BlueCarbon™
Sequestration to Credits

BLUE CARBON ECOSYTEM RESTORATION
PERMANENCE PLAN

Blue Carbon S2C Pty Ltd

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Document History

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Review

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CONTENTS

GLOSSARY OF TERMS

Term	***Meaning / Definition***
ACCUs	Australian Carbon Credit Units
ALRA	*Aboriginal Lands Right Act 1976*
BCEMZ	Blue Carbon Ecosystem Management Zones
BC-S2C	Blue Carbon S2C Pty Ltd
CEA	Carbon Estimation Area
CFI	*Carbon Credits (Carbon Farming Initiative) Act 2011*
CLA	*Crown Lands Act 1992*
CPAs	Carbon Project Agreements
EP Act	*Environmental Protection Act 2019*
EPBC	*Environment Protection Biodiversity Conservation Act 1999*
ERF	Emissions Reduction Fund
MRV	Monitoring, Reporting and Verification
NTA	*Native Title Act 1993*
PLA	*Pastoral Lands Act 1992*

1 Context

1.1 Overview

Naturally sequestered carbon can be released back into the atmosphere by human influenced or natural events. If this were to occur it would reverse the environmental benefit of blue carbon restoration efforts. Sequestration is regarded as having a 'permanent' benefit to the atmosphere, particularly if it is maintained for a period of 100 years. Because of this, any blue carbon sequestration project undertaken by Blue Carbon S2C Pty Ltd (**BC-S2C**) are subject to permanence obligations connected to the land upon which the project is registered.

The obligations which BC-S2C must adhere to will either relate to project registration criteria under the Australian Government Emissions Reduction Fund (**ERF**) blue carbon methodology (Clean Energy Regulatory, 2022) or, under any international standard such as Verra. These obligations mandate that BC-S2C maintains carbon storage on a net basis for 100-years to generate carbon credits.

The permanence period commences once a proponent has generated carbon credits from its project.

1.2 Reporting

Under the Australian ERF method, the first offsets report is due, at the latest, six (6) months after the end of the first reporting period. The first reporting period can be up to 5 years after project registration. Under VERRA, BC-S2C will report annually.

1.3 Legal governance

The following Acts of parliament will apply to BC-S2C activities during the 100-year permanence period:

- Commonwealth *Carbon Credits (Carbon Farming Initiative) Act 2011* (**CFI Act**).
- Commonwealth *Native Title Act 1993* (**NTA**).
- Commonwealth *Environment Protection Biodiversity Conservation Act 1999* (**EPBC Act**).
- NT *Environmental Protection Act 2019* (**EP Act**)
- NT *Crown Lands Act 1992* (**CLA**).
- NT *Pastoral Lands Act 1992* (**PLA**).
- NT *Aboriginal Lands Right Act 1976* (**ALRA**).
- NT *Territory Parks and Wildlife Conservation Act 1976* (**TPWC Act)**

1.4 Legal obligations

BC-S2C is targeting a permanence period of 100 years for its blue carbon restoration projects. A project can be registered under the *Carbon Credits (Carbon Farming Initiative) Act 2011* or, under international standards including the VERRA methodology for restoring tidal wetlands[1]. This means:

[1] *VM0033 Methodology for Tidal Wetland and Seagrass Restoration Version 1.0 2015*

- There can be no double-counting of credits on a parcel of land[2].
- For any project site BC-S2C registers under the Australian ERF methodology, it will be recorded under the Emissions Reduction Fund Project Register. Subsequently, anyone buying land can check whether the land is covered by a 25 year or 100-year permanence obligation.
- BC-S2C must maintain that parcel of land to ensure carbon is sequestered within a coastal wetland ecosystem.
- If a BC-S2C project ceases or carbon stores are reversed, then some or all of the carbon credits may have to be returned.
- The permanence period begins when a BC-S2C project first receives carbon credits.
- If a fire, flood, or other form of disturbance occurs in the Project's designated Carbon Estimation Area (CEA) reducing in the amount of Carbon stored, regrowth must be managed to allow the carbon stock to return to reported baseline levels.
- Landholders with a registered sequestration project should inform prospective buyers and property agents of any permanence obligations associated with the land when selling their property.
- It is the responsibility of the proponent (i.e., BC-S2C) to ensure they have legal right to conduct blue carbon restoration projects which may provide the right to trade carbon credits (either Australian Carbon Credit Units [ACCUs] or Voluntary Carbon Units (VCUs).
- Permanence obligations allows landholders to earn credits by storing carbon or reducing greenhouse gas emissions. Once issued, credits can be sold or traded.
- If a landowner wishes to sell land upon which an Carbon Project Agreement exists with BC-S2C, should inform prospective buyers and property agents of actual or potential permanence obligations (refer to Section 2.1) associated with such land.

[2] *Clean Energy Regulator Emissions Reduction Fund – Identifying land subject to permanence obligations.*

2 Retaining Carbon

BC-S2C will retain Carbon stored in wetland vegetation and soils over the duration of the 100-year permanence period by achieving one or a combination of the following:

2.1 Landowner agreements

Entering into legally binding 100-year Carbon Project Agreements (**CPAs**) with landholders. Depending on the nature of land tenure, the CPAs will vary. They may either be on of, or a combination of, the following:

- Blue Carbon Project Indigenous Land Use Agreement required under the NTA.
- Blue Carbon Project Section 11A Agreement required under the NT ALRA
- Blue Carbon Project Section 19 Agreement required under the NT ALRA.
- Blue Carbon Pastoral Access Arrangement required under the NT PLA.
- Blue Carbon Occupation Licence required under the NT CLA.
- Blue Carbon Permit under the TPWC Act.

The details of such Agreements are commercially sensitive. However, one of the minimum requirements for landowners and the proponent would be to abstain from clearing or burning any wetland vegetation contained within the defined Blue Carbon Ecosystem Management Zone (**BCEMZ**).

2.2 Blue carbon ecosystem management zones

Each Blue Carbon Project Agreement referenced above will be made in line with a project BCEMZ. The BCEMZ are large areas that are mapped to provide:

- BC-S2C the flexibility to research blue carbon projects.
- The opportunity to convert BCEMZ into blue Carbon conservation zones.
- Complete baseline Carbon stock analysis.
- Complete hydrological modelling.
- Complete landcover mapping.
- Establish project CEA.

2.3 Carbon estimation areas

The ability to sequester soil Carbon over the 100-year permanency period will be made possible by CEAs. CEA boundaries will:

- Be established by a combination of desktop modelling and field work.
- Be mapped by BC-S2C.
- Be surveyed by a registered surveyor and authorised by the NT government.
- Be protected within each BCEMZ.

- Form part of legal tenure with all landowners by way of Carbon Project landowner agreements.

3 Monitoring, reporting, and verification

Monitoring, Reporting and Verification (**MRV**) are operational activities that will be undertaken by BC-S2C after construction restoration activities have ceased. MRV activities and actions that will be undertaken to avoid and reduce potential loss of credited carbon in each CEA and BCEMZ will include:

- Annual asset inspections of modified tidal structures such as box culverts, bridges, or levees (BC-S2C document reference Project Operations and Maintenance Plan - BCO-PLN-200-2023-010).
- Five yearly maintenance on wetland drainage channels.
- Annual soil Carbon monitoring across a representative area within the defined CEA and compared to the Project's reference point.
- Annual landcover (mangrove and saltmarsh cover) mapping using Landsat imagery.
- Soil and water quality monitoring as required by BC-S2C's Acid Sulfate Soils Plan of Management (document reference BCO-PLN-200-2023-003).
- Hydrological (water level) monitoring.
- If required, pro-active water level management.
- Coastal geomorphological assessessments.
- Feral animal control.
- Biosecurity monitoring and management as defined by BC-S2C's Biosecurity Monitoring Management Plan (document reference BCO-PLN-200-2023-011).

4 References

1. **Australian Government Clean Energy Regulator:** *Emissions Reduction Fund – Identifying land subject to permanence obligations.*

2. **Verra** - *VM0033 Methodology for Tidal Wetland and Seagrass Restoration Version 1.0 2015.*

BLUE CARBON ECOSYTEM RESTORATION
PROJECT OPERATIONS & MAINTENANCE PLAN

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CONTENTS

List of Figures

List of Tables

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ALRA	*Aboriginal Lands Right Act 1976*
BCEMZ	Blue Carbon Ecosystem Management Zones
BCER	Blue Carbon Ecosystem Restoration
BC-S2C	Blue Carbon S2C Pty Ltd
CEA	Carbon Estimation Area
CFI	*Carbon Credits (Carbon Farming Initiative) Act 2011*
CLA	*Crown Lands Act 1992*
CPAs	Carbon Project Agreements
EP Act	*Environmental Protection Act 2019*
EPBC	*Environment Protection Biodiversity Conservation Act 1999*
ERF	Emissions Reduction Fund
MRV	Monitoring, Reporting and Verification
NT	Northern Territory
NTA	*Native Title Act 1993*
PLA	*Pastoral Lands Act 1992*
POMP	Project Operations and Maintenance Plan

1 Introduction

Blue Carbon S2C Pty Ltd (**BC-S2C**) are planning to restore wetland habitats in the Northern Territory (**NT**) Gulf of Carpentaria. Wetland habitats are also known as Blue Carbon Ecosystems and comprise seagrass, mangroves, saltmarsh, mudflats, and littoral forests.

The operational obligations which BC-S2C must adhere to will either relate to project registration criteria under the Australian Government Emissions Reduction Fund (**ERF**) blue carbon methodology (Clean Energy Regulatory, 2022) or, under any international standard such as Verra. These obligations mandate that BC-S2C maintains carbon storage on a net basis for 100-years to generate carbon credits.

This Project Operations and Maintenance Plan (**POMP**) is requirement of project registration under the Australian Government's *Carbon Credits (Carbon Farming Initiative – Tidal Restoration of Blue Carbon Ecosystems) Methodology Determination 2022.*

This POMP safeguards each BC-S2C Blue Carbon Ecosystem Restoration (**BCER**) project. It ensures each BCER project will sequester soil Carbon and continue to generate Carbon credits and co-benefits, during the 100-year permanence period.

1.1 Objectives

This POMP will:

- Map the location of activities that require the alteration, modification, or removal of tidal restrictions or, flow impediments.
- Describe drainage modifications, flood mitigation and design specifications.
- List controls for identified environmental aspects and impacts.
- List relevant legal obligations that may be relevant to BCER activities.
- Describe the type and frequency of maintenance actions.

1.2 Definitions

- **Blue Carbon Ecosystem Management Zone:** The area in which BC-S2C has mapped to conduct blue carbon scientific research to define Carbon Estimation Areas (**CEAs**).
- **Permanence period:** The timeframe in which each BCER project will be registered. BC-S2C will seek a 100-year permanence period for its BCER projects.
- **Operations:** Is the period in which BCER project Monitoring, Reporting and Verification (**MRV**) activities occur. MRV activities are intended to be sustained over the Project's registered permanence period.
- **Maintenance:** The types of activities undertaken to ensure project success over the registration period. '

2 Governance

2.1 Legal obligations

Section 5 and 14 of the Commonwealth *Carbon Credits (Carbon Farming Initiative – Tidal Restoration of Blue Carbon Ecosystems) Methodology Determination 2022* requires BC-S2C to prepare this POMP for project registration. In addition, Other likely regulatory requirements during operation (i.e., **MRV**) of BCER projects undertaken by BC-S2C may include compliance under the:

- Commonwealth *Native Title Act 1993* (**NTA**).
- Commonwealth *Environment Protection Biodiversity Conservation Act 1999* (**EPBC Act**).
- NT *Environmental Protection Act 2019* (**EP Act**)
- NT *Crown Lands Act 1992* (**CLA**).
- NT *Pastoral Lands Act 1992* (**PLA**).
- NT *Aboriginal Lands Right Act 1976* (**ALRA**).
- NT *Territory Parks and Wildlife Conservation Act 1976* (**TPWC Act)**.

