Appendix I1

Interpretive soils report

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Santos Ltd

Narrabri Gas Project

Interpretive Soils Report

August 2016

Executive summary

The Proponent is proposing to develop natural gas from the Gunnedah Basin in New South Wales (NSW), southwest of Narrabri.

The Narrabri Gas Project (the Project) seeks to develop gas wells, gas and water gathering systems, and supporting infrastructure. The natural gas produced would be treated at a central gas processing facility on a local rural property (the Leewood property).

The Project is permissible with development consent under the State Environmental Planning Policy (Mining, Petroleum and Extractive Industries) 2007, and is identified as 'State significant development' under section 89C(2) of the Environmental Planning and Assessment (EP&A) Act and the State Environmental Planning Policy (State and Regional Development) 2011.

This report is guided by the NSW Department of Planning and Environment's Secretary's Environmental Assessment Requirements (SEARs). The SEARs require an assessment of the likely impacts of the development on the soils and land capability of the site and surrounds, including likely erosion and salinity impacts.

A desktop assessment of existing information and data provided an understanding of the initial characteristics of soils, geology, landforms and environmental landscapes of the project. A soil survey conducted at a scale of approximately 1:75 000 then provided further information to assess and classify soils and their distribution within the project area.

The dominant land use in the northern portion of the project area is grazing, with cropping being the secondary land use in favourable seasons. Land use in the southern portion of the site is associated with conservation (i.e. State Forest).

A total of 46 soil profiles were recorded and described, with 35 sites analysed by a National Association of Testing Authority (NATA) accredited laboratory. From this survey, the following six broad soil types were identified and characterised; Red brown earths, Brigalow grey clays, Red brown clays, Sandy sodic duplex, Recent alluvium and Acidic sands.

Potential impacts from the project were identified as being disturbance and erosion of topsoil from well-pad construction, and topsoil stripping and stockpiling for well-pads, flowline trenches and major facilities establishment. Potential impacts affecting soils in the project area were considered by understanding the hazards associated with each soil type.

Soil hazards identified are wind erosion, water erosion, dispersion, soil structural decline, salinity, chemical fertility and waterlogging. All soils investigated were found to be susceptible to construction work impacts, although all impacts can be mitigated through applying the appropriate guidelines and procedures for erosion and sediment control, and rehabilitation. It is emphasised that the area of direct disturbance, and therefore impact on soil, is about 1 per cent of the overall project area of approximately 95,000 hectares.

Some mitigation measures relevant to these soils and stated impact hazards are provided. Mitigation and control would be achieved through site-specific soil management plans and erosion and sediment control plans for the disturbed areas.

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1. Introduction

1.1 Overview

The Proponent is proposing to develop natural gas in the Gunnedah Basin in New South Wales (NSW), southwest of Narrabri (refer Figure 1-1).

The Narrabri Gas Project (the project) seeks to develop and operate a gas production field, requiring the installation of gas wells, gas and water gathering systems, and supporting infrastructure. The natural gas produced would be treated at a central gas processing facility on a local rural property (Leewood), approximately 25 kilometres south-west of Narrabri. The gas would then be piped via a high-pressure gas transmission pipeline to market. This pipeline would be part of a separate approvals process and is therefore not part of this development proposal.

The primary objective of the project is to commercialise natural gas to be made available to the NSW gas market and to support the energy security needs of NSW. Production of natural gas from coal seams under the project would deliver economic, environmental and social benefits to the Narrabri region and the broader NSW community. The key benefits of the project can be summarised as follows:

- Development of a new source of gas supply into NSW would lead to an improvement in energy security and independence to the State. This would give NSW gas markets greater choice when entering into gas purchase arrangements. Potential would also exist for improved competition on price. Improved competition on price would have flow on benefits for NSW's economic efficiency, productivity and prosperity.
- The provision of a reduced greenhouse gas emission fuel source for power generation in NSW as compared to traditional coal-fired power generation.
- Increased local production and regional economic development through employment and provision of services and infrastructure to the project.
- The establishment of a regional community benefit fund equivalent to five per cent of the royalty payment made to the NSW Government within the future production licence area. If matched by the NSW Government, the fund could reach $120 million over the next two decades.

1.2 Description of the project

The project would involve the construction and operation of a range of exploration and production activities and infrastructure including the continued use of some existing infrastructure. The key components of the project are presented in Table 1-1, and are shown on Figure 1-1.

Table 1-1 Key project components

Component	Infrastructure or activity
Major facilities	
Leewood	• a central gas processing facility for the compression, dehydration and treatment of gas • a central water management facility including storage and treatment of produced water and brine • optional power generation for the project • a safety flare • treated water management infrastructure to facilitate the transfer of treated water for irrigation, dust suppression, construction and drilling activities • other supporting infrastructure including storage and utility buildings, staff amenities, equipment shelters, car parking, and diesel and chemical storage • continued use of existing facilities such as the brine and produced water ponds • operation of the facility
Bibblewindi	• in-field compression facility • a safety flare • supporting infrastructure including storage and utility areas, treated water holding tank, and a communications tower • upgrades and expansion to the staff amenities and car parking • produced water, brine and construction water storage, including recommissioning of two existing ponds • continued use of existing facilities such as the 5ML water balance tank • operation of the expanded facility
Bibblewindi to Leewood infrastructure corridor	• widening of the existing corridor to allow for construction and operation of an additional buried medium pressure gas pipeline, a water pipeline, underground (up to 132 kV) power, and buried communications transmission lines
Leewood to Wilga Park underground power line	• installation and operation of an underground power line (up to 132 kV) within the existing gas pipeline corridor
Gas field	
Gas exploration, appraisal and production infrastructure	• seismic geophysical survey • installation of up to 850 new wells on a maximum of 425 well pads – new well types would include exploration, appraisal and production wells – includes well pad surface infrastructure • installation of water and gas gathering lines and supporting infrastructure • construction of new access tracks where required • water balance tanks • communications towers • conversion of existing exploration and appraisal wells to production

Component	Infrastructure or activity
Ancillary	• upgrades to intersections on the Newell Highway • expansion of worker accommodation at Westport • a treated water pipeline and diffuser from Leewood to Bohena Creek • treated water irrigation infrastructure including: – pipeline(s) from Leewood to the irrigation area(s) – treated water storage dam(s) offsite from Leewood • operation of the irrigation scheme

The project is expected to generate approximately 1,300 jobs during the construction phase and sustain around 200 jobs during the operational phase; the latter excluding an ongoing drilling workforce comprising approximately 100 jobs.

Subject to obtaining the required regulatory approvals, and a financial investment decision, construction of the project is expected to commence in early 2018, with first gas scheduled for 2019/2020. Progressive construction of the gas processing and water management facilities would take around three years and would be undertaken between approximately early/mid-2018 and early/mid-2021. The gas wells would be progressively drilled during the first 20 or so years of the project. For the purpose of impact assessment, a 25-year construction and operational period has been adopted.

1.3 Project location

The project would be located in north-western NSW, approximately 20 kilometres south-west of Narrabri, within the Narrabri local government area (LGA) (see Figure 1-1).

The project area covers about 950 square kilometres (95,000 hectares), and the project footprint would directly impact about one per cent of that area.

The project area contains a portion of the region known as 'the Pilliga', which is an agglomeration of forested area covering more than 500,000 hectares in north-western NSW around Coonabarabran, Baradine and Narrabri. Nearly half of the Pilliga is allocated to conservation, managed under the NSW *National Parks and Wildlife Act 1974*. The Pilliga has spiritual meaning and cultural significance for the Aboriginal people of the region.

Other parts of the Pilliga were dedicated as State forest, and set aside for the purpose of 'forestry, recreation and mineral extraction, with a strategic aim to "provide for exploration, mining, petroleum production and extractive industry" under the *Brigalow and Nandewar Community Conservation Area Act 2005*. The parts of the project area on state land are located within this section of the Pilliga.

The semi-arid climate of the region and general unsuitability of the soils for agriculture have combined to protect the Pilliga from widespread clearing. Commercial timber harvesting activities in the Pilliga were preceded by unsuccessful attempts in the mid-1800s to establish a wool production industry. Resource exploration has been occurring in the area since the 1960s; initially for oil, but more recently for coal and gas.

The ecology of the Pilliga has been fragmented and otherwise impacted by commercial timber harvesting and related activities over the last century through:

- the establishment of more than 5,000 kilometres of roads, tracks and trails
- the introduction of pest species
- the occurrence of drought and wildfire.

The project area avoids the Pilliga National Park, Pilliga State Conservation Area, Pilliga Nature Reserve and Brigalow Park Nature Reserve. Brigalow State Conservation Area is within the project area but would be protected by a 50 metre exclusion zone.

Agriculture is a major land use within the Narrabri LGA; about half of the LGA is used for agriculture, split between cropping and grazing. Although the majority of the project area would be within State forests, much of the remaining area is situated on agricultural land that supports dry-land cropping and livestock. No agricultural land in the project area is mapped by the NSW Government to be biophysical strategic agricultural land (BSAL) and detailed soil analysis has established the absence of BSAL. This has been confirmed by the issuance of a BSAL Certificate for the project area by the NSW Government.

1.4 Planning framework

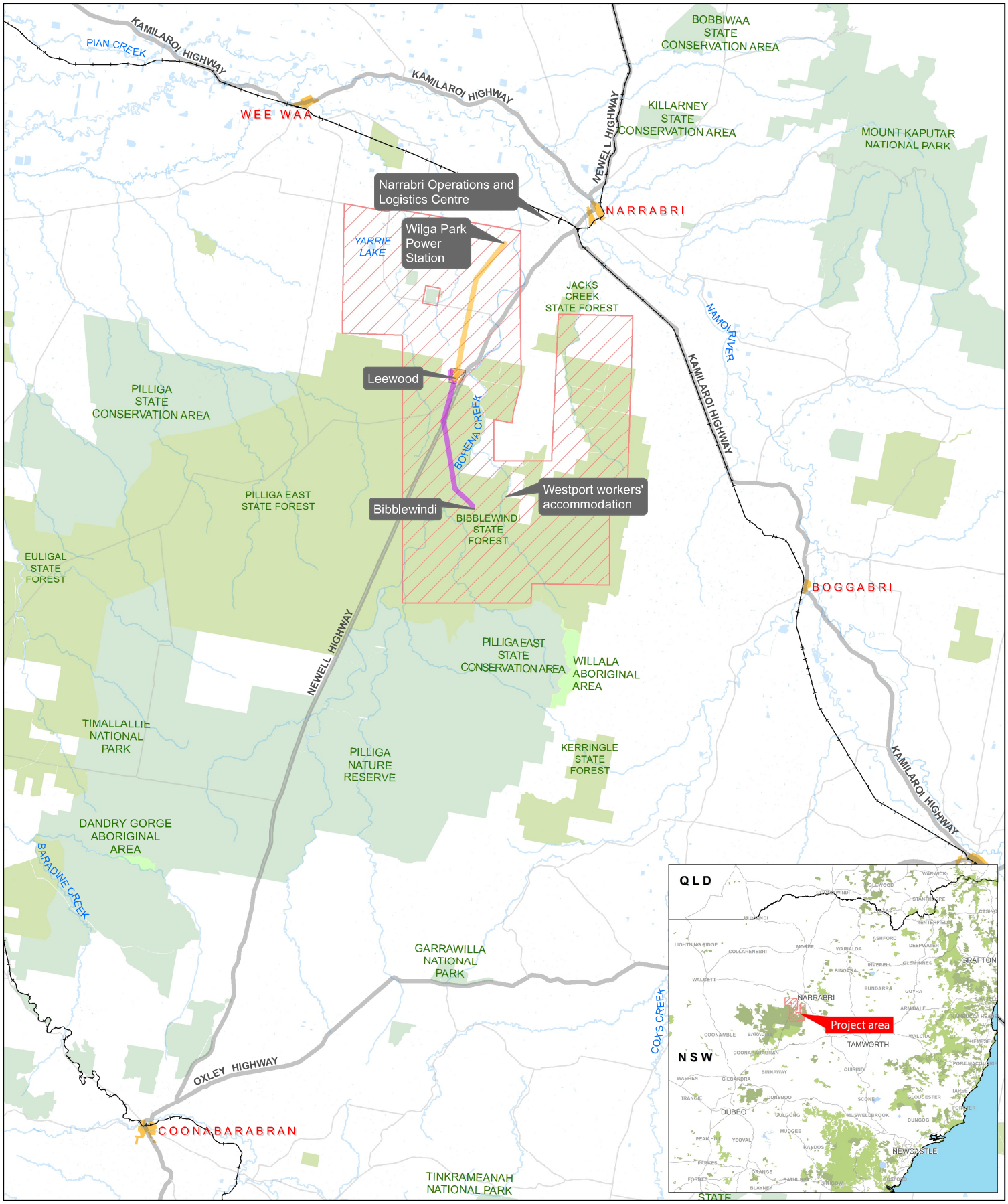
The project is permissible with development consent under the *State Environmental Planning Policy (Mining, Petroleum and Extractive Industries) 2007*, and is identified as 'State significant development' under section 89C(2) of the *Environmental Planning and Assessment Act 1979* (EP&A Act) and the *State Environmental Planning Policy (State and Regional Development) 2011*.

The project is subject to the assessment and approval provisions of Division 4.1 of Part 4 of the EP&A Act. The Minister for Planning is the consent authority, who is able to delegate the consent authority function to the Planning Assessment Commission, the Secretary of the Department of Planning and Environment or to any other public authority.

The project is also a controlled action under the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999*. The project was declared to be a controlled action on 5 December 2014, to be assessed under the bilateral agreement between the Commonwealth and NSW Governments, and triggering the following controlling provisions:

- listed threatened species and ecological communities
- a water resource, in relation to coal seam gas development and large coal mining development
- Commonwealth land.

This report is guided by the NSW Department of Planning and Environment Secretary's Environmental Assessment Requirements (SEARs). The SEARs require an assessment of the likely impacts of the development on the soils and land capability of the site and surrounds, including likely erosion and salinity impacts.



LEGEND

- Project area
- Leewood
- Urban
- State forest
- Parks and reserves
- Aboriginal areas
- Lakes and dams
- Watercourses
- Highways
- Major Roads
- Train line
- Leewood to Wilga Park infrastructure corridor
- Bibblewindi to Leewood infrastructure corridor

0 5 10 20
Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Narrabri Gas Project
EIS Technical Appendix Landscape and Visual Impact

Job Number 21-22463
Revision A
Date 12 Mar 2015

Regional context and location of key infrastructure

Figure 1-1

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1.5 Purpose of this report

This report has been prepared for Santos New South Wales (Eastern) Pty Ltd (Santos) by GHD Pty Ltd (GHD). This report aims to identify soil characteristics and soil type distribution relevant to the Narrabri Gas Project (the project). The project covers an area of agricultural land and State forest in the Pilliga, south east of Narrabri (the 'project area') (see Figure 1-1).

The information obtained from this report will be used to inform the Agricultural Impact Statement. Therefore, the detailed soil assessment in this report is on the land in the project area that is already under agricultural use or has been cleared, or partially cleared, for productive use and is under private property tenure. The area covered by the survey and assessment is henceforth known as the 'investigation area'.

The information in this report will also aid input into required environmental approvals and soil and environmental management plan development. This information will therefore help provide the basis to identify soil suitability for rehabilitation, provided prescriptive measures with regards to soil handling, management and the identification and management of problematical soils for the project.

1.6 Previous soil assessments

Previous soil investigations that have been undertaken within the project area are:

- Sampling recorded in the NSW Soil and Land Information System (SALIS, 2014).
- Soils Assessment for Narrabri Coal Seam Gas Utilisation Project (for Eastern Star Gas) (Geoff Cunningham Natural Resource Consultants, 2008).
- Soil Landscapes of the Baan Baa 1:100,000 Sheet, Liverpool Plains portion. (Pengelly, 2010).
- Leewood and Albion Park properties soil survey (BeneTerra, 2014).
- RPS soil sampling for Biophysical Strategic Agricultural Land risk assessment. (RPS, 2013).

The information from these previous soil surveys has been used in the initial desktop assessment of the project area to establish a base map for the soil survey. The data for the Leewood and Albion Park properties was intensive and comprehensive enough to allow those areas to be covered by boundary-check sites and soil type confirmation sites only for the field assessment.

1.7 Guidelines and reference documents

This interpretive soil assessment was undertaken with reference to the following guidelines:

- Australian Soil and Land Survey: Guidelines for Survey Soil and Land Resources (McKenzie *et al*, 2008)
- Australian Soil Classification (Isbell, 2002)
- Australian Soil Survey and Land Survey Field Handbook (National Committee on Soil and Terrain (NCST), 2009)
- Interpreting Soil Test Results – What Do All The Numbers Mean? (Hazelton and Murphy, 2007)
- Australian Soil and Land Survey: Guidelines for conducting surveys (Gunn *et al*., 1998)

- Guideline for Land Suitability Assessment Techniques (DME, 1995)
- Guidelines for Surveying Soil and Land Resources (McKenzie *et al*., 2008)
- Agricultural Impact Statement Guideline (NSW Department of Primary Industries, November 2012)
- Agricultural Impact Statement Technical Notes (NSW Department of Primary Industries, April 2003).

1.8 Scope of works and limitations

The scope of works is to provide an assessment of the distribution of soil types in the project area for the purposes of defining potential impacts to the soil resource of the project in accordance with the NSW AIS Guideline. This includes possible impacts to land capability.

A soil survey was undertaken across the project area in privately held land that has been cleared, or partially cleared for productive land use. The purpose was to characterise soil types sufficiently by their morphological and chemical characteristics, and define the extent of the soil types that may be impacted within the project area. The survey data is also to inform the study to identify suitable land for irrigation in the greater vicinity of the Leewood proposed water processing facility, undertaken by BeneTerra, and the surface hydrology studies as part of the EIS.

2. Methodology

2.1 Desktop assessment

A desktop assessment of the project area used existing publicly available and client-supplied resources to provide initial characterisation of soil and land within the project area. The desktop assessment assisted in identifying locations where field investigations were to focus.

Preliminary data collected and reviewed for the desktop assessment included geology maps and reports, NSW soils and land reports, Namoi Catchment Management Authority (CMA) reports, and site-specific information collected to date for the project (for example, geotechnical information).

A terrain analysis was undertaken to assist in the improved delineation and classification of soil types and map units within the project area. The terrain analysis considered slope gradient, topography, and landform using a digital elevation model (DEM) and remote sensing data. Remote sensing data included aerial photography supplied by Santos, Google Earth Pro imagery, Landsat imagery, 'radiometrics' (or airborne gamma-ray spectrometry data (AGS)) and geomagnetics. LiDAR data supplied by Santos was also used for the DEM analysis.

The use of AGS and geophysical data analysis assisted in the accuracy of soil landscape modelling and to produce preliminary soil mapping units (PSMUs) in the investigation area. PSMUs were created to identify tracts of land that are expected to share similar soil attributes (related to geology, vegetation, and landform patterns, and geomorphological processes).

A brief overview of specific data sources used to inform this study is provided below.

Topography

A description of the topography over the project area was extracted from Namoi CMA (2009). The topography and patterns of landforms are derived from DEM analysis of the region and LiDAR imagery, as well as LiDAR-derived topography processed at 1 metre contour intervals across the project area.

Surrounding land use

Surrounding land use was compiled from data produced by the Office of Environment and Heritage (2012) and Namoi CMA (2009) including broad-scale mapping of soil fertility and land capability rating.

Geology data sources

The local geology resource mapping completed for the area is described by the NSW Department of Mines (Wallis 1968), 1:250,000 Geological Series Sheet for Narrabri (Sheet SH/55-12) and the accompanying explanatory notes compiled by Brown *et al.* (1992).

Surface geology resource mapping was done by Geoscience Australia (Raymond *et al*. 2012a).

2.2 Field work

2.2.1 Objectives of field assessments

The field work component sought to identify soil types occurring within the investigation area. Chemical analysis was completed to identify soil properties that may require consideration during the construction and operational phases of the project and to provide adequate data to evaluate land capability. The results of this investigation can be applied in the development of appropriate

management strategies for implementation during the proposed construction and operational phases. The results also serve to evaluate the land for irrigation suitability and land capability in general.

2.2.2 Ground observation types and proportions

Site investigations included soil coring to facilitate morphological descriptions of the soil, in addition to mapping observations to assist in determining the likely extent of soil types observed. Soil core locations were identified prior to commencing field work via a site recognisance field trip and PSMUs. A detailed understanding of the soil types and limitations was able to be established based on the collected information.

2.2.3 Data collection

Data collected from ground observation locations was in accordance with the *Australian Soil Survey and Land Survey Field Handbook* (The National Committee on Soil and Terrain, 2009). At all locations this data included; but was not limited to:

- coordinates showing the geographical location of the soil core
- a description of land use management practices
- landscape attributes (landform, vegetation, land degradation, erosion, scalds; etc.)
- extent of micro-relief
- full morphological description or correlation to existing mapping locations within the survey.

2.2.4 Soil profile morphology descriptions

Full soil profile morphology descriptions (at 25-40% of the locations) were completed in general accordance with the National Standard (The National Committee on Soil and Terrain, 2009). The minimum data set included information on:

- horizon depths
- horizon designation
- boundary distinctness
- field texture
- colour
- mottles
- coarse fragments
- structure
- segregations
- field tests (e.g. pH).

2.2.5 Laboratory analysis

Laboratory analysis was undertaken by laboratories accredited by the National Association of Testing Authorities (NATA) or the Australian Soil and Plant Analysis Council (ASPAC). The analytical suite is included below:

- dispersion (Emerson Dispersion test)
- soil texture
- particle size analysis (measured, not estimated with a soil texture assessment) of particles less than 2 mm
- gravel content
- organic carbon
- pH (in 0.01 M $CaCl_2$)
- total and available nitrogen
- available phosphorus
- phosphorus buffering index
- exchangeable potassium
- exchangeable cations, cation exchange capacity (CEC), and exchangeable sodium percent (ESP)
  - if pH ≥7.0: the 15C1 (Rayment and Lyons, 2011) alcoholic cations method for exchangeable cations were used.
  - if pH <7.0: the 15A1 or 15D1 (Rayment and Lyons, 2011) aqueous cations method or non-aqueous cation method for exchangeable cations, were used, and the sodium value adjusted for soluble sodium.
  - if pH < 5.5: (i.e. strongly acid soils): effective cation exchange capacity (ECEC) were determined. This is the sum of exchangeable cations plus exchange acidity (Al^{3+} + H^{+}).
- exchangeable sodium, exchangeable calcium, exchangeable potassium, exchangeable magnesium, exchangeable aluminium
- soluble cations
- electrical conductivity (ECe). If significant, identify total soluble salts, salt type
- presence of carbonates and gypsum.

2.2.6 Sample collection protocol

Sample collection was undertaken at pre-determined depth intervals, modified to avoid soil layers identified within the profile. Samples were collected to a maximum depth of 1.2 m, to the C horizon, or to the depth of refusal; whichever was encountered first. A maximum sampling interval of 0.1 m in the upper 0.3 m of the profile, and a maximum interval of 0.3 m between 0.3 m and 1.5 m were adopted (McKenzie, *et al.,* 2008).

In collecting samples from the soil profile, the following practices were adopted:

- samples did not span significant layer boundaries
- samples were not bulked between locations, except for surface samples
- samples were from a detailed soil profile description location
- 500 - 1000g samples were placed into zip-locked plastic bags for chemical analysis.

Samples were labelled, then stored and transported in cooler boxes with ice-packs to GHD offices in Brisbane before sending on with chain-of-custody documentation to ALS laboratory, Brisbane for analysis.

2.3 Soil classification

Soils were classified according to *The Australian Soil Classification* (Isbell, 2002) into Soil Orders, Suborders, Great Groups and Subgroups.

Soil and landscape descriptions were recorded with reference to the Australian Soil and Land Survey Field Handbook (NCST, 2009) and the New South Wales Soil and Land Information System (Milford *et al.*, 2001).

2.4 Laboratory data assessment criteria

Laboratory data was interpreted using the following resources:

- Interpreting soil test results (Hazelton and Murphy, 2007)
- Salinity Management Handbook (Department of Natural Resources, 1997)
- Interpreting soil analysis – for agricultural land use in Queensland (Baker and Eldershaw, 1993).

Laboratory supplied assessment criteria was also used to provide indications of soil limitations.

3. Desktop review

3.1 Topography and landform

Topography of the region ranges from low tablelands to long, low slopes and level to gently sloping plains, each of which are distinguished by patterns of soils, drainage, native vegetation, land use and settlement (Namoi CMA 2009). The topography and patterns of landforms are shown in Figure 3-1 as derived from DEM analysis of the region encompassing the project area.

3.2 Geology

Two separate geology maps were reviewed in association with the project area. The local geology is described by the NSW Department of Mines (Wallis 1968), 1:250,000 Geological Series Sheet for Narrabri (Sheet SH/55-12) and the accompanying explanatory notes compiled by Brown *et al.* (1992). Surface geology has been mapped by Geoscience Australia (Raymond *et al.* 2012a).

Mapping of local geology (Wallis 1968; Brown *et al*. 1992) in the northern portion of the project area comprises entirely Quaternary-aged sediment (map symbol Qd), which has been deposited by fluvial activity. This material is largely composed of alluvial sand, with a smaller composition of silty sand. Clay, laterite, calcrete, and magnesite deposits are frequently observed in the material. Quaternary sediments are common in the regional context of the project area characterised by expansive floodplains.

Local geology (Wallis 1968; Brown *et al*. 1992) of the southern portion of the project area is composed not only of Quaternary-aged sediments, but also Jurassic-aged quartz, pebbly sandstone, claystone, and minor conglomerate referred to as the Pilliga Sandstone (Jps). This Pilliga Sandstone originated mostly from fluvial deposition by braided streams, and can occur to depths of 300 metres. Within the project area where associations exist between the Pilliga Sandstone and Quaternary-aged sediments, the former material is largely obscured by the latter clays, sands and sandy talus material.

Surface geology of the project area is summarised in Table 3-1 and Figure 3-2. Raymond *et al*. (2012b) mapped the project area as national coverage of “outcropping bedrock and unconsolidated or poorly consolidated regolith material covering bedrock”. The dataset is based on mapping undertaken at a 1:250,000 scale. Where this data was not available, 1:1,000,000 scale mapping was used.

Table 3-1 Mapped surface geology within the project area (Geosciences Australia 2011)

Map Symbol	Unit	Age	Lithology	Lithology type	Lithology description
Czs	Sand plains 38499	Cainozoic	Regolith	sand, unknown origin	Sand plain, may include some residual alluvium; sand dominant, gravel, clay
Qa	Alluvium 38485	Quaternary	Regolith	alluvial sediment	Channel and flood plain alluvium; gravel, sand, silt, clay

Map Symbol	Unit	Age	Lithology	Lithology type	Lithology description
Qrc	Colluvium 38491	Quaternary	Regolith	sand, unknown origin, gravel, unknown origin	Colluvium and/or residual deposits, talus, scree, sheet wash; boulder, gravel, sand; may include minor alluvial or sand plain deposits
Jkse	Keelindi beds	Upper Jurassic	sedimentary siliciclastic	sandstone	Off-white, fine to coarse grained, poorly to well sorted, quartzose sandstone, pebbly sandstone and conglomerate interbedded with minor shale, siltstone and coal. Cross-bedded, kaolinitic and iron stained. Rare silicified wood,
Jsip	Pilliga Sandstone	Upper Jurassic	quartz-rich arenite to rudite	sandstone	Medium to very coarse grained, well sorted, angular to subangular quartzose sandstone and conglomerate. Minor interbeds of mudstone, siltstone and fine grained sandstone and coal. Common carbonaceous fragments and iron staining. Rare lithic fragments

3.3 Surrounding land use

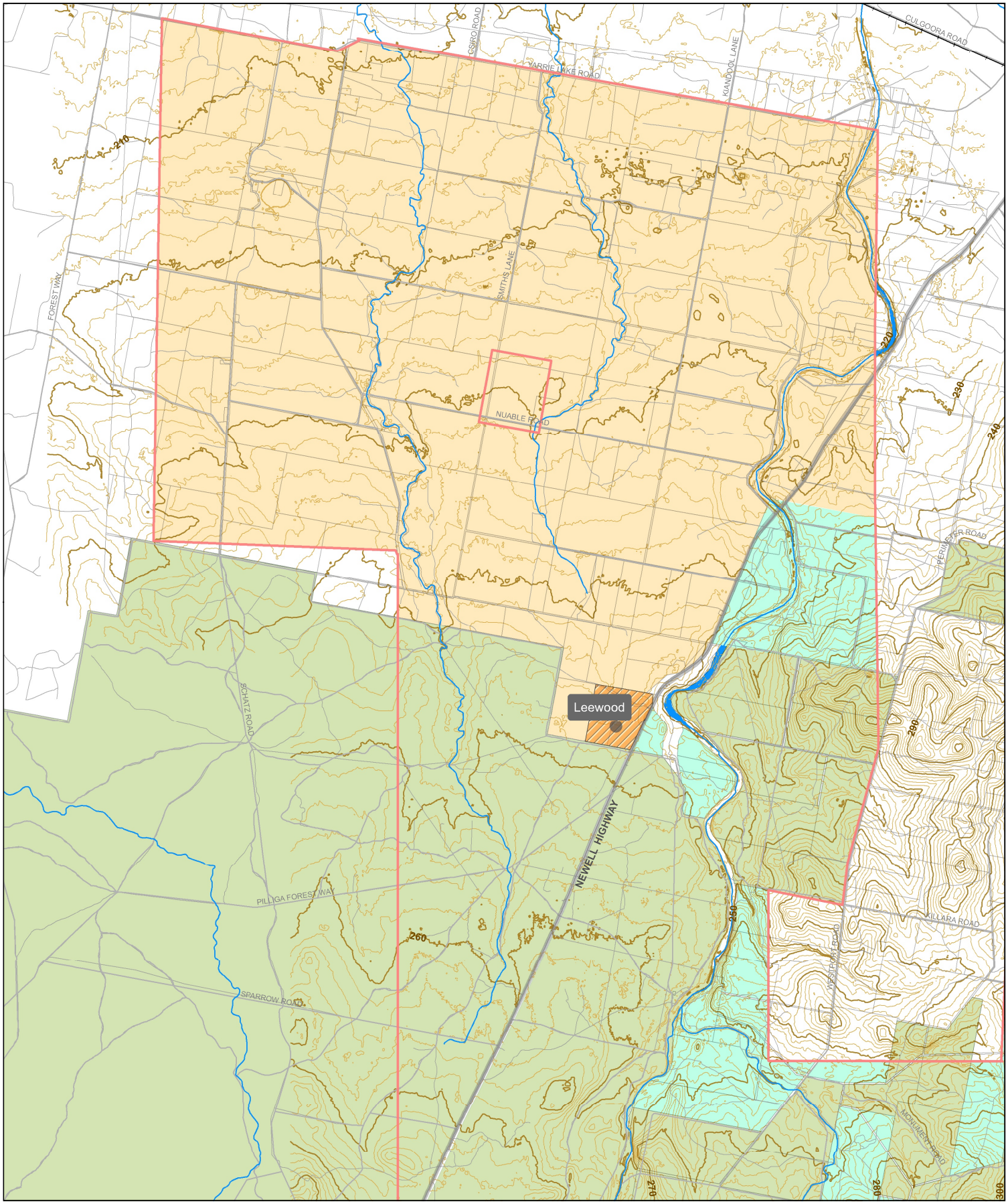
The project area is situated in the Narrabri Shire Local Government Area (LGA) (Namoi CMA 2009) and is also covered by the Namoi Catchment Management Authority. Figure 3-3 depicts the land and soil capability of the project area. Figure 3-4 depicts soil fertility in the project area. The region is dominated by the agriculture (broadacre cropping, cotton and intensive irrigated copping and pastoral industries) sheep and beef cattle grazing industries. Historically, coal mining, quarrying, and forestry have been significant industries in the area.

