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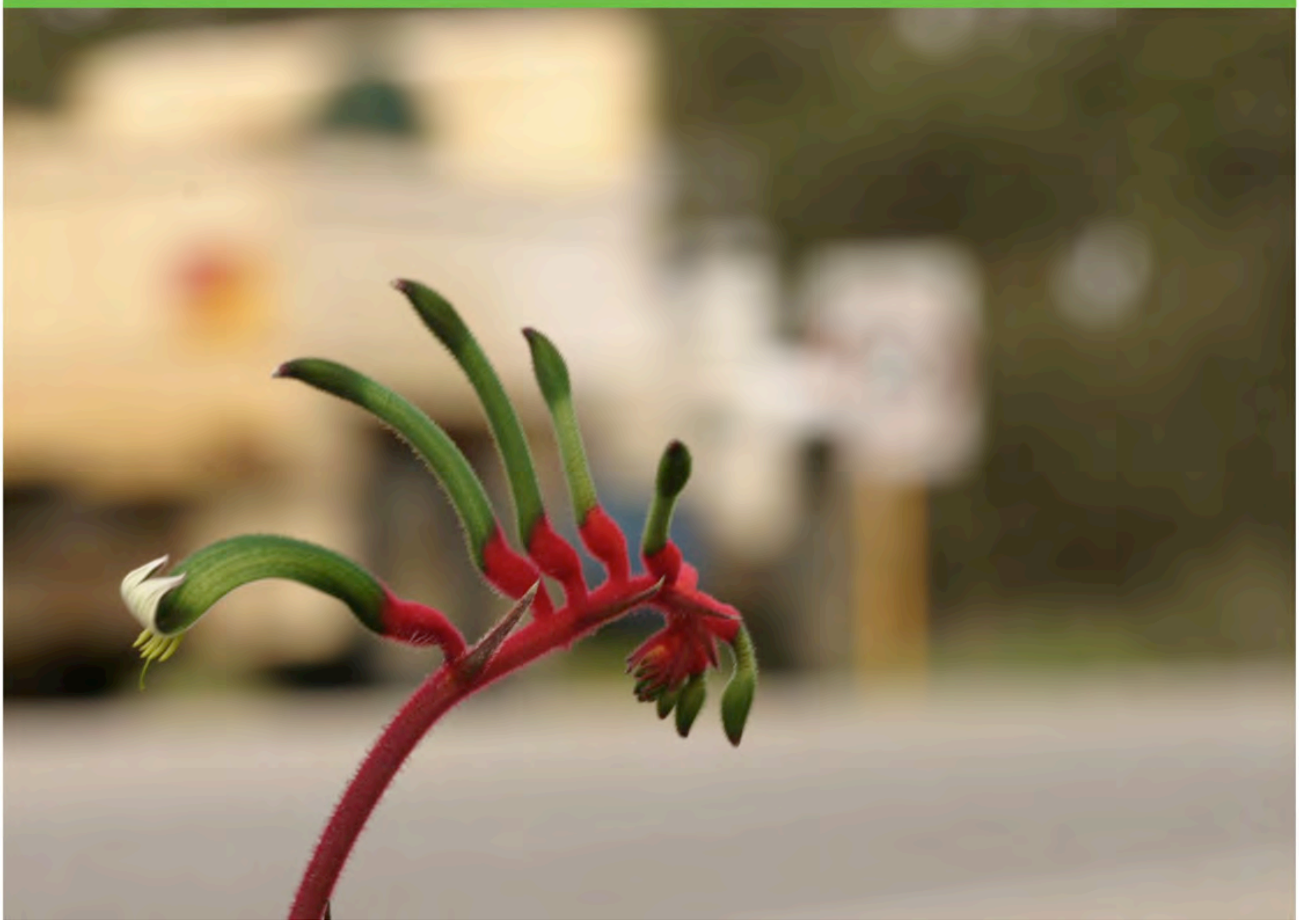
Perth-Darwin National Highway

# Baseline Survey Plan

## Inland Waters Environmental Quality – Hydrological Processes

Perth–Darwin National Highway (Swan Valley Section)

FEBRUARY 2017



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Document *Control*

| Revision | Date | Description | Prepared | Reviewed | Approved |
|---|---|---|---|---|---|
| A | 11/07/2016 | Draft (Coffey v1) | T. Vu | E. Waterhouse | B. Napier |
| B | 12/08/2016 | Draft (Coffey v2) | T. Vu | C. Baldock | D. Morley |
| 0 | 08/12/2016 | Final for submission to OEPA (Coffey v3) | T. Vu | D. Morley | D. Morley |
| 1 | 10/02/2017 | Addressed OEPA comments (Coffey v4) | T. Vu | D. Morley | D. Morley |
| 2 | 28/02/2017 | Addressed OEPA comments (Coffey v5) | T. Vu<br>R. Bunbury | M. Caldwell | D. Morley |

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# 1 INTRODUCTION

Main Roads Western Australia (MRWA) proposes to construct a new 38 km section of the Perth-Darwin National Highway (Swan Valley Section) (Figure 1) between Malaga and Muchea in Western Australia (the proposal). The proposal is a dual carriageway highway and will connect the intersection of Tonkin Highway and Reid Highway in the south with Great Northern Highway and Brand Highway in the north.

This Baseline Survey Plan (this plan) for the Inland Waters Environmental Quality – Hydrological Processes – Condition Environmental Management Plan (Condition EMP) is submitted in accordance with Ministerial Statement No. 1036 conditions 13-4 to 13-6 for the proposal.

## 1.1 Objective

This plan will detail the survey method, identification and rationale for the survey site locations and the frequency and timing of the baseline survey relevant to the groundwater quality within the Gnangara Underground Water Pollution Control Area (GUWPCA) and surface water quality within the Ellen Brook.

In accordance with condition 13-4, this plan will:

*(1) When implemented, determine the baseline water quality within the GUWPCA and the Ellen Brook.*

*(2) Detail the proposed methodology for the baseline surveys.*

*(3) Identify and spatially define the proposed survey locations and reference/control sites and provide rationale for the location of the sites.*

*(4) Detail the proposed frequency and timing for the baseline surveys.*

## 1.2 Background

In December 2015, MRWA commenced a pre-construction baseline groundwater and surface water survey program for the proposal. The pre-construction baseline groundwater and surface water survey program was comprised of the following tasks:

- Desktop assessment of groundwater survey well locations and confirmation of serviceability of the existing well network.
- Pre-construction baseline groundwater and surface water survey program (the baseline survey).

The baseline survey includes monthly survey events for:

- Nineteen groundwater survey well locations in the GUWPCA.
- Three surface water sampling locations in the Ellen Brook.
- Full analytical suite analysis for every survey round.
- On-going monthly survey rounds until construction of the proposal.

The pre-construction baseline groundwater and surface water survey program has been conducted in accordance with the method described in this plan and will be included in the final baseline survey report.

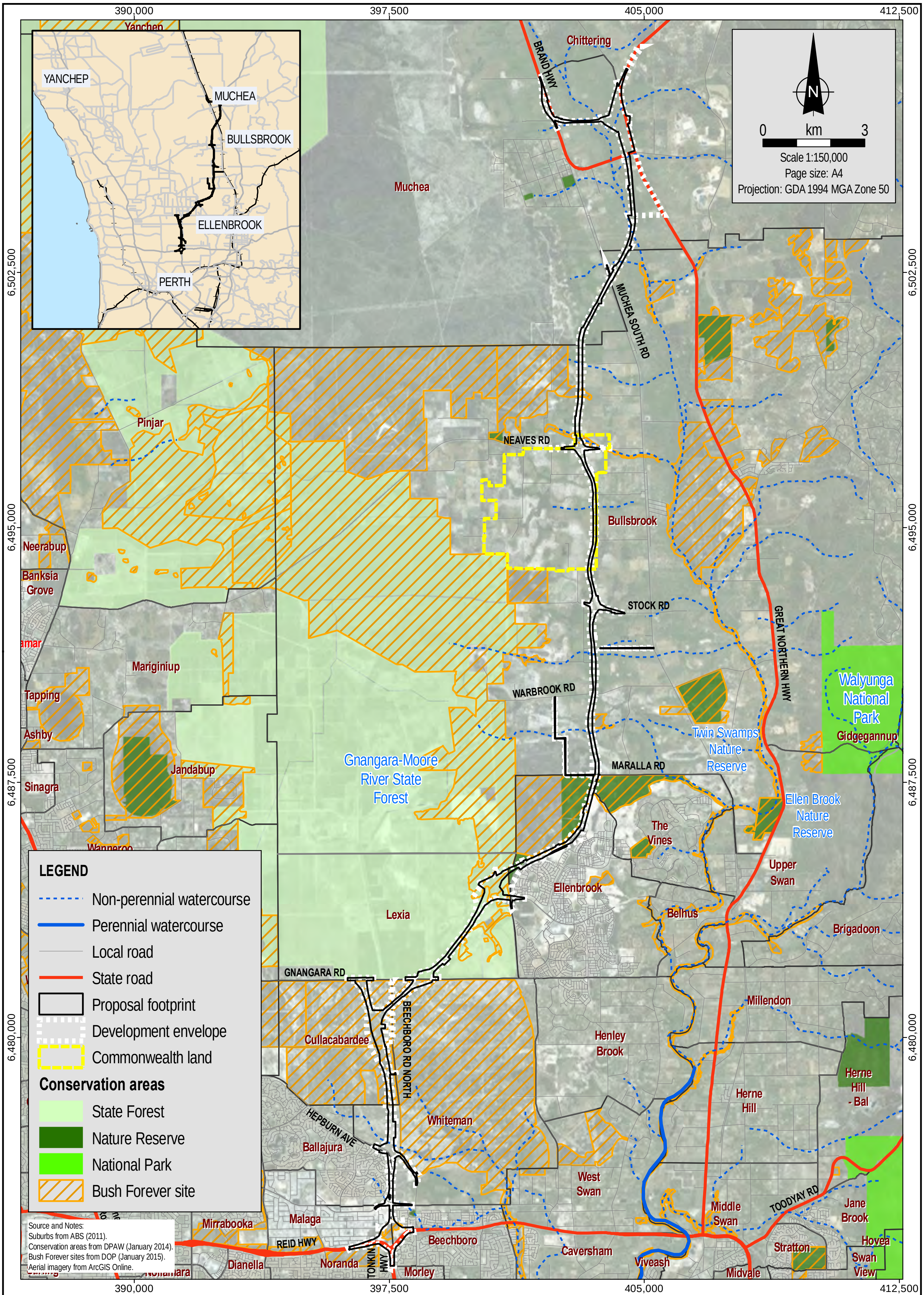
## 1.3 Requirements of the Condition

Condition requirement and in-plan section references are provided in Table 1.

