# The Benefit Cost Analysis of the Aggregator`s Position as it Relates to the Nitrous Oxide Emission Reductions Protocol

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# Disclaimer

This document has been produced independently by Dr. Paul Thomassin and The Prasino Group at the request of the Climate Change Emissions Management (CCEMC) Corporation as specified under contract for the Protocol Validation Studies. It was produced according to the requirements in the Alberta Offset System's Nitrous Oxide Emissions Reduction in Agriculture Quantification Protocol v 1.0 October 2013[1]. The views expressed in this report are not necessarily the views of the Climate Change Emissions Management (CCEMC) Corporation.

[1] See http://environment.gov.ab.ca/info/library/8294.pdf

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# 1. Introduction

Changes in fertilizer management practices by agricultural producers can result in a decrease in the amount of greenhouse gas emissions being generated as compared to the baseline production practice. The Quantification Protocol for Agricultural Nitrous Oxide Emissions Reductions outlines the 4R Consistent Nitrogen Stewardship plan which can reduce the amount of nitrous oxide emissions that result from nitrogen fertilizer applications. The 4R Stewardship plan consists of applying the Right source of nitrogen fertilizer at the Right rate, at the Right time and the Right place.

The decrease in nitrous oxide emissions from the 4R Consistent Stewardship plan can be sold in the Alberta Offset System. The aggregator will work with the producer and the agricultural professional in order to ensure that the project that is developed will be in accordance with the protocol. One of the areas where there is little information is the economics of the aggregation function for the 4R Consistent Stewardship plan. This study attempts to address this lack of information by investigating the costs and benefits of the aggregation function as it relates to the Nitrous Oxide Emissions Reductions Protocol.

# 2. Function of the Aggregator

The aggregator will work with the producer and the agricultural professional to ensure that the protocol is being followed but is also involved in the marketing and selling of credits into the Alberta Offset System. More specifically, the role of the aggregator is to gather the data on both the baseline and new management system (project condition) in order that the generation of offset credits can be justified. In this regard, the aggregator has to gather data that can be used to justify the selling of credits into the offset market. The aggregator will be responsible for data collection, legal costs, registry costs, verification costs, marketing and other costs.

# 3. Assumptions and Data Inputs

It was assumed that an existing aggregator would already have established a robust agronomic reporting framework that could keep track of agricultural practices and performance and that the aggregation functions would be an expansion of current information systems. This assumption was made after discussions with individuals in the industry who suggested that the cost of developing a robust agronomic reporting system, which would be needed for the nitrous oxide emission reductions protocol, would be prohibitively large if some form of it was not already in existence. Given this assumption, the estimated costs included in this study are the additional costs of developing the offset information into an existing agronomic reporting framework.

Another important assumption made in the study was the split in revenue between the agricultural producer and the aggregator. After several discussions, it was assumed that the producer would receive 60 percent of the carbon price, while the aggregator would receive 40 percent of the market price. This assumption seems reasonable since the agriculture producer is implementing the

protocol and providing the aggregator with the data. The aggregator, ensures that the protocol is being followed, gathers the data, and markets the offset credits.

The analysis assumes a seven year timeframe for the aggregator. It is expected that there will be substantial initial or start-up costs to modify the existing agronomic framework to take into account the aggregation function, but these modification and infrastructure developments would be available for a number of years. The analysis undertaken will estimate the present value of the aggregation function taking into account the initial cost of establishing the infrastructure, the annual operating costs, and the revenue generated from the sale of carbon offset credits.

An aggregator was contacted in order to get an understanding of the aggregation function as it related to the nitrous oxide emissions reductions protocol (NERP). These discussions included identifying the costs associated with the aggregation function as well as the benefits. Several of the assumptions made above were the result of these discussions. Given this information, a spreadsheet survey instrument was designed to estimate the costs and benefits associated with the aggregation function as it relates to NERP.

The survey instrument was a spreadsheet containing multiple sheets that asked the respondents to place their best estimates on the costs and revenue questions that were asked of them. Result sheets take this information and estimate the net present value of the project, the costs per credit and the revenue per credit, as well as the net present value of the project for the aggregator. This tool was specifically designed to study the NERP aggregation function.