Land use mapping by the OEH (2012) covers the region within and surrounding the project area at a scale of 1:100,000. The primary land use within the northern portion of the project area has been mapped as grazing, with cropping being the secondary land use. Minor areas have been allocated as conservation, urban and tree / shrub cover (OEH 2012).

Land use in the majority of the southern portion of the project area is associated with forestry (including Jacks Creek, Bibblewindi and Pilliga State Forests); with comparatively minor areas of urban and tree/shrub cover (OEH 2012).

3.4 Acid sulfate soils

Commensurate with the low risk of encountering potential, or actual, acid sulfate soils in the project area, official NSW Government mapping is limited to the NSW coastal fringe; which contain environments higher in risk of encountering these soil types. Confirmation of this low risk was verified via the Atlas of Australian Acid Sulfate Soils (CSIRO 2011), with the possible exception of relatively small area beneath Yarrie Lake which was mapped as having high probability. The project area excludes Yarrie Lake, including a 200 metre buffer zone.



LEGEND

- Project area
- Leewood
- Bibblewindi
- State forest
- Lakes and dams
- Watercourses
- Roads
- 10 m contour
- 2 m contour
- Forested properties
- Non-forested properties

Slope gradient (% slope)

- < 5%
- 5 - 10%
- > 10%

0 1 2 4
Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Narrabri Gas Project
EIS Technical Appendix Soils Assessment

Job Number	21-22463
Revision	A
Date	12 Mar 2015

Topography and slope in the project area

Figure 3-1

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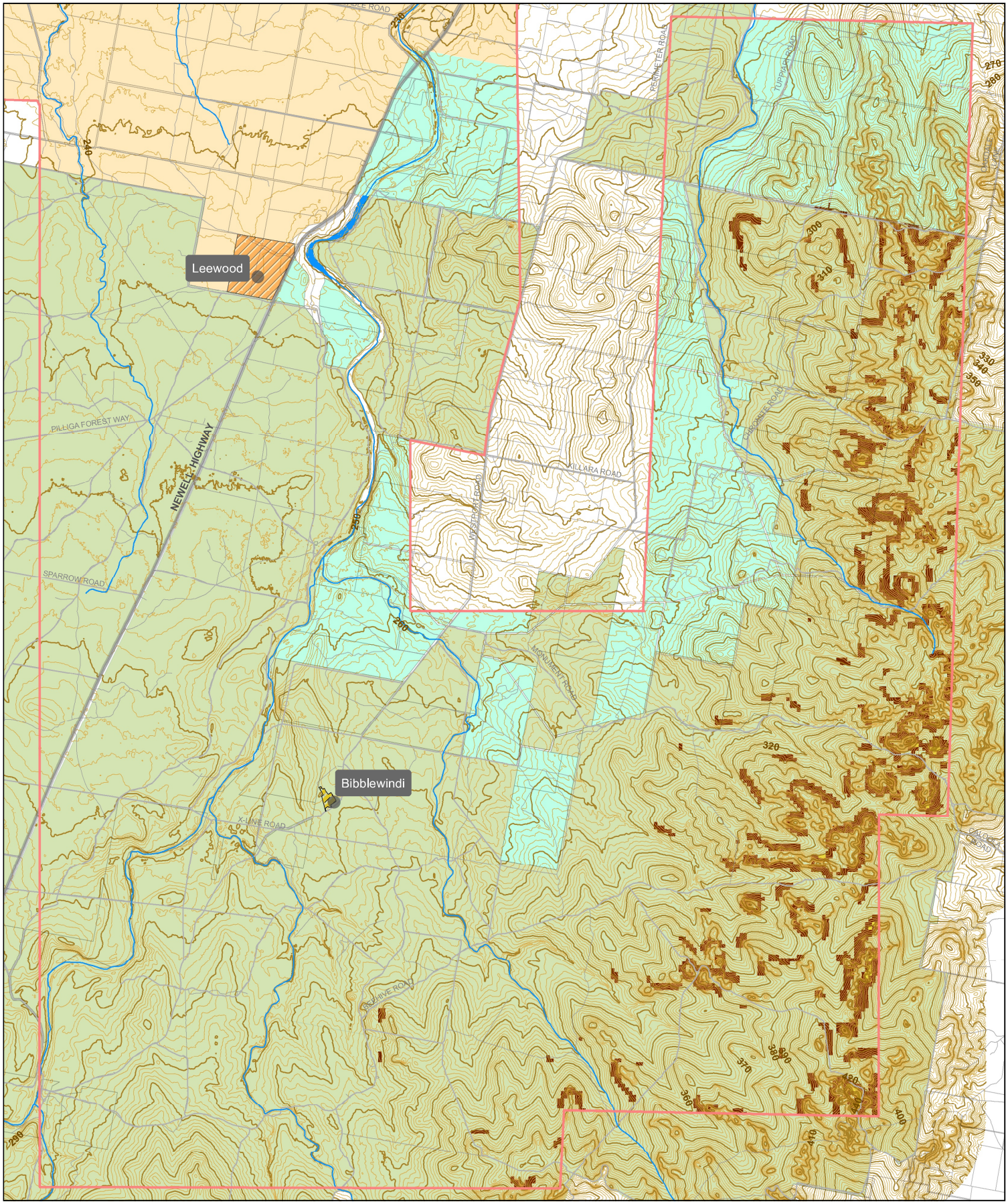
Level 15, 133 Castlereagh Street Sydney NSW 2000 **T** 61 2 9239 7100 **F** 61 2 9239 7199 **E** sydmail@ghd.com.au **W** www.ghd.com.au



LEGEND

- Project area
- Leewood
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- State forest
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Slope gradient (% slope)

- < 5%
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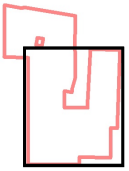
- > 10%



0 1 2 4
Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

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GHD

Narrabri Gas Project
EIS Technical Appendix Soils Assessment

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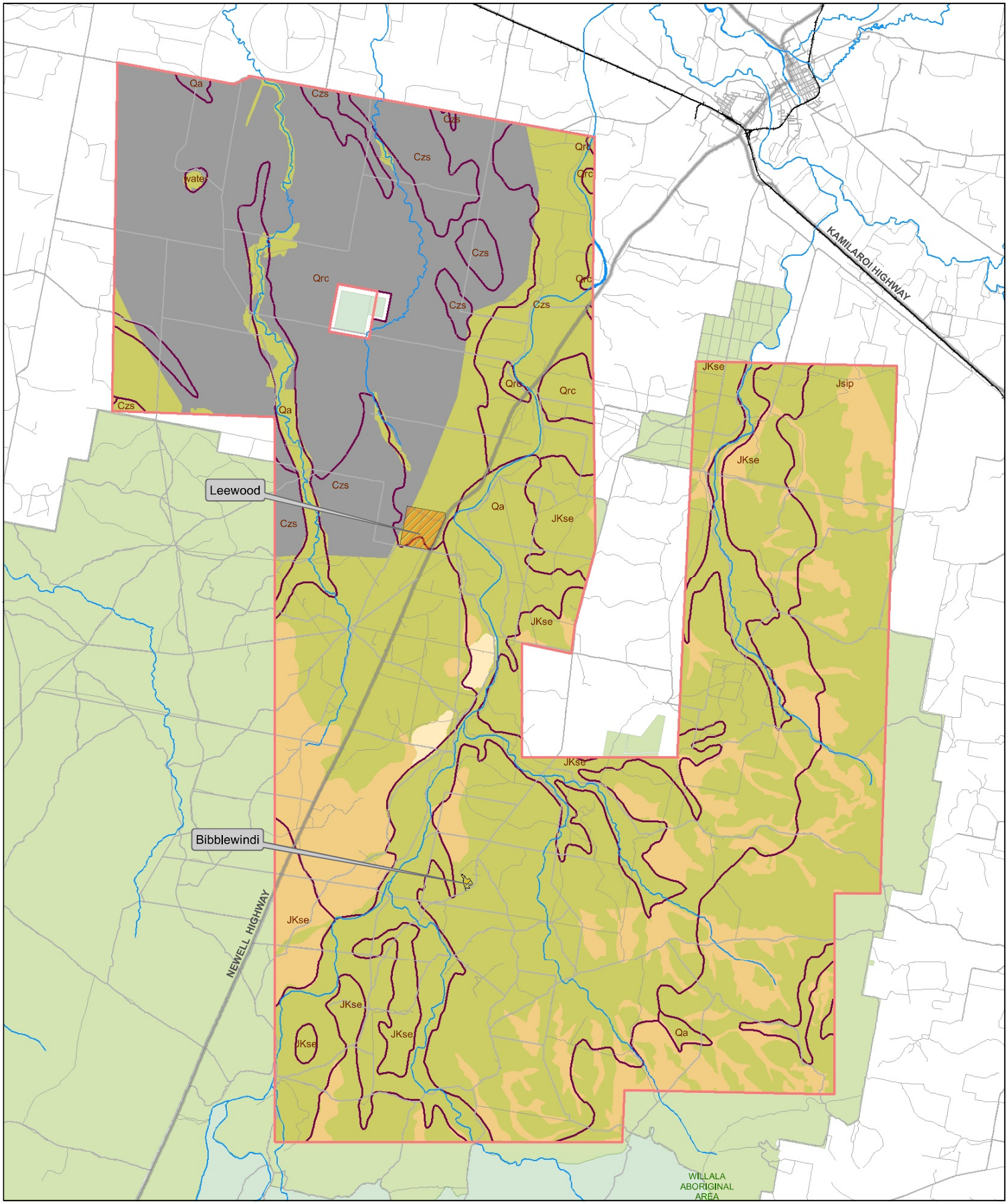
Topography and slope in the project area

Figure 3-1

G:\21\22463\GIS\Maps\21_22463_Z074.mxd

Level 15, 133 Castlereagh Street Sydney NSW 2000 **T** 61 2 9239 7100 **F** 61 2 9239 7199 **E** sydmail@ghd.com.au **W** www.ghd.com.au



LEGEND

- Project area
- Leewood
- Bibblewindi
- Parks and reserves
- State forest
- Aboriginal areas
- Lakes and dams
- Watercourses
- Roads
- Geology boundary (DPI NSW 2012)

Australian Soil Classification (ASC) - Order (OEH, 2012)

- Rudosols
- Rudosols and Tenosols
- Sodosols
- Vertosols

Geology

- Czs, Cainozoic, sand plain
- JKse, Mesozoic, Keelindi beds
- Jsip, Mesozoic, Pilliga Sandstone
- Qa, Quaternary, alluvium
- Qrc, Quaternary, colluvium

0 2 4 8
Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

GHD

Narrabri Gas Project
EIS Technical Appendix Soils Assessment

Job Number 21-22463
Revision A
Date 25 Jul 2016

Geology and soil classifications in the project area

Figure 3-2

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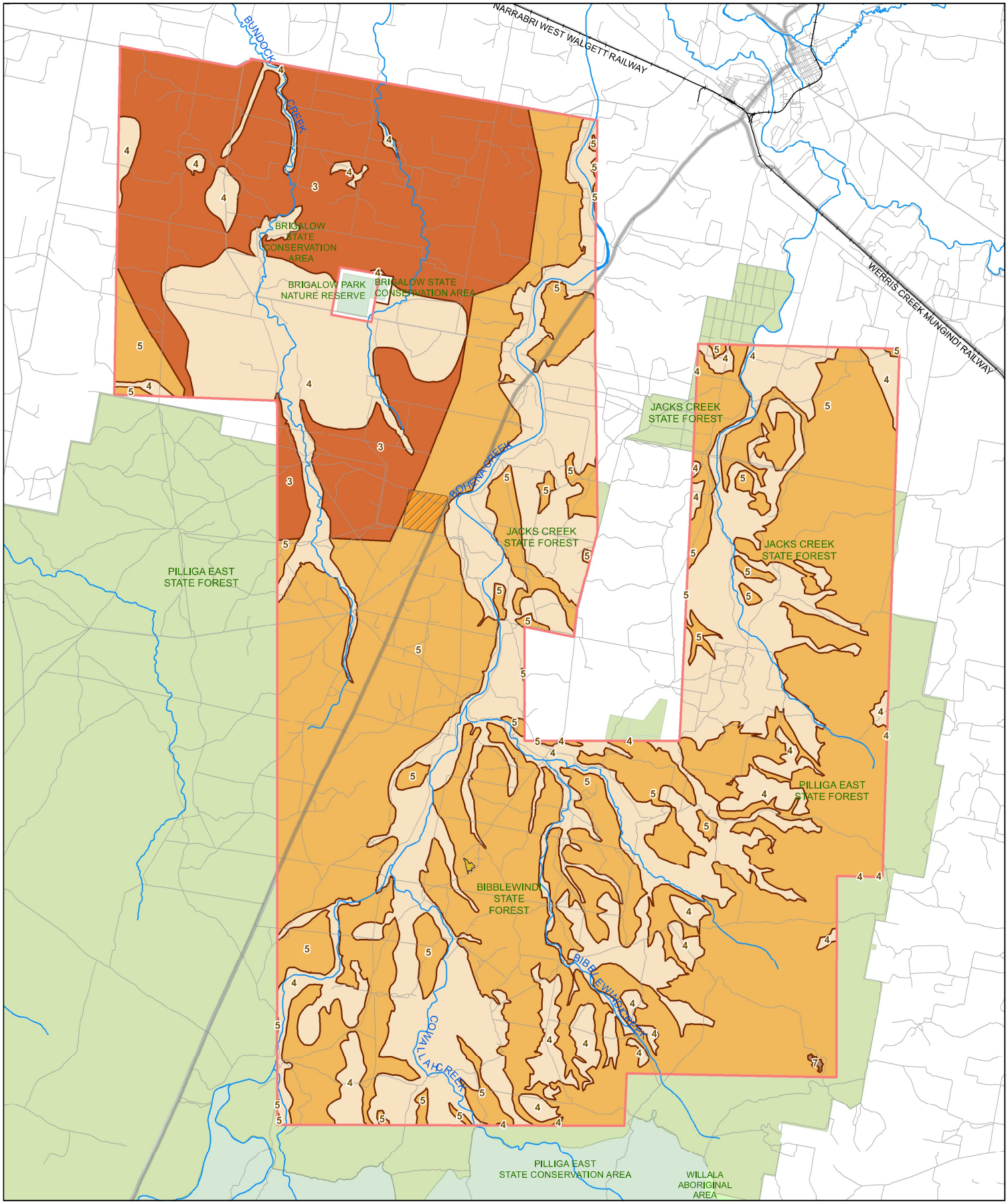
Level 15, 133 Castlereagh Street Sydney NSW 2000 T 61 2 9239 7100 F 61 2 9239 7199 E sydmail@ghd.com.au W www.ghd.com.au



LEGEND

- Project area
- Leewood
- Bibblewindi
- Parks and reserves
- State forest
- Aboriginal areas
- Lakes and dams
- Watercourses
- Roads
- Train line

Land and soil capability (LSC) classes

- 3
- 4
- 5
- 7

0 1.75 3.5 7

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

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Land and soil capability in the project area

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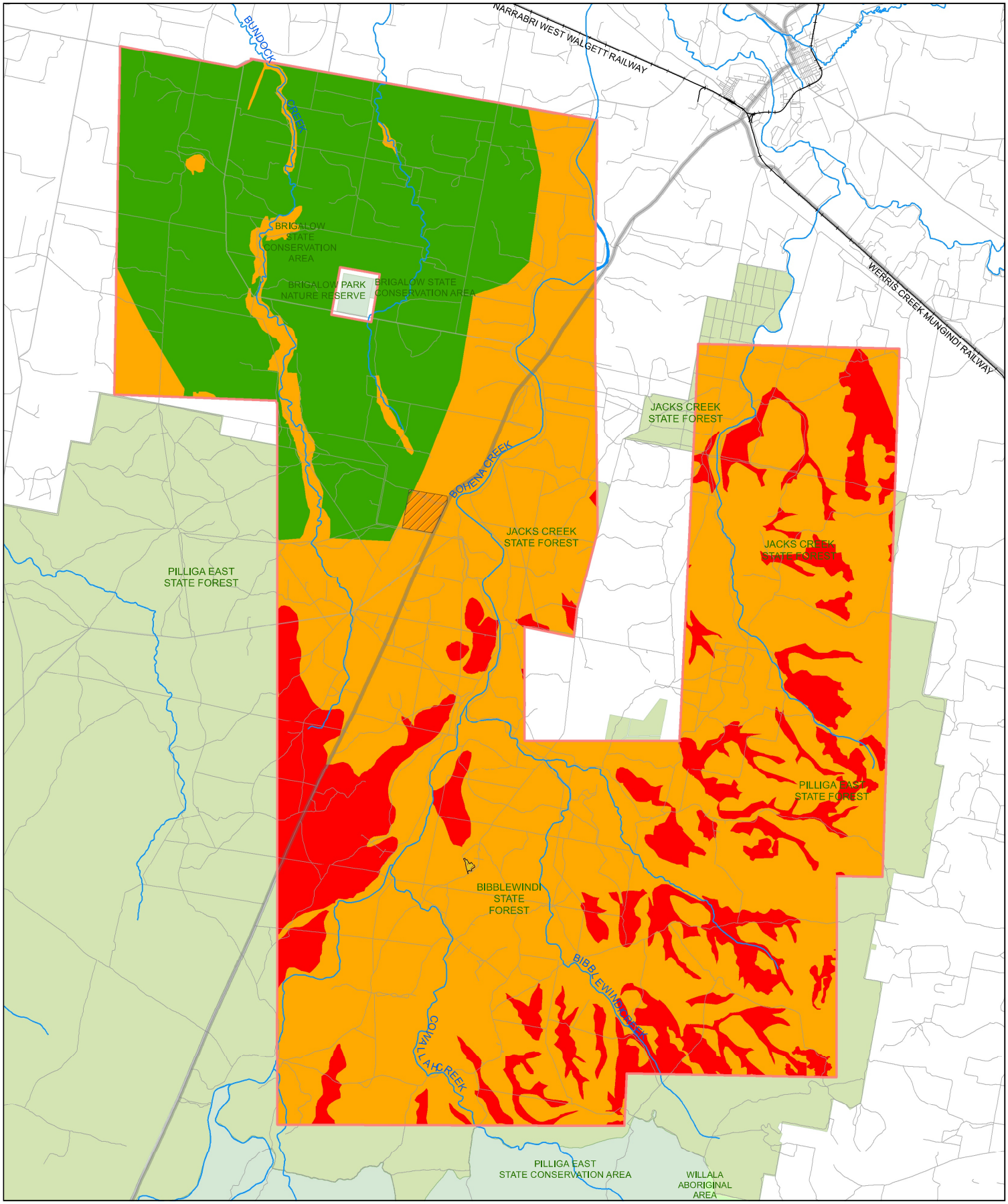
Figure 3-3

N:\AU\Sydney\Projects\21\22463\GIS\Maps\21_22463_KBM29_.mxd [KBM: 149]

Data source: NSW Department of Lands: DTDB and DCDB - 2012-13. Santos: Operational and Base Data - 2013. Created by: jrichardson

Level 15, 133 Castlereagh Street Sydney NSW 2000 T 61 2 9239 7100 F 61 2 9239 7199 E sydmail@ghd.com.au W www.ghd.com.au



LEGEND

- Project area
- Leewood
- Bibblewindi
- Parks and reserves
- State forest
- Aboriginal areas
- Lakes and dams
- Watercourses
- Roads
- Train line

Surface Fertility (OEH 2012)

- Low
- Moderately low
- Moderate

0 1.75 3.5 7
Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Narrabri Gas Project
EIS Technical Appendix Soils Assessment

Soil fertility in the project area

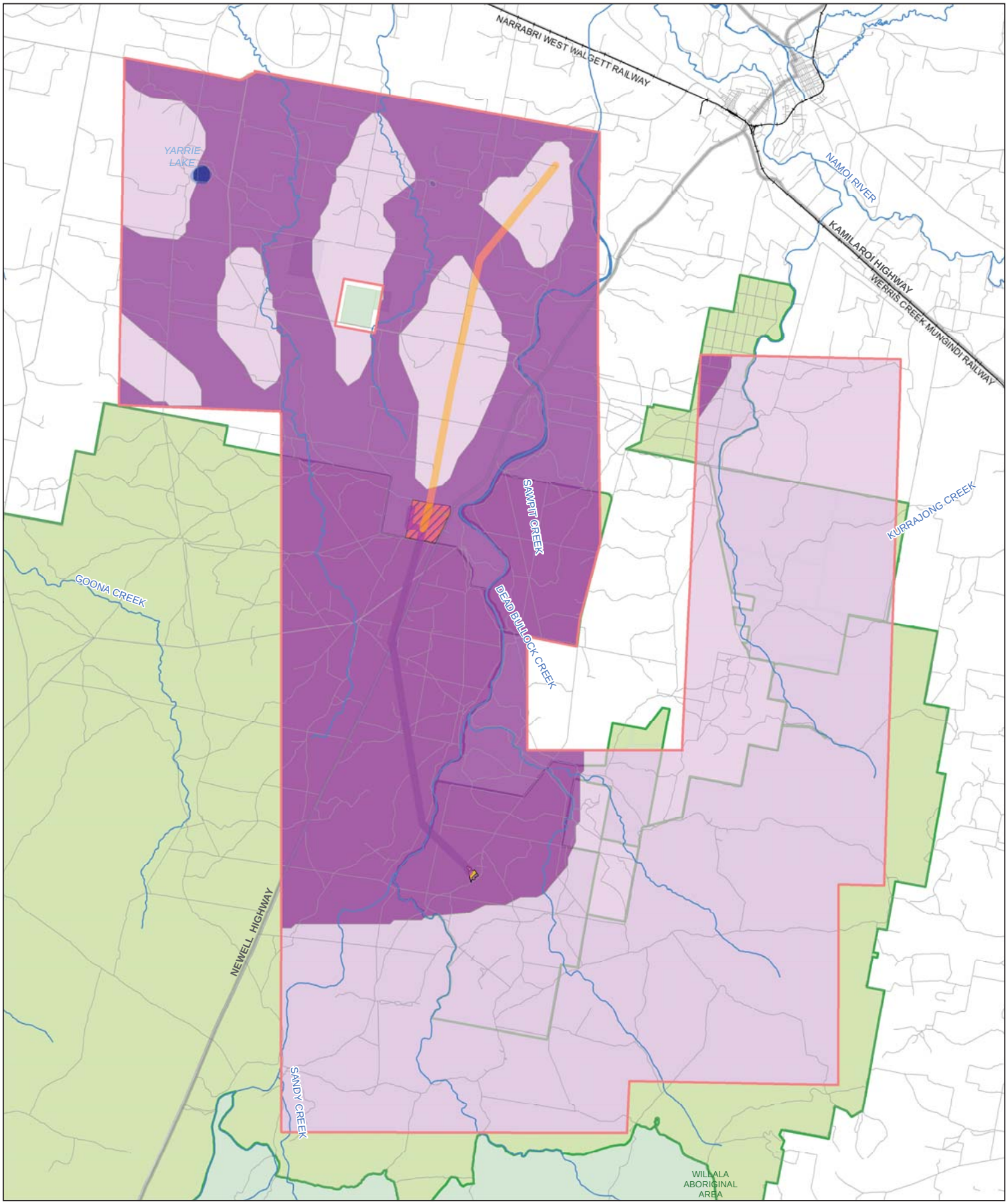
Job Number 21-22463
Revision A
Date 25 Jul 2016

Figure 3-4

N:\AU\Sydney\Projects\21\22463\GIS\Maps\21_22463_KBM29_.mxd [KBM: 150]

Data source: NSW Department of Lands: DTDB and DCDB - 2012-13. Santos: Operational and Base Data - 2013. Created by: jrichardson

Level 15, 133 Castlereagh Street Sydney NSW 2000 T 61 2 9239 7100 F 61 2 9239 7199 E sydmail@ghd.com.au W www.ghd.com.au



LEGEND

- Project area
- Leewood
- Bibblewindi
- Parks and reserves
- State forest
- Aboriginal areas
- Lakes and dams
- Watercourses
- Roads
- Train line
- Leewood to Wilga Park infrastructure corridor
- Bibblewindi to Leewood infrastructure corridor

Acid sulfate soil risk

- High probability (very low confidence)
- Low probability (very low confidence)
- Extremely low probability (very low confidence)

0 1.75 3.5 7

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Narrabri Gas Project
EIS Technical Appendix Soils Assessment

Job Number 21-22463
Revision A
Date 12 Aug 2016

Acid sulfate soil risk

Figure 3-5

G:\21\22463\GIS\Maps\21_22463_Z153.mxd

Data source: NSW Department of Lands: DTDB and DCDB - 2012-13. Santos: Operational and Base Data Created by:afoddy

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4. Soil survey results

4.1 Site investigation works

The soil survey was undertaken between 2 and 10 June 2014. Intrusive observations were achieved by soil coring, using a trailer-mounted pneumatic soil corer towed behind a 4-wheel-drive vehicle. Surface (non-intrusive) observations were used to help delineate soil map unit boundaries and soil map unit homogeneity.

Figure 4-1 details the location of the ground observation locations within the project area.

This soil investigation was designed to inform future soil management planning for the project.

4.2 Soil mapping units

Soils in the project area have been grouped into six broad soil types and are given generalised names. The generalised names relate to physical and chemical properties and landscape associations that are common characteristics of the soil profiles and surface observations. Whilst the selected representative soil profiles have been classified according to the Australian Soil Classification, this was not used specifically to group the soils.

Figure 4-1 depicts the soil types identified within the project area. Table 4-1 summaries soil types, corresponding map unit identification (ID), and sample/observation sites. Section 4.3 summarises the six broad soil types using a representative soil profile for each type, with the exception of Recent Alluvium and complex units. Profiles grouped within the Recent Alluvium soil type are termed *sub-types*, as no simple overall 'parent' soil type can be defined.

Information specific to the selected profiles include surface characteristics, horizon details, physical (morphological) characteristics, chemical characteristics, and interpretation.

