STRATFORDCOAL
Part of the Yancoal Australia Group

Stratford Extension Project
Environmental Impact Statement



APPENDIX K



AGRICULTURAL ASSESSMENT

STRATFORD EXTENSION PROJECT

AGRICULTURAL ASSESSMENT

STRATFORDCOAL
Part of the Yancoal Australia Group

PREPARED BY
STRATFORD COAL PTY LTD

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1 INTRODUCTION

The Stratford Mining Complex comprises the Stratford Coal Mine (SCM) and Bowens Road North Open Cut (BRNOC), two open cut mining operations located some 10 kilometres (km) south of Gloucester and approximately 100 km north of Newcastle, New South Wales (NSW) (Figure 1). The Stratford Mining Complex is owned and operated by Stratford Coal Pty Ltd (SCPL), a wholly owned subsidiary of Yancoal Australia Limited.

The SCM commenced operations in 1995 and is approved to produce up to approximately 2.1 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal. The BRNOC has been in operation since 2003 and is approved to produce up to approximately 1 Mtpa of ROM coal. The proposed Stratford Extension Project (the Project) would involve the continuation and extension of open cut coal mining and processing activities at the Stratford Mining Complex. The Project would extend the life of the current open cut operations to 2024, and would facilitate a ROM coal production rate of up to 2.6 Mtpa. A description of the Project is provided in Section 2 in the Main Report of the Environmental Impact Statement (EIS).

SCPL is seeking approval for the Project from the NSW Minister for Planning and Infrastructure in accordance with Division 4.1, Part 4 of the NSW *Environmental Planning and Assessment Act, 1979* (EP&A Act).

The purpose of this Agricultural Assessment is to consider the potential impact of the Project on agricultural resources or industries and to quantify the potential loss of agricultural land in the region that would arise as a result of the Project.

This report documents the nature and values of the agricultural resources that would be potentially impacted by the Project and the potential flow on effects to associated enterprises, and provides a conclusion regarding the acceptability of the identified potential impacts.

1.1 PROJECT OVERVIEW

The main activities associated with the development of the Project would include (Figure 2):

- ROM coal production up to 2.6 Mtpa for an additional 11 years (commencing approximately 1 July 2013 or upon the grant of all required approvals), including mining operations associated with:
  - completion of the BRNOC;
  - extension of the existing Roseville West Pit; and
  - development of the new Avon North and Stratford East Open Cuts;
- exploration activities;
- progressive backfilling of mine voids with waste rock behind the advancing open cut mining operations;
- continued and expanded placement of mine waste rock in the Stratford Waste Emplacement and Northern Waste Emplacement;
- progressive development of new haul roads and internal roads;
- coal processing at the existing Coal Handling and Preparation Plant (CHPP) including Project ROM coal, sized ROM coal received and unloaded from the Duralie Coal Mine (DCM) and material recovered periodically from the western co-disposal area;
- stockpiling and loading of product coal to trains for transport on the North Coast Railway to Newcastle;

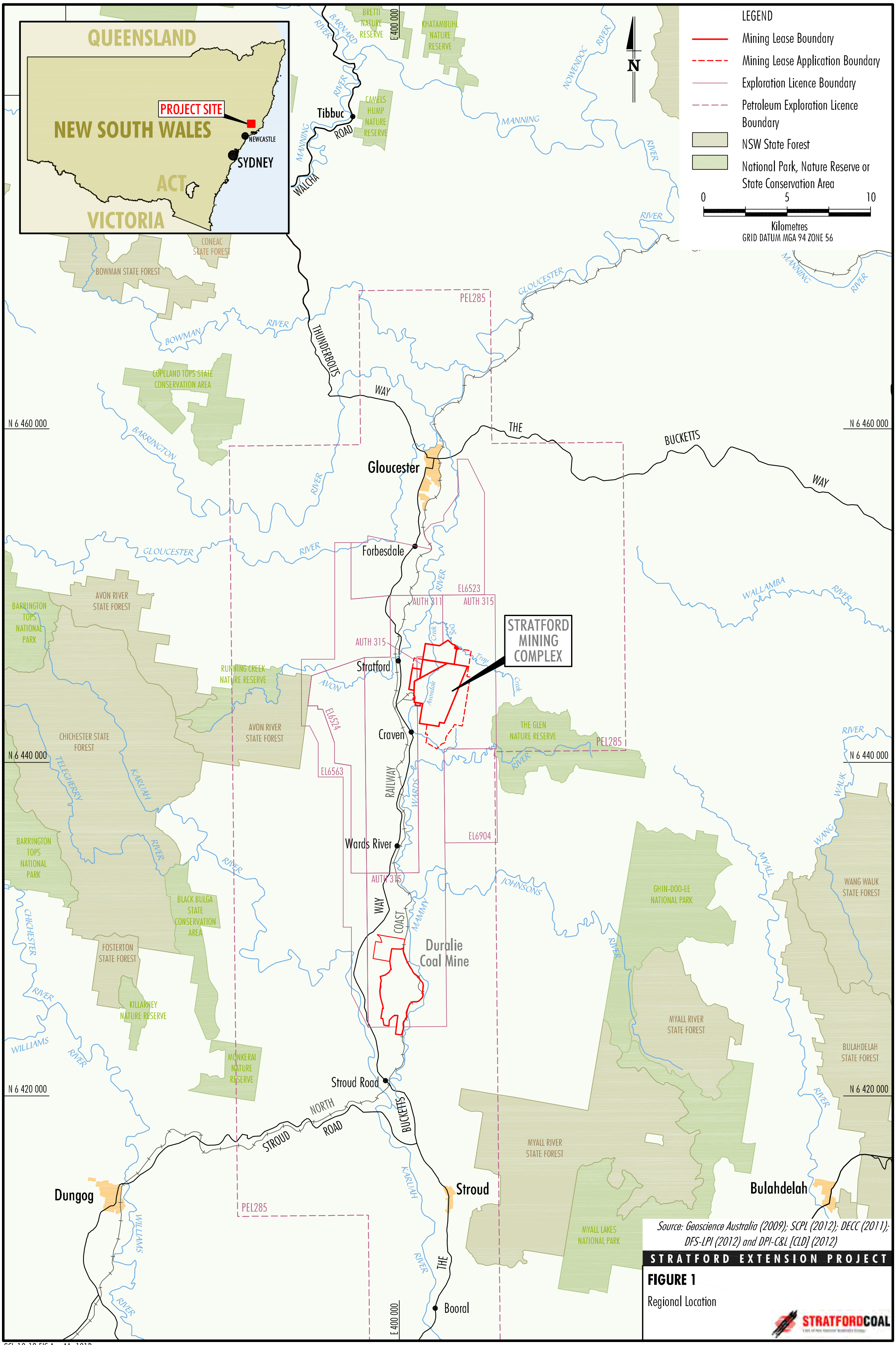

FIGURE 1
Regional Location

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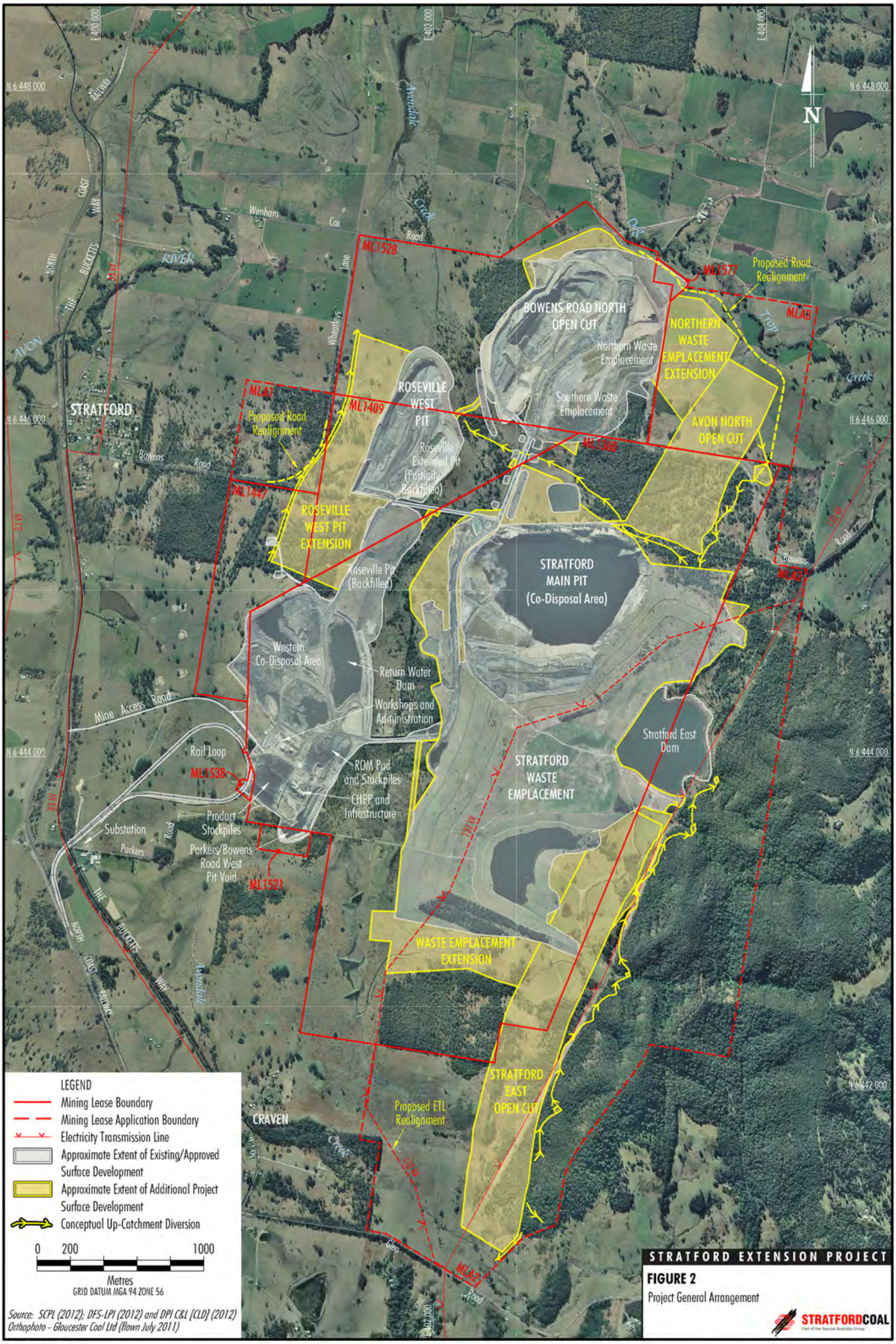

Source: SCPL (2012); DFS-LPI (2012) and DPI C&L [CLD] (2012)
Orthophoto - Gloucester Coal Ltd (flown July 2011)

STRATFORD EXTENSION PROJECT

FIGURE 2

Project General Arrangement

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- disposal of CHPP rejects via pipeline to the existing co-disposal area in the Stratford Main Pit and, later in the Project life, the Avon North Open Cut void;
- realignments of Wheatleys Lane, Bowens Road and Wenham Cox/Bowens Road;
- realignment of a 132 kilovolt (kV) power line for the Stratford East Open Cut;
- continued use of existing contained water storages/dams and progressive development of additional sediment dams, pumps, pipelines, irrigation infrastructure and other water management equipment and structures;
- development of soil stockpiles, laydown areas and gravel/borrow areas, including modifications and alterations to existing infrastructure as required;
- monitoring and rehabilitation;
- all activities approved under DA 23-98/99 and DA 39-02-01; and
- other associated minor infrastructure, plant, equipment and activities, including minor modifications and alterations to existing infrastructure as required.

1.2 BACKGROUND

This Agricultural Assessment has been prepared to address the following components of the Director-General's Environmental Assessment Requirements for the Project:

***Land Resources** - including a detailed assessment of the potential impacts on:*

…

- *agricultural resources and/or enterprises in the local area, with particular reference to highly productive alluvial soils that may be impacted directly or indirectly by the project, and including:*
    - *pre-mining and postmining agricultural assessment and mapping (including Land Capability and Agricultural Suitability mapping) of soil characteristics across all proposed disturbance areas, and an assessment of their value and rehabilitation limitations;*
    - *any change in land-use arising from requirements for biodiversity offsets;*
    - *a detailed description of the measures that would be implemented to avoid, reduce or mitigate impacts of the development on local agricultural resources and/or enterprises; and*
    - *justification for any significant long term changes to agricultural resources, particularly highly productive soils potentially affected by the development;*

…

This report has also been prepared in consideration of the NSW Department of Planning and Infrastructure (DP&I) (2012a) *Guideline for Agricultural Impact Statements* and the *Draft Strategic Regional Land Use Plan – Upper Hunter* (Upper Hunter DSRLUP) (DP&I, 2012b), both published in March 2012.

1.3 CONSULTATION

SCPL has ongoing community consultation mechanisms and undertook further extensive consultation in support of the Project, including consultation with the State and local government agencies and the community through a number of forums. These consultation programmes, key issues raised and ongoing consultation mechanisms are described in Section 3 in the Main Report of the EIS.

The key issues raised during consultation that are of particular relevance to this assessment included concerns raised by local landholders regarding the ongoing use of SCPL-owned non-mining lands and the status of weed and pest control on these lands.

1.4 STRUCTURE OF THIS REPORT

This document is structured as follows:

Section 1 Provides an introduction and overview of the Project.

Section 2 Provides a description of the existing agricultural resources, production and enterprises in the region.

Section 3 Describes the potential impacts of the Project on agricultural resources and enterprises, including potential impacts on water resources.

Section 4 Summarises the mitigation and management measures to be implemented with respect to Project impacts on agricultural resources and enterprises.

Section 5 Provides a conclusion and justification for the changes to agricultural resources that would arise due to the Project.

Section 6 References.

Attachment A provides supporting information in the form of a detailed Agricultural Resource Assessment (ARA) prepared by McKenzie Soil Management (Dr David McKenzie) (2012).

The following reports that have been prepared in support of the Project should also be read in conjunction with this assessment:

- Groundwater Assessment (Heritage Computing, 2012) (Appendix A of the EIS);
- Surface Water Assessment (Gilbert & Associates, 2012) (Appendix B of the EIS);
- Noise and Blasting Assessment (SLR Consulting, 2012) (Appendix C of the EIS);
- Air Quality and Greenhouse Gas Assessment (PAE Holmes, 2012) (Appendix D of the EIS);
- Non-Aboriginal Heritage Assessment (Heritage Management Consultants, 2012) (Appendix J of the EIS);
- Road Transport Assessment (Halcrow, 2012) (Appendix N of the EIS);
- Visual Assessment (Resource Strategies, 2012) (Appendix O of the EIS); and
- Socio-Economic Assessment (Gillespie Economics, 2012) (Appendix P of the EIS).

Where relevant, summary content sourced from these documents is provided in this report.

2 EXISTING AGRICULTURAL RESOURCES, PRODUCTION AND ENTERPRISES

2.1 AGRICULTURAL RESOURCES

2.1.1 Climate

Long-term meteorological data for the region is available from the Commonwealth Bureau of Meteorology (BoM) meteorological stations, while shorter term local records are available from on-site weather stations located at the Stratford Mining Complex and at the DCM located some 20 km to the south of the Project.

Temperature

The Chichester Dam and Dungog (BoM, 2011) metrological station records show that temperatures are warmest from November to February and coolest from June to August.

The Dungog Post Office meteorological station records show that monthly-average daily maximum temperatures are highest in January (34 degrees Celsius [ºC]) and monthly-average daily minimum temperatures are lowest in July (0.3ºC).

Rainfall

The long-term average annual rainfall recorded at the Gloucester Post Office, Craven (Longview), and Gloucester (Hiawatha) was 983 millimetres (mm) 1,057 mm and 1,021 mm, respectively.

The months with the highest monthly-average rainfalls at the Gloucester Post Office, Craven (Longview) and Gloucester (Hiawatha) meteorological stations are February and March.

For the period 1996 to 2011, the average annual rainfall recorded by the Stratford Mining Complex meteorological station is 924 mm, with maximum monthly rainfall typically occurring during the warmer months from November to March.

The distribution of annual average precipitation across the Project area is highest in elevated areas to the south and east. Average annual rainfall is relatively lower in areas to the north of the Project area along the Avon River (Gilbert & Associates, 2012).

Evaporation

The Chichester Dam, Taree Airport and Paterson (Tocal) meteorological stations recorded average annual evaporation of approximately 1,059 mm, 1,607 mm and 1,571 mm, respectively.

Measured monthly-average evaporation is recorded as exceeding the measured monthly-average rainfall for most of the year.

Further description of the climate of the Project area, including tabulated climatic data and a description of winds are presented in Section 4.2 in the Main Report of the EIS.

2.1.2 Land Use

McKenzie Soil Management (2012) describes that the Stratford Mining Complex is located in a rural area characterised by vegetated areas, cattle grazing for beef and dairy products on native and improved pastures and the existing/approved SCM and BRNOC mines. Most of the pasture is rain-fed, however approximately 35 hectares (ha) is under centre-pivot irrigation on the rehabilitated Stratford Waste Rock Emplacement (Figure 3) (Attachment A).

The existing Stratford Mining Complex mining leases (MLs) and the Project Mining Lease Application (MLA) areas comprise a combination of existing disturbed areas and cleared agricultural areas (Figure 3).

Agricultural activities known to have been conducted in the Project area include cattle grazing for beef and dairy products, and small areas were observed to have been used for cultivation for forage crops. There was, however, no evidence of crop production for grains or intensive horticulture (Attachment A).

Further description of land use of the Project area and surrounds is presented in Section 4.3 in the Main Report of the EIS.

2.1.3 Landforms

Local topography in the vicinity of the Project is characterised by a north-south oriented linear ridge to the east, transitioning to undulating lowlands and valley floor floodplains towards the west which form part of the Gloucester Valley (Attachment A).

The ridgeline to the east of the Project area rises to approximately 470 metres (m) Australian Height Datum (AHD), and is moderately to steeply sloping. The elevation of the valley floor within the Project area ranges from approximately 140 m AHD to approximately 115 m AHD.

Further description of land use of the Project area and surrounds is presented in Section 4.3 in the Main Report of the EIS. Slopes are described further in Attachment A and the discussion regarding soils below.

2.1.4 Soil Survey

A soil survey was conducted by McKenzie Soil Management (2012) to characterise and assess the soils in the Project area as part of the ARA (Attachment A). The fieldwork was carried out over 12 days in April and June 2011. Some 68 soil pits were assessed that covered the main variations in vegetation type, topography and land use, with a focus on the areas to be potentially disturbed by the Project. The soil pit locations and field soil description methods are outlined in Attachment A. The soil profiles were classified according to the Australian Soil Classification system (Isbell, 2002).

The main soil types mapped in the Project area comprise Kurosols (38 percent [%]) and Kandosols (22%) and Anthroposols (disturbed lands) (16%), while lesser areas of Sodosols, Tenosols, Chromosols and Dermosols were also observed (Attachment A).

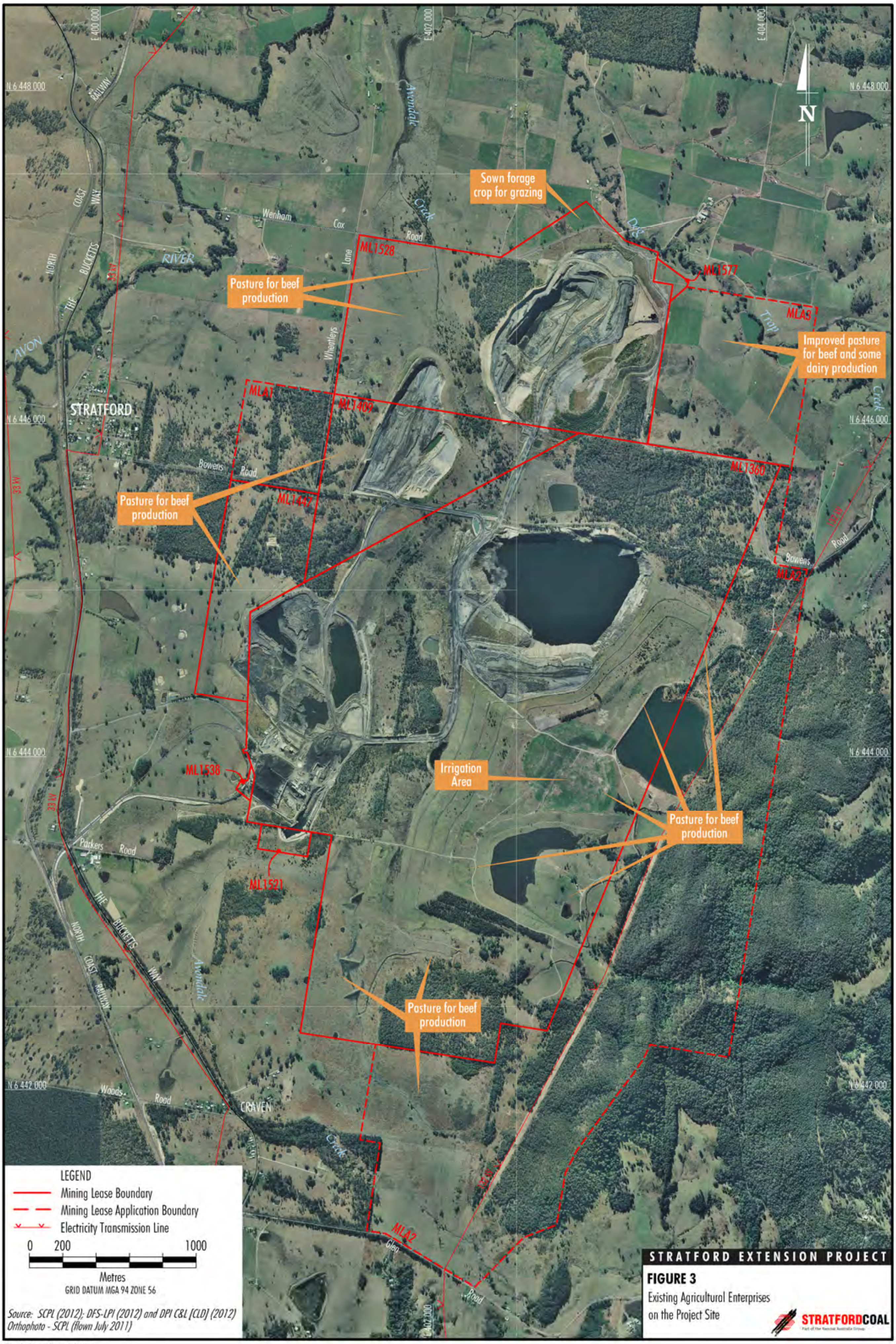


FIGURE 3
Existing Agricultural Enterprises on the Project Site

Soil Landscape units containing groupings of the above soil types were identified during the soil survey as including:

- Disturbed lands with a broad range of slopes: Anthroposols.
- Alluvial/Colluvial Plains, <3% slope: dominated by Kandosols; sub-dominant Kurosols, Sodosols and Chromosols.
- Alluvial/Colluvial Plains, flat and swampy: dominated by Kandosols; sub-dominant Kurosols, Sodosols and Chromosols.
- Lower slopes, 3% to 10% slope: dominated by Kurosols; sub-dominant Kandosols, Sodosols and Chromosols.
- Mid-slopes, 10% to 25% slope on sedimentary rock: mosaic of Tenosols, Kurosols, Kandosols and Sodosols.
- Mid-slopes, 10% to 25% slope on basalt: Dermosol.
- Upper slopes, >25% slope: Tenosols and Rudosols.

The extent of these soil landscape groupings within the area surveyed and mapped by McKenzie Soil Management (2012) is shown on Figure 9 of the ARA (Attachment A).

Soil Condition

A broad range of soil physical and chemical constraints for agricultural land use were identified on the Project site including (Attachment A):

- **Subsoil acidity and associated aluminium toxicity** is a major constraint to agricultural productivity. The strongly acidic subsoil lacks versatility in terms of agricultural management as most plant species would be unable to survive this chemical constraint to crop/pasture production.
- **A lack of water holding capacity** where there is a large stone content in the soil and/or bedrock close to the soil surface, or poor subsoil structure.
- **Dispersive subsoil** due to sodicity and excessive exchangeable magnesium percentage.
- **Subsoil salinity** in low-lying areas in the northern part of the Project site. Some pasture species, particularly legumes, have a poor ability to extract water from the soil when soil salinity is elevated.
- **Nutrient deficiencies**, particularly phosphorus, limit the growth of plants even when other essential requirements such as water and adequate aeration are present in the soil.

The soil testing pits located in existing Stratford Mining Complex rehabilitated areas had a wide range of soil conditions for plant growth, ranging from areas with low water holding capacity associated with rock close to the surface, to areas with much higher water storage capacity and favourable subsoil pH associated with excellent deep root growth that was not seen in most of the “natural” soil profiles under pasture (Attachment A).

2.1.5 Rural Land Capability

The Rural Land Capability classification system is used to delineate the various classes of rural land on the basis of the capability of the land to remain stable under particular uses (Attachment A). Land is allocated to one of the following eight classes:

Land Suitable for Regular Cultivation/Cropping

Class I: No special soil conservation works or practices necessary.

Class II: Soil conservation practices such as strip cropping, conservation tillage and adequate crop rotations are necessary.

Class III: Soil conservation practices such as graded banks and waterways are necessary, together with all the soil conservation practices as in Class II.

Land Suitable Mainly for Grazing

Class IV: Soil conservation practices such as pasture improvement, stock control, application of fertiliser, and minimal cultivation for the establishment or re-establishment of permanent pasture, maintenance of good ground cover.

Class V: Soil conservation works such as diversion banks and contour ripping, in addition to the practices in Class IV.

Land Suitable for Grazing

Class VI: Not capable of cultivation. Soil conservation practices include limitation of stock, broadcasting of seed and fertiliser, promotion of native pasture regeneration, prevention of fire, destruction of vermin, maintenance of good ground cover and possibly some structural works.

Land Suitable for Tree Cover

Class VII: Land best protected by trees.

Land Unsuitable for Agriculture

Class VIII: Cliffs, lakes or swamps where it is impractical to grow crops or graze pasture.

McKenzie Soil Management (2012) assessed Rural Land Capability classes across the surveyed Project area as ranging from Class IV to Class VIII, with the major factor influencing the classification being land slope in conjunction with soil stability in water. Comparison of the results of the NSW Government regional Rural Land Capability and site specific mapping is provided in Figures 10 and 11 of the ARA (Attachment A).

The rehabilitated flat areas on the Stratford Waste Emplacement were allocated Class IV, and the other rehabilitated areas on the Stratford Waste Emplacement and the Northern Waste Emplacement were allocated to Class V (Attachment A). The flat areas on the Stratford Waste Emplacement were observed to have similar, and in some cases better, soil conditions than that observed in the “natural” soil profiles under pasture on the Project site (Attachment A).

Adjoining Lands

Rural Land Capability mapping prepared by the NSW Department of Environment and Climate Change (DECC) is available for surrounding lands and is shown on Figure 10 of the ARA (Attachment A), including land that is owned and managed by SCPL.

The majority of adjoining SCPL-owned land in the vicinity of the Project comprises Rural Land Capability Classes IV and V, although there are also significant areas of SCPL-owned land to the south of MLA 2 that are mapped as Classes VI and VII.

Project Biodiversity Offset Areas

Rural Land Capability mapping prepared by the DECC is available for the Project biodiversity offset areas. Figure 10 of the ARA (Attachment A) shows the boundaries of the proposed Project biodiversity offset areas and the regional Rural Land Capability mapping, which indicates that the offset areas comprise a combination of Classes IV, V, VI and VII, with the higher classes primarily occurring in the southern and eastern parts of the proposed offset areas.

More detail on the Rural Land Capability mapping is provided in Attachment A.

2.1.6 Agricultural Suitability

The Agricultural Suitability system is used to classify land in terms of its suitability for general agricultural use. Agricultural land is classified by evaluating biophysical, social and economic factors that may constrain the use of land for agriculture.

The essential characteristics of the five classes are as follows (Attachment A):

Class 1: Arable land suitable for intensive cultivation where constraints to sustained high levels of agricultural production are minor or absent.

Class 2: Arable land suitable for regular cultivation for crops, but not suited to continuous cultivation. It has a moderate to high suitability for agriculture but soil factors or environmental constraints reduce the overall level of production and may limit the cropping phase to a rotation with sown pastures.

Class 3: Grazing land or land well suited to pasture improvement. It may be cultivated or cropped in rotation with sown pasture. The overall production level is moderate because of soil or environmental constraints. Erosion hazard, soil structural breakdown or other factors, including climate, may limit the capacity for cultivation and soil conservation or drainage works may be required.

Class 4: Land suitable for grazing but not for cultivation. Agriculture is based on native pastures and improved pastures established using minimum tillage techniques. Production may be seasonally high but the overall production level is low as a result of major environmental constraints.

Class 5: Land unsuitable for agriculture, or at best suited only to light grazing. Agricultural production is very low or zero as a result of severe constraints, including economic factors which prevent land improvement.

Agricultural Suitability mapping of the Project area was prepared and based on the results of the soil survey (McKenzie Soil Management, 2012). To aid in assessing the agricultural suitability, 11 soil related factors at 10 locations across the Project area were assessed (Appendix 7 of Attachment A).

Agricultural Suitability classes identified across the site included Class 4 and Class 5 lands.

No Class 3, 2 or 1 Agricultural Suitability lands were identified within the Project disturbance areas, and the rehabilitated areas on the waste rock emplacements were allocated by McKenzie Soil Management (2012) to Class 4.

Soil limitations included various combinations of the following factors: erosion hazards associated with steep slopes, shallowness, dispersion, acidity, nutrient deficiencies and compaction (Attachment A).

It is noted that the regional Agricultural Suitability mapping indicates that the suitability of the land is generally better than the site specific mapping completed by McKenzie Soil Management in 2012, based on assessed local conditions.

Adjoining Lands

Regional Agricultural Suitability mapping provided by the NSW Department of Primary Industries (DPI) is available for adjoining lands and is shown on Figure 12 of the ARA (Attachment A), including land that is owned and managed by SCPL. The majority of adjoining SCPL-owned land in the vicinity of the Project comprises Agricultural Suitability Classes 3, 4 and 5.

Project Biodiversity Offset Areas

Figure 12 of the ARA (Attachment A) shows the boundaries of the proposed Project biodiversity offset areas and the regional Agricultural Suitability mapping provided by the DPI.

The Project biodiversity offset areas include Agricultural Suitability Classes 3, 4 and 5. The Class 3 mapped areas are associated with the generally cleared areas to the west, whereas the Class 4 and Class 5 areas are associated with the ridgeline in the eastern sections of the two southern offset areas.

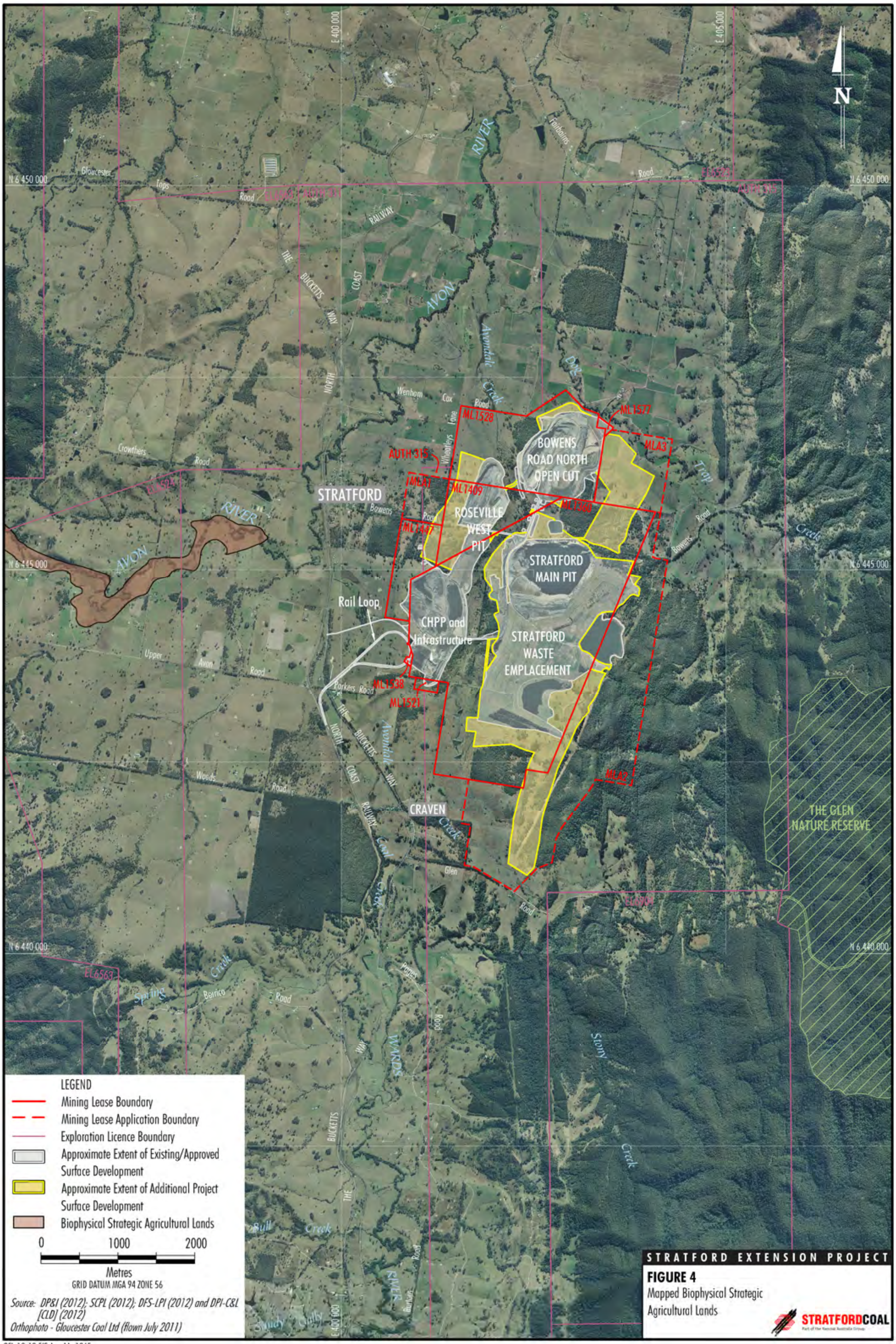
More detail on the Agricultural Suitability mapping is provided in Attachment A.

2.1.7 Identification of Strategic Agricultural Lands

In March 2012, the NSW Government through the DP&I released the Upper Hunter DSRLUP (DP&I, 2012b). The Upper Hunter DSRLUP includes the Gloucester Local Government Area (LGA) and identifies areas of land that have particularly high agricultural values.

A review of the regional mapping in the Upper Hunter DSRLUP indicates that no biophysical strategic agricultural land has been mapped in the immediate vicinity of the Project. The nearest mapped strategic agricultural land in the region is located on the Avon River approximately 2 km to the west of the Project (Figure 4).

It is therefore concluded that based on the limitations identified in the site soil survey (Section 2.1.4), Rural Land Capability mapping (Section 2.1.5), Agricultural Suitability mapping (Section 2.1.6) and review of regional mapping of strategic agricultural lands, the Project area does not include highly productive soils, nor does it include areas of high value or strategic agricultural lands. Similarly, adjoining SCPL-owned lands and the proposed Project biodiversity offset areas also do not comprise high value or strategic agricultural lands based on the available mapping information.



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2.1.8 Water Resources

Groundwater

A Groundwater Assessment for the Project was undertaken by Heritage Computing (2012) and is presented in Appendix A of the EIS. The following discussion is based on this assessment and Section 4.4 in the Main Report of the EIS.

Existing Groundwater Regime

Two groundwater systems exist in the Project area and surrounds, including:

- Fractured rock groundwater system – including shallow rock aquifer and the Gloucester Coal Measures and underlying Dewrang Group; and
- Alluvial groundwater system – including alluvial (narrow channel) sediments associated with Dog Trap Creek, Avondale Creek and the Avon River.

Recharge to the groundwater systems occurs from rainfall and runoff infiltration, lateral groundwater flow and some leakage from surface water storages (e.g. Stratford East Dam) and streams (e.g. Dog Trap Creek). Although groundwater levels are sustained by rainfall infiltration, they are controlled by topography, geology and surface water levels in local drainages.

Local groundwater tends to mound beneath hills (e.g. to the east of the Stratford Mining Complex), with ultimate discharge to local drainages and loss by evapotranspiration where the watertable is near the ground surface (generally 2 m to 3 m below ground level). The typical depth to water is generally 1 m to 10 m in the vicinity of the Stratford Mining Complex tenements.

The direction of groundwater flow in the vicinity of the Stratford Mining Complex is from the south-east to the north-west, and the main groundwater discharge zones are Dog Trap Creek, Avondale Creek and the Avon River.

Groundwater Quality and Use

Heritage Computing (2012) indicates that groundwater in the coal seams is highly mineralised and hard, with a slightly acidic to neutral pH which is unsuitable for domestic consumption and in some cases unsuitable for stock/irrigation. Groundwater samples taken close to Avondale Creek show generally high salinities in the alluvium, and in sub-cropping coal seams. Intermittent seepage of more saline groundwater from sub-cropping coal seams into Avondale Creek has caused gradually increasing salinity of surface water in the downstream direction. Apart from two private bores, most groundwaters are beyond the limit of potable use but on the basis of salinity are suitable for livestock, irrigation and other general uses (Heritage Computing, 2012).

Locally there is little reliance on groundwater bores as a source of water, as agricultural enterprises predominantly rely on surface water sources. The number of privately held bores in the Project area and surrounds is low due to the high rainfall and subsequent high rates of runoff (Heritage Computing, 2012).

A search of the NSW Office of Water Pinneena Groundwater Works Database identified 62 registered bores and wells within approximately 5 km of the Project open cuts, the majority (48) of these being bores on land owned by SCPL. The 12 bores not on SCPL land comprise some 11 bores at Stratford Village and one private bore to the south of the Project that are licensed for stock and domestic use (refer Appendix A of the EIS). One privately-owned bore is located more than 5 km from the Project.

Existing Influence of the Stratford Mining Complex

Groundwater monitoring bores that are in close proximity to the mining operations have shown responses to the effect of mining, however, there have been no recorded mining responses at the nearby privately-owned Stratford Village bores. A SCPL bore located at the eastern edge of the village has recorded a mild decline of about 0.5 m from 2003 to 2010 (Heritage Computing, 2012).

Surface Water

A Surface Water Assessment for the Project was undertaken by Gilbert & Associates (2012) and is presented in Appendix B of the EIS. The following discussion is based on this assessment and Section 4.5 in the Main Report of the EIS.

The Project area is located in an upper catchment of the Manning River system within the NSW Lower North Coast Water Management Area. The Avon River is a tributary of the Gloucester River which ultimately flows to the Manning River. Flows in the Avon River are unregulated and therefore water users rely on the natural flow regime for their water supplies.

The existing Stratford Mining Complex is located within the Avondale Creek and Dog Trap Creek sub-catchments which converge and flow into the Avon River to the north of the Project.

Avondale Creek

Within the Project area, Avondale Creek is considered an ephemeral waterway, which experiences some extended periods of no or negligible flow during dry weather. Upstream of the Project area Avondale Creek flows to the west, before draining north through the Stratford Mining Complex, and eventually joining Dog Trap Creek approximately 1 km north (and downstream) of the Project area.

A portion (27%) of the catchment reporting to Avondale Creek has been diverted from its original flow path to be captured within the existing/approved Stratford Mining Complex water management systems to prevent mine water and sediment laden runoff entering the creek.

Dog Trap Creek

Dog Trap Creek borders the northern extent of the Project area and flows toward the north-west.

Observation and anecdotal evidence from SCPL staff indicate that streamflow in Dog Trap Creek has similar flow characteristics to Avondale Creek and is considered ephemeral.

A small portion (approximately 1%) of the catchment of Dog Trap Creek has also been diverted from its original flow path to be captured within the existing/approved Stratford Mining Complex (specifically the BRNOC) water management systems to prevent mine water and sediment laden runoff entering the creek.

Surface Water Quality

Water quality of the Avon River is generally characterised by low levels of salinity (i.e. electrical conductivity [EC]). Based on the available data sets since 1994, there is no visually apparent upward trend in EC with time increasing at lower flow rates. The available data for Avondale Creek and Dog Trap Creek indicate that the local surface water resources are generally characterised by near neutral pH conditions and recorded EC of local surface water resources was generally low with the exception of the downstream sections of Avondale Creek due to the outcropping/sub-cropping of coal seams within the catchment and associated slow seepage of more saline groundwater into the creek (Gilbert & Associates, 2012).

Existing Influence of the Stratford Mining Complex

The Project has resulted in changes to flows in local creeks due to the progressive extension of the open cut mining operations and associated subsequent capture and re-use of drainage from operational catchment areas. The water balance at the Stratford Mining Complex has historically been in surplus and irrigation of water from the Stratford East Dam occurs over approved areas of the Stratford Waste Rock Emplacement to provide contingency for mine water storage.

The existing Stratford Mining Complex water management system does not release water from disturbed areas off-site other than from sediment dams and rehabilitated landforms in accordance with existing approvals.

Other Surface Water Users

Water in the Avon River is used for stock watering purposes and irrigation purposes. There are 45 surface water licences in the Avon River Water Source, with a total volumetric surface water licence of 1,997 megalitres per year (ML/year) of which 95% is used for irrigation purposes. There are two licences on Dog Trap Creek with a total volumetric licence of 140 ML/year and no records of surface water licences on Avondale Creek (Gilbert & Associates, 2012). With the exception of four properties, SCPL owns all other lands with direct access to Avondale Creek.

2.2 AGRICULTURAL PRODUCTION AND ENTERPRISES

Gillespie Economics (2012) has completed an Agricultural Economic Analysis of the Project, which is presented in the Project Socio-Economic Assessment (Appendix P to the EIS). In Attachment A to Appendix P of the EIS, Gillespie Economics has analysed the relative contribution of agricultural production to the state of NSW and the local region (Gloucester and Great Lakes LGAs).

The NSW agricultural industry directly provides employment for 76,261 people or 2.7% of total employment in NSW, and agricultural lands cover approximately 81% of NSW (Gillespie Economics, 2012). Trends in agriculture are leading to improved productivity, but reduced economic stimulus in regional areas, as demand for inputs such as labour decline. In general, the prosperity of rural areas that are reliant on agriculture has subsequently been in decline (Gillespie Economics, 2012).

The Gloucester LGA is located in the wider Upper Hunter Region. The Upper Hunter DSRLUP describes the wider regional context of agricultural production over an area that comprises an area of some 2.2 million hectares and includes the LGAs of Singleton, Muswellbrook, Dungog, Upper Hunter and Gloucester (DP&I, 2012b). The Upper Hunter DSRLUP (DP&I, 2012b) notes that in the Dungog and Gloucester LGAs extensive beef cattle grazing and crop production remain the mainstay of the local economies.

The Gloucester and Great Lakes region (i.e. the Gloucester and Great Lakes LGAs) has a land area of 633,000 ha, of which approximately 36% is agricultural land and the total value of agricultural production in 2006 was estimated at $63.7 million (M) (Gillespie Economics, 2012). Total employment in the agricultural industry in the Gloucester and Great Lakes LGAs is 829, with the main agricultural employment being in specialised beef cattle farming (Gillespie Economics, 2012).

2.2.1 Agricultural History of the Local Area

Heritage Management Consultants Pty Ltd (2012) has prepared a Non-Aboriginal Heritage Assessment for the Project (Appendix J to the EIS). This report indicates that while the Australian Agricultural Company developed land in the wider region from the 1830s, the Project area appears to have been largely wooded during the Australian Agricultural Company period, and was cleared for dairying in the early 20th century (Heritage Management Consultants, 2012).

2.2.2 Local Agricultural Productivity and Enterprises

As described above, the primary agricultural sector in the Gloucester and Great Lakes LGAs is beef cattle farming.

McKenzie Soil Management (2012) has identified that agricultural enterprises known to have been conducted in the Project area include cattle grazing for beef and dairy products on improved and unimproved pastures, with beef production being the dominant agricultural activity. Small areas were also observed to have cultivation for forage crops, but there was no evidence of crop production for grains or intensive horticulture. A dairy operation is located within and north of MLA3 on land owned by SCPL (Figure 3). Soil pit data indicates that the improved pasture used for this dairy production within MLA3 is generally not considered to be of high productivity (i.e. the area has been mapped as Rural Land Capability Class 4) (Attachment A).

Based on McKenzie Soil Management's analysis and review of the agricultural operations on surrounding lands, it is considered that the majority of the agricultural lands on the Project site and surrounds are unimproved pasture or low productivity improved pastures, while areas of low or no agricultural capability (particularly on the ridgeline to the east of the Project) remain as areas of remnant vegetation that are not utilised for agriculture.

Figure 3 and Plates 1 to 4 illustrate the existing rehabilitation areas at the Stratford Mining Complex that are currently being used for agricultural production. Approximately 70 cows plus progeny graze on about 200 ha of land (including approximately 35 ha of irrigated pasture). The irrigated area is typically planted with fodder crops (e.g. oats and rye).

McKenzie Soil Management (2012) has estimated the gross margins for beef cattle grazing on improved and unimproved pastures in the Project area and surrounds as being approximately $135 and $53 per hectare, per year respectively (Attachment A).

Project Biodiversity Offset Areas

Agricultural activities historically conducted in the Project biodiversity offset areas primarily include cattle grazing on improved and unimproved pastures. The Agricultural Suitability classification of the existing agricultural areas in the Project biodiversity offset areas is typically a combination of Classes 3 and 4, based on regional DPI mapping.

2.2.3 Support Infrastructure, Suppliers and Services

Local rural suppliers and/or equipment suppliers are located in Gloucester, Stroud, Dungog and Booral. The Project area and surrounds are well serviced for support infrastructure being located adjacent to The Bucketts Way and some 10 km south of Gloucester. The Project area is also serviced by the North Coast Railway, which forms part of the rail link between Brisbane and Sydney.

