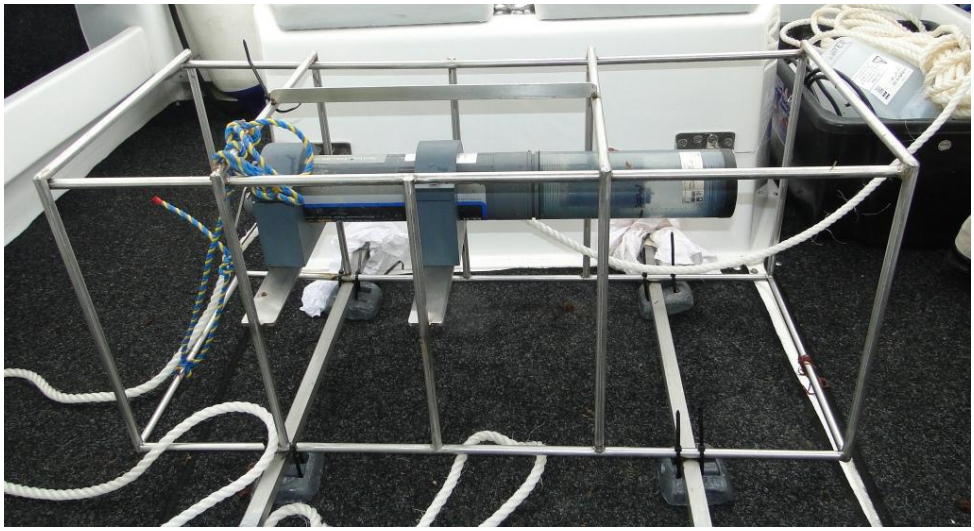
# ADELAIDE DESALINATION PROJECT



## Salinity, pH and dissolved oxygen water quality data from the ADP marine exclusion zone

January 2013

Report prepared by

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Revision History

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| | | | |

# 1 Introduction

In December 2007, the South Australian Government announced the proposal to construct a reverse osmosis seawater desalination plant at Port Stanvac. The Adelaide Desalination Project was initiated to provide metropolitan Adelaide with a sustainable and secure supply of drinking water. The project aims to deliver a climate independent water source that will supplement and secure the metropolitan area's water supply and reduce the reliance on traditional water sources, such as the River Murray.

A multi-national consortium, AdelaideAqua, compromising McConnell Dowell Constructors, Abigroup Contractors, ACCIONA Agua, and United Utilities Australia, were awarded the contract to design, build, operate and maintain the plant for 20 years. As AdelaideAqua D&C Consortium, the joint venture between McConnell Dowell Constructors, Abigroup Contractors and ACCIONA Agua will deliver the 50 GL plant in 2011, with the 100 GL plant to be fully operational by the end of 2012.

Port Stanvac was selected as the preferred site for the Adelaide Desalination Plant (ADP) due to accessibility of relatively deep seawater, good oceanographic dispersion characteristics, its proximity to the water supply network, suitable land availability and lower construction costs.

The initial development phase of the Adelaide Desalination Project identified a number of important environmental issues to take into consideration when operating the plant (EIS 2008), in particular minimising the impact of discharging saline concentrate into the sea.

Concerns were raised by the public, in the initial development of the project, in regards to the potential reduction of dissolved oxygen at the seabed due to the discharge of saline concentrate into the region (EIS Response Document 2009). The risk of depleting oxygen on the seabed was considered low but to provide assurance that dissolved oxygen (DO) concentrations in the region were remaining above 6 mg/L (EPA Water Quality criteria for the protection of marine ecosystems), it was proposed that *in situ* measurments of DO concentrations should be incorporated into the monitoring program.

The EPA Licence (26902) granted to Adelaide Aqua to operate the desalination plant stipulates that DO and pH must be monitored twice per month for at least 24 hours under a variety of different operational modes and receiving environment conditions.

The scope of this study is to characterise ambient DO and pH concentrations on the seafloor, approximately 100 metres from the ADP diffuser, for periods greater than 24 hours under different plant operational modes and receiving environment conditions.