The spreadsheet instrument contained eight sheets. The first sheet provided an introduction and brief instructions on how to complete the other sheets. The second sheet contained information on the start-up costs for the aggregator (See Table 1 below). The start-up costs are the initial costs that are needed to establish the infrastructure to collect and store the necessary information to generate offset credits. The items included in the start-up costs are: equipment, office space, administrative support, software development, programmer costs, security, data storage, training, marketing, title searches, financial and legal costs. Most of the costs will occur in the initial period; however, the model has been designed so that other infrastructure costs can be added in future periods to take into account things such as additional programmer time, new equipment, etc. The information generated for the start-up costs will be transferred to the results sheets as a component of total costs in order to estimate the cost of generating the carbon offset credits.

The next three sheets request information on the operating or input costs of the aggregator. The operating costs are the annual costs that will be incurred by the aggregator to generate the carbon offset credits. Three sheets have been designed to take into account three possible scenarios; expected costs, optimistic costs, and pessimistic costs. These three scenarios were defined by the number of credits generated in each scenario, the annual costs associated with generating those credits and the discount rate. After discussions with existing aggregators, the expected scenario

was based on 50,000 tonnes of carbon offsets, the optimistic scenario generated 75,000 tonnes of carbon offsets, while the pessimistic scenario generated 25,000 tonnes annually.

The first question asked in the input sheets was the discount rate that should be applied (Table 2). The discount rate is used to estimate the present value of the costs and/or benefits that do not occur in the initial time period. The discount rate measures the aggregator's time value of money.

The second question asked the price expectations for the carbon offset credits (Table 2). The respondent is able to provide an expected annual price path for carbon offset credits for the next seven years. The price path can be varied by scenario: expected, optimistic, and pessimistic.

The worksheet allows the respondent to split the carbon revenue between the agricultural producer and the aggregator. As stated above, in the analysis it was assumed that the split between the agricultural producer and the aggregator was 60 percent and 40 percent respectively.

Existing aggregators identified that the annual operating costs could be divided into two categories (Table 2). The first group of costs would be somewhat constant for any number of credits being generated. These costs included such things as: travel and marketing, legal costs, additional computer storage space, management costs, software up-grades, marketing, and accounting costs. This category of costs is important because as more carbon offset credits are generated the cost per credit of this category of costs decreases. Similarly, as the number of carbon offset credits decreases the cost per credit of this category goes up.

The second category of costs that are included are those that vary per carbon offset credit generated. Two costs fall into this group: data gathering and verification costs. The cost per data gathering and verification costs were estimated based on the price of the carbon offset credit. In this analysis, the data gathering costs were estimated to be 10 percent of the carbon offset price, while the verification cost was estimated to be 3 percent of the carbon offset price (Table 2).

The final three sheets in the model provide estimates of the results given the input values estimated by the aggregator. As noted previously, optimistic, expected and pessimistic values were requested to provide a range of values for the number of credits, carbon price and discount rate. A sensitivity analysis was undertaken for each of the three scenarios (optimistic, expected and pessimistic) in order to estimate how variations in the variables impacted the results.

Table 1: Start-Up Cost Sheet in the Program

| Start-up Costs | Initial Costs | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 |
|---|---|---|---|---|---|---|---|---|
| | | $ | $ | $ | $ | $ | $ | $ |
| Equipment | | | | | | | | |
| Capital Purchases | | | | | | | | |
| Laptops | | | | | | | | |
| Servers | | | | | | | | |
| Office Space | | | | | | | | |
| Admin Support | | | | | | | | |
| Software Development | | | | | | | | |
| Programmer Costs | | | | | | | | |
| IT Security | | | | | | | | |
| Off-site Data Storage | | | | | | | | |
| Training | | | | | | | | |
| Marketing | | | | | | | | |
| Collateral Materials | | | | | | | | |
| Financing Costs | | | | | | | | |
| Legal Costs (Contract Development) | | | | | | | | |
| Certification for Approved Advisors | | | | | | | | |
| **Total Start Up Costs** | | | | | | | | |

