SARFIIP SMM Investigations

Drilling Program: Groundwater Well Design and Construction on Pike Floodplain and Katarapko Floodplain 2015 (Phase 1 and 2A)

DEWNR Technical note 2016/15

Government of South Australia
Department of Environment, Water and Natural Resources

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Drilling Program: Groundwater Well Design and Construction on Pike Floodplain and Katarapko Floodplain 2015 (Phase 1 and 2A)

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Contents

List of figures

List of tables

1 Introduction

1.1 Project background

The South Australian Riverland Floodplains Integrated Infrastructure Program (SARFIIP) is a large-scale infrastructure project that is designed to enable floodplain inundation for the South Australian Riverland region between the border and Lock 1. Inherent in planning and design is a specific focus on the Pike and Katarapko floodplains. Commencing in 2012, the program aims to restore the vegetation health of these floodplains. This program will build on the investment undertaken by the Riverine Recovery Project (RRP) at these sites and allow for an integrated approach to management that will deliver regional environmental benefits.

SARFIIP is being undertaken on behalf of the Murray-Darling Basin Authority (MDBA) by the River Murray Operations and Major Projects (RMOMP) Branch of the Department of Environment, Water and Natural Resources (DEWNR), in partnership with the Science, Monitoring and Knowledge (SMK) Branch of DEWNR, and Natural Resources SA Murray-Darling Basin Management Board (NRSAMDB). SMK is supporting RMOMP through the delivery of scientific and technical services that assist with the assessment of floodplain and salinity management options, including data management, field investigations and modelling. Collectively, these tasks described as the SARFIIP Science Program.

The SARFIIP Science Program incorporates a number of managed projects of work including:

- Preliminary Investigations (Project 1)
- Salinity Investigations (Project 4)
- Salinity Knowledge, Data Analysis and Modelling (Project 6).

These projects fall under the Salinity Management Measures (SMM) project delivered by RMOMP. The Salinity Investigations employ a number of targeted groundwater field studies whereas the Salinity Knowledge, Data Analysis and Modelling works are primarily focused on the construction of a Pike Floodplain numerical groundwater model to support concept design options. The targeted groundwater field investigations provide baseline data, enabling greater understanding of floodplain processes and thereby informing the floodplain hydrogeological conceptual model and numerical modelling requirements.

During the Preliminary Investigations phase (Project 1), SMK and RMOMP identified a number of field-based tasks required to support numerical groundwater modelling and development of SMM concept design options. One task implemented in Project 1 during 2014 was a bore audit that provided a stocktake of groundwater well infrastructure, status and condition across the study areas of Pike Floodplain and Katarapko Floodplain. Since the existing groundwater wells had been sited and designed for other purposes (i.e. not specifically for SARFIIP), drilling and construction of additional wells were required as a key task under the Salinity Investigations project.

This document details the drilling program conducted during 2015 under the SARFIIP SMM Salinity Investigations project.

1.2 Drilling program objectives

The objective of the SARFIIP SMM Salinity Investigations drilling program was to drill and construct additional groundwater observation and production wells on the Pike and Katarapko Floodplain study areas to aid SARFIIP SMM investigations. The drilling program was divided into a number of stages of on-ground works (Phase 1 and Phase 2A) as a contingency against extended periods of wet weather and to accommodate additional information delivered by the SMM concept design engineer.

During an informal technical meeting held between SMK and RMOMP in April 2015, it was decided that new well installation on the Pike Floodplain would have a higher priority than the Katarapko Floodplain in order to:

- Focus efforts on one floodplain in an attempt to maximise the level of detail and subsequent understanding so that any lessons learnt could be translated to the other floodplain
- Assist in the development of the Pike Floodplain groundwater flow model currently under construction. In contrast, the Katarapko groundwater flow model is planned as a future project, and hence has a lower priority.

Phase 1 of the program specifically focused on drilling and construction of observation wells only. The main purpose for these wells were to:

- Target freshwater lenses identified within the Monoman Formation to enable the assessment of their salinity, depth and extent. Additionally, these wells provided an opportunity to obtain groundwater measurements of the overlying Coonambidgal Formation. Data from these wells will be used in the ARC-linkage freshwater lens characterisation study.
- Provide in-fill to the groundwater monitoring network across the floodplain study areas. Data from these wells will be used in model development and calibration and will increase understanding baseline floodplain conditions.
- Align with vegetation health survey locations (historical and current) to determine the influence of groundwater conditions on vegetation health
- Site wells in areas where inundation is proposed.

In addition, one deep observation well was drilled on Katarapko Floodplain to provide information on the thickness of the aquitard (i.e. the Bookpurnong Formation) between the Monoman Formation and deeper Pata Formation aquifer. The hydrogeological characteristics and spatial extent of this this aquitard are unknown in the vicinity of the Katarapko Floodplain and therefore this well provides useful information for the development of a floodplain conceptual model. While determining the thickness of this aquitard was the primary objective, constructing a well screened into the Pata Formation below allows on-going groundwater level measurement.

Phase 2A of the drilling program was designed by the SMM concept design engineer and was finalised while drilling related fieldwork was being conducted for Phase 1. The specific purposes for the Phase 2A observation wells were to:

- Determine river skin conductance, or in other words, measure the hydraulic connection between surface water bodies and the aquifer. This included the drilling of one production well (or groundwater testing well). This was done to aid in an assessment of freshwater lens manipulation.
- In-fill the groundwater monitoring network across the floodplains to inform groundwater model development and calibration, and aid in understanding baseline floodplain conditions.
- Further target freshwater lenses to enable quantification of the effects of the SMM concept design, provide more informed modelling inputs and allow assessment of vegetation dependency on groundwater conditions.

Finally, it should be noted that for both phases of work, final well site locations adhered to Cultural Heritage direction and clearance, site access feasibility and the avoidance of private lands.

In addition to the drilling program, an airborne electromagnetic (AEM) survey was flown across the Pike and Katarapko floodplains study area (including Gurra Gurra Lakes) in May 2015 as part of the Salinity Investigations project. The AEM survey over the Katarapko Floodplain was extensive and undertaken as an important aid for well site selection. In contrast, the AEM survey over the Pike Floodplain was limited only covering a small portion of the floodplain as a verification aid for AEM data previously collected from this area in 2008.

1.3 Study area

1.3.1 Pike Floodplain

Pike Floodplain is located south of the township of Renmark and consists of a large anabranch system of approximately 67 km^2 (Fig. 1). Lock 5 is the closest of the River Murray locks and is located to the north of the floodplain.

Deep Creek feeds the anabranch system and Margaret Dowling Creek, north of Lock 5, provides regulated inflows to the floodplain. The system is made up of several creeks or anabranches namely: Mundic Creek, Pike Lagoon, Pike River (Upper, Mid and Lower), Snake Creek, Tanyacka Creek and Rumpagunyah Creek. Mundic Creek and Pike River are the largest with Pike River providing water for one of South Australia's oldest irrigation communities. Further downstream in the Pike River, water for irrigation is regulated by the Col Col Embankment.

The floodplain can be divided into the Upper Pike Floodplain and Lower Pike Floodplain. The Upper Pike Floodplain can only be accessed by road via Mundic Creek Road in the north. Until recently (mid-2015), the floodplain could also be accessed in the east by Coombs Bridge however that bank has since been removed. While technically both sections of the floodplain are islands, the Lower Pike Floodplain is considered a permanent island because access can only be achieved by watercraft.

A series of levee banks or bridges that allow access to the majority of the floodplain proper, have been upgraded over time. At present, the usable levee banks include Bank B, Bank C, Bank E, Bank D, Bank F, Bank F1 and Bank G.

The Pike Floodplain is a high-priority ecological and cultural area of the River Murray. The floodplain contains a variety of aquatic habitats, but currently suffers from declining ecological health. Key threats to this ecosystem include highly saline groundwater close to the ground surface and altered flow regimes. Groundwater salinity impacts to the River Murray and Pike Floodplain are currently mitigated through the operation of the Pike River Salt Interception Scheme (SIS), which has four operational production wells located immediately south of the floodplain near the Lower Pike River.

Recent efforts to improve ecosystem health have included artificial inundation of Duck Hole, an adjacent wetland and the Inner Mundic Flood runner on the north western Pike Floodplain.

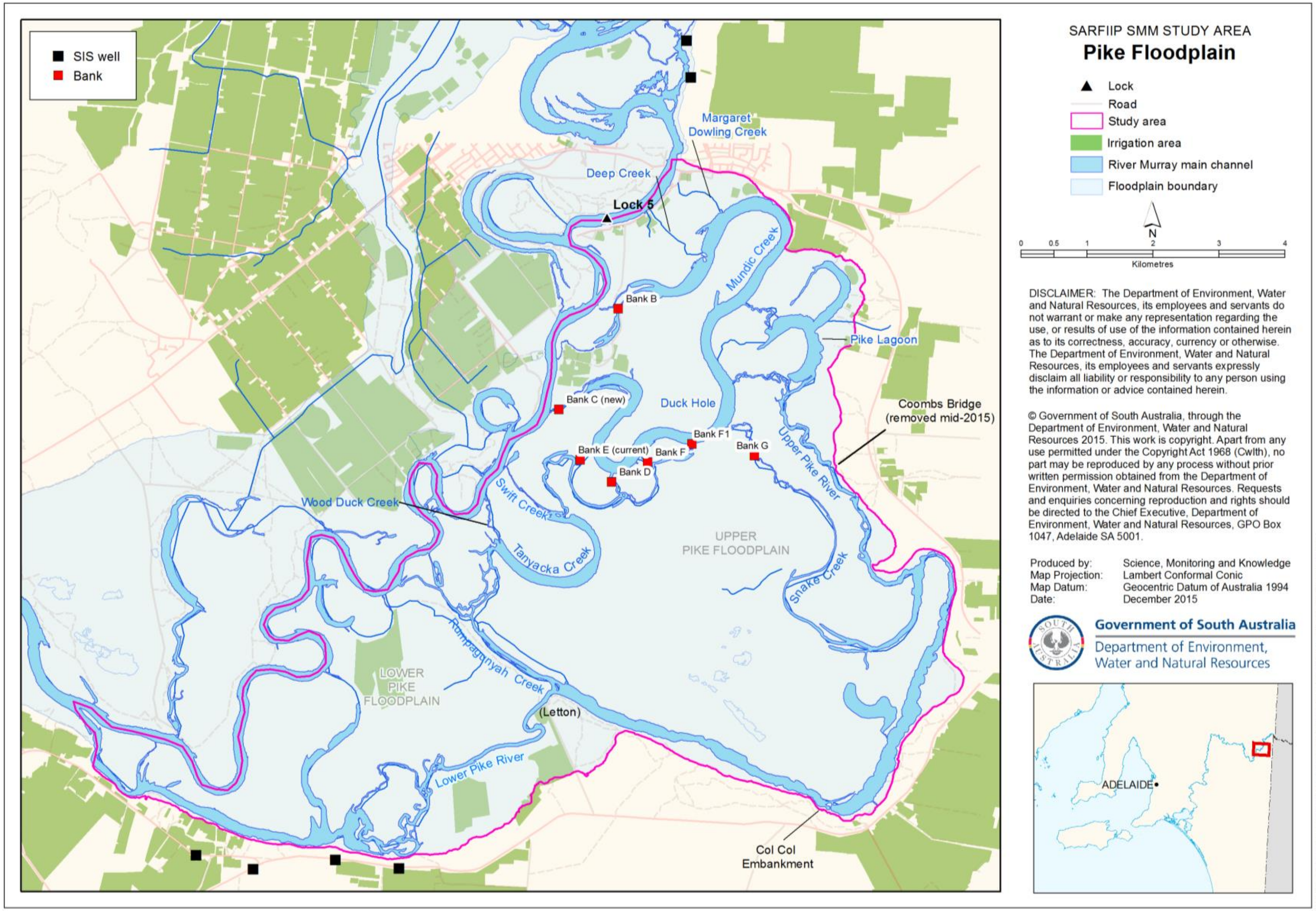

Figure 1 Location of Pike Floodplain and surrounding areas

1.3.2 Katarapko Floodplain

The Katarapko Floodplain is located between the townships of Berri and Loxton and consists of a large anabranch system that covers an area of approximately 90 km^2 (Fig. 2). Lock 4 is the closest of the River Murray locks and is located in the north of the floodplain. The Katarapko Floodplain is part of Katfish Reach project area; the name Katfish Reach was established 7 years ago and stands for Katarapko Native Fish Demonstration Reach. Most of the area is included within the Murray River National Park (Katarapko), with the remaining area a mixture of private land, Crown Land and the Gerard Aboriginal Reserve.

Bank N, Bank K and Bank J located north of Lock 4 feed the anabranch system, which provide regulated inflows through a series of anabranches. These anabranches include Northern Arm, Bank K Creek, Eckert Creek, and Southern Arm. These provide flows to the bulk of the system downstream, which include Eckert Wide Water, Ngak Indau wetland, Sawmill Creek, Eckert Creek (downstream), The Splash, Katarapko Creek, Piggy Creek and Carpark Lagoons. The Berri Saline Water Disposal Basin is located in the north of the project area.

A complex system of lakes called the Gurra Gurra Lakes is located within the north east portion of the project area and will be the subject of further investigation in the future.

Habitats within Katfish Reach include permanent flowing creeks, freshwater complexes, saline wetlands and floodplains. These habitats support a variety of wildlife that includes a number of threatened species. River regulation and historic land management practices have adversely affected the health of these ecosystems.

Groundwater salinity impacts to the River Murray and Katarapko Floodplain are currently mitigated through the operation of the Bookpurnong and Loxton SIS's, which have approximately 27 operational production wells and a highland horizontal drainage well located adjacent to the study area.

Recent efforts to improve ecosystem health have included artificial inundation trails at a number of Katarapko Floodplain sites, including Ngak Indau Wetland, Piggy Creek and Carpark Lagoons.

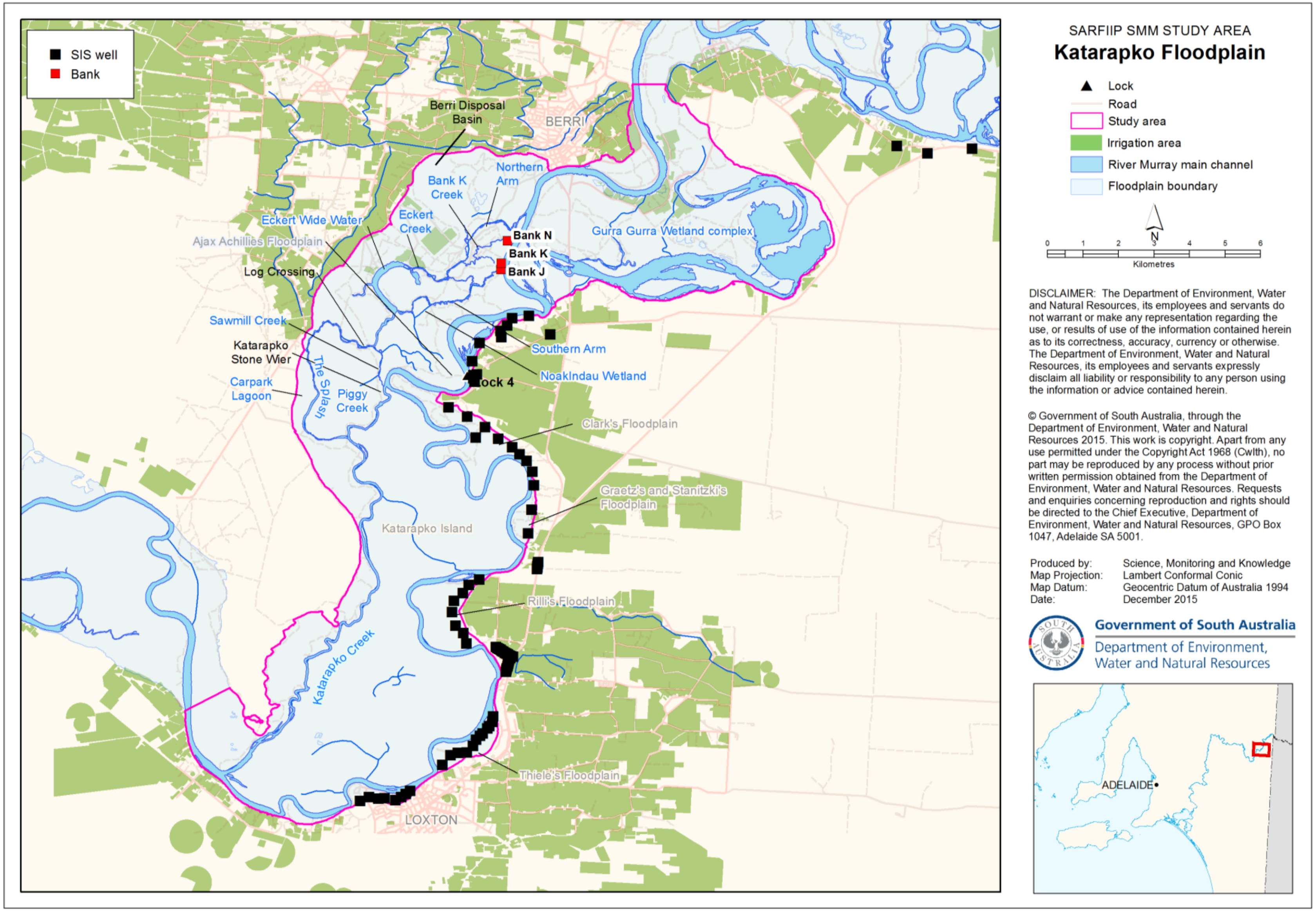

Figure 2 Location of Katarapko Floodplain and surrounding areas

2 Hydrogeology

2.1 Regional hydrogelogy

The Riverland of South Australia forms part of the Mallee region of the larger Murray Basin, a shallow geological basin that covers about 300 000 km^2, across the states of Victoria, South Australia and New South Wales. The Murray Basin is a closed groundwater basin containing Cenozoic unconsolidated sediments up to 600 metres in thickness, within which a number of regional aquifer systems have been identified (Evans and Kellett, 1989). From 65 million years ago (Pliocene) to the present, the depositional and erosional patterns of the western Murray Basin have been dominated by a combination of changing sea levels, cyclically driving sea inundation of the continent and incision of river valleys and minor tectonic movements (Drexel and Preiss, 1995).

Within South Australia, and for the purposes of this report, there are four sequences of sediments that are identified as aquifers. These include the Renmark Group, the Murray Group, the Loxton Sands and lateral equivalents, and the Monoman Formation (Fig. 3). Additionally, perched aquifer systems also exist within the Woorinen Formation found in some irrigation areas. A summary of the hydrostratigraphy is provided in Table 1.

Of significance to this investigation is the fact that the Monoman Formation unconformably overlies the Loxton Sands beneath the floodplain near the Murray River. This depositional relationship evolved during the last glacial maximum (~65 000 years before present) in which the Loxton Sands were eroded by channel development and the Monoman Formation and later Coonambidgal Formation sediments subsequently deposited (Rogers, 1995). With respect to the regional hydrogeology, groundwater is interpreted to flow from the Loxton Sands into the Monoman Formation.

In-situ weathering and regolith development (e.g. crete-formation, mineral dissolution or oxidation or bio- or rhizoturbation) may affect the hydrogeological properties of the various hydrostratigraphic units. However, it is currently uncertain whether such processes have affected exposed strata significantly enough to warrant mapping weathering horizons as separate hydrostratigraphic entities.

Table 2 Summary of hydrostratigraphy of the area of investigation (Summarised from Rogers, 1995; Rogers et al, 1995, Firman 1973 and Lawrence 1966 and Cowley and Barnett, 2007)

Period	Group name	Formation name	Lithology description	Depositional environment	Hydrogeological characteristics
Holocene		Coonambidgal Formation	Slightly micaceous silty clay. Variable amounts of silt sand and gravel.	Floodplain alluvial. Paired terraces evident along stream channels	Aquitard. Groundwater found in sandier units
Pleistocene		Monoman Formation	Coarse grained quartz sand, silts and alluvial clay	Alluvial	Aquifer
Middle Pleistocene to Holocene		Woorinen Formation	Pale reddish brown silty and clayey quartz sand with layers of pedogenic carbonate	Dunal	Perched aquifers present
Late Pliocene to Middle		Blanchetown Clay	Greenish grey sandy clay. Thin layers of limestone and quartz sand. Gypsiferous near top. Calcareous septarian nodules	Lacustrine. (Lake Bungunnia)	Aquitard
Late Pliocene to Middle		Chowilla Sand	Fine to medium grained quartz sand	Fluvial	Aquifer. Restricted to areas upstream from Berri
Early to Late Pliocene		Loxton Sands (inc. Parilla Sand)	Glauconitic micaceous and shelly fine sand, planar to cross-bedded fine to coarse sand and fine gravel and planar-bedded calcareous and micaceous, shelly medium to coarse grained sandstone. A sequence of clay and shells is found at the base. This sequence is referred to as the “Lower Loxton Shells and Clay” in Yan et al. 2005a	Shallow water and marginal marine transitioning to beach and coastal barrier. Regressional sequence. Parilla Sand is non-marine.	Aquifer (Lower Loxton shells and clay interpreted as an aquitard)
Late Miocene to Early Pliocene		Bookpurnong Formation	Marl, silty clay and minor fine sand	Shallow marine	Aquitard
Early Miocene		Winnambool Formation	Fossiliferous marl, glauconitic marly limestone and marly clay	Shallow, restricted marine and lagoon	Aquitard
Early Miocene		Geera Clay	Black and grey-green carbonaceous, pyritic clay	Marginal marine and tidal sediments	

Period	Group name	Formation name	Lithology description	Depositional environment	Hydrogeological characteristics
Early Miocene	Murray Group	Pata Formation	Bryozoan limestone and marl	Marine	Aquifer
		Morgan Subgroup	Low energy carbonate ramp sediments. Consists of the Cadell Formation (marl), Glenforslan Formation (carbonate sediments with abundant bryozoans and molluscs) and the Finniss Formation (carbonate clay)	Marine. Low energy carbonate ramp	Possible limestone aquifer. Clays may act as localised aquitards.
		Mannum Formation (Inc. Upper and Lower Mannum Frms.	Echinoidal and bryozoal calcareous sandstone and sandy limestone.	Shallow marine	Aquifer
Early Oligocene to Early Miocene	Murray Group	Ettrick Formation	Glauconitic and fossiliferous marl, calcareous clay and mudstone. Some silt and fine grained sand	Marine	Aquitard
Late Palaeocene to Middle Eocene	Renmark Group	Olney Formation	Thinly bedded carbonaceous sand, silt, clay and lignite	Fluvial, lacustrine and swamp environments	Aquifer. Basin wide.
		Warina Sands	Medium to coarse-grained quartz sand. Minor thin lenticular inter-beds of carbonaceous silty clay	Non-marine	Aquifer. Restricted to deeper parts of the basin

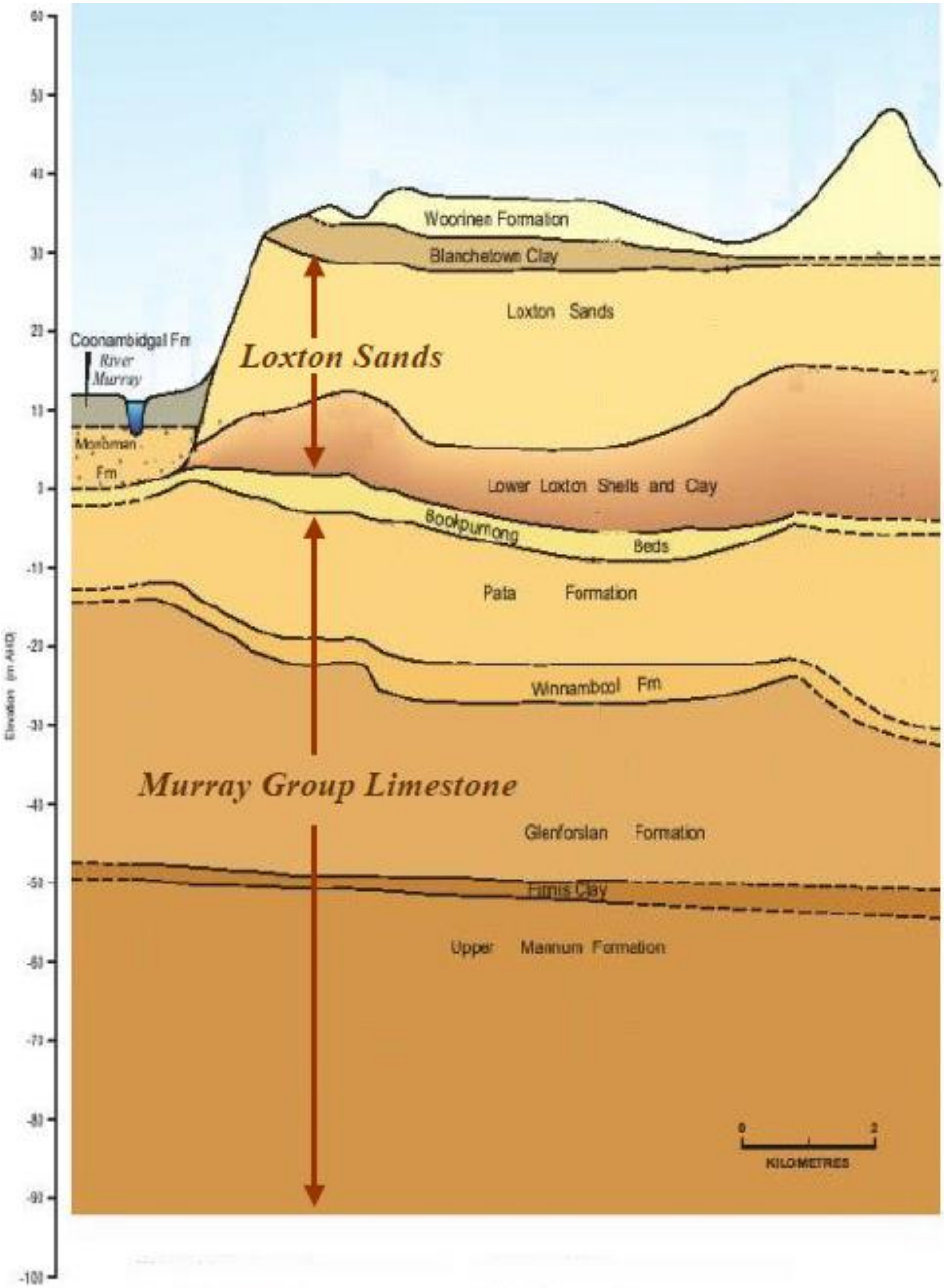

Figure 3 Hydrogeological cross-section of the Riverland environment (Yan et al, 2005a)

Table 2 below details the basic characteristics of each hydrogeological unit in the project area.

Table 2 Hydrogeological units of the study area

Hydrogeological unit	Aquifer/Aquitard	Salinity range (mg/L)	Yield range (L/s)
Coonambidgal Formation	Aquitard	NA	NA
Monoman Formation	Aquifer (floodplain)	7000-60 000	0.5-10
Loxton Sand	Aquifer (highland)	7000-40 000	0.5-5
Lower Loxton Clay	Aquitard	NA	NA
Bookpurnong Formation	Aquitard	NA	NA
Pata Formation (Murray Group)	Aquifer	10 000-30 000	0.5-1
Winnambool Formation (Murray Group)	Aquitard	NA	NA
Glenforslan Formation (Morgan Subgroup)	Aquifer	5000-30 000	0.5-2
Finnis Formation (Morgan Subgroup)	Aquitard	NA	NA
Upper Mannum Formation (Murray Group)	Aquifer	3000-25 000	5-10
Lower Mannum Formation (Murray Group)	Aquifer	NA	NA
Ettick Formation (Murray Group)	Aquitard	NA	NA
Renmark Group	Aquifer	NA	NA

Previously reported (Yan et. al., 2005b)

2.2 Floodplain hydrogeology

As discussed briefly in Section 2.1, the River Murray is located within a broad trench, formed during the last glacial maximum (~65 000 years BP), when sea levels were lower and the river accordingly cut deeper into the surrounding landscape. After sea levels rose, the trench gradually filled with the floodplain sediments of the Monoman Formation and Coonambidgal Formation (Rogers, 1995). The Monoman Formation is the major aquifer beneath the floodplain.

The Monoman Formation and Loxton Sands aquifers provide the majority of the salt load entering the River Murray because they are the main aquifer units in contact with surface water flow. Therefore, groundwater migration between the Loxton Sands and Monoman Formation is an important component in salt migration across the area. The hydraulic conductivity of the Loxton Sands and the hydraulic head difference between the river and nearby groundwater controls the flux of saline groundwater entering the River Murray. Consequently, these two aquifers are the primary targets for salt interception.

Figure 4 presents a schematic diagram of the conceptual hydrogeological model including a description of groundwater flow between the aquifers, the broader regional groundwater flow system, inter-aquifer flow and local recharge mechanisms.

2.2.1 Groundwater levels

There is a substantial historical record of groundwater level data near the Pike Floodplain, although most data is restricted to the highland and irrigation areas where the Loxton Sands aquifer predominates. However there are still a number of observation wells completed in the Coonambidgal and Monoman Formations within the Pike Floodplain from which groundwater level data may be obtained.

On the Katarapko Floodplain, groundwater level monitoring is restricted to the eastern side of Katarapko Creek and is centred on the extensive SIS in the area. Groundwater well infrastructure itself is limited on the Katarapko Floodplain study area and where wells exist, they may be screened across both Coonambidgal and Monoman Formations.

Groundwater flow within the Monoman Formation and Loxton Sands broadly follows the stream and topographic gradient. Based on monitoring results over the past 12 months, depth to water (DTW) for the Monoman Formation/Loxton Sands aquifer has varied between 41.5 m below natural surface (mBNS) (7029-1978) and 0.89 mBNS (7029-1217) within the Pike Floodplain study area. For the Katarapko Floodplain study area, water levels have ranged between 41.4 mBNS (7029-1424) and 3.01 mBNS (7029-1301) over the same period of time. Typically depth to water at the shallow end of the range is attributed to the Monoman Formation (i.e. the floodplain) whereas the deeper measurements are measured on the highland and Loxton Sands aquifer. It is noted that irrigation drainage on the highlands may create perched lenses of groundwater that are not connected to the regional watertable.

Historical groundwater level measurements are stored in the state groundwater database (available online at WaterConnect).

2.2.2 Groundwater salinity

Measurements of groundwater salinity are limited and are generally only representative of salinity at the time of construction and well development. The salinity of groundwater sampled from shallow monitoring bores and drilling across the floodplain typically ranges from 7 000 to 40 000 mg/L (12 200 to 60 500 µS/cm) but can be as high as 75 000 mg/L (107 150 µS/cm).

Historical salinity measurements are stored in the state groundwater database (available online at WaterConnect).

