Appendix G Erosion and Sediment Control Technical Memo

FMFTECHNICAL NOTE			
Memo No.	001	Date:	1 October 2021
Revision:	Rev 3	Prepared for:	Pacific Hydro
Discipline:	Environment	Originator:	Levi Cook / Anthony Moll
Subject:	Erosion and Sediment Control Assessment	Reviewer / Approver:	Alexander Williams / Eladio Perez / Daniel Saunders

1 Introduction

The Daroobalgie Solar Farm (the project) encompasses a solar farm site consisting of approximately 420,000 solar photovoltaic (PV) panels and associated infrastructure, an electricity transmission line (ETL) and a switchyard site. The project will connect to an existing 132 kilovolt (kV) powerline west of Newell Highway. The project will have an estimated capacity of approximately 100 megawatts (MW) and will provide enough electricity to power up to the equivalent of 34,000 homes each year.

The project is in the Forbes Shire Council Local Government Area (LGA) of central western New South Wales.

SMEC Australia Pty Ltd (SMEC) has prepared this technical assessment to inform the environmental impact statement (EIS) being prepared for the proposal. The purpose of this technical assessment is to outline erosion and sediment control measures to mitigate any impacts associated with construction activities. The assessment addresses one of the key issues identified within the Secretary's Environment Assessment Requirements (SEARs), specifically in relation to water (refer to Table 1-1).

Table 1-1 SEARs Water

SECRETARY'S ENVIRONMENTAL ASSESSMENT REQUIREMENTS	WHERE ADDRESSED IN THIS TECHNICAL ASSESSMENT
Key Issues **Water** – including an assessment of the likely impacts of the development (including flooding) on surface water and groundwater resources (including the unnamed water course traversing the site), drainage channels, wetlands, riparian land, farm dams, groundwater dependent ecosystems and acid sulfate soils), related infrastructure, adjacent licensed water users and basic landholder rights, and measures proposed to monitor, reduce and mitigate these impacts	Refer to Flood Impact Assessment Refer to Hydrogeological Assessment Report
details of water requirements and supply arrangements for construction and operation; and	Refer to Hydrogeological Assessment Report
a description of the erosion and sediment control measures that would be implemented to mitigate any impacts in accordance with *Managing Urban Stormwater: Soils & Construction* (Landcom 2004);	This technical note

2 Assessment methodology

2.1 Scope of work

Assessment of erosion and sediment impacts and proposed control measures comprised the following scope of work:

- Desktop review of relevant published information on the existing environment including:
  - Topography and drainage
  - Geology
  - Soil landscapes
  - Acid sulfate soils
  - Hydrogeology information searches of nearby registered groundwater bores with NSW Department of Industry, WaterNSW
  - Geotechnical information presented within Preliminary Geotechnical Investigation Report (Golder, Ref: 18113974-001-R-Rev0, Revision 0, dated 4 April 2019)
  - Erosion potential based on review of site observations made during a site visit (April 2020) and the geotechnical investigation completed by Golder Pty Ltd (January 2019).
- Assessment of potential erosion impacts from construction including:
  - Review concept designs of proposed development to identify preliminary construction catchments within the proposed construction footprint only, slope gradient/slope lengths and likely construction water flow paths
  - Calculating potential sediment loads using the Revised Universal Soil Loss Equation (RUSLE) during construction phase only
  - Discussion of potential impact of construction activities on soils and the potential for sediment mobilisation into receiving waterways.
- Recommendations of control measures to mitigate potential impacts during construction.

2.2 Published guidelines

The following published policies and guidelines are considered relevant and have been referred to in accordance with the SEARs:

- Managing Urban Stormwater: Soils & Construction ('Blue Book'), Volume 1 (Landcom, 2004)
- Managing Urban Stormwater: Soils and Construction Volume 2D, Main Road Construction (NSW Department of Environment and Climate Change, 2008)
- Soil and Landscape Issues in Environmental Impact Assessment (DLWC, 2000).

3 Existing environment

3.1 Topography and drainage

The project is located on land that relatively flat and is surrounded by land that is used predominately for agricultural purposes. The Forbes Central West Livestock Exchange is located on Back Yamma Road, 2.5 km to the west of the project. Back Yamma State Forest is situated 7 km to the east at an elevation of 340 m AHD, and the closest National Park is Goobang National Park, 30 km to the north east.

The Lachlan River runs near the project, approximately 3.5km south of the solar farm site's southern boundary. Both on the subject site and surrounding the project there are several small dams to collect local surface runoff, presumably to support livestock and crops on local farming properties. The locations of these dams are indicative of the slope and overland surface flow paths. Manmade landscape features, such as channels and floodways, are also located near the project.

The solar farm site is located on approximately 300 hectares (ha) of land legally described as Lot 77 in Deposited Plan 750183. The land is largely cleared, having been highly modified by past disturbances associated with land clearing, cropping, and livestock grazing. The solar farm site is located on land with gentle slopes from north to south from around 250 m AHD at the northern boundary on Troubalgie Road to around 244 m AHD at the southern boundary and generally slopes towards the Lachlan River located some 3.5 km to the south. The nearest elevated land is the Back Yamma State Forrest at 340 m AHD approximately seven kilometres to the east of the Project.

A natural watercourse runs to the east of the site, and intersects the solar farm site at the southeast corner. Small ephemeral waterholes, known locally as gilgai, are present in some paddocks, mainly within the south eastern section of the site. These have been progressively ploughed and levelled by farming activities over time.

In summary the following drainage features are identified within the solar farm site (SMEC; 30 April 2020):

- Troubalgie Road is elevated compared to adjacent land. There is a sag point in the northern side of the road in which there is a box culvert allowing runoff resulting from upstream catchment to enter the site
- A second box culvert crossing the Troubalgie Road near the western side of the solar farm site, connecting to a downstream floodway. A third box culvert is located near the junction of Troubalgie Road and Forest Road
- There are shallow berms or swales along the western and eastern boundaries restricting surface run-on and run-off respectively from adjacent properties
- There is a main shallow north south spoon drain constructed almost at the centre of the solar farm site possibly resulting from pasture development and past tillage practices
- There are also minor sub catchment channels constructed across the site to divert the local surface flows from the main abovementioned spoon drain to each of the constructed dams located between the centre of the site and the western boundary
- A constructed channel diverts flow from the end of the main channel / floodway to a dam adjacent to the western boundary
- There are six dams within the solar farm site (refer to Figure 3-1):
  - The “first” dam is near the solar farm site entrance from Troubalgie Road
  - The second dam is located almost at centre of the solar farm site along the main flood way. Berms have been constructed to divert runoff into this dam. The berms’ elevation appears to be higher than adjacent land elevations. This means that water elevation within the constructed floodway needs to reach a certain level before it enters the dam
  - A third dam is located between the centre of the solar farm site and western boundary
  - There are two dams along the western boundary
  - The sixth dam is almost at south-eastern corner of the solar farm site. An unnamed water course running south along outside of the eastern boundary of the solar farm site flows into and beyond this dam.

During heavy rainfall events, stormwater runoff from the site is inferred to flow south east into the unnamed water course, which discharges into the Lachlan River once it traverses under The Escort Way via culverts. During the site visit in April 2020, minor surface flows were observed moving through the proposed solar farm site. Forbes Shire Council confirmed during a meeting held in January 2020 that the solar farm site is prone to occasional flooding. An assessment of the likely extent of flooding across the solar farm site is provided in the Flood Assessment Report (SMEC; 2021)

The Lachlan River and its floodplain areas (located approximately 3 km and 1 km south of the solar farm site respectively) have been identified as a major river and key fish habitat.

Two major overland flow paths are identified as traversing the solar farm site. The first originates from the north and crosses the site near the south western boundary where there are 3 existing farm dams within the solar farm site (). The other major flow path affecting the site is at the south eastern corner where there is an existing creek. Flood inundation is much greater in this area compared with the site of the 3 dams. Further details are provided in the Flood Assessment Report (SMEC; 2021).

The ETL is approximately 8.5 km long and traverses a number of private properties and road reserves. The ETL easement will be 45m wide. The land is described as being flat and generally slopes to the south towards the Lachlan River located at least 3.5 km away. The nearest elevated land is located at Back Yamma State Forrest at 340m AHD approximately 7 km to the east of the site.

The 132 kV switchyard will occupy approximately 0.5 ha. Its tallest component is the landing gantry will reach approximately 12-14 m high. The site will be accessed from Daroobalgie Road. The land around the switchyard site is generally flat.

Topographic mapping of 5 m LiDAR contours are shown in Figure 3-1.

3.2 Geology

The Project is predominately situated on recent Quaternary and Tertiary sediments consisting of gilgai and shallow slope colluvial plains and rises with some residual veneer interfingers with inactive alluvial plains (Parks 1:100,000 Geological Map Sheet 8531, 1st Ed 2000). The recent sediments overlay Ordovician age metasediments of the Kirribilli Formation and Mugincobla Chert and intermediate - mafic volcanics, intrusives and associated volcaniclastic sediments and limestones. The north western corner of the solar farm site may overlay the edge of the Silurian – Ordovician sedimentary Cotton Formation.

The Recent Quaternary and Tertiary sediments may be up to 100 m thick and are commonly known as the Cowra Formation. The Cowra Formation consists of a complex pile of interbedded generally fine grained clays, silts and sands with lesser course sand and gravel palaeo channels.

The solar farm site, the majority of the ETL and the switchyard site are located on CZ_a - Alluvium and Q_ca - Mixed colluvial, alluvial and aeolian deposits (Figure 3-2). A small portion of the ETL does cross over Q_afs - Alluvial floodplain deposits - swamp facies and Q_ca - Mixed colluvial, alluvial and aeolian deposits.

