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Lower Mainland Afforestation Site; an Experimental Carbon Offset Project

This paper describes the modeling of an afforestation project in the Lower Mainland. It follows the BC Forest Carbon Offset Protocol and it uses Tipsy 4.2 and the Canadian Carbon Budget Model to model forest stand dynamics and to examine the changing levels of ecosystem carbon throughout the project lifecycle. Over 100 years, the 10 hectare project sequesters 5,947 tonnes of carbon which is equal to 21,806 tonnes of CO_2 equivalents. Once offsets are modeled and verified, they can be marketed on either voluntary or compliance markets. Some of the issues surrounding carbon offsets include their permanence, their additionality, and their affect on the BC forest industry and these issues are discussed in this paper.

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1.0 Introduction

Afforestation is the reforestation of land that was not previously forested. Afforestation projects are one type of carbon offset project that is eligible for use in British Columbia (BC) today. This paper's objective is to describe an afforestation project in the Lower Mainland and quantify the carbon sequestration derived from the project over its lifecycle. The carbon sequestration is quantified by modeling the forest growth with Tipsy 4.2 and measuring the total ecosystem carbon over the project lifecycle with the Carbon Budget Model (CBM-CFS3). The process throughout was guided by the BC Emissions Offset Regulation (BC EOR) and the BC Forest Carbon Offset Protocol (BC FCOP). The objectives will be to discuss some of the key issues surrounding carbon offsets, illustrate the salient aspects of the afforestation project, and in the next section, describe the methods for modeling the Lower Mainland Afforestation Project.

2.0 Methods

The methods section will describe an afforestation scenario in the Lower Mainland. The Lower Mainland is characterized by a moist, moderate climate with generally favourable and rich sites. This project could occur on a number of different sites of varying quality ranging from rich moist minimally disturbed sites to highly disturbed poor quality sites. Given the variability of sites, the afforestation data will only represent an example of a probable afforestation scenario that could occur in the lower mainland. The site modelled is 10 hectares in size which is equivalent to a square piece of land with 316 metre sides.

2.1 Tipsy 4.2

The growth and Yield data for the site was processed in TIPSY 4.2. Tipsy is a stand and landscape modelling program which allows the user to input various stand characteristics in order to produce growth and yield information such as tree volume and density. The geographic description used in Tipsy 4.2 was the coast forest region in the Chilliwack forest district. The species used were Douglas-fir (Fd) *pseudotsuga menzizizii,* Western Red Cedar (Cw) *Thuja plicata,* and Western Hemlock (Hw) *Tsuga heterophylla* with site indexes of 30, 25 and 27.5 respectively. The site indexes are conservative estimates of the heights (in metres) that each species would reach at age 50.

Figure 1 shows how the afforestation site is planted at 1600 stems per hectare (st/ha) and after 275 years the density drops to 2560 stems per hectare. This is due to natural mortality and competition for light and canopy space as the stand grows. Figure 2 shows that as the density falls the volume of the stand increases as the trees grow large. Figure 3 shows that at approximately age 70 the stand achieves its largest annual growth increment and after this point, the annual growth decreases continuously. This is also reflected in the shape of the curve in figure 2 as the volume growth increases to a point where it would level out and eventually drop off as the tree dies. The drop off is not modelled as the stand would normally keep growing well after 280 years. The growth and yield curves that describe the lower mainland site are in appendix 3

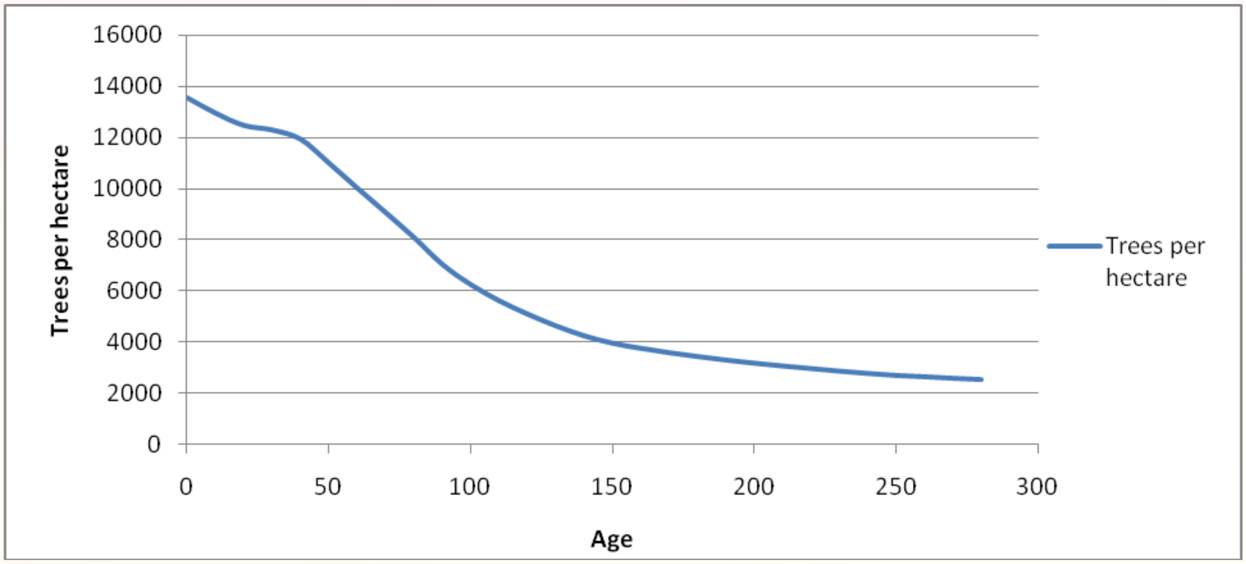

Figure 1 The density of the stand over 280 years.