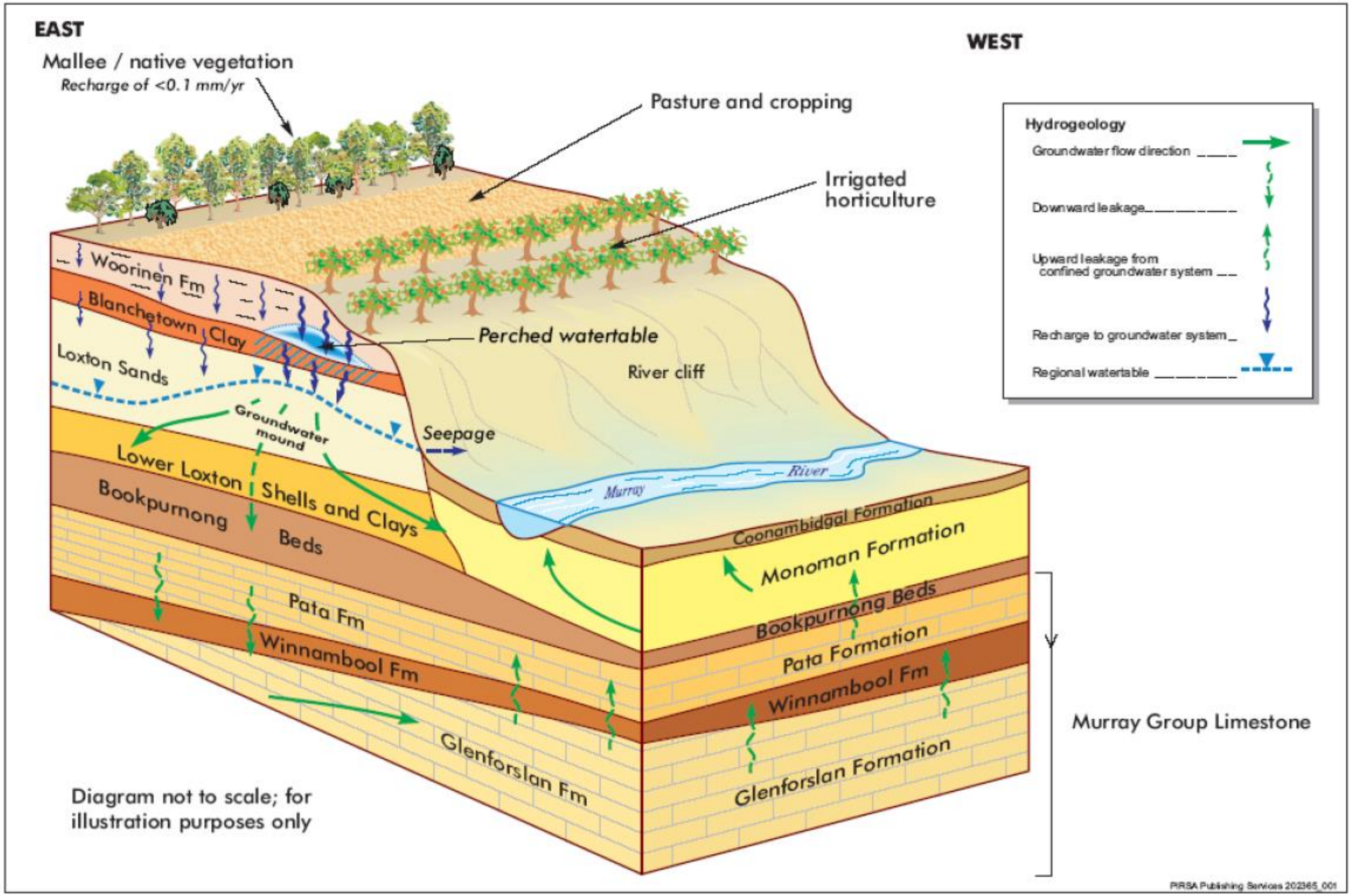

Figure 4 **Hydrogeological conceptual processes of the Riverland environment (Yan et al, 2005a)**

2.3 Groundwater well networks and monitoring

A number of groundwater monitoring networks were active (or current) near the study area in 2014. Their primary functions were to monitor water levels beneath irrigation areas that are located on the highland areas adjacent to the floodplain or for monitoring of SIS operations. Consequently, few of these monitoring networks included wells located on the floodplain itself. The only pre-2015 monitoring network that did include wells located on the Pike Floodplain was the Pike Murtho Irrigation Area monitoring well network. In 2015, the groundwater monitoring networks were rationalised leading to some network closures, well optimisation in remaining networks and reductions in measurement frequency.

Good quality, long term monitoring data is generally restricted to water levels collected from wells completed in shallow aquifers. Salinity data in contrast, is limited and typically consists of one sample collected during the well construction stage. Table 3 provides a collation of the known historical (pre-2015) groundwater monitoring networks in close proximity to the Pike and Katarapko floodplains. Table 4 presents information on the current (post-2015) groundwater monitoring networks near the study areas. It should be noted that wells on the Pike Floodplain that were monitored under the (pre-2015) Pike Murtho Irrigation Areas network are no longer currently monitored.

Table 3 Details of relevant historical (pre-2015) groundwater monitoring networks

Name	Closest floodplain study area	No of wells	Water level data Length of record	Salinity data	Location description
Pike Murtho Irrigation Areas	Pike	139	Since 1968	0	The network stretches north of Renmark along the River Murray to Murtho Forest and south to the Gurra Gurra Wetland complex. Some FP study area monitoring but mainly restricted to highland areas northeast and southwest of Pike. Those wells that are located on the FP monitor groundwater in both the Monoman and Coonambidgal formations.
Renmark-Cooltong Irrigation Areas	Pike	219	Since 1955	0	Centred on Renmark. The network stretches north past Cooltong and south to an area located just north of Pike FP study area. No FP study area monitoring.
Berri-Barmera Irrigation Areas	Katarapko	128	Since 1955	0	Centred on Berri and Barmera. The network stretches west to Loveday and south to the community of Gerard. No FP study area monitoring.
Bookpurnong SIS	Katarapko	31	Since 2001	0	Centred on Bookpurnong and restricted to the highland area east of the River Murray and north of Loxton. No FP study area monitoring.
Gurra Gurra Wetland Complex	Katarapko	13	Since 1883	0	Centred on the Gurra Gurra Wetland complex
Loxton Irrigation Areas	Katarapko	49		0	Restricted to highland area east of FP study area and east of Loxton.
Loxton SIS	Katarapko	119	Since 1990	0	Network extends north of Loxton to Rilli's FP and SW to Pyap. Some FP monitoring mainly Rilli's FP and limited wells west of the River Murray on Katarapko Island.. Also included is one well west of Katarapko Ck. No FP study area monitoring apart for two wells to the south.

As available online October 2014 from the state's groundwater database (WaterConnect). Note that changes to networks including closure and reductions in number of wells across networks occurred during 2015 as part of an optimisation project.

Table 4 Details of relevant current (post-2015) groundwater monitoring networks

Name	Closest floodplain study area	No of wells	Wells with current water level status	Salinity status	Location description
Pike Murtho Irrigation Areas	Pike	127	57	0	Centred on Renmark. The network stretches NE of Renmark to just south of Murtho and just over the border into VIC and as far south as the Gurra Gurra Wetlands complex and Yamba. No current FP study area monitoring.
Berri and Renmark Irrigation Areas	Pike/ Katarapko	341	82	0	Centred on Renmark and Berri. Network stretches north of Renmark as far as Cooltong, south of Renmark to the River Murray, north of Berri toward Monash and west of Berri toward Loveday. No current FP study area monitoring.
Loxton-Bookpurnong Irrigation Areas	Katarapko	186	77	0	Centred on Berri and Loxton. Network stretches from an area south of Berri inclusive of the Gurru Gurra Wetlands complex to Pyap. The network also extends to the south and approximately 10km east of Loxton. There is minor historical monitoring in the southern part of the Katarapko FP.
Waikerie Moorook Irrigation Areas	Katarapko	227	120	0	Centred on Waikerie. The network stretches east towards Loxton, north of Overland Corner and west toward Morgan. No current FP study area monitoring.

3 Drilling program methodology

3.1 Geophyscial surveys

Airborne electromagnetics (AEM) is a geophysical survey technique that measures the electrical conductivity of the near-surface environment. AEM is useful in groundwater assessment studies since it acquires electrical conductivity data (over large areas) which may be used as a proxy for salinity. Given that the freshwater zones (or lenses) within the floodplain environments of this study are primarily located in the top five metres of the sub-surface, AEM data was a useful tool to locate freshwater lenses across the large floodplain areas.

While the Katarapko Floodplain AEM survey would introduce current data, the Pike Floodplain AEM data was historical (2008) apart from a small strip surveyed on Pike as part of the 2015 Katarapko survey. To verify the 2008 AEM survey over Pike Floodplain and the location of freshwater zones, a ground-based geophysical survey was conducted in March 2015. This survey employed the EM31-type instrument, which is sensitive to shallow conductivity variations. Of primary interest was the AEM depth slice of 2–4 mBNS. The results of the ground-based AEM survey correlated well with the AEM data collected in 2008 across the Pike Floodplain, thus verifying the location of the freshwater zones which are a key target for the drilling program.

Site selection was finalised for the Pike (and Katarapko) Floodplain using AEM data.

3.2 Drilling and well construction

In total, 25 observation wells were drilled during the Phase 1 works. Phase 2 was initially designed to accommodate up to 45 groundwater wells, however due to financial constraints, this phase of works was split into Phase 2A and Phase 2B. Phase 2A consisted of 16 observation and one production well limited to the Pike Floodplain, with the remainder forming Phase 2B which were not constructed as part of this phase of drilling works (SMM concept design) but may form part of the SMM detailed design in 2016.

3.2.1 Drilling contractor selection

A select group of drilling contractors were invited to submit tenders to conduct drilling works for the construction of groundwater wells as specified. RXG Drilling (based in Hawker, South Australia) was awarded the contract on 7 July 2015. The final contract was the subject of considerable negotiation to ensure the efficient execution of the drilling contract for Phase 1 and then subsequently Phase 2A, the latter dependent on performance during Phase1. The relatively close proximity of the drilling contractor to the area of investigation facilitated the supply and resupply of materials, maintenance support and flexibility with respect to coping with inclement weather condition and related access issues to the floodplain.

The drilling rig used was an Ingersoll Rand TH60 with on-board compressor and mud pump, capable of rotary air or rotary mud drilling methods. The drilling rig has an air-drillhole depth capacity of 800 metres.

3.2.2 General drilling methodology

The ideal drilling method for unconsolidated sands, which tend to be dominant in a floodplain environment, is mud rotary because this drilling technique helps keep the unconsolidated formation material out of the hole during construction of the well. Due to the sensitivity of the environment, other drilling methods such as hollow flight auger and dual tube methodologies were investigated because the disposal of drilling muds (required for mud rotary) can be problematic in isolated floodplain environments.

It soon became evident that the hollow flight auger technique would not accommodate the final well design in terms of well diameter and depth penetration, and therefore was removed from consideration. A dual tube methodology was selected as an alternative to the hollow flight auger and trialed on-site, however this technique proved unsuccessful during the initial stages of Phase 1 due to the nature of the unconsolidated sands. As a result drilling reverted to a mud rotary methodology for the remainder of the program, which proved to be successful. The employment of this technique did require extra operations on-site to remove the drilling muds and cuttings.

On-site, the general work method for each well included an initial 152 mm pilot hole drilled using air until circulation was lost. Drilling muds were then prepared for mud rotary drilling to depth with a 235 mm drill bit. Drill cuttings were captured in above ground tanks.

3.2.3 Well design

Well design incorporated a number of different features depending on the application. Key elements included:

- Screen length – Long screens, discrete screens
- Screen type – PVC vee-wire screens
- Well transects and multi or clustered wells.

Well completion consisted of several designs depending on the purpose:

- Monoman Formation observation well (1) discrete screen (2) long screen
- Monoman Formation production well
- Coonambidgal Formation observation well
- Pata Formation observation well.

A key objective for Phase 1 was to measure and monitor several freshwater lenses found within the Pike Floodplain study area that were located adjacent to vegetation health assessment sites. Three separate sites across the floodplain were selected based on the 2008 AEM data and vegetation health survey locations. Each site had the following key elements:

- A transect of three wells separated by approximately 50–70 m.
- The transect to be aligned perpendicular to the freshwater lens (as assessed by the 2008 AEM data)
- Each well site included two observation wells: one observation well completed within the Monoman Formation and the other completed in the Coonambidgal Formation.
- The Monoman Formation observation wells were constructed with long screens that penetrated most of the aquifer thickness (< 10 m).
- The Coonambidgal Formation observation wells were constructed with discrete screens (< 1 m).

Other areas of the floodplain (including the Katarapko Floodplain) incorporated a conventional observation well construction with a discrete 3 m screens and sump penetrating the Monoman Formation.

Basic casing and screen specifications are contained in Table 5.

Table 5 Phase 1 and Phase 2A well specification types

Well design	Casing material	Nominal diameter (mm)	Screen type	Screen aperture (mm)	Screen length (m)	Sump (m)
Monoman Formation Observation Well (1)	C12 PVC	80	Machine slotted C12 PVC	1	< 3	1
Monoman Formation Observation Well (2)	C12 PVC	80	Machine slotted C12 PVC	1	> 10	-
Monoman Formation Production Well	C12 PVC	100	Machine slotted C12 PVC	1	> 10	-
Coonambidgal Formation Observation Well	C12 PVC	100	C18 PVC vee-wire	0.25	< 3	-
Pata Formation Observation Well	C12 PVC	80	Machine slotted C12 PVC	1	< 3	1

3.2.4 Well construction

Appendix A and Appendix B provide diagrams summarizing the well construction and geological logs for each well installed during Phase 1 and Phase 2A respectively.

All casings were glued and then screwed together using stainless steel screws that did not penetrate the inner diameter of the casing. Centralisers were inserted to center the casing in the drillhole. Slotted PVC screens were installed in-line with the casing.

A gravel pack was inserted around the slotted screen to filter groundwater flowing into the well and to provide a platform for the grout mix and bentonite seal. The gravel pack extended approximately 0.5 m above the top of the slotted screen to prevent either grout or bentonite from entering the screen. Sibelco Premium Graded 8/16 sand was used as gravel pack in all Monoman Formation and Pata Formation wells whereas a finer grade (18/40) was used for the finer aperture screens in the Coonambidgal Formation wells. The depth of gravel pack was confirmed from surface during installation.

A 0.5 m thick pack of hydrated medium bentonite chips was placed above the gravel pack as a seal. The annulus of the drillhole between the bentonite and the surface was then fully grouted. The grout mix consisted of a 20 kg/15L Portland cement/water grout mix for Phase 1 wells, whereas a 5% bentonite/grout mix was used during Phase 2A.

Well development was undertaken using trailer mounted Grundfos SQ pump for Phase 1, whereas Phase 2A well development was undertaken using TH60 and MD400 RC rig mounted air compressors. Wells were developed until drilling fluids were removed, fines clearly reduced and water was relatively clear. The wells were then sterilised using a minimum of two well volumes of water containing 100mg/L free available chlorine. The chlorine solution was left in the well undisturbed for a minimum of approximately 60 minutes. The well was then re-developed until discharge was clean and effectively sand free.

Wells were fitted with 80 mm and 100 mm environmental plugs and protected using lockable galvanized standpipes embedded in surface cement.

Cuttings were placed in the local vicinity for all Pike Floodplain, wells however cuttings from the Katarapko Floodplain wells were removed from site for disposal at local EPA approved facility.

4 Results

4.1.1 Phase 1 program

RXG Drilling mobilized to the Riverland area from Hawker on 31 August 2015. Phase 1 drilling commenced on 1 September 2015 at Katarapko Floodplain and was completed on 19 September 2015 on Pike Floodplain. Phase 1 consisted of four sites (five observation wells) on Katarapko Floodplain and eight sites (20 observation wells) on Pike Floodplain (Fig. 5 and 6). Note that one well was drilled and backfilled (P12-1-C) on Pike Floodplain. Well development for all Phase 1 wells commenced on 20 September 2015 and concluded on 24 September 2015. Table 6 provides a summary of basic well construction details for wells installed during Phase 1 and Appendix A provides diagrams summarizing the well construction and geological log.

Table 6 Phase 1 basic well construction details

Unit no. (Name)	Permit no.	Construct-ion date	Final depth (m)	Easting	Northing	FP/High-land	Screen length (m)	Aquifer monitored	Well design
7029-2839 (K7)	244610	7-Sep-15	11.2	457129	6199953	FP	3	Monoman	Monoman Formation Observation Well (1)
7029-2836 (K11)	244608	5-Sep-15	10.5	459232	6200090	FP	3	Monoman	Monoman Formation Observation Well (1)
7029-2840 (K13a)	244593	8-Sep-15	12.5	456869	6198381	FP	3	Monoman	Monoman Formation Observation Well (1)
7029-2837 (K17-M)	248861	7-Sep-15	11	458303	6195810	FP	3	Monoman	Monoman Formation Observation Well (1)
7029-2838 (K17-P)	248862	6-Sep-15	19.5	458304	6195815	FP	3	Pata	Pata Formation Observation Well
7029-2851 (P1a-1-C)	247888	16-Sep-15	3.5	481591	6213864	FP	1	Coonam-bidgal	Coonambidgal Formation Observation Well
7029-2850 (P1a-1-M)	247889	16-Sep-15	17	481594	6213863	FP	12.5	Monoman	Monoman Formation Observation Well (2)
7029-2849 (P1a-2-C)	247890	15-Sep-15	4.5	481557	6213806	FP	4.4	Coonam-bidgal	Coonambidgal Formation Observation Well

Unit no. (Name)	Permit no.	Construct-ion date	Final depth (m)	Easting	Northing	FP/High-land	Screen length (m)	Aquifer monitored	Well design
7029-2848 (P1a-2-M)	247891	15-Sep-15	19.5	481559	6213808	FP	13.5	Monoman	Monoman Formation Observation Well (2)
7029-2847 (P1a-3-C)	247892	15-Sep-15	3.8	481509	6213719		0.5	Coonam-bidgal	Coonambidgal Formation Observation Well
7029-2846 (P1a-3-M)	247893	15-Sep-15	21.5	481511	6213717	FP	17	Monoman	Monoman Formation Observation Well (2)
7029-2854 (P2-1-M)	247895	18-Sep-15	16	479271	6214386	FP	15	Monoman	Monoman Formation Observation Well (2)
7029-2852 (P2-2-M)	247897	17-Sep-15	16.9	479344	6214469	FP	15	Monoman	Monoman Formation Observation Well (2)
7029-2853 (P2-3-M)	247899	17-Sep-15	14	479403	6214489	FP	12.5	Monoman	Monoman Formation Observation Well (2)
7029-2843 (P7)	247907	11-Sep-15	9.5	479453	6213338	FP	3	Monoman	Monoman Formation Observation Well (1)
7029-2845 (P10)	244208	13-Sep-15	11.5	479524	6212633	FP	3	Monoman	Monoman Formation Observation Well (1)
7029-2860 (P12-1-C)	247902	18-Sep-15	2.5	480716	6213757	FP	-	Coonam-bidgal	Coonambidgal Formation Observation Well
7029-2855 (P12-1-M)	247903	18-Sep-15	16	480717	6213756	FP	12.75	Monoman	Monoman Formation Observation Well (2)
7029-2857 (P12-2-C)	247904	19-Sep-15	3.5	480730	6213611	FP	1	Coonam-bidgal	Coonambidgal Formation Observation Well

Unit no. (Name)	Permit no.	Construct-ion date	Final depth (m)	Easting	Northing	FP/High-land	Screen length (m)	Aquifer monitored	Well design
7029-2856 (P12-2-M)	247905	19-Sep-15	18	480732	6213613	FP	13.25	Monoman	Monoman Formation Observation Well (2)
7029-2859 (P12-3-C)	247900	19-Sep-15	3.5	480685	6213492	FP	1	Coonam-bidgal	Coonambidgal Formation Observation Well
7029-2858 (P12-3-M)	247901	19-Sep-15	17	480684	6213495	FP	12	Monoman	Monoman Formation Observation Well (2)
7029-2841 (P14)	244197	10-Sep-15	12.5	477560	6213027	FP	2	Monoman	Monoman Formation Observation Well (1)
7029-2842 (P15)	244198	10-Sep-15	13	477960	6212646	FP	3	Monoman	Monoman Formation Observation Well (1)
7029-2844 (P20)	247909	12-Sep-15	13	479178	6209897	FP	3	Monoman	Monoman Formation Observation Well (1)

4.1.2 Phase 2A program

RXG Drilling were engaged to commence on-ground works for Phase 2A on 21 October 2015 with completion on 31 October 2015 on Pike Floodplain. Phase 2A consisted of 17 wells at 16 sites (16 observation wells and one production well) on Pike Floodplain (Fig. 5). Well development for all Phase 2A wells commenced 29 October 2015 and concluded 2 November 2015. Table 7 provides a summary of basic well construction details for wells installed during Phase 2A and Appendix B provides diagrams summarizing well construction and encountered geology.

Table 7 Phase 2A basic well construction details

Unit no. (Name)	Permit no.	Construct-ion date	Final depth (m)	Easting	Northing	FP/High-land	Screen length (m)	Aquifer monitored	Well design
7029-2879 (PMW02)	251857	24-Oct-15	24.75	477670	6208823	FP	18	Monoman	Monoman Formation Observation Well (2)
7029-2865 (PMW04)	251860	30-Oct-15	22.3	478601	6212443	FP	18	Monoman	Monoman Formation Observation Well (2)

Unit no. (Name)	Permit no.	Construct-ion date	Final depth (m)	Easting	Northing	FP/High-land	Screen length (m)	Aquifer monitored	Well design
7029-2867 (PMW05)	251861	30-Oct-15	23.5	478502	6212309	FP	18	Monoman	Monoman Formation Observation Well (2)
7029-2876 (PMW06)	251867	30-Oct-15	20.5	477914	6213982	FP	18	Monoman	Monoman Formation Observation Well (2)
7029-2869 (PMW09)	251873	26-Oct-15	20	482283	6208602	FP	14.5	Monoman	Monoman Formation Observation Well (2)
7029-2875 (PMW10)	251874	31-Oct-15	25.5	482162	6208200	FP	18	Monoman	Monoman Formation Observation Well (2)
7029-2871 (PMW11)	251887	27-Oct-15	12	480589	6209262	FP	9	Monoman	Monoman Formation Observation Well (2)
7029-2877 (PMW12)	251875	27-Oct-15	11.5	483300	6210016	FP	9	Monoman	Monoman Formation Observation Well (2)
7029-2868 (PMW13)	251876	26-Oct-15	12.5	482223	6210258	FP	6	Monoman	Monoman Formation Observation Well (2)
7029-2878 (PMW15)	251862	28-Oct-15	12	478969	6211833	FP	5	Monoman	Monoman Formation Observation Well (2)
7029-2873 (PMW16)	251890	28-Oct-15	13.5	477581	6210939	FP	6	Monoman	Monoman Formation Observation Well (2)
7029-2870 (PMW17)	251877	27-Oct-15	12.3	483799	6211995	FP	6	Monoman	Monoman Formation Observation Well (2)
7029-2872 (PMW18)	251863	30-Oct-15	23	478504	6213122	FP	18	Monoman	Monoman Formation Observation Well (2)
7029-2874 (PMW19)	251869	31-Oct-15	20.5	478853	6214214	FP	18	Monoman	Monoman Formation Observation Well (2)

Unit no. (Name)	Permit no.	Construct-ion date	Final depth (m)	Easting	Northing	FP/High-land	Screen length (m)	Aquifer monitored	Well design
7029-2866 (PMW23)	251889	28-Oct-15	14	480351	6211076	FP	8	Monoman	Monoman Formation Observation Well (2)
7029-2880 (PMW27)	252557	21-Oct-15	42	482124	6207848	Highland	12	Loxton S	Monoman Formation Observation Well (2)
7029-2864 (PTW04)	252556	23-Oct-15	49	482070	6207859	Highland	20	Loxton S	Monoman Formation Production Well

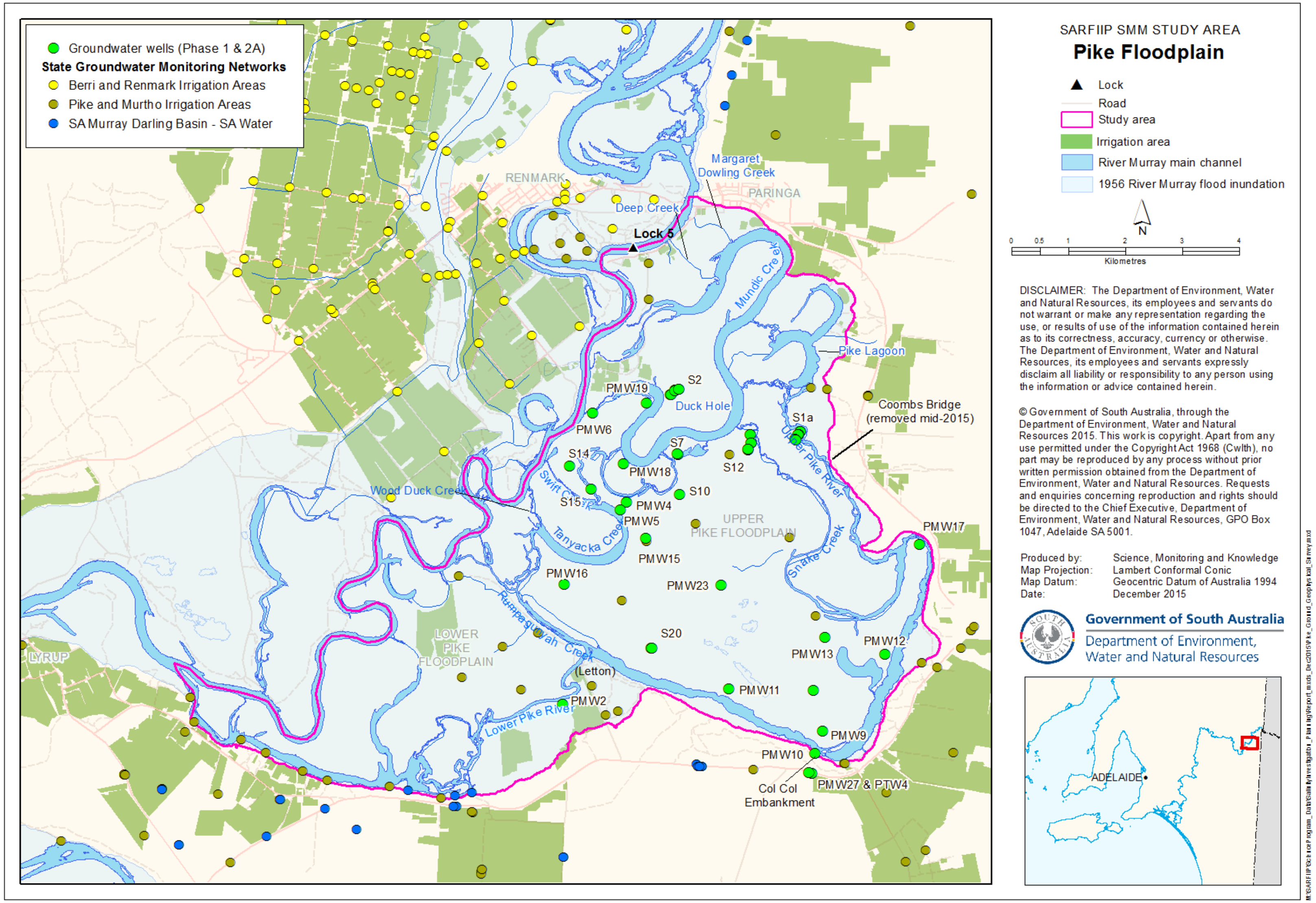

Figure 5 Location of Pike Floodplain Phase 1 and Phase 2A wells

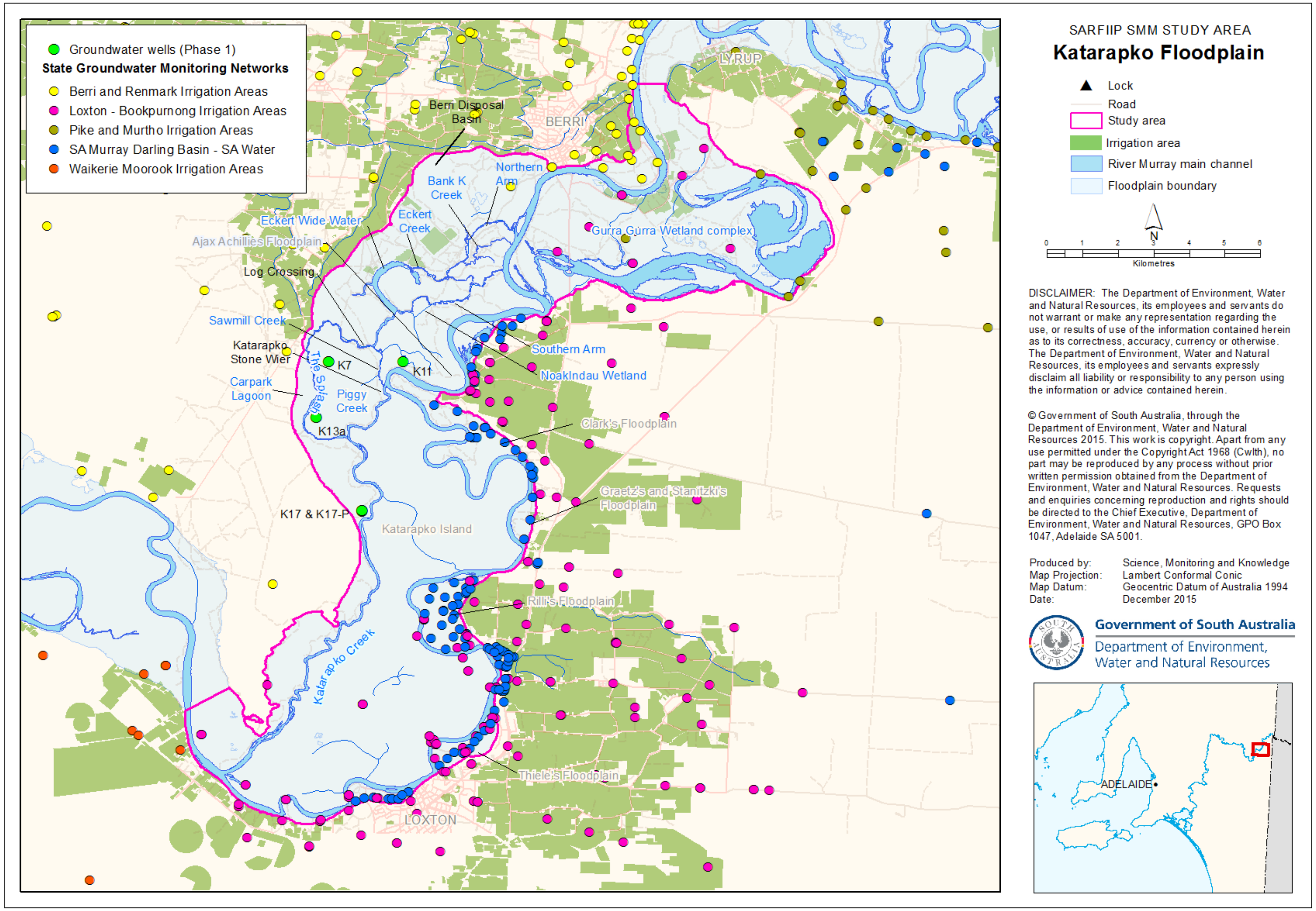

Figure 6 Location of Katarapko Floodplain Phase 1 wells

5 Conclusions

In total, 25 observation wells were constructed during the Phase 1 works commencing on 1 September 2015 with completion on 19 September 2015. Well development of these Phase 1 wells commenced on 20 September 2015 and was concluded on 24 September 2015.

That part of Phase 2 drilling and well installation undertaken during this investigation (Phase 2A) commenced on 21 October 2015 and was completed on 31 October 2015. Phase 2A consisted of 16 observation and 1 production well. Well development commenced on 29 October 2015 and was concluded on 2 November 2015.

Although the original intention was to use either hollow flight augers or a dual tube drilling method in order to minimize the disposal requirements of drilling muds in such a sensitive environment, the drilling conditions encountered on the floodplains necessitated a reversion to mud rotary drilling. This technique proved reliable, however extra on-site operations were required to remove the drilling muds and cuttings.

AEM data proved useful with respect to targeting freshwater lenses within the Pike and Katarapko floodplain areas.

