Rotunda Forest Carbon Project

Document Prepared by GreenRaise Consulting GmbH

Project Title	Rotunda Forest Carbon Project
Version	4.0
Date of Issue	29-January-2021 (revised 30-August-2021)
Prepared By	GreenRaise Consulting GmbH
Contact	1010 Vienna, Rudolfsplatz 9/8, Austria, Tel: +1 604 619 1585 Email: admin@green-raise.com Website: www.green-raise.com; www.globalforestsupport.com

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1. Project Details

1.1. Summary Description of Project

The objective of the carbon offset project is to achieve greenhouse gas (GHG) emission reductions and removals through the cessation of commercial harvesting. The project will implement the methodologies outlined with the Verified Carbon Standard (VCS) VM0012 – Improved Forest Management in Temperate and Boreal Forests (LtPF), v1.2.

The project is located on a freehold 1,556-hectare property within the Hunedoara County of Romania. Prior to the implementation of the project, the lands were managed under the forest management plan "Fondului Forestier Proprietate Privata Apartinand S.C. Rotunda S.R.L., Miercurea Ciuc".

Through the use of the Operational-Scale Carbon Budget Model of the Canadian Forest Sector (CBM-CFS3) - Version 1.2, carbon emission offsets will be calculated by comparing a project scenario of the cessation of commercial harvesting, to a baseline scenario. The most plausible baseline scenario consists of the continuation of allowable commercial harvesting for the next 100 years. Under the baseline scenario a harvest schedule is implemented with the typical regional practice of clearcut logging, patch cutting and comparable regional practices.

The project scenario will consist of conservation management activities, wherein SC Rotunda SRL (Rotunda) undertakes the carbon offset project and ecosystem protection. The project scenario will anticipate a low level of timber removal as part of conservation management activities for ecosystem/habitat enhancement and risk management. Under this project scenario it is anticipated that an average of 5,638 tonnes of carbon dioxide equivalent (tCO_2e) per year and ~169,128 tCO_2e total over the 30-year project period will be reduced from entering the atmosphere.

1.2. Sectoral Scope and Project Type

Sectoral Scope 14

Improved Forest Management (IFM)

Logged to Protected Forest (LtPF)

The Rotunda Forest Carbon Project is not a grouped project.

1.3. Project Eligibility

The Rotunda project meets the listed criteria for the VCS Improved Forest Management – Logged to Protected (IFM-LtPF) as defined in the VCS AFOLU Requirements v3.6 as well as the applicability condition as described within the VCS-VM0012:

1. The project meets the most recent approved criteria for VCS IMF-LtPF eligible projects:
    a. The project is protecting currently logged or degraded stands from further harvesting and,
    b. Is protecting unharvested forests that would otherwise be harvested.

2. The project is located in the Temperate Global Ecological Zone (as defined by Food and Agriculture Organization of the United Nations (FAO) (FAO, 2001), are forest lands remaining forest lands (as defined by IPCC (IPCC, 2003)), and which meet IPCC GPG LULUCF Tier III inventory and data requirements (IPCC, 2003).
3. The project meets the most current approved VCS Standard requirements for ownership, by being able to demonstrate Proof of Right of Right of Use ownership of carbon rights in accordance with VCS requirements:
   a. Rotunda – fee simple ownership of the land, title rights and carbon rights.
4. There are *de minimis* amounts of illegal, unplanned or fuelwood removals from the Rotunda property in the baseline scenario.
5. The project area does not encompass peatland forests as defined by IPCC GPG LULUCF.
6. The project area does not include wetlands.
7. There is no additional planned harvesting on other lands held by Rotunda. Activity shifting leakage will be monitored and reported on annually as required by VCS standards.
8. It is not planned to apply organic or inorganic fertilizer in the project scenario.

1.4. Project Design

The Rotunda Forest Carbon Project has been designed and will be implemented as a single activity project.

1.5. Project Proponent

Table 1: Project Proponent information

Organization name	SC Rotunda SRL
Contact person	Nikolaus Pongracz
Role in the project	Project Proponent, Listing Representative
Title	General Manager
Address	Bulevardul Timisorarei nr. 10, SPII/A, Miercurea Ciuc Harghita, Romania

Organization name	Global Forest Support GmbH
Role in the project	Project Proponent, Authorized Representative
Contact person	Jason Zimmermann
Title	Director
Address	1010 Vienna, Rudolfsplatz 9/8, Austria
Telephone	+ 1 604 619 1585
Email	jason@green-raise.com

1.6. Other Entities Involved in the Project

Table 2: Other entity information

Organization name	GreenRaise Consulting GmbH
Role in the project	Authorized Representative, Project Developer
Contact person	Jason Zimmermann
Title	Director
Address	1010 Vienna, Rudolfsplatz 9/8, Austria
Telephone	+ 1 604 619 1585
Email	jason@green-raise.com

1.7. Ownership

The freehold 1,556-hectare Rotunda property was established by virtue by Rotunda in 2007. Title documentation has been provided and verified by GreenRaise Consulting GmbH (GreenRaise).

1.8. Project Start Date

The project start date is January 1, 2018. As of January 1, 2018, S.C. Rotunda S.R.L. was issued a Forest Management Plan enabling the commencement of legal harvesting within the Rotunda estate. From January 1, 2018 – July 29, 2019 harvesting activities on the project property occurred in a minimal capacity and as of July 30, 2019, harvesting activities were ceased for the purpose of initiating a forest protection program (the Rotunda Forest Carbon Project).

1.9. Project Crediting Period

The project crediting period is from 01/01/2018 to 12/31/2047 with a total length of 30 years.

1.10. Project Scale and Estimated GHG Emission Reductions or Removals

Table 3: Project scale

Project Scale	
Project	X
Large project	

Table 4: Estimated GHG Emission reductions of removals.

Year	Estimated GHG emission reductions or removals (tCO_2e)
2018	2898
2019	346
2020	4414
2021	4458
2022	4680
2023	6068
2024	5190
2025	6375
2026	5594
2027	5700
2028	5798
2029	5891
2030	5976
2031	6052
2032	6119
2033	6184
2034	6248
2035	6308
2036	6348
2037	6410
2038	6174

2039	6177
2040	6182
2041	6188
2042	6201
2043	6212
2044	6219
2045	6229
2046	6240
2047	6250
Total estimated ERs	169,128
Total number of crediting years	30
Average annual ERs	5,638

1.11. Description of the Project Activity

The Rotunda Forest Carbon Project will create GHG emission reductions by avoiding the release of carbon associated with timber harvesting, road building and other forestry operations that would be expected to be carried out in the baseline (business-as-usual) scenario.

In contrast to the baseline scenario, the Rotunda Forest Carbon Project will retain and restore the land to conservation-based forests for the duration of the project. This will retain the carbon contained in the current and future forest biomass and avoid emissions from logging in the baseline scenario.

As a conservation based IFM project, there are no specific technologies, products, or services involved in the implementation of the project. Beyond the creation and sale of verified emissions reductions, the Rotunda Project will be primarily focused on property supervision and monitoring, conservation research and other conservation-based land management activities. A low level of ongoing forest management activity will be expected in the project scenario for conservation management purposes (hygiene cutting and planting where required) which will result in GHG emissions that will need to be accounted for in the carbon flow projections.

The project is not located within a jurisdiction covered by a jurisdictional REDD+ program.

1.12. Project Location

The Rotunda property is located in western Romania adjacent to the Retezat Mountains in Hunedoara County (Figure 1). The Rotunda property is a total area of 1,556 hectares comprised of non-contiguous parcels. The property is bounded by Lake Gura Apelor, state owned lands, private lands, public grazing properties and public forest lands. The property has been surveyed.

Geodetic coordinates for the extent of the project area are provided in Table 5.

Table 5: Geodetic Coordinates for the Project Area

Property	Extent Coordinates (WGS 1984 UTM Zone 34N)			
	North	South	East	West
Klopotiva	5025800 m	5021127 m	636902 m	631211 m
Pui	5048695 m	5045540 m	676638 m	675012 m

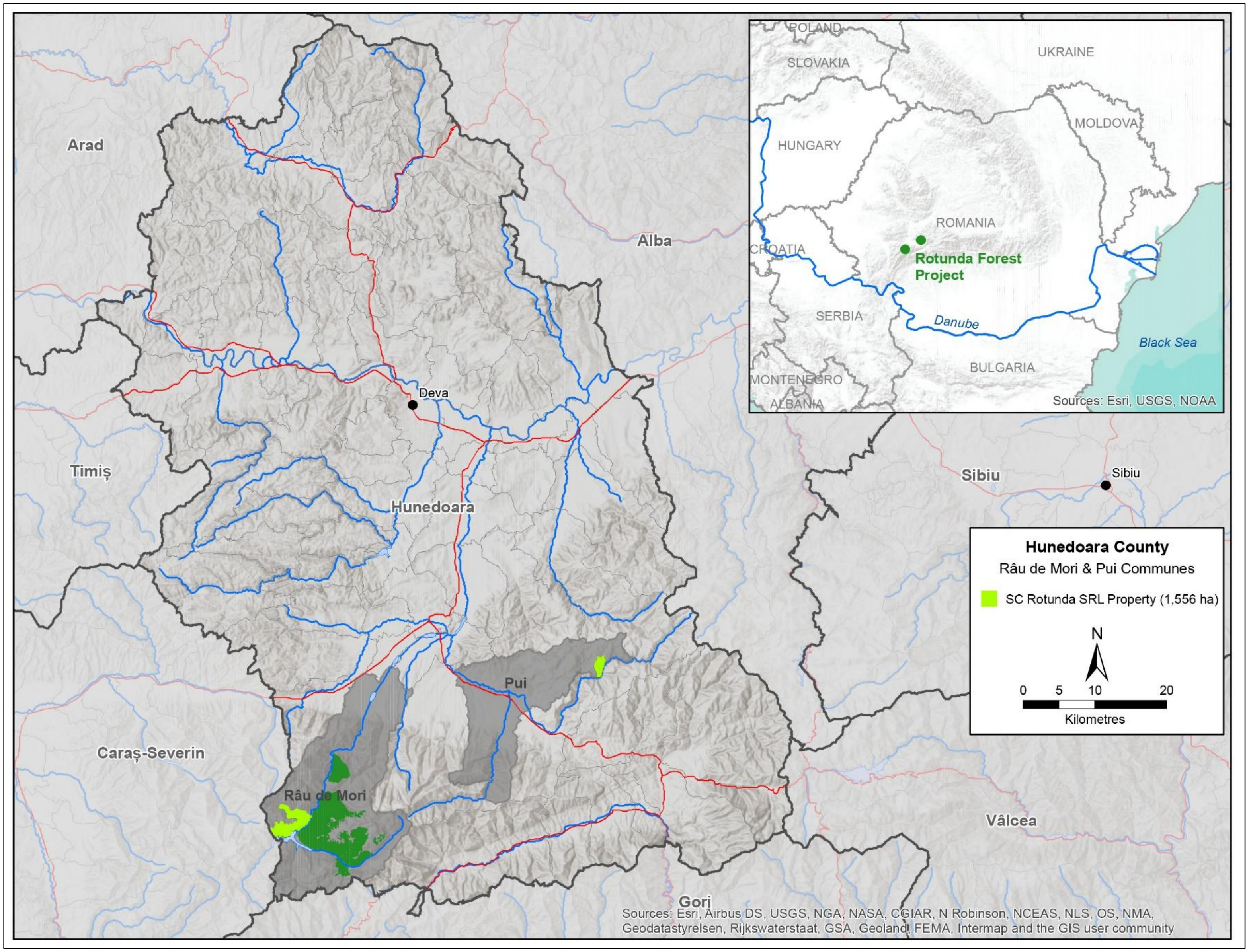

Figure 1: Overview location of SC Rotunda SRL estate (shown in green) and the Rotunda Forest Carbon Project (shown in light green).

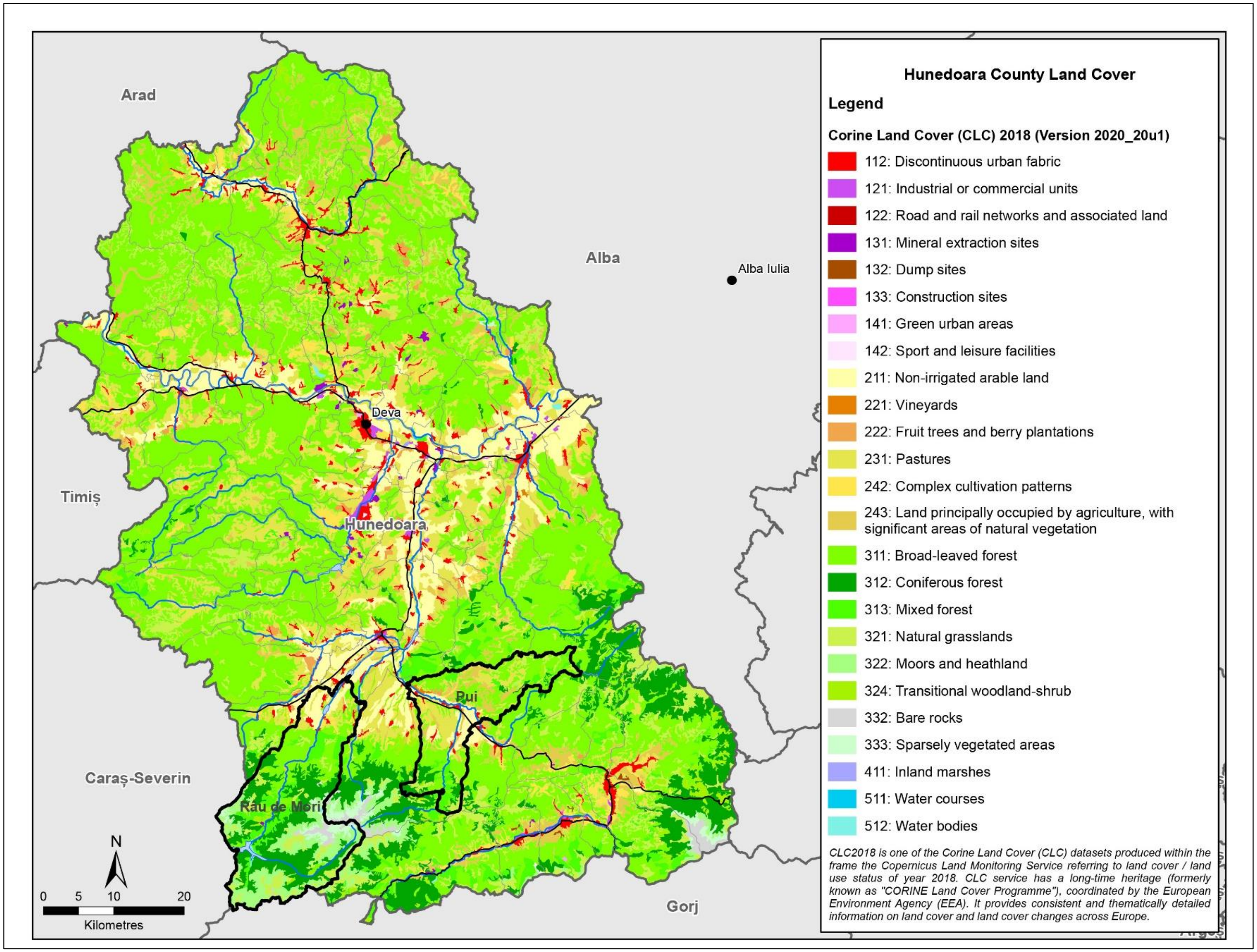

Figure 2: Landcover overview of Hunedoara County (location of Rotunda project).

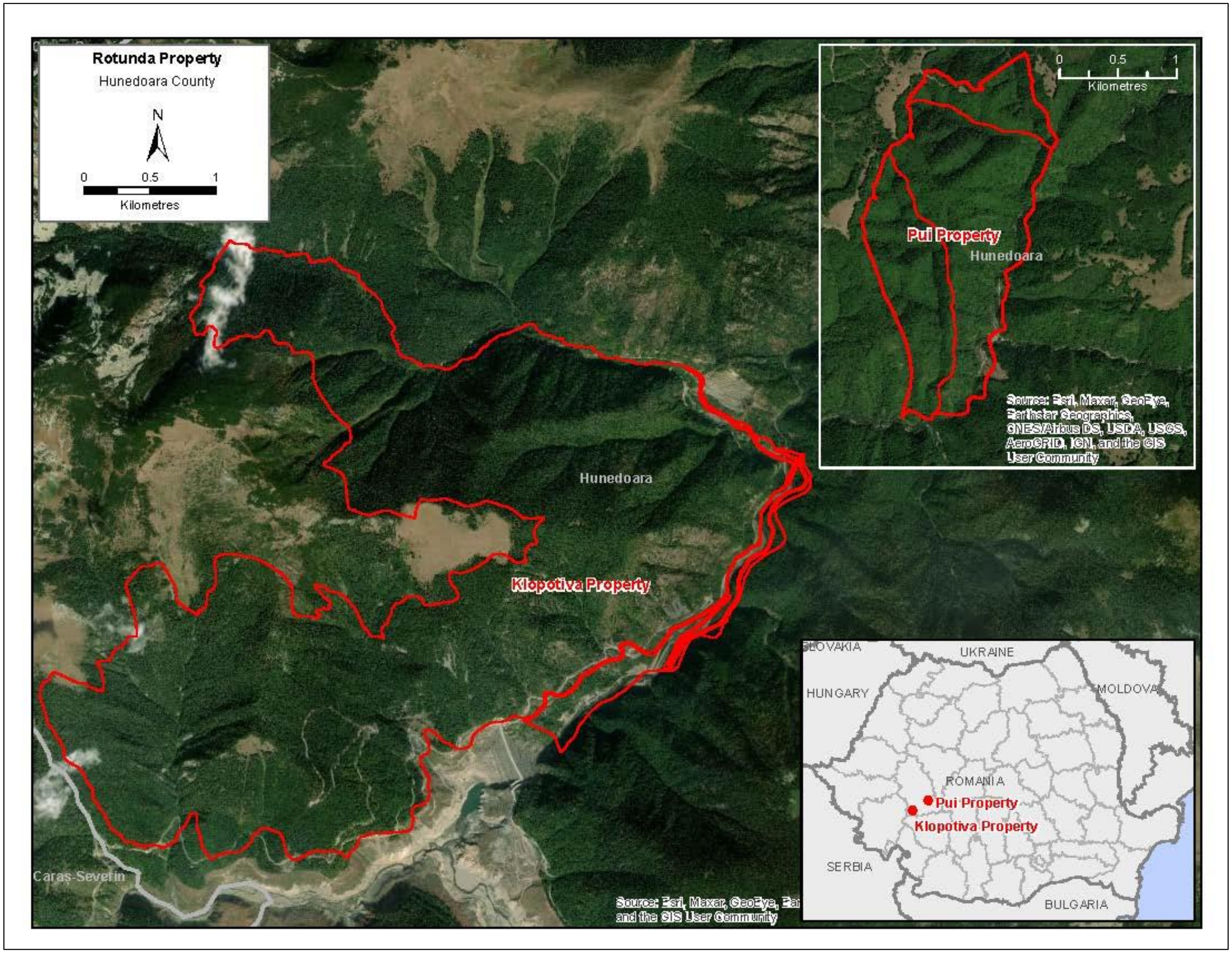

Figure 3: Detailed overview of Rotunda Forest Carbon Project property.