# 2 Methods

## 2.1 *In situ* water quality assessment

*In situ* water quality is assessed using a YSI 6600 series V4 sonde (instrument specifications provided in Table 1), that measures a variety of different parameters. The parameters measured include:

Conductivity (µS/cm);
Specific conductivity (µS/cm);
Dissolved Oxygen (mg/L);
pH;
Turbidity (NTU); and
Water temperature (degrees Celsius)

The sonde is fixed within a stainless steel cage (see cover photo) and lowered to the seafloor, approximately 100 metres north of the ADP diffuser. Water quality data are logged and stored every ten minutes, which includes the instruments depth (metres). The depth data provides information on tidal movement during day, as the instrument is fixed 0.50 m above the seafloor, thus any change in depth is directly related to either tidal or swell patterns during the day.

## 2.2 Salinity Computation

The AWQC has undertaken significant work in calculating total dissolved solids (TDS) from specific conducitivity measurements, to provide a measure of the concentration of salt in solution (g/L). Through the analyses of hundreds of water samples across South Australia, a relationship between electrical conductivity (EC) and salinity (TDS) has been derived (Equation 1).

### *Calculation of Total Dissolved Solids*

TDS is a measure of the combined content of all inorganic and organic substances contained in seawater, of which salt is the dominant constituent. Total dissolved solids concentration (g/L) is calculated from specific conductivity using the empirically formula:

$$TDS = ((0.548 \times EC) + (2.2 \times 10^{-6} \times EC^{2}) - (2.06 \times 10^{-12} \times EC^{3}))/1000 \quad \text{[Equation 1]}$$

Where:

TDS is Total Dissolved Solids (g/L)
EC is specific conductivity (µS/cm) noramilsed to 25$^{o}$C (based on 2% per degree difference from 25 $^{0}$C).

### *Conversion of TDS from g/L to ppt*

TDS (g/L) is expressed as parts per thousand (ppt) by dividing by 1.026. This assumes an average seawater density of 1.026 g/ml based on a salinity of 37 psu and a water temperature of 20 $^{o}$C at a depth of 15 metres.

## 2.3 Instrument Location

The water quality instrument was placed 100 metres south west of the diffuser (Figure 1), at a depth of approximately 20 metres, 0.5m off the seafloor.

