# Windsor Bridge Replacement Project

Transport for NSW

## Water Quality Management Program

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IA098200

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# Windsor Bridge Replacement Project

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## Document history and status

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| A | 20/4/2016 | Technical review | J Bell | Technical | D. Wagner |
| B | 23/05/2016 | Technical review | K Byrnes | Technical | D. Wagner |
| C | 10/06/2016 | Editorial Review | S Craig | Quality | D. Wagner |
| D | 25/10/2016 | Amendments based on DPI comments | J Tait / K Byrnes | Quality | D. Wagner |
| E | 31/03/2017 | Amendments based on additional DPI Comments | S Craig / S Douglass | Quality | D. Wagner |
| F | 19/04/2017 | Amendments based on RMS comments | S Craig / S Douglass | Technical | D. Wagner |
| Final Rev 0 | 4/06/2017 | Amendments based on DPE comments | D. Wagner | Editorial | D. Wagner |
| Rev 1 | 15/06/2020 | Amendments based on annual review | | | |

## Contents

## 1.6 Objectives

The objective of the WQMP is to monitor and manage the construction, demolition and operational impacts of the construction of the new Windsor Bridge on surface water bodies and groundwater resources.

The key surface water quality objectives are to:

- Protect downstream aquatic ecosystems.
- Maintain downstream visual amenity.
- Maintain downstream water quality for primary (e.g. water skiing) and secondary contact secondary contact recreation (e.g. boating, wading, fishing etc.).

The key groundwater objectives are to:

- Minimise interference with the aquifer during construction, demolition and operation which could alter groundwater levels, groundwater flow direction and potentially impact local groundwater users.
- Minimise pollution of the aquifer during construction, demolition and operation.

The implementation of this WQMP will assist in ensuring that both the construction and operation of the new Windsor Bridge (including the demolition of the existing bridge) will minimise potential negative impacts on sensitive receiving environments.

# 2. Planning and Statutory Requirements

The Instrument of Approval was granted by the Minister for Planning and Infrastructure on 20th December 2013 for the Windsor Bridge Replacement Project. The Approval includes the following conditions with respect to Soil and Water Quality:

**Condition C24 – Water Quality Management Program:** *The applicant shall prepare and implement a **Water Quality Management Program** (WQMP) to monitor and minimise the impacts of the project on surface and groundwater quality and resources and wetlands, during construction and operation of the proposed Windsor Bridge, and demolition of the existing bridge. The program shall be developed in consultation with the Office of Environment and Heritage (OEH), Environmental Protection Agency (EPA), Department of Primary Industry (DPI) Fishing and Aquaculture and NOW (currently DPI Water) and shall include but not necessarily be limited to* [the items in **Table 2-1**].

Table 2-1: Instrument of Approval Requirements for the Water Quality Management Program

| Item | Details | Addressed in |
|---|---|---|
| a) | Identification of surface and groundwater quality monitoring locations (including watercourses and waterbodies) which are representative of the potential extent of impacts from the project. | Section 5 |
| b) | The results of the groundwater modelling undertaken under this consent. | Section 4.6 |
| c) | Identification of works and activities during construction, demolition and operation of the project, including emergencies and spill events, that have the potential to impact on surface water quality of potentially affected waterways. | Section 4 |
| d) | Development and presentation of parameters and standards against which any changes to water quality will be assessed, having regard to the *Australia and New Zealand Guidelines for Fresh and Marine Water Quality 2000* (Australian and New Zealand Environment Conservation Council, 2000. | Section 7 |
| e) | Representative background monitoring of surface and groundwater quality parameters for a minimum of six months (considering seasonality) prior to the commencement of construction, to establish baseline water conditions, unless otherwise agreed by the Director-General. | Completed |
| f) | A minimum monitoring period of three years following the completion of construction or until the affected waterways and/or groundwater resources are certified by an independent expert as being rehabilitated to an acceptable condition. The monitoring shall also confirm the establishment of operational water control measures (such as sedimentation basins and vegetation swales). | Detailed in Section 6 |
| g) | Contingency and ameliorative measures in the event that adverse impacts to water quality are identified. | Section 8 |
| h) | Reporting of the monitoring results to the Department, OEH, EPA and NOW (DPI Water). | Section 7.7 |
| | The Program shall be submitted to the Director-General for approval 6 months prior to the commencement of construction of the project, or as otherwise agreed by the Director-General. A copy of the Program shall be submitted to the OEH, EPA, DPI (Fishing and Aquaculture) and NOW prior to its implementation. | Section 1.3 |

# 3. Existing Water Quality

## 3.1 Surface Water Quality

Water quality monitoring in the vicinity of the Project has been routinely undertaken since the 1980's with most of the water quality sampling undertaken by WaterNSW (formerly Sydney Catchment Authority), Office of Environment and Heritage (OEH) and Sydney Water. Water quality testing was most recently undertaken in June 2013 upstream and downstream of the current and proposed location of the Windsor Bridge and found to be consistent with previous assessments undertaken by DECC in 2009 and WaterNSW in 2012 as follows:

- Conductivity, pH, and turbidity levels were frequently within the ANZECC guideline values over the whole record.
- Dissolved oxygen levels have been steady over time and the majority were within guideline values.
- There has been an improvement in phosphorus (total and filterable phosphorus) levels over time, and the majority of recent monitoring data has met the ANZECC guideline values.
- Nitrogen (total, oxides of nitrogen, and ammonium) levels and chlorophyll-a levels frequently exceed the ANZECC guideline values over the whole record.

## 3.2 Groundwater Quality

A search of the DPI Water's PINNEENA database identified no registered groundwater bores or piezometers within the project area. However, one existing well GW106373, (labelled RBHO1 within the WQMP) is immediately adjacent to the project site, on the corner of Wilberforce and Freemans Reach roads. Several other wells where located within a 1km radius of the project site but deemed too far away to be impacted or to be used for groundwater monitoring.

The groundwater bore information found using PINNEENA suggests:

- That in areas where there are gravels and sands in the top soil profile layers, there is an aquifer of good quality and low salinity water.
- That in areas where there are no are gravel and sands in the top soil profile layers, groundwater is only encountered at depths greater than at least 25m below surface and the groundwater is of relatively high salinity.

Furthermore, two geotechnical bores (**Table 3.1**) on the north and south banks of the river, located on the centre lines of the proposed road works, have been temporarily converted into groundwater monitoring piezometers. These sacrificial piezometers will be used for baseline groundwater monitoring and will need to be replaced for construction, demolition and operational monitoring. Replacement bores will be installed at least one month prior to the sacrificial bores being destroyed.

Groundwater level measurements were recently undertaken by Jacobs on 21 April 2016 at the groundwater monitoring piezometers (**Table 3.1**). Groundwater levels were close to the level of the river during normal flow periods.

Groundwater flow direction at the project site is towards the river, as this is, generally, the hydraulic control with respect to the aquifer (on the northern side with respect to sands and gravels) and the aquitard (on the southern side with respect to siltstone and clays), being the lowest hydraulic level.

Table 3.1: Windsor bridge existing groundwater piezometer details

| Bore ID | Date of Inspection | Static Water Level (mbgl) | Surface RL (metres AHD) | Static Water Level (metres AHD) | Total Depth (m) | Screened Section (m) |
|---|---|---|---|---|---|---|
| NP-BH02 | 21/04/2016 | 7.44 | 7.76 | 0.32 | 25.40 | 19.40 – 25.40 |
| SP-BH01 | 21/04/2016 | 8.34 | 8.79 | 0.45 | 12.00 | 6.00 – 12.00 |
| NP- RBHO1 (GW106373) | 18/10/2106 | 10.62 | Not surveyed | Not surveyed | 12.00 | 0.00 – 12.00 |

# 4. Risks to Water Quality

## 4.1 Risk to Surface Water

There are several risks posed to surface waters by the construction, demolition and operation of Windsor Bridge. These were largely presented in the EIS[1] and are summarised below.

### 4.1.1 Construction Phase

During the construction, the highest risk of impacts to water quality would be associated with activities that expose soils such as:

- Earthworks, including stripping of vegetation and topsoil, excavation or filling.
- Stockpiling of topsoil, vegetation and other construction materials.
- Transportation of cut or fill materials.
- Movement of heavy vehicles across exposed earth.
- Removal of riparian vegetation.
- Construction in areas of highly erodible soils.
- Construction in any contaminated land.
- Construction in any acid sulphate soils (ASS).

The impact of unmitigated construction activities on receiving surface waters could include:

- Increased sedimentation, smothering aquatic life and affecting the ecosystems of the river.
- Increased levels of nutrients, metals and other pollutants, transported via sediment to the river.
- Fuel, chemicals, oils, grease and petroleum hydrocarbon spills from construction machinery directly polluting the river and soils.
- Spills of concrete during concrete pours directly polluting the river and soils.
- Contamination from site compounds, chemical storage areas and wash down locations.
- Increased levels of litter from construction activities polluting the river.
- Contamination of the river as a result of disturbance of contaminated land.
- Acidification of the river as a result of disturbance of acid sulphate soils during construction.
- Any sediment from below the Hawkesbury River should be subject to ASS screening and treated appropriately. It is identified in the EIS that analysis of riverbed sediments indicated there may be low strength ASS present within the sediments near the southern bank, however, it is acknowledged there is potential for false positives where there is a high proportion of organic matter in the sample. In accordance with the EIS, screening for ASS should be undertaken and, if identified, an Acid Sulphate Management Plan is to be developed and implemented.

[1] Extract from Working Paper 7: Soil, Sediments, Water and Waste Water - Windsor Bridge Replacement EIS (SKM 2012)

- The ASS risk assessment map suggests soils on the northern side of the Project, unconsolidated sands and gravels, are Soil Class 4 meaning that work 2m below ground level (bgl) should also be subject to screening for ASS, however, it is not expected that ASS on the northern side of the Project will be identified.