2.2 Landowner agreements

BC-S2C will enter into legally binding 100-year Carbon Project Agreements (**CPAs**) with landholders. Depending on the nature of land tenure, the CPAs will vary. They may either be on of, or a combination of, the following:

- Blue Carbon Project Indigenous Land Use Agreement required under the NTA.
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- Blue Carbon Project Section 19 Agreement required under the NT ALRA.
- Blue Carbon Pastoral Access Arrangement required under the NT PLA.
- Blue Carbon Occupation Licence required under the NT CLA.
- Blue Carbon Permit under the TPWC Act.

The details of such Agreements are commercially sensitive. However, one of the minimum requirements for landowners and the proponent would be to agree MRV and maintenance activities within its defined Blue Carbon Ecosystem Management Zone (**BCEMZ**).

2.3 Blue carbon ecosystem management zones

Each Blue Carbon Project Agreement referenced above will be made in line with a project BCEMZ. The BCEMZ are large areas that are mapped to provide:

- BC-S2C the flexibility to research blue carbon projects.

- The opportunity to convert BCEMZ into blue Carbon conservation zones.
- Complete baseline Carbon stock analysis during the MRV period.
- Complete hydrological modelling during the MRV period.
- Complete landcover mapping during the MRV period.
- Maintain project CEAs.

2.4 Carbon estimation areas

The ability to sequester soil Carbon over the 100-year permanency period will be made possible by CEAs. CEA boundaries will:

- Be protected within each BCEMZ.
- Be established by a combination of desktop modelling and field work.
- Be mapped by BC-S2C and included into project registration applications and CPAs with landowners.
- Be surveyed by a registered surveyor and authorised by the NT government.

3 Operational restoration actions

There are five BCER actions planned for each project site. They are:

1. Hydrological restoration.
2. Topographical restoration.
3. Pro-active water level management.
4. Reforestation.
5. Rehabilitation of culverts.

3.1 Hydrological restoration

Hydrological rehabilitation and restoration will include, where determined via desktop modelling and ground-truthing, one of or a combination of the following activities:

- Removal of tidal impediment structures to restore tidal extents across blue carbon ecosystems.
- Modification of existing tidal impediment structures.
- De-silting existing (natural) channels and, where appropriate, creating new channels that mimic the surrounding environment.

The hypothesis is that once hydrology has been restored, and water levels and salinity levels are maintained to an appropriate level, adequate conditions are slowly recovered, enabling the natural establishment of mangroves and salt marshes from the seedlings and wildlings from the existing neighbouring Blue Carbon Ecosystem (**BCE**) populations. An example of this technique is shown in Figure 3-1.

With natural succession, a greater volume of organic matter is deposited leading to an increased potential for carbon sequestration. In both instances, the channels will carry tidal water into the BCE where saltwater has been identified by BC-S2C and its independent consultants as having the potential to exist or did exist. Our project restoration actions are not planting mangroves necessarily, its restoring conditions for these trees to grow.

3.1.1 Wetland drainage designs

Hydrological rehabilitation is aimed at removing factors that may have previously led to the degradation or loss of mangrove species and supporting habitat. Phase1 (6 ha) and Phase 2 (1,000 ha) will experiment, examine, and assess the de-silting of existing channels and, the creation of new drainage channels.

1. Primary (main) channel only (refer to Figure 3-1).
2. Primary (main) channel with secondary (side) fish bone channels (Figure 3-1).
3. Primary channel with secondary (side) herringbone / zig zag channels (Figure 3-1).

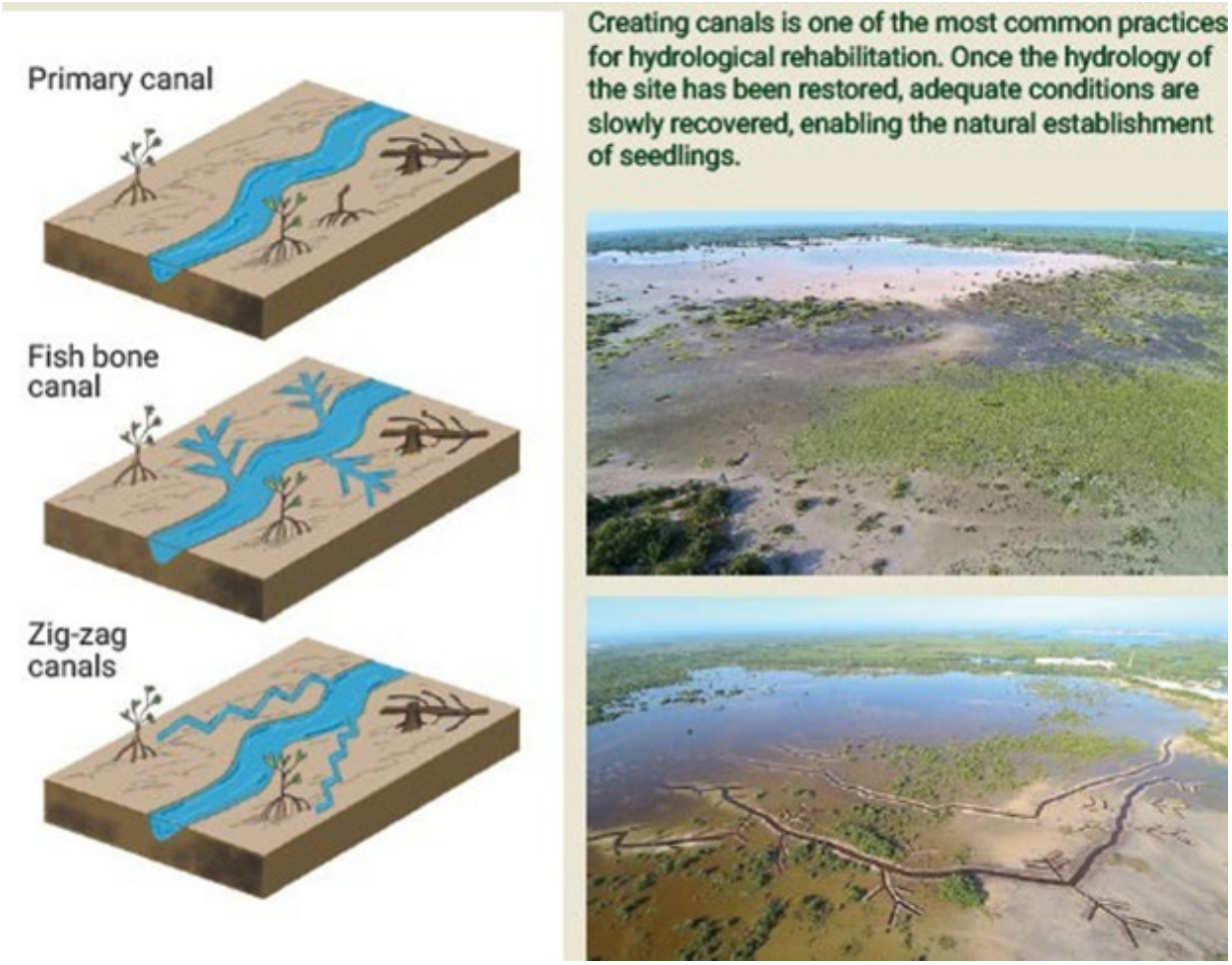


Figure 3-1 Hydrological rehabilitation techniques that will be trialled during Phase 1 and 2 works.

BC-S2C is planning for most channels to have an inclination of approximately 30-45º and a depth of approximately 1 meter and 0.5 meters in very shallow soils to provide heterogeneity (Figure 3-2). This will also allow the ebb and flow of water to not erode the slopes of the channels, reducing the frequency of maintenance[1].

For planning purposes, the primary and secondary channels will vary as detailed in Table 3-1. Only if these trials prove successful will these techniques be carried into Phase 3. The creation of new channels will support desilting existing channels. This will be undertaken to ensure a continuous supply of tidal water flow over the permanency period within the mapped CEA.

3.1.2 Primary and secondary channel specification

Final specifications for new channels will depend on further eco-hydrology research and modelling. Any new channel depth and width will vary and depends on site specific conditions.

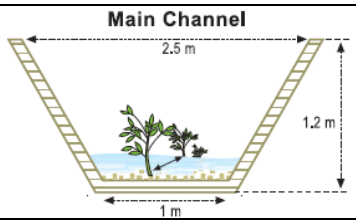
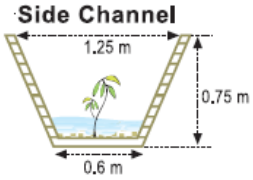
3.1.3 Sediment from creating new canals and desilting existing canals

The sediment removed from the excavator bucket should not be left on the channel banks as this prevents the influence of the canal from spreading beyond its edges. BC-S2C will use equipment (like blowers) to spread the

[1] *Pg 52 Manual for the ecological restoration of mangroves in the Mesoamerican Reef System and the Wider Caribbean*

sediment when excavating, or have it used for other complementary actions, such as filling sites with a lower topographic level (topographical restoration).

Table 3-1 Specifications[2] for new channels

CHANNELS	PRIMARY (MAIN)	SECONDARY (SIDE)
Top Width	2.5 m	1.25 m
Bottom Width	1.0 m	0.60 m
Depth (deeper soils)	1.25 m	0.75 m
Depth (deeper soils)	1.25 m	0.75 m
Inclination	~ 30-45º	~ 30-45º
Angle with the Sea/River/Creek/ Canal	Right Angle	**N/A**
Angle with the Main Channel	**N/A**	Right Angle
Distance between Main Channels	75m	**N/A**
Distance between Side Channels	**N/A**	8.75m
Diagrams		

3.1.4 Creating new channels

Creating new drainage channels must be considered when the desilting of natural drainage channels is not enough to restore the hydrology of a site. The objective of creating new channels is to ensure continuous water flow with inlets and outlets. The channel network is established using information collected from environmental baseline studies. The building of new drainage channels will require heavy machinery, such as excavators, but it will depend on the characteristics of the site and the size and resources of the project.

3.1.5 Equipment for digging drainage channels at scale - amphibious excavators with accessories

An amphibious excavator (or pontoon excavator or floating excavator) is a type of excavator that can perform dredging while afloat on soft terrain such as swamp, wet land, and shallow water. An amphibious excavator is better adapted for removing silty clay, clearing silted trenches, swampland operation, and shallow water operation than traditional barge-mounted dredgers.