1.13. Conditions Prior to Project Initiation

The Rotunda property[1] has a diverse mix of forest types, topography, age class, and forest conditions well distributed across the land base (Figure 2). Approximately 50% of the property is considered operable for timber harvesting. The property has reasonable access with forestry roads, that provide access to 72% of the forestry fund and 59% of the harvestable property.

Climatic conditions in the project area are driven by continental and oceanic influences, as the project area contains depressional lands, hills, and mountains. The Transylvania depression and Southern Carpathian Mountains create complex topoclimates representative of the Haţeg Depression and the Retezat Mountains which support forest, mountain, and alpine meadow ecotypes.

According to the Köppen climate classification, the basic unit falls into the climatic following provinces:

- Dfbk - with a humid boreal climate and harsh winters, but with cool summers - corresponds to the range altitude 500 - 800 m asl;
- Dfk - with humid boreal climate and harsh winters, but with cooler summers than at Dfbk – corresponds altitude range 800 - 1000 m;
- Dfck '- with the coolest boreal climate - corresponds to the high mountain area.

Topographical characteristics of the Rotunda project result in pronounced climatic differentiations between lower elevations and the mountain meadows.

The average annual temperature in the project area is 4.6°c, with variations from 8°c in the depression area, to -2°c on high elevation peaks. The vertical thermal gradient is 0.4 - 0.5°c / 100 m. The absolute minimum temperature recorded was about - 30°c, and the maximum recorded temperature is approximately + 30°c. The first frost usually occurs in September and stops occurring in May. The annual average number of the days with frost is 170. The bioactive period lasts approximately 240 days with the average growing season is lasting 120 days. The average annual relative humidity is 80% and annual rainfall in the area is 981 mm per year.

The project area is predominantly subject to north and west winds. Western winds usually bring moisture-laden ocean air masses. Wind speed increases with altitude, from 2-3 m/s at the base of the mountains, up to 10 - 11 m/s per hill. Wind damage is common in pure conifer stands, single species stands with unified vertical structures, stands with large diameter trees, trees affected by rot, following periods of excessive rain, soils with reduced physiological thickness, and during periods of high snow accumulation in tree crowns.

Several soil types have been identified in the project area, with Dystric cambisols being dominant. Dystric cambisols (brown acid soils) are formed on slope deposits with parent materials that include medium and fine textured acidic rocks and CaCo free sedimentary rocks. Cambisols will contain the beginning of horizon differentiation in the subsoil, resulting from changes in structure, and clay or carbonate content.

The project area is located within the temperate continental FAO ecological zone within Romania. The existing forest stands are spruce (*Picea abies)* dominant with beech (*Fagus sylvatica)*, birch (*Betula pendula)*, silver fir (*Abies alba)*, and sycamore maple (*Acer pseudoplantanus).*

[1] Reference for all described characteristics of the Rotunda property is SC Rotunda SRL 2018.

Prior to the Rotunda Forest Carbon Project, the property has a forest management plan in place that allows harvest on 748 hectares of forest lands. The plan prescribed harvests at intervals of 40-40-30 years for a total rotation of 110 years. The total volume allocated for harvest equates to:

1. 2,310 m^3/year of primary wood cuttings in small patch cuts,
2. 561 m^3/year of secondary wood products (thinning)
3. 2,994 m^3/year of select conservation cuttings, maximum of 10% of standing volume.
4. 581 m^3/year hygiene cuttings (these will continue to occur throughout the project)

To date, minimal harvesting under the current forest management plan has occurred.

1.14. Compliance with Laws, Statutes and Other Regulatory Frameworks

Rotunda obtained the legal right to harvest within Harghita county following the transfer of landownership under Law no. 1/2000 for Kenedeffy owners Maria and Pongracz Elisabeta, according to the Property Titles no. 90878/646 page 1-3 from 0.6.12.2006, 90538/901 of 06.12.2006 and 90878/647 of 06.12.2006. The transfer of title was completed by the County Commission for establishment of the property right on Hunedoara lands.

Prior to any timber harvesting, the contractor or landowner is required to obtain a harvesting permit from the forest district. The guidelines for timber harvesting are further outlined in the Forest Code and the Ministerial Order 1540/2011 on harvesting rules. Additionally, the following are required to initiate harvesting practices within Romania:

- Harvesting Certificate
- Harvesting Permit
- Volume Estimation Document
- Environmental Permit
- Approval from the National Park Administrator
- Approval from the Natura 2000 Site Custodian

These requirements have been fulfilled and described as part of the SC Rotunda Forest Management Plan development. In Romania, a Forest Management Plan is required for all harvesting areas larger than 10 hectares, as described in the Forest Code. Each forest management plan contains a harvesting plan and a forest tending plan for pre-commercial and commercial thinning. Permits to harvest from forests are issued to the harvesting company, SC Rotunda, based on the timber inventory within the management area and an estimation of the volume within the Volume Estimation Document. SC Rotunda has successfully completed all requirements to obtain a legal harvesting permit via the submission of their Forest Management Plan and are therefore legally permitted to complete forest management practices within the proposed project area.

1.15. Participation under Other GHG Programs

1.15.1 Projects Registered (or seeking registration) under Other GHG Program(s)

This project (in whole or in part) is not registered (or seeking registration) under other GHG Programs.

1.15.2 Projects Rejected by Other GHG Programs

1.16. This project (in whole or in part) has not been rejected by other GHG Programs Other Forms of Credit

No other Forms of Credits are associated with this project.

1.16.1 Emissions Trading Programs and Other Binding Limits

This project (in whole or in part) is not associated with other emissions trading programs or other binding limits.

1.16.2 Other Forms of Environmental Credit

This project (in whole or in part) is not associated with other forms of environmental credits.

1.17. Additional Information Relevant to the Project

Leakage Management

Activity Shifting Leakage Monitoring

Rotunda will provide evidence that no alternative harvesting operations have been initiated to compensate for losses incurred during the carbon project. Such evidence may include financial statements to show that no additional land acquisition with the intent of harvest has occurred.

Market Shifting Leakage Monitoring

Rotunda will report market leakage following VCS Option 3, where the project proponent will re-evaluate market leakage data and calculations at each validation period.

Commercially Sensitive Information

None of the contents this PDD are considered confidential. However, elements of the reference materials and supplement evidence materials, including financial modeling, information and business plans provided to validators and verifiers outside this PDD document are confidential, unless otherwise indicated. Other confidential information may be identified during validation or verifications.

Sustainable Development

Implementation of the Rotunda Forest Carbon Project contributes to Sustainable Development Goal 1.4 Conservation and Management of Natural Resources, (d) to preserve biodiversity and the natural heritage by supporting the management of protected areas, including the implementation of the Natura 2000 Network (Gov. of Romania 2008).

Further Information

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2. Safeguards

2.1. No Net Harm

There are no known or anticipated potential negative and socio-economic impacts related to the Rotunda Forest Carbon Project, specifically due to the nature of the project being the retention of natural forests. Following the procedures described within the GreenRaise, Greenhouse Gas – Safeguards Standard Operating Procedure (SOP) a Life Cycle and Aspects analysis was conducted. Refer to Section 2.5 below for a full description of this process.

2.2. Local Stakeholder Consultation

Local stakeholder consultation was conducted for a 30-day period from November 20, 2020 and December 20, 2020, prior to project validation. Consultation was conducted both via electronic documents delivered by email, as well as an in-person meeting held on November 23, 2020 at the office of the Ocolul Silvic Retezatul Clopotiva Râu de Mori forestry District. The meeting was chaired by Nikolaus Pongracz of SC Rotunda SRL. Attendance was taken at local stakeholder meetings and is kept on file. Stakeholder Information relating to the project design and implementation, results of monitoring, any risks, costs or benefits to local stakeholders, all relevant law and regulations covering workers' rights in Romania, and the validation and verification process was provided via the GreenRaise website (https://green-raise.com/projects/). Links to the Verra Project Registry are also provided on the GreenRaise website. If required throughout the life of the project, any additional information that is required to be communicated to local stakeholders will follow the same process of electronic correspondence via email and information provided via the GreenRaise website.

An online form was made available on the GreenRaise website and was used to collect stakeholder comments and feedback. All responses from this form were automatically entered into a Consultation Database managed by GreenRaise. This form will remain accessible to the public throughout the lifetime of the project, allowing for continual stakeholder engagement.

All public comments received through the online comment form were recorded within the Consultation Database. Response, and any required project design updates to the project design relating to comments received from Stakeholders were also tracked within the Consultation Database. The Consultation Database will be made available to the VVB during project Validation and Verification. Refer to the GreenRaise GHG - Safeguards SOP for additional details relating to Stakeholder consultation processes.

To date, no comments have been received through the local stakeholder consultation process.

2.3. Environmental Impact

No applicable. An Environmental Impact Assessment was not required for the Rotunda Forest Carbon project.

2.4. Public Comments

The Rotunda Forest Carbon Project Listing Project Description Document (V1.0) was listed on the Verra Project Registry on December 15, 2020. Public consultation was conducted through Verra for 30 days following the listing.

No public comments during the Verra consultation period were received.

2.5. AFOLU-Specific Safeguards

Refer to the GreenRaise GHG – Safeguards SOP for details relating to the process used to determine local stakeholder identification. Additionally, the SOP outlines the Life Cycle and Aspect Analyses used to determined risks to local stakeholders and their resources.

Table 6 below outlines the identified aspects, impacts, potential risks, risk category (based on Table 1 within the GHG-Safeguards SOP), risk ranking (based on the Risk Ranking Matrix within the GHG – Safeguards SOP) and mitigation measures applied (if any).

Grievance Redress Procedure

GreenRaise has developed a Grievance Redress procedure which is outlined within the GHG – Safeguards SOP. Similar to the process for Stakeholder Consultation, the Grievance Procedures as well as a Grievance Submission Form are posted on the GreenRaise website (https://green-raise.com/projects/). All grievances submitted to GreenRaise will be tracked utilizing the Grievance Record Database.

Table 6: Aspects Analysis Results

Activity	Aspect	Impact	Potential Risk to local Stakeholders	Risk Category	Risk Rating and Justification	Mitigation Measures (implemented by project proponent)
Halting/ reduction of harvesting activities: Reduced Impact Logging (RIL), Logged to Protected Forest (LtPF), Extended Rotation Age / Cutting Cycle (ERA)	Reduced/ no requirement for harvesting labour	Loss of income/ livelihood	Loss of income to local communities could result in the degradation of local communities (i.e., reduction in community resources, loss of community members due to moving, etc.).	Social/ Socio economic	**Low** – Baseline harvest is low volume of timber; labour requirements are minimal.	Mitigation Measures are not required risks being designated as “Low Risk”.
	Reduction/ no requirement for energy (fuel) consumption	Loss of income/ livelihood	Loss of income to local economy due to reduced need for fuel.	Social/ Socio economic	**Low** – Baseline harvest is low volume of timber; fuel requirements are minimal	
	Reduction of fuelwood produced	Loss of wood for heating/ fuel purposes	Loss of access to fuel source for home heating	Social/ Socio economic	**Low** – Continued hygiene harvests are intended to produce fuel wood for local communities.	
	Public Access reduced or denied	Public recreation opportunities reduced or denied	Increase in illegal trespass instances. Reduced public health (mental and	Social/ Socio economic Traditional/ Human Rights	**Low** – Public access will not be reduced in project scenario	

Activity	Aspect	Impact	Potential Risk to local Stakeholders	Risk Category	Risk Rating and Justification	Mitigation Measures (implemented by project proponent)
			physical) due to reduced access to recreation			
		Public access for foraging/ hunting purposes reduced or denied	Increase in illegal trespass instances. Reduced access to food sources		**Low** – Public access will not be reduced in project scenario	
	Reduction in harvesting/ controlled burns for purposes of fire prevention	Increase risk of forest fire	Local communities exposed to higher risk of forest fire.	Environmental	**Low** – Rotunda Forest Carbon Project area is not located near local communities.	
	Complete termination of project area maintenance	Road failure	Increased landslide risk to local communities. Watershed/ water quality degradation due to landslides and lack of sediment control.	Environmental	**Low** – Rotunda will continue maintenance of the project area (i.e., completing hygiene cuttings)	
		Pest or Disease Outbreak	Spread of disease to local community forests. Watershed/ water quality degradation due to transition to	Environmental		

Activity	Aspect	Impact	Potential Risk to local Stakeholders	Risk Category	Risk Rating and Justification	Mitigation Measures (implemented by project proponent)
			low productivity stands			
		Public safety	Increase in accident or injury within project area accessible to public	Social/ Socio - economic		
	Property rights are undefined/ disputed	Loss of property rights	Project encroaches on private property Project encroaches on government property Project relocates people off their lands	Legal Social/ Socio economic	**Low** – Rotunda property rights have been verified and are not disputed	Additional measures: refer to *Respect for Local Stakeholder Resources: Property Rights (GHG Safeguards SOP)*

Activity	Aspect	Impact	Potential Risk to local Stakeholders	Risk Category	Risk Rating and Justification	Mitigation Measures (implemented by project proponent)
	Participation in project design, implementation, and/or consultation	Safety of local stakeholders	Increased risk to stakeholder safety due to opposing opinions, cultural/ religious differences, land holder grievances or disputes, government or local oppression of freedom of expression.	Social/ Socio economic	**Low** – Refer to Universal Control; There is no evidence of the suppression of freedom of speech within Romania.	Universal Control = All stakeholder contact information (Name, Address, etc.) will be kept confidential. Stakeholder responses will be number coded as to keep public record of responses anonymous.

3. Application Methodology

3.1. Title and Reference of Methodology

The methodology selected for the project is VM0012: Improved Forest Management in Temperate and Boreal Forests (LtPF) v1.2. Additional tools to be applied include:

- AFOLU Non-Permanence Risk Tool: VCS Version 3 (Procedural document 19 October 2016, v3.3)
- VT0001 – Tool for Demonstrating and Assessment of Additionality in VCS Agriculture, Forestry, and Other Land Use (AFOLU) Project Activities – Version 3.0, Sectoral scope 14.