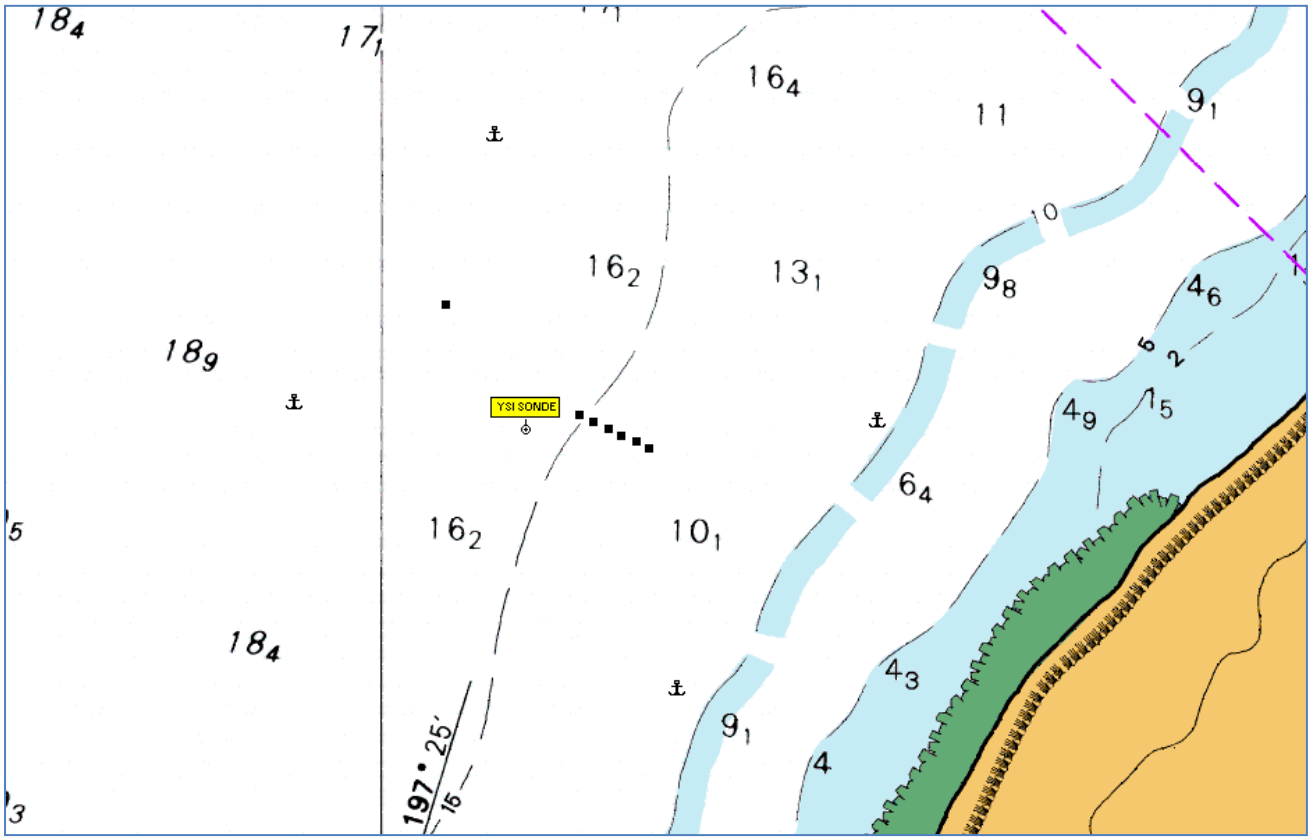


**Figure 1** Location of YSI sonde in relation to diffusers (six black boxes). Anchor symbols represent the ed

## 2.4 Instrument Specifications

Table 1. **YSI 6600 series V4 sonde specifications detailing range, accuracy and resolution**

| Parameter | Sensor Type | Range | Accuracy | Resolution |
|---|---|---|---|---|
| **Specific Conductivity** | 4 electrode cell with autoranging | 0-100 mS/cm | +/- 0.5% of reading + 0.001 mS/cm | 0.001 mS/cm to 0.1 mS/cm (range dependent) |
| **Water temperature** | Thermistor | -5 to 45 °C | +/- 0.15 °C | 0.01 °C |
| **Dissolved Oxygen** | Optical, Luminescence lifetime | 0-50 mg/L | +/- 1% of reading or 0.1 mg/L (whichever is greater) | 0.01 mg/L |
| **pH** | Glass combination electrode | 0-14 units | +/- 0.2 | 0.01 units |
| **Turbidity** | Optical, 90° scatter, with mechanical cleaning | 0-1000 NTU | +/- 5% of reading or 2 NTU (whichever is greater), relative to calibration standards | 0.1 NTU |

## 2.5 Quality Control/Assurance

Individual sensors are calibrated before each sampling trip, using procedures outlined in the YSI technical manual. Conductivity and pH standards are prepared by AWQC's Analytical Quality Control Laboratory to ISO 9001 requirements. Turbidity is calibrated using a standard solution (ACR Standard Turbidity Solution 4000 NTU) diluted to 40 NTU.

## 2.6 Data analysis

The data are presented in a graphical format comparing changes in salinity to tidal variation and changes in pH (pH units), DO (% saturation and mg/L) and water temperature ($^{o}$C) with salinity (ppt).

The water quality data are summarised for each sampling period as:

- Maximum and minimum average daily range
- Maximum daily variation
- Average daily variation

# 3 Results

## 3.1 Plant operations

Saline concentrate was discharged to the marine environment via the ADP diffusers from the 16th of October to the 23rd of January, 2013. Drinking water production ranged between 129 ML/day (19th January) to 230 ML/day (17th January).

## 3.2 Salinity

The daily average salinity concentration ranged between 37.0 ppt to 37.5 ppt. Maximum instantaneous daily variation was 1.2 ppt (20/01/2013). Average daily variation, over a 24 hour period, was 0.7 ppt.

