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Municipality of North Cowichan (MNC) Carbon Project Feasibility Assessment

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List of Acronyms

3GT:	3GreenTree Ecosystem Services Ltd.
ASL:	Activity shifting leakage
AFOLU:	Agriculture, Forestry and Other Land Use
BAU:	Business-as-usual
BCFCOP:	British Columbia Forest Carbon Offset Protocol
CAR:	California Action Reserve
CCB:	Climate, Community and Biodiversity
CH_4:	Methane
CO_2e:	Carbon dioxide equivalent
CORSIA:	Carbon Offsetting and Reduction Scheme for International Aviation
DCF:	Discounted Cash Flow
EM:	Ecosystem Marketplace
ERA:	Extended Rotation Age / Cutting Cycle
FAC:	Forest Advisory Committee
FMP:	forest management plan
GHG:	Greenhouse Gas
ICAO:	International Civil Aviation Organization
IFM:	Improved Forest Management
LiDAR:	Light Detection and Ranging
LtHP:	Low-Productive to High-Productive Forest
LtPF:	Logged to Protected Forest
MFR:	Municipal Forest Reserve
ML:	Market leakage
MNC:	Municipality of North Cowichan
NBS:	Nature-Based Solutions
N_2O:	Nitrous oxide
NPV:	Net Present Value
PDD:	Project Design Document
REDD:	Reduced Emissions from Deforestation and Degradation
RIL:	Reduced Impact Logging
SSR:	Sources, sinks, and reservoirs
TV:	Terminal value
VCS:	Verified Carbon Standard
VRI:	Vegetation Resource Inventory

Section 1 - Introduction

Nature-based solutions

Nature-Based Solutions (NBS) are the ways natural systems can be managed to mitigate carbon emissions and minimize negative impacts on ecosystem services. Forest carbon projects are one example of an NBS. When structured appropriately, a forest ecosystem is management such that it generates carbon credits, which are greenhouse gas (GHG) mitigation outcomes that can be used to compensate for emissions created elsewhere[1].

Carbon credits are used by firms or individuals as a means for offsetting their activity-related emissions. One criticism is that rather than investing in decarbonizing or reducing GHG-intensive activities, instead they constitute a "license to pollute", which results in no net-benefit for the environment. There are, however, strong arguments for their use as a tool for NBS[2]:

- The private sector pays for carbon offsets, which allows capital to flow directly to priority areas for NBS that have been traditionally underfunded.
- There are now robust carbon offset frameworks that provide strong measuring, reporting and verification requirements to ensure projects result in genuine benefits.
- Carbon offsets can lower compliance costs for entities that must reduce their carbon footprint.
- Cost-effective mitigation options like offsets will help lower the overall costs of transitioning to a low-carbon economy.
- Carbon offsets broaden sources of revenue to the forest sector beyond timber extraction (conservation-based management, for example).

To ensure a carbon project delivers benefits to the atmosphere, emission reductions must be:

- Real: Conservative baselines are used as the counterfactual against which emission reductions are evaluated to ensure project benefits are not exaggerated.
- Permanent: Risks of unplanned reversals of the GHG benefits are mitigated or reduced.
- Additional: The emissions reductions would not have taken place without the carbon project.
- Verifiable: The emissions reductions can be demonstrated to have occurred.
- Avoid Leakage: These are no net increases in emissions by GHG sources that occur outside the project boundary, which are attributable to the project.

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[1] The terms 'carbon credit' and 'carbon offset' are often used interchangeably. In practice, a carbon project generates credits. Credits have no inherent value, however, until they are used to reduce (offset) the impact of the same amount of GHG emissions elsewhere, hence the conflation of terms.

[2] After Monahan et al. 2020. NATURE-BASED SOLUTIONS: POLICY OPTIONS FOR CLIMATE AND BIODIVERSITY. Smart Prosperity Institute, University of Ottawa, Ottawa, ON. (institute.smartprosperity.ca).

As part of a broader mandate[3], 3GreenTree[4] was engaged by the Municipality of North Cowichan (MNC) to undertake a feasibility analysis of its current fee-simple forest property portfolio (the Municipal Forest Reserve) as the basis for a carbon project. The general intent is to use the sale of carbon credits to finance and support alternative methods of property management and reduce overall carbon emissions, preserve or enhance additional ecological services, and support socioeconomic and conservation objectives. The analysis does not include consideration of potential future property acquisitions by MNC, or provisions for incorporating private landowners into the project, within the municipal boundary[5].

The overall objectives of this feasibility assessment are to determine: 1. If an MNC forest carbon project would meet the requirements of one or more, internationally recognized standards; 2. If there are any significant risks to project development or operations; and 3. Estimate the carbon credits and financial returns under different potential management scenarios.

Section 2 – Methodology requirements

Choice of Carbon Standard

Carbon standards define a set of rules which lead to a certification that carbon credits arising from offset projects comply with environmental and/or social criteria. Each standard sets its own requirements and certification criteria.

A number of carbon standards would likely be applicable to a forest carbon project in the MNC. These include the Verified Carbon Standard (VCS), California Action Reserve (CAR), California Air Resources Board, the British Columbia Forest Carbon Offset Protocol (BCFCOP), and the American Carbon Registry. Each standard has its strengths and weaknesses[6], the details of which are beyond the scope of this document. In the opinion of 3GreenTree, however, the VCS represents the standard best aligned with the goals and objectives of the MNC (details below). It is regionally applicable, flexible in its approach and application, and includes robust procedures for risk assessment and mitigation.

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[3] Evaluation of multi-objective forest management strategies and options for the North Cowichan Municipal Forest towards the development of interim and long-term sustainable forest management plans**.**

[4] 3GreenTree Ecosystem Services, Ltd. is a turn-key forest carbon project development company. It was the principal developer in several leading voluntary carbon projects in North America, including the 44,000 ha Darkwoods Forest Carbon Project in Nelson, British Columbia, and the 2,800 ha Afognak Forest Carbon Project near Kodiak, Alaska. The firm built one of the first forestry methodologies approved under the Verified Carbon Standard (VM0012).

[5] Should these circumstances prevail, the project would need to be defined as a 'Grouped project'. Grouped projects provide for the inclusion of new project activity instances (e.g., private lands) subsequent to the initial validation of the project (see Section 8 - Additional considerations).

[6] Kenneth R Richards & Grant E Huebner (2012) Evaluating protocols and standards for forest carbon-offset programs, Part A: additionality, baselines and permanence, Carbon Management, 3:4, 393-410, DOI: 10.4155/cmt.12.38; Part B: leakage assessment, wood products, validation and verification, Carbon Management, 3:4, 411-425, DOI: 10.4155/cmt.12.39

Project Eligibility

Under VCS, there are two forest carbon project categories, 'Improved Forest Management (IFM)' and 'Reduced Emissions from Deforestation and Degradation (REDD)'[7] , which fall under their Agriculture, Forestry and Other Land Use (AFOLU) subprogram. Eligible IFM activities are planned forest management practices that increase carbon sequestration and/or reduce GHG emissions on forest lands managed and maintained for wood products such as sawtimber, pulpwood and fuelwood. Eligible REDD activities are those that reduce net GHG emissions by reducing deforestation and/or degradation of forests. Deforestation is the direct, human-induced conversion of forest land to non-forest land. Degradation is the unplanned but permanent reduction of carbon stocks in a forest due to human activities such as animal grazing, fuelwood extraction, timber removal or other such activities, but which does not result in the conversion of forest to non-forest land (this would be classified as deforestation).