Table 2: The Expected Input Sheet in the Program

| **Expected Returns** | **Year 1** | **…** | **Year 7** |
|---|---|---|---|
| **Discount Rate (ex. 3%; Entered as = 0.03) Enter for Each Year** | | | |
| **Tonnes of Carbon Generated (in Tonnes)** | | | |
| **Carbon Price (in $/tonne)** | | | |
| | | | |
| **Split Between Aggregator and Producer For Each Year** | | | |
| Producer's Portion (in %, 60%=0.60) | | | |
| Aggregator's Portion (in %; 40%=0.40) | | | |
| Summing Portions should equal 1. | | | |
| | | | |
| **Annual Costs (costs that do not vary by the number of tonnes)** | | | |
| Travel and Marketing Costs | | | |
| Legal Costs for selling carbon offsets | | | |
| Additional Computer Storage Space | | | |
| Management Costs | | | |
| Software Up-grade and Development | | | |
| Marketing and Print Campaigns | | | |
| Accounting costs | | | |
| **Total Annual Fixed Costs** | | | |
| | | | |
| **Annual Costs that Vary as a Percentage of the Carbon Price** | | | |
| Data Gathering (as a percentage of carbon credit price, ex. 10% = 0.10) | | | |
| Verification Costs (as a percentage of carbon credit price; ex. 3%= 0.03) | | | |
| | | | |
| **Dollar Value of the Annual Costs that Vary as a Percentage of the Carbon Price** | | | |
| Data Gathering Costs | | | |
| Verification Costs | | | |
| | | | |
| **Total Annual Costs that Vary as a Percentage of the Carbon Price** | | | |
| | | | |
| **Total Annual Costs** | | | |

# 4. Results

The results are given in terms of a number of indicators: net present value of the project, cost per credit and revenue per credit. The start-up costs were the same for each of the three scenarios (optimistic, expected, and pessimistic). The annual costs varied by scenario based on the number

of credits that were generated. The revenue for each scenario varied due to different price expectations and the quantity of carbon offset credits generated over time. Each of the three scenarios will be reported separately.

## 4.1 The Expected Scenario

The price expectations, carbon offset credit generation, and discount rate for the expected scenario are given in Table 3. It was expected that the current market price for carbon offset credits would continue for two years and then increase to $23.00 per tonne. The quantity of carbon offset credits generated remained the same at 50,000 tonnes per year. Finally, the discount rate was set at three percent over the seven years.

Table 3: Carbon Price, Carbon Offsets Generated and the Discount Rate for the Expected Scenario

| | **Price of Carbon Offset ($)** | **Carbon Offsets Generated (Tonnes)** | **Discount Rate (as a %)** |
|---|---|---|---|
| Year 1 | $13.00 | 50,000 | 3 |
| Year 2 | $13.00 | 50,000 | 3 |
| Year 3 | $23.00 | 50,000 | 3 |
| Year 4 | $23.00 | 50,000 | 3 |
| Year 5 | $23.00 | 50,000 | 3 |
| Year 6 | $23.00 | 50,000 | 3 |
| Year 7 | $23.00 | 50,000 | 3 |

The annual flow of costs and revenue for the expected scenario are given in Table 4. The revenue generated in each year is greater that the costs in any year, except for the start-up period. The present value of the costs and revenue, cost per credit generated, revenue per credit and the net present value are given in Table 5. The results from the expected scenario indicate that the net present value of the stream of benefits and costs would be $479,000.00 over seven years. The cost per offset credit generated was $5.73 and the revenue per offset credit was $7.09. The net revenue per credit for the aggregator over the seven years was $1.36 per credit. These results would indicate that under the expected scenario assumptions the aggregator would be expected to make a profit.

