**Document Status Record**

Report Type: Erosion and Sediment Control Plan

Project Title: Wellard Integrated Live Export Facility (ILEF)

Client: Wellard Rural Exports Pty Ltd

Project Document Number: 23919.80376

File Name: 23919.80376_150914_Wellards Darwin_ESCP_Rev B.docx

<table>
<thead>
<tr>
<th>Revision</th>
<th>Date of Issue</th>
<th>Author</th>
<th>Reviewed</th>
<th>Quality Assurance</th>
<th>Approved</th>
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<tbody>
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**Distribution:**

Rev B: Draft report (clients comments)

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Executive Summary

EnviroAg Australia Pty Ltd has been engaged to provide an Erosion and Sediment Control Plan for the construction activities associated with Wellard’s Livingstone Integrated Live Export Facility (ILEF).

The development is located on the property known as “Livingstone Valley” (Lot 5544, Hundred of Strangways) on the Stuart Highway at Livingstone, Northern Territory. It is situated 50 km south-south east (SSE) of Darwin; 40 km south east of the Darwin harbour, and about 8 km west of Berry Springs.

This Erosion and Sediment Control Plan (ESCP) outlines management conditions for best practice soil and water management. These include construction sequence, erosion and sediment control measures, waste management, stabilisation and rehabilitation, as well as monitoring and maintenance requirements.
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1. **Introduction**

Wellard Rural Exports Pty Ltd is constructing an Integrated Live Export Facility (ILEF) at Livingstone, Northern Territory (NT). To mitigate environmental impacts during the construction phase of the project an Erosion and Sediment Control Plan will be enacted.

This ESCP plan has been prepared in consideration of the following guidelines and standards:


1.1 **Objectives**

The objectives of this ESCP are to:

- Implement best practice soil and water management;
- Provide management conditions for managers and construction personnel in relation to best practice erosion and sediment control;
- Reduce pollution and minimise impacts from construction works on soils, landforms and receiving waters; and
- Reduce land degradation and improve rehabilitation outcomes.

1.2 **Scope**

This ESCP is limited to the following construction activities within the project site, including construction of:

- Care takers house;
- Commodity and fodder storage sheds;
- Feed mill;
- Freshwater storage (ring tank and clean water tanks), for capture and storage of roof runoff and storage of ground waters for stock water supply;
- Pre-Export Quarantine (PEQ) holding yard (Normalised holding capacity 3,000 SCU, with a 12,000 head ‘peak’ short term (~4 day average) holding capacity over a 16 day shipment cycle time (25% occupancy);
- Livestock Truck washing facility;
- 1,000 SCU (Short term) feedlot; for holding stock for up to 30 days;
- Installation of water pipes for pivot irrigators;
- Fresh water supply turkeys nest;
- Primary waste water pond;
- Wet weather storage pond;
- Fresh water runoff dam;
- Sedimentation basins;
- Hard Stand Area;
- Contour banks; and
- Clearing of native vegetation.

The proposed ILEF will be constructed in two stages, with an early works package preceding the works to provide access, erosion and sediment control measures, temporary site facilities and water infrastructure for construction works to commence (Figure 2). The early works is expected to commence in late 2015 followed by Stages 1 and 2, to have all the works completed by September 2016.
Stage 1 includes the construction of most of the ILEF facilities (induction yards, bore, feedmill, office, commodity storage sheds, wastewater treatment ponds, clean water storage, diversion drains and the irrigation area). It also includes 80% of the short term holding pre export quarantine (PEQ) yards. The yard would then be ready to receive and process cattle.

Stage 2 would see the construction of the final rows of the short term feedlot, additional storage sheds and feed mill facilities. This stage is planned for construction in 2017.
Figure 1  The undeveloped site as it currently is
Figure 2  Early works erosion and sediment control drainage system
Figure 3  Site plan for Wellard's Integrated Live Export Facility
2. Project Area and Site Characteristics

2.1 Geography

“Livingstone Valley” drains from east to west, with elevation varying from approximately 60 AHD (Australian Height Datum) to 40 AHD across the site. The gradient is approximately 1.5% to 3%.