Plate 1: Stratford Waste Emplacement - Existing Rehabilitation

Plate 2: Stratford Waste Emplacement - Existing Rehabilitation to Grazing Land

STRATFORD EXTENSION PROJECT

PLATES 1 & 2

Rehabilitation and Revegetation Photographic Plates

STRATFORDCOAL

Plate 3: Stratford Waste Emplacement - Existing Rehabilitation to Grazing Land (Irrigated Pasture)

Plate 4: Stratford Waste Emplacement - Existing Rehabilitation to Grazing Land

STRATFORD EXTENSION PROJECT

PLATES 3 & 4
Rehabilitation and Revegetation Photographic Plates

STRATFORDCOAL

Access to regional road transport routes are readily available from the Project area which is located approximately 1 hour drive from the Pacific Highway at Nabiac (i.e. north via Gloucester) or at Twelve Mile Creek (i.e. south via Stroud). Stratford is also located within a two hour drive from the major regional centre of Newcastle and a similar distance from the town of Singleton in the Hunter Valley.

The Project is also located within approximately 1.5 hours drive of the Tocal College, a NSW Industry & Investment college with associated large commercial farms located in the Hunter Valley.

General agricultural improvements (e.g. stock fences and farm dams) are in place across most of the Project area and surrounds that reflect its historical development for dairying and beef production. A centre-pivot irrigation system has also been established by SCPL on the rehabilitated Stratford Waste Emplacement (Figure 3).

3 POTENTIAL IMPACTS

This section provides an assessment of the potential impacts of the Project (including the proposed Project biodiversity offset areas) on agricultural resources and productivity.

3.1 CONSIDERATION OF RISKS

As a component of the analysis of the potential environmental impacts of the Project, both a Preliminary Hazard Analysis and Environmental Risk Analysis have been completed (Appendices Q and R of the EIS). The potential impacts of the Project on groundwater and surface water resources have been considered in the Groundwater and Surface Water Assessments for the Project (Appendices A and B of the EIS). Potential impacts on adjoining lands through the potential impacts of operational noise, blasting, air quality emissions and road transport have been considered in the Noise and Blasting, Air Quality and Greenhouse Gas and Road Transport Assessments (Appendices C, D and N of the EIS).

The existing Stratford Mining Complex rehabilitation success provides a working demonstration of the practical application of rehabilitating mining operational disturbance areas (e.g. waste rock emplacements) to productive agricultural land uses.

3.2 AGRICULTURAL RESOURCES

3.2.1 Land Resources during the Project Life

Project Site

The Project would disturb approximately 690 ha of existing agricultural land, including large agricultural areas associated with Stratford Mining Complex which have been rehabilitated to date (e.g. the rehabilitated Stratford and Roseville waste emplacements include approximately 200 ha of agricultural lands). This existing agricultural land consists of a combination of improved and unimproved pastures, primarily on mapped Class 4 Agricultural Suitability lands (Attachment A). The impacts of the Project on improved pastures used for dairy production in MLA3 would result in a loss of approximately 20% of the total land used for the dairy operation to the north of the Project. The dairy operator has indicated an intent to continue the dairy operations following the excision of this land.

These existing agricultural areas on the Project site could continue to be used for agricultural activities until they are required for the Project.

Adjoining Lands

SCPL-owned lands that adjoin the Project area would continue to be used for agricultural uses (e.g. via agistment of stock, leasing or agreements with previous landholders).

Project Biodiversity Offset Areas

The Project biodiversity offset areas (Figure 5) include approximately 380 ha of cleared land outside of the Project MLs and MLAs[1] which is grazing land, based on existing Rural Land Capability and Agricultural Suitability mapping (Sections 2.1.5 and 2.1.6) and recent aerial photography.

[1] To avoid double counting, this does not include an existing agricultural area within MLA 2, and an existing agricultural area in MLA 1 that are included in the offset areas.

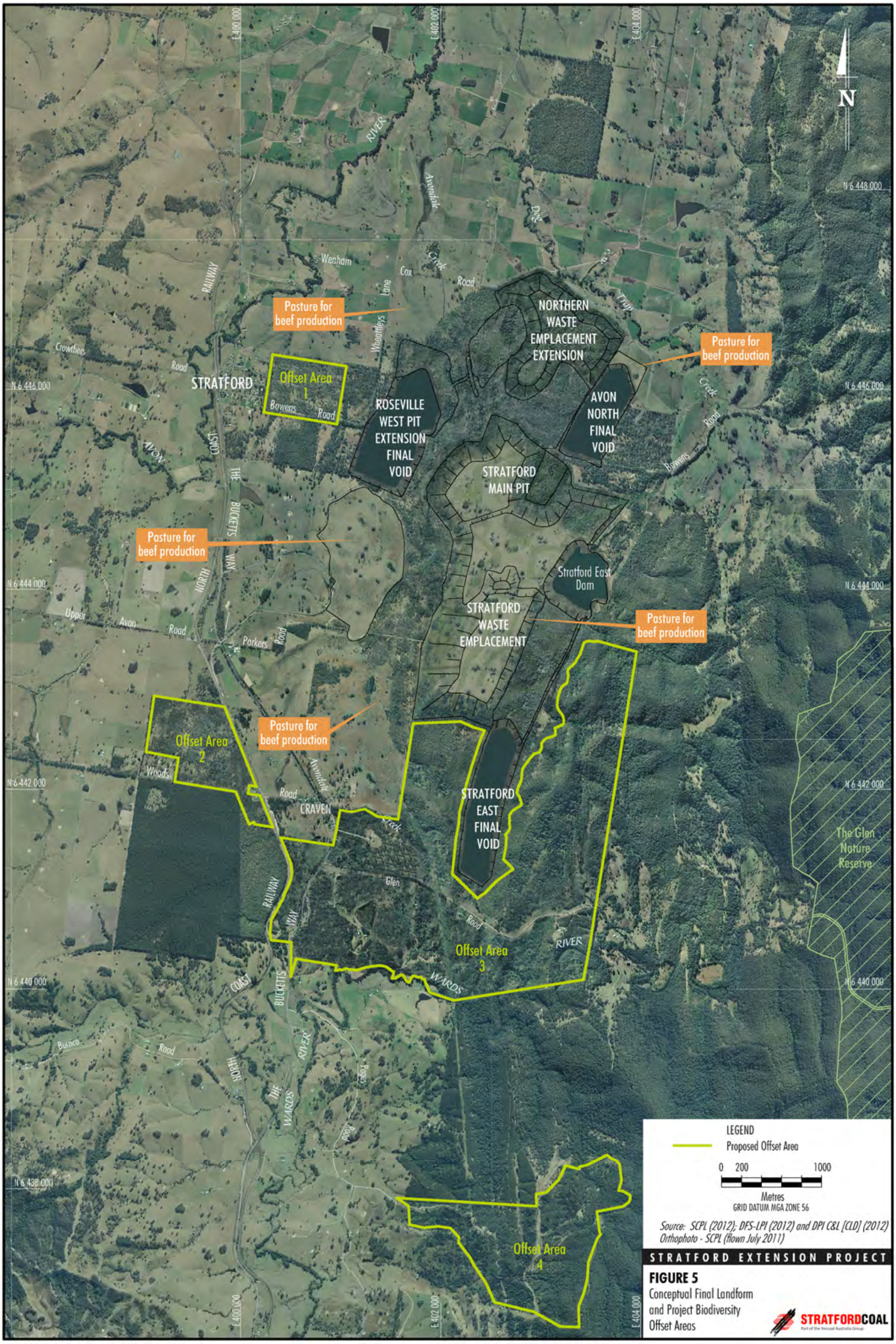

FIGURE 5
Conceptual Final Landform and Project Biodiversity Offset Areas

The offset proposal for the Project involves conserving local areas with existing fauna and flora conservation values and providing active management to maintain and enhance the flora and fauna values. Agricultural activities would therefore not be undertaken on the Project biodiversity offset areas and therefore it is assumed that an additional 380 ha of grazing lands outside of the immediate Project area would be sterilised by the biodiversity offset areas.

3.2.2 Land Resources Post-Mining

Project Site

Project disturbance areas would be progressively rehabilitated in a manner that provides a balance between post-mining agricultural land use and native vegetation regeneration areas. The Project final landform and the proposed post-mine land uses (including some 300 ha of restoration of land suitable for grazing) are presented on Figure 5.

A review of the physical and chemical properties of the soil resources within Project disturbance areas has established that in-situ soil resources are suitable as a rehabilitation medium for agricultural (grazing) and native vegetation land uses on the Project site, with the implementation of suitable soil management measures (Attachment A). Based on experience to date of the Stratford Mining Complex, SCPL anticipates that rehabilitated grazing lands would be of comparable Agricultural Suitability to neighbouring areas with similar topographic locations and slopes.

McKenzie Soil Management (2012) has recommended that 15 to 20 centimetres (cm) of soil be placed on agricultural land use rehabilitation areas and some 10 cm of soil be applied to native vegetation land use areas during rehabilitation (Attachment A). Soil stripping, stockpiling and application management measures that would be implemented at the Project are detailed in Attachment A.

Adjoining Lands

At the completion of the Project, SCPL may no longer require company-owned lands that adjoin the Project site. It is therefore expected that these properties would be sold and therefore would continue to be used for agricultural purposes in the future.

Project Biodiversity Offset Areas

The Project biodiversity offset areas (Figure 5) would be permanently conserved and as a result, approximately 380 ha of existing grazing land in these areas would be sterilised in perpetuity.

3.2.3 Availability of Water for Agriculture

As described in the Groundwater and Surface Water Assessments (Appendices A and B of the EIS), it is not anticipated that the Project would require any additional groundwater or surface water licence volumetric entitlements beyond the existing surface water and groundwater volumetric entitlements held by SCPL for the existing Stratford Mining Complex.

Notwithstanding, the Project would result in some residual catchment excision due to the presence of the final open cut voids and groundwater would continue to report to these voids for an extended period following the cessation of mining and reducing during recovery (Appendices A and B of the EIS). On this basis potential impacts of the Project on the availability of surface water and groundwater for agricultural uses are described in summary form below.

Groundwater

The numerical modelling shows that potential changes in water level in each of the 12 privately owned bores identified is expected to be negligible, and concludes that there is expected to be negligible impact on groundwater levels or groundwater yield for groundwater users with privately owned bores in any groundwater system attributable to the Project (Appendix A of the EIS).

The Groundwater Assessment also concludes that there would be no deleterious effect on the beneficial uses of any groundwater sources, as the final voids would remain groundwater sinks (Appendix A of the EIS).

Consideration of the economic flow-on effects of utilising groundwater for the Project rather than agricultural uses is provided in Appendix P of the EIS.

Surface Water

The maximum predicted reduction in contributing catchment over the life of the Project is 2.7% of the total catchment of the Avon River at the confluence with the Gloucester River (Appendix B of the EIS). Following the completion of rehabilitation post-mining, only the catchment area of the final voids would remain excised from the Avon River (approximately 0.7% of the total catchment of the Avon River at the confluence with the Gloucester River) (Appendix B of the EIS).

With the implementation of the proposed surface water management and mitigation measures the Project would have a low risk of adversely affecting downstream water users (Appendix B of the EIS).

Compared to the existing/approved total catchment area excised by the Stratford Mining Complex, the Project is not expected to result in a measurable change to downstream flows in Avondale Creek, Dog Trap Creek or the Avon River (Appendix B of the EIS). Specifically for licensed surface water users on the Avon River and Dog Trap Creek, this is estimated to be a small reduction in average flows of the order of 3% to 4% (Appendix B of the EIS).

Consideration of the economic flow-on effects of utilising surface water for the Project, rather than agricultural uses is provided in Appendix P of the EIS.

3.2.4 Amenity Effects

Consideration of the potential impacts of the Project with respect to human health and amenity criteria for nearby private landholders is considered in the Noise and Blasting and Air Quality and Greenhouse Gas Assessments (Appendices C and D of the EIS). In addition, potential impacts of the Project on visual amenity, the safety and efficiency of the road network in the vicinity of the Project have been considered in the Visual and Road Transport Assessments (Appendices O and N of the EIS).

No potential impacts have been identified in these assessments that would materially affect the agricultural productivity of adjoining privately-owned lands.

3.3 AGRICULTURAL PRODUCTION, AGRICULTURAL INFRASTRUCTURE, SUPPLIERS AND SUPPORT SERVICES

The area of grazing agricultural lands that would be temporarily removed by the Project open cut mining (a maximum of approximately 690 ha over the life of the mine), and consideration of the area of comparable grazing lands that would be re-instated with the Project rehabilitation programme (approximately 300 ha), along with sterilisation of existing grazing agricultural lands in the Project biodiversity offset areas (approximately 380 ha) can be considered in the context of the area of land under agricultural production in the State of NSW and in the Gloucester/Great Lakes region (Table 1).

Table 1
Potential Impacts of the Project on Regional and State Agricultural Land Area

Region	Approximate Area under Agricultural Use (ha)	Project Maximum Impact*		Residual Impact of Project Final Landform*	
		(ha)	(%)	(ha)	(%)
NSW	65,000,000	1070	0.002	770	0.001
Gloucester/Great Lakes	125,000		0.856		0.616

After: Gillespie Economics (2012)

* Including agricultural lands in Project biodiversity offset areas.

As shown in Table 1, the potential impact of the Project on the area of land that is subject to agricultural use in NSW and in the Gloucester/Great Lakes region would be very small. In addition, none of the existing agricultural land that has been identified as being potentially impacted by the Project is considered to be highly productive or of strategic importance (Section 2.1.7).

Gillespie Economics (2012) (Appendix P of the EIS) has considered the potential impacts of the Project sterilisation of agricultural land and the use of some water resources that may otherwise have been available for agriculture on the Gloucester/Great Lakes region. This analysis indicates that approximately $1.9M would be in lost agricultural production (in perpetuity) as a result of the Project.

Regional economic impacts were also evaluated and indicate that the Project use of agricultural land and water is predicted to reduce direct agricultural employment in the Gloucester/Great Lakes region by approximately three people, and reduce agricultural output by some $0.3M per annum (Appendix P of the EIS).

Consideration of the above indicates that the Project has very little potential to materially affect regional agricultural production or demand for agricultural infrastructure, supplies or services at a local or regional level.

Consideration of the potential impacts of the Project on the availability of employees in the agricultural sector (i.e. flow-on effects of Project employment demand in a tight labour market) and potential impacts to population and housing are provided in Appendix P of the EIS.

3.4 CONSIDERATION OF POTENTIAL CUMULATIVE IMPACTS

Approved Projects

The Stage 1 of the AGL Gloucester LE Pty Ltd (AGL) Gloucester Gas Project was granted Project Approval (08_0154) under Part 3A of the EP&A Act in February 2011. AGL is the proponent of the Gloucester Gas Project. Infrastructure associated with Stage 1 of the AGL Gloucester Gas Project overlays and is adjacent to the existing mining and exploration tenements at the Stratford Mining Complex (Figure 6).

The *Gloucester Gas Project Environmental Assessment* (AECOM Australia, 2009) indicates the following for the Stage 1 gas field development area (Figure 6):

- the land is largely rural land which would traditionally have been used for agricultural purposes and can support grazing;
- the proposed development would not preclude the use of the land for agriculture, and certain agricultural uses could coexist with the presence of scattered gas wells;

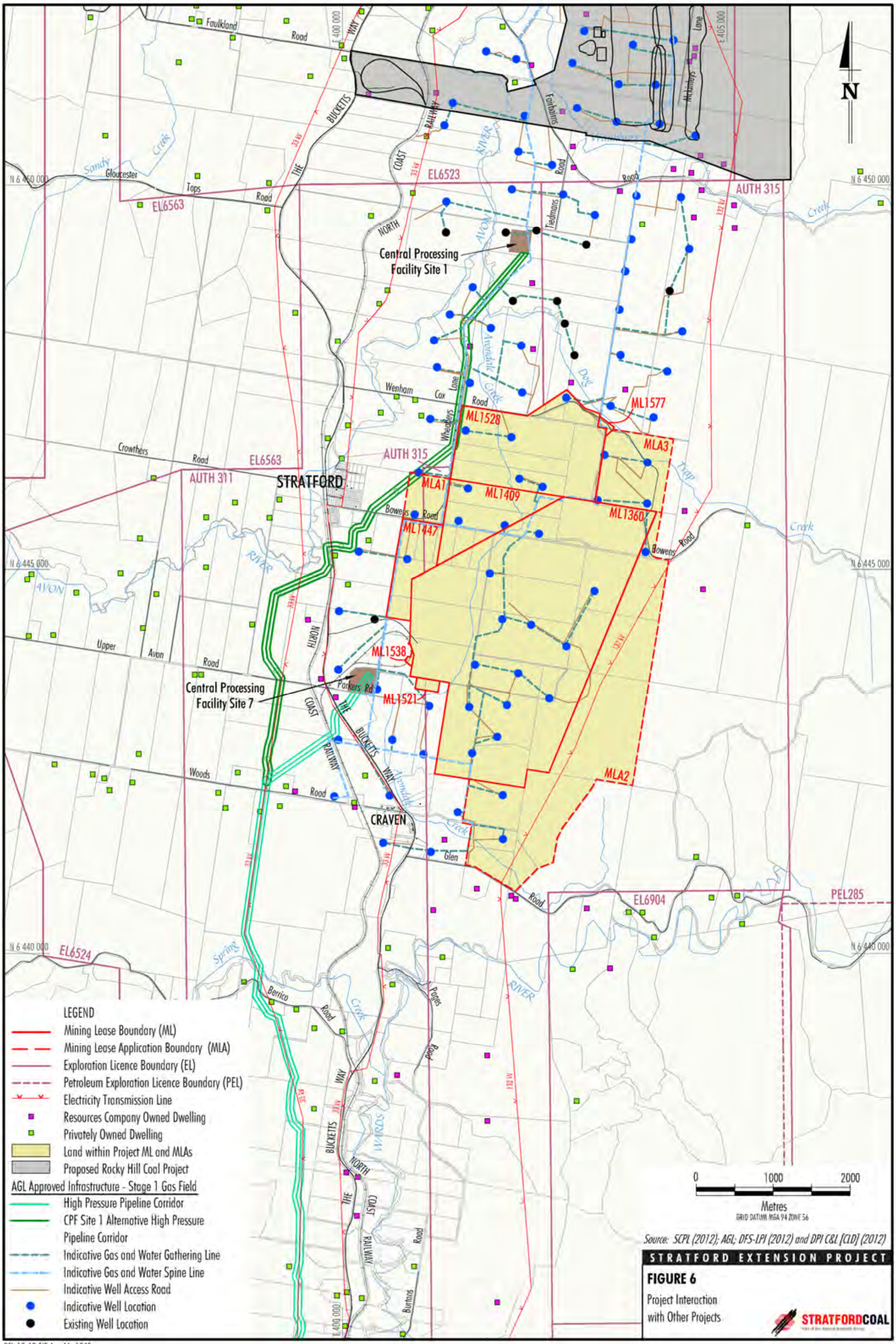

FIGURE 6
Project Interaction with Other Projects

GCL-10-12 EIS App AA_104E

- gas wells and associated infrastructure (e.g. gas and water gathering lines) would be sited adjacent to existing fence lines and access tracks where possible to minimise potential restrictions on the agricultural use of the land; and
- any (temporary) restriction on the agricultural use of the land would be completely removed upon decommissioning of the wells.

The Duralie Extension Project at the DCM was approved on 26 November 2010. The Duralie area is also characterised by cattle grazing on native and improved pastures and the approved mine involves the permanent removal of some areas of existing pastoral production, particularly associated with biodiversity offset areas that would no longer be available for pastoral use (Duralie Coal Pty Ltd, 2010). Rehabilitation of the approved mine disturbance areas would include a combination of native woodland and grazing uses.

Based on review of the above and the existing area of agricultural land in the region (Table 1), no significant cumulative impacts on regional agricultural production and associated support industries are anticipated to arise from the co-incident development of the Project, approved DCM and AGL's Gloucester Gas Project.

Proposed Projects

The proposed Gloucester Resources Limited (GRL) Rocky Hill Coal Project is located approximately 5 km to the north of the Project (Figure 6) and would disturb an area of approximately 560 ha of land (R.W. Corkery and Co. Pty Limited, 2012). *Documentation Supporting an Application for Director-General's Requirements for the Rocky Hill Coal Project* (R.W. Corkery and Co. Pty Limited, 2012) indicates the following with respect to that project's potential impacts on agricultural land:

- the majority of the site is used for cattle grazing;
- progressive restoration of disturbance areas to a level of agricultural productivity similar to existing levels; and
- a low risk of site activities leading to a loss of important agricultural land.

TransGrid is the proponent of the Stroud to Lansdowne Project. The Stroud to Lansdowne Project would involve construction of a single-circuit 330 kV transmission line between Essential Energy's Stroud Substation and a new substation near Lansdowne (north of Taree). Because of the nature of this proposal (i.e. above ground transmission lines with associated tower installations), no material impacts on agricultural production in the vicinity of the Project are anticipated.

If the proposed Rocky Hill Coal Project or the Stroud to Lansdowne Project are approved in the future, the cumulative impacts of these developments are also considered to be unlikely to result in significant impacts on regional agriculture or associated supporting industries. However, it is anticipated that these developments would be subject to their own cumulative agricultural impact assessments.

4 MITIGATION AND MANAGEMENT MEASURES

As described in Section 3, the potential impacts of the Project on agricultural resources and associated employment and support industries would be small in the context of the existing agricultural activities in the region. In addition, consideration of the cumulative impacts of the approved DCM, AGL Gloucester Gas Project and the proposed Stroud to Landsdowne and GRL Rocky Hill Coal Projects also indicate that even accounting for these other approved and proposed developments, the potential cumulative impacts on local and regional agriculture would be minor.

Notwithstanding, SCPL would implement a number of mitigation and management measures that would reduce the potential impacts of the Project on agriculture as described below.

4.1 MINIMISATION OF DISTURBANCE TO AGRICULTURAL LANDS

The area of agricultural land disturbed by the Project at any one time would be minimised so that beneficial agricultural uses can continue to be undertaken on available Project grazing lands. As demonstrated by SCPL at the existing Stratford Mining Complex to date, grazing agricultural activities can be readily undertaken in conjunction with the operation of a mine.

4.2 MANAGEMENT OF SOIL RESOURCES

General soil resource management practices would include the stripping and stockpiling of soil resources prior to any mine-related disturbance for use in rehabilitation, including the use in rehabilitation of agricultural land use areas. Project soil resource management measures are outlined in detail in Attachment A and Section 5 in the Main Report of the EIS.

The success of the existing Stratford Mining Complex soil management and rehabilitation practices is demonstrated by the existing rehabilitation areas (Section 2.2.2).

4.3 MANAGEMENT OF ADJOINING SCPL-OWNED LANDS

Adjoining SCPL-owned lands would continue to be used for agricultural uses, where practicable.

A Property Management Strategy would be prepared by a suitably qualified person(s) to facilitate the management of agricultural land in the Project area and on adjoining SCPL-owned lands. The Property Management Strategy is expected to include property and grazing management measures, erosion, weed and pest controls to be applied across all of the lands controlled by SCPL. The Property Management Strategy may also include various measures to optimise biodiversity outcomes within agricultural lands.

At the renewal of leases or agreements with private landholders that conduct agricultural activities on SCPL-owned land, SCPL would require all lessees to comply with the erosion, weed and pest control measures that are described in the Property Management Strategy.

The implementation of the Property Management Strategy would serve to minimise the potential direct impacts of the Project on agricultural production within the Project area and SCPL-owned land, and potential indirect impacts (e.g. weeds and pests) on surrounding agricultural lands.

At the completion of the Project, it is expected that SCPL would sell adjoining properties it holds.

4.4 RE-ESTABLISHMENT OF AGRICULTURAL LANDS

The rehabilitation and mine closure strategy for the Project includes restoration of approximately 300 ha of agricultural land suitable for grazing (Figure 5). The rehabilitation of this land reduces the area of agricultural land that would be sterilised by the Project.

This re-establishment of agricultural lands would be undertaken progressively as a component of the Project rehabilitation programme as described in Section 5 in the Main Report of the EIS.

As has already been successfully demonstrated at the Stratford Waste Emplacement, SCPL anticipates rehabilitated agricultural lands would be of comparable Agricultural Suitability classification to neighbouring areas with similar topographic locations and slopes.

4.5 WATER RESOURCES

Measures to minimise the potential impacts of the Project on water resources, including water resources used by other licensed users of water for agriculture are provided in Appendices A and B, and Sections 4.4 and 4.5 in the Main Report of the EIS.

The existing Stratford Mining Complex Water Management Plan would be reviewed and revised to describe any additional measures/procedures to be implemented over the life of the Project. This updated plan would include measures to respond to any potential exceedances of surface water or groundwater related criteria, and to provide contingent mitigation/compensation/ offset measures that would be implemented in the event that downstream surface water users or groundwater users are adversely affected by the Project.

To address potential cumulative impacts on groundwater in the context of predicted AGL Gloucester Gas Project impacts on local groundwater resources, SCPL proposes to augment the existing groundwater monitoring programme and utilise the results of other groundwater monitoring programmes in the vicinity of the Project (i.e. AGL Gloucester Gas Project and proposed Rocky Hill Coal Project).

The Stratford East Dam would be retained post-mining as a resource for future land use (e.g. cattle grazing and cropping) (Appendix B). In addition, upon consultation with relevant landholders and users, sediment and retention dams may be retained for future agricultural use.

4.6 OTHER MEASURES

SLR Consulting (2012) assessed blast vibration and airblast safe working distances in relation to impacts on livestock. The findings of this assessment are discussed in Appendix C.

Section 4 in the Main Report of the EIS describes a range of management and mitigation measures for potential environmental impacts arising from the Project, including relevant contingency measures.

5 JUSTIFICATION OF PROPOSED CHANGES TO AGRICULTURAL LANDS

The results of the site specific soil survey, Rural Land Capability mapping, Agricultural Suitability mapping and review of regional mapping of strategic agricultural land in the Upper Hunter DSRLUP indicate that the Project area does not comprise strategic value or high productivity agricultural lands.

Similarly, adjoining SCPL-owned lands and the proposed Project biodiversity offset areas also do not comprise strategic value or high productivity agricultural lands.

In summary:

- The Project would at maximum disturb some 1,070 ha of existing grazing agricultural lands that are used for beef production.
- The Project would re-instate some 300 ha of grazing agricultural land within the Project disturbance area as a component of the progressive rehabilitation programme.
- The Project would involve the residual sterilisation of some 770 ha of existing grazing agricultural land (primarily associated with the loss of agricultural land to revegetation of Project biodiversity offset areas and Project disturbance areas).
- The Project residual impacts on agricultural lands would, at State and regional levels, be very minor.
- The Project potential cumulative impacts on local or regional agriculture support industries would not be material.

The agricultural economic analysis conducted by Gillespie Economics (2012) indicates that the economic benefits of the Project far outweigh the potential economic costs associated with the reduction in regional agricultural production that would arise due to the sterilisation of some 770 ha of grazing agricultural lands due to the Project and associated biodiversity offsets.

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ATTACHMENT A

AGRICULTURAL RESOURCE ASSESSMENT

March

2012

Agricultural Resource Assessment: "Stratford Extension Project", Gloucester NSW

Prepared for Stratford Coal Pty Ltd.

Dr. David McKenzie

McKenzie Soil Management Pty. Ltd.

Orange NSW

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1 INTRODUCTION

1.1 Background

The Stratford Coal Mine (SCM) and Bowens Road North Open Cut (BRNOC) (both mines referred to collectively as the Stratford Mining Complex) are located approximately 100 kilometres north of Newcastle, New South Wales (NSW) in the Gloucester Basin (Figure 1). The Stratford Mining Complex is owned and operated by Stratford Coal Pty Ltd (SCPL), a wholly owned subsidiary of Gloucester Coal Ltd.

The SCM commenced operations in 1995 and is approved to produce up to approximately 2.1 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal. The BRNOC has been in operation since 2003 and is approved to produce up to approximately 1 Mtpa of ROM coal. The proposed Stratford Extension Project (the Project) would involve the continuation and extension of open cut coal mining and processing activities at the Stratford Mining Complex. The Project would extend the life of the current open cut operations by an additional 11 years of mining and five years of processing to 2024, and would facilitate a ROM coal production rate of up to 2.6 Mtpa.

The approximate extent of the existing and approved surface development at the Stratford Mining Complex is shown on Figure 2.

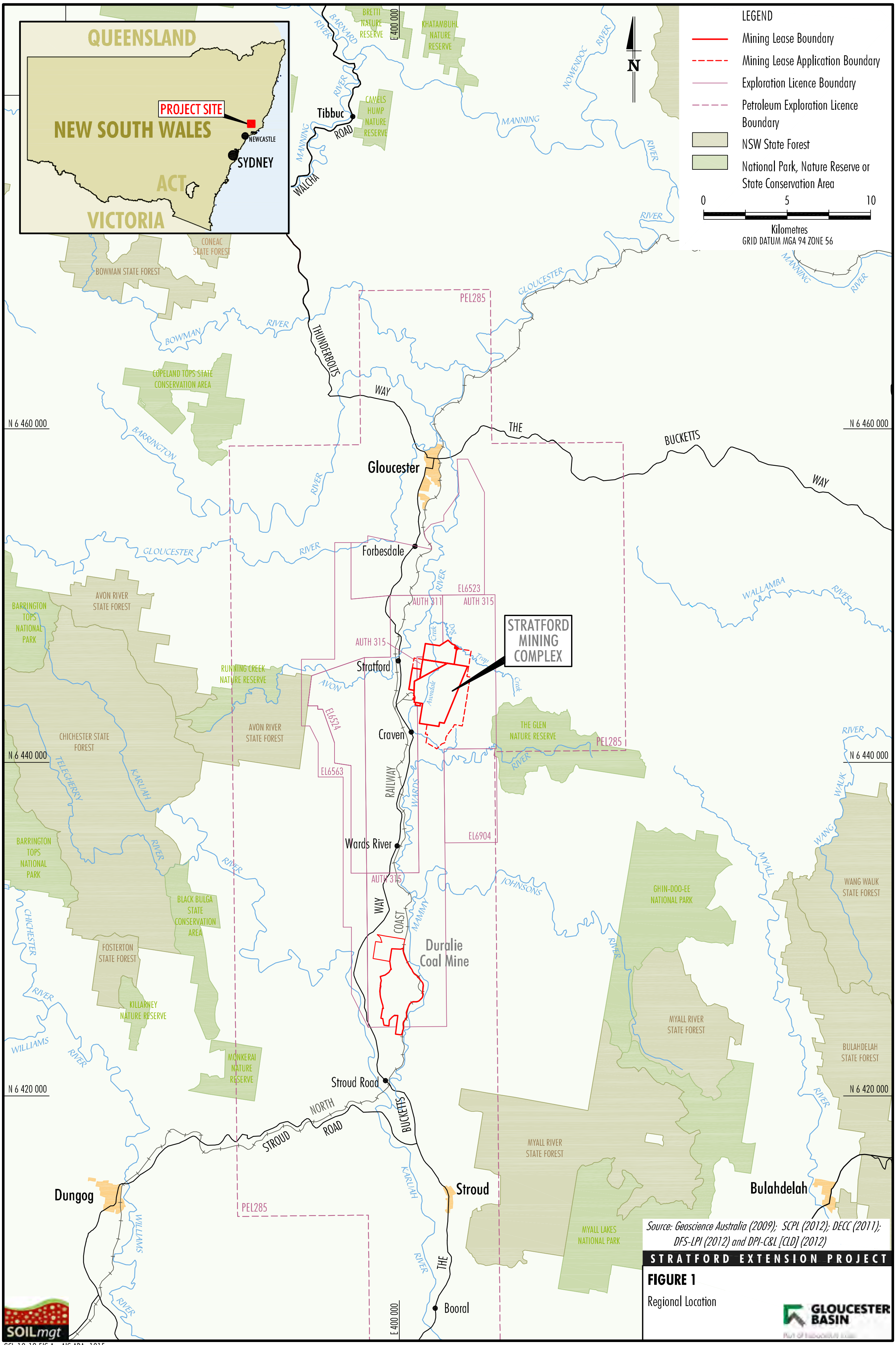
A detailed description of the Project is provided in Section 2 in the Main Report of the Environmental Impact Statement (EIS).

1.2 Scope and Objectives

This assessment has been prepared to assist with addressing of the following components of the Director General's Environmental Assessment Requirements for the Project:

Land Resources *- including a detailed assessment of the potential impacts on:*

- *soils and land capability (including salinisation and contamination);*
- *landforms and topography, including cliffs, rock formations, steep slopes, etc;*
- *land use, including agricultural, forestry, conservation and recreational use;*
- *agricultural resources and/or enterprises in the local area, with particular reference to highly productive alluvial soils that may be impacted directly or indirectly by the project, and including:*
  - *pre-mining and postmining agricultural assessment and mapping (including Land Capability and Agricultural Suitability mapping) of soil characteristics across all proposed disturbance areas, and an assessment of their value and rehabilitation limitations;*
  - *any change in land-use arising from requirements for biodiversity offsets;*
  - *a detailed description of the measures that would be implemented to avoid, reduce or mitigate impacts of the development on local agricultural resources and/or enterprises; and*
  - *justification for any significant long term changes to agricultural resources, particularly highly productive soils potentially affected by the development;*



STRATFORD EXTENSION PROJECT

FIGURE 1
Regional Location

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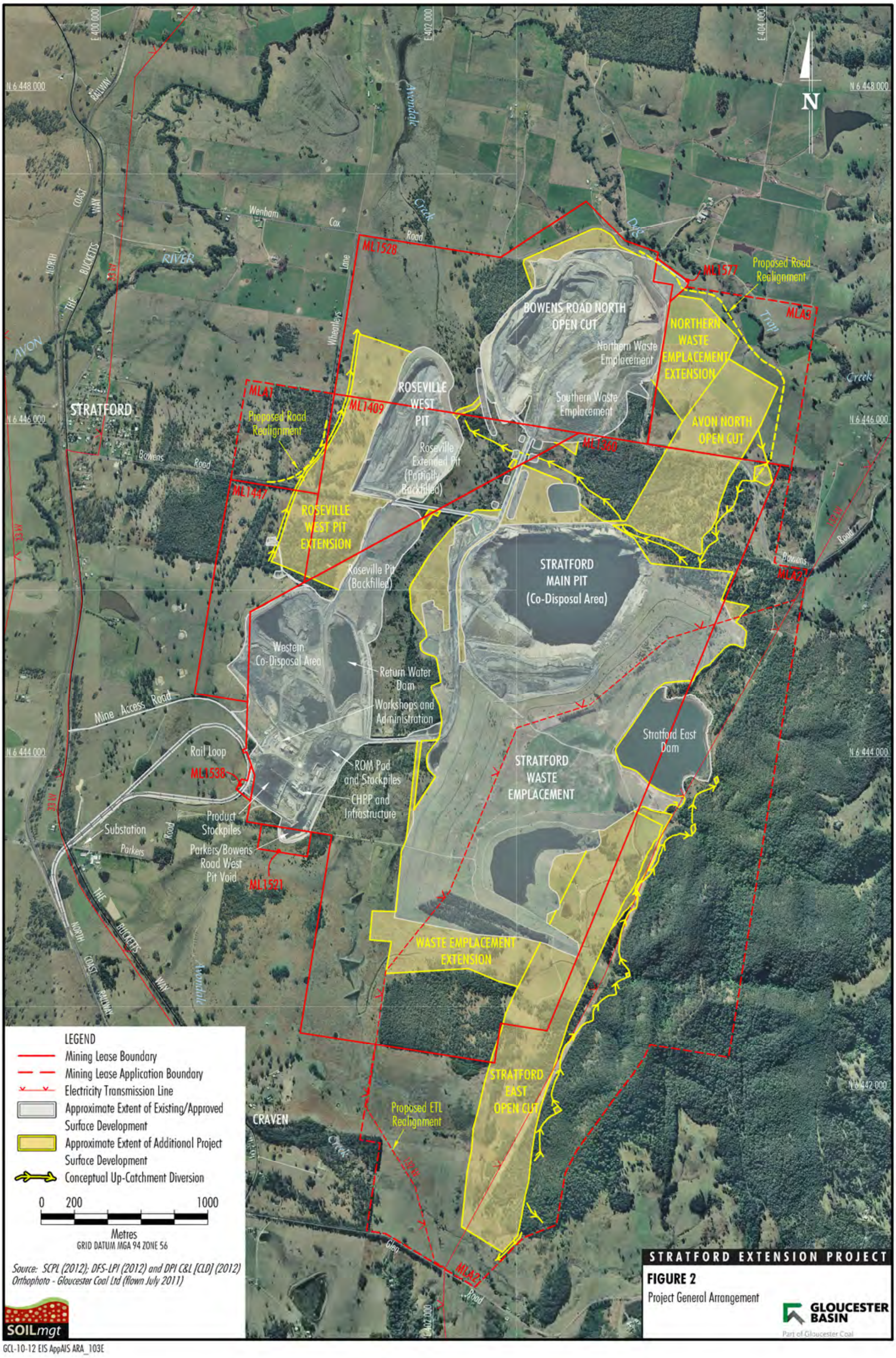

STRATFORD EXTENSION PROJECT

FIGURE 2

Project General Arrangement

GLOUCESTER BASIN
Part of Gloucester Coal

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Additional detail on the water resources used or capable of being used for agriculture is provided in the Groundwater Assessment (Heritage Computing, 2012) (Appendix A of the EIS), Surface Water Assessment (Gilbert & Associates, 2012) (Appendix B of the EIS) and the Agricultural Assessment (Resource Strategies, 2012) (Appendix K of the EIS).

The objectives of this study were to provide the following:

- Describe the agricultural resources and enterprises of the lands associated with the Project site.
- Estimate the post-mining agricultural resources of the lands associated with the Project site.
- Recommend management measures for agricultural resources, with emphasis on soil assessment and management at the Project site.

2 PROJECT OVERVIEW

The main activities associated with the development of the Project would include (Figure 2):

- ROM coal production up to 2.6 Mtpa for an additional 11 years (commencing approximately 1 July 2013 or upon the grant of all required approvals), including mining operations associated with:
  - completion of the BRNOC;
  - extension of the existing Roseville West Pit; and
  - development of the new Avon North and Stratford East Open Cuts;
- exploration activities;
- progressive backfilling of mine voids with waste rock behind the advancing open cut mining operations;
- continued and expanded placement of waste rock in the Stratford Waste Emplacement and Northern Waste Emplacement;
- progressive development of new haul roads and internal roads;
- coal processing at the existing Coal Handling and Preparation Plant (CHPP) including Project ROM coal, sized ROM coal received and unloaded from the DCM and material recovered periodically from the western co-disposal area;
- stockpiling and loading of product coal to trains for transport on the North Coast Railway to Newcastle;
- disposal of CHPP rejects via pipeline to the existing co-disposal area in the Stratford Main Pit and, later in the Project life, the Avon North Open Cut void;
- realignments of Wheatleys Lane, Bowens Road, and Wenham Cox/Bowens Road;
- realignment of a 132 kilovolt power line for the Stratford East Open Cut;
- continued use of existing contained water storages/dams and progressive development of additional sediment dams, pumps, pipelines, irrigation infrastructure and other water management equipment and structures;
- development of soil stockpiles, laydown areas and gravel/borrow areas, including modifications and alterations to existing infrastructure as required;
- monitoring and rehabilitation;
- all activities approved under DA 23-98/99 and DA 39-02-01; and
- other associated minor infrastructure, plant, equipment and activities, including minor modifications and alterations to existing infrastructure as required.

The proposed life of the Project is 11 years, commencing 1 July 2013, or when all necessary approvals are in place (both State and Federal), with an additional five years of processing.

3 PROJECT SITE DESCRIPTION

The Project would be located within existing mining tenements Mining Leases (ML) 1528, ML 1577, ML 1409, ML 1360, ML 1447, ML 1538 and ML 1521 and would extend into new Mining Lease Application (MLA) areas MLA 1, MLA 2 and MLA 3 (Figure 2).

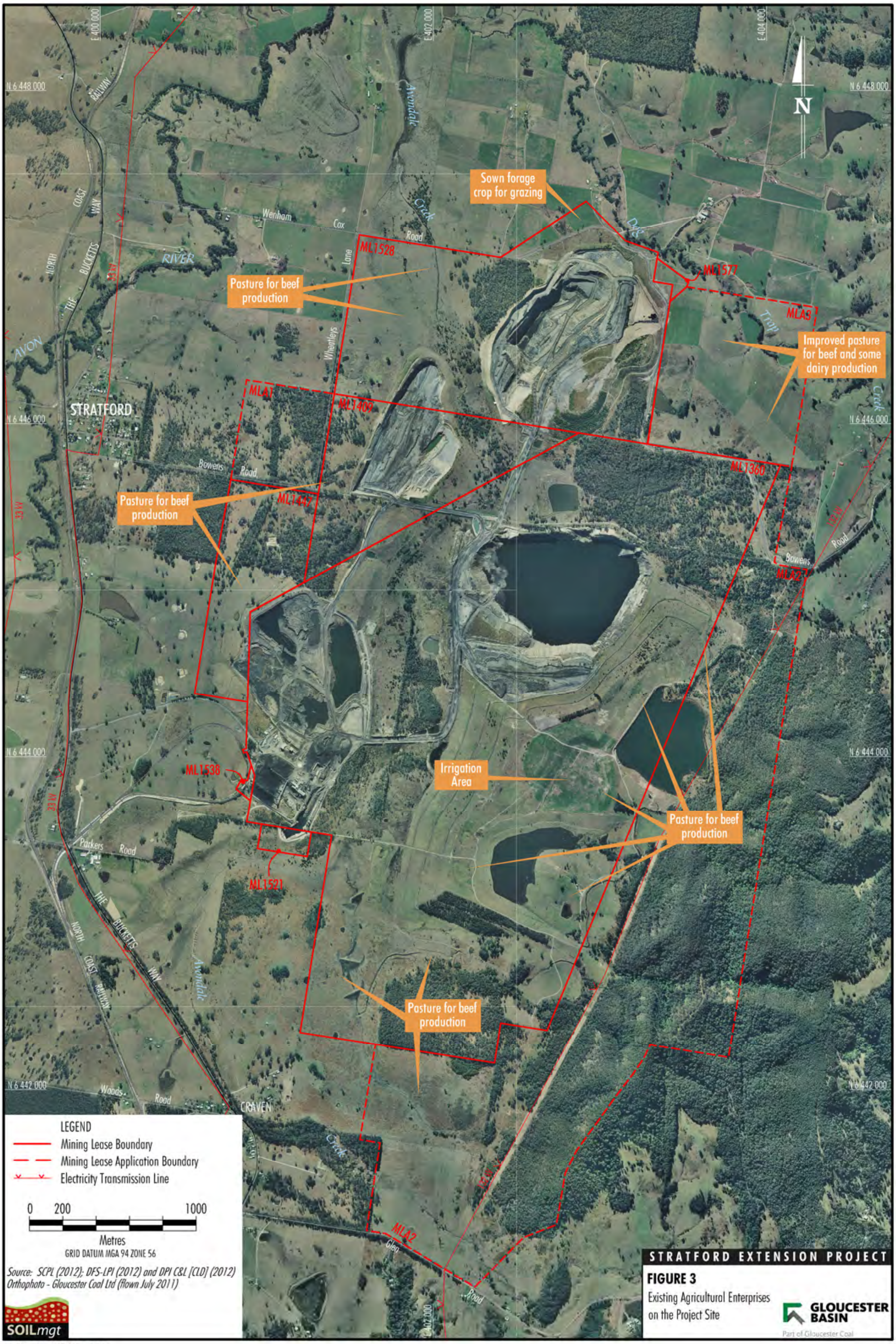
The topography of the area within and immediately surrounding the Project is characterised by a north-south oriented linear ridge on the east transitioning to undulating lowlands and valley floor floodplains towards the west, which form part of the Gloucester Valley.

The ridge line to the east of the Project rises to 470 metres (m) Australian Height Datum (AHD), and is moderately to steeply sloping and mostly timbered. The elevation of the valley floor within the Project area is approximately 115 m AHD.

The Stratford Mining Complex is located in a rural area characterised by cattle grazing for beef and dairy products on improved and unimproved pastures. Cleared agricultural areas are located in the existing MLs, MLA 3 and the south-western areas of MLA 1 and MLA 2 (Figure 3). The remainder of MLA 1 and MLA 2 comprise vegetated areas (Figure 3). Other areas of the Project site consist of the existing/approved SCM and BRNOC.

Approximately 830 hectares (ha) of agricultural lands currently occur on the Project site. Agricultural enterprises known to have been conducted on the Project site include cattle grazing for beef and dairy products on improved and unimproved pastures. Beef production is the dominant agricultural activity on the Project site, with only very small sections of the northern extent of the Project site used for cattle grazing for dairy products (Figure 3). Most of the pasture is rain-fed, however approximately 35 ha is under centre-pivot irrigation on the rehabilitated waste rock emplacement (Figure 3). Small areas at the northern end of the Project site were observed to have cultivation for forage crops, but there was no evidence of crop production for grains or intensive horticulture. Figure 3 shows the areas of the Project site that are known to have been used for agricultural enterprises.

An aerial image of the Project site is shown on Figure 3. Elevation data supplied by SCPL are shown on **Map 1**.



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4 SOIL RESOURCES

4.1 Existing Information

The following existing information relevant to the Project site was available for this assessment:

- Soil Landscapes of the Dungog 1:100 000 Sheet (Gresford, Dungog, Stroud, Gloucester) (Henderson 2000);
- Stratford Coal Environmental Impact Statement (SCPL 1994); and
- Soils, Rural Land Capability and Agricultural Suitability (Resource Strategies 2001).

A brief summary of relevant information from the reports above is provided below.

Soil Landscapes of the Dungog 1:100 000 Sheet

Henderson (2000) conducted a Soil Landscapes study across the region. The soil profile data used in their study are available from the NSW Government Soil Profile Attribute Data Environment (SPADE) Website (part of the NSW Natural Resource Atlas).

