Alberta Guidance for Protocol Development
Technical Protocol Plan

Part B
Description of Technical Protocol Plan Content

This section is an overview of the Protocol including: project type, project-specific technology, quantification methodology and how the projects using the protocol will reduce GHGs.

B.1. Description of the Project Type: (The **project type** is a set of project practices or technologies that represent the change from a normal business operation/practices or common industry practice.)

Pulp sludge is a traditionally discarded by-product created by the operations of mechanical pulp mills. Land application of mechanical pulp sludge is an improved, environmentally responsible alternative to incineration and landfilling sludge.

Mechanical pulp sludge provides benefits to the soil such as added nutrients and organic matter and improved physical properties such as soil structure and water holding capacity, resulting in enhanced above and below ground carbon reservoirs. The sludge contains approximately 45% carbon, which when added to soil results in an increase in the initial soil carbon (below ground carbon) reservoir, which in turn enhances the above ground carbon reservoirs (crop growth) which subsequently produces increased root biomass which is contributed to the soil resulting in additional carbon being stored in the below ground reservoir.

Description of how real reductions or removals will be achieved: (The Protocol Developer must ensure the GHG(s) that will be reduced by the activities for this project type are within the scope and criteria of the Alberta Offset System.)

The opportunities for generating carbon offsets with this protocol arise mainly from the quantification of direct and indirect reduction of atmospheric greenhouse gases (GHG) through the application of mechanical pulp mill sludge on agricultural land as opposed to the previous practices of incineration or landfilling the waste material. This protocol can theoretically be applied to all mechanical pulp mills spreading sludge on all agricultural land and crop types across the province, however more research may need to be done on sludge application to crop types other than forage and grain crops and in different soil zones. Business as usual practices for sludge handling includes drying, incineration, and beehive burner combustion. Emissions from these practices are avoided through utilization of sludge by agricultural application. A further reduction in GHG reductions are achieved by increased carbon biomass and soil carbon storage. This protocol is focused on emissions avoidance, increased carbon biomass and soil carbon storage resulting from sludge land application.

B.2. Description of Background Information/Best Practice Guidance Used:

Table 2.1. Good Practice Guidance

1. Document Title	2. Publishing Body/Date	3. Description
National Inventory Report, 1990-2004 Greenhouse Gas Sources and Sinks	*Environment Canada, 2004*	*Description of quantification methods greenhouse gases emitted from landfills and incineration*
American National Standard: Greenhouse Gases- Part 2	*American Society for Quality* (ANSI/ISO/ASQ E14064-2:2006(E))	*Specification with guidance at the project level for quantification, monitoring and reporting of greenhouse gas emission reductions or removal enhancements*
Canada's National Inventory	*Government of Canada, 2006*	*Description of IPCC tier 2 and 3 applications for quantifying GHGs from sectors at a national level*
Standards and guidelines for	*Alberta Environmental*	*Standards and guidelines*

the land application of mechanical pulp mill sludge to agricultural land	*Protection, 1999*	*developed for operations involving land application of Mechanical pulp mill sludge on agricultural land*

B.3. Regulatory, Legal Requirements and/or Government Incentive/Grant Programs:

List of potentially relevant regulations/legal requirements: N/A

List of potentially relevant climate change incentives: N/A

B.4. Barriers to Implementation:

Technology operation and maintenance: Most pulping processes produce sludge which is not suitable for land application due to high B, Na, metal concentrations or chlorinated compounds.
Infrastructure: Type and amount of land available for sludge land application limits the facilities capable of implementing this practice.
Institutional: Landowners required assurance that the sludge was beneficial to their farming practices and thus third party verification was required.
Other: Regulation barriers: There were no regulations to implement for land applying sludge therefore the mills participated in the development of the regulations.

