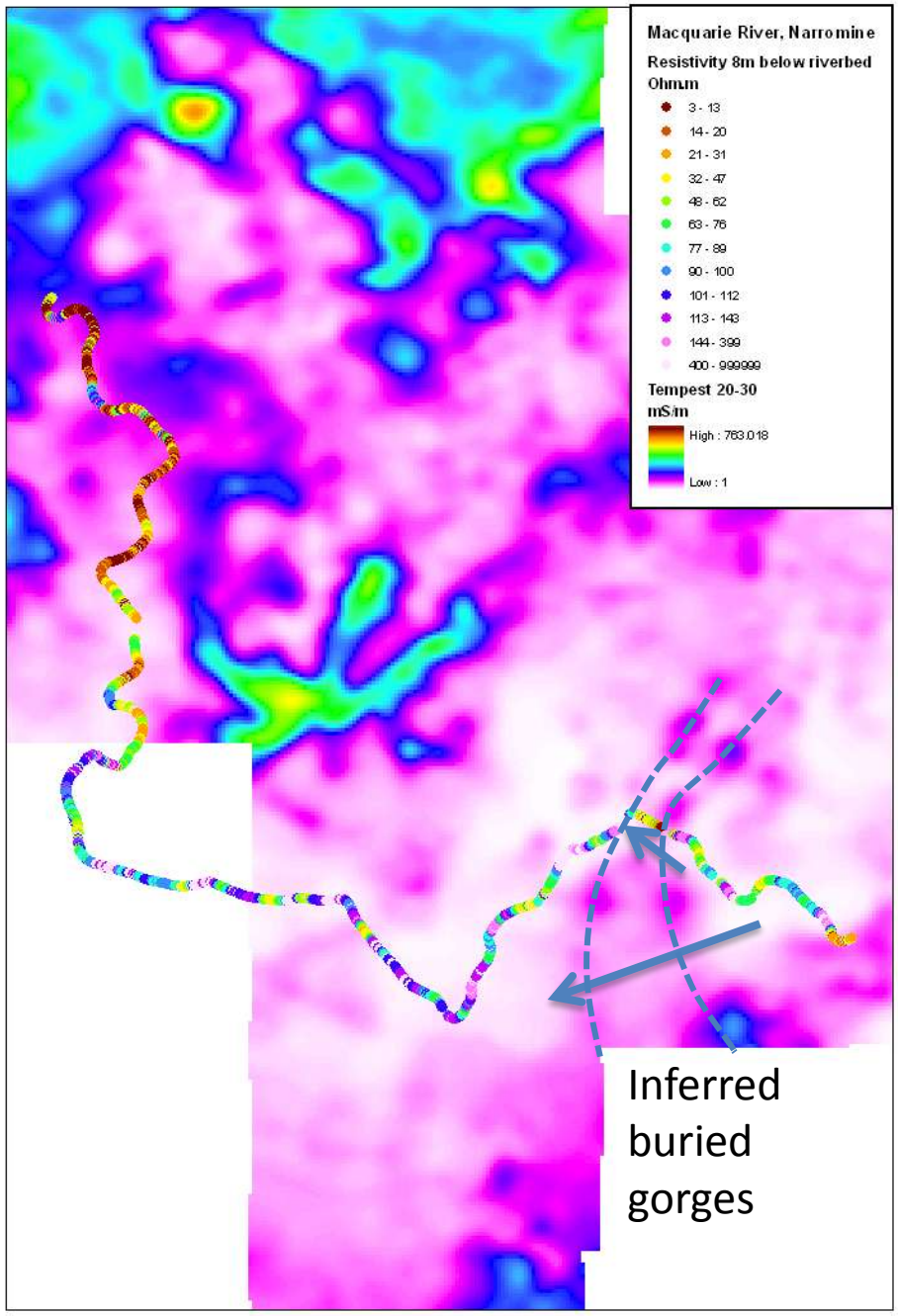
Macquarie River Geo-electric Resistivity at 8m below the river bed superimposed over Fugro-Tempest EC at 20-30m depth

Tempest colour stretch is equal area.

No attempt to standardize the Tempest and Geo-electric colour scales has been made because they are drastically different.

When comparing depths beware that the river is incised sharply 6 to 12 metres deep.

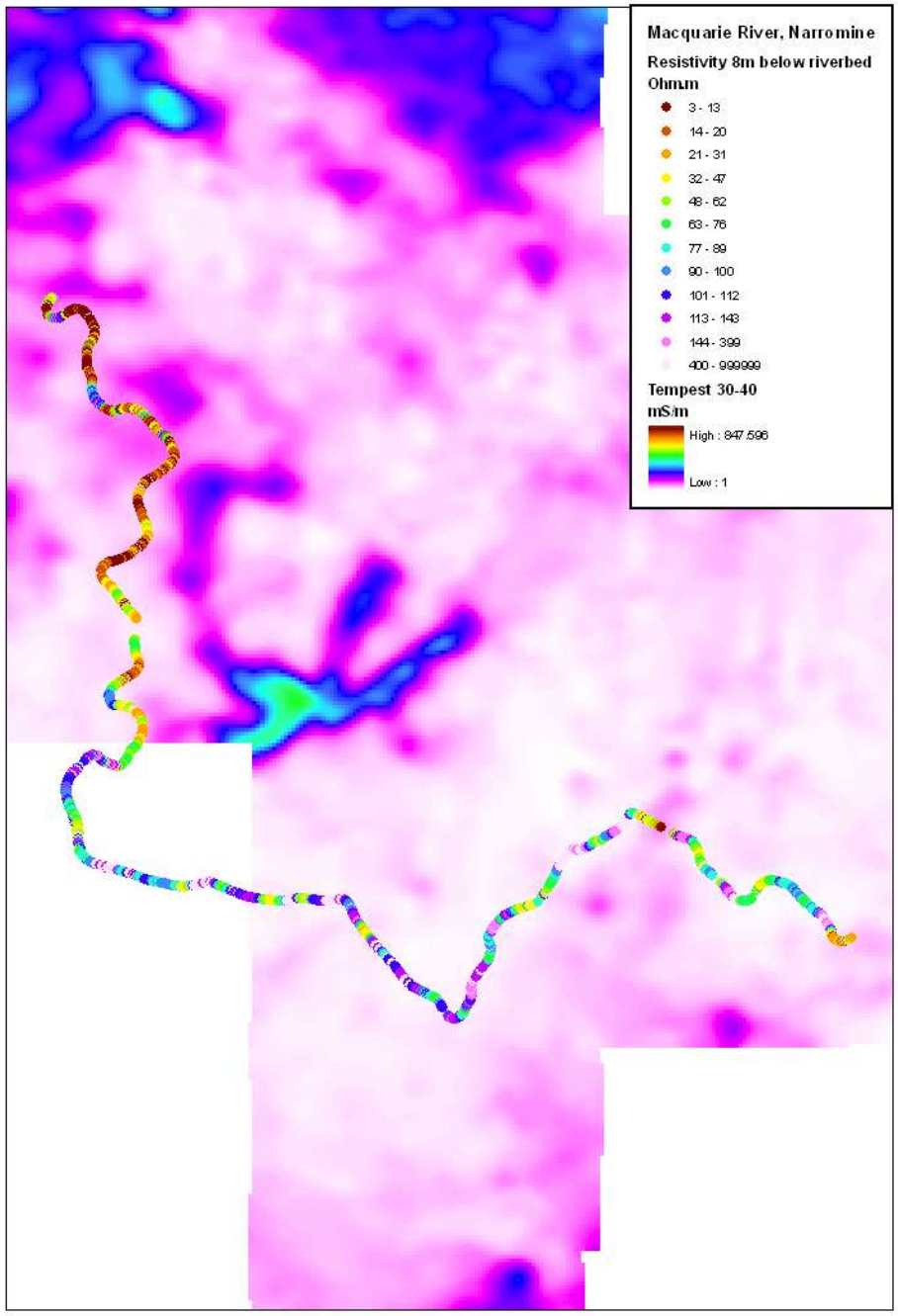
Horizontal smoothing of the Tempest data has blurred most of the details evident in the geo-electric data.



Tempest data sourced from:
Noteboom, M., and Stenning, L., 2007, Lower Macquarie River TEMPEST AEM Survey, NSW, Final Data (P1140), Geoscience Australia GeoCat # 67211
ISBN 978-1-921498-17-6

The upper reaches of the geo-electric survey cross Tempest conductivity trends suggesting that the underlying palaeovalley passes through a gorge.

Macquarie River Geo-electric Resistivity at 8m below the river bed superimposed over Fugro-Tempest EC at 30-40m depth



Tempest colour stretch is equal area.

No attempt to standardize the Tempest and Geo-electric colour scales has been made because they are drastically different.

When comparing depths beware that the river is incised sharply 6 to 12 metres deep.

Horizontal smoothing of the Tempest data has blurred most of the details evident in the geo-electric data.

Tempest data sourced from:
Noteboom, M., and Stenning, L., 2007, Lower Macquarie River TEMPEST AEM Survey, NSW, Final Data (P1140), Geoscience Australia GeoCat # 67211
ISBN 978-1-921498-17-6

By 30m deep, Tempest is observing a combination of relatively fresh basement rock and gravel valley fill both of which appear to have similar resistivity. Dominant features are basement conductors of little significance to this study.

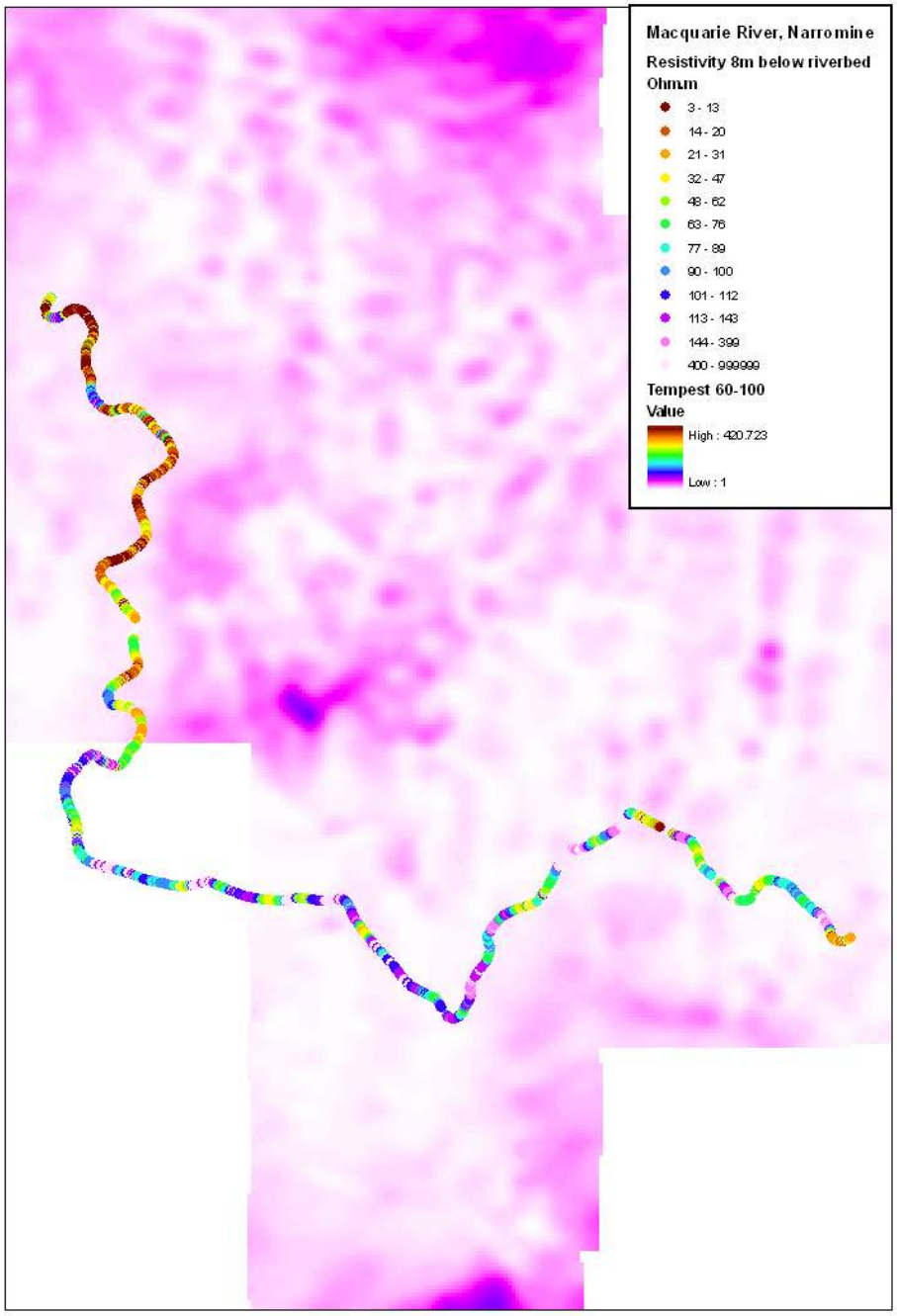
Macquarie River Geo-electric Resistivity at 8m below the river bed superimposed over Fugro-Tempest EC at 60-100m depth

Tempest colour stretch is equal area.

No attempt to standardize the Tempest and Geo-electric colour scales has been made because they are drastically different.

When comparing depths beware that the river is incised sharply 6 to 12 metres deep.

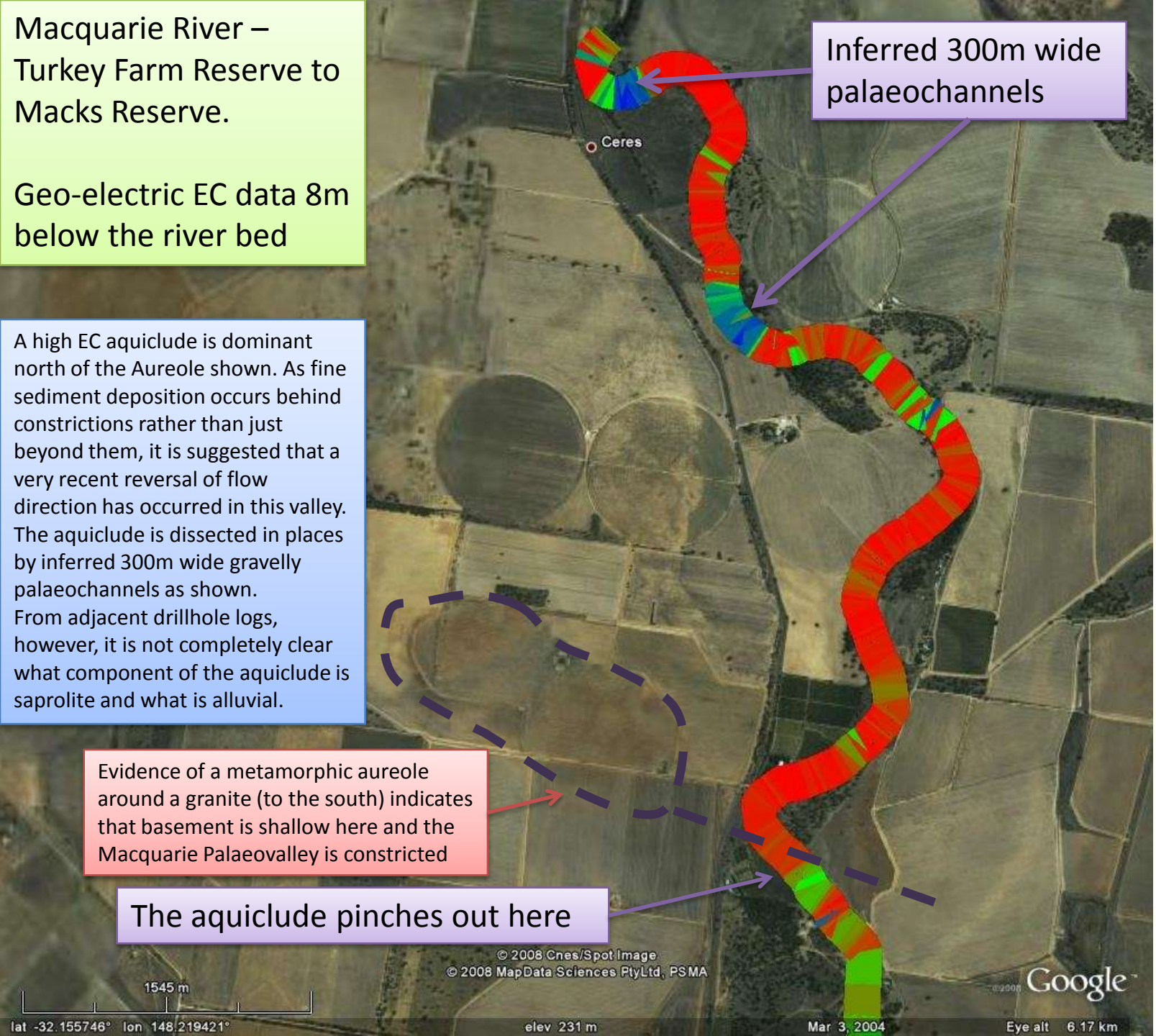
Horizontal smoothing of the Tempest data has blurred most of the details evident in the geo-electric data.



Tempest data sourced from:
Noteboom, M., and Stenning, L., 2007, Lower Macquarie River TEMPEST AEM Survey, NSW, Final Data (P1140), Geoscience Australia GeoCat # 67211
ISBN 978-1-921498-17-6

1. Turkey Farm Reserve to Mack Reserve

The Macquarie River at Mack Reserve – photo courtesy of Rob Brownbill


Macquarie River – Turkey Farm Reserve to Macks Reserve.
Geo-electric EC data 8m below the river bed
Inferred 300m wide palaeochannels
Ceres
A high EC aquiclude is dominant north of the Aureole shown. As fine sediment deposition occurs behind constrictions rather than just beyond them, it is suggested that a very recent reversal of flow direction has occurred in this valley. The aquiclude is dissected in places by inferred 300m wide gravelly palaeochannels as shown.
From adjacent drillhole logs, however, it is not completely clear what component of the aquiclude is saprolite and what is alluvial.
Evidence of a metamorphic aureole around a granite (to the south) indicates that basement is shallow here and the Macquarie Palaeovalley is constricted
The aquiclude pinches out here
© 2008 Cnes/Spot Image
© 2008 MapData Sciences PtyLtd, PSMA
1545 m
lat -32.155746° lon 148.219421°
elev 231 m
Mar 3, 2004
Eye alt 6.17 km
Google

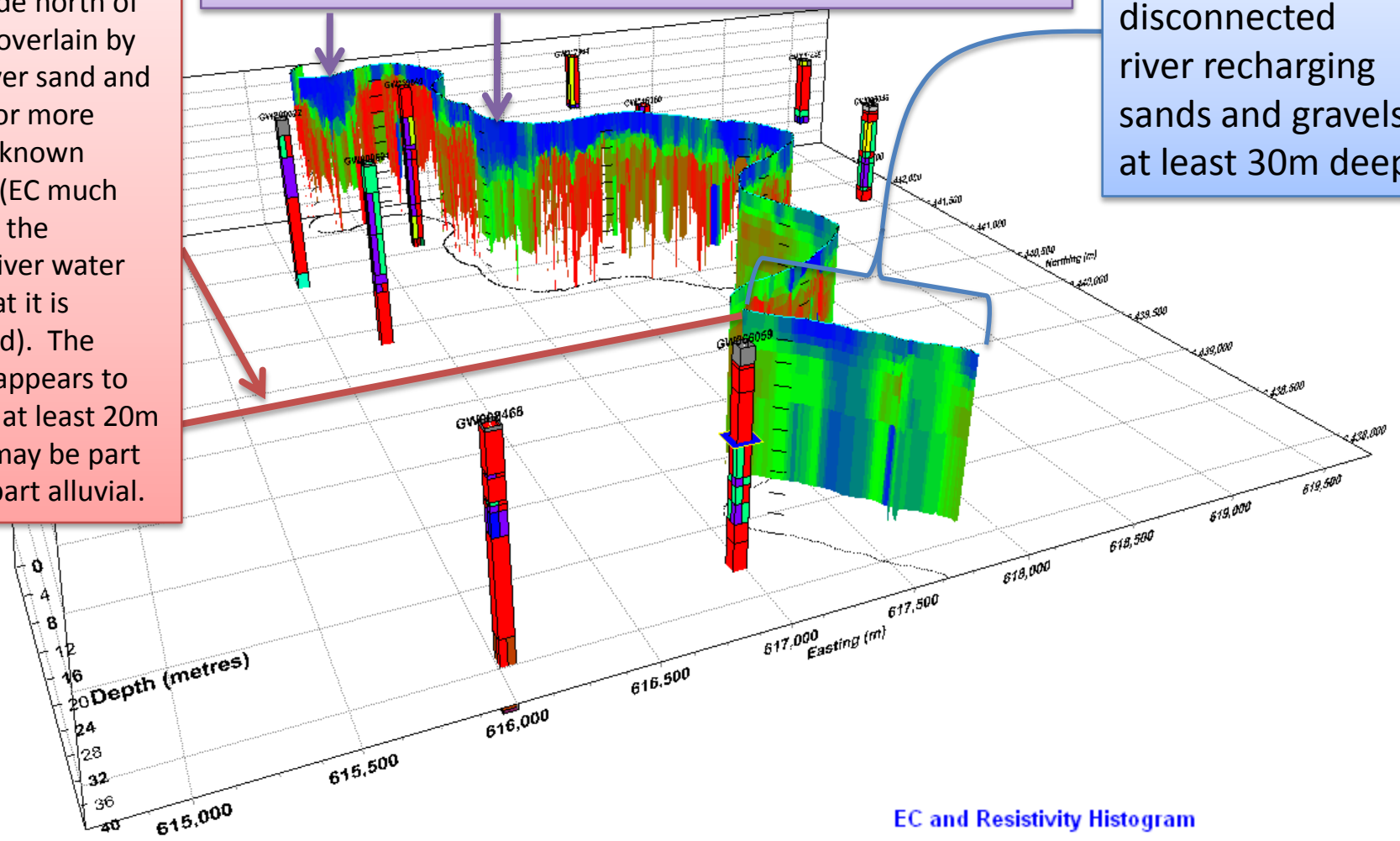
Macquarie River - Turkey Farm Reserve to Macks Reserve.

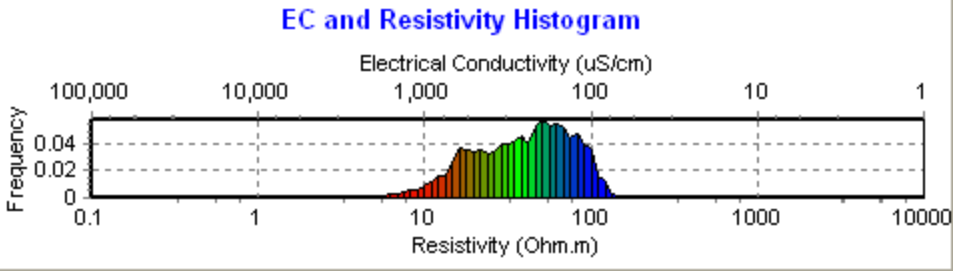
Project: NSW Losing/Disconnected Rivers Investigation
Site: Macquarie River - Turkey Farm Reserve to Macks Reserve Client: NSW DWE
Data Provider: Groundwater Imaging Pty Ltd JobNum: 1
Survey Equipment: RIP924, 100m streamer, sonar and water pH, Temp and EC loggers Survey Date: 1/07/2008

Gravel filled channels (see drill logs) incise clay substrate

Inferred losing/ disconnected river recharging sands and gravels at least 30m deep

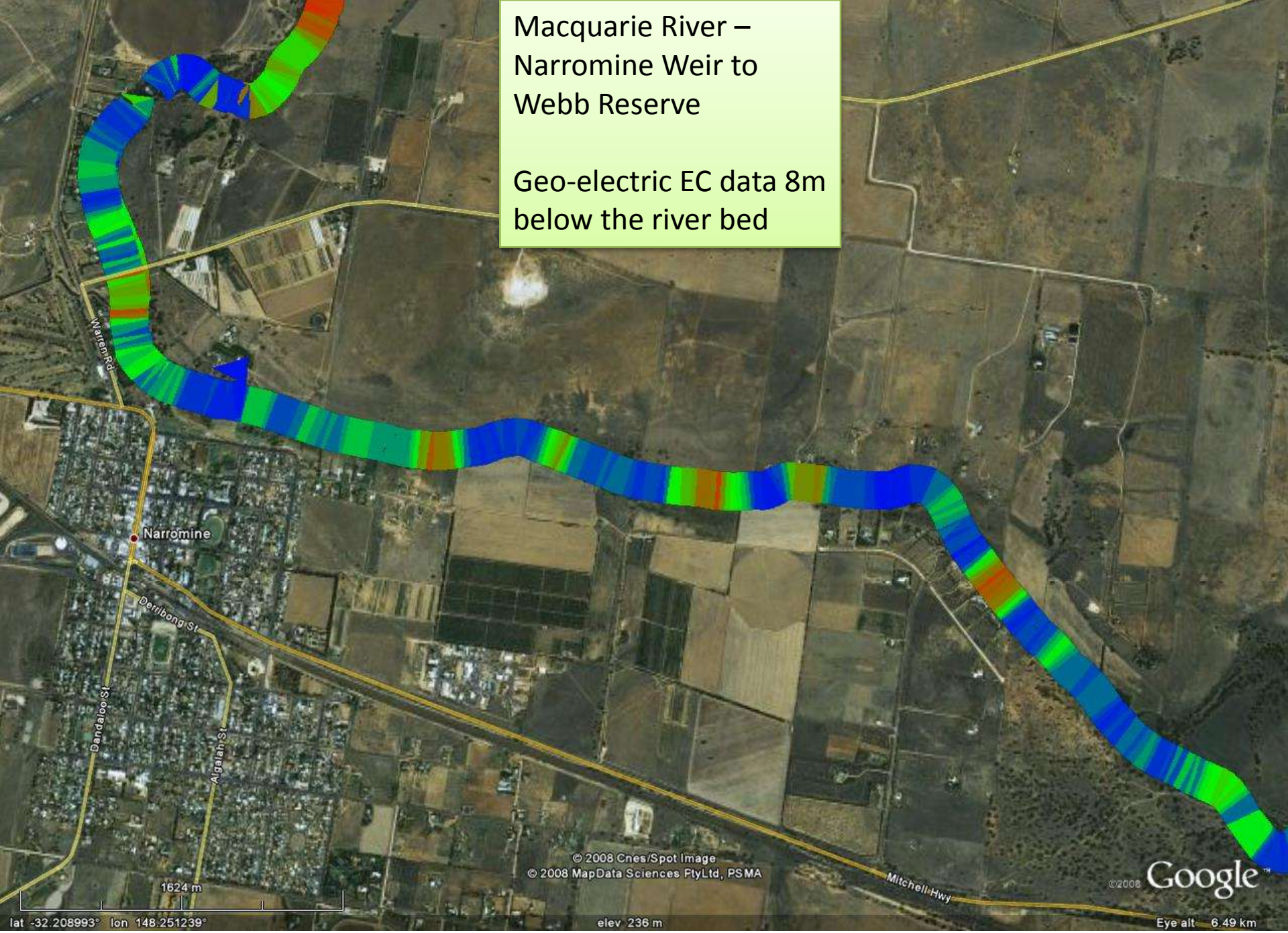
An aquiclude north of this line is overlain by inferred river sand and gravel 4m or more deep of unknown saturation (EC much lower than the overlying river water suggest that it is unsaturated). The aquiclude appears to extends to at least 20m deep and may be part saprolite, part alluvial.





Linear Depth Scale

3. Narromine Weir to Webb Reserve


Macquarie River –
Narromine Weir to
Webb Reserve
Geo-electric EC data 8m
below the river bed
Warren Rd
Narromine
Dertibong St
Dandaloo St
Algalah St
Mitchell Hwy
1624 m
© 2008 Cnes/Spot Image
© 2008 MapData Sciences PtyLtd, PSMA
©2008 Google
lat -32.208993° lon 148.251239°
elev 236 m
Eye alt 6.49 km

Macquarie River – Narromine Weir to Webb Reserve

Project: NSW Losing/Disconnected Rivers Investigation
Site: Macquarie River - Narromine Weir to Webb Reserve Client: NSW DWE
Data Provider: Groundwater Imaging Pty Ltd JobNum: 1
Survey Equipment: RIP924, 100m streamer, sonar and water pH, Temp and EC loggers Survey Date: 3/07/2008

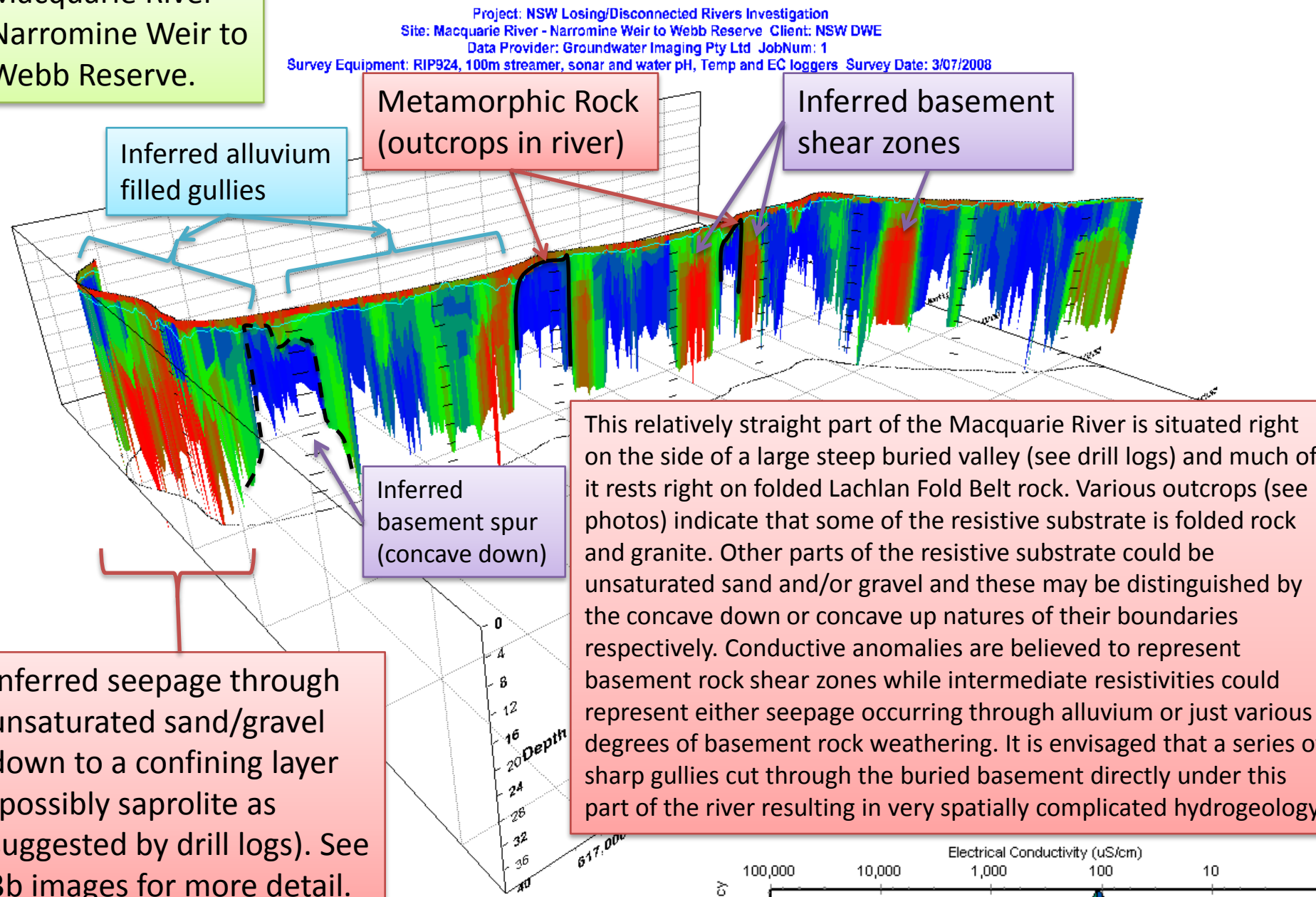
Lachlan Fold Belt Rocks Outcropping in the Macquarie River

EC 8m beneath the river bed

Northing (m)
6,435,500
6,435,000
6,434,500
6,434,000
6,433,500
6,433,000
6,432,500
6,432,000

Easting (m)
616,500
617,000
617,500
618,000
618,500
619,000
619,500
620,000
620,500
621,000
621,500
622,000
622,500

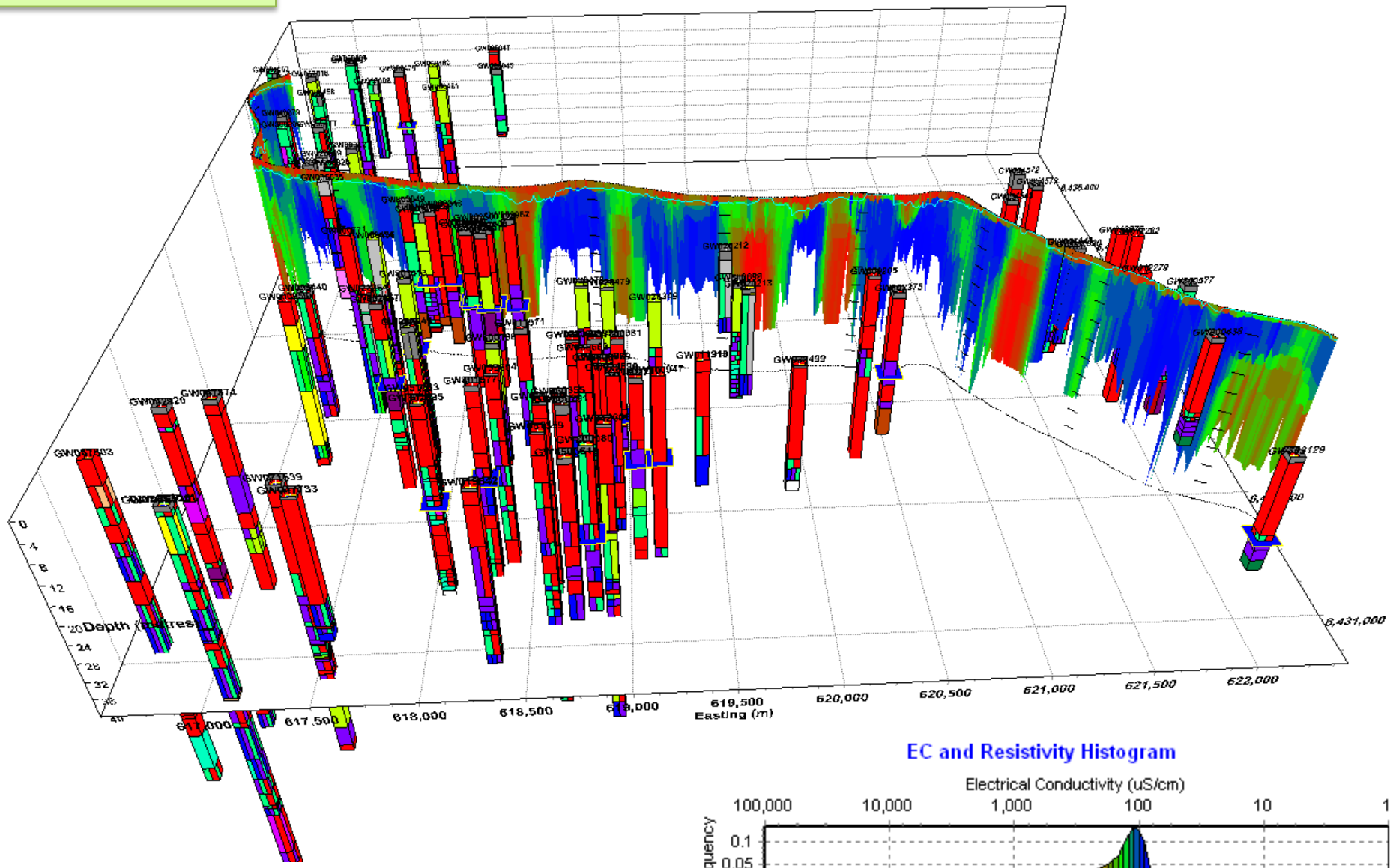
Macquarie River – Narromine Weir to Webb Reserve.



This relatively straight part of the Macquarie River is situated right on the side of a large steep buried valley (see drill logs) and much of it rests right on folded Lachlan Fold Belt rock. Various outcrops (see photos) indicate that some of the resistive substrate is folded rock and granite. Other parts of the resistive substrate could be unsaturated sand and/or gravel and these may be distinguished by the concave down or concave up natures of their boundaries respectively. Conductive anomalies are believed to represent basement rock shear zones while intermediate resistivities could represent either seepage occurring through alluvium or just various degrees of basement rock weathering. It is envisaged that a series of sharp gullies cut through the buried basement directly under this part of the river resulting in very spatially complicated hydrogeology.

Macquarie River – Narromine Weir to Webb Reserve.