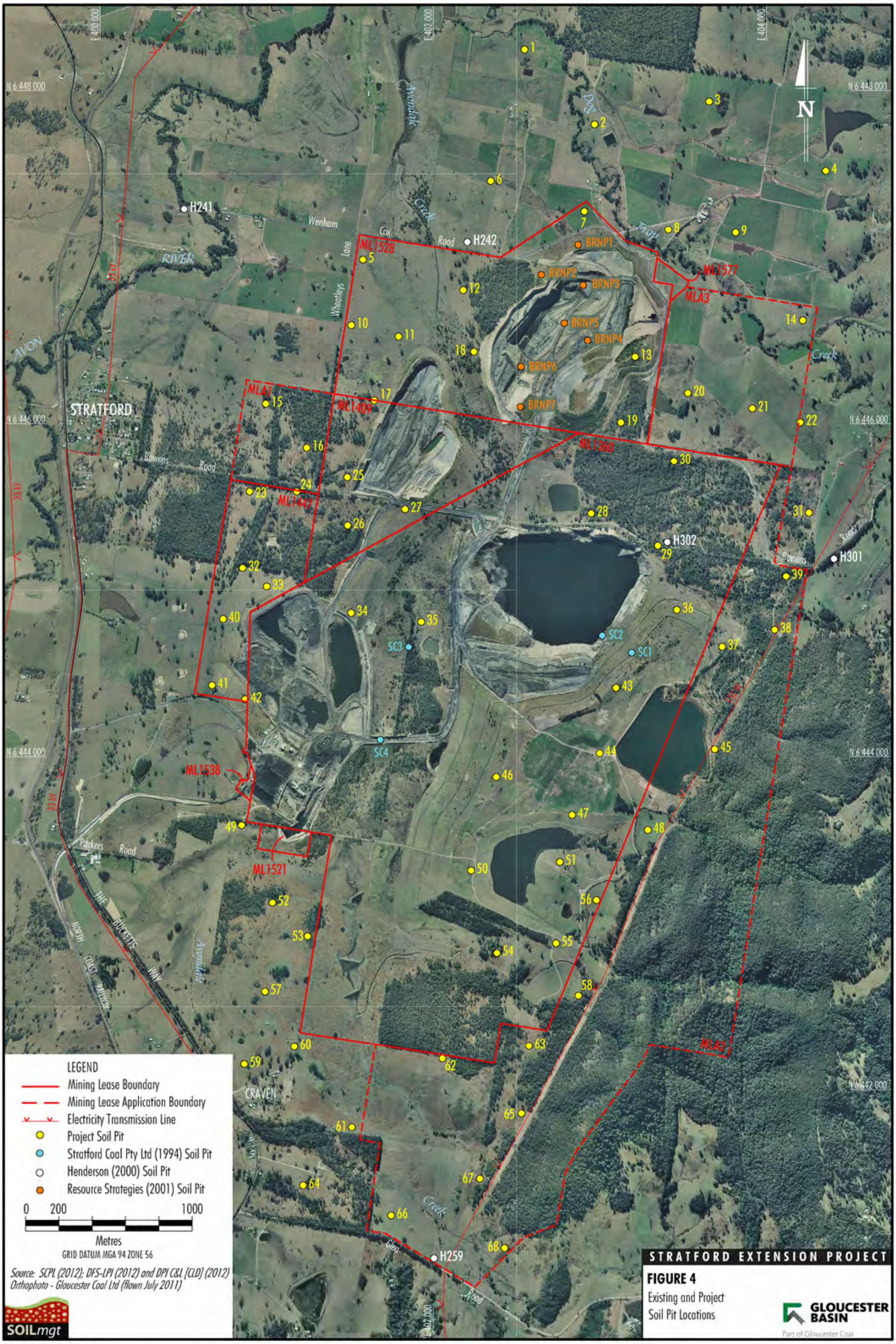
Five soil profile descriptions in – or very close to – the Project site are available from this study (Appendix 1; Profiles 241, 242, 259, 301, 302). Their locations are shown on Figure 4. A sub-set of the Soil Landscapes map prepared by Henderson (2000) is shown on Figure 5, with updated boundaries of the disturbed areas. Features of the Soil Landscape units that occur in the Project site are described in Table 1.

The Stratigraphic Units (parent materials for soil formation) of the Project site are shown in Figure 6.

Previous EIS reports for the Stratford Mining Complex

Soil at the site of the existing SCM was assessed by SCPL (1994). Resource Strategies (2001) also carried out a soil assessment for inclusion in the EIS document associated with the BRNOC.

An overview of their findings is shown in Table 2.



STRATFORD EXTENSION PROJECT

FIGURE 4
Existing and Project Soil Pit Locations

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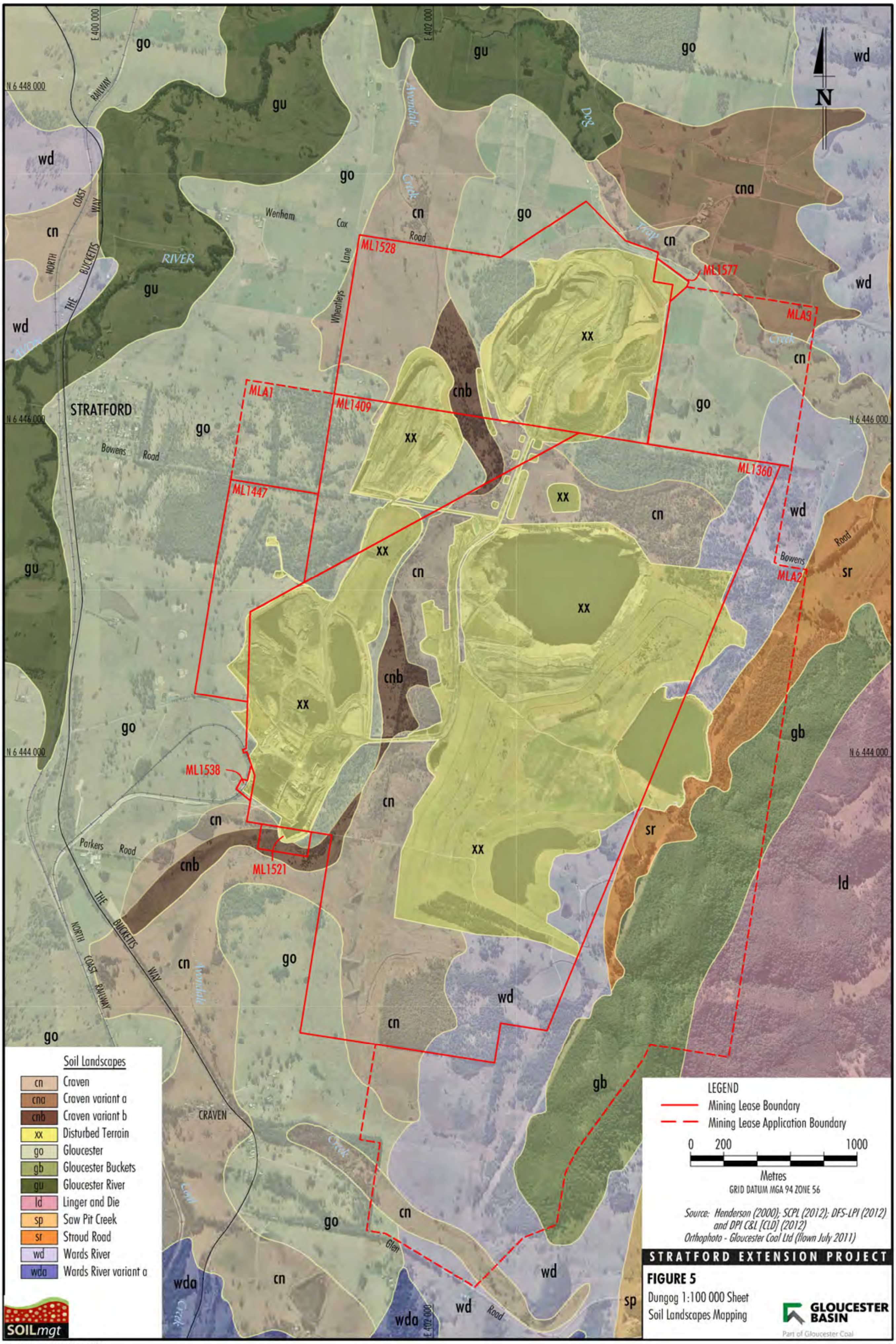

FIGURE 5
Dungog 1:100 000 Sheet Soil Landscapes Mapping

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Table 1. Soil Landscape units for the Project site (Henderson 2000)

Soil Landscape Unit	Position in Landscape	Soil Types (Australian Soil Classification)	Qualities and Limitations
Craven (cn)	Low wide drainage depressions on Quaternary alluvium	Imperfectly drained Natric Yellow Kurosols	Highly erodible sodic/dispersive soils, strongly acidic, seasonal waterlogging, dryland salinity
Craven Variant a (cna)	Low gradient alluvial fans	As above	As above
Craven Variant b (cnb)	Narrow elongated swamps	As above	As above
Gloucester River (gu)	Broad level alluvial plains	Imperfectly drained Yellow Chromosols	Flood hazard, seasonal waterlogging
Gloucester (go)	Undulating low hills on Permian sediments (sandstone, siltstone, shale, coal and conglomerate); relief <50 m; slopes <10%	Brown Sodosols and Grey Kurosols on imperfectly to moderately well-drained sideslopes and crests; Shallow Tenosols on crests and steeper sideslopes	Highly erodible sodic/dispersive soils, strongly acidic, seasonal waterlogging (lower slopes)
Wards River (wd)	Rolling low hills on sediments of the Gloucester Coal Measures (sandstone, conglomerate, siltstone, shale and coal); relief <30-100 m; slopes <25%	Brown, Yellow and Grey Kurosols with some Tenosols	Highly erodible, very strongly acidic, seasonal waterlogging (lower slopes), localised shallow and steep soils
Stroud Road (sr)	Rolling to undulating low hills on Permian Volcanics (basalt, rhyolite, sandstone and conglomerate); relief 40-90 m; slopes 2-<25%	Bown Dermosols and Red Ferrosols on basalt; Tenosols on rhyolite, sandstone and conglomerate	Erosion risk, seasonal waterlogging, high shrink-swell (localised), strongly acidic (localised), shallow soil (localised)
Gloucester Buckets (gb)	Rolling to very steep hills on Permian basic and acidic volcanics and sediments; relief 60-350 m; slopes 25-50%	Tenosols and Rudosols	Highly erodible; shallow, strongly acidic stony soils of low fertility
Linger and Die (ld)	Steep to very steep hills on Carboniferous sediments and some acid volcanic	Tenosols	Highly erodible; shallow stony soils of low fertility and poor moisture availability
Disturbed Terrain (xx)	Broad range of conditions	-	Variable

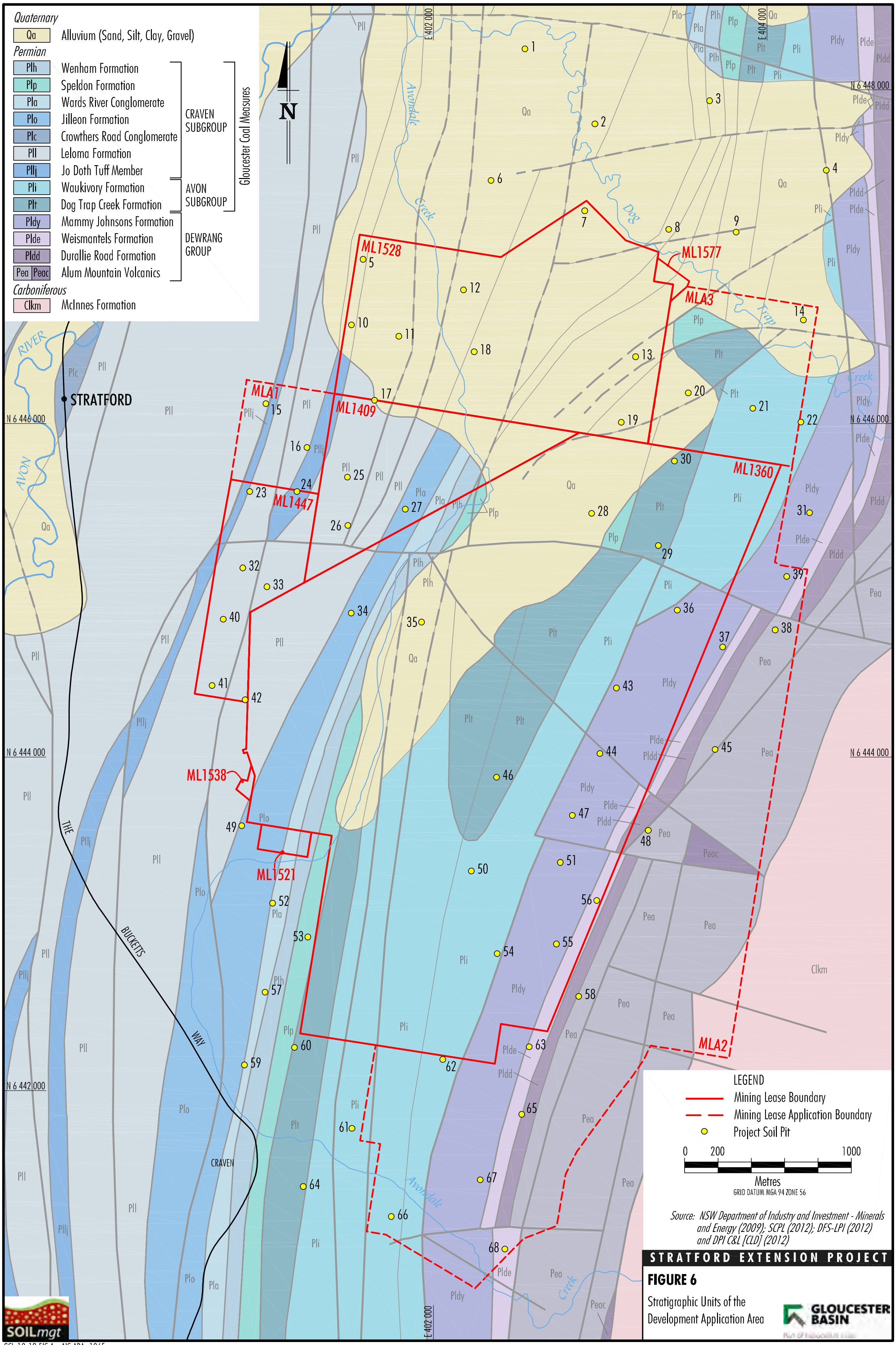

FIGURE 6
Stratigraphic Units of the Development Application Area

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Table 2. Soil features at the Stratford Coal Mine (Stratford Coal Pty Ltd 1994) and Bowens Road North Open Cut (Resource Strategies 2001) prior to development

Assessment Component	Stratford Coal Mine	Bowens Road North Open Cut
Prior land use	Extensive clearing for grazing; sheet erosion widespread; cattle grazing on unimproved pasture	-
Major soil types	Yellow podzolic, brown podzolic, alluvial, lithosol	Alluvial, yellow soloths, brown podzolics on Permian sediments
Soil sampling sites	Four test pits and 25 auger sites	Seven soil sampling sites over 242 ha; bulking of some samples prior to analysis
Soil features	Good water holding capacity; pH in range acceptable for revegetation	-
Soil problems	Dispersive topsoil; highly leached with low nutrient concentrations; salinity in northern sections	Shallow soil, poor internal drainage, dispersible subsoil (very low calcium/magnesium ratios)
Rural land capability	Class VI – alluvials Class IV, V and VI – rest of site	Mainly Class IV, some Class V and VI
Agricultural suitability	-	Class 4
Soil stripping depths	0.2 m on slopes and ridges; 0.5 m in alluvium; sufficient material for 0.2 m topdressing over the post-mining landform	0.1 m on yellow soloths Subsoil can be used following treatment to deal with dispersibility

4.2 Methodology

A soil survey was conducted to characterise and assess the soils in the Project site. This section provides a description of the soil survey methodology and outcomes.

The following soil information is regarded by Ward (1998) as being important for soil and overburden assessment associated with mine site reclamation:

- Classification (structure, texture etc); allows existing data and experience on managing similar soils elsewhere to be applied.
- Dispersion index and particle size analysis; indicates soil structural stability and erodibility.
- pH; need to identify extreme ranges for treatment of lime or selection of suitable plant species.
- Electrical conductivity (EC); indicates soluble salt status.
- Macro- and micro-nutrients.

More specifically, Elliott and Reynolds (2007) suggest that the following soil factors need to be considered when assessing suitability of topdressing materials for mine site reclamation:

- Structure grade, which affects the ability of water and oxygen to enter soil.
- The ability of a soil to maintain structure grade following mechanical work associated with the extraction, transportation and spreading of topdressing material.
- The ability of soil peds to resist deflocculation when moist.
- Macrostructure; where soil peds are larger than 100 millimetres (mm) in the subsoil, they are likely to slake or be hardsetting and prone to surface sealing.
- Mottling; its presence may indicate reducing conditions and poor soil aeration.
- Texture; soil with textures equal to or coarser than sandy loam are considered unsuitable as topdressing materials because they are extremely erodible and have low water holding capacities.
- Material with a gravel and sand content greater than 60% is unsuitable.
- Saline material is unsuitable.

These soil factors have been taken into account when planning the soil assessment methodology for the Project.

The assessment has also been prepared with regard to 'Soil and Landscape Issues in Environmental Impact Assessment' (Department of Land and Water Conservation 2000).

Field Survey

The field work was carried out over 12 days between 5 and 10 April 2011 and between 22 and 27 June 2011 during a time of above average rainfall. Sixty-eight pits were assessed and the locations are shown on Figure 4. The pits were located in a way that covered the main variations in vegetation type, topography and land use – and with a focus on zones to be disturbed as part of the Project.

A 'Magellan Explorist 210' GPS instrument with an accuracy of about ±4 m was used to record the pit co-ordinates (Appendix 2).

The soil was examined using pits approximately 1.4 m deep (shallower where hard rock was encountered) that were dug with a backhoe. They were trimmed with a geological pick to allow photography and description of the undisturbed structure and root growth.

Twenty-nine of the pits were sampled for laboratory analysis. At some of these sites, extra pits were dug more deeply (and immediately refilled) to allow collection of deeper soil samples, where possible, to a depth of 3 m.

Soil pits that are on or very close to areas that would be disturbed are as follows (Figure 4):

- **Roseville West Extension Open Pit**: Soil pits 10, 11, 17, 24, 25, 26.
- **Avon North Open Pit**: Soil pits 20, 21, 30.
- **Stratford East Open Pit**: Soil pits 47, 48, 51, 54, 56, 58, 63, 65, 67, 68.

The field description methods were as described in the 'Australian Soil and Land Survey Field Handbook' (National Committee on Soil and Terrain 2009) and the 'Guidelines for Surveying Soil and Land Resources, Chapter 29' (McKenzie *et al*. 2008). The soil profiles have been classified (Appendix 2) according to the Australian Soil Classification (Isbell 2002).

Field Soil Observations/Testing

The following characteristics were assessed for the layers identified in each of the soil profiles:

- thickness of each layer (horizon);
- soil moisture status at the time of sampling;
- pH (using Raupach test kit);
- colour of moistened soil (using Munsell reference colours);
- pedality of the soil aggregates;
- amount and type of coarse fragments (gravel, rock, manganese oxide nodules);
- texture (proportions of sand, silt and clay), estimated by hand;
- presence/absence of free lime and gypsum;
- root frequency; and
- dispersibility and the degree of slaking in deionised water (after 10 minutes).

Field observations for each pit are presented in Appendices 2 and 3.

The soil structure information (Appendix 4) has been summarised to give SOILpak 'compaction severity' scores (McKenzie 2001). This allows deep tillage recommendations to be made from the structure observations. The score is on a scale of 0.0 to 2.0, with a score of 0.0 indicating very poor structure for crop root growth and water entry/storage. Ideally, the SOILpak score of the root zone should be in the range 1.5–2.0.

Hand texturing provides an approximation of the clay content of a soil (Table 3). In conjunction with the estimation of coarse fragment (gravel) content, it provides a low-cost alternative to particle size analysis.

Total available water (TAW) for the upper 1 m of soil has been estimated using texture, structural form and coarse fragment content data (McKenzie *et al.* 2008).

Table 3. Relationship between hand texture descriptions and the clay content of a soil (NCST 2009)

Texture Description	Approximate Clay Content (%)
Sand	commonly <5%
Loamy sand	about 5%
Clayey sand	5-10%
Sandy loam	10-20%
Loam	about 25%
Silty loam	about 25%
Sandy clay loam	20-30%
Clay loam	30-35%
Silty clay loam	30-35%
Light clay	35-40%
Light medium clay	40-45%
Medium clay	45-55%
Medium heavy clay	50% or more
Heavy clay	50% or more

Laboratory Soil Testing

A total of 116 × 1 kilogram (kg) soil samples were collected from 29 pits:

- 0-15 centimetres (cm): 29 samples;
- 15-30 cm: 29 samples;
- 30-60 cm: 25 samples;
- 60-90 cm: 21 samples (some of the hill sites had hard rock below 60 cm);
- 90-120 cm: 4 samples (only collected where a contrasting/important layer of soil was observed below 90 cm);
- 2 m: 4 samples (alluvial sites); and
- 3 m: 4 samples (alluvial sites).

Where a distinct A2 horizon was present, for example between 10-25 cm, the sampling depths were adjusted to keep the contrasting layers separate. In this case, 0-15 cm became 0-10 cm and 15-30 cm became 15-25 cm.

The soil was analysed by Incitec-Pivot Laboratory, Werribee Victoria for exchangeable cations, pH, EC, chlorides, nutrient status (nitrate-nitrogen, phosphorus, sulfur, zinc, copper, boron) and organic matter content. An ammonium acetate method was used for the extraction of exchangeable cations. The cation exchange capacity (CEC) values are the sum of exchangeable sodium, potassium, calcium, and magnesium. Phosphorus was determined using the Colwell method, sulphur by the CPC method, boron by a calcium chloride ($CaCl_2$) extraction and zinc/copper by a DTPA extraction (see Rayment and Lyons [2011] for further details).

Soil dispersibility, as measured by the Aggregate Stability in Water (ASWAT) test (Field *et al.* 1997), was assessed by McKenzie Soil Management in Orange. The results are presented in Appendix 5. The ASWAT test has been related to the well known Emerson aggregate stability test by Hazelton and Murphy (2007) – see Table 4. An advantage of the ASWAT test is that the results can be linked with management issues such as the need for gypsum application and avoidance of wet working (Figure 7).

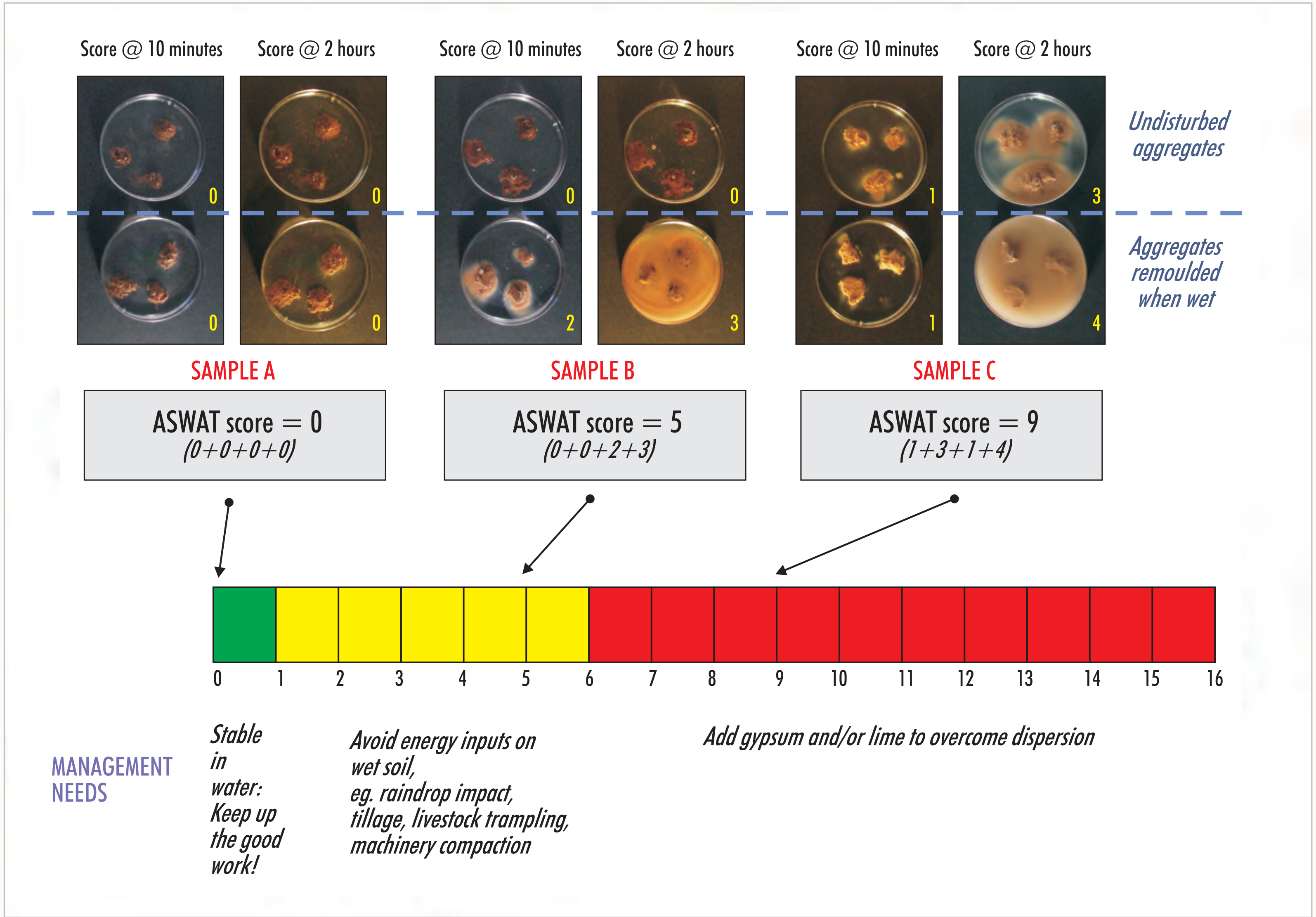
Table 4. The relationship between the Emerson aggregate stability test and the ASWAT test that assess the severity of dispersion when soil aggregates are added to water

Dispersibility	Emerson Aggregate Classes	Probable Score for the ASWAT Test (Field *et al.* 1997)
Very high	1 and 2(3)	12-16
High	2(2)	10-12
High to moderate	2(1)	9-10
Moderate	3(4) and 3(3)	5-8
Slight	3(2), 3(1) and 5	0-4
Negligible/aggregated	4, 6, 7, 8	0

The conversion factors of Slavich and Petterson (1993) allowed the electrical conductivity of saturated paste extracts (EC_e) to be calculated from the EC of 1:5 soil:water suspensions ($EC_{1:5}$) and texture.

Seven calibration samples (2 kg samples from Pit 14 [*Field number = 6*] [0-15 cm, 15-30 cm, 30-60 cm] and Pit 29 [*Field number = 16*] [0-15 cm, 15-30 cm, 30-60 cm, 60-90 cm]) were analysed by NSW Soil Conservation Service (SCS) Laboratory for the following analyses, which are part of the 'Erosion and sediment control' package (Appendix 6):

- Dispersion percentage.
- Emerson aggregate test.
- Organic carbon.
- Particle size analysis.
- Particle size analysis – mechanical dispersion.
- Soil erodibility factor (K factor).



Source: Central West Catchment Management Authority (2011)

STRATFORD EXTENSION PROJECT

FIGURE 7

The Link between ASWAT Results and Soil Management Options

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Part of Gloucester Coal

SOILmgt

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The following important key soil factors are attached in the form of colour coded maps:

Map 2. Soil Types (Australian Soil Classification).
Map 3. Depth to Rock.
Map 4. Total Available Water (TAW).
Map 5. Depth of Waterlogged Layer, if Present.
Map 6. pH ($CaCl_2$).
Map 7. Dispersion (ASWAT Scores).
Map 8. Dispersion (ESP Values).
Map 9. Compaction Severity (SOILpak Score).
Map 10. Cation Exchange Capacity.
Map 11. Salinity (ECe).
Map 12. Phosphorus (Colwell P).
Map 13. Organic Carbon.

4.3 Soil Types and Mapping

General Description of Soil Types

The Australian Soil Classification (Isbell 2002) has been used to determine soil types at each of the 68 pits (**Map 2**). A summary of the soil types observed during the survey is shown in Table 5.

Table 5. Soil types, according to the Australian Soil Classification

SOIL GROUPINGS	Australian Soil Classification Orders	Australian Soil Classification Suborders	Number of Soil Profiles in Each Category
Rehabilitated Mining Land (11)	Anthroposol (11)	Spolic	11
Shallow Stony Soil (5)	Tenosol (5)	Leptic	5
Duplex Soil – loam topsoil, clay-rich subsoil (36)	Kurosol (26) (*acidic subsoil*)	Brown	12
		Yellow	4
		Grey	9
		Red	1
	Sodosol (7) (*sodic subsoil*)	Brown	5
		Yellow	1
		Grey	1
	Chromosol (3)	Brown	2
		Yellow	1
Non-Duplex Loams (16)	Kandosol (15)	Brown	7
		Yellow	1
		Grey	6
		Red	1
	Dermosol (1)	Yellow	1

The main soil types were Kurosols (38%) and Kandosols (22%). Anthroposols (16%), Sodosols (10%), Tenosols (7%), Chromosols (4%), and Dermosols (1%) were also observed[1]:

- Kurosols are duplex soils with strongly acidic subsoil. Many of them have unusual subsoil chemical features (e.g. high aluminium and sodium).
- Kandosols lack strong texture contrast and have poorly structured massive subsoils.
- Anthroposols are soil types that are formed from human activities that have caused profound modification, mixing, truncation or burial of the original soil horizons (McKenzie *et al.* 2004).
- Sodosols have a strong texture contrast between topsoil and sodic (exchangeable sodium percentage [ESP] of 6 or greater) subsoil which is not strongly acidic.
- Tenosols are shallow stony soils with only weak pedological development.
- Chromosols are duplex, i.e. a strong contrast in texture between topsoil and subsoil. They have subsoil (B horizon) which is not strongly acidic and not sodic.
- Dermosols also lack strong texture contrast, but have structured B horizons.

Photos of representative soil profiles identified during the survey and in rehabilitated areas are presented in Figures 8a and 8b.

1 Due to rounding, the percentages do not equal 100%.

Brown Kurosol – Pit 12

Yellow Kurosol – Pit 20

Grey Kurosol – Pit 58

Red Kurosol – Pit 48

Brown Sodosol – Pit 8

Brown Kandosol – Pit 1

Grey Kandosol – Pit 14

Brown Chromosol – Pit 57

Leptic Tenosol – Pit 37

Yellow Dermosol – Pit 39

Figure 8a. Examples of the Soil Types Identified during the Survey

Anthroposol – Pit 50

Anthroposol – Pit 44

Anthroposol – Pit 43

Anthroposol – Pit 27

Anthroposol – Pit 55

Figure 8b. Examples of the Soil Profiles Observed in the Rehabilitated Areas

Approximate correlations between the Australian Soil Classification (Isbell 2002) and the superseded Great Soil Group (Stace *et al.* 1968) terminology are shown in Table 6.

Table 6. Association between Australian Soil Classification and Great Soil Groups for Soil in the Project site

Australian Soil Classification	Great Soil Group
Kurosols	Many podzolic soils and soloths
Kandosols	Red, yellow and grey earths, calcareous red earths
Anthroposols	–
Sodosols	Solodized solonetz and solodic soils, some soloths and red-brown earths
Tenosols	Lithosols, silicious and earthy sands
Chromosols	Non-calcic brown soils, some red-brown earths and a range of podzolic soils
Dermosols	Prairie soils, chocolate soils, some red and yellow podzolic soils

The Soil Landscape units that contain groupings of these soil types identified during the survey are shown in Figure 9. Their descriptions are as follows:

Disturbed Lands – Disturbed lands with a broad range of slopes: Anthroposols.

Alluvial Plain Variant A – Alluvial/Colluvial Plains, <3% slope: dominated by Kandosols; sub-dominant Kurosols, Sodosols, Chromosols.

Alluvial Plain Variant B – As for Variant A but flat and swampy.

Lower Slopes – 3-10% slope: dominated by Kurosols; sub-dominant Kandosols, Sodosols, Chromosols.

Mid-slope Variant A – 10-25% slope on sedimentary rock: mosaic of Tenosols, Kurosols, Kandosols, Sodosols.

Mid-slope Variant B – 10-25% slope, apparently on basic volcanic rock: Dermosol.

Upper Slope – >25% slope: Tenosols and Rudosols.

4.4 Soil Conditions for Plant Growth

Soil Depth, Texture and Water Holding Capacity

As soil becomes shallower, stonier and/or sandier, its ability to store water declines (White 2006).

Map 3 shows the patterns of variation in depth to rock. The shallowest soil was in the rehabilitation areas, and in the steep areas along the eastern side of the Project site.

Map 4 reflects the impact of profile shallowness and stoniness on the ability of the soil to store Plant Available Water (TAW) on the Project site. Much of the rehabilitated waste rock emplacement area contains 30-45 mm water for plant growth in the upper 1 m of soil profile.

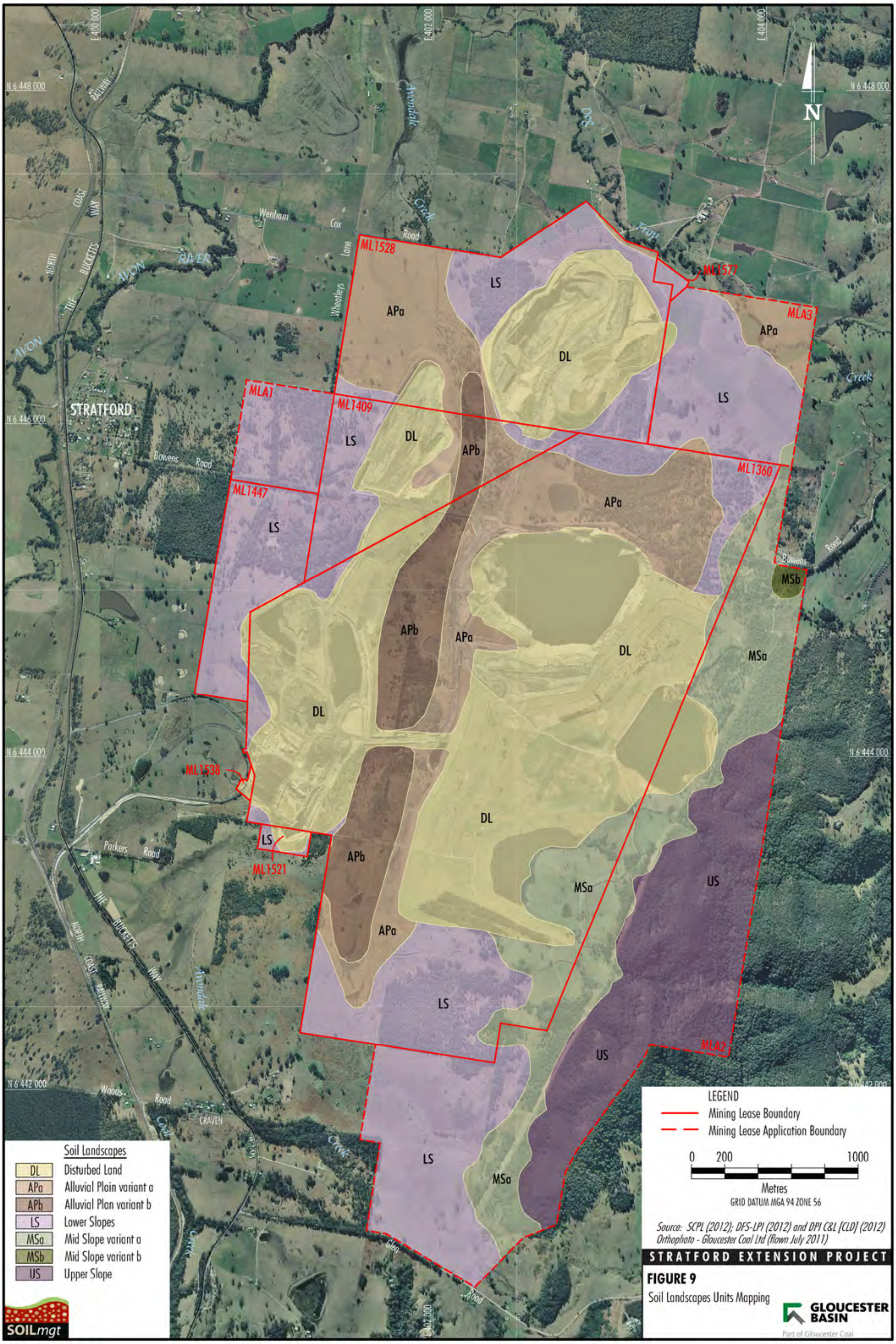

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FIGURE 9

Soil Landscapes Units Mapping

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Plants are more likely to suffer drought stress where soil has a poor water storage capacity, particularly in hot weather with extended dry periods between rainfall events. At the Project site, the lack of waterholding capacity in shallow soils is a major constraint to agricultural productivity. However, the lack of water holding capacity at the Project site is less of a constraint than for other areas in NSW that receive less rainfall.

Pit 44 is located on the rehabilitated waste rock emplacement (Figure 4) under the centre-pivot irrigation system (Figure 3) with a waterholding capacity (TAW) of 44 mm. Table 10.6 of Geeves *et al.* (2007) indicates that the surface soil at this site, with its combination of light clay texture, weak structure grade and an ESP of <6, is likely to have a hydraulic conductivity in the range 0.5 – 2.5 mm/hour. Once the water storage capacity of this soil is saturated, any extra water will either runoff, or become deep drainage water that flows down beyond the root zone and carries any dissolved salts with it.

Waterlogging Hazard

When soil is waterlogged, several adverse processes take place (Batey 1988):

- The lack of oxygen reduces the ability of plant roots to function properly.
- Anaerobic conditions can cause large losses of soil nitrogen to the atmosphere.
- Near-surface waterlogging is associated with inefficient storage of water due to excessive evaporation losses.

Map 5 shows that most soil in the Project site has evidence of waterlogging, i.e. subsoil mottling, within 50 cm of the soil surface.

pH Imbalance

Topsoil and subsoil acidity was widespread across the Project site (**Map 6**) and was associated with the presence of exchangeable aluminium (Appendix 5).

Soil Stability in Water – Dispersion and Slaking

Dispersion is the separation of soil micro-aggregates into sand, silt and clay particles, which tend to block soil pores and create problems with poor aeration (Levy 2000). It is a process with the potential to reduce root growth and adversely affect profitability of most crop and pasture enterprises.

Dispersion may be associated with slaking, which is the collapse of soil aggregates to form micro-aggregates under moist conditions (So and Aylmore 1995). Slaking is associated with a lack of organic matter, which is important for the binding of soil micro-aggregates.

Soil prone to slaking, and particularly dispersion, is much more likely to be lost by water erosion than stable soil. This is because the soil tends to seal over under moist conditions and lose water as runoff, rather than taking in the water for storage in the subsoil (So and Aylmore 1995).

Two maps relating to soil stability in water are presented. The ASWAT score (**Map 7**) shows how prone the soil is to dispersion under conditions that existed when the soil was sampled (Field *et al.* 1997). The 'working when wet' procedure that is part of the ASWAT test is a simulation of processes such as raindrop impact on wet soil and the cutting/stockpiling of moist soil. Much of the topsoil and subsoil in the Project site is prone to dispersion, particularly after being worked when wet. ESP values (**Map 8**) mostly are high in the subsoil. However, these dispersion problems can be overcome in a cost-effective manner through the use of gypsum application.

The main chemical factors influencing the behaviour of clay particles in sodic soils are exchangeable sodium and low electrolyte concentrations, but elevated exchangeable magnesium concentrations (Calcium/Magnesium ratios <1; see Appendix 5) also can make clay particles in soil less stable in water (Levy 2000). Exchangeable aluminium, however, is a trivalent cation that tends to minimise dispersion.

Results of laboratory analysis of soil erosion hazard are shown in Appendix 6 for two of the pits (Pit 14 and Pit 29).

Compaction Status

Compaction can strongly restrict plant growth because of poor water entry, poor efficiency of water storage, waterlogging when moist, and poor access to nutrients by plant roots (McKenzie 1998).

Compaction was assessed in this study using the SOILpak scoring system (**Map 9**). Most of the topsoil was not compacted and was associated with relatively high organic carbon contents (Appendix 5). However, deeper layers were mostly in a compacted state because of subsoil dispersion.

Structure Self-repair Ability

The ability of a soil to overcome compaction through shrinking and swelling induced by wet-dry cycles (soil structural resilience) can be estimated via CEC values (**Map 10**) (McKenzie 1998). Much of the topsoil had a poor to moderate shrink-swell capacity, so the rate of recovery from compaction damage would be slow. Much of the subsoil had a sufficiently high content of swelling clay minerals to have favourable structural resilience.

Salt Concentrations and Watertable Status

Most of the topsoil in the Project site is non-saline (**Map 11**). An exception is Pit 44 under the centre-pivot irrigation system where gypsum application appears to have contributed to elevated salinity and high sulfate concentrations. Also, some of the salt would have been imported via the irrigation water, given that Stratford East Dam (source of the irrigation water) had an EC value of approximately 1.2 deciSiemens per metre (dS/m) in mid-2011.

Nutrients

Much of the soil was deficient (from an agricultural perspective) in phosphorus in the Project site (**Map 12**). Sulfur and nitrogen deficiencies also were widespread (Appendix 5). As the sum of exchangeable cations (an approximation of CEC) increases, the ability of soil to hold cation nutrients such as calcium, magnesium and potassium becomes greater (White 2006). CEC values (**Map 10**) show a strong ability for the subsoil to store cation nutrients.

Soil Carbon and Soil Biological Health

The favourable organic carbon concentrations in the topsoil (0-15 cm) (**Map 13**) mean that beneficial soil organisms have a ready supply of food.

Rehabilitated Areas

The pits located in rehabilitated areas have a wide range of soil conditions for plant growth. The profiles in Figure 8b show the limitations at Pit 50 (waterlogged because of excessive flatness associated with uneven settling of the underlying waste rock). Pit 43 has low water holding capacity associated with rock close to the surface. In contrast, Pit 27 has a much higher water storage capacity. The favourable subsoil pH at Pits 20 and 55 was associated with excellent deep root growth that was not seen in most of the "natural" soil profiles under pasture.

Summary of Soil Constraints

A broad range of soil physical and chemical constraints for agricultural land use have been identified on the Project site including:

- **Subsoil acidity and associated aluminium toxicity** is a major constraint to agricultural productivity. The strongly acidic subsoil lacks versatility in terms of agricultural management as most plant species would be unable to survive this chemical constraint to crop/pasture production. The high clay content means that lime requirements are very high and expensive (e.g. approximately 120 tonnes per hectare [t/ha] of agricultural lime would be required at some of the sites to raise the pH of the 0-90 cm layer based on Fenton [2003]). In addition, the required mechanical incorporation of agricultural lime would be very difficult to achieve.

- **A lack of water holding capacity** where there is a large stone content in the soil and/or bedrock close to the soil surface; poor subsoil structure limits root growth and creates a similar effect. This is not a major concern when irrigation water and/or frequent showers of rain are applied to soil, but prolonged dry spells will induce drought stress in plants when they are grown in shallow and/or stony soil.
- **Dispersive subsoil** due to sodicity and excessive exchangeable magnesium percentage. As discussed above, dispersion induces waterlogging stress under moist conditions and excessive hardness when the soil is dry.
- **Subsoil salinity** in low-lying areas in the northern part of the Project site. Some pasture species, particularly legumes, have a poor ability to extract water from the soil when soil salinity is elevated.
- **Nutrient deficiencies**, particularly phosphorus, limit the growth of plants even when other essential requirements such as water and adequate aeration are present in the soil.

5 RURAL LAND CAPABILITY ASSESSMENT

5.1 Background

The rural land capability classification in NSW was developed by the NSW SCS (Emery 1986). It was derived from the scheme of Klingebiel and Montgomery (1961).

Land is allocated to one of eight classes, with emphasis on the erosion hazards in the use of the land. The rural land capability classes are as follows (Emery 1986; Sonter and Lawrie 2007):

Land Suitable for Regular Cultivation / Cropping

Class I: No special soil conservation works or practices necessary.

Class II: Soil conservation practices such as strip cropping, conservation tillage and adequate crop rotations are necessary.

Class III: Soil conservation practices such as graded banks and waterways are necessary, together with all the soil conservation practices as in Class II.

Land Suitable Mainly for Grazing

Class IV: Soil conservation practices such as pasture improvement, stock control, application of fertiliser, minimal cultivation for the establishment or re-establishment of permanent pasture and maintenance of good ground cover.

Class V: Soil conservation works such as diversion banks and contour ripping, in addition to the practices in Class IV.

Land Suitable for Grazing

Class VI: Not capable of cultivation. Soil conservation practices include limitation of stock, broadcasting of seed and fertiliser, promotion of native pasture regeneration, prevention of fire, destruction of vermin, maintenance of good ground cover and possibly some structural works.

Land Suitable for Tree Cover

Class VII: Land best protected by trees.

Land Unsuitable for Agriculture

Class VIII: Cliffs, lakes or swamps where it is impractical to grow crops or graze pasture.

A New Approach: 'Land and Soil Capability'

The existing rural land capability system (Emery 1986) has an emphasis on the construction of earthworks, which are no longer a frontline erosion control mechanism for cropping lands (B. Murphy, pers. comm.).

Staff from the NSW Office of Environment and Heritage are in the process of developing a 'Land and Soil Capability' (LSC) scheme that builds on the rural land capability system by including land degradation issues such as salinity, sodicity and acidity. As the LSC approach is still being developed and requires further testing, the existing Emery (1986) rural land capability system has been used in this assessment.

5.2 Existing Information

The following existing information relevant to the Project site was available for this assessment:

- Rural land capability 1:100,000 mapping prepared by NSW government departments (Figure 10).
- Rural land capability mapping for earlier stages of the Stratford Mining Complex (SCPL 1994; Resource Strategies 2001).

5.3 Rural Land Capability Classification

Rural land capability mapping (Figure 11) was prepared based on the results of the soil survey (Section 4).

Land slope is a primary determinant of land capability because erosion hazard increases with slope steepness and because slope steepness imposes physical limits on many types of land usage (Sonter and Lawrie 2007). The slope categories in Table 1 of Murphy and Taylor (2008) assisted in determining the class allocation.

Estimates of rural land capability across the Project site are shown on Figure 11. Values ranged from Class IV to Class VIII. The major factor influencing the classification was land slope, in conjunction with soil stability in water. The slope of the land ranged from approximately 2% in the northern Class IV areas to >25% on the steepest hillsides with a Class VI classification. The 'final void' areas infilled with water have been allocated to Class VIII.