3.1.5.1 Walking and working

The amphibious excavator can walk or work in water because the chassis crawler floats on sealed pontoons. It may swing or even roll over when excavating with no support underneath. It moves using a dual-body boat form buoyancy tank. A reducer drives the crawler chain, allowing free and smooth movement. Its upper structure is a modified excavator that allows 360° full rotation and hydraulic operation.

3.1.5.2 Sealed pontoon

The pontoons are manufactured from high tension steel, and they are atmospheric corrosion- and saltwater-resistant. Each pontoon has five independent watertight compartments with maintenance holes. The bottoms of the pontoons are reinforced for rough terrain operation. The power for the pontoon tracks is provided by an excavator engine and main hydraulic pumps with traveling motors.

[2] *Pg 46 -Technical Manual for Restoration of Mangroves - Orissa Forestry Sector Development Project*

3.1.5.3 Accessories

Common accessories include a side pontoon—increase flotation, piling vibrator, Excavation bucket, Clamshell, Demolition sorting grab, Dredging pumps, U and D Ditch accessories.

Figure 3-2 Steps and recommendations to building new drainage channels.

3.1.5.4 Excavator equipment and accessory equipment selection

The following excavators (42 in total) were selected for desilting channels and creating new channels in the BCER area:

- Twelve 3.5 T CAT excavators on tracks (different accessories) for primary channels (2.5 m top width & 1.0 m bottom).
- Thirty 1.7 T CAT excavators on tracks (different accessories) for secondary channels (1.25 m top width & 0.6 m bottom).

In the next study stage, further investigation on the excavators and accessory equipment selection is required with emphasis on the amphibious equipment providers (especially those used in countries with decades of experience in channel digging (e.g., Holland with their extensive dykes and cannels experience and, the USA in states like Mississippi, Florida (Everglades), Louisiana etc).

RUSCA have a civils team, that own and rent excavators. RUSCA along with other Australian and international parties will be consulted. Organisations with experience mobilising and demobilising heavy equipment (e.g., NORFORCE) in and out of wetlands, coastal areas will also be consulted.

3.5 T CAT excavator on tracks (different accessories) for primary channels

1.7 T CAT excavator on tracks (different accessories) for secondary channels

20T CAT amphibious excavator (different accessories)

CAT amphibious excavator – extended arm (12m, 15m, 18m, 22m reach)

JCB amphibious excavator (different accessories)

Hyundai amphibious excavator (different accessories)

Ultrtrex AX80LR mini amphibious excavator (shallow water 1m)

River Excavator mini amphibious excavator

Mini amphibious carriers

Excavator ditching accessories – U ditchers

MarshMaster – different design to an excavator

V and U Ditch accessories

3.2 Topographical restoration

Modifies the field level to restore adequate flooding levels for the establishment of plants like sediment redistribution (e.g., lowering topography). This activity involves reusing soft sediments and muds generated by drainage/channelling works. Dispersal centres (raising topography) will be trialled during Phase 1.

This action takes place when the topography of the area to be restored presents changes compared to the reference site in good condition. The topographical changes in the degraded site impact the hydrology of the site, eroding the sediment or altering flooding levels and frequency. Therefore, it does not enable the establishment of mangroves, which is when sediment must be removed. There can also be permanently flooded areas (> 1 m) due to the sinking of sediment because of decayed organic material, thus increasing the flooding level and preventing mangrove seedlings or seeds from establishing, in which case the topography needs to be elevated.

A heterogeneous ecosystem will favour the replenishment with different species, giving way to a secondary succession process and providing better chances of withstanding or recovering from an impact, as compared to a homogenous system, such as monospecific reforestation.

Figure 3-3 Steps and recommendations for sediment removal for the topography rehabilitation.

Figure 3-4 heterogeneous ecosystem will favour the replenishment with different species,

Figure 3-5 BC-S2C team looking at dead mangroves in areas requiring hydrological restoration

3.3 Pro-active water level management

This method to re-wet selected BCE areas with groundwater will be researched and trialled during Phase 1. When tidal levels temporarily drop below modelling and design criteria, groundwater will be sourced temporarily from shallow ground water bores to provide sufficient saline/brackish water levels to prevent mangrove and saltmarsh

dieback (which has occurred in the region during the early 1980's and again in 2016- see Figure 3-6). The pro-active management measure will be researched and trialled during Phase 1 and Phase II.

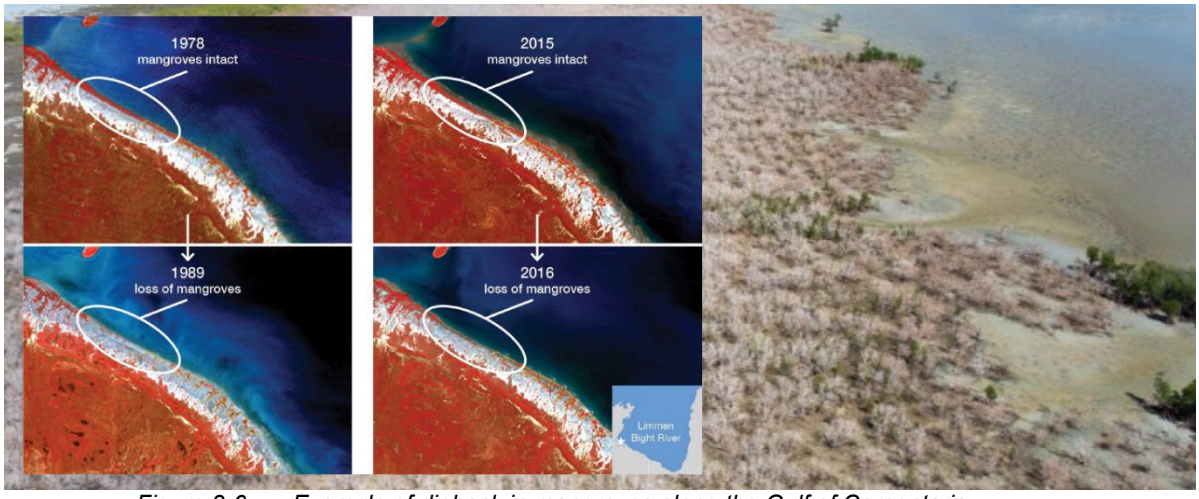


Figure 3-6 Example of dieback in mangroves along the Gulf of Carpentaria

3.4 Reforestation

Only where baseline modelling results deems it appropriate, hydrological restoration may require the planting of mangrove and saltmarsh seedlings to assist and accelerate natural regeneration.

Figure 3-7 Collection of mangrove propagules and seeds

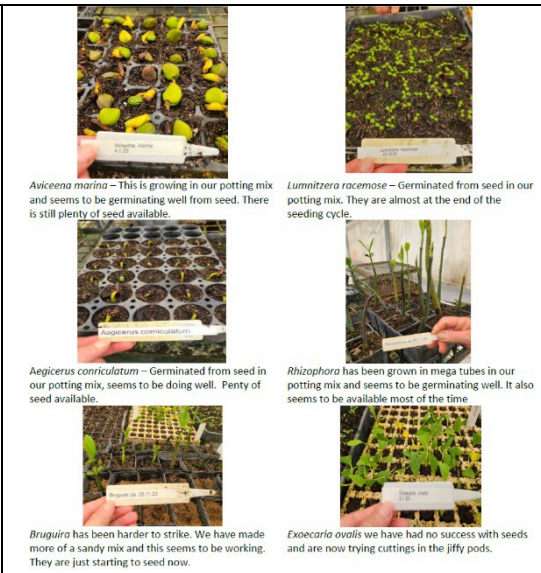


Figure 3-8 Progress on collecting mangrove seeds and growing seedlings

Active reforestation has historically been the most used technique globally for mangrove restoration projects (FAO, 1994; Teutli-Hernández, 2017). However, based on lessons learnt over the decades, the most sustainable results have been obtained through hydrological and topographical restoration actions focused on restoring conditions for these trees to grow. Where our eco-hydrological studies deem it appropriate, hydrological restoration may also require the planting of mangrove and saltmarsh species to assist and accelerate natural regeneration.

Many failed reforestations projects root cause is due to improper eco-hydrological studies of the environmental conditions in which the site is found and planting the wrong species in the wrong place or the right species in the wrong space. This results in a waste of resources and effort and an unsuccessful endeavour. When reforestation

is chosen as an action to take, the site to be restored will have the proper environmental conditions (hydrological and physicochemical) for the establishment of plant material (seeds, seedlings, and propagules). If conditions are not suitable, the corresponding restoration actions will be carried out before planting, and seedlings will be previously acclimated to the salinity, soil, and light exposure of the restoration sites. The reforestation we implement will foster the environmental heterogeneity (multiple native species planted) referencing good condition neighbouring mangroves, which provides a higher resilience to the system.

3.4.1 Seed collection and origin

The seeds used in restoration will come from mostly preserved areas close to the site and will consider its composition for species selection. We plan to collect seed from different trees which promotes genetic diversity of propagules to be planted. We will use contracted seed collectors and our own seed collectors. We intend involving local ranger groups and aboriginal communities who are familiar with local fruiting season, trained to distinguish if seeds or propagules are healthy, mature, and disease-free and are familiar with the local environmental risks in these remote sites.

3.4.2 Species collection

Reforestation must consider the species autecology, as well as the species found in the reference site. Reforestation species will be selected based on those recorded in the preserved or reference site.

3.4.3 Biosecurity plan

The Proposal would include a Biosecurity Monitoring & Management Plan (“BMMP”) to control the threat of introducing invasive species across the Site. The Nursery Facility will be a separate area to the Research and Training Facility and will have appropriate bio-security controls.

3.4.4 Plant nurseries

The Proponent will use a contracted nursery/nurseries and our own nursery at the BC-I to store seed, pot, grow, manage and package ready for transport the mangrove and salt marsh species ready for reforestation. The BC-I nursery seedlings will be acclimatised to field conditions using similar salinity, soil, and light conditions of the restoration sites. The nursery design will allow for plants to undergo periodical flooding and have access to fresh and salt water. This way they are accustomed to local conditions to reduce stress at planting.

3.4.5 Planting techniques

The Proponent will experiment with both mechanical (drone and helicopter) and hand planting of seed and seedlings. We intend involving local ranger groups and aboriginal communities who are trained to plant and are familiar with the local environmental risks in these remote sites.

3.4.6 Plant spacing

For planning purposes, the Proponent assume the mangroves will be spaced at three-meter spacings parallel to either the desilted channels or the newly created channels. Phase I and Phase II will experiment with different direct planting techniques to monitor and record its success in conjunction with nature-based re-wetting actions.

3.5 Rehabilitation of culverts

In some locations, where roads have restricted water flows, we may need to replace culverts and make them bigger to allow more water to flood the mangroves and salt marsh areas. This work will allow the natural tide to re-wet the mud flats salt marshes and helping the mangrove trees to grow.

Figure 3-9 BC-S2C team looking at culverts requiring rehabilitation

Figure 3-10 Culvert rehabilitation to restore water flow in affected sites due to road

4 Infrastructure

This section of the POMP will be updated following detailed design and specifications for blue carbon restoration activities. The location of proposed alterations to existing infrastructure will be mapped. The design dimensions and design specifications of new or upgraded infrastructure will be briefly described. The design specifications of new infrastructure will meet appropriate Australian Standards.