Table 4: Start –Up Costs, Annual Operating Costs and Annual Revenue for the Expected Scenario

| | **Start-up Costs** | **Annual Costs** | **Annual Revenue** |
|---|---|---|---|
| Initial Costs | $250,000.00 | $0.00 | $0.00 |
| Year 1 | $0.00 | $236,500.00 | $260,000.00 |
| Year 2 | $0.00 | $236,500.00 | $260,000.00 |
| Year 3 | $0.00 | $301,500.00 | $460,000.00 |
| Year 4 | $0.00 | $301,500.00 | $460,000.00 |
| Year 5 | $0.00 | $301,500.00 | $460,000.00 |
| Year 6 | $0.00 | $301,500.00 | $460,000.00 |
| Year 7 | $0.00 | $301,500.00 | $460,000.00 |

Table 5: Present Value of the Costs and Revenue, Cost per Credit, Revenue per Credit and Net Present Value for the Expected Scenario

| Indicator | Present Value |
|---|---|
| Present Value of the Costs | $2,004,054.78 |
| Present Value of the Revenue | $2,483,236.22 |
| Cost Per Offset Credit Generated | $5.73 |
| Revenue Per Offset Credit Generated | $7.09 |
| Net Present Value | $479,181.44 |

A sensitivity analysis was undertaken to investigate how sensitive these results were to changes in various parameters. Keeping all of the parameters in the model the same, the annual costs that were in the fixed or constant category were increased by the same percentage rate each year. Table 6 provides the results of increasing these annual fixed costs. Increasing these costs by 10 percent or 20 percent still results in a positive net present value for the aggregator. The break-even increase in annual fixed costs is approximately 27.32 percent.

Table 6: Impact of Increasing the Annual Fixed Costs on the Net Present Value of the Aggregator - Expected Scenario

| | Present Value of the Benefits | Present Value of the Costs | Net Present Value |
|---|---|---|---|
| 10% per year increase in Annual Fixed Costs | $2,483,236.22 | $2,179,460.26 | $303,775.96 |
| 20% per year increase in Annual Fixed Costs | $2,483,236.22 | $2,354,865.74 | $128,370.48 |
| 27.32% per year increase in Annual Fixed Costs | $2,483,236.22 | $2,483,262.55 | -$26.33 |

Two additional sensitivity analyses were undertaken. The first investigated the break-even prices of carbon offset credits that would equate the present value of the benefits to the present value of the costs. It was assumed that the carbon offset credit price would remain the same for the first two years at its current price ($13.00 per tonne). The price was allowed to decrease in year's three to seven at the same rate. The price of carbon could decrease to approximately $14.77 in years three to seven to break-even given that all other parameters remained the same (Table 7).

Table 7: Carbon Offset Prices and the Aggregator's Present Value - Expected Scenario

| | Assumed Carbon Offset Prices | Break-Even Carbon Offset Prices | Present Value |
|---|---|---|---|
| Year 1 | $13.00 | $13.00 | |
| Year 2 | $13.00 | $13.00 | |
| Year 3 | $23.00 | $14.77 | |
| Year 4 | $23.00 | $14.77 | |
| Year 5 | $23.00 | $14.77 | |
| Year 6 | $23.00 | $14.77 | |
| Year 7 | $23.00 | $14.77 | |
| **Present Value of the Benefits of the Break-Even Carbon Offset Prices** | | | $1,772,688.76 |
| **Present Value of the Costs of the Break-Even Carbon Offset Prices** | | | $1,773,126.86 |
| **Net Present Value with the Break-Even Carbon Prices** | | | -$438.10 |

The final sensitivity analysis was undertaken to investigate the decrease in the quantity of carbon offset credits generated that would be acceptable to break-even. It was assumed for this break-even analysis that the number of credits would be the same for each year. The analysis would indicate that the quantity of offset credits could decrease to approximately 35,705 offset credits from the assumed 50,000 offset credits per year. The net present value when only 35,705 offset credits were generated annually was a -$39.69.

## 4.2 The Optimistic Scenario

A number of the assumptions were changed in the optimistic scenario. These included the carbon price, the quantity of carbon offset credits produced and the discount rate. For this scenario, it was assumed that the carbon price remained the same for the first two years and then increased to $27.00 per tonne in year's three to seven. The number of carbon offset tonnes generated was also increased to 75,000 tonnes per year. Finally, the discount rate used in this analysis was two percent (Table 8).