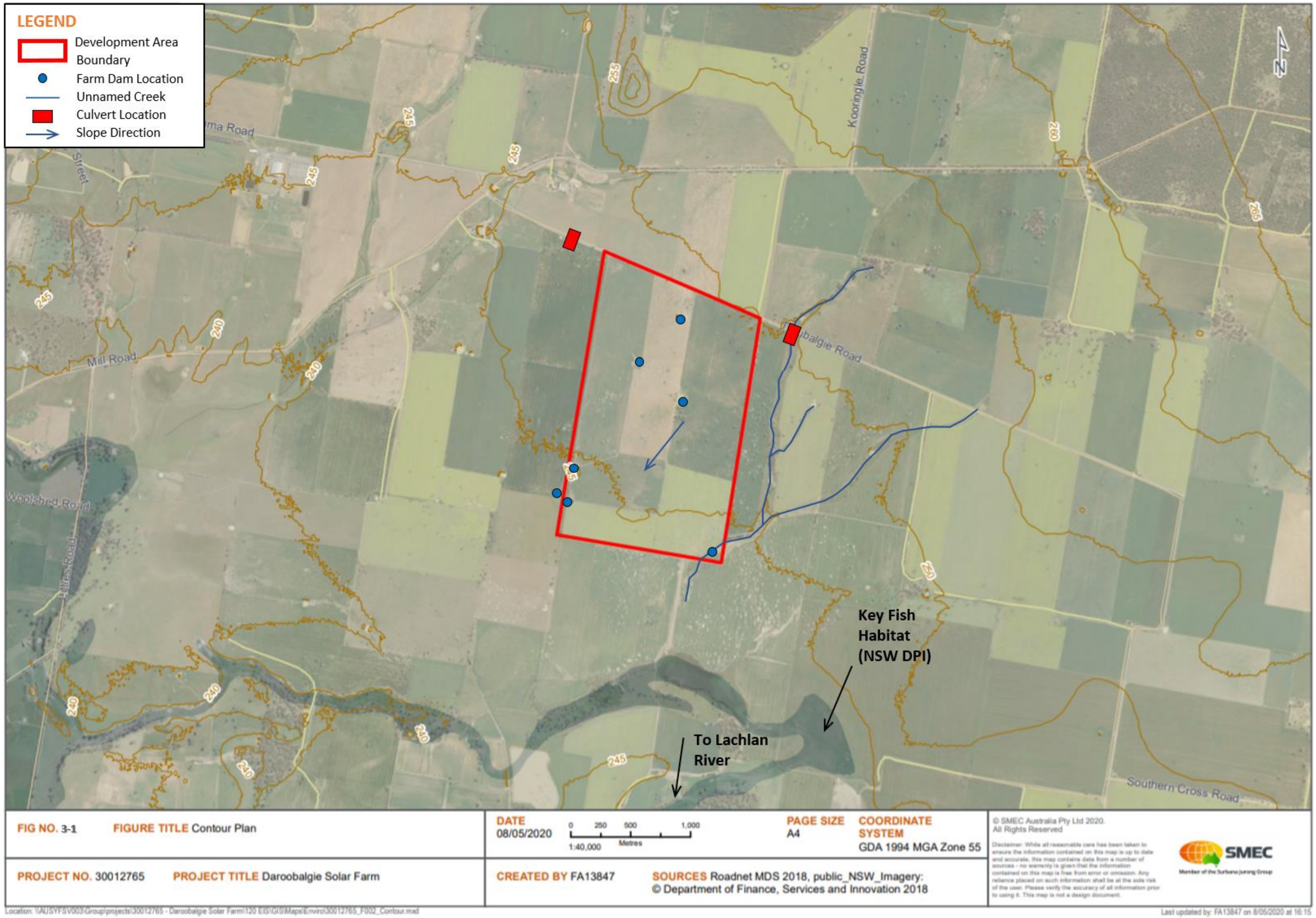

Figure 3-1 Existing Site topography and drainage features at the solar farm site

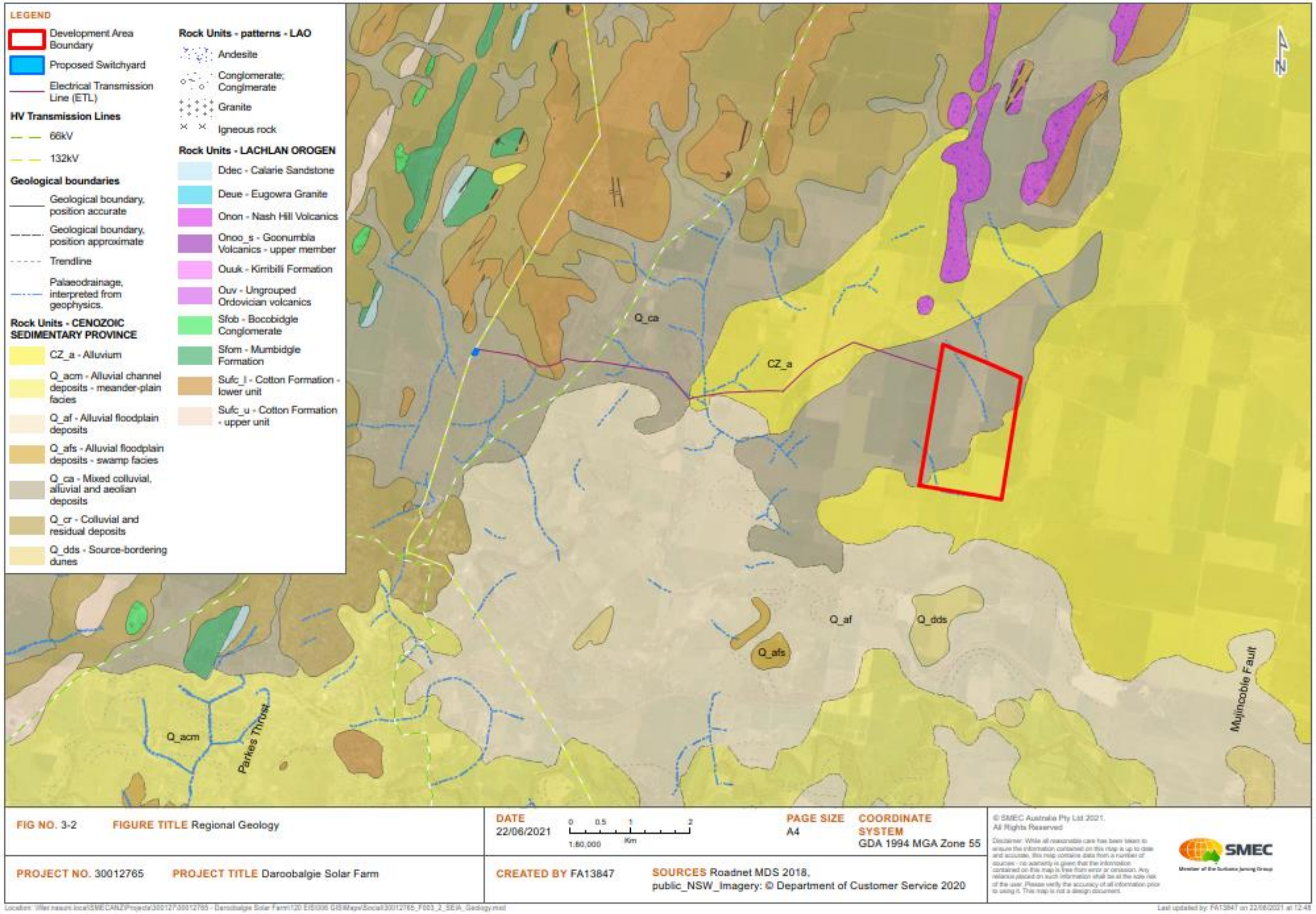

Figure 3-2 Regional geology

3.3 Soil landscapes

Two soil landscape classifications are identified on the NSW Office of Environment and Heritage (2019) eSPADE web application across the project construction footprint with the potential for a third landscape. The Brolgan Plain Alluvium and Daroobalgie Alluvium underlie the northern portion and southern portion of the solar farm site respectively. The Waughan Alluvium may be present to the immediate south of the solar farm site, noting soil landscapes boundaries may vary somewhat from the mapping.

The switchyard site is located west of the site in the Parkes soil landscape. The ETL passes through; Parkes, Waughan and Broglan plain soil landscapes. Soil Landscape Mapping for the general area is shown in Figure 3-3. The relevant soil landscapes are briefly described below.

Brolgan plain alluvium

Broglan Plain Alluvium (Figure 3-3) is a quarternary alluvium consisting of sandy loam, clay loam and sandy clay loam undulating plains. The dominant soils are deep, imperfectly drained Red Brown Earths and Non-calcic Brown Soils. Deep, moderately well-drained Red Podolic Soils and Red Earths also occur on some plains. Deep, poorly drained Yellow Solodic Soils occupy small drainage lines and drainage depressions. Rare, very deep, poorly drained Brown Clays occur on some lower lying plains. The topsoils have high erodibility while more clay-rich subsoils have a moderate erodibility, however due to low slope gradients (0-2%) the erosion hazard is low to moderate. This may increase in areas of higher concentrated surface water flows.

Daroobalgie alluvium

Daroobalgie Alluvium (Figure 3-3) is a quaternary alluvium (with minor areas of slope colluvium) consisting of clay and clay loam unpronounced gilgai. The dominant soils are very deep, moderately well-drained Red Brown Earths occurring on gilgai crests and very deep, very poorly drained Grey Clays occurring on gilgai depressions. Soil erodibility is moderate to high, however due to low slope gradients (<1%) the erosion hazard is low to moderate.

Waughan alluvium

Waughan Alluvium (Figure 3-3) is a quaternary alluvium consisting of clay, clay loam and sandy clay loam floodplains and terraces. The dominant soils in higher elevated areas are deep, imperfectly drained Red Brown Earths, while deep, imperfectly drained Yellow Podsolic Soils and occasional poorly drained Brown and Red Clays occur on prior streams, abandoned channels and backswamps. Deep, Red Podzolic Soils and Red and Brown Solodic Soils occur on some plains, and Alluvial Soils occur along some active stream channels. The erosion hazard is moderate, and a severe wind erosion hazard applies to cultivated paddocks with exposed soil.

Parkes

Parkes soil landscape limitation are described as water erosion hazard and high run on. The Erodibility and erosion hazard are described as moderate to high and the erosion hazard is high.