6 References

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7 Appendices

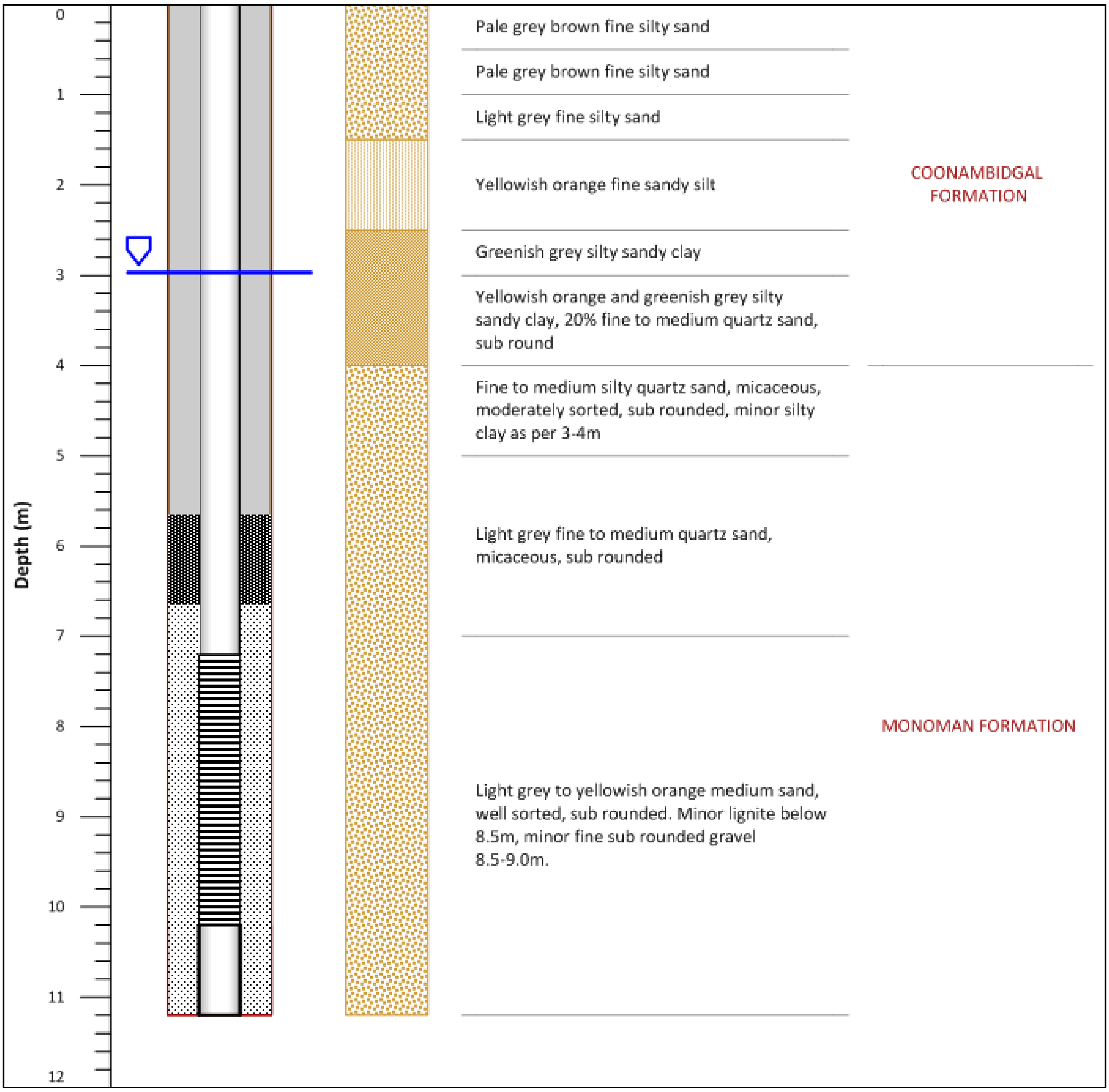
A. Stage 1 Well Construction Diagrams

SARFIIP SMM Phase 1 Well Construction - Schematic Diagram

Unit No: **7029-2839**	Name: **K7**	Well Type: **Observation**	Final Depth (m): **11.2**
Permit No: **244610**	Easting: **457129**	Northing: **6199953**	Zone: **54**

Government of South Australia
Department of Environment, Water and Natural Resources

Construction Detail	Major Lithology	Lithological Description	Stratigraphic Unit



Construction Details

Well Component	ID (mm)	Material	Interval (m)	Aperture (mm)	Type
Casing	79	C12 PVC	0 - 7.2	-	-
Production Zone	79	C12 PVC	7.2 - 10.2	1	Slotted casing
Sump	79	C12 PVC	10.2 - 11.2	-	-

Lithological/Construction Symbology

SWL, Slotted casing, Clay, Drillhole, Cement, Silt, Gravel pack, Natural fill, Sand, Bentonite, Limestone, Casing

Note:-
Datum: GDA 94
Wellsite Hydrogeologist: Ian Schneider (DEWNR)/Damian Newham (AWE)

Current as at: 7-Jan-16

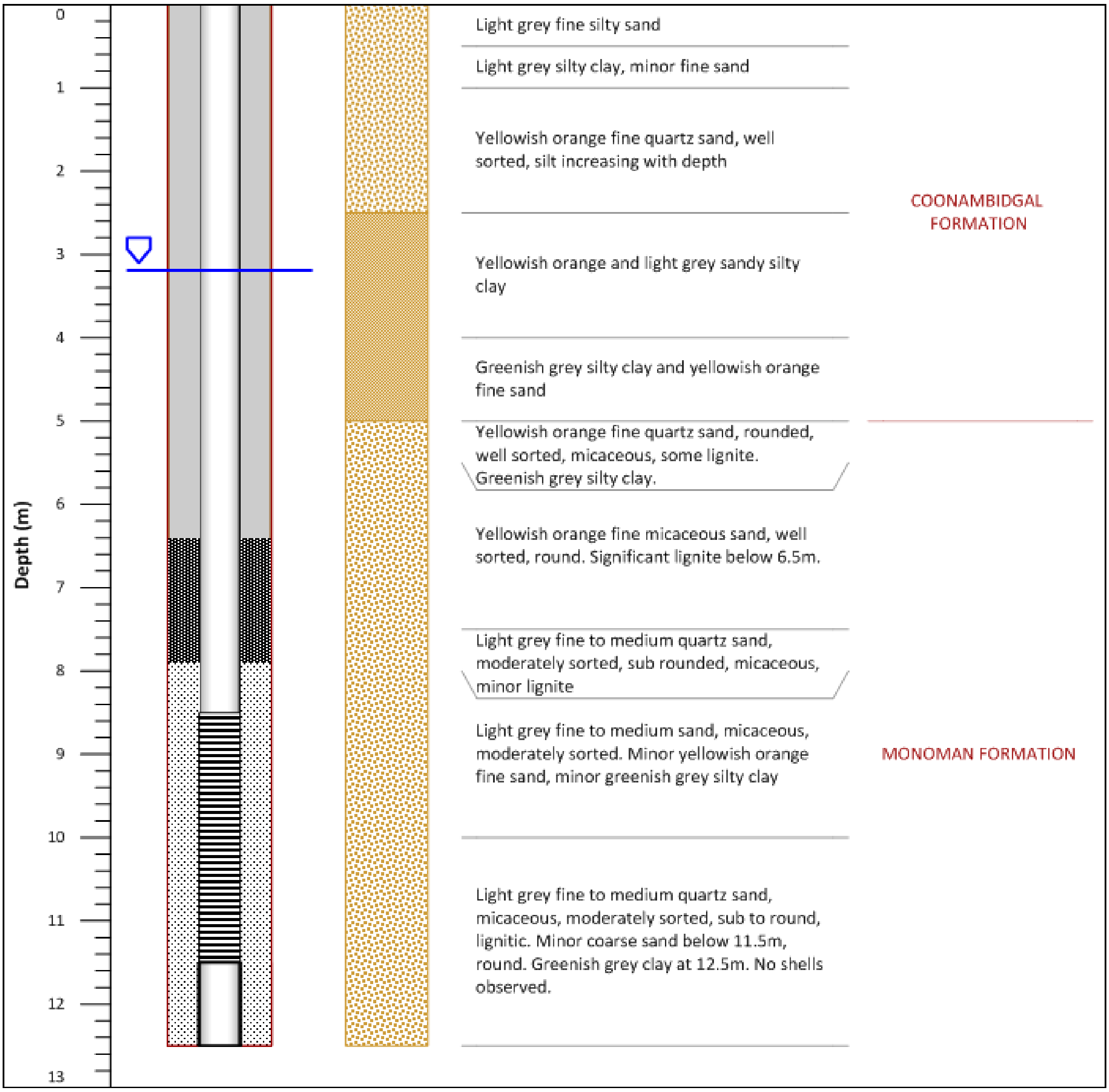
SARFIIP SMM Phase 1 Well Construction - Schematic Diagram

Unit No: **7029-2840** Name: **K13a** Well Type: **Observation** Final Depth (m): **12.5**

Permit No: **244593** Easting: **456869** Northing: **6198381** Zone: **54**

Government of South Australia
Department of Environment, Water and Natural Resources

Construction Detail	Major Lithology	Lithological Description	Stratigraphic Unit



Construction Details

Well Component	ID (mm)	Material	Interval (m)	Aperture (mm)	Type
Casing	79	C12 PVC	0 - 8.5	-	-
Production Zone	79	C12 PVC	8.5 - 11.5	1	Slotted casing
Sump	79	C12 PVC	11.5 - 12.5	-	-

Lithological/Construction Symbology

SWL, Slotted casing, Clay, Drillhole, Cement, Silt, Gravel pack, Natural fill, Sand, Bentonite, Limestone, Casing

Note:-
Datum: GDA 94
Wellsite Hydrogeologist: Ian Schneider (DEWNR)/Damian Newham (AWE)

Current as at: 7-Jan-16

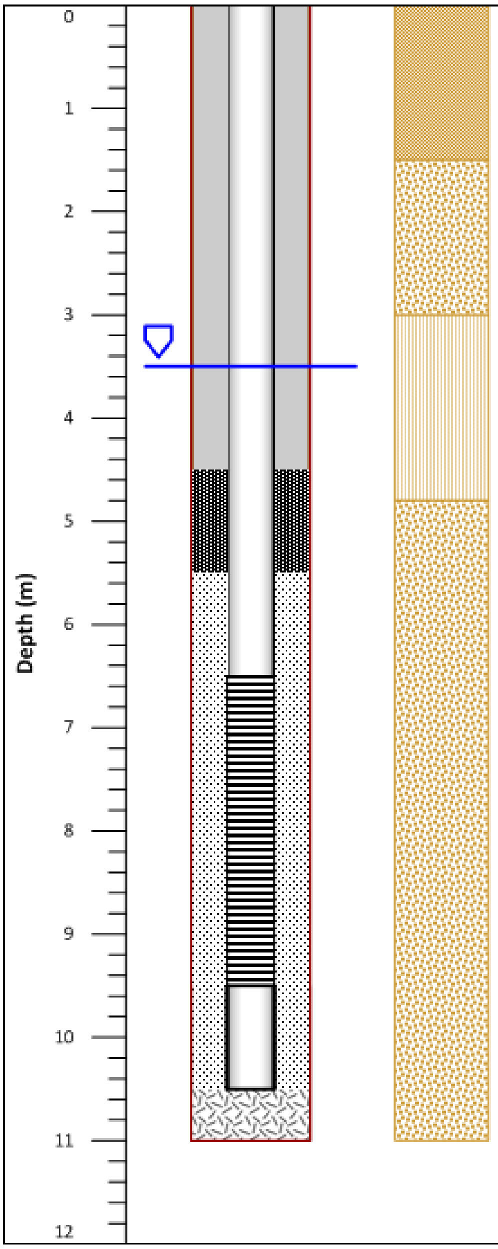
SARFIIP SMM Phase 1 Well Construction - Schematic Diagram

Unit No: **7029-2836** Name: **K11** Well Type: **Observation** Final Depth (m): **10.5**

Permit No: **244608** Easting: **459232** Northing: **6200090** Zone: **54**

Government of South Australia
Department of Environment, Water and Natural Resources

Construction Detail	Major Lithology	Lithological Description	Stratigraphic Unit

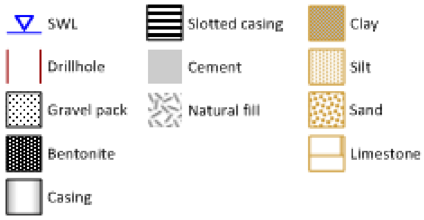


Lithological Description	Stratigraphic Unit
Light grey clay	COONAMBIDGAL FORMATION
Olive grey clay	COONAMBIDGAL FORMATION
Pale olive grey silty clay	COONAMBIDGAL FORMATION
Yellowish orange silty fine sand	COONAMBIDGAL FORMATION
Yellowish orange very fine quartz sand	COONAMBIDGAL FORMATION
Olive grey sandy silt	COONAMBIDGAL FORMATION
Yellowish orange medium sand, moderately to well sorted, sub rounded to round	MONOMAN FORMATION
Yellowish orange medium sand, well sorted below 6m	MONOMAN FORMATION
Yellowish orange medium quartz sand, well sorted, sub rounded	MONOMAN FORMATION
Medium quartz sand, moderately sorted, sub round. Minor lignite 8.5-9.9, presence of coarse sand below 10.5m.	MONOMAN FORMATION

Construction Details

Well Component	ID (mm)	Material	Interval (m)	Aperture (mm)	Type
Casing	79	C12 PVC	0 - 6.5	-	-
Production Zone	79	C12 PVC	6.5 - 9.5	1	Slotted casing
Sump	79	C12 PVC	9.5 - 10.5	-	-

Lithological/Construction Symbology



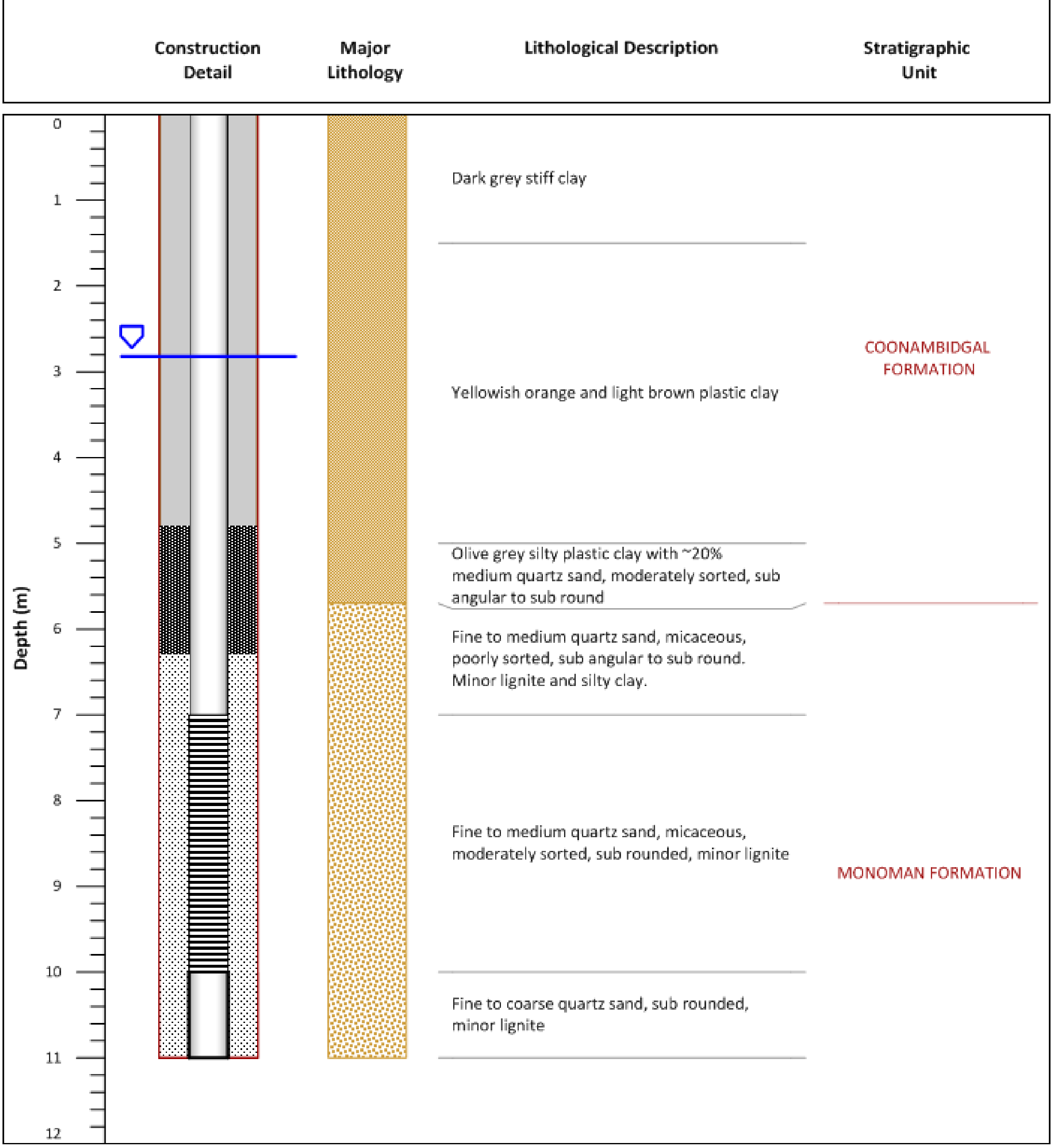
Note:-
Datum: GDA 94
Wellsite Hydrogeologist: Ian Schneider (DEWNR)/Damian Newham (AWE)

Current as at: 7-Jan-16

SARFIIP SMM Phase 1 Well Construction - Schematic Diagram

Unit No: **7029-2837**	Name: **K17**	Well Type: **Observation**	Final Depth (m): **11**
Permit No: **248861**	Easting: **458303**	Northing: **6195810**	Zone: **54**

Government of South Australia
Department of Environment, Water and Natural Resources



Construction Details

Well Component	ID (mm)	Material	Interval (m)	Aperture (mm)	Type
Casing	79	C12 PVC	0 - 7	-	-
Production Zone	79	C12 PVC	7 - 10	1	Slotted casing
Sump	79	C12 PVC	10 - 11	-	-

Lithological/Construction Symbology

SWL, Drillhole, Gravel pack, Bentonite, Casing, Slotted casing, Cement, Natural fill, Clay, Silt, Sand, Limestone

Note:-
Datum: GDA 94
Wellsite Hydrogeologist: Ian Schneider (DEWNR)/Damian Newham (AWE)

Current as at: 7-Jan-16

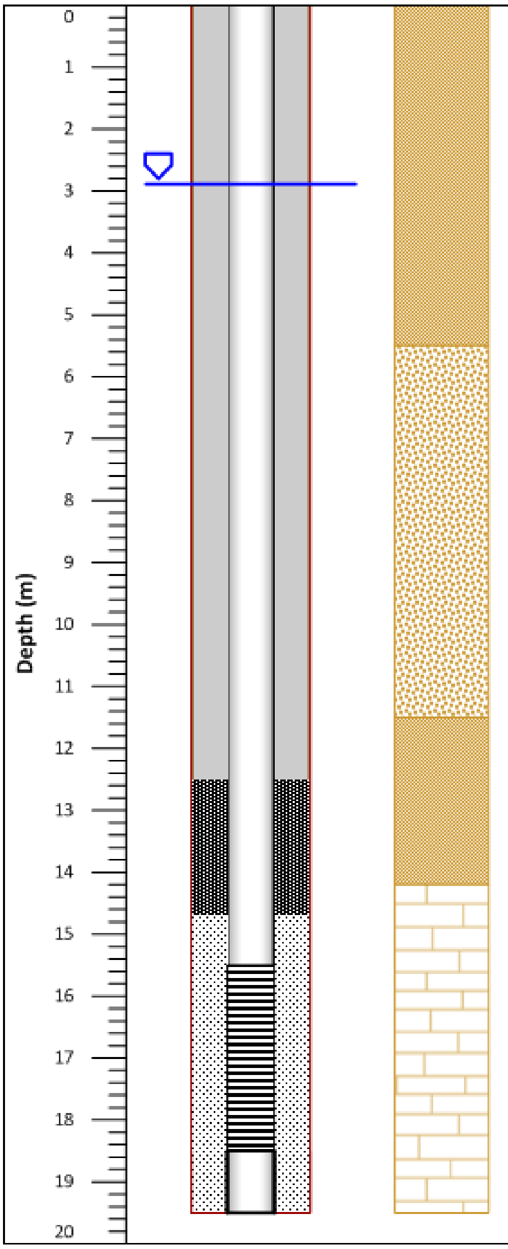
SARFIIP SMM Phase 1 Well Construction - Schematic Diagram

Unit No: **7029-2838** Name: **K17 Pata** Well Type: **Observation** Final Depth (m): **19.5**

Permit No: **248862** Easting: **458304** Northing: **6195815** Zone: **54**

Government of South Australia
Department of Environment, Water and Natural Resources

Construction Detail	Major Lithology	Lithological Description	Stratigraphic Unit



Lithological Description	Stratigraphic Unit
Olive grey firm clay	COONAMBIDGAL FORMATION
Greenish grey clay	
Yellowish orange silty clay	
Greenish grey and yellowish orange mottled plastic clay	
Olive grey and minor light brown plastic clay, lignitic and micaceous at base	
Fine to medium quartz sand, poorly sorted, sub angular to sub rounded, micaceous. Minor clay.	MONOMAN FORMATION
Fine to coarse quartz sand, poorly sorted sub angular to sub round, lignitic, grain size decreasing with depth	
Fine to medium sand, moderately sorted with decayed wood/lignite	
Fine to medium quartz sand, well sorted, micaceous, minor lignite. Becoming poorly sorted and coarser with depth.	
Greenish grey shelly silty clay. Significant decayed wood/lignite 11.5-12.5m.	BOOKPURNONG FORMATION
Light grey limestone, poor to moderately consolidated, hard band at 14.2m. Thin small shell fragments 14.2-15m, bivalve shells to 15mm 15-15.5m.	PATA FORMATION
Light grey limestone, poor to moderately consolidated	

Construction Details

Well Component	ID (mm)	Material	Interval (m)	Aperture (mm)	Type
Casing	79	C12 PVC	0 - 15.5	-	-
Production Zone	79	C12 PVC	15.5 - 18.5	1	Slotted casing
Sump	79	C12 PVC	18.5 - 19.5	-	-

Lithological/Construction Symbology

SWL, Drillhole, Gravel pack, Bentonite, Casing, Slotted casing, Cement, Natural fill, Clay, Silt, Sand, Limestone

Note:-
Datum: GDA 94
Wellsite Hydrogeologist: Ian Schneider (DEWNR)/Damian Newham (AWE)

Current as at: 7-Jan-16

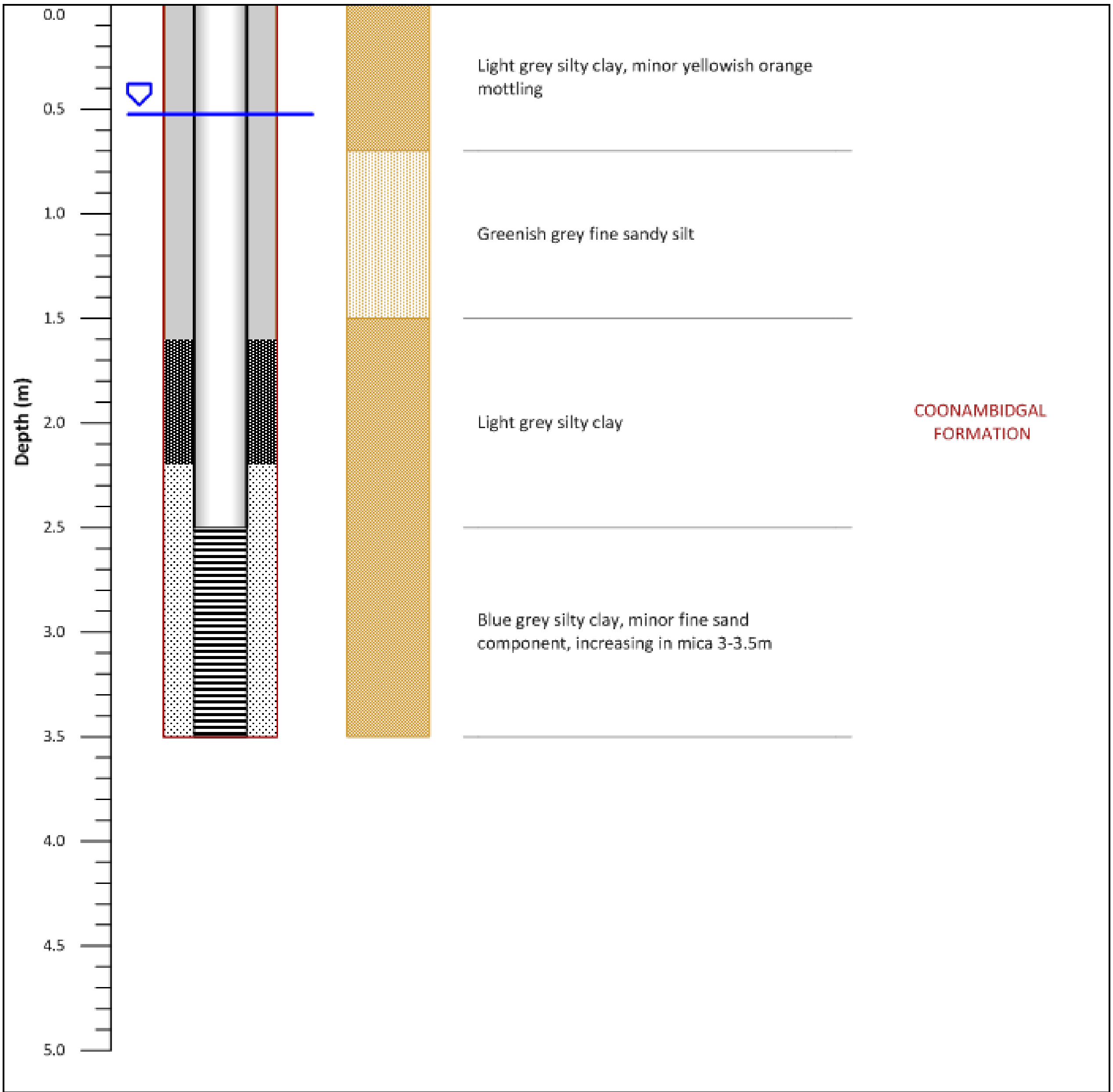
SARFIIP SMM Phase 1 Well Construction - Schematic Diagram

Government of South Australia
Department of Environment, Water and Natural Resources

Unit No: **7029-2851** Name: **P1A-1 (C)** Well Type: **Observation** Final Depth (m): **3.5**

Permit No: **247888** Easting: **481591** Northing: **6213864** Zone: **54**

Construction Detail	Major Lithology	Lithological Description	Stratigraphic Unit



Construction Details

Well Component	ID (mm)	Material	Interval (m)	Aperture (mm)	Type
Casing	100	C12 PVC	0 - 2.5	-	-
Production Zone	100	C12 PVC	2.5 - 3.5	0.25	PVC Vee-Wire
Sump	-	-	-	-	-

Lithological/Construction Symbology

SWL, Slotted casing, Clay, Drillhole, Cement, Silt, Gravel pack, Natural fill, Sand, Bentonite, Limestone, Casing

Note:-
Datum: GDA 94
Wellsite Hydrogeologist: Ian Schneider (DEWNR)/Damian Newham (AWE)

Current as at: 12-Jan-16

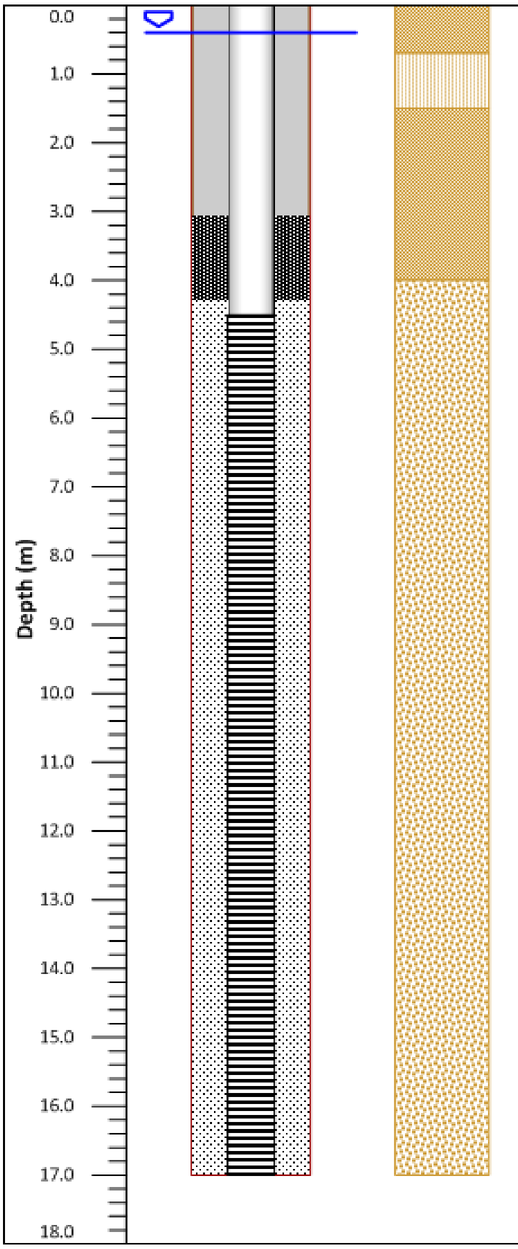
SARFIIP SMM Phase 1 Well Construction - Schematic Diagram

Government of South Australia
Department of Environment, Water and Natural Resources

Unit No: **7029-2850** Name: **P1A-1 (M)** Well Type: **Observation** Final Depth (m): **17**

Permit No: **247889** Easting: **481594** Northing: **6213863** Zone: **54**

Construction Detail	Major Lithology	Lithological Description	Stratigraphic Unit



Light grey silty clay, minor yellowish orange mottling

Greenish grey fine sandy silt

Light grey silty clay

Blue grey silty clay, minor fine sand, increasingly micaceous 3-4m

COONAMBIDGAL FORMATION

Light medium grey fine to medium quartzose sand, well sorted, sub rounded to round, micaceous

Yellowish orange medium quartzose sand, well sorted, sub to round, becoming light grey 9.5-10.5m

Light grey fine to medium sand, sub rounded, moderately sorted. Minor lignite decreasing 11-13m. Significant peaty layer 14m.

Medium grey fine quartz sand, well sorted, micaceous, significant lignite

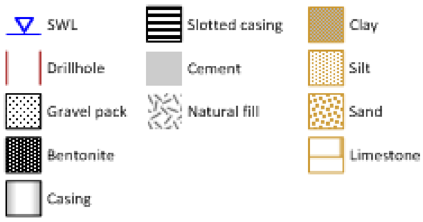
Medium grey fine quartz sand, well sorted, significant lignite. Blue grey silty clay at 17m.

