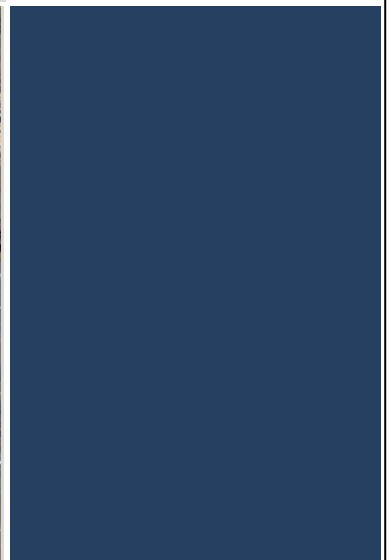




Standard Operating Procedure: *Groundwater Sampling*



Document Control Record

REVISION STATUS

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Recipients are responsible for eliminating all superseded documents in their possession.

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Appendix A – Field Data Sheet, Groundwater Sampling

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1 Introduction

1.1 Purpose

Ensure sampling methods obtain samples representative of actual groundwater composition at the site. Also to ensure all sampling is consistent, undertaken in a safe manner and follows best-practice procedures in accordance with relevant standards.

1.2 Scope

This procedure applies to all groundwater sampling undertaken by EcOz personnel, noting that some sampling requirements may vary on a project-specific basis. Groundwater quality monitoring is generally focussed on identifying any impacts on groundwater aquifers from industrial sites (e.g. mining, airports, fuel storage, sewage) on the environmental, cultural and water supply (domestic, agricultural) values of the groundwater.

This usually includes both the measurement of water quality parameters in the field (e.g. temperature, pH, electrical conductivity, dissolved oxygen, ORP and turbidity), and the collection of water samples for subsequent laboratory analysis (e.g. metals, major cations and major anions, hydrocarbons, microbiological, nutrients).

1.3 Definitions and Abbreviations

COC – Chain of Custody

DO – Dissolved Oxygen

EC – Electrical Conductivity

N.A.T.A – National Association of Testing Authorities

ORP – Oxidation Reduction Potential

pH – ranges between 1 and 14 and provides a measure of acidity/alkalinity

PPE – Personal Protective Equipment

QA / QC - Quality Assurance / Quality Control, which may include:

- Duplicate sample – collected during each sampling event (1 duplicate for every 10 sample sites) to detect both natural environmental variation, and any errors from field sampling methodologies.
- Split sample – collected during each sampling event (1 split for every 10 sample sites) and sent to a different laboratory to detect any Lab-based discrepancies.
- Field blank sample - collected during each sampling event to evaluate potential contamination from personnel and/or sampling equipment.

SWQ – Surface Water Quality

1.4 Standards and other requirements

To ensure the quality and accuracy of measurements, these sampling procedures were developed in accordance with the following standards and guidelines:

- NT Department of Mines and Energy *Methodology for the Sampling of Groundwaters*, Advisory Note, 2009. Northern Territory Department of Mines and Energy (DME), NT Government, Darwin.
- Australian/New Zealand Standard on Water Quality Sampling - Part 1: *Guidance on the design of sampling programs, sampling techniques and the preservation and handling of samples* (AS/NZS 5667.1:1998), Standards Australia, New South Wales.
- Australian/New Zealand Standard on Water Quality Sampling – Part 11: *Guidance on sampling of groundwater* (AS/NZS 5667.11:1998), Standards Australia, New South Wales.
- ANZECC & AMRCANZ 2000, *Australian Guidelines for Water Quality Monitoring and Reporting*, National Water Quality Management Strategy Paper No 7, Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ), Canberra.
- ANZECC & AMRCANZ 2000, *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*, National Water Quality Management Strategy Paper No 4, Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ), Canberra.

Personnel must ensure that any required permits (e.g. Indigenous Land Access Permit), and/or land access permissions are obtained prior to undertaking water sampling. These shall be saved in the Vantage VBM Document Management System in folder B0305.

