CASE STUDY 1
Iron Oxide Residues Reduce Pump Efficiency

OVERVIEW
A Burdekin sugarcane farmer furrow irrigates 50 hectares of sugarcane using mainly ground water. The farm is located in an area in which iron bacteria is prevalent in the groundwater. Prior to the energy efficiency assessment conducted through the EEGAI project, the farmer suspected that his pump efficiency at this particular site was likely to be low since it had received minimal maintenance over the years. The assessment revealed excessive suction at the pump inlet, indicating a restriction of flow in the bore. Upon dismantling the pipe and pump assembly it became obvious that iron oxide build up in the pipeline had dramatically reduced the capacity of the pipe to deliver water (See figure 1).

The iron oxide deposits are a result of the oxygen hungry iron bacteria naturally present in the Delta water supply converting the soluble ferrous iron into insoluble ferric iron, which is a reddish precipitate in water. The farmer was surprised at the extent of the iron oxide residue build-up and the restriction caused by it, since his plastic fluming had remained relatively clean. Removing the iron residue from inside the pipes resulted in a 39% decrease in energy costs associated with pumping and also allowed irrigation water to be applied on the paddock at a greatly increased rate and at reduced cost.

Although I suspected that the efficiency of this particular pump might not be very good, I was very surprised at just how bad it was and how much improvement was achieved by clearing the infrastructure.”

THE ASSESSMENT
An energy efficiency assessment was undertaken on the aged 25hp centrifugal pump. This assessment involved collecting inlet and outlet pressure at the pump, water flow measured in L/s using an ultrasonic flow meter, and energy consumption measured in kilowatt hours (kWh) using the electricity meter at the site. During this procedure the pump was set to perform its normal duty, and was allowed a period of time to stabilise before any measurements were taken. Water flow and energy consumption were measured over a one hour period to overcome any short term fluctuations. The measured values indicated that the pump was operating at very low efficiency and with a strong likelihood that there was severe restriction of flow to the pump. Local knowledge suggested that there was a strong possibility of the presence of iron oxide deposits within the pipe and bore.

RECOMMENDATIONS
The energy efficiency assessment revealed that there are a number of ways energy savings could be made in this situation including:

→ Investigate the possibility of iron oxide deposits and remove them from the bore and associated pipes;
→ Upgrading the aged Kelly & Lewis pump; and
→ Increasing irrigation efficiency in the field.

The farmer decided to do one thing at a time so that they could measure how much each change contributed to an increase in efficiency. Checking for and removing the iron oxide residue was the most logical place to start.

Figure 1 – Pipe with iron oxide build up

Figure 2 – Cross section view of bore and associated infrastructure
**OUTCOMES**

Prior to treatment, the water bore was pumping at 31 L/s. After the iron bacteria was treated and the pipework cleaned, flow increased to 59 L/s. A 90% increase in volume. The energy consumption per mega-litre of water pumped was reduced 39%, from 96.4 kWh/ML to 58.7 kWh/ML. This resulted in a reduction in pumping costs from $23.50/ML to $14.30/ML (Figure 3), a 39% reduction.

If this bore were to pump 200 ML per year, it would take just over 2 years for the investment to pay itself off. This calculation is based only on the cost of pumping and does not include the costs saved from increased irrigation application efficiency. Treating the iron oxide problem regularly to minimise iron oxide deposition, and reconfiguring pipework to allow easy maintenance is also likely to reduce the cost of managing the issue in the future.

Due to the increase in pumping capacity, additional energy savings were also able to be made as the time needed to apply the required amount of water to the crop was significantly reduced. For example the time needed to irrigate an 8.8 hectare portion of the property was reduced from 108 hours to 50 hours. So this sugarcane farmer is well on his way to saving even more money due to increased irrigation application efficiency!

As a result of the energy efficiency assessment, the sugarcane farmer is now assessing other pump installations on his property and prioritising the higher use installations, in the hope of receiving a quicker payback period on the money spent for these pumps. He intends to do a cost benefit analysis on each installation before deciding which areas to spend money on, since each situation is different.

As iron bacteria cannot be completely removed from the groundwater system, it is important that water flow (e.g. litres/second) and energy consumption (e.g. kWh) be regularly monitored and recorded at each pump on the property so that in the future, iron oxide deposits can be identified and treated early. This farmer also plans to equip his pumps and pipes with pressure sensors to allow readings to be easily taken to establish a baseline for future monitoring.

**RESULTS**

The results of the pump assessment provided information about rate of water pumped, energy consumed, pump operating efficiency and energy costs. From this data the key information was calculated as below.

<table>
<thead>
<tr>
<th>Measured Parameter</th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow Rate (l/s)</td>
<td>31</td>
<td>59</td>
</tr>
<tr>
<td>Energy Consumption (kWh/ML)</td>
<td>96.4</td>
<td>58.7</td>
</tr>
<tr>
<td>Energy Cost ($/ML) *</td>
<td>23.50</td>
<td>14.30</td>
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</tbody>
</table>

*(The energy use calculation was based on Tariff 65, and assuming equal usage during peak and off-peak)*

**IRON BACTERIA FACTS**

- Many bores contain large populations of naturally occurring un-harmful bacteria.
- When conditions are right, certain types of bacteria excrete iron, creating a rust coloured residue within the bore and pipes. This can greatly reduce the efficiency of bore water extraction.
- The build-up of this residue will be enhanced by high velocities, turbulence, oxygen and high iron levels.

**ACKNOWLEDGEMENTS**

BBIFMAC would like to acknowledge Carl List (Ayr Boring Company) for his advice regarding iron oxide residue removal as well as Merv Jessen (irrigation services contractor) for conducting the pump efficiency assessments.

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“This bore hadn’t been cleaned for at least 17 years. Prior to that it was being cleaned after each crop cycle. We will probably go back to cleaning every crop cycle in the future.”

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