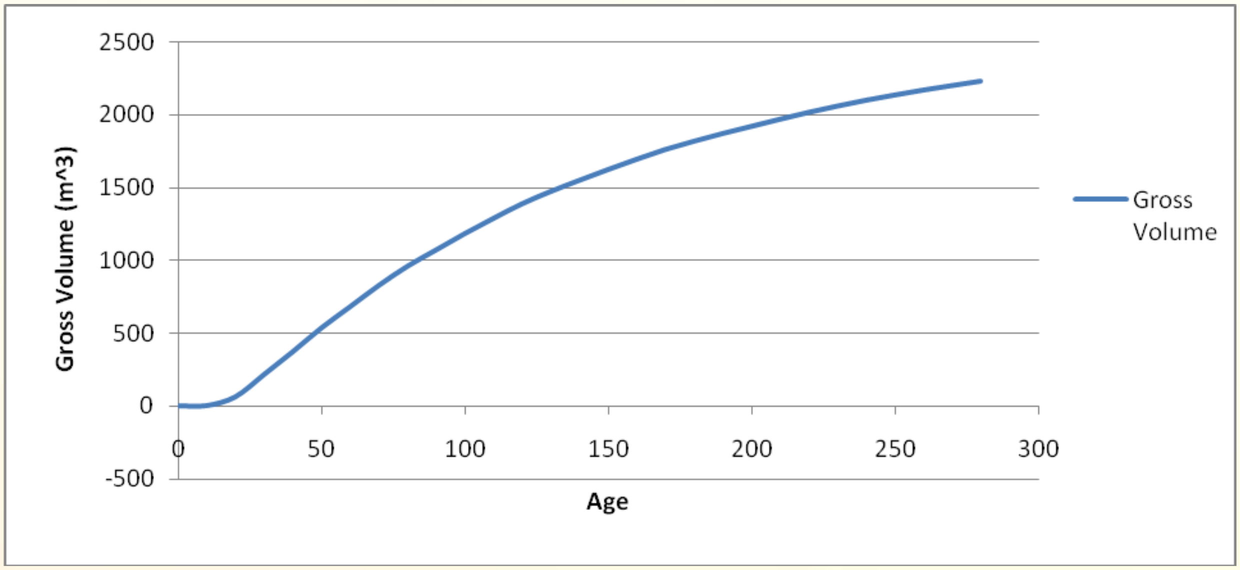

Figure 2 The gross volume of the stand over 280 years.

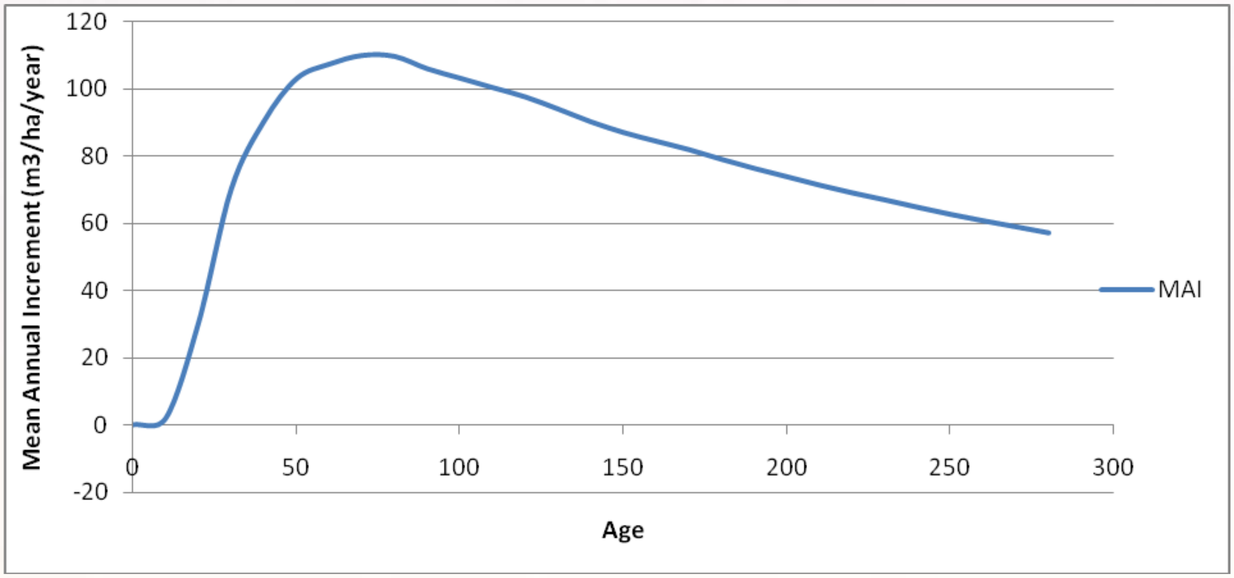

Figure 3 The mean annual increment of the stand over 280 years.