3.2. Applicability of Methodology

Table 7:. Compliance with VCS VM0012 Methodology Criteria

	Summarized Methodology Applicability Criteria	Rotunda Forest Carbon Project Fit
1.	Project meets criteria for IFM-LtPF projects	Rotunda meets both criteria
2.	Project is located in Temperate or Boreal Domain Global Ecological Zones and meet Tier III inventory and data requirements	Rotunda is located in the Temperate Ecological Zone. Rotunda utilizes detailed site level inventory meeting Tier III criteria
3.	Project meets VCS Standard requirements for ownership	The Rotunda project can demonstrate Proof of Right and Right of Use.
4.	Annual illegal, unplanned and fuelwood removals are <5% of total annual harvest levels	Rotunda has no illegal or unplanned harvesting and, de-minimis fuelwood removals
5.	No managed peatland forests in project	Rotunda does not contain managed peatland forests
6.	Total percentage of wetlands in project area not expected to change due to project activities	Rotunda will not materially alter the percentage of wetlands on the project area
7.	No activity shifting leakage to other Rotunda lands at the start of the project	Rotunda must demonstrate baseline activities are not being shifted to other conservation land holdings

	Summarized Methodology Applicability Criteria	Rotunda Forest Carbon Project Fit
8.	Project does not include non-de minimis application of fertilizer in the project scenario	Rotunda will not include any application of fertilizer in the project area

3.3. Project Boundary

The Rotunda Forest Project is bounded by the harvestable forest lands within the entire legal area presented within Section 1.12, within which the project considers the following GHG sources, sinks and reservoirs:

Table 8: Rotunda Forest Carbon Project sources, sinks and reservoirs

Source		Gas	Included?	Justification/Explanation
	Note: CH_4 and N_2O excluded from Baseline and Project calculations			
Baseline	Above Ground Biomass (Live)	CO_2	Yes	Sink – Biomass re-growth after harvest disturbance Source – Carbon flows resulting from timber harvest removals and adjacent biomass impacts during operations (shifted to other carbon pools) Source – Emissions from mortality and decay in remaining forests.
Baseline	Below Ground Biomass Pool (Live and Dead)	CO_2	Yes	Sink – Biomass re-growth after forest management activities Source – Carbon flows resulting from forest management harvesting removals (shifting to other carbon pools) Source – Emissions from mortality and decay in remaining forests (shifted to other carbon pools)
Baseline	Dead Wood Pool	CO_2	Yes	Sink – Dead snags, course branches and stems before and after forest management activities Source – Decay of deadwood pool
Baseline	Wood Products Pool	CO_2	Yes	Sink – Carbon in permanent storage in harvested wood products Source – Emissions from decaying wood products
Project	Above Ground Biomass (Live)	CO_2	Yes	Sink – Biomass accumulation in growing retained forest Reservoir – Biomass in un-harvested forest

Source		Gas	Included?	Justification/Explanation
	Below Ground Biomass Pool (Live and Dead)	CO_2	Yes	Reservoir – Biomass retained in forest Sink – Biomass accumulation in avoided harvest
	Dead Wood Pool	CO_2	Yes	Sink – Dead snags, course branches and stems Source – Decay of deadwood pool
	Wood Products Pool	CO_2	Yes	Sink – Carbon in permanent storage in harvested wood products Source – Decay of harvested wood products
Sources Excluded from the Baseline and Project scenarios				
Excluded	Above-ground Non-Tree Biomass (Live)	CO_2	No	Sources and sinks are *de minimus*
	Litter Pool	CO_2	No	Litter is a short-lived transition pool, and differences between the project and baseline are *de minimus* over time.
	Soil Carbon Pool	CO_2	No	Soil carbon is a reservoir of long-lived carbon storage which is likely unaffected by timber harvesting
	Combustion of Fossil Fuels by Vehicles/ Equipment	CO_2	No	Carbon emissions from harvesting equipment, log transport, and primary forest product manufacturing are listed as being an optional inclusion within VM0012 and therefore are being excluded due to the project scenario consisting of conservation with harvesting occurring only to maintain the health of the stand. Therefore any emissions due to vehicle/ equipment use will be minimal.

3.4. Baseline Scenarios

STEP 1 – Identify Plausible Alternative Baseline Scenarios to the VCS Activity

The Rotunda Carbon Project has identified four potential baseline scenarios that were evaluated in the baseline selection process. Italicized text indicates methodology or VCS requirements in baseline scenario selection.

1. Historical Practice

The VCS standard and VM0012 require the consideration of historical practice as a baseline scenario in step 2a. It is noted in the Rotunda Forest management plan that historic data is uncertain. The current management plan provides information back to 2008 as the property was acquired in 2007. Between 2008 and 2017 it is estimated that the total commercial and pre-commercial harvest combined was 73,007 m^3 for an annual average of 7,300.7 m^3. The current management plan described below in Step 2a details the current allowable annual cut for the property (SC Rotunda SRL 2018).

2. Common Practices

Maximizing the allowable harvest within the current forest management plan is the common practice scenario. In Romania, forest management plans are required by law to be completed every 10 years (Romanian Forest Code, technical regulation no. 5/2005). The common practice would be to harvest the allowable annual cut (AAC) detailed in the management plan (SC Rotunda SRL 2018).

3. Acquisition for conversion to real estate development lands

A potential baseline scenario is that an entity would acquire the lands (or the current owner would implement this directly), with the intent of financial return on investment from the development and sale of rural residential and vacation properties. Due to geography, it is clear that extensive development across all land parcels is unlikely, so this scenario would focus on maximizing real estate opportunities within the highest and best use areas. These areas would include shorelines along lakes and streams and would most likely be supplemented with timber harvesting. Information on real estate opportunity within the project area has been provided through correspondence with Nikolaus Pongracz of SC Rotunda SRL.

4. Acquisition for conversion to conservation lands

The last potential baseline scenario is the acquisition of the forest for conservation purposes. This scenario is representative of, or comparable to, the project scenario without carbon. There is no credible market-based business model for this baseline scenario to provide financial returns for private investment capital, as there are no material revenue returns from conservation activities similar to the project scenario. The inclusion of this scenario also meets element 2.1.1 a), item ii) in the VCS Additionality Tool VT0001. Land acquisition for conservation purposes has occurred in one other project completed by the Foundation Conservation Carpathia (FCC 2009). Lands were acquired in the Făgăraș Mountains for an ecosystem conservation project with the goal of conserving and restoring the natural Carpathian ecosystem.

The areas in italics in the following are the baseline selection criteria outlined in the methodology.

Each prospective baseline scenario meets the following baseline selection scenario eligibility criteria, except where noted and excluded:

1. *Including activities and areas where forests remaining as forests* – this criterion eliminated the potential Baseline Scenario 3 "Acquisition for conversion to real estate development lands".
2. *Comply with legal requirements for forest management and land use in the area* – all remaining baseline scenarios would meet the minimum practice requirements of either Romanian Forest Act or general rural residential laws and requirements.

3. *Demonstrate that the "projected baseline scenario environmental practices equal or exceed those commonly considered a minimum standard among landowners in the area" (Voluntary Carbon Standard, 2008a)* – all the prospective baseline scenarios could have complied with minimum environmental performance of landowners in the area.

Step 2 – Selection of a Single Plausible Baseline Scenario for the Project

Project proponents shall select a single plausible baseline scenario for the project using the following steps:

Step 2a – The Historical Baseline Scenario – based on historical operating practices on the property

2a.1 The project proponent has at least 5 years historical harvest level data history.

Rotunda has a forest management plan in place that commenced January 1, 2018 and is valid for ten years. As stated in the VM0012 methodology, "projects may use a forward-looking forest management plan as the historical baseline data". The AAC is set within the forest management plan. The area available for harvesting operations is 748 ha with an AAC of 6,446 m^3.

Table 9: Breakdown of AAC by harvest type

Volume (m^3)	Type
2,310	Primary – small patches
2,994	Conservation Cutting – max 10% of stand volume
561	Secondary Cutting – thinning
581	Hygiene Cutting – removing non-vigorous, broken etc.

As stated in the forest management plan, this is the first plan completed to current standards making it difficult to accurately portray historic events. Over the prior ten-year period (2008-2017) it is estimated that the total commercial and pre-commercial harvest combined was 73,007 m^3 for an annual average of 7,300.7 m^3. Since the historic harvest levels are relatively uncertain, the project will utilize the conservative approach of using the AAC from the forward-looking forest management plan for the historical baseline data.

The baseline scenario based on actual property harvest history has been selected because the project proponent has at least 5 years historical harvest level data history. Step 2b and 2c will be omitted due to the acceptance of the historical baseline scenario in Step 2a.

Step 3 – Additionality Test

The project is additional as per Section 3.5 in a manner consistent with the baseline selection method.

3.5. Additionality

The project uses the Tool for the Demonstration and Assessment of Additionality in VCS Agriculture, Forestry and Other Land Use (AFOLU) Project Activities:

This Rotunda project meets the eligibility requirements of this tool by:

1. The project activities are not in violation of any applicable law (refer to Section 1.14 above);
2. The project employs a stepwise method to determine the most plausible baseline scenario, which is consistent with the application of this tool (refer to section 3.4 above).

Step 1a – Identification of plausible baseline scenarios

1. Historical Practice (selected baseline scenario)
2. Common Practice
3. Acquisition for conversion to real estate development lands
4. Acquisition for conversion to conservation lands

Step 1b – Legal tests

All plausible baseline scenarios could be undertaken within the legal requirements of private forestland or private rural residential land in Romania (refer to Section 3.4).

Step 1c – Selection of Most Plausible Baseline Scenario

See Step 2a – The Historical Baseline Scenario – based on historical operating practices on the property for a description of the baseline selection process.

The outcome of the selection process is to select the “Historical Practice” using the forward-looking forest management plan.

Step 2 – Investment Analysis

In general, the project scenario is less financially attractive then the alternative baseline scenarios. As a Logged to Protected Forest conservation project, the project scenario for the Rotunda project generates no material financial or economic benefits other than VCS related income, and therefore is suitable for Option 1 – Simple Cost Analysis

Investment Analysis – Option 1 Simple Cost Analysis

Pre-project operating expenses and revenue for the Rotunda Forest is confidential information. Baseline income and cashflow estimates were provided by Rotunda forest managers. Net cash flows from the historical baseline scenario are greater than the project scenario.

The operating costs of the Rotunda carbon project specific to the carbon project itself are projected to be approximately 140,000 Euros[2] in the first year (including verification, issuance and registration, project management) and an estimated 25,000 Euros/ year (including monitoring, and sales costs; not including capital costs, management overhead costs, road costs, conservation activities costs, or taxes).

Rotunda will also undertake additional property and conservation management activities (road maintenance, biodiversity research, inventory, access management, etc.) that require substantially greater cost than projected here. The majority of these costs (which is difficult to isolate) would be attributed to property management costs of the carbon project related to the carbon project implementation, regardless of other biodiversity and conservation objectives underlying Rotunda’s management activities in the project scenario. In other words, any entity acquiring the land strictly for the purpose of carbon offsets with no other interests would face these costs as well. Rotunda’s carbon budget will be summarized at the time of validation and provided to the Validation and Verification Body within a separate document. .

Rotunda has alternate sources of revenue (i.e., real estate, compensation for protected lands, pastures) that would be intended to offset any additional costs incurred by the implementation of the carbon project.

Additionally, the project scenario does include a low level of timber harvest as part of conservation management and community engagement that does generate revenue from timber sales. However, the low level of harvest and high cost of expected conservation harvesting is expected to be operationally break-even at best. The operational revenue and costs are not detailed further here because it is obvious once capital costs and other property management costs are included that it is impossible for these timber harvests to cover

[2] Additional details of cost modeling available upon request.

overall costs. However, actual details of current and projected project activity revenue and costs are available upon request.

To summarize, the Rotunda carbon project and only material commercial revenue and profit opportunity within the carbon project is from the sale of VCU's. Option 2 and Option 3 are not considered further because there is no reasonable alternative business model for a private entity to maintain this land for the purposes which achieve similar emissions reductions, given the high acquisition cost and lack of revenue options from conservation activities without carbon. Carbon finance provides the only reasonable revenue opportunity to cover project costs, property management costs, and capital costs in the project scenario.

Step 3. Barrier Analysis (supporting information only)

In addition to the Investment Analysis above, there is a clearly related applicable barrier, described below:

Step 3a – Identify barriers that would prevent the implementation of the type of proposed project activity

There are barriers for AFOLU project activities undertaken and operated by private entities:

Similar conservation activities have only been implemented with grants or other non-commercial finance terms (FCC 2009). In this context similar activities are defined as activities of a similar scale that take place in a comparable environment with respect to regulatory framework and are undertaken in the relevant geographical area. The project activity will be the "first of its kind". No similar project activities are currently operational in Eastern Europe with Verified Carbon Standard, The Gold Standard or the Clean Development Mechanism.

Step 3b – Show that the identified barriers would not prevent the implementation of at least one of the alternative land use scenarios (except the proposed project activity).

The other scenarios relating to historic practice and common practice are not affected by the above barrier. Income would come from the harvesting of forests that are slated for conservation in the project scenario. The real-estate development scenario would also not be affected by the above listed barrier. In all scenarios, except the project scenario, financial benefits would be received from the sale of land or fiber from the land. The project scenario is unlikely to produce economic benefits or be financially attractive without financial benefits from the VCS AFOLU project.

Step 4. Common Practice Analysis

Rotunda is the first IFM-LtPF carbon project proposed in Romania and the only forest carbon project considered in Romania to date[3]. Conservation projects in Romania have been completed in the past with private and public money. An example of this is Foundation Conservation Carpathia, founded in 2009 by philanthropists and conservationists to protect privatized forest lands in the Făgăraș Mountains (FCC 2009). Some maintenance costs of Carpathia are offset by leasing hunting rights and donations with the goal to return the landholdings to the public domain for permanent protection as a national park.

There are no comparable projects that could be considered common practice, and which achieve similar scale or employ similar project activities. Similar acquisitions are only achieved with non-commercial funding and capital sources.

Based on the application of this VCS tool, the Rotunda Forest Carbon Project is clearly additional based on Investment Analysis.

[3] VCS Project Database

3.6. Methodology Deviations

No methodology deviations have been requested.

4. Quantification of GHG Emission Reductions and Removals

4.1. Baseline Emissions

Validating Inventory Requirements

The Rotunda Forest Carbon Project meet the Valid Starting Inventory Requirements from the methodology (methodology criteria in italics):

1. *Pertaining directly to the entire project area; the Rotunda inventory data (2017) covers the entire project area, and meets this criteria.*
2. *Created, updated, or validated <10 years ago; and,*

The latest base inventory (2017 field season) was created and received approval under the Romania Forest Fund in 2018. The inventory meets these criteria.

3. *Documentation is available describing the methods used to create, update, or otherwise validate the starting inventory, including statistical analysis, field data, and/or other evidence.*

The inventory methods and related inventory updates are regulated by the provisions of the Forest Code (Law 46/2008 with subsequent completions and modifications, respectively Law 175/2017).; which therefore meets the criteria.

Baseline Scenario Area Stratification

STEP 1 - Stratify to create homogeneous units.

The Rotunda forest inventory is contained within a Geographic Information System dataset. The number of polygons is 56, with the average area of 27.78 ha is based on Management requirements of the Romanian Forest Fund. The Inventory covers the entire property of UP II Rotunda Clopotiva on an area of 1555.82 ha.

The polygons are homogeneous based on forest cover species, stand age, productivity class, and other stand attributes including operability. The Carbon modeling is specific to the forest lands intended for regulated harvesting. Romanian Forestry law regulates minimum harvest age and harvest intensity. Regulation of primary forest products (SUP ‘J’) covers 427.71ha. Additional harvest opportunities are feasible on constrained sites and forests under the special conservation regime (SUP ‘M) and covers and additional 1,062.21ha.

For modelling purposes, inventory polygons were further refined into Analysis Units based on leading species, productivity class and intended legal harvest regime (SUP J-primary or SUP M-conservation). Carbon curves were developed for and assigned to each of the analysis units as described below.

Table 10: Description of Forest Analysis Units Defined in the Project Area

AU	Name	Description
1	Conifer-Good - J	Spruce Leading on good sites (I - II) & primary harvest (30% cut)
2	Conifer-Moderate - J	Spruce Leading on moderate sites (III) & primary harvest (30% cut)
3	Conifer-Poor -J	Spruce Leading on poor sites (IV - V) & primary harvest (30% cut)
4	Deciduous-All - J	Deciduous Leading on all sites (I - V) & primary harvest (30% cut)
5	Conifer-Good - M	Spruce Leading on good sites (I - II) & conservation (10% cut)
6	Conifer-Moderate - M	Spruce Leading on moderate sites (III) & conservation (10% cut)
7	Conifer-Poor - M	Spruce Leading on poor sites (IV - V) & conservation (10% cut)
8	Deciduous-All - M	Deciduous Leading on all sites (I - V) & conservation (10% cut)

Model Selection and Use

The Carbon Budget Model of the Canadian Forest Sector (CBM-CFS3) is an inventory-based, yield-curve-driven model that simulates the stand- and landscape-level C dynamics of above- and belowground biomass, dead organic matter (DOM; litter and dead wood) and mineral soil (Kurz et al., 2009). The CBM-CFS3 is a stand- and landscape-level modeling framework that can be used to simulate the dynamics of all forest carbon stocks required under the United Nations Framework Convention on Climate Change. It is compliant with the carbon estimation methods outlined in the guidelines of the Intergovernmental Panel on Climate Change. The model uses much of the same information that is required for forest management planning activities (e.g., forest inventory, growth and yield curves, natural and human-induced disturbance information, forest management schedule, and land-use change information), supplemented with information from national ecological parameter databases.

The model, developed by the Canadian Forest Service, was recently applied to 26 EU countries, mainly using National Forest Inventories (NFI) input data, to estimate the European Union (EU) forest Carbon dynamics from 2000 to 2012, including the effects of natural disturbances and land-use change (Pilli et al., 2016a, b).

The (CBM-CFS3) has been adapted, tested, and applied to forests of 26 EU countries over the last 7 years for EU policy making and scientific research. The overall purpose of this exercise is to increase the transparency of how the EU Archive Index Database (EU-AIDB) was parameterized while supporting both the policy making and research communities interested in applying the CBM-CFS3 with ecological parameters specific to the EU context. In addition to preparing model input data reflecting various management and disturbance scenarios for CBM-CFS3 projects, an essential step was to update the original AIDB with information specific to the EU context and create an EU-AIDB. The AIDB is the Microsoft Access database behind the CBM-CFS3 that stores default ecological information and parameters pertaining to the forest ecosystems of a country, among other functions.

The EU-JRC (Joint Research Centre) developed an EU-Archive Index Database (AIDB) (https://data.jrc.ec.europa.eu/dataset/jrc-cbm-eu-aidb)

CBM is a robust model pre-populated with many well-referenced default settings for the EU. These model assumptions, algorithms, and default values are well tested and based on validation by the Canadian Forest Service Experts and those of the EU-JRC (Joint Research Centre) utilizing experts opinion, referenced research, and data from the EU National Forest Inventory reports

Preparation of Stand-level Carbon Curves in CBM

The CBM model was used to create a series of stand attribute curves for each analysis unit to predict/ simulate forest development, merchantable timber volume, and carbon storage and dynamics by carbon pool over time. Data from project inventory plots were used to set a representative yield curve for the analysis units (AUs).