Table 8: Carbon Price, Carbon Offsets Generated and the Discount Rate for the Optimistic Scenario

| | Price of Carbon Offset ($) | Carbon Offsets Generated (Tonnes) | Discount Rate (as a %) |
|---|---|---|---|
| Year 1 | $13.00 | 75,000 | 2 |
| Year 2 | $13.00 | 75,000 | 2 |
| Year 3 | $27.00 | 75,000 | 2 |
| Year 4 | $27.00 | 75,000 | 2 |
| Year 5 | $27.00 | 75,000 | 2 |
| Year 6 | $27.00 | 75,000 | 2 |
| Year 7 | $27.00 | 75,000 | 2 |

As expected, both the aggregator's annual costs and annual revenues increased with this scenario, however, the revenue increased at a faster rate (Table 9). In this scenario, the net present value after seven years was $1.7 million. The cost per carbon offset tonne decreased from $5.73 in the

expected scenario to $5.17 in the optimistic scenario. The decrease in the cost per credit is the result of the larger volume of credits being sold by the aggregator; i.e. 75,000 tonnes versus 50,000 tonnes. The impact of the increased number of tonnes generated can also be seen in the present value of the revenue generated. The present value of the revenue increased from $2.4 million in the expected scenario to $4.4 million with the optimistic scenario (Table 10).

Table 9: Start –Up Costs, Annual Operating Costs and Annual Revenue for the Optimistic Scenario

| | Start-up Costs | Annual Costs | Annual Revenue |
|---|---|---|---|
| Initial Costs | $250,000.00 | $0.00 | $0.00 |
| Year 1 | $0.00 | $280,750.00 | $390,000.00 |
| Year 2 | $0.00 | $283,750.00 | $390,000.00 |
| Year 3 | $0.00 | $420,250.00 | $810,000.00 |
| Year 4 | $0.00 | $420,250.00 | $810,000.00 |
| Year 5 | $0.00 | $424,250.00 | $810,000.00 |
| Year 6 | $0.00 | $424,250.00 | $810,000.00 |
| Year 7 | $0.00 | $424,250.00 | $810,000.00 |

Table 10: Present Value of the Costs and Revenue, Cost per Credit, Revenue per Credit and Net Present Value for the Optimistic Scenario

| Indicator | Present Value |
|---|---|
| Present Value of the Costs | $2,712,547.05 |
| Present Value of the Revenue | $4,426,857.17 |
| Cost Per Offset Credit Generated | $5.17 |
| Revenue Per Offset Credit Generated | $8.43 |
| Net Present Value | $1,714,310.12 |

A sensitivity analysis was undertaken to investigate by how much the annual fixed cost could increase by to reach a break-even position. The annual fixed costs were increased by a given percentage each year to determine the break-even value. As can be seen in Table 11, the break-even increase in annual fixed cost was approximately 69.9 percent. This would indicate that the increase in the carbon offset credits sold provides a buffer for potential increases in costs.

Table 11: Impact of Increasing the Annual Fixed Costs on the Net Present Value of the Aggregator - Optimistic Scenario

| | Present Value of the Benefits | Present Value of the Costs | Net Present Value |
|---|---|---|---|
| 10% per year increase in Annual Fixed Costs | $4,426,857.17 | $2,958,801.76 | $1,468,055.42 |
| 30% per year increase in Annual Fixed Costs | $4,426,857.17 | $3,451,311.17 | $975,546.00 |
| 50% per year increase in Annual Fixed Costs | $4,426,857.17 | $3,943,820.58 | $483,036.59 |
| 69.9% per year increase in Annual Fixed Costs | $4,426,857.17 | $4,426,479.80 | $377.37 |

A sensitivity analysis was also undertaken to determine the break-even price that would be necessary to bring the net present value close to zero. For this analysis, it was assumed that the current carbon price was set for the first year. However, the carbon price could vary after this period over the next six years. The break-even carbon price was approximately $9.13 in years two through seven (Table 12). This would indicate that aggregator price risk was very low given the assumptions on costs, volume and discount rate.

