April 2011

MACRAES PHASE III PROJECT

Environmental Water Quality Data Summary Report

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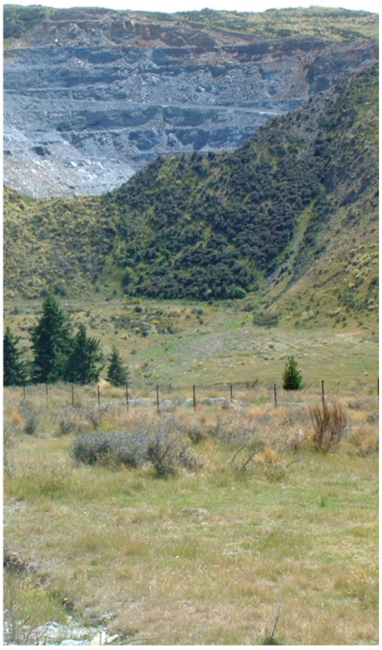

REPORT

Report Number. 0978110-562 R012 vC

Distribution:

Debbie Clarke, Oceana Gold (New Zealand) Limited

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ABBREVIATIONS

CTI	Concentrate Tailings Impoundment
FTI	Flotation Tailings Impoundment
MGP	Macraes Gold Project
MTG	Maori Tommy Gully
MTI	Mixed Tailings Impoundment
SIN	Soluble inorganic nitrogen
SPI	Southern Pit Impoundment
TSF	Tailings Storage Facility
WAD	Weak acid dissociable
WRS	Waste rock storage stacks
WSR	Water storage reservoir

1.0 INTRODUCTION

1.1 Background

Oceana Gold (New Zealand) Limited (OceanaGold) owns and operates the Macraes Gold Project (MGP), located in east Otago approximately 80 km north of Dunedin and 25 km northwest of Palmerston. The MGP has been in operation since 1990 and, since 2007, has also been processing ore from OceanaGold's Reefton Gold Project.

As a result of a recent review of ore reserves at the MGP, OceanaGold propose to expand operations, with this expansion termed the "Macraes Phase III Project". As part of investigations to support applications for resource consents authorising the Macraes Phase III Project, OceanaGold has engaged Golder Associates (NZ) Limited (Golder) to conduct a review of the environmental water quality database for the MGP.

This report[1] provides a summary of current and historic water quality at the MGP, and builds on conclusions drawn in Golder (2010) through the inclusion of data collected in the interim from additional sites throughout the MGP. The data presented in this report have been used to produce water quality input parameters for surface water and groundwater models of the site, which are used to assess future mine water quality and potential environmental effects associated with proposed activities.

1.2 Project Description

As illustrated on Figure 1, the major features of the MGP include:

- A series of open cast pits, some of which have been partially or completely backfilled.
- An underground mine with the mine portal located in Frasers Pit.
- An ore processing plant.
- The Mixed Tailings Impoundment (MTI) and the Southern Pit Tailings Impoundment (SPI).
- Deepdell, Northern Gully, Back Road, Frasers West and Frasers East (under construction) waste rock storage stacks (WRS).
- Deepdell North, Deepdell South, Maori Tommy Gully, Battery Creek, Northern Gully, Frasers West and Murphys Creek silt ponds.
- The Lone Pine water reservoir and a water supply pipeline from the Taieri River.

Tailings storage at the site began in 1990 with the construction of the Flotation Tailings Impoundment (FTI) and the Concentrate Tailings Impoundment (CTI) in Maori Tommy Gully (MTG). The two impoundments were used until1993 when the flotation and concentrate tailings streams were combined and deposited into the FTI, which was subsequently renamed the Mixed Tailings Impoundment (MTI).

The CTI subsequently remained unused until 1998. At this time it was decided to introduce a pressure oxidation stage to the process plant and the concentrate tailings were again separated and deposited in the CTI in preparation for later processing. Once the pressure oxidation process was brought on-line, all tailings were discharged to the Mixed Tailings Impoundment. During 2000, the removal of tailings from the CTI began in order to allow extraction of the remaining gold. The storage space made available by this process was subsequently incorporated into the MTI in 2004.

[1] This report is provided subject to the limitations presented in Appendix A.

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TITLE SITE LAYOUT

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PROJECT 0978110562

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As the MGP expanded, additional tailings storage space was required. The SPI was constructed, beginning with the SP10 Impoundment (SP10), which has since been incorporated within the larger SP11 Impoundment (SP11). Tailings storage in SP10 was initiated in February 2002, with tailings deposition alternating between the MTI and the SPI since that date. The tailings deposition schedule is summarised in Table 1.

Table 1: MGP tailings deposition schedule.

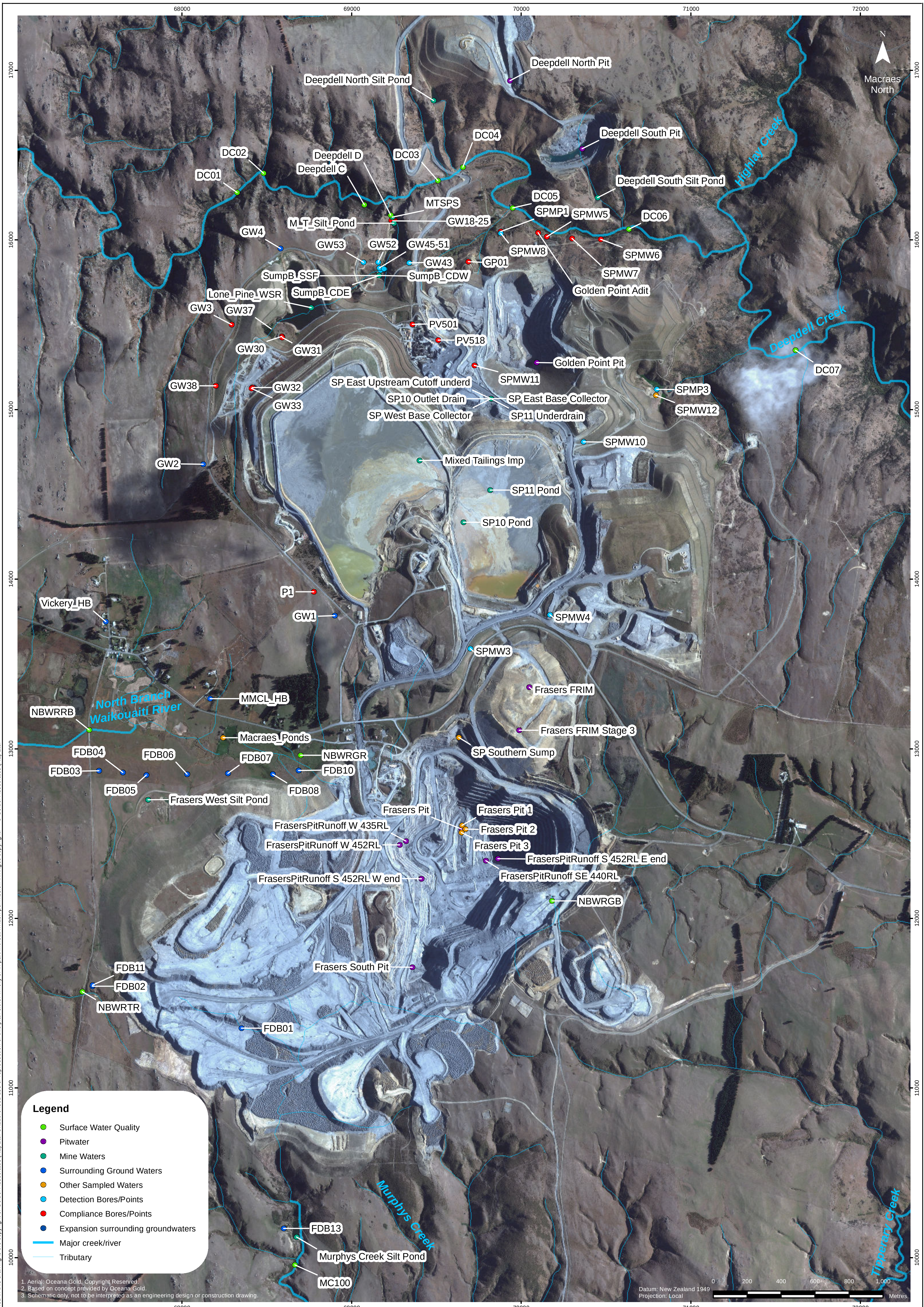
Period start [1]	Period end	Active tailings storage facility
10 February 1992	7 February 2002	MTI
7 February 2002	27 May 2003	SP10
27 May 2003	18 May 2004	MTI
18 May 2004	25 November 2004	SP10
25 November 2004	22 March 2006	MTI
22 March 2006	13 December 2007	SP11
13 December 2007	20 May 2009	MTI
20 May 2009	13 February 2010	SP11
13 February 2010	Present (November 2010)	MTI

Note: [1] Data provided by OceanaGold.

A comprehensive environmental water quality monitoring programme has been undertaken by OceanaGold since the early 1990s. This programme has included compliance monitoring in addition to supplementary testing to evaluate process water quality and environmental conditions at the site.

Sampling has been undertaken at various sites, as shown on Figure 2 and Figure 3, including:

- Tailings decant water from ponds on each tailing storage facility (TSF).
- Drainage systems collecting seepage water from each TSF.
- Groundwater monitoring wells down-gradient from each TSF.
- Groundwater monitoring wells down-gradient from Frasers West WRS.
- Drains installed beneath the Northern Gully WRS.
- Frasers Pit wall runoff.
- Pit sumps and silt ponds.
- The Lone Pine reservoir.
- Surface water monitoring sites on Deepdell Creek, the Shag River, Tipperary Creek, the North Branch Waikouaiti River and Murphys Creek.



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TITLE ENVIRONMENTAL MONITORING SITES

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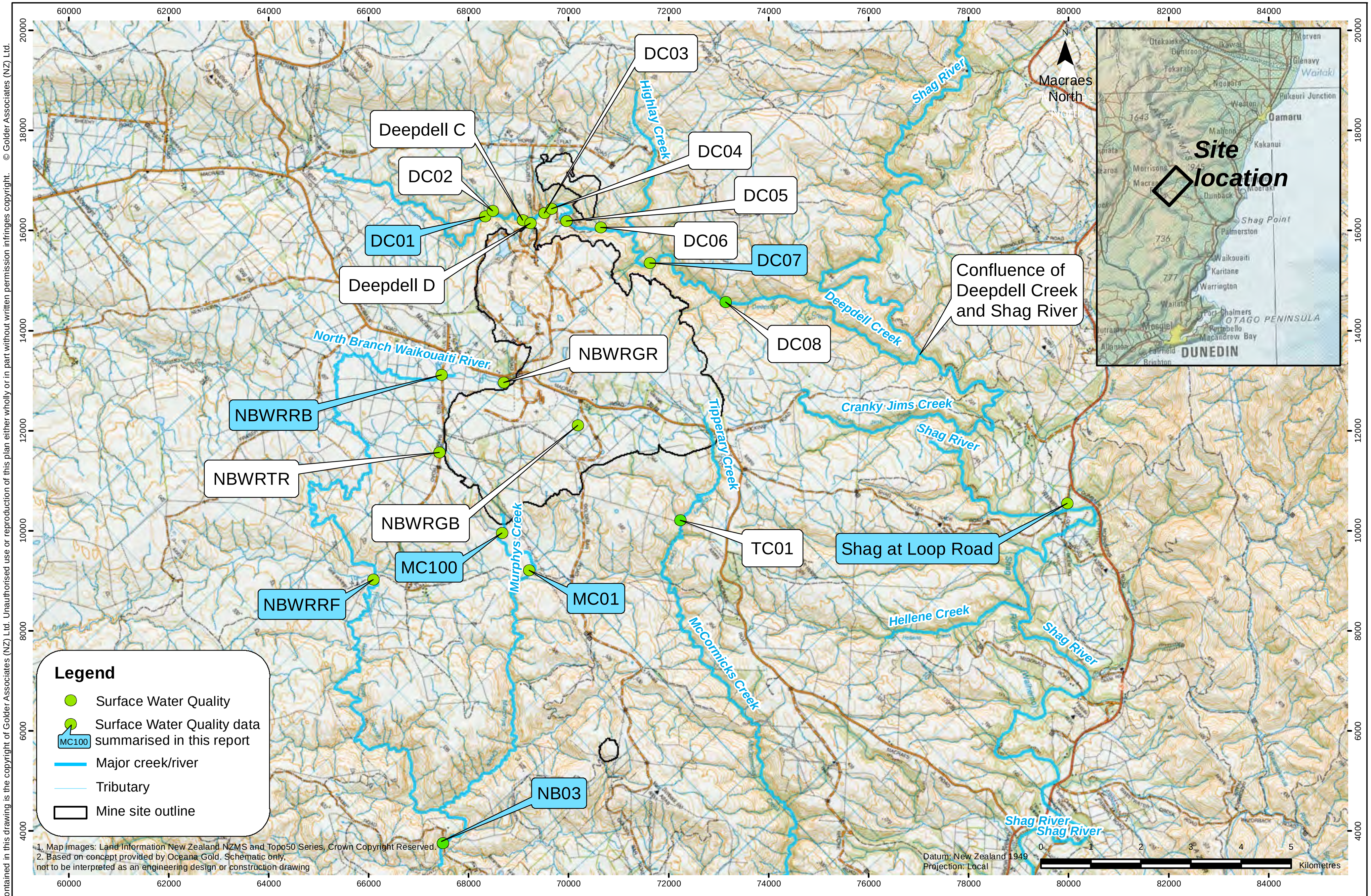

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TITLE SURFACE WATER QUALITY MONITORING SITES

MARCH 2011

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2.0 TAILINGS DECANT WATER

2.1 Introduction

Tailings generated by the MGP are discharged to the tailings storage facilities as a slurry with the process water. During operations there is a permanent standing pool of water covering part of the tailings surface. Water is recycled from this pond to the plant or lost through evaporation or seepage into the tailings mass. This standing pool of water is referred to as decant water. Samples of the decant water are collected on a regular basis.

Decant water quality is influenced by a number of factors including:

- The chemical composition of the ore being processed in the plant.
- The processing conditions in the plant.
- The pumping of clean water into the decant ponds for process reasons.
- The ongoing recycling of tailings water through the plant, leading to a reduction in the quality of the plant feed water.
- Environmental factors, such as concentration by evaporation or dilution by rainfall.
- Geochemical processes occurring in the plant and the decant water ponds.

Over the past 20 years, changes have occurred in all of these factors. These changes, which have influenced the water quality of the decant ponds, include:

- Expansion of the tailings storage footprint, with changes to the associated environmental factors.
- Implementation of a pressure oxidation process at the process plant in 1999.
- An increase in the ore processing rate to the maximum plant capacity in 2006.
- Introduction of ore derived from OceanaGold’s Reefton operation during 2007.
- A reduction in the dosing of lime to the process plant.
- Ongoing optimisation of the pressure oxidation and other treatment processes.

The plant is currently operating at maximum capacity and, following recent changes in plant management, optimal oxidation conditions. OceanaGold expects the water quality in the tailings slurry to stabilise in the near future following these recent changes (pers. comm. J. Bywater, OceanGold).

2.2 Types of Decant Water

Two types of tailings are produced at the site, flotation tailings and concentrate tailings. Flotation tailings are produced through the initial separation of high gold content minerals from the low gold content ore by a flotation process. Low gold ore is processed through a froth flotation cycle and the resulting waste material is referred to as flotation tailings. High gold concentrate produced from the flotation circuit is processed by pressure oxidation and multiple cyanide leaches, with the resulting waste product referred to as concentrate tailings.

Sampling of decant water has been undertaken on a regular basis since the start of operations at the MGP. The following decant water quality data sets are available:

- CTI decant pond (1990 – 2004).
- FTI decant pond (1991 – 2006).
- MTI decant pond (2006 – 2010).
- SP10 decant pond (2002 – 2007).
- SP11 decant pond (2006 – 2010).

2.3 Decant Water Quality

Decant water quality has changed over time due to changes in the factors identified in Section 2.1. This section summarises by parameter decant water data collected by OceanaGold. Data are shown graphically in Appendix B with tabulated summaries for each decant pond. The key findings are:

- The pH of the tailings decant water has decreased over time; during the last three years, the pH has ranged from 3 to 6. The decrease in pH can be attributed to the introduction of the pressure oxidation process (which converts sulfide minerals to sulphates), a reduction in lime dosing to the process plant, and the introduction of Reefton ore to the plant in 2006.
- Sulphate concentrations in tailings decant water have increased over time. The observed increase in concentrations since 2000 may be due to the recycling of tailings water to the plant or to continued increases in plant throughput. The increased variability of results since 2002 is, in part, due to the alternating tailings deposition between the MTI and the SPI, with consequent dilution of inactive decant ponds by rainfall and tailings impoundment dust suppression systems that operate during the impoundment resting periods.
- Since 1999, calcium concentrations have increased and become more variable, typically ranging from 200 g/m^3 to 900 g/m^3.
- Ongoing optimisation of the process plant has led to a reduction in cyanide use. Consequently, no weak acid dissociable cyanide (CN_{WAD}) concentrations exceeding 4.0 g/m^3 have been measured in tailings decant water since 2003, with most concentrations less than 1.0 g/m^3.
- Since 1999, total arsenic concentrations have typically been below 10 g/m^3.
- Copper concentrations have varied considerably over time; however, since 1999, have typically been less than 1.0 g/m^3.
- Since 2006, the total iron concentrations detected in the decant water have increased, with measured concentrations typically higher than 400 g/m^3, with some results exceeding 1,000 g/m^3.

Samples of decant water from the MTI and the SPI were collected during three rounds of sampling in 2009 to allow for the analysis of soluble concentrations of metals/metalloids and additional parameters not captured during the long term monitoring programme. The analysis results, which are presented in Table 2, indicate:

- The total metals results are similar to the dissolved metals results for each of the parameters tested.
- The concentrations for each of the parameters tested were substantially higher in the active decant pond than in the inactive pond. The differences between the two ponds are likely to be partly due to dilution from rainfall and the addition of water to operate dust suppression systems and partly from sediment settling. It is however expected that chemical reactions and precipitation of metal compounds is likely to be the main reason for the decreased concentrations detected in the inactive decant pond.

Table 2: Total and soluble metal/metalloid concentrations in tailings decant water.

Parameter	MTI (inactive)			SP11 (active)		
	20-Jul-09	22-Jul-09	27-Jul-09	22-Jul-09	20-Jul-09	27-Jul-09
Soluble arsenic	0.0023	0.0081	<0.0050	8.1	11	5.7
Total arsenic	0.033	0.43	0.024	7.8	13	7.3
Soluble cadmium	0.00047	0.00039	0.00056	0.0087	0.010[1]	0.0078
Total cadmium	0.00061	0.00039	0.00040	0.0093	0.0087[1]	0.0094
Soluble iron	5.4	2.8	0.93	870[1]	950[1]	830
Total iron	6.3	9.9	3.5	840	860[1]	970
Soluble lead	<0.00020	<0.00020	<0.00050	<0.0010	0.0014	<0.0010
Total lead	0.00064	0.0099	<0.00053	0.0072	0.0049	<0.0011
Soluble manganese	9.4[1]	8.6[1]	9.3	43[1]	49[1]	41
Total manganese	8.7[1]	8.5[1]	10	41[1]	43[1]	47
Soluble nickel	0.47	0.35[1]	0.50	4.3	4.8	4.5
Total nickel	0.53	0.34	0.53	4.5	5.1	4.5
Soluble zinc	0.58	0.43	0.57	9.7	9.0	9.5
Total zinc	0.66	0.45	0.64	9.7	9.7	9.9

Note: All units g/m^3 unless otherwise stated; all values are presented to two significant figures; and [1]results for soluble fraction reported to be greater than the total fraction but within analytical variation of the method.

3.0 WASTE SEEPAGE

3.1 Tailings Seepage

3.1.1 Introduction

Following deposition of the tailings into a TSF the solids settle out of the slurry and a decant pond forms from the accumulating water. As the tailings mass increases in thickness, settlement of the tailings results in further water being forced upward out of the tailings to the decant pond. This compaction is expected to primarily influence the uppermost 5 m of the tailings mass. Below that depth the seepage of pore water is downward toward the TSF drainage systems as well as into the underlying bedrock.

Water incorporated in the tailings mass has a quality initially representative of the slurry water quality at the time of deposition. As the pore water seeps through the tailings mass, the water interacts with the solids. In the process, the pore water quality changes due to dissolution and precipitation reactions. In addition, tailings water at, or near, the tailings surface is initially under oxidising conditions. The pore water becomes deoxygenated with depth and the reducing conditions dominate in the centre and toward the base of the tailings mass. Consequently the quality of water discharging from chimney drains and underdrains installed in the impoundments can differ substantially from the decant water quality. In summary, the seepage water quality from the tailings impoundments is influenced by factors including:

- Decant water quality.
- Seepage travel time through the tailings mass.
- The geochemistry of the tailings.
- Changes in the redox environment within the tailings mass.

3.1.2 Sample sites

Tailings seepage water quality has been evaluated from water samples collected from the impoundment underdrains and chimney drains listed in Table 3. Underdrains predominately collect pore water from close to the base of the tailings mass and therefore provide a good indication of the tailings seepage water quality and geochemical conditions in the tailings mass. The chimney drains are more strongly influenced by slurry water seeping downward close to the TSF embankment. Discharges from other drainage systems installed in the upstream raises of both embankments are not sampled for water quality on a regular basis.

During the operational period of the MGP numerous changes have been made to the gold extraction process. The quality of water discharging from the MTI chimney and underdrains is considered to be indicative of seepage water derived from tailings deposited relatively early in the mine life.

From the start of mining until 1993, tailings deposited in the FTI (now the MTI) were predominately flotation tailings. Water samples obtained from the MTI chimney drains during this period are considered to be reasonably representative of flotation tailings seepage water quality. Samples collected from drains underneath the SPI are considered to be more representative of the seepage quality from tailings deposited during the past 6 years.

3.1.3 Water quality

This section summarises, by parameter, tailings seepage data measured by OceanaGold. Data are shown graphically in Appendix C with tabulated summaries for each drainage water. The key findings are:

- The pH of the tailings drainage water has remained relatively stable over time, ranging from 6 to 7 at most sites, probably because of the buffering capacity of the tailings mass, which has a considerable acid neutralising capacity.
- Sulphate concentrations in the MTI drains have increased over time, with measurements typically ranging from 1,500 g/m^3 to 3,000 g/m^3. Although sulphate concentrations in the SP10 and SP11 drain discharges were similar to those in the MTI drains between 2003 and 2005, more recent concentrations have been considerably higher, ranging from 3,000 g/m^3 and 4,000 g/m^3.
- Calcium concentrations in the MTI drain discharge water have increased over time, with concentrations now generally exceeding 200 g/m^3. The Sump B_SSF underdrain, which is installed along the invert of Maori Tommy Gully at the base of the tailings mass, contains notably higher concentrations of calcium (exceeding 400 g/m^3). Calcium concentrations in SP10 and SP11 drain water are typically higher than those measured from the MTI drains with concentrations ranging from 400 g/m^3 to 600 g/m^3.
- Sodium concentrations in the MTI chimney drains increased from approximately 100 g/m^3 in 1992 to approximately 500 g/m^3 in 1998, but have remained relatively stable since this date. Concentrations in the SP10 and SP11 drain discharges range between 400 g/m^3 and 500 g/m^3.
- CN_{WAD} concentrations in the MTI drain discharges decreased rapidly in early 2008 to typically less than 0.6 g/m^3, reflecting changes in the decant water quality. Concentrations in the SP11 drain discharges, which best reflect tailings conditions, have typically been below 0.05 g/m^3 since early 2008.
- Soluble inorganic nitrogen (SIN) concentrations in the Western CDBC have remained unchanged over the monitoring period, while concentrations within the chimney and toe drains within the eastern and western embankments of the MTI, have increased. SP10 and SP11 drainage water SIN concentrations remained relatively unchanged, as did those in the Sump B_SSF, although concentrations peaked between 1995 and 2002.

Table 3: Tailings storage facility drainage systems.

Drain designation	Type	Other influences	Sample date range
MTI			
Western CDBC	Western embankment chimney drain and basal collector.		18 October 1994 – 3 August 2010
Sump B_CDW	Chimney drain and toe drain incorporated in western embankment face (>25 m below 2010 tailings surface).	Potential for decant water and shallower pore water to infiltrate to the drain	27 November 1991 – 2 Sept 2010
Sump B_CDE	Chimney drain and toe drain incorporated in eastern embankment face (>25 m below 2010 tailings surface).	Potential for decant water and shallower pore water to infiltrate to the drain	27 November 1991 – 2 Sept 2010
Sump B_SSF	Combined main underdrains installed along the invert of Maori Tommy Gully at the base of the tailings mass.	Tailings seepage only	27 July 1991 – 3 August 2010
SP10			
S_Pit_toe_ drain	Drain along base of SP10 embankment below tailings mass.	Tailings seepage only	7 January 2003 – 9 Aug 2005
S_Pit_chimney_ drain	SP10 embankment chimney drain.	Potential for decant water and shallower pore water to infiltrate to the drain	27 February 2004 – 8 February 2006
SP10_combined_ seepage_outlet.	Combined discharge of above two drains following construction of SP11.	Tailings seepage only	12 June 2006 – 2 September 2010
SP11			
CDBC_western_ outlet	Western chimney drain and basal collector to SP11 embankment.	Potential for decant water and shallower pore water to infiltrate to the drain	12 June 2006 – 2 September 2010
CDBC_eastern_ outlet	Eastern chimney drain and basal collector to SP11 embankment.	Potential for decant water and shallower pore water to infiltrate to the drain	12 June 2006 – 2 September 2010
US_USCO_ eastern_outlet	Eastern underdrain/upstream cutoff drain	Tailings seepage only	12 June 2006 – 2 September 2010
US_USCO_ western_outlet	Western underdrain /upstream cutoff drain	Tailings seepage only	30 June 2005 – 2 September 2010

- Arsenic concentrations in the MTI chimney drain discharge water increased until 2006, reflecting the increasing concentrations in the decant water. Since 2006, concentrations have been relatively stable between 3 g/m^3 and 7 g/m^3. MTI underdrain discharge concentrations (Sump B_SSF) have remained below those detected in the chimney drains. In 2006, arsenic concentrations in the SP10 and SP11 underdrain discharges were similar to those measured from the MTI drains, but have subsequently increased to between 12 g/m^3 to 19 g/m^3 in 2010.

- Total iron concentrations in the MTI chimney drain discharges have been relatively stable within a range of 2.5 g/m^3 to 13 g/m^3, as have the concentrations in the MTI underdrains. Concentrations in SPI drain discharges have been considerably higher, ranging from 14 g/m^3 to 35 g/m^3 at the SP10 outlet drain and from 40 g/m^3 to 70 g/m^3 at the SP11 underdrain.

3.2 Waste Rock Seepage

3.2.1 Northern Gully springs and drains

Two underdrains (Northern Gully Seep East and Northern Gully Seep West) were installed in Northern Gully prior to construction of the Northern Gully WRS. The discharge water from these drains is considered to be the most reliable indicator of waste rock seepage water quality available for the MGP site. Seepage from waste rock above the old underground portal, which is located to the southeast of the underdrains, is considered to be of a similar nature, and for this reason has been sampled since early 2010.

The results of the analysis of a limited number of samples is summarised below and shown graphically in Appendix D with a tabulated summary. Given the limited number of samples, these results are considered indicative only. The key findings are:

- The pH of the samples ranged from 6.7 to 8.0, and has not changed substantially over time.

- The concentrations of major ions were lower than measured in tailings impoundment seepage water. Sodium, potassium and chloride concentrations have not increased over time, while concentrations of magnesium and sulphate have increased. Sulphate concentrations have increased from approximately 1,250 g/m^3 in 2002 to approximately 2,500 g/m^3 in 2010. Analysis using PHREEQC indicates the 2010 samples are saturated with respect to sulphate. It is noted the sulfate concentrations measured in the underdrains may be influenced by low grade ore stockpiles located on top of the Northern Gully WRS.

- Analysis results indicated low, but detectable, concentrations of cadmium, manganese, nickel and zinc.

- The concentrations of arsenic, copper and iron were, on occasion, below the respective detection limits, while lead concentrations were consistently below the detection limit.

3.2.2 Supporting information

Due to the limited number of samples obtained from springs and drains considered to be indicative of waste rock seepage, further supporting information relating to waste rock seepage water quality has been obtained from the following sites:

- Frasers West silt pond.

- Murphy's Creek silt pond,

- Monitoring wells located down-gradient from the Frasers West WRS.

The data measured at these sites, which is discussed in Section 5.4 (Frasers West and Murphy's Creek silt ponds) and Section 6.8 (Frasers West WRS monitoring wells), indicates that concentrations are increasing towards those measured in drainage water from the Northern Gully underdrains. For example, the sulphate concentrations detected in the FDB06 monitoring well down-gradient from the Frasers West WRS currently range from 1,300 g/m^3 to 1,700 g/m^3 , while concentrations in the silt ponds, which are further down gradient, have increased to over 500 g/m^3 over the last year.

The trends in water quality indicated by the monitoring data measured at the silt ponds and monitoring wells support the use of Northern Gully drainage water as a proxy for waste rock seepage.

4.0 OPENCAST PITS

4.1 Introduction

There are six opencast pits within the MGP for which water quality data are available. These are:

- Frasers Pit
- Golden Point Pit
- Golden Bar Pit
- Innes Mills Pit
- Round Hill Pit
- Southern Pit

The analytical results relating to water samples collected from each of these open pits is summarised in Sections 4.2 to 4.7. Data are shown graphically in Appendix E together with tabulated summaries.

4.2 Frasers Pit

4.2.1 Sump water quality

The key findings from the sump water quality data measured in Frasers Pit are:

- In general, the pH of the water within Frasers Pit is neutral to slightly alkaline.
- Concentrations for sodium, calcium, chloride, sulphate, potassium and magnesium have been relatively consistent over the monitoring period, although concentrations of sulphate, calcium and magnesium have been slightly higher during the last two sampling rounds compared to those measured previously.
- Soluble concentrations of iron, copper, zinc and lead are consistently close to or below detection limits. However, it is noted, the determination of copper and lead has not been undertaken since 2007, while zinc concentrations have not been measured since 2003.
- Arsenic concentrations are typically less than 0.2 g/m^3. However, concentrations are, on occasion, higher, with the most recent of these being in Jan 2010 when 0.39 g/m^3 was measured.
- Concentrations of CN_{WAD} have typically been below the limit of detection of 0.005 g/m^3. It is noted the determination of CN_{WAD} has not been undertaken since 2004.

4.2.2 Runoff water quality

Water runoff from the Frasers Pit area has been monitored at a number of locations including:

- FR3 North Wall
- Frasers East Wall 1-7
- Frasers Pit Runoff S452RL
- SE 440RL
- W 435RL
- W 452RL

The analytical results relating to the runoff water samples that were collected by OceanaGold until sampling ceased in 2005 are shown graphically in Appendix F together with a tabulated data summary. In general:

- The pH ranges from 8.0 to 8.5.
- Concentrations of sodium, sulphate, calcium, chloride, magnesium and potassium are relatively consistent over the monitoring period.
- Soluble concentrations of iron, copper and lead are typically close to or below detection limits.
- Arsenic concentrations increased slightly in 2000 and again in 2003 but returned to levels below or close to detection limits in the later samples.

4.3 Golden Bar Pit

The key findings from the sump water quality data measured in Golden Bar Pit between 2004 and 2010 are:

- In general, the pH ranged from 8.0 to 8.5.
- Concentrations of sodium, calcium, chloride and potassium have been relatively consistent over the monitoring period, while the concentrations of sulphate and magnesium are generally increasing.
- Soluble concentrations of iron, copper and lead are consistently close to or below detection limits.
- Arsenic concentrations have been decreasing since 2007 when concentrations peaked at 0.72 g/m^3. Concentrations generally range from 0.07 g/m^3 to 0.36 g/m^3.

4.4 Golden Point Pit

4.4.1 Sump water quality

The key findings from the sump water quality data measured in Golden Point Pit are:

- The pH typically ranges from 7.0 to 8.0.
- Concentrations of sodium, sulphate, calcium, chloride, magnesium and potassium all show a general upward trend until 2006 before trending downward.
- Soluble concentrations of arsenic and iron have decreased over the monitoring period and are now close to below detection limits. However, it is noted the most recently collected sample had an arsenic concentration of 0.12 g/m^3.

- Samples were tested for CN_{WAD} on five occasions between 2001 and 2003. The first sample had a CN_{WAD} concentration of 0.04 g/m^3; however, CN_{WAD} was not detected in the following four samples.

4.4.2 Adit water quality

Sampling of the Golden Point Adit discharges began in 1993 and was undertaken every two years until 2007 when the sampling frequency was increased to monthly. An evaluation of the data collected indicates that:

- The pH typically ranges from 7.0 and 8.0.
- Concentrations of sodium, sulphate, calcium, chloride, magnesium and potassium all show a general upward trend until 2007 before trending downward.
- Soluble concentrations copper, iron and lead were typically below detection limits.
- Arsenic concentrations between 2007, when regular monitoring commenced, and 2010 ranged from 0.014 g/m^3 to 0.23 g/m^3. Arsenic concentrations decreased between 2007 and 2009, but since mid 2009 have trended upwards.
- CN_{WAD} was sampled in 1996 and then regularly from 2007. Concentrations have, with one exception, been below the detection limit. CN_{WAD} was detected in the sample collected on 28 May 2009 when a concentration of 0.011 g/m^3 was measured.

4.5 Innes Mills Pit – Stage 3

Tailings decant water was stored in Innes Mills Pit for an extended period before it was backfilled with waste rock from Frasers Pit. The key findings from the data measured between 1999 and 2002 are:

- In general, pH was neutral to slightly alkaline, ranging from 7.3 to 8.3.
- Concentrations of sodium, calcium, chloride, sulphate, potassium and magnesium were relatively consistent over the monitoring period.
- Soluble concentrations of lead and copper were consistently close to or below detection limits.
- Iron concentrations were typically less than 1.0 g/m^3, although on one sampling occasion the concentration was 8.2 g/m^3.
- The concentrations of arsenic ranged from less than the detection limit of 0.005 g/m^3 to approximately 0.05 g/m^3 over the monitoring period. No trend was evident.
- Concentrations of CN_{WAD} ranged from <0.005 g/m^3 to 0.87 g/m^3 with a mean of 0.020 g/m^3.

The data presented for Innes Mills Pit above and in Appendix E partly reflects tailings decant water which was stored in Innes Mills pit for an extended period of time due to a temporary surplus of water at the site. This use of the pit for decant water storage is the reason for unusually high CN_{WAD} and sulphate results from this data set.

4.6 Round Hill Pit

No samples have been taken from this location since 1998. An interpretation of the limited dataset has not been provided, as the data are unlikely to represent current conditions.

4.7 Southern Pit

Water quality sampling of the Southern Pit began in 1996 and continued until 2002. The key findings from the data obtained are:

- The pH ranged from 7.9 to 8.3.
- Concentrations for sodium, calcium, chloride, sulphate, potassium and magnesium have been consistently low.
- Concentrations of iron and copper in the samples were consistently close to or below detection limits, as were concentrations of CN_{WAD}.
- Lead concentrations were consistently low, while zinc was not analysed in the Southern Pit.
- Arsenic concentrations ranged from 0.15 g/m^3 to 1.2 g/m^3.

5.0 WATER STORAGE FACILITIES

5.1 Introduction

There are seven water storage facilities in the MGP for which water quality data are available. These are:

- Clydesdale Silt Pond
- Deepdell North Silt Pond
- Deepdell South Silt Pond
- Frasers West Silt Pond
- Maori Tommy Gully Silt Pond
- Murphy's Creek Silt Pond
- Lone Pine Water Storage Reservoir

The analytical results relating to water samples collected from these ponds is summarised in Sections 5.2 to 5.6, and shown graphically in Appendix G together with tabulated summaries. Section 5.3 summarises the water quality of both the Deepdell North Silt Pond and Deepdell South Silt Pond, while water quality of Frasers West Silt Pond and Murphy's Creek Silt Pond, which were constructed to manage run-off from the Frasers West WRS, is discussed in Section 5.4.

5.2 Clydesdale Silt Pond

The Clydesdale silt pond is located close to the Golden Bar Pit, to the south of the main MGP operational area. The catchment is dominated by the Golden Bar WRS. An evaluation of the data measured in the Clydesdale Silt Pond since quarterly sampling began in 2003 indicates:

- The concentrations of calcium, sodium, magnesium and sulphate are all increasing with time. In contrast, potassium and chloride concentrations have not increased since sampling was initiated.

- Soluble concentrations of arsenic, iron, lead and copper in the first sample collected were anomalously high, and have been excluded from this assessment as all samples collected since this sampling occasion have returned concentrations close to or below detection limits.
- CN_{WAD} was sampled in 2009 and 2010. In both instances, concentrations were less than the detection limit of 0.001 g/m^3.

5.3 Deepdell Silt Ponds

The Deepdell North and South silt pond were constructed at about the same time. Water sampling from both ponds began during 2001 or 2002 and has been undertaken on a quarterly basis since then. Deepdell North silt pond receives seepage and run-off water from the Deepdell North WRS, which was constructed inside the Deepdell North Pit. In contrast, the Deepdell South silt pond only received surface run-off from a small catchment of approximately 5 ha, including no stored waste rock. The difference in water quality between the two monitoring sites is therefore expected to primarily reflect the waste rock seepage and run-off water quality to Deepdell North.

The key findings from the data measured in the Deepdell silt ponds since 2001 are:

- The pH in the Deepdell North silt pond is not dissimilar to the pH in the Deepdell South Silt Pond.
- Since 2006, concentrations of sodium, chloride, calcium, magnesium and sulphate have increased in the Deepdell North silt pond. This may be the result of waste rock inside the former pit becoming saturated and overflowing to the silt pond. During the same period, the concentrations of these ions have, with the exception of sodium and chloride, decreased in the Deepdell South silt pond.
- Sampling for soluble arsenic, copper, lead and iron has been undertaken at both ponds on an annual basis since monitoring commenced. Arsenic concentrations in both ponds have decreased over time, and since 2007 have consistently been between 0.002 g/m^3 and 0.006 g/m^3. The results do not show a substantial difference between the ponds in either trend or magnitude.
- Iron concentrations in both ponds have typically been below 0.5 g/m^3. Prior to 2008, copper and lead concentrations were below their respective detection limits; however, with a reduction in the detection limit in 2008, copper has been detected in both ponds at between 0.0005 g/m^3 and 0.0015 g/m^3, while lead concentrations remain at or below the improved detection limit of 0.0001 g/m^3.
- Water samples from the Deepdell North silt pond have been analysed for CN_{WAD} on two occasions since sampling commenced in 2001, while Deepdell South silt pond water has been analysed for CN_{WAD} once over this period. In each case, concentrations were below the detection limit.

5.4 Frasers West WRS Silt Ponds

Two silt ponds have been constructed to manage run-off from the Frasers West WRS. These are:

- Frasers West Silt Pond
- Murphy's Creek Silt Pond

Water sampling from Frasers West silt pond began in 1998 and has been undertaken on a quarterly basis since this date. Sampling from Murphy's Creek silt pond began in 2005 and has also been undertaken on a quarterly basis. By 2010, both silt ponds had catchments predominantly covered by stored waste rock. The Frasers West silt pond is geometrically broader and likely to have substantially greater evaporative losses. The source of water to Frasers West silt pond is likely to be dominated by surface run-off whereas Murphy's Creek silt pond is likely to collect a greater proportion of waste rock seepage water.

The key findings from the data measured in these silt ponds are:

- The pH of water in the two silt ponds is slightly alkaline, typically ranging from 7.5 to 8.5. The pH of Frasers West silt pond is more variable than that observed in Murphy's Creek silt pond.
- Concentrations for calcium, chloride, magnesium, potassium, sodium and sulphate in the Frasers West silt pond have been relatively stable since 2000, although substantially higher concentrations for most of the major ions were detected during the summer period of 2009/10. Since January 2006, with the exception of chloride, the concentrations of each of the major ions in the Murphys Creek silt pond have trended upwards. This trend probably reflects the increasing area of the catchment being covered by waste rock during this period. The increase in the concentrations of calcium, sodium, magnesium and sulphate is similar to that observed in the Clydesdale silt pond.
- Arsenic concentrations in both silt ponds have typically been below 0.02 g/m^3. Higher concentrations were measured on occasion in the Frasers West silt pond, with the highest concentration (0.17 g/m^3) measured in March 2010. There is no indication of a general increase in concentration over time.
- There is no indication of a general increase in the concentrations of copper, iron or lead over time.

5.5 Maori Tommy Gully Silt Pond

Maori Tommy Gully silt pond is located directly downstream from the MTI. Water quality in the silt pond is influenced by:

- Surface water run-off from disturbed areas around the silt pond.
- Seepage through the MTI embankment, which may be expected to reflect waste rock stack seepage water quality.
- Seepage from the tailings stored in the MTI.
- Excess water from the Environmental Sump at the processing plant.

An evaluation of the data measured in Maori Tommy Gully silt pond since sampling began in 1990 indicates:

- Since 2002, the pH has remained between 7.5 and 8.5.
- Concentrations of sodium, chloride, sulphate, calcium, potassium and magnesium trend upwards until 2007. Since 2007 the concentrations of these ions have decreased. The groundwater quality of the detection wells installed in Maori Tommy Gully, which are located upstream from the silt pond, have also trended downwards over the last few years (refer Section 6.5.2) although this trend is not consistent in all wells.
- Sampling for soluble concentrations of arsenic, copper, lead, iron and zinc has been inconsistent, with samples taken in 1993 and then not again until 2005 (arsenic and iron) and 2008 (copper and lead); zinc has not been tested since 1993. The metal/metalloid concentrations measured since 2005 have been below or close to detection limits. Soluble arsenic concentrations are similar to those measured in the samples collected from most of the detection wells.
- CN_{WAD} concentrations have been monitored monthly since 1990. Since 1993, concentrations have consistently been below or close to detection limits. The results are at least an order of magnitude lower than the concentrations detected in groundwater samples from most of the detection wells.

5.6 Lone Pine Water Storage Reservoir

Water is pumped to the Lone Pine water storage reservoir from the Taieri River as well as from the Maori Tommy Gully silt pond, and as such, the water quality in the reservoir is dominated by these two sources. Water sampling from the Lone Pine water storage reservoir has been undertaken on a monthly basis since sampling commenced in 1992.

The key finding from the data measured are:

- The pH has typically ranged between 7.5 and 8.5. A number of the samples taken between 2000 and 2003 had a higher pH, on one occasion exceeding a pH of 10.
- The concentrations of all major ions have increased between 1992 and 2003; however, since 2003, concentrations appear to have stabilised, although considerable variability remains.
- Concentrations of arsenic and iron appear to have decreased since monitoring commenced, with the most recent concentrations at or below the respective detection limits.
- Copper and zinc has not been detected in the reservoir water; however, these metals have not been analysed since 2003. Only four samples have been analysed for lead, with the maximum concentration detected being 0.02 g/m^3.
- CN_{WAD} concentrations have consistently been at or below the detection limit. It is noted the detection limit was changed in 2008 from 0.005 g/m^3 to 0.001 g/m^3.

6.0 GROUNDWATER QUALITY

6.1 Introduction

The following sections summarise the groundwater quality data measured by OceanaGold. Data are shown graphically in Appendix H together with data summary tables.

6.2 Compliance Limits

There are compliance limits that apply to compliance wells down-gradient of both the MTI and SPI. These consented water quality limits are presented in Table 4.

Table 4: Consented ground water quality limits.

Parameter	Compliance limit
pH (unitless)	6.0-9.5
CN_{WAD}	0.10
Arsenic	0.15
Copper[A]	0.009
Iron	1.0
Lead[A]	0.0025
Zinc[A]	0.12

Notes: Units g/m^3 unless otherwise stated; arsenic, copper, iron, lead and zinc are (filtered) concentrations; [A] compliance limits for copper, lead and zinc are hardness dependent; and the limits in this table have been calculated [2] assuming a hardness of 100 g/m^3.

[2] Copper (g/m^3) = $(0.96\exp^{0.8545[\ln(hardness)] - 1.702})$ / 1000

Lead (g/m^3) = $(1.46203 - [\ln(hardness)(0.145712)]\exp^{1.273[\ln(hardness)] - 4.705})$ / 1000

Zinc (g/m^3) = $(0.986\exp^{0.8473[\ln(hardness)] + 0.884})$ / 1000.

6.3 Background Groundwater Quality

Groundwater samples obtained from GW1, which is located south (up-gradient) of the MTI, are considered to be representative of background groundwater quality outside the mineralized zone. However, as reported in Golder (2010), initial analysis of the groundwater quality at GW1 in February 2010 indicates that mining operations may have affected groundwater quality at this location. A Mann Kendall analysis was undertaken to determine if there are any long term trends and a number of findings were reported in Golder (2010). The Mann Kendall analysis has not been re-run following the most recent rounds of sampling but the following comments are made based on the additional analytical results:

- The pH of the groundwater at GW1 has typically ranged from 7.0 to 8.0.
- The concentrations of calcium, sulphate, CN_{WAD}, arsenic, copper, lead and iron have generally been near their respective detection limits.
- Calcium, sulphate, arsenic and iron concentrations have not changed over time.
- SIN concentrations have increased steadily since monitoring commenced in 1994. However, the last two sampling rounds have shown decreasing concentrations.

6.4 Private Bores

The private Vickery and MMCL water bores, located near the Macraes Township, are monitored for water quality. Monitoring at the MMCL bore was first undertaken in 1990, when a single sample was taken, and then quarterly from 1995. Regular quarterly monitoring of the Vickery bore has been undertaken since 1991. The key findings from the data measured are:

- The pH in the groundwater within each bore is circumneutral, ranging from 7.0 to 8.0.
- Groundwater from the MMCL bore has consistently higher concentrations for each of the major ions compared to those measured in the Vickery water bore. However, with the exception of sulphate, the concentrations do not appear to have increased substantially over the monitoring period.
- Sulphate concentrations in the groundwater from both bores increased until 2002, when concentrations stabilised at less than 4 g/m^3.
- Since 1995, concentrations of CN_{WAD}, arsenic, copper and lead are all reported as close to or below their respective detection limits.

6.5 Mixed Tailings Impoundment Monitoring Wells

6.5.1 Introduction

The potential effects of the MTI derived seepage water on the down-gradient groundwater are monitored using two sets of monitoring wells. Monitoring wells GW46 to GW50 are designated as “detection” wells. These wells are installed down gradient of the MTI to provide early indications of changes to groundwater quality attributable to seepage from the MTI.

Monitoring wells GW18 to GW25 are designated “compliance” wells, situated down-gradient from both the MTI and the silt settling pond in MTG. Both sets of wells were installed to monitor changes in groundwater quality in Maori Tommy Gully prior to the groundwater reaching Deepdell Creek.

6.5.2 Detection wells

Groundwater quality in detection wells GW46 to GW50 has changed over time, reflecting the movement of tailings seepage water in a plume from the MTI. In summary:

- The pH of the groundwater in each detection well has typically remained between 6.5 and 7.2.
- The concentrations of the conservatively transported major ions, sulphate, calcium and sodium have increased at all five detection wells since monitoring began. The highest concentrations are found in GW46, while the lowest concentrations are measured in GW50.
- Since late 2007, the rate of increase in concentrations of major ions in the detection wells appears to have slowed and in some cases started to decrease. However, this trend is not consistent for all the major ions and in all detection wells. In particular, sulphate concentrations detected in GW46 continue to increase and have recently reached concentrations exceeding 1,400 g/m^3.
- SIN concentrations do not appear to have increased since mid 2005.
- CN_{WAD} concentrations have shown an overall increasing trend with the exception of those measured in GW50, which have remained below 0.2 g/m^3.
- Lead and copper concentrations have typically remained close to or below detection limits.
- Iron and arsenic concentrations in each of the detection wells have stabilised or decreased over the monitoring period.

6.5.3 Compliance wells

Groundwater quality in compliance wells GW18 to GW25 has also changed over time, again reflecting the movement of tailings seepage water in a plume from the MTI. Prior to October 2005, there was no evidence tailings seepage water from the MTI was affecting the groundwater quality at the compliance wells; however, since then, concentrations of some species, in particular, sulphate and calcium, have increase sharply, which indicates tailing seepage water from the MTI is present in the groundwater within this area. In summary:

- The pH of the groundwater in each compliance well remained relatively stable over the monitoring period and was consistently within the compliance limits of 6.0 to 9.5.
- Since October 2005, concentrations of sulphate and calcium in all compliance wells have increased, with sulphate concentrations presently ranging from 150 g/m^3 to 450 g/m^3 and calcium concentrations presently ranging from 80 g/m^3 to 190 g/m^3. Based on the concentrations measured in the detection wells (refer Section 6.5.2), this trend of increasing concentration for sulphate and calcium is expected to continue.
- Sodium concentrations, like SIN concentrations, have remained relatively constant since the beginning of the monitoring period.
- CN_{WAD} continues to return concentrations well below the consent standard of 0.1 g/m^3 and generally return levels close to or below laboratory detection limits.
- Concentrations of arsenic, copper, lead and zinc have typically been below or close to detection limits, which are substantially below compliance limits.
- Soluble iron concentrations remain around the consent compliance standard of 1.0 g/m^3. Results from the last five monitoring rounds for GW20 and GW21 indicate generally increasing concentrations. The iron concentrations of the groundwater samples collected from GW20 in June, July and August 2010 samples exceeded the consent compliance limit, as did the iron concentration in the August sample from GW21.

6.6 Southern Pit Impoundment (SPI)

6.6.1 Introduction

The potential effects of SPI derived seepage water on surrounding groundwater are monitored using two sets of monitoring wells. Monitoring wells SPMW3 and SPMW4 are designated as “detection wells”. These wells are located to the north (down-gradient) of the SP11 embankment to provide early warning of changes to groundwater quality potentially attributable to tailings seepage. Monitoring wells SPMW5, SPMW6 and SPMW7 are designated “compliance wells” and were installed to detect changes in groundwater quality prior to reaching Deepdell Creek. Resource consent compliance limits are applicable to these three compliance wells, which are located adjacent to Deepdell Creek at the base of the rock ridge remaining between the Golden Point Pit and Deepdell Creek.

6.6.2 Detection wells

An evaluation of the groundwater quality data measured within the detection wells down-gradient of the SP11 embankment indicates that:

- The pH of the groundwater in SPMW3 and SPMW4 was typically circumneutral, and remained relatively stable throughout the monitoring period.
- Sulphate, sodium and calcium concentrations in SPMW3 have increased since January 2005. Although the concentrations of these species have not increased at SPMW4, there is considerable variability.
- Concentrations of soluble arsenic in both detection wells have remained well below 0.15 g/m^3. Prior to 2009, the concentrations detected in SPMW3 were substantially higher than those detected in SPMW4. Since then, the concentrations in SPMW3 have declined to be similar to those in SPMW4.
- Soluble iron concentrations in both wells have regularly exceeded 1 $g/m^{3;}$ however, concentrations at SPMW4 have decreased since 2005 and are now consistently less than 1 g/m^3.
- Concentrations of lead, copper and CN_{WAD} are typically close to or below their respective laboratory detection limits.

6.6.3 Compliance wells

The groundwater quality at the Southern Pit Compliance Wells is strongly influenced by geochemical issues associated with the historical underground workings with the result that water quality differs significantly from one well to the next. Monitoring well SPMW7 is considered to be the most strongly influenced by these workings, with SPMW6 the least influenced. The key findings from the data measured in these wells are:

- The pH of the groundwater at SPMW7 has varied over the monitoring period between 6.5 and 7.4. Since January 2007, the pH has consistently been between 6.5 and 7.0. The concentrations of both sulphate and calcium at SPMW7 vary inversely with pH. Since January 2007, concentrations of sulphate have ranged from 1,000 g/m^3 to 2,000 g/m^3. During the same period, calcium concentrations have typically been between 400 g/m^3 and 550 g/m^3. In contrast, sodium concentrations have varied in concert with pH, with concentrations, since January 2007, at or below 110 g/m^3.
- Compared to SPMW7, the water quality in both SPMW5 and SPMW6 has remained relatively stable since monitoring began in late 2001. The groundwater at both wells has a pH of between 7 and 7.5. Sulphate concentrations generally range from 100-200 g/m^3 in SPMW5 and from 10-30 g/m^3 in SPMW6. The concentrations in both wells do not vary greatly and indicate stable water quality. The calcium and sodium concentrations detected in these wells have changed little since January 2005 and vary within relatively small ranges.

- Soluble iron concentrations in all three compliance wells have been below 0.6 g/m^3 since monitoring began, with SPMW7 results generally being lower than those from the other two wells.
- Arsenic concentrations in SPMW6 are typically below 0.01 g/m^3. The concentrations in SPMW7 have decreased from approximately 0.2 g/m^3 in January 2007 to less than 0.03 g/m^3 in early 2010. The most recent data indicate concentrations have increased slightly to 0.1 g/m^3, although this remains below the compliance limit of 0.15 g/m^3. In contrast, arsenic concentrations in SPMW5 have been higher than the limit since monitoring began, with concentrations averaging 0.63 g/m^3.
- Soluble lead and copper concentrations in all three monitoring wells have been at or below detection limits since monitoring began.
- CN_{WAD} concentrations have been consistently close to or below the detection limit in all three compliance wells.

6.7 Mixed Tailing Impoundment Western Monitoring Wells

A series of monitoring wells have been installed along the western margin of the MTI. Data from a selection of these wells is documented in this report to summarise the effects of the MTI on water quality to the west of the TSF. The ground to the west of the MTI drops off into a shallow gully that limits the potential for seepage losses from the MTI to be transported toward the township. Further to the south the ground elevation rises above the tailings elevation in the MTI.

The selected monitoring wells, labelled P1, GW2, GW38 and GW3, are located in a line along the access road around the western margin of the TSF. Monitoring Well P1 is located close to GW1 (refer Section 6.3) and both are likely to represent background groundwater quality at the site. Monitoring wells GW2 and GW38 are located to the west of the shallow gully discussed above. Monitoring well GW3 is located further to the northwest, to the west of the Lone Pine WSR.

An evaluation of the groundwater quality data measured in these wells indicates that:

- The pH of the groundwater in P1 is consistently around 6.0, while the pH in GW3 is slightly more neutral at 6.5. The pH the groundwater in GW38 is circumneutral, ranging from 6.5 to 7.5. GW2 returns the most consistent pH of around 8.
- The concentrations of calcium, sodium and sulphate in the groundwater sampled at GW3 and P1 have been relatively stable over the monitoring period, while the concentrations in GW2 ground water are particularly variable. The highest concentrations of these species were measured at GW2. The concentrations of major ions in GW38 groundwater were consistent until 2007 when they became much more variable.
- GW38 has returned some highly variable SIN concentrations and this has been repeated in the most recent sampling rounds. Concentrations in the other three wells are close to detection limits.
- Iron concentrations in GW2 and P2 are consistently 1 g/m^3, while concentrations in GW3 and GW38 are higher, ranging from 1 to 16 g/m^3.
- CN_{WAD}, copper, arsenic and zinc concentrations are consistently close to or below detection limits. Lead concentrations have, on occasion, been greater than 0.0025 g/m^3, the compliance limit that applies to the compliance wells down gradient of the MTI and SPI.

6.8 Fraser West WRS Monitoring Wells

The monitoring wells around the Fraser West WRS are labelled FDB01 through FDB10. Monitoring has been undertaken since 2001, when monitoring wells FDB03, FDB05, FDB07 and FDB09 were sampled quarterly. Sampling of the remaining wells did not commence until 2005 or, in some cases, 2006. The key findings from the groundwater quality data measured in wells FDB03 through FDB10 are:

- In general, the pH of the groundwater in the FDB03, FDB04, FDB05 and FDB10 monitoring wells is between 6.0 and 9.5. The pH of the groundwater from monitoring wells FDB06 and FDB07 is more acidic, ranging from 5.0 to 6.5. FDB08 and FDB09 groundwater has a pH of between 6 and 6.5.
- Concentrations for three of the conservatively transported major ions (calcium, sodium and sulphate) appear relatively stable in monitoring wells FDB03, FDB05, FDB07 and FDB10. The water quality in FDB08 appears relatively constant until 2009, when the concentrations of these ions began to increase. The concentrations measured in FDB04 and FDB06 groundwater is showing an upward trend indicative of seepage water reaching these monitoring wells from the Frasers West WRS.
- Soluble iron concentrations in FDB03, FDB04, FDB05, FDB07 and FDB10 have on occasion been higher than the compliance limit of 1.0 g/m^3 that applies to compliance wells down gradient of the MTI and SPI. However, concentrations in these wells have decreased since monitoring started and, with the exception of those measured in FDB003, are now close to, or below, detection limits. Iron concentrations were below the detection limit in the three samples collected from FDB06 and in two of the three samples collected from FDB08. Iron concentrations at FDB09 ranged up to 0.34 g/m^3.
- Concentrations of arsenic, copper and lead are typically below detection limits, and in all cases, below the compliance limits of 0.15 g/m^3, 0.009 g/m^3 and 0.0025 g/m^3, respectively, that apply to compliance wells down gradient of the MTI and SPI.

7.0 SURFACE WATER QUALITY

7.1 Introduction

There are five water courses in the MGP for which surface water quality data are available. These are:

- Deepdell Creek
- Shag River
- Murphy’s Creek
- North Branch Waikouaiti River
- Tipperary Creek

The analytical results relating to the water samples collected by OceanaGold is presented, by watercourse, in Sections 7.3 to 7.7, and shown graphically in Appendix I together with tabulated summaries.

7.2 Compliance Limits

There are compliance limits provided in Schedule I of Resource Consents 2006.304-305 and 2006.307-308 that apply to one site in Deepdell Creek (DC07) and one site within the Shag River (Loop Road). Schedule I of Resource Consents 2003.635-638, 2004.362-763, 2005.208-210 and 2007.583 provide compliance limits that apply to two sites within Murphy’s Creek (Sites MC100 and MC01) and to two sites on the North Branch of the Waikouaiti River (NBWRRB and NBWRRF). These water quality limits are presented in Table 5.

Table 5: Consented receiving water quality limits.

Parameter	Deepdell Ck	Shag River	Murphy's Creek		North Branch Waikouaiti	
Site	**DC07**	**Loop Road**	**MC100 (upstream)**	**MC01 (downstream)**	**NBWRRB**	**NBWRRF**
pH (unitless)	6.0-9.5	7.0-8.5	6.0-9.5	6.0-9.5	6.0-9.5	6.0-9.5
Arsenic	0.15	0.01	0.15	0.01	0.15	0.01
CN_{WAD}	0.10	0.10	-	-	-	-
Copper[A]	0.009	0.009	0.009	0.009	0.009	0.009
Iron	1.0	0.2	1.0	1.0	1.0	1.0
Lead[A]	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025
Zinc[A]	0.12	-	0.12	0.12	0.12	0.12
Sulphate	1,000	250	-	-	-	-

Notes: Units g/m^3 unless otherwise stated, arsenic, copper, iron, lead and zinc are (filtered) concentrations; [A] compliance limits for copper, lead and zinc are hardness dependent, the limits in this table have been calculated [3] assuming a hardness of 100 g/m^3. However, the formula provided in Schedule I of Resource Consents 2003.635-638, 2004.362-763, 2005.208-210 and 2007.583 to derive the limit for copper in Murphy's Creek and the North Branch of the Waikouaiti River ($0.96\exp^{0.8545[\ln(\text{hardness})] - 1.465}$) / 1000) does not give the values reported in the schedule (and summarised above). Due to the presence of this equation, it is understood that the intent of the consent was to require a compliance limit of 0.009 g/m^3 for copper at MC01 and NBWRRF (based on an assumed hardness of 100 g/m^3) and therefore surface water quality at these compliance points have been compared with the interpreted intended concentration rather than 0.0014 g/m^3 which is reported in the consent table.

It is noted there are compliance limits provided in Schedule I of Resource Consents 2002.491, 2002.759 and 2002.763 that apply to a third site on the North Branch of the Waikouaiti River (Site NB03). However, these consents are related to the Golden Bar Development, and are therefore outside the scope of this work.

7.3 Deepdell Creek

7.3.1 Introduction

The Deepdell Creek water quality monitoring sites used in this assessment are listed in Table 6 together with a description of the location.

Table 6: Monitoring points along Deepdell Creek and the associated catchment areas.

Site	Location
DC01	Upstream of MGP
DC06	Downstream of Golden Point adit and the SPI and upstream of the Northern Gully confluence
DC07	Downstream of the Northern Gully confluence

[3] Copper (g/m^3) = ($0.96\exp^{0.8545[\ln(\text{hardness})] - 1.702}$) / 1000
Lead (g/m^3) = ($1.46203 - [\ln(\text{hardness})(0.145712)]\exp^{1.273[\ln(\text{hardness})] - 4.705}$) / 1000
Zinc (g/m^3) = ($0.986\exp^{0.8473[\ln(\text{hardness})] + 0.884}$) / 1000.

Site DC01 is upstream from the MGP and considered to provide background water quality data for Deepdell Creek. Site DC07, which is located downstream from the Northern Gully confluence, is one of two water compliance sites for the MGP; the other site is located on Shag River and will be discussed in Section 7.4.

Water quality samples have been collected from monitoring sites DC01, DC06 and DC07 on a regular basis since August 2005. Prior to this date, background water quality was assessed upstream of the mine at Site Deepdell C, while compliance was assessed at Deepdell L. For the purpose of this assessment, background surface quality has been summarised from data measured at Deepdell C between 1990 and 1994 and at DC01 between 2005 and 2010. Similarly, data measured at Site DC07 between 2005 and 2010 have been appended to the data collected from Deepdell L between 1990 and 2004.

7.3.2 Background surface water quality

The key finding from the water quality data measured at DC01 in Deepdell Creek upstream of the MGP are:

- The pH of Deepdell Creak is slightly alkaline (mean pH 7.8).
- Allowing for natural variation, which is a function of rainfall, run-off and groundwater recharge, concentrations of all species monitored have not significantly changed since monitoring began.

7.3.3 DC06

The water quality at the DC06 site, which is located downstream of the Golden Point underground workings discharges, differs from that measured at the upstream control site (DC01). These changes in water quality may be attributable to:

- Run-off and groundwater seepage from waste rock storage areas close to the Deepdell Pits.
- Run-off from the haul road leading to the Deepdell pits.
- Minor run-off discharging as surface water flows down Battery Creek.
- Seepage through the intact rock barrier between Golden Point Pit and Deepdell Creek.
- Surface water discharges from the historical Golden Point underground workings that intersect Golden Point Pit.
- Groundwater seepage from historical workings in and around the Golden Point Historic Reserve.

In general, the monitoring data measured at DC06 indicate:

- While concentrations of chloride, potassium, sodium, CN_{WAD}, copper, iron and lead are comparable to those measured upstream, concentrations of calcium, magnesium, sulphate and arsenic are higher.
- Prior to October 2006, sulphate concentrations at DC06 were similar to those measured at Site DC01. Since then, concentrations have been noticeably higher at DC06 (mean of 260 g/m^3 at DC06 compared to 4.5 g/m^3 at DC01). This is most likely due to discharges from the Golden Point Adit (refer Section 4.4.2) which started to flow strongly around this time. Prior to this time these discharges has practically ceased following mining of Golden Point Pit.

7.3.4 Deepdell Creek compliance point water quality - DC07

An evaluation of the water quality data measured at the Deepdell Creek compliance point between 1990 and 2010 indicates that:

- Like Site DC06, compliance site concentrations of chloride, potassium, sodium, CN_{WAD}, copper, iron and lead were comparable to those measured at the upstream control site, while concentrations of calcium, magnesium, sulphate and arsenic were higher (but similar to those measured at Site DC06).

- Concentrations of copper, lead and CN_{WAD} are typically below the detection limits and no analysis results have exceeded the respective compliance limits.
- OceanaGold achieved a high level of compliance at the Deepdell Creek compliance point between 1994 and 2010; however, there have been a small number of technical non-compliances over this period, as listed below:
  - The compliance limit for sulphate of 1,000 g/m^3 was exceeded on a single occasion, on 23 November 2006, when the sulphate concentration was 1,020 g/m^3. This is minor and considered to be within the analytical error of the measurement.
  - The compliance limit for iron of 1.0 g/m^3 was exceeded on two occasions, once on 15 August 1992, when the iron concentration was 1.1 g/m^3 and once on 30 November 2004, when the concentration was 1.95 g/m^3.
  - There were four exceedances of the hardness dependent limit for lead over the monitoring period. These exceedances occurred on 28 August and 18 October 1990, 25 September 1991 and 30 November 2004. Lead concentrations upstream from the MGP at Deepdell C during each of the first three exceedances were also higher than the associated compliance limit. These results indicate the earlier exceedances are not related to mining operations. Upstream concentrations were not assessed on 30 November 2004.
- The detection limits for arsenic, copper and lead were, on occasion, higher than the compliance limits for these species, and as such no assessment of compliance could be made on these occasions.
- Although there is a gap in surface water sulphate measurements for the period between 1994 and 2000 it is apparent that sulphate concentrations have increased since MGP operations began in 1990. Sulphate concentrations detected between 2002 and 2006 were typically higher than detected at the same site previously (1990 to 1994) and at upstream sites during the same period. This increase has been attributed to seepage losses from the waste rock storage areas (Kingett Mitchell 2005).
- Since 2006 the sulphate concentrations detected have been typically an order of magnitude higher than those detected both at the same site previously and at upstream sites during the same period. A maximum concentration of 1,020 g/m^3 has been reported. The increased concentrations since 2006 appear to be primarily a result of discharges from the Golden Point underground workings which receive seepage water from the tailing impoundments. The discharges from the Golden Point underground workings increased due to MGP water management issues that have subsequently been corrected (pers. comm. J. Bywater, OceanaGold). The concentrations of soluble arsenic and iron have remained stable over the monitored period, as has pH.

7.4 Shag River Compliance Point

The Shag River compliance monitoring site is located at Loop Road downstream from the confluence of Deepdell Creek and the Shag River. This site, like Site DC07, is a surface water compliance site. An evaluation of the data measured at the Shag River compliance site since monitoring commenced in 2006, indicates that:

- With the exception of sulphate, the concentrations of major ions detected at the Shag River water quality compliance monitoring site are similar to those measured in Deepdell Creek upstream of the MGP (at Site DC01/Deepdell C). The measured pH is also similar to that measured at the upstream control site.
- It is likely the elevated concentrations of sulphate detected at the Loop Road monitoring site in 2006 and 2007 were a consequence of the increased discharges from the Golden Point underground workings. The measured sulphate concentrations have subsequently decreased as the Golden Point discharges have been brought under control.

- The concentrations of CN_{WAD}, arsenic, copper, iron and lead at the Shag River compliance site between 2005 and 2010 were typically below their respective detection limits.
- With the exception of pH, there have been no exceedances of the limits since monitoring began. A pH of 6.9 was recorded on 13 August 2009, which was outside the permitted range of 7.0-8.5; however, this exceedance is minor and considered to be within the analytical error for pH measurement.

7.5 Murphy's Creek

The water quality of Murphy's Creek is monitored at Site MC100[4] and MC01[5] located, respectively, 100 m and 1,000 m, downstream from Murphy's Creek Silt Pond. Both sites are surface water compliance sites. Water quality samples have been collected from Site MC100 since June 2004 and from Site MC01 since December 2003. The key findings from the data measured are:

- The concentrations measured at Site MC100 towards the end of the monitoring period were higher than those measured a further 900 m downstream at Site MC01. The pH was unchanged between sites.
- There has been a general increase over time in the concentrations of major ions at both sites. The concentrations of the trace elements at both sites have not changed greatly over the monitoring period.
- The compliance limits for pH, arsenic, copper, lead and zinc were not exceeded in any of the samples collected from either site. However, the compliance limit for iron of 1.0 g/m^3 was exceeded on two occasions at Site MC01 during the monitoring period. The first exceedance occurred on 15 December 2003 when a concentration of 1.3 g/m^3 was recorded, while the second occurred during the next round of sampling on 15 March 2004 when an iron concentration of 2.0 g/m^3 was measured. Concentrations at Site MC01 have ranged from 0.04 g/m^3 to 0.77 g/m^3 in the interim, with a mean of 0.42 g/m^3.

7.6 North Branch Waikouaiti River

The water quality of the North Branch of the Waikouaiti River (NBWR) is monitored at three locations:

- NBWR Redbank Road (NBWRRB)[6]
- NBWR Ross Ford (NBWRRF)[7]
- NB03

The NBWRRB site is located to the northwest of Frasers West WRS, while the NBWRRF site is some 8 km further downstream. Both sites are compliance sites. Site NB03[8] is located a further 8 km downstream of Site NBWRRF and is downstream of the confluence with Murphy's Creek. Water quality samples have been collected from NBWRRF since June 2004 and from Site NBWRRB since August 1999. Site NB03 water quality has been assessed since December 2003. An evaluation of the data measured at these sites indicates that:

- Site NB03 had the lowest measured concentrations of the three sites.
- The concentrations at Sites NBWRRB and NBWRRF were, with the exception of sulphate, comparable to one another. Sulphate concentrations were higher at Site NBWRRB compared to Site NBWRRF.

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4 Site MC100 is referred to as Site MC01 in the relevant resource consents, but has subsequently been renamed Site MC100.

5 Site MC01 is referred to as Site MC02 in the relevant resource consents, but has subsequently been renamed Site MC01.

6 Site NBWRRB is referred to as Site NB03 in the relevant resource consents, but has subsequently been renamed Site NBWRRB.

7 Site NBWRRF is referred to as Site NB04 in the relevant resource consents, but has subsequently been renamed Site NBWRRF.

8 Not to be confused with the site of the same name that has subsequently been renamed Site NBWRRB.

- Since 2008, there has been an increase in the concentrations of calcium, magnesium, sodium and sulphate at all sites. Potassium concentrations have also increased, most notably at Site NBWRRF.
- There is no indication of a general increase in the concentrations of copper, iron, lead or zinc over time. However, arsenic concentrations at Site NBWRRB appear to have increased since monitoring began.
- OceanaGold achieved a high level of compliance at Sites NBWRRB and NBWRRRF; however, iron concentrations exceeded the compliance limit for iron of 1.0 g/m^3 on eight occasions at Site NBWRRB and on one occasion at Site NBWRRF. Since 2007, there have been no exceedances at either site with iron concentrations ranging from <0.02 g/m^3 to 0.31 g/m^3 at Site NBWRRB and from 0.12 g/m^3 to 0.6 g/m^3 at Site NBWRRF.

7.7 Tipperary Creek

Water samples were collected from Site TC01 between May 2009 and July 2009 and analysed to assess the current water quality in Tipperary Creek. The results indicate the water quality of Tipperary Creek is similar to the background water quality in Deepdell Creek (Section 7.3.3). The key points are:

- A near neutral to mildly alkaline pH with low concentrations of major ions.
- Soluble arsenic and lead concentrations were less than the respective detection limits in all samples.
- The concentration of CN_{WAD} was below the detection limit in five of the seven samples and the maximum detected concentration was 0.002 g/m^3.

8.0 REFERENCES

Golder 2010. Macraes Gold Project - Back Road Tailings Storage Facility: Water quality review and contaminant transport model water quality inputs. Report prepared for Oceana Gold (New Zealand) Limited by Golder Associates (NZ) Limited, February 2010.

Kingett Mitchell 2005. Macraes Gold Project groundwater and contaminant transport assessment. Report prepared for Oceana Gold (New Zealand) Limited by Kingett Mitchell Limited.

APPENDIX A

Report limitations

REPORT LIMITATIONS

This Document has been provided by Golder Associates (NZ) Ltd (“Golder”) subject to the following limitations:

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iv) In addition, it is recognised that the passage of time affects the information and assessment provided in this Document. Golder’s opinions are based upon information that existed at the time of the production of the Document. It is understood that the Services provided allowed Golder to form no more than an opinion of the actual conditions of the site at the time the site was visited and cannot be used to assess the effect of any subsequent changes in the quality of the site, or its surroundings, or any laws or regulations.

v) Any assessments made in this Document are based on the conditions indicated from published sources and the investigation described. No warranty is included, either express or implied, that the actual conditions will conform exactly to the assessments contained in this Document.

vi) Where data supplied by the client or other external sources, including previous site investigation data, have been used, it has been assumed that the information is correct unless otherwise stated. No responsibility is accepted by Golder for incomplete or inaccurate data supplied by others.

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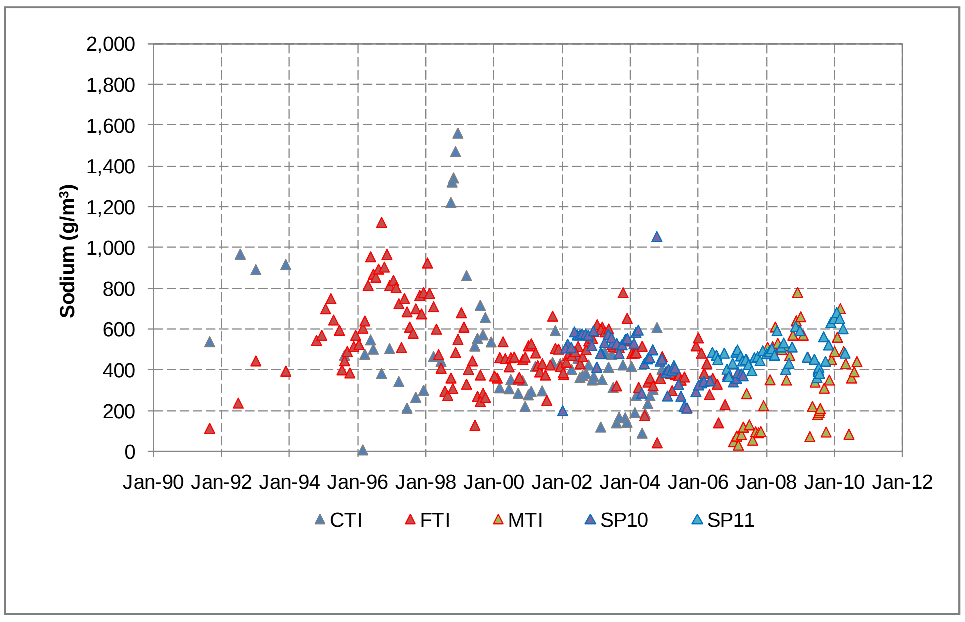
APPENDIX B

Decant pond water quality data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1,600
1,400
1,200
1,000
800
600
400
200
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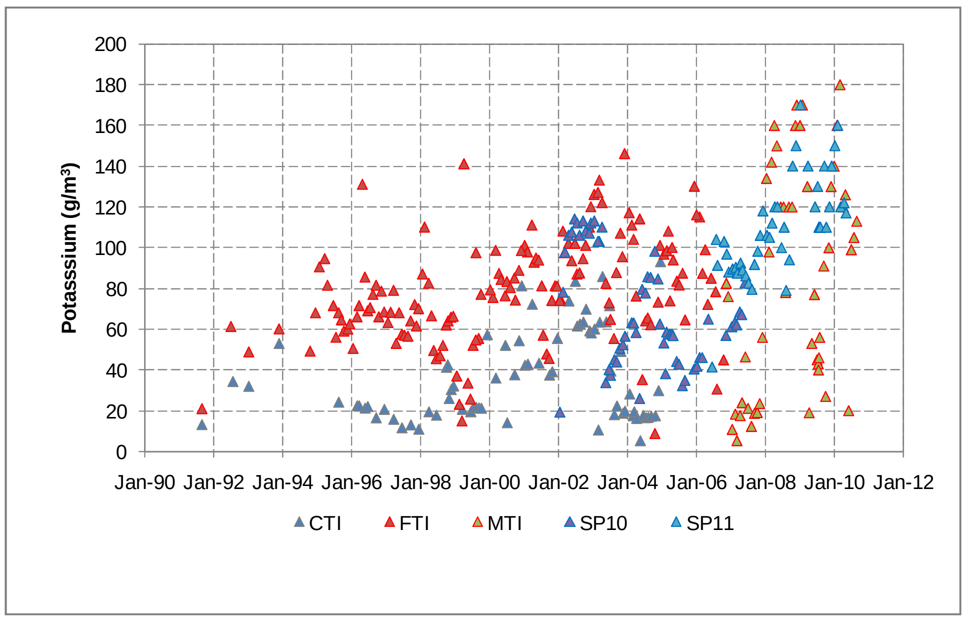
CTI FTI MTI SP10 SP11


Potasssium (g/m³)
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140
120
100
80
60
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20
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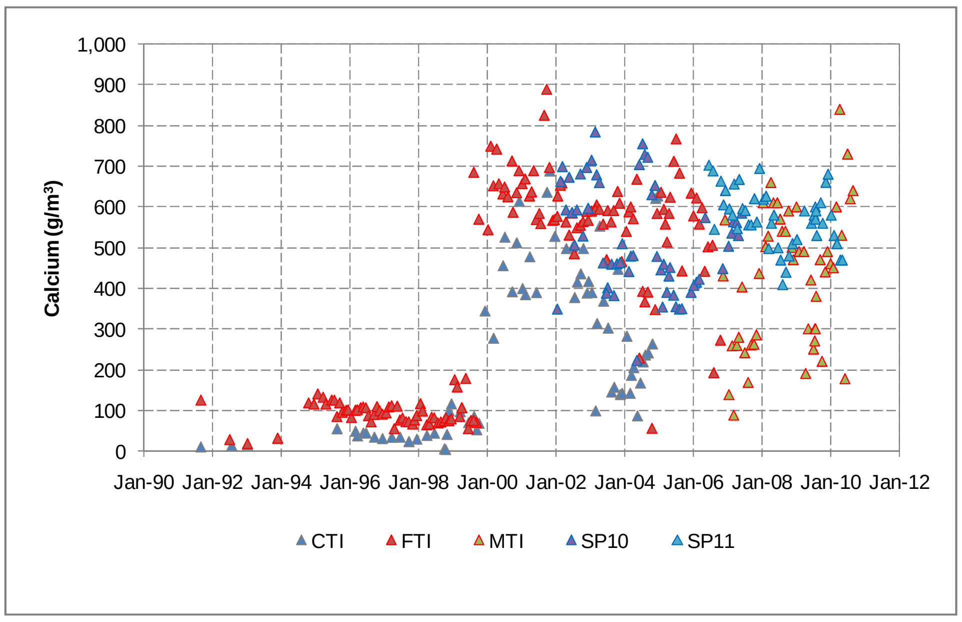
Jan-90 Jan-92 Jan-94 Jan-96 Jan-98 Jan-00 Jan-02 Jan-04 Jan-06 Jan-08 Jan-10 Jan-12
CTI FTI MTI SP10 SP11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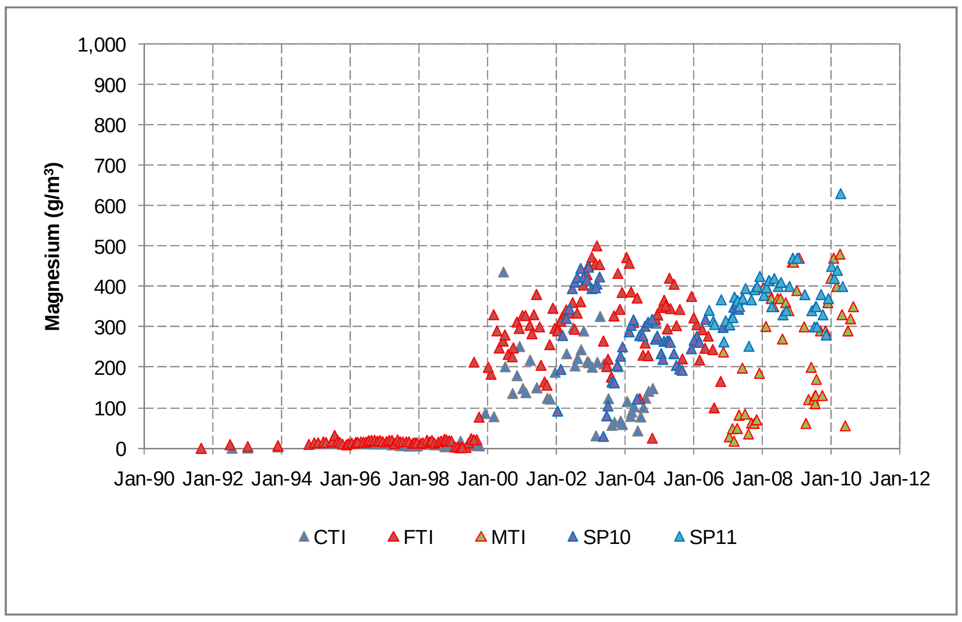
800
700
600
500
400
300
200
100
0
Jan-90 Jan-92 Jan-94 Jan-96 Jan-98 Jan-00 Jan-02 Jan-04 Jan-06 Jan-08 Jan-10 Jan-12
CTI FTI MTI SP10 SP11


Magnesium (g/m³)
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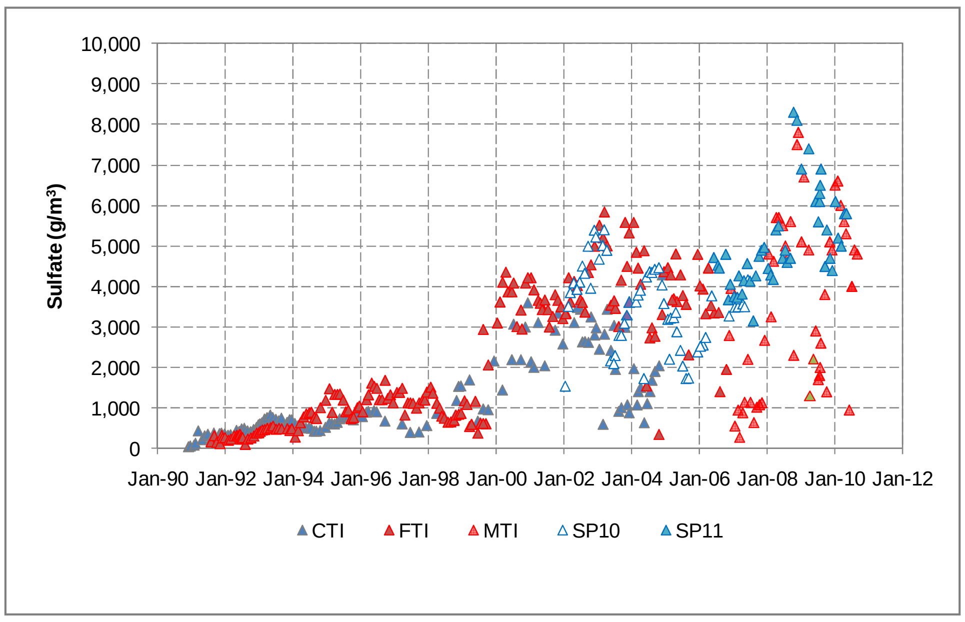
800
700
600
500
400
300
200
100
0
Jan-90 Jan-92 Jan-94 Jan-96 Jan-98 Jan-00 Jan-02 Jan-04 Jan-06 Jan-08 Jan-10 Jan-12
CTI FTI MTI SP10 SP11


Sulfate (g/m³)
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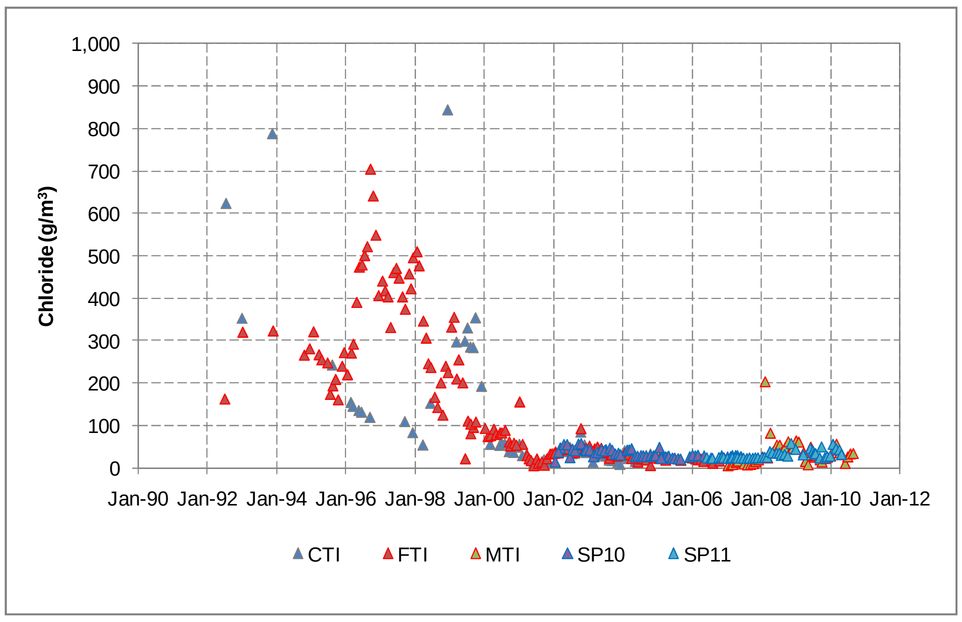
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
Jan-90 Jan-92 Jan-94 Jan-96 Jan-98 Jan-00 Jan-02 Jan-04 Jan-06 Jan-08 Jan-10 Jan-12
CTI FTI MTI SP10 SP11


Chloride (g/m³)
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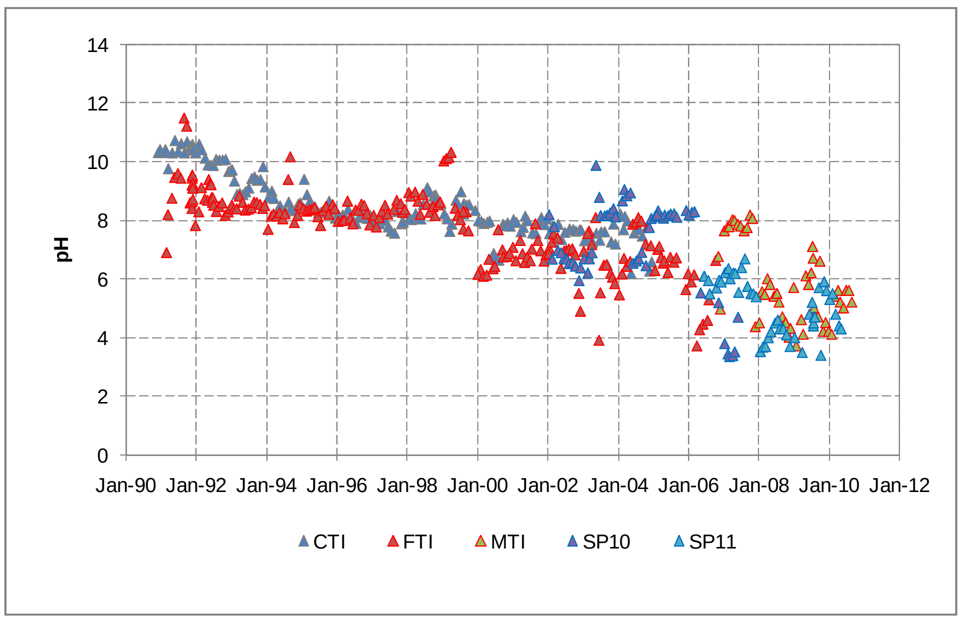
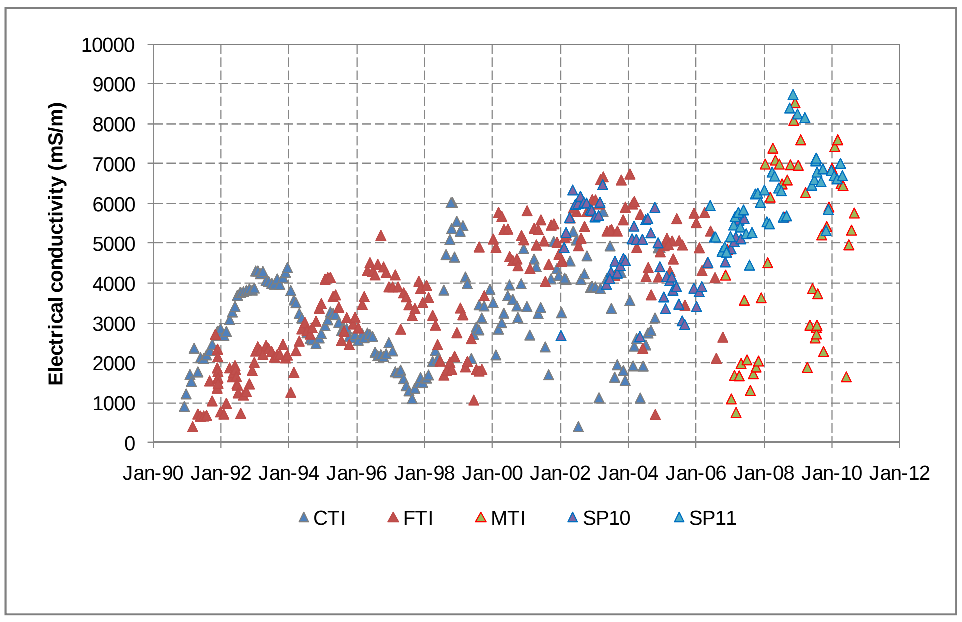
900
800
700
600
500
400
300
200
100
0
Jan-90 Jan-92 Jan-94 Jan-96 Jan-98 Jan-00 Jan-02 Jan-04 Jan-06 Jan-08 Jan-10 Jan-12
CTI FTI MTI SP10 SP11


pH
14
12
10
8
6
4
2
0
Jan-90 Jan-92 Jan-94 Jan-96 Jan-98 Jan-00 Jan-02 Jan-04 Jan-06 Jan-08 Jan-10 Jan-12
CTI FTI MTI SP10 SP11


Electrical conductivity (mS/m)
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
Jan-90 Jan-92 Jan-94 Jan-96 Jan-98 Jan-00 Jan-02 Jan-04 Jan-06 Jan-08 Jan-10 Jan-12
CTI FTI MTI SP10 SP11

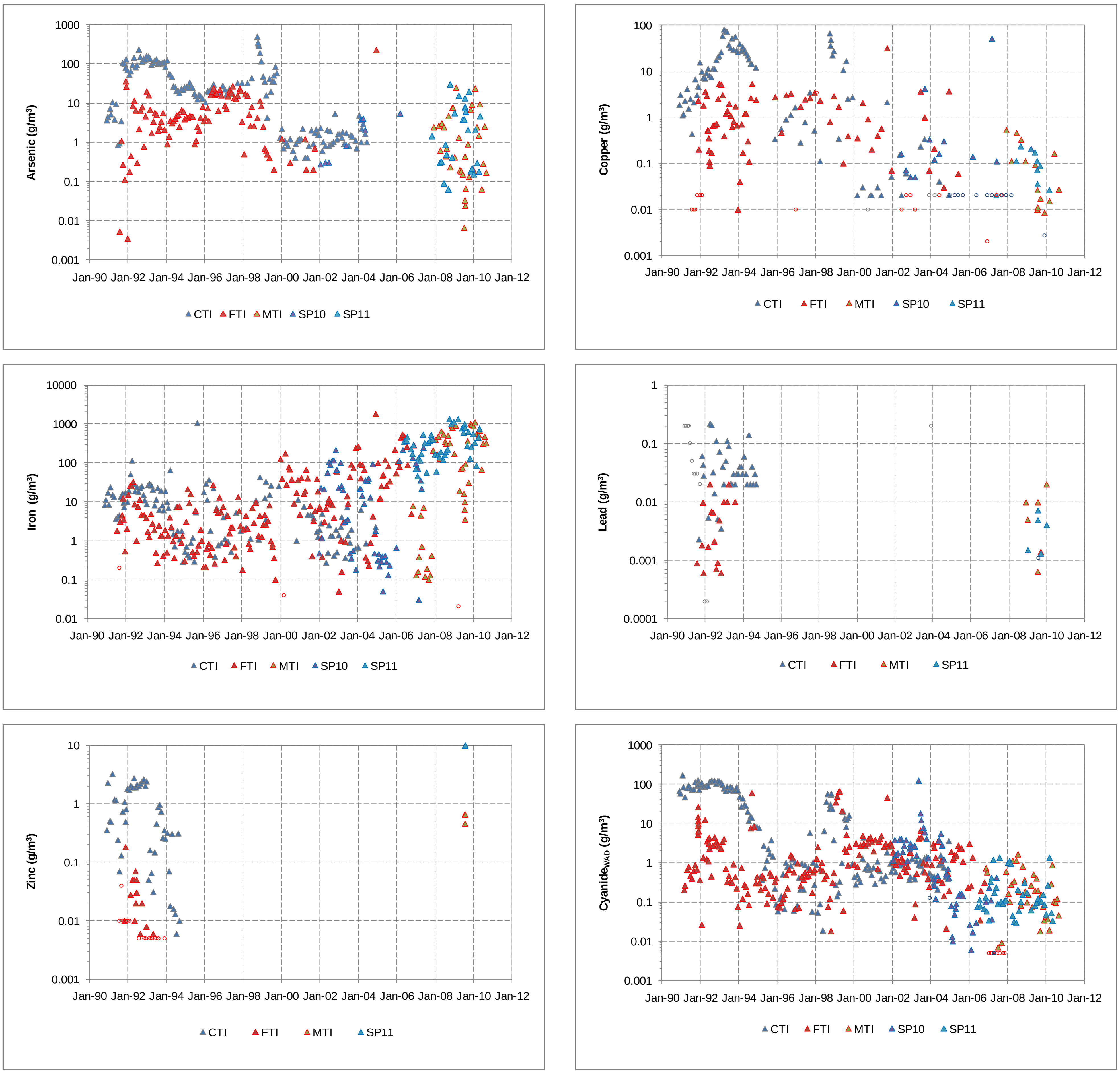


Figure B1: Tailings decant water quality.