As required under condition 5-1, this plan will be made publicly available for the life of the proposal.

**Table 1 Condition requirements and in-plan section references**

| Condition No. | Condition | Section in this plan |
|---|---|---|
| 13-4 | In the event baseline surveys are required, the proponent shall prepare in consultation with the Department of Water, and submit a Baseline Survey Plan to the CEO. The Baseline Survey Plan shall: | |
| | 1. When implemented, determine the baseline water quality within the GUWPCA and the Ellen Brook. | Section 4 |
| | 2. Detail the proposed methodology for the baseline surveys. | Section 3 |
| | 3. Identify and spatially define the proposed survey locations and reference/control sites and provide rationale for the location of the sites. | Section 2.1 |
| | 4. Detail the proposed frequency and timing for the baseline surveys. | Section 3 |
| 13-5 | After receiving notice in writing from the CEO that the Baseline Survey Plan satisfies the requirements of condition 13-4, the proponent shall undertake the baseline surveys in accordance with the requirements of the Baseline Survey Plan. | This plan |
| 13-6 | On completion of the baseline surveys the proponent shall report to the CEO on the following: | Section 4 |
| | 1. Completion of the baseline surveys in accordance with the Baseline Survey Plan. | |
| | 2. The results of the baseline surveys. | Section 4 |

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| NorthLinkWA | coffey (A TETRA TECH COMPANY) | Date: 29.06.2016<br>MXD: 4483AA_68_GIS001_1<br>File Name: 4483AA_68_F001_GIS | **Perth–Darwin National Highway**<br>Baseline Survey Plan - Inland Waters Environmental Quality - Hydrological Processes | **Proposal overview** | Figure No: **1** |

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# 2 BASELINE SURVEY APPROACH

Site-specific groundwater and surface water quality data is required to establish environmental criteria to support the environmental outcome detailed in condition 13-1(1) of Ministerial Statement No. 1036. The outcome is to ensure that:

- Construction and operation of the proposal shall not result in a decline in water quality of the GUWPCA and the Ellen Brook.

This section describes the baseline survey approach to determine the baseline groundwater and surface water quality of the GUWPCA and the Ellen Brook. The approach utilised information gathered from the following:

- Relevant environmental values.
- Environment aspects of the proposal and related impacts.
- Relevant environmental policies, strategies and criteria.

The information presented in this section will also identify and provide rationale against the identified and spatially defined survey well locations.

## 2.1 Identification and Rationale for the Locations of the Survey and Temporal Reference Sites

The location of survey sites is based on the Australian Drinking Water Guidelines, the location of infiltration and retention basins in and adjacent to the GUWPCA and the Ellen Brook and risks to the environmental values of the GUWPCA and the Ellen Brook. The survey sites, which also act as temporal reference sites, are shown in Figure 2 and listed in Table 2. Coordinates for the survey sites are provided in Appendix A.

**Table 2 Rationale for the location of the survey sites**

| Applicable guidelines adopted in target areas | Rationale | Groundwater and surface water survey sites |
|---|---|---|
| NHMRC and NRMMC (2011) Australian Drinking Water Guidelines - Drinking Water Health Values. | Wells located in the GUWPCA.<br><br>Surface water at the Ellen Brook and Chandala Brook within proximity to the development envelope. | **Groundwater Sampling Group GUWPCA**<br><br>MW7, MW8, MW9, MW10, MW11, MW12, MW13, MW14, MW15, MW16, MW17, MW18, MW19, MW20, MW21, MW22, MW23, MW24, MW25<br><br>**Surface Water Sampling Group Ellen Brook**<br><br>SWL18, SWL20, SWL21, SWL22 |
| ANZECC and ARMCANZ (2000) Australian Water Quality Guidelines (AWQG) Fresh water aquatic ecosystem (slightly to moderately disturbed ecosystems). | Sediment samples will be collected from a downstream location within Ellen Brook. The downstream sample will be collected from a meander (river bend) where natural sediment deposition occurs. | **Sediment Sampling Location Ellen Brook**<br><br>SWL22 |

The survey will occur along the extent of the road within and adjacent to the GUWPCA at 19 groundwater survey wells and the Ellen Brook at four surface water locations. At each surface water location, three samples will be taken to ensure a representative and comparable baseline dataset is collected for the surface water survey site. At surface water location SWL22, sediment samples at the three sample locations will also be taken. Survey sites used for data collection as part of the baseline survey are expected to continue to be used throughout the life of the project for ongoing monitoring, where possible.

Survey sites are shown in Figure 2 and will be used during construction and operation as monitoring sites.

Baseline survey sites shown in Figure 2 are also the temporal reference sites for the proposal. Baseline data from the survey sites will define the reference condition of water quality at the GUWPCA and the Ellen Brook. This represents measurements made before a disturbance and before management actions are implemented. Given suitable reference data can be derived from the survey sites prior to construction, the use of additional spatial reference sites is not considered necessary. ANZECC and ARMCANZ (2000) states the best reference condition is pre-disturbance data, which forms a valuable basis from which to define the reference condition. If the disturbance has already occurred then data from spatial reference sites can be used. Given the proposal has not commenced and baseline reference data of sufficient quality and timespan can be obtained to provide valid comparisons with post-disturbance data, pre-disturbance data will act as the reference control data for this proposal; i.e., survey sites will act as temporal reference sites.

## 2.2 Environmental Values

The Public Environmental Review for the Perth-Darwin National Highway (Swan Valley Section) identified the Gnangara groundwater mound, associated Wellhead Protection Zones (WHPZs) around Water Corporation bores and the Ellen Brook as significant environmental values with the potential to be impacted by the proposal. The relevant environmental values are described in the PER (Coffey, 2015) and Inland Waters Environmental Quality – Hydrological Processes – Condition Environmental Management Plan (Coffey, 2016).

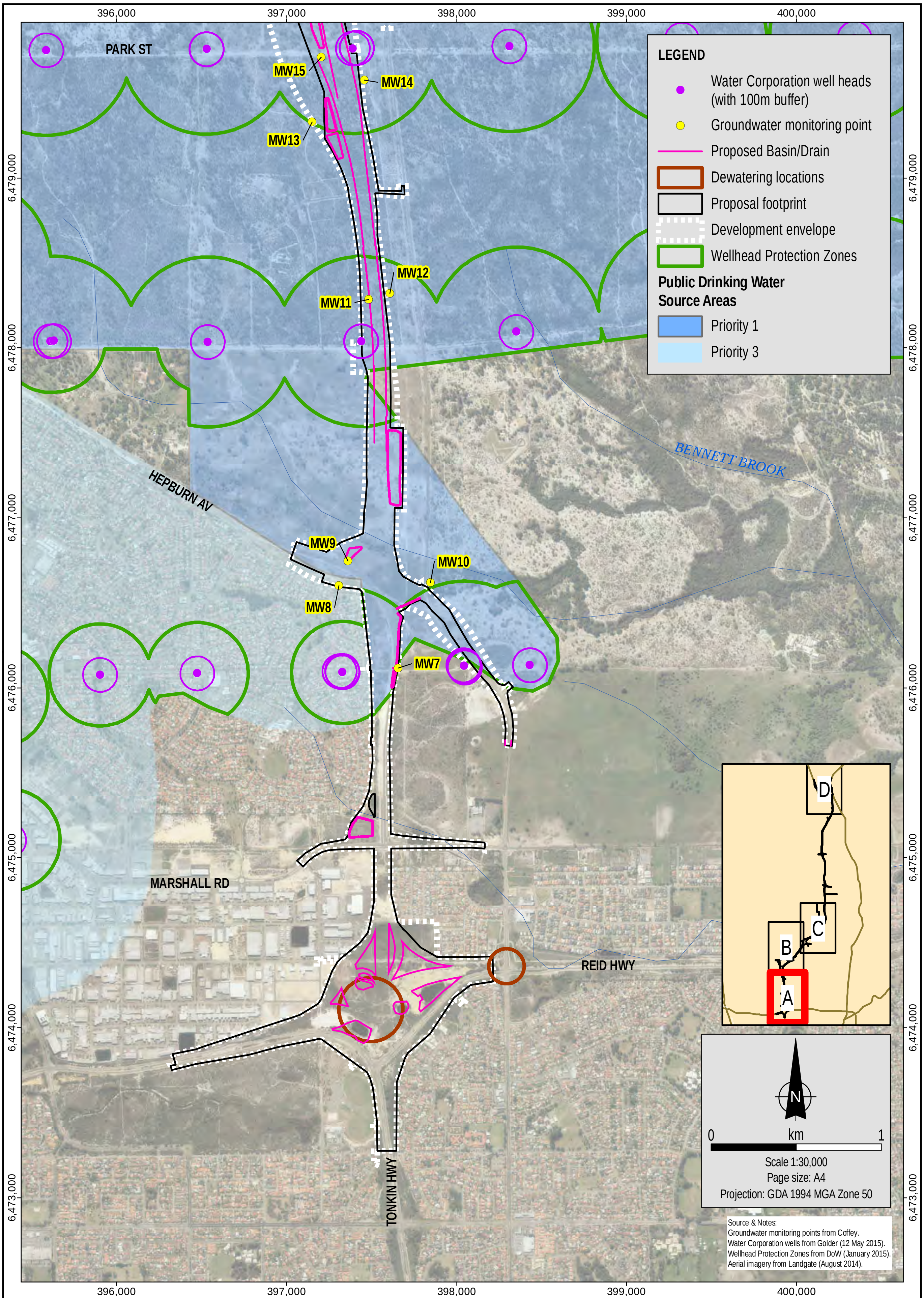
## 2.3 Environmental Policies, Strategies and Criteria

Relevant guidelines were reviewed to establish regulatory requirements associated with the protection of the GUWPCA and the Ellen Brook to meet the condition environmental outcome.

