



Surface Water Monitoring Procedure

1. Purpose

This procedure details the collection of surface water samples for compliance to the current WDL and monthly sampling to provide information for the management of discharges from designated sites. Current sampling locations are shown in Figure 1. This procedure details sample collection and analysis, quality, documentation, and reporting. The primary reason for surface monitoring programs is to obtain chemical and physical system attributes that allows sample results to be analysed for:

- Identification of contaminant sources;
- Regulation of activities to ensure compliance with the Mining Management Plan, and Waste Discharge Licence commitments;
- Assessment of water quality against the dilution factors for Batman Pit, RP1 and TSF1, site specific trigger values (SSTVs) (GHD 2012), defined guidelines and standards such as the Australian and New Zealand Environment and Conservation Council (ANZECC & ARMCANZ 2000) water quality guidelines for ecosystem protection;
- Development and refinement of water management plans, site water balances, and rehabilitation strategies; and
- Demonstration of environmental due diligence and measure future improved environmental performance.
- Investigate options to manage any identified impacts that result from the discharge.

2. Scope

The scope of this procedure applies to:

- Discharge of waste water into the Edith River from Vista Gold Australia Pty Ltd Mount Todd Project Mine Lease Northern (MLN) number 1071 which also receives surface waters from within MLN 1070; and
- Other monitoring programs that aid progress in meeting the water management
 - objectives.

3. Legal framework

The principal articles of legislation dealing with surface and ground water monitoring at the Mt Todd Project site are:

- *The NT Water act 2004;*
- *The NT Mining Act; 1980 and*
- *The NT Mining Management Act, 2008.*

4. Standards

The following documents were used in the development of this procedure.

- AS/NZS 5667.1:1998 Water quality – Sampling. Part 1: Guidance on the design of sampling programs, sampling techniques and the preservation and handling of samples.
- AS/NZS 5667.4:1998 Water quality – Sampling. Part 4: Guidance on sampling from lakes, natural and man-made.



- AS/NZS 5667.6:1998 Water quality – Sampling. Part 6: Guidance on sampling of rivers and streams.

5. Site Safety when Collecting Samples

Surface water (SW) monitoring sites should be kept free from anything which may provide a risk whilst collecting samples. If a site provides a risk of any nature, it should be noted on the field data sheet, with the Environmental Manager notified upon the field staff members' return. All sample sites listed in this SOP have been assessed under Vista Gold Safety and Risk Assessment Procedures, including site specific job safety environmental assessments. Any new sites will be assessed by the Environmental Manager and/or Site Safety Supervisor under existing OH&S protocols as required.

A range of factors may preclude sampling on a given day; potentially including safety (access/flooding) and/or environmental reasons.

Any incidents should be reported to the Environment Manager immediately.

6. Ordering Sample Bottles

Clean sample bottles are required and available through Envirolab Services. Envirolab Services (Aileen Hie) can be contacted on 02 9910 6200 or email ahie@envirolabservices.com.au.

Order clean sample bottles sufficient for the number of samples plus field duplicates (plus spares). The bottles required for each sampling event are shown in Table 1.

Table 1: Bottles Required

Monthly Surface Water per Sample (17 sites)	Parameters
1 x 500mL Plastic Unpreserved (Green Label)	TSS, TDS, Anions, Cations, Hardness, (DOC, TOC: SW2, SW4only)
1 x 60mL Plastic NaOH Preserved (Blue Label)	WAD CN
1 x 60mL Plastic HNO ₃ Preserved (Red Label)	Total Metals
1 x 60mL Plastic HNO ₃ Preserved (Red Label)	Dissolved Metals (field filter and tick label)
1 x 100 mL Plastic Unpreserved (Green Label)	NO ₃ and PO ₄ (field filter and freeze. SW2, SW4 only)
1 x 200mL Glass Unpreserved (Green Label)	TRH (C10-C36)
Daily Waste Discharge per Sample (3 sites)	Parameters
1 x 500mL Plastic Unpreserved (Green Label)	Anions, Cations, Hardness, TDS, TSS, (DOC, TOC: SW2, SW4 only)
1 x 100mL Plastic NaOH Preserved (Blue Label)	WAD CN and Cr VI
1 x 60mL Plastic HNO ₃ Preserved (Red Label)	Total Metals
1 x 60mL Plastic HNO ₃ Preserved (Red Label)	Dissolved Metals (field filter and tick label)
1 x 100 mL Plastic Unpreserved (Green Label)	NO ₃ and PO ₄ (field filter and freeze. SW2, SW4 only)
1 x 100mL Plastic Unpreserved (Green Label) – SW4 only	For Location SW4 (in case Chelex needed)



