AI Carbon

Evaluation of carbon storage and potential value of improved ecosystem services provided by the Coorong, Lower Lakes & Murray Mouth Rehabilitation Project

A prefeasibility study of pathways to creating ongoing value based on environmental improvement, economic development and social engagement in natural resource management

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Executive summary

The costs of facilitating adaptation to future climate change and associated environmental changes may be offset by value created by quantifying and selling the benefit associated with carbon sequestration. Additional values associated with biodiversity enhancement and protection, and important ecological functions that have potential economic values need to be considered in future environmental rehabilitation projects. Assessment of ecosystem services and functional values may represent significant value to society that is not currently considered when developing and implementing environmental management actions.

In recent times, the region has suffered significant negative environmental, economic and social impacts as a result of historical and upstream water and land management decisions. The Murray Futures Coorong and Lower Lakes Recovery Program was designed in partnership between Australian, South Australian and Local Government and representative community groups. The plan is intended not to be a "static" plan, but one that is adaptive and responsive to learnings and opportunities that emerge through collaboration, research and on-ground applied learnings. The over-arching intent of the plan is to build resilience into the social, environmental and economic systems of the region by improving environmental quality and ability to respond to change.

Within that broader context, this report was developed as a starting point to come to an understanding of the sequestration potential and carbon market potential as a source of income from an ecological service provided by the Coorong, Lower Lakes & Murray Mouth rehabilitation project. Specifically, the project was undertaken to 1) consider possible economic value of carbon sequestration achieved by biodiverse revegetation in the Coorong, Lower Lakes & Murray Mouth region, and 2) consider potential opportunities to realise some of that value given current policy settings. The decision to participate or not in any market requires an understanding of demand and supply drivers, costs of production and an understanding of the broader political and policy framework which the market exists within. This project has been developed within the broader context of Australia's commitments to protect important wetlands (Ramsar Convention), reduce greenhouse gas emission levels (Kyoto Protocol) and to conserve and protect biological diversity (Rio Convention).

Under the Kyoto Protocol, Australia agrees to apply internationally developed rules and protocols regarding accounting for greenhouse gas emission sinks and sources. This report applies the general rules for carbon sinks in Land, Land Use Change & Forestry (LULUCF), as developed by the Intergovernmental Panel on Climate Change (IPCC) 2006 Guidelines for National Greenhouse Inventories, Volume 4: Forests. The report also highlights there is a need for the National accounting approach to be updated in wetlands to reflect the recently released IPCC report 2013 Supplement to the 2006 IPCC Guidelines: Wetlands. It does not currently appear the National Inventory and related legislation are consistent with those updated international guidelines in the case of wetlands emission accounting.

Translating the international accounting greenhouse gas sink and source protocols to the level of a "project" such as the CLLMM revegetation project, a series of analyses of what type of planting was put down when, and where, and over what area were undertaken. This was done to attempt to come to an understanding of what impact the project had in terms of carbon dioxide equivalent sequestered in biodiverse plantings. The project level accounting aimed to meet the following criteria: the results must be relevant, complete, consistent, transparent, accurate and conservative. A series of assumptions were required to be made to undertake the analyses. These assumptions were detailed and specified to allow for assessment of project report findings to be judged against the above criteria. Data for analyses were supplied by the Department of Environment, Water & Natural Resources Major Project CLLMM team.

The total area planted out to “forest” is expected to be 1,578 hectares to the end of 2014, with 295 hectares of non-forest terrestrial plantings and 1 hectare of non-forest aquatic revegetation.

Two different carbon stock change models were applied to determine the likely range of carbon sequestration. The first was the Reforestation Modelling Tool (RMT), as supplied by the Australian Government Department of Environment. This model is known to be poorly suited to estimating carbon stock change rates in environmental plantings, and represents a limited functionality version of the Full Carbon Accounting Model (FullCAM). The second model was developed, in part, by South Australian Department of Environment, Water & Natural Resources (the “Hobbs model”), and represents locally calibrated data that will eventually propagate into the FullCAM. The RMT suggests annual average carbon sequestration in the area of 1.5tCO_2e/ha/year for the next 30 years across the terrestrial forest areas planted. The Hobbs model suggests 7.71 tCO2e/ha/year as the average rate for the same plantings. Under the RMT forecasts, the terrestrial forests are expected to sequester around 70,000 7.71 tCO_2e to 2040, while the Hobbs model suggest around 300,000 tCO_2e over the same period. This is roughly equal to taking 90,000 cars off the road in Australia for a whole year. Analysis of current Australian Government legislation and policy suggests that the Hobbs model should be able to be applied in the foreseeable future (e.g. within 6 months of this report being released). The RMT model could be used immediately to launch a carbon farming project.

Using the carbon stock forecasts, and again using specified and detailed assumptions, there is a real possibility that the potential revenues that could be gained across the entire planted area could exceed project costs. This is a first order or preliminary examination that requires more detailed technical and commercial investigation. The project valuation is seen to be sensitive to both changing carbon price and estimates of sequestration per hectare. There is strong potential for this project to return revenue to landholders in the form of biodiversity incentive payments, which could be as high as $1m to participating land managers out to 2030. This may represent significant additional opportunities for the Natural Resources SA Murray-Darling Basin if they become the project owner, and are able to ensure revenue in excess of costs was returned to important environmental initiatives, rather than to general revenue. This model represents an innovative market based instrument that is consistent with the Kyoto Protocol and the Rio Convention on finding new ways to develop important environmental outcomes.

Further opportunity may exist be applying the IPCC 2013 Wetlands Accounting guidance to see how improved river level and wetland management has influenced greenhouse gas emissions, which this project didn’t not have the scope to undertake. This paper has also identified significant benefits delivered to society as a whole (as greenhouse gas emissions sequestered) undertaken by private land managers undertaking changed land management on their properties. This may also have ancillary benefits to agricultural and horticultural activity on those private lands. In the context of a “regional marketing plan”, the “carbon, biodiversity, food, fibre, wine, and community engagement” that the CLLMM project helped develop helps to create a compelling for any party in the voluntary market seeking “high quality” carbon credits. This may then create a pathway to market for land managers who seek to create carbon neutral produce, or who are seeking to attract buyers who are interested in the “green” production approach.

Following on from the findings of this report, future actions should include:

- examination of pathways to market for carbon and biodiversity offsets,
- reconsidering how greenhouse gas accounting is undertaken in the CLLMM Ramsar Wetlands area using the most up to date procedures,
- developing a more detailed understanding of broader economic benefits of environmental improvement projects (across ecosystem services as regulation of flooding and drying cycles, primary production and biodiversity maintenance), and
- consideration of the role of environmental flows in stimulating new biodiverse native carbon forests.

This study is important in that it has enabled the quantification of direct economic benefit of ecosystem services that are being delivered mostly on private lands as a result of public private partnerships and investment into environmental rehabilitation. Investigating more than just the one ecosystem service (carbon sequestration) directly quantified here will doubtless enable natural resource managers to provide better cost: benefit evaluations to base judgements on how to direct natural resource management in the future to deliver maximum benefit.

Glossary and important definitions

afforestation means the planting of a new forest

Article 3.3 (Kyoto Protocol) means the emissions or removals resulting from land which was converted, after 31 December 1989, to or from a forest through afforestation, reforestation or deforestation. Australia has defined a forest as an area with:
- tree crown cover of 20% canopy
- minimum land area of 0.2 hectares, and
- minimum tree height of 2 metres

Article 3.4 (Kyoto Protocol) covers land use that is not afforestation, reforestation or deforestation. This includes:
- forest management
- cropland management
- grazing land management, and
- revegetation.

carbon pool means the living biomass and the dead organic matter.

carbon stock change means the difference in the carbon stock in the relevant carbon pools in an area over a specified period of time.

deforestation means the clearing of a forest

densely stocked planting means plantings where, after the first 3 years post-establishment, the number of individual trees (excluding ground-cover plants and grasses) per hectare remains relatively high at >1,500 individuals per hectare, in mixed-species environmental plantings

planted area
The spatial area defining the planting that is used to estimate carbon abatement where:

a. For blocks or belts in which plants are established in rows:
   - i. the location of the outside edge of the long axis of the rows is a distance from the outer row of stems one half of the average spacing between trees within rows within the planted area;
   - ii. the location of the outside edge perpendicular to rows is a distance from the outer row of stems one half of the average spacing between trees within the planted area;
   - iii. the location of an edge internal to the planting perimeter bordering on an exclusion area is a distance of one half of the average width of the rows within the planted area from the outermost stem; and
   - iv. requirements for the minimum area of the planting and exclusion areas are set out in the CFI Mapping Guidelines; and

b. For blocks or belts in which plants are established randomly (i.e. not in rows):
   - i. the location of any outside edge from the outer stems is equal to zero meters from the outer stems;
   - ii. the location of an edge internal to the planting perimeter bordering on an exclusion area is equal to zero meters from the outermost stem; and
   - iii. requirements for the minimum area of the planting and exclusion areas are set out in the CFI Mapping Guidelines;

project area means the subjectively defined spatial area defining the planting/s managed under the project including
exclusions and spaces between adjacent linear plantings. *Note*: Planted area, not project area is used to estimate carbon abatement.

mixed-species environmental planting
A planting that consists of a mixture of tree and shrub species that:

a. are native to the local area of the planting; and

b. are sourced from seeds:

i. from within the natural distribution of the species; and

ii. that are appropriate to the biophysical characteristics of the area of the planting and

c. may be a mix of trees, shrubs, and understorey species where the mix reflects the structure and composition of the local native vegetation community, and

d. are established through tube stock, direct seeding or broadcast seeding. That is it does not include mixed-species regenerated naturally without planting seeds or seedlings (i.e. natural regeneration or regrowth).

r**eforestation** means the replanting of a forest that has been lost for any reason

revegetation means replanting by direct seeding or use of tube stock to replace non-forest vegetation where the vegetation covers a minimum area of 0.05 hectares and does not meet the definitions of afforestation and reforestation contained here

non-forested land is land that does not have trees situated on it that: (a) have attained, or have the potential to attain, a crown cover of at least 20% across the area of land; and (b) have reached, or have the potential to reach, a height of at least 2 metres.

