Golder Associates

# TECHNICAL MEMORANDUM

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**GROUNDWATER CONSERVATION ZONE MAPS FOR THE TANGGUH LNG FACILITY, WEST PAPUA**

## 1.0 BACKGROUND

### 1.1 Introduction

The BP Berau Ltd Tangguh LNG Facility (Tangguh LNG) is situated at Bintuni and Berau Bays in the "Birds Head" region of West Papua, Indonesia, about 3,000 kilometres east-north-east of Jakarta. As shown in **Figure 1** the facility is situated in a remote area with minimal local infrastructure and logistic support. The existing Tangguh LNG Facility Site Layout is shown in **Figure 2**.

Tangguh LNG is expanding its off-shore gas and on-shore site facilities. The proposed expansion will include the construction of two new LNG trains (which will be the 3rd and 4th trains at the LNG facility), associated on-shore receiving facilities, a new (2nd) LNG loading jetty and general cargo jetty, and the development of the ROA and WDA fields, together with associated transmission pipelines.

As part of the expansion, Tangguh LNG is proposing to use groundwater to replace or supplement the existing desalination system and has commenced investigation into the potential sustainable yield from deep aquifers below 150 m depth at the site. The ultimate operational water demand for all existing and currently proposed LNG trains at the Tangguh LNG Facility is estimated to be about 4,320 $m^3$/day (50 L/s), with a peak demand during construction of 8,500 $m^3$/day (or 95 L/s) for about 100 days. The LNG facility is expected to have an operational life of 25 years.

The use of groundwater was not permitted in the original Analisis Mengenai Dampak Lingkungan (AMDAL, 2002) however the use of groundwater has been included in the AMDAL to be submitted for the Tangguh Expansion Project.

The Ministry of Environment has requested that a Groundwater Conservation Zone (GCZ) map be included in the AMDAL for the Tangguh Expansion Project. The GZC map is to be prepared in accordance with the descriptions presented in *Indonesian Government Regulation 43 of 2008* titled *Groundwater,* and as per our Contract scope of work is limited to the LNG facility property boundary.

The LNG facility lies within the Kanoka-Babo groundwater basin as designated in Presidential Decree Keppres 26/2011. The basin covers parts of the three Kabupatens, namely those of Fak Fak, Teluk Bintuni and Teluk Wondamae Bintuni and has an area of 16,870 $km^2$.

This Technical Memorandum presents the GCZ maps developed for the Tangguh LNG facility. It also describes the information inputs for the generation of the GCZ maps for aquifers at and underlying the facility and includes our conceptual groundwater model for the property and surrounds which was used in the development of the GCZ maps.

It is understood that the GCZ maps presented in this Technical Memorandum will form preliminary input into the development of GCZ map(s) for the Kanoka-Babo groundwater basin by the governments of Teluk Bintuni, and possibly those of Fak Fak and Teluk Wondamae Bintuni as well.

## 1.2 Project Commission

The work described in this Technical Memorandum has been carried out under the terms and conditions of Contract No. 4420000665 (the Contract) between BP Berau Ltd and the consortium of Golder Associates (Golder) companies including PT. Geotechnical and Environmental Services Indonesia (GESI) and Golder Associates Pty Ltd (GAP).

Specifically the GCZ maps relate to the tasks described in the Contract Work Breakdown Structure (WBS) 9 titled *Groundwater Conservation Zone Mapping* whilst the information in this Technical Memorandum fulfils in part the reporting component to be included in the Preliminary Report described in WBS 10 of the Contract.

## 1.3 Depth References Used in this Technical Memoradum

All depths stated in this Technical Memorandum are referenced to ground surface (i.e. m below ground surface – m bgs). It is understood that, in the past, the aquifers of the Upper Steenkool Formation both beneath the LNG facility and beneath the villages of Saengga and Tanah Merah Baru have been defined on the basis of their depth beneath ground surface hence this system of has been used in this document for consistency.

# 2.0 INFORMATION SOURCES FOR THE GCZ MAP AND CONCEPTUAL HYDROGEOLOGICAL MODEL

The GCZ maps and accompanying conceptual hydrogeological model presented in this Technical Memorandum have been developed utilising data from a number of sources. These include:

- Published geological and hydrogeological maps and references for the Bintuni and greater “Birds Head” region of West Papua
- Discussions with hydrogeologists and senior staff from the Centre for Geological Survey of Indonesia regarding groundwater characteristics and information sources for the Bintuni Bay area and greater Kanoka-Babo groundwater basin
- Historical reports describing the geological, hydrogeological and hydrological setting at the LNG facility and immediate surrounds
- Historical reports describing the numerical modelling of predicted groundwater abstractions from the aquifer systems beneath the LNG facility
- Groundwater quality and water level information for each of the monitoring wells surrounding the organic waste pit, inert landfill, organic waste landfill and new inert and organic waste landfill at the LNG facility
- Groundwater salinity information from a number of oil and gas exploration boreholes for the lowermost 300 m of the Steenkool Formation, the Kais Formation and the Faumai Formation
- Copies of seismic reflection profiles for three sections passing through the LNG facility
- Site topography and drainage maps
- Locations of prior gas exploration and production wells constructed by Tangguh LNG and other companies including recent drilling by Genting within and adjacent to the Tangguh property
- Locations of additional seismic investigations/profiles within and adjacent to the Tangguh LNG facility property which may become available in the future for update of the GCZ maps, and
- Historical aerial photography and satellite imagery of the facility and the surrounding areas.

Further information regarding information sources, data availability and relevance to the development of the GCZ maps for the Tangguh LNG facility is presented in **Attachment A**.

## 3.0 CONCEPTUAL HYDROGEOLOGICAL MODEL

A conceptual hydrogeological model of the groundwater system beneath the site and indeed in much of the larger groundwater sub-basin in which the LNG facility is situated was prepared prior to the development of the GCZ maps. The key objectives of the conceptual model are to:

- characterise the geological setting at the site and in the greater groundwater sub-basin
- identify geological features which will likely influence groundwater flow characteristics
- identify key aquifer zones
- ascertain the likely recharge and discharge areas for the key aquifer zones
- ascertain the likely salinity of groundwater in the key aquifer zones beneath the site
- identify groundwater use at the LNG facility and surrounds, and
- identify areas of impacted groundwater and/or areas at the facility which may affect groundwater quality.

The conceptual hydrogeological model developed for the Tangguh LNG facility and surrounds is presented in **Attachment B**. Key features of the conceptual hydrogeological model include the following:

- The Tangguh LNG facility is located above a multi-layer aquifer system situated within the southern portion of the Bintuni Basin and in the northern portion of the regionally significant Kanoka-Babo groundwater basin.
- The Bintuni Basin sits within a deep Tertiary basement depression which (at its thickest) is dominated by a 4000 m accumulation of relatively immature and variably sorted sediments known as the Steenkool Formation.

  Beneath the LNG facility the Steenkool Formation is estimated (from seismic reflection traverses) to be about 2000 m thick. Seismic profiles show that the sedimentary pile is generally flat-lying to depths of about 500 m, however dips at about 2 or 3° to the southeast as the depth of the sedimentary pile increases. None of the seismic reflection sections beneath and immediately surrounding the Tangguh property suggest the presence of any regional or local-scale folding in the Steenkool Formation.

  Copies of three seismic reflection profiles showing the inferred thickness and structural orientation of the Steenkool, Kais and Faumai Formations beneath the Tangguh property and surrounds is shown on **Figure 3**. A diagrammatic prepared by Tangguh LNG showing the inferred structural orientation of these formations passing north – south beneath the Tangguh property and Bintuni Bay is shown on **Figure 4**.
- The Kanoka-Babo groundwater basin is delineated by the accumulation of Miocene to Quaternary-aged sediments in the southern portion of the Bintuni Basin, the most notable of which is the Steenkool Formation.

  According to the Papua Island Groundwater Basin Map Sheet 11 the average annual recharge of the unconfined aquifers in the Kanoka-Babo groundwater basin has been estimated to be about 11,267 M $m^3$ (360,000 L/s).

  Average annual recharge of the confined aquifers has been estimated to be about 558 M $m^3$ (17,700 L/s).
- The Tangguh LNG facility is situated in a watershed sub-basin at the northern end of the Kanoka-Babo groundwater basin. The sub-basin is bound by Bintuni Bay to the north, east, and north-west, and surface water catchment divides to the south, south-east and south-west. It has an area of about 750 $km^2$ (i.e. 75,000 ha) of which the Tangguh property occupies an area of 3200 ha (i.e. 32 $km^2$).

  Assuming rainfall and recharge are relatively similar across the Kanoka-Babo groundwater basin the average annual recharge of the unconfined aquifers in the watershed sub-basin is about 500 M $m^3$ (about 16,000 L/s) whilst annual recharge of the confined aquifers in the watershed sub-basin is about 25 M $m^3$ (about 800 L/s).

  The location of the Kanoka-Babo groundwater basin and the sub-basin in which the Tangguh LNG facility is situated is shown on **Figure 5**.

- The Steenkool Formation is underlain by the Kais and Faumai Formations. Both of these formations comprise regionally significant limestone units of the New Guinea Limestone Supergroup and form the basement units of the Bintuni Basin and Kanoka-Babo groundwater basin beneath and surrounding the LNG facility (**Figures 3 and 4**).
- Beneath the north-western portion of the Tangguh property there are five major subdivisions within the upper 300 m of the Steenkool Formation. From youngest to oldest these are:

  1) a clay-dominant layer with thickness ranging between about 10 and 60 m
  2) an 'upper' sand-dominant layer with thickness ranging between 60 to 90 m
  3) a clay-dominant layer which with thickness ranging between about 130 and 250 m and appears to thicken to the east
  4) a 'lower' sand dominant layer with thickness ranging between about 30 and 70 m and appears to thin to the east, and
  5) a clay-dominant layer of unknown thickness.

  An alluvial sequence, which lines the valley floors throughout the area and is of variable lithology and thickness, is also situated around the northern, eastern and parts of the southern boundary of the site.

  It is noted that the geological profile beneath the northwestern corner of the Tangguh property to depths of about 300 m is relatively well known from the number of groundwater exploration initiatives in this area; these initiatives have included exploration drilling, well installation and surface and downhole geophysical surveys. The geological and hydrogeological setting between 300 and 600 m depth beneath the Tangguh property has been inferred from seismic reflection profiles traversing the property and surrounds.
- Several faults have been either mapped or inferred at the Tangguh LNG facility. Most are located in the north-western portion of the property, are orientated either north-west to south-east or north-east to south-west, and are inferred by Baynes Geologic (2006) to be strike-slip faults.

  The Fak Fak 1:250,000 scale geological map sheet suggests that two faults are located to the south of the Tangguh LNG facility. These are:

  - a 10 km long east-west trending fault about 1 km south of the facility, and
  - an 8 km long north-west – south-east trending fault situated about 10 km south of the facility.

  Both of these faults are postulated to be small-displacement, left-lateral motion strike-slip faults, with neither expected to be a significant barrier to groundwater flow.
- Three 'layered' aquifer zones have been identified to depths of 300 m beneath the Tangguh LNG facility and surrounding area. These are:

  1) a number of unconfined aquifers associated with Quaternary deposits at elevations typically less than 15 m throughout the area, most notably within valleys and gullies along the eastern, north-western and south-western portions of the site; the shallow hand-dug community wells at Saengga and Tanah Merah Baru are thought to have been completed in these aquifers
  2) a series of confined aquifers generally between about 30 and 150 m depth: these are the aquifers screened within the community groundwater supply wells at Saengga and Tanah Merah Baru and are referred to as the the 'upper Steenkool aquifers' in this Technical Memorandum), and
  3) a series of confined aquifers between about 200 and 300 m depth: these are the aquifers that may be screened within any groundwater abstraction wells installed at the Tangguh LNG facility property and are referred to as the 'lower Steenkool aquifers' in this Technical Memorandum.

- A section showing inferred aquifer and aquitard distribution in the Steenkool Formation beneath the north-western portion of the site are presented in **Figure 6**.

  The depth, thickness and continuity of the aquifer and aquitard units shown on **Figure 6** were estimated from vertical electrical (resistivity) sounding traverses in the northwestern corner of the Tangguh LNG facility by Badan Pengkajian dan Penerapan Teknologi (BPPT) following recalibration of the data set with the geological and down-hole geophysical profiles from the 'Slim Hole' drilled near the northern boundary of the property. Yellow and orange layers on these sections represent inferred sand and gravel-dominant units of the Steenkool Formation respectively, both of which form productive aquifers beneath the site. Green layers on these sections coincide with clay-dominant units of the Steenkool Formation; these are inferred to be regionally significant aquitards.

  The geological and geophysical logs for the previous groundwater investigation boreholes drilled at the LNG facility, trial groundwater pumping well TW-2, and the community water supply wells at Tanah Merah Baru and Saengga infer that aquifer and aquitard units to depths of 150 m in the Steenkool Formation are generally continuous beneath the north-western portion of the LNG facility (**Figure 7**). These logs also suggest that the aquifer targeted for use in the community water supply wells dips very gently to the east and may also thin in this direction.

  The geological log for the Slim Hole indicates that the sand-dominant unit between about 260 and 295 m depth in this borehole is separated from the aquifer used in the community water supply wells at Saengga and Tanah Merah Baru by a clay-dominant unit of the Steenkool Formation which, in the vicinity of the Slim Hole, is over 100 m thick.

  The inferred hydrogeological setting between the community supply well at Saengga (in the southwest) and the Slim Hole (in the east) beneath the northwestern portion of the LNG facility is shown on **Figure 7**.

- Confined aquifer zones are separated by what are anticipated to be regionally significant aquitards ranging between about 10 and 200 m thick. These aquitards are expected to be leaky although the magnitude of any leakage is not known.

- Individual aquifers within the larger aquifer zones are expected to comprise either homogeneous and anisotropic or (more commonly) heterogeneous and anisotropic water-bearing units. In both situations, permeability is expected to be similar within horizontal layers (i.e. $K_x \approx K_y$), however permeability across layers ($K_z$) is expected to be significantly smaller, possibly by an order of magnitude or more.

- Interpreted aquifers and aquitards to depths of about 500 m are generally flat-lying with groundwater flow controlled by the elevation of recharge and discharge areas.

- Recharge areas for the 'upper' and 'lower' confined aquifers in the Steenkool Formation are located as close as 5 km and as far as about 40 km to the south and south-west of the facility where sand-dominant Steenkool Formation outcrops (see insert in lower-left corner of **Figure 8**).

- Groundwater flow in the confined aquifers of the Steenkool Formation is expected to be to the north or north-west of the facility beneath Bintuni Bay with possible discharge to:

  (i) Bintuni Bay via faults or structural highs where the sand-dominant units of the Steenkool Formation may rise towards the base of the bay, or

  (ii) further to the west and ultimately the Banda Sea.

- Groundwater salinity in the unconfined aquifers within the alluvial deposits at the LNG facility is expected to be low. However, occurrences of saline water are expected in these aquifers along the coastal fringe of the Tangguh property, particularly at depth.

  Groundwater resources in the unconfined aquifers are expected to be suitable for agricultural, industrial, ecological or possibly domestic purposes although are expected to be susceptible to contamination – albeit in differing degrees – from a number of on-site activities.

There are four lined landfills for inert and organic waste on site which have the (albeit low) potential for leachate to seep to the shallow perched aquifers and unconfined aquifers. These landfills are subject to detailed monitoring by independent external laboratories as part of the AMDAL commitments in the Environmental Monitoring Plan (i.e. the RPL) for the LNG facility. Landfill locations are shown on **Figure 2** and **Figure 8**.

Historically shallow groundwater at (the former) Tanah Merah well was contaminated by domestic effluent and ablutions. Shallow community wells in Tanah Merah Baru and Saennga are also contaminated as described in the draft AMDAL for the Tangguh Expansion Project.

- Groundwater in the upper 150 m of the Steenkool Formation is of low salinity (based on available data) and appears suitable for potable use.

  Groundwater samples collected from the community supply wells screened to depths of up to 150 m have total dissolved solid contents (TDS) less than 300 mg/L whilst major ion chemistry suggests the flushing of more saline water from these aquifers. Groundwater from these wells is used for domestic purposes which is understood to include potable use.

  PT ERM Indonesia (ERM) indicate that information from the single point resistance and spontaneous potential geophysical logging of the Slim Hole suggests that groundwater in the 'lower Steenkool aquifers' is of low salinity and is likely to have TDS concentrations typically less than 500 mg/L.

  The location of the fresh water / saline water interface in these aquifers is not known. For aquifers within the Steenkool Formation to depths of about 600 m it is considered that the fresh water / saline water interface will lie beneath Bintuni Bay. Beyond 600 m depth it is anticipated the interface will progressively move inland beneath the LNG facility.

Further details regarding the conceptual hydrogeological model used in the development of the GCZ maps (including figures showing the model domains and visual representation of the groundwater setting at both regional and local scales) are presented in **Attachment B**.

# 4.0 DEVELOPMENT OF THE GCZ MAPS

## 4.1 GCZ MAP Objectives

The GCZ maps presented in this Technical Memorandum were prepared in accordance with Paragraph 3 Article 24 (Determination of Conservation Zones) of *Indonesian Government Regulation 43 of 2008 Groundwater*. As such the objective of the GCZ maps is to provide information regarding:

- zones of groundwater protection covering groundwater recharge, and
- zones of groundwater utilization, which will outline the safe, vulnerable, critical and damaged zones.

In accordance with the Scope of Work presented in Exhibit B-1 of Contract No. 4420000665 the GCZ maps are limited to the Tangguh LNG facility property boundary.

## 4.2 Aquifer Zones and GCZ Maps

From the information presented in **Section 3.0** and **Attachment B** it is evident that:

- the LNG facility is situated above a multi-layered aquifer system
- several of the aquifer zones beneath the Tangguh property have similar (albeit different) hydrogeological characteristics, most importantly recharge and discharge areas, and
- groundwater resources in the two confined aquifer zones in the Steenkool Formation beneath the Tangguh property have or will be allocated for different uses, namely:

- groundwater resources in those aquifers between about 30 and 150 m bgs are protected from groundwater abstraction at the Tangguh property under the conditions in the Environmental Management Plan and Environmental Monitoring Plan (i.e. the RKL and RPL) and the AMDAL for the Tangguh Expansion Project in order to protect community access to potable quality water from these 'accessible' aquifers (as such these groundwater resources are embargoed from further abstraction beneath the Tangguh property), whilst

- groundwater resources in aquifers between 150 and 600 m bgs are proposed to be developed for the Tangguh LNG Expansion project.

  Should any additional demands be placed on this aquifer by other users (e.g. new industry or new gas exploration) then the cumulative impact will need to be assessed before additional groundwater allocations can be approved.

Considering the hydrogeological setting above, two GCZ maps have been produced for the LNG facility covering groundwater occurrences at different depths, namely in:

- the unconfined aquifers hosted within the Quaternary alluvial sediments and perched and confined aquifers in the Steenkool Formation between 30 m above ground surface (ags) and 150 m bgs – GCZ Map 1, and
- confined aquifers in the Steenkool Formation between 150 and 600 m bgs – GCZ Map 2.

Development of the two GCZ maps is thought to best represent the different recharge mechanisms, discharge mechanisms and groundwater use from the relevant aquifer zones beneath the LNG facility and allow for more appropriate management of the groundwater resources in these aquifers.

## 4.3 Groundwater Quality Beneath the LNG Facility

The quality of groundwater resources in the aquifer zones beneath the LNG facility is a primary consideration in the delineation of potential groundwater utilisation zones and the development of the GCZ maps for a nominated area. In the case of the Tangguh LNG facility, groundwater in those aquifers to depths of at least 600 m is expected to have salinities less than 1000 mg/L (and as low as 500 mg/L to depths of about 300 m). Salinity though is expected to increase with depth.

Provisionally it is inferred that groundwater salinities will be less than about 1000 mg/L to 600 m depth.

An overview of groundwater quality (most importantly salinity) in each of the aquifers identified beneath the Tangguh property in the Steenkool Formation to 600 m depth is outlined as follows.

Unconfined Alluvial and Perched Aquifers in the Steenkool Formation

Groundwater salinity in the unconfined alluvial and perched aquifers in the Steenkool Formation is not known; it is though expected to be low given the anticipated high rainfall recharge rates and groundwater fluxes in these aquifers.

Occurrences of saline water are likely in these aquifers along the coastal fringe of the Tangguh property, particularly at depth beneath the fresh water / saline water interface. It is recognised though that there may be some variation in groundwater quality with fresh groundwater resources likely in sands and gravels with 'poorer' quality water (albeit not necessarily unusable) possibly associated with clay-rich units and the presence of any acid-sulphate soils in these sediments.

Monitoring of shallow groundwater around the landfills at the LNG facility [which are lined with high-density polyethylene (i.e. HDPE) liners and have subsurface leachate collection systems] has shown no evidence of groundwater contamination. Some concentrations of dissolved metals exceeding Indonesian government specified concentrations regarding the suitability of water quality have been identified in several groundwater monitoring wells to date, however these are considered to be indicative of natural background conditions rather than landfill-impacted groundwater.

Copies of tables summarising the groundwater quality monitoring analytical results for each groundwater monitoring well surrounding the organic waste pit, inert landfill, organic waste landfill and new inert and organic waste landfill is presented in **Attachment C**. The location of these landfill facilities and accompanying monitoring wells are shown on **Figure 2** and **Figure 8.**

Low-pH groundwater (typically about pH 2 to 3) was observed draining from what are thought to be perched aquifers in the Steenkool Formation during the construction of Temporary Construction Camp No. 2. The groundwater was thought to become acidic following the partial draining and subsequent oxidation of groundwater and sediments in these aquifers following excavations for a number of embankments in this area. Acid sulphate soils were also exposed during cut and fill operations for the construction of Train 1 and Train 2.

There is no known information regarding the quality of groundwater in these aquifers beneath the LNG infrastructure at the Tangguh LNG facility.

Confined Aquifers in the Steenkool Formation Between 30 and 150 m bgs

Groundwater in the confined aquifers in the Steenkool Formation between 30 and 150 m bgs is typically of good quality and of low salinity. These resources are used as a potable water supply in the villages of Tanah Merah Baru and Saengga and have been used in the past for potable water purposes at the former Tangguh LNG survey and construction camps at Tanah Merah.

Four groundwater samples were collected from test abstraction well TW-2 installed (albeit now lost) in the northwestern corner of the Tangguh property. Analytical results indicated that the samples had total dissolved solid contents (TDS) concentrations of between 350 and 400 mg/L, dissolved iron concentrations of about 0.8 mg/L, dissolved manganese concentrations typically less than 0.1 mg/L, and ammonia concentrations up to about 4 mg/L.

It is noted though that the screens in this well were not aligned with the targeted aquifers during well construction and the well also produced significant amounts of silt during development; this suggests that the targeted aquifer zones may not have been sufficiently isolated and that the groundwater sampled may have been impacted by other waters. This groundwater though is considered suitable for potable use, however concentrations of ammonia and iron may preclude the use of this water for potable purposes on aesthetic considerations (taste, precipitation of iron from solution etc).

Groundwater samples collected from the community supply wells in the villages of Tanah Merah Baru and Saengga situated to the west and south-west of the Tangguh property typically had TDS concentrations less than 300 mg/L, dissolved iron concentrations typically less than about 0.3 mg/l, and dissolved manganese concentrations less than 0.1 mg/L. This groundwater is considered suitable for domestic purposes however the concentration of dissolved iron may occasionally preclude the use of this water for potable use given adverse taste issues. It is noted however that the groundwater from the deeper community wells developed in the same aquifer interval as TW-2 (refer to the hydrogeological section shown in **Figure 7**) have not returned elevated iron or ammonia concentrations and it is probable that the results from TW-2 were anomalous.

Major ion chemistry in TW-2 and several of the community supply wells indicated that the groundwater in these aquifers is sodium and bicarbonate dominant. This suggests that the 'freshening' of groundwater resources in these aquifers may be occurring with fresh groundwater under high hydraulic pressure from recharge areas to the south and southwest of the LNG facility flushing (possibly) connate seawater from these aquifers.

There is no information regarding the location of the fresh water / saline water interface in this aquifer zone. Given the major ion chemistry in TW-2 and several of the community supply wells though it is considered that the fresh water / saline water interface is located to the north or northwest of these wells, most likely beneath Bintuni Bay.

Confined Aquifers in the Steenkool Formation Between 150 and 600 m bgs

Information regarding groundwater salinity in the 'lower Steenkool aquifers' is limited to single point resistance measurements collected during the geophysical logging of the Slim Hole in the northwestern portion of the property; these measurements extend between ground surface and 300 m depth. ERM indicate that these measurements suggest groundwater in these aquifers to depths of 300 m typically have TDS concentrations less than 500 mg/L, whilst it is inferred by Tangguh LNG's Technical Advisor that groundwater in those aquifers between 300 and 600 m depth are likely to have salinities less than 1000 mg/L. As such groundwater in this depth range is expected to be suitable for industrial, agricultural, and ecological use, and may be suitable for domestic use including potable use.

Again the location of the fresh water / saline water interface in this aquifer is not known, however is likely to be located further to the north and northwest of the Tangguh LNG facility.

Potential Confined Aquifers in the Steenkool Formation below 600 m bgs

There is no information regarding groundwater salinity in any confined aquifers in the Steenkool Formation below 600 m bgs. It is inferred though that salinity will increase with depth in these aquifers.

Again the location of the fresh water / saline water interface in this aquifer is not known, however is likely to be located further to the north and northwest of the Tangguh LNG facility.

## 4.4 Groundwater Utilisation

### 4.4.1 Current Groundwater Utilisation at the Facility

The use of groundwater resources was not permitted in the original AMDAL for the LNG facility. As such groundwater is not currently being abstracted or used at the Tangguh property.

It is noted though that the AMDAL being prepared for the Tangguh Expansion Project will include the use of groundwater during both the construction and ongoing operation phases of the LNG facility. In light of the embargo excluding the use of groundwater resources between 30 and 150 m bgs in the Steenkool Formation beneath the Tangguh property for purposes other than community water supply, Tangguh LNG propose to abstract groundwater resources in the deeper aquifer zones between 150 and 600 m bgs within the Steenkool Formnation. As such the aquifers between these depths may become groundwater utilisation zones with groundwater abstraction the subject of issuance of a formal abstraction permit by the Bintuni government.

### 4.4.2 Potential Utilisation of Groundwater Resources Beneath the Facility

As mentioned in **Section 4.3** groundwater between 30 m ags and 150 m bgs in the Steenkool Formation beneath the Tangguh property is likely to be suitable for potable use; indeed these groundwater resources are used for domestic use (which is understood to include potable use) in a number of community water supply wells to the west and south-west of the property. As such it is considered unlikely that there will be any limitations on the use of these groundwater resources on the basis of water quality, however it is noted that these resources beneath the Tangguh property are embargoed from further abstraction in order to protect potable water supplies for the villages of Tanah Merah Baru and Saengga. As such utilisation of these resources is not permitted.

Groundwater in those aquifer zones between 150 and 600 m bgs in the Steenkool Formation appears to be of low salinity. Although groundwater samples have not yet been collected from these aquifer intervals to confirm this, it is likely that these groundwater resources will be suitable for agricultural, industrial, ecological and possibly domestic purposes.

Groundwater resources below 600 m depth are likely to be saline with salinity increasing with depth. As such the use of these groundwater resources is likely to be limited primarily to the possible disposal of drill cuttings and mud as well as potential disposal of produced water.

### 4.4.3 Potential Utilisation of Groundwater Resources Surrounding the Facility

Groundwater resources in the Steenkool Formation to a depth of at least 300 m bgs are considered suitable for a wide range of uses, the most notable being domestic purposes. In stating this however, these groundwater resources are expected to be targeted primarily by growing palm oil plantations to the south of the facility coupled possibly with groundwater abstraction associated with any future LNG facilities developed in the groundwater sub-basin. Both of these could comprise exhaustive groundwater abstraction activities which may:

- impact on other groundwater users in the groundwater sub-basin, including BP, and
- influence the development of groundwater use policy in the Kanoka-Babo groundwater basin.

Groundwater abstraction from the Steenkool Formation aquifers for domestic purposes is not expected to impart a significant impact in groundwater resources. However, such abstraction may have a significant influence on the development of groundwater policy in the Kanoka-Babo groundwater basin with the implementation of additional groundwater embargo zones possible in those areas close to where new or existing community groundwater wells have been installed.

The Faumai Formation and possibly (albeit less likely) the Kais Formation may be impacted by the reinjection of drill cuttings from any future oil and gas boreholes drilled throughout the area. Groundwater in these formations though is typically saline hence no adverse impacts on these resources are anticipated.

## 4.5 Identification of Groundwater Recharge and Conservation Zones

Groundwater conservation zones (i.e. groundwater recharge areas) at the Tangguh property are broadly divided into two groups. These are:

1. unconfined aquifers associated with the alluvial deposits along the rivers and streams which originate at and cross the LNG facility, and
2. perched aquifers in the upper 30 m or so of the Steenkool Formation.

Both of these aquifer groups are recharged via rainfall infiltration across their surface outcrops, whilst the alluvial aquifers are also recharged by stream flow and flood events.

Both of these recharge zones are shown on **Figure 8** (GCZ Map 1).

Given the 'layered' hydrogeological setting throughout the greater area it is considered that there are no groundwater recharge mechanisms at the Tangguh property for the confined aquifer zones in the Steenkool Formation. Rather groundwater in the confined aquifers is expected to flow beneath the Tangguh property from recharge areas to the south and southwest of the property (i.e. from those areas where sand-dominant units of the Steenkool Formation are known to outcrop) to discharge areas to the north and/or northwest of the LNG facility. This mechanism is shown by the aquifer 'inflow' fluxes along the southern boundary of the facility for the confined aquifers beneath 30 m bgs on the GCZ maps presented in **Figures 8 and 9** (i.e. GCZ Map 1 and GCZ Map 2 respectively).

## 4.6 Identification of Groundwater Discharge Zones

Given the topographical and hydrogeological setting in the Bintuni Basin coupled with the structural orientation of the aquifers beneath the Tangguh property, groundwater discharge zones are expected to be associated with one of two groundwater flow systems:

1. groundwater flow in the unconfined aquifers hosted within alluvial deposits and perched aquifers in the upper 30 m or so of the Steenkool Formation, and
2. groundwater flow in the confined aquifers in the Steenkool Formation.

The location of groundwater discharge zones for both of these flow systems are governed by the groundwater flow direction in these aquifers and down-gradient outcrops. In both systems this is expected to be to the north and/or northwest of the facility however there may be some variation outlined as follows.

Unconfined Alluvial and Perched Aquifers in the Steenkool Formation

Groundwater flow directions in the unconfined alluvial aquifers and perched aquifers in the Steenkool Formation at the Tangguh property are expected to vary significantly. Flow directions in these aquifers are expected to be governed by the local topographic setting with locally significant hills and ridges delineating local groundwater divides. As such groundwater at higher elevations in localised catchments is expected to flow roughly perpendicular to nearby groundwater divides, and is expected to change and generally conform with surface water flow directions at lower elevations. There may also be a northerly flow-component in this system aligning with the regional influence of topography on groundwater flow, particularly at lower elevations.

Groundwater discharge from the unconfined aquifers hosted within alluvial deposits and perched aquifers in the upper 30 m or so of the Steenkool Formation in the eastern portion of the property is expected to flow in a northerly direction along the eastern boundary of the site before discharging from the north-eastern boundary of the property (i.e. discharging to Bintuni Bay). Localised groundwater discharge at springs and seeps though may also occur where geological and topographical conditions are favourable.

Groundwater in the unconfined aquifers hosted within alluvial deposits and perched aquifers in the upper 30 m or so of the Steenkool Formation in the central and western portions of the LNG facility is expected to flow to the south and south-west (i.e. towards and to the south of Tanah Merah Baru) where it will likely discharge to either Texas Creek and (ultimately) the Saengga River to the west of the Tangguh property. Again localised groundwater discharge at springs and seeps though may also occur where geological and topographical conditions are favourable.

Shallow groundwater along most (if not all) the northern boundary of the property is expected to discharge to Bintuni Bay.

Surface water sub-catchments, expected groundwater flow directions and discharge zones from these aquifers at the property are shown on **Figure 8** (GCZ Map 1).

<u>Aquifers Between Ground Surface and 600 bgs in the Steenkool Formation</u>

The groundwater flow direction associated with the aquifers in the Steenkool Formation is expected to be consistent irrespective of depth. Based on the information presented in the conceptual hydrogeological model, these aquifers are confined beneath the Tangguh property hence there are no active groundwater discharge mechanisms <u>at the property</u>. Rather groundwater is expected to flow beneath the Tangguh property from recharge areas to the south and southwest to discharge areas further to the north and/or northwest of the facility. This mechanism is shown by the aquifer 'outflow' fluxes along the northern boundary of the facility on the GCZ maps presented in **Figures 8 and 9** (namely GCZ Map 1 and GCZ Map 2 respectively).

## 4.7 Delineation of Groundwater Utilisation Zones

In accordance with Paragraph 3 Article 24 (Determination of Conservation Zones) of *Indonesian Government Regulation 43 of 2008 Groundwater,* utilisation of groundwater resources from an aquifer needs to be ascertained in order to determine safe, vulnerable, critical and damaged zones.

For the production of the GCZ maps presented in this Technical Memorandum the following descriptions have been used for the delineation of groundwater utilisation zones.

- Safe – groundwater resources that are not over-abstracted or under threat of over-abstraction, nor has groundwater quality been impacted or is likely to be impacted by anthropogenic activities and/or influences.
- Vulnerable – sustainable yields are likely to be low, with current groundwater abstraction close to or possibly exceeding the sustainable yield of the aquifer, or groundwater quality may be impacted by anthropogenic activities and/or non-direct influences.
- Critical – groundwater abstraction exceeds the sustainable yield and/or groundwater quality is impacted by anthropogenic activities and/or non-direct influences. Improvement in groundwater quality and/or recovery of groundwater resources likely though if these groundwater resources were more appropriately management.
- Damaged – groundwater resources under duress due to abstraction in excess of sustainable yields and/or groundwater quality significantly impacted by anthropogenic activities. Recovery of useable groundwater resources or improvement in groundwater quality unlikely.

Safe, vulnerable, critical and damaged groundwater zones identified for each of the aquifer zones beneath the Tangguh property are outlined as follows.