MONOMAN FORMATION

Construction Details

Well Component	ID (mm)	Material	Interval (m)	Aperture (mm)	Type
Casing	79	C12 PVC	0 - 4.5	-	-
Production Zone	79	C12 PVC	4.5 - 17	1	Slotted casing
Sump	-	-	-	-	-

Lithological/Construction Symbology



Note:-
Datum: GDA 94
Wellsite Hydrogeologist: Ian Schneider (DEWNR)/Damian Newham (AWE)

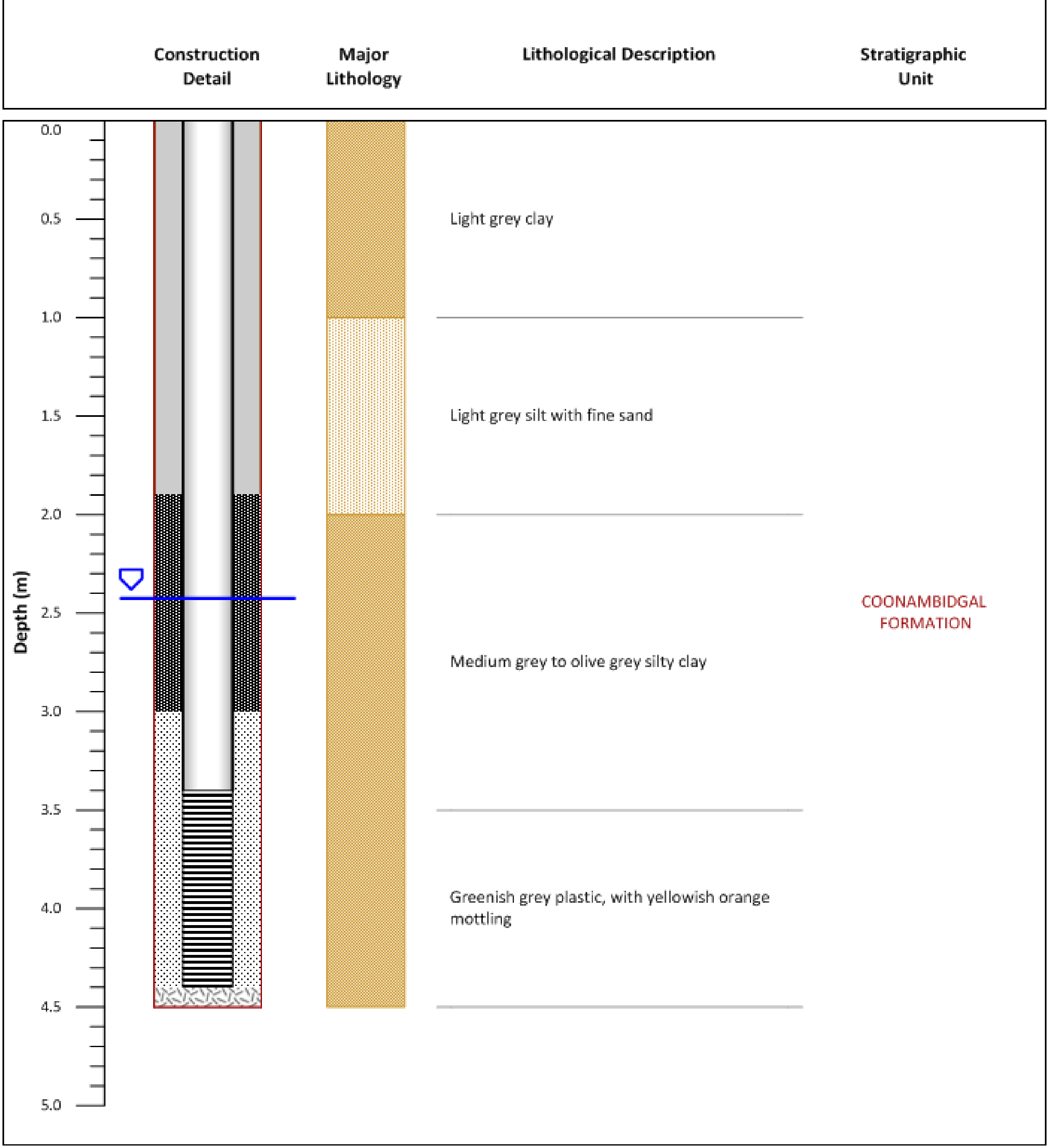
Current as at: 12-Jan-16

SARFIIP SMM Phase 1 Well Construction - Schematic Diagram

Unit No: **7029-2849** Name: **P1A-2 (C)** Well Type: **Observation** Final Depth (m): **4.4**

Permit No: **247890** Easting: **481557** Northing: **6213806** Zone: **54**

Government of South Australia
Department of Environment, Water and Natural Resources



Construction Details

Well Component	ID (mm)	Material	Interval (m)	Aperture (mm)	Type
Casing	100	C12 PVC	0 - 3.4	-	-
Production Zone	100	C12 PVC	3.4 - 4.4	0.25	PVC Vee-Wire
Sump	-	-	-	-	-

Lithological/Construction Symbology

SWL, Slotted casing, Clay, Drillhole, Cement, Silt, Gravel pack, Natural fill, Sand, Bentonite, Limestone, Casing

Note:-
Datum: GDA 94
Wellsite Hydrogeologist: Ian Schneider (DEWNR)/Damian Newham (AWE)

Current as at: 12-Jan-16

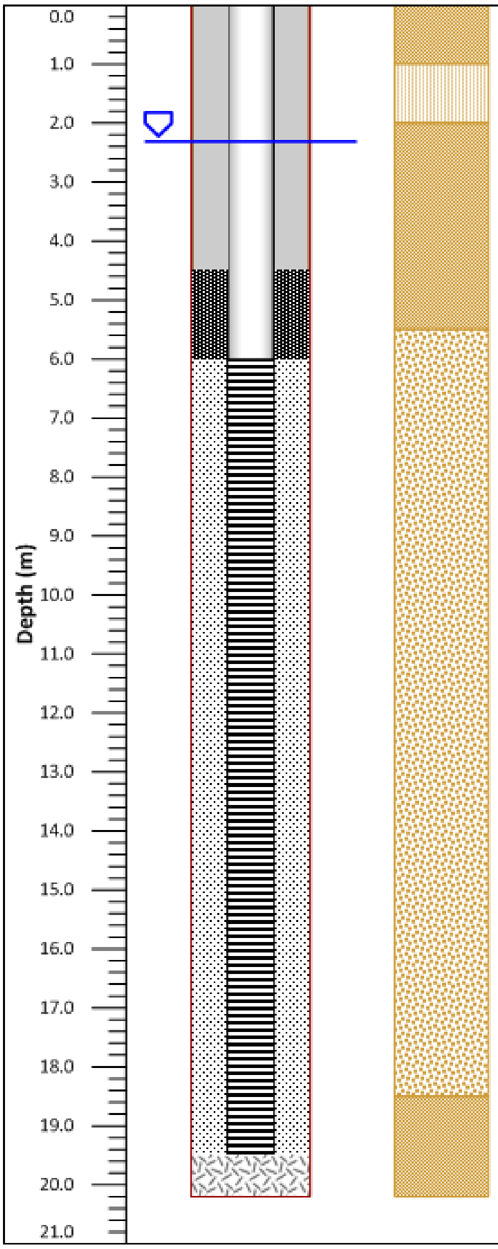
SARFIIP SMM Phase 1 Well Construction - Schematic Diagram

Unit No: **7029-2848** Name: **P1A-2 (M)** Well Type: **Observation** Final Depth (m): **19.5**

Permit No: **247891** Easting: **481559** Northing: **6213808** Zone: **54**

Government of South Australia
Department of Environment, Water and Natural Resources

Construction Detail	Major Lithology	Lithological Description	Stratigraphic Unit



Lithological Description	Stratigraphic Unit
Light grey clay	COONAMBIDGAL FORMATION
Light grey silt with fine sand	
Medium olive grey silty clay	
Greenish grey silty plastic clay, yellowish orange mottling	
Blue grey plastic silty clay, minor very fine sand increasing with depth	
Medium grey fine to medium quartzose sand, moderately sorted, sub round	MONOMAN FORMATION
Yellowish orange medium sand, well sorted, sub rounded. Pale yellowish orange below 9.5m. Increased fine sand 12.5-13.5m, becoming coarser with depth.	
Light grey fine to medium sand, moderately sorted, sub round	
Medium to dark grey silty, clayey sand, lignitic. Significant lignitic components 16m and 18m.	
Dark grey to olive grey silty and sandy clay	LOWER LOXTON CLAYS/BOOKPURNONG FORMATION

Construction Details

Well Component	ID (mm)	Material	Interval (m)	Aperture (mm)	Type
Casing	79	C12 PVC	0 - 6	-	-
Production Zone	79	C12 PVC	6 - 19.5	1	Slotted casing
Sump	-	-	-	-	-

Lithological/Construction Symbology

SWL, Slotted casing, Clay, Drillhole, Cement, Silt, Gravel pack, Natural fill, Sand, Bentonite, Limestone, Casing

Note:-
Datum: GDA 94
Wellsite Hydrogeologist: Ian Schneider (DEWNR)/Damian Newham (AWE)

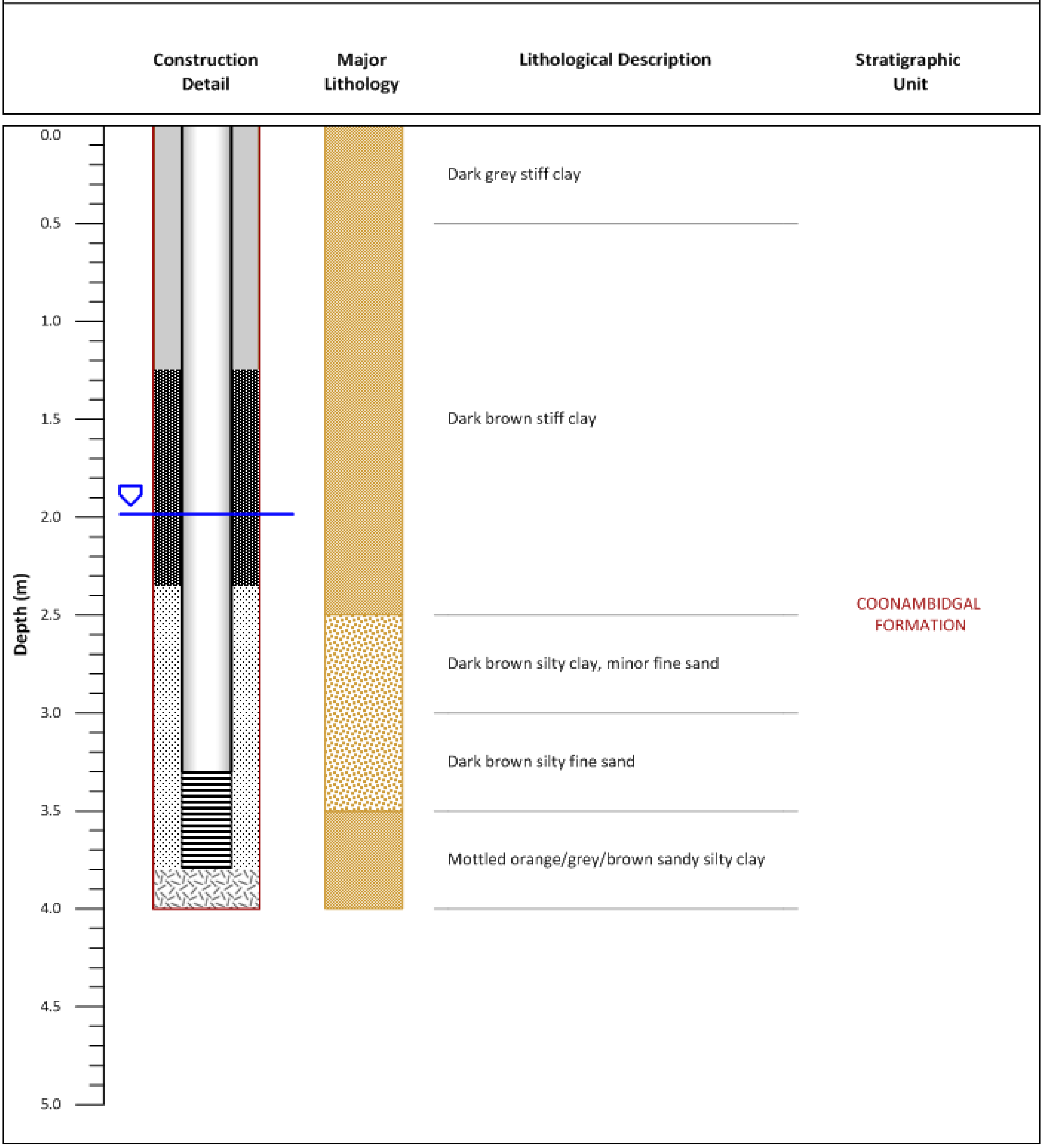
Current as at: 12-Jan-16

SARFIIP SMM Phase 1 Well Construction - Schematic Diagram

Unit No: **7029-2847** Name: **P1A-3 (C)** Well Type: **Observation** Final Depth (m): **3.8**

Permit No: **247892** Easting: **481509** Northing: **6213719** Zone: **54**

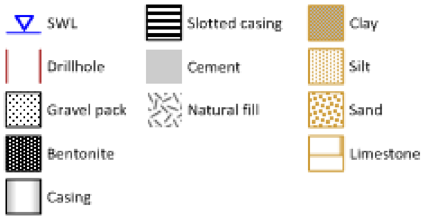
Government of South Australia
Department of Environment, Water and Natural Resources



Construction Details

Well Component	ID (mm)	Material	Interval (m)	Aperture (mm)	Type
Casing	100	C12 PVC	0 - 3.3	-	-
Production Zone	100	C12 PVC	3 .3 - 3.8	0.25	PVC Vee-Wire
Sump	-	-	-	-	-

Lithological/Construction Symbology



Note:-
Datum: GDA 94
Wellsite Hydrogeologist: Ian Schneider (DEWNR)/Damian Newham (AWE)

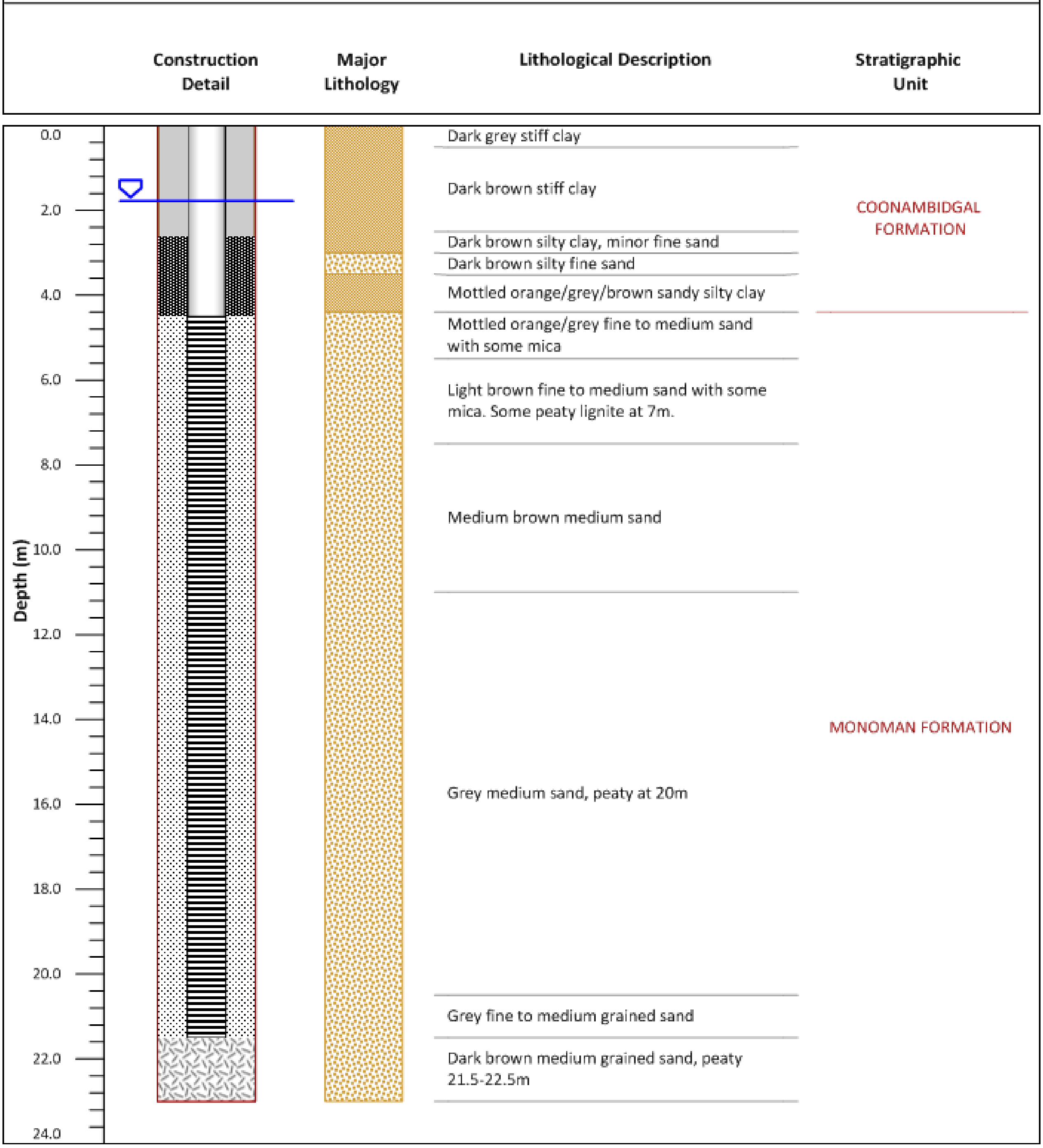
Current as at: 12-Jan-16

SARFIIP SMM Phase 1 Well Construction - Schematic Diagram

Unit No: **7029-2846** Name: **P1A-3 (M)** Well Type: **Observation** Final Depth (m): **21.5**

Permit No: **247893** Easting: **481511** Northing: **6213717** Zone: **54**

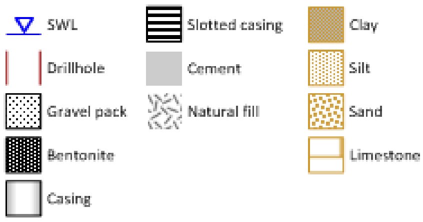
Government of South Australia
Department of Environment, Water and Natural Resources



Construction Details

Well Component	ID (mm)	Material	Interval (m)	Aperture (mm)	Type
Casing	79	C12 PVC	0 - 4.5	-	-
Production Zone	79	C12 PVC	4.5 - 21.5	1	Slotted casing
Sump	-	-	-	-	-

Lithological/Construction Symbology



Note:-
Datum: GDA 94
Wellsite Hydrogeologist: Ian Schneider (DEWNR)/Damian Newham (AWE)

Current as at: 12-Jan-16

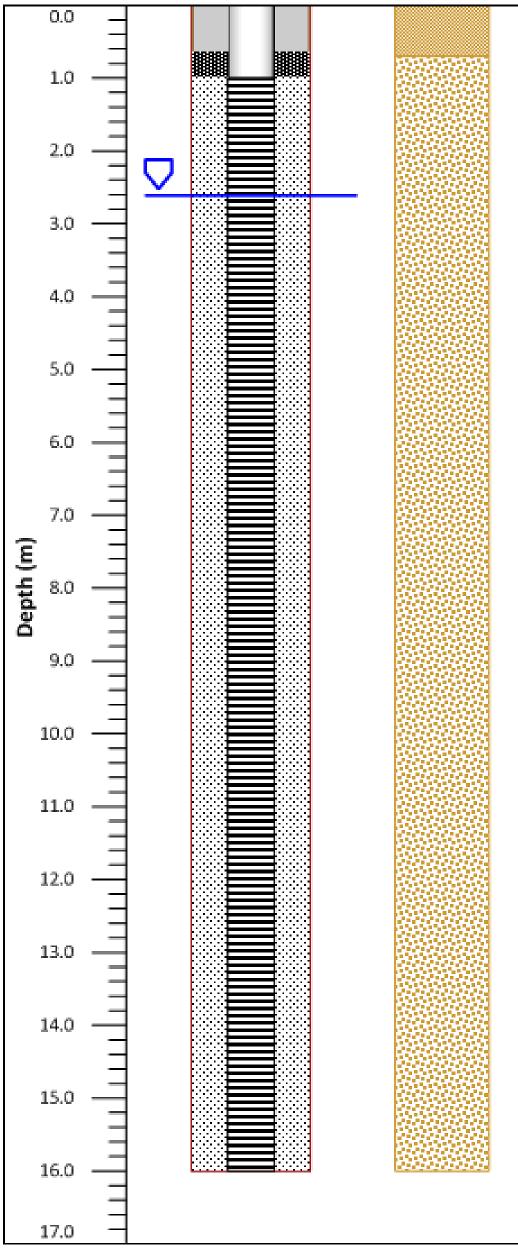
SARFIIP SMM Phase 1 Well Construction - Schematic Diagram

Government of South Australia
Department of Environment, Water and Natural Resources

Unit No: **7029-2854** Name: **P2-1 (M)** Well Type: **Observation** Final Depth (m): **16**

Permit No: **247895** Easting: **479271** Northing: **6214386** Zone: **54**

Construction Detail	Major Lithology	Lithological Description	Stratigraphic Unit



COONAMBIDGAL FORMATION

Medium brown/light grey silty clay

MONOMAN FORMATION

Pale yellowish orange silty fine sand. Minor red brown fine sand components

Yellowish orange silty fine to medium sand, minor light grey silty and clayey fine sand

Yellowish orange and light grey silty fine sand. Micaceous, minor red brown mottling.

Pale yellowish orange fine to medium sand, micaceous, greenish grey silty clay ~0.2m thick from 3.2m

Pale yellowish orange fine to medium sand, moderately sorted, sub rounded to round. Minor lignite and finer sand 4.0-4.5m.

Pale yellowish orange fine to medium sand, moderately sorted, sub to round, minor lignite

Pale yellowish orange fine to medium sand, moderately sorted, sub to round. Significant lignite at 6.5m, large tree root (est. diameter 100mm) at 9.7m.

Light grey fine to medium sand, sub rounded. Grain size increasing with depth, coarse sand 13.5-14m.

Light grey fine sand, well sorted, sub angular to sub rounded, lignitic

Medium grey fine to coarse sand, poorly sorted, sub rounded, brown sandy silt increasing below 15.5m

Construction Details

Well Component	ID (mm)	Material	Interval (m)	Aperture (mm)	Type
Casing	79	C12 PVC	0 - 1	-	-
Production Zone	79	C12 PVC	1 - 16	1	Slotted casing
Sump	-	-	-	-	-

Lithological/Construction Symbology

SWL, Drillhole, Gravel pack, Bentonite, Casing, Slotted casing, Cement, Natural fill, Clay, Silt, Sand, Limestone

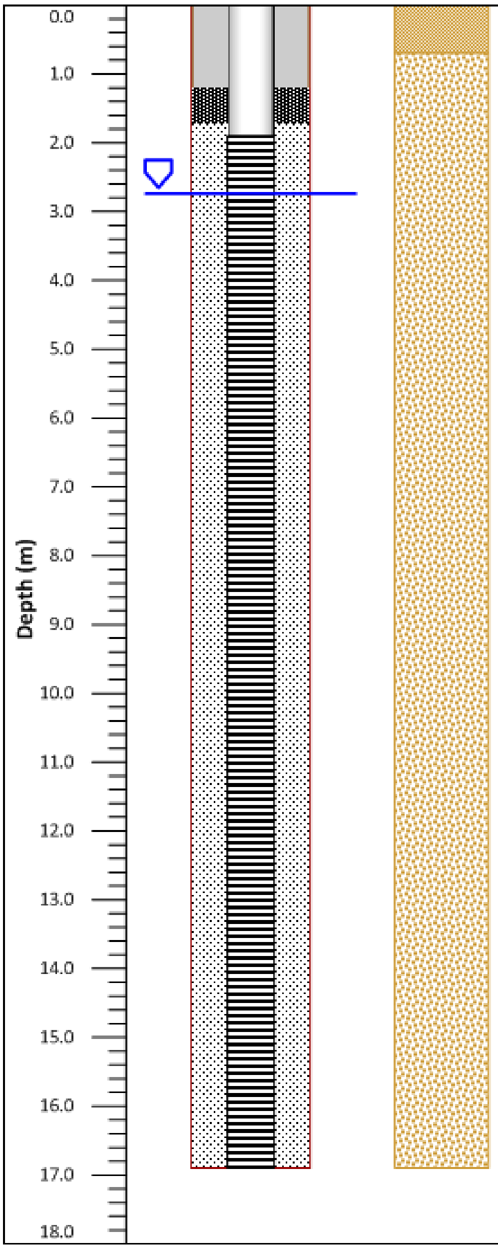
Note:-
Datum: GDA 94
Wellsite Hydrogeologist: Ian Schneider (DEWNR)/Damian Newham (AWE)

Current as at: 12-Jan-16

SARFIIP SMM Phase 1 Well Construction - Schematic Diagram

Government of South Australia
Department of Environment, Water and Natural Resources

Unit No: **7029-2852**	Name: **P2-2 (M)**	Well Type: **Observation**	Final Depth (m): **16.9**
Permit No: **247897**	Easting: **479344**	Northing: **6214469**	Zone: **54**



Lithological Description	Stratigraphic Unit
Medium brown plastic clay	COONAMBIDGAL FORMATION
Off white fine silty sand, well sorted	
Yellowish orange very fine sand, well sorted	
Yellowish orange fine to medium sand, sub rounded to round, minor light grey clay 3-4.5m	
Pale yellowish orange to light grey medium sand, well sorted, sub rounded	
Yellowish orange to light grey medium sand, well sorted, rounded. Lignite at 8m.	
Yellowish orange to light grey medium sand, mica and lignite, moderately sorted, sub rounded to round. Lignite layer 10.5m.	MONOMAN FORMATION
Medium grey fine to medium sand, poorly sorted. Minor lignite. Coarsening with depth, rounded gravel to 3mm at 12.5m. Minor brown silt 12.5-14.5m.	
Medium brown fine to coarse silty sand, poorly sorted, mica	
Medium brown fine silty sand, well sorted, mica	

Construction Details

Well Component	ID (mm)	Material	Interval (m)	Aperture (mm)	Type
Casing	79	C12 PVC	0 - 1.9	-	-
Production Zone	79	C12 PVC	1.9 - 16.9	1	Slotted casing
Sump	-	-	-	-	-

Lithological/Construction Symbology

SWL, Slotted casing, Clay, Drillhole, Cement, Silt, Gravel pack, Natural fill, Sand, Bentonite, Limestone, Casing

Note:-
Datum: GDA 94
Wellsite Hydrogeologist: Ian Schneider (DEWNR)/Damian Newham (AWE)

Current as at: 12-Jan-16

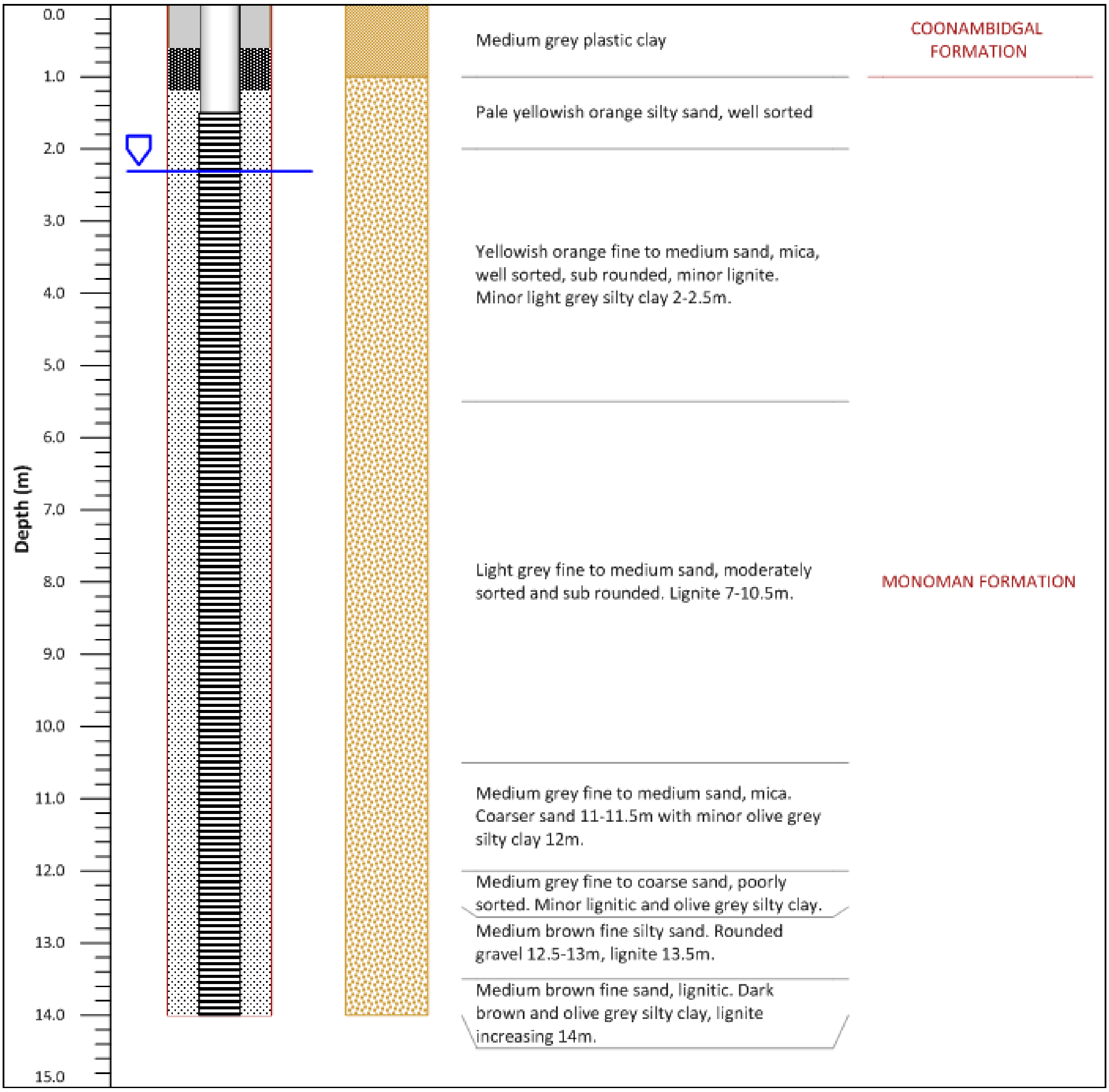
SARFIIP SMM Phase 1 Well Construction - Schematic Diagram

Unit No: **7029-2853** Name: **P2-3 (M)** Well Type: **Observation** Final Depth (m): **14**

Permit No: **247899** Easting: **479403** Northing: **6214489** Zone: **54**

Government of South Australia
Department of Environment, Water and Natural Resources

Construction Detail	Major Lithology	Lithological Description	Stratigraphic Unit



Construction Details

Well Component	ID (mm)	Material	Interval (m)	Aperture (mm)	Type
Casing	79	C12 PVC	0 - 1.5	-	-
Production Zone	79	C12 PVC	1.5 - 14	1	Slotted casing
Sump	-	-	-	-	-

Lithological/Construction Symbology

SWL, Slotted casing, Clay, Drillhole, Cement, Silt, Gravel pack, Natural fill, Sand, Bentonite, Limestone, Casing

Note:-
Datum: GDA 94
Wellsite Hydrogeologist: Ian Schneider (DEWNR)/Damian Newham (AWE)

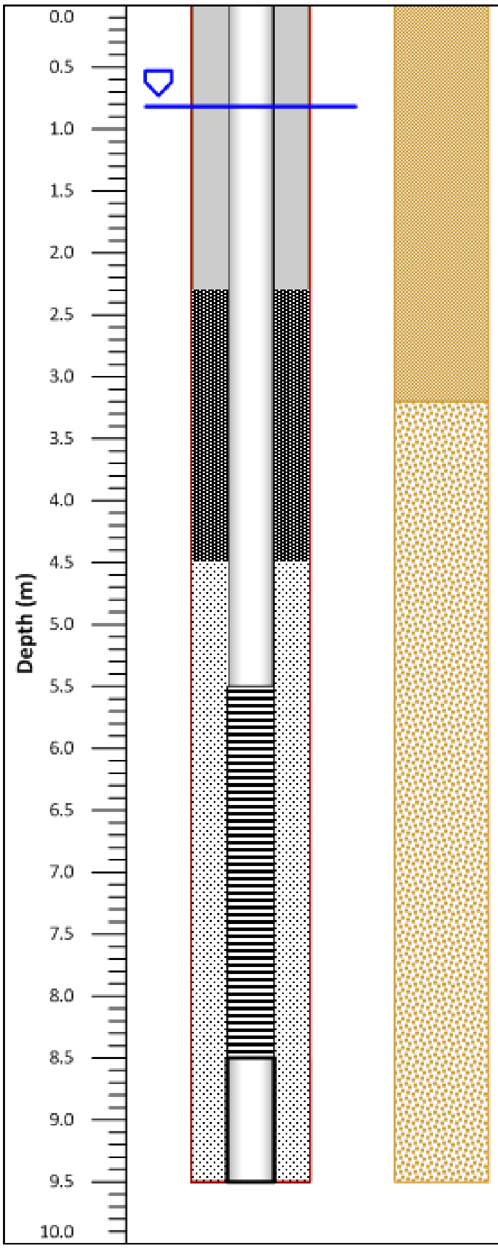
Current as at: 12-Jan-16

SARFIIP SMM Phase 1 Well Construction - Schematic Diagram

Government of South Australia
Department of Environment, Water and Natural Resources

Unit No: **7029-2843**	Name: **P7**	Well Type: **Observation**	Final Depth (m): **9.5**
Permit No: **247907**	Easting: **479453**	Northing: **6213338**	Zone: **54**

Construction Detail	Major Lithology	Lithological Description	Stratigraphic Unit



Dark grey stiff clay

Orange grey plastic clay, yellowish orange mottling, minor fine sand

Greenish grey plastic clay

Light grey silty clay

COONAMBIDGAL FORMATION

Yellowish orange medium sand, moderately sorted, sub rounded

Light grey fine to medium sand, moderately sorted, sub to round, minor greenish grey silty clay

Light grey fine to medium sand, moderately sorted, sub rounded to round

Fine sand, well sorted sub rounded to round

Light grey fine to medium sand, moderately sorted, sub rounded to round. Lignite 9.0-9.4m. Shell fragments at 9.4-9.5m.