Table B1: Summary of CTI decant water quality.

Parameter	Minimum	Mean	95th Percentile	Maximum
pH (unitless)	6.2	8.5	11	11
Conductivity (mS/m)	390	3,200	5,100	6,000
Calcium	5.2	370	700	890
Chloride	9.2	170	930	1,300
Magnesium	0.56	110	300	440
Potassium	5.1	36	76	93
Sodium	4.9	460	1,300	1,600
Sulphate	24	1,200	3,200	4,300
CN_{WAD}	0.019	28	110	170
Arsenic	<0.20	<44	150	490
Copper	<0.010	<14	57	79
Iron	0.18	17	29	1,000
Lead[A]	<0.00020	<0.046	0.15	0.22
Zinc	<0.006	<0.95	2.5	3.2

Notes: All units g/m^3 unless stated; all data presented to two significant figures or less; and [A] summary statistics were derived after excluding detection limits that have been superseded by lower limits.

Table B2: Summary of FTI decant water quality.

Parameter	Minimum	Mean	95th Percentile	Maximum
pH (unitless)	3.7	7.8	9.5	11
Conductivity (mS/m)	400	3,600	5,900	6,700
Calcium	20	370	700	890
Chloride	6.4	160	480	700
Magnesium	0.08	180	430	500
Manganese	<0.06	<12	22	23
Potassium	8.8	79	130	150
Sodium	42	500	850	1,100
Sulphate	82	2,100	4,900	5,800
CN_{WAD}	0.018	3.8	13	65
Arsenic	<0.20	<5.6	20	230
Copper	<0.010	<1.6	3.6	31
Iron	<0.040	<39	125	1,800
Lead[A]	<0.0002	<0.0025	0.0077	0.0097
Zinc	<0.005	<0.023	0.060	0.18

Notes: All units g/m^3 unless stated; all data presented to two significant figures or less; and [A] summary statistics were derived after excluding detection limits that have been superseded by lower limits.

Table B3: Summary of MTI decant water quality.

Parameter	Minimum	Mean	95th Percentile	Maximum
pH (unitless)	3.7	5.8	8.0	8.2
Conductivity (mS/m)	760	4,600	7,600	8,500
Calcium	88	440	700	840
Chloride	5.1	33	63	200
Magnesium	17	250	470	480
Potassium	5.3	85	170	180
Sodium	31	340	650	780
Sulphate	280	3,500	6,700	7,800
CN_{WAD}	<0.005	<0.25	1.0	1.6
Arsenic	<0.80	<2.5	9.1	24
Copper	<0.002	<0.11	0.46	0.52
Iron	<0.021	<290	940	1,100
Lead[A]	<0.00053	<0.0046	0.0099	0.0099
Zinc	0.45	0.58	0.66	0.66

Notes: All units g/m^3 unless stated; all data presented to two significant figures or less; and [A] summary statistics were derived after excluding detection limits that have been superseded by lower limits.

Table B4: Summary of SP10 decant water quality.

Parameter	Minimum	Mean	95th Percentile	Maximum
pH (unitless)	3.4	7.2	8.9	9.9
Conductivity (mS/m)	2,700	4,800	6,000	6,500
Calcium	220	520	720	780
Chloride	15	33	54	56
Magnesium	28	280	420	450
Potassium	19	69	110	110
Sodium	200	450	590	1,100
Sulphate	1,500	3,500	5,100	5,400
CN_{WAD}	<0.005	<4.1	8.8	120
Arsenic	<0.20	<1.0	3.8	5.3
Copper	<0.02	<3.4	14	51
Iron	0.030	43	170	250

Notes: All units g/m^3 unless otherwise stated; all data presented to two significant figures or less; and lead and zinc were not assessed in SP10 decant water.

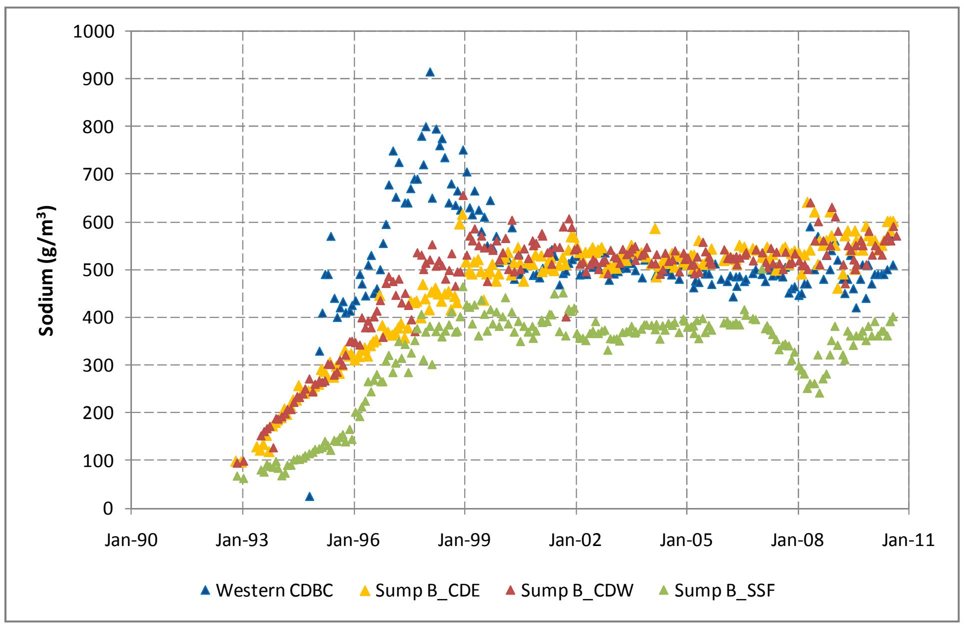
Table B5: Summary of SP11 decant water quality.

Parameter	Minimum	Mean	95th Percentile	Maximum
pH (unitless)	3.4	5.0	6.3	6.7
Conductivity (mS/m)	4,500	6,200	8,200	8,800
Calcium	410	570	690	700
Chloride	22	31	49	58
Magnesium	250	370	470	630
Potassium	41	110	150	170
Sodium	360	480	650	680
Sulphate	3,200	5,100	7,300	8,300
CN_{WAD}	0.029	0.26	1.1	1.3
Arsenic	<0.80	<3.2	15	29
Copper	<0.0027	<0.072	0.21	0.23
Iron	46	420	1,100	1,300
Lead	0.0011	0.0033	0.0066	0.0072
Zinc	9.7	9.8	9.9	9.9

Notes: All units g/m^3 unless otherwise stated; and all data presented to two significant figures or less.

APPENDIX C

Tailings seepage water quality data


Sodium (g/m³)
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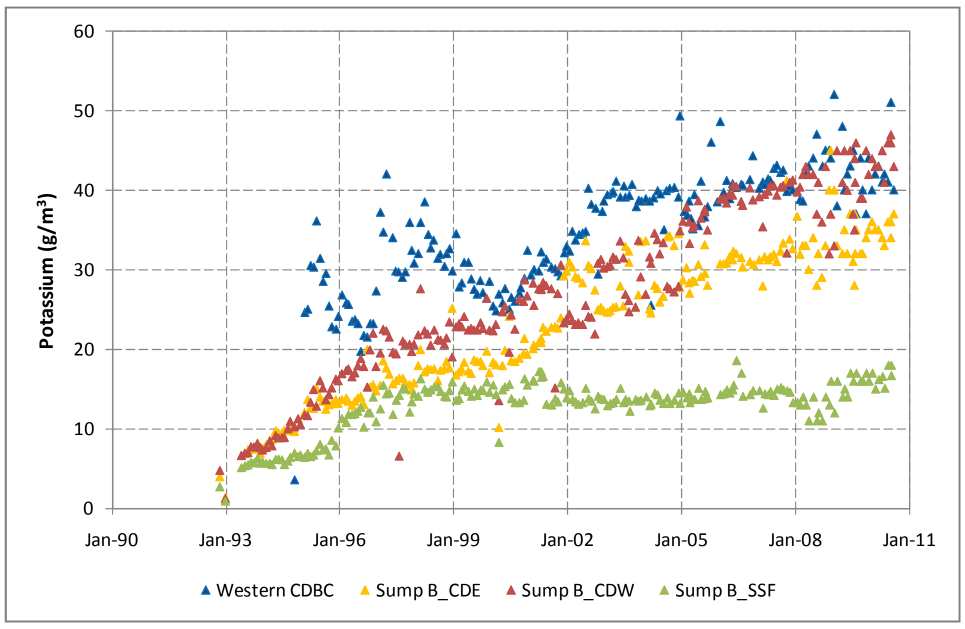
100
200
300
400
500
600
700
800
900
1000
Jan-90
Jan-93
Jan-96
Jan-99
Jan-02
Jan-05
Jan-08
Jan-11
Western CDBC
Sump B_CDE
Sump B_CDW
Sump B_SSF


Potassium (g/m³)
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20
30
40
50
60
Jan-90
Jan-93
Jan-96
Jan-99
Jan-02
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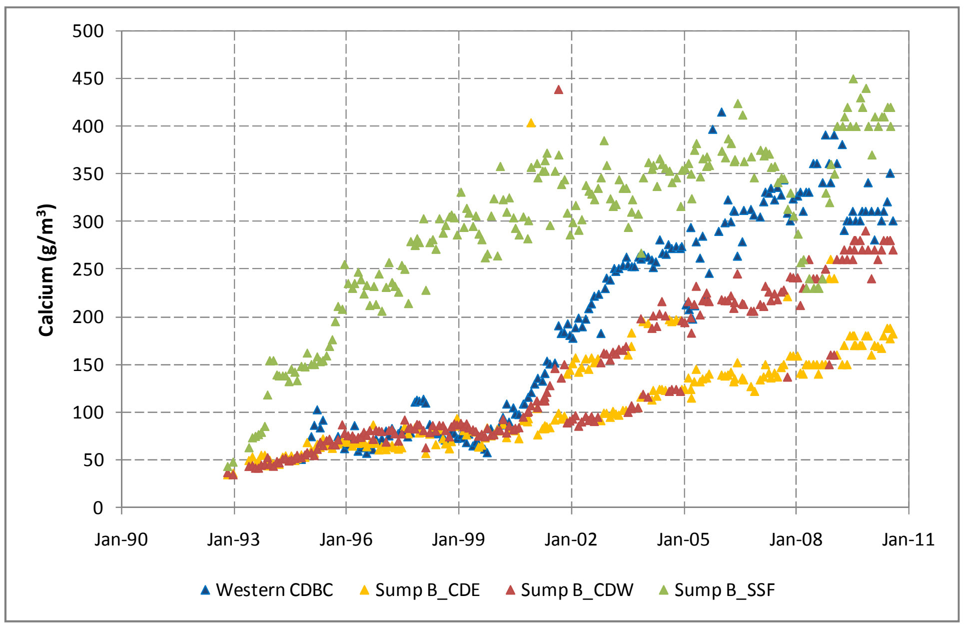
Sump B_CDW
Sump B_SSF


Calcium (g/m³)
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50
100
150
200
250
300
350
400
450
500
Jan-90
Jan-93
Jan-96
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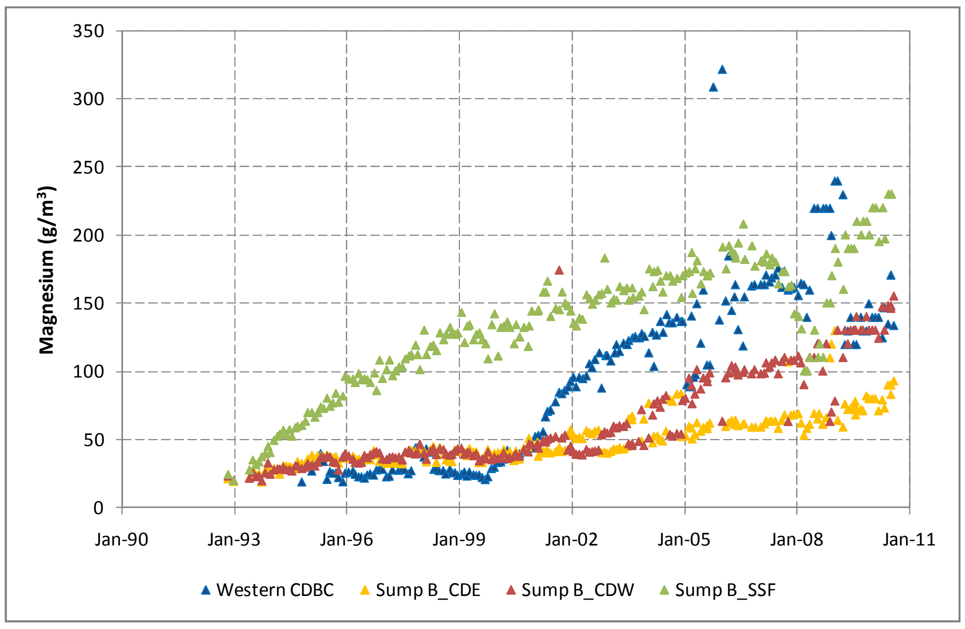
Sump B_CDE
Sump B_CDW
Sump B_SSF


Magnesium (g/m³)
0
50
100
150
200
250
300
350
Jan-90
Jan-93
Jan-96
Jan-99
Jan-02
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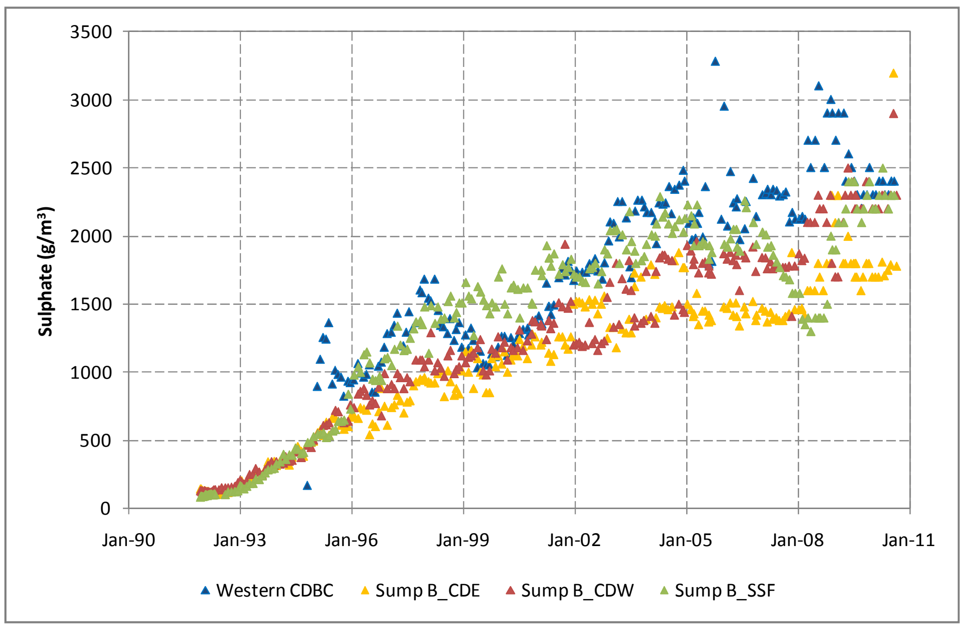
Sump B_CDW
Sump B_SSF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1000
1500
2000
2500
3000
3500
Jan-90
Jan-93
Jan-96
Jan-99
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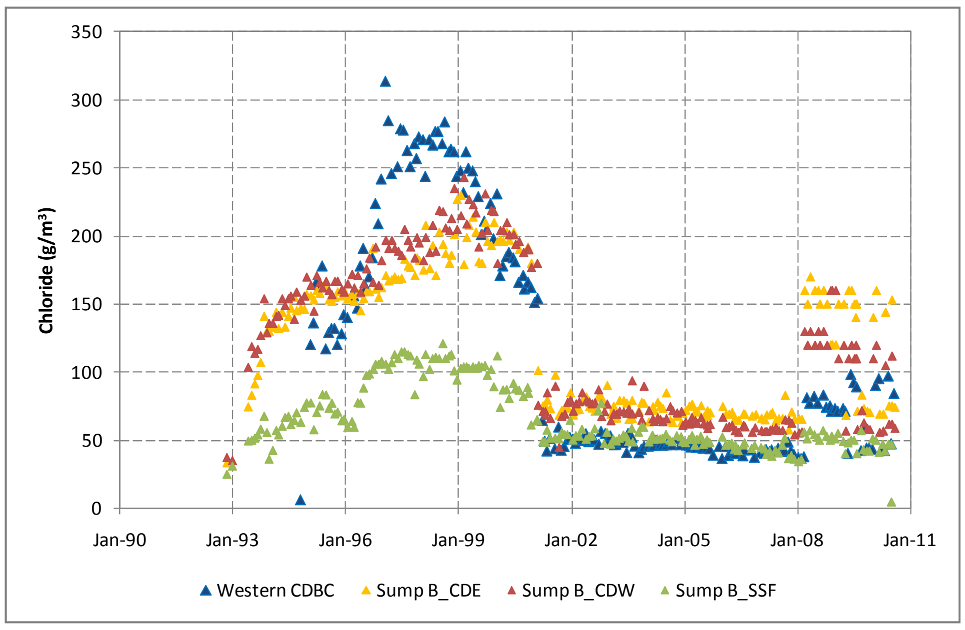
Sump B_CDE
Sump B_CDW
Sump B_SSF


Chloride (g/m³)
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50
100
150
200
250
300
350
Jan-90
Jan-93
Jan-96
Jan-99
Jan-02
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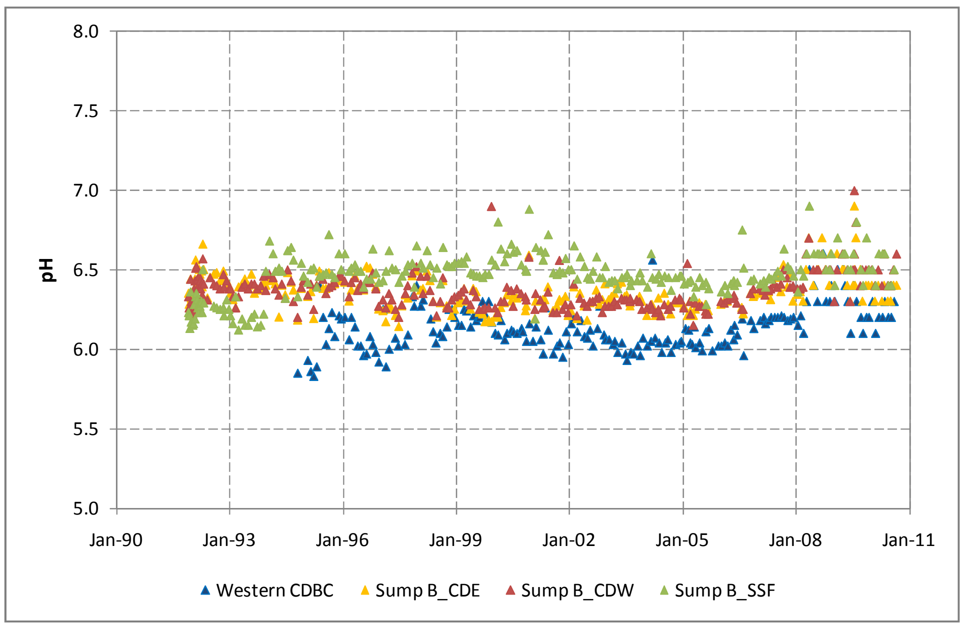
Sump B_CDW
Sump B_SSF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5.5
6.0
6.5
7.0
7.5
8.0
Jan-90
Jan-93
Jan-96
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Sump B_CDW
Sump B_SSF

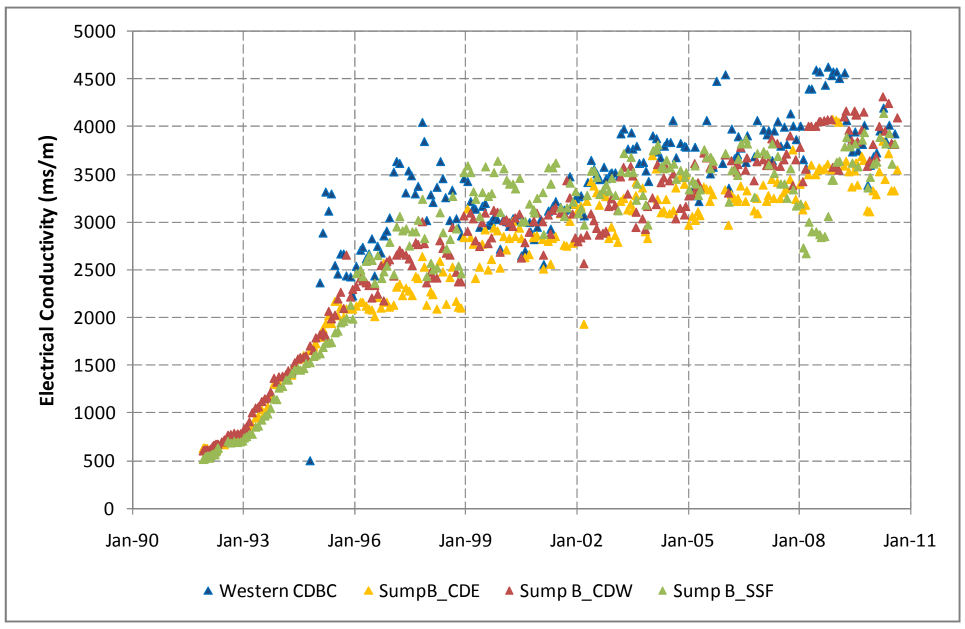
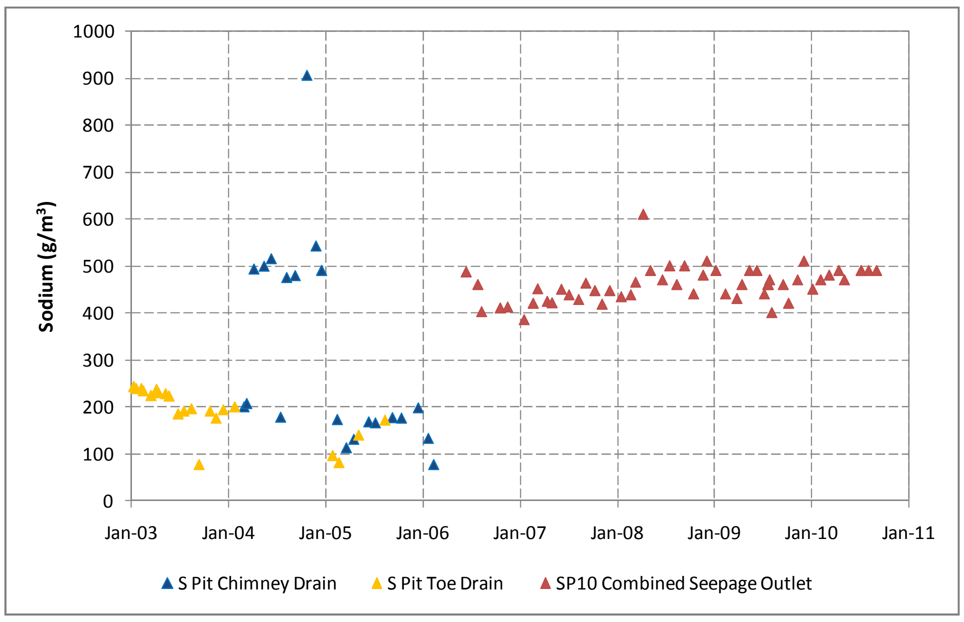
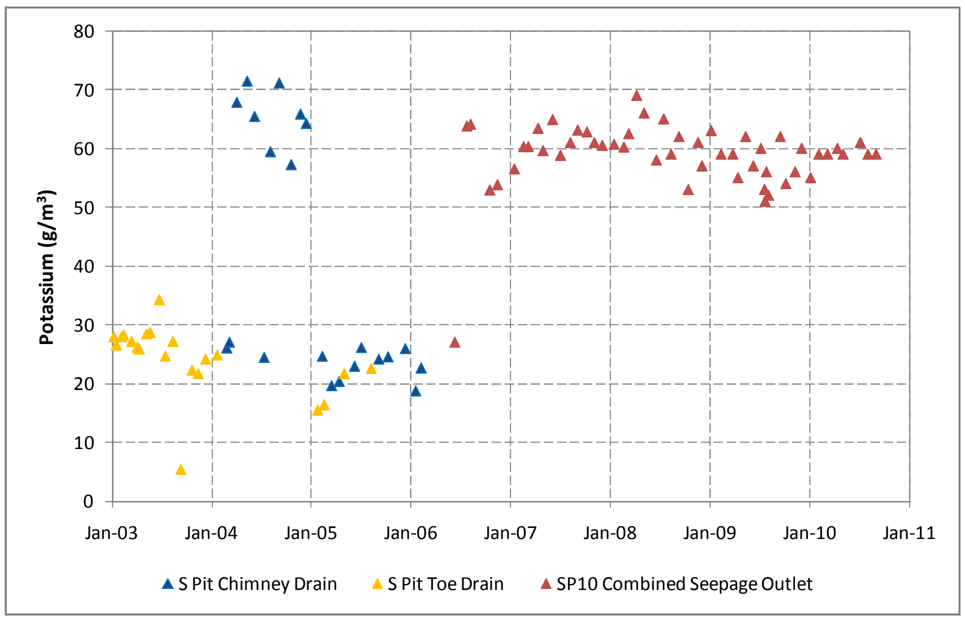
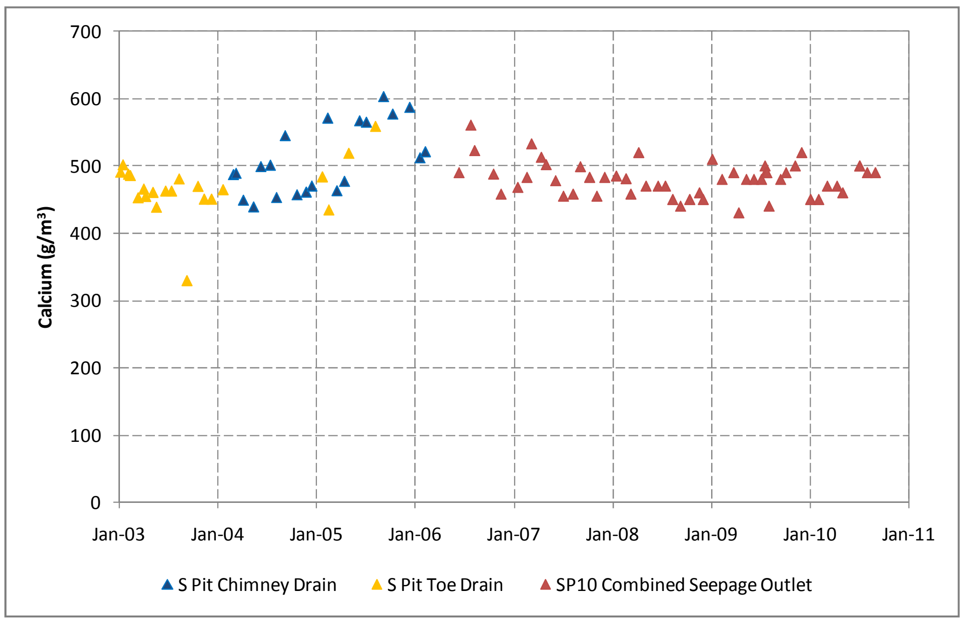
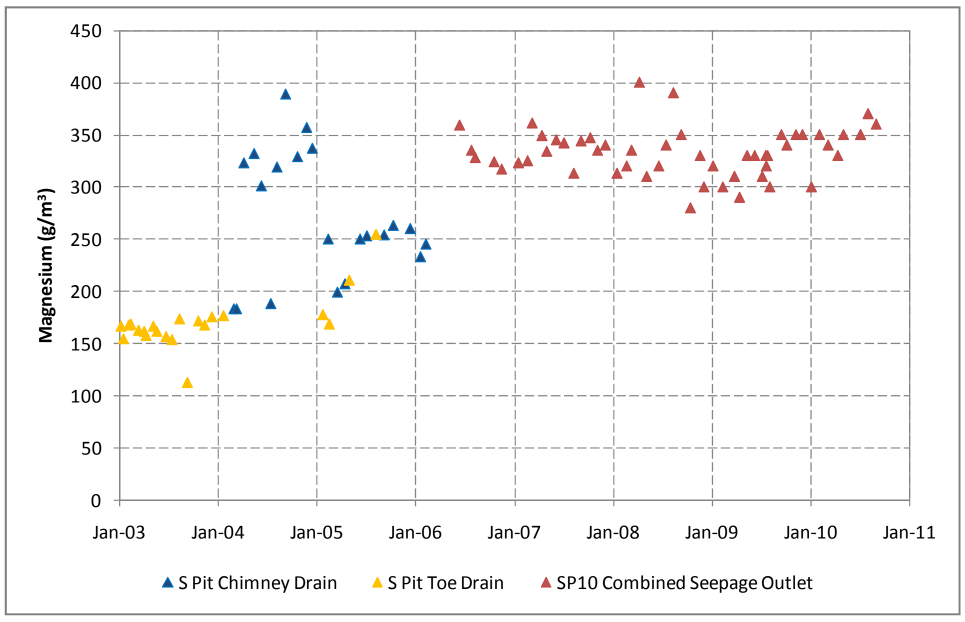

Electrical Conductivity (ms/m)
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
Jan-90
Jan-93
Jan-96
Jan-99
Jan-02
Jan-05
Jan-08
Jan-11
Western CDBC
SumpB_CDE
Sump B_CDW
Sump B_SSF

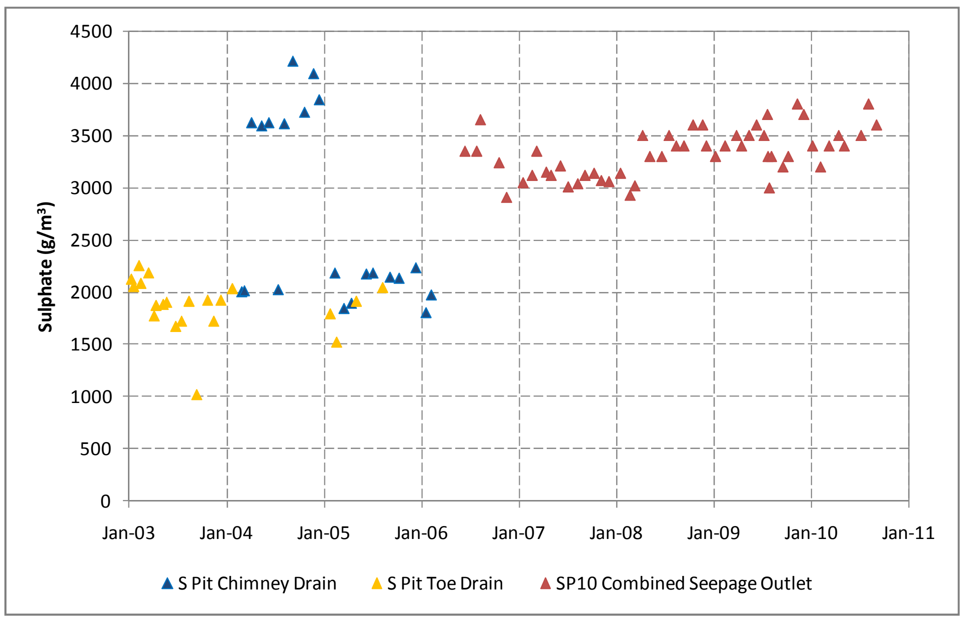
Figure C1: Mixed Tailings Impoundment seepage water quality.

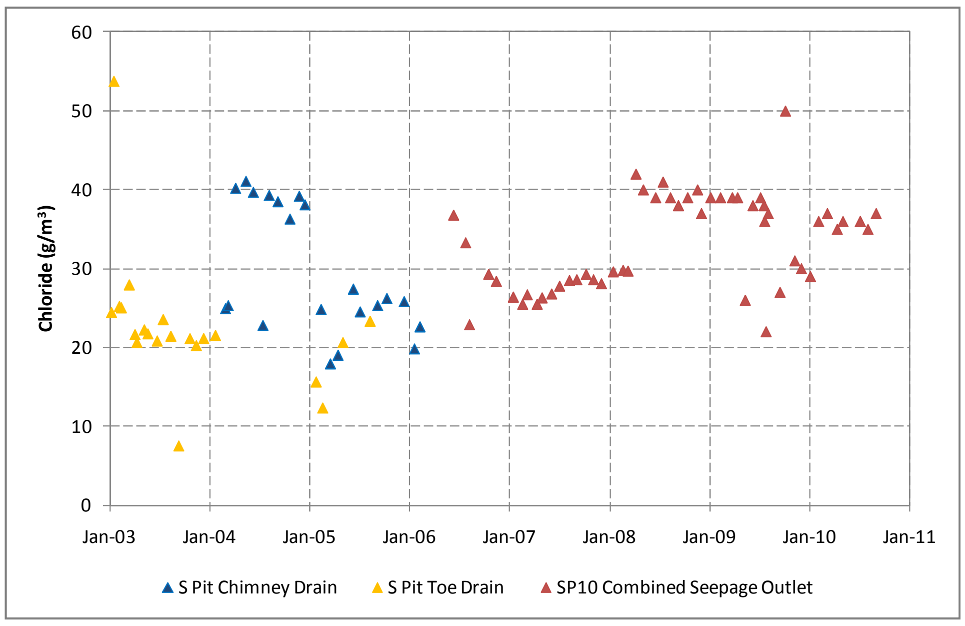

Sodium (g/m³)
Jan-03 Jan-04 Jan-05 Jan-06 Jan-07 Jan-08 Jan-09 Jan-10 Jan-11
S Pit Chimney Drain
S Pit Toe Drain
SP10 Combined Seepage Outlet

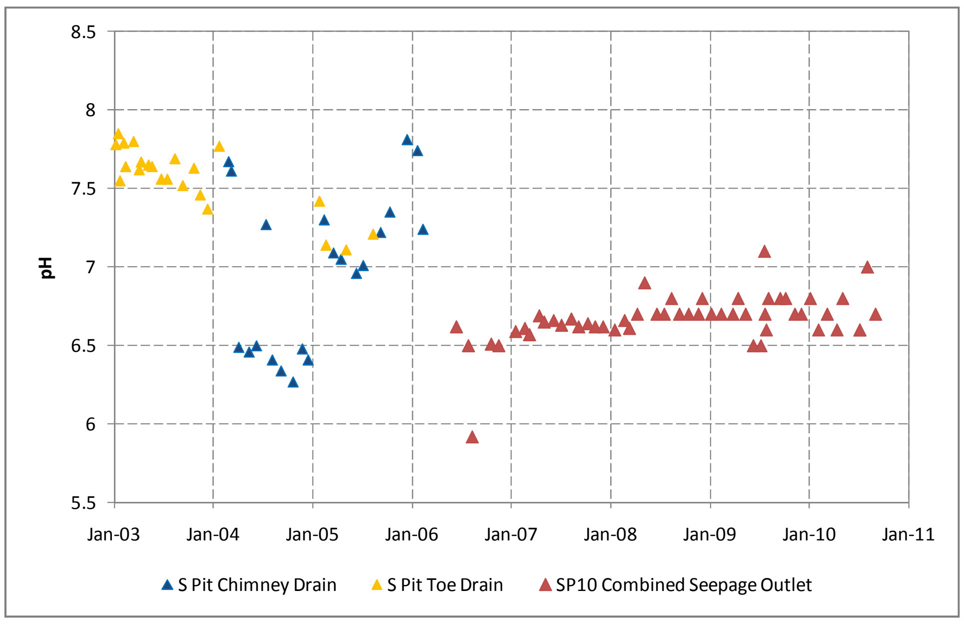

Potassium (g/m³)
Jan-03 Jan-04 Jan-05 Jan-06 Jan-07 Jan-08 Jan-09 Jan-10 Jan-11
S Pit Chimney Drain
S Pit Toe Drain
SP10 Combined Seepage Outlet

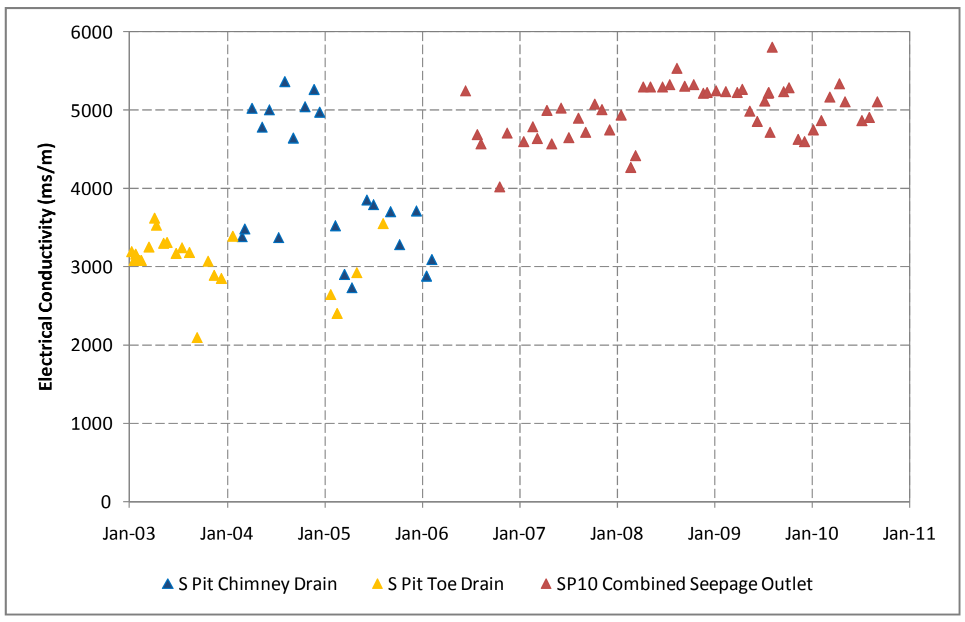

Calcium (g/m³)
Jan-03 Jan-04 Jan-05 Jan-06 Jan-07 Jan-08 Jan-09 Jan-10 Jan-11
S Pit Chimney Drain
S Pit Toe Drain
SP10 Combined Seepage Outlet


Magnesium (g/m³)
Jan-03 Jan-04 Jan-05 Jan-06 Jan-07 Jan-08 Jan-09 Jan-10 Jan-11
S Pit Chimney Drain
S Pit Toe Drain
SP10 Combined Seepage Outlet


Sulphate (g/m³)
Jan-03 Jan-04 Jan-05 Jan-06 Jan-07 Jan-08 Jan-09 Jan-10 Jan-11
S Pit Chimney Drain
S Pit Toe Drain
SP10 Combined Seepage Outlet


Chloride (g/m³)
Jan-03 Jan-04 Jan-05 Jan-06 Jan-07 Jan-08 Jan-09 Jan-10 Jan-11
S Pit Chimney Drain
S Pit Toe Drain
SP10 Combined Seepage Outlet


pH
Jan-03 Jan-04 Jan-05 Jan-06 Jan-07 Jan-08 Jan-09 Jan-10 Jan-11
S Pit Chimney Drain
S Pit Toe Drain
SP10 Combined Seepage Outlet


Electrical Conductivity (ms/m)
Jan-03 Jan-04 Jan-05 Jan-06 Jan-07 Jan-08 Jan-09 Jan-10 Jan-11
S Pit Chimney Drain
S Pit Toe Drain
SP10 Combined Seepage Outlet

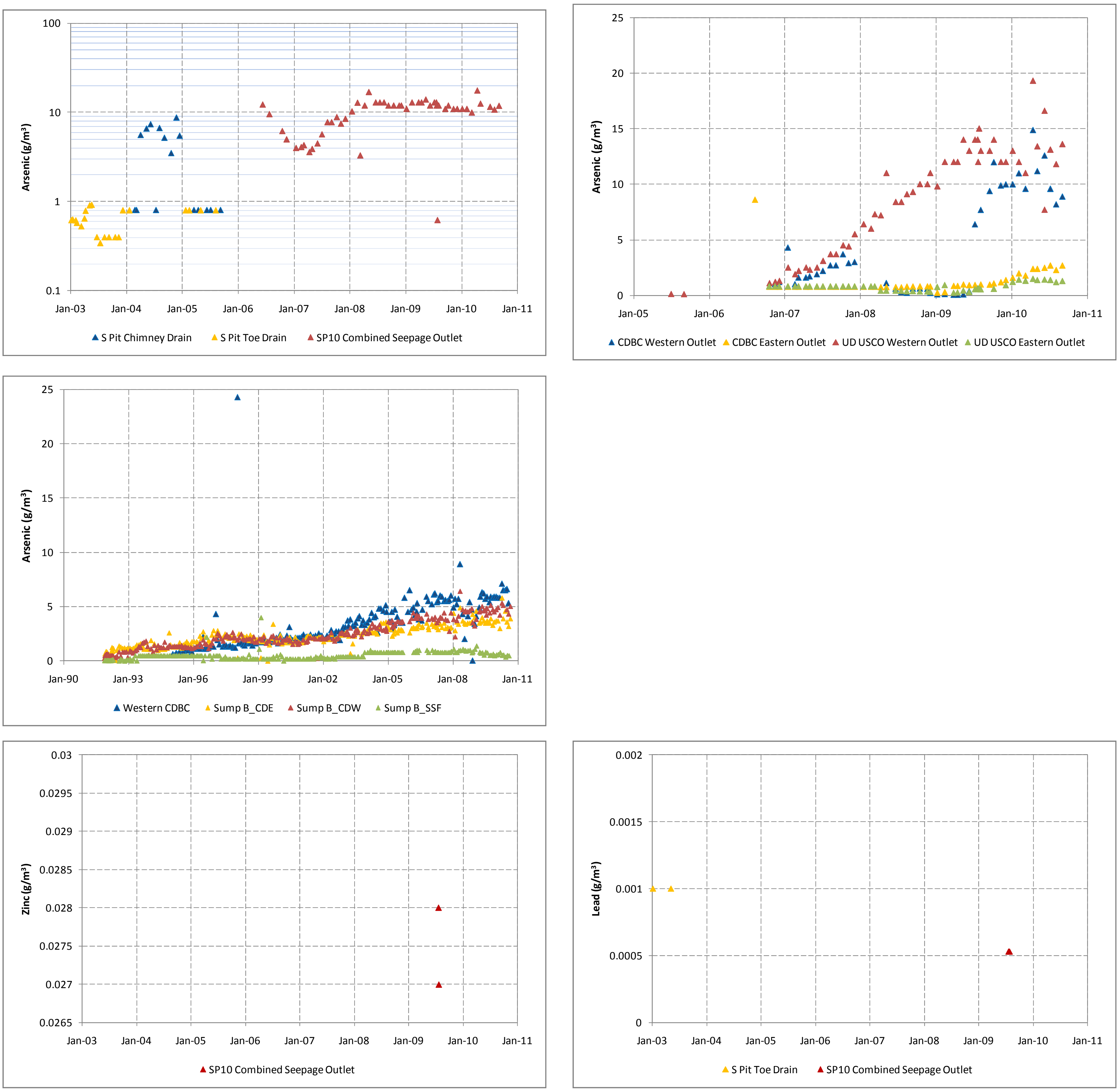
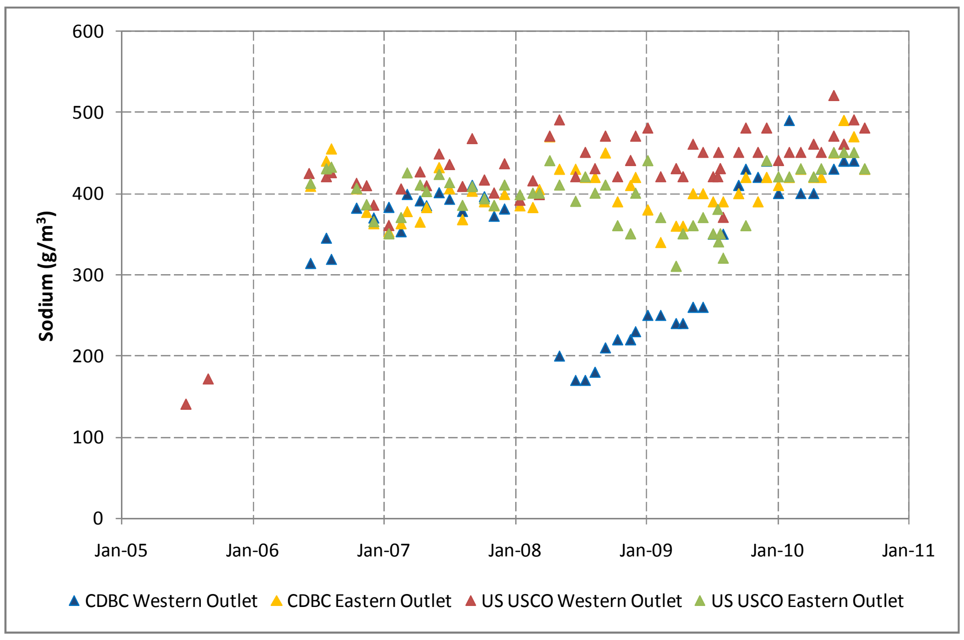
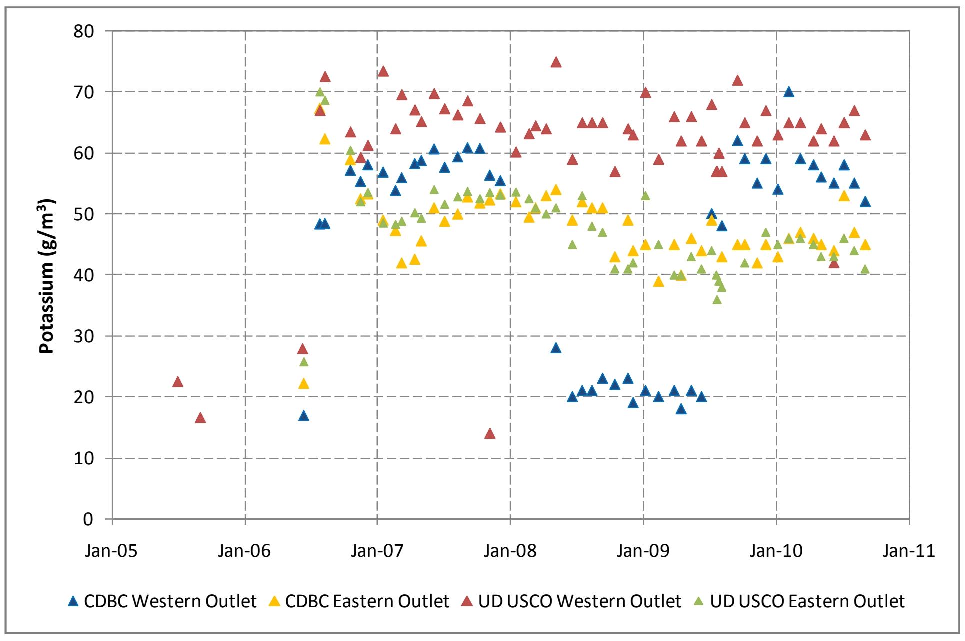
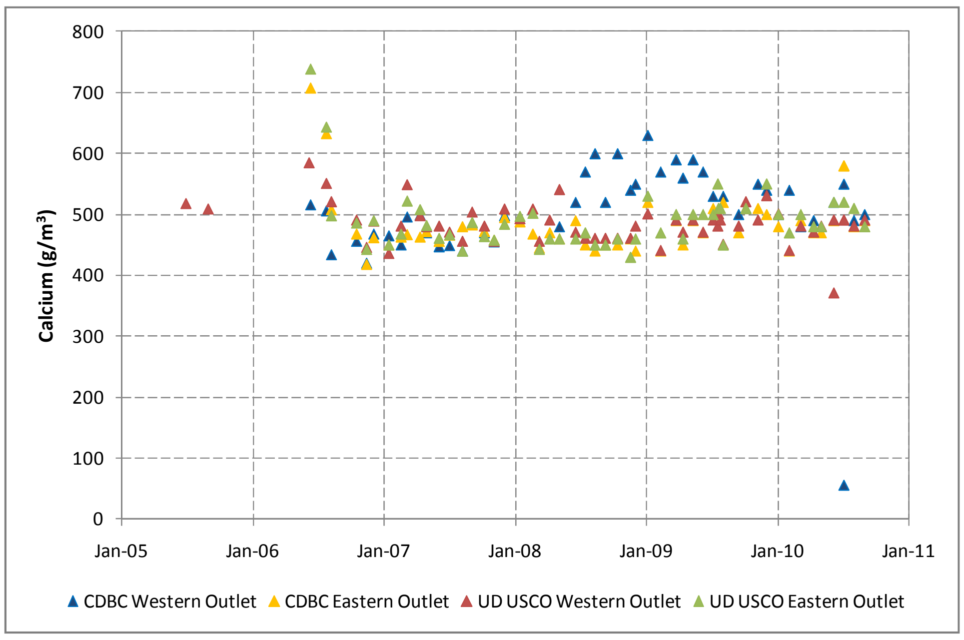
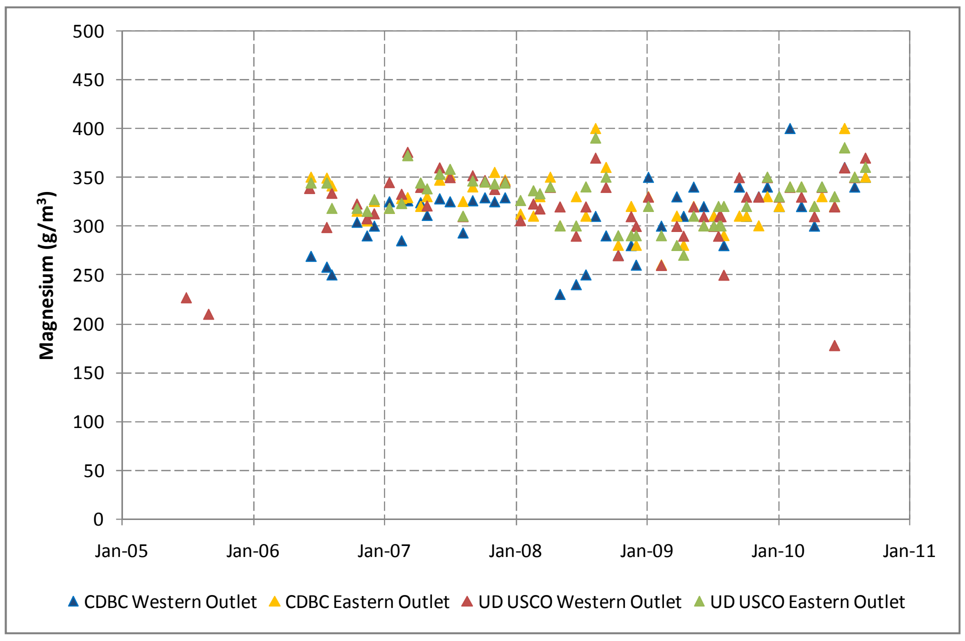


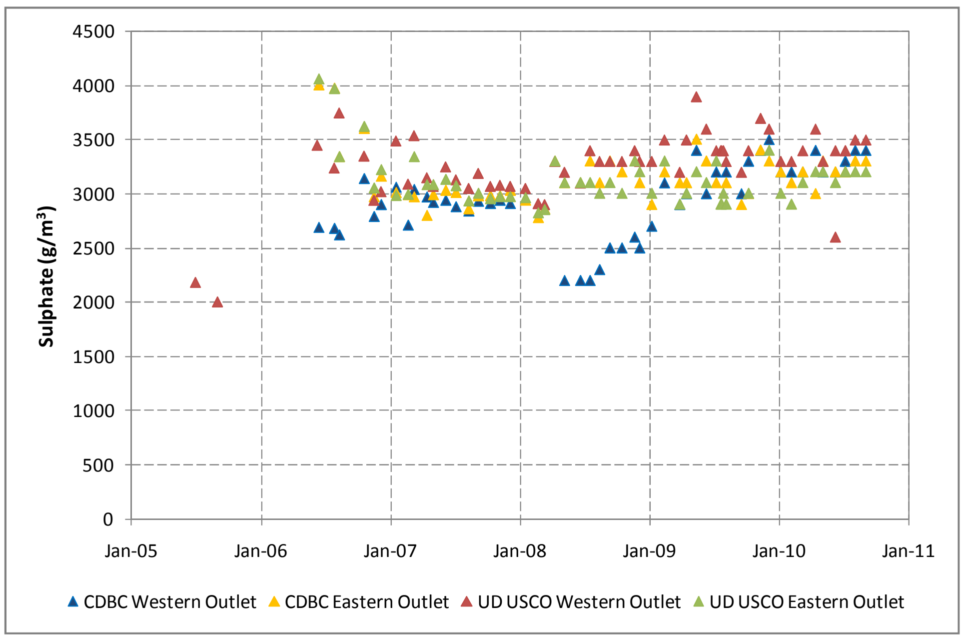
Figure C2: SP10 seepage water quality.

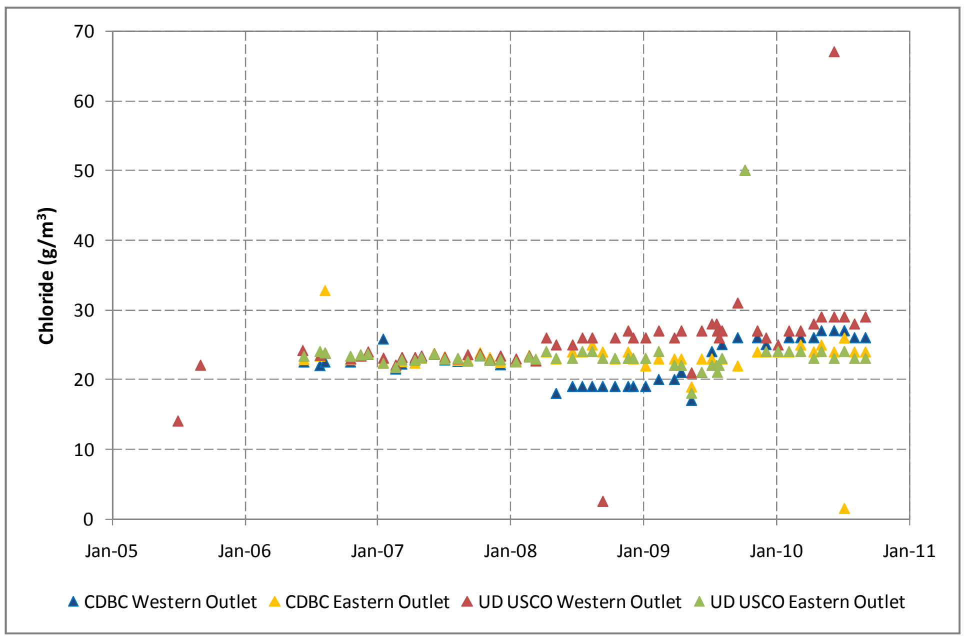

Sodium (g/m³)
600
500
400
300
200
100
0
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
CDBC Western Outlet
CDBC Eastern Outlet
US USCO Western Outlet
US USCO Eastern Outlet

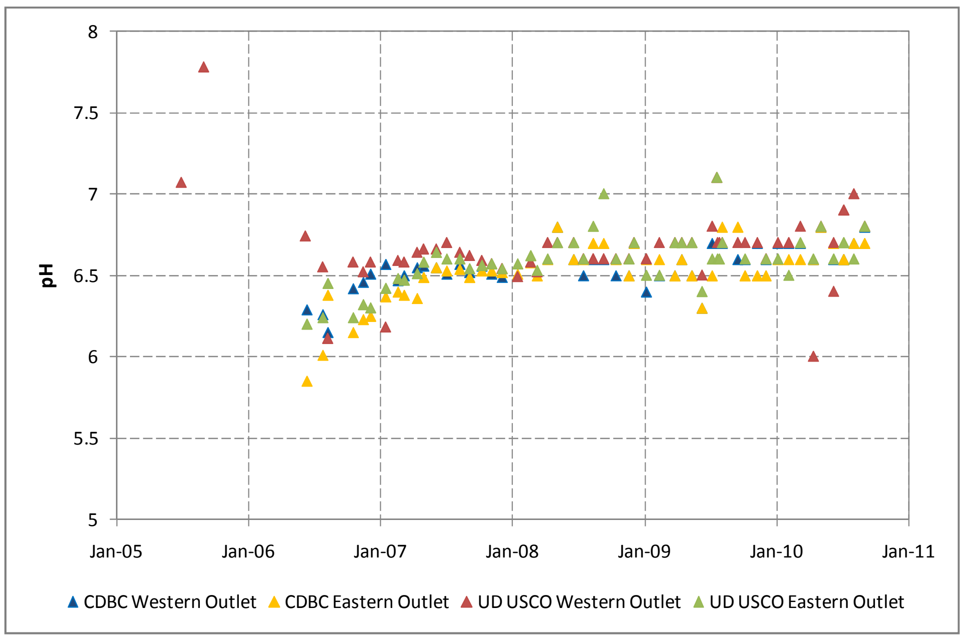

Potassium (g/m³)
80
70
60
50
40
30
20
10
0
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
CDBC Western Outlet
CDBC Eastern Outlet
UD USCO Western Outlet
UD USCO Eastern Outlet

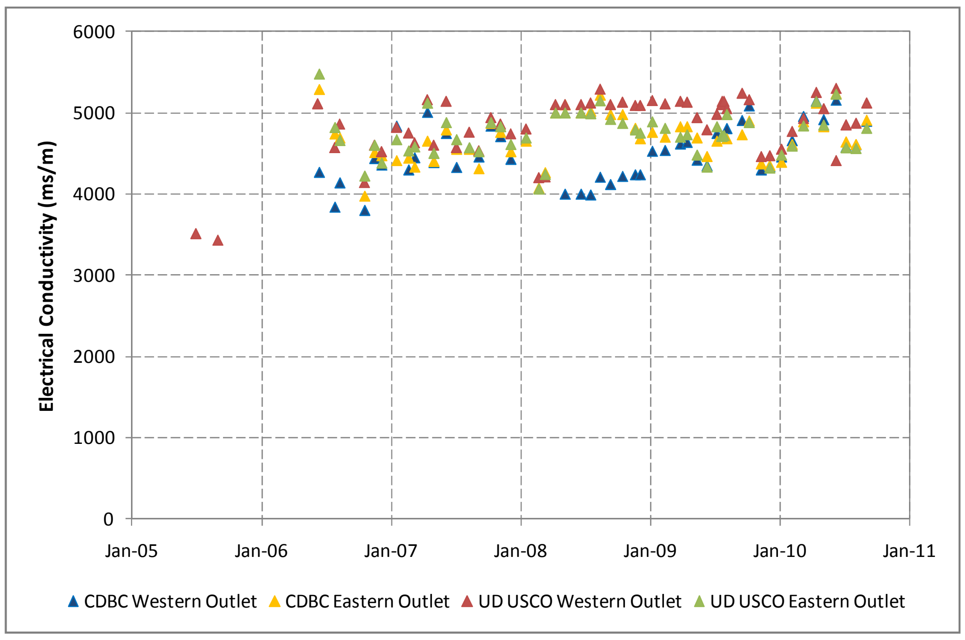

Calcium (g/m³)
800
700
600
500
400
300
200
100
0
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
CDBC Western Outlet
CDBC Eastern Outlet
UD USCO Western Outlet
UD USCO Eastern Outlet

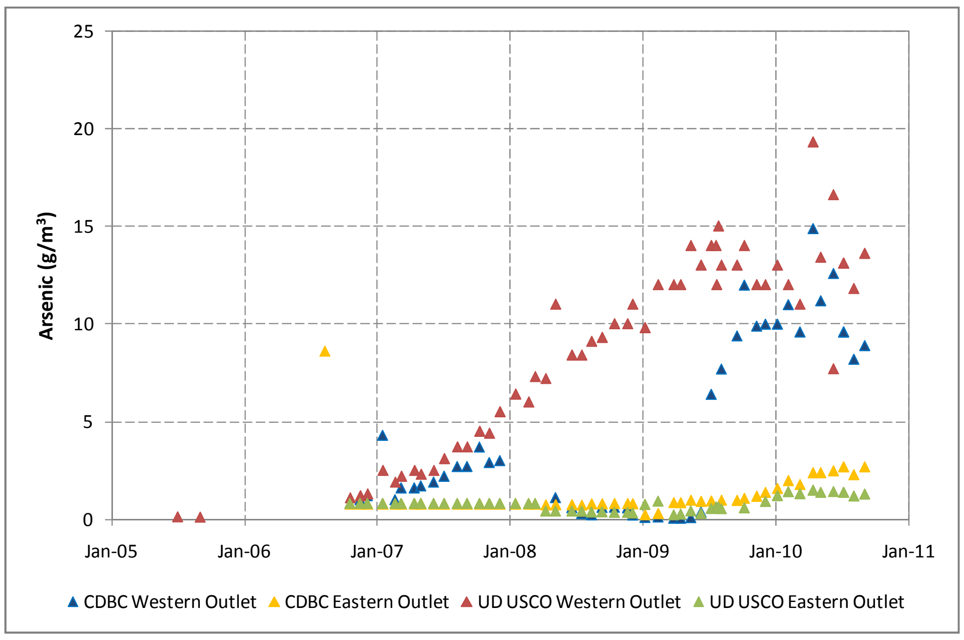

Magnesium (g/m³)
500
450
400
350
300
250
200
150
100
50
0
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
CDBC Western Outlet
CDBC Eastern Outlet
UD USCO Western Outlet
UD USCO Eastern Outlet

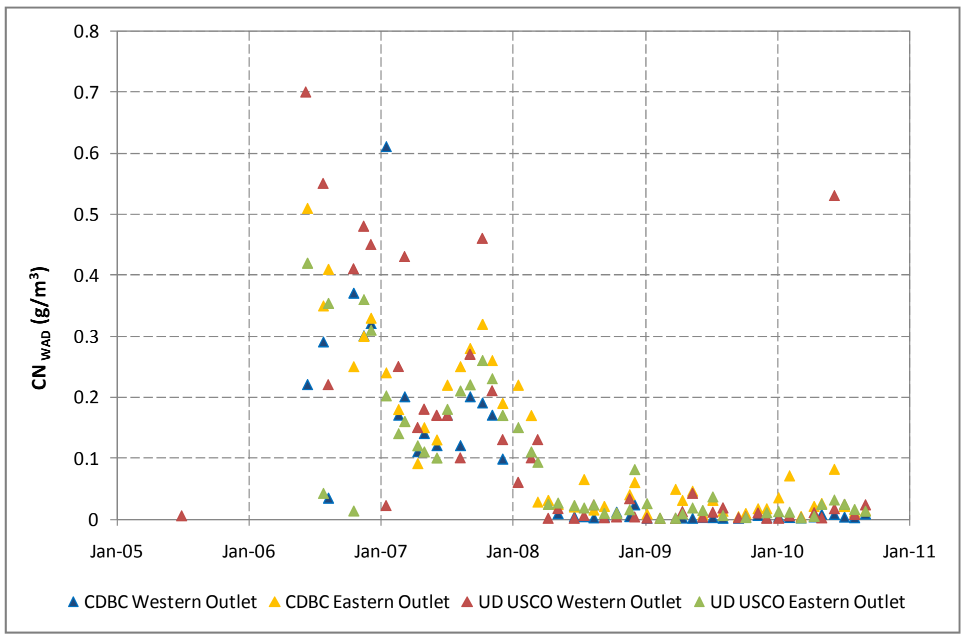

Sulphate (g/m³)
4500
4000
3500
3000
2500
2000
1500
1000
500
0
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
CDBC Western Outlet
CDBC Eastern Outlet
UD USCO Western Outlet
UD USCO Eastern Outlet

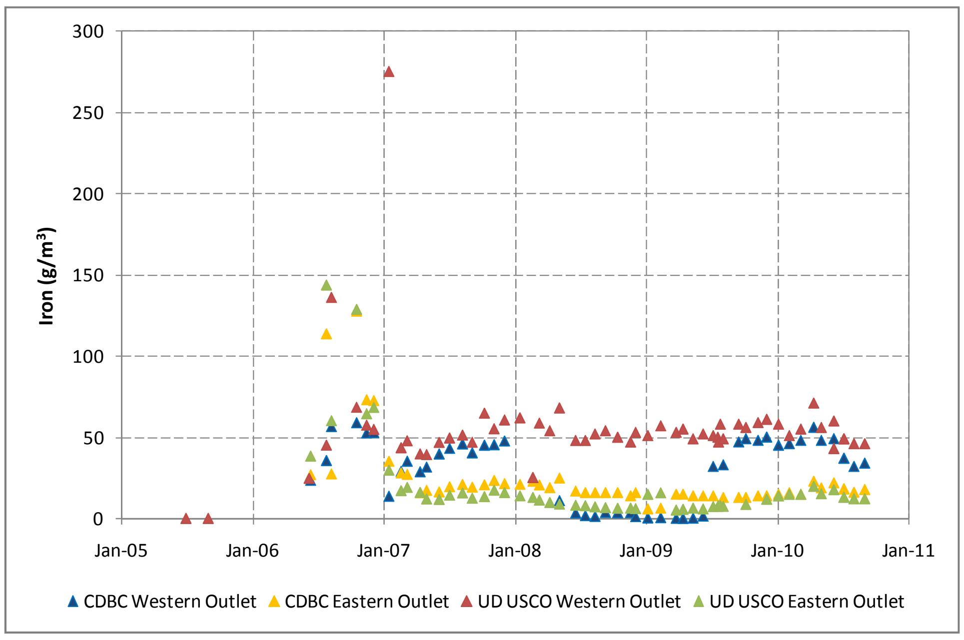

Chloride (g/m³)
70
60
50
40
30
20
10
0
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
CDBC Western Outlet
CDBC Eastern Outlet
UD USCO Western Outlet
UD USCO Eastern Outlet

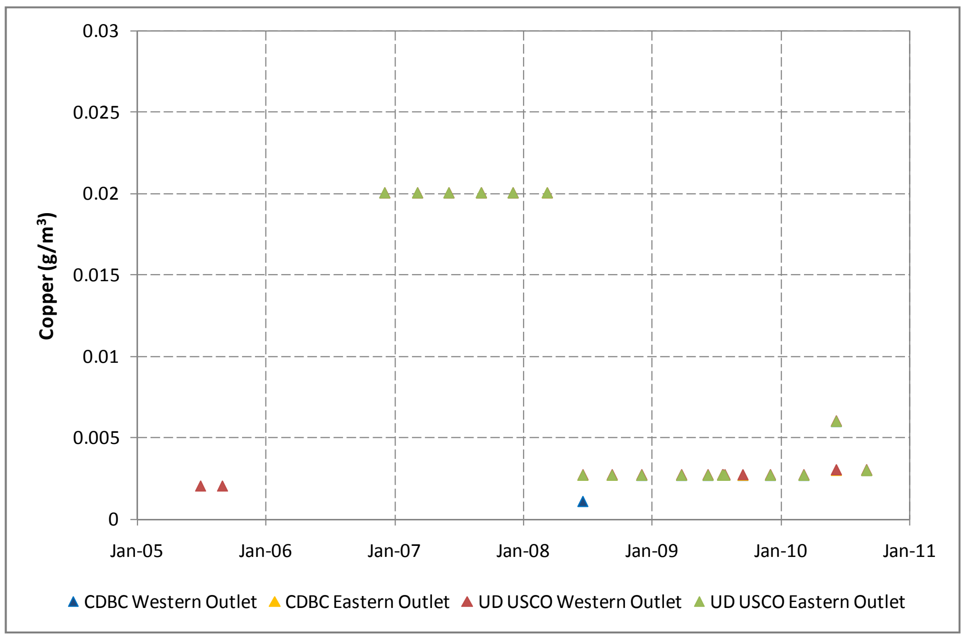

pH
8
7.5
7
6.5
6
5.5
5
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
CDBC Western Outlet
CDBC Eastern Outlet
UD USCO Western Outlet
UD USCO Eastern Outlet


Electrical Conductivity (ms/m)
6000
5000
4000
3000
2000
1000
0
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
CDBC Western Outlet
CDBC Eastern Outlet
UD USCO Western Outlet
UD USCO Eastern Outlet









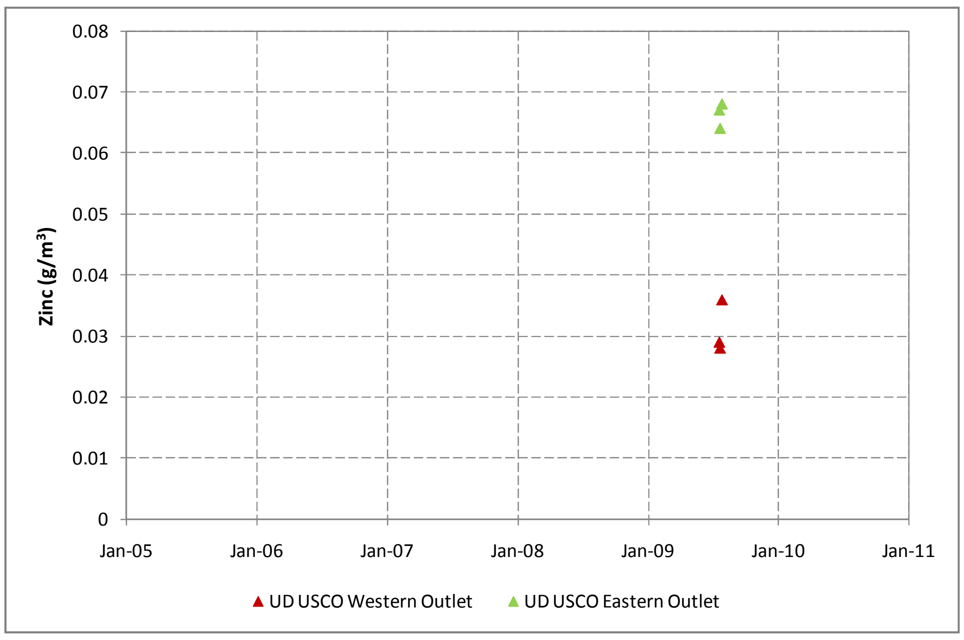


Figure C3: SP11 seepage water quality.

Table C1: Summary of MTI drain water quality.

Parameter	Minimum	Mean	95th Percentile	Maximum
pH (unitless)	3.3	6.3	6.6	7.0
Conductivity (mS/m)	500	2,800	4,000	4,600
Calcium	35	190	370	450
Chloride	4.5	105	220	310
Magnesium	19	86	180	320
Potassium	0.89	24	42	52
Sodium	25	440	600	920
Sulphate	84	1,300	2,300	3,300
Soluble inorganic nitrogen	1.9	9.3	14	19
CN_{WAD}	0.0063	0.80	1.5	2.6
Arsenic	<0.020	<2.1	5.1	24
Cadmium[A]	<0.000010	<0.000039	0.00011	0.00027
Copper	<0.0010	<0.012	<0.020	0.080
Iron	0.26	10	23	90
Lead	<0.0002	<0.0029	0.020	0.030
Mercury	<0.00007	<0.00024	<0.00050	0.0080
Nickel[A]	<0.010	<0.018	0.030	0.030

Notes: All units g/m^3 unless otherwise stated; all data given to two significant figures or less; data measured at Western CDBC, Sump B SSF, Sump B CDE and Sump B CDW; and [A] summary statistics were derived after excluding detection limits superseded by lower limits.

Table C2: Summary of SP10 drain water quality.

Parameter	Minimum	Mean	95th Percentile	Maximum
pH (unitless)	5.9	6.9	7.8	7.9
Conductivity (mS/m)	2,100	4,300	5,300	5,800
Calcium	330	480	570	600
Chloride	7.5	30	40	54
Magnesium	110	280	360	400
Potassium	5.4	47	66	72
Sodium	77	370	510	910
Sulphate	1,000	2,900	3,700	4,200
Soluble inorganic nitrogen	2.2	9.3	13	14
CN_{WAD}	<0.005	<0.17	0.59	0.76
Arsenic	0.34	6.70	13	18
Cadmium[A]	<0.00027	NA	NA	NA
Copper	<0.0020	<0.0089	0.020	0.030
Iron	<0.04	<23	37	110
Lead[B]	<0.00053	NA	NA	<0.0010
Nickel[C]	0.13	0.16	0.19	0.20
Zinc[C]	0.027	NA	NA	0.028

Notes: All units g/m^3 unless stated; all data given to two significant figures or less; NA = not applicable; data measured at S. Pit Chimney Drain, S. Pit Toe Drain and Combined Seepage Outlet; [A] cadmium was analysed on three occasions, all of which were below the detection limit of 0.00027 g/m^3; [B] lead was analysed on five occasions – two were below a detection limit of 0.00053 g/m^3 while the remaining two were below a detection limit of 0.001 g/m^3; and [C] nickel was analysed on three occasions, while zinc was analysed on two occasions.

Table C3: Summary of SP11 drain water quality.

Parameter	Minimum	Mean	95th Percentile	Maximum
pH (unitless)	5.9	6.6	6.8	7.8
Conductivity (mS/m)	3,400	4,700	5,200	5,500
Calcium	55	490	580	740
Chloride	1.6	24	29	67
Magnesium	180	320	370	400
Potassium	14	51	68	75
Sodium	140	420	480	520
Sulphate	2,000	3,100	3,600	4,100
Soluble inorganic nitrogen	1.0	7.2	11	13
CN_{WAD}	<0.001	<0.10	0.41	0.70
Arsenic	0.041	3.9	13	19
Cadmium	<0.00027	<0.00028	0.00032	0.00034
Copper[A]	<0.0011	<0.0029	0.0051	0.0060
Iron	<0.040	<33	68	280
Lead[B]	<0.00053	NA	NA	NZ
Nickel	0.16	0.19	0.21	0.21
Zinc	0.028	0.049	0.068	0.068

Notes: All units g/m^3 unless stated; all data given to two significant figures or less; NA = not applicable; data measured at CDBC Western and Eastern Outlets and UD USCO Eastern and Western Outlets; [A] summary statistics were derived after excluding detection limits superseded by lower limits; and [B] lead was analysed on six occasions, all of which were below the detection limit of 0.00053 g/m^3.