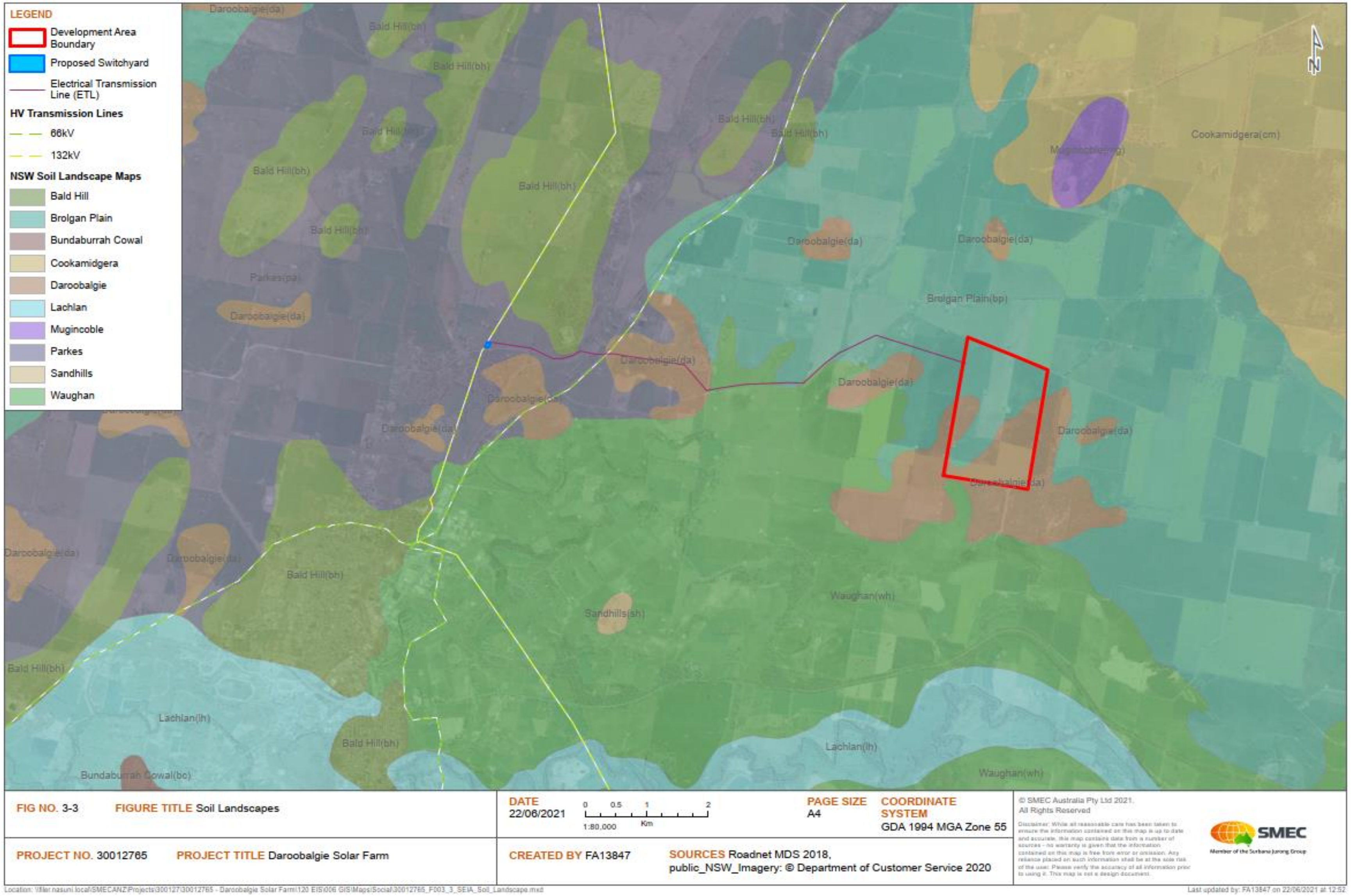

Figure 3-3 Soil landscapes in site location (Source: NSW OEH (2019)

3.4 Hydrogeology

A review of groundwater bore mapping and summary sheets from the NSW Department of Industry, WaterNSW website (https://realtimedata.waternsw.com.au/water.stm accessed 6 May 2020) shows registered groundwater bores within a 5 km radius of the project (see Figure 3-4). Most groundwater bores are privately owned and used for stock domestic freshwater supply. One groundwater bore (GW702506) located above The Escort Way noted a standing water level of 9 m below ground surface level, whereas remaining bores were not specified.

One groundwater bore (GW051594) is potentially within the solar farm site boundary in the south-eastern corner, however the location was not confirmed. This bore is listed as a stock and domestic water source. There are no known bores at the switchyard site or within the alignment of the ETL.

Additional Hydrogeology assessment is provided in the Hydrogeological Assessment Report.

3.5 Acid sulfate soils

Acid sulfate soils (ASS) are naturally occurring soils, sediments or organic substrates (e.g. peat) that are formed under waterlogged conditions. Coastal acid sulfate soils are not relevant to the project based on the site locality. The CSIRO (website) Australian Soil Resource Information System (ASRIS) shows the project mapped (see Figure 3-5) as having predominantly 'low' probability (yellow) and 'extremely low' (green) probability of ASS occurrence. On this basis, no further assessment of inland acid sulfate soils was recommended.

3.6 Geotechnical

A Preliminary Geotechnical Investigation Report was prepared (Golder Associates Pty Ltd; April 2019). A total of six boreholes were drilled to depths of greater than 5 m across the solar farm site to assess subsurface conditions. Detailed methodology is included within the Geotechnical Investigation Report.

The preliminary geotechnical investigations identified the following relevant subsurface conditions:

- No groundwater table / aquifer was encountered during the investigations, which were undertaken to a maximum of 7.5 m below ground surface level. Golder Associates (2019) found in February 2019, using WaterNSW real-time borehole data captured approx. 5-7 km south-east of the solar farm site, that the groundwater table was 40m below the ground surface level
- The solar farm site consists of 100 – 200 millimetre (mm) topsoil, underlain by highly reactive colluvial / alluvial soil. Across gilgai areas, highly reactive alluvial soils were observed to have infilled the gilgai depressions by up to 2.6 m thick. Based on these observations and laboratory results, soils in the location of the solar farm site are highly reactive with potential surface movements of 80-110 mm. There is the potential for more than 30 mm differential movements across footings founded across variable material types in gilgai areas
- Two Emerson Class Number tests were undertaken, revealing the soils are generally non-dispersive in their natural state unless exposed to sodium rich water. It is also noted that if these soils are remoulded, there is a risk they may become dispersive if exposed to water turbulence or rapid concentrated water flow.

3.7 Erosion

A preliminary assessment of existing erosion impacts was undertaken based on visual observations made during an initial site visit on 30 April 2020, and during the previous geotechnical field investigation completed by Golder in January 2019. Due to wet weather prior to and during the site visit, large areas of the ground surface were obscured by surface runoff preventing visual observations of scour / erosion in these areas.

During Golder's geotechnical investigation it was noted that there was little evidence of surface erosion (sheet and rill) with the exception of gully erosion along drainage paths leading to dams and basins.

Roads in the general area of the project are a mix of unsealed and sealed roads. Vehicles entering and leaving the project during construction may introduce dust management issues, depending on the construction phase of the project. This may potentially result in an increased sediment laden runoff. This may require further consideration when designing sediment basins for construction stages.