The site is located in the NT Van Diemen soils group. Within this zone the landscape is undulating to rolling hills and rises with mostly poorly developed, shallow and gravelly Kandosols, though Tenosols dominate the southern half of the zone.

2.2 Geology

The Kandosol soils overlie a sedimentary geology. The Kandosols contain varying amounts of clay. Clays are generally shallow on the upper slopes or exposed hill crests; these are the likely recharge areas.

Haig and Townsend (date) describe the geology:

- The bedrock geology consists of dolomite, carbonate rocks, sandstone, shale, siltstone, schist, granite and metamorphic rocks. The highest yielding bedrock aquifers are the dolomites and carbonate rocks. Lesser yielding aquifers are found in the fractured sandstones and siltstone. Schist, granite and metamorphic rocks are low yielding aquifers.

- Most of the region is covered with 20 to 50 metres of more recent sandstone, siltstone and claystone. There is a 5 to 10 metre thick layer of laterite ie. a residual clayey layer mainly consisting of hydrosides of iron and aluminium formed under tropical climatic conditions by the weathering of igneous rocks, that forms a capping layer over most of the area.

- Recharge to the regional aquifers is a result of direct infiltration of rain through the surface deposits. The average annual rainfall in the region is 1,700 mm, as much as 200 mm is recharged to some of the more transmissive areas in the catchment.

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Horizon</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0 - 0.10</td>
<td>A1</td>
<td>Dark brown sandy silt trace of clay. Massive structure with humic layer at a A0 with minor gravel</td>
</tr>
<tr>
<td>0.10 - 0.20</td>
<td>A2</td>
<td>Light yellow brown sandy silt. Massive structure, saturated, weak and partially leached</td>
</tr>
<tr>
<td>0.20 - 0.30</td>
<td>B1</td>
<td>Orangey yellow clayey, sandy silt. Massive structure.</td>
</tr>
<tr>
<td>0.30 - 0.65</td>
<td>B2</td>
<td>Red silty (20-30%) clay (20-30%) with gravel. Massive structure.</td>
</tr>
<tr>
<td>0.65 - 0.90</td>
<td>B3</td>
<td>Red/Yellow gravelly clay. Massive structure with decomposed ferricrete and red yellow mottles.</td>
</tr>
<tr>
<td>0.90 - 1.20</td>
<td>C1</td>
<td>Ferricrete rock with red yellow mottles.</td>
</tr>
</tbody>
</table>

2.3 Hydrology

The site has no creeks and is situated at the top of a watershed. Water runs off to the west. The site does not flood.

Low lying areas in the north-west corner of the property, where it is lowest, and proximate to the railway line are flat and become inundated with runoff from upslope.
Areas to the east of Stuart Highway are considered to be recharge areas. There is some connectivity between these recharge areas, ground waters and downslope surface waters. Berri Creek gains water from the shallow groundwater systems and it is groundwater that delivers water to this system during the dry season.

The chosen site is underlain by a considerable depth of clay and, as such, transmission of surface waters from the property to the ground waters is at best slow, if not unlikely.

### 2.4 Vegetation and Current Land Use

The site has predominantly been cleared and developed. 2.6 ha of degraded remnant vegetation remains onsite (Figure 1). Some exotic trees have been planted proximate to the existing residence. The vast majority of the property has been cultivated and sown to improved pasture species; Jarra and Tully grasses. The remnant vegetation will need to be cleared for development (Figure 3).

### 2.5 Soil Erosion Assessment

An erosion risk assessment has been completed for the ILEF Darwin site in accordance with the principles outlined in Matthews (2008). The assessment concluded that during the land disturbance activities (12 months) the total soil loss would equal approximately 101.71 tonnes (Table 2). An area of approximately 51.63 ha would be disturbed during this period. (Calculation presented in Appendix A)

Further to this, IECA (2008) states that developments disturbing more than 4 ha require 5 soil samples per every 2 ha of disturbance. As such it could be argued that the amount of soil samples supporting this erosion risk assessment is insufficient in order to be representative for the whole site. However, the samples taken are representative of the areas which will be disturbed and increase the erodibility of the site, hence; the erosion risk assessment has covered the worst case scenario.