#### 4.1.2 Operational Phase

Risks to surface water quality during the operation of the project would be associated with the runoff of pollutants from the new road surface. The likelihood and severity of these impacts would be minimised through the incorporation of mitigation measures into the design of the bridge upgrade. Details of these mitigation measures are described in Section 8. However, pollutants sources would typically include:

- Hydrocarbons and combustion derivatives, lubricating oil, rubber, heavy metals (such as lead, zinc, copper, cadmium, chromium and nickel) and brake pad dust.

- Non-biodegradable garbage and food wastes.

- Accidental spillage of petroleum, chemicals or other hazardous liquids.

These pollutants can impact on the water quality, amenity and aquatic conditions during the operation of the project if washed into downstream watercourses.

#### 4.1.3 Demolition Phase

The EIS has noted that lead base paints were used at the current Windsor Bridge and will need to be managed accordingly to minimise impacts on the environment and human health. The effects of lead based paint on water quality would be elevated concentrations of lead which are especially toxic to aquatic organisms and possibly deterioration in visual amenity. Furthermore, increased sedimentation while removing bridge piers and accidental release of chemicals during instream works have the potential to impact water quality if not managed appropriately.

### 4.2 Risk to Groundwater

This section provides background information regarding potential groundwater impacts due to the proposed Windsor Bridge replacement project. The information in this section is largely taken from Section 7 of the EIS[2].

#### 4.2.1 Construction Phase

During construction, the risks to groundwater are:

- Interference with the local groundwater aquifer by dewatering which can change groundwater flow paths and groundwater levels potentially affecting local groundwater users.

- Contamination of groundwater through hydrocarbon, chemical and hazardous liquid spills.

The main concern with the construction, demolition and operation of the Windsor Bridge is groundwater contamination. The extent and degree of groundwater contamination is dependent on factors such as the geology, depth to water and permeability and the properties and characteristics of the pollutant. In general, the process of infiltration is effective in filtering sediments and therefore contamination by particulate bound pollutants such as heavy metals is considered low. Low density pollutants such as insoluble hydrocarbons would be preferentially retained in the soil profile and unlikely to contaminate groundwater. Soluble pollutants such as acids and alkalis, nitrates and salts and soluble hydrocarbons have the ability to infiltrate soils and potentially contaminate groundwater. This is more relevant on the northern side of the Hawkesbury River, due to presence of unconsolidated sands and gravels.

[2] Extract from Soil, Sediments, Water and Waste Water Working Paper Windsor Bridge Replacement EIS (SKM 2012)

Interference with the local aquifer is governed by the *Water Management Act 2000.* The NSW Aquifer Interference Policy defines and assesses aquifer interference activities and determines subsequent licensing requirements. Interference with the local aquifer is considered minimal as the proposed method of construction for the bridge piers is through piling, and as such, excavation of the anchor points on both sides of the river is expected to be minimal. An access licence from the NSW Office of Water is not required as construction activities are not expected to result in the use of more than three mega litres (3000 $m^3$) of groundwater per year.

### 4.2.2 Operational Phase

The EIS has stated negligible risk to groundwater during operational stage. However, risks to groundwater during the operational stage could involve pollutant runoff from the bridge and nearby road surfaces infiltrating groundwater. It is understood that effective measures of storm water runoff collection and control will be implemented into the design of the bridge to minimise contamination of surface water, groundwater and soils.

### 4.2.3 Demolition Phase

The EIS has stated negligible risk to groundwater during the demolition phase.

### 4.2.4 Risk to Groundwater Dependent Ecosystems (GDE's)

There are no GDE's within the working area of the proposed Windsor Bridge (Bureau of Meteorology (BoM) 2009). There is no high priority GDEs within the working area of the proposed Windsor Bridge listed in the Schedule of the Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011. Pitt Town Lagoon is located 3km northeast of the site and is of sufficient distance down-gradient that there is no expected impact.

A search of the BoM Atlas of GDEs (date of search, 18 May 2016) identifies Cumberland River Flat Forest, located approximately 1km upstream of the Project, as having a high potential for groundwater interaction, however, this ecosystem is not noted in the Schedule of the Water Sharing Plan as a high priority endangered ecological vegetation community. Nevertheless, this potential GDE is located sufficiently upstream that there is no expected impact due to the Project.

## 4.3 Sensitive Receiving Environments and High Risk Areas

Sensitive receiving environments, in general, include;

- National parks.
- Marine parks.
- Nature reserves.
- State conservation areas.
- Threatened ecological communities associated with aquatic ecosystems.
- Potential habitats for threatened fish.

There are no known sensitive receiving environments or high risk areas related to surface and groundwater.

## 4.4 Surface and Groundwater Interactions

Given the nature of construction (piling and minor excavations) direct interaction between surface water and groundwater is expected to be minimal.

Piles, by the nature of their construction, will seal the connection between ground surface and groundwater

[4] Working Paper 7: Soil, Sediments, Water and Waste Water - Windsor Bridge Replacement EIS - Phase 1 Assessment - p31: (SKM 2012).

units.

As noted above, potential risk is considered to be infiltration of surface contaminants and site works will be managed to prevent spillage.

## 4.5 Influence on Local Waterways and Storm Water Outlets

The location of the proposed works means there is a direct influence on surface water as a result of construction, demolition and operation. Effectively managing the following features during construction, demolition and operation is essential to maintaining the quality and aesthetics of the Hawkesbury River:

- Soil erosion.
- Storm water runoff.
- Vegetation removal.
- Storm water outlets.
- Slope degree and length.

## 4.6 Groundwater Modelling

A detailed assessment of the available data, proposed construction measures and potential impacts on groundwater has been undertaken. Results indicate that the proposed method for the construction of the bridge is piling which is considered non-obtrusive and unlikely to affect natural groundwater flows. The piling will be fully grouted creating negligible risk of aquifer mixing during and post construction. Therefore impacts to groundwater are considered minimal based on the following reasons:

- Groundwater levels were found to be approximately at the water level of the Hawkesbury River (SKM, 2013). These groundwater levels were confirmed during a recent site visit. Proposed depth of open excavations on both southern and northern side of the Hawkesbury River are above the observed water table level.
- Piling is not expected to alter groundwater flows and/or directions. Piles, post-construction, will be impermeable leading to negligible risk of aquifer mixing.
- An increase in river levels could also cause groundwater levels to concurrently rise, however, if a significant flood event was to occur, works would cease and any flooded excavation managed accordingly.

[4] Working Paper 7: Soil, Sediments, Water and Waste Water - Windsor Bridge Replacement EIS - Phase 1 Assessment - p31: (SKM 2012).

# 5. Monitoring Locations

Monitoring locations for surface water and groundwater quality during pre-construction[3], construction, demolition and operation are shown in **Table 5.1** and **Figures 1** to **4**.

Sampling locations will be named according to **Table 5.1**. Monitoring locations are unchanged for reference and control sites for all phases of monitoring. Groundwater piezometer locations are expected to change given current locations are intended to be sacrificial. Indicative locations for replacement piezometers are provided in the attached figures and further details of installation provided in Table 5.1 to be concluded during the construction phase.

Abbreviations are intended to identify during what phase water quality samples were taken. The abbreviations are explained:

### Pre-construction

- NP – North bank pre-construction phase monitoring
- SP – South bank pre-construction phase monitoring.

### Construction and Demolition

- NC – North bank construction phase monitoring.
- SC – South bank construction phase monitoring.

### Operation

- NO – North bank operational phase monitoring.
- SO – South bank operational phase monitoring.

[3] The installation of a borehole at the before pre-construction stage of works requires approval from DPE, due to heritage constraints on the site.

[4] Working Paper 7: Soil, Sediments, Water and Waste Water - Windsor Bridge Replacement EIS - Phase 1 Assessment - p31: (SKM 2012).

Table 5.1 : Water quality monitoring location details

| Monitoring Site | Construction Phase | Monitoring Nomenclature | Coordinates | Water Type | Description and location details |
|---|---|---|---|---|---|
| North Bank Borehole 2 | Pre-construction (Baseline) (Sacrificial) | NP – BH02 | 0297947<br>6279798 | Groundwater | North bank, 25.4m deep. Alluvial with Permian bedrock |
| North Bank Borehole 2 | Construction, Operation | North BH – East<br>North BH – West | 0298050<br>6279855 | Groundwater | North bank, 25m deep. Two separate screens installed for the alluvial (6-12m (west)) and Permian bedrock (19-25m (east)) |
| South Bank Borehole 1 | Pre-construction (Baseline) (Sacrificial) | SP – BH01 | 0298008<br>6279649 | Groundwater | South bank, 13.00 m<br>deep, Alluvium with Permian bedrock (4 – 13m). |
| South Bank Borehole 1 | Construction, Operation | South BH | 0298036<br>6279678 | Groundwater | Southbank, 13m deep. One screen in Alluvial bedrock (4-10m) |
| Reference Borehole | Alll Stages | Ref BH – South<br>Ref BH – North | 0297982<br>6279973 | Groundwater | Two separate wells on private property north of Wilberforce Rd |
| Reference Site 1 | All Stages | SW – Site 1 | 0297857<br>6279621 | Surface Water | South bank, 100m<br>upstream of existing bridge and upstream of SP – CS2. |
| Reference Site 2 | All Stages | SW – Site 2 | 0297857<br>6279621 | Surface Water | South bank, 100m<br>upstream of existing bridge and upstream of SP – CS2. |
| Impact Site 1 | Construction | SW – Site 3 | 0297940<br>6279773 | Surface Water | North bank 10m upstream and downstream of proposed bridge |
| | | SW – Site 4 | 0297967<br>6279783 | | |
| Impact Site 2 | Construction | SW – Site 5 | 0297979<br>6279676 | Surface Water | South bank 10m upstream and downstream of proposed bridge |
| | | SW – Site 6 | 0298008<br>6279683 | | |