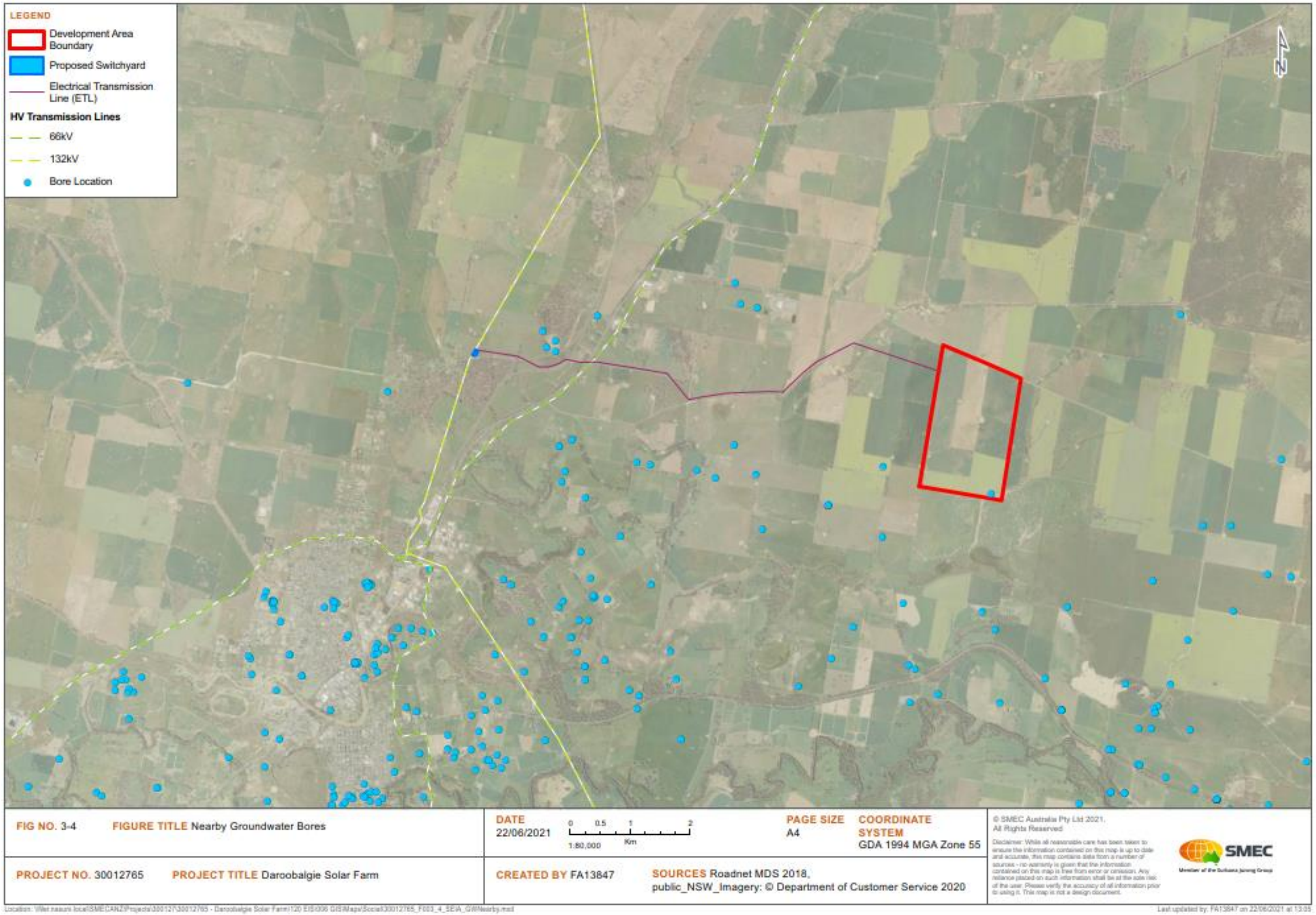

Figure 3-4 Nearby groundwater bores to Site location

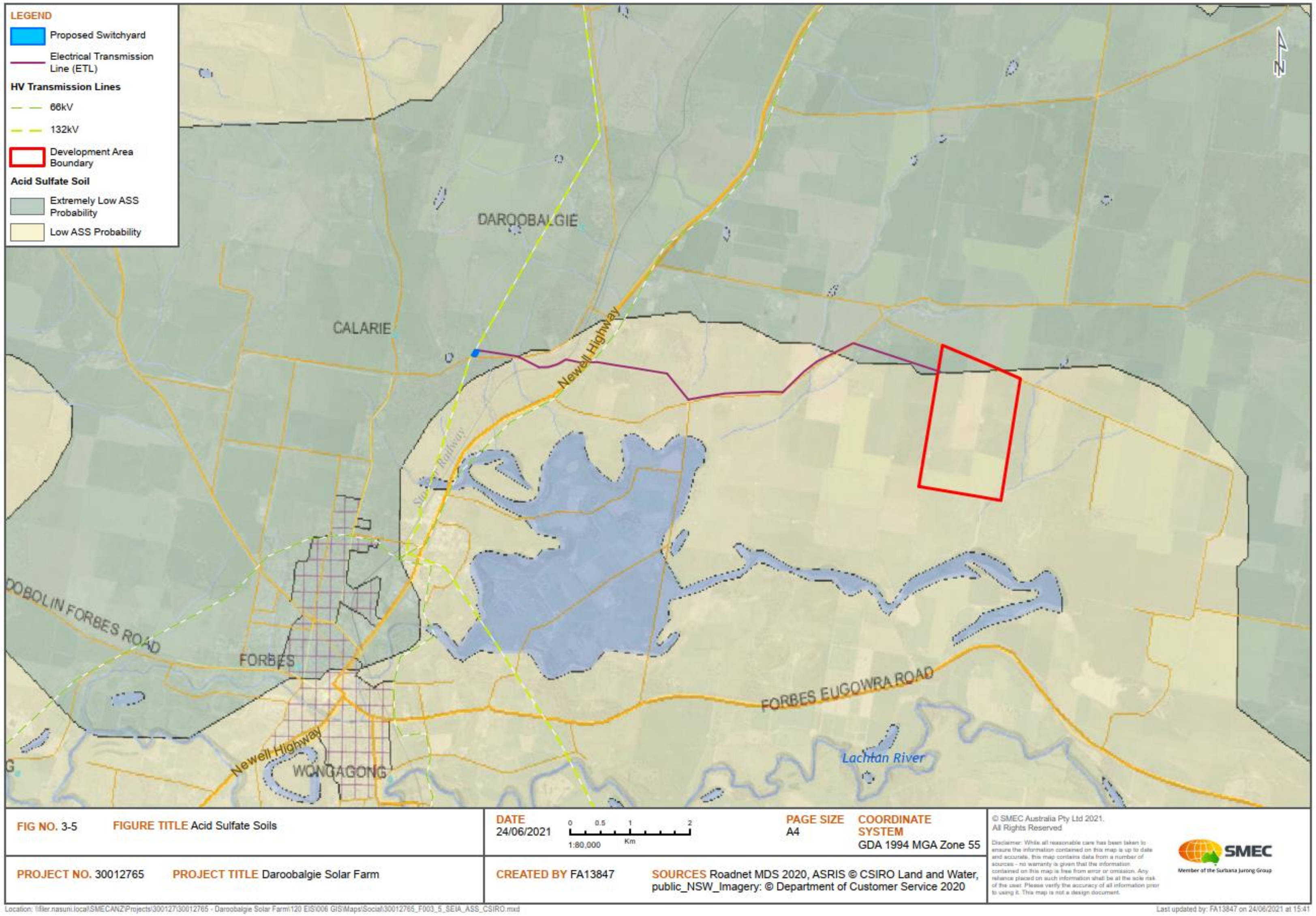

Figure 3-5 Acid sulphate soil mapping of site location (ASRIS, accessed May 2020)

4 Potential construction impacts

4.1 Construction activities

Section 3.2.1 of the Preliminary Environmental Assessment (PEA) (Pacific Hydro, 2019) outlines the following key components of the Daroobalgie Solar Farm.

Solar farm site

- A network of PV solar panel arrays and Power Conversion Units (PCUs) (DC-AC inverters)
- Battery energy storage system (BESS) with embedded storage of approximately 40MW/160MWh
- Electrical collection systems, substation and control room
- Temporary construction compound
- Operations and Maintenance (O&M) facility, including demountable offices, amenities, equipment sheds, storage and parking areas
- Internal access tracks.

Electricity Transmission Line

- A new, ~8.5 km single-circuit, 132 kV transmission line. Towers are likely to be monopole structures 25-30 m high

Switchyard site

- A 132 kV switchyard to connect to the existing TransGrid Transmission Line

The solar farm site would connect to the switchyard site (via the ETL) located adjacent to the existing Forbes-Parkes 132 kV transmission line located approximately 500 m west of the Newell Highway. Figure 4-1 shows the proposed ETL route.

The total construction period for the project is expected to be approximately 12-18 months including the final testing and commissioning phase. The bulk of the earthworks at the solar farm site (site mobilisation, set-up/access roads and HV trenching) will occur over the first 6 months. Construction of the ETL will take approximately 3 months (installation of monopole structures over a distance of 8.5 km is currently the assumed ETL structure for the purpose of assessments). The switchyard construction (will take approximately 30 weeks, with the bulk of the earthworks taking place over about an initial 8 week period.

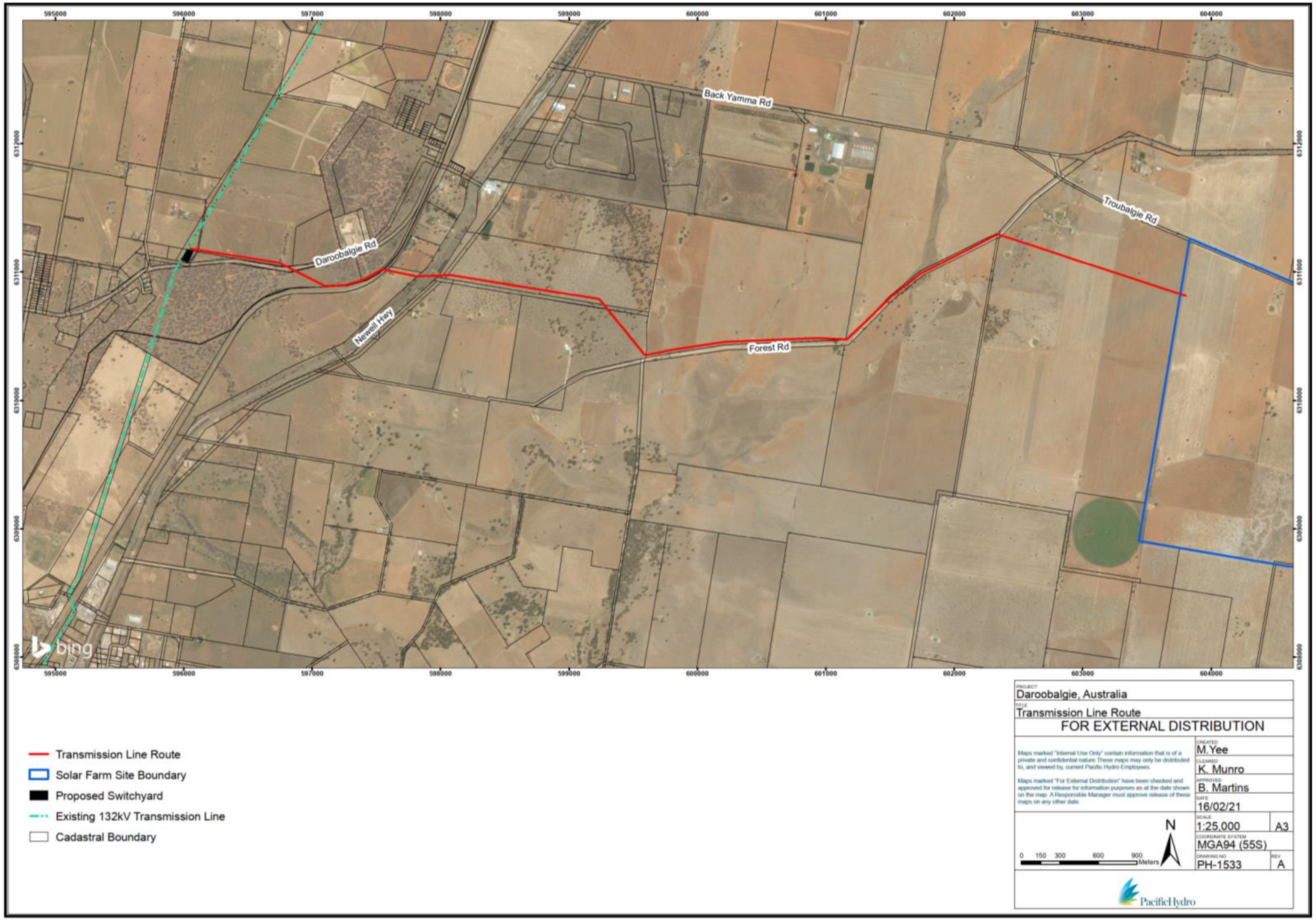

Figure 4-1 Transmission line route (shown in red), the switchyard site (shown in black) and part of the solar farm site (shown in blue)

4.2 Ground disturbance areas expected

Based on the construction activities, the solar farm site is expected to generally require a minimal depth of broad earthworks (estimated less than 0.5m) associated with the establishment and regrading of site roads and site recontouring. This will involve disturbance of surface soils and subsoils across the soil landscape. Minor ground disturbance at footings may be required for installation of piles to support solar PV structures.

The ETL is expected to involve localised ground disturbance at location of overhead power poles and along the ETL easement during construction.

The switchyard site is expected to undergo minor ground disturbance associated with the preparation of the site, stripping of topsoil, excavation of foundations and placement of the impervious surface. For the purposes of this assessment a catchment assessment of the switchyard site was carried out (refer to Section 4.4 below). The assessment shows soil loss at the switchyard site during construction would be very low and no sediment basins would be required at the site.

Construction catchment assessment is not required for the ETL as the ground disturbance would be minor and localised.

4.3 Erosion hazard assessment

The potential erosion hazard was initially assessed using Figure 4-2 in accordance with Section 4.4.1 of the 'Blue Book' (Landcom, 2004). Considering the geographic location of Daroobalgie, a rainfall erosivity (R-Factor) of 1,250 was estimated based on available mapping (refer to Appendix B, Landcom, 2004). Site topography mapping (5m LiDAR) shows negligible site slope (<1%), however, to be conservative it is assumed some localised areas may have up to 2% slope gradients. Figure 4-2 shows the potential erosion hazard for the study area is below the A-line indicating that the proposal has low erosion hazards.