The key to determining which of IFM and REDD is the most applicable to the MNC is an understanding of how current and future land use activities impact carbon emissions. The basis for a carbon project is the Municipal Forest Reserve (MFR). An area of 5,344 ha, the lands were acquired from non-payment of taxes during the 1930's and 40s, and in 1946, were formally recognized by council. The MFR remained un-managed until the 1960s when a consulting forester was hired to create a Forest Management Plan. The outcome of this plan was to divide the MFR into ten woodlots that were harvested by local operators by "diameter limit cutting," which permitted the logging of trees greater than a set diameter. This practice continued until 1981 when local concerns over the future of the forests initiated the creation of a Forestry Advisory Committee (FAC). The FAC consisted of volunteers from the Municipality with experience in forest resources management. The FAC was asked by Council to recommend future management options and operational budgets for the MFR. In 1981, the FAC report entitled "Management of the Forester Reserves – An Investment in the Future" has served to guide management of the MFR to the present day.

The MFR is located to the north and east of Duncan, entirely within the District Municipal boundaries, in six major landholdings, Mt. Prevost, Mt. Sicker, Maple Mountain, Mt. Richards, Mt. Tzouhalem, and Stony Hill. Other smaller, isolated blocks are present, most notably in Copper Canyon. Most of the MFR lies within the Coastal Western Hemlock Dry Maritime biogeoclimatic sub-zone, but small eastern portions are classified as Coastal Douglas-fir Moist Maritime or are transitional (e.g. Stony Hill, Chemainus, Fuller Lake and parts of Maple Mountain). Vegetation is dominated by Douglas-fir, Garry oak, Western red cedar, Grand fir, and Red alder. There are also Bigleaf maple, Arbutus, and other minor species within the Reserve.

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[7] Some standards (for example, CAR and BCFCOP) utilize a category of Avoided Conversion (AC) which pertains to deforestation only. See https://verra.org/wp-content/uploads/2018/03/AFOLU_Requirements_v3.6.pdf.

Multiple use is the philosophy underlying MFR management activities. Harvesting has been conducted from the beginning on a long-term sustained yield basis with a view to protecting water quality and fish habitat, conserving soil productivity, and to facilitate outdoor recreational activities. Beginning in the 1950's, harvesting activities on the MFR have been in accordance with a series of 5-year forest management plans (FMPs). These plans included silvicultural prescriptions that ensure successful stand regeneration post-harvest. A Forest Advisory Committee (FAC) was established in early 1960 to oversee the management of the MFR. Since that time, it is the FAC who developed the FMPs and ensured their successful implementation.

Aside from land-use change (converting forests to another use), the key distinction between IFM and forest degradation (as per REDD) is occurrence of planned versus unplanned activities on forest land that remains as forest land. Under IFM, forest removals are a planned activity, whereas the loss of carbon under REDD occurs inadvertently (unplanned) through poor management practices or illegal logging. Given the stated intent of activities on the MFR are sustained yield harvesting, conducted in accordance with explicit forest management plans, IFM represents the most suitable project category in terms of eligibility.

Various sanctioned forest management activities may be changed to increase carbon stocks and/or reduce emissions, but only a subset of these activities makes a measurable difference to the long-term increase in net GHG emissions compared to the baseline scenario. These activities, eligible under IFM, include:

1) Reduced Impact Logging (RIL)

Practices that reduce net GHG emissions by switching from conventional logging to RIL during timber harvesting.

2) Logged to Protected Forest (LtPF)

Practices that reduce net GHG emissions primarily by converting logged forests to protected forests. By eliminating harvesting for timber, biomass carbon stocks are protected and can increase as the forest re-grows and/or continues to grow. Limited harvesting of trees is also permitted, however.

3) Extended Rotation Age / Cutting Cycle (ERA)

Practices that reduce net GHG emissions of evenly aged managed forests by extending the rotation age or cutting cycle and increasing carbon stocks. Modified harvesting is the focus of ERA, rather than, for example, conservation.

4) Low-Productive to High-Productive Forest (LtHP)

Practices that increase carbon sequestration by converting low-productivity forests to high-productivity forests. This project activity is specific in its application and does not include conservation.

Of the four eligible activities, LtPF has the greatest flexibility and can include components of the other activities. Projects may include multiple activities where the methodology applied allows it or where projects apply more than one methodology. In the latter case, projects must comply with the respective project requirements of each included AFOLU category. This approach is not recommended for the MFR due to the increased costs incurred by applying multiple methodologies. Typically, LtPF projects are based on: (a) Reduced logging activity overall, (b) Protecting currently logged or degraded forests from further logging, and (c) Protecting unlogged forests that would otherwise be logged. Hence, LtPF is likely best suited to the goals and objectives of MNC with respect to the future management of the MFR.

Carbon credits are generated from the specific activities undertaken to achieve a net reduction in GHG emissions (expressed as CO_2e) [8]. Each carbon standard provides one or more established methodologies that define the rules and regulations which must be followed in order to derive the credits.[9] VCS IFM LtPF activities have several methodologies that apply specifically to LtPF activities. Two methodologies, in particular, are VM0012 (Improved Forest Management in Temperate and Boreal Forests (LtPF), v1.2) and VM0034 (the British Columbia Forest Carbon Offset Methodology). Their relative merits in regard to a carbon project on the MRF will be discussed below.

Project boundary

Refers to the physical location(s) of the project boundaries that define the project area, and the GHG sources, sinks and reservoirs (or pools) relevant to the project and baseline scenarios. In the MNC, the project boundary will, as a minimum, be defined by those areas constituting the MFR. Under VCS rules, this would be considered a non-grouped project. There are several options by which the project boundary could be expanded in the future. One is that the MNC add private lands to the project portfolio through purchases or from donation. Another option is to allow private landowners to enroll in the project and thus participate directly in project activities. Either of these cases, if they occur, would require the project be defined as a grouped carbon project (which must be done prior to project validation). This option is discussed further in Section 8

For sources, sinks, and reservoirs (SSRs), all protocols require the inclusion of the most important SSRs. The BCFCOP requires the consideration of a more comprehensive set of SSR's, than VM0012, which could result in higher project costs. Associated GHGs that must be accounted for are also more comprehensive under FCOP (CO_2, CH_4, and N_2O) than VM0012 (CO_2, only).

Project Start Date

[8] Carbon dioxide equivalent" or "CO_2e" is a term for describing different greenhouse gases in a common unit. For any quantity and type of greenhouse gas, CO_2e signifies the amount of CO_2 which would have the equivalent global warming impact. In this analysis, CO_2 is the only GHG under consideration, and so CO_2 and CO_2e are equivalent and interchangeable.

[9] The rigor associated with a given methodology depends on whether credits are intended to be sold or used internally; requirements in the latter case tend to be less onerous.

To encourage project participation, the VCS standard contains provisions to incorporate climate emissions reductions that may have been initiated prior to final project development and approval. Hence, under VCS rules, the project start date can be retroactive to the date on which activities that lead to the generation of GHG emission reductions or removals are implemented. In the case of the MFR, these activities began formally in year 2020. Hence, the project start date will be January 1, 2020.