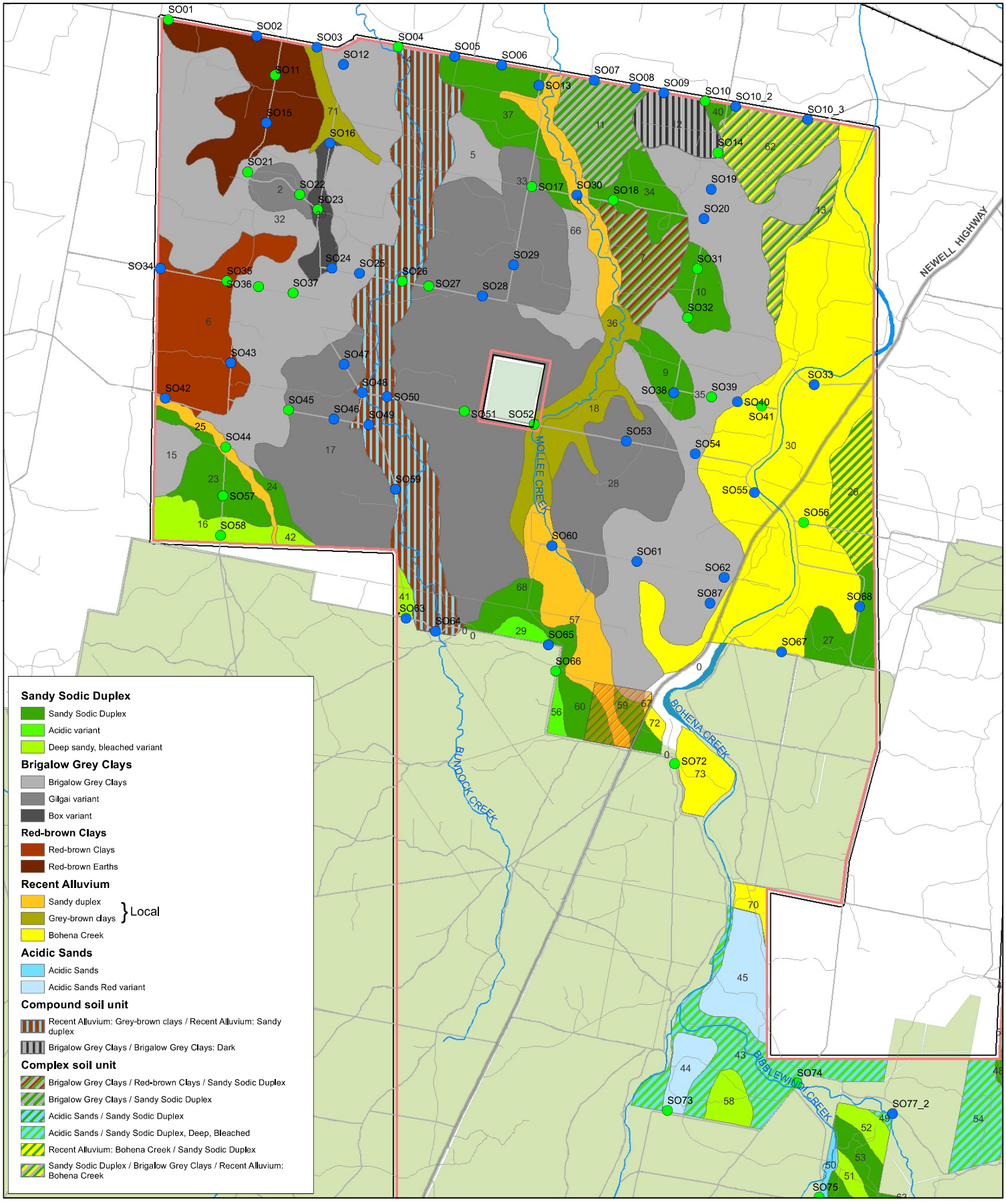
Variants of soil groups have been identified within the project area for the following soil types:

- Brigalow Grey Clays; three variants identified: Gilgai; Dark; Box.
- Sandy Sodic Duplex; two variants identified: Deep sandy, bleached; Acidic.
- Acidic Sands; one variant identified: Red.

Variants exhibit similar characteristics and limitations to the broader soil type, and will require comparable management protocols upon disturbance, except, possibly, for their main variant-determining feature.

For mapping at 1:100,000 scale some soil map units have to be defined as:

- 'Compound' between two or more soil types (soil pattern identifiable at finer scale): two map units
- 'Complex' between two of more soil types (soil pattern not clearly definable at a finer scale – the geographical relationship is complex): six map units.



0 1 2 4
Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Narrabri Gas Project
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Revision A
Date 25 Jul 2016

Soils mapped in the project area

Figure 4-1

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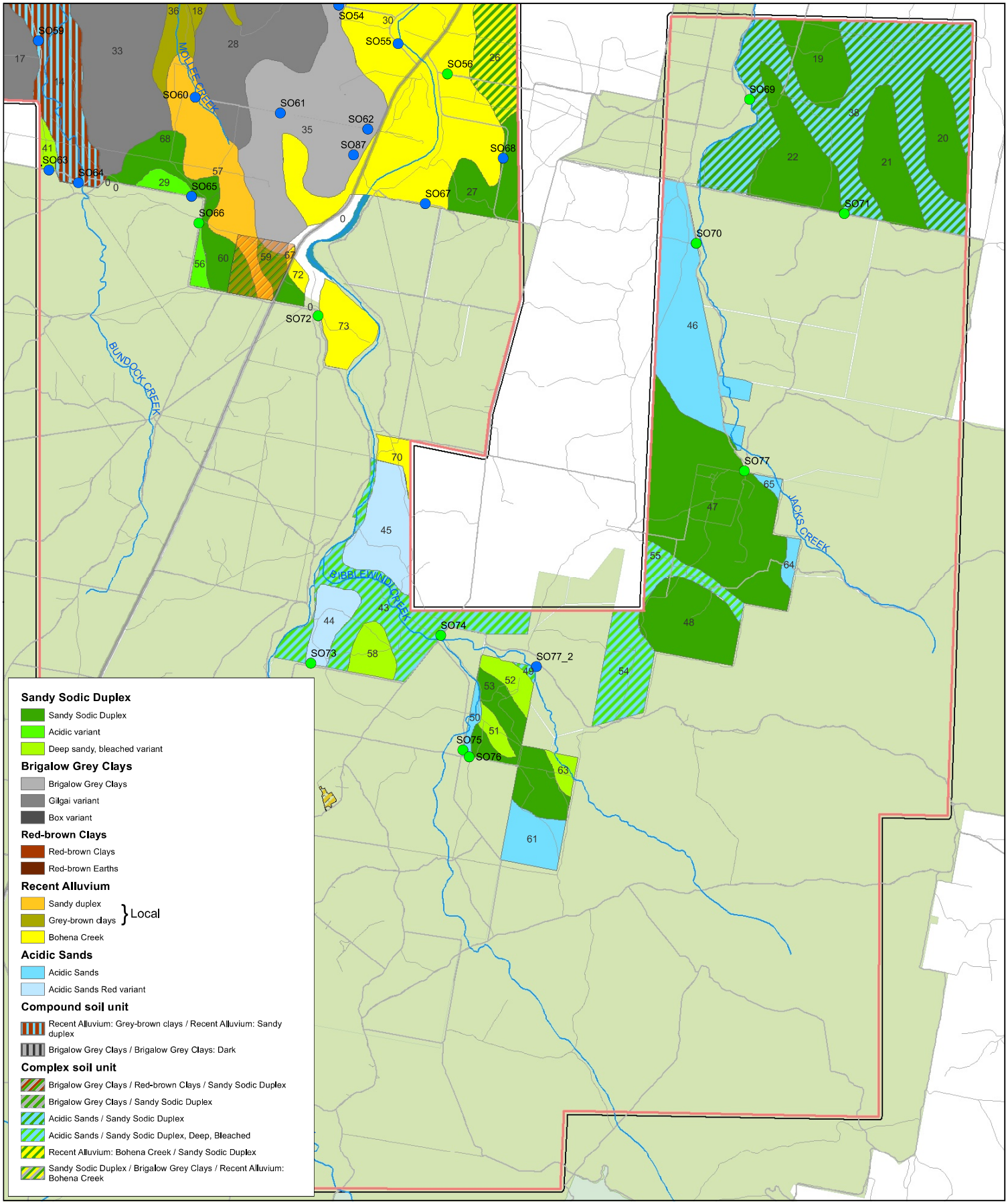


LEGEND

- Project area
- Leewood
- Bibblewindi
- State forest
- Aboriginal areas
- Lakes and dams
- Waterways
- Roads
- 100m assessment buffer

Surface Observation Locations

- Soil cores
- Surface Observations

0 1 2 4
Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Narrabri Gas Project
EIS Technical Appendix Soils Assessment

Job Number 21-22463
Revision A
Date 25 Jul 2016

Soils mapped in the project area

Figure 4-1

Level 15, 133 Castlereagh Street Sydney NSW 2000 T 61 2 9239 7100 F 61 2 9239 7199 E sydmail@ghd.com.au W www.ghd.com.au

Table 4-1 Summary of soil types and soil map units for the investigation area

Soil Type	Description	Map unit ID	Relevant soil core sites	Relevant surface observation sites	Approximate Area (ha)
Sandy Sodic Duplex	Brown to yellow and grey texture contrast soil with fine sandy loam to loamy fine sand topsoils. Strong, mottled brown, yellow, or grey sandy clay subsoils. Subsoils often dispersible and sometimes eroded. Associated with box, cypress pine, and bull oak vegetation.	9	SO38	-	6,830
		10	SO31 SO32	-	
		19	-	-	
		20	-	-	
		21	-	-	
		22	-	-	
		23	SO57	-	
		24	-	-	
		27	-	SO68	
		34	SO18	-	
		37	SO06	SO05, SO13	
		40	-	-	
		47	SO77	-	
		48	-	-	
		53	SO76	-	
		59	-	-	
		60	-	-	
		68	-	-	
Sandy Sodic Duplex: Acidic Variant	Brown to dark yellow texture contrast soil with sandy to coarse sandy loam to sandy clay loam topsoils with strong, brown, dispersible, sandy clay subsoils. Black, organic topsoil and litter layer. Associated with cypress pine, and bull oak forest.	29	SO65	-	115
		56	SO66	-	
Sandy Sodic Duplex: Deep Sandy, Bleached variant	Red-brown to yellow texture contrast soil with deep, loamy fine to medium sand topsoils with conspicuously bleached A2 horizon above strong, brown, dispersible, sandy clay subsoils. Associated with box, cypress pine, and bull oak vegetation.	16	SO58	-	780
		41	-	SO63	
		42	-	-	
		51	-	-	
		52	-	-	
		58	-	-	
		63	-	-	
Brigalow Grey Clays	Gradational grey to black cracking clays. Minor brown clays. Clays usually sandy throughout. Usually crusting surface with strong structure throughout, often with calcareous segregations in the upper or mid-B2 horizon. Lower subsoil often mottled grey and yellow. Interspersed with sub-dominant sandy texture-contrast soils.	5	-	-	7,760
		15	-	-	
		32	SO21 SO36 SO37	SO12 SO24 SO25	
		35	SO39 SO61	SO19 SO20 SO54	

Soil Type	Description	Map unit ID	Relevant soil core sites	Relevant surface observation sites	Approximate Area (ha)
		66	-	-	
Brigalow Grey Clays: Gilgai variant	Gradational grey to grey-brown cracking clays. Often sandy clay topsoils. Generally crusting (depressions and mounds) and some self-mulching (mounds) surface with strong structure throughout, often with calcareous segregations in the upper or mid-B2 horizon. Mounds show sandiness and carbonate at surface.	2	SO22	-	5,680
		17	SO45 SO46	SO47	
		28	-	SO53	
		33	SO27 SO51	-	
Brigalow Grey Clays: Box variant	Gradational grey, cracking sandy clays. Crusting surface with strong structure throughout, often with calcareous segregations in the upper or mid-B2 horizon. Pronounced yellow and grey mottling in lower subsoil. Eroded surface with stunted, poorly structured woodland vegetation.	39	SO23	SO16	205
Red Brown Clays	Gradational brown, red-brown, and grey cracking sandy clays. Crusting surface with strong structure throughout, often with calcareous segregations in the upper or mid-B2 horizon. Sometimes include gravel in the subsoil. Interspersed with brown to red-brown texture contrast soils. Often sodic.	6	SO35	SO34 SO43	1,940
		31	SO17 SO29	SO28	
Red Brown Earths	Gradational, red-brown clay loams on deeply weathered substrates on level to gently undulating plains. Sandy topsoil, sometimes deep, with mottled subsoil. Brown and red-brown texture contrast soils with yellow and grey mottled subsoils. Shallow to moderately deep sandy loam topsoils, sometimes absent.	1	SO01 SO11	SO02 SO15	965
Recent Alluvium: Local -Sandy Duplex	Brown to yellow-brown texture contrast soil with sandy loam to loamy sand topsoils with strong, brown, dispersible, sandy clay subsoils. Occurring in drainage lines and bottomlands, and often strongly eroded. Associated with box, cypress pine, and bull oak vegetation.	8	-	SO30	1,210
		25	SO44	SO42	
		57	SO60	-	
Recent Alluvium: - Local -Grey-Brown Clays	Gradational grey to brown, cracking clays. Crusting to massive surface with strong structure throughout, often with ferruginous or ferromanganiferous segregations in both topsoil and subsoil.	18	-	-	890
		36	SO52		
		71		SO03	
Recent Alluvium: Bohena Creek	Red, red-brown, yellow, to grey gradational soils of variable depth with sandy topsoils to sandy clay subsoils, often coarse sandy. Occurs on levees,	30	SO41 SO56 SO62	SO33 SO40	4,730

Soil Type	Description	Map unit ID	Relevant soil core sites	Relevant surface observation sites	Approximate Area (ha)
	cut-offs, fans, and splays associated with Bohena Creek. Variable vegetation associations.			SO55 SO67	
		67	-	-	
		70	-	-	
		72	-	-	
		73	SO72	-	
Acidic Sands	Deep, pale brown to pale yellow sandy to coarse sandy soils with shallow organic layer, often with bleached A2 horizon, occurring as alluvium and on rises and low ridges.	46	SO70	-	1,240
		50	SO75	-	
		61	-	-	
		64	-	-	
		65	-	-	
Acidic Sands: Red variant	Deep, red brown to pink sandy to coarse sandy soils with shallow organic layer, sometimes with paler A2 horizon, occurring as ridges with distinct slopes close to Bohena Creek.	44	SO73	-	630
		45	-	-	
COMPOUND UNITS					
Recent Alluvium: Grey-Brown Clays / Sandy Duplex		14	SO04 SO26 SO59	SO48 SO49 SO50, SO64	2,105
Brigalow Grey Clays / Brigalow Grey Clays: Dark		12	SO10 SO14	SO08 SO09	375
COMPLEX UNITS					
Brigalow Grey Clays / Red-Brown Clays / Sandy Sodic Duplex		7	-	-	465
Brigalow Grey Clays / Sandy Sodic Duplex		11	-	SO07	495
Sandy Sodic Duplex / Brigalow Grey Clays / Recent Alluvium: Bohena Creek		13	-	-	780
		62	-	SO10_3	
Recent Alluvium: Bohena Creek / Sandy Sodic Duplex		26			430
Acidic Sands / Sandy Sodic Duplex		38	SO69 SO71	-	1,980
Acidic Sands / Sandy Sodic Duplex: Deep, Bleached		43	SO74	-	
		49		SO77_2	1,375
		54	-	-	
		55	-	-	
Total for the investigation area (note that the investigation area is a subset of the project area)		-	-	-	40,980

4.3 Soil types

The soil descriptions presented in Table 4-2 to Table 4-15 are representative of the typical soil types identified in the soil survey, summarised from complete sampling results in Appendix A. Each table incorporates a photographic record illustrating the soil profile, the typical landscape at the site and the surface condition/land cover at the site, all of which are necessary for reference in soil management plans and rehabilitation management.

Coloured values within the soil chemical tables represent properties that will require management (based on Hazelton and Murphy, 2007; Baker and Eldershaw, 1993).

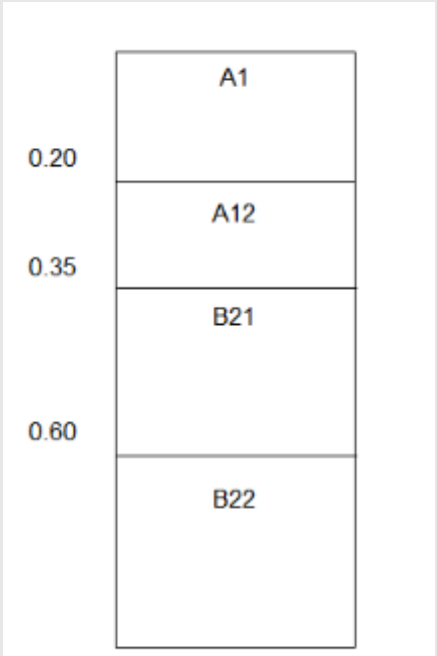
chemistry that presents a hazard for construction and / or rehabilitation activities

chemistry that presents a higher level of hazard if left untreated.

Abbreviations:

- ERD: Effective rooting depth
- PAWC: Plant Available Water Capacity
- ESP: Exchangeable Sodium Percentage
- ECEC: Effective Cation Exchange
- Emerson Class: Emerson Aggregate Stability Test Classes 1 - 8
- mBGL: metres below ground level

Table 4-2 Red-Brown Earths

Reference soil type site: SO11	
Concept	Gradational, red-brown clay loams on deeply weathered substrates on level to gently undulating plains. Sandy topsoil, sometimes deep, with mottled subsoil. Brown and red-brown texture contrast soils with yellow and grey mottled subsoils. Shallow to moderately deep sandy loam topsoils, sometimes absent.
Australian Soil Classification	Mottled, Eutrophic, Brown Chromosol
Landform/s	Level to gently undulating plain
Microrelief	None
Surface features	Soft to firm surface, minor to severe sheet erosion, absence of coarse fragments, supports tree species including Cypress Pine, Ironbark spp. and Wilga
Runoff	Moderately slow
Soil water regime	Topsoil permeable; subsoil moderately permeable
ERD and PAWC	No physical or chemical limitations for ERD and PAWC within the upper 0.75 metres below ground level (mBGL).
Relevant sites (soil map unit)	SO01; SO02; SO11, SO15
Relevant analysed sites	SO01; SO11
Horizon Details	
	**A1** – SANDY CLAY LOAM Dark brown (7.5YR 3/4 moist), weak, subangular blocky structure, peds 2-10 mm of very weak consistence strength, 2-10 % abundance of soft, ferruginous segregations, gradual boundary. **A12** – SANDY LOAM Strong brown (7.5YR 4/6 moist), no segregations or coarse fragments, clear boundary. **B21 –** CLAY LOAM SANDY Strong brown (7.5YR 5/8 moist), no segregations or coarse fragments, gradual boundary. **B22 –** LIGHT CLAY (SANDY) Strong brown (7.5YR 5/8), with red (2.5YR 5/8) segregations.

Soil Chemical Properties (SO11)

Sample depth mBGL (horizon)	pH 1:5 water	ECe (ds/m)	Chloride (mg/kg)	ECEC (meq/100 g)	Exchangeable cations (meq/100 g)				Calculated attributes	
					Ca	Mg	K	Na	ESP (%)	Ca:Mg
0-0.10	6.4	0.64	<10	6.7	4.8	1.2	0.6	<0.1	<0.1	4.0
0.20-0.30	6.9	0.20	<10	4.8	3.1	1.2	0.5	<0.1	<0.1	2.6
0.30-0.40	7.6	0.24	10	4.2	2.6	1	0.6	<0.2	<0.2	2.6
0.50-0.60	7.2	0.34	10	7.6	4	2.4	1.1	<0.1	<0.1	1.7
0.80-0.90	7.8	0.30	<10	5.2	2.7	1.7	0.8	<0.2	<0.2	1.6

Ratings						
Sample depth mBGL	**pH**	**Salinity rating (chloride)**	**Sodicity rating (ESP)**	**Ca:Mg rating**	**ECEC**	**Emerson Class**
0-0.10	Slightly acidic	very low	non-sodic	low calcium / balanced	low	3
0.20-0.30	neutral	very low	non-sodic	low calcium	very low	3
0.30-0.40	mildly alkaline	very low	non-sodic	low calcium	very low	3
0.50-0.60	neutral	very low	non-sodic	low calcium	low	3
0.80-0.90	mildly alkaline	very low	non-sodic	low calcium	very low	3

Soil Chemistry Summary

- The pH of the surface layer is slightly acidic, becoming neutral to mildly alkaline from the lower A1 horizon.
- Salinity (chloride and ECe) is very low throughout the profile.
- Levels of calcium are low, with comparatively higher levels of magnesium.
- Probability of dispersion is low given the low sodicity and ECe.
- Total nitrogen, measured in the upper A1 horizon, is considered low, while total organic carbon is high.
- Exchangeable potassium is moderate in the upper 0.40 m of the profile, becoming high with depth.
- Exchangeable sodium is very low to low throughout, as is the ECEC.

Soil qualities and limitations

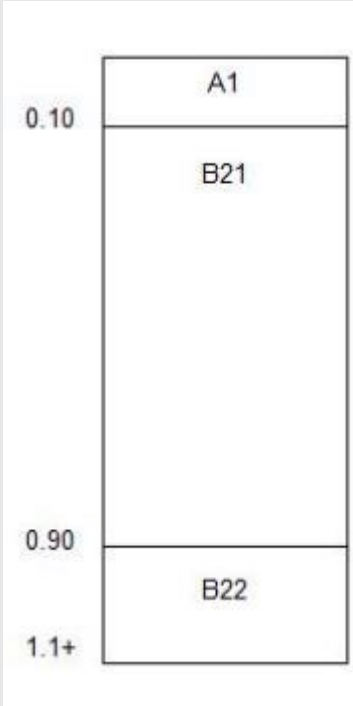
Topsoil (A horizons)

- Very low to low ECEC: limited fertility
- Low exchangeable calcium: limited fertility and reduced structural capacity
- No apparent sodicity
- Very high level of organic matter: improved soil fertility and soil stability

Subsoil (B horizon)

- low concentrations of calcium: decrease fertility
- No apparent sodicity
- Low to very low ECEC: low fertility

Table 4-3 Brigalow Grey Clays

Reference soil type site: SO14	
Concept	Gradational grey to black cracking clays. Minor brown clays. Clays usually sandy throughout. Usually crusting surface with strong structure throughout, often with calcareous segregations in the upper or mid-B2 horizon. Lower subsoil often mottled grey and yellow. Interspersed with sub-dominant sandy texture-contrast soils.
Australian Soil Classification	Haplic, Crusty, Black Vertosol
Landform/s	Level to gently undulating alluvial plains
Microrelief	None to shallow normal and melonhole gilgai
Surface features	Cracking surface crust, soft, minor sheet erosion
Runoff	Moderately rapid
Soil water regime	Moderately poorly to poorly drained below 0.5 mBGL. Common gleying or pale mottling. Moderately well drained on rises.
ERD and PAWC	ERD to the upper 0.3 – 0.5 m (sodicity, wetness); negatively impacts PAWC.
Relevant sites (soil map unit)	SO07 (Complex); SO08 (Compound); SO09 (Compound); SO10 (Compound); SO10_2 (Complex); SO10_3 (Complex); SO12, SO14 (Compound);SO19; SO20; SO21; SO24; SO25, SO36; SO37; SO39; SO54; SO61
Relevant analysed sites	SO10; SO14; SO21; SO36; SO37; SO39; SO61
Horizon Details	
	**A1** – HEAVY CLAY Dark grey (10YR 4/1), polyhedral structure, no coarse fragments or segregations, clear boundary. **B21** – HEAVY CLAY Grey (10YR 5/1), strong polyhedral structure, no coarse fragments or segregations, gradual boundary. **B22** – HEAVY CLAY Greyish brown (10YR 5/2), polyhedral structure, no coarse fragments or segregations.

Soil Chemical Properties (SO27)

Sample depth mBGL (horizon)	pH 1:5 water	ECe (ds/m)	Chloride (mg/kg)	ECEC (meq/100g)	Exchangeable cations (meq/100g)				Calculated attributes	
					Ca	Mg	K	Na	ESP (%)	Ca:Mg
0-0.10	5.9	0.31	10	24.6	8.8	13.9	0.5	1.4	5.7	0.63
0.10-0.20	5.8	1.30	160	23.8	7	12.2	0.2	3.2	13.5	0.53
0.30-0.40	5.4	4.29	960	19.5	4.6	11.4	0.1	3.3	16.9	0.40
0.80-0.90	5.9	3.81	740	14.4	2.9	8.1	<0.1	3.3	22.9	0.36

Ratings

Sample depth mBGL	pH	Salinity rating (chloride)	Sodicity rating (ESP)	Ca:Mg rating	ECEC	Emerson Class
0-0.10	moderate acidity	very low	slightly sodic	calcium deficient	moderate	3
0.10-0.20	moderate acidity	low	sodic	calcium deficient	moderate	3
0.30-0.40	moderate acidity	high	strongly sodic	calcium deficient	moderate	1
0.80-0.90	moderate acidity	high	strongly sodic	calcium deficient	moderate	2

Soil Chemistry Summary

Moderately acidic throughout the profile.

The topsoil is likely moderately fertile, with high levels of total organic carbon and moderate exchangeable calcium and ECEC.

However, the concentration of total nitrogen is low, and the level of magnesium is very high and sodium is high, potentially causing toxicity to plants.

Exchangeable magnesium is considered high throughout the profile. Exchangeable sodium is very high from 0.10 mBGL, which in conjunction with the high ESP of the subsoil, indicates moderate to strong sodic conditions, and high probability of dispersion

Soil qualities and limitations

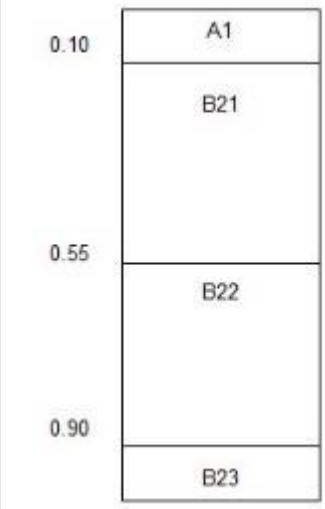
Topsoil (A horizon)

- High concentrations of magnesium and sodium: potential for salt toxicity for plant growth

Subsoil (B horizon)

- Moderate to high salinity: potential for salt toxicity for plant growth
- High concentrations of magnesium and very high concentrations of sodium: potential for salt toxicity for plant growth
- Very low concentrations of potassium and low concentrations of calcium: limited fertility and increased potential for dispersion
- Sodic (ESP>6%) to strongly sodic: potential for dispersion, potential chemical rooting barrier for plant growth

Table 4-4 Brigalow Grey Clays: Gilgai variant

Reference soil type site: SO51 (depression)	
Concept	Gradational grey to grey-brown cracking clays. Often sandy clay topsoils. Generally crusting (depressions and mounds) and some self-mulching (mounds) surface with strong structure throughout, often with calcareous segregations in the upper or mid-B2 horizon. Mounds show sandiness and carbonate at surface.
Australian Soil Classification	Epihypersodic, Massive, Grey Vertosol
Landform/s	Moderate to strong microrelief on gently undulating plains
Microrelief	Normal and melonhole, sometimes deep, wide, and irregular
Surface features	Firm surface, minor sheet erosion
Runoff	Moderately slow, ponding
Soil water regime	Moderately poorly to poorly drained below 0.5 mBGL. Common gleying or pale mottling. Moderately well drained on rises
ERD and PAWC	ERD to the upper 0.3 – 0.5 m (sodicity, wetness), to 0.1 m in depressions; negatively impacts PAWC.
Relevant sites (soil map unit)	SO22; SO27; SO45; SO46; SO47; SO51; SO53.
Relevant analysed sites	SO22; SO27; SO45; SO46; SO51.
Horizon Details	
	A1 – HEAVY CLAY Brown (10YR 4/3 moist), weakly structured, subangular and polyhedral peds (< 2-5 mm), of firm consistence, clear boundary. B21 – HEAVY CLAY Dark grey (10YR 4/1 moist), moderately structured, polyhedral (2-10 mm) peds, of very firm consistence, gradual boundary. B22 – HEAVY CLAY, sandy Brown (7.5YR 4/2 moist), moderately structured, polyhedral (2-10 mm) peds, of very firm consistence, gradual boundary. B23 – MEDIUM HEAVY CLAY, sandy Greyish brown (10YR 5/2 moist), with brown mottles (10YR 5/3), very firm consistence.

Soil Chemical Properties (SO51)

Sample depth mBGL (horizon)	pH 1:5 water	ECe (ds/m)	Chloride (mg/kg)	ECEC (cmol+/kg)	Exchangeable cations (cmol+/kg)				Calculated attributes	
					Ca	Mg	K	Na	ESP (%)	Ca:Mg
0-0.10	5.5	0.39	30	11	4.5	5.5	0.6	0.4	3.6	0.82
0.10-0.20	6	1.81	260	28.3	6.6	16.7	0.8	4.2	14.8	0.39
0.30-0.40	5.9	3.60	720	13.7	2.3	8.9	0.1	2.4	17.5	0.26
0.50-0.60	5.8	4.09	770	12.7	1.5	8.2	<0.1	2.8	22.1	0.18
0.80-0.90	5.9	3.30	580	7.1	0.9	4.7	<0.1	1.5	21.1	0.19

Ratings						
Sample depth mBGL	**pH**	**Salinity rating (chloride)**	**Sodicity rating (ESP)**	**Ca:Mg rating**	**ECEC**	**Emerson Class**
0-0.10	strongly acidic	very low	non-sodic	calcium deficient	low	4
0.10-0.20	moderate acidity	low	sodic	calcium deficient	high	1
0.30-0.40	moderate acidity	high	strongly sodic	calcium deficient	moderate	2
0.50-0.60	moderate acidity	high	strongly sodic	calcium deficient	moderate	2
0.80-0.90	moderate acidity	moderate	strongly sodic	calcium deficient	low	1

Soil Chemistry Summary

- Strongly acidic in the first 0.10 m of topsoil and moderately acidic throughout the rest of the profile.
- Calcium flocculation (segregations) reduce the calcium availability, resulting in very low Ca:Mg ratios.
- Concentrations of magnesium are consistently high to very high.
- Concentrations of potassium are moderate to high in the topsoil and upper subsoil and very low in the lower subsoil.
- Concentrations of nitrogen and phosphorous in the topsoil are considered to be low.
- Topsoil is non-sodic; however, high ESP in the subsoil is indicative of strong sodicity.
- The non-sodic and low saline nature of the topsoil results in a low potential for soil dispersion. Visual evidence of dispersed topsoils from the mounds however.
- The subsoil is potentially dispersive due to strong sodicity.