Wetland accounting
The 2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories:
Wetlands (Wetlands Supplement) provides methods for estimating anthropogenic emissions and removals of greenhouse gases from lands with wet and drained soils, and constructed wetlands for wastewater treatment. It follows the same approach to estimating emissions and removals as the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (2006 IPCC Guidelines). The report has been developed by an international team of authors who were selected by the Bureau of the IPCC Task Force on National Greenhouse Gas Inventories (IPCC TFI). It has undergone a multi-stage review process involving expert reviewers and governments and was presented to IPCC member governments for adoption and acceptance in October 2013.

The Australian Government has chosen to exclude wetland accounting from eligibility to participate in the CFI and ERF. It is not clear whether the Australian Government has elected to update national Greenhouse Gas Emissions Inventory (NGGI) to include the most recent IPCC guidance on wetland accounting.

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1. Introduction & background

The impacts of prolonged drought and water over-allocation across the Murray-Darling Basin left the internationally significant Coorong and Lower Lakes wetlands on the brink of environmental collapse. Positive relationships built between Federal, State and local partners, including the Ngarrindjeri native title holders have allowed significant environmental improvement projects to be developed and implemented since 2009, consistent with the Long Term Plan (*Securing the Future: a long-term plan for the Coorong, Lower Lakes and Murray Mouth).*

The Murray Futures Coorong and Lower Lakes Recovery program has delivered a range of projects to address environmental issues facing the region, such as salinity, acid sulphate soils and loss of habitat, and rebuild a healthy ecosystem that can better adapt to changing conditions in the future. During the next 20 years, the long-term plan will work towards introducing more variable water levels and building resilience in the region's environment so the site can recover from unprecedented low water levels, salinity and acidification and adapt to changing conditions. The actions proposed in the plan will take account of variables such as inflows and climatic conditions, as well as information gathered and lessons learned from previous actions.

It is intended that the plan will be regularly reviewed based on emerging information, science and knowledge, as well as being responsive to cultural and community guidance, and the development of a close working relationship with the Ngarrindjeri Regional Authority. As part of this adaptive learning approach to management, there is strong interest from stakeholders with regards to valuation of the improvements to the environment from economic and marketing perspectives. It is expected that activities under the Recovery Program will impact several significant greenhouse gas sinks and sources. The underlying interest from stakeholders is to determine whether there are alternative economic values that could be achieved by quantifying environmental improvement values in terms of carbon markers or payment for ecosystem services. Even if direct economic values cannot be directly achieved (e.g. by sale of environmental improvement commodities, such as carbon or biodiversity credits), there may be secondary economic values associated with the marketing of produce from the region being related to environmental improvements. For example, there may be brand or product differentiation where the producer can show a link with how they manage their land and enterprise to maximise both profit and environmental conditions, rather than purely managing for profit that may lead to environmental degradation.

One often mentioned market in the payment for environmental services discussion is in carbon credit production and sale: carbon trading. The service provision is the storage of carbon drawn from the atmosphere by biodiverse revegetation schemes, thereby serving to slow the impacts of human induced climate change. Such biodiverse plantings also deliver ancillary benefits to biodiversity, improve water and nutrient cycling processes, and allow for enhanced economically productive uses of the land. The historic role of carbon within the Lake sediments is a very important one for the CLLMM site. Carbon is in limited supply within the lake sediments which has resulted in reduced ability for the ecosystem to cycle nutrients and to facilitate sulfate reduction.

The idea of whether or not to become involved in the Carbon Farming Initiative (CFI, the regulated carbon credit producing scheme in Australia) has become a vexed issue for many landholders and land management agencies across Australia. One the one hand, there appears to be opportunities to raise additional sources of capital for management and of improved land management practice through the sale of carbon credits related to environmental rehabilitation. New sources of capital are always welcome to land management agencies that have traditionally struggled to attract and maintain long-term funding arrangements to manage rehabilitation activities. On the other, the development of carbon markets is slow, fragmented, and subject to significant pricing volatility and regulatory uncertainty. Overlaying these concerns is the potential for long term obligations to rest on land title, with the perception of risk of devaluing land values or restricting future use options for the rehabilitated land.

In short, while the upside of receiving revenue for the delivery of biodiverse carbon sequestration outcomes is apparent, the risks associated with the unknown conditions that surround participation in the carbon market create real uncertainty for stakeholders.

This is particularly true as the complexity of issues in deciding to participate in a market based opportunity to fund capital and operational costs of environmental rehabilitation ranges across political, scientific, financial and legal aspects. Adding to the complexity is the typical lack of familiarity of both landholders and land management agencies in dealing with complex financial instruments and unfamiliar market conditions, and constantly changing political tides.

To make the situation worse, the idea of carbon trading as both a policy based instrument to deal with human induced climate change is often muddied in stakeholders minds by concern raised in the mainstream media over “whether climate change is real” and the idea that “carbon trading is just there to make money for the traders, the big banks and the middlemen (financial services sector)”. Finally, there is a dearth of competent advisory services that can provide balanced views of risk and opportunity for land & natural resource managers regarding participation in carbon markets to finance development and ongoing maintenance of landscape rehabilitation.

Without any doubt, the situation surrounding the CFI and the evolving policy environment around the Australian Governments’ Direct Action and Emission Reduction Fund is complex.

However, the Department of Environment, Water & Natural Resources (DEWNR), Major Projects Branch has identified that complexity does not mean that no action should be taken.

This project (“*Carbon Sequestration and Market Value from the CLLMM Revegetation Program Project*”) developed by the Program Leader, Partnerships and Landscapes (Russell Seaman) within DEWNR, indicates an interest in dealing with the very broad issues that need to be considered in assessing potential viability of participation in market based opportunities associated with environmental management and improvement. In this case, environmental improvements are the outcomes that have occurred as a result of the significant investment in native habitat restoration that has been undertaken in the CLLMM region. This project has been proposed to come to an understanding of the sequestration potential and carbon market potential as a source of income from an ecological service. In effect, the project takes the general form of a business feasibility study that takes into account the Major Projects Branch interest in the opportunity to leverage future value from activities undertaken to date. We consider it important to also provide broader contextual understanding on how the information and knowledge developed through this project may apply more broadly to the operations of DEWNR. The resultant report and presentation will be important in presenting a clear understanding of risk and opportunity for DEWNR & regional stakeholders.

This project effectively takes form of pre-feasibility study that seeks to determine the benefits of the activity to date, to identify possible ways that the identified benefit can be described, communicated and valued. The project has been developed to determine if there is a plausible pathway to also create additional economic value or identify and value indirect economic value that could contribute to ongoing rehabilitation and improvement of environmental conditions in the region.

International and national significance and relevant policy settings

The project presented here is consistent with a suite of obligations and intents to protect, conserve and improve the environment and quality of life of people, and to use economic innovation to drive these outcomes. The key policy drivers for the development of this project are:

- Australia has obligations to conserve and protect wetlands of international significance (Ramsar)
- Australia is seeking to reduce its greenhouse gas emissions (Kyoto, Direct Action & Emission Reduction Fund, Carbon Farming Initiative)
- Australia is seeking to conserve and protect biodiversity through innovative approaches (Rio Convention on Protection of Biological Diversity innovative financing mechanisms; Environment Protection and Biodiversity Conservation Act)
- Australian Government in partnership with the States and Territories is seeking to increase rates of Indigenous Economic Participation and reduce rates of disadvantage between Indigenous and non-Indigenous Australians (Closing the Gap, National Partnership on Indigenous Economic Participation)
- Australian Government is seeking State based proposals for participation in the Emission Reduction Fund
- Significant investment is occurring within the riverine landscape to restore ecological function of wetlands and floodplains. This includes a substantial restoration program in the Lower Murray.
- The implementation of the Basin Plan over the next few years is a key driver in restoring river health and promotion of localism which links to economic productivity lifecycles.

2. Measuring carbon stock change, national and international accounting rules

Australia, like all other countries that have commitments to the Kyoto protocol, have agreed to follow specified protocols and rules about how to go about accounting for greenhouse gas emission sources and sinks across all sectors. One of the most complex sectors to confidently estimate the level of emissions moving into and out of greenhouse gas sinks and sources is the agriculture and land management sector. The Intergovernmental Panel on Climate Change (IPCC) provides technical advice on, amongst other things, how to quantify emission sinks and sources in the land sector (agriculture, forestry and other land use “AFOLU”/land use land use change & forestry “LULUCF”).

The standardised approach to land sector emission accounting is provided for the IPCC 2006 Guidelines for National Greenhouse Inventories. There are several chapters dedicated to forest and non-forest accounting associated with carbon sequestration in vegetation, but “Volume 4: Forests” is the definitive guide with respect to land management. Associated with this guidance is the approach each nation takes with its unilateral decision to account for, or to exclude emission sinks and sources from its accounting report.