7. Equipment

Equipment to be used to collect samples must be appropriately cleaned and decontaminated, field meters should be calibrated according to the manufacturer's instructions and sufficient sample bottles prepared.

7.1 Calibration of Equipment

Daily calibration of the pH meter, EC meter and DO meter is required following YSI User Manual procedures. A calibration sheet is attached to this SOP.

Equipment Required:

- YSI ProODO: Dissolved Oxygen (% saturation and ppm)
- YSI pH100: pH (pH units)
- YSI EC300: Conductivity (mS/cm)

Note: It is important to carry the water meter manuals for troubleshooting purposes.

pH: The pH meter should be calibrated according to the manufacturers requirements, using a two point calibration with buffers of pH 4 and 7. Calibration standards should be stored appropriately (e.g. do not exceed "use by" dates, refrigeration) to ensure their accuracy.

Temperature: The temperature of the water to be sampled will change throughout the day and influence parameters such as pH and dissolved oxygen. Temperature will move toward ambient upon sampling so should be recorded as soon as a stable reading is obtained after collection.

Conductivity: The electrical conductivity (EC) of the water is a measure of the concentration of chemical ions in the water. The total dissolved solids in the sample water can be calculated from this reading using the following formula:

$$\text{TDS (mg/L)} = 0.5 * 1000 * \text{EC mS/cm}$$

As with pH measurement, calibration of conductivity meters should be performed using standards of a known concentration appropriate to the anticipated range of conductivity of the water to be sampled (i.e. 146.9 $\mu\text{S/cm}$ for fresh water off site and 1.413 mS/cm for Retention Pond [RP] water). Calibration standards should be stored appropriately (e.g. do not exceed "use by" dates, refrigeration) to ensure their accuracy.

Dissolved Oxygen: The amount of dissolved oxygen in a sample can vary with depth, temperature, and biological demand. Measurements of dissolved oxygen can be most accurately obtained by placing the probe directly into the water body to be sampled in an area with flow or moved, not too vigorously, to simulate flow.

7.2 Other Items Required for Field Sampling

- Clipboard and pencil;
- Labelled sample bottles;
- Chain of Custody form;
- A copy of this procedure;
- Field sample collection sheets;
- A reach pole or bailer and rope for hard to reach areas;

- Plastic syringe, filter cup and 45 µm filter papers for dissolved metals filtration in the field (you may need 2–3 filters per sample depending on suspended solids);
- Powder-less nitrile gloves (blue);
- Powder-less latex gloves (white);
- Permanent marker;
- Clear sticky tape;
- Esky with ice bricks;
- Decon 90; and
- Personal Protective Equipment, first aid and communication equipment.

8. Field Sample Collection Sheet Details

At each sample location, details relevant to the subsequent analysis and interpretation are recorded on the field sheets. Information recorded on the field sheets includes:

- Name and location of sampling point;
- Date and time of sample collection;
- Any relevant descriptive information, e.g. water level/flow;
- Sample appearance at the time of collection, eg colour, clarity and odour;
- Field parameters measured or results of any on site analysis (EC, pH, DO & Temp);
and
- Sample treatment post collection, eg filtration, preservation, analysis required.

9. WDL 178-5 Surface Water Monitoring Locations

The surface water monitoring program is a requirement of WDL 178-05 (commencing 16 January 2017 and expiring 31 August 2018) and is outlined in Sections 26-34 and Appendix 4 of the licence.

Presented in Table 2 are the authorised monitoring points for the Surface Water Monitoring Program. The points are also illustrated in the map presented in Figure 1.