#### Table 2   Summary of site characteristics and constraints

<table>
<thead>
<tr>
<th>Characteristic/Constraint</th>
<th>Value/Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rainfall erosivity (R)</td>
<td>13,738</td>
</tr>
<tr>
<td>General slope gradient</td>
<td>1.2 %</td>
</tr>
<tr>
<td>Potential erosion hazard</td>
<td>Low, slopes &lt; 10% (from figure 4.4 in Matthews (2008))</td>
</tr>
<tr>
<td>Calculated soil loss</td>
<td>1.97 tonnes/ha/year</td>
</tr>
<tr>
<td>Total soil loss</td>
<td>101.71 tonnes</td>
</tr>
<tr>
<td>Soil loss class</td>
<td>Class 1 Very Low (from table 4.2 in Matthews (2008))</td>
</tr>
<tr>
<td>Soil texture group</td>
<td>Type C and D (Australian Soil Classification)</td>
</tr>
<tr>
<td>Runoff coefficient for ARI of 10 years</td>
<td>1.54</td>
</tr>
<tr>
<td>Volumetric runoff coefficient</td>
<td>0.8(^1)</td>
</tr>
<tr>
<td>Soil hydrological group</td>
<td>Group D Clay (Dept. LRM)</td>
</tr>
<tr>
<td>Total site area</td>
<td>90.5 ha</td>
</tr>
<tr>
<td>Disturbed site area</td>
<td>51.63 ha</td>
</tr>
<tr>
<td>Annual mean rainfall</td>
<td>1698 mm (Bureau of Meteorology 2014, Berry Springs)</td>
</tr>
<tr>
<td>75(^{th}) percentile, 5-day rainfall event</td>
<td>36 mm</td>
</tr>
<tr>
<td>Duration of project (Construction)</td>
<td>12 months</td>
</tr>
</tbody>
</table>

\(^1\) Pilgrim, 2001
2.6 Estimated Soil Loss

The estimated soil loss (tonnes/ha/year) is derived from the Revised Universal Soil Loss equation (RUSLE), Equation 2 below.

\[ A = R \times K \times LS \times P \times C \]  
(Equation 2)

Where;
- \( A \) = computed soil loss (tonnes/ha/year);
- \( R \) = rainfall erosivity factor;
- \( K \) = soil erodibility;
- \( LS \) = slope length/gradient factor;
- \( P \) = erosion control practice factor;
- \( C \) = ground cover factor.

The site specific values used to calculate the soil loss for the Darwin ILEF are shown in Table 3. Applying the site specific values, calculation of RUSLE results in a soil loss of approximately 1.97 tonnes/ha/year.

Table 3  Site specific values for calculation of RUSLE

<table>
<thead>
<tr>
<th>Factor</th>
<th>Site Specific Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rainfall erosivity (R)</td>
<td>13,738</td>
</tr>
<tr>
<td>Soil erodibility (K)</td>
<td>0.012</td>
</tr>
<tr>
<td>Length-Slope (LS)</td>
<td>0.12</td>
</tr>
<tr>
<td>Erosion control practice (P)</td>
<td>1(^2)</td>
</tr>
<tr>
<td>Ground cover (C)</td>
<td>0.1(^3)</td>
</tr>
</tbody>
</table>

\(^2\) Due to a lack of spatial data and tillage practices, it is assumed that the value of the P factor is 1. The estimated soil loss ratio reflects the erosion potential under conditions with no soil conservation support practices (Lu. et. al., 2001).

\(^3\) Grazing modified pastures, Table 6.5 (DHACERG, 2006)
3. **ESCP Control Conditions**

A revised ESCP including a diagram with the mapped control measures throughout the construction phases of the project will be provided on finalisation of the detailed design.