Historically, Australia has chosen to account for sinks and sources as identified by Article 3.3 of the Kyoto Protocol, applying the guidance of the IPCC Volume 4. This effectively covers all “forests” In Australia on lands that were clear of vegetation at January 1 1990. Australia elected to exclude emissions from Article 3.4 sinks and sources (including vegetation that would not reach the definition of forest) in the first commitment period of the Kyoto Protocol (2008-2012). This decision was reversed at international negotiations for the 2013-2020 reporting period, with Article 3.4 now being “Kyoto compliant” and a measured set of emission sinks and sources in Australia. This means in effect that if a project is able to apply a methodology that measures non-forest carbon sequestration (such as revegetation of small shrubs, grasses and other non-forest vegetation), it should be able to use those credits in a way that the Government acknowledges to reduce Australia’s net emissions.

Alongside Australia not reporting Article 3.4 non-forest revegetation in the land sector reporting, emissions from wetlands and coasts were poorly represented in the IPCC measurement and estimations guidance. This was due to the scientific and technical problems of dealing with variability of the biogeochemical processes that drive change in emission sinks and sources related to wetlands.

The IPCC has recently released the 2013 Supplement to the 2006 IPCC Guidelines: Wetlands. This is the new and updated methodological guidance on lands with wet and drained soil and constructed wetlands for wastewater treatment. The treatment of wetland emission sinks and sources is somewhat uncertain from a crediting perspective at present, and this is discussed in more detail in Section 6 of this report dealing with the amendments to legislation being proposed at the time of development of this report.

The international conventions that drive Australia’s emission reporting have direct implications for project scale reporting of carbon stock change. At the project level, any carbon stock change needs to be consistent with the rules applied at the national level. This has direct implications for the development of project scale carbon stock change estimates in this report.

3. Project level carbon forecasting

The purpose of this section of the project is to use a defensible approach to determine total amount of carbon sequestered:

- to date by the CLLMM plantings,
- into the future by the CLLMM existing plantings, and
- by planned future plantings lifetime carbon sequestration.

This requires an understanding of the approaches taken to determine carbon stock change in vegetation under both legislated and regulated voluntary carbon markets. The greenhouse gas accounting is done at a "project" level where the project has a clearly defined physical and activity boundary, and the sources and sinks of emissions within the project boundary are identified and can be quantified.

Best practice guidance on project level GHG accounting is well identified by The GHG Protocol for Project Accounting (WRI & WBCSD; 2004). The GHG Protocol is reflected by the CFI legislation in Australia. Of importance to this project at the pre-feasibility & investigations phase is the need for project level accounting to be *relevant*, *complete*, *consistent*, *transparent*, *accurate* and *conservative*. The findings of this report are judged against these standards.

For the purposes of this project, the project boundary would include the sinks and sources of greenhouse gas emissions identified in Table 1.

Table 1. Project emissions accounting boundary for CLLMM project (including terrestrial forest, non-forest land and aquatic vegetation)

Carbon pools and emission sources	**Greenhouse gas**
Live above-ground biomass	Carbon dioxide (CO_2)
Live below-ground biomass	Carbon dioxide (CO_2)
Dead plant material and debris	Carbon dioxide (CO_2)
Fuel use	Methane (CH_4) Nitrous oxide (N_2O) Carbon dioxide (CO_2)
Fire	Methane (CH_4) Nitrous oxide (N_2O) Carbon dioxide (CO_2)
Biogeochemical processes	Biogeochemical processes associated with wetland draining and re-wetting are excluded, but this is only done for lack of available data and cannot be interpreted to be conservative. Further guidance is required from the Australian Government on the relationship between project & national accounting rules and the new international protocols on wetland accounting.

3.1 CLLMM planting program and design

Over time, the CLLMM planting project reports have developed a greater level of consistency across reports and have eventually taken the general agreement as to what "zone" represents what biological zonation, rather than a project or site specific planting area.

The general form is based on the landscape "zonation" as per Figure 1.

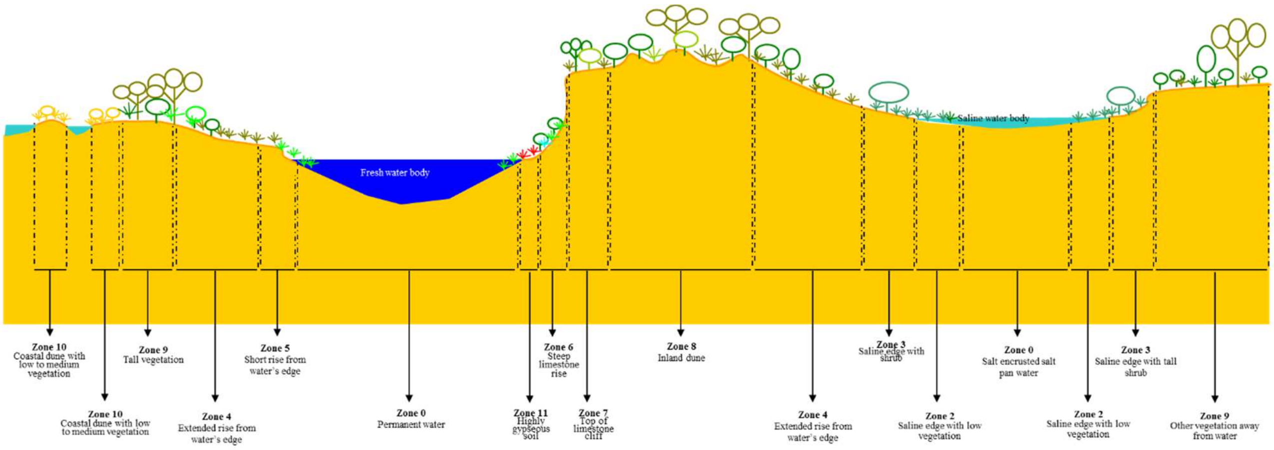

Figure 1. Generalisation of landscape zones across the CLLMM project area.

3.2 Estimating carbon sequestration rates

A detailed report on carbon sequestration estimation is provided at Appendix 1. A summary of the approach is given here.

Assumptions

This project required a set of assumptions to be made in relation to the activities of the project.

1. There was a zero carbon stock baseline (i.e. the carbon stock change estimations do not take into account change in carbon stock change in vegetation already in existence when the CLLMM project was initiated). This differs from the current CFI regulations that discount to zero any carbon stock change prior to 1 July 2010.
2. All plantings within a specified estimation area occurred within 30 days of initiation
3. All lands are eligible "Kyoto" lands (i.e. were free of native vegetation at 31 December 1989) or have been continually clear of vegetation for the last 5 years.
4. All plantings were made by direct seeding or using tube stock, rather than by assisting natural regeneration.
5. Lifetime sequestration of planted vegetation is maximised at 30 years, and further carbon stock change is incrementally small after this point and can be assumed to be zero in the absence of disturbance events.
6. Assumption regarding canopy forming plants is that if they were present in the original planting plan, they would achieve forest condition as the natural environment & rainfall wold ordinarily naturally configure to forest state.

7. While there were some plantings intended to create open grassland or shrub land, with most sites having large proportion of canopy forming plants at initiation. It was assumed that information from project planting reports including number and identity of species planted could allow a determination to be made as to whether a “forest” would result or now.
8. Only planted area was used to assess carbon stock change rates.

The full data set of all project reports from all plantings for the CLLMM project and associated database information including GIS coordinates, species lists and planting plans for all project areas were supplied by the CLLMM project team. These pieces of information were used to determine the total areas planted. These data were then further disaggregated into the data classifications shown in Figure 2.

Plantings were divided into “year” classification with the expectation that all plantings within “year” occurred within the planting season of a single year (e.g. June-September) and that is an approach that is consistent with a CFI methodology. The date of planting was estimated to be 1 September in the estimation year. The GIS database information was initially filtered to get all planting data for each given year of the project.

Project planting plans for each project were then used to determine whether or not the plantings in each planting area within the CLLMM project area were likely to be have the potential to attain “forest classification” (greater than 0.2ha area at >10m width, with the potential to reach >2m crown height at maturity with >20% crown cover). This was based on a qualitative and semi-quantitative estimation of the species mix, and number of over story seedlings that were reported as being planted (where over story seedlings were represented at >200+ seedlings/ha). This information was combined with qualitative estimations. Given that significant local expert knowledge was applied in the planning process, it was assumed that where project report indicated a “tall shrub land” or “open forest grassland” was expected to be the outcome of the planting, that planting area was classified as forest for the purposes of this analysis.

The project planning report information on planting zones could be used to be the basis of different planting activities based on differing soil and vegetation assemblages that would be recognised as different “carbon estimation areas” or CEAs in the language of the Carbon Farming Initiative.

All “forest area” was assessed for carbon stock change over 25 years using the Australian Government Reforestation Modelling Tool.

All plantings that did not meet the forest classification are classified here to be “revegetation”. The terrestrial non-forest carbon sequestration from the period 2011 to 2040 (29 years) was assessed using the DEWNR carbon sequestration from revegetation tool (the Hobbs model).

Non-forest carbon stock change estimates were assessed using technical report information as provided by Hobbs model, where the setting “percentage of trees” in planting was set to zero, representing a low-shrub revegetation estimate.