Soil qualities and limitations

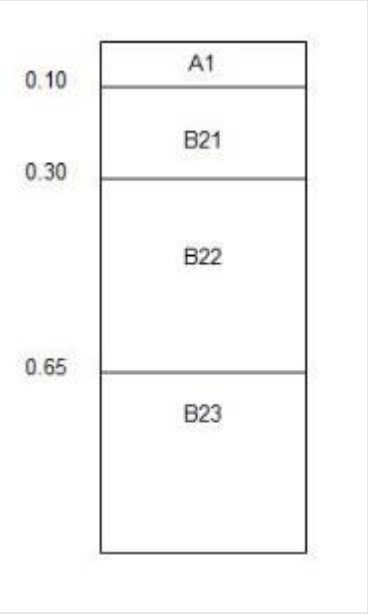
Topsoil (A horizon)

- High to very high concentrations of magnesium, potassium and sodium: potential for salt toxicity for plant growth
- Low phosphorus (Colwell) and nitrogen: decreases fertility

Subsoil (B horizon)

- Calcium deficient in much of the profile: decreases fertility and increases potential for dispersion
- Slight to moderate salinity: decreases fertility
- Sodic to strongly sodic (14.84 – 22.05 % ESP): decreases fertility and increases potential for dispersion

Table 4-5 Brigalow Grey Clays: Dark variant

Reference soil type site: SO10	
Concept	Gradational grey, cracking clays. Crusting surface with strong structure throughout, often with calcareous segregations in the upper or mid-B2 horizon
Australian Soil Classification	Haplic, Crusty, Black Vertosol
Landform/s	Flat morphology, occurring on a level plain
Microrelief	Normal
Surface features	Cracking surface crust, firm surface, no erosion
Runoff	Moderately rapid
Soil water regime	Moderately drained
ERD and PAWC	No physical or chemical limitations for ERD and PAWC within the upper 0.75 mBGL.
Relevant sites (soil map unit)	SO08 (Compound); SO09 (Compound); SO10 (Compound); SO14 (Compound)
Relevant analysed sites	SO10; SO14
Horizon Details	
	A1 – MEDIUM HEAVY CLAY Brown (10YR 4/3 moist), clear boundary.
	B21 – HEAVY CLAY Very dark greyish brown (10YR 3/2 moist), gradual boundary.
	B22 – HEAVY CLAY Very dark greyish brown (10YR 3/2 moist), < 2 % abundance of soft, calcareous and manganiferous segregations (< 2-6 mm), gradual boundary.
	B23 – HEAVY CLAY Yellowish brown (10YR 5/4 moist), 10-20 % abundance of calcareous and manganiferous segregations (soft and nodules; < 2-20 mm).

Soil Chemical Properties (SO10)

Sample depth mBGL (horizon)	pH 1:5 water	ECe (ds/m)	Chloride (mg/kg)	ECEC (cmol+/kg)	Exchangeable cations (cmol+/kg)				Calculated attributes	
					Ca	Mg	K	Na	ESP (%)	Ca:Mg
0-0.10	6.3	0.47	<10	11.3	7.6	2.9	0.4	0.3	2.655	2.62
0.20-0.30	8.4	0.52	40	12.2	6.6	4.5	<0.2	1.1	9.016	1.47
0.30-0.40	9	0.93	80	15	7.2	5.9	0.3	1.6	10.67	1.22
0.50-0.60	9.1	1.93	120	12.2	5	5.4	<0.2	1.8	14.75	0.93

Ratings						
Sample depth mBGL	**pH**	**Salinity rating (chloride)**	**Sodicity rating (ESP)**	**Ca:Mg rating**	**ECEC**	**Emerson Class**
0-0.10	slightly acidic	very low	non-sodic	low calcium	low	3
0.20-0.30	moderately alkaline	very low	sodic	low calcium	moderate	3
0.30-0.40	strongly alkaline	very low	sodic	low calcium	moderate	3
0.50-0.60	strongly alkaline	low	sodic	calcium deficient	moderate	1

Soil Chemistry Summary

- Slightly acidic topsoil, grading from moderately alkaline in the upper subsoil to strongly alkaline in the lower subsoil.
- Calcium flocculation (segregations) reduces the calcium availability, resulting in very low Ca:Mg ratios.
- Concentrations of magnesium are high in the subsoil and moderate in the topsoil.
- The ECEC is low in the topsoil and moderate throughout the subsoil.
- Topsoil is non-sodic; however, the subsoil is sodic.
- The high values of the EAT indicate a low probability of topsoil dispersion.
- The subsoil is potentially dispersive as it is sodic and non-saline.

Soil qualities and limitations

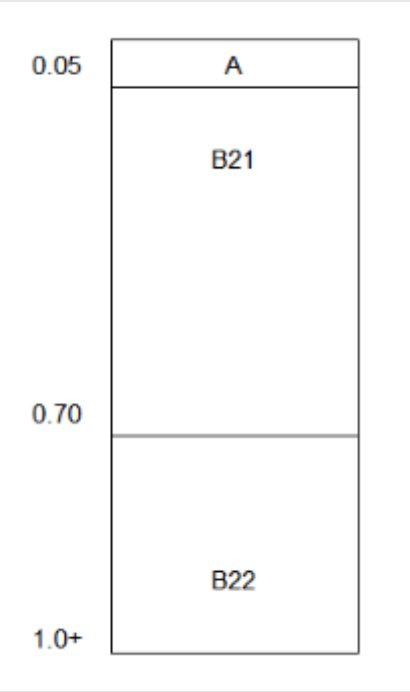
Topsoil (A horizon)

- Low ECEC as well as low concentrations of phosphorus and nitrogen: decreases fertility
- Non-sodic and non-saline topsoil, with moderate concentrations of organic matter, total organic carbon, magnesium and potassium: may allow moderate fertility

Subsoil (B horizon)

- Moderate to strongly alkaline: this increases precipitation of particular compounds, such as calcium carbonate, which removes these nutrients from solution, soil structure and plant uptake
- Calcium deficient: decreases fertility and increases potential for dispersion
- Sodic soil (9.02 – 14.75 % ESP): decreases fertility and increases potential for dispersion

Table 4-6 Brigalow Grey Clays: Box variant

Reference soil type site: SO23	
Concept	Gradational grey, cracking sandy clays. Crusting surface with strong structure throughout, often with calcareous segregations in the upper or mid-B2 horizon. Pronounced yellow and grey mottling in lower subsoil. Eroded surface with stunted, poorly structured woodland vegetation.
Australian Soil Classification	Episodic, Crusty, Grey Vertosol
Landform/s	Flat morphology, occurring on a level plain
Microrelief	Normal
Surface features	Cracking surface crust, soft surface, moderate to severe sheet erosion
Runoff	Moderately rapid
Soil water regime	Moderately drained
ERD and PAWC	ERD to the upper 0.1 m of the profile (sodicity, wetness); negatively impacts PAWC.
Relevant sites (soil map unit)	SO16; SO23
Relevant analysed sites	SO23
Horizon Details	
	A – MEDIUM CLAY Brown (10YR 4/3 moist), weakly structured, angular peds, of firm consistence, clear boundary.
	B21 – MEDIUM CLAY Grey brown (10YR 5/1 moist), moderately structured, angular and lenticular peds, of very firm consistence, soft calcareous segregations (2-10 % abundance), gradual boundary.
	B22 – MEDIUM CLAY Grey brown (10YR 5/1 moist), moderately structured, angular and lenticular peds, of very firm consistence, soft calcareous segregations (2-10 % abundance).

Soil Chemical Properties (SO23)

Sample depth mBGL (horizon)	pH 1:5 water	ECe (ds/m)	Chloride (mg/kg)	ECEC (cmol+/kg)	Exchangeable cations (cmol+/kg)				Calculated attributes	
					Ca	Mg	K	Na	ESP (%)	Ca:Mg
0-0.10	6.4	0.27	20	9.3	2.6	5.4	0.2	1	10.7	0.48
0.10-0.20	6.7	1.05	70	14.2	4.9	6.4	<0.1	2.7	19.0	0.76
0.30-0.40	8.4	3.55	270	14.3	5	7.3	<0.2	2	13.9	0.68
0.50-0.60	8.1	4.02	310	11.9	3.5	6.3	<0.2	2.1	17.6	0.55
0.80-0.90	5.2	4.61	330	10.4	2.2	5.8	0.2	2.2	21.1	0.38

Ratings						
Sample depth mBGL	**pH**	**Salinity rating (chloride)**	**Sodicity rating (ESP)**	**Ca:Mg rating**	**ECEC**	**Emerson Class**
0-0.10	slightly acidic	very low	sodic	calcium deficient	low	3
0.10-0.20	neutral	very low	strongly sodic	calcium deficient	moderate	3
0.30-0.40	moderately alkaline	low	sodic	calcium deficient	moderate	3
0.50-0.60	moderately alkaline	moderate	strongly sodic	calcium deficient	low	3
0.80-0.90	strongly acidic	moderate	strongly sodic	calcium deficient	low	2

Soil Chemistry Summary

Slightly acidic topsoil, grading from neutral in the upper subsoil to moderately alkaline in the mid subsoil to strongly acidic in the lower subsoil.

Calcium flocculation (segregations) reduces the calcium availability, resulting in very low Ca:Mg ratios.

Concentrations of magnesium are high throughout the soil profile.

The ECEC is low in the topsoil and low to moderate throughout the subsoil.

ESP values are indicative of sodicity throughout the profile, with the upper and lower subsoil having the strongest sodicity.

The topsoil and subsoil are potentially to dispersive as they are sodic and non-saline, to slightly saline.

Soil qualities and limitations

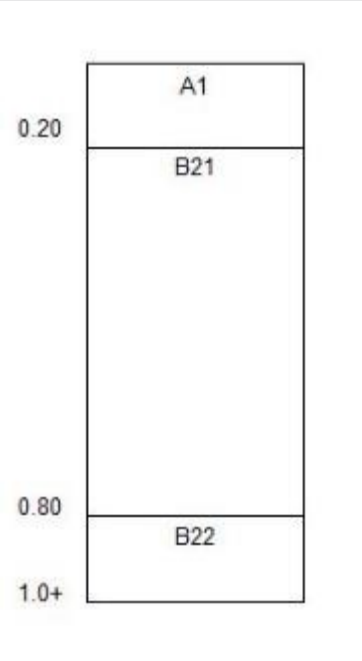
Topsoil (A horizon)

- Low to moderate ECEC as well as low concentrations of phosphorus and nitrogen: decreases fertility
- Sodic soil (10.75 % ESP): decreases fertility and increases potential for dispersion

Subsoil (B horizon)

- Moderately alkaline in upper to mid subsoil: this increases precipitation of particular compounds, such as calcium carbonate, which removes these nutrients from solution, soil structure and plant uptake
- Calcium deficient: decreases fertility and increases potential for dispersion
- Sodic soil (14.0 – 21.1% ESP): decreases fertility and increases potential for dispersion

Table 4-7 Red-Brown Clays

Reference soil type site: SO35	
Type Concept	Gradational brown to red-brown, cracking sandy clays. Crusting surface with strong structure throughout, often with calcareous segregations in the upper or mid-B2 horizon. Sometimes include gravel in the subsoil.
Australian Soil Classification	Endohypersodic, Crusty, Brown Vertosol
Landform/s	Flat morphology, occurring on a level plain
Microrelief	Normal
Surface features	Cracking surface crust, soft surface, no coarse fragments
Runoff	Moderately
Soil water regime	Moderately well drained
ERD and PAWC	ERD to the upper 0.5 m (sodicity); negatively impacts PAWC.
Relevant sites (soil map unit)	SO17; SO28; SO29; SO34; SO35; SO43
Relevant analysed sites	SO17; SO29; SO35
Horizon Details	
	**A1** – LIGHT MEDIUM CLAY, sandy Dark reddish brown (5YR3/2 moist), moderately structured, angular block and polyhedral peds of weak consistence, clear boundary. **B21** – MEDIUM HEAVY CLAY Brown (7.5YR 4/2 moist), with dark grey (7.5YR 4/1) mottles, strong structured, angular block and polyhedral peds of very firm consistence, gradual boundary. **B22** – HEAVY CLAY Brown (7.5YR 4/3 moist), with strong brown (7.5YR 4/6) mottles, strong structured, angular blocky and polyhedral peds of very firm consistence, <2 % abundance of calcareous segregations (soft and concretions)

Soil Chemical Properties (SO35)

Sample depth mBGL (horizon)	pH 1:5 water	ECe (ds/m)	Chloride (mg/kg)	ECEC (cmol+/kg)	Exchangeable cations (cmol+/kg)				Calculated attributes	
					Ca	Mg	K	Na	ESP (%)	Ca: Mg
0-0.10	5.9	0.22	10	9.4	5.8	3.2	0.3	0.2	2.128	1.81
0.20-0.30	7.6	0.34	<10	11.3	6.2	4.4	<0.2	0.6	5.31	1.41
0.50-0.60	8.8	2.30	200	13.9	2.8	8.1	<0.2	2.9	20.86	0.35
0.80-0.90	9.2	4.12	290	15.4	4.1	8.8	<0.2	2.5	16.23	0.46

Ratings						
Sample depth mBGL	**pH**	**Salinity rating (chloride)**	**Sodicity rating (ESP)**	**Ca:Mg rating**	**ECEC**	**Emerson Class**
0-0.10	moderately acidic	very low	non-sodic	low calcium	low	3
0.20-0.30	mildly alkaline	very low	sodic	low calcium	low	2
0.50-0.60	strongly alkaline	low	strongly -sodic	calcium deficient	moderate	1
0.80-0.90	very strongly alkaline	low	strongly -sodic	calcium deficient	moderate	1

Soil Chemistry Summary

- The pH of the topsoil is moderately acidic, while the subsoil pH grades from mildly alkaline to very strongly alkaline with depth.
- ECEC is considered to be low in the topsoil and upper subsoil, but increases to moderate down the profile (clay content).
- The Ca:Mg ratio indicates that relative to magnesium, calcium is low in the topsoil and upper subsoil, becoming deficient in the mid and lower subsoil.
- Exchangeable concentrations of magnesium are high, while exchangeable concentrations of sodium and potassium are low.
- The topsoil and upper subsoil is non-sodic and non-saline, giving a low dispersivity, while the mid and lower subsoil is strongly sodic and slight to moderately saline giving soil at these depths a high potential to disperse.

Soil qualities and limitations

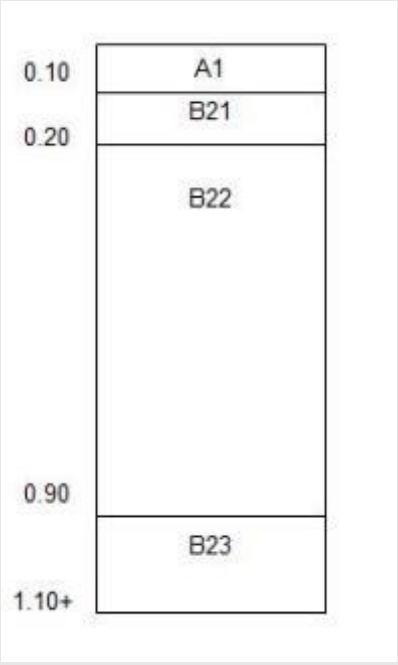
Topsoil (A horizon)

- Low ECEC, phosphorus, nitrogen and potassium: decreases fertility
- High organic matter percentage: improves fertility and soil stability

Subsoil (B horizon)

- Low concentrations of calcium and very low concentrations of potassium: limitation for plant growth/less soil stability
- High concentrations of magnesium: limitation for plant growth
- Strongly sodic mid and lower subsoil (16.2 – 20.9% ESP): decreases fertility and increases potential for dispersion

Table 4-8 Sandy Sodic Duplex

Reference soil type site: SO06	
Type Concept	Brown to yellow and grey texture contrast soil with fine sandy loam to loamy fine sand topsoils. Strong, mottled brown, yellow, or grey sandy clay subsoils. Subsoils often dispersible and sometimes eroded. Associated with box, cypress pine, and bull oak vegetation.
Australian Soil Classification	Mesotrophic, Mottled-Mesonatric, Yellow Sodosol
Landform/s	Flat morphology, occurring on a level plain
Microrelief	Nil
Surface features	Firm surface, moderate sheet erosion
Runoff	Moderately slow to moderately rapid
Soil water regime	Moderately permeable but imperfectly drained
ERD and PAWC	ERD to the upper 0.5 m (sodicity); negatively impacts PAWC.
Relevant sites (soil map unit)	SO05; SO06; SO07 (Complex); SO10_2 (Complex); SO10_3 (Complex); SO13; SO18; SO31; SO32; SO38; SO57; SO68; SO69 (Complex); SO71 (Complex); SO76; SO77
Relevant analysed sites	SO06; SO18; SO31; SO32; SO38; SO57; SO59; SO69; SO71; SO76; SO77
Horizon Details	
	**A1** – SANDY CLAY LOAM Dark brown (10YR 3/3 moist), weakly structured, subangular block peds (2-10 mm) of weak consistence, no segregations or coarse fragments, abrupt boundary. **B21** – LIGHT MEDIUM CLAY, coarse sandy Yellowish brown (10YR 5/6 moist), with very pale grey (10YR 7/3) and brownish yellow (10YR 6/6) mottles, weakly structured, subangular block peds of firm consistence, no segregations or coarse fragments, clear boundary. **B22** – MEDIUM CLAY Brown (10YR 5/3), with common, pale brown (10YR 6/3) mottles, moderately structured, subangular blocky peds of firm consistence, no segregations or coarse fragments, gradual boundary. **B23** – MEDIUM CLAY Brown (10YR 5/3), with common, reddish brown (5YR 4/4) mottles, moderately structured, subangular blocky peds, of firm consistence, 2-10 % abundance of soft, calcareous segregations (2-6 mm).

Soil Chemical Properties (S006)

Sample depth mBGL (horizon)	pH 1:5 water	ECe (ds/m)	Chloride (mg/kg)	ECEC (cmol+/kg)	Exchangeable cations (cmol+/kg)				Calculated attributes	
					Ca	Mg	K	Na	ESP (%)	Ca: Mg
0-0.10	6.2	0.47	<10	5.1	2.9	1.9	0.3	<0.1	<0.1	1.52
0.10-0.20	6.3	0.18	<10	11.1	5.1	5.4	0.2	0.4	3.6	0.94
0.20-0.30	7.1	0.27	<10	8.6	3.7	4.1	0.1	0.6	6.9	0.90
0.50-0.60	9.2	1.75	180	11.7	2.7	6.6	<0.2	2.4	20.5	0.41
0.80-0.90	9.3	2.56	230	12.8	2.4	7.4	<0.2	3	23.4	0.32

Ratings

Sample depth mBGL	pH	Salinity rating (chloride)	Sodicity rating (ESP)	Ca:Mg rating	ECEC	Emerson Class
0-0.10	slightly acidic	very low	optimal	low calcium	very low	8
0.10-0.20	slightly acidic	very low	non-sodic	calcium deficient	low	3
0.20-0.30	neutral	very low	sodic	calcium deficient	low	3
0.50-0.60	very strongly alkaline	low	strongly-sodic	calcium deficient	low	1
0.80-0.90	Very strongly alkaline	low	strongly-sodic	calcium deficient	moderate	2

Soil Chemistry Summary

- The pH of the soil is slightly acidic in the topsoil and upper subsoil, progressing to neutral in the mid subsoil and very strongly alkaline in the lower subsoil.
- ECEC is considered to be very low in the topsoil and low in the upper subsoil, grading to moderate in the lower subsoil (clay content).
- The Ca:Mg ratio indicates that relative to magnesium, calcium is low in the topsoil, becoming deficient in the subsoil.
- Exchangeable concentrations of magnesium are low in the topsoil and high in the subsoil. Exchangeable potassium concentrations are low in the topsoil and upper subsoil, decreasing to very low in the lower subsoil.
- The topsoil and upper subsoil is non-sodic and non-saline, giving a low dispersibility, while the mid and lower subsoil is sodic to strongly sodic and non-saline to slightly saline, giving these depths the potential to disperse.
- The topsoil contains very low concentrations of phosphorus and nitrogen and a low ECEC, exchangeable potassium and exchangeable calcium concentration.

Soil qualities and limitations

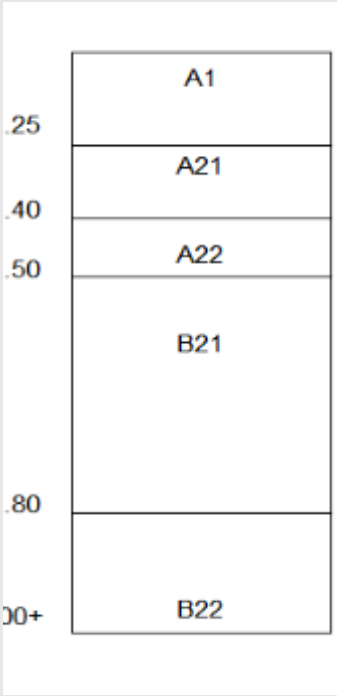
Topsoil (A horizon)

- Very low phosphorus and nitrogen: limited fertility
- Low ECEC: limited fertility
- Low exchangeable potassium and exchangeable calcium : limited fertility and decreased soil stability

Subsoil (B horizon)

- Low calcium: limiting for plant growth and decreased soil stability
- High magnesium: limitation for plant growth
- Very low potassium: limited fertility
- Sodic to strongly sodic (7 – 23.4 % ESP): decreases fertility and increases potential for dispersion

Table 4-9 Sandy Sodic Duplex: Deep Sandy, Bleached variant

Reference soil type site: SO58	
Type Concept	Red-brown to yellow texture contrast soil with deep, loamy fine to medium sand topsoils with conspicuously bleached A2 horizon above strong, brown, dispersible, sandy clay subsoils. Associated with box, cypress pine, and bull oak vegetation
Australian Soil Classification	Magnesic, Mottled-Hypernatric, Brown Sodosol
Landform/s	Slightly sloping rises, on a gently undulating plain
Microrelief	Nil
Surface features	Soft surface, minor sheet erosion, no coarse surface fragments
Runoff	Moderately slow
Soil water regime	Moderately permeable but imperfectly drained
ERD and PAWC	ERD to the upper 0.3 m (Ca:Mg ratio); negatively impacts PAWC.
Relevant sites (soil map unit)	SO58, SO63, SO74 (Complex), SO77_2 (Complex)
Relevant analysed sites	SO58, SO74
Horizon Details	
	**A1** – SANDY CLAY LOAM Yellowish brown (10YR 5/4 moist), weakly structured, subangular block peds (2-10 mm) of weak consistence, no segregations or coarse fragments, clear boundary. **A21** – SANDY LOAM Very pale brown (10YR 7/3 moist), massive structure, no segregations or coarse fragments, clear boundary. **A22** – LOAMY SAND White (10YR 8/1 dry) and light grey (10YR 7/1 moist), massive structure, no segregations or coarse fragments, abrupt boundary. **B21** – LIGHT CLAY Brown (10YR 5/3), with pale brown (10YR 6/3) mottles, massive structure, no segregations or coarse fragments, gradual boundary. **B22** – SANDY CLAY LOAM Yellowish brown (10YR 5/4 moist), massive structure, no segregations or coarse fragments.

Soil Chemical Properties (SO58)

Sample depth mBGL (horizon)	pH 1:5 water	ECe (ds/m)	Chloride (mg/kg)	ECEC (cmol+/kg)	Exchangeable cations (cmol+/kg)				Calculated attributes	
					Ca	Mg	K	Na	ESP (%)	Ca: Mg
0-0.10	5.2	0.45	<10	1	0.5	0.4	<0.1	<0.1	<0.1	1.25
0.20-0.30	6.1	0.59	20	1.2	<0.1	0.6	<0.1	0.4	33.3	<0.1
0.30-0.40	6.3	0.65	30	2	<0.1	1.1	<0.1	0.8	40	<0.1
0.50-0.60	8	1.95	340	9	<0.2	6.3	<0.2	2.7	30	<0.2
0.80-0.90	8.1	2.33	350	11.9	<0.2	8.2	0.3	3.4	28.5	<0.2

Ratings						
Sample depth mBGL	**pH**	**Salinity rating (chloride)**	**Sodicity rating (ESP)**	**Ca:Mg rating**	**ECEC**	**Emerson Class**
0-0.10	strongly acidic	very low	non-sodic	low calcium	very low	7
0.20-0.30	slightly acidic	very low	strongly sodic	calcium deficient	very low	7
0.30-0.40	slightly acidic	very low	strongly sodic	calcium deficient	very low	2
0.50-0.60	moderately alkaline	moderate	strongly sodic	calcium deficient	low	2
0.80-0.90	moderately alkaline	moderate	strongly sodic	calcium deficient	low	3

Soil Chemistry Summary

- The pH of the upper topsoil is strongly acidic, progressing to slightly acidic in the lower topsoil.
- The subsoil pH is moderately alkaline. ECEC is considered to be very low in the topsoil and low in the subsoil.
- The Ca:Mg ratio indicates that relative to magnesium, calcium is low in the upper topsoil, becoming deficient in the remainder of the profile.
- Exchangeable calcium and potassium concentrations are very low throughout the soil, with exchangeable potassium concentrations slightly increasing to low in the lower subsoil.
- The upper topsoil is non-sodic and non-saline, resulting in a low dispersibility index, while the remainder of the soil is strongly sodic resulting in the potential for soil dispersion.
- The topsoil contained very low concentrations of nitrogen, extractable phosphorus, exchangeable calcium, exchangeable potassium and a low ECEC.

Soil qualities and limitations

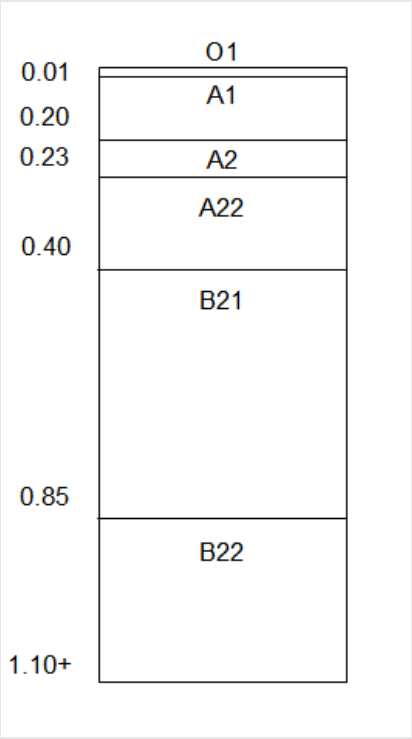
Topsoil (A horizon)

- Very low phosphorus and nitrogen: limited fertility
- Low ECEC: limited fertility
- Very low exchangeable potassium and exchangeable calcium : limited fertility and decreased soil stability
- Strongly sodic lower A horizon (33.3 – 40 % ESP) : decreases fertility and increases potential for dispersion

Subsoil (B horizon)

- Very low calcium: limiting for plant growth and decreased soil stability
- High magnesium: limitation for plant growth
- Very low to low potassium: limited fertility
- Sodic to strongly sodic (30 – 28.6 % ESP): decreases fertility and increases potential for dispersion

Table 4-10 Sandy Sodic Duplex: Acidic variant

Reference soil type site: SO66	
Type Concept	Brown to dark yellow texture contrast soil with sandy to coarse sandy loam to sandy clay loam topsoils with strong, brown, dispersible, sandy clay subsoils. Black, organic topsoil and litter layer. Associated with cypress pine, and bull oak forest.
Australian Soil Classification	Haplic, Magnesic-Natric, Brown Kurosol
Landform/s	Flat morphology, occurring on a gently undulating plain
Microrelief	Nil
Surface features	Soft surface, no erosion
Runoff	Moderately well drained
Soil water regime	Moderately permeable
ERD and PAWC	ERD to the upper 0.2 m (sodicity, Ca:Mg ratio); negatively impacts PAWC.
Relevant sites (soil map unit)	SO65, SO66
Relevant analysed sites	SO65, SO66
Horizon Details	
	**O1** – ORGANIC MATTER Black (10YR 2/1 moist) organic matter layer, no segregations or coarse fragments, abrupt boundary. **A1** – SANDY CLAY LOAM Dark yellowish brown (10YR 4/6 moist), weakly structured, subangular block peds (< 2-5 mm) of very weak consistence, no segregations or coarse fragments, clear boundary. **A2** – SANDY LOAM Light brownish grey (10YR 6/2 moist), massive structure, very weak consistence, no segregations or coarse fragments, abrupt boundary. **B21** – MEDIUM CLAY, coarse sandy Brown (10YR 4/3), massive structure, weak consistence, no segregations or coarse fragments, gradual boundary. **B22** – MEDIUM CLAY Dark yellowish brown (10YR 4/4), massive structure, weak consistence, no segregations or coarse fragments.

Soil Chemical Properties (SO66)

Sample depth mBGL (horizon)	pH 1:5 water	ECe (ds/m)	Chloride (mg/kg)	ECEC (cmol+/kg)	Exchangeable cations (cmol+/kg)				Calculated attributes	
					Ca	Mg	K	Na	ESP (%)	Ca: Mg
0-0.10	5	0.79	20	5.3	2.5	2.2	0.4	0.1	1.8	1.13
0.20-0.30	6	0.78	100	3.7	<0.1	2.6	<0.1	1	27.0	<0.1
0.30-0.40	6.7	1.35	180	13.6	<0.1	9	<0.1	4.4	32.3	<0.1
0.80-0.90	6.2	2.17	300	16.2	0.1	10.3	0.1	5.6	34.5	0.01

Ratings

Sample depth mBGL	pH	Salinity rating (chloride)	Sodicity rating (ESP)	Ca:Mg rating	ECEC	Emerson Class
0-0.10	very strongly acidic	very low	non-sodic	low calcium	very low	7
0.20-0.30	moderately acidic	low	strongly sodic	calcium deficient	very low	3
0.30-0.40	neutral	low	strongly sodic	calcium deficient	moderate	3
0.80-0.90	slightly acidic	low	strongly sodic	calcium deficient	moderate	3

Soil Chemistry Summary

The pH of the topsoil grades from very strongly acidic at the top, progressing to neutral in the lower topsoil. pH of the subsoil is slightly acidic.