Ownership

VCS rules state that the project proponent demonstrate control over the entire project area with documentary evidence establishing project ownership. In terms of their fee simple properties, the MNC has clear rights and title to any carbon credits derived from a project developed on these lands, as per VCS requirements. Should the MNC pursue a grouped project, private landowners will be subject to meeting ownership requirements vis a vis any carbon credits generated.

Permanence and Project Length

For IFM projects under VCS, the project crediting period (project length) can be a minimum of 20 years to a maximum 100 years. Though not mandatory, there are benefits within the VCS program where projects can demonstrate that activities will maintain the carbon stocks on which GHG credits have been issued, beyond the crediting period. In the case of shorter crediting periods, the project may be renewed at most four times with a total crediting period not to exceed 100 years. Shorter crediting might be appealing to owners averse to encumbering their land for protracted periods but project renewal would also entail additional financial costs. For the MNC carbon project, the recommended project length for the MFR is 100 years.

The permanence of carbon credits issued to the project is assessed in VCS through a detailed risk assessment process conducted for a mandatory 100-year period, a time frame that encompasses all project crediting periods. Assessment includes risks associated with project management, longevity, ownership, financial viability, and natural disturbance. This process generates a score that determines the proportion of offsets deposited into a Buffer Pool.[10] A low risk project might be required to contribute 10-15% of emission reductions to the Buffer Pool, while a high-risk project might contribute as much as 60% of emission reductions. In the case of the BCFCOP methodology, there is an additional requirement. The BC Emission Offset Regulation requires that projects involving removals by controlled sinks and avoided emissions from reservoirs / pools prepare a risk mitigation and contingency plan for ensuring that the

[10] The VCS Buffer Pool is a group program that provides all-cause insurance to cover carbon emission reversals related to any project in the VCS portfolio. The buffer pool serves to protect the integrity of the emission reductions acquired by carbon offset buyers from a VCS project.

atmospheric effect of removals and avoided emissions endures for at least 100 years after the last offset was claimed[11].

Based on 3GreenTree's experience with the application of the risk tool, our expectation is that the MNC project will have a low risk rating.

Additionality

Additionality refers to whether claimed emission reductions are in excess of what would have happened had the project not been undertaken, as described and quantified in the baseline (see Section 3). All carbon methodologies provide methods to assess additionality. VCS has three basic criteria. 1. Regulatory surplus: Project activities cannot be required by law, statute, or any regulatory framework. Landowners, for example, are legally required to maintain stream buffers, making these carbon stocks ineligible. 2. Implementation barriers: The project must face one or more distinct barrier(s) compared with any alternatives (i.e., the potential baselines) to the proposed activities. These barriers might be financial, technological, or institutional. Additionality requires that project activities must play a role in overcoming these barriers. 3. Common practice: Activities must go beyond what might be considered common practice to be additional.

Key elements most relevant to MNC forest carbon project would be the forest protection requirements and restrictions mandated under the Forest and Range Practices Act (FRPA), the forest management plans and activities applied to the MFR, and financial returns from forest management activities. Should MNC wish to pursue a grouped project by allowing private landowner participation, the Private Managed Forest Land Act would determine the minimum standards and practices against which these lands will be assessed for additionality within the project. Finally, in terms of any subsequent property acquisitions (purchased or deeded) by MNC, those made for conservation purposes on land that would have been utilized for other purposes, are considered additional by default because there is no compelling business case to conserve forests beyond carbon income. Acquisitions that add to the harvestable timber supply would be subject to the same criteria for additionality as current MNC timberland.

Leakage

One of the more challenging aspects of carbon projects. Leakage relates to the risk that project implementation will directly or indirectly increase carbon emissions elsewhere (but within the host country). VCS recognizes two types for forestry-based projects, activity-shifting and market leakage.

[11] Under the BCFCOP then, if a project's last issuance is at year 75 of an 80-year crediting period, for example, the mitigation and contingency plan must be operational for another 100 years thereafter, or 175 years after the project start date.

Activity shifting leakage (ASL) occurs when there is an increase in GHG emissions by the project proponent from areas outside the project boundary in response to restrictions imposed by the carbon project itself. For instance, a project that requires a reduction in harvest level of a forested property to conserve carbon stocks and the developer simply increases the harvest level on another owned property to make up the shortfall.

Market leakage (ML) occurs when there is an increase in GHG emissions from areas outside the project boundary as a result of the project significantly reducing the production of a commodity, causing a change in the supply and market demand equilibrium, which favors a shift of production elsewhere. For example, if sufficient volume of timber is removed from the supply chain as per the requirements of a carbon project, prices may rise in response to a reduced supply which incentivizes more harvesting overall in the region.

Both the VM0012 and BCFCOP methodologies provide guidelines for calculating leakage and assessing the resulting carbon credit discount. ASL is not a concern on the MFR but may be of some concern if private landowners are included as part of a grouped project. ML should be a minor issue because the harvested annual volumes from the MFR are relatively low. Both methodologies provide an option of using default discount factors or undertaking a series of calculations. The maximum default factors are in excess of 65%, which means that most of the benefits from a harvest reduction would be lost due to the leakage penalty. This provides a strong incentive for proponents to calculate their own leakage discount, which is likely to be much lower.

Section 3 - The Baseline Scenario

The baseline is a counterfactual forecast of what would have happened on the project area and the resulting GHG emissions, in the absence of the chosen alternative (i.e., the actual project scenario). VM0012 requires a 3-step process to determine a project-specific baseline, the result of which must be consistent with the rules for additionality. BCFCOP combines the baseline and additionality analyses to also derive a project-specific scenario.

In practical terms, carbon flows among all required pools that would have occurred from activities conducted under the baseline scenario, are accounted for. This includes emissions related to harvesting and from the subsequent decay of needles, branches, stumps, and roots. As a counterbalance to emissions, the analysis includes carbon stored in wood products following harvest and sequestered through forest growth.

In the case of the MFR, a single baseline will be utilized. Termed business-as-usual (BAU), it is a continuation of the harvesting and silvicultural practices employed on the MFR over the recent past. An annual harvest target of 17,600 m^3 was determined based on an evaluation of the temporal trends in historical harvesting on the MNC forest landbase (See Section 5).

Section 4 - The Project Scenario

The project scenario describes activities that represent a deviation from the baseline and whose outcome therefore results in emission reductions and/or enhanced carbon storage. The decrease in net emissions under the project scenario versus the baseline represents the gross amount of offset credits potentially available. Under VM0012, the IFM project category permits considerable flexibility in terms of management activities Under the Logged to Protected Forest (LtPF) activity. The majority of carbon benefits, however, accrue from conserving existing carbon stocks through reduced harvest levels. Note that areas retained/conserved as per legislated requirements (buffer zones, for example) are applied in both the baseline and project scenarios and therefore net each other out. As a result, there is no net emission reduction that can be claimed by the project for these activities.

The carbon assessment below (Section 5) provides a reasonable approximation of the credit potential that could be derived from a project developed within the MNC[12]. The analysis uses a baseline scenario for the MFR derived from prior harvesting levels and forest management plans, termed business-as-usual (BAU). Application of the BAU generates harvest volume but does not generate any carbon credits. The alternative scenarios assume a reduction in the harvest levels, relative to the baseline, of 50% (1/2 BAU), 75% (1/4 BAU), and 100% (i.e., a complete cessation of harvesting). This results in greater carbon storage, from which carbon credits are calculated. Actual, revised harvest levels will be ascertained at a later date through a community consultation process, as well as the methods employed to achieve a reduction in harvest. This process will be informed by a scenario analysis conducted by the 3GreenTree-UBC team.