<u>Unconfined and Perched Aquifers Between 30 m asl and 30 m bgs (GCZ Map 1 – **Figure 8**)</u>

- Safe zones – no zones identified.
- Vulnerable zones – three vulnerable groundwater utilisation zones have been identified at the Tangguh property:
  1. those areas of the property underlain by alluvial deposits
  2. those areas of the property underlain by clay-dominant units of the Steenkool Formation which host perched and/or locally significant semi-confined aquifers, and

3. groundwater beneath and down-gradient of the organic waste pit, inert landfill, organic waste landfill and new inert and organic waste inert and organic waste landfill.

Groundwater hosted within the alluvial deposits and perched aquifers in the Steenkool Formation are considered vulnerable groundwater utilisation zones given that:

- groundwater resources in these aquifers are expected to be minimal and have very low sustainable – if not unsustainable – yields
- groundwater in these aquifers beneath active areas of the Tangguh property is expected to be vulnerable to pollution from site infrastructure, site activities or incidents, including:
  - the accidental release of aqueous products (e.g. hydrocarbons) in areas where spillage control cannot be adequately managed
  - leakage from infrastructure at the LNG facility (including sewage) and chemical storage areas
  - migration of leachate from the landfill facilities, and
  - the use of herbicides and/or pesticides at the facility.
- use of or interference with these groundwater resources may result in the oxidation of any sulphides in these aquifers and the subsequent generation of acidic groundwater conditions.

Groundwater beneath and down-gradient of the organic waste pit, inert landfill, organic waste landfill and the new inert and organic waste landfill is considered to be potentially vulnerable to leachate emanating from these facilities. Monitoring of shallow groundwater around these facilities (which are either single or double lined with high-density polyethylene liners and have subsurface leachate collection systems) though has shown no evidence of groundwater contamination. Some regulatory exceedences of dissolved metal concentrations have been noted in the groundwater quality monitoring data set generated to date, however these are considered to be indicative of natural background conditions and not leakage from the landfills.

If the migration of leachate is expected following future groundwater monitoring events then the groundwater utilisation classification in this area would change to either Critical or Damaged depending on the magnitude of contamination and the effectiveness of potential remedial and/or management options to negate ongoing impacts on groundwater quality and useability.

- Critical zones – no zones identified.
- Damaged zone – no zones identified, however it is noted that there is no information regarding groundwater quality beneath and in the vicinity of the LNG processing facility.

Confined Aquifers in the Steenkool Formation Between 30 and 150 m bgs (GCZ Map 1 – **Figure 8**)

- Safe zones – no zones identified.
- Vulnerable zones – groundwater resources in these aquifers beneath the Tangguh property are embargoed prohibiting further groundwater abstraction. On this basis these groundwater resources are considered to be classified as vulnerable groundwater utilisation zones in recognition of their protected status.

  It is recognised this classification been applied in light of the conservative protection of these aquifers as opposed to any known or anticipated reasons regarding the abstraction of groundwater at rates that may exceed the safe yield of these aquifers and/or known or likely impacts on groundwater quality.
- Critical zones – no zones identified.
- Damaged zone – no zones identified.

Confined Aquifers in the Steenkool Formation Between 150 and 600 m bgs (GCZ Map 2 – **Figure 9**)

- Safe zones – no zones identified.
- Vulnerable zones – the expectation of reasonably high yielding aquifers coupled with anticipated low salinity groundwater and no known abstraction from these aquifers (at the Tangguh property) make these groundwater resources a viable target for use at the LNG facility. It is recognised however that these groundwater resources may also be an attractive option for other future industrial activities near the Tangguh property.

  If other parties are granted permits to abstract groundwater from these aquifers in close proximity to the Tangguh property then this may result in the over-abstraction of these groundwater resources resulting in reduced yields, increasing salinity and potential land subsidence issues.

  Given the above groundwater resources in these confined aquifers are classified as a vulnerable groundwater utilization zone.
- Critical zones – no zones identified.
- Damaged zone – no zones identified.

## 4.8 Groundwater Conservation Zone Maps

GCZ maps for the selected aquifer zones in the Steenkool Formation are presented in the following figures:

- GCZ Map 1 **Figure 8** – unconfined and perched aquifers between 30 m asl and -150 m bgs, and
- 150GCZ Map 2 **Figure 9** – confined aquifers between 150 and 600 m bgs.

When referring to the groundwater utilization zones shown on **Figures 8 and 9** reference should be made to each of the groundwater utilization descriptions detailed in **Section 4.7** of this Technical Memorandum.

# 5.0 CONCLUDING COMMENTS

If you have any comments or queries about the above please feel free to contact Craig Wicenciak or Geoff Perryman in our Jakarta office.

For and on Behalf of

**CONSORTIUM OF PT GEOTECHNICAL AND ENVIRONMENTAL SERVICES INDONESIA (GESI)**

**AND GOLDER ASSOCIATES PTY LTD (GAP)**

G. E. Perryman

| | |
|---|---|
| Craig Wicenciak | Geoff Perryman |
| Hydrogeologist | Associate, Project Manager |

CBW / DB GEP / cbw

**FIGURES**



**ATTACHMENTS**



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| | CHECKED BY<br>CW | DATE<br>15/04/2014 | | |
| | SCALE<br>NTS | SHEET SIZE<br>A4 | PROJECT No 138716004 · DOC No 013 · DOC TYPE F · FIGURE No 1 · REVISION 0 | FIGURE 1 |

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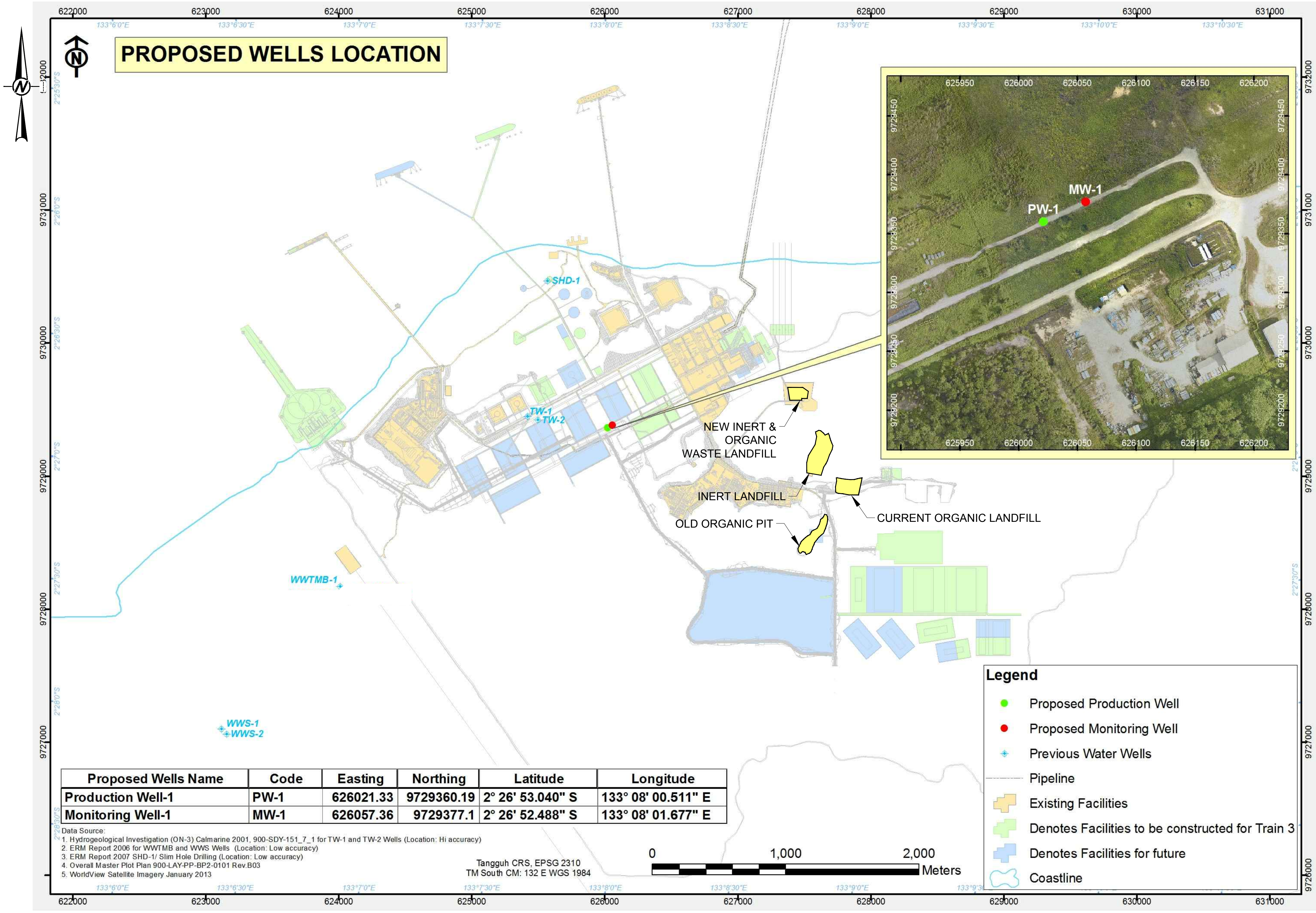


| Proposed Wells Name | Code | Easting | Northing | Latitude | Longitude |
|---|---|---|---|---|---|
| Production Well-1 | PW-1 | 626021.33 | 9729360.19 | 2° 26' 53.040" S | 133° 08' 00.511" E |
| Monitoring Well-1 | MW-1 | 626057.36 | 9729377.1 | 2° 26' 52.488" S | 133° 08' 01.677" E |

Data Source:
1. Hydrogeological Investigation (ON-3) Calmarine 2001, 900-SDY-151_7_1 for TW-1 and TW-2 Wells (Location: Hi accuracy)
2. ERM Report 2006 for WWTMB and WWS Wells (Location: Low accuracy)
3. ERM Report 2007 SHD-1/ Slim Hole Drilling (Location: Low accuracy)
4. Overall Master Plot Plan 900-LAY-PP-BP2-0101 Rev.B03
5. WorldView Satellite Imagery January 2013

**Legend**
- Proposed Production Well
- Proposed Monitoring Well
- Previous Water Wells
- Pipeline
- Existing Facilities
- Denotes Facilities to be constructed for Train 3
- Denotes Facilities for future
- Coastline

SOURCE : BP BERAU LTD

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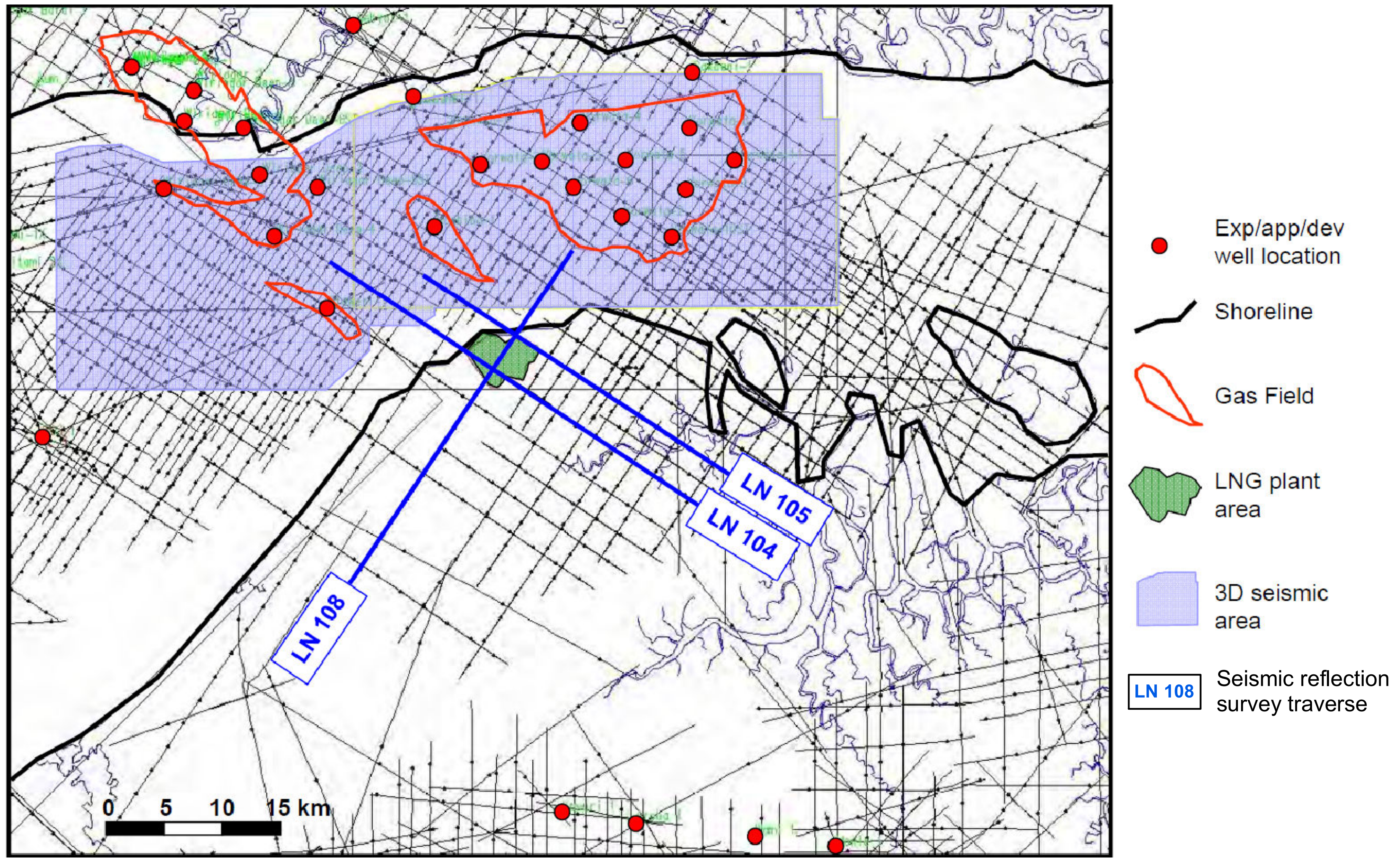
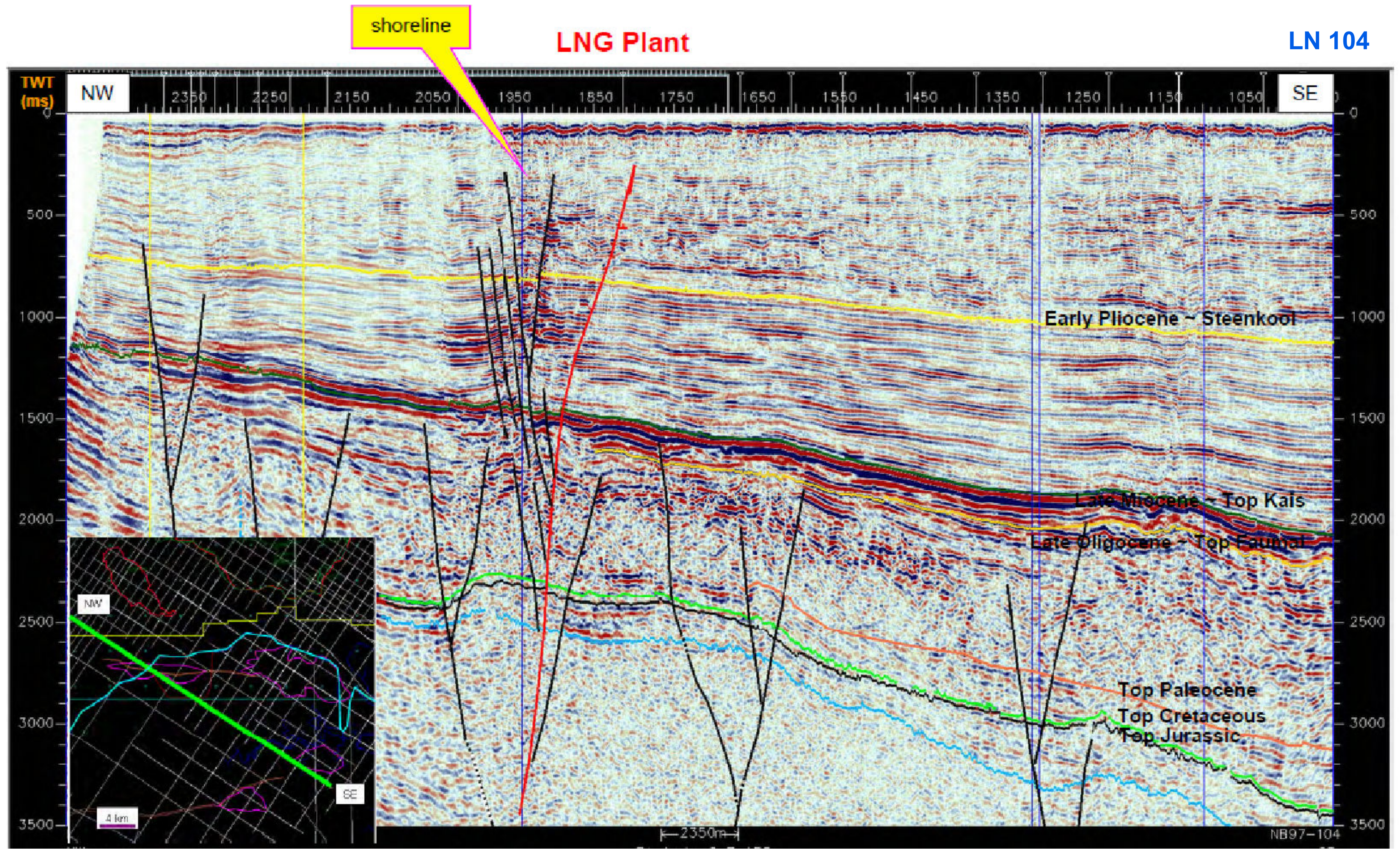
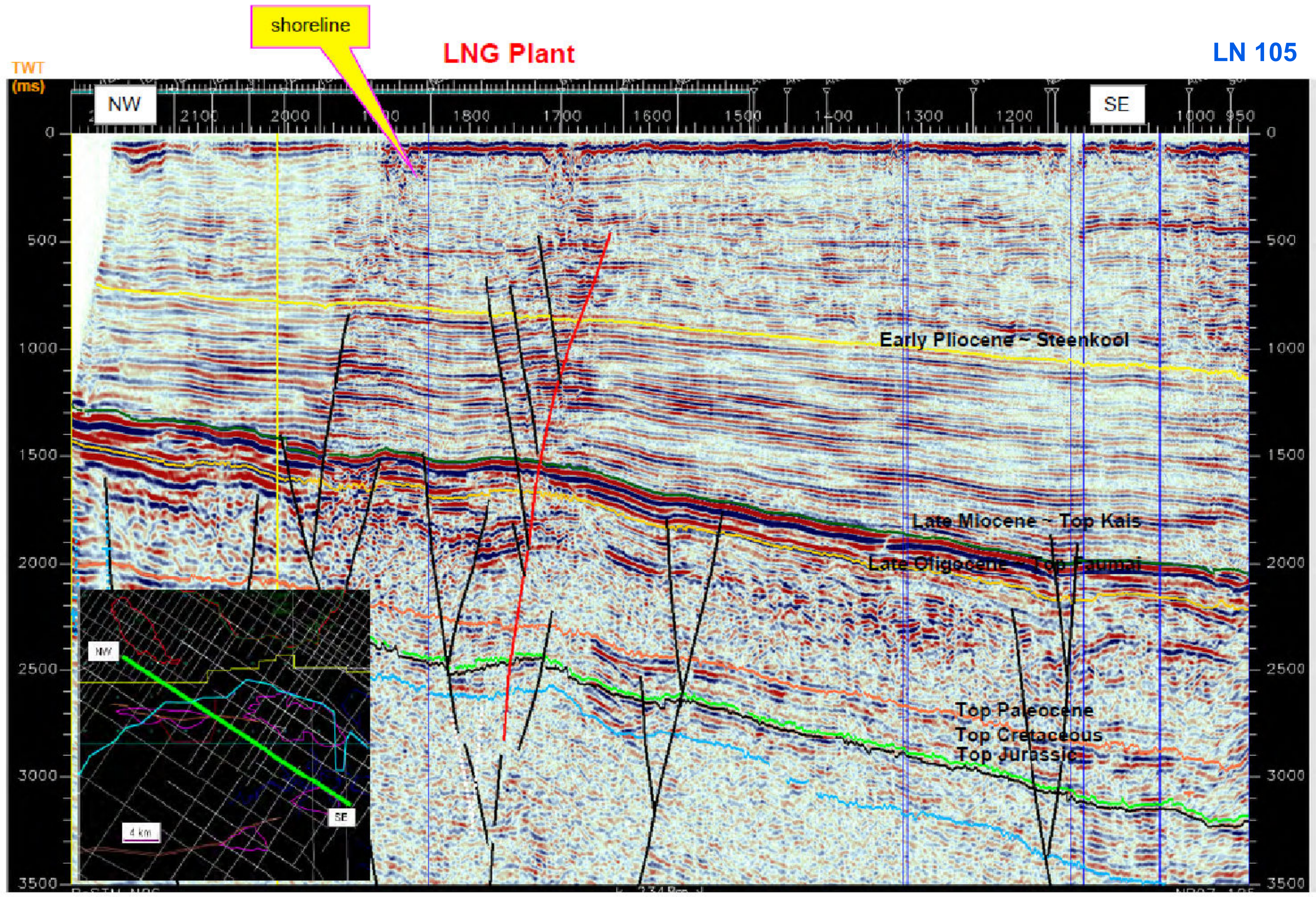
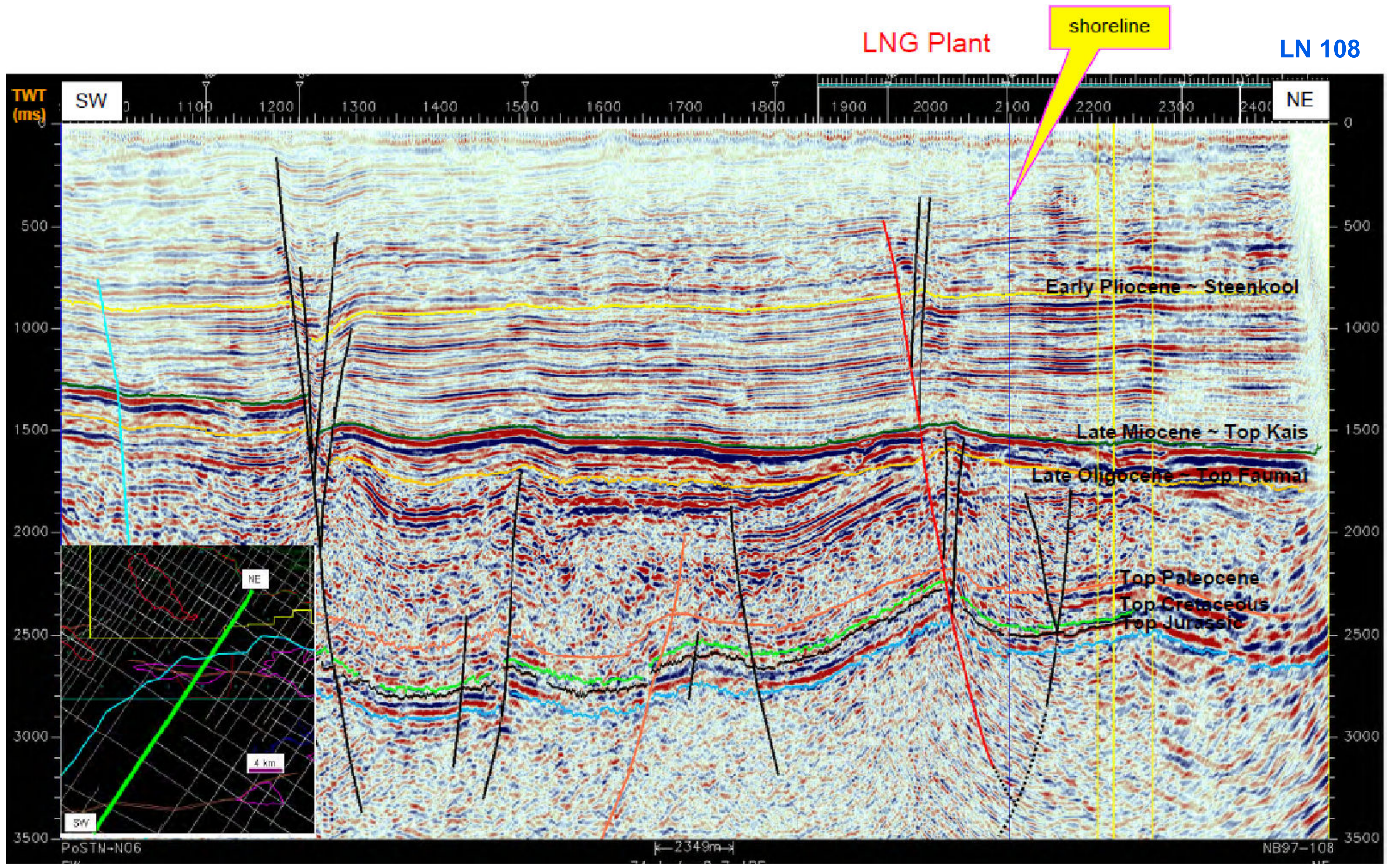
Plot Date: 15 April 2014 Time:2:11:58 PM By: Dwi Lestari, Nuryati Path: J:\Water\2013\138716004-BP Tangguh\08Technical Doc\CAD\Figures - File Name:138716004-013-F-002-Rev1-SiteLayout.dwg
Xref: GAP_LOGO-A3.dwg; proposed water wells.jpg; Well Location Figure 2a.jpg;




SOURCE : TANGGUH LNG

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| | DRAWN BY<br>NDL | DATE<br>5/03/2014 | DRAWING TITLE<br>SEISMIC REFLECTION PROFILES SHOWING INFERRED THICKNESS AND STRUCTURAL ORIENTATION OF THE STEENKOOL, KAIS AND FAUMAI FORMATIONS BENEATH THE TANGGUH PROPERTY AND SURROUNDS |
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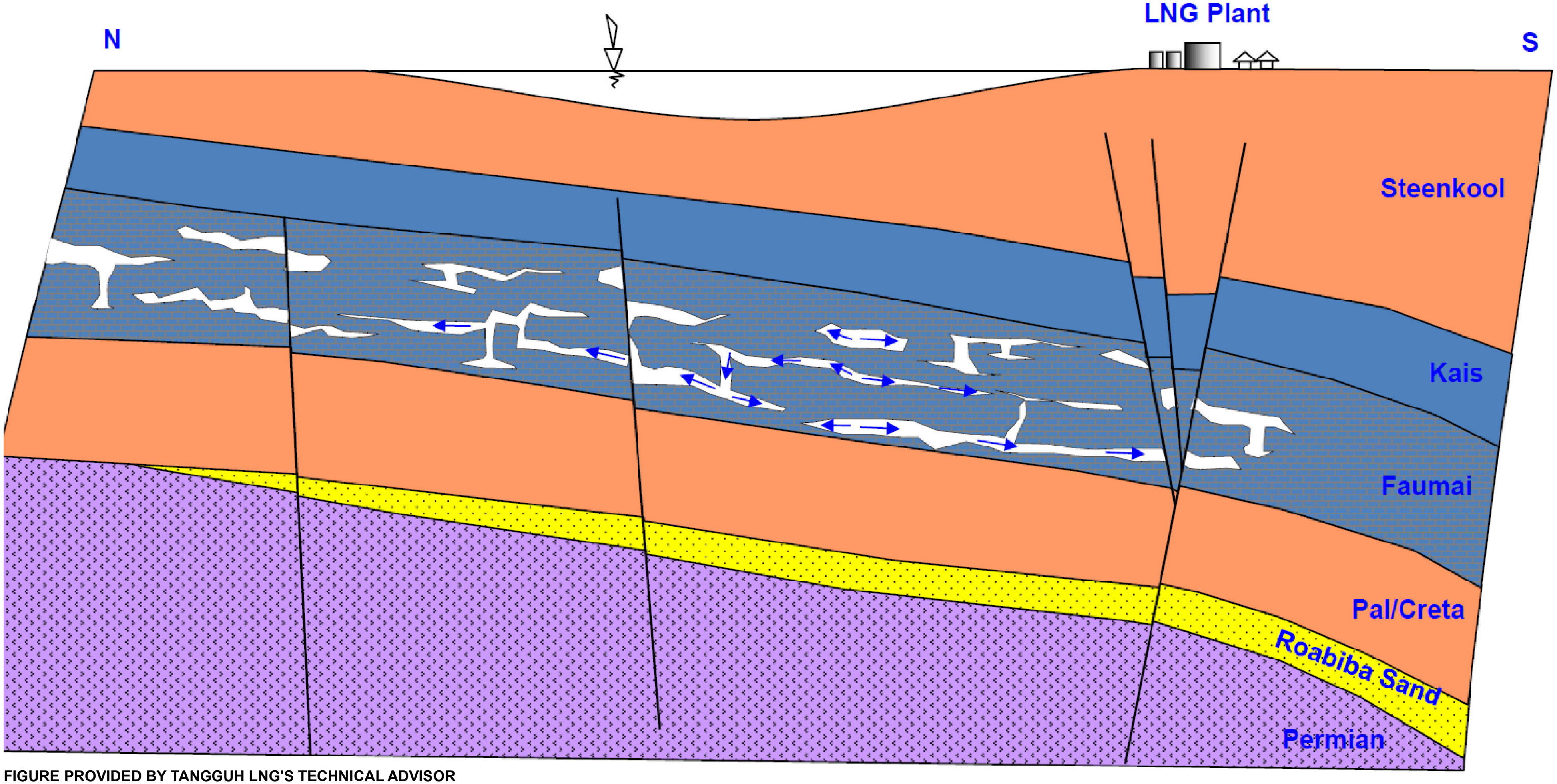


FIGURE PROVIDED BY TANGGUH LNG'S TECHNICAL ADVISOR

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| | DRAWN BY<br>NDL | DATE<br>5/03/2014 | DRAWING TITLE<br>GEOLOGICAL INTERPRETATION BENEATH<br>THE TANGGUH LNG FACILITY AND BINTUNI BAY | |
| | CHECKED BY<br>CW | DATE<br>5/03/2014 | | |
| | SCALE<br>NTS | SHEET SIZE<br>A4 | PROJECT No 138716004 \| DOC No 013 \| DOC TYPE F \| FIGURE No 04 \| REVISION 0 | FIGURE 4 |

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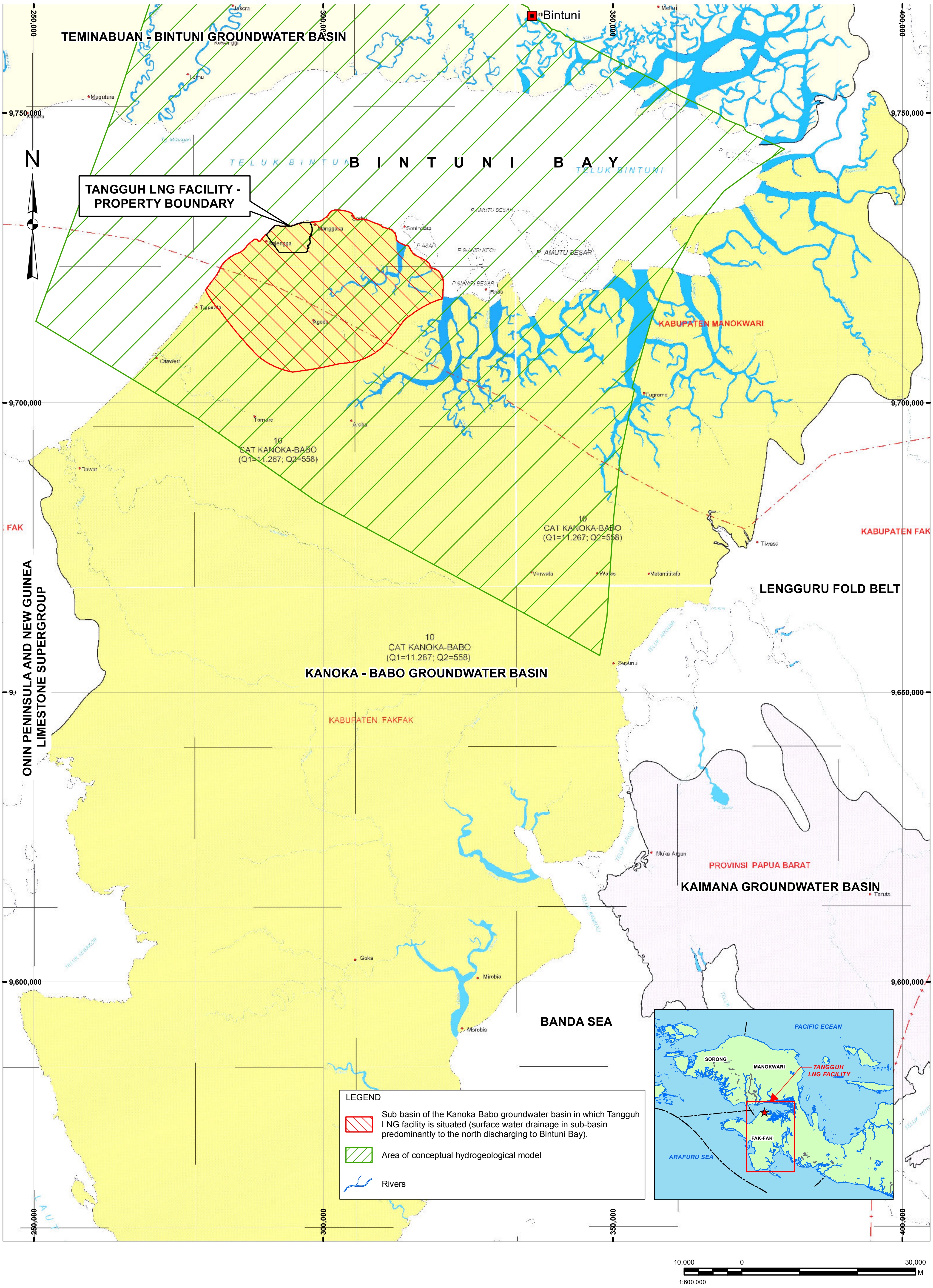


NOTE

Q1 = estimate of total recharge of unconfined aquifers in the Kanoka-Babo Groundwater Basin ( M $m^3$/year).

Q2 = estimate of total recharge of confined aquifers in the Kanoka-Babo Groundwater Basin ( M $m^3$/year).