### 3.1 General Instructions

- This ESCP shall be read in conjunction with engineering plans and any other plans or written instructions issued in relation to the development;
- All personnel, including contractors and subcontractors, must understand their responsibility to minimise the potential for soil and water pollution and undertake all measures described in this ESCP;
- Land disturbance is to be kept to a minimum at all times and where possible be limited to a maximum of 5 meters from the edge of any essential construction activity. Land clearing must be delayed as long as practicable and disturbed areas rehabilitated as soon as practical;
- Temporary end-of-day control measures must be put in place in the event that significant rainfall is expected. These may include the application of flow diversion banks, straw bales and geo-textile; and,
- Diversion banks shall be constructed along the top side of paddocks where required to intercept run-on from adjacent land away from the project site. All banks shall be seeded and/or lined with suitable material to prevent erosion. Run-on shall be directed to stable, well grassed waterways or drainage lines.

### 3.2 Construction Sequence

All work must be undertaken in the following sequence. Each subsequent stage is not to commence until the previous one is completed.

<table>
<thead>
<tr>
<th>Sequence Number</th>
<th>Construction Stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Construct stabilised site access</td>
</tr>
<tr>
<td>2</td>
<td>Mark access tracks, sensitive areas and no-go zones as required. Temporary fencing may be used to mark access roads and no-go zones. Access areas should be limited to a maximum width of 10m</td>
</tr>
<tr>
<td>3</td>
<td>Install clean water diversion banks where required, directing overland flow away from disturbed areas and into stable areas. Stabilise drains with suitable material to prevent erosion.</td>
</tr>
<tr>
<td>4</td>
<td>Install sediment fences or other appropriate sediment controls downslope from disturbed areas.</td>
</tr>
<tr>
<td>5</td>
<td>Clear site, strip and stockpile topsoil/seedbed for later reinstatement or landscaping purposes.</td>
</tr>
<tr>
<td>6</td>
<td>Perform earth works as required and in accordance with engineering plans.</td>
</tr>
<tr>
<td>7</td>
<td>Apply erosion control measures to disturbed areas as required.</td>
</tr>
<tr>
<td>8</td>
<td>Monitor and improve controls as necessary.</td>
</tr>
<tr>
<td>9</td>
<td>Undertake final site stabilisation.</td>
</tr>
</tbody>
</table>
3.3 Site Specific Conditions

3.3.1 Clearing of Native Vegetation

Clearing of native vegetation must be kept to a minimum at all times. Where clearing is required temporary sediment controls such as sediment fences must be installed prior to commencing clearing activities. Cleared vegetation should be mulched and used for soil stabilisation within the project site or relocated to adjacent vegetated areas within the project site to provide shelter and refuge habitat for fauna.

3.3.2 Installation of Pivot Irrigation

To manage erosion and sedimentation from pipe installation for pivot irrigators, disturbed areas shall be seeded with a quick germinating annual and covered with jute matting as soon as practical after installation of pipe. Temporary sediment controls shall be applied as necessary to ensure pollution of downslope lands does not occur.

3.3.3 Access Roads

Control measures outlined in this section apply to the construction of all access roads within the Project Site. All work must be undertaken in the sequence listed in Table 5. Each subsequent stage is not to commence until the previous one is completed.

<table>
<thead>
<tr>
<th>Sequence Number</th>
<th>Construction Stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Construct stabilised site access</td>
</tr>
<tr>
<td>2</td>
<td>Install clean water diversion banks where required, directing overland flow away from disturbed areas and into stable, well grassed waterways or drainage lines. In sensitive areas, such as heritage listed sites, biosocks, sandbags or similar may be used in lieu of earth banks. Construct level spreaders at the end of diversion banks to disperse water over stabilised area and apply suitable erosion controls for diversion banks, such as a quick germinating annual and jute mat.</td>
</tr>
<tr>
<td>3</td>
<td>Construct dirty water diversion channels and install u-shaped sediment traps at suitable intervals along the bank so that catchment area does not exceed 1000 m². U-shaped sediment fences will be constructed for minor concentrated flows. Apply suitable erosion controls for diversion channels, such as a quick germinating annual and jute mat.</td>
</tr>
<tr>
<td>4</td>
<td>Strip and stockpile topsoil in designated stockpiling areas.</td>
</tr>
<tr>
<td>5</td>
<td>Construct access road in accordance with engineering plans.</td>
</tr>
<tr>
<td>6</td>
<td>Construct road drainage controls.</td>
</tr>
<tr>
<td>7</td>
<td>Apply additional erosion control measures to disturbed areas as required.</td>
</tr>
<tr>
<td>8</td>
<td>Monitor and improve controls as necessary.</td>
</tr>
<tr>
<td>9</td>
<td>Undertake final site stabilisation.</td>
</tr>
</tbody>
</table>
3.3.4 Construction of Contour Banks