ECEC is very low in the upper and mid topsoil, increasing to moderate in the lower topsoil and in the subsoil.

The Ca:Mg ratio indicates that relative to magnesium, calcium is low in the upper topsoil, becoming deficient in the remainder of the profile.

The upper topsoil is non-sodic and non-saline, resulting in a low dispersivity index, while the remainder of the soil is strongly sodic with no or slight salinity, resulting in a moderate to high dispersibility potential.

The topsoil contained very low ECEC and very low concentrations of extractable phosphorus.

Concentrations of nitrogen and exchangeable calcium in the topsoil were low, while the concentrations of exchangeable magnesium and potassium were moderate.

Soil qualities and limitations

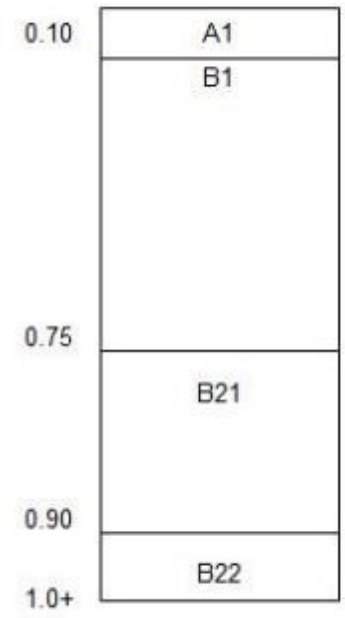
Topsoil (A horizon)

- Very low phosphorus and low nitrogen: limited fertility
- Very low ECEC: limited fertility
- Low exchangeable calcium : limited fertility and decreased soil stability
- Very high magnesium in the lower subsoil: limitation for plant growth
- Strongly sodic lower A horizon (27 – 32.4 % ESP) : decreases fertility and increases potential for dispersion

Subsoil (B horizon)

- Very low calcium and potassium: limiting for plant growth and decreased soil stability
- Very high magnesium: limitation for plant growth
- Strongly sodic (34.6 % ESP): decreases fertility and increases potential for dispersion

Table 4-11 Recent Alluvium - Local: Sandy Duplex

Reference soil type site: SO44	
Type concept	Brown to yellow-brown texture contrast soil with sandy loam to loamy sand topsoils with strong, brown, dispersible, sandy clay subsoils. Occurring in drainage lines and bottomlands, and often strongly eroded. Associated with box, cypress pine, and bull oak vegetation
Australian Soil Classification	Mesotrophic, Mesonatric, Brown Sodosol
Landform / landscape position	Flat morphology
Microrelief	Nil
Surface features	Soft to firm surface, moderate gully and sheet erosion, disturbed by grazing and extensive clearing
Runoff	Moderate to moderately rapid
Soil water regime	Moderately permeable, moderately to imperfectly drained
ERD and PAWC	ERD to the upper 0.1 m (sodicity); negatively impacts PAWC.
Relevant sites (soil map unit)	SO04 (Compound), SO26 (Compound), SO30, SO42, SO44, SO48 (Compound), SO49 (Compound), SO50 (Compound), SO59 (Compound), SO60, SO64 (Compound)
Relevant analysed sites	SO04, SO26, SO44, SO59, SO60
Horizon Details	
	A1 – LOAMY SAND Dark yellowish brown (10YR 4/4), weakly structured, subangular blocky peds, of weak consistence, clear boundary.
	B1 – CLAY LOAM SANDY, coarse sandy Brown (10YR 5/3), no coarse fragments or segregations, clear boundary.
	B21 – LIGHT MEDIUM CLAY Yellowish brown (10YR 5/4), with very pale brown (10YR 7/4) mottles, clear boundary.
	B22 – CLAYEY SAND, coarse sandy Pale brown (10YR 6/3), no coarse fragments or segregations.

Soil Chemical Properties (SO44)

Sample depth mBGL (horizon)	pH 1:5 water	ECe (ds/m)	Chloride (mg/kg)	ECEC (cmol+/kg)	Exchangeable cations (cmol+/kg)				Calculated attributes	
					Ca	Mg	K	Na	ESP (%)	Ca: Mg
0-0.10	5.3	0.18	<10	3.7	1.2	2.1	0.2	0.1	2.7	0.57
0.10-0.20	5.7	0.67	20	4.6	0.7	2.6	<0.1	1.2	26.1	0.27
0.30-0.40	7.9	2.74	210	7.6	1.4	4.5	<0.2	1.7	22.4	0.31
0.80-0.90	8.4	2.11	150	6.9	<0.2	4.7	<0.2	2.2	31.9	<0.20

Ratings						
Sample depth mBGL	**pH**	**Salinity rating (chloride)**	**Sodicity rating (ESP)**	**Ca:Mg rating**	**ECEC**	**Emerson Class**
0-0.10	strongly acidic	very low	Non-sodic	calcium deficient	very low	3
0.10-0.20	moderately acidic	very low	strongly sodic	calcium deficient	very low	2
0.30-0.40	moderately alkaline	low	strongly sodic	calcium deficient	low	2
0.80-0.90	moderately alkaline	low	strongly sodic	calcium deficient	low	2

Soil Chemistry Summary

The pH of the topsoil is strongly acidic, while the subsoil pH grades from moderately acidic to moderately alkaline with depth. The ECEC is very low to low throughout the profile (low clay content). The Ca:Mg ratio indicates that relative to magnesium, calcium is deficient throughout the profile. Concentrations of magnesium are moderate in topsoil and upper subsoil, increasing to high in the mid and lower subsoil. Exchangeable calcium and potassium concentrations are very low and low respectively in the topsoil, and very low in the remainder of the profile. The upper topsoil is non-sodic, resulting in a low dispersibility index.

Soil qualities and limitations

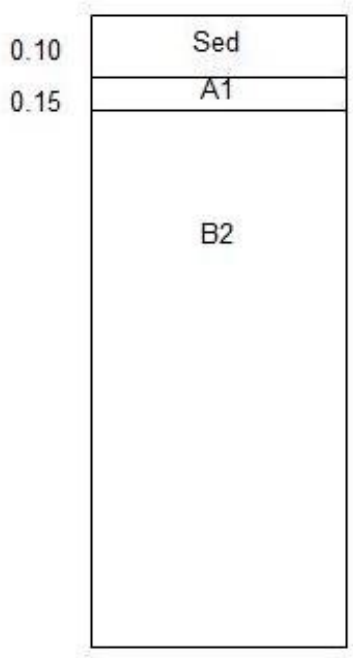
Topsoil (A horizon)

- Very low phosphorus and low nitrogen: limited fertility
- Very low ECEC: limited fertility
- Very low exchangeable calcium and low exchangeable potassium : limited fertility and decreased soil stability
- No apparent sodicity
- Fine surface soil liable to wind and water erosion when exposed

Subsoil (B horizon)

- Very low calcium and potassium: limiting for plant growth and decreased soil stability
- Moderate to high magnesium: limitation for plant growth
- Strongly sodic (26.1 – 31.9 % ESP): decreases fertility and increases potential for dispersion

Table 4-12 Recent Alluvium - Local: Grey-Brown Clay variant

Reference soil type site: SO52	
Type concept	Gradational grey to brown, cracking clays. Crusting to massive surface with strong structure throughout, often with ferruginous or ferromanganiferous segregations in both topsoil and subsoil.
Australian Soil Classification	Endohypersodic, Massive, Grey Vertosol
Landform / landscape position	Open depression, occurring on gently undulating plains
Microrelief	Normal
Surface features	Soft to firm, minor sheet erosion, no coarse fragments
Runoff	Well drained
Soil water regime	Highly permeable
ERD and PAWC	ERD to the upper 0.5 m (sodicity); negatively impacts PAWC.
Relevant sites (soil map unit)	SO03, SO04 (Compound), SO26 (Compound), SO48 (Compound), SO49 (Compound), SO50 (Compound), SO52, SO59 (Compound), SO64 (Compound)
Relevant analysed sites	SO04, SO26, SO52, SO59
Horizon Details	
	**Sed** – CLAYEY SAND Dark brown (10YR 3/3 moist), massive structure, abrupt boundary. **A1** – MEDIUM HEAVY CLAY Very dark greyish brown (10YR 3/2 moist), moderately structured, angular blocky and polyhedral peds, of firm consistence, 5-10 mm cracks, < 2 % abundance of soft ferromanganiferous concretions, clear boundary. **B2** – HEAVY CLAY Weak red (2.5YR 4/2 moist), strong structured, polyhedral peds, of very firm consistence, 5-20 mm cracks, 10-20 % abundance of ferromanganiferous concretions.

Soil Chemical Properties (SO52)

Sample depth mBGL (horizon)	pH 1:5 water	ECe (ds/m)	Chloride (mg/kg)	ECEC (cmol+/kg)	Exchangeable cations (cmol+/kg)				Calculated attributes	
					Ca	Mg	K	Na	ESP (%)	Ca: Mg
0-0.10	6.6	0.95	40	25.2	16.2	7	1.2	0.7	2.8	2.31
0.10-0.20	8	0.90	50	22	10.6	9.9	<0.2	1.6	7.3	1.07
0.20-0.30	7.9	1.26	110	18.6	6.6	9.9	<0.2	2	10.7	0.67
0.50-0.60	6	5.98	1000	17.4	2.7	11.6	<0.1	3	17.2	0.23
0.80-0.90	6.2	6.15	1040	18.5	2.8	12.3	0.1	3.4	18.4	0.23

Ratings						
Sample depth mBGL	**pH**	**Salinity rating (chloride)**	**Sodicity rating (ESP)**	**Ca:Mg rating**	**ECEC**	**Emerson Class**
0-0.10	neutral	very low	non-sodic	low calcium	high	3
0.10-0.20	moderately alkaline	very low	sodic	low calcium	moderate	3
0.20-0.30	moderately alkaline	low	sodic	calcium deficient	moderate	3
0.50-0.60	moderately acidic	high	strongly sodic	calcium deficient	moderate	3
0.80-0.90	slightly acidic	high	strongly sodic	calcium deficient	moderate	2

Soil Chemistry Summary

The alluvial layer (0 – 0.1 m) has neutral pH, while the A1 horizon, below the alluvial layer, has a moderately alkaline pH. The pH of the subsoil grades from moderately alkaline to moderately acidic. The alluvial layer has high concentrations of exchangeable calcium, magnesium, potassium and sodium. Together with a high ECEC, a very high percentage of organic matter and moderate concentrations of nitrogen and extractable phosphorus; likely give the alluvial layer moderate fertility. The A1 horizon and subsoil have low to moderate concentrations of exchangeable calcium and high concentrations of magnesium leading to low calcium availability in these horizons. Exchangeable potassium is present in very low concentrations in the A1 and subsoil horizons. The alluvial layer is non-sodic, resulting in a low dispersibility index. The mid to lower subsoil has a high salinity rating as measured by chloride concentration.

Soil qualities and limitations

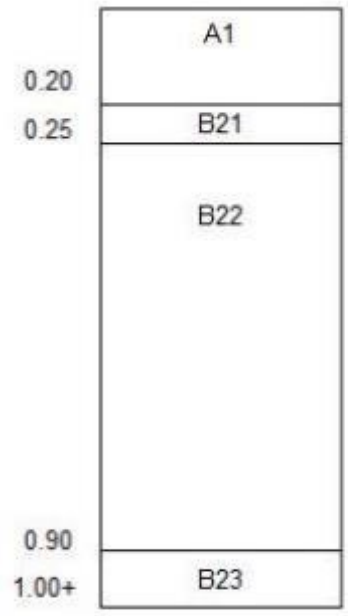
Topsoil (A horizon)

- High concentrations of exchangeable calcium, magnesium, potassium, a high ECEC and moderate concentrations of nitrogen and extractable phosphorus: good for soil fertility
- Very high percentage of organic matter: improved soil fertility and soil stability
- No apparent sodicity
- Fine surface soil liable to wind and water erosion when exposed

Subsoil (B horizon)

- Low calcium in lower subsoil and very low potassium in subsoil: limiting for plant growth and decreased soil stability
- Very high magnesium: limitation for plant growth
- Sodic to strongly sodic soil (ESP 10.8 – 18.4 %): decreases fertility and increases potential for dispersion

Table 4-13 Recent Alluvium – Bohena Creek

Reference soil type site: SO62	
Type concept	Red, red-brown, yellow, to grey gradational soils of variable depth with sandy topsoils to sandy clay subsoils, often coarse sandy. Occurs on levees, cut-offs, fans, and splays associated with Bohena Creek. Variable vegetation associations
Australian Soil Classification	Acid-sodic, Magnesic, Red Dermosol
Landform / landscape position	Flat morphology
Microrelief	Nil
Surface features	soft, sandy surface, no erosion
Runoff	Moderately low.
Soil water regime	Moderately permeable and moderately well-drained
ERD and PAWC	ERD to the upper 0.1 m (Ca:Mg ratio); negatively impacts PAWC.
Relevant sites (soil map unit)	SO10_2 (Complex) SO10_3 (Complex), SO33, SO40, SO41, SO55, SO56, SO62, SO67, SO72
Relevant analysed sites	SO41, SO56, SO62, SO72
Horizon Details	
	**A1** – LOAMY SAND Dark reddish grey (5YR4/2 moist), weakly structured, subangular blocky peds of very weak consistence, clear boundary.
	B21 – CLAY LOAM SANDY Reddish brown (5YR 4/4 moist), with common dark reddish brown (5YR 3/3) mottles, moderately structured, subangular blocky peds of firm consistence, gradual boundary.
	B22 – LIGHT CLAY Yellowish red (5YR 5/6), with many dark greyish red (5YR 4/2) mottles, moderately structured, subangular blocky peds of firm consistence, gradual boundary.
	B23 – MEDIUM CLAY Dark reddish grey (5YR 4/2), with many yellowish red (5YR 5/6) mottles, moderately structured, subangular blocky peds of firm consistence.

Soil Chemical Properties (SO62)

Sample depth mBGL (horizon)	pH 1:5 water	ECe (ds/m)	Chloride (mg/kg)	ECEC (cmol+/kg)	Exchangeable cations (cmol+/kg)				Calculated attributes	
					Ca	Mg	K	Na	ESP (%)	Ca: Mg
0-0.10	5.5	0.45	10	4.2	1.7	2.1	0.3	0.1	2.4	0.81
0.20-0.30	5.9	0.21	20	5.6	<0.1	4.3	0.4	0.8	14.3	<0.1
0.30-0.40	5.2	1.09	100	9.4	<0.1	7.1	0.3	1.9	20.2	<0.1
0.80-0.90	5.4	2.53	430	10.7	<0.1	6.9	<0.1	3.7	34.6	<0.1

Ratings						
Sample depth mBGL	**pH**	**Salinity rating (chloride)**	**Sodicity rating (ESP)**	**Ca:Mg rating**	**ECEC**	**Emerson Class**
0-0.10	strongly acidic	very low	non-sodic	calcium deficient	very low	8
0.20-0.30	moderately acidic	very low	sodic	calcium deficient	very low	3
0.30-0.40	strongly acidic	low	strongly sodic	calcium deficient	low	3
0.80-0.90	strongly acidic	moderate	strongly sodic	calcium deficient	low	2

Soil Chemistry Summary

The pH of the topsoil is strongly acidic, while the subsoil pH grades from moderately acidic to strongly acidic with depth. The ECEC is very low to low throughout the profile. The Ca:Mg ratio indicates that relative to magnesium, calcium is deficient throughout the profile. Concentrations of magnesium are moderate in topsoil increasing to high in the subsoil. Exchangeable calcium concentrations are very low throughout the soil profile. The upper topsoil is non-sodic, resulting in a low dispersibility index, while the remainder of the soil is sodic to strongly sodic with very low to moderate salinity, resulting in the potential for soil dispersal.

Soil qualities and limitations

Topsoil (A horizon)

- Very low phosphorus and low nitrogen: limited fertility
- Very low ECEC: limited fertility
- Very low exchangeable calcium: limited fertility and decreased soil stability
- No apparent sodicity
- Fine surface soil liable to wind and water erosion when exposed

Subsoil (B horizon)

- Very low calcium and very low potassium in lower subsoil: limiting for plant growth and decreased soil stability
- High magnesium: limitation for plant growth
- Strongly sodic (20.2 – 34.6 % ESP): decreases fertility and increases potential for dispersion
- Low ECEC: low fertility

Table 4-14 Acidic Sands

Reference soil type site: SO74	
Type concept	Deep, pale brown to pale yellow sandy to coarse sandy soils with shallow organic layer, often with bleached A2 horizon, occurring as alluvium and on rises and low ridges.
Australian Soil Classification	Acidic, n/a Arenic Rudosol
Landform / landscape position	Mid-slope morphology, occurring on undulating rises
Microrelief	Nil
Surface features	Loose, soft to firm surface, minor sheet erosion
Runoff	Well drained
Soil water regime	Highly permeable
ERD and PAWC	ERD to the upper 0.2 m (Ca:Mg ratio); negatively impacts PAWC. ECEC < 1 between 0.2 and 0.4 mBGL.
Ground observations	SO69 (complex), SO70, SO71 (complex); SO74 (complex), SO75, SO77_2 (complex)
Analysed ground observations	SO69, SO70, SO71, SO74, SO75
Horizon Details	
	A1 – CLAY LOAM SANDY Strong brown (7.5YR 4/6), apedal massive, gradual boundary.
	A2 – SANDY CLAY LOAM Pink (7.5YR 7/4 dry), apedal massive, abrupt boundary.
	B21 – CLAY LOAM SANDY Brown (7.5YR 5/3), with yellowish red (5YR4/6) mottles, weak structure, sub-angular blocky peds, clear boundary.
	B22 – CLAY LOAM SANDY Light brown (7.5YR 6/4), with many yellowish red (5YR4/6) mottles, weak structure, sub-angular blocky peds.

Soil Chemical Properties (SO74)

Sample depth mBGL (horizon)	pH 1:5 water	ECe (ds/m)	Chloride (mg/kg)	ECEC (cmol+/kg)	Exchangeable cations (cmol+/kg)				Calculated attributes	
					Ca	Mg	K	Na	ESP (%)	Ca: Mg
0-0.10	4.6	0.20	<10	1.7	0.8	0.7	0.2	<0.1	<0.1	1.14
0.20-0.30	4.9	0.14	<10	0.6	<0.1	0.3	0.2	<0.1	<0.1	<0.1
0.30-0.40	5.2	0.16	<10	0.6	<0.1	0.3	0.2	<0.1	<0.1	<0.1
0.80-0.90	5.5	1.07	60	3.7	<0.1	2.6	0.3	0.8	21.6	<0.1

Ratings						
Sample depth mBGL	**pH**	**Salinity rating (chloride)**	**Sodicity rating (ESP)**	**Ca:Mg rating**	**ECEC**	**Emerson Class**
0-0.10	very strongly acidic	very low	non-sodic	low calcium	very low	3
0.20-0.30	very strongly acidic	very low	non-sodic	calcium deficient	very low	3
0.30-0.40	strongly acidic	very low	non-sodic	calcium deficient	very low	3
0.80-0.90	strongly acidic	very low	strongly sodic	calcium deficient	very low	3

Soil Chemistry Summary

The pH of the topsoil is very strongly acidic, while the subsoil pH is strongly acidic. The ECEC is very low throughout the profile reflecting the small percentage of clay. The Ca:Mg ratio indicates that relative to magnesium, calcium is in low supply in the top of the topsoil and deficient throughout the remainder of the profile. Very low salinity (chloride) was present throughout the profile. Strongly sodic (ESP = 21.6%) in the lower subsoil. The topsoil and upper subsoil are non-sodic, resulting in a low dispersibility index, while the remainder of the lower subsoil, which is strongly sodic, has the potential for dispersion.

Soil qualities and limitations

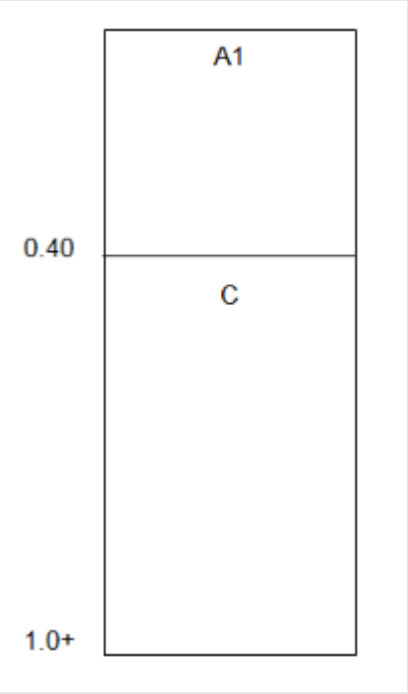
Topsoil (A horizon)

- Very low phosphorus and nitrogen: limited fertility
- Very low ECEC: limited fertility
- Very low exchangeable calcium and low potassium: limited fertility and decreased soil stability
- No apparent sodicity

Subsoil (B horizon)

- Very low calcium and low potassium: limiting for plant growth and decreased soil stability
- High magnesium in lower subsoil: limitation for plant growth
- Strongly sodic in lower subsoil (21.6 % ESP): decreases fertility and increases potential for dispersion
- Very low ECEC: low fertility

Table 4-15 Acidic Sands: Red Variant

Reference soil type site: SO73	
Type concept	Deep, red brown to pink sandy to coarse sandy soils with shallow organic layer, sometimes with paler A2 horizon, occurring as ridges with distinct slopes close to Bohena Creek.
Australian Soil Classification	Acidic, n/a Arenic Rudosol
Landform / landscape position	Crest morphology, occurring on undulating rises
Microrelief	Nil
Surface features	Loose, soft surface, moderate sheet erosion
Runoff	Well drained
Soil water regime	Highly permeable
ERD and PAWC	ERD to the upper 0.2 m (Ca:Mg ratio); negatively impacts PAWC. ECEC < 1 below 0.2 mBGL.
Ground observations	SO73
Analysed ground observations	SO73
Horizon Details	
	A1 – LOAMY SAND Brown (7.5YR 5/4 moist), apedal massive, clear boundary.
	C – SAND Pink (7.5YR 7/4 moist), apedal massive.

Soil Chemical Properties (SO73)

Sample depth mBGL (horizon)	pH 1:5 water	ECe (ds/m)	Chloride (mg/kg)	ECEC (cmol+/kg)	Exchangeable cations (cmol+/kg)				Calculated attributes	
					Ca	Mg	K	Na	ESP (%)	Ca: Mg
0-0.10	4.6	0.20	<10	0.7	0.5	0.1	<0.1	<0.1	<0.1	5
0.20-0.30	4.8	0.09	<10	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
0.30-0.40	4.8	0.09	<10	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
0.80-0.90	5.6	0.04	<10	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

Ratings

Sample depth mBGL	pH	Salinity rating (chloride)	Sodicity rating (ESP)	Ca:Mg rating	ECEC	Emerson Class
0-0.10	very strongly acidic	very low	N/A	balanced	very low	8
0.20-0.30	very strongly acidic	very low	N/A	calcium deficient	very low	8
0.30-0.40	very strongly acidic	very low	N/A	calcium deficient	very low	8
0.80-0.90	moderately acidic	very low	N/A	calcium deficient	very low	8

Soil Chemistry Summary

The pH of the top soil and upper to mid subsoil is very strongly acidic, while the lower subsoil pH is moderately acidic. The ECEC is very low throughout the profile reflecting the small percentage of clay. Exchangeable calcium concentrations are balanced with exchangeable magnesium concentrations in the topsoil, however in the subsoil calcium is deficient. Very low salinity (chloride) and sodicity (ESP) were present throughout the profile. Low sodicity and salinity throughout the soil profile result in high aggregate stability.

Soil qualities and limitations

Topsoil (A horizon)

- Very low phosphorus and nitrogen: limited fertility
- Very low ECEC: limited fertility
- Very low exchangeable calcium and low potassium: limited fertility and decreased soil stability
- No apparent sodicity

Subsoil (B horizon)

- Very low calcium and low potassium: limiting for plant growth and decreased soil stability
- No apparent sodicity
- Very low ECEC: low fertility

5. Impact upon the soil resource

5.1.1 Potential impacts of the project on the soil resource

The agricultural and productive soil resource within the project area would potentially be impacted by the construction of project components including:

- gas and water gathering systems
- well pads
- access tracks
- in-field gas compression at Bibblewindi
- water management, power generation and gas processing facilities at Leewood.

Construction works can disturb soils potentially leading to soil structure breakdown, compaction, hardsetting topsoil, erosion by wind and water, sedimentation, waterlogging.

Other project activities with the potential to impact soil resources include usage of water for dust suppression and irrigation. Usage of treated water for dust suppression at construction sites, access tracks and other disturbed areas creates the potential for erosion, sedimentation of drainage lines, and waterlogging of soil. Potential usage of treated water for irrigated cultivation at selected sites within the project area, if inappropriately managed, could lead to waterlogging, increasing salinity, erosion and sedimentation.

During construction and operation impacts to the soil resource will be directly associated with the features of the land and soil including landform, slope gradient, drainage, vegetation (including crops and pasture), soil surface, soil type, and soil physical and chemical characteristics. This Section identifies potential soil hazards associated with soil types identified in Section 4 and the potential impact to these soil types as a result of the project.

5.1.2 Soil hazard and impact assessment

The soil hazard and impact assessment uses features of the land and soil to identify soil hazards for each soil type. The hazards identified are

- water erosion
- wind erosion
- dispersion
- soil structure decline
- increased salinity
- chemical fertility
- waterlogging.

Table 5-1 identifies potential impacts relevant to each soil hazard.

Table 5-2 provides a summary of soil hazards relevant to each soil type.

Identifying soil hazards provides an indication of the land management practices to apply to soils to prevent degradation to the land and soil within the project area. The management of the soil resource should consider the project's impact and soil hazard.

Good quality agricultural land or high capability land with few hazards may be more resilient to impacts by construction works than poorer quality land. Therefore good quality agricultural land may not need high levels of impact management, except to reinstate productive capacity to original levels.

Lower quality land that has lower capability because of erodibility, poor structure and/or low fertility for example may be more susceptible to impacts from engineering works and therefore represents a greater hazard, requiring more investment to mitigate. The impact on productive capacity of the soils will, however, be less.

Land in the investigation area is of moderate quality and capability and the soils present varying degrees of limitations that present hazards to construction works. These hazards are primarily surface erosion by wind and water because of fine-textured topsoils and sodicity in topsoils allowing high dispersion of the clay aggregates. This erosion will also lead to organic matter decline in these soils. Sodicity in subsoils presents a significant erosion and sedimentation hazard to disturbance and stockpiling.

Other land within the project area that is under forest will also be impacted by the project activities, particularly well construction and facility development at and around Bibblewindi.

However, the soils that will be impacted in this area are the low fertility, low capability sands and sandy duplex soils that exhibit varying levels of sodicity and clay content. Soils likely to be affected are the Sandy Sodic Duplex soils (particularly the Acidic and Deep Sandy, Bleached variants), the Sandy Duplex and Bohena Creek Recent Alluvium, and the Acidic sands, including the Red variant.

Topsoils of all these soils are prone to erosion, although topsoils are not necessarily dispersive. Sandy Sodic Duplex soils on the bedrock areas would have dispersive topsoils, however. Most of these soils are sodic at depth with varying amounts of clay. The clay is invariably sodic and requires management of dispersion and sedimentation from erosion. Most of the soils have deep sandy topsoils that have low water holding capacity, but, where underlain by clays (Sandy Sodic Duplex, Acidic Sands) can be prone to waterlogging. All soils will require fertilisation for rehabilitation. Subsoils will require gypsum application and the Acidic Sands will require lime for stockpiling and for reinstatement and rehabilitation.

Interaction with acid sulfate soils is considered very unlikely as the project area is hundreds of kilometres from coastal areas where these soils tend to occur.

5.1.3 Impacts of construction works on soils

Potential main impacts of the engineering works are likely to be

- disturbance and erosion of topsoil from well-pad construction
- disturbance and erosion from topsoil stripping
- disturbance and erosion from stockpiling for well-pads and flowline trenches
- disturbance and erosion from earthworks (e.g. ramparts and banks)

The area of this impact is confined to the construction area itself, although sedimentation and increased runoff can impact soils and drainage lines off-site.

Access track construction is likely to increase runoff potential and therefore drainage must be planned for to avoid excessive erosion and sedimentation.

Water applied for dust suppression, if excessive, could lead to erosion and sedimentation of drains and drain outflows. Unprotected sodic soils bounding access tracks and construction sites would be prone to erosion and crusting/sealing in the event of excessive water application. Water used for dust suppression would be fit for purpose and appropriately managed in its application.

Sandy Sodic Duplex, Acidic Sands and Recent Alluvium soils

The sandy topsoils of the Sandy Sodic Duplex and Recent Alluvium soils will be susceptible to structural breakdown, leading to increased erosion, organic matter loss, and water-holding capacity. Many of these topsoils show hardsetting characteristics which can be very erodible if broken up or stripped.

The Acidic Sands have little structure and organic matter to begin with, and will not be impacted in the same way.

The subsoils of these soils, including the Acidic Sands, are susceptible to dispersion and erosion, therefore vegetative cover and topsoil with some organic component is necessary to maintain the integrity of these soils for productive (pasture) purposes.

The sodicity and fine-sand content in these subsoils make them susceptible to tunnel erosion and collapse (or cavitation) in trenches and deep excavations if they remain exposed for a length of time to rainfall and/or overland flow.

These are the soils that are likely to be encountered within the Pilliga Forest and will be impacted by development around Bibblewindi, Westport workers' accommodation, well pads and access track / flowline construction.

Potential long term impacts on these soils are eroded topsoils and gully erosion if they are not restored after disturbance. Fertility levels of these soils are already low and constitute the Class 4 and 5 land capability. Fertility is unlikely to be impacted by these construction and operational activities.