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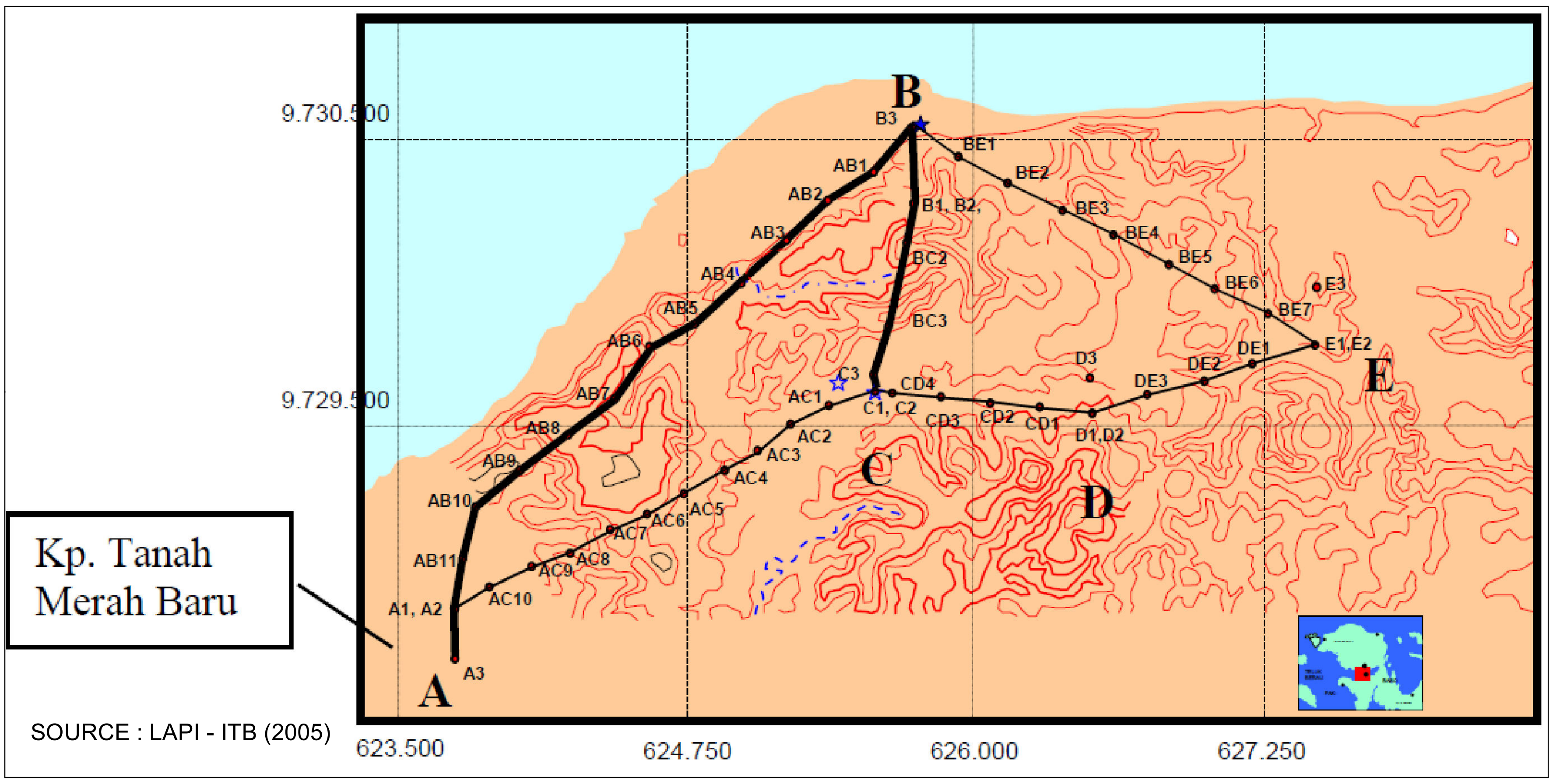
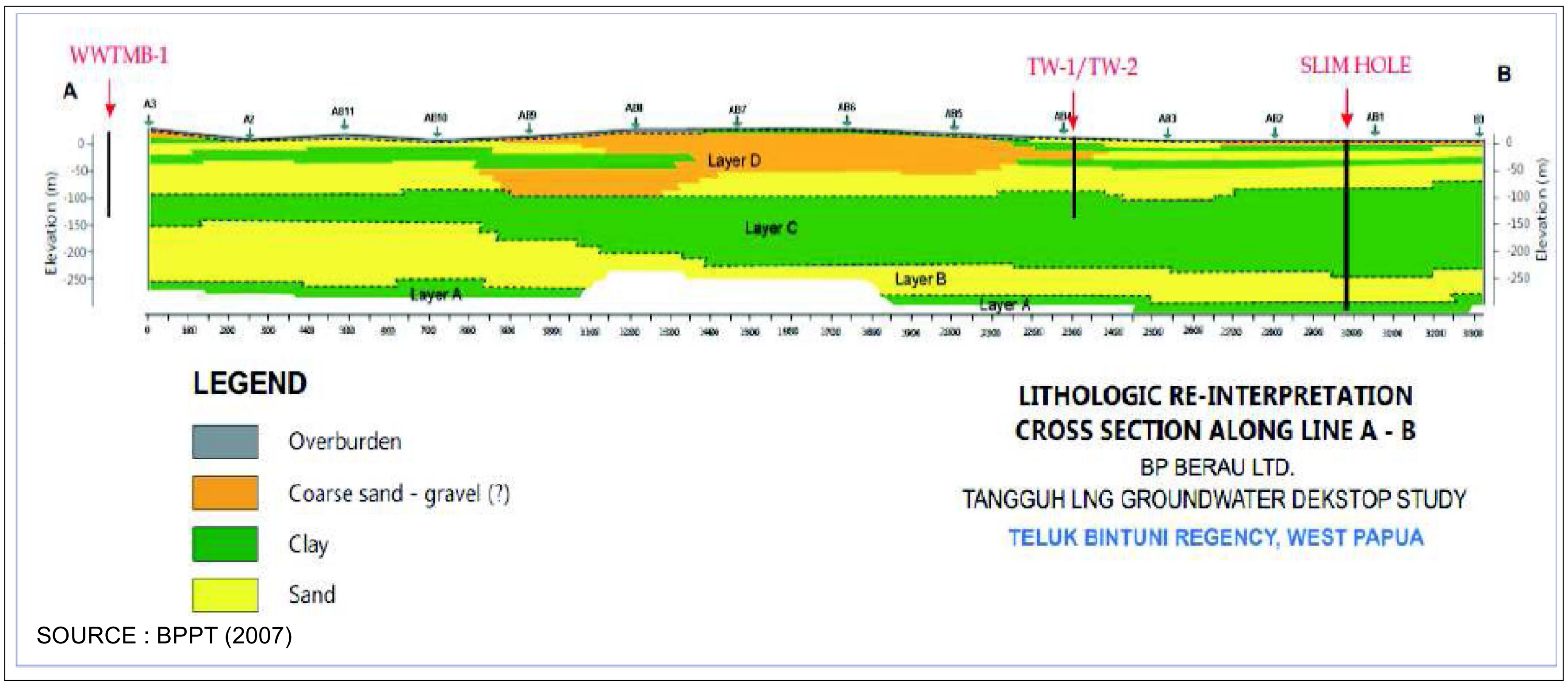
| DRAWN BY: NDL | DATE: 15/04/2014 | DRAWING TITLE: LOCATION OF THE KANOKA-BABO GROUNDWATER BASIN AND TANGGUH LNG FACILITY SUB-BASIN | |
| CHECKED BY: CW | DATE: 15/04/2014 | | |
| SCALE: 1:600,000 | SHEET SIZE: A3 | PROJECT No: 138716004 | DOC No: 013 / DOC TYPE: F / FIGURE No: 05 / REVISION: 0 / FIGURE 5 |




6 (a) Location of geo-electric survey traverses in the northwestern portion of the Tangguh LNG Facility.




6 (b) Inferred lithological section from BPPT along geo-electric survey traverse A-B.

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| | CHECKED BY: CW | DATE: 15/04/2014 | | |
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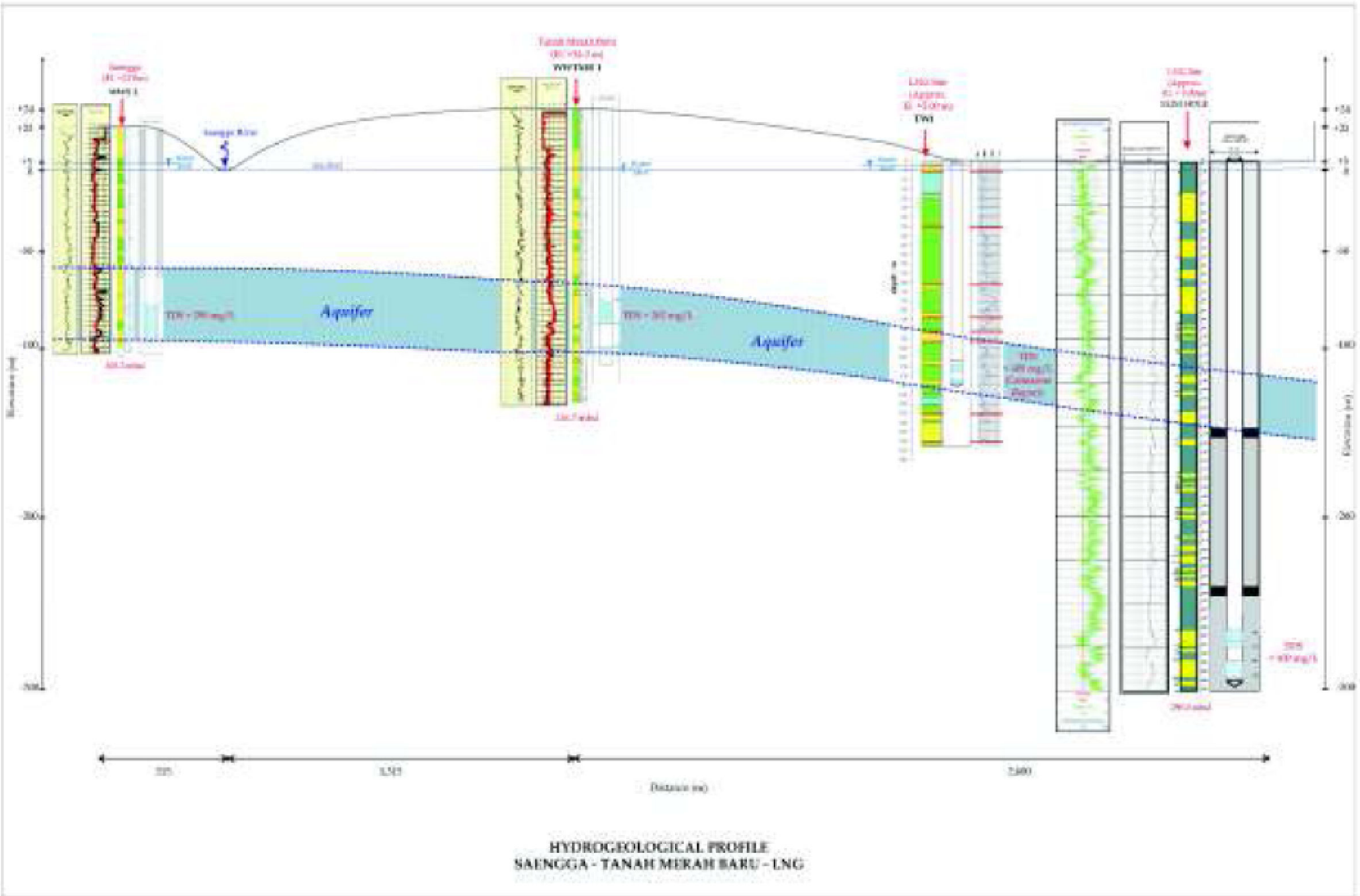


SOURCE : ERM (2008)

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| | DRAWN BY<br>NDL | DATE<br>5/03/2014 | DRAWING TITLE<br>INFERRED HYDROGEOLOGICAL PROFILE FROM THE COMMUNITY SUPPLY WELL AT SAENGGA IN THE SOUTHWEST AND THE SLIMHOLE IN THE EAST BENEATH THE NORTHWESTERN PORTION ON THE LNG FACILITY | |
| | CHECKED BY<br>CW | DATE<br>5/03/2014 | | |
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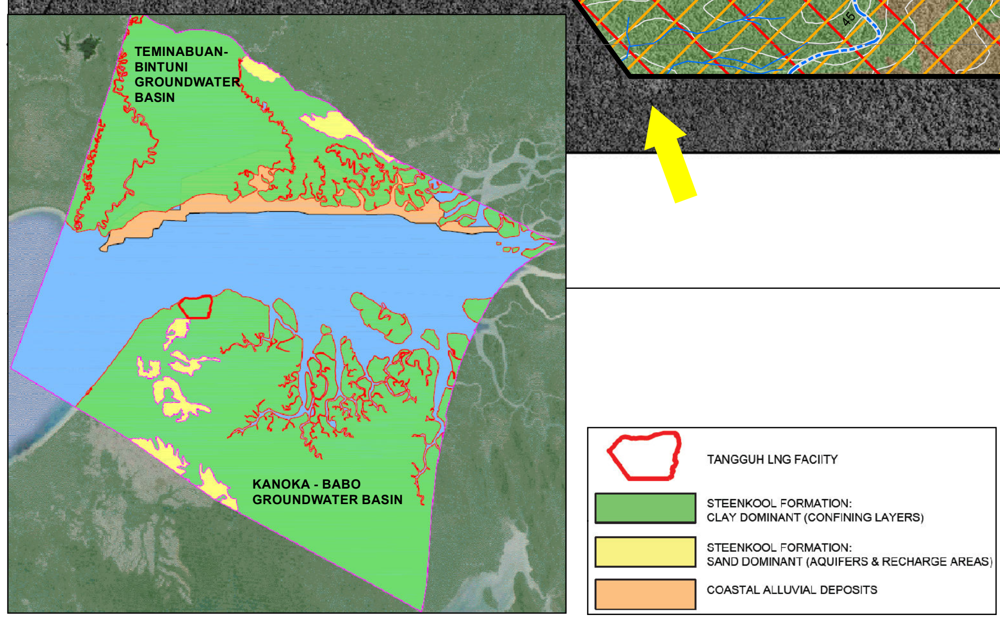


## LEGEND

- Tangguh LNG Facility - Property Boundary
- MW-1 Proposed groundwater monitoring well to be screened in the Steenkool Formation aquifer zones between 30 and 150 m bgs.
- PW-1 Proposed test groundwater production well to be screened in the Steenkool Formation in aquifer zones between 150 and 400 m bgs.
- Slim Hole Groundwater investigation borehole drilled into the aquifer zones between 150 and 400 m bgs in the Steenkool Formation.
- Groundwater investigation borehole drilled into the aquifer zones between 30 and 150 m bgs in the Steenkool Formation.
- Test groundwater production well screened in the Steenkool Formation in aquifer zones between 30 and 150 m bgs.
- Comunity groundwater supply well screened in aquifer zones between 30 and 150 m bgs in the Steenkool Formation.
- Groundwater monitoring well screened in clay dominant Steenkool Formation between 30 m msl and -10 m msl.
- Provisional location for groundwater production well.
- Collar, alignment and termination point of Genting oil and gas exploration borehole.
- Surface waterway
- Surface water catchment divide
- Likely dominant groundwater flow direction in alluvial and perched aquifers in the Steenkool Formation.
- Vertical electrical sounding traverse
- Groundwater recharge area and conservation zone: unconfined alluvial aquifers.
- Groundwater recharge and conservation zone : perched aquifers in the Steenkool Formation.
- Groundwater discharge areas for shallow aquifers between 30 m msl and -30 m msl Steenkool Formation.
- Landfill locations

**GROUNDWATER UTILISATION ZONE CLASSIFICATION**

- VULNERABLE
- Groundwater recharge/ conservation zone and abstraction embargo zone / Steenkool Formation aquifers between 30 and 150 m bgs.
- Groundwater inflow into the zones aquifers in the Steenkool Formation between 30 and 150 m bgs beneath the property (recharge areas to the south and southwest of the Tangguh LNG Facility). Likely groundwater flow direction shown by orientation of arrows.
- Groundwater outflow from the aquifer intervals between 30 and 150 m bgs in the Steenkool Formation (discharge areas likely to be to the north, northwest or west of the Tangguh LNG Facility). Likely groundwater flow direction shown by orientation of arrows.

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| | DRAWN BY: NDL | DATE: 5/03/2014 | DRAWING TITLE: GROUNDWATER CONSERVATION ZONE MAP 1 : SHALLOW AQUIFERS IN THE STEENKOOL FORMATION BETWEEN 30 M AGS AND 150 M BGS AT THE TANGGUH LNG FACILITY | | | | | |
| | CHECKED BY: CW | DATE: 5/03/2014 | | | | | | |
| | SCALE: 1:30,000 | SHEET SIZE: A2 | PROJECT No: 138716004 | DOC No: 013 | DOC TYPE: F | FIGURE No: 08 | REVISION: 0 | FIGURE 8 |

SOURCE : TANGGUH LNG

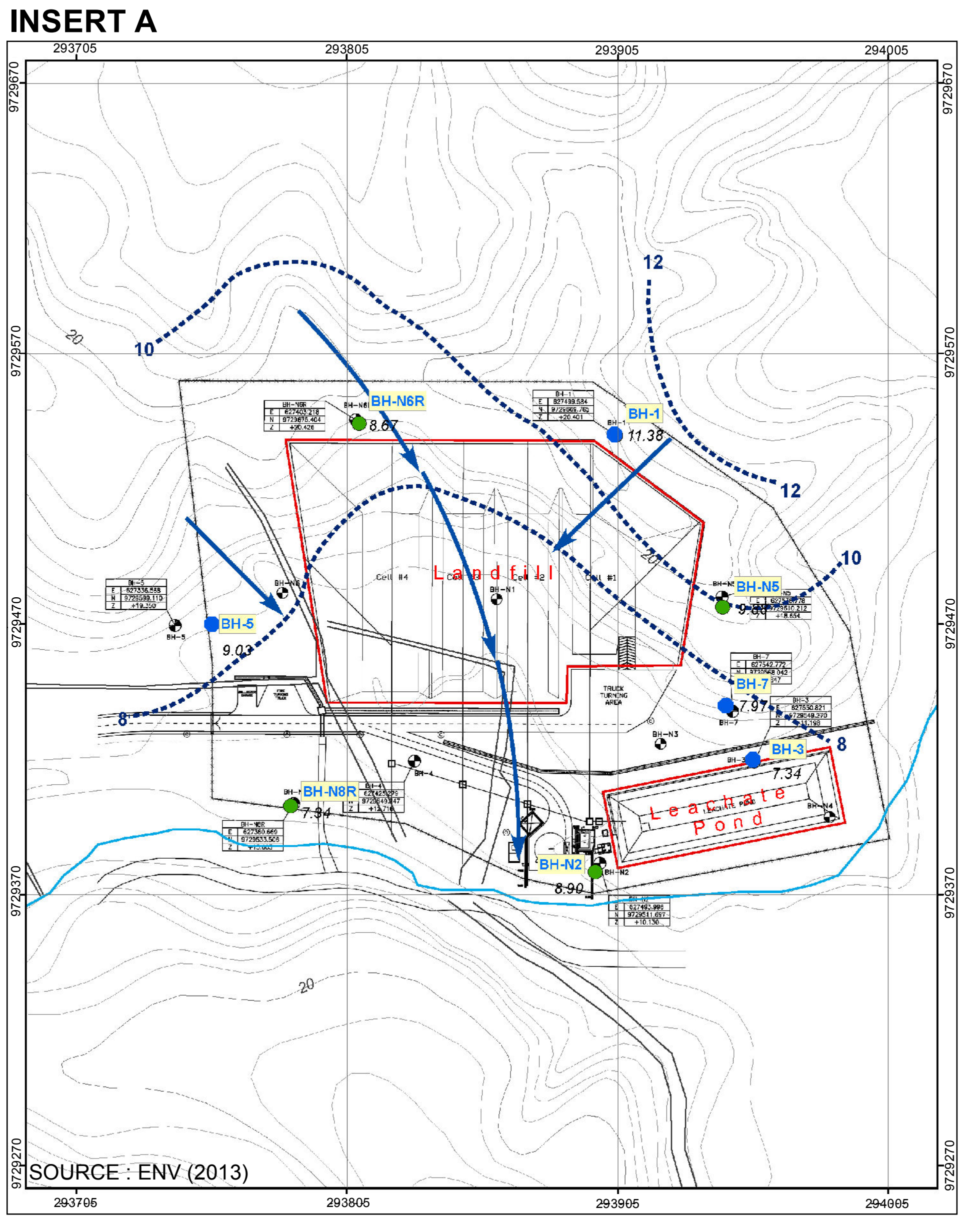
**Groundwater monitoring wells at the old & current organic landfills and the inert landfill**


**Coordinates for ITB Vertical Electrical (Resistivity) Sounding Locations, 2004**

| VES name | Easting (mE) | Northing (mN) | Elevation (m msl) |
|---|---|---|---|
| A1 | 290161.3 | 9728313.7 | 8.3 |
| A2 | 290161.3 | 9728313.7 | 8.3 |
| A3 | 290175.6 | 9728068.6 | 28.6 |
| AB1 | 291982.1 | 9730216.3 | 4.8 |
| AB10 | 290239.4 | 9728759.5 | 4.7 |
| AB11 | 290184.7 | 9728538.6 | 18.5 |
| AB2 | 291780.7 | 9730081.9 | 3.0 |
| AB3 | 291588.7 | 9729910.9 | 3.5 |
| AB4 | 291382.2 | 9729751.4 | 9.9 |
| AB5 | 291183.6 | 9729589.2 | 17.0 |
| AB6 | 290981.4 | 9729453.0 | 28.5 |
| AB7 | 290820.5 | 9729253.2 | 28.5 |
| AB8 | 290619.0 | 9729083.6 | 26.6 |
| AB9 | 290413.5 | 9728932.1 | 14.4 |
| AC1 | 291790.7 | 9729231.7 | 18.7 |
| AC10 | 290312.6 | 9728406.0 | 4.9 |
| AC2 | 291626.2 | 9729123.7 | 20.0 |
| AC3 | 291470.6 | 9729023.6 | 10.3 |
| AC4 | 291310.0 | 9728925.7 | 13.5 |
| AC5 | 291152.3 | 9728829.5 | 25.7 |
| AC6 | 290978.1 | 9728740.1 | 30.5 |
| AC7 | 290809.2 | 9728670.9 | 17.5 |
| AC8 | 290640.8 | 9728590.7 | 9.0 |
| AC9 | 290478.9 | 9728502.5 | 12.4 |
| B1 | 292182.6 | 9730075.2 | 28.2 |
| B2 | 292142.6 | 9730075.2 | 28.2 |
| B3 | 292147.2 | 9730413.0 | 1.7 |
| BC1 | 292142.6 | 9730075.2 | 28.2 |
| BC1 | 292142.6 | 9730075.2 | 28.2 |

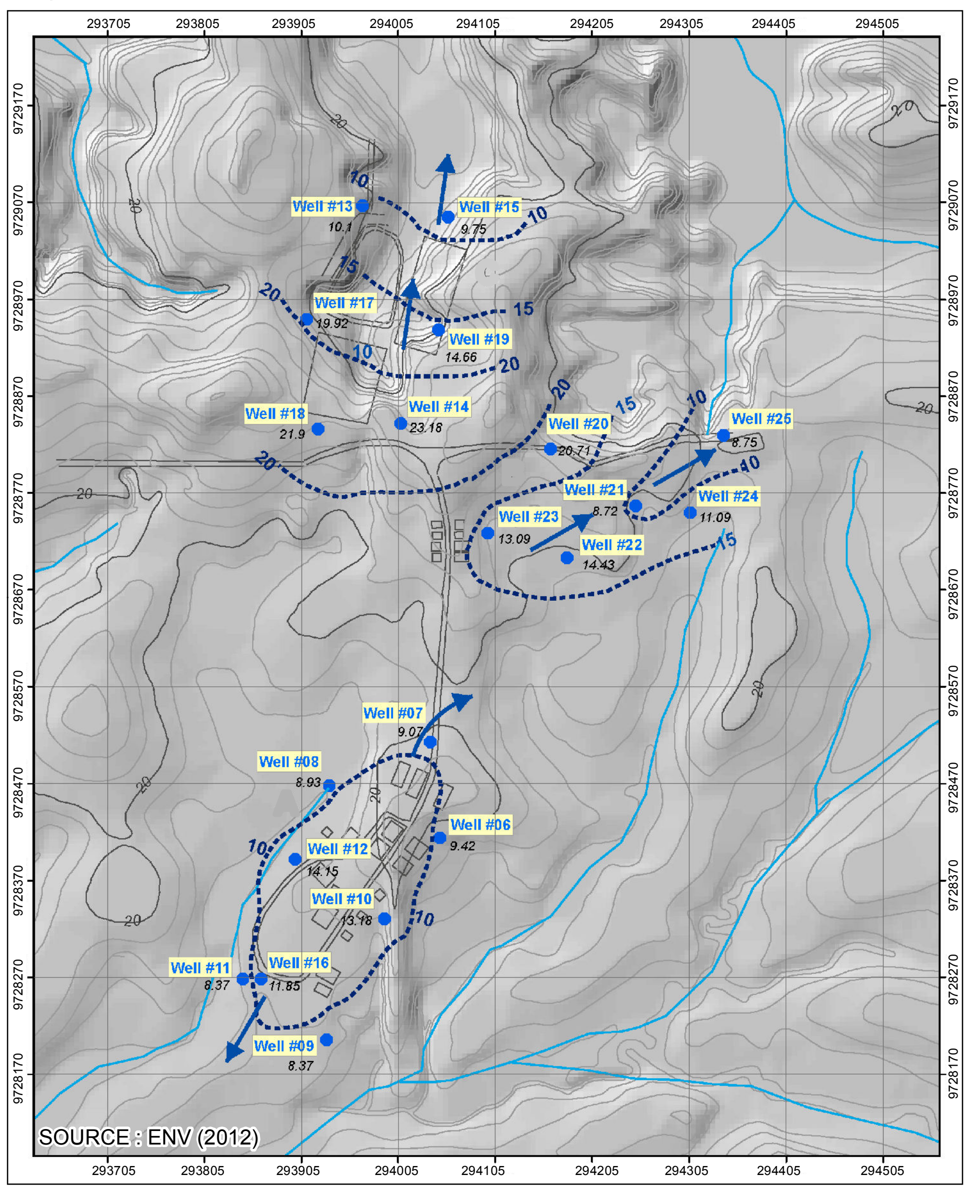
| VES name | Easting (mE) | Northing (mN) | Elevation (m msl) |
|---|---|---|---|
| BC2 | 292132.6 | 9729897.5 | 31.4 |
| BC2 | 292132.6 | 9729897.5 | 31.4 |
| BC3 | 292046.6 | 9729562.7 | 38.0 |
| BC3 | 292046.6 | 9729562.7 | 38.4 |
| BE1 | 292349.0 | 9730293.9 | 24.5 |
| BE2 | 292559.7 | 9730181.2 | 25.8 |
| BE3 | 292786.7 | 9730059.9 | 24.4 |
| BE4 | 293017.7 | 9729936.4 | 27.3 |
| BE5 | 293240.7 | 9729817.2 | 16.0 |
| BE6 | 293452.4 | 9729704.1 | 20.6 |
| BE7 | 293667.8 | 9729591.3 | 23.1 |
| C1 | 291977.6 | 9729283.2 | 16.0 |
| C2 | 291977.6 | 9729283.2 | 16.0 |
| C3 | 292002.1 | 9729368.8 | 14.0 |
| CD1 | 292659.2 | 9729235.8 | 23.7 |
| CD2 | 292483.8 | 9729252.3 | 12.6 |
| CD3 | 292274.3 | 9729465.0 | 10.8 |
| CD4 | 292059.7 | 9729281.0 | 15.2 |
| D1 | 292934.6 | 9729211.6 | 22.5 |
| D2 | 292934.6 | 9729211.6 | 22.5 |
| D3 | 292934.6 | 9729358.6 | 18.8 |
| DE1 | 293598.6 | 9729397.3 | 17.2 |
| DE2 | 293396.8 | 9729337.7 | 23.5 |
| DE3 | 293154.9 | 9729274.6 | 26.4 |
| E1 | 293858.2 | 9729490.6 | 15.2 |
| E2 | 293858.2 | 9729490.6 | 15.2 |
| E3 | 293858.2 | 9729685.6 | 15.2 |

**INSERT A**




Groundwater levels and inferred flow directions : inert & organic waste landfill

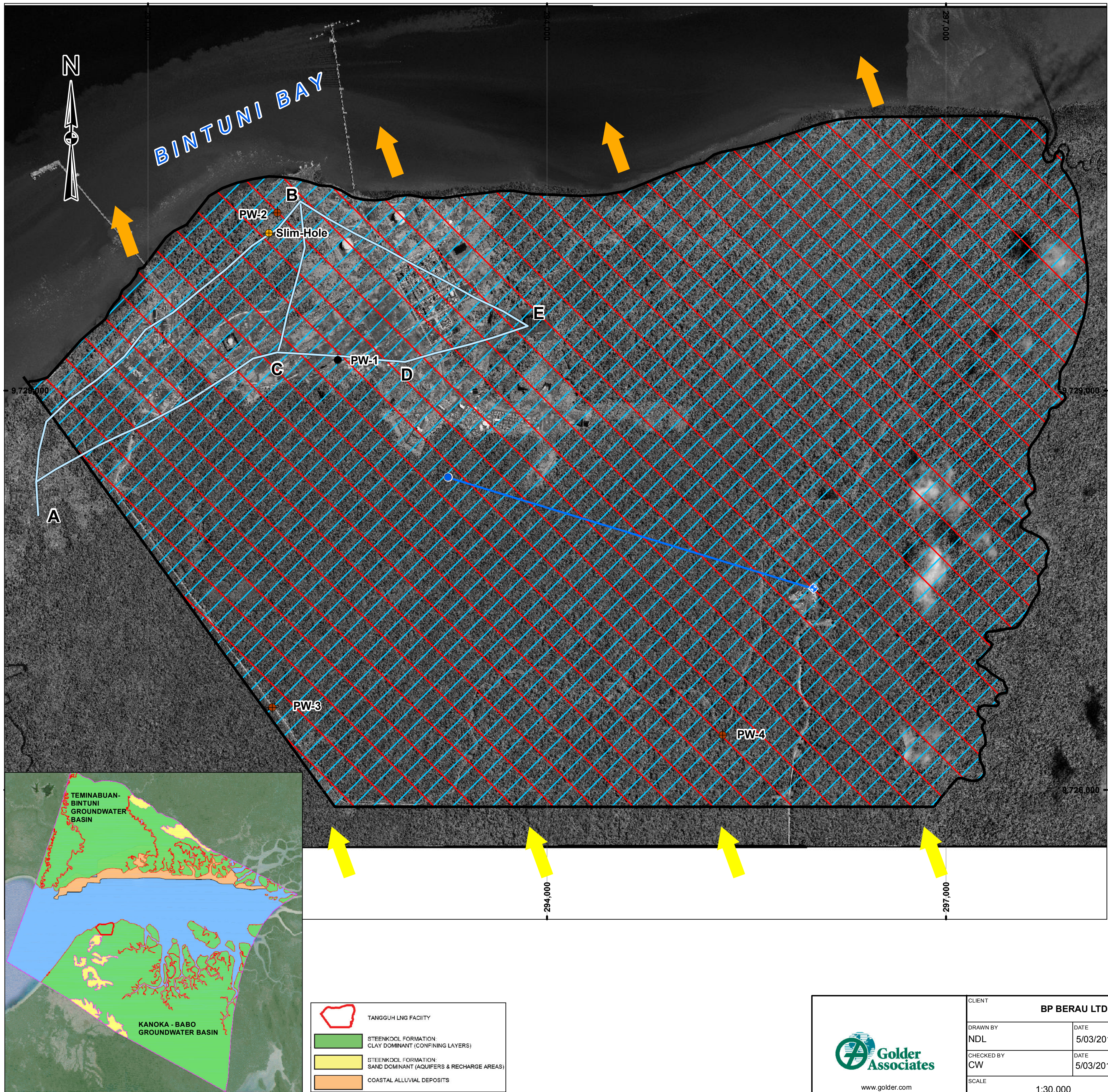
**INSERT B**




Groundwater levels and inferred flow directions : old organic landfill, current organic landfill and inert landfill

**LEGEND**

- Well #25 — Monitoring Well
- 8.75 — Water Table m asl, August 2012
- Groundwater Flow Direction
- 10 — Water Table Contour m asl
- Stream
- 20 — Topographic Contour m asl




## LEGEND

- Tangguh LNG Facility - Property Boundary
- Slim Hole Groundwater investigation borehole drilled in the Steenkool Formation into aquifer zones between 150 and 400 m bgs.
- PW-1 Proposed groundwater investigation well to be screened in the Steenkool Formation within aquifer zones between 150 and 400 m bgs.
- Provisional location for groundwater production well.
- Groundwater Conservation Zone : proposed groundwater abstraction embargo zone to allow development of aquifer resources by Tangguh LNG.
- Groundwater inflow to the aquifer intervals between 150 and 600 m bgs in the Steenkool Formation beneath the LNG facility (recharge areas to the south and south west of the Tangguh LNG Facility and cannot be shown on map). Likely groundwater flow direction shown by orientation of arrows.
- Groundwater outflow from the aquifer intervals between 150 and 600 m bgs in the Steenkool Formation beneath the Facility (discharge areas thought to be to the north, northwest or west of the Tangguh LNG Facility and cannot be shown on map). Likely groundwater flow direction shown by orientation of arrows.
- Collar, alignment and termination point of Genting oil and gas exploration borehole.
- Vertical electrical sounding traverse

**GROUNDWATER UTILISATION ZONE CLASSIFICATION**

- VULNERABLE

500 0 2,000 M
1:30,000

| | | | | |
|---|---|---|---|---|
| Golder Associates<br>www.golder.com<br>GOLDER ASSOCIATES | CLIENT: BP BERAU LTD | | PROJECT: TANGGUH LNG EXPANSION PROJECT - GROUNDWATER STUDY | |
| | DRAWN BY: NDL | DATE: 5/03/2014 | DRAWING TITLE: GROUNDWATER CONSERVATION ZONE MAP 2 : CONFINED AQUIFERS IN THE STEENKOOL FORMATION BETWEEN 150 AND 600m bgs BENEATH THE TANGGUH LNG FACILITY | |
| | CHECKED BY: CW | DATE: 5/03/2014 | | |
| | SCALE: 1:30,000 | SHEET SIZE: A3 | PROJECT No: 138716004; DOC No: 013; DOC TYPE: F; FIGURE No: 09; REVISION: 0 | FIGURE 9 |

Date Saved: 5/03/2014 1:49:52 PM User: NLestari Path: J:\Water\2013\138716004-BP Tangguh\08Technical Doc\GIS\Project\Arcgis\2014-03-05\138716004-013-F009-Rev0-FIGURE 9.mxd

# ATTACHMENT A – INFORMATION SOURCES AND DATA AVAILABILITY

## A.1 Information Sources

The GCZ map and accompanying groundwater conceptual model presented in this Technical Memorandum have been based on a number of data sources. These have included:

- Published geological and hydrogeological maps and references for the Bintuni and greater "Birds Head" area of West Papua, including:
  - the 1:250,000 scale geological map sheet titled *Geology of the Fak Fak Sheet Area, Irian Jaya*, *Quadrangle 2913*
  - the explanatory notes booklet accompanying the *Geology of the Fak Fak Sheet Area, Irian Jaya*, *Quadrangle 2913* map sheet
  - the 1:2,500,000 scale hydrogeological map sheet of Indonesia
  - the 1:100,000 scale hydrogeological map sheet titled *Hydrogeological Map of Indonesia, Sheet V Morotai and Sheet 7 Ambon* published by the Department of Energy and Natural Mineral Resources
  - groundwater basin area and annual groundwater recharge estimates for the unconfined and confined aquifers in the Kanoka-Babo groundwater basin presented on the groundwater basin maps of West Papua prepared by the Department of Water Resources, Environment and Geology.
- Discussions with Hydrogeologists from the Centre for Geological Survey of Indonesia regarding groundwater characteristics and information sources for the Bintuni Bay area and greater Kanoka-Babo groundwater basin.
- Past reports describing the geological, hydrogeological and hydrological setting at the Tangguh property and immediate surrounds including:
  - A report prepared by Baines Geologic summarising a number of geological, geotechnical, hydrogeological and geomorphological facets of the Tangguh property and their influence on the development of the LNG facility.
    - Baynes Geologic Pty Ltd (2006), *Tangguh Project, Engineering Geology Assessment, Consolidated Report*. Report No. 165/3/1 060721 dated 21 July 2006.
  - A report prepared by Environmental Resources Management Australia (ERM) describing the results of preliminary groundwater numerical modelling work carried out to provide Tangguh LNG with an overview of the potential feasibility, sustainability and likely impacts of using the deeper aquifer system beneath the property as a water supply for the (then) proposed project.
    - Environmental Resources Management Australia (2004), *Numerical Groundwater Model to Estimate Potential Pumping Rates for Tangguh LNG Project, Papua, Indonesia*. Reference No. 'International Report' dated 10 April 2004.
  - A report prepared by Lembaga Afiliasi Penelitian dan Industri – Institut Teknologi Bandung describing (among other things):
    - (i) the local and regional geological and hydrogeological setting based on lithological descriptions from offshore oil and gas exploration boreholes Nambumbi-1 and Roabiba-1, onshore groundwater exploration borehole TW-1, and trial groundwater abstraction well TW-2
    - (ii) preliminary groundwater numerical modelling carried out to estimate the likely impacts of proposed groundwater abstraction at the Tangguh property on groundwater resources targeted by the community water supply wells installed at Tanah Merah Baru
    - (iii) an assessment of the likelihood of seawater intrusion and/or 'upconing' of saline water as a result of potential groundwater abstraction at the facility, and

(iv) the potential for and magnitude of land subsidence associated with any future groundwater abstraction at the Tangguh property.