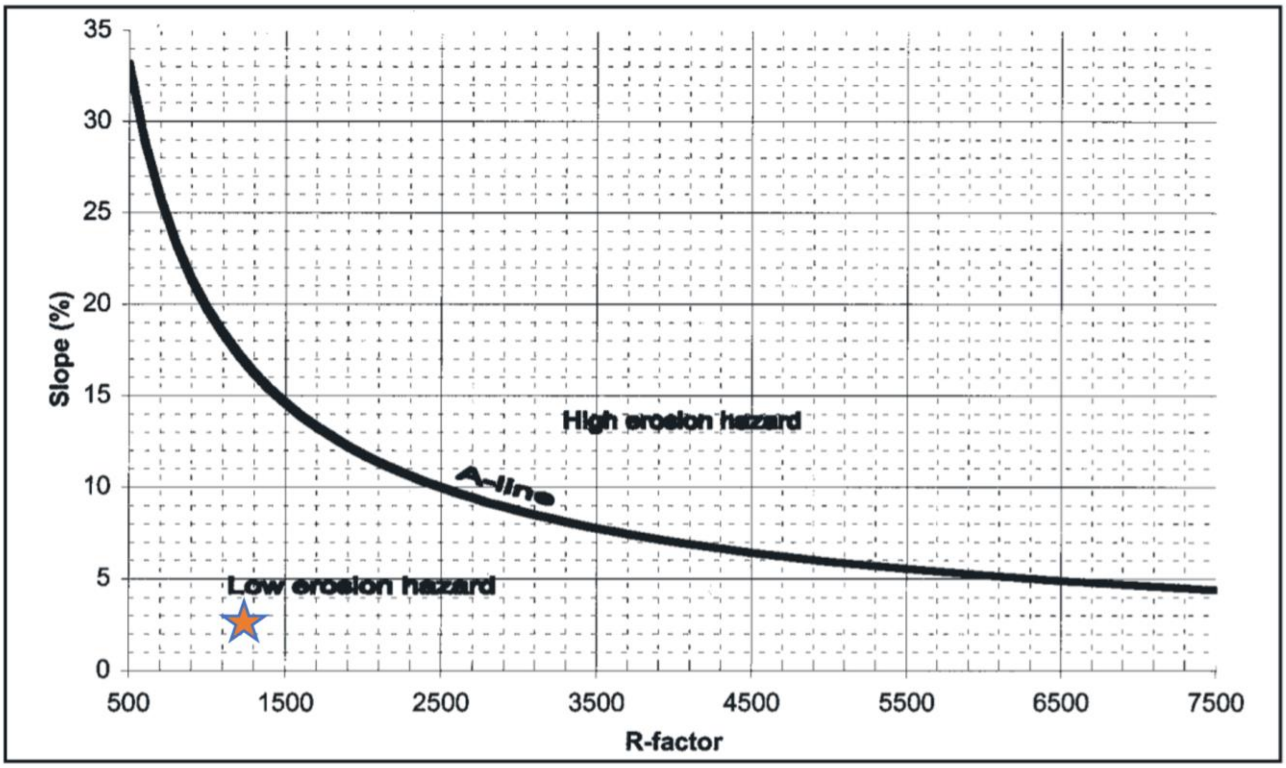

Figure 4-2 Assessment of potential erosion hazard

4.4 Catchment assessment

Assessment of construction catchments was carried out in accordance with Section 4.4.2 of the 'Blue Book' (Landcom, 2004). The solar farm site was divided into construction sub-catchments (as shown in Figure 4-3 below) considering the solar farm site topography noting these are estimated areas that would be refined by construction contractor to suit construction staging and earthworks plan. Individual catchment areas and slope gradients were calculated for the purposes of soil loss estimation. A high level assessment was carried out for the switchyard site and results are provided below in Section 4.5

The calculated soil loss (tonnes/ha/yr) for the solar farm site was carried out for individual construction catchments using the Revised Universal Soil Loss Equation (refer to the Appendix A of the Blue Book). Assumed parameters are provided in Table 4-1.

Table 4-1 Catchment assessment parameters

PARAMETER	VALUE	*'MANAGING URBAN STORMWATER: SOILS & CONSTRUCTION* (LANDCOM 2004)
Rainfall Erosivity (R factor)	1250	Map 9: Rainfall Erosivity of the Newcastle 1:250,000 topographic Sheet (Appendix B)
Soil Erodibility (K factor)	0.05	Unknown. Conservatively assumed high. To be confirmed as Appendix C holds insufficient data for the region surrounding Daroobalgie
Slope-length gradient Factor (LS factor)	Steepest Catchment = 2%, Slope Length = 80m, LS = 0.41	NA
Erosion Control Practice (P factor)	1.3 (compacted and smooth)	Table A2: P-factors for construction sites (Appendix A)
Ground Cover and Management Factor (C factor)	1	Section A6: Cover Factor – C (Appendix A)

Soil loss calculation for individual catchments are included in Appendix A. Table 4-2 includes a summary of individual construction catchment details. Based on the computed soil loss class, an assessment was made for the need for sediment basins where total annual soil loss from the disturbance areas is more than 150 cubic metres. Table 4-2 below summarises the overall results of the erosion hazard assessment.

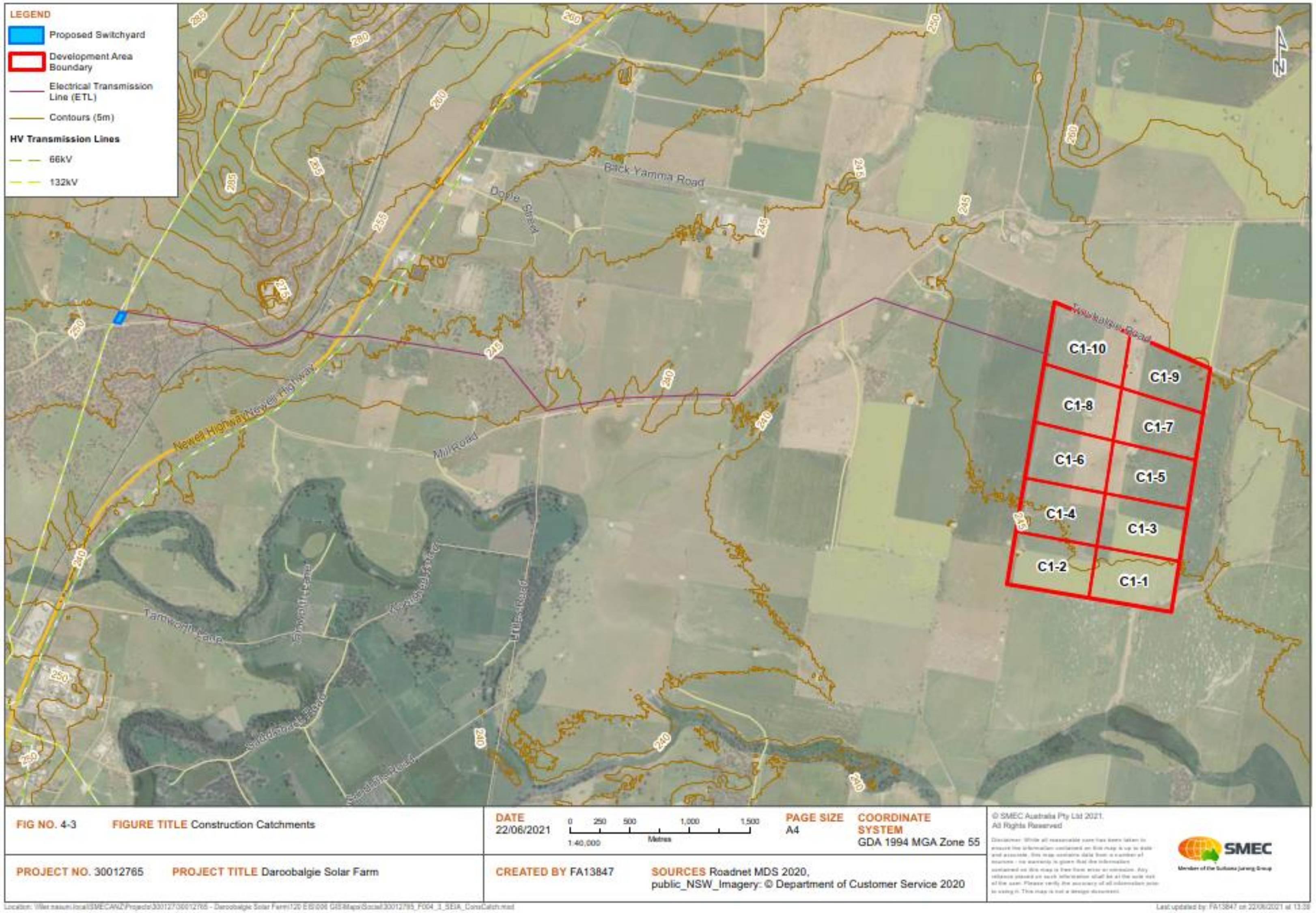

Figure 4-3 Proposed construction catchments at the solar farm site

Table 4-2 Construction catchment details for the solar farm site and switchyard site

CATCHMENT ID	AREA (HA)	TYPE / STAGE	SLOPE GRADIENT (%)	SOIL LOSS (TONNES/HA/YR)	SOIL LOSS CLASS	COMPUTED SOIL LOSS (M3/PER YEAR)	SEDIMENT BASIN REQUIRED (YES/NO?)
C1-1	30.6	Proposed main works area – Stage 1	1	12	1 – Very low	369	Yes[1]
C1-2	30.3	Proposed main works area – Stage 2	1	12	1 – Very low	365	Yes[1]
C1-3	31.5	Proposed main works area – Stage 3	1	12	1 – Very low	379	Yes[1]
C1-4	31.1	Proposed main works area – Stage 4	1	12	1 – Very low	375	Yes[1]
C1-5	30.0	Proposed main works area – Stage 5	1	12	1 – Very low	361	Yes[1]
C1-6	31.3	Proposed main works area – Stage 6	1	12	1 – Very low	377	Yes[1]
C1-7	31.8	Proposed main works area – Stage 7	1	12	1 – Very low	383	Yes[1]
C1-8	29.3	Proposed main works area – Stage 8	1	12	1 – Very low	353	Yes[1]
C1-9	29.0	Proposed main works area – Stage 9	1	12	1 – Very low	349	Yes[1]
C1-10	32.7	Proposed main works area – Stage 10	1	12	1 – Very low	394	Yes[1]
Switch Yard	0.523	Construction	2	33	1 – Very low	25	No

1. A sediment basin is usually recommended for annual soil loss greater than 150m^3 per year. Given the specific site constraints of relatively flat topography, sediment basins may not be practical to implement to capture the design rainfall. Consideration instead has been given to sediment treatment options such as rock check dams (refer to Table 4-3 and Section 5.1 below).