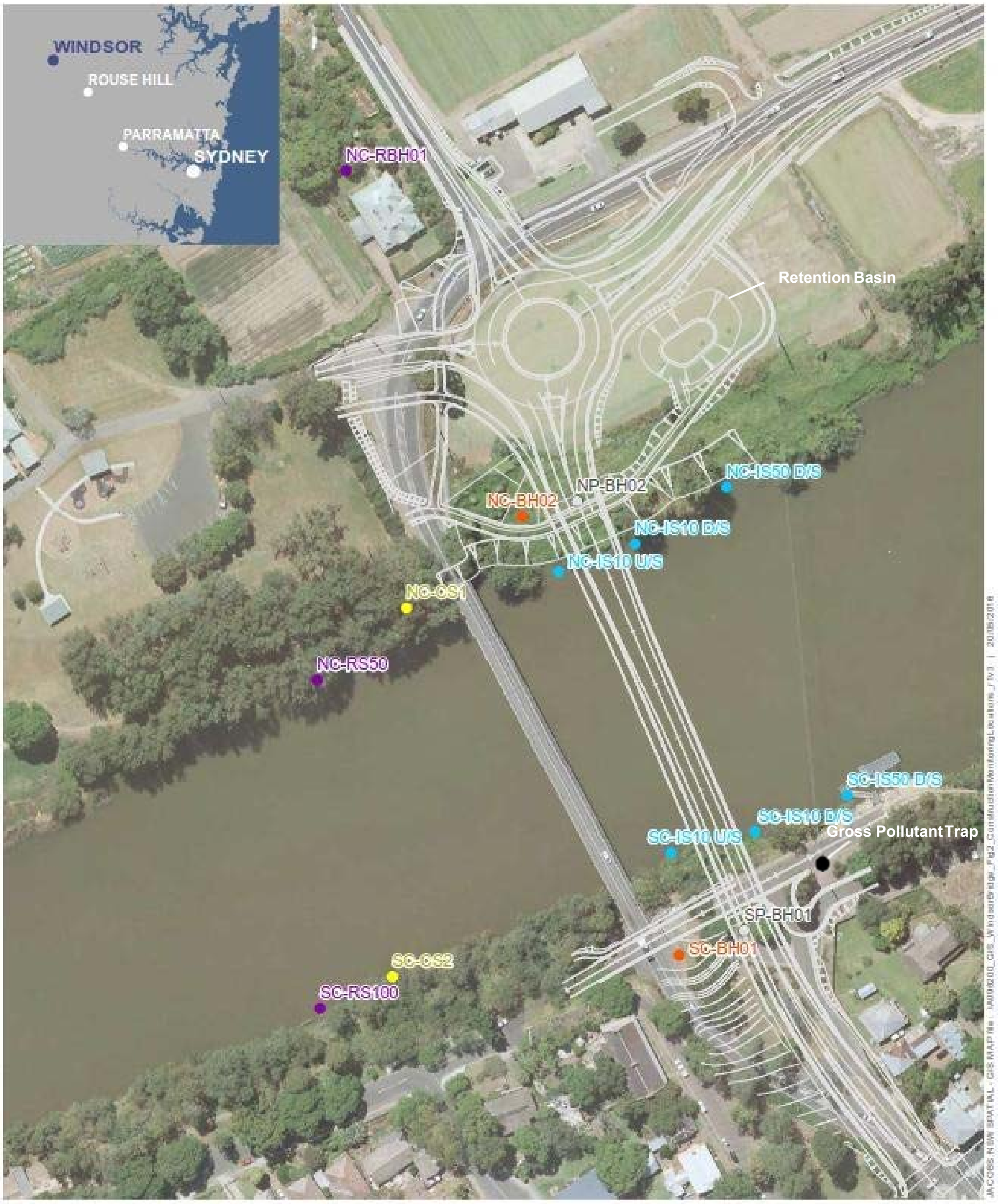
[4] Working Paper 7: Soil, Sediments, Water and Waste Water - Windsor Bridge Replacement EIS - Phase 1 Assessment - p31: (SKM 2012).

| Monitoring Site | Construction Phase | Monitoring Nomenclature | Coordinates | Water Type | Description and location details |
|---|---|---|---|---|---|
| Impact Site 3 | All Stages | SW – Site 7 | 0297998<br>6279802 | Surface Water | North bank 50m downstream of proposed bridge |
| Impacts Site 4 | All Stages | SW – Site 8 | 0298040<br>6279695 | Surface Water | South bank 50m downstream of proposed bridge |
| Control Site 1 | Pre-construction, construction | SW – Site 9 | 0297888<br>6279761 | Surface Water | North bank storm water outlet upstream of existing bridge (wet weather only) |
| Control Site 2 | Pre-construction, construction | SW – Site 10 | 0297882<br>6279632 | Surface Water | South bank storm water outlet upstream of existing bridge (wet weather only) |

[4] Working Paper 7: Soil, Sediments, Water and Waste Water - Windsor Bridge Replacement EIS - Phase 1 Assessment - p31: (SKM 2012).


Figure 1 | Windsor Bridge Pre-construction Monitoring Locations

4 Working Paper 7: Soil, Sediments, Water and Waste Water - Windsor Bridge Replacement EIS - Phase 1 Assessment - p31: (SKM 2012).




Legend

Concept design

Monitoring Locations
- Borehole (Indicative)
- Control Site
- Impact Site
- Reference Site
- Borehole (Pre-construction)

0 20 40 60Metres

1:2,000 @ A4

N

Data sources
Jacobs 2015
Ausimage 2014
RMS 2015
LPI 2015

Figure 2 | Windsor Bridge Construction Monitoring Locations

4 Working Paper 7: Soil, Sediments, Water and Waste Water - Windsor Bridge Replacement EIS - Phase 1 Assessment - p31: (SKM 2012).


Data sources
Jacobs 2015
Ausimage 2014
RMS 2015
LPI 2015

Figure 4 | Windsor Bridge Operations Monitoring Locations

[4] Working Paper 7: Soil, Sediments, Water and Waste Water - Windsor Bridge Replacement EIS - Phase 1 Assessment - p31: (SKM 2012).

# 6. Sampling Regime and Parameters

## 6.1 Monitoring Duration

The monitoring regimes for surface and groundwater have been developed with regards to the RTA's *Guideline for Construction Water Quality Monitoring* (RTA ND) and *Groundwater Sampling and Analysis – A Field Guide* (Geoscience Australia). As per the instrument of approval, the minimum monitoring period for the pre-construction, construction, demolition and operational phases of the project are:

- Pre-construction monitoring to establish baseline conditions for a minimum of six months prior to the commencement of construction as per approval **Condition C24 (e)** (refer **Section 2** of this report).

- Construction phase monitoring will be undertaken for the duration of the construction period including the demolition of the existing Windsor Bridge

- Operational phase monitoring will be undertaken for a minimum of three years following the completion of construction or until the affected waterways are certified by an independent expert as being rehabilitated to an acceptable condition, as per approval **Condition C24(f)** (refer **Section 2** of this report).

There will be a two month overlap of pre-construction and construction boreholes, therefore at one stage there will be four boreholes for two months of monitoring. This will allow for an appropriate period of monitoring overlap to provide continuity of data collection, as additional assessment of groundwater flow can be undertaken at this point. Based on the results, further consideration will be made as to whether another borehole is required to complete further assessment of groundwater flow (refer to **Section 6.4** of this report).

## 6.2 Wet Weather Monitoring

Wet weather monitoring events will be determined as 20mm or more of rain within 24 hours recorded at the nearest Bureau of Meteorology (BoM) sites. Sampling will occur within the following 24 hours of the rain event. Either of the following rainfall gauges will be used to obtain daily rainfall figures:

- Richmond RAAF NSW – Station No. 067105: Lat. 33.60ºS, Long 150.78ºE, Elevation 19m.
- Richmond UWS Hawkesbury – Station No. 067021: Lat. 33.62ºS, Long 150.75ºE, Elevation 20m.

## 6.3 Surface Water

Surface water sampling will be undertaken during outgoing tides from the north and south banks during all monitoring phases as to avoid confounding factors downstream.

Surface water quality will include both field parameters and laboratory analysis. The analytical suite is presented in **Table 6.1**. The parameters are based on the DPI (Water) Standard Suite of Analytes, with proposed analytes amended, based on what is expected to be potentially modified by the project.

Parameters listed in **Table 6.1** will be analysed during all phases of surface water monitoring.

[4] Working Paper 7: Soil, Sediments, Water and Waste Water - Windsor Bridge Replacement EIS - Phase 1 Assessment - p31: (SKM 2012).

Table 6-1 Surface Water Sampling – Analytical Suite

| Field Parameters | Laboratory Analysis |
|---|---|
| pH | Total suspended solids (TSS) |
| Turbidity (NTU) | Total dissolved solids (TDS) |
| Temperature (ºC) | Total Nitrogen (TN) |
| Dissolved oxygen (% saturation and mg/L) | Total Phosphorus (TP) |
| Electrical Conductivity (µS/cm) | Inorganics and heavy metals (Al, Sb, As, Ba, B, Cd, Cr, Cu, Fe, Pb, Li, Mn, Hg, Ni, Se, Ag, Zn) |
| Redox potential (eH) | Organic compounds (BTEX, pesticides, PAHs, TPHs) |
| | Major anions ($SO_4$, Cl, $HCO_3$) |
| | Major cations (calcium (Ca), magnesium (Mg), sodium (Na), potassium (K)) |

**Note:** Alkalinity, total hardness, microbial organisms (faecal coliforms, faecal streptococci, *Eschericia coli*) and ammonia have not been included in the surface water sampling analytical suite as these parameters are not relevant to assessing impacts associated with construction and operation of the new bridge and demolition of the existing bridge. Nutrients ($NH_3$, $NO_3$) have not been included as the surface water quality program includes monitoring nitrate and phosphorus (TN and TP) which will provide an indication of nutrients entering the water from soil disturbance associated with the construction. A selection of specific organic compounds (SVOCs, VOCs, Chlorinated aliphatics, phenols and PCBs) has not been included as they are not considered contaminants of concern[4].

### 6.3.1 Pre-construction phase

Sampling over the pre-construction monitoring period will be undertaken at monitoring sites shown in **Figure 1** and will comprise:

- One dry weather event sampling per month for 6 months at 4 sites listed in **Table 5.1**.
- Three wet weather sampling events over the 6 month period at all 6 sites (additional 2 wet weather sites) listed in **Table 5.1**.