Project: NSW Losing/Disconnected Rivers Investigation
Site: Macquarie River - Narromine Weir to Webb Reserve Client: NSW DWE
Data Provider: Groundwater Imaging Pty Ltd JobNum: 1
Survey Equipment: RIP924, 100m streamer, sonar and water pH, Temp and EC loggers Survey Date: 3/07/2008



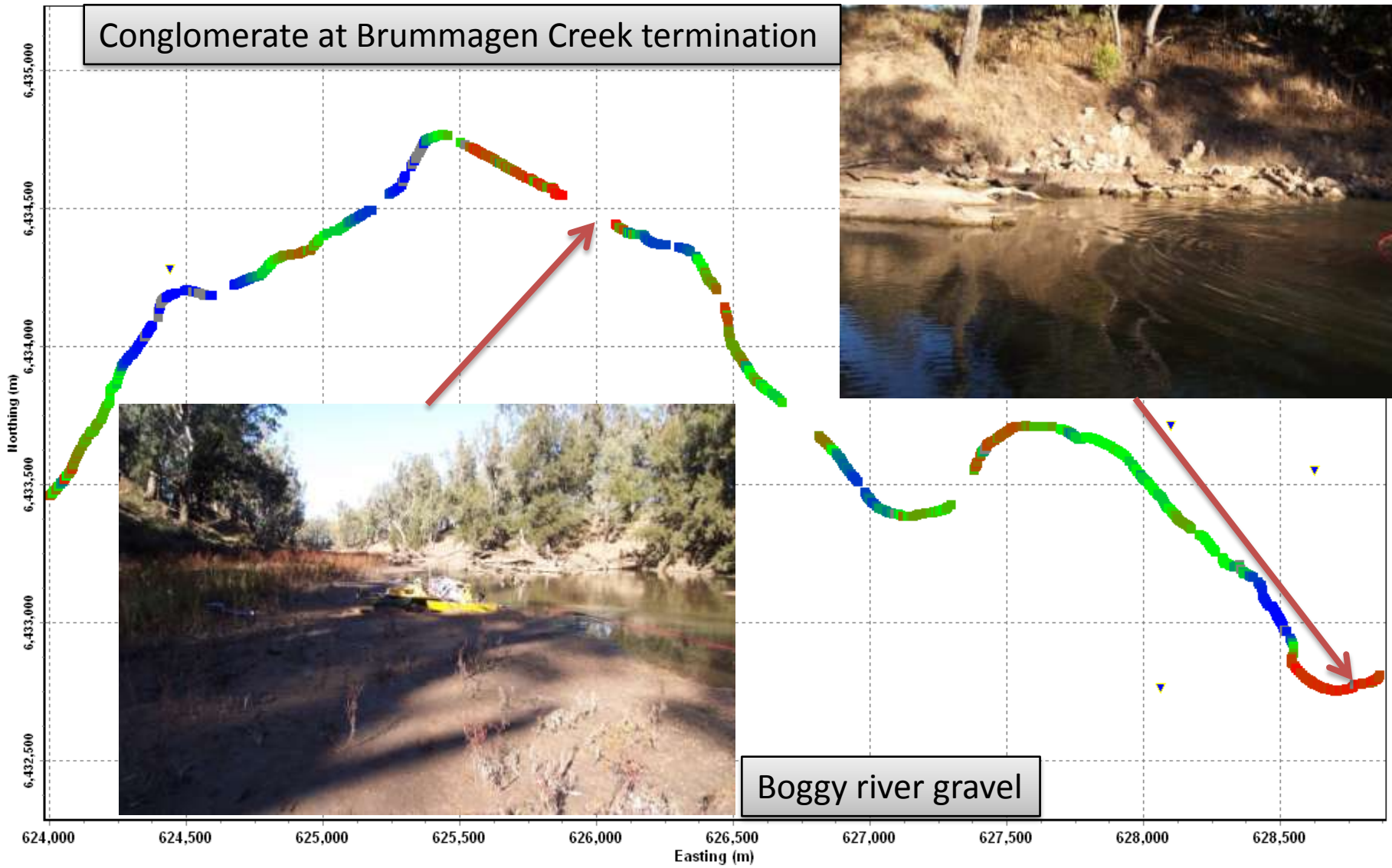
Linear Depth Scale

4. Webb Reserve to Brummagen Creek

Project: NSW Losing/Disconnected Rivers Investigation
Site: Macquarie River - Webb Reserve to Brummagen Creek Client: NSW DWE
Data Provider: Groundwater Imaging Pty Ltd JobNum: 1
Survey Equipment: RIP924, 100m streamer, sonar and water pH, Temp and EC loggers Survey Date: 4/07/2008

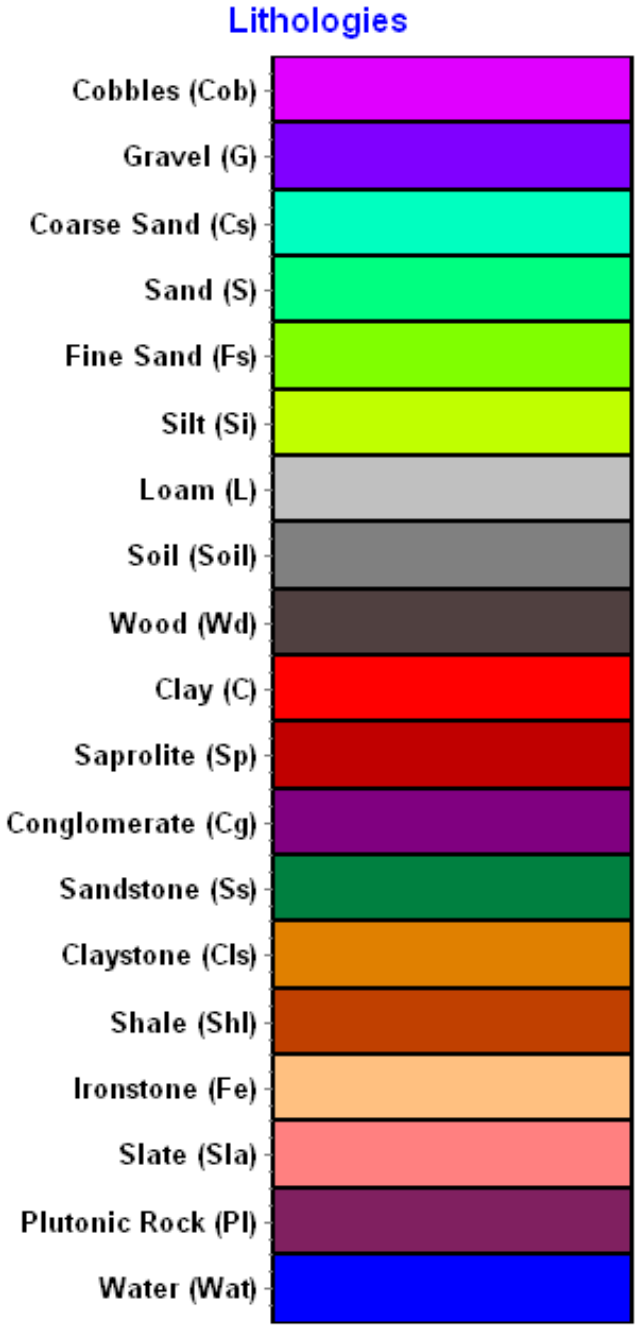
Some granite outcrops in the Macquarie River

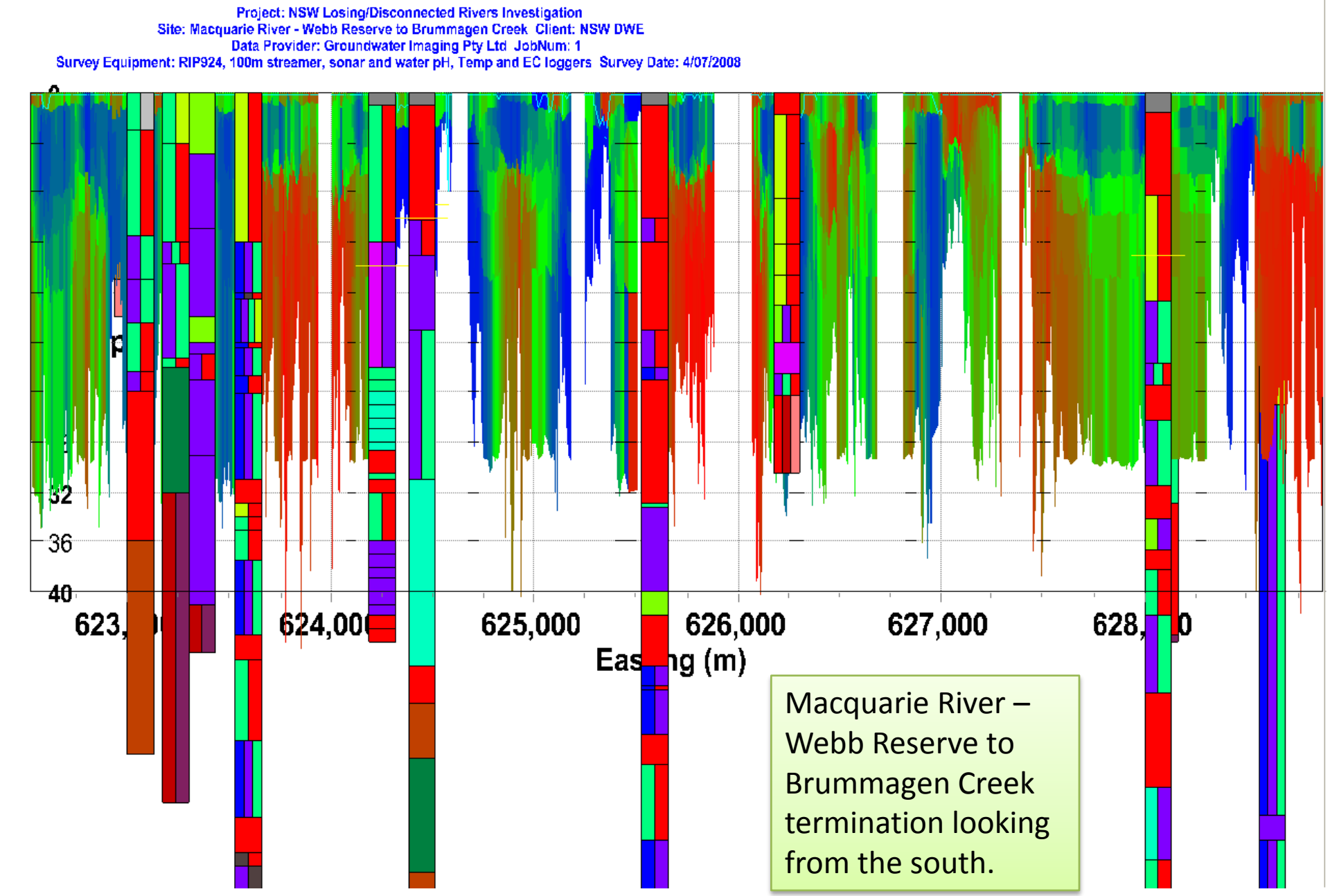
Project: NSW Losing/Disconnected Rivers Investigation
Site: Macquarie River - Webb Reserve to Brummagen Creek Client: NSW DWE
Data Provider: Groundwater Imaging Pty Ltd JobNum: 1
Survey Equipment: RIP924, 100m streamer, sonar and water pH, Temp and EC loggers Survey Date: 4/07/2008



Conglomerate at Brummagen Creek

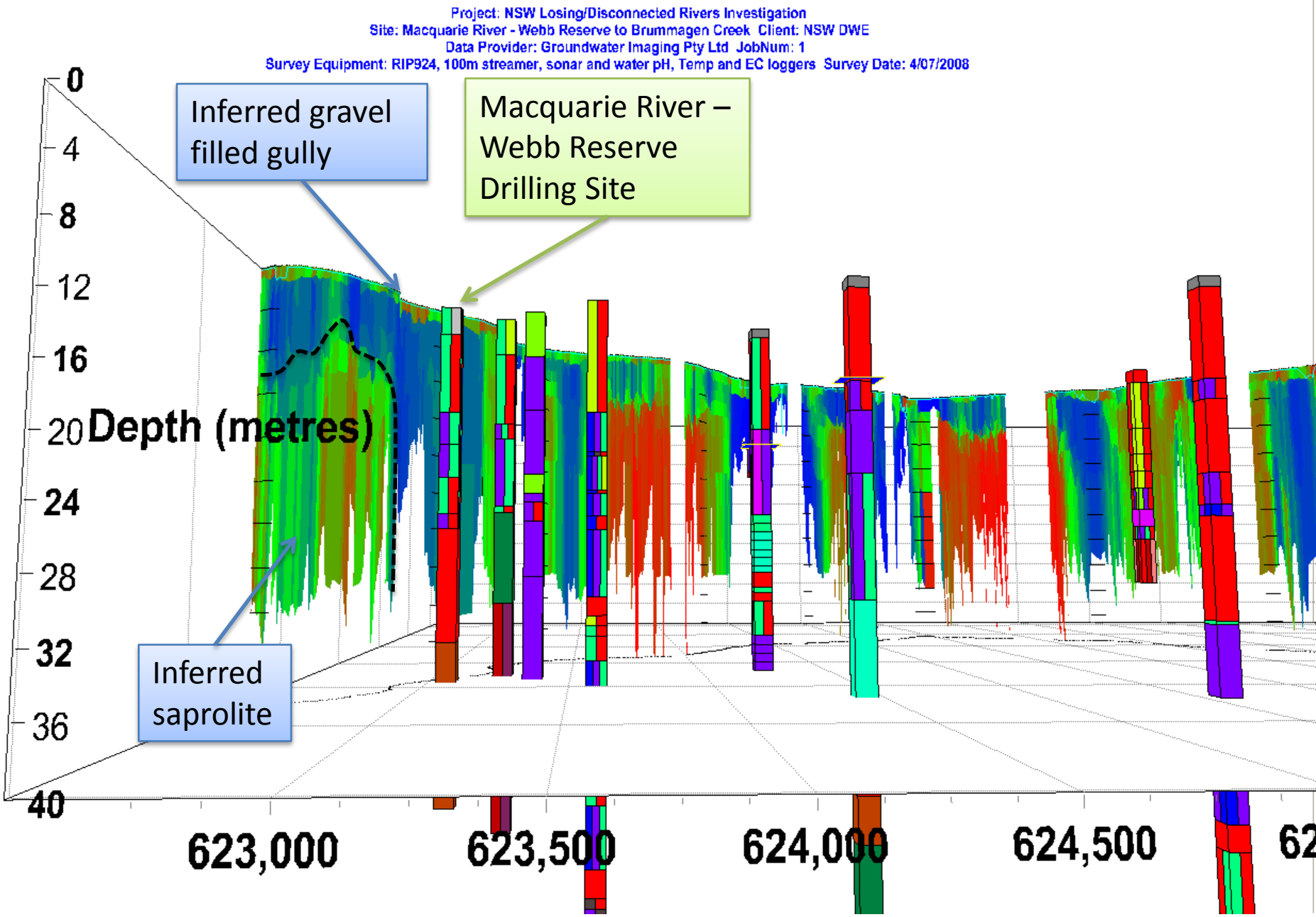
It is suggested that this cobble cementation at Brummagen Creek is the result of mixing of river water with brackish groundwater inflow driven by flow along a fault co-incident with the creek.

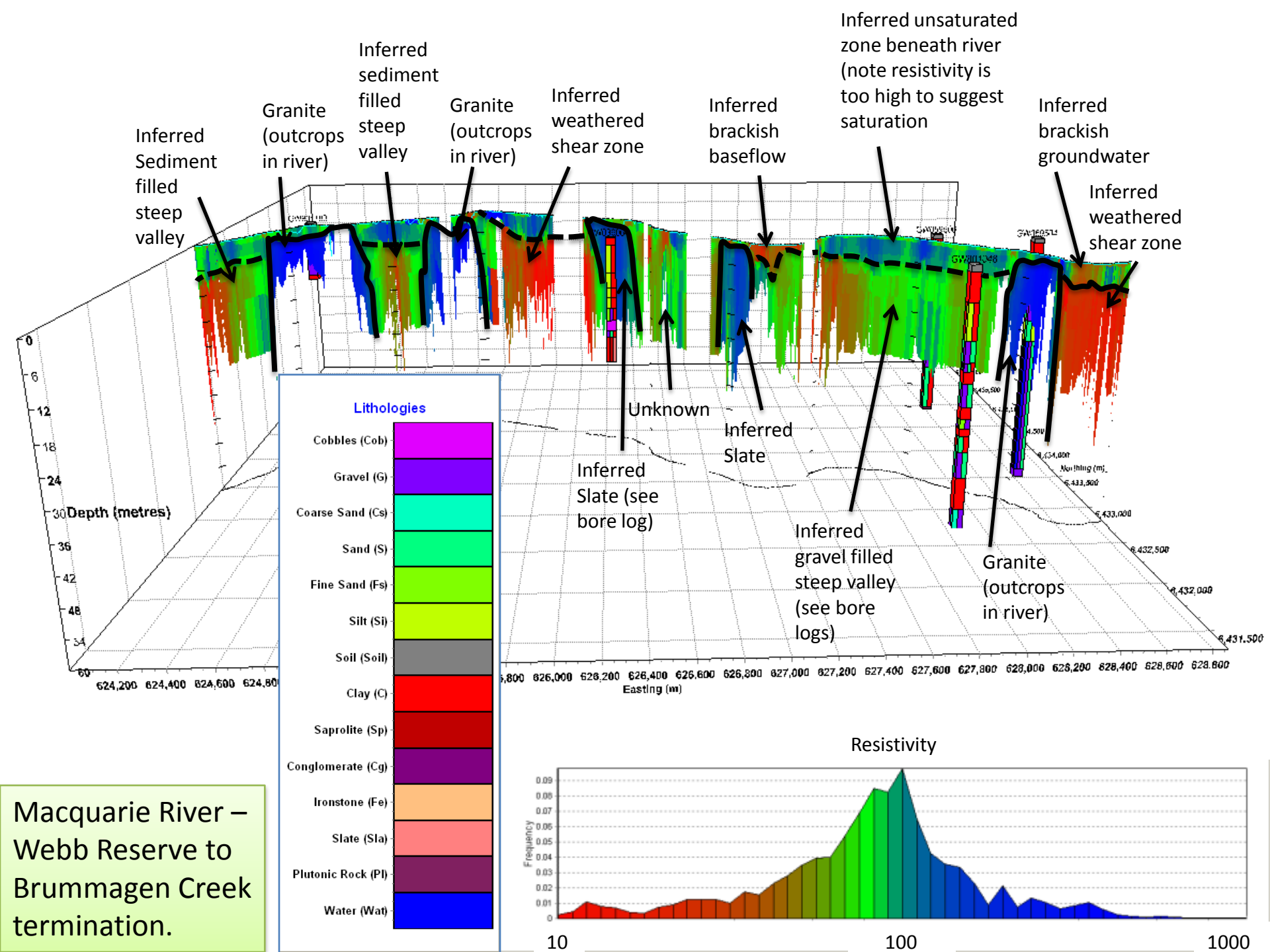




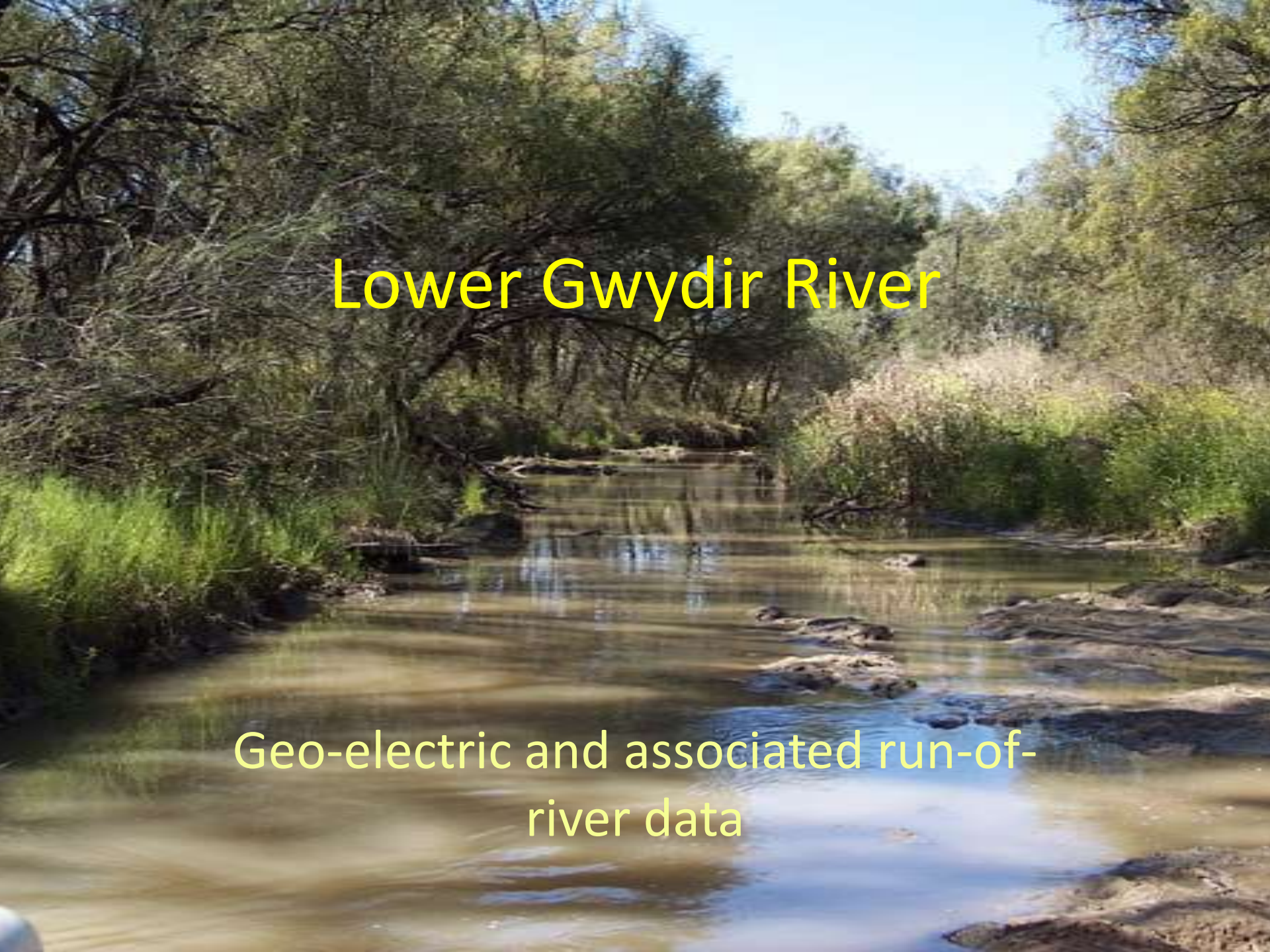
Macquarie River – Webb Reserve to Brummagen Creek termination looking from the south.

Linear Depth Scale

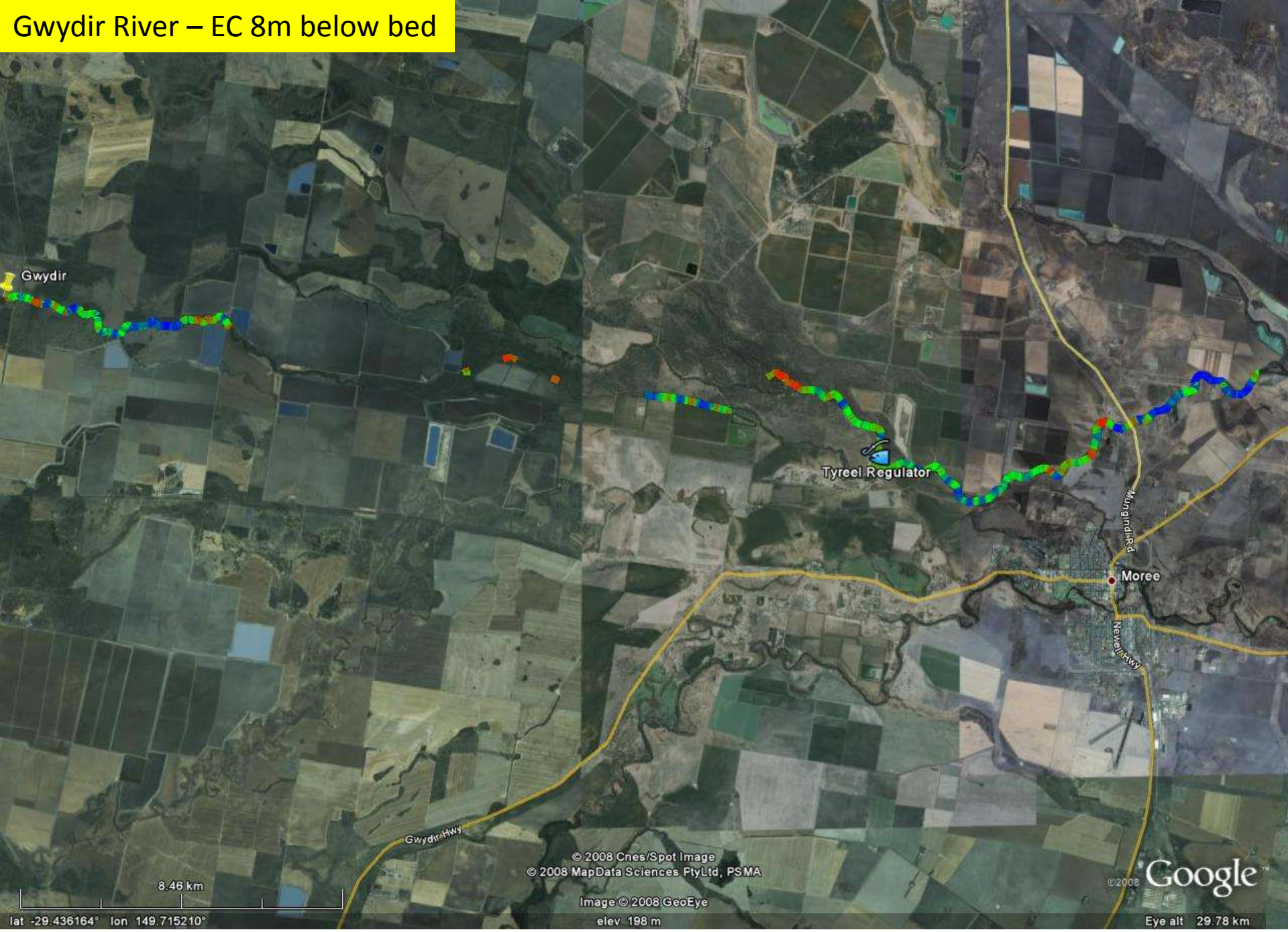

Project: NSW Losing/Disconnected Rivers Investigation
Site: Macquarie River - Webb Reserve to Brummagen Creek Client: NSW DWE
Data Provider: Groundwater Imaging Pty Ltd JobNum: 1
Survey Equipment: RIP924, 100m streamer, sonar and water pH, Temp and EC loggers Survey Date: 4/07/2008
Inferred gravel filled gully
Macquarie River – Webb Reserve Drilling Site
Depth (metres)
0
4
8
12
16
20
24
28
32
36
40
Inferred saprolite
623,000
623,500
624,000
624,500



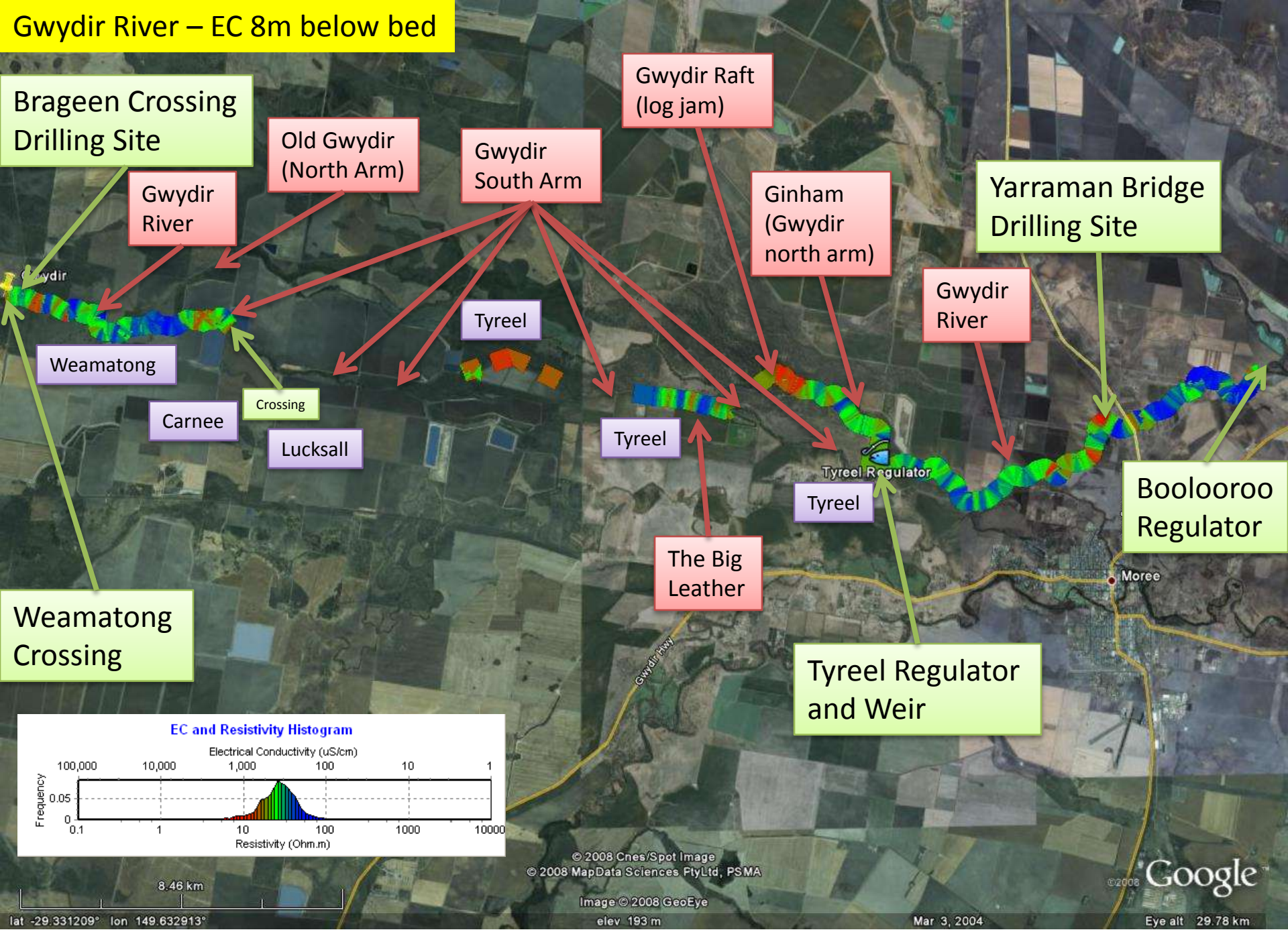
Macquarie River – Webb Reserve to Brummagen Creek termination.


Lower Gwydir River
Geo-electric and associated run-of-river data

Gwydir River – EC 8m below bed

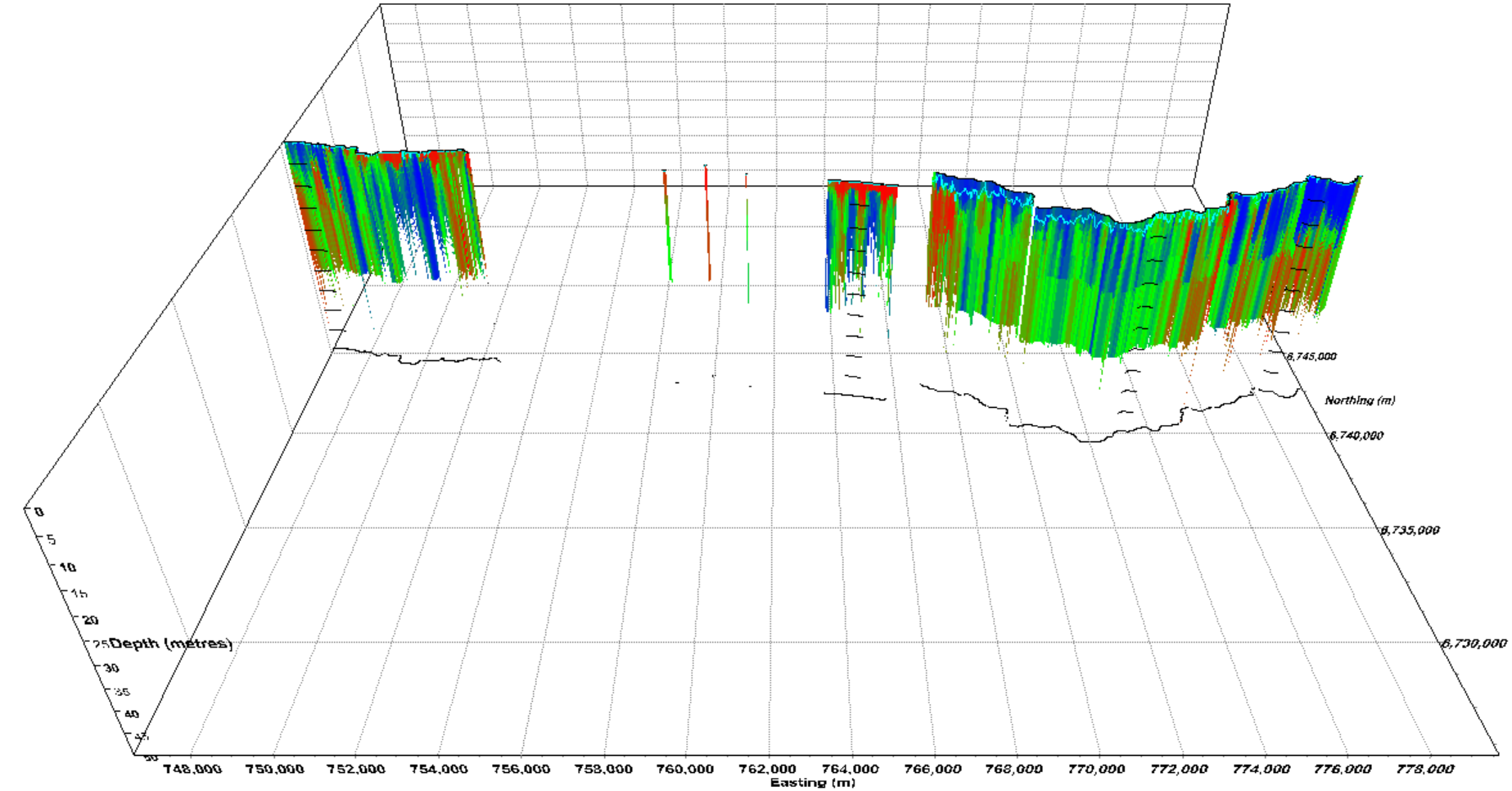


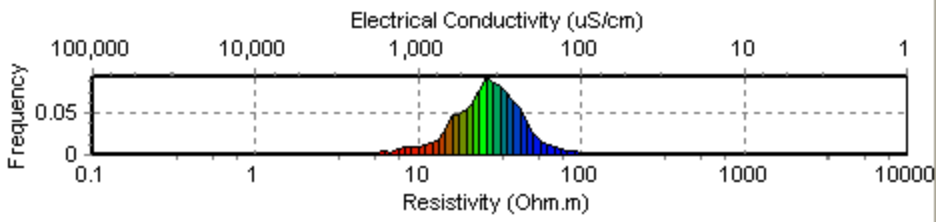
Gwydir River – EC 8m below bed



EC beneath the Lower Gwydir River

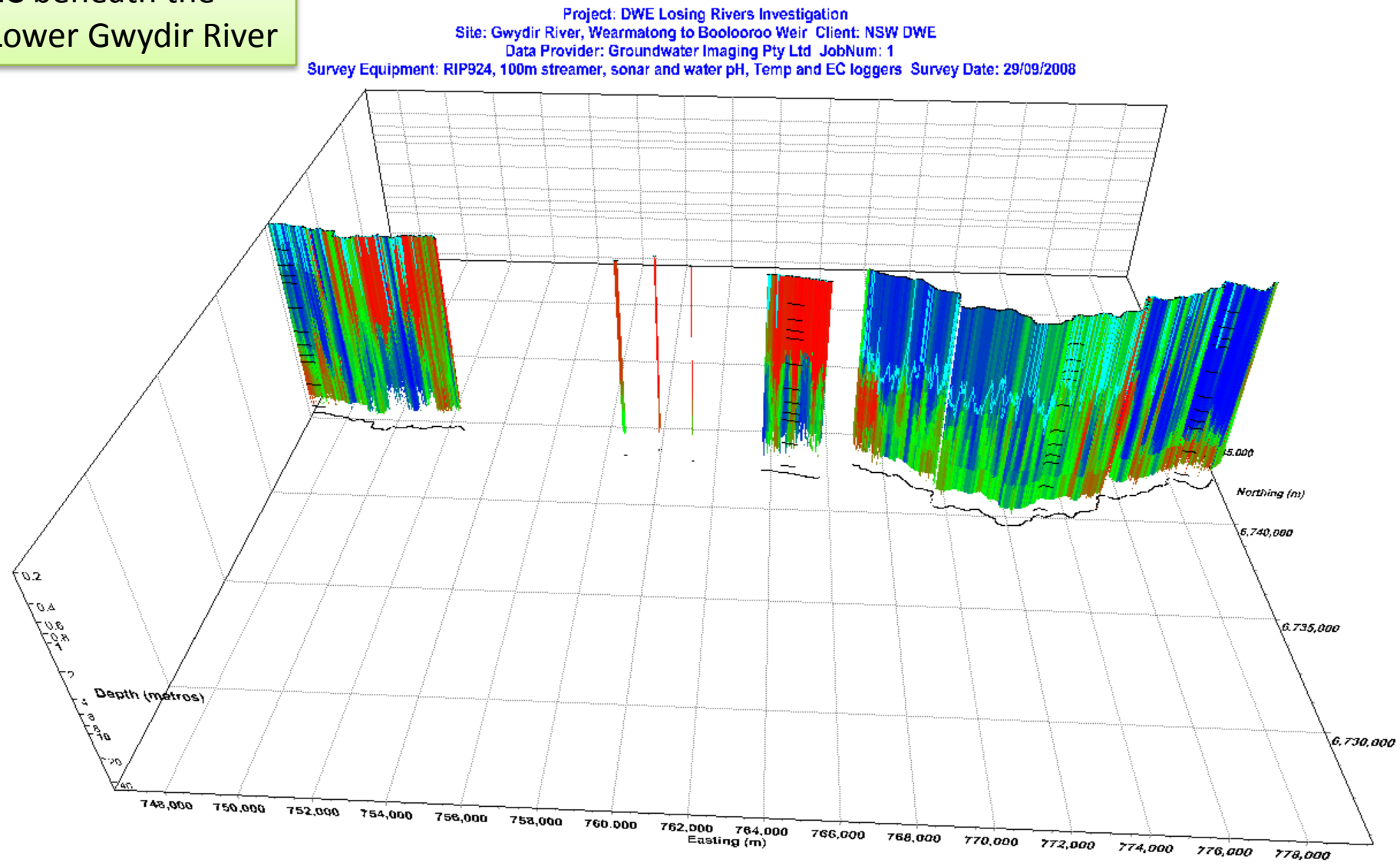
Project: DWE Losing Rivers Investigation
Site: Gwydir River, Wearmatong to Boolooroo Weir Client: NSW DWE
Data Provider: Groundwater Imaging Pty Ltd JobNum: 1
Survey Equipment: RIP924, 100m streamer, sonar and water pH, Temp and EC loggers Survey Date: 29/09/2008

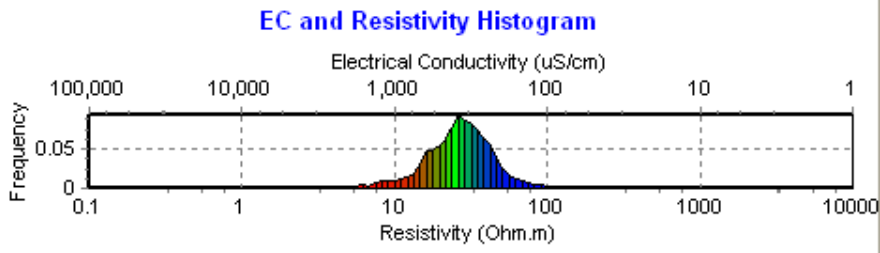




Linear Depth Scale 0 to 50m

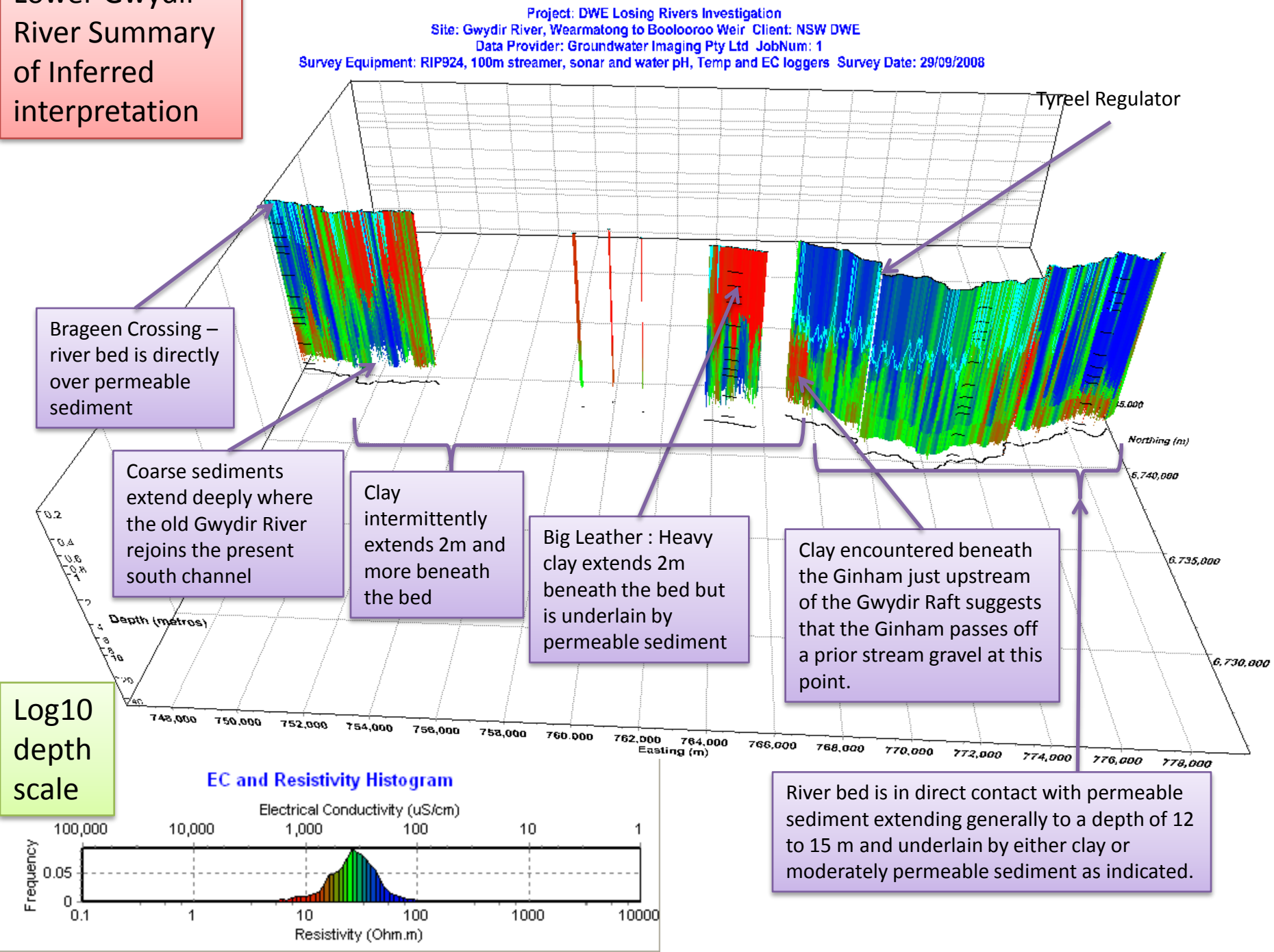
EC beneath the Lower Gwydir River



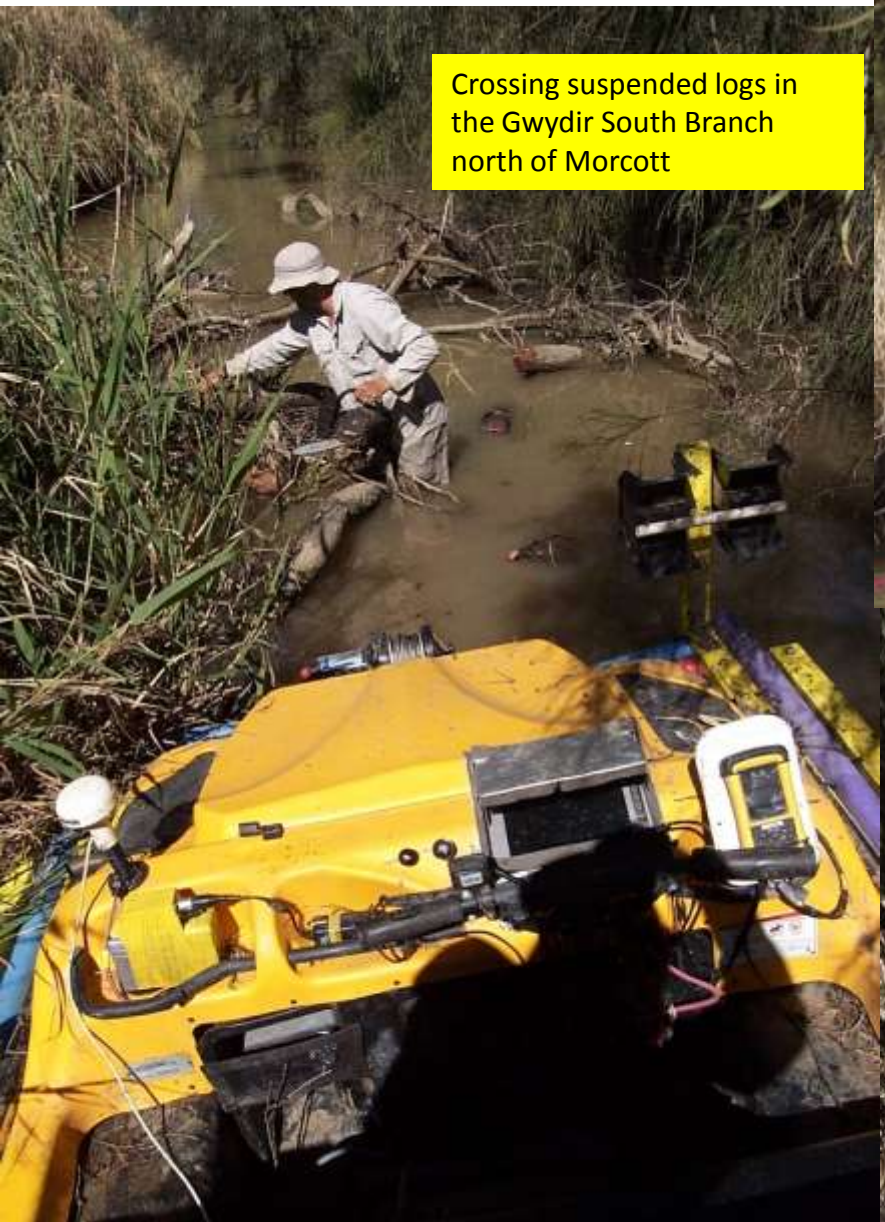


Log10 depth scale 0.2 to 50m

Lower Gwydir River Summary of Inferred interpretation



Gwydir Photos



Crossing suspended logs in the Gwydir South Branch north of Morcott

Gwydir Survey – Yarraman Bridge

Gwydir Survey – Crossing clay bed just downstream of Yarraman Bridge

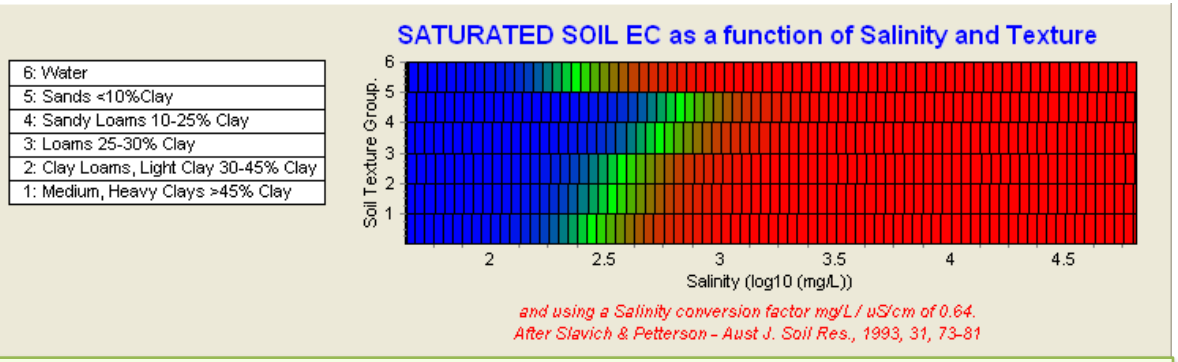
Weamatong Crossing (just downstream of Brageen Crossing)