APPENDIX D

Waste rock seepage water quality data

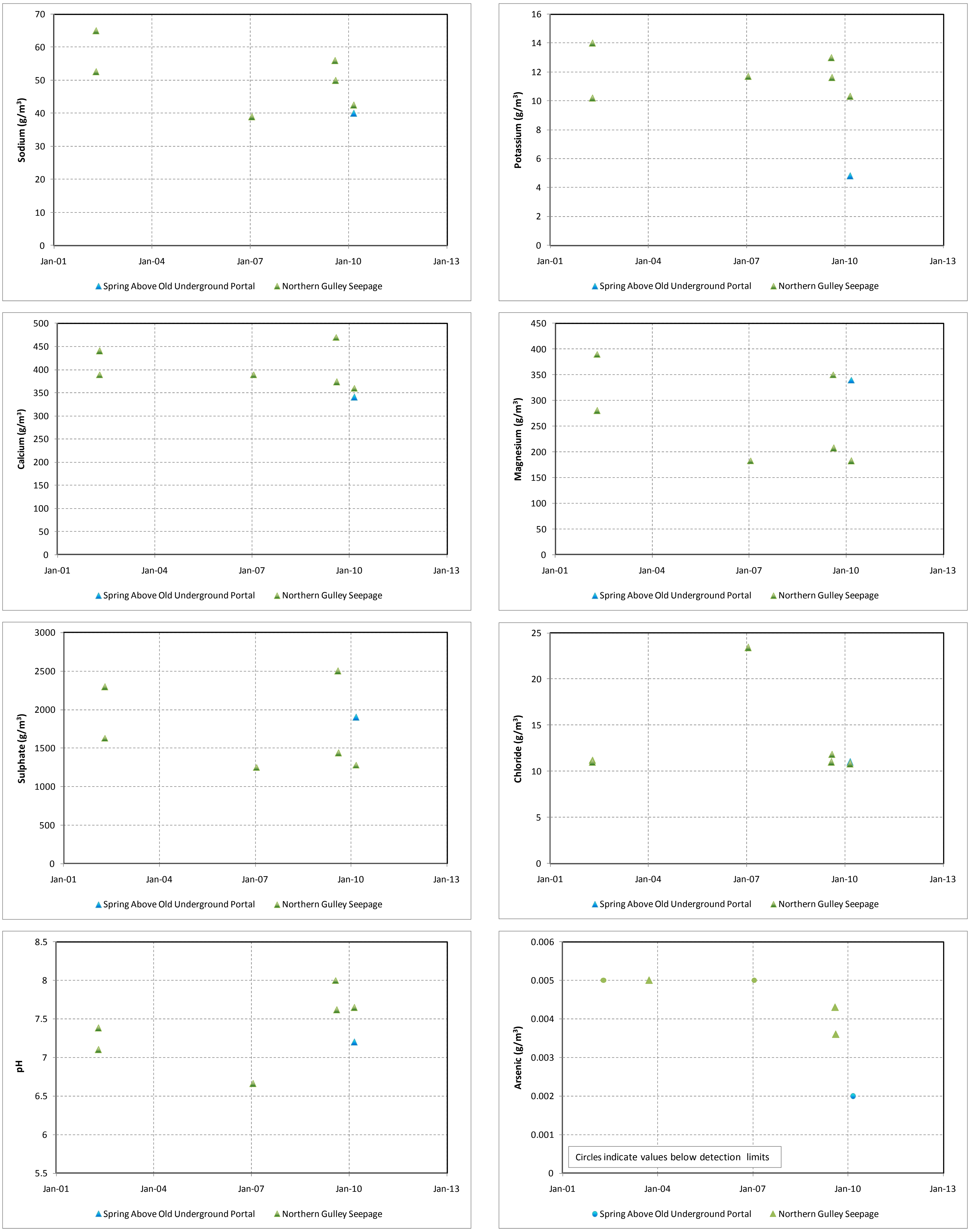


Figure D1: WRS seepage water quality.

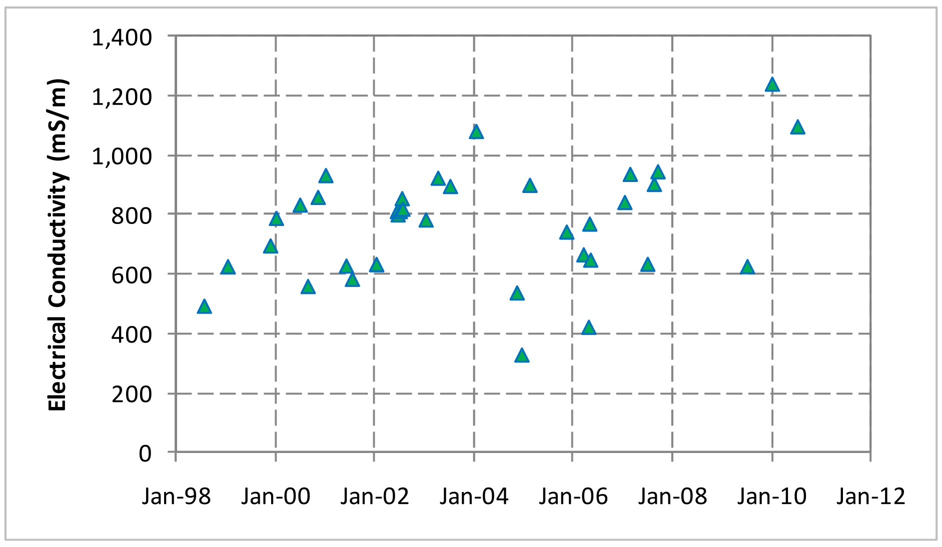
Table D1: Summary of WRS seepage water quality.

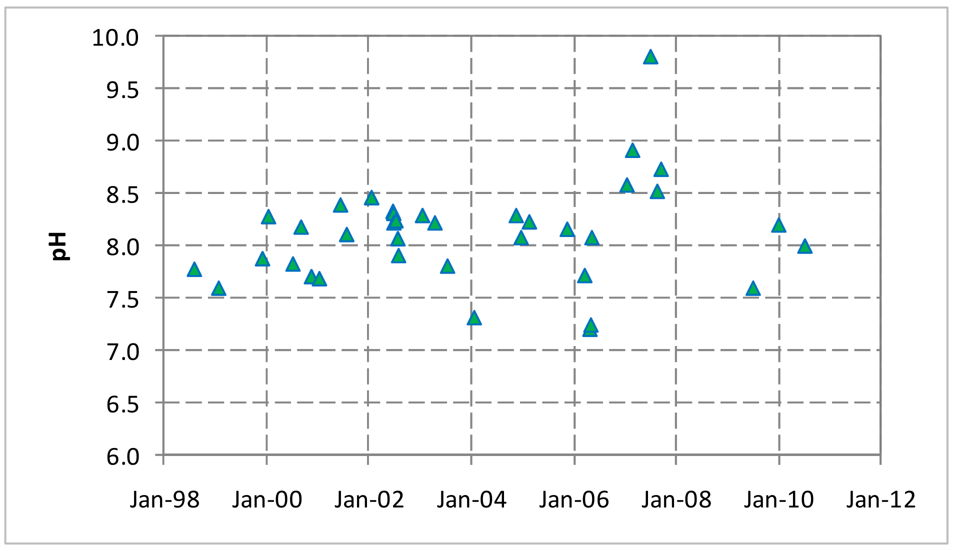
Parameter	Minimum	Mean	95th Percentile	Maximum
pH (unitless)	6.7	7.4	7.9	8.0
Conductivity (mS/m)	2,500	3,000	3,800	3,800
Calcium	340	390	460	470
Chloride	11	13	20	23
Magnesium	180	280	380	390
Potassium	4.8	11	14	14
Sodium	39	49	62	65
Sulphate	1,300	1,800	2,400	2,500
CN_{WAD}[A]	<0.005	NA	NA	NA
Arsenic[B]	<0.0020	<0.0040	0.0042	0.0043
Cadmium[A]	0.00012	NA	NA	0.00016
Copper	<0.0027	<0.0028	0.0030	0.0030
Iron	0.042	0.16	0.36	0.42
Lead[C]	<0.00021	NA	NA	<0.001
Nickel[A]	0.043	NA	NA	0.044
Zinc[A]	0.031	NA	NA	0.038

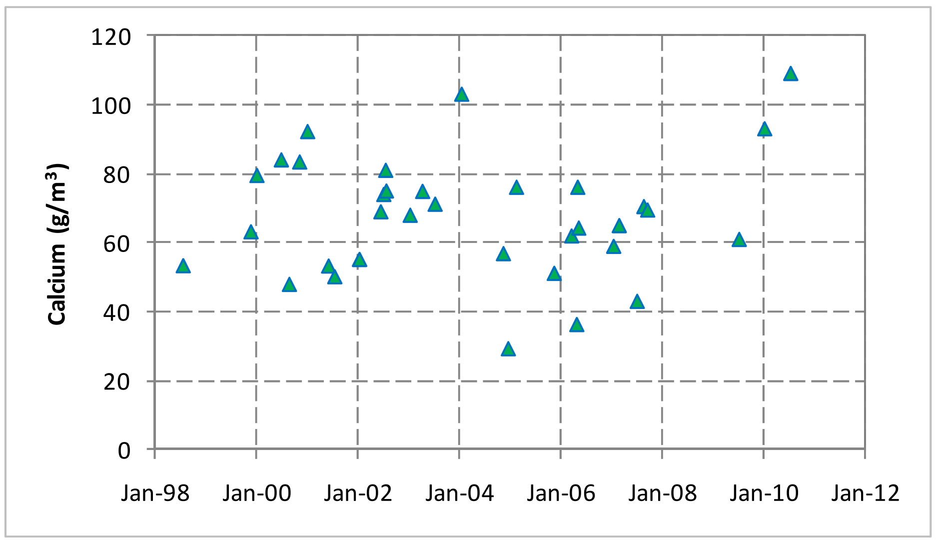
Notes: All units g/m^3 unless otherwise stated; all data given to two significant figures or less; NA = not applicable; [A] CN_{WAD} was analysed on one occasion, while cadmium, nickel and zinc were each analysed on two occasions; [B] summary statistics were derived after excluding detection limits that have been superseded by lower limits; and [C] lead was analysed on three occasions – two were below a detection limit of 0.00021 g/m^3 while the remaining two were below a detection limit of 0.001 g/m^3.

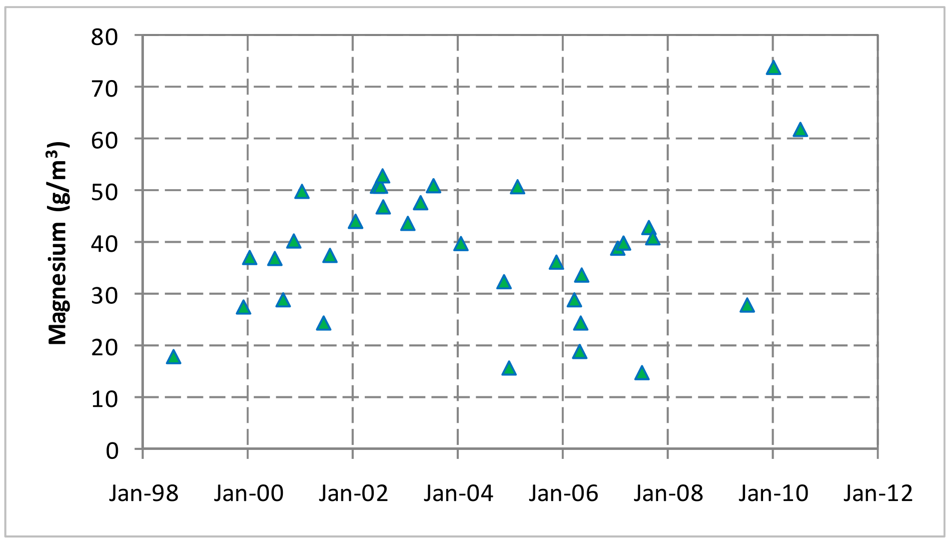
APPENDIX E

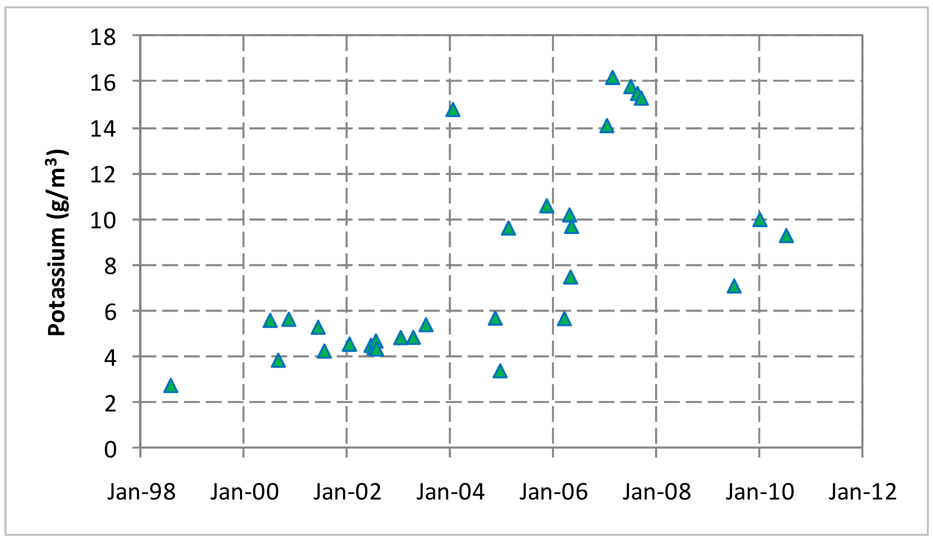
Open pit water quality data

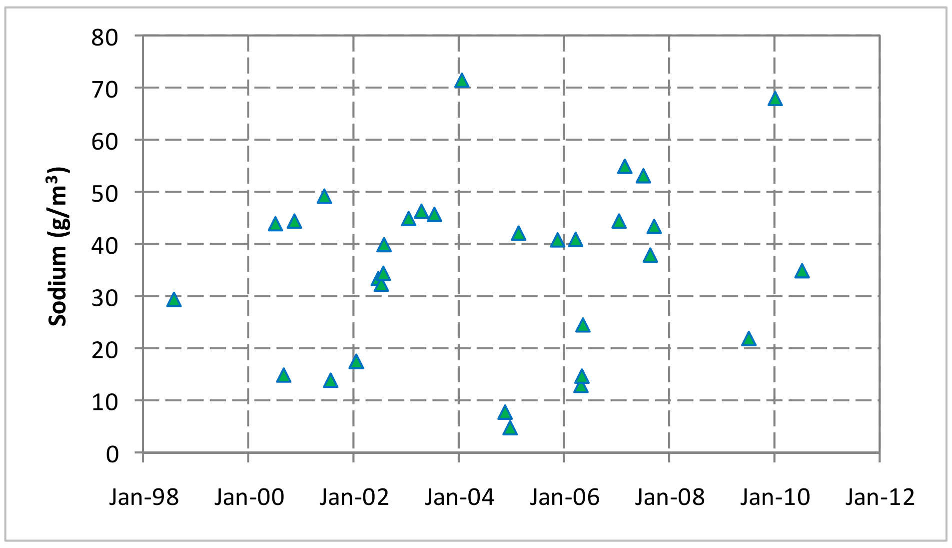

1,400
1,200
1,000
800
600
400
200
0
Electrical Conductivity (mS/m)
Jan-98 Jan-00 Jan-02 Jan-04 Jan-06 Jan-08 Jan-10 Jan-12

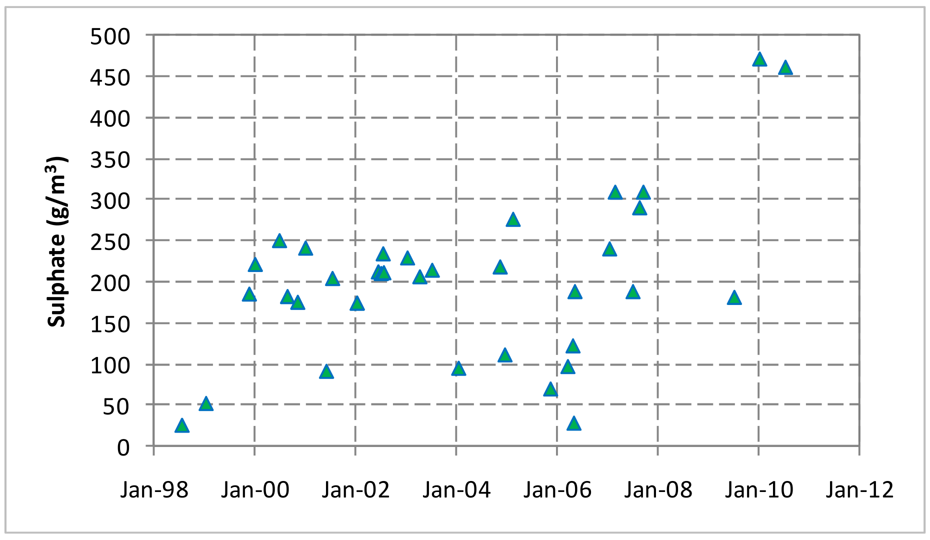

10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
pH
Jan-98 Jan-00 Jan-02 Jan-04 Jan-06 Jan-08 Jan-10 Jan-12

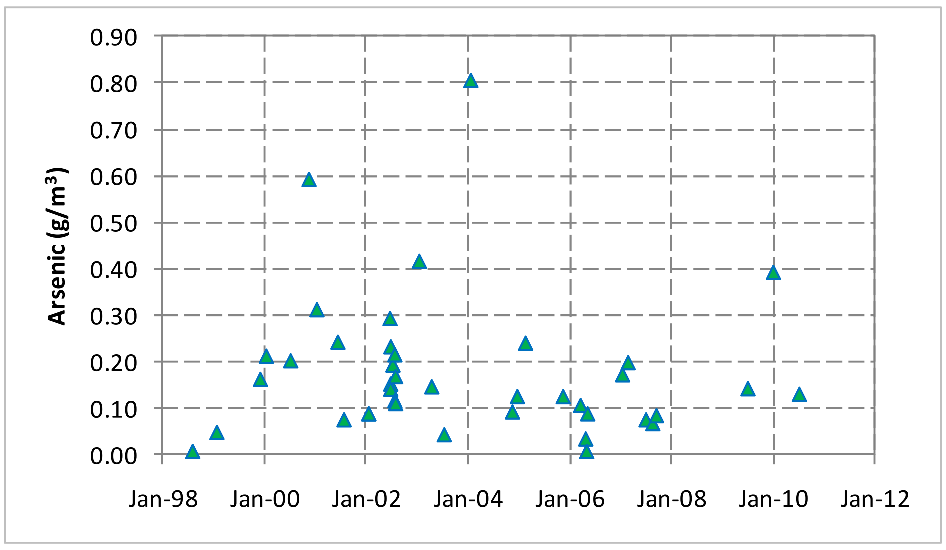

120
100
80
60
40
20
0
Calcium (g/m³)
Jan-98 Jan-00 Jan-02 Jan-04 Jan-06 Jan-08 Jan-10 Jan-12


80
70
60
50
40
30
20
10
0
Magnesium (g/m³)
Jan-98 Jan-00 Jan-02 Jan-04 Jan-06 Jan-08 Jan-10 Jan-12


18
16
14
12
10
8
6
4
2
0
Potassium (g/m³)
Jan-98 Jan-00 Jan-02 Jan-04 Jan-06 Jan-08 Jan-10 Jan-12


80
70
60
50
40
30
20
10
0
Sodium (g/m³)
Jan-98 Jan-00 Jan-02 Jan-04 Jan-06 Jan-08 Jan-10 Jan-12


500
450
400
350
300
250
200
150
100
50
0
Sulphate (g/m³)
Jan-98 Jan-00 Jan-02 Jan-04 Jan-06 Jan-08 Jan-10 Jan-12


0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
Arsenic (g/m³)
Jan-98 Jan-00 Jan-02 Jan-04 Jan-06 Jan-08 Jan-10 Jan-12

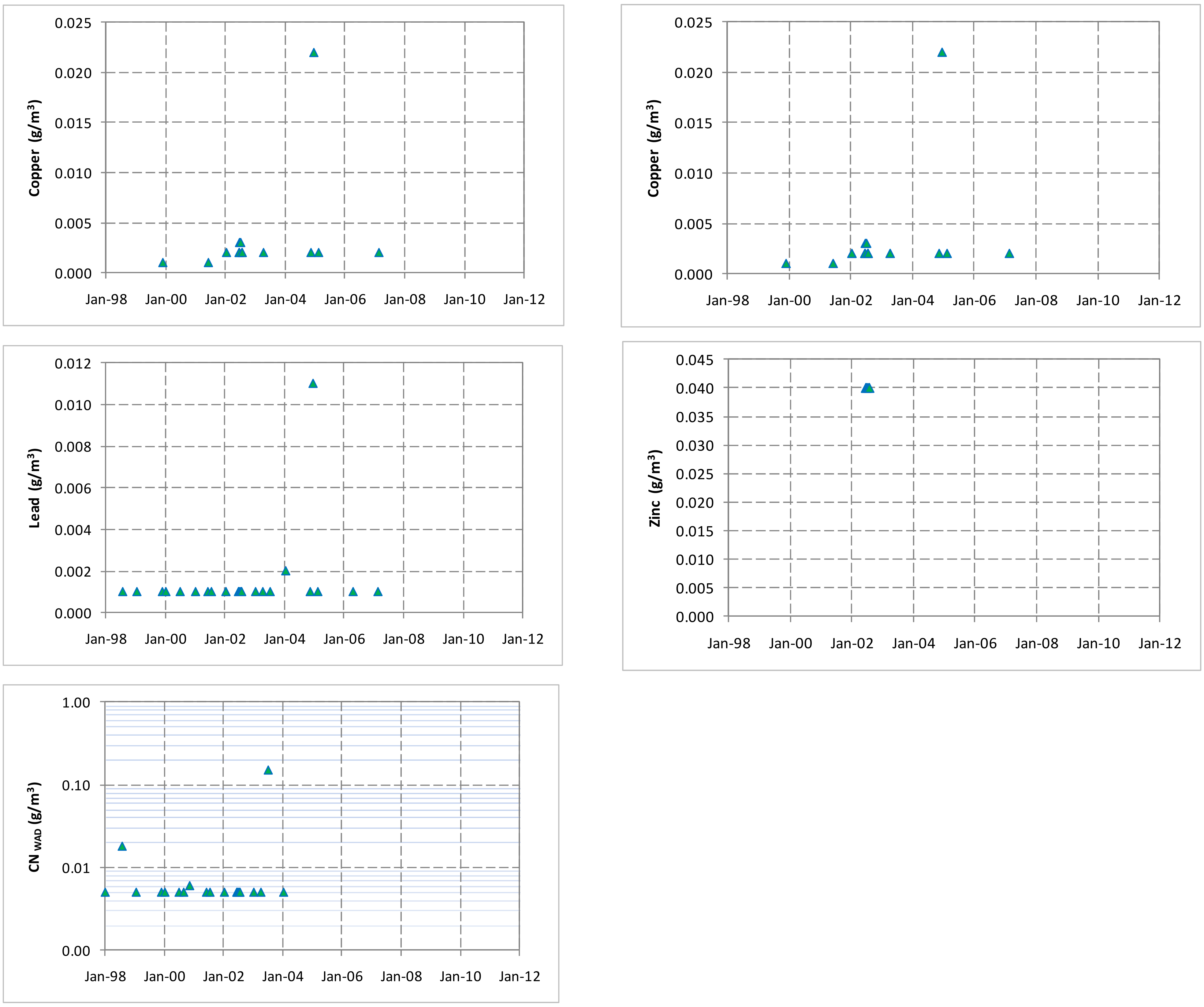
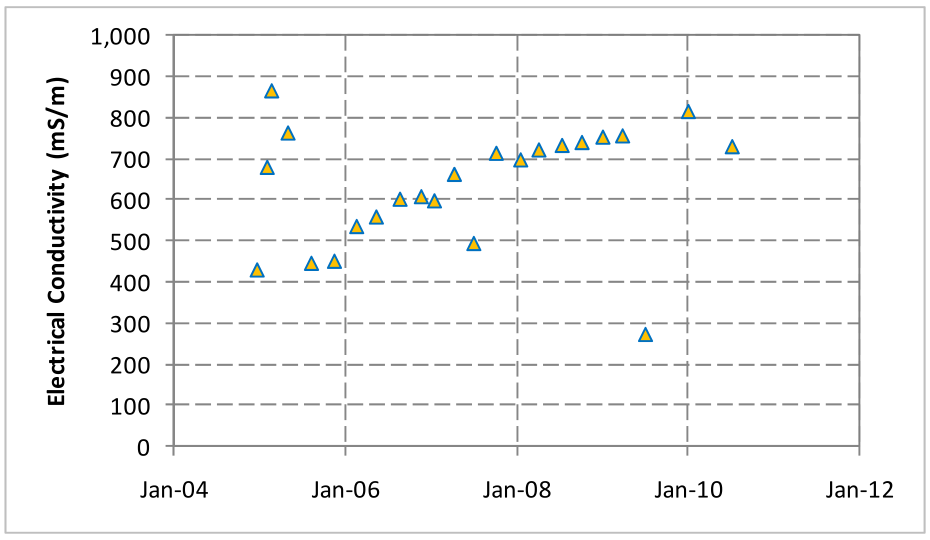
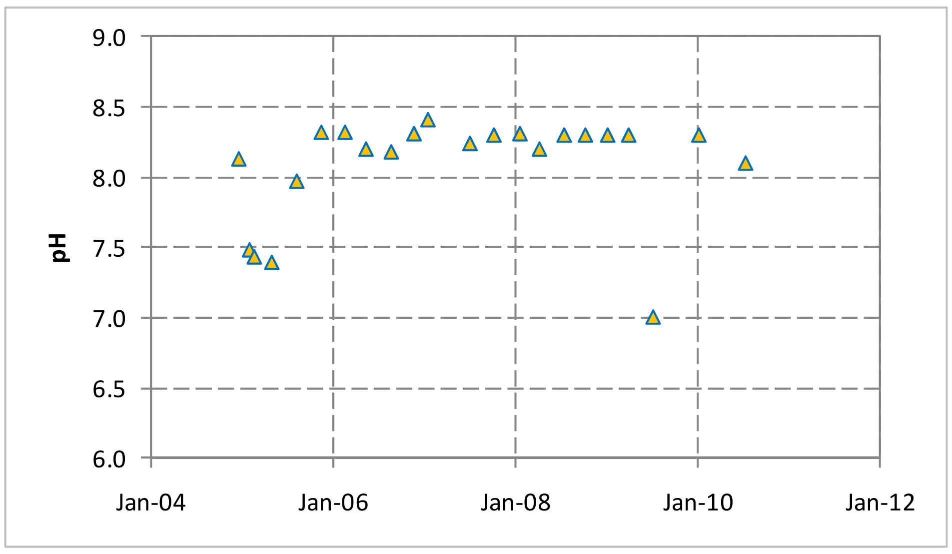
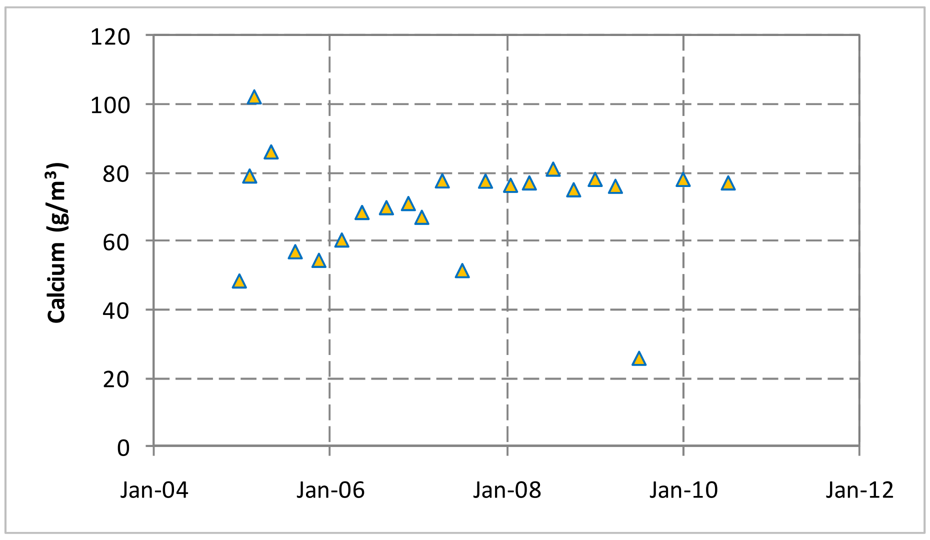
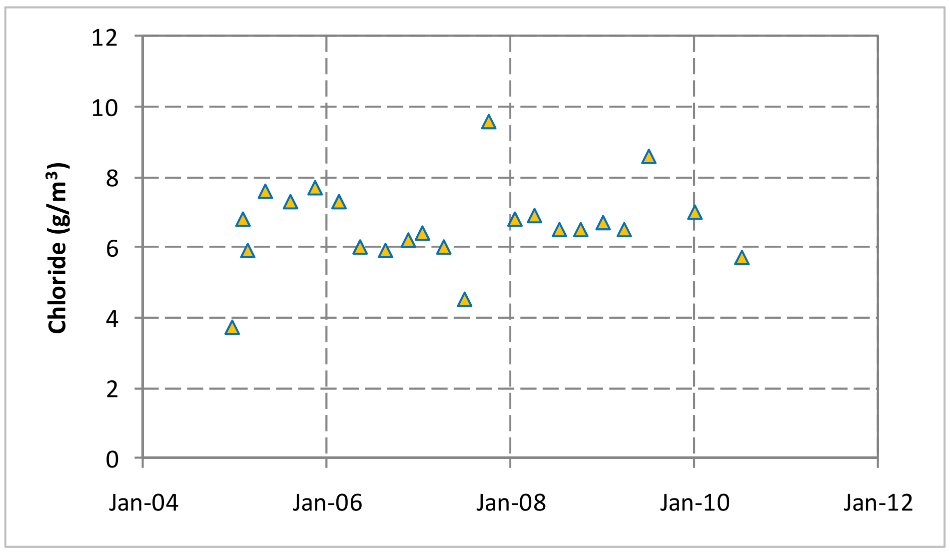


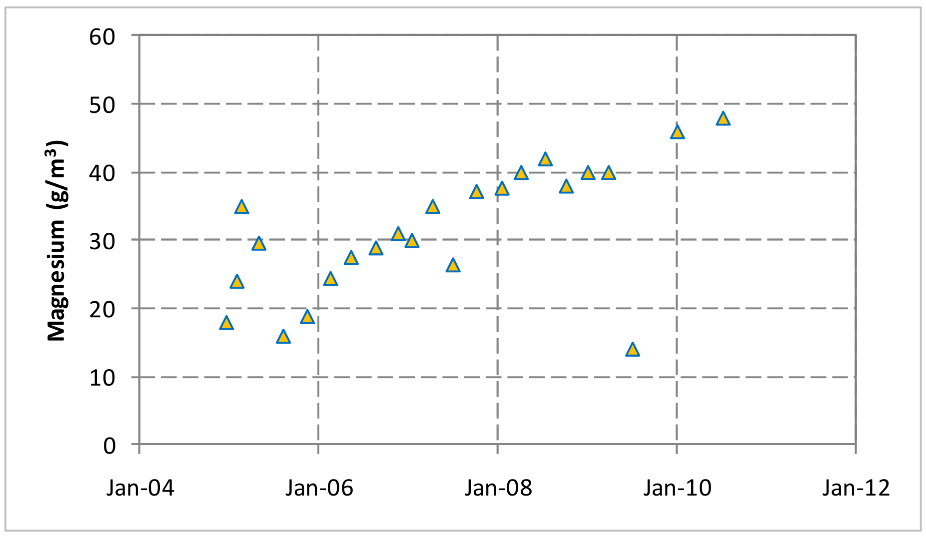
Figure E1: Frasers Pit water quality.

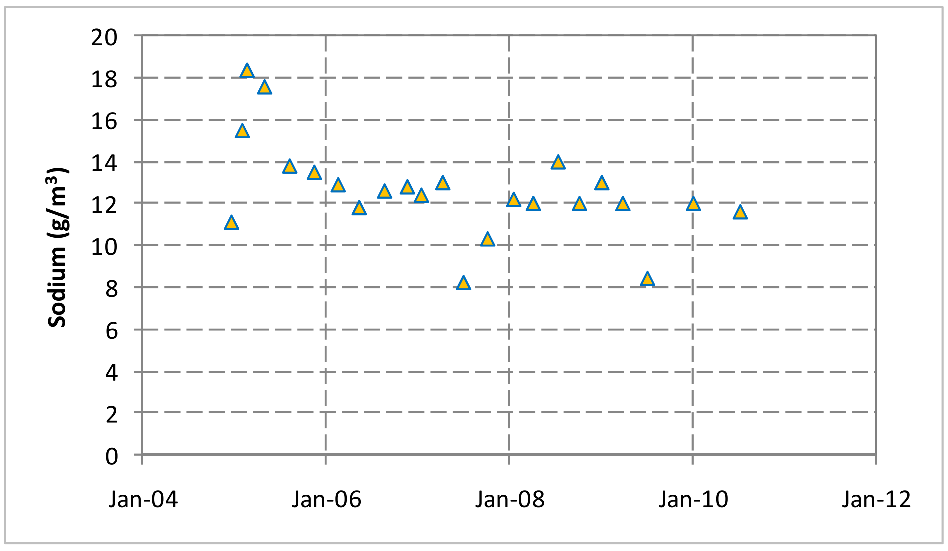

Electrical Conductivity (mS/m)
1,000
900
800
700
600
500
400
300
200
100
0
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12

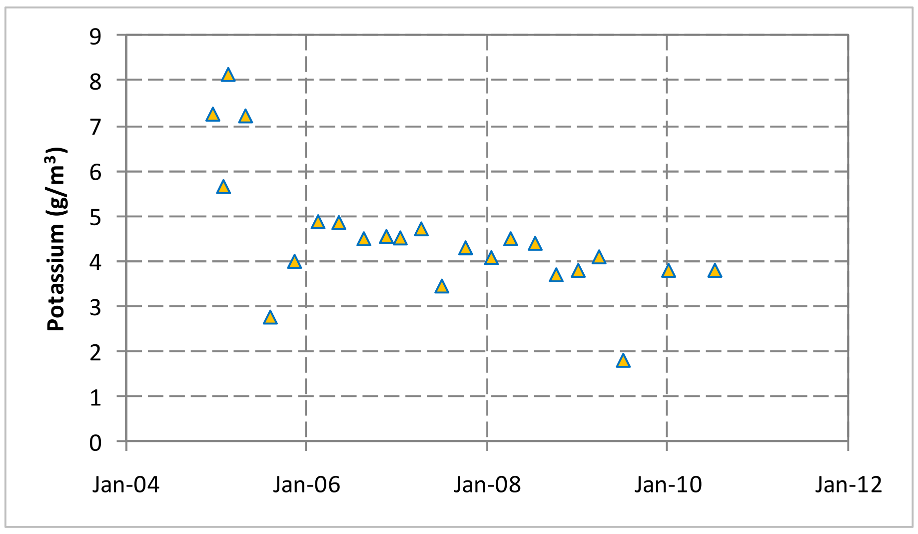

pH
9.0
8.5
8.0
7.5
7.0
6.5
6.0
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12

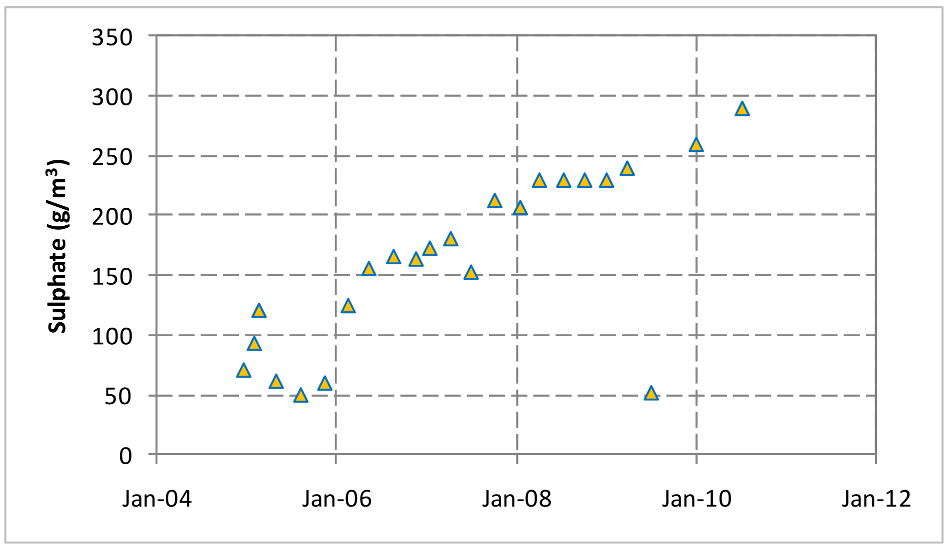

Calcium (g/m³)
120
100
80
60
40
20
0
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12


Chloride (g/m³)
12
10
8
6
4
2
0
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12


Magnesium (g/m³)
60
50
40
30
20
10
0
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12


Sodium (g/m³)
20
18
16
14
12
10
8
6
4
2
0
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12


Potassium (g/m³)
9
8
7
6
5
4
3
2
1
0
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12


Sulphate (g/m³)
350
300
250
200
150
100
50
0
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12

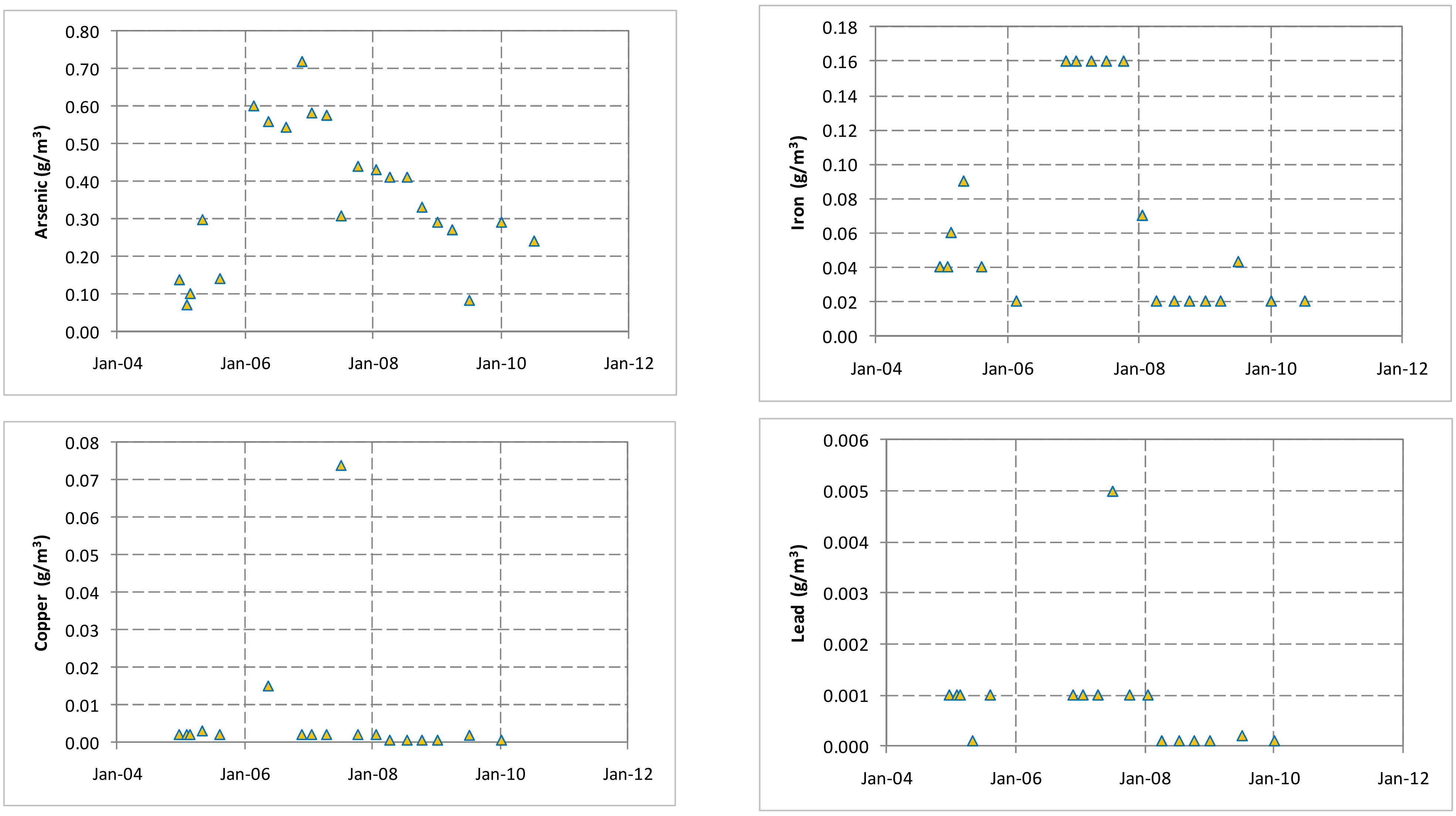
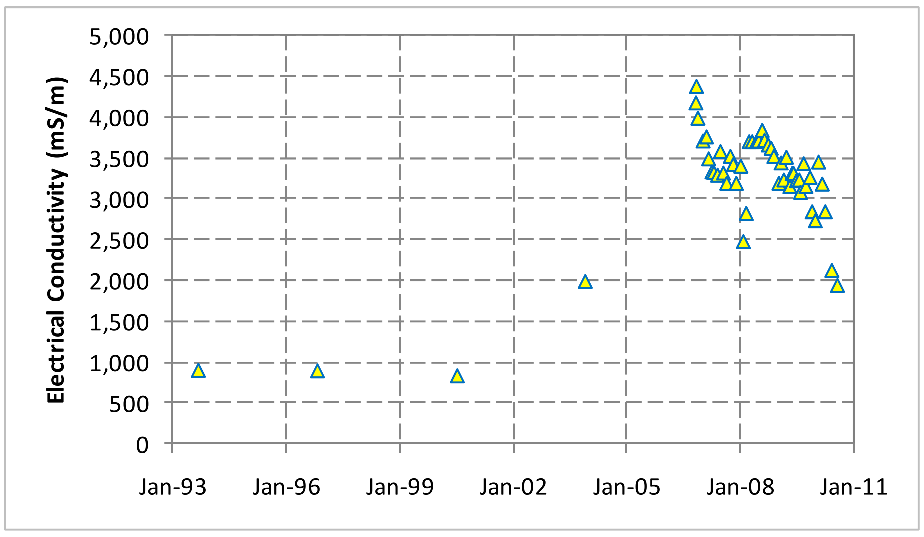
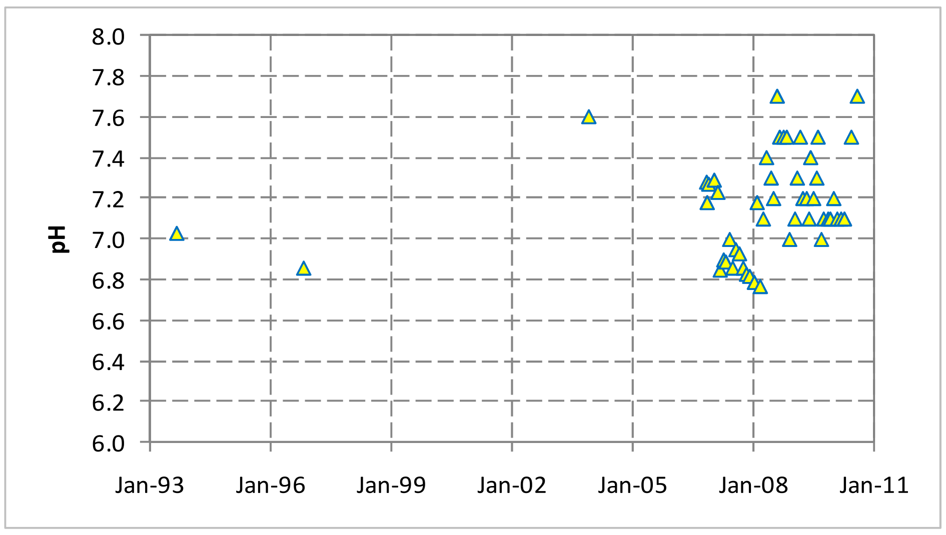
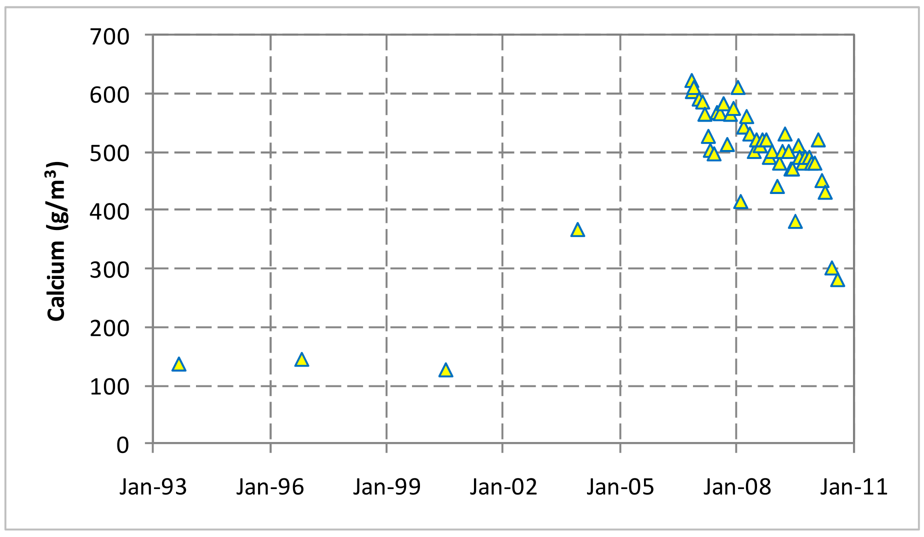
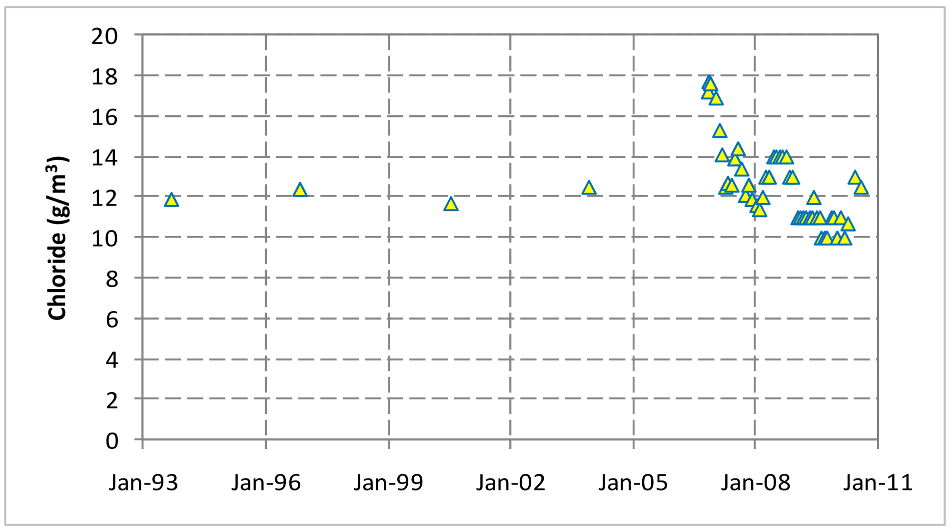


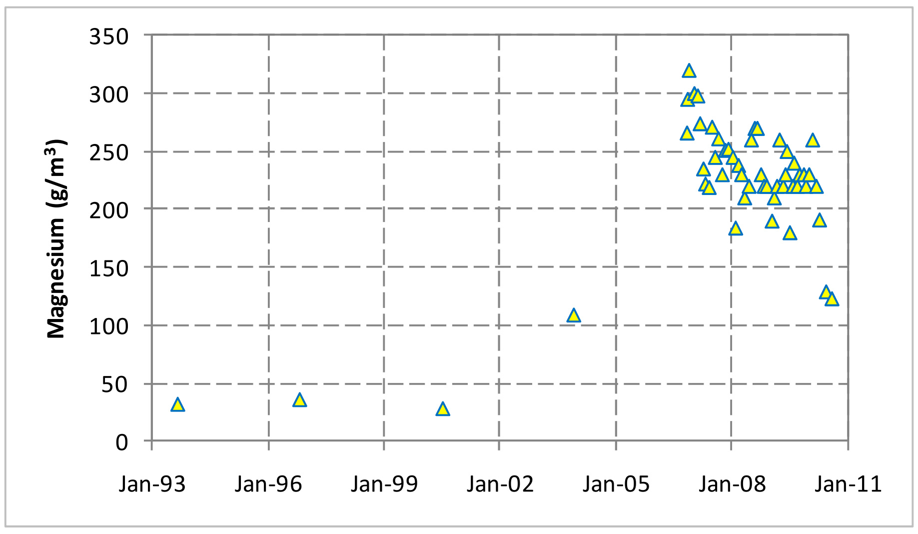
Figure E2: Golden Bar Pit water quality.

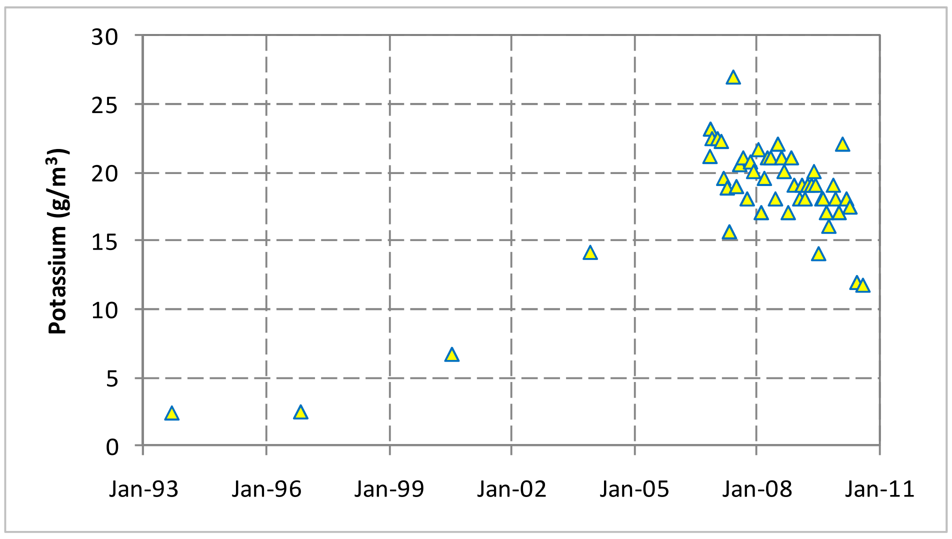

Electrical Conductivity (mS/m)
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
Jan-93
Jan-96
Jan-99
Jan-02
Jan-05
Jan-08
Jan-11

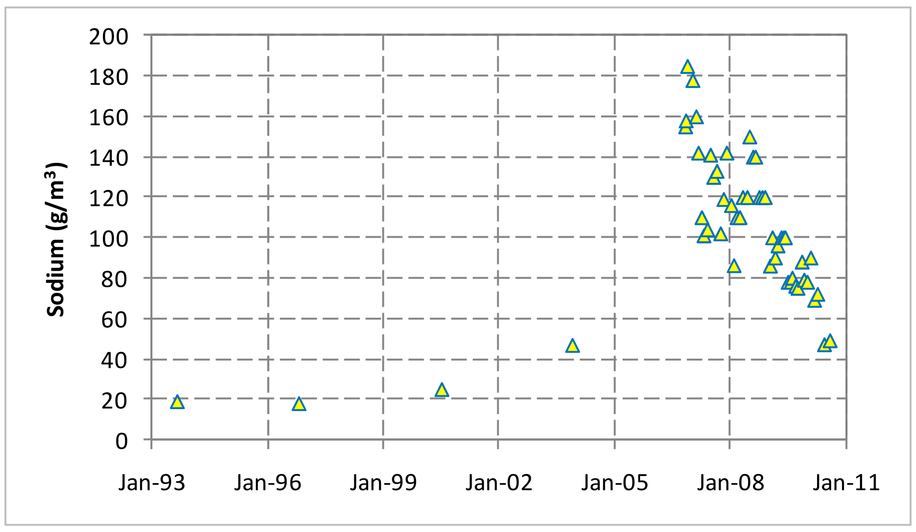

pH
8.0
7.8
7.6
7.4
7.2
7.0
6.8
6.6
6.4
6.2
6.0
Jan-93
Jan-96
Jan-99
Jan-02
Jan-05
Jan-08
Jan-11

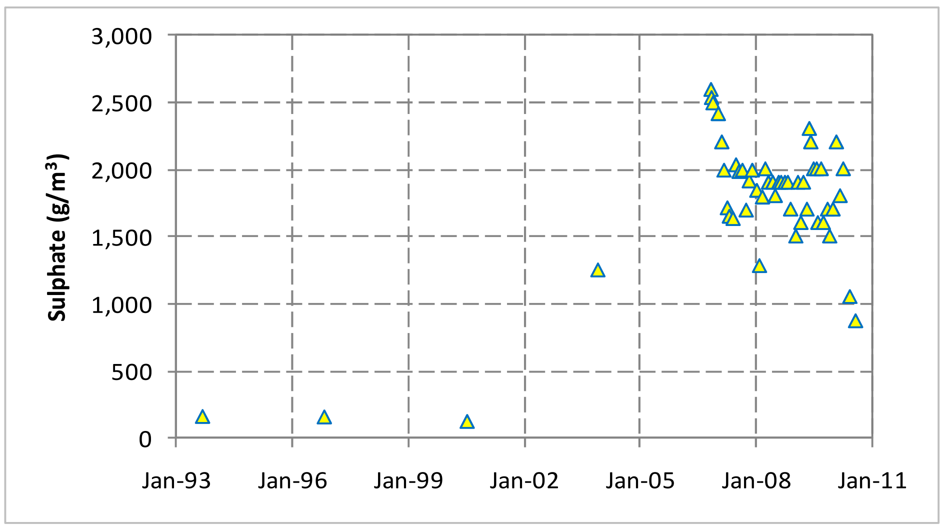

Calcium (g/m³)
700
600
500
400
300
200
100
0
Jan-93
Jan-96
Jan-99
Jan-02
Jan-05
Jan-08
Jan-11


Chloride (g/m³)
20
18
16
14
12
10
8
6
4
2
0
Jan-93
Jan-96
Jan-99
Jan-02
Jan-05
Jan-08
Jan-11


Magnesium (g/m³)
350
300
250
200
150
100
50
0
Jan-93
Jan-96
Jan-99
Jan-02
Jan-05
Jan-08
Jan-11


Potassium (g/m³)
30
25
20
15
10
5
0
Jan-93
Jan-96
Jan-99
Jan-02
Jan-05
Jan-08
Jan-11


Sodium (g/m³)
200
180
160
140
120
100
80
60
40
20
0
Jan-93
Jan-96
Jan-99
Jan-02
Jan-05
Jan-08
Jan-11


Sulphate (g/m³)
3,000
2,500
2,000
1,500
1,000
500
0
Jan-93
Jan-96
Jan-99
Jan-02
Jan-05
Jan-08
Jan-11

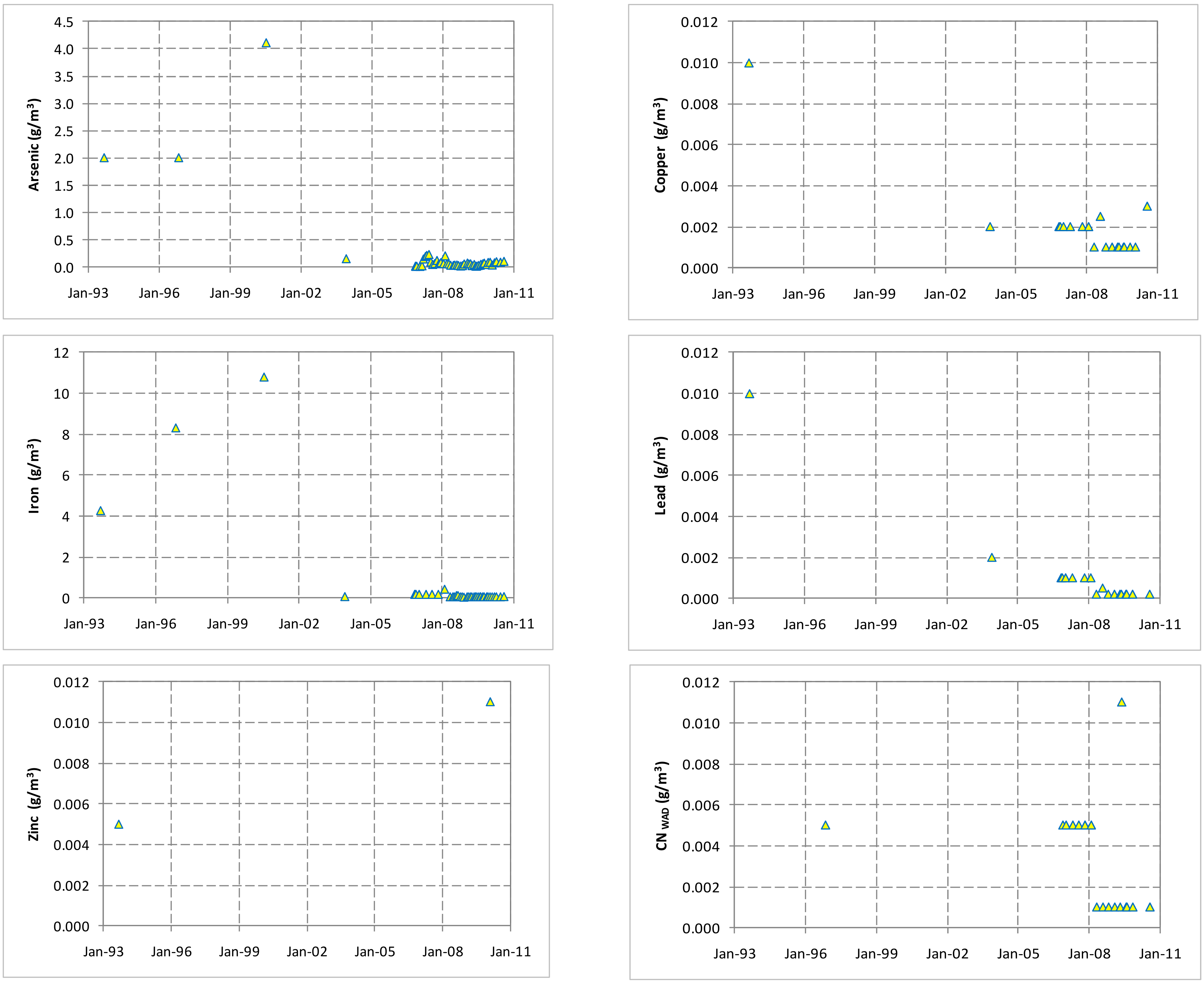
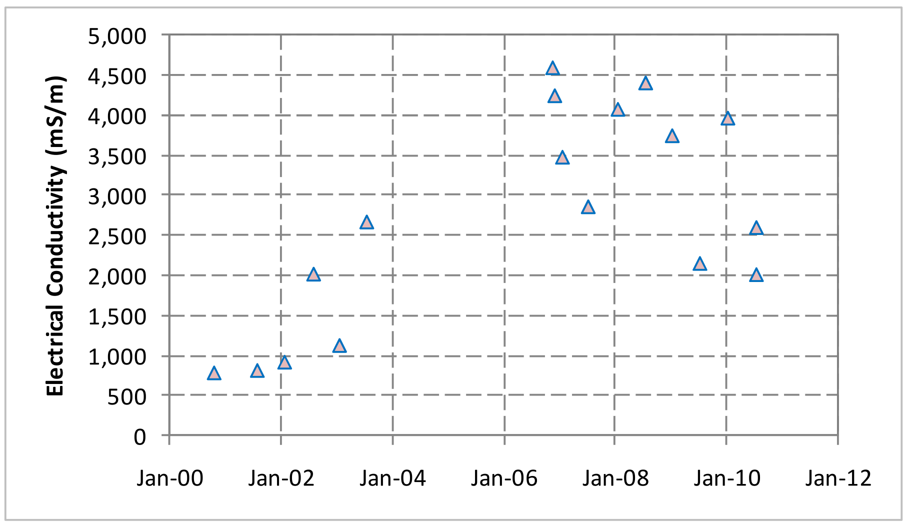
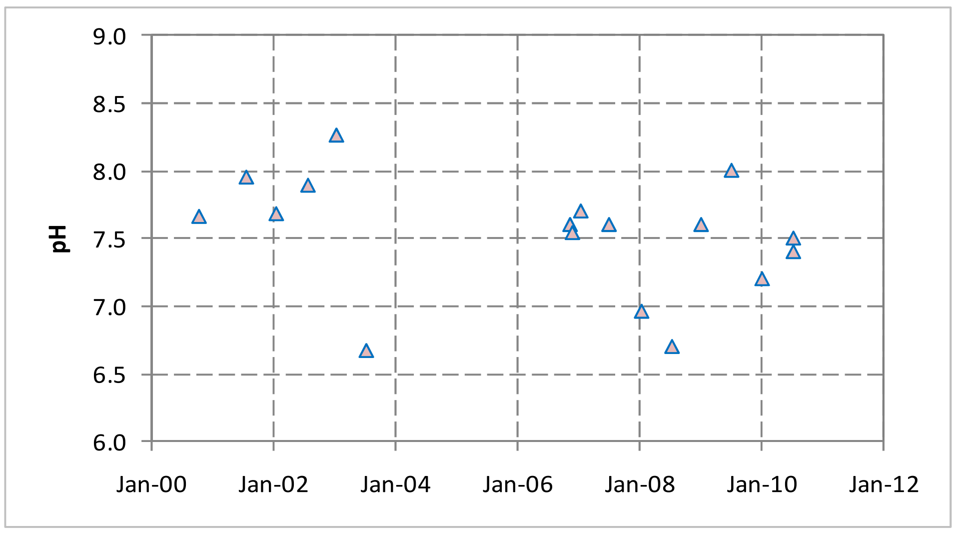
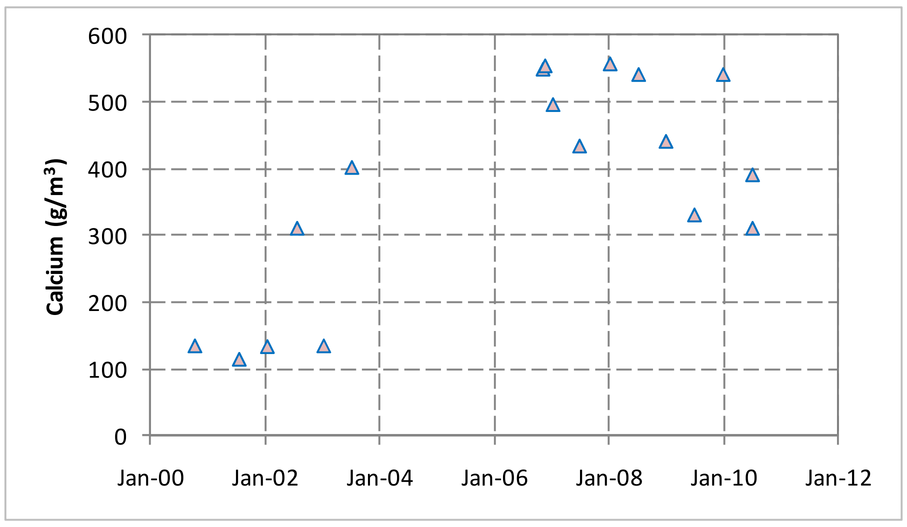
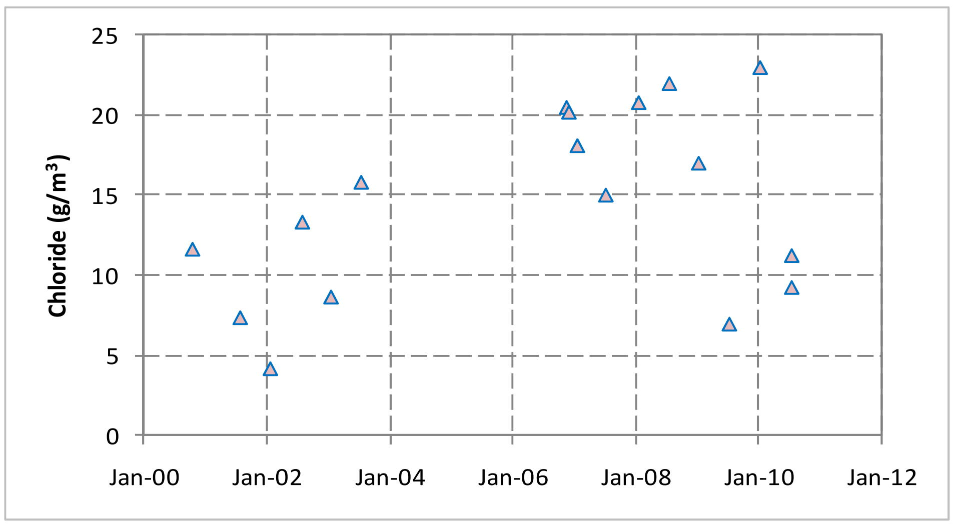


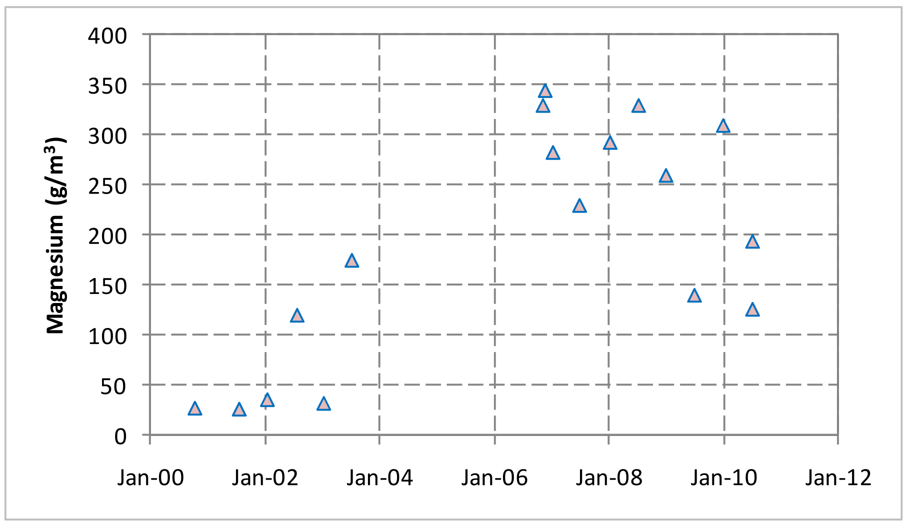
Figure E3: Golden Point Adit water quality.

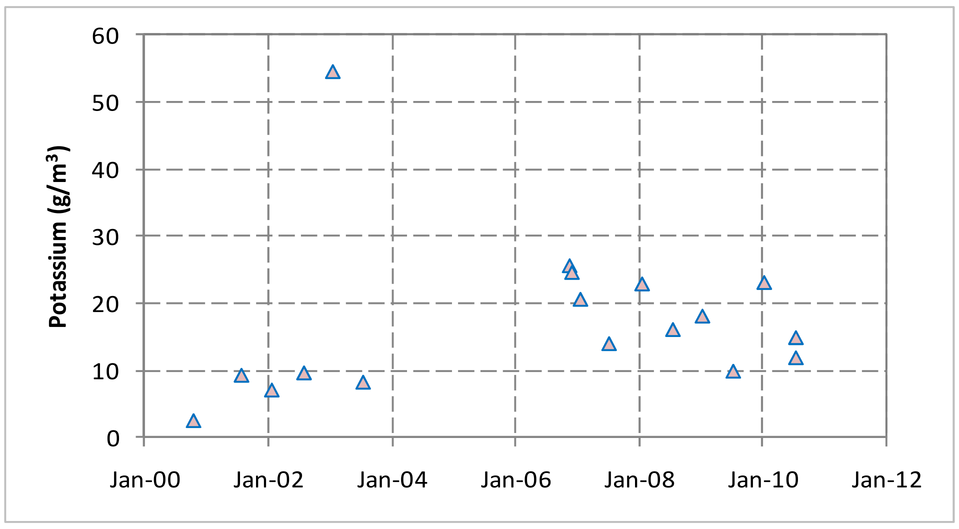

Electrical Conductivity (mS/m)
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12

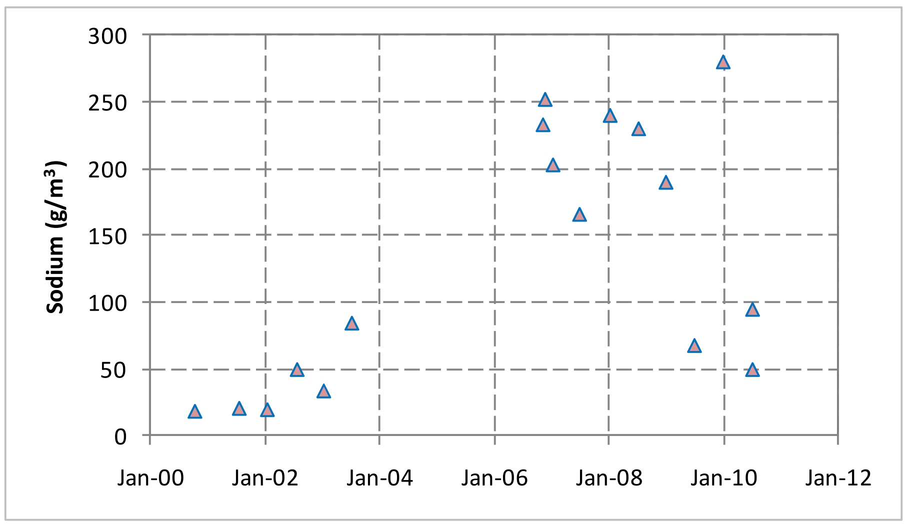

pH
9.0
8.5
8.0
7.5
7.0
6.5
6.0
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12

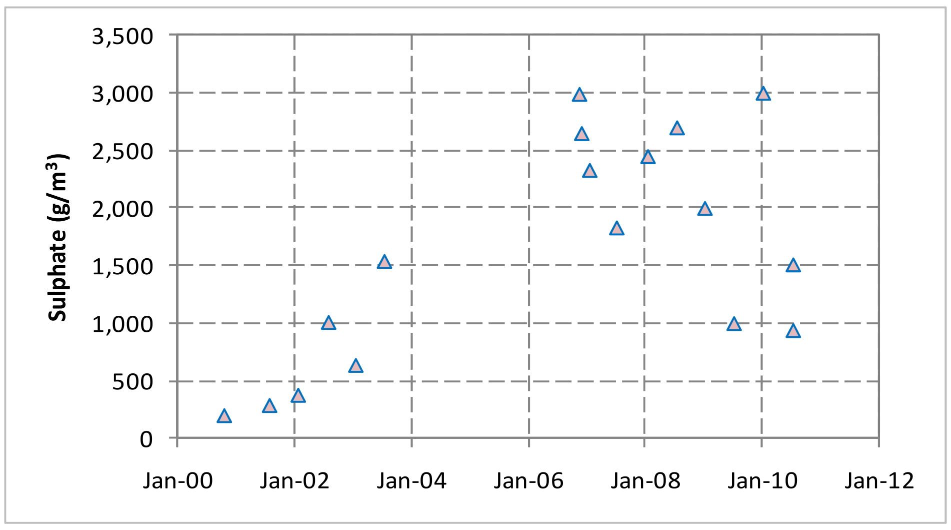

Calcium (g/m³)
600
500
400
300
200
100
0
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12


Chloride (g/m³)
25
20
15
10
5
0
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12


Magnesium (g/m³)
400
350
300
250
200
150
100
50
0
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12


Potassium (g/m³)
60
50
40
30
20
10
0
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12


Sodium (g/m³)
300
250
200
150
100
50
0
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12


Sulphate (g/m³)
3,500
3,000
2,500
2,000
1,500
1,000
500
0
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12

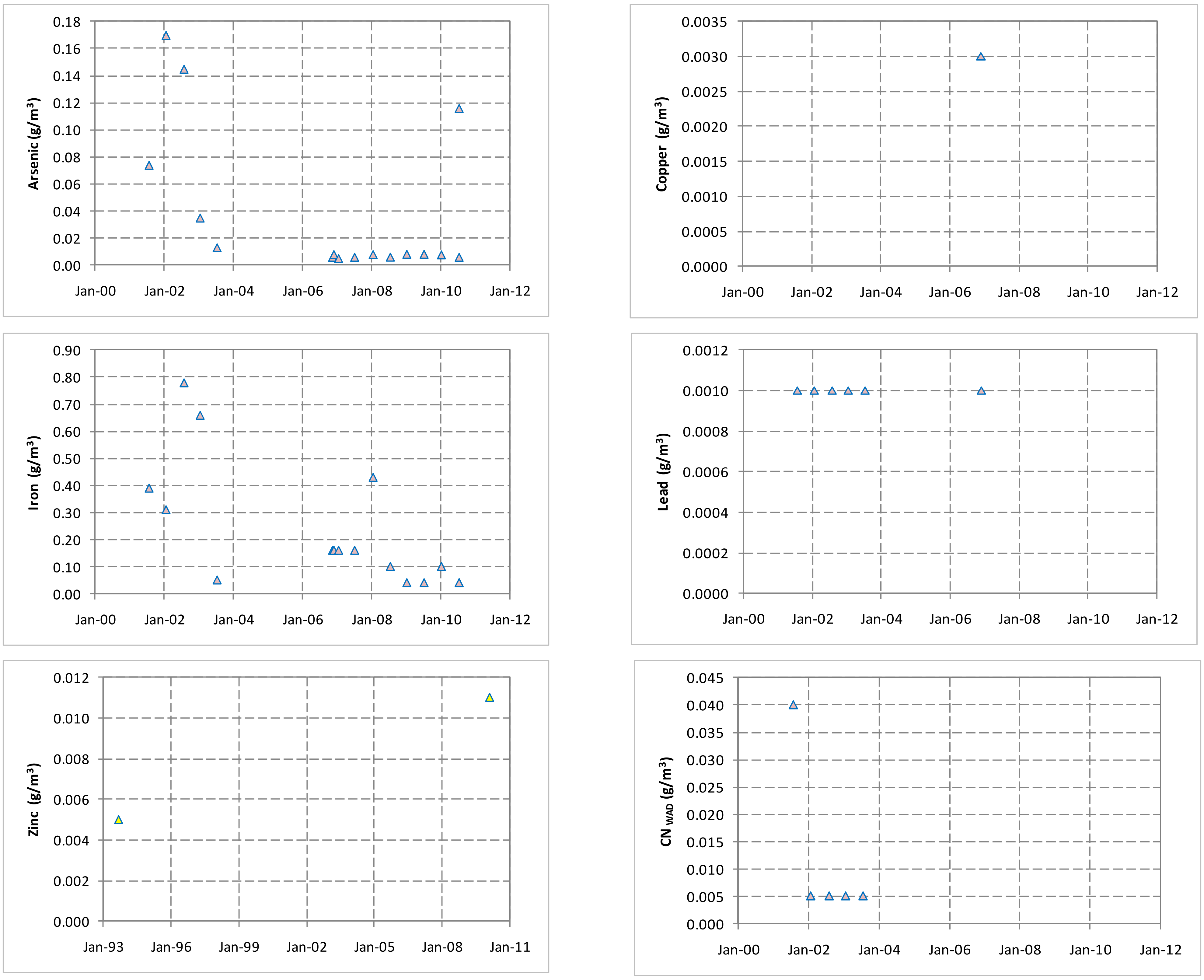
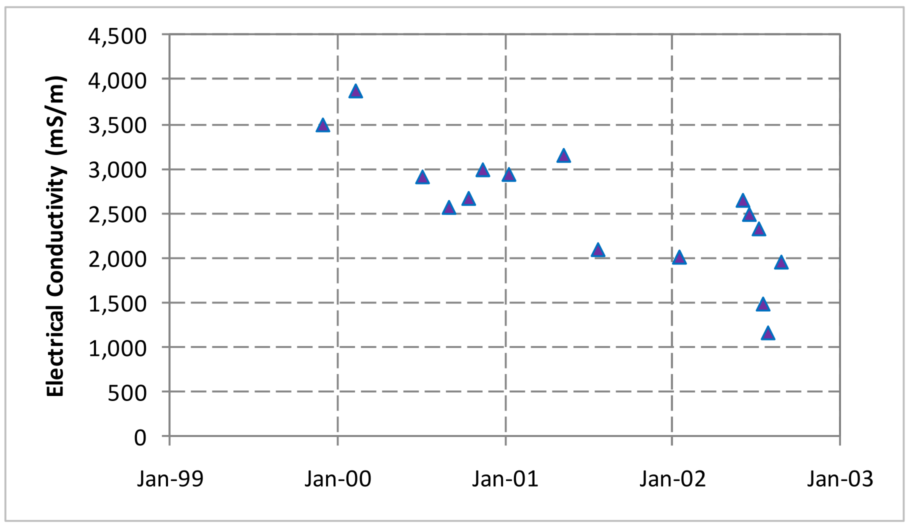
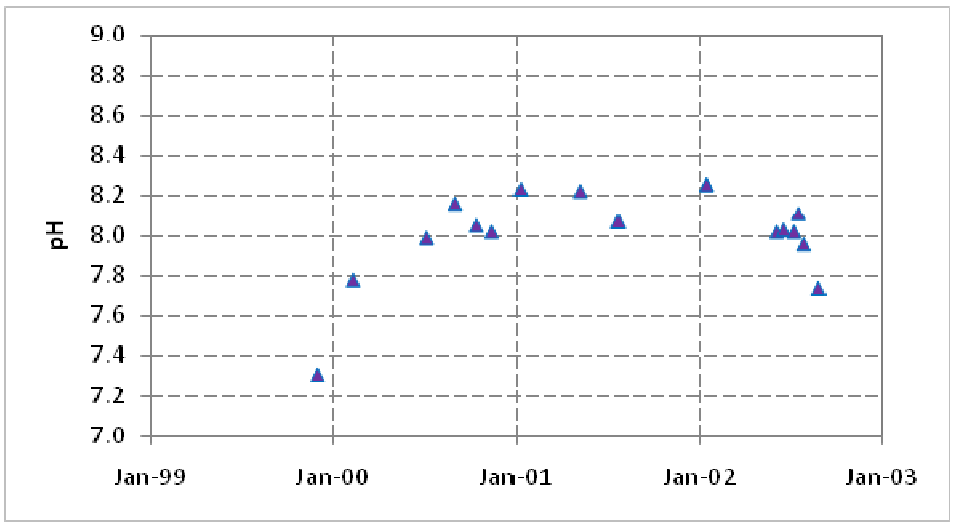
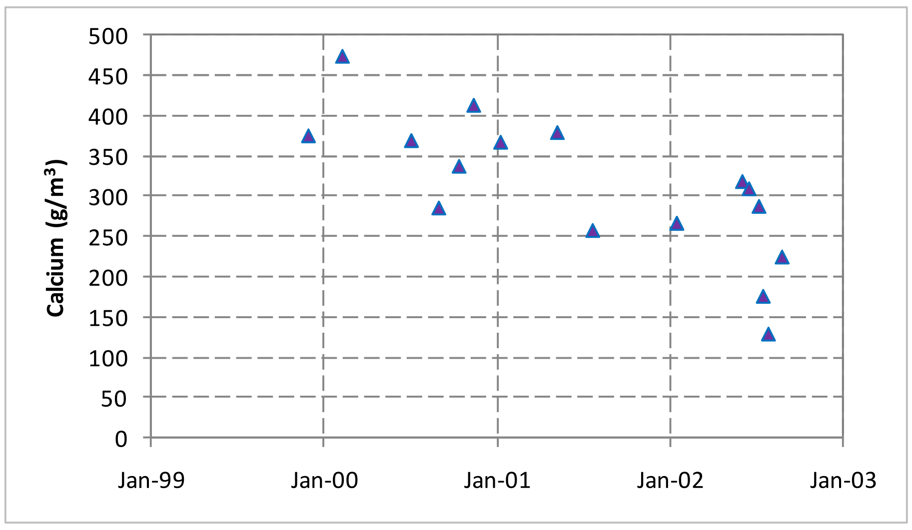
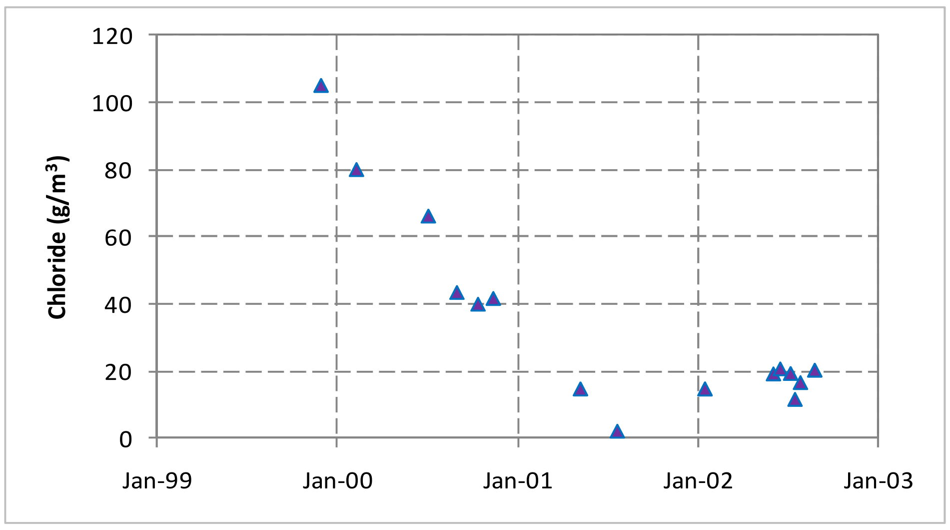


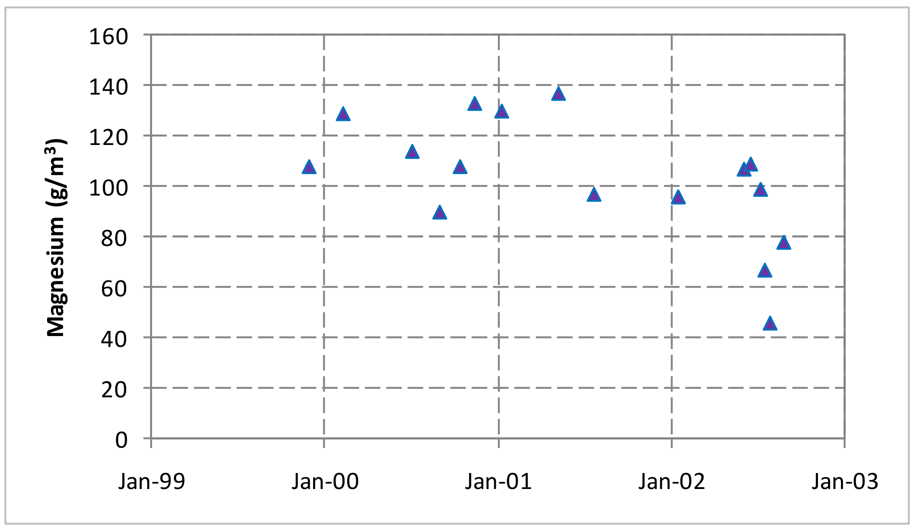
Figure E4: Golden Point Pit water quality.