Construction of contour banks is an efficient measure to control run-off from cropping land. Contour banks are earthen banks constructed at intervals across a slope to intercept and divert run-off into waterways or natural depressions. If no natural waterways exist, contour banks can be constructed in a suitable location. By ensuring that contour banks are protected from erosion by either a crop or crop residues, there will be minimal movement of sediment into the contour bank channels.

Contour banks can be constructed as narrow- or broad-based contour banks. Narrow based contours are grassed batters that are too steep to cultivate and broad based are contour banks that can easily be cultivated. Recommended contour bank specifications are described in Table 6.

| Table 6 Contour bank specifications for lands with a slope of 1-5% (DERM 2004) |
|----------------------------------|-----------|-----------|-----------|-----------|-----------|-------|
| Land slope                       | Unit      | 1 %       | 1.5 %     | 2 %       | 3 %       | 4 %   | 5 %   |
| Top section gradient             | %         |           |           | 0.15      | 0.2       | 0.2   | 0.2   |
| Middle section gradient          | %         |           |           | 0.15      | 0.25      | 0.25  | 0.25  |
| Outlet section gradient          | %         |           |           | 0.2       | 0.3       | 0.3   | 0.3   |
| Maximum bank length              | m         | 2500      | 2000      | 1750      | 1500      | 1000  | 750   |
| Single spacing V:H               | m         | 0.9:90    |           | 1.2:60    | 1.4:45    | 1.6:40| 1.8:36|
| Double spacing V:H               | m         | 1.8:180   |           | 2.4:120   | 2.8:90    | 3.2:80| 3.6:72|
| Batter on bank (bank height of 0.5 m) | -       |           |           | 1:4       | 1:4       | 1:3   | 1:3   |
| Batter on inlet into channel (bank height of 0.5 m) | - |           |           | 1:50      | 1:20      | 1:10  | 1:5   |
| Bottom width (bank height of 0.5 m) | m     |           |           | 4         | 4         | 2     | 2     |
| Cross sectional area (bank height of 0.5 m) | m² |           |           | 8.75      | 5         | 2.63  | 2     |
3.3.5 Water Storage Area

The water storage area is subject to the following control measures (Table 7). Each subsequent stage is not to commence until the previous one is completed.

Table 7 Water Storage Area Construction Sequence staging

<table>
<thead>
<tr>
<th>Sequence Number</th>
<th>Construction Stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Install clean water diversion banks where required.</td>
</tr>
<tr>
<td>2</td>
<td>Install sediment fences downslope of lands to be disturbed for construction of the CAR dam and storage ponds.</td>
</tr>
<tr>
<td>3</td>
<td>Stabilise land surfaces disturbed by construction of CAR basin and storage ponds as soon as final levels are established.</td>
</tr>
<tr>
<td>4</td>
<td>Construct dirty water diversion channels to direct run-off from disturbed areas</td>
</tr>
<tr>
<td>5</td>
<td>Strip and stockpile topsoil from areas to be disturbed from construction.</td>
</tr>
<tr>
<td>6</td>
<td>Perform earth works as required and in accordance with engineering plans.</td>
</tr>
<tr>
<td>7</td>
<td>Apply erosion control measures to disturbed areas as required.</td>
</tr>
<tr>
<td>8</td>
<td>Monitor and improve controls as necessary.</td>
</tr>
<tr>
<td>9</td>
<td>Undertake final site stabilisation</td>
</tr>
</tbody>
</table>

3.3.6 Hardstand Area

The hardstand area is subject to the following control measures (Table 8). Each subsequent stage is not to commence until the previous one is completed.