2.2 CBM-CFS3

The Carbon Budget Model (CBM-CFS3) is a stand and landscape level model that simulates stand level carbon dynamics. The data it produces includes above and below ground biomass, litter, dead organic matter and soil carbon (Carbon Budget Model, 2011). The modeling process that was used for the afforestation site includes site specifications, event modeling, inputting the growth and Yield data from Tipsy 4.2, and entering the disturbance regime. The forest schedule is described below in table 1.

Table 1: The site history and forest schedule.

Year	Disturbance Event
0	new forest growth using natural stand growth and yield
200	wildfire and re-growth with natural stand growth and yield
296	deforestation and conversion to non-forest podzolic soil type
326	afforestation with managed stand growth and yield

The project was modeled once with the afforestation at year 326 and another time without the afforestation. The scenario that does not have the afforestation event is known as the baseline scenario. The baseline scenario is shown in figure 4 (Baselines and baseline selection will be discussed in more detail in section 2.3.2). The modeled site history and forest growth follows the red biomass curve in figures 4 and 5. It shows how a 200 year old stand burned in a wildfire, naturally regenerated and then was deforested after 96. Figure 5 shows how the afforestation project begins at year 326.

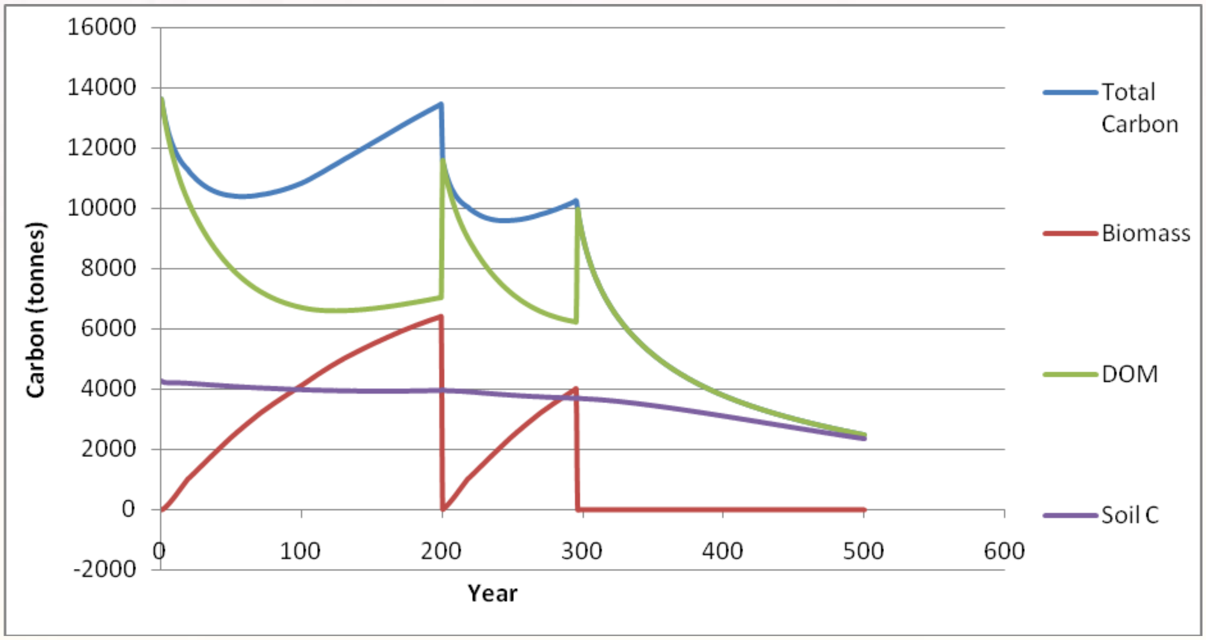

Figure 4 The carbon model of the baseline scenario.