The following guidelines were used to determine the requirements in undertaking this baseline survey:

- Australian Drinking Water Guidelines (NHMRC and NRMMC, 2011).
- Australian Water Quality Guidelines (AWQG) Fresh water aquatic ecosystem (slightly to moderately disturbed ecosystems) (ANZECC and ARMCANZ, 2000).
- CSIRO’s Handbook for Sediment Quality Assessment (Simpson et al., 2005).
- Department of Environment Regulation’s (DER) Treatment and management of soil and water in acid sulfate soil landscapes (DER, 2015).
- DER’s Contaminated Sites Guidelines: Assessment and Management of Contaminated Sites (DER, 2014).
- Australian Standard AS 5667.11:1998 Water Quality-Sampling – Guidance on Sampling of Groundwaters.
- Australian Standard AS 5667.6:1998 Water Quality Sampling – Guidance on Sampling of Rivers and Streams.

- National Environment Protection Council 1999 (amended 2013) National Environment Protection (Assessment of Site Contamination) Measure (NEPM), Schedule B2: Guideline on Data Collection, Sample Design and Reporting.

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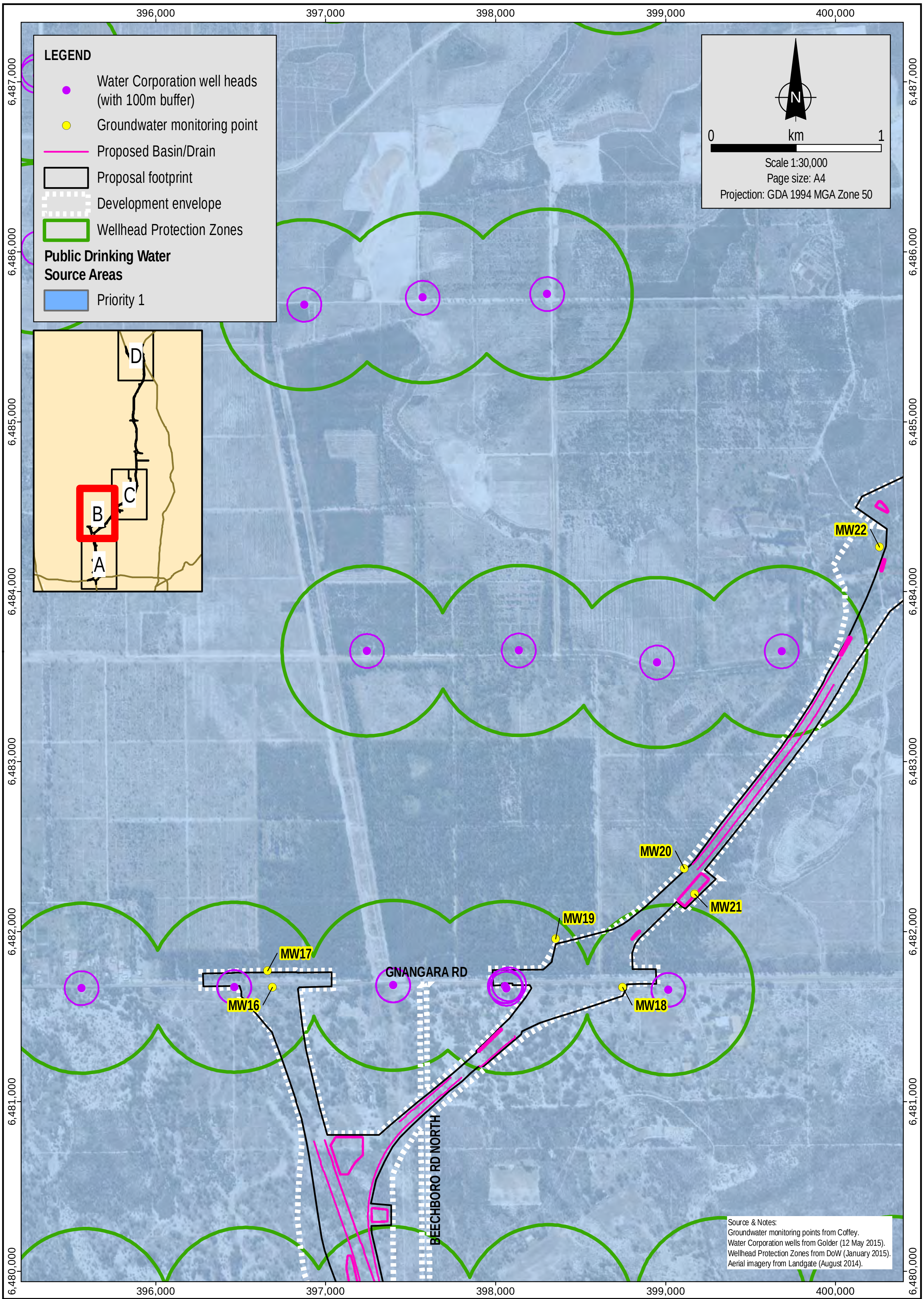


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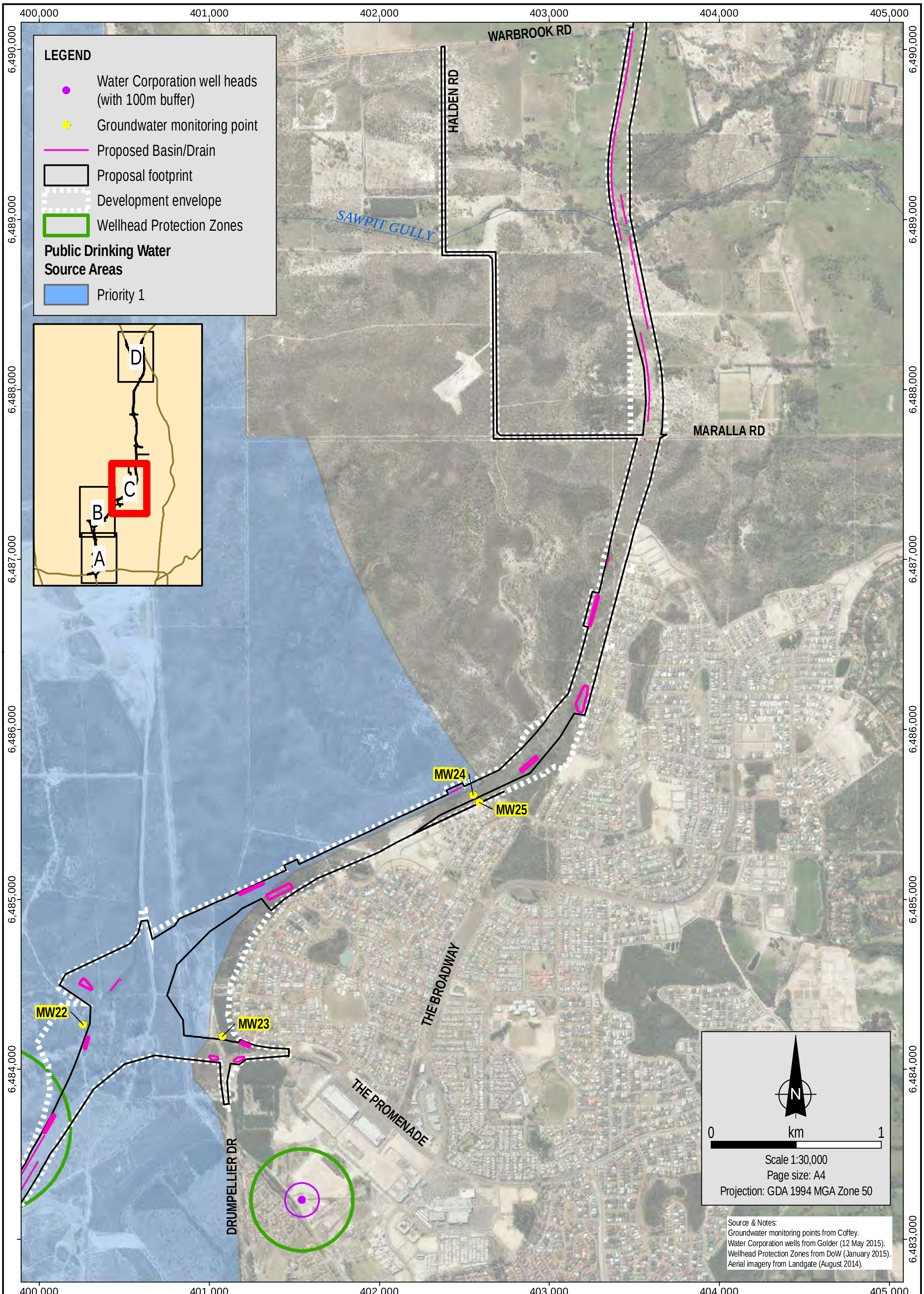