Table 8 Hardstand Area Construction Sequence staging

<table>
<thead>
<tr>
<th>Sequence Number</th>
<th>Hardstand Construction Stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Install clean water diversion banks where required.</td>
</tr>
<tr>
<td>2</td>
<td>Strip and stockpile topsoil from areas to be disturbed from construction</td>
</tr>
<tr>
<td>3</td>
<td>Perform earth works as required and in accordance with engineering plans</td>
</tr>
<tr>
<td>4</td>
<td>Construct rock lined chutes and outlet structures for cut and fill.</td>
</tr>
<tr>
<td>5</td>
<td>Apply erosion control measures to disturbed areas as required.</td>
</tr>
<tr>
<td>6</td>
<td>Monitor and improve controls as necessary.</td>
</tr>
<tr>
<td>7</td>
<td>Undertake final site stabilisation</td>
</tr>
</tbody>
</table>

3.4 Erosion Control Conditions

The following erosion control measures are applicable to all construction works associated with the Livingstone ILEF Development.

- Clearly visible barrier fencing shall be installed at the discretion of the site superintendent to limit unnecessary disturbance.
- Soil materials must be replaced in the same order they are removed from the ground.
- Topsoil/seedbed shall be stockpiled for later reinstatement or landscaping purposes.
Disturbed areas must be seeded with a quick germinating annual as soon as practical after earth works have been completed. All disturbed areas are to have a maximum C-factor of 0.15 (minimum of 50 percent ground cover) after 20 days of inactivity, even though works might continue later.

Stockpiles that are to be stored for more than 10 days also have to have a maximum C-factor of 0.15 within 20 days (50 percent ground cover). This can be achieved by using a quick germinating annual or geo-textile.

Ensure the time from starting land disturbance activities to stabilisation is less than six months.

Mulch cleared vegetation and place on disturbed areas to improve soil stability.

Ideally, handle topsoil when moist (not wet or dry) to avoid deterioration of soil structure.

Apply additional erosion control measures as required and in particular to areas of high erosion risk. Additional erosion control products include, but are not limited to geo-textile, jute-mesh, mulch, hydraulic seeding. Erosion blankets should be installed as per standard drawing ECM-01.

Synthetic reinforced erosion control mats and blankets must not be placed within or adjacent to riparian zones and watercourses if such materials are likely to cause environmental harm to wildlife or wildlife habitats.

Disturbed ground is not to exceed a slope length of 40 meters and 2 percent, unless additional erosion controls are applied. To reduce the slope length mid-slope flow control berms may be installed.

All earthworks, including waterways, drains, spillways and their outlets, will be constructed to be stable in at least the 10-year ARI time of concentration storm event.

Ensure effective weed control management is implemented.

Construct earth batter with as low gradient as possible, but not steeper than 2(H):1(V) if the total slope length is 10 meters, 3(H):1(V) if the total slope length is 15 meters, 4(H):1(V) if the total slope length is 22 meters and 5(H):1(V) if the total slope length is 30 meters.

Ensure discharged water does not cause an increased erosion hazard to downslope lands and waterways, which can be achieved by using geo-textile, installing energy dissipaters as per standard drawing OS-01 or constructing level spreaders as per standard drawing LS-01.

### 3.5 Pollution Control Conditions

All stockpiled material must be located within designated stockpiling areas and be constructed as low, elongated mounds, no more than 2 m high. Stockpiles of erodible material must have sediment filters installed on the downslope side to trap sediment from run-off, as well as an earth bank constructed on the upslope side to divert run-on water around stockpile.

Stockpiles must not be placed closer than 2 m from hazard areas such as concentrated water flows, gutters and existing vegetation and at least 40 m away from any riparian lands.