Table 4-3 Summary of erosion hazard assessment

TRIGGERS	YES / NO	COMMENT
Does the complexity or size of the project result in it being inherently high risk as ongoing installation and maintenance of controls will require extensive coordinated resources	No	Sitewide shallow earthworks across broad areas are expected due to the large footprint of the solar farm works. Construction earthworks activities are likely to be relatively short duration (< 2 months) prior to restoring suitable ground cover to minimise erosion and sediment risks from ground disturbances. Construction would allow standard industry practice measures to mitigate potential areas of erosion.
Assess the erosion hazard of each catchment area to be disturbed for the proposed project Are any of the proposed construction areas defined as High Erosion Hazard?	No	Construction catchments within the solar farm site are included within Figure 4-3. The calculated soil loss (tonnes/ha/yr.) was carried out for individual construction catchments using the Revised Universal Soil Loss Equation (refer to the Appendix A of the Blue Book) and results are included in Table 4-2. In summary, all construction catchments showed 'Very low' soil loss class. Although the initial estimated annual soil exceeded the threshold for sediment basins, this was based on a conservative assessment and due to the solar farm site's flat topography and the relatively short duration of ground disturbance, alternative sediment treatment devices would be more appropriate. Sediment-treatment devices (such as rock check dams, silt fencing, low earth berms etc) are expected to be required at most construction catchments in the main works area based on the scale of earthworks (refer to Table 4-2). Details on sizing, type and location of sediment treatment methods are not provided as part of the scope of this assessment, as these would be prepared within Progressive Erosion and Sediment Control Plans during early construction stages. Sediment-treatment devices or basins are not expected to be required for the ETL and the switchyard site. Sediment fences slope breaks maybe required on the down gradient slope where surface waters may leave site on the southern boundary. Exposed soils may also require temporary
Are there any known site constraints that limit the implementation of appropriate erosion and sediment controls measures?	No	Construction techniques and methodologies will be further developed during detailed design and the preparation of Environmental Management Plans (EMPs), however at this stage are expected to be typical for general earthworks and pavement construction. Limitations associated with the solar farm site include: • Lack of grade across site – this can result in a waterlogged site following significant rainfall events, and therefore delay construction programs. In addition, the diversion of water may be challenging in large flat areas, and erosion and sediment controls would require regular maintenance. Sediment basins are unlikely to be appropriate due to the relatively flat grade across the solar farm site surface, making it difficult to intercept dirty water runoff surface without installing basins below surrounding ground level

TRIGGERS	YES / NO	COMMENT
		• Limited data for desktop erosion and sediment hazard assessment – additional investigations would be required to determine the true soil erodibility and volumetric runoff coefficient • Geological landscape – the presence of gilgais in the south-eastern portion of the solar farm site will need to be addressed during detailed design and construction of the solar farm due to the high reactivity of these landscapes.
Are there any identified sensitive receiving environments that will receive stormwater discharge from the construction project?	No	The proposal would not discharge to any of the following receptors: • State and National Parks • Littoral Rainforest (SEPP26) • Drinking water catchment • Coastal Wetlands (SEPP14). If correct industry standard sediment and erosion practices are implemented and considering the distance from disturbed soil to the sensitive receiver, this is not a concern.

As outlined within Table 4-3, this assessment determined the study area as having potentially 'very low' erosion hazards. Due to the size of the construction catchments and expected duration of disturbance, it is recommended that standard erosion and sedimentation controls are implemented as defined in the 'Blue Book' (Landcom, 2004). These are considered adequate for construction planning.

An Erosion and Sedimentation Control Plan will be developed as part of the Construction Environmental Management Plan (CEMP) during pre-construction phase to provide details on how erosion and sediment controls are to be managed and mitigated during the construction phase of the project.

4.5 Construction impacts

During construction, there is potential for sediment and nutrient laden runoff from areas disturbed by construction to impact water quality in downstream waterways. Areas which would present a higher risk of soil erosion include locations where both surface gradients and slope lengths combined would increase the erosive potential of stormwater runoff.

Activities which have the highest risk of sedimentation and erosion impacts include:

- General earthworks, including stripping of topsoil, excavation of material or filling of material
- Stockpiling (if required)
- Transportation of materials
- Movement of heavy vehicles across exposed earth
- Works in or near drainage lines and water courses (if required)
- Removal of surface vegetation.

During earthworks, vegetation would be removed, exposing soils and increasing the potential for erosion and sedimentation during rainfall events. The quality of surface runoff from the construction facilities (including lay down areas and access tracks) may also potentially be impacted by the build-up of contaminants including hydrocarbons, fuel additives and lubricants.

Construction of the Project has the potential for the following impacts:

- Excavation works may directly result in erosion impacts due to the exposure and mobilisation of soils during construction via the following erosion mechanisms associated with construction disturbance:
  – Potential for sheet and rill erosion is noted where ground disturbance reduces the ground cover.

- Wind erosion potential is noted across dry unsealed ground, particularly associated with Waughan Alluvium soil landscape (offsite to the south).
- Gully erosion potential is highest where concentrated flows occur along drainage lines, dam spillways, gutters and water courses.

- Changes to stormwater runoff and increased water velocities at stormwater culvert outlets may result in scour and erosion within drainage lines
- Reduction in surface water quality through increased turbidity, nutrients and suspended solids, causing harm to downstream sensitive receptors (i.e. farm dams, aquatic ecosystems)

5 Erosion and sediment control planning

5.1 Solar farm site

Key management strategies for the project will include the preparation and implementation of erosion and sediment control plans. It is recommended that these plans includes mitigations such as:

- Minimising the extent and duration of disturbance
- Retention of three existing farm dams
- Control stormwater flows onto, through and from the project (including separation of 'clean' and 'dirty' stormwater runoff)
- Use erosion control measures to prevent onsite damage
- Use sediment control measures to prevent off site damage
- Stabilise disturbed areas quickly and progressively throughout construction staging
- Regular inspection and maintaining control measures.

It is recommended that 'Blue Book' (Landcom, 2004) standard controls are utilised to achieve the above strategies. For example, the construction phase could include earth banks (low flow) along sub-catchment contours as per SD 5-5 of Bluebook. This would reduce flow lengths, velocities and therefore the need to implement complex erosion and sediment controls.

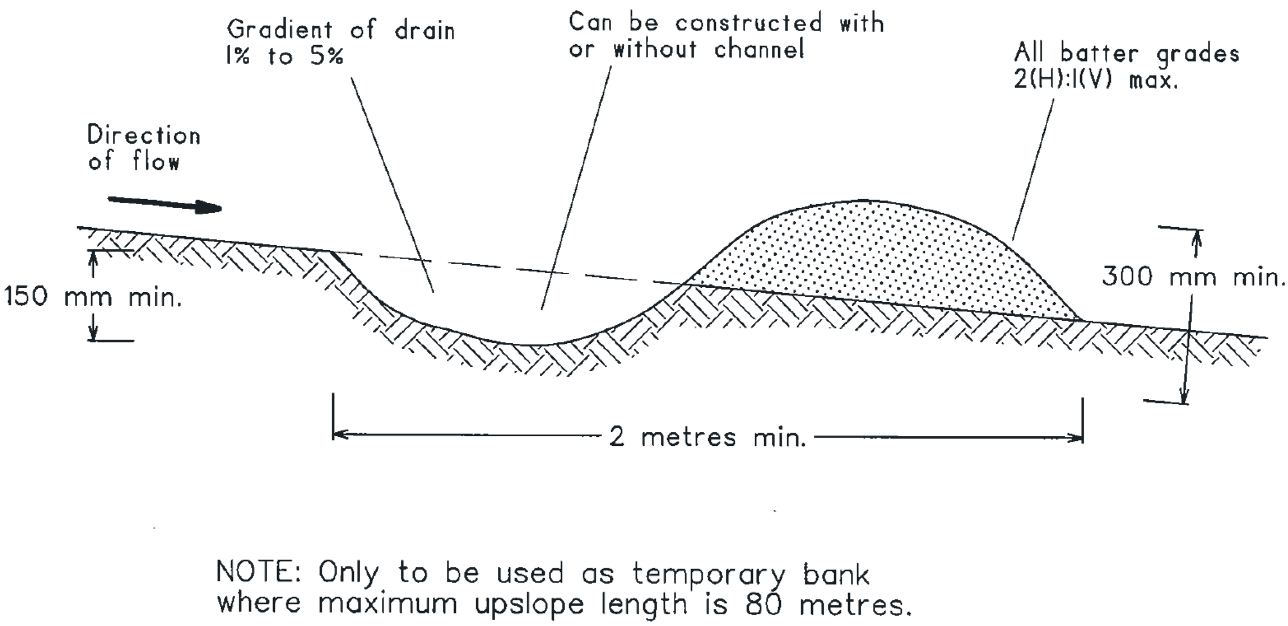

Figure 5-1 A typical earth bank (low flow) (Landcom, 2004)

Sediment treatment measures such as rock check dams (for example) may be used to treat any sediment laden water prior to discharging water from the project. Silt fencing at disturbed areas would also assist to manage sediment.