Non-forest aquatic vegetation carbon sequestration rates were assessed by the use of locally derived empirical sequestration rates as estimated by Sullivan et al. 2013.

Details of total areas for each classification are presented in Table 2.

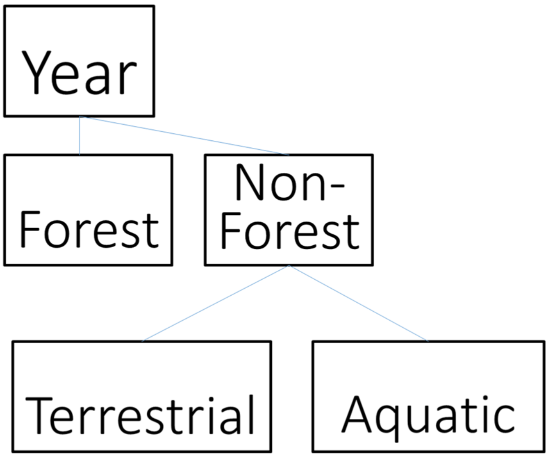

Figure 2 Data breakdown used to undertake carbon stock change modelling.

Table 2 Estimated areas of each classification of different planting types over time. Data all presented in hectares (ha). Areas are rounded for presentation purposes.

Year	Forest	Non-forest terrestrial	Non-forest aquatic
2010	120	5	0
2011	478	49	0
2012	294	166	0.38
2013	295	39	0.3
2014	391	37	0.32
Total areas (hectares)	**1578**	**295**	**1**

Once areal extents were determined for each planting type, then total carbon sequestration to 2040 was determined on an annual basis. This was done for forest type using both Reforestation Modelling Tool (RMT) and the SA model for estimating carbon sequestration rates for endemic vegetation associations developed by DWENR (Hobbs et al. 2013).

The RMT takes into account all of the carbon pools that would be associated with an environmental planting, and assume there is some understory plantings to enhance the "biodiversity" effect. Data used to establish each year's model run in RMT were area planted in that year, using a low density (<800 stems/ha) planting number. No detailed event activities other than initial weed treatment and planting were programmed in to the event log file. The geographic coordinate for rainfall, soil types and native vegetation growth maximum for the area was centred on Meningie (35.6883° S, 139.3378° E) for the purposes of this analysis. Given these simple assumptions, the outcome of the analysis only represents a coarse estimate of likely carbon outcomes at the aggregate level, and does not reflect a site specific or carbon estimation area level of accuracy. Given the location's annual average rainfall, the carbon forecasts are likely to be conservatively low.

The Hobbs model is focussed on extrapolation from real data surveyed across SA, and is available in an Excel spreadsheet format from http://www.environment.sa.gov.au/files/0dcbe5c6-337f-4810-

a160-a26d00f7d8f0/carbon-sequestration-from-revegetation-estimator-version1-gen.xlsx. The full details of how carbon stock change data were derived are presented in Hobbs et al 2013. The tool was used to determine the average annual carbon sequestration for an "average" hectare of land in the area "Meningie", with all other default settings accepted. The values for environmental plantings in Hobbs have been incorporated into the approved methodology "Quantifying carbon sequestration by permanent native mixed species environmental or mallee plantings using the Full Carbon Accounting Model".

Non-forest terrestrial for grassland plantings were estimated using the default values in Hobbs model by setting the planting density of trees to "0", setting the vegetation description to "Shrubby Environmental Planting", and the planted tree density to 200/ha. This is non-conservative in situations where the planting was actually a grassland and not a shrubby environmental planting.

Estimates of carbon sequestration amounts in aquatic non-forest vegetation plantings are simply based on the range of data developed by Sullivan et al. 2013.

3.3 Results of carbon stock change assessment

The results of the data analysis and carbon sequestration modelling based on various areas of different planting types yield the data presented in Table 3.

The largest area of total plantings was assessed to be "forest", at 1,578 hectares, or around 84% or total planted area. The non-forest terrestrial plantings represented just over 15% of total planted area, and the non-forest aquatic plantings (*S. validus*) only took up around 1 hectare, or less than 1% of total planted area. There were no records of *Ruppia* spp. plantings, although it is understood that there were plantings of these species within the region over the time of the project.

On an annual per unit basis, the RMT suggests that each hectare of low density environmental planting in the Meningie area will sequester 0.45 tonnes carbon per year out to 2040, or an annual average of 1.5 tCO_2e per hectare. It must be remembered that this model is poorly locally calibrated. The model suggested a total carbon sequestration of plantings to date of 2,750tCO_2e. This is likely to be an underestimate of actual sequestration that has occurred to date.

The Hobbs model, using locally calibrated data, suggests an annual average carbon sequestration rate of 2.1tC/ha/year, or 7.71 tCO_2e/ha/year. This number is significantly higher than the number forecast by RMT for the same location, and is likely to be a function of the poor calibration of RMT. Using the annual average sequestration rate over the lifetime of the plantings, it is suggested that the sequestration of all plantings to date is on the order of around 300,000tCO_2e. This is likely to be an overestimate in early years as plantings establish, but actual tree growth would be very likely to meet the predicted over a 30 year period in the absence of catastrophic losses to fire/disease/storm events.

The terrestrial non-forest sequestration rate was estimated to be 1.3tC/ha/yr, or 4.7tCO_2e/ha/year. It is likely to be reasonably representative of the situation for shrubby environmental plantings, but unlikely to be representative of carbon sequestration rates in grasslands.

The smallest area of vegetation type replanted, aquatic non-forest plantings, represented by *Schoenoplectus validus* reeds is expected to sequester carbon at a rate between 500 – 1000kgC/ha/year while rehabilitation is ongoing, and this is not expected to vary much with changing species identity. This equates to a range of 1.8-3.9tCO2e/ha/year. Rates of seagrass carbon sequestration were not considered by this study.

Table 3. Total carbon sequestration over 30 years for each vegetation type planted by CLLMM project (assuming only 85% of modelled is credited)

Vegetation type	**Model**	**Area**	**tCO_2e total production to 2040**	**Confidence**	**Challenges**
Forest-RMT	RMT	1,578	69,756	High (extremely conservative)	Model doesn't take into account real conditions and is excessively conservative
	Hobbs	1,578	297,688	High (relatively conservative; based on relevant data)	Robust, locally data and analysis
Non-forest terrestrial	Hobbs	295	~40,000	Limited	Disentangling "shrubby revegetation" data from "grassland" data
Non-forest aquatic	South Cross University (Sullivan et al. 2013)	1	52-111	Reasonable	Large range but locally relevant data source
Seagrass (e.g. *Ruppia* spp.)		Not recorded	Requires investigation		Local data acquisition

3.4 Summary of carbon stock change forecast and way forward

It can be seen that the plantings undertaken by the CLLMM project have resulted in significant carbon sequestration., and for the future sequestration to be of real importance. Different models of carbon stock change forecast will give different carbon stock change estimates. Clearly in this case, the "Hobbs" model provides a higher estimate of total carbon sequestration compared to the RMT. It is likely that the Hobbs model provides a more realistic estimate, given it is locally calibrated using environmental plantings rather than providing estimates based on more coarse local assumptions as the RMT does.

Further, project level accounting did not take into account biogeochemical processes that would impact be impact by hydrological wetting and drying cycles of wetlands. This may be an important source of emissions or emission reductions, depending on the anthropogenic influences at play. Whole of project area carbon accounting is considered in more detail in the next section.

4. Application of carbon quantification methodologies & project level carbon accounting

With an understanding of the likely "biological" responses of the system to rehabilitation in terms of rates of carbon sequestration over a variety of different vegetation types, this study turns to focus on carbon market and policy considerations. This is done with a view to answering the question "is it possible to crystallise the value of the carbon sequestration potential of the CLLMM plantings?".

Ideally, when an environmental planting project is established with a view to earning carbon credits, it would be designed to conform to all of the methodological project design requirements from the outset. While it was clearly an intent of project owners and developers (as seen in CLLMM project justifications, applications and project reports) to achieve a carbon sequestration and climate benefit, there was only limited investigation into how to participate in carbon markets at an early stage.

In the absence of these prior considerations, we here give consideration to which methodology might be available to apply to the CLLMM environmental plantings to enable plantings to be able to earn carbon credits. These credits may be sold to create ongoing revenue for forest and vegetation management, or development of additional reforestation and revegetation activities in the region, with additional regional economic development benefits.

This report provides information of relevance to "applicability conditions" that describe when a CFI methodology can be applied, and consider the relevance of the methodology to the CLLMM plantings. This is done with a practical view of attempting to determine whether or not it is possible to create enduring economic value based on carbon sequestration on different lands as managed by the CLLMM project.

The consideration is broadened to the "whole of ecosystem" (i.e. beyond just "terrestrial reforestation") for a more thorough perspective of all of the potential carbon sinks and sources of relevance to the CLLMM aims of riverine recovery and rehabilitation, in line with this project's aims of evaluating environmental economic benefits.

4.1 Environmental Plantings

The unique aspect of the CFI Environmental Plantings methodology when compared to other carbon sequestration methodologies is that it requires the use of a computer model to estimate carbon sequestration. The CFI Environmental Planting methodology uses the Reforestation Modelling Tool (RMT). RMT is a restricted version of FullCAM (or Full Carbon Accounting Model), the carbon accounting system that the Australian Government use to determine land use land use change forestry (LULUCF) emissions at the national level. The RMT is designed to be simple to use, with a restricted level of variables that can be modified and will give a conservative output estimate of carbon stock change forecast. This is the model that was applied in carbon sequestration forecast modelling in the previous section of this report.