MONOMAN FORMATION

Construction Details

Well Component	ID (mm)	Material	Interval (m)	Aperture (mm)	Type
Casing	79	C12 PVC	0 - 5.5	-	-
Production Zone	79	C12 PVC	5.5 - 8.5	1	Slotted casing
Sump	79	C12 PVC	8.5 - 9.5	-	-

Lithological/Construction Symbology

SWL, Slotted casing, Clay, Drillhole, Cement, Silt, Gravel pack, Natural fill, Sand, Bentonite, Limestone, Casing

Note:-
Datum: GDA 94
Wellsite Hydrogeologist: Ian Schneider (DEWNR)/Damian Newham (AWE)

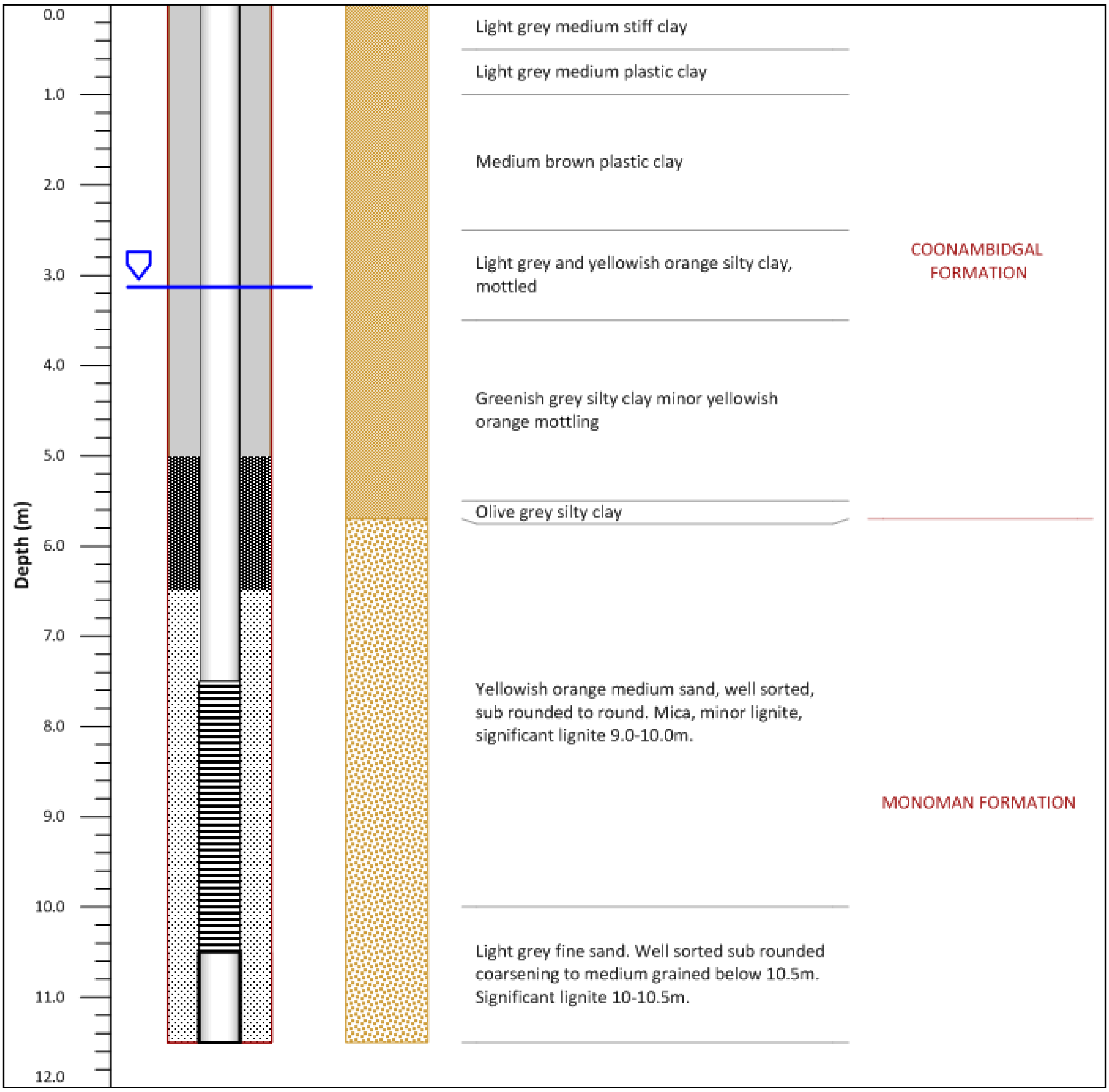
Current as at: 12-Jan-16

SARFIIP SMM Phase 1 Well Construction - Schematic Diagram

Government of South Australia
Department of Environment, Water and Natural Resources

Unit No: **7029-2845**	Name: **P10**	Well Type: **Observation**	Final Depth (m): **11.5**
Permit No: **244208**	Easting: **479524**	Northing: **6212633**	Zone: **54**

Construction Detail	Major Lithology	Lithological Description	Stratigraphic Unit



Construction Details

Well Component	ID (mm)	Material	Interval (m)	Aperture (mm)	Type
Casing	79	C12 PVC	0 - 7.5	-	-
Production Zone	79	C12 PVC	7.5 - 10.5	1	Slotted casing
Sump	79	C12 PVC	10.5 - 11.5	-	-

Lithological/Construction Symbology

SWL, Slotted casing, Clay, Drillhole, Cement, Silt, Gravel pack, Natural fill, Sand, Bentonite, Limestone, Casing

Note:-
Datum: GDA 94
Wellsite Hydrogeologist: Ian Schneider (DEWNR)/Damian Newham (AWE)

Current as at: 12-Jan-16

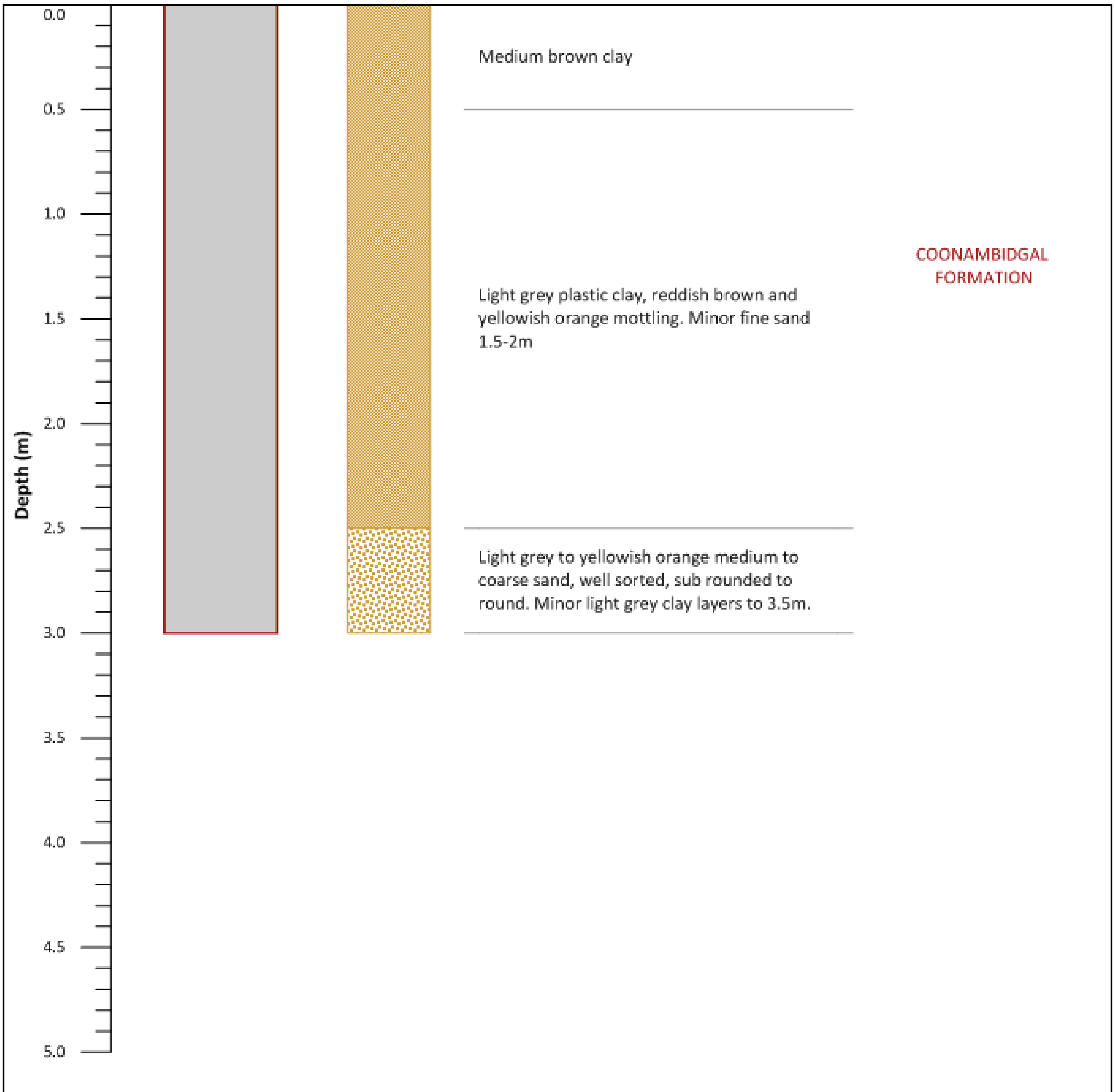
SARFIIP SMM Phase 1 Well Construction - Schematic Diagram

Government of South Australia
Department of Environment, Water and Natural Resources

Unit No: **7029-2860** Name: **P12-1 (C)** Well Type: **Backfilled** Final Depth (m): **2.5**

Permit No: **247902** Easting: **N/A** Northing: **N/A** Zone: **54**

Construction Detail	Major Lithology	Lithological Description	Stratigraphic Unit



Construction Details

Well Component	ID (mm)	Material	Interval (m)	Aperture (mm)	Type
Casing	-	-	-	-	-
Production Zone	-	-	-	-	-
Sump	-	-	-	-	-

Lithological/Construction Symbology

SWL, Slotted casing, Clay, Drillhole, Cement, Silt, Gravel pack, Natural fill, Sand, Bentonite, Limestone, Casing

Note:-
Datum: GDA 94
Wellsite Hydrogeologist: Ian Schneider (DEWNR)/Damian Newham (AWE)

Current as at: 12-Jan-16

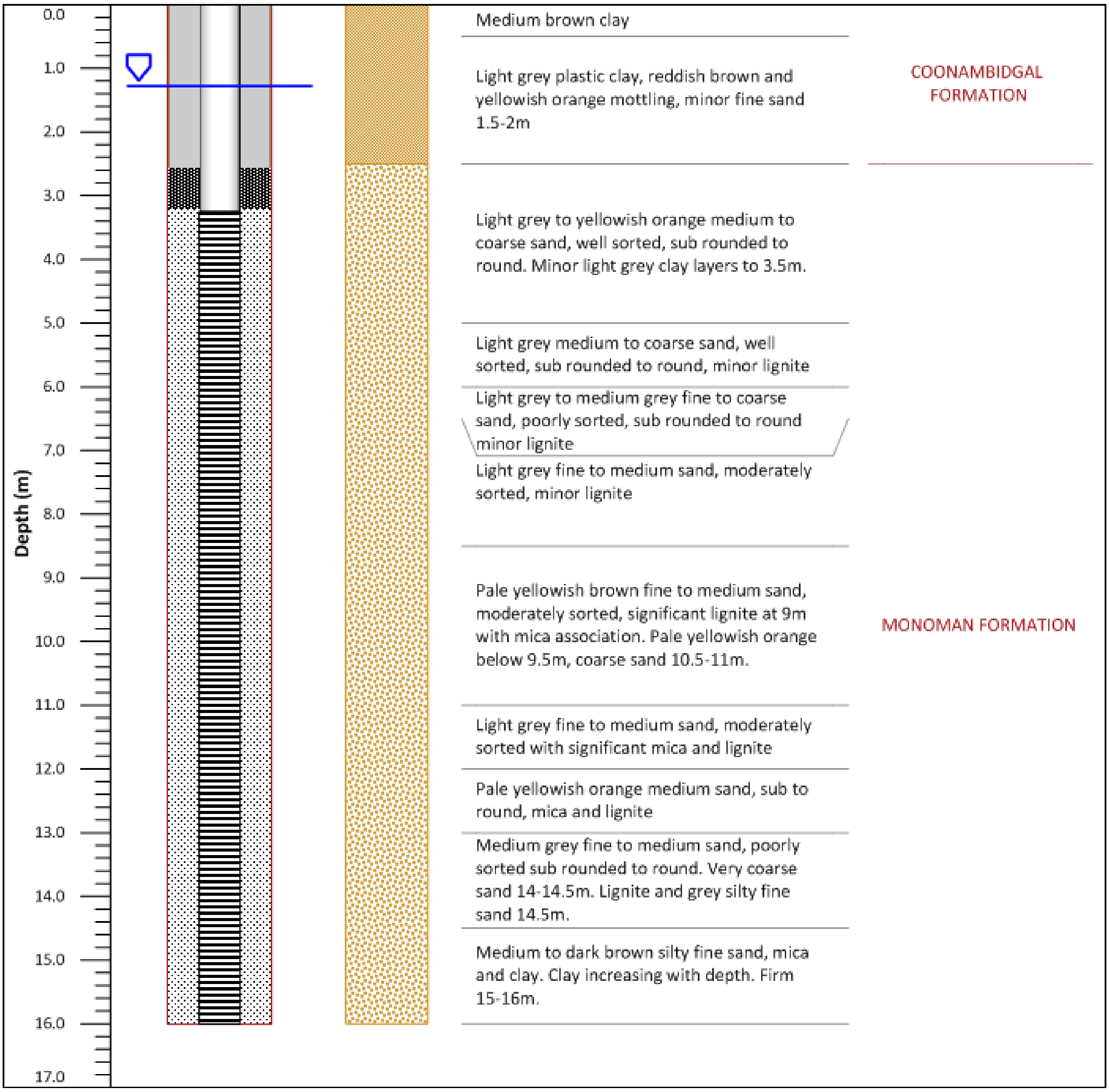
SARFIIP SMM Phase 1 Well Construction - Schematic Diagram

Unit No: **7029-2855** Name: **P12-1 (M)** Well Type: **Observation** Final Depth (m): **16**

Permit No: **247903** Easting: **480717** Northing: **6213756** Zone: **54**

Government of South Australia
Department of Environment, Water and Natural Resources

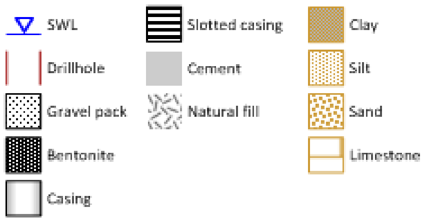
Construction Detail	Major Lithology	Lithological Description	Stratigraphic Unit



Construction Details

Well Component	ID (mm)	Material	Interval (m)	Aperture (mm)	Type
Casing	79	C12 PVC	0 - 3.25	-	-
Production Zone	79	C12 PVC	3.25 - 16	1	Slotted casing
Sump	-	-	-	-	-

Lithological/Construction Symbology



Note:-
Datum: GDA 94
Wellsite Hydrogeologist: Ian Schneider (DEWNR)/Damian Newham (AWE)

Current as at: 12-Jan-16

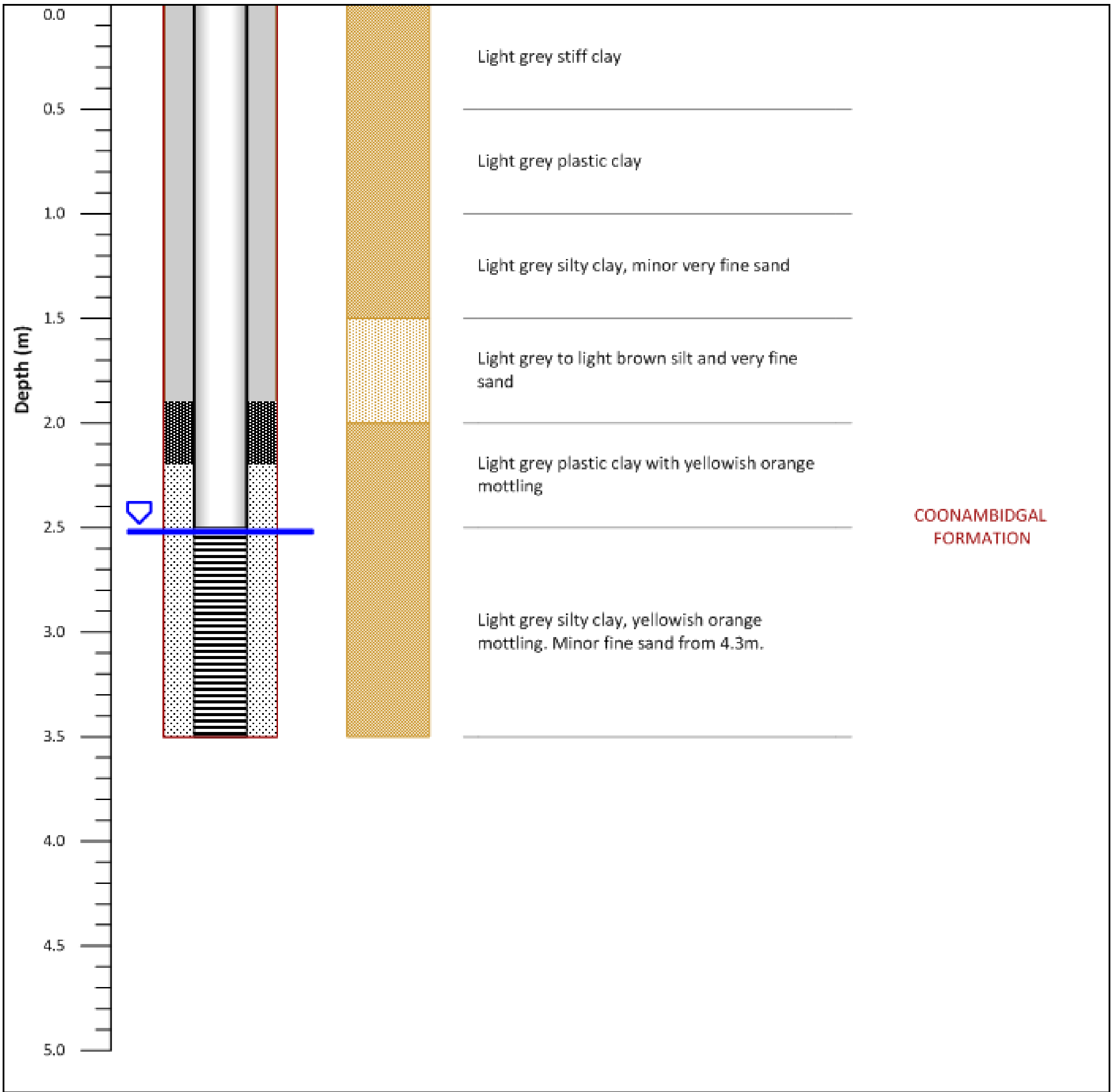
SARFIIP SMM Phase 1 Well Construction - Schematic Diagram

Government of South Australia
Department of Environment, Water and Natural Resources

Unit No: **7029-2857** Name: **P12-2 (C)** Well Type: **Observation** Final Depth (m): **3.5**

Permit No: **247904** Easting: **480730** Northing: **6213611** Zone: **54**

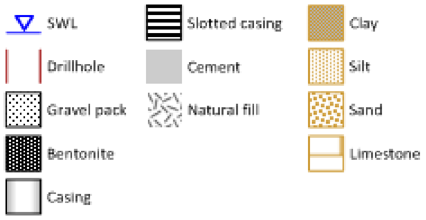
Construction Detail	Major Lithology	Lithological Description	Stratigraphic Unit



Construction Details

Well Component	ID (mm)	Material	Interval (m)	Aperture (mm)	Type
Casing	100	C12 PVC	0 - 2.5	-	-
Production Zone	100	C12 PVC	2.5 - 3.5	0.25	PVC Vee-Wire
Sump	-	-	-	-	-

Lithological/Construction Symbology



Note:-
Datum: GDA 94
Wellsite Hydrogeologist: Ian Schneider (DEWNR)/Damian Newham (AWE)

Current as at: 12-Jan-16

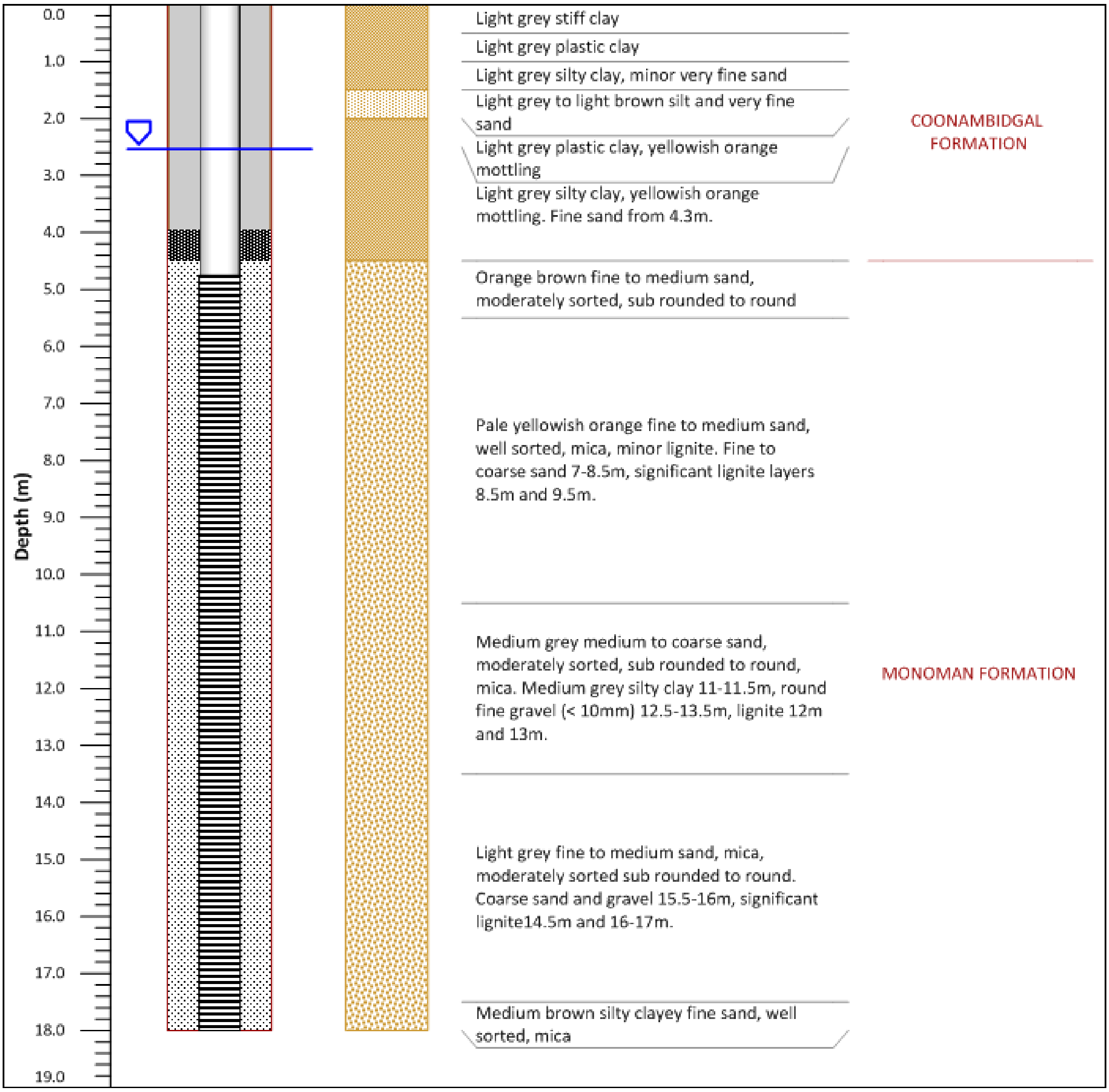
SARFIIP SMM Phase 1 Well Construction - Schematic Diagram

Unit No: **7029-2856** Name: **P12-2 (M)** Well Type: **Observation** Final Depth (m): **18**

Permit No: **247905** Easting: **480732** Northing: **6213613** Zone: **54**

Government of South Australia
Department of Environment, Water and Natural Resources

Construction Detail	Major Lithology	Lithological Description	Stratigraphic Unit



Construction Details

Well Component	ID (mm)	Material	Interval (m)	Aperture (mm)	Type
Casing	79	C12 PVC	0 - 4.75	-	-
Production Zone	79	C12 PVC	4.75 - 18	1	Slotted casing
Sump	-	-	-	-	-

Lithological/Construction Symbology

SWL, Slotted casing, Clay, Drillhole, Cement, Silt, Gravel pack, Natural fill, Sand, Bentonite, Limestone, Casing

Note:-
Datum: GDA 94
Wellsite Hydrogeologist: Ian Schneider (DEWNR)/Damian Newham (AWE)

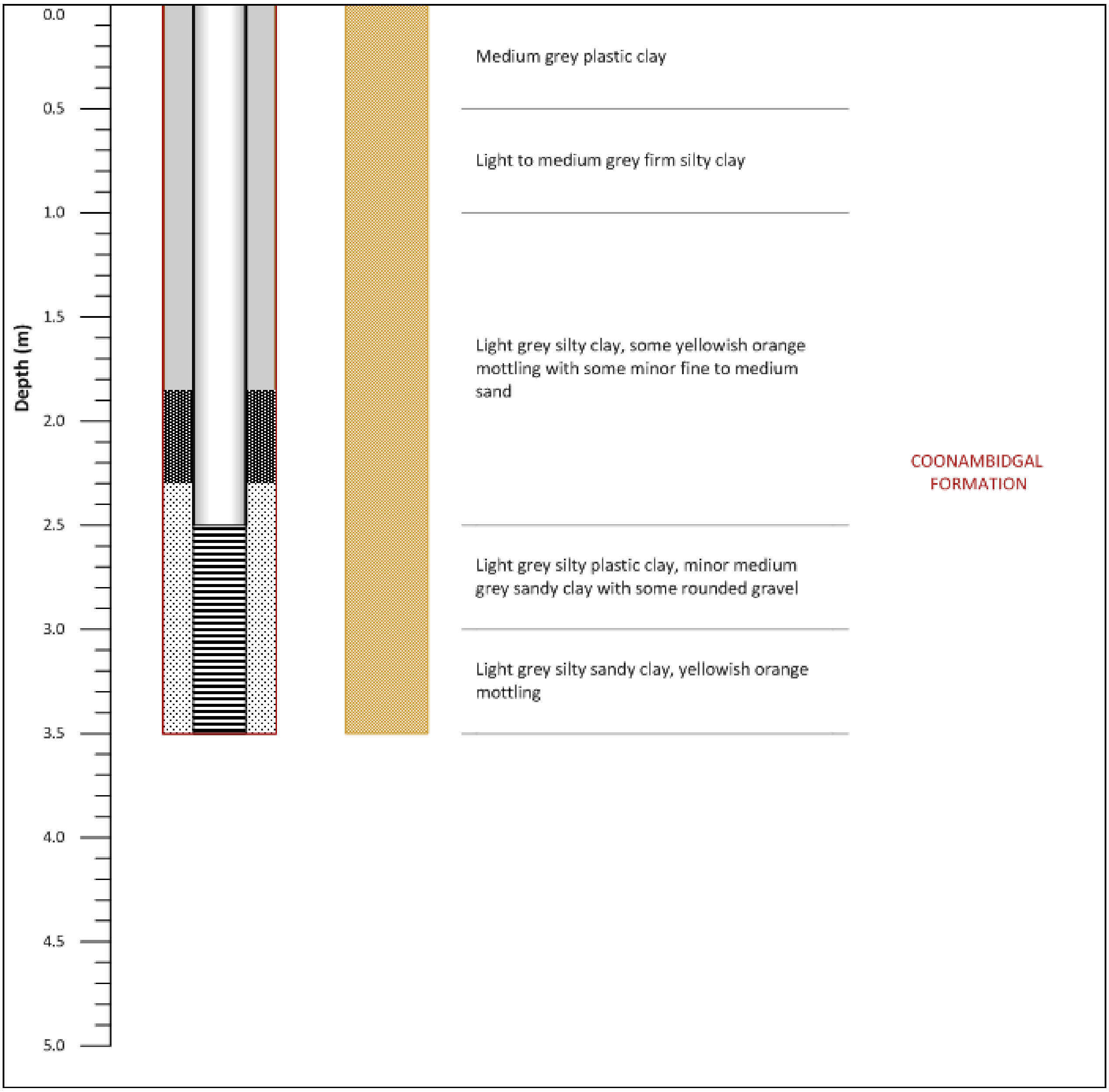
Current as at: 12-Jan-16

SARFIIP SMM Phase 1 Well Construction - Schematic Diagram

Government of South Australia
Department of Environment, Water and Natural Resources

Unit No: **7029-2859**	Name: **P12-3 (C)**	Well Type: **Observation**	Final Depth (m): **3.5**
Permit No: **247900**	Easting: **480685**	Northing: **6213492**	Zone: **54**

Construction Detail	Major Lithology	Lithological Description	Stratigraphic Unit



Construction Details

Well Component	ID (mm)	Material	Interval (m)	Aperture (mm)	Type
Casing	100	C12 PVC	0 - 2.5	-	-
Production Zone	100	C12 PVC	2.5 - 3.5	0.25	PVC Vee-Wire
Sump	-	-	-	-	-

Lithological/Construction Symbology

SWL, Slotted casing, Clay, Drillhole, Cement, Silt, Gravel pack, Natural fill, Sand, Bentonite, Limestone, Casing

Note:-
Datum: GDA 94
Wellsite Hydrogeologist: Ian Schneider (DEWNR)/Damian Newham (AWE)

Current as at: 12-Jan-16

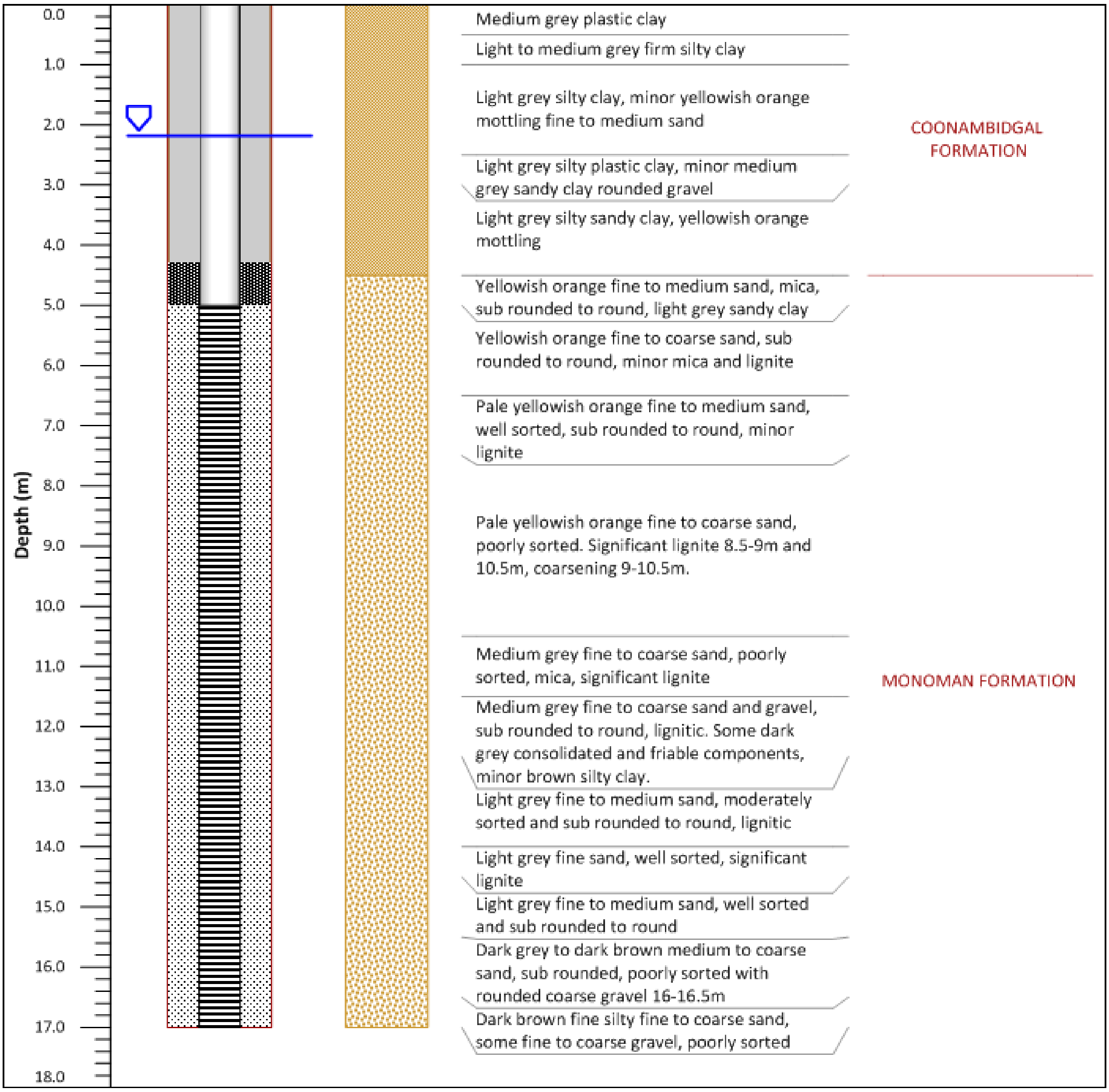
SARFIIP SMM Phase 1 Well Construction - Schematic Diagram