The objective was to calibrate the CBM forest type for each Analysis Unit to generally match the actual species mix found in the carbon monitoring plots (at age ~110 years being the minimum final felling age), which are then being represented by the simplified AU groupings with forest types based on species composition, site productivity and disturbance regime/ harvest history.

The AIDB spatial units (SPU220) Romania was used for each analysis unit. A SPU in the EU-AIDB is the spatial resultant from the intersection of 204 European administrative regions (defined at the Nomenclature of territorial units for statistics - NUTS 1 and NUTS 2 levels for most of the EU countries), and 35 ecological boundaries representing climatic units.

The CBM 'MAKELIST' is a preprocessing program that is used to format the inventory information for input into the CBM-CFS3 and to initialize the DOM carbon pools. These pools include carbon from aboveground and belowground dead tree biomass (e.g., coarse woody debris; litter, fibric, and humic layers; and mineral soil). MAKELIST uses the same algorithms and parameters as the CBM-CFS3 and simulates each stand record through a number of natural disturbance cycles (grow, burn, grow, burn, etc.) until the slow DOM carbon pool at the end of two successive rotations meets a user-defined criterion (for which the default tolerance is 0.1%). By default, MAKELIST assumes that the historical natural disturbance regime is stand-replacing fire, and it therefore grows stands for X years.

Biomass Carbon Modeling

Total biomass flows for each analysis unit were calculated using equations embedded in the CBM-CFS3 and output by representative carbon curves and tracked by carbon pool (see Table 2 below). The model simulates detailed forest growth and development over time and links this forest development to detailed biomass accumulation and decay functions to track carbon biomass by pool through time. The SPU220 Romania includes validated and referenced default parameters well suited to the project area (Pilli et al., 2016a). The CBM convert the merchantable volume per ha reported by the growth curves (i.e., YT, yield tables) to tonnes of dry biomass through species-specific allometric equations (used as Biomass Expansion and Conversion Factors, without any additional value of wood density).

The CBM-CFS3 carbon pools are divided into pools as noted in the table below. This project considers the following four carbon pools:

1. Aboveground Tree Biomass (including Standing dead trees and the subset Merchantable Carbon/ Wood Products pool)
2. Belowground Biomass
3. Dead Wood (including Litter Pool)

Although the model does address the Soil Carbon Pool it is considered optional in VCS AFOLU IFM projects. As a conservative approach and considering there are no afforestation projects associated with the project changes to soil carbon from harvesting are assumed to be *de minimis*.

Table 11: CBM Carbon Pool allocation as detailed with Kurz et al., 2009 (Table 2)

Table 2 – Correspondence between pools in the Carbon Budget Model of the Canadian Forest Sector 3—version 1.1 (CBM-CFS3) and recommended pools by the Intergovernmental Panel on Climate Change Good Practice Guidance (GPG) (IPCC, 2003). SW = softwood, HW = hardwood, DOM = dead organic matter.

CBM-CFS3 pool	Description	GPG pool
Merchantable + bark (SW or HW)	Live stemwood of merchantable size[a] plus bark	Aboveground biomass
Other wood + bark (SW or HW)	Live branches, stumps and small trees including bark	Aboveground biomass
Foliage (SW or HW)	Live foliage	Aboveground biomass
Fine roots (SW or HW)	Live roots, approximately <5 mm diameter	Belowground biomass
Coarse roots (SW or HW)	Live roots, approximately ≥5 mm diameter	Belowground biomass
Snag stems DOM (SW or HW)	Dead standing stemwood of merchantable size including bark	Dead wood
Snag branches DOM (SW or HW)	Dead branches, stumps and small trees including bark	Dead wood
Medium DOM	Coarse woody debris on the ground	Dead wood
Aboveground fast DOM	Fine and small woody debris plus dead coarse roots in the forest floor, approximately ≥5 and <75 mm diameter	Litter
Aboveground very fast DOM	The L horizon[b] comprised of foliar litter plus dead fine roots, approximately <5 mm diameter	Litter
Aboveground slow DOM	F, H and O horizons[b]	Litter
Belowground fast DOM	Dead coarse roots in the mineral soil, approximately ≥5 diameter	Dead wood
Belowground very fast DOM	Dead fine roots in the mineral soil, approximately <5 mm diameter	Soil organic matter
Belowground slow DOM	Humified organic matter in the mineral soil	Soil organic matter

[a] Definition of merchantable size dimensions are model parameters, see Table 3.
[b] Soil Classification Working Group (1998).

Harvested Wood Product Modeling

The CBM-CFS3 tracks Aboveground Tree Biomass (and the subset Merchantable Carbon/ Wood Products pool) harvested wood products (HWP) in Tonnes of Carbon (t C) and satisfies the requirements of Step 1 of the methodology.

VM0012 requires calculation of 3 harvested wood pools:

1. Short-lived wood products (SL HWP), which are defined as wood products in use for <3 years; and assumed to be emitted immediately.
2. Medium-lived wood products (ML HWP), which are defined as wood products in use for 3-100 years; and assumed to be emitted on a 20-year straight line decay curve.
3. Long-lived wood products (LL HWP), which are wood products in use for 100+ years.

Note: products in landfill are assumed to be “in use” and treated as per these 3 HWP pools.

Historical harvest in Rotunda between 2008 and 2019 indicates the following breakdown by product type (k) categories: Softwoods 89% sawlog & 11% pulpwood; Hardwoods 60% sawlogs & 40% pulpwood.

For the purposes of Step 2 (Carbon contained in harvested timber after milling) Forest Product Conversion Factors for the EU Region published by the United Nations Economic Commission for Europe was used to determine the total carbon in harvested timber that will enter the wood products pool by product type accounting for mill efficiencies and estimated product disposition percentages ($CBSL_{MILL,h}$; t C). The gross quantity of carbon contained in harvested timber for each of the four product types (k) described in Step 1 must be decremented to account for losses during processing and is calculated within HWP PRJ Roaded_20201130 excel spread sheet.

For the final step 3 (Carbon storage in medium-term and long-term wood products) the total carbon lost in short-lived products and stored in medium-term and long-term products used Smith, et al (2006) reference tables and factors to calculate the result is a fraction of the Wood Products pool being emitted or stored annually based on each In-Use category based on product, decay and storage factors.

These HWP modelling calculations are applied equally to any timber harvesting in either the Baseline or Project Scenario.

Overview of Baseline and Project Scenarios using CBM-CFS3 Outputs and a Microsoft Excel Application

The CBM-CFS3 model and supporting Excel spreadsheets were developed to house the data and perform and track the carbon modeling results by polygon and carbon pool over time and across the Baseline Scenario (and Project Scenario) activities by project instance. Data from the CBM-CFS3 output Delta Ecosystem Reports and Merchantable Carbon/ Wood Products Reports were exported into excel spreadsheets. These carbon reports consist of tables that contain carbon pool and harvested wood products pool information in 10-year increments (as a result of inventory information) across all site classes and analysis units, which are interpolated evenly to 1-year increments. They include both project and baseline scenarios. Polygon-based forest inventory data, in a tabular format, were used to populate the model.

Each polygon included sufficient information to allow filtering into its assigned analysis unit (Table 1). The legal harvest regime (e.g. SUP J) was used to link each specific polygon with other descriptive tables including disturbance type and intensity in each baseline scenario. The analysis unit field was used in combination with polygon area to match up the modeled inventory polygon to the correct carbon yield curve data.

The CBM-CFS3 derived stand and carbon curves are modeled on an assumed fully stocked representative stand in each AU and applies carbon and merchantable volume outcomes for each polygon based on the analyzed percentage of full stocking. The model includes discrete sections that represent the project and specific baseline disturbances/ activities (partial cutting 30%, thinning and conservation cutting along with hygiene cuts). The CBM-CFS3 then simulates and tracks the fate of carbon in all applicable carbon pools over time by polygon, including for Wood Products pool after any scheduled or monitored activity in either scenario. Carbon calculations can then be summarized for the project and baseline scenarios for each project year across all project instances.

Baseline emissions are calculated by applying a Baseline disturbance to each AU, and then modeling the baseline activities and the related carbon flows using CBM-CFS3. The methods described are equivalent to the equations and processes outlined in VM0012.

Calculating Baseline Scenario Live Biomass Gain

For the Common Practice Baseline Scenario (as described in Section 3.4), a set of assumed baseline activities (disturbances) was developed based on harvest details within the current management plan. All baseline management activities are assumed to occur/begin at year 1.

Live biomass gain ($\Delta C_{BSL,G,t}$, Eqn 4,5a-b) is calculated by CBM-CFS3 based on the project area stratifications, regionally specific forest dynamics (SPU220), and the related carbon curves discussed above, and tracked and reported by carbon pool (Aboveground Live, Belowground Live), and reported in the Delta Ecosystem Reports and Merchantable Carbon/ Wood Products Reports which is then tracked by polygon, by year in the Access database. Additional details about related model default values, functionality, and parameters are found in Kull (2016) & Kurz (2009).

Calculating Baseline Scenario Live Biomass Loss

Live biomass loss ($\Delta C_{BSL,L,t}$, Eqn 6,7,8,9) is calculated by CBM-CFS3 based on the project area stratifications, regionally specific forest dynamics (SPU220) and the related carbon curves discussed above. Default parameters and algorithms within CBM-CFS3 model and track all stand dynamics, including natural tree mortality, harvesting scenario felling/removals, blowdown, and any other biomass loss. Generally, mortality related live biomass is shifted into dead biomass pools by CBM-CFS3 (Aboveground Standing Dead (snags), Aboveground Downed and Dead Wood (DOM), Belowground DOM), which are reported in the Delta Ecosystem Reports. Harvesting related biomass loss is tracked and reported as Merchantable Carbon/ Wood Products Reports. Additional details about related model default values, functionality, and parameters are found in Kull (2016) & Kurz (2009).

Calculating Baseline Scenario Dead Organic Matter Dynamics

Dead organic matter dynamics ($\Delta C_{BSLDOM,t}$, Eqn 10,11a-b,12,13,14a-b,15,16,17a-d) are calculated by CBM-CFS3 based on the project area stratifications, regionally specific forest dynamics (SPU220) and the related carbon curves discussed above. Default parameters and algorithms within CBM-CFS3 model and track all stand dead wood dynamics, including standing dead, downed dead, and below ground dead organic matter. CBM-CFS3 uses the SPU220 variant data and related parameters to model and track dead organic matter between carbon pools (Aboveground Dead (i.e. Stem Snags), Belowground Dead, Aboveground Slow DOM (VM0012 calls this Lying Dead Wood)), and decay within each pool.

Additionally, CBM-CFS3 tracks dead organic matter dynamics related to harvesting or other events when applied. The project uses the default decay factors and dead matter dynamics that are set within the CBM-CFS3 model and specific to the SPU220 variant dataset. The results of dead organic matter dynamics are reported in the Delta Ecosystem Reports. Additional details about related model default values, functionality, and parameters are found in Kull (2016) & Kurz (2009). Generally, carbon stocks are transitioned between dead biomass pools, and emitted as they decayed.

Calculating Baseline Scenario Harvested Wood Products (HWP)

Harvested Wood Product dynamics ($\Delta C_{BSLHWP,t}$, Eqn 18,19,20,21,22,23a-c,24) are calculated with a combination of CBM-CFS3 output and additional calculations in the project Excel Spreadsheets following regional factors derived from EU reports.

The CBM-CFS3 report does not match the requirements of VM0012, and as such the project has adapted CBM-CFS3 outputs for application against the relevant factors to follow VM0012.

The project utilizes CBM-CFS3 data to begin the HWP calculations and to connect to carbon pool tracking and reporting, then transitions, using the local data, to allocate harvested material to product type (k). The project starts with Merchantable Carbon/ Wood Products Reports. CBM-CFS3 outputs HWP using the same categories and measures for product type categories described in VM0012 Step 1 and uses species specific allometric formulas.

Note this is conservative as the Wood Products pool is a gross carbon volume in merchantable log sizes (before deductions for waste and utilization), whereas the Smith analysis starts with removed timber volume (i.e. after waste and utilization).

Historical harvest in Rotunda between 2008 and 2019 indicates the following breakdown by product type (k) categories: Softwoods 89% sawlog & 11% pulpwood; Hardwoods 60% sawlogs & 40% pulpwood.

For the purposes of Step 2 (Carbon contained in harvested timber after milling) Forest Product Conversion Factors for the EU Region published by the United Nations Economic Commission for Europe was used to determine the total carbon in harvested timber that will enter the wood products pool by product type accounting for mill efficiencies and estimated product disposition percentages ($CBSL_{MILL,h}$; t C). The gross quantity of carbon contained in harvested timber for each of the four product types (k) described in Step 1 must be decremented to account for losses during processing and is calculated within HWP PRJ Roaded_20201130 excel spreadsheet.

Step 3 calculates (Carbon storage in medium-term and long-term wood products) the total carbon lost in short-lived products and stored in medium-term and long-term products was using reference tables and factors from Smith, et al (2006). The result is a fraction of the Wood Products pool being emitted or stored annually for each In-Use category based on product, decay, and storage factors.

Constants from Smith, et al (2006) Table 6 – the Northeast Softwoods, Saw Logs and Pulpwood; along with the Northeast Hardwood tables were applied. The respective volumes were calculated by species and product type (hardwood sawlog and pulpwood are added back together to use these tables). Constants were used from the relevant "In Use" column to finalize calculations for the following HWP categories:

a) Short-lived HWP – multiplied (Year 1 – 3 look-up factor) for each of the tables against the respective remaining In-Use carbon volumes. This calculates the fraction of net Merch Carbon Removed that is In-Use as Short-lived HWP. Following VM0012, the sum of al Short-lived HWP is assumed to be emitted immediately.
b) Long-lived HWP – applied the look-up factor for Year 100 for each of the tables against the respective remaining In-Use carbon volumes. This calculates the fraction of net Merch Carbon Removed that is In-Use as Short-lived HWP. Following VM0012, the sum of all Long-lived HWP is assumed to be permanently stored.
c) Medium-Lived HWP – the difference between the carbon remaining In-Use at Year 3 and at Year 100 is then calculated using each table look-up factors and carbon volumes, respectively to calculate the Medium-Lived HWP. The sum of all Medium-Lived HWP is then modelled to emit on a straight line 20-year decay curve, starting in year 0 and being fully emitted in year 20.

Note that the remaining Merch Carbon Removed after accounting for Short-, Medium-, and Long-lived HWP is emitted immediately as a combination of emissions due to waste carbon being used for Energy and Emitted w/o Energy.

Note that the project has not included the optional emissions from equipment fossil fuels ($\Delta C_{BSL,EMITFOSSIL,t}$, Eqn 25,26a-b,27), and any related variable is assumed to be zero.

Baseline Scenario GHG Emissions Calculation Summary

The CBM-CFS3 model and the supporting spreadsheets were used based on spatial forest inventory data to calculate and track all annual changes in both the live biomass ($\Delta C_{BSL,LB,t}$) and dead organic matter pools (($\Delta C_{BSL,DOM,t}$) for the baseline scenario in a method consistent with the formulas in VM0012. Carbon storage changes in harvested wood products **(**$\Delta C_{BSl,HWP,t}$), summarized net carbon balances, and other deductions and buffer discounts were determined in the supporting spreadsheets.

The total annual carbon balance in year, t, for the baseline scenario (ΔCBSL,t, in t C yr-1) was calculated as:

$$\Delta \mathbf{C}_{\mathbf{BSL,t}} = \Delta \mathbf{C}_{\mathbf{BSL,P,t}} \qquad \mathbf{(1)}$$

where:

$\Delta C_{BSL,P,t}$ is the annual change in carbon stocks in all pools in the baseline across the project activity area (including all project instances); t C yr-1.

The annual change in carbon stocks in all pools in the baseline across the project activity area ($\Delta C_{BSL,P,t}$; t C yr^{-1}) was calculated as:

$$\Delta \mathbf{C}_{\mathbf{BSL,P,t}} = \Delta \mathbf{C}_{\mathbf{BSL,LB,t}} + \Delta \mathbf{C}_{\mathbf{BSL,DOM,t}} + \Delta \mathbf{C}_{\mathbf{BSl,HWP,t}} \qquad \mathbf{(2)}$$

where:

$\Delta C_{BSL,LB,t}$ = annual change in carbon stocks in living tree biomass (above- and belowground); t C yr^{-1}

$\Delta C_{BSL,DOM,t}$ = annual change in carbon stocks in dead organic matter; t C yr^{-1}

$\Delta C_{BSl,HWP,t}$ is the annual change in carbon stocks associated with harvested wood products, t C yr^{-1}.

The annual change in carbon stocks in living tree biomass (above- and belowground) in the baseline scenario ($\Delta C_{BSL,LB,t}$; t C yr^{-1}) was calculated as:

$$\Delta \mathbf{C}_{BSL,LB,t} = \Delta \mathbf{C}_{BSL,G,t} - \Delta \mathbf{C}_{BSL,i,t} \quad \textbf{(3)}$$

where:

$\Delta C_{BSL,G,t}$ = annual increase in tree carbon stock from growth; t C yr^{-1}

$\Delta C_{BSL,L,t}$ = annual decrease in tree carbon stock from a reduction in live biomass; t C yr^{-1}.

The annual change in carbon stocks in dead organic matter (DOM) ($\Delta C_{BSL,DOM}$; t C yr^{-1}) in the baseline scenario was calculated as:

$$\Delta \mathbf{C}_{BSL,DOM,t} = \Delta \mathbf{C}_{BSL,LDW,t} + \Delta \mathbf{C}_{BSL,SNAG,t} + \Delta \mathbf{C}_{BSL,DBG,t} \qquad \textbf{(10)}$$

where:

$\Delta C_{BSL,LDW,t}$ = change in lying dead wood (LDW) carbon stocks in year, t; t C yr^{-1}

$\Delta C_{BSL,SNAG,t}$ = change in snag carbon stock in year, t; t C yr^{-1}

$\Delta C_{BSL,DBG,t}$ = change in dead below-ground biomass carbon stock in year, t; t C yr^{-1}.