- Institut Teknologi Bandung (2005), *Revised Technical Proposal for the Trial Use of Groundwater*. Report dated January 2005.

- A report prepared by PT Calmarine Indonesia describing the onshore hydrogeological investigations carried out at the Tangguh property in 2001 with an emphasis on the installation and attempted hydraulic testing of a trail groundwater extraction well (TW-2).

  It is noted that the screens in TW-2 were not aligned with the targeted aquifers and that it produced significant silt during development. Its neighbouring borehole, TW-1, was abandoned during reaming when the drill bit became stuck at a depth of about 132 m.

  - PT Calmarine Indonesia (2001), *Hydrogeological Investigation (ON-3)*. Document No. 900-SDY-151 dated 1 March 2001.

- A report published by PT ERM Indonesia following the drilling and geophysical logging of a groundwater exploration borehole (identified as the Slim Hole) along the northern boundary of the Tangguh property.

  - PT ERM Indonesia (2007), *Slim Hole Drilling, Tangguh LNG Project*. Report dated March 2007.

- A number of reports prepared by PT ERM Indonesia following the installation and hydraulic testing of community groundwater supply wells at the villages of Onar Baru, Onar Lama, Saengga and Tanah Merah Baru to the west and southwest of the Tangguh property.

  - PT ERM Indonesia (2006), *Waterwell Construction Report, Onar Baru*. Report dated October 2006
  - PT ERM Indonesia (2006), *Waterwell Construction Report, Onar Lama*. Report dated October 2006
  - PT ERM Indonesia (2006), *Waterwell Construction Report, Saengga*. Report dated October 2006, and
  - PT ERM Indonesia (2006), *Waterwell Construction Report, Tanah Merah Baru*. Report dated October 2006.

- A report prepared by the Indonesian Agency for Assessment and Application of Technology (BPPT) describing the reassessment and reinterpretation of geo-electrical resistivity survey work (previously carried out by Institut Teknologi Bandung) in light of additional geological and downhole geophysical information obtained from the Slim Hole.

  - Badan Pengkajian dan Penerapan Teknologi Indonesia (2007), *Re-Calibration and Re-Interpretation of VES Data Line AB, Tanah Merah – TLNG Site, Kabupaten Bintuni, Papua Barat*. Report dated 2007.

- Groundwater salinity information for the Kais, Faumai and lowermost 300 m of the Steenkool Formation estimated from a number of onshore and offshore oil and gas boreholes and presented in an internal report prepared by BP.

  - BP Berau Ltd (2002), *Result of Steenkool – Kais – Faumai Water Salinity Study*. Report dated 28 March 2002.

- Two reports prepared by PT Taka Hydrocore Indonesia describing the installation of groundwater monitoring wells and subsequent groundwater level and quality monitoring at, surrounding and down-gradient of the organic waste pit, inert landfill, organic waste landfill and new inert and organic waste inert and organic waste landfill at the LNG facility.

  - PT Taka Hydrocore Indonesia (2009), *Final Report, Geotechnical and Monitoring Well Drilling for Proposed New Landfill Development*. Report No. 185/HC-Rep/11.09 Rev 2 dated 12 November 2009.
  - PT Taka Hydrocore Indonesia (2012), *Final Report, Evaluation of Groundwater Monitoring, BP Environmental – THI Cooperation, Tangguh LNG, West Papua*. Report dated 18 December 2012.

- A summary table of hydraulic conductivity values estimated from four undisturbed samples collected from a claystone layer of the Steenkool Formation during the geotechnical investigation for the new inert and organic waste landfill at the Tangguh property. Table was provided by BP's Technical Consultant and was sourced from ITP's report referenced 89-RPT-CV-0006 dated 11 January 2013.
- Copies of seismic reflection profiles for three sections (namely LN 104, LN 105 and LN 108) which pass north-west to south-east and north-east to south-west through the LNG facility.
- Copies of Microsoft Excel spreadsheets summarising groundwater quality and water level information for each of the monitoring wells surrounding the organic waste pit, inert landfill, organic waste landfill and new inert and organic waste landfill.
- Aerial photography of the facility and the surrounding areas.

## A.2 Data Coverage

As mentioned in **Section A1** of this attachment, geological and hydrogeological data for the study area and surroundings were derived from a number of sources, including maps and references published by the Indonesian Department of Mines and Energy, Geological Research and Development Centre of Indonesia, the Department of Energy and Natural Mineral Resources, and a number of consultants, the most notable of which being a number of reports prepared by PT ERM Indonesia. These information sources all contributed to the conceptual hydrogeological model of the study area presented in this attachment, but in varying degrees. Some contributed less than originally hoped.

**Table A1** presents an overview of the different data types and provides an appraisal of their input into the production of the groundwater conceptual model and GCZ maps.

**Table A1: Overview of Data Coverage**

| Data Type | Comments |
|---|---|
| Topographic map sheets | Topography of the Tangguh property shown on a number of geological and geomorphological map sheets produced at 1:10,000 scale; elevation data referenced by 2 metres contour lines which are thought to be accurate to the nearest metre mean sea level. |
| Geological map sheets and accompanying published notes | Surface geology of the LNG facility – and indeed much of the greater Kanoka-Babo groundwater basin – is shown on the Fak Kak 1:250,000 scale geological map sheet.<br><br>Surface geology for most of the area included in the conceptual hydrogeological model is covered on the Fak Fak, Teminabuan, Ransiki and Steenkool 1:250,000 scale geological map sheets.<br><br>Differentiation between different rock types and formations generally appears satisfactory for the generation of the GCZ maps, however it is noted that the information presented on these maps has mostly been based on aerial photograph interpretation supported by 'limited' outcrop assessment.<br><br>General stratigraphy and orientation of the Steenkool Formation is also presented in the notes accompanying the geological map sheets. This information is based on the geological logs for a number of oil and gas exploration boreholes drilled in the Bintuni Basin, however it is noted that the closest of these referenced in these notes is some 27 km to the northwest of the LNG LNG facility, whilst most of the boreholes are more than 50 km to the south, southeast and southwest of the LNG facility.<br><br>Finally, information regarding regional-scale folding of the Steenkool Formation within the Bintuni Basin is considered to be somewhat sporadic, with only limited information (mostly broad descriptions) noted in the published notes accompanying the map sheets. |
| Hydrogeological map sheets | General geological, hydrogeological and hydrological characteristics likely at the property (and indeed in the greater Kanoka-Babo groundwater basin) are shown on a series of maps produced by various Indonesian government offices. Characteristics shown include:<br><br>▪ General descriptions of aquifer rock types – namely sedimentary (loose sediments, consolidated sediments, and chemical precipitates) versus igneous and metamorphic |

| Data Type | Comments |
| --- | --- |
| | aquifer domains.<br>▪ Likely groundwater prospect potential (ranked from very high to moderate to low)<br>▪ Likely aquifer 'productivity' (which is ranked as either high, moderate, locally productive aquifers, low, or regions without exploitable groundwater as a function of likely aquifer transmissivities, water level measurements and known spring yields)<br>▪ Estimates of annual groundwater recharge for unconfined and confined aquifer types<br>▪ Known areas of poor groundwater quality<br>▪ Locations of major rivers and basin divides, and<br>▪ Contours of average annual rainfall. |

| Data Type | Comments |
|---|---|
| Consultant reports describing the geological and hydrogeological setting <u>at the LNG facility</u>. | Information regarding the geological setting in the north-western corner of the LNG facility is well covered at a number of scales to depths of about 50 m. Outside of this area and beyond this depth though the amount of information decreases significantly and is limited to:<br>▪ geological and geophysical information obtained during the drilling of two groundwater exploration boreholes (identified as TW-1 and the 'Slim Hole')<br>▪ geological and geophysical information obtained the installation of a trail groundwater production well (identified as TW-2), and<br>▪ interpretive information from the geo-electrical geophysical surveys carried out by ITB and subsequently reinterpreted by the Indonesian Agency for Assessment and Application of Technology.<br>The above information is also augmented by broad descriptions of the stratigraphy of the Bintuni Basin which have been obtained from the geological logs for a number of oil and gas exploration boreholes drilled in the Bintuni Basin, the closest of which is some 27 km to the northwest of the LNG facility.<br>In comparison, hydrogeological information for the aquifers in the Steenkool Formation is limited to that obtained during the drilling of groundwater exploration boreholes TW-1 and the Slim Hole and the installation of trial production well TW-2. As such there is very little information regarding the hydrogeological conditions of the aquifer(s) targeted during the installation of test production well PW-1 with the exception of interpretive information obtained from the geological and geophysical logs from the Slim Hole.<br>Hydrogeological information obtained from these investigations is summarised below.<br>▪ Estimates of hydraulic parameters – a constant rate pumping test was carried out in trial groundwater production well TW-2 by PT Calmarine Indonesia in 2001. Estimates of transmissivity and storativity for the 'upper Steenkool' aquifers were calculated from this test, however are considered approximate at best given problems associated with incorrect screen placement during well installation and the clogging of the well screens during the pumping test.<br>There are no hydraulic parameter measurements for the 'lower Steenkool' aquifers; this is considered to be a significant data gap.<br>Estimates of the hydraulic conductivity of the claystone/mudstone aquitards of the Steenkool Formation were summarised in ITP's (2013) geotechnical investigation report for the new inert and organic waste landfill. ITP note that four undisturbed samples were collected from a claystone layer of the Steenkool Formation during the geotechnical investigation for the new inert and organic waste landfill at the Tangguh property. These samples were submitted for laboratory determination of hydraulic conductivity. There is no discussion as to whether they are likely to be 'leaky' or not.<br>▪ Hydraulic head measurements – groundwater level measurements were recorded in TW-2 following the development of this well.<br>Anecdotal evidence regarding groundwater pressures was also obtained from TW-1 and the Slim Hole. Artesian flows were observed from TW-1 after the borehole was abandoned suggesting confined aquifer conditions and piezometric head elevations above the elevation of the borehole collar in the screened aquifers.<br>The elevation of the water table in the Slim Hole on completion of drilling is noted on the geophysical log for this borehole. It is noted thought that the Slim Hole was not developed before geophysical logging was carried out hence the degree of hydraulic connection between the borehole and the aquifers (if any) cannot be confirmed, and as such the accuracy of this measurement is considered approximate at best.<br>▪ Groundwater quality information – four groundwater samples were collected from TW-2 during and on completion of the pumping test. These samples were subsequently submitted for laboratory analysis, with each sample analysed for a number of groundwater |

| Data Type | Comments |
|---|---|
| | quality indicators including major anions and cations, dissolved metals, and nutrients.<br><br>Groundwater samples have been collected from a number of shallow groundwater monitoring wells installed around each of the landfills at the LNG facility. Samples were first collected in 2009 and have been analysed for a number of groundwater quality parameters including total dissolved solids, pH, chloride, sulphate, sulphide, nitrate, nitrite and a number of common heavy metals.<br><br>Non-direct information regarding the quality of groundwater in each of the aquifer intervals beneath the site is also available from the geophysical logs for TW-1, TW-2 and the Slim Hole.<br><br>General descriptions of low-pH groundwater was noted by Baines Geologic to be seeping from a cutting at Temporary Construction Camp No. 2. The groundwater was thought to become acidic following the oxidation of perched groundwater zones in the clay-dominant Steenkool Formation following excavations in the area which allowed (possibly oxygen-poor) groundwater to drain from these units.<br><br>Groundwater salinity information for the lower-most 300 m of the Steenkool Formation (i.e. between about -1700 and -2000 m bgs) as well as the Kais and Faumai Formations is also available.<br><br>No information regarding the location of the fresh water / saline water interface was available for any of the aquifers beneath the site during the development of the GCZ maps or accompanying conceptual hydrogeological model. |

| **Data Type** | **Comments** |
|---|---|
| Consultant reports describing the geological and hydrogeological setting surrounding the LNG facility. | Information available regarding the geological setting in the area surrounding the LNG facility is generally well covered with information available from the1:250,000 scale Fak Fak geological map sheet together with the geological logs for each of the community groundwater supply wells installed in the villages of Saengga and Tanah Merah Baru.<br>In stating the above, however, it is noted that data gaps exist:<br>1) in those areas to the south and east of the LNG facility, and<br>2) at depths greater than about 100 m, in particular for the aquifer(s) that will be targeted during the installation of test production well PW-1.<br>The most useful information for the areas to the east and south of the LNG facility appears to be broad descriptions regarding the stratigraphy of the Bintuni Basin which have been obtained from the geological logs for a number of oil and gas exploration boreholes drilled in the Bintuni Basin, the closest of which is about 13 km to the northwest of the LNG facility.<br>Information regarding the hydrogeological setting surrounding the LNG facility appears to be limited to information collected during the installation and hydraulic testing of the community groundwater supply wells at Saengga and Tanah Merah Baru. Specifically this information includes:<br>▪ geological information highlighting aquifer and aquitard occurrence to depths up to 135 m<br>▪ estimates of aquifer transmissivity and specific capacity for each aquifer and well combination<br>▪ groundwater quality information, including analytical results for groundwater samples collected from each well at the end of the pumping tests, and<br>▪ measurements of water levels (and estimation of hydraulic heads).<br>In addition to the above, non-direct information regarding likely groundwater quality and aquifer lithology was also available from the geophysical logs for these boreholes.<br>Again though, there is no information regarding the hydrogeological characteristics of the aquifer(s) that will be targeted during the installation of test production well PW-1. This is considered to be a significant data gap. |
| Seismic reflection sections | General information regarding the thickness, orientation and degree of faulting of the Steenkool Formation (beneath about 500 m), Kais Formation and – to a lesser degree – the Faumai Formation available from seismic sections LN 014, LN 105 and LN 108. |
| Aerial photography. | Good coverage of the LNG property and immediate surrounds available although aerial photographs are somewhat dated showing the condition of the property prior to the development of the LNG facility. |
| Discussions with senior personnel from the Indonesian Department of Water Resources, Environment and Geology regarding available hydrogeological information for the Kanoka-Babo groundwater basin. | Information regarding groundwater debit from the Kanoka-Babo groundwater basin was passed on, however this was of limited use.<br>Other information passed on supported that referenced in other information sources however no new information was provided. |

## ATTACHMENT B – CONCEPTUAL HYDROGEOLOGICAL MODEL

To formulate an understanding of the hydrogeology and the groundwater regime both beneath and in the immediate vicinity of the Tangguh property, a conceptual groundwater model of the area was developed.

A conceptual groundwater model is a simplified non-mathematical presentation of the hydrogeology of a region. Its purpose is to provide a *visualisation* of the hydrogeological system being assessed and may include descriptions of the various components of the subsurface groundwater environment (the groundwater flow processes which operate there). It is largely based on available published information (in this case those information sources described in **Attachment A**) although also includes reviewer input based on geological and hydrogeological principals.

The conceptual groundwater model for the aquifer systems beneath and in the immediate vicinity of the Tangguh LNG facility is summarised in **Table B1.** The system is also shown schematically in **Figure B1** and in planar representation in **Figure B2** (regional setting) and **Figure B3** (local setting).

**Table B1: Conceptual Hydrogeological Model of the Tangguh LNG Facility and Immediate Surrounds**

| Component | Description |
|---|---|
| Model dimensions | The conceptual model covers an area of about 9200 $km^2$; the LNG facility has an area of about 3200 ha.<br><br>Approximate coordinates for the corners of the concept model are:<br><br>▪ North-eastern corner – 9,746,000 mN 378,000 mE<br>▪ North-western corner – 9,789,000 mN 280,000 mE<br>▪ South-eastern corner – 9,659,000 mN 347,000 mE<br>▪ South-western corner – 9,713,000 mN 252,000 mE<br><br>The base of the conceptual model is delineated by a no-flow boundary at the contact between the Steenkool Formation and New Guinea Limestone Supergroup (in this case the Kais Formation) which varies between depths of about 200 (?) m in the northern portion of the model area to over 4000 m in the south; these sediments are up to 3200 m thick in oil and gas exploration borehole South Jarua 1 about 50 kilometres south-east of the LNG facility.<br><br>Beneath the LNG facility though the thickness of the Steenkool Formation has been estimated from seismic reflection traverses to be between about 2000 m. |

| Component | Description |
|---|---|
| Model boundaries | ▪ **Constant-head boundaries** in the conceptual model are located:<br>➢ along the axis and projected axial trace of the unnamed anticline on the northern side of Bintuni Bay where clay-dominant units of the Steenkool Formation outcrop; this anticline axis is expected to delineate the groundwater sub-basin divide to the north of the LNG facility<br>➢ along the axis and projected axial trace of the unnamed anticline on the southern side of Bintuni Bay where clay-dominant units of the Steenkool Formation outcrop; this anticline axis is expected to delineate the groundwater sub-basin divide to the north of the LNG facility, and<br>➢ Along the margins of the model domain defined by Bintuni Bay and the Banda Sea.<br>Constant-head boundaries to the north and south of the LNG facility have been selected as these geological structures are considered to be the defining element controlling groundwater recharge, discharge and flow mechanisms in the aquifers of interest beneath the Tangguh LNG facility.<br>▪ **No-flow boundaries** in the conceptual model are located:<br>➢ along the axis of the unnamed anticline on the northern side of Bintuni Bay where sand-dominant units of the Steenkool Formation outcrop<br>➢ along the axis of the unnamed anticline to the south of the oil and gas exploration boreholes Kasuri-1, Aroba-1, Wami-1, South Moni-1, and Sungai Jarua-1 (as shown on the Fak Fak geological map sheet) where sand-dominant units of the Steenkool Formation outcrop<br>➢ along the trace of the Arguni Thrust Fault to the east and southeast of the LNG facility, and<br>➢ at the base of the Steenkool Formation.<br>▪ Faulting of the Steenkool Formation to the south of the LNG facility is not thought to impede groundwater flow in the sand-dominant units hence is not considered to be a no-flow boundary. |
| Geological setting | The Bintuni Basin sits within a deep Tertiary basement depression which (at its thickest) is dominated by a 4000 m thick accumulation of relatively immature, possibly very gently folded, and variably sorted sediments known as the Steenkool Formation.<br>Beneath the LNG facility the Steenkool Formation consists of interbedded mudstones and sandstones about 2000 m thick. Seismic profiles across the site and Bintuni Bay show that the sedimentary pile to depths of about 500 m is generally flat-lying (with dips typically 0.5° or less), however dips increase to 2 or 3° to the southeast as the thickness of the Steenkool Formation increases.<br>Figure 3 of the Baynes Geologic (2006) report shows that several faults have been either mapped or inferred at the Tangguh LNG facility. Most of these are located in the north-western portion of the property and are orientated either north-west to south-east or north-east to south-west, and whilst their slips or throws are not known most are inferred by Baynes Geologic (2006) to be strike-slip faults.<br>Reference to seismic lines 104, 105 and 108 which traverse the onshore area close to the location of the proposed test production well (PW-1) suggest some faulting in the Steenkool Formation is observable at depths of greater than 500 m. However, given the limited definition of the seismic data above about 500 m depth, it is not possible to ascertain whether the underlying faults in the Steenkool Formation (at depths greater than 500 m) extend to the surface in the immediate vicinity of the Tangguh LNG facility. Tangguh LNG's Subsurface Exploration Team indicate that there are no known faults in the immediate vicinity of the LNG facility.<br>The Fak Fak 1:250,000 scale geological map sheet suggests that two faults are located to the south of the Tangguh LNG facility. These are:<br>▪ a 10 km long east-west trending fault about 1 km south of the facility, and<br>▪ an 8 km long north-west – south-east trending fault situated about 10 km south of the facility.<br>Baynes Geologic (2006) postulates that both of these faults are small-displacement, left-lateral motion strike-slip faults, Hence, neither are expected to be significant barriers to groundwater flow.<br>Any faults through the claystones of the Steenkool Formation are likely to act as barriers to groundwater flow rather than conduits. If any faulting did act as a conduit then this would allow saline groundwaters from the Lower Steenkool to migrate to the Upper Steenkool. No evidence suggesting the vertical upward migration of saltwater was observed down to 300 m in the Slim Hole or in the |

| Component | Description |
|---|---|
| | resistivity traverses carried out by LAPI-ITB.<br><br>Five major subdivisions in the upper 300 m of the Steenkool Formation have been observed in the groundwater exploration boreholes drilled at the Tangguh Property (i.e. namely TW-1, TW-2 and the Slim Hole) and those drilled at the villages of Saengga and Tanah Merah Baru. These are:<br><br>1) A clay-dominant layer which contains some thin, albeit continuous, sand layers and is estimated to be between about 10 and 60 m thick.<br><br>2) An 'upper' sand-dominant layer some 60 to 90 m thick which contains some 'thin' – and again continuous – clay and silt layers; this layer forms the upper groundwater resource utilised in the community groundwater supply wells at the villages of Saengga and Tanah Merah Baru.<br><br>3) A clay-dominant layer (again containing some thin and continuous sand layers) which is between about 130 and 250 m thick; this unit also appears to thicken to the east beneath the northwestern portion of the site.<br><br>4) A 'lower' sand dominant layer (which again contains some 'thin' – albeit apparently continuous – clay and silt layers) which is between about 30 and 70 m thick. This layer appears to thin to the east and is the series of aquifers targeted for groundwater abstraction at the Tangguh LNG facility.<br><br>5) A clay-dominant layer of unknown thickness.<br><br>An alluvial sequence, which lines the valley floors throughout the area and is of variable lithology and thickness, is also situated around the northern, eastern, north-western and parts of the southern boundary of the site. |

| Component | Description |
| --- | --- |
| Hydrogeological setting – aquifers and aquitards | The Kanoka-Babo groundwater basin is a designated groundwater zone in the kabupatens of Fak Fak, Teluk Bintuni and Wondamae Bintuni in West Papua. The basin has an area of about 16,870 $km^2$, is delineated by the accumulation of mixed Miocene to Quaternary sediments in the Bintuni Basin, and is bounded as follows:<br>➢ to the north by Bintuni Bay and the Temanibuan-Bintuni groundwater basin<br>➢ to the east and north-east by the Lengguru Fold Belt<br>➢ to the southeast by the Arafura Sea<br>➢ to the south, southwest and west by the Banda Sea, and<br>➢ to the northwest by limestones of the New Guinea Limestone Supergroup.<br>According to the Papua Island Groundwater Basin Map Sheet 11 the average annual recharge of the unconfined aquifers in the Kanoka-Babo groundwater basin has been estimated to be about 11,267 M $m^3$. The average annual recharge of the confined aquifers in the basin has been estimated to be about 558 M $m^{3.}$<br>The Tangguh property is situated in a groundwater sub-basin at the northern end of the Kanoka-Babo groundwater basin. The sub-basin is bound by Bintuni Bay to north, east, and north-west, and surface water catchment divides to the south, south-east and south-west. It has an area of about 750 $km^2$ (i.e. 75,000 ha) of which the LNG facility occupies 32 $km^2$ (i.e. 3200 ha).<br>Three aquifers (or more precisely aquifer zones) have been identified to depths of 300 m both beneath and in the area surrounding the LNG facility. These are:<br>▪ a number of unconfined aquifers associated with Quaternary coastal and fluvial deposits at elevations typically less than 5 m throughout the area<br>▪ a series of confined aquifers generally between about 30 and 150 m bgs in what is referred to as the upper Steenkool Formation in this Technical Memorandum, and<br>▪ a series of confined aquifers between about 200 and 300 m bgs in what is referred to as the lower Steenkool Formation in this Technical Memorandum.<br>▪ Hydrostragraphic work carried out by ERM (2007) suggests aquifers in the upper 150 m of the Steenkool Formation may be continuous beneath much of the western portion of the Tangguh LNG facility and the villages of Tanah Merah Baru and Saengga. This interpretation, which was based on geological and down-hole geophysical profiles as well as groundwater quality information from the community supply wells at Tanah Merah Baru and Saengga as well as groundwater exploration boreholes TW1, TW2 and the Slim Hole at the Tangguh LNG facility, and also suggests:the dip of the sediments in the Upper Steenkool Formation is, on average, less than 1°<br>▪ aquifers in the Upper and Lower Steenkool Formation are separated by a regionally significant aquitard, and<br>▪ sand dominant layers in the Lower Steenkool Formation appear to become thicker and more common below a depth of about 250 m.<br>Each of the above aquifers zones above is separated by what are expected to be regionally significant aquitards which are between about 10 and 200 m thick. It is not known whether these aquifers are leaky or not.<br>The geological and geophysical logs for groundwater exploration boreholes TW1 and Slim Hole, trial groundwater abstraction well TW-2, and the community water supply wells at Tanah Merah Baru and Saengga suggest that several aquifer and aquitard units in the Steenkool Formation are continuous beneath the north-western portion of the Tangguh property. These logs also indicate that the aquifer targeted for use in the community water supply wells at Saengga and Tanah Merah Baru dips very gently to the east and may also thin in this direction.<br>The geological log for the Slim Hole also indicates that the sand-dominant unit between about 260 and 295 m depth is separated from the aquifer used in the community water supply wells at the villages of Saengga and Tanah Merah Baru by a clay-dominant unit which, in the vicinity of the Slim Hole, is over 100 m thick. |

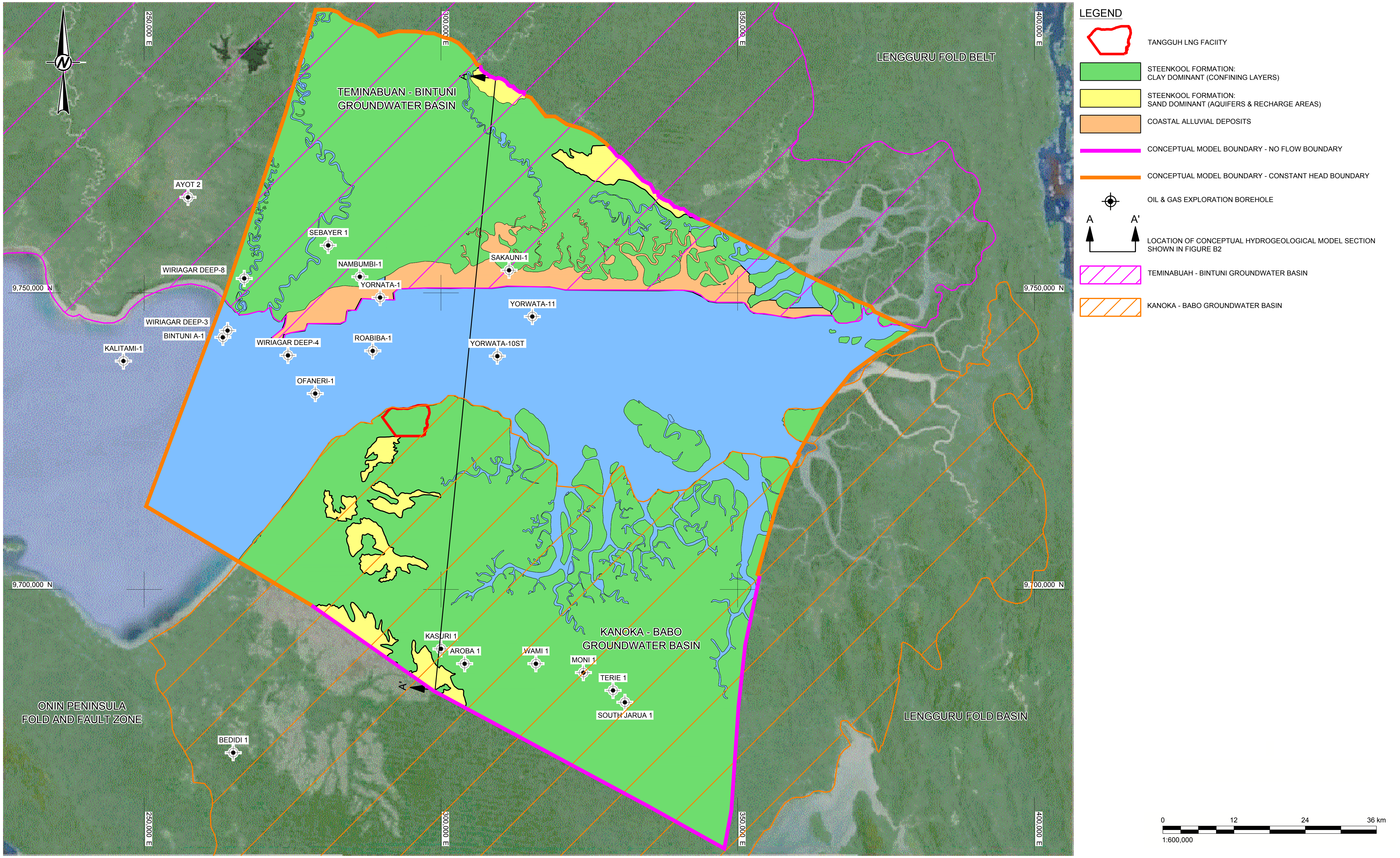
| Component | Description |
|---|---|
| | In stating the above however it is noted that:<br>▪ Individual aquifers within the larger aquifer zones are expected to comprise homogeneous and anisotropic or (more commonly) heterogeneous and anisotropic water-bearing units. Individual aquifers within the larger aquifer zones are expected to commonly be heterogeneous and anisotropic. In both aquifers and aquifer zones, horizontal permeability is expected to be homogeneous or nearly so (i.e. $K_x \approx K_y$). However, vertical permeability ($K_z$) is expected to be significantly smaller.<br>▪ Not all of the saturated thickness of the ‘aquifer zones’ are aquifers; indeed the aquifers in these intervals are formed by thin zones of more permeable materials typically between 5 and 20 m thick frequently hosted within what are thought to form regionally significant aquitards.<br>▪ Aquifer zones are of variable thickness and although their lateral continuity is not known regionally, it is expected beneath the LNG facility.<br>▪ Additional aquifer zones may be present in the Steenkool Formation below 300 m depth.<br>▪ Some authors note that the Steenkool Formation may become more ‘sandier’ at depth.<br>▪ Aquitards below 300 m depth could have greater thicknesses than those to depths of 300 m. |