The rehabilitated flat areas on the Stratford Waste Emplacement have been allocated Class IV and the other rehabilitated areas on the Stratford Waste Emplacement and the Northern Waste Emplacement have been allocated Class V. The flat areas on the Stratford Waste Emplacement were observed to have similar and in some cases better soil conditions than that observed in the "natural" soil profiles under pasture on the Project site (Section 4.4). The Class V areas on the waste rock emplacements have been allocated this class due to the slope.

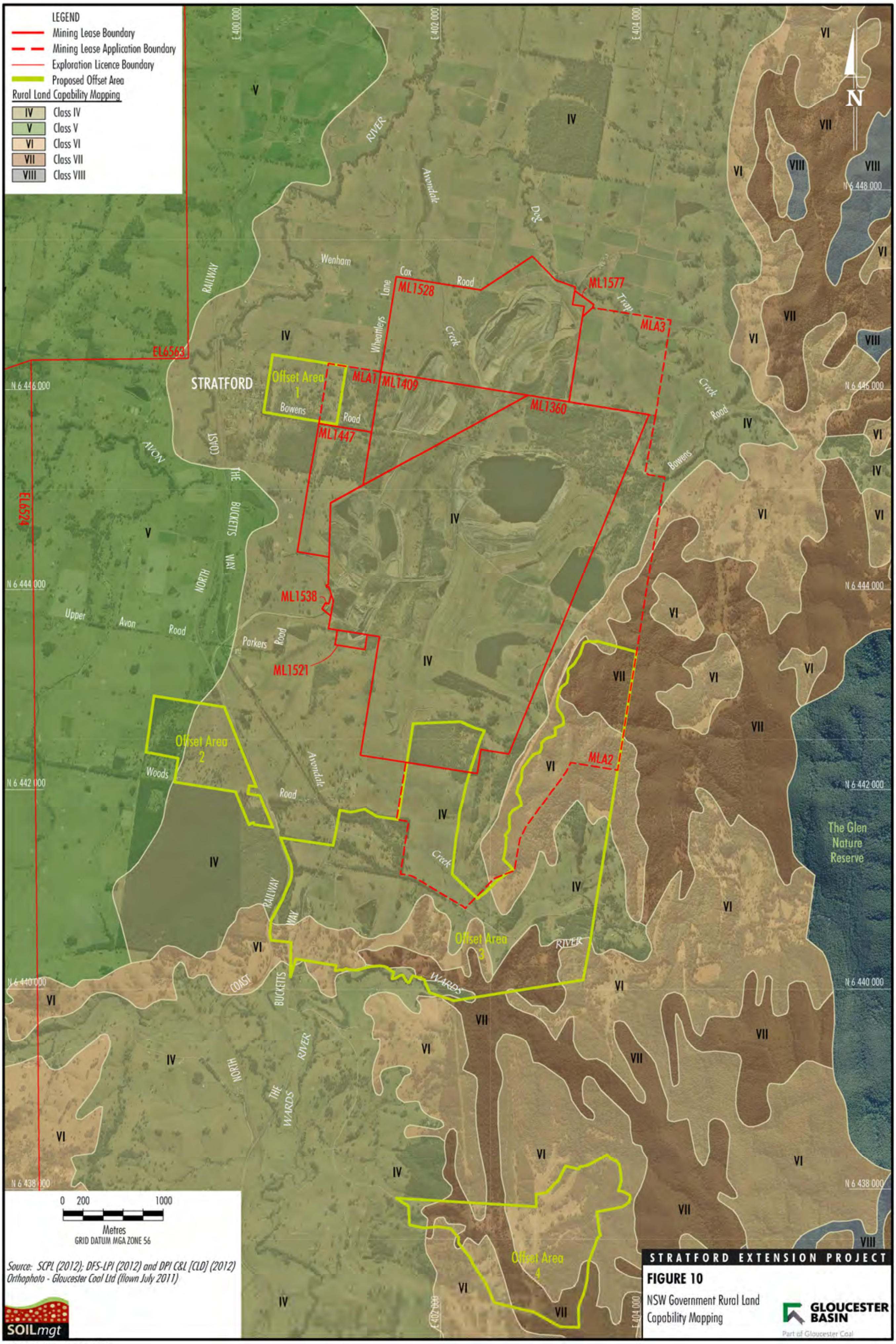

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FIGURE 10

NSW Government Rural Land Capability Mapping

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GCL-10-12 EIS AppAIS ARA_112E

GCL-10-12 EIS AppAIS ARA_109E

6 AGRICULTURAL SUITABILITY

6.1 Background

This five class system used by NSW Agriculture classifies land in terms of its suitability for general agricultural use (Hulme *et al*. 2002). It was developed specifically to meet the objectives of the NSW *Environmental Planning and Assessment Act, 1979*.

Agricultural land is classified by evaluating biophysical, social and economic factors that may constrain the use of land for agriculture. In general terms, the fewer the constraints on the land, the greater its value for agriculture (Hulme *et al*. 2002). Higher quality lands (Classes 1 and 2) have fewer constraints and a greater versatility for agriculture than poorer quality lands.

The essential characteristics of the five classes are as follows (Hulme *et al*. 2002):

Class 1: Arable land suitable for intensive cultivation where constraints to sustained high levels of agricultural production are minor or absent.

Class 2: Arable land suitable for regular cultivation for crops, but not suited to continuous cultivation. It has a moderate to high suitability for agriculture but soil factors or environmental constraints reduce the overall level of production and may limit the cropping phase to a rotation with sown pastures.

Class 3: Grazing land or land well suited to pasture improvement. It may be cultivated or cropped in rotation with sown pasture. The overall production level is moderate because of soil or environmental constraints. Erosion hazard, soil structural breakdown or other factors, including climate, may limit the capacity for cultivation and soil conservation or drainage works may be required.

Class 4: Land suitable for grazing but not for cultivation. Agriculture is based on native pastures and improved pastures established using minimum tillage techniques. Production may be seasonally high but the overall production level is low as a result of major environmental constraints.

Class 5: Land unsuitable for agriculture, or at best suited only to light grazing. Agricultural production is very low or zero as a result of severe constraints, including economic factors which prevent land improvement.

Hulme *et al.* (2002) recognised that agriculture suitability classification maps have a limited life because of changes in social and economic factors. They also note that agricultural land classification maps produced at small scales (1:50,000 to 1:100,000) are inappropriate for making decisions about individual development applications because of a lack of detail.

6.2 Existing Information

The following existing information relevant to the Project site was available for this assessment:

- Agriculture suitability 1:100,000 mapping (Figure 12) prepared by NSW government departments.
- Agriculture suitability mapping prepared for earlier stages of the Stratford Mine development (Figure 13).

6.3 Agricultural Suitability Classification

Agricultural suitability mapping (Figure 13) was prepared based on the results of the soil survey (Section 4). To help assess the agricultural suitability of the Project site, 11 soil related factors at 10 locations across the Project site were assessed; they are shown in Appendix 7.

Estimates of agricultural suitability across the Project site are shown on Figure 13. Agricultural suitability classes identified across the site ranged from Class 4 to Class 5.

The rehabilitated areas on the waste rock emplacements have been allocated Class 4. The rehabilitated areas on the waste rock emplacements were observed to have similar or even better soil conditions than that observed in the "natural" soil profiles under pasture on the Project site (Section 4.4).

Soil limitations include various combinations of the following factors: erosion hazard associated with steep slopes, shallowness, dispersion, acidity, nutrient deficiencies and compaction.

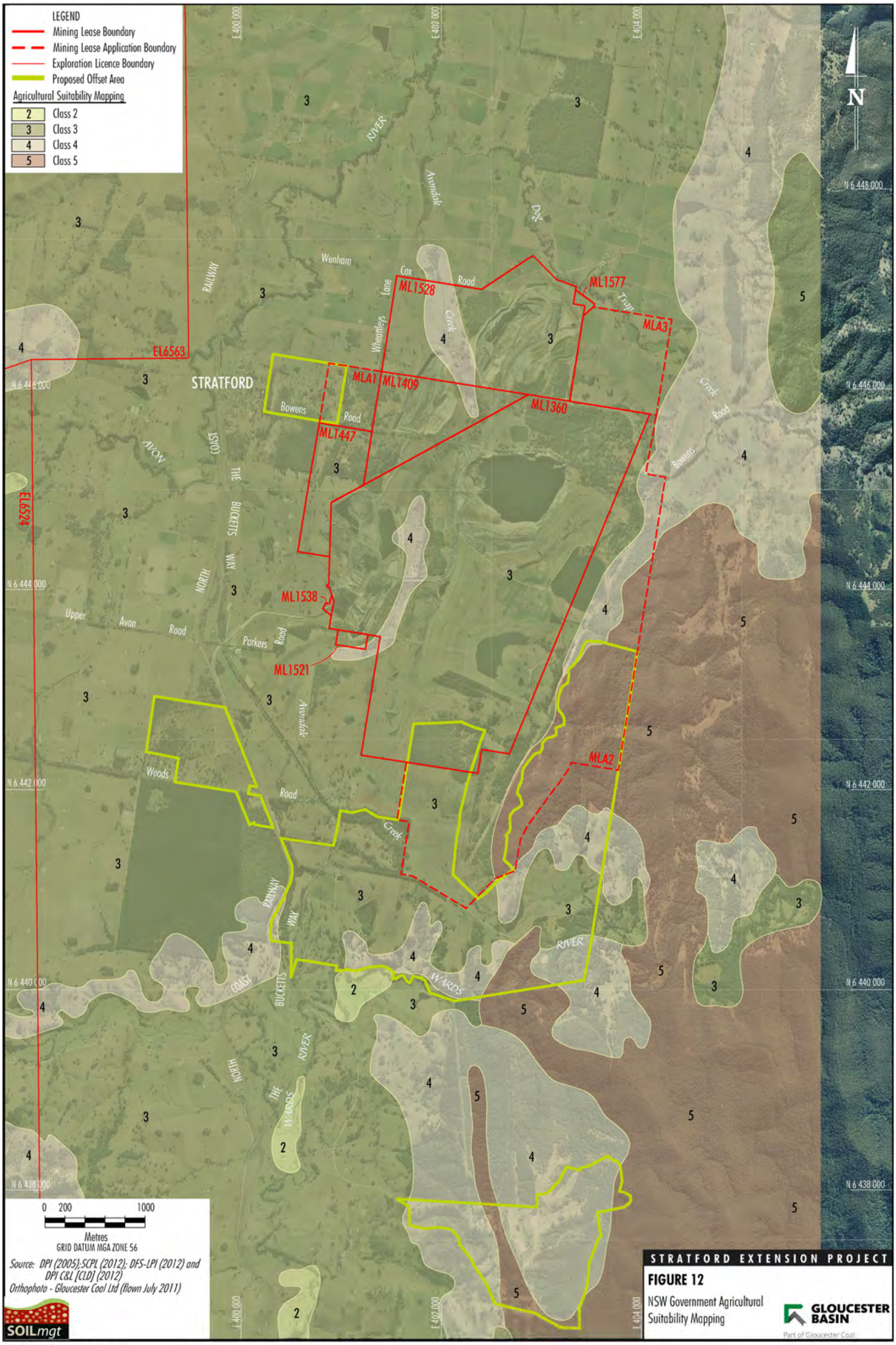

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FIGURE 12

NSW Government Agricultural Suitability Mapping

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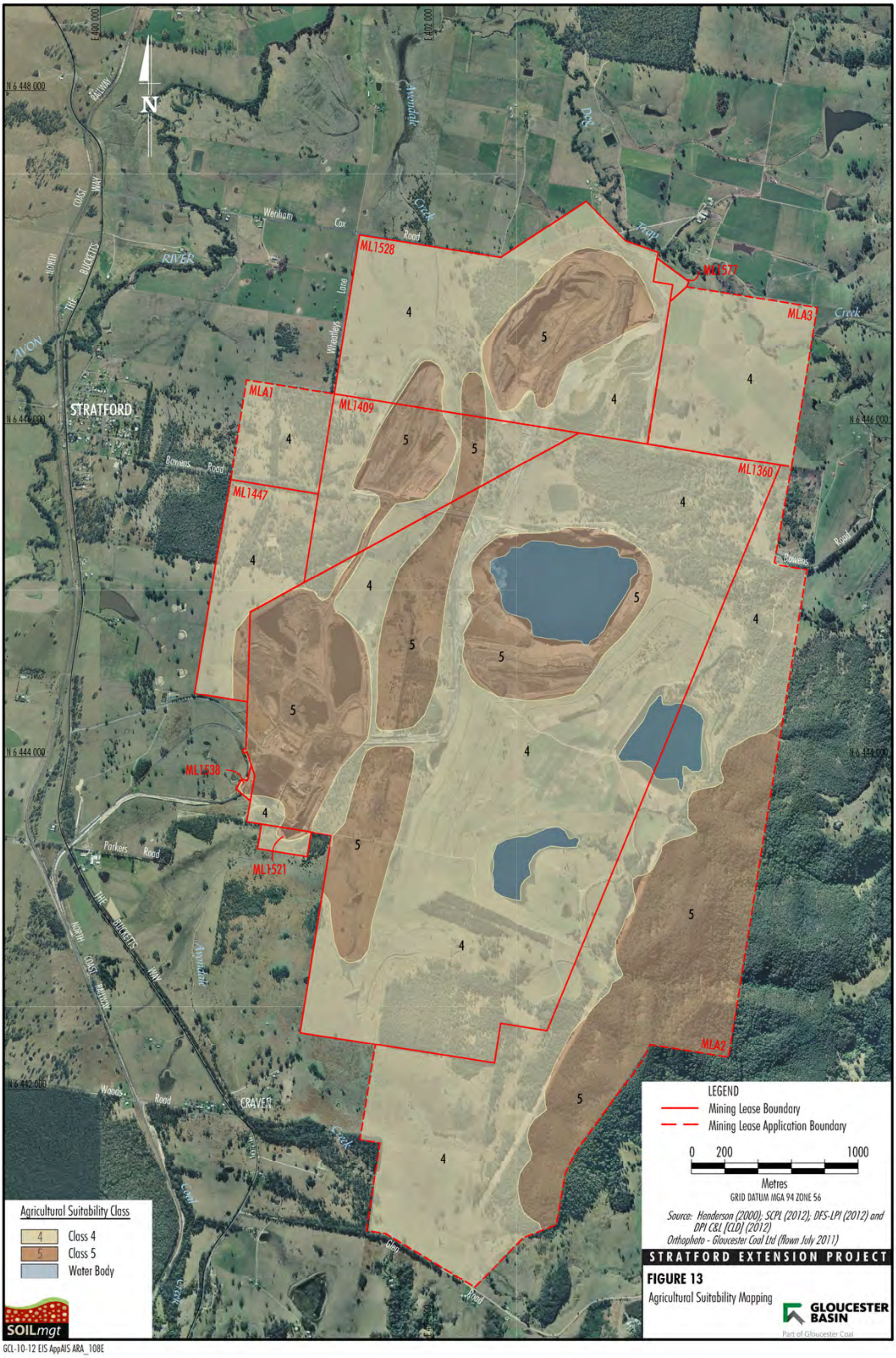
GCL-10-12 EIS AppAIS ARA_113D



Source: Henderson (2000); SCPL (2012); DFS-LPI (2012) and DPI C&L [CLD] (2012)
Orthophoto - Gloucester Coal Ltd (flown July 2011)

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FIGURE 13

Agricultural Suitability Mapping

GCL-10-12 EIS AppAIS ARA_108E

7 REHABILITATION AND SOIL MANAGEMENT

7.1 Proposed Rehabilitation Strategy

Post-mining land use in the Project site would comprise a combination of agricultural and nature conservation land use areas. The revegetated mine landforms would include a mix of endemic woodland/open forest species (nature conservation land use areas) and pastures (agricultural land use areas). Approximately 300 ha of agricultural land use areas and approximately 350 ha of nature conservation land use areas would be re-established post-mining. Figure 14 illustrates the Project conceptual final landform rehabilitation.

The details of the proposed rehabilitation strategy for the Project are presented in Section 5 in the Main Report of the EIS.

7.2 Soil Resource Estimate

The available soil resource for rehabilitation at the Project has been estimated. The stripping depth has been selected such that only soils suitable for use as plant growth media for at least one of the following post-mine land uses at the Project would be stripped:

- agriculture – pastures; and
- native conservation – woodland/open forest.

The suitability of the soils for each of these post-mine land uses has been determined based on a comparison of the results of the soil survey observations and laboratory analytical results against the criteria outlined in Table 7. It has also been assumed that appropriate management practices (Section 7.4) are implemented during soil handling and relevant amelioration measures (Section 7.3) are applied where necessary.

Based on the results of the soil survey (Section 4) and consideration of the soil specifications in Table 7, the suggested depth for soil stripping for the additional disturbance areas at the Project and the existing rehabilitated areas that would be disturbed is 0.15 m (Figure 15).

The topsoil has some constraints for plant growth (e.g. nutrient deficiencies and acidity), however, it is worth stripping and using for rehabilitation because of its favourable organic matter contents. The acidity and nutrient deficiency limitations for this stripped material can be ameliorated in a cost-effective manner, if required (Section 7.3).

There was no evidence of favourable deeper soil layers that would be suitable for rehabilitation. An attempt was made to find deep alluvium with favourable subsoil properties (with potential for use as a rehabilitation material) in the alluvial/colluvial areas through the use of 3 m deep pits but no such soils were identified on the Project site.

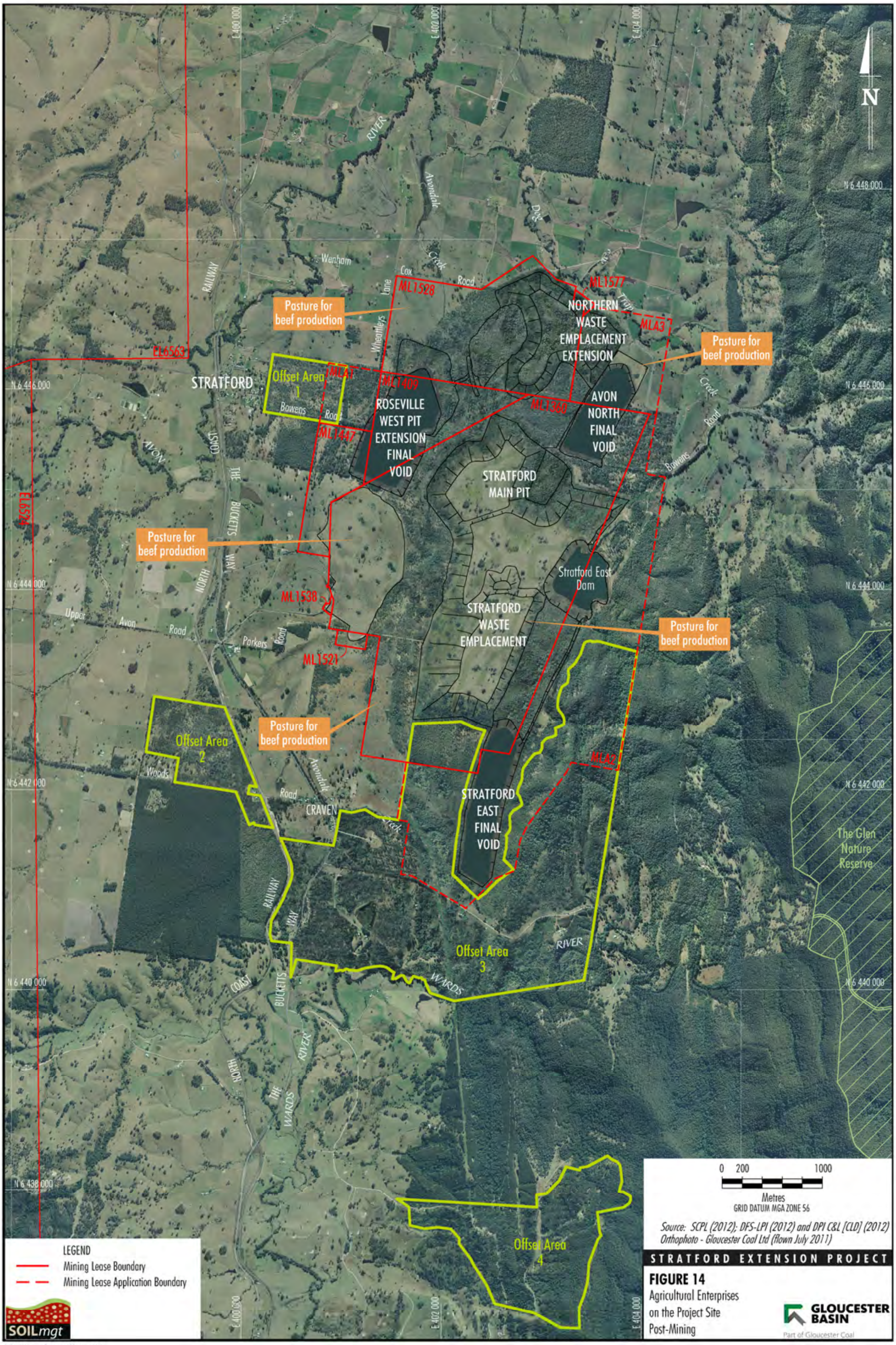

FIGURE 14
Agricultural Enterprises on the Project Site Post-Mining

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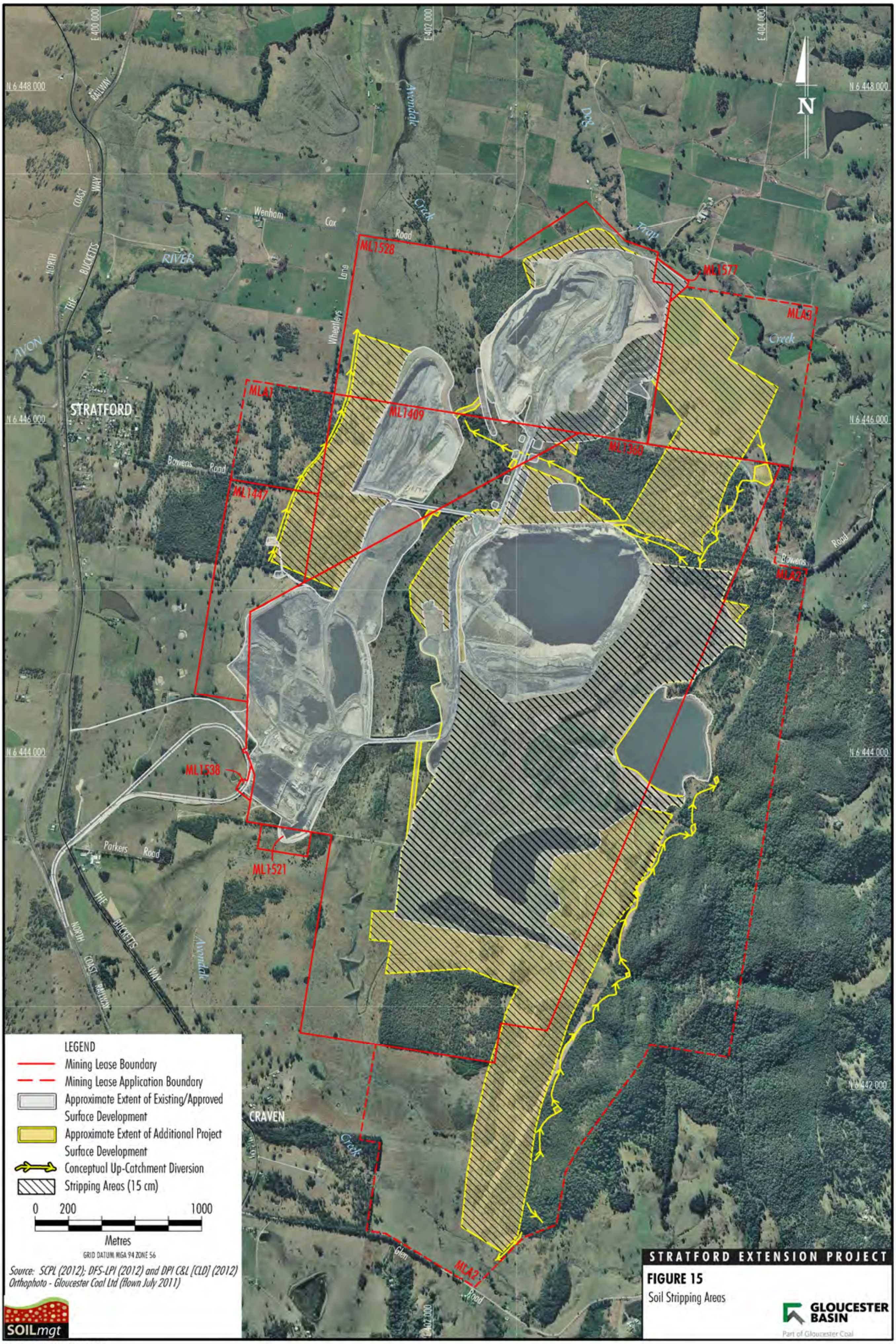

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FIGURE 15

Soil Stripping Areas

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GCL-10-12 EIS AppAIS ARA_107H

Table 7. Soil specifications for the proposed post-mining land uses

Parameter	Pasture Targets	Woodland/Open Forest Targets
Compaction severity (SOILpak score); minimize to allow unimpeded root growth	Topsoil: >1.5 Subsoil: >1.0	Topsoil: >1.5 Subsoil >1.0
Exchangeable Sodium Percentage; minimize to reduce the risk of soil erosion by water	Topsoil: <2 Subsoil: <6	As close to baseline conditions as possible or conditions determined to be suitable by rehabilitation trials
Acidity (pH $CaCl_2$)	>5.5, <8.0	As close to baseline conditions as possible or conditions determined to be suitable by rehabilitation trials
Salinity (ECe, dS/m)	<1.5	As close to baseline conditions as possible or conditions determined to be suitable by rehabilitation trials
Cation Exchange Capacity (CEC, meq/100 g)	>15	As close to baseline conditions as possible or conditions determined to be suitable by rehabilitation trials
Phosphorus (Colwell P; mg/kg)	>30	As close to baseline conditions as possible or conditions determined to be suitable by rehabilitation trials
Depth	50 cm root zone with as few coarse fragments as possible	As close to baseline conditions as possible or conditions determined to be suitable by rehabilitation trials

meq/100 g = milliequivalent of hydrogen per 100 grams.

mg/kg = milligrams per kilogram.

The approximate volume of soil that would be available for rehabilitation purposes based on this suggested stripping depth is provided in Table 8.

Table 8. Soil resource availability

Recommended Stripping Depth (cm)	Approximate Stripping Area (ha)	Approximate Volume (m^3)
0 – 15	500	750,000
Currently Stockpiled	-	250,000
Total	-	**1,000,000**

m^3 = cubic metres.

Preliminary material balance calculations based on the recommended soil stripping depth indicate an approximate topsoil volume of 750,000 m^3 would be available from the Project disturbance area for use during future rehabilitation. In addition, approximately 250,000 m^3 of soil is currently stockpiled at the Stratford Mining Complex (SCPL, 2011). The total available soil resource would be approximately 1,000,000 m^3.

7.3 Soil Ameliorants

A summary of the soil constraints and measures which could be implemented on the stripped soil (Section 7.2) or other areas of the Project site to ameliorate the constraints is provided in Table 9. The estimated application rates are also provided in Table 9.

Table 9. Summary of soil constraints at the Project site and possible ameliorants

Soil Constraint	Ameliorants	Application Details
Acidity	Application of finely-ground limestone ('lime'); incorporated via deep ripping. A lime slotting technology was developed for acidic subsoil amelioration by the Cassegrain family, Port Macquarie, but is not considered economically viable at the Project site.	Overcoming acidity in the 0-15 cm layer would require approximately 5 t/ha for pH increases to 5.5; Fenton (2003) calculations.
Dispersion	Application of coarse-grade (20-50 mm) recycled gypsum on the areas with dispersible subsoil. Gypsum has a two-fold effect – it reduces sodicity through the displacement of exchangeable sodium and magnesium by calcium, and provides a mildly saline soil solution that creates a beneficial electrolyte effect.	An appropriate gypsum application rate for sodic/magnesic soil in the Gloucester district has not been determined experimentally, but it is likely to be approx. 2.5 t/ha in the first instance; So and McKenzie (1984)[1].
Compaction	Mechanical disruption of compacted layers with an implement such as a deep ripper. Procedures to minimise the risk of re-compaction, e.g. avoidance – where possible – of grazing under moist conditions, would have to be implemented.	Shatter compacted layers to a depth of approximately 40 cm with a once-only deep ripping (carried out, if possible, with soil water content at or just below the 'plastic limit'; ripping directed and spaced in a way that minimises the risk of soil erosion).
Organic Carbon	Application of organic amendments is effective, but unlikely to be economically viable under rainfed pasture in the Gloucester area. Instead, maximise soil organic matter via conservation of organic residues produced by pasture.	N/A
Water Holding Capacity	There are no cost effective management measures to ameliorate the presence of bedrock and/or coarse gravel close to the surface.	N/A
Nutrient Deficiency	Fertilisers are available to address nutrient deficiencies that have been identified.	Blackwood *et al.* (2006) discuss fertiliser application options.

1 Follow-up applications may be needed if very wet weather rapidly leaches the dissolved gypsum.

7.4 Soil Resource Management Measures

General soil resource management practices, where surface development is proposed within the Project site, should involve the stripping and stockpiling of soil resources prior to any mine-related disturbance, other than clearing vegetation. The general strategy should be for those disturbance areas to be rehabilitated progressively, or at the completion of mining activities.

The objectives of soil resource management for the Project should be to:

- Identify and quantify potential soil resources for rehabilitation.
- Optimise the recovery of useable soil resources during stripping operations.
- Manage soil reserves so as not to degrade the resource when stockpiled.
- Establish effective soil amelioration procedures to maximise the availability of soil reserves for future rehabilitation works.
- Where soil profiles are to be reconstructed for native woodland/open forest, take into account both the natural soil requirements of the local native vegetation, and the need to provide soil conditions that minimise the risk of soil loss via wind and water erosion during and after rehabilitation.

Stripping

The following management measures should be implemented during the stripping of soils at the Project:

- Areas of disturbance are to be stripped progressively, as required, to reduce potential erosion and sediment generation, and to minimise the extent of soil stockpiles and the period of soil storage.
- Areas of disturbance requiring soil stripping are to be clearly defined following vegetation clearing.
- Soil stripping during periods of high soil moisture content (i.e. following heavy rain) is to be avoided to reduce the likelihood of damage to soil structure.

The degree of success of a stripping and stockpiling program is strongly influenced by soil water content. Stripping during periods of high soil moisture content can result in excessive compaction and/or remoulding of the soil.

Where soil dispersion problems are aggravated by stripping during periods of high moisture content, gypsum should be applied to encourage re-stabilisation of the stripped soil.

Soil recovery during stripping on the existing rehabilitated areas may be reduced because of the presence of the underlying waste rock. It is recommended that soil recovery be monitored during stripping operations on the existing rehabilitated areas and if monitoring indicates poor soil recovery, the soil stripping methodology should be reviewed and modified (e.g. use of truck and shovel rather than scrapers) to improve soil recovery, if necessary.

Stockpile Management

The following management measures should be implemented during the stockpiling/storage of soils at the Project:

- Soil stockpiles should be retained at a height of 3 m, with slopes no greater than 1:2 (vertical to horizontal) and a slightly roughened surface to minimise erosion.
- Construct soil stockpiles in a way that minimises erosion, encourages drainage, and promotes revegetation.
- Where amendments such as lime, gypsum and fertiliser are needed to improve the condition of cut soil, they should be applied to the stockpiles in-between the application of separate layers.
- Wherever practicable, soil should not be trafficked, deep ripped or removed in wet conditions to avoid breakdown in soil structure.
- All soil stockpiles should be seeded with a non-persistent cover crop to reduce erosion potential as soon as practicable after completion of stockpiling. Where seasonal conditions preclude adequate development of a cover crop, stockpiles should be treated with a straw/vegetative mulch to improve stability.
- Grow deep-rooting vegetation to encourage organic matter accumulation and maintain microbial activity. Stockpile height can be excessive because of limited space at mine sites, but try to keep it as low as possible. This maximises the chances of plenty of plant roots reaching the base of the stockpile as it awaits redistribution.
- There should be as little vehicle access as possible on soil stockpiles.
- Soil stockpiles should be located in positions to avoid surface water flows. Silt stop fencing would be placed immediately down-slope of stockpiles until stable vegetation cover is established.
- In the event that unacceptable weed generation is observed on soil stockpiles, a weed eradication program should be implemented.
- An inventory of soil resources (available and stripped) on the Project site should be maintained and regularly reconciled with rehabilitation requirements.
- In preference to stockpiling, wherever practicable, stripped soil should be directly replaced on completed sections of the final landform.

Application of Soil on Rehabilitated Landforms

The following management measures should be implemented during the application of soils on rehabilitated landforms at the Project:

- Prior to soil placement, remove as many large rocks (diameter greater than about 0.5 m) within 0.5 m of the surface as practicable to minimise the potential for root impedance. Where possible, deposit the coarsest waste rock deeply in the waste rock emplacements and then deposit the finer waste rock as the final layer prior to soil placement to improve water holding capacity of the rehabilitated landform. As the degree of fineness of the waste rock increases, its water holding capacity becomes greater.
- Soil placement shall only proceed once the final landform and major drainage works (i.e. graded banks, drainage channels and rock waterways if required) have been completed.
- Soil placement is to be undertaken from the top of slopes or top of sub drainage catchment to minimise erosion damage created by storm runoff from bare upslope areas.
- Soil placement is to be conducted along the general run of the contour to minimise the incidence of erosion.
- Soil is not to be placed in the invert of drainage lines or drainage works.

Rehabilitation Management Plan

It is recommended that a Rehabilitation Management Plan for the Project be prepared by a suitability qualified expert to detail the soil resource management measures outlined in the sections above. The Rehabilitation Management Plan should be progressively updated to cater for the site-specific management requirements of soils as the Project progresses.

Irrigation Area

As described in Section 3, irrigation is undertaken on the Stratford Waste Emplacement (Figure 3). A summary of the irrigation water quality during January to September 2011 is provided in Table 10.

Table 10. Summary of irrigation water quality during January to September 2011

Parameter	Range	Average
pH	7.3-8.2	7.9
EC	0.97-1.35 dS/m	1.19 dS/m
Sodium Adsorption Ratio (SAR)	4.5-5.1	4.8

The Project would involve the contingent use of existing approved irrigation areas (i.e. on the Stratford Waste Emplacement) as well as the development of new areas on an as-required basis as new rehabilitated areas become available. Irrigation would only occur on rehabilitated or topsoiled areas that report to contained water storages or open pits. In addition, active waste rock emplacements and haul roads would be watered as a dust control measure. The following recommendations are only relevant to the irrigation of rehabilitated or topsoiled areas of waste rock emplacements.

As the water quality of the Stratford East Dam would vary over the life of the Project, it is recommended that soils in the Project irrigation areas and irrigation water quality be monitored at the Project. Irrigation water quality samples should be analysed for the following at monthly intervals:

- pH;
- EC; and
- SAR.

The following contingency measures should apply if the irrigation water quality for the Project irrigation areas changes as indicated.

- An EC (water) above 2.5 dS/m (Yiasoumi *et al*. 2005) should initiate a review of factors that are likely to affect soil salinity, noting that some salts that contribute to the water EC may not be harmful to soils, and that some plant species have a greater tolerance to salinity than others.
- A SAR above 3.0 (Yiasoumi *et al*. 2005) should initiate a review of salt budgets with particular focus on the permeability hazard and to assist in determining if treatments to reduce the bicarbonate or sodium concentrations are required. Some soil amelioration treatments that are described below could also be relevant with the prevailing water quality conditions.
- An increase in the pH above 8.5 could indicate that acid treatment is required to reduce the bicarbonate load.
- If the pH decreases below 6.0 the source of the acidity should be tracked and rectified via lime addition.

The soils in the Project irrigation area should be monitored for the following at three-monthly intervals:

- pH;
- EC; and
- ESP.

The following contingency measures should be applied if the following soil conditions in the Project irrigation areas prevail:

- An increase in the soil pH above 7.5 should be addressed by reducing the pH of the irrigation water (see above).
- A decrease in the soil pH below 5.5 should be addressed by increasing the pH of the irrigation water (see above), or by liming the soil.
- An increase in the soil ECe above 3.0 dS/m should be addressed by measures to reduce the soil salinity. Some options include (a) reducing the salt load of the irrigation water, (b) applying leaching irrigations to maintain salt concentrations below threshold levels for the plant species being grown, and/or (c) choose plant species that are tolerant of salinity stress.
- An ESP above 6.0, and associated declines in surface infiltration, should be addressed by reducing the sodium concentration in the irrigation water, or facilitating the leaching of sodium from the soil, or both. A common remedial treatment for a high ESP/SAR is to add gypsum to the soil.
- Leaf scorching is indicative of excessive sodium, chloride, or other salts in the irrigation water. It can be lessened by avoiding watering during the middle of hot days, but in the long run would require some improvement in water quality (see measures described above).

7.5 Rehabilitation – Agricultural Land Uses

Chemical and physical assessment of the soil properties of the Project site indicate that the soil resources quantified in Table 8 would be suitable for rehabilitation purposes provided appropriate management practices (Section 7.4) are implemented during handling and relevant amelioration measures (Section 7.3) are applied where necessary. This section focuses on the rehabilitation of lands proposed for agricultural land uses post-mining.

It is considered that the soil resource could be used as a rehabilitation medium for agricultural uses (grazing) post-mining because:

- Organic carbon concentrations are favourable;
- Acidity problems can be overcome easily with lime application, if required;
- ESP values are low enough to be treated easily with coarse-grade gypsum; and
- Most of the soil is non-saline.

These chemical properties would not be modified greatly during the stripping, stockpiling and spreading of the soils.

It is recommended that the agricultural areas (Figure 14) should be prepared with 0.15-0.20 m layer of stripped soil placed over waste rock (as per existing rehabilitation at the Stratford Mining Complex) which should provide an overall rooting depth of at least 0.5 m. This overall rooting depth (i.e. at least 0.5 m) was observed in most of the pits located on the rehabilitated waste emplacements (Figures 4 and 8b) during the field surveys. It is therefore considered that the waste rock would allow for root penetration to this target depth (i.e. at least 0.5 m). These agricultural areas should also be sloped to allow suitable drainage so that waterlogging can be avoided.

Soil profile reconstruction following major earthworks has been conducted at the Stratford Mining Complex previously. The waste rock on the Stratford Waste Emplacement was covered with 0.15-0.20 m of stripped soil and then subject to site preparation works (e.g. chisel ploughing) prior to progressive revegetation with a pasture cover crop and areas of endemic woodland/open forest shrubs and trees. In addition, the waste rock on the Southern and Northern Waste Emplacements (Figure 2) was covered with approximately 0.10 m of stripped soil and was then subject to site preparation works prior to progressive revegetation with endemic woodland/open forest shrubs and trees. Rehabilitation works on the Stratford Waste Emplacement (Figure 2) have been completed, and as described in Section 3, a portion of the rehabilitated emplacement is supporting grazing and is irrigated by a centre-pivot irrigation system (Figure 3).

The soil profile described above would provide rootzone chemical and physical conditions that are at least as favourable for pasture production as the existing agricultural areas, with the possible exception of water holding capacity reductions caused by high coarse fragment content in the reconstructed soil. Based on the soil quantities detailed in Table 8 and a 0.15-0.20 m layer of reapplied stripped soil, there is adequate soil resource to re-establish the proposed area of agricultural land (suitable for grazing) post-mining (i.e. 300 ha) (Section 8.2). In addition there would be adequate soil resource to provide at least a 0.10 m layer of reapplied stripped soil on the nature conservation land use areas.

8. PROJECT SITE AGRICULTURAL ACTIVITIES

8.1 Existing

Agricultural Enterprises and Productivity

Approximately 830 ha of agricultural lands currently occur on the Project site. Agricultural enterprises known to have been conducted on the Project site include cattle grazing for beef and dairy products on improved and unimproved pastures. Beef production is the dominant agricultural activity on the Project site, with only very small sections of the northern extent of the Project site used for cattle grazing for dairy products (Figure 3). Small areas at the northern end of the Project site were observed to have cultivation for forage crops, but there was no evidence of crop production for grains or intensive horticulture.

The Project site consists of areas of improved and unimproved pastures. The 35 ha area under centre-pivot irrigation on the rehabilitated Stratford Waste Emplacement (Figures 2 and 3) can be referred to as improved pasture because of its inputs of fertilizer and regular waterings. The remainder of the pasture across the Project site is a mosaic with a range of improvements in pasture composition, but with several major soil constraints (poor soil nutrient status, especially phosphorus and conspicuous subsoil constraints, particularly acidity and waterlogging) that prevent attainment of the high pasture productivities observed on the best soil in the district. It is considered that the majority of the agricultural lands on the Project site are unimproved pasture or low productivity improved pastures.

Most of the pasture is rain-fed, however approximately 35 ha is under centre-pivot irrigation on the rehabilitated waste rock emplacement (Figures 2 and 3). A positive feature of the Project site is the favourable rainfall of approximately 1,100 mm per annum. This rainfall regime allows pasture with shallow rooting systems in soil with a poor water holding capacity to continue growing in most years. This same soil in a drier landscape would be much more prone to drought stress than a deep soil with favourable subsoil conditions.

The Project would reduce the area of agricultural land on the Project site by approximately 390 ha. These post-mining non-agricultural areas would consist of final voids, final void batters and native regeneration areas.

Agricultural Infrastructure

Agricultural infrastructure located on the Project site includes:

- fences;
- small farm dams; and
- centre-pivot irrigator and associated infrastructure.

Agricultural Productivity

Beef production currently occurs on the rehabilitated Stratford Waste Emplacement at the Project site. Approximately 70 cattle breeding units (i.e. cow plus offspring) graze on about 200 ha (including approximately 35 ha of irrigated pasture). The irrigated area is typically planted with fodder crops (e.g. oats and rye).

The grazing area consists of a number of paddocks that are grazed on a rotational basis within the irrigated area. The irrigated area is typically grazed for 3 to 4 weeks at a time and then rested for approximately 4 weeks.

Based on the information above, the stocking rate on this sub-section of the Project site is approximately 5 Dry Sheep Equivalents per hectare (DSE/ha). This stocking rate is higher than the typical stocking rate on unimproved pasture (approx. 3 DSE/ha) and lower than the typical stocking rate on improved pasture with moderate fertility (9 DSE/ha) in the Gloucester region (Blackwood *et al.* 2006).

The NSW Department of Primary Industries Gross Margin Budget for 'North Coast Weaners – Unimproved Land'[2] and 'North Coast Weaners – Improved Land'[3] would provide the best estimate of productivity on the Project site. The productivities of the different agricultural enterprises have been summarised in Table 11.

Table 11. Approximate productivity of the agricultural enterprises on the Project site

Enterprise	Stocking Rate (DSE/ha)	Gross Margin ($/ha/year)
Beef cattle grazing (weaners) on improved pastures; conducted on the minority of agricultural areas on the Project site	9	134.81
Beef cattle grazing (weaners) on unimproved pastures or low productivity improved pastures; conducted on the majority agricultural areas on the Project site	3	53.06

8.2 Post-Mining

As described in Section 7.1, areas of the rehabilitated Project site would be established for agricultural purposes (Figure 14). Approximately 300 ha of grazing land for beef production would be re-established on Project disturbance areas post-mining. In addition, 140 ha of undisturbed agricultural land within the Project site would remain post-mining. The productivity per hectare of beef production that would be re-established post-mining is expected to be very similar to existing productivities (Table 11).