Unit No: **7029-2858** Name: **P12-3 (M)** Well Type: **Observation** Final Depth (m): **17**

Permit No: **247901** Easting: **480684** Northing: **6213495** Zone: **54**

Government of South Australia
Department of Environment, Water and Natural Resources

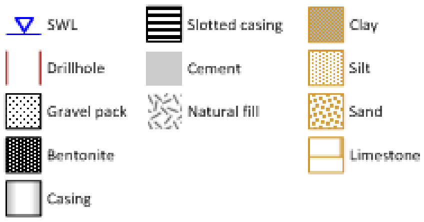
Construction Detail	Major Lithology	Lithological Description	Stratigraphic Unit



Construction Details

Well Component	ID (mm)	Material	Interval (m)	Aperture (mm)	Type
Casing	79	C12 PVC	0 - 5	-	-
Production Zone	79	C12 PVC	5 - 17	1	Slotted casing
Sump	-	-	-	-	-

Lithological/Construction Symbology



Note:-
Datum: GDA 94
Wellsite Hydrogeologist: Ian Schneider (DEWNR)/Damian Newham (AWE)

Current as at: 12-Jan-16

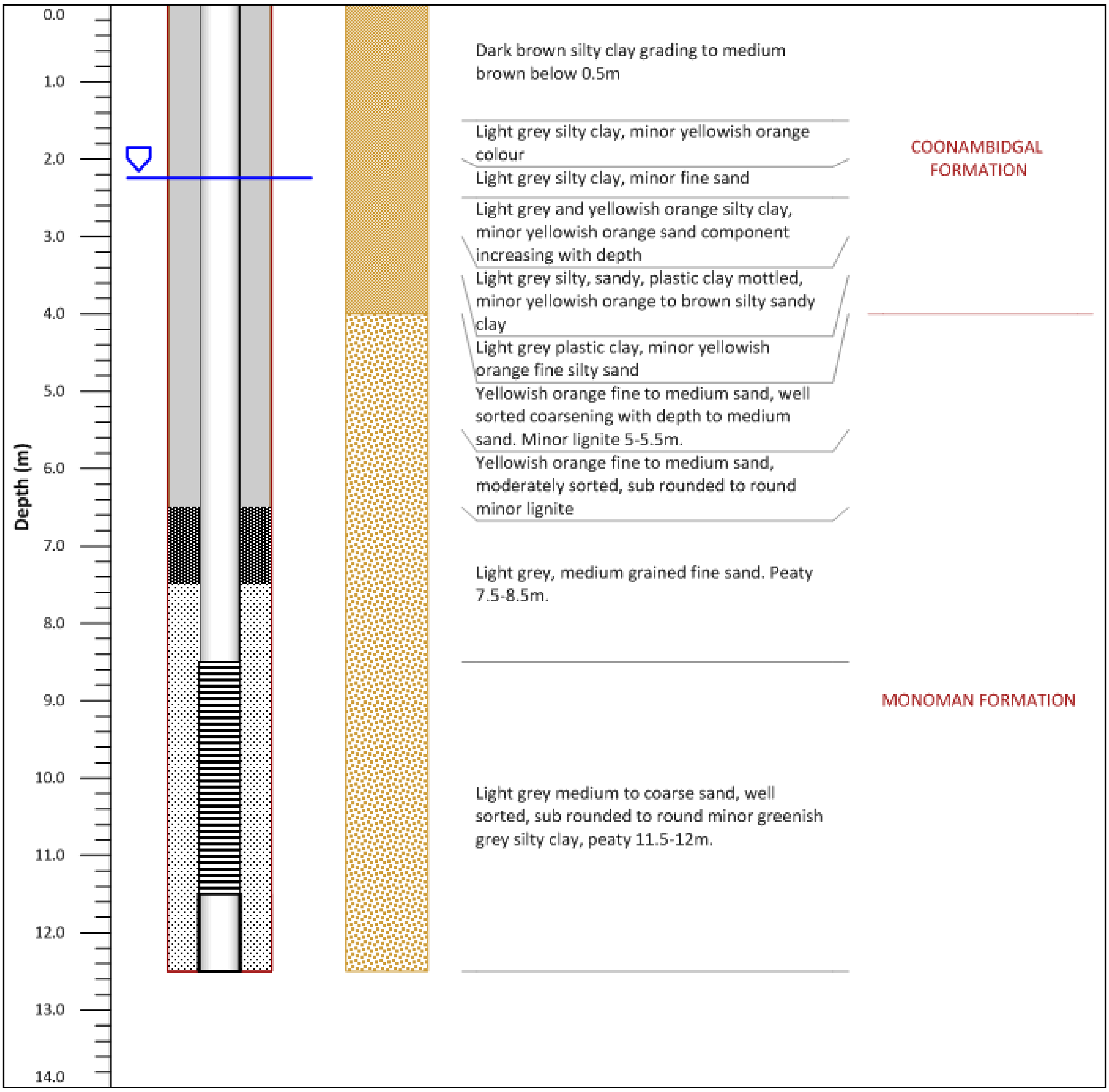
SARFIIP SMM Phase 1 Well Construction - Schematic Diagram

Unit No: **7029-2841** Name: **P14** Well Type: **Observation** Final Depth (m): **12.5**

Permit No: **244197** Easting: **477560** Northing: **6213027** Zone: **54**

Government of South Australia
Department of Environment, Water and Natural Resources

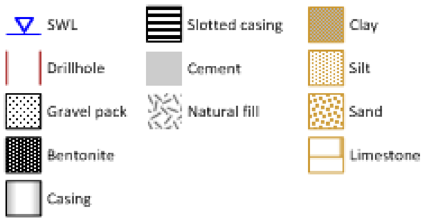
Construction Detail	Major Lithology	Lithological Description	Stratigraphic Unit



Construction Details

Well Component	ID (mm)	Material	Interval (m)	Aperture (mm)	Type
Casing	79	C12 PVC	0 - 8.5	-	-
Production Zone	79	C12 PVC	8.5 - 11.5	1	Slotted casing
Sump	79	C12 PVC	11.5 - 12.5	-	-

Lithological/Construction Symbology



Note:-
Datum: GDA 94
Wellsite Hydrogeologist: Ian Schneider (DEWNR)/Damian Newham (AWE)

Current as at: 12-Jan-16

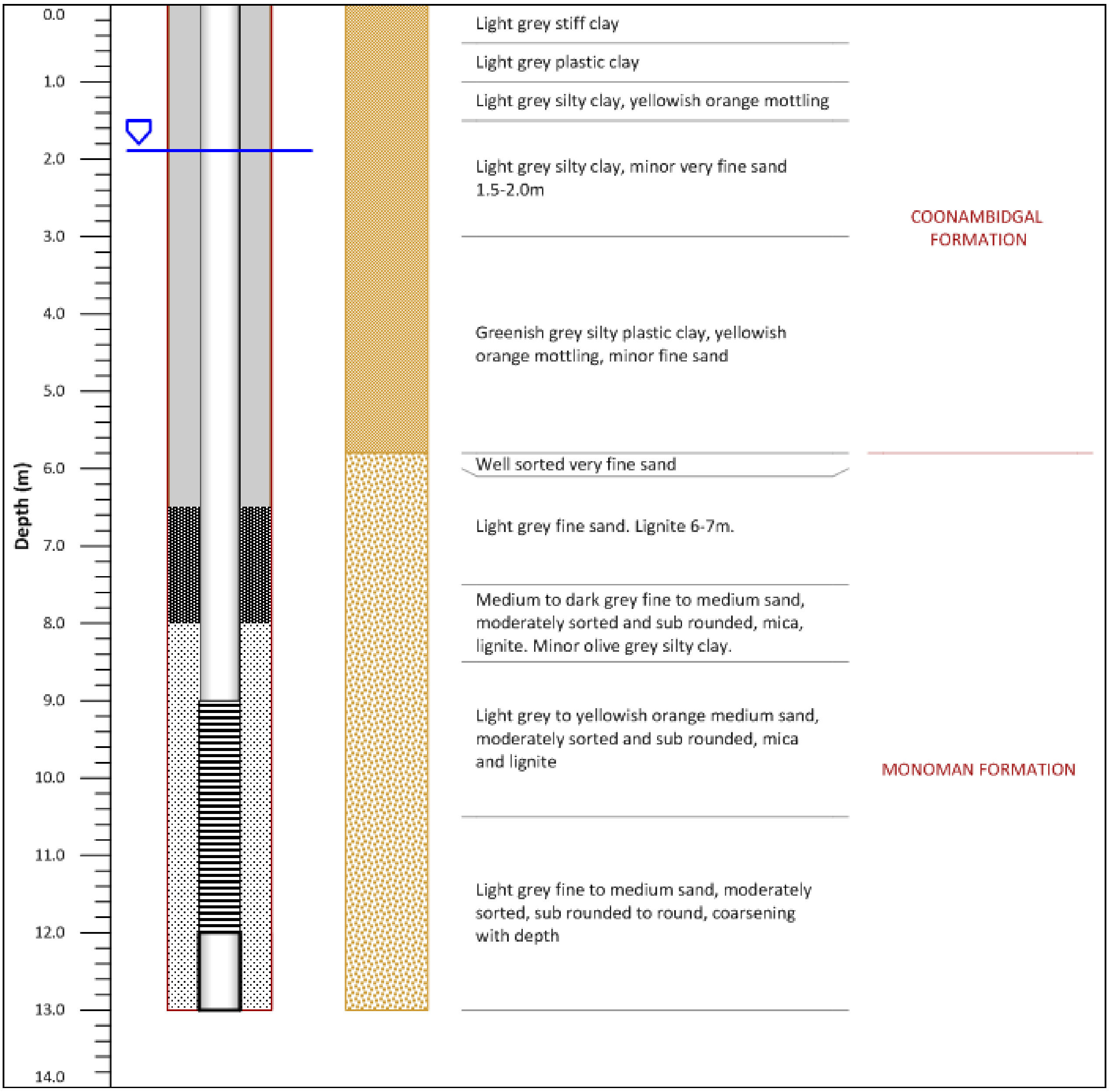
SARFIIP SMM Phase 1 Well Construction - Schematic Diagram

Government of South Australia
Department of Environment, Water and Natural Resources

Unit No: **7029-2842** Name: **P15** Well Type: **Observation** Final Depth (m): **13**

Permit No: **244198** Easting: **477960** Northing: **6212646** Zone: **54**

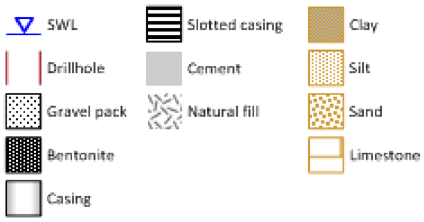
Construction Detail	Major Lithology	Lithological Description	Stratigraphic Unit



Construction Details

Well Component	ID (mm)	Material	Interval (m)	Aperture (mm)	Type
Casing	79	C12 PVC	0 - 9	-	-
Production Zone	79	C12 PVC	9 - 12	1	Slotted casing
Sump	79	C12 PVC	12 - 13	-	-

Lithological/Construction Symbology



Note:-
Datum: GDA 94
Wellsite Hydrogeologist: Ian Schneider (DEWNR)/Damian Newham (AWE)

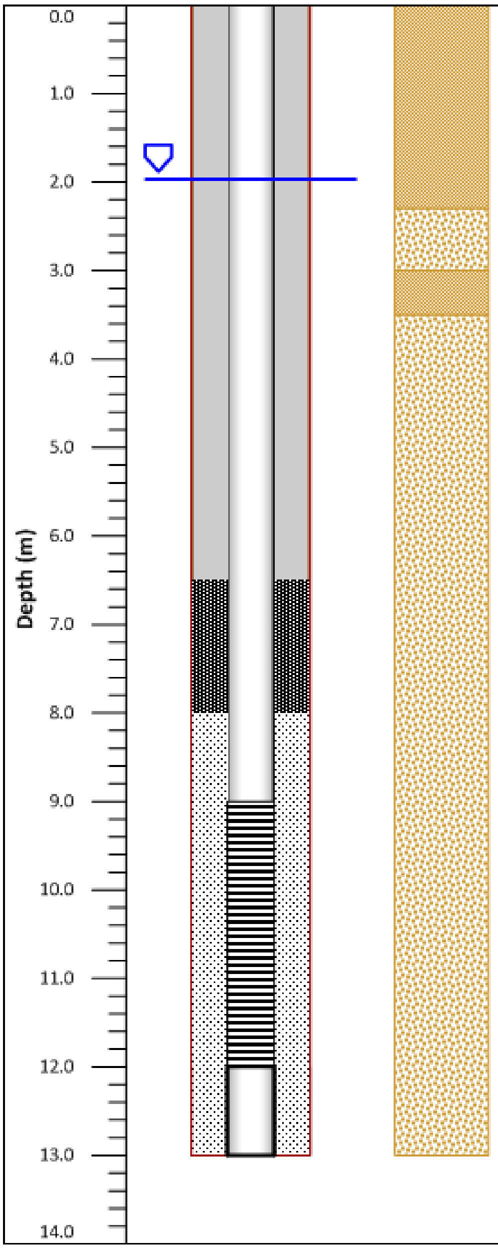
Current as at: 12-Jan-16

SARFIIP SMM Phase 1 Well Construction - Schematic Diagram

Government of South Australia
Department of Environment, Water and Natural Resources

Unit No: **7029-2844**	Name: **P20**	Well Type: **Observation**	Final Depth (m): **13**
Permit No: **247909**	Easting: **479178**	Northing: **6209897**	Zone: **54**

Construction Detail | **Major Lithology** | **Lithological Description** | **Stratigraphic Unit**



Lithological Description

- Olive grey stiff clay
- Light grey medium plastic clay, yellowish orange mottling 1-1.5m
- Yellowish grey silty clay
- Yellowish orange fine silty sand, well sorted sub rounded to round
- Light grey silty clay, minor yellowish orange fine sand
- Yellowish orange and minor greenish grey silty fine sand
- Yellowish orange silty well sorted sand, minor yellowish orange and light grey silty clay
- Olive grey silty sand, becoming light grey from 5.5m. Significant lignite 5-5.5m.
- Yellowish orange fine sand, well sorted, sub rounded to round, mica, lignite, medium sand 7-8m
- Light grey medium to coarse sand, moderately sorted, sub rounded to round. Lignite 10.5-11m.
- Light grey medium to coarse sand, moderately sorted, sub rounded to round. Medium grey and coarse 12-13m.

Stratigraphic Unit

COONAMBIDGAL FORMATION

MONOMAN FORMATION

Construction Details

Well Component	ID (mm)	Material	Interval (m)	Aperture (mm)	Type
Casing	79	C12 PVC	0 - 9	-	-
Production Zone	79	C12 PVC	9 - 12	1	Slotted casing
Sump	79	C12 PVC	12 - 13	-	-

Lithological/Construction Symbology

SWL, Slotted casing, Clay, Drillhole, Cement, Silt, Gravel pack, Natural fill, Sand, Bentonite, Limestone, Casing

Note:-
Datum: GDA 94
Wellsite Hydrogeologist: Ian Schneider (DEWNR)/Damian Newham (AWE)

Current as at: 12-Jan-16

B – Stage 2A Well Construction Diagrams

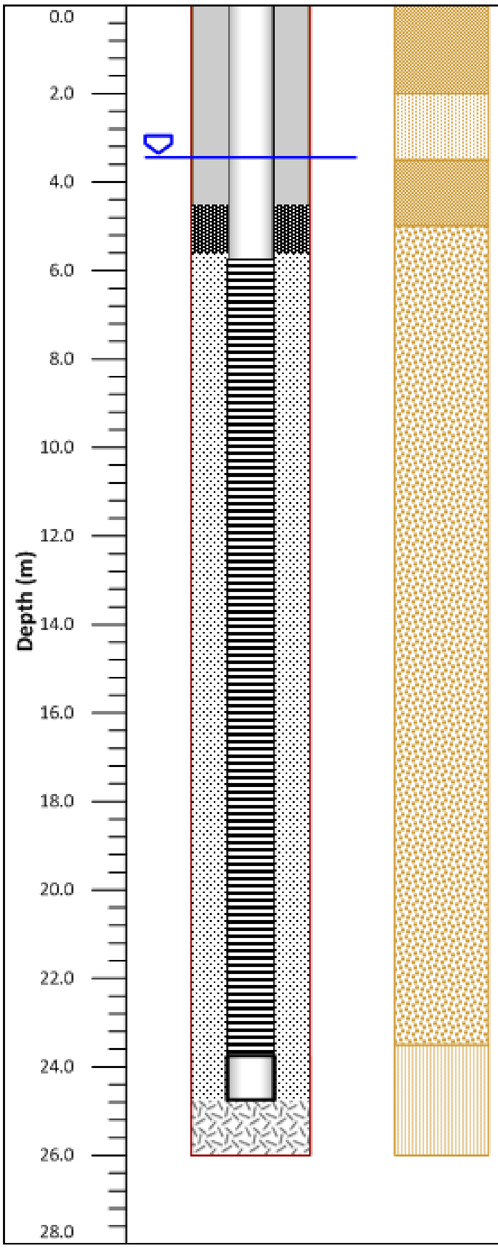
SARFIIP SMM Phase 2 Well Construction - Schematic Diagram

Government of South Australia
Department of Environment, Water and Natural Resources

Unit No: **7029-2879** Name: **PMW02** Well Type: **Observation** Final Depth (m): **24.75**

Permit No: **251857** Easting: **477670** Northing: **6208823** Zone: **54**

Construction Detail	Major Lithology	Lithological Description	Stratigraphic Unit



Lithological Description	Stratigraphic Unit
Olive grey clay. Minor calcrete and orange brown fine sand	COONAMBIDGAL FORMATION
Yellowish orange silty clay	COONAMBIDGAL FORMATION
Yellowish orange fine sandy silt	COONAMBIDGAL FORMATION
Light-medium brown, yellow-orange mottled fine sandy clay with minor silt	COONAMBIDGAL FORMATION
Light grey sandy plastic clay. Mottled with yellowish orange silty clay 4.5-5m	COONAMBIDGAL FORMATION
Yellowish orange fine to coarse sand. Poorly sorted, sub rounded. Light to olive grey silty clay layer at 5.3m	MONOMAN FORMATION
Yellowish orange fine to medium quartz sand. Moderately sorted and sub rounded with some olive grey plastic clay	MONOMAN FORMATION
Yellowish orange fine to coarse quartz sand. Moderately sorted and sub rounded	MONOMAN FORMATION
Yellowish orange fine to medium quartz sand. Moderately to poorly sorted with some olive grey plastic clay	MONOMAN FORMATION
Light grey medium to coarse quartz sand. Moderately sorted, sub to rounded. Rounded gravel fraction (to 10mm) 11-12m. Minor olive grey plastic clay layers	MONOMAN FORMATION
Light grey medium to coarse quartz sand. Moderately sorted, sub to rounded. Rounded gravel as per 11-12m. Minor lignite and thin dark brown consolidated interbeds.	MONOMAN FORMATION
Light grey fine to medium micaceous sand. Lignitic with some recent tree root in sample. Some thin moderately cemented components 15-15.5m	MONOMAN FORMATION
Olive grey micaceous and carbonaceous fine sand. Well sorted, lignitic, with minor medium brown silty clay.	MONOMAN FORMATION
Medium grey to dark grey micaceous and carbonaceous fine sand with dark grey silty clay increasing with depth	MONOMAN FORMATION
Dark grey micaceous fine sandy silt. Silt content increasing with depth.	MONOMAN FORMATION

Construction Details

Well Component	ID (mm)	Material	Interval (m)	Aperture (mm)	Type
Casing	79	C12 PVC	0 - 5.75	-	-
Production Zone	79	C12 PVC	5.75 - 23.75	1	Slotted casing
Sump	79	C12 PVC	23.75 - 24.75	-	-

Lithological/Construction Symbology

SWL, Slotted casing, Clay, Drillhole, Cement, Silt, Gravel pack, Natural fill, Sand, Bentonite, Limestone, Casing

Note:-
Datum: GDA 94
Wellsite Hydrogeologist: Ian Schneider (DEWNR)/Damian Newham (AWE)

Current as at: 25-Jan-16

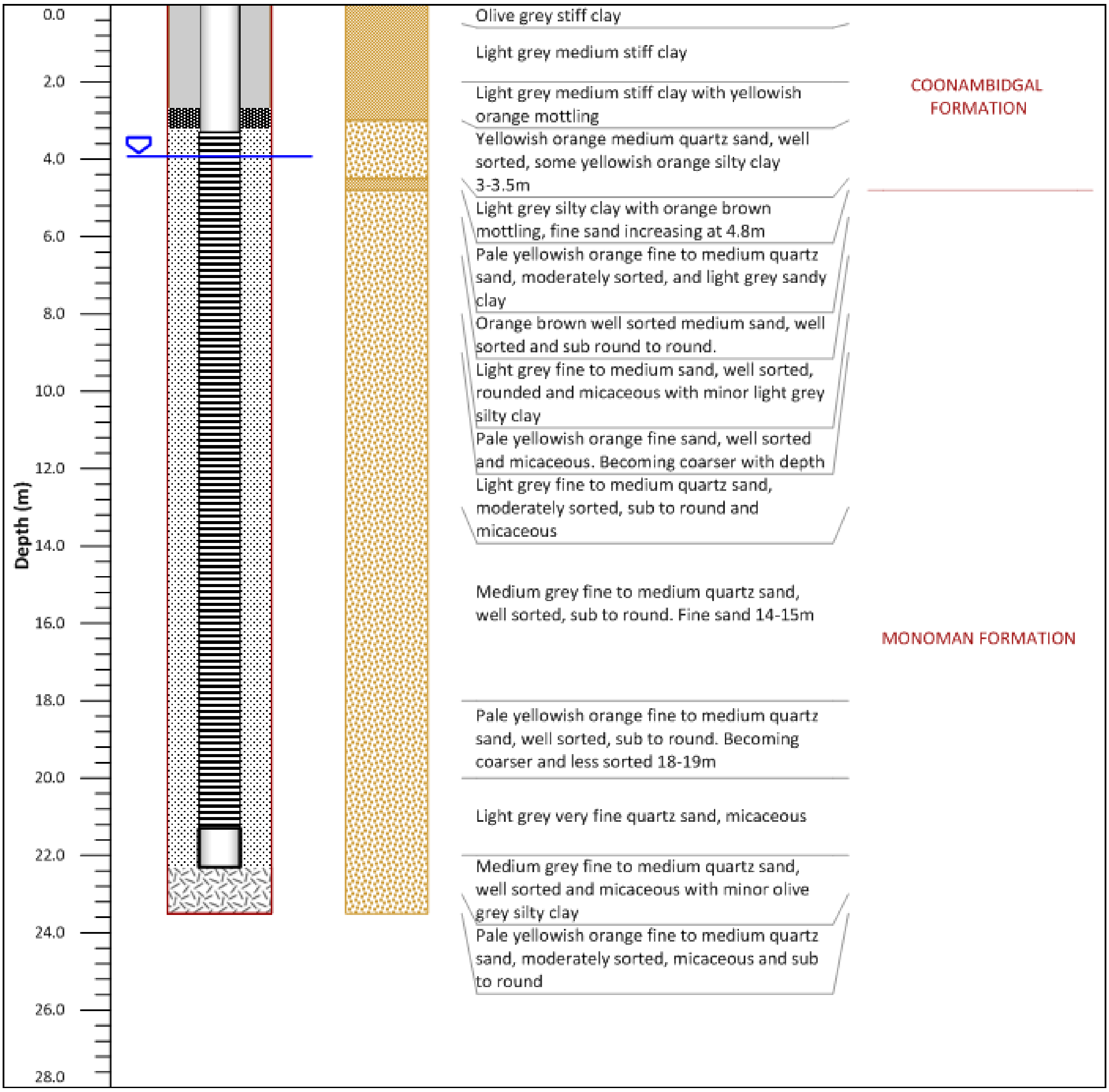
SARFIIP SMM Phase 2 Well Construction - Schematic Diagram

Unit No: **7029-2865** Name: **PMW04** Well Type: **Observation** Final Depth (m): **22.3**

Permit No: **251860** Easting: **478601** Northing: **6212443** Zone: **54**

Government of South Australia
Department of Environment, Water and Natural Resources

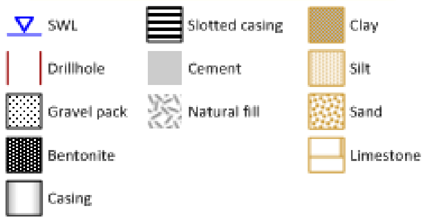
Construction Detail	Major Lithology	Lithological Description	Stratigraphic Unit



Construction Details

Well Component	ID (mm)	Material	Interval (m)	Aperture (mm)	Type
Casing	79	C12 PVC	0 - 3.3	-	-
Production Zone	79	C12 PVC	3.3 - 21.3	1	Slotted casing
Sump	79	C12 PVC	21.3 - 22.3	-	-

Lithological/Construction Symbology



Note:-
Datum: GDA 94
Wellsite Hydrogeologist: Ian Schneider (DEWNR)/Damian Newham (AWE)

Current as at: 25-Jan-16

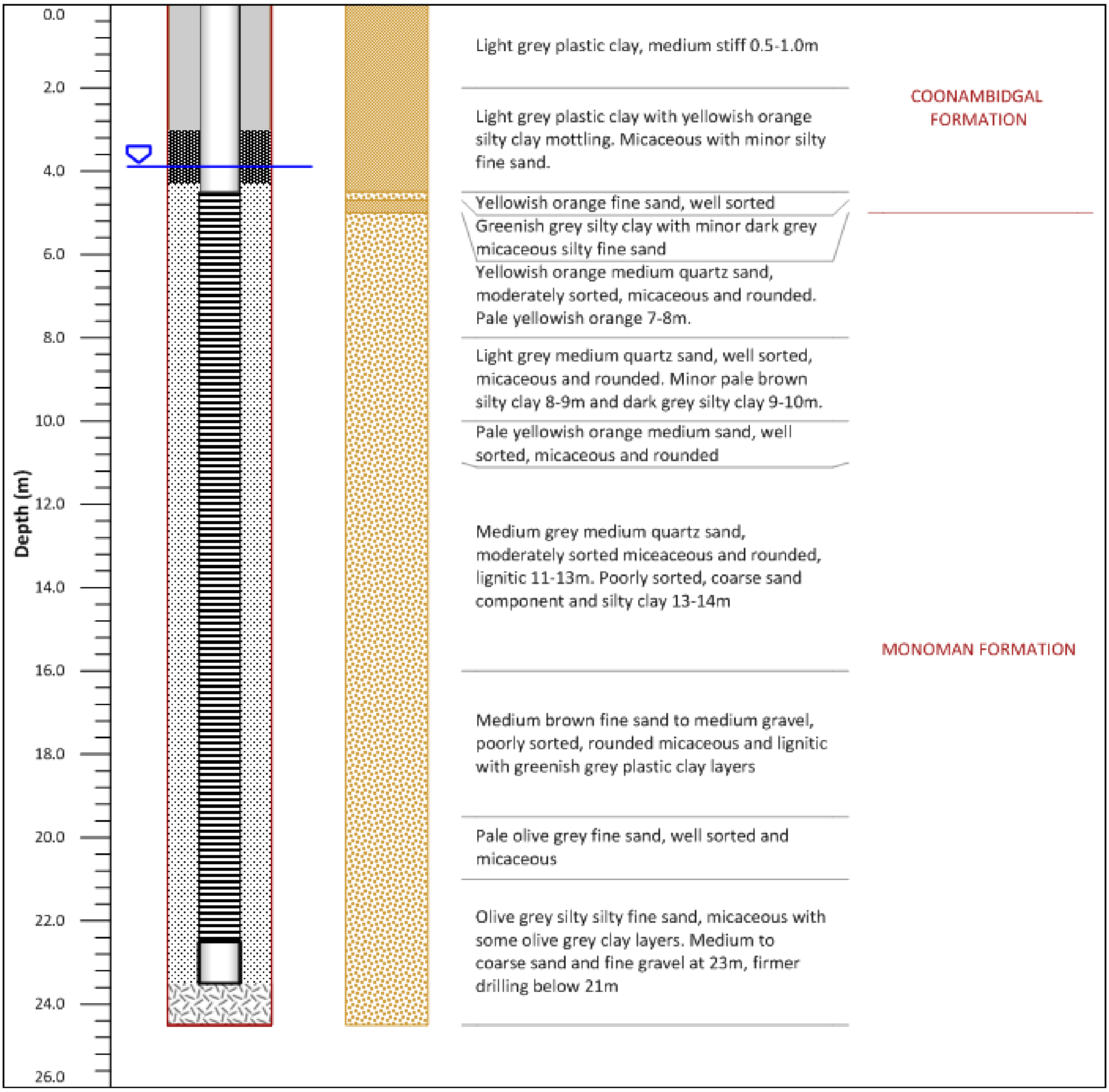
SARFIIP SMM Phase 2 Well Construction - Schematic Diagram

Government of South Australia
Department of Environment, Water and Natural Resources

Unit No: **7029-2867** Name: **PMW05** Well Type: **Observation** Final Depth (m): **23.5**

Permit No: **251861** Easting: **478502** Northing: **6212309** Zone: **54**

Construction Detail	Major Lithology	Lithological Description	Stratigraphic Unit



Construction Details

Well Component	ID (mm)	Material	Interval (m)	Aperture (mm)	Type
Casing	79	C12 PVC	0 - 4.5	-	-
Production Zone	79	C12 PVC	4.5 - 22.5	1	Slotted casing
Sump	79	C12 PVC	22.5 - 23.5	-	-

Lithological/Construction Symbology

SWL, Slotted casing, Clay, Drillhole, Cement, Silt, Gravel pack, Natural fill, Sand, Bentonite, Limestone, Casing

Note:-
Datum: GDA 94
Wellsite Hydrogeologist: Ian Schneider (DEWNR)/Damian Newham (AWE)