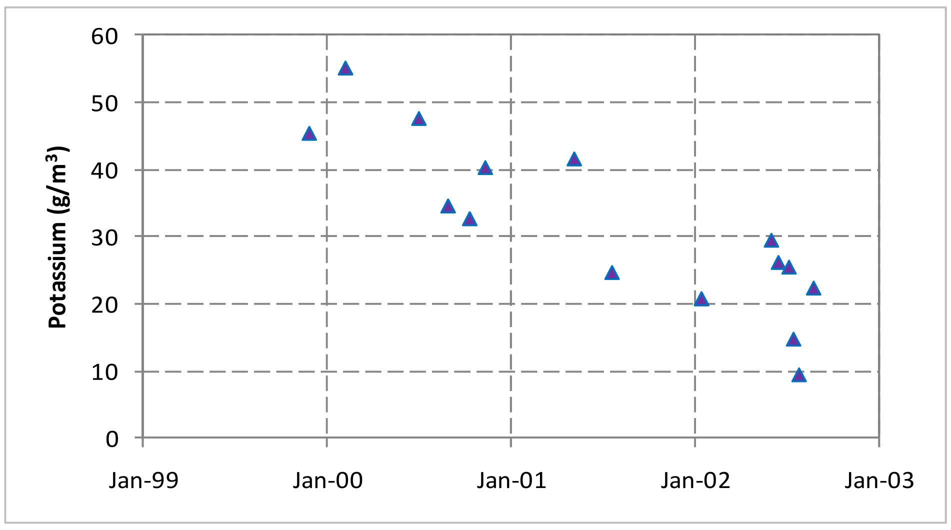

Electrical Conductivity (mS/m)
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03

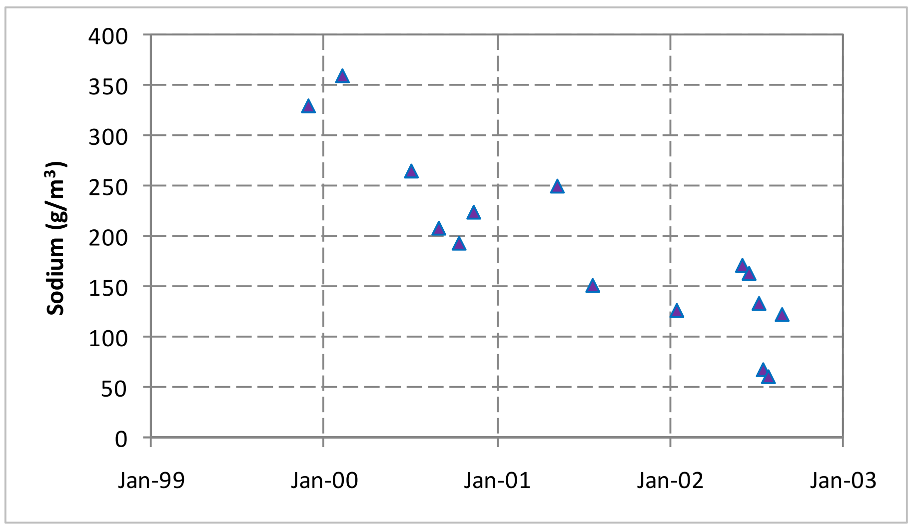

pH
9.0
8.8
8.6
8.4
8.2
8.0
7.8
7.6
7.4
7.2
7.0
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03

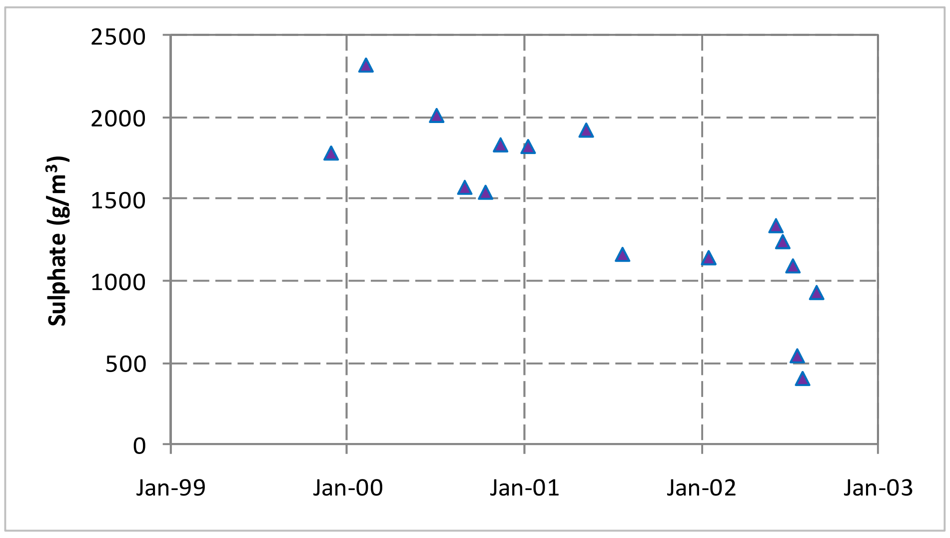

Calcium (g/m³)
500
450
400
350
300
250
200
150
100
50
0
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03

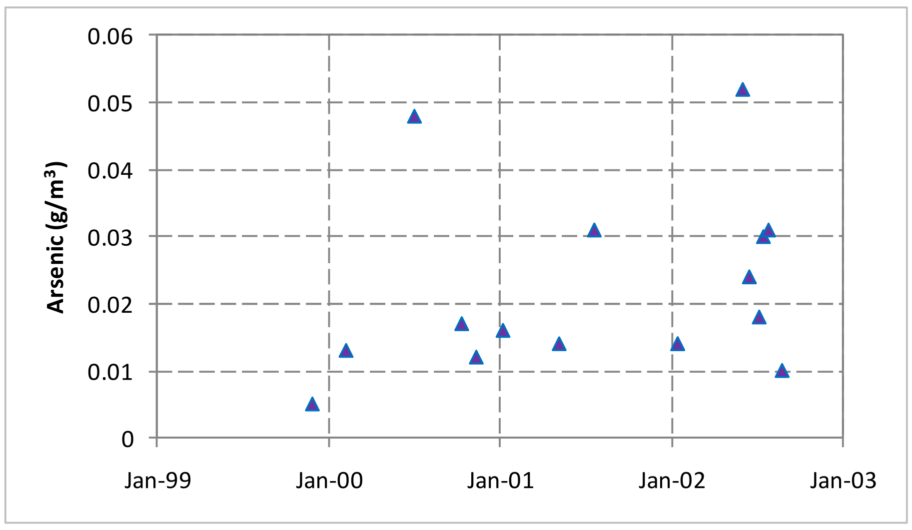

Chloride (g/m³)
120
100
80
60
40
20
0
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03

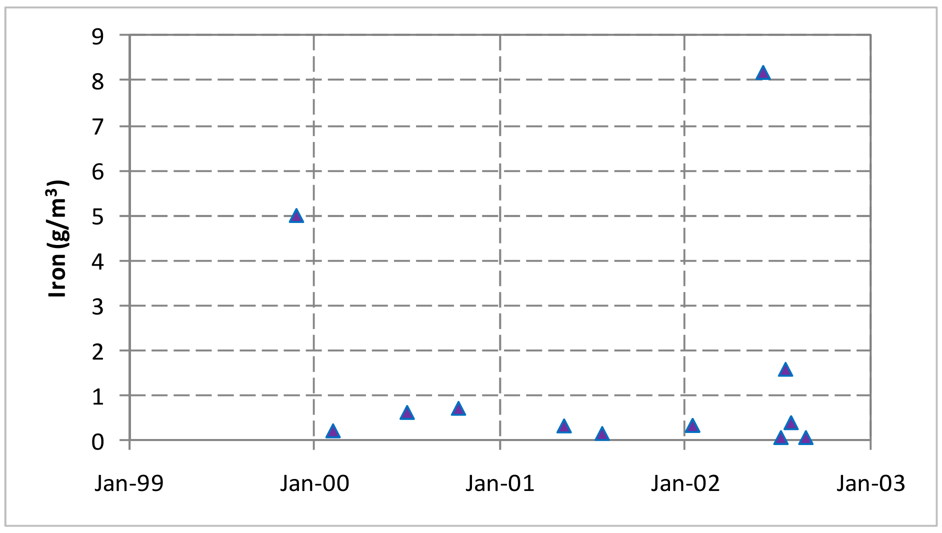

Magnesium (g/m³)
160
140
120
100
80
60
40
20
0
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03

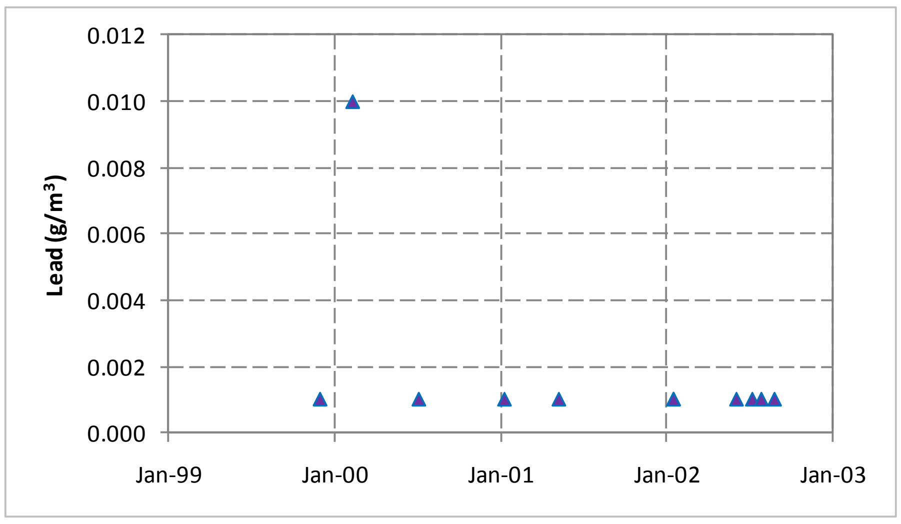

Potassium (g/m³)
60
50
40
30
20
10
0
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03

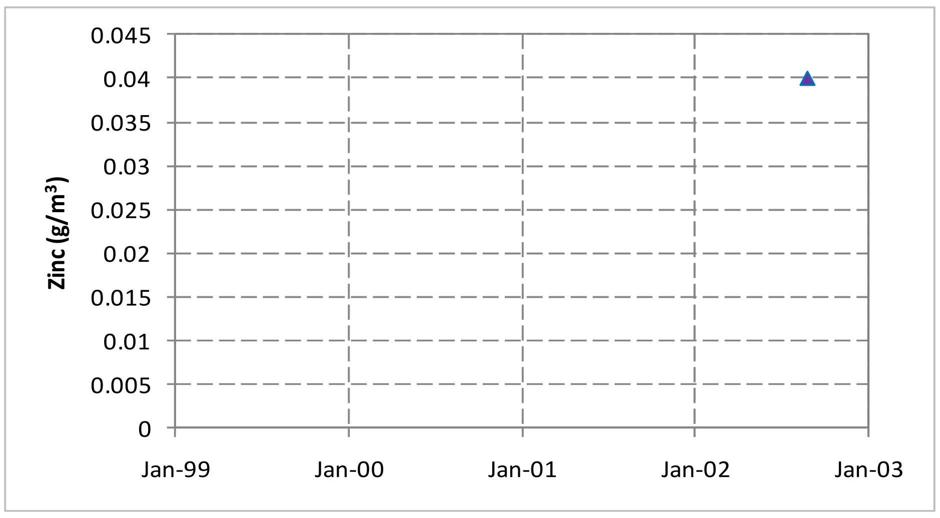

Sodium (g/m³)
400
350
300
250
200
150
100
50
0
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03


Sulphate (g/m³)
2500
2000
1500
1000
500
0
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03









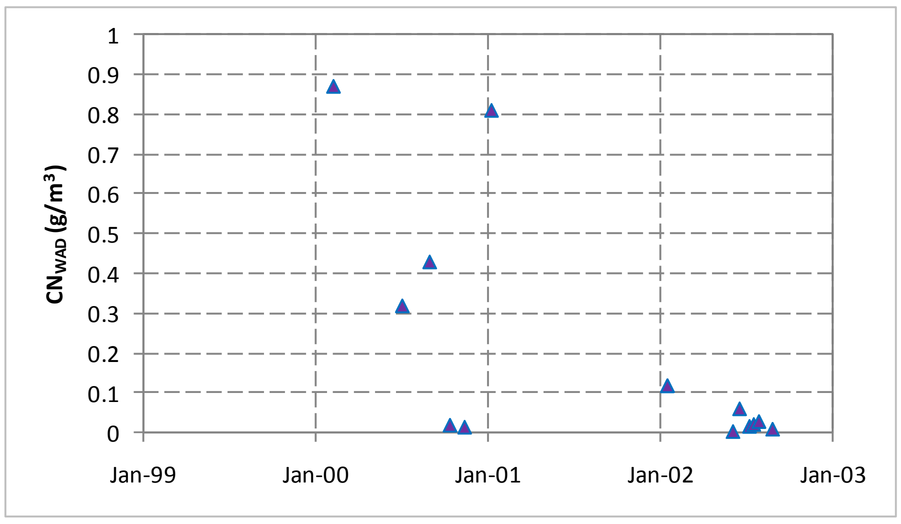


Figure E5: Innes Mills South Pit water quality.

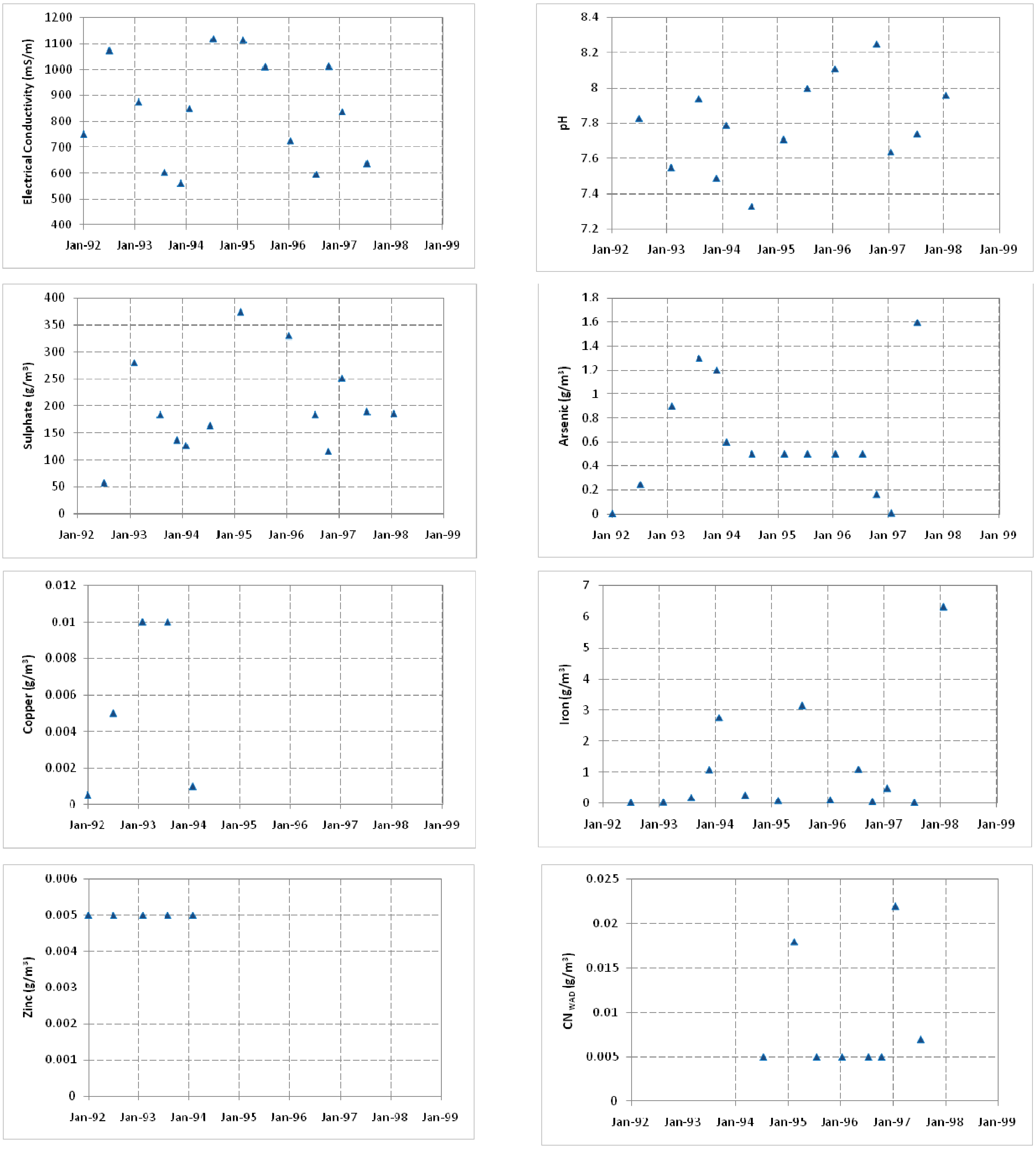
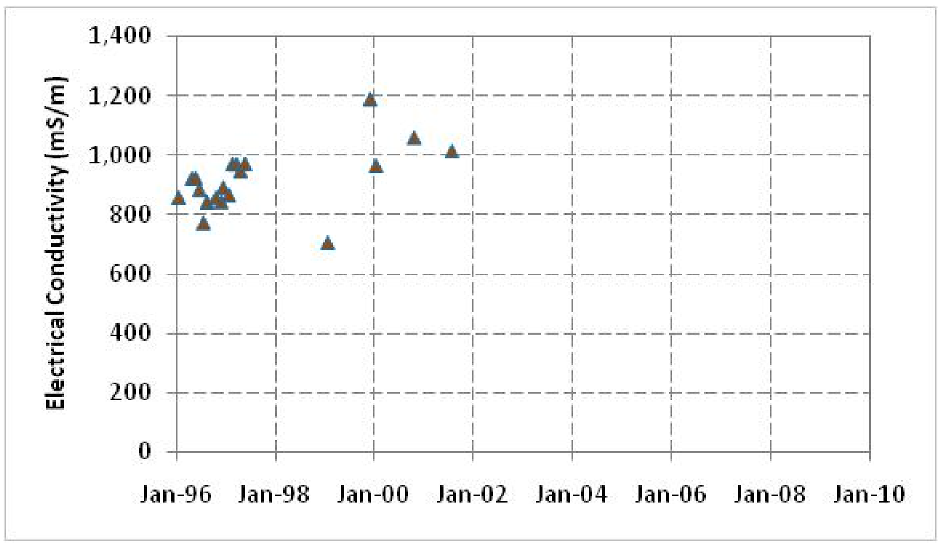
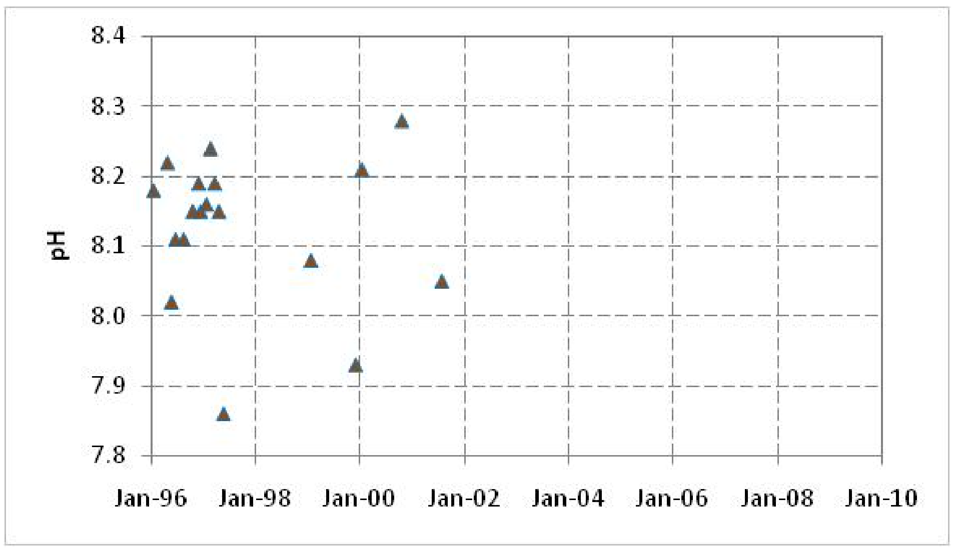
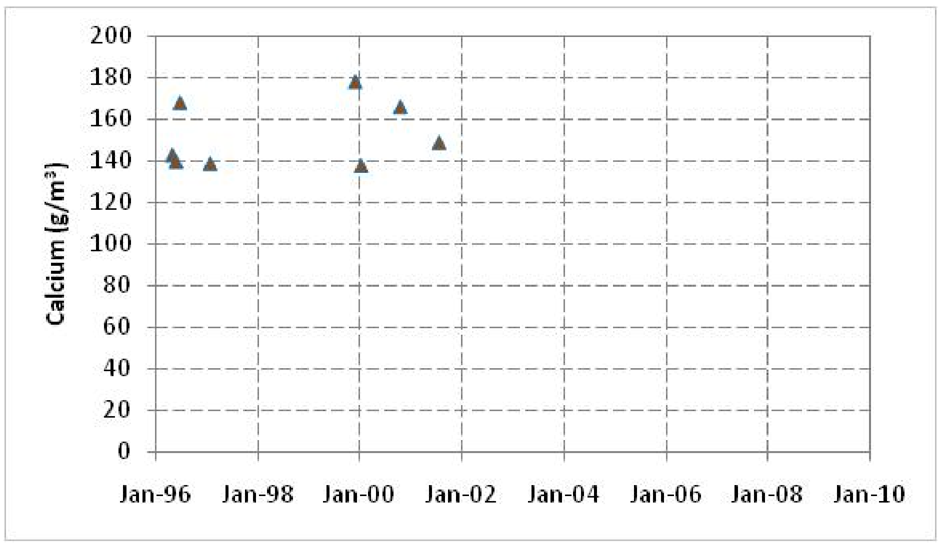
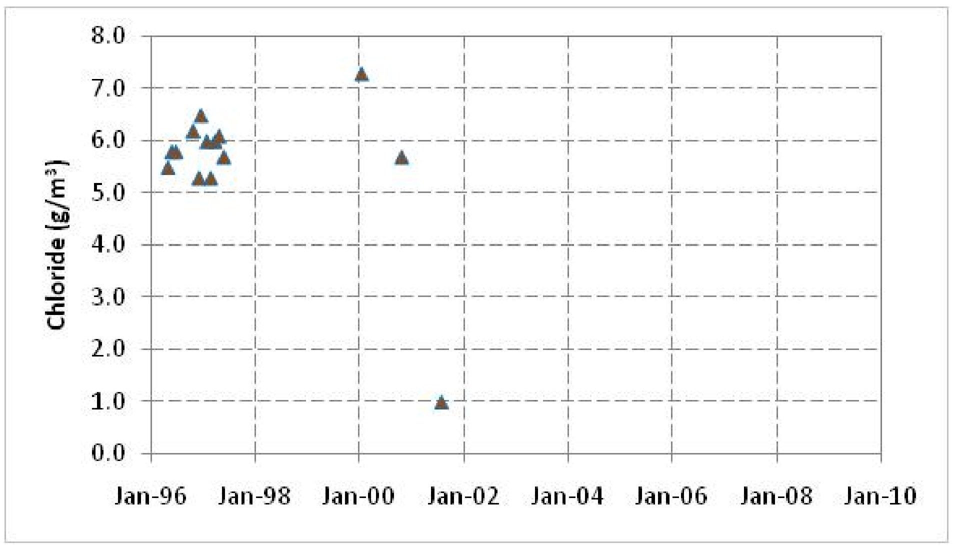


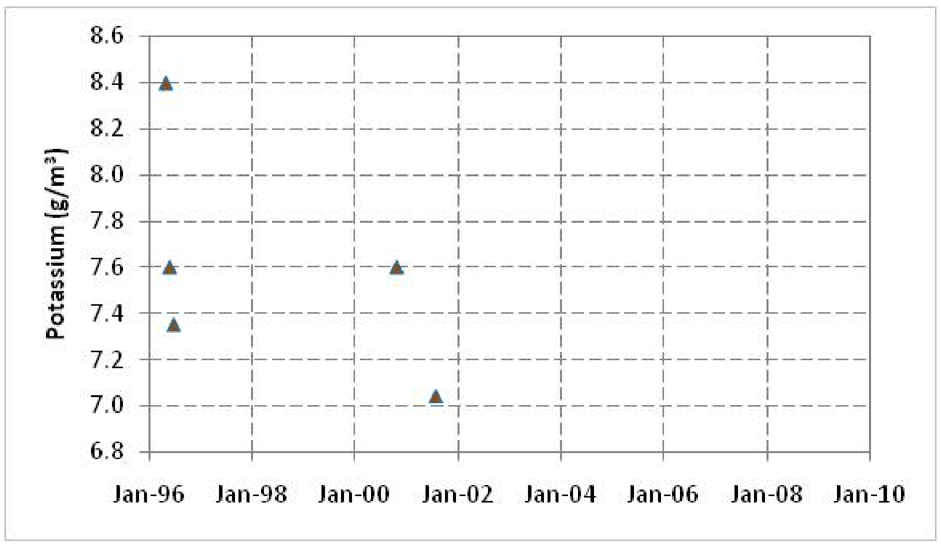
Figure E6: Round Hill Pit water quality.

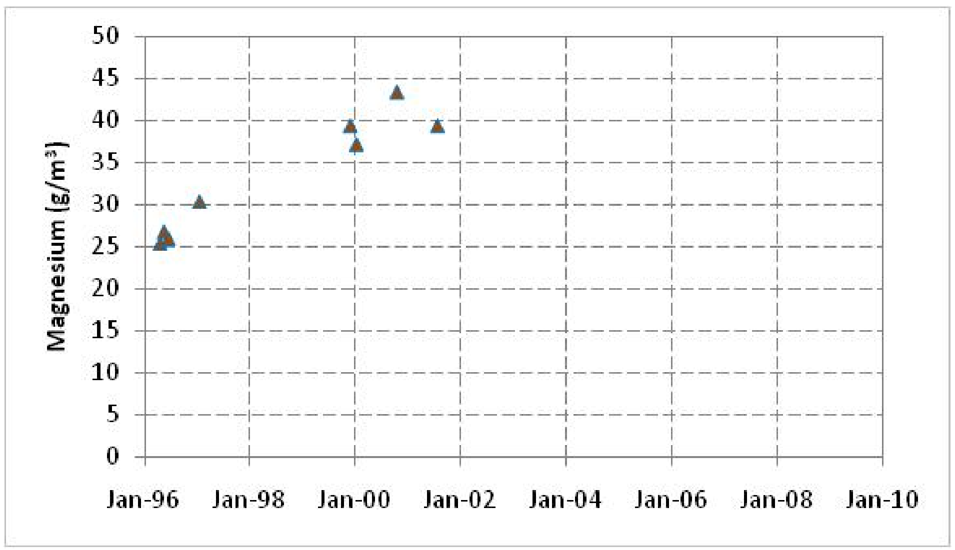

Electrical Conductivity (mS/m)
1,400
1,200
1,000
800
600
400
200
0
Jan-96 Jan-98 Jan-00 Jan-02 Jan-04 Jan-06 Jan-08 Jan-10

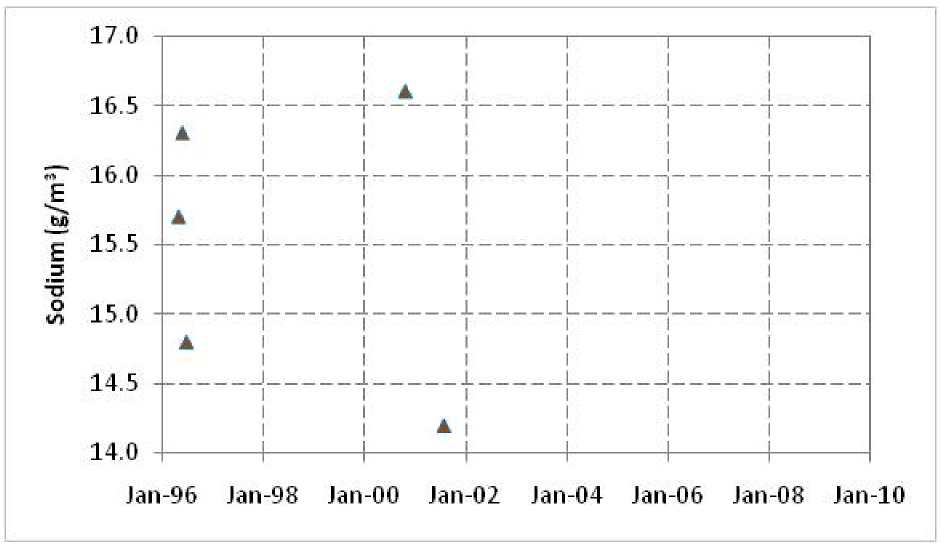

pH
8.4
8.3
8.2
8.1
8.0
7.9
7.8
Jan-96 Jan-98 Jan-00 Jan-02 Jan-04 Jan-06 Jan-08 Jan-10

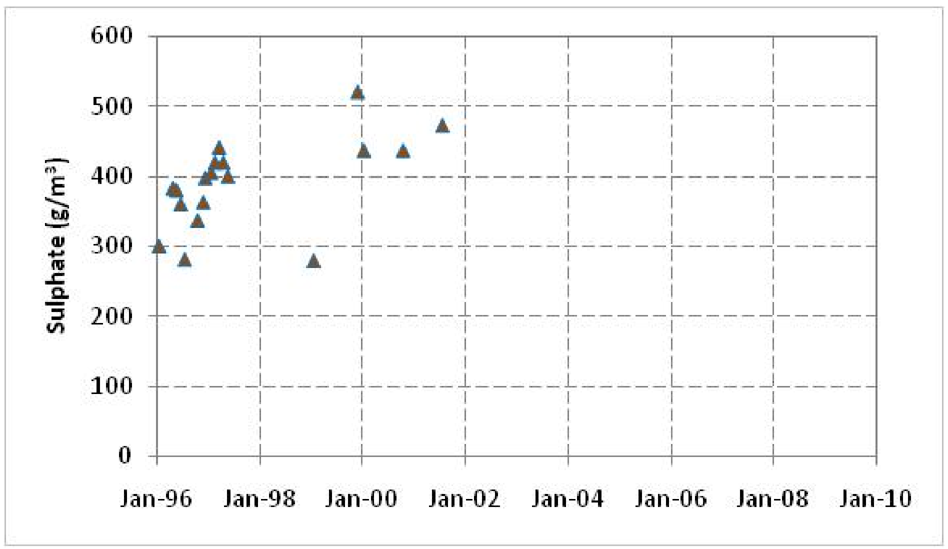

Calcium (g/m³)
200
180
160
140
120
100
80
60
40
20
0
Jan-96 Jan-98 Jan-00 Jan-02 Jan-04 Jan-06 Jan-08 Jan-10


Chloride (g/m³)
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Jan-96 Jan-98 Jan-00 Jan-02 Jan-04 Jan-06 Jan-08 Jan-10


Potassium (g/m³)
8.6
8.4
8.2
8.0
7.8
7.6
7.4
7.2
7.0
6.8
Jan-96 Jan-98 Jan-00 Jan-02 Jan-04 Jan-06 Jan-08 Jan-10


Magnesium (g/m³)
50
45
40
35
30
25
20
15
10
5
0
Jan-96 Jan-98 Jan-00 Jan-02 Jan-04 Jan-06 Jan-08 Jan-10


Sodium (g/m³)
17.0
16.5
16.0
15.5
15.0
14.5
14.0
Jan-96 Jan-98 Jan-00 Jan-02 Jan-04 Jan-06 Jan-08 Jan-10


Sulphate (g/m³)
600
500
400
300
200
100
0
Jan-96 Jan-98 Jan-00 Jan-02 Jan-04 Jan-06 Jan-08 Jan-10

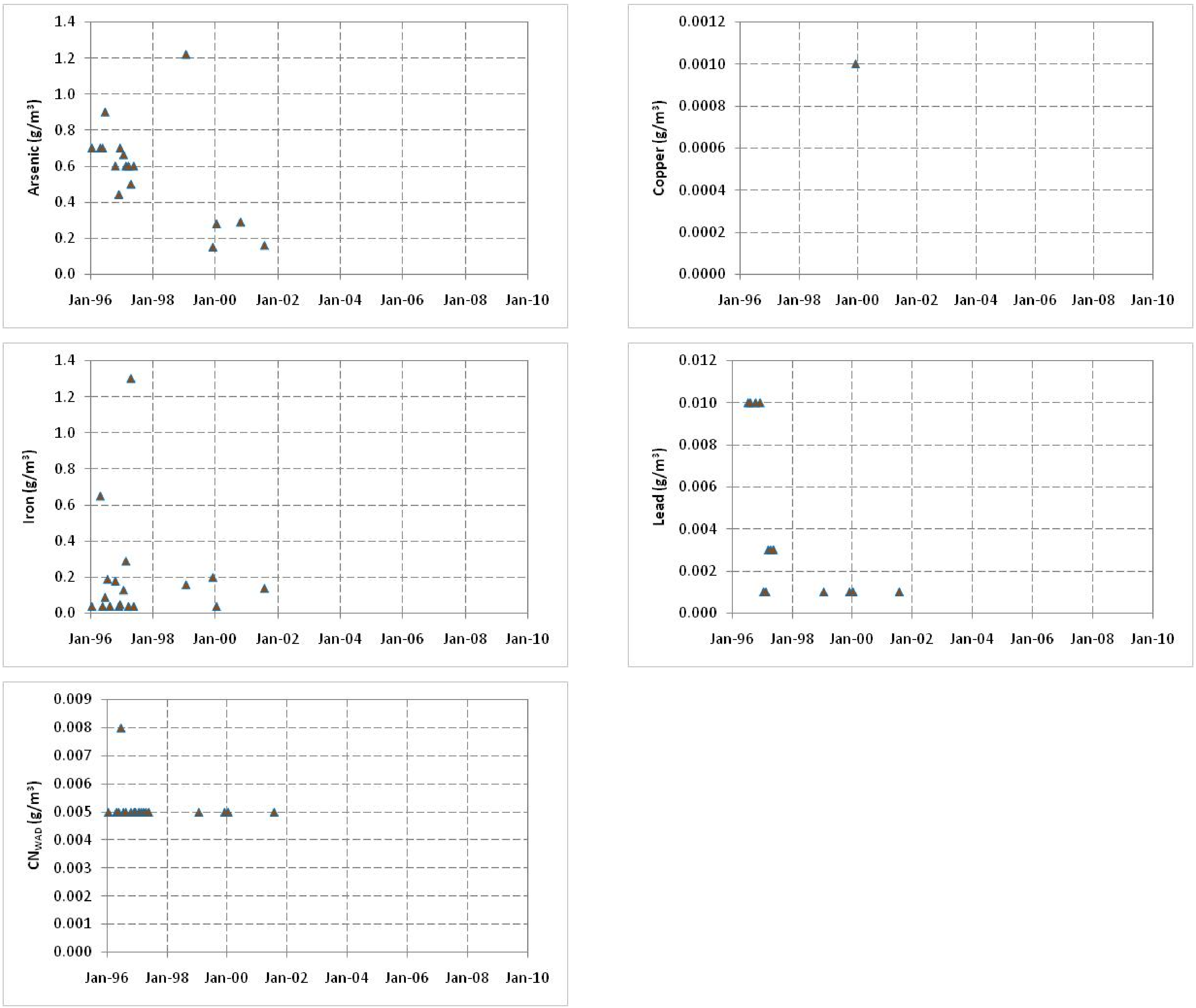


Figure E7: Southern Pit water quality.

Table E1: Summary of Fraser Pit water quality.

Parameter	Minimum	Mean	95th Percentile	Maximum
pH (unitless)	7.2	8.1	8.8	9.8
Conductivity (mS/m)	320	760	1,100	1,200
Calcium	29	67	96	110
Chloride	1.7	11	18	20
Magnesium	15	39	56	74
Potassium	2.8	7.8	16	16
Sodium	4.9	35	61	72
Sulphate	24	200	350	470
CN_{WAD}	<0.005	<0.013	0.018	0.15
Arsenic	<0.005	<0.18	0.42	0.80
Copper	<0.001	<0.003	0.010	0.022
Iron	<0.02	<0.17	0.60	1.2
Lead	<0.0010	<0.0010	0.0020	0.011

Notes: All units g/m^3 unless otherwise stated; and all data presented to two significant figures or less.

Table E2: Summary of Golden Bar Pit water quality.

Parameter	Minimum	Mean	95th Percentile	Maximum
pH(unitless)	7.0	8.1	8.3	8.4
Conductivity (mS/m)	270	640	810	860
Calcium	26	70	86	100
Chloride	3.7	6.6	8.5	9.6
Magnesium	14	32	46	48
Potassium	1.8	4.6	7.3	8.2
Sodium	8.2	13	17	18
Sulphate	50	160	260	290
Arsenic	0.07	0.36	0.60	0.72
Copper	<0.001	<0.006	0.024	0.074
Iron	<0.02	<0.067	0.16	0.16
Lead	<0.0001	<0.001	0.002	0.005

Notes: All units g/m^3 unless otherwise stated; and all data presented to two significant figures or less.

Table E3: Summary of Golden Point Adit water quality.

Parameter	Minimum	Mean	95th Percentile	Maximum
pH(unitless)	6.8	7.2	7.6	7.7
Conductivity (mS/m)	830	3,200	3,900	4,400
Calcium	130	480	610	620
Chloride	10	13	17	18
Magnesium	28	220	300	320
Potassium	2.4	18	22	27
Sodium	18	100	160	190
Sulphate	120	1,800	2,500	2,600
CN_{WAD}	<0.001	<0.0032	0.0062	0.011
Arsenic	0.014	0.23	1.1	4.1
Copper[A]	<0.0010	<0.0016	0.0026	0.003
Iron	<0.02	<0.65	4.5	11
Lead	<0.0002	<0.0011	0.0032	0.010
Zinc[B]	<0.005	NA	NA	0.011

Notes: All units g/m^3 unless stated; all data presented to two significant figures or less; NA = not applicable; [A] summary statistics were derived after excluding detection limits superseded by lower limits; and [B] zinc was analysed twice and was below detection on one occasion.

Table E4: Summary of Golden Point Pit water quality.

Parameter	Minimum	Mean	95th Percentile	Maximum
pH(unitless)	6.7	7.5	8.1	8.3
Conductivity (mS/m)	780	2,700	4,400	4,600
Calcium	110	370	550	560
Chloride	4.1	14	22	23
Magnesium	26	192	333	345
Potassium	2.4	17	31	54
Sodium	19	130	260	280
Sulphate	200	1,600	3,000	3,000
CN_{WAD}[A]	<0.005	NA	NA	0.040
Arsenic	<0.005	<0.039	0.15	0.17
Iron	<0.04	<0.23	0.69	0.78
Lead[B]	<0.001	NA	NA	NA

Notes: All units g/m^3 unless stated; all data presented to two significant figures or less; NA = not applicable; [A] CN_{WAD} was analysed five times, with all but one below a detection limit of 0.005 g/m^3; and [B] lead was below the detection limit on each sampling occasion.

Table E5: Summary of Innes Mills South Pit water quality.

Parameter	Minimum	Mean	95th Percentile	Maximum
pH(unitless)	7.3	8.0	8.3	8.3
Conductivity (mS/m)	1,200	2,500	3,600	3,900
Calcium	130	310	430	470
Chloride	1.8	33	86	110
Magnesium	46	100	130	140
Potassium	9.4	31	49	55
Sodium	60	180	340	360
Sulphate	400	1,400	2,100	2,300
$Cyanide_{(WAD)}$	<0.005	<0.20	0.83	0.87
Arsenic	<0.005	<0.022	0.049	0.052
Copper	<0.001	<0.016	0.057	0.060
Iron	<0.050	<1.4	6.3	8.2
Lead[A,B]	<0.001	NA	NA	NA
Zinc[C]	<0.04	NA	NA	NA

Notes: All units g/m^3 unless stated; all data presented to two significant figures or less; NA = not applicable; [A] summary statistics were derived after excluding detection limits superseded by lower limits; [B] lead was below the detection limit on each sampling occasion; and [C] sampled on only one occasion.

Table E6: Summary of Round Hill Pit water quality.

Parameter	Minimum	Mean	95th Percentile	Maximum
pH(unitless)	7.3	7.8	8.2	8.3
Conductivity (mS/m)	560	840	1,100	1,100
Sulphate	58	200	350	370
CN_{WAD}	<0.005	<0.009	0.021	0.022
Arsenic	<0.002	<0.61	1.4	1.6
Copper[A]	<0.0005	NA	NA	NA
Iron	<0.040	<1.1	4.3	6.3
Lead[A]	<0.0002	NA	NA	NA
Zinc[A]	<0.005	NA	NA	NA

Notes: All units g/m^3 unless stated; all data presented to two significant figures or less; NA = not applicable; and [A] copper, lead and zinc concentrations were below the respective detection limits on each sampling occasion.

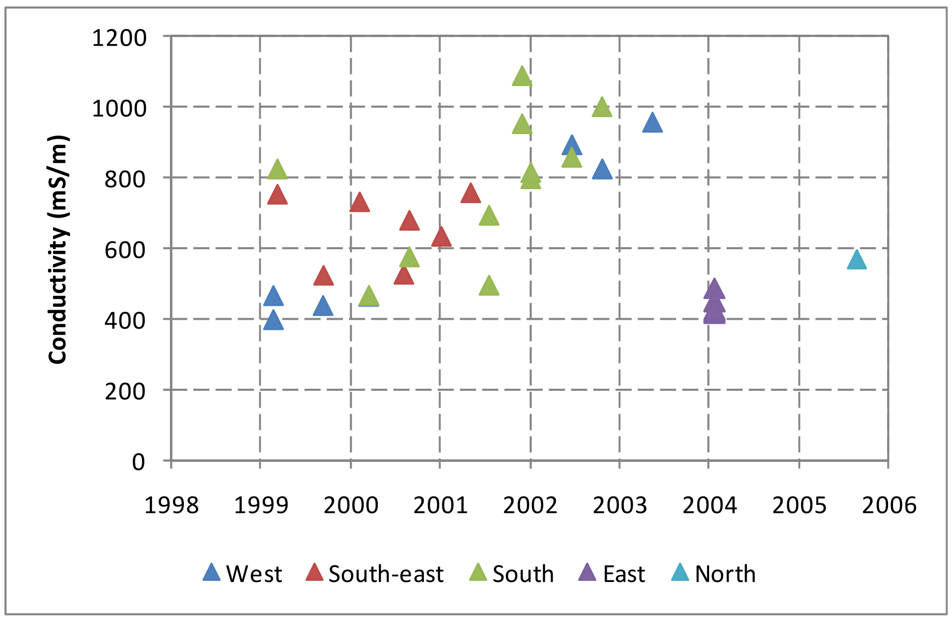
Table E7: Summary of Southern Pit water quality.

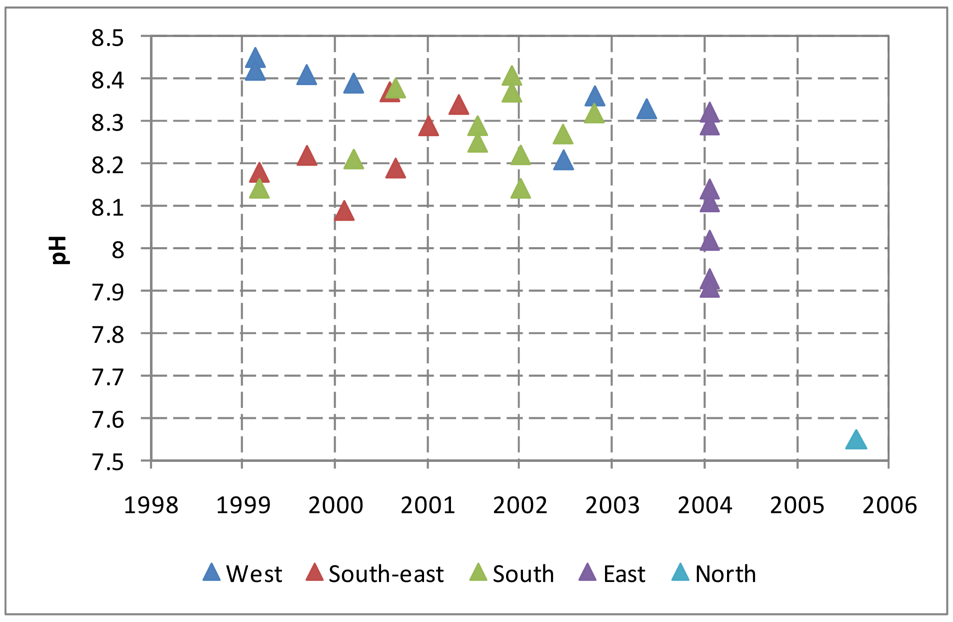
Parameter	Minimum	Mean	95th Percentile	Maximum
pH(unitless)	7.9	8.1	8.2	8.3
Conductivity (mS/m)	710	920	1,100	1,200
Calcium	140	150	180	180
Magnesium	25	34	42	43
Potassium	7.0	7.6	8.2	8.4
Sodium	14	16	17	17
Chloride	<1.0	<5.6	6.8	7.3
Sulphate	280	390	480	520
CN_{WAD}[A]	<0.005	NA	NA	0.008
Arsenic[B]	0.15	0.58	0.96	1.2
Copper[C]	<0.001	NA	NA	NA
Iron	<0.04	<0.20	0.75	1.3
Lead[D]	<0.001	NA	NA	NA

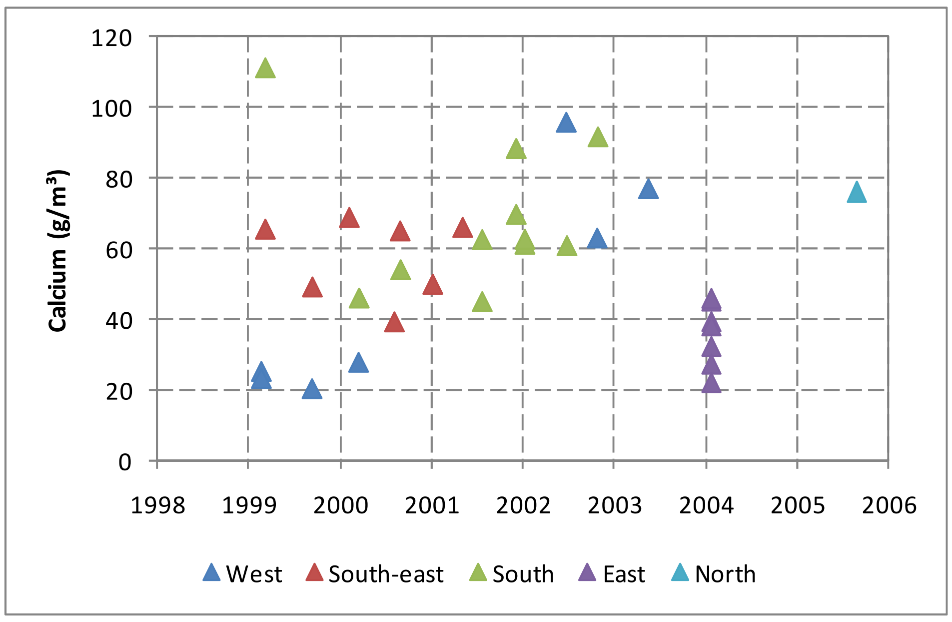
Notes: All units g/m^3 unless stated; data presented to two significant figures or less; NA = not applicable; [A] CNWAD was analysed on 18 occasions, with all but one below a detection limit of 0.005 g/m^3; [B] summary statistics were derived after excluding detection limits superseded by lower limits; [C] copper was analysed on one occasion and was below a detection limit of 0.001 g/m^3; and [D] lead was below the detection limit on each sampling occasion.

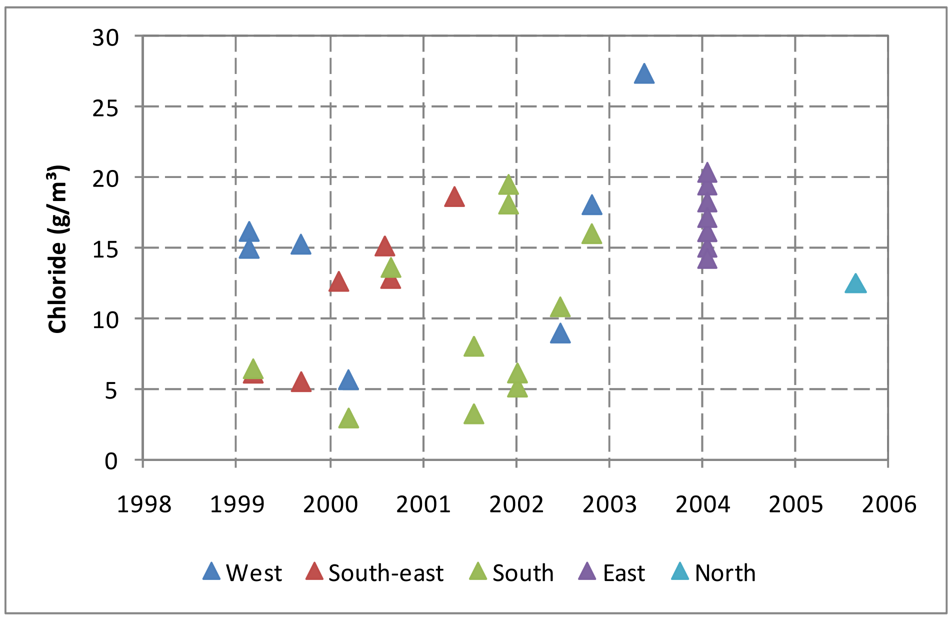
APPENDIX F

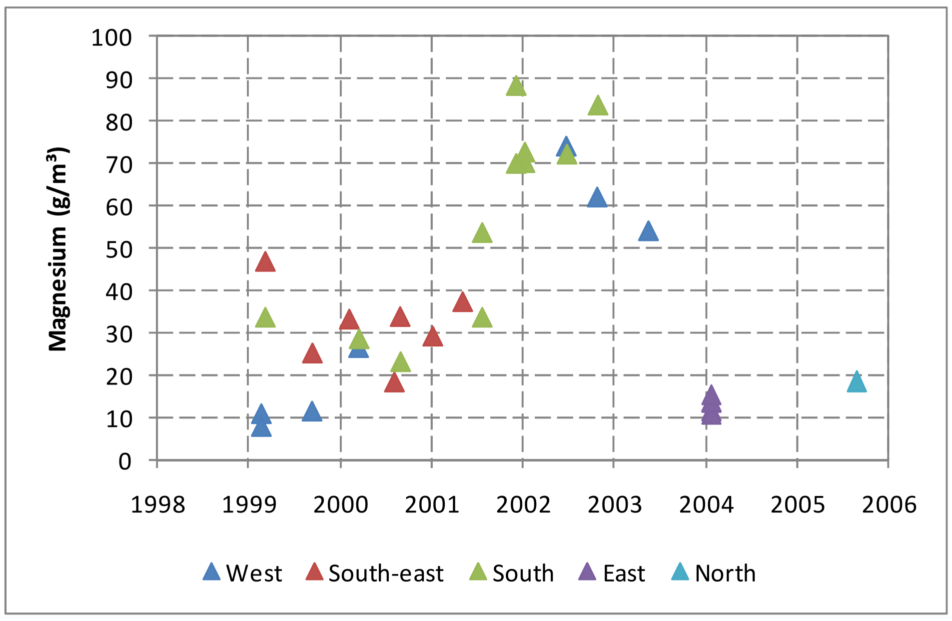
Frasers Pit runoff water quality data

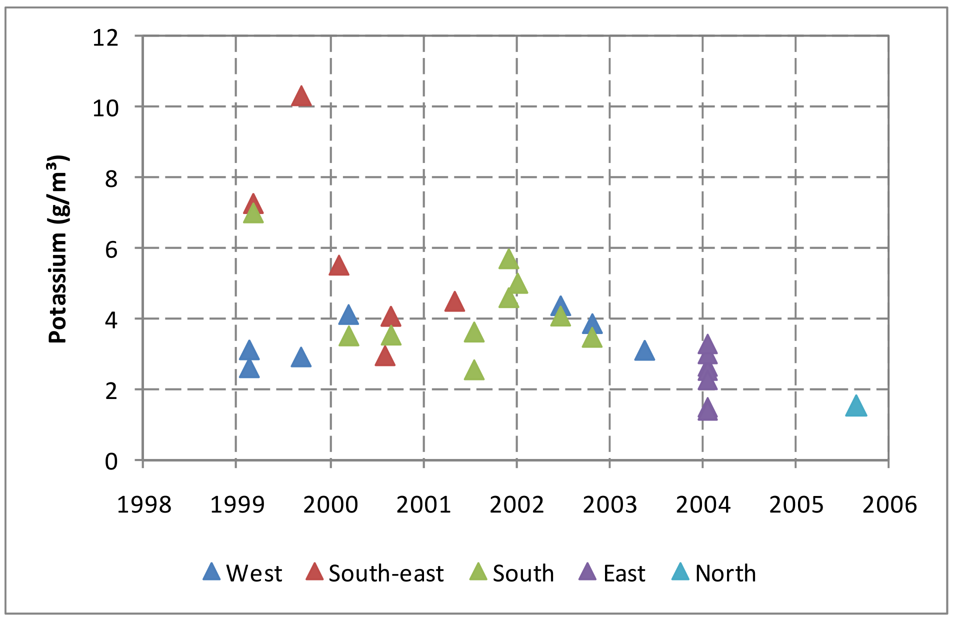

Conductivity (mS/m)
0
200
400
600
800
1000
1200
1998
1999
2000
2001
2002
2003
2004
2005
2006
West
South-east
South
East
North

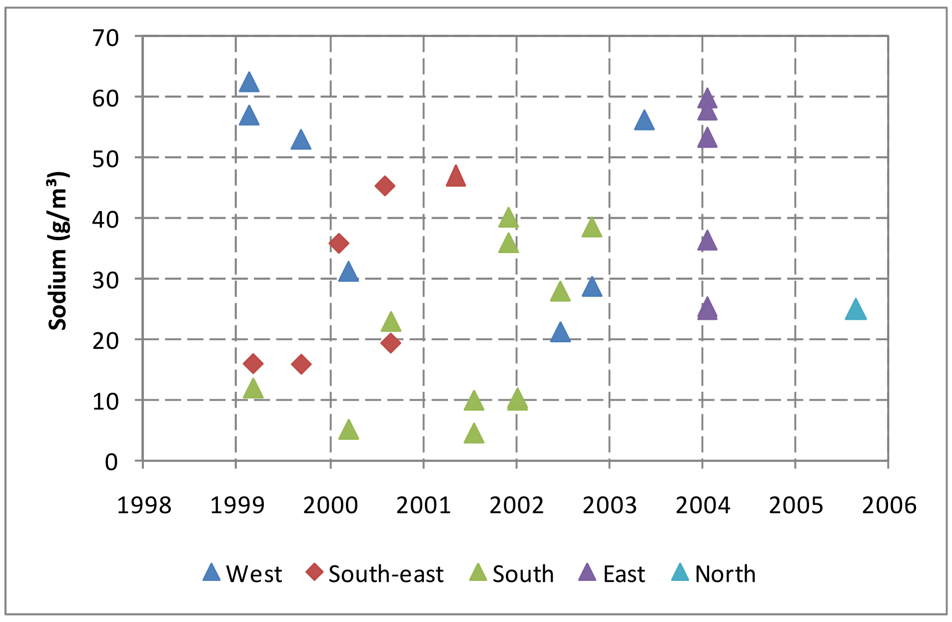

pH
7.5
7.6
7.7
7.8
7.9
8
8.1
8.2
8.3
8.4
8.5
1998
1999
2000
2001
2002
2003
2004
2005
2006
West
South-east
South
East
North

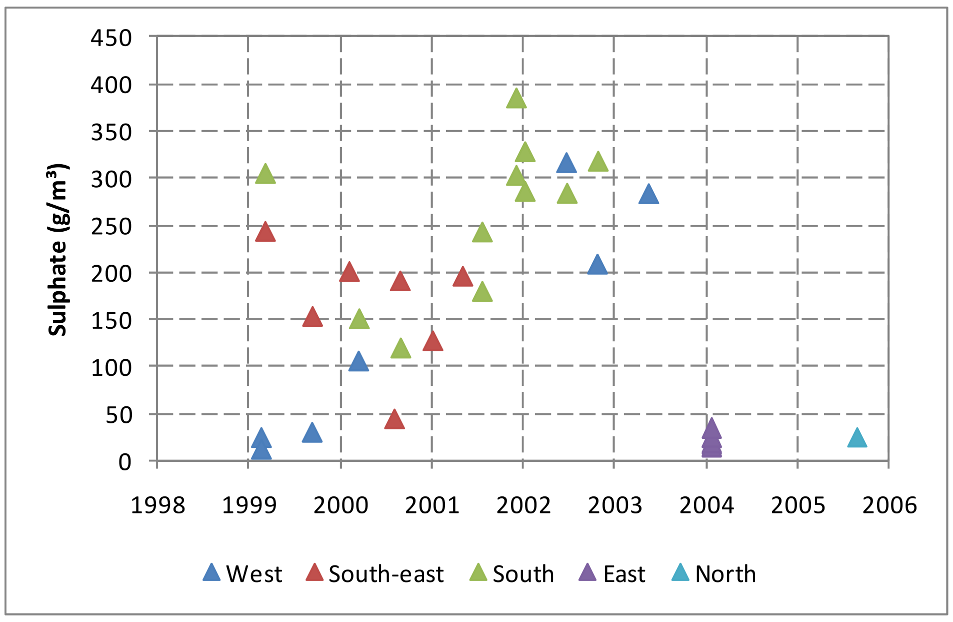

Calcium (g/m³)
0
20
40
60
80
100
120
1998
1999
2000
2001
2002
2003
2004
2005
2006
West
South-east
South
East
North


Chloride (g/m³)
0
5
10
15
20
25
30
1998
1999
2000
2001
2002
2003
2004
2005
2006
West
South-east
South
East
North


Magnesium (g/m³)
0
10
20
30
40
50
60
70
80
90
100
1998
1999
2000
2001
2002
2003
2004
2005
2006
West
South-east
South
East
North


Potassium (g/m³)
0
2
4
6
8
10
12
1998
1999
2000
2001
2002
2003
2004
2005
2006
West
South-east
South
East
North


Sodium (g/m³)
0
10
20
30
40
50
60
70
1998
1999
2000
2001
2002
2003
2004
2005
2006
West
South-east
South
East
North


Sulphate (g/m³)
0
50
100
150
200
250
300
350
400
450
1998
1999
2000
2001
2002
2003
2004
2005
2006
West
South-east
South
East
North

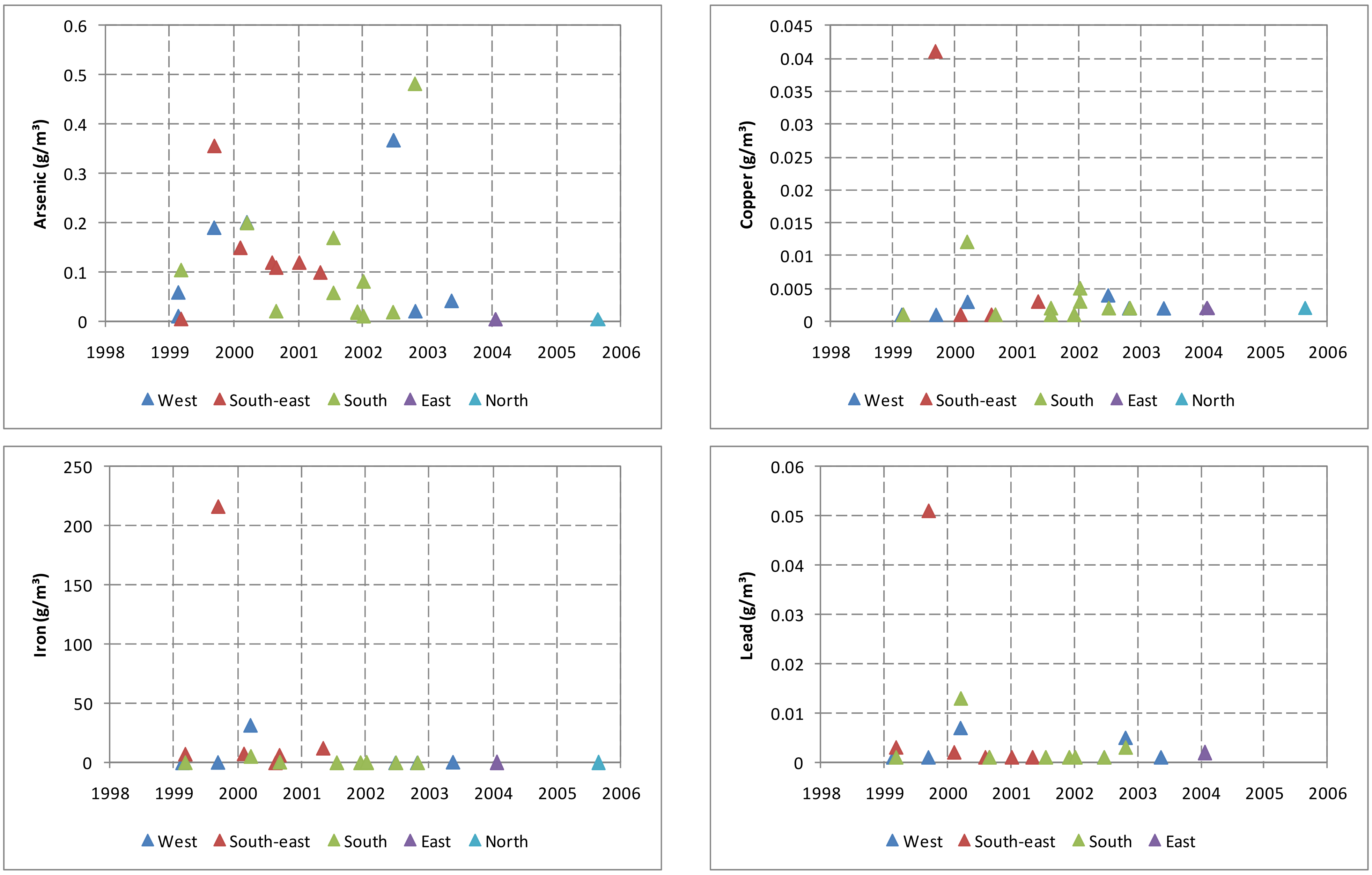


Figure F1: Frasers Pit runoff water quality.

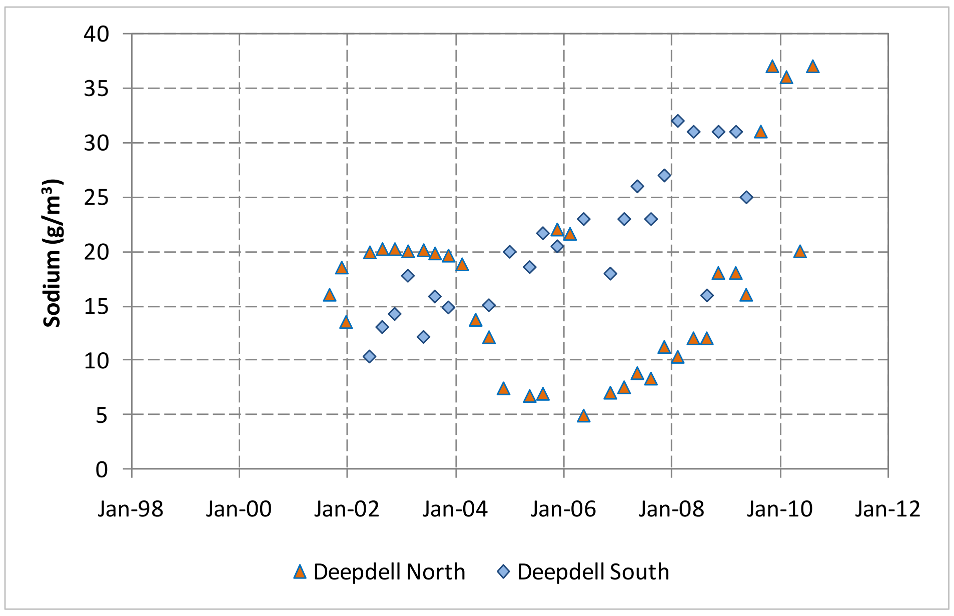
Table F1: Summary of Frasers Pit runoff water quality.

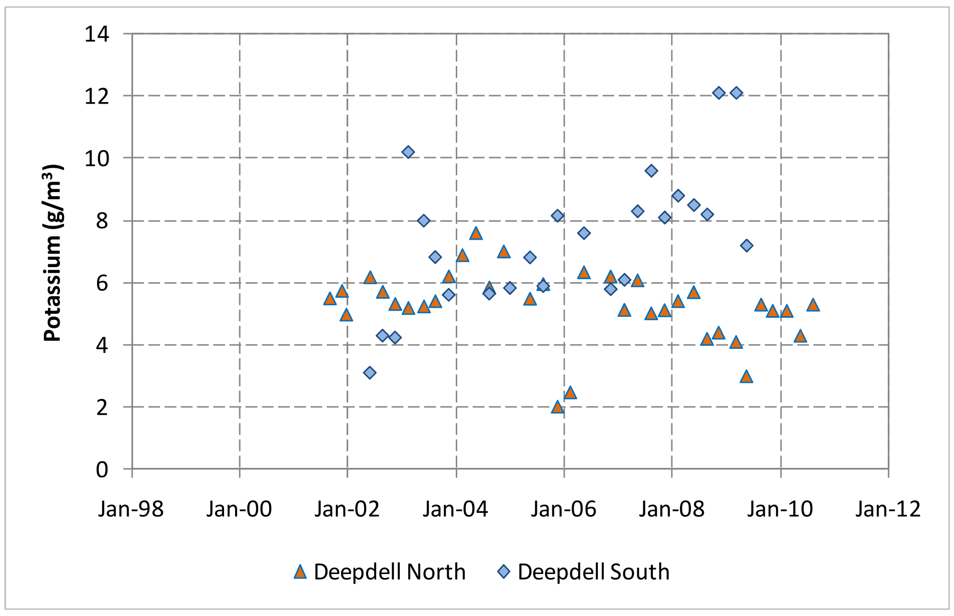
Parameter	Minimum	Mean	95th Percentile	Maximum
pH (unitless)	7.6	8.2	8.4	8.5
Conductivity (mS/m)	400	640	970	1,100
Calcium	20	55	93	110
Chloride	2.9	13	20	27
Magnesium	7.8	37	78	88
Potassium	1.4	3.9	7.1	10
Sodium	4.6	33	59	63
Sulphate	12	160	320	390
Arsenic	<0.005	<0.093	0.36	0.48
Copper	<0.001	<0.0034	0.0082	0.041
Iron	<0.040	<9.1	21	220
Lead	<0.001	<0.004	0.010	0.051

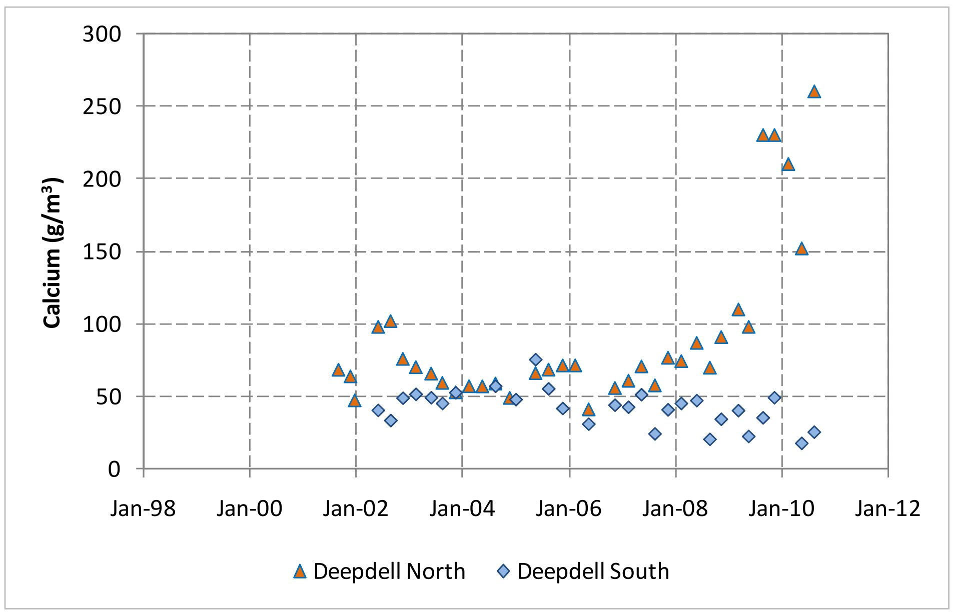
Notes: All units g/m^3 unless otherwise stated; all results presented to two significant figures or less; and data measured at FR3 North Wall, Frasers East Wall, S452RL, SE440RL and W435RL.

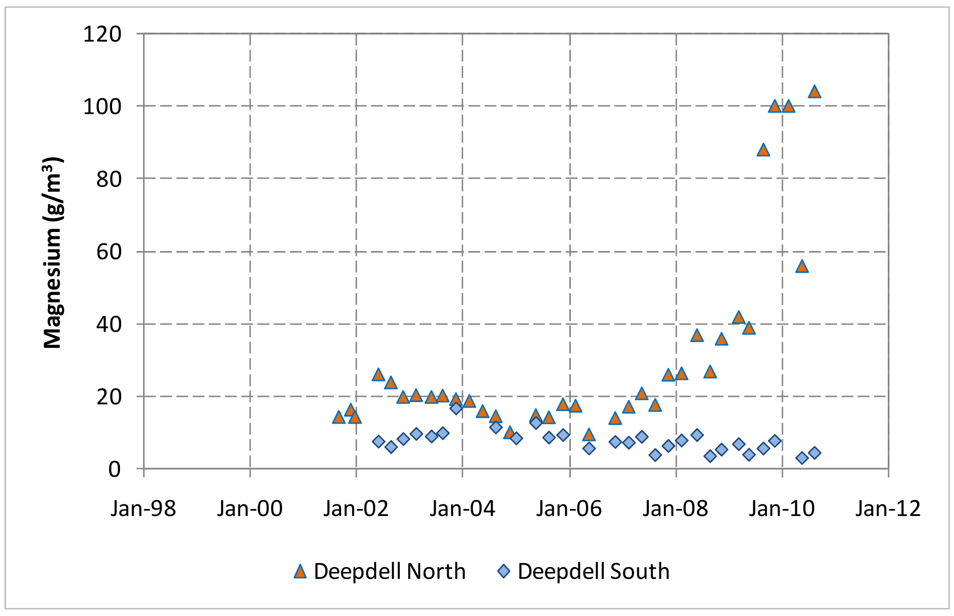
APPENDIX G

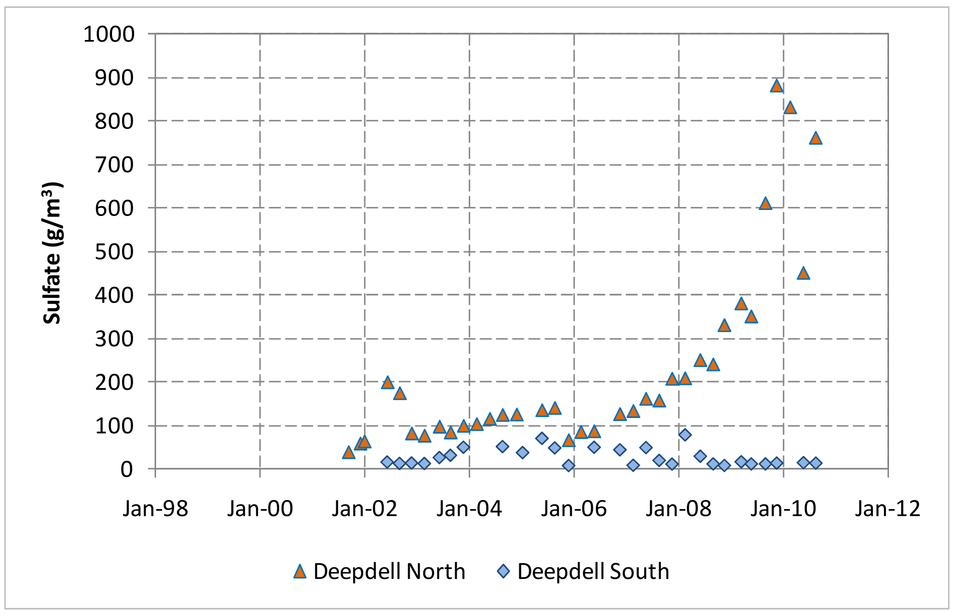
Water storage facility water quality data

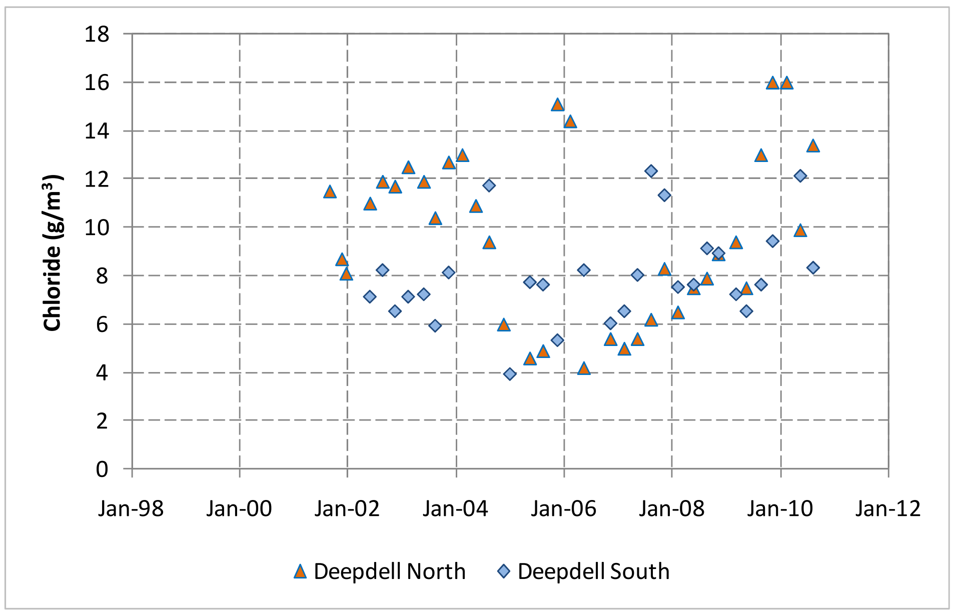

Sodium (g/m³)
0
5
10
15
20
25
30
35
40
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Deepdell North
Deepdell South

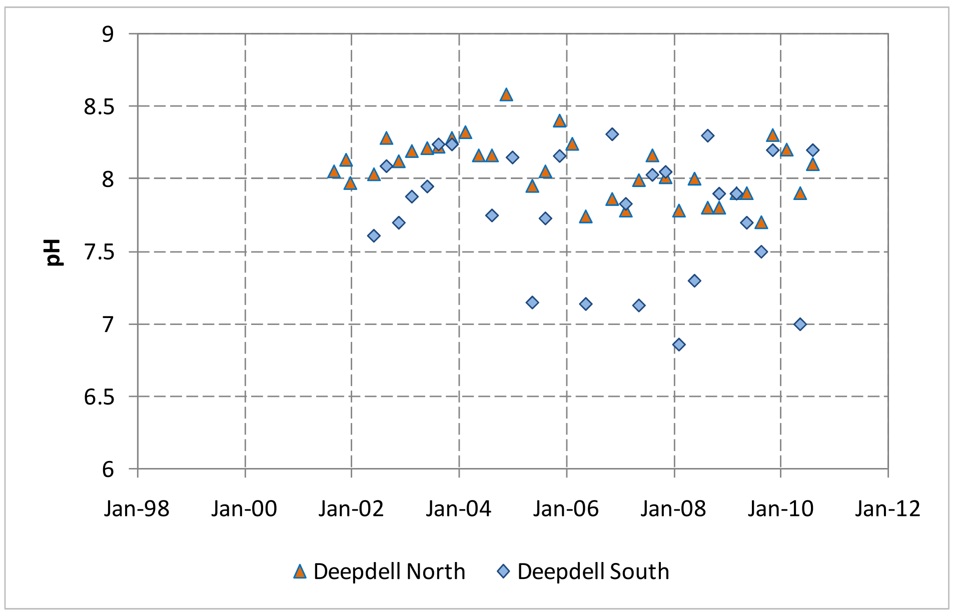

Potassium (g/m³)
0
2
4
6
8
10
12
14
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Deepdell North
Deepdell South

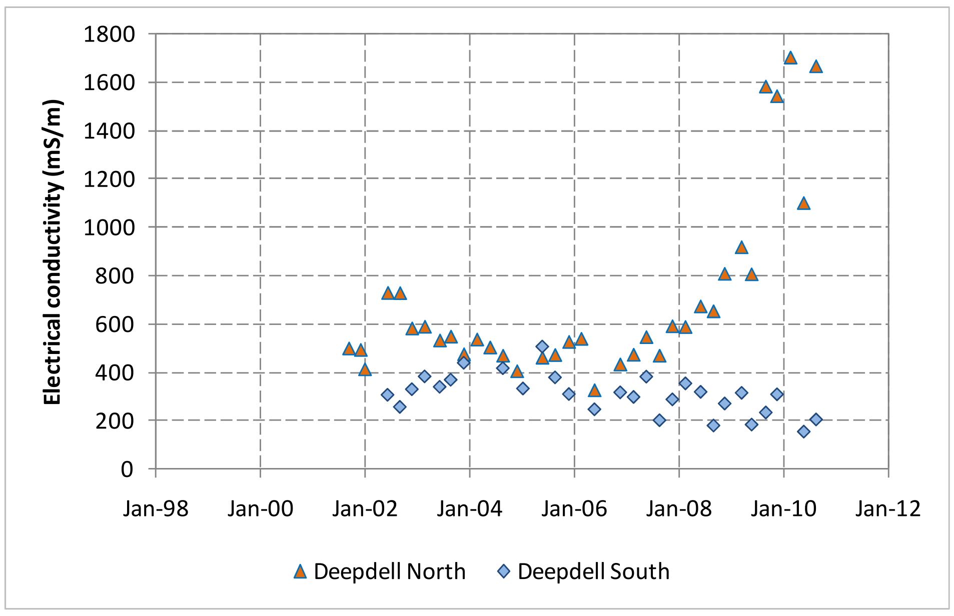

Calcium (g/m³)
0
50
100
150
200
250
300
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Deepdell North
Deepdell South


Magnesium (g/m³)
0
20
40
60
80
100
120
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Deepdell North
Deepdell South


Sulfate (g/m³)
0
100
200
300
400
500
600
700
800
900
1000
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Deepdell North
Deepdell South


Chloride (g/m³)
0
2
4
6
8
10
12
14
16
18
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Deepdell North
Deepdell South


pH
6
6.5
7
7.5
8
8.5
9
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Deepdell North
Deepdell South


Electrical conductivity (mS/m)
0
200
400
600
800
1000
1200
1400
1600
1800
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Deepdell North
Deepdell South

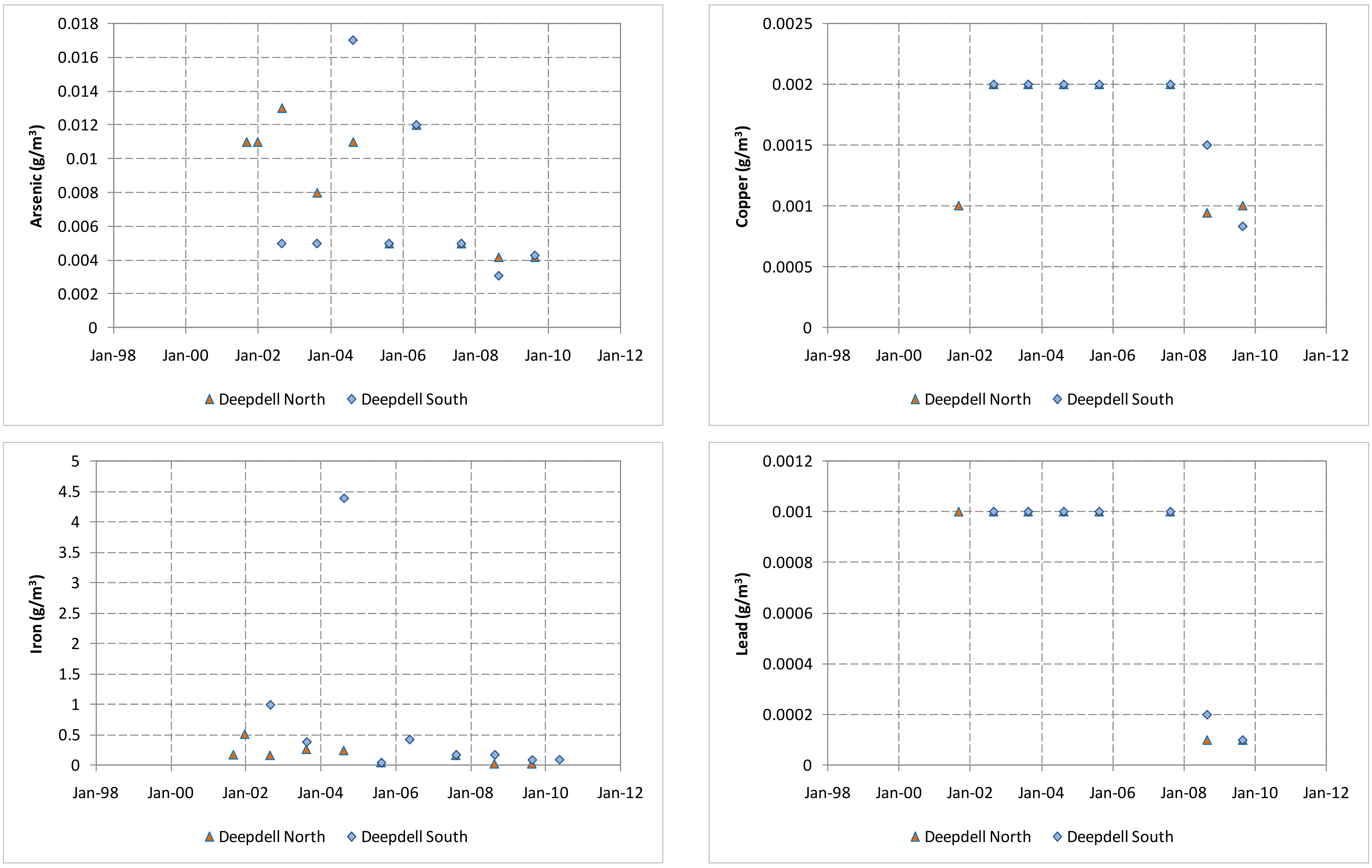
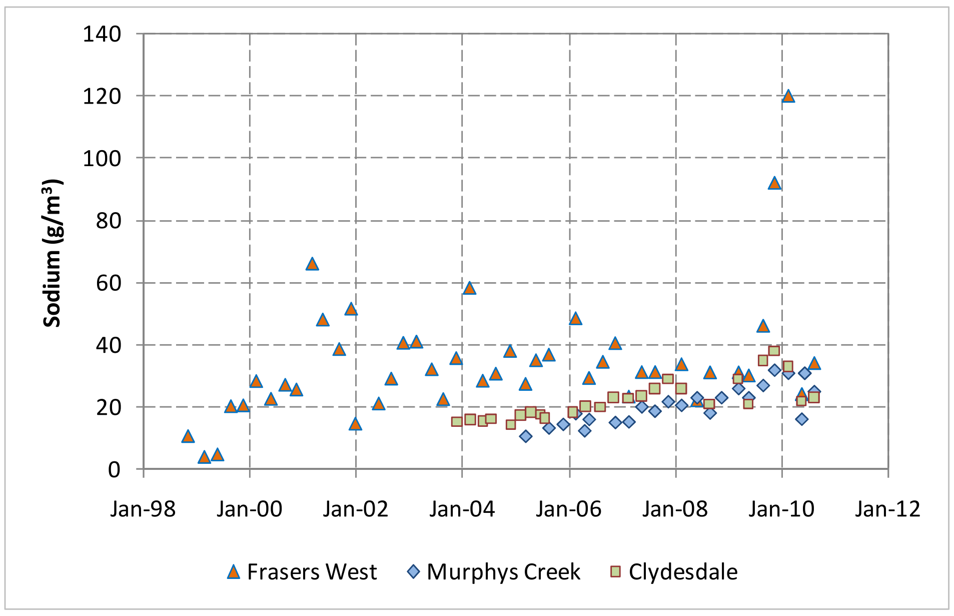
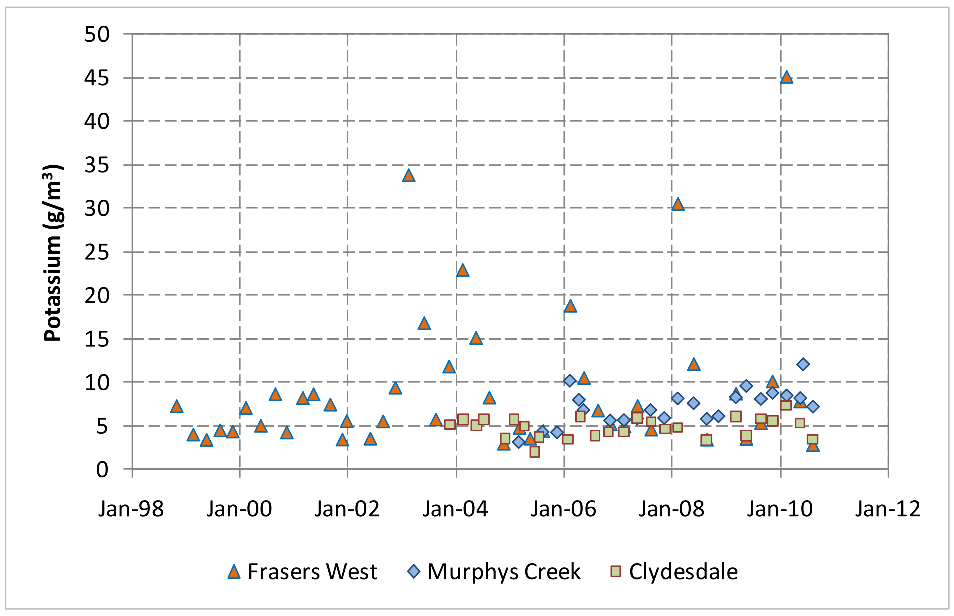
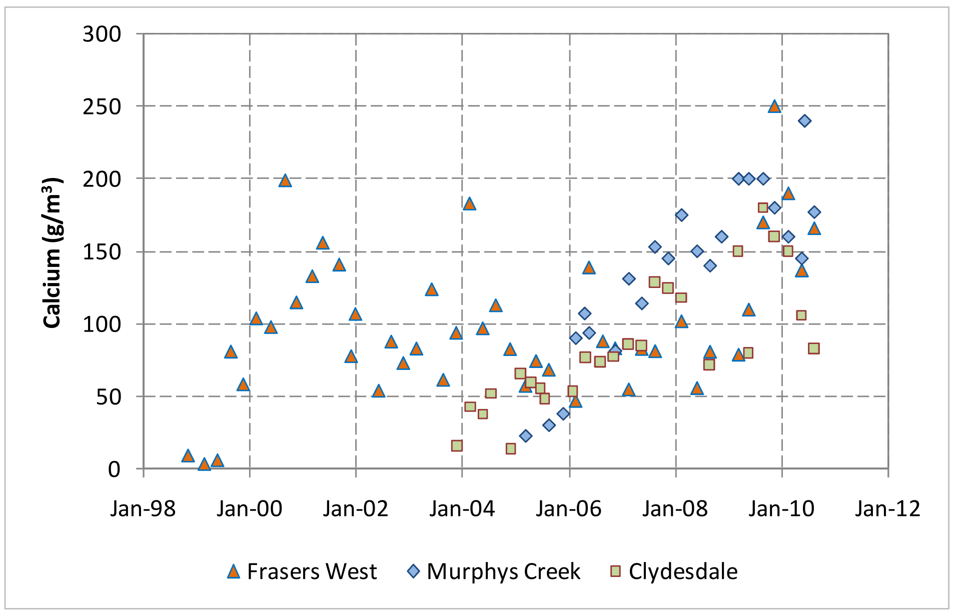
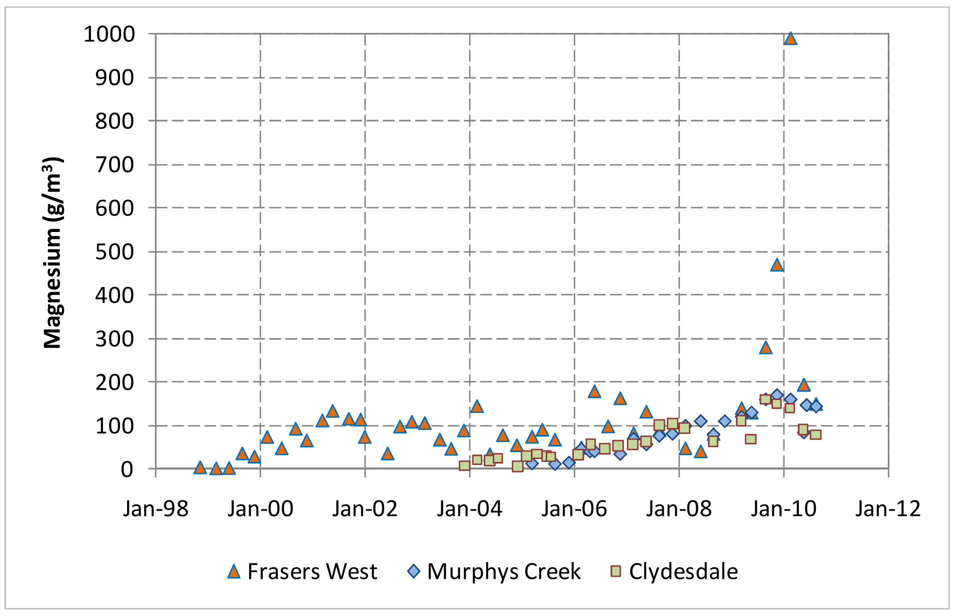


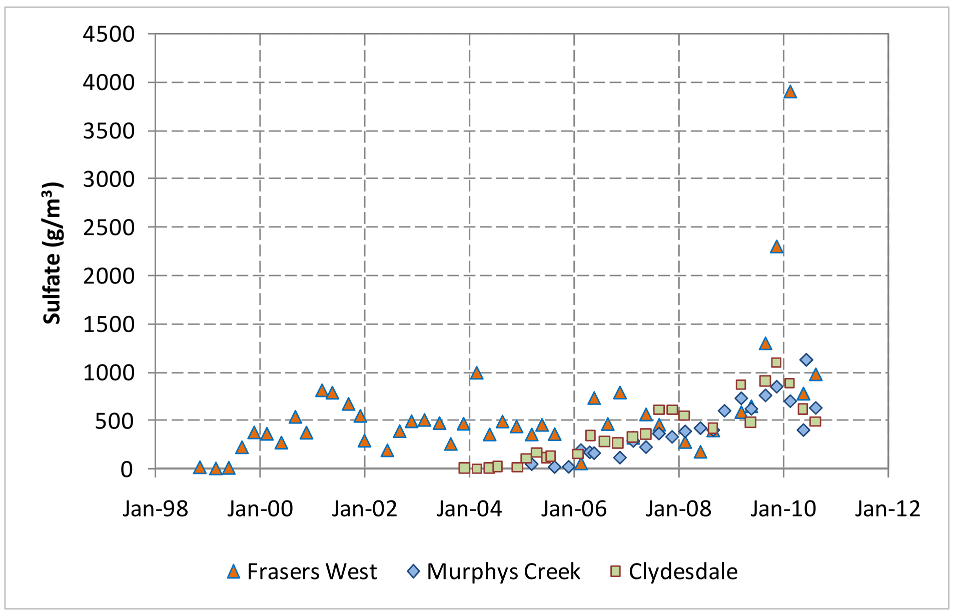
Figure G1: Deepdell North and Deepdell South water quality.