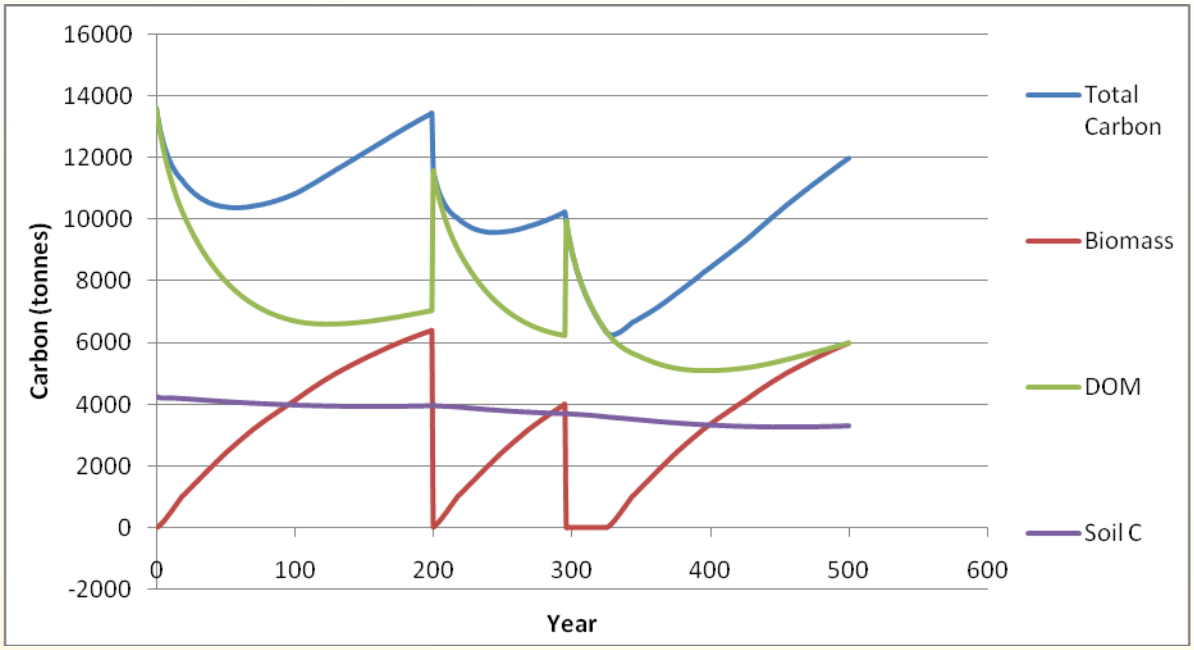

Figure 5 The carbon model of the afforestation scenario.

After developing the baseline scenario in figure 4 and the project scenario in figure 5 the projects could be compared to determine the total amount of carbon produced. Figure 6 displays the total amount of carbon after 175 years which is 9,498 tonnes.

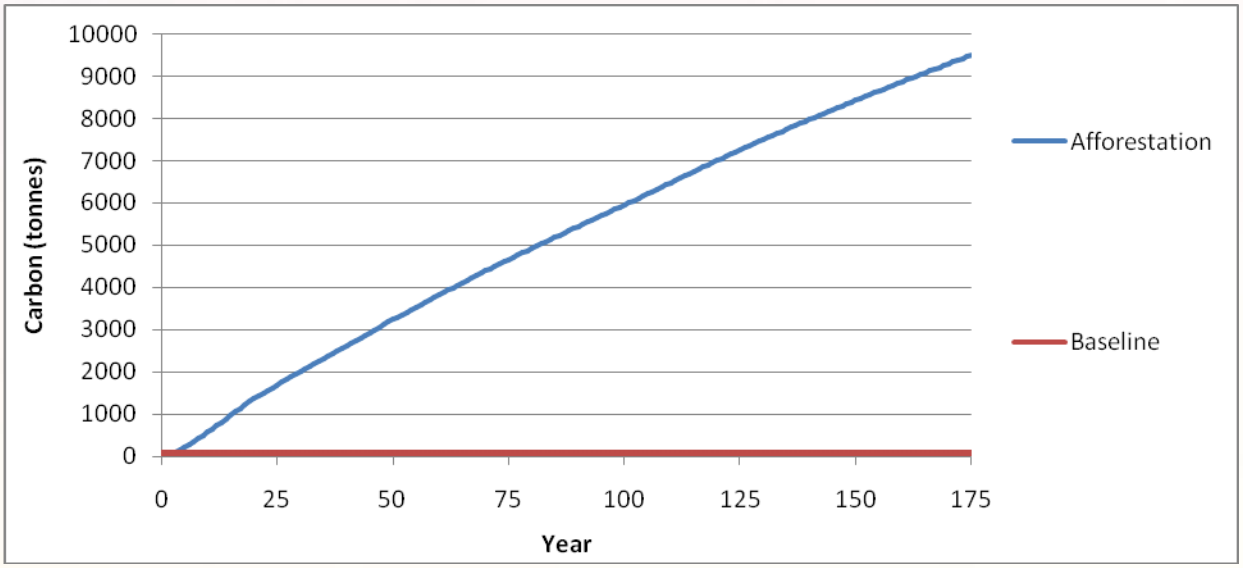

Figure 6 The change in carbon over 175 years.

Carbon offsets are measured in terms of their carbon dioxide equivalent ($C0_2e$). There are several GHGs including:

- carbon dioxide ($C0_2$),
- methane (CH_4),
- nitrous oxide (N_20),
- perflourocarbons (PFCs),
- hydroflourocarbons (HFSs), and
- sulfur hexafluoride (SF_6).

All of these GHGs contribute to global warming at different magnitudes. Sulfur hexafluoride traps 2280 times more heat in the atmosphere than $C0_2$ so it would take 2280 times more emissions offsets compared to CO_2 emissions. All GHGs are compared according to their global warming potential and they are all converted to CO_2e when they are measured and quantified (IPCC, 2009). Figure 7 shows the change in CO_2e over 175 years