Table 2 Authorised Monitoring Points

Authorised Monitoring Point	Description	Location	
		Latitude	Longitude
SW4	Waste water discharge monitoring site Edith River.	-14.17067	132.09835
SW2	Edith River at Edith Falls Road. Non-impacted reference. Northern side of the stream to minimise discharge from Phillips Creek.	-14.17195	132.11990
SW13	Stow Creek. Non-impacted reference site.	-14.15605	132.12989
SW3	Stow Creek at Jatbula Road Bridge. Impacted information site.	-14.16144	132.11851
SW10	Edith River at causeway of Old Stuart Highway. Downstream information site.	-14.18464	132.03037
RP3	In-flow sampling tap on discharge pipe from Batman Pit to authorised discharge point (discharge side of the RP3 pumps).	-14.14109	132.10322



9.1 Parameters

Parameters to be monitored from WDL 178-05 are listed in Table 3.

Table 3 Parameters to Measure at Sample Locations SW2, SW3, SW4, SW10, SW13 and RP3 Plus Additional Parameters for Mine Water Discharge Management

Parameter	Methodology	Comments
River flow	Flow (m3/s)	SW4 (field) and SW4 (online) only
Water level	Gauge height (m)	SW4 and RP3 only
Dissolved oxygen	In-situ (% saturation)	
Water temperature	In-situ (°C)	All sites (SW4 - Field and online)
Electrical conductivity	In-situ & lab (µS/cm)	All sites (SW4 - Field and online)
pH	In-situ & lab (pH units)	SW4 & RP3 only. Online measured value required for operational control to provide warning that water quality has changed and to trigger operational corrective action, if required.
Aluminium	Lab - Filtered/unfiltered (µg/L)	
Boron	Lab - Filtered (µg/L)	
Cadmium	Lab - Filtered/unfiltered (µg/L)	
Cobalt	Lab – Filtered (µg/L)	
Copper	Lab – Filtered/unfiltered (µg/L)	
Chromium	Lab – Filtered (µg/L)	If total chromium of the filtered sample returns a result greater than the practical quantification limit (PQL), the sample is to be reanalysed for speciated chromium
Flouride	Lab – Filtered (µg/L)	
Iron	Lab - Filtered/unfiltered (µg/L)	
Lead	Lab – Filtered (µg/L)	
Lithium	Lab – Filtered (µg/L)	
Manganese	Lab – Filtered (µg/L)	
Mercury	Lab – Filtered (µg/L)	
Nickel	Lab – Filtered (µg/L)	
Zinc	Lab – Filtered (µg/L)	
Total Nitrogen	Lab – Unfiltered (µg/L)	
Nitrate	Lab – Filtered (µg/L)	
Nitrite	Lab – Filtered (µg/L)	
Ammonia	Lab – Filtered (µg/L)	
Total phosphorus	Lab – Unfiltered (µg/L)	
Organic carbon (total)	Lab – Unfiltered (µg/L)	
Bicarbonate	Lab – Filtered (mg/L)	
Calcium	Lab – Filtered (mg/L)	



Chloride	Lab – Filtered (mg/L)	
Sodium	Lab – Filtered (mg/L)	
Magnesium	Lab – Filtered (mg/L)	
Potassium	Lab – Filtered (mg/L)	
Sulphate	Lab – Filtered (mg/L)	
Total Dissolved solids	Lab – Calculated (mg/L)	
Unfiltered Alkalinity (Acid Neutralising Capacity)	Lab – Unfiltered (mg/L)	
Hardness	Lab – Filtered (mg/L)	
Total Suspended Solids	Lab – Unfiltered (residue remaining 0.45 µm)	
Total Cyanide	Lab – Unfiltered (mg/L)	
WAD Cyanide	Lab – (mg/L)	Only required if Total CN analysis is greater than 0.004 mg/L. Must be conducted on same day as for Total CN.

Note: Filtered samples must be filtered in the field at the time of sample using membrane filters with pore diameter of 0.45µm.

9.2 Sample Frequency

The frequency and timing of sample events required by site and by parameter are presented in Table 4.