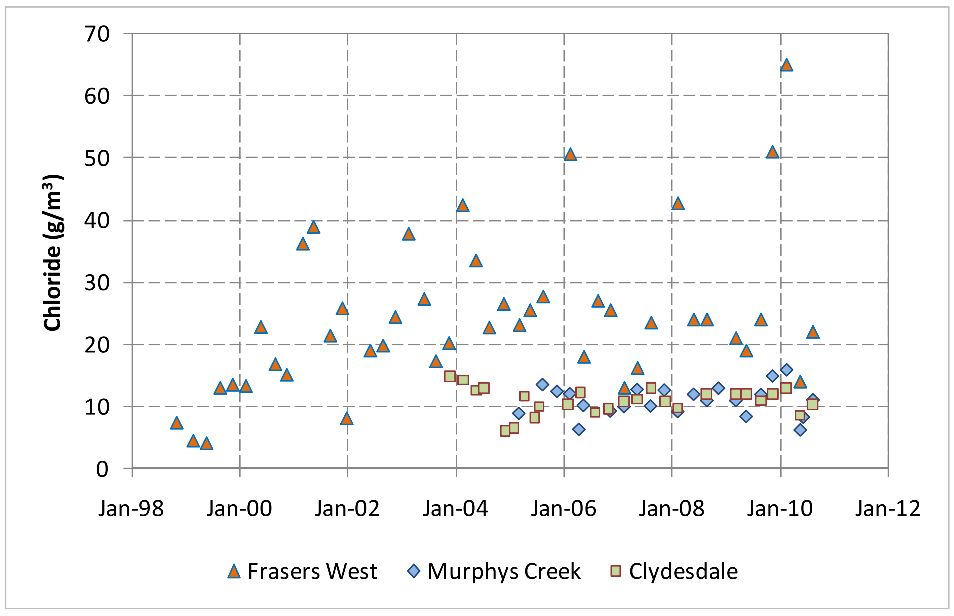

Sodium (g/m³)
0
20
40
60
80
100
120
140
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Frasers West
Murphys Creek
Clydesdale

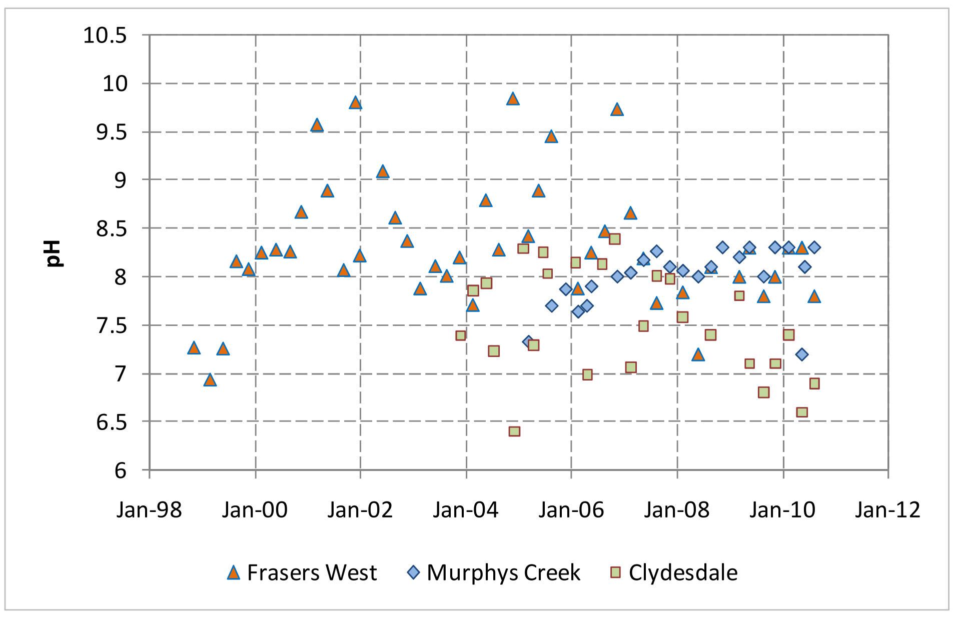

Potassium (g/m³)
0
5
10
15
20
25
30
35
40
45
50
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Frasers West
Murphys Creek
Clydesdale

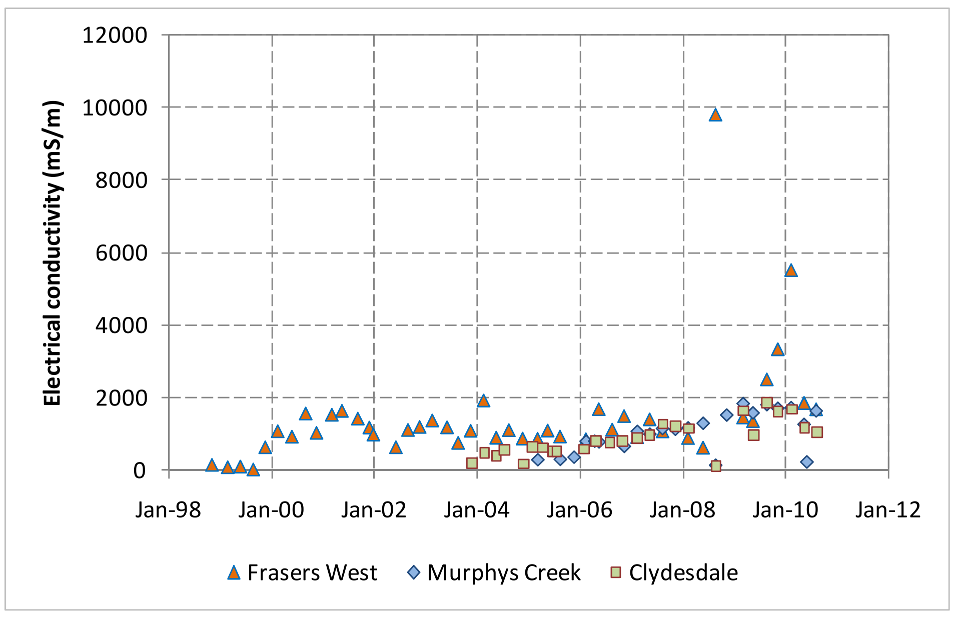

Calcium (g/m³)
0
50
100
150
200
250
300
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Frasers West
Murphys Creek
Clydesdale


Magnesium (g/m³)
0
100
200
300
400
500
600
700
800
900
1000
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Frasers West
Murphys Creek
Clydesdale


Sulfate (g/m³)
0
500
1000
1500
2000
2500
3000
3500
4000
4500
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Frasers West
Murphys Creek
Clydesdale


Chloride (g/m³)
0
10
20
30
40
50
60
70
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Frasers West
Murphys Creek
Clydesdale


pH
6
6.5
7
7.5
8
8.5
9
9.5
10
10.5
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Frasers West
Murphys Creek
Clydesdale


Electrical conductivity (mS/m)
0
2000
4000
6000
8000
10000
12000
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Frasers West
Murphys Creek
Clydesdale

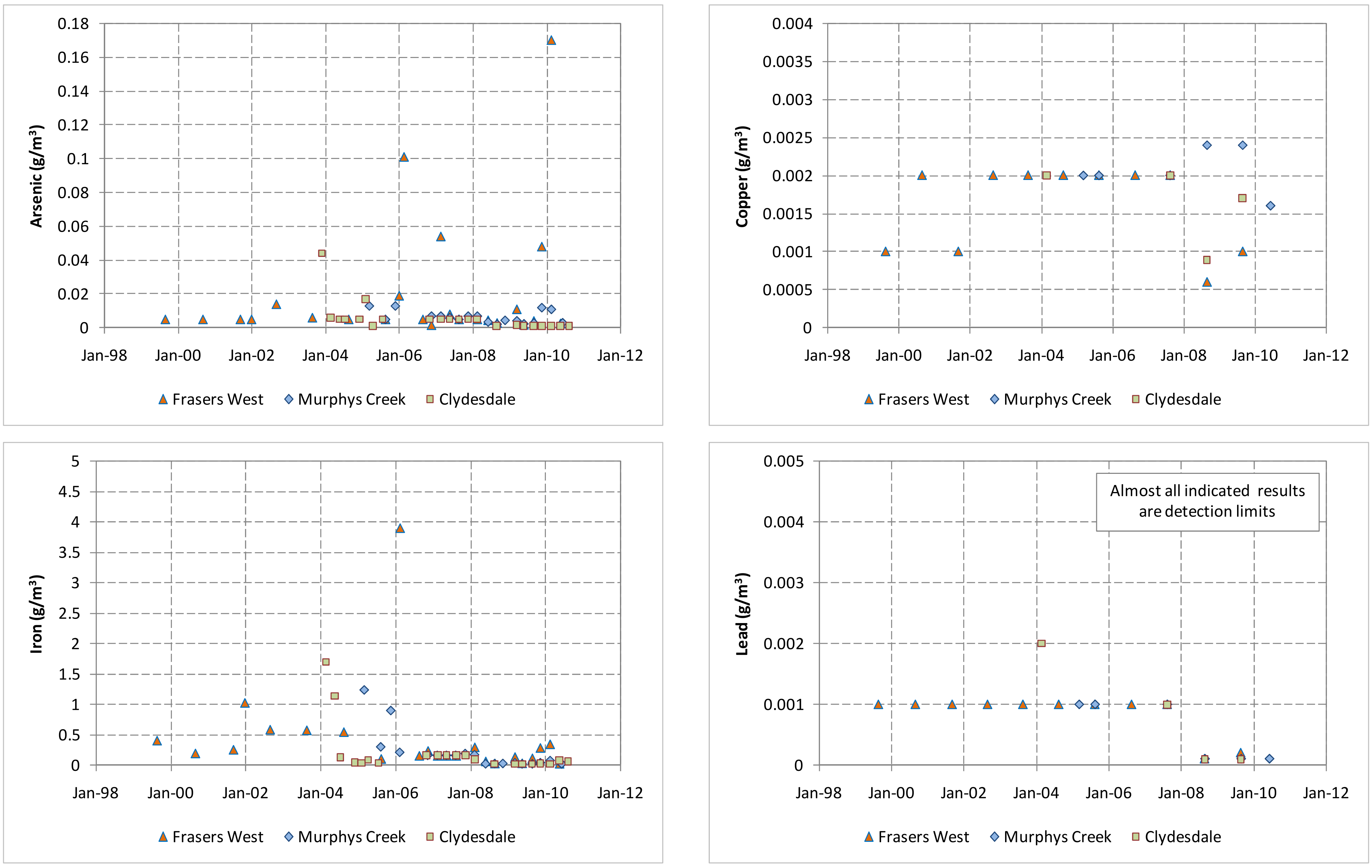
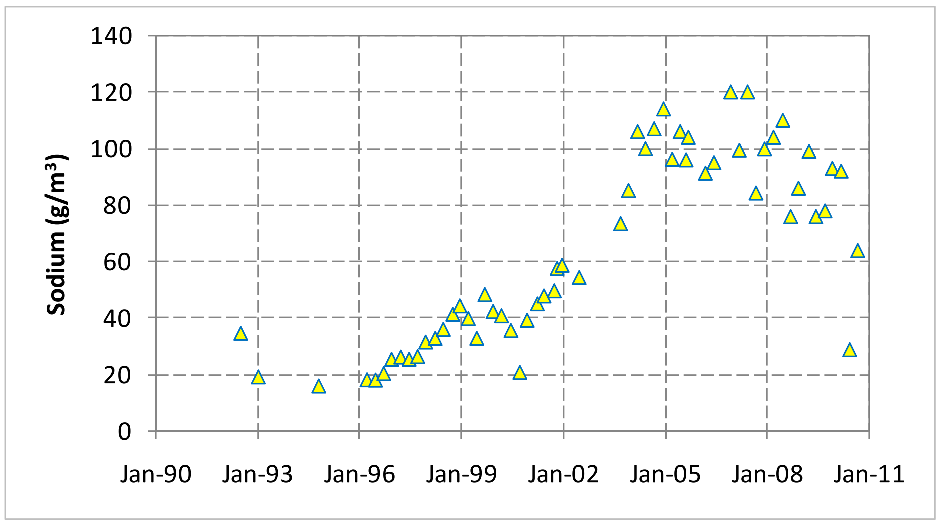
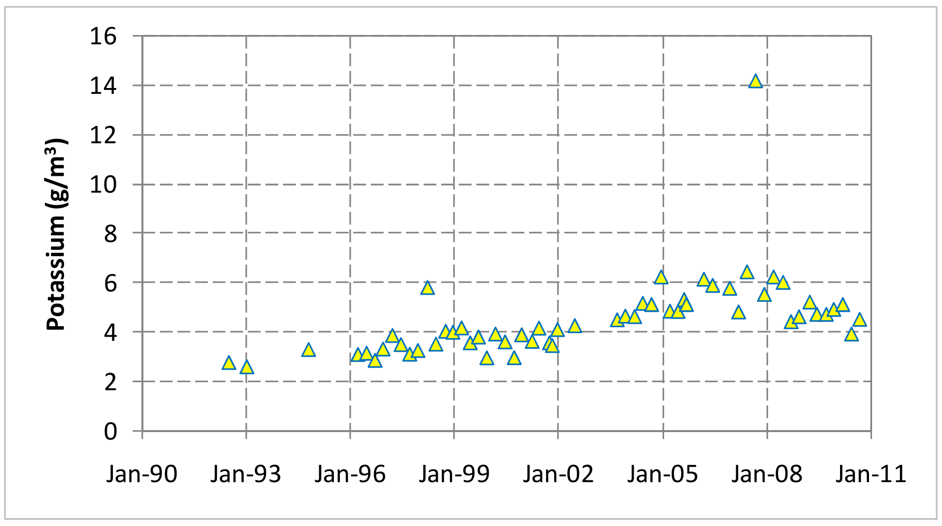
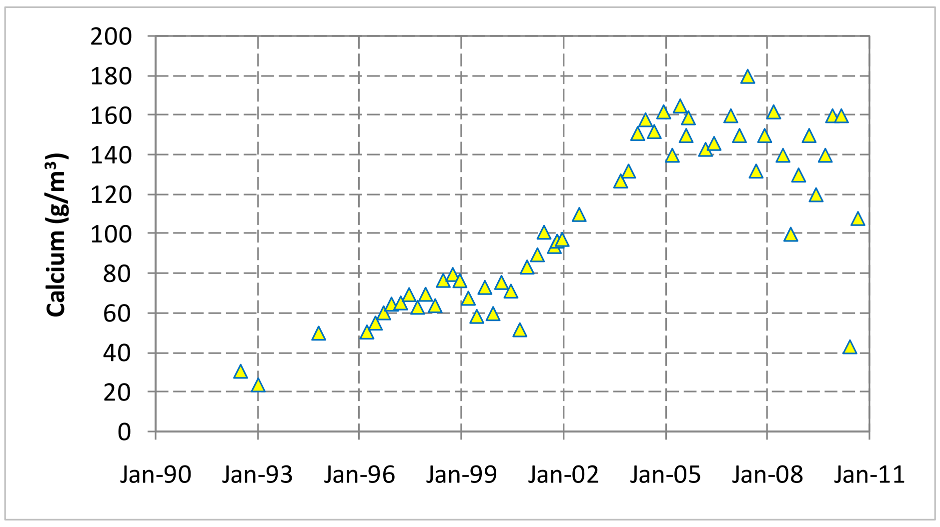
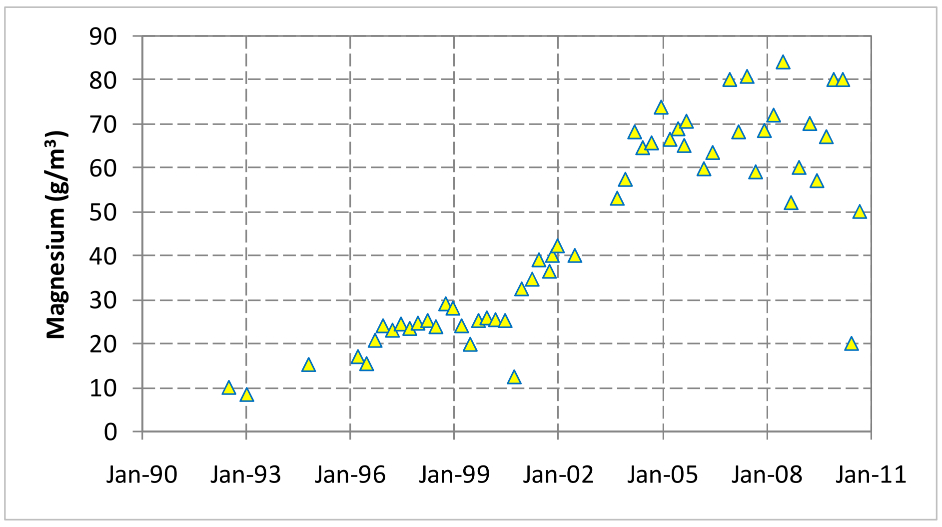


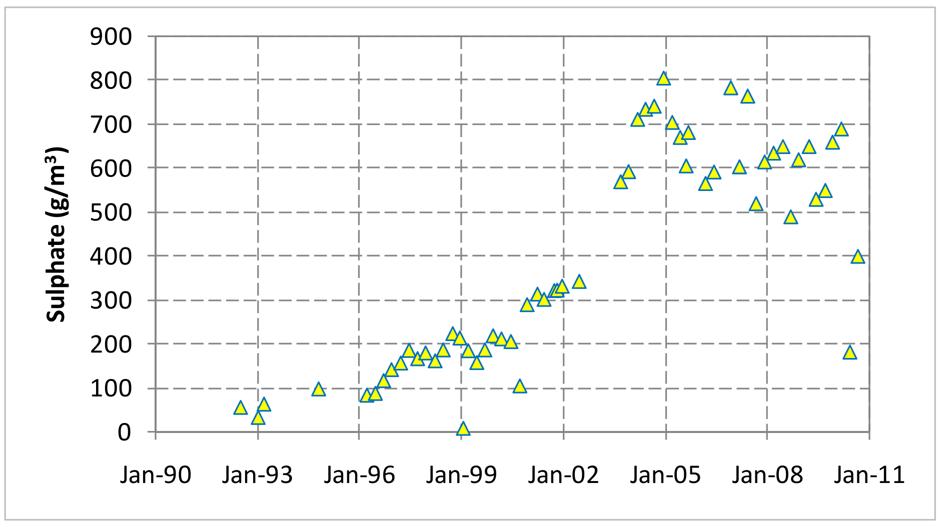
Figure G2: Frasers West, Murphy's Creek and Clydesdale silt pond water quality.

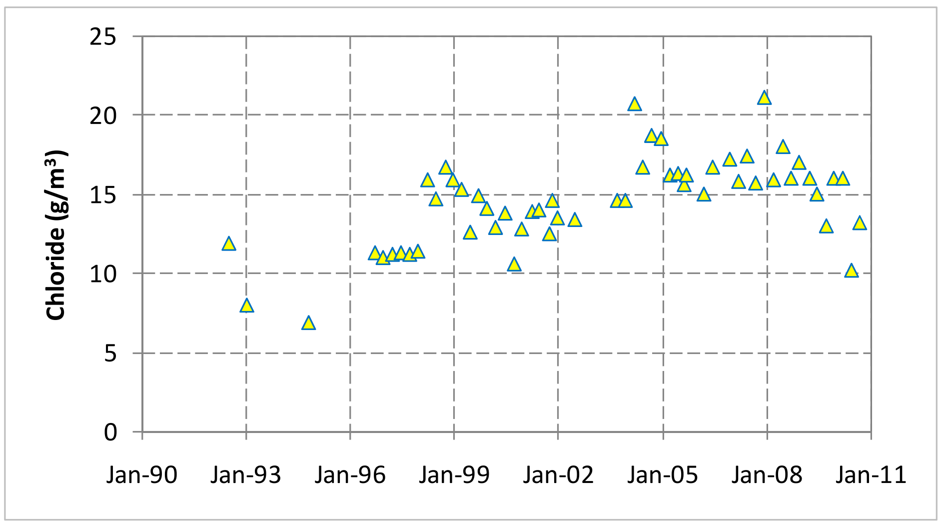

Sodium (g/m³)
0 20 40 60 80 100 120 140
Jan-90 Jan-93 Jan-96 Jan-99 Jan-02 Jan-05 Jan-08 Jan-11

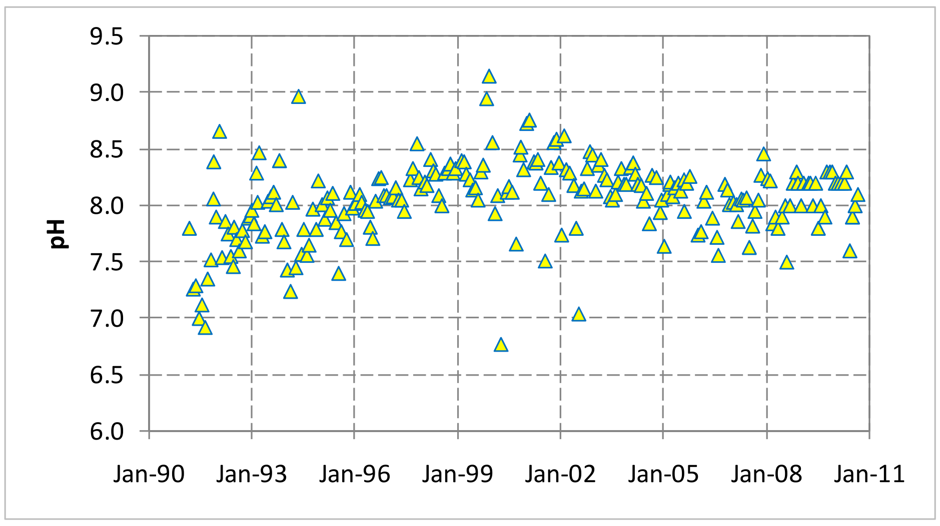

Potassium (g/m³)
0 2 4 6 8 10 12 14 16
Jan-90 Jan-93 Jan-96 Jan-99 Jan-02 Jan-05 Jan-08 Jan-11

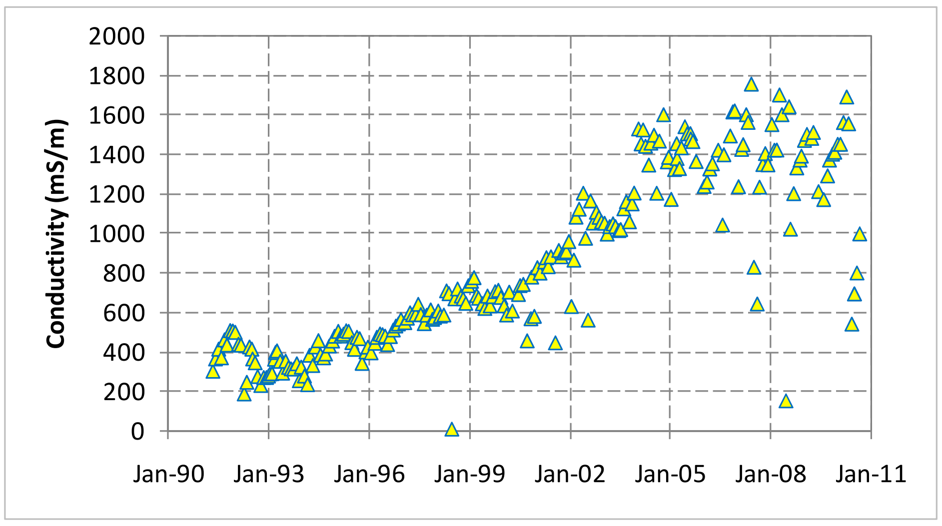

Calcium (g/m³)
0 20 40 60 80 100 120 140 160 180 200
Jan-90 Jan-93 Jan-96 Jan-99 Jan-02 Jan-05 Jan-08 Jan-11


Magnesium (g/m³)
0 10 20 30 40 50 60 70 80 90
Jan-90 Jan-93 Jan-96 Jan-99 Jan-02 Jan-05 Jan-08 Jan-11


Sulphate (g/m³)
0 100 200 300 400 500 600 700 800 900
Jan-90 Jan-93 Jan-96 Jan-99 Jan-02 Jan-05 Jan-08 Jan-11


Chloride (g/m³)
0 5 10 15 20 25
Jan-90 Jan-93 Jan-96 Jan-99 Jan-02 Jan-05 Jan-08 Jan-11


pH
6.0 6.5 7.0 7.5 8.0 8.5 9.0 9.5
Jan-90 Jan-93 Jan-96 Jan-99 Jan-02 Jan-05 Jan-08 Jan-11


Conductivity (mS/m)
0 200 400 600 800 1000 1200 1400 1600 1800 2000
Jan-90 Jan-93 Jan-96 Jan-99 Jan-02 Jan-05 Jan-08 Jan-11

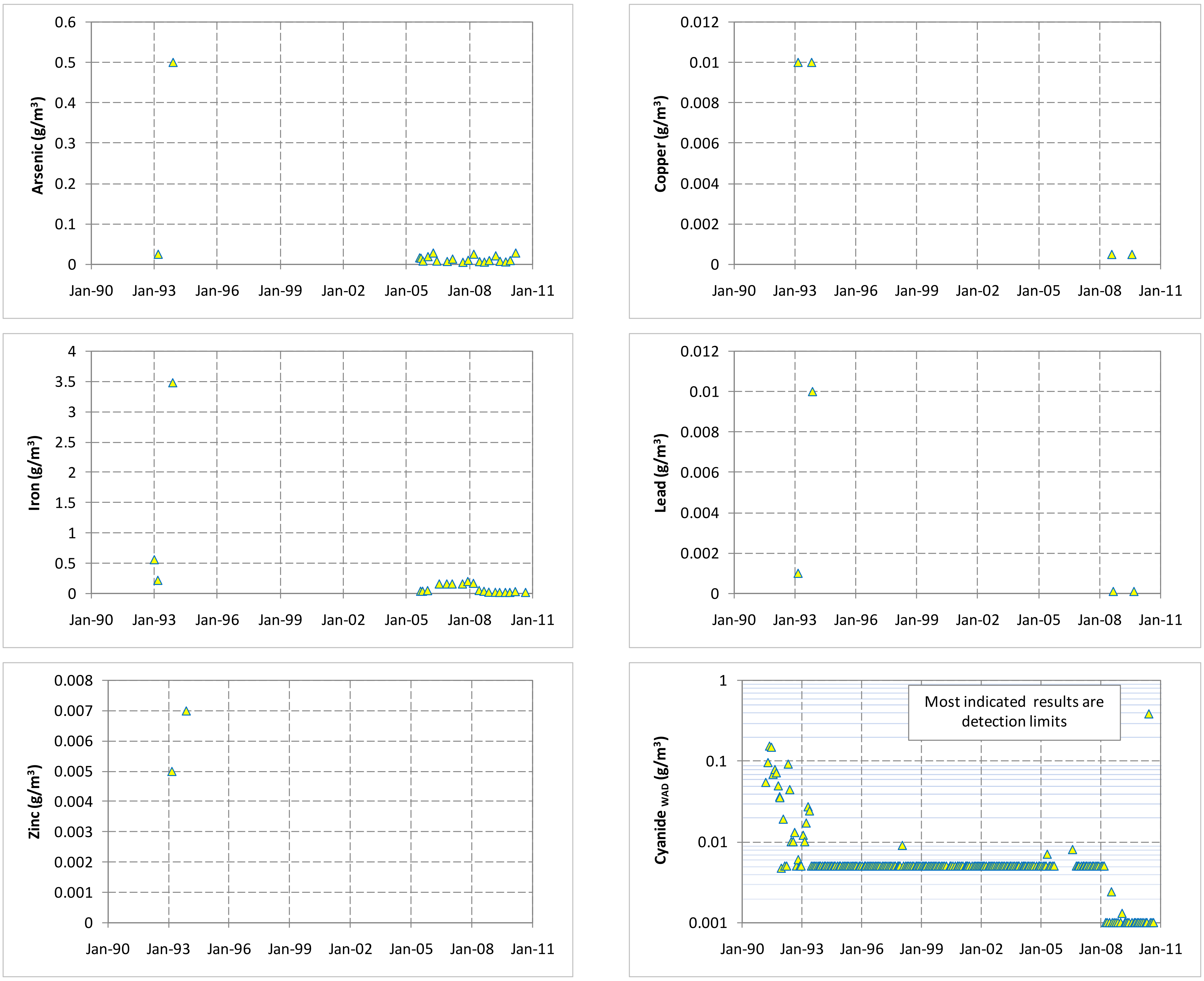
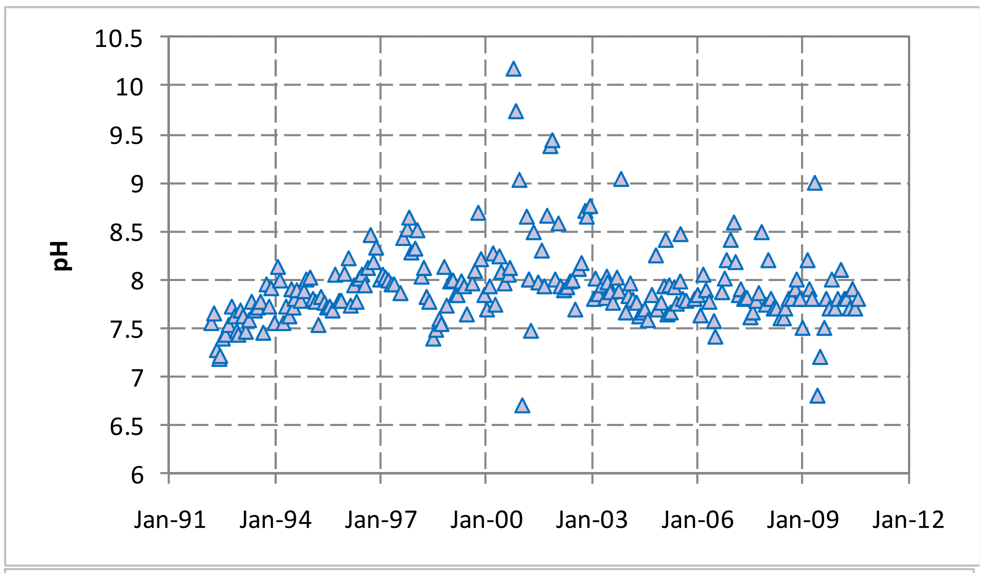
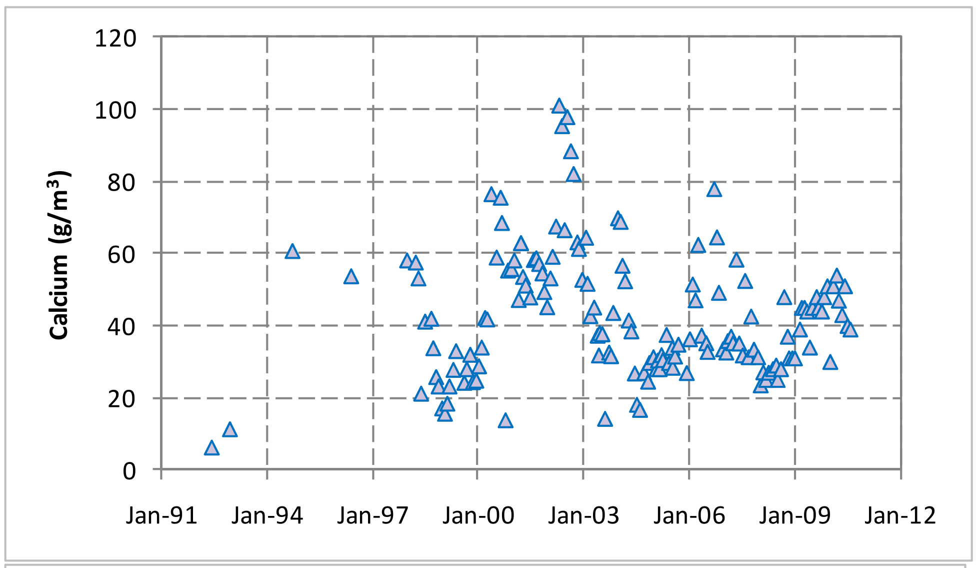
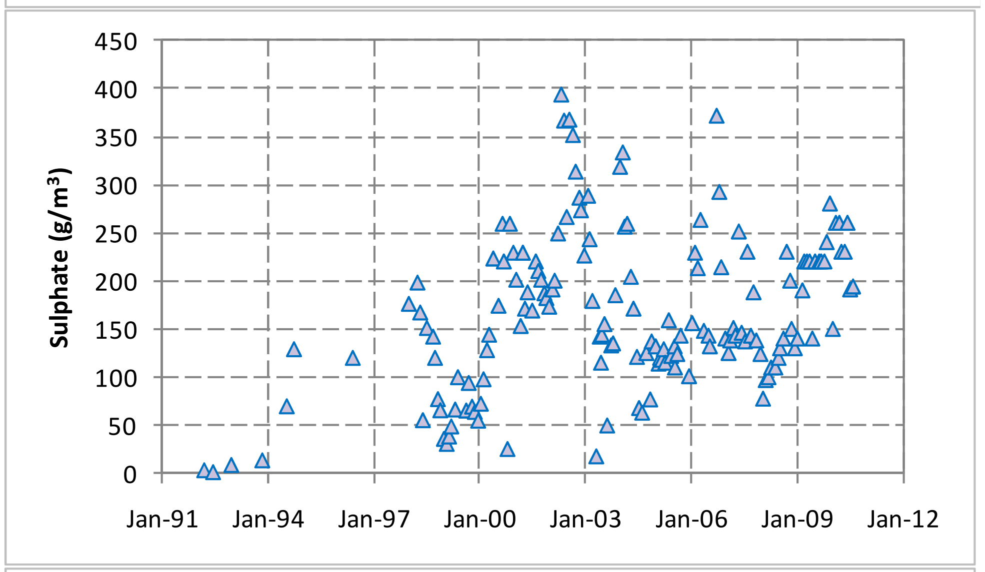
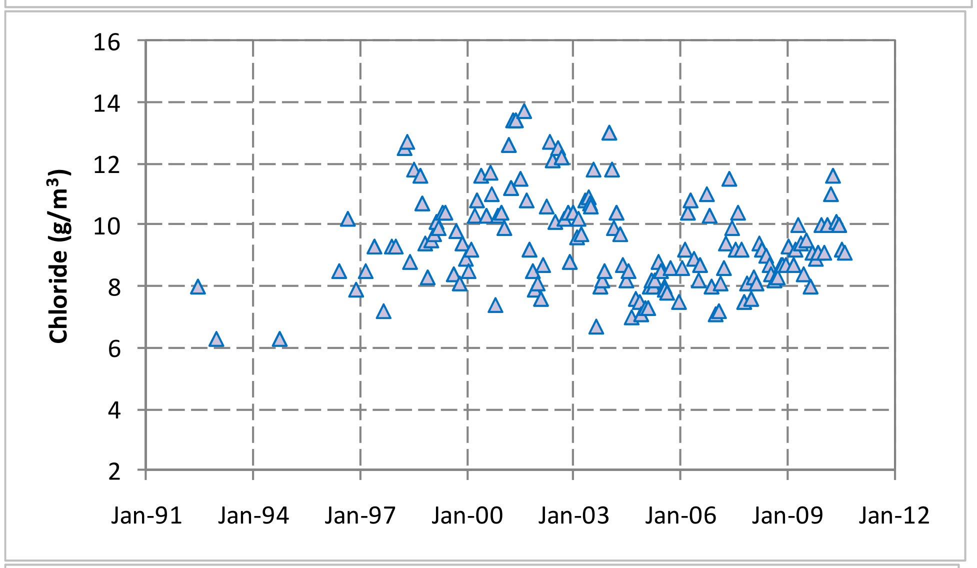


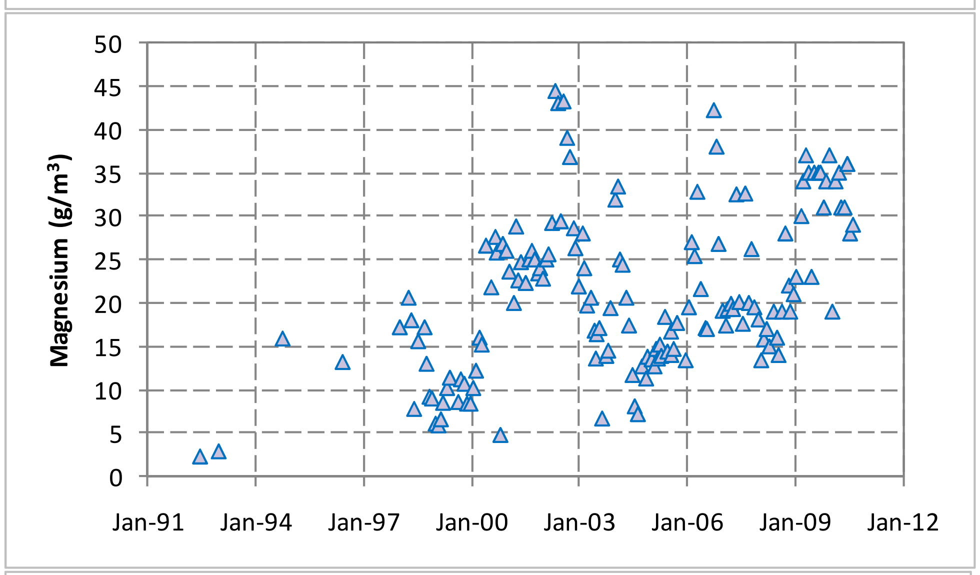
Figure G3: Maori Tommy Gully silt pond water quality.

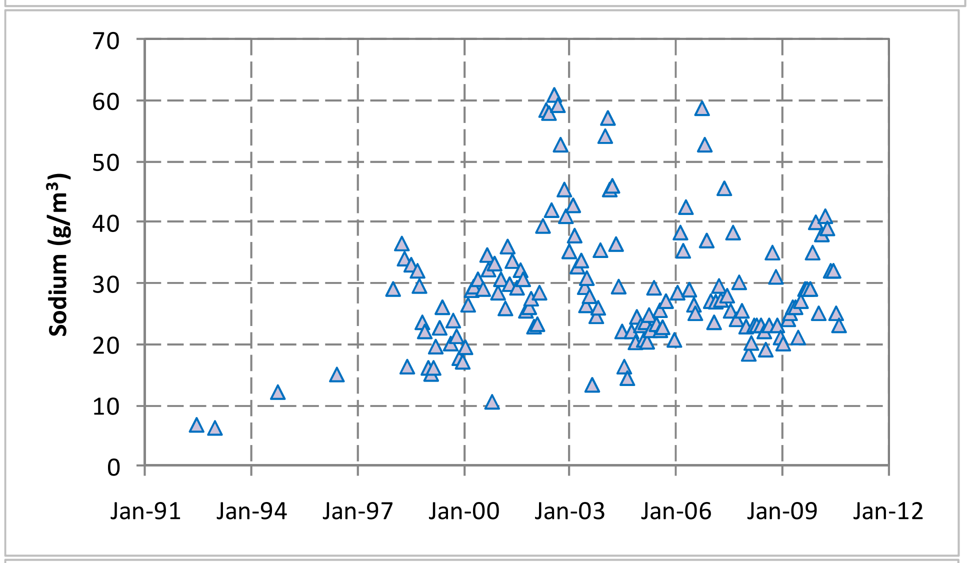

pH
10.5
10
9.5
9
8.5
8
7.5
7
6.5
6
Jan-91 Jan-94 Jan-97 Jan-00 Jan-03 Jan-06 Jan-09 Jan-12


Calcium (g/m³)
120
100
80
60
40
20
0
Jan-91 Jan-94 Jan-97 Jan-00 Jan-03 Jan-06 Jan-09 Jan-12


Sulphate (g/m³)
450
400
350
300
250
200
150
100
50
0
Jan-91 Jan-94 Jan-97 Jan-00 Jan-03 Jan-06 Jan-09 Jan-12


Chloride (g/m³)
16
14
12
10
8
6
4
2
Jan-91 Jan-94 Jan-97 Jan-00 Jan-03 Jan-06 Jan-09 Jan-12


Magnesium (g/m³)
50
45
40
35
30
25
20
15
10
5
0
Jan-91 Jan-94 Jan-97 Jan-00 Jan-03 Jan-06 Jan-09 Jan-12


Sodium (g/m³)
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60
50
40
30
20
10
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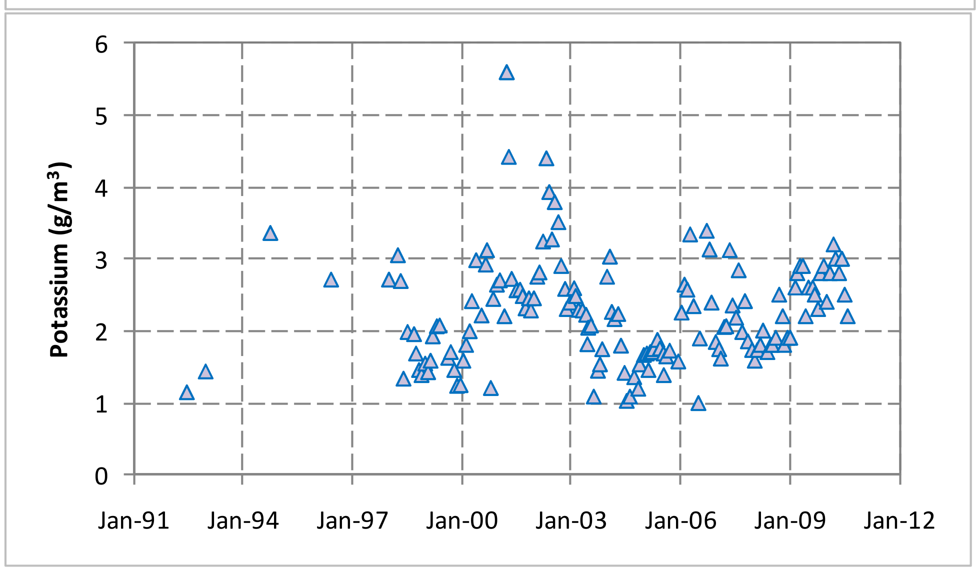
Jan-91 Jan-94 Jan-97 Jan-00 Jan-03 Jan-06 Jan-09 Jan-12


Potassium (g/m³)
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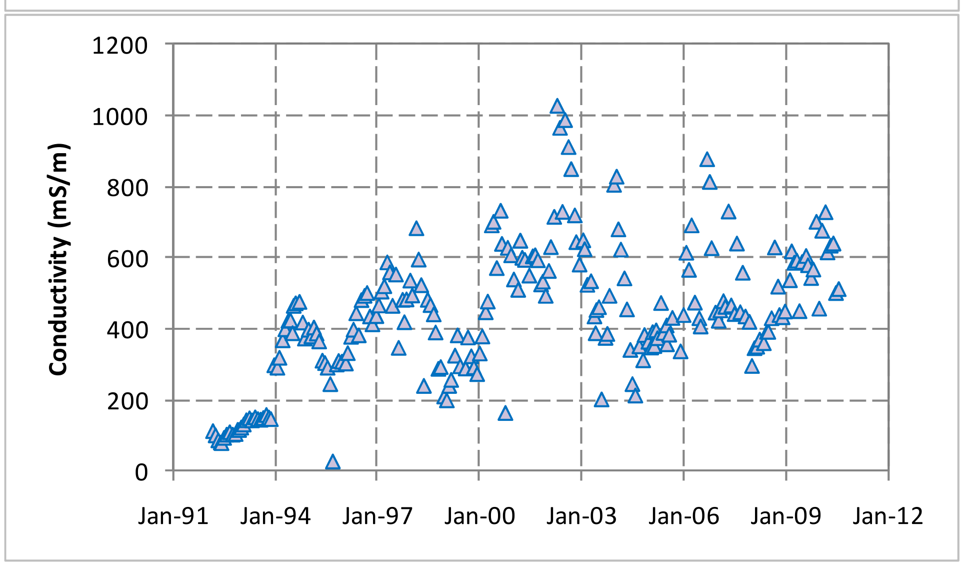
5
4
3
2
1
0
Jan-91 Jan-94 Jan-97 Jan-00 Jan-03 Jan-06 Jan-09 Jan-12


Conductivity (mS/m)
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1000
800
600
400
200
0
Jan-91 Jan-94 Jan-97 Jan-00 Jan-03 Jan-06 Jan-09 Jan-12

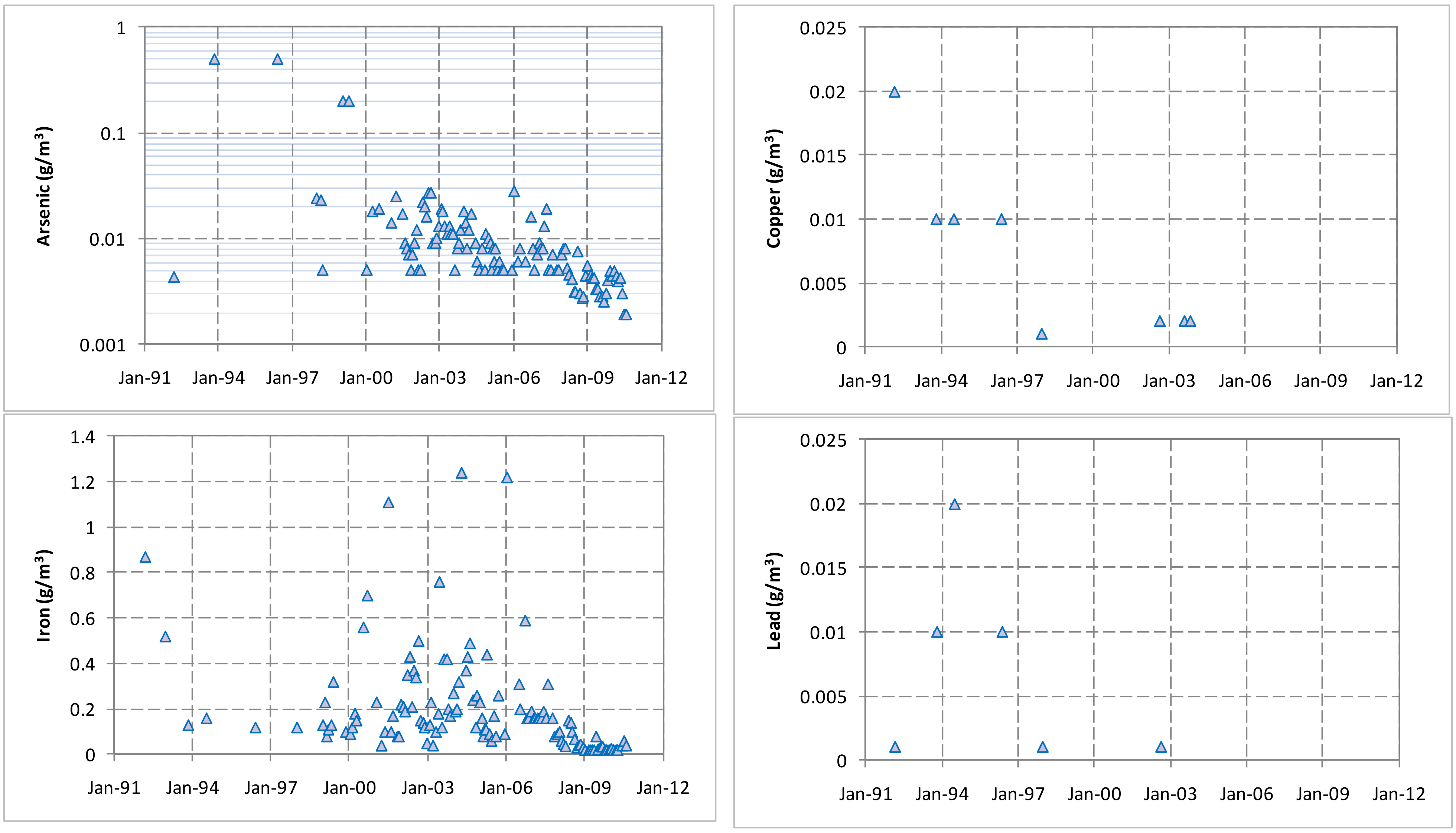


Figure G4: Lone Pine Water Storage Reservoir water quality

Table G1: Summary of Clydesdale silt pond water quality.

Parameter	Minimum	Mean	95th Percentile	Maximum
pH (unitless)	6.4	7.5	8.3	8.4
Conductivity (mS/m)	98	870	1,700	1,900
Calcium	14	85	160	180
Chloride	6.1	11	14	15
Magnesium	6.4	64	150	160
Potassium	2.0	4.8	6.0	7.3
Sodium	14	22	35	38
Sulphate	2.4	380	910	1,100
Arsenic	<0.0010	<0.0039	0.0060	0.017
Copper[A]	0.0009	NA	NA	0.0017
Iron	<0.020	<0.21	1.1	1.7
Lead[B]	<0.0001	NA	NA	<0.002

Notes: All units g/m^3 unless otherwise stated; all data presented to two significant figures or less; NA = not applicable; [A] copper was analysed on four occasions, two of which were below a detection limit that has since been superseded by a lower limit; [B] lead was analysed on four occasions - one was below a detection limit of 0.002 g/m^3, another below a detection limit of 0.001 g/m^3, while the remaining two were below a detection limit of 0.0001 g/m^3.

Table G2: Summary of Deepdell South silt pond water quality.

Parameter	Minimum	Mean	95th Percentile	Maximum
pH (unitless)	6.9	7.8	8.3	8.3
Conductivity (mS/m)	160	310	430	510
Calcium	17	42	56	76
Chloride	3.9	8.0	12	12
Magnesium	3.2	7.8	12	17
Potassium	0.94	2.6	6.5	8.5
Sodium	7.7	12	16	20
Sulphate	7.1	27	64	79
Arsenic	<0.0050	<0.0071	0.015	0.017
Copper[A]	0.00083	NA	NA	0.0015
Iron	<0.040	<0.29	0.79	0.99
Lead[B]	<0.0001	NA	NA	<0.001

Notes: All units g/m^3 unless otherwise stated; all data presented to two significant figures or less; NA = not applicable; [A] copper was analysed on four occasions, two of which were below a detection limit that has since been superseded; [B] lead was analysed on seven occasions - one was below a detection limit of 0.0002 g/m^3, another below a detection limit of 0.0001 g/m^3, while the remaining five were below a detection limit of 0.001 g/m^3.

Table G3: Summary of Deepdell North silt pond water quality.

Parameter	Minimum	Mean	95th Percentile	Maximum
pH (unitless)	7.7	8.1	8.3	8.6
Conductivity (mS/m)	320	690	1,600	1,700
Calcium	41	91	230	260
Chloride	4.2	10	15	16
Magnesium	10	31	100	100
Potassium	2.0	5.3	6.9	7.6
Sodium	4.9	17	36	37
Sulphate	39	230	780	880
Arsenic	<0.0050	<0.0084	0.013	0.013
Copper[A]	0.00094	NA	NA	NA
Iron	<0.020	<0.18	0.41	0.51
Lead[B]	<0.0001	NA	NA	<0.001

Notes: All units g/m^3 unless stated; all data presented to two significant figures or less; NA = not applicable; [A] copper was analysed on eight occasions, all but of which one were below a detection limit that has since been superseded; [B] lead was analysed on seven occasions – two were below a detection limit of 0.0001 g/m^3, while the remaining five were below a detection limit of 0.001 g/m^3.

Table G4: Summary of Frasers West silt pond water quality.

Parameter	Minimum	Mean	95th Percentile	Maximum
pH(unitless)	6.9	8.3	9.7	9.8
Conductivity (mS/m)	7.8	1,400	3,100	9,800
Calcium	3.8	100	190	250
Chloride	4.1	24	49	65
Magnesium	1.9	120	260	990
Potassium	2.7	9.1	29	45
Sodium	3.8	34	64	120
Sulphate	8.0	590	1,200	3,900
Arsenic	<0.0050	<0.020	0.092	0.17
Copper[A]	0.0006	NA	NA	NA
Iron	<0.16	<0.27	0.59	1.0
Lead[B]	<0.0001	NA	NA	<0.0010

Notes: All units g/m^3 unless otherwise stated; all data presented to two significant figures or less; NA = not applicable; [A] copper was analysed on 11 occasions, all but one of which were below a detection limit that has been superseded; [B] lead was analysed on 11 occasions - one was below a detection limit of 0.0002 g/m^3, another a limit of 0.0001 g/m^3, while the remainder were below a detection limit of 0.001 g/m^3.

Table G5: Summary of Murphy's Creek silt pond water quality.

Parameter	Minimum	Mean	95th Percentile	Maximum
pH(unitless)	7.2	8.0	8.3	8.3
Conductivity (mS/m)	130	1,000	1,800	1,900
Calcium	23	140	230	240
Chloride	6.2	11	15	16
Magnesium	12	89	160	170
Potassium	3.1	7.4	12	12
Sodium	10	21	31	32
Sulphate	16	450	1,100	1,100
Arsenic	<0.0050	<0.0062	0.013	0.013
Copper[A]	0.0016	0.0020	0.0024	0.0024
Iron	<0.02	<0.20	0.92	1.2
Lead[B]	<0.0001	NA	NA	<0.001

Notes: All units g/m^3 unless otherwise stated; all data presented to two significant figures or less; NA = not applicable; [A] summary statistics were derived after excluding detection limits superseded by lower limits; [C] lead was analysed on seven occasions – three were below a detection limit of 0.001 g/m^3, while the remaining nine were below a detection limit of 0.0001 g/m^3.

Table G6: Summary of Maori Tommy Gully silt pond water quality.

Parameter	Minimum	Mean	95th Percentile	Maximum
pH (unitless)	6.8	8.1	8.5	9.2
Conductivity (mS/m)	6	850	1,600	1,800
Calcium	24	110	160	180
Chloride	6.9	15	19	21
Magnesium	8.4	45	80	84
Potassium	2.6	4.5	6.2	14
Sodium	16	64	110	120
Sulphate	8.4	390	740	810
CN_{WAD}	<0.0010	<0.011	0.036	0.38
Arsenic	<0.0050	<0.014	0.028	0.028
Iron	<0.020	<0.11	0.24	0.56
Lead[A]	<0.0001	NA	NA	<0.010
Zinc[B]	<0.0050	NA	NA	0.0070

Notes: All units g/m^3 unless otherwise stated; all data presented to two significant figures or less; NA = not applicable; [A] lead was analysed on four occasions – one was below a detection limit of 0.001 g/m^3, while the remaining three were below a detection limit of 0.0001 g/m^3; [B] zinc was analysed on two occasions – one of which was below a detection limit of 0.005 g/m^3.

Table G7: Summary of Lone Pine Water Storage Reservoir water quality.

Parameter	Minimum	Mean	95th Percentile	Maximum
pH (unitless)	6.7	7.9	8.7	10
Conductivity (mS/m)	28	440	730	1,000
Calcium	6.2	43	72	100
Magnesium	2.3	21	37	44
Potassium	0.99	2.3	3.4	5.6
Sodium	6.1	29	53	61
Chloride	6.3	9.4	13	14
Sulphate	1.5	170	300	390
CN_{WAD}	<0.001	<0.0045	0.005	0.008
Arsenic[A]	0.0019	0.0093	0.023	0.028
Copper[B]	<0.001	NA	NA	<0.02
Iron	<0.02	<0.20	0.59	1.2
Lead[C]	<0.0010	NA	NA	0.020
Zinc[D]	<0.005	NA	NA	NA

Notes: All units g/m^3 unless otherwise stated; all data presented to two significant figures or less; NA = not applicable; [A] summary statistics were derived after excluding detection limits that have been superseded by lower limits; [B] copper was analysed on eight occasions – one was below a detection limit of 0.02 g/m^3, another three below 0.01 g/m^3, while the remaining four were below a detection limit of 0.001 g/m^3 or 0.002 g/m^3; [C] lead was analysed on six occasions with all but one below the detection limit; and [D] zinc was below the limit of detection on the three occasions it was analysed.

APPENDIX H

Groundwater quality data

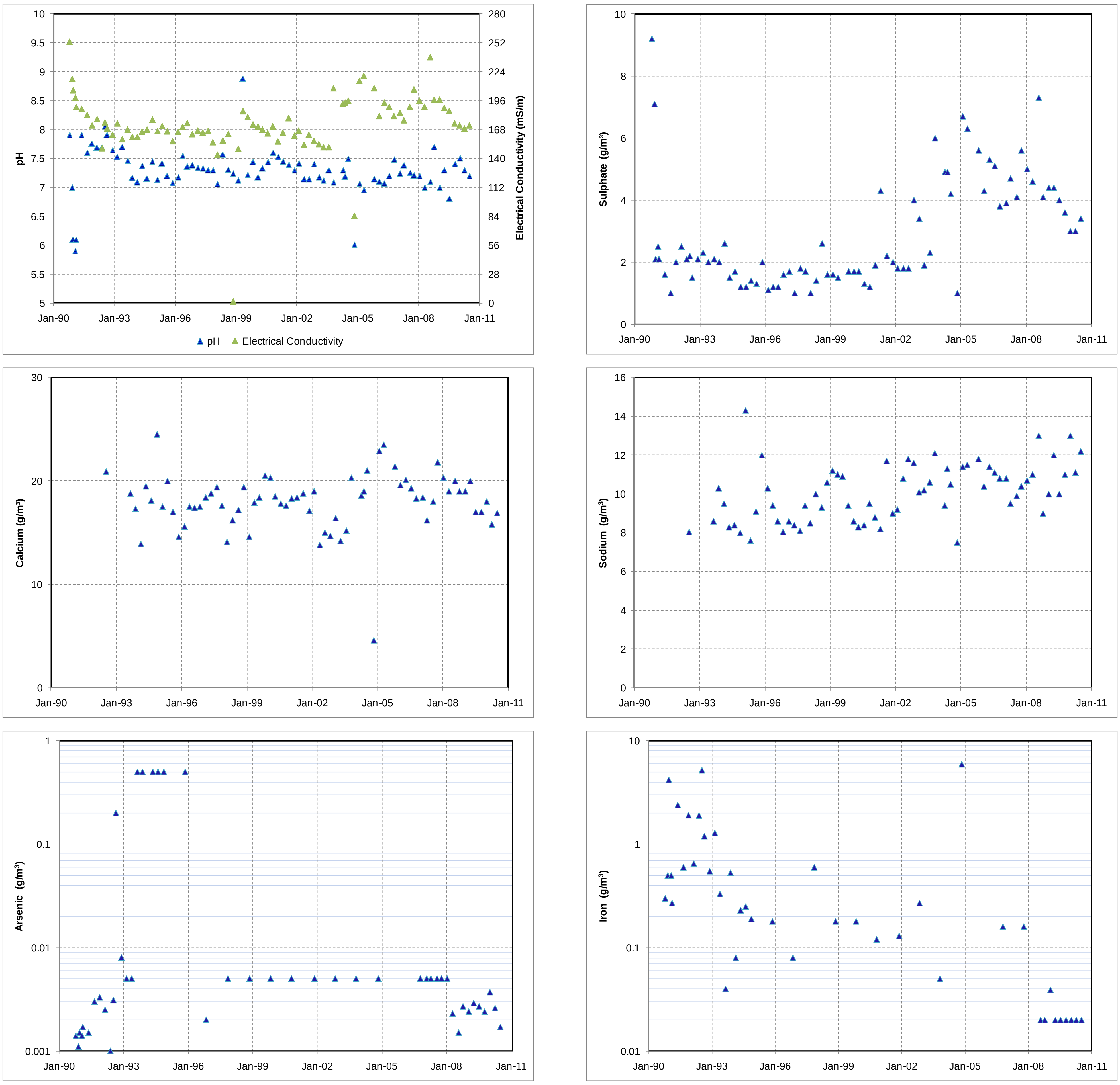


Figure H1: GW1 – Background groundwater quality.

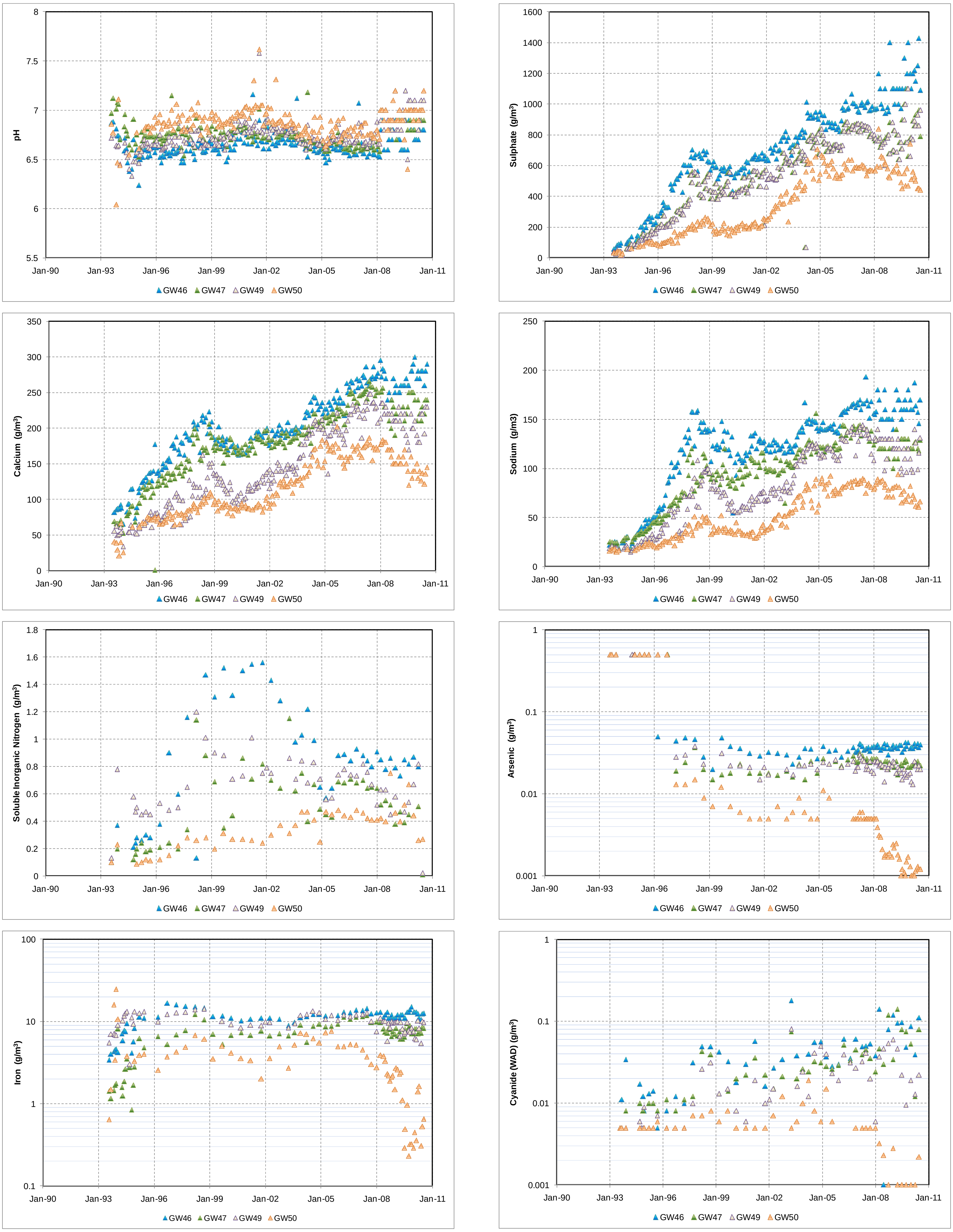
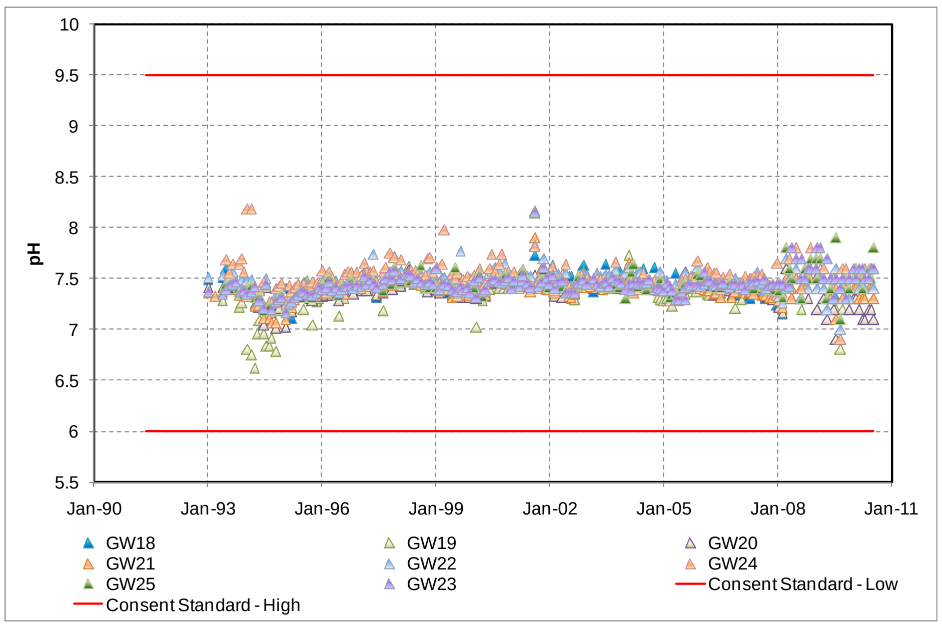
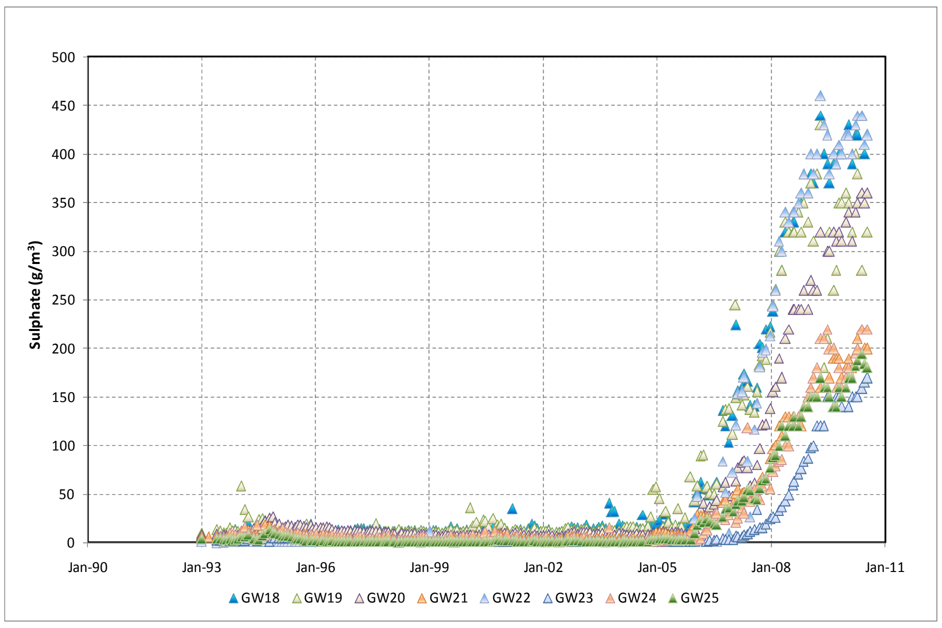
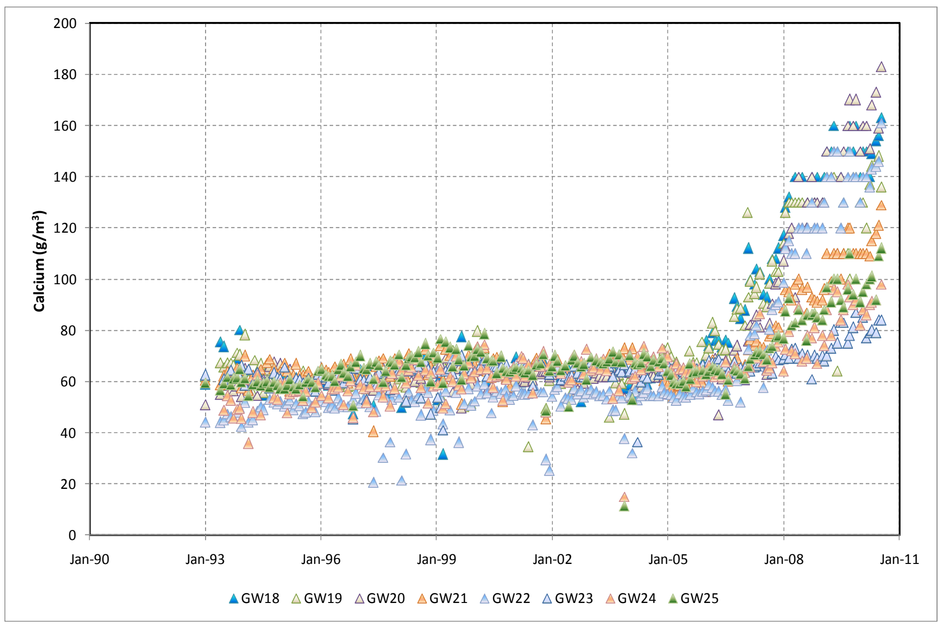
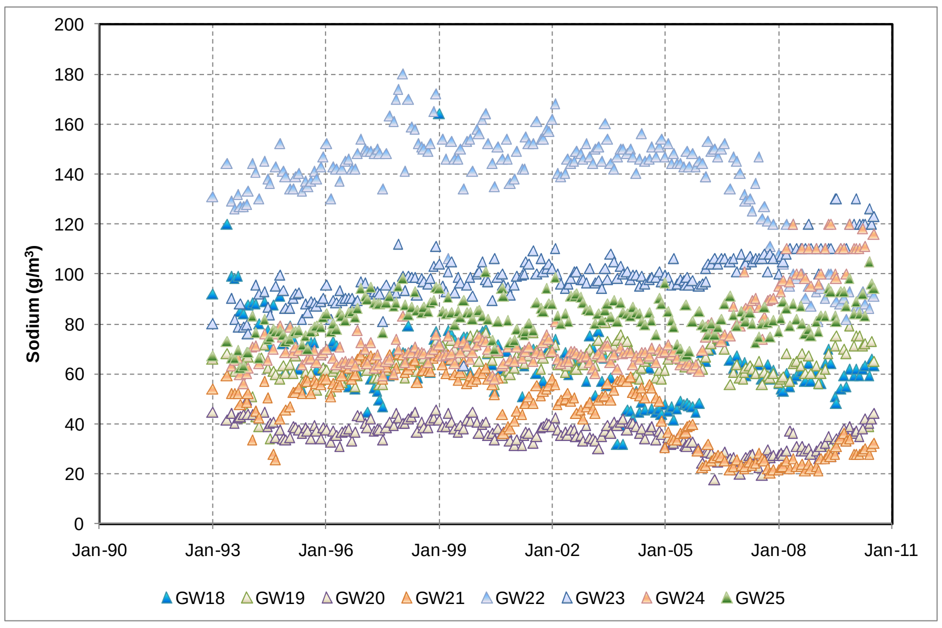


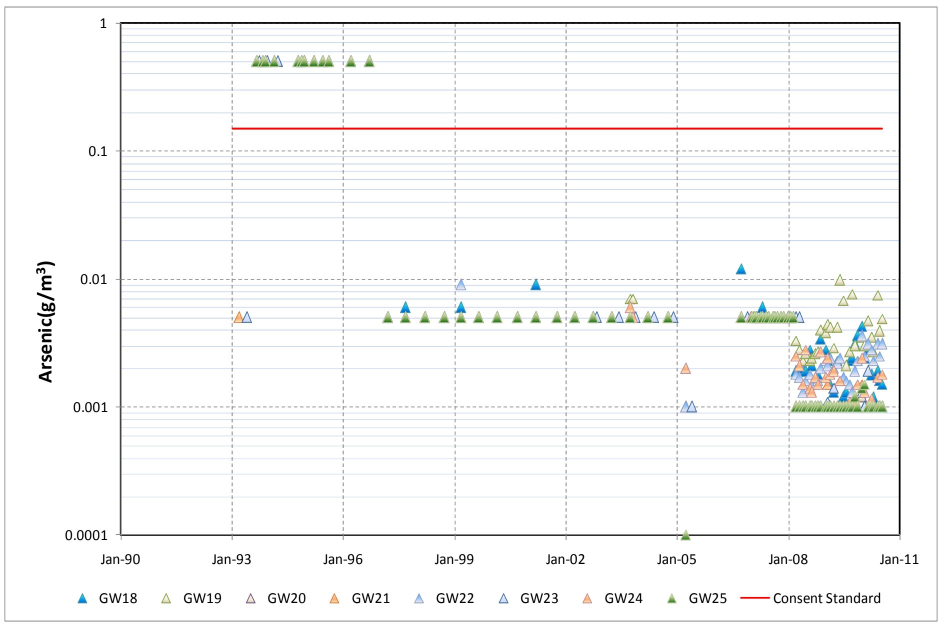
Figure H2: MTI detection well groundwater quality.











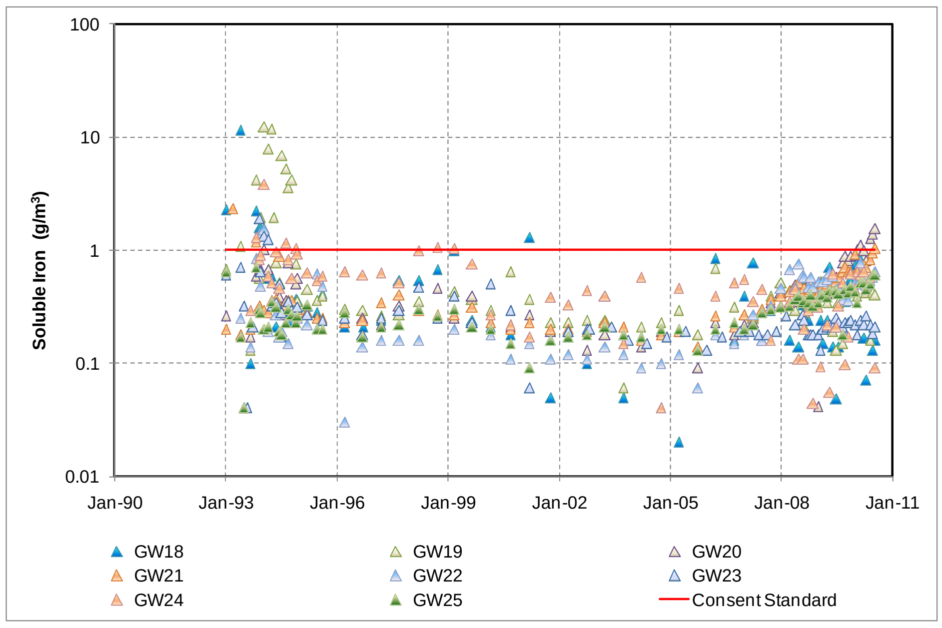
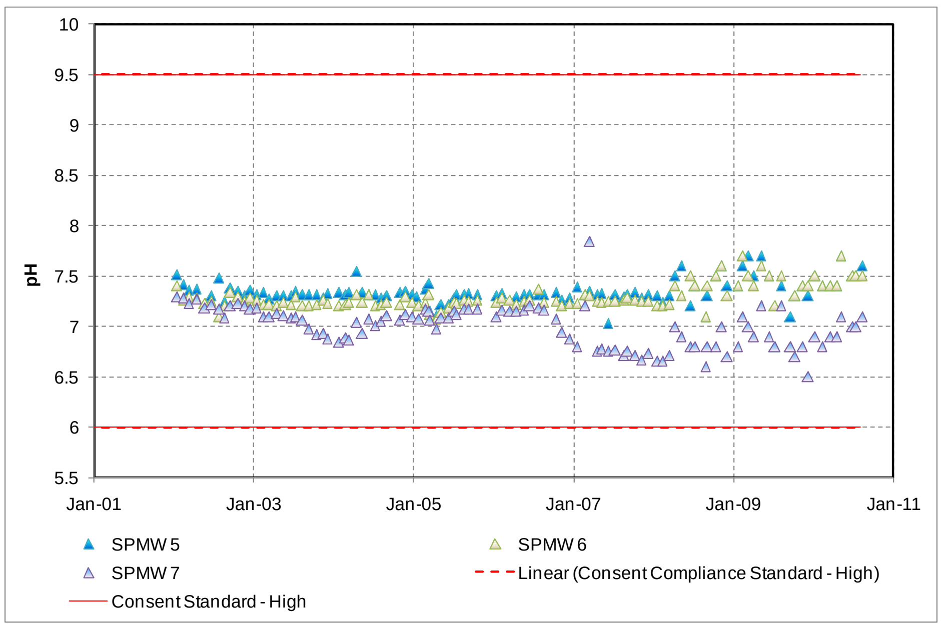
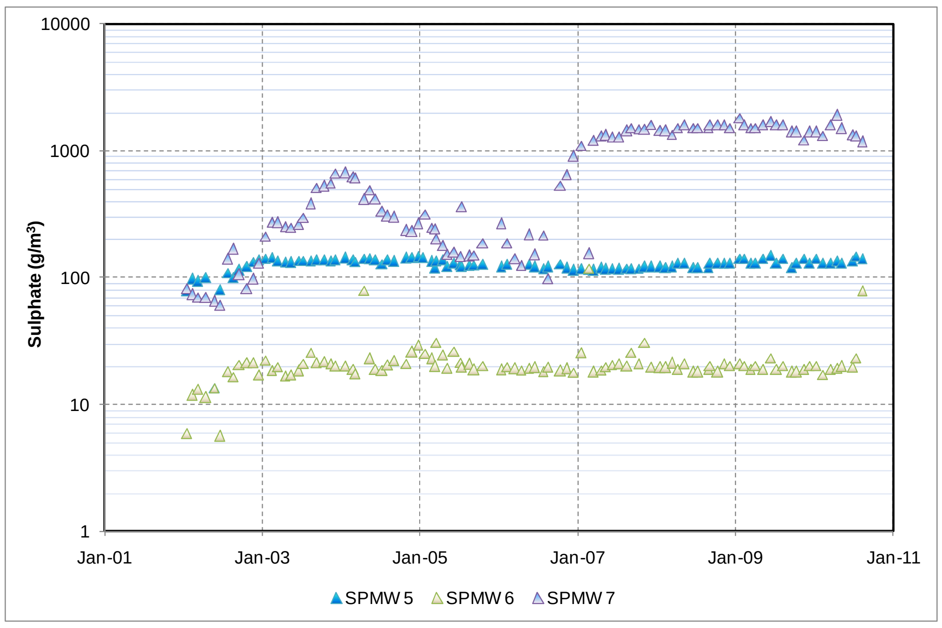
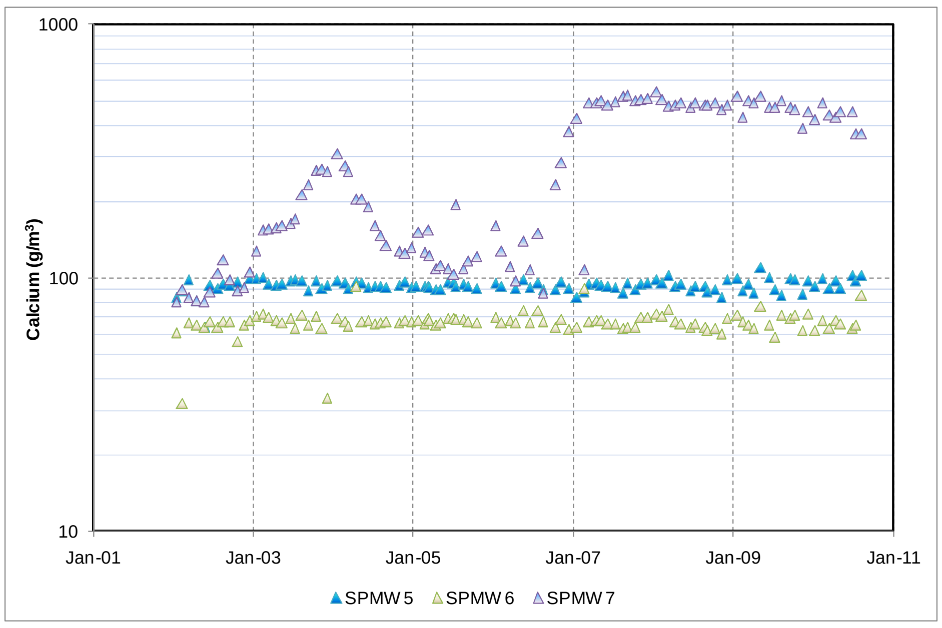


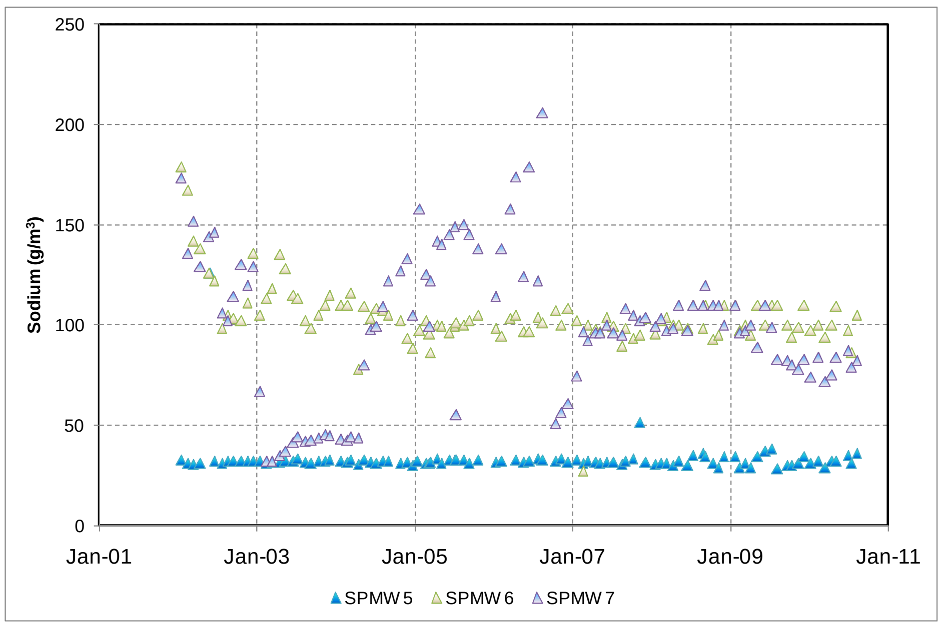
Figure H3: MTI compliance well groundwater quality.