During the current phase (development) BC-S2C has identified several locations where tidal limits are restricted because of introduced road infrastructure. However, further details on their locations cannot be provided due to ongoing commercially sensitive landowner negotiations and project registration requirements.

5 Monitoring, Reporting and Verification

All Commonwealth and Territory government requirements will be addressed during BC-S2C's MRV operational activities. These activities will be supported by an overarching Environmental Management Plan (BC-S2C document reference BCO-PLN-200-2023-004) which is supported by bespoke environmental management plans addressing environmental aspects and impacts raised in the Project's environmental scoping and referral process:

- **Permanence Plan** (BC-S2C document reference BCO-PLN-200-2023-009).
- **Acid Sulfate Soils Plan of Management** (BC-S2C document reference BCO-PLN-200-2023-003).
- **Biodiversity Management Plan** to protect flora, fauna and where required, nationally important wetlands (BC-S2C document reference BCO-PLN-200-2023-003).
- **Biosecurity Monitoring Management Plan** (document reference BCO-PLN-200-2023-011) to control risks from feral animals, weeds, or disease.
- Annual asset inspections of modified tidal structures such as box culverts, bridges, or levees (refer to Section 5).
- Five yearly maintenance programs on wetland drainage channels (refer to Section 5).
- Annual soil Carbon stock assessment within the CEA and compared to the Project's reference point.
- Annual landcover (mangrove and saltmarsh cover) mapping using Landsat imagery.
- Eco-hydrological (water level) monitoring and modelling to determine the success of its BCER actions.
- Bi-annual soil and water quality monitoring to determine the CEA and offsite areas on private land surrounding the CEA is not contaminated. Monitoring will include organics and inorganics. All monitoring will form part of the Acid Sulfate Soils Plan of Management.
- If required, pro-active water level management to control flooding or reduced water levels.
- Coastal geomorphological assessessments (timeframes to be determined by BC-S2C).

6 Maintenance

This section describes the likely maintenance actions required, their frequency and necessary skills or qualifications required to carry out required maintenance actions described below. The types of maintenance actions required will be:

- Plant and equipment.
- Drainage channels
- Infrastructure and assets
- Reforestation

6.1 Plant and equipment

In the next study stage, further investigation is required on the operational maintenance of the excavators and accessories. The proposed Blue Carbon Institute currently only has a small workshop in its design, a larger workshop/shed with an overhead >20t internal crane maybe required after the equipment selection is completed for lifting the bigger excavators (20t) off their tracks / floating ponds. RUSCA along with other Australian and international parties will be consulted.

6.2 Drainage channels

Desilting of natural or engineered channels will be required. Refer to Section 3.1.3 for more information.

6.3 Infrastructure and assets

The likely types of infrastructure and assets to be maintained as part of BCER actions carried out by BC-S2C are:

- Single span bridges.
- Large box culverts.
- Scour or gabion wall protection.
- Clay cored earth embankments / levees.

6.4 Reforestation

If and where required, BC-S2C may support its BCER actions with direct planting of indigenous mangrove species. Any reforestation program will be supported by the local Land and Sea Ranger group and, if possible, members of local communities or families.

6.5 Frequency of maintenance and inspections

6.5.1 Drainage channels

- Inspected annually for their operational performance. Reports will be generated and recorded within BC-S2C's cloud-based Integrated Management System (**IMS**).

- De-silted and maintained to ensure their correct hydrological operating performance every five years. If required, they can be maintained earlier and in accordance with inspection report recommendations.

6.5.2 Infrastructure and assets

Infrastructure and assets controlling tidal exchange will be inspected annually. Inspection reports will be generated and recorded within BC-S2C's cloud-based IMS. If required, they can be maintained earlier and in accordance with inspection report recommendations.

6.5.3 Reforestation

Reforestation will occur quarterly and tie-in with BC-S2C's consultation and engagement activities.

6.6 Skills and competency

In the next study stage, further investigation is required on the training of the operators. RUSCA have a civils team. They own and rent excavators and have been involved in their training. RUSCA along with other Australian and international parties will be consulted.

7 References

1. **Australian Government Clean Energy Regulator:** *Emissions Reduction Fund – Identifying land subject to permanence obligations.*

2. **Verra** - *VM0033 Methodology for Tidal Wetland and Seagrass Restoration Version 1.0 2015.*

BLUE CARBON ECOSYTEM RESTORATION

EROSION AND SEDIMENT CONTROL GUIDELNIE

Blue Carbon S2C Pty Ltd

info@bluecarbons2c.com

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Document History

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0	Erosion & Sediment Control Guideline	RP	GW	GW	RP	27.01.2023

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Review

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CONTENTS

LIST OF FIGURES

LIST OF TABLES

GLOSSARY OF TERMS

Term	*Meaning / Definition*
BC-I	BlueCarbon Institute
BC-OC	BlueCarbon OnCountry
BC-S2C	Blue Carbon S2C Pty Ltd
ESCG	Erosion & Sediment Control Guideline
ESCP	Erosion & Sediment Control Plan
ha	hectares

Guiding principles for erosion and sediment control

1. Understand this erosion and sediment control plan prior to commencing work.
2. Continually amend the erosion and sediment control plan where necessary to minimise environmental harm.
3. Minimise disturbance across the work site.
4. Divert water around the work area.
5. Protect the soil against erosion initiated by rain, wind, or concentrated flows.
6. Control stormwater flows onto, through and from the site.
7. Use sediment controls to prevent off-site impacts.
8. Stabilise disturbed areas progressively.
9. Inspect and maintain control measures.

1 Introduction

1.1 Context

Blue Carbon S2C Pty Ltd (**BC-S2C**) has prepared this Erosion and Sediment Control Guideline (**ESCG**) to support construction and blue carbon restoration activities it undertakes (**BCH-GUI-200-2023-001)**. This ESCG must:

a) Be used to prepare a site-specific Erosion and Sedimentation Control Plan (**ESCP**) for the BlueCarbon Institute (**BC-I**).

b) Be used to prepare site specific erosion and sediment controls for Blue Carbon ecosystem restoration activities undertaken by BC-S2C's subsidiary company, BlueCarbon OnCountry (**BC-OC**).

c) Be read in conjunction with BC-S2C's Acid Sulphate Soils Plan of Management - document reference **BCO-PLN-200-2023-003-Acid Sulphate Soils Management Plan**.

Soil erosion occurs when soil particles are dislodged and transported by the action of water and/or wind. Sediment is the material produced by erosion. This guideline addresses erosion and sediment control as three separate components for clearer understanding:

i. **Erosion control:** methods for keeping soils on a site.

ii. **Drainage control:** moving clean and dirty water within stable channels.

iii. **Sediment control:** allowing water to slow so that sediment can settle via gravity.

1.2 Objectives

The objectives of this ESCG are:

- To provide BC-OC staff guidance on what erosion and sediment control measures could be implemented for the BC-I and, where appropriate, Blue Carbon ecosystem restoration projects.
- To prevent environmental harm.
- To prevent offsite transport of sediments.

1.3 Legislative requirements

The Northern Territory *Environment Protection Act 2019* (**EP Act**) is the principal environmental legislation safeguarding the environment. Under the EP Act, there are several aspects that are applicable to this ESCG and any site-specific ESCP. They include:

- General environmental duty.
- Duty to notify environmental harm.
- Environmental harm.

2 Erosion, drainage, or sediment control – which one?

2.1 Context

Erosion control and sediment control are different processes and need to be managed differently. Refer to Figure

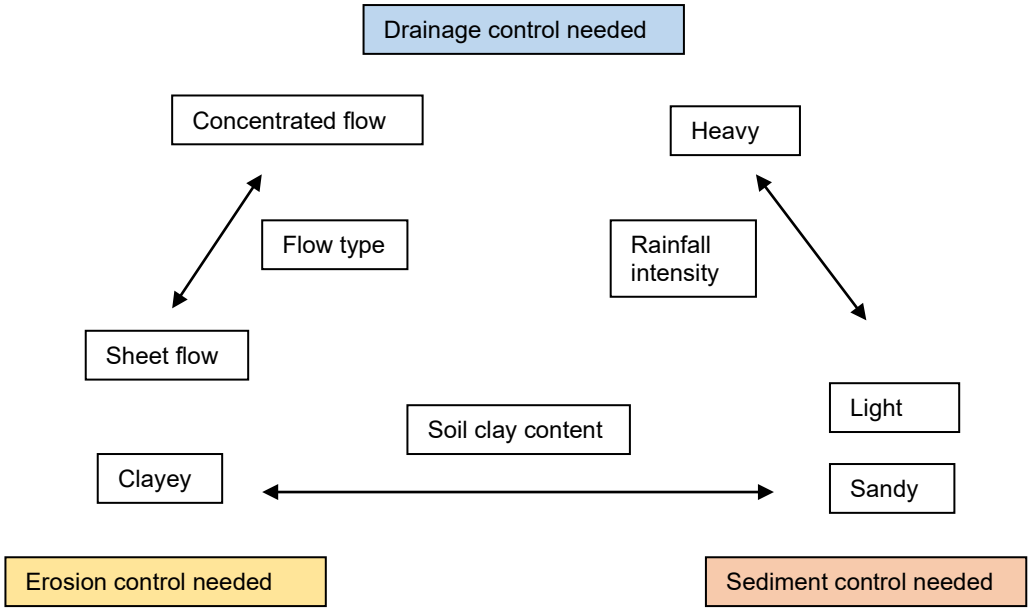

Figure 2-1 Deciding what method of control is needed

2.2 Principles of erosion and sediment control

The goals of construction site erosion and sediment control are to:

- Protect the land surface from erosion.
- Intercept, divert, and safely dispose of “clean” run-on water from undisturbed areas, clear of any disturbed areas, or to pass “clean” water through the site without mixing with “dirty” (sediment contaminated) site run-off.
- Progressively revegetate or stabilise disturbed areas.
- Prevent sediment-contaminated water leaving the site.

These goals can be achieved by applying the following principles, which are discussed below:

- Integrate project design with site constraints.
- Plan and integrate erosion and sediment control with construction activities.
- Minimise the extent and duration of disturbance.
- Control stormwater flows onto, through, and from the site in stable drainage structures.

- Use erosion controls to prevent on-site damage.
- Use sediment controls to prevent off-site damage.
- Control erosion and sediment at the source.
- Stabilise disturbed areas promptly.
- Inspect and maintain control measures.

2.3 Erosion control and soil protection

Having an erosion resistant ground cover in place is critical to avoiding erosion. This can be achieved through having:

- Good grass cover.
- Mulch in the form of chipped timber or straw.
- Soil with high gravel content.

2.4 Drainage

Good drainage and flow-paths is an excellent way of minimising erosion across a site. The use of check dams to slow water, and lined drains can assist with preventing erosion.

2.5 Sediment control

Slowing water velocity is key to minimising the transport of sediment within a site and, preventing it moving offsite. Well thought-out and designed flow paths will help control water flow velocity. Other structures like sediment fences and basins are important tools to implement on a work site.

Where appropriate, the construction of diversion banks or drains to keep water out of the work area is recommended.

Where fine-grained soils (clays) predominate, an emphasis on erosion control (i.e., keeping the soil in situ) and, stable drainage is required.

Where soils are coarse (silts, sands, and gravels), sediment control techniques are effective.