Current as at: 25-Jan-16

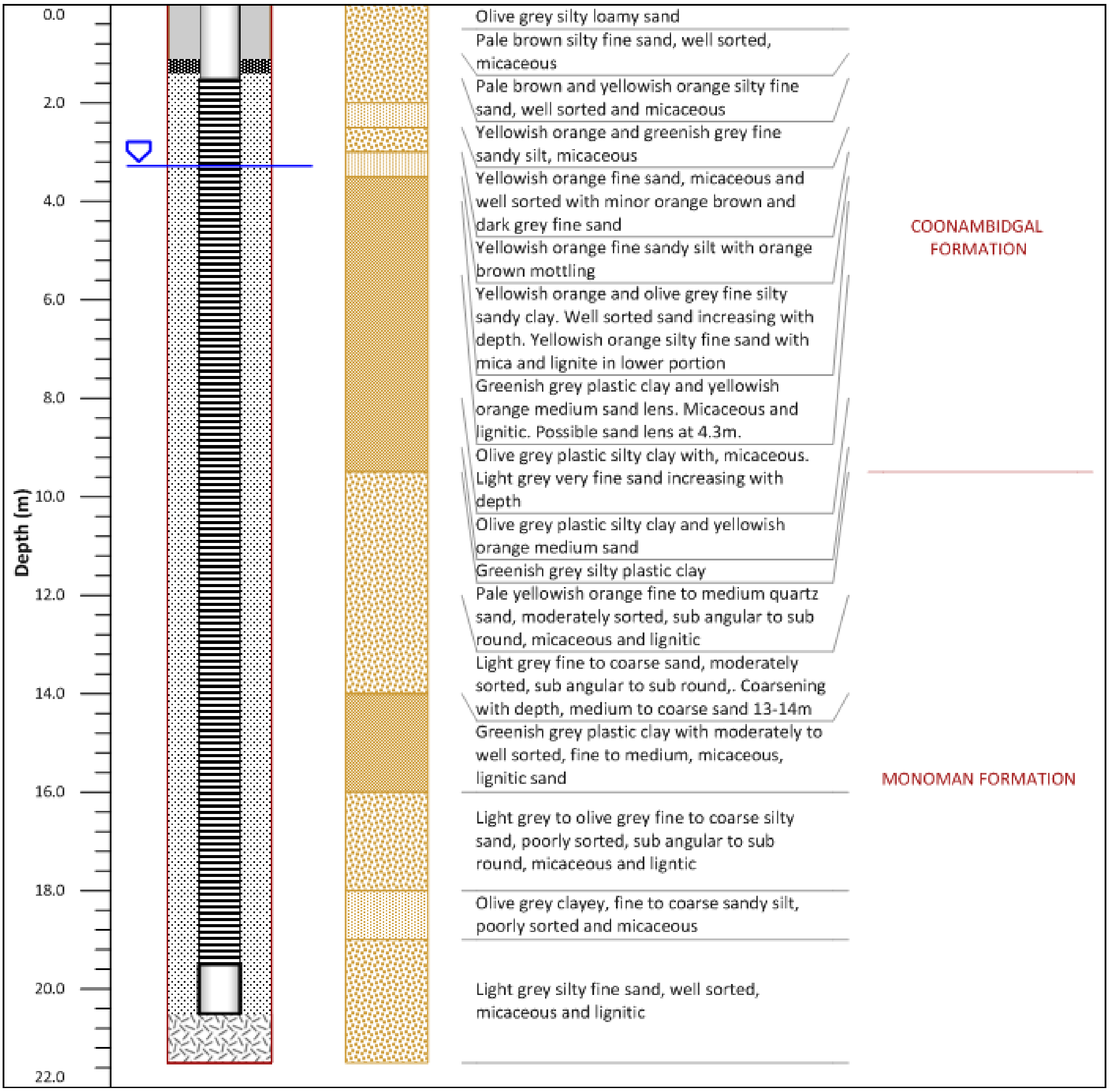
SARFIIP SMM Phase 2 Well Construction - Schematic Diagram

Government of South Australia
Department of Environment, Water and Natural Resources

Unit No: **7029-2876** Name: **PMW06** Well Type: **Observation** Final Depth (m): **20.5**

Permit No: **251867** Easting: **477914** Northing: **6213982** Zone: **54**

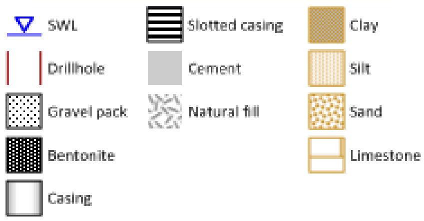
Construction Detail	Major Lithology	Lithological Description	Stratigraphic Unit



Construction Details

Well Component	ID (mm)	Material	Interval (m)	Aperture (mm)	Type
Casing	79	C12 PVC	0 - 1.5	-	-
Production Zone	79	C12 PVC	1.5 - 19.5	1	Slotted casing
Sump	79	C12 PVC	19.5 - 20.5	-	-

Lithological/Construction Symbology



Note:-
Datum: GDA 94
Wellsite Hydrogeologist: Ian Schneider (DEWNR)/Damian Newham (AWE)

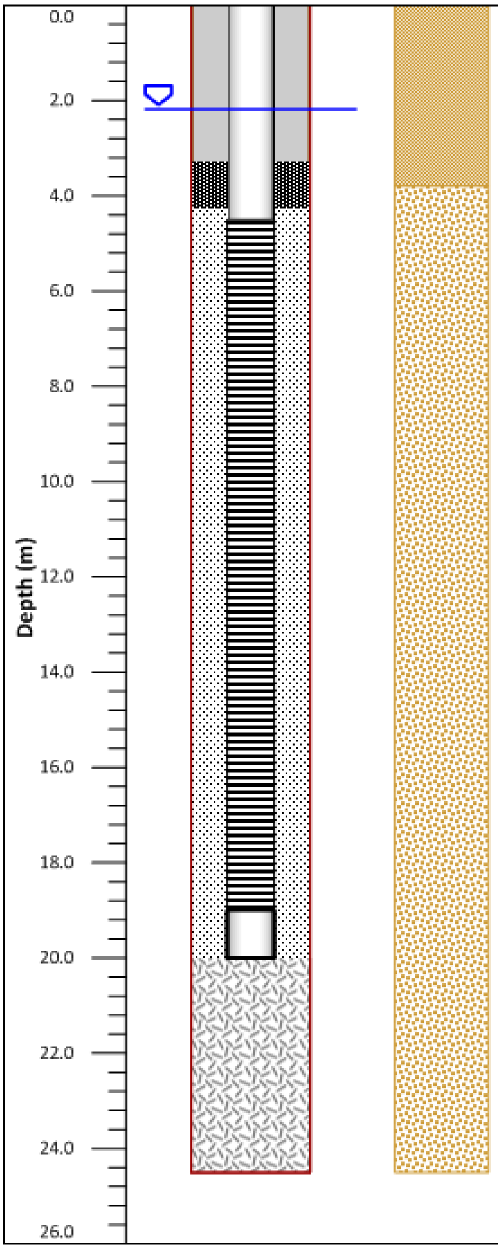
Current as at: 25-Jan-16

SARFIIP SMM Phase 2 Well Construction - Schematic Diagram

Unit No: **7029-2869**	Name: **PMW09**	Well Type: **Observation**	Final Depth (m): **20**
Permit No: **251873**	Easting: **482283**	Northing: **6208602**	Zone: **54**

Government of South Australia
Department of Environment, Water and Natural Resources

Construction Detail	Major Lithology	Lithological Description	Stratigraphic Unit



Lithological Description	Stratigraphic Unit
Olive grey stiff clay. Minor yellowish orange fine sand 0.5-1m.	COONAMBIDGAL FORMATION
Olive grey plastic clay. Minor off white silt.	
Yellowish orange well sorted fine silty sand	
Pale yellowish orange fine sand. Well sorted and micaceous.	
Medium grey fine sand. Well sorted and very lignitic.	
Yellowish orange fine to medium quartz sand. Well sorted and micaceous.	
Light grey fine quartz sand. Well sorted and micaceous.	MONOMAN FORMATION
Light grey medium to coarse quartz sand. Moderately sorted, sub round and micaceous sorted and micaceous.	
Light grey fine quartz sand. Well sorted and micaceous.	
Medium grey fine to medium sand. Moderately sorted and micaceous.	

Construction Details

Well Component	ID (mm)	Material	Interval (m)	Aperture (mm)	Type
Casing	79	C12 PVC	0 - 4.5	-	-
Production Zone	79	C12 PVC	4.5 - 19	1	Slotted casing
Sump	79	C12 PVC	19 - 20	-	-

Lithological/Construction Symbology

SWL, Slotted casing, Clay, Drillhole, Cement, Silt, Gravel pack, Natural fill, Sand, Bentonite, Limestone, Casing

Note:-
Datum: GDA 94
Wellsite Hydrogeologist: Ian Schneider (DEWNR)/Damian Newham (AWE)

Current as at: 25-Jan-16

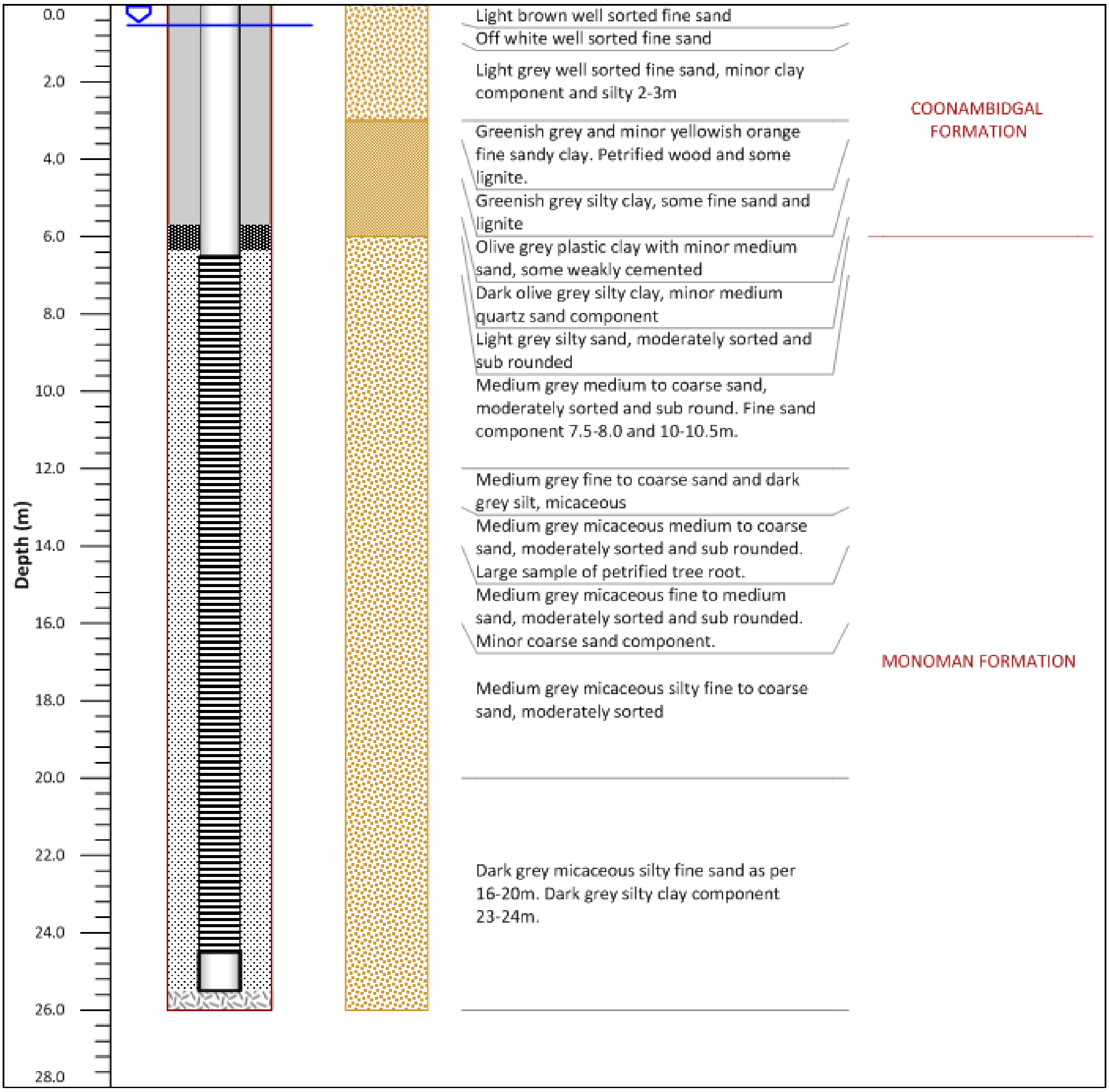
SARFIIP SMM Phase 2 Well Construction - Schematic Diagram

Unit No: **7029-2875** Name: **PMW10** Well Type: **Observation** Final Depth (m): **25.5**

Permit No: **251874** Easting: **482162** Northing: **6208200** Zone: **54**

Government of South Australia
Department of Environment, Water and Natural Resources

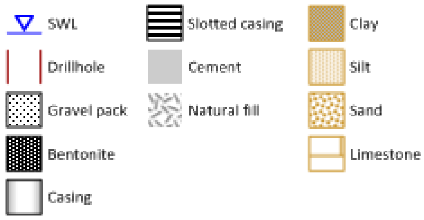
Construction Detail	Major Lithology	Lithological Description	Stratigraphic Unit



Construction Details

Well Component	ID (mm)	Material	Interval (m)	Aperture (mm)	Type
Casing	79	C12 PVC	0 - 6.5	-	-
Production Zone	79	C12 PVC	6.5 - 24.5	1	Slotted casing
Sump	79	C12 PVC	24.5 - 25.5	-	-

Lithological/Construction Symbology



Note:-
Datum: GDA 94
Wellsite Hydrogeologist: Ian Schneider (DEWNR)/Damian Newham (AWE)

Current as at: 25-Jan-16

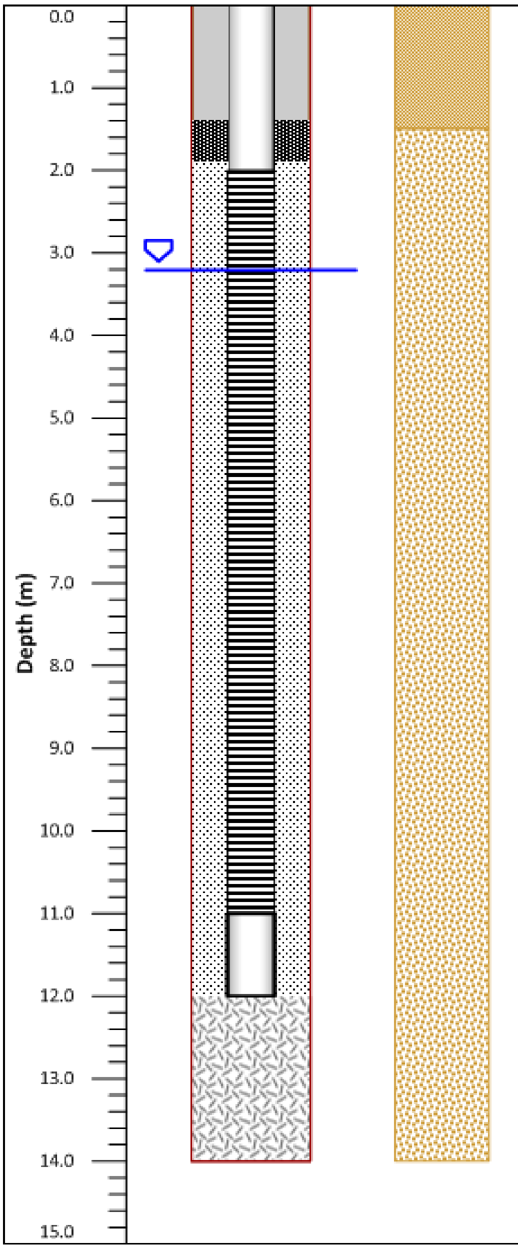
SARFIIP SMM Phase 2 Well Construction - Schematic Diagram

Unit No: **7029-2871** Name: **PMW11** Well Type: **Observation** Final Depth (m): **12**

Permit No: **251887** Easting: **480589** Northing: **6209262** Zone: **54**

Government of South Australia
Department of Environment, Water and Natural Resources

Construction Detail	Major Lithology	Lithological Description	Stratigraphic Unit



Medium stiff clay

Yellowish brown silty clay with minor sand

Yellowish orange silty fine sand, micaceous

Yellowish brown silty fine miceaceous sand with medium brown silt component

Yellowish orange silty fine sand, well sorted, micaceous and lignitic with minor greenish grey silty clay

Yellowish orange, dark brown and light grey silty fine sand, well sorted and micaceous

Yellowish orange, olive grey and dark grey silty fine sand, micaceous and lignitic. Thin well cemented dark grey sand.

Yellowish orange and olive grey fine sand, micaceous, well sorted and silty. Dark grey highly micaceous and lignitic sandy silt layer 6-7m.

Yellowish orange fine sand, well sorted and micaceous with minor lignite. Tree root and thin bed of dark grey well cemented sand at 8.5m.

Yellowish orange to light grey quartz sand, well sorted and sub round with significant lignite components

Yellowish orange and light grey coarse sand to fine gravel, moderately sorted, sub round with minor dark grey silt and lignite

Light grey fine to coarse sand and fine gravel, poorly, sub rounded and micaceous

Light grey to yellowish orange fine to medium quartz sand, well sorted, micaceous with minor lignitic components

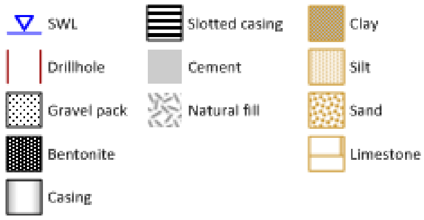
COONAMBIDGAL FORMATION

MONOMAN FORMATION

Construction Details

Well Component	ID (mm)	Material	Interval (m)	Aperture (mm)	Type
Casing	79	C12 PVC	0 - 2	-	-
Production Zone	79	C12 PVC	2 - 11	1	Slotted casing
Sump	79	C12 PVC	11 - 12	-	-

Lithological/Construction Symbology



Note:-
Datum: GDA 94
Wellsite Hydrogeologist: Ian Schneider (DEWNR)/Damian Newham (AWE)

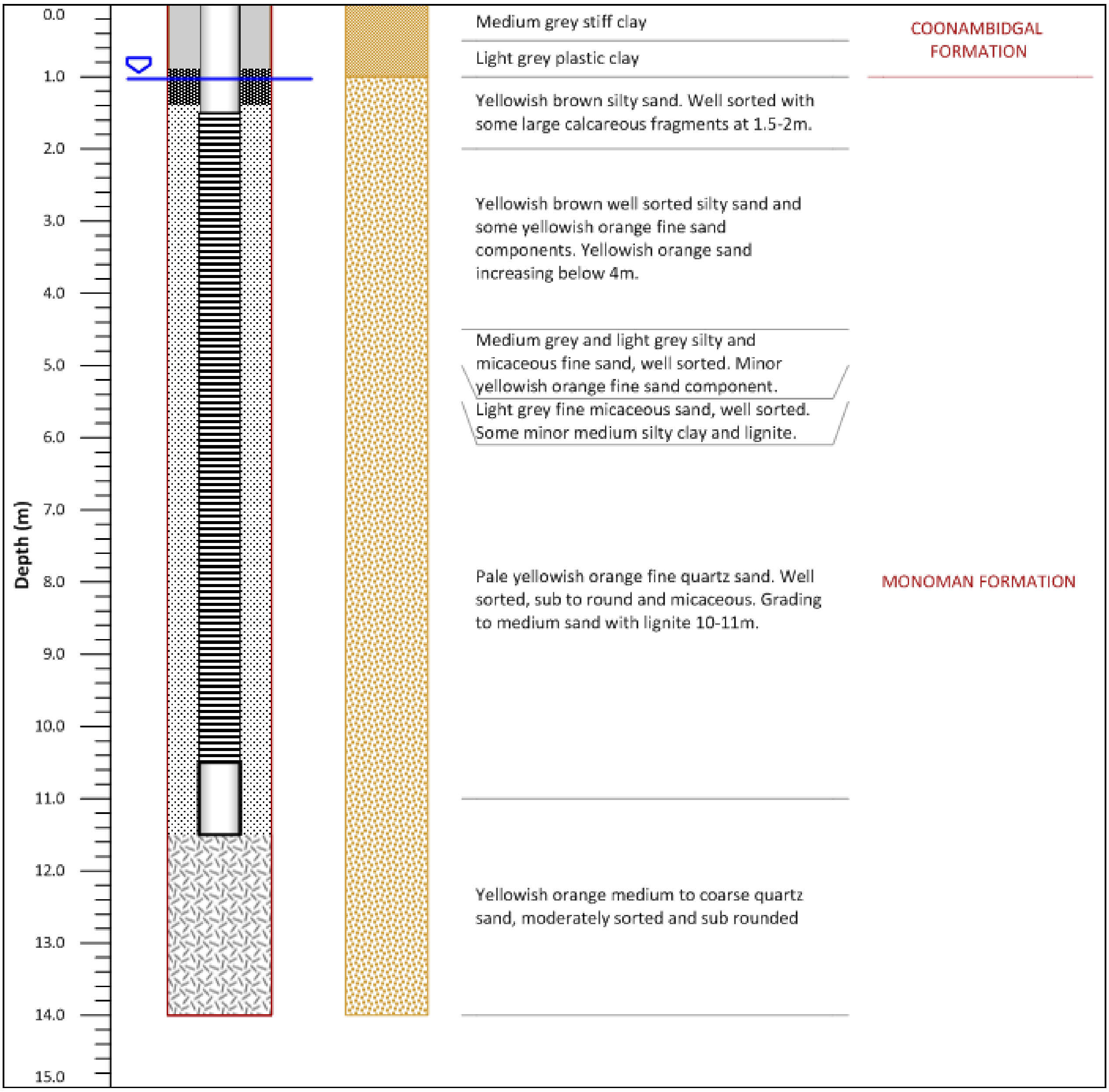
Current as at: 25-Jan-16

SARFIIP SMM Phase 2 Well Construction - Schematic Diagram

Government of South Australia
Department of Environment, Water and Natural Resources

Unit No: **7029-2877**	Name: **PMW12**	Well Type: **Observation**	Final Depth (m): **11.5**
Permit No: **251875**	Easting: **483300**	Northing: **6210016**	Zone: **54**

Construction Detail	Major Lithology	Lithological Description	Stratigraphic Unit



Construction Details

Well Component	ID (mm)	Material	Interval (m)	Aperture (mm)	Type
Casing	79	C12 PVC	0 - 1.5	-	-
Production Zone	79	C12 PVC	1.5 - 10.5	1	Slotted casing
Sump	79	C12 PVC	10.5 - 11.5	-	-

Lithological/Construction Symbology

SWL, Slotted casing, Clay, Drillhole, Cement, Silt, Gravel pack, Natural fill, Sand, Bentonite, Limestone, Casing

Note:-
Datum: GDA 94
Wellsite Hydrogeologist: Ian Schneider (DEWNR)/Damian Newham (AWE)

Current as at: 25-Jan-16

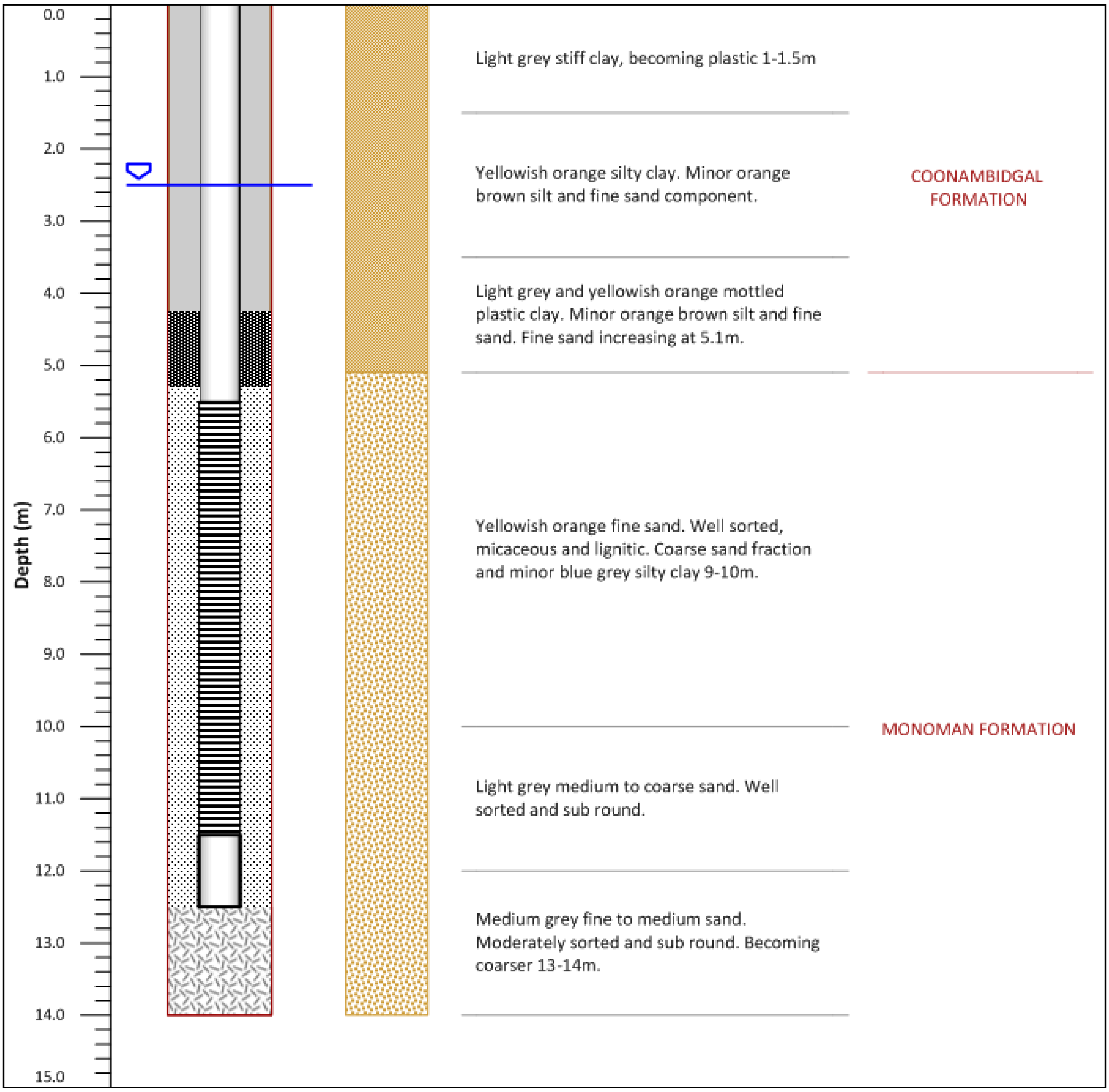
SARFIIP SMM Phase 2 Well Construction - Schematic Diagram

Unit No: **7029-2868** Name: **PMW13** Well Type: **Observation** Final Depth (m): **12.5**

Permit No: **251876** Easting: **482223** Northing: **6210258** Zone: **54**

Government of South Australia
Department of Environment, Water and Natural Resources

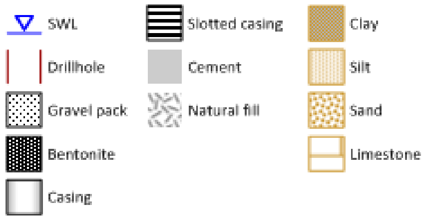
Construction Detail	Major Lithology	Lithological Description	Stratigraphic Unit



Construction Details

Well Component	ID (mm)	Material	Interval (m)	Aperture (mm)	Type
Casing	79	C12 PVC	0 - 5.5	-	-
Production Zone	79	C12 PVC	5.5 - 11.5	1	Slotted casing
Sump	79	C12 PVC	11.5 - 12.5	-	-

Lithological/Construction Symbology



Note:-
Datum: GDA 94
Wellsite Hydrogeologist: Ian Schneider (DEWNR)/Damian Newham (AWE)

Current as at: 25-Jan-16

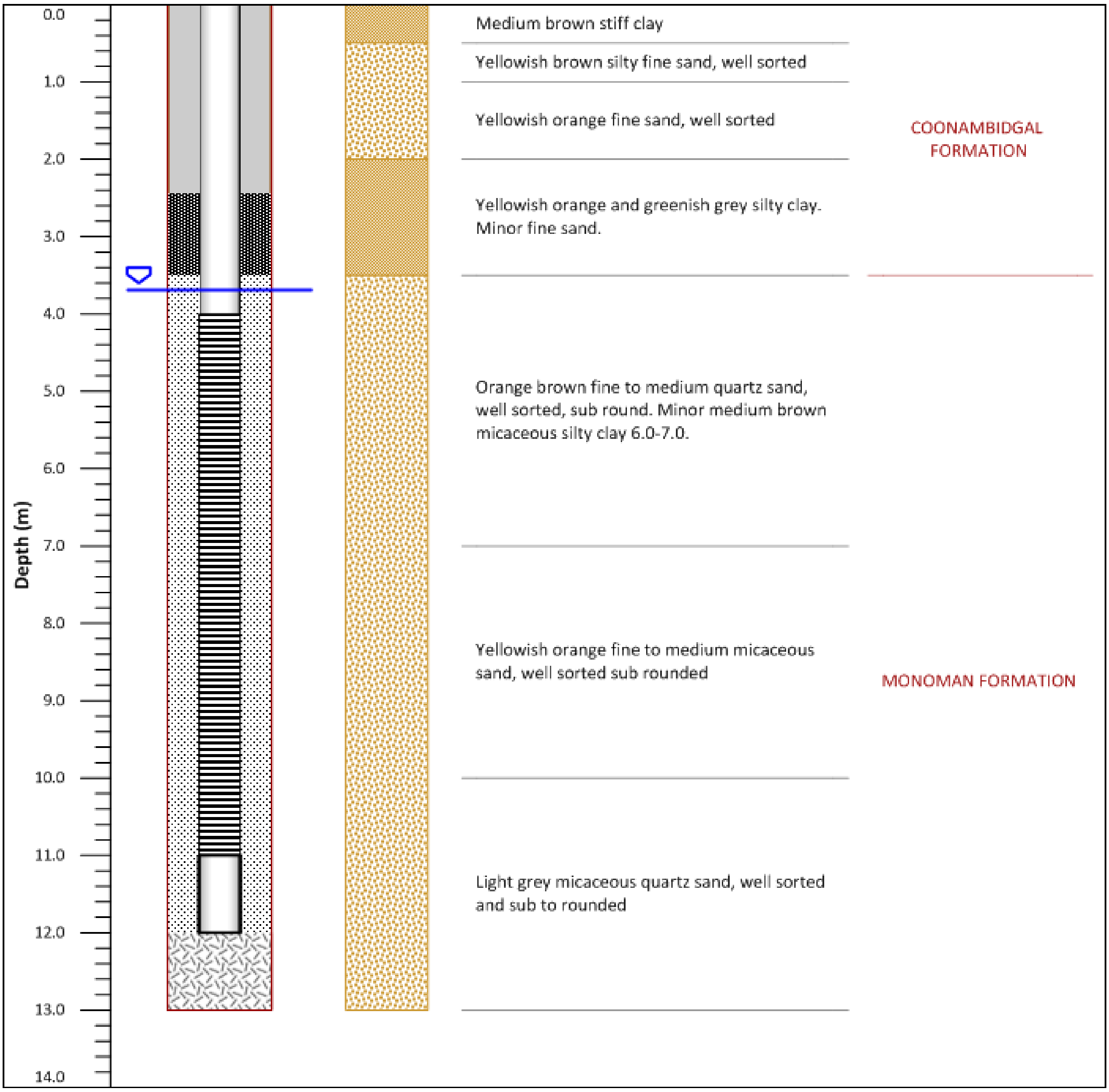
SARFIIP SMM Phase 2 Well Construction - Schematic Diagram

Government of South Australia
Department of Environment, Water and Natural Resources

Unit No: **7029-2878** Name: **PMW15** Well Type: **Observation** Final Depth (m): **12**

Permit No: **251862** Easting: **478969** Northing: **6211833** Zone: **54**

Construction Detail	Major Lithology	Lithological Description	Stratigraphic Unit



Construction Details

Well Component	ID (mm)	Material	Interval (m)	Aperture (mm)	Type
Casing	79	C12 PVC	0 - 4	-	-
Production Zone	79	C12 PVC	4 - 11	1	Slotted casing
Sump	79	C12 PVC	11 - 12	-	-

Lithological/Construction Symbology

SWL, Slotted casing, Clay, Drillhole, Cement, Silt, Gravel pack, Natural fill, Sand, Bentonite, Limestone, Casing

Note:-
Datum: GDA 94
Wellsite Hydrogeologist: Ian Schneider (DEWNR)/Damian Newham (AWE)

