Contents

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1. Introduction

Development of a prawn farm is planned for a site of approximately 800 hectares west of the Elliot River near Guthalungra North Queensland. As part of preliminary site investigations EM34 surveys were carried out.

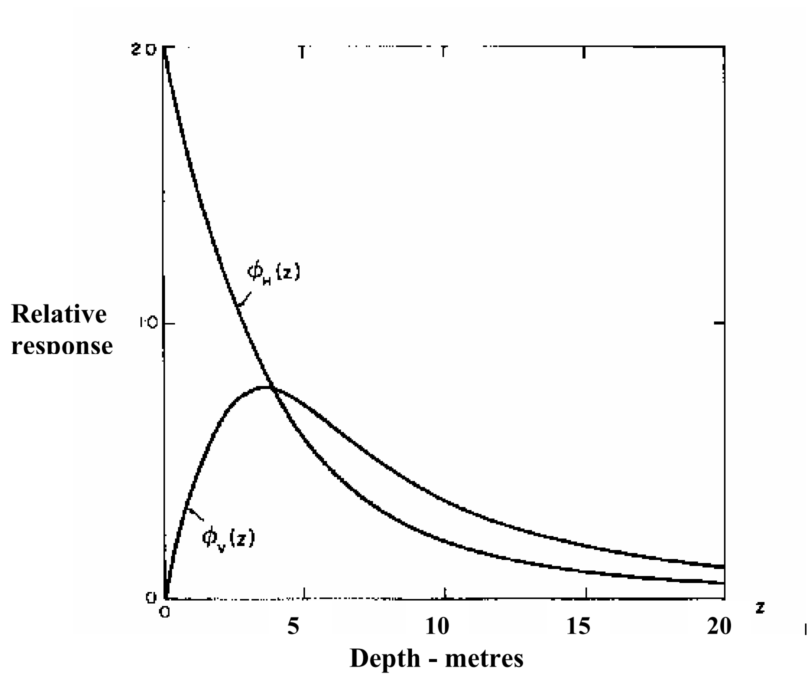
The surveys were carried out over three days between 17 to 19 June 2002.

The objective of the surveys was to:

- Find best placement for observation bores for long term groundwater monitoring;
- Locate potential fresh groundwater resources; and to
- Provide baseline site information to assist with hydro-geological characterisation of the site

2. Method

A Geonics EM-34-3 frequency domain EM system was used. Coils were oriented vertically (horizontal dipole mode) with a coil separation of 10 metres. Readings were taken every 10 metres along east-west lines 200 metres apart. Figure 2.1 (McNeill, 1980) shows how the EM-34 responds to conductivity material at depth. In the configuration used ($\phi_H(z)$) the greatest response comes from the near surfac anm dteh relative contribution of deeper material decreases with depth. Thus for these surveys we can assume that the bulk of the conductivity response on the EM-34 is coming from material in the top 7.5 metres. Alternatively one can assume the horizontal dipole measures a cumulative conductivity with greatest influence from the near surface material with minimal contribution below 7.5 metres below surface.



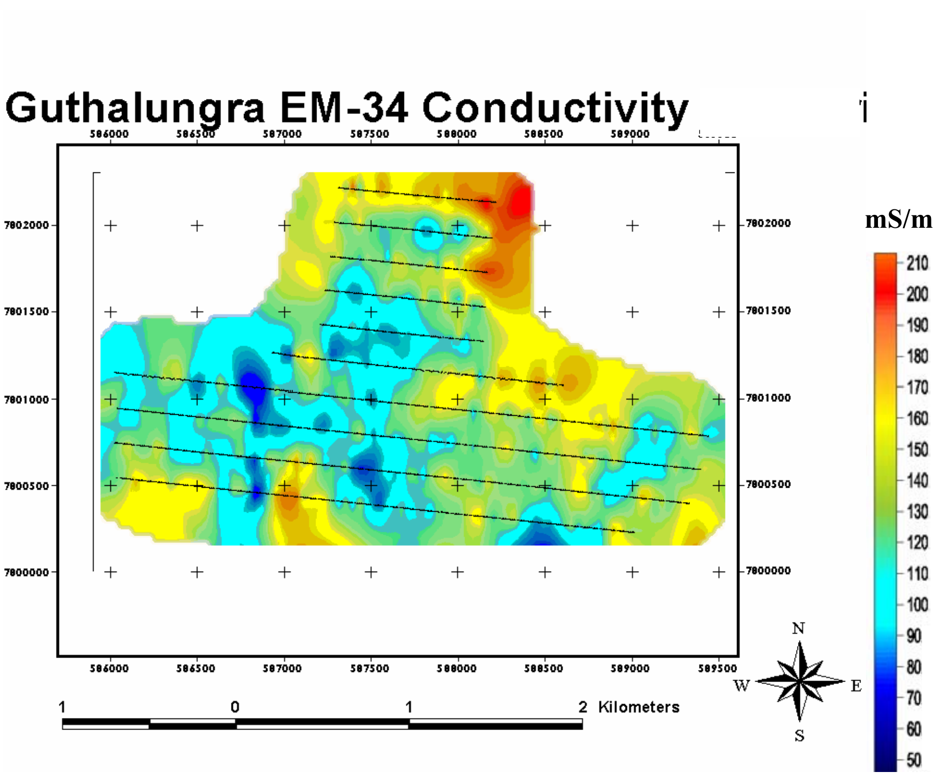
- **Figure 2-1 Depth response of horizontal (*$\phi_H(z)$* and vertical *$\phi_v(z)$* dipoles for EM-34 (McNeill, 1980) with 10m dipole separation.**