2.6 What is erosion

Erosion is the wearing away of the land by water, rainfall, or wind. Natural erosion does occur but, accelerated erosion generally comes from human disturbances.

2.7 What are the types of erosion

- Raindrop impact - soil particles can be moved up to one metre from the impact of a raindrop.
- Sheet erosion - this is the removal of a shallow and uniform layer of soil from the surface. Accumulated sediment at the bottom of the slope is often the only indicator.

- Rill erosion - is the removal of soil from the surface whereby small channels or rills up to 300mm are formed. It is caused by runoff concentrating into depressions, wheel tracks etc.

- Gully erosion - is the removal of soil from the surface and sub-surface caused by concentrated runoff eroding channels greater than 300mm deep.

2.8 What factors influence erosion

2.8.1 Rainfall

High-intensity, short-duration storm events have much greater erosion potential than low intensity, longer duration storm events with the same runoff volume. Intense storms produce larger raindrops and are more likely to break up the soil and dislodge particles.

2.8.2 Soil erodibility

Soil erodibility is determined by the soils ability to resist detachment and transport due to rainfall, runoff, and infiltration capacity. Well-structured soils with a high clay content are generally least erodible. If clays in the work area are dispersible, they can easily break down when wet and become highly erodible. Silts and fine sands are highly erodible.

2.8.3 Length and steepness of slope

Steeper slopes cause runoff flow velocities to increase, resulting in increased erosion. As the slope length increases the opportunity for runoff to concentrate and achieve an erosive velocity increases.

2.8.4 Soil surface cover

Soil surface covers such as vegetation and mulches protect the soil surface from raindrop impact, reduce flow velocity, disperse flow, and promote infiltration and the deposition of sediment.

2.8.5 Management practices

Recommended site management practices to prevent and minimise erosion includes:

- Breaking long slopes into smaller ones.
- Staging the works to minimise the amount of area exposed, and duration of that exposure.
- Initiating measures to neutralise or minimise the disturbance to dispersive soils.

3 Identification and treatment of problem soils

3.1 Identification

There are a number of factors that contribute to soil erosivity and, can hinder revegetation. Some of these factors include:

- Dispersion.
- Sodicity.
- Salinity.
- Acidity.
- Low or unbalanced nutrient status.

Dispersive soils erode chemically. When water is added to a dispersive soil, sodium in the soil attaches to the clay and forces the clay particles apart.

3.2 Application

Soil testing must be undertaken when finalising the site specific ESCG as understanding the limitations of the soil will dictate which erosion and sediment control measures are appropriate for a particular site.

Soils must be tested for dispersion, sodicity, acidity, and nutrient status before embarking on any erosion and sediment control program. Specific soil tests should include:

i. Universal Soil Classification System to infer soil reaction to water.
ii. Emerson Aggregate Test to determine slake and dispersion probabilities.
iii. Dominant particle size to determine the potential sediment type.
iv. Soil erodibility (the 'K factor') to determine sediment types (A to F) and likelihood of erosion controls (refer to Chapter 4).
v. pH.

Testing must include all soil types and include both topsoil and subsoils.

Soil dispersion can be tested simply in the field. Take a clod of soil and place it in a beaker of distilled or deionised water. If the clod starts to break apart and the water becomes cloudy then the soil is dispersive. If the clod breaks apart but the water doesn't become cloudy it is known as a slaking soil.

3.3 Treatment

The best treatments for dispersive soils from most to least successful are:

- Treatment with gypsum at a rate of 15 to 28 tonnes per hectare, (best checked via soil analysis).
- Compaction of the soil, covering with a good layer of topsoil, and then revegetation.
- Removal and burial.

Sodic soils are typically dispersive. Most physical erosion BMP's are ineffective on dispersive soils. Acidity can be treated with the application of agricultural lime (calcium carbonate). Application rates can only be determined by soil testing.

Low nutrient status can be treated via the application of fertilisers and other elements. Application rates can only be determined by soil testing.

4 Erosion control techniques

4.1 Perimeter banks

These can be implemented to divert run-off away from batter slopes towards sediment basins in small catchments less than 2 hectares (ha). The grade of a bank should not exceed 1 %. Banks should be re-vegetated immediately following construction.

4.2 Diversion banks

To divert run-off around disturbed areas, and to divert contaminated run-off to sediment traps and basins. Used when catchment area exceeds 2 ha.

4.3 Level spreader

Should only be used where good vegetation cover exists. Never to be used in areas with dispersible soils. This technique involves levelling a large area of ground downstream of a diversion bank that will allow non-erosive sheet flow.

4.4 Erosion blankets / matting

Erosion blankets are commonly made from biodegradable material. They are used on embankments (e.g., with 2:1 slopes) and other sheet flow environments to protect soils from erosion whilst promoting vegetation.

4.5 Erosion mats

These are best used where concentrated flows exist. The mats are very durable and designed to protect the soil surface from the shear stress of moving water with high velocities. Some mats do come with grass roots to reinforce the soil.

4.6 Root reinforcing mats

These are best used where concentrated flows exist and, in conjunction with a permanent grass cover to protect soils from shear stress where water has medium to high velocity. It is recommended to initially pin the mats whilst the grass cover establishes itself.

4.7 Geo-logs

Placed in a shallow trench and pegged on the contour in sheet flow environments to reduce slope length and flow velocity. Can also be used in flow lines to protect banks from erosion. Often used in creek bank stabilisation projects to isolate the creek flow from the disturbed environment.

Geo-logs must follow the contour line when they are installed. It is recommended they are spaced 1 to 4 metres apart. Geo-logs will biodegrade and can be backfilled and re-vegetated. They are useful where dispersive soils exist.

4.8 Cellular confinement

Cellular confinement products are three-dimensional honeycomb HDPE mesh developed originally to allow heavy trucks to traverse sand dunes. The mesh confines in-fill material to resist flows, minimise erosion and prevent the downward migration of embankment materials. May also be used to contain sand and mud material to be used as temporary roads or creek crossings.

4.9 Rock mulching

For use on slopes where protection from raindrop impact and sheet flows are required. Generally used as an alternative to measures involving vegetation where the establishment and maintenance of a permanent vegetative cover is difficult.

The placement of geotextile under the rock and the use of cut-off trenches can limit the potential for erosion.

4.10 Bonded fibre matrix

Bonded Fibre Matrix (BFM) is appropriate for erosion control, weed control and revegetation purposes in a wide range of environments. It is not recommended for use in Blue Carbon restoration activities. This approach is more suited to large civil / road projects where embankments have been constructed.

4.11 Vegetation

Any erosion control program will benefit from temporary and permanent vegetation covers. The above ground vegetative material provides protection from raindrop impact, slows flow velocities and traps eroded soil particles. Roots help bind the soil surface thus minimising erosion. For erosion purposes vegetation includes native grasses, sterile introduced grasses, ground covers, shrubs, and trees.

4.12 Geo-tubes and geo-bags

These are geotextile filter fabric sausage like structure that are filled with sediment. The purpose of these structures is to protect areas such as shorelines from severe erosion. They can also be used for managing dredge spoil.

5 Drainage controls

5.1 Concrete lined channels

Are permanent structures suitable for use on in-situ soils where protection from high velocity flows is required. Also used where non-porous erosion protection is required such as on dispersible soils. Channel cross sectional area and capacity should be designed to safely convey the peak discharge from the design storm event. Some form of energy dissipater is required at the outlet to the lined drain. Cut-off trenches are required to prevent water entry under the concrete.

5.2 Rock lining

The placement of sufficient thickness of rock in a concentrated flow situation to protect the soil surface from erosion. Rock lining is one of the simplest forms of erosion protection in concentrated flow situations. Applicable for channel grades of 5 – 10% and supported by a geotextile. Rock sizes should be calculated based on result of the corresponding particle size when the cumulative percentage reaches 50 %.

5.3 Turfing

Turf and Reinforced Turf can be used in both sheet flow and concentrated flow situation to provide erosion protection. It is often used as a “softer” alternative to “hard” channel linings such as rock and concrete in urban situations. Turf is only capable of withstanding relatively low flow velocities (2m/second, and up to 0.35m deep).

5.4 Check dams

To be used as temporary erosion protection and limited coarse sediment retention in concentrated flow environments such as perimeter and table drains by limiting flow velocity and therefore reducing the erosive potential upon the channel. Not to be in used major flow lines or streams.

5.5 Rock outlet protection

Similar to rock lining, except that rocks are placed at the outlet of a drainage structure to dissipate energy and reduce the velocity of flow. To be used where the discharge velocity of a drainage structure exceeds the maximum permissible velocity of the receiving channel or disposal area. The downstream rock size must be correctly sized to avoid unnecessary erosion.

5.6 Rock gabions

Designed to provide erosion protection in a wide range of environments where rock protection is not sufficient. In addition to erosion protection, rock filled wire baskets are commonly used for geotechnical purposes such as retaining walls.

5.7 Grouted rock

The use of rock bound with concrete to provide erosion protection. Generally used when rock size is too small to withstand flow velocities. Commonly used for bridge abutment protection, culvert protection, and grade stabilisation structures.

5.8 Concrete chutes and flumes

Concrete chutes and flumes are typically used in concentrated flow environments to safely convey run-off from one level to another without causing erosion.

6 Sediment controls

6.1 Sediment fence

A sediment fence is a temporary barrier of semi-permeable geo-textile, partially installed in a trench and supported by posts. Suitable for containing course sediments in sheet flow environments. Not to be used in concentrated flow. Silt fence should be installed on the contour with the ends turned up so that the turn-up ground level is equal to the top fabric level at its lowest point. Attention should be given to the point where overflow will occur as this is a common erosion source. It needs to be anchored in a 0.2m deep compacted backfilled trench.

6.2 Buffer zones

An area of natural vegetation or re-vegetated area the purpose of which is to separate a sensitive area from a disturbed area. A buffer zone serves to trap sediment and nutrients not contained using a conventional erosion and sediment control program. It is recommended they are a minimum of 3 metres wide.

6.3 Check dams

Refer to Section 5.4.

6.4 Gully pits

These are not recommended for use in high rainfall areas as they do not trap fine clays. Water also tends to flow around these structures. Consequently, the risk of contamination in waterways is high.

6.5 Sediment traps

Are a reliable measure for containing sediments. Sediment traps are measures that capture eroded sediments by slowing the velocity of water so that the soil particles settle out. They generally consist of a stable inlet and outlet, and some form of pond. It is recommended sediment traps be used where concentrated flows exist.

6.6 Sediment basins

These structures tend to be permanent and designed to contain coarse and fine sediments. Inlet and outlet pipes, an emergency spillway and a riser pipe are typical design features. The riser pipe is used for dewatering. Landcom 2004 recommends sediment basins have should have a length to width ratio 3:1. If risks to human life are high, they should be fenced.

6.7 Flocculants

Chemical flocculation systems are used where the performance of sediment retention ponds needs to be increased to reduce the immediate effect of sediment on the receiving environment and/or reduce the cumulative effect of sediment yield within the catchment.

Chemical treatment systems are also particularly useful in reducing visual impact (amenity values) and the detrimental effect on water quality resulting from highly turbid discharges (such as dispersive clays).