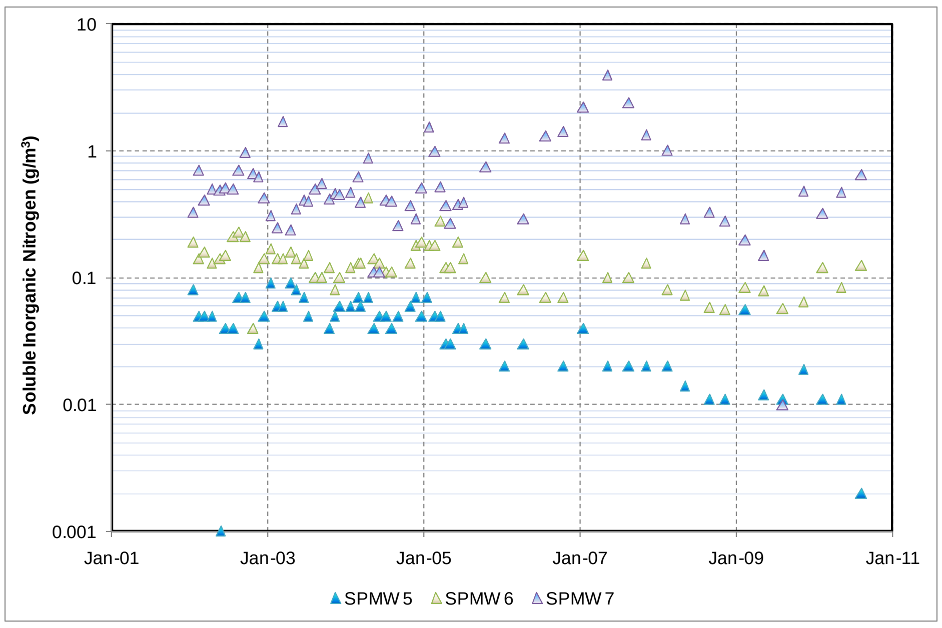
Figure H4: SPI detection well groundwater quality.

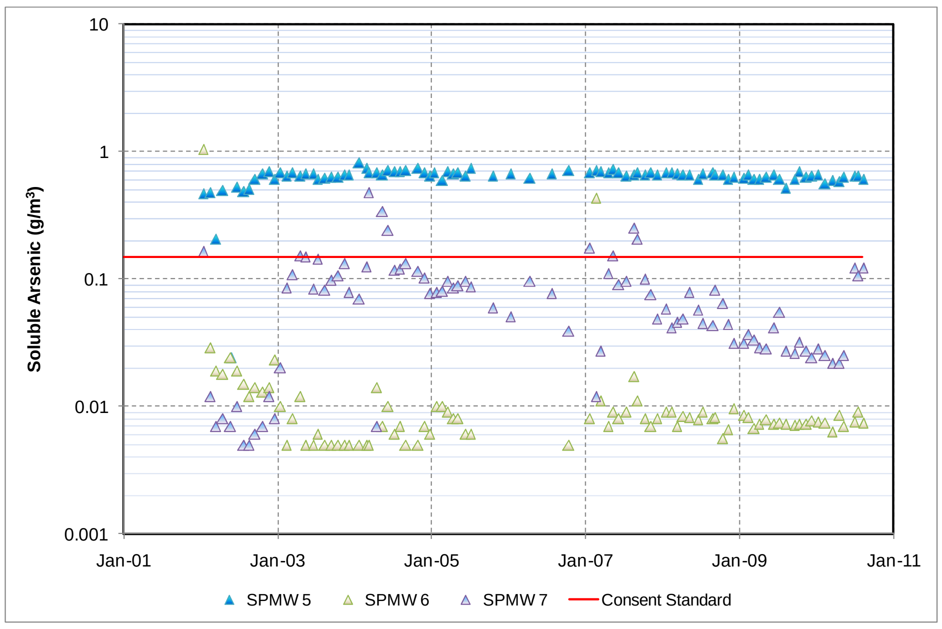












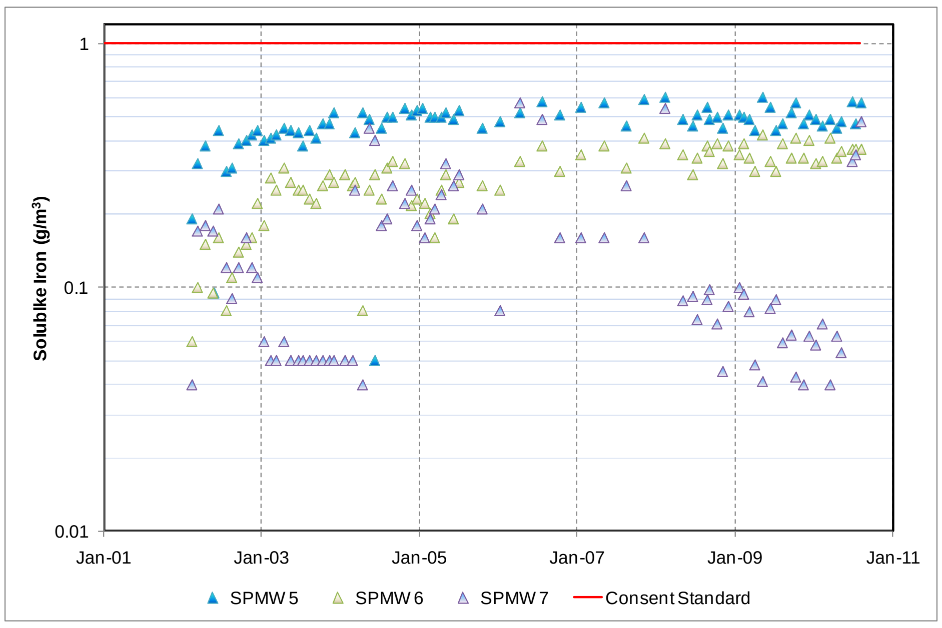
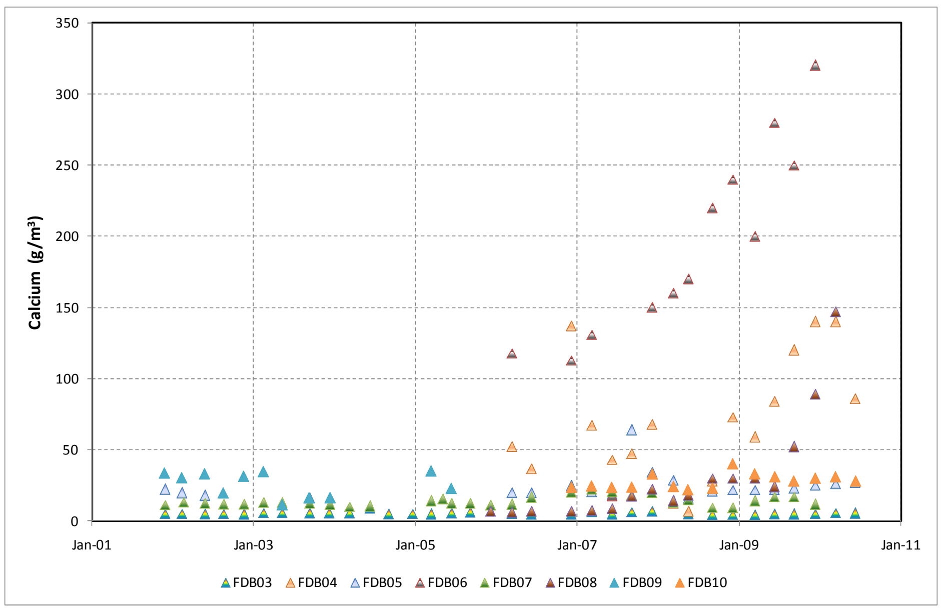
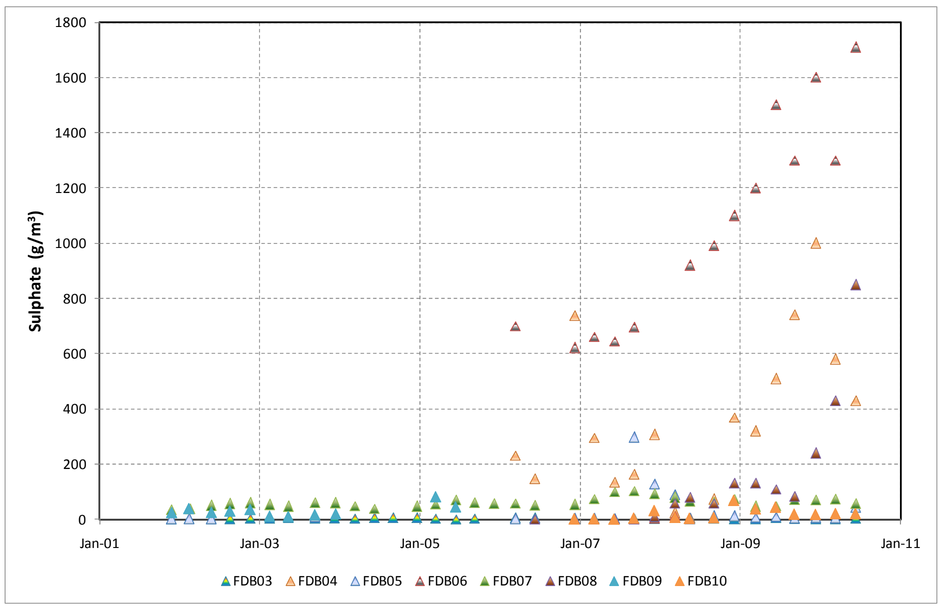


Figure H5: Selected SPI compliance well groundwater quality.

Figure H6: Groundwater quality within the MTI western monitoring wells.


Calcium (g/m³)
0
50
100
150
200
250
300
350
Jan-01
Jan-03
Jan-05
Jan-07
Jan-09
Jan-11
FDB03 FDB04 FDB05 FDB06 FDB07 FDB08 FDB09 FDB10


Sulphate (g/m³)
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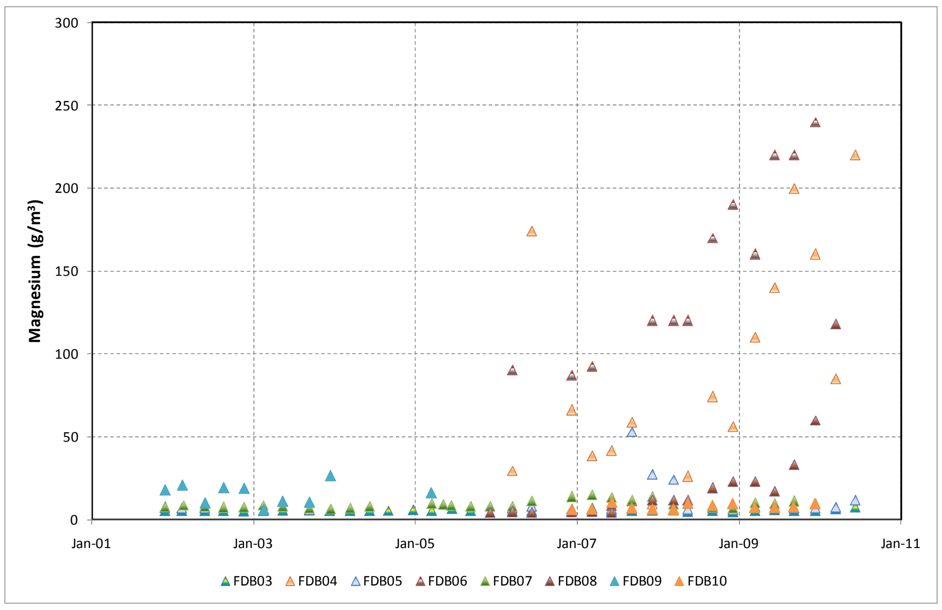
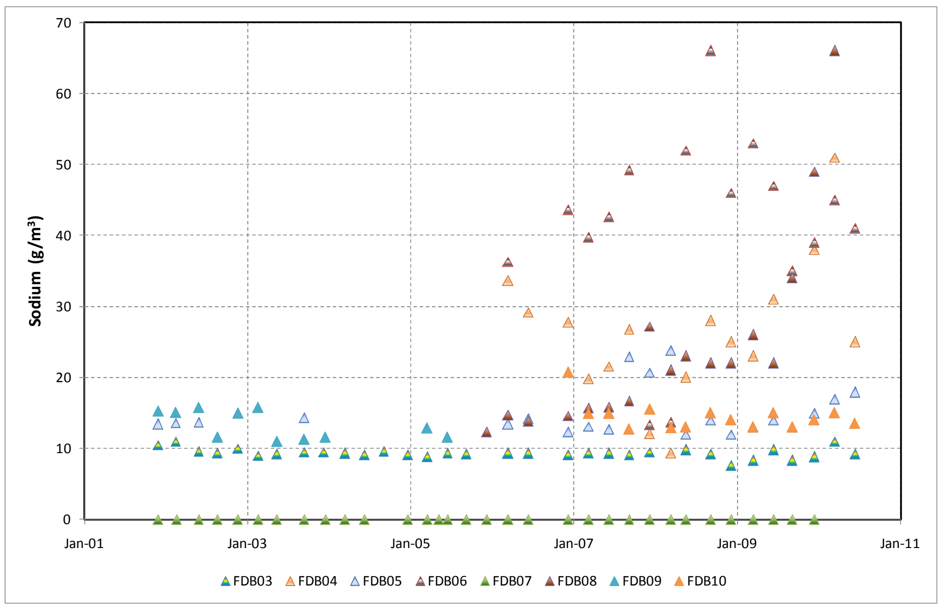
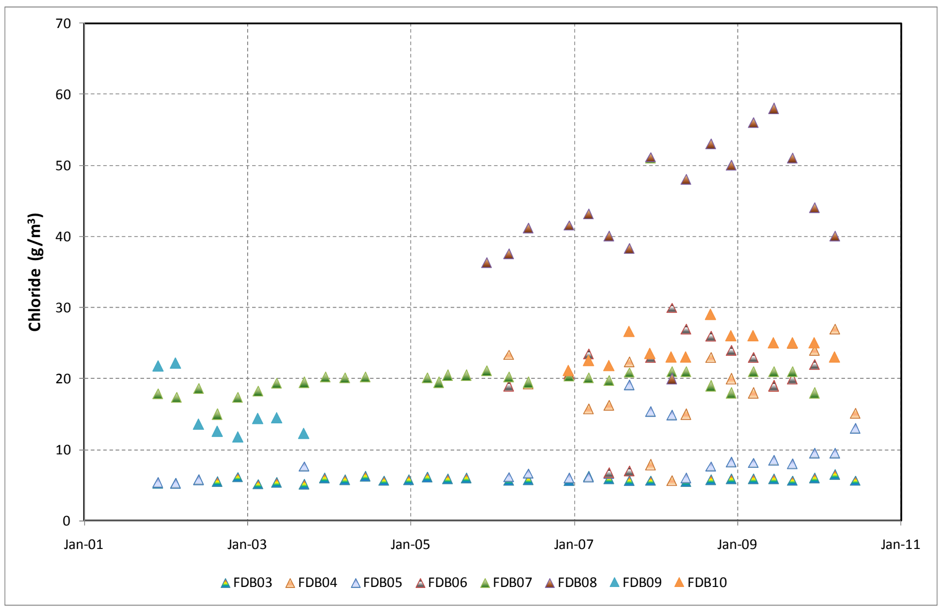
200
400
600
800
1000
1200
1400
1600
1800
Jan-01
Jan-03
Jan-05
Jan-07
Jan-09
Jan-11
FDB03 FDB04 FDB05 FDB06 FDB07 FDB08 FDB09 FDB10


Magnesium (g/m³)
0
50
100
150
200
250
300
Jan-01
Jan-03
Jan-05
Jan-07
Jan-09
Jan-11
FDB03 FDB04 FDB05 FDB06 FDB07 FDB08 FDB09 FDB10


Sodium (g/m³)
0
10
20
30
40
50
60
70
Jan-01
Jan-03
Jan-05
Jan-07
Jan-09
Jan-11
FDB03 FDB04 FDB05 FDB06 FDB07 FDB08 FDB09 FDB10


Chloride (g/m³)
0
10
20
30
40
50
60
70
Jan-01
Jan-03
Jan-05
Jan-07
Jan-09
Jan-11
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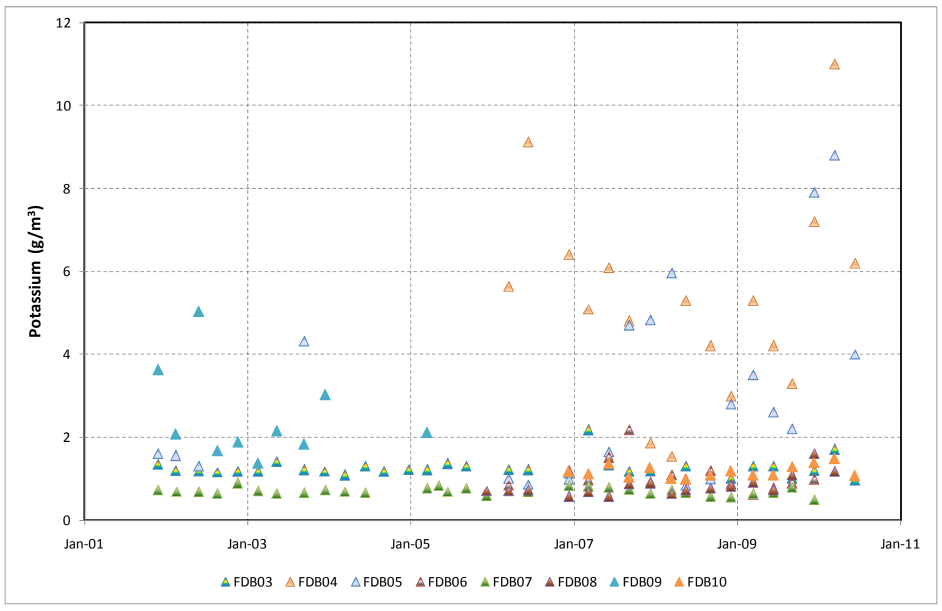
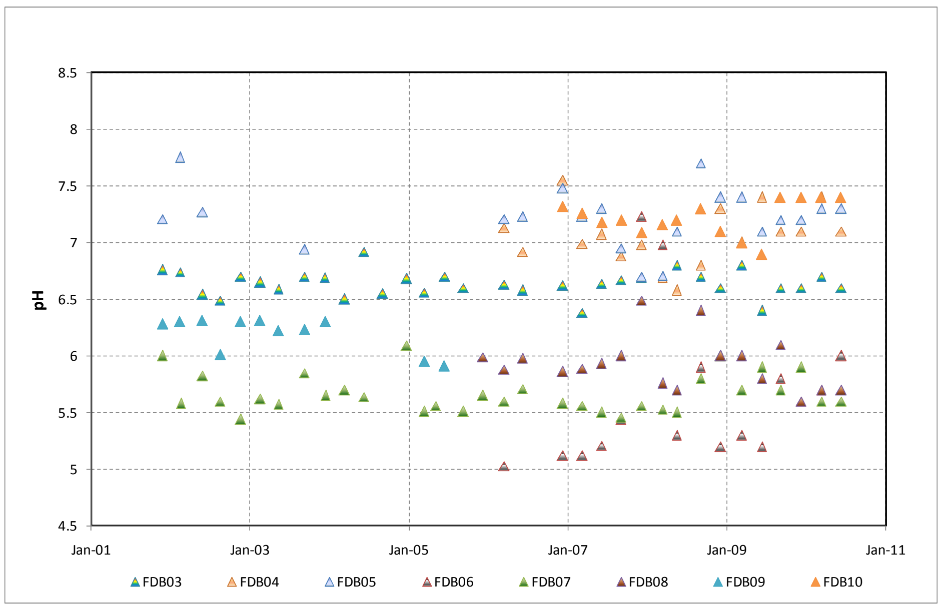
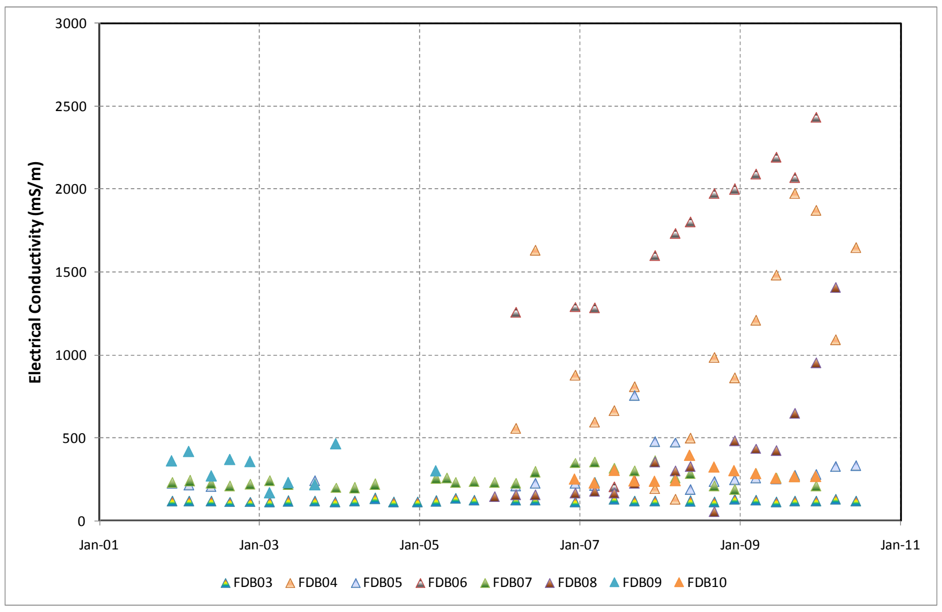

Potassium (g/m³)
0
2
4
6
8
10
12
Jan-01
Jan-03
Jan-05
Jan-07
Jan-09
Jan-11
FDB03 FDB04 FDB05 FDB06 FDB07 FDB08 FDB09 FDB10


pH
4.5
5
5.5
6
6.5
7
7.5
8
8.5
Jan-01
Jan-03
Jan-05
Jan-07
Jan-09
Jan-11
FDB03 FDB04 FDB05 FDB06 FDB07 FDB08 FDB09 FDB10


Electrical Conductivity (mS/m)
0
500
1000
1500
2000
2500
3000
Jan-01
Jan-03
Jan-05
Jan-07
Jan-09
Jan-11
FDB03 FDB04 FDB05 FDB06 FDB07 FDB08 FDB09 FDB10

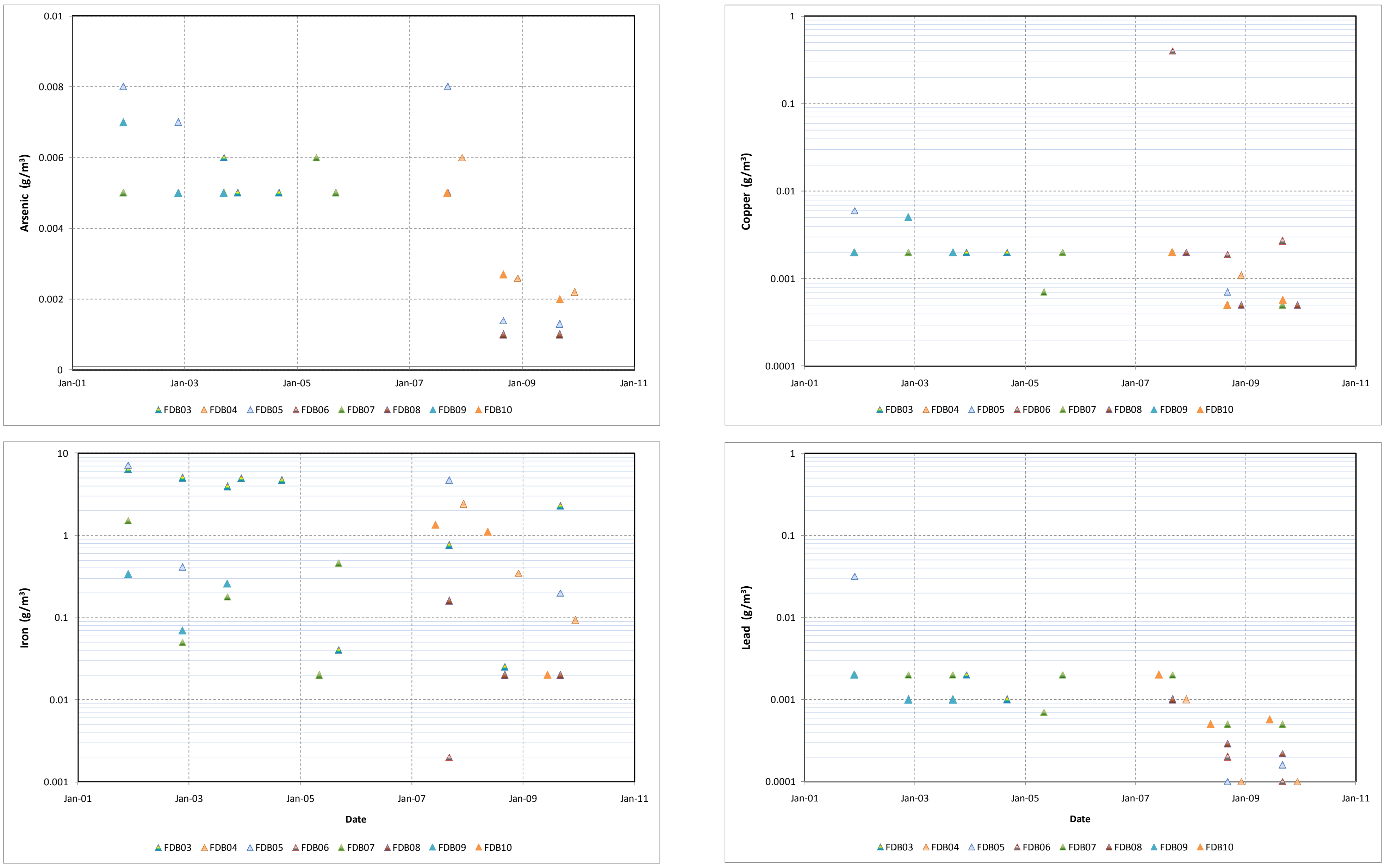


Figure H7: Groundwater quality within the Frasers West WRS monitoring wells.

Table H1: Summary of GW1 groundwater quality.

Parameter	Minimum	Mean	95th percentile	Maximum
pH (unitless)	5.9	7.3	7.9	8.9
Conductivity (mS/m)	1.6	170	210	250
Calcium	4.6	18	22	25
Chloride	5.7	13	17	23
Magnesium	1.7	4.4	5.5	5.9
Potassium	0.56	0.82	0.9	6.8
Sodium	7.5	10	12	14
Sulphate	1.0	3.9	6.7	84
SIN	<0.020	<0.38	0.87	1.3
CN_{WAD} [A]	<0.0050	NA	NA	NA
Arsenic[B]	<0.0010	<0.0035	<0.0050	0.0080
Cadmium[B]	<0.000040	<0.000062	0.00012	0.00014
Copper[B]	<0.0005	<0.0020	0.0054	0.0063
Iron	<0.02	<0.75	4.1	5.9
Lead	<0.0001	<0.0058	0.021	0.024
Nickel[A]	<0.0050	NA	NA	NA
Zinc	<0.0050	<0.017	0.045	0.050

Notes: All units g/m^3 unless otherwise stated; and all data presented to two significant figures or less; NA = not applicable; [A] CN_{WAD} and nickel was below the detection limit on all sampling occasions; and [B] summary statistics were derived after excluding detection limits that have been superseded by lower limits.

Table H2: MMCL and Vickery bore water quality.

Parameter	Minimum	Mean	95th percentile	Maximum
pH (unitless)	6.9	7.5	7.8	8.0
Conductivity (mS/m)	180	240	300	660
Calcium	19	27	34	38
Chloride	4.7	7.4	10	11
Magnesium	3.8	6.6	8.6	19
Potassium	0.73	1.1	1.3	3.7
Sodium	7.3	16	20	21
Sulphate	0.70	3.2	3.8	5.5[A]
CN_{WAD}[B]	<0.0050	NA	NA	NA
Arsenic[C]	<0.00080	<0.0032	<0.0050	0.0060
Copper[D]	<0.0005	NA	NA	0.00077[E]
Iron	0.02	1.3	2.4	6.8
Lead[C]	<0.0001	<0.0006	0.023	0.003[E]
Zinc[C]	<0.005	<0.029	0.077	0.079[E]

Notes: All units g/m^3 unless otherwise stated; all data presented to two significant figures or less; NA = not applicable; [A] two anomalously large values not included in table; [B] CN_{WAD} was below the detection limit on all sampling occasions; [C] summary statistics were derived after excluding detection limits that have been superseded by lower limits; [D] copper concentrations were, with one exception, below the limit of detection; [E] first sample from MMCL bore returned anomalously high results for copper, lead and zinc that have not been included in table.

Table H3: Summary of GW46 groundwater quality.

Parameter	Minimum	Mean	95th percentile	Maximum
pH(unitless)	6.2	6.7	6.9	7.2
Conductivity (mS/m)	480	1,600	2,200	2,400
Calcium	66	200	280	300
Chloride	10	35	56	62
Magnesium	12	56	83	91
Potassium	2.3	6	7.3	8
Sodium	19	121	170	190
Sulphate	26	700	1,100	1,400
Soluble inorganic nitrogen	<0.01	<0.83	1.5	1.6
CN_{WAD}	<0.001	<0.044	0.12	0.18
Arsenic[A]	0.020	0.036	0.043	0.048
Copper[B]	<0.0005	NA	NA	NA
Iron	2.8	11	15	17
Lead[B]	<0.0001	NA	NA	NA

Notes: All units g/m^3 unless otherwise stated; all data presented to two significant figures or less; NA = not applicable; [A] summary statistics were derived after excluding detection limits that have been superseded by lower limits; and [B] copper and lead were below the detection limit on all sampling occasions.

Table H4: Summary of GW47 groundwater quality.

Parameter	Minimum	Mean	95th percentile	Maximum
pH(unitless)	6.5	6.8	7.0	7.2
Conductivity (mS/m)	420	1,400	1,900	2,000
Calcium	1.1	180	250	630
Chloride	8.4	33	49	56
Magnesium	9.5	46	67	71
Potassium	2.2	4.5	5.9	6.2
Sodium	17	96	140	160
Sulphate	15	530	870	1,100
Soluble inorganic nitrogen	<0.01	<0.50	0.87	1.2
CN_{WAD}	<0.005	<0.032	0.079	0.14
Arsenic[A]	0.015	0.037	0.023	0.029
Copper[B]	<0.0005	NA	NA	NA
Iron	0.84	6.9	11	12
Lead[C]	<0.0001	NA	NA	0.00013

Notes: All units g/m^3 unless otherwise stated; all data presented to two significant figures or less; NA = not applicable; [A] summary statistics were derived after excluding detection limits that have been superseded by lower limits; [B] copper was below the detection limit on all sampling occasions; and [C] lead was below the limit of detection on all but one sampling occasion.

Table H5: Summary of GW49 groundwater quality.

Parameter	Minimum	Mean	95th percentile	Maximum
pH(unitless)	6.3	6.8	7.0	7.6
Conductivity (mS/m)	22	1,200	1,900	2,000
Calcium	34	150	230	250
Chloride	7.4	22	33	40
Magnesium	8.6	44	76	83
Potassium	2.12	4.86	6.60	7.1
Sodium	15	83	140	140
Sulphate	15	510	920	1,200
Soluble inorganic nitrogen	0.02	0.66	0.97	1.2
CN_{WAD}	<0.005	<0.021	0.052	0.081
Arsenic[A]	0.013	0.038	0.022	0.029
Copper[B]	<0.0005	NA	NA	NA
Iron	3.0	9.8	13	14
Lead[A]	<0.0001	<0.00011	0.00015	0.00018

Notes: All units g/m^3 unless otherwise stated; all data presented to two significant figures or less; NA = not applicable; [A] summary statistics were derived after excluding detection limits that have been superseded by lower limits; and [B] copper was below the detection limit on all sampling occasions.

Table H6: Summary of GW50 groundwater quality.

Parameter	Minimum	Mean	95th percentile	Maximum
pH(unitless)	6.0	6.9	7.1	7.6
Conductivity (mS/m)	250	930	1,400	1,500
Calcium	21	120	180	200
Chloride	7.6	15	20	24
Magnesium	2.5	28	48	57
Potassium	2.3	3.6	4.7	4.9
Sodium	15	53	87	94
Sulphate	20	350	640	840
Soluble inorganic nitrogen	0.09	0.34	0.51	0.75
CN_{WAD}	<0.001	<0.0055	0.012	0.019
Arsenic[A]	<0.001	<0.015	0.0045	0.012
Copper[B]	<0.0005	NA	NA	NA
Iron	0.23	3.8	7.6	25
Lead[A]	<0.0001	<0.00013	0.00028	0.00046

Notes: All units g/m^3 unless otherwise stated; and all data presented to two significant figures or less; NA = not applicable; and [A] summary statistics were derived after excluding detection limits that have been superseded by lower limits; and [B] copper was below the detection limit on all sampling occasions.

Table H7: Summary of GW18 groundwater quality.

Parameter	Minimum	Mean	95th percentile	Maximum	Compliance limit	Exceedances
pH(unitless)	6.9	7.43	7.6	7.8	6 to 9.5	0
Conductivity (mS/m)	450	700	1,100	1,200	-	-
Calcium	32	78	150	160	-	-
Chloride	11	20	23	26	-	-
Magnesium	4.9	13	23	27	-	-
Potassium	1.9	2.5	3.0	3.6	-	-
Sodium	32	64	87	160	-	-
Sulphate	1.0	80	400	440	-	-
Soluble inorganic nitrogen	0.02	0.40	0.46	12	-	-
CN_{WAD}[A]	<0.001	NA	NA	0.0028	0.1	0
Arsenic[B]	0.0012	0.0030	0.0069	0.012	0.15	0
Copper[A]	<0.0005	NA	NA	0.003	0.009[C]	0
Iron	<0.02	<0.59	1.6	11	1	7
Lead[B]	<0.0001	<0.0089	0.057	0.070	0.0025[C]	2[D]

Notes: All units g/m^3 unless stated; all data presented to two significant figures or less; NA = not applicable; [A] CN_{WAD} and copper were below the detection limit on all but one sampling occasion; [B] summary statistics were derived after excluding detection limits superseded by lower limits; [C] compliance limits for copper and lead are hardness dependent. The limits provided in this table have been calculated assuming a hardness of 100 g/m^3; and [D] non-exceedances for lead occurred on two occasions, both in 1993, when concentrations of 0.05 g/m^3 and 0.07 g/m^3 were measured - as hardness was not measured concurrently the associated compliance limit was calculated assuming a hardness of 100 g/m^3.

Table H8: Summary of GW19 groundwater quality.

Parameter	Minimum	Mean	95^{th} percentile	Maximum	Compliance limit	Exceedances
pH(unitless)	6.6	7.4	7.6	8.2	6 to 9.5	0
Conductivity (mS/m)	480	690	1,000	1,100	-	-
Calcium	35	75	130	150	-	-
Chloride	8.7	19	22	28	-	-
Magnesium	8.2	12	20	99	-	-
Potassium	2.0	2.5	3.3	5.2	-	-
Sodium	31	64	75	88	-	-
Sulphate	9.5	74	350	430	-	-
Soluble inorganic nitrogen	0.026	0.15	0.21	2.9	-	-
CN_{WAD}^{A}	<0.001	NA	NA	NA	0.1	0
Arsenic[B]	0.0020	0.0040	0.0075	0.0098	0.15	0
Copper[B]	<0.0005	<0.00053	0.00069	0.00085[C]	0.009[C]	0
Iron	<0.04	<1.1	5.6	12	1	11
Lead[B]	<0.00010	<0.00013	0.00020	0.00021	0.0025[C]	0

Notes: All units g/m^3 unless stated; all data rounded to two significant figures or less; NA = not applicable; [A] CN_{WAD} was below the detection limit on all sampling occasions; [B] summary statistics were derived after excluding detection limits that have been superseded by lower limits; and [C] compliance limits for copper and lead are hardness dependent. The limits provided in this table have been calculated assuming a hardness of 100 g/m^3.

Table H9: Summary of GW20 groundwater quality.

Parameter	Minimum	Mean	95^{th} percentile	Maximum	Compliance limit	Exceedances
pH(unitless)	6.9	7.4	7.5	7.6	6 to 9.5	0
Conductivity (mS/m)	330	560	940	1,100	-	-
Calcium	47	75	150	180	-	-
Chloride	2.3	11	13	15	-	-
Magnesium	5.3	8.6	16	18	-	-
Potassium	2.7	3.6	4.3	4.7	-	-
Sodium	18	36	44	49	-	-
Sulphate	5.3	56	310	360	-	-
Soluble inorganic nitrogen	0.004	0.079	0.19	0.56	-	-
CN_{WAD}^{A}	<0.0005	NA	NA	NA	0.1	0
Arsenic[B]	<0.001	NA	NA	0.0012	0.15	0
Copper[A]	<0.0005	NA	NA	NA	0.009[C]	0
Iron	<0.04	<0.46	1.0	1.6	1	4
Lead[A]	<0.0001	NA	NA	NA	0.0025[C]	0

Notes: All units g/m^3 unless otherwise stated; all data rounded to two significant figures or less; NA = not applicable; [A] CN_{WAD}, copper and lead were below the detection limit on all sampling occasions; [A] arsenic was below the detection limit on all but one sampling occasion; and [C] compliance limits for copper and lead are hardness dependent. The limits provided in this table have been calculated assuming a hardness of 100 g/m^3.

Table H10: Summary of GW21 groundwater quality.

Parameter	Minimum	Mean	95^{th} percentile	Maximum	Compliance limit	Exceedances
pH(unitless)	7.0	7.4	7.5	7.9	6 to 9.5	0
Conductivity (mS/m)	420	580	710	760	-	-
Calcium	40	71	110	130	-	-
Chloride	8.5	13	16	19	-	-
Magnesium	6.8	8.8	11	13	-	-
Potassium	2.2	3.5	4.3	4.6	-	-
Sodium	20	46	66	70	-	-
Sulphate	1.0	33	180	220	-	-
Soluble inorganic nitrogen	0.003	0.22	0.17	6.4	-	-
CN_{WAD}^{A}	<0.0005	NA	NA	NA	0.1	0
Arsenic[B]	<0.001	<0.001	0.0014	0.0015	0.15	0
Copper[A]	<0.0005	NA	NA	NA	0.009[D]	0
Iron	<0.04	<0.43	0.93	2.3	1	3
Lead[B]	<0.0001	<0.00023	0.00085	0.0012	0.0025[D]	0
Zinc[C]	0.006	NA	NA	NA	0.12[D]	0

Notes: All units g/m^3 unless otherwise stated; all data rounded to two significant figures or less; NA = not applicable; [A] CN_{WAD} and copper were below the detection limit on all sampling occasions; [B] summary statistics were derived after excluding detection limits that have been superseded by lower limits; [C] zinc was analysed on one occasion; [D] compliance limits for copper, lead and zinc are hardness dependent. The limits provided in this table have been calculated assuming a hardness of 100 g/m^3.

Table H11: Summary of GW22 groundwater quality.

Parameter	Minimum	Mean	95th percentile	Maximum	Compliance limit	Exceedances
pH(unitless)	7.0	7.5	7.6	7.8	6 to 9.5	0
Conductivity (mS/m)	630	900	1,100	1,200	-	-
Calcium	21	65	23	25	-	-
Chloride	3.1	20	24	29	-	-
Magnesium	4.0	10	23	25	-	-
Potassium	2.1	3.3	3.6	3.9	-	-
Sodium	72	140	160	180	-	-
Sulphate	<1	69	410	460	-	-
Soluble inorganic nitrogen	0.004	0.21	0.19	5.4	-	-
CN_{WAD} [A]	<0.001	NA	NA	NA	0.1	0
Arsenic[B]	<0.0010	<0.0023	0.0034	0.0090	0.15	0
Copper[A]	<0.0005	NA	NA	NA	0.009[C]	0
Iron	0.03	0.37	0.76	1.5	1	2
Lead[A]	<0.0001	NA	NA	NA	0.0025[C]	0

Notes: All units g/m^3 unless stated; all data rounded to two significant figures or less; NA = not applicable; [A] CN_{WAD}, copper and lead were below the detection limit on all sampling occasions; [B] summary statistics were derived after excluding detection limits superseded by lower limits; [C] limits for copper lead are hardness dependent and the limits provided in Table H11 were calculated at hardness of 100 g/m^3.

Table H12: Summary of GW23 groundwater quality.

Parameter	Minimum	Mean	95th percentile	Maximum	Compliance limit	Exceedances
pH(unitless)	7.2	7.5	7.6	8.2	6 to 9.5	0
Conductivity (mS/m)	620	740	910	980	-	-
Calcium	36	65	80	94	-	-
Chloride	12	19	22	40	-	-
Magnesium	6.8	8.5	11	12	-	-
Potassium	2.8	3.4	3.7	4.2	-	-
Sodium	63	100	120	130	-	-
Sulphate	1.0	21	150	170	-	-
Soluble inorganic nitrogen	0.003	0.11	0.17	0.85	-	-
CN_{WAD} [A]	<0.001	NA	NA	0.006	0.1	0
Arsenic[B]	<0.000	<0.0011	0.0014	0.0019	0.15	0
Copper[B]	<0.0005	<0.0007	0.0016	0.0030	0.009[D]	0
Iron	<0.04	<0.3	0.66	1.9	1	3
Lead[C]	<0.0001	NA	NA	NA	0.0025[E]	0
Zinc[D]	0.005	NA	NA	NA	0.12[E]	0

Notes: All units g/m^3 unless otherwise stated; all data rounded to two significant figures or less; NA = not applicable; [A] CN_{WAD} was below the detection limit on all but one sampling occasion; [B] summary statistics were derived after excluding detection limits superseded by lower limits; [C] lead was below the detection limit on all sampling occasions; [D] zinc was analysed on one occasion; and [E] compliance limits for copper, lead and zinc are hardness dependent. The limits provided in this table have been calculated assuming a hardness of 100 g/m^3.

Table H13: Summary of GW24 groundwater quality.

Parameter	Minimum	Mean	95th percentile	Maximum	Compliance limit	Exceedances
pH(unitless)	6.9	7.5	7.7	11	6 to 9.5	1
Conductivity (mS/m)	400	660	920	1,000	-	-
Calcium	15	65	89	98	-	-
Chloride	10	17	21	23	-	-
Magnesium	5.2	14	8.4	14	-	-
Potassium	2.8	4	4.5	5.7	-	-
Sodium	56	76	110	130	-	-
Sulphate	1.0	32	180	220	-	-
Soluble inorganic nitrogen	0.04	0.098	0.17	0.55	-	-
CN_{WAD} [A]	<0.001	NA	NA	NA	0.1	0
Arsenic[B]	<0.001	<0.0017	0.0028	0.006	0.15	0
Copper[B]	<0.0005	<0.0008	0.0025	0.003	0.009[C]	0
Iron	<0.04	<0.52	1	3.8	1	6
Lead[B]	<0.0001	<0.001	0.004	0.004	0.0025[C]	3[D]

Notes: All units g/m^3 unless stated; all data presented to two significant figures or less; NA = not applicable; [A] CN_{WAD} was below the detection limit on all sampling occasions; [B] summary statistics were derived after excluding detection limits superseded by lower limits; [C] compliance limits for copper and lead are hardness dependent. The limits provided in this table have been calculated assuming a hardness of 100 g/m^3; [D] non-exceedances for lead occurred on three occasions, all in 2000, when concentrations of 0.003 g/m^3 to 0.004 g/m^3 were measured - as hardness was not measured concurrently the associated compliance limit was calculated assuming a hardness of 100 g/m^3.

Table H14: Summary of GW25 groundwater quality.

Parameter	Minimum	Mean	95th percentile	Maximum	Compliance limit	Exceedances
pH(unitless)	7.1	7.4	7.6	8.1	6 to 9.5	0
Conductivity (mS/m)	430	710	860	940	-	-
Calcium	11	69	96	110	-	-
Chloride	12	18	20	25	-	-
Magnesium	7.0	9.7	13	15	-	-
Potassium	3.3	4.4	5	5.3	-	-
Sodium	62	83	94	110	-	-
Sulphate	<1	28	160	190	-	-
Soluble inorganic nitrogen	0.004	0.1	<0.2	0.21	-	-
CN_{WAD}[A]	<0.001	NA	NA	NA	0.1	0
Arsenic[B]	0.0010	0.0010	0.0013	0.0015	0.15	0
Copper[A]	<0.0005	NA	NA	NA	0.009[C]	0
Iron	<0.04	<0.3	0.53	0.7	1	0
Lead[A]	<0.0001	NA	NA	NA	0.0025[C]	0

Notes: All units g/m^3 unless otherwise stated; all data presented to two significant figures or less; NA = not applicable; [A] CN_{WAD}, copper and lead were below the detection limit on all sampling occasions; [B] summary statistics were derived after excluding detection limits that have been superseded by lower limits; and [C] compliance limits for copper and lead are hardness dependent. The limits provided in this table have been calculated assuming a hardness of 100 g/m^3.

Table H15: Summary of SPMW3 groundwater quality.

Parameter	Minimum	Mean	95th percentile	Maximum
pH(unitless)	6.4	6.99	7.23	8.01
Conductivity (mS/m)	120	1,300	2,500	3,100
Calcium	7.8	250	460	540
Chloride	3.6	9.3	11	20
Magnesium	3.5	43	150	330
Potassium	1.5	2.7	5.8	9.7
Sodium	7.2	19	30	41
Sulphate	7.1	540	1,500	1,800
Soluble inorganic nitrogen	0.011	0.73	1.4	22
CN_{WAD}[A]	<0.001	NA	NA	NA
Arsenic[B]	<0.002	<0.064	0.15	0.18
Copper[B]	<0.0005	<0.0012	0.0029	0.0030
Iron	<0.04	<1.6	5.3	14
Lead[B]	<0.0001	<0.0007	0.0036	0.0050

Notes: All units g/m^3 unless otherwise stated; and all data presented to two significant figures or less; NA = not applicable; [A] CN_{WAD} was below the detection limit on all sampling occasions; and [B] summary statistics were derived after excluding detection limits superseded by lower limits.

Table H16: Summary of SPMW4 groundwater quality.

Parameter	Minimum	Mean	95th percentile	Maximum
pH(unitless)	2.9	7.0	7.7	7.9
Conductivity (mS/m)	180	790	1,100	1,200
Calcium	23	130	190	200
Chloride	1.3	5.7	7.8	15
Magnesium	4.3	22	32	40
Potassium	1.3	3.3	8.7	15
Sodium	3.5	15	19	36
Sulphate	58	250	380	780
Soluble inorganic nitrogen	0.04	0.44	2.2	3.6
CN_{WAD}[A]	<0.001	NA	NA	NA
Arsenic[B]	0.0015	0.0092	0.023	0.035
Copper[B]	<0.0005	<0.0042	0.019	0.043
Iron	<0.02	<1.6	3.9	12
Lead[B]	<0.0001	<0.0009	0.0038	0.0070

Notes: All units g/m^3 unless otherwise stated; and all data presented to two significant figures or less; NA = not applicable; [A] CN_{WAD} was below the detection limit on all sampling occasions; and [B] summary statistics were derived after excluding detection limits superseded by lower limits.

Table H17: Summary of SPMW5 groundwater quality.

Parameter	Minimum	Mean	95th percentile	Maximum	Compliance limit	Exceedances
pH(unitless)	6.8	7.4	7.6	7.7	6 to 9.5	0
Conductivity (mS/m)	620	700	732	890	-	-
Calcium	64	93	100	110	-	-
Chloride	10	15	16	18	-	-
Magnesium	16	21	22	24 (2)	-	-
Potassium	1.2	1.5	1.6	3.8	-	-
Sodium	28	33	36	130	-	-
Sulphate	13	130	140	150	-	-
Soluble inorganic nitrogen	0.011	0.045	0.081	0.090	-	-
CN_{WAD} [A]	<0.001	NA	NA	0.0012	0.1	0
Arsenic	0.024	0.63	0.72	0.82	0.15	92
Copper[B]	<0.0005	<0.0058	0.028	0.066	0.009[D]	2
Iron[C]	0.050	0.47	0.58	0.60	1	0
Lead[B]	<0.0001	<0.0021	0.011	0.024	0.0025[D]	2

Notes: All units g/m^3 unless stated; all data presented to two significant figures or less or less; NA = not applicable; [A] CN_{WAD} was below the detection limit on all but one sampling occasion; [B] summary statistics were derived after excluding detection limits superseded by lower limits; [C] three anomalous iron concentrations (12.5 g/m^3, 6.32 g/m^3 and 3.06 g/m^3) have been excluded from dataset; and [D] compliance limits for copper and lead are hardness dependent. The limits provided in this table have been calculated assuming a hardness of 100 g/m^3.

Table H18: Summary of SPMW6 groundwater quality.

Parameter	Minimum	Mean	95th percentile	Maximum	Compliance limit	Exceedances
pH(unitless)	6.8	7.3	7.5	7.7	6 to 9.5	0
Conductivity (mS/m)	690	810	910	1,000	-	-
Calcium	32	67	74	92	-	-
Chloride	10	16	17	18	-	-
Magnesium	14	17	19	21	-	-
Potassium	1.4	3.4	3.9	5.8	-	-
Sodium	27	100	130	180	-	-
Sulphate	5.6	22	29	120	-	-
Soluble inorganic nitrogen	0.057	0.14	0.21	0.43	-	-
CN_{WAD} [A]	<0.001	NA	NA	0.0044	0.1	0
Arsenic[B]	<0.005	<0.0089	0.019	0.029	0.15	0
Copper[C]	<0.0005	<0.0017	0.0058	0.009	0.009[E]	0
Iron[D]	0.060	0.28	0.40	0.42	1	0
Lead[C]	0.0001	0.0027	0.014	0.034	0.0025[E]	1

Notes: All units g/m^3 unless stated; all data presented to two significant figures or less; NA = not applicable; [A] CN_{WAD} was below the detection limit on all but one sampling occasion; [B] two anomalous arsenic concentrations (0.43 g/m^3 and 1.0 g/m^3) have been excluded from dataset; [C] summary statistics were derived after excluding detection limits superseded by lower limits; [D] an anomalous iron concentration (10.8 g/m^3) has been excluded from dataset; and [E] compliance limits for copper and lead are hardness dependent. The limits provided in this table have been calculated assuming a hardness of 100 g/m^3.

Table H19: Summary of SPMW7 groundwater quality.

Parameter	Minimum	Mean	95th percentile	Maximum	Compliance limit	Exceedances
pH(unitless)	6.5	7	7.2	7.8	6 to 9.5	0
Conductivity (mS/m)	910	1,900	3,100	3,200	-	-
Calcium	80	290	510	540	-	-
Chloride	8.5	14	19	19	-	-
Magnesium	18	89	180	200	-	-
Potassium	1.7	3.7	5.7	6.2	-	-
Sodium	32	100	160	210	-	-
Sulphate	61	770	1,600	1,900	-	-
Soluble inorganic nitrogen	0.010	0.66	1.7	4.0	-	-
CN_{WAD} [A]	<0.001	NA	NA	NA	0.1	0
Arsenic	<0.005	<0.078	0.19	0.48	0.15	9
Copper[B]	<0.0005	<0.0024	0.0044	0.0050	0.009[D]	0
Iron[C]	0.04	0.15	0.45	0.57	1	0
Lead[B]	0.0001	0.0009	0.0042	0.0080	0.0025[D]	1

Notes: All units g/m^3 unless stated; all data presented to two significant figures or less; NA = not applicable; [A] CN_{WAD} was below the detection limit on all sampling occasions; [B] summary statistics were derived after excluding detection limits superseded by lower limits; [C] an anomalous iron concentration (7.44 g/m^3) has been excluded from dataset; and [D] compliance limits for copper and lead are hardness dependent. The limits provided in this table have been calculated assuming a hardness of 100 g/m^3.

Table H20: Summary of P1 ground water quality.

Parameter	Minimum	Mean	95th percentile	Maximum
pH(unitless)	5.9	6.3	6.7	7.2
Conductivity (mS/m)	71	94	94	800
Calcium	4	5.21	6.075	20
Chloride	9.3	11	12	15
Magnesium	1.5	1.8	2.1	5.1
Potassium	0.49	0.84	1.7	4.1
Sodium	5.9	7.1	8.1	11
Sulphate	0.5	1.1	2.3	6.8
Soluble inorganic nitrogen	0.38	0.43	0.53	0.61
CN_{WAD} [A]	<0.001	NA	NA	NA
Arsenic[B]	<0.001	<0.0018	0.0030	0.017
Copper[B]	<0.0005	<0.0033	0.016	0.033
Iron[C]	<0.020	<0.061	0.16	0.46
Lead[B]	<0.0001	<0.0055	0.028	0.068

Notes: All units g/m^3 unless otherwise stated; and all data presented to two significant figures or less; NA = not applicable; [A] CN_{WAD} was below the detection limit on all sampling occasions; [B] Summary statistics were derived after excluding detection limits that have been superseded by lower limits; and [C] an anomalous iron concentration (30.9 g/m^3) has been excluded from dataset.

Table H21: Summary of GW2 groundwater quality.

Parameter	Minimum	Mean	95th percentile	Maximum
pH(unitless)	6.2	7.77	8.159	8.22
Conductivity (mS/m)	280	320	432	510
Calcium	40	48	54	55
Chloride	-	-	-	-
Magnesium	2.6	4.4	5.1	5.4
Potassium	0.8	0.99	1.2	1.4
Sodium	7.8	12	18	23
Sulphate	2.4	13	28	61
Soluble inorganic nitrogen	0.014	0.07	0.20	0.28
CN_{WAD} [A]	<0.005	NA	NA	NA
Arsenic[B]	<0.00080	<0.0039	0.0073	0.0080
Copper[B]	<0.0005	<0.0013	0.0027	0.0030
Iron	<0.02	<0.70	4.5	6.1
Lead[B]	<0.0001	<0.0064	0.016	0.016

Notes: All units g/m^3 unless stated; all data presented to two significant figures or less; NA = not applicable; [A] CN_{WAD} was below the detection limit on all sampling occasions; and [B] summary statistics were derived after excluding detection limits that have been superseded by lower limits.

Table H22: Summary of GW38 groundwater quality.

Parameter	Minimum	Mean	95th percentile	Maximum
pH(unitless)	6.2	6.9	7.2	7.5
Conductivity (mS/m)	79.00	250	360	550
Calcium	4.9	31	44	83
Chloride	7.8	14	20	28
Magnesium	2.0	4.2	6.6	11
Potassium	0.51	3.0	8.0	11
Sodium	7.1	11	14	20
Sulphate	0.72	4.8	9.3	32
Soluble inorganic nitrogen	0.13	4.3	16	18
CN_{WAD}	<0.001	<0.0046	0.0063	0.030
Arsenic[A]	<0.001	<0.0056	0.012	0.018
Copper[A]	<0.0005	<0.0022	0.0071	0.0090
Iron	<0.02	<2.4	4.6	7.9
Lead[A]	0.00010	0.0013	0.0058	0.0070

Notes: All units g/m^3 unless otherwise stated; all data presented to two significant figures or less; and [A] summary statistics derived after excluding detection limits that have been superseded by lower limits.

Table H23: Summary of GW3 groundwater quality.

Parameter	Minimum	Mean	95th percentile	Maximum
pH(unitless)	6.0	6.5	6.9	7.4
Conductivity (mS/m)	99	117	130	160
Calcium	1.2	4.5	6.4	31
Chloride	7.2	8.7	9.3	10
Magnesium	2.4	4.7	5.3	5.9
Potassium	0.52	1.1	1.2	2.4
Sodium	8.7	11	11	12
Sulphate	0.2	4.3	5.8	9.9
Soluble inorganic nitrogen	0.01	0.04	0.086	0.11
CN_{WAD} [A]	<0.001	NA	NA	NA
Arsenic[B]	<0.001	<0.0013	0.0026	0.0043
Copper[C]	<0.0005	NA	NA	0.00053
Iron	0.15	4.3	11	17
Lead[B]	<0.0001	<0.0021	0.011	0.013

Notes: All units g/m^3 unless otherwise stated; all data presented to two significant figures or less; NA = not applicable; [A] CN_{WAD} was below the detection limit on all sampling occasions; [B] summary statistics were derived after excluding detection limits superseded by lower limits; and [C] copper was below the detection limit on all but one sampling occasion.

Table H24: Summary of FDB03 groundwater quality.

Parameter	Minimum	Mean	95th percentile	Maximum
pH	6.4	6.7	7.0	7.1
Conductivity (mS/m)	110	160	650	760
Calcium	4.5	7.9	44	52
Chloride	5.1	7.3	21	35
Magnesium	4.6	7.6	38	48
Potassium	0.97	1.5	5.1	4.7
Sodium	7.6	11	31	37
Sulphate	<1	<16	190	230
Arsenic[A]	<0.001	<0.0027	0.0055	0.0060
Copper[B]	<0.0005	NA	NA	NA
Iron	0.03	2.7	5.0	5.0
Lead[B]	<0.0001	NA	NA	NA

Notes: All units g/m^3 unless stated; all data presented to two significant figures or less; NA = not applicable; [A] summary statistics were derived after excluding detection limits superseded by lower limits; and [B] copper and lead were below the detection limit on all sampling occasions.

Table H25: Summary of FDB04 groundwater quality.

Parameter	Minimum	Mean	95th percentile	Maximum
pH	6.6	7.1	7.6	7.9
Conductivity (mS/m)	130	990	1,900	2,000
Calcium	6.8	76	140	160
Chloride	5.6	20	28	35
Magnesium	5.7	86	203	220
Potassium	1.5	5.3	9.4	11
Sodium	9.4	27	40	51
Sulphate	7.2	390	900	1,000
Arsenic[A]	0.0022	0.0036	0.0057	0.0060
Copper[A]	<0.0005	<0.0008	0.0011	0.0011
Iron	0.09	0.95	2.2	2.4
Lead[B]	<0.0001	NA	NA	NA

Notes: All units g/m^3 unless stated; all data presented to two significant figures or less; NA = not applicable; [A] summary statistics were derived after excluding detection limits superseded by lower limits; and [B] lead was below the detection limit on all sampling occasions.

Table H26: Summary of FDB05 groundwater quality.

Parameter	Minimum	Mean	95th percentile	Maximum
pH	6.7	7.2	7.7	7.8
Conductivity (mS/m)	190	290	480	760
Calcium	16	24	34	64
Chloride	5.3	8.8	15	19
Magnesium	6.1	11	27	53
Potassium	0.81	3.0	7.9	8.8
Sodium	12	15	23	24
Sulphate	2.2	31	130	300
Arsenic[A]	0.0013	0.0051	0.0080	0.0080
Copper[A]	<0.0005	<0.0024	0.0055	0.0060
Iron	<0.02	<2.5	6.7	7.2
Lead[A]	<0.0001	<0.011	0.029	0.032

Notes: All units g/m^3 unless stated; all data presented to two significant figures or less; and [A] summary statistics were derived after excluding detection limits superseded by lower limits.

Table H27: Summary of FDB06 groundwater quality.

Parameter	Minimum	Mean	95th percentile	Maximum
pH	5.0	5.6	7.0	7.2
Conductivity (mS/m)	210	1,500	2,300	2,400
Calcium	18	160	290	320
Chloride	6.8	21	28	30
Magnesium	8.8	130	230	240
Potassium	0.62	1.1	1.7	2.2
Sodium	13	41	56	66
Sulphate	5.4	940	1,600	1,700
Arsenic[A]	<0.001	NA	NA	NA
Copper[B]	0.0019	0.13	0.36	0.40
Iron[A]	<0.02	NA	NA	NA
Lead[B]	<0.0001	<0.00015	0.0002	0.0002

Notes: All units g/m^3 unless stated; all data presented to two significant figures or less; NA = not applicable; [A] arsenic and iron were below the detection limit on all sampling occasions; and [B] summary statistics were derived after excluding detection limits superseded by lower limits.

Table H28: Summary of FDB07 groundwater quality.

Parameter	Minimum	Mean	95th percentile	Maximum
pH	5.4	5.7	5.9	6.1
Conductivity (mS/m)	190	250	350	360
Calcium	9.2	14	20	23
Chloride	15	20	21	51
Magnesium	6.3	9.1	14	15
Potassium	0.49	0.70	0.83	0.89
Sodium	15	18	22	25
Sulphate	34	62	96	100
Arsenic[A]	<0.001	<0.0027	0.0055	0.0060
Copper[A]	<0.0005	<0.00057	0.00068	0.00070
Iron	<0.02	<0.30	1.1	1.5
Lead[A]	<0.0001	<0.00014	0.00018	0.00019

Notes: All units g/m^3 unless stated; all data presented to two significant figures or less; and [A] summary statistics were derived after excluding detection limits superseded by lower limits.

Table H29: Summary of FDB08 groundwater quality.

Parameter	Minimum	Mean	95th percentile	Maximum
pH	5.6	5.9	6.4	6.5
Conductivity (mS/m)	53	370	1,000	1,400
Calcium	6.3	29	98	150
Chloride	20	44	56	58
Magnesium	4.3	20	69	120
Potassium	0.57	0.83	1.2	1.6
Sodium	12	24	52	66
Sulphate	1.0	137	535	850
Arsenic[A]	<0.001	NA	NA	NA
Copper[A]	<0.0005	NA	NA	NA
Iron	<0.02	<0.07	0.15	0.16
Lead[B]	0.00022	0.00026	0.00029	0.00029

Notes: All units g/m^3 unless stated; all data presented to two significant figures or less; NA = not applicable; [A] arsenic and copper were below the detection limit on all sampling occasions; and [B] summary statistics were derived after excluding detection limits superseded by lower limits.

Table H30: Summary of FDB09 groundwater quality.

Parameter	Minimum	Mean	95th percentile	Maximum
pH	5.9	6.2	6.3	6.3
Conductivity (mS/m)	170	320	440	460
Calcium	12	26	35	35
Chloride	11	16	24	27
Magnesium	6.2	16	24	27
Potassium	1.4	2.4	4.3	5.0
Sodium	11	13	16	16
Sulphate	12	33	65	83
Arsenic[A]	0.0070	NA	NA	NA
Copper[B]	<0.002	NA	NA	NA
Iron	0.07	0.22	0.33	0.34
Lead[B]	<0.001	NA	NA	NA

Notes: All units g/m^3 unless stated; all data presented to two significant figures or less; NA = not applicable; [A] arsenic was sampled on one occasion; and [B] copper and lead were below the detection limit on all sampling occasions.

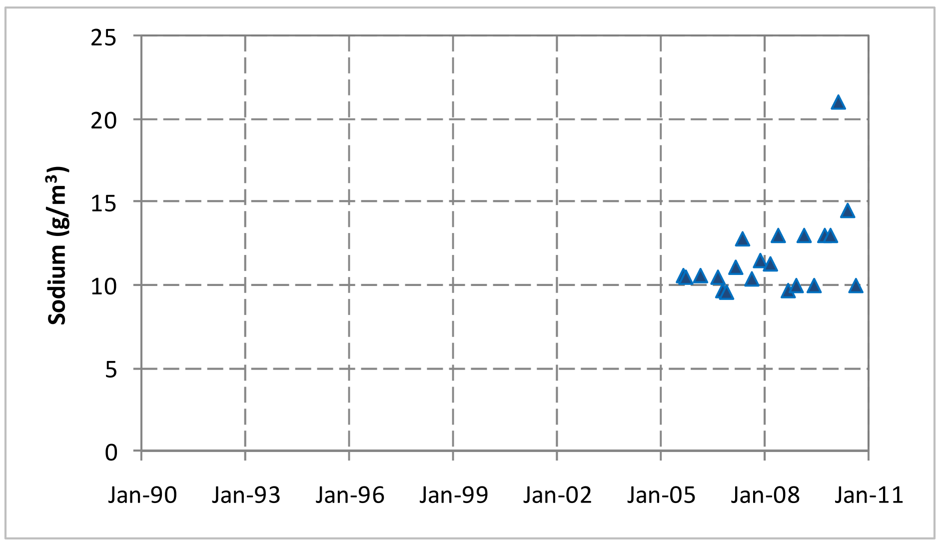
Table H31: Summary of FDB10 groundwater quality.

Parameter	Minimum	Mean	95th percentile	Maximum
pH	6.9	7.2	7.4	7.4
Conductivity (mS/m)	230	280	350	400
Calcium	22	28	35	40
Chloride	21	24	27	29
Magnesium	6.2	7.8	10	11
Potassium	1.0	1.2	1.4	1.5
Sodium	13	14	17	21
Sulphate	1.5	19	51	68
Arsenic[A]	<0.002	<0.0024	0.0027	0.0027
Copper[B]	<0.0005	NA	NA	0.00057
Iron	<0.02	<0.82	1.3	1.3
Lead[A]	<0.0001	<0.00012	0.00014	0.00014

Notes: All units g/m^3 unless stated; all data presented to two significant figures or less; NA = not applicable; [A] summary statistics were derived after excluding detection limits superseded by lower limits; and [B] copper was below the detection limit on one of two sampling occasions.

APPENDIX I

Surface water quality data


Sodium (g/m³)
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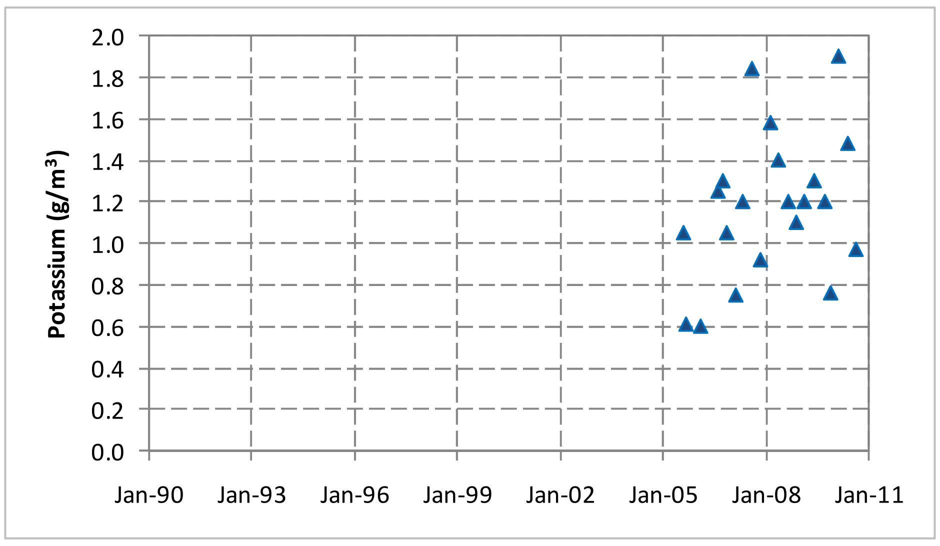
20
25
Jan-90
Jan-93
Jan-96
Jan-99
Jan-02
Jan-05
Jan-08
Jan-11


Potassium (g/m³)
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0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
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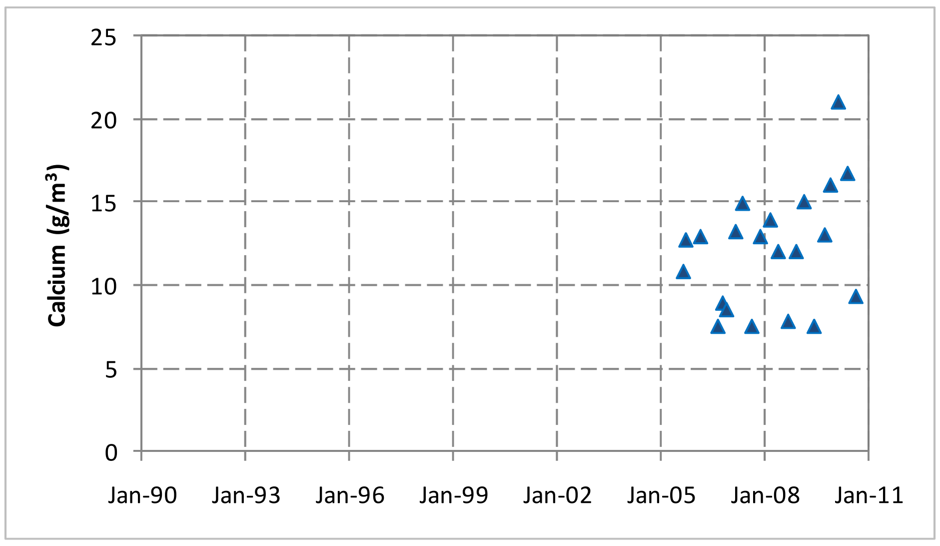
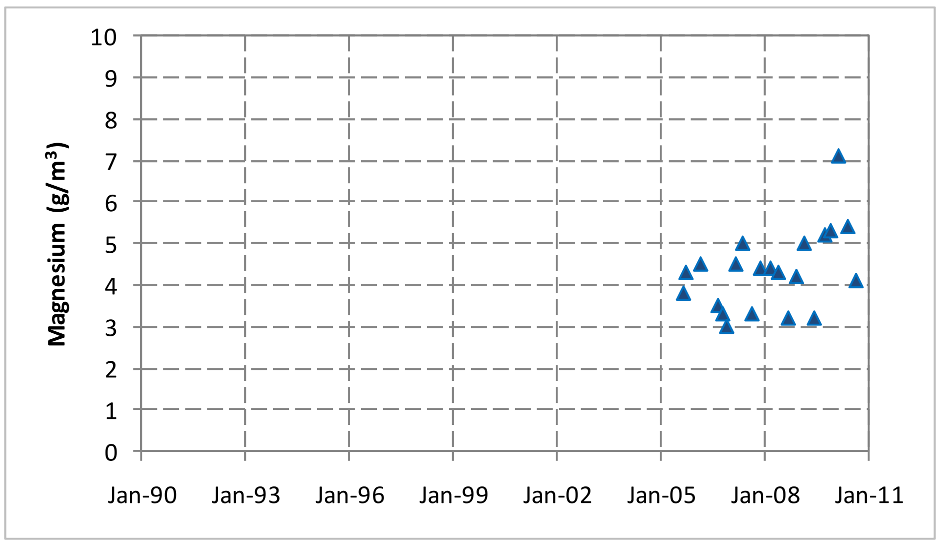
Jan-05
Jan-08
Jan-11


Calcium (g/m³)
0
5
10
15
20
25
Jan-90
Jan-93
Jan-96
Jan-99
Jan-02
Jan-05
Jan-08
Jan-11


Magnesium (g/m³)
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1
2
3
4
5
6
7
8
9
10
Jan-90
Jan-93
Jan-96
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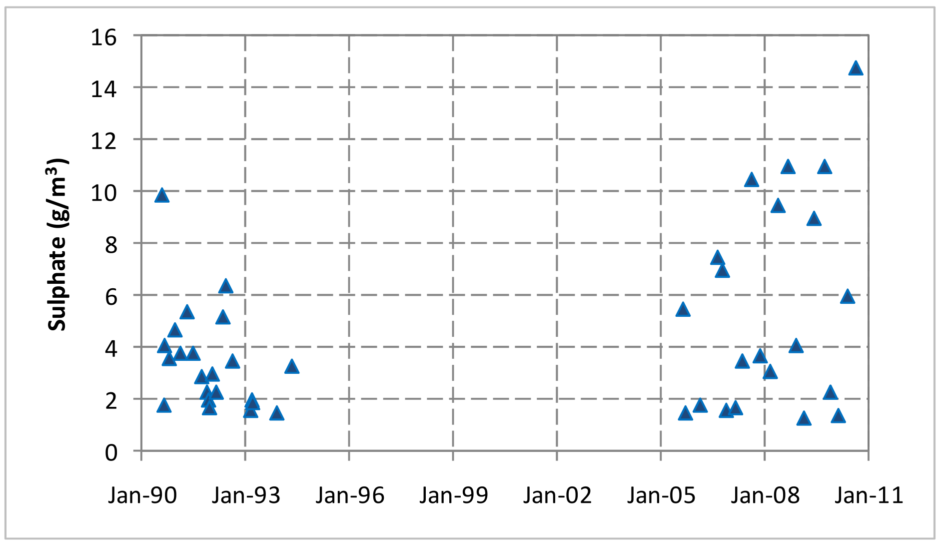
Jan-05
Jan-08
Jan-11


Sulphate (g/m³)
0
2
4
6
8
10
12
14
16
Jan-90
Jan-93
Jan-96
Jan-99
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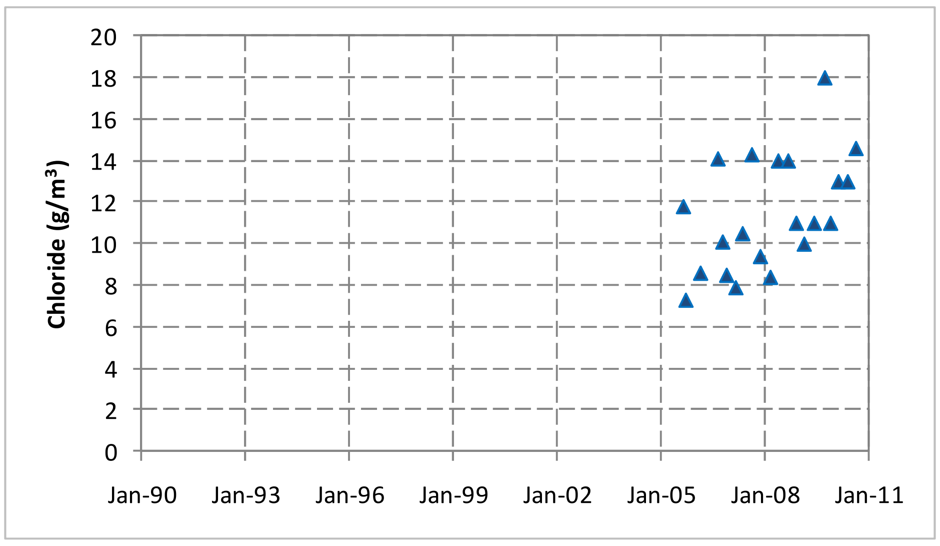
Jan-05
Jan-08
Jan-11


Chloride (g/m³)
0
2
4
6
8
10
12
14
16
18
20
Jan-90
Jan-93
Jan-96
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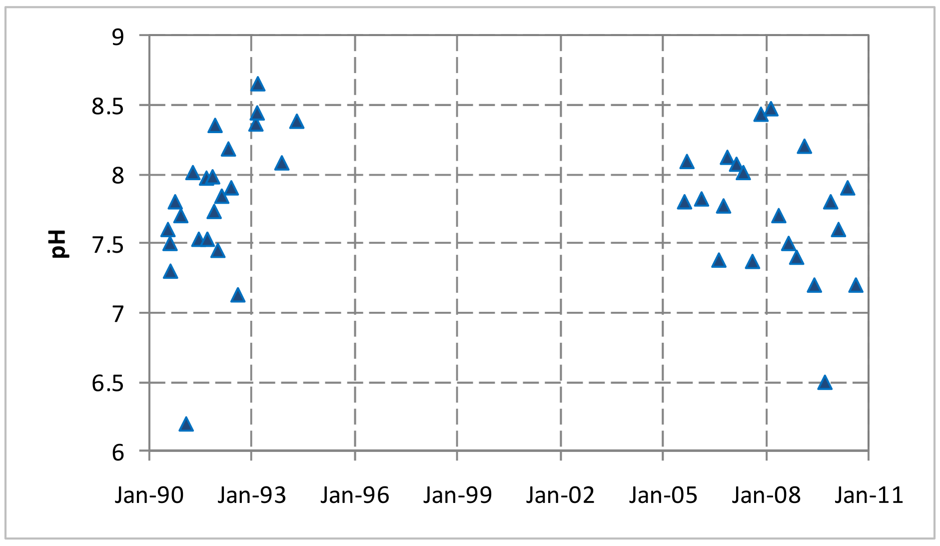
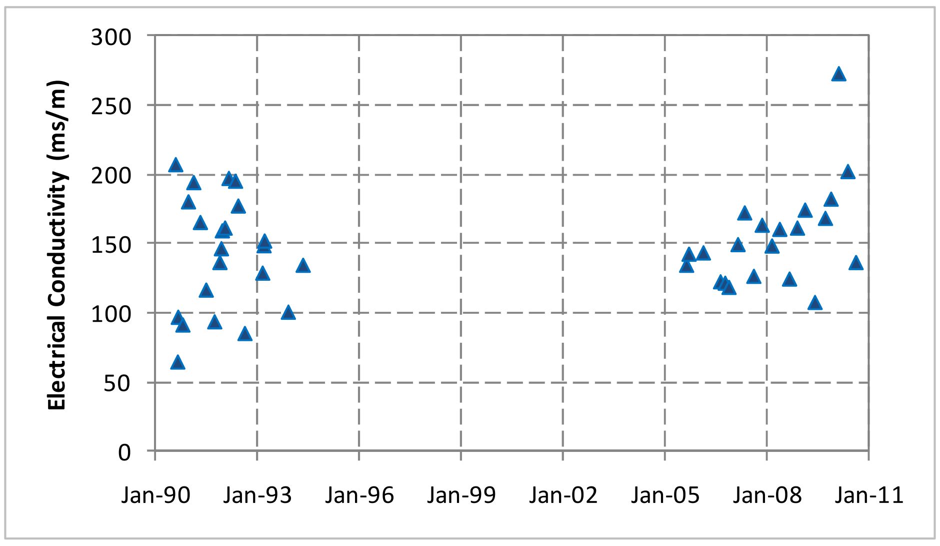
Jan-05
Jan-08
Jan-11


pH
6
6.5
7
7.5
8
8.5
9
Jan-90
Jan-93
Jan-96
Jan-99
Jan-02
Jan-05
Jan-08
Jan-11


Electrical Conductivity (ms/m)
0
50
100
150
200
250
300
Jan-90
Jan-93
Jan-96
Jan-99
Jan-02
Jan-05
Jan-08
Jan-11

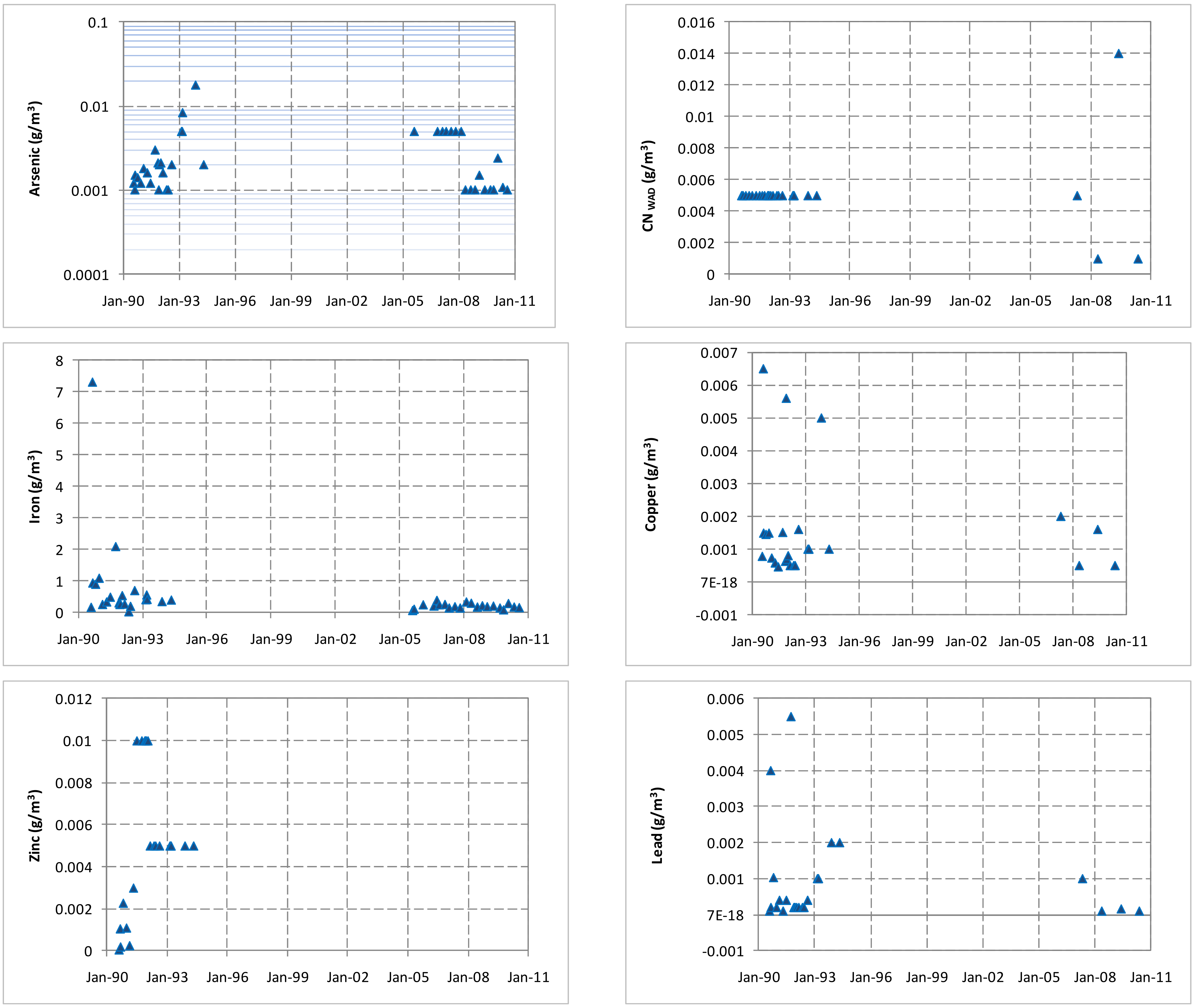
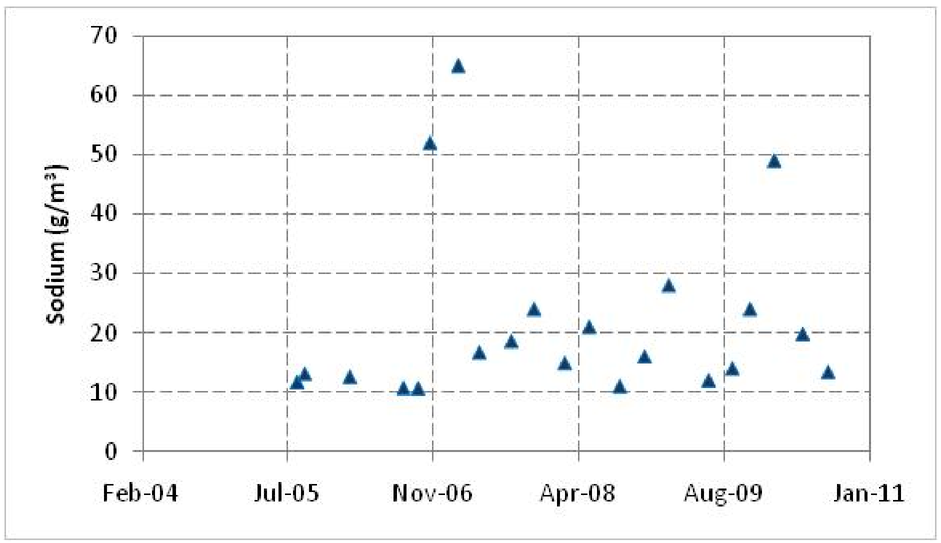