An Omnistar differential GPS receiver was used for navigation along lines and for recording of points every 500 metres along lines. Positional accuracy is considered to be better than +/-10m.

3. Results and processing

An image of the EM-34 conductivity for the area is presented as figure 3.1.

The image was prepared using CHRIS-DBF software with a grid cell size of 40 metres. This software interpolates the readings between the lines on a cell size of 40m the resulting grid can then be imaged or contour with further interpolation to give a smooth looking change in response across the image. Griding is normally done at around ¼ to 1/5 the line spacing.



■ **Figure 3-1 EM-34 conductivity from surface to a depth of 7.5m.**

4. Interpretation

EM-34 conductivity data shows a range of conductivity from around 40 mS/m (400EC) up to a maximum of 225 mS/m (2250 EC). The data is not corrected for non-linearity of the EM-34 response and true conductivity range would be around 50 to 500 mS/m. Recent heavy rain with extensive remaining puddles of surface water indicated the soils were probably fully saturated. The water level in the estuary to the north-east was a few metres below the majority of the survey area.

High Conductivity Areas

In the field the maximum values were noted to be predominantly over areas of heavy black soil. The highest conductivity corresponds to:

- A saturated clay formation of smectite clays;
- A kaolinite clay with pore water in excess of 10,000 mg/L;
- River sand with water salinity close to seawater; or
- Higher salinity (10,000 to 34,000mg/L) water in a sand/clay mixture.

(Emerson, 1997)

No soil analysis was available but these high conductivities are typically seen over black soil areas in the north of Australia. Therefore at this site the high conductivity is considered to mostly reflect heavy smectite clays which remain highly conductive even during long dry periods due to retained pore water and high cation exchange capacity. The increase in conductivity towards the northeast probably reflects occasional inundation and/or sub-surface infiltration of saltwater

Low Conductivity Areas

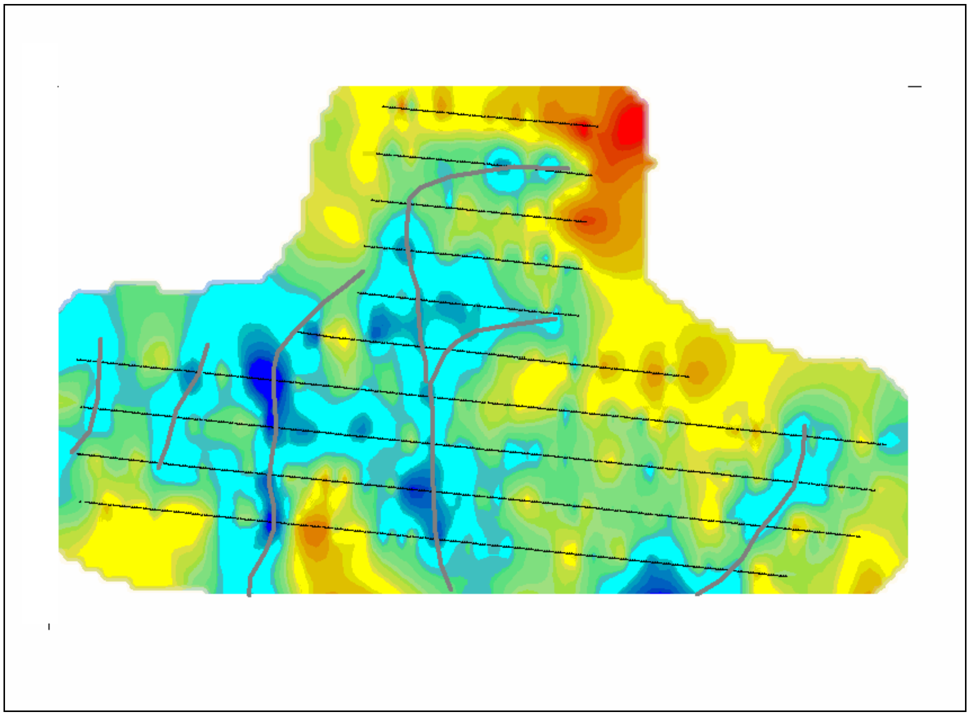
The lowest conductivity corresponds to

- a river sand with water salinity around 800mg/L.
- a sand clay mix with salinity as low as 200mg/L

Three well defined zones of low conductivity were noted in the field to correspond with more sandy soils. The biggest trees were also noted to occur in the lowest conductivity sections particularly to the western side of the grid. These low conductivity sections are considered to represent alluvial sands deposited in stream channels flowing from the south. They are thus likely to be more permeable sections and possible sources of reasonable quality groundwater.