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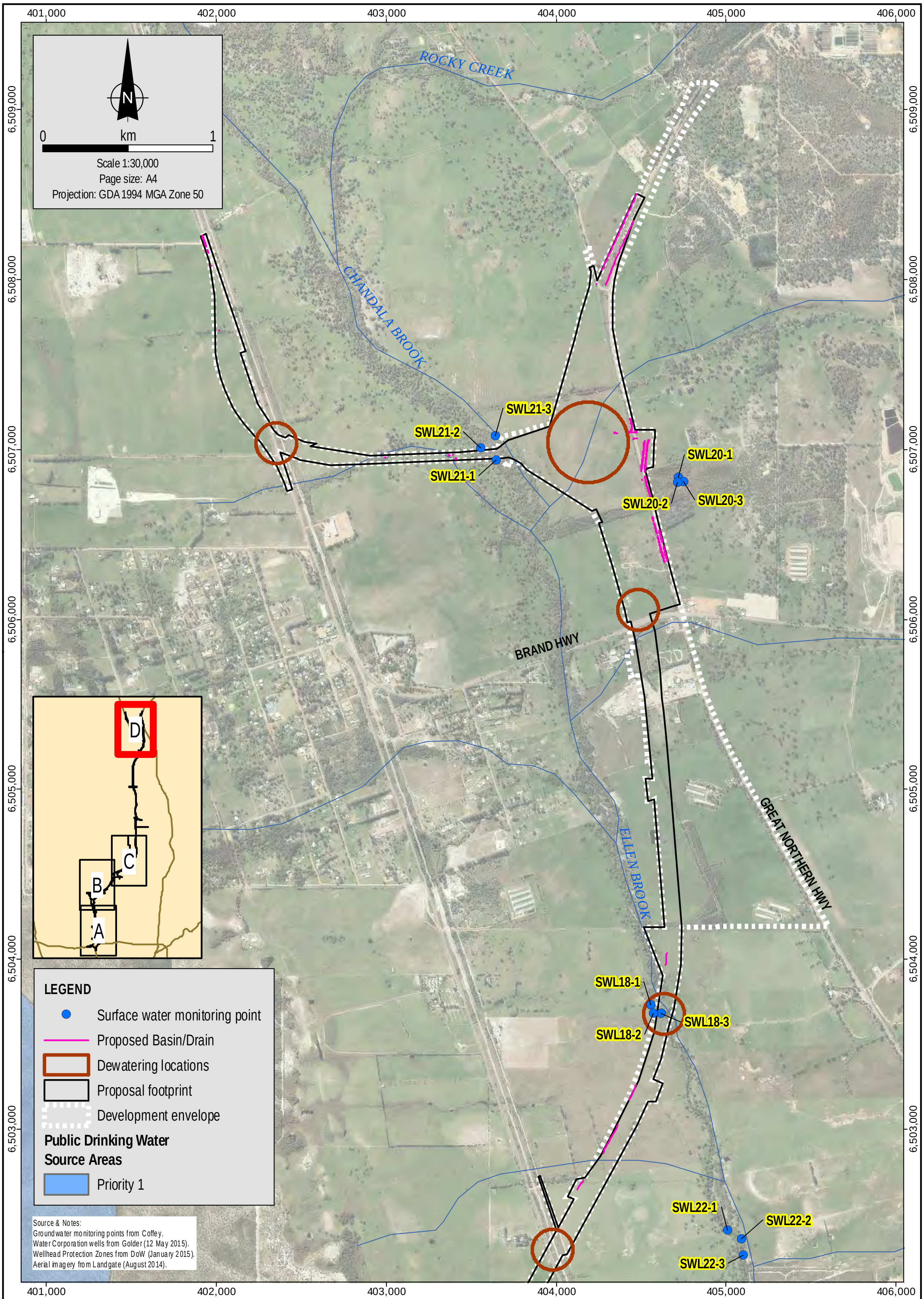
**Monitoring network for groundwater and surface water features Map 3 of 4**

Figure No: **2C**

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**Perth-Darwin National Highway**
Baseline Survey Plan - Inland Waters Environmental Quality - Hydrological Processes

**Monitoring network for groundwater and surface water features**
**Map 4 of 4**

Figure No: **2D**

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# 3 SURVEY METHOD

## 3.1 Baseline Survey Program

To obtain required baseline data, the baseline survey commenced in December 2015 and will continue for a minimum of 12 months and then until construction commences. The baseline survey comprises monthly survey events.

The analytical suite selected was primarily based on key indicators of ASS disturbance. This ASS analytical suite is complemented by a secondary analytical suite reflecting contaminants of potential concern (CoPC) associated with nearby land uses. Sampling and analysis of the full analytical suite is required for every survey event to establish a robust baseline.

The following sections provide an overview of the baseline survey for survey events 1 and 2 and the program for ongoing survey events until commencement of construction.

### 3.1.1 Survey Event 1

Survey event 1 was comprised of the following tasks:

- Desktop assessment of existing well construction details and previous sampling methods.
- Submission of Bore Access Request form to Department of Water.
- Review and evaluation of existing groundwater survey wells, including:
  - Location of existing groundwater survey wells.
  - Assessment of well condition for suitability to be used for baseline sampling.
  - Assessing accessibility and marking locations identified as requiring installation of new groundwater survey wells.

The review and evaluation of the existing groundwater well network determined that the existing well network was unsuitable due to inappropriate screen depths (i.e. screens were at a depth where potential 'initial' impact from road construction may not be identified) and locations. Accordingly, monitoring at these wells was discontinued. Critical data gaps were identified within the existing groundwater survey network, resulting in additional survey wells being installed. The baseline survey was revised based on the identified gaps and implemented in part for survey event 2 and in full for survey event 3 onwards.

### 3.1.2 Survey Event 2

Survey event 2 was comprised of the following tasks:

- Additional groundwater survey wells installed. Table 3 details the groundwater well installation method for survey event 2.
- Soil conditions logged during drilling (to be presented as borelogs in the final baseline survey report).
- Surveying additional survey wells to GDA94 MGA Zone 50 and Australian Height Datum (AHD).
- Conducting groundwater sampling using dedicated HYDRAsleeve for each monitoring location.
- Measuring physiochemical water quality for all survey sites (pH, Temperature, Electrical Conductivity, Dissolved Oxygen and Redox Potential), using a calibrated (calibrated by the supplier prior to use) Insitu smarTROLL Multiparameter Water Quality meter (copies of the calibration certification included in sampling reports).
- Remaining parameters (refer to Table 4) to be laboratory analysed including pH and Electrical Conductivity.

**Table 3 Groundwater survey well installation method**

| Activity | Details |
|---|---|
| Review of service plans | Service plans of the area from 'Dial Before You Dig' were reviewed prior to marking out and clearing sampling locations. |
| Service location | Service location was organised and supervised by Coffey to clear each soil bore and groundwater monitoring well location. Each location was cleared to 2 mbgs using non-destructive digging (NDD) (where geology allowed) prior to mechanical drilling. |
| Drilling method | Motorised drilling of soil bores was undertaken by Strataprobe Pty Ltd under the supervision of Coffey using solid auger drilling techniques where geology allowed. |
| Soil logging | Soil type classifications and descriptions are based on the Unified Soil Classification System (USCS). |
| Well construction | All monitoring wells were installed using 50 mm diameter Class 18 un-plasticised polyvinyl chloride (uPVC) with 3 m slotted screen. Screens were installed to allow 2 m of submerged screen below the standing water level and 1 m above. Monitoring wells were installed to a depth of between 5 and 7 mbgs depending on where groundwater was encountered.<br><br>Each monitoring well was backfilled with gravel to 0.5 m above the slotted screen, above which a 0.5 m long bentonite seal was established with the remainder of the hole backfilled with cuttings. Monitoring wells were finished with either a steel monument, or in the case of trafficable areas, a flush-mounted steel gatic cover. |
| Well survey | All new groundwater monitoring wells were surveyed for positional co-ordinates to Map Grid of Australia (MGA) and elevation from top of casing to metres above Australian Height Datum (mAHD) by professional surveyors, PGS Hope Pty Ltd. |
| Decontamination procedure | Drilling equipment was decontaminated between holes using laboratory grade detergent and scheme water. |
| Waste disposal | Soil cuttings generated from the soil investigation were returned to hole. Where surplus soil cuttings were present, cuttings were removed from site by the drilling contractor and disposed of accordingly. |

### 3.1.3 Survey Events 3 and Onwards

Survey events 3 and onwards until commencement of construction will follow the baseline survey program outlined in Table 4 and detailed in Sections 3.1.3.1 and 3.1.3.2.

**Table 4 Groundwater and surface water baseline survey program for survey events 3 and onwards**

| Location | Parameters to be analysed | Methodology | Frequency |
|---|---|---|---|
| All locations | **In-situ measurements:**<br>pH, conductivity (EC), dissolved oxygen, temperature, total dissolved solids (TDS), oxidative/reductive potential.<br>**Laboratory analysis:**<br>pH, EC, turbidity.<br>Major anions and cations – Na, K, Ca, Mg, Cl, $SO_4$, $CO_3$, $HCO_3$.<br>Total acidity and total alkalinity.<br>12 dissolved and total metals (Al, As, Cd, Cr, Cu, Fe, Pb, Mn, Hg, Ni, Se, Zn).<br>Nutrients – Total N, $NO_3$, $NO_2$, $NH_3$, Total P and Filterable Reactive Phosphorus (FRP).<br>Total Recoverable Hydrocarbons (TRH), benzene, toluene, ethylbenzene, xylene (BTEX) – all locations (survey event 3 only).<br>Bacteria (thermotolerant bacteria, E. coli) – P1 locations.<br>Organochlorine pesticides (OCPs), organophosphorus pesticides (OPP) – all locations (survey event 3 only). | **Groundwater:**<br>• Gauge 19 groundwater survey wells.<br>• Measure physicochemical water quality in-situ, using a calibrated water quality meter.<br>• Collect groundwater samples using a passive sampling device or other industry accepted method deemed suitable for groundwater survey purposes.<br>**Surface water:**<br>• Measure physicochemical water quality at surface water locations SWL18, SWL20, SWL21 and SWL22 and collect samples.<br>• To ensure a representative and comparable baseline dataset, surface water samples are to be collected from each wetland sampling location.<br>Note: TRH/BTEX will be sampled for at all locations during survey event 3 in order to gather baseline data. Based on field evidence (with the exception of Sims Metals) TRH/BTEX is not considered a priority chemical of potential concern, however, during the construction phase monitoring of these parameters may be required (e.g. in the event of a fuel or chemical leak/spill). For baseline purposes, the post-summer round (March 2016) will provide the most conservative baseline result which coincides with groundwater lows.<br>OCP/OPPs will be sampled at all groundwater locations during survey event 3 in order to gather baseline data. Although not considered a priority chemical of potential concern due to the residential/agricultural setting through which the road development envelope is proposed, it is considered prudent to prove the baseline of these chemicals nonetheless.<br>Survey for TRH/BTEX and OCP/OPP was discontinued after survey event 3 as there were no detections at relevant survey sites above the Limit of Reporting for all TRH/BTEX and OCP/OPP analytes.<br>Survey for TRH/BTEX was reintroduced at survey event 6 and will be measured again in survey event 12. | Monthly |

#### 3.1.3.1 Groundwater Sampling Method

Table 5 details the groundwater sampling method from survey event 3 and onwards. Groundwater survey sites are shown in Figure 2.