Upstream of Brageen Crossing

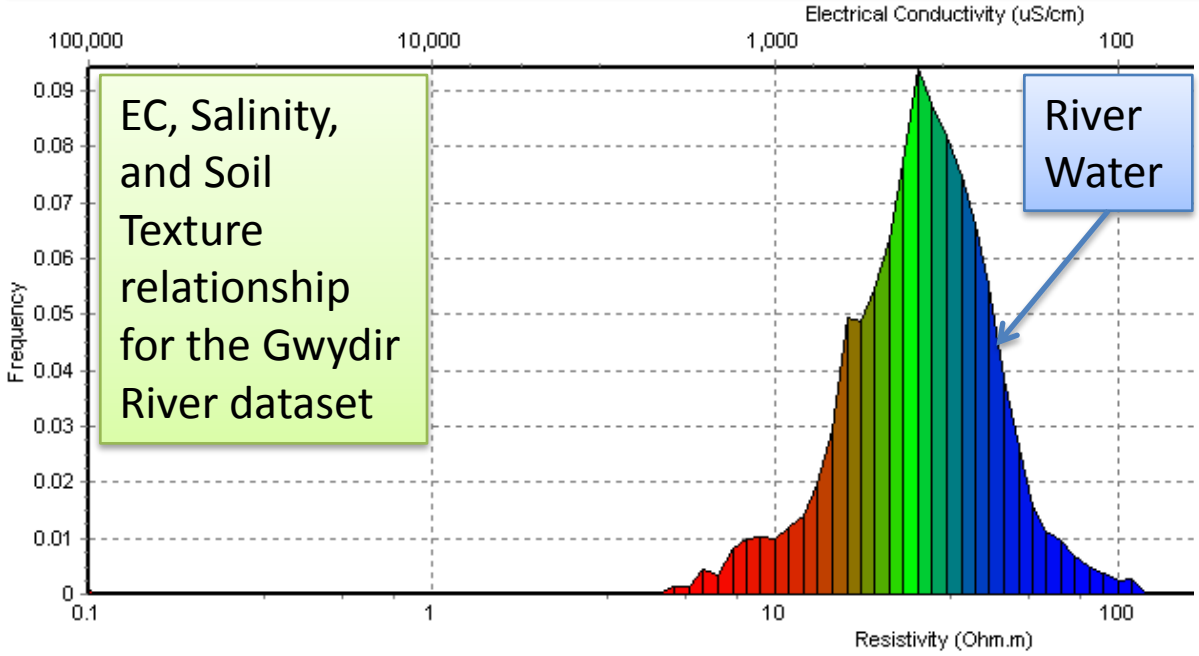
Gwydir south branch –
Tyreel north of Morcott

Gwydir Raft,
the Gingham

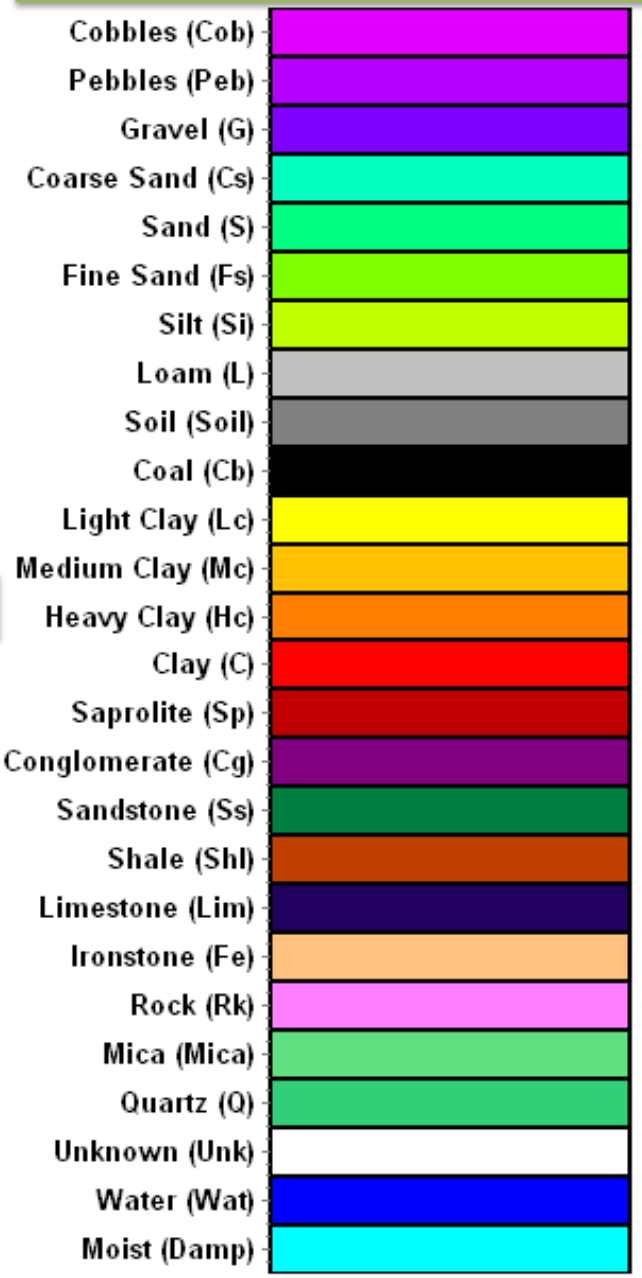
Lower Gwydir Modelled Resistivity Images - Key



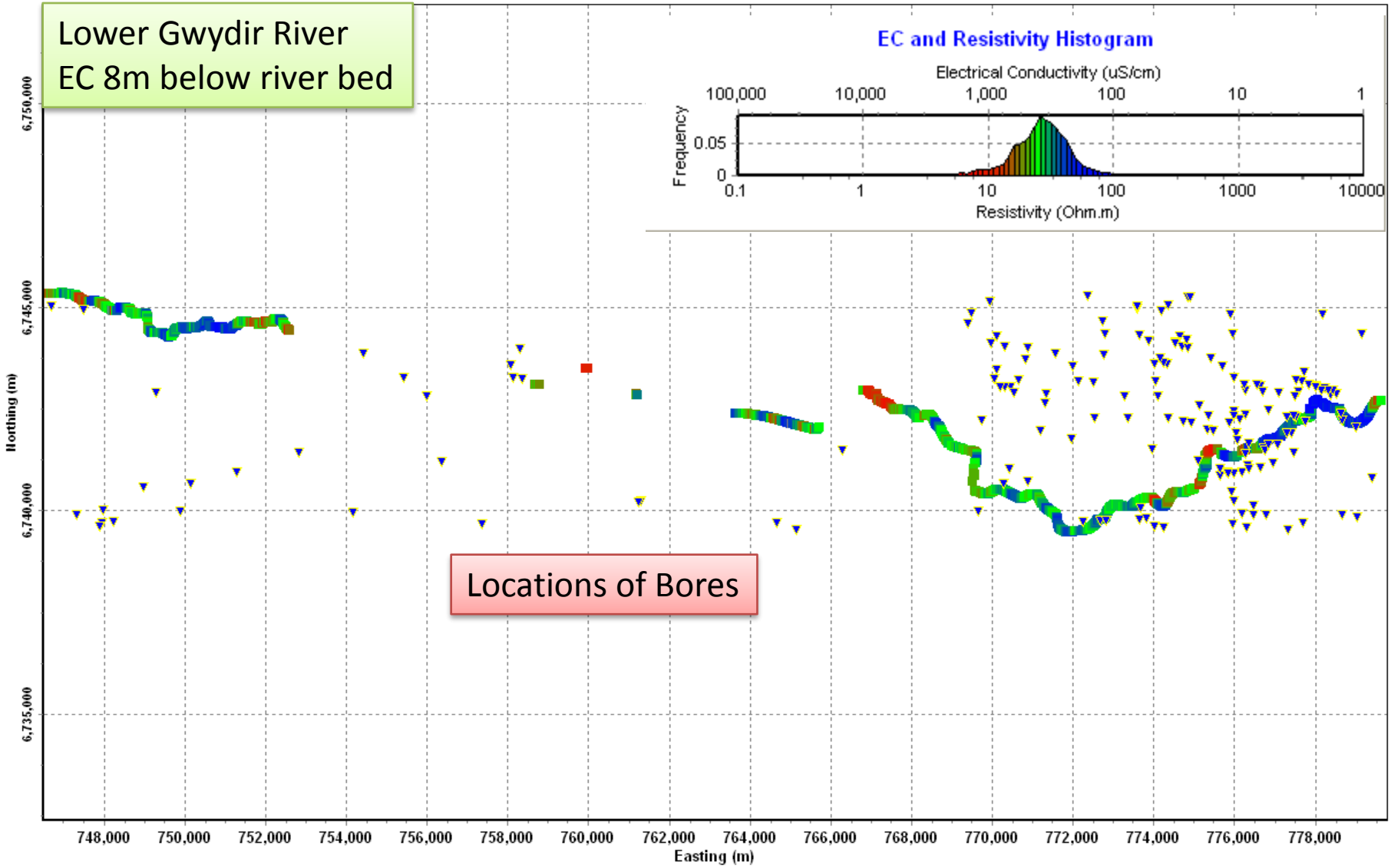
EC histogram and colour stretch for the entire Gwydir River dataset.



Lithologies encountered in drillers logs near the Gwydir River

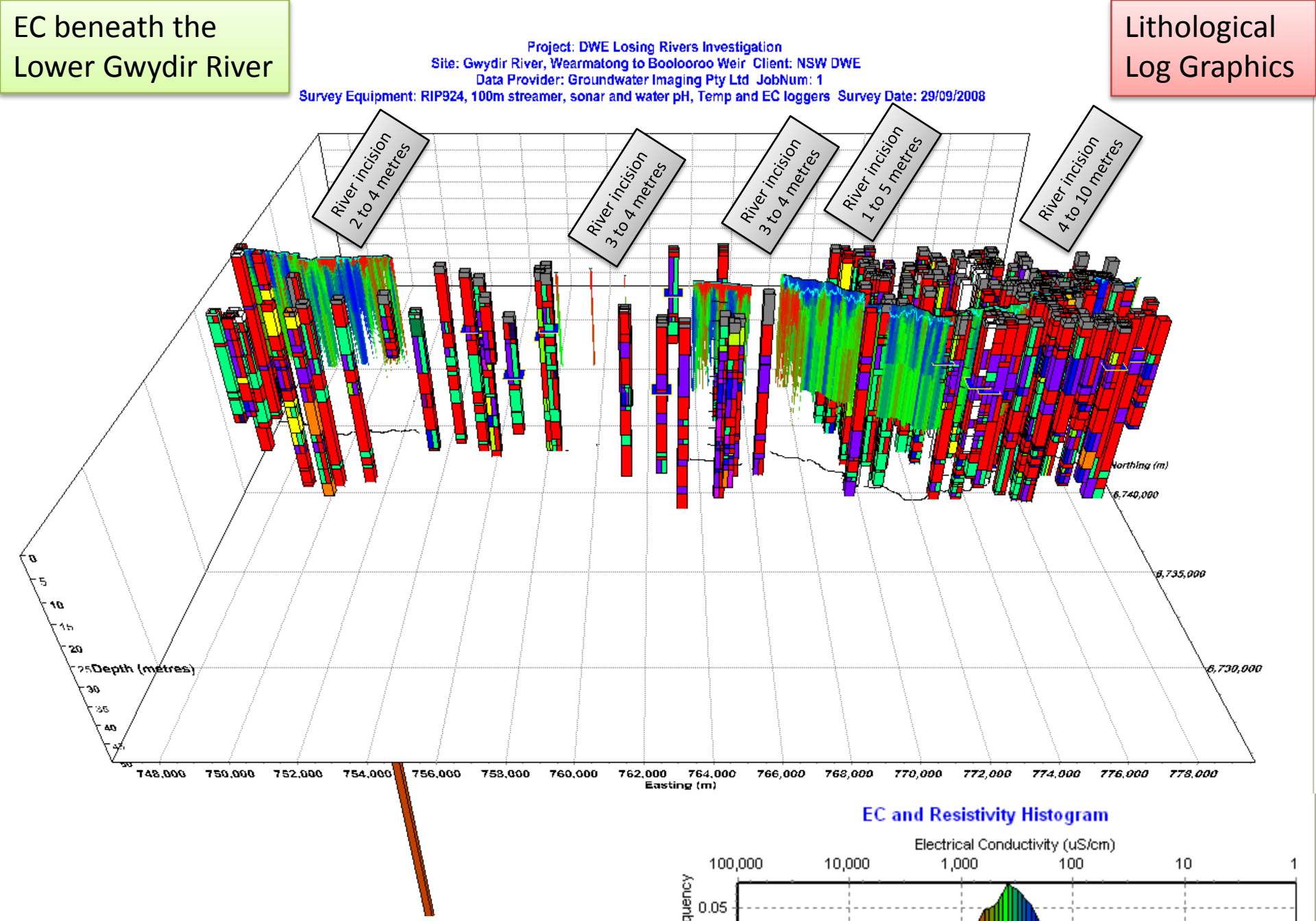


Project: DWE Losing Rivers Investigation
Site: Gwydir River, Wearmatong to Booloroo Weir Client: NSW DWE
Data Provider: Groundwater Imaging Pty Ltd JobNum: 1
Survey Equipment: RIP924, 100m streamer, sonar and water pH, Temp and EC loggers Survey Date: 29/09/2008



EC beneath the Lower Gwydir River

Lithological Log Graphics



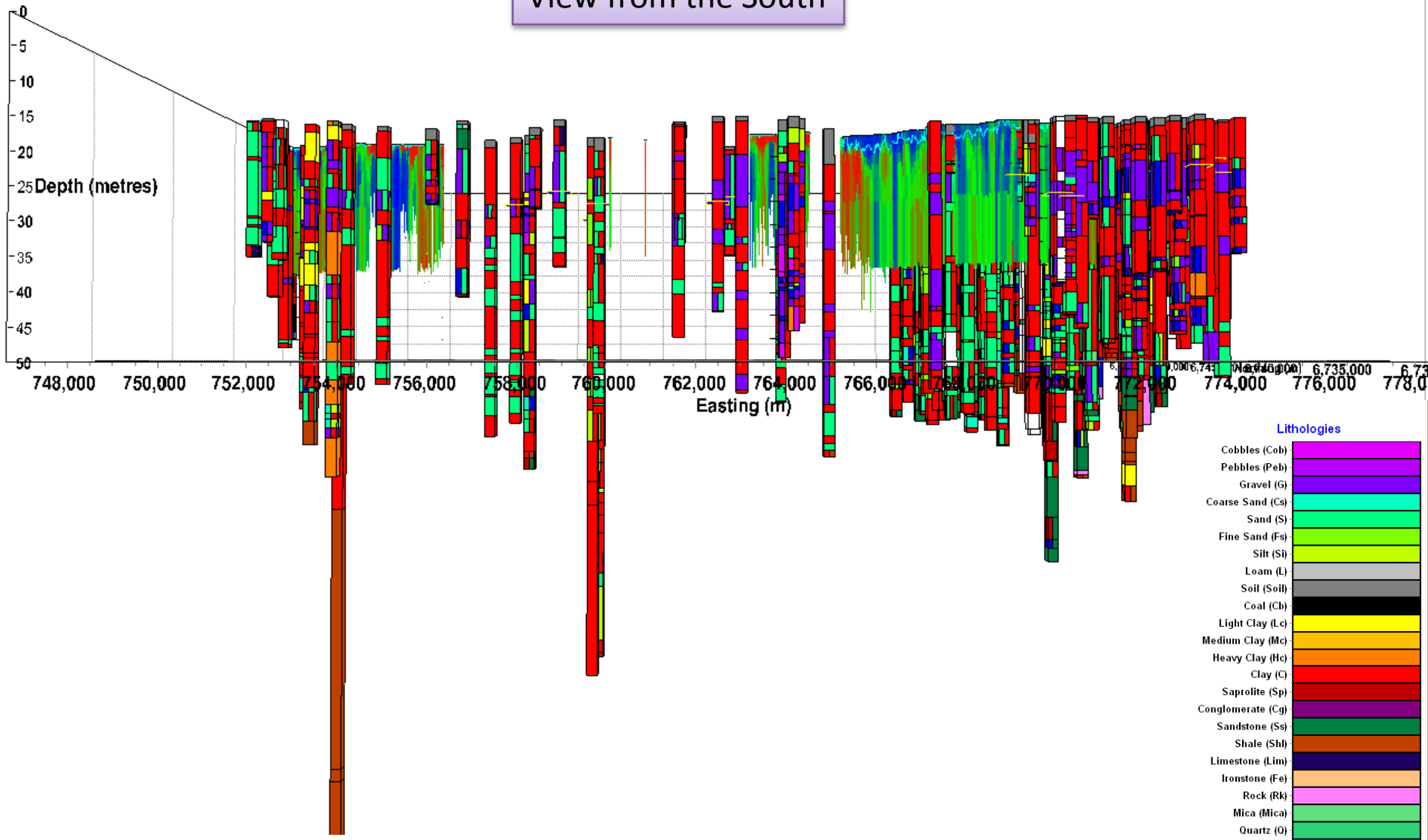
Linear Depth Scale 0 to 50m

EC beneath the Lower Gwydir River

Lithological Log Graphics

Project: DWE Losing Rivers Investigation
Site: Gwydir River, Wearmatong to Booloorоо Weir Client: NSW DWE
Data Provider: Groundwater Imaging Pty Ltd JobNum: 1
Survey Equipment: RIP924, 100m streamer, sonar and water pH, Temp and EC loggers Survey Date: 29/09/2008

View from the South



Linear Depth Scale 0 to 50m

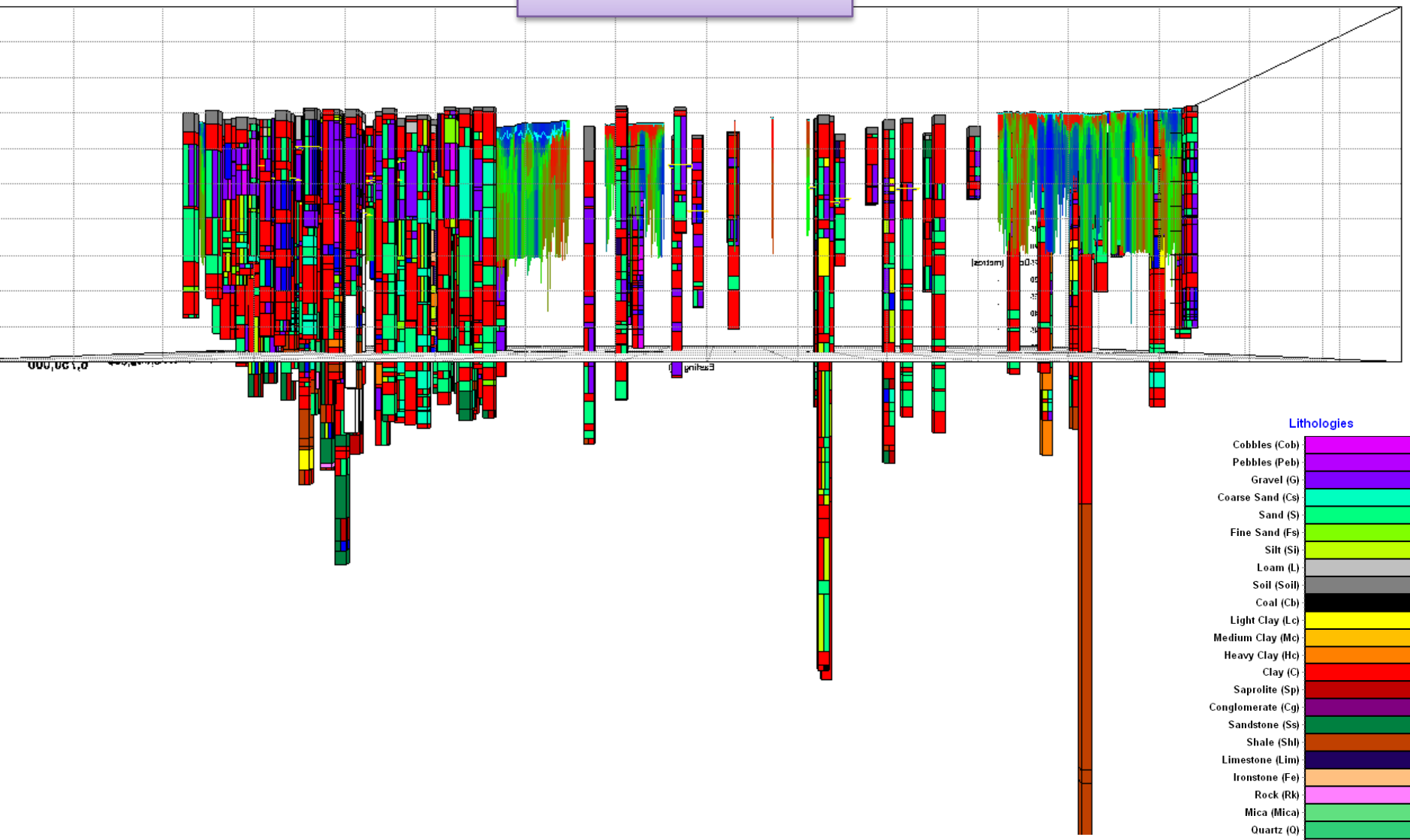
River incision 2 to 10m

EC beneath the Lower Gwydir River

Project: DWE Losing Rivers Investigation
Site: Gwydir River, Wearmatong to Booloorroo Weir Client: NSW DWE
Data Provider: Groundwater Imaging Pty Ltd JobNum: 1
Survey Equipment: RIP924, 100m streamer, sonar and water pH, Temp and EC loggers Survey Date: 29/09/2008

Lithological Log Graphics

View from the North



Lithologies
- Cobbles (Cob)
- Pebbles (Peb)
- Gravel (G)
- Coarse Sand (Cs)
- Sand (S)
- Fine Sand (Fs)
- Silt (Si)
- Loam (L)
- Soil (Soil)
- Coal (Cb)
- Light Clay (Lc)
- Medium Clay (Mc)
- Heavy Clay (Hc)
- Clay (C)
- Saprolite (Sp)
- Conglomerate (Cg)
- Sandstone (Ss)
- Shale (Shl)
- Limestone (Lim)
- Ironstone (Fe)
- Rock (Rk)
- Mica (Mica)
- Quartz (Q)
- Unknown (Unk)
- Water (Wat)
- Moist (Damp)

Linear Depth Scale 0 to 50m

River incision 2 to 10m

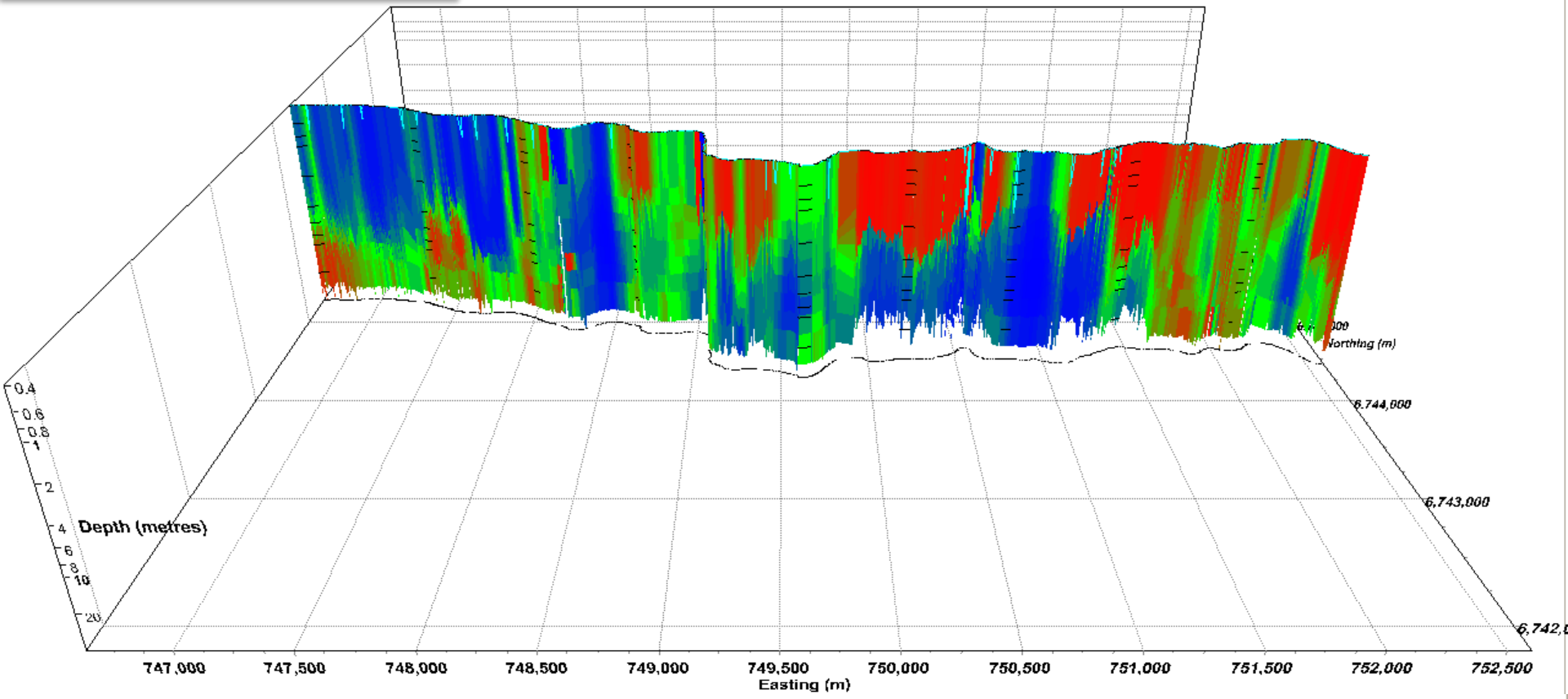
Gwydir River -Weamatong to Carnee

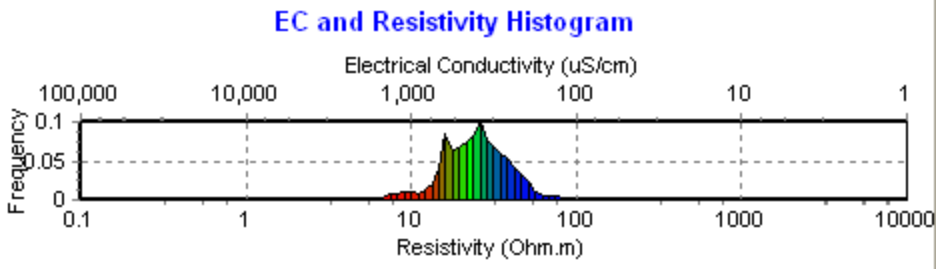
Brageen Crossing

Numerous Yellow and Red Bellied Black Snakes were encountered

Project: DWE Losing Rivers Investigation
Site: Gwydir River, Wearmatong Client: NSW DWE
Data Provider: Groundwater Imaging Pty Ltd JobNum: 1
Survey Equipment: RIP924, 100m streamer, sonar and water pH, Temp and EC loggers Survey Date: 29/09/2008

Gwydir River -Weamatong to Carnee (Morcott)





Log10 Depth Scale

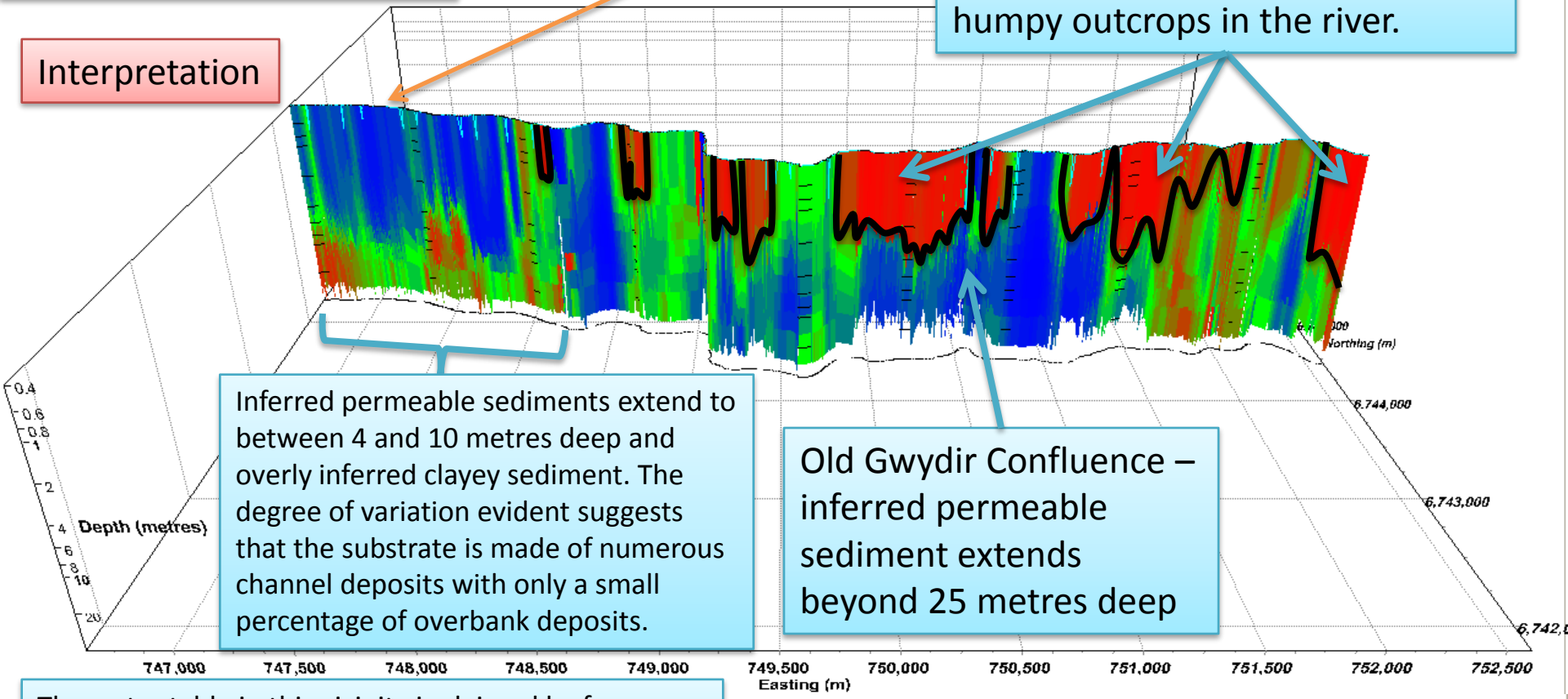
Project: DWE Losing Rivers Investigation
Site: Gwydir River, Wearmatong Client: NSW DWE
Data Provider: Groundwater Imaging Pty Ltd JobNum: 1
Survey Equipment: RIP924, 100m streamer, sonar and water pH, Temp and EC loggers Survey Date: 29/09/2008

Gwydir River -Weamatong to Carnee (Morcott)

Brageen Crossing

An intermittent thin (typically 2m) veneer of heavy clay is evident as humpy outcrops in the river.

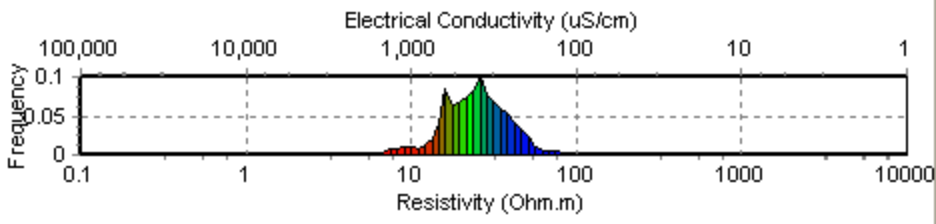
Interpretation



Inferred permeable sediments extend to between 4 and 10 metres deep and overly inferred clayey sediment. The degree of variation evident suggests that the substrate is made of numerous channel deposits with only a small percentage of overbank deposits.

Old Gwydir Confluence – inferred permeable sediment extends beyond 25 metres deep

The water table in this vicinity is claimed by farmers to be beyond the depth of this survey however even the maximum resistivity observed here suggests that sub-river sediment is at least very moist.