Sedimentation at this site has resulted in a sand and clay sequence which is reflected at the surface by the presence of sandy and clay soils. The geophysics shows the sands are broader at depth than seen at the surface but the EM-34 has not resolved deeper features. Sandy channels at 5 to 10 metres below surface would probably not be 'seen' with the EM-34 method. The sandy channels at surface may be linked at depth to older sand deposits offset form surface expression and in addition there may be discrete sandy bodies in palaeo-drainage channels.

The sandy channels are likely to carry freshwater into the site from upslope areas to the south and west. If resolution of these channels is a priority then further geophysics could be considered using a time domain EM system. This would produce sections down to depth of around 50m across the site and allow a more accurate groundwater model to be developed.

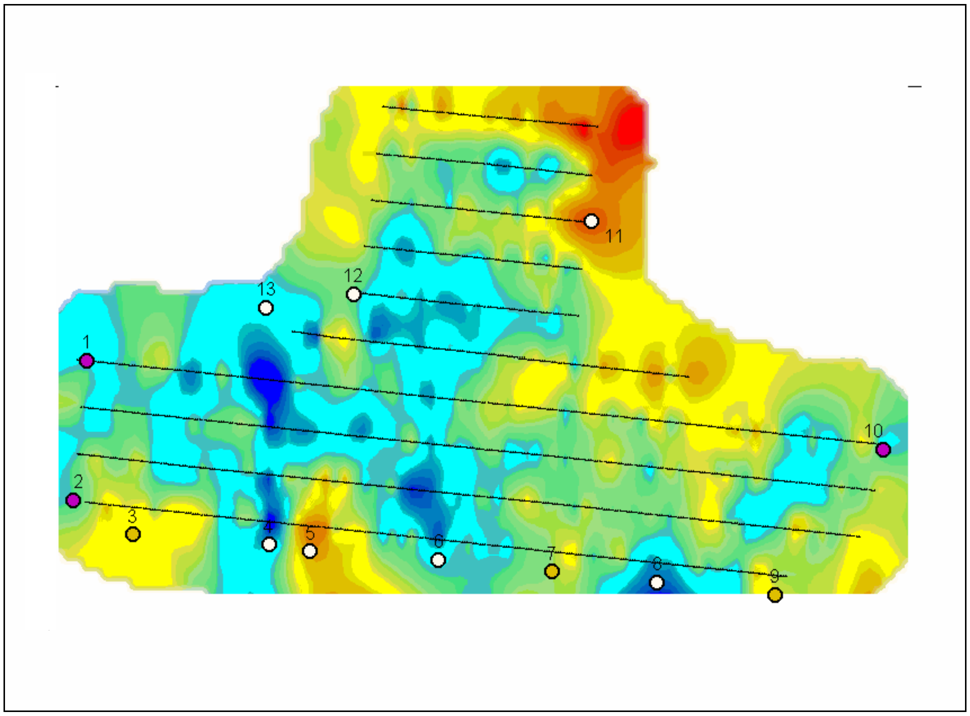


■ **Figure 4-1 map of conductivity showing possible pathways for groundwater from south to north.**

5. Recommendations

Sites of low, medium and high conductivity should be investigated with drillholes. Figure 5.1 shows recommended sites. These sites have been placed along the boundary of the property so they can be used as long term monitoring bores.

Bores marked as low conductivity in table 5.1 are possible sites of fresh groundwater



■ **Figure 5-1 EM-34 conductivity with 13 recommended drillhole sites. See table 5.1 for locations.**

BORE_NO	CONDUCTIVI	EASTING	NORTHING
12	Low	587190	7801430
4	Low	586830	7800370
6	Low	587540	7800310
1	Medium to low	586050	7801150
8	Low	588460	7800220
10	Medium to low	589430	7800770
7	Medium	588020	7800250
3	Medium	586250	7800420
9	Medium	588970	7800150
11	High	588180	7801740
5	High	587000	7800330
2	Medium to low	585990	7800560
13	Low	586820	7801370

■ **Table 5-1 Recommended drillsites for investigation/monitoring bores.**