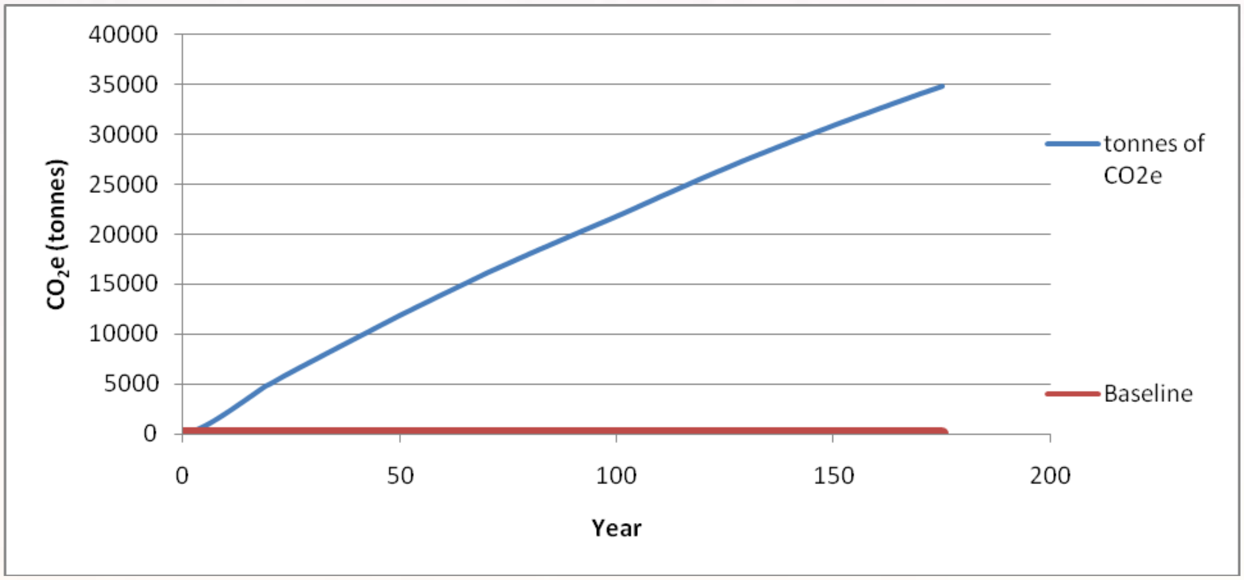

Figure 7 The change in CO_2e over 175 years.

Appendix 1 describes the chemical processes that underlie the conversion of carbon to CO_2e and shows how one tonne of carbon is equal to 3.667 tonnes of CO_2e. Figure 7 shows that after 175 years, this project sequesters 34,828 tonnes of CO_2. Offset credits are measured in tonnes of CO_2e. Each tonne equals one offset and these offsets can be marketed as long as they follow an accepted protocol with verifiable standards. The British Columbia Forest Carbon Offset Protocol (BC FCOP) was the procedural framework that was used to create a valid offset project. The methods for the process are laid out in the next section.

2.3Protocol methods

The BC FCOP describes the GHG accounting process for eligible forest projects in BC and following its methods ensures compliance with the BC EOR. It is the essential process that a project proponent follows to obtain BC certified carbon credits. Its methods are guided by a number of globally used GHG quantification standards and forestry-specific guidance methodologies (Tim Lesiuk, 2011).

2.3.1 Applicable Projects and Eligible Forest Types

There are 4 types of forest projects that the protocol recognizes: afforestation, reforestation, improved forest management, and conservation/avoided deforestation. The project type is considered afforestation because the area has been converted from forest land to non-forest land for at least 20 years prior to project commencement.

Eligible forest types include sites that are greater than one hectare in size and able to achieve 5 m of growth with 25% crown closure at maturity. The site must also conform to the appropriate forest regulations and legislations such as the appropriate use of a genetically diverse and productive stock as stated in the BC Chief Forester's Standards for Seed Use (Tim Lesiuk, 2011).

2.3.2 Determining the Baseline type

The baseline scenario is the likely course of events that would occur if the project did not take place; it is often referred to as the status quo. There are different types of baselines that can be used to describe different scenarios. The assumption for the afforestation site is that it would have persisted as a non-forested site. According to the BC FCOP it is appropriate to use the historical benchmark baseline type when assuming that the practices or land use prior to project commencement would be likely to persist if the afforestation does not occur (Tim Lesiuk, 2011).

2.3.3 Identification of Sources, Sinks and Pools

One way to track sources, sinks and pools (SSP)s is by following a lifecycle assessment of the relevant SSPs of the project (Tim Lesiuk, 2011). Some of the common practices include identifying a single contiguous area and tracking the amount of carbon stored at different times, and the total change in carbon would represent the change in total carbon stored (Tim Lesiuk, 2011). In determining SSPs, it is also required to determine the relevant or related upstream and downstream emissions sources. For some projects, this may include identification of GHG sources that occur outside of the project area but that still must be included in the GHG accounting. Some common examples are the production of fertilizer or fossil fuel combustion.

The assumption for the afforestation site is that it is a homogenous site with exposed podzolic soils and minimal vegetation yielding net emissions from CO_2 and CH_4 from decomposing biomass and exposed soils. This is accounted for in the baseline scenario and can be seen in the diminishing levels of soil carbon in Figure 4.

For the afforestation project, fossil fuel combustion is an applicable emission source at multiple stages of the project life cycle. It must be accounted for if there is site preparation and when personnel and equipment are transported to and from the site. This emissions calculation is available in Appendix 2. Fertilizer usage was not modelled but if it was, there could be both emissions from the production and delivery of the fertilizer, and also sequestration from increased growth rates.

2.3.4 Determining Baseline SSPs and comparing baseline SSPs to Project SSPs

The project proponent must identify a list of the relevant SSPs for both the project and the baseline, compare the two pools and finally estimate and monitor these pools throughout the project lifespan. The afforestation site is a relatively easy example to understand but the procedure can be very complex with large areas and multiple SSPs. The project and baseline SSPs are listed below in Table 2 and the entire project SSPs pooled with the baseline SSPs gives the total ecosystem carbon.