Topsoils stripped for stockpiling would require gypsum and fertiliser application before stockpiling and at reinstatement. Vegetative cover on stockpiles and after reinstatement is essential to avoid erosion and sedimentation by water and wind.

Brigalow Clay soils and Grey-brown clays of the Recent Alluvium

The Brigalow Clay soils and clay alluvium are moderately productive if they are not saline or sodic in their topsoils, and if the sodicity and salinity in the subsoil is kept below the root zone. These soils are still dispersive and erodible by water, however. Careful soil management is required during construction and stockpiling to avoid erosion and sedimentation.

Fertility levels of these soils are moderate to moderately low and constitute the Class 3 and 4 land capability. Fertility is unlikely to be impacted by normal construction and operational activities.

Topsoils stripped for stockpiling would require gypsum application before stockpiling and at reinstatement. Vegetative cover on stockpiles and after reinstatement is essential to avoid erosion by water.

Long term impacts on these soils will be minimal if their fertility is maintained.

Red-brown Earths and Red-brown Clays

The red-brown soils are moderately productive if they are not sodic in their topsoils, and if the sodicity and salinity in the subsoil is kept below the root zone. These soils are still erodible by water. The topsoils of the Red-brown Earths are also susceptible to wind erosion. Careful soil management is required during construction and stockpiling to avoid erosion and sedimentation.

Fertility levels of these soils are moderate to moderately low and constitute the Class 3 and 4 land capability under the NSW Land and Soil Capability classification system (Office of Environment and Heritage, 2012d). Fertility is unlikely to be impacted by normal construction and operational activities.

Topsoils stripped for stockpiling would require some low levels of gypsum and fertiliser application before stockpiling and at reinstatement. Vegetative cover on stockpiles and after reinstatement is essential to avoid erosion and sedimentation by water and wind.

Table 5-1 Potential impacts per soil hazard

Hazard	Impact
Water erosion	• loss of the soil from the landscape, subsequently deteriorating landscape's productive capacity and ecosystem functionality • movement of soil materials, associated nutrients and chemicals into water bodies, consequently reducing water quality • damage to infrastructure caused by erosion and deposition of soil materials • change in surface water flow due to irrigation activities, potentially creating new channels where erosion may occur.
Wind erosion	• loss of the soil from the landscape, subsequently deteriorating landscape's productive capacity and ecosystem functionality • disproportionate loss of nutrients and organic carbon from soils as finer and more nutrient-rich fractions are winnowed out by wind erosion • damage to infrastructure, or at least increased maintenance costs due to the need to remove deposited soil material • movement of suspended soil materials by dust cloud adversely affecting visibility, air quality and impacting on infrastructure due to dust deposition.
Dispersion	• increases erodibility considerably due to degraded soil structure • leads to hard setting topsoils when dry • reduced soil structure / hardsetting topsoils limit water and air movement and penetration through the soil profile, impacting water storage for plant growth. Increases runoff and waterlogging potential. • leads to tunnel erosion in subsoils and cavitation/collapse in gullies and trenches. • levelling of gilgai may expose sodic subsoils that will be prone to erosion.
Soil structural decline	• low infiltration and increased runoff resulting in water erosion and sub-optimal use of rainfall for plant growth • increases erodibility • overall poor plant growth • poor germination and emergence of crops / pastures • poor friability of soils requiring increased management inputs.

Hazard	Impact
Salinity	• direct impact on biological and plant growth systems • increased presence of some toxic elements, including aluminium at low pH levels. • reduction in availability of some plant nutrients • increased salinity if insufficient leaching occurs when applying irrigation water. Refer to Chemical fertility impacts (below) for impacts resulting from poor plant growth.
Chemical fertility	• reduced plant growth; pasture/crop failure; reduced farm productivity • low organic matter leads to structural decline and increased potential for soil erosion • increased recharge into groundwater systems leading to increased salinity hazard reduced biodiversity • application of irrigation water and consequent cropping will lead to further removal of nutrients within the soil.
Water logging	• adverse impact on agricultural production and land use • prevents / restricts supply of oxygen to plant roots, severely impacting on plant health and survival • inhibits vehicular access, tillage and sowing operations and stock management • can lead to soil compaction if vehicular, tillage and sowing operations, irrigation activities, and stock management are not controlled • application of irrigation water to soils of coarse subsoil structure will increase saturation of the soils, particularly if irrigation coincides with heavy rainfall. Soils may remain waterlogged for days after flow stops • accumulation of nutrients and water in depressions of soil identified as having strong gilgai • change in surface flow of water from irrigation activities. Note: plants and crops have differing abilities to tolerate waterlogged conditions (i.e. cotton requires waterlogged soils; however, most agricultural crop and pasture plants will suffer in water logged conditions).

Table 5-2 Relevant soil hazards per soil type

Soil type	Topsoil / subsoil	Water erosion (incl. tunnel & cavitation)*	Wind erosion	Dispersion	Soil structure decline	Salinity	Chemical fertility	Waterlogging
Sandy Sodic Duplex	Topsoil	Prone – potential dispersion & sodic	Prone – fine sand	Potential for dispersion Non-sodic	Prone to mechanical structural instability	Very low	Limited fertility	Imperfectly drained
	Subsoil	Prone – potential dispersion & sodic	Unlikely	Potential for dispersion Sodic to strongly sodic	Reduced structural stability	Low	Limited fertility	Imperfectly drained
Sandy Sodic Duplex: Acidic Variant	Topsoil	Prone – potential dispersion& sodic	Prone – fine sand	Potential for dispersion Strongly sodic	Reduced structural stability	Very low	Limited fertility	Well drained
	Subsoil	Prone – potential dispersion & sodic	Unlikely	Potential for dispersion Strongly sodic	Reduced structural stability	Low	Limited fertility	Well drained
Sandy Sodic Duplex: Deep Sandy, Bleached variant	Topsoil	Prone – potential dispersion e & sodic	Prone – fine sand	Potential for dispersion Strongly sodic	Reduced structural stability	Very low	Limited fertility	Imperfectly drained
	Subsoil	Prone – potential dispersion e & sodic	Unlikely	Potential for dispersion Strongly sodic	Reduced structural stability	Moderate	Limited fertility	Imperfectly drained
Brigalow Grey Clays	Topsoil	Prone – potential dispersion & calcium deficient	Unlikely	Potential for dispersion Non-sodic to sodic	Prone to mechanical structural instability	Potential salt toxicity for plant growth	Limited fertility	Prone to waterlogging
	Subsoil	Prone – Potential for dispersion& sodic	Unlikely	Potential for dispersion Sodic to strongly sodic	Reduced structural stability	High salinity	Limited fertility	Prone to waterlogging

Soil type	Topsoil / subsoil	Water erosion (incl. tunnel & cavitation)*	Wind erosion	Dispersion	Soil structure decline	Salinity	Chemical fertility	Waterlogging
Brigalow Grey Clays:Gilgai variant	Topsoil	Prone – dispersive and sodic	Unlikely	Sodic Dispersive	Reduced structural stability	Potential high salinity	Limited fertility	Prone to waterlogging
	Subsoil	Prone – Potential for dispersion, sodic	Unlikely	Potential for dispersion Strongly sodic	Reduced structural stability	High salinity	Limited fertility	Prone to waterlogging
Brigalow Grey Clays: Box variant	Topsoil	Prone – potential dispersion	Unlikely	Potential for dispersion No apparent sodicity	Prone to mechanical structural instability	Non-saline	Low to moderate fertility	Moderately drained
	Subsoil	Prone – Potential for dispersion, sodic & low calcium	Unlikely	Potential for dispersion Sodic	Reduced structural stability	Non-saline	Decreased fertility – calcium deficient	Moderately drained
Red Brown Clays	Topsoil	Prone – potential dispersion	Prone - fine sand	Potential for dispersion No apparent sodicity	Structural stability increased by organic matter	Non-saline	Limited fertility improved by organic matter	Moderately well drained
	Subsoil	Prone – potential dispersion, strongly sodic	-	Potential for dispersion Strongly sodic	Reduced structural stability	Low	Limited fertility	Moderately drained
Red Brown Earths	Topsoil	Prone – potential for dispersion	Prone - fine sand	Potential for dispersion No apparent sodicity	Prone to mechanical structural instability	Very low	Limited fertility	Moderately well drained
	Subsoil	Prone to mechanical structural instability	Prone - fine sand	Potential for dispersion No apparent sodicity	Prone to mechanical structural instability	Very low	Low fertility	Moderately drained
Recent Alluvium: Sandy Duplex	Topsoil	Prone when exposed - fine sand, potential dispersion	Prone - fine sand	Potential for dispersion No apparent sodicity	Prone to mechanical structural instability	Very low	Limited fertility	Imperfectly drained

Soil type	Topsoil / subsoil	Water erosion (incl. tunnel & cavitation)*	Wind erosion	Dispersion	Soil structure decline	Salinity	Chemical fertility	Waterlogging
	Subsoil	Prone when exposed - fine sand, potential dispersion	Unlikely	Potential for dispersion Strongly sodic	Reduced structural stability	Low	Limited fertility	Imperfectly drained
Recent Alluvium: Grey-Brown Clays	Topsoil	Prone when exposed - fine sand, potential dispersion	Prone when exposed- fine sand	Potential for dispersion No apparent sodicity	Structural stability increased by organic matter	Very low	Fertile	Well drained
	Subsoil	Prone when exposed - fine sand, potential dispersion	Prone when exposed- fine sand	Potential for dispersion Strongly sodic	Reduced structural stability	High	Limited fertility	Well drained
Recent Alluvium: Bohena Creek	Topsoil	Prone when exposed - fine sand	Prone when exposed- fine sand	No apparent sodicity	Reduced structural stability	Very low	Limited fertility	Moderately well-drained
	Subsoil	Prone – dispersive, sodic	Prone when exposed	Dispersive Strongly sodic	Reduced structural stability	Low	Limited fertility	Moderately well-drained
Acidic Sands	Topsoil	Prone when exposed - fine sand, potential dispersion	Prone when exposed- fine sand	Potential for dispersion No apparent sodicity	Prone to mechanical structural instability	Very low	Limited fertility	Well drained
	Subsoil	Prone – dispersive, sodic	Prone when exposed- fine sand	Potential for dispersion Strongly sodic	Reduced structural stability	Very low	Limited fertility	Well drained
Acidic Sands: Red variant	Topsoil	Prone when exposed- fine sand	Prone when exposed- fine sand	No apparent sodicity	Reduced structural stability	Very low	Limited fertility	Well drained
	Subsoil	Prone when exposed- fine sand	Prone when exposed- fine sand	No apparent sodicity	Reduced structural stability	Very low	Limited fertility	Well drained

* Tunnel erosion can occur from trenching or exposure of subsoil to surface water. Cavitation is the slumping or collapse of side walls in trenches and banks owing to saturation and/or dispersion in subsoils.

6. Summary of soil assessment and potential impacts

6.1 The soil assessment

A soil assessment and survey was undertaken for the agricultural land and cleared, or partly cleared, private properties in the Pilliga within the project area.

A desktop assessment of existing information and data provided background information to the characteristics of soil, geology, landform and environmental landscape for a soil survey to assess and classify soils and their distribution in the investigation area.

A total of 44 soil profiles were recorded and described, with 31 profiles analysed by a National Association of Testing Authority accredited laboratory. From this survey, six broad soil types, were identified and characterised namely Red-brown earths, Red brown Clays Brigalow Grey clays, Sandy Sodic Duplex, Recent Alluvium and Acidic sands.

The distribution of these soils has been mapped for the investigation area. From the field investigations and the laboratory analysis these soils have been interpreted for hazards that they may represent to project engineering works.

6.2 Soil impact hazards

Soil hazards identified for the purpose of impact assessment are:

- wind erosion
- water erosion
- dispersion
- soil structural decline
- salinity
- chemical fertility
- waterlogging.

The following summarizes the hazards represented by the identified soil types.

- All of the soils types are sodic in the subsoils to some degree, and are therefore potentially dispersive and prone to water erosion.
- The topsoils of all soils are potentially erodible owing to the fine-sand content in all but the Brigalow Grey Clays and Grey-brown Clays of the Recent Alluvium, or the sodicity levels indicating potential dispersivity.
- Most of the clay soils in the area are sodic in the topsoils, as are the Sandy Sodic Duplex and sandy Recent Alluvium. They are all therefore prone to water and wind erosion, because of clay dispersion.
- The Red-brown Earths have topsoils susceptible to erosion because of fine-sand content but have comparatively stable subsoils. The Red-brown Clays are more susceptible to erosion in the subsoil because of fine sand content and sodicity, and accompanying dispersivity.

- The topsoils of the Sandy Sodic Duplex and sandy Recent Alluvium are prone to structural decline if mechanically disturbed. Many of these topsoils show hardsetting characteristics which can be very erodible if broken up or stripped.
- The subsoils of Sandy Sodic Duplex and sandy Recent Alluvium are prone to tunnel erosion and cavitation from deep excavation or trenching.
- Most of the Brigalow Grey Clays and Recent Alluvium are saline in the subsoil from about 0.5 metres depth.

6.2.1 The forest soils

Other land within the project area that is under forest that will be impacted by the project activities are the Sandy Sodic Duplex soils (particularly the Acidic and Deep Sandy, Bleached variants), the Sandy Duplex and Bohena Creek Recent Alluvium, and the Acidic sands, including the Red variant. The above hazards apply to the soils in the forest areas also. However, clearing of forest and scrub vegetation will disturb topsoils and subsoils to a greater degree than the cleared soils. Therefore greater attention should be given to subsoil hazards in these circumstances. Topographic relief in the forest areas can be greater than in the agricultural areas so disturbed soil materials are more prone to surface erosion by water.

Waterlogging on top of the sodic clays is more common in the drainage lines here, especially where medium to coarse sandy topsoils occur, and where tree and shrub cover has been removed.

6.3 Summary of impacts

Impacts of activities associated with the project are largely confined to potential erosion and sedimentation by water for all the soils identified and by wind for all but the Brigalow Grey Clays and Grey-brown clays of the Recent Alluvium.

Fertility is not likely to be impacted to a significant level as most soils have a comparatively low fertility in their current state, but all exposed topsoils (and stockpiled soils) will need to be fertilised and mulched.

The Brigalow Grey Clays are prone to waterlogging, especially the Gilgai variant. Erosion during engineering activities could result. However, these soils are resilient to structural disturbance. Therefore long-term impacts to structure and stability of these soils will be minimal.

Application of saline waters, through irrigation programs, stockpile, management and rehabilitation needs to be planned and managed in accordance with the water salinity levels and soil types affected so that short-term effects can be controlled and long-term effects are monitored, where appropriate.

All the soils in the project area are susceptible to engineering works impact, although all impacts can be mitigated if appropriate guidelines and procedures for erosion and sediment control, and rehabilitation are followed through the establishment and use of site-specific soil management plans and erosion and sediment control plans.

6.4 Mitigation measures

Potential impacts relating to soils would be managed through the implementation of a rehabilitation strategy and an erosion and sediment control plan.

The rehabilitation strategy would include guidance on soil stripping, handling, stockpiling, spreading and rehabilitation practices. The plan would include soil-specific guidance including measures to ameliorate erosion and dispersion.

The erosion and sediment control plan would be based on *Managing Urban Stormwater – Soils and Construction Vol. 1* (Blue Book) and would include:

- erosion and sediment controls for activity-based scenarios including regular activities, instream works, road construction
- guidance on determination of site conditions, control selection criteria and soil types
- design standards, technical notes and implementation considerations for erosion, drainage and sediment controls based on site conditions
- monitoring requirements including water quality monitoring and site inspections.

Topsoil would be stripped, stockpiled and managed in accordance with the rehabilitation strategy and erosion and sediment control plan. As such, measures would be applied at soil stockpiles to preserve or improve soil structure and prevent loss of soil resource through erosion and sedimentation.

Irrigation of treated water would be undertaken in accordance with an irrigation management plan. The plan would seek to ensure that soil structure, stability and productive capacity is maintained, and erosion and effective tail water and stormwater runoff controls are appropriate. It would also include a program of regular and appropriate monitoring.

Only treated, amended or bore water would be used for dust suppression and rehabilitation. Dust suppression and rehabilitation activities would take into consideration:

- managing spraying to avoid ponding and runoff of water
- avoiding spraying during rainfall events
- adjusting application rates based on surface conditions and frequency of application
- routine visual inspection to check for ponding or runoff.

The rehabilitation plan would include measures to rip, plough and ameliorate compacted soils if necessary to improve soil quality as growth media for revegetation.

7. Qualifications

GHD otherwise disclaims responsibility to any person other than Santos arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

Investigations undertaken in respect of this report are constrained by the particular site conditions, such as the location of infrastructure and vegetation. As a result, not all relevant site features and conditions may have been identified in this report.

Site conditions may change after the date of this Report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

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Appendices

Appendix A – Tabulated results

				Moisture	Table 1						Table 2						Table 3							Table 4									Major Cations				Inorganics
				Moisture	pH (1:5 water)	pH (CaCl2)	EC	ECe	CaCO3 Equivalent	Chloride	Kjeldahl Nitrogen Total	Organic Matter	Fluoride Extractable P (Bray)	Nitrogen (Total Oxidised)	Nitrogen (Total)	TOC	Exchangeable Calcium	Exchangeable Magnesium	Exchangeable Potassium	Exchangeable Sodium	CEC	ESP	Calcium Magnesium ratio	Clay (<2 µm)	Fine Sand (0.02-0.2 mm)	Coarse Sand (0.2-2.0 mm)	Silt (2-20 µm)	Gravel (>2mm)	Soil Texture	Color (Munsell)	Emerson Class Number	Calcium	Magnesium	Potassium	Sodium	Total Solids
				%	pH Unit	pH Unit	dS/m	dS/m	%	mg/kg	mg/kg	%	mg/kg	mg/kg	mg/kg	%	meq/100g	meq/100g	meq/100g	meq/100g	meq/100g	%	-	%	%	%	%	%	-	-	-	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
EQL				1	0.1	0.1	0.001		0.01	10	20	0.5	1	0.1	20	0.5	0.1	0.1	0.1	0.1	0.1			1	1	1	1	1				10	10	10	10	5
BSAL criteria (NSW Govt, April 2013)					5-8.9	4.5-8.1		4		800												15	0.1-100												
LocCode	Field_ID	Sample_D	Sampled_Date-Time																																	
SO01	SO01_SOI	0-10	5/06/2014	2.7	7	6.7	0.02	0.172	5.03	<10	650	0.7	5.3	4.2	650	<0.5	7.1	1.4	0.5	<0.1	9	<0.1	5.071	-	-	-	-	-	Sandy clay	Dark brown	3	20	<10	10	<10	65
SO01	SO01_SOI	10-20	5/06/2014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	18	27	45	10	<1	-	-	-	-	-	-	-	-
SO01	SO01_SOI	20-30	5/06/2014	2.8	6.2	5.2	0.013	0.1118	3.77	<10	-	-	-	-	-	-	3.6	1.1	0.3	<0.1	5.1	<0.1	3.273	-	-	-	-	-	ndy clay loa	Dark brown	3	<10	<10	<10	<10	42
SO01	SO01_SOI	30-40	5/06/2014	3.3	7.3	6.1	0.014	0.1204	5.28	<10	-	-	-	-	-	-	3.5	1.8	0.4	0.2	5.9	3.39	1.944	-	-	-	-	-	Sandy clay	Dark brown	3	<10	<10	<10	10	46
SO01	SO01_SOI	50-60	5/06/2014	3	7.2	5.9	0.02	0.172	5.58	20	-	-	-	-	-	-	1.7	1.8	0.3	0.3	4	7.5	0.9444	-	-	-	-	-	ndy clay loa	Brown	3	<10	<10	<10	20	65
SO04	SO04_SOI	0-10	6/06/2014	3.7	5.2	4.1	0.014	0.1204	4.07	<10	920	2.8	4.1	4.4	920	1.6	1.6	1.7	0.5	<0.1	3.9	<0.1	0.9412	-	-	-	-	-	ndy clay loa	Dark brown	4	<10	<10	10	<10	46
SO04	SO04_SOI	10-20	6/06/2014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	26	22	39	13	<1	-	-	-	-	-	-	-	-
SO04	SO04_SOI	20-30	6/06/2014	4.6	5.7	4.1	0.005	0.043	4.63	<10	-	-	-	-	-	-	1.9	2.1	0.2	<0.1	4.3	<0.1	0.9048	-	-	-	-	-	Sandy clay	Dark brown	4	<10	<10	<10	<10	16
SO04	SO04_SOI	30-40	6/06/2014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	26	21	40	13	<1	-	-	-	-	-	-	-	-
SO04	SO04_SOI	50-60	6/06/2014	5.8	6.4	4.8	0.046	0.3956	4.37	50	-	-	-	-	-	-	0.5	2.6	<0.1	0.7	3.9	17.95	0.1923	-	-	-	-	-	Sandy clay	Dark brown	1	<10	<10	<10	40	150
SO04	SO04_SOI	80-90	6/06/2014	5.4	6.6	5.5	0.113	0.9718	4.42	120	-	-	-	-	-	-	0.9	7.2	0.2	2.6	10.8	24.07	0.125	-	-	-	-	-	Sandy clay	Dark brown	1	<10	<10	<10	100	367
SO06	SO06_SOI	0-10	6/06/2014	2.7	6.2	5.1	0.021	0.4767	5.18	<10	480	1.9	4.7	6	490	1.1	2.9	1.9	0.3	<0.1	5.1	<0.1	1.526	-	-	-	-	-	Sand	Dark brown	8	<10	<10	<10	<10	68
SO06	SO06_SOI	10-20	6/06/2014	2	6.3	5.2	0.021	0.1806	6.99	<10	-	-	-	-	-	-	5.1	5.4	0.2	0.4	11.1	3.604	0.9444	-	-	-	-	-	ndy clay lo	ry dark bro	3	<10	<10	<10	20	68
SO06	SO06_SOI	20-30	6/06/2014	1.3	7.1	5.8	0.02	0.276	5.08	<10	-	-	-	-	-	-	3.7	4.1	0.1	0.6	8.6	6.977	0.9024	-	-	-	-	-	Sandy loam	Dark brown	3	<10	<10	<10	10	65
SO06	SO06_SOI	30-40	6/06/2014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	27	19	47	7	<1	-	-	-	-	-	-	-	-
SO06	SO06_SOI	50-60	6/06/2014	8.4	9.2	7.8	0.204	1.754	3.67	180	-	-	-	-	-	-	2.7	6.6	<0.2	2.4	11.7	20.51	0.4091	-	-	-	-	-	Silty clay	Dark brown	1	<10	<10	<10	220	663
SO06	SO06_SOI	80-90	6/06/2014	7.6	9.3	8	0.298	2.563	5.08	230	-	-	-	-	-	-	2.4	7.4	<0.2	3	12.8	23.44	0.3243	-	-	-	-	-	Silty clay	Brown	2	<10	<10	<10	330	968
SO10	SO10_SOI	0-10	8/06/2014	4.5	6.3	5.3	0.055	0.473	4.32	<10	1360	2.1	3.8	12.4	1370	1.2	7.6	2.9	0.4	0.3	11.3	2.655	2.621	-	-	-	-	-	Silty clay	ery dark gre	3	<10	<10	<10	30	179
SO10	SO10_SOI	10-20	8/06/2014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	34	21	32	12	1	-	-	-	-	-	-	-	-
SO10	SO10_SOI	20-30	8/06/2014	5.9	8.4	7	0.06	0.516	4.12	40	-	-	-	-	-	-	6.6	4.5	<0.2	1.1	12.2	9.016	1.467	-	-	-	-	-	Silty clay	ery dark gre	3	<10	<10	<10	50	195
SO10	SO10_SOI	30-40	8/06/2014	4.4	9	7.8	0.108	0.9288	6.44	80	-	-	-	-	-	-	7.2	5.9	0.3	1.6	15	10.67	1.22	-	-	-	-	-	Silty clay	ery dark gre	3	<10	<10	<10	120	351
SO10	SO10_SOI	50-60	8/06/2014	5.2	9.1	7.6	0.225	1.935	7.89	120	-	-	-	-	-	-	5	5.4	<0.2	1.8	12.2	14.75	0.9259	-	-	-	-	-	Sandy clay	k greyish br	1	<10	<10	<10	290	731
SO10	SO10_SOI	80-90	8/06/2014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	27	26	35	11	1	-	-	-	-	-	-	-	-
SO11	SO11_SOI	0-10	5/06/2014	5.2	6.4	5.2	0.028	0.6356	5.23	<10	820	3.3	5	9.4	830	1.9	4.8	1.2	0.6	<0.1	6.7	<0.1	4	-	-	-	-	-	Loamy sand	ry dark bro	3	<10	<10	40	<10	91
SO11	SO11_SOI	10-20	5/06/2014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	17	23	52	8	<1	-	-	-	-	-	-	-	-
SO11	SO11_SOI	20-30	5/06/2014	1.7	6.9	5.9	0.023	0.1978	5.08	<10	-	-	-	-	-	-	3.1	1.2	0.5	<0.1	4.8	<0.1	2.583	-	-	-	-	-	ndy clay loa	ry dark bro	3	<10	<10	30	<10	75
SO11	SO11_SOI	30-40	5/06/2014	3.6	7.6	6.2	0.028	0.2408	4.52	10	-	-	-	-	-	-	2.6	1	0.6	<0.2	4.2	<0.2	2.6	-	-	-	-	-	ndy clay loa	Dark brown	3	<10	<10	40	<10	91
SO11	SO11_SOI	50-60	5/06/2014	5.5	7.2	6.6	0.04	0.344	3.57	10	-	-	-	-	-	-	4	2.4	1.1	<0.1	7.6	<0.1	1.667	-	-	-	-	-	Sandy clay	Dark brown	3	<10	<10	60	<10	130
SO11	SO11_SOI	80-90	5/06/2014	4.5	7.8	6.9	0.035	0.301	3.37	<10	-	-	-	-	-	-	2.7	1.7	0.8	<0.2	5.2	<0.2	1.588	-	-	-	-	-	ndy clay loa	Dark brown	3	<10	<10	40	<10	114
SO14	SO14_SOI	0-10	8/06/2014	5.4	6.2	4.8	0.016	0.1376	3.57	<10	800	1.4	5.2	1.9	800	0.8	4.6	2	0.2	0.1	7	1.429	2.3	-	-	-	-	-	ndy clay loa	ery dark gre	3	<10	<10	<10	10	52
SO14	SO14_SOI	10-20	8/06/2014	12	8.2	6.3	0.069	0.6555	4.42	<10	-	-	-	-	-	-	14.3	5.2	<0.2	<0.2	19.5	<0.2	2.75	-	-	-	-	-	ilty clay loa	ery dark gre	4	20	<10	<10	60	224
SO14	SO14_SOI	20-30	8/06/2014	13	8.8	7.6	0.127	1.207	7.09	<10	-	-	-	-	-	-	18.2	7.3	<0.2	0.5	26	1.923	2.493	-	-	-	-	-	ilty clay loa	ery dark gre	4	20	<10	<10	160	413
SO14	SO14_SOI	30-40	8/06/2014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	44	18	26	10	2	-	-	-	-	-	-	-	-
SO14	SO14_SOI	50-60	8/06/2014	12.4	9	7.9	0.277	2.632	9.55	60	-	-	-	-	-	-	12.8	9.5	<0.2	2	24.3	8.23	1.347	-	-	-	-	-	ilty clay loa	k greyish br	4	<10	<10	<10	360	900
SO14	SO14_SOI	80-90	8/06/2014	11.4	9.4	8.1	0.37	3.515	5.33	120	-	-	-	-	-	-	10.6	10.2	<0.2	3.6	24.4	14.75	1.039	-	-	-	-	-	ilty clay loa	k greyish br	3	<10	<10	<10	470	1200
SO17	SO17_SOI	0-10	6/06/2014	13.2	6.5	5.8	0.039	0.3705	3.72	20	510	0.7	2.5	11.5	520	<0.5	13.7	8.2	0.5	0.7	23	3.043	1.671	-	-	-	-	-	ilty clay loa	ark greyish	4	<10	<10	<10	40	127
SO17	SO17_SOI	10-20	6/06/2014	11.3	7.1	5.8	0.033	0.2838	4.42	30	-	-	-	-	-	-	13.1	8.2	0.2	1.8	23.3	7.725	1.598	-	-	-	-	-	Silty clay	ark greyish	3	<10	<10	<10	40	107
SO17	SO17_SOI	20-30	6/06/2014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	47	20	21	12	<1	-	-	-	-	-	-	-	-
SO17	SO17_SOI	30-40	6/06/2014	11	8.8	7.9	0.371	3.191	7.44	340	-	-	-	-	-	-	11.1	7.9	<0.2	2.6	21.7	11.98	1.405	-	-	-	-	-	Silty clay	Dark grey	4	<10	<10	<10	430	1200
SO17	SO17_SOI	50-60	6/06/2014	10.8	8.8	7.8	0.392	3.371	4.58	350	-	-	-	-	-	-	9.7	7.7	<0.2	2.8	20.3	13.79	1.26	-	-	-	-	-	Silty clay	Dark grey	3	<10	<10	<10	430	1270
SO17	SO17_SOI	80-90	6/06/2014	10.5	7.7	6.3	0.423	3.638	6.34	430	-	-	-	-	-	-	6.6	6.6	<0.2	3	16.2	18.52	1	-	-	-	-	-	Silty clay	k greyish br	1	<10	<10	<10	450	1370
SO18	SO18_SOI	0-10	6/06/2014	5.4	6.7	5.2	0.023	0.1978	5.58	<10	530	3.8	3.4	8.4	540	2.2	3	2.5	0.3	0.4	6.2	6.452	1.2	-	-	-	-	-	ndy clay loa	ry dark bro	3	<10	<10	<10	20	75
SO18	SO18_SOI	10-20	6/06/2014	4.3	7	5	0.041	0.3526	4.07	30	-	-	-	-	-	-	2.1	2.5	<0.1	0.9	5.6	16.07	0.84	-	-	-	-	-	Sandy clay	ry dark bro	3	<10	<10	<10	30	133
SO18	SO18_SOI	20-30	6/06/2014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	29	18	47	6	<1	-	-	-	-	-	-	-	-
SO18	SO18_SOI	30-40	6/06/2014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	27	19	45	9	<1	-	-	-	-	-	-	-	-
SO18	SO18_SOI	80-90	6/06/2014	9.6	9.1	8.1	0.661	5.685	5.18	770	-	-	-	-	-	-	4.8	7.2	<0.2	3.1	15	20.67	0.6667	-	-	-	-	-	Silty clay	k greyish br	2	<10	<10	<10	910	2150
SO21	SO21_SOI	0-10	5/06/2014	10.2	6.2	5.1	0.027	0.2322	4.37	20	1460	3.5	3.3	5.6	1460	2	7.1	3.8	0.8	0.3	12	2.5	1.868	-	-	-	-	-	Silty clay	ry dark bro	3	<10	<10	<10	30	88
SO21	SO21_SOI	10-20	5/06/2014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	39	19	34	8	<1	-	-	-	-	-	-	-	-
SO21	SO21_SOI	20-30	5/06/2014	8.6	8.9	7.7	0.109	0.9374	5.83	20	-	-	-	-	-	-	9.3	4	0.4	<0.2	13.7	<0.2	2.325	-	-	-	-	-	Silty clay	ark greyish	3	<10	<10	10	190	354
SO21	SO21_SOI	30-40	5/06/2014	11.5	9	8	0.214	1.84	7.84	70	-	-	-	-	-	-	10.2	7.3	0.3	0.9	18.7	4.813	1.397	-	-	-	-	-	Silty clay	ark greyish	3	10	<10	<10	340	696
SO21	SO21_SOI	50-60	5/06/2014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	39	21	34	6	<1	-	-	-	-	-	-	-	-
SO21	SO21_SOI	80-90	5/06/2014	8.9	9.4	7.9	0.463	3.982	5.58	310	-	-	-	-	-	-	4.9	8.4	<0.2	2.5	15.8	15.82	0.5833	-	-	-	-	-	Silty clay	k greyish br	3	<10	<10	<10	750	1500
SO22	SO22_SOI	0-10	5/06/2014	10.4	9.9	5.3	0.028	0.2408	5.33	20	800	1.4	2.7	2.8	800	0.8	6.9	5.1	0.3	0.4	12.8	3.125	1.353	-	-	-	-	-	Silty clay	ark greyish	4	<10	<10	<10	30	91
SO22	SO22_SOI	10-20	5/06/2014	12.6	7	5.7	0.048	0.4128	4.07	50	-	-	-	-	-	-	12.2	11.9	0.5	1.5	26.1	5.747	1.025	-	-	-	-	-	Silty clay	k greyish br	4	<10	<10	<10	50	156
SO22	SO22_SOI	20-30	5/06/2014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	58	16	16	10	<1	-	-	-	-	-	-	-	-
SO22	SO22_SOI	30-40	5/06/2014	11.7	7.4	6.4	0.185	1.591	5.13	280	-	-	-	-	-	-	8.8	8	<0.2	1.4	18.2	7.692	1.1	-	-	-	-	-	Silty clay	ark greyish	4	<10	<10	<10	200	601
SO22	SO22_SOI	50-60	5/06/2014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	43	24	23	10	<1	-	-	-	-	-	-	-	-