Table 4 Timing of Sampling Events for Sample Types (WDL 178-05)

Sampling Point	Field Parameters (pH, EC, Temp, Flow, DO)	Total, filtered metals and metalloids	Other major cations/anions	Nutrients	Total CN
SW2	D	D	D	TN and TP = D, others = M	M
SW3	M	M	M	M	M
SW4 (field)	D	D	D	TP = D Others = M	D
SW4 (online)	C	N/A	N/A	N/A	N/A
SW13	M	M	M	M	M
RP3	EC and pH = C, others = D	M	M	TN and TP = D, others = M	M
SW10	M	M	M	M	M

C: Continuous, real-time, online management

D: Daily when discharging for any period of time in any day, also one week after the cessation of discharge and once during the period of the first flush, otherwise monthly testing.

M: Once per month

10. Surface Water Monitoring for Mt Todd Surrounds

The following sample sites have been identified to provide additional data for water management on the site, with the following provision:



The sites are safely accessible in wet weather.

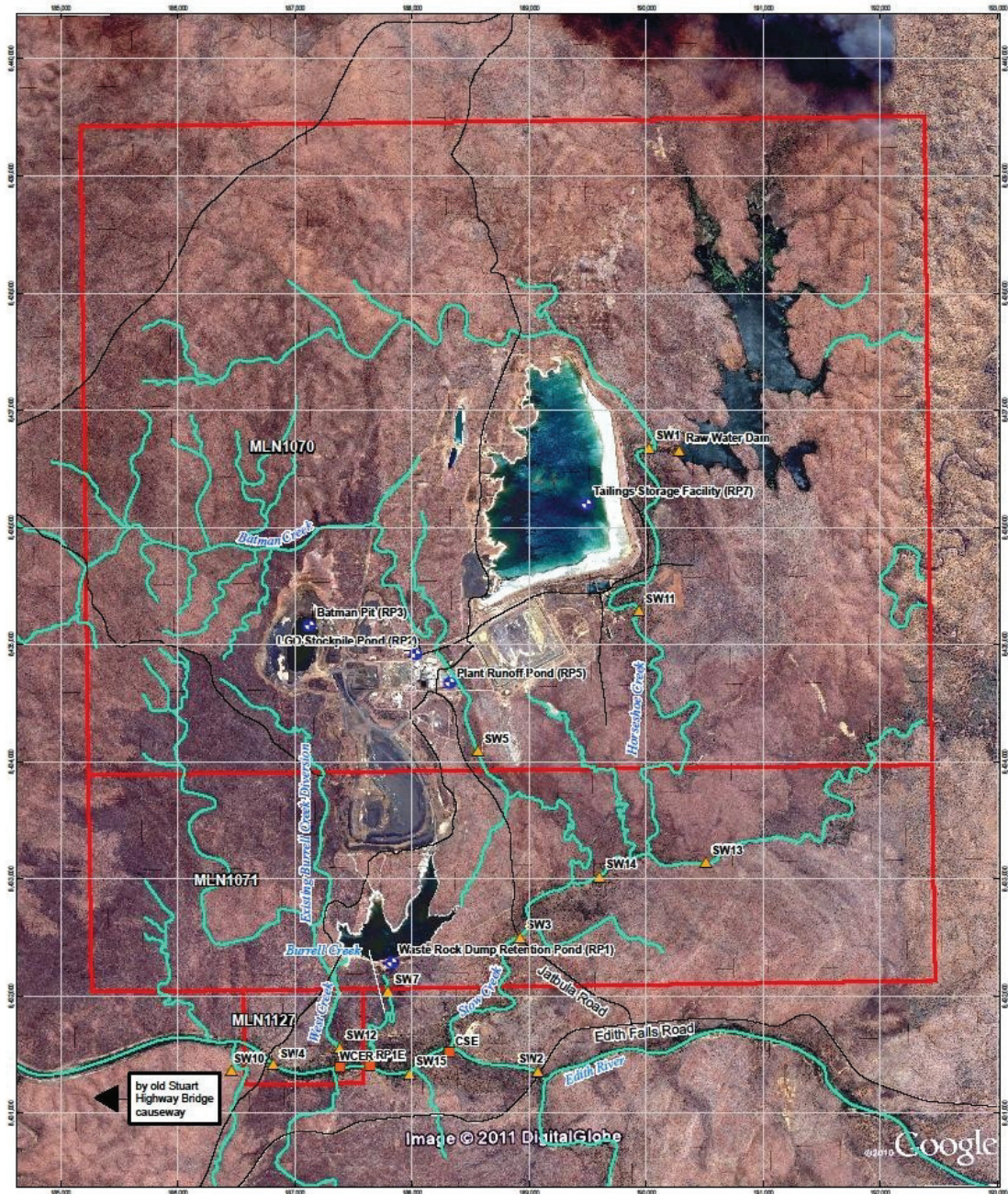
In addition to the SW2, SW3, SW4, SW10, SW13 and RP3 the sites listed in Table 5 are to be sampled. These sites are shown in Figure 2.