Personnel must also ensure that all site induction requirements are fulfilled, ID Cards (e.g. ASIC, MSIC), Licences, contractor induction cards/certificates and keys are obtained and are carried with you prior to mobilising to site.

Ensure you know of any site restrictions such as possession and/or use of mobile phones, cameras, flammables, particular chemicals.

2 Equipment, safety and training

2.1 Equipment

The following equipment list is provided for guidance and personnel should consider project-specific sampling requirements when preparing for field sampling:

- Map(s) showing monitoring sites.
- GPS – with coordinates uploaded for locating sites.
- Any site access or permit requirements such as keys, ID Cards, Contractor Induction Certificates, ASIC, Boat/Vehicle Licence, Indigenous Land Access Permit.
- Printed JSEA for the job. This includes all emergency contacts.
- *EcOz Groundwater Sampling Field Data Sheet* – enough for all sample sites plus some spares – See Appendix A.
- Bore construction reports for each bore.
- Folder/clipboard and waterproof notebook.
- Stationary: Pens / pencils, permanent markers for completing sample bottle labelling.
- Sample bottles obtained from the relevant Laboratories being used (i.e. usually ALS, Envirolabs or AWQC). Make sure you have the specific bottle types required for each parameter to be tested. Remember also to prepare a full set of sample bottles for duplicate, split, and field blank samples (see definitions above). Also take some spares, especially the glass bottle types.
- Fox whistle or electronic dip meter for measuring standing water level (SWL).
- Bucket (20 L).
- Hand tools to open bore caps and keys if bores are locked.
- Calculator
- Water/time keeper
- Eskies with frozen ice bricks.
- Calibrated field test meters (pH, Temperature, EC, DO, ORP, Turbidity).
- Calibration solutions and copies of the *EcOz Calibration Record Sheet* (if in field for > 1 day) – See Appendix B for Calibration Record Sheet.
- Camera.
- Jug(s) for filling sample bottles if unable to fill bottles directly from hose.
- Small folding table and shelter.
- Tarpaulin to keep all equipment off the ground.
- Groundwater rig mounted on back of ute including pump, hose, compressor, tools, fuel etc – this set-up is to be checked by the Equipment Officer (Casey Hawkey) prior to leaving to ensure set up is correct, you have everything, and it is in good working order.
- Decon 90 solution mixed with deionised water (1:20) to clean equipment between sample sites.
- Deionised water for collection of field blanks and rinsing equipment between sample sites.

- Syringes and Filters (if sampling dissolved metals).
- Powder-free gloves.
- Spare batteries/charger for camera, GPS and field test meters.
- Chain of Custody (COC) forms from the relevant Laboratories (i.e. usually ALS, Envirolabs or AWQC); one for bulk of samples and one for Spilt samples.
- Plastic sleeves (snap-lock bags) to protect COC forms inside the eskies.
- Consignment (Con) Notes for Freighting samples to Laboratories (either using Toll, Australian Air Express or TNT depending on the client and sampling location), pre-filled as much as possible with relevant Account Number, Laboratory Address, Contacts etc.
- Tape and security seal for eskies; also stickers such as address label, fragile, keep chilled etc.
- Communications equipment (e.g. mobile/satellite phone, radio, EPIRB).
- PPE – see below.
- Garbage bag for used filters, syringes, gloves and other general waste generated during sampling.