Section 5 - MNC Carbon Project Modeling and Financial Assessment

Project costs

Initial costs (see Table 1) are the conceptual project design, the feasibility assessment, and development of the formal Project Design Document (PDD)[13]. The PDD describes in detail, the GHG emission reduction or removal activities and the resulting GHG balances. After the PDD is completed, the next step is to obtain a 3rd-party Validation audit, the result of which confirms that the project activities are consistent with the requirements of a given methodology. This is followed by a 3rd-party Verification audit. The initial verification confirms the accuracy of any carbon credits claimed by the project from its beginning to the audit date[14]. This credit tranche

[12] This exercise is for illustrative purposes. Until the actual input values are verified, the projected carbon credit benefits should be used for general guidance only.

[13] Sometimes referred to as the Project *Description* Document.

[14] Note that for all leading carbon standards, only *ex-poste* credits are acceptable. This refers to credits that have already accrued versus credits that may accrue at some future data (termed, *ex ante*).

can now be offered for sale. Typically, validation and the first verification are conducted simultaneously, usually requiring several months to complete, but this saves both time and money. Subsequent verifications confirm the integrity of new credits generated in the period following the previous verification. Under VCS, a project must re-verify a maximum of every five years. Finally, the project is also required to implement a monitoring program that includes a series of permanent sample plots, as well as remote sensing data. Monitoring activities occur on a regular basis in order to track conditions on the project area (documenting any unplanned carbon losses from fire, illegal harvesting, leakage, for example) and estimate carbon stocks resulting from planned harvests and re-growth. Table 1 provides estimates of the initial and ongoing project costs.[15]

Table 1. Project cost estimates

Activity	Initial cost estimate	Ongoing cost estimate
Setup costs*	$150,000	$0
Project development	$30,000	$0
Validation/verification	$65,000	$25,000 (at verification)
Project management	$0	$5,000 per annum
Plot installation	$7,600	$0
Maintain, re-measure plots	$0	$1,600 (at verification)
Registration/issuance fees	$1,260	~ $1,260 per annum
Brokerage fees	$1,578	~ $1,578 per annum

* These costs are principally associated with developing the preliminary and long-term forest management plan in conjunction with the carbon project.

Carbon credit prices and harvesting returns

Determining the 'actual' price for a carbon offset is a challenge. As with all products, annual prices can vary substantially in relation to demand, but they also depend on which standard the project conforms to (the Verified Carbon Standard, for example, tends to command higher prices), its location (local projects have greater buyer appeal), and the project type (forestry and land use credits often sell for the highest price). The volume of credits purchased is another important factor; credit prices tend to be lower for higher volumes (> 25,000 tonne CO_2e). Data show that many transactions involve relatively small volumes and these are more likely to realize prices substantially higher than the 'average' for a given project type. To accommodate uncertainty in credit value, a range in prices was utilized, consisting of a starting price of $5, 10,

[15] Note, there may be some fixed and capital costs from harvesting, above and beyond the ongoing estimates used in the current analysis (see Table 1), that could be included in the financial calculations. These costs require careful consideration because they would serve to increase the carbon credit price required to break-even when compared with revenues derived from the baseline harvesting scenario. Conversely, adding financial co-benefits from a carbon project (recreational revenue, for example) would reduce the break-even credit price; co-benefits were not included in the financial analysis.

and \$20 per tonne CO_2e (all prices in CAD). Prices were assumed to rise in value by 1% per annum to reflect the anticipated growth in the carbon credit market. After 30 years, the three respective credit prices had increased to \$6.67, \$13.35, and \$26.69 per tonne CO_2e.

Harvesting returns were derived from annual financial statements generated for the Forest Advisory Committee. Estimates of annual profit were utilized in the financial analysis for the years 1987 to 2019 because this metric reflected the actual benefits returned to the community from the forestry program. Profits showed considerable variation over this 30-year period, including 7 years with negative returns. As with carbon credits, profits depend on numerous factors (operating costs, lumber quality, volumes harvested, lumber prices, etc.), most of which are difficult to predict *a priori*. Variation in profit was therefore derived by plotting annual profit against volume harvested in that year and fitting the data with a simple linear regression model (forced through the zero intercept). The resulting equation was:

Annual profit (\$ CAD) = \$9.36 * Volume harvested (m^3), $r^2 = 0.14$.

As with carbon credits, the \$9.36 profit per m^3 was assumed to rise in value by 1% per annum. Its value after 30 years was therefore \$12.49 per m^3.

Model simulations

Carbon storage and volume flow for the MNC forest landbase was modelled using a combination of stand and landscape-level models, using the following steps:

1. **Landscape stratification.** The landbase was stratified by polygon in accordance with the Vegetation Resource Inventory (VRI) provided by North Cowichan, updated to year 2019. Each forested polygon was assigned to an analysis unit using the criteria described in Table 2. A breakdown of the forest area by age class is shown in Table 3. Regional LiDAR[16] data from 2017 were used to estimate forest cover within inventory polygons and to confirm forest age.

Table 2. Stand-level analysis units used to model the forested land base.

Analysis Unit	Criteria	Area (ha)
Douglas-fir Dominated	≥ 80% Douglas-fir	3,985
Douglas-fir - Mixed conifer	< 80% Douglas-fir & ≥ 75% conifer	422
Mixedwood with conifer lead	< 80% conifer lead with deciduous component	456
Mixedwood with deciduous lead	< 80% deciduous lead with conifer component	226
Deciduous dominated	≥ 80% Deciduous	263

[16] Light Detection and Ranging (LiDAR). LiDAR is a remote sensing method that measures distance to a target by illuminating the target with laser light and measuring the reflected light with a sensor. It is often used in forestry applications to estimate tree height and forest cover.

Total		**5,352**

Table 3. Area by age class at the start of the simulation (year 2019).

Age Class	Age Criteria	Area (ha)
1	1 to 20	345
2	21 to 40	1,416
3	41 to 60	2,201
4	61 to 80	1,194
5	81 to 100	148
6	101 to 120	33
7	121 to 140	13
	Total	**5,352**

2. **Harvesting Landbase.** The harvesting landbase was identified by removing areas within riparian buffer zones and areas in which harvesting has been historically restricted.[17]

3. **Stand-level growth projections.** Forest growth in each analysis unit was modelled using the FORECAST[18] model and its output (merchantable volume and net ecosystem carbon storage) stored in a database as input to the landscape-scale model (the full output dataset is available in a separate file; see Appendix 2). Net ecosystem carbon storage includes above and below-ground tree biomass, dead and downed wood, and dead below-ground tree biomass (root litter created after harvest). Understory plant biomass, non-woody above-ground litter and soil organic matter are excluded.[19]

4. **Landscape-scale modelling.** The landscape-scale model uses the information in the stand-level database to assign volume and carbon storage information for each forested polygon. A spreadsheet-based model was then constructed in Excel to simulate the impact of harvesting activities on volume yield and landscape-level carbon storage within the MNC