Table 5 Summary of Water Sampling Sites for Mt Todd Mine

Site	Water body
Raw Water Dam	Raw water supply
SW1	
SW11	Horseshoe Creek
SW5	Batman Creek
SW7	Burrell Creek
SW15	Edith River
SW12	West Creek
TSF1	Tailings Storage Area
BATMAN PIT	Batman Pit
RP 1	Waste Rock Retention Pond
Heap Leach Pad Moat	Heap leach pad
PWP	Process Water Pond
TWHT	Treated Water Holding Tank
LGRP	Low Grade Ore Retention Pond



Figure 1 Sample Locations (WDL178-05)



LEGEND

- Impoundment Sampling Location
- Access Roads
- Mine to Edith River discharge point
- Waterways
- Surface Water Sampling Station
- Mt Todd Mining Leases



Vista Gold Australia Pty Ltd
Mt Todd Gold Project

Job Number 43-21801
Revision 0
Date 16 Nov 2012

Location of Surface Water Sampling Figure 10-6

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Data source: Google - Imagery (Data extracted: 28/03/2011), NRETA6 - Mining Leases (2011), GHD - Sampling Sites, Access Roads, Waterways (2012). Created by: CM

Figure 2 Additional Sample Locations



10.1 Water Quality Parameters and Sampling Regime

Tables 6a and 6b outline the parameters to be monitored for each site as specified on a monthly basis.

Table 6a: Parameters to be Monitored Monthly

Sample Sites	Raw water dam, SW1, SW11, SW5, SW3, SW13, SW14, SW7, SW2, SW15, SW4, SW10, SW12, TSF1, BATMAN PIT, RP1, Heap Leach Pad Moat
In situ	Parameter
	Flow
	Dissolved Oxygen (mg/L and % Saturation)
	Temperature (°C)
	Electrical Conductivity (µS/cm)
Laboratory	pH
	Total Suspended Solids (mg/L)
	Total Dissolved Solids at 180° C (mg/L)
	Dissolved Organic Carbon (SW2 and SW4 only)
	Total Organic Carbon
	Unfiltered Alkalinity, bicarbonate, carbonate (mg/L)
	Major cations: Na, K, Ca, Mg (mg/L)
	Major anions: Cl, SO ₄ (mg/L)
	Nitrate and Phosphate (mg/L)
	Hardness (mg/L)
	Cyanide-WAD (µg/L)
	TRH C10 – C36 (µg/L)
	Dissolved Metals (0.45µm) (Al, As, Cd, Co, Cu, Cr, Fe, Pb, Mn, Hg, Ni, U, Zn) (µg/L)
	Total Metals (Al, As, Cd, Co, Cu, Cr, Fe, Pb, Mn, Hg, Ni, U, Zn) (µg/L)

Table 6b: Additional Sites/Parameters to be monitored monthly (WDL 178-05)

Sample Sites	SW2, SW3, SW4, SW10, SW13, RP3
	Parameter
Laboratory	Nitrite - Filtered (µg/L)
	Ammonia - Filtered (µg/L)
	Organic Carbon (total)

11. Surface Water Sampling Monitoring Methodology

Sampling should only be undertaken by appropriately trained and experienced personnel. Preparation for a sampling event must include knowledge of and compliance with site Occupational Health and Safety protocols for the sampling activities, including familiarisation with relevant Material Safety Data sheets and precautions necessary for handling chemicals.