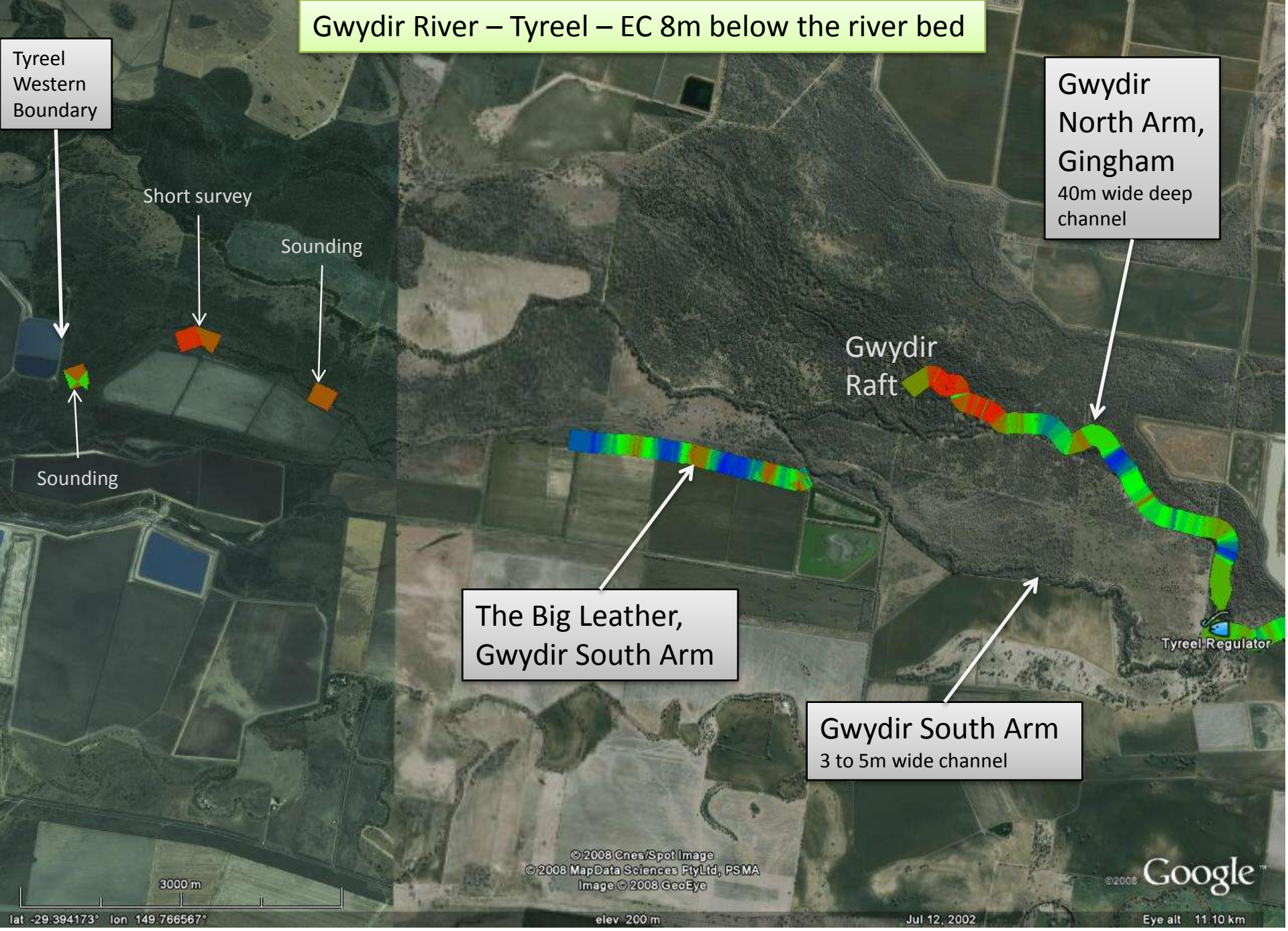


Log10 Depth Scale

Gwydir River - Tyreel

From the Western boundary of Tyreel to the Tyreel Regulator

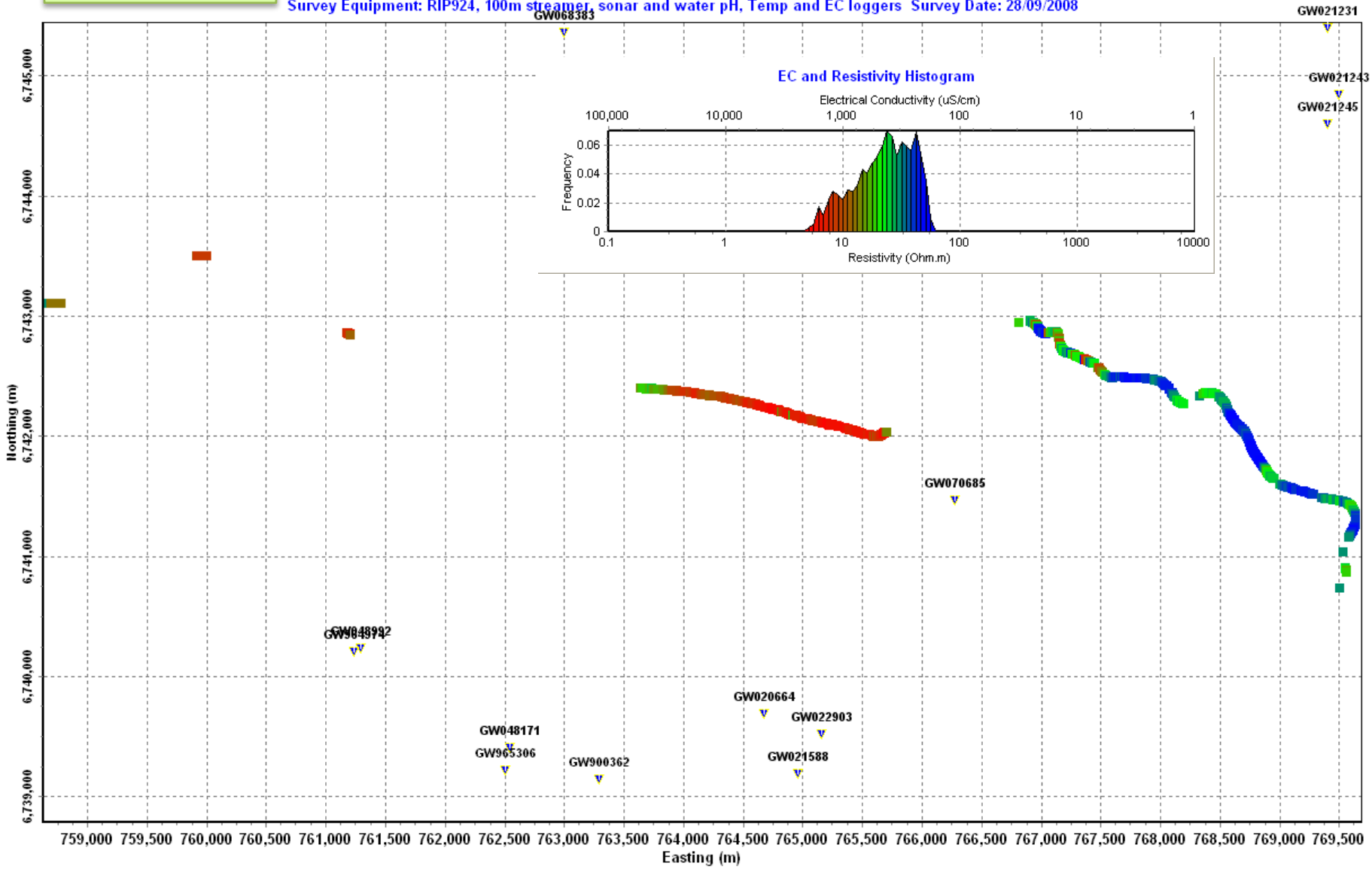
The Gwydir Raft


Gwydir River – Tyreel – EC 8m below the river bed
Tyreel Western Boundary
Short survey
Sounding
Sounding
Gwydir North Arm, Gingham
40m wide deep channel
Gwydir Raft
The Big Leather, Gwydir South Arm
Gwydir South Arm
3 to 5m wide channel
Tyreel Regulator
© 2008 Cnes/Spot Image
© 2008 MapData Sciences PtyLtd, PSMA
Image © 2008 GeoEye
3000 m
©2008 Google
lat -29.394173° lon 149.766567°
elev 200 m
Jul 12, 2002
Eye alt 11.10 km

Gwydir River Tyreel Station

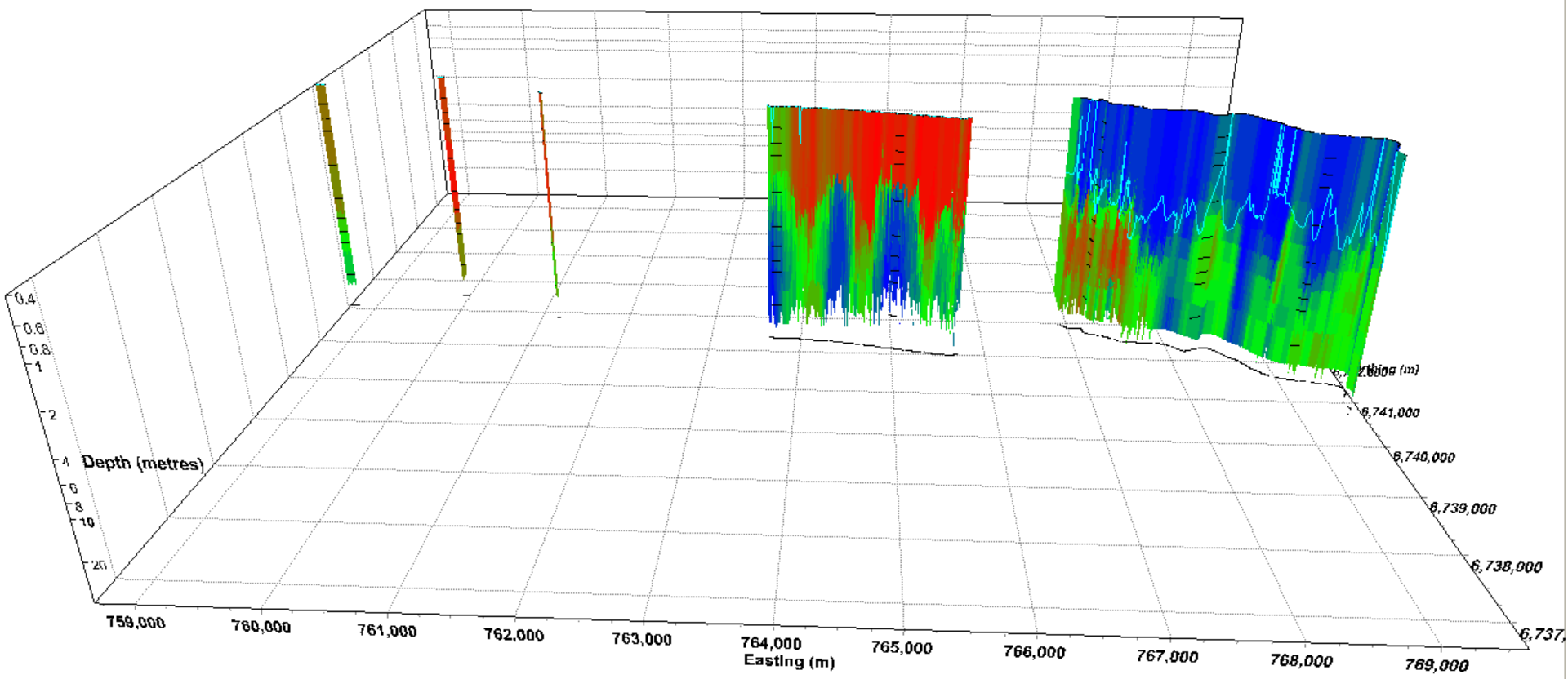
EC 1m below the river bed

Project: DWE Losing Rivers Investigation
Site: Gwydir River, Tyreel Downstream Client: NSW DWE
Data Provider: Groundwater Imaging Pty Ltd JobNum: 1
Survey Equipment: RIP924, 100m streamer, sonar and water pH, Temp and EC loggers Survey Date: 28/09/2008

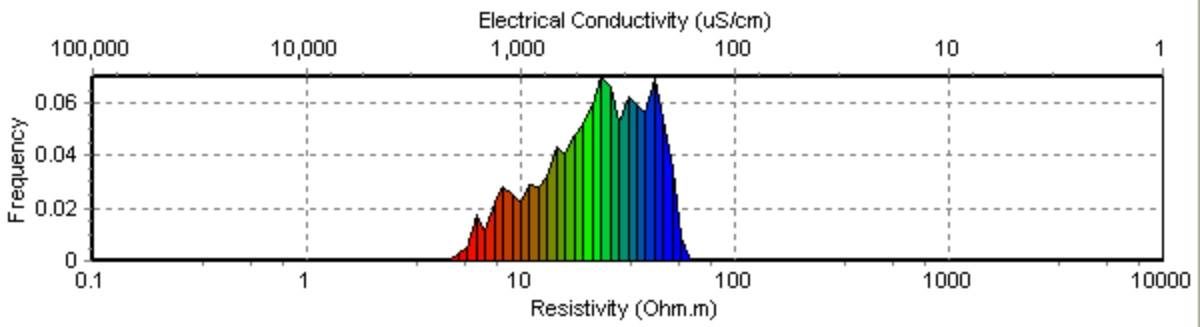


Gwydir River Tyreel Station

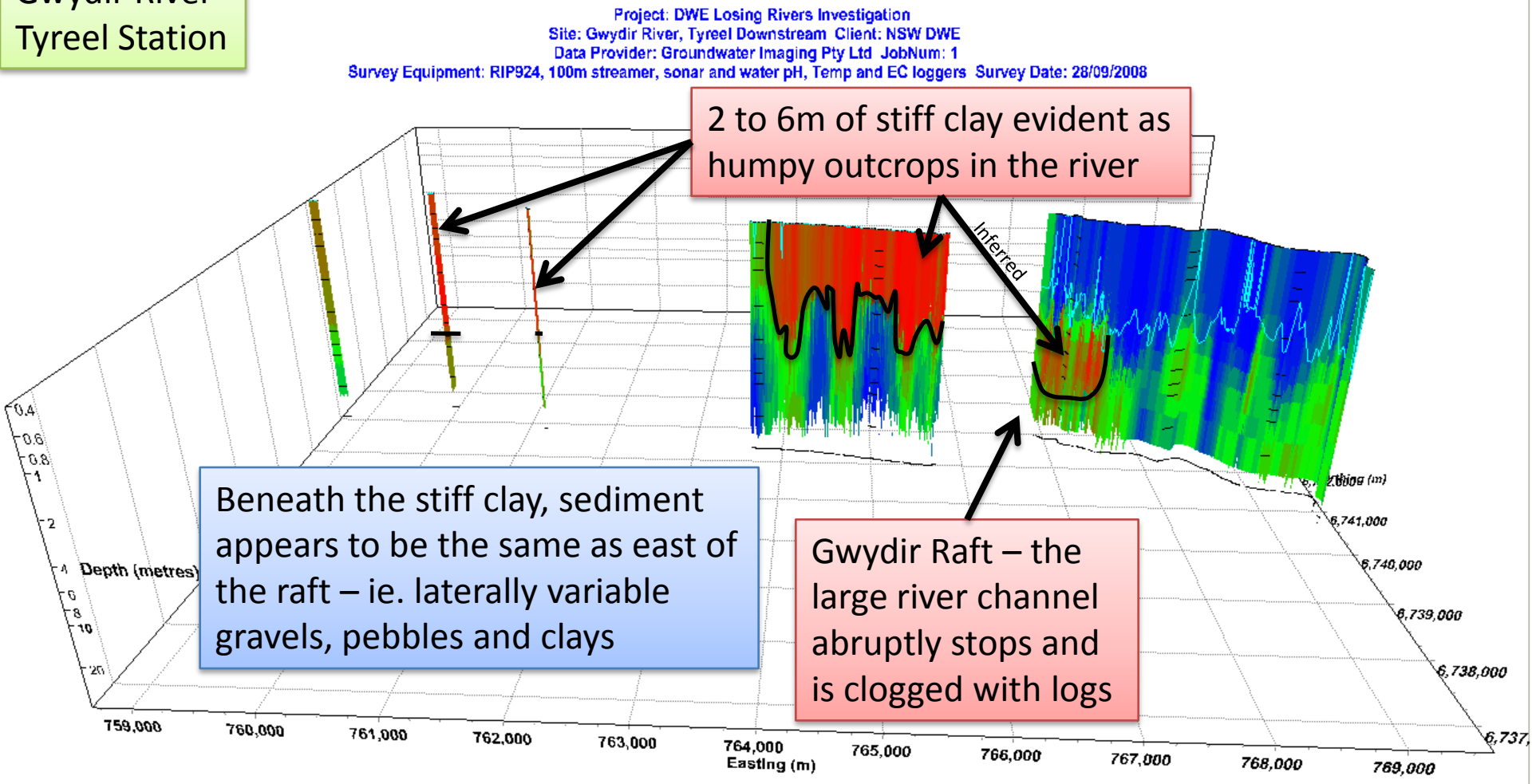
Project: DWE Losing Rivers Investigation
Site: Gwydir River, Tyreel Downstream Client: NSW DWE
Data Provider: Groundwater Imaging Pty Ltd JobNum: 1
Survey Equipment: RIP924, 100m streamer, sonar and water pH, Temp and EC loggers Survey Date: 28/09/2008



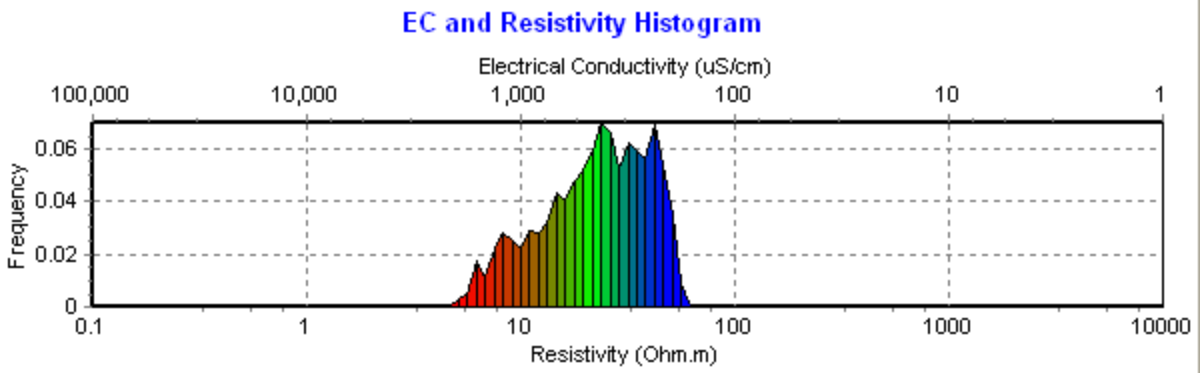
EC and Resistivity Histogram



Gwydir River Tyreel Station



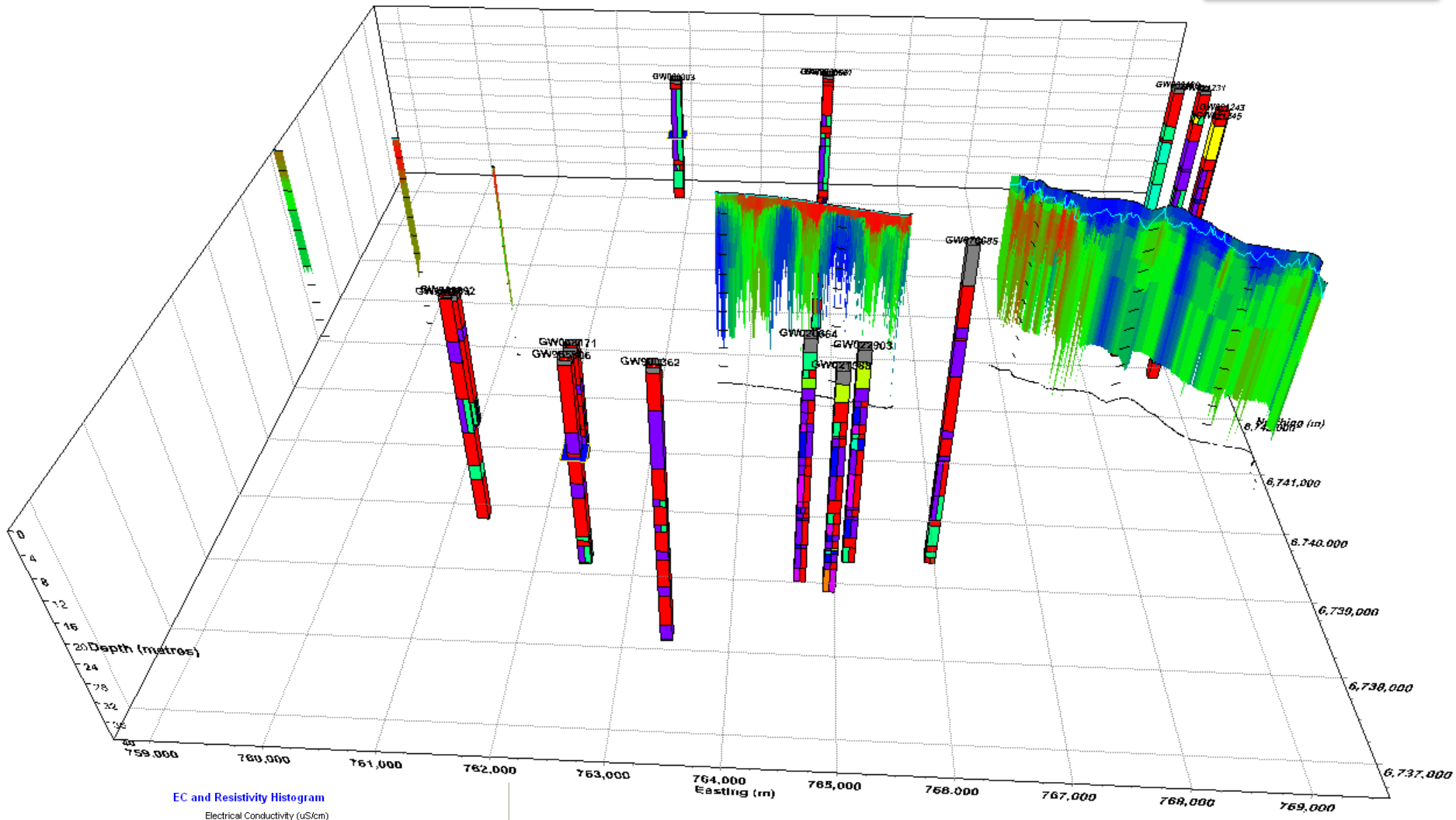
River sourced recharge in this vicinity is inferred to be either very high (through the gravel and pebble rich sediment) or non-existent (through the stiff clay).

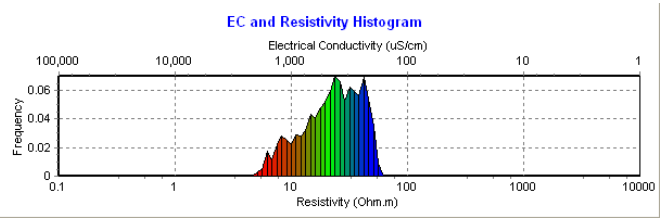


Gwydir River Tyreel Station

Project: DWE Losing Rivers Investigation
Site: Gwydir River, Tyreel Downstream Client: NSW DWE
Data Provider: Groundwater Imaging Pty Ltd JobNum: 1
Survey Equipment: RIP924, 100m streamer, sonar and water pH, Temp and EC loggers Survey Date: 28/09/2008

River incision
1 to 5 metres

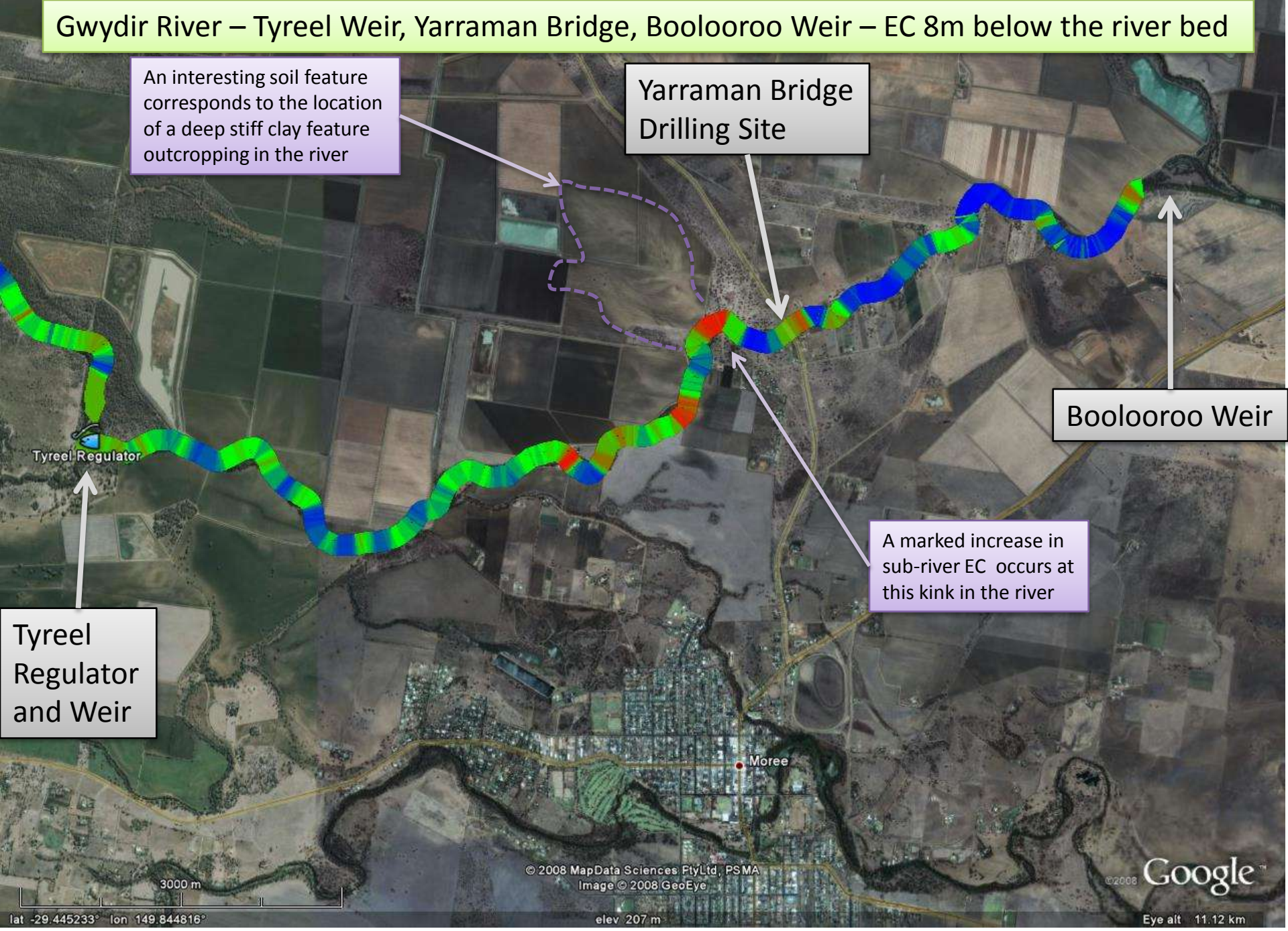




Gwydir River – Tyreel Weir to Boolooroo Weir

Clay obstruction downstream of Yarraman Bridge

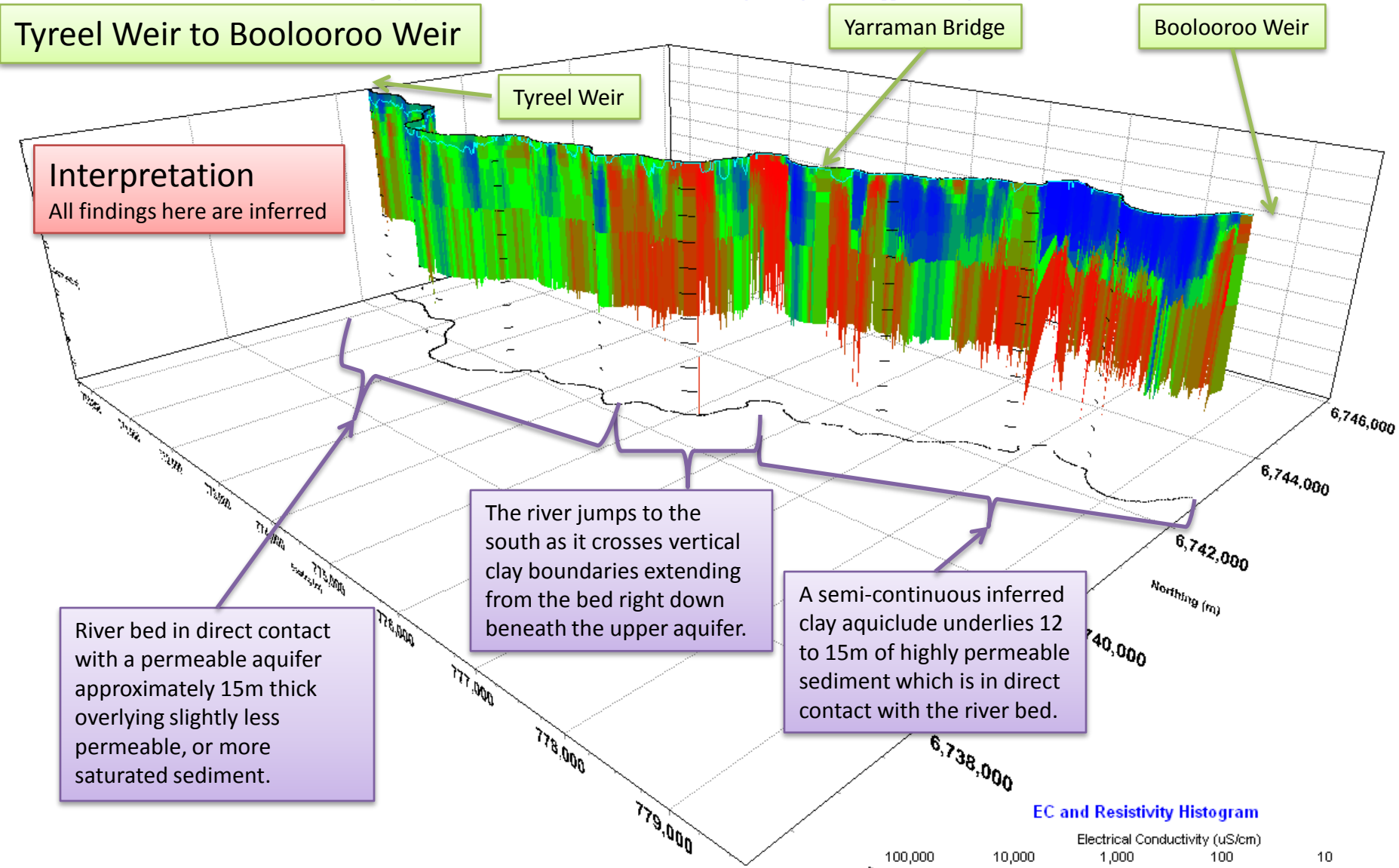
Gwydir River – Tyreel Weir, Yarraman Bridge, Boolooroo Weir – EC 8m below the river bed



Gwydir River

Project: DWE Losing Rivers Investigation
Site: Gwydir River, Tyreel to Boolooroo Client: NSW DWE
Data Provider: Groundwater Imaging Pty Ltd JobNum: 1
Survey Equipment: RIP924, 100m streamer, sonar and water pH, Temp and EC loggers Survey Date: 27/09/2008

Tyreel Weir to Boolooroo Weir



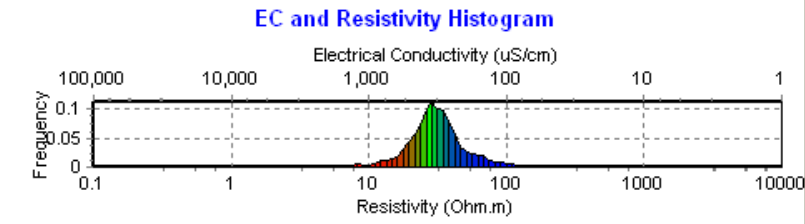
Interpretation

All findings here are inferred

River bed in direct contact with a permeable aquifer approximately 15m thick overlying slightly less permeable, or more saturated sediment.

The river jumps to the south as it crosses vertical clay boundaries extending from the bed right down beneath the upper aquifer.

A semi-continuous inferred clay aquiclude underlies 12 to 15m of highly permeable sediment which is in direct contact with the river bed.



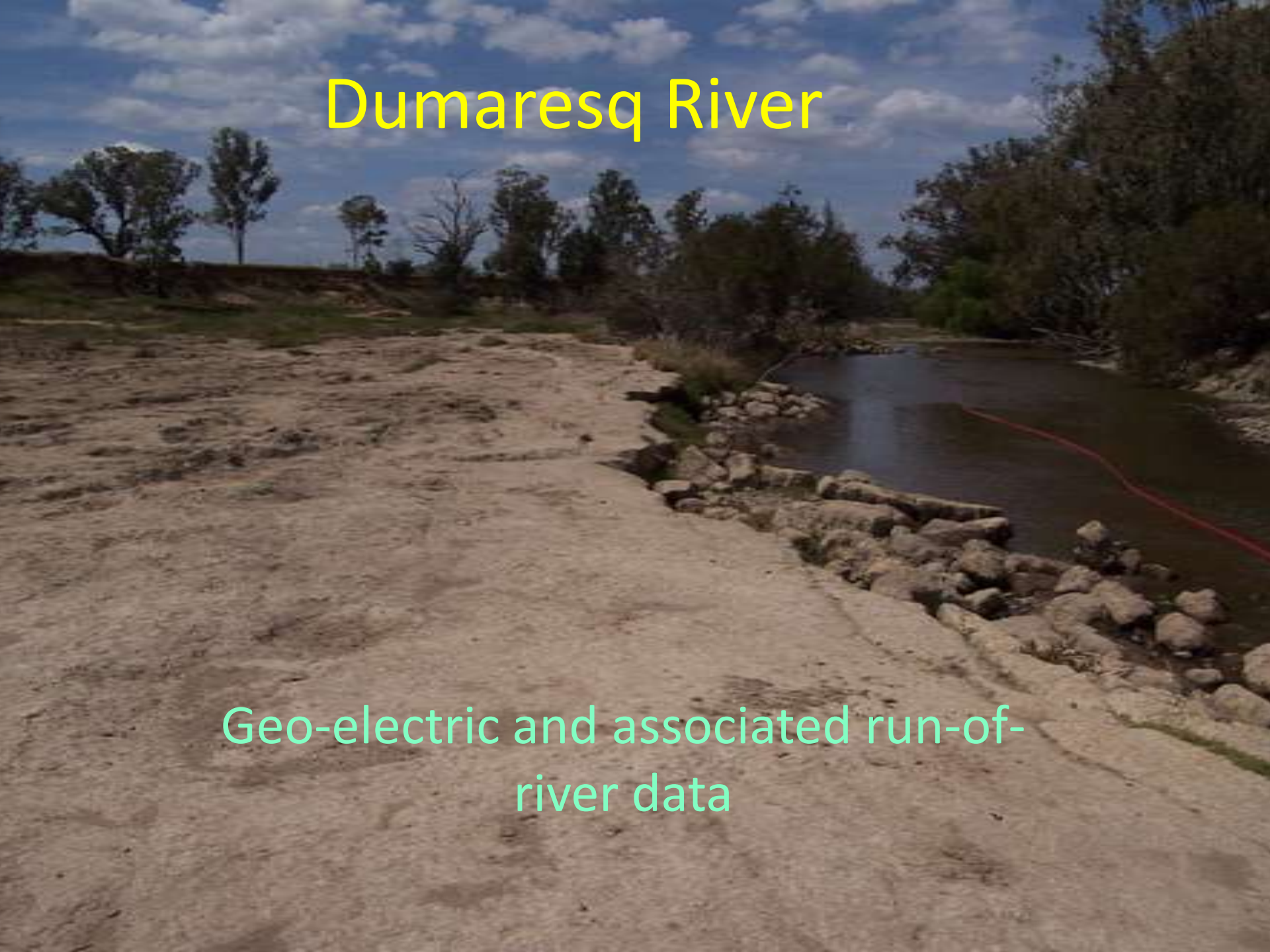
Linear depth scale from 0 to 50m

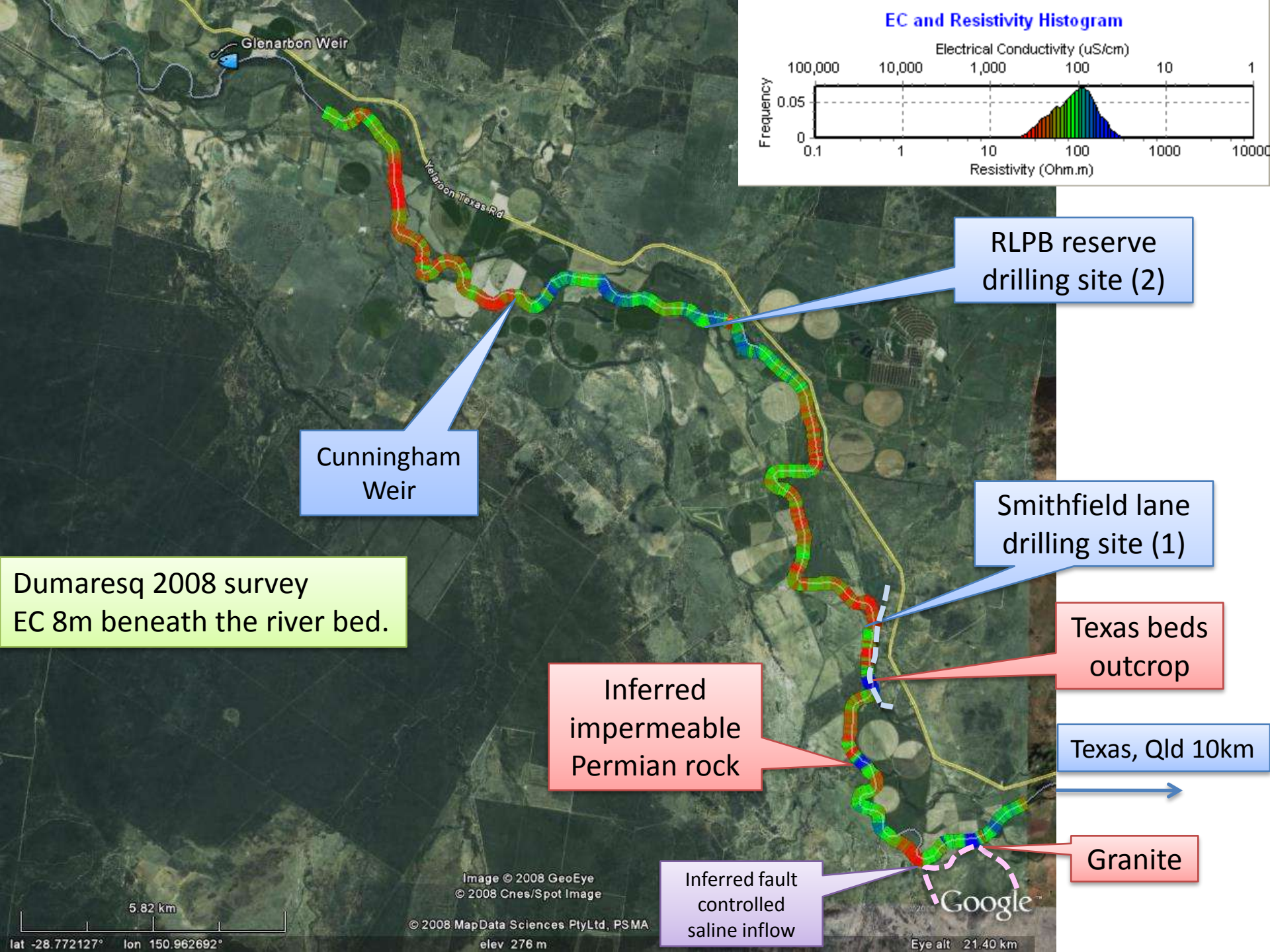
Gwydir Video – Access at

http://www.youtube.com/watch?v=j1tCiC1CDRk (Compressed)

2 minutes

by M. Toft
& D. Allen


Dumaresq River
Geo-electric and associated run-of-river data


EC and Resistivity Histogram
Electrical Conductivity (uS/cm)
100,000
10,000
1,000
100
10
1
Frequency
0.05
0
0.1
1
10
100
1000
10000
Resistivity (Ohm.m)
Glenarbon Weir
Yelarbon Texas Rd
RLPB reserve drilling site (2)
Cunningham Weir
Smithfield lane drilling site (1)
Dumaresq 2008 survey
EC 8m beneath the river bed.
Texas beds outcrop
Inferred impermeable Permian rock
Texas, Qld 10km
Granite
Inferred fault controlled saline inflow
Image © 2008 GeoEye
© 2008 Cnes/Spot Image
© 2008 MapData Sciences PtyLtd, PSMA
5.82 km
lat -28.772127° lon 150.962692°
elev 276 m
Google
Eye alt 21.40 km

Lithologies encountered in drillers logs near the Dumaresq River

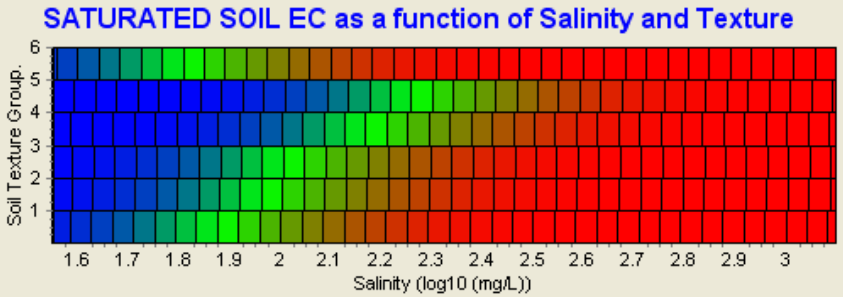
Dumaresq Modelled Resistivity Key

Lithologies

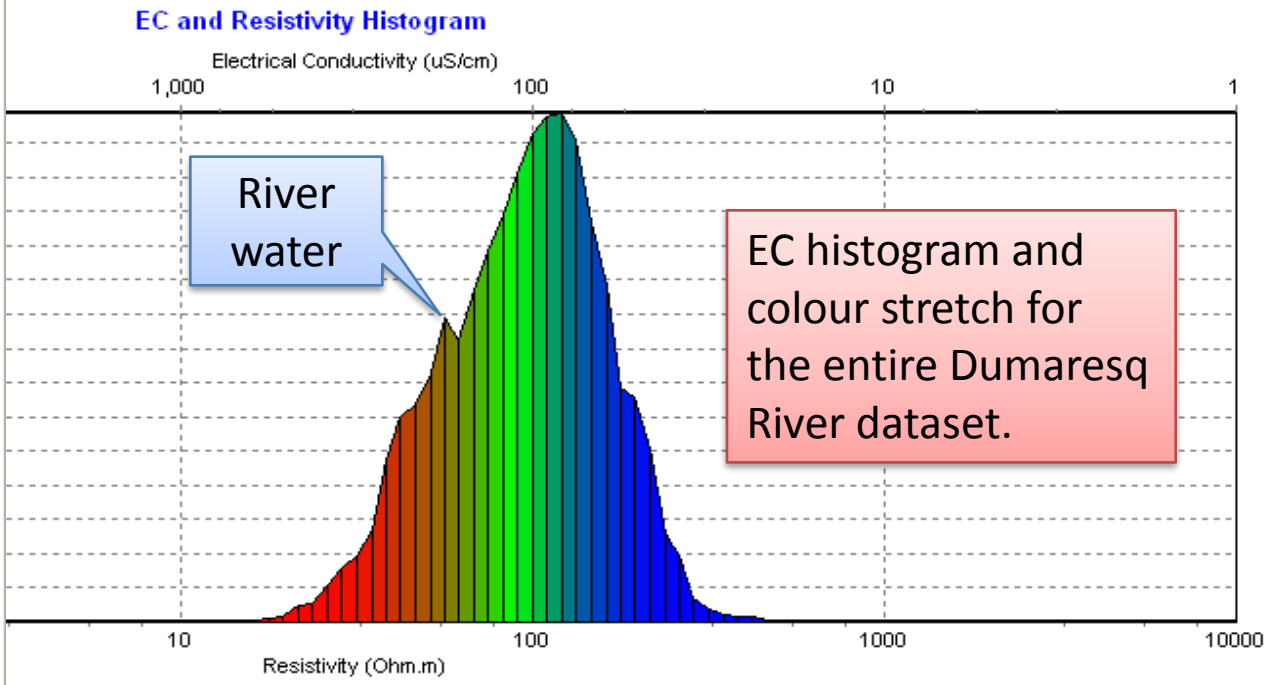
- Cobbles (Cob)
- Gravel (G)
- Coarse Sand (Cs)
- Sand (S)
- Fine Sand (Fs)
- Silt (Si)
- Loam (L)
- Soil (Soil)
- Wood (Wd)
- Light Clay (Lc)
- Clay (C)
- Saprolite (Sp)
- Conglomerate (Cg)
- Sandstone (Ss)
- Claystone (Cls)
- Shale (Shl)
- Marl (Marl)
- Ironstone (Fe)
- Rock (Rk)
- Quartzite (Qzt)
- Quartz (Q)
- Unknown (Unk)
- Fluid Loss (Fl)
- Water (Wat)