[17] The Maple mountain forest preservation zone was excluded from harvesting in the baseline scenario. Required 30-m buffers were used to exclude forest areas adjacent to riparian features from harvest.
[18] FORECAST is an approved model for use under the British Columbia Forest Carbon Offset Protocol, and it was one of four models approved for government funding of model development, testing, validation and application under the BC Forest Science Program. It has been subject to a successful independent audit by three accredited firms, Rainforest Alliance, SCS and DNV. These audits sought to confirm that FORECAST is well-established in terms of its development timeline and applications, adequately described in the professional literature, appropriate for simulating the biomass dynamics of forest ecosystems (in this case, within the context of a carbon offset project), and its user-group possesses the requisite skills to apply the model correctly. In 2008, the model was one of a small number of models approved by the Canadian government for simulating carbon (i.e., biomass) dynamics.
[19] These are the pools included/excluded in forest carbon projects developed under the VCS methodology.

forest landbase. The model was designed to take account of annual volume growth and net ecosystem carbon storage within each forested inventory polygon over a 30-year time period. An annual harvest schedule was generated by identifying all eligible stands, sorting those stands by age class and, starting with oldest age-class, randomly harvesting polygons within each age class until the annual volume target was achieved. Annual variation in projected harvest volumes for the BAU scenario (see Figure 1) occurred because the volume target could not always be achieved. When a stand (inventory polygon) was harvested, its age was reset to 1 to reflect the removal of volume and biomass carbon. The total volume flow, growing stock and net ecosystem carbon storage for the landbase was summarized across all polygons for each annual timestep for the harvesting scenarios (See Figure 1).

The financial viability of the carbon project compares the three alternative project scenarios against the BAU option. A financial analysis was conducted using the simulated carbon credit flow in conjunction with the establishment and operating costs of a carbon project, and the range in credit prices and harvesting returns, as described above. Calculations include Discounted Cash Flow (DCF), and Net Present Value (NPV). DCF is a valuation method used to estimate the value of an investment based on future cash flows; the value of a company today, based on projections of how much money it will generate in the future. NPV is used to analyze the profitability of a projected investment or project; an investment with a positive NPV will be profitable, while a negative NPV will result in a net loss (see Appendix 1 for further details on these metrics). NPV then accounts for what it costs to set up the carbon project in relation to anticipated returns. These metrics were applied to compare the BAU scenario (continued harvesting at historical rates) against the three alternative carbon project scenarios.

Timber harvest and carbon credits

Under BAU, harvesting was projected to remove, on average, 17,630 m^3 of timber annually over the 30-year project period (Figure 1). This varied from a minimum of 15,155 to a maximum of 19,546 m^3. When harvesting is reduced, the flow of carbon credits is expected to increase over the first 10 years of the project and be stable thereafter (Figure 1). 'No-harvesting' generates the most credits (average = 19,138 t CO_2e per year), followed by ¼ BAU (average = 14,353 t CO_2e), then ½ BAU (average = 9.569 t CO_2e). This is a consequence of the fact that less logging reduces harvested volume, which preserves carbon stocks thereby generating more credits.

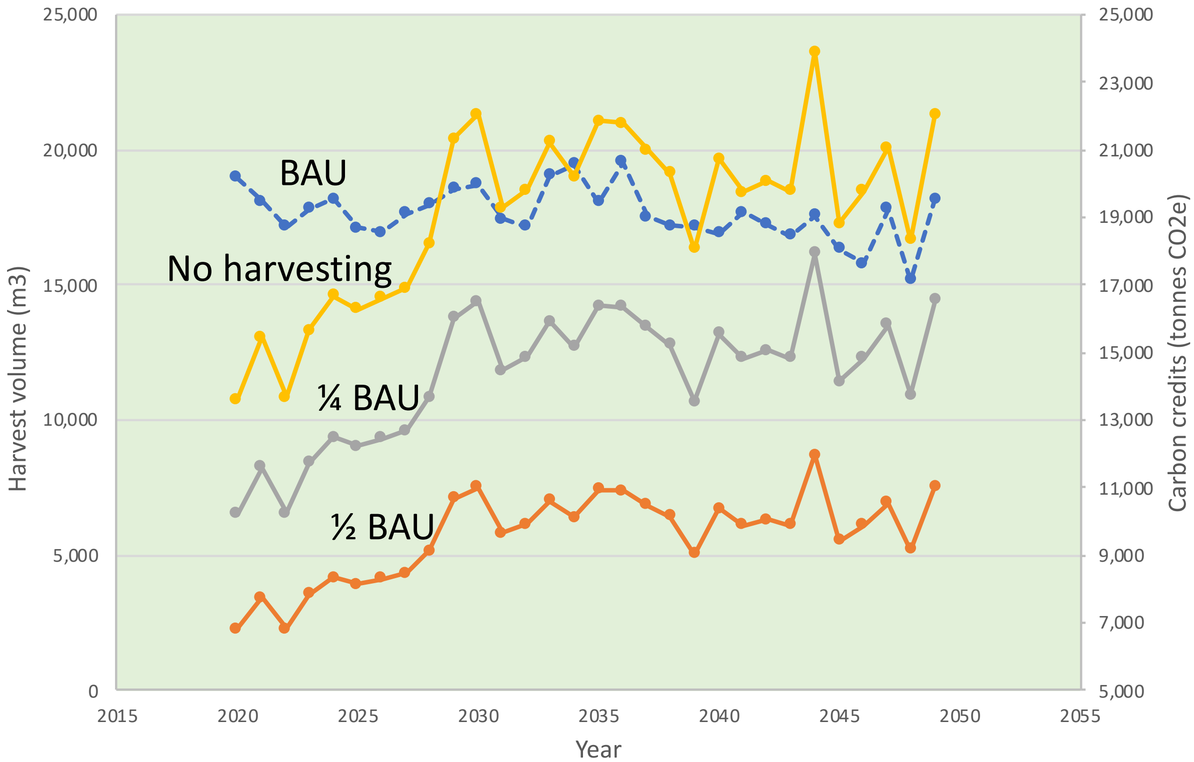
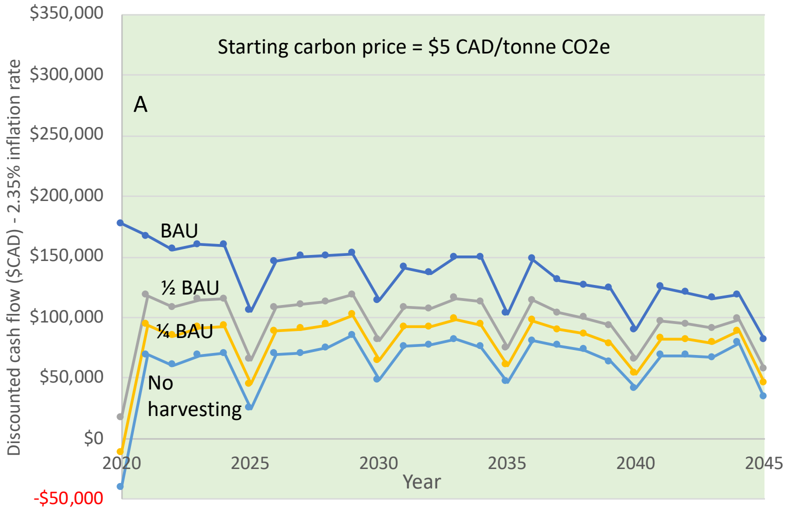


Figure 1. Annual harvest volumes (m^3; blue dashed line, left axis) and carbon credits (t CO_2e; right axis) anticipated over the next 30 years. Business-as-usual (BAU) sets the baseline and reflects harvest levels based on historical rates; BAU does not generate any carbon credits. Harvesting is reduced by 50% (½ BAU; orange line), 75% (¼ BAU; grey line), and 100% (No harvesting; yellow line), which results in a corresponding production of carbon credits.