[2] http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0005/175523/16-North-Coast-store-weaners-unimproved-country.pdf

[3] http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0004/175522/18-North-coast-store-weaners-improved-country.pdf

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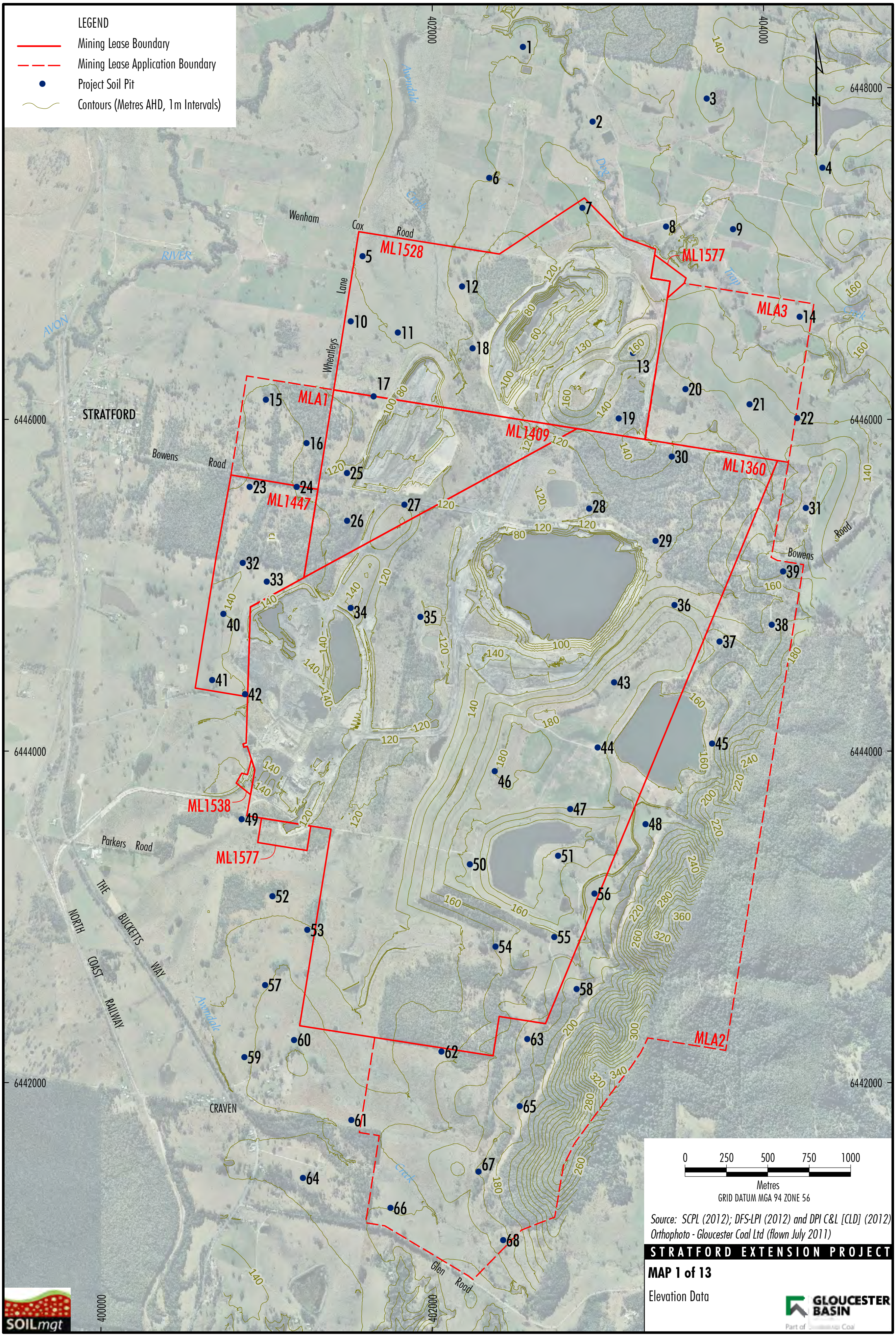
Maps



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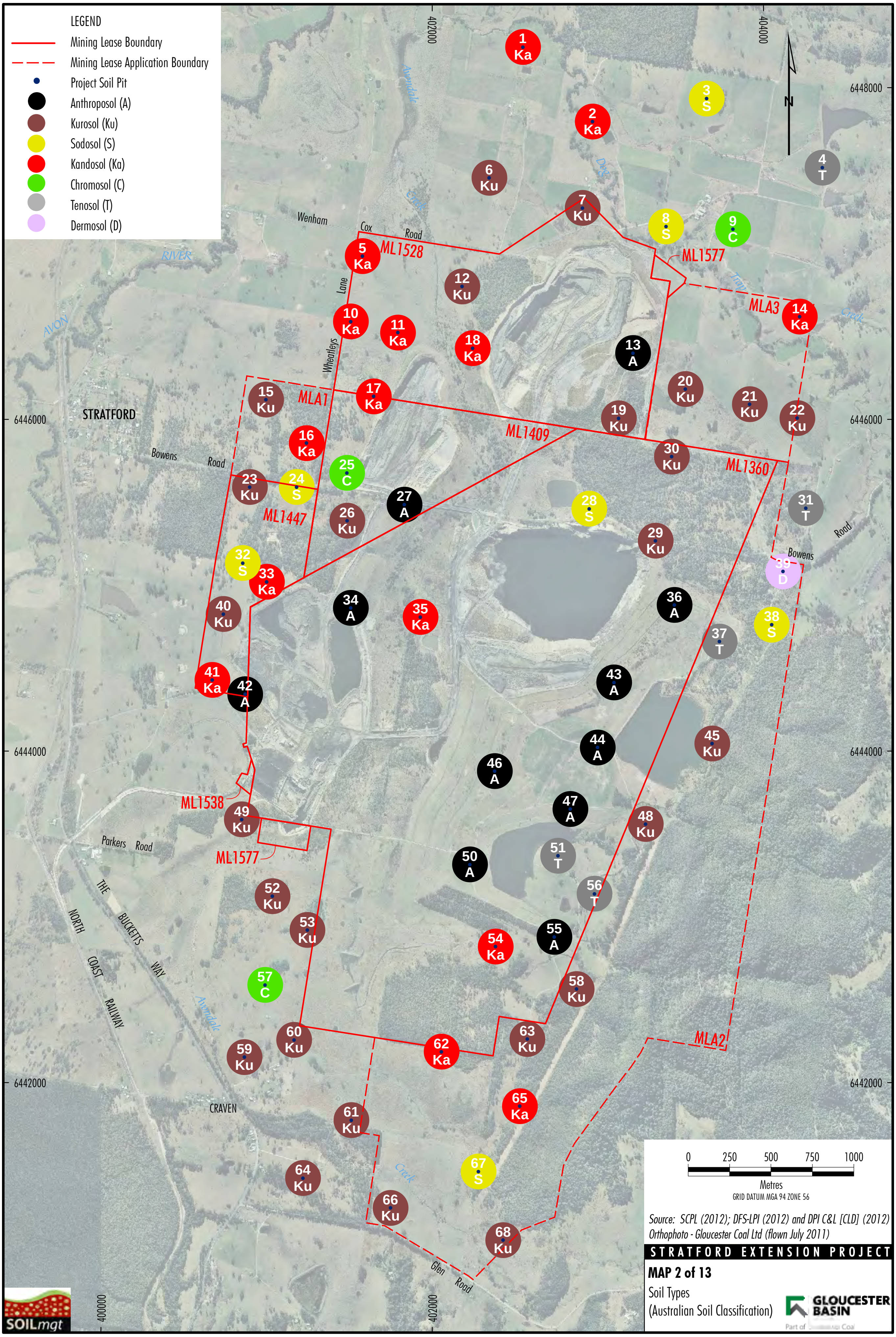

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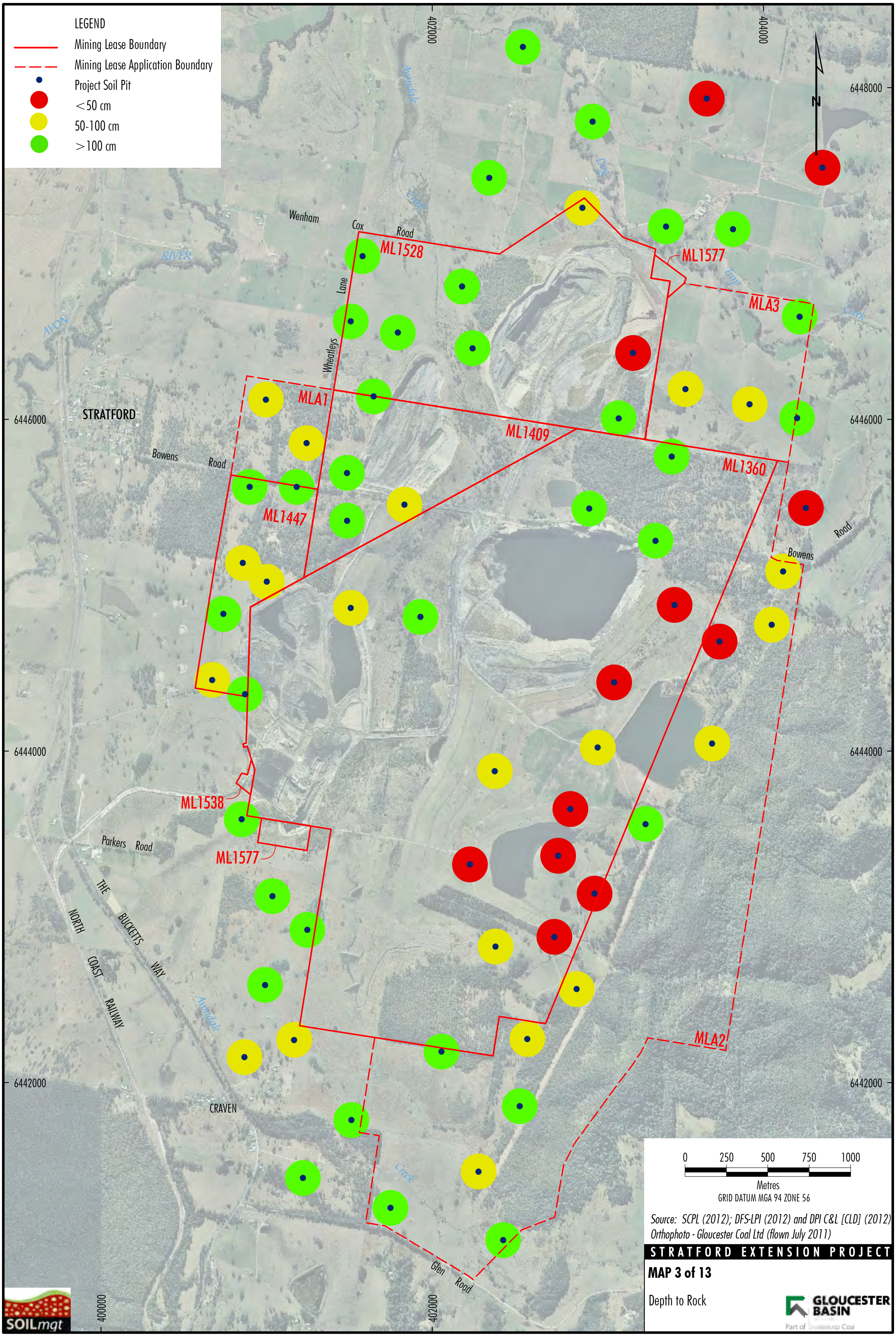

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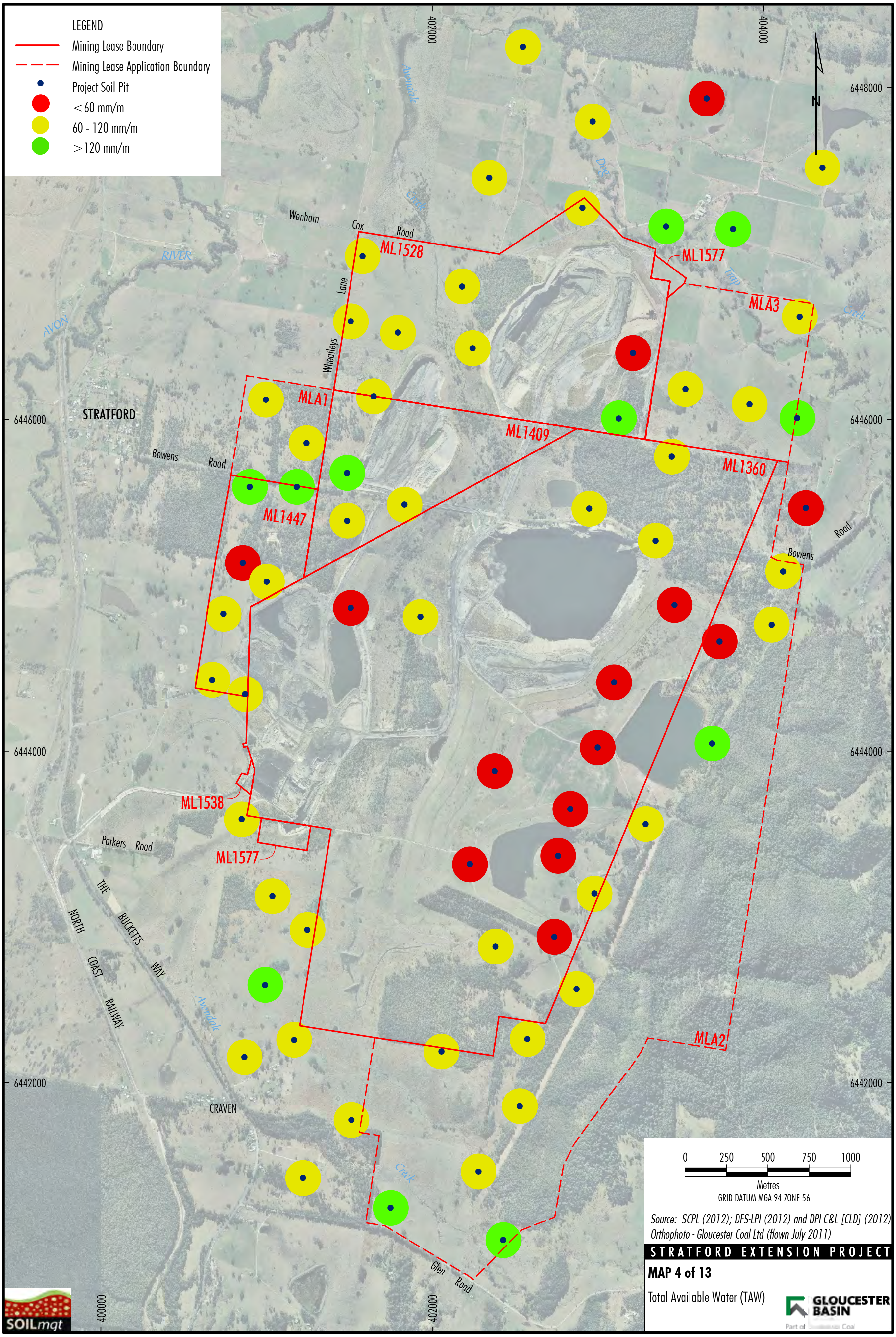


Source: SCPL (2012); DFS-LPI (2012) and DPI C&L [CLD] (2012)
Orthophoto - Gloucester Coal Ltd (flown July 2011)

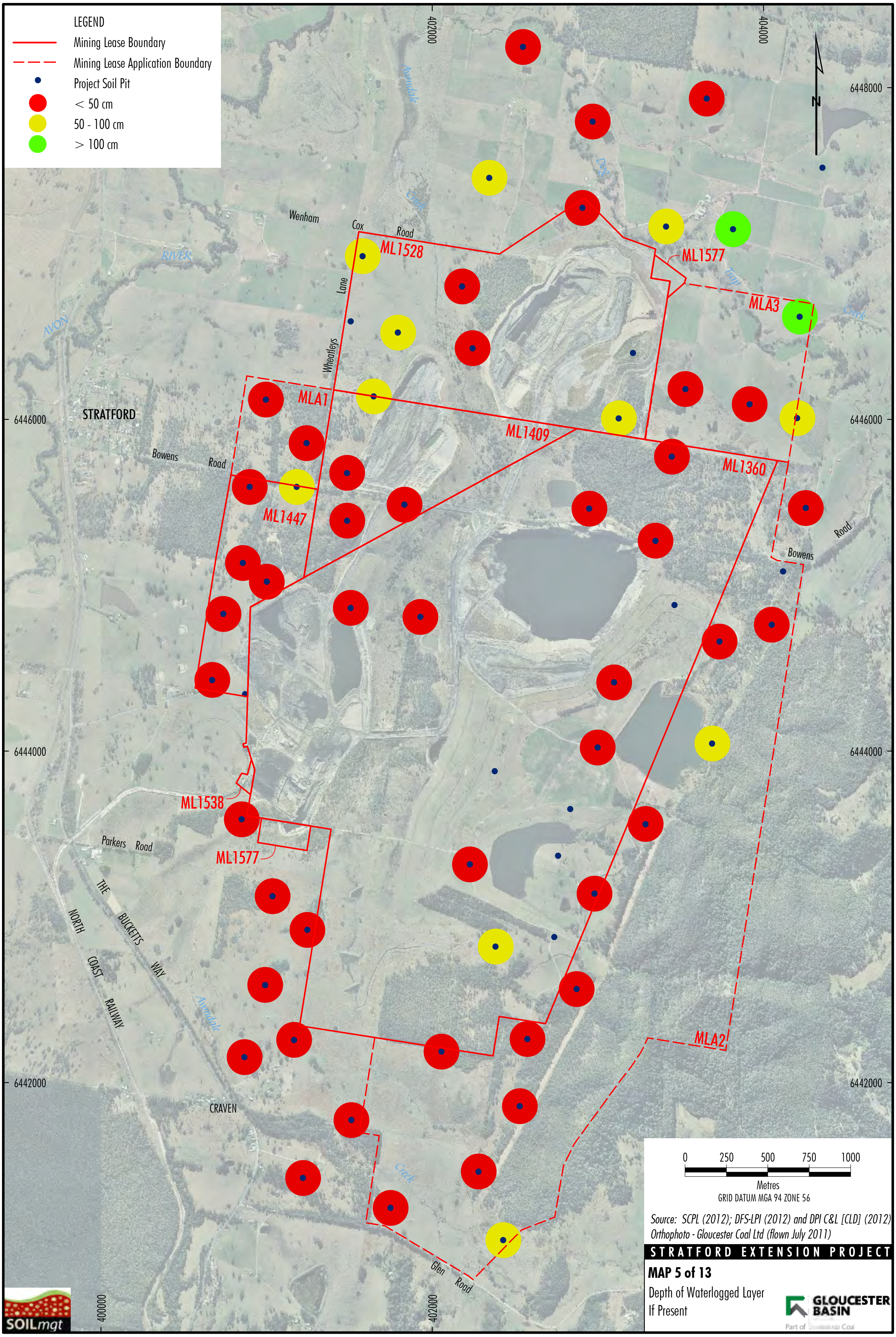
STRATFORD EXTENSION PROJECT

MAP 4 of 13

Total Available Water (TAW)

GLOUCESTER BASIN

GCL-10-12 EIS AppAIS ARA_204B



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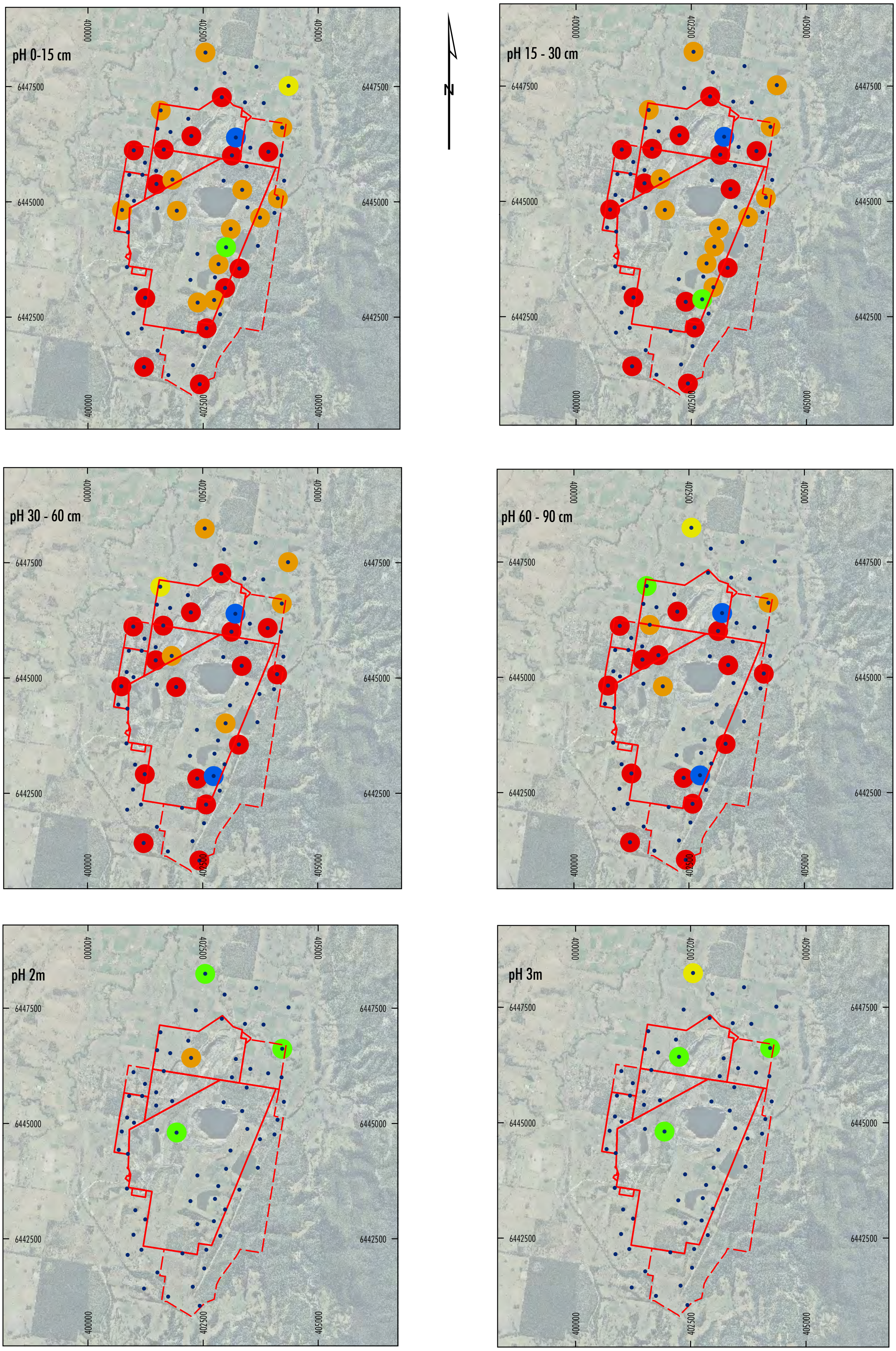


LEGEND

- Mining Lease Boundary
- Mining Lease Application Boundary
- Project Soil Pit

- < 4.5
- 4.5 - 5.5
- 5.6 - 6.5
- 6.6 - 7.5
- > 7.5

0 1000 2000 3000 4000

Metres

GRID DATUM MGA 94 ZONE 56

Source: SCPL (2012); DFS-LPI (2012) and DPI C&L [CLD] (2012)

Orthophoto - Gloucester Coal Ltd (flown July 2011)

STRATFORD EXTENSION PROJECT

MAP 6 of 13

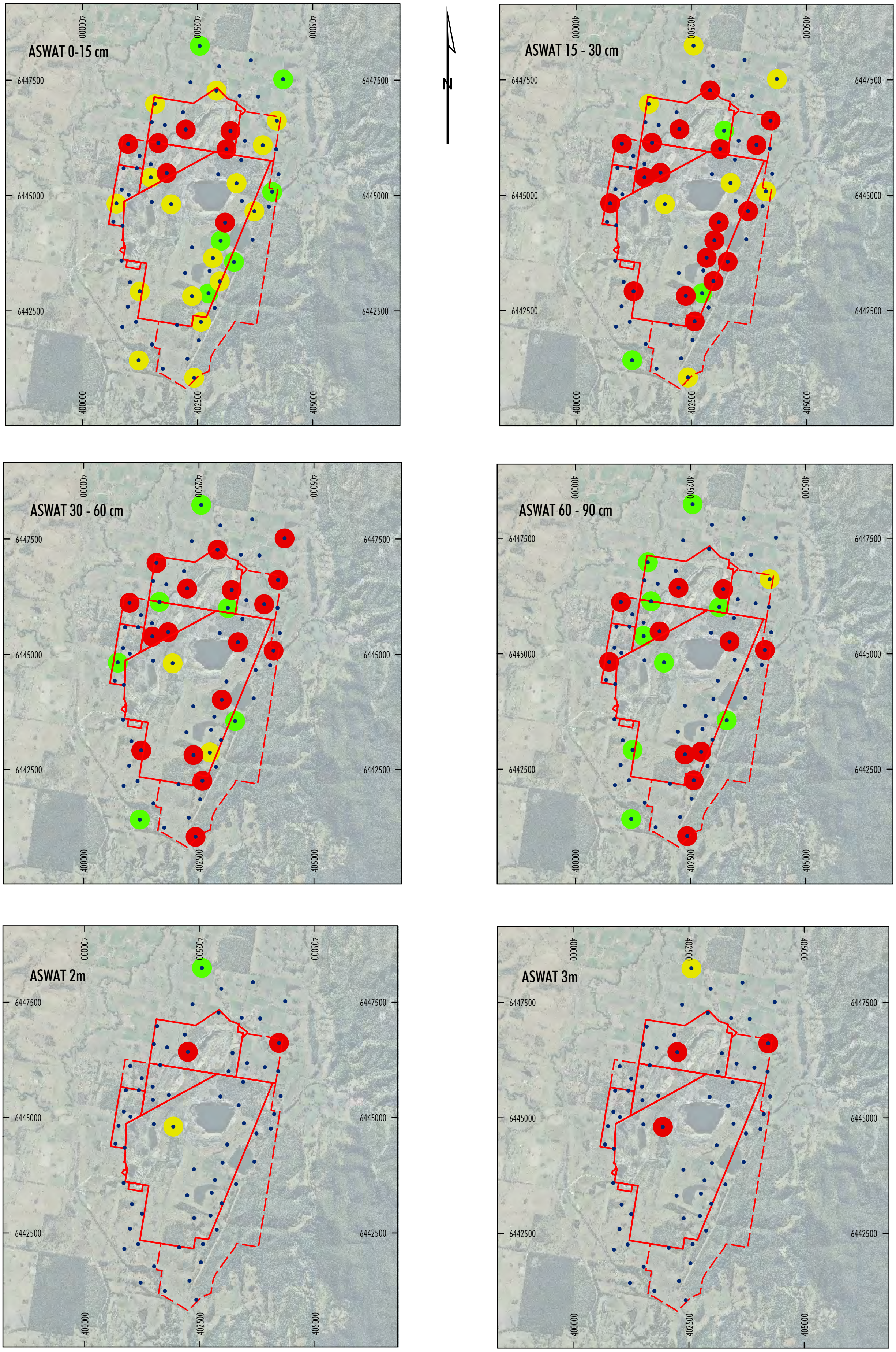
pH ($CaCl_2$)

GLOUCESTER BASIN

Part of

SOILmgt

GCL-10-12 EIS AppAIS ARA_214B



LEGEND

- Mining Lease Boundary
- Mining Lease Application Boundary
- Project Soil Pit
- >6
- 2 - 6
- < 2

0 1000 2000 3000 4000

Metres

GRID DATUM MGA 94 ZONE 56

Source: SCPL (2012); DFS-LPI (2012) and DPI C&L [CLD] (2012)
Orthophoto - Gloucester Coal Ltd (flown July 2011)

SOILmgt

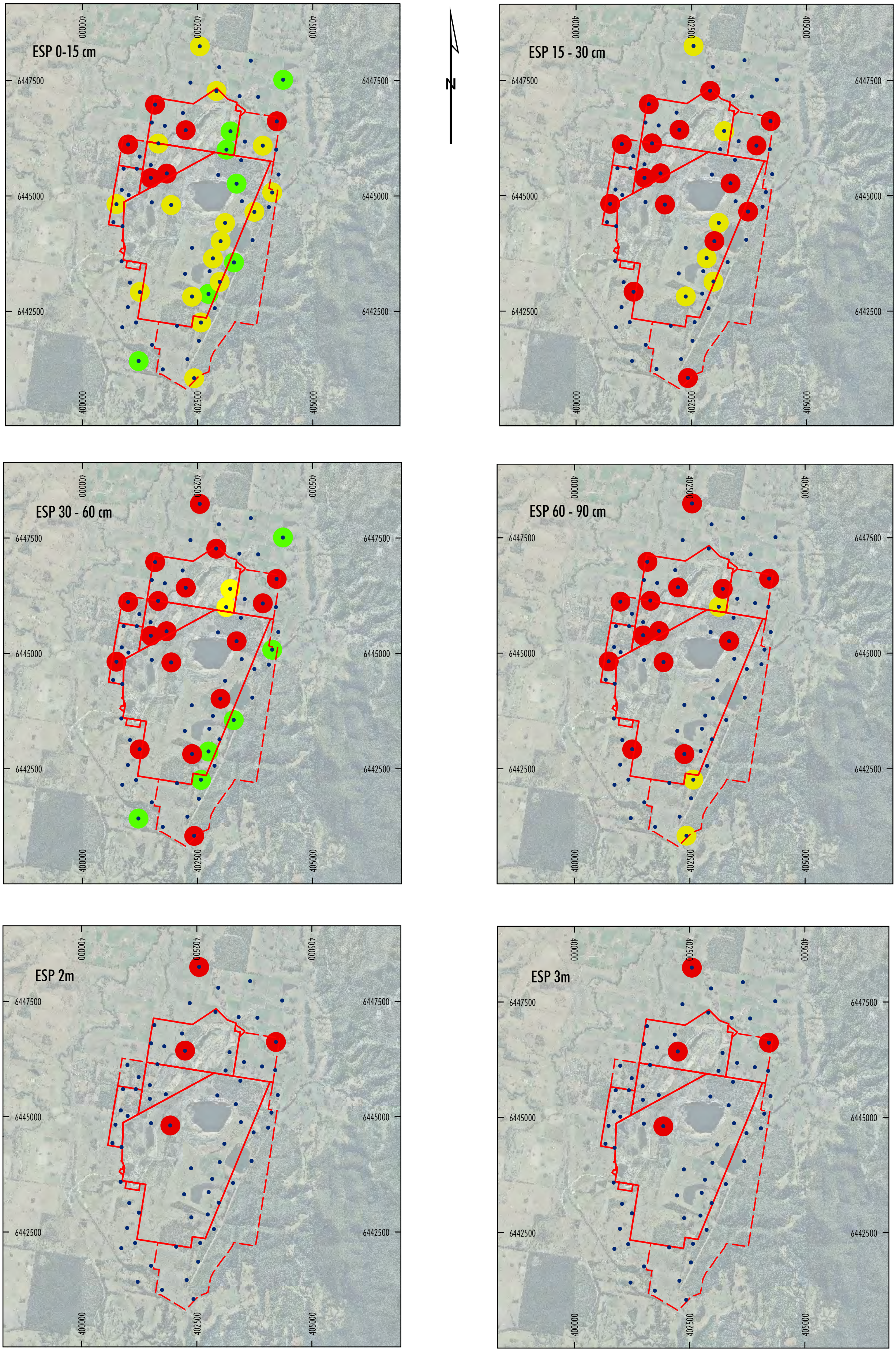
STRATFORD EXTENSION PROJECT

MAP 7 of 13

Dispersion (ASWAT Scores)

GLOUCESTER BASIN

GCL-10-12 EIS AppAIS ARA_207B



LEGEND

- Mining Lease Boundary
- Mining Lease Application Boundary
- Project Soil Pit
- < 3
- 3 - 6
- > 6

0 1000 2000 3000 4000

Metres

GRID DATUM MGA 94 ZONE 56

Source: SCPL (2012); DFS-LPI (2012) and DPI C&L [CLD] (2012)

Orthophoto - Gloucester Coal Ltd (flown July 2011)

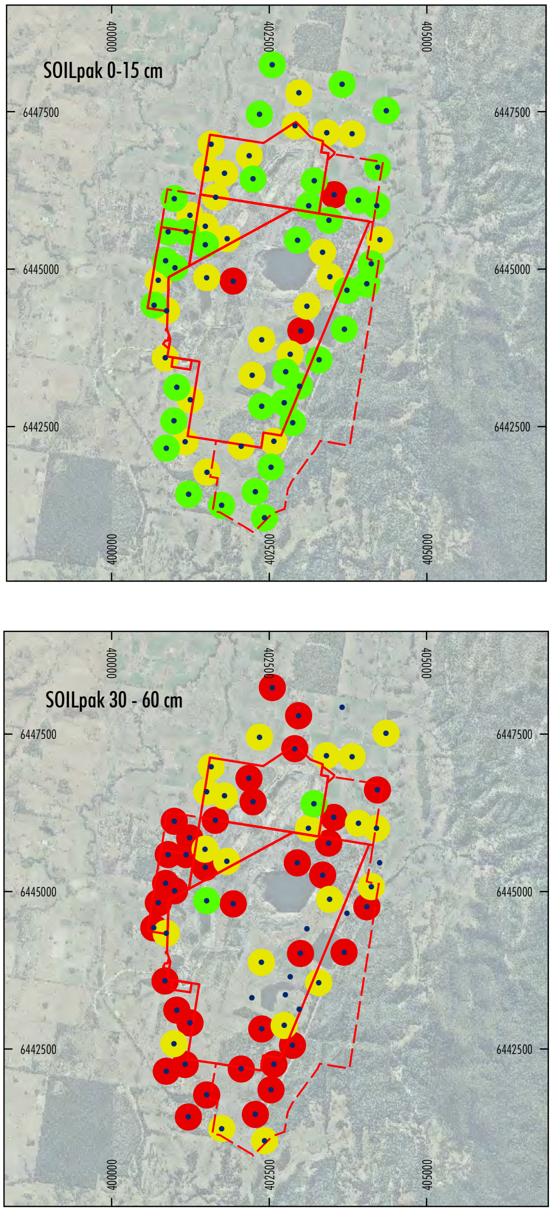
STRATFORD EXTENSION PROJECT

MAP 8 of 13

Dispersion (ESP Values)

SOILmgt

GLOUCESTER BASIN



LEGEND

- Mining Lease Boundary
- Mining Lease Application Boundary
- Project Soil Pit
- < 1.0
- 1.0 - 1.5
- >1.5

0 1000 2000 3000 4000
Metres
GRID DATUM MGA 94 ZONE 56

Source: SCPL (2012); DFS-LPI (2012) and DPI C&L [CLD] (2012)
Orthophoto - Gloucester Coal Ltd (flown July 2011)

STRATFORD EXTENSION PROJECT

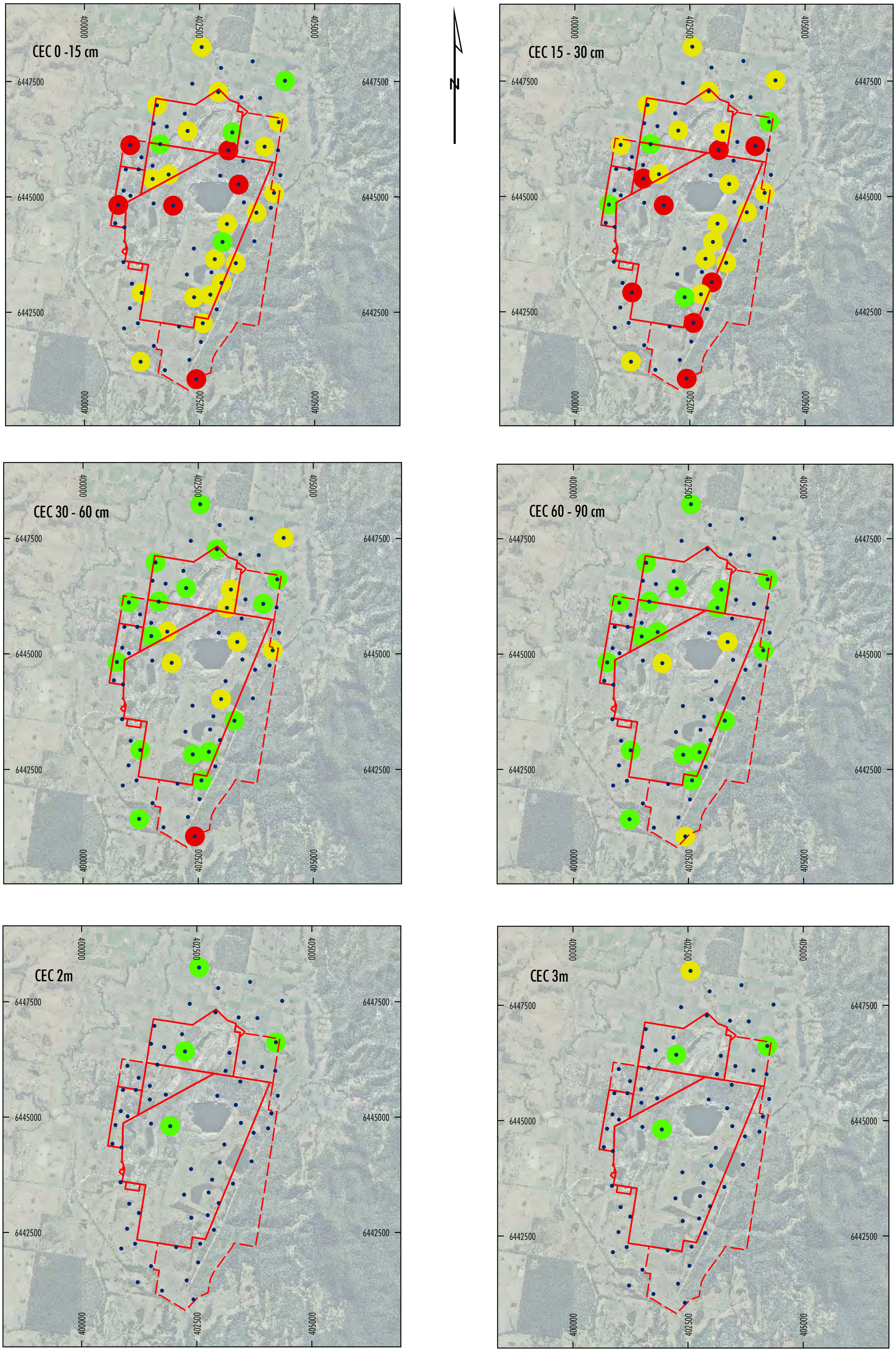
MAP 9 of 13

Compaction Severity
(SOILpak Score)

GLOUCESTER BASIN

SOILmgt

GCL-10-12 EIS AppAIS ARA_209B



LEGEND

- Mining Lease Boundary
- Mining Lease Application Boundary
- Project Soil Pit
- < 5 (meq/100g)
- 5 - 15 (meq/100g)
- >15 (meq/100g)

0 1000 2000 3000 4000

Metres

GRID DATUM MGA 94 ZONE 56

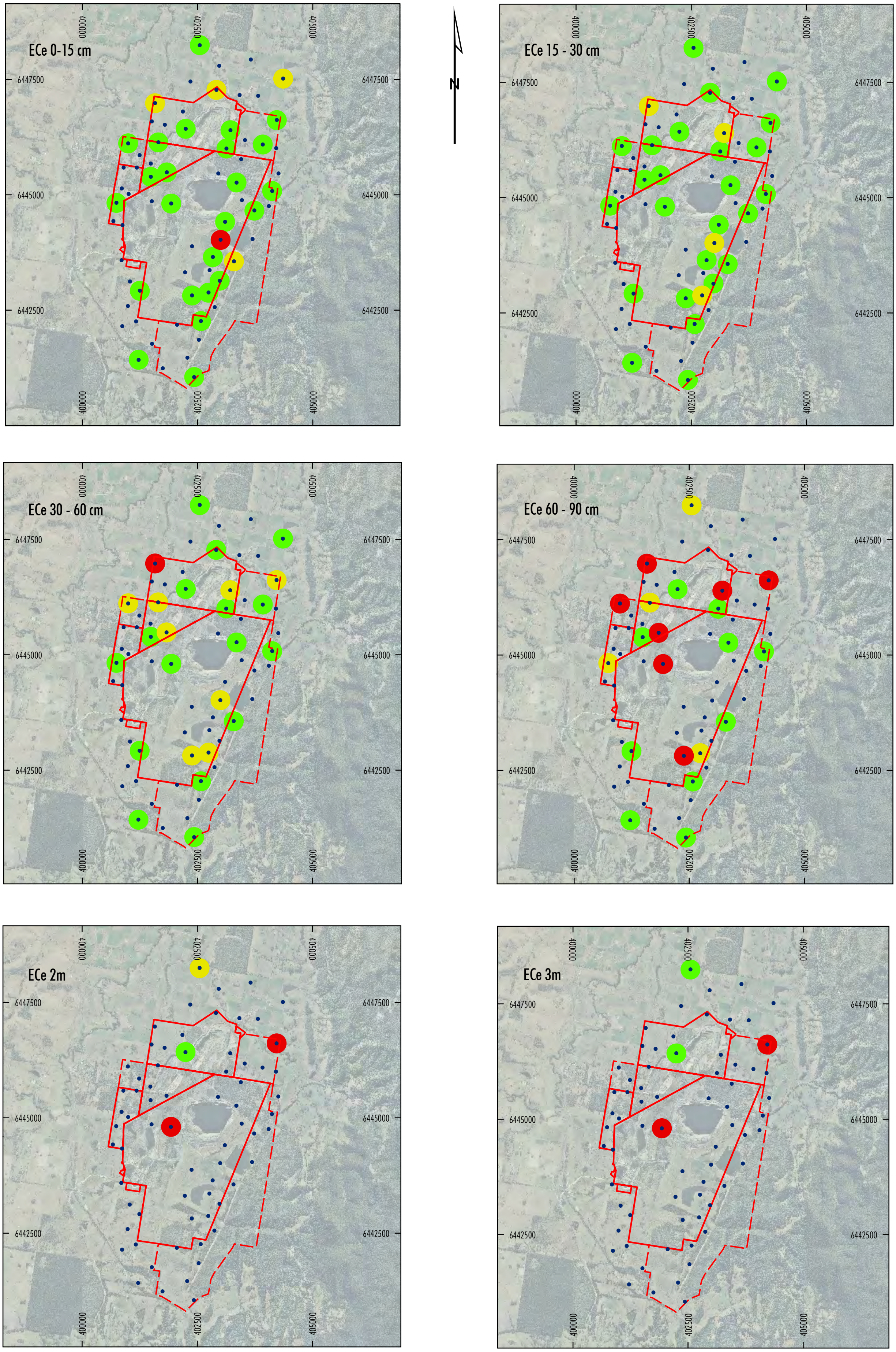
Source: SCPL (2012); DFS-LPI (2012) and DPI C&L [CLD] (2012)
Orthophoto - Gloucester Coal Ltd (flown July 2011)

SOILmgt

STRATFORD EXTENSION PROJECT

MAP 10 of 13
Cation Exchange Capacity (CEC)

GLOUCESTER BASIN



LEGEND

- Mining Lease Boundary
- Mining Lease Application Boundary
- Project Soil Pit
- > 3.0 dS/m
- 1.5 - 3.0 dS/m
- < 1.5 dS/m

0 1000 2000 3000 4000

Metres

GRID DATUM MGA 94 ZONE 56

Source: SCPL (2012); DFS-LPI (2012) and DPI C&L [CLD] (2012)
Orthophoto - Gloucester Coal Ltd (flown July 2011)

STRATFORD EXTENSION PROJECT

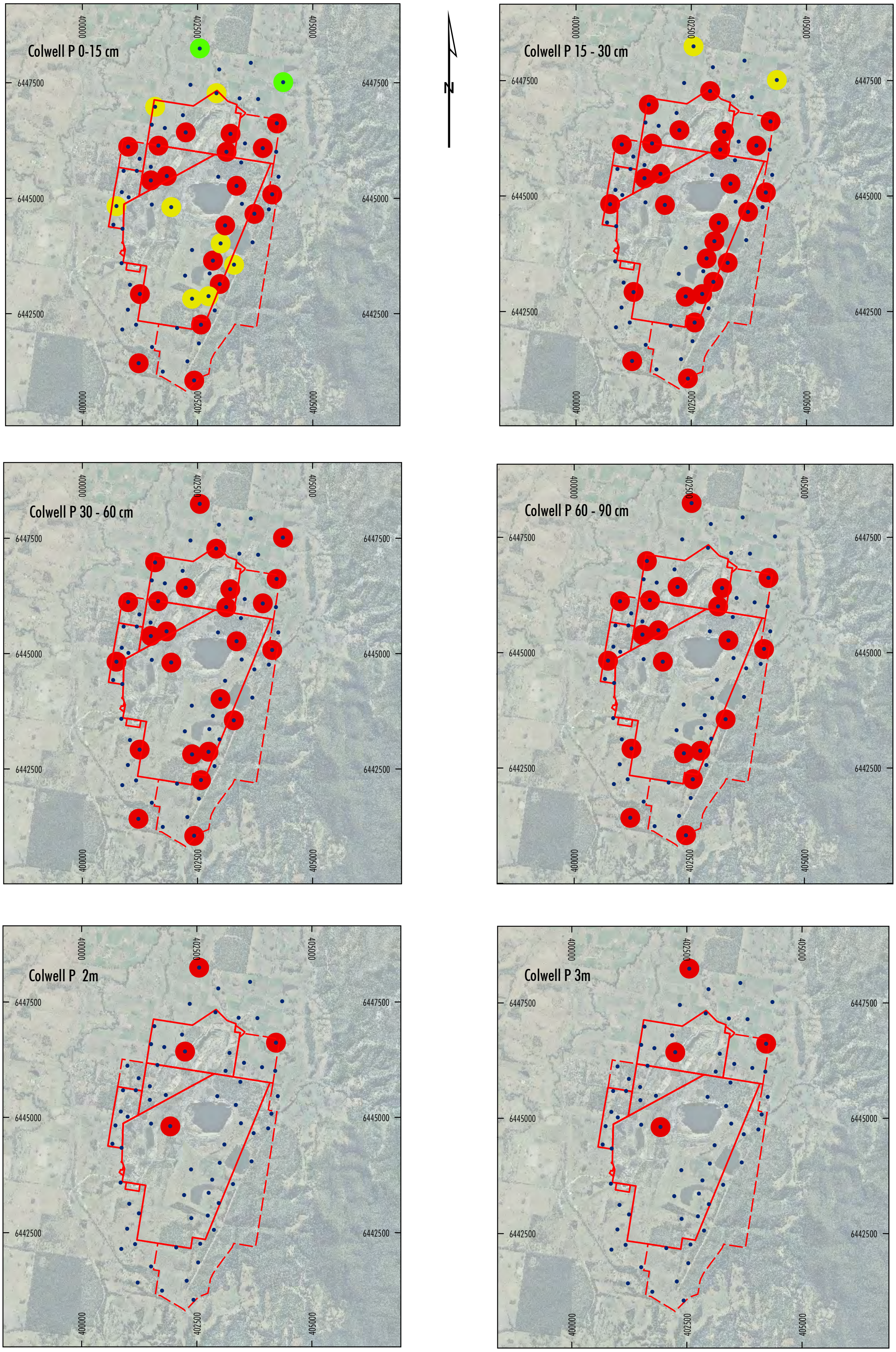
MAP 11 of 13

Salinity (ECe)

GLOUCESTER BASIN

SOILmgt

GCL-10-12 EIS AppAIS ARA_211B



LEGEND

Mining Lease Boundary

Mining Lease Application Boundary

Project Soil Pit

< 10 mg/kg

10 - 30 mg/kg

> 30 mg/kg

0 1000 2000 3000 4000

Metres

GRID DATUM MGA 94 ZONE 56

Source: SCPL (2012); DFS-LPI (2012) and DPI C&L [CLD] (2012)

Orthophoto - Gloucester Coal Ltd (flown July 2011)