Table 2.The SSPs for the project and the baseline.

Project SSPs	Relevant/Optional	Onsite Baseline SSPs	Relevant/Optional
Standing live trees	Relevant	Fossil fuel combustion	Relevant
Shrubs and understory	Relevant	Industrial emissions	Relevant
Live roots	Relevant	Agricultural methane	Relevant
Dead organic matter	Relevant	Energy production	Relevant
Litter and forest floor	Relevant		
Soil carbon	Optional		
Harvested wood products	Optional		
Fossil fuel combustion	Relevant		

2.3.5Regulatory Requirements

Project proponents are required to establish that afforestation projects would have likely not occurred given existing or proposed regulatory requirements (Tim Lesiuk, 2011).Since there are no existing reasons to believe that the site would be afforested, and the Pacific Carbon Trust (PCT), a BC crown corporation, is actively seeking out offset projects to meet its public sector carbon neutrality requirements, the project meets the regulatory requirement criteria. With the afforestation project modelled, the results will reveal the total change in ecosystem carbon, the amount of CO_2e, and the marketing potential of the offsets.

3.0 Results

The results of the carbon modeling procedure are laid out in table 3 below. The table shows both the total carbon and the total CO_2e in tonnes. After 20 years, the afforestation site produces 1,360 tonnes of carbon in biomass, soil carbon and dead organic matter which is equivalent to 4,986 tonnes of CO_2e. The table also shows how the site develops carbon over time. After 100 years the site produces 5,947 tonnes of carbon which is equal to 21,806 tonnes of CO_2e. Although the project itself is modelled for 175 years, the carbon data from age 0 to age 20 gives us a scenario for modelling a 20 year carbon contract. These details will be covered in the marketing of offsets in the next section.

Table 3 The carbon and CO_2 levels over 100 years.

Year	Carbon (tonnes)	CO_2e (tonnes)
20	1360	4986
40	1263	4630
60	1199	4396
80	1105	4051
100	1021	3743
Total	**5947**	**21806**

4.0 Marketing Offsets

The total amount of CO_2e transacted in the global market place in 2010 was 131.2 million tonnes (Mt) compared to a 2009 value of 98 Mt (Molly Peters-Stanley, 2011). The volumes grew by 34% in a time where global recessions were impacting all markets. As table 3 shows, the project produces 5,947 tonnes of carbon after 100 years which is equal to 21,806 tonnes of CO_2e. The value that these offsets could produce depends on many variables such as the nature of the project, the risk involved, the market place and many other factors. Some of the potential revenue streams based on some buying prices are laid out in table 4. The net present values are taken for each period with a 5% interest rate. A 20 year carbon contract would be appropriate for this project because it takes at least 20 years to build up enough carbon for a project this small. The PCT is currently anticipating the purchase of 800, 000 tonnes per year with a buying price that ranges between 10 and 17 dollars (Pacific Carbon Trust, 2011). The carbon produced from years 20 to 100 gives an indication of the revenue potential for the project after 20 years; at this point they can decide how and where to market the offset credits.

Table 4.The net present values for the reporting periods at years 20, 40, 60, 80 and 100 at different offset prices.

Reporting Period (year)	tonnes of CO_2 E	$10	$12	$14	$16
20 (0-20)	**4,986**	18,792	22,550	26,308	30,067
40 (21-40)	**4,630**	6,577	7,892	9,207	10,523
60 (41-60)	**4,396**	2,353	2,824	3,295	3,765
80 (61-80)	**4,051**	817	981	1,144	1,308
100 (81-100)	**3,743**	285	342	398	455

4.1 Voluntary and Compliance Markets

Carbon offsets can be bought or sold in both voluntary and compliance markets. The act of purchasing offsets is defined as voluntary as long as the carbon offsets are not employed to meet some regulatory purpose (Anaerobic Advisory Committee, 2011). The BC government imposed compliance market has a limited scope of their purchasing capability, so it may be necessary for project proponents to market offsets on the voluntary market. There are a number of large scale emitters that want to offset their emissions in order to create a green image or to prepare for a cap and trade system that may eventually be imposed.

4.1.1 Compliance Markets; the Pacific Carbon Trust

Public institutions including schools, health authorities and provincial ministries are required to become carbon neutral. They can do this by purchasing BC-based carbon offsets to reduce their emissions (Greig, 2011). The PCT actively purchases offsets from proponents of valid and verified projects. The PCT uses the Markit Environmental Registry to assist with providing independent review of the offset project documents as well as ensuring that projects comply with the Pacific Carbon Standard (PCS). The PCS outlines the requirements for developing high-quality offsets based on the BC EOR (PCT Registry, 2011).

4.1.2 Voluntary Markets; the Verified Carbon Standard

Recognition of the BC FCOP as an approved methodology under the Verified Carbon Standard (VCS) program will increase opportunities for BC forest carbon offset project developers to sell offsets internationally (Hickli, 2012). This will also improve international alignment and increase fungibility with standards that can be marketed internationally. In 2010, the VCS was the most widely used standard for accounting for over a third of all voluntary carbon credits (Hickli, 2012). The total amount was over 14 million tonnes of credits. By June 2012, the VCS should make their final approval on BCs standards for verification and validation which would improve market conditions for the sale of offsets.