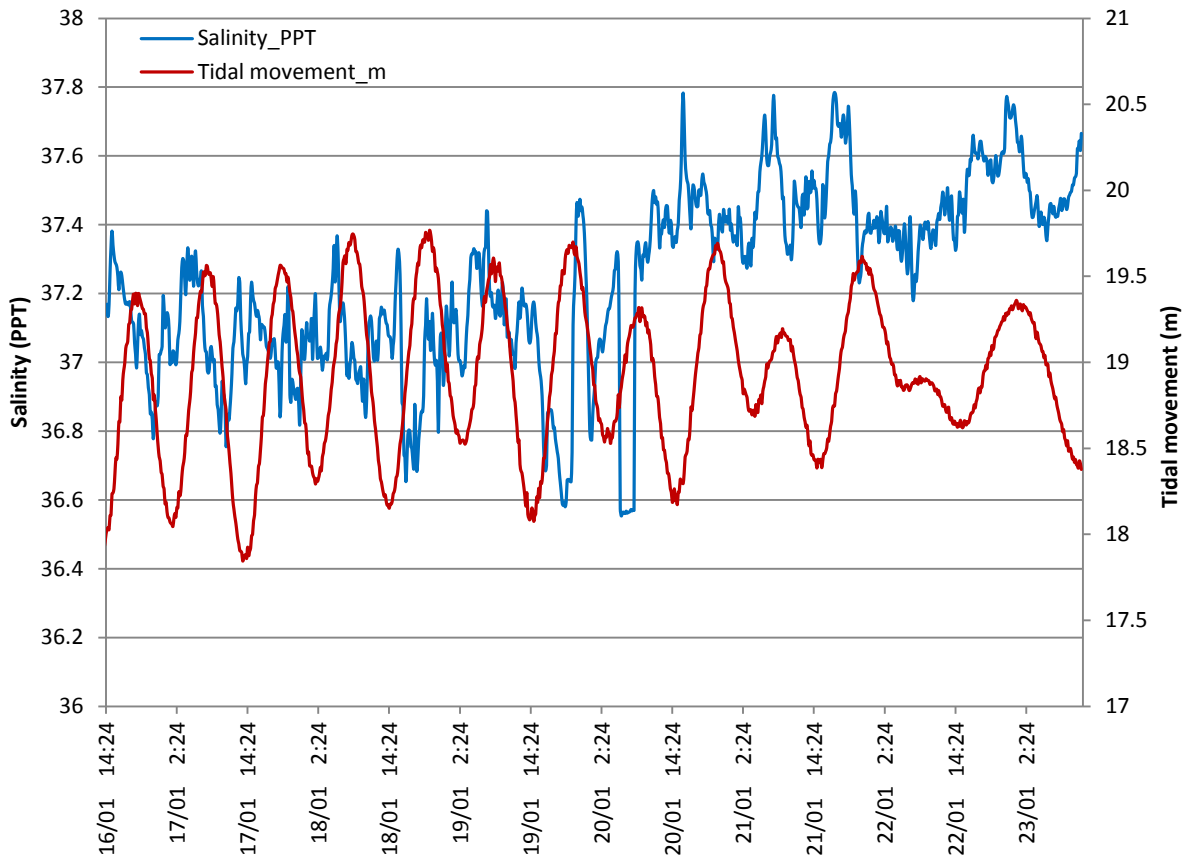


**Figure 1**. Changes in salinity (ppt) with tide (metres) over eight days, from 16th January to 23rd January 2013.

## 3.3 Dissolved oxygen

The daily average oxygen concentration ranged between 102.7 % to 106.7 %. Maximum instantaneous daily variation was 12.2 % (17/01/2013). Average daily variation, over a 24 hour period, was 6.6 %.