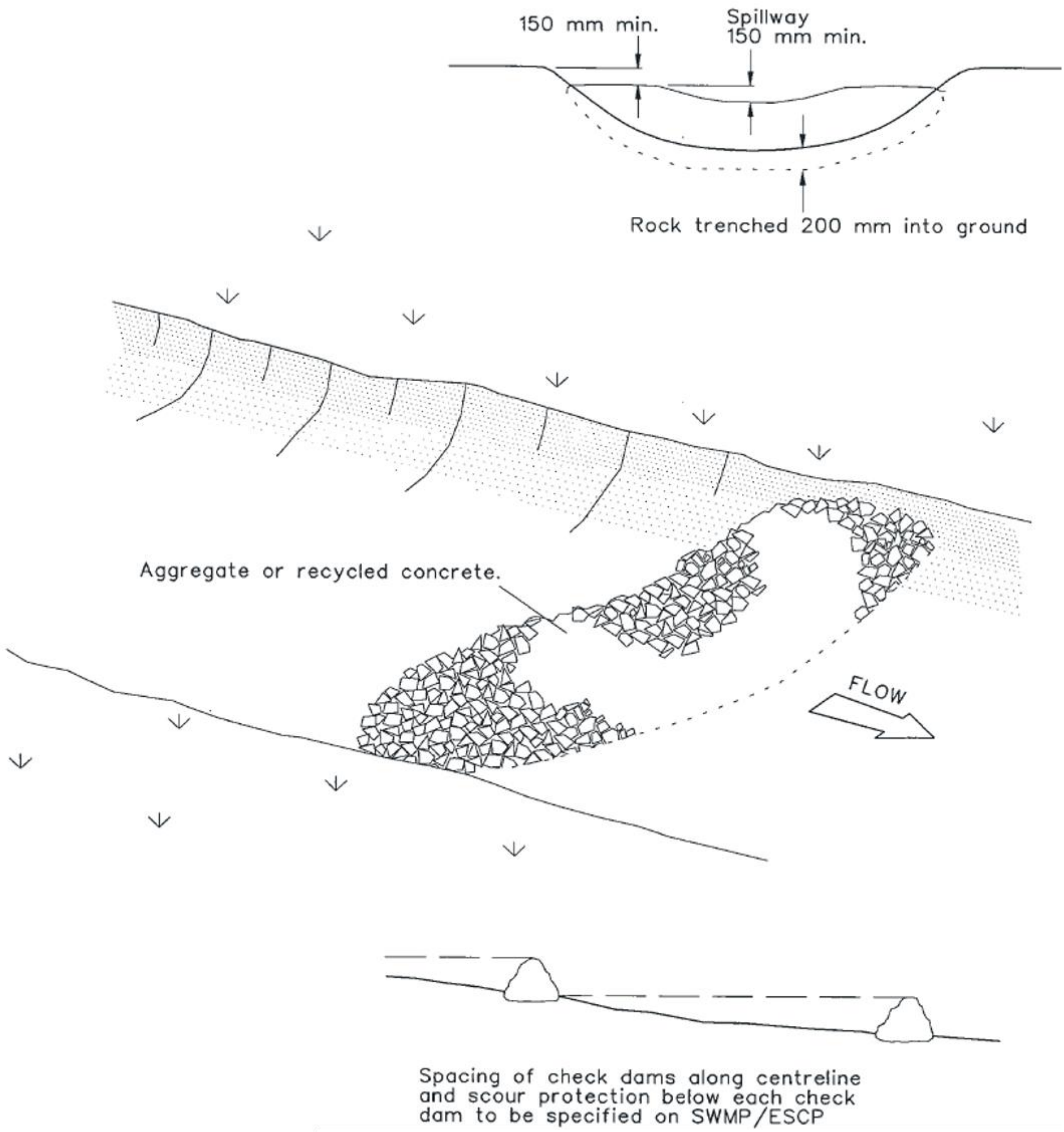

Figure 5-2 A typical rock check dam (Landcom, 2004)

Wind erosion minimisation techniques should be considered by the construction contractor. Grass seeding for site revegetation may also require additional water application. Given the poor fertility of the soils landscapes a revegetation hydromulch product or equivalent that can be engineered to suit with specific amelioration NPK and site-specific seed mix to produce long term stable groundcover, should be considered (such as VE Gro-Matt or equivalent). Also, the use of spray polymer seals to prevent wind erosion should be considered by the construction contractor (Stonewall or equivalent).

5.2 Standard erosion and sediment controls for the solar farm site

The following standard erosion and sediment controls are indicative of controls to be used to manage soil and water impacts during construction. Table 5-1 details the relevant section from the following guidelines where the drawings are detailed. Controls should be implemented where appropriate and maintained to ensure proper function. Selection of control measures requires the following:

- Identifying the problem – erosion or sedimentation to be managed?
- Where the problem is erosion, identifying whether it is caused by raindrop impact or concentrated flow
- Where the problem is sedimentation, identifying if sediment is conveyed by sheet or concentrated flow
- Selecting the appropriate techniques depending on the identified specific nature of the problem.

Table 5-1 Standard erosion and sediment controls

CONTROL	DRAWING REFERENCE	SOURCE PAGE REFERENCE	CATCHMENT / PROPOSAL ELEMENTS	
			C1-1 to C-10	Electrical Transmission Line and Switchyard
Stockpiles	SD 4-1	4-5, Bluebook	Yes	Yes
Replacing topsoil	SD 4-2	4-6, Bluebook	Yes	Yes
Rock check dams	SD 5-4	5-22, Bluebook	Yes[1]	Yes[1]
Earth bank (low flow)	SD 5-5	5-25, Bluebook	Yes	No
Concentrated flow (batter chute)	SD 5-7	5-28, Bluebook	Yes	No
Energy dissipater	SD 5-8	5-34, Bluebook	Yes[1]	No
Sediment fence	SD 6-8	6-36, Bluebook	Yes	Yes
Rock sediment basin	SD 6-1	6-16, Bluebook	No[2]	No
Gabion sediment basin	SD 6-1	6-17, Bluebook	No[2]	No
Earth basin - wet	SD 6-4	6-19, Bluebook	No[2]	No
Stabilised site access	SD 6-14	6-48, Bluebook	Yes	Yes
Control of wind erosion	SD 6-15	6-69, Bluebook	Yes[3]	Yes
Temporary waterway crossing	SD 5-1	5-14 Bluebook	No	Yes

Notes:

1. Temporary waterway crossing required to be located within proposed construction haul route wherever ephemeral streams are required to be crossed.
2. Sediment basin type to be selected based on constructability and suitability at the proposed location.
3. Control of wind erosion should consider reducing dependence on water requirements in preference for maintaining ground cover and/or polymer applications.

These standard sediment controls must be implemented with the hydraulic understanding of the site as per the flood risk assessment and must be adjusted accordingly final design and adopted construction sequences in accordance with the approved CEMP.

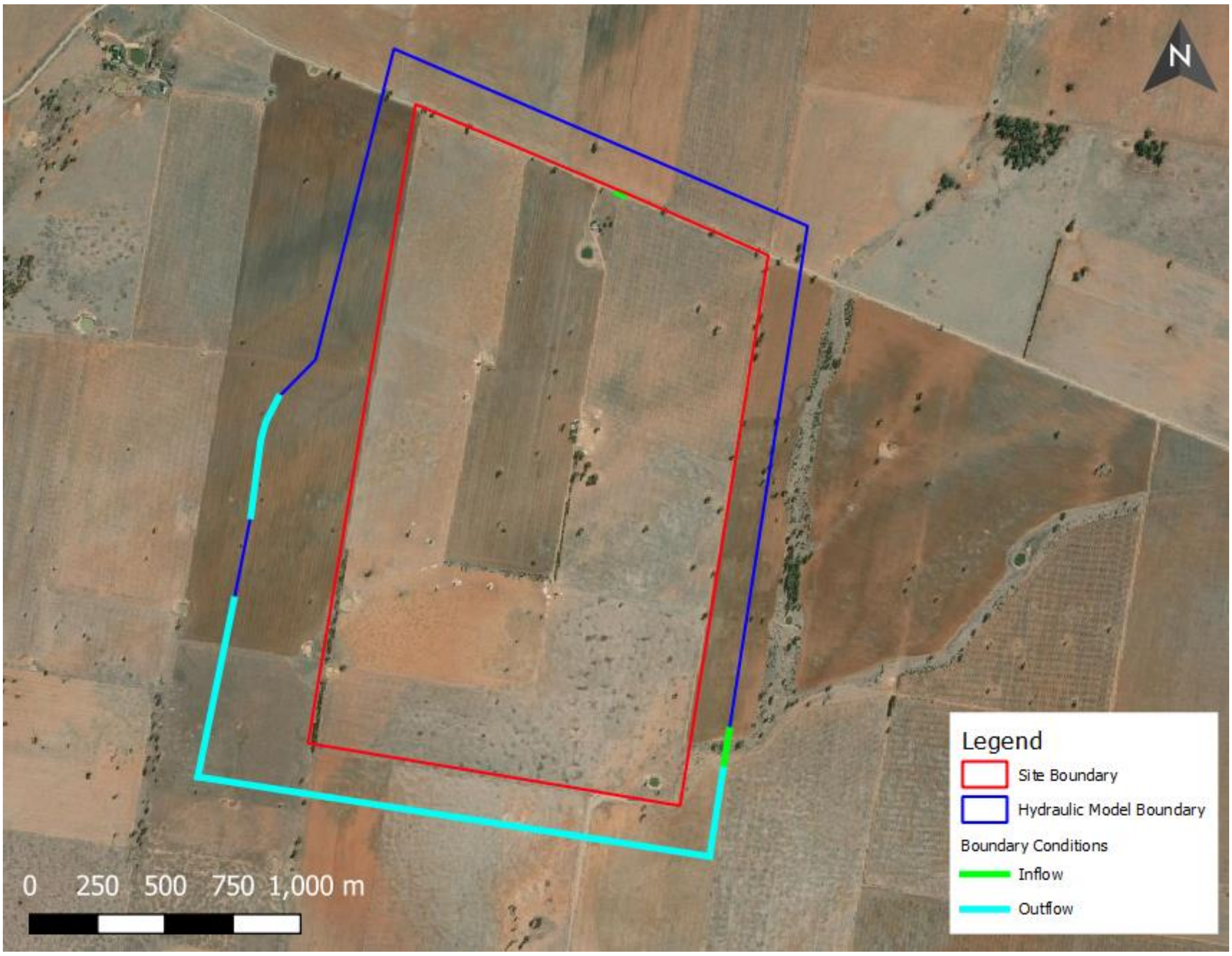

Figure 5-3 Hydraulic modelling of site inflows and out flow (Flooding Risk Impact Assessment Report, SMEC 2020).

5.3 Electricity transmission line and switchyard

An ETL will be constructed from the substation at the solar farm site to the switchyard proposed adjacent to the existing Forbes-Parkes 132 kV transmission line located approximately 500 m west of the Newell Highway. The ETL is approximately 8.5 km long and traverses a number of private properties, road reserves and Crown Land. The ETL easement will be 45 m wide. Towers are likely to be monopole structures 25-30 m high.

The electricity transmission line is expected to be installed as overhead wiring, with boring or piling required for the installation of monopoles.

The proposed route crosses approximately four unnamed water courses between the solar farm and the switchyard. To prevent sediment laden runoff discharging into water courses all overhead power pole construction works in proximity to creeks shall require additional erosion and sediment controls.

The switch yard construction may require sediment fence protection in southern corner to slow down surface flows before they leave site towards the road culvert to the south. In addition to sediment controls, the exposed soils in the workings area may also require some temporary exposed soil protection from a sprayed polymer as an erosion control solution to provide a suitable durable layer to prevent sediment mobilising from rains drops and surface flows.

In addition, an increase in traffic loads is expected on access routes crossing water courses, therefore it can be assumed the condition of unsealed roads along these routes will worsen at an increased rate. Unsealed roads may be impacted by heavy vehicles or the erection of power poles. These activities may result in an increased sediment load in stormwater runoff and therefore indirectly impact the nearby water courses. A polymer spray (e.g. Vital Bon-matt HR or equivalent) is recommended where haulage routes cross water courses.

Standard 'Blue Book' erosion and sediment controls for construction works in proximity to water courses are outlined in Table 5-1 above.