| Component | Description |
|---|---|
| Hydraulic properties | ▪ Unconfined aquifer – unknown but 'textbook' values for common lithologies suggest permeabilities between about $10^{-2}$ and $10^{2}$ m/day and specific yields between about 0.02 (e.g. for clays) and 0.24 (somewhat clean medium-grained sands).<br>Heterogeneous and anisotropic distribution of hydraulic characteristics expected.<br>▪ Hydraulic (slug) testing carried out by PT Hydrocore and PT Taka Hydrocore in near surface exposures of clay-dominant Steenkool Formation (most notably sand-dominant lenses) close to the landfill facilities at the Tangguh property suggests that the permeability of these perched aquifers and near surface confined aquifers is likely to be about 1 m/day; values though ranged between about 4 x $10^{-5}$ and 3.3 m/day.<br>▪ Upper Steenkool Formation aquifers – estimates of hydraulic conductivity from pumping tests suggest more promising aquifer layers in this unit have horizontal permeabilities between about 1 and 15 m/day and typically about 4 m/day.<br>Values of transmissivity estimated from pumping tests vary between about 15 and 50 $m^2$/day; estimates of specific capacity varied between about 7 and 40 $m^3$/day per m drawdown.<br>Given the layered aquifer-aquitard arrangement permeability is expected to be similar in horizontal layers (i.e. $K_x \approx K_y$) whilst permeability across layers ($K_z$) is expected to be markedly smaller.<br>Although no estimates of storativity were possible from the pumping test, ERM suggested (following calibration of its numerical groundwater model) that storativity could be estimated by multiplying the aquifer thickness by 3 x $10^{-6}$. Based on his relationship individual aquifers in this unit would have storativity estimates of between about 5 x $10^{-4}$ and 5 x $10^{-3}$.<br>The value of storativity for the Upper Steenkool Formation aquifers derived from the calibration of ERM's numerical groundwater flow model was 0.0009.<br>▪ Lower Steenkool Formation aquifers – not known but <u>may</u> be similar to those of the Upper Steenkool Formation aquifers.<br>▪ Aquifers deeper than 300 m in the Steenkool Formation – not known but <u>may</u> be similar to those of the Upper Steenkool Formation aquifers.<br>▪ Aquitards – estimates of hydraulic conductivity from four undisturbed samples of claystone collected from the Steenkool Formation during the geotechnical investigation for the new inert and organic waste landfill indicate that the aquitards are likely to have very low permeabilites. Estimates of permeability derived from laboratory testing of the undisturbed samples ranged between 2 x $10^{-5}$ and 4 x $10^{-4}$ m/day (reported as between 2.5 x $10^{-8}$ and 4.4 x $10^{-7}$ cm/s in ITP's report).<br>Estimates of horizontal permeability (i.e. both $K_x$ and $K_y$) used by ERM in past numerical modelling were about 0.015 m/day with estimates of vertical permeability ($K_z$) about 0.0015 m/day. Estimates of storativity were about 0.005.<br>Leakage from the aquitards is also anticipated however the magnitude of this mechanism is not known. |
| Recharge mechanisms | ▪ Unconfined aquifer – rainfall infiltration across most areas where these sediments outcrop as well as localised gains from losing streams.<br>▪ Upper Steenkool Formation aquifers – rainfall infiltration across most areas where these aquifers outcrop (i.e. areas where sand-dominant Steenkool Formation outcrop), most notably those areas to the south and south-west of the LNG facility.<br>Minor recharge also likely from the vertical leakage of groundwater under pressure from the underlying Lower Steenkool Formation aquifers.<br>▪ Lower Steenkool Formation aquifers – rainfall infiltration on outcrop exposures of sand-dominant Steenkool Formation to the south and southwest of the LNG facility.<br>▪ Aquifers deeper than 300 m in the Steenkool Formation – not known. Recharge areas may lie to the south and south-west of the Tangguh property or outside of the bounds of this conceptual model. |

| Component | Description |
|---|---|
| Discharge mechanisms | ▪ Unconfined aquifer – groundwater discharge to Bintuni Bay coupled with possible (albeit minor) leakage into the underlying aquitard.<br>▪ Upper Steenkool Formation aquifers – discharge to the ocean (Bintuni Bay and further west in the Banda Sea) by vertical leakage over large areas, and abstraction of groundwater from a number of community groundwater supply wells.<br>▪ Lower Steenkool Formation aquifers – discharge to the north-west of the LNG facility possibly coupled with some (albeit minor) upward leakage to the Upper Steenkool Formation aquifers.<br>▪ Aquifers deeper than 300 m in the Steenkool Formation – not known but expected to be to the north, north-west or west of the LNG facility. |
| Groundwater and piezometric level trends | ▪ Unconfined aquifer – no information regarding groundwater level trends in these aquifers is known. Groundwater levels though are expected to fluctuate with seasonal changes in rainfall recharge and any local groundwater abstraction (if any).<br>▪ Upper Steenkool Formation aquifers – fluctuations in aquifer pressure have been observed in groundwater monitoring well TW-2. Fluctuations appear to mimic the tidal regime in Bintuni Bay and are thought to reflect hydrostatic pressure changes associated with tidal fluctuations above this (confined) unit as opposed to changing water levels associated with partial or complete hydraulic connection with Bintuni Bay.<br>▪ Lower Steenkool Formation aquifers – no information known.<br>▪ Aquitards – no information available. |
| Groundwater flow direction | ▪ Unconfined aquifer – expected to mimic the topographic expression of the area with an overall and somewhat ‘governing’ flow direction to the north towards Bintuni Bay.<br>▪ Upper Steenkool Formation aquifers – groundwater head measurements suggest a groundwater flow direction to the north or north-west of the LNG facility.<br>Major ion groundwater chemistry in well TW-2 (where $Na^+$ is the dominant cation and $HCO_3^-$ the dominant) suggests groundwater is moving from recharge areas in the south and south-west of the Bintuni Basin to potential discharge areas to the north and north-west of the LNG facility.<br>Limited vertical groundwater flow will likely take place perpendicular to the orientation of this aquifer system whilst some (albeit likely low flux) discharge to the overlying unconfined aquifers and/or Bintuni Bay is possible.<br>▪ Lower Steenkool Formation aquifers – not known but groundwater is expected to flow from the south and south-west of the LNG facility to the north and north-west.<br>Limited vertical groundwater flow will likely take place perpendicular to the orientation of this aquifer system although some discharge to the overlying Upper Steenkool Formation aquifers is likely. The magnitude of this discharge mechanism though is not known. |
| Groundwater quality | ▪ Unconfined aquifer – not known yet likely to be variable; low salinity groundwater is likely in sands and gravels however occurrences of saline water are likely in these aquifers along the coastal fringe of the property.<br>Monitoring of shallow groundwater around the landfills at the property (which are lined with high-density polyethylene liners and have subsurface leachate collection systems) has shown no evidence of groundwater contamination. Some regulatory exceedences of dissolved metal concentrations have been noted in the groundwater quality monitoring data set generated to date, however these are considered to be indicative of natural background conditions.<br>Low-pH groundwater (typically about pH 2 to 3) has also been observed draining from what are thought to be perched aquifers in the Steenkool Formation at Temporary Construction Camp No. 2. The groundwater was thought to become acidic following the partial draining and subsequent oxidation of groundwater in these aquifers following the excavation of a number of embankments in this area.<br>There is no known information regarding the quality of groundwater in these aquifers beneath the LNG infrastructure at the property. |

| Component | Description |
|---|---|
| | ▪ Upper Steenkool Formation aquifers – groundwater samples collected from each of the community groundwater supply wells at Tanah Merah Baru and Saengga indicate that the water in this aquifer zone is typically fresh and of low salinity.<br><br>Major ion chemistry from groundwater monitoring well TW-2 – which is sodium and bicarbonate dominant – also suggest that groundwater is possibly flushing connate (?) salt from the aquifer.<br><br>Anecdotal evidence suggests that groundwater pumped from the well at the former Calmarine survey camp at Tanah Merah village is of low salinity and frequently used for domestic purposes. This well was screened over three intervals in the sand-dominant units if the upper Steenkool Formation and is understood to have been operational in the late 1990's and early 2000's. It is understood however that faecal coliforms were identified in this well at some stage of its operation, possibly resulting in its abandonment.<br><br>Unfortunately there is no information regarding the location of the fresh water / saline water interface in this aquifer other than to say it is likely located to the north or northwest of TW-2 and the Slim Hole, most likely beneath the coastal fringe of the Tangguh property.<br><br>▪ Lower Steenkool Formation aquifers – ERM note that single point resistance and self-potential logs from the Slim Hole indicate groundwater in these aquifers is of low salinity and may have TDS concentrations of less than 500 mg/L.<br><br>There is no information regarding the location of the fresh water / saline water interface in this aquifer other than to say it is located to the north or northwest of the Slim Hole and may be located beneath the coastal fringe of the LNG facility.<br><br>▪ Location of the fresh water / saline water interface in the Steenkool Formation is not known. Groundwater head measurements from the Upper Steenkool Formation aquifers coupled with groundwater quality observed in the community groundwater supply wells infers that in those aquifers in the Steenkool Formation to depths of about 600 m the fresh water / saline water interface is most likely situated beneath the northern boundary of the Tangguh property.<br><br>▪ Potential aquifers greater than 600 m depth in the Steenkool Formation – not known but salinity is expected to increase with depth. |
| Groundwater usage | ▪ Unconfined aquifer – local abstraction noted from three shallow wells in Saengga and two in Tanah Merah Baru. Debits though are expected to be minimal and inconsequential to groundwater resource availability.<br><br>▪ Upper Steenkool Formation aquifers – a number of community groundwater supply wells have been installed in this aquifer as part of BP's CSR program. Wells were installed at the villages of Saengga and Tanah Merah Baru where yields are understood to be about 3 L/s for about 8 hours per day.<br><br>A number of former BP 'camp supply' wells have been installed in this aquifer however their ongoing use is not known.<br><br>It is noted that groundwater resources in this aquifer zone have been embargoed (i.e. no further extraction is permitted) with this groundwater resource set aside for community potable water supply needs.<br><br>▪ Lower Steenkool Formation aquifers – no groundwater use occurrences known or expected in the area surrounding the site.<br><br>Groundwater abstraction though may occur from this aquifer on the northern side of Bintuni Bay.<br><br>▪ Kais and Faumai Formations – no groundwater use occurrences known or expected in the area surrounding the site. |

**Figures**

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| | | | |
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| DRAWN BY | DS | DATE | 26.02.2014 |
| CHECKED BY | CW | DATE | 26.02.2014 |
| SCALE | AS SHOWN | SHEET SIZE | A3 |

PROJECT
TANGGUH LNG EXPANSION PROJECT - GROUNDWATER STUDY

DRAWING TITLE
CONCEPTUAL HYDROGEOLOGICAL MODEL
MODEL AREA AND BOUNDARIES

| PROJECT No | DOC No | DOC TYPE | FIGURE No | REVISION | |
|---|---|---|---|---|---|
| 138716004 | 013 | F | B1 | 1 | FIGURE B1 |



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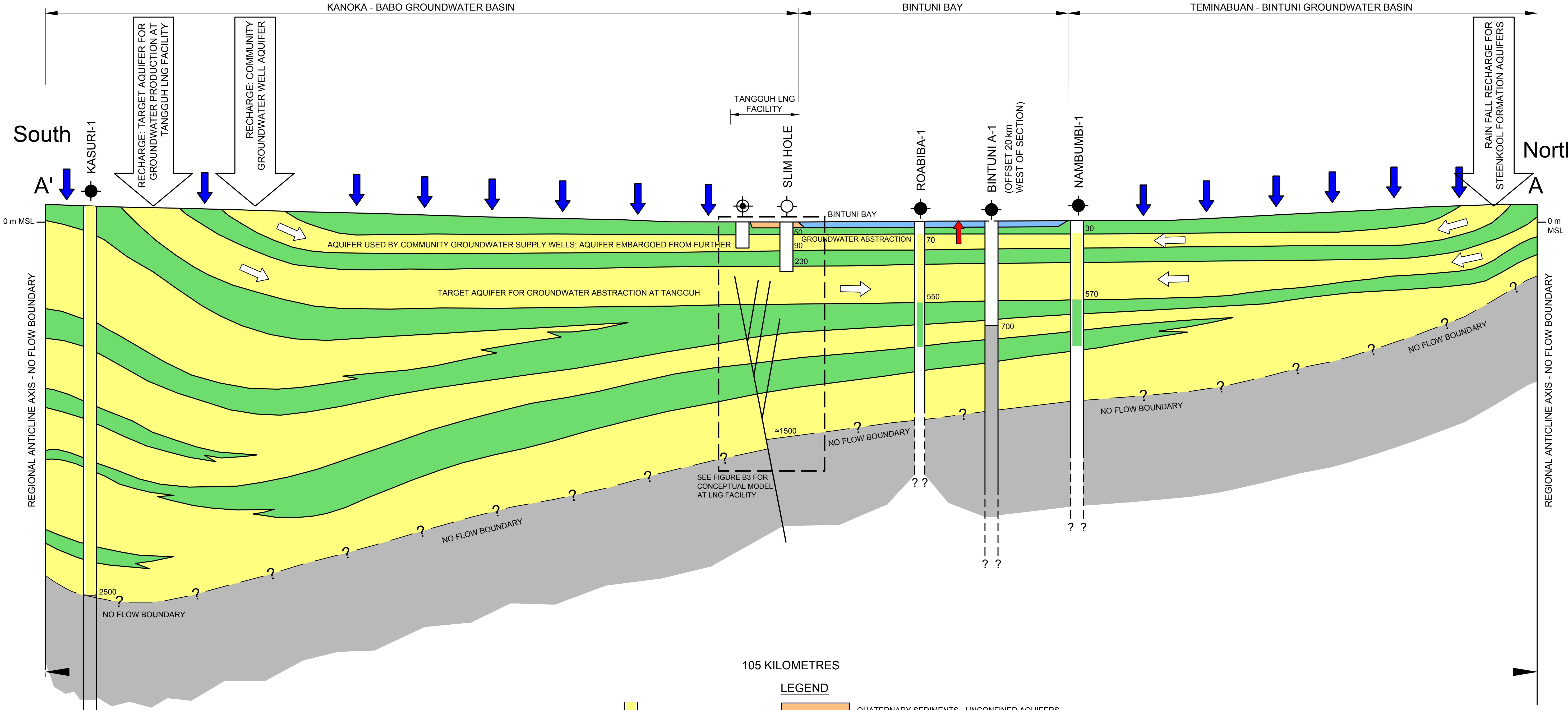


## CONCEPTUAL DIAGRAM ONLY

NOT TO SCALE

## LEGEND

BOREHOLE LOG STEENKOOL FORMATION SAND DOMINANT

BOREHOLE LOG STEENKOOL FORMATION CLAY DOMINANT

BOREHOLE LOG KAIS FORMATION

550 DEPTH OF SIGNIFICANT LITHOLOGICAL CHANGE IN BOREHOLE

RAINFALL RECHARGE

DISCHARGE TO BINTUNI BAY

QUATERNARY SEDIMENTS - UNCONFINED AQUIFERS

STEENKOOL FORMATION: CLAY DOMINANT - AQUITARDS

STEENKOOL FORMATION: SAND DOMINANT - CONFINED AQUIFERS

NEW GUINEA LIMESTONE SUPERGROUP: KAIS FORMATION - BASEMENT

SLIM HOLE — GROUNDWATER EXPLORATION BOREHOLE

KASURI-1 — OIL & GAS EXPLORATION BOREHOLE

COMMUNITY GROUNDWATER SUPPLY WELL. WELLS INSTALLED AT TANAH MERAH BARU AND SAENGGA.

FAULTING

CONCEPTUAL GROUNDWATER FLOW DIRECTION

| | | | | |
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| | DRAWN BY: DS | DATE: 26.02.2014 | DRAWING TITLE: CONCEPTUAL HYDROGEOLOGICAL MODEL REGIONAL SETTING | |
| | CHECKED BY: CW | DATE: 26.02.2014 | | |
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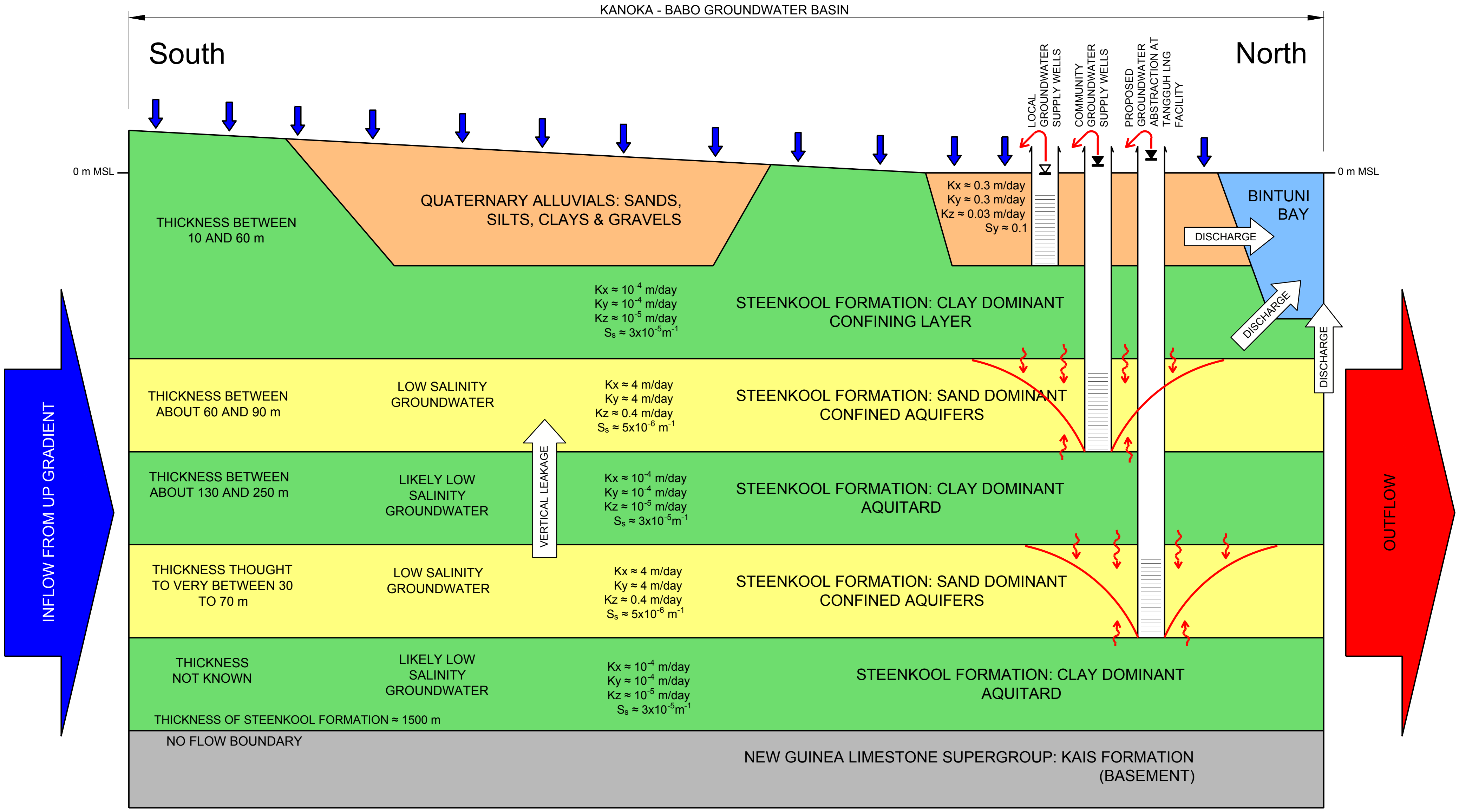


CONCEPTUAL DIAGRAM ONLY

NOT TO SCALE

LEGEND

PIEZOMETER LEVEL - CONFINED AQUIFERS

GROUNDWATER LEVEL - UNCONFINED AQUIFERS

RAINFALL RECHARGE

LEAKAGE INDUCED BY PUMPING

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| DRAWN BY: DS | DATE: 26.02.2014 | DRAWING TITLE: CONCEPTUAL HYDROGEOLOGICAL MODEL LOCAL SETTING | |
| CHECKED BY: CW | DATE: 26.02.2014 | | |
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## ATTACHMENT C – GROUNDWATER QUALITY MONITORING RESULTS FOR THE LANDFILL FACILITIES

A summary of the analytical results for the groundwater samples collected from the monitoring wells at each of the landfill facilities is presented in the following tables. Monitoring well locations are shown on **Figures 2 and 6** whilst well identifiers at each facility are summarised below.

<u>Old Organic Pit</u>

- Well 6
- Well 7
- Well 8
- Well 9
- Well 10
- Well 11
- Well 12
- Well 16

<u>Inert Landfill</u>

- BH-1
- BH-N2
- BH-3
- BH-5
- BH-N5
- BH-N6R
- BH-7
- BH-N8R

<u>Current Organic Landfill</u>

- Well 20
- Well 22
- Well 23
- Well 24
- Well 25

<u>New Inert and Organic Waste Landfill</u>

- Well 13
- Well 14
- Well 15
- Well 17
- Well 18
- Well 19

**Borehole Name: BH-01**

| Laboratory Sample I.D : | | | | | |
|---|---|---|---|---|---|
| **Date Sampled :** | | | | | **2009** |
| **No.** | **Test Description** | **Unit** | **Methods** | **Regulatory Limit** | **Aug** |
| | **Water Level Information** | | | | |
| 1 | Well depth | Meter | - | - | |
| 2 | Initial (Before Purging) | Meter | - | - | |
| 3 | Initial (After Purging) | | | | |
| 4 | Initial (Before Sampling) | Meter | - | - | |
| | | | | | |
| | **Physical Tests** | | | | |
| 1 | pH [1)] | - | APHA 4500HB | 6.0 - 9.0 | 7.2 |
| 2 | Total Dissolved Solids, TDS | mg/L | APHA 2540C | 1000 | |
| | | | | | |
| | **Anions** | | | | |
| 1 | Chloride, $Cl^-$ | mg/L | APHA 4110B | - | 4.0 |
| 2 | Sulphate, $SO_4$ | mg/L | APHA 4110B | - | 177 |
| 3 | Sulphide, as $H_2S$ | mg/L | APHA 4500S-G | 0.002 | ND |
| | | | | | |
| | **Nutrients** | | | | |
| 1 | Nitrate, $NO_3$-N | mg/L | APHA 4110B | 20 | 0.068 |
| 2 | Nitrite, $NO_2$-N | mg/L | APHA 4110B | 0.06 | ND |
| | | | | | |
| | **Dissolved Metals** | | | | |
| 1 | Arsenic, As | mg/L | APHA 3114C | 1 | 0.006 |
| 2 | Cadmium, Cd | mg/L | APHA 3111B | 0.01 | 0.0002 |
| 3 | Copper, Cu | mg/L | APHA 3111B | 0.02 | ND |
| 4 | Lead, Pb | mg/L | APHA 3113B | 0.03 | 0.070 |
| 5 | Mercury, Hg | mg/L | USEPA 245.7 | 0.002 | 0.00007 |
| 6 | Sodium, Na | mg/L | APHA 3111B | - | 8.12 |
| 7 | Zinc, Zn | mg/L | APHA 3111B | 0.05 | 0.04 |

* = Replicate

**Borehole Name: BH-02**

| Laboratory Sample I.D : | | | | | |
|---|---|---|---|---|---|
| **Date Sampled :** | | | | | **2009** |
| **No.** | **Test Description** | **Unit** | **Methods** | **Regulatory Limit** | **Aug** |
| | **Water Level Information** | | | | |
| 1 | Well depth | Meter | - | - | |
| 2 | Initial (Before Purging) | Meter | - | - | |
| 3 | Initial (After Purging) | | | | |
| 4 | Initial (Before Sampling) | Meter | - | - | |
| | | | | | |
| | **Physical Tests** | | | | |
| 1 | pH [1)] | - | APHA 4500HB | 6.0 - 9.0 | 7.1 |
| 2 | Total Dissolved Solids, TDS | mg/L | APHA 2540C | 1000 | |
| | | | | | |
| | **Anions** | | | | |
| 1 | Chloride, $Cl^-$ | mg/L | APHA 4110B | - | 2.5 |
| 2 | Sulphate, $SO_4$ | mg/L | APHA 4110B | - | 29 |
| 3 | Sulphide, as $H_2S$ | mg/L | APHA 4500S-G | 0.002 | ND |
| | | | | | |
| | **Nutrients** | | | | |
| 1 | Nitrate, $NO_3$-N | mg/L | APHA 4110B | 20 | 0.056 |
| 2 | Nitrite, $NO_2$-N | mg/L | APHA 4110B | 0.06 | ND |
| | | | | | |
| | **Dissolved Metals** | | | | |
| 1 | Arsenic, As | mg/L | APHA 3114C | 1 | 0.008 |
| 2 | Cadmium, Cd | mg/L | APHA 3111B | 0.01 | 0.0004 |
| 3 | Copper, Cu | mg/L | APHA 3111B | 0.02 | 0.04 |
| 4 | Lead, Pb | mg/L | APHA 3113B | 0.03 | 0.071 |
| 5 | Mercury, Hg | mg/L | USEPA 245.7 | 0.002 | ND |
| 6 | Sodium, Na | mg/L | APHA 3111B | - | 4.36 |
| 7 | Zinc, Zn | mg/L | APHA 3111B | 0.05 | 0.14 |

* = Replicate

**Borehole Name: BH-03**

| | | | | | |
|---|---|---|---|---|---|
| **Laboratory Sample I.D :** | | | | | |
| **Date Sampled :** | | | | | **2009** |
| **No.** | **Test Description** | **Unit** | **Methods** | **Regulatory Limit** | **Aug** |
| | **Water Level Information** | | | | |
| 1 | Well depth | Meter | - | - | |
| 2 | Initial (Before Purging) | Meter | - | - | |
| 3 | Initial (After Purging) | | | | |
| 4 | Initial (Before Sampling) | Meter | - | - | |
| | | | | | |
| | **Physical Tests** | | | | |
| 1 | pH 1) | - | APHA 4500HB | 6.0 - 9.0 | 6.8 |
| 2 | Total Dissolved Solids, TDS | mg/L | APHA 2540C | 1000 | |
| | | | | | |
| | **Anions** | | | | |
| 1 | Chloride, $Cl^-$ | mg/L | APHA 4110B | - | 4.5 |
| 2 | Sulphate, $SO_4$ | mg/L | APHA 4110B | - | 30 |
| 3 | Sulphide, as $H_2S$ | mg/L | APHA 4500S-G | 0.002 | ND |
| | | | | | |
| | **Nutrients** | | | | |
| 1 | Nitrate, $NO_3$-N | mg/L | APHA 4110B | 20 | 0.049 |
| 2 | Nitrite, $NO_2$-N | mg/L | APHA 4110B | 0.06 | ND |
| | | | | | |
| | **Dissolved Metals** | | | | |
| 1 | Arsenic, As | mg/L | APHA 3114C | 1 | 0.015 |
| 2 | Cadmium, Cd | mg/L | APHA 3111B | 0.01 | 0.0001 |
| 3 | Copper, Cu | mg/L | APHA 3111B | 0.02 | ND |
| 4 | Lead, Pb | mg/L | APHA 3113B | 0.03 | 0.017 |
| 5 | Mercury, Hg | mg/L | USEPA 245.7 | 0.002 | ND |
| 6 | Sodium, Na | mg/L | APHA 3111B | - | 13.30 |
| 7 | Zinc, Zn | mg/L | APHA 3111B | 0.05 | 0.02 |

* = Replicate

**Borehole Name: BH-04**

| | | | | | |
|---|---|---|---|---|---|
| **Laboratory Sample I.D :** | | | | | |
| **Date Sampled :** | | | | | **2009** |
| **No.** | **Test Description** | **Unit** | **Methods** | **Regulatory Limit** | **Aug** |
| | **Water Level Information** | | | | |
| 1 | Well depth | Meter | - | - | |
| 2 | Initial (Before Purging) | Meter | - | - | |
| 3 | Initial (After Purging) | | | | |
| 4 | Initial (Before Sampling) | Meter | - | - | |
| | | | | | |
| | **Physical Tests** | | | | |
| 1 | pH 1) | - | APHA 4500HB | 6.0 - 9.0 | 6.6 |
| 2 | Total Dissolved Solids, TDS | mg/L | APHA 2540C | 1000 | |
| | | | | | |
| | **Anions** | | | | |
| 1 | Chloride, $Cl^-$ | mg/L | APHA 4110B | - | 3.7 |
| 2 | Sulphate, $SO_4$ | mg/L | APHA 4110B | - | 11 |
| 3 | Sulphide, as $H_2S$ | mg/L | APHA 4500S-G | 0.002 | ND |
| | | | | | |
| | **Nutrients** | | | | |
| 1 | Nitrate, $NO_3$-N | mg/L | APHA 4110B | 20 | 0.027 |
| 2 | Nitrite, $NO_2$-N | mg/L | APHA 4110B | 0.06 | 0.014 |
| | | | | | |
| | **Dissolved Metals** | | | | |
| 1 | Arsenic, As | mg/L | APHA 3114C | 1 | 0.088 |
| 2 | Cadmium, Cd | mg/L | APHA 3111B | 0.01 | 0.0008 |
| 3 | Copper, Cu | mg/L | APHA 3111B | 0.02 | ND |
| 4 | Lead, Pb | mg/L | APHA 3113B | 0.03 | 0.027 |
| 5 | Mercury, Hg | mg/L | USEPA 245.7 | 0.002 | ND |
| 6 | Sodium, Na | mg/L | APHA 3111B | - | 36.00 |
| 7 | Zinc, Zn | mg/L | APHA 3111B | 0.05 | ND |

* = Replicate

**Borehole Name: BH-05**

| **Laboratory Sample I.D :** | | | | | |
|---|---|---|---|---|---|
| **Date Sampled :** | | | | | **2009** |
| **No.** | **Test Description** | **Unit** | **Methods** | **Regulatory Limit** | **Aug** |
| | **Water Level Information** | | | | |
| 1 | Well depth | Meter | - | - | |
| 2 | Initial (Before Purging) | Meter | - | - | |
| 3 | Initial (After Purging) | | | | |
| 4 | Initial (Before Sampling) | Meter | - | - | |
| | | | | | |
| | **Physical Tests** | | | | |
| 1 | pH [1)] | - | APHA 4500HB | 6.0 - 9.0 | 6.4 |
| 2 | Total Dissolved Solids, TDS | mg/L | APHA 2540C | 1000 | |
| | | | | | |
| | **Anions** | | | | |
| 1 | Chloride, $Cl^-$ | mg/L | APHA 4110B | - | 19.9 |
| 2 | Sulphate, $SO_4$ | mg/L | APHA 4110B | - | 2 |
| 3 | Sulphide, as $H_2S$ | mg/L | APHA 4500S-G | 0.002 | ND |
| | | | | | |
| | **Nutrients** | | | | |
| 1 | Nitrate, $NO_3$-N | mg/L | APHA 4110B | 20 | 0.078 |
| 2 | Nitrite, $NO_2$-N | mg/L | APHA 4110B | 0.06 | 0.005 |
| | | | | | |
| | **Dissolved Metals** | | | | |
| 1 | Arsenic, As | mg/L | APHA 3114C | 1 | 0.008 |
| 2 | Cadmium, Cd | mg/L | APHA 3111B | 0.01 | 0.0001 |
| 3 | Copper, Cu | mg/L | APHA 3111B | 0.02 | ND |
| 4 | Lead, Pb | mg/L | APHA 3113B | 0.03 | 0.074 |
| 5 | Mercury, Hg | mg/L | USEPA 245.7 | 0.002 | ND |
| 6 | Sodium, Na | mg/L | APHA 3111B | - | 8.98 |
| 7 | Zinc, Zn | mg/L | APHA 3111B | 0.05 | 0.04 |

* = Replicate

**Borehole Name: BH-06**

| **Laboratory Sample I.D :** | | | | | |
|---|---|---|---|---|---|
| **Date Sampled :** | | | | | **2009** |
| **No.** | **Test Description** | **Unit** | **Methods** | **Regulatory Limit** | **Aug** |
| | **Water Level Information** | | | | |
| 1 | Well depth | Meter | - | - | |
| 2 | Initial (Before Purging) | Meter | - | - | |
| 3 | Initial (After Purging) | | | | |
| 4 | Initial (Before Sampling) | Meter | - | - | |
| | | | | | |
| | **Physical Tests** | | | | |
| 1 | pH [1)] | - | APHA 4500HB | 6.0 - 9.0 | 7.1 |
| 2 | Total Dissolved Solids, TDS | mg/L | APHA 2540C | 1000 | |
| | | | | | |
| | **Anions** | | | | |
| 1 | Chloride, $Cl^-$ | mg/L | APHA 4110B | - | 3.2 |
| 2 | Sulphate, $SO_4$ | mg/L | APHA 4110B | - | 58 |
| 3 | Sulphide, as $H_2S$ | mg/L | APHA 4500S-G | 0.002 | ND |
| | | | | | |
| | **Nutrients** | | | | |
| 1 | Nitrate, $NO_3$-N | mg/L | APHA 4110B | 20 | 0.031 |
| 2 | Nitrite, $NO_2$-N | mg/L | APHA 4110B | 0.06 | ND |
| | | | | | |
| | **Dissolved Metals** | | | | |
| 1 | Arsenic, As | mg/L | APHA 3114C | 1 | 0.006 |
| 2 | Cadmium, Cd | mg/L | APHA 3111B | 0.01 | 0.0004 |
| 3 | Copper, Cu | mg/L | APHA 3111B | 0.02 | ND |
| 4 | Lead, Pb | mg/L | APHA 3113B | 0.03 | 0.050 |
| 5 | Mercury, Hg | mg/L | USEPA 245.7 | 0.002 | ND |
| 6 | Sodium, Na | mg/L | APHA 3111B | - | 5.69 |
| 7 | Zinc, Zn | mg/L | APHA 3111B | 0.05 | 0.07 |

* = Replicate

**Borehole Name: Well 1**

| **Laboratory Sample I.D :** | | | | | |
|---|---|---|---|---|---|
| **Date Sampled :** | | | | | **2009** |
| **No.** | **Test Description** | **Unit** | **Methods** | **Regulatory Limit** | **May** |
| | **Water Level Information** | | | | |
| 1 | Well depth | Meter | - | - | |
| 2 | Initial (Before Purging) | Meter | - | - | |
| 3 | Initial (After Purging) | | | | |
| 4 | Initial (Before Sampling) | Meter | - | - | |
| | | | | | |
| | **Physical Tests** | | | | |
| 1 | pH [1)] | - | APHA 4500HB | 6.0 - 9.0 | 6.9 |
| 2 | Total Dissolved Solids, TDS | mg/L | APHA 2540C | 1000 | |
| | | | | | |
| | **Anions** | | | | |
| 1 | Chloride, $Cl^-$ | mg/L | APHA 4110B | - | 6.1 |
| 2 | Sulphate, $SO_4$ | mg/L | APHA 4110B | - | 136 |
| 3 | Sulphide, as $H_2S$ | mg/L | APHA 4500S-G | 0.002 | ND |
| | | | | | |
| | **Nutrients** | | | | |
| 1 | Nitrate, $NO_3$-N | mg/L | APHA 4110B | 20 | 0.057 |
| 2 | Nitrite, $NO_2$-N | mg/L | APHA 4110B | 0.06 | ND |
| | | | | | |
| | **Dissolved Metals** | | | | |
| 1 | Arsenic, As | mg/L | APHA 3114C | 1 | 0.001 |
| 2 | Cadmium, Cd | mg/L | APHA 3111B | 0.01 | ND |
| 3 | Copper, Cu | mg/L | APHA 3111B | 0.02 | ND |
| 4 | Lead, Pb | mg/L | APHA 3113B | 0.03 | 0.011 |
| 5 | Mercury, Hg | mg/L | USEPA 245.7 | 0.002 | ND |
| 6 | Sodium, Na | mg/L | APHA 3111B | - | 9.66 |
| 7 | Zinc, Zn | mg/L | APHA 3111B | 0.05 | 0.07 |