### 6.3.2 Construction and Demolition Phase

Surface water sampling during the construction phase monitoring period will be undertaken at monitoring sites shown in **Figure 2** and will comprise:

- One dry weather sample collected at the end of each month at 8 sites listed in **Table 5.1**. and;
- One wet weather sampling event from all 10 sites (including wet weather sites, as listed in Table 5.1) within 24 hours of a rainfall event greater than 20mm.

[4] Working Paper 7: Soil, Sediments, Water and Waste Water - Windsor Bridge Replacement EIS - Phase 1 Assessment - p31: (SKM 2012).

### 6.3.3 Operational Phase

The main operational water control measures to be installed within the project area are:

- Water retention basin located on the northern side of the Hawkesbury River as detailed in **Figure 1 – 4**. This collects the majority of surface flows from the northern project area prior to discharge into the Hawkesbury River via the stormwater drainage system.
- Gross Pollutant Trap (GPT) located on the southern side of the Hawkesbury River as detailed in **Figure 1- 4**. This collects the majority of surface flows from the southern project area prior to discharge into the Hawkesbury River via the stormwater drainage system.
- Vegetated swales:
  - On the southern side of the Hawkesbury River at the bottom (north end) of the Thompson Square Park
  - On the northern side of the Hawkesbury River under the bridge abutment and adjacent to the shared path

Monthly monitoring is proposed for the first year of operation. Surface water sampling during the operational phase monitoring period will be undertaken at monitoring sites shown in **Figure 4** and will comprise:

- One sample per month at 4 sites listed in **Table 5.1** during times when there is no rainfall.
- A single wet weather event per month (when rainfall greater than 20mm in a 24 hour period) for a minimum of 6 months or until confirmation by an independent expert that water quality control measures are working effectively.

The operational surface water monitoring period is three years (refer to Section 6.1) following the completion of construction or until the affected waterways are certified by an independent expert as being rehabilitated to an acceptable condition, as per the below criteria.

Operational data will be collated after the first year of sampling and assessed by the independent water quality expert to review sampling data, sampling regime and frequency to determine if monitoring commitments can be reduced, changes can be made to improve the sampling regime or if surface water quality monitoring is to be discontinued.

Key criteria to be considered by the Independent water quality expert are:

- rehabilitated areas disturbed by the project are to have sufficient ground cover established to prevent erosion, and may be considered adequately rehabilitated once a C-factor of 0.05 (equivalent to 70 per cent ground cover) is achieved and is likely to be maintained (Landcom, 2004)
- Operational phase monitoring confirms operational water control measures (northern retention basin, southern Gross Pollutant Trap (GPT) and surface control measures including the vegetated swales) are meeting water quality parameters representative of baseline results and relevant receiving water parameter guidelines.

## 6.4 Groundwater

Ground water quality will include both *in-situ* physical parameters and grab samples for laboratory analysis. The analytical suite is presented in **Table 6.2**. The parameters are based on the DPI (Water) Standard Suite of Analytes, with proposed analytes amended, based on what is expected to be potentially modified by the project.

During the pre-construction phase all parameters listed in **Table 6.2** will be analysed. During the construction, demolition and operational phases only *in-situ* physical parameters will be measured.

[4] Working Paper 7: Soil, Sediments, Water and Waste Water - Windsor Bridge Replacement EIS - Phase 1 Assessment - p31: (SKM 2012).

In the event of elevated electrical conductivity against historic baseline data during construction and operational phases, a groundwater sample will be taken for major ions and sent for laboratory analysis.

Table 6-2 Ground Water Sampling – Analytical Suite

| Field Parameters | Laboratory Analysis |
|---|---|
| pH | Total Suspended solids (TSS) |
| Turbidity (NTU) | Total dissolved solids (TDS) |
| Temperature (ºC) | Total Nitrogen (TN) |
| Dissolved oxygen (% saturation and mg/L) | Total Phosphorus (TP) |
| Electrical Conductivity (µS/cm) | Inorganics and heavy metals (Al, Sb, As, Ba, B, Cd, Cr, Cu, Fe, Pb, Li, Mn, Hg, Ni, Se, Ag, Zn) |
| Redox potential (mV) | Organic compounds (BTEX, pesticides, PAHs, TPHs) |
| | Major anions ($SO_4$, Cl, $HCO_3$) |
| | Major cations (calcium (Ca), magnesium (Mg), sodium (Na), potassium (K)) |

In addition to the above field parameters ground water level will be recorded at the top of the casing during sampling events. In addition automatic groundwater loggers will be installed across the three existing bores (and any required new monitoring bores) to record groundwater levels continually during the monitoring program. This will be undertaken prior to the commencement of baseline monitoring period.

**Note:** Alkalinity, total hardness, microbial organisms (faecal coliforms, faecal streptococci, *Eschericia coli*) and ammonia have not been included in the groundwater sampling analytical suite as these parameters not relevant to assessing impacts associated with construction and operation of the new bridge and demolition of the existing bridge. Nutrients ($NH_3$, $NO_3$) have not been included as the groundwater quality program includes monitoring nitrate and phosphorus (TN and TP) which will provide an indication of nutrients entering the water from soil disturbance associated with the construction. A selection of specific organic compounds (SVOCs, VOCs, Chlorinated aliphatics, phenols and PCBs) has not been included as they are not considered contaminants of concern[5].

### 6.4.1 Pre-construction phase

Water quality will be measured for parameters listed in **Section 6.3**. Groundwater quality and levels over the pre-construction phase monitoring period are shown in **Figure 1** and will comprise:

- One dry weather groundwater sample and automatic groundwater level measurement event per month for 6 months at 3 groundwater piezometers listed in **Table 5.1**.
- Three wet weather groundwater sampling and automatic groundwater level measurement events over the 6 month period at 3 groundwater piezometers.

### 6.4.2 Construction Phase

Groundwater quality and levels over the construction phase monitoring period are shown in **Figure 2** and will comprise:

[4] Working Paper 7: Soil, Sediments, Water and Waste Water - Windsor Bridge Replacement EIS - Phase 1 Assessment - p31: (SKM 2012).

- One groundwater sampling and automatic groundwater level measurement event per month at 3 groundwater piezometers for the duration of the active construction phase when there is no rainfall.
- One groundwater sampling and automatic groundwater level measurements per month at 3 groundwater piezometers during periods when rainfall is greater than 20mm in a 24 hour period.

Note: No groundwater impacts are expected once the new Windsor Bridge is constructed however, groundwater monitoring will be continued with surface water quality monitoring as a form of due diligence. Groundwater quality and levels over the operational phase monitoring period are shown in Figure 3 and will comprise:

- Quarterly groundwater level recording at 3 groundwater piezometers for the duration of the demolition phase.

### 6.4.3 Operation Phase

During the operational phase quarterly groundwater level recording of 3 groundwater piezometers will be undertaken.

Operational data will be collated after the first year of sampling and assessed by an independent water quality expert to review sampling data, sampling regime and frequency to determine potential improvements, and identify whether if monitoring commitments can be reduced or discontinued. The operational monitoring period is three years (refer to **Section 6.1**) following the completion of construction or until the affected groundwater resources are certified by an independent expert as being rehabilitated to an acceptable condition. The target for certifying rehabilitation to an acceptable condition is outlined below.

Following the demolition phase, operational groundwater data will be reconciled against the Aquifer Interference Policy (AIP) Table 1 – Minimal Impact Considerations for highly productive alluvial water sources (NSW Department of Primary Industries, 2012). Table 1 of the AIP quantifies impacts to nearby water supply works and connected surface water sources, which would be borehole GW106373 (reference site: NP-RBH01) and the Hawkesbury River (as measured at downstream reference sites NP-IS50D/S and SP-IS50D/S) respectively.

The relevant thresholds for water supply works documented in Table 1 of the AIP is a maximum water table decline of 2 m cumulatively and that any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 m from the activity. The relevant threshold for connected water sources documented in Table 1 of the AIP is no increase of more than 1% per activity in long-term average salinity in a highly connected surface water source at the nearest point to the activity.

If, at the cessation of the demolition phase, it is determined that the impact criteria quantified in Table 1 of the AIP has not been met, and therefore no impact has occurred, groundwater monitoring will be discontinued.

## 6.5 Quality Assurance (QA) and Quality Control (QC)

### 6.5.1 Sample Collection

Details regarding QA/QC procedures can be seen **Appendix A**.

[4] Working Paper 7: Soil, Sediments, Water and Waste Water - Windsor Bridge Replacement EIS - Phase 1 Assessment - p31: (SKM 2012).

When undertaking field sampling using a water quality probe the following should be adhered to for quality purposes:

- All measurements should be taken *in situ* using a water quality probe for measurement of depth, temperature, pH, DO, turbidity and conductivity as the value of the indicator may change in sample after collection.
- Calibration of all water quality probes should be undertaken prior to each field trip.
- Samplers should carry the required equipment in the field for basic repairs such as replacement of dissolved oxygen membranes and batteries.
- Samplers should follow manufacturer's instructions on use, maintenance and storage of the water quality probe.
- A regular service regime should be maintained for all water quality probes using an accredited repairer.
- A log for the water quality probe that details service history, repairs, calibration and other relevant information should be maintained.

#### 6.5.2 Sample Preservation and Transport

Samples will be placed in an insulated cool box (or equivalent) with ice to be kept ≤6ºC for preservation.

#### 6.5.3 Chain of Custody

Chain of Custody (COC) forms are used to keep track of samples from the field, to the laboratory and then to the database.

#### 6.5.4 Laboratory Analysis

A Certificate of Analysis (COA) is supplied by the laboratory as an official documentation of sample analysis. COA's will be stored on the Jacobs database.

#### 6.5.5 Quality Control Samples

Duplicate water quality samples will be taken every 10 water samples (or thereabouts) per monitoring round to verify laboratory QA and QC. Further to this, internal laboratory QA/QC is conducted on a batch basis, as per standard laboratory practise, and therefore may not be specific to samples. In the event that laboratory QA/QC is conducted on our samples, this information will also be compared.