6.8 Sediment curtains and turbidity barriers

Consists of a curtain geotextile filter fabric or plastic attached to series of floats. The curtain extends from the surface of the water to stream/ lakebed. The purpose of these structures is to contain sediments resulting from disturbance to the stream bed or bank. A geotextile filter fabric curtain will contain coarse sediments. A plastic curtain will control turbid waters.

It is recommended for use where stream flow velocities are low. Importantly, the curtain must be used to allow for tidal movement or wave action. They should not limit fish passage or become hazards to watercraft.

6.9 Geo-tubes and geo-bags

Refer to Section 4.12.

7 Maintenance and monitoring

Regular effective maintenance of erosion and sediment controls will help prevent erosion and the loss of sediments offsite. Site specific ESCP must include an appropriate maintenance program.

Under the NT EP Act, there is a legal responsibility to ensure that runoff leaving a construction site, including water being discharged from sediment basins after storm events, has an acceptable water quality.

The parameters and limits to be monitored at a BC-S2C project site should correspond to the water quality parameters listed in Table 7-1. These parameters are required to be achieved usually within 5 days of a rainfall event.

Table 7-1 Water quality parameters recommended for monitoring

Water Quality Parameter	Recommended limit imposed by BC-S2C
Total Suspended Solids	< 50 mg/l
pH	6.5 to 8.5
Oil & grease	< 10 mg/l

8 References

1. **Managing Urban Storm Water: Soils and Construction**; Volume 1, 2004; Landcom.

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BLUE CARBON ECOSYSTEM RESTORATION

Biting Insects Management Plan

Blue Carbon S2C Pty Ltd

Blue Carbon S2C Pty Ltd
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Document History

JOB NUMBER: BCO-2023-001			DOCUMENT REF: BCO-PLN-200-2023-001			
Revision	Purpose	Originated	Checked	Reviewed	Authorised	Date
0	Management Plan - Biting Insects	RP	RM	DvM	RP	25.01.2023

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CONTENTS

LIST OF FIGURES

LIST OF TABLES

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BC-S2C	Blue Carbon S2C Pty Ltd
BCER	Blue Carbon Ecosystem Restoration
BC-I	BlueCarbon Institute
BC-OC	BlueCarbon OnCountry
BIMP	Biting Insects Management Plan
Development	Phase I Research Project – Kangaroo Island Northern Territory Gulf of Carpentaria
GIS	Geographic Information System
ha	hectares
NT	Northern Territory

1 Introduction

The Northern Territory (**NT**) Gulf of Carpentaria coastline has extensive areas of mangrove lined rivers, estuaries, mud and sand flats, creeks, and freshwater floodplains. Blue Carbon restoration activities in these environments undertaken by the project sponsor, Blue Carbon S2C Pty Ltd (**BC-S2C**) will encounter biting insects.

Biting insects include mosquitos and midges. These insects are very likely to occur in very high numbers in the Gulf of Carpentaria. The potential human health issues associated with biting insects include:

- Nuisance and annoyance caused by biting insects.
- Painful bites, intense itching, infection, and scarring (following scratching); and
- Transmission of viruses.

This Biting Insect Management Plan (**BIMP**) has been prepared to address biting insects during Blue Carbon Ecosystem Restoration (**BCER**) activities (the **Project**). It shall be applied to BC-S2C's BlueCarbon Institute (**BC-I**) and Blue Carbon Project sites. It shall be implemented by the General Manager of BlueCarbon OnCountry (**BC-OC**).

1.1 Proponent details

Details for the Proponent are summarised in Table 1-1.

Table 1-1 Proponent details

Proponent:	BC-S2C
Contact:	Mr Richard Phillips
Position:	Chief Scientist
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Email:	info@samadvice.com

1.2 Project overview

BCER activities across mangrove and saltmarsh environments will span approximately 385 kilometres along the NT Gulf of Carpentaria (refer to Figure 1-1). The BCER activities will occur over three phases:

- **Phase I** 6-hectare (**ha**) research project (2023/2024) including a 12 month monitoring period.
- **Phase II** 1,000 ha pilot project (2024/2025) including a long-term monitoring program.
- **Phase III** Landscape scale BCER across the Gulf of Carpentaria coastline involving 39,000 ha. Long-term monitoring will occur.

BCER activities will involve hydrological and topographical restoration techniques supported by direct planting.

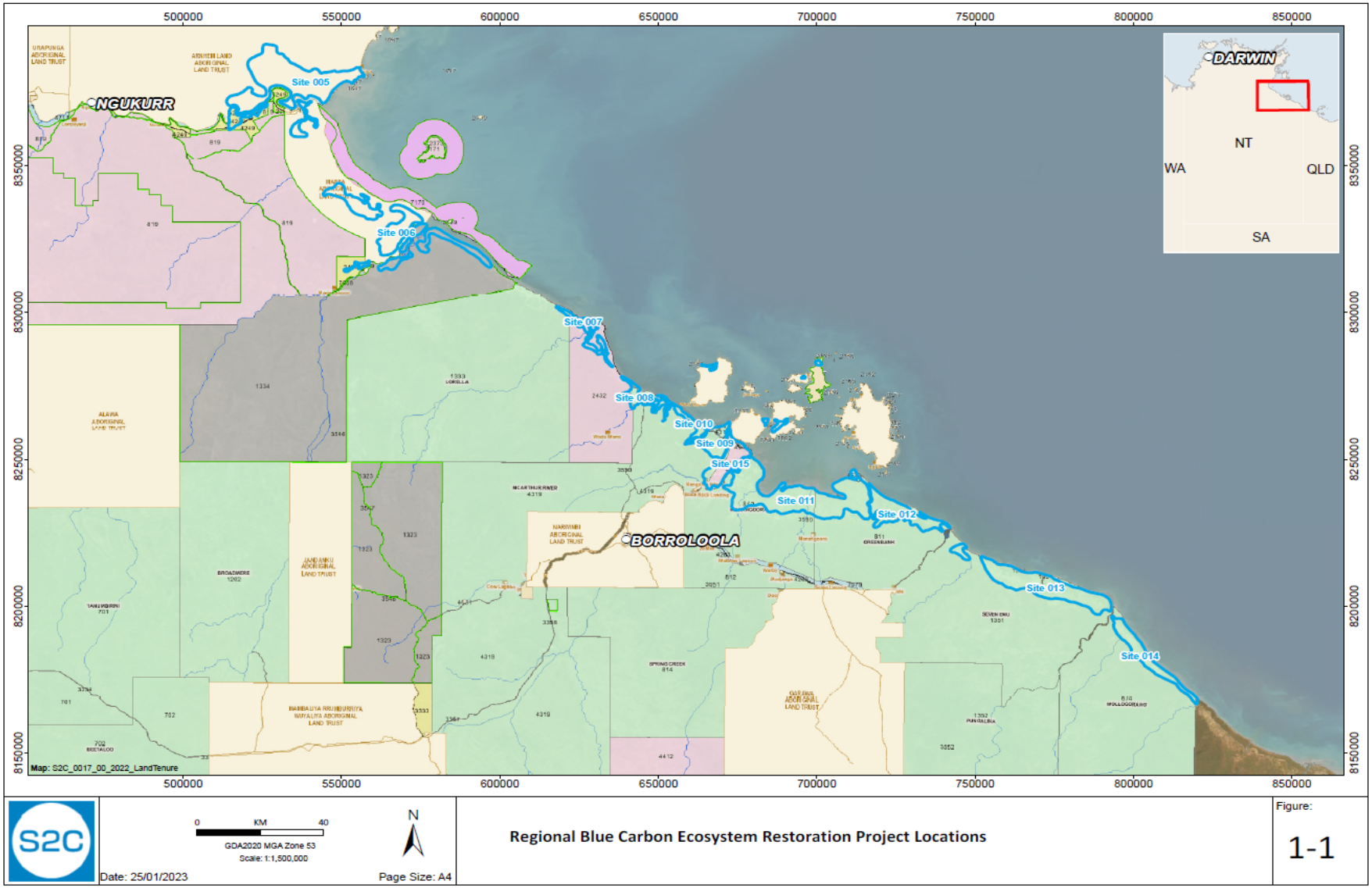

Figure 1-1 Regional Blue Carbon Ecosystem Project locations - NT Gulf of Carpentaria

1.3 Management plan objectives

This BIMP aims to:

- Control the effects of biting insects on personnel working on BCER programs.
- Ensure preventative control measures are implemented so personnel avoid biting insects and, to prevent the occurrence of breeding sites.
- Inform personnel about the risks regarding biting insects and the potential diseases they carry.
- Explain health and safety legislation and guidelines regarding biting insects.
- Assist the Proponent to set and achieve goals for biting insect management and monitoring.

1.4 Legislative context

The BIMP will assist all BC-OC personnel working on BCER programs to identify and appropriately manage risks associated with biting insects. This BIMP considers the requirements of the following NT legislation and guidance:

- *Public and Environmental Health Act 2011*.
- NT Public and Environmental Health Regulations 2014.
- *Work Health and Safety (National Uniform Legislation) Act 2011*;
- Constructed Wetlands in the NT – Guidelines to Prevent Mosquito Breeding (Warchot & Whelan, 2008).

The BIMP will be subject to ongoing review and change to ensure it remains relevant to NT legislation and guidance documents throughout BCER programs.

2 Biting insect species and facts

2.1 Facts to be aware of

- Mangrove and saltmarsh habitats support biting insects. All BCER programs and project sites will encounter biting insects.
- Different species of biting insects have differing patterns of distribution and seasonal changes in abundance.
- Biting midges cause irritation and nuisance, however, mosquitoes are potential vectors for disease to humans.
- Some species of biting insects carry diseases such as Ross River Virus and Murray Valley Encephalitis.
- The dry season poses a greater risk than wet season effects.
- Mosquitoes generally breed in stagnant water which can be created by, for example, rainfall in any ponding areas or water holding receptacles.

2.2 Biting Midges

The intertidal mangrove biting midge *Culicoides ornatus* occupies mangrove areas throughout the NT coastline, especially in the intertidal zone (i.e., between low and high tide levels) of estuarine creek systesm. It breeds in mud under dense mangrove canopies.

Culicoides ornatus is expected to occur in very high seasonal numbers as follows:

- Extremely high seasonal numbers from August to November (late dry season);
- Very high numbers from April to July (early to mid-dry season); and
- High numbers December to March (wet season).

Greatest effects are encountered for a period of 6 days around a full and new moon, during the two hours on sunset and sunrise. Night-time effects may also be encountered.

Another species, *Culicoides flumineus* may cause pest problems; although they are rarely found outside of mangrove forests (Whelan, 2003).

2.3 Mosquitoes

Within the NT there are approximately 100 species of mosquitoes, with only 40 of these known to bite people and only 20 occurring in sufficient numbers to cause pest problems (Whelan, 2010a). The most common and important mosquitoes occurring in the NT are described in Appendix A.

3 Impacts

Potential impacts to BCER activities are listed in

Table 3-1 Potential impacts to BCER activities without mitigation in place

Biting insect type	Risk and impact
Mosquitos	Irritation and annoyance.
	Loss of workforce or disruption to BCER activities.
	Secondary effects after being bitten.
	Transmission of disease such as the Ross River virus.
Midges	Pain and extreme discomfort from intense itching.
	Loss of workforce or disruption to BCER activities.
	Infection and scarring.