The annual change in emissions associated with the production of harvested wood products (HWP), $\Delta C_{BSl,HWP,t}$, is calculated as:

$$\Delta \mathbf{C}_{BSl,HWP,t} = \Delta \mathbf{C}_{BSL,STORHWP,t} - \Delta \mathbf{C}_{BSL,EMITFOSSIL,t,} \quad \textbf{(18)}$$

$\Delta C_{BSL,STORHWP,t}$ = the annual change in harvested carbon that remains in storage after conversion to wood products (t C yr^{-1})

$\Delta C_{BSL,EMITFOSSIL,t}$ = the annual change in fossil fuel emissions from harvesting (logging and log transport) and processing of the various wood products. The project has not included the optional equipment emissions carbon pool and hence this variable = 0.

4.2. Project Emissions

Project emissions and carbon flows are calculated in the same manner as the baseline emissions discussed in the Section 4.1. Calculations use the same forest inventory data, analysis units and polygons, and modeling tools under the Project Scenario activities. Project and Baseline Scenarios and polygon versions of each are tracked and calculated simultaneously in the supporting spreadsheets using the same parameters, outputs, and analysis under each scenario. In the project scenario, carbon flows are modeled using project activities which includes only hygiene cutting with a focus on maintaining forest health throughout the term of the project.

Project activities affecting GHG emissions were carried out during the initial project period (2018-2020) however, no project scenario activities were projected on an ex-ante basis except for hygiene cutting. Future years may include various project forest management activities that affect ex-post carbon stocks and which will be monitored and reported on in future verifications (e.g. salvage due to significant fire or forest health loss). Project activities will be based on actual monitoring results (see Section 5) and any resulting emissions netted against emission reductions.

The methods described are equivalent to the equations and processes outlined in VM0012.

Development of Project Scenarios and Assumptions

The project scenario is modeled as conservation with hygiene cutting, focusing on maintaining forest health. No other activities affecting carbon stocks are scheduled on an ex-ante basis, aside from normal forest growth and development as modeled by CBM-CFS3.

Determination of Actual Onsite Carbon Stocks

Ex-ante Project Scenario carbon stocks are calculated in the same manner as the baseline emissions discussed in Section 4.1. Calculations are completed using the same forest inventory data, analysis units and polygons, and modeling tools under the Project Scenario activities.

Ex-Post Calculations of Carbon Stocks

Ex-post carbon stocks in the Project Scenario are determined at each verification following the steps outlined in VM0012. Each monitoring report will detail the data and calculations for ex-post onsite carbon stocks at the time of verification. However, as the project start date (2018) is prior to validation, the initial period (2018-2020) ex-ante carbon stocks are also the ex-post carbon stocks.

Project carbon stocks from 2021 forward are on an estimated ex-ante basis.

The ex-post carbon calculations are made for the Baseline and Project Scenarios as outlined in Section 4.1 and 4.2, with updates to carbon inventory, spatial data, project instances, and other data for each verification period.

For the 2018-2020 period, the project begins from, and carbon stocks are calculated from, the latest set of inventory and spatial data, which inherently include ex-post monitoring for that period.

Crews installed 28 permanent carbon plots in 2020-2021 (See Section 5.34.1) with representation across all Analysis Units to monitor inventory and model accuracy. Additional permanent sample plots may be installed to improve inventory accuracy, spatial coverage, and Analysis Unit representation as deemed necessary. The initial ex-post carbon stock spatial forest inventory and analysis is using the latest available ortho-imagery, LiDAR data, and other GIS datasets, in conjunction with site visits from Rotunda staff to confirm the status of project activities and disturbances. The modeling related to these data has been applied across both the Project Scenario and Baseline Scenarios. The uncertainty calculations (Section 4.4) in the first verification period are up to date for the latest inventory plot data and modeling results.

In future verification periods, the project will calculate ex-post carbon stocks by addressing any spatial changes to the project area, then updating the forest inventory and carbon modeling results, including for any other monitoring results or updates.

Additional carbon plots may be installed to improve inventory accuracy, spatial coverage, and/or Analysis Unit representation. Ex-post carbon calculations will be undertaken using the latest imagery, LiDAR, and GIS datasets for the project area. Project activities and disturbances will be monitored by remote sensing or field visits and updated into the forest inventory prior to the following verification period. All modeling and inventory updates and calibrations will be applied equally across the Project and Baseline Scenarios. The uncertainty factor, leakage assessments, and non-permanence risk factors will be recalculated using the latest forest inventory, plot data, and project information.

Calculating Project Scenario Live Biomass Gain

Live biomass gain ($\Delta C_{PRJ,G,t}$, Eqn 32,33a-b) is calculated the same as in the Baseline Scenario, Section 3.1, using project scenario polygons and data.

Calculating Project Scenario Live Biomass Loss

Live biomass loss ($\Delta C_{PRJ,L,t}$, Eqn 34,35,36,37) is calculated the same as in the Baseline Scenario, Section 3.1, using project scenario polygons and data.

Calculating Project Scenario Dead Organic Matter Dynamics

Dead organic matter dynamics ($\Delta C_{PRJ,DOM,t}$, Eqn 38,39a-b,40,41,42a-b,43,44,45a-d) are Calculated the same as in the Baseline Scenario, Section 3.1, using project scenario polygons and data.

Calculating Project Scenario Harvested Wood Products (HWP)

Harvested Wood Product dynamics ($\Delta C_{PRJ,HWP,t}$, Eqn 46,47,48,49,50a-c,51) are calculated the same as in the Baseline Scenario, Section 3.1 with respect to any timber harvesting in the project scenario. Currently there is no timber harvesting in the project scenario, although it may occur in the future. Note that the project has not included the optional emissions from equipment fossil fuels ($\Delta C_{PRJ,EMITFOSSIL,t}$, Eqn 52,53,54,55), and any related variable is assumed to be zero.

Project Scenario GHG Emissions Calculation Summary

The CBM-CFS3 and supporting spreadsheets were used in combination with the spatial forest inventory data to calculate and track annual changes in both the biomass ($\Delta C_{PRJ,LB,t}$) and dead organic matter pools ($\Delta C_{PRJ,DOM,t}$) for the project scenario. Changes in carbon storage in harvested wood products ($\Delta C_{PRJ,HWP,t}$) and summarized net carbon balances and buffer discounts were determined within the applicable spreadsheets.

The total annual carbon balance in year, t, for the project scenario ($\Delta C_{PRJ,t}$, in t C yr^{-1}) was calculated as:

$$\Delta C_{PRJ,t} = \Delta C_{PRJ,P,t} \qquad \textbf{(29)}$$

where:

$\Delta C_{PRJ,P,t}$ is the annual change in carbon stocks in all pools in the baseline across the project activity area; t C yr^{-1}.

The annual change in carbon stocks in all pools in the project scenario across the project activity area ($\Delta C_{PRJ,P,t}$; t C yr^{-1}) was calculated as:

$$\Delta C_{PRJ,P,t} = \Delta C_{PRJ,LB,t} + \Delta C_{PRJ,DOM,t} + \Delta C_{PRJ,HWP,t} \qquad \textbf{(30)}$$

where:

$\Delta C_{PRJ,LB,t}$ = annual change in carbon stocks in living tree biomass (above- and belowground); t C yr^{1}

$\Delta C_{PRJ,DOM,t}$ = annual change in carbon stocks in dead organic matter; t C yr^{-1}

$\Delta C_{PRJ,HWP,t}$ is the annual change in carbon stocks associated with harvested wood products, t C yr^{1}.

The annual change in carbon stocks in living tree biomass (above- and belowground) in the project scenario ($\Delta C_{PRJ,LB,t}$; t C yr^{-1}) was calculated as:

$$\Delta C_{PRJ,LB,t} = \Delta C_{PRJ,G,t} - \Delta C_{PRJ,L,t} \quad (31)$$

where:

$\Delta C_{PRJ,G,t}$ = annual increase in tree carbon stock from growth; t C yr^{-1}

$\Delta C_{PRJ,L,t}$ = annual decrease in tree carbon stock from a reduction in live biomass; t C yr^{-1}.

The annual change in carbon stocks in dead organic matter (DOM) ($\Delta C_{PRJ,DOM}$; t C yr^{-1}) in the project scenario was calculated as:

$$\Delta C_{PRJ,DOM,t} = \Delta C_{PRJ,LDW,t} + \Delta C_{PRJ,SNAG,t} + \Delta C_{PRJ,DBG,t} \quad (38)$$

where:

$\Delta C_{PRJ,LDW,t}$ = change in lying dead wood (LDW) carbon stocks in year, t; t C yr^{-1}

$\Delta C_{PRJ,SNAG,t}$ = change in snag carbon stock in year, t; t C yr^{-1}

$\Delta C_{BSL,DBG,t}$ = change in below-ground carbon stock in year, t; t C yr^{-1}.

The annual change in the carbon stored in harvested wood products (HWP), ($\Delta C_{PRJ,HWP,t}$; t C yr^{-1}) in the project scenario was calculated as:

$$\Delta C_{PRJ,HWP,t} = \Delta C_{PRJ,STORHWP,t} - \Delta C_{PRJ,EMITFOSSIL,t,} \quad (46)$$

$\Delta C_{PRJ,STORHWP,t}$ = the annual change in harvested carbon that remains in storage after conversion to wood products (t C yr^{-1})

$\Delta C_{PRJ,EMITFOSSIL,t}$ = the annual change in fossil fuel emissions from harvesting (logging and log transport) and processing of the various wood products. The project has not included the optional equipment emissions carbon pool and hence this variable = 0.

4.3. Leakage

Activity Shifting Leakage

Rotunda does not own any other properties within the country. There is no risk of activity shifting of commercial timber operations to a different property. The additional parcels owned by Rotunda covered under the same Forest Management Plan but excluded from the carbon project area are not eligible for forest harvesting due to being classified as conservation areas. Therefore, activity shifting leakage to these areas would not be possible.

Market Leakage

The methodology provides three options for market leakage. The Rotunda property has selected to apply the most current VCS Market Leakage Tool (VCS AFOLU Requirements v3.6, Section 4.6.14).

The VCS method involves applying the appropriate market leakage discount factor identified in Table 3 to the net change in carbon stock associated with the activity that reduces timber harvest.

Romania has 6,380,000 ha of forest cover and an annual allowable cut of 14.8 million m^3 (FAO). The Rotunda property is located within the Hunedoara Department, which manages 146,135 ha of public forest, containing 42,670 ha of timber production forests. In 2019, the AAC was 232,655 m^3 within the production forest.

Between 2008-2017 the Rotunda property harvested 18,141 m^3 of wood products (1,814 m^3 annually). Excluding all other harvest on private lands, this is 0.78% of the annual harvest on public lands within this region. Section 4.6.4 of the AFOLU Requirements v3.6 states that "Projects shall account for market leakage where the production of a commodity is significantly affected by the project". In regard to Section 4.6.14, Table 3, there is minimal affect on total timber harvest volumes therefore the Market Leakage Discount Factor is 0%.

Table 12: Historical Harvest Operations Within the Project Area

Year	Thinning (ha)	Regeneration Cuts (ha)	Conservation Cuts (ha)	Hygiene Cuts* (ha)	Accidental** (ha)	Total (ha)
2008-2017	1,197	1,463	8,029	715	6,737	18,141

*Hygiene cuttings are anticipated to continue through the life of the project.
**Accidental cuts are completed after a natural disturbance (drought, pest, snow, wind).

4.4. Net GHG Emission Reductions and Removals

Calculation of the Uncertainty Factor

As per the methodology monitoring section specification, the project has installed at least one field plot in each Analysis Unit (except AU 3 due to the small amount of area dispersed throughout the project area). The project has installed 28 permanent carbon plots in 2020 and 2021.

The project-level uncertainty factor is calculated by a function within the Uncertainty Calculations_20210120 excel spreadsheet, following the formulas below:

Step 1 – the project calculated the average percent model error (E_M) for the project based on the average area-weighted difference between measured values in monitored plot observations and model-predicted values using Equations 60a, b.

$$\mathbf{E_M = 100 \bullet \left(\sum y_{d,h,i} / \sum (A_{PRJ,h} \bullet y_{m,h,i})\right)} \quad \textbf{(60a)}$$

where:

The summation is across all plot observations, i, and across all analysis units, h;

$$\mathbf{y_{d,h,i} = A_{PRJ,h} \bullet (y_{p,h,I} - y_{m,h,i})} \quad \textbf{(60b)}$$

E_M = Mean model error for the project (%)

$y_{d,h,i}$ = the area-weighted difference between measured and predicted carbon storage in analysis unit, h, plot observation, i (t C)

$y_{m,h,i}$ = carbon storage measured in analysis unit, h, plot observation, i (t C ac^{-1})

$y_{p,h,i}$ = carbon storage predicted by model for analysis unit , h, plot observation, i (t C ac^{-1}) $A_{PRJ,h}$ = area of project analysis unit, h (ac)

Step 2 – The project calculated the inventory error (E_I) at a 90 percent confidence interval expressed as a percentage of the mean area-weighted inventory estimate from the measured plots. Inventory error is estimated based upon the difference between modeled and measured values for monitoring plots established in polygons grouped within analysis units.

Inventory error, E_I, is estimated by first calculating the standard error of the area-weighted differences between the plot observation measurement and the associated model-predicted carbon storage (both on a per acre basis) for analysis units. The standard error is then multiplied by the *t*- value for the 90 percent confidence interval. Finally, E_I is expressed in relative terms (in Equation 60c) by dividing the 90% confidence interval of the area-weighted differences between predicted and measured values in all plots by the area-weighted average of the measured values in all monitoring plots.

$$E_I = 100 \bullet [SE * 1.654 / ((1/N) \bullet \sum(A_{PRJ,h} \bullet y_{m,h,i}))] \quad (60c)$$

where:

E_I = Inventory error for the project (%)

SE = the project level standard error of the area weighted differences between measured plot observation and predicted values of carbon storage.

N = total number of plot observations in all analysis units 1.654 = the 90% confidence interval t-value

All other terms as defined in equation 60a.

$$SE = S/ \sqrt{N} \quad (60d)$$

where:

N = total number of plot observations in all analysis units

S = the standard deviation of the area weighted differences between measured and predicted values of carbon storage across all analysis units.

$$S = \sqrt{[(1/ N - 1) \bullet \sum(y_{d,h,i} - \bar{y}bar_d)^2]} \quad (60e)$$

where:

$ybar_d$ = the project-level mean of the area weighted differences between measured plot observation and predicted values of carbon storage. See equation 60b for the calculation of $y_{d,h,i}$

All other terms as defined in equation 60b and 60c.

Step 3 - The total error for the project (E_P; %) is calculated by adding the model and inventory error terms, as calculated in Steps 1 and 2.

$$E_P = E_M + E_I \qquad (60f)$$

Step 4 – Compare the result of Step 3 against Table 7to determine the uncertainty factor.

Table 13: Uncertainty Factor calculation.

Estimated Project Error, E_P (%)	Uncertainty Factor (= $ER_{Y,ERR}$)
0 – 10%	= 1.5%
>10%	= 1.5% + E_P – 10%

Initial Estimate of Uncertainty

Carbon plot volumes were compiled using CBM-CFS3. The inventory error term (E_I) was calculated to be 1.97% while the model error term (E_M) was 0.77%. As shown in Equation 60f, the project error term (E_P) was calculated as the sum of E_M and E_I (2.75%). Thus, the uncertainty factor ($ER_{Y,ERR}$) was calculated (based upon Table 13) to be 1.5%.

This uncertainty factor will be re-assessed at verification and adjusted annually to reflect improved field data from the project monitoring plot network.

Calculation of Gross Emissions Reductions

Gross carbon emissions reductions ($ER_{y,GROSS}$; t CO_2e yr^{-1}) created by the Rotunda Carbon Project were calculated annually as the difference between the baseline and project scenario emission reductions/emissions:

$$ER_{y,GROSS} = (\Delta C_{BSL,t} - \Delta C_{PRJ,t}) \bullet 44/12 \qquad (57)$$

Where,

$\Delta C_{BSL,t}$ = total baseline scenario emissions calculated from equation 1 (t C yr^{-1}).

$\Delta C_{PRJ,t}$ = total project scenario emissions calculated from equation 29 (t C yr^{-1}).

44/12 = factor to convert C to CO_2e

The gross emissions reductions calculated for the Rotunda project are shown in

Table 14: Ex-Ante Estimate of Emission Reductions and Leakage Related to Project Activities.