SO22	SO22_SOI	80-90	5/06/2014	10.5	8.7	7.8	0.287	2.468	7.09	310	-	-	-	-	-	-	9.1	9.7	<0.2	1.8	20.6	8.738	0.9381	-	-	-	-	-	Silty clay	Dark grey	3	<10	<10	<10	310	933
SO23	SO23_SOI	0-10	5/06/2014	8.4	6.4	4.5	0.031	0.2666	4.22	20	780	1.9	4.4	3.7	780	1.1	2.6	5.4	0.2	1	9.3	10.75	0.4815	-	-	-	-	-	Silty clay	ark greyish	3	<10	<10	<10	20	101
SO23	SO23_SOI	10-20	5/06/2014	9.3	6.7	5.8	0.122	1.049	4.83	70	-	-	-	-	-	-	4.9	6.4	<0.1	2.7	14.2	19.01	0.7656	-	-	-	-	-	Silty clay	ark greyish	3	<10	<10	<10	130	396
SO23	SO23_SOI	20-30	5/06/2014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	27	30	31	12	<1	-	-	-	-	-	-	-
SO23	SO23_SOI	30-40	5/06/2014	6.7	8.4	7.7	0.413	3.552	5.13	270	-	-	-	-	-	-	5	7.3	<0.2	2	14.3	13.99	0.6849	-	-	-	-	-	Silty clay	ery dark gre	3	<10	<10	<10	510	1340
SO23	SO23_SOI	50-60	5/06/2014	6.3	8.1	7.1	0.467	4.016	4.58	310	-	-	-	-	-	-	3.5	6.3	<0.2	2.1	11.9	17.65	0.5556	-	-	-	-	-	Silty clay	ark greyish	3	<10	<10	<10	520	1520
SO23	SO23_SOI	80-90	5/06/2014	7.4	5.2	4.4	0.536	4.61	3.42	330	-	-	-	-	-	-	2.2	5.8	0.2	2.2	10.4	21.15	0.3793	-	-	-	-	-	Silty clay	k greyish br	2	<10	<10	<10	610	1740
SO26	SO26_SOI	0-10	6/06/2014	3	5.8	5	0.062	0.589	3.97	<10	1230	1.4	28.4	9.8	1240	0.8	3.6	1.4	0.6	<0.1	5.7	<0.1	2.571	-	-	-	-	-	Loam	ry dark brov	3	<10	<10	20	<10	202
SO26	SO26_SOI	10-20	6/06/2014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11	50	30	9	<1	-	-	-	-	-	-	-
SO26	SO26_SOI	20-30	6/06/2014	<1	5.2	4.1	0.019	0.4313	3.02	<10	-	-	-	-	-	-	1.2	1	0.1	0.1	2.4	4.167	1.2	-	-	-	-	-	Loamy sand	Dark brown	3	<10	<10	<10	10	62
SO26	SO26_SOI	30-40	6/06/2014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	46	33	7	<1	-	-	-	-	-	-	-
SO26	SO26_SOI	50-60	6/06/2014	1.8	5.4	4	0.019	0.4313	3.22	10	-	-	-	-	-	-	0.7	1.2	<0.1	0.1	2.1	4.762	0.5833	-	-	-	-	-	Loamy sand	Dark brown	3	<10	<10	<10	10	62
SO26	SO26_SOI	80-90	6/06/2014	<1	5.4	4	0.013	0.2951	4.17	<10	-	-	-	-	-	-	0.3	0.8	<0.1	<0.1	1.2	<0.1	0.375	-	-	-	-	-	Loamy sand	yellowish b	3	<10	<10	<10	<10	42
SO27	SO27_SOI	0-10	6/06/2014	20.8	5.9	4.7	0.036	0.3096	4.32	10	1480	4	5.1	9.3	1490	2.3	8.8	13.9	0.5	1.4	24.6	5.691	0.6331	-	-	-	-	-	Silty clay	ark greyish	3	<10	<10	<10	30	117
SO27	SO27_SOI	10-20	6/06/2014	12.9	5.8	4.7	0.151	1.299	3.97	160	-	-	-	-	-	-	7	13.2	0.2	3.2	23.8	13.45	0.5303	-	-	-	-	-	Silty clay	ark greyish	3	<10	<10	<10	170	491
SO27	SO27_SOI	20-30	6/06/2014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	55	17	16	12	<1	-	-	-	-	-	-	-
SO27	SO27_SOI	30-40	6/06/2014	13	5.4	4.6	0.498	4.283	3.77	960	-	-	-	-	-	-	4.6	11.4	0.1	3.3	19.5	16.92	0.4035	-	-	-	-	-	Silty clay	Dark grey	1	<10	<10	<10	620	1620
SO27	SO27_SOI	80-90	6/06/2014	10	5.9	5	0.443	3.81	2.56	740	-	-	-	-	-	-	2.9	8.1	<0.1	3.3	14.4	22.92	0.358	-	-	-	-	-	Silty clay	Dark grey	2	<10	<10	<10	460	1440
SO29	SO29_SOI	0-10	8/06/2014	5.3	6.1	5.2	0.071	0.6745	4.07	10	1590	0.7	4.4	14.4	1600	<0.5	7	1.8	1.1	0.1	10.1	0.9901	3.889	-	-	-	-	-	ilty clay loa	ry dark brov	4	<10	<10	40	10	231
SO29	SO29_SOI	10-20	8/06/2014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	19	31	41	9	<1	-	-	-	-	-	-	-
SO29	SO29_SOI	20-30	8/06/2014	5.2	7	5.9	0.023	0.1978	3.97	<10	-	-	-	-	-	-	4.4	2	0.5	0.1	7	1.429	2.2	-	-	-	-	-	Clay loam	k greyish br	3	<10	<10	<10	10	75
SO29	SO29_SOI	30-40	8/06/2014	8.8	7.3	6.5	0.022	0.1892	4.78	<10	-	-	-	-	-	-	6	4.8	0.5	0.4	11.8	3.39	1.25	-	-	-	-	-	Silty clay	ry dark brov	3	<10	<10	<10	20	72
SO29	SO29_SOI	50-60	8/06/2014	8.7	8	6.2	0.032	0.2752	6.03	<10	-	-	-	-	-	-	5	4.8	0.4	<0.2	10.1	<0.2	1.042	-	-	-	-	-	Silty clay	k reddish br	3	<10	<10	<10	30	104
SO29	SO29_SOI	80-90	8/06/2014	9.4	8	6.4	0.069	0.5934	5.23	<10	-	-	-	-	-	-	4.1	5.5	0.3	0.9	10.8	8.333	0.7455	-	-	-	-	-	Clay loam	k reddish br	3	<10	<10	<10	60	224
SO31	SO31_SOI	0-10	8/06/2014	2.5	6.5	5.7	0.052	1.18	7.83	10	1240	4.9	3.2	16.8	1260	2.8	6.2	1.6	0.3	<0.1	8.2	<0.1	3.875	-	-	-	-	-	Sand	ry dark brov	8	30	<10	30	<10	169
SO31	SO31_SOI	10-20	8/06/2014	1.8	7.6	6.4	0.03	0.414	5.24	<10	-	-	-	-	-	-	2.1	1.3	<0.2	<0.2	3.4	<0.2	1.615	-	-	-	-	-	Sandy loam	Dark brown	3	<10	<10	10	20	98
SO31	SO31_SOI	20-30	8/06/2014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	17	24	54	5	<1	-	-	-	-	-	-	-
SO31	SO31_SOI	30-40	8/06/2014	9.6	8.7	7.4	0.168	1.445	4.69	90	-	-	-	-	-	-	0.9	4.3	<0.2	1.4	6.5	21.54	0.2093	-	-	-	-	-	ndy clay loa	Brown	2	<10	10	<10	160	546
SO31	SO31_SOI	50-60	8/06/2014	8.2	8.4	7.3	0.271	2.331	5.98	270	-	-	-	-	-	-	0.8	3	<0.2	1	4.8	20.83	0.2667	-	-	-	-	-	Clay loam	reyish brow	2	<10	<10	<10	250	881
SO32	SO32_SOI	0-10	8/06/2014	1.8	5.2	4.2	0.019	0.4313	6.43	<10	720	3.5	1.4	3.5	720	2	1.5	0.4	0.2	<0.1	2.1	<0.1	3.75	-	-	-	-	-	Sand	ry dark brov	8	<10	<10	10	<10	62
SO32	SO32_SOI	10-20	8/06/2014	1.6	5	3.8	0.008	0.1816	5.58	<10	-	-	-	-	-	-	0.4	0.3	<0.1	<0.1	0.7	<0.1	1.333	-	-	-	-	-	Sand	ry dark brov	8	<10	<10	<10	<10	26
SO32	SO32_SOI	20-30	8/06/2014	1.5	5.3	4	0.006	0.1362	5.29	<10	-	-	-	-	-	-	0.4	0.4	<0.1	<0.1	0.8	<0.1	1	-	-	-	-	-	Sand	ry dark brov	8	<10	<10	<10	<10	20
SO32	SO32_SOI	30-40	8/06/2014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6	24	65	5	<1	-	-	-	-	-	-	-
SO32	SO32_SOI	50-60	8/06/2014	3.3	5.8	4	0.048	0.4128	4.44	40	-	-	-	-	-	-	0.1	1.4	<0.1	0.5	2.1	23.81	0.07143	-	-	-	-	-	ndy clay loa	Brown	2	<10	<10	<10	40	156
SO32	SO32_SOI	80-90	8/06/2014	6.9	5.5	4.2	0.11	0.946	2.85	110	-	-	-	-	-	-	0.5	3.9	0.2	1.4	6.1	22.95	0.1282	-	-	-	-	-	ndy clay loa	trong brow	2	<10	10	10	100	358
SO35	SO35_SOI	0-10	5/06/2014	9.6	5.9	4.8	0.023	0.2185	5.83	10	1050	4.4	2	3.8	1050	2.5	5.8	3.2	0.3	0.2	9.4	2.128	1.813	-	-	-	-	-	ilty clay loa	ry dark brov	3	<10	<10	<10	20	75
SO35	SO35_SOI	10-20	5/06/2014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	31	27	37	5	<1	-	-	-	-	-	-	-
SO35	SO35_SOI	20-30	5/06/2014	10.2	7.6	6.2	0.039	0.3354	6.98	<10	-	-	-	-	-	-	6.2	4.4	<0.2	0.6	11.3	5.31	1.409	-	-	-	-	-	ndy clay loa	Dark brown	2	10	20	10	40	127
SO35	SO35_SOI	30-40	5/06/2014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	38	22	33	7	<1	-	-	-	-	-	-	-
SO35	SO35_SOI	50-60	5/06/2014	13.2	8.8	7.6	0.268	2.305	6.78	200	-	-	-	-	-	-	2.8	8.1	<0.2	2.9	13.9	20.86	0.3457	-	-	-	-	-	Silty clay	Dark brown	1	<10	<10	<10	270	871
SO35	SO35_SOI	80-90	5/06/2014	11.1	9.2	7.5	0.488	4.197	9.47	290	-	-	-	-	-	-	4.1	8.8	<0.2	2.5	15.4	16.23	0.4659	-	-	-	-	-	Silty clay	Dark brown	1	<10	<10	<10	600	1590
SO36	SO36_SOI	0-10	5/06/2014	7.4	6.4	6.4	0.03	0.285	3.54	<10	1900	4.9	31.1	8.9	1910	2.8	7.5	3	0.8	0.1	11.5	0.8696	2.5	-	-	-	-	-	ilty clay loa	Black	3	<10	<10	10	10	98
SO36	SO36_SOI	10-20	5/06/2014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	38	23	28	11	<1	-	-	-	-	-	-	-
SO36	SO36_SOI	20-30	5/06/2014	9.2	8	6.4	0.045	0.387	5.44	10	-	-	-	-	-	-	5.5	5.4	<0.2	1.1	11.9	9.244	1.019	-	-	-	-	-	Silty clay	ark greyish	3	<10	<10	<10	40	146
SO36	SO36_SOI	30-40	5/06/2014	8.7	8.1	7.1	0.057	0.4902	5.49	30	-	-	-	-	-	-	4.2	4.8	<0.2	1.2	10.3	11.65	0.875	-	-	-	-	-	Clay loam	ery dark gre	2	<10	<10	<10	50	185
SO36	SO36_SOI	50-60	5/06/2014	10.5	8.7	7.6	0.235	2.021	5.88	180	-	-	-	-	-	-	4.2	6.2	<0.2	2.3	12.6	18.25	0.6774	-	-	-	-	-	Silty clay	k greyish br	1	<10	<10	<10	250	764
SO36	SO36_SOI	80-90	5/06/2014	10.6	8.4	7.4	0.461	3.965	5.44	470	-	-	-	-	-	-	3.4	6	<0.2	2.1	11.6	18.1	0.5667	-	-	-	-	-	Silty clay	Brown	2	<10	<10	<10	570	1500
SO37	SO37_SOI	0-10	5/06/2014	14.5	6.7	4.9	0.024	0.2064	4.19	<10	750	3.4	3.2	3.6	750	2	5.8	10.7	0.3	1.5	18.3	8.197	0.5421	-	-	-	-	-	Silty clay	ark greyish	3	<10	<10	<10	20	78
SO37	SO37_SOI	10-20	5/06/2014	11.6	6.6	5.8	0.077	0.6622	5.24	40	-	-	-	-	-	-	8.6	12.2	0.2	3.1	24.2	12.81	0.7049	-	-	-	-	-	Silty clay	ery dark gre	3	<10	<10	<10	70	250
SO37	SO37_SOI	20-30	5/06/2014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	50	22	13	15	<1	-	-	-	-	-	-	-
SO37	SO37_SOI	30-40	5/06/2014	9.4	7.3	6.8	0.326	2.804	6.13	380	-	-	-	-	-	-	6.9	9.6	0.1	3	19.6	15.31	0.7188	-	-	-	-	-	Silty clay	Black	3	<10	<10	<10	340	1060
SO37	SO37_SOI	80-90	5/06/2014	10.4	7.3	6.6	0.474	4.076	5.04	610	-	-	-	-	-	-	5.4	9.8	0.1	3.4	18.8	18.09	0.551	-	-	-	-	-	Silty clay	k greyish br	3	<10	<10	<10	490	1540
SO38	SO38_SOI	0-10	7/06/2014	2.7	5	4.2	0.029	0.6583	6.08	10	1050	3.4	15.1	6.8	1060	2	2.2	1.5	0.4	<0.1	4.2	<0.1	1.467	-	-	-	-	-	Sand	ry dark brov	8	<10	<10	10	10	94
SO38	SO38_SOI	10-20	7/06/2014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	20	22	53	5	<1	-	-	-	-	-	-	-
SO38	SO38_SOI	20-30	7/06/2014	4.3	6.1	4.4	0.18	1.548	5.49	150	-	-	-	-	-	-	0.4	3.4	<0.1	2.3	6.2	37.1	0.1176	-	-	-	-	-	Clay loam	Dark brown	1	<10	<10	<10	160	585
SO38	SO38_SOI	30-40	7/06/2014	8.6	7.2	6.8	0.389	3.345	6.88	470	-	-	-	-	-	-	1.2	9	0.1	3.2	13.5	23.7	0.1333	-	-	-	-	-	Silty clay	Brown	2	<10	<10	<10	410	1260
SO38	SO38_SOI	50-60	7/06/2014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	30	19	40	11	<1	-	-	-	-	-	-	-
SO38	SO38_SOI	80-90	7/06/2014	7	6.7	6.9	0.734	6.312	9.97	640	-	-	-	-	-	-	17.3	11.3	0.2	2.1	30.9	6.796	1.531	-	-	-	-	-	Silty clay	Dark brown	1	<10	10	<10	870	2380
SO39	SO39_SOI	0-10	7/06/2014	8.2	8	7.5	0.025	0.215	6.73	<10	1590	4.2	1.7	4.9	1590	2.4	5.7	2.9	0.9	<0.2	9.4	<0.2	1.966	-	-	-	-	-	Silty clay	ry dark brov	3	<10	<10	20	20	81
SO39	SO39_SOI	10-20	7/06/2014	11.2	7.3	6.4	0.139	1.195	6.53	130	-	-	-	-	-	-	13.4	12.6	0.2	1.9	28.2	6.738	1.063	-	-	-	-	-	Silty clay	ery dark gre	4	<10	<10	<10	140	452
SO39	SO39_SOI	20-30	7/06/2014	12.4	8.7	7.4	0.197	1.694	6.93	50	-	-	-	-	-	-	12.6	11.2	<0.2	1.2	25.1	4.781	1.125	-	-	-	-	-	Silty clay	ark greyish	4	10	<10	<10	250	640
SO39	SO39_SOI	30-40	7/06/2014	12.1	8.7	7.5	0.398	3.423	6.83	240	-	-	-	-	-	-	8.7	12.2	<0.2	1.6	22.5	7.111	0.7131	-	-	-	-	-	Silty clay	Dark brown	4	<10	10	<10	420	1290
SO39	SO39_SOI	50-60	7/06/2014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	47	20	27	6	<1	-	-	-	-	-	-	-
SO39	SO39_SOI	80-90	7/06/2014	7.6	8.9	7.8	0.799	6.871	8.42	740	-	-	-	-	-	-	6	13.3	<0.2	2.7	22.1	12.22	0.4511	-	-	-	-	-	Silty clay	k greyish br	3	20	20	<10	930	2600
SO41	SO41_SOI	0-10	7/06/2014	3	4.6	4.6	0.023	0.5221	3.14	<10	790	4.4	<1	1.2	790	2.5	1.3	0.8	0.2	<0.1	2.4	<0.1	1.625	-	-	-	-	-	Sand	k reddish br	8	<10	<10	10	<10	75
SO41	SO41_SOI	10-20	7/06/2014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11	22	63	4	<1	-	-	-	-	-	-	-
SO41	SO41_SOI	20-30	7/06/2014	2.6	5	4.2	0.008	0.1816	3.84	<10	-	-	-	-	-	-	<0.1	0.6	0.1	<0.1	0.8	<0.1	<0.1	-	-	-	-	-	Loamy sand	Dark Red	3	<10	<10	<10	<10	26
SO41	SO41_SOI	30-40	7/06/2014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15	23	59	3	<1	-	-	-	-	-	-	-
SO41	SO41_SOI	50-60	7/06/2014	4.3	5.5	4.1	0.006	0.1362	5.04	<10	-	-	-	-	-	-	<0.1	1.2	0.3	<0.1	1.5	<0.1	<0.1	-	-	-	-	-	Loamy sand	Dark Red	4	<10	<10	<10	<10	20
SO41	SO41_SOI	80-90	7/06/2014	5.5	5.4	4.1	0.01	0.227	0.95	<10	-	-	-	-	-	-	<0.1	1.6	0.3	<0.1	2	<0.1	<0.1	-	-	-	-	-	Loamy sand	Dark Red	4	<10	<10	<10	<10	32
SO44	SO44_SOI	0-10	5/06/2014	8.5	5.3	4	0.013	0.1794	2.55	<10	550	2	4.3	2.8	550	1.2	1.2	2.1	0.2	0.1	3.7	2.703	0.5714	-	-	-	-	-	Sandy loam	Dark brown	3	<10	<10	<10	10	42