* = Replicate

**Borehole Name: Well 2**

| **Laboratory Sample I.D :** | | | | | |
|---|---|---|---|---|---|
| **Date Sampled :** | | | | | **2009** |
| **No.** | **Test Description** | **Unit** | **Methods** | **Regulatory Limit** | **May** |
| | **Water Level Information** | | | | |
| 1 | Well depth | Meter | - | - | |
| 2 | Initial (Before Purging) | Meter | - | - | |
| 3 | Initial (After Purging) | | | | |
| 4 | Initial (Before Sampling) | Meter | - | - | |
| | | | | | |
| | **Physical Tests** | | | | |
| 1 | pH [1)] | - | APHA 4500HB | 6.0 - 9.0 | 6.8 |
| 2 | Total Dissolved Solids, TDS | mg/L | APHA 2540C | 1000 | |
| | | | | | |
| | **Anions** | | | | |
| 1 | Chloride, $Cl^-$ | mg/L | APHA 4110B | - | 5.3 |
| 2 | Sulphate, $SO_4$ | mg/L | APHA 4110B | - | 34 |
| 3 | Sulphide, as $H_2S$ | mg/L | APHA 4500S-G | 0.002 | ND |
| | | | | | |
| | **Nutrients** | | | | |
| 1 | Nitrate, $NO_3$-N | mg/L | APHA 4110B | 20 | 0.033 |
| 2 | Nitrite, $NO_2$-N | mg/L | APHA 4110B | 0.06 | ND |
| | | | | | |
| | **Dissolved Metals** | | | | |
| 1 | Arsenic, As | mg/L | APHA 3114C | 1 | 0.005 |
| 2 | Cadmium, Cd | mg/L | APHA 3111B | 0.01 | ND |
| 3 | Copper, Cu | mg/L | APHA 3111B | 0.02 | ND |
| 4 | Lead, Pb | mg/L | APHA 3113B | 0.03 | 0.018 |
| 5 | Mercury, Hg | mg/L | USEPA 245.7 | 0.002 | ND |
| 6 | Sodium, Na | mg/L | APHA 3111B | - | 4.68 |
| 7 | Zinc, Zn | mg/L | APHA 3111B | 0.05 | 0.02 |

* = Replicate

**Borehole Name: Well 3**

| **Laboratory Sample I.D :** | | | | | |
|---|---|---|---|---|---|
| **Date Sampled :** | | | | | **2009** |
| **No.** | **Test Description** | **Unit** | **Methods** | **Regulatory Limit** | **May** |
| | **Water Level Information** | | | | |
| 1 | Well depth | Meter | - | - | |
| 2 | Initial (Before Purging) | Meter | - | - | |
| 3 | Initial (After Purging) | | | | |
| 4 | Initial (Before Sampling) | Meter | - | - | |
| | | | | | |
| | **Physical Tests** | | | | |
| 1 | pH [1)] | - | APHA 4500HB | 6.0 - 9.0 | 6.6 |
| 2 | Total Dissolved Solids, TDS | mg/L | APHA 2540C | 1000 | |
| | | | | | |
| | **Anions** | | | | |
| 1 | Chloride, $Cl^-$ | mg/L | APHA 4110B | - | 2.3 |
| 2 | Sulphate, $SO_4$ | mg/L | APHA 4110B | - | 64 |
| 3 | Sulphide, as $H_2S$ | mg/L | APHA 4500S-G | 0.002 | ND |
| | | | | | |
| | **Nutrients** | | | | |
| 1 | Nitrate, $NO_3$-N | mg/L | APHA 4110B | 20 | ND |
| 2 | Nitrite, $NO_2$-N | mg/L | APHA 4110B | 0.06 | ND |
| | | | | | |
| | **Dissolved Metals** | | | | |
| 1 | Arsenic, As | mg/L | APHA 3114C | 1 | 0.014 |
| 2 | Cadmium, Cd | mg/L | APHA 3111B | 0.01 | ND |
| 3 | Copper, Cu | mg/L | APHA 3111B | 0.02 | ND |
| 4 | Lead, Pb | mg/L | APHA 3113B | 0.03 | 0.026 |
| 5 | Mercury, Hg | mg/L | USEPA 245.7 | 0.002 | ND |
| 6 | Sodium, Na | mg/L | APHA 3111B | - | 14.8 |
| 7 | Zinc, Zn | mg/L | APHA 3111B | 0.05 | 0.03 |

* = Replicate

**Borehole Name: Well 4**

| **Laboratory Sample I.D :** | | | | | |
|---|---|---|---|---|---|
| **Date Sampled :** | | | | | **2009** |
| **No.** | **Test Description** | **Unit** | **Methods** | **Regulatory Limit** | **May** |
| | **Water Level Information** | | | | |
| 1 | Well depth | Meter | - | - | |
| 2 | Initial (Before Purging) | Meter | - | - | |
| 3 | Initial (After Purging) | | | | |
| 4 | Initial (Before Sampling) | Meter | - | - | |
| | | | | | |
| | **Physical Tests** | | | | |
| 1 | pH [1)] | - | APHA 4500HB | 6.0 - 9.0 | 6.7 |
| 2 | Total Dissolved Solids, TDS | mg/L | APHA 2540C | 1000 | |
| | | | | | |
| | **Anions** | | | | |
| 1 | Chloride, $Cl^-$ | mg/L | APHA 4110B | - | 4.2 |
| 2 | Sulphate, $SO_4$ | mg/L | APHA 4110B | - | 19 |
| 3 | Sulphide, as $H_2S$ | mg/L | APHA 4500S-G | 0.002 | ND |
| | | | | | |
| | **Nutrients** | | | | |
| 1 | Nitrate, $NO_3$-N | mg/L | APHA 4110B | 20 | 0.058 |
| 2 | Nitrite, $NO_2$-N | mg/L | APHA 4110B | 0.06 | ND |
| | | | | | |
| | **Dissolved Metals** | | | | |
| 1 | Arsenic, As | mg/L | APHA 3114C | 1 | 0.048 |
| 2 | Cadmium, Cd | mg/L | APHA 3111B | 0.01 | ND |
| 3 | Copper, Cu | mg/L | APHA 3111B | 0.02 | ND |
| 4 | Lead, Pb | mg/L | APHA 3113B | 0.03 | 0.080 |
| 5 | Mercury, Hg | mg/L | USEPA 245.7 | 0.002 | ND |
| 6 | Sodium, Na | mg/L | APHA 3111B | - | 39.3 |
| 7 | Zinc, Zn | mg/L | APHA 3111B | 0.05 | 0.03 |

* = Replicate

**Borehole Name: Well 5**

| | | | | | |
|---|---|---|---|---|---|
| **Laboratory Sample I.D :** | | | | | |
| **Date Sampled :** | | | | | **2009** |
| **No.** | **Test Description** | **Unit** | **Methods** | **Regulatory Limit** | **May** |
| | **Water Level Information** | | | | |
| 1 | Well depth | Meter | - | - | |
| 2 | Initial (Before Purging) | Meter | - | - | |
| 3 | Initial (After Purging) | | | | |
| 4 | Initial (Before Sampling) | Meter | - | - | |
| | | | | | |
| | **Physical Tests** | | | | |
| 1 | pH [1)] | - | APHA 4500HB | 6.0 - 9.0 | 6.6 |
| 2 | Total Dissolved Solids, TDS | mg/L | APHA 2540C | 1000 | |
| | | | | | |
| | **Anions** | | | | |
| 1 | Chloride, $Cl^-$ | mg/L | APHA 4110B | - | 16.0 |
| 2 | Sulphate, $SO_4$ | mg/L | APHA 4110B | - | ND |
| 3 | Sulphide, as $H_2S$ | mg/L | APHA 4500S-G | 0.002 | ND |
| | | | | | |
| | **Nutrients** | | | | |
| 1 | Nitrate, $NO_3$-N | mg/L | APHA 4110B | 20 | 0.060 |
| 2 | Nitrite, $NO_2$-N | mg/L | APHA 4110B | 0.06 | ND |
| | | | | | |
| | **Dissolved Metals** | | | | |
| 1 | Arsenic, As | mg/L | APHA 3114C | 1 | 0.005 |
| 2 | Cadmium, Cd | mg/L | APHA 3111B | 0.01 | ND |
| 3 | Copper, Cu | mg/L | APHA 3111B | 0.02 | ND |
| 4 | Lead, Pb | mg/L | APHA 3113B | 0.03 | 0.123 |
| 5 | Mercury, Hg | mg/L | USEPA 245.7 | 0.002 | ND |
| 6 | Sodium, Na | mg/L | APHA 3111B | - | 8.93 |
| 7 | Zinc, Zn | mg/L | APHA 3111B | 0.05 | 0.04 |

* = Replicate

**Borehole Name: Well 6**

| No. | Test Description | Unit | Methods | Regulatory Limit | 2009 May | 2009 Aug | 2009 Dec | 2010 May | 2010 Sep | 2010 Sep* | 2010 Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Laboratory Sample I.D :** | | | | | | | | | | | |
| **Date Sampled :** | | | | | | | | | | | |
| | **Water Level Information** | | | | | | | | | | |
| 1 | Well depth | Meter | - | - | | | | | | | |
| 2 | Initial (Before Purging) | Meter | - | - | | | | | | | |
| 3 | Initial (After Purging) | | | | | | | | | | |
| 4 | Initial (Before Sampling) | Meter | - | - | | | | | | | |
| | | | | | | | | | | | |
| | **Physical Tests** | | | | | | | | | | |
| 1 | pH [1)] | - | APHA 4500HB | 6.0 - 9.0 | 7.0 | 7.9 | 8.1 | 7.4 | 7.3 | 7.3 | 7.4 |
| 2 | Total Dissolved Solids, TDS | mg/L | APHA 2540C | 1000 | | | | | | | |
| | | | | | | | | | | | |
| | **Anions** | | | | | | | | | | |
| 1 | Chloride, $Cl^-$ | mg/L | APHA 4110B | - | 3.6 | 4.7 | 4.0 | 0.8 | <0.5 | <0.5 | 1.3 |
| 2 | Sulphate, $SO_4$ | mg/L | APHA 4110B | - | 76 | ND | 8 | <2 | <2 | <2 | 3 |
| 3 | Sulphide, as $H_2S$ | mg/L | APHA 4500S-G | 0.002 | ND | ND | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 |
| | | | | | | | | | | | |
| | **Nutrients** | | | | | | | | | | |
| 1 | Nitrate, $NO_3$-N | mg/L | APHA 4110B | 20 | 0.057 | ND | <0.005 | <0.005 | 0.049 | 0.049 | <0.005 |
| 2 | Nitrite, $NO_2$-N | mg/L | APHA 4110B | 0.06 | 0.007 | 0.050 | <0.001 | 0.020 | 0.003 | 0.003 | 0.037 |
| | | | | | | | | | | | |
| | **Dissolved Metals** | | | | | | | | | | |
| 1 | Arsenic, As | mg/L | APHA 3114C | 1 | 0.004 | ND | <0.01 | <0.001 | <0.001 | <0.001 | <0.001 |
| 2 | Cadmium, Cd | mg/L | APHA 3111B | 0.01 | ND | ND | 0.0004 | 0.0004 | <0.0001 | <0.0001 | <0.0001 |
| 3 | Copper, Cu | mg/L | APHA 3111B | 0.02 | ND | ND | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 4 | Lead, Pb | mg/L | APHA 3113B | 0.03 | 0.047 | ND | 0.004 | <0.001 | <0.001 | <0.001 | 0.001 |
| 5 | Mercury, Hg | mg/L | USEPA 245.7 | 0.002 | ND | ND | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 |
| 6 | Sodium, Na | mg/L | APHA 3111B | - | 6.15 | 12.00 | 6.59 | 8.70 | 8.46 | 8.61 | 9.74 |
| 7 | Zinc, Zn | mg/L | APHA 3111B | 0.05 | 0.09 | ND | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 |

* = Replicate

**Borehole Name: Well 7**

| No. | Test Description | Unit | Methods | Regulatory Limit | 2009 May | 2009 Aug | 2009 Dec | 2010 May | 2010 Sep | 2010 Dec |
|---|---|---|---|---|---|---|---|---|---|---|
| **Laboratory Sample I.D :** | | | | | | | | | | |
| **Date Sampled :** | | | | | | | | | | |
| | **Water Level Information** | | | | | | | | | |
| 1 | Well depth | Meter | - | - | | | | | | |
| 2 | Initial (Before Purging) | Meter | - | - | | | | | | |
| 3 | Initial (After Purging) | | | | | | | | | |
| 4 | Initial (Before Sampling) | Meter | - | - | | | | | | |
| | | | | | | | | | | |
| | **Physical Tests** | | | | | | | | | |
| 1 | pH [1)] | - | APHA 4500HB | 6.0 - 9.0 | 6.0 | 6.9 | 8.1 | 7.3 | 7.3 | 7.3 |
| 2 | Total Dissolved Solids, TDS | mg/L | APHA 2540C | 1000 | | | | | | |
| | | | | | | | | | | |
| | **Anions** | | | | | | | | | |
| 1 | Chloride, $Cl^-$ | mg/L | APHA 4110B | - | 4.9 | 0.6 | <0.5 | <0.5 | <0.5 | <0.5 |
| 2 | Sulphate, $SO_4$ | mg/L | APHA 4110B | - | 2490 | ND | <2 | <2 | <2 | 4 |
| 3 | Sulphide, as $H_2S$ | mg/L | APHA 4500S-G | 0.002 | ND | ND | <0.002 | <0.002 | <0.002 | <0.002 |
| | | | | | | | | | | |
| | **Nutrients** | | | | | | | | | |
| 1 | Nitrate, $NO_3$-N | mg/L | APHA 4110B | 20 | 0.081 | 0.020 | <0.005 | <0.005 | 0.018 | <0.005 |
| 2 | Nitrite, $NO_2$-N | mg/L | APHA 4110B | 0.06 | ND | 0.001 | 0.006 | 0.005 | <0.001 | 0.034 |
| | | | | | | | | | | |
| | **Dissolved Metals** | | | | | | | | | |
| 1 | Arsenic, As | mg/L | APHA 3114C | 1 | 0.009 | ND | <0.01 | <0.001 | <0.001 | <0.001 |
| 2 | Cadmium, Cd | mg/L | APHA 3111B | 0.01 | 0.0005 | ND | 0.0017 | 0.0006 | <0.0001 | <0.0001 |
| 3 | Copper, Cu | mg/L | APHA 3111B | 0.02 | ND | ND | <0.01 | <0.01 | <0.01 | <0.01 |
| 4 | Lead, Pb | mg/L | APHA 3113B | 0.03 | 0.099 | 0.004 | 0.005 | <0.001 | <0.001 | 0.009 |
| 5 | Mercury, Hg | mg/L | USEPA 245.7 | 0.002 | ND | ND | <0.00005 | <0.00005 | <0.00005 | <0.00005 |
| 6 | Sodium, Na | mg/L | APHA 3111B | - | 25.6 | 11.20 | 13.20 | 10.7 | 10.2 | 11.7 |
| 7 | Zinc, Zn | mg/L | APHA 3111B | 0.05 | 0.47 | 0.05 | 0.01 | <0.01 | <0.01 | <0.01 |

* = Replicate

**Borehole Name: Well 8**

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Laboratory Sample I.D :** | | | | | | | | | | |
| **Date Sampled :** | | | | | **2009** | | | **2010** | | |
| **No.** | **Test Description** | **Unit** | **Methods** | **Regulatory Limit** | **May** | **Aug** | **Dec** | **May** | **Sep** | **Dec** |
| | **Water Level Information** | | | | | | | | | |
| 1 | Well depth | Meter | - | - | | | | | | |
| 2 | Initial (Before Purging) | Meter | - | - | | | | | | |
| 3 | Initial (After Purging) | | | | | | | | | |
| 4 | Initial (Before Sampling) | Meter | - | - | | | | | | |
| | | | | | | | | | | |
| | **Physical Tests** | | | | | | | | | |
| 1 | pH 1) | - | APHA 4500HB | 6.0 - 9.0 | 6.3 | 7.0 | 7.8 | 7.0 | 7.0 | 7.0 |
| 2 | Total Dissolved Solids, TDS | mg/L | APHA 2540C | 1000 | | | | | | |
| | | | | | | | | | | |
| | **Anions** | | | | | | | | | |
| 1 | Chloride, $Cl^-$ | mg/L | APHA 4110B | - | 5.3 | 1.6 | <0.5 | <0.5 | 0.6 | <0.5 |
| 2 | Sulphate, $SO_4$ | mg/L | APHA 4110B | - | 981 | ND | <2 | <2 | <2 | <2 |
| 3 | Sulphide, as $H_2S$ | mg/L | APHA 4500S-G | 0.002 | ND | ND | <0.002 | <0.002 | <0.002 | <0.002 |
| | | | | | | | | | | |
| | **Nutrients** | | | | | | | | | |
| 1 | Nitrate, $NO_3$-N | mg/L | APHA 4110B | 20 | 0.056 | 0.034 | 0.012 | <0.005 | 0.073 | 0.013 |
| 2 | Nitrite, $NO_2$-N | mg/L | APHA 4110B | 0.06 | ND | 0.006 | 0.006 | 0.005 | 0.017 | 0.012 |
| | | | | | | | | | | |
| | **Dissolved Metals** | | | | | | | | | |
| 1 | Arsenic, As | mg/L | APHA 3114C | 1 | 0.003 | 0.020 | <0.01 | <0.001 | <0.001 | 0.002 |
| 2 | Cadmium, Cd | mg/L | APHA 3111B | 0.01 | ND | ND | <0.0001 | 0.0003 | <0.0001 | <0.0001 |
| 3 | Copper, Cu | mg/L | APHA 3111B | 0.02 | ND | ND | <0.01 | <0.01 | <0.01 | <0.01 |
| 4 | Lead, Pb | mg/L | APHA 3113B | 0.03 | 0.065 | 0.003 | 0.002 | <0.001 | 0.003 | 0.004 |
| 5 | Mercury, Hg | mg/L | USEPA 245.7 | 0.002 | ND | ND | <0.00005 | <0.00005 | <0.00005 | <0.00005 |
| 6 | Sodium, Na | mg/L | APHA 3111B | - | 16.3 | 13.20 | 13.00 | 10.7 | 9.54 | 11.2 |
| 7 | Zinc, Zn | mg/L | APHA 3111B | 0.05 | 7.28 | ND | 0.01 | <0.01 | <0.01 | <0.01 |

* = Replicate

**Borehole Name: Well 9**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Laboratory Sample I.D :** | | | | | | | | | |
| **Date Sampled :** | | | | | **2009** | | **2010** | | |
| **No.** | **Test Description** | **Unit** | **Methods** | **Regulatory Limit** | **Aug** | **Dec** | **May** | **May*** | **Sep** |
| | **Water Level Information** | | | | | | | | |
| 1 | Well depth | Meter | - | - | | | | | |
| 2 | Initial (Before Purging) | Meter | - | - | | | | | |
| 3 | Initial (After Purging) | | | | | | | | |
| 4 | Initial (Before Sampling) | Meter | - | - | | | | | |
| | | | | | | | | | |
| | **Physical Tests** | | | | | | | | |
| 1 | pH 1) | - | APHA 4500HB | 6.0 - 9.0 | 7.3 | 7.9 | 7.3 | 7.3 | 7.3 |
| 2 | Total Dissolved Solids, TDS | mg/L | APHA 2540C | 1000 | | | | | |
| | | | | | | | | | |
| | **Anions** | | | | | | | | |
| 1 | Chloride, $Cl^-$ | mg/L | APHA 4110B | - | 1.6 | 1.9 | 0.6 | 0.6 | 0.6 |
| 2 | Sulphate, $SO_4$ | mg/L | APHA 4110B | - | ND | <2 | <2 | <2 | <2 |
| 3 | Sulphide, as $H_2S$ | mg/L | APHA 4500S-G | 0.002 | ND | <0.002 | <0.002 | <0.002 | <0.002 |
| | | | | | | | | | |
| | **Nutrients** | | | | | | | | |
| 1 | Nitrate, $NO_3$-N | mg/L | APHA 4110B | 20 | ND | 0.158 | <0.005 | <0.005 | 0.016 |
| 2 | Nitrite, $NO_2$-N | mg/L | APHA 4110B | 0.06 | 0.001 | <0.001 | <0.001 | <0.001 | 0.005 |
| | | | | | | | | | |
| | **Dissolved Metals** | | | | | | | | |
| 1 | Arsenic, As | mg/L | APHA 3114C | 1 | ND | <0.01 | <0.001 | <0.001 | <0.001 |
| 2 | Cadmium, Cd | mg/L | APHA 3111B | 0.01 | 0.0001 | 0.0003 | 0.0002 | 0.0002 | <0.0001 |
| 3 | Copper, Cu | mg/L | APHA 3111B | 0.02 | ND | <0.01 | <0.01 | <0.01 | <0.01 |
| 4 | Lead, Pb | mg/L | APHA 3113B | 0.03 | ND | 0.006 | <0.001 | <0.001 | 0.002 |
| 5 | Mercury, Hg | mg/L | USEPA 245.7 | 0.002 | ND | <0.00005 | <0.00005 | <0.00005 | <0.00005 |
| 6 | Sodium, Na | mg/L | APHA 3111B | - | 22.50 | 24.00 | 19.7 | 19.4 | 20.1 |
| 7 | Zinc, Zn | mg/L | APHA 3111B | 0.05 | 0.01 | 0.01 | <0.01 | <0.01 | <0.01 |

* = Replicate

**Borehole Name: Well 10**

| Laboratory Sample I.D : | | | | | | | | | | | EV120116-28 | EV120759-17 | EV130143-10 | EV130628-33 | EV131143-19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Date Sampled :** | | | | | 2009 | | 2010 | | | 2011 | 2012 | | 2013 | | |
| **No.** | **Test Description** | **Unit** | **Methods** | **Regulatory Limit** | **Aug** | **Dec** | **May** | **Sep** | **Dec** | **Aug** | **Feb** | **Sep** | **Feb** | **Jun** | **Nov** |
| | **Water Level Information** | | | | | | | | | | | | | | |
| 1 | Well depth | Meter | - | - | | | | | | | | | | 7.28 | 6.86 |
| 2 | Initial (Before Purging) | Meter | - | - | | | | | | | | 2.40 | 2.53 | 2.50 | 2.82 |
| 3 | Initial (After Purging) | | | | | | | | | | | | 7.10 | | |
| 4 | Initial (Before Sampling) | Meter | - | - | | | | | | | | 2.50 | 2.62 | 2.56 | 2.88 |
| | | | | | | | | | | | | | | | |
| | **Physical Tests** | | | | | | | | | | | | | | |
| 1 | pH [1)] | - | APHA 4500HB | 6.0 - 9.0 | 9.2 | 7.8 | 7.0 | 7.1 | 7.0 | 6.6 | 6.97 | 7.43 | 6.56 | 7.07 | 6.75 |
| 2 | Total Dissolved Solids, TDS | mg/L | APHA 2540C | 1000 | | | | | | | 368 | 325 | 333 | 266 | 268 |
| | | | | | | | | | | | | | | | |
| | **Anions** | | | | | | | | | | | | | | |
| 1 | Chloride, $Cl^-$ | mg/L | APHA 4110B | - | 5.1 | 0.8 | 0.9 | 5.1 | 5.1 | 7.8 | 6.4 | 11.9 | 8.9 | 8.3 | 8.4 |
| 2 | Sulphate, $SO_4$ | mg/L | APHA 4110B | - | 24 | 6 | <2 | 15 | 12 | 13 | 9 | 13 | 12 | 9 | 8 |
| 3 | Sulphide, as $H_2S$ | mg/L | APHA 4500S-G | 0.002 | ND | <0.002 | <0.002 | <0.002 | <0.002 | **0.015** | <0.002 | <0.002 | <0.002 | <0.002 | <0.001 |
| | | | | | | | | | | | | | | | |
| | **Nutrients** | | | | | | | | | | | | | | |
| 1 | Nitrate, $NO_3$-N | mg/L | APHA 4110B | 20 | ND | 0.072 | <0.005 | 0.025 | 0.020 | <0.005 | <0.005 | 0.009 | 0.043 | <0.005 | <0.005 |
| 2 | Nitrite, $NO_2$-N | mg/L | APHA 4110B | 0.06 | ND | <0.001 | **0.082** | <0.001 | <0.001 | <0.001 | <0.001 | 0.005 | <0.001 | <0.001 | <0.001 |
| | | | | | | | | | | | | | | | |
| | **Dissolved Metals** | | | | | | | | | | | | | | |
| 1 | Arsenic, As | mg/L | APHA 3114C | 1 | 0.008 | <0.01 | <0.001 | <0.001 | 0.001 | <0.001 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 |
| 2 | Cadmium, Cd | mg/L | APHA 3111B | 0.01 | ND | 0.0009 | 0.0004 | <0.0001 | <0.0001 | <0.0001 | <0.005 | 0.0003 | <0.005 | <0.005 | <0.005 |
| 3 | Copper, Cu | mg/L | APHA 3111B | 0.02 | ND | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.001 | <0.01 | <0.01 | <0.01 |
| 4 | Lead, Pb | mg/L | APHA 3113B | 0.03 | ND | 0.005 | <0.001 | 0.002 | 0.003 | 0.010 | <0.001 | <0.001 | <0.001 | 0.002 | 0.006 |
| 5 | Mercury, Hg | mg/L | USEPA 245.7 | 0.002 | 0.00008 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 |
| 6 | Sodium, Na | mg/L | APHA 3111B | - | 2.78 | 13.70 | 2.28 | 2.48 | 2.90 | 2.69 | 2.71 | 4.17 | 3.13 | 2.91 | 2.23 |
| 7 | Zinc, Zn | mg/L | APHA 3111B | 0.05 | ND | 0.01 | <0.01 | 0.01 | <0.01 | <0.05 | 0.006 | 0.010 | 0.008 | 0.012 | 0.008 |

* = Replicate

**Borehole Name: Well 11**

| **Laboratory Sample I.D :** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Date Sampled :** | | | | | **2009** | | **2010** | | |
| **No.** | **Test Description** | **Unit** | **Methods** | **Regulatory Limit** | **Aug** | **Dec** | **May** | **Sep** | **Dec** |
| | **Water Level Information** | | | | | | | | |
| 1 | Well depth | Meter | - | - | | | | | |
| 2 | Initial (Before Purging) | Meter | - | - | | | | | |
| 3 | Initial (After Purging) | | | | | | | | |
| 4 | Initial (Before Sampling) | Meter | - | - | | | | | |
| | | | | | | | | | |
| | **Physical Tests** | | | | | | | | |
| 1 | pH [1)] | - | APHA 4500HB | 6.0 - 9.0 | 8.6 | 8.1 | 7.3 | 7.6 | 7.1 |
| 2 | Total Dissolved Solids, TDS | mg/L | APHA 2540C | 1000 | | | | | |
| | | | | | | | | | |
| | **Anions** | | | | | | | | |
| 1 | Chloride, $Cl^-$ | mg/L | APHA 4110B | - | 1.1 | <0.5 | 5.9 | <0.5 | <0.5 |
| 2 | Sulphate, $SO_4$ | mg/L | APHA 4110B | - | 13 | 9 | 11.5 | 7 | 6 |
| 3 | Sulphide, as $H_2S$ | mg/L | APHA 4500S-G | 0.002 | ND | <0.002 | <0.002 | <0.002 | <0.002 |
| | | | | | | | | | |
| | **Nutrients** | | | | | | | | |
| 1 | Nitrate, $NO_3$-N | mg/L | APHA 4110B | 20 | 0.005 | <0.005 | <0.005 | 0.01 | <0.005 |
| 2 | Nitrite, $NO_2$-N | mg/L | APHA 4110B | 0.06 | 0.002 | 0.022 | <0.001 | 0.003 | 0.018 |
| | | | | | | | | | |
| | **Dissolved Metals** | | | | | | | | |
| 1 | Arsenic, As | mg/L | APHA 3114C | 1 | 0.005 | <0.01 | <0.001 | 0.002 | 0.002 |
| 2 | Cadmium, Cd | mg/L | APHA 3111B | 0.01 | 0.0002 | 0.0011 | 0.0001 | <0.0001 | <0.0001 |
| 3 | Copper, Cu | mg/L | APHA 3111B | 0.02 | ND | <0.01 | <0.01 | <0.01 | <0.01 |
| 4 | Lead, Pb | mg/L | APHA 3113B | 0.03 | 0.005 | 0.009 | <0.001 | 0.003 | 0.005 |
| 5 | Mercury, Hg | mg/L | USEPA 245.7 | 0.002 | ND | <0.00005 | <0.00005 | <0.00005 | <0.00005 |
| 6 | Sodium, Na | mg/L | APHA 3111B | - | 11.60 | 13.50 | 13.3 | 10.9 | 13.7 |
| 7 | Zinc, Zn | mg/L | APHA 3111B | 0.05 | ND | 0.02 | <0.01 | <0.01 | <0.01 |

* = Replicate

**Borehole Name: Well 12**

| **Laboratory Sample I.D :** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Date Sampled :** | | | | | **2009** | | **2010** | | |
| **No.** | **Test Description** | **Unit** | **Methods** | **Regulatory Limit** | **Aug** | **Dec** | **May** | **Sep** | **Dec** |
| | **Water Level Information** | | | | | | | | |
| 1 | Well depth | Meter | - | - | | | | | |
| 2 | Initial (Before Purging) | Meter | - | - | | | | | |
| 3 | Initial (After Purging) | | | | | | | | |
| 4 | Initial (Before Sampling) | Meter | - | - | | | | | |
| | | | | | | | | | |
| | **Physical Tests** | | | | | | | | |
| 1 | pH [1)] | - | APHA 4500HB | 6.0 - 9.0 | 6.6 | 7.8 | 6.6 | 6.7 | 6.4 |
| 2 | Total Dissolved Solids, TDS | mg/L | APHA 2540C | 1000 | | | | | |
| | | | | | | | | | |
| | **Anions** | | | | | | | | |
| 1 | Chloride, $Cl^-$ | mg/L | APHA 4110B | - | 5.5 | 3.4 | 2.9 | 2.8 | 4.3 |
| 2 | Sulphate, $SO_4$ | mg/L | APHA 4110B | - | 6 | 8 | <2 | 3 | 7 |
| 3 | Sulphide, as $H_2S$ | mg/L | APHA 4500S-G | 0.002 | ND | <0.002 | <0.002 | <0.002 | <0.002 |
| | | | | | | | | | |
| | **Nutrients** | | | | | | | | |
| 1 | Nitrate, $NO_3$-N | mg/L | APHA 4110B | 20 | ND | <0.005 | <0.005 | 0.046 | 0.037 |
| 2 | Nitrite, $NO_2$-N | mg/L | APHA 4110B | 0.06 | ND | <0.001 | <0.001 | <0.001 | 0.001 |
| | | | | | | | | | |
| | **Dissolved Metals** | | | | | | | | |
| 1 | Arsenic, As | mg/L | APHA 3114C | 1 | ND | <0.01 | <0.001 | 0.001 | 0.002 |
| 2 | Cadmium, Cd | mg/L | APHA 3111B | 0.01 | ND | 0.0008 | 0.0004 | <0.0001 | <0.0001 |
| 3 | Copper, Cu | mg/L | APHA 3111B | 0.02 | ND | <0.01 | <0.01 | <0.01 | <0.01 |
| 4 | Lead, Pb | mg/L | APHA 3113B | 0.03 | 0.002 | 0.004 | <0.001 | <0.001 | 0.002 |
| 5 | Mercury, Hg | mg/L | USEPA 245.7 | 0.002 | 0.00006 | <0.00005 | <0.00005 | <0.00005 | <0.00005 |
| 6 | Sodium, Na | mg/L | APHA 3111B | - | 3.72 | 5.35 | 4.11 | 4.00 | 2.7 |
| 7 | Zinc, Zn | mg/L | APHA 3111B | 0.05 | ND | 0.01 | 0.01 | <0.01 | <0.01 |

* = Replicate

**Borehole Name: Well 13**

| Laboratory Sample I.D : | | | | | | | | | | | | EV120116-29 | EV120759-18 | EV130143-11 | EV130628-27 | EV131143-20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Date Sampled :** | | | | | **2009** | | **2010** | | | | **2011** | **2012** | | **2013** | | |
| **No.** | **Test Description** | **Unit** | **Methods** | **Regulatory Limit** | **Aug** | **Dec** | **May** | **Sep** | **Dec** | **Dec*** | **Aug** | **Feb** | **Sep** | **Feb** | **Jun** | **Nov** |
| | **Water Level Information** | | | | | | | | | | | | | | | |
| 1 | Well depth | Meter | - | - | | | | | | | | | | | 20.7 | 17.5 |
| 2 | Initial (Before Purging) | Meter | - | - | | | | | | | | | 9.07 | 10.0 | 10.1 | 10.5 |
| 3 | Initial (After Purging) | | | | | | | | | | | | | 16.4 | | |
| 4 | Initial (Before Sampling) | Meter | - | - | | | | | | | | | 10.12 | 10.1 | 10.2 | 10.5 |
| | | | | | | | | | | | | | | | | |
| | **Physical Tests** | | | | | | | | | | | | | | | |
| 1 | pH [1)] | - | APHA 4500HB | 6.0 - 9.0 | 7.5 | 7.9 | 7.5 | 7.5 | 7.5 | 7.5 | 7.0 | 7.37 | 8.05 | 7.15 | 7.63 | 7.37 |
| 2 | Total Dissolved Solids, TDS | mg/L | APHA 2540C | 1000 | | | | | | | | 350 | 314 | 335 | 288 | 298 |
| | | | | | | | | | | | | | | | | |
| | **Anions** | | | | | | | | | | | | | | | |
| 1 | Chloride, $Cl^-$ | mg/L | APHA 4110B | - | 3.2 | 1.0 | 1.5 | 2.5 | 0.9 | 0.9 | 3.4 | 2.1 | 2.6 | 3.4 | 2.9 | 2.8 |
| 2 | Sulphate, $SO_4$ | mg/L | APHA 4110B | - | 16 | 18 | 16.8 | 18 | 17 | 17 | 45 | 17 | 20 | 20 | 18 | 17 |
| 3 | Sulphide, as $H_2S$ | mg/L | APHA 4500S-G | 0.002 | ND | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.001 |
| | | | | | | | | | | | | | | | | |
| | **Nutrients** | | | | | | | | | | | | | | | |
| 1 | Nitrate, $NO_3$-N | mg/L | APHA 4110B | 20 | ND | 0.074 | <0.005 | 0.078 | 0.064 | 0.066 | 0.015 | 0.024 | 0.071 | 0.041 | 0.054 | 0.008 |
| 2 | Nitrite, $NO_2$-N | mg/L | APHA 4110B | 0.06 | 0.006 | <0.001 | <0.001 | 0.004 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | 0.004 | <0.001 | 0.036 |
| | | | | | | | | | | | | | | | | |
| | **Dissolved Metals** | | | | | | | | | | | | | | | |
| 1 | Arsenic, As | mg/L | APHA 3114C | 1 | ND | <0.01 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 |
| 2 | Cadmium, Cd | mg/L | APHA 3111B | 0.01 | ND | 0.0007 | 0.0002 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.005 | 0.0001 | <0.005 | <0.005 | <0.005 |
| 3 | Copper, Cu | mg/L | APHA 3111B | 0.02 | ND | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.001 | <0.01 | <0.01 | <0.01 |
| 4 | Lead, Pb | mg/L | APHA 3113B | 0.03 | 0.002 | 0.005 | <0.001 | 0.002 | 0.002 | 0.002 | 0.003 | <0.001 | <0.001 | <0.001 | 0.002 | 0.003 |
| 5 | Mercury, Hg | mg/L | USEPA 245.7 | 0.002 | ND | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 |
| 6 | Sodium, Na | mg/L | APHA 3111B | - | 6.78 | 7.56 | 6.69 | 6.59 | 7.14 | 7.09 | 6.68 | 6.62 | 6.79 | 6.87 | 8.20 | 4.54 |
| 7 | Zinc, Zn | mg/L | APHA 3111B | 0.05 | 0.01 | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.05 | <0.005 | <0.005 | <0.005 | 0.007 | <0.005 |