Table 12: Carbon Offset Prices and the Aggregator's Present Value - Optimistic Scenario

| | Assumed Carbon Offset Prices | Break-Even Carbon Offset Prices | Present value |
|---|---|---|---|
| Year 1 | $13.00 | $13.00 | |
| Year 2 | $13.00 | $9.13 | |
| Year 3 | $27.00 | $9.13 | |
| Year 4 | $27.00 | $9.13 | |
| Year 5 | $27.00 | $9.13 | |
| Year 6 | $27.00 | $9.13 | |
| Year 7 | $27.00 | $9.13 | |
| **Present Value of the Benefits with the Break-Even Carbon Prices** | | | $1,886,501.88 |
| **Present Value of the Costs with the Break-Even Carbon prices** | | | $1,886,931.58 |
| **Net Present Value with the Break-Even Carbon Prices** | | | -$429.70 |

As with the previous scenario, a break-even volume of carbon offset credits was estimated for the optimistic scenario. It was assumed that the volume of offset credits would remain the same over the seven year period. In this case, the volume of carbon offset credits could decrease to approximately 39,170 offset credits. With this volume of credits annually, the net present value for the optimistic scenario was -$78.86.

## 4.3 The Pessimistic Scenario:

The final scenario investigated was the pessimistic scenario. In this scenario the number of carbon offset credits generated and the prices of the offset credits were lower than in the two previous scenarios and the discount rate was higher. For this scenario, the price of carbon offset credits is assumed to remain constant at $13.00 per tonne over the seven year period, the volume of offset credits was decreased to 25,000 tonnes and the discount rate increased to five percent (Table 13).

Table 13: Carbon Price, Carbon Offsets Generated and the Discount Rate for the Pessimistic Scenario

| | **Price of Carbon Offset ($)** | **Carbon Offsets Generated (Tonnes)** | **Discount Rate (as a %)** |
|---|---|---|---|
| Year 1 | $13.00 | 25,000 | 5 |
| Year 2 | $13.00 | 25,000 | 5 |
| Year 3 | $13.00 | 25,000 | 5 |
| Year 4 | $13.00 | 25,000 | 5 |
| Year 5 | $13.00 | 25,000 | 5 |
| Year 6 | $13.00 | 25,000 | 5 |
| Year 7 | $13.00 | 25,000 | 5 |

Given the assumptions in the pessimistic scenario it is not surprising that the annual costs are higher than the annual revenue for this scenario (Table 14). This would indicate that under these conditions it would not be profitable to be an aggregator. Taking into account the present value of the costs and benefits over the seven years, the net present value for the aggregator would be a negative $621,000 (Table 15). In this scenario the cost to the aggregator of generating the carbon offset was $7.85 per tonne while the revenue was only $4.30 per tonne. Under these conditions aggregators would leave the market.

Table 14: Start – Up Costs, Annual Operating Costs and Annual Revenue for the Pessimistic Scenario

| | **Start-up Costs** | **Annual Costs** | **Annual Revenue** |
|---|---|---|---|
| Initial Costs | $250,000.00 | $0.00 | $0.00 |
| Year 1 | $0.00 | $194,250.00 | $130,000.00 |
| Year 2 | $0.00 | $194,250.00 | $130,000.00 |
| Year 3 | $0.00 | $194,250.00 | $130,000.00 |
| Year 4 | $0.00 | $194,250.00 | $130,000.00 |
| Year 5 | $0.00 | $194,250.00 | $130,000.00 |
| Year 6 | $0.00 | $194,250.00 | $130,000.00 |
| Year 7 | $0.00 | $194,250.00 | $130,000.00 |

Table 15: Present Value of the Costs and Revenue, Cost per Credit, Revenue per Credit and Net Present Value for the Pessimistic Scenario

| Indicator | Present Value |
|---|---|
| Present Value of the Costs | $1,374,003.03 |
| Present Value of the Revenue | $752,228.54 |
| Cost Per Offset Credit Generated | $7.85 |
| Revenue Per Offset Credit Generated | $4.30 |
| Net Present Value | -$621,774.49 |

A sensitivity analysis was undertaken of the pessimistic scenario to investigate how much fixed annual costs would have to decrease in order to break-even. In this analysis, the annual fixed cost portion of total costs would have to decrease by approximately 55.3 percent in order to break-even (Table 16). Such a large decrease in fixed annual costs would be difficult to achieve.