[4] Working Paper 7: Soil, Sediments, Water and Waste Water - Windsor Bridge Replacement EIS - Phase 1 Assessment - p31: (SKM 2012).

# 7. Measurement and Assessment Criteria

The proposed method of analysing changes in surface and groundwater quality is based on the *Australian and New Zealand guidelines for fresh and marine water quality – volume 1* (ANZECC / ARMCANZ 2000a) and the *Australian guidelines for water quality monitoring and reporting* (ANZECC / ARMCANZ 2000b).

In the absence of suitable reference or baseline data, median values for water quality during pre-construction monitoring at all sites will be compared to the ANZECC/ARMCANZ (2000a) guidelines. Thereafter, pre-construction and reference site monitoring data provides baseline conditions for comparison with construction and operational data.

Site specific trigger values (SSTV's) will be developed using the methods proposed in ANZECC / ARMCANZ (2000a) guidelines. Once sufficient data is available to develop SSTV's, construction, operation and demolition data will be compared to SSTV's, which is the 80$^{th}$ or 20$^{th}$ (depending on the parameter) percentile of a data set, of the reference and baseline data set.

The SSTV's for reference and upstream sites for surface and groundwater quality (and levels for groundwater) are to be consistently (after each monitoring event) updated with newly collected monitoring data. The updated SSTV's at reference/upstream sites will be an evolving mechanism to identify water quality impacts.

Data collected during construction and operation of Windsor Bridge will be compared to the respective SSTV's derived during pre-construction baseline site data and evolving upstream and reference site data. This method of comparing impact sites to upstream and reference sites allows consideration of climatic variations to identify disparity between climatic and construction/operational impacts on water quality.

## 7.1 Surface Water

### 7.1.1 Comparison of Sampling Data and Baseline Data

Data collected during construction/ demolition/operation will be compared to their relative ANZECC/ARMCANZ (2000a) guidelines or SSTV's from upstream and downstream data. Collected data during construction/operation/demolition will be compared to reference sites to ensure climatic variations are considered and aid in the identification of construction/operation/demolition impacts on water quality.

The following approach will be adopted when comparing construction, operational and demolition data to trigger values during each sampling event:

1. Compare each downstream construction, operational and demolition sampling results with the corresponding trigger value.

    a) Compare dry sampling events with the trigger values for dry events and wet sampling events with trigger values for wet events.

2. If a downstream result is outside the trigger value range then compare the downstream and upstream sampling results for that location.

    a) If the downstream result is less than (or within the threshold; for example with pH and EC) the upstream result no further action is required.

    b) If the downstream result is greater (or lower depending on the parameter) than the upstream result then further investigate existing water quality control measures unless more detailed analysis of the available data indicates that this is not necessary.

        - Notify the EPA representative if there is a significant difference between upstream and downstream results. Noting that a significant difference

[4] Working Paper 7: Soil, Sediments, Water and Waste Water - Windsor Bridge Replacement EIS - Phase 1 Assessment - p31: (SKM 2012).

would be determined by undertaking statistical analysis on water quality data that continually exceeds the 80th percentile of the chosen reference sites.

## 7.2 Groundwater Quality

Sampling data from construction and operation will be compared to their relative ANZECC/ARMCANZ (2000a) or SSTV's.

The following approach will be adopted when comparing construction, operational and demolition data to baseline trigger values during each sampling event:

1. Compare construction, operation and demolition data with the corresponding baseline trigger value.

   a) If the sampling result is less than (or within the threshold; for example with pH and EC) the trigger value then no action is required.

   b) If the sampling result is greater (or lower depending on the parameter) than the baseline trigger value then further investigate available data (rainfall, cumulative rainfall deviation (CRD), groundwater levels).

      - If the exceedance is believed to be caused by natural variation no action is required.

      - If the exceedance is believed to be caused by the construction/operation, investigate existing water quality control measures

   c) Notify the EPA if there is a significant difference between sample result and the 80th percentile trigger value. Noting that a significant difference would be determined by undertaking statistical analysis on water quality data that continually exceeds the 80th percentile of the chosen reference sites.

## 7.3 Comparing sampling results

Sampling results for surface water and groundwater will be compared to trigger values using tabulated results or control charts. Put simply, sampling results from construction, demolition and operation will be charted against trigger values and rainfall/CRD. Visual inspection of the chart and/or table will indicate exceedance of the trigger value which will prompt action. An example of a control chart can be seen in **Figure 7.1** which has been taken from the ANZECC/ARMCANZ (2000a) guidelines.

[4] Working Paper 7: Soil, Sediments, Water and Waste Water - Windsor Bridge Replacement EIS - Phase 1 Assessment - p31: (SKM 2012).

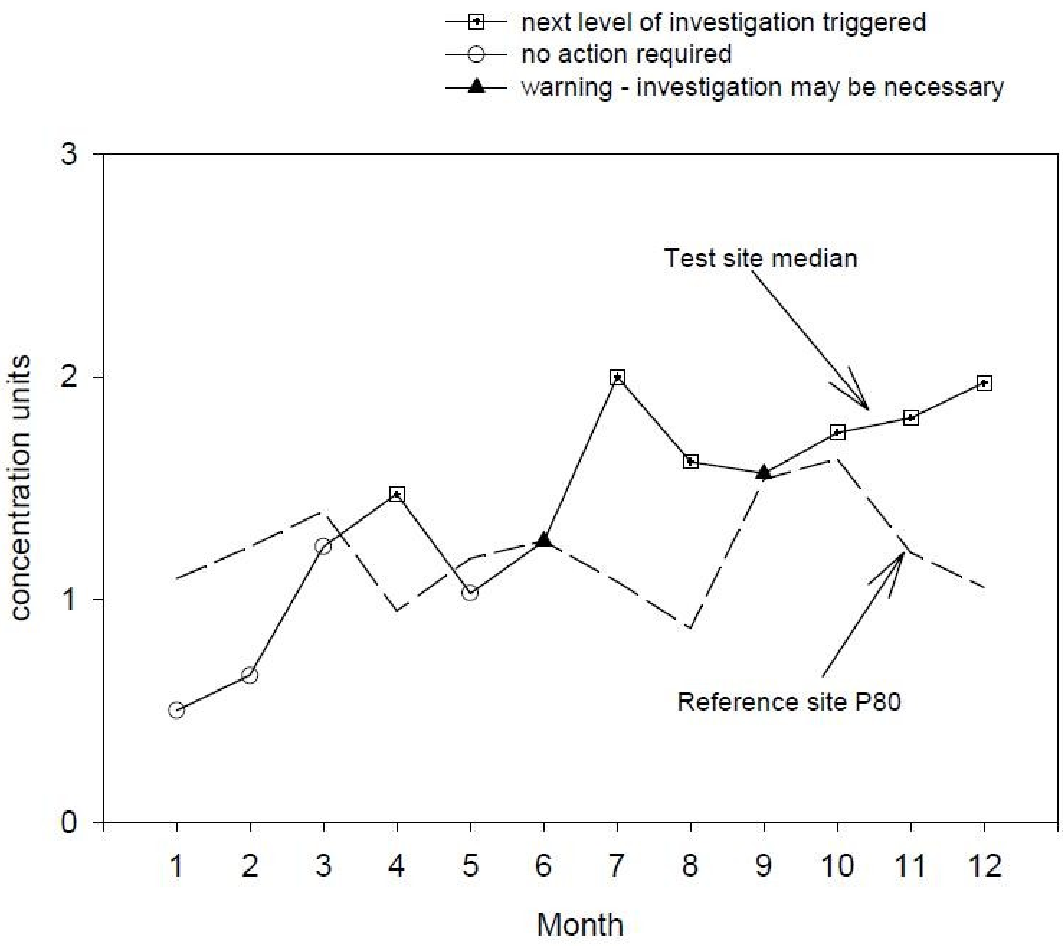



Figure 7.1 : Example control chart

## 7.4 Adding to the surface and groundwater quality baseline dataset

Reference and upstream monitoring site trigger values will be updated with data collected during construction operation and demolition phases of the Project. By supplementing the data sets with new data it provides a more holistic approach to encompass factors such as natural variation which in turn can potentially be used to explain variations at impact sites.

## 7.5 Data Interpretation

After the data has been analysed the information will be collated into a statistical summary and charts to be assessed using the described methods below.

### 7.6.1 Construction Phase

Interpretation of the data during construction will address:

#### Surface water quality

- Update baseline reference and upstream site data with newly collected data. Recalculate trigger values where applicable for the next monitoring event.
- Identify potential impacts the construction may be having on surface water quality and ecosystems and provide some discussion for the data observed.

[4] Working Paper 7: Soil, Sediments, Water and Waste Water - Windsor Bridge Replacement EIS - Phase 1 Assessment - p31: (SKM 2012).

- Provide recommendations to improve surface water quality management.

**Groundwater quality**

- Update baseline reference piezometer data with collected data. Recalculate trigger values where applicable for the next monitoring event.
- Identify any impacts the construction is having on groundwater quality and provide some discussion of the data observed.
- Provide recommendations to improve groundwater quality management.

**Groundwater levels**

- Update baseline reference piezometer data with collected data. Recalculate trigger values where applicable for the next monitoring event.
- Identify any impacts the construction is having on groundwater levels and provide some discussion of the data observed.
- Provide recommendations to improve groundwater level management.

### 7.6.2 Operation and demolition Phase

Interpretation of the data during operation and demolition will address:

**Surface water quality**

- Update baseline reference and upstream site data with newly collected data. Recalculate trigger values where applicable for the next monitoring event.
- Identify potential impacts the operation/demolition may be having on surface water quality and ecosystems and provide some discussion for the data observed.
- Provide recommendations to improve surface water quality management.

**Groundwater quality**

- Update baseline reference piezometer data with collected data. Recalculate trigger values where applicable for the next monitoring event.
- Identify any impacts the operation may be having on groundwater quality and provide some discussion for the data observed.
- Provide recommendations to improve groundwater quality management.