EC, Salinity, and Soil Texture relationship for the Dumaresq River dataset

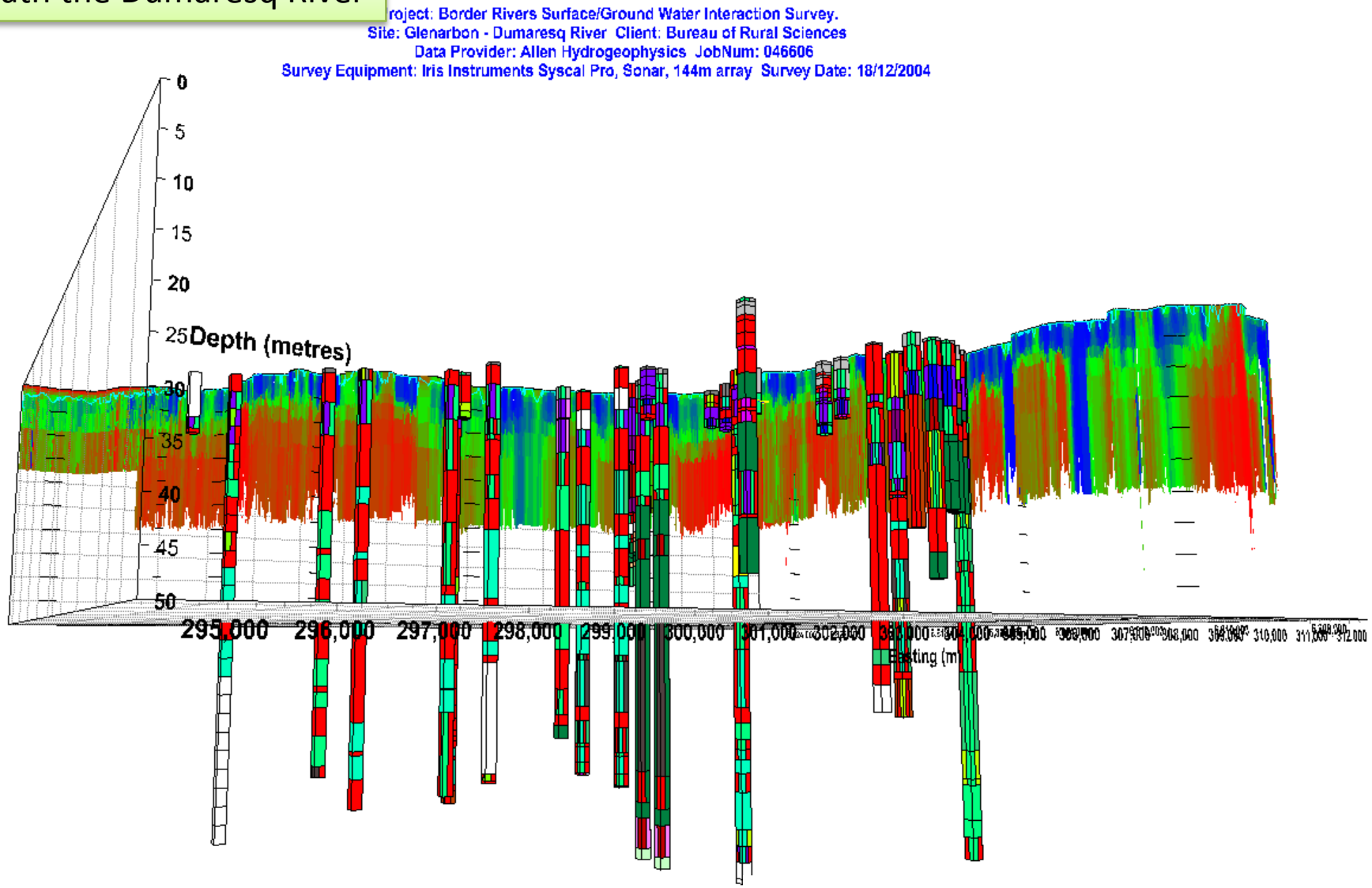
6: Water
5: Sands <10%Clay
4: Sandy Loams 10-25% Clay
3: Loams 25-30% Clay
2: Clay Loams, Light Clay 30-45% Clay
1: Medium, Heavy Clays >45% Clay

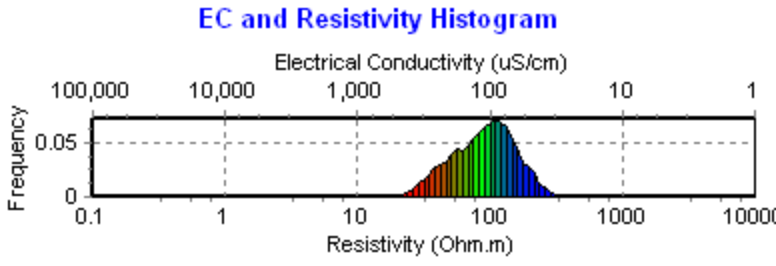


and using a Salinity conversion factor mg/L / uS/cm of 0.64.
After Slavich & Petterson - Aust J. Soil Res., 1993, 31, 73-81



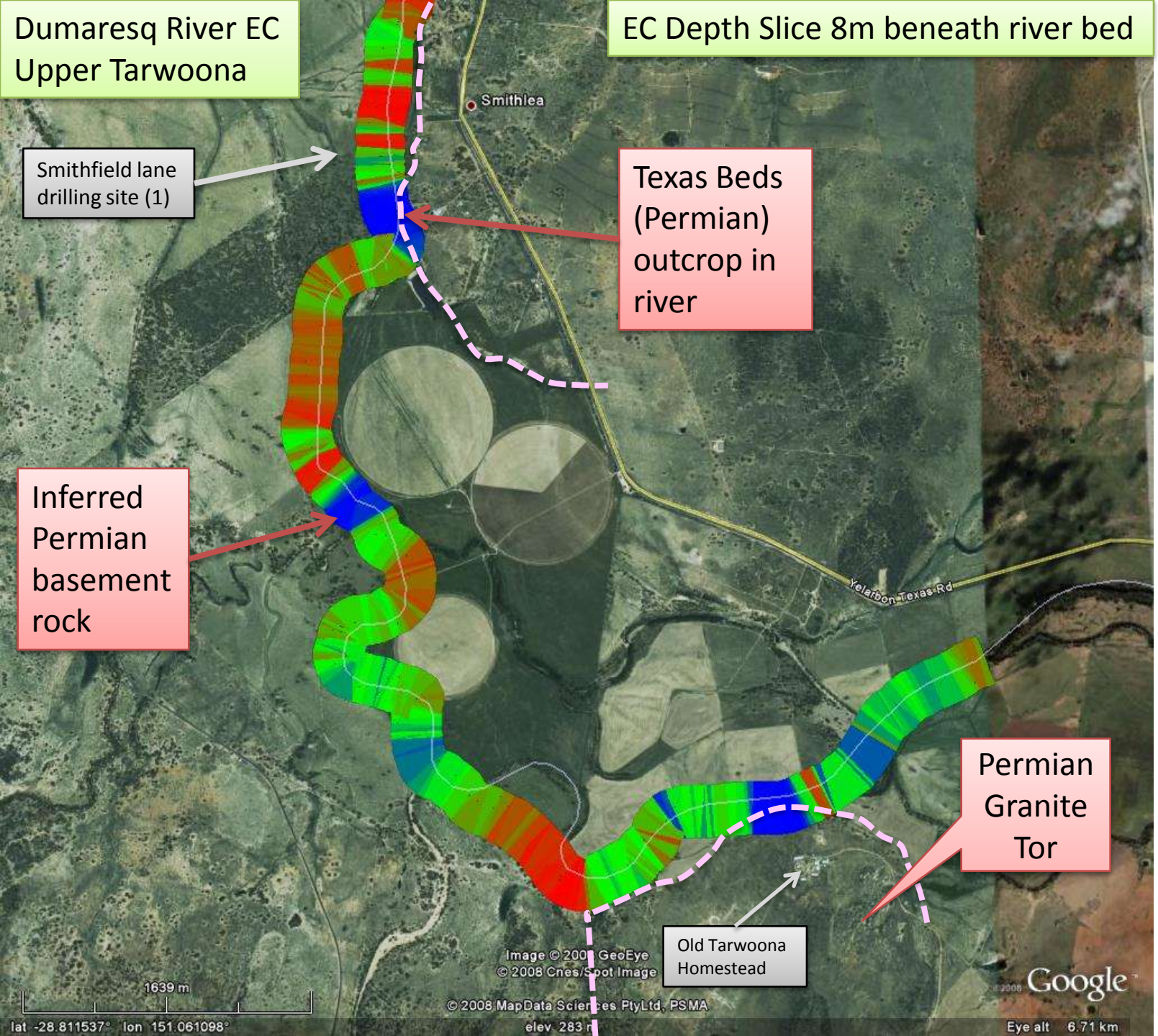
EC beneath the Dumaresq River





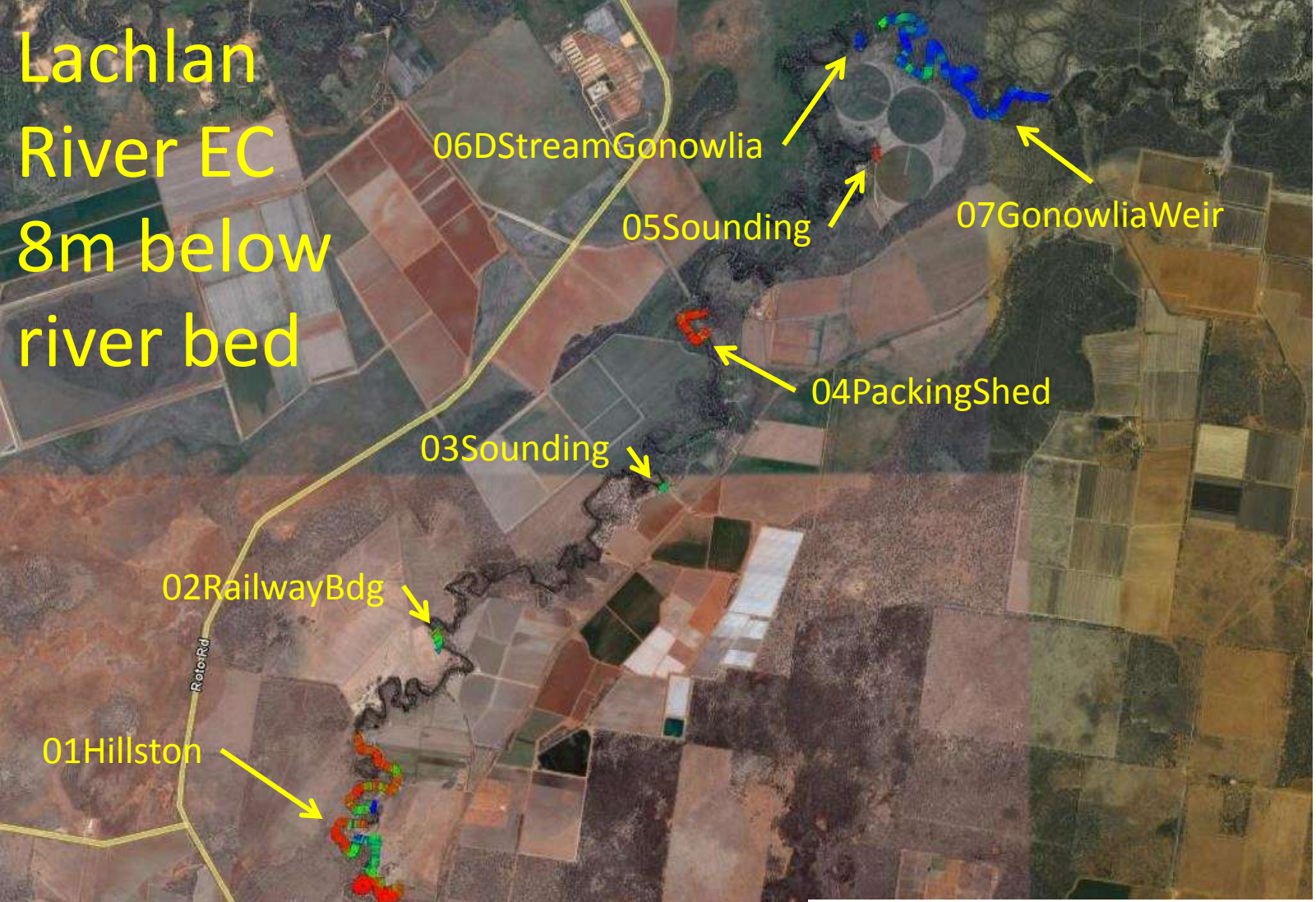
River incision: 4 to 12 metres

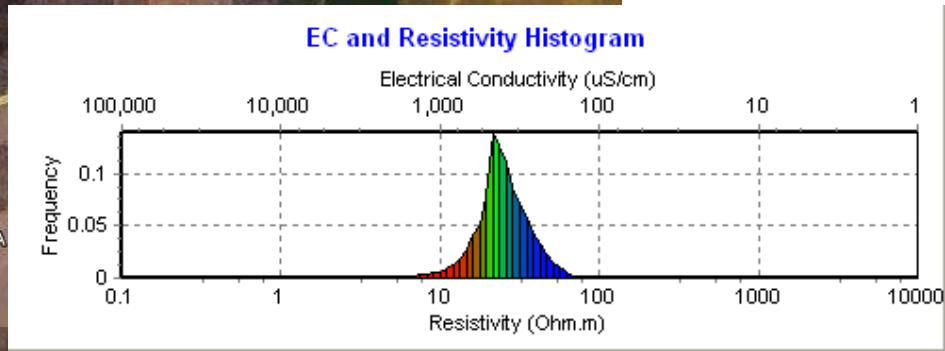
Linear depth scale 0 to 50 m


Dumaresq River EC
Upper Tarwoona
EC Depth Slice 8m beneath river bed
Smithlea
Smithfield lane drilling site (1)
Texas Beds (Permian) outcrop in river
Inferred Permian basement rock
Yelarbon Texas Rd
Permian Granite Tor
Old Tarwoona Homestead
Image © 2008 GeoEye
© 2008 Cnes/Spot Image
© 2008 MapData Sciences PtyLtd, PSMA
1639 m
lat -28.811537° lon 151.061098°
elev 283 m
Eye alt 6.71 km
Google


Lachlan River
Geo-electric and associated run-of-river data

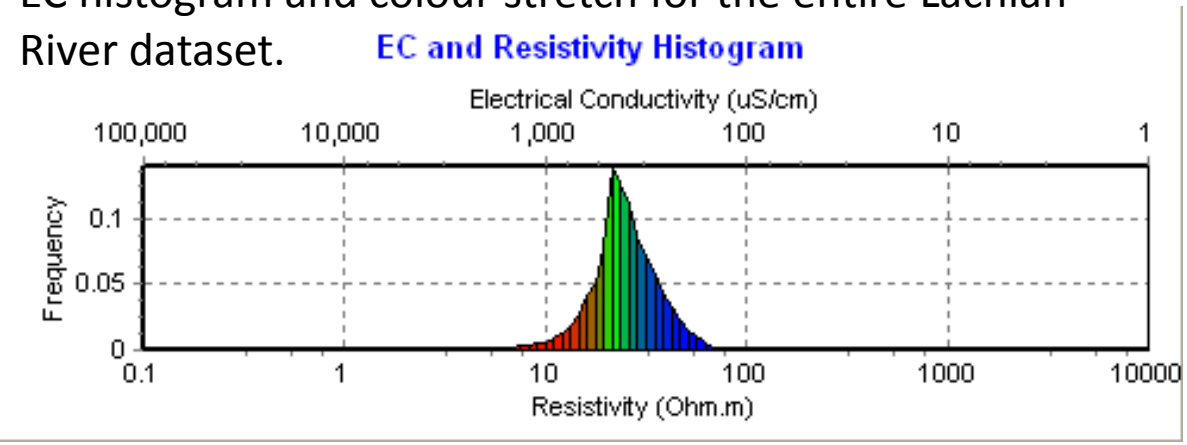
Lachlan River EC 8m below river bed



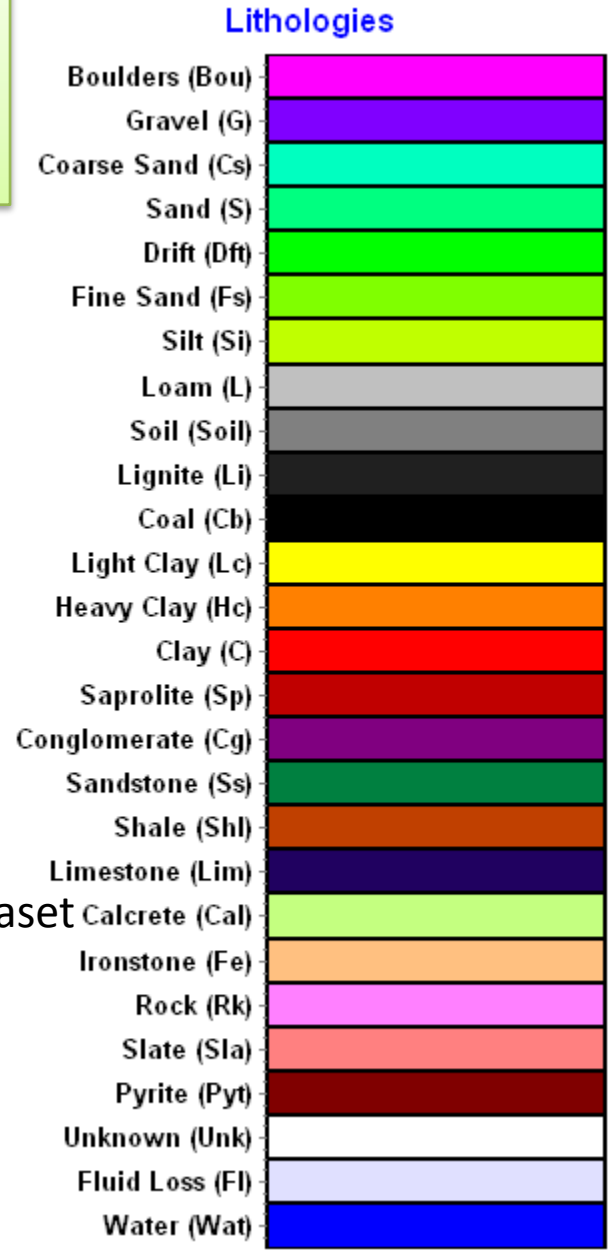


Lachlan Modelled Resistivity Images - Key

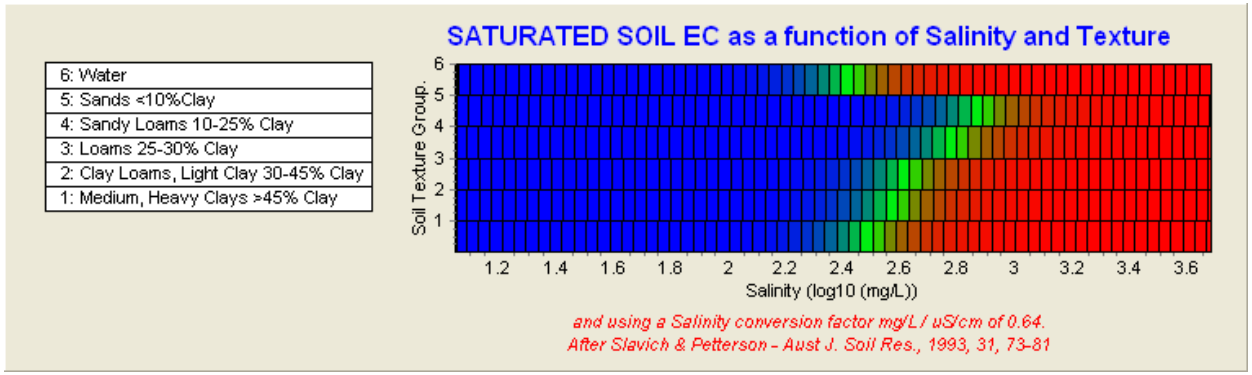
EC histogram and colour stretch for the entire Lachlan River dataset.



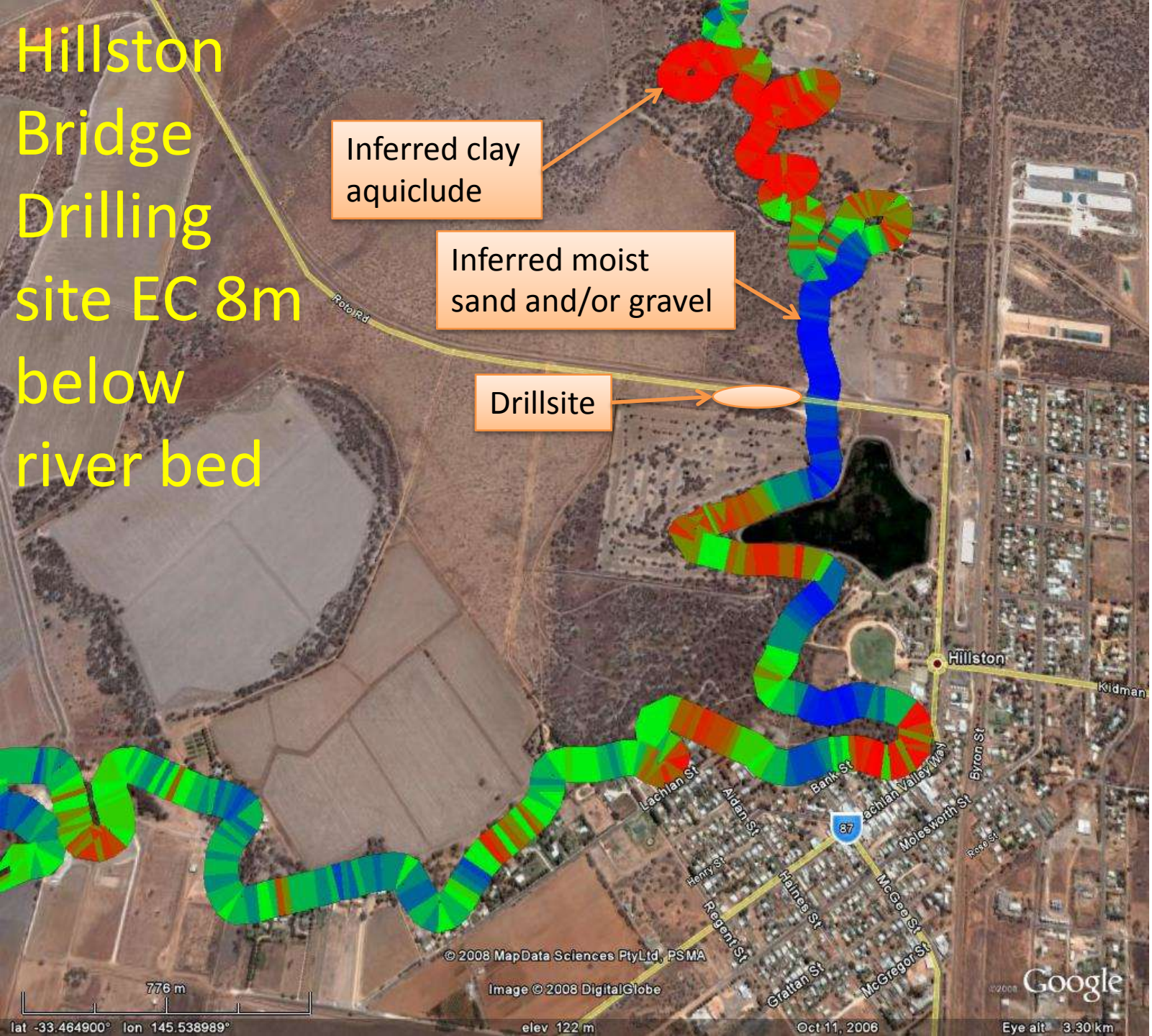
Lithologies encountered in drillers logs near the Lachlan River

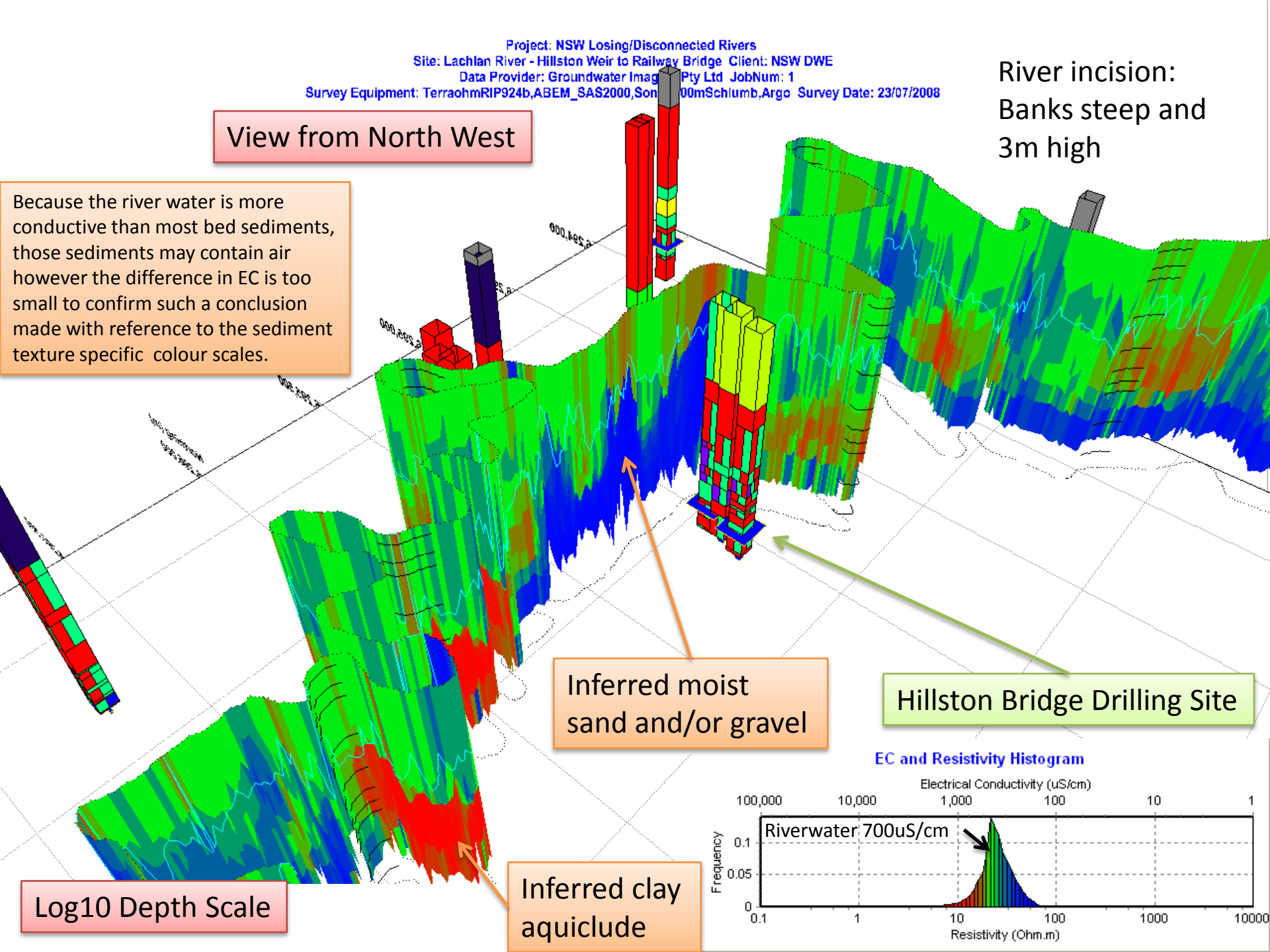


EC, Salinity, and Soil Texture relationship for the Lachlan River dataset



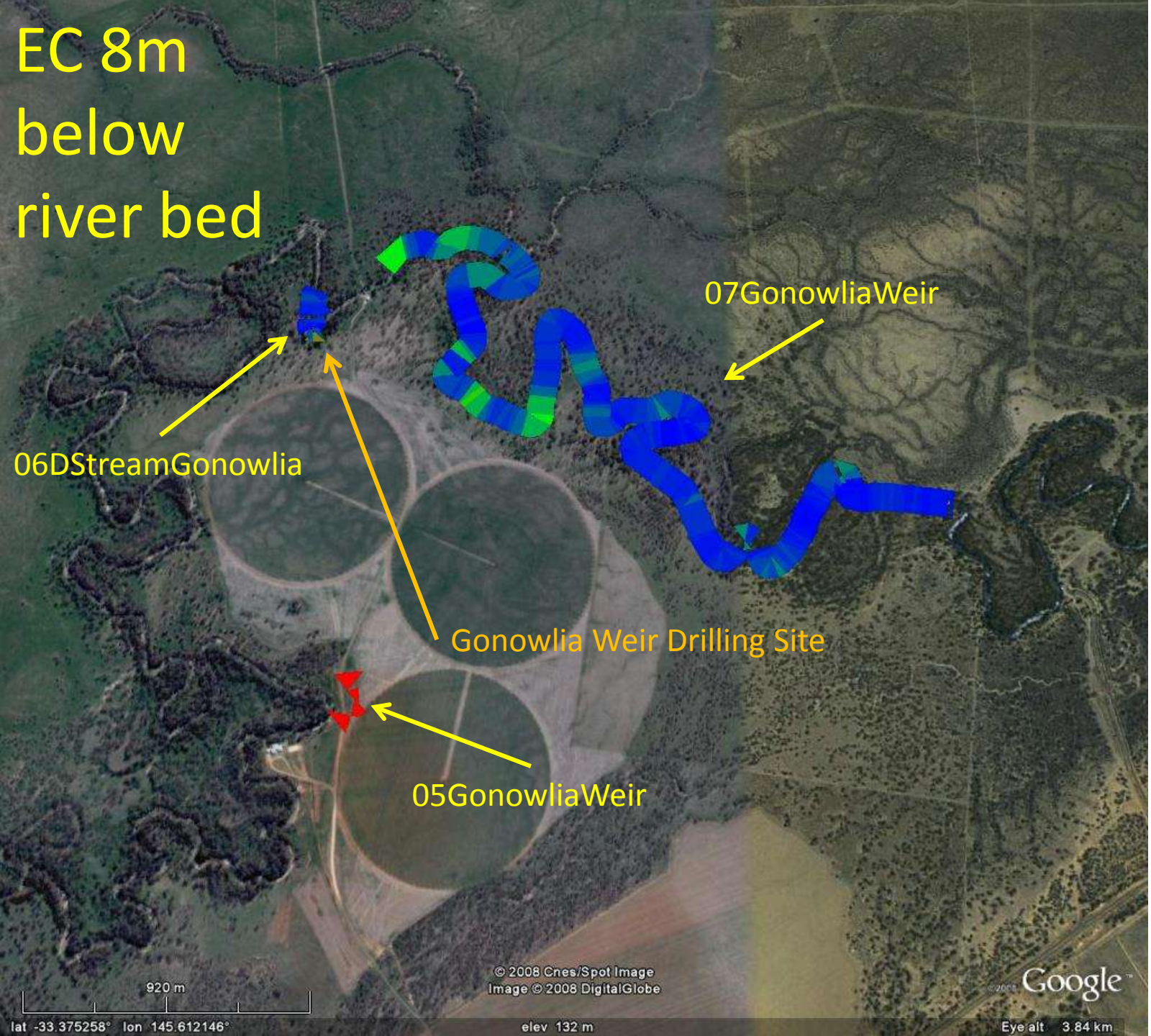
Hillston Weir Pool


Hillston Bridge Drilling site EC 8m below river bed
Inferred clay aquiclude
Inferred moist sand and/or gravel
Drillsite
Roto Rd
Hillston
Kidman
Lachlan St
Aidan St
Bank St
Byron St
Molesworth St
Henry St
Haines St
McGee St
Regent St
Gratian St
McGregor St
87
© 2008 MapData Sciences PtyLtd, PSMA
Image © 2008 DigitalGlobe
776 m
Google
lat -33.464900° lon 145.538989°
elev 122 m
Oct 11, 2006
Eye alt 3.30 km


Project: NSW Losing/Disconnected Rivers
Site: Lachlan River - Hillston Weir to Railway Bridge Client: NSW DWE
Data Provider: Groundwater Imag Pty Ltd JobNum: 1
Survey Equipment: TerraohmRIP924b,ABEM_SAS2000,Son 00mSchlumb,Argo Survey Date: 23/07/2008
View from North West
River incision: Banks steep and 3m high
Because the river water is more conductive than most bed sediments, those sediments may contain air however the difference in EC is too small to confirm such a conclusion made with reference to the sediment texture specific colour scales.
Inferred moist sand and/or gravel
Hillston Bridge Drilling Site
EC and Resistivity Histogram
Electrical Conductivity (uS/cm)
100,000
10,000
1,000
100
10
1
Riverwater 700uS/cm
Frequency
0.1
0.05
0
0.1
1
10
100
1000
10000
Resistivity (Ohm.m)
Log10 Depth Scale
Inferred clay aquiclude

07GonowliaWeir

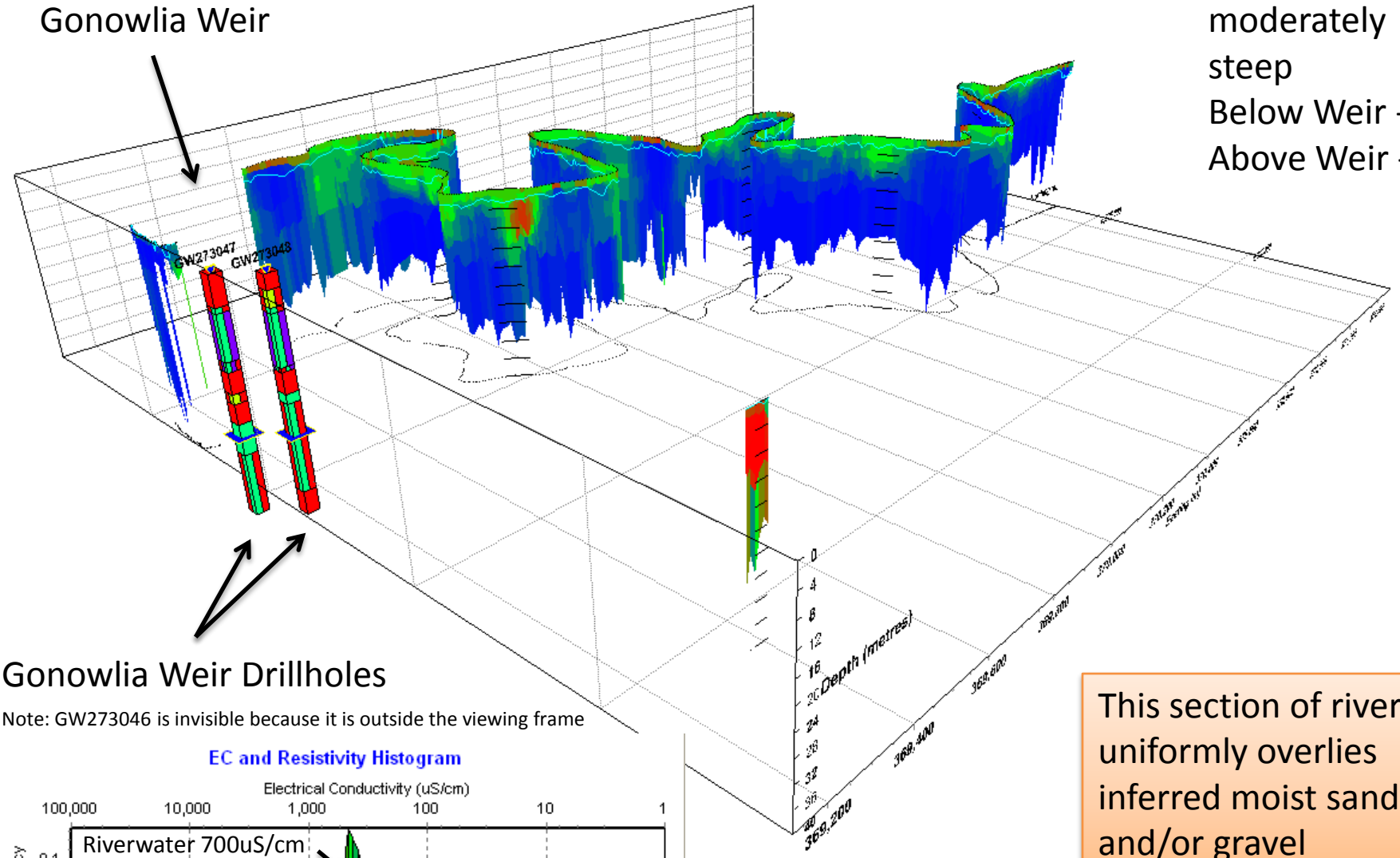
+ 06DStreamGonowlia & 05Sounding


EC 8m
below
river bed
07GonowliaWeir
06DStreamGonowlia
Gonowlia Weir Drilling Site
05GonowliaWeir
© 2008 Cnes/Spot Image
Image © 2008 DigitalGlobe
920 m
Google
lat -33.375258° lon 145.612146°
elev 132 m
Eye alt 3.84 km

Project: NSW Losing/Disconnected Rivers
Site: Lachlan River - Gonowlia Weir upstream plus 2 remote soundings downstream Client: NSW DWE
Data Provider: Groundwater Imaging Pty Ltd JobNum: 1
Survey Equipment: TerraohmRIP924b,ABEM_SAS2000,Sonar,100mSchlumb,Argo Survey Date: 24/07/2008

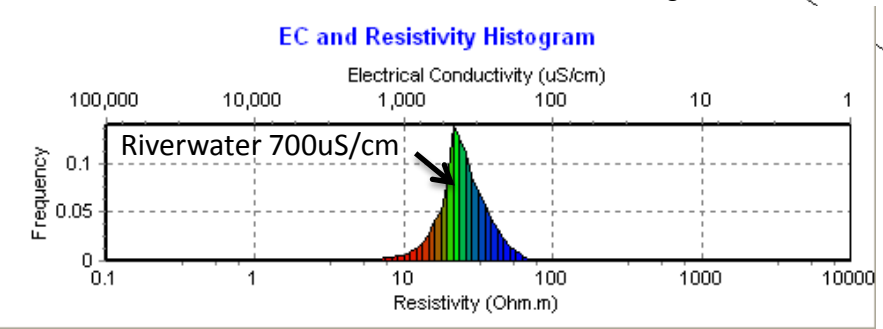
Gonowlia Weir

River incision:
Banks moderately steep
Below Weir - 4m
Above Weir - 2m



Gonowlia Weir Drillholes

Note: GW273046 is invisible because it is outside the viewing frame

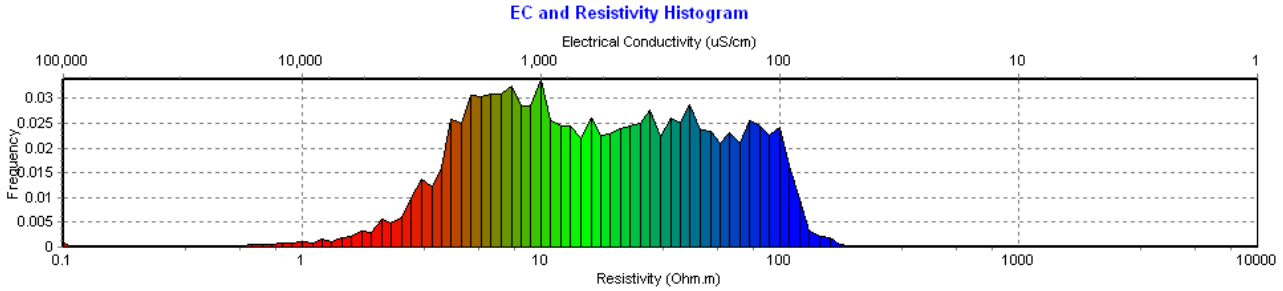


This section of river uniformly overlies inferred moist sand and/or gravel

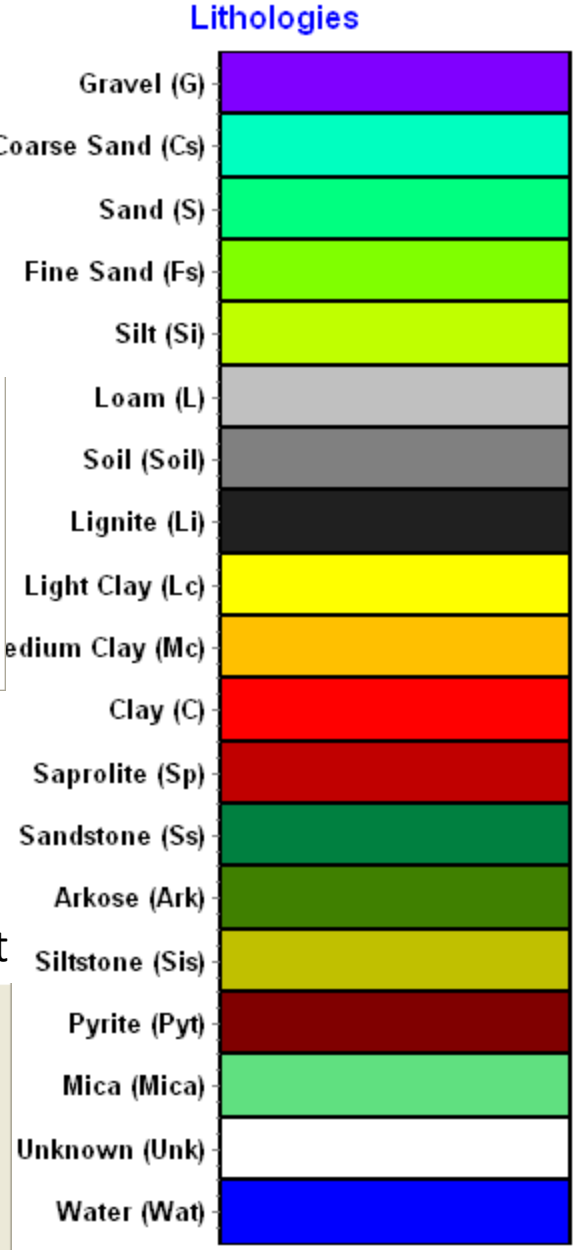

Billabong Creek - Jerilderie
Geo-electric and associated run-of-river data

Modelled Resistivity Images - Key

EC histogram and colour stretch for the entire Billabong Creek dataset.