Starting carbon price = $5 CAD/tonne CO2e
A
BAU
½ BAU
¼ BAU
No harvesting
Discounted cash flow ($CAD) - 2.35% inflation rate
$350,000
$300,000
$250,000
$200,000
$150,000
$100,000
$50,000
$0
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2020
2025
2030
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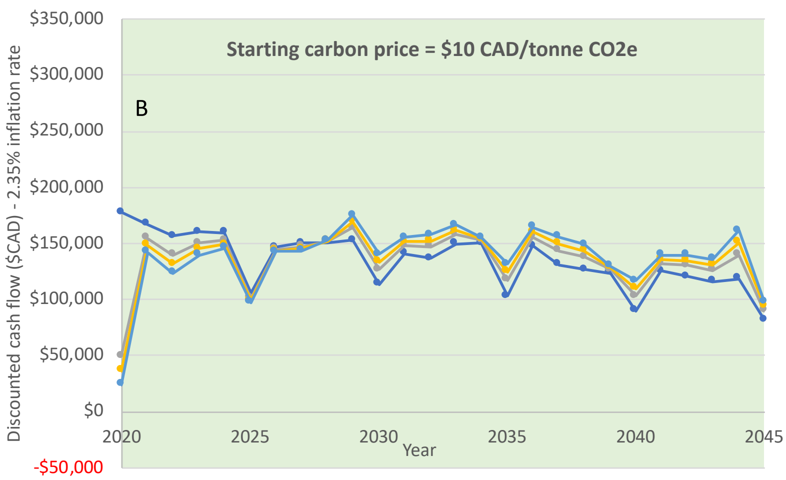
2040
2045
Year


Starting carbon price = $10 CAD/tonne CO2e
B
Discounted cash flow ($CAD) - 2.35% inflation rate
$350,000
$300,000
$250,000
$200,000
$150,000
$100,000
$50,000
$0
-$50,000
2020
2025
2030
2035
2040
2045
Year

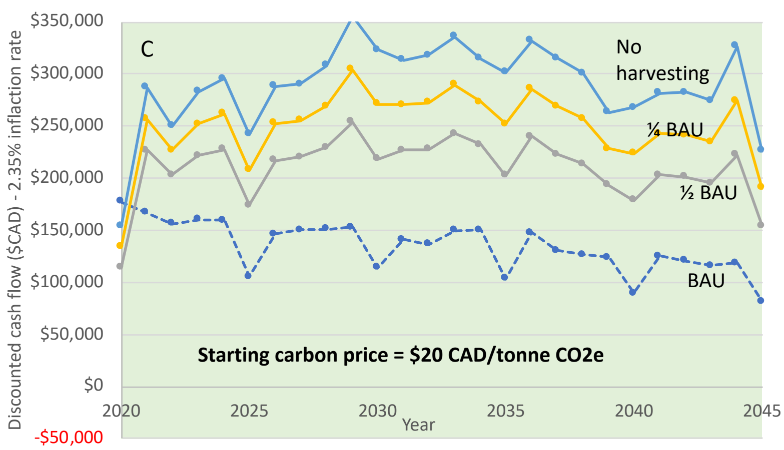

C
No harvesting
¼ BAU
½ BAU
BAU
Starting carbon price = $20 CAD/tonne CO2e
Discounted cash flow ($CAD) - 2.35% inflaction rate
$350,000
$300,000
$250,000
$200,000
$150,000
$100,000
$50,000
$0
-$50,000
2020
2025
2030
2035
2040
2045
Year

Figure 2. Discounted cash flow over the next 25 years from logging, and for carbon credit prices starting at $5 (panel A), $10 (panel B), and $20 per t CO_2e (panel C). Business-as-usual (BAU) only generates logging revenue. Harvesting is reduced by 50% (½ BAU), 75% (¼ BAU), and 100% (No harvesting), which then results in a corresponding production of carbon credits.

Discounted cash flow (DCF) over the next 30 years from logging at BAU levels averaged $131,736 per annum (this calculation does not include a terminal value; TV). DCF from a carbon project is less profitable than BAU if credit prices are below $10 per t CO_2e (Figures 2A, B). At $5 per t CO_2e, for example, the no-harvesting scenario is the least favorable option with an average annual DCF = $62,138 (no TV), followed by ¼ BAU (average annual DCF = $78,653; no TV) and then ½ BAU (average annual DCF = $95,168; no TV). The order of the carbon scenarios relative to harvesting is a result of the fact that, at $5 per t CO_2e, the carbon credit price does not compensate for the loss in timber revenue. This effect is amplified when the number of carbon credits increases as harvesting is reduced. At $10 per t CO_2e, carbon credit DCFs are similar to each other and to BAU timber harvesting (Figure 2B). Hence, a carbon project can substitute for the revenue stream derived historically from logging if credit prices are around $10 per tonne CO_2e (Figure 2B). If credits are sold at $20 per t CO_2e, revenues always exceed those anticipated from harvesting (Figure 2C). At average annual revenues of $211,434 (½ BAU), $249,425 (¼ BAU), and $287,415 (no-harvesting), these returns are not trivial (52%, 79%, and 107% higher, respectively).

Terminal value calculations from BAU indicate a long-term value of harvesting (i.e., beyond the 30-year project period) of $2,750,625 (Table 4). This valuation exceeds that from carbon credits at $5 per t CO_2e (by 25 to 48%). However, TV from carbon credits is greater than harvesting TV at $10 (between 6 and 14%) and substantially more at $20 per t CO_2e (67 to 136%).

Table 4. Terminal value calculations at year 30 of the simulations for carbon credit prices starting at $5, $10, and $20 per t CO_2e. Business-as-usual (BAU) only generates logging revenue. When harvesting is reduced by 50% (½ BAU), 75% (¼ BAU), and 100% (No harvesting), this results in a corresponding production of carbon credits. Red values indicate TVs less than BAU.

Carbon price	BAU harvesting	50% less	75% less	None
$5	$2,750,625	$2,230,030	$1,969,733	$1,709,436
$10	$2,750,625	$3,112,594	$3,293,579	$3,474,564
$20	$2,750,625	$4,877,722	$5,941,271	$7,004,820

Net present values (NPV) from either BAU harvesting or a carbon project are always positive (Figure 3), indicating that projected earnings exceed anticipated costs. As with the DCF analysis, NPVs from carbon credits selling at $5 per t CO_2e are less than BAU (=$6,270,088), ranging from 25% (½ BAU) to 48% lower (no-harvesting). NPVs from a carbon project are somewhat better than BAU at $10 per t CO_2e, ranging from 6% to 14%, and by 63% to 125% more than BAU (½ BAU and no-harvesting, respectively) at $20 per t CO_2e (Figure 3).