**Groundwater levels**

- Update baseline reference piezometer data with collected data. Recalculate trigger values where applicable for the next monitoring event.
- Identify any impacts the operation may be having on groundwater quality and provide some discussion for the data observed.
- Provide recommendations to improve groundwater level management.

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[4] Working Paper 7: Soil, Sediments, Water and Waste Water - Windsor Bridge Replacement EIS - Phase 1 Assessment - p31: (SKM 2012).

## 7.7 Reporting

### 7.7.1 Construction, demolition and operational phase

Annual reporting will be undertaken during the construction, demolition and operational phases of the Project. The reports aim to provide relevant information and results for the on-going management of surface and groundwater quality.

In accordance to **Condition C24 (h)** of the Instrument of Approval, reports will be forwarded to OEH, EPA, DPI Fishing and Aquaculture and DPI Water.

Reports during construction and operation will include –

- Introduction and background to the work being undertaken.
- Details regarding the sampling regime, parameters measured, sampling locations, sampling methodology and analysis used to assess the data.
- Presentation, interpretation and discussion of the results addressing the items outlined in **Section 7.6**.
- Review and recommendations such as methods to improve water quality management, assessment of water quality control measures in place and/or monitoring efficiencies during the construction and operational phases.
- Appendices and figures providing laboratory data, charts, data tables or other relevant information.

[4] Working Paper 7: Soil, Sediments, Water and Waste Water - Windsor Bridge Replacement EIS - Phase 1 Assessment - p31: (SKM 2012).

# 8. Management Actions

This section (largely based on measures outlined in the EIS) provides a brief overview of potential contingency and ameliorative measures that can be implemented to reduce impact on surface and groundwater quality during construction, operation and demolition. The contingency and mitigation measures have been designed and implemented with regards to the following documentation:

- *RTA Erosion and Sedimentation Management Procedure (RTA 2008).*
- *RMS Procedure for managing Hazardous Chemicals (RMS 2013).*
- *RMS Technical Guideline – Temporary storm water drainage for road construction (RMS 2011).*
- *Managing Urban Stormwater – Soils and Construction – Volume 1 (Landcom 2004).*

## 8.1 Surface and Groundwater Risk Management

The management of surface and groundwater quality is highly dependent on sufficient control of sedimentation and pollutants such as hydrocarbons, chemicals and fuels. Management measures to minimise impacts to surface water and groundwater during construction and operation is provided in **Table 8.1** below.

**Note:** Management measures provided in **Table 8.1** would be further refined through the construction environmental management plans for the project, and provide contingencies for potential impacts to surface and groundwater quality due to potentially high risk works.

Table 8.1 : Surface and Groundwater Management Measures

| ID | Environmental management measures | Phase of Project |
|---|---|---|
| SW1 | An erosion and sediment control plan will be developed during detailed design in accordance with Managing Urban Stormwater – Soils and Construction Volume 1 (Landcom, 2004) and Volume 2D (DECC, 2008). This plan will incorporate erosion control measure to limit the movement of soil from disturbed areas, and sediment control measures to remove any sediment from runoff prior to discharge into the river. | Pre-construction |
| SW2 | Appropriate measure will be implemented to contain any turbid water by applying best management practices such as silt curtains or similar. | Pre-construction |
| SW3 | A water quality monitoring program in compliance with RMS guidelines will be developed and implemented to assist in identifying water quality issues during construction and assessing the effectiveness of mitigation measures. | Detailed design |
| SW4 | Water quality controls will be incorporated into the drainage design. This will include controls such as:<br>• An end of pipe net type gross pollutant trap connected to the stormwater outlet will be provided.<br>• A lockable shut-off valve will be provided at the stormwater pit immediately upstream of the outlet to mitigate the potential impact of spills of hazardous liquids.<br>• The water quality basin on the northern bank will be fitted with an underflow baffle arrangement to provide accidental spill capture. | Construction / post construction |
| SW5 | The existing bridge will be demolished in a way to reduce the risk of debris falling into the river. | Demolition |
| SW6 | Debris and rubble will be prevented from entering the river. | Demolition |

[4] Working Paper 7: Soil, Sediments, Water and Waste Water - Windsor Bridge Replacement EIS - Phase 1 Assessment - p31: (SKM 2012).

| | | |
|---|---|---|
| SW7 | Disturbance or turbidity will be contained by installing self-containment equipment such | Demolition |

[4] Working Paper 7: Soil, Sediments, Water and Waste Water - Windsor Bridge Replacement EIS - Phase 1 Assessment - p31: (SKM 2012).

| ID | Environmental management measures | Phase of Project |
|---|---|---|
| | as silt curtains | |
| SW8 | Water quality in the river will be monitored in accordance with the RMS Guideline for Construction Water Quality Monitoring to assess the effectiveness of water quality mitigation measures. | Demolition |
| SW9 | Demolition activities will be schedule to avoid or minimise works taking place during times of higher rainfall and river flows. | Demolition |
| SW10 | During excavations, soil and fill material will be visually monitored to identify the potential contaminated material or soils. | Construction |
| SW11 | If potentially contaminated material or soils is suspected, works will cease in the area and additional investigations and monitoring will be undertaken. | Construction |
| SW12 | If it is confirmed that contaminated material or soils is present on site, an appropriate remediation plan will be developed and implemented. | Construction |
| SW13 | All fuels and chemicals will be stored and used in compliance with appropriate guidelines and standards. A spill management procedure will be developed and implemented if required. | Construction |
| SW20 | Further Acid Sulphate Soils investigations would be undertaken during detailed design of the project. | Pre-construction |
| SW21 | If the presence of ASS is confirmed in the river sediment near the existing bridge, an ASS management plan will be developed and implemented. The plan will detail the management, handling, treatment and disposal of ASS and will be prepared in compliance with the Acid Sulphate Soils Assessment Guidelines (ASSMAC, 1998) and the Guidelines for Managing Acid Sulphate Soils (RTA, 2005). | Pre-construction |
| SW22 | Monitoring of groundwater at piezometers installed for the project and the adjacent groundwater bore will be undertaken to identify any impacts during construction. If any impacts on groundwater levels or quality are detected, the potential cause and environmental management measures will be identified and developed. | Pre-construction/ Construction |
| SW23 | Demolition of bridge structures containing lead based paints will be undertaken in accordance with the following:<br>• Australian Standard AS 436101 – 1995 Guide to lead paint management, Part 1: Industrial applications.<br>• Australian Standard AS 4361.2 – 1998, Guide to lead paint management, Part 2: Residential and commercial buildings.<br>• Australian Standard AS 2601 – 2001, The demolition of structures.<br>The preferred option for management of lead based paints and the associated mitigation measures will be identified during the construction and demolition planning process. The demolition plan for the existing Windsor bridge would include the details on the reuse, recycling and/or disposal of the demolished components. | Demolition |

[4] Working Paper 7: Soil, Sediments, Water and Waste Water - Windsor Bridge Replacement EIS - Phase 1 Assessment - p31: (SKM 2012).

## 8.3 Demolition Risk Management

As mentioned in **Section 4.1.3**, the existing Windsor Bridge was historically painted using lead based paints. **Table 8.2** provides mitigation measures will be used to maintain water quality during the demolition of the old Windsor Bridge.

Table 8.2 : Demolition Management Measures

| ID | Environmental management measures | Phase of Project |
|---|---|---|
| SW5 | The existing bridge will demolished in a way to reduce the risk of debris falling into the river using a variety of containment methods. | Demolition |
| SW6 | Debris and rubble will be prevented from entering the river. | Demolition |
| SW7 | Disturbance or turbidity will be contained by installing self-containment equipment such as silt curtains. | Demolition |
| SW8 | Water quality in the river will be monitored in accordance with the RMS Guideline for Construction Water Quality Monitoring to assess the effectiveness of water quality mitigation measures. | Demolition |
| SW9 | Demolition activities will be schedule to avoid or minimise works taking place during times of higher rainfall and river flows. | Demolition |
| SW23 | Demolition of bridge structures containing lead based paints will be undertaken in accordance with the following:<br>• Australian Standard AS 436101 – 1995 Guide to lead paint management, Part 1: Industrial applications.<br>• Australian Standard AS 4361.2 – 1998, Guide to lead paint management, Part 2: Residential and commercial buildings.<br>• Australian Standard AS 2601 – 2001, The demolition of structures.<br>The preferred option for management of lead based paints and the associated mitigation measures will be identified during the construction and demolition planning process. The demolition plan for the existing Windsor bridge would include the details on the reuse, recycling and/or disposal of the demolished components.<br>Measures include:<br>• Paint stabilisation – existing surfaces to be stabilised with another non-hazardous covering.<br>• Paint removal – will require the existing painted surfaces to be removed prior to demolition. During paint removal, a high level of containment will be required. | Demolition |

[4] Working Paper 7: Soil, Sediments, Water and Waste Water - Windsor Bridge Replacement EIS - Phase 1 Assessment - p31: (SKM 2012).

# 9. References

ANZECC/ARMCANZ, 2000a. *National Water Quality Management Strategy – Paper No. 4: Australian and New Zealand Guidelines for Fresh and Marine Water Quality – Volume 1*. Reference No. ISBN 09578245 0 5, dated October 2000.

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NSW Department of Primary Industries, 2012. NSW Aquifer Interference Policy. Publication number: 11445. http://www.water.nsw.gov.au/water-management/law-and-policy/key-policies/aquifer-interference

RTA (ND) *Guideline for Construction Water Quality Monitoring,* Roads and Traffic Authority.

SKM (2013) *Windsor Bridge Replacement – Detailed Design,* Geotechnical Investigation Report, Project No. NB98005, dated 28 June 2013.

Sundaram, B., Feitz, A., Caritat, P. de, Plazinska, A., Brodie, R., Coram, J. and Ransley, T., 2009. Groundwater Sampling and Analysis – A Field Guide. Geoscience Australia, Record 2009/27 95 pp

[4] Working Paper 7: Soil, Sediments, Water and Waste Water - Windsor Bridge Replacement EIS - Phase 1 Assessment - p31: (SKM 2012).