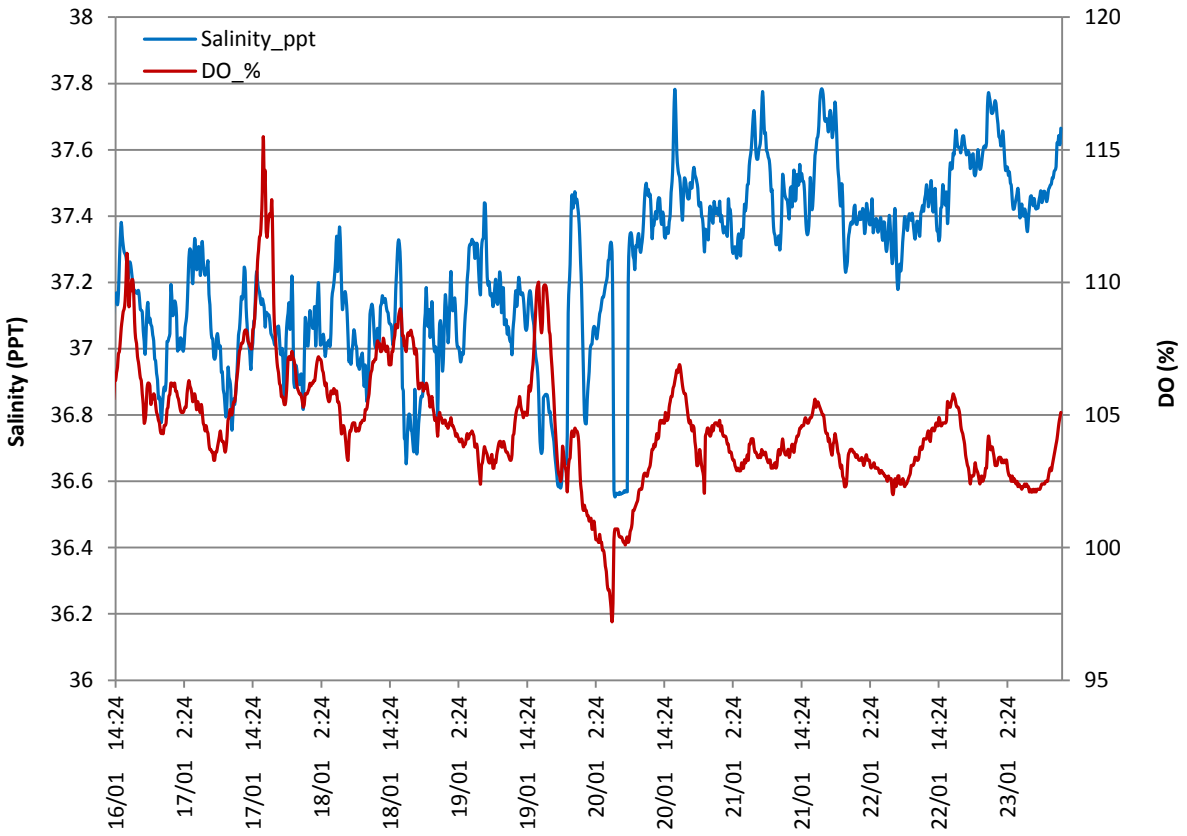


**Figure 2**. Changes in salinity (ppt) with dissolved oxygen (% saturation) over eight days, from 16th January to 23rd January 2013.

The daily average oxygen concentration ranged between 7.2 mg/L to 7.5 mg/L. Maximum daily variation was 0.8 mg/L (17/01/2013). Average daily variation, over a 24 hour period, was 0.43 mg/L.