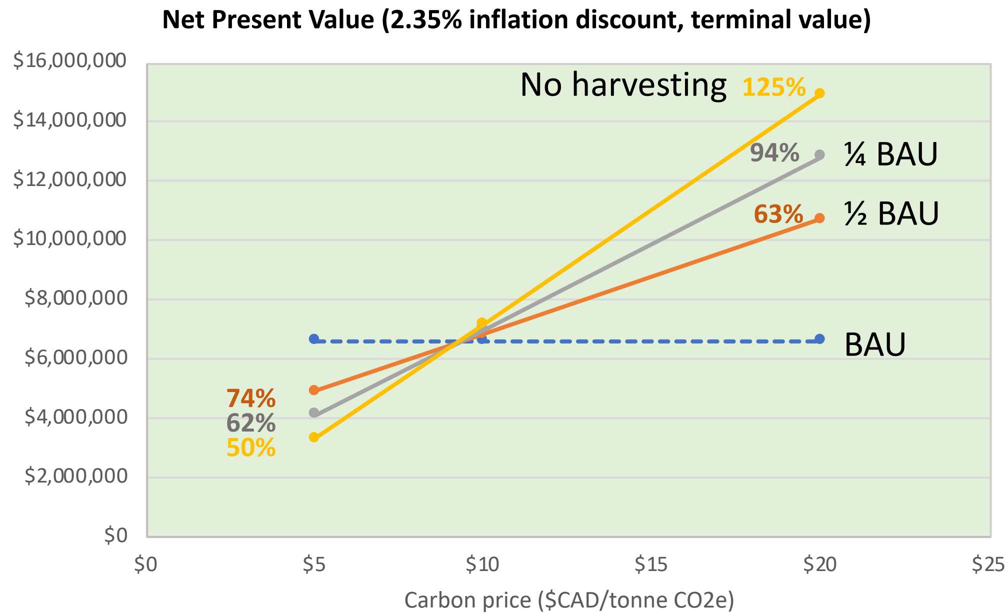


Figure 3. Net present value calculated over the next 30 years from logging, and for carbon credit prices starting at $5, $10, and $20 per t CO_2e. Business-as-usual (BAU) only generates logging revenue. Harvesting is reduced by 50% (½ BAU), 75% (¼ BAU), and 100% (No harvesting), which then results in a corresponding production of carbon credits.

Section 6 - What is the market for carbon credits?

Demand versus supply trends

As the financial analysis indicates, the relative returns from a carbon project depend heavily on the anticipated price at which credits can be sold. Market prices are, in part, a function of the forces of supply and demand. The most reliable sources for information on the voluntary market are the annual reports generated by Ecosystem Marketplace (EM; www.ecosystemmarketplace.com), an initiative of the non-profit organization, Forest Trends (www.forest-trends.org). EM has provided summary information on voluntary carbon markets every year since 2006. Their latest survey (for the year, 2018)[20] indicates that, across seven project categories, 98.4 million t CO_2e of carbon offsets were transacted for the year, with a market value of $295.7 million USD.

For some large credit producers (generating annual credits in excess of 50,000 t CO_2e), oversupply and low prices have been problematic, for a variety of reasons. As noted above, nature-based solutions (NBS) have been gaining popularity in recent years, a trend that is likely

[20] Forest Trends' Ecosystem Marketplace. Financing Emission Reductions for the Future: State of Voluntary Carbon Markets 2019. Washington DC: Forest Trends, 2019.

to continue. The Paris Climate Accord (signed in 2016) should have a positive impact on credit demand. There is a gap between the level of emissions that countries have committed to under the Accord and the emissions trajectory that climate scientists predict is necessary to keep global warming within 2°C. Closing this gap will likely require significant action by non-state actors thus providing opportunities for the voluntary market. The Government of Canada pledged to achieve 30 million tonnes of annual net GHG sequestration in the year 2030 as part of Canada's efforts towards achieving its 2030 Paris climate commitments. The federal government's Output Based Pricing System (OBPS) outlines how carbon offsets can be used for regulatory compliance with Canada's GHG emissions limits. Large industrial emitters that emit over their sector benchmark have three options: (1) purchase offset credits, (2) buy surplus credits from other regulated firms[21], or (3) pay a direct charge to government. If priced competitively, offsets could make a significant contribution to satisfying these obligations.

Another major developing initiative is the International Civil Aviation Organization's (ICAO) CORSIA (Carbon Offsetting and Reduction Scheme for International Aviation) program, part of an international agreement to cap emissions from international passenger flights. Beginning in 2021, CORSIA will allow airlines to meet their emissions obligations by purchasing ICAO-recognized offsets. Projected demand from airlines for carbon offsets is substantial: 142–174 Mt by 2025, increasing to 443–596 Mt by 2035. Which offset types will be recognized under the program has yet to be defined.

Prices

Despite large transactional volumes and growing demand for voluntary carbon credits, the price per offset in 2019 across 7 project categories, averaged only $3.01 USD per tonne CO_2e[17]. This value can be misleading, however, because the vast bulk of transactions are at the lowest prices. A 2017 EM review[22], for example, showed that there were just as many credit sales in the highest carbon price category ($12+ USD) as the lowest category (< $1 USD), but that buyers in the former purchased offsets in much smaller quantities. It is worth noting that the highest prices were more than $50 USD per t CO_2e. The Forest and Land Use project category tends to command the highest average prices, particularly the Improved Forest Management (IFM) project type (i.e., the same type as the MFR project). In 2016, for example, IFM credits sold for an average of $9.50 USD per t CO_2e, when the overall average was just $3.00 USD per t CO_2e.

Internationally, the volume of carbon credits is oversupplied on the voluntary market but demand is strong for the highest quality units, particularly those with certified co-benefits (see Section 8). Other important considerations in marketing the MNC carbon project is that buyers

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[21] Post 2020, facilities will only be able to cover 75% of their compliance obligation through offsets and surplus credits.

[22] Forest Trends' Ecosystem Marketplace, Unlocking Potential State of the Voluntary Carbon Markets 2017. Washington DC: Forest Trends, 2017.

tend to pay more for offsets that originate close to their own business operations; if a project provides benefits to nearby communities, such as training, job, tourism, and recreational opportunities; if there are ancillary benefits (biodiversity, habitat, etc.); and which particular standard the project is verified under (VCS credits, for example, are considered of high quality with better prices).

Section 7 – Conclusions

1. Ownership and management activities on MNC MFR satisfy the requirements for a carbon offset project.
2. The Verified Carbon Standard represents the standard best aligned with the goals and objectives of the MNC.
3. Of the four eligible activities under VCS, Logged to Protected Forest (LtPF) has the greatest flexibility and is likely best suited to the future management of the MFR.
4. The VM0012 methodology (Improved Forest Management in Temperate and Boreal Forests (LtPF). v1.2) is highly applicable to the MFR lands. It is well established and has formed the basis for three carbon credit projects in western North America.
5. The VM0012 methodology uses the VCS risk analysis only and which, at a minimum, is applied to the project crediting period. Other methodologies are more onerous, requiring a risk mitigation and contingency plan that extends 100 years past the last offset issuance date.
6. Initial estimates indicate that a carbon offset project on the MFR could provide an ongoing, stable revenue source to the MNC competitive with the current logging model, while ensuring that the additional ecosystem services of importance to the local community, are maintained or enhanced.
7. The future for nature-based climate solutions in terms of both voluntary and compliance carbon credits appears strong. This has led to optimism regarding the credit market with the expectation of rising prices in the near and far-term.
8. Sales conducted through established carbon credit exchanges (e.g., Markit) are likely not the best venue for MNC. These markets are highly competitive and credit prices tend to be lower than desired.
9. MNC should develop relationships among local entities (businesses, NGOs, government) interested in offsetting their carbon emissions, as purchasers of the MFR carbon credits. These over-the-counter transactions have better prospects for prices that reflect the high value of the credits generated from the project.