SO44	SO44_SOI	10-20	5/06/2014	4.4	5.7	4.1	0.049	0.6762	3.59	20	-	-	-	-	-	-	0.7	2.6	<0.1	1.2	4.6	26.09	0.2692	-	-	-	-	-	Sandy loam	Dark brown	2	<10	<10	<10	50	159
SO44	SO44_SOI	20-30	5/06/2014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	21	33	41	5	<1	-	-	-	-	-	-	-	-
SO44	SO44_SOI	30-40	5/06/2014	8.5	7.9	6.7	0.319	2.743	4.19	210	-	-	-	-	-	-	1.4	4.5	<0.2	1.7	7.6	22.37	0.3111	-	-	-	-	-	Sandy clay	ery dark gre	2	<10	<10	<10	340	1040
SO44	SO44_SOI	50-60	5/06/2014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	19	34	34	13	<1	-	-	-	-	-	-	-	-
SO44	SO44_SOI	80-90	5/06/2014	4.8	8.4	6.8	0.245	2.107	5.13	150	-	-	-	-	-	-	<0.2	4.7	<0.2	2.2	6.9	31.88	<0.2	-	-	-	-	-	Sandy clay	k greyish br	2	<10	<10	<10	340	796
SO45	SO45_SOI	0-10	6/06/2014	15.5	7.2	6.3	0.046	0.3956	0.75	10	1370	2.2	<1	17.5	1390	1.3	25.7	10.5	1.1	0.4	37.8	1.058	2.448	-	-	-	-	-	Silty clay	ark greyish	3	<10	<10	10	40	150
SO45	SO45_SOI	10-20	6/06/2014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	47	24	17	12	<1	-	-	-	-	-	-	-	-
SO45	SO45_SOI	20-30	6/06/2014	14.7	8.6	6.9	0.128	1.101	1.05	70	-	-	-	-	-	-	11	8.5	<0.2	1.2	20.6	5.825	1.294	-	-	-	-	-	Silty clay	ark greyish	3	<10	<10	<10	170	416
SO45	SO45_SOI	30-40	6/06/2014	13.5	8.8	7.8	0.151	1.299	2.3	80	-	-	-	-	-	-	8.1	9.7	<0.2	1.8	19.7	9.137	0.8351	-	-	-	-	-	Silty clay	Dark brown	3	<10	<10	<10	210	491
SO45	SO45_SOI	50-60	6/06/2014	11.8	9.1	8.1	0.435	3.741	2.41	560	-	-	-	-	-	-	5.5	8.9	<0.2	2.9	17.3	16.76	0.618	-	-	-	-	-	Silty clay	Dark brown	2	<10	<10	<10	490	1410
SO45	SO45_SOI	80-90	6/06/2014	11.7	8	6.7	0.476	4.094	1.8	660	-	-	-	-	-	-	3.5	9.1	<0.2	3.2	15.8	20.25	0.3846	-	-	-	-	-	Silty clay	ark greyish	2	<10	<10	<10	600	1550
SO46	SO46_SOI	0-10	6/06/2014	9.2	8	7.2	0.141	1.213	3.51	10	1560	3.1	22	7.4	1570	1.8	15	1.6	0.9	<0.2	17.5	<0.2	9.375	-	-	-	-	-	Silty clay	Black	4	130	10	30	20	458
SO46	SO46_SOI	10-20	6/06/2014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	54	19	15	12	<1	-	-	-	-	-	-	-	-
SO46	SO46_SOI	20-30	6/06/2014	13	8.4	7.4	0.203	1.746	0.6	180	-	-	-	-	-	-	5.7	4.9	<0.2	0.7	11.4	6.14	1.163	-	-	-	-	-	Silty clay	ark greyish	3	<10	<10	<10	240	660
SO46	SO46_SOI	30-40	6/06/2014	12.6	9	7.4	0.318	2.735	3.41	210	-	-	-	-	-	-	8.7	11.5	<0.2	2	22.2	9.009	0.7565	-	-	-	-	-	Silty clay	ark greyish	3	<10	<10	<10	390	1030
SO46	SO46_SOI	50-60	6/06/2014	12.9	9.2	8	0.349	3.001	1.75	240	-	-	-	-	-	-	8.6	12.1	<0.2	2.4	23.1	10.39	0.7107	-	-	-	-	-	Silty clay	k greyish br	3	<10	<10	<10	450	1130
SO51	SO51_SOI	0-10	7/06/2014	15.4	5.5	4.4	0.046	0.3956	0.7	30	1290	2.1	8.9	14.7	1300	1.2	4.5	5.5	0.6	0.4	11	3.636	0.8182	-	-	-	-	-	Silty clay	ark greyish	4	<10	<10	<10	40	150
SO51	SO51_SOI	10-20	7/06/2014	18.8	6	4.8	0.21	1.806	1.4	260	-	-	-	-	-	-	6.6	16.7	0.8	4.2	28.3	14.84	0.3952	-	-	-	-	-	Silty clay	ark greyish	1	<10	<10	<10	230	682
SO51	SO51_SOI	20-30	7/06/2014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	54	18	15	13	<1	-	-	-	-	-	-	-	-
SO51	SO51_SOI	30-40	7/06/2014	11.8	5.9	5.1	0.418	3.595	1.8	720	-	-	-	-	-	-	2.3	8.9	0.1	2.4	13.7	17.52	0.2584	-	-	-	-	-	Silty clay	ry dark brov	2	<10	<10	<10	440	1360
SO51	SO51_SOI	50-60	7/06/2014	10.2	5.8	4.8	0.476	4.094	1.6	770	-	-	-	-	-	-	1.5	8.2	<0.1	2.8	12.7	22.05	0.1829	-	-	-	-	-	Silty clay	ark greyish	2	<10	<10	<10	460	1550
SO51	SO51_SOI	80-90	7/06/2014	10.1	5.9	4.8	0.384	3.302	1.85	580	-	-	-	-	-	-	0.9	4.7	<0.1	1.5	7.1	21.13	0.1915	-	-	-	-	-	Clay loam	ark greyish	1	<10	<10	<10	360	1250
SO52	SO52_SOI	0-10	7/06/2014	10.8	6.6	5.8	0.11	0.946	1.6	40	2070	10.6	28.5	11.1	2080	6.1	16.2	7	1.2	0.7	25.2	2.778	2.314	-	-	-	-	-	Silty clay	Black	3	20	<10	30	60	358
SO52	SO52_SOI	10-20	7/06/2014	12.1	8	6.4	0.105	0.903	<0.01	50	-	-	-	-	-	-	10.6	9.9	<0.2	1.6	22	7.273	1.071	-	-	-	-	-	Silty clay	ry dark brov	3	<10	<10	<10	110	341
SO52	SO52_SOI	20-30	7/06/2014	13.1	7.9	6.5	0.147	1.264	0.65	110	-	-	-	-	-	-	6.6	9.9	<0.2	2	18.6	10.75	0.6667	-	-	-	-	-	Silty clay	ry dark brov	3	<10	<10	<10	160	478
SO52	SO52_SOI	30-40	7/06/2014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	49	23	18	10	<1	-	-	-	-	-	-	-	-
SO52	SO52_SOI	50-60	7/06/2014	12.9	6	5.3	0.695	5.977	1.3	1000	-	-	-	-	-	-	2.7	11.6	<0.1	3	17.4	17.24	0.2328	-	-	-	-	-	Silty clay	Dark grey	3	<10	10	<10	760	2260
SO52	SO52_SOI	80-90	7/06/2014	11.7	6.2	5.8	0.715	6.149	<0.01	1040	-	-	-	-	-	-	2.8	12.3	0.1	3.4	18.5	18.38	0.2276	-	-	-	-	-	Silty clay	Dark grey	2	<10	10	<10	770	2320
SO56	SO56_SOI	0-10	7/06/2014	4.1	6.1	4.8	0.06	1.362	<0.01	<10	760	1.2	14.2	2.2	760	0.7	4	2.5	0.5	0.2	7.3	2.74	1.6	-	-	-	-	-	Loamy sand	ry dark brov	7	<10	<10	<10	20	195
SO56	SO56_SOI	10-20	7/06/2014	5.9	7.9	6.4	0.077	0.6622	<0.01	50	-	-	-	-	-	-	2.7	4.7	<0.2	0.7	8.1	8.642	0.5745	-	-	-	-	-	Sandy clay	ry dark brov	3	<10	<10	<10	60	250
SO56	SO56_SOI	20-30	7/06/2014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	29	24	38	9	<1	-	-	-	-	-	-	-	-
SO56	SO56_SOI	30-40	7/06/2014	10.1	6	5.1	0.337	2.898	0.9	400	-	-	-	-	-	-	1.1	10.5	0.1	3.2	14.9	21.48	0.1048	-	-	-	-	-	Silty clay	k reddish br	3	<10	<10	<10	370	1100
SO56	SO56_SOI	50-60	7/06/2014	10.6	7.5	6.7	0.644	5.538	1.4	910	-	-	-	-	-	-	0.8	13.5	<0.2	4.5	18.8	23.94	0.05926	-	-	-	-	-	Silty clay	Dark brown	3	<10	<10	<10	760	2090
SO56	SO56_SOI	80-90	7/06/2014	12.4	8.8	7.5	0.82	7.052	1.4	1100	-	-	-	-	-	-	0.9	13.2	<0.2	3.7	17.9	20.67	0.06818	-	-	-	-	-	Silty clay	k greyish br	3	<10	20	<10	950	2660
SO57	SO57_SOI	0-10	7/06/2014	4.7	5.5	4.5	0.062	1.407	0.9	10	610	0.9	2.2	6.3	620	0.5	1.2	0.9	0.2	<0.1	2.3	<0.1	1.333	-	-	-	-	-	Sand	Dark brown	8	<10	<10	<10	10	202
SO57	SO57_SOI	10-20	7/06/2014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	34	51	5	<1	-	-	-	-	-	-	-	-
SO57	SO57_SOI	20-30	7/06/2014	2.6	6	4.5	0.017	0.3859	1.8	10	-	-	-	-	-	-	0.7	1.4	0.2	0.2	2.5	8	0.5	-	-	-	-	-	Loamy sand	Dark brown	7	<10	<10	<10	20	55
SO57	SO57_SOI	30-40	7/06/2014	2.8	6.2	4.9	0.078	0.6708	0.55	80	-	-	-	-	-	-	0.3	2	0.1	1.1	3.5	31.43	0.15	-	-	-	-	-	Silty clay	k greyish br	3	<10	<10	<10	80	254
SO57	SO57_SOI	50-60	7/06/2014	10	8.1	6.8	0.357	3.07	0.04	530	-	-	-	-	-	-	<0.2	8	<0.2	3.6	11.6	31.03	<0.2	-	-	-	-	-	Silty clay	k greyish br	3	<10	<10	<10	400	1160
SO57	SO57_SOI	80-90	7/06/2014	8.9	8.3	6.9	0.321	2.761	0.34	480	-	-	-	-	-	-	<0.2	6	<0.2	2.9	8.9	32.58	<0.2	-	-	-	-	-	Silty clay	Dark brown	3	<10	<10	<10	360	1040
SO58	SO58_SOI	0-10	5/06/2014	2.5	5.2	4.3	0.02	0.454	<0.01	<10	360	2.1	1.9	1.4	360	1.2	0.5	0.4	<0.1	<0.1	1	<0.1	1.25	-	-	-	-	-	Loamy sand	Dark brown	7	<10	<10	<10	<10	65
SO58	SO58_SOI	10-20	5/06/2014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	36	46	8	<1	-	-	-	-	-	-	-	-
SO58	SO58_SOI	20-30	5/06/2014	1.5	6.1	4.2	0.026	0.5902	<0.01	20	-	-	-	-	-	-	<0.1	0.6	<0.1	0.4	1.2	33.33	<0.1	-	-	-	-	-	Loamy sand	Brown	3	<10	<10	<10	20	84
SO58	SO58_SOI	30-40	5/06/2014	1.1	6.3	5.1	0.029	0.6583	<0.01	30	-	-	-	-	-	-	<0.1	1.1	<0.1	0.8	2	40	<0.1	-	-	-	-	-	Loamy sand	reyish brow	2	<10	<10	<10	30	94
SO58	SO58_SOI	50-60	5/06/2014	8.9	8	6.5	0.227	1.952	<0.01	340	-	-	-	-	-	-	<0.2	6.3	<0.2	2.7	9	30	<0.2	-	-	-	-	-	Silty clay	k greyish br	2	<10	<10	<10	270	738
SO58	SO58_SOI	80-90	5/06/2014	10.3	8.1	6.9	0.272	2.339	1.3	350	-	-	-	-	-	-	<0.2	8.2	0.3	3.4	11.9	28.57	<0.2	-	-	-	-	-	Silty clay	k greyish br	3	<10	<10	<10	310	884
SO59	SO59_SOI	0-10	6/06/2014	7.1	6	4.3	0.026	0.2236	1.4	<10	690	2.6	2.5	0.7	690	1.5	1.4	1.8	0.2	0.4	3.9	10.26	0.7778	-	-	-	-	-	ndy clay lo	ry dark brov	3	<10	<10	<10	10	84
SO59	SO59_SOI	10-20	6/06/2014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	16	31	43	10	<1	-	-	-	-	-	-	-	-
SO59	SO59_SOI	20-30	6/06/2014	2.8	6.8	4.8	0.032	0.7264	<0.01	30	-	-	-	-	-	-	0.7	1.7	<0.1	0.7	3.1	22.58	0.4118	-	-	-	-	-	Loamy sand	k greyish br	3	<10	<10	<10	30	104
SO59	SO59_SOI	30-40	6/06/2014	7.8	6.4	5.3	0.26	2.236	<0.01	230	-	-	-	-	-	-	0.5	5.7	<0.1	3.6	9.9	36.36	0.08772	-	-	-	-	-	Silty clay	ark greyish	2	<10	<10	<10	240	845
SO59	SO59_SOI	50-60	6/06/2014	9.6	6.2	5.3	0.519	4.463	0.9	520	-	-	-	-	-	-	0.2	7.3	<0.1	3.3	10.9	30.28	0.0274	-	-	-	-	-	Silty clay	k greyish br	2	<10	<10	<10	580	1690
SO59	SO59_SOI	80-90	6/06/2014	10.4	6.1	5.1	0.574	4.936	<0.01	610	-	-	-	-	-	-	0.2	9	0.1	4.4	13.7	32.12	0.02222	-	-	-	-	-	Silty clay	k greyish br	1	<10	<10	<10	610	1860
SO60	SO60_SOI	0-10	6/06/2014	4.8	6	5.1	0.056	1.271	1.3	10	1110	2.1	5.7	9.8	1120	1.2	6.2	1.4	0.5	<0.1	8.2	<0.1	4.429	-	-	-	-	-	Loamy sand	ry dark brov	7	<10	<10	20	<10	182
SO60	SO60_SOI	10-20	6/06/2014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	16	29	44	11	<1	-	-	-	-	-	-	-	-
SO60	SO60_SOI	20-30	6/06/2014	7	8.1	6.7	0.08	0.688	1.5	20	-	-	-	-	-	-	5.8	5	0.7	0.7	12.3	5.691	1.16	-	-	-	-	-	Silty clay	k reddish br	3	<10	<10	<10	80	260
SO60	SO60_SOI	30-40	6/06/2014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	29	24	35	12	<1	-	-	-	-	-	-	-	-
SO60	SO60_SOI	50-60	6/06/2014	11	9.1	7.9	0.23	1.978	1.95	190	-	-	-	-	-	-	2.3	7.5	0.5	2.7	13	20.77	0.3067	-	-	-	-	-	Silty clay	k reddish br	1	<10	<10	<10	240	748
SO60	SO60_SOI	80-90	6/06/2014	9.7	9.1	8.1	0.43	3.698	1.7	430	-	-	-	-	-	-	1.3	6.2	0.3	2.6	10.4	25	0.2097	-	-	-	-	-	Silty clay	k reddish br	1	<10	<10	<10	470	1400
SO61	SO61_SOI	0-10	6/06/2014	11.4	6.8	6.3	0.053	0.4558	0.04	10	860	2.4	1.9	21	880	1.4	12.6	6	1.2	0.2	19.9	1.005	2.1	-	-	-	-	-	Silty clay	ark greyish	4	10	<10	20	20	172
SO61	SO61_SOI	10-20	6/06/2014	12.5	8	7.3	0.061	0.5246	0.85	20	-	-	-	-	-	-	14.7	7.2	1.2	<0.2	23.1	<0.2	2.042	-	-	-	-	-	Silty clay	ery dark gre	3	10	<10	20	50	198
SO61	SO61_SOI	20-30	6/06/2014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	45	25	19	11	<1	-	-	-	-	-	-	-	-
SO61	SO61_SOI	30-40	6/06/2014	11.8	8.2	7.6	0.182	1.565	0.95	120	-	-	-	-	-	-	9	9	0.6	1.5	20	7.5	1	-	-	-	-	-	Silty clay	Dark grey	3	<10	<10	<10	200	592
SO61	SO61_SOI	50-60	6/06/2014	11	9	8	0.358	3.079	1.4	360	-	-	-	-	-	-	6.3	8.9	0.4	2	17.5	11.43	0.7079	-	-	-	-	-	Silty clay	Dark grey	3	<10	<10	<10	390	1160
SO61	SO61_SOI	80-90	6/06/2014	12.2	8.9	8	0.505	4.343	<0.01	560	-	-	-	-	-	-	5	9	0.3	2.3	16.6	13.86	0.5556	-	-	-	-	-	Silty clay	Dark grey	1	<10	<10	<10	570	1640
SO62	SO62_SOI	0-10	6/06/2014	2.4	5.5	4.4	0.02	0.454	1.14	10	900	2.4	<1	2.4	900	1.4	1.7	2.1	0.3	0.1	4.2	2.381	0.8095	-	-	-	-	-	Sand	Dark brown	8	<10	<10	<10	10	65
SO62	SO62_SOI	10-20	6/06/2014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	22	19	52	6	1	-	-	-	-	-	-	-	-
SO62	SO62_SOI	20-30	6/06/2014	7.4	5.9	4.1	0.025	0.215	0.94	20	-	-	-	-	-	-	<0.1	4.3	0.4	0.8	5.6	14.29	<0.1	-	-	-	-	-	Silty clay	Brown	3	<10	<10	<10	20	81
SO62	SO62_SOI	30-40	6/06/2014	10.2	5.2	4.1	0.127	1.092	2.99	100	-	-	-	-	-	-	<0.1	7.1	0.3	1.9	9.4	20.21	<0.1	-	-	-	-	-	Silty clay	Brown	3	<10	<10	<10	110	413
SO62	SO62_SOI	50-60	6/06/2014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	29	20	43	8	<1	-	-	-	-	-	-	-	-
SO62	SO62_SOI	80-90	6/06/2014	9.3	5.4	4.2	0.294	2.528	2.19	430	-	-	-	-	-	-	<0.1	6.9	<0.1	3.7	10.7	34.58	<0.1	-	-	-	-	-	Silty clay	Brown	2	<10	<10	<10	290	956
SO65	SO65_SOI	0-10	6/06/2014	5.5	5.4	3.9	0.038	0.361	2.59	20	1270	4.9	8.4	5.2	1280	2.8	1.4	2.7	<0.5	<0.5	4.5	<0.5	0.5185	-	-	-	-	-	Silty loam	ark greyish	7	<10	<10	<10	20	124
SO65	SO65_SOI	10-20	6/06/2014	4.6	5.1	4	0.061	0.5246	1.04	40	-	-	-	-	-	-	<0.5	5.3	<0.5	1.4	6.8	20.59	<0.5	-	-	-	-	-	Silty clay	ark greyish	3	<10	<10	<10	40	198

SO65	SO65_SOI	20-30	6/06/2014	11	5.2	3.9	0.105	0.903	2.24	40	-	-	-	-	-	-	<0.5	7.9	<0.5	2.6	10.6	24.53	<0.5	-	-	-	-	-	Silty clay	ark greyish	3	<10	<10	<10	100	341
SO65	SO65_SOI	30-40	6/06/2014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	30	23	34	13	<1	-	-	-	-	-	-	-
SO65	SO65_SOI	80-90	6/06/2014	9.2	5.4	4.2	0.379	3.259	1.94	410	-	-	-	-	-	-	<0.1	5.8	<0.1	2.4	8.4	28.57	<0.1	-	-	-	-	-	Silty clay	ark greyish	2	<10	<10	<10	380	1230
SO66	SO66_SOI	0-10	6/06/2014	4.8	5	4.3	0.035	0.7945	1.64	20	1180	4.9	2	7	1190	2.8	2.5	2.2	0.4	0.1	5.3	1.887	1.136	-	-	-	-	-	Loamy sand	ry dark brov	7	<10	<10	10	20	114
SO66	SO66_SOI	10-20	6/06/2014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15	31	44	10	<1	-	-	-	-	-	-	-
SO66	SO66_SOI	20-30	6/06/2014	4.6	6	4.3	0.091	0.7826	1.19	100	-	-	-	-	-	-	<0.1	2.6	<0.1	1	3.7	27.03	<0.1	-	-	-	-	-	Clay loam	k greyish br	3	<10	<10	<10	90	296
SO66	SO66_SOI	30-40	6/06/2014	8.4	6.7	5.1	0.158	1.359	2.74	180	-	-	-	-	-	-	<0.1	9	<0.1	4.4	13.6	32.35	<0.1	-	-	-	-	-	Silty clay	yellowish b	3	<10	<10	<10	160	514
SO66	SO66_SOI	50-60	6/06/2014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	21	32	37	10	<1	-	-	-	-	-	-	-
SO66	SO66_SOI	80-90	6/06/2014	10.7	6.2	5.1	0.253	2.176	2.69	300	-	-	-	-	-	-	0.1	10.3	0.1	5.6	16.2	34.57	0.009709	-	-	-	-	-	Silty clay	Brown	3	<10	<10	<10	280	822
SO69	SO69_SOI	0-10	4/06/2014	5.8	4.6	3.8	0.014	0.3178	1.74	<10	580	3.9	<1	3.2	580	2.2	0.2	0.4	<0.1	<0.1	0.8	<0.1	0.5	-	-	-	-	-	Loamy sand	Dark brown	7	<10	<10	<10	<10	46
SO69	SO69_SOI	10-20	4/06/2014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	26	59	5	1	-	-	-	-	-	-	-
SO69	SO69_SOI	20-30	4/06/2014	4.5	4.9	4	0.006	0.1362	1.64	<10	-	-	-	-	-	-	<0.1	0.6	<0.1	<0.1	0.7	<0.1	<0.1	-	-	-	-	-	Loamy sand	Dark brown	4	<10	<10	<10	<10	20
SO69	SO69_SOI	30-40	4/06/2014	8.4	5.8	4.2	0.024	0.3312	1.59	20	-	-	-	-	-	-	<0.1	1.3	<0.1	0.2	1.5	13.33	<0.1	-	-	-	-	-	Sandy loam	llowish brov	3	<10	<10	<10	20	78
SO69	SO69_SOI	50-60	4/06/2014	11.1	6	4.4	0.042	0.3612	2.99	50	-	-	-	-	-	-	<0.1	3.8	<0.1	0.9	4.8	18.75	<0.1	-	-	-	-	-	Sandy clay	llowish brov	2	<10	<10	<10	40	136
SO69	SO69_SOI	80-90	4/06/2014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	31	12	50	5	2	-	-	-	-	-	-	-
SO70	SO70_SOI	0-10	4/06/2014	4.2	5.1	4.3	0.009	0.2043	1.09	<10	340	2.5	<1	0.8	340	1.5	0.2	0.4	0.1	<0.1	0.8	<0.1	0.5	-	-	-	-	-	Sand	Dark brown	4	<10	<10	<10	<10	29
SO70	SO70_SOI	10-20	4/06/2014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	21	69	2	<1	-	-	-	-	-	-	-
SO70	SO70_SOI	20-30	4/06/2014	3.5	5.6	4.3	0.006	0.1362	2.74	<10	-	-	-	-	-	-	<0.1	0.7	0.2	<0.1	1	<0.1	<0.1	-	-	-	-	-	Sand	Yellowish re	4	<10	<10	<10	<10	20
SO70	SO70_SOI	30-40	4/06/2014	2.5	5.7	4.2	0.005	0.1135	1.24	<10	-	-	-	-	-	-	<0.1	0.7	0.2	<0.1	0.9	<0.1	<0.1	-	-	-	-	-	Sand	Yellowish re	4	<10	<10	<10	<10	16
SO70	SO70_SOI	50-60	4/06/2014	3.2	5.1	4.5	0.005	0.1135	1.49	<10	-	-	-	-	-	-	<0.1	1.3	0.2	<0.1	1.6	<0.1	<0.1	-	-	-	-	-	Sand	Yellowish re	4	<10	<10	<10	<10	16
SO70	SO70_SOI	80-90	4/06/2014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15	21	60	3	1	-	-	-	-	-	-	-
SO71	SO71_SOI	0-10	4/06/2014	9	4.9	3.8	0.041	0.9307	2.29	<10	890	5.2	2.3	3	890	3	0.4	0.7	0.4	<0.1	1.6	<0.1	0.5714	-	-	-	-	-	Loamy sand	ry dark brov	3	<10	<10	<10	<10	133
SO71	SO71_SOI	10-20	4/06/2014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	48	28	6	4	-	-	-	-	-	-	-
SO71	SO71_SOI	20-30	4/06/2014	3.6	4.6	3.8	0.049	1.112	4.09	60	-	-	-	-	-	-	0.1	0.8	0.2	0.3	1.4	21.43	0.125	-	-	-	-	-	Loamy sand	ry dark brov	3	<10	<10	<10	40	159
SO71	SO71_SOI	30-40	4/06/2014	3	5.6	4	0.025	0.5675	1.49	30	-	-	-	-	-	-	<0.1	1	0.2	0.2	1.5	13.33	<0.1	-	-	-	-	-	Sand	Dark brown	8	<10	<10	<10	20	81
SO71	SO71_SOI	50-60	4/06/2014	9.6	5.9	4.6	0.23	1.978	0.94	350	-	-	-	-	-	-	<0.1	7	0.4	2.3	9.7	23.71	<0.1	-	-	-	-	-	Silty clay	Brown	1	<10	<10	<10	220	748
SO71	SO71_SOI	80-90	4/06/2014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	28	40	16	13	3	-	-	-	-	-	-	-
SO72	SO72_SOI	0-10	7/06/2014	4.4	5.5	5	0.02	0.454	2.39	<10	1120	5	10.8	2.3	1120	2.9	7.7	1.8	0.6	<0.1	10.1	<0.1	4.278	-	-	-	-	-	Loamy sand	Black	7	<10	<10	10	<10	65
SO72	SO72_SOI	10-20	7/06/2014	4.1	5.6	4.1	0.083	0.7138	1.59	90	-	-	-	-	-	-	0.8	2.7	<0.1	1.2	4.8	25	0.2963	-	-	-	-	-	ndy clay lo	ark greyish	3	<10	<10	<10	80	270
SO72	SO72_SOI	20-30	7/06/2014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25	28	34	13	<1	-	-	-	-	-	-	-
SO72	SO72_SOI	30-40	7/06/2014	10.7	7.1	5.5	0.393	3.38	4.94	700	-	-	-	-	-	-	0.1	8.6	0.2	5.5	14.5	37.93	0.01163	-	-	-	-	-	Silty clay	k greyish br	3	<10	<10	<10	490	1280
SO72	SO72_SOI	50-60	7/06/2014	10.5	6.8	5.9	0.468	4.025	1.34	810	-	-	-	-	-	-	0.1	8.7	0.3	6.4	15.6	41.03	0.01149	-	-	-	-	-	Silty clay	k greyish br	3	<10	<10	<10	590	1520
SO73	SO73_SOI	0-10	7/06/2014	4.8	4.6	3.9	0.009	0.2043	1.49	<10	330	1.7	<1	2.3	330	1	0.5	0.1	<0.1	<0.1	0.7	<0.1	5	-	-	-	-	-	Sand	Dark brown	8	<10	<10	<10	<10	29
SO73	SO73_SOI	10-20	7/06/2014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	14	79	3	<1	-	-	-	-	-	-	-
SO73	SO73_SOI	20-30	7/06/2014	3	4.8	4	0.004	0.0908	2.29	<10	-	-	-	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-	-	Sand	Brown	8	<10	<10	<10	<10	13
SO73	SO73_SOI	30-40	7/06/2014	1.3	4.8	4	0.004	0.0908	4.14	<10	-	-	-	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-	-	Sand	Brown	8	<10	<10	<10	<10	13
SO73	SO73_SOI	50-60	7/06/2014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	18	76	3	<1	-	-	-	-	-	-	-
SO73	SO73_SOI	80-90	7/06/2014	1.2	5.6	4.2	0.002	0.0454	1.74	<10	-	-	-	-	-	-	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	-	-	-	-	-	Sand	Brown	8	<10	<10	<10	<10	6
SO74	SO74_SOI	0-10	7/06/2014	4	4.6	3.8	0.009	0.2043	1.79	<10	460	2.4	1.2	2.4	460	1.4	0.8	0.7	0.2	<0.1	1.7	<0.1	1.143	-	-	-	-	-	Loamy sand	Brown	3	<10	<10	<10	<10	29
SO74	SO74_SOI	10-20	7/06/2014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	51	34	6	<1	-	-	-	-	-	-	-
SO74	SO74_SOI	20-30	7/06/2014	3.4	4.9	3.8	0.006	0.1362	2.39	<10	-	-	-	-	-	-	<0.1	0.3	0.2	<0.1	0.6	<0.1	<0.1	-	-	-	-	-	Loamy sand	k reddish br	3	<10	<10	<10	<10	20
SO74	SO74_SOI	30-40	7/06/2014	2.2	5.2	3.7	0.007	0.1589	2.14	<10	-	-	-	-	-	-	<0.1	0.3	0.2	<0.1	0.6	<0.1	<0.1	-	-	-	-	-	Loamy sand	ellowish re	3	<10	<10	<10	<10	23
SO74	SO74_SOI	50-60	7/06/2014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	52	32	6	<1	-	-	-	-	-	-	-
SO74	SO74_SOI	80-90	7/06/2014	4.1	5.5	4.3	0.047	1.067	1.69	60	-	-	-	-	-	-	<0.1	2.6	0.3	0.8	3.7	21.62	<0.1	-	-	-	-	-	Loamy sand	Dark brown	3	<10	<10	<10	40	153
SO75	SO75_SOI	0-10	7/06/2014	5.5	4.7	3.8	0.008	0.1816	3.94	<10	650	3	<1	1.4	650	1.8	0.1	0.2	<0.1	<0.1	0.4	<0.1	0.5	-	-	-	-	-	Sand	Dark brown	8	<10	<10	<10	<10	26
SO75	SO75_SOI	10-20	7/06/2014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6	30	62	2	<1	-	-	-	-	-	-	-
SO75	SO75_SOI	20-30	7/06/2014	4	5.3	3.9	0.006	0.1362	1.89	<10	-	-	-	-	-	-	<0.1	0.2	<0.1	<0.1	0.3	<0.1	<0.1	-	-	-	-	-	Sand	yellowish b	8	<10	<10	<10	<10	20
SO75	SO75_SOI	30-40	7/06/2014	3.3	4.9	4	0.005	0.1135	2.94	<10	-	-	-	-	-	-	<0.1	0.4	0.1	<0.1	0.5	<0.1	<0.1	-	-	-	-	-	Sand	Strong brow	8	<10	<10	<10	<10	16
SO75	SO75_SOI	50-60	7/06/2014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	31	59	2	<1	-	-	-	-	-	-	-
SO76	SO76_SOI	0-10	6/06/2014	5.5	6.1	4.8	0.019	0.4313	2.79	<10	980	5.2	1.9	3.9	980	3	7.1	3.2	0.5	0.1	10.9	0.9174	2.219	-	-	-	-	-	Loamy sand	ry dark brov	8	<10	<10	<10	10	62
SO76	SO76_SOI	10-20	7/06/2014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	26	30	33	5	6	-	-	-	-	-	-	-
SO76	SO76_SOI	20-30	6/06/2014	10.1	6.7	5.3	0.187	1.608	3.53	240	-	-	-	-	-	-	2.4	12.2	0.3	3.4	18.3	18.58	0.1967	-	-	-	-	-	Silty clay	Dark brown	3	<10	<10	<10	180	608
SO76	SO76_SOI	30-40	7/06/2014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33	25	34	4	4	-	-	-	-	-	-	-
SO76	SO76_SOI	50-60	6/06/2014	8.9	7.9	6	0.189	1.625	1.59	220	-	-	-	-	-	-	1.9	7.2	0.3	1.4	10.8	12.96	0.2639	-	-	-	-	-	Silty clay	Dark brown	3	<10	<10	<10	200	614
SO77	SO77_SOI	0-10	4/06/2014	4.8	5.2	4	0.01	0.227	2.39	<10	690	2.2	2.5	1.7	690	1.3	0.5	0.8	0.2	<0.1	1.5	<0.1	0.625	-	-	-	-	-	Loamy sand	ry dark brov	3	<10	<10	<10	<10	32
SO77	SO77_SOI	10-20	4/06/2014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	30	53	6	1	-	-	-	-	-	-	-
SO77	SO77_SOI	20-30	4/06/2014	2.1	5.4	3.9	0.011	0.2497	1.22	10	-	-	-	-	-	-	<0.1	0.8	<0.1	<0.1	1	<0.1	<0.1	-	-	-	-	-	Loamy sand	Dark brown	3	<10	<10	<10	<10	36
SO77	SO77_SOI	30-40	4/06/2014	2.7	5.9	4.2	0.041	0.3526	2.53	50	-	-	-	-	-	-	<0.1	1.1	0.1	0.3	1.5	20	<0.1	-	-	-	-	-	ndy clay loa	Brown	3	<10	<10	<10	40	133
SO77	SO77_SOI	50-60	4/06/2014	9.6	6.3	4.9	0.182	1.565	0.21	260	-	-	-	-	-	-	<0.1	8.5	0.6	2.7	11.8	22.88	<0.1	-	-	-	-	-	Silty clay	yellowish b	2	<10	<10	<10	190	592

Statistical Summary

Number of Results				194	194	194	194	194	194	194	45	45	45	45	45	45	194	194	194	194	194	194	194	65	65	65	65	65	0	0	194	194	194	194	194	194
Number of Detects				192	194	194	194	194	182	135	45	45	38	45	45	42	157	191	108	142	192	142	157	65	65	65	65	12	0	0	194	12	10	27	152	194
Minimum Concentration				<1	4.6	3.7	0.002	0.043	<0.01	<10	330	0.7	<1	0.7	330	<0.5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.009709	3	12	13	2	<1	0	0	1	<10	<10	<10	<10	6
Minimum Detect				1.1	4.6	3.7	0.002	0.043	0.04	10	330	0.7	1.2	0.7	330	0.5	0.1	0.1	0.1	0.1	0.1	0.8696	0.009709	3	12	13	2	1	ND	ND	1	10	10	10	10	6
Maximum Concentration				20.8	9.9	8.1	0.82	7.052	9.97	1100	2070	10.6	31.1	21	2080	6.1	25.7	16.7	1.2	6.4	37.8	41.03	9.375	58	52	79	15	6	0	0	8	130	20	60	950	2660
Maximum Detect				20.8	9.9	8.1	0.82	7.052	9.97	1100	2070	10.6	31.1	21	2080	6.1	25.7	16.7	1.2	6.4	37.8	41.03	9.375	58	52	79	15	6	ND	ND	8	130	20	60	950	2660
Average Concentration				7.6	6.8	5.6	0.16	1.5	3.4	162	958	3.1	5.9	6.3	963	1.8	3.9	5.2	0.25	1.3	11	11	0.96	26	26	39	8.2	0.82			3.4	6.3	5.4	7.2	176	527
Median Concentration				8.3	6.45	5.3	0.0615	0.7009	3.465	35	860	2.6	3.2	4.4	880	1.5	2.55	4.8	0.1	0.9	10.2	8.2815	0.60065	26	24	37	8	0.5			3	5	5	5	50	200
Standard Deviation				4	1.4	1.4	0.19	1.6	2.2	241	417	1.8	7.6	4.9	420	1	4.4	3.9	0.25	1.4	7.7	11	1.2	15	8.8	15	3.5	0.97			1.9	9.4	2.1	7.5	225	611
Number of Guideline Exceedances				0	36	65	0	18	0	6	0	0	0	0	0	0	0	0	0	0	0	69	46	0	0	0	0	0	0	0	0	0	0	0	0	0
Number of Guideline Exceedances(Detects Only)				0	36	65	0	18	0	6	0	0	0	0	0	0	0	0	0	0	0	69	46	0	0	0	0	0	0	0	0	0	0	0	0	0

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