Year	Estimated baseline emissions or removals (tC)	Estimated project emissions or removals (tC)	Estimated leakage emissions (tCO2e)	Estimated net GHG emission reductions or removals (tCO2e)
2018	-155	635	0	2,898
2019	149	244	0	346
2020	7	1,211	0	4,414
2021	-3	1,212	0	4,458
2022	-63	1,214	0	4,680
2023	-438	1,217	0	6,068
2024	-197	1,219	0	5,190
2025	-514	1,224	0	6,375
2026	-301	1,224	0	5,594
2027	-330	1,224	0	5,700
2028	-476	1,105	1	5,798
2029	-503	1,104	2	5,891
2030	-526	1,103	3	5,976
2031	-549	1,101	4	6,052
2032	-569	1,100	5	6,119
2033	-584	1,103	6	6,184
2034	-600	1,104	7	6,248
2035	-615	1,105	8	6,308
2036	-628	1,104	9	6,348
2037	-646	1,102	10	6,410
2038	-705	979	11	6,174
2039	-708	977	12	6,177
2040	-710	976	13	6,182
2041	-714	973	14	6,188
2042	-720	971	15	6,201
2043	-725	969	16	6,212
2044	-727	969	17	6,219
2045	-728	971	18	6,229
2046	-732	969	19	6,240
2047	-736	968	20	6,250
Total	**-14,748**	**31,378**	**210**	**169,128**

Table 15: Ex-Ante Estimate of Verified Carbon Units (VCUs) Produced From Project Activities

Year	Estimated Gross Emissions reductions (tCO_2e)	Estimated leakage emissions (tCO_2e)	Non-Permanence Buffer Contribution (tCO_2e)	Buffer release (tCO_2e)	Annual Saleable VCU's (tCO2e)
2018	2897.6	0	347.7		2,506
2019	346.1	0	41.5		299
2020	4413.8	0	529.7		3,818
2021	4457.6	0	534.9		3,856
2022	4679.9	0	561.6	302.3	4,350
2023	6068.2	0	728.2		5,249
2024	5190.0	0	622.8		4,489
2025	6375.5	0	765.1		5,515
2026	5593.8	0	671.3		4,839
2027	5699.8	0	684.0	777.7	5,708
2028	5798.2	0	695.8		5,015
2029	5891.2	0	706.9		5,096
2030	5975.6	0	717.1		5,169
2031	6051.9	0	726.2		5,235
2032	6119.1	0	734.3	1198.1	6,491
2033	6184.1	0	742.1		5,349
2034	6248.5	0	749.8		5,405
2035	6308.2	0	757.0		5,457
2036	6347.8	0	761.7		5,491
2037	6410.5	0	769.3	1585.3	7,130
2038	6173.8	0	740.9		5,340
2039	6176.7	0	741.2		5,343
2040	6181.8	0	741.8		5,347
2041	6188.1	0	742.6		5,353
2042	6200.8	0	744.1	1904.1	7,268
2043	6212.1	0	745.4		5,373
2044	6218.9	0	746.3		5,379
2045	6228.6	0	747.4		5,388
2046	6239.9	0	748.8		5,398
2047	6249.9	0	750.0	2179.2	7,585
Total	**169,128**	**-**	**20,295**	**7,947**	**154,242**

Calculation of Net Emissions Reductions

The annual net GHG emissions reductions are calculated each year using Equation 58.

$ER_y = ER_{y,GROSS} - LE_y$ (58)

where:

ER_y = the net GHG emissions reductions and/or removals in year y (the overall annual carbon change between the baseline and project scenarios, net all discount factors except the permanence buffer) (t CO_2e yr^{-1}).

$ER_{y,GROSS}$ =the difference in the overall annual carbon change between the baseline and project scenarios (t CO_2e yr^{-1}).

LE_y = Leakage in year y (t CO_2e yr^{-1}), as calculated in equation 56.

Calculation of Voluntary Credit Units (VCUs)

The number of VCU's the Rotunda carbon project generates as available for issuance and sale in year, *y* (VCU_y; t CO_2e yr^{-1}), is calculated as:

$VCU_y = ER_y \bullet (1 - ER_{y,ERR}) - BR_y$ (59)

where:

ER_y = the net GHG emissions reductions and/or removals in year (t CO_2e yr^{-1}), as calculated in equation 58.

$ER_{y,ERR}$ = the uncertainty factor for year, y, (calculated in Section 3.4), expressed as a proportion.

BR_y = estimated VCU-equivalent tCO_2e issued to the VCS Buffer Pool in year, *y*, calculated using the latest version of the VCS Tool for AFOLU Non-Permanence Risk Analysis and Buffer (Voluntary Carbon Standard, 2008).

BRy is calculated by multiplying the most current verified permanence risk Buffer Withholding Percentage for the project by the change in carbon stocks (difference between baseline and project scenario) for the project area.

The project VCS Buffer Discount Factor (BR_Y) was calculated as 12%, as per the non-permanence risk assessment(s) referenced in Appendix 1. The BR factor will be re-assessed at each verification, as necessary.

The uncertainty factor was determined to be 1.5%, as calculated above. The uncertainty factor will be re-calculated from field plot data at each verification.

The annual VCUs projected for the Rotunda Project are shown in Table 15.

5. Monitoring

5.1. Data and Parameters Available at Validation

Data / Parameter	ABSL,i, APRJ,i
Data unit	Hectares
Description	Respective areas of baseline and project polygon, i for all project instances
Source of data	Spatial inventory data
Value applied	Each polygon has an area
Justification of choice of data or description of measurement methods and procedures applied	2018 Rotunda Management Plan
Purpose of the data	Required for baseline and project calculations
Comments	Includes delineation and identification of non-timber harvesting landbase area polygons.

Data / Parameter	CF
Data unit	t C t-1 d.m.
Description	Carbon fraction of dry matter
Source of data	IPCC 2006
Value applied	0.5
Justification of choice of data or description of measurement methods and procedures applied	Best available data
Purpose of the data	Required for baseline and project calculations

Comments	Imbedded in CBM-CFS3 EU-AIDB

Data / Parameter	Ri
Data unit	unitless
Description	Root:shoot ratio in polygon, i
Source of data	CBM-CFS3 EU-AIDB default values
Value applied	CBM-CFS3 variants calculates belowground biomass as a function of species and tree size.
Justification of choice of data or description of measurement methods and procedures applied	CBM-CFS3 data is widely reviewed and accepted.
Purpose of the data	Required for calculation of baseline and project emissions
Comments	

Data / Parameter	fBSL,NATURAL,i,t, fPRJ,NATURAL,i,t
Data unit	unitless (0 < fBSL,NATURALi, fPRJ,NATURAL,i,t < 1)
Description	The proportion of biomass that dies from natural mortality in polygon, i, year, t, in the baseline and project cases, respectively.
Source of data	Modeled by CBM-CFS3 using CBM-CFS3 EU-AIDB for Spatial Unit (SPU) 220
Value applied	Default settings in CBM-CFS3 for Spatial Unit (SPU) 220.
Justification of choice of data or description of measurement methods and procedures applied	CBM-CFS3 is widely accepted.
Purpose of the data	Required for calculation of baseline and project emissions

Comments	

Data / Parameter	fBSL,HARVEST,i,t, fPRJ,HARVEST,i,t
Data unit	unitless (0 < fBSL,HARVESTi, fPRJ,HARVEST,i,t < 1)
Description	The proportion of biomass removed by harvesting from polygon, i, in year, t, in the baseline and project cases, respectively.
Source of data	Calculated by CBM-CFS3.
Value applied	Default settings in CBM-CFS3 for Spatial Unit (SPU) 220
Justification of choice of data or description of measurement methods and procedures applied	CBM-CFS3 widely accepted.
Purpose of the data	Required for calculation of baseline and project emissions
Comments	

Data / Parameter	fBSL,DAMAGE,i,t, fPRJ,DAMAGE,i,t
Data unit	unitless (0 < fBSL,DAMAGEi, fPRJ,DAMAGE,i,t < 1)
Description	The proportion of additional biomass removed by for road and landing construction in polygon, i, year, t, in the baseline and project cases, respectively.
Source of data	As described in the management plan for road development. Monitoring data on an ex-post basis in the project scenario. (See page 11 of the management Plan for details.) 10.32km
Value applied	Variable on an ex-post basis in the project scenario - digitized in the project scenario on an ex-post basis if visible in remote sensing, or captured by standing stocking estimates. Captured within the Clearing component of the baseline scenarios.

Justification of choice of data or description of measurement methods and procedures applied	Estimated based on expert opinion based on regional experience.
Purpose of the data	Required for calculation of baseline and project emissions
Comments	

Data / Parameter	fBSL,BLOWDOWN,i,t, fPRJ,BLOWDOWN,i,t
Data unit	unitless (0 < fBSL,BLOWDOWNi, fPRJ,BLOWDOWN,i,t < 1)
Description	The proportion of live aboveground tree biomass subject to blowdown in polygon, i, year, t, in the baseline and project cases, respectively.
Source of data	Included within the natural mortality factors calculated in fBSL,NATURAL,i,t, fPRJ,NATURAL,i,t by CBM-CFS3 Also captured by spatial monitoring if >4ha, which would be incorporated as a new polygon on an ex-post basis.
Value applied	Zero for the baseline and project ex-ante calculations (part of the natural mortality modeling in CBM-CFS3).
Justification of choice of data or description of measurement methods and procedures applied	CBM-CFS3 is widely accepted.
Purpose of the data	Required for calculation of baseline and project emissions
Comments	

Data / Parameter	fBSL,BRANCH,i,t, fPRJ,BRANCH,i,t
Data unit	unitless (0 < fBSL,BRANCHi, fPRJ,BRANCH,i,t < 1)

Description	The proportion of aboveground tree biomass comprised of branches > 2 in diameter in polygon, i, year, t, in the baseline and project cases, respectively.
Source of data	Calculated within CBM-CFS3
Value applied	Variable, see source of data.
Justification of choice of data or description of measurement methods and procedures applied	CBM-CFS3 is widely accepted.
Purpose of the data	Required for baseline and project calculations
Comments	

Data / Parameter	fBSL,BUCKINGLOSS,i,t, fPRJ,BUCKINGLOSS,i,t
Data unit	unitless (0 < fBSL,BUCKINGLOSSi, fPRJ,BUCKINGLOSS,i,t < 1)
Description	The proportion of the log bole biomass left on site after assessing and/or merchandizing the log bole for quality, in polygon, i, year, t, in the baseline and project cases, respectively.
Source of data	CBM-CFS3 default values for SPU220.
Value applied	CBM-CFS3 default values for SPU220.
Justification of choice of data or description of measurement methods and procedures applied	CBM-CFS3 is widely accepted.
Purpose of the data	Required for calculation of baseline and project emissions
Comments	

Data / Parameter	fBSL,SNAGFALLDOWN,i,t, fPRJ,SNAGFALLDOWN,i,t

Data unit	unitless (0 < fBSL,SNAGFALLDOWNi, fPRJ,SNAGFALLDOWN,i,t < 1)
Description	The proportion of snag biomass in polygon, i, year, t, that falls over, in the baseline and project cases, respectively.
Source of data	Modeled by CBM-CFS3
Value applied	Variable, depending on species and dbh. Modeled by species and age class within CBM-CFS3.
Justification of choice of data or description of measurement methods and procedures applied	CBM-CFS3 is widely accepted.
Purpose of the data	Required for calculation of baseline and project emissions
Comments	

Data / Parameter	fBSL,LWDECAY,i,t, fPRJ,LWDECAY,i,t
Data unit	unitless (0 < fBSL,LWDECAYi, fPRJ,LWDECAY,i,t < 1)
Description	The annual proportional loss of lying dead biomass due to decay, in polygon i, year, t in the baseline and project cases, respectively.
Source of data	Modeled by CBM-CFS3
Value applied	CBM-CFS3 default settings for SPU220.
Justification of choice of data or description of measurement methods and procedures applied	CBM-CFS3 is widely accepted.
Purpose of the data	Required for calculation of baseline and project emissions
Comments	

Data / Parameter	fBSL,SWDECAY,i,t, fPRJ,SWDECAY,i,t

Data unit	unitless (0 < fBSL,SWDECAYi, fPRJ,SWDECAY,i,t < 1)
Description	The proportional loss of snag biomass due to decay, in polygon, i, year, t, in the baseline and project cases, respectively.
Source of data	Modeled by CBM-CFS3
Value applied	CBM-CFS3 default settings for SPU220.
Justification of choice of data or description of measurement methods and procedures applied	CBM-CFS3 is widely accepted.
Purpose of the data	Required for calculation of baseline and project emissions
Comments	

Data / Parameter	fBSL,DBGDECAY,i,t, fPRJ,DBGDECAY,i,t
Data unit	unitless (0 < fBSL,DGBDECAYi, fPRJ,DBGDECAY,i,t < 1)
Description	The proportional loss of dead belowground biomass due to decay, in polygon i, year, t, in the baseline and project cases, respectively.
Source of data	Modeled by CBM-CFS3
Value applied	CBM-CFS3 default settings for SPU220.
Justification of choice of data or description of measurement methods and procedures applied	CBM-CFS3 is widely accepted.
Purpose of the data	Required for calculation of baseline and project emissions
Comments	

Data / Parameter	EM
Data unit	%
Description	An estimate of model error based on the relative area-weighted difference between model-predicted values of carbon storage and those values measured in field plots
Source of data	Model output and field data (see Equation 60a)
Value applied	0.77%
Justification of choice of data or description of measurement methods and procedures applied	Value determined using approach described in the VM0012 Methodology
Purpose of the data	Calculation of baseline & project emissions
Comments	

Data / Parameter	EI
Data unit	%
Description	An estimate of Inventory sampling error calculated as the 90% confidence limit of the area-weighted differences between the model-predicted values of carbon storage and those values measured in field plots
Source of data	Model output and field data (see Equation 60c)
Value applied	1.97%
Justification of choice of data or description of measurement methods and procedures applied	Value determined using approach described in the VM0012 Methodology
Purpose of the data	Calculation of baseline & project emissions
Comments	

Data / Parameter	EP
Data unit	%
Description	An estimate of total project error used to determine the uncertainty factor.
Source of data	Model output and field data (see Equation 60f)
Value applied	2.75%
Justification of choice of data or description of measurement methods and procedures applied	Value determined using approach described in the VM0012 Methodology
Purpose of the data	Calculation of baseline & project emissions
Comments	

Data / Parameter	ERy,ERR,
Data unit	%
Description	The uncertainty factor calculated for year 'y' (See Section 4.4.3)
Source of data	Model output and field data (see Equation 60f)
Value applied	1.5%
Justification of choice of data or description of measurement methods and procedures applied	Value determined using approach described in the VM0012 Methodology
Purpose of the data	Calculation of baseline & project emissions
Comments	

Data / Parameter	MLF_y
Data unit	%
Description	The market leakage factor determined for year ‘y’
Source of data	Determined based upon the approach defined in Section 3.3
Value applied	0%
Justification of choice of data or description of measurement methods and procedures applied	Value determined using the latest version of the VCS Market Leakage Tool as defined in Agriculture, Forestry and Other Land Use (AFOLU) Requirements v3.6 and specified in the VM0012 Methodology
Purpose of the data	Calculation of leakage
Comments	

Data / Parameter	Component Ratio Method (Biomass Expansion Factors)
Data unit	Unitless
Description	Used to convert height and DBH into biomass of component pools. Utilized to calculate biomass measured in field plots.
Source of data	Modeled by CBM-CFS3 (FVS CRM).
Value applied	CBM-CFS3 default settings for SPU220.
Justification of choice of data or description of measurement methods and procedures applied	CBM-CFS3 is widely accepted.
Purpose of the data	Required for calculation of baseline and project emissions
Comments	

5.2. Data and Parameters Monitored

Table 16: Data and parameters monitored.

Data / Parameter	APRJ,i
Data unit	Hectares
Description	Area of forest land in polygon, i
Source of data	Latest version of the spatial inventory data.
Description of measurement methods and procedures to be applied	GIS inventory data updated from GPS coordinates and Remote Sensing data.
Frequency of monitoring/recording	Prior to every verification period
Value monitored	See inventory data
Monitoring equipment	Visual, satellite, aerial photos, LiDAR data
QA/QC procedures to be applied	Standard GIS QA/QC procedures. GreenRaise Greenhouse Gas – Monitoring Standard Operating Procedures (SOP)
Purpose of the data	Required for project calculations
Calculation method	Determined from GIS software
Comments	

Data / Parameter	APSP,i,
Data unit	Hectares
Description	Area of permanent sample plot in polygon, i
Source of data	Field measurement
Description of measurement methods and procedures to be applied	Fixed radius permanent sample plot design
Frequency of monitoring/recording	Plot measurements are repeated on 5-year intervals
Value monitored	See compiled plot data MS Excel File

Monitoring equipment	GPS, measuring tape
QA/QC procedures to be applied	GPS of plot center. GreenRaise Standard Operating Procedures (SOP) followed, including check cruising processes.
Purpose of the data	Required for determination of Uncertainty Factor
Calculation method	Measured
Comments	

Data / Parameter	$DBH_{i,t}$
Data unit	cm
Description	Diameter at breast height measured for each tree in the sample plot at time, t
Source of data	Field measure
Description of measurement methods and procedures to be applied	Field measurements in permanent sample plots. Measurement with DBH tape for trees ≥ 5cm in DBH.
Frequency of monitoring/recording	Individual plot tree re-measurements are repeated on 5-year intervals
Value monitored	See compiled plot data MS Excel File
Monitoring equipment	DBH tape, data logger
QA/QC procedures to be applied	GreenRaise Greenhouse Gas – Monitoring Standard Operating Procedures (SOP)
Purpose of the data	Required for determination of Uncertainty Factor
Calculation method	Measured
Comments	

Data / Parameter	$Height_{i,t}$
Data unit	m
Description	Tree height measured for each tree in the sample plots at time, t
Source of data	Field measure

Description of measurement methods and procedures to be applied	Field measurements in permanent sample plots. Measurement with vertex to nearest 0.1m for trees ≥ 5cm DBH.
Frequency of monitoring/recording	Individual plot tree re-measurements are repeated on 5-year intervals
Value monitored	See compiled plot data MS Excel File
Monitoring equipment	Vertex IV type Hypsometer, a transit, a clinometer, a relaskop, a laser or other instrument designed for the measuring height.
QA/QC procedures to be applied	GreenRaise Greenhouse Gas – Monitoring Standard Operating Procedures (SOP)
Purpose of the data	Required for determination of Uncertainty Factor
Calculation method	Measured
Comments	

Data / Parameter	BAG i,t
Data unit	t d.m. ac^{-1}
Description	Aboveground live tree biomass in polygon, i, year, t, in the project case.
Source of data	Permanent sample plots
Description of measurement methods and procedures to be applied	Calculated from Heighti,t, DBHi,t, and APSPi,
Frequency of monitoring/recording	Upon establishment of PSP. Every 5 years, thereafter.
Value monitored	See compiled plot data MS Excel File
Monitoring equipment	
QA/QC procedures to be applied	GreenRaise Greenhouse Gas – Monitoring Standard Operating Procedures (SOP)
Purpose of the data	Required for determination of Uncertainty Factor

Calculation method	Above ground biomass for each tree within a permanent sample plot will be calculated using plot data entered into CBM-CFS3.
Comments	

Data / Parameter	BBG i,t
Data unit	t d.m. ac^{-1}
Description	Belowground live tree biomass in polygon, i, year, t, in the project case.
Source of data	Derived from above ground biomass calculations within permanent sample plots.
Description of measurement methods and procedures to be applied	Calculated using plot data in CBM-CFS3
Frequency of monitoring/recording	Upon establishment of PSP. Every 5 years, thereafter.
Value monitored	See compiled plot data MS Excel File
Monitoring equipment	
QA/QC procedures to be applied	GreenRaise Greenhouse Gas – Monitoring Standard Operating Procedures (SOP)
Purpose of the data	Required for determination of Uncertainty Factor
Calculation method	Calculated using plot data in CBM-CFS3
Comments	

Data / Parameter	BTOTAL i,t
Data unit	t d.m. ac^{-1}
Description	Sum of BAGi,t and BBGi,t
Source of data	Derived from above ground biomass calculations within permanent sample plots.