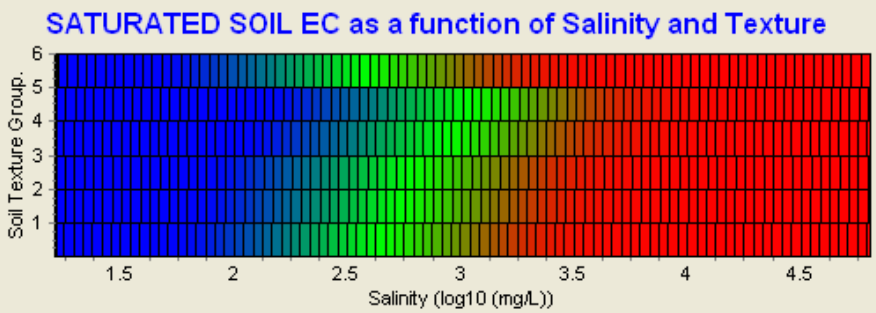


Lithologies encountered in drillers logs near Billabong Creek

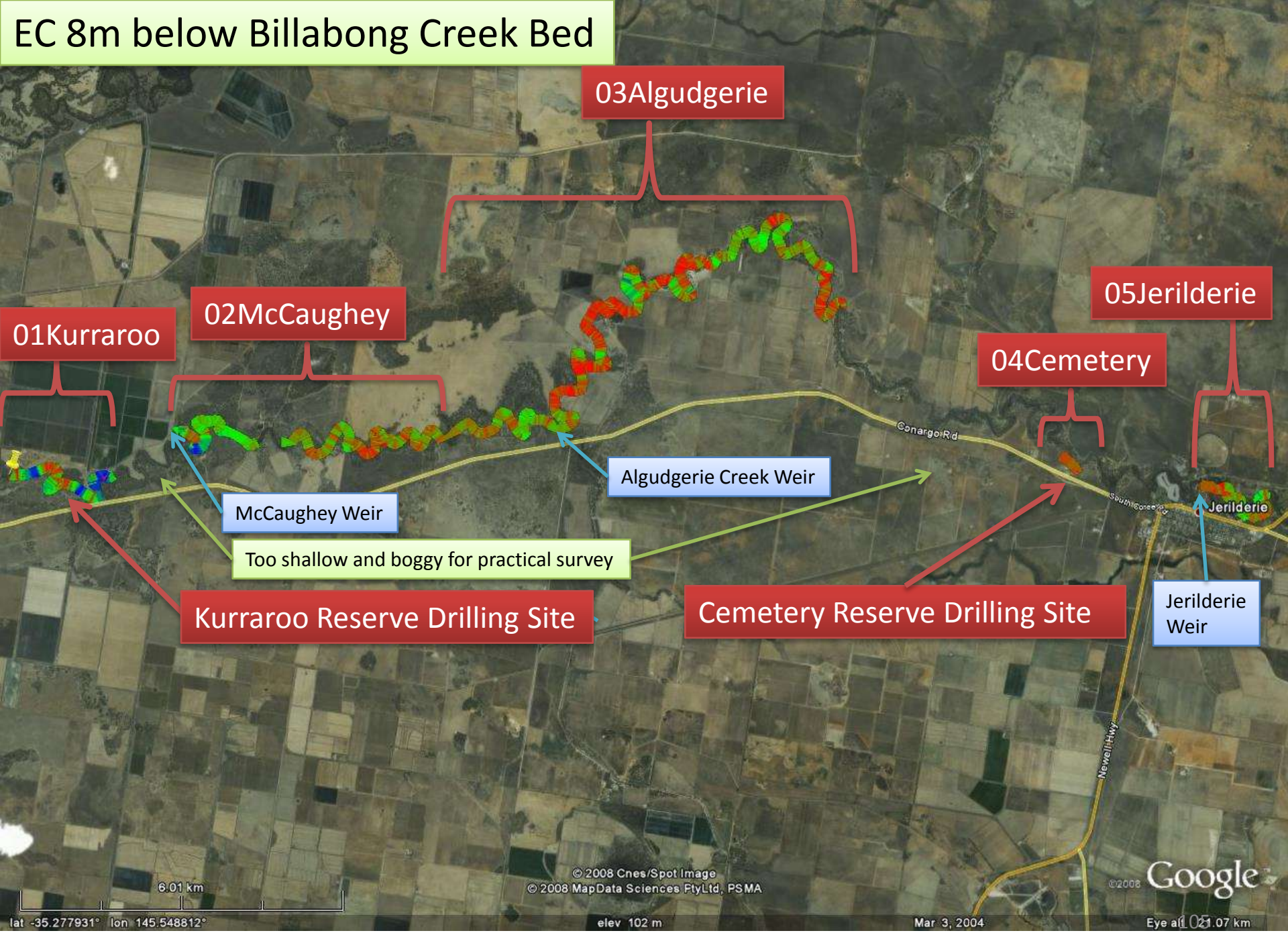


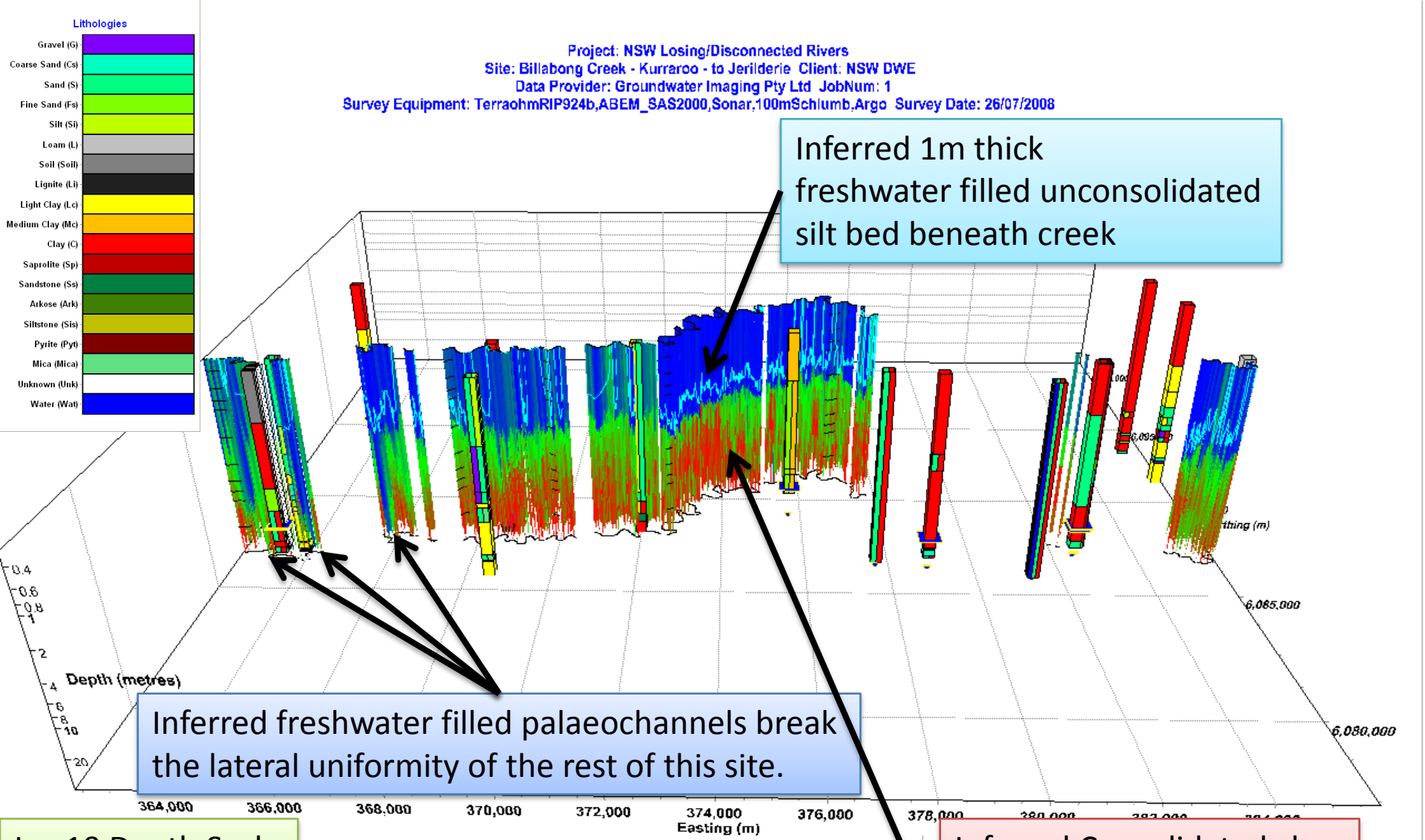
EC, Salinity, and Soil Texture relationship for Billabong Creek dataset

6: Water
5: Sands <10%Clay
4: Sandy Loams 10-25% Clay
3: Loams 25-30% Clay
2: Clay Loams, Light Clay 30-45% Clay
1: Medium, Heavy Clays >45% Clay



and using a Salinity conversion factor mg/L / uS/cm of 0.64.
After Slavich & Petterson - Aust J. Soil Res., 1993, 31, 73-81


EC 8m below Billabong Creek Bed
03Algudgerie
01Kurraroo
02McCaughey
05Jerilderie
04Cemetery
Conargo Rd
Algudgerie Creek Weir
McCaughey Weir
Too shallow and boggy for practical survey
Kurraroo Reserve Drilling Site
Cemetery Reserve Drilling Site
Jerilderie
Jerilderie Weir
Newell Hwy
6.01 km
© 2008 Cnes/Spot Image
© 2008 MapData Sciences PtyLtd, PSMA
Google
lat -35.277931° lon 145.548812°
elev 102 m
Mar 3, 2004

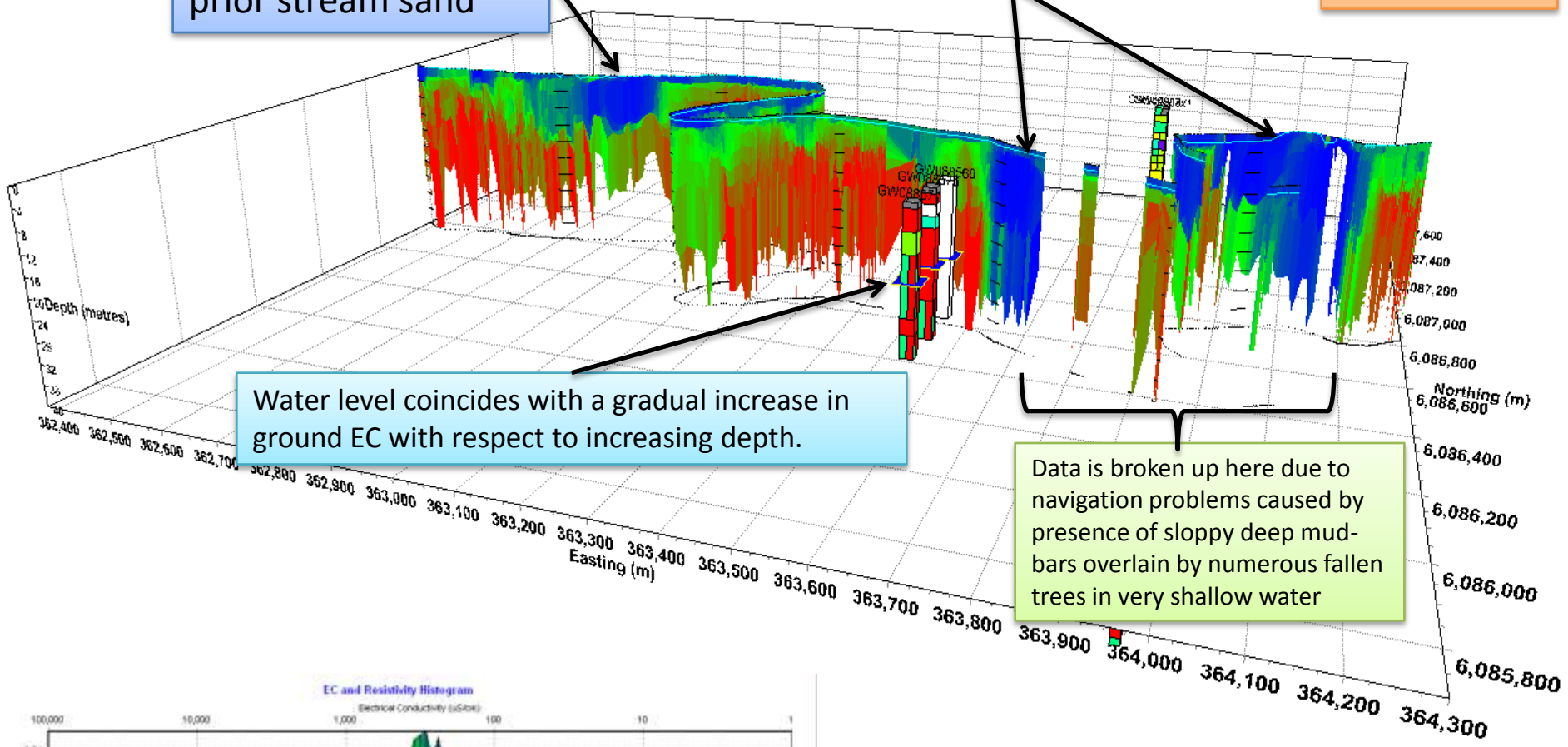

Lithologies
Gravel (G)
Coarse Sand (Cs)
Sand (S)
Fine Sand (Fs)
Silt (Si)
Loam (L)
Soil (Soil)
Lignite (Li)
Light Clay (Lc)
Medium Clay (Mc)
Clay (C)
Saprolite (Sp)
Sandstone (Ss)
Arkose (Ark)
Siltstone (Sis)
Pyrite (Pyt)
Mica (Mica)
Unknown (Unk)
Water (Wat)
Project: NSW Losing/Disconnected Rivers
Site: Billabong Creek - Kurraroo - to Jerilderie Client: NSW DWE
Data Provider: Groundwater Imaging Pty Ltd JobNum: 1
Survey Equipment: TerraohmRIP924b,ABEM_SAS2000,Sonar,100mSchlumb,Argo Survey Date: 26/07/2008
Inferred 1m thick freshwater filled unconsolidated silt bed beneath creek
Depth (metres)
0.4
0.6
0.8
1
2
4
6
8
10
20
364,000
366,000
368,000
370,000
372,000
374,000
376,000
378,000
Easting (m)
6,065,000
6,080,000
Inferred freshwater filled palaeochannels break the lateral uniformity of the rest of this site.
Log10 Depth Scale
EC and Resistivity Histogram
Electrical Conductivity (uS/cm)
100,000
10,000
1,000
100
10
1
Frequency
0.03
0.025
0.02
0.015
0.01
0.005
0
0.1
1
10
100
1000
10000
Resistivity (Ohm.m)
Inferred Consolidated clay and sandy clay containing old saline water:
Green = partially saturated
Red = fully saturated

Project: NSW Losing/Disconnected Rivers
Site: Billabong Creek - Kurraroo - Downstream Investigation site Client: NSW DWE
Data Provider: Groundwater Imaging Pty Ltd JobNum: 1
Survey Equipment: TerraohmRIP924b,ABEM_SAS2000,Sonar,100mSchlumb,Argo Survey Date: 26/07/2008

Inferred 12m deep prior stream sand

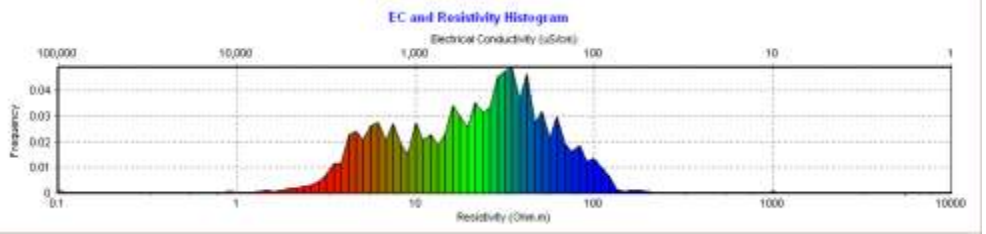
Inferred prior streams more than 30 metres deep containing fresh water below 12 metres.

River incision: banks here are gently sloping and rise about 2 metre above the water which ranges from about 10 cm deep to 1m deep.



Water level coincides with a gradual increase in ground EC with respect to increasing depth.

Data is broken up here due to navigation problems caused by presence of sloppy deep mud-bars overlain by numerous fallen trees in very shallow water



Aquifer continuance imaging beneath the Namoi River, Mollee Weir to Gunidgera Weir

by David Allen, National Centre for Groundwater Management, UTS,
David@GroundwaterImaging.com ,
Bryce Kelly, UNSW School of BEES
and Ke Ye, National Centre for Groundwater Management, UTS.

National Centre for Groundwater Management

UNIVERSITY OF TECHNOLOGY SYDNEY

Australian Government

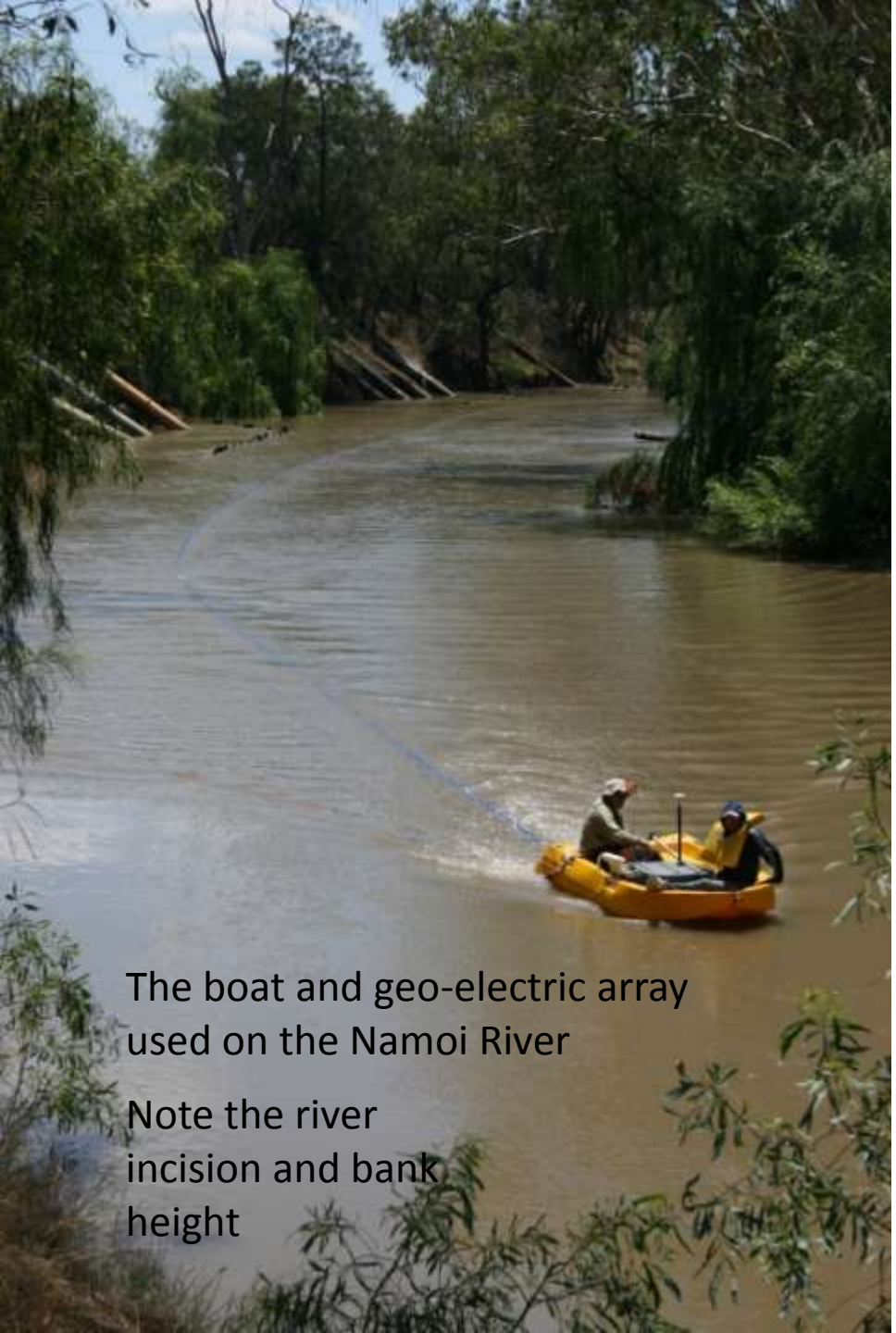
Cotton Research and Development Corporation

Cotton Catchment Communities CRC

GROUNDWATER IMAGING

UNSW - School of Civil and Environmental Engineering

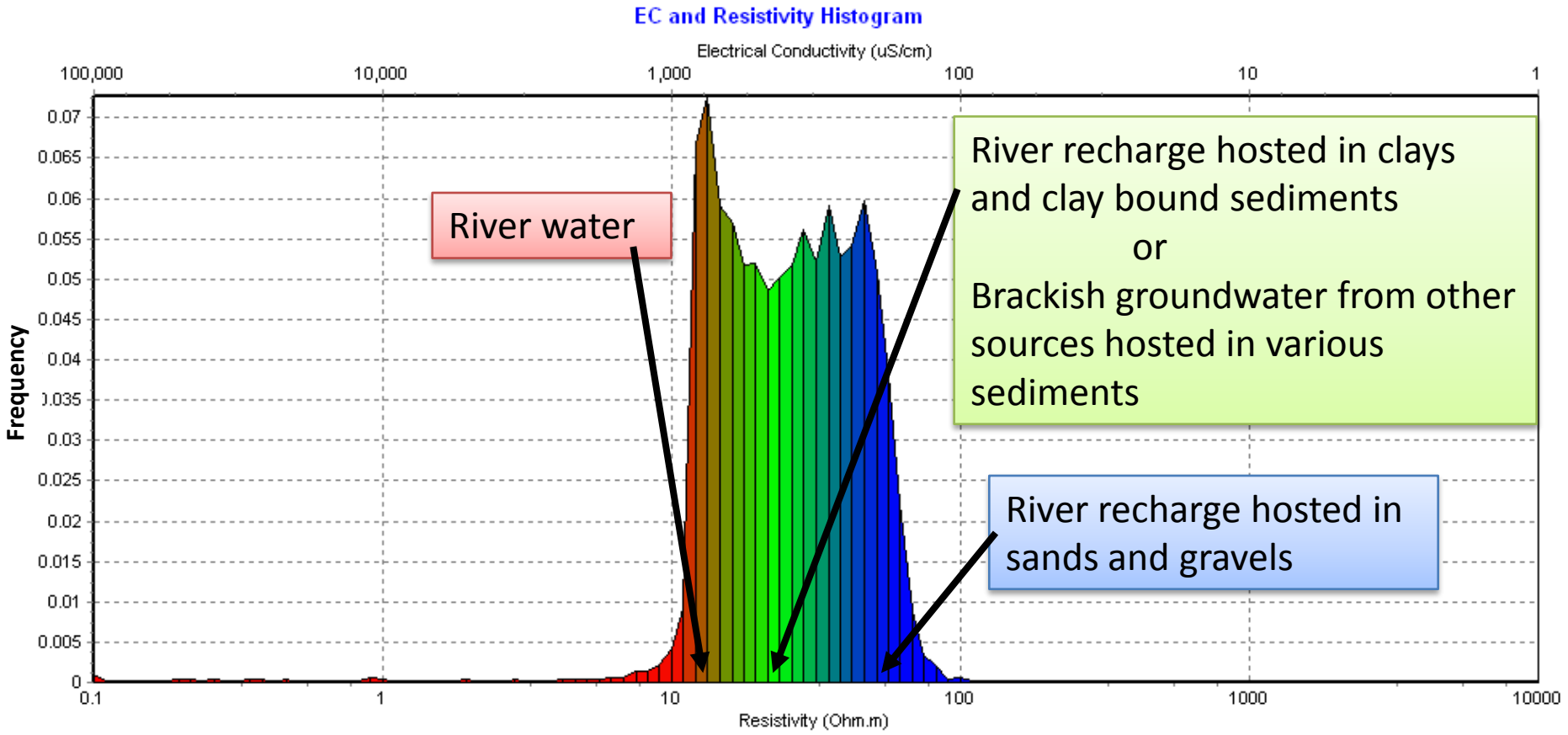
Water Research Laboratory



The boat and geo-electric array used on the Namoi River

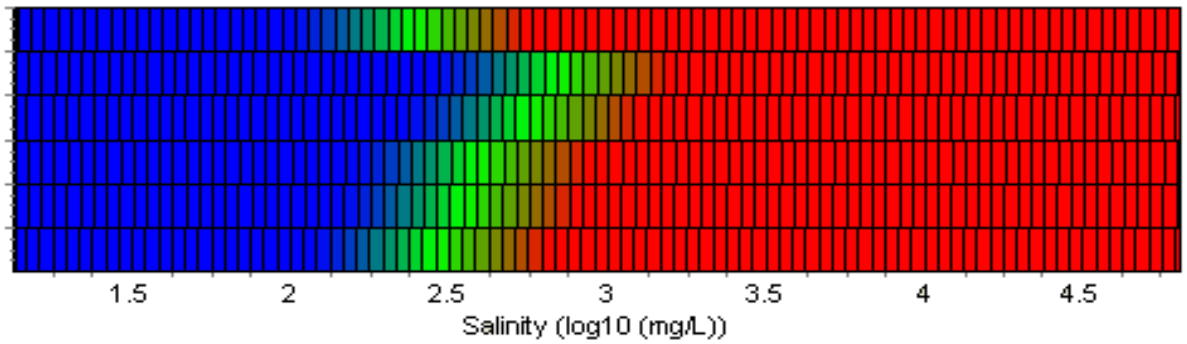
Note the river incision and bank height

Contents

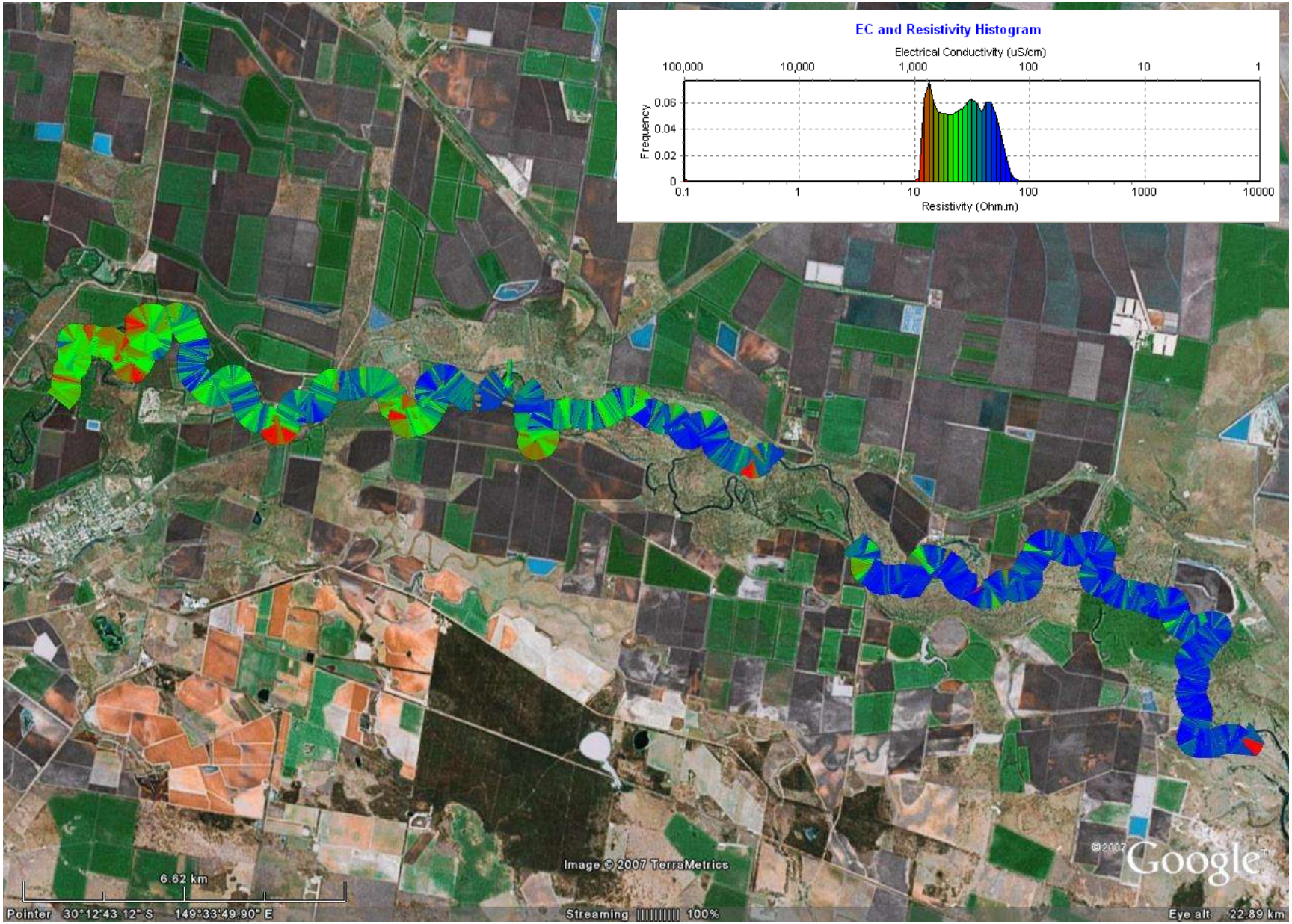


Sediment texture group

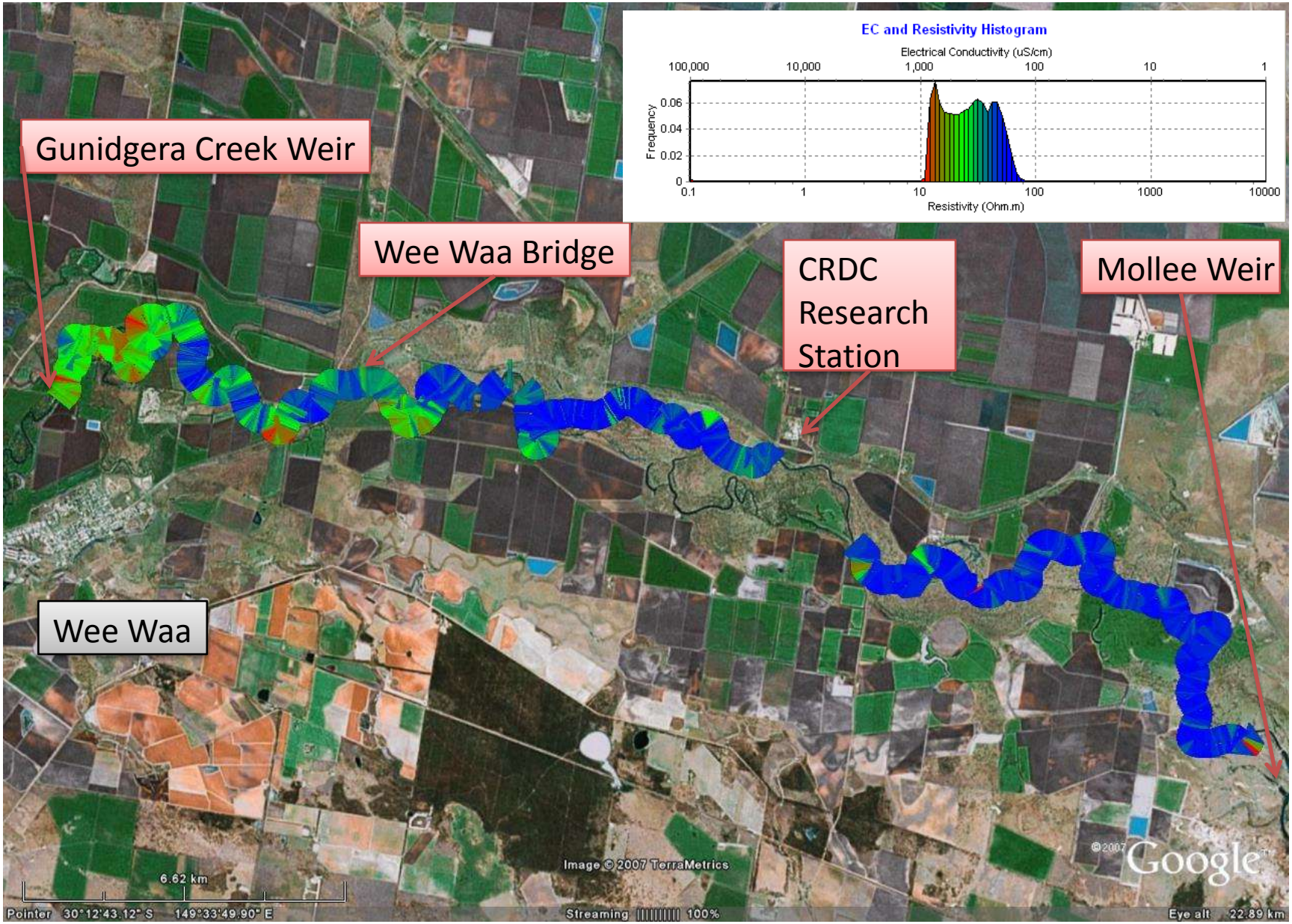
100% WATER (NO SEDIMENT
SANDS <10% Clay
SANDY LOAMS 10-25% Clay
LOAMS 25-30% Clay
CLAY LOAMS, LIGHT CLAYS 30-45% Clay
MEDIUM, HEAVY CLAYS >45% Clay



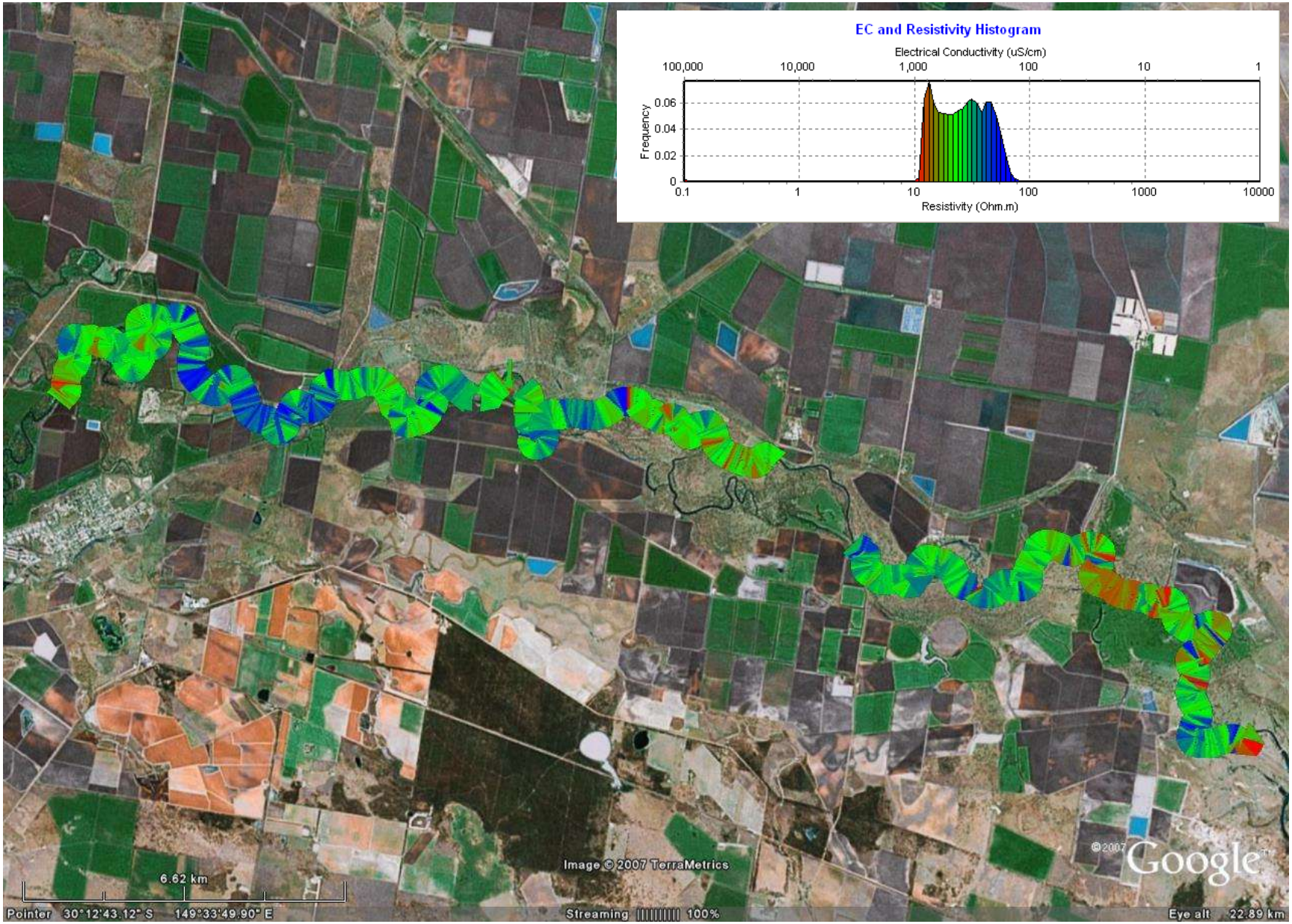
and using a Salinity conversion factor mg/L / uS/cm of 0.64.
After Slavich & Petterson - Aust J. Soil Res., 1993, 31, 73-81



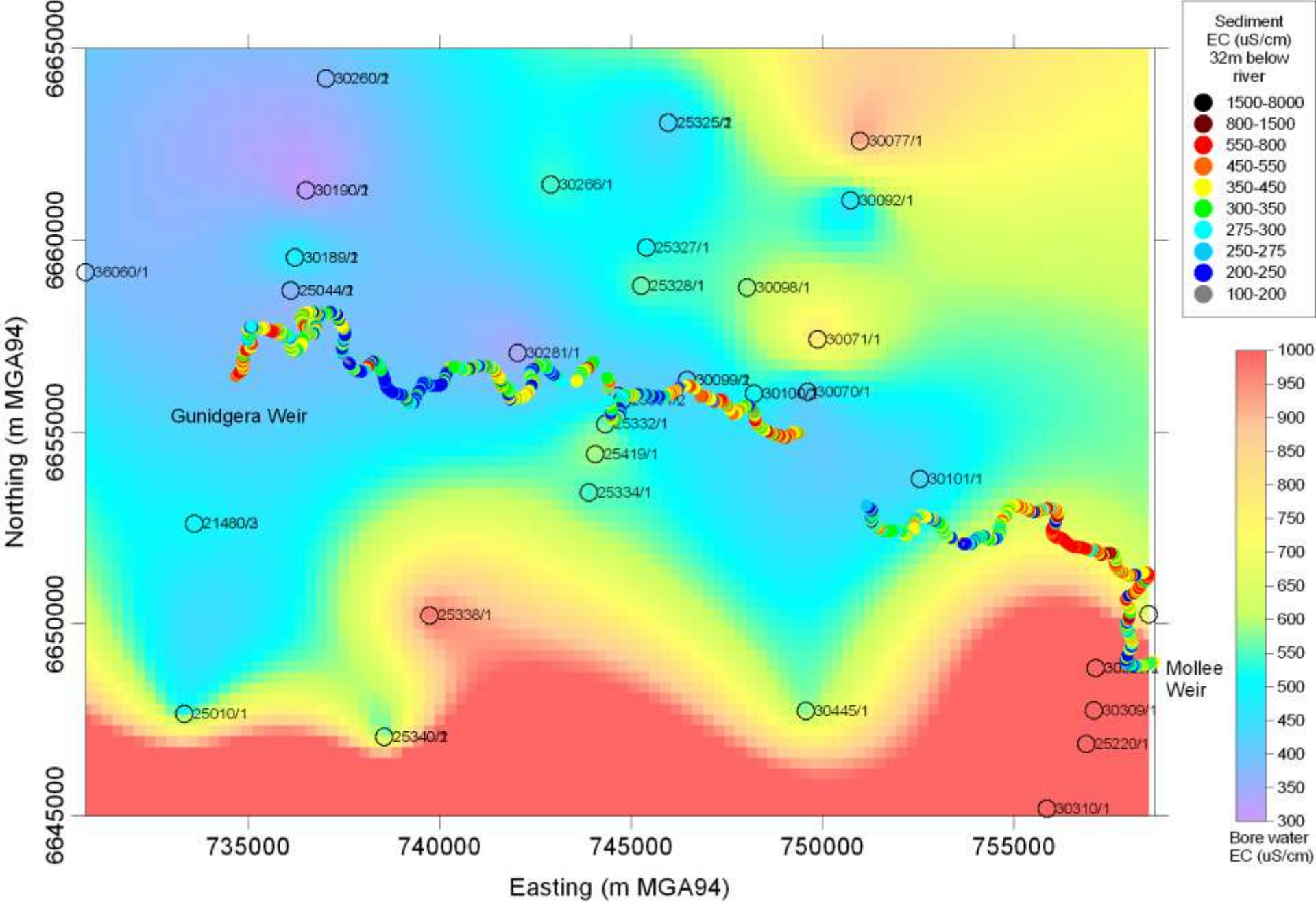
EC data at a depth of 1m below river bed