6 Conclusion and Recommendations

In conclusion, based on catchment assessments and the 'Blue Book' RUSLE calculations, overall the project is considered to have potentially 'very low' erosion hazards. However, due to the size of the construction catchments and expected duration of disturbance such as at the solar farm site, it is recommended that standard erosion and sedimentation controls are implemented as defined in the 'Blue Book' (Landcom, 2004) for the project. These are considered adequate for construction planning.

It is recommended that an Erosion and Sedimentation Control Plan be developed as part of the Construction Environmental Management Plan (CEMP) during pre-construction phase to providing further details on how erosion and sediment controls are to be managed during the construction phase.

It is recommended that these plans include mitigations such as:

- Minimising extent and duration of disturbance
- Retaining three farm dams on the solar farm site
- Control stormwater flows onto, through and from the project (including separation of 'clean' and 'dirty' stormwater runoff)
- Use erosion control measures to prevent onsite damage
- Use sediment control measures to prevent off site damage
- Stabilise disturbed areas quickly and progressively throughout construction staging
- Regular inspection and maintaining control measures.

7 References

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Appendix A Soil loss calculations

1. Erosion Hazard and Sediment Basins

Site Name: Daroobalgie Solar Farm

Site Location: Daroobalgie, NSW

Precinct/Stage: EIS

Other Details: Main Works Area

Site area	Sub-catchment or Name of Structure						Notes
	SY	C1-1	C1-2	C1-3	C1-4	C1-5	
Total catchment area (ha)	0.523	30.6	30.3	31.5	31.1	30	
Disturbed catchment area (ha)	0.523	30.6	30.3	31.5	31.1	30	

Soil analysis (enter sediment type if known, or laboratory particle size data)

Sediment Type (C, F or D) if known:	C	C	C	C	C	C	From Appendix C (if known)
% sand (fraction 0.02 to 2.00 mm)							Enter the percentage of each soil fraction. E.g. enter 10 for 10%
% silt (fraction 0.002 to 0.02 mm)							
% clay (fraction finer than 0.002 mm)							
Dispersion percentage							E.g. enter 10 for dispersion of 10%
% of whole soil dispersible							See Section 6.3.3(e). Auto-calculated
Soil Texture Group	C	C	C	C	C	C	Automatic calculation from above

Rainfall data

Design rainfall depth (no of days)	5	5	5	5	5	5	See Section 6.3.4 and, particularly, Table 6.3 on pages 6-24 and 6-25.
Design rainfall depth (percentile)	85	85	85	85	85	85	
x-day, y-percentile rainfall event (mm)	32.2	32.2	32.2	32.2	32.2	32.2	
Rainfall R-factor (if known)	1250	1250	1250	1250	1250	1250	Only need to enter one or the other here
IFD: 2-year, 6-hour storm (if known)							

RUSLE Factors

Rainfall erosivity (*R* -factor)	1250	1250	1250	1250	1250	1250	Auto-filled from above
Soil erodibility (*K* -factor)	0.05	0.05	0.05	0.05	0.05	0.05	RUSLE LS factor calculated for a high rill/interrill ratio.
Slope length (m)	80	80	80	80	80	80	
Slope gradient (%)	2	1	1	1	1	1	
Length/gradient (*LS* -factor)	0.41	0.19	0.19	0.19	0.19	0.19	
Erosion control practice (*P* -factor)	1.3	1.3	1.3	1.3	1.3	1.3	
Ground cover (*C* -factor)	1	1	1	1	1	1	

Sediment Basin Design Criteria (for Type D/F basins only. Leave blank for Type C basins)

Storage (soil) zone design (no of months)	12	12	12	12	12	12	Minimum is generally 2 months
Cv (Volumetric runoff coefficient)	0.35	0.35	0.35	0.35	0.35	0.35	See Table F2, page F-4 in Appendix F

Calculations and Type D/F Sediment Basin Volumes

Soil loss (t/ha/yr)	33	16	16	16	16	16	
Soil Loss Class	1	1	1	1	1	1	See Table 4.2, page 4-13

Soil loss (m^3/ha/yr)	25	12	12	12	12	12	Conversion to cubic metres
Sediment basin storage (soil) volume (m^3)	13	369	365	379	375	361	See Sections 6.3.4(i) for calculations
Sediment basin settling (water) volume (m^3)	59	3449	3415	3550	3505	3381	See Sections 6.3.4(i) for calculations
Sediment basin total volume (m^3)	72	3818	3780	3929	3880	3742	

NB for sizing of Type C (coarse) sediment basins, see Worksheet 3 (if required).

1. Erosion Hazard and Sediment Basins

Site Name: Daroobalgie Solar Farm

Site Location: Daroobalgie, NSW

Precinct/Stage: EIS

Other Details: Main Works Area

Site area	Sub-catchment or Name of Structure						Notes
	C1-6	C1-7	C1-8	C1-9	C1-10		
Total catchment area (ha)	31.3	31.8	29.3	29	32.7		
Disturbed catchment area (ha)	31.3	31.8	29.3	29	32.7		

Soil analysis (enter sediment type if known, or laboratory particle size data)

Sediment Type (C, F or D) if known:	C	C	C	C	C		From Appendix C (if known)
% sand (fraction 0.02 to 2.00 mm)							Enter the percentage of each soil fraction. E.g. enter 10 for 10%
% silt (fraction 0.002 to 0.02 mm)							
% clay (fraction finer than 0.002 mm)							
Dispersion percentage							E.g. enter 10 for dispersion of 10%
% of whole soil dispersible							See Section 6.3.3(e). Auto-calculated
Soil Texture Group	C	C	C	C	C		Automatic calculation from above

Rainfall data

Design rainfall depth (no of days)	5	5	5	5	5		See Section 6.3.4 and, particularly, Table 6.3 on pages 6-24 and 6-25.
Design rainfall depth (percentile)	85	85	85	85	85		
x-day, y-percentile rainfall event (mm)	32.2	32.2	32.2	32.2	32.2		
Rainfall R-factor (if known)	1250	1250	1250	1250	1250		Only need to enter one or the other here
IFD: 2-year, 6-hour storm (if known)							

RUSLE Factors

Rainfall erosivity (*R* -factor)	1250	1250	1250	1250	1250		Auto-filled from above
Soil erodibility (*K* -factor)	0.05	0.05	0.05	0.05	0.05		RUSLE LS factor calculated for a high rill/interrill ratio.
Slope length (m)	80	80	80	80	80		
Slope gradient (%)	1	1	1	1	1		
Length/gradient (*LS* -factor)	0.19	0.19	0.19	0.19	0.19		
Erosion control practice (*P* -factor)	1.3	1.3	1.3	1.3	1.3	1.3	
Ground cover (*C* -factor)	1	1	1	1	1	1	

Sediment Basin Design Criteria (for Type D/F basins only. Leave blank for Type C basins)

Storage (soil) zone design (no of months)	12	12	12	12	12	12	Minimum is generally 2 months
Cv (Volumetric runoff coefficient)	0.35	0.35	0.35	0.35	0.35	0.35	See Table F2, page F-4 in Appendix F

Calculations and Type D/F Sediment Basin Volumes

Soil loss (t/ha/yr)	16	16	16	16	16		
Soil Loss Class	1	1	1	1	1		See Table 4.2, page 4-13

Soil loss (m^3/ha/yr)	12	12	12	12	12		Conversion to cubic metres
Sediment basin storage (soil) volume (m^3)	377	383	353	349	394		See Sections 6.3.4(i) for calculations
Sediment basin settling (water) volume (m^3)	3528	3584	3302	3268	3685		See Sections 6.3.4(i) for calculations
Sediment basin total volume (m^3)	3905	3967	3655	3617	4079		

NB for sizing of Type C (coarse) sediment basins, see Worksheet 3 (if required).

1. Erosion Hazard and Sediment Basins

Site Name: Daroobalgie Solar Farm

Site Location: Daroobalgie, NSW

Precinct/Stage: EIS

Other Details: Electrical Trenching

Site area	Sub-catchment or Name of Structure						Notes
	C2-1	C2-2	C2-3				
Total catchment area (ha)	1.1	1.03	0.72				
Disturbed catchment area (ha)	1.1	1.03	0.72				

Soil analysis (enter sediment type if known, or laboratory particle size data)

Sediment Type (C, F or D) if known:	F/D	F/D	F/D				From Appendix C (if known)
% sand (fraction 0.02 to 2.00 mm)							Enter the percentage of each soil fraction. E.g. enter 10 for 10%
% silt (fraction 0.002 to 0.02 mm)							
% clay (fraction finer than 0.002 mm)							
Dispersion percentage							E.g. enter 10 for dispersion of 10%
% of whole soil dispersible							See Section 6.3.3(e). Auto-calculated
Soil Texture Group	F/D	F/D	F/D				Automatic calculation from above

Rainfall data

Design rainfall depth (no of days)	5	5	5				See Section 6.3.4 and, particularly, Table 6.3 on pages 6-24 and 6-25.
Design rainfall depth (percentile)	80	80	80				
x-day, y-percentile rainfall event (mm)	20.6	20.6	20.6				
Rainfall R-factor (if known)	1500	1500	1500				Only need to enter one or the other here
IFD: 2-year, 6-hour storm (if known)							

RUSLE Factors

Rainfall erosivity (*R*-factor)	1500	1500	1500				Auto-filled from above
Soil erodibility (*K*-factor)	0.05	0.05	0.05				RUSLE LS factor calculated for a high rill/interrill ratio.
Slope length (m)	80	80	80				
Slope gradient (%)	2	2	2				
Length/gradient (*LS*-factor)	0.41	0.41	0.41				
Erosion control practice (*P*-factor)	1.3	1.3	1.3	1.3	1.3	1.3	
Ground cover (*C*-factor)	1	1	1	1	1	1	

Sediment Basin Design Criteria (for Type D/F basins only. Leave blank for Type C basins)

Storage (soil) zone design (no of months)	2	2	2				Minimum is generally 2 months
Cv (Volumetric runoff coefficient)	0.5	0.5	0.5				See Table F2, page F-4 in Appendix F

Calculations and Type D/F Sediment Basin Volumes

Soil loss (t/ha/yr)	40	40	40				
Soil Loss Class	1	1	1				See Table 4.2, page 4-13
Soil loss (m^3/ha/yr)	31	31	31				Conversion to cubic metres
Sediment basin storage (soil) volume (m^3)	6	5	4				See Sections 6.3.4(i) for calculations
Sediment basin settling (water) volume (m^3)	113	106	74				See Sections 6.3.4(i) for calculations
Sediment basin total volume (m^3)	119	111	78				

NB for sizing of Type C (coarse) sediment basins, see Worksheet 3 (if required).