Description of measurement methods and procedures to be applied	Sum of BAGi,t and BBGi,t
Frequency of monitoring/recording	Upon establishment of PSP. Every 5 years, thereafter.
Value monitored	Calculated using plot data in CBM-CFS3
Monitoring equipment	
QA/QC procedures to be applied	GreenRaise Greenhouse Gas – Monitoring Standard Operating Procedures (SOP)
Purpose of the data	Required for determination of Uncertainty Factor
Calculation method	Sum of BAGi,t and BBGi,t
Comments	

Data / Parameter	CLB i,t
Data unit	t C ac^{-1}
Description	Total carbon storage in live tree biomass in polygon, i, year, t, in the project case.
Source of data	Permanent sample plots.
Description of measurement methods and procedures to be applied	Calculated from BTOTALi,t and CF
Frequency of monitoring/recording	Upon establishment of PSP. Every 5 years, thereafter.
Value monitored	See compiled plot data MS Excel File
Monitoring equipment	
QA/QC procedures to be applied	GreenRaise Greenhouse Gas – Monitoring Standard Operating Procedures (SOP)
Purpose of the data	Required for determination of Uncertainty Factor
Calculation method	As calculated by CBM-CFS3 from plot data, or BTOTALi,t * CF

Comments	

Data / Parameter	CDOM i,t
Data unit	t C ac^{-1}
Description	Total carbon storage in dead organic matter in polygon, i, year, t, in the project case.
Source of data	Permanent sample plots.
Description of measurement methods and procedures to be applied	Calculated from DOMSNAGi,t and DOMLDWi,t and CF
Frequency of monitoring/recording	Upon establishment of PSP. Every 5 years, thereafter.
Value monitored	See compiled plot data MS Excel File
Monitoring equipment	
QA/QC procedures to be applied	GreenRaise Greenhouse Gas – Monitoring Standard Operating Procedures (SOP)
Purpose of the data	Required for determination of Uncertainty Factor
Calculation method	As calculated by CBM-CFS3 from plot data. Or (DOMSNAGi,t + DOMLDWi,t)* CF
Comments	

Data / Parameter	fPRJ,NATURAL,i,t
Data unit	unitless (0 < fPRJ,NATURAL,i,t < 1)
Description	The proportion of biomass that dies from natural mortality in polygon, i, year, t, in the project case.
Source of data	Permanent sample plots, remote sensing
Description of measurement methods and procedures to be applied	Height and dbh of dead trees in permanent sample plots will be recorded. Areas of stand replacing fires will be delineated if >1.0hectares.
Frequency of monitoring/recording	Annually in the case of fires, every 5 years in the case of individual plot trees
Value monitored	See compiled plot data MS Excel File
Monitoring equipment	Observation

QA/QC procedures to be applied	GreenRaise Greenhouse Gas – Monitoring Standard Operating Procedures (SOP)
Purpose of the data	Required for project calculations
Calculation method	Observation in plot, and/or calculated by CBM-CFS3 and/or GIS/GPS delineation
Comments	

Data / Parameter	fPRJ,HARVEST,i,t
Data unit	unitless (0 < fPRJ,HARVEST,i,t < 1)
Description	The proportion of biomass removed by harvesting from polygon, i, in year, t, in the project case.
Source of data	Rotunda harvesting records
Description of measurement methods and procedures to be applied	Volume derived from harvesting records. Modeled estimates of total biomass in polygon, i, used to derive parameter.
Frequency of monitoring/recording	Annually
Value monitored	See harvest areas
Monitoring equipment	GPS, remote sensing
QA/QC procedures to be applied	Data will be verified by ground-truthing and comparison with remote sensing information.
Purpose of the data	Required for project calculations
Calculation method	Modeled by CBM-CFS3 based on actual removals
Comments	

Data / Parameter	fPRJ,DAMAGE,i,t
Data unit	unitless (0 < fPRJ,DAMAGE,i,t < 1)
Description	The proportion of additional biomass removed for road and landing construction in polygon, i, year, t, in the project case.
Source of data	Remote sensing
Description of measurement methods and procedures to be applied	A real estimate of removals derived from remote sensing data and construction records.

Frequency of monitoring/recording	Annually
Value monitored	See GIS delineations construction records
Monitoring equipment	Aerial photos
QA/QC procedures to be applied	Data will be verified by ground-truthing or remote sensing information.
Purpose of the data	Required for project calculations
Calculation method	Areal estimate of removals is multiplied by average carbon density within a polygon.
Comments	

Data / Parameter	DOMSNAG,i,t
Data unit	t d.m. ac^{-1} (d.m. = dry matter)
Description	Total mass of dead organic matter contained in standing dead wood in polygon, i, year, t in the project case.
Source of data	Permanent sample plots
Description of measurement methods and procedures to be applied	Calculated from Heighti,t, DBHi,t, and APSP,i of dead trees measured in permanent sample plots
Frequency of monitoring/recording	Every 5 years
Value monitored	See compiled plot data MS Excel File
Monitoring equipment	n/a
QA/QC procedures to be applied	GreenRaise Greenhouse Gas – Monitoring Standard Operating Procedures (SOP)
Purpose of the data	Required for determination of Uncertainty Factor
Calculation method	Calculated by CBM-CFS3 from plot data
Comments	

Data / Parameter	DOMLDW,i,t
Data unit	t d.m. ac^{-1} (d.m. = dry matter)
Description	Total mass of dead organic matter contained in lying dead wood in polygon, i, year, t in the project case.
Source of data	Permanent sample plots

Description of measurement methods and procedures to be applied	Calculated from the line intersect method (GreenRaise Greenhouse Gas – Monitoring Standard Operating Procedures (SOP))
Frequency of monitoring/recording	Every 5 years
Value monitored	See compiled plot data MS Excel File
Monitoring equipment	Tape and visual inspection
QA/QC procedures to be applied	GreenRaise Greenhouse Gas – Monitoring Standard Operating Procedures (SOP)
Purpose of the data	Required for determination of Uncertainty Factor
Calculation method	Calculated using the following field- measured parameters Li,t, dni,t, DLDWc,i,t , and N i,t
Comments	

Data / Parameter	VLDW,i,t
Data unit	m^3 ha^{-1}
Description	Total volume of dead organic matter contained in lying dead wood in polygon, i, year, t in the project case.
Source of data	Permanent sample plots
Description of measurement methods and procedures to be applied	Calculated from the line intersect method (GreenRaise Greenhouse Gas – Monitoring Standard Operating Procedures (SOP)).
Frequency of monitoring/recording	Every 5 years
Value monitored	See compiled plot data MS Excel File
Monitoring equipment	Tape and visual inspection
QA/QC procedures to be applied	GreenRaise Greenhouse Gas – Monitoring Standard Operating Procedures (SOP)
Purpose of the data	Required for determination of Uncertainty Factor
Calculation method	Calculated using the following field- measured parameters Li,t, DLDWc,i,t , and N i,t
Comments	

Data / Parameter	Li,t

Data unit	m
Description	Calculation of lying dead wood: Length of the transect used to determine volume of lying dead wood in the sample plot, at time, t (default 100m)
Source of data	Permanent sample plots
Description of measurement methods and procedures to be applied	Field measurements
Frequency of monitoring/recording	Every 5 years
Value monitored	50m per transect
Monitoring equipment	Tape
QA/QC procedures to be applied	GreenRaise Greenhouse Gas – Monitoring Standard Operating Procedures (SOP)
Purpose of the data	Required for determination of Uncertainty Factor
Calculation method	
Comments	

Data / Parameter	Dn,i,t
Data unit	cm
Description	Calculation of lying dead wood: Diameter of each piece n of dead wood along the transects in the sample plot at time, t
Source of data	Permanent sample plots
Description of measurement methods and procedures to be applied	Lying dead wood must be sampled using the line intersect method (Harmon & Sexton, 1996). Two 50-m lines are established bisecting each plot and the diameters of the lying wood (> 4 in diameter) intersecting the lines are measured. Minimum measurement diameter must not be less than 5 cm.
Frequency of monitoring/recording	Every 5 years
Value monitored	See compiled plot data MS Excel File
Monitoring equipment	Caliper, diameter tape

QA/QC procedures to be applied	GreenRaise Greenhouse Gas – Monitoring Standard Operating Procedures (SOP)
Purpose of the data	Required for determination of Uncertainty Factor
Calculation method	
Comments	

Data / Parameter	Ni,t
Data unit	unitless
Description	Total number of wood pieces intersecting the transect in the sample plot, in time t.
Source of data	Field Measurement
Description of measurement methods and procedures to be applied	Lying dead wood is sampled using the line intersect method (Harmon & Sexton, 1996). Two 50-m lines are established bisecting each plot and the total number of wood pieces intersecting transect are counted.
Frequency of monitoring/recording	Every 5 years
Value monitored	See Plot Data MS Excel file.
Monitoring equipment	Visual observation
QA/QC procedures to be applied	GreenRaise Greenhouse Gas – Monitoring Standard Operating Procedures (SOP)
Purpose of the data	Required for determination of Uncertainty Factor
Calculation method	
Comments	

Data / Parameter	EM
Data unit	%
Description	An estimate of model error
Source of data	Model output and field data
Description of measurement methods and procedures to be applied	Calculated value determined difference between of model- predicted values of carbon storage and those values measured in field plots (see Equation 60a)
Frequency of monitoring/recording	At each verification

Value monitored	0.77%
Monitoring equipment	N/A
QA/QC procedures to be applied	N/A
Purpose of the data	Required for determination of Uncertainty Factor
Calculation method	Equation (60a)
Comments	

Data / Parameter	EI
Data unit	%
Description	An estimate of Inventory sampling error
Source of data	Model output and field data
Description of measurement methods and procedures to be applied	Calculated as the 90% confidence limit of the area-weighted differences between the model-predicted values of carbon storage and those values measured in field plots
Frequency of monitoring/recording	At each verification
Value monitored	1.97%
Monitoring equipment	
QA/QC procedures to be applied	
Purpose of the data	Required for determination of Uncertainty Factor
Calculation method	Equation (60c)
Comments	

Data / Parameter	EP
Data unit	%
Description	An estimate of total project error calculated as the sum of the model and inventory error terms
Source of data	Model output and field data
Description of measurement methods and procedures to be applied	Calculated as the sum of EM and EI (Equation 60e)
Frequency of monitoring/recording	At each verification

Value monitored	2.75%
Monitoring equipment	
QA/QC procedures to be applied	
Purpose of the data	Required for determination of Uncertainty Factor
Calculation method	Equation (60f)
Comments	

Data / Parameter	ERy,ERR
Data unit	%
Description	The uncertainty factor calculated for year 'y'
Source of data	Model output and field data
Description of measurement methods and procedures to be applied	Calculated value
Frequency of monitoring/recording	At each verification
Value monitored	1.5%
Monitoring equipment	
QA/QC procedures to be applied	
Purpose of the data	Required for project calculations
Calculation method	
Comments	

Data / Parameter	MLFy
Data unit	%
Description	The market leakage factor determined for year 'y'
Source of data	Model output and field data
Description of measurement methods and procedures to be applied	Determined based upon the approach defined in Section 3.3
Frequency of monitoring/recording	At each verification
Value monitored	0%
Monitoring equipment	

QA/QC procedures to be applied	
Purpose of the data	Calculation of leakage
Calculation method	Value determined using the latest version of the VCS Market Leakage Tool as defined in Agriculture, Forestry and Other Land Use (AFOLU) Requirements v3.6 and specified in the VM0012 Methodology
Comments	

5.3. Monitoring Plan

The objective of the project monitoring plan is to reliably monitor changes in carbon stocks related to the calculation of VCU's prior to each verification. In particular, the program will monitor changes in spatial forest inventory conditions and collect field data on carbon stocks to compare against modeled carbon stocks and to calculate an uncertainty factor.

Ongoing monitoring is the primary operational task for the project, which will be completed by the carbon project manager and Rotunda onsite supervisor.

At each verification, reported on an annualized basis, the project will make the following inventory updates, as applicable:

1. Collect geo-referenced information on new project activities, including any forest management or silvicultural activities on any project instance that materially affects GHG emissions.
2. Annually monitor for forest disturbances through remote sensing, field observation, and/ or aerial observation.

The inventory will be updated at a minimum, for:

1. Natural disturbance events > 4 hectares (for example, fires, high mortality pest and disease areas, blowdown areas, slides, etc.).
2. Project activities (e.g., timber harvesting/ thinning, road construction/ reclamation, reforestation/restoration, etc.). A minimum polygon size of 1 hectare can be used but is not a mandatory minimum.
3. Unplanned anthropogenic disturbances (for example, non-de minimis illegal or unplanned harvests) affecting a non-de minimis amount of carbon stocks.

These monitored spatial elements will be updated in the project GIS inventory database and the Rotunda inventory database (or equivalent) annually, or at minimum at each verification on an annualized basis.

Other Monitoring Requirements:

Rotunda will also document the following:

1. Activity shifting leakage (monitored annually, reported at each verification) – the project will report and assess the activity shifting leakage risks based on the timber harvest levels on lands owned or controlled by Rotunda that are outside the project area.
2. Market leakage calculations (at each verification, applied annually) - market leakage calculations will be confirmed at each verification using the latest plot inventory data and best available regional leakage area analysis.

At verification, the project will update the inventory, uncertainty calculations, and carbon calculations from field plot measurement data as outlined in Sections 4.2 and 5.3. The project may also undertake the following monitoring related tasks as appropriate:

1. Refine the project analysis units based on new forest inventory data or to meet the needs of future project instances;
2. Refine or calibrate carbon models based on updated inventory data, as appropriate;
3. Update or modify inventory polygons base on updated remote sensing, forest inventory data, or field truthing, or as a result of project activities or disturbances.

All inventory, data, and modeling changes must be applied equally to the baseline and project carbon calculations, as applicable.

As per Section 0, note that the project may choose to (but is not required to) claim a leakage mitigation credit in future verifications. This will require the determination of a monitoring program for this leakage mitigation process, which can be added and verified at the verification period where it becomes applicable.

Carbon Stock Field Plot Monitoring

The Rotunda Rural Forest Carbon Project was initiated with inventory work completed in 2017 using a fixed radius and geo-located plot network for monitoring changes in stand-level forest volume and merchantable timber. A statistical inventory was carried out over 212.47 ha or approximately 14% of the 1,556 ha in the Forest Fund.

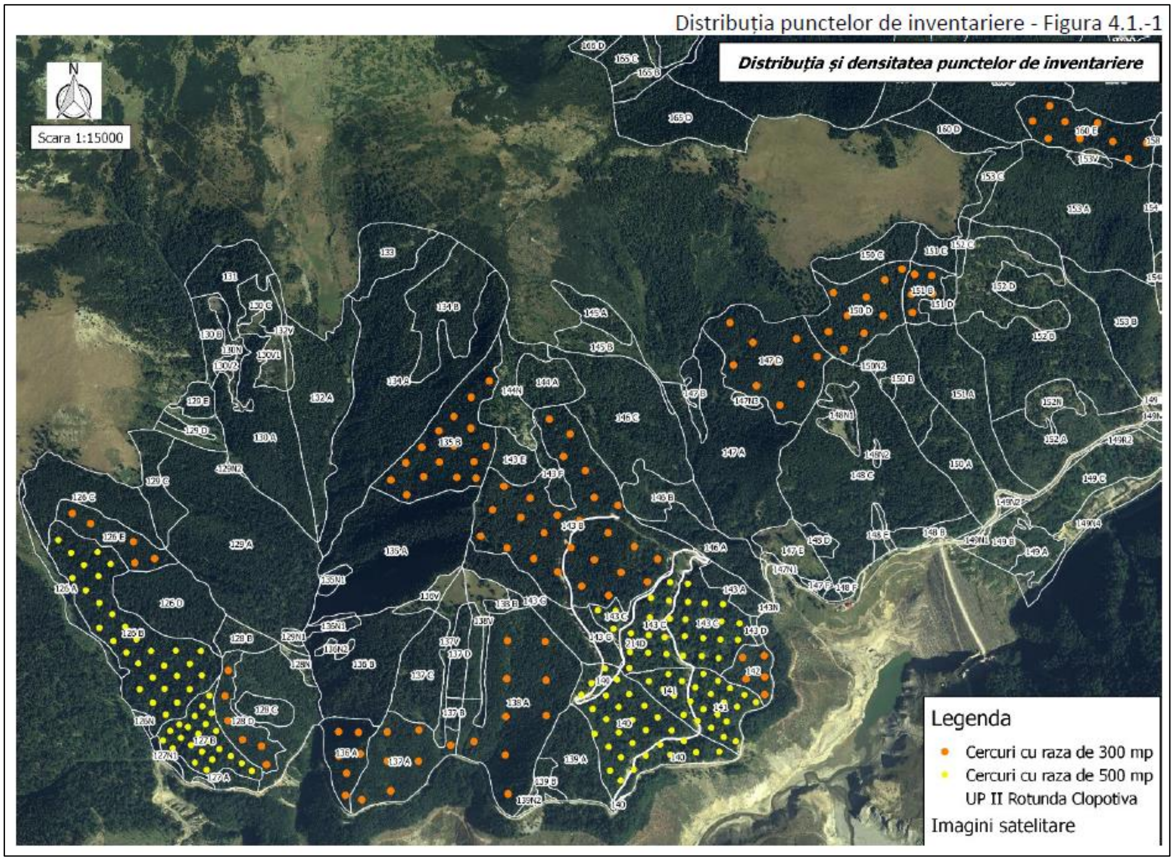

Figure 4: Fixed radius plots utilized for forest inventory calculations in 2017.