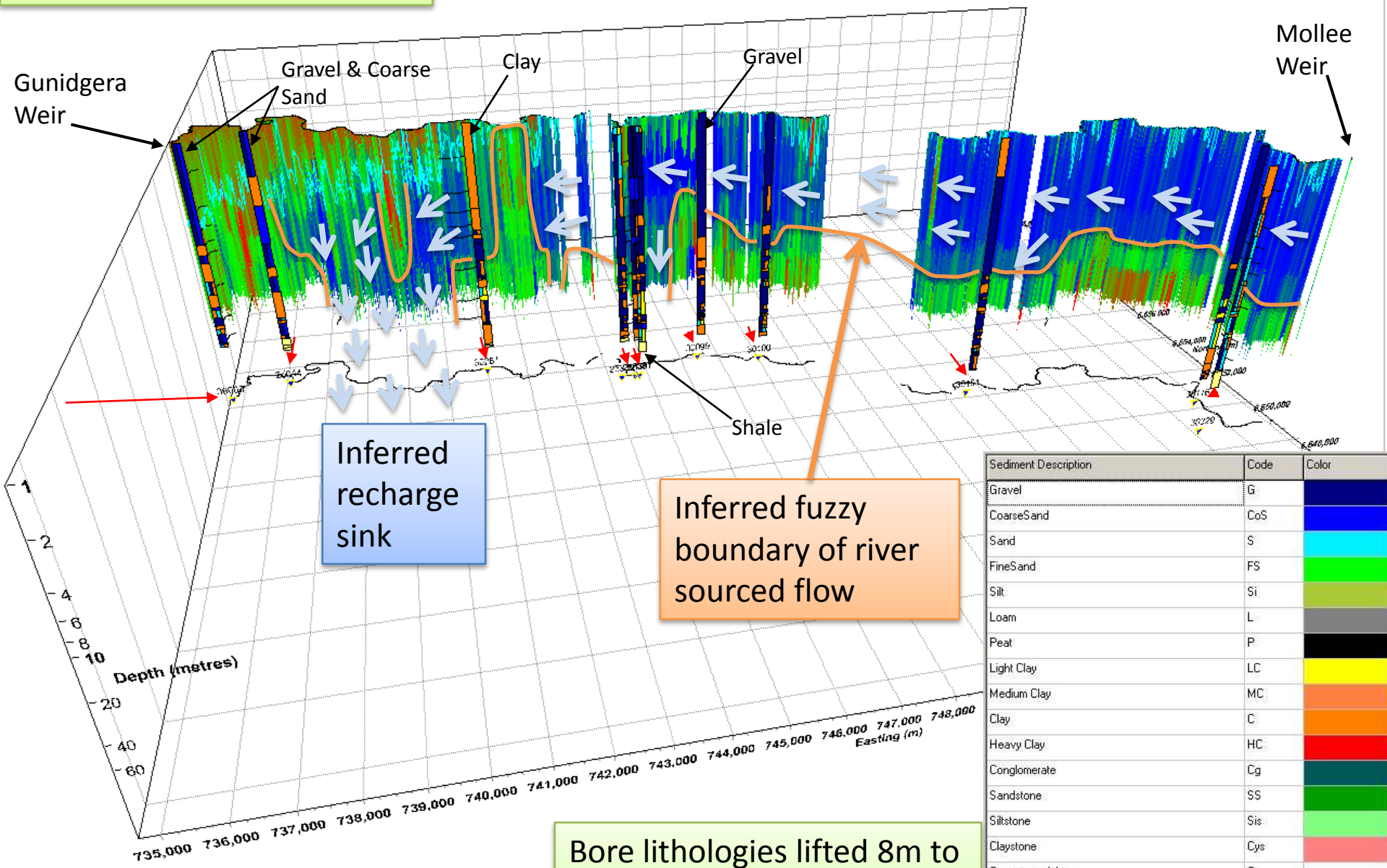
EC data at a depth of 4m below river bed



EC data at a depth of 32m below river bed


Sediment EC (uS/cm) 32m below river
1500-8000
800-1500
550-800
450-550
350-450
300-350
275-300
250-275
200-250
100-200
1000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
Bore water EC (uS/cm)
Northing (m MGA94)
6665000
6660000
6655000
6650000
6645000
Easting (m MGA94)
735000
740000
745000
750000
755000
Gunidgera Weir
Mollee Weir
30260/2
25325/2
30077/1
30190/2
30266/1
30092/1
30189/2
36060/1
25327/1
25044/2
25328/1
30098/1
30071/1
30281/1
30099/2
30070/1
25332/1
25419/1
30101/1
25334/1
21480/3
25338/1
25010/1
25340/2
30445/1
30309/1
25220/1
30310/1

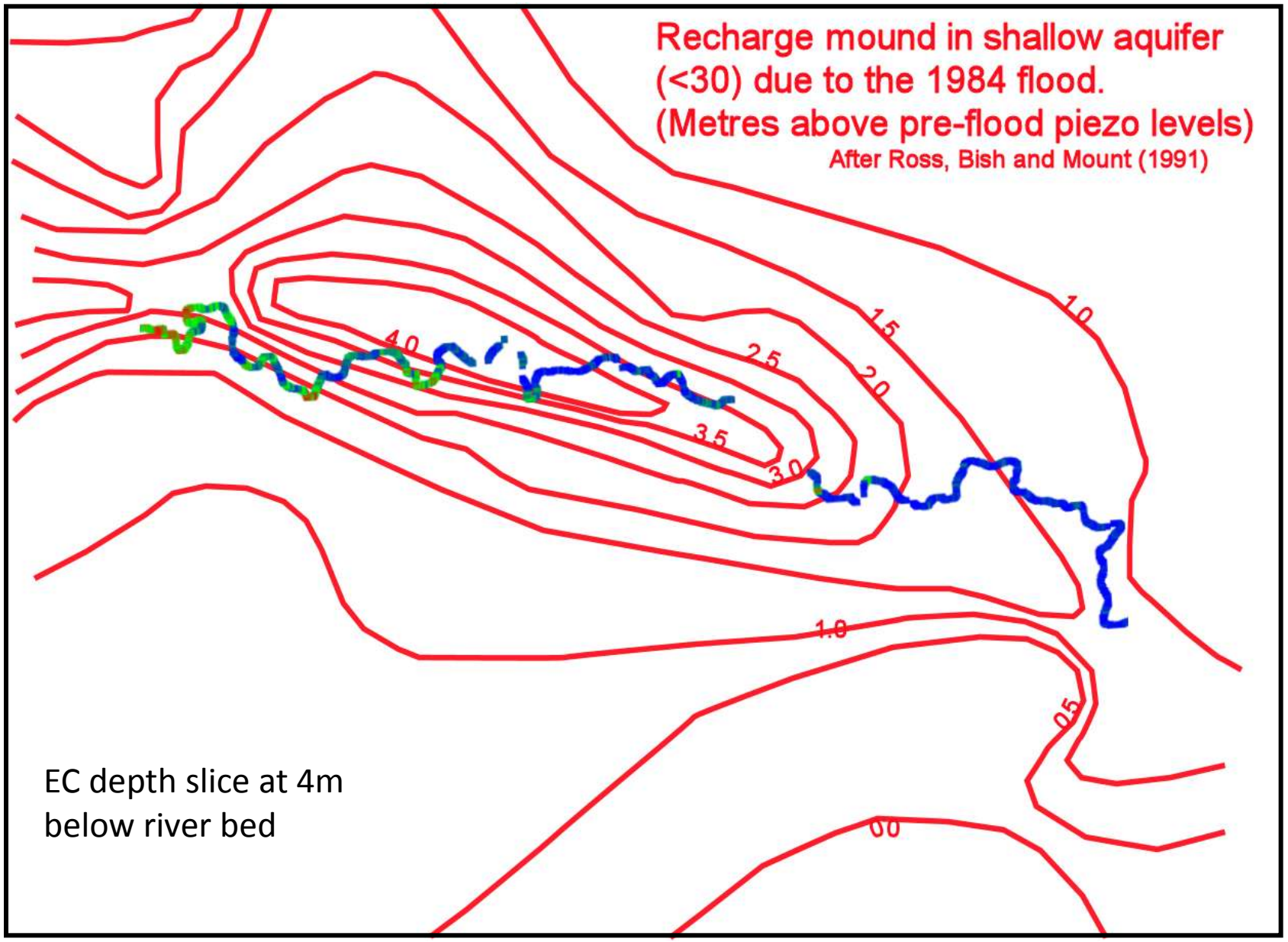
EC beneath the Namoi River



Sediment Description	Code	Color
Gravel	G	
CoarseSand	CoS	
Sand	S	
FineSand	FS	
Silt	Si	
Loam	L	
Peat	P	
Light Clay	LC	
Medium Clay	MC	
Clay	C	
Heavy Clay	HC	
Conglomerate	Cg	
Sandstone	SS	
Siltstone	Sis	
Claystone	Cys	
Gypsum nodules	Gy	
Metamorphic Rock	Met	
Limestone	Ls	
Dolomite	Dol	
Shale	Sh	

Bore lithologies lifted 8m to account for river incision

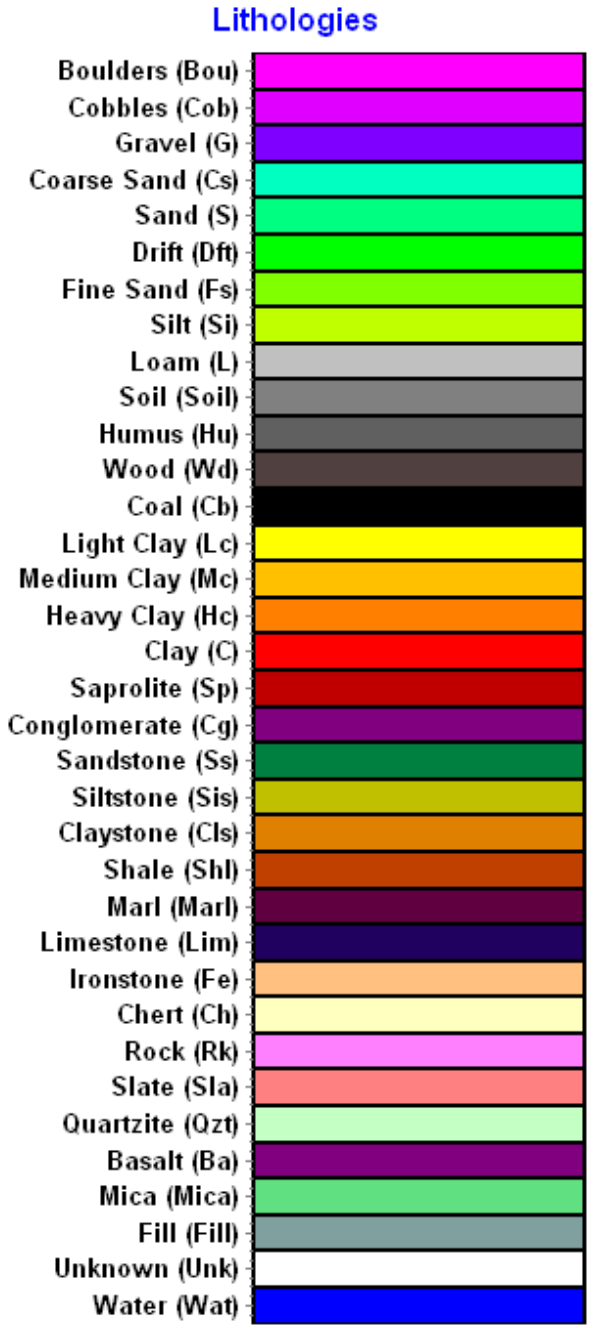
Log10 Depth Scale


Recharge mound in shallow aquifer
(<30) due to the 1984 flood.
(Metres above pre-flood piezo levels)
After Ross, Bish and Mount (1991)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
1.0
0.5
0.0
EC depth slice at 4m
below river bed

2008 Bore log analysis

Contents:

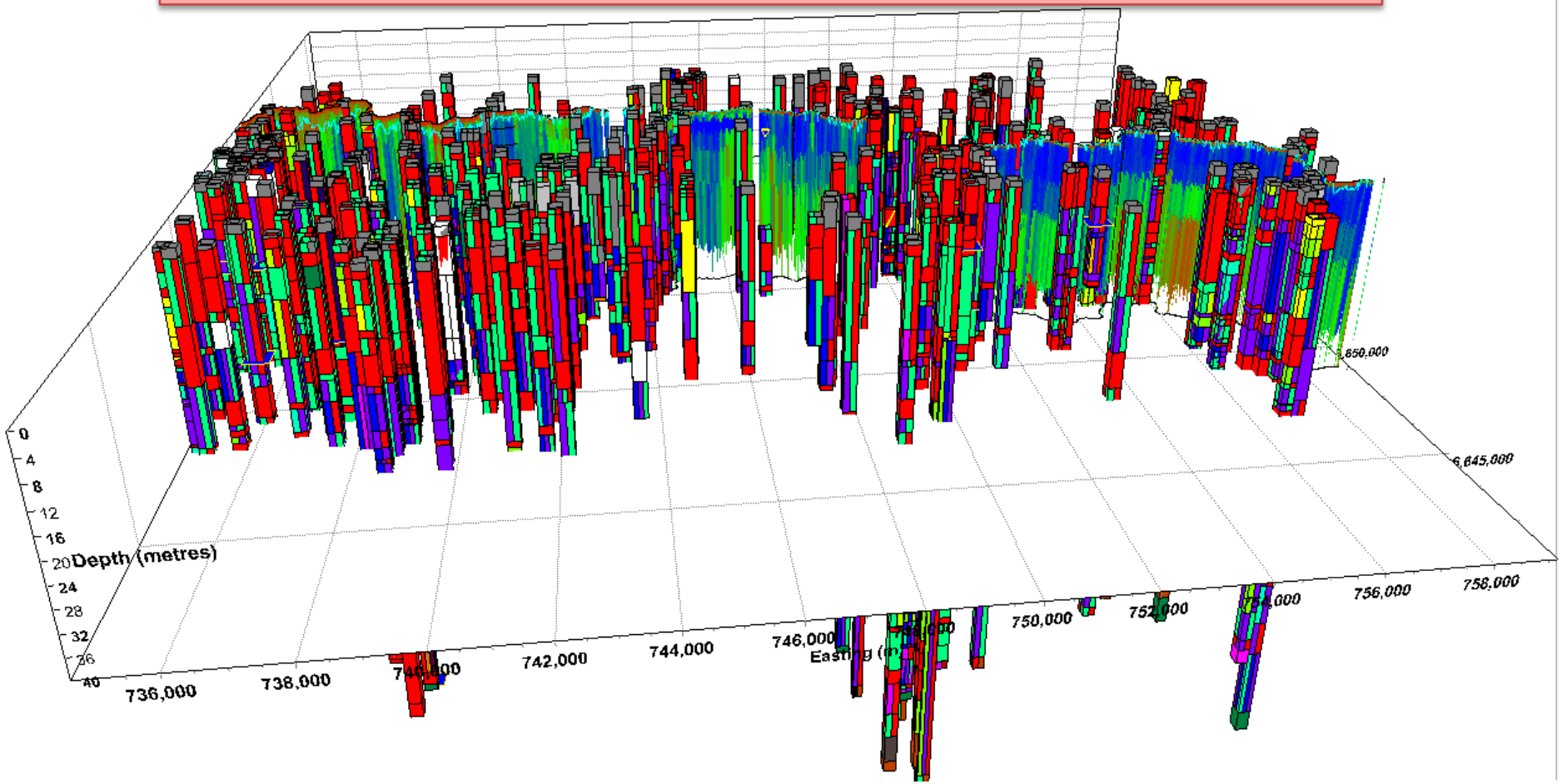
- Views of the entire dataset (TOO MANY BORES)
- Views of bores just close to the river
- Views of Mollee Weir to the CRDC research station
- Views of CRDC Research Station to Wee Waa Bridge
- Views of Wee Waa Bridge to Gunidgera Weir



Project: Wee Waa Recharge
Site: Mollee Weir to Gunidgera Creek Weir Client: CRDC
Data Provider: Groundwater Imaging Pty Ltd JobNum: 1
Survey Equipment: RIP924, 156m streamer, sonar and water pH, Temp and EC loggers Survey Date: 11/07/2004

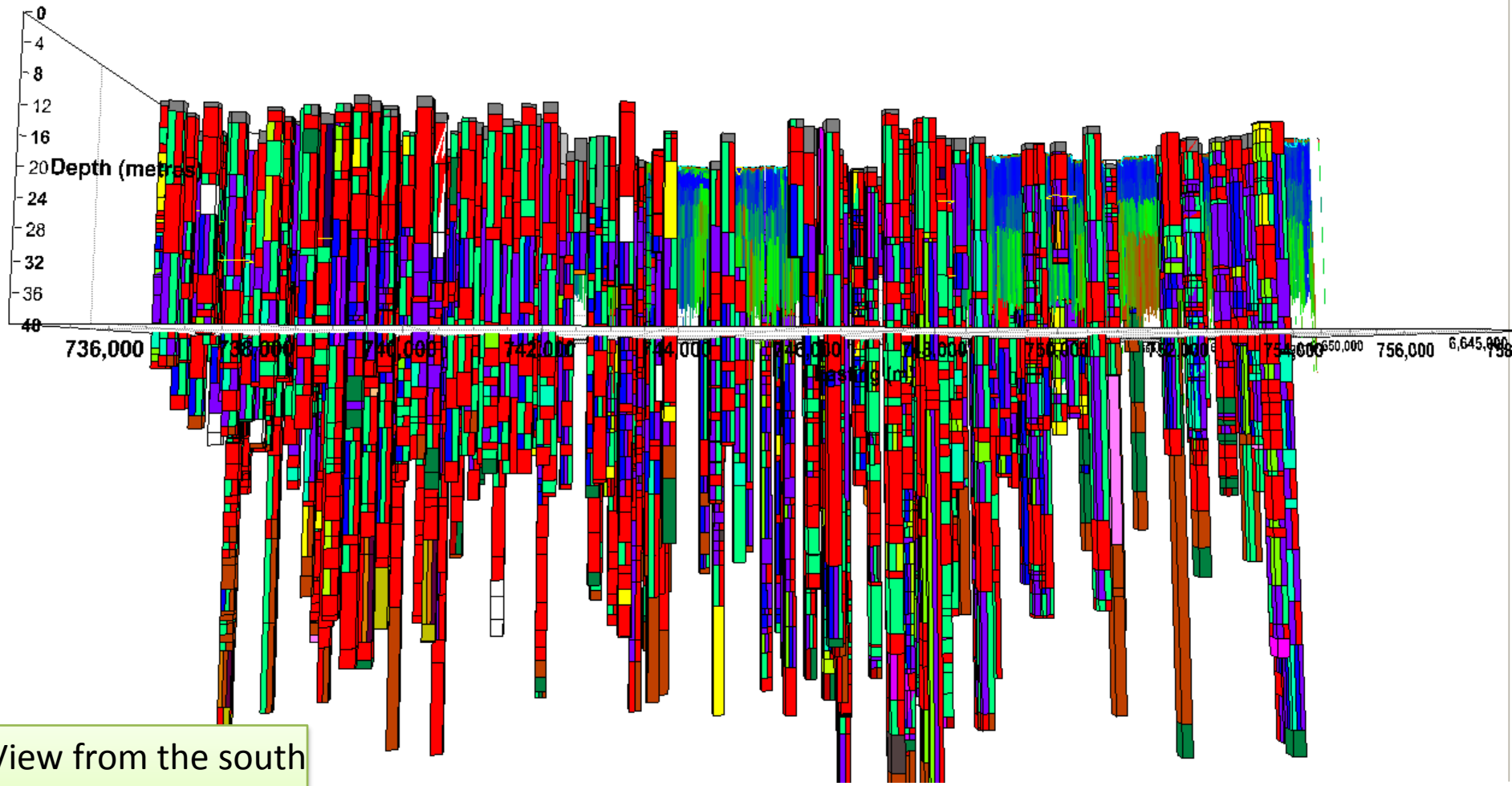
Lower Namoi Bores and geo-electric data comparison – Gunidgera Ck Weir to Mollee Weir

See also Zoomed in Sub-sampled images – they are more comprehensible



River incision: 3 to 10 m

Project: Wee Waa Recharge
Site: Mollee Weir to Gunidgera Creek Weir Client: CRDC
Data Provider: Groundwater Imaging Pty Ltd JobNum: 1
Survey Equipment: RIP924, 156m streamer, sonar and water pH, Temp and EC loggers Survey Date: 11/07/2004



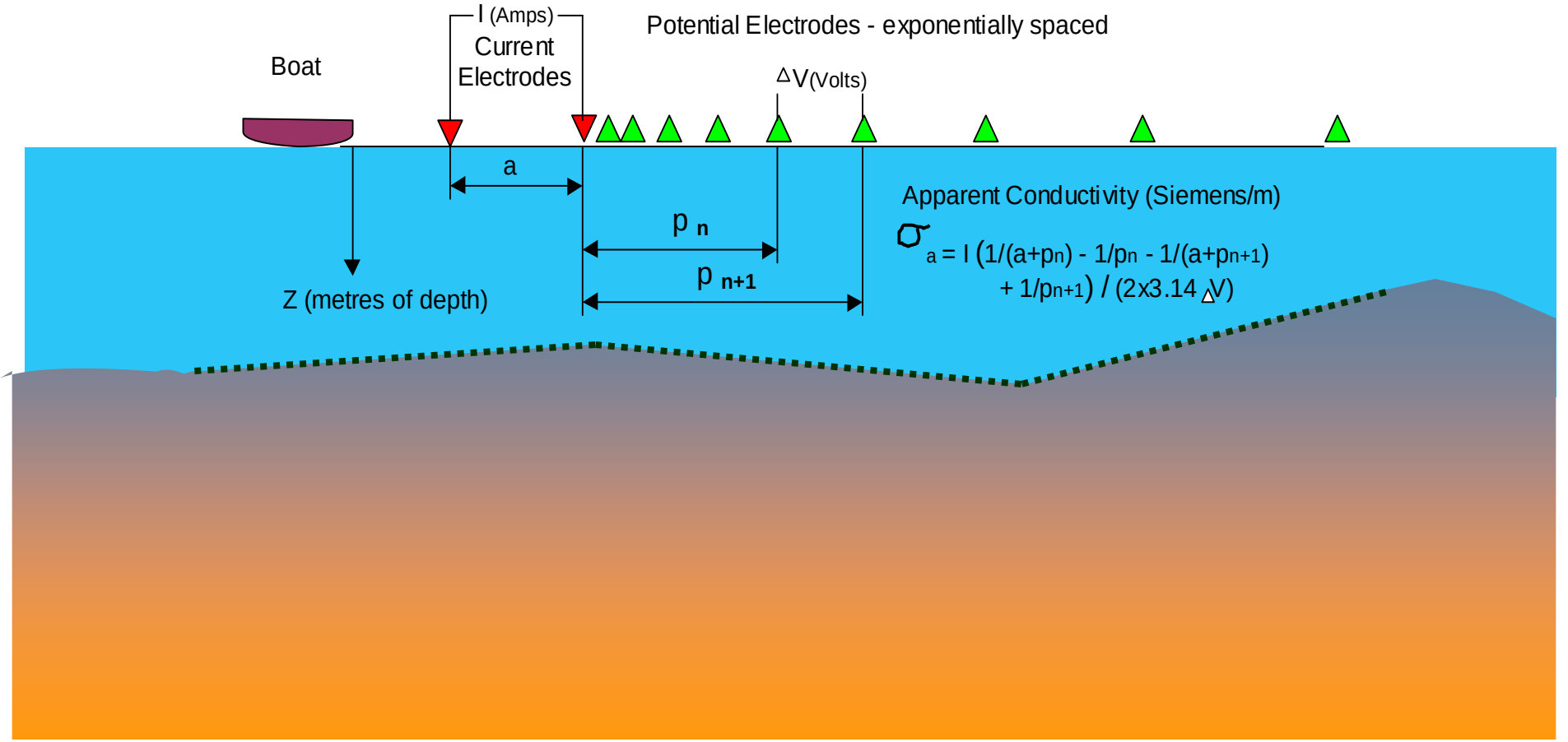
View from the south
Linear Depth Scale
from 0m to 40m

River incision: 3 to 10 m

Geo-electric Equipment Description

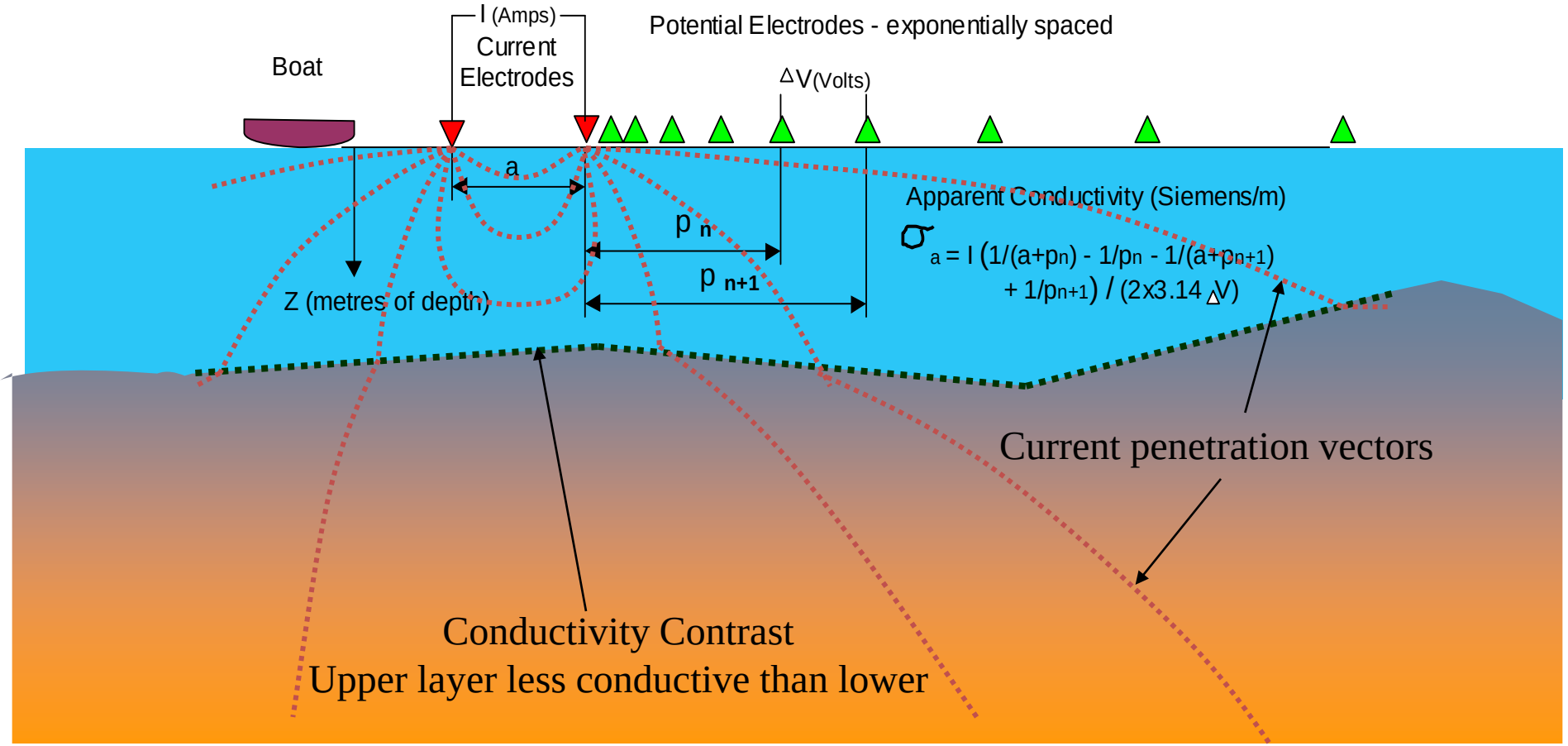
An exponentially spaced electrode array for use on watercourses

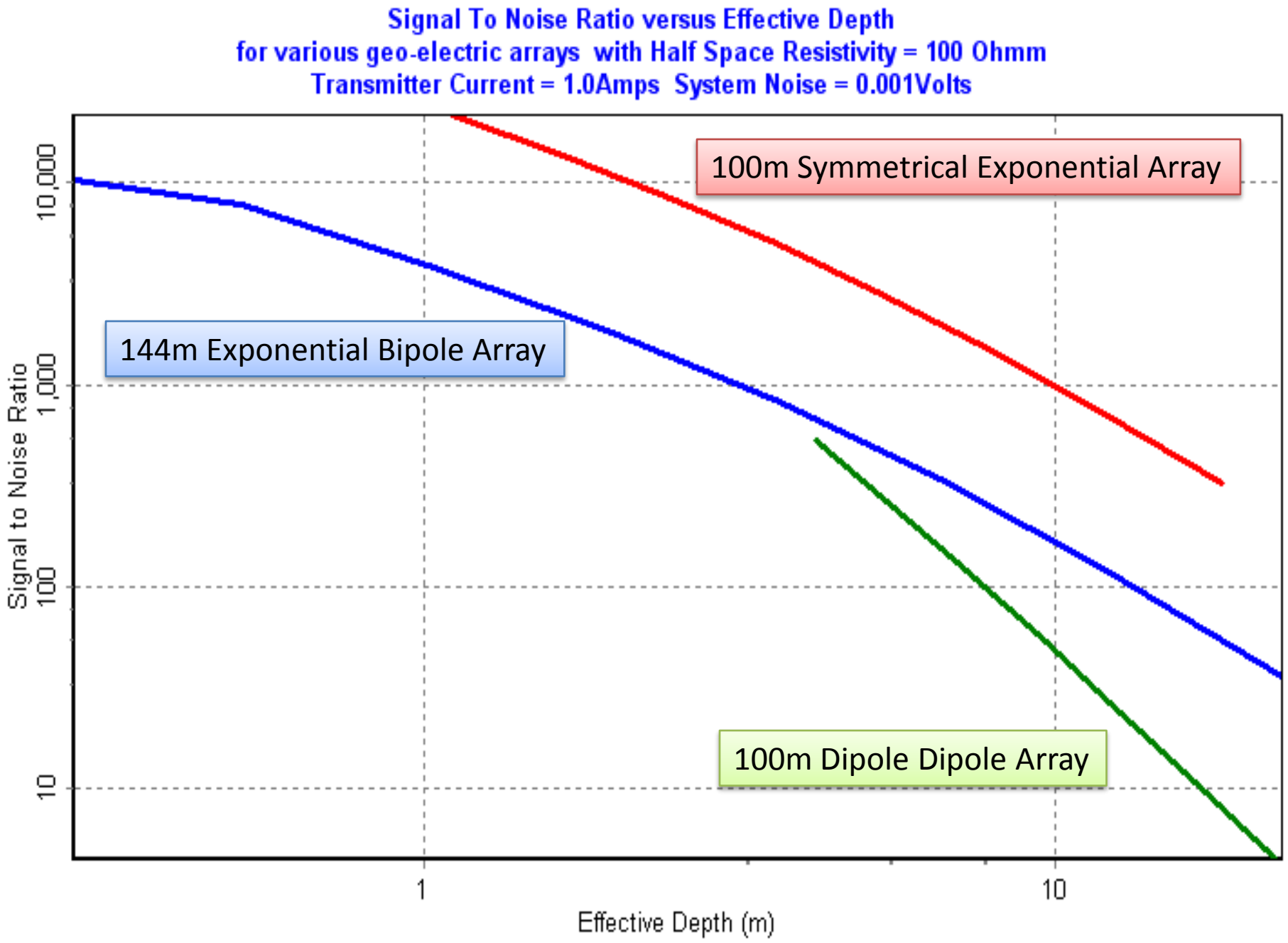
Presented by
David.A1@bigpond.com



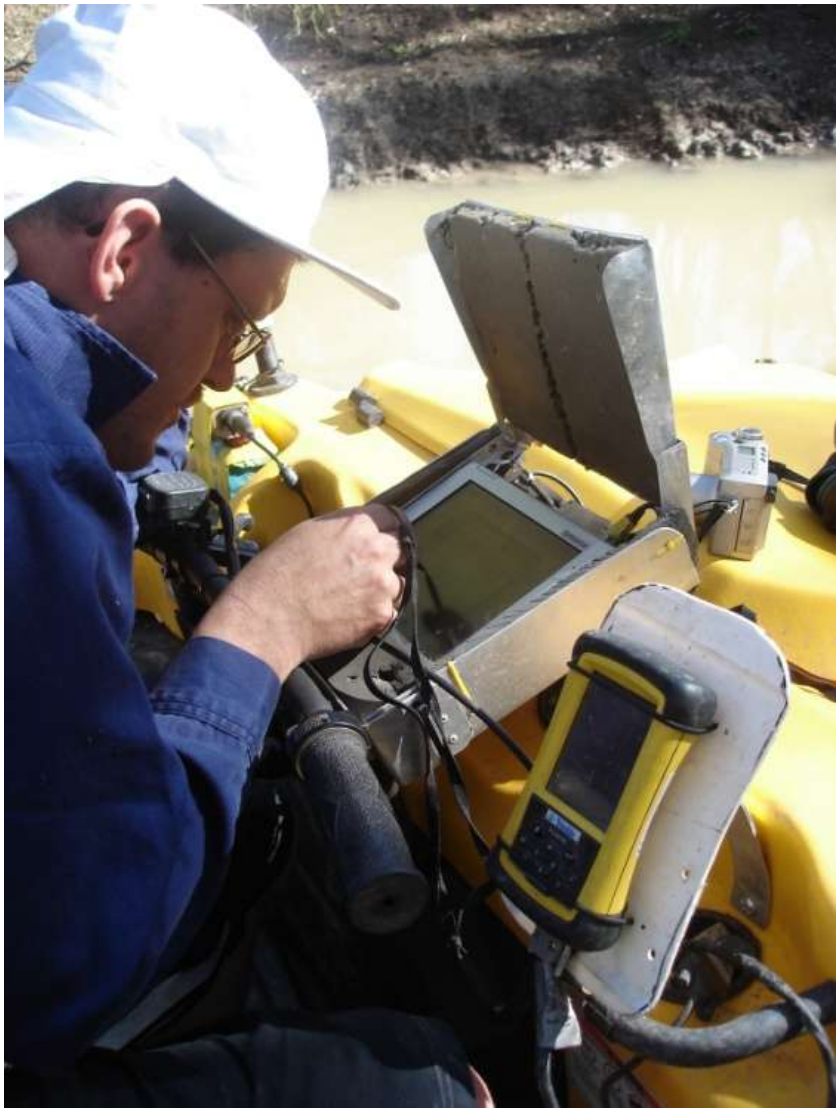
Electric fields are distorted across conductivity contrast boundaries

Presented by
David.A1@bigpond.com




Signal To Noise Ratio versus Effective Depth
for various geo-electric arrays with Half Space Resistivity = 100 Ohmm
Transmitter Current = 1.0Amps System Noise = 0.001Volts
100m Symmetrical Exponential Array
144m Exponential Bipole Array
100m Dipole Dipole Array
Signal to Noise Ratio
10,000
1,000
100
10
1
10
Effective Depth (m)

Argo based river surveys



Argo Based River Surveys

Data is located during postprocessing using a time index merge

Air vent

Greenspan Smartlogger

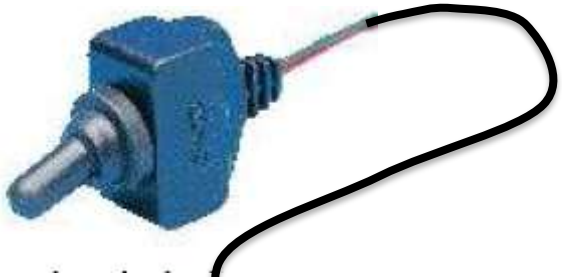
Air vent

EC sensor

pH sensor

Rubber seals

Sump



Flushing point at gravitational sediment accumulation point

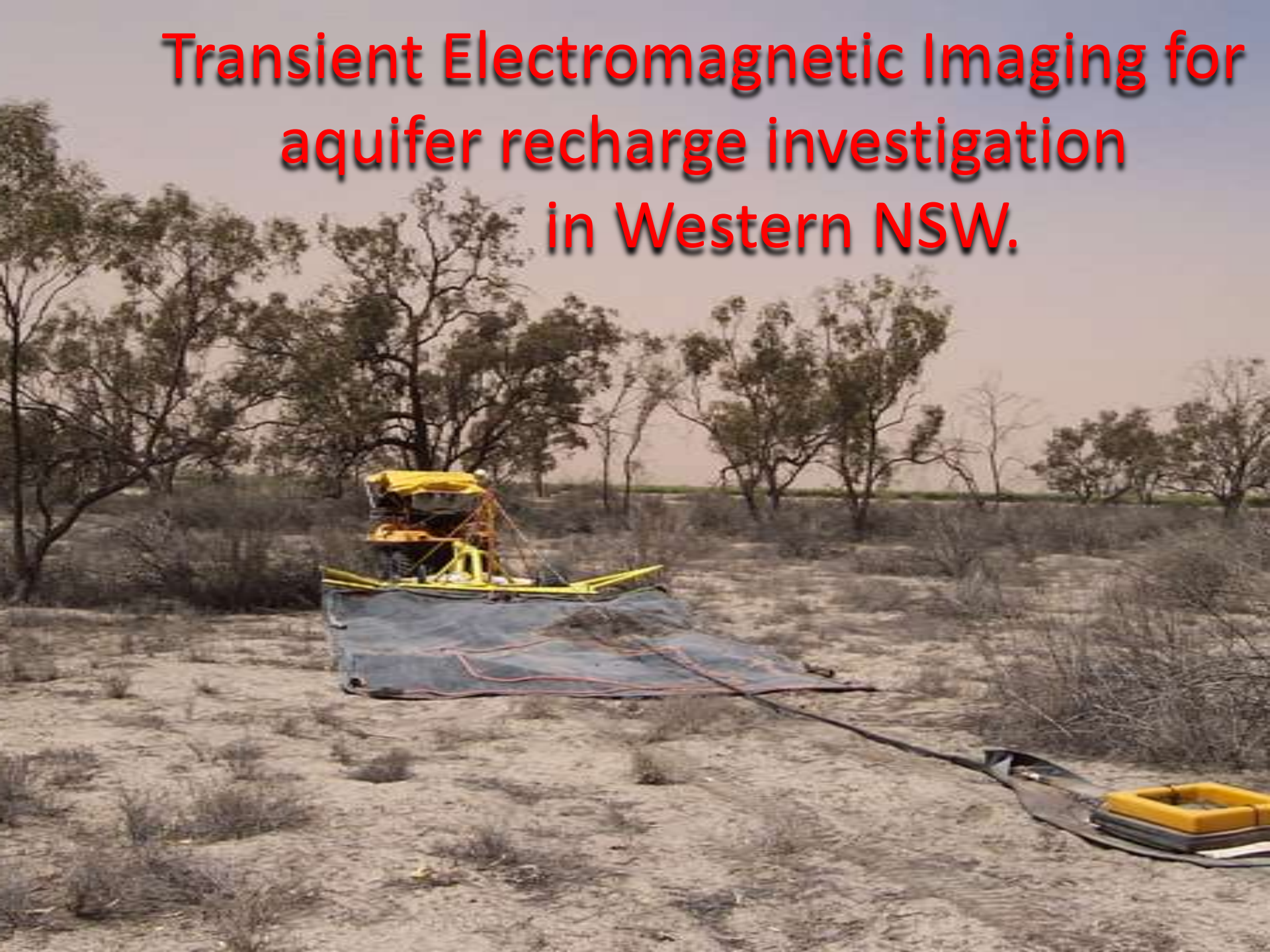
Pump, flow sensors, auto-restart, and intake filter all attached to the back of the water vessel.

Outlet

Towards quick survey past canal obstacles


RN635-G1
RN635-G2

Transient Electromagnetic Imaging for aquifer recharge investigation in Western NSW.