Figure I1: DC01 water quality


Sodium (g/m³)
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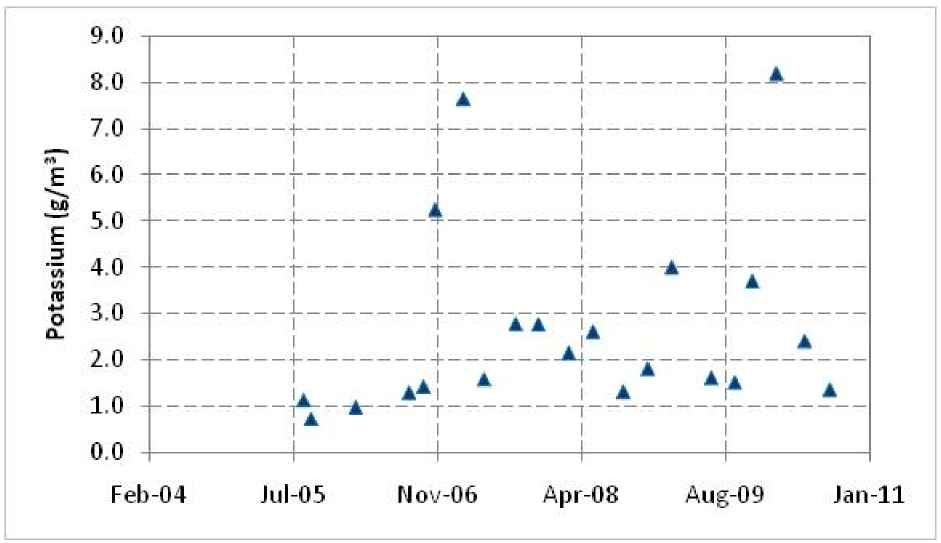
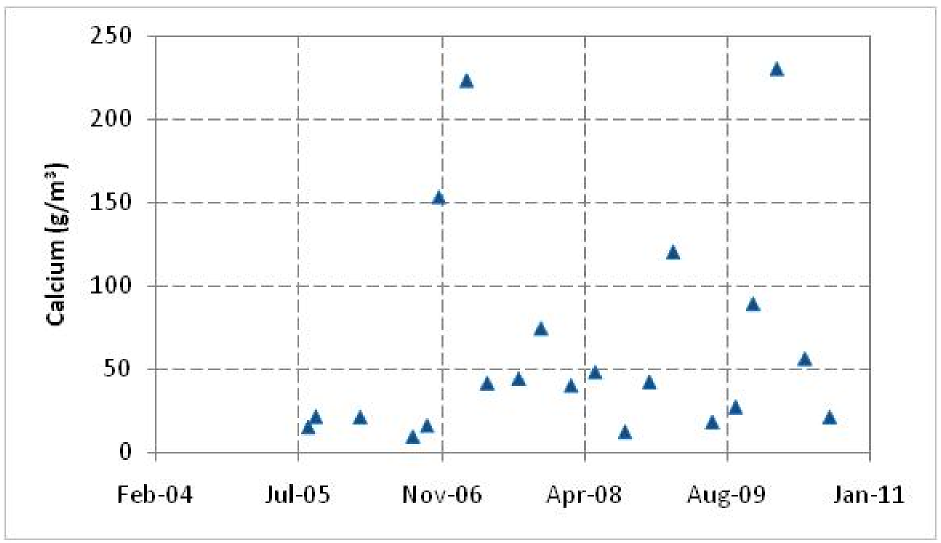
10
20
30
40
50
60
70
Feb-04
Jul-05
Nov-06
Apr-08
Aug-09
Jan-11


Potassium (g/m³)
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
Feb-04
Jul-05
Nov-06
Apr-08
Aug-09
Jan-11


Calcium (g/m³)
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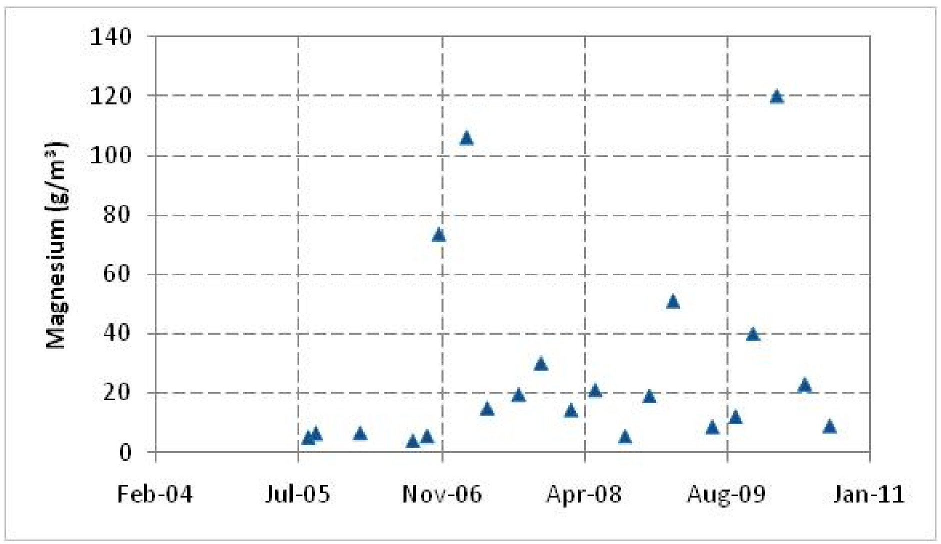
50
100
150
200
250
Feb-04
Jul-05
Nov-06
Apr-08
Aug-09
Jan-11


Magnesium (g/m³)
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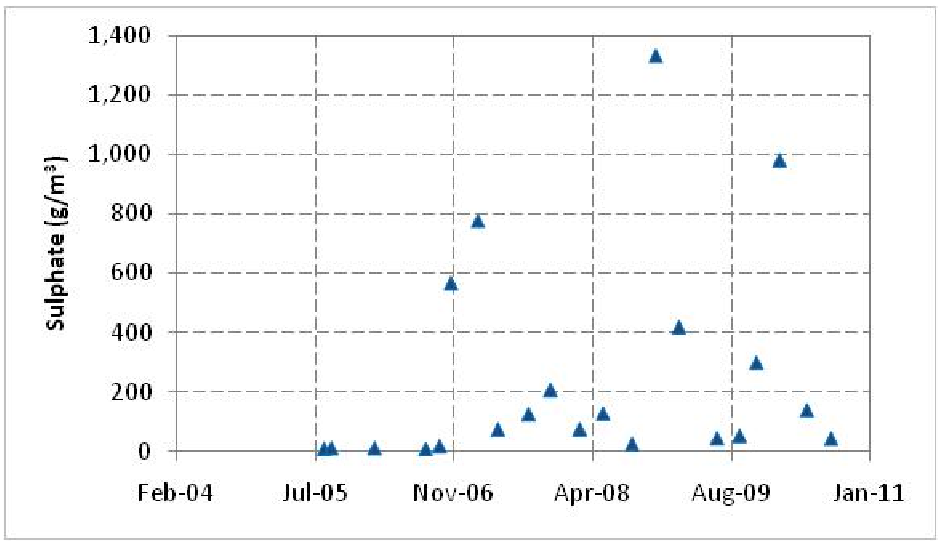
20
40
60
80
100
120
140
Feb-04
Jul-05
Nov-06
Apr-08
Aug-09
Jan-11


Sulphate (g/m³)
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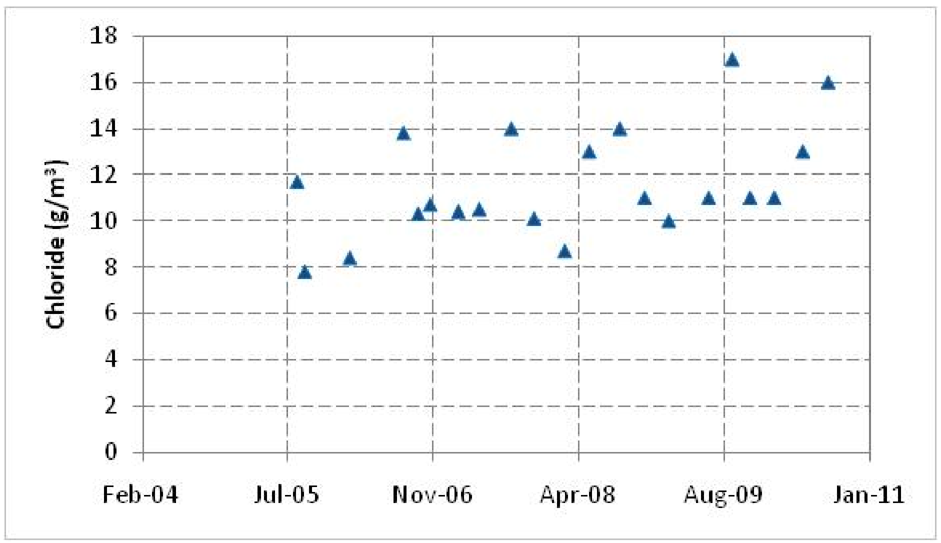
200
400
600
800
1,000
1,200
1,400
Feb-04
Jul-05
Nov-06
Apr-08
Aug-09
Jan-11


Chloride (g/m³)
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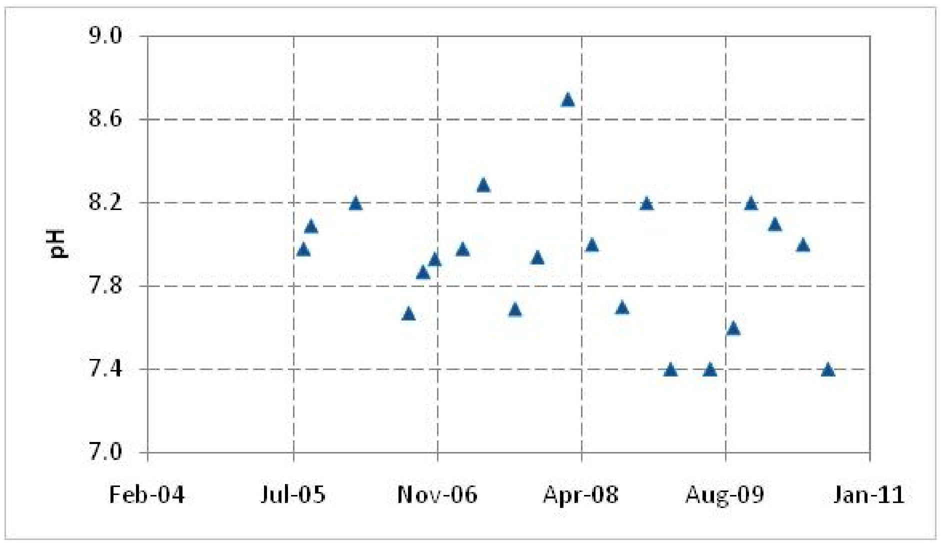
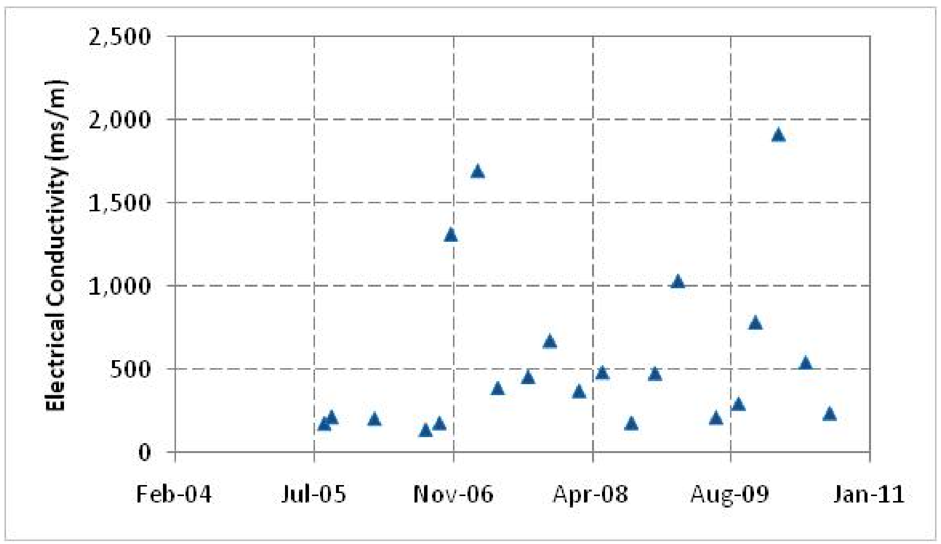
2
4
6
8
10
12
14
16
18
Feb-04
Jul-05
Nov-06
Apr-08
Aug-09
Jan-11


pH
7.0
7.4
7.8
8.2
8.6
9.0
Feb-04
Jul-05
Nov-06
Apr-08
Aug-09
Jan-11


Electrical Conductivity (ms/m)
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500
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1,500
2,000
2,500
Feb-04
Jul-05
Nov-06
Apr-08
Aug-09
Jan-11

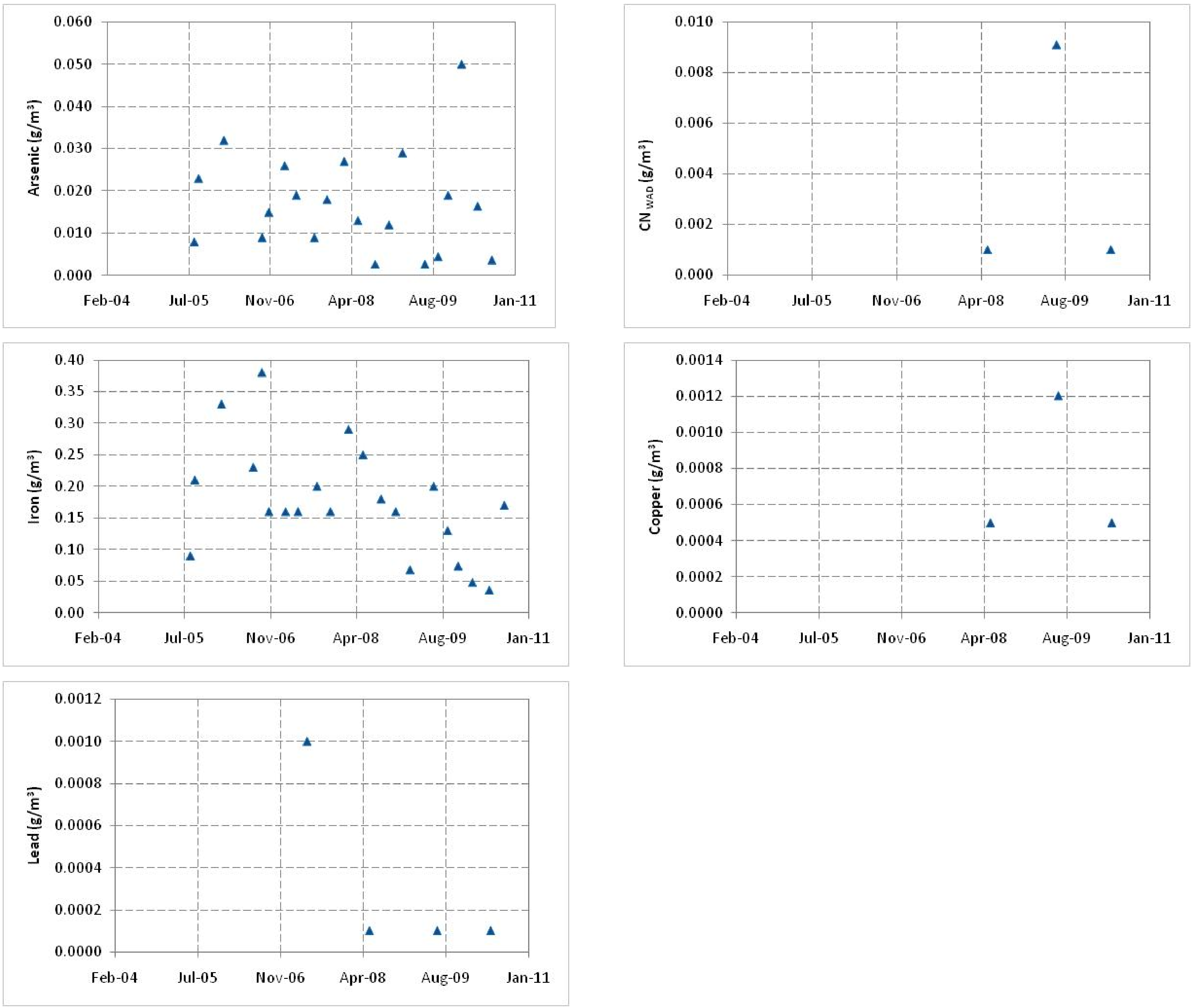
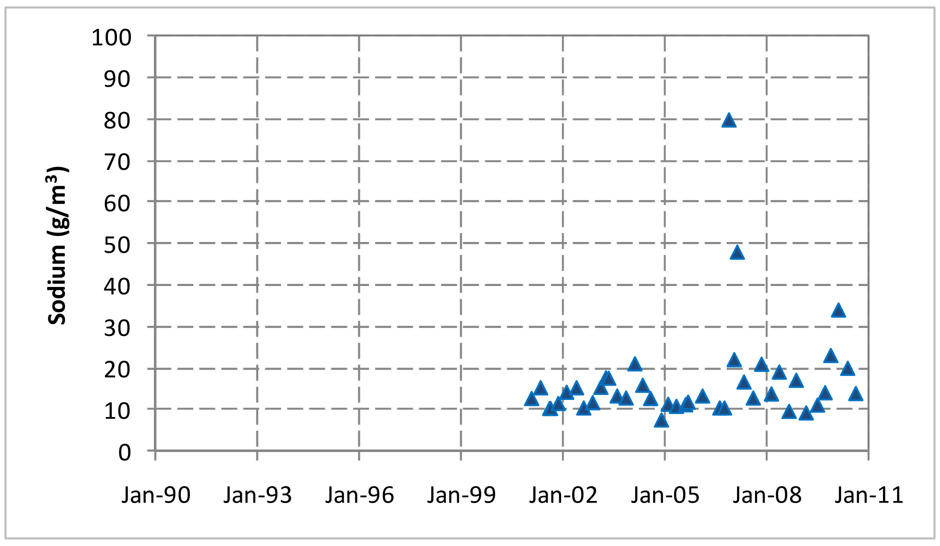


Figure I1: DC06 water quality


Sodium (g/m³)
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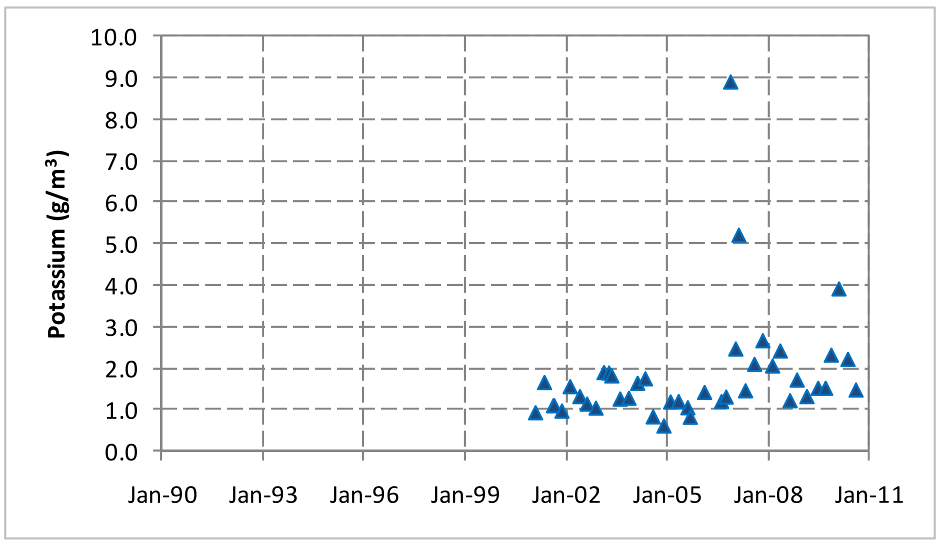
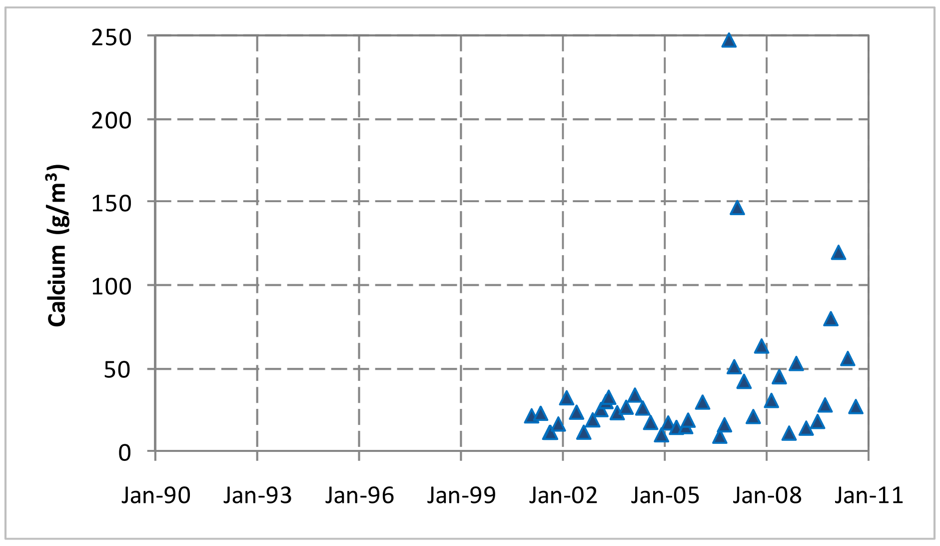
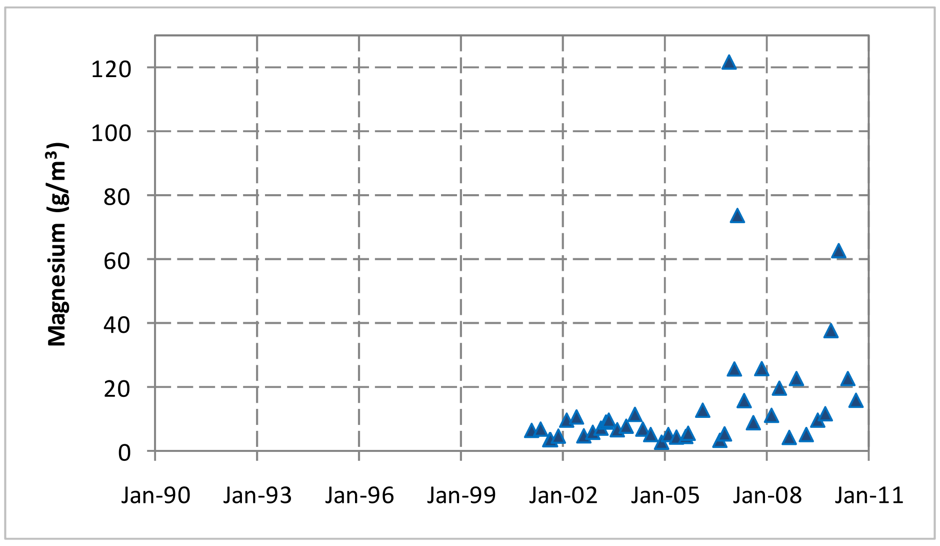
90
80
70
60
50
40
30
20
10
0
Jan-90 Jan-93 Jan-96 Jan-99 Jan-02 Jan-05 Jan-08 Jan-11


Potassium (g/m³)
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Jan-90 Jan-93 Jan-96 Jan-99 Jan-02 Jan-05 Jan-08 Jan-11


Calcium (g/m³)
250
200
150
100
50
0
Jan-90 Jan-93 Jan-96 Jan-99 Jan-02 Jan-05 Jan-08 Jan-11


Magnesium (g/m³)
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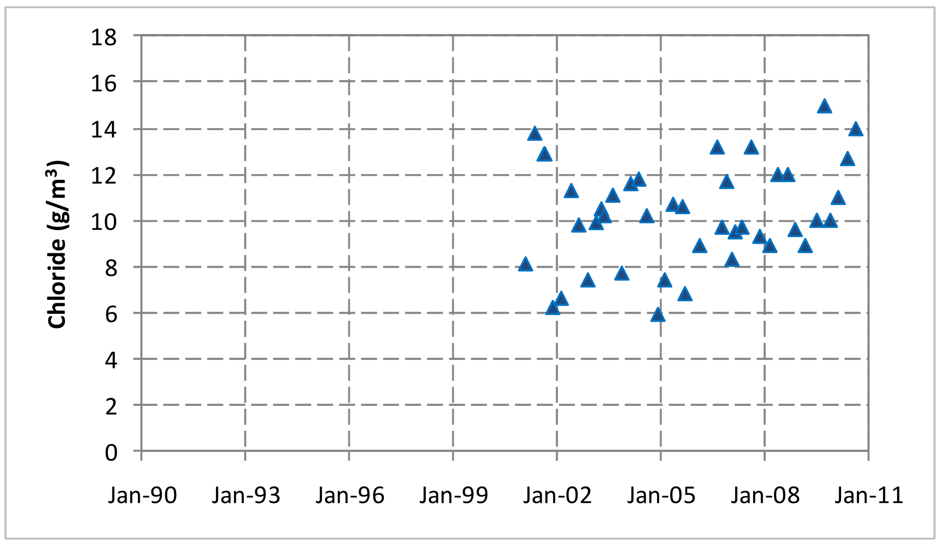
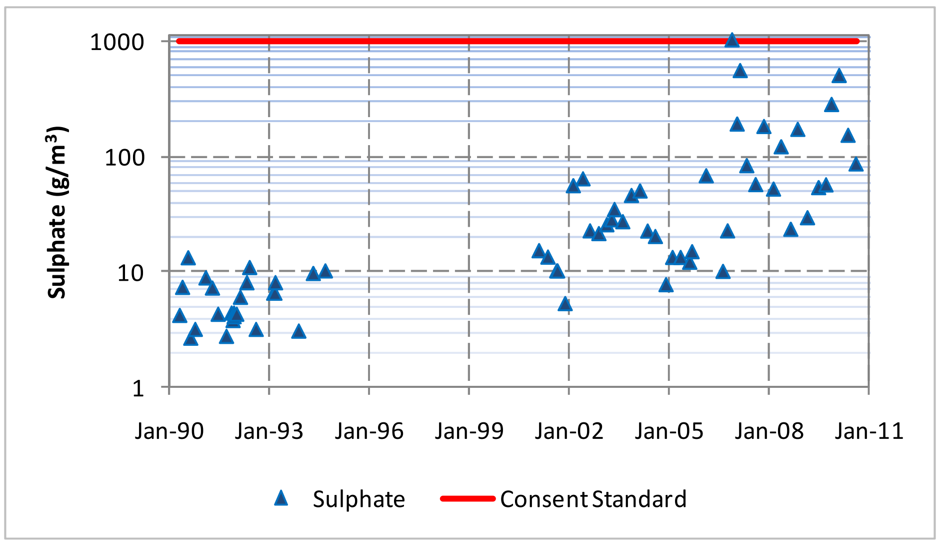
100
80
60
40
20
0
Jan-90 Jan-93 Jan-96 Jan-99 Jan-02 Jan-05 Jan-08 Jan-11


Chloride (g/m³)
18
16
14
12
10
8
6
4
2
0
Jan-90 Jan-93 Jan-96 Jan-99 Jan-02 Jan-05 Jan-08 Jan-11


Sulphate (g/m³)
1000
100
10
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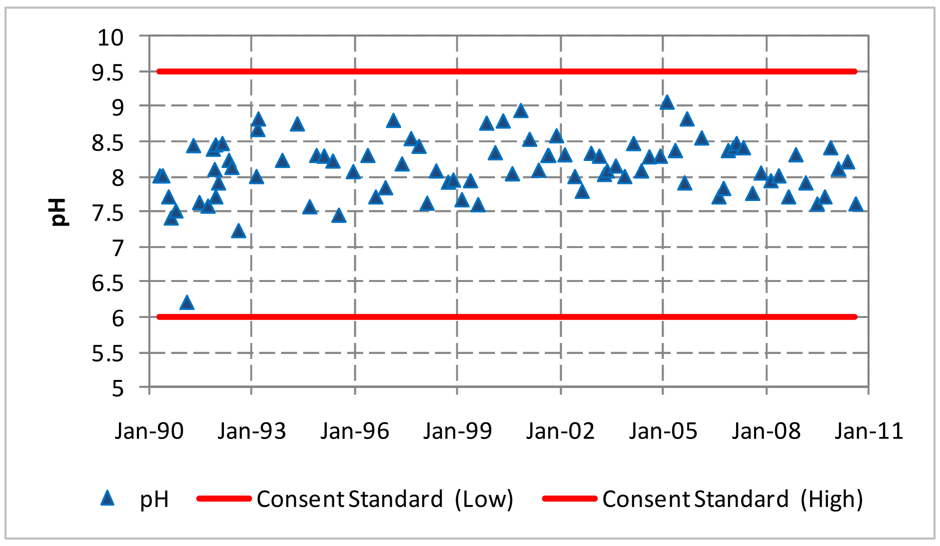
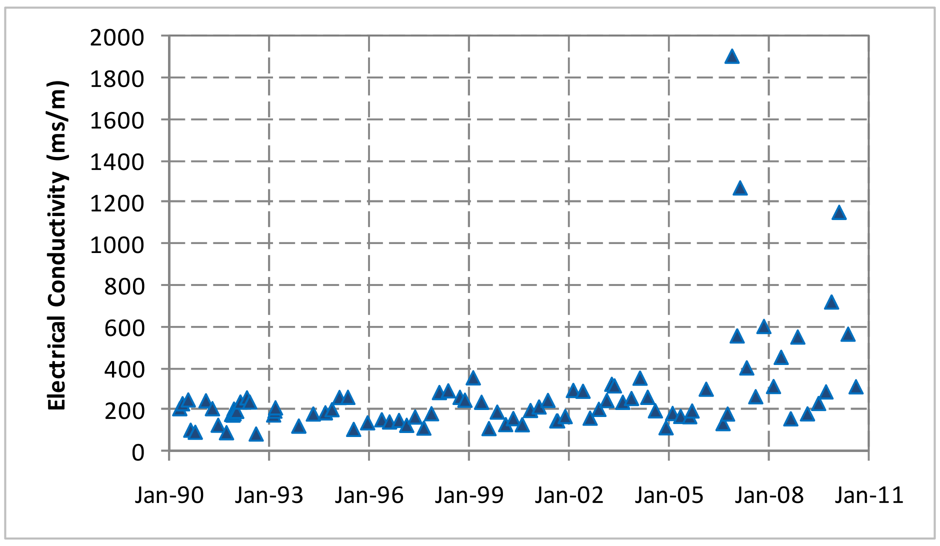
Jan-90 Jan-93 Jan-96 Jan-99 Jan-02 Jan-05 Jan-08 Jan-11
Sulphate
Consent Standard


pH
10
9.5
9
8.5
8
7.5
7
6.5
6
5.5
5
Jan-90 Jan-93 Jan-96 Jan-99 Jan-02 Jan-05 Jan-08 Jan-11
pH
Consent Standard (Low)
Consent Standard (High)


Electrical Conductivity (ms/m)
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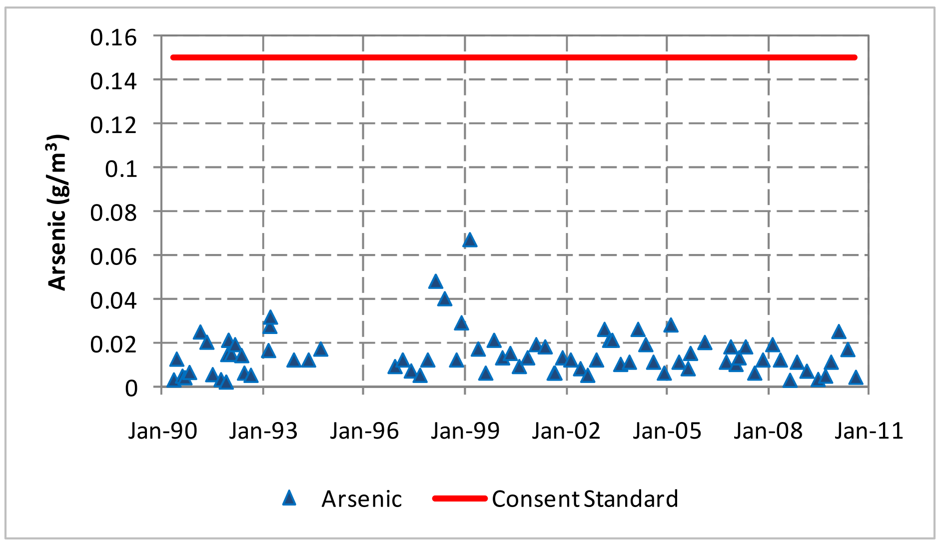
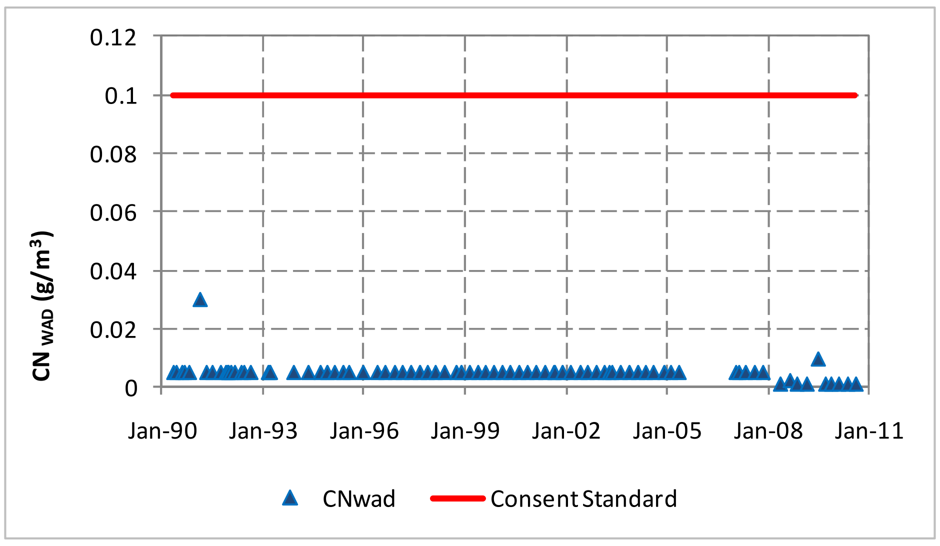
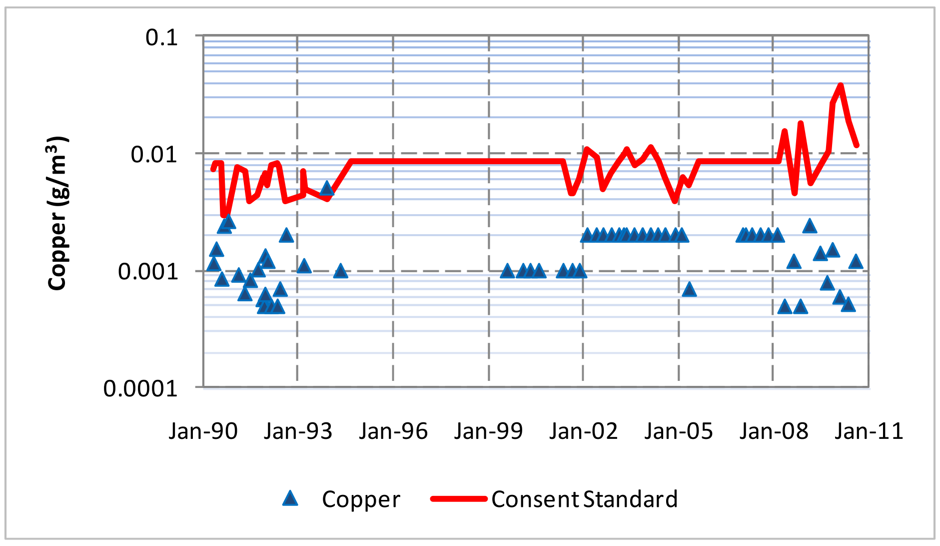
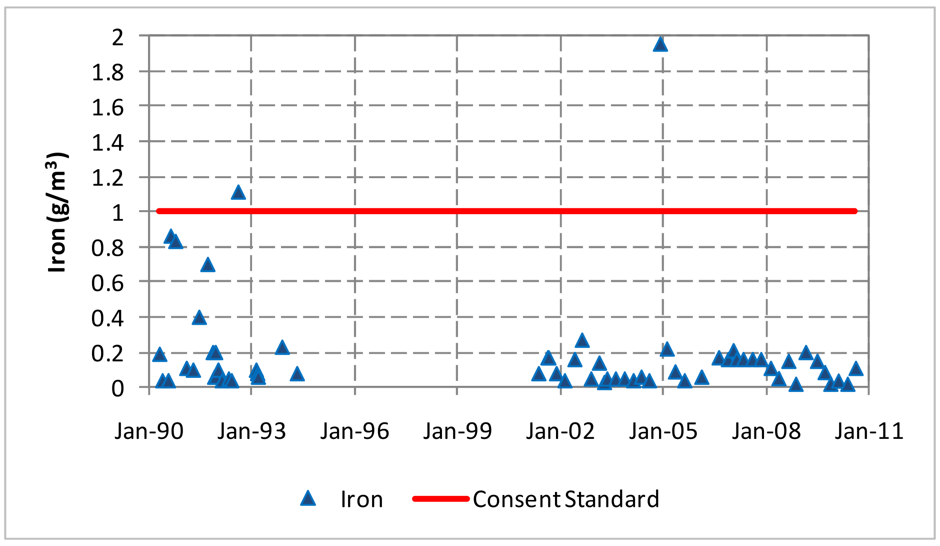
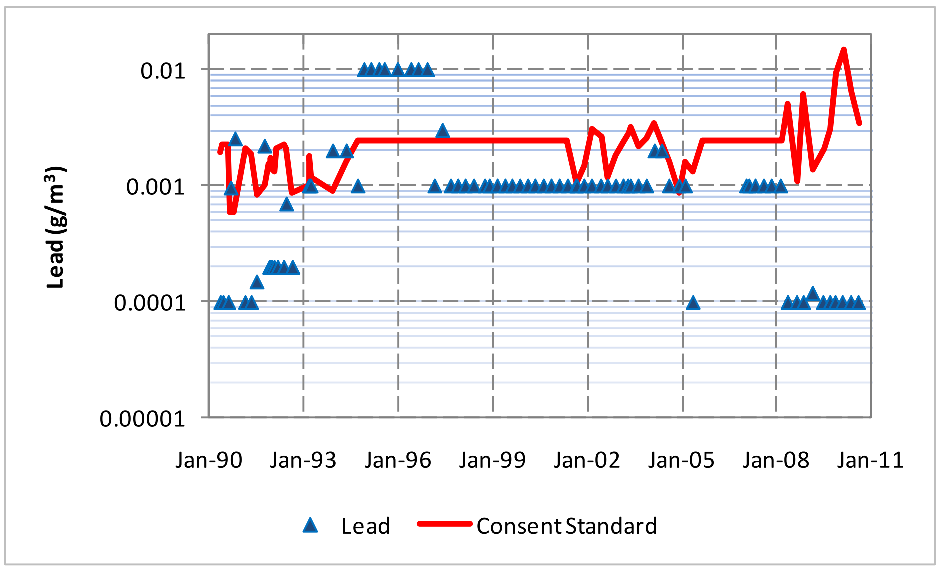
1800
1600
1400
1200
1000
800
600
400
200
0
Jan-90 Jan-93 Jan-96 Jan-99 Jan-02 Jan-05 Jan-08 Jan-11











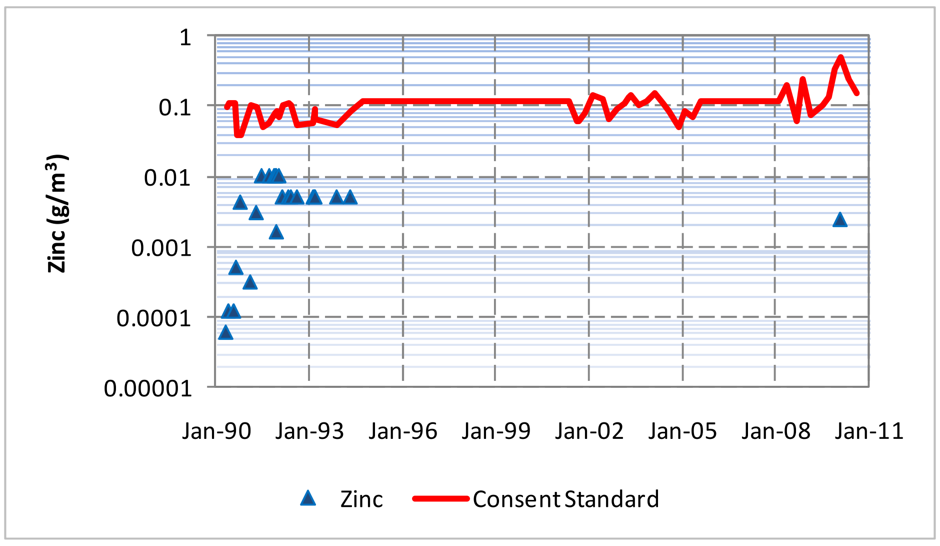
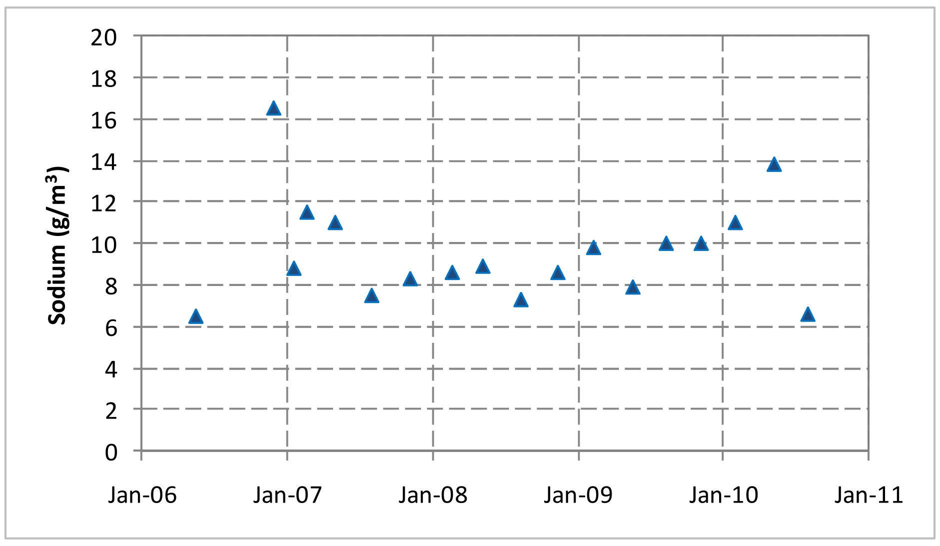
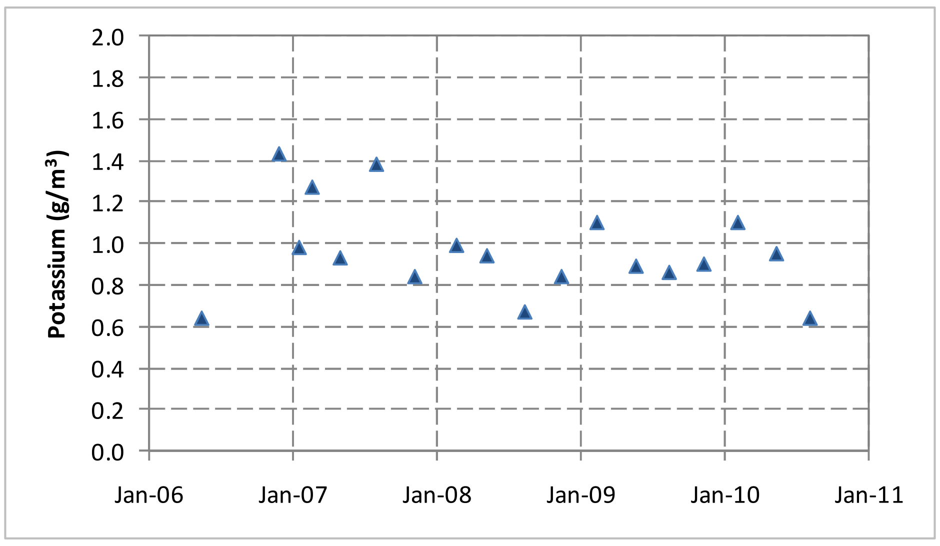
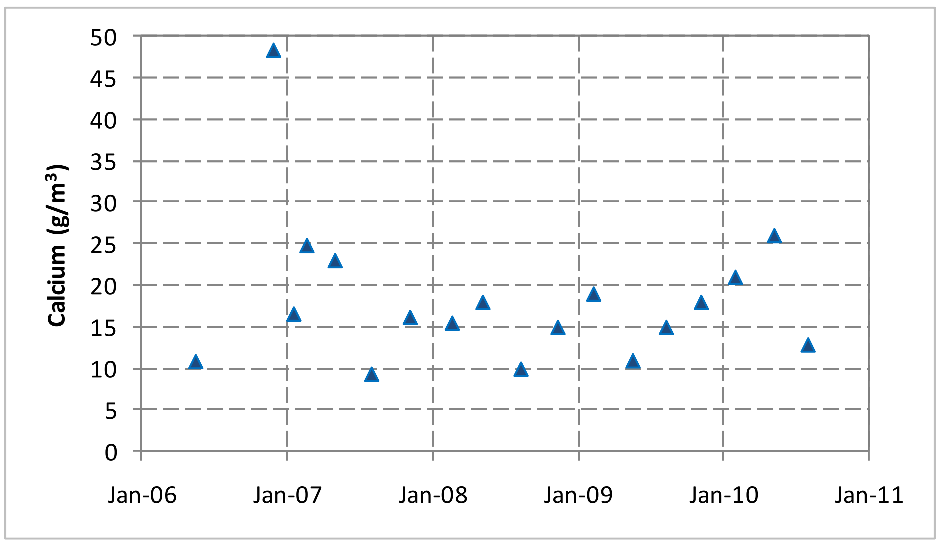
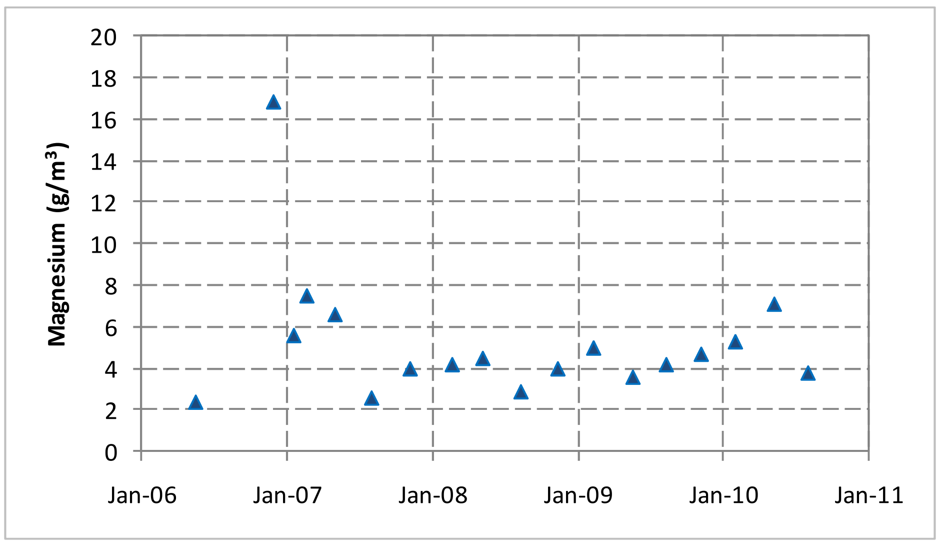


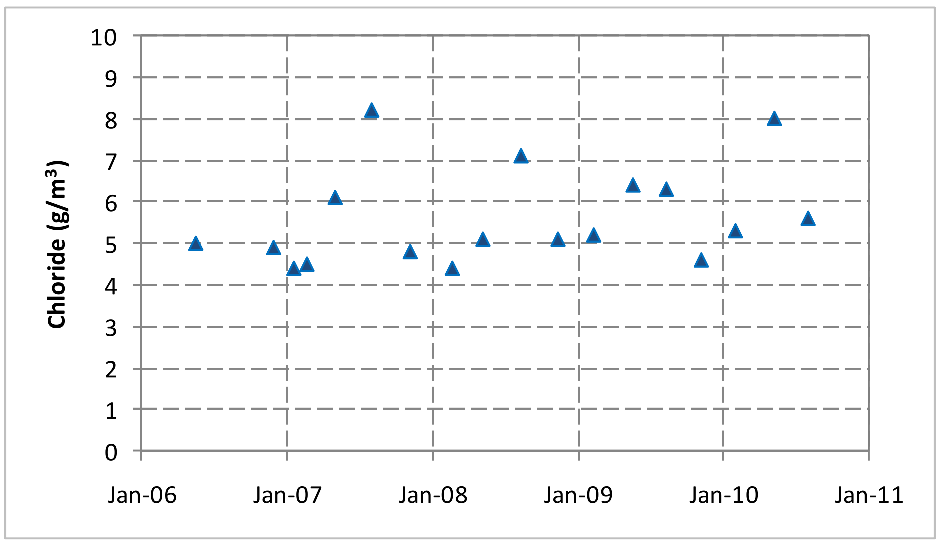
Figure I2: DC07 water quality.

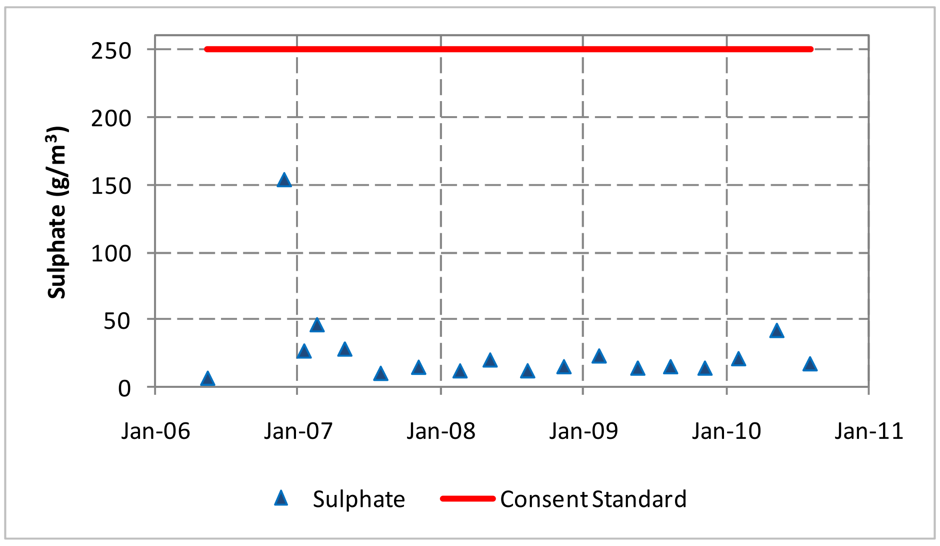

Sodium (g/m³)
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11

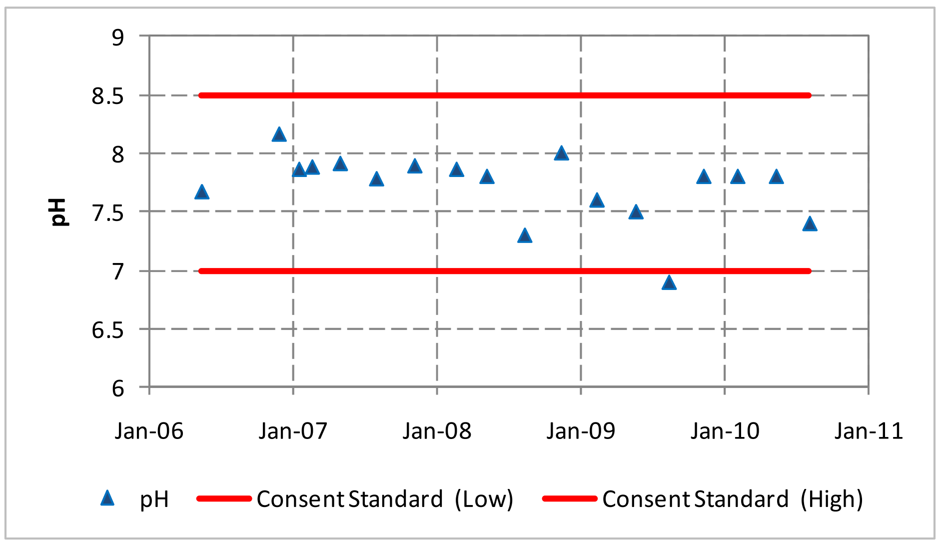

Potassium (g/m³)
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11

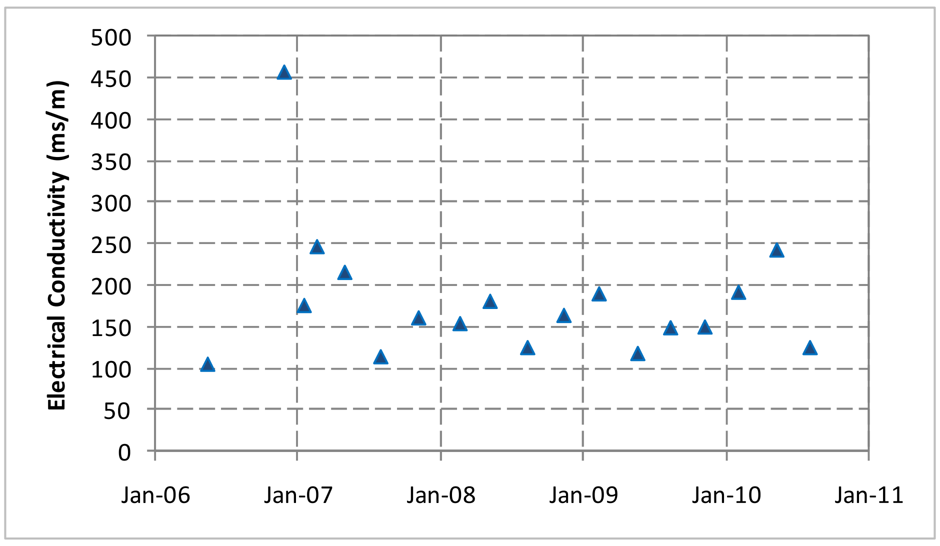

Calcium (g/m³)
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11


Magnesium (g/m³)
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11


Chloride (g/m³)
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11


Sulphate (g/m³)
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Sulphate
Consent Standard


pH
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
pH
Consent Standard (Low)
Consent Standard (High)


Electrical Conductivity (ms/m)
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11

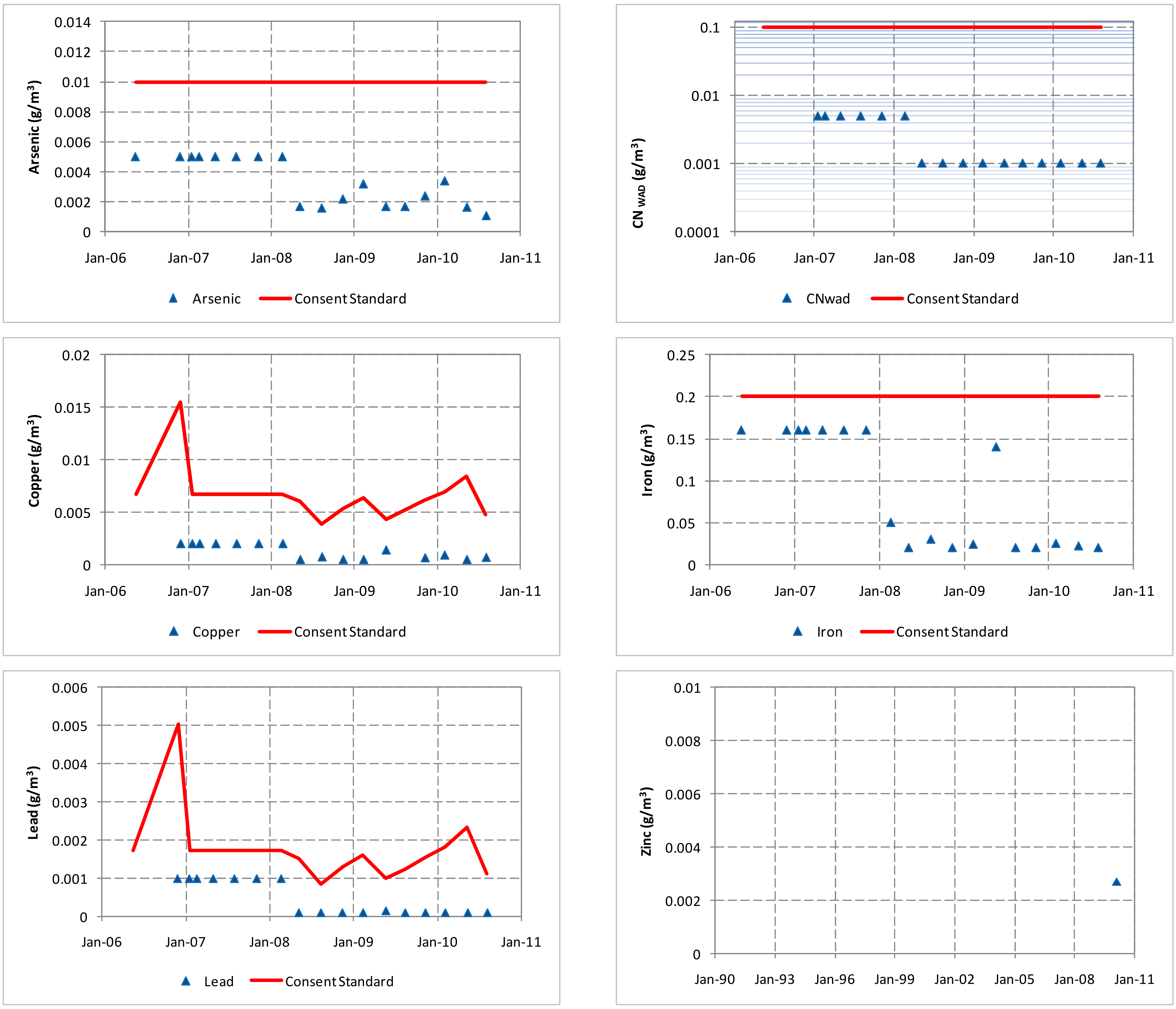
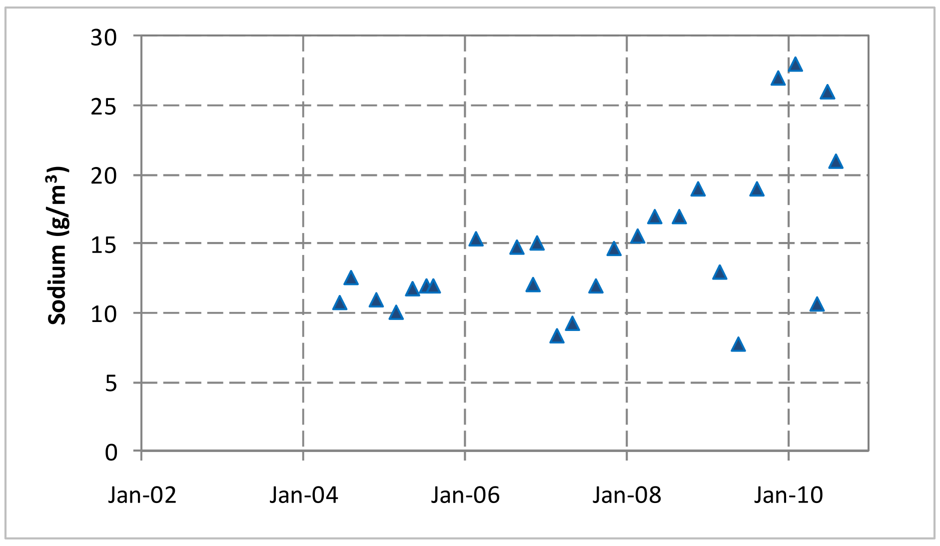
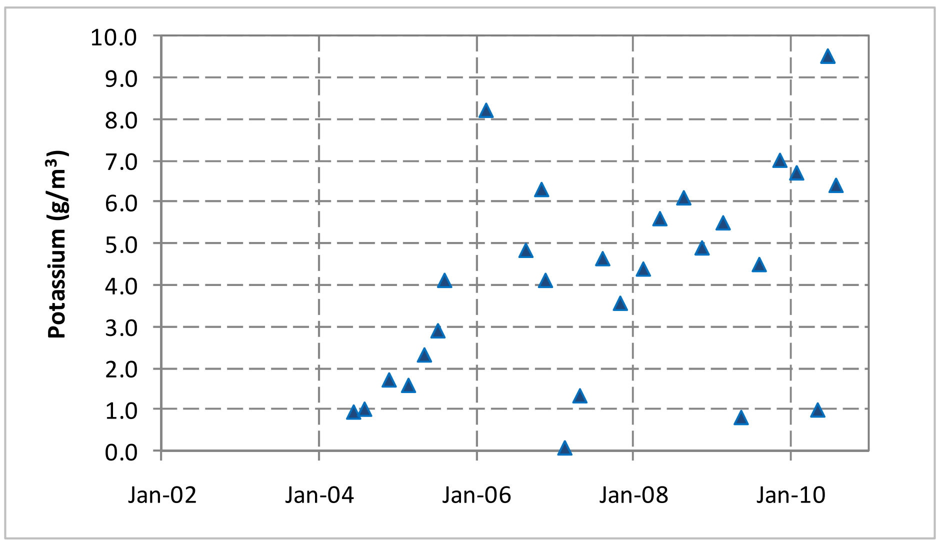
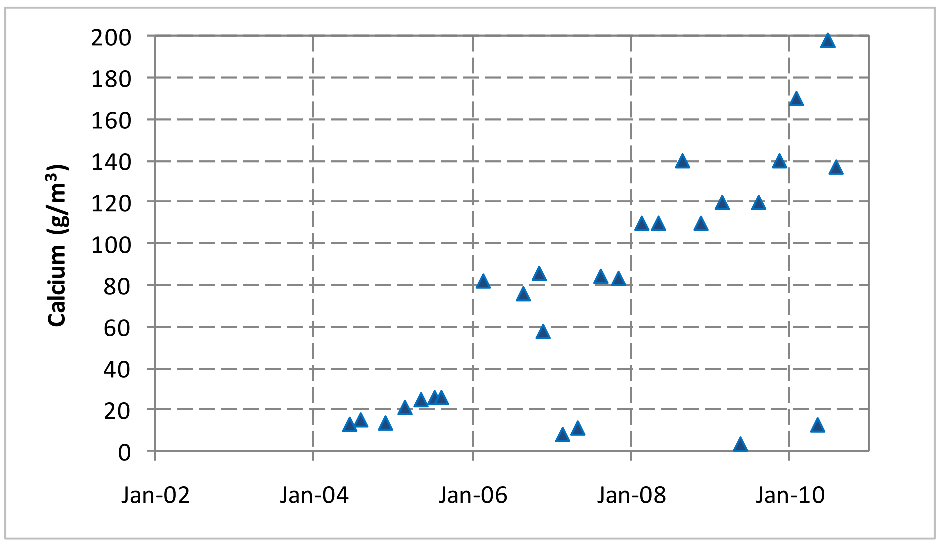
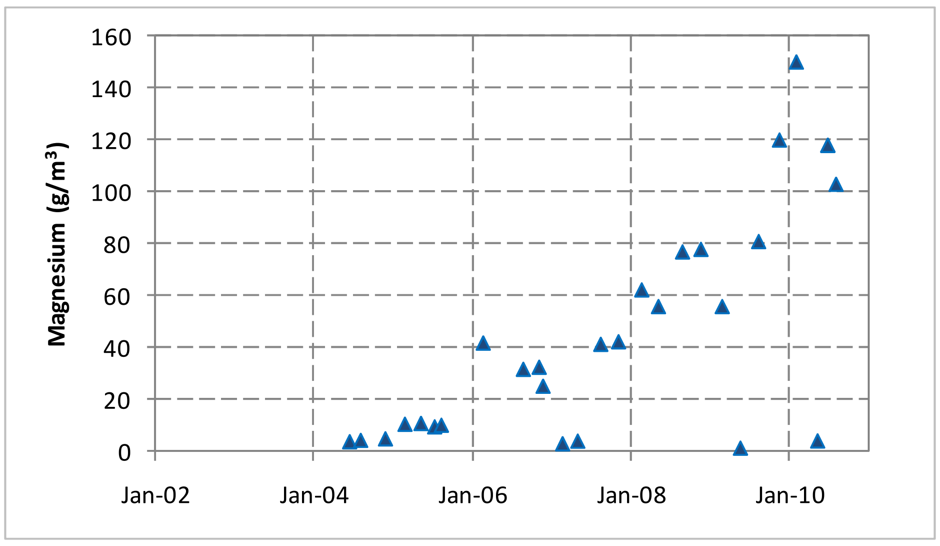


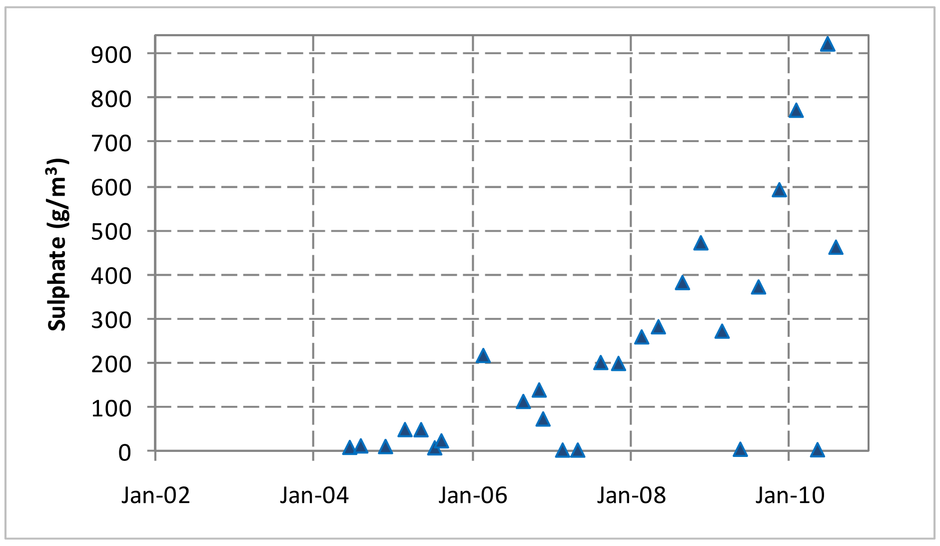
Figure I3: Shag River at Loop Road water quality.

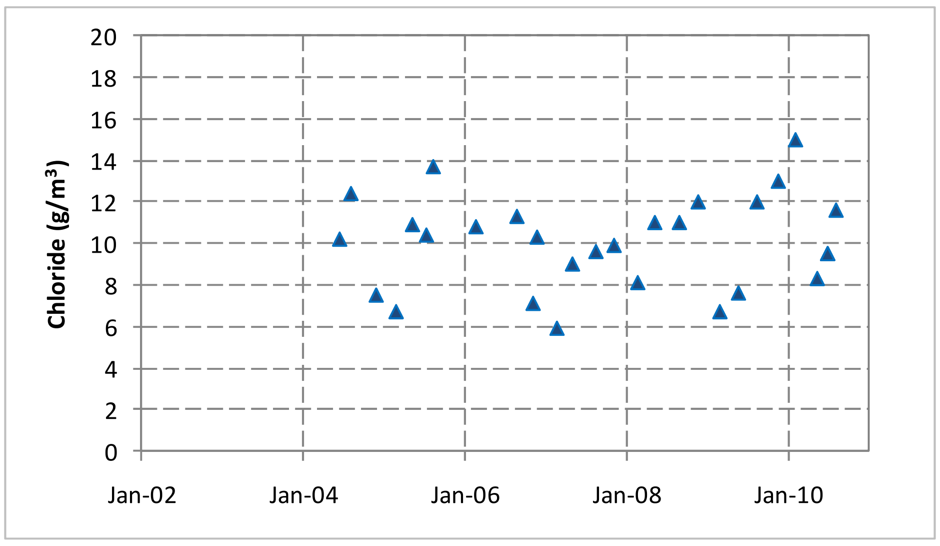

Sodium (g/m³)
0
5
10
15
20
25
30
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10

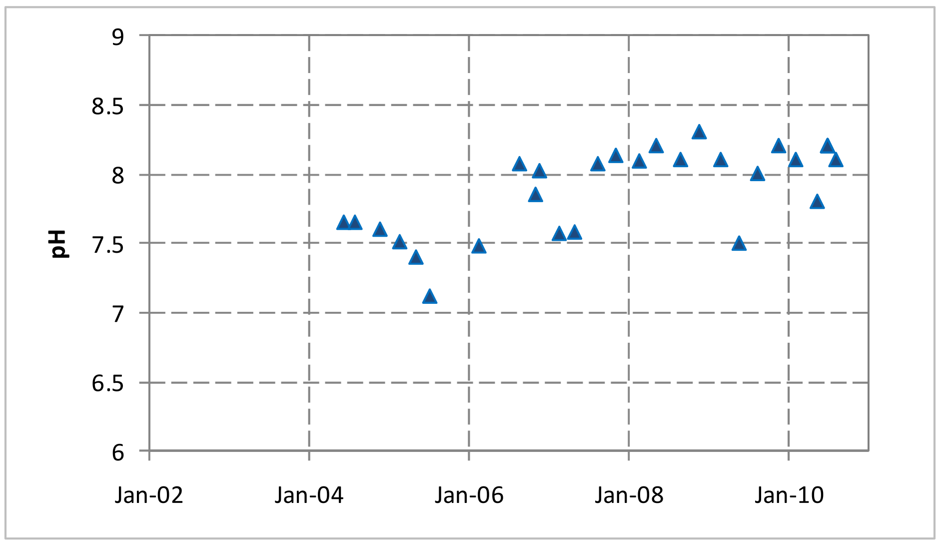

Potassium (g/m³)
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10

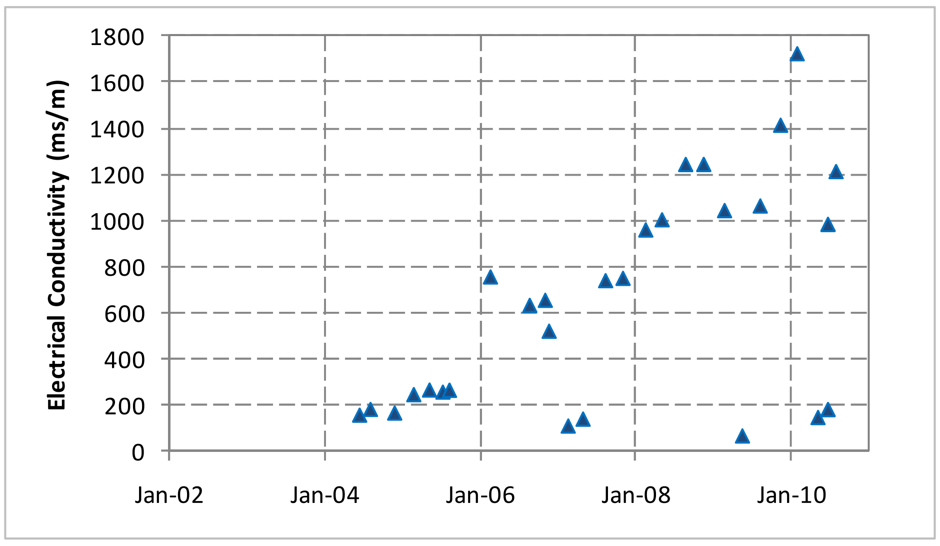

Calcium (g/m³)
0
20
40
60
80
100
120
140
160
180
200
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10


Magnesium (g/m³)
0
20
40
60
80
100
120
140
160
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10


Sulphate (g/m³)
0
100
200
300
400
500
600
700
800
900
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10


Chloride (g/m³)
0
2
4
6
8
10
12
14
16
18
20
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10


pH
6
6.5
7
7.5
8
8.5
9
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10


Electrical Conductivity (ms/m)
0
200
400
600
800
1000
1200
1400
1600
1800
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10

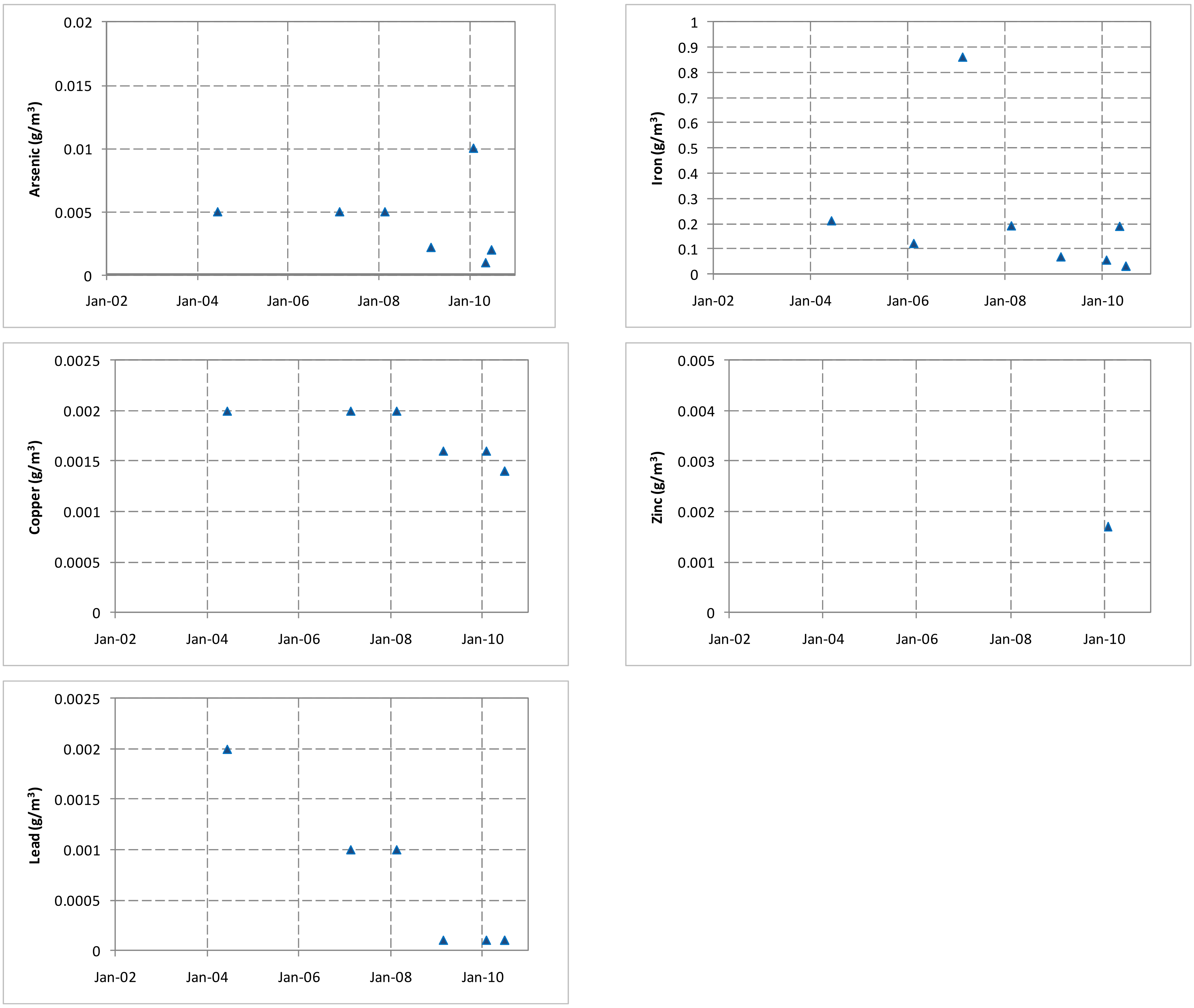
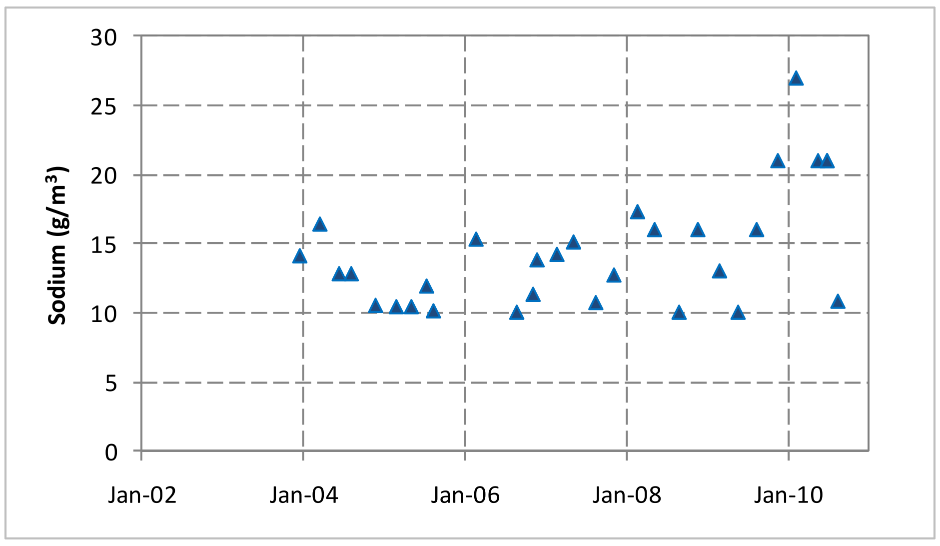
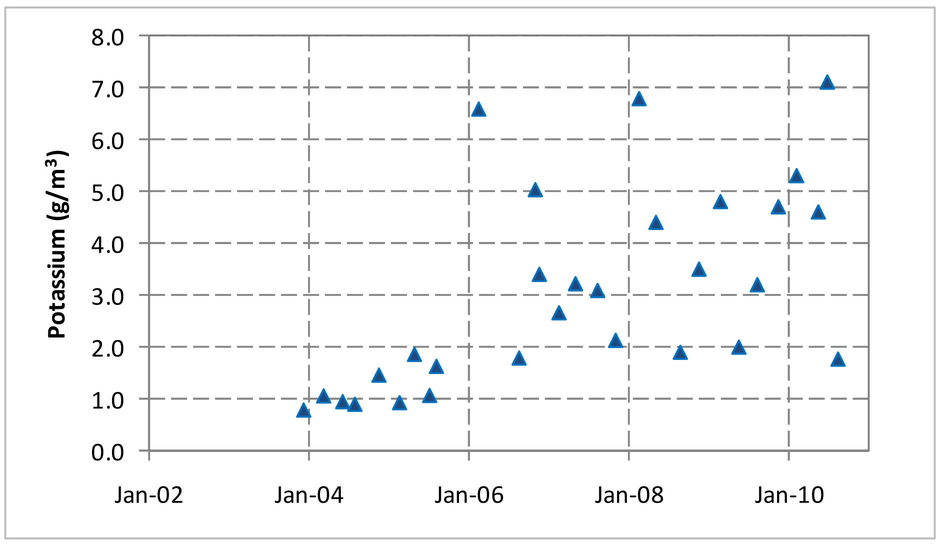
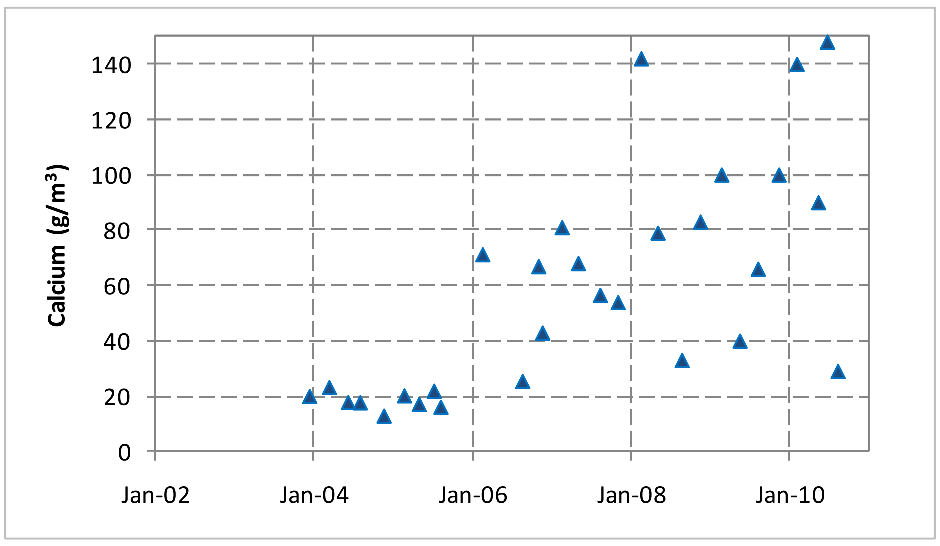
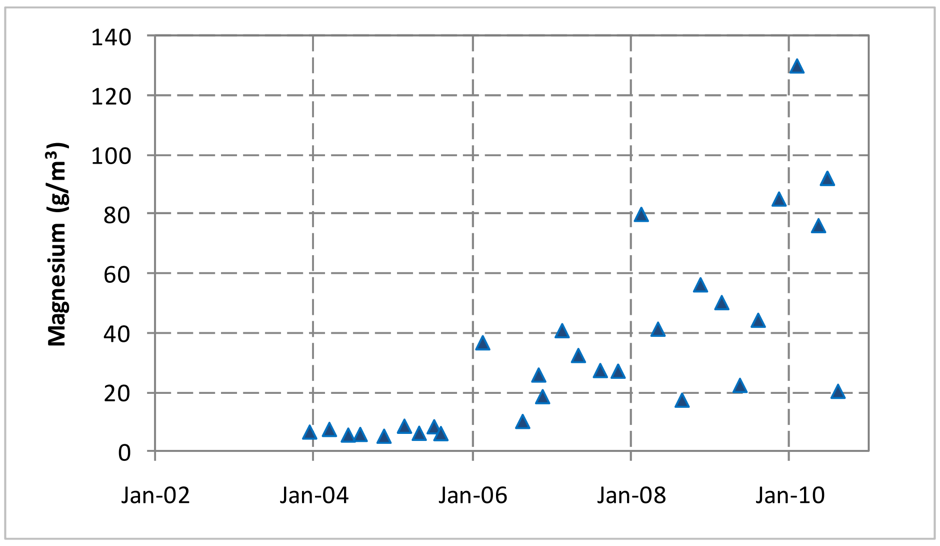


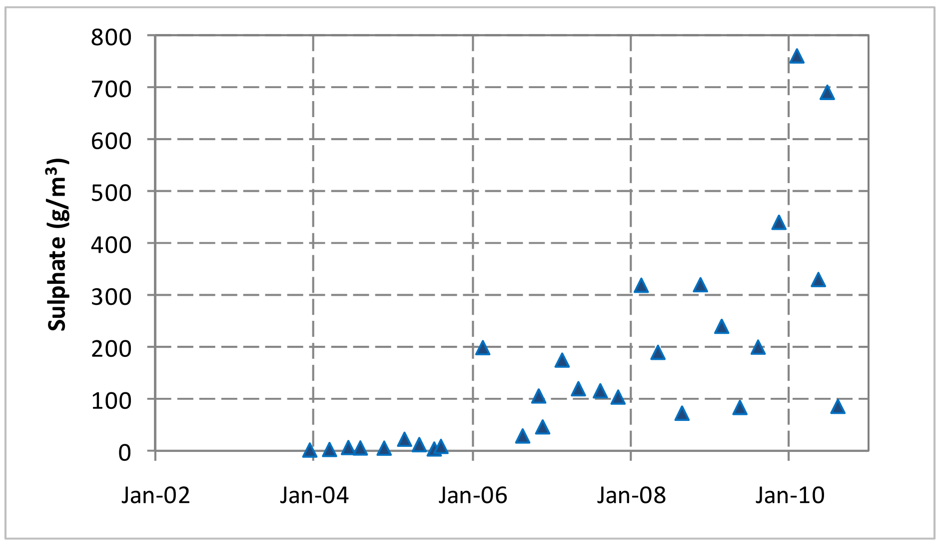
Figure I4: MC100 water quality.