Current as at: 25-Jan-16

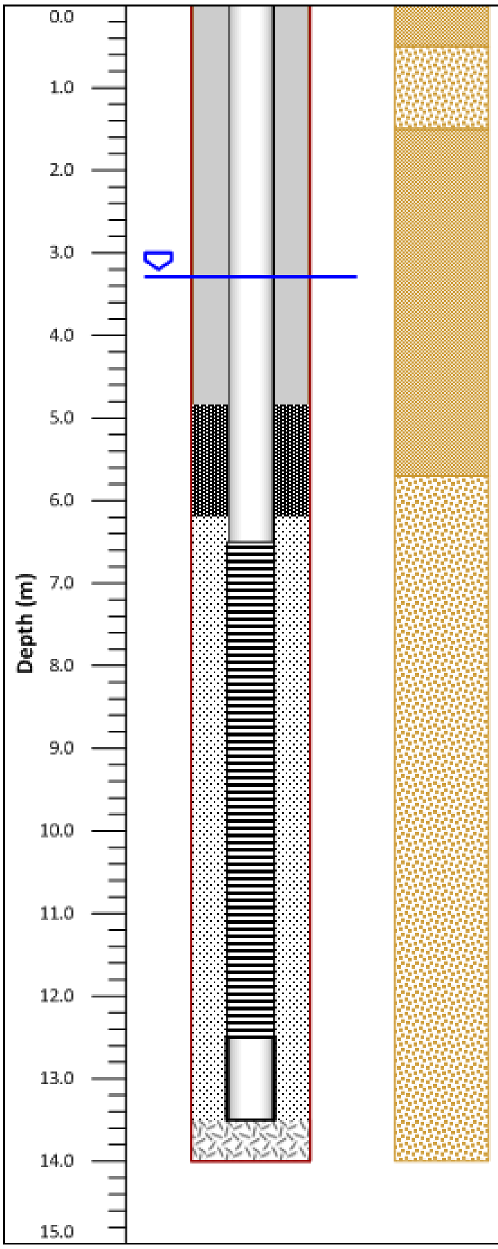
SARFIIP SMM Phase 2 Well Construction - Schematic Diagram

Unit No: **7029-2873** Name: **PMW16** Well Type: **Observation** Final Depth (m): **13.5**

Permit No: **251890** Easting: **477581** Northing: **6210939** Zone: **54**

Government of South Australia
Department of Environment, Water and Natural Resources

Construction Detail	Major Lithology	Lithological Description	Stratigraphic Unit
		Light grey stiff clay	COONAMBIDGAL FORMATION
		Light brown well sorted silty sand	
		Yellowish orange silty fine sand, well sorted	
		Yellowish orange silty clay	
		Yellowish orange and light grey mottled silty clay with fine micaceous sand component	
		Light grey and yellowish orange mottled silty clay with minor mica and fine silty sand	
		Yellowish orange fine sand, micaceous and well sorted. Some minor greenish grey silty clay layers to 7.0m. Coarse sand and olive grey silty clay 7.5-8.0m.	MONOMAN FORMATION
		Yellowish orange fine to coarse, poorly sorted quartz sand, sub rounded and micaceous. Minor dark grey silty fine sand.	
		Medium grey medium to coarse sand and fine gravel, poorly sorted, sub round and lignitic. Minor dark grey silty micaceous fine sand component.	
		Yellowish orange medium to coarse sand, moderately sorted, sub round, micaceous and lignitic	



Construction Details

Well Component	ID (mm)	Material	Interval (m)	Aperture (mm)	Type
Casing	79	C12 PVC	0 - 6.5	-	-
Production Zone	79	C12 PVC	6.5 - 12.5	1	Slotted casing
Sump	79	C12 PVC	12.5 - 13.5	-	-

Lithological/Construction Symbology

SWL, Slotted casing, Clay, Drillhole, Cement, Silt, Gravel pack, Natural fill, Sand, Bentonite, Limestone, Casing

Note:-
Datum: GDA 94
Wellsite Hydrogeologist: Ian Schneider (DEWNR)/Damian Newham (AWE)

Current as at: 25-Jan-16

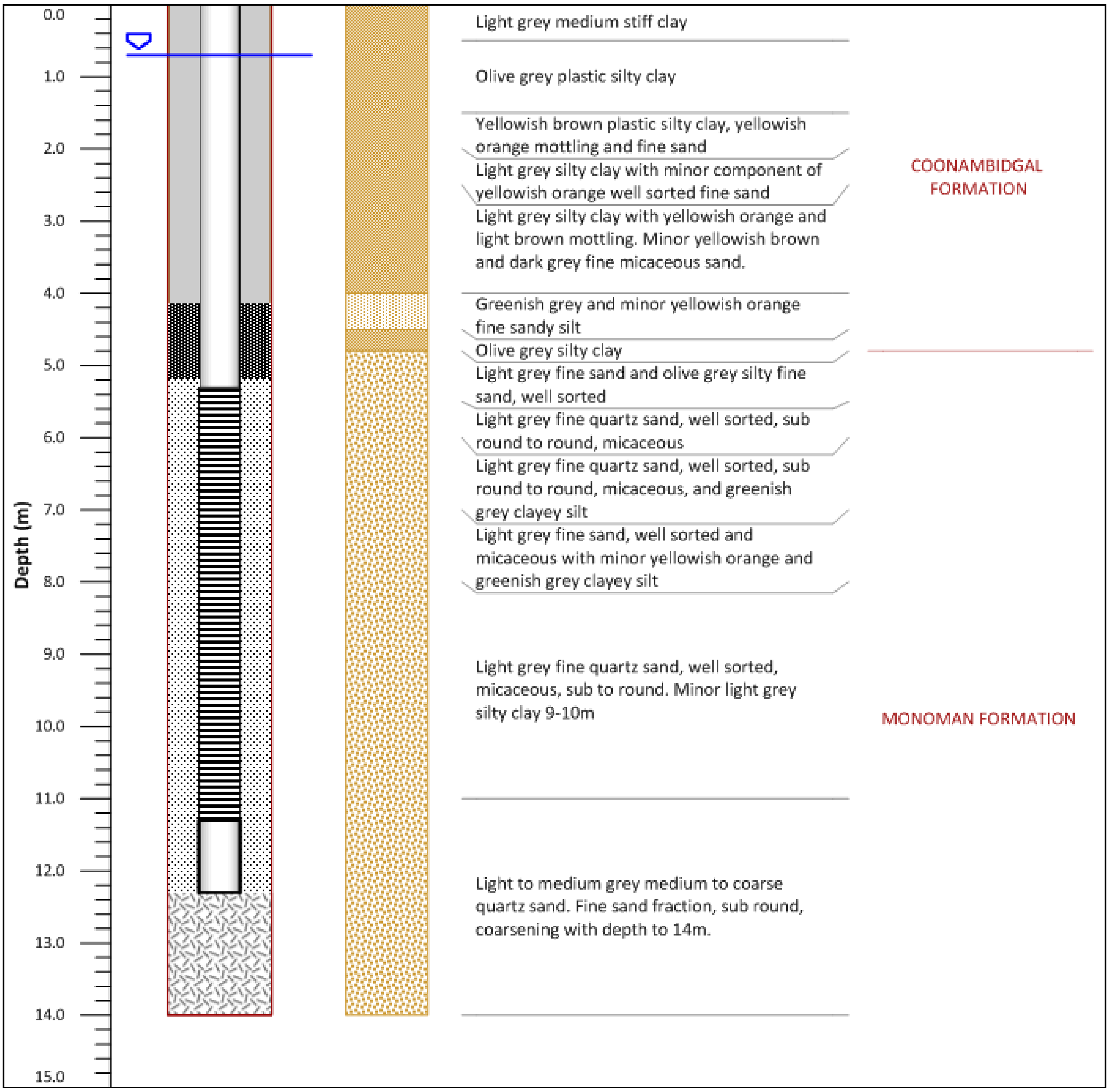
SARFIIP SMM Phase 2 Well Construction - Schematic Diagram

Unit No: **7029-2870** Name: **PMW17** Well Type: **Observation** Final Depth (m): **12.3**

Permit No: **251877** Easting: **483799** Northing: **6211995** Zone: **54**

Government of South Australia
Department of Environment, Water and Natural Resources

Construction Detail	Major Lithology	Lithological Description	Stratigraphic Unit



Construction Details

Well Component	ID (mm)	Material	Interval (m)	Aperture (mm)	Type
Casing	79	C12 PVC	0 - 5.3	-	-
Production Zone	79	C12 PVC	5.3 - 11.3	1	Slotted casing
Sump	79	C12 PVC	11.3 - 12.3	-	-

Lithological/Construction Symbology

SWL, Slotted casing, Clay, Drillhole, Cement, Silt, Gravel pack, Natural fill, Sand, Bentonite, Limestone, Casing

Note:-
Datum: GDA 94
Wellsite Hydrogeologist: Ian Schneider (DEWNR)/Damian Newham (AWE)

Current as at: 25-Jan-16

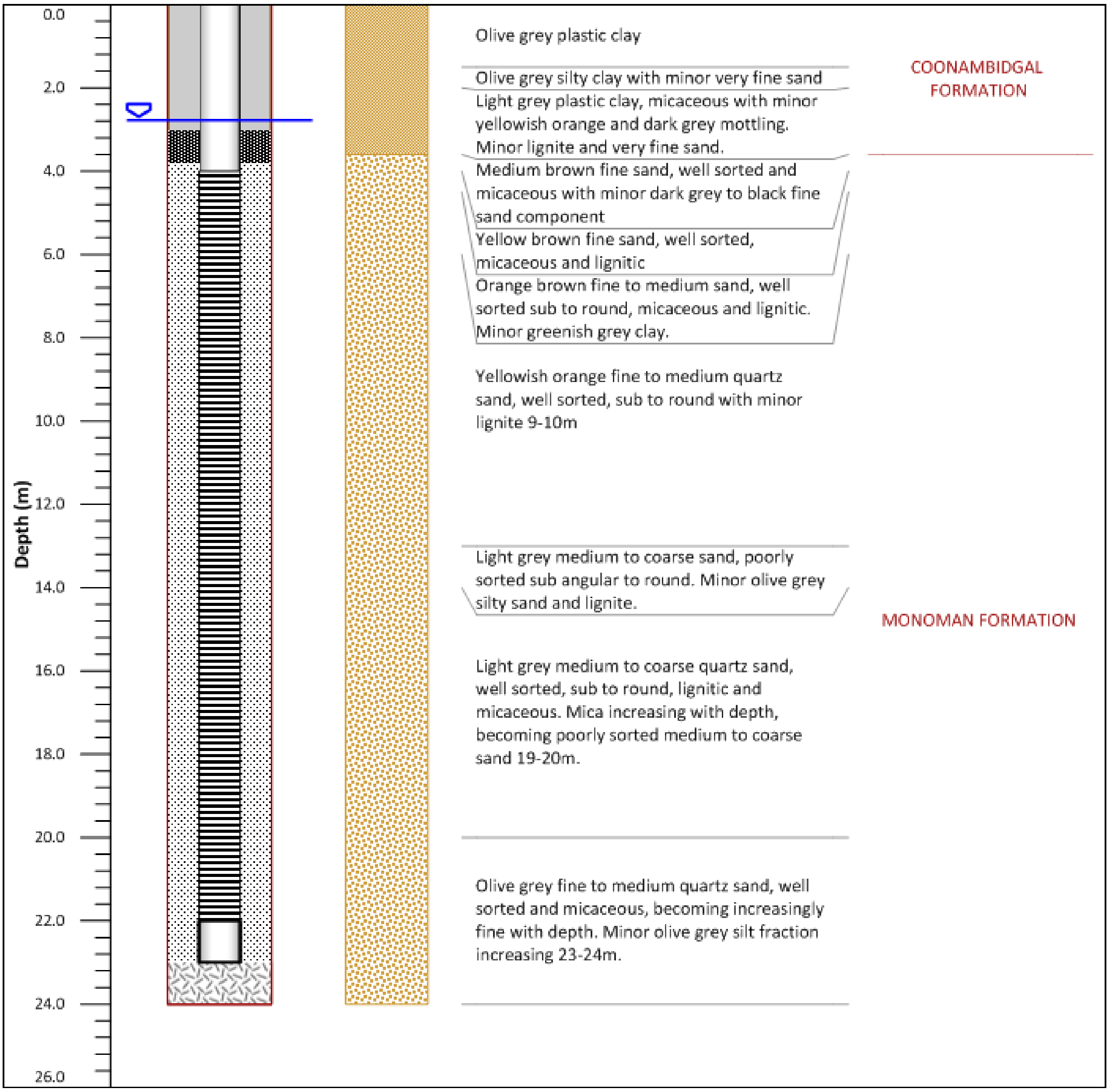
SARFIIP SMM Phase 2 Well Construction - Schematic Diagram

Unit No: **7029-2872** Name: **PMW18** Well Type: **Observation** Final Depth (m): **23**

Permit No: **251863** Easting: **478504** Northing: **6213122** Zone: **54**

Government of South Australia
Department of Environment, Water and Natural Resources

Construction Detail	Major Lithology	Lithological Description	Stratigraphic Unit



Construction Details

Well Component	ID (mm)	Material	Interval (m)	Aperture (mm)	Type
Casing	79	C12 PVC	0 - 4	-	-
Production Zone	79	C12 PVC	4 - 22	1	Slotted casing
Sump	79	C12 PVC	22 - 23	-	-

Lithological/Construction Symbology

SWL, Slotted casing, Clay, Drillhole, Cement, Silt, Gravel pack, Natural fill, Sand, Bentonite, Limestone, Casing

Note:-
Datum: GDA 94
Wellsite Hydrogeologist: Ian Schneider (DEWNR)/Damian Newham (AWE)

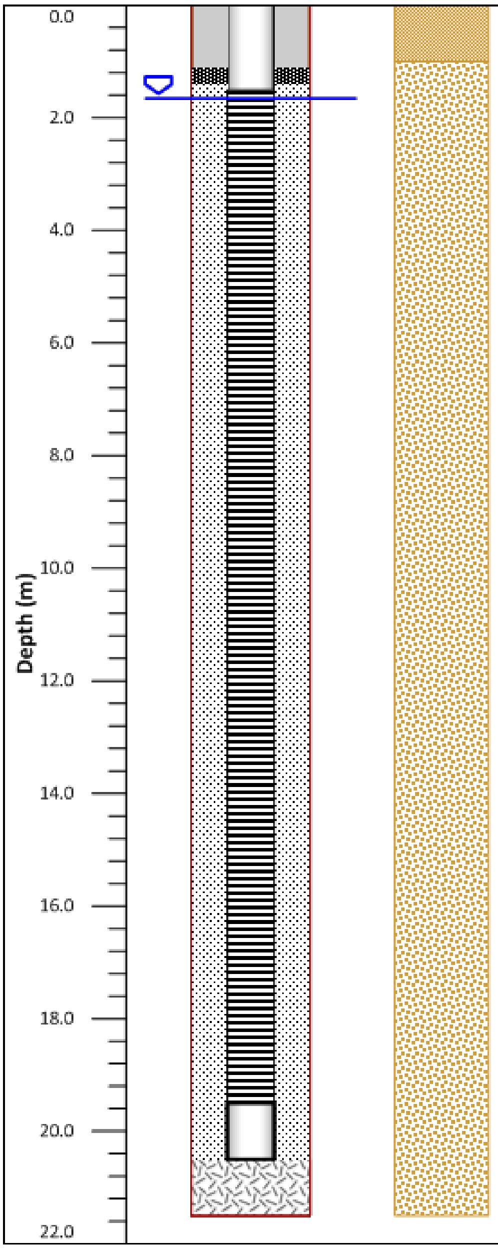
Current as at: 25-Jan-16

SARFIIP SMM Phase 2 Well Construction - Schematic Diagram

Unit No: **7029-2874**	Name: **PMW19**	Well Type: **Observation**	Final Depth (m): **20.5**
Permit No: **251869**	Easting: **478853**	Northing: **6214214**	Zone: **54**

Government of South Australia
Department of Environment, Water and Natural Resources

Construction Detail	Major Lithology	Lithological Description	Stratigraphic Unit



Lithological Description	Stratigraphic Unit
Medium grey stiff clay	COONAMBIDGAL FORMATION
Light grey plastic clay with minor yellowish orange silty fine sand mottling, lignite and mica	MONOMAN FORMATION
Pale yellowish orange silty very fine sand, well sorted with minor lignite and mica	
Greenish grey silty fine sand, well sorted, micaceous. Silt increasing 2.25m with thin yellowish orange silty clay layer.	
Yellowish orange medium quartz sand, well sorted, rounded, micaceous and lignitic	
Yellowish brown fine to medium quartz sand, moderately sorted, sub to round and micaceous. Minor light grey fine sandy clay.Ligntic layer 3-3.5m.	
Pale yellowish brown fine to medium quartz sand, moderately sorted, sub to round. Coarse sand and fine rounded gravel 7-8m, lignite 9-10m.	
Light grey fine to coarse sand, moderately sorted, lignite	
Light grey fine to medium sand, moderately sorted, micaceous and lignitic. Fine to coarse sand 16-17m.	
Dark olive grey silty fine sand to rounded fine gravel, poorly sorted, micaceous and lignitic. Silt increasing with depth, sandy silt 19-20m.	
Olive grey silty medium sand, well sorted, sub to round and micaceous	

Construction Details

Well Component	ID (mm)	Material	Interval (m)	Aperture (mm)	Type
Casing	79	C12 PVC	0 - 1.5	-	-
Production Zone	79	C12 PVC	1.5 - 19.5	1	Slotted casing
Sump	79	C12 PVC	19.5 - 20.5	-	-

Lithological/Construction Symbology

SWL
Slotted casing
Clay
Drillhole
Cement
Silt
Gravel pack
Natural fill
Sand
Bentonite
Limestone
Casing

Note:-
Datum: GDA 94
Wellsite Hydrogeologist: Ian Schneider (DEWNR)/Damian Newham (AWE)

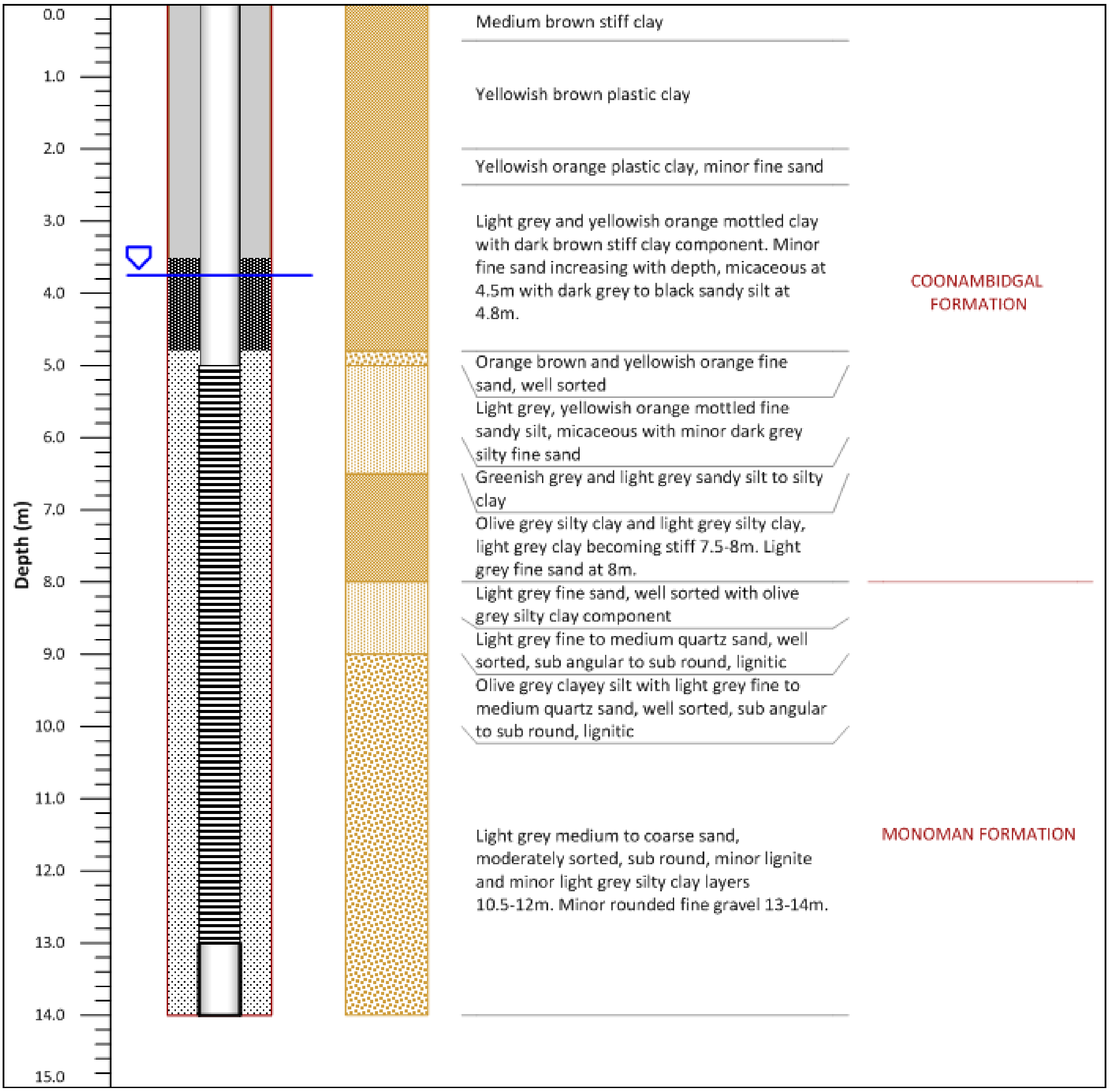
Current as at: 25-Jan-16

SARFIIP SMM Phase 2 Well Construction - Schematic Diagram

Government of South Australia
Department of Environment, Water and Natural Resources

Unit No: **7029-2866**	Name: **PMW23**	Well Type: **Observation**	Final Depth (m): **14**
Permit No: **251889**	Easting: **480351**	Northing: **6211076**	Zone: **54**

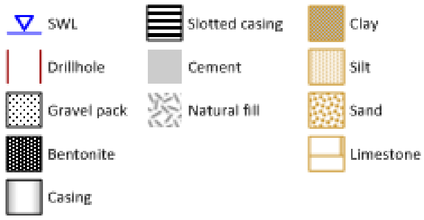
Construction Detail	Major Lithology	Lithological Description	Stratigraphic Unit



Construction Details

Well Component	ID (mm)	Material	Interval (m)	Aperture (mm)	Type
Casing	79	C12 PVC	0 - 5	-	-
Production Zone	79	C12 PVC	5 - 13	1	Slotted casing
Sump	79	C12 PVC	13 - 14	-	-

Lithological/Construction Symbology



Note:-
Datum: GDA 94
Wellsite Hydrogeologist: Ian Schneider (DEWNR)/Damian Newham (AWE)

Current as at: 25-Jan-16

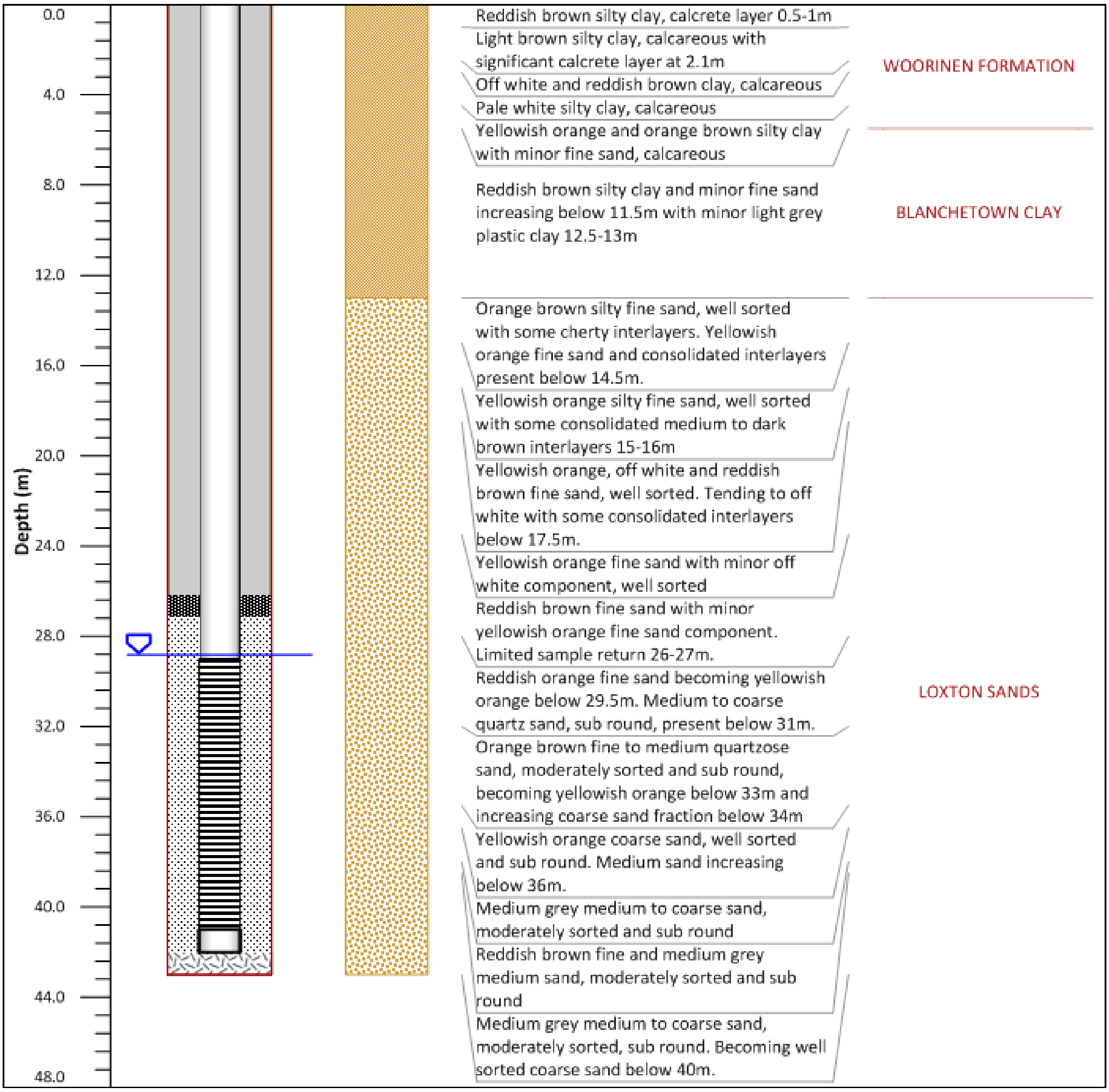
SARFIIP SMM Phase 2 Well Construction - Schematic Diagram

Unit No: **7029-2880** Name: **PMW27** Well Type: **Observation** Final Depth (m): **42**

Permit No: **252557** Easting: **482124** Northing: **6207848** Zone: **54**

Government of South Australia
Department of Environment, Water and Natural Resources

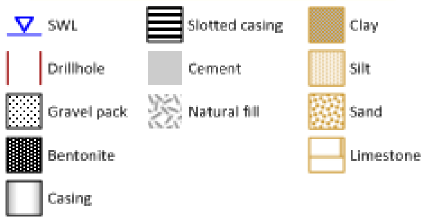
Construction Detail	Major Lithology	Lithological Description	Stratigraphic Unit



Construction Details

Well Component	ID (mm)	Material	Interval (m)	Aperture (mm)	Type
Casing	79	C12 PVC	0 - 29	-	-
Production Zone	79	C12 PVC	29 - 41	1	Slotted casing
Sump	79	C12 PVC	41 - 42	-	-

Lithological/Construction Symbology



Note:-
Datum: GDA 94
Wellsite Hydrogeologist: Ian Schneider (DEWNR)/Damian Newham (AWE)

Current as at: 25-Jan-16

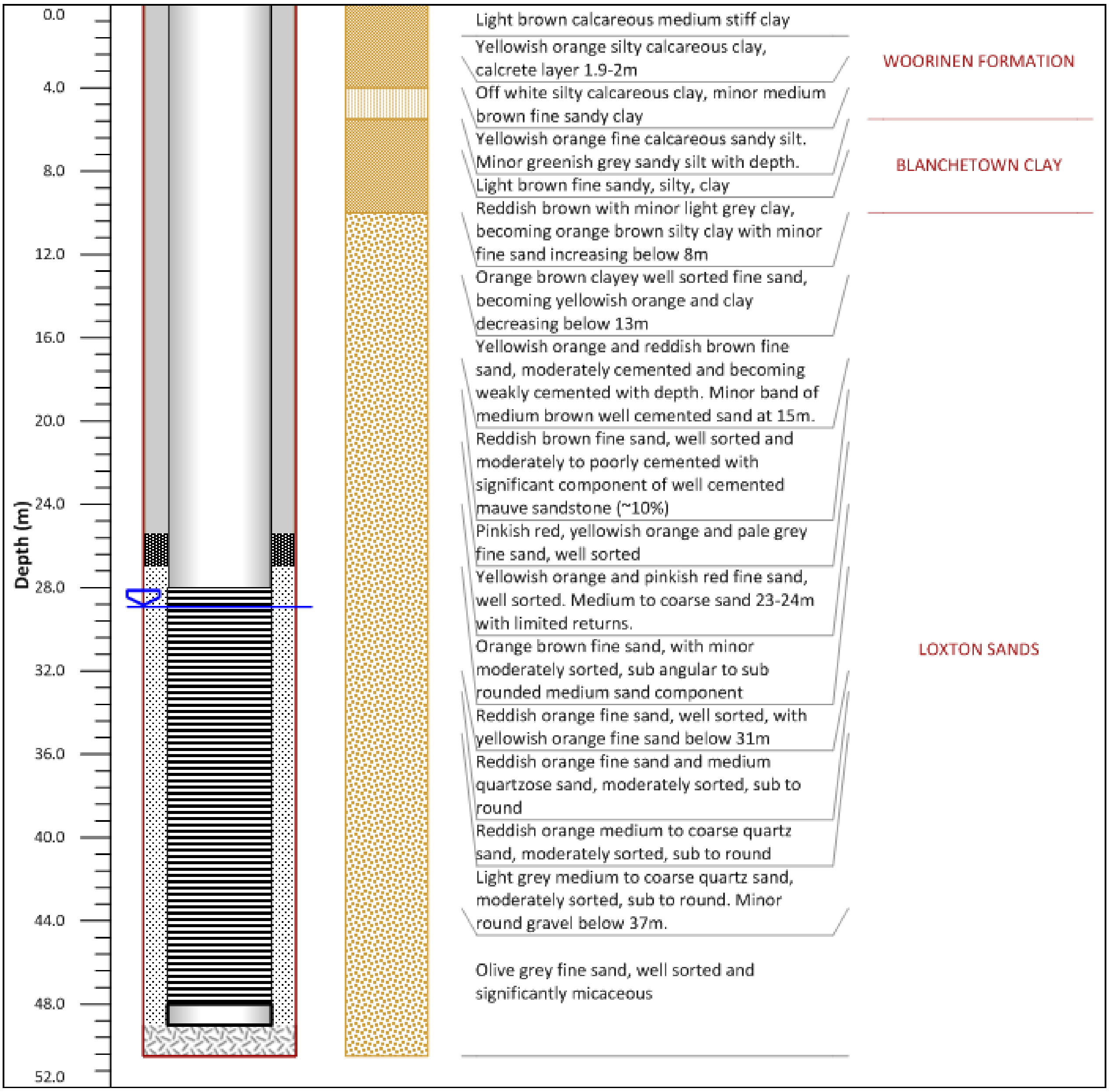
SARFIIP SMM Phase 2 Well Construction - Schematic Diagram

Government of South Australia
Department of Environment, Water and Natural Resources

Unit No: **7029-2864** Name: **PTW04** Well Type: **Production** Final Depth (m): **49**

Permit No: **252556** Easting: **482070** Northing: **6207859** Zone: **54**

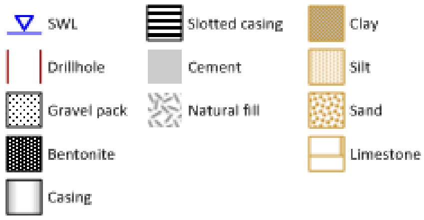
Construction Detail	Major Lithology	Lithological Description	Stratigraphic Unit



Construction Details

Well Component	ID (mm)	Material	Interval (m)	Aperture (mm)	Type
Casing	203	C12 PVC	0 - 28	-	-
Production Zone	203	C12 PVC	28 - 48	1	Slotted casing
Sump	203	C12 PVC	48 - 49	-	-

Lithological/Construction Symbology



Note:-
Datum: GDA 94
Wellsite Hydrogeologist: Ian Schneider (DEWNR)/Damian Newham (AWE)

Current as at: 25-Jan-16

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