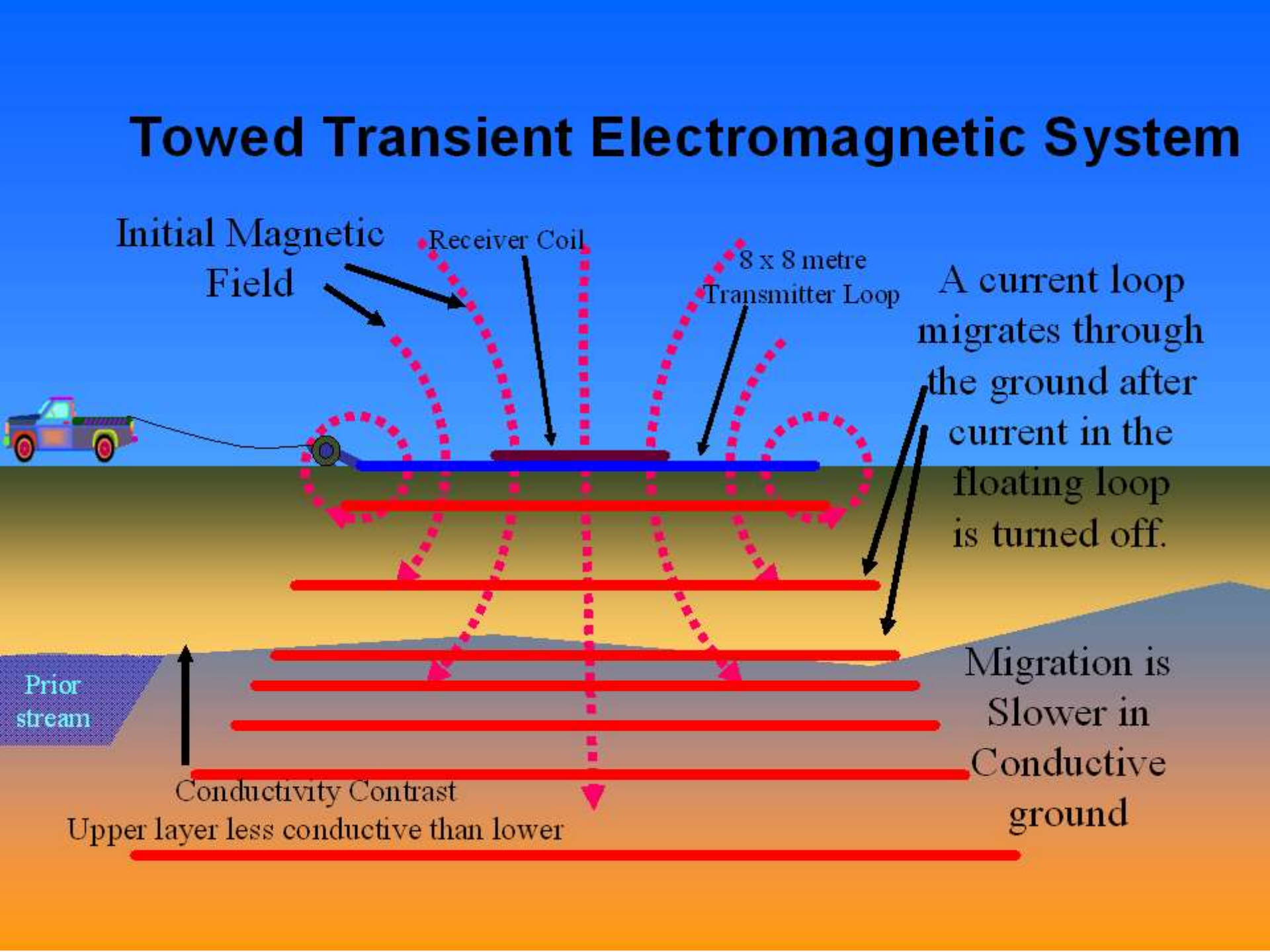
Planning for Managed Aquifer Recharge near Menindee Lakes

C. M. Jewell & Associates Pty Ltd

countryenergy

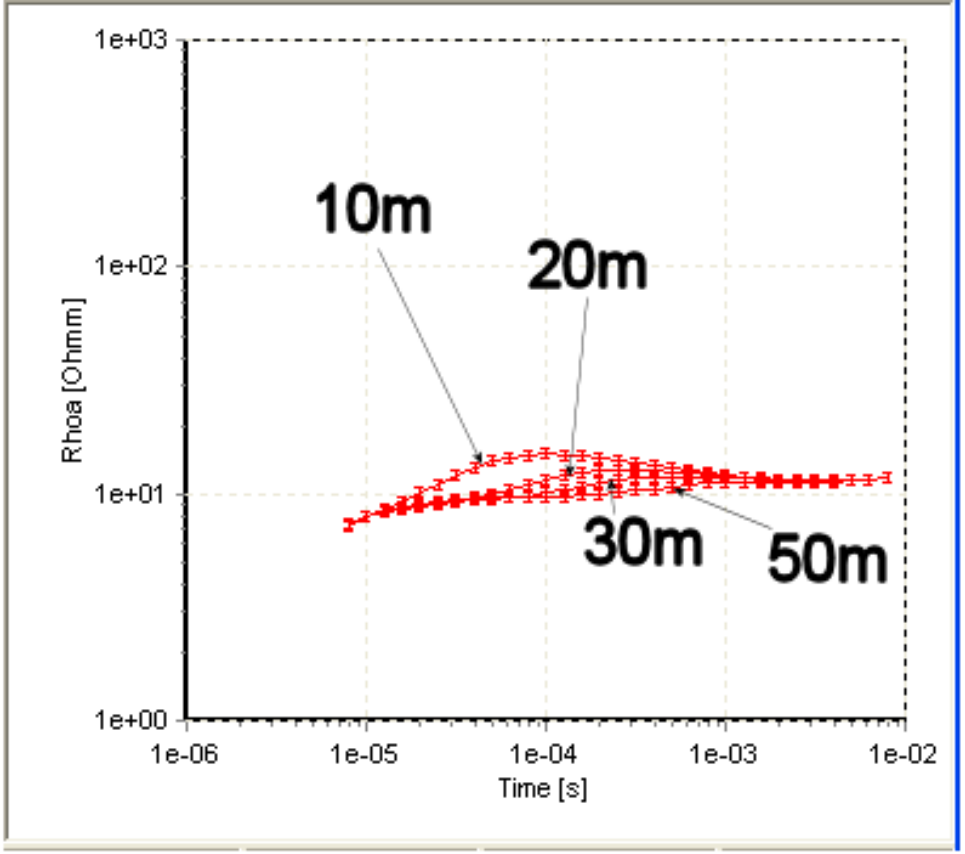
countrywater

Towed Transient Electromagnetic System



Towed TEM Photos

Towed TEM Photos



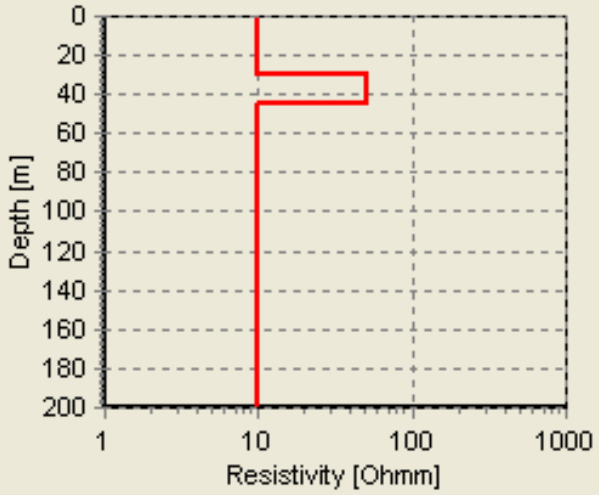
TEM responses of a 15m thick 50 ohm.m (20mS/m) layer at specified depths within a 10 ohm.m (100mS/m) host

Sample Model

Model parameters

	Res	ResApriS	Thk	ThkApriS
Layer 1	10.0	99.000	30	99.000
Layer 2	50.0	99.000	15.0	99.000
Layer 3	10.0	99.000		

Commands

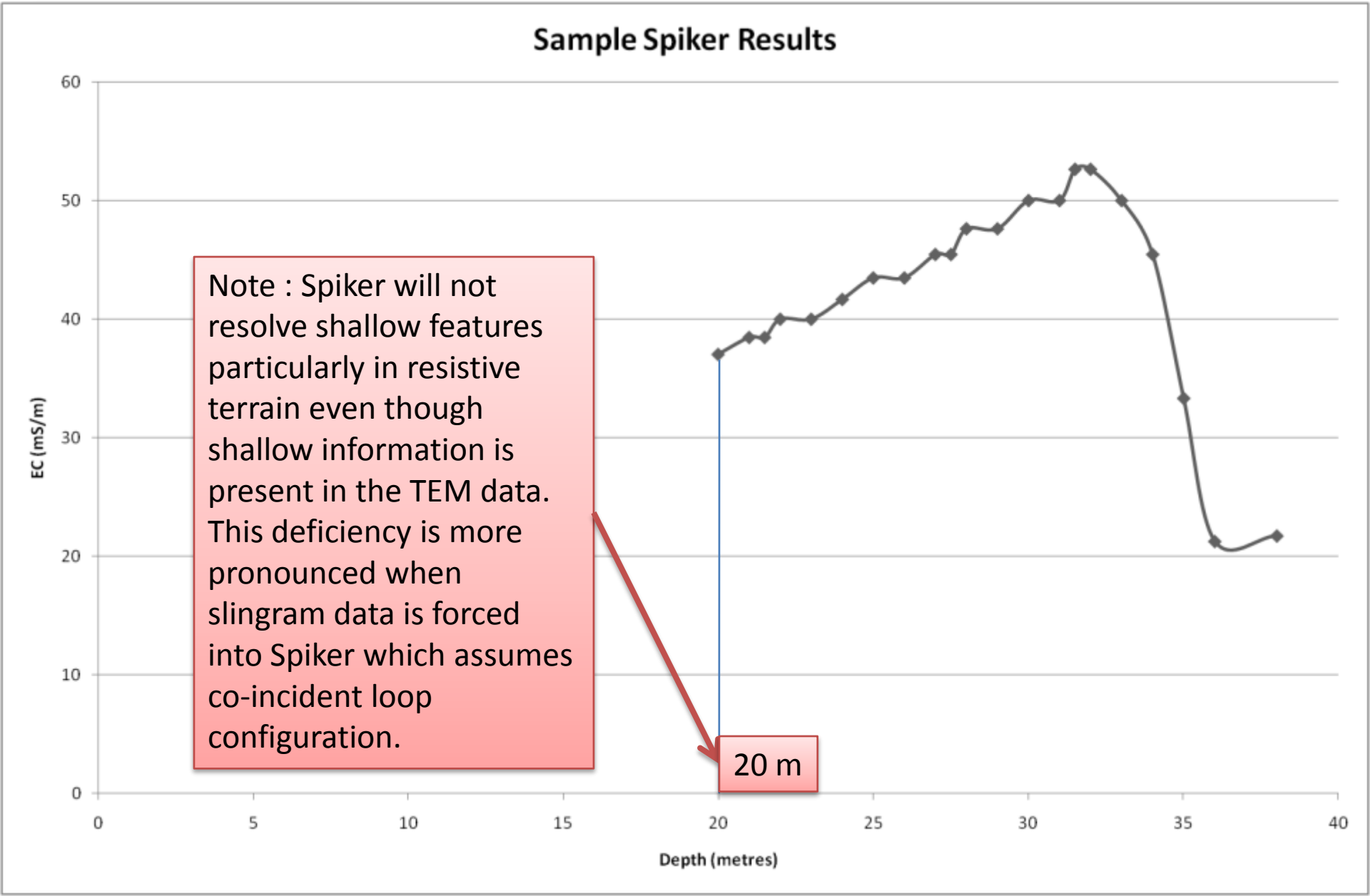


Towed TEM on a plastic sheet – geophysics on a shoestring


6,178,000
6,177,500
6,177,000
6,176,500
6,176,000
Northing (m)
425,000
425,500
426,000
427,000
428,000
428,500
429,000
Easting (m)

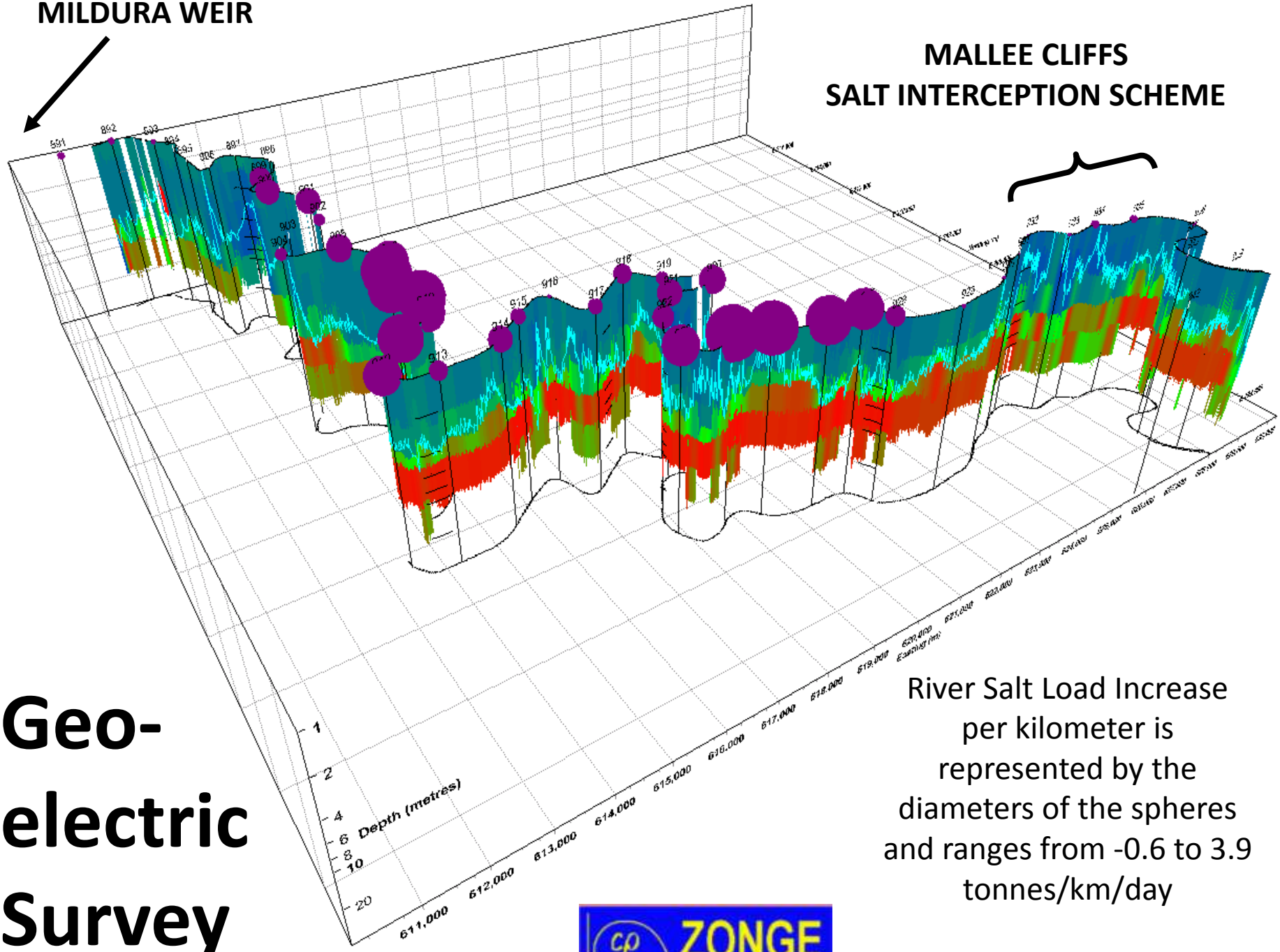
ZONGE

ONE TEM SOUNDING



MILDURA WEIR

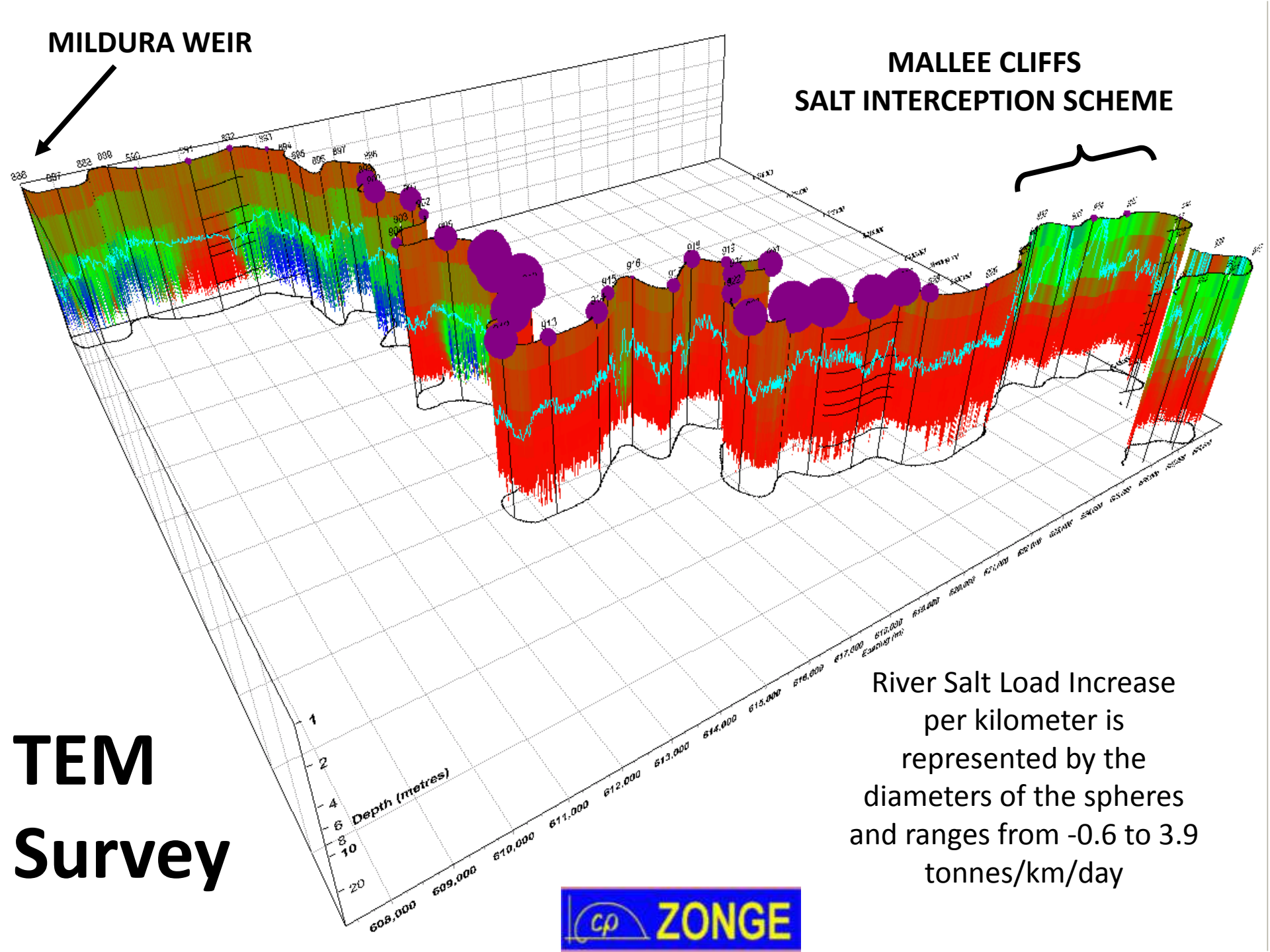
MALLEE CLIFFS
SALT INTERCEPTION SCHEME



Geo-electric Survey

River Salt Load Increase per kilometer is represented by the diameters of the spheres and ranges from -0.6 to 3.9 tonnes/km/day

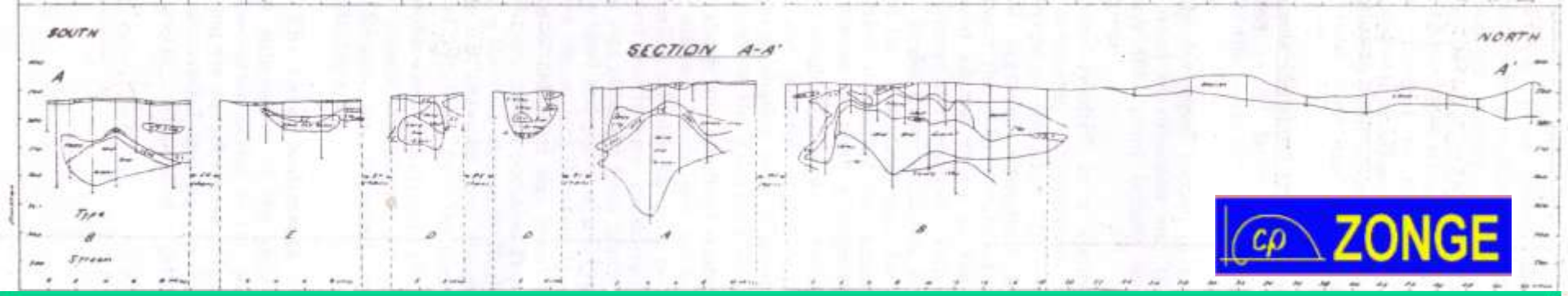
ZONGE



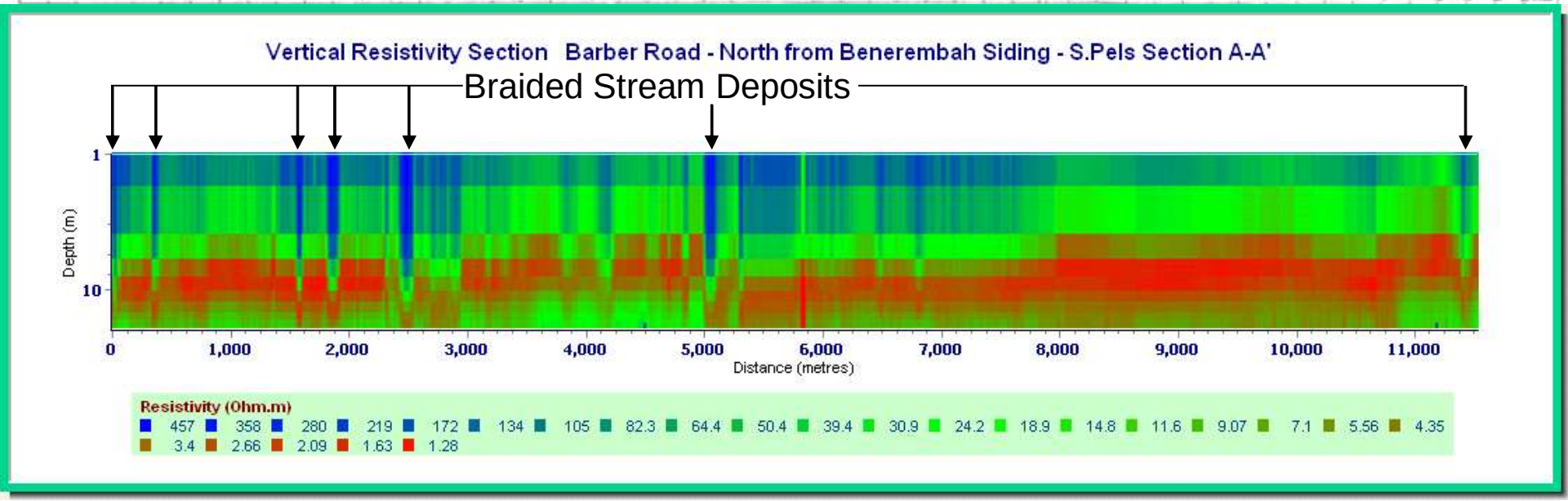
TEM Survey

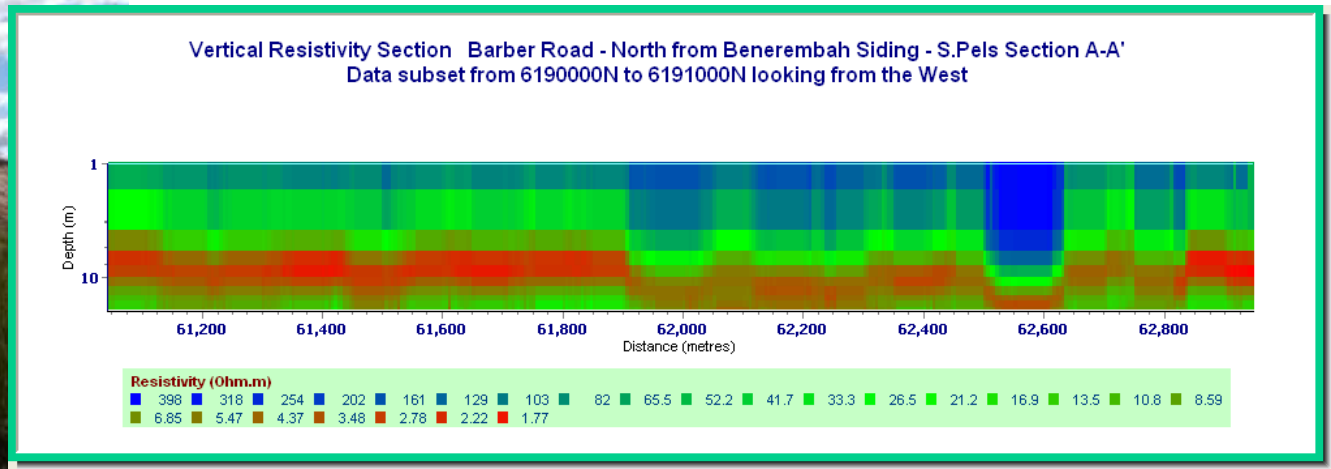
River Salt Load Increase per kilometer is represented by the diameters of the spheres and ranges from -0.6 to 3.9 tonnes/km/day

ZONGE

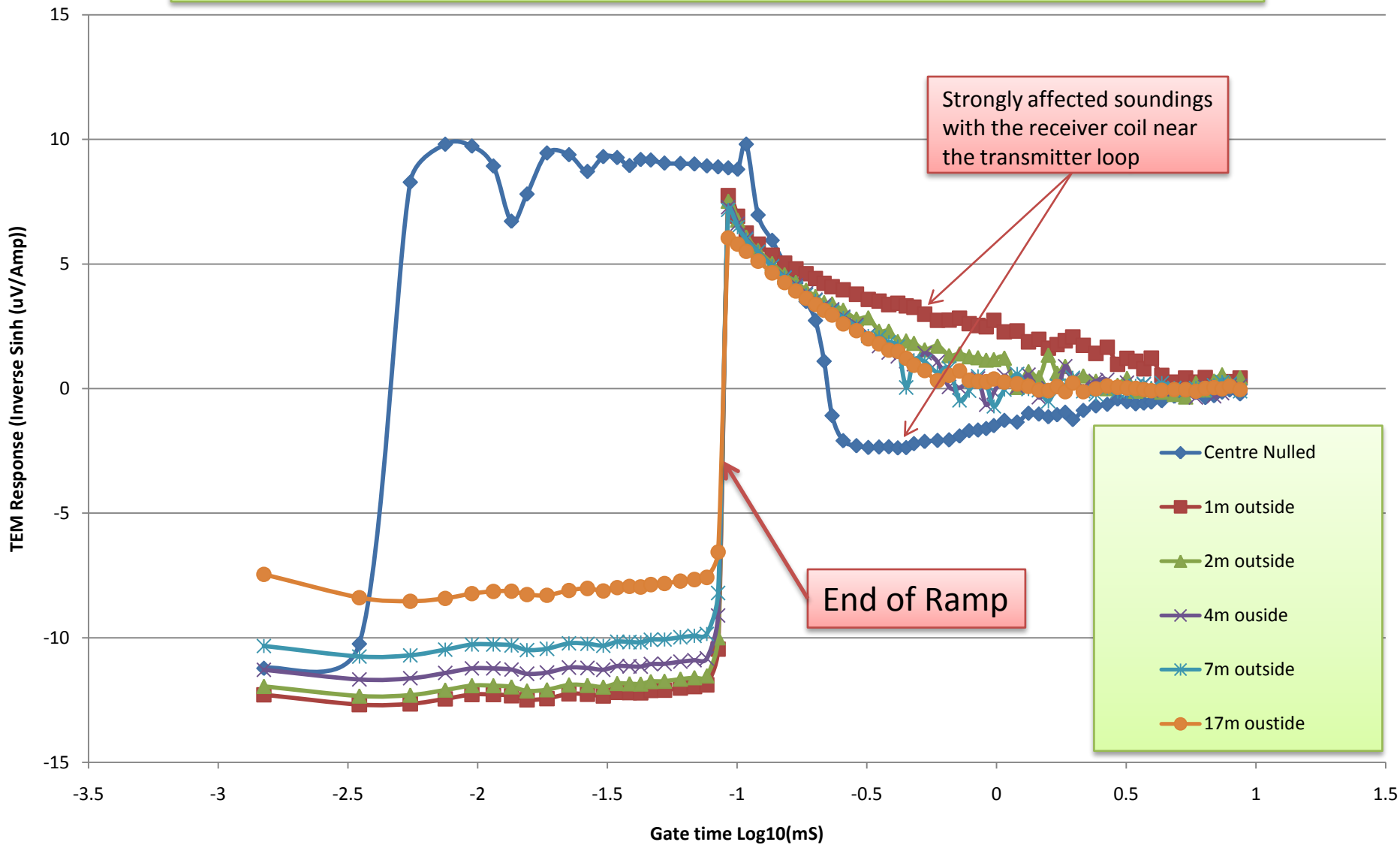

SOUTH
SECTION A-A'
NORTH
A
A'

ZONGE

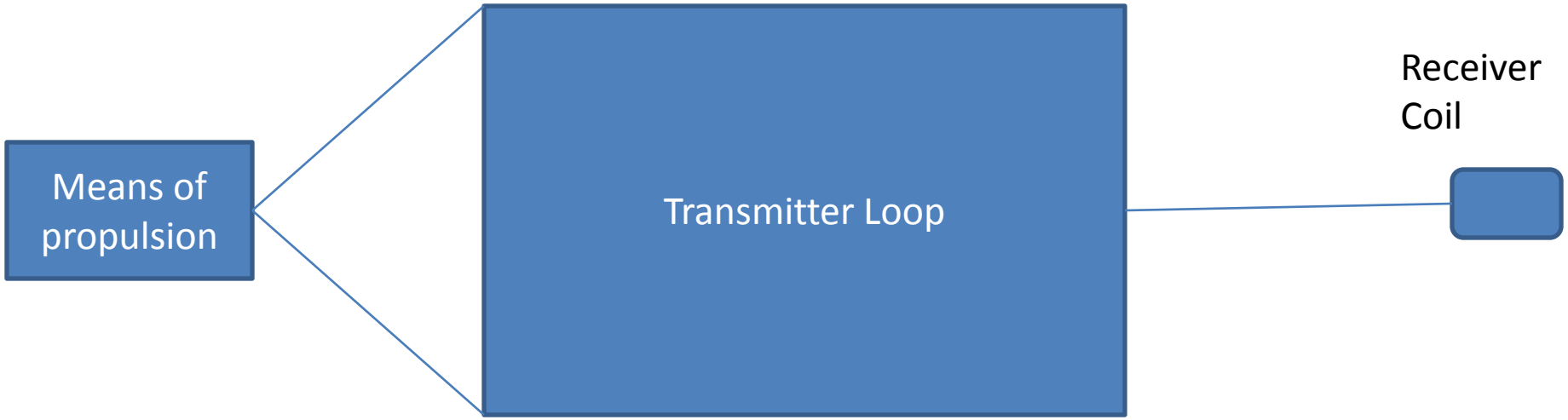

Vertical Resistivity Section Barber Road - North from Benerembah Siding - S.Pels Section A-A'
Braided Stream Deposits
Depth (m)
1
10
0
1,000
2,000
3,000
4,000
5,000
6,000
7,000
8,000
9,000
10,000
11,000
Distance (metres)
Resistivity (Ohm.m)
457 358 280 219 172 134 105 82.3 64.4 50.4 39.4 30.9 24.2 18.9 14.8 11.6 9.07 7.1 5.56 4.35
3.4 2.66 2.09 1.63 1.28


Vertical Resistivity Section Barber Road - North from Benerembah Siding - S.Pels Section A-A'
Data subset from 6190000N to 6191000N looking from the West
Depth (m)
1
10
61,200
61,400
61,600
61,800
62,000
62,200
62,400
62,600
62,800
Distance (metres)
Resistivity (Ohm.m)
398 318 254 202 161 129 103 82 65.5 52.2 41.7 33.3 26.5 21.2 16.9 13.5 10.8 8.59
6.85 5.47 4.37 3.48 2.78 2.22 1.77

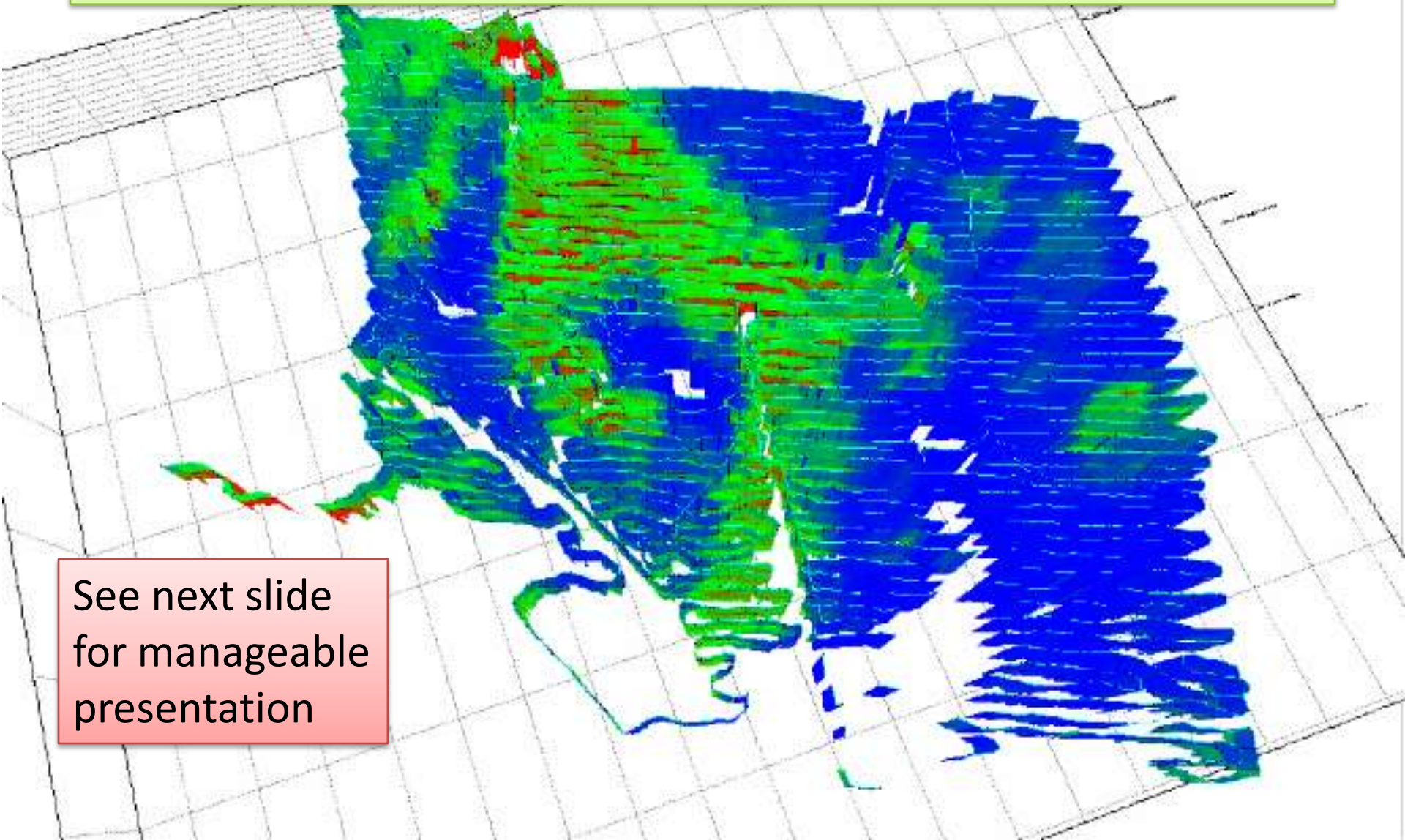
A problem with induced polarization and/or super-paramagnetic effects



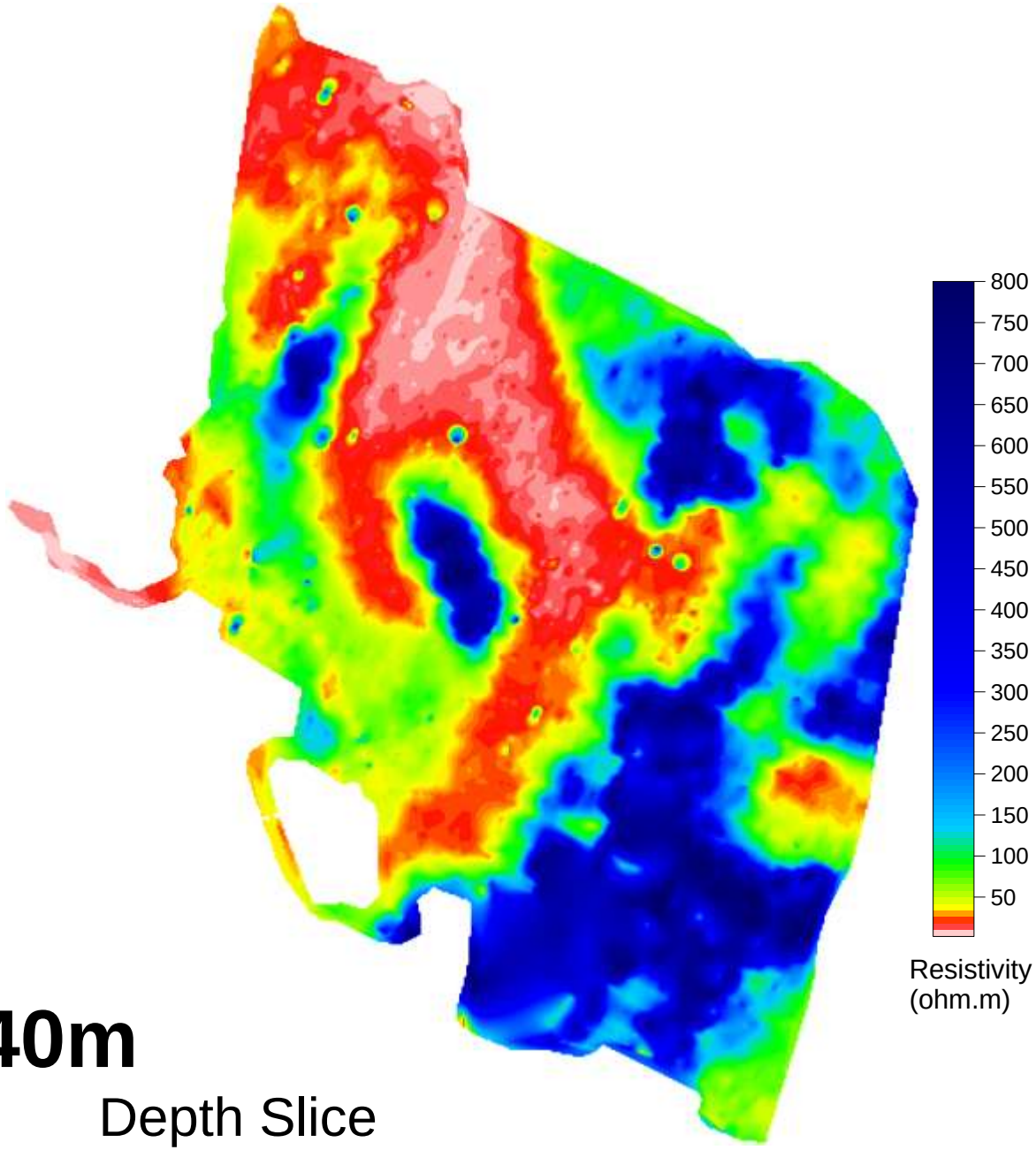
Towed TEM – Slingram Arrangement



Towed TEM data



See next slide for manageable presentation



Towed TEM data

Deep Electrical Conductivity Imaging

- is suited to recharge pathway investigation
- Recharge pathways from surface water bodies are clearly identified by geo-electric survey.
- Potential recharge from dry land is best identified by towed or airborne EM equipment configured to resolve an appropriate depth interval.

The need for recharge management

- Large scale artificial recharge has been proposed regularly over the years for agriculture by hydrogeologists. This presentation shows that, to achieve this, weirs have been installed in appropriate places along inland rivers.

- Potential artificial recharge schemes such as proposed for the Namoi back in 1994 by Woolley et al. are now of great potential for water value adding via re-regulation.

Woolley, D., Forest, J., Green, J., Latty, K., Williams, R.M., 1994, Proposals for Artificial Recharge in the Namoi Valley: Dept. of Water Resources Technical Services Division, July, TS94.061