Table 16: Impact of Decreasing the Annual Fixed Costs on the Net Present Value of the Aggregator - Pessimistic Scenario

| | Present Value of the Benefits | Present Value of the Costs | Net Present Value |
|---|---|---|---|
| 10% per year increase in Annual Fixed Costs | $752,228.54 | $1,261,602.73 | -$509,374.19 |
| 30% per year increase in Annual Fixed Costs | $752,228.54 | $1,036,802.12 | -$284,573.58 |
| 50% per year increase in Annual Fixed Costs | $752,228.54 | $812,001.52 | -$59,772.97 |
| 55.3% per year increase in Annual Fixed Costs | $752,228.54 | $752,429.36 | -$200.81 |

One means of addressing the negative net present value in this scenario would be to increase the volume of carbon offsets being generated. An analysis was undertaken to estimate the increase in carbon offsets that were necessary to break-even. It was estimated that approximately 55,600 tonnes of carbon offsets would be required in each of the seven years in order to break-even. With this volume of credits the net present value for the aggregator was -$283.27. This increased volume of carbon offsets to break-even is substantially higher than the assumed volume in this scenario but is close to the volume in the expected scenario.

Another means of breaking-even with the pessimistic scenario would be to increase the price of carbon. For this analysis, it was assumed that the current price of carbon would remain for the first year but then the price of carbon was allowed to increase. The price of carbon would have to increase to approximately $32.05 per tonne in order for the net present value for the aggregator to be a negative $183.49 (Table 17). The price increase to break-even in this situation was greater than the price scenario in the optimistic scenario. In addition, the price increase was faster, i.e. in the second year, and at a much higher level.

Table 17: Carbon Offset Prices and the Aggregator's Present Value - Pessimistic Scenario

| | Assumed Carbon Offset Prices | Break-Even Carbon Offset Prices | Present Value |
|---|---|---|---|
| Year 1 | $13.00 | $13.00 | |
| Year 2 | $13.00 | $32.05 | |
| Year 3 | $13.00 | $32.05 | |
| Year 4 | $13.00 | $32.05 | |
| Year 5 | $13.00 | $32.05 | |
| Year 6 | $13.00 | $32.05 | |
| Year 7 | $13.00 | $32.05 | |
| **Present Value of the Benefits with the Break-Even Carbon Offset Prices** | | | $1,673,104.10 |
| **Present Value of the Costs with the Break-Even Carbon Offset Prices** | | | $1,673,287.59 |
| **Net Present Value with the Break-Even Carbon Offset Prices** | | | -$183.49 |

# 5. Conclusions

This study provides insight into the economics of the aggregation function for the 4R Consistent Stewardship plan that fulfills the requirements of the nitrous oxide emission reductions protocol of Alberta. It was assumed that the aggregator already had a robust agronomic framework and that the aggregation function would be an added service. This assumption was made after discussions with individuals in the industry who stated that if a robust agronomic framework did not already exist it would be uneconomic to design one for only the NERP aggregation function.

Three scenarios were evaluated: expected scenario, optimistic scenario, and pessimistic scenario. The expected scenario assumed a moderate level of carbon offset credit generation by the aggregator of 50,000 tonnes, a moderate increase in the carbon price and a discount rate of three percent. In this scenario the net present value to the aggregator of a seven year aggregation plan was $479,181. This would indicate that there would be some incentive to pursue being an aggregator that included the NERP.

In the optimistic scenario, the number of offset credits generated increased to 75,000 tonnes; with a larger increase in the carbon offset price and a discount rate of two percent. The net present value of the seven year analysis was $1.7 million. This analysis would suggest that there are adequate incentives to become an aggregator that included the NERP.

In the pessimistic scenario the number of tonnes generated was substantially less, i.e. 25,000 tonnes. The price of carbon offsets was held constant at the rate of $13.00 per tonne and the discount rate was increased to five percent. In this scenario, the net present value was a negative $621,774. This result would suggest that aggregators would leave the industry given the negative economic returns.

A sensitivity analysis was undertaken for all three scenarios. From this analysis it was shown that the price of the carbon offsets, the volume of offsets generated, the annual fixed or constant costs

and the discount rate were all important variables in determining the incentives to become an aggregator.