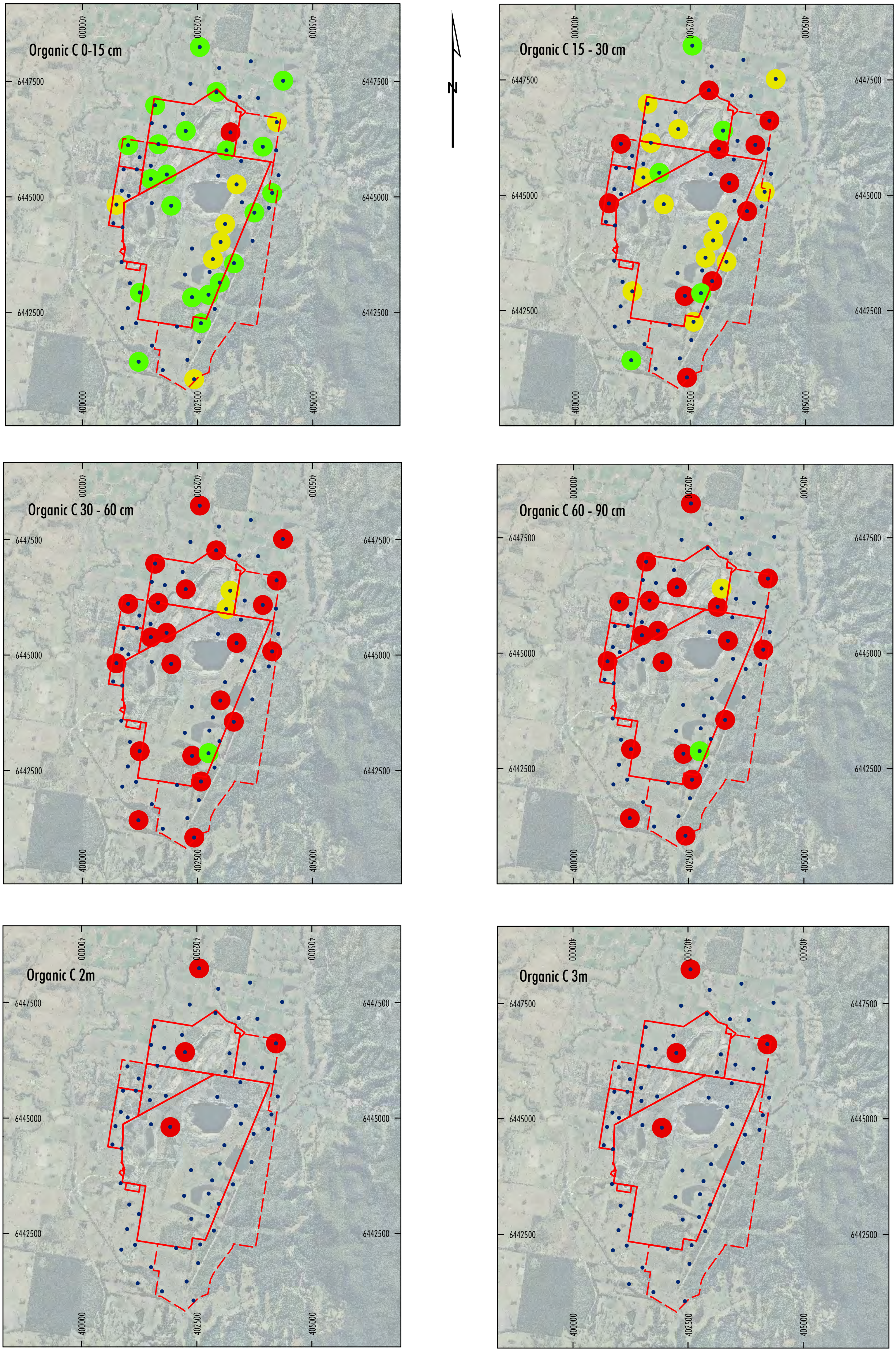
STRATFORD EXTENSION PROJECT

MAP 12 of 13

Phosphorus (Colwell P)

GLOUCESTER BASIN

SOILmgt



LEGEND

- Mining Lease Boundary
- Mining Lease Application Boundary
- Project Soil Pit

- < 0.8 %
- 0.8 - 1.5 %
- > 1.5 %

0 1000 2000 3000 4000

Metres

GRID DATUM MGA 94 ZONE 56

Source: SCPL (2012); DFS-LPI (2012) and DPI C&L [CLD] (2012)

Orthophoto - Gloucester Coal Ltd (flown July 2011)

STRATFORD EXTENSION PROJECT

MAP 13 of 13

Organic Carbon

GLOUCESTER BASIN

SOILmgt

GCL-10-12 EIS AppAIS ARA_213B

Appendix 1 Pre-existing Soil Information

1.1 SPADE Data

Henderson Profile 241

NSW SOIL AND LAND INFORMATION SYSTEM

Soil Profile Report

Site Location:	WENHAMS COX ROAD
Profile Details:	Soil Landscapes of the Dungog 1:100 000 Sheet Survey, Profile 241 , collected from a batter by Linda Henderson on February 23, 1996
Map Reference:	MGA Grid Reference ; Easting 400505, Northing 6447289 DUNGOG (9233) 1:100,000 sheet
Physiography:	flat on plain under unknown on not identified lithology ; Slope 1 % (estimated) , elevation 118 m , local relief extremely low (< 9m) , run-on is none , run-off is none
Vegetation/Land Use:	unknown , with occasional cultivation at the site , used for timber/scrub/unused , improved pasture in the general area
Surface Condition:	expected to be hardsetting when dry ground cover is 100%
Erosion/Land Degradation:	slight ; sheet erosion at the site is minor , stable
Soil Hydrology:	profile is slowly permeable profile is imperfectly drained
Soil Type:	Bleached-Mottled,Humose-Mottled Mesotrophic Yellow Chromosol (ASC) , Soloth (Solod) (GSG) , Dy3.32 (PPF)

Soil Description:

Layer 0

Layer 1 0 - .05 m A1 Horizon	Texture:	silty loam
	Colour:	dark brown 10YR 3/3 with mottles
	Structure:	(, 2 - 5 mm, fabric is rough-faced peds).
	Coarse Fragments:	
	Pans:	
	Segregations:	
	Roots:	common (10-25/10x10cm) (Root size <1 mm), few (1-10/10x10cm) (Root size 1-2 mm).
	Soil fauna:	Activity is
	Cracks/Macropores:	Cracks are Macropores are

	Moisture/Consistence:	dry, disruptive test result was moderately weak force, shearing test result was crumbly,
	Erodibility Tests:	Crumb (EAT) test showed no change,
	Field chemical tests:	Field pH is 6 (Raupach) ,
	Sample taken:	
	Layer Notes:	
	Lower Boundary:	boundary to...
Layer 2 .05 - .3 m A2 sporadically bleached Horizon	Texture:	light sandy clay loam
	Colour:	dark yellowish brown (brown) 10YR 4/4 with mottles
	Structure:	(fabric is earthy),
	Coarse Fragments:	
	Pans:	
	Segregations:	
	Roots:	common (10-25/10x10cm) (Root size <1 mm), few (1-10/10x10cm) (Root size 1-2 mm),
	Soil fauna:	Activity is
	Cracks/Macropores:	Cracks are evident width 5-10 mm, Macropores are
	Moisture/Consistence:	dry, disruptive test result was moderately weak force, shearing test result was crumbly,
	Erodibility Tests:	Crumb (EAT) test showed no change,
	Field chemical tests:	Field pH is 6.5 (Raupach) ,
	Sample taken:	
	Layer Notes:	
	Lower Boundary:	boundary to...
Layer 3 .3 - 1.2 m B Horizon	Texture:	silty clay
	Colour:	light yellowish brown (dull yellow orange) 10YR 6/4 with 20% - 50% distinct unspecified orange mottles , and 2% - 10% faint unspecified grey
	Structure:	(, 10 - 20 mm, fabric is smooth-faced peds),
	Coarse Fragments:	
	Pans:	
	Segregations:	
	Roots:	common (10-25/10x10cm) (Root size <1 mm), few (1-10/10x10cm) (Root size 1-2 mm),

Soil fauna:	Activity is
Cracks/Macropores:	Cracks are evident width 5-10 mm, Macropores are few (<1/10 x 10mm) (width <1 mm), few (<1/10 x 10mm) (width 1-2 mm),
Moisture/Consistence:	dry, slightly sticky, disruptive test result was moderately strong force, shearing test result was no change,
Erodibility Tests:	Crumb (EAT) test showed aggregates disperse,
Field chemical tests:	Field pH is 6.5 (Raupach) ,
Sample taken:	
Layer Notes:	
Lower Boundary:	boundary to...

LABORATORY TESTS:

Sample No:	393
Depth:	00.00 - 00.05 m
Test Results	
N504.99 [Oven-dry moisture content]	1.3
N518.99 [Volume expansion]	5
N517.99_CL [PSA clay - SDS]	10
N517.99_SI [PSA silt - SDS]	15
N517.99_FS [PSA fine sand - SDS]	47
N517.99_CS [PSA coarse sand - SDS]	28
N517.99_GR [PSA gravel - SDS]	0
N514.99 [Dispersion percentage]	20
N513.98 [Emerson aggregate test SCS method]	2(1)
N550.01 [USCS - lab]	SM-ML
N504.02_FC [Field Capacity, SWC pressure plate]	24.9
N504.02_PWP [Permanent Wilt Point, SWC pressure plate]	6.4
N515.99 [Wind erodible aggregate percentage]	58
N505.99 [Water repellence field method]	1
N3A1 [EC of 1:5 soil/water extract]	0.08
N4A1 [pH of 1:5 soil/water suspension]	5.9
N4B1 [pH of 1:5 soil/0.01M CaCl2 extract - direct, no stir]	5.1
N15F1_CEC [CEC by 0.01M silver-thiourea (AgTU)+, no pret.]	8.4
N15F1_CA [Exchangeable Ca - 0.01M (AgTU)+, no pretreatment]	3.9
N15F1_MG [Exchangeable Mg - 0.01M (AgTU)+, no pretreatment]	1.8
N15F1_NA [Exchangeable Na - 0.01M (AgTU)+, no pretreatment]	0.3
N15F1_K [Exchangeable K - 0.01M (AgTU)+, no pretreatment]	1.4
N15F1_AL [Exch. bases (Al+), 0.01M (AgTU)+, no pretreat.]	0.1
N6A1 [Organic carbon - Walkley & Black]	1.60
N9E1 [Fluoride-extractable P (Bray 1-P) - manual colour]	15
N9I1 [Phosphate sorption index]	184

Sample No:	394
Depth:	00.05 - 00.30 m
Test Results	
N504.99 [Oven-dry moisture content]	1.2

N518.99 [Volume expansion]	4
N517.99_CL [PSA clay - SDS]	16
N517.99_SI [PSA silt - SDS]	21
N517.99_FS [PSA fine sand - SDS]	46
N517.99_CS [PSA coarse sand - SDS]	17
N517.99_GR [PSA gravel - SDS]	0
N514.99 [Dispersion percentage]	33
N513.98 [Emerson aggregate test SCS method]	3(1)
N550.01 [USCS - lab]	ML
N504.02_FC [Field Capacity, SWC pressure plate]	25.2
N504.02_PWP [Permanent Wilt Point, SWC pressure plate]	7.6
N515.99 [Wind erodible aggregate percentage]	77
N505.99 [Water repellence field method]	1
N3A1 [EC of 1:5 soil/water extract]	0.03
N4A1 [pH of 1:5 soil/water suspension]	5.7
N4B1 [pH of 1:5 soil/0.01M CaCl2 extract - direct, no stir]	5.0
N15F1_CEC [CEC by 0.01M silver-thiourea (AgTU)+, no pret.]	7.5
N15F1_CA [Exchangeable Ca - 0.01M (AgTU)+, no pretreatment]	3.8
N15F1_MG [Exchangeable Mg - 0.01M (AgTU)+, no pretreatment]	2.1
N15F1_NA [Exchangeable Na - 0.01M (AgTU)+, no pretreatment]	0.4
N15F1_K [Exchangeable K - 0.01M (AgTU)+, no pretreatment]	0.7
N15F1_AL [Exch. bases (Al+), 0.01M (AgTU)+, no pretreat.]	0.1
N6A1 [Organic carbon - Walkley & Black]	0.71
N9E1 [Fluoride-extractable P (Bray 1-P) - manual colour]	2
N9I1 [Phosphate sorption index]	228

Sample No: 395
Depth: 00.30 - 01.20 m
Test Results

N504.99 [Oven-dry moisture content]	2.8
N518.99 [Volume expansion]	9
N517.99_CL [PSA clay - SDS]	40
N517.99_SI [PSA silt - SDS]	23
N517.99_FS [PSA fine sand - SDS]	33
N517.99_CS [PSA coarse sand - SDS]	4
N517.99_GR [PSA gravel - SDS]	0
N514.99 [Dispersion percentage]	26
N513.98 [Emerson aggregate test SCS method]	8
N550.01 [USCS - lab]	CL
N504.02_FC [Field Capacity, SWC pressure plate]	33.1
N504.02_PWP [Permanent Wilt Point, SWC pressure plate]	14.5
N515.99 [Wind erodible aggregate percentage]	94
N505.99 [Water repellence field method]	0
N3A1 [EC of 1:5 soil/water extract]	0.03
N4A1 [pH of 1:5 soil/water suspension]	5.6
N4B1 [pH of 1:5 soil/0.01M CaCl2 extract - direct, no stir]	4.6
N15F1_CEC [CEC by 0.01M silver-thiourea (AgTU)+, no pret.]	13.9
N15F1_CA [Exchangeable Ca - 0.01M (AgTU)+, no pretreatment]	4.5
N15F1_MG [Exchangeable Mg - 0.01M (AgTU)+, no pretreatment]	5.2
N15F1_NA [Exchangeable Na - 0.01M (AgTU)+, no pretreatment]	0.7
N15F1_K [Exchangeable K - 0.01M (AgTU)+, no pretreatment]	0.3
N15F1_AL [Exch. bases (Al+), 0.01M (AgTU)+, no pretreat.]	0.5
N6A1 [Organic carbon - Walkley & Black]	0.36
N9E1 [Fluoride-extractable P (Bray 1-P) - manual colour]	nd
N9I1 [Phosphate sorption index]	455

Henderson Profile 242

NSW SOIL AND LAND INFORMATION SYSTEM

Soil Profile Report

Site Location:	WENHAMS COX ROAD
Profile Details:	Soil Landscapes of the Dungog 1:100 000 Sheet Survey, Profile 242 , collected from a batter by Linda Henderson on February 23, 1996
Map Reference:	MGA Grid Reference ; Easting 402205, Northing 6447089 DUNGOG (9233) 1:100,000 sheet
Physiography:	simple slope on hillslope under woodland grass u'storey on not identified lithology ; Slope 5 % (estimated) , elevation 120 m , local relief low (30-90 m) , aspect north west , run-on is moderate , run-off is moderate
Vegetation/Land Use:	woodland grass u'storey , with occasional cultivation at the site , used for improved pasture , improved pasture in the general area
Surface Condition:	expected to be hardsetting when dry ground cover is 100%
Erosion/Land Degradation:	moderate , erosion at site is none
Soil Hydrology:	profile is imperfectly drained
Soil Type:	Bleached-Mottled Natric Brown Kurosol (ASC) , Soloth (Solod) (GSG) , Dy3.41 (PPF)

Soil Description:

Layer 1 0 - .1 m A1 Horizon	Texture:	silty clay loam
	Colour:	dark yellowish brown (dark brown) 10YR 3/4 with mottles
	Structure:	(fabric is earthy),
	Coarse Fragments:	
	Pans:	
	Segregations:	
	Roots:	common (10-25/10x10cm) (Root size <1 mm).
	Soil fauna:	Activity is
	Cracks/Macropores:	Cracks are Macropores are
	Moisture/Consistence:	dry, slightly sticky, disruptive test result was moderately firm force, shearing test result was crumbly.

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	Erodibility Tests:	Crumb (EAT) test showed no change,
	Field chemical tests:	Field pH is 5.5 (Raupach) ,
	Sample taken:	
	Layer Notes:	
	Lower Boundary:	boundary to
Layer 2 .1 - .3 m A2 conspicuously bleached Horizon	Texture:	silty clay loam
	Colour:	dark yellowish brown (brown) 10YR 4/4 with 10% - 20% distinct unspecified orange mottles
	Structure:	(fabric is earthy),
	Coarse Fragments:	
	Pans:	
	Segregations:	
	Roots:	common (10-25/10x10cm) (Root size <1 mm),
	Soil fauna:	Activity is
	Cracks/Macropores:	Cracks are Macropores are few (<1/10 x 10mm) (width <1 mm), none (width 1-2 mm),
	Moisture/Consistence:	dry, slightly sticky, disruptive test result was very firm force, shearing test result was brittle,
	Erodibility Tests:	Crumb (EAT) test showed no change,
	Field chemical tests:	Field pH is 5.5 (Raupach) ,
	Sample taken:	
	Layer Notes:	
	Lower Boundary:	boundary to ,
Layer 3 .3 - .6 m B Horizon	Texture:	light medium clay
	Colour:	yellowish brown 10YR 5/6 with 10% - 20% distinct unspecified orange mottles , and 2% - 10% faint unspecified grey
	Structure:	(, 20 - 50 mm, also columnar 50 - 100 mm fabric is smooth-faced peds), ped coatings are common (10-50%),
	Coarse Fragments:	
	Pans:	
	Segregations:	
	Roots:	common (10-25/10x10cm) (Root size <1 mm),

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Soil fauna:	Activity is
Cracks/Macropores:	Cracks are none width <5 mm. Macropores are none (width <1 mm), none (width 1-2 mm).
Moisture/Consistence:	dry, slightly sticky, disruptive test result was moderately strong force, shearing test result was no change.
Erodibility Tests:	Crumb (EAT) test showed aggregates disperse.
Field chemical tests:	Field pH is 5 (Raupach) .
Sample taken:	
Layer Notes:	Surface peds fret to <10 mm aggregates
Lower Boundary:	boundary to...

LABORATORY TESTS:

Sample No: 173
Depth: 00.00 - 00.10 m
Test Results

N504.99 [Oven-dry moisture content]	2.8
N518.99 [Volume expansion]	7
N517.99_CL [PSA clay - SDS]	19
N517.99_SI [PSA silt - SDS]	19
N517.99_FS [PSA fine sand - SDS]	48
N517.99_CS [PSA coarse sand - SDS]	11
N517.99_GR [PSA gravel - SDS]	3
N514.99 [Dispersion percentage]	25
N513.98 [Emerson aggregate test SCS method]	8
N550.01 [USCS - lab]	ML
N504.02_FC [Field Capacity, SWC pressure plate]	35.0
N504.02_PWP [Permanent Wilt Point, SWC pressure plate]	13.8
N515.99 [Wind erodible aggregate percentage]	74
N505.99 [Water repellence field method]	1
N3A1 [EC of 1:5 soil/water extract]	0.06
N4A1 [pH of 1:5 soil/water suspension]	5.0
N4B1 [pH of 1:5 soil/0.01M CaCl2 extract - direct, no stir]	4.5
N15F1_CEC [CEC by 0.01M silver-thiourea (AgTU)+, no pret.]	14.9
N15F1_CA [Exchangeable Ca - 0.01M (AgTU)+, no pretreatment]	3.5
N15F1_MG [Exchangeable Mg - 0.01M (AgTU)+, no pretreatment]	5.7
N15F1_NA [Exchangeable Na - 0.01M (AgTU)+, no pretreatment]	0.4
N15F1_K [Exchangeable K - 0.01M (AgTU)+, no pretreatment]	1.3
N15F1_AL [Exch. bases (Al+), 0.01M (AgTU)+, no pretreat.]	0.8
N6A1 [Organic carbon - Walkley & Black]	2.45
N9E1 [Fluoride-extractable P (Bray 1-P) - manual colour]	5
N9I1 [Phosphate sorption index]	362

Sample No: 174
Depth: 00.10 - 00.30 m
Test Results

N504.99 [Oven-dry moisture content]	2.3
N518.99 [Volume expansion]	3

N517.99_CL [PSA clay - SDS]	21
N517.99_SI [PSA silt - SDS]	20
N517.99_FS [PSA fine sand - SDS]	45
N517.99_CS [PSA coarse sand - SDS]	14
N517.99_GR [PSA gravel - SDS]	0
N514.99 [Dispersion percentage]	31
N513.98 [Emerson aggregate test SCS method]	8
N550.01 [USCS - lab]	ML
N504.02_FC [Field Capacity, SWC pressure plate]	30.0
N504.02_PWP [Permanent Wilt Point, SWC pressure plate]	11.3
N515.99 [Wind erodible aggregate percentage]	71
N505.99 [Water repellence field method]	0
N3A1 [EC of 1:5 soil/water extract]	0.04
N4A1 [pH of 1:5 soil/water suspension]	5.1
N4B1 [pH of 1:5 soil/0.01M CaCl2 extract - direct, no stir]	4.3
N15F1_CEC [CEC by 0.01M silver-thiourea (AgTU)+, no pret.]	7.6
N15F1_CA [Exchangeable Ca - 0.01M (AgTU)+, no pretreatment]	1.1
N15F1_MG [Exchangeable Mg - 0.01M (AgTU)+, no pretreatment]	3.2
N15F1_NA [Exchangeable Na - 0.01M (AgTU)+, no pretreatment]	0.4
N15F1_K [Exchangeable K - 0.01M (AgTU)+, no pretreatment]	0.6
N15F1_AL [Exch. bases (Al+), 0.01M (AgTU)+, no pretreat.]	1.9
N6A1 [Organic carbon - Walkley & Black]	1.23
N9E1 [Fluoride-extractable P (Bray 1-P) - manual colour]	2
N9I1 [Phosphate sorption index]	551

Sample No: 175
Depth: 00.30 - 00.60 m
Test Results

N504.99 [Oven-dry moisture content]	5.0
N518.99 [Volume expansion]	11
N517.99_CL [PSA clay - SDS]	40
N517.99_SI [PSA silt - SDS]	10
N517.99_FS [PSA fine sand - SDS]	9
N517.99_CS [PSA coarse sand - SDS]	3
N517.99_GR [PSA gravel - SDS]	38
N514.99 [Dispersion percentage]	48
N513.98 [Emerson aggregate test SCS method]	2(1)
N550.01 [USCS - lab]	CL
N504.02_FC [Field Capacity, SWC pressure plate]	42.8
N504.02_PWP [Permanent Wilt Point, SWC pressure plate]	20.9
N515.99 [Wind erodible aggregate percentage]	98
N505.99 [Water repellence field method]	0
N3A1 [EC of 1:5 soil/water extract]	0.04
N4A1 [pH of 1:5 soil/water suspension]	5.3
N4B1 [pH of 1:5 soil/0.01M CaCl2 extract - direct, no stir]	4.3
N15F1_CEC [CEC by 0.01M silver-thiourea (AgTU)+, no pret.]	24.9
N15F1_CA [Exchangeable Ca - 0.01M (AgTU)+, no pretreatment]	2.2
N15F1_MG [Exchangeable Mg - 0.01M (AgTU)+, no pretreatment]	9.3
N15F1_NA [Exchangeable Na - 0.01M (AgTU)+, no pretreatment]	1.1
N15F1_K [Exchangeable K - 0.01M (AgTU)+, no pretreatment]	0.8
N15F1_AL [Exch. bases (Al+), 0.01M (AgTU)+, no pretreat.]	6.2
N6A1 [Organic carbon - Walkley & Black]	0.73
N9E1 [Fluoride-extractable P (Bray 1-P) - manual colour]	3
N9I1 [Phosphate sorption index]	686

For information on laboratory test data and units of measure, please see the SPADE Help page

Henderson Profile 259

NSW SOIL AND LAND INFORMATION SYSTEM

Soil Profile Report

Site Location:	Unknown
Profile Details:	Soil Landscapes of the Dungog 1:100 000 Sheet Survey. Profile 259 , collected from a batter by Linda Henderson on March 13, 1996
Map Reference:	MGA Grid Reference ; Easting 402005, Northing 6440989 DUNGOG (9233) 1:100,000 sheet
Physiography:	lower slope on footslope under dry sclerophyll forest on not identified lithology with nil rock outcrop ; Slope 2 % (estimated) , elevation 160 m , local relief very low (9-30 m) , aspect north west , run-on is low , run-off is low
Vegetation/Land Use:	dry sclerophyll forest , with limited clearing at the site
Surface Condition:	expected to be hardsetting when dry ground cover is 100%
Erosion/Land Degradation:	moderate , sheet erosion at the site is minor , stable
Soil Hydrology:	profile is slowly permeable profile is imperfectly drained
Soil Type:	Bleached Natric Brown Kurosol (ASC) , Brown Podzolic Soil (GSG) , Db1.21 (PPF)

Soil Description:

Layer 1 0 - .05 m A1 Horizon	Texture:	loam
	Colour:	(brownish black) 10YR 2/3 with mottles
	Structure:	
	Coarse Fragments:	
	Pans:	
	Segregations:	
	Roots:	common (10-25/10x10cm) (Root size <1 mm),
	Soil fauna:	Activity is
	Cracks/Macropores:	Cracks are Macropores are
	Moisture/Consistence:	dry, disruptive test result was moderately weak force, shearing test result was crumbly,

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	Erodibility Tests:	
	Field chemical tests:	Field pH is 6 (Raupach)
	Sample taken:	
	Layer Notes:	
	Lower Boundary:	boundary to..
Layer 2 .05 - .25 m A2 Horizon	Texture:	sandy clay loam
	Colour:	dark yellowish brown (dark brown) 10YR 3/4 with mottles
	Structure:	
	Coarse Fragments:	
	Pans:	
	Segregations:	
	Roots:	few (1-10/10x10cm) (Root size <1 mm),
	Soil fauna:	Activity is
	Cracks/Macropores:	Cracks are Macropores are
	Moisture/Consistence:	dry, disruptive test result was moderately firm force, shearing test result was brittle,
	Erodibility Tests:	
	Field chemical tests:	Field pH is 5 (Raupach) ,
	Sample taken:	
	Layer Notes:	
	Lower Boundary:	boundary to..
Layer 3 .25 - .6 m B Horizon	Texture:	light medium clay
	Colour:	dark yellowish brown (brown) 10YR 4/4 with mottles
	Structure:	(, 20 - 50 mm, fabric is smooth-faced peds),
	Coarse Fragments:	
	Pans:	
	Segregations:	
	Roots:	few (1-10/10x10cm) (Root size <1 mm),
	Soil fauna:	Activity is
	Cracks/Macropores:	Cracks are Macropores are
	Moisture/Consistence:	dry, disruptive test result was moderately strong force, shearing test result was no change,

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Erodibility Tests:

Field chemical tests: Field pH is 4.5 (Raupach)

Sample taken:

Layer Notes:

Lower Boundary: boundary to...

LABORATORY TESTS:

Sample No: 182
Depth: 00.00 - 00.05 m
Test Results

N504.99 [Oven-dry moisture content]	3.2
N518.99 [Volume expansion]	2
N517.99_CL [PSA clay - SDS]	16
N517.99_SI [PSA silt - SDS]	25
N517.99_FS [PSA fine sand - SDS]	50
N517.99_CS [PSA coarse sand - SDS]	8
N517.99_GR [PSA gravel - SDS]	1
N514.99 [Dispersion percentage]	33
N513.98 [Emerson aggregate test SCS method]	8
N550.01 [USCS - lab]	OL
N504.02_FC [Field Capacity, SWC pressure plate]	34.8
N504.02_PWP [Permanent Wilt Point, SWC pressure plate]	12.4
N515.99 [Wind erodible aggregate percentage]	64
N505.99 [Water repellence field method]	6
N3A1 [EC of 1:5 soil/water extract]	0.07
N4A1 [pH of 1:5 soil/water suspension]	5.6
N4B1 [pH of 1:5 soil/0.01M CaCl2 extract - direct, no stir]	5.0
N15F1_CEC [CEC by 0.01M silver-thiourea (AgTU)+, no pret.]	16.3
N15F1_CA [Exchangeable Ca - 0.01M (AgTU)+, no pretreatment]	7.2
N15F1_MG [Exchangeable Mg - 0.01M (AgTU)+, no pretreatment]	5.2
N15F1_NA [Exchangeable Na - 0.01M (AgTU)+, no pretreatment]	0.6
N15F1_K [Exchangeable K - 0.01M (AgTU)+, no pretreatment]	1.0
N15F1_AL [Exch. bases (Al+), 0.01M (AgTU)+, no pretreat.]	0.4
N6A1 [Organic carbon - Walkley & Black]	4.09
N9E1 [Fluoride-extractable P (Bray 1-P) - manual colour]	5
N9I1 [Phosphate sorption index]	469

Sample No: 183
Depth: 00.05 - 00.25 m
Test Results

N504.99 [Oven-dry moisture content]	1.9
N518.99 [Volume expansion]	1
N517.99_CL [PSA clay - SDS]	12
N517.99_SI [PSA silt - SDS]	12
N517.99_FS [PSA fine sand - SDS]	41
N517.99_CS [PSA coarse sand - SDS]	25
N517.99_GR [PSA gravel - SDS]	10
N514.99 [Dispersion percentage]	38
N513.98 [Emerson aggregate test SCS method]	8

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N550.01 [USCS - lab]	SM
N504.02_FC [Field Capacity, SWC pressure plate]	fs
N504.02_PWP [Permanent Wilt Point, SWC pressure plate]	fs
N515.99 [Wind erodible aggregate percentage]	54
N505.99 [Water repellence field method]	25
N3A1 [EC of 1:5 soil/water extract]	0.09
N4A1 [pH of 1:5 soil/water suspension]	5.0
N4B1 [pH of 1:5 soil/0.01M CaCl2 extract - direct, no stir]	4.2
N15F1_CEC [CEC by 0.01M silver-thiourea (AgTU)+, no pret.]	10.9
N15F1_CA [Exchangeable Ca - 0.01M (AgTU)+, no pretreatment]	2.0
N15F1_MG [Exchangeable Mg - 0.01M (AgTU)+, no pretreatment]	3.5
N15F1_NA [Exchangeable Na - 0.01M (AgTU)+, no pretreatment]	0.7
N15F1_K [Exchangeable K - 0.01M (AgTU)+, no pretreatment]	0.8
N15F1_AL [Exch. bases (Al+), 0.01M (AgTU)+, no pretreat.]	1.3
N6A1 [Organic carbon - Walkley & Black]	1.29
N9E1 [Fluoride-extractable P (Bray 1-P) - manual colour]	4
N9I1 [Phosphate sorption index]	362

Sample No: 184
Depth: 00.25 - 00.60 m
Test Results

N504.99 [Oven-dry moisture content]	3.5
N516.99 [Volume expansion]	6
N517.99_CL [PSA clay - SDS]	43
N517.99_SI [PSA silt - SDS]	20
N517.99_FS [PSA fine sand - SDS]	25
N517.99_CS [PSA coarse sand - SDS]	7
N517.99_GR [PSA gravel - SDS]	5
N514.99 [Dispersion percentage]	33
N513.98 [Emerson aggregate test SCS method]	5
N550.01 [USCS - lab]	CL
N504.02_FC [Field Capacity, SWC pressure plate]	35.6
N504.02_PWP [Permanent Wilt Point, SWC pressure plate]	17.7
N515.99 [Wind erodible aggregate percentage]	96
N505.99 [Water repellence field method]	0
N3A1 [EC of 1:5 soil/water extract]	0.26
N4A1 [pH of 1:5 soil/water suspension]	4.4
N4B1 [pH of 1:5 soil/0.01M CaCl2 extract - direct, no stir]	3.8
N15F1_CEC [CEC by 0.01M silver-thiourea (AgTU)+, no pret.]	19.6
N15F1_CA [Exchangeable Ca - 0.01M (AgTU)+, no pretreatment]	0.4
N15F1_MG [Exchangeable Mg - 0.01M (AgTU)+, no pretreatment]	1.8
N15F1_NA [Exchangeable Na - 0.01M (AgTU)+, no pretreatment]	1.2
N15F1_K [Exchangeable K - 0.01M (AgTU)+, no pretreatment]	0.5
N15F1_AL [Exch. bases (Al+), 0.01M (AgTU)+, no pretreat.]	12.1
N6A1 [Organic carbon - Walkley & Black]	0.68
N9E1 [Fluoride-extractable P (Bray 1-P) - manual colour]	3
N9I1 [Phosphate sorption index]	748

For information on laboratory test data and units of measure, please see the SPADE Help page

SALIS Soil Profile Report   To contact us email: soils@dnr.nsw.gov.au   Thu Dec 01 11:34:43 EST 2011

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Henderson Profile 301

NSW SOIL AND LAND INFORMATION SYSTEM

Soil Profile Report

Site Location:	Unknown
Profile Details:	Soil Landscapes of the Dungog 1:100 000 Sheet Survey, Profile 301 , collected from a batter by Linda Henderson on March 29, 1996
Map Reference:	MGA Grid Reference ; Easting 404405, Northing 6445189 DUNGOG (9233) 1:100,000 sheet
Physiography:	mid-slope on hillslope under woodland grass u'storey on conglomerate lithology with nil rock outcrop ; Slope 10 % (estimated) , elevation 160 m , local relief low (30-90 m) , aspect north east , run-on is moderate , run-off is moderate
Vegetation/Land Use:	woodland grass u'storey , with extensive clearing at the site , used for volun./native pasture , volun./native pasture in the general area
Surface Condition:	ground cover is 80%
Erosion/Land Degradation:	high ; sheet erosion at the site is minor , partly stabilised ; gully erosion at the site is minor , partly stabilised gully 1.5-3.0 m depth
Soil Hydrology:	profile is moderately permeable profile is well drained
Soil Type:	Humose-Acidic Lithic Bleached-Leptic Tenosol (ASC) , Lithosol (GSG) , Um2.12 (PPF)
Profile Field Notes:	Occasionally small pockets of subsoil occur.

Soil Description:

Layer 1 0 - .2 m A1 Horizon	Texture:	sandy loam
	Colour:	very dark grey (brownish black) 7.5YR 3/1 with mottles
	Structure:	(, fabric is rough-faced peds),
	Coarse Fragments:	common (10-20%), as parent material, sub-rounded,sub-angular, fine gravel (2-6 mm),gravel (6-20 mm),
	Pans:	
	Segregations:	
	Roots:	common (10-25/10x10cm) (Root size <1 mm),
	Soil fauna:	Activity is
	Cracks/Macropores:	Cracks are Macropores are

	Moisture/Consistence:	dry, disruptive test result was very weak force, shearing test result was crumbly,
	Erodibility Tests:	
	Field chemical tests:	Field pH is 5.5 (Raupach) ,
	Sample taken:	
	Layer Notes:	
	Lower Boundary:	boundary to...
Layer 2 .2 - .6 m A2 conspicuously bleached Horizon	Texture:	sandy clay loam
	Colour:	grey (brownish grey) 7.5YR 5/1 with mottles
	Structure:	(fabric is earthy),
	Coarse Fragments:	many (20-50%), as parent material, sub-rounded,sub-angular, fine gravel (2-6 mm),gravel (6-20 mm),
	Pans:	
	Segregations:	
	Roots:	few (1-10/10x10cm) (Root size <1 mm),
	Soil fauna:	Activity is
	Cracks/Macropores:	Cracks are Macropores are
	Moisture/Consistence:	dry, disruptive test result was very weak force, shearing test result was brittle,
	Erodibility Tests:	
	Field chemical tests:	Field pH is 5.5 (Raupach) ,
	Sample taken:	
	Layer Notes:	
	Lower Boundary:	boundary to...

LABORATORY TESTS:

Sample No:	194
Depth:	00.00 - 00.20 m
Test Results	
N504.99 [Oven-dry moisture content]	2.4
N518.99 [Volume expansion]	3
N517.99_CL [PSA clay - SDS]	9
N517.99_SI [PSA silt - SDS]	17
N517.99_FS [PSA fine sand - SDS]	36
N517.99_CS [PSA coarse sand - SDS]	31
N517.99_GR [PSA gravel - SDS]	7

N514.99 [Dispersion percentage]	22
N513.98 [Emerson aggregate test SCS method]	8
N550.01 [USCS - lab]	SM
N504.02_FC [Field Capacity, SWC pressure plate]	32.7
N504.02_PWP [Permanent Wilt Point, SWC pressure plate]	9.8
N515.99 [Wind erodible aggregate percentage]	55
N505.99 [Water repellence field method]	7
N3A1 [EC of 1:5 soil/water extract]	0.08
N4A1 [pH of 1:5 soil/water suspension]	5.5
N4B1 [pH of 1:5 soil/0.01M CaCl2 extract - direct, no stir]	4.9
N15F1_CEC [CEC by 0.01M silver-thiourea (AgTU)+, no pret.]	13.0
N15F1_CA [Exchangeable Ca - 0.01M (AgTU)+, no pretreatment]	6.2
N15F1_MG [Exchangeable Mg - 0.01M (AgTU)+, no pretreatment]	4.0
N15F1_NA [Exchangeable Na - 0.01M (AgTU)+, no pretreatment]	0.5
N15F1_K [Exchangeable K - 0.01M (AgTU)+, no pretreatment]	1.4
N15F1_AL [Exch. bases (Al+), 0.01M (AgTU)+, no pretreat.]	0.2
N6A1 [Organic carbon - Walkley & Black]	3.53
N9E1 [Fluoride-extractable P (Bray 1-P) - manual colour]	9
N9I1 [Phosphate sorption index]	236

Sample No: 195
Depth: 00.20 - 00.60 m
Test Results

N504.99 [Oven-dry moisture content]	1.3
N518.99 [Volume expansion]	sh
N518.01 [Linear shrinkage]	2.5
N517.99_CL [PSA clay - SDS]	8
N517.99_SI [PSA silt - SDS]	20
N517.99_FS [PSA fine sand - SDS]	21
N517.99_CS [PSA coarse sand - SDS]	30
N517.99_GR [PSA gravel - SDS]	21
N514.99 [Dispersion percentage]	58
N513.98 [Emerson aggregate test SCS method]	8
N550.01 [USCS - lab]	SM
N504.02_FC [Field Capacity, SWC pressure plate]	18.8
N504.02_PWP [Permanent Wilt Point, SWC pressure plate]	5.5
N515.99 [Wind erodible aggregate percentage]	66
N505.99 [Water repellence field method]	2
N3A1 [EC of 1:5 soil/water extract]	0.04
N4A1 [pH of 1:5 soil/water suspension]	5.0
N4B1 [pH of 1:5 soil/0.01M CaCl2 extract - direct, no stir]	4.2
N15F1_CEC [CEC by 0.01M silver-thiourea (AgTU)+, no pret.]	6.4
N15F1_CA [Exchangeable Ca - 0.01M (AgTU)+, no pretreatment]	1.3
N15F1_MG [Exchangeable Mg - 0.01M (AgTU)+, no pretreatment]	1.9
N15F1_NA [Exchangeable Na - 0.01M (AgTU)+, no pretreatment]	0.4
N15F1_K [Exchangeable K - 0.01M (AgTU)+, no pretreatment]	0.8
N15F1_AL [Exch. bases (Al+), 0.01M (AgTU)+, no pretreat.]	1.3
N6A1 [Organic carbon - Walkley & Black]	0.75
N9E1 [Fluoride-extractable P (Bray 1-P) - manual colour]	5
N9I1 [Phosphate sorption index]	339

For information on laboratory test data and units of measure, please see the SPADE Help page

SALIS Soil Profile Report   To contact us email:soils@dnr.nsw.gov.au   Thu Dec 22 10:55:08 EST 2011

Henderson Profile 302

NSW SOIL AND LAND INFORMATION SYSTEM

Soil Profile Report

Site Location:	Unknown
Profile Details:	Soil Landscapes of the Dungog 1:100 000 Sheet Survey, Profile 302 , collected from a batter by Linda Henderson on March 29, 1996
Map Reference:	MGA Grid Reference ; Easting 403405, Northing 6445289 DUNGOG (9233) 1:100,000 sheet
Physiography:	lower slope on plain under woodland grass u'storey on not identified lithology ; Slope 2 % (measured) , elevation 150 m , aspect west , run-on is moderate , run-off is moderate
Vegetation/Land Use:	woodland grass u'storey , with extensive clearing at the site , used for volun./native pasture , volun./native pasture in the general area
Surface Condition:	expected to be hardsetting when dry ground cover is 100%
Erosion/Land Degradation:	high , sheet erosion at the site is minor , stable ; no salting evident
Soil Hydrology:	profile is very slowly permeable profile is imperfectly drained
Soil Type:	Bleached-Mottled Natric Brown Kurosol (ASC) , Soloth (Solod) (GSG) , Db2.41 (PPF)

Soil Description:

Layer 1 0 - .15 m A1 Horizon	Texture:	loam
	Colour:	(brownish black) 7.5YR 2/2 with mottles
	Structure:	(, 5 - 10 mm, fabric is rough-faced peds),
	Coarse Fragments:	
	Pans:	
	Segregations:	
	Roots:	common (10-25/10x10cm) (Root size <1 mm),
	Soil fauna:	Activity is
	Cracks/Macropores:	Cracks are Macropores are
	Moisture/Consistence:	dry, disruptive test result was moderately weak force, shearing test result was crumbly,

http://spade.dnr.nsw.gov.au/SoilProfile.jsp?p_profile_id=15309 1/12/2011

	Erodibility Tests:	
	Field chemical tests:	Field pH is 6.5 (Raupach) ,
	Sample taken:	
	Layer Notes:	
	Lower Boundary:	boundary to..
Layer 2 .15 - .25 m A2 conspicuously bleached Horizon	Texture:	sandy clay loam
	Colour:	brown (greyish brown) 7.5YR 4/2 with mottles
	Structure:	(, 50 - 100 mm, fabric is rough-faced peds),
	Coarse Fragments:	
	Pans:	
	Segregations:	
	Roots:	common (10-25/10x10cm) (Root size <1 mm),
	Soil fauna:	Activity is
	Cracks/Macropores:	Cracks are Macropores are
	Moisture/Consistence:	dry, disruptive test result was moderately weak force, shearing test result was brittle.
	Erodibility Tests:	
	Field chemical tests:	Field pH is 5.5 (Raupach) ,
	Sample taken:	
	Layer Notes:	
	Lower Boundary:	boundary to..
Layer 3 .25 - .7 m B Horizon	Texture:	medium heavy clay
	Colour:	brown (dull yellowish brown) 10YR 4/3 with 10% - 20% distinct unspecified orange mottles
	Structure:	(, 20 - 50 mm, also columnar 20 - 50 mm fabric is smooth-faced peds),
	Coarse Fragments:	
	Pans:	
	Segregations:	
	Roots:	few (1-10/10x10cm) (Root size <1 mm),
	Soil fauna:	Activity is
	Cracks/Macropores:	Cracks are Macropores are

Moisture/Consistence:	dry, disruptive test result was moderately strong force shearing test result was no change,
Erodibility Tests:	
Field chemical tests:	Field pH is 5 (Raupach)
Sample taken:	
Layer Notes:	
Lower Boundary:	boundary to..

LABORATORY TESTS:

For information on laboratory test data and units of measure, please see the SPADE Help page.