5.0 Discussion

5.1 Additionality of Project

Project additionality refers to the demonstration that the project overcomes some sort of obstacle (usually financial or technological) in order to pursue the incentive of reducing GHGs and receiving offset credits (Tim Lesiuk, 2011). A site that is required to be reforested by law for instance is not additional. There are a number of ways to demonstrate additionality and show how the project goes beyond the business as usual requirements. Since this project would not be profitable without the purchase of offsets, the afforestation is additional. Since there are a number of other projects that could be implemented that would be more profitable without the sale of offsets, the project is additional, and finally there is a high upfront capital investment required to implement the project which shows how the project proponent must go beyond the status quo to achieve offsets (Tim Lesiuk, 2011). All of these factors show how the project is additional especially with the high cost of afforestation and the limited expectation of revenue in the short term. Usually, afforestation projects qualify as additional as long as they can demonstrate that they are not required by law.

Other eligible forest carbon offset projects such as the Dark Woods and Timber West improved forest management projects claim offsets by conserving their land. They use previous land use practices and past harvest rates to model how much carbon is stored compared to how much carbon would have been lost. The Dark Woods project claims 450,000 tonnes of offsets and the Timber West claims 600,000 tonnes of carbon offsets (Our Projects, 2011). This is a contentious issue for some who believe that the additionality demonstrated in these scenarios is weak and arbitrary. The way they demonstrate additionality is not arbitrary, but it is based on an estimate of what would happen in the area, and therefore has been subject to claims that any claims of harvest rates and land use practices could be justified in one way or another. The proponents of the project satisfied the process requirements, but compared to afforestation where there are tangible, quantitative elements that can be measured the projects will likely to continue to fall under scrutiny as real contributors to GHG reductions.

5.2 Permanence

The permanence of the project refers to how the project maintains its emissions reductions over the long term. In BC, a proponent can reduce emissions through technological innovation or renewable energy projects and the permanence is evident in the onetime permanent reductions. Plantations do have atmospheric benefits, but unlike emissions reductions or renewable energy projects, plantation permanence can be difficult to predict and protect in perpetuity. Natural and human caused disturbances or even a shift in societal values are difficult to predict and the effects of a reversal event could completely negate the emissions reductions. The BC EOR takes these concerns into consideration in the methods for managing reversal events. There are multiple ways to manage for reversal events and ensure that the atmospheric effects endure for at least 100 years.

The BC EOR specifies that a project proponent include a risk mitigation plan to ensure that the atmospheric effects of the project persist (British Columbia, 2008). Some of the potential risks include wildfire, windthrow, insect attack and human induced disturbance. There are multiple ways of managing for human and natural disturbances such as fuel management, fire breaks or silvicultural techniques to avoid insect outbreak (Tim Lesiuk, 2011). These practices reduce risk but do not eliminate it completely. In order to manage financial risk the proponent should create a contingency plan to address the risks of reversal. Aside from modeling the disturbance events, the proponent could also establish a buffer pool of credits to be able to repay the costs of lost offsets from a reversal event. They could also set aside funds in a contingency account or simply purchase insurance to replace offsets in the case of a reversal (Tim Lesiuk, 2011). In the near future, multiple project holders, with similar interests, may choose to spread out their risk by aggregating projects into a large pool which may increase the risk of an event occurring within the pool but minimize the overall effect of the event on the whole group.

5.3 The Forest Industry and Carbon Offsets

The forests in British Columbia are valued for countless environmental, social and cultural reasons. BCs forests cover two thirds of the province and are over 60 million hectares in size. It is evident that the economic importance of our forest industry is paramount. The strategy for integrating offset projects into the current economic structure is not certain although there have been some recent projects which indicate the direction we are heading in. The BC Ministry of Forests, Ranges and Natural Resource Operations recently released a request for proposal to address poor stocking levels and degraded sites in BC. They want to restore at least 500 hectares of land per year and improve stocking levels on these degraded sites. This is a large scale offset project which has multiple benefits for both project proponents to receive carbon offset credits, the government to improve the sites, and for the creation of a number of silvicultural jobs in perpetuity. The benefits of integrating GHG mitigation into BC crown forests are evident here in the mitigation of climate change, the creation of jobs, and the restoration of degraded ecosystems.

5.4 Applicable forest projects

The development of urban and residential private property has always been one of the causes of deforestation. The BC EOR states that forest projects must be at least one hectare in size but this constraint could be seen as a disincentive for private land owners to reforest their property. Since projects greater than one hectare are applicable, an aggregation of small parcels of land could be developed that amount to a similar size and significant amount of emission reductions over time. A project template could be implemented in areas where multiple private properties with grass yards or agricultural lands could be pooled together as an aggregation of forest offset projects. The afforestation project utilizes an initial tree density of 1600 stems per hectare which over time drops considerably due to space and light competition. If 1600 trees were planted in aggregated areas, the trees would theoretically sequester more carbon due to lack of density dependent mortality, increased amounts of stem branches and higher growth rates. In the future, there will hopefully be an urban forest carbon offset template that can be used to both address urban deforestation and also qualify for carbon offsets.