To determine whether or not a project activity is consistent with the requirements of the Environmental Plantings methodology, the project proponent needs to be able to show that the planted area, for five years prior to project activity either:

- has been used for grazing, pasture management, cropping, nature conservation, settlement or
- has not been used for any purpose, has been non-forested land and has not had woody plants removed, other than known weed species required to be cleared by law.

The CLLMM projects all generally would be seen to comply with this condition, but individual circumstances may vary.

The environmental planting must have been established by direct seeding or planting; and (b) contain trees that, on the project area, have the potential to attain a crown cover of at least 20% across the area of land and a height of at least 2 metres (that is, attain a "forest" condition). *This requirement has been assessed by the current project, and the total area of CLLMM plantings that are or should be able to achieve this condition was estimated in this report to be 1,574 hectares.*

Ripping and mounding must not be used for site preparation over more than 10% of a carbon estimation area if, according to the CFI rainfall map, the area receives greater than 800mm long-term average annual rainfall. *This condition will relate to a detailed investigation on a case-by case basis, however the majority of all project sites would probably meet this requirement given regional rainfall characteristics.*

Each carbon estimation area must have uniform site characteristics, including soil type, aspect, and position on slope. In terms of species composition, each carbon estimation area needs to have been be planted or seeded with the same species or combination of species and be established and managed using the same methods, including preparation prior to planting, planting, thinning, weed control treatment and the application of fertiliser. *The detailed project site plans for each CLLMM planting generally provide enough evidence to be able to justify that the CLLMM project planting zones can be classified as discrete CEAs according to the CFI methodology.*

The Environmental Planting methodology requires and understanding of the total emissions of greenhouse gases associated with this project. This would be expected to include fuel used in transport, delivery and operation of the project (land preparation, tree planting and maintenance). *In terms of being able to quantify greenhouse gas emissions from fuel use associated with project development, the current Environmental Plantings methodology requires fuel use data to be provided in project reporting as invoices and vehicle logs. It is currently unclear whether or not these data are available, and lack of these data will preclude the CLLMM projects from applying to be granted carbon credits from the Clean Energy Regulator.*

4.2 Afforestation & Reforestation

The Afforestation & Reforestation (A&R) methodology was developed to meet the needs of commercial plantation and carbon project developers who have very large areas of carbon plantings. The key difference between the A&R methodology and the Environmental Plantings methodology is the use of direct measurement of carbon stocks in the A&R methodology as opposed to the modelled estimates used under the Environmental Plantings methodology. The level of statistical accuracy and precision required by the methodology will lead to physical sampling (including destructive sampling) would be expensive to undertake.

The reason that private "carbon focused" developers would seek to apply a direct measurement approach rather than the more cost effective modelled approach offered by the Environmental Plantings methodology is due to the relative conservatism of the Environmental Plantings methodology. The Environmental Plantings methodology RMT is intentionally designed to err on the side of caution when forecasting or predicting carbon sequestration rates. The Environmental Plantings model will always predict there to be less carbon sequestered than there actually is sequestered. This then creates a tension in cost: benefit of using a modelled and direct measurement approach to quantify the number of credits that should be issued to a project. A direct measurement approach will likely lead to more credits issued compared to the modelled approach. The modelled approach is simpler and less expensive to implement. The most cost effective solution (i.e. lowest cost per credit issued) will vary on a project by project basis.

Typically, carbon project developers in the afforestation/reforestation area will seek to grow high yielding monocultures that maximise carbon sequestration rates per planted area. Akin to forestry plantations, such plantings seek to maximise tree growth at the expense of structural and species diversity. As a result, the plantings have very few of the environmental and ecological values achieved by the CLLMM plantings. So while there may be an economic benefit from undertaking direct measurement in a high-yielding carbon forestry project, it's unlikely to be true for plantings undertaken to primarily deliver a biodiversity benefit alongside its carbon sequestration benefit.

However project developers who are seeking to maximise financial returns from carbon plantings (as opposed to deliver broader environmental benefits) will seek to minimise the level of conservatism and maximise credit issuance. The cost-benefit ratio and sensitivity assessment of whether or not it would be more advantageous for the CLLMM project to go down the direct measurement approach rather than the modelled approach is beyond the scope of this study. It is unlikely for the CLLMM project plantings to be of a scale worth further investigation.

4.3 Quantifying carbon sequestration by permanent native mixed species environmental or mallee plantings using the Full Carbon Accounting Model

The tension between cost effective monitoring and confidence in reporting conservatism is the reason there is often a preference to use a "model" to forecast and grant credits. This was the reason behind the work undertaken by Hobbs et al. (2013) in seeking to gain more accurate understanding of actual carbon sequestration rates in environmental plantings in SA to better calibrate RMT/FullCAM. So while RMT as applied by the Environmental Plantings methodology meets the Australian Government's need for project level accounting requirements of conservatism, such an approach does not provide best value for project proponents seeking to create value in environmental plantings by being so conservative in crediting.

Obviously from the results of this project assessment, the RMT is excessively conservative compared to the outputs of the Hobbs model, and would issue just less than 25% of the credits the improved FullCAM methodology would credit for exactly the same planting in the same location. Obviously from a cash flow and project revenue perspective, a greater level of issuance from the same or similar cost is preferred.

The data provided by Hobbs have been integrated into the “parent” model of the RMT, FullCAM and approved as the new methodology “Quantifying carbon sequestration by permanent native mixed species environmental or Mallee plantings using the Full Carbon Accounting Model”. As such, this would allow increased crediting and limited new cost compared to development under the new improved methodology than the old environmental planting/RMT model.

However, the methodology has not yet been made into a determination.

It remains to be seen how methodologies that are “in transition” between the CFI under the previous Government, and the CFI as amended by the current Government as the updated methodology using Hobbs et. al’s data is. If the approved methodologies are able to transition promptly to the new CFI arrangements, then there may be value in promptly seeking to register projects under the favourable new methodology than the excessively conservative Environmental Plantings methodology.

4.4 Verified Carbon Standard Coastal wetlands methodology

The Verified Carbon Standard (VCS; the global benchmark non-Government carbon credit awarding scheme) methodologies can be used to earn carbon credits under a “voluntary” arrangement, away from any government mandated credit award schemes such as the CFI. It needs to be made clear that at present, credits from a VCS registered project cannot be used for sale to the Emission Reduction Fund. However, the VCS presents an alternative pathway for earning credits if it is seen that the CFI is restrictive to project proponent needs. Credits earned through the application of “voluntary standards” such as those governed by the VCS could be sold to companies in Australia or overseas who are seeking to reduce their emission profile or to go carbon neutral. In Australia the National Carbon Offset Standard (NCOS) allows the use of VCS credits to achieve “carbon neutral status”. Several projects have previously been registered in Tasmania under a VCS methodology.

There is currently a VCS approved a methodology for coastal wetland creation in January 2014. This methodology looks to quantify carbon sequestration benefits associated with improved management of coastal aquatic ecosystems through slowing water flow and increase vegetation and silt accretion.

However, while it would seem to be directly relevant to carbon sequestration rates as described by Sullivan et al. (2013), the VCS seem to have a current policy of not allowing credits to be earned in the situation where the Australian Government also may seek to lay claim to that carbon benefit. As such, without clarity on where the Australian Government sits with respect to measurement of the carbon sequestration associated with rehabilitation of the CLLMM, it is unlikely for the VCS to allow a project to be registered in this situation without greater information.

This should be a point of further clarification between the VCS and Australian Government.

4.5 IPCC Guidance on wetland carbon accounting

The IPCC Wetland Supplement Guidance (2014) was developed to allow National Greenhouse Gas Emission Inventory builders a starting point to assess sinks and sources of greenhouse gas emissions that can be measured and managed by human interactions and activities in the environment. The IPCC Guidance directs users in the first instance to the Ramsar database of the Ramsar Convention for information of relevance to classify wetland type and to begin to assess greenhouse gas emission and sequestration rates. This is important, given the recognition of the CLLMM region under the Ramsar Convention.

This is an important platform for data for environmental emissions sinks, sources and default factors that enable consistent greenhouse gas reporting between countries and consistency across time series. Now that this guidance is available, a detailed study should be undertaken to apply the new IPCC wetland Guidance in the context of the CLLMM project area. This will give a more definitive “project level” understanding of how environmental rehabilitation is influencing carbon sinks and emission over time. Applying the new guidance will put the CLLMM team at the international forefront of reporting emissions sink and source dynamics. This is important given the international significance of the CLLMM wetlands. This also has important implications at the national level. The Wetlands Guidance also provides advice for the most appropriate ways to develop locally relevant and locally derived real data (where possible or feasible, or where it is expected that the sink or source is significant) rather than use default values. Here, the research work undertaken by Sullivan et al (2013) is important to whole of CLLMM greenhouse gas inventory reporting.

Further, the IPCC guidance provides both default factors and scientific research methods to derive locally relevant data for reporting the effect of wetting and drying cycles in carbon sequestration and emissions avoidance. These data were alluded to by Sullivan et al. 2013 as an important “next research step”. The release of the IPCC guidance is critical information to further guide more detailed emission accounting.