Section 8 - Additional considerations

Development of a grouped project.

The analysis did not include consideration of potential future property acquisitions by MNC, or provisions for allowing private landowners to participate in the project. Should this option be exercised, the project would be defined under VCS as a 'grouped' project. Grouped projects allow for the expansion of activities beyond the 'initial project activity instance'[23].

Grouped projects provide a means by which the community-at-large can participate directly in the local government's climate change initiatives and for government to expand its forest holdings within the context of the carbon project. This project type, however, has a more complex structure than the 'standard' project described above and it must be defined before the validation stage. For example, the project area would need to be expanded to encompass potential future forested parcels that are additional to the existing MFR. Each project stratum would also need a corresponding baseline. A new property is then assigned to a given stratum based on the most plausible development scenario. Because the project area includes multiple strata, it thus contains multiple baselines, and project carbon calculations must be tracked for each baseline stratum.

For new properties to be added to the project, each must be validated as meeting the project requirements. Though the initial setup procedure is complex, it is a relatively simple process to add properties in conjunction with subsequent verification audits. There are some additional project management costs to prepare these new properties for monitoring and inclusion in the project - these costs should be minimal.

Credit stacking

One of the benefits of the forest carbon project are the multiple benefits it can provide in terms of ecosystem services. These can be broad ranging, including habitat improvements, water quality and quantity, recreation, etc. In the US, some of these co-benefits have been formally recognized as a type of environmental 'credit' and are monetized as such. Payments for ecosystem services are becoming an increasingly important part of the U.S. business and regulatory landscape. If a project receives payments for more than one of the ecosystem services that it generates, these credits are considered as "stacked"[24]. Credit stacking can, in principle, then expand the revenue potential of a project. Unfortunately, in Canada, formal markets for credits other than carbon are not as well-developed as in the US[25]. One option for MNC is to market the co-benefits of the project to interested parties (NGOs, conservation groups, etc.) informally and seek compensation for supporting project activities specific to their local interests.[26] It is worth nothing that no co-benefits from the carbon project were included in the financial analysis.

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[23] The initial activity instance is defined at the first project validation, and would be restricted to the MFR lands only. Adding more activity instances (private land, for example) would occur at a later date. With a grouped project, the project description must set out the geographic areas within which new project activity instances may be developed and the eligibility criteria for their inclusion. New instances meeting these pre-established criteria may then be added at a later date.

[24] Credit stacking is in contrast to "bundling" whereby environmental benefits a grouped within a unified credit rather than as separate, marketable credits.

[25] See: Poulton, David, Stacking of Multiple Environmental Credits: An Alberta Discussion Paper (August 28, 2014). Available at SSRN: https://ssrn.com/abstract=2560656 or http://dx.doi.org/10.2139/ssrn.2560656

[26] For example, groups who benefit from water quality improvements, enhanced recreational opportunities, etc.

Stacking does come with caveats. As with carbon credits, payments for ecosystem services must be for an environmental benefit that would not have otherwise occurred, or to prevent an environmental harm that would have occurred in the absence of the project.

Co-benefit certification

Despite the benefits of credit stacking, none of the leading voluntary standards incorporate co-benefits directly. Instead, they encourage project proponents to acquire co-benefit certification as an add-on to the project. These certification schemes provide formal mechanisms for describing and measuring any of the project co-benefits. This can lend additional (indirect) value to the carbon credits; buyers motivated by ideological, social license, or public relations concerns are often willing to pay a premium for these credit bundles to support a more robust narrative of their environmental initiatives. For the project proponent, creating a 'multi-benefit' credit incurs costs additional to generating credits purely for GHG mitigation outcomes. Typically, these costs are not prohibitive, however.

The largest of the certification schemes is the Climate, Community and Biodiversity (CCB) Standard (www.climate-standards.org). The CCB Standard provides comprehensive and objective criteria to assess and identify social and environmental risks, and to deliver significant benefits to local communities, biodiversity and the climate. The criteria ensure that projects:

- Identify all stakeholders and ensure their full and effective participation
- Recognize and respect customary and statutory rights
- Obtain free, prior and informed consent
- Assess and monitor direct and indirect costs, benefits and risks
- Identify and maintain high conservation values
- Demonstrate net positive climate, community and biodiversity benefits

Many VCS projects have obtained CCB certification.

A second potential certification scheme is Social Carbon (SC; www.socialcarbon.org). The Standard guarantees a transparent and participatory method of monitoring a project's co-benefits through a tool box of indicators that point to degrees of sustainability correlated to six resources:

- Social
- Human
- Financial
- Natural
- Biodiversity or technology
- Carbon

With a focus on local participation and engagement, as well as sustainable livelihood initiatives, this standard appears to be most applicable to developing countries.

Appendix 1. Financial metrics

Discounted cash flow (DCF) is a valuation method used to estimate the value of an investment based on future cash flows; the value of a company today, based on projections of how much money it will generate in the future. The present value of expected future cash flows is determined using a discount rate (the discount rate expresses the time value of money).

DCF is calculated as follows:

- CF = Cash Flow
- r = discount rate
- DCF is also known as the Discounted Cash Flows Model

$$DCF = \sum_{t=1}^{n} \frac{CF}{(1+r)^t}, \quad (1)$$

calculated annually for year *t* to *n* (the project forecast period). In the case of the carbon project, the forecast period is 30 years. CF refers to the net amount of cash and cash-equivalents being transferred into and out of a business. In this analysis, CF refers to earnings from timber sales (net profit) and the sale of carbon credits (net of operating expenses) but does not include any interest, taxes, depreciation, or amortization costs. DCF includes a discount factor to account for the time value of money. The average annual rate of inflation for Canada (2.35%), as derived from the Consumer Price Index calculated on a yearly basis over the previous 35 years, was used as the discount factor (*r* = 2.35%).

Application of the DCF has two components—the forecast period (as per equation 1) and a Terminal Value (TV). TV determines a company's value into perpetuity beyond the forecast period, and often comprises a large percentage of the total assessed value. There are two commonly used methods to calculate terminal value—perpetual growth and exit multiple. The perpetual growth method assumes that a business will continue to generate cash flows at a constant rate forever, while the exit multiple method assumes that a business will be sold for a multiple of some market metric. Since the MFR is government-owned, the perpetual growth method was used.

The formula to calculate terminal value (TV) is:

$$TV = \frac{FCF * (1+g)}{r-g}$$

Where:

FCF = Free (discounted) cash flow for the last forecast period
g = Terminal growth rate
r = discount rate (2.35%)

Terminal growth rate is usually in line with the long-term rate of inflation (2.35%). In this analysis, however, g is set conservatively at 1% per annum.

Net present value (NPV) is the difference between the present value of cash inflows and the present value of cash outflows over a period of time.

NPV=TVECF−TVIC,

Where TVECF = Today's (discounted) value of the expected cash flows, and TVIC = Today's value of invested cash. TVECF is calculated as per equation 1.

A positive net present value indicates that the projected earnings generated by a project or investment - in present dollars - exceeds the anticipated costs, also in present dollars. One of its uses is to analyze the profitability of a projected investment or project. It is assumed that an investment with a positive NPV will be profitable, and an investment with a negative NPV will result in a net loss.

In this analysis, NPV was calculated with and without a TV. The latter would be applicable if, for example, the carbon project was terminated after the 30-year period.

Appendix 2

The full output dataset is contained in an accompanying file: MNC carbon dataset output.