The symptoms of mosquito borne disease may include (Whelan and Hurk, 2003):

- Pain in joints of the extremities.
- Lethargic or tiredness.
- Aching tendons.
- Skin rashes.
- Fever.
- Headaches.
- Swollen lymph nodes.
- Tingling in the palms of the hands or soles of the feet.

4 Management and mitigation

4.1 Management plan

This BIMP must be made available to all BC-OC staff.

4.2 Personal protection

Personal protection for staff and guests is an important strategy in reducing the risks and impacts from biting insects. Table 5-1 details management measures to improve personal protection.

Table 4-1 Personal protection against biting insects

Mitigation Strategy	
Employees / Contractors	Personal protective clothing adequate to protect against bites will be made available to all BC-OC staff and visitors to BCER sites.
	Insect repellent will always be accessible.
	Sources, risks and mitigation measures associated with biting insects will be incorporated into Site Inductions.
	Entry of biting insects into indoor spaces, such as offices and work areas, will be prevented or at least minimised by sealing off and air-conditioning of buildings (where possible) and implementing window screen protection.
	Any personnel suspected of suffering from mosquito borne disease must be kept free from mosquito bites until medically declared clear to prevent the spread of the disease.
Visitors	Information on biting insects, including personal avoidance strategies, will be provided to visitors.
	Where appropriate, insect repellent will be made available.

4.3 Structures and potential breeding sites

- Drainage and sediment basin structures associated with the BlueCarbon Institute (**BC-I**) should be kept as level as possible to prevent the creation of small water pools.
- New drainage channels associated with BCER activities are expected to encourage breeding habitat.
- Any BC-I structures should be designed to encourage full drainage.
- Remove or cover any objects that could collect water follow rainfall.

4.4 Inspections

- Management must ensure all personnel are wearing the appropriate personal protective equipment daily. Where personnel are in breach of this requirement, it must be logged within BC-S2C's cloud-based Business Management System.
- Conduct and record inspections around structures, depressions and drainage infrastructure on a weekly basis.

4.5 Chemical control

Where larvae or adult insects are identified within the site or, are in very high numbers, chemical control measures may be employed. Advice must be sought from the NT Medical Entomology Branch in regard to choosing a suitable method of control for the eradication of biting insects, prior to proceeding with chemical eradication options.

Address: Northern Territory Medical Entomology Branch, Department of Health and Community Services, PO Box 41326, Casuarina, NT 0811; (08) 8922 8901 or via email: MedicalEntomologyRDH.THS@nt.gov.au

Chemical control must be undertaken by a licensed operator. All chemicals must be stored in accordance with the Safety Data Sheet or manufactures guidelines. A chemical register will be in place.

5 Monitoring and reporting

Key performance indicators of the BIMP include:

- No increased larvae or adult mosquito activity present in the BC-I area.
- No increased complaints from personnel about impacts from biting insects.
- Minimal impacts and bites from mosquitos reported from personnel or visitors.

5.1 Monitoring methodology

Visual inspections of ponded water areas will be undertaken during peak breeding season between December to March. The Proponent does not intend to sample mosquito larvae. If further assistance is required, the Proponent will contact the medical entomology branch.

5.2 Biting insects register

The Biting Insects Register (**BIR**) will assist in identifying infestation "hot-spot" areas. The following data will be recorded within the BIR:

- GPS location (MGA 94) is to be recorded.
- The area to be mapped within the Proponent's Geographic Information System (**GIS**).
- Type of water bodies.
- Size of the infestation and suggested control method.

5.3 Chemical treatment register

A Chemical Treatment Register (**CTR**) for the control of biting insects must be developed and updated immediately after chemical control methods have been utilised. The CTR for mosquito control treatment will be maintained by BC-OC Management. Data to be recorded includes:

- Date and time of treatment.
- Location of treatment and mapped in the GIS.
- Equipment/chemicals used (including batch numbers).
- Dose rates applied.
- Results of follow up inspections to determine treatment success.
- Detail follow up actions required (if any).
- Details and signature of Operator applying chemical control.

5.4 Roles and responsibilities

It is responsibility of all BC-OC personnel, contractors, and visitors to follow the requirements of the BIMP. The BIMP is considered a minimum standard and compliance is mandatory throughout all BCER activities and other operational activities where biting insects are a threat.

The BC-OC General Manager has ultimate control and will co-ordinate the implementation of the BIMP. He/she will be supported by the other on-site Managers/Supervisors.

The BC-OC General Manager will identify a responsible delegate who will be suitably trained and will coordinate implementation of the BIMP including site inductions, training and awareness.

6 Training and awareness

All personnel and subcontractors shall receive suitable BIMP induction/training. The aim of the training is to ensure that all site personnel are aware of the issues relating to biting insects, of their responsibilities and are competent to carry any required works.

Access to the BIMP will be made available during induction and maintained on BC-S2C BMS. During inductions and training the following information will be provided to personnel:

- Seasonal information e.g., a year calendar showing main pest problem periods and alerts to personnel at the start of worst periods.
- Personal protection strategies to avoid effects of biting insects (clothing requirements).
- Description of the different types of biting insects and the potential issues associated with them.
- How to keep up to date with information regarding this issue.
- Who to contact if there are concerns or questions.
- Early symptoms associated with exposure to mosquito borne diseases.

All such inductions and other training shall be recorded in the Site Induction & Training Register.

6.1 More information

For more information on biting insect borne diseases in the Darwin area contact:

- Public Health Unit, Disease Control, Royal Darwin Hospital.
- Phone: (08) 8922 8044, or 1800 008 002.

For more information on mosquitoes and virus ecology contact:

- Medical Entomology Branch, Department of Health.
- Email: MedicalEntomologyRDH.THS@nt.gov.au
- Phone: (08) 8922 8901.

7 References

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Department of Health, 2017, *Guidelines for Preventing Mosquito Breeding Associated with Construction Practice Near Tidal Areas in the NT*, Medical Entomology, Centre for Disease Control.

Medical Entomology Branch 2010, *Common mosquitoes of the Northern Territory*. Northern Territory Department of Health and Families. Available from: <https://digitallibrary.health.nt.gov.au/prodjspui/bitstream/10137/735/1/Common%20Mosquitoes%20of%20the%20Northern%20territory.pdf

Whelan, PI & Hurk, A 2003, 'Medically important insects in the Northern Territory and how disasters may affect them'. The Northern Territory Disease Control Bulletin, vol 10, no.1, pp. 27-38.

8 Appendices

Appendix A: Mosquito Species in the Northern Territory

A.1 Common mosquito species in the Northern Territory

Species	Distribution	Disease potential
Aedes notoscriptus - Receptacle Mosquito	Extensively in coastal to sub-coastal areas in the Gulf of Carpentaria in the NT.	Potential for Ross River Virus in the NT.
Aedes tremulus - Pale Larvae Mosquito	Extensively in coastal to sub-coastal areas in the Gulf of Carpentaria in the NT.	Not known to spread human disease in Australia.
Aedes vigilax – Northern Saltmarsh Mosquito	Extensively in coastal to sub-coastal areas in the Gulf of Carpentaria in the NT.	• Ross River Virus and Barmah Forest Virus in late dry season to early wet season. • Possible vector for Murray Valley Encephalitis.
Anopheles annulipes – Common Australian Anopheline	Extensively in coastal to sub-coastal areas in the Gulf of Carpentaria in the NT.	Capable of carrying malaria.
Anopheles bancroftii - Black Australian Anopheline	Extensively in coastal to sub-coastal areas in the Gulf of Carpentaria in the NT.	Capable of carrying malaria.
Anopheles farauti s.l. – Australian Malaria Mosquito	Extensively in coastal to sub-coastal areas in the Gulf of Carpentaria in the NT.	Malaria.
Anopheles hilli – Saltwater Anopheles Mosquito	Extensively in coastal to sub-coastal areas in the Gulf of Carpentaria in the NT.	Capable of carrying malaria.
Anopheles meraukensis - Freshwater Reed Anopheles	Extensively in coastal to sub-coastal areas in the Gulf of Carpentaria in the NT.	Capable of carrying malaria.
Coquillettidia xanthogaster - Golden Mosquito	Extensively in coastal to sub-coastal areas in the Gulf of Carpentaria in the NT.	Potential for Ross River Virus in the NT.
Culex annulirostris - Common Banded Mosquito	Extensively in coastal to sub-coastal areas in the Gulf of Carpentaria in the NT.	• Murray Valley Encephalitis. • Ross River Virus between January to April. • Capable of carrying Kunjin Virus, Barmah Forest Virus and other viruses.
Culex quinquefasciatus - Brown House Mosquito	Extensively in coastal to sub-coastal areas in the Gulf of Carpentaria in the NT.	Potential for Murray Valley Encephalitis and Ross River Virus.
Culex sitiens - Saltwater Culex Mosquito	Extensively in coastal to sub-coastal areas in the Gulf of Carpentaria in the NT.	Not known to spread human disease in Australia.

Species	Distribution	Disease potential
Mansonia uniformis - Aquatic Plant Mosquito	Extensively in coastal to sub-coastal areas in the Gulf of Carpentaria in the NT.	Not known to spread human disease in Australia.
Verrallina funereal - Brackish Forest Mosquito	Extensively in coastal to sub-coastal areas in the Gulf of Carpentaria in the NT.	• Probable vector for Ross River Virus in tropical Australia. • Potential vector of Murray Valley Encephalitis and Kunjin Virus.

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BLUE CARBON ECOSYSTEM RESTORATION

Biosecurity Monitoring & Management Plan

Blue Carbon S2C Pty Ltd
info@bluecarbons2c.com

Notice

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Document History

DOCUMENT REF: BCO-PLN-200-2023-011						
Revision	Purpose	Originated	Checked	Reviewed	Authorised	Date
0	Biosecurity Management Plan	RP	RM	DvM	RP	25.01.2023

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Review

This Management Plan should be reviewed annually or, when required. It must be reviewed following significant incidents and updated where appropriate to ensure that it remains relevant and effective throughout Blue Carbon restoration activities. All reviews, changes or updates are to be recorded using the Document History box provided above.

CONTENTS

LIST OF FIGURES

GLOSSARY OF TERMS

Term	*Meaning / Definition*
BC-S2C	Blue Carbon S2C Pty Ltd
BCE	Blue Carbon Ecosystems
BCER	Blue Carbon Ecosystem Restoration
BMP	Biosecurity Management Plan
ha	hectares
NT	Northern Territory

1 Introduction

The Northern Territory (**NT**) Gulf of Carpentaria coastline has extensive areas of mangrove lined rivers, estuaries, mud and sand flats, creeks, and freshwater floodplains. Blue Carbon restoration activities in these environments undertaken by the project sponsor, Blue Carbon S2C Pty Ltd (**BC-S2C**).

This Biosecurity Monitoring Management Plan (**BMMP**) has been prepared to minimise the threat and impact of plant and animal pests and diseases to Blue Carbon Ecosystems (**BCE**) because of BC-S2C's Blue Carbon Ecosystem Restoration (**BCER**) activities (the **Project**). BCE include terrestrial or aquatic plants and animals.

1.1 Proponent details

Details for the Proponent are summarised in Table 1-1.