**Table 5 Groundwater sampling method**

| Activity | Details |
|---|---|
| Groundwater quality monitoring | Prior to collection of groundwater samples to be laboratory analysed, water quality at the allocated groundwater sampling locations will be measured in-situ by a multi parameter water meter for physicochemical parameters including pH, oxidative/reductive potential, DO, temperature and electrical conductivity. |
| Sampling method | HydraSleeve Standard Operating Procedure (SOP) will be implemented as the groundwater sampling method (Appendix B). Collection of QC samples will include one field duplicate and one interlab duplicate (at a rate of one per twenty samples), collection of one combined field and rinsate blank (one per day of fieldwork) and one trip blank (one per esky). |
| Decontamination procedure | All non-disposable sampling equipment (IP and water quality meter) will be decontaminated with laboratory grade detergent and rinsed with deionised water between sample locations. Dedicated nitrile gloves and disposable HydraSleeves will be used for each location. |
| Sample preservation | Samples will be collected in laboratory supplied bottles containing appropriate preservatives and immediately stored in an insulated cooler chilled with ice upon sampling and ice bricks during air freight to the laboratory. Samples collected for analysis of metals will be filtered in the field using 0.45 µm disposable filters. Samples will be submitted to the National Association of Testing Authorities (NATA) accredited laboratory accompanied by chain of custody (COC) documentation. |
| Waste disposal | Groundwater recovered during the purging of monitoring wells will be returned to ground. |

#### 3.1.3.2 Surface Water Sampling Method

Table 6 details the surface water sampling method from survey event 3 and onwards. Surface water survey sites are shown in Figure 2.

**Table 6 Surface water sampling method**

| Activity | Details |
|---|---|
| Surface water quality monitoring | Prior to collection of groundwater samples to be laboratory analysed, water quality at the allocated groundwater sampling locations will be measured in-situ by a multi parameter water meter for physicochemical parameters including pH, oxidative/reductive potential, DO, temperature and electrical conductivity. |
| Sampling method | Surface water sampling will be undertaken using a sampling pole with attached dedicated container to collect samples from the centre of each lake. The bottle will be immersed to a depth of approximately 15 cm, laying it flat with its mouth towards the flow of the water. Water will then be decanted directly into laboratory supplied sample containers. Note: for metal analysis, bottles will not be rinsed and will be filled by decanting from another, rinsed bottle |

| Activity | Details |
|---|---|
| Decontamination procedure | Water monitoring equipment such as the multi parameter water meter will be decontaminated with laboratory grade detergent and rinsed with deionised water between sample locations. The sample containers used with the sample pole will be replaced between sampling locations to prevent cross contamination. Dedicated disposable nitrile gloves will be used during the collection of each sample. |
| Sample preservation | Samples will be collected in laboratory supplied bottles containing appropriate preservatives and immediately stored in an insulated cooler chilled with ice bricks upon sampling and during road freight to the laboratory. Samples for total metals analysis were not filtered. Samples will be submitted to the laboratory accompanied by COC documentation. |
| Waste disposal | Surface water samples taken for field water quality analysis will be returned to each location after sampling. |

### 3.1.4 Survey Events 13 and Onwards

From survey event 13 and onwards until commencement of construction, surface water quality at SWL22 will also be measured and recorded. The surface water baseline survey program is detailed in Table 4.

SWL22 acts as a downstream surface water monitoring location along Ellen Brook located at a natural slow point that may build up excess sediment attributed to increased turbidity levels from construction activities. The location of SWL 22 is shown in Figure 2.

### 3.1.5 Survey Events 15 and Onwards

From survey event 15 and onwards until commencement of construction, sediment quality at SWL22 will be measured and recorded on a monthly basis in conjunction with surface water monitoring at SWL22.

Sediment sample parameters to be analysed will be conducted by laboratory analysis. The list of sediment sample parameters is provided in Section 3.2.

#### 3.1.5.1 Sediment Sampling Method

The sediment baseline survey method for survey events 15 and onwards is detailed in Table 7.

**Table 7 Sediment sampling method**

| Activity | Details |
|---|---|
| Surface water quality monitoring above sediment sample site | Prior to collection of sediment samples to be laboratory analysed, surface water quality at the allocated sediment sampling locations will be measured in-situ by a multi parameter water meter for physicochemical parameters including pH, oxidative/reductive potential, DO, temperature and electrical conductivity. The multi parameter water meter will be positioned approximately 10 cm above the sediment sampling location. |

| Activity | Details |
|---|---|
| Sampling method | • Sampler to avoid sediment disturbance as much as possible prior to sampling event.<br>• Sediment sampling will be undertaken using a grab sampler with samples collected from surficial sediments (0-10 cm). The sample depth has been determined with consideration given to Chapman et al. (2005) which states “generally most epifaunal and infaunal organisms are found in the upper 10 cm of sediments”.<br>• Record water column conditions during sampling (tides, waves, clarity).<br>• Collect surface sediment samples at SWL22 and photograph sediment sample.<br>• Record sediment properties (gravel, sand, silty-sand, silt), occurrence of debris (wood, shells, plant), visual evidence of potential contamination and sample depth.<br>• Record changes in strata with depth recorded (texture, consistency, colour, presence of biota). |
| Decontamination procedure | Sediment sampling equipment will be decontaminated with laboratory grade detergent and rinsed with deionised water between sample locations. Dedicated disposable nitrile gloves will be used during the collection of each sample. |
| Sample preservation | Samples will be collected in laboratory supplied jars containing appropriate preservatives and immediately stored in an insulated cooler chilled with ice bricks upon sampling and during road freight to the laboratory.<br>Samples will be submitted to the laboratory accompanied by COC documentation. |
| Waste disposal | Excess sediment taken for sediment samples will be returned to the surface water location after sampling. |

## 3.2 Laboratory Analysis Program

Groundwater and surface water samples have been and will be analysed for the following:

- Physicochemical parameters measured in-situ (using a water quality meter): pH, EC, TDS, dissolved oxygen, temperature.
- Parameters for laboratory analysis:
  - Physicochemical parameters: pH, and EC and turbidity.
  - Major anions and cations: Na, K, Ca, Mg, Cl, $SO_4$, $CO_3$, $HCO_3$.
  - Total acidity.
  - Total alkalinity.
  - 12 dissolved metals (dissolved Al, As, Cd, Cr, Cu, Fe, Pb, Mg, Hg, Ni, Se, Zn).
  - Nutrients: Total N, $NO_3$, $NO_2$, $NH_3$, Total P and FRP.
  - OCPs/OPP (survey event 3 only).
  - TRH (survey event 3, 6 and 12 only).
  - BTEX (survey event 3, 6 and 12 only).

Survey event 2 was conducted prior to the revised baseline survey program. As a result, it did not include collection and analysis of the full analytical suite – only physiochemical parameters were measured.

OCPs/OPP have not been undertaken since survey event 3. TRH/BTEX will be analysed only in survey events 3, 6 and 12.

Sediment samples from survey events 15 and onwards will be analysed for the following:

- Parameters for laboratory analysis:
  - 10 total metals (As, Cd, Cr, Cu, Mn, Ni, Pb, Se, Zn, Fe).
  - Total TPH, total PAHs.
  - Glyphosate.
  - Total organic carbon.
  - Net acidity.
  - pH.

### 3.3 Quality Assurance and Quality Control

All QA/QC procedures shall meet the requirements of the NEPM Schedule B2 Guideline on Data Collection, Sample Design and Reporting as follows:

- Collection of QA/QC samples to include one field duplicate sample (at a rate of one per twenty samples), collection of equipment rinsate samples (one per day of fieldwork), field blanks (one per day of fieldwork) and trip blanks (one per esky).
- Standardised field sampling forms detailing each phase of the investigation will be completed and appended to the final baseline survey report. Sample collection, sample storage and chain-of-custody procedures will align with best practice methods.
- Sampling equipment will be decontaminated (where necessary for non-dedicated sample equipment) between sampling locations in order to prevent cross-contamination.
- All equipment used for this investigation will be calibrated and calibration certificates appended to the report.
- Laboratories accredited by the National Association of Testing Authorities (NATA) for the full analytical suite will be used. NATA accredits laboratories on a parameter by parameter basis and the laboratories must provide quantitative evidence of their ability and competence to produce reliable results against recognised benchmarks (i.e. NATA proficiency programs, other national and international proficiency programs, and performance against certified reference materials). Accredited laboratories are able to demonstrate the ability to produce reliable, repeatable results for a range of parameters within a range of sample matrices.

### 3.4 Schedule

The baseline survey is currently conducted on a monthly basis, having commenced in December 2015, and will continue for a minimum of 12 months and then until construction commences.