11.1 Procedure (*in situ* physico-chemical analysis)

Setup water quality meters and ensure they are functional and calibrated
Place probes into the water body, ensuring there is at least 10 cm of water covering all probes and that the probes do not touch the bottom.

Wait at least 1 minute for the instrument to initialise, and then allow the parameters to stabilize.

Record time and other parameters on field sheets; including anything untoward including weather etc.

11.2 Procedure (laboratory samples for Envirolab Services)

Fill each sample bottle by transferring sample using a reach pole/bailer.

Note that one of the two red preserved metals bottle (dissolved) requires the sample to be field filtered through the 0.45 µm filter paper and syringe, as the sample is transferred into the bottle. This latter bottle will then be identified via the tick box on the label stating it is to be analysed for dissolved metals.

Label each sample bottle, ensuring that the following information is provided:

- Date
 - SW site
 - Sampler's initials
 - Analysis required; (distinguishing total or dissolved metals on preserved red bottles)
- Note that two blind field duplicate samples will be collected for analysis by Envirolab.

11.4 Collection for Analysis

The choice of sample collection device is influenced by the nature of the sample site and the type of sample required. For example, a sample pole and container may be necessary where steep banks make accessing the water a safety risk. A clean pair of gloves should be worn at each sample site to minimise potential contamination problems. To collect a grab sample from shallow water body or a channel of flowing water:

Select a point in the stream that is downstream of any channel braiding or inputs from tributaries to allow thorough mixing.



Remove sample container lid (for locations with known very low concentrations of analytes this may need to be performed beneath the surface of the water to reduce contamination risk)

Immerse sample container with the opening pointing directly down to maintain a volume of air in the container, thereby avoiding the collection of any surface films.

Once under the surface of the water point the mouth of the sample container up stream so that gloved hands, sample container and/or sample collection device is downstream of the sample being collected.

When sampling from a shallow water body, where possible select a point that is a reasonable distance from the edge. If the water is still (or flowing very slowly) move the sample container forward away from the sampler and any equipment to collect a continuous uncontaminated sample.

Fill container, rinse and empty rinse water downstream or at a sufficient distance from sample site to prevent mixing of rinse water with the water to be sampled. Repeat.

Fill container completely to exclude air and replace cap.

Perform necessary filtration and/or preservation procedures, ensuring that sufficient sample is collected to perform the required analyses and any repeat analyses necessary.

Complete sample labels and field data sheets.

11.4.1 Grab Sampling

Grab samples can be collected using a hand-held plastic scoop or bottle, depending on the depth of water, and if required, composited into a narrow-mouth plastic container. Volatile organic sample containers (inc TRH) should be filled directly from the source by dipping the sample container into the liquid. The remaining sample containers can be filled from the composite sample. Care must be taken to minimise aeration.

The procedure for grab sampling is normally as follows:

Place container by hand directly into water body, open end vertically down and fill with an arc motion with the bottle mouth facing upstream. Take care to avoid collecting surface films. For waters less than half a metre in depth, collect a grab sample at half the water depth. For waters greater than half a metre in depth, a grab sample should be taken at 20 to 30 cm below the surface water.

- If collecting a grab sample from a stream bank, weir or jetty:
 - select a sampling site which is representative of the stream;
 - avoid disturbance at the sampling site, particularly at the stream bank. If disturbance occurs
 - collect the sample upstream; and
 - collect grab sample as described previously.

11.4.2 To Collect a Grab Sample at Depth:

Specific depth sampling equipment is required, either pump and tubing, or sample collection device.

If the sample is to be pumped, ensure that sufficient volume has passed through the collection tubing to rinse the tube thoroughly.

Sample collection for field measurements and for laboratory analysis can then begin as previous.

11.4.3 Sample Storage and Transport

Place samples into an ice chilled esky and continue to next location; repeat. Once sampling run is completed; store samples prior to transport at 4°C in the fridge (be aware of holding



times), When sufficient numbers of samples have been collected proceed by driving samples to Katherine for transfer and analysis.