# Appendix A. Monitoring procedures

[4] Working Paper 7: Soil, Sediments, Water and Waste Water - Windsor Bridge Replacement EIS - Phase 1 Assessment - p31: (SKM 2012).

# Work Instruction 22 - Field Quality Control Sampling

## General

### Why?

To ensure that the quality of data collected is known and that it meets the project's data quality objectives.

### When?

Quality control samples should be collected and analysed whenever the precision and/or bias of the sampling and analysis processes must be determined.

## Procedure

The procedures outlined in the following sections follow a logical order. However, some of the stages may need to be undertaken in parallel. To ensure this is undertaken when required please read this entire section prior to undertaking the works to understand potential interaction between procedures.

### 1. Developing the Project Data Quality Objectives (DQO's)

- DQO's should be defined in the initial stages of a project.
- Quality Assurance (QA) procedures (incl. the collection of field QC samples and their required frequencies, should be established in order to monitor whether the DQO's are being met during the course of the project.
- QC results should be reviewed and interpreted on an on-going basis.

### 2.Definition of Terms

- Precision: How reliably a measurement can be repeated.
    - Random errors such as instrument noise decrease the precision of a measurement.
- Bias: The bias in a measurement is caused by systematic errors in the sampling or analysis procedures.
    - E.g. Causes of Bias include improperly calibrated instruments and contaminated sampling equipment.

Representativeness: There are three common sampling approaches utilised to characterise a site or a particular portion of a site:

1) Judgemental Sampling: Strategy focuses on a known or likely area of environmental concern to possibly delineate the extent of contamination.
2) Systematic Sampling: Using a grid like systems to locate sample areas across a site where little is known about the site and where to focus investigations. A downfall of this sampling method may include missing a potential point source of contamination.
3) Random Sampling: Sampling in random locations to reduce the likelihood that unknown contamination sources are overlooked during an investigation.

It may be advisable to combine the above sampling strategies. If randomly collected samples are consistent with those from a systematic grid, the results are most likely representative of the area sampled.

Completeness: The number of samples to be collected should be defined in the sampling plan and is dependent upon the intended use of the data. For a complete data set, more samples should be collected than the sampling plan stipulates to account for unforeseen circumstances and human error.

A percentage of the sample results specified in the sampling plan that were obtained at the completion of the project should be included in the project report.

Comparability: If the project analytical results are to be compared to regulatory or guideline action levels, it is important to verify that the analytical laboratory is certified for the compounds of interest. In the absence of available certification, reference standards should be analysed to confirm that the results obtained from the laboratory are in fact comparable to the applicable action levels.

Detection Limit Requirements: The analytical methods selected for the project must have detection limits below the applicable regulatory criteria. In general, the closer a reported value is to the detection limit, the more uncertain it is. If decisions of consequence will be based on the analytical results, consideration should be given to selecting the analytical method with detection limits well below the action levels for the chemical compounds of interest.

### 3. Types of Quality Control Samples

- During the planning stage of the project, two basic sampling decisions must be made: what are the types and the number of QC samples to be collected.
- Field Quality Control (QC) samples indicate the precision (random variation) and bias (systematic error) associated with field sampling. The types of samples

that may be collected and analysed with respect to sampling precision are:

  - **Field Duplicate Samples:** (a split of the same sample) measure the sampling precision. 1 duplicate for every 20 samples collected.
  - **Field Replicate Samples:** (repeat samples from the same location) also a measure of sampling precision.

- The types of samples which may be collected and analysed with respect to sampling bias are:
  - **Blank samples:** indicate whether samples have been contaminated during the sampling or analysis process. If there is a potential source of contamination identified (for example, a bailer or filtering apparatus), a blank sample should be used to detect any bias from the contamination. Types of blank samples are discussed in detail in Section 4.
  - **Trip blanks (or travel or transport blanks):** are used to detect cross-contamination between samples during transport of the sample bottles to the site and back to the lab. A trip blank, prepared by the analytical laboratory and shipped with the bottles, should accompany each set of samples to be analysed for volatile organic compounds.
  - **Field Blanks:** To detect contamination present in the sampling environment (e.g., air).
  - **Reagent Blank:** Analysed to detect any background contamination present in de-ionised or distilled water used during sampling.
  - **Equipment Blank:** Analysed to detect any contamination associated with sampling equipment after decontamination has taken place.

- Laboratory QC samples indicate the precision and bias associated with laboratory analysis. Samples are analysed to measure the precisions and bias:
  - **Lab duplicates:** Splits of the sample, taken in the lab and used to measure the precision of the analytical methods used by the lab.
  - **Spiked samples:** Samples which have had a known concentration of a substance added and analysed by the laboratory to determine the instrument biases and whether the sample matrix has any influence on the quality of the result.
  - **Reference Standards:** Samples prepared by the lab or an outside body and contain specified concentrations of chemical compounds, with a specified margin of error. Reference standards are run to test the instruments bias.

## 4. Collect Field Quality Control Samples

Soil QC Samples:

- **Field Duplicates:** Collect the soil sample via the standard procedures outlined in other work instructions and then split the sample in two.
- **Field Replicates (in situ):** Collect two separate samples from the same location using the sampling procedures and separate them into containers.
- **Field Replicates (stockpile):** Collect the first stockpile composite (replicate). Repeat the procedure for the second replicate by collecting new discrete samples and compositing them.

Water QC Samples:

- Field Duplicates: Collect sequential samples from groundwater wells or surface water locations.
- **Trip Blanks:** The laboratory should supply the trip blanks for volatile organic compound samples. The trip blanks should be transported to the site, stored with other samples and returned to the laboratory unopened.
- **Field Blanks:** Transport triple distilled water from the laboratory to the site and then transfer to a clean sample container so that the water is exposed to the same sampling environment.
- **Reagent Blanks:** Collect a sample of any reagent water used during sampling.
- **Equipment Blanks:** Collect a rinsate of the sampling equipment after decontamination has taken place between sampling locations.

## 5. Interpretation of Quality Control Sample Results

- Results of QC sample analysis may be checked and interpreted using the following statistical measures.

**Blank** – To analyses for sample contamination; No statistical measures

**Field Duplicate** – Sampling Precision; *Statistical Measures*: Relative Standard Deviation (RSD) and Relative Percentage Difference (RPD)

**Lab Duplicate** – Analytical Method Precision; *Statistical Measure*: RSD and RPD

**Spiked Sample** – Matrix effects and analytical instrument bias; *Statistical Measure*: Recovery, Bias

**Reference Standard** – Analytical Instrument Bias; *Statistical Measure*: Bias

**Field Replicate** (2 samples from same location) – Repeatability of Sampling; *Statistical Measure*: RSD and RPD

RSD = Relative Standard Deviation = St. Dev / Mean for Duplicates

$$\%RSD = \frac{2(X_1 - X_2)}{\sqrt{2}\,(X_1 + X_2)} \times 100$$

RPD – Relative Percentage Difference for duplicates

$$\%RPD = \frac{2(X_1 - X_2)}{(X_1 + X_2)} \times 100$$

$$\%\ Bias = \%\ Recovery - 100 = \frac{C - C_{standard}}{C_{standard}} \times 100$$

# Work Instruction 15 - Groundwater Gauging

## General

### Why?

To determine the depth of the water table below the ground surface or the pressure head in a confined aquifer.

### When?

Measurements are obtained on a quarterly or yearly basis during site inspections, groundwater sampling rounds, and/or when well response tests are conducted.

### Equipment Required

The following provides a checklist of equipment that is generally required when undertaking groundwater gauging:

- Calculator
- Appropriate Health and Safety Equipment (Health and Safety Plan)
- Field book, pens, pencils
- Access to well: Key, socket wrench for opening bolt down well covers and/or pry bar or screw driver (if needed) to open surface covers
- Water level probe with tape markings in inches and feet or centimetres and metres.
- Spare batteries for water level probe
- Decontamination materials

If an acoustic plopper is used to measure depth:

- String (Clean and Strong)
- Bolt or other objects for weight
- Plopper head

### Forms

- Well history data sheet
- Water level monitoring forms

### Related Guidelines

General:

- US EPA (1996) Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures
- US EPA (January 1991) Compendium of ERT Groundwater Sampling Procedures. EPA/540-P-91-007
- US EPA (Sept 1985) Practical guide for ground-water sampling

## Procedure

The procedures outlined in the following sections follow a logical order. However, some of the stages may need to be undertaken in parallel. To ensure this is undertaken when required please read this entire section prior to undertaking the works to understand potential interaction between procedures.

### 1. Preparing for Water-Level Monitoring (office)

- Ensure equipment has been decontaminated
- Check to see if equipment/batteries are in working order
- Check the probe operation by immersing the probe tip into a glass or bucket of water
- Note weather conditions as pressure systems may effect water levels

### 2. Measuring the Water-Level (Depth to Water)

- Open the well and check for venting hole or slot in the well casing.
- Establish or locate the datum from which measurements will be taken
- Measure the depth to water in the well as follows

A. ELECTRIC WATER-LEVEL PROBE:

- Turn probe on and test;
- Lower the probe into the well until it sounds
- Measure water level 3 times;
- Record measurements on data sheet/field book
- Calculate water level elevation;
- Check measured water-level elevation against previous records to ensure it makes sense;
- Measure depth to water to the nearest 0.001 m (1 mm), if repeatability is greater than 0.005 m, measure to the nearest 0.005 m (5 mm);
- Remove probe from well; and

B. IF USING AN ACOUSTIC PLOPPER:

- Slide plopper head onto the string (approx. 0.5 m)
- Tie the bolt (weight) to the string so that it hangs vertically
- Slide the plopper head down to the top of the weight
- Knot string above the plopper so that it is snug against the top of the weight
- Lower the plopper to the water table and listen for the plop noise
- Pinch the string at the datum point and remove the device from the well
- Measure the distance of the string
- And repeat the measuring process 3 times aiming to keep the measurements within 0.005 m of each other.
- Dispose of the string

4. Decontaminating the Sampling Equipment

- Decontaminate the water level probe and tape and bolt before measuring the water level in each well.