6.0 Conclusion

The carbon offset project in this paper has shown to sequester 21,806 tonnes of CO_2 e over 100 years. This is just one of the many projects that could take place in this bourgeoning industry. With the PCT calling for 800,000 tonnes of offset credits to be purchased annually, there is an opportunity for this industry to grow in British Columbia and spread globally. BC was the first public sector to seek out carbon neutrality so it makes sense that they also set the precedent in carbon management. Offset projects have faced controversy for their band aid approach to the larger scale issue of fossil fuel addiction but this industry is just being developed and is changing rapidly. The offset markets may not be the ideal solution to solving our emissions problems and it has been proven to be controversial in many circles, but the dependence on fossil fuels is a heated political problem which has proved time and time again difficult to address. Fifty years ago many jurisdictions were not even replanting trees after harvesting and today BC has a net-zero deforestation mandate and a regulated process by which we can plant trees to mitigate the effects of climate change. Fifty years from now as environmental and energy policies evolve, offsets may not be the tools being used to deal with their climate issues, but at least today they are a step in the right direction.

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Appendix1 Carbon and Wood Chemistry

A tree is composed of 50% cellulose, 25% hemicellulose and 25% lignin (Northway, 2008). If you proportionally weight each compound, you end up with the approximate empirical formula of a tree being $C_{6.75}H_{10.75}O_{4.5}$ (Northway, 2008). To convert from carbon to CO_2e you use the ratio of the atomic masses of CO_2 to C is which is 44:12. It means that you multiply the carbon by 44/12 or 3.667 to get CO_2e. This is one of the ways of determining the amount of carbon and CO_2 from sequestration projects. Knowing the different levels of carbon per species, we can determine carbon in each species and then convert that value to the total amount of CO_2e. Each tree species has a different specific gravity of oven dried weight per cubic metre. Douglas-fir has a specific gravity of approximately .5kg/m^3 which means that about .5 of the .5kg/m^3 of douglas-fir tree is carbon.

Appendix 2 Quantification of GHG emissions

Each time a proponent prepares an emissions reduction report to assess the net change in emissions in a project period the quantification of the relevant SSPs is required.

The total project emissions are described by **formula 1** below:

Formula 1:

$$\Delta GHG_{j,Project,t} = (GHG_{j,Project\ Forest\ Pools,t} - GHG_{j,Project\ Forest\ Pool,t-1}) + GHG_{j,Project\ HWP\ Pool,t} - GHG_{j,Project\ Emission\ Sources,t} - GHG_{j,Leakage,t}$$

$\Delta GHG_{j,Project,t}$

This describes the change (Δ) in GHG emissions during a reporting period (t). A negative number indicates a removal of GHG emissions. The reporting period used is 20 years.

$GHG_{j,Project\ Forest\ Pools,t}$

This value is the total ecosystem carbon at year 20 for the site. The total carbon is 1360 tonnes of carbon which is 4986 tonnes of CO_2 equivalents.

$GHG_{j,Project\ Forest\ Pool,t-1}$

This describes the CO_2 at the beginning of reporting period t and is equal to 0.

$GHG_{j,Project\ HWP\ Pool,t}$

Harvested wood products and wood products in landfills are known to store carbon at rates that decrease over time as they degrade. Some projects would need to implement quantification procedures to model for this but it is beyond the requirements of this afforestation project as the project is planned to persist past 100 years without harvesting.

$GHG_{j,Project\ Emission\ Sources,t}$

The amount of emissions associated with the afforestation project from factors such as emissions from equipment and personnel transport must be accounted for in time period t. An estimate based on following Formula 2 below is used

$GHG_{j,emissions\ sources,\ t} = \sum GHG_{j,\ PEi,t}$

The formula describes the project emissions from SSP PE_i during time period t. The total emissions will be monitored and accounted for time period t or the 20 year period.

An approximate value for CO_2 equivalent emissions for a Ford E-350 crew cab driven 1000km/year over the 20 year time period is 9.4 tonnes in 20 years (Falcon Solutions, 2011). That is likely an over estimate and therefore would be considered conservative in estimation.

$GHG_{j,Leakage,t}$

Leakage is a term that describes a market force that reduces the supply of a good such as wood products in one area and encourages a greater production of the product outside the project area (Tim Lesiuk, 2011).

There are two forms of leakage that must be assessed for forest offset projects:

- Land use shifting leakage
- Harvest shifting leakage

For the afforestation project there is no harvest shifting leakage because the change in land use would not affect other harvesting rates and is therefore zero. The land use shifting leakage is more complex and requires that the proponent assess the potential baseline scenarios that may have occurred in absence of the project. For this scenario the assumption is that the site would have remained deforested and that no land use shifting leakage would occur.

Appendix 3 Growth and Yield Curves

	Douglas-fir	Hemlock	Cedar
Year	gross volume (m^3)		
0	0	0	0
10	2	1	1
20	65	56	56
30	192	232	232
40	318	416	416
50	458	613	613
60	579	801	801
70	687	976	976
80	785	1124	1124
90	873	1277	1277
100	949	1423	1423
110	1020	1546	1546
120	1083	1650	1650
130	1147	1758	1758
140	1204	1858	1858
150	1258	1943	1943
160	1308	2019	2019
170	1353	2094	2094
180	1397	2167	2167
190	1438	2235	2235
200	1476	2296	2296
210	1511	2350	2350
220	1543	2401	2401
230	1572	2448	2448
240	1600	2494	2494
250	1626	2541	2541
260	1650	2585	2585
270	1673	2626	2626
280	1692	2665	2665
290	1711	2701	2701