All disturbed areas are to have sediment control measures installed on the downslope side of the disturbance and be designed to withstand at least a 10-year ARI storm event.

Installed sediment controls are to be maintained and improved until site has been successfully stabilised.

Minimise dust generation and wind erosion by applying water, gluon or erosion control blankets where necessary.

Sediment fences will:
- Be installed where shown on the Erosion & Sediment Control Plan Drawing and elsewhere at the discretion of the site superintendent.
- Have no larger catchment than 1000 m2, or have returns of 1 metre upslope at intervals along the fence so that the catchment area does not exceed 1000 m2.
- Be placed in a way that keeps the sediment as close to its source as possible.
4. Waste Management

The following waste management principles are to be implemented throughout the project:

- Separation of reusable and recyclable materials from waste.
- Storage of waste receptacles away from watercourses and intertidal areas.
- Emptying of waste bins as required and disposal of waste appropriately.
- Wash down of materials and equipment to be undertaken away from watercourses and intertidal areas and sediment filters to be used if required.
- Where practical, waste materials should be reused on-site, for example by chipping or mulching cleared vegetation.
- For vegetation that cannot be reused on-site, approval from council should be sought before disposing of it at landfill or burning it on-site.
- Maintain and regularly check plant and equipment for leaks (e.g. fuels, oils, hydraulic fluids).
- Bund all fuel and oil storage areas to contain 120 percent of the maximum capacity of the largest storage container. These storage facilities and bunds must be regularly inspected for spills and drained of rainwater so there is sufficient storage volume in the event of a spill.
- Emergency spill response kits must be available on-site at all times. These kits must contain spill absorbent and containment materials to ensure materials do not migrate off-site, reach water bodies or create risk to employees.
- In the event of an emergency or spill, work must cease immediately and appropriate action undertaken. Actions may include, but are not limited to, containment of the spill, clean-up of contaminated soil and rectification of the problem that resulted in the spill.
5. Stabilisation and Rehabilitation

During all stages of the development, all disturbed areas, including stockpiles, are to have a maximum C-factor of 0.15 (50 percent ground cover or more) after 20 days. Additionally, upon reinstatement and site close-out the site is to achieve a C-factor of less than 0.05 (70 percent cover or more) within 60 days of completion.

Guiding principle to achieve successful stabilisation and rehabilitation of disturbed lands, include:

- Prepare a good seedbed and loosen compacted soil before sowing any seed;
- Avoid cultivation in very wet or very dry conditions;
- Apply appropriate ameliorants and/or fertilisers as required;
- Use plant species that are consistent within the existing soil conditions and climate;
- Undertake effective weed management; and
- Implement maintenance regimes.

Temporary erosion and sediment controls are not to be removed before the site has been adequately stabilised and rehabilitated.
6. Monitoring and Maintenance

During all stages of the development, site inspections are to be carried out at least weekly, immediately before site closure and immediately following/during rain events that cause run-off. These site inspections may be implemented as part of a broader project specific Construction Environmental Management Plan (CEMP). Site inspections shall be done in a systematic manner and include recordings of:

- The condition and effectiveness of control measures; and
- Any maintenance requirements, including removal of sediment trapped in sediment fences, diversion drains, sediment basins and waterways etc. Ensure that:
  - Sediment filters are maintained so that no more than 30 percent of their design capability is lost to accumulated sediment.
  - Any sediment removed is placed in areas where further pollution to down slope lands and water will not occur.
  - Construction materials are replaced as required.
  - Installed sediment controls are maintained until site has been appropriately stabilised.
- Any improvements required, including additional sediment fences and maintenance of diversion banks;
- Maintenance requirements for grass cover in waterways;
- The condition of recently stabilised areas and any required repairs or measures to be initiated;
- Vehicle movements and signs of sediment being transported off-site through vehicle movements;
- Condition of waste bins; and
- Any modifications required to this plan.