All historical and Rotunda monitoring to date has been incorporated into the property inventory and GIS data updates used in this project design document.

The new plot monitoring program for carbon stocks will establish new permanent sample plots within the analysis units. Each plot will collect data on overstory trees, dead standing trees, and lying deadwood. As part of ongoing project monitoring the project will periodically review the need for additional permanent sample plots or incorporation of other forest and carbon inventory updates or improvements over time. The methodology does not specify a number of plots, with error over the target (10% @ 90%CI) being accounted for in the uncertainty factor deduction (Section 4.4).

Monitoring Carbon Plot Sampling Design Overview:

A total of 28 PSPs were planned for establishment within the project area, with each analysis unit containing 4 plots. Analysis units 3 (management unit J, softwood stands on poor sites) and 7 (management unit M, softwood stands on poor sites) were combined due to the spatial restrictions and small total area (1.34 ha) of management unit 3. Subsequently, the plots established in the new combined analysis unit were used for verification of carbon estimates modelled in analysis units 3 and 7.

Although 28 plots were planned for measurement, weather conditions restricted access to the entire project area. Crews were able to establish and measure 24 plots at the time of project submission, with the intent of completing the sampling protocol when weather conditions permit.

Plot Layout - Permanent plot locations were located using UTM coordinates randomly selected via GIS analysis tools. Plot locations were buffered by 60m from anthropogenic features such as roads and cutblocks, and from the analysis unit boarder. Buffering was completed to minimize the possible influence of edge effects on plot locations. A minimum buffer distance of 50m was also implemented between plots to ensure an appropriate distribution.

Size and Shape of Sample Plots – Permanent sample plots will be circular with a fixed radius of 11.29m (400m^2).

Plot measurements – plots are installed, measured, and re-measured following the latest version of the GreenRaise Greenhouse Gas – Monitoring Standard Operating Procedure (SOP). Plot measurements include live trees (aboveground live biomass); standing dead trees (aboveground dead biomass); and lying dead wood (aboveground dead biomass).

Given the dynamics of forest processes, the permanent plots will be re-measured at intervals not exceeding 5 field season years, beginning at the year of installation. As noted, permanent plots may be established over multiple years, and such re-measurement schedules will be tracked for each plot based on its establishment year.

Biomass Estimations from Plot Data:

Trees – standing live and dead tree biomass is calculated from plot data using the CBM-CFS3 model.

Lying Deadwood – the mass of lying deadwood was measured in the plots using the line intersect method. Following the Plot SOP, two permanently marked 50m transect lines were placed at right angles across the plot center. The diameters of all pieces of wood ≥5cm diameter that intersect the line were measured and assigned to one of three density classes: sound (1), intermediate (2), and rotten (3).

The volume per unit area was calculated for each density class using Equations 60a-c (pg 75), as described in the VM0012 methodology.

The density of lying deadwood in the classes was assumed to be 0.58, 0.37, 0.24 (t m-3) for hard woods (Muller-Using and Bartsch 2009), and 0.45, 0.39, and 0.22 (t m-3) for soft woods (Petrillo et al. 2016) in the sound, intermediate, and rotten classes, respectively. The total mass of lying deadwood was calculated as the average of all transects.

Volume (m3 /ha) =π 2 * [($d_1^2 + d_2^2$ …….d_n^2) / 8L]

Where d_1, d_2, d_n = diameter (cm) of each of the n pieces intersecting the line, and L = the length of the line.

Quality Assurance/Quality Control Measures (QA/QC):

Rotunda has standard operating procedures for: (1) collecting reliable field measurements; (2) verifying laboratory procedures; (3) verifying data entry and analysis techniques; and (4) data maintenance and archiving.

QA/QC for Field Measurements - the plot network was installed by trained field crews with previous experience installing similar permanent plots and forestry related experience. The GreenRaise Greenhouse Gas Monitoring SOP requires blind check-cruises of a minimum of 10% of the plots, with 100% re-measurement of all variables which meet met the minimum DBH, height, and tree count accuracy thresholds (+/- 10% standard error at 90% confidence interval). This meets the methodology QA/QC 10% check cruise requirement. Data results will be reported in the project monitoring plan for each verification.

QA/QC for Laboratory Measurements - no laboratory measurements were taken for the Rotunda sampling, and so this section is This section is intentionally left blank.. See GreenRaise GHG – Monitoring SOP.

QA/QC for Data Entry - Field data is collected on digital data recorders and is transferred electronically to minimize data entry and transfer errors. If there are anomalies that cannot be resolved noted within plot data, the plot will be re-measured, or data will be omitted from the analysis.

QA/QC for Data Archiving - Rotunda has document control procedures which apply to the carbon monitoring data, including retaining the following for 2 years past the duration of the project: original electronic copies of the field measurement, check plots, and related data summaries; copies of monitoring data analyses, models, model input and output files, carbon calculations required for this methodology, GIS inventory dated by year, and copies of the monitoring reports; records of the version and relevant change history of software or data storage media changed between monitoring periods.

6. References

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Appendix 1 – Non-Permanence Risk Report

Appendix 2 – Output from CBM-CFS3 Model Runs

Table 17: Delta (Change) for Total Ecosystem in the Baseline and Project Scenario (tC)

Time Step (BSL Rd V2 Default Simulation Assumption)	Delta Total Ecosystem(BSL Rd V2 Default Simulation Assumption)	Delta Total Ecosystem(PRJ Rd-HWP Default Simulation Assumption)
0.0	0.0	0.0
1.0	-154.8	757.0
2.0	149.1	799.5
3.0	7.5	1211.2
4.0	-3.2	1212.5
5.0	-62.8	1213.5
6.0	-437.7	1217.3
7.0	-196.9	1218.5
8.0	-514.5	1224.3
9.0	-301.3	1224.2
10.0	-330.5	1224.0
11.0	-476.2	1105.1
12.0	-502.6	1104.1
13.0	-526.3	1103.4
14.0	-549.2	1101.3
15.0	-569.2	1099.7
16.0	-583.9	1102.7
17.0	-600.3	1103.9
18.0	-615.4	1105.0
19.0	-627.6	1103.6
20.0	-646.0	1102.3
21.0	-704.7	979.0
22.0	-708.0	976.6
23.0	-709.8	976.2

Time Step (BSL Rd V2 Default Simulation Assumption)	Delta Total Ecosystem(BSL Rd V2 Default Simulation Assumption)	Delta Total Ecosystem(PRJ Rd-HWP Default Simulation Assumption)
24.0	-714.2	973.5
25.0	-720.1	971.0
26.0	-725.4	968.8
27.0	-727.4	968.7
28.0	-727.8	970.9
29.0	-732.4	969.4
30.0	-736.5	968.0

Table 18: CBM-CFS3 output table for the baseline (BSL) scenario in each of the modeled ecosystem pools for each simulation year. Total Ecosystem, Biomass (Aboveground + belowground), deadwood and litter (tC).

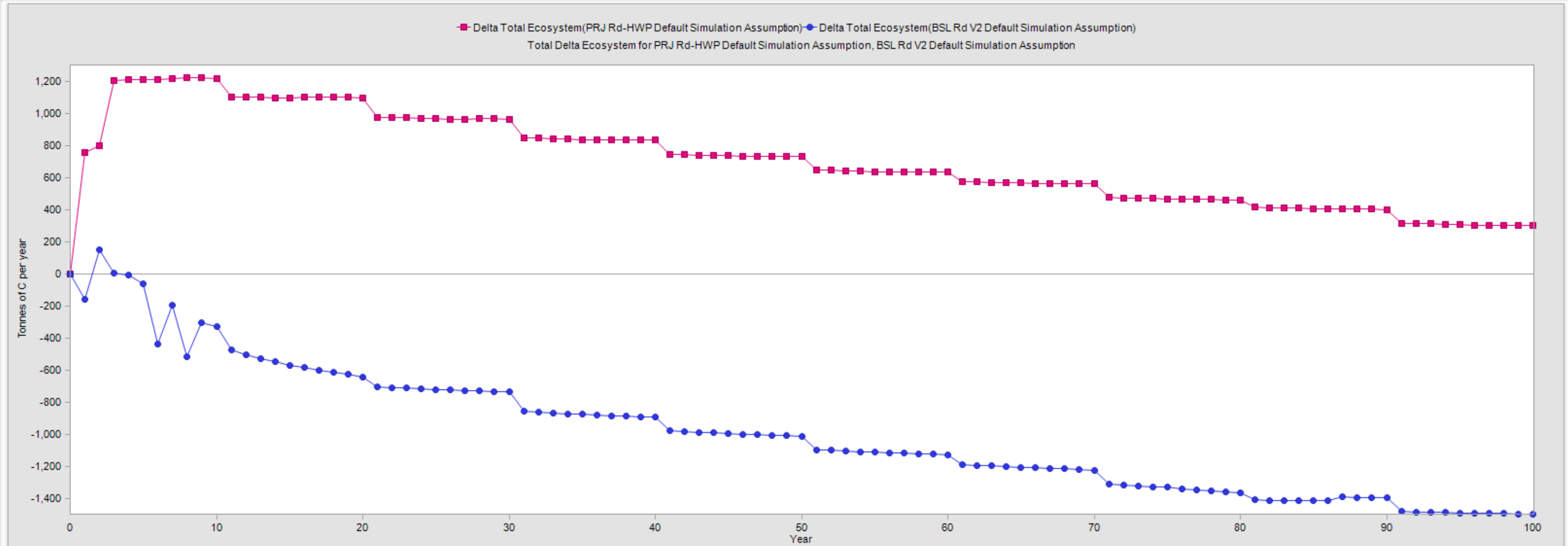
BSL Time Step	Total Ecosystem	Biomass	Aboveground Biomass	Belowground Biomass	Deadwood	Litter
0	322084	181621	147862	33758	20074	26652
1	321929	180385	146845	33540	20514	27180
2	322078	179884	146430	33454	20876	27463
3	322085	179270	145923	33347	21200	27741
4	322082	178752	145495	33257	21486	27964
5	322019	178231	145064	33167	21739	28163
6	321582	177170	144191	32979	21982	28467
7	321385	176650	143761	32889	22174	28599
8	320870	175655	142944	32711	22360	28822
9	320569	175129	142510	32619	22510	28902
10	320238	174599	142073	32526	22643	28970
11	319762	173947	141536	32411	22760	29026
12	319260	173295	140999	32296	22862	29069
13	318733	172643	140462	32181	22949	29101
14	318184	171991	139926	32065	23021	29121
15	317615	171343	139393	31950	23080	29131
16	317031	170694	138859	31835	23132	29133
17	316431	170040	138321	31719	23180	29127

BSL Time Step	Total Ecosystem	Biomass	Aboveground Biomass	Belowground Biomass	Deadwood	Litter
18	315815	169384	137781	31603	23222	29113
19	315188	168714	137228	31486	23271	29093
20	314542	168053	136683	31370	23302	29064
21	313837	167391	136138	31254	23297	29013
22	313129	166735	135598	31138	23289	28957
23	312419	166084	135062	31022	23278	28896
24	311705	165436	134529	30907	23264	28831
25	310985	164782	133990	30791	23252	28764
26	310260	164128	133453	30675	23237	28694
27	309532	163482	132922	30559	23217	28621
28	308804	162838	132394	30445	23195	28545
29	308072	162192	131863	30329	23174	28467
30	307336	161546	131332	30214	23150	28388

Table 19: CBM-CFS3 output table for the project (PRJ) scenario in each of the modeled ecosystem pools for each simulation year. Total Ecosystem, Biomass (Aboveground + belowground), deadwood and litter (tC).

PRJ Time Step	Total Ecosystem	Biomass	Aboveground Biomass	Belowground Biomass	Deadwood	Litter
0	322084	181621	147862	33758	20074	26652
1	322841	181818	148030	33789	20272	26953
2	323640	182204	148351	33853	20466	27163
3	324851	183223	149192	34031	20538	27275
4	326064	184237	150029	34208	20612	27389
5	327277	185248	150864	34384	20688	27504
6	328495	186258	151699	34560	20765	27619
7	329713	187267	152531	34735	20844	27735
8	330937	188277	153366	34911	20925	27852
9	332162	189284	154198	35086	21006	27969
10	333386	190288	155027	35261	21089	28087
11	334491	191172	155758	35414	21174	28204
12	335595	192054	156487	35567	21259	28320

PRJ Time Step	Total Ecosystem	Biomass	Aboveground Biomass	Belowground Biomass	Deadwood	Litter
13	336698	192936	157216	35720	21344	28434
14	337800	193815	157942	35872	21430	28548
15	338899	194691	158667	36024	21517	28660
16	340002	195571	159394	36177	21604	28772
17	341106	196451	160122	36329	21693	28883
18	342211	197331	160849	36481	21781	28994
19	343315	198208	161575	36633	21871	29105
20	344417	199084	162299	36784	21960	29215
21	345396	199836	162922	36914	22051	29323
22	346372	200587	163543	37044	22142	29430
23	347349	201339	164165	37173	22232	29535
24	348322	202089	164786	37303	22323	29639
25	349293	202837	165406	37432	22414	29741
26	350262	203584	166024	37560	22505	29842
27	351231	204331	166642	37689	22595	29943
28	352201	205080	167262	37818	22686	30042
29	353171	205828	167881	37947	22777	30141
30	354139	206574	168499	38075	22869	30239



	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Delta Total Ecosystem(PRJ Rd-HWP Default Simulation Assumption)	0	757	800	1,211	1,212	1,214	1,217	1,219	1,224	1,224	1,224	1,105	1,104	1,103	1,101	1,100	1,103
Delta Total Ecosystem(BSL Rd V2 Default Simulation Assumption)	0	-155	149	7	-3	-63	-438	-197	-514	-301	-330	-476	-503	-526	-549	-569	-584

	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Delta Total Ecosystem(PRJ Rd-HWP Default Simulation Assumption)	1,104	1,105	1,104	1,102	979	977	976	973	971	969	969	971	969	968	850	848
Delta Total Ecosystem(BSL Rd V2 Default Simulation Assumption)	-600	-615	-628	-646	-705	-708	-710	-714	-720	-725	-727	-728	-732	-736	-857	-861

Figure 5: CBM-CFS graphical output of Delta Total Ecosystem between Baseline (blue) and Project (pink) scenario (tC).

Appendix 3 – Supporting Data Files

The following table identifies the key data files used for calculating all aspects of the Project Development Document. All additional files not submitted here will be provided to the Auditors upon request.

Table 20: List of reporting document files used in the formation of the Rotunda Project Development Document

Description	Filename	Format	Date
Spatial inventory data for the Rotunda project area	Rotunda_ProjectLocation	Arc database	TBD
Forest inventory data used for modelling	Os5004a (DB).xls Os5004s (DB).xls	Microsoft Excel	2020-11-18 2020-11-27
Rotunda growth curves for projecting forest growth	Growth Curves.xls	Microsoft Excel	2020-10-23
CBM-CFS3 Input project and baseline data files	Input All Run BSL (20201023) – Roaded.xls Input All Run PRJ (20201120) – BuiltHWP.xls	Microsoft Excel	2020-11-11 2021-01-22
Carbon projection export files from CBM-CFS3	PRJ Above BM DOM FA All (V2).xls PRJ Above BM DOM FA MOII.xls PRJ Above BM DOM FA MOI-II.xls PRJ Above BM DOM FA MOIV.xls	Microsoft Excel	2021-01-21 2021-01-21 2021-01-21 2021-01-21
CBM-CFS3 Calibration tool for European Forests (Provided by Natural Resources Canada)	ArchiveIndex_Beta_Install_EU_IV.mdb	Microsoft Access Database	2021-01-14
Rotunda Risk Report Calculation Tool for VM0012 projects	Rotunda – VCS-Risk-Report-Calculation-Tool-v4.0.xls	Microsoft Excel	2021-01-25
Rotunda Uncertainty Calculation Tool for VM0012 projects	Uncertainty Calculaitons_20210120.xls	Microsoft Excel	2021-01-21
Rotunda monitoring plot locations	Rotunda_AUSamplingALL_Jan2021.pdf	Adobe Acrobat Document	2021-01-02