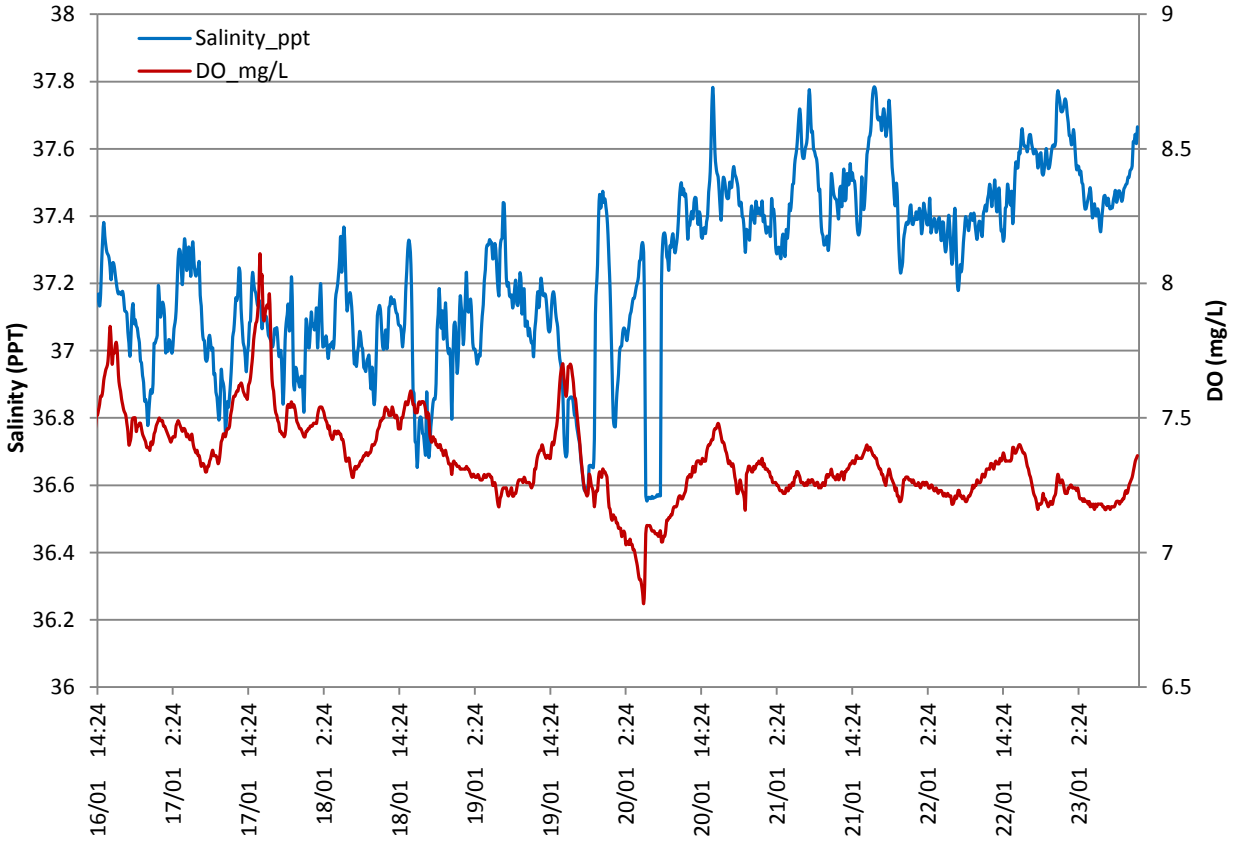


**Figure 3**. Changes in salinity (ppt) with dissolved oxygen (mg/L) over eight days, from 16th January to 23rd January 2013.

## 3.4 pH

The daily average pH value ranged between 8.1 and 8.2. Maximum and average daily variation was less than 0.1 pH units.