## Relevant Work Instructions

The following work Instructions are also relevant:

WI 16 Groundwater Sampling

# Work Instruction 16 - Groundwater Sampling

## General

### When?

Whenever groundwater sampling is undertaken in association with contaminated sites projects.

### Equipment Required

The following provides a checklist of equipment that is generally required when undertaking groundwater sampling:

- Appropriate purging and sampling device for anticipated contaminants
- Water level measuring devices;
- Field Metre(s) to measure pH, electrical conductivity, temperature and dissolved oxygen;
- Calibration solutions for field metres;
- Sample bottles with appropriate preservatives (if necessary);
- Decontamination materials;
- Groundwater filters;
- Esky and ice or frozen ice packs;
- Field forms including:
  - Groundwater purging and sample record form; and
  - Chain of custody paperwork

### Related Guidelines

Australia

VIC: EPA Vic Groundwater Sampling Guidelines

## Procedure

The procedures outlined in the following sections follow a logical order. However, some of the stages may need to be undertaken in parallel. To ensure this is undertaken when required please read this entire section prior to undertaking the works to understand potential interaction between procedures.

### 1. Prepare Equipment

Check batteries and all equipment are functioning in the office prior to travelling to site location.

Ensure equipment has been calibrated and has appropriate certificates.

Ensure equipment is suitable for the field parameters.

### 2. Obtain Groundwater Depth

Measure the groundwater depth in accordance with the procedures detailed in WI 15 (Groundwater Gauging).

### 3. Groundwater Purging

To obtain representative groundwater samples of groundwater from the formation, rather than stagnant water within the annulus of the groundwater monitoring borehole undertake the following steps:

- Bores should always be purged and sampled in the order of least to most contaminated if known;
- Field parameters (e.g.) pH, specific conductance, dissolved oxygen, redox potential, temperature and turbidity) should stabilise (within 10%) before samples are obtained;
- Field measurements of stabilisation criteria should be recorded;
- Bailers/inertial samplers should not be used for low- flow purging as they can cause disturbances and mixing of bore water;
- Use consistent purging and sampling methods for each bore over time;
- The purging method used should be recorded on the field record sheets (Refer to forms at the end of this Work Instruction)

### 4. Field Measurements

To obtained accurate measurements of water quality parameters during purging.

- A flow cell should be used to obtain field measurements when groundwater is pumped.
- Field meters must be calibrated according to manufacturer's instructions and according to NATA publications, General requirements for Registration: Supplementary Requirements: Chemical Testing (NATA 1993) and Technical Note No. 19 (NATA 1994).
- During continuous use of field metres (i.e. over an entire day), they should be intermittently re-calibrated by taking periodic readings of reference solution.

### 5. Field Measurements

To minimise the impacts on the samples representativeness due to the method by which they were collected.

- Only once the groundwater's chemistry has stabilised should a groundwater sample be collected.
- Disconnect or bypass the flow cell before any samples are collected.
- The same device that was used for purging should also be used for sampling.

The device used to sample should cause minimal physical/chemical alteration to the sample.

### 6. Filtration of Groundwater Samples and Sample Containers

To allow for the samples to be preserved as soon as possible following sampling without the suspended solid matter adversely influencing the sample.

- In order to determine the truly dissolved concentrations of analytes, filtration should be undertaken.
- Filtration should be avoided where it is possible to change the sampling method to eliminate the turbidity caused by purging/sampling discuss with the analytical laboratory if unsure;
- Filtration should occur immediately after each sample has been collected and before any chemical preservation occurs;
- Regardless of whether or not filtration occurs the decision must be reported with resultant analytical data; and
- Sample container selection, preservation, labelling, logging and transport must be made during the planning phases of field work.
- Preservation, holding periods and containers should be in accordance with AS4482.1 Guide to the Investigation and Sampling of Sites with Potentially Contaminated Soil.

### 7. Decontamination

On completion of the groundwater sampling at a particular borehole, decontamination of the sampling equipment including the dip metre should be undertaken to avoid cross-contamination of groundwater samples.

- Decontaminate groundwater sampling equipment between each sampling location.
- Rinse and wash equipment first with contaminant free water followed by de-ionised water.
- Rinsate (QC) sample should then be taken from equipment to demonstrate decontamination was successful.

## Relevant Work Instructions

The following work Instructions are also relevant:

- WI 15 Groundwater Gauging

## Key Points

- Ensure the correct purging and sampling techniques are used as these can greatly influence the results of laboratory analysis and validity of the entire sampling program;
- Field measurements can only be obtained once. Make sure they are recorded legibly and consistently;
- Decontaminate between sampling locations as cross - contamination could provide the wrong information that is used in the decision-making process such as type of remediation and placement of additional groundwater investigation boreholes.

JACOBS

# Work Instruction 23 - Sample Management (preservation, transport and chain of custody)

## General

### Why?

To ensure accurate and appropriate collection and transportation of both water and soil samples and to provide evidence of the history and traceability of each sample. To prevent cross contamination between samples and sampling locations and to ensure that results of chemical analyses are reliable and representative.

### When?

The following procedures should be followed on all sites where samples are taken.

### Equipment Required

The following provides a checklist of equipment that is generally required when undertaking preservation and transport of samples:

- Potable water supply
- Deionised water
- Distilled water
- Laboratory-grade non-phosphate detergent (e.g. Alconox)
- Paper towels
- Containers (e.g. buckets or drums with lids, or a tank) to collect wash water if necessary
- Appropriate solvents (e.g. technical grade hexane, acetone, methanol, and/or dilute nitric acid solution)
- Squeeze bottles (for distilled/deionised water)
- Garbage bag
- Bottle brush
- Pressure washer or steam cleaner
- Broom
- Plywood or plastic sheeting
- Several pairs of latex gloves (or others depending on contaminants)
- Field notebook, pens, pencil
- Sample Chain of Custody (COC) Forms
- Any existing decontamination procedures identified as part of the field program

## Procedure

The procedures outlined in the following sections follow a logical order. However, some of the stages may need to be undertaken in parallel. To ensure this is undertaken when required please read this entire section prior to undertaking the works to understand potential interaction between procedures.

### 1. Planning and Preparing for Sample Collection and Analysis

- Finalise and determine the number of samples and types of analyses to be conducted.
- Include an appropriate number of quality control samples and extra or duplicate samples if the site is remote or collection is particularly costly or time- consuming
- Determine the types and numbers of bottles (including lids) required for the sampling program.
- Check available supplies and determine whether additional bottles should be requested from the analytical laboratory.
- Request bottles, preservative and any other relevant sampling media (such as swabs) from the laboratory.
- If the possibility exists that additional analysis may be performed on the sample, or if extra sample will be needed consider requesting bottles of larger volume.
- Review the sampling program schedule and confirm whether the laboratory will be able to analyse the samples within the maximum holding times.
- Determine whether arrangements must be made for couriering or pick-up of samples.
- Determine whether Material Safety Data Sheets (MSDS) must be kept on hand.
- Freeze ice packs, or purchase ice, if necessary.

- Lay out plywood or plastic sheeting, if appropriate, adjacent to sampling location, and place sampling equipment, bottles and cooler (with cold packs or heat packs) as appropriate) on sheeting.
- Lay out the bottles required for sampling.
- Refer to the specific procedures for the collection of soil, water and other matrix samples.

Water Samples

- Check the sample bottle to determine whether a preservative is present in the bottle, or whether it must be added.
- If the sample does not require a preservative, rinse the inside of the sample bottle and lid three time and then fill the bottle to the rim.
- For samples to be analysed for VOC's fill the bottle completely until the water mounds on top of the rim and tighten the lid to ensure that no air bubbles are trapped in the bottle. Check this by tipping the bottle upside down and tapping the bottle to dislodge any bubbles.

- If the sample requires preservative and it is already present in the bottle:
    - Filter the sample if it is to be sampled for dissolved metals
    - Place in bottle
    - For other chemical parameters add the sample directly to the bottle, filling to the rim

If the preservative is to be added:

- Filter for dissolved metals
- Add sample to bottle leaving space for preservative
- Top up sample
- For other chemical parameters follow the same steps except the filtration

Place the appropriate cap on the bottle and fasten.

Soil Samples:

- Fill the sample jar as full as possible and ensure that the appropriate lid is used and fasten. For samples to be analysed for:
    - VOC, ensure that there is no headspace (no room between the soil sample and the lid) before fastening the lid
    - Organic compounds (e.g. hydrocarbons, pesticides, PCB) use a foil or Teflon lined lid.
    - Inorganic compounds (e.g. Metals) use a plastic or Teflon-lined lid.

## 4. Completing the Label on the Sample Bottle

- Complete label on bottle with a permanent marker
- Main info which can be completed on the label before commencing the sampling program:
    - Client Name
    - Site ID
    - Sample ID
    - Matrix Type
    - Date and Time of sample collection
    - Chemical parameters to be analyses
    - Preservative added
    - Note if the sample was filtered or not
    - Sampler Name or Initials
    - Place in esky
    - Repeat steps 2 to 4 for next sample

## 5. Completing the Sample Chain of Custody Form

- The form should be completed following the collection of all samples in a given batch. In all cases a sample chain of custody form must be completed.
- Fill out all relevant fields for each sample collected.
- State whether samples have been filtered in the field.

## 6. Packing and Storing the Samples

- If the samples are not to be collected by the laboratory immediately, store the sample in a fridge or esky with cold packs.
- If samples are to be transported a significant distance the type of container, packing material and coolant should be considered.
- Continually check and refresh the ice packs as necessary.
- If possible and appropriate, place the sample bottles into the original boxes that they were shipped in from the lab.
- Pack samples carefully avoiding breakages and avoid packing the samples too loosely.
- Close the cooler and bind it securely using packing tape or duct tape.

## 7. Submitting the Samples

- Samples should be submitted to the laboratory as soon as possible following their collection
- Samples should be shipped with the signed COC
- Ensure the lab forwards a copy of the sample COC with the final lab analytical results