The CFI legislation will always seek to reflect the National Greenhouse Gas Emission Inventory (NGGI) data sources and default factors so that emissions sinks and sources reported at the CFI project level can be reflected at the level of the national accounts. As such, the release of the IPCC Guidance for wetlands marks a critical point in greenhouse gas reporting standards for important wetlands such as the CLLMM region.

At this point, it not possible to estimate the scale or value of how changed wetting and drying cycles will specifically impact carbon sequestration or emission rates in the CLLMM region. However, as a general principle, if wetland systems are artificially raised or dried out by restriction of natural immersion and flows, they will be a net source of greenhouse gas emissions. If they are re-wet or immersed through reinstatement of the natural hydrological cycle, they will tend to increase carbon sequestration and have reduced greenhouse gas emissions relative to their degraded state. Reversal of human induced emissions cause by drying could then deliver an emission avoidance benefit. This should be carefully considered in future research and commercialisation activities.

4.6 Summary of project level accounting issues and way forward

What is clear from the review of project level accounting of emissions there are several potential methodologies that could be applied under the Carbon Farming Initiative. The most prospective for use to attempt to create carbon credits would be the “Quantifying carbon sequestration by permanent native mixed species environmental or mallee plantings using the Full Carbon Accounting Model”. In general, all of the applicability conditions of the methodology could be met by the project.

It is currently unclear as to exactly how a project could be put up under the methodology, given current political uncertainty relating to proposed changes to the CFI legislation currently proposed.

It is clear that alongside the use of a CFI methodology to earn carbon credits, a broader assessment of the whole of ecosystem effects of improved hydrological conditions and rehabilitated environmental conditions should lead to further emissions avoidance and carbon sequestration. The recently released international guidance on emissions accounting for wetlands should be implemented to develop more detailed understanding of the importance of the CLLMM project to ecosystem carbon accounting.

5. Project development costs and possible returns

General context

It is important to note at the outset of this section of the report that the carbon credits that can be awarded to project proponents as considered by the previous section, Australian Carbon Credit Units (ACCUs) are deemed to be financial products. This means activities relating to these units are regulated by the Australian Securities & Investment Commission (ASIC). A concise description of the nature of these units is available here (http://www.cleanenergyregulator.gov.au/ANREU/Concise-description-of-units/Australian-carbon-credit-units/Pages/default.aspx). Advising, dealing, arranging or brokering services in relation to these units generally requires the party providing the services to hold an Australian Financial Services Licence. More details on carbon trading and financial services law can be found at the ASIC website (http://www.asic.gov.au/asic/ASIC.NSF/byHeadline/ASICs_role_in_carbon_markets). That background information is provided to ensure that parties interested in further development in this arena are aware of the regulatory environment.

To provide a full cost of development and cash flow forecast based on expected revenue from carbon credit sales can only be done in a general fashion regarding the "whole of the Lakes Alexandrina, Albert and Coorong wetlands or the River Murray Restoration in general" project. To provide further detail at the scale of an individual property may be misconstrued by private landholders as advice on whether or not to participate in a scheme. The work here, as identified by the report disclaimer, is general in nature and the findings are not specifically applicable to any individual circumstance.

Development and implementation costs versus possible revenue

A range of costs will be incurred through the development of a project seeking to crystallise value associated with carbon sequestration in vegetation delivered by the Riverine Restoration project. Taking the outcomes of the carbon sequestration modelling (section 3) and methodology & policy assessment (Section 4), this project forms the position that the "Quantifying carbon sequestration by permanent native mixed species environmental or mallee plantings using the Full Carbon Accounting Model" presents the optimal balance of cost effective development and reasonable volumes of credit issuance.

The following assessment looks at the cost of development of a CFI project under this methodology, and provides a rough estimate of cost: benefit ratio of development.

Assumptions

- Project reports once every four years on average over a 15 year crediting period
- Total volume of credits sold 190,000
- All eligible forest areas included in CFI project
- Costs and revenue are not indexed in these calculations
- Flat carbon price of $15/ACCU
- 10% of issued credits are withheld from sale: 5% by the Australian Government and 5% by the project owner as self-insurance against loss events (retained as an asset but not valued in this simple assessment)
- No cash flow viability assessment has been undertaken
- No sensitivity assessment has been undertaken on key cost variables
- No optimisation testing of frequency of credit issuance has been tested

- No key economic performance indicators have been tested (e.g. ROI, NPV etc. all require cash flow forecast to be developed)
- No consideration of tax or GST implications are given here
- Assumes carbon sequestration derived ACCUs can be sold during modelled period of 2015-2030.
- Assumes no subsequent crediting period (although modelling suggests additional 100,00 ACCCUs could be earned from 2030 to 2040)

Table 4 Estimated project costs and revenue, derived using stated assumptions

Costs items	**Estimated cost (current value)**	**When incurred**
Initial project design	$35,000	Once off, development 2014
Landholder negotiation	$35,000	Once off, development 2014
Registration of project (inc legals)	$25,000	Once off, development 2014
Mapping, data acquisition & project report template development	$25,000	Once off, development 2014
Reporting at issuance	$40,000	At issuance (e.g. four times in project lifetime)
Audit and verification	$40,000	At issuance (e.g. four times in project lifetime)
Brokerage & marketing	10% of trade value	At issuance (e.g. four times in project lifetime)
Landholder biodiversity incentive	$250,000 between all landholders	At issuance (e.g. four times in project lifetime)
Estimated total project costs	On the order of around $1,800,000 over project lifetime (relatively fixed)	
Revenue	**Volume**	**When achieved**
Carbon credit sales	297,000	Four times in project lifetime
Estimated project revenue	On the order of around $4,300,000 over project lifetime (subject to potential volatility from carbon price)	

As can be seen, at the coarse level of economic evaluation applied here, the project looks to be able to produce more revenue that incurred costs over its lifetime, if all of the assumptions hold true. Of course the project viability needs more detailed investigation, including sensitivity testing, cash flow analysis, testing of willingness of landholders to participate in return for biodiversity incentive payments. There also appears to be a small annual cash benefit of the project, which could be used for further regional biodiversity enhancement and ongoing contribution to Riverine Restoration activities.

The opportunity will be negatively impacted by lower carbon prices than the value used in the assessment, and positively impacted by higher carbon prices. A limited sensitivity test of carbon price yields the results seen in Table 5.

Table 5. Results of limited carbon price sensitivity testing on project revenue

Carbon price start	Indexation	Total revenue (2015-2030)
$12/ACCU	0	$2m
$15/ACCU	0	$2.5m
$18/ACCU	0	$3m
$12/ACCU	+5%/annum	$2.3m
$15/ACCU	+5%/annum	$2.9m
$18/ACCU	+5%/annum	$3.5m

The potential project revenue appears to have the potential to exceed costs where the carbon price is in excess of $12/ACCU. There are some significant potential risks that need to be further considered, and it's important to recognise that real effort would need to be made to achieve this outcome. This does not indicate profitability of project, nor does the examination give consideration to how any "excess revenue" could be allocated. Subsequent credit earnings in the years 2030-2040 have been discounted to zero in this analysis. If the credits could be earned between 2030 and 2040, this would have a substantial influence on project economic viability, especially if fixed costs remained relatively constant.

The project evaluation here suggests landholder biodiversity incentive payments to maintain the plantings on the order of $1m over the course of the project to 2030. This could be used by landholders to further improve environmental conditions on lands under their management, and represents new investment from an innovative market based instrument. Any revenue in excess of costs could be further directed to ongoing environmental improvements & associated economic development in the region. This would be especially true if the Natural Resources SA Murray-Darling Basin was the project owner, and was able to ensure revenue in excess of costs was returned to important environmental initiatives, and revenues were not directed entirely to private interests or directed to general revenue for the State.

It is assumed that project costs are relatively fixed, and so the greater the number of landholders that participate, the lower the unit costs of production. Lower numbers of participating landholders will reduce project viability. The project "break-even" costs and minimum scale of operation need to be evaluated in more detail. However, even given the risks and effort required to develop this as a pilot project, the opportunity to leverage further investment into the region to support the long-term goals of the rehabilitation plan is seen to be worthy of more detailed investigation. A possible public-private partnership model is considered at Appendix 2.

6. Analysis of Direct Action and Emission Reduction Fund: barriers and opportunity

Given that the Australian Government is proposing some significant changes to the structure of how carbon credits can be produced and potential markets for those credits in Australia, it's important to review the proposed policy environment. This simple summary of proposed changes included in the Carbon Credits (Carbon Farming Initiative) Amendment Bill 2014 and Emission Reduction Fund White Paper.

Backdating

If a project was developed after 1 July 2007 and there is documentary evidence that it was developed for an emission reduction purpose, it may be eligible to enter the CFI scheme. If the project applies a methodology that had a methodology determination before 30 June 2013, it can apply for credits to be backdated to 1 July 2010. The implication is that, all other applicability conditions being met, a project could apply the environmental plantings methodology and be backdated for all vegetation growth back to 1 July 2010.

Implication: the Environmental Planting methodology could be applied by the project and apply for credits to be issued for backdated growth since 1 July 2010. However, given the very limited volume of credits that the methodology would provide the project in the time period from 2010-2014/15, this is not seen as important for a long term project.

Grandfathering old rules & transfer to new methodologies

For projects that are seeking to enter the scheme, they can apply a methodology that had a determination developed prior to the amendments proposed to the CFI. The rules in existence at the start of the project will continue to apply to the project, rather than new scheme rules. For a transitional period until 1 July 2015, applications for project registration can be made under the eligibility rules and methods which are in place prior to the start of the Emissions Reduction Fund (when the ERF becomes law). This means the "common practice test" as applied to the CLLMM projects would still be eligible to enter the scheme.