Appendix 2 Overview Data

Sampling Site	Site Description	Landuse/ Vegetation Type	Landscape Position	Easting, m WGS84	Northing, m WGS84	Australian Soil Classification	Depth to Rock (cm)	TAW 0-100 cm (mm)	Depth to Mottled Layer (cm)	Depth to Watertable (cm)	Water EC (dS/m)	Other Comments
1	Possible northern irrigated area	Pasture	Floodplain near creek	56402548	6448246	Brown Kandosol	>130	97	28			
2	Possible northern irrigated area	Pasture	Floodplain near creek	56402968	6447796	Yellow Kandosol	>300	95	30	260	1.49	
3	Possible northern irrigated area	Pasture	Gentle upper slope	56403656	6447935	Brown Sodosol	30	59	18			
4	Possible northern irrigated area	Pasture	Lower slope	56404356	6447518	Leptic Tenosol	45	61	–			
5	Mining Lease	Pasture	Backplain	56401578	6446984	Brown Kandosol	>150	111	70	145	16.55 (clear)	
6	Possible northern irrigated area	Pasture	Backplain	56402345	6447457	Brown Kurosol	>130	119	70			
7	Mining Lease	Recently sown forage	Gentle mid-slope	56402907	6447275	Brown Kurosol	75	98	12			
8	Possible northern irrigated area	Pasture	Floodplain near creek	56403411	6447164	Brown Sodosol	>200	128	75			
9	Possible northern irrigated area	Pasture	Alluvial terrace	56403815	6447147	Brown Chromosol	>300	122	125			
10	Mining Lease	Pasture	Backplain	56401508	6446591	Brown Kandosol	>140	107	–			
11	Mining Lease	Pasture	Backplain	56401792	6446523	Grey Kandosol	>140	108	60			
12	Mining Lease	Pasture	Gentle lower slope	56402180	6446801	Brown Kurosol	>140	119	27			
13	Rehabilitated area	Pasture & shrubs	Gentle upper slope	56403212	6446400	Spolic Anthroposol	12	35	–			
14	Mining Lease - application	Pasture	Alluvial terrace	56404218	6446620	Grey Kandosol	>140	99	115			
15	Mining Lease - application	Pasture	Broad hillcrest	56400995	6446119	Grey Kurosol	100	105	20			
16	Mining Lease - application	Pasture & shrubs	Gentle mid-slope	56401241	6445856	Brown Kandosol	75	72	13			
17	Mining Lease	Pasture	Gentle mid-slope	56401646	6446139	Brown Kandosol	>140	95	50			
18	Mining Lease	Pasture	Floodplain near creek	56402244	6446430	Grey Kandosol	>140	99	15		0.32 (A1 seepage)	0.63 dS/m @ 3 m
19	Mining Lease	Forest	Gentle upper slope	56403126	6446007	Brown Kurosol	>140	122	65			
20	Mining Lease - application	Recent timber clearing	Gentle mid-slope	56403528	6446183	Yellow Kurosol	95	85	2			
21	Mining Lease - application	Pasture	Gentle mid-slope	56403915	6446091	Grey Kurosol	70	77	25			
22	Mining Lease - application	Pasture	Gentle mid-slope	56404203	6446008	Grey Kurosol	>140	149	60			
23	Mining Lease	Pasture	Gentle mid-slope	56400898	6445592	Brown Kurosol	>140	128	10			Earthworm @ 5 cm

Sampling Site	Site Description	Landuse/ Vegetation Type	Landscape Position	Easting, m WGS84	Northing, m WGS84	Australian Soil Classification	Depth to Rock (cm)	TAW 0-100 cm (mm)	Depth to Mottled Layer (cm)	Depth to Watertable (cm)	Water EC (dS/m)	Other Comments
24	Mining Lease	Pasture	Moderate mid-slope	56401181	6445592	Brown Sodosol	110	131	50			
25	Mining Lease	Pasture	Gentle mid-slope	56401484	6445678	Yellow Chromosol	>130	127	35			Pockets of 10YR4/2
26	Mining Lease	Pasture	Gentle mid-slope	56401486	6445389	Brown Kurosol	>140	117	25			
27	Rehabilitated area	Pasture	Steep mid-slope	56401831	6445486	Spolic Anthroposol	90	95	25			Earthworm @ 15 cm
28	Mining Lease	Forest	Lower slope colluvium	56402948	6445461	Brown Sodosol	>135	106	40			Shrinkage cracks in B2
29	Mining Lease	Forest	Gentle mid-slope	56403348	6445268	Grey Kurosol	>120	110	15			
30	Mining Lease	Forest	Moderate mid-slope	56403445	6445775	Grey Kurosol	>140	108	35			
31	Mining Lease - application	Pasture	Gentle upper slope	56404255	6445465	Leptic Tenosol	30	36	8	40	0.14	
32	Mining Lease	Pasture	Broad hillcrest	56400856	6445134	Yellow Sodosol	50	56	28			Earthworm @ 5 cm
33	Mining Lease	Pasture	Gentle upper slope	56401001	6445021	Grey Kandosol	85	80	10			
34	Rehabilitated area	Pasture & shrubs	Gentle upper slope	56401507	6444863	Spolic Anthroposol	35	36	20			
35	Mining Lease	Pasture	Floodplain near creek	56401928	6444809	Brown Kandosol	>140	93	13			
36	Rehabilitated area	Pasture & shrubs	Steep mid-slope	56403462	6444881	Spolic Anthroposol	41	58	–			Earthworm @ 5 cm
37	Mining Lease - application	Rough pasture	Gentle mid-slope	56403734	6444660	Leptic Tenosol	35	48	15			
38	Mining Lease - application	Forest	Moderate mid-slope	56404049	6444762	Brown Sodosol	60	64	20			
39	Mining Lease - application	Forest	Moderate mid-slope	56404118	6445083	Yellow Dermsosol	75	93	–			
40	Mining Lease	Pasture	Broad hillcrest	56400739	6444826	Yellow Kurosol	105	118	20			
41	Mining Lease	Pasture	Broad hillcrest	56400672	6444429	Brown Kandosol	65	97	23			
42	Topsoil stockpile	Pasture	Gentle mid-slope	56400870	6444343	Spolic Anthroposol	>130	116	–			
43	Rehabilitated area	Pasture & shrubs	Flat hillcrest	56403097	6444414	Spolic Anthroposol	35	44	0			
44	Rehab. area - Centre Pivot	Bare soil	Flat midslope	56402998	6444021	Spolic Anthroposol	50	44	5			EC (puddle = 2.56 dS/m)
45	Mining Lease - application	Forest	Steep lower slope	56403689	6444045	Grey Kurosol	85	123	55			
46	Rehabilitated area	Pasture & shrubs	Gentle upper slope	56402378	6443879	Spolic Anthroposol	55	40	–			
47	Rehabilitated area	Pasture	Gentle upper slope	56402833	6443650	Spolic Anthroposol	25	37	–			
48	Mining Lease - application	Pasture	Gentle mid-slope	56403288	6443560	Red Kurosol	>130	116	15	65	0.13	
49	Possible SW irrigated area	Pasture	Gentle lower slope	56400850	6443588	Brown Kurosol	>140	109	25			
50	Rehabilitated area	Pasture	Flat hillcrest	56402227	6443317	Spolic Anthroposol	10	31	0	20	0.27	EC (puddle = 0.16 dS/m)
51	Mining Lease	Pasture	Gentle mid-slope	56402760	6443368	Leptic Tenosol	30	44	–	30	0.13	

Sampling Site	Site Description	Landuse/ Vegetation Type	Landscape Position	Easting, m WGS84	Northing, m WGS84	Australian Soil Classification	Depth to Rock (cm)	TAW 0-100 cm (mm)	Depth to Mottled Layer (cm)	Depth to Watertable (cm)	Water EC (dS/m)	Other Comments
52	Possible SW irrigated area	Pasture	Gentle lower slope	56401035	6443124	Brown Kurosol	>140	119	33		0.23 (A2 seepage)	
53	Possible SW irrigated area	Pasture	Gentle lower slope	56401246	6442921	Brown Kurosol	>140	113	15			
54	Mining Lease	Pasture	Gentle mid-slope	56402382	6442821	Grey Kandosol	100	93	85			Earthworm X 2 @ 20 cm
55	Rehabilitated area	Pasture	Gentle mid-slope	56402737	6442879	Spolic Anthroposol	20	55	–			
56	Mining Lease	Pasture	Gentle mid-slope	56402979	6443140	Leptic Tenosol	35	64	20	35	0.15	
57	Mining Lease	Pasture	Gentle mid-slope	56400990	6442590	Brown Chromosol	>140	138	30			
58	Mining Lease - application	Pasture	Moderate mid-slope	56402871	6442565	Grey Kurosol	85	103	25			
59	Possible SW irrigated area	Pasture	Moderate mid-slope	56400866	6442154	Yellow Kurosol	85	107	30			
60	Possible SW irrigated area	Pasture	Gentle upper slope	56401166	6442259	Brown Kurosol	65	74	15			
61	Possible SW irrigated area	Pasture	Gentle upper slope	56401511	6441774	Brown Kurosol	>130	96	8			
62	Mining Lease - application	Pasture	Lower slope colluvium	56402055	6442187	Grey Kandosol	>125	105	20			
63	Mining Lease - application	Pasture	Moderate mid-slope	56402574	6442263	Grey Kurosol	100	112	45	28	0.06	
64	Possible SW irrigated area	Pasture	Gentle mid-slope	56401219	6441425	Yellow Kurosol	>140	108	30			
65	Mining Lease - application	Pasture	Moderate mid-slope	56402529	6441858	Red Kandosol	>130	98	25	95	0.05	
66	Mining Lease - application	Pasture	Gentle mid-slope	56401747	6441245	Brown Kurosol	>125	125	25			
67	Mining Lease - application	Pasture	Moderate mid-slope	56402280	6441465	Grey Sodosol	65	106	45	65	0.09	Earthworm @ 5 cm
68	Mining Lease - application	Pasture	Moderate mid-slope	56402428	6441050	Grey Kurosol	110	163	60			

cm = centimetres
mm = millimetres
ds/m = deciSiemens per metre

Appendix 3 Layer Data

Pit (New #)	Pit (Field)	Horizon	Lower Depth (cm)	Texture	pH Water	Moist Soil Colour (Munsell)	Colour	Mottles	SOILpak Compaction Score	Gravel Fragments (%)	Dispersion 10 minutes	Moisture	Lime		Root Score
													%	Type	
1	11	A11	15	Light medium clay	6.0	7.5YR3/2	Dark brown	–	1.7	0	0	Moist	–	–	3
		A12	28	Light clay	6.5	7.5YR3/2	Dark brown	–	1.8	0	1	Moist	–	–	3
		2B21b	60	Medium heavy clay	7.0	10YR5/6	Yellowish brown	Grey	0.7	0	0	Moist	–	–	2
		2B22b	130+	Heavy clay	7.5	10YR6/1	Grey	Yellow	1.0	0	0	Moist	–	–	1
2	4	A1	15	Light clay	6.5	7.5YR4/2	Brown	–	1.5	0	0	Moist	–	–	3
		B1	30	Light medium clay	6.5	10YR5/3	Brown	–	0.8	0	3	Moist	–	–	3
		B21	70	Heavy clay	6.5	10YR6/4	Light yellowish brown	Sl grey	0.9	0	1	Moist	–	–	2
		B22	140+	Medium heavy clay	8.0	10YR6/6	Brownish yellow	Strong grey	0.4	0	0	Slight/Moist	–	–	1
			200	Sandy light clay	7.5	10YR6/1	Grey	–		0	0		–	–	
			300	Clayey sand	8.0	10YR5/2	Greyish brown	–		75	1		–	–	
3	3	A11	10	Sandy loam	7.0	7.5YR3/2	Dark brown	–	1.7	0	0	Moist	–	–	3
		A12	18	Sandy loam	6.5	7.5YR3/2	Dark brown	–	1.4	0	0	Moist	–	–	3
		B21	45	Medium clay	6.0	10YR5/6	Yellowish brown	Strong grey	1.2	0	2	Wet	–	–	2
		C	46+							100			–	–	
4	2	A11	10	Clay loam	8.0	7.5YR3/2	Dark brown	–	1.8	0	0	Moist	–	–	4
		A12	20	Clay loam	6.5	7.5YR4/3	Brown	–	1.6	0	0	Moist	–	–	3
		B1	45	Light clay	6.5	7.5YR4/4	Brown	–	1.4	0	0	Moist	–	–	3
		C	120+							97			–	–	

Pit (New #)	Pit (Field)	Horizon	Lower Depth (cm)	Texture	pH Water	Moist Soil Colour (Munsell)	Colour	Mottles	SOILpak Compaction Score	Gravel Fragments (%)	Dispersion 10 minutes	Moisture	Lime		Root Score
													%	Type	
5	42	A1	10	Silty clay loam	6.0	10YR3/2	Very dark greyish brown	–	1.3	0	2	Moist/Wet	–	–	3
		B1	30	Medium heavy clay	6.0	10YR4/2	Dark greyish brown	–	1.3	0	0	Moist/Wet	–	–	2
		B21	70	Heavy clay	7.0	10YR5/3	Brown	–	1.2	0	0	Moist	–	–	1
		B22	150+	Heavy clay	9.0	10YR6/4	Light yellowish brown	Strong grey	0.8	0	0	Moist	–	–	0
6	12	A11	10	Silty clay loam	6.0	7.5YR4/3	Brown	–	1.8	0	0	Moist	–	–	4
		A12	25	Silty clay loam	6.0	10YR4/3	Brown	–	1.7	0	1	Moist	–	–	3
		B21	70	Medium heavy clay	5.5	10YR5/4	Yellowish brown	–	1.2	3	0	Moist	–	–	2
		B22	130+	Heavy clay	5.5	10YR6/2	Light brownish grey	Red	0.7	0	0	Moist	–	–	1 (90)
7	10	A1	12	Sandy loam	6.5	7.5YR2.5/2	Very dark brown	–	1.3	0	0	Moist	–	–	2
		B21	30	Sandy medium clay	6.0	10YR5/4	Yellowish brown	Slight yellow	0.8	0	3	Moist	–	–	1
		B22	60	Medium heavy clay	5.5	10YR6/2	Light brownish grey	Strong yellow	0.5	0	1	Moist	–	–	0.5
		C	77+							100			–	–	
8	5	A1	20	Silty clay loam	6.0	7.5YR4/2	Brown	–	1.5	0	0	Moist	–	–	4
		A3	23	Light clay	6.5	10YR5/2	Greyish brown	–	1.2	0	3	Moist	–	–	3
		B2	75	Heavy clay	6.5	10YR5/3	Brown	–	1.0	0	2	Moist	–	–	3
		2B1b	95	Medium heavy clay	7.5	10YR5/1	Grey	Slight yellow	1.0	0	0	Slight/Moist	–	–	2
		2B2b	130+	Medium clay	8.5	10YR5/1	Grey	Strong yellow	1.3	2	0	Slight/Moist	–	–	1
			2 m	Light medium clay	8.5	10YR5/2	Greyish brown	–		0	2		–	–	

Pit (New #)	Pit (Field)	Horizon	Lower Depth (cm)	Texture	pH Water	Moist Soil Colour (Munsell)	Colour	Mottles	SOILpak Compaction Score	Gravel Fragments (%)	Dispersion 10 minutes	Moisture	Lime		Root Score
													%	Type	
9	1	A11	15	Silty clay loam	6.5	7.5YR4/3	Brown	–	1.5	0	0	Moist	–	–	4
		A12	25	Silty clay loam	7.0	7.5YR4/2	Brown	–	1.2	0	0	Moist	–	–	3
		B21	72	Heavy clay	8.0	10YR5/4	Yellowish brown	–	1.0	0	0	Moist	–	–	2
		B22	125	Heavy clay	9.0	10YR5/2	Greyish brown	–	0.8	0	1	Moist	–	–	1
		B23	140+	Medium clay	8.5	10YR5/2	Greyish brown	Orange	0.8	0	0	Slight/Moist	–	–	0
			2 m	Medium clay	8.0	10YR5/3	Brown	Orange		0	1	Moist	–	–	
			3 m	Light medium clay	8.0	10YR5/3	Brown	Brown		5	3	Moist	–	–	
10	41	A1	17	Light medium clay	6.5	10YR4/3	Brown	Slight orange	1.4	0	2	Wet	–	–	2
		B21	55	Heavy clay	6.5	10YR5/4	Yellowish brown	Slight grey	1.2	0	2	Moist	–	–	2
		B22	140+	Medium heavy clay	6.0	2.5Y5/1	Grey	Red yellow	0.7	0	0	Moist/Wet	–	–	0.5 (110)
11	43	A1	10	Light medium clay	6.5	10YR4/3	Brown	–	1.2	0	1	Moist/Wet	–	–	2
		B21	60	Heavy clay	5.5	10YR4/2	Dark greyish brown	–	1.0	0	0	Moist	–	–	1
		B22	140+	Heavy clay	5.5	2.5Y5/2	Greyish brown	Red	0.6	0	0	Moist	–	–	0.5 (100)
12	68	A1	12	Fine sandy loam	6.5	10YR4/3	Brown	–	1.5	0	0	Moist	–	–	2
		A2	27	Fine sandy loam	6.0	10YR5/3	Brown	–	1.2	1	3	Moist	–	–	2
		B21	50	Heavy clay	5.5	10YR5/4	Yellowish brown	Slight grey	0.5	0	1	Moist	–	–	2
		B22	75	Heavy clay	5.5	10YR5/6	Yellowish brown	Grey	0.8	0	0	Moist	–	–	0.5
		B23	140+	Sandy medium clay	5.5	10YR5/4	Yellowish brown	Strong grey & red	0.8	0	0	Slight/Moist	–	–	0.5 (95)

Pit (New #)	Pit (Field)	Horizon	Lower Depth (cm)	Texture	pH Water	Moist Soil Colour (Munsell)	Colour	Mottles	SOILpak Compaction Score	Gravel Fragments (%)	Dispersion 10 minutes	Moisture	Lime %	Lime Type	Root Score
13	40	A1	12	Light medium clay	8.0	10YR5/4	Yellowish brown	Strong grey	1.6	5	2	Moist	–	–	4
		B11	70	Light clay	8.5	10YR3/1	Very dark grey	–	1.7	80	0	Moist	–	–	3
		B12	130+	Light clay	9.5	10YR3/1	Very dark grey	–	1.8	80	0	Moist	–	–	3
14	6	A1	15	Light clay	6.0	7.5YR4/2	Brown	–	1.6	0	2	Moist	–	–	3
		2B1b	30	Heavy clay	6.0	7.5YR4/2	Brown	–	1.0	0	2	Moist	–	–	3
		2B21b	115	Medium heavy clay	5.5	10YR5/2	Greyish brown	–	0.4	0	1	Moist	–	–	2
		2B22b	140+	Medium heavy clay	7.5	10YR5/3	Brown	Slight yellow	1.0	0	1	Moist	–	–	1
15	46	A11	12	Fine sandy clay loam	6.0	10YR4/2	Dark greyish brown	–	1.8	0	0	Moist	–	–	3
		A3	20	Light clay	6.0	10YR5/3	Brown	–	1.2	0	2	Moist	–	–	3
		B21	45	Heavy clay	6.0	10YR5/2	Greyish brown	Slight grey/ yellow	0.8	0	1	Moist	–	–	1
		B22	100	Heavy clay	5.5	10YR5/6	Yellowish brown	Strong grey	1.1	0	0	Slight/Moist	–	–	0.5
		C	120+							100			–	–	
16	47	A1	13	Light clay	6.5	10YR3/2	Very dark greyish brown	–	1.4	0	2	Moist	–	–	3
		B21	45	Heavy clay	6.0	7.5YR4/4	Brown	Grey	0.7	0	2	Moist	–	–	1
		B22	75	Heavy clay	6.0	10YR6/4	Light yellowish brown	Strong grey	0.8	0	1	Moist	–	–	0.5 (60)
		C	110+							100			–	–	
17	44	A1	15	Medium clay	6.0	10YR4/3	Brown	–	1.3	0	1	Moist	–	–	2
		B21	50	Heavy clay	6.5	10YR5/4	Yellowish brown	–	0.7	0	0	Moist	–	–	2
		B22	100	Heavy clay	6.5	2.5Y6/2	Light brownish grey	Strong red	0.9	0	0	Moist	–	–	1 (90)
		B23	140+	Heavy clay	7.0	2.5Y7/2	Light grey	Strong yellow	1.1	0	1	Slight/Moist	–	–	0

Pit (New #)	Pit (Field)	Horizon	Lower Depth (cm)	Texture	pH Water	Moist Soil Colour (Munsell)	Colour	Mottles	SOILpak Compaction Score	Gravel Fragments (%)	Dispersion 10 minutes	Moisture	Lime		Root Score
18	67	A1	15	Silty clay loam	6.0	10YR3/2	Very dark greyish brown	–	1.6	0	2	Wet	–	–	2
		A3	30	Silty clay loam	6.0	2.5Y4/2	Dark greyish brown	Slight orange	1.3	0	2	Moist	–	–	2
		B21	70	Medium heavy clay	5.5	2.5Y5/2	Greyish brown	Orange	0.9	0	0	Moist	–	–	3
		B22	140+	Medium heavy clay	6.0	5Y6/1	Grey	Orange	0.4	0	0	Moist	–	–	0.5 (110)
19	39	A11	10	Sandy loam	6.5	10YR4/2	Dark greyish brown	–	1.6	0	1	Moist	–	–	3
		A2	25	Sandy loam	6.5	10YR5/2	Greyish brown	–	1.1	15	2	Wet	–	–	4
		B21	65	Medium heavy clay	6.0	10YR5/4	Yellowish brown	–	1.3	0	0	Moist	–	–	4
		B22	90	Medium heavy clay	6.0	10YR6/4	Light yellowish brown	Grey/Orange	1.0	0	0	Moist	–	–	3
		B23	140+	Light medium clay	5.5	10YR6/6	Brownish yellow	Strong orange/red/grey	1.3	0	0	Slight/Moist	–	–	2
20	9	A1	2	Sandy loam	7.0	10YR3/2	Very dark greyish brown	–	0.9	0	0	Moist	–	–	3
		B1	12	Sandy loam	6.5	10YR5/4	Yellowish brown	Slight yellow	0.7	0	1	Moist	–	–	3
		B21	45	Medium heavy clay	5.5	10YR6/6	Brownish yellow	Grey	0.6	0	0	Moist	–	–	2
		B22	95	Medium heavy clay	5.5	10YR5/6	Yellowish brown	Strong grey	0.4	0	1	Moist	–	–	1
		C	130+							100			–	–	0.5
21	8	A11	12	Sandy loam	7.0	7.5YR2.5/1	Black	–	1.8	0	0	Moist	–	–	3
		A12	25	Clayey sand	6.0	7.5YR5/2	Brown	–	1.4	0	1	Moist	–	–	2
		B2	70	Medium heavy clay	5.5	2.5Y5/1	Grey	Yellow	1.1	0	2	Moist	–	–	1 (60)
		C	72+							100			–	–	

Pit (New #)	Pit (Field)	Horizon	Lower Depth (cm)	Texture	pH Water	Moist Soil Colour (Munsell)	Colour	Mottles	SOILpak Compaction Score	Gravel Fragments (%)	Dispersion 10 minutes	Moisture	Lime		Root Score
													%	Type	
22	7	A11	15	Sandy loam	6.5	7.5YR3/2	Dark brown	–	1.6	0	0	Moist	–	–	3
		A12	30	Sandy loam	6.0	7.5YR4/2	Brown	–	1.7	0	0	Moist	–	–	3
		A3	60	Fine sandy clay loam	6.0	10YR4/3	Brown	–	1.4	0	2	Moist	–	–	2
		B21	120	Sandy light clay	5.5	10YR5/1	Grey	Strong yellow	1.1	0	1	Moist	–	–	1 (90)
		B22	140+	Medium heavy clay	5.5	2.5Y4/1	Dark grey	Red	1.3	0	0	Moist	–	–	0
23	49	A1	10	Fine sandy clay loam	6.5	10YR4/2	Dark greyish brown	–	1.7	0	0	Moist	–	–	4
		B21	35	Medium heavy clay	6.0	10YR5/6	Yellowish brown	Slight grey & red	0.8	0	2	Moist	–	–	2
		B22	75	Heavy clay	5.5	5YR5/6	Yellowish red	Grey	0.8	0	0	Moist	–	–	1
		B23	140+	Medium clay	5.5	2.5Y6/3	Light yellowish brown	Yellow	0.9	0	1	Slight/Moist	–	–	0.5 (110)
24	48	A11	10	Fine sandy clay loam	6.5	7.5YR4/2	Brown	–	1.7	0	0	Moist	–	–	3
		A12	15	Fine sandy clay loam	6.5	7.5YR4/3	Brown	–	1.3	0	2	Moist	–	–	3
		B21	50	Heavy clay	6.5	10YR5/4	Yellowish brown	–	0.6	0	2	Moist	–	–	2
		B22	110	Heavy clay	6.5	10YR7/6	Yellow	Strong grey	0.8	0	1	Slight	–	–	1
		C	125+							100			–	–	
														–	
25	45	A1	9	Fine sandy clay loam	7.0	10YR3/2	Very dark greyish brown	–	1.5	0	1	Moist	–	–	3
		B21	35	Heavy clay	6.5	10YR6/6	Brownish yellow	–	1.2	0	1	Wet	–	–	2
		B22	60	Heavy clay	6.0	10YR5/6	Yellowish brown	Slight red & yellow	1.0	0	0	Moist	–	–	1
		B23	130+	Heavy clay	6.0	2.5YR5/8	Red	Grey	0.7	0	0	Moist	–	–	0.5 (90)

Pit (New #)	Pit (Field)	Horizon	Lower Depth (cm)	Texture	pH Water	Moist Soil Colour (Munsell)	Colour	Mottles	SOILpak Compaction Score	Gravel Fragments (%)	Dispersion 10 minutes	Moisture	Lime		Root Score
													%	Type	
26	66	A11	11	Fine sandy clay loam	6.5	7.5YR3/1	Very dark grey	–	1.9	0	1	Slight/Moist	–	–	4
		A12	25	Fine sandy clay loam	6.0	10YR4/3	Brown	–	1.5	0	0	Moist	–	–	2
		B21	60	Heavy clay	6.0	10YR5/6	Yellowish brown	Slight grey	0.8	0	0	Moist	–	–	3
		B22	140+	Heavy clay	5.5	2.5YR4/6	Red	Strong grey	0.9	0	0	Slight/Moist	–	–	1
27	65	A1	22 - 28	Light clay	5.5	7.5YR4/2	Brown	–	1.3	0	2	Moist	–	–	4
				15% Heavy clay clods	5.0	10YR5/4	Yellowish brown	–	0.3	0	3	Moist	–	–	2
		B11	45	Light medium clay	5.0	10YR6/6	Brownish yellow	Grey	1.5	15	3	Moist	–	–	3
		B12	60 - 75	Light medium clay	5.0	10YR6/2	Light brownish grey	Orange	1.3	15	0	Moist	–	–	2
		B13	90	Medium heavy clay	5.0	10YR5/4	Yellowish brown	Slight grey	1.3	30	0	Moist	–	–	2
		B14	150+	Light clay	8.0	10YR4/2	Dark greyish brown	–	1.6	75	0	Slight/Moist	–	–	2
28	15	A1	15	Fine sandy clay loam	6.0	7.5YR4/3	Brown	–	1.6	0	0	Moist	–	–	3
		B2	40	Medium clay	6.0	10YR4/3	Brown	–	0.8	0	2	Slight	–	–	2
		2B21b	70	Medium heavy clay	5.5	10YR5/3	Brown	Strong grey	0.6	0	2	Moist	–	–	2
		2B22b	95	Light medium clay	5.5	10YR5/6	Yellowish brown	Strong yellow	0.3	0	1	Moist	–	–	1
		2B23b	125	Light medium clay	5.5	10YR5/2	Greyish brown	Yellow	0.7	0	1	Slight/Moist	–	–	1
		3Bb	135+	Medium heavy clay	5.5	10YR4/1	Dark grey		0.9	0	0	Slight/Moist	–	–	1
29	16	A11	5	Sandy loam	7.0	10YR4/2	Dark greyish brown	–	1.5	0	0	Wet	–	–	3
		A12	15	Sandy loam	6.5	10YR5/4	Yellowish brown	–	1.3	0	0	Moist	–	–	3
		B21	40	Sandy loam	6.5	10YR6/3	Pale brown	Orange & pale grey	1.4	0	3	Moist	–	–	3
		B22	120+	Heavy clay	5.5	10YR6/2	Light brownish grey	Orange	0.5	0	0	Slight/Moist	–	–	2

Pit (New #)	Pit (Field)	Horizon	Lower Depth (cm)	Texture	pH Water	Moist Soil Colour (Munsell)	Colour	Mottles	SOILpak Compaction Score	Gravel Fragments (%)	Dispersion 10 minutes	Moisture	Lime		Root Score
30	38	A11	15	Sandy loam	6.0	7.5YR3/2	Dark brown	–	1.6	0	2	Moist	–	–	3
		A12	35	Sandy loam	6.0	7.5YR5/2	Brown	–	1.3	0	2	Wet	–	–	3
		B21	60	Heavy clay	5.5	7.5YR5/2	Brown	Yellow	0.8	0	1	Moist	–	–	4
		B22	100	Heavy clay	6.0	2.5YR5/6	Red	Grey	0.7	0	0	Moist	–	–	3
		B23	140+	Light medium clay	6.0	2.5Y7/3	Pale brown	Red & yellow	1.5	0	0	Slight/Moist	–	–	2
31	13	A1	8	Clay loam	7.0	7.5YR4/2	Brown	–	1.5	0	2	Moist	–	–	3
		B2	30	Light medium clay	6.0	10YR6/6	Brownish yellow	Strong grey & orange	0.7	0	2	Moist	–	–	2
		BC	40	Light medium clay	6.0	10YR6/6	Pale brown	–	0.7	97	2	Moist	–	–	1
		C	42+							100			–	–	
32	51	A1	10	Fine sandy clay loam	6.5	10YR4/2	Dark greyish brown	–	1.7	0	0	Moist	–	–	3
		B21	28	Heavy clay	6.0	10YR6/4	Light yellowish brown	–	0.6	0	3	Moist	–	–	2
		B22	50	Heavy clay	6.0	10YR6/6	Brownish yellow	Strong grey	0.8	0	3	Moist	–	–	1
		C	55+							100			–	–	
														–	
33	50	A1	10	Light clay	6.0	10YR3/2	Very dark greyish brown	–	1.6	0	0	Moist	–	–	3
		B21	30	Heavy clay	5.5	10YR5/4	Yellowish brown	Grey	0.7	0	3	Moist	–	–	2
		B22	85	Heavy clay	5.5	2.5Y6/2	Light brownish grey	Str. orange & yellow	0.9	0	1	Moist	–	–	1
		C	140+							100		Slight	–	–	
														–	
34	64	A1	20	Light medium clay	6.0	10YR4/2	Dark greyish brown	–	1.3	0	2	Moist	–	–	3
				20% Heavy clay clods	6.0	10YR6/4	Light yellowish brown	Slight grey	0.3	0	1	Moist	–	–	1
		B11	35	Light clay	8.5	2.5Y3/1	Very dark grey	–	1.6	60	0	Moist	–	–	1
		B12	65+	Light clay	8.5	2.5Y3/1	Very dark grey	–	1.6	80	0	Moist	–	–	1

Pit (New #)	Pit (Field)	Horizon	Lower Depth (cm)	Texture	pH Water	Moist Soil Colour (Munsell)	Colour	Mottles	SOILpak Compaction Score	Gravel Fragments (%)	Dispersion 10 minutes	Moisture	Lime		Root Score
35	63	A1	13	Sandy light clay	6.0	10YR4/2	Dark greyish brown	–	0.9	0	0	Wet	–	–	2
		A2	20-26	Sandy light clay	6.0	10YR5/2	Greyish brown	Orange	1.0	0	2	Wet	–	–	1
		B21	50	Heavy clay	5.5	10YR5/4	Yellowish brown	Grey	0.6	0	1	Moist	–	–	2
		B22	95	Heavy clay	5.5	2.5Y5/2	Greyish brown	Yellow	0.8	0	1	Moist	–	–	1 (70)
		B23	140+	Heavy clay	7.0	5Y5/1	Grey	Orange	0.7	0	1	Moist	–	–	0
36	62	A11	10	Medium clay	6.0	10YR3/2	Very dark greyish brown	–	1.0	3	3	Moist	–	–	2
		A12	41	Medium clay	6.0	10YR3/2	Very dark greyish brown	–	1.5	1	1	Moist	–	–	3
		B1	110+	Silty clay loam	9.5	10YR2/1	Black	–	1.7	90	0	Moist	5	D	3
37	18	A1	15	Fine sandy clay loam	6.5	10YR3/2	Very dark greyish brown	–	1.6	0	2	Wet	–	–	4
		A3	35	Fine sandy clay loam	6.5	10YR5/3	Brown	Slight yellow	0.7	0	3	Moist	–	–	2
		BC	60	Fine sandy clay loam	6.5	10YR5/3	Brown	Slight yellow	0.7	98	3	Moist	–	–	1
		C	62+							100			–	–	
38	17	A11	12	Sandy loam	6.5	7.5YR2.5/1	Black	–	1.8	0	0	Wet	–	–	4
		A12	20	Sandy loam	6.5	10YR4/1	Dark grey	–	1.4	0	2	Wet	–	–	4
		B2	60	Medium clay	6.0	10YR5/3	Brown	Slight yellow	0.6	0	3	Moist	–	–	3
		BC	80	Medium clay	6.0	10YR6/3	Pale brown	Slight yellow	0.9	98	3	Moist	–	–	1
		C	82+							100			–	–	

Pit (New #)	Pit (Field)	Horizon	Lower Depth (cm)	Texture	pH Water	Moist Soil Colour (Munsell)	Colour	Mottles	SOILpak Compaction Score	Gravel Fragments (%)	Dispersion 10 minutes	Moisture	Lime		Root Score
													%	Type	
39	14	A1	10	Silty clay loam	6.5	7.5YR3/2	Dark brown	–	1.8	0	0	Moist	–	–	4
		A3	55	Sandy light clay	6.0	7.5YR4/4	Brown	–	1.5	0	2	Moist	–	–	2
		B2	75	Light clay (sub-plastic)	6.0	7.5YR6/4	Light brown	–	1.2	0	3	Moist	–	–	2
		BC	100	Light clay (sub-plastic)	6.0	7.5YR6/4	Light brown	–	1.2	98	3	Moist	–	–	1
		C	105+							100			–	–	
40	52	A11	12	Fine sandy clay loam	6.5	7.5YR3/2	Dark brown	–	1.5	0	1	Moist	–	–	3
		A12	20	Fine sandy clay loam	6.5	10YR5/3	Brown	–	0.8	0	0	Moist	–	–	2
		B21	50	Heavy clay	6.0	10YR6/6	Brownish yellow	–	0.6	0	0	Moist	–	–	2
		B22	105	Heavy clay	6.0	10YR6/6	Brownish yellow	–	1.0	0	2	Slight/Moist	–	–	1
		C	120+							100			–	–	
41	53	A11	11	Light clay	6.5	7.5YR2.5/2	Very dark brown	–	1.8	0	0	Moist	–	–	4
		A12	23	Sandy light clay	6.0	10YR5/3	Brown	–	1.0	1	2	Moist	–	–	2
		B21	45	Heavy clay	5.5	10YR5/3	Brown	Slight yellow	0.5	0	1	Moist	–	–	1
		B22	65	Heavy clay	5.5	10YR5/6	Yellowish brown	Grey & red	0.7	0	0	Moist	–	–	1
		BC	130+							99			–	–	1 (115)
42	54	A1	15	Light clay	6.0	10YR3/2	Very dark greyish brown	–	1.2	15	0	Moist	–	–	3
		2A	65	Sandy light clay	6.5	10YR4/3	Brown	–	1.2	2	1	Moist	–	–	2
		3A	130+	Light clay	7.0	10YR4/2	Dark greyish brown	–	1.5	0	1	Moist	–	–	0.5

Pit (New #)	Pit (Field)	Horizon	Lower Depth (cm)	Texture	pH Water	Moist Soil Colour (Munsell)	Colour	Mottles	SOILpak Compaction Score	Gravel Fragments (%)	Dispersion 10 minutes	Moisture	Lime		Root Score
													%	Type	
43	61	A11	10	Light clay	6.0	10YR4/2	Dark greyish brown	Slight yellow	1.0	3	1	Slight/Moist	–	–	3
		A12	35	Light medium clay	6.5	10YR4/2	Dark greyish brown	Slight yellow	1.3	3	3	Moist	–	–	3
		B1	60+			10YR2/1	Black	–		90			–	–	0
44	20	A11	5	Light clay	8.5	10YR5/2	Greyish brown	–	1.2	10	1	Wet	–	–	1
		A12	30	Medium clay	6.0	10YR3/2	Very dark greyish brown	Orange flecks	0.8	5	1	Wet	–	–	1
		B11	50	Sandy light clay	9.5	10YR6/2	Light brownish grey	Orange	0.8	5	1	Moist	–	–	1
		B12	65+							95			–	–	
45	19	A11	12	Fine sandy clay loam	6.5	10YR3/2	Very dark greyish brown	–	1.8	3	0	Moist	–	–	4
		A12	25	Fine sandy clay loam	6.5	10YR5/1	Grey	–	1.4	2	2	Moist	–	–	2
		B21	55	Medium heavy clay	5.5	10YR6/2	Light brownish grey	–	0.9	0	1	Moist	–	–	2
		B22	85	Medium clay	5.5	10YR6/2	Light brownish grey	Strong orange	0.4	0	1	Slight/Moist	–	–	1
		C	100+										–	–	
46	60	A1	26	Light clay	6.0	10YR5/3	Brown	–	1.0	3	1	Slight/Moist	–	–	3
		B11	55	Clayey sand	8.0	10YR4/1	Dark grey	–	1.5	75	0	Moist	–	–	2
		B12	140+	Clayey sand	8.0	10YR4/1	Dark grey	–	1.5	85	0	Moist	–	–	2
47	22	A11	12	Silty clay loam	6.5	10YR4/2	Dark greyish brown	–	1.5	3	2	Moist	–	–	3
		A12	25	Sandy light clay	7.5	10YR4/2	Dark greyish brown	–	1.4	5	1	Moist	–	–	3
		B1	70+		8.5	10YR2/1	Black	–		95			–	–	2

Pit (New #)	Pit (Field)	Horizon	Lower Depth (cm)	Texture	pH Water	Moist Soil Colour (Munsell)	Colour	Mottles	SOILpak Compaction Score	Gravel Fragments (%)	Dispersion 10 minutes	Moisture	Lime		Root Score
													%	Type	
48	21	A1	10	Fine sandy clay loam	6.5	10YR3/1	Very dark grey	–	1.7	0	0	Moist	–	–	4
		B1	15	Light clay	6.0	10YR4/2	Dark greyish brown	–	1.7	0	2	Moist	–	–	3
		B21	60	Medium heavy clay	5.5	5YR5/4	Reddish brown	Grey	1.1	0	0	Moist	–	–	2
		B22	130+	Heavy clay	5.0	10YR6/2	Light brownish grey	Orange	0.7	0	1	Moist	–	–	2
49	59	A11	10	Fine sandy loam	6.0	10YR4/3	Brown	–	1.3	0	2	Moist	–	–	3
		A12	25	Fine sandy loam	6.0	10YR5/3	Brown	–	0.9	0	0	Moist	–	–	2
		B21	85	Heavy clay	6.0	10YR5/4	Yellowish brown	Slight grey	0.5	0	0	Moist/Wet	–	–	0.5
		B22	140+	Heavy clay	5.5	10YR6/4	Light yellowish brown	Strong grey & red	0.3	0	0	Moist	–	–	0.5
50	23	A1	10	Fine sandy clay loam	6.0	7.5YR3/1	Very dark grey	–	1.5	0	0	Wet	–	–	2
		B11	25	Heavy clay	5.0	10YR5/3	Brown	Grey	0.6	15	3	Wet	–	–	1
		B12	35+							99					
51	24	A1	17	Fine sandy clay loam	6.5	10YR3/2	Very dark greyish brown	–	1.6	0	1	Moist	–	–	3
		B1	30	Light clay	6.0	10YR4/2	Dark greyish brown	–	0.8	3	2	Moist	–	–	3
		C	32+							100			–	–	
52	58	A1	13	Fine sandy clay loam	6.0	7.5YR3/2	Dark brown	–	1.6	0	0	Moist	–	–	2
		A2	30-35	Fine sandy loam	5.5	10YR5/3	Brown	–	1.0	0	1	Wet	–	–	2
		B21	90	Heavy clay	5.5	10YR5/4	Yellowish brown	Slight red	0.7	0	1	Moist	–	–	1
		B22	140+	Heavy clay	5.5	2.5YR5/6	Red	Strong grey	1.1	0	0	Moist	–	–	0.5

Pit (New #)	Pit (Field)	Horizon	Lower Depth (cm)	Texture	pH Water	Moist Soil Colour (Munsell)	Colour	Mottles	SOILpak Compaction Score	Gravel Fragments (%)	Dispersion 10 minutes	Moisture	Lime		Root Score
													%	Type	
53	57	A11	15	Fine sandy loam	6.0	10YR3/2	Very dark greyish brown	–	1.3	0	0	Moist	–	–	3
		A12	30	Fine sandy loam	6.0	10YR4/2	Dark greyish brown	Slight yellow	0.9	0	0	Moist	–	–	3
		B21	75	Heavy clay	5.5	10YR5/4	Yellowish brown	Slight grey & red	0.5	0	1	Moist	–	–	1
		B22	95	Heavy clay	5.5	2.5YR5/6	Red	Grey	0.8	0	0	Moist	–	–	1
		B23	140+	Heavy clay	5.5	10YR5/6	Yellowish brown	Strong grey	0.9	0	1	Slight/Moist	–	–	0
54	28	A1	12	Light clay	7.0	7.5YR3/2	Dark brown	–	1.8	0	1	Moist	–	–	3
		A3	50	Light medium clay	6.0	7.5YR4/2	Brown	–	0.9	0	3	Moist/Wet	–	–	3
		B21	85	Medium heavy clay	5.5	10YR5/2	Greyish brown	–	0.4	0	1	Moist	–	–	2
		B22	100	Medium clay	5.5	10YR6/2	Light brownish grey	Orange	0.8	0	0	Moist	–	–	1
		C	105+							100			–	–	
55	26	A1	20	Fine sandy clay loam	6.0	10YR3/2	Very dark greyish brown	–	1.6	2	0	Moist	–	–	3
		B1	120+	Sandy loam	9.5	7.5YR2.5/1	Black	–	1.3	85	0	Moist	–	–	2
56	25	A11	20	Fine sandy loam	6.0	10YR3/2	Very dark greyish brown	–	1.7	2	1	Moist	–	–	
		A12	35	Fine sandy loam	6.0	10YR5/2	Greyish brown	Orange	1.1	15	3	Wet	–	–	
		BC	70							99			–	–	
		C	72+							100					
57	37	A11	12	Sandy clay loam	6.5	10YR2/2	Very dark brown	–	1.7	0	0	Moist	–	–	3
		A2	30	Fine sandy loam	6.5	10YR3/2	Very dark greyish brown	–	1.2	0	2	Moist/Wet	–	–	2
		B21	65	Medium heavy clay	6.0	10YR4/4	Dark yellowish brown	Slight grey	1.0	0	0	Moist	–	–	1 (55)
		B22	140+	Heavy clay	6.0	10YR5/6	Yellowish brown	Strong grey	1.2	0	1	Moist	–	–	0

Pit (New #)	Pit (Field)	Horizon	Lower Depth (cm)	Texture	pH Water	Moist Soil Colour (Munsell)	Colour	Mottles	SOILpak Compaction Score	Gravel Fragments (%)	Dispersion 10 minutes	Moisture	Lime		Root Score
58	27	A11	10	Fine sandy clay loam	7.0	7.5YR2.5/1	Black	–	1.6	0	0	Moist	–	–	3
		A2	25	Fine sandy clay loam	6.0	10YR5/2	Greyish brown	–	1.2	0	2	Moist	–	–	3
		B2	85	Medium heavy clay	5.5	10YR6/2	Light brownish grey	Orange	0.7	0	2	Moist	–	–	3
			90+							100			–	–	
59	56	A11	15	Fine sandy clay loam	6.0	7.5YR3/2	Dark brown	–	1.8	0	0	Moist	–	–	3
		A12	30	Fine sandy clay loam	6.0	7.5YR4/2	Brown	–	1.2	4	1	Moist	–	–	3
		B2	85	Heavy clay	5.5	7.5YR6/4	Light brown	Grey	0.5	0	2	Moist	–	–	1
		C	120+							100			–	–	
60	36	A11	10	Fine sandy clay loam	6.5	10YR3/2	Very dark greyish brown	–	1.4	0	0	Moist	–	–	4
		A12	15	Fine sandy loam	6.0	10YR5/2	Greyish brown	–	1.0	0	2	Moist	–	–	2
		B21	65	Heavy clay	5.5	10YR5/4	Yellowish brown	Slight grey	0.3	0	1	Moist	–	–	1
		BC	85							98			–	–	
		C	87+							100			–	–	
61	35	A1	8	Clay loam	6.5	10YR3/2	Very dark greyish brown	–	1.5	0	0	Moist	–	–	3
		B21	45	Heavy clay	5.5	10YR5/6	Yellowish brown	Grey red	0.8	0	1	Moist	–	–	2
		B22	120	Heavy clay	5.5	10YR5/6	Yellowish brown	Strong grey, sl. red	0.4	0	2	Moist	–	–	1 (110)
		B23	130+	Heavy clay	5.5	10YR6/2	Light brownish grey	–	0.7	0	1	Slight/Moist	–	–	0

Pit (New #)	Pit (Field)	Horizon	Lower Depth (cm)	Texture	pH Water	Moist Soil Colour (Munsell)	Colour	Mottles	SOILpak Compaction Score	Gravel Fragments (%)	Dispersion 10 minutes	Moisture	Lime		Root Score
													%	Type	
62	31	A11	10	Light clay	6.5	10YR4/2	Dark greyish brown	–	1.5	0	3	Wet	–	–	2
		A12	20	Silty clay loam	6.5	10YR5/2	Greyish brown	–	0.7	0	2	Moist	–	–	3
		B21	70	Medium heavy clay	6.5	10YR5/2	Greyish brown	Slight yellow	0.4	0	1	Moist	–	–	2
		B22	115	Medium heavy clay	6.0	10YR6/2	Light brownish grey	Strong yellow	1.0	0	0	Moist	–	–	0.5
		B3	125	Medium heavy clay	6.0	10YR6/2	Light brownish grey	Strong yellow	1.0	45	0	Moist	–	–	0.5
63	29	A11	20	Fine sandy clay loam	6.5	10YR2/1	Black	–	1.5	0	2	Moist/Wet	–	–	3
		A12	45	Fine sandy clay loam	6.0	10YR4/2	Dark greyish brown	–	0.7	2	4	Moist/Wet	–	–	3
		B2	100	Medium heavy clay	5.5	10YR4/1	Dark grey	Orange & red	0.3	0	0	Moist/Wet	–	–	2
		C	105+							100			–	–	
64	55	A1	12	Fine sandy loam	6.0	10YR3/2	Very dark greyish brown	–	1.8	2	0	Moist	–	–	2
		A3	30	Light clay	6.0	10YR4/2	Dark greyish brown	–	1.3	0	1	Moist	–	–	2
		B21	75	Heavy clay	5.5	10YR6/6	Brownish yellow	Grey red	0.7	0	0	Moist	–	–	1
		B22	110	Heavy clay	5.5	10YR6/6	Brownish yellow	Strong grey & red	0.8	0	0	Moist	–	–	0
		B23	140+	Heavy clay	5.5	10YR8/2	Very pale brown	Red & orange	0.5	0	0	Moist	–	–	0
65	30	A1	12	Light clay	7.0	10YR3/2	Very dark greyish brown	–	1.6	0	0	Moist	–	–	4
		A3	25	Light clay	6.5	10YR4/2	Dark greyish brown	–	1.4	0	2	Moist	–	–	3
		B21	85	Heavy clay	6.0	5YR4/6	Yellowish red	Grey	0.7	0	0	Moist	–	–	2
		B22	130+	Heavy clay	5.5	10YR6/8	Brownish yellow	Grey	0.3	0	1	Moist/Wet	–	–	1

Pit (New #)	Pit (Field)	Horizon	Lower Depth (cm)	Texture	pH Water	Moist Soil Colour (Munsell)	Colour	Mottles	SOILpak Compaction Score	Gravel Fragments (%)	Dispersion 10 minutes	Moisture	Lime		Root Score
													%	Type	
66	34	A1	10	Fine sandy clay loam	7.0	7.5YR2.5/1	Black	–	1.8	0	0	Moist	–	–	4
		A3	25	Light clay	6.5	7.5YR3/2	Dark brown	–	1.4	0	1	Moist	–	–	2
		B21	90	Heavy clay	5.5	7.5YR4/6	Strong brown	Grey	1.0	0	0	Moist	–	–	1
		B22	125+	Heavy clay	5.5	5YR4/6	Yellowish red	Strong grey & yellow	0.3	0	0	Moist	–	–	1
67	32	A11	15	Fine sandy loam	6.5	10YR3/1	Very dark grey	–	1.7	0	0	Moist/Wet	–	–	2
		A12	45	Fine sandy loam	6.0	10YR4/1	Dark grey	–	1.1	0	3	Moist/Wet	–	–	3
		B2	65	Medium clay	6.0	10YR4/1	Dark grey	Orange	0.6	0	2	Moist/Wet	–	–	1
		C	68+							100			–	–	
68	33	A11	18	Fine sandy clay loam	6.5	10YR3/2	Very dark greyish brown	–	1.6	2	0	Moist	–	–	3
		A12	60	Fine sandy clay loam	6.0	10YR6/2	Light brownish grey	–	1.1	1	3	Moist/Wet	–	–	2
		B2	110	Heavy clay	5.5	10YR6/2	Light brownish grey	Orange	0.6	0	1	Moist/Wet	–	–	1
		C	115+							100			–	–	

cm = centimetres

Appendix 4 Layer Data – Soil Structure Details

PIT (New #)	Horizon	Lower depth (cm)	PEDALITY			FABRIC	CONSISTENCE	SOILpak Compaction Score
			Grade	Type	Size (mm)			
1	**11**	15	S	SB	4	E	2	1.7
		28	S	SB	3	E	2	1.8
		60	W	LE	14	RP	3	0.7
		130+	M	B	10	RP	3	1.0
2	**4**	15	M	SB	7	RP	2	1.5
		30	W	LE	15	RP	2	0.8
		70	W	LE	10	RP	3	0.9
		140+	M	B	20	RP	4	0.4
3	**3**	10	M	SB	3	E	2	1.7
		18	M	PO	7	E	2	1.4
		45	M	PO	10	RP	3	1.2
4	**2**	10	S	SB	2	E	1	1.8
		20	S	SB	4	E	2	1.6
		45	M	PO	7	E	3	1.4
5	**42**	10	M	PO	7	RP	3	1.3
		30	M	LE	10	RP	2	1.3
		70	M	LE	14	RP & SP	3	1.2
		150+	M	LE	20	RP & SP	4	0.8
6	**12**	10	S	SB	3	E	1	1.8
		25	M	PO	5	E	1	1.7
		70	M	PO	10	RP	3	1.2
		130+	W	B	18	RP	4	0.7
7	**10**	12	M	PO	10	E	2	1.3
		30	W	LE	18	RP	3	0.8
		60	W	B	22	RP	3	0.5
8	**5**	20	M	SB	5	E	2	1.5
		23	M	LE	10	E	2	1.2
		75	W	LE	10	RP	3	1.0
		95	M	LE	14	RP	3	1.0
		130+	S	PO	7	RP	3	1.3