B.5. Review of Technology/Scientific Knowledge:

The carbon offsets from this protocol will be based on the quantification of increased carbon stocks and decreased GHGs resulting from the application of pulp sludge to agricultural land compared to incineration or placement in a landfill. The sludge is traditionally a discarded by-product of the pulp mill and at baseline is incinerated or put in landfills which are practices that produce GHGs. Sludge application significantly increases crop yields and residues on agricultural land thus increasing the carbon reservoir (both above and below ground) (Macyk and Faught 2000). The carbon reservoirs store and accumulate carbon rather than releasing greenhouse gases to the atmosphere. The Alberta Research Council has been doing research on the land application of sludge for 16 years. Initial work began with characterization of the sludge material and evaluation for the suitability of land application through green house trials and plot scale field investigations. The work conducted by the Alberta Research Council resulted in guidelines being developed for the operational spreading of mechanic pulp mill sludge (Standards and Guidelines for the Land Application of Mechanical Pulp Mill Sludge to Agricultural Land, Alberta Environmental Protection, 1999. Publication No.: 0-7785-0426-3). A summary of the research studies up to 1999 is provided in the guidelines. Additional results from some of their work have been attached as an appendix. The activities that are included in the quantification of carbon offset credits are above and below ground carbon accumulation, avoided use of fossil fuels for sludge incineration and drying, CO_2 emissions from sludge incineration, landfill GHG emissions, sludge transportation, and fertilizer and sludge N_20 emissions.

B.6. Review of Existing Projects: (Review of trends and statistics on existing practices/projects in the Alberta and/or Canadian context.)

The Alberta Research Council has been conducting research on the benefits of land application of sludge since 1991. A summary of the research studies up to 1999 is provided in Publication No.: 0-7785-0426-3; Standards and Guidelines for the Land Application of Mechanical Pulp Mill Sludge to Agricultural Land (Alberta Environmental Protection, 1999). These guidelines were developed to set the standards for the type of land sludge could be applied on, the storage, spreading and incorporation requirements of sludge, and sampling requirements. Prior to these guidelines companies were not legally able to apply sludge to agricultural land and the sludge was either landfilled or incinerated. There are currently 3 mechanical pulp mills in Alberta (Alberta Newsprint Company, Slave Lake Pulp, and Millar Western Forest Products) who are applying this practice. Other mechanical mills in the Canadian industry have not implemented this practice for various reasons, such as different pulping processes leading to sludge which is unsuitable for land application, inappropriate or insufficient land base for spreading sludge, etc.

B.7. Summary of Quantification Approaches: (Include a summary of GHG quantification approaches and methodologies. At a broad level, not exact formulae and emission factors, but where formulae will come from, activity data and emission factors, ie. Best Practice Guidance.)

The amount of sludge applied by each mill will equal a set "reduction coefficient" equal to the difference from the baseline of GHGs reduced through its use. Baseline emissions for each project area will be determined through the use of control groups following identical farming and cropping practices. This protocol will deal with emission reductions from utilization of sludge for agricultural application. Business as usual practices for sludge handling includes drying, incineration, and beehive burner combustion. The amount of greenhouse gases emitted from these activities will be quantified using the methods listed in Environment Canada's 2004 National Inventory Report on Greenhouse Gas Sources and Sinks. Emissions from these practices are avoided through utilization of sludge by agricultural application. A further reduction in GHG reductions are achieved by increased carbon biomass and soil carbon storage which will be quantified based on actual measurement data obtained from control areas and treatment areas to determine the increase in carbon sequestration.

An assurance factor will account for the average risk of reversal for all agricultural sludge utilization projects. Since the effects of increasing the carbon reservoir would be measured during the credit allocation period, the assurance factor will be assessed on a site specific basis. Based on the analysis of available data from 16 years of research conducted by the Alberta Research Council of sludge utilization on agricultural land, a reasonable assurance factor of 90% will be deemed reasonable.

B.8. Other Impacts (Optional): (Include other air emissions, odours, risks, environmental impacts on vegetation, wildlife, water resources etc.)

There is the possibility of a slight odor when sludge is applied to land. It is recommended, as in the Standards and Guidelines for the Land Application of Mechanical Pulp Mill Sludge to Agricultural Land, that the sludge be incorporated as soon as possible to negate this issue.

B.9. Assessment of Baseline Scenarios

a) Evaluate all possible Baseline Approaches in the list below, and identify which ones are appropriate for the Projected Protocol. Justify why each selected Baseline Scenarios is appropriate. Also justify why the other Baseline Scenarios are not appropriate and are excluded from the