"Existing projects" will be able to use new methods that apply to their project in the future. Applying a new method will not change the approved project's crediting period or other aspects of the project registration, if the project was in place before the legislation changed.

If a project is registered after the ERF legislation comes into effect, then it is only eligible for a 15 year crediting period, with a 25 year permanence obligation instead of the current 100 years. With the reduced permanence obligations comes a reduction in the number of credits the project will be issued: a 20% reduction in total credit production will be issued to the project owner.

Implication: The "old" environmental plantings methodology could be used to establish the project. The project could then "switch" to the new "improved environmental plantings" methodology with the higher crediting rate. If the project is established prior to the ERF legislation coming into effect, it will have a 100 year permanence obligation, two 15 year crediting periods and credits will be issued at 95% of model forecast.

If the project is registered after the ERF legislation comes into effect, it can nominate for 100 year permanence, a single crediting period of 15 years and 95% crediting of model forecast, or a 25 year permanence period, a single crediting period of 15 years and 80% crediting of model forecast.

Crediting

It is proposed that new projects are only able to earn credits for a single 15 year crediting period.

Implication: projects in the future, once the legislation changes, will only have 15 years to recoup capital and operating costs of revegetation, requiring a higher carbon price than they would under current arrangements with a potential 30 year crediting lifetime.

New activities

The amended CFI legislation requires that all activities to be “new” and to have not occurred prior to the start of the scheme. This would mean that if projects are not established over CLLMM plantings prior to end of June 2015, any plantings in place prior to that date cannot earn carbon credits.

Not occurring as a result of another Government scheme

The new additionally rules require that the activity proposed to earn credits cannot have occurred as a result of another government program. How this is interpreted with regard to investment by Government programs that are seeking to drive environmental improvement development of ecosystem function is currently unclear.

Purchasing credits by ERF

The ERF is proposing to develop a five year contract offtake agreement with carbon project owners. The project owners would have a single shot bid (or tender) to win an offtake contracts from the Government. There is limited transparency about pricing with the proposed arrangement. Carbon sequestration projects may not be able to secure contracts from the Government if they cannot compete on a “lowest cost” base with energy efficiency projects. It is difficult to assess what the ERF clearing price will be in advance, although the Government may announce an “upper limit” price in advance of the first call to tender.

While carbon prices in an emission trading scheme may be subject to some volatility, a cap on total emissions will inevitably create scarcity for carbon credits, in turn driving credit prices up. The proposed arrangements under the ERF remove the cap on emissions, which means credits are simply worth “what a buyer is prepared to pay” and the creation of a buyers’ market.

Complexity and the CLLMM project falling between the cracks

As described, there is a limited window of opportunity to take advantage of the current arrangements that enable 30 year crediting periods for carbon sequestration projects.

The simple implication of the above issues are summarised here.

1) The Australian Government is proposing to reduce the “permanence obligations” on a carbon sequestration project to 25 years from 100 to remove a perceived barrier to participation. This is probably not a major issue for the CLLMM project, as land owners probably would be pleased to have the biodiverse revegetation in place “permanently”. This rule change is likely to benefit monoculture forestry plantations that can drive multiple revenue streams rather than biodiversity plantings that have only carbon markets as potential revenue stream.
2) The reduction of crediting periods to 25 years from 30 years limits the potential to secure credits that would enable capital development and operations costs to be recouped from a biodiverse revegetation project. This is a significantly negative change with regards to commercialising the CLLMM project to drive revenue for future management and development.
3) Currently there is no other alternative way to generate carbon revenue from the ecosystem services provided by the CLLMM plantings. If no project is registered, the Australian Government will claim the full value of the carbon sequestration, and count that towards Australia meeting its international commitment. This provides a free subsidy for all other emitters of greenhouse gases in Australia, by reducing the cost and effort required to meet greenhouse gas obligations. This means there are significant public and broad private benefits at the expense of private landholders who have provided the service.

Opportunity

While there are obvious barriers to participation in the CFI and there may be challenges to crystallising value associated with carbon sequestration, this project has identified some important valuation points.

First, the current and planned project plantings are expected to sequester close to 300,000 tonnes of carbon dioxide equivalent to 2040. This is roughly equal to taking 90,000 cars off the road in Australia for a whole year.

Second, the project assessment has only looked at the carbon sequestration potential of plantings. The new IPCC guidance will provide the project with the opportunity to quantify the emission avoidance and carbon sequestration associated with reinstating environmental flow characteristics. This provides the CLLMM project team with the opportunity to be the global leader, and the first Ramsar wetland to quantify the emissions reduction benefits associated with large-scale environmental rehabilitation.

Third, the ecosystem improvements in terms of biodiversity, improvements in regional agricultural and horticultural productivity (especially for food and fibre production, as well as wine) along with local community development and engagement actually create a compelling case for sale of not just “carbon” but a suite of associated benefits. It may be that the development of a broader marketing strategy that pulls together the “carbon, biodiversity, food, fibre, wine and community engagement” elements of the program would add significantly to the value of any carbon credits produced, for the right type of buyer. This could be part of a broader integrated offering, where the carbon credit sales are associated with local produce. Carbon neutral produce could provide a strong marketing advantage to niche products coming from a “clean and green” region. This is considered in more detail in Appendix 2. This could mean that there is an option to not require the Australian Government to be the primary buyer of credits from the project, but that they could be sold to other voluntary buyers with some form of association with the region. The product differentiators for credits that could flow from the CLLMM project are significant, and offer the opportunity to leverage significantly higher than "market" prices to the right buyer. This would need to be part of a broader, integrated marketing strategy. It may also require a "subjective" approach to market pricing.

The valuation of the "biodiverse carbon" could be valued in another innovative and quantitative way. It is well known that an area of monoculture forest, such as Tasmanian Blue Gum or *Pinus radiata*, would be much more effective in sequestering carbon than an equivalent area of native species/biodiverse planting. One possible way to "value" the biodiverse carbon is to compare carbon sequestration rates side by side of a monoculture and a biodiverse planting.

For example, a monoculture may produce 100 tCO_2e/ha over time. Over the same amount of time at the same location, a biodiverse planting may only produce 60tCO_2e/ha. To achieve the same "total dollar value per hectare", the biodiverse planting needs 1.6 (or 100/60) times the carbon price a monoculture could achieve for the values to be equal per hectare. This could be the "biodiverse carbon" value. Say the monoculture carbon sold for \$15/tCO_2e, a hectare would be worth \$1,500 over time. The biodiverse carbon would need to be sold at (1.6*\$15/tCO_2e) or \$25tCO_2e to achieve the same value per hectare.

7. Project appraisal, summary and recommendations

The project aimed to deliver a project with results that were

- relevant,
- complete,
- consistent,
- transparent,
- accurate, and
- conservative.

Did it achieve these aims?

With regards to the relevant sinks and sources of emissions that could be quantified, the project was reasonably relevant. It did not undertake assessment of emissions from stock or fertiliser that may have changed as a result of changed management, although it could be reasonably assumed that stocking rates and fertiliser application rates would not have changed appreciably in the project areas. The project did not have the scope to apply all of the new sink-source equations for wetlands that the 2013 IPCC Wetlands guidance would require. Aside from this major exception, the project applied relevant data.

The project was incomplete owing to the project scope being limited to just carbon sequestration. It did not take into account emission sink/source as the IPCC now require. This is a limitation. The project gave detailed and complete accounting assessment of the carbon sequestration of the major vegetation associations planted. Therefore, with regards to carbon sequestration, the project reporting and analysis was reasonably complete.

The project applied the same assumptions sets to all analyses and so can be seen to be consistent. Accounting consistency is important for time-series accounting in particular, however this project represents a single snap-shot in time. However, for the data tested, the treatment can be seen to be consistent.

In terms of transparency, all modelling tools applied were taken from public sources, and using the stated assumptions, other users will reach the same conclusions as those reported here.

In terms of accuracy of outcomes, the data have not been third party validated. Care was taken during analysis and interpretation, and data were recorded in excel spreadsheets. These have been supplied with project reporting that would enable testing of accuracy of findings.

Finally, the findings are expected to be conservative (i.e. erring in favour of lower forecasts and expectations of whether or not a "forest" would result from the plantings.

What is immediately clear from this report is that the amount of carbon sequestered is of meaningful significance. At a total estimated carbon sequestration volume of around 300,000 tCO2e by 2040, the project would is doing the equivalent of removing almost 90,000 cars from the road for an entire year.

Assuming that there are 220,000 cars passing through the Adelaide CBD every day (Infraplan 2014), this would be the environmental equivalent of almost halving the total number of cars in the city for a year. Any way you look at it, it's a significant number. At the current prices of around $24tCO2e (prior to the rolling back of the Carbon Price Mechanism) those credits would be valued at around $7million dollars. That's a public return on investment made to deliver the project, with the majority of vegetation occurring on private lands.

Maintaining the biodiversity value of the works will inevitably require longer term operational and capital investment. The carbon markets should be much more carefully examined in future iterations of the regional natural resource management plan to ensure that environmental market based opportunities can be capitalised on to contribute towards future environmental improvement.

The project has identified that there is now an internationally relevant approach to estimating emissions from wetlands, as they vary with different management interventions. This internationally relevant approach is an approach that needs to be adopted in each State by the agencies that report State level emissions to the Federal Government. In this case, DEWNR needs to take the lead in adopting the new standard for reporting on emissions from changed hydrology.