A completed CoC form in a waterproof ziplock bag is to be placed in the esky with the samples.

Address for samples:
 Envirolab Services
 12 Ashley St
 Chatswood NSW 2067
 Phone: 02 9910 6200
 Fax: 02 9910 6201
 Aileen Hie (Client contact)

11.4.4 Sample Holding Times

Table 7 shows the hold times for each sample type. The laboratory must receive and analyse the samples within these time to ensure accuracy of the results.

Table 7 Sample holding times

Bottle Label	Tests	Bottle	Volume mL	Preservation	Holding Time
Green	TSS, TDS, anions, cations, hardness, DOC, TOC	Plastic	500	Cool to 4°C	TSS, TDS 7 d Others 28 d
Blue	WAD cyanide and Cr VI	Plastic	100	pH >12 (NaOH), cool to 4°C, dark	14 d (WAD) CN) 40 d (Cr VI)
Red	Metals Dissolved and Total	Plastic	60	pH <2 (HNO ₃)	Metals 6 m Hg 28 d
Green	TRH	Glass	200	Cool to 4°C	7 d
Green	NO ₃ and PO ₄	Plastic	100	Filter and Freeze	28 d

12. Quality Assurance/Quality Control

To ensure the reliability and interpretability of the collected data, appropriate documentation has been incorporated into the monitoring program that records sample movement from collection to data reporting and ensures that analytical data is ascribed to the correct location (Chain of Custody documentation). Appropriate chain of custody information for collected samples commences with the completion of a “Field Sample Collection Sheet”.

Once collected, samples are stored, handled, and transported in such a manner as to:

- prevent damage to containers or labels,
- minimise or eliminate degradation of the sample, and
- prevent contamination of the sample.

Upon delivery to the analytical laboratory, information relating to the time between sample receipt and analysis, storage and preservation methodology employed at the laboratory, and analytical technique is documented in the returned Chain of Custody, a Sample Receipt Advice and Certificate of Analysis documentation.



Quality Assurance (QA) practices applied during SW sample collection and analysis include:

- Field notes including in situ water quality parameters;
- Field equipment in-house calibration sheet;
- Sample holding times;
- Field blind duplicates (1 in 10);
- The use of NATA accredited laboratory;
- COC documentation. The Chain of Custody form tracks samples by label data. The completed form must accompany the SW samples from the field to the laboratory; and
- Laboratory internal analytical QA/QC procedures (where appropriate) including:
 - – Laboratory duplicates;
 - – NATA approved analytical methods;
 - – Sample holding times;
 - – Sample preservation (as recorded on CoC); and
 - – Laboratory limit of reporting

13. Document Control

The following information is to be saved in hard copy in the Surface Water Monitoring folder in the site office:

- The equipment calibration sheet.
- A photocopy of the signed CoC.
- The completed field data sheet.
- The laboratory results including laboratory QA/QC report.

The equipment calibration sheet, the signed CoC, and the field data sheet are all to be scanned and uploaded to the monthly results folder

14. WDL Reporting

As specified in the current WDL.

15. Responsibilities

Environment Manager

The Environment Managers is to ensure that the field staff undertaking testing are familiar with this procedure and briefed on any relevant community, ecological, environmental or other issues which might affect the sampling process on the given day of testing. They are also responsible for ensuring field staff are suitably trained.

Field Staff

Field staff using this procedure are to ensure that; equipment is arranged and serviceable, that access to sampling sites is confirmed, and that the sample collection and testing is conducted, documented and entered correctly. Any requirement for modification to this procedure should be communicated to the Environmental Manager, such that revision can occur.

16. Attachments

The following will be attached to the hard copy of the SOP.

- Daily Calibration Sheet
- pH Meter Manual
- EC Meter Manual
- DO Meter Manual



Surface Water Monitoring Standard Operating Procedure July 2017

- Envirolab chain of custody monthly sampling
- Envirolab chain of custody daily sampling
- SW Field Data Sheet monthly sampling
- SW Field Data Sheet daily sampling



SW2



SW3



SW4



SW10