PIT (New #)	Horizon	Lower depth (cm)	PEDALITY			FABRIC	CONSISTENCE	SOILpak Compaction Score
			Grade	Type	Size (mm)			
9	**1**	15	M	PO	8	E	2	1.5
		25	M	PO	10	RP	3	1.2
		72	M	LE	13	RP	3	1.0
		125	S	LE	15	RP	4	0.8
		140+	S	LE	15	RP	4	0.8
10	**41**	17	M	PO	7	E	2	1.4
		55	M	PO	9	RP	2	1.2
		140+	W	LE	18	RP	3	0.7
11	**43**	10	M	PO	8	RP	2	1.2
		60	S	LE	15	RP & SP	2	1.0
		140+	S	LE	20	RP	3	0.6
12	**68**	12	M	PO	7	E	1	1.5
		27	M	LE	12	E	2	1.2
		50	W	LE	20	RP	4	0.5
		75	M	LE	12	RP	3	0.8
		140+	S	AB	12	RP & SP	4	0.8
13	**40**	12	M	PO	7	RP	2	1.6
		70	M	PO	4	E	1	1.7
		130+	M	PO	3	E	1	1.8
14	**6**	15	M	PO	5	E	2	1.6
		30	M	LE	12	RP	3	1.0
		115	W	B	20	RP	4	0.4
		140+	M	B	12	RP	3	1.0
15	**46**	12	M	SB	3	E	1	1.8
		20	W	LE	10	E	2	1.2
		45	W	LE	15	RP	3	0.8
		100	M	AB	12	RP	4	1.1
16	**47**	13	M	PO	7	E	1	1.4
		45	W	LE	20	RP	3	0.7
		75	W	LE	18	RP	3	0.8
17	**44**	15	M	PO	8	RP	2	1.3
		50	W	LE	15	RP	3	0.7
		100	W	LE	12	RP	3	0.9
		140+	M	LE	10	RP	4	1.1

PIT (New #)	Horizon	Lower depth (cm)	PEDALITY			FABRIC	CONSISTENCE	SOILpak Compaction Score
			Grade	Type	Size (mm)			
18	**67**	15	M	PO	6	RP	1	1.6
		30	M	LE	10	RP	2	1.3
		70	M	LE	14	RP	3	0.9
		140+	W	LE	25	RP	4	0.4
19	**39**	10	M	SB	5	E	1	1.6
		25	W	LE	8	E	2	1.1
		65	S	AB	10	RP & SP	3	1.3
		90	M	LE	14	RP	4	1.0
		140+	M	LE	9	RP	3	1.3
20	**9**	2	W	PL	7	E	2	0.9
		12	M	B	12	E	2	0.7
		45	W	LE	15	RP	3	0.6
		95	W	B	18	RP	4	0.4
21	**8**	12	M	SB	3	E	1	1.8
		25	M	PO	7	E	2	1.4
		70	M	LE	15	RP	3	1.1
22	**7**	15	M	PO	8	E	2	1.6
		30	M	PO	6	E	2	1.7
		60	W	LE	10	E	2	1.4
		120	M	LE	15	RP	3	1.1
		140+	M	LE	12	RP	2	1.3
23	**49**	10	M	PO	4	E	1	1.7
		35	W	LE	12	RP	2	0.8
		75	W	LE	12	RP	2	0.8
		140+	M	LE	10	RP	3	0.9
24	**48**	10	M	PO	4	E	1	1.7
		15	M	PO	6	E	2	1.3
		50	W	LE	20	RP	3	0.6
		110	M	AB	23	RP	5	0.8
25	**45**	9	M	PO	6	E	2	1.5
		35	M	LE	9	RP	2	1.2
		60	M	LE	14	RP	2	1.0
		130+	W	LE	17	RP	3	0.7

PIT (New #)	Horizon	Lower depth (cm)	PEDALITY			FABRIC	CONSISTENCE	SOILpak Compaction Score
			Grade	Type	Size (mm)			
26	**66**	11	S	SB	3	E	1	1.9
		25	M	LE	7	E	2	1.5
		60	W	LE	18	RP	3	0.8
		140+	W	LE	14	RP	4	0.9
27	**65**	22 - 28	M	PO	8	RP	3	1.3
		45	M	PO	6	RP	2	1.5
		60 - 75	M	PO	8	RP	3	1.3
		90	M	PO	8	RP	3	1.3
		150+	M	PO	5	RP	2	1.6
28	**15**	15	M	SB	7	E	2	1.6
		40	S	PO	20	RP	4	0.8
		70	W	B	25	RP	4	0.6
		95	M	LE	15	RP	6	0.3
		125	M	LE	12	RP	5	0.7
		135+	S	LE	10	RP	5	0.9
29	**16**	5	M	SB	3	E	2	1.5
		15	W	PO	8	E	3	1.3
		40	M	PO	6	E	2	1.4
		120+	W	B	15	RP	5	0.5
30	**38**	15	M	PO	5	E	1	1.6
		35	W	LE	7	E	2	1.3
		60	W	LE	10	RP	3	0.8
		100	W	AB	14	RP	4	0.7
		140+	M	PO	6	RP	3	1.5
31	**13**	8	M	PO	5	E	2	1.5
		30	W	LE	15	RP	3	0.7
32	**51**	10	M	PO	5	E	1	1.7
		28	W	LE	25	RP	4	0.6
		50	W	LE	18	RP	4	0.8
33	**50**	10	M	PO	4	RP	1	1.6
		30	W	LE	17	RP	3	0.7
		85	M	LE	15	RP	3	0.9

PIT (New #)	Horizon	Lower depth (cm)	PEDALITY			FABRIC	CONSISTENCE	SOILpak Compaction Score
			Grade	Type	Size (mm)			
34	**64**	20	M	PO	7	RP	3	1.3
		35	M	PO	5	RP	2	1.6
		65+	M	PO	5	RP	2	1.6
35	**63**	13	W	LE	12	RP	2	0.9
		20-26	W	LE	10	RP	2	1.0
		50	W	LE	20	RP	3	0.6
		95	W/M	LE	15	RP	2	0.8
		140+	W	LE	15	RP	3	0.7
36	**62**	10	M	PO	15	RP	3	1.0
		41	S	PO	7	RP	2	1.5
		110+	M	PO	4	RP	2	1.7
37	**18**	15	M	PO	5	E	1	1.6
		35	M	LE	8	E	3	0.7
38	**17**	12	S	SB	3	E	1	1.8
		20	M	PO	8	E	2	1.4
		60	W	LE	12	RP	3	0.6
		80	W	LE	6	RP	3	0.9
39	**14**	10	S	SB	4	E	1	1.8
		55	M	PO	7	E	2	1.5
		75	M	LE	10	RP	3	1.2
40	**52**	12	M	PO	6	E	2	1.5
		20	M	LE	14	E	3	0.8
		50	W	LE	15	RP	4	0.6
		105	M	PO	10	RP	3	1.0
41	**53**	11	S	PO	5	RP	2	1.8
		23	M	LE	12	RP	3	1.0
		45	W	LE	18	RP	3	0.5
		65	M	LE	15	RP	4	0.7
42	**54**	15	W	PO	8	E	3	1.2
		65	W	PO	12	E	2	1.2
		130+	M	PO	8	E	2	1.5
43	**61**	10	M	PO/LE	10	RP	3	1.0
		35	M	PO/LE	7	RP	2	1.3

PIT (New #)	Horizon	Lower depth (cm)	PEDALITY			FABRIC	CONSISTENCE	SOILpak Compaction Score
			Grade	Type	Size (mm)			
44	**20**	5	W	PO	7	E	2	1.2
		30	W	B	15	RP	3	0.8
		50	W	LE	15	RP	3	0.8
45	**19**	12	S	SB	3	E	1	1.8
		25	M	PO	7	E	1	1.4
		55	M	B	14	RP	4	0.9
		85	M	B	18	RP	6	0.4
46	**60**	26	M	PO/LE	15	E	3	1.1
		55	W	PO/LE	10	E	3	1.5
		140+	W	1	0	E	3	1.5
47	**22**	12	W	PO	5	E	1	1.5
		25	M	PO	7	E	2	1.4
48	**21**	10	S	SB	4	E	1	1.7
		15	S	PO	4	RP	1	1.7
		60	M	PO	9	RP	3	1.1
		130+	W	LE	14	RP	3	0.7
49	**59**	10	M	PO	7	E	2	1.3
		25	M	LE	10	E	3	0.9
		85	W	LE	25	RP	4	0.5
		140+	W	LE	30	RP	4	0.3
50	**23**	10	M	PO	5	E	1	1.5
		25	W	LE	20	RP	3	0.6
51	**24**	17	M	SB	4	E	2	1.6
		30	W	LE	12	RP	2	0.8
52	**58**	13	M	PO	6	E	1	1.6
		30-35	M	LE	8	E	1	1.0
		90	W	LE	15	RP	3	0.7
		140+	M	LE	11	RP	2	1.1
53	**57**	15	M	PO	7	E	1	1.3
		30	W	LE	15	E	2	0.9
		75	W	LE	20	RP	3	0.5
		95	M	LE	14	RP	3	0.8
		140+	M	LE	12	RP	4	0.9

PIT (New #)	Horizon	Lower depth (cm)	PEDALITY			FABRIC	CONSISTENCE	SOILpak Compaction Score
			Grade	Type	Size (mm)			
54	**28**	12	S	SB	5	RP	1	1.8
		50	W	LE	14	RP	2	0.9
		85	W	LE	23	RP	3	0.4
		100	M	LE	15	RP	3	0.8
55	**26**	20	S	SB	4	E	2	1.6
		120+	W	PO	7	E	2	1.3
56	**25**	20	S	SB	4	E	1	1.7
		35	W	LE	12	RP	1	1.1
57	**37**	12	M	SB	4	E	1	1.7
		30	W	PO	12	E	1	1.2
		65	M	PO	15	RP	3	1.0
		140+	M	PO	10	RP	3	1.2
58	**27**	10	M	SB	5	E	1	1.6
		25	W	PO	10	E	2	1.2
		85	W	LE	15	RP	4	0.7
59	**56**	15	S	PO	4	E	1	1.8
		30	M	LE	8	E	2	1.2
		85	W	LE	20	RP	4	0.5
60	**36**	10	M	PO	7	E	2	1.4
		15	W	LE	9	E	2	1.0
		65	W	LE	20	RP	4	0.3
61	**35**	8	M	PO	7	E	1	1.5
		45	W	LE	15	RP	3	0.8
		120	W	LE	22	RP	4	0.4
		130+	M	LE	18	R	4	0.7
62	**31**	10	M	PO	5	RP	1	1.5
		20	W	LE	12	RP	2	0.7
		70	W	LE	15	RP	3	0.4
		115	M	LE	10	RP	3	1.0
		125	M	LE	10	RP	3	1.0
63	**29**	20	M	PO	7	E	1	1.5
		45	W	LE	15	E	2	0.7
		100	W	LE	25	RP	4	0.3

PIT (New #)	Horizon	Lower depth (cm)	PEDALITY			FABRIC	CONSISTENCE	SOILpak Compaction Score
			Grade	Type	Size (mm)			
64	**55**	12	S	PO	5	E	1	1.8
		30	M	PO	10	RP	2	1.3
		75	W	LE	22	RP	3	0.7
		110	W	LE	18	RP	4	0.8
		140+	W	LE	25	RP	4	0.5
65	**30**	12	M	SB	6	RP	2	1.6
		25	M	PO	8	RP	3	1.4
		85	W	LE	20	RP	4	0.7
		130+	W	LE	25	RP	5	0.3
66	**34**	10	S	SB	4	E	1	1.8
		25	W	LE	8	RP	2	1.4
		90	M	LE	13	RP	2	1.0
		125+	W	B	20	RP	4	0.3
67	**32**	15	M	SB	4	E	1	1.7
		45	W	LE	10	E	2	1.1
		65	W	LE	15	RP	3	0.6
68	**33**	18	M	SB	7	E	1	1.6
		60	W	PO	12	E	2	1.1
		110	W	LE	18	RP	3	0.6

# = number
cm = centimetres
mm = millimetres

Appendix 5 Laboratory Data

Site New#	Depth (cm)	pH CaCl2	EC 1:5 dS/m	ECe dS/m	Chloride mg/kg	Exchangeable Cations, meq/100g				Al	CEC	ESP	ESI	Ca/Mg	EAlP	ASWAT Score	NO3-N mg/kg	Colwell-P mg/kg	SO4-S mg/kg	DTPA-Zn mg/kg	DTPA-Cu mg/kg	Boron mg/kg	Org. C %
						Ca	Mg	K	Na														
1	15	4.6	0.13	1.12	33	6.5	3.5	0.4	0.6	0.8	11.7	4.9	0.03	1.86	6.4	1	37	36	8	4.40	0.60	0.53	3.20
1	30	4.7	0.14	1.20	15	7.0	3.8	0.2	0.6	0.6	12.3	5.0	0.03	1.84	5.1	4	12	16	3	2.90	0.51	0.41	2.00
1	60	5.2	0.14	0.94	140	10.0	9.1	0.3	1.3	0.2	21.0	6.2	0.02	1.10	1.1	0	3	5	9	0.19	0.22	0.23	0.54
1	90	6.3	0.47	2.73	640	11.0	11.0	0.2	2.8	0.0	25.0	11.2	0.04	1.00	0.0	0	<1	<5	7	0.05	0.13	0.10	0.24
1	200	6.6	0.29	2.18	320	8.5	8.2	0.2	2.2	0.0	19.1	11.5	0.03	1.04	0.0	1	<1	<5	6	0.37	0.52	0.07	0.18
1	300	6.0	0.16	1.20	220	6.0	5.9	0.2	1.4	0.0	13.5	10.4	0.02	1.02	0.0	3	<1	<5	6	0.36	0.35	0.08	0.17
4	15	6.2	0.18	1.55	15	15.0	2.0	0.4	0.1	0.0	17.5	0.5	0.39	7.50	0.0	0	55	200	20	20.00	7.80	0.56	3.50
4	30	4.5	0.07	0.60	14	4.4	2.4	0.3	0.1	1.0	8.2	0.7	0.10	1.83	12.0	2	6	12	20	0.95	0.35	0.25	1.10
4	60	4.5	0.12	1.03	13	3.5	7.0	0.3	0.3	1.8	12.9	2.1	0.06	0.50	13.9	11	<1	<5	54	0.22	0.12	0.21	0.37
5	15	4.6	0.18	1.55	170	1.9	2.6	0.3	0.9	0.3	6.0	15.1	0.01	0.73	4.8	3	7	23	13	1.00	0.17	0.41	2.40
5	30	4.8	0.27	1.81	320	1.3	2.9	0.2	1.3	0.2	5.9	22.1	0.01	0.45	3.2	4	<1	5	8	0.14	0.04	0.28	0.84
5	60	6.4	0.69	4.00	740	2.2	11.0	0.3	5.2	0.0	18.7	27.8	0.02	0.20	0.0	12	<1	<5	37	0.04	0.02	0.47	0.48
5	90	7.5	1.23	7.13	1500	2.0	12.0	0.2	9.1	0.0	23.3	39.0	0.03	0.17	0.0	0	<1	<5	88	0.03	0.02	0.12	<0.2
5	120	7.8	1.43	8.29	1800	2.0	12.0	0.2	10.0	0.0	24.2	41.4	0.03	0.17	0.0	0	<1	<5	110	0.04	<0.01	0.09	<0.2
7	15	4.3	0.20	1.72	16	2.1	2.6	0.4	0.2	0.7	6.0	3.5	0.06	0.81	11.8	2	110	24	8	6.80	0.13	0.31	2.10
7	30	4.3	0.06	0.35	27	0.9	7.7	0.2	1.1	1.9	11.8	9.3	0.01	0.12	16.1	14	4	<5	2	0.65	0.01	0.19	0.41
7	60	4.2	0.09	0.52	58	0.2	7.1	0.2	1.7	9.3	18.5	9.2	0.01	0.02	50.4	15	2	<5	7	0.53	<0.01	0.15	0.18
13	15	7.8	0.11	0.95	<10	9.5	6.0	0.3	0.4	0.0	16.2	2.3	0.05	1.58	0.0	13	<1	<5	3	0.58	0.25	0.05	0.23
13	30	8.1	0.18	1.55	<10	7.0	6.7	0.3	0.5	0.0	14.5	3.3	0.05	1.04	0.0	1	<1	<5	56	0.84	0.30	0.02	1.70
13	60	8.1	0.29	2.49	<10	7.0	6.7	0.4	0.8	0.0	14.9	5.6	0.05	1.04	0.0	11	<1	<5	150	1.30	0.34	<0.02	1.20
13	90	8.1	0.76	6.54	26	9.5	6.7	0.3	1.2	0.0	17.7	6.8	0.11	1.42	0.0	12	<1	<5	520	1.60	0.28	<0.02	1.20

Site New#	Depth (cm)	pH CaCl2	EC 1:5 dS/m	ECe dS/m	Chloride mg/kg	Exchangeable Cations, meq/100g				Al	CEC	ESP	ESI	Ca/Mg	EAlP	ASWAT Score	NO3-N mg/kg	Colwell-P mg/kg	SO4-S mg/kg	DTPA-Zn mg/kg	DTPA-Cu mg/kg	Boron mg/kg	Org. C %
						Ca	Mg	K	Na														
14	15	4.5	0.08	0.69	54	2.5	2.7	0.2	0.6	0.4	6.4	9.0	0.01	0.93	6.3	4	7	8	6	0.84	0.62	0.39	1.50
14	30	4.5	0.13	0.75	98	4.7	12.0	0.3	2.2	2.9	22.1	10.0	0.01	0.39	13.2	15	<1	<5	6	0.14	0.49	0.35	0.73
14	60	4.5	0.44	2.95	520	3.6	14.0	0.3	4.4	3.3	25.6	17.2	0.03	0.26	12.9	10	<1	<5	26	0.08	0.24	0.13	0.40
14	90	5.0	0.66	4.42	710	3.9	16.0	0.3	6.5	0.9	27.6	23.6	0.03	0.24	3.2	3	<1	<5	31	0.06	0.44	0.08	0.20
14	200	6.8	0.54	3.62	760	3.7	7.7	0.2	4.4	0.0	16.0	27.5	0.02	0.48	0.0	13	<1	<5	16	0.08	0.14	0.05	<0.2
14	300	7.0	0.71	4.76	830	5.5	11.0	0.3	6.1	0.0	22.9	26.6	0.03	0.50	0.0	13	<1	<5	19	0.11	0.21	0.07	<0.2
15	15	4.4	0.06	0.52	27	0.9	2.2	0.3	0.4	1.0	4.8	9.2	0.01	0.41	20.4	11	<1	7	6	0.82	0.13	0.26	1.60
15	30	4.4	0.12	0.90	76	0.6	8.2	0.4	1.7	3.4	14.2	12.0	0.01	0.07	23.9	15	<1	<5	5	0.18	<0.01	0.25	0.64
15	60	4.3	0.31	2.33	390	0.3	11.0	0.4	3.2	4.2	19.1	16.8	0.02	0.03	22.1	13	<1	<5	21	0.39	0.08	0.15	0.39
15	90	4.3	0.57	3.31	580	0.2	14.0	0.5	5.2	3.8	23.7	22.0	0.03	0.01	16.1	13	<1	<5	36	0.97	0.46	0.06	0.19
17	15	4.4	0.06	0.45	16	2.1	7.4	0.4	0.8	5.0	15.7	5.0	0.01	0.28	31.8	14	<1	<5	5	0.75	0.07	0.46	2.20
17	30	4.4	0.10	0.58	38	1.3	11.0	0.3	1.4	7.3	21.3	6.6	0.02	0.12	34.4	11	<1	<5	11	0.06	<0.01	0.32	0.93
17	60	4.4	0.28	1.62	160	0.4	13.0	0.3	2.8	8.7	25.2	11.1	0.03	0.03	34.5	0	<1	<5	65	<0.02	<0.01	0.18	0.53
17	90	4.5	0.51	2.96	300	0.1	15.0	0.3	4.4	6.6	26.5	16.6	0.03	0.01	24.9	0	<1	<5	130	0.09	<0.01	0.09	0.25
18	15	4.3	0.07	0.60	20	2.8	4.5	0.2	0.8	3.6	12.0	6.9	0.01	0.62	30.1	14	<1	<5	11	0.37	0.14	0.44	1.90
18	30	4.2	0.07	0.60	27	1.6	2.6	0.1	0.7	3.1	8.2	9.1	0.01	0.62	38.0	14	<1	<5	10	0.15	0.05	0.31	1.20
18	60	4.1	0.22	1.47	71	3.6	5.3	0.3	2.7	9.8	21.7	12.5	0.02	0.68	45.3	10	<1	<5	54	<0.02	<0.01	0.26	0.76
18	90	4.3	0.21	1.41	75	3.6	4.8	0.2	2.5	4.6	15.7	16.0	0.01	0.75	29.4	12	<1	<5	67	0.02	<0.01	0.12	0.22
18	200	4.6	0.21	1.41	100	4.6	8.2	0.2	3.8	0.5	17.3	21.9	0.01	0.56	2.9	14	<1	<5	46	0.10	0.20	0.04	<0.2
18	300	6.7	0.15	1.01	79	8.0	8.2	0.2	4.8	0.0	21.2	22.6	0.01	0.98	0.0	15	<1	<5	27	0.10	0.19	0.03	0.17

Site New#	Depth (cm)	pH CaCl2	EC 1:5 dS/m	ECe dS/m	Chloride mg/kg	Exchangeable Cations, meq/100g				Al	CEC	ESP	ESI	Ca/Mg	EAlP	ASWAT Score	NO3-N mg/kg	Colwell-P mg/kg	SO4-S mg/kg	DTPA-Zn mg/kg	DTPA-Cu mg/kg	Boron mg/kg	Org. C %
						Ca	Mg	K	Na														
19	15	4.0	0.03	0.41	14	0.3	1.2	0.3	0.1	2.9	4.8	1.7	0.02	0.23	60.7	11	1	<5	2	0.30	0.04	0.39	1.80
19	30	4.3	0.02	0.28	12	0.1	0.8	0.3	0.1	2.0	3.1	2.2	0.01	0.06	63.7	13	<1	<5	1	0.11	0.01	0.17	0.68
19	60	4.2	0.05	0.34	22	0.0	3.7	0.3	0.5	9.6	14.1	3.4	0.01	0.01	68.1	0	<1	<5	8	<0.02	<0.01	0.35	0.98
19	90	4.0	0.08	0.54	78	0.0	2.4	0.2	0.5	14.0	17.1	3.0	0.02	0.01	81.9	0	<1	<5	13	<0.02	<0.01	0.11	0.23
21	15	4.3	0.04	0.55	28	2.3	0.9	0.2	0.3	1.3	5.0	6.0	0.01	2.53	25.8	3	7	6	4	0.87	0.08	0.26	2.10
21	30	4.2	0.03	0.27	27	0.4	0.8	0.2	0.3	2.0	3.7	7.7	0.00	0.47	54.8	8	<1	<5	1	0.10	0.04	0.14	0.53
21	60	4.2	0.08	0.54	67	0.0	5.3	0.4	1.2	9.2	16.1	7.5	0.01	0.00	57.1	14	<1	<5	6	0.25	0.02	0.15	<0.2
26	15	4.3	0.06	0.52	35	1.6	3.3	0.4	0.5	2.1	7.9	6.1	0.01	0.48	26.6	4	2	8	5	1.80	0.07	0.65	3.90
26	30	4.3	0.03	0.26	27	0.2	1.6	0.1	0.3	2.0	4.2	6.3	0.00	0.12	48.1	12	<1	<5	2	0.39	0.03	0.33	1.10
26	60	4.2	0.20	1.16	200	0.2	8.2	0.1	2.1	12.0	22.7	9.3	0.02	0.03	53.0	11	<1	<5	19	<0.02	<0.01	0.63	0.53
26	90	4.1	0.22	1.28	200	0.1	9.1	0.2	2.8	17.0	29.1	9.6	0.02	0.01	58.3	0	<1	<5	43	0.03	<0.01	0.26	0.26
27	15	4.5	0.04	0.34	14	1.7	2.4	0.2	0.4	1.4	6.1	6.6	0.01	0.71	22.9	11	<1	8	4	0.86	0.20	0.42	1.90
27	30	4.5	0.05	0.43	17	1.5	2.6	0.2	0.7	1.4	6.4	11.6	0.00	0.58	21.9	11	<1	8	5	0.68	0.16	0.43	1.90
27	60	4.6	0.18	1.55	120	0.8	9.1	0.3	2.8	0.6	13.6	20.6	0.01	0.09	4.5	14	<1	<5	33	1.60	1.40	0.07	0.25
27	90	4.3	0.55	4.73	450	1.6	7.2	0.5	3.5	4.3	17.1	20.5	0.03	0.22	25.2	13	<1	<5	130	0.86	0.42	0.29	0.40
27	120	7.0	0.65	4.36	330	5.0	8.2	0.3	2.8	0.0	16.3	17.2	0.04	0.61	0.0	14	<1	<5	250	7.10	2.40	0.07	2.00
29	15	4.6	0.05	0.69	19	1.8	2.1	0.4	0.1	0.2	4.7	2.8	0.02	0.86	5.2	2	8	<5	3	1.20	0.15	0.26	1.00
29	30	4.3	0.06	0.83	29	1.1	2.9	0.2	0.4	1.1	5.7	7.7	0.01	0.38	19.3	6	<1	<5	10	0.34	0.14	0.19	0.35
29	60	4.3	0.10	0.58	66	1.6	3.4	0.1	1.0	0.8	6.9	13.9	0.01	0.47	12.0	13	<1	<5	16	0.12	0.11	0.18	0.48
29	90	4.0	0.16	0.93	140	0.9	4.0	0.2	1.5	4.3	10.9	13.8	0.01	0.21	39.6	14	<1	<5	26	0.14	0.09	0.13	0.25

Site New#	Depth (cm)	pH CaCl2	EC 1:5 dS/m	ECe dS/m	Chloride mg/kg	Exchangeable Cations, meq/100g				Al	CEC	ESP	ESI	Ca/Mg	EAlP	ASWAT Score	NO3-N mg/kg	Colwell-P mg/kg	SO4-S mg/kg	DTPA-Zn mg/kg	DTPA-Cu mg/kg	Boron mg/kg	Org. C %
						Ca	Mg	K	Na														
35	15	4.5	0.05	0.43	29	1.5	2.1	0.3	0.2	0.5	4.6	5.0	0.01	0.71	11.7	4	1	10	4	1.90	0.19	0.29	1.90
35	30	4.5	0.05	0.43	39	1.1	1.4	0.1	0.3	0.4	3.3	8.7	0.01	0.79	12.9	4	<1	6	3	0.71	0.11	0.17	0.87
35	60	4.3	0.24	1.39	320	2.0	5.3	0.2	2.2	2.2	11.9	18.5	0.01	0.38	18.5	2	<1	<5	14	0.05	0.03	0.20	0.42
35	90	4.7	0.62	3.60	810	2.1	6.7	0.2	4.8	0.5	14.3	33.5	0.02	0.31	3.6	0	<1	<5	44	0.04	0.06	0.06	0.21
35	120	5.7	0.96	5.57	1300	3.0	9.1	0.2	7.4	0.0	19.7	37.5	0.03	0.33	0.0	2	<1	<5	55	0.07	0.08	0.04	<0.2
35	200	7.0	0.77	4.47	960	3.8	8.2	0.2	6.5	0.0	18.7	34.7	0.02	0.46	0.0	2	<1	<5	36	0.07	0.09	0.05	<0.2
35	300	7.2	0.81	4.70	930	6.0	12.0	0.3	8.7	0.0	27.0	32.2	0.03	0.50	0.0	11	<1	<5	42	0.06	0.16	0.09	<0.2
37	15	4.5	0.04	0.36	14	3.3	3.0	0.5	0.3	1.0	8.0	3.9	0.01	1.10	12.0	4	<1	6	5	0.89	0.24	0.31	1.60
37	30	4.6	0.05	0.43	13	1.1	2.9	0.2	0.6	0.9	5.6	10.1	0.00	0.38	15.3	12	1	<5	6	0.14	0.10	0.19	0.50
39	15	4.7	0.06	0.57	35	5.0	3.0	0.5	0.3	0.3	9.1	3.1	0.02	1.67	3.1	1	<1	5	5	2.10	0.32	0.41	2.60
39	30	4.5	0.02	0.19	<10	3.4	2.1	0.3	0.1	1.6	7.5	0.9	0.02	1.62	21.4	4	<1	<5	<1	0.13	0.10	0.21	0.84
39	60	4.3	0.01	0.09	<10	1.3	4.0	0.2	0.1	4.7	10.4	1.3	0.01	0.33	45.4	11	<1	<5	<1	0.08	0.08	0.07	0.31
39	90	4.0	0.01	0.09	<10	0.7	4.3	0.3	0.4	10.0	15.6	2.5	0.00	0.15	64.1	12	<1	<5	<1	0.24	0.05	0.06	0.63
40	15	4.5	0.04	0.34	18	1.5	1.6	0.4	0.2	0.7	4.4	5.5	0.01	0.94	15.8	4	1	12	4	2.00	0.19	0.23	1.40
40	20	4.7	0.03	0.26	15	1.0	1.3	0.2	0.2	0.3	3.0	7.7	0.00	0.77	9.1	12	<1	<5	2	0.37	0.03	0.12	0.51
40	30	4.4	0.08	0.46	28	1.8	8.2	0.3	1.3	3.7	15.3	8.5	0.01	0.22	24.2	15	<1	<5	3	0.12	<0.01	0.33	0.57
40	60	4.3	0.15	0.87	110	1.0	9.1	0.3	1.9	5.1	17.4	10.9	0.01	0.11	29.3	1	2	<5	16	0.24	0.01	0.28	0.43
40	90	4.3	0.30	1.74	310	0.2	9.9	0.4	3.2	2.7	16.4	19.5	0.02	0.02	16.5	11	<1	<5	28	0.46	0.21	0.11	0.15
43	15	5.1	0.04	0.34	14	3.1	4.7	0.3	0.3	0.1	8.5	3.5	0.01	0.66	1.5	12	<1	<5	9	0.36	0.12	0.24	0.82
43	30	4.6	0.04	0.34	12	2.1	3.5	0.1	0.3	0.7	6.7	4.2	0.01	0.60	9.9	11	<1	<5	7	0.52	0.19	0.25	1.10

Site New#	Depth (cm)	pH CaCl2	EC 1:5 dS/m	ECe dS/m	Chloride mg/kg	Exchangeable Cations, meq/100g				Al	CEC	ESP	ESI	Ca/Mg	EAlP	ASWAT Score	NO3-N mg/kg	Colwell-P mg/kg	SO4-S mg/kg	DTPA-Zn mg/kg	DTPA-Cu mg/kg	Boron mg/kg	Org. C %
						Ca	Mg	K	Na														
44	15	6.8	1.18	10.15	40	17.0	4.0	0.5	0.7	0.0	22.2	3.3	0.35	4.25	0.0	1	24	26	1100	1.40	0.23	0.29	0.88
44	30	5.1	0.28	2.10	120	4.7	5.4	0.4	1.8	0.1	12.4	14.5	0.02	0.87	0.8	11	15	8	100	1.20	0.32	0.30	1.00
44	60	5.0	0.27	2.32	160	2.8	5.6	0.3	2.7	0.2	11.6	23.4	0.01	0.50	1.8	15	<1	<5	84	0.28	0.08	0.06	<0.2
47	15	4.6	0.09	0.86	21	3.1	3.6	0.5	0.3	0.4	7.9	3.7	0.02	0.86	4.9	4	19	7	11	1.40	0.21	0.41	1.30
47	30	4.8	0.06	0.52	41	3.4	4.1	0.2	0.4	0.2	8.4	5.3	0.01	0.83	2.3	11	<1	5	12	1.60	0.34	0.34	1.20
48	15	4.3	0.21	1.81	24	3.7	3.0	1.3	0.2	1.7	9.9	1.7	0.12	1.23	17.2	0	94	20	14	3.10	0.23	0.61	4.50
48	30	4.1	0.03	0.20	15	1.1	1.7	0.3	0.2	11.0	14.3	1.4	0.02	0.65	76.9	12	<1	<5	4	0.03	<0.01	0.54	0.85
48	60	3.9	0.03	0.20	<10	0.4	1.5	0.3	0.2	19.0	21.3	1.1	0.03	0.24	89.0	0	<1	<5	10	<0.02	<0.01	0.38	0.35
48	90	3.8	0.04	0.23	12	0.1	1.6	0.3	0.4	19.0	21.4	1.9	0.02	0.07	88.9	1	<1	<5	18	0.02	<0.01	0.21	0.20
53	15	4.3	0.03	0.41	14	1.2	1.6	0.2	0.2	2.0	5.2	4.0	0.01	0.75	38.2	5	<1	6	3	0.52	0.10	0.26	2.10
53	30	4.4	0.02	0.28	<10	0.6	1.3	0.1	0.2	1.3	3.5	6.9	0.00	0.46	37.1	11	<1	<5	<1	0.11	0.03	0.12	0.99
53	60	4.2	0.12	0.70	42	0.7	9.1	0.2	1.7	13.0	24.7	6.9	0.02	0.07	52.7	13	<1	<5	21	<0.02	<0.01	0.30	0.49
53	90	4.2	0.23	1.33	80	0.2	11.0	0.3	2.6	16.0	30.1	8.6	0.03	0.02	53.1	0	<1	<5	74	0.04	<0.01	0.12	<0.2
54	15	4.9	0.15	1.29	30	4.2	4.8	0.9	0.4	0.1	10.3	3.4	0.04	0.88	1.0	2	58	13	10	4.00	0.34	0.69	3.90
54	30	4.1	0.05	0.43	24	1.0	6.0	0.7	0.8	8.1	16.6	4.7	0.01	0.17	48.9	15	<1	<5	4	0.52	0.02	0.35	0.68
54	60	4.0	0.18	1.55	150	0.3	11.0	0.8	2.4	16.0	30.5	7.9	0.02	0.02	52.5	12	<1	<5	18	0.45	<0.01	0.29	0.62
54	90	3.9	0.47	3.15	440	0.1	12.0	0.8	4.4	13.0	30.3	14.6	0.03	0.01	43.0	11	<1	<5	40	0.66	<0.01	0.18	0.36
55	15	5.0	0.06	0.52	20	3.7	2.8	0.7	0.0	0.1	7.4	0.5	0.11	1.32	1.4	0	14	10	5	1.70	0.30	0.36	2.10
55	30	7.1	0.11	1.52	15	11.0	3.3	0.5	0.0	0.0	14.9	0.3	0.41	3.33	0.0	1	5	<5	3	0.64	0.36	0.15	1.90
55	60	8.0	0.11	1.52	16	17.0	4.6	0.4	0.0	0.0	22.1	0.2	0.61	3.70	0.0	6	<1	<5	2	0.40	0.32	0.14	2.60
55	90	8.2	0.12	1.66	15	14.0	7.2	0.4	0.1	0.0	21.6	0.2	0.52	1.94	0.0	12	<1	<5	4	0.44	0.26	0.14	2.40

Site New#	Depth (cm)	pH CaCl2	EC 1:5 dS/m	ECe dS/m	Chloride mg/kg	Exchangeable Cations, meq/100g				Al	CEC	ESP	ESI	Ca/Mg	EAIP	ASWAT Score	NO3-N mg/kg	Colwell-P mg/kg	SO4-S mg/kg	DTPA-Zn mg/kg	DTPA-Cu mg/kg	Boron mg/kg	Org. C %
						Ca	Mg	K	Na														
56	15	4.4	0.08	1.10	24	2.0	1.8	0.4	0.2	1.2	5.6	3.9	0.02	1.11	21.3	2	29	6	5	0.61	0.15	0.33	1.70
56	30	4.5	0.05	0.69	32	1.2	1.4	0.4	0.1	1.1	4.2	3.3	0.02	0.86	26.1	11	15	<5	3	0.07	0.04	0.19	0.69
63	15	4.3	0.04	0.34	27	0.7	1.6	0.5	0.2	2.9	5.9	3.7	0.01	0.44	49.1	6	<1	7	6	0.41	0.11	0.46	3.60
63	30	4.3	0.02	0.17	17	0.5	0.9	0.3	0.1	2.9	4.7	2.8	0.01	0.49	61.4	11	<1	<5	2	0.14	0.03	0.22	1.50
63	60	4.1	0.03	0.20	17	0.5	4.4	0.4	0.5	12.0	17.8	2.9	0.01	0.11	67.6	10	<1	<5	7	<0.02	<0.01	0.31	0.33
63	90	4.0	0.05	0.34	21	0.1	6.3	0.4	1.0	12.0	19.8	5.1	0.01	0.02	60.7	10	<1	<5	17	<0.02	<0.01	0.13	0.17
64	15	4.1	0.03	0.41	16	0.8	0.7	0.2	0.2	5.1	7.0	2.4	0.01	1.10	72.6	2	<1	6	3	0.36	0.11	0.41	4.00
64	30	4.2	0.02	0.17	12	0.1	0.4	0.1	0.2	7.5	8.3	1.8	0.01	0.31	90.4	1	1	<5	2	0.04	<0.01	0.33	1.70
64	60	3.9	0.03	0.17	12	0.2	1.1	0.2	0.3	30.0	31.8	1.0	0.03	0.20	94.3	0	<1	<5	10	<0.02	<0.01	0.45	0.74
64	90	3.8	0.04	0.23	13	0.1	1.0	0.2	0.4	33.0	34.8	1.2	0.03	0.14	95.0	1	<1	<5	21	0.04	<0.01	0.36	0.30
64	120	3.8	0.05	0.29	12	0.1	1.8	0.2	0.7	30.0	32.8	2.1	0.02	0.04	91.5	0	<1	<5	25	0.10	<0.01	0.26	0.20
68	15	4.4	0.04	0.34	22	1.0	1.0	0.4	0.2	1.1	3.7	4.9	0.01	1.01	30.1	4	5	<5	4	0.51	0.11	0.25	1.50
68	30	4.4	0.02	0.17	<10	0.4	0.8	0.2	0.2	1.2	2.8	6.2	0.00	0.56	43.6	6	1	<5	1	0.05	0.01	0.11	0.44
68	60	4.3	0.01	0.09	13	0.2	1.6	0.2	0.2	1.7	3.9	6.2	0.00	0.11	43.8	14	<1	<5	<1	0.04	<0.01	0.10	0.25
68	90	4.1	0.03	0.17	13	0.3	5.3	0.4	0.7	7.3	14.0	5.3	0.01	0.05	52.2	11	<1	<5	7	<0.02	<0.01	0.24	0.15

cm = centimetres EC = electrical conductivity ds/m = deciSiemens per metre

EC_e = EC of the saturation extract; a measure of the salinity of a soil sample. It is assessed using a 1:5 soil:water extract, then multiplied by a conversion factor that takes into account the influence of texture (clay content) on the response of plants to salinity.

mg/kg = milligrams per kilogram

meq/100 g = milliequivalent of hydrogen per 100 grams.

CEC: Cation Exchange Capacity (sum of exchangeable cations); exchangeable cations are positively charged ions held loosely on negatively charged soil particles, and readily exchanged with other ions in the soil solution.

ESP: The quantity of exchangeable sodium ions as a percentage of all exchangeable cations held by soil. The critical ESP above which dispersion occurs ranges from 2 to 15, depending on the amount of electrolyte in soil solution.

ESI: Electrochemical Stability Index; $EC_{1:5}$ (dS/m) divided by ESP; it is a measure of soil stability in water; aim for values greater than 0.05.

EAIP = The quantityof exchangeable aluminium ions as a percentage of all exchangeable cations held by soil.

ASWAT = aggregate stability in water.

DTPA = Diethylene triamine pentaacetic acid.

Appendix 6 SCS Laboratory; Calibration Data

Please note: Field Pit number 6 is referred to in the report as **Pit 14**; Field Pit number 16 is referred to in the report as **Pit 29**.

NSW Soil Conservation Service

David McKenzie
McKenzie Soil Management Pty Ltd
PO Box 2171
Orange NSW 2800

24 August 2011 SCO11/240

Dear David McKenzie

Analysis of eight soil samples – Erosion and sediment control package

The Soil Conservation Service has completed the analysis of eight soil samples (Soil test report SCO11/240R1). The samples were analysed for: particle size (clay, silt, fine sand, coarse sand and gravel); dispersion percentage (D%); Emerson aggregate test (EAT); organic carbon (OC); and particle size analysis-mechanical dispersion (clay, silt, fine sand, coarse sand and gravel). The soil erodibility factor (K factor) has been determined (as described by Rosewell 1993) using the particle size analysis-mechanical dispersion and the organic carbon. The surface soil structure was assumed to be medium granular and the profile permeability was assumed to be slow to moderate.

Lab No	Sample Id	K factor	Rating
1	SCPL Pit 6 0-15	0.051	High
2	SCPL Pit 6 15-30	0.029	Moderate
3	SCPL Pit 6 30-60	0.031	Moderate
4	SCPL Pit 6 60-90	0.016	Low
5	SCPL Pit 16 0-15	0.041	High
6	SCPL Pit 16 15-30	0.042	High
7	SCPL Pit 16 30-60	0.031	Moderate
8	SCPL Pit 16 60-90	0.035	Moderate

This interpretation was based on the soil samples supplied being representative, and literature guidelines. If you have any queries, please contact me on (02) 6545 1666.

Yours faithfully

SR Young

References

Rosewell CJ (1993) Soiloss – A program to assist in the selection of management practices to reduce erosion. Department of Conservation and Land Management.

NSW Soil Conservation Service

SOIL TEST REPORT

Page 1 of 3

Scone Research Centre

REPORT NO:	SCO11/240R1
REPORT TO:	David McKenzie McKenzie Soil Management Pty Ltd PO Box 2171 Orange NSW 2800
REPORT ON:	Eight soil samples
PRELIMINARY RESULTS ISSUED:	Not issued
REPORT STATUS:	Final
DATE REPORTED:	24 August 2011
METHODS:	Information on test procedures can be obtained from Scone Research Centre

TESTING CARRIED OUT ON SAMPLE AS RECEIVED
THIS DOCUMENT MAY NOT BE REPRODUCED EXCEPT IN FULL

SR Young
(Laboratory Manager)

Scone Research Centre, PO Box 283 Scone 2337, 709 Gundy Road Scone 2337
Ph: 02 6545 1666, Fax: 02 6545 2520

SOIL CONSERVATION SERVICE
Scone Research Service Centre

Report No: SCO11/240R1
Client Reference: David McKenzie
McKenzie Soil Management Pty Ltd
PO Box 2171
Orange NSW 2800

Lab No	Method	P7B/2 Particle Size Analysis (%)					P8A/2	P9B/2	C6A/2
	Sample Id	clay	silt	f sand	c sand	gravel	D%	EAT	OC (%)
1	SCPL Pit 6 0-15	15	39	33	7	6	44	7	1.41
2	SCPL Pit 6 15-30	46	27	21	5	1	70	2(1)	0.88
3	SCPL Pit 6 30-60	67	23	9	1	<1	48	2(2)	0.54
4	SCPL Pit 6 60-90	64	24	10	2	<1	94	2(2)	0.23
5	SCPL Pit 16 0-15	13	16	52	18	1	44	5	1.53
6	SCPL Pit 16 15-30	17	12	51	17	3	43	3(1)	0.37
7	SCPL Pit 16 30-60	39	20	33	8	<1	55	3(2)	0.50
8	SCPL Pit 16 60-90	38	19	36	7	<1	51	2(1)	0.38

SOIL CONSERVATION SERVICE
Scone Research Service Centre

Report No: SCO11/240R1
Client Reference: David McKenzie
McKenzie Soil Management Pty Ltd
PO Box 2171
Orange NSW 2800

Lab No	Method	P7C/2 Particle Size Analysis - mechanical dis (%)				
	Sample Id	clay	silt	f sand	c sand	gravel
1	SCPL Pit 6 0-15	15	35	34	10	6
2	SCPL Pit 6 15-30	44	30	20	5	1
3	SCPL Pit 6 30-60	44	33	19	4	<1
4	SCPL Pit 6 60-90	66	22	10	2	<1
5	SCPL Pit 16 0-15	14	14	47	24	1
6	SCPL Pit 16 15-30	17	11	45	24	3
7	SCPL Pit 16 30-60	38	19	32	11	<1
8	SCPL Pit 16 60-90	36	19	37	8	<1

END OF TEST REPORT

Appendix 7 Agricultural Suitability of Key Sites under the Current Management Regime

Pit	Agricultural Suitability Factors										
	Slope/ erosion hazard	Depth to hard rock	Waterlogging hazard	Acidic topsoil	Acidic subsoil	Compacted topsoil	Compacted subsoil	Dispersive topsoil	Dispersive subsoil	Salinity	Nutrient deficiency	**OVERALL RATING**
17	3	2	3	4	4	3	4	4	2	3	4	**4**
21	3	4	4	4	4	2	3	3	4	2	4	**4**
26	3	2	4	4	4	1	4	3	4	2	4	**4**
29	2	3	4	3	4	3	3	3	4	2	4	**4**
47	4	4	2	3	-	3	-	3	-	-	4	**4**
48	4	3	4	4	4	2	3	2	2	2	4	**4**
54	4	3	3	3	4	2	4	3	4	4	4	**4**
56	4	4	4	4	-	2	-	3	-	-	4	**4**
63	4	3	4	4	4	3	4	3	4	2	4	**4**
68	4	3	3	4	4	2	3	3	4	2	4	**4**