While it was beyond the scope of this project to deploy the new internationally applied wetland carbon accounting rules, the general proposition is that returning the natural hydrological cycle will lead to reduced greenhouse gas emissions and increased carbon sequestration rates.

Undertaking assessment using the relevant guidance will allow the future iterations of regional natural resource management plan to quantify in more detail the economic values associated with ecosystem service values of environmental water flows. In this way, it will possible to develop a "book of accounts" that balances the cost of investment against the public return on investment that accrues from improved ecosystem services and function.

This kind of valuation may come from activities such as weir pool water level raising and lowering, and the broader wetting and drying of wetlands and floodplains associated with the Riverine Recovery Project. Likely environmental and ecosystem function and service benefits will probably come from improved fish stocks, biodiversity enhancement, protection of riverbank property assets and avoidance of costs from negative impacts such as acid sulphate dust impacting asset values. Other projects that use biomass fuel grown in the region could produce "carbon neutral" fuel sources, or soil carbon additions that can drive enhanced agricultural productivity as well as carbon sequestration.

Another project that needs to be considered as a potential significant carbon sequestration opportunity will come from the re-wetting of the Pike and Katfish Reach flood plains. There is significant potential to collaborate with other landholders in this region to see the enhanced and reinstated natural hydrological cycle leading to massive increases in carbon sequestration through enhanced River Red Gum recruitment.

It is recommended that in the future, the research findings of Sullivan et al. 2013 should be used in conjunction with the estimation methods for aquatic ecosystem carbon accounting provided by 2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands (2013) and Verified Carbon Standard Methodology for Coastal Wetland Creation (2014) to determine greenhouse gas emission reductions and carbon stock change for other vegetation types. This is important to do, given the Australian Government would now be expected under international emission accounting protocols to start to apply the IPCC Guidance for aquatic and wetland accounting systems.

This study is important in that it has enabled the quantification of direct economic benefit of ecosystem services that are being delivered mostly on private lands as a result of public private partnerships and investment into environmental rehabilitation. Investigating more than just the one ecosystem service (carbon sequestration) directly quantified here will doubtless enable natural resource managers to provide better cost: benefit evaluations to base judgements on how to direct natural resource management in the future to deliver maximum benefit.

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Appendix 1. Evaluation of carbon storage in CLLMM project area technical report

Table of Contents

1. Introduction

The Coorong, Lower Lakes & Murray Mouth carbon storage and ecosystem valuation project required an analysis to be undertaken to determine the total area of vegetation planted out as part of the rehabilitation project to allow for valuation to be assessed. To do so required an assessment of what "category" the revegetation/reforestation could be assessed as, as described by relevant Carbon Credits (Carbon Farming Initiative) Act (C'wealth).

More significant details regarding the definition of key terms and terminology is given in the project report.

This short paper is provide as a guide to the contents of the Microsoft Excel spreadsheet document titled "Forest cover and carbon calculations 20140609.xls" as provided to DEWNR via email on 9th June 2014. This short paper should be read in conjunction with the spreadsheet.

This also includes a description of the methods used to undertake analysis to determine relative areas of each forest classification as required in the main report.

2. Purpose

The purpose of the data manipulation and analysis undertaken for the project was to determine the areas of each of the following vegetation classifications planted by the project as described in the main project report. This level of data breakdown was required to develop an understanding of likely carbon sequestration rates through time over the expected lifetime of vegetative growth.

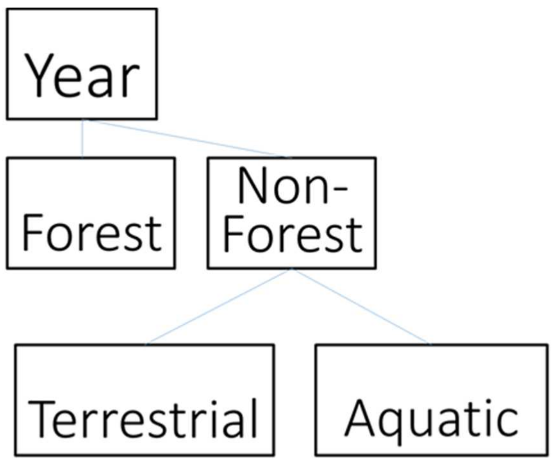

Figure 1 Forest type classification. Forest is classed as vegetation of an area greater than 0.1ha area, greater than 10m wide and has vegetation that should reach ≥ 2m height at maturity, with 60% canopy cover. Non-forest vegetation is not able to reach forest classification and is classed as "revegetation", either aquatic or terrestrial. All types have different relative rates of carbon sequestration.

3. Materials supplied

Data were supplied in electronic format. Files that were used in this analysis were:

4. Tabs

Along the bottom of the spreadsheet are a series of tabs.

They are:

- 2010
- 2011
- 2012
- 2013
- 2014
- Species list
- Database download
- Forest classification
- Area by years by type
- Carbon raw data
- Carbon calcs

The contents of each tab are described below.

5. "Year" tabs (2010-2014)

The year tabs all have the same forma of columns:

Site_Name

Uses the site name from the project plan reports

Species

Describes the species planted in the site of that name in that year

Zone

Describes the Zone in which the species described was planted

Num_Planted

Gives total number of individuals of species described in zone in site described in year described.

6. Species planted tab

The species planted tab has two columns:

Species planted

Gives the scientific name for the species planted

Stratum

Describes the general final growth form of the species planted that is either upper ("canopy forming") or lower (ground cover or low shrubs).

7. Database download

The database download tab contains information extracted from the GIS files supplied by the Project Manager. The principles products of interest that were taken from the GIS files were imported in the following columns:

Year

Refers to the year of planting, and refers to data in Tab ("year" e.g. 2010-2014).

Site_Name

Refers to the site name of the project report

Zone_no

Refers to the zone number planted referred to in project report and site detail in "year" tab

m2

gives the area of the specified zone in the site of the given year

8. Forest classification

The majority of analytic work and assessment in determining "forest classification type" (as per Figure 1) is represented in this tab.

The work required both subjective qualitative and quantitative assessment.

The data were taken from the "year" tab in the first instance, and information was presented in the same format as the "year" tab for

- Year
- Site name
- Zone

Project reports for each year for each site (as supplied) and species list tab data were used in a subjective qualitative and quantitative assessment to make a professional judgement on what the final configuration of the vegetation would take (as per Figure 1 descriptions).

This was a significantly time consuming exercise, and also represents a potential source of assessment error.

It is recommended that in the future and the recording of an additional data attribute (vegetation type- forest/non-forest-(aquatic/terrestrial)) should be undertaken at project planning/reporting stage.

Data were recorded as simple "presence/absence" with an "x". Given data were mutually exclusive (i.e. the vegetation condition could only be one of the options) this was considered adequate for analytical purposes.

The columns reflect the data breakdown as described in Figure 1:

- Forest
- Non-forest
- Terrestrial
- Aquatic

Additional data (area, in metres squared) were taken for each zone and vegetation type from the Database download tab for the relevant site/year/zone combination.

Metres squared was converted to hectares (ha).

9. Areas by year by type

The summed data for each category (year/forest-non-forest-(terrestrial/aquatic) are broken down in a table. These data were calculated by summing data for each category from the forest classification tab.

10. Carbon raw data

A Reforestation Modelling Tool (RMT) model run, using the "environmental plantings" data (current online database at 05/05/14: http://ncat.climatechange.gov.au/cfirefor/) was undertaken using a previously downloaded version of RMT software. To simplify the assessment a series of assumptions were made. They included:

1. Model Carbon Estimation Area (CEA) was based on a centroid of Meningie (35.6883° S, 139.3378° E).
2. Planting was defined as "direct planting of tube stock, low density of ≤800 stems/ha
3. Planting occurred over a 3 month period from June –Sept in year of development
4. No further treatments (e.g. follow up planting, weeding) were applied in the model run
5. It was assumed the land was clear of native vegetation at 31 December 1989
6. Plantings should be able to attain forest classification at maturity.

11. Carbon raw data

The total area of forest area planted (by year) were used as input, and five sequential years were run (2010-2014). RMT model outputs (as tonnes elemental carbon for total planted area by year) were taken directly from the RMT outputs monthly change data and recorded.

Year on year change was calculated as (sum all growth year X) minus (sum all growth year X-1) and so on. Data were recorded annually at September of model year (X).

12. Carbon calcs

Two carbon sequestration models were compared on this tab.

The first was the output of the RMT analysis (as described from 10 & 11 above).

The second was undertaken using the Microsoft Excel spreadsheet "carbon sequestration from revegetation estimator version 1 gen" (hereafter "the Hobbs model" downloaded from (http://www.environment.sa.gov.au/Science/Science_research/land-condition-sustainable-management/carbon-from-revegetation) on 1st May 2014.

Data were entered into the Hobbs model on the following basis:

Locality: Meningie, Hundred of Bonney (cleared agricultural lands).

Defaults accepted for soil types and planting types accepted.

25 year annual average sequestration rate forecast as 7.92 tCO_2e/ha.

The output of the two carbon models were both multiplied by 0.85 to obtain a credit issuance rate of 85% of predicted, providing a conservative model output.

Appendix 2. Potential commercialisation pathway for CLLMM

Provided separately given that the paper contains commercial in confidence material and material that needs to be read in context of provision of general advice to Government.