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# 4 REPORTING

Upon completion of the final survey event a baseline survey report will be provided to the CEO in accordance with conditions 13-6(1) and 13-6(2). The report will present data collected including an assessment of groundwater and surface water quality of the GUWPCA and the Ellen Brook against available criteria and trend analysis.

The report will identify exceedances of applicable published criteria and determine site specific threshold criteria applicable the GUWPCA and Ellen Brook for incorporation into monitoring regimes implemented during the construction and operation phases.

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# 5 REFERENCES


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APPENDIX A

# Survey Site Locations

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**Table A1 Approximate locations of groundwater and surface water survey sites**

| Survey location | Easting | Northing |
|---|---|---|
| SWL18 | 404,668 | 6,503,678 |
| SWL20 | 402,896 | 6,506,926 |
| SWL21 | 403,643 | 6,506,940 |
| SWL22 | 405, 084 | 6,502,429 |
| MW7 | 397,646 | 6,476,115 |
| MW8 | 397,305 | 6,476,607 |
| MW9 | 397,357 | 6,476,750 |
| MW10 | 397,844 | 6,476,609 |
| MW11 | 397,483 | 6,478,289 |
| MW12 | 397,607 | 6,478,318 |
| MW13 | 397,143 | 6,479,335 |
| MW14 | 397,457 | 6,479,575 |
| MW15 | 397,218 | 6,479,728 |
| MW16 | 396,687 | 6,481,671 |
| MW17 | 396,656 | 6,481,761 |
| MW18 | 398,747 | 6,481,664 |
| MW19 | 398,355 | 6,481,955 |
| MW20 | 399,110 | 6,482,360 |
| MW21 | 399,180 | 6,482,221 |
| MW22 | 400,262 | 6,484,100 |
| MW23 | 401,076 | 6,484,193 |
| MW24 | 402,445 | 6,485,651 |
| MW25 | 402,526 | 6,485,551 |

Note: Eastings and northings are in GDA94 MGA Zone 50.

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APPENDIX B

# HydraSleeve Standard Operating Procedure

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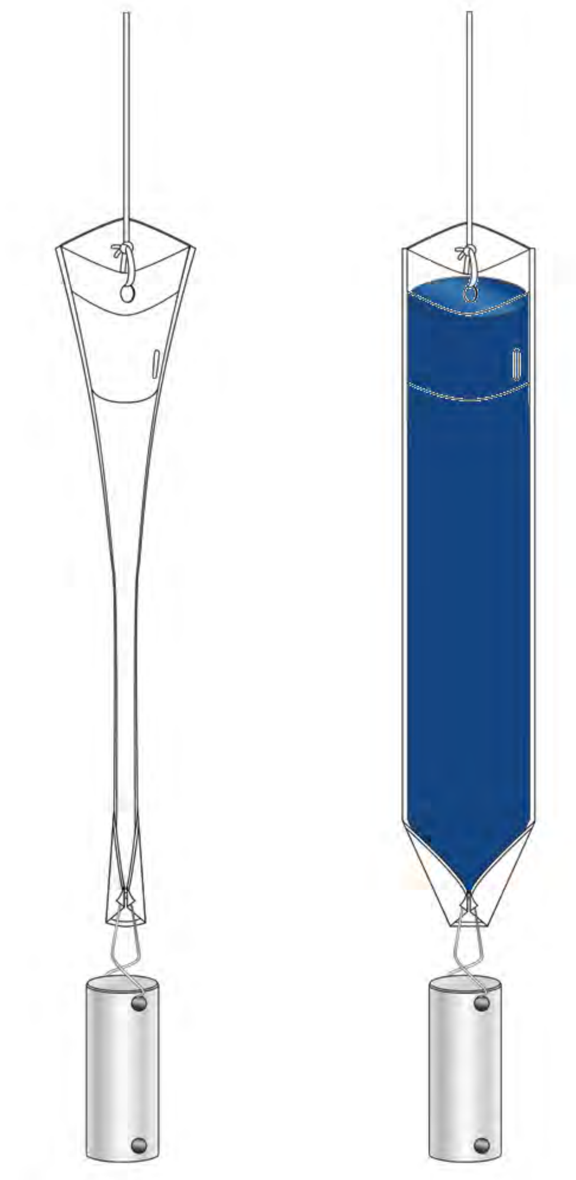
HYDRASleeve™

Simple by Design US Patent No. 6,481,300; No. 6,837,120 others pending

# Standard Operating Procedure: Sampling Ground Water with a HydraSleeve



This Guide should be used in addition to field manuals appropriate to sampling device (i.e., HydraSleeve or Super Sleeve).

Find the appropriate field manual on the HydraSleeve website at http://www.hydrasleeve.com.

For more information about the HydraSleeve, or if you have questions, contact:
GeoInsight, 2007 Glass Road, Las Cruces, NM 88005, 1-800-996-2225, info@hydrasleeve.com.



## Table of Contents

## Introduction

The HydraSleeve is classified as a no-purge (passive) grab sampling device, meaning that it is used to collect ground-water samples directly from the screened interval of a well without having to purge the well prior to sample collection. When it is used as described in this Standard Operating Procedure (SOP), the HydraSleeve causes no drawdown in the well (until the sample is withdrawn from the water column) and only minimal disturbance of the water column, because it has a very thin cross section and it displaces very little water (<100 ml) during deployment in the well. The HydraSleeve collects a sample from within the screen only, and it excludes water from any other part of the water column in the well through the use of a self-sealing check valve at the top of the sampler. It is a single-use (disposable) sampler that is not intended for reuse, so there are no decontamination requirements for the sampler itself.

The use of no-purge sampling as a means of collecting representative ground-water samples depends on the natural movement of ground water (under ambient hydraulic head) from the formation adjacent to the well screen through the screen. Robin and Gillham (1987) demonstrated the existence of a dynamic equilibrium between the water in a formation and the water in a well screen installed in that formation, which results in formation-quality water being available in the well screen for sampling at all times. No-purge sampling devices like the HydraSleeve collect this formation-quality water as the sample, under undisturbed (non-pumping) natural flow conditions. Samples collected in this manner generally provide more conservative (i.e., higher concentration) values than samples collected using well-volume purging, and values equivalent to samples collected using low-flow purging and sampling (Parsons, 2005).

## Applications of the HydraSleeve

The HydraSleeve can be used to collect representative samples of ground water for all analytes (volatile organic compounds [VOCs], semi-volatile organic compounds [SVOCs], common metals, trace metals, major cations and anions, dissolved gases, total dissolved solids, radionuclides, pesticides, PCBs, explosive compounds, and all other analytical parameters). Designs are available to collect samples from wells from 1" inside diameter and larger. The HydraSleeve can collect samples from wells of any yield, but it is especially well-suited to collecting samples from low-yield wells, where other sampling methods can't be used reliably because their use results in dewatering of the well screen and alteration of sample chemistry (McAlary and Barker, 1987).

The HydraSleeve can collect samples from wells of any depth, and it can be used for single-event sampling or long-term ground-water monitoring programs. Because of its thin cross section and flexible construction, it can be used in narrow, constricted or damaged wells where rigid sampling devices may not fit. Using multiple HydraSleeves deployed in series along a single suspension line or tether, it is also possible to conduct in-well vertical profiling in wells in which contaminant concentrations are thought to be stratified.

As with all groundwater sampling devices, HydraSleeves should not be used to collect groundwater samples from wells in which separate (non-aqueous) phase hydrocarbons (i.e., gasoline, diesel fuel or jet fuel) are present because of the possibility of incorporating some of the separate-phase hydrocarbon into the sample.

## Description of the HydraSleeve

The HydraSleeve (Figure 1) consists of the following basic components:

- A suspension line or tether (A.), attached to the spring clip or directly to the top of the sleeve to deploy the device into and recover the device from the well. Tethers with depth indicators marked in 1-foot intervals are available from the manufacturer.
- A long, flexible, 4-mil thick lay-flat polyethylene sample sleeve (C.) sealed at the bottom (this is the sample chamber), which comes in different sizes, as discussed below with a self-sealing reed-type flexible polyethylene check valve built into the top of the sleeve (B.) to prevent water from entering or exiting the sampler except during sample acquisition.
- A reusable stainless-steel weight with clip (D.), which is attached to the bottom of the sleeve to carry it down the well to its intended depth in the water column. Bottom weights available from the manufacturer are 0.75" OD and are available in three sizes: 5 oz. (2.5" long); 8 oz. (4" long); and 16 oz. (8" long). In lieu of a bottom weight, an optional top weight may be attached to the top of the HydraSleeve to carry it to depth and to compress it at the bottom of the well (not shown in Figure 1);
- A discharge tube that is used to puncture the HydraSleeve after it is recovered from the well so the sample can be decanted into sample bottles (not shown).
- Just above the self-sealing check valve at the top of the sleeve are two holes which provide attachment points for the spring clip and/or suspension line or tether. At the bottom of the sample sleeve are two holes which provide attachment points for the weight clip and weight.

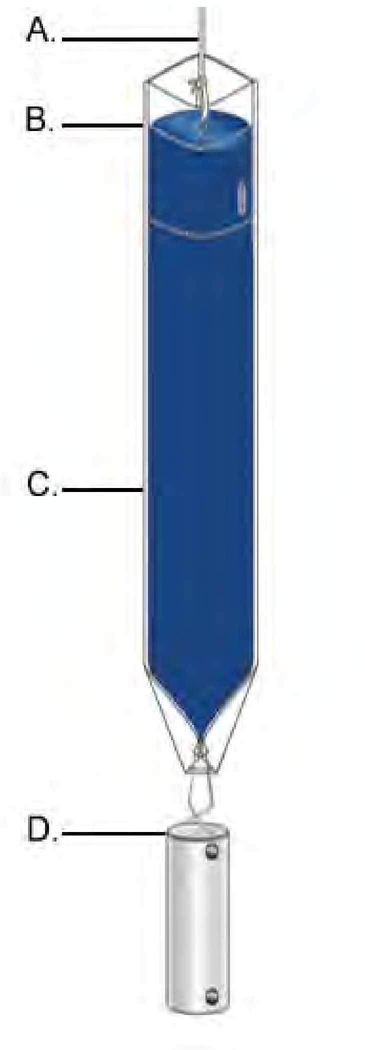


Figure 1. HydraSleeve components.