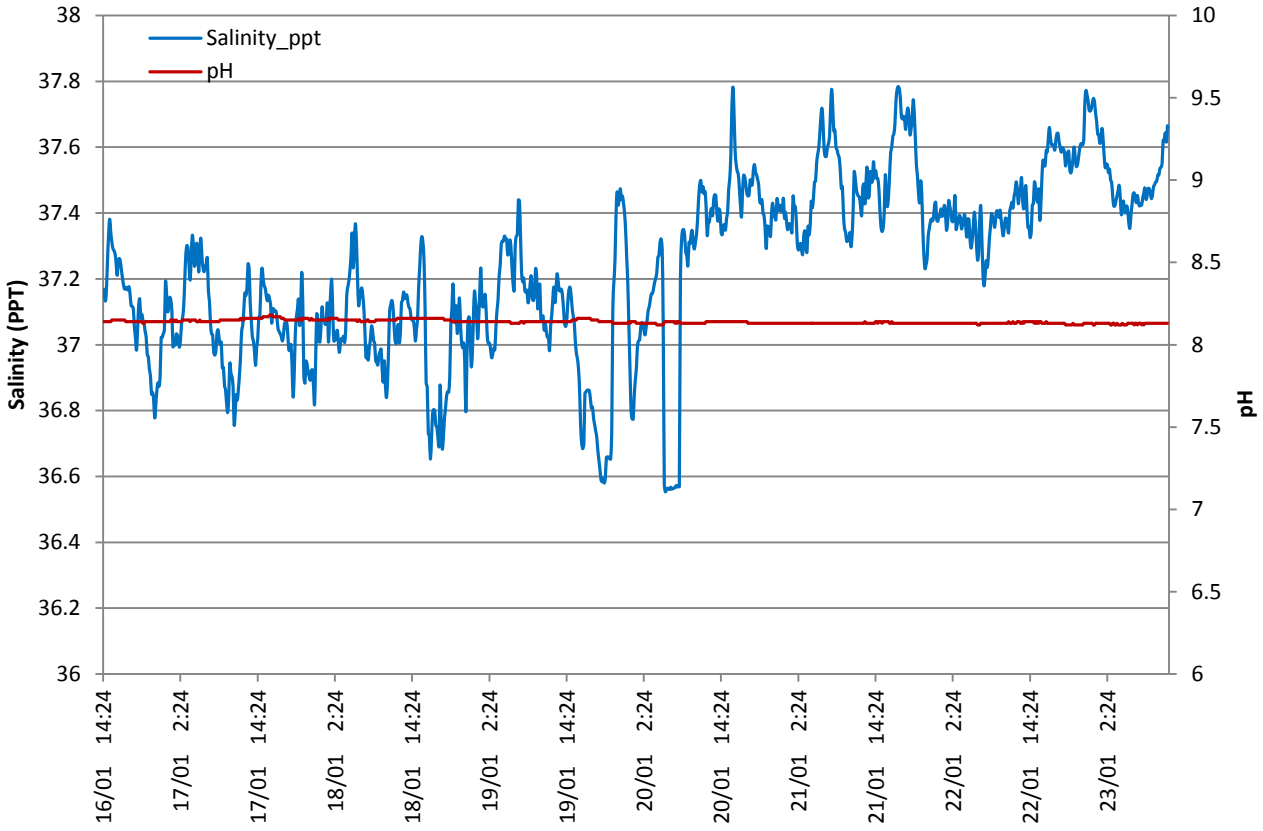


**Figure 4**. Changes in salinity (ppt) with pH over eight days, from 16th January to 23rd January 2013.

## 3.5 Temperature

The daily average temperature value ranged between 21.6°C and 22.1°C. Maximum daily variation was 0.6°C (18/01/2013). Average daily variation, over a 24 hour period, was 0.3°C.

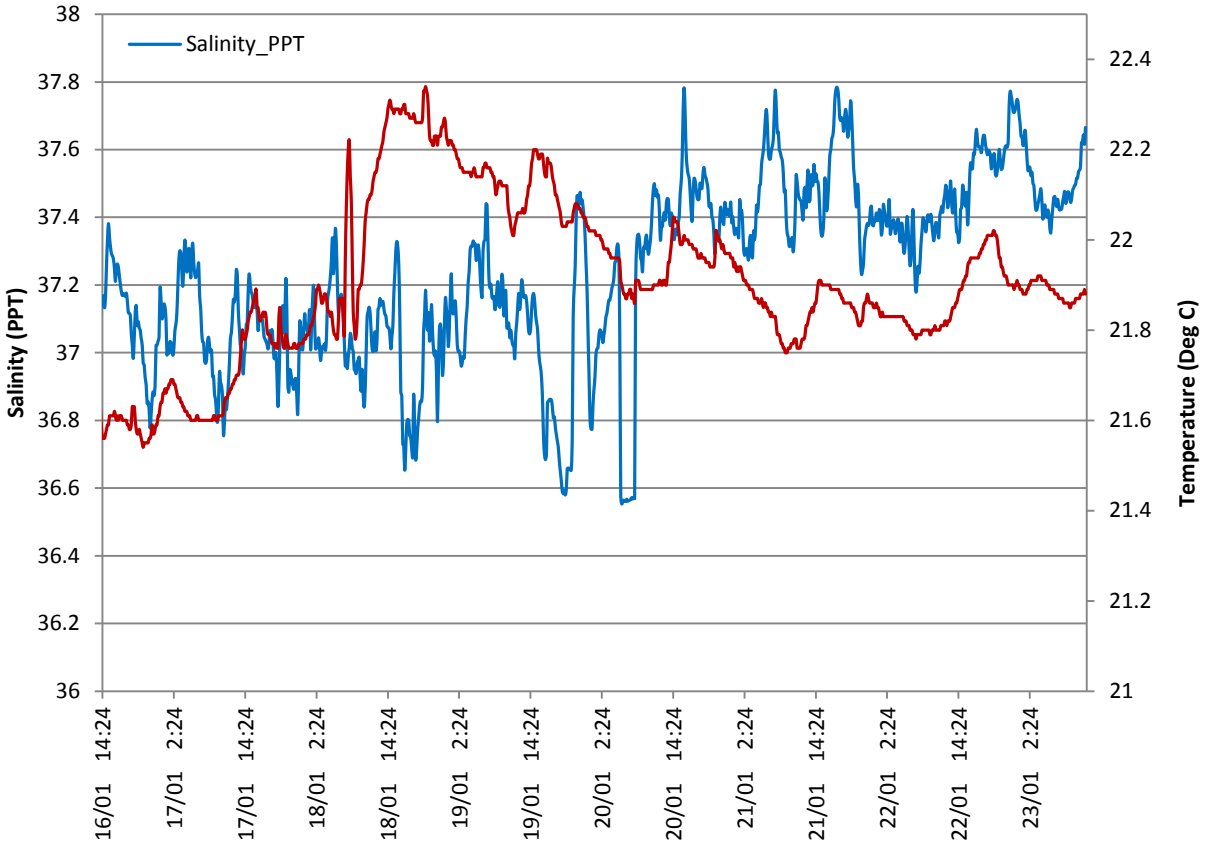


**Figure 5**. Changes in salinity (ppt) with temperature (°C) over eight days, from 16th January to 23rd January 2013.