Sediment basins must be kept in good working condition and attention will be given to:

- Recent works to ensure drains and basins have been constructed suitably to the local conditions and that sediment laden water is managed appropriately;
- Degradable products to ensure they are replaced as necessary;
- Sediment removal to ensure the design capacity or less remains in the settling zone; and
- Waters in sediment basins that occupy more than one quarter of the design capacity will be treated with a flocculating agent and discharged within five days from any storm event large enough to fill the basin to that level.

Furthermore, should significant erosion occur, demonstrated by visual loss of topsoil, subsoil or stockpiled material, all efforts must be made to address further loss from the site. This includes, but is not limited to:

- Diversion or slowing of water onto and away from the eroded area. Care should be taken not to unduly disturb other surfaces capable of becoming erosion sources.
- Improvements to earthworks to reduce or stabilise erodible slopes.
- The installation or improvement of sediment control structures.
7. References


The Clean Water Team Guidance Compendium for Watershed Monitoring and Assessment (2011) State Water Resources Control Board 5.1.3 FS--(RC)


8. Appendices

Appendix A. Soil Erosion Assessment Calculations A-1
Appendix A.  Soil Erosion Assessment Calculations
Erosion Risk Assessment

According to Matthews (2008) the erosion risk for a particular area can be calculated with Equation 1.

\[ R = A \times B \times T \quad (\text{Equation 1}) \]

Where \( R \) = predicted total soil loss in tonnes, \( A \) = calculated soil loss in tonnes/hectare/year, \( B \) = surface area of disturbance (hectares), \( T \) = predicted duration of the disturbance (months disturbed/12).

The soil loss (tonnes/ha/year) is derived from the Universal Soil Loss Equation, Equation 2 below.

\[ A = R \times K \times LS \times P \times C \quad (\text{Equation 2}) \]

Where, \( A \) = computed soil loss (tonnes/ha/yr), \( R \) = rainfall erosivity factor, \( K \) = soil erodibility factor, \( LS \) = slope length/gradient factor, \( P \) = erosion control practice factor, \( C \) = ground cover factor.

**Calculation of Equation 2**

To \( R \)-factor was calculated from rainfall data from the Darwin Airport (Yu, 1998) to be 13,738.

The \( LS \) factor for the ILEF development site was 0.12, which corresponds to a typical slope length of 1.2 percent over 575 meters.

The \( P \) factor was set to 1 (default)

The \( C \) factor to 1 (Grazing modified pastures).

The \( K \) factor was derived from the soil data in Table 1 and the data of the disturbed soil was used, resulting in a \( K \)-factor of 0.012.

The resulting soil loss (tonnes/ha/year) is then calculated as below:

\[ A = 13,738 \times 0.012 \times 0.12 \times 1 \times 0.1 = 1.97 \text{ tonnes/ha/year} \]
Calculation of Equation 1

The total soil loss is calculated by multiplying the estimated soil loss (1.97 tonnes/ha/year) with the total area of ground disturbance (51.63 ha) and the duration of the project (12 months/12):

\[ R = 1.97 \times 51.63 \times (12/12) = 101.71 \text{ tonnes} \]

Coefficient Calculation

To determine the peak volumetric flow the formula for the Rational Method (Pilgrim, 2001) is applied:

\[ Q_y = 0.278 \times C \times I_t \times A \]  

Where \( Q_y \) = peak volumetric flow (m³/s) having an ARI of \( y \) years, \( C \) = runoff coefficient (typically 0.8), \( I_t \) = rainfall intensity (mm/h) of design storm having duration \( t_c \), and \( A \) = catchment area (km²).

For the runoff coefficient of a 10 year ARI rainfall event:

The runoff coefficient (C) is 0.08 in accordance with Pilgrim (2001).

The rainfall intensity (\( I_t \)) of a 10 year ARI rainfall event is 76.5 mm/h.

The catchment area of the Wellard’s ILEF site is 0.905 km².

The resulting peak volumetric flow having a 10 year ARI is below:

\[ Q_y = 0.278 \times 0.08 \times 76.5 \times 0.905 = 1.54 \text{ (m}^3\text{/s)} \].