> **Note:** The sample sleeve and the discharge tube are designed for one-time use and are disposable. The spring clip, weight and weight clip may be reused after thorough cleaning. Suspension cord is generally disposed after one use although, if it is dedicated to the well, it may be reused at the discretion of the sampling personnel.

## Selecting the HydraSleeve Size to Meet Site-Specific Sampling Objectives

It is important to understand that each HydraSleeve is able to collect a finite volume of sample because, after the HydraSleeve is deployed, you only get one chance to collect an undisturbed sample. Thus, the volume of sample required to meet your site-specific sampling and analytical requirements will dictate the size of HydraSleeve you need to meet these requirements.

The volume of sample collected by the HydraSleeve varies with the diameter and length of the HydraSleeve. Dimensions and volumes of available HydraSleeve models are detailed in Table 1.

**Table 1. Dimensions and volumes of HydraSleeve models.**

| Diameter | Volume | Length | Lay-Flat Width | Filled Dia. |
|---|---|---|---|---|
| *2-Inch HydraSleeves* | | | | |
| Standard 625-ml HydraSleeve | 625 ml | < 30” | 2.5” | 1.4” |
| Standard 1-Liter HydraSleeve | 1 Liter | 38” | 3” | 1.9” |
| 1-Liter HydraSleeve SS | 1 Liter | 36” | 3” | 1.9” |
| 2-Liter HydraSleeve SS | 2 Liters | 60” | 3” | 1.9” |
| *4-Inch HydraSleeves* | | | | |
| Standard 1.6-Liter HydraSleeve | 1.6 Liters | 30” | 3.8” | 2.3” |
| Custom 2-Liter HydraSleeve | 2 Liters | 36” | 4” | 2.7” |

HydraSleeves can be custom-fabricated by the manufacturer in varying diameters and lengths to meet specific volume requirements. HydraSleeves can also be deployed in series (i.e., multiple HydraSleeves attached to one tether) to collect additional sample to meet specific volume requirements, as described below.

If you have questions regarding the availability of sufficient volume of sample to satisfy laboratory requirements for analysis, it is recommended that you contact the laboratory to discuss the minimum volumes needed for each suite of analytes. Laboratories often require only 10% to 25% of the volume they specify to complete analysis for specific suites of analytes, so they can often work with much smaller sample volumes that can easily be supplied by a HydraSleeve.

# HydraSleeve Deployment

## Information Required Before Deploying a HydraSleeve

Before installing a HydraSleeve in any well, you will need to know the following:

- The inside diameter of the well
- The length of the well screen
- The water level in the well
- The position of the well screen in the well
- The total depth of the well

The inside diameter of the well is used to determine the appropriate HydraSleeve diameter for use in the well. The other information is used to determine the proper placement of the HydraSleeve in the well to collect a representative sample from the screen (see HydraSleeve Placement, below), and to determine the appropriate length of tether to attach to the HydraSleeve to deploy it at the appropriate position in the well.

Most of this information (with the exception of the water level) should be available from the well log; if not, it will have to be collected by some other means. The inside diameter of the well can be measured at the top of the well casing, and the total depth of the well can be measured by sounding the bottom of the well with a weighted tape. The position and length of the well screen may have to be determined using a down-hole camera if a well log is not available. The water level in the well can be measured using any commonly available water-level gauge.

## HydraSleeve Placement

The HydraSleeve is designed to collect a sample directly from the well screen, and it fills by pulling it up through the screen a distance equivalent to 1 to 1.5 times its length. This upward motion causes the top check valve to open, which allows the device to fill. To optimize sample recovery, it is recommended that the HydraSleeve be placed in the well so that the bottom weight rests on the bottom of the well and the top of the HydraSleeve is as close to the bottom of the well screen as possible. This should allow the sampler to fill before the top of the device reaches the top of the screen as it is pulled up through the water column, and ensure that only water from the screen is collected as the sample. In short-screen wells, or wells with a short water column, it may be necessary to use a top-weight on the HydraSleeve to compress it in the bottom of the well so that, when it is recovered, it has room to fill before it reaches the top of the screen.

**Example**

2" ID PVC well, 50' total depth, 10' screen at the bottom of the well, with water level above the screen (the entire screen contains water).

*Correct Placement (figure 2):* Using a standard HydraSleeve for a 2" well (2.6" flat width/1.5" filled OD x 30" long, 650 ml volume), deploy the sampler so the weight (an 8 oz., 4"-long weight with a 2"-long clip) rests at the bottom of the well. The top of the sleeve is thus set at about 36" above the bottom of the well. When the sampler is recovered, it will be pulled upward approximately 30" to 45" before it is filled; therefore, it is full (and the top check valve closes) at approximately 66" (5 ½ feet) to 81" (6 ¾ feet) above the bottom of the well, which is well before the sampler reaches the top of the screen. In this example, only water from the screen is collected as a sample.

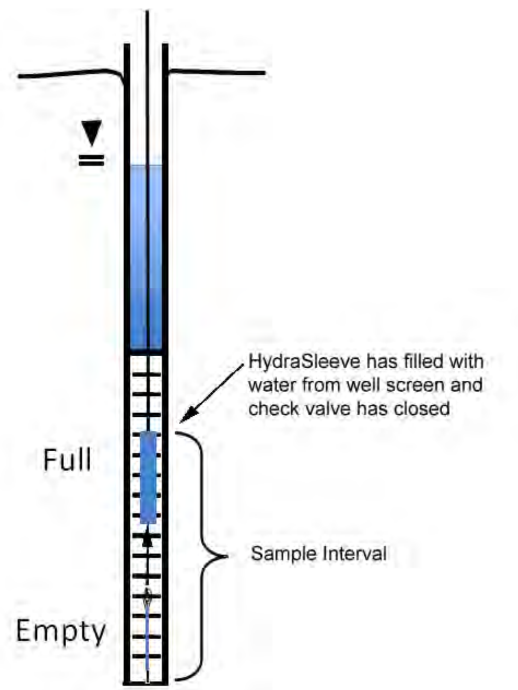



Figure 2. Correct placement of HydraSleeve.

*Incorrect Placement (figure 3):* If the well screen in this example was only 5' long, and the HydraSleeve was placed as above, it would not fill before the top of the device reached the top of the well screen, so the sample would include water from above the screen, which may not have the same chemistry.

*The solution?* Deploy the HydraSleeve with a top weight, so that it is collapsed to within 6" to 9" of the bottom of the well. When the HydraSleeve is recovered, it will fill within 39" (3 ¼ feet) to 54" (4 ½ feet) above the bottom of the well, or just before the sampler reaches the top of the screen, so it collects only water from the screen as the sample.

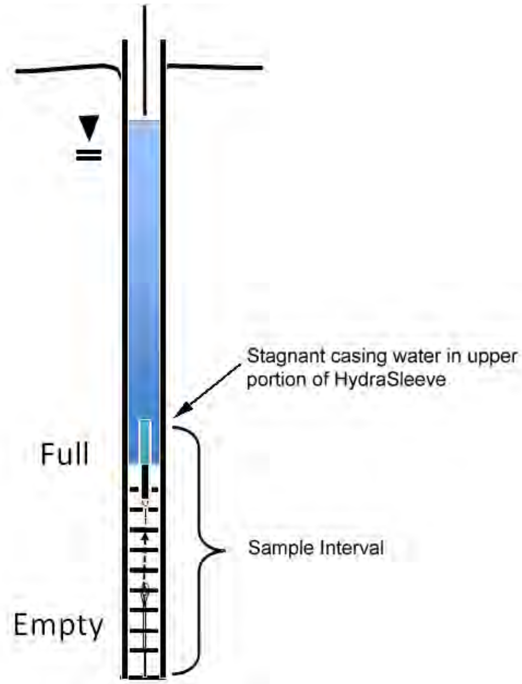



Figure 3. Incorrect placement of HydraSleeve.

This example illustrates one of many types of HydraSleeve placements. More complex placements are discussed in a later section.

## Procedures for Sampling with the HydraSleeve

Collecting a ground-water sample with a HydraSleeve is a simple one-person operation.

> **Note:** Before deploying the HydraSleeve in the well, collect the depth-to-water measurement that you will use to determine the preferred position of the HydraSleeve in the well. This measurement may also be used with measurements from other wells to create a ground-water contour map. If necessary, also measure the depth to the bottom of the well to verify actual well depth to confirm your decision on placement of the HydraSleeve in the water column.
>
> Measure the correct amount of tether needed to suspend the HydraSleeve in the well so that the weight will rest on the bottom of the well (or at your preferred position in the well). Make sure to account for the need to leave a few feet of tether at the top of the well to allow recovery of the sleeve

> **Note:** Always wear sterile gloves when handling and discharging the HydraSleeve.

### I. Assembling the HydraSleeve

1. Remove the HydraSleeve from its packaging, unfold it, and hold it by its top.
2. Crimp the top of the HydraSleeve by folding the hard polyethylene reinforcing strips at the holes.
3. Attach the spring clip to the holes to ensure that the top will remain open until the sampler is retrieved.
4. Attach the tether to the spring clip by tying a knot in the tether.

> **Note:** Alternatively, attach the tether to one (NOT both) of the holes at the top of the Hydrasleeve by tying a knot in the tether.

5. Fold the flaps with the two holes at the bottom of the HydraSleeve together and slide the weight clip through the holes.
6. Attach a weight to the bottom of the weight clip to ensure that the HydraSleeve will descend to the bottom of the well.