Table 1-1 Proponent details

Proponent:	BC-S2C
Contact:	Mr Richard Phillips
Position:	Chief Scientist
Postal address:	Level 29 Chifley Tower | *2* Chifley Plaza Sydney | NSW | 2000
Phone:	+61 2 9231 8667
Email:	info@bluecarbons2c.com

1.2 Project overview

BCER activities across mangrove and saltmarsh environments will span approximately 385 kilometres along the NT Gulf of Carpentaria (refer to Figure 1-1). BCER activities will occur over three phases:

- **Phase I** 6-hectare (**ha**) research project (2023/2024) including a 12-month monitoring period.
- **Phase II** 1,000 ha pilot project (2024/2025) including a long-term monitoring program.
- **Phase III** Landscape scale BCER across the Gulf of Carpentaria coastline involving 39,000 ha. Long-term monitoring will occur.

1.3 What s biosecurity?

Biosecurity is the management of risks to the economy, the environment and our community posed by the impacts of plant and animal (including fish) pests and diseases entering, emerging, establishing or spreading in the NT (NT Government, 2016).

1.4 Objectives

This BMP aims to:

- Create the best possible biosecurity outcomes by partnering with landowners and sharing responsibilities.
- Take a risk-based approach to biosecurity and BCER activities.
- Be innovative.
- Minimise the likelihood of pests and diseases impacting BCE.

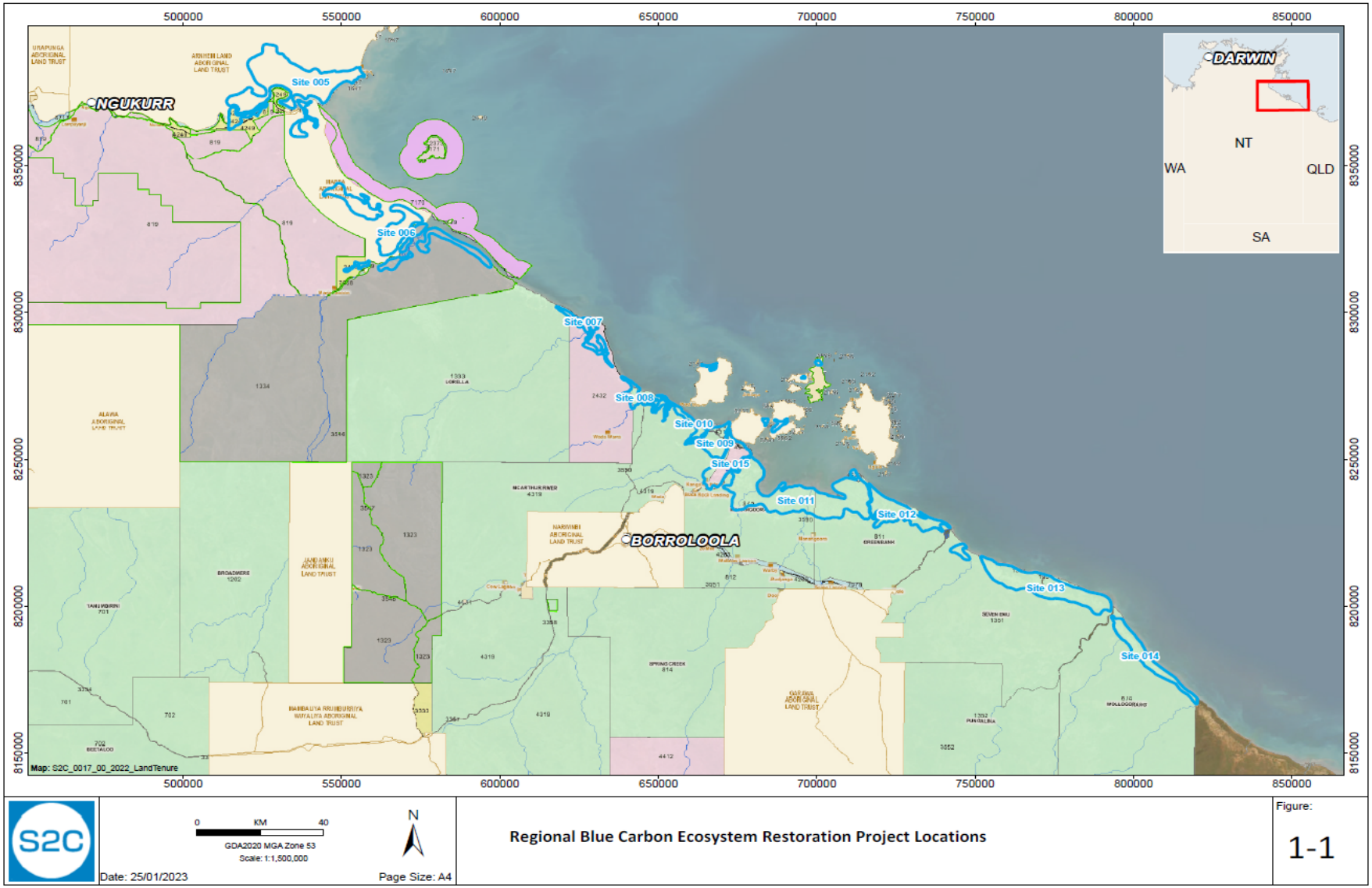

Figure 1-1 Blue Carbon Ecosystem Restoration Project locations - NT Gulf of Carpentaria

2 Legislative context

2.1 Context

The NT government is a signatory to the Intergovernmental Agreement on Biosecurity, under which nationally agreed approaches are established and all jurisdictions have roles and responsibilities. Accordingly, the NT must ensure it is a contemporary and effective biosecurity delivery agent, and that our policy direction is both aligned with national goals and objectives and remains relevant to the local context.

The Commonwealth *Biosecurity Act 2016* is the primary piece of national biosecurity legislation. It is co-administered by the Ministers responsible for Agriculture and Water Resources and Health.

2.2 Obligations to which this Plan applies

The NT has the following international and national obligations:

- **International Biosecurity Commitments** including those under the World Trade Organisaiton
- **National Biosecurity Commitments** including cost-sharing agreements in relation to emergency animal disease, plant pest invasion and environmental biosecurity threats.

3 Management approach

3.1 Funding

BC-S2C will ensure it has sufficient funding to deal with environmental biosecurity emergencies or threats.

3.2 Human resources

BC-S2C will ensure sufficient human resources to assist the NT government with biosecurity management across all of its BCER projects.

3.3 Prevention

Prevention is the best approach to reducing risks from the threats of introduced plants and animals. Prevention will be achieved by:

- Minimising the likelihood of entry from land or sea either overseas, interstate or between BCE zones in the NT Gulf of Carpentaria.
- Controlling emergence and spread of plant and animal pests and diseases.

3.4 Elimination

BC-S2C will promptly detect, contain, and eradicate plant and animal pests and diseases that have potential to cause significant adverse impacts.

3.5 Management steps

- Establish a Project biosecurity register that takes a risk-based approach for identifying introduced plants and feral animals unique to each BCER project site.
- Using a Geographic Information System, map risks into low, medium and high.
- Liaise with the relevant NT agencies if introduced plant and animal pests are detected on BCER project sites.
- Implement this BMP across all BCER project sites.
- Partner with the NT government and landowners to implement innovative measures for prevention, detection, and elimination of introduced plants and feral animals.
- Work sites will be audited and inspected to ensure compliance with the commitments made in this BMP.
- BC-S2C will complete annual reports on its biosecurity register and any actions that may arise from it (i.e., accountability and transparency).

3.6 Monitoring and auditing

Audit and inspection frequencies are detailed in Appendix A.

4 Training and awareness

All personnel and subcontractors shall receive suitable BMP induction/training. The aim of the training is to ensure that all site personnel are aware of the issues relating to environmental biosecurity risks, their responsibilities and, they are competent to carry any required works.

Access to the BMP will be made available during induction and maintained on BC-S2C BMS. During inductions and training the following information will be provided to personnel:

- Personal protection strategies to avoid effects of biting insects (clothing requirements).
- Identification of different introduced plant and animal pests.
- How to keep up to date with biosecurity information.
- Who to contact if there are concerns or questions.

All such inductions and other training shall be recorded in the Site Induction and Training Register.

4.1 More information

For more information contact the NT Parks and Wildlife Commission.

5 References

Northern Territory Government 2016 – 2026: Northern Territory Biosecurity Strategy.

6 Appendices

Appendix A: BIOSECURITY MANAGEMENT MEASURES

A.1 Outline biosecurity commitments

Works phase	Subject	Proposed mitigation measure	Responsibility	Timing	Performance measure
Pre-restoration	Baseline weed & feral animal survey	Undertake baseline weed and feral animal survey(s) to identify their presence and location	Environmental Management Representative (EMR)	Pre-construction (i.e., restoration activities)	Location of weeds and feral animals identified throughout construction areas to facilitate best practice control measures.
Restoration activities	Onsite staff induction and training	• Instruction and training of all site staff on identification of fauna, native vegetation, and biosecurity risks. • Train site personnel in biosecurity management.	EMR	Onsite personnel induction Toolbox briefings	All staff inducted prior to commencing work onsite.
	Mulching	No declared weeds shall be mulched.	EMR	Ongoing	No mulching of declared weeds.
	Weed disposal	Declared and environmental weeds to be disposed of at a licensed waste facility.	EMR	Ongoing	No proliferation of weeds through construction activities due to weed disposal methods.
	Weed, feral animal and pathogen control	• Any feral animal sited shall be given a easting & northing reference and reported to the EMR. • Weed propagules or weed infested topsoil should not be imported to site. • Weed hygiene measures will be followed by all construction personnel entering and exiting construction areas. • Ensure machinery remains dedicated to discrete construction sites within the project area where possible. • Ensure any plant and equipment which must move between discrete construction sites is cleaned prior to entering a new property. • Cleaning all machinery of soil and vegetation prior to entry and exit of site in dedicated wash down areas with water collection system on impermeable hardstand. • Complete vehicle and machinery inspection form for all plant entering and exiting site. • Weeds and pathogens in the contractor's activity zone shall be always controlled. Any outbreak of	EMR	Ongoing	• No weeds, pests or pathogens introduced into construction areas. • Weeds, pests pathogens already existing in construction area are not spread through construction activities. • No off-target damage.

Works phase	Subject	Proposed mitigation measure	Responsibility	Timing	Performance measure
		weeds prior to issue of final certificate in this zone or in land adjoining this zone directly attributable to the works should be notified to the site superintendent immediately. • • Any pest/disease control measures to be agreed with superintendent prior to implementation.			
	Target weed control	All herbicide application is to be undertaken in accordance with Operational Instruction Repeat treatments to be undertaken, desirably in growing season to maximise effect.	Spraying will be carried out by suitably qualified contractors Site Environment Officer (SEO)	Ongoing and post-construction	Identified weeds within project.
	Herbicide application register	Maintain daily records of herbicide applications.	EMR	Ongoing	Register available upon completion of works.
	Disease, weed & feral animal register	Biosecurity Register will be always made available to all onsite staff.	EMR	Ongoing	All onsite personnel familiar with key weed species identification.
	Phytophthora control	If identified, onsite controls to be implemented in accordance with TSD operational instruction 21.3; Phytopthora / dieback control.	EMR	Ongoing	No spread of Phytophthora within the construction area.

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