* = Replicate

**Borehole Name: Well 14**

| Laboratory Sample I.D : | | | | | | | | | | | | | EV120116-30 | EV120759-19 | EV130143-12 | EV130628-29 | EV131143-21 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Date Sampled :** | | | | | **2009** | | | | **2010** | | | **2011** | **2012** | | **2013** | | |
| **No.** | **Test Description** | **Unit** | **Methods** | **Regulatory Limit** | **Aug** | **Aug*** | **Dec** | **Dec*** | **May** | **Sep** | **Dec** | **Aug** | **Feb** | **Sep** | **Feb** | **Jun** | **Nov** |
| | **Water Level Information** | | | | | | | | | | | | | | | | |
| 1 | Well depth | Meter | - | - | | | | | | | | | | | | 12.8 | 12.2 |
| 2 | Initial (Before Purging) | Meter | - | - | | | | | | | | | | 4.25 | 4.32 | 4.15 | 4.30 |
| 3 | Initial (After Purging) | | | | | | | | | | | | | | 12.4 | | |
| 4 | Initial (Before Sampling) | Meter | - | - | | | | | | | | | | 4.60 | 4.60 | 4.15 | 4.62 |
| | | | | | | | | | | | | | | | | | |
| | **Physical Tests** | | | | | | | | | | | | | | | | |
| 1 | pH [1)] | - | APHA 4500HB | 6.0 - 9.0 | 7.4 | 7.5 | 7.9 | - | 7.3 | 7.2 | 7.3 | 6.9 | 7.16 | 7.67 | 6.64 | 7.36 | 6.96 |
| 2 | Total Dissolved Solids, TDS | mg/L | APHA 2540C | 1000 | | | | | | | | | 412 | 358 | 407 | 416 | 436 |
| | | | | | | | | | | | | | | | | | |
| | **Anions** | | | | | | | | | | | | | | | | |
| 1 | Chloride, $Cl^-$ | mg/L | APHA 4110B | - | 2.5 | 2.5 | 1.2 | 1.3 | 1.9 | 2 | 0.7 | 2.9 | 2.5 | 2.9 | 3.2 | 3.1 | 3.0 |
| 2 | Sulphate, $SO_4$ | mg/L | APHA 4110B | - | 52 | 52 | 68 | 68 | 71.3 | 64 | 70 | 30 | 91 | 92 | 87 | 76 | 83 |
| 3 | Sulphide, as $H_2S$ | mg/L | APHA 4500S-G | 0.002 | ND | ND | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.001 |
| | | | | | | | | | | | | | | | | | |
| | **Nutrients** | | | | | | | | | | | | | | | | |
| 1 | Nitrate, $NO_3$-N | mg/L | APHA 4110B | 20 | 0.020 | 0.019 | 0.038 | 0.037 | <0.005 | 0.03 | 0.043 | <0.005 | 0.041 | 0.009 | 0.054 | 0.113 | 0.012 |
| 2 | Nitrite, $NO_2$-N | mg/L | APHA 4110B | 0.06 | ND | ND | 0.005 | 0.005 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | 0.016 | 0.002 | <0.001 | 0.053 |
| | | | | | | | | | | | | | | | | | |
| | **Dissolved Metals** | | | | | | | | | | | | | | | | |
| 1 | Arsenic, As | mg/L | APHA 3114C | 1 | ND | ND | <0.01 | <0.01 | <0.001 | <0.001 | <0.001 | <0.001 | <0.0005 | 0.0006 | <0.0005 | 0.0005 | 0.0005 |
| 2 | Cadmium, Cd | mg/L | APHA 3111B | 0.01 | ND | ND | 0.0009 | 0.0008 | 0.0002 | <0.0001 | <0.0001 | <0.0001 | <0.005 | <0.0001 | <0.005 | <0.005 | <0.005 |
| 3 | Copper, Cu | mg/L | APHA 3111B | 0.02 | ND | ND | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.001 | <0.01 | <0.01 | <0.01 |
| 4 | Lead, Pb | mg/L | APHA 3113B | 0.03 | 0.006 | 0.006 | 0.006 | 0.005 | <0.001 | 0.003 | 0.004 | 0.005 | <0.001 | <0.001 | <0.001 | <0.001 | 0.002 |
| 5 | Mercury, Hg | mg/L | USEPA 245.7 | 0.002 | 0.00017 | 0.00017 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 |
| 6 | Sodium, Na | mg/L | APHA 3111B | - | 8.40 | 8.46 | 8.32 | 8.48 | 7.45 | 7.73 | 7.96 | 6.73 | 7.10 | 6.79 | 6.57 | 6.93 | 4.38 |
| 7 | Zinc, Zn | mg/L | APHA 3111B | 0.05 | ND | ND | 0.02 | 0.02 | <0.01 | <0.01 | <0.01 | 0.01 | 0.013 | <0.005 | 0.009 | <0.005 | <0.005 |

* = Replicate

**Borehole Name: Well 15**

| Laboratory Sample I.D : | | | | | | | | | | | | EV120116-31 | EV120759-20 | EV130143-13 | EV130628-26 | EV131143-22 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Date Sampled :** | | | | | **2009** | | **2010** | | | | **2011** | **2012** | | **2013** | | |
| **No.** | **Test Description** | **Unit** | **Methods** | **Regulatory Limit** | **Aug** | **Dec** | **May** | **Sep** | **Sep*** | **Dec** | **Aug** | **Feb** | **Sep** | **Feb** | **Jun** | **Nov** |
| | **Water Level Information** | | | | | | | | | | | | | | | |
| 1 | Well depth | Meter | - | - | | | | | | | | | | | 11.2 | 10.0 |
| 2 | Initial (Before Purging) | Meter | - | - | | | | | | | | | 5.15 | 5.25 | 5.18 | 5.37 |
| 3 | Initial (After Purging) | | | | | | | | | | | | | 10.6 | | |
| 4 | Initial (Before Sampling) | Meter | - | - | | | | | | | | | 5.20 | 5.24 | 5.17 | 5.35 |
| | | | | | | | | | | | | | | | | |
| | **Physical Tests** | | | | | | | | | | | | | | | |
| 1 | pH 1) | - | APHA 4500HB | 6.0 - 9.0 | 7.3 | 7.9 | 7.1 | 7.2 | 7.2 | 7.6 | 6.9 | 7.09 | 7.58 | 6.74 | 7.45 | 6.76 |
| 2 | Total Dissolved Solids, TDS | mg/L | APHA 2540C | 1000 | | | | | | | | 338 | 309 | 333 | 246 | 358 |
| | | | | | | | | | | | | | | | | |
| | **Anions** | | | | | | | | | | | | | | | |
| 1 | Chloride, $Cl^-$ | mg/L | APHA 4110B | - | 1.9 | 2.2 | 2.2 | 1.4 | 1.5 | <0.5 | 2.8 | 2 | 2.6 | 2.8 | 2.2 | 2.6 |
| 2 | Sulphate, $SO_4$ | mg/L | APHA 4110B | - | 4 | 5 | 3.6 | 8 | 8 | 9 | 9 | 4 | 7 | 8 | 13 | 7 |
| 3 | Sulphide, as $H_2S$ | mg/L | APHA 4500S-G | 0.002 | ND | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.001 |
| | | | | | | | | | | | | | | | | |
| | **Nutrients** | | | | | | | | | | | | | | | |
| 1 | Nitrate, $NO_3$-N | mg/L | APHA 4110B | 20 | ND | 0.078 | <0.005 | 0.041 | 0.041 | 0.027 | <0.005 | 0.006 | 0.006 | 0.038 | 0.068 | 0.006 |
| 2 | Nitrite, $NO_2$-N | mg/L | APHA 4110B | 0.06 | 0.003 | 0.004 | <0.001 | <0.001 | <0.001 | 0.003 | 0.005 | <0.001 | 0.003 | 0.002 | <0.001 | <0.001 |
| | | | | | | | | | | | | | | | | |
| | **Dissolved Metals** | | | | | | | | | | | | | | | |
| 1 | Arsenic, As | mg/L | APHA 3114C | 1 | 0.003 | <0.01 | <0.001 | 0.004 | 0.004 | 0.003 | 0.003 | <0.0005 | 0.0025 | 0.0023 | 0.0015 | 0.0020 |
| 2 | Cadmium, Cd | mg/L | APHA 3111B | 0.01 | 0.0001 | 0.0008 | 0.0008 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.005 | <0.0001 | <0.005 | <0.005 | <0.005 |
| 3 | Copper, Cu | mg/L | APHA 3111B | 0.02 | ND | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.001 | <0.01 | <0.01 | <0.01 |
| 4 | Lead, Pb | mg/L | APHA 3113B | 0.03 | ND | 0.010 | <0.001 | 0.004 | 0.004 | 0.003 | 0.008 | <0.001 | <0.001 | <0.001 | <0.001 | 0.007 |
| 5 | Mercury, Hg | mg/L | USEPA 245.7 | 0.002 | ND | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 |
| 6 | Sodium, Na | mg/L | APHA 3111B | - | 5.76 | 5.84 | 4.73 | 4.82 | 4.75 | 5.42 | 5.02 | 4.67 | 4.77 | 4.86 | 4.82 | 3.44 |
| 7 | Zinc, Zn | mg/L | APHA 3111B | 0.05 | ND | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | 0.01 | <0.005 | <0.005 | 0.006 | <0.005 | 0.010 |

**Borehole Name: Well 16**

| Laboratory Sample I.D : | | | | | | | | | | | | EV120116-32 | EV120759-21 | EV130143-14 | EV130628-34 | EV131143-18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Date Sampled :** | | | | | **2009** | | **2010** | | | | **2011** | **2012** | | **2013** | | |
| **No.** | **Test Description** | **Unit** | **Methods** | **Regulatory Limit** | **Aug** | **Dec** | **May** | **Sep** | **Dec** | **Dec*** | **Aug** | **Feb** | **Sep** | **Feb** | **Jun** | **Nov** |
| | **Water Level Information** | | | | | | | | | | | | | | | |
| 1 | Well depth | Meter | - | - | | | | | | | | | | | 7.20 | 6.96 |
| 2 | Initial (Before Purging) | Meter | - | - | | | | | | | | | 1.57 | 1.70 | 1.20 | 1.48 |
| 3 | Initial (After Purging) | | | | | | | | | | | | | 7.17 | | |
| 4 | Initial (Before Sampling) | Meter | - | - | | | | | | | | | 1.84 | 2.00 | 1.80 | 1.50 |
| | | | | | | | | | | | | | | | | |
| | **Physical Tests** | | | | | | | | | | | | | | | |
| 1 | pH [1)] | - | APHA 4500HB | 6.0 - 9.0 | 6.8 | 7.8 | 6.6 | 6.7 | 6.6 | 6.6 | 6.4 | 6.57 | 6.93 | 6.19 | 6.68 | 6.17 |
| 2 | Total Dissolved Solids, TDS | mg/L | APHA 2540C | 1000 | | | | | | | | 323 | 292 | 335 | 242 | 272 |
| | | | | | | | | | | | | | | | | |
| | **Anions** | | | | | | | | | | | | | | | |
| 1 | Chloride, $Cl^-$ | mg/L | APHA 4110B | - | 2.8 | 1.0 | 2.4 | 2.4 | 1.1 | 1.1 | 3.7 | 3 | 3.6 | 3.2 | 3.0 | 3.4 |
| 2 | Sulphate, $SO_4$ | mg/L | APHA 4110B | - | ND | <2 | 4 | 4 | 9 | 9 | 13 | 8 | 15 | 11 | 12 | 14 |
| 3 | Sulphide, as $H_2S$ | mg/L | APHA 4500S-G | 0.002 | ND | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | **0.005** | <0.002 | <0.002 | <0.002 | <0.002 | <0.001 |
| | | | | | | | | | | | | | | | | |
| | **Nutrients** | | | | | | | | | | | | | | | |
| 1 | Nitrate, $NO_3$-N | mg/L | APHA 4110B | 20 | ND | 0.046 | <0.005 | 0.293 | 0.029 | 0.029 | <0.005 | <0.005 | 0.005 | 0.024 | <0.005 | <0.005 |
| 2 | Nitrite, $NO_2$-N | mg/L | APHA 4110B | 0.06 | ND | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | 0.002 | <0.001 | <0.001 | <0.001 |
| | | | | | | | | | | | | | | | | |
| | **Dissolved Metals** | | | | | | | | | | | | | | | |
| 1 | Arsenic, As | mg/L | APHA 3114C | 1 | 0.001 | <0.01 | <0.001 | <0.001 | 0.003 | 0.003 | 0.002 | <0.0005 | 0.0007 | <0.0005 | <0.0005 | 0.0007 |
| 2 | Cadmium, Cd | mg/L | APHA 3111B | 0.01 | 0.0001 | 0.0008 | 0.0006 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.005 | 0.0002 | <0.005 | <0.005 | <0.005 |
| 3 | Copper, Cu | mg/L | APHA 3111B | 0.02 | ND | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.001 | <0.01 | <0.01 | <0.01 |
| 4 | Lead, Pb | mg/L | APHA 3113B | 0.03 | ND | 0.004 | <0.001 | <0.001 | 0.002 | 0.002 | 0.007 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 5 | Mercury, Hg | mg/L | USEPA 245.7 | 0.002 | ND | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | 0.00011 | <0.00005 |
| 6 | Sodium, Na | mg/L | APHA 3111B | - | 3.66 | 4.14 | 3.16 | 8.79 | 3.64 | 3.65 | 3.32 | 3.30 | 3.34 | 3.37 | 3.10 | 1.99 |
| 7 | Zinc, Zn | mg/L | APHA 3111B | 0.05 | 0.03 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.05 | 0.009 | 0.006 | 0.010 | 0.009 | 0.009 |

**Borehole Name: Well 17**

| Laboratory Sample I.D : | | | | | | | | | | | EV120116-33 | EV120759-22 | EV130143-15 | EV130628-28 | EV131143-23 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Date Sampled :** | | | | | **2009** | | **2010** | | | **2011** | **2012** | | **2013** | | |
| **No.** | **Test Description** | **Unit** | **Methods** | **Regulatory Limit** | **Aug** | **Dec** | **May** | **Sep** | **Dec** | **Aug** | **Feb** | **Sep** | **Feb** | **Jun** | **Nov** |
| | **Water Level Information** | | | | | | | | | | | | | | |
| 1 | Well depth | Meter | - | - | | | | | | | | | | 7.35 | 7.00 |
| 2 | Initial (Before Purging) | Meter | - | - | | | | | | | | 3.63 | 3.85 | 4.24 | 4.12 |
| 3 | Initial (After Purging) | | | | | | | | | | | | 7.07 | | |
| 4 | Initial (Before Sampling) | Meter | - | - | | | | | | | | 3.85 | 3.90 | 3.84 | 4.10 |
| | | | | | | | | | | | | | | | |
| | **Physical Tests** | | | | | | | | | | | | | | |
| 1 | pH [1)] | - | APHA 4500HB | 6.0 - 9.0 | 7.2 | 7.6 | 7.2 | 7.1 | 7.4 | 6.8 | 7.14 | 7.70 | 6.49 | 7.25 | 7.01 |
| 2 | Total Dissolved Solids, TDS | mg/L | APHA 2540C | 1000 | | | | | | | 418 | 400 | 487 | 272 | 492 |
| | | | | | | | | | | | | | | | |
| | **Anions** | | | | | | | | | | | | | | |
| 1 | Chloride, $Cl^-$ | mg/L | APHA 4110B | - | 2.2 | 1.9 | 2.9 | 2.2 | 2.1 | 3.8 | 2.9 | 3.8 | 3.5 | 2.4 | 3.1 |
| 2 | Sulphate, $SO_4$ | mg/L | APHA 4110B | - | 74 | 76 | 63.4 | 55 | 60 | 49 | 44 | 110 | 80 | 18 | 64 |
| 3 | Sulphide, as $H_2S$ | mg/L | APHA 4500S-G | 0.002 | ND | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.001 |
| | | | | | | | | | | | | | | | |
| | **Nutrients** | | | | | | | | | | | | | | |
| 1 | Nitrate, $NO_3$-N | mg/L | APHA 4110B | 20 | ND | 0.037 | <0.005 | 0.025 | 0.023 | <0.005 | <0.005 | 0.120 | 0.065 | 0.325 | 0.028 |
| 2 | Nitrite, $NO_2$-N | mg/L | APHA 4110B | 0.06 | ND | 0.005 | <0.001 | <0.001 | 0.002 | 0.006 | <0.001 | 0.005 | 0.008 | <0.001 | <0.001 |
| | | | | | | | | | | | | | | | |
| | **Dissolved Metals** | | | | | | | | | | | | | | |
| 1 | Arsenic, As | mg/L | APHA 3114C | 1 | ND | <0.01 | <0.001 | <0.001 | <0.001 | <0.001 | <0.0005 | 0.0007 | <0.0005 | 0.0010 | 0.0007 |
| 2 | Cadmium, Cd | mg/L | APHA 3111B | 0.01 | 0.0001 | 0.0004 | 0.0002 | <0.0001 | <0.0001 | <0.0001 | <0.005 | <0.0001 | <0.005 | <0.005 | <0.005 |
| 3 | Copper, Cu | mg/L | APHA 3111B | 0.02 | ND | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.001 | <0.01 | <0.01 | <0.01 |
| 4 | Lead, Pb | mg/L | APHA 3113B | 0.03 | 0.003 | 0.001 | <0.001 | 0.002 | <0.001 | 0.005 | <0.001 | <0.001 | <0.001 | 0.006 | 0.003 |
| 5 | Mercury, Hg | mg/L | USEPA 245.7 | 0.002 | 0.00016 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | 0.00019 | <0.00005 |
| 6 | Sodium, Na | mg/L | APHA 3111B | - | 9.18 | 14.30 | 8.66 | 8.55 | 9.68 | 8.39 | 8.16 | 8.53 | 8.39 | 4.81 | 5.79 |
| 7 | Zinc, Zn | mg/L | APHA 3111B | 0.05 | 0.01 | 0.01 | <0.01 | <0.01 | <0.01 | <0.05 | <0.005 | <0.005 | 0.007 | 0.015 | 0.006 |

**Borehole Name: Well 18**

| Laboratory Sample I.D : | | | | | | | | | | | | EV120116-34 | EV120759-23 | EV130143-17 | EV130628-30 | EV131143-24 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Date Sampled :** | | | | | **2009** | | **2010** | | | | **2011** | **2012** | | **2013** | | |
| **No.** | **Test Description** | **Unit** | **Methods** | **Regulatory Limit** | **Aug** | **Dec** | **May** | **May*** | **Sep** | **Dec** | **Aug** | **Feb** | **Sep** | **Feb** | **Jun** | **Nov** |
| | **Water Level Information** | | | | | | | | | | | | | | | |
| 1 | Well depth | Meter | - | - | | | | | | | | | | | 13.2 | 12.8 |
| 2 | Initial (Before Purging) | Meter | - | - | | | | | | | | | 5.58 | 5.70 | 5.50 | 5.72 |
| 3 | Initial (After Purging) | | | | | | | | | | | | | 13.1 | | |
| 4 | Initial (Before Sampling) | Meter | - | - | | | | | | | | | 6.17 | 6.30 | 4.48 | 6.17 |
| | | | | | | | | | | | | | | | | |
| | **Physical Tests** | | | | | | | | | | | | | | | |
| 1 | pH [1)] | - | APHA 4500HB | 6.0 - 9.0 | 6.9 | 7.7 | 7.5 | 7.5 | 6.5 | 7.4 | 7.0 | 7.17 | 7.86 | 6.44 | 7.55 | 7.18 |
| 2 | Total Dissolved Solids, TDS | mg/L | APHA 2540C | 1000 | | | | | | | | 392 | 326 | 389 | 290 | 406 |
| | | | | | | | | | | | | | | | | |
| | **Anions** | | | | | | | | | | | | | | | |
| 1 | Chloride, $Cl^-$ | mg/L | APHA 4110B | - | 1.7 | 1.0 | 0.9 | 0.9 | 5.7 | <0.5 | 1.6 | 1.1 | 1.3 | 1.6 | 1.7 | 2.9 |
| 2 | Sulphate, $SO_4$ | mg/L | APHA 4110B | - | 48 | 48 | 46.5 | 46.5 | 40 | 41 | 41 | 50 | 54 | 49 | 35 | 37 |
| 3 | Sulphide, as $H_2S$ | mg/L | APHA 4500S-G | 0.002 | ND | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | **0.070** | <0.002 | <0.002 | <0.002 | <0.002 | <0.001 |
| | | | | | | | | | | | | | | | | |
| | **Nutrients** | | | | | | | | | | | | | | | |
| 1 | Nitrate, $NO_3$-N | mg/L | APHA 4110B | 20 | 0.062 | 0.054 | <0.005 | <0.005 | 0.054 | 0.035 | <0.005 | <0.005 | 0.066 | 0.023 | <0.005 | 0.013 |
| 2 | Nitrite, $NO_2$-N | mg/L | APHA 4110B | 0.06 | 0.001 | 0.008 | <0.001 | <0.001 | 0.002 | 0.001 | 0.010 | <0.001 | 0.036 | 0.007 | <0.001 | <0.001 |
| | | | | | | | | | | | | | | | | |
| | **Dissolved Metals** | | | | | | | | | | | | | | | |
| 1 | Arsenic, As | mg/L | APHA 3114C | 1 | ND | <0.01 | <0.001 | <0.001 | 0.001 | <0.001 | <0.001 | <0.0005 | 0.0006 | <0.0005 | 0.0006 | 0.0007 |
| 2 | Cadmium, Cd | mg/L | APHA 3111B | 0.01 | ND | 0.0003 | 0.0003 | 0.0002 | <0.0001 | <0.0001 | <0.0001 | <0.005 | <0.0001 | <0.005 | <0.005 | <0.005 |
| 3 | Copper, Cu | mg/L | APHA 3111B | 0.02 | ND | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.001 | <0.01 | <0.01 | <0.01 |
| 4 | Lead, Pb | mg/L | APHA 3113B | 0.03 | 0.003 | 0.005 | <0.001 | <0.001 | 0.002 | 0.003 | 0.006 | <0.001 | 0.001 | 0.002 | 0.002 | 0.006 |
| 5 | Mercury, Hg | mg/L | USEPA 245.7 | 0.002 | ND | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 |
| 6 | Sodium, Na | mg/L | APHA 3111B | - | 10.50 | 11.60 | 10.1 | 10.0 | 4.52 | 11.3 | 9.97 | 10.1 | 9.30 | 9.61 | 8.03 | 6.55 |
| 7 | Zinc, Zn | mg/L | APHA 3111B | 0.05 | ND | 0.04 | <0.01 | <0.01 | <0.01 | <0.01 | <0.05 | 0.007 | <0.005 | 0.007 | 0.012 | <0.005 |

**Borehole Name: Well 19**

| Laboratory Sample I.D : | | | | | | | | | | | | EV120116-35 | EV120759-24 | EV130143-17 | EV130628-25 | EV131143-25 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Date Sampled :** | | | | | **2009** | | **2010** | | | **2011** | | **2012** | | **2013** | | |
| **No.** | **Test Description** | **Unit** | **Methods** | **Regulatory Limit** | **Aug** | **Dec** | **May** | **Sep** | **Dec** | **Aug** | **Aug*** | **Feb** | **Sep** | **Feb** | **Jun** | **Nov** |
| | **Water Level Information** | | | | | | | | | | | | | | | |
| 1 | Well depth | Meter | - | - | | | | | | | | | | | 15.9 | 14.5 |
| 2 | Initial (Before Purging) | Meter | - | - | | | | | | | | | 6.89 | 6.00 | 5.66 | 5.60 |
| 3 | Initial (After Purging) | | | | | | | | | | | | | 15.1 | | |
| 4 | Initial (Before Sampling) | Meter | - | - | | | | | | | | | 7.00 | 6.00 | 5.61 | 6.56 |
| | | | | | | | | | | | | | | | | |
| | **Physical Tests** | | | | | | | | | | | | | | | |
| 1 | pH [1)] | - | APHA 4500HB | 6.0 - 9.0 | 6.8 | 7.5 | 6.7 | 7.3 | 6.6 | 6.4 | 6.4 | 6.59 | 7.09 | 6.34 | 6.85 | 6.42 |
| 2 | Total Dissolved Solids, TDS | mg/L | APHA 2540C | 1000 | | | | | | | | 492 | 578 | 529 | 378 | 510 |
| | | | | | | | | | | | | | | | | |
| | **Anions** | | | | | | | | | | | | | | | |
| 1 | Chloride, $Cl^-$ | mg/L | APHA 4110B | - | 9.6 | 8.6 | 13.1 | 0.8 | 4.3 | 6.8 | 6.7 | 6.2 | 7.70 | 6.5 | 4.6 | 6.2 |
| 2 | Sulphate, $SO_4$ | mg/L | APHA 4110B | - | 50 | 43 | 50.9 | 47 | 43 | 36 | 34 | 29 | 32 | 24 | 20 | 18 |
| 3 | Sulphide, as $H_2S$ | mg/L | APHA 4500S-G | 0.002 | ND | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.001 |
| | | | | | | | | | | | | | | | | |
| | **Nutrients** | | | | | | | | | | | | | | | |
| 1 | Nitrate, $NO_3$-N | mg/L | APHA 4110B | 20 | ND | 0.012 | <0.005 | 0.383 | <0.005 | <0.005 | <0.005 | <0.005 | 0.028 | 0.084 | 0.007 | 0.007 |
| 2 | Nitrite, $NO_2$-N | mg/L | APHA 4110B | 0.06 | ND | <0.001 | <0.001 | 0.002 | 0.040 | <0.001 | <0.001 | <0.001 | 0.016 | 0.014 | <0.001 | <0.001 |
| | | | | | | | | | | | | | | | | |
| | **Dissolved Metals** | | | | | | | | | | | | | | | |
| 1 | Arsenic, As | mg/L | APHA 3114C | 1 | ND | <0.01 | <0.001 | <0.001 | 0.001 | <0.001 | <0.001 | <0.0005 | 0.0009 | <0.0005 | 0.0005 | 0.0024 |
| 2 | Cadmium, Cd | mg/L | APHA 3111B | 0.01 | ND | 0.0005 | 0.0009 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.005 | <0.0001 | <0.005 | <0.005 | <0.005 |
| 3 | Copper, Cu | mg/L | APHA 3111B | 0.02 | ND | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.001 | <0.01 | <0.01 | <0.01 |
| 4 | Lead, Pb | mg/L | APHA 3113B | 0.03 | 0.005 | 0.004 | <0.001 | 0.002 | 0.004 | 0.010 | 0.010 | <0.001 | 0.001 | <0.001 | <0.001 | 0.008 |
| 5 | Mercury, Hg | mg/L | USEPA 245.7 | 0.002 | ND | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 |
| 6 | Sodium, Na | mg/L | APHA 3111B | - | 5.35 | 5.74 | 4.66 | 9.59 | 5.07 | 4.12 | 4.15 | 3.71 | 4.00 | 3.77 | 2.95 | 2.55 |
| 7 | Zinc, Zn | mg/L | APHA 3111B | 0.05 | 0.02 | 0.02 | 0.02 | <0.01 | 0.02 | <0.05 | <0.05 | 0.014 | 0.010 | 0.009 | 0.005 | 0.008 |

**Borehole Name: Well 20**

| Laboratory Sample I.D : | | | | | | | | | | | EV120116-36 | EV120759-25 | EV130143-18 | EV130628-35 | EV131143-26 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Date Sampled :** | | | | | **2009** | | **2010** | | | **2011** | **2012** | | **2013** | | |
| **No.** | **Test Description** | **Unit** | **Methods** | **Regulatory Limit** | **Aug** | **Dec** | **May** | **Sep** | **Dec** | **Aug** | **Feb** | **Sep** | **Feb** | **Jun** | **Nov** |
| | **Water Level Information** | | | | | | | | | | | | | | |
| 1 | Well depth | Meter | - | - | | | | | | | | | | 12.5 | 13.2 |
| 2 | Initial (Before Purging) | Meter | - | - | | | | | | | | 9.01 | 9.00 | 5.96 | 9.19 |
| 3 | Initial (After Purging) | | | | | | | | | | | | 14.0 | | |
| 4 | Initial (Before Sampling) | Meter | - | - | | | | | | | | 9.00 | 9.00 | 8.94 | 9.12 |
| | | | | | | | | | | | | | | | |
| | **Physical Tests** | | | | | | | | | | | | | | |
| 1 | pH [1)] | - | APHA 4500HB | 6.0 - 9.0 | 6.7 | 7.8 | 7.2 | 7.2 | 7.1 | 6.8 | 7.32 | 7.83 | 6.99 | 7.48 | 7.43 |
| 2 | Total Dissolved Solids, TDS | mg/L | APHA 2540C | 1000 | | | | | | | 334 | 354 | 416 | 324 | 414 |
| | | | | | | | | | | | | | | | |
| | **Anions** | | | | | | | | | | | | | | |
| 1 | Chloride, $Cl^-$ | mg/L | APHA 4110B | - | 4.6 | 15.1 | 6.4 | 4.3 | 4.2 | 5.0 | 4.6 | 4.8 | 4.7 | 3.6 | 4.4 |
| 2 | Sulphate, $SO_4$ | mg/L | APHA 4110B | - | 58 | 39 | 51.8 | 48 | 40 | 48 | 35 | 36 | 30 | 33 | 33 |
| 3 | Sulphide, as $H_2S$ | mg/L | APHA 4500S-G | 0.002 | ND | <0.002 | <0.002 | <0.002 | <0.002 | **0.055** | 0.014 | <0.002 | <0.002 | <0.002 | <0.001 |
| | | | | | | | | | | | | | | | |
| | **Nutrients** | | | | | | | | | | | | | | |
| 1 | Nitrate, $NO_3$-N | mg/L | APHA 4110B | 20 | ND | 0.361 | 0.17 | 0.045 | 0.054 | 0.116 | 0.059 | 0.233 | 0.116 | 0.104 | 0.132 |
| 2 | Nitrite, $NO_2$-N | mg/L | APHA 4110B | 0.06 | ND | <0.001 | <0.001 | 0.003 | <0.001 | <0.001 | <0.001 | 0.006 | 0.003 | <0.001 | <0.001 |
| | | | | | | | | | | | | | | | |
| | **Dissolved Metals** | | | | | | | | | | | | | | |
| 1 | Arsenic, As | mg/L | APHA 3114C | 1 | 0.021 | <0.01 | <0.001 | 0.002 | 0.002 | 0.002 | <0.0005 | 0.0007 | <0.0005 | 0.0009 | 0.0017 |
| 2 | Cadmium, Cd | mg/L | APHA 3111B | 0.01 | 0.0003 | 0.0007 | 0.0002 | <0.0001 | <0.0001 | <0.0001 | 0.006 | <0.0001 | <0.005 | <0.005 | <0.005 |
| 3 | Copper, Cu | mg/L | APHA 3111B | 0.02 | ND | 0.02 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.001 | <0.01 | <0.01 | <0.01 |
| 4 | Lead, Pb | mg/L | APHA 3113B | 0.03 | ND | 0.013 | <0.001 | 0.005 | 0.009 | 0.004 | <0.001 | <0.001 | 0.002 | 0.003 | 0.004 |
| 5 | Mercury, Hg | mg/L | USEPA 245.7 | 0.002 | ND | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 |
| 6 | Sodium, Na | mg/L | APHA 3111B | - | 16.60 | 14.10 | 10.9 | 12.3 | 13.1 | 9.38 | 9.10 | 8.72 | 9.75 | 8.81 | 7.37 |
| 7 | Zinc, Zn | mg/L | APHA 3111B | 0.05 | 0.04 | 0.49 | 0.04 | 0.07 | <0.01 | **0.11** | 0.010 | 0.034 | 0.021 | 0.019 | 0.040 |