## II. Deploying the HydraSleeve

1. Using the tether, carefully lower the HydraSleeve to the bottom of the well, or to your preferred depth in the water column

   During installation, hydrostatic pressure in the water column will keep the self-sealing check valve at the top of the HydraSleeve closed, and ensure that it retains its flat, empty profile for an indefinite period prior to recovery.

**Note:** Make sure that it is not pulled upward at any time during its descent. If the HydraSleeve is pulled upward at a rate greater than 0.5'/second at any time prior to recovery, the top check valve will open and water will enter the HydraSleeve prematurely.

2. Secure the tether at the top of the well by placing the well cap on the top of the well casing and over the tether.

**Note:** Alternatively, you can tie the tether to a hook on the bottom of the well cap (you will need to leave a few inches of slack in the line to avoid pulling the sampler up as the cap is removed at the next sampling event).

## III. Equilibrating the Well

The equilibration time is the time it takes for conditions in the water column (primarily flow dynamics and contaminant distribution) to restabilize after vertical mixing occurs (caused by installation of a sampling device in the well).

- Situation: The HydraSleeve is deployed for the first time or for only one time in a well

  The HydraSleeve is very thin in cross section and displaces very little water (<100 ml) during deployment so, unlike most other sampling devices, it does not disturb the water column to the point at which long equilibration times are necessary to ensure recovery of a representative sample.

  In most cases, the HydraSleeve can be recovered immediately (with no equilibration time) or within a few hours. In regulatory jurisdictions that impose specific requirements for equilibration times prior to recovery of no-purge sampling devices, these requirements should be followed.

- Situation: The HydraSleeve is being deployed for recovery during a future sampling event

  In periodic (i.e., quarterly or semi-annual) sampling programs, the sampler for the current sampling event can be recovered and a new sampler (for the next sampling event) deployed immediately thereafter, so the new sampler remains in the well until the next sampling event.

Thus, a long equilibration time is ensured and, at the next sampling event, the sampler can be recovered immediately. This means that separate mobilizations, to deploy and then to recover the sampler, are not required. HydraSleeves can be left in a well for an indefinite period of time without concern.

## IV. HydraSleeve Recovery and Sample Collection

1. Hold on to the tether while removing the well cap.

2. Secure the tether at the top of the well while maintaining tension on the tether (but without pulling the tether upwards)

3. Measure the water level in the well.

4. In one smooth motion, pull the tether up between 30” to 45” (36” to 54” for the longer HydraSleeve) at a rate of about 1’ per second (or faster).

   The motion will open the top check valve and allow the HydraSleeve to fill (it should fill in about 1 to 1.5 times the length of the HydraSleeve). This is analogous to coring the water column in the well from the bottom up.

   When the HydraSleeve is full, the top check valve will close. You should begin to feel the weight of the HydraSleeve on the tether and it will begin to displace water. The closed check valve prevents loss of sample and entry of water from zones above the well screen as the HydraSleeve is recovered.

5. Continue pulling the tether upward until the HydraSleeve is at the top of the well.

6. Decant and discard the small volume of water trapped in the Hydrasleeve above the check valve by turning the sleeve over.

## V. Sample Collection

**Note:** Sample collection should be done immediately after the HydraSleeve has been brought to the surface to preserve sample integrity.

1. Remove the discharge tube from its sleeve.

2. Hold the HydraSleeve at the check valve.

3. Puncture the HydraSleeve just below the check valve with the pointed end of the discharge tube

4. Discharge water from the HydraSleeve into your sample containers.

Control the discharge from the HydraSleeve by either raising the bottom of the sleeve, by squeezing it like a tube of toothpaste, or both.

5. Continue filling sample containers until all are full.

## Measurement of Field Indicator Parameters

Field indicator parameter measurement is generally done during well purging and sampling to confirm when parameters are stable and sampling can begin. Because no-purge sampling does not require purging, field indicator parameter measurement is not necessary for the purpose of confirming when purging is complete.

If field indicator parameter measurement is required to meet a specific non-purging regulatory requirement, it can be done by taking measurements from water within a HydraSleeve that is not used for collecting a sample to submit for laboratory analysis (i.e., a second HydraSleeve installed in conjunction with the primary sample collection HydraSleeve [see Multiple Sampler Deployment below]).

## Alternate Deployment Strategies

**Deployment in Wells with Limited Water Columns**

For wells in which only a limited water column exists to be sampled, the HydraSleeve can be deployed with an optional top weight instead of a bottom weight, which collapses the HydraSleeve to a very short (approximately 6” to 9”) length, and allows the HydraSleeve to fill in a water column only 36” to 45” in height.

**Multiple Sampler Deployment**

Multiple sampler deployment in a single well screen can accomplish two purposes:

- It can collect additional sample volume to satisfy site or laboratory-specific sample volume requirements.
- It can accommodate the need for collecting field indicator parameter measurements.
- It can be used to collect samples from multiple intervals in the screen to allow identification of possible contaminant stratification.

It is possible to use up to 3 standard 30” HydraSleeves deployed in series along a single tether to collect samples from a 10’ long well screen without collecting water from the interval above the screen.

The samplers must be attached to the tether at both the top and bottom of the sleeve. Attach the tether at the top with a stainless-steel clip (available from the manufacturer). Attach the tether at the bottom using a cable tie. The samplers must be attached as follows (figure 4):

- The first (attached to the tether as described above, with the weight at the bottom) at the bottom of the screen
- The second attached immediately above the first
- The third (attached the same as the second) immediately above the second

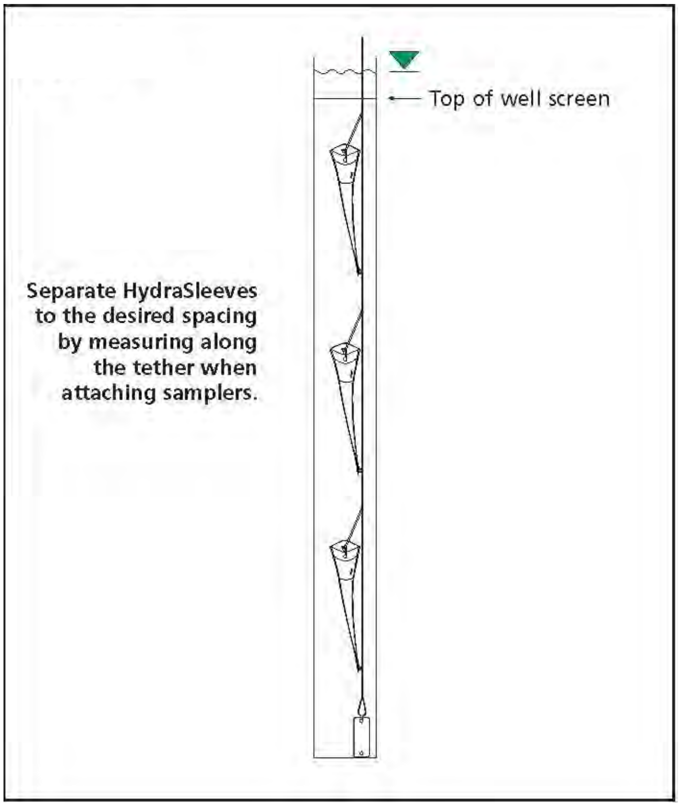



Figure 4. Multiple HydraSleeve deployment.

Alternately, the first sampler can be attached to the tether as described above, a second attached to the bottom of the first using a short length of tether (in place of the weight), and the third attached to the bottom of the second in the same manner, with the weight attached to the bottom of the third sampler (figure 5).

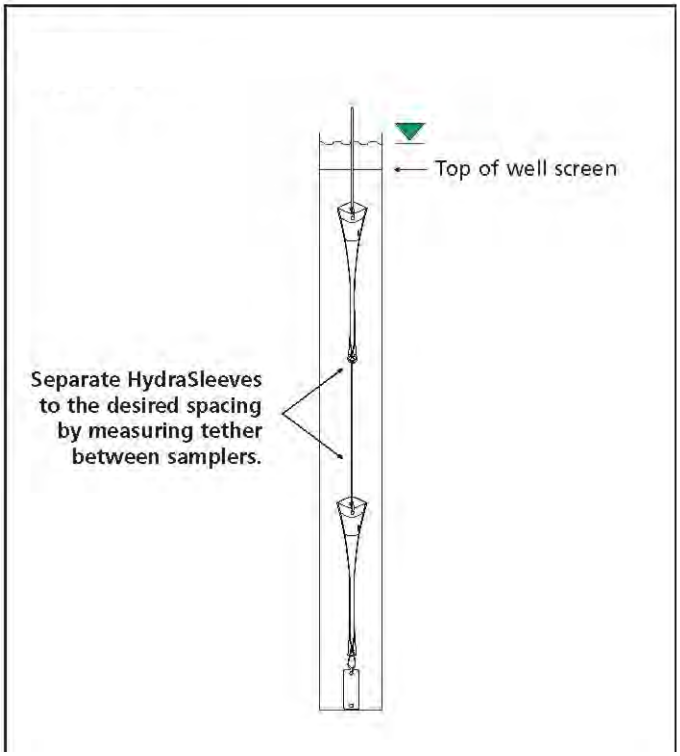



Figure 5. Alternative method for deploying multiple HydraSleeves.

In either case, when attaching multiple HydraSleeves in series, more weight may be required to hold the samplers in place in the well than would be required with a single sampler. Recovery of multiple samplers and collection of samples is done in the same manner as for single sampler deployments.

## Post-Sampling Activities

The recovered HydraSleeve and the sample discharge tubing should be disposed as per the solid waste management plan for the site. To prepare for the next sampling event, a new HydraSleeve can be deployed in the well (as described previously) and left in the well until the next sampling event, at which time it can be recovered.

The weight and weight clip can be reused on this sampler after they have been thoroughly cleaned as per the site equipment decontamination plan. The tether may be dedicated to the well and reused or discarded at the discretion of sampling personnel.

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