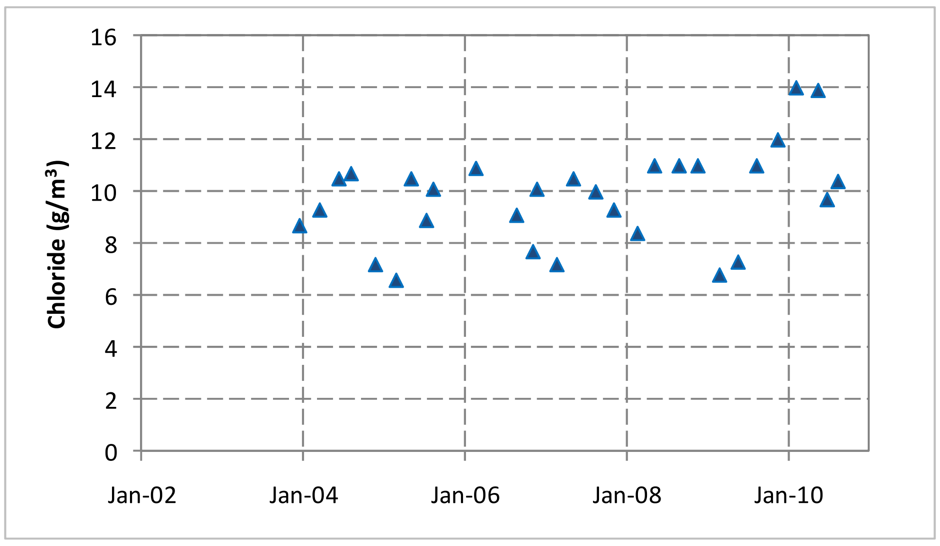

Sodium (g/m³)
30
25
20
15
10
5
0
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10

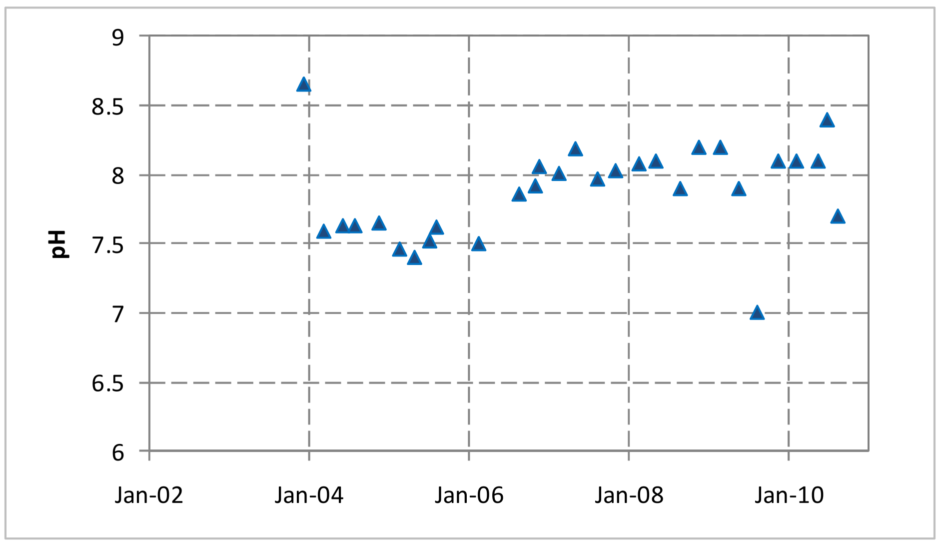

Potassium (g/m³)
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10

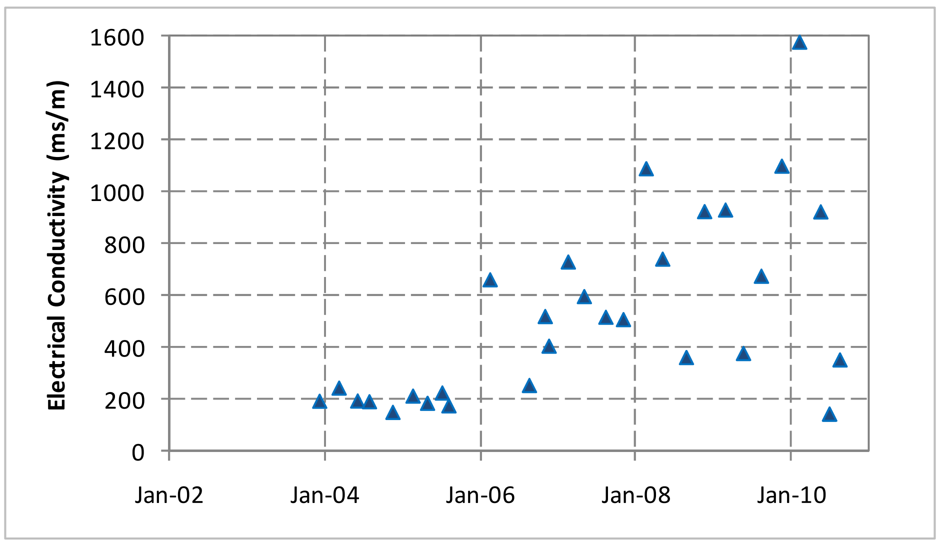

Calcium (g/m³)
140
120
100
80
60
40
20
0
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10


Magnesium (g/m³)
140
120
100
80
60
40
20
0
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10


Sulphate (g/m³)
800
700
600
500
400
300
200
100
0
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10


Chloride (g/m³)
16
14
12
10
8
6
4
2
0
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10


pH
9
8.5
8
7.5
7
6.5
6
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10


Electrical Conductivity (ms/m)
1600
1400
1200
1000
800
600
400
200
0
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10

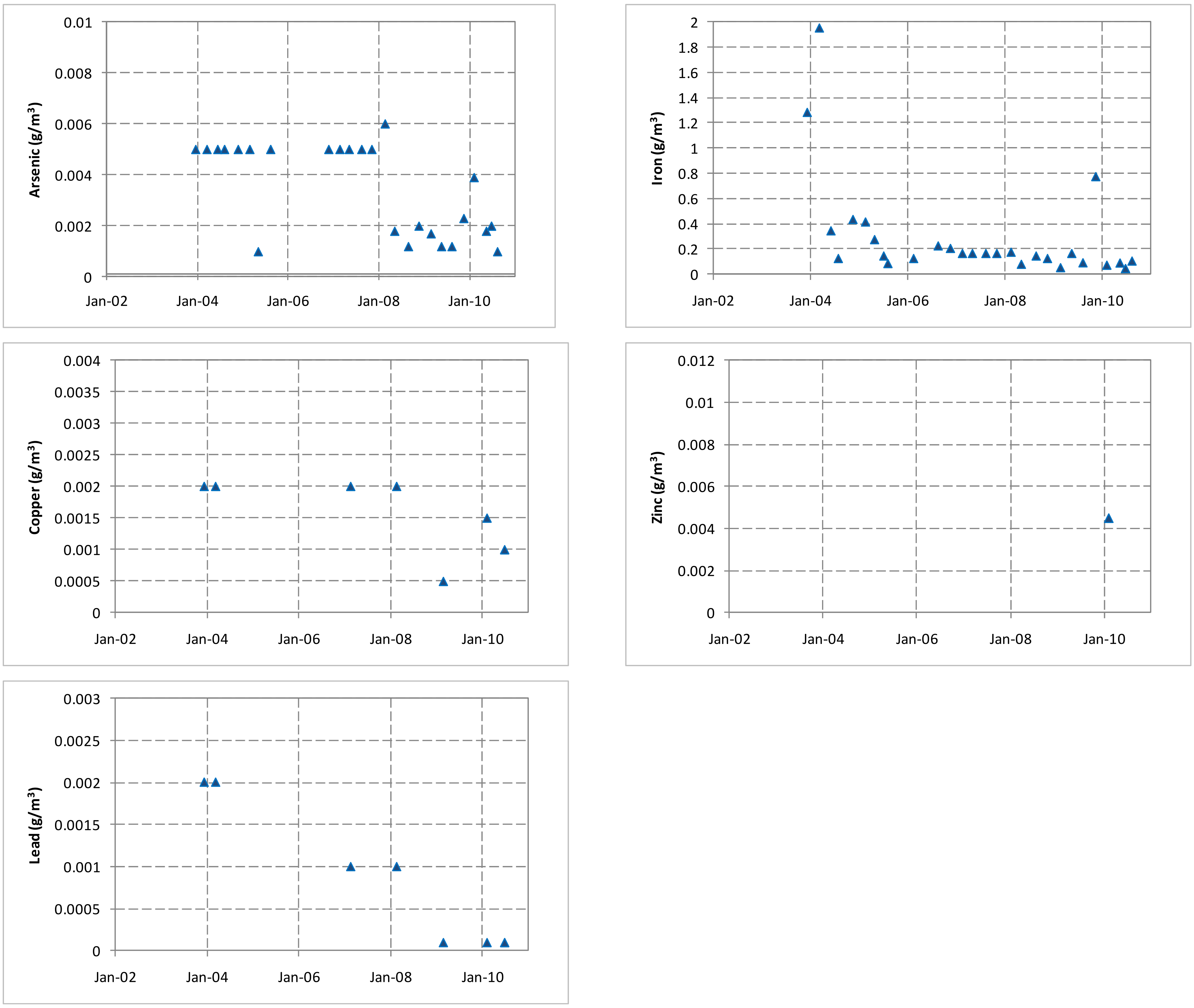
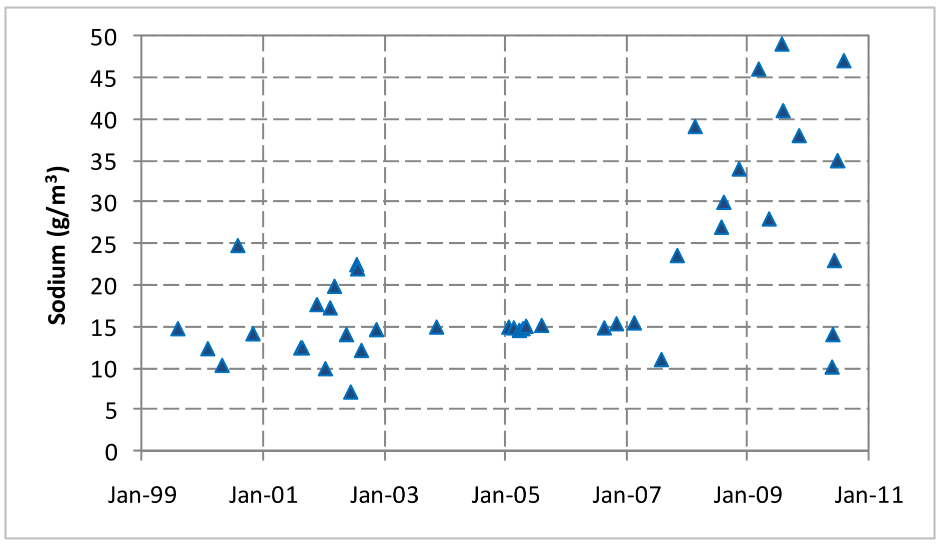
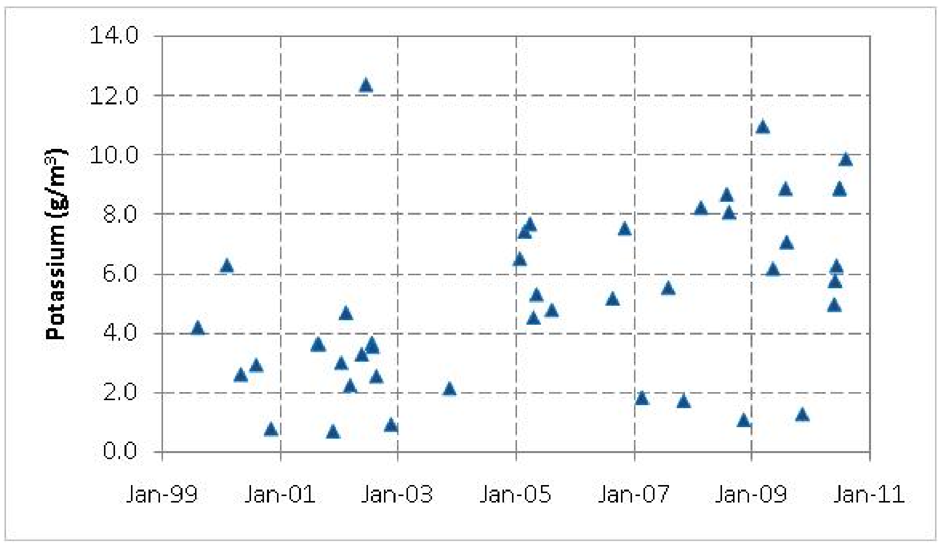
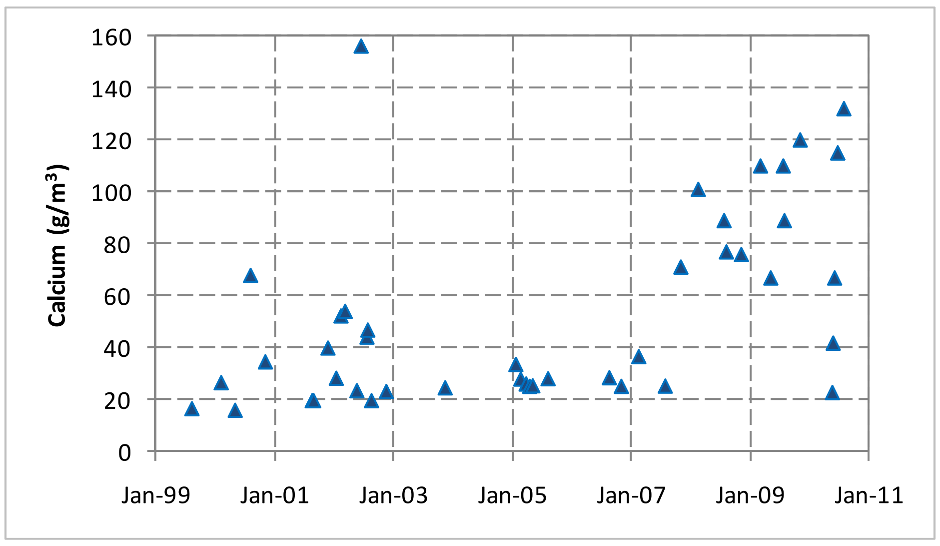
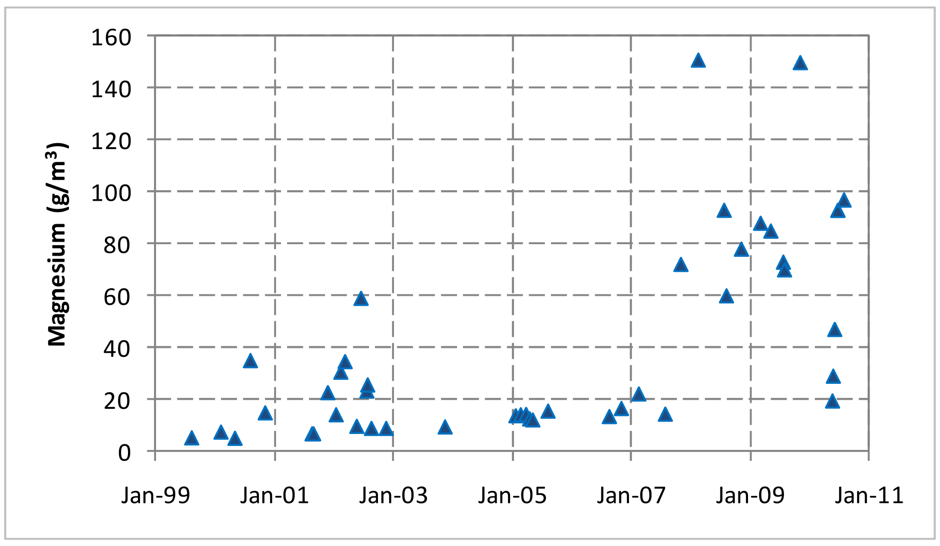


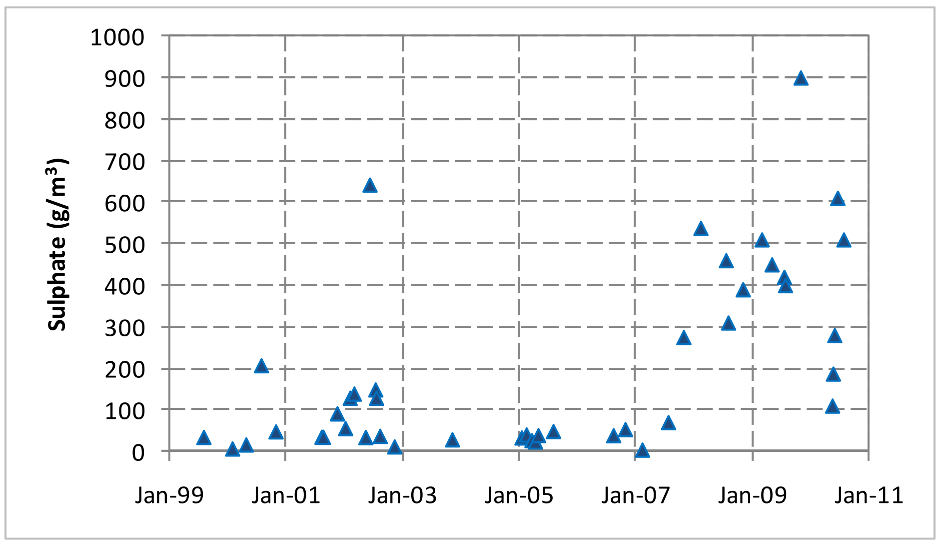
Figure I5: MC01 water quality.

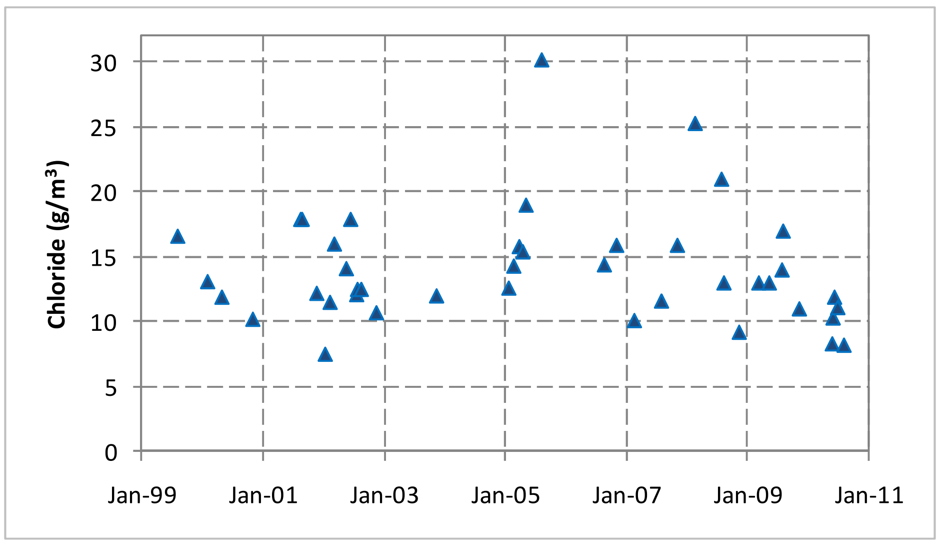

Sodium (g/m³)
0
5
10
15
20
25
30
35
40
45
50
Jan-99
Jan-01
Jan-03
Jan-05
Jan-07
Jan-09
Jan-11

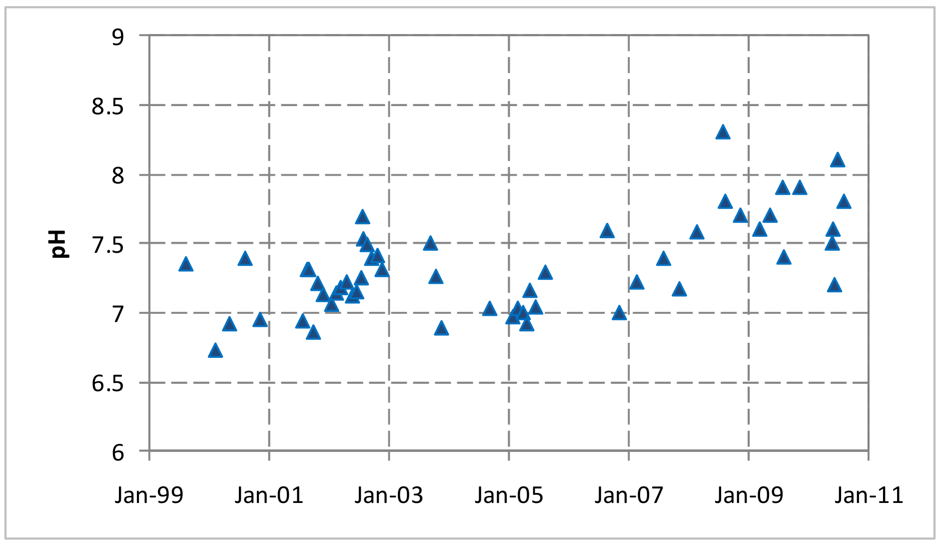

Potassium (g/m³)
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
Jan-99
Jan-01
Jan-03
Jan-05
Jan-07
Jan-09
Jan-11

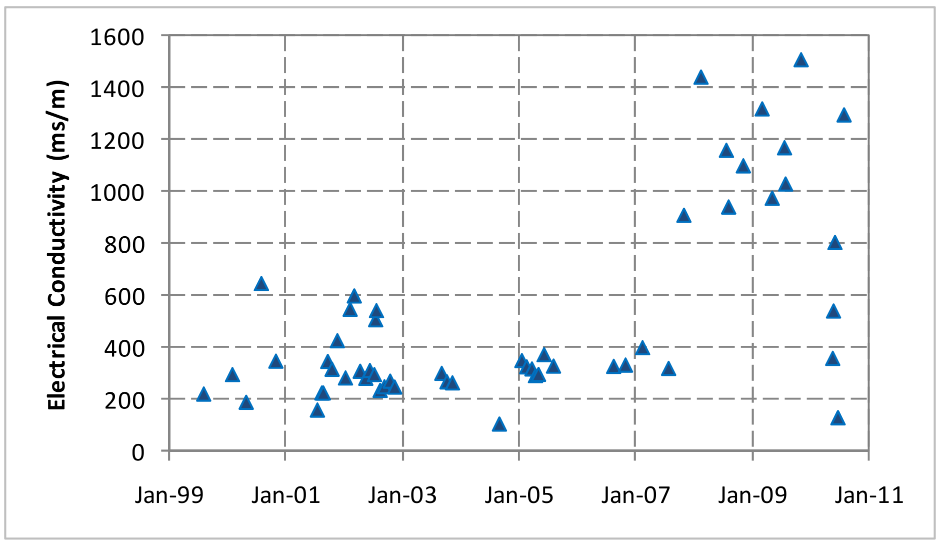

Calcium (g/m³)
0
20
40
60
80
100
120
140
160
Jan-99
Jan-01
Jan-03
Jan-05
Jan-07
Jan-09
Jan-11


Magnesium (g/m³)
0
20
40
60
80
100
120
140
160
Jan-99
Jan-01
Jan-03
Jan-05
Jan-07
Jan-09
Jan-11


Sulphate (g/m³)
0
100
200
300
400
500
600
700
800
900
1000
Jan-99
Jan-01
Jan-03
Jan-05
Jan-07
Jan-09
Jan-11


Chloride (g/m³)
0
5
10
15
20
25
30
Jan-99
Jan-01
Jan-03
Jan-05
Jan-07
Jan-09
Jan-11


pH
6
6.5
7
7.5
8
8.5
9
Jan-99
Jan-01
Jan-03
Jan-05
Jan-07
Jan-09
Jan-11


Electrical Conductivity (ms/m)
0
200
400
600
800
1000
1200
1400
1600
Jan-99
Jan-01
Jan-03
Jan-05
Jan-07
Jan-09
Jan-11

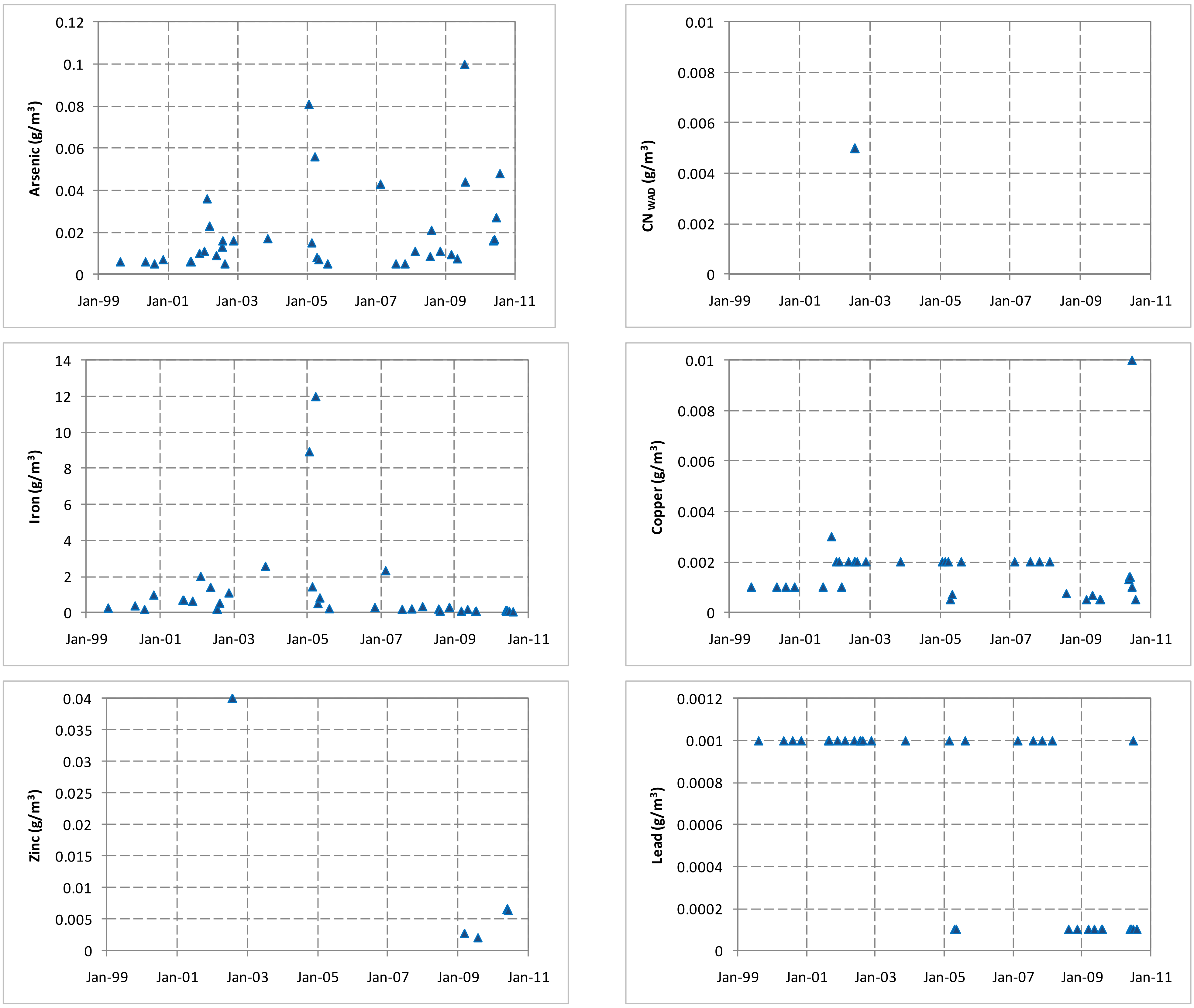
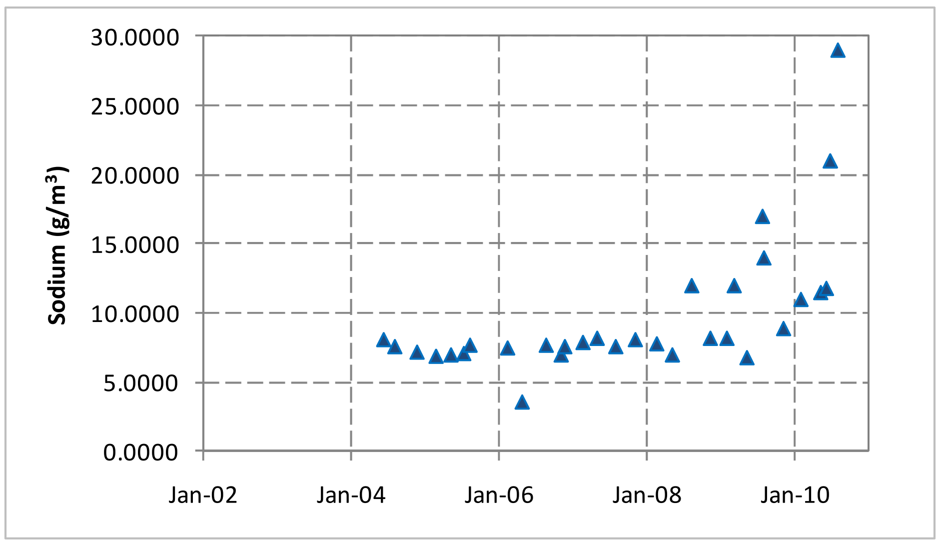
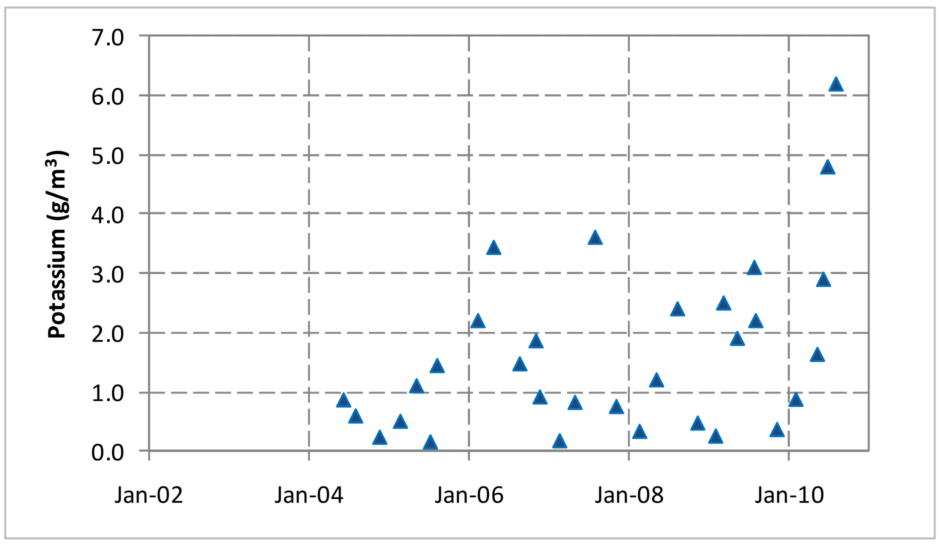
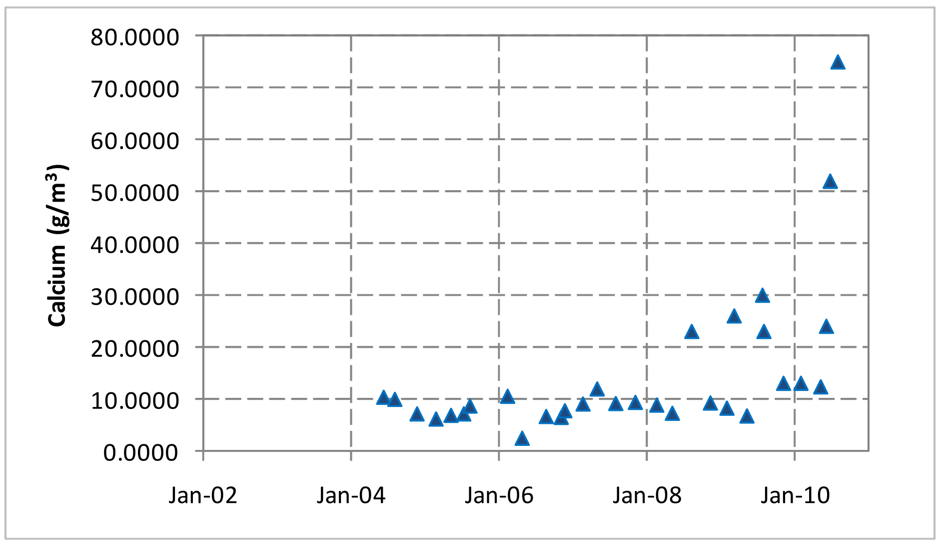
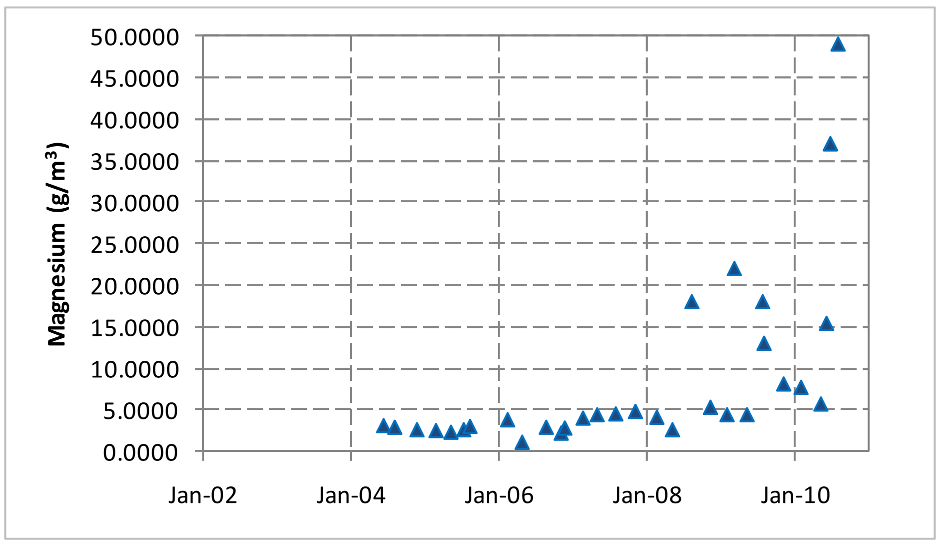


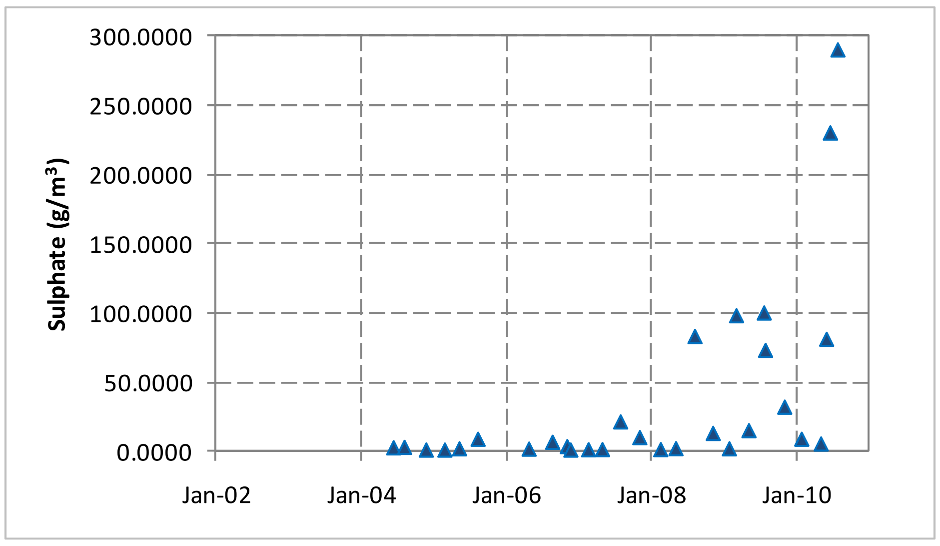
Figure I6: NBWRRB water quality.

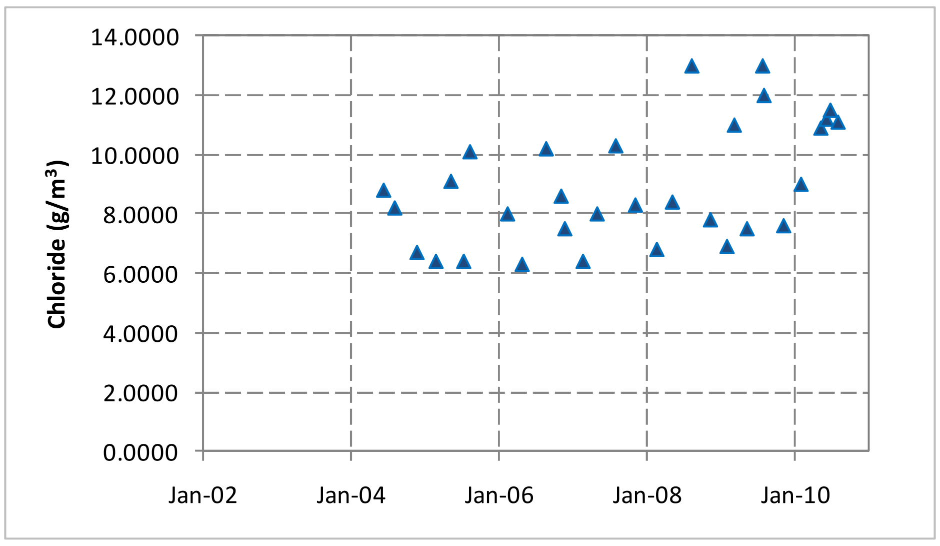

Sodium (g/m³)
30.0000
25.0000
20.0000
15.0000
10.0000
5.0000
0.0000
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10

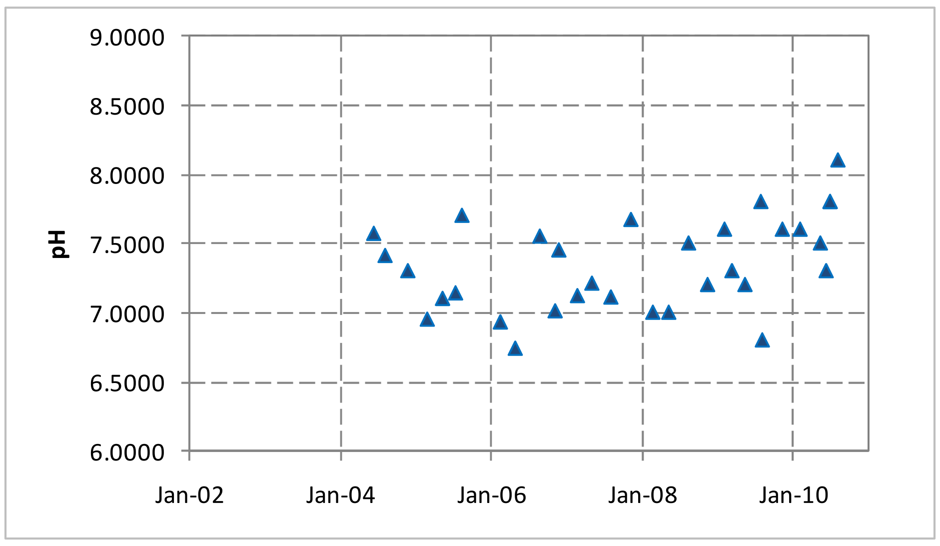

Potassium (g/m³)
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10

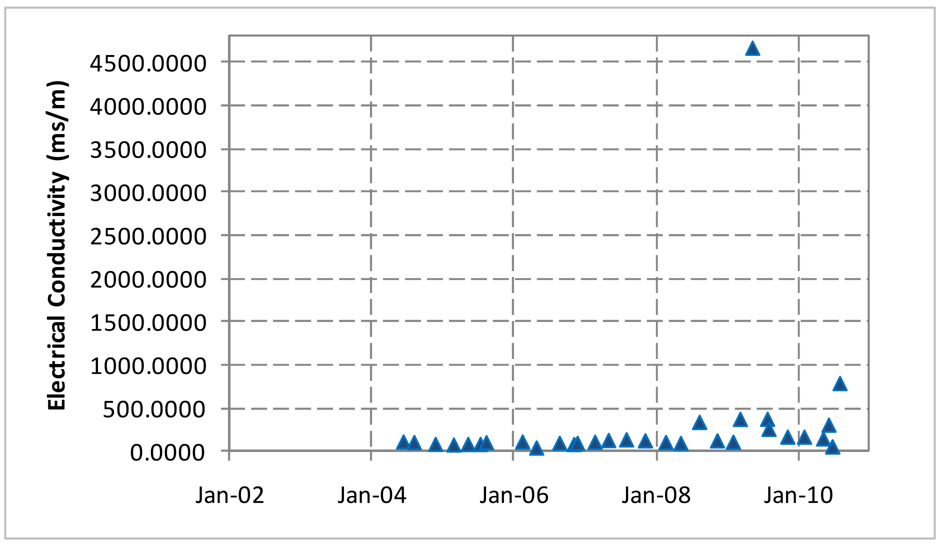

Calcium (g/m³)
80.0000
70.0000
60.0000
50.0000
40.0000
30.0000
20.0000
10.0000
0.0000
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10

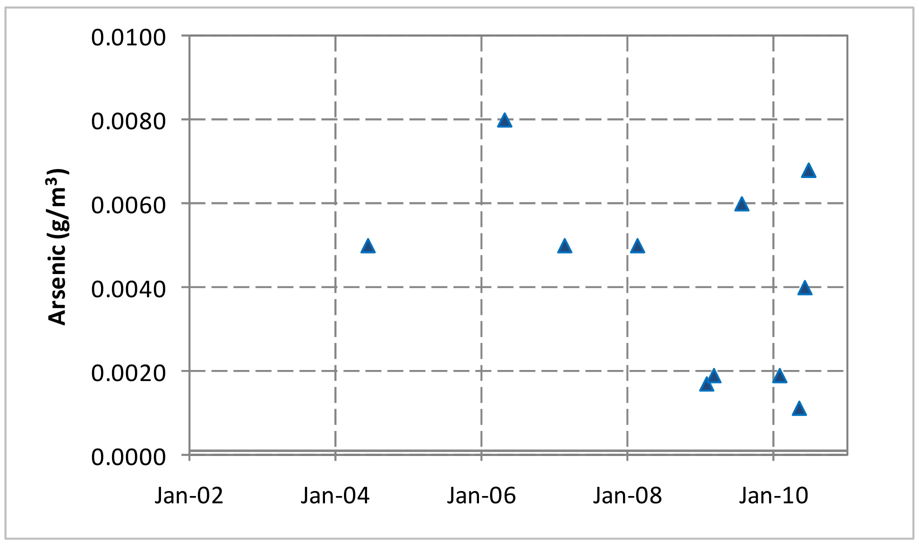

Magnesium (g/m³)
50.0000
45.0000
40.0000
35.0000
30.0000
25.0000
20.0000
15.0000
10.0000
5.0000
0.0000
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10

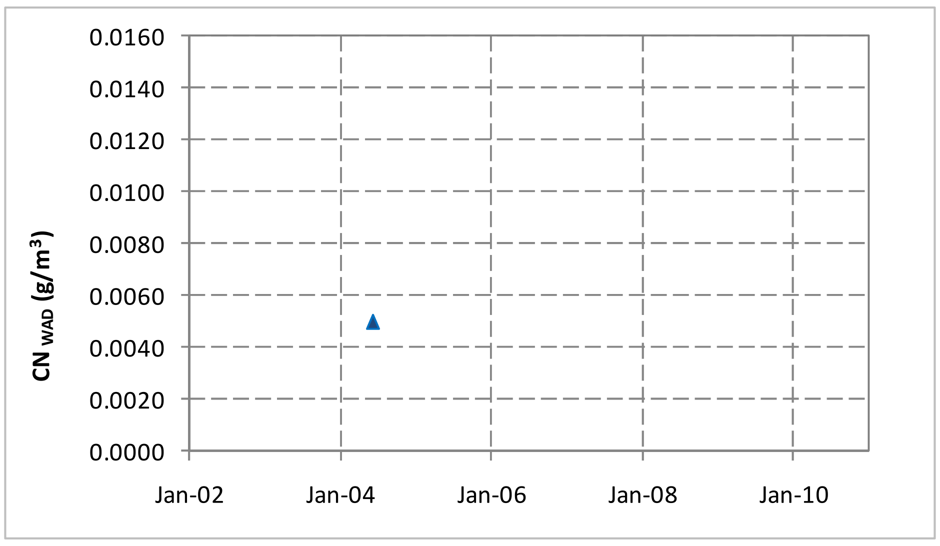

Sulphate (g/m³)
300.0000
250.0000
200.0000
150.0000
100.0000
50.0000
0.0000
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10

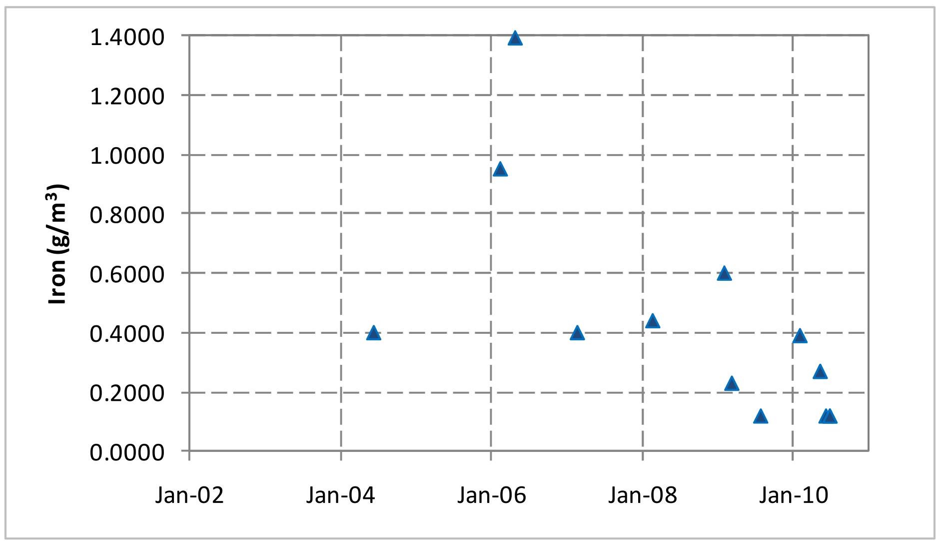

Chloride (g/m³)
14.0000
12.0000
10.0000
8.0000
6.0000
4.0000
2.0000
0.0000
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10

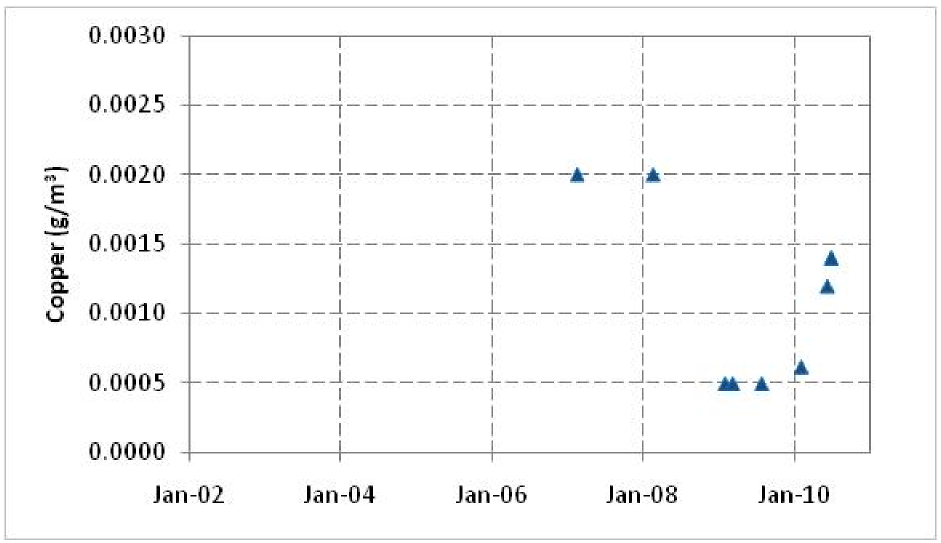

pH
9.0000
8.5000
8.0000
7.5000
7.0000
6.5000
6.0000
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10

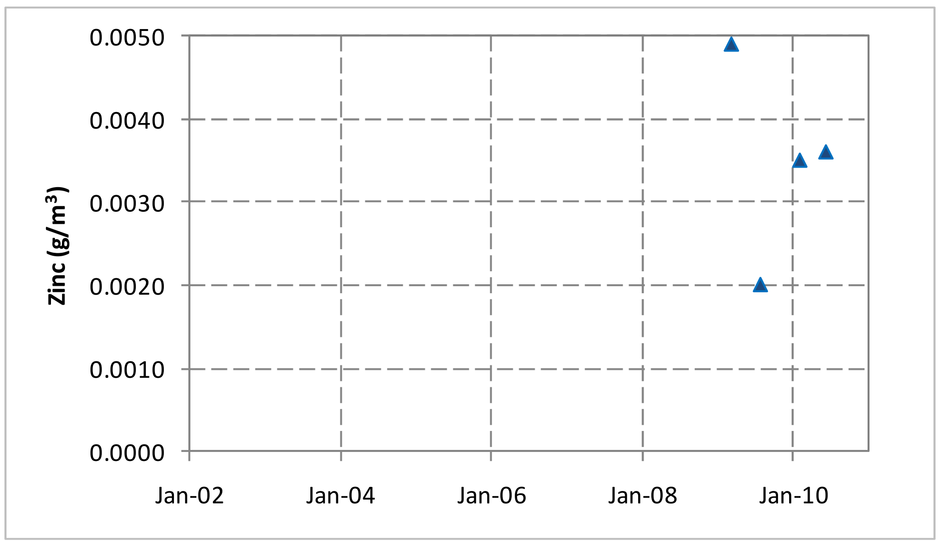

Electrical Conductivity (ms/m)
4500.0000
4000.0000
3500.0000
3000.0000
2500.0000
2000.0000
1500.0000
1000.0000
500.0000
0.0000
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10











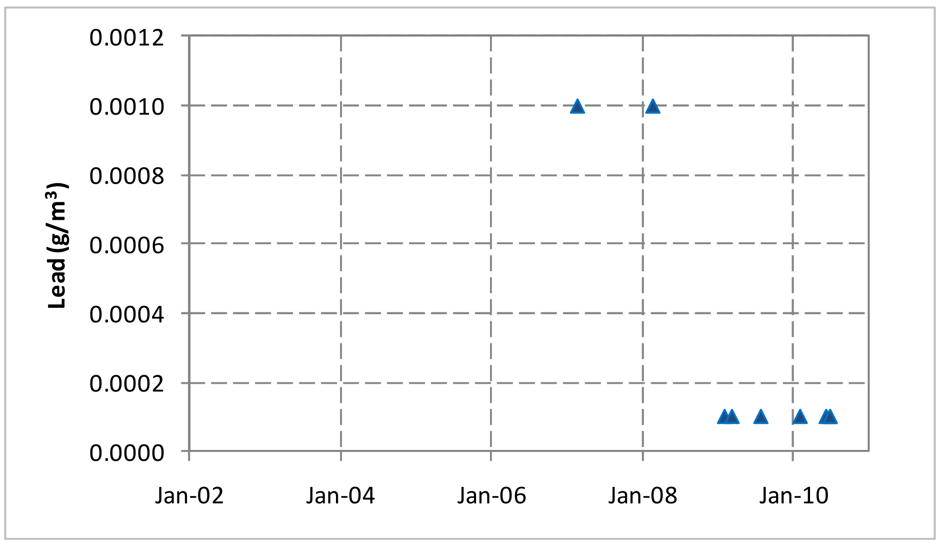
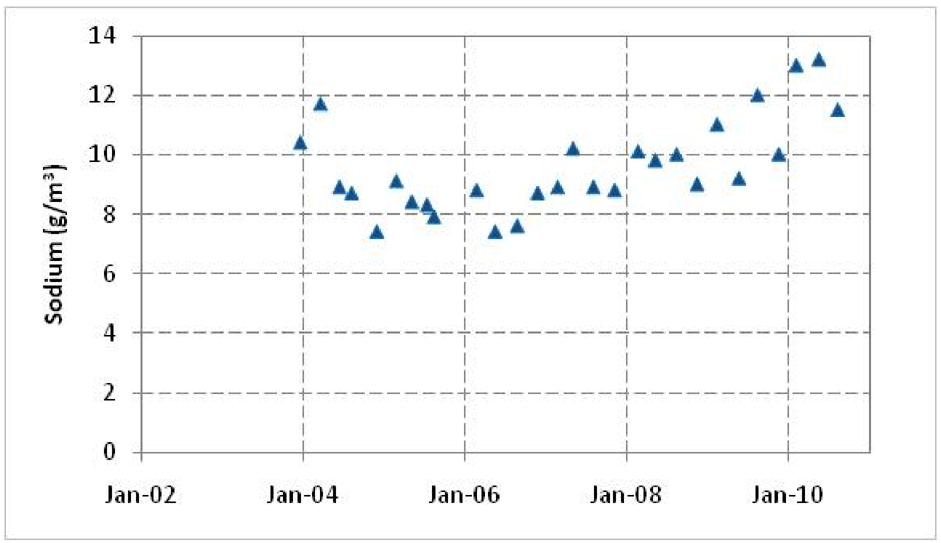
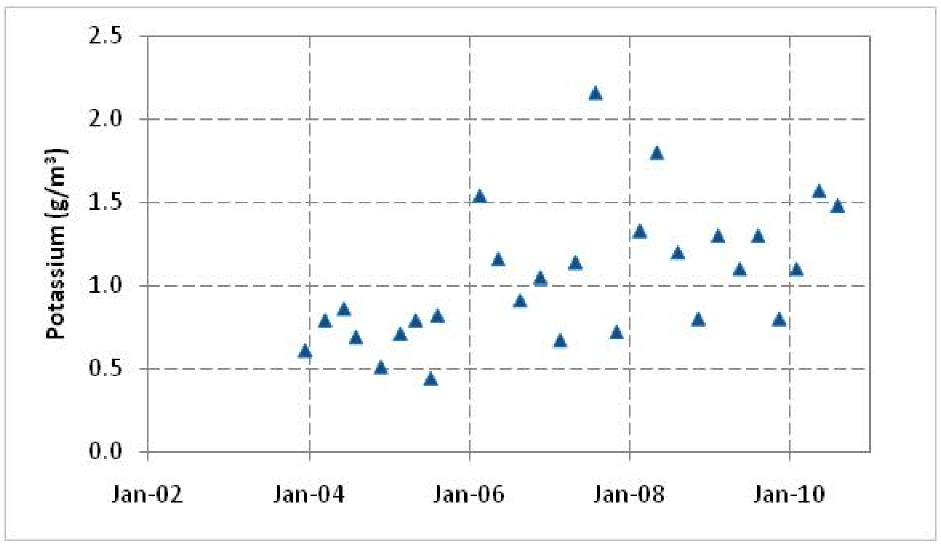


Figure I7: NBWRRF water quality.


Sodium (g/m³)
14
12
10
8
6
4
2
0
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10


Potassium (g/m³)
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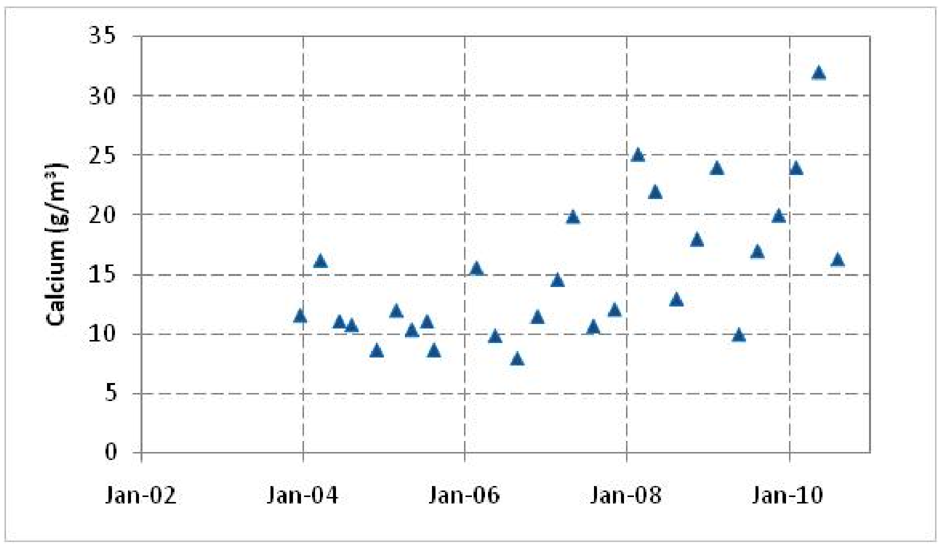
2.0
1.5
1.0
0.5
0.0
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10


Calcium (g/m³)
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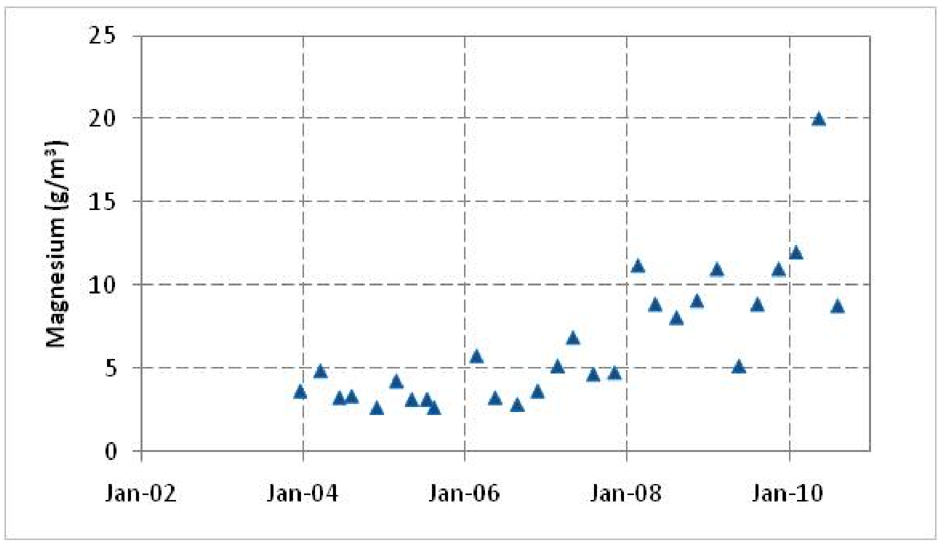
30
25
20
15
10
5
0
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10


Magnesium (g/m³)
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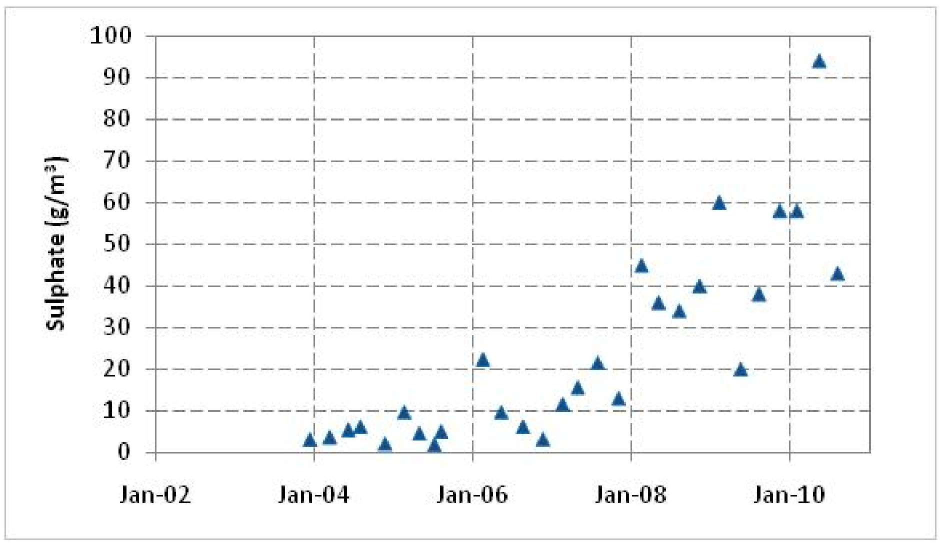
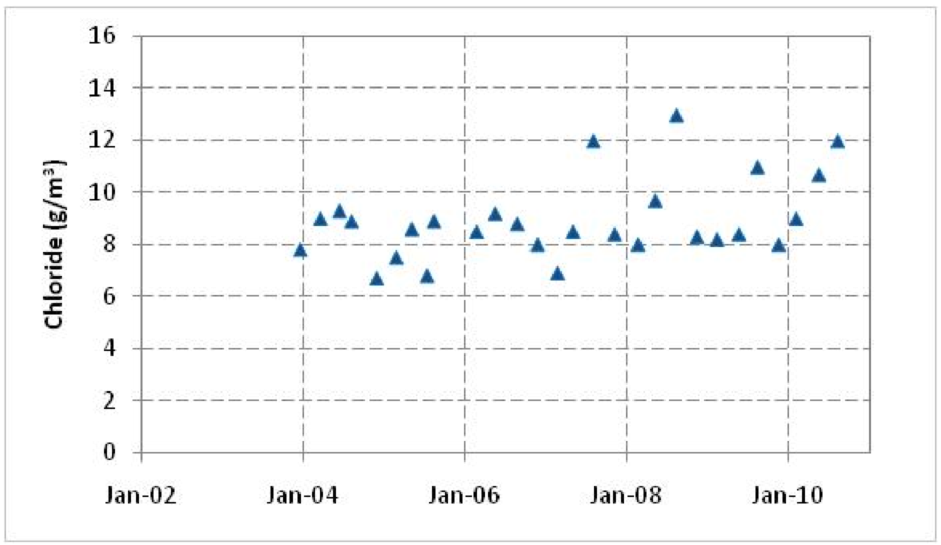
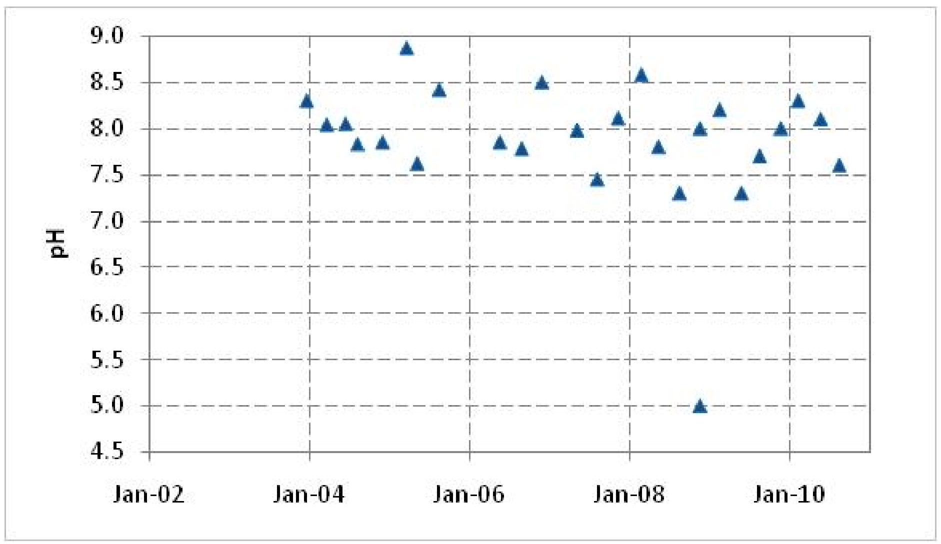
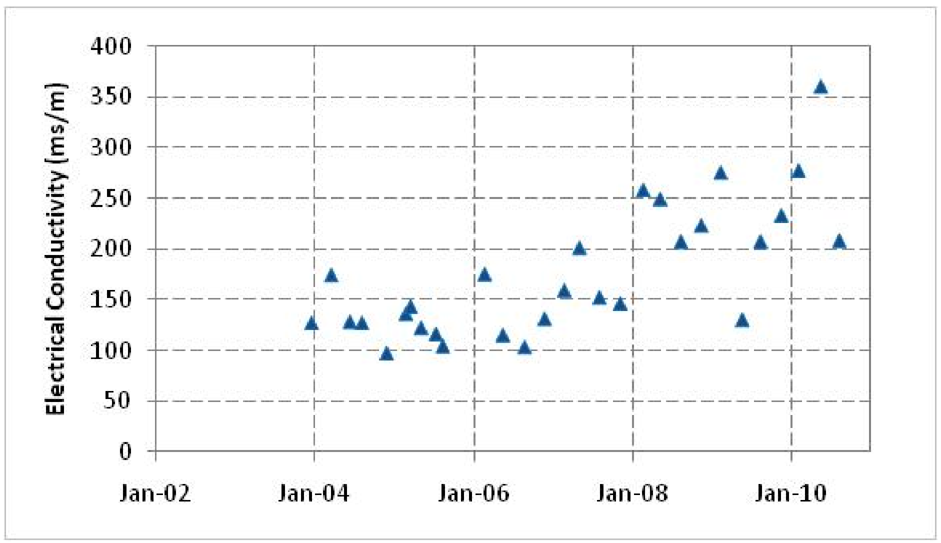
20
15
10
5
0
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10


Sulphate (g/m³)
100
90
80
70
60
50
40
30
20
10
0
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10


Chloride (g/m³)
16
14
12
10
8
6
4
2
0
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10


pH
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10


Electrical Conductivity (ms/m)
400
350
300
250
200
150
100
50
0
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10

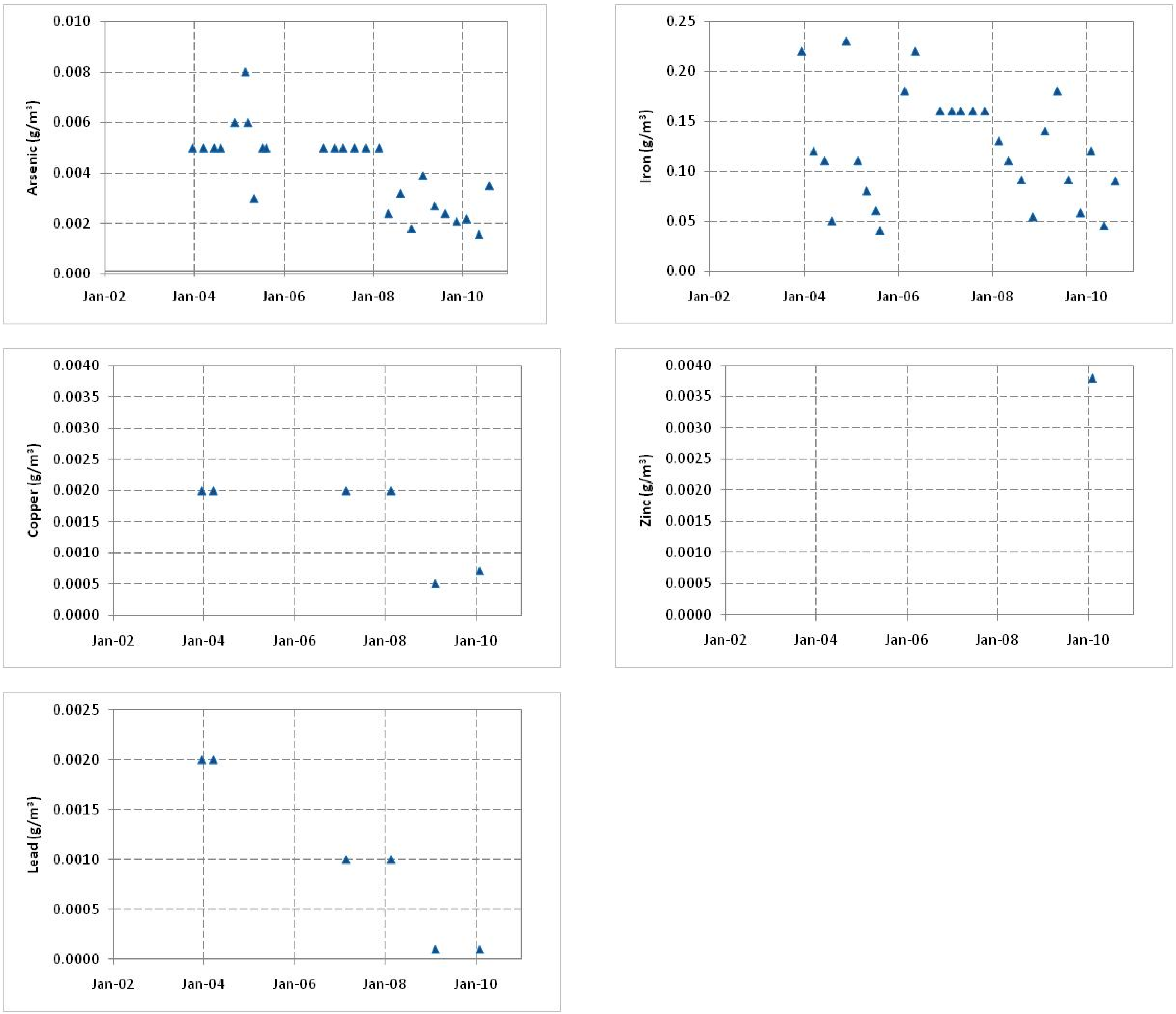


Figure I8: NB03 water quality.

Table I1: Summary of water quality at Site DC01.

Parameter	Minimum	Mean	95th Percentile	Maximum
pH (unitless)	6.2	7.8	8.4	8.7
Conductivity (mS/m)	64	150	200	270
Calcium	7.5	12	17	21
Chloride	7.3	11	15	18
Magnesium	3.0	4.3	5.4	7.1
Potassium	0.60	1.2	1.8	1.9
Sodium	9.6	12	15	21
Sulphate	1.3	4.5	11	15
CN_{WAD}	<0.0010	<0.0050	<0.0050	0.014
Arsenic	<0.0010	<0.0029	0.0053	0.018
Copper	<0.00050	<0.0015	0.0055	0.0065
Iron	<0.040	<0.54	1.1	7.3
Lead	<0.00010	<0.00085	0.0035	0.0055
Zinc[A]	0.000060	0.00083	0.0020	0.0023

Notes: All units g/m^3 unless otherwise stated; and all data presented to two significant figures; and [A] summary statistics were derived after excluding detection limits that have been superseded by lower limits.

Table I2: Summary of water quality at Site DC06.

Parameter	Minimum	Mean	95th Percentile	Maximum
pH (unitless)	7.4	7.9	8.3	8.7
Conductivity (mS/m)	140	570	1,700	1,900
Calcium	9.3	63	220	230
Chloride	7.8	12	16	17
Magnesium	3.9	28	110	120
Potassium	0.71	2.7	7.7	8.2
Sodium	11	22	52	65
Sulphate	10	260	980	1,300
CN_{WAD}[A]	<0.0010	NA	NA	0.0090
Arsenic	0.0027	0.020	0.033	0.050
Copper[B]	<0.0005	<0.0007	0.0011	0.0012
Iron	<0.04	<0.18	0.33	0.38
Lead[C]	<0.0001	NA	NA	<0.001

Notes: All units g/m^3 unless otherwise stated; and all data presented to two significant figures; NA = not applicable; [A] CN_{WAD} was analysed on three occasions, two of which were below a detection limit of 0.001 g/m^3; [B] summary statistics were derived after excluding detection limits that have been superseded by lower limits; and [C] lead was analysed on four occasions – three were below a detection limit of 0.001 g/m^3, while the remaining one was below a detection limit of 0.0001 g/m^3.

Table I3: Summary of water quality at Site DC07.

Parameter	Minimum	Mean	95th Percentile	Maximum	Compliance Limit	Exceedances
pH (unitless)	6.2	8.1	8.8	9.1	6.0-9.5	0
Conductivity (mS/m)	80	270	580	1,900	-	-
Calcium	9.1	37	120	250	-	-
Chloride	5.9	10	14	15	-	-
Magnesium	3.1	16	62	120	-	-
Potassium	0.59	1.8	3.8	8.9	-	-
Sodium	7.4	17	33	80	-	-
Sulphate	2.6	66	260	1,000	1,000	1
CN_{WAD}	<0.0010	<0.0049	<0.0050	0.030	0.10	0
Arsenic[A]	0.0019	0.015	0.029	0.067	0.15	0
Copper[A]	<0.00050	<0.0011	0.0024	0.0026	0.009[B]	0
Iron	<0.020	<0.19	0.82	2.0	1.0	2
Lead[A]	<0.0001	0.0008	0.0020	0.0025	0.0025[B]	4
Zinc[A]	0.000060	0.0012	0.0036	0.0042	0.12[B]	0

Notes: All units g/m^3 unless otherwise stated; all data presented to two significant figures or less; [A] summary statistics were derived after excluding detection limits that have been superseded by lower limits; and [B] for hardness dependent metals (copper, lead and zinc), the compliance standards provided in Table I3 have been calculated assuming a hardness of 100 g/m^3 as $CaCO_3$.

Table I4: Summary of water quality at Shag River at Loop Road.

Parameter	Minimum	Mean	95th Percentile	Maximum	Compliance Limit	Exceedances
pH (unitless)	6.9	7.7	8.0	8.2	7.0-8.5	1
Conductivity (mS/m)	100	180	280	460	-	-
Calcium	9.4	18	29	48	-	-
Chloride	4.4	5.6	8.0	8.2	-	-
Magnesium	2.4	5.3	8.9	17	-	-
Potassium	0.64	0.96	1.4	1.4	-	-
Sodium	6.5	9.6	14	17	-	-
Sulphate	6.5	27	62	150	250	0
CN_{WAD}[A]	<0.0010	NA	NA	NA	0.10	0
Arsenic[B]	0.0011	0.0021	0.0033	0.0034	0.010	0
Copper[B]	<0.00050	<0.00072	0.0012	0.0014	0.009[D]	0
Iron[B]	<0.020	<0.036	0.10	0.14	0.20	0
Lead[B]	<0.00010	<0.00011	0.00013	0.00015	0.0025[D]	0
Zinc[C]	0.0027	NA	NA	NA	-	-

Notes: All units g/m^3 unless stated; data presented to two significant figures or less; NA = not applicable; [A] CNWAD was below the limit of detection on all sampling occasions; [B] summary statistics were derived after excluding detection limits that have been superseded by lower limits; [C] analysed on only one occasion; and [D] for hardness dependent metals (copper and lead), the compliance standards provided in Table I4 have been calculated assuming a hardness of 100 g/m^3 as $CaCO_3$.

Table I5: Summary of water quality at MC100.

Parameter	Minimum	Mean	95th Percentile	Maximum	Compliance limit	Exceedances
pH (unitless)	7.1	7.9	8.2	8.3	6.0-9.5	0
Conductivity (mS/m)	63	640	1,300	1,700	-	-
Calcium	3.8	83	200	200	-	-
Chloride	5.9	10	13	15	-	-
Magnesium	1.6	49	120	150	-	-
Potassium	0.10	4.5	9.5	9.5	-	-
Sodium	7.8	16	27	28	-	-
Sulphate	<1.0	270	920	920	-	-
Arsenic	<0.0010	<0.0038	0.0080	0.010	0.15	0
Copper[A]	0.0014	0.0015	0.0016	0.0016	0.009[D, E]	0
Iron	0.030	0.18	0.57	0.86	1.0	0
Lead[B]	<0.0001	NA	NA	NA	0.0025[D]	0
Zinc[C]	0.0017	NA	NA	NA	0.12[D]	0

Notes: All units g/m^3 unless stated; all data presented to two significant figures or less; NA = not applicable; [A] summary statistics were derived after excluding detection limits that have been superseded by lower limits; [B] lead was below the detection limit on all sampling occasions; [C] zinc was analysed on only one occasion; and [D] for hardness dependent metals (copper, lead and zinc), the compliance standards provided in Table I5 have been calculated assuming a hardness of 100 g/m^3 as $CaCO_3$; and [E] the formula provided in Schedule I of Resource Consents 2003.635-638, 2004.362-763, 2005.208-210 and 2007.583 to derive the limit for copper (0.96exp$^{0.8545[\ln(hardness)] - 1.465}$) / 1000) does not give the values reported in the schedule (and given above).

Table I6: Summary of water quality at MC01.

Parameter	Minimum	Mean	95th Percentile	Maximum	Compliance limit	Exceedances
pH (unitless)	7.0	7.9	8.4	8.7	6.0-9.5	0
Conductivity (mS/m)	140	510	1,100	1,600	-	-
Calcium	13	61	150	150	-	-
Chloride	6.6	9.8	13	14	-	-
Magnesium	4.8	36	92	130	-	-
Potassium	0.79	3.2	7.0	7.1	-	-
Sodium	10	14	21	27	-	-
Sulphate	2.1	180	690	760	-	-
Arsenic[A]	<0.001	<0.0021	0.0046	0.0060	0.01	0
Copper[A]	<0.0005	<0.0010	0.0014	0.0015	0.009[D, E]	0
Iron	0.040	0.28	1.1	2.0	1.0	2
Lead[B]	<0.0001	NA	NA	NA	0.0025[D]	0
Zinc[C]	0.0045	NA	NA	NA	0.12[D]	0

Notes: All units g/m^3 unless stated; all data presented to two significant figures or less; NA = not applicable; [A] summary statistics were derived after excluding detection limits that have been superseded by lower limits; [B] lead was below the detection limit on all sampling occasions; [C] zinc was analysed on only one occasion; [D] for hardness dependent metals (copper, lead and zinc), the compliance standards provided in Table I6 have been calculated assuming a hardness of 100 g/m^3 as $CaCO_3$; and [E] the formula provided in Schedule I of Resource Consents 2003.635-638, 2004.362-763, 2005.208-210 and 2007.583 to derive the limit for copper (0.96exp$^{0.8545[\ln(hardness)] - 1.465}$)/1000) does not give the values reported in the schedule (and given above).

Table I7: Summary of water quality at NBWRRB.

Parameter	Minimum	Mean	95th Percentile	Maximum	Compliance limit	Exceedances
pH (unitless)	6.7	7.3	8.0	8.3	6.0-9.5	0
Conductivity (mS/m)	100	500	1,300	1,500	-	-
Calcium	16	55	120	160	-	-
Chloride	7.5	14	21	30	-	-
Magnesium	5.0	40	96	150	-	-
Potassium	0.72	5.2	9.8	12	-	-
Sodium	7.2	21	45	49	-	-
Sulphate	4.0	210	610	900	-	-
CN_{WAD}[A]	<0.0050	NA	NA	NA	-	-
Arsenic	<0.0050	<0.020	0.059	0.10	0.15	0
Copper	<0.00050	<0.0017	0.0023	0.010	0.009[C, D]	0
Iron	0.020	1.0	3.5	12	1.0	8
Lead[A]	<0.0001	NA	NA	NA	0.0025[C]	0
Zinc[B]	0.0021	0.0049	0.0067	0.0067	0.12[C]	0

Notes: All units g/m^3 unless stated; all data presented to two significant figures or less; NA = not applicable; [A] CN_{WAD} and lead were below the detection limit on all sampling occasions; and [B] summary statistics were derived after excluding detection limits that have been superseded by lower limits; [C] for hardness dependent metals (copper, lead and zinc), the compliance standards provided in Table I7 have been calculated assuming a hardness of 100 g/m^3 as $CaCO_3$; [D] the formula provided in Schedule I of Resource Consents 2003.635-638, 2004.362-763, 2005.208-210 and 2007.583 to derive the limit for copper (0.96exp$^{0.8545[\ln(hardness)] - 1.465}$)/1000) does not give the values reported in the schedule (and above).

Table I8: Summary of water quality at NBWRRF.

Parameter	Minimum	Mean	95th Percentile	Maximum	Compliance limit	Exceedances
pH (unitless)	6.7	7.3	7.8	8.1	6.0-9.5	0
Conductivity (mS/m)	48	310	560	4,700	-	-
Calcium	2.4	16	52	75	-	-
Chloride	6.3	9.0	12	13	-	-
Magnesium	1.1	9.4	37	49	-	-
Potassium	0.15	1.8	4.8	6.2	-	-
Sodium	3.6	10	21	29	-	-
Sulphate	<1.0	44	230	290	-	-
CN_{WAD} [A]	<0.0050	NA	NA	NA	-	-
Arsenic	0.0011	0.0044	0.0073	0.0080	0.01	0
Copper[B]	<0.00050	<0.00087	0.0014	0.0014	0.009[D, E]	0
Iron	0.12	0.43	1.1	1.4	1.0	1
Lead[C]	<0.0001	NA	NA	NA	0.0025[D]	0
Zinc	0.0020	0.0035	0.0047	0.0049	0.12[D]	0

Notes: All units g/m^3 unless stated; all data presented to two significant figures or less; NA = not applicable; [A] CN_{WAD} was analysed on only one occasion; [B] summary statistics were derived after excluding detection limits that have been superseded by lower limits; [C] lead was below the detection limit on all sampling occasions; [D] for hardness dependent metals (copper, lead and zinc), the compliance standards provided in Table I8 have been calculated assuming a hardness of 100 g/m^3 as $CaCO_3$; and [E] the formula provided in Schedule I of Resource Consents 2003.635-638, 2004.362-763, 2005.208-210 and 2007.583 to derive the limit for copper ($0.96\exp^{0.8545[\ln(hardness)] - 1.465}$) / 1000) does not give the values reported in the schedule (and given above).

Table I9: Summary of water quality at NB03.

Parameter	Minimum	Mean	95th Percentile	Maximum
pH (unitless)	5.0	8.0	9.2	9.5
Conductivity (mS/m)	98	180	280	360
Calcium	8.0	15	25	32
Chloride	6.7	8.9	12	13
Magnesium	2.7	6.5	12	20
Potassium	0.44	1.0	1.7	2.2
Sodium	7.4	9.6	13	13
Sulphate	1.9	24	59	94
Arsenic[A]	0.0016	0.0036	0.0066	0.0080
Copper[A]	<0.00050	<0.00061	0.00070	0.00071
Iron[A]	<0.040	<0.11	0.22	0.23
Lead[B]	<0.0001	NA	NA	NA
Zinc[C]	0.0038	NA	NA	NA

Notes: All units g/m^3 unless stated; all data presented to two significant figures or less; NA = not applicable; [A] summary statistics were derived after excluding detection limits that have been superseded by lower limits; [B] lead was below the detection limit on all sampling occasions; and [C] zinc was analysed on only one occasion.

Table I10: Summary of water quality at Tipperary Creek.

Parameter	Minimum	Mean	95th Percentile	Maximum
pH (unitless)	7.1	7.4	7.9	8.0
Conductivity (mS/m)	120	140	160	160
Calcium	8.3	10.3	11	11
Chloride	11	13	15	15
Magnesium	2.9	3.6	4.0	4.0
Potassium	0.76	0.94	1.1	1.1
Sodium	11	12	14	14
Sulphate	6.2	9.2	10	10
CN_{WAD}	<0.0010	<0.0012	0.0016	0.0017
Arsenic[A]	<0.0010	NA	NA	NA
Copper	0.00061	0.00088	0.0012	0.0013
Iron	0.094	0.12	0.16	0.17
Lead[A]	<0.00010	NA	NA	NA
Zinc[B]	0.021	NA	NA	NA

Notes: All units g/m^3 unless stated; all data presented to two significant figures or less; NA = not applicable; [A] arsenic and lead were below the detection limit on all sampling occasions; and [B] zinc was analysed on only one occasion.

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