**Borehole Name: Well 21**

| | | | | | | |
|---|---|---|---|---|---|---|
| **Laboratory Sample I.D :** | | | | | | |
| **Date Sampled :** | | | | | **2009** | |
| **No.** | **Test Description** | **Unit** | **Methods** | **Regulatory Limit** | **Aug** | **Aug*** |
| | **Water Level Information** | | | | | |
| 1 | Well depth | Meter | - | - | | |
| 2 | Initial (Before Purging) | Meter | - | - | | |
| 3 | Initial (After Purging) | | | | | |
| 4 | Initial (Before Sampling) | Meter | - | - | | |
| | | | | | | |
| | **Physical Tests** | | | | | |
| 1 | pH [1)] | - | APHA 4500HB | 6.0 - 9.0 | 7.4 | 7.4 |
| 2 | Total Dissolved Solids, TDS | mg/L | APHA 2540C | 1000 | | |
| | | | | | | |
| | **Anions** | | | | | |
| 1 | Chloride, $Cl^-$ | mg/L | APHA 4110B | - | 22.5 | 22.5 |
| 2 | Sulphate, $SO_4$ | mg/L | APHA 4110B | - | 35 | 35 |
| 3 | Sulphide, as $H_2S$ | mg/L | APHA 4500S-G | 0.002 | ND | ND |
| | | | | | | |
| | **Nutrients** | | | | | |
| 1 | Nitrate, $NO_3$-N | mg/L | APHA 4110B | 20 | ND | ND |
| 2 | Nitrite, $NO_2$-N | mg/L | APHA 4110B | 0.06 | ND | ND |
| | | | | | | |
| | **Dissolved Metals** | | | | | |
| 1 | Arsenic, As | mg/L | APHA 3114C | 1 | 0.005 | 0.005 |
| 2 | Cadmium, Cd | mg/L | APHA 3111B | 0.01 | 0.0002 | 0.0002 |
| 3 | Copper, Cu | mg/L | APHA 3111B | 0.02 | ND | ND |
| 4 | Lead, Pb | mg/L | APHA 3113B | 0.03 | 0.060 | 0.058 |
| 5 | Mercury, Hg | mg/L | USEPA 245.7 | 0.002 | ND | ND |
| 6 | Sodium, Na | mg/L | APHA 3111B | - | 10.20 | 10.70 |
| 7 | Zinc, Zn | mg/L | APHA 3111B | 0.05 | 0.03 | 0.02 |

**Borehole Name: Well 22**

| Laboratory Sample I.D : | | | | | | | | | | | EV120116-37 | EV120759-26 | EV130143-19 | EV130628-31 | EV131143-27 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Date Sampled :** | | | | | **2009** | | **2010** | | | **2011** | **2012** | | **2013** | | |
| **No.** | **Test Description** | **Unit** | **Methods** | **Regulatory Limit** | **Aug** | **Dec** | **May** | **Sep** | **Dec** | **Aug** | **Feb** | **Sep** | **Feb** | **Jun** | **Nov** |
| | **Water Level Information** | | | | | | | | | | | | | | |
| 1 | Well depth | Meter | - | - | | | | | | | | | | 15.0 | 14.0 |
| 2 | Initial (Before Purging) | Meter | - | - | | | | | | | | 5.32 | 5.35 | 5.36 | 5.60 |
| 3 | Initial (After Purging) | | | | | | | | | | | | 11.6 | | |
| 4 | Initial (Before Sampling) | Meter | - | - | | | | | | | | 5.31 | 5.38 | 5.37 | 5.60 |
| | | | | | | | | | | | | | | | |
| | **Physical Tests** | | | | | | | | | | | | | | |
| 1 | pH 1) | - | APHA 4500HB | 6.0 - 9.0 | 7.1 | 7.7 | 7.3 | 7.2 | 7.1 | 6.9 | 7.19 | 7.74 | 6.92 | 7.48 | 6.91 |
| 2 | Total Dissolved Solids, TDS | mg/L | APHA 2540C | 1000 | | | | | | | 355 | 360 | 375 | 322 | 340 |
| | | | | | | | | | | | | | | | |
| | **Anions** | | | | | | | | | | | | | | |
| 1 | Chloride, $Cl^-$ | mg/L | APHA 4110B | - | 7.2 | <0.5 | <0.5 | 1.2 | <0.5 | 1.6 | 0.8 | 1.20 | 1.5 | 0.8 | 1.1 |
| 2 | Sulphate, $SO_4$ | mg/L | APHA 4110B | - | 14 | 11 | 8.7 | 18 | 21 | 24 | 7 | 15 | 15 | 13 | 13 |
| 3 | Sulphide, as $H_2S$ | mg/L | APHA 4500S-G | 0.002 | ND | <0.002 | <0.002 | <0.002 | <0.002 | **0.525** | <0.002 | <0.002 | <0.002 | <0.002 | <0.001 |
| | | | | | | | | | | | | | | | |
| | **Nutrients** | | | | | | | | | | | | | | |
| 1 | Nitrate, $NO_3$-N | mg/L | APHA 4110B | 20 | 0.059 | 0.035 | <0.005 | 0.072 | 0.075 | 0.511 | 0.028 | 0.024 | 0.047 | 0.023 | 0.066 |
| 2 | Nitrite, $NO_2$-N | mg/L | APHA 4110B | 0.06 | ND | <0.001 | <0.001 | <0.001 | <0.001 | 0.001 | <0.001 | 0.007 | 0.010 | <0.001 | <0.001 |
| | | | | | | | | | | | | | | | |
| | **Dissolved Metals** | | | | | | | | | | | | | | |
| 1 | Arsenic, As | mg/L | APHA 3114C | 1 | 0.002 | <0.01 | <0.001 | 0.001 | 0.002 | 0.002 | <0.0005 | 0.0008 | <0.0005 | <0.0005 | 0.0009 |
| 2 | Cadmium, Cd | mg/L | APHA 3111B | 0.01 | ND | 0.0002 | 0.0003 | <0.0001 | <0.0001 | <0.0001 | <0.005 | <0.0001 | <0.005 | <0.005 | <0.005 |
| 3 | Copper, Cu | mg/L | APHA 3111B | 0.02 | ND | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.001 | <0.01 | <0.01 | <0.01 |
| 4 | Lead, Pb | mg/L | APHA 3113B | 0.03 | 0.059 | 0.029 | <0.001 | 0.001 | 0.011 | 0.004 | <0.001 | <0.001 | <0.001 | 0.005 | 0.006 |
| 5 | Mercury, Hg | mg/L | USEPA 245.7 | 0.002 | 0.00008 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 |
| 6 | Sodium, Na | mg/L | APHA 3111B | - | 9.82 | 8.92 | 7.32 | 7.80 | 8.73 | 7.77 | 9.01 | 7.79 | 7.05 | 6.73 | 4.96 |
| 7 | Zinc, Zn | mg/L | APHA 3111B | 0.05 | 0.03 | 0.02 | <0.01 | 0.01 | <0.01 | 0.01 | 0.017 | <0.005 | 0.005 | 0.009 | 0.009 |

**Borehole Name: Well 23**

| Laboratory Sample I.D : | | | | | | | | | | | EV120116-38 | EV120759-27 | EV130143-20 | EV130628-32 | EV131143-28 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Date Sampled :** | | | | | **2009** | | **2010** | | | **2011** | **2012** | | **2013** | | |
| **No.** | **Test Description** | **Unit** | **Methods** | **Regulatory Limit** | **Aug** | **Dec** | **May** | **Sep** | **Dec** | **Aug** | **Feb** | **Sep** | **Feb** | **Jun** | **Nov** |
| | **Water Level Information** | | | | | | | | | | | | | | |
| 1 | Well depth | Meter | - | - | | | | | | | | | | 7.60 | 14.4 |
| 2 | Initial (Before Purging) | Meter | - | - | | | | | | | | 8.06 | 8.10 | 8.06 | 8.28 |
| 3 | Initial (After Purging) | | | | | | | | | | | | 15.0 | | |
| 4 | Initial (Before Sampling) | Meter | - | - | | | | | | | | 8.07 | 8.16 | 8.20 | 8.31 |
| | | | | | | | | | | | | | | | |
| | **Physical Tests** | | | | | | | | | | | | | | |
| 1 | pH [1)] | - | APHA 4500HB | 6.0 - 9.0 | 8.8 | 7.8 | 7.5 | 7.5 | 7.4 | 7.1 | 7.35 | 8.01 | 7.06 | 7.54 | 7.26 |
| 2 | Total Dissolved Solids, TDS | mg/L | APHA 2540C | 1000 | | | | | | | 340 | 314 | 338 | 318 | 308 |
| | | | | | | | | | | | | | | | |
| | **Anions** | | | | | | | | | | | | | | |
| 1 | Chloride, $Cl^-$ | mg/L | APHA 4110B | - | ND | 1.1 | 1 | 0.6 | <0.5 | 1.6 | 0.9 | 1.7 | 1.6 | 0.9 | 1.0 |
| 2 | Sulphate, $SO_4$ | mg/L | APHA 4110B | - | 5 | 7 | 7.4 | 9 | 7 | 8 | 3 | 6 | 6 | 4 | 5 |
| 3 | Sulphide, as $H_2S$ | mg/L | APHA 4500S-G | 0.002 | ND | <0.002 | <0.002 | <0.002 | <0.002 | **0.514** | <0.002 | <0.002 | <0.002 | <0.002 | <0.001 |
| | | | | | | | | | | | | | | | |
| | **Nutrients** | | | | | | | | | | | | | | |
| 1 | Nitrate, $NO_3$-N | mg/L | APHA 4110B | 20 | ND | 0.144 | <0.005 | 0.04 | 0.049 | 0.028 | <0.005 | 0.254 | 0.046 | 0.094 | 0.147 |
| 2 | Nitrite, $NO_2$-N | mg/L | APHA 4110B | 0.06 | ND | 0.010 | <0.001 | <0.001 | <0.001 | 0.016 | <0.001 | 0.003 | 0.009 | <0.001 | <0.001 |
| | | | | | | | | | | | | | | | |
| | **Dissolved Metals** | | | | | | | | | | | | | | |
| 1 | Arsenic, As | mg/L | APHA 3114C | 1 | 0.005 | <0.01 | <0.001 | 0.004 | 0.003 | 0.003 | <0.0005 | 0.0014 | 0.0023 | 0.0026 | 0.0021 |
| 2 | Cadmium, Cd | mg/L | APHA 3111B | 0.01 | 0.0002 | <0.0001 | 0.0002 | <0.0001 | <0.0001 | <0.0001 | <0.005 | <0.0001 | <0.005 | <0.005 | <0.005 |
| 3 | Copper, Cu | mg/L | APHA 3111B | 0.02 | ND | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.001 | <0.01 | <0.01 | <0.01 |
| 4 | Lead, Pb | mg/L | APHA 3113B | 0.03 | 0.016 | 0.017 | <0.001 | 0.006 | 0.010 | 0.002 | <0.001 | <0.001 | <0.001 | 0.001 | 0.003 |
| 5 | Mercury, Hg | mg/L | USEPA 245.7 | 0.002 | 0.00006 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 |
| 6 | Sodium, Na | mg/L | APHA 3111B | - | 22.50 | 14.10 | 11.4 | 11.3 | 12.4 | 11.1 | 10.5 | 11.9 | 11.4 | 10.9 | 7.17 |
| 7 | Zinc, Zn | mg/L | APHA 3111B | 0.05 | 0.99 | 0.04 | <0.01 | 0.03 | <0.01 | <0.05 | <0.005 | <0.005 | 0.007 | 0.006 | <0.005 |

**Borehole Name: Well 24**

| Laboratory Sample I.D : | | | | | | | | | | | | EV120116-39 | EV120759-28 | EV130143-21 | EV130628-36 | EV131143-29 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Date Sampled :** | | | | | **2009** | | | **2010** | | | **2011** | **2012** | | **2013** | | |
| **No.** | **Test Description** | **Unit** | **Methods** | **Regulatory Limit** | **Aug** | **Dec** | **Dec*** | **May** | **Sep** | **Dec** | **Aug** | **Feb** | **Sep** | **Feb** | **Jun** | **Nov** |
| | **Water Level Information** | | | | | | | | | | | | | | | |
| 1 | Well depth | Meter | - | - | | | | | | | | | | | 15.2 | 14.2 |
| 2 | Initial (Before Purging) | Meter | - | - | | | | | | | | | 5.93 | 5.76 | 5.70 | 6.00 |
| 3 | Initial (After Purging) | | | | | | | | | | | | | 14.6 | | |
| 4 | Initial (Before Sampling) | Meter | - | - | | | | | | | | | 5.95 | 5.79 | 5.72 | 6.00 |
| | | | | | | | | | | | | | | | | |
| | **Physical Tests** | | | | | | | | | | | | | | | |
| 1 | pH [1)] | - | APHA 4500HB | 6.0 - 9.0 | 7.2 | 7.8 | - | 7.3 | 7.2 | 7.3 | 7.0 | 7.23 | 7.97 | 7.21 | 7.70 | 7.29 |
| 2 | Total Dissolved Solids, TDS | mg/L | APHA 2540C | 1000 | | | | | | | | 307 | 285 | 310 | 252 | 314 |
| | | | | | | | | | | | | | | | | |
| | **Anions** | | | | | | | | | | | | | | | |
| 1 | Chloride, $Cl^-$ | mg/L | APHA 4110B | - | 11.8 | 1.7 | 1.7 | 2.7 | 1.5 | <0.5 | 3.3 | 2.7 | 2.2 | 2.8 | 1.9 | 1.2 |
| 2 | Sulphate, $SO_4$ | mg/L | APHA 4110B | - | 12 | 7 | 7 | 11.9 | 7 | 9 | 9 | 7 | 8 | 10 | 8 | 13 |
| 3 | Sulphide, as $H_2S$ | mg/L | APHA 4500S-G | 0.002 | ND | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | **0.002** | <0.002 | <0.002 | <0.002 | <0.002 | <0.001 |
| | | | | | | | | | | | | | | | | |
| | **Nutrients** | | | | | | | | | | | | | | | |
| 1 | Nitrate, $NO_3$-N | mg/L | APHA 4110B | 20 | 0.075 | 0.014 | 0.014 | <0.005 | 0.01 | 0.045 | 0.192 | 0.027 | 0.045 | 0.067 | 0.020 | 0.057 |
| 2 | Nitrite, $NO_2$-N | mg/L | APHA 4110B | 0.06 | ND | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| | | | | | | | | | | | | | | | | |
| | **Dissolved Metals** | | | | | | | | | | | | | | | |
| 1 | Arsenic, As | mg/L | APHA 3114C | 1 | 0.008 | <0.01 | <0.01 | <0.001 | <0.001 | 0.003 | 0.001 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 |
| 2 | Cadmium, Cd | mg/L | APHA 3111B | 0.01 | 0.0002 | 0.0002 | 0.0002 | 0.0003 | <0.0001 | <0.0001 | <0.0001 | <0.005 | <0.0001 | <0.005 | <0.005 | <0.005 |
| 3 | Copper, Cu | mg/L | APHA 3111B | 0.02 | 0.03 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.001 | <0.01 | <0.01 | <0.01 |
| 4 | Lead, Pb | mg/L | APHA 3113B | 0.03 | 0.076 | 0.019 | 0.019 | <0.001 | <0.001 | 0.018 | 0.008 | <0.001 | <0.001 | <0.001 | 0.003 | 0.002 |
| 5 | Mercury, Hg | mg/L | USEPA 245.7 | 0.002 | ND | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | 0.00006 | <0.00005 |
| 6 | Sodium, Na | mg/L | APHA 3111B | - | 6.37 | 6.82 | 6.77 | 6.25 | 6.04 | 7.02 | 6.18 | 6.00 | 6.59 | 5.93 | 5.71 | 4.12 |
| 7 | Zinc, Zn | mg/L | APHA 3111B | 0.05 | 0.12 | 0.03 | 0.03 | <0.01 | 0.02 | <0.01 | 0.03 | 0.010 | <0.005 | 0.006 | 0.008 | <0.005 |

**Borehole Name: Well 25**

| Laboratory Sample I.D : | | | | | | | | | | | | EV120116-40 | EV120759-29 | EV130143-22 | EV130628-37 | EV131143-30 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Date Sampled :** | | | | | **2009** | | **2010** | | | | **2011** | **2012** | | **2013** | | |
| **No.** | **Test Description** | **Unit** | **Methods** | **Regulatory Limit** | **Aug** | **Dec** | **May** | **Sep** | **Sep*** | **Dec** | **Aug** | **Feb** | **Sep** | **Feb** | **Jun** | **Nov** |
| | **Water Level Information** | | | | | | | | | | | | | | | |
| 1 | Well depth | Meter | - | - | | | | | | | | | | | 15 | 14.9 |
| 2 | Initial (Before Purging) | Meter | - | - | | | | | | | | | 11.54 | 11.6 | 11.5 | 11.7 |
| 3 | Initial (After Purging) | | | | | | | | | | | | | 13.7 | | |
| 4 | Initial (Before Sampling) | Meter | - | - | | | | | | | | | 11.62 | 11.6 | 11.5 | 11.7 |
| | | | | | | | | | | | | | | | | |
| | **Physical Tests** | | | | | | | | | | | | | | | |
| 1 | pH [1)] | - | APHA 4500HB | 6.0 - 9.0 | 7.3 | 7.7 | 7.3 | 7.2 | 7.2 | 7.3 | 6.9 | 7.24 | 7.74 | 6.98 | 7.41 | 7.03 |
| 2 | Total Dissolved Solids, TDS | mg/L | APHA 2540C | 1000 | | | | | | | | 364 | 366 | 409 | 372 | 402 |
| | | | | | | | | | | | | | | | | |
| | **Anions** | | | | | | | | | | | | | | | |
| 1 | Chloride, $Cl^-$ | mg/L | APHA 4110B | - | 1.5 | 2.5 | 2.6 | 2.1 | 2.2 | 1.9 | 3.4 | 3.0 | 2.2 | 4.5 | 2.5 | 2.9 |
| 2 | Sulphate, $SO_4$ | mg/L | APHA 4110B | - | 36 | 67 | 40.7 | 53 | 53 | 22 | 21 | 31 | 25 | 31 | 27 | 15 |
| 3 | Sulphide, as $H_2S$ | mg/L | APHA 4500S-G | 0.002 | ND | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.001 |
| | | | | | | | | | | | | | | | | |
| | **Nutrients** | | | | | | | | | | | | | | | |
| 1 | Nitrate, $NO_3$-N | mg/L | APHA 4110B | 20 | 0.095 | 0.038 | <0.005 | 0.118 | 0.118 | 0.042 | 0.033 | 0.021 | 0.026 | 0.079 | 0.013 | 0.028 |
| 2 | Nitrite, $NO_2$-N | mg/L | APHA 4110B | 0.06 | ND | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| | | | | | | | | | | | | | | | | |
| | **Dissolved Metals** | | | | | | | | | | | | | | | |
| 1 | Arsenic, As | mg/L | APHA 3114C | 1 | ND | <0.01 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 |
| 2 | Cadmium, Cd | mg/L | APHA 3111B | 0.01 | 0.0002 | <0.0001 | 0.0006 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.005 | <0.0001 | <0.005 | <0.005 | <0.005 |
| 3 | Copper, Cu | mg/L | APHA 3111B | 0.02 | ND | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.001 | <0.01 | <0.01 | <0.01 |
| 4 | Lead, Pb | mg/L | APHA 3113B | 0.03 | 0.024 | 0.008 | <0.001 | 0.003 | 0.003 | 0.016 | 0.006 | <0.001 | <0.001 | <0.001 | <0.001 | 0.004 |
| 5 | Mercury, Hg | mg/L | USEPA 245.7 | 0.002 | 0.00010 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 |
| 6 | Sodium, Na | mg/L | APHA 3111B | - | 7.79 | 11.20 | 8.19 | 7.36 | 7.32 | 9.79 | 8.81 | 8.27 | 8.37 | 10.3 | 7.61 | 5.86 |
| 7 | Zinc, Zn | mg/L | APHA 3111B | 0.05 | 0.01 | 0.04 | <0.01 | <0.01 | <0.01 | <0.01 | 0.02 | <0.005 | <0.005 | 0.007 | <0.005 | <0.005 |

**Borehole Name: New BH-3**

| | | | | | | |
|---|---|---|---|---|---|---|
| **Laboratory Sample I.D :** | | | | | EV130883-18 | EV131006-02 |
| **Customer Sample I.D :** | | | | | BH 3 | BH 3 |
| **Date Sampled :** | | | | | 29-Aug-13 | 02-Oct-13 |
| **Sample Matrix :** | | | | | Ground Water | Ground Water |
| **No.** | **Test Description** | **Unit** | **Methods** | **Regulatory Limit** | **Results** | |
| | **Water Level Information** | | | | | |
| 1 | Well depth | Meter | - | - | N.A | 13.2 |
| 2 | Initial (Before Purging) | Meter | - | - | N.A | 2.90 |
| 3 | Initial (Before Sampling) | Meter | - | - | N.A | 2.94 |
| | | | | | | |
| | **Physical Tests** | | | | | |
| 1 | pH [1)] | - | APHA 4500HB | 6.0 - 9.0 | 6.85 | 6.45 |
| 2 | Total Dissolved Solids, TDS | mg/L | APHA 2540C | 1000 | 448 | 496 |
| | | | | | | |
| | **Anions** | | | | | |
| 1 | Chloride, $Cl^-$ | mg/L | APHA 4110B | - | 4.6 | 4.8 |
| 2 | Sulphate, $SO_4$ | mg/L | APHA 4110B | - | 53 | 44 |
| 3 | Sulphide, as $H_2S$ | mg/L | APHA 4500S-G | 0.002 | <0.001 | <0.001 |
| | | | | | | |
| | **Nutrients** | | | | | |
| 1 | Nitrate, $NO_3$-N | mg/L | APHA 4110B | 20 | <0.005 | <0.005 |
| 2 | Nitrite, $NO_2$-N | mg/L | APHA 4110B | 0.06 | <0.001 | <0.001 |
| | | | | | | |
| | **Dissolved Metals** | | | | | |
| 1 | Arsenic, As | mg/L | APHA 3114C | 1 | 0.0019 | 0.0074 |
| 2 | Cadmium, Cd | mg/L | APHA 3111B | 0.01 | <0.005 | <0.005 |
| 3 | Copper, Cu | mg/L | APHA 3111B | 0.02 | <0.01 | <0.01 |
| 4 | Lead, Pb | mg/L | APHA 3113B | 0.03 | <0.05 | 0.003 |
| 5 | Mercury, Hg | mg/L | USEPA 245.7 | 0.002 | <0.00005 | <0.00005 |
| 6 | Sodium, Na | mg/L | APHA 3111B | - | 14.4 | 14.1 |
| 7 | Zinc, Zn | mg/L | APHA 3111B | 0.05 | 0.024 | 0.012 |
| | | | | | | |

**Borehole Name: New BH-5**

| | | | | | | |
|---|---|---|---|---|---|---|
| **Laboratory Sample I.D :** | | | | | EV130883-19 | EV131006-06 |
| **Customer Sample I.D :** | | | | | BH 5 | BH 5R |
| **Date Sampled :** | | | | | 29-Aug-13 | 02-Oct-13 |
| **Sample Matrix :** | | | | | Ground Water | Ground Water |
| **No.** | **Test Description** | **Unit** | **Methods** | **Regulatory Limit** | **Results** | **Results** |
| | **Water Level Information** | | | | | |
| 1 | Well depth | Meter | - | - | N.A | 15.6 |
| 2 | Initial (Before Purging) | Meter | - | - | N.A | 9.56 |
| 3 | Initial (Before Sampling) | Meter | - | - | N.A | 9.50 |
| | | | | | | |
| | **Physical Tests** | | | | | |
| 1 | pH [1)] | - | APHA 4500HB | 6.0 - 9.0 | 6.52 | 6.29 |
| 2 | Total Dissolved Solids, TDS | mg/L | APHA 2540C | 1000 | 680 | 578 |
| | | | | | | |
| | **Anions** | | | | | |
| 1 | Chloride, $Cl^-$ | mg/L | APHA 4110B | - | 14.1 | 11.5 |
| 2 | Sulphate, $SO_4$ | mg/L | APHA 4110B | - | 9 | 12 |
| 3 | Sulphide, as $H_2S$ | mg/L | APHA 4500S-G | 0.002 | <0.001 | <0.001 |
| | | | | | | |
| | **Nutrients** | | | | | |
| 1 | Nitrate, $NO_3$-N | mg/L | APHA 4110B | 20 | <0.005 | <0.005 |
| 2 | Nitrite, $NO_2$-N | mg/L | APHA 4110B | 0.06 | <0.001 | <0.001 |
| | | | | | | |
| | **Dissolved Metals** | | | | | |
| 1 | Arsenic, As | mg/L | APHA 3114C | 1 | 0.0050 | 0.0027 |
| 2 | Cadmium, Cd | mg/L | APHA 3111B | 0.01 | <0.005 | <0.005 |
| 3 | Copper, Cu | mg/L | APHA 3111B | 0.02 | 0.01 | <0.01 |
| 4 | Lead, Pb | mg/L | APHA 3113B | 0.03 | <0.05 | 0.004 |
| 5 | Mercury, Hg | mg/L | USEPA 245.7 | 0.002 | <0.00005 | <0.00005 |
| 6 | Sodium, Na | mg/L | APHA 3111B | - | 9.61 | 9.05 |
| 7 | Zinc, Zn | mg/L | APHA 3111B | 0.05 | 0.119 | 0.022 |
| | | | | | | |

**Borehole Name: New BH-N2**

| | | | | | | |
|---|---|---|---|---|---|---|
| **Laboratory Sample I.D :** | | | | | EV130883-20 | EV131006-01 |
| **Customer Sample I.D :** | | | | | BHN 2 | BH N2 |
| **Date Sampled :** | | | | | 29-Aug-13 | 02-Oct-13 |
| **Sample Matrix :** | | | | | Ground Water | Ground Water |
| **No.** | **Test Description** | **Unit** | **Methods** | **Regulatory Limit** | **Results** | **Results** |
| | **Water Level Information** | | | | | |
| 1 | Well depth | Meter | - | - | N.A | 15.2 |
| 2 | Initial (Before Purging) | Meter | - | - | N.A | 2.30 |
| 3 | Initial (Before Sampling) | Meter | - | - | N.A | 2.22 |
| | | | | | | |
| | **Physical Tests** | | | | | |
| 1 | pH [1)] | - | APHA 4500HB | 6.0 - 9.0 | 6.54 | 6.10 |
| 2 | Total Dissolved Solids, TDS | mg/L | APHA 2540C | 1000 | 354 | 368 |
| | | | | | | |
| | **Anions** | | | | | |
| 1 | Chloride, $Cl^-$ | mg/L | APHA 4110B | - | 2.0 | 3.5 |
| 2 | Sulphate, $SO_4$ | mg/L | APHA 4110B | - | 9 | 17 |
| 3 | Sulphide, as $H_2S$ | mg/L | APHA 4500S-G | 0.002 | <0.001 | <0.001 |
| | | | | | | |
| | **Nutrients** | | | | | |
| 1 | Nitrate, $NO_3$-N | mg/L | APHA 4110B | 20 | <0.005 | <0.005 |
| 2 | Nitrite, $NO_2$-N | mg/L | APHA 4110B | 0.06 | <0.001 | <0.001 |
| | | | | | | |
| | **Dissolved Metals** | | | | | |
| 1 | Arsenic, As | mg/L | APHA 3114C | 1 | 0.0017 | 0.0022 |
| 2 | Cadmium, Cd | mg/L | APHA 3111B | 0.01 | <0.005 | <0.005 |
| 3 | Copper, Cu | mg/L | APHA 3111B | 0.02 | <0.01 | <0.01 |
| 4 | Lead, Pb | mg/L | APHA 3113B | 0.03 | <0.05 | 0.007 |
| 5 | Mercury, Hg | mg/L | USEPA 245.7 | 0.002 | <0.00005 | <0.00005 |
| 6 | Sodium, Na | mg/L | APHA 3111B | - | 47.3 | 50.5 |
| 7 | Zinc, Zn | mg/L | APHA 3111B | 0.05 | 0.233 | 0.023 |
| | | | | | | |

**Borehole Name: New BH-N8R**

| | | | | | | |
|---|---|---|---|---|---|---|
| **Laboratory Sample I.D :** | | | | | EV130883-21 | EV131006-05 |
| **Customer Sample I.D :** | | | | | BHNN 8 R | BH N8R |
| **Date Sampled :** | | | | | 29-Aug-13 | 02-Oct-13 |
| **Sample Matrix :** | | | | | Ground Water | Ground Water |
| **No.** | **Test Description** | **Unit** | **Methods** | **Regulatory Limit** | **Results** | **Results** |
| | **Water Level Information** | | | | | |
| 1 | Well depth | Meter | - | - | N.A | 16.8 |
| 2 | Initial (Before Purging) | Meter | - | - | N.A | 4.86 |
| 3 | Initial (Before Sampling) | Meter | - | - | N.A | 4.86 |
| | | | | | | |
| | **Physical Tests** | | | | | |
| 1 | pH [1)] | - | APHA 4500HB | 6.0 - 9.0 | 7.25 | 6.91 |
| 2 | Total Dissolved Solids, TDS | mg/L | APHA 2540C | 1000 | 308 | 324 |
| | | | | | | |
| | **Anions** | | | | | |
| 1 | Chloride, $Cl^-$ | mg/L | APHA 4110B | - | 2.3 | 2.3 |
| 2 | Sulphate, $SO_4$ | mg/L | APHA 4110B | - | 23 | 18 |
| 3 | Sulphide, as $H_2S$ | mg/L | APHA 4500S-G | 0.002 | <0.001 | <0.001 |
| | | | | | | |
| | **Nutrients** | | | | | |
| 1 | Nitrate, $NO_3$-N | mg/L | APHA 4110B | 20 | <0.005 | <0.005 |
| 2 | Nitrite, $NO_2$-N | mg/L | APHA 4110B | 0.06 | <0.001 | 0.029 |
| | | | | | | |
| | **Dissolved Metals** | | | | | |
| 1 | Arsenic, As | mg/L | APHA 3114C | 1 | 0.0008 | 0.0007 |
| 2 | Cadmium, Cd | mg/L | APHA 3111B | 0.01 | <0.005 | <0.005 |
| 3 | Copper, Cu | mg/L | APHA 3111B | 0.02 | <0.01 | <0.01 |
| 4 | Lead, Pb | mg/L | APHA 3113B | 0.03 | <0.05 | 0.003 |
| 5 | Mercury, Hg | mg/L | USEPA 245.7 | 0.002 | <0.00005 | <0.00005 |
| 6 | Sodium, Na | mg/L | APHA 3111B | - | 33.9 | 34.9 |
| 7 | Zinc, Zn | mg/L | APHA 3111B | 0.05 | 0.009 | 0.008 |
| | | | | | | |

**Borehole Name: New BH-1**

| | | | | | |
|---|---|---|---|---|---|
| **Laboratory Sample I.D :** | | | | | EV131006-03 |
| **Customer Sample I.D :** | | | | | BH 1 |
| **Date Sampled :** | | | | | 02-Oct-13 |
| **Sample Matrix :** | | | | | Ground Water |
| **No.** | **Test Description** | **Unit** | **Methods** | **Regulatory Limit** | **Results** |
| | **Water Level Information** | | | | |
| 1 | Well depth | Meter | - | - | 12.3 |
| 2 | Initial (Before Purging) | Meter | - | - | 10.8 |
| 3 | Initial (Before Sampling) | Meter | - | - | 10.8 |
| | | | | | |
| | **Physical Tests** | | | | |
| 1 | pH [1)] | - | APHA 4500HB | 6.0 - 9.0 | 6.73 |
| 2 | Total Dissolved Solids, TDS | mg/L | APHA 2540C | 1000 | 592 |
| | | | | | |
| | **Anions** | | | | |
| 1 | Chloride, $Cl^-$ | mg/L | APHA 4110B | - | 3.9 |
| 2 | Sulphate, $SO_4$ | mg/L | APHA 4110B | - | 194 |
| 3 | Sulphide, as $H_2S$ | mg/L | APHA 4500S-G | 0.002 | <0.001 |
| | | | | | |
| | **Nutrients** | | | | |
| 1 | Nitrate, $NO_3$-N | mg/L | APHA 4110B | 20 | <0.005 |
| 2 | Nitrite, $NO_2$-N | mg/L | APHA 4110B | 0.06 | <0.001 |
| | | | | | |
| | **Dissolved Metals** | | | | |
| 1 | Arsenic, As | mg/L | APHA 3114C | 1 | <0.0005 |
| 2 | Cadmium, Cd | mg/L | APHA 3111B | 0.01 | <0.005 |
| 3 | Copper, Cu | mg/L | APHA 3111B | 0.02 | <0.01 |
| 4 | Lead, Pb | mg/L | APHA 3113B | 0.03 | 0.003 |
| 5 | Mercury, Hg | mg/L | USEPA 245.7 | 0.002 | <0.00005 |
| 6 | Sodium, Na | mg/L | APHA 3111B | - | 8.75 |
| 7 | Zinc, Zn | mg/L | APHA 3111B | 0.05 | 0.011 |
| | | | | | |

**Borehole Name: New BH-N6R**

| | | | | | |
|---|---|---|---|---|---|
| **Laboratory Sample I.D :** | | | | | EV131006-04 |
| **Customer Sample I.D :** | | | | | BH N6R |
| **Date Sampled :** | | | | | 02-Oct-13 |
| **Sample Matrix :** | | | | | Ground Water |
| **No.** | **Test Description** | **Unit** | **Methods** | **Regulatory Limit** | **Results** |
| | **Water Level Information** | | | | |
| 1 | Well depth | Meter | - | - | 13.8 |
| 2 | Initial (Before Purging) | Meter | - | - | 11.6 |
| 3 | Initial (Before Sampling) | Meter | - | - | 11.5 |
| | | | | | |
| | **Physical Tests** | | | | |
| 1 | pH [1)] | - | APHA 4500HB | 6.0 - 9.0 | 6.89 |
| 2 | Total Dissolved Solids, TDS | mg/L | APHA 2540C | 1000 | 730 |
| | | | | | |
| | **Anions** | | | | |
| 1 | Chloride, $Cl^-$ | mg/L | APHA 4110B | - | 6.8 |
| 2 | Sulphate, $SO_4$ | mg/L | APHA 4110B | - | 126 |
| 3 | Sulphide, as $H_2S$ | mg/L | APHA 4500S-G | 0.002 | <0.001 |
| | | | | | |
| | **Nutrients** | | | | |
| 1 | Nitrate, $NO_3$-N | mg/L | APHA 4110B | 20 | <0.005 |
| 2 | Nitrite, $NO_2$-N | mg/L | APHA 4110B | 0.06 | <0.001 |
| | | | | | |
| | **Dissolved Metals** | | | | |
| 1 | Arsenic, As | mg/L | APHA 3114C | 1 | <0.0005 |
| 2 | Cadmium, Cd | mg/L | APHA 3111B | 0.01 | <0.005 |
| 3 | Copper, Cu | mg/L | APHA 3111B | 0.02 | <0.01 |
| 4 | Lead, Pb | mg/L | APHA 3113B | 0.03 | 0.009 |
| 5 | Mercury, Hg | mg/L | USEPA 245.7 | 0.002 | <0.00005 |
| 6 | Sodium, Na | mg/L | APHA 3111B | - | 8.20 |
| 7 | Zinc, Zn | mg/L | APHA 3111B | 0.05 | 0.015 |
| | | | | | |