2.2 OH&S requirements

Each groundwater sampling task must be covered by a specific Job Safety and Environment Analysis (JSEA) developed in consultation with all field party members. Examples of hazards/risks to be considered must include at least the following:

- Travel: vehicle accident, road conditions (e.g. bogging), mechanical issues (e.g. break-down, flat tyres) and driver fatigue, working from boats/helicopters
- Cuts/abrasions
- Trips/slips/strains
- Crocodiles
- Insect bites/stings etc
- Snakes
- Exposure: dehydration, sunburn
- Environmental impacts such as fuel spills, chemical spills, and waste

The JSEA shall also include details of personal protective equipment (PPE), such as:

- Sturdy boots (steel cap if industrial/mine site)
- Hat, safety/polaroid sunglasses, sunscreen etc for sun protection
- Hard hat (if industrial/mine site)
- Long pants and shirt (high-visibility if industrial/mine site)
- Gloves if handling heavy equipment

For safety reasons, field sampling should always be undertaken by at least two personnel and if working in remote areas, the JSEA must include a communications plan and emergency contact details.

The JSEA template is available through the Document Management System (Vantage VBM). Once completed, each JSEA must be read and understood by all field party members and signed off by the Fieldwork Leader / Project Manager, EcOz OH&S Officer and EcOz Manager. All JSEA's are saved in the Vantage VBM project folder B0304.

2.3 Training and competency

All personnel conducting water sampling shall be familiar with this SOP and have received field training from experienced personnel. This includes training in sample collection, using and calibrating field meters.

Operation of the ute-mounted groundwater rig is only to be undertaken by experienced personnel who have used it previously and/or used it under instruction from an experienced operator. The rig must be set up and checked by the Equipment Officer (Casey Hawkey) prior to your leaving for the site.

All personnel conducting water sampling shall have a current first-aid certificate.

2.4 Contamination prevention precautions

- 2.4.1 Keep hands away from sample bottle openings and the inside of bottle lids. Be aware that sources of contamination include smoking, permanent markers, insect repellent, sunscreen, deodorant, dust and perspiration.
- 2.4.2 Always wear powder free gloves and use new gloves for each sample site.
- 2.4.3 Do not allow the opening of sample bottles and bottle lids to touch the ground.
- 2.4.4 Only clean, sealed and pre-prepared preserved sample bottles obtained from a NATA Accredited laboratory (usually ALS) are to be used.
- 2.4.5 Ensure equipment is cleaned thoroughly after each sample site with decon 90 solution (5%) and rinsed with deionised water.
- 2.4.6 Ensure sample bottles are filled to the top leaving no headspace unless otherwise specified by the laboratory.
- 2.4.7 Do not overfill the bottle, particularly not for sample bottles with preservative.
- 2.4.8 For the bottles containing preservative, after sample collection, put the lid on and shake immediately.
- 2.4.9 After sample collection, ensure all sample bottles are tightly sealed and stored upright in an esky (with ice-bricks) or fridge at $<4^{\circ}\text{C}$. Do not use ice as this can contaminate the samples if they are left in the melted ice water.

3 Procedure

3.1 Preparation

- 3.1.1 Prior to undertaking a field sampling trip, ensure that a JSEA has been completed and that forecast and current weather conditions (e.g. stream levels, wind, tides etc) do not pose a risk to personnel safety and/or obtaining an appropriate sample.
- 3.1.2 Get together all the equipment listed in Section 2.1 (and any additional task-specific equipment) ready to go, ideally packing most of the gear together into a large plastic crate.
- 3.1.3 Bottles may need to be ordered from the laboratory (e.g. ALS, Envirolabs or AWQC). Contact the laboratory for advice on what bottles are required (certain analytes require particular bottles and preservatives).
- 3.1.4 Put together a package of sample bottles for each site (i.e. in a large snap-lock bag), including bottles for duplicates, split samples and blanks.
- 3.1.5 Label each bottle with the site name, or duplicate, split, blank, etc.
- 3.1.6 For metals, tick the box on the bottle label for either *filtered* or *total*, depending on whether samples for metals analysis will be filtered in the field.
- 3.1.7 Calibrate the field test meters (e.g. pH, EC, Turbidity, DO, ORP) according to the laminated instruction card provided in the Calibration Folder and/or manufacturer's instructions. Fill out the *EcOz Calibration Record Sheet* and file in the Calibration Record Sheet Folder. See Appendix B for Calibration Record Sheet.
- 3.1.8 Ensure camera and GPS are fully charged and have a cleared memory.
- 3.1.9 Depending on the number of sites being sampled, prepare a sufficient volume of Decon 90 solution (i.e. 1:20 Decon:de-ionised water) to use for cleaning sampling equipment in the field.
- 3.1.10 Print out required number of blank Groundwater Sampling Data Sheets (Appendix A), COC forms, maps and bore reports.
- 3.1.11 Ensure that ice bricks have been put in the freezer.

3.2 Travel to sampling site

- 3.2.1 Review JSEA prior to travel to ensure that all safety risks are covered and personnel are familiar with any risks.
- 3.2.2 When undertaking routine groundwater sampling, it is best that at least one of the field team has previous experience sampling all the sites.
- 3.2.3 The map and marked GPS locations should be used to confirm the correct location of bores.

3.3 Bore purging

- 3.3.1 The standing water within a monitoring bore is not representative of the surrounding groundwater. Sampling of a monitoring bore must be undertaken in such a way that groundwater surrounding the bore is sampled and not the standing water within the bore (or a mixture of both).
- 3.3.2 It is standard practice to purge a minimum of 3 casing volumes-worth of water from the bore prior to sampling and/or to pump water at a steady state equal to the groundwater recharge rate from the bore until successive readings of water quality parameters remain stable.
- 3.3.3 Back the ute up so the groundwater rig is over the bore so the pump can be lowered directly into the bore.
- 3.3.4 Fill in the Groundwater Sampling Data Sheet with the Bore ID, date, time, your name, bore head condition, casing height, etc
- 3.3.5 Open bore cap using hand tools and key if locked.
- 3.3.6 Lower whistle/or electronic dip meter into the bore and measure the SWL.
- 3.3.7 Record this initial SWL on Data Sheet.
- 3.3.8 Calculate the volume of water in the bore using this calculation:
- 3.3.9 $\pi r^2 (D-SWL) \times 1000$
 r = radius of inner bore casing (in meters)
 π = pi (3.14)
 D = total depth of the bore (in meters)
SWL = Standing Water Level (distance from ground to water level – in meters)
- Obtain radius of the inner bore casing and depth of bore from the bore reports to calculate volume of water using above equation.
- 3.3.10 Lower pump into bore to the level where the bore casing is slotted (known from the bore report).
- 3.3.11 Lower dip meter back into bore so that SWL can be continuously measured during pumping – the pumping rate must be adjusted so that change in SWL is minimal i.e pumping rate = recharge rate.
- 3.3.12 Record time pumping is started on the Data Sheet.
- 3.3.13 Place end of hose into a 20 L bucket and let the bucket fill and spill over making sure the water flows well away from the bore – make a small channel using a shovel if required.
- 3.3.14 Continue to pump and observe any reduction in SWL to match pumping rate with recharge rate.
- 3.3.15 After about 5 minutes of pumping take a photo of the water colour and make any observations such as colour, sediment, odour or contamination etc
- 3.3.16 Record time, SWL and flow rate on the Data Sheet.
- 3.3.17 Place field meters into the bucket and take readings as water continues to flow past the meters.

- 3.3.18 Record field parameters (Time, SWL, pH, Dissolved Oxygen [DO], Electrical Conductivity [EC], Temperature, Oxidation Reduction Potential [ORP], Turbidity) every 5 minutes until three consecutive readings stabilise within 5% of each other. Record all readings on the Data Sheet.
- 3.3.19 Once a stable chemistry is reached (usually after about 30 min of pumping depending on the bore), record the final time, SWL and field parameters and collect water samples for laboratory analysis as per instructions below.

3.4 Sample collection

- 3.4.1 Wear powder-free gloves
- 3.4.2 Take out the required pre-labelled sample bottles.
- 3.4.3 Ensure when taking lids off that you don't touch the opening of the bottle or contaminate the inside of the bottle lid.
- 3.4.4 Fill the bottles from the hose making sure they are completely full with no headspace. Be careful not to overfill bottles which contain preservatives. If the flow rate is very rapid it may be required to fill the bottles containing preservative using a jug (pre-cleaned with decon and de-ionised water).
- 3.4.5 For samples requiring field filtering (e.g. dissolved metals), draw some water from the jug into a syringe, put a filter on the end of the syringe, rinse the filter by pushing a few drops of the sample through onto the ground, then fill the bottle leaving no headspace. Depending on the size of the syringe, it may be necessary to draw several syringes-full of water to fill the sample bottle.
- 3.4.6 Once all bottles are filled and tightly capped with lids, place them upright into the esky and store below 4°C.

3.5 Collection of field blanks, split samples and duplicates

- 3.5.1 To collect a field blank, simply follow the steps outlined in 3.4 above using de-ionised water instead of water from the site being sampled.
- 3.5.2 For split samples and duplicates, repeat all the above steps outlined in 3.4 above at the site(s) chosen for these samples (generally at least 1 in 10 sample sites). Be sure to note collection of these samples on the Groundwater Sampling Data Sheet otherwise it will not be possible to track which site these samples were collected because the site name is not permitted to be recorded on the bottle.

3.6 Pack up and cleaning of field equipment

- 3.6.1 Wind up hose reel and bring pump out of bore.
- 3.6.2 Place pump into the 20 L bucket with deionised water to flush the hose and also rinse the external hose.
- 3.6.3 Turn off air compressor.
- 3.6.4 Pack all gear back into vehicle.
- 3.6.5 Close the bore cap and lock.

- 3.6.6 Clean all meter probes, small jug and other equipment with the decon solution and rinse all equipment with deionised water (if not already done so for collecting a rinsate blank sample).
- 3.6.7 Be sure that all equipment is cleaned and rinsed using the above steps after sampling each bore.
- 3.6.8 Dispose of used filters, syringes, and gloves appropriately.

3.7 Sample dispatch

- 3.7.1 Once sampling is completed, pack the samples securely in an esky with ice bricks. Ensure that samples have sufficient contact with the ice bricks to stay as cool as possible.
- 3.7.2 Fill out the COC, put in a plastic sleeve (snap-lock bag) and place inside the esky.
- 3.7.3 If required, provide a copy of the COC to the client.
- 3.7.4 Samples must be dispatched to the laboratory within the required holding times, noting that:
- Samples must be dropped off at the ALS office in Woolner (Unit 4, 16 Charlton Ct) no later than 3pm each day.
 - Sample dispatch on Fridays and Saturdays is not acceptable for sample analysis with short holding times (e.g. microbiological, nutrients) as samples will not be delivered to the labs until Monday morning. Other parameters with longer holding times can be kept in a fridge until dispatch on Sunday or Monday.
- 3.7.5 If sending samples direct to the laboratories:
- Tape up the esky and put on address label and stickers as appropriate (e.g. fragile, keep chilled etc).
 - Fill out consignment note and stick on esky.
 - Deliver samples direct to freight company or organise pick-up, ensuring that samples will be dispatched in time to meet laboratory holding times (usually by 16:00 on day of sampling for overnight priority service).
- 3.7.6 Remember to also prepare a small esky containing the split sample for sending to a separate laboratory.

Appendix A – Field Data Sheet, Groundwater Sampling

Groundwater Sampling Data Sheet

Site/Project:	
Sample Date:	
Bore Name:	
Sampled By:	
Bore Head Condition:	
Total Depth (mbgl):	
Screen Intervals (mbgl):	
Pump Depth:	

SWL Initial (m below top of casing):			
Casing Height (m above ground):			
SWL Initial (m below ground level):			
Casing:	Colour at Start:	Odour:	Equip?
PVC		Nil	Y N
Steel	Colour at End:	H ₂ S	psi
Other		Other:	L/s
Comments:			

Time started Pumping/Purging:										
Time										24hr
EC										µs/cm
pH										
Temp										°C
Turbidity										NTU
Salinity										ppt
TDS										g/L
ORP										mV
D.O.										%sat
SWL										mbtoc
Flow Rate										L/min

Time										24hr
EC										µs/cm
pH										
Temp										°C
Turbidity										NTU
Salinity										ppt
TDS										g/L
ORP										mV
D.O.										%sat
SWL										mtoc
Flow Rate										L/min

Time Lab Samples Collected:

Comments:

Appendix B – Calibration Record Sheet, Water Sampling Meters

CALIBRATION RECORD – WATER SAMPLING METERS

Date:				Calibrated By:			
Probe Calibrated: <small>(Enter ID of each probe i.e. #1, #2, or #3)</small>		pH:		EC:		DO:	
						Turbidity:	
Pre-Calibration Reading:				Post Calibration Reading (Checking):			
pH							
pH 7.00 Standard:		pH 4.01 Standard:		pH 7.00 Standard:		pH 4.01 Standard:	
pH:	Temp:	pH:	Temp:	pH:	Temp:	pH:	Temp:
pH readings (circle): Good Some Problems - explain here:							
EC							
EC Calibration Solution Used (circle): 447 µS/cm 1413 µS/cm 2570 µS/cm 12880 µS/cm							
EC µS/cm:	TDS g/L:	Sal ppt:	EC µS/cm:	TDS g/L:	Sal ppt:	EC µS/cm:	TDS g/L:
EC readings (circle): Good Some Problems - explain here:							
Turbidity							
Turbidity Standard 10 NTU:				Turbidity Standard 10 NTU:			
Turbidity 20 NTU:		Turbidity 100 NTU:		Turbidity 800 NTU:			
Turbidity readings (circle): Good Some Problems - explain here:							
DO							
Barometric Pressure (mb) entered for DO: <small>Look up on BoM website for your locality</small>				Salinity (ppt) entered for DO: <small>i.e zero if samples will be freshwater or 35 ppt for marine samples</small>			
DO 100% sat:				DO 100% sat:			
DO readings (circle): Good Some Problems - explain here:							
Probes require servicing? (e.g. DO membrane needs changing, probes need to be cleaned or sent away, batteries need replacing)							
						Actioned (tick): <input type="checkbox"/>	
						Date:	
Any other actions required? (e.g. order more calibration solutions or DO replacement membranes)							
						Actioned (tick): <input type="checkbox"/>	
						Date:	

Signature:

Calibration Notes:

- Refer to laminated calibration card (located in calibration record sheet folder) for step-by-step instructions on calibrating each meter.
- Always allow plenty of time for readings to stabilize before calibrating.
- Gently tap the EC probe against side of container or agitate the probe while submerged in the solution to dislodge any bubbles that may be clinging to the probe lens.
- The EC probe will not work properly unless immersed in at least 7cm of water.
- Be careful when taking field measurements as EC probe switches between $\mu\text{S}/\text{cm}$ and mS/cm without notice – be aware of this when writing down readings!
- Only record the EC reading with flashing $^{\circ}\text{C}$ symbol. This is the standard at 25°C . Ignore the other one.
- When calibrating pH always calibrate in pH 7.00 solution before pH 4.01 solution.
- The Temperature reading must be stable before calibrating DO 100% sat.
- Ensure no water droplets are clinging to the DO probe before calibrating DO 100% sat.
- If readings are unstable or out of expected range the probes may need cleaning or servicing – see instruction manual on how to clean the EC electrodes, change the DO membrane, clean the pH or turbidity probes.
- Meter instruction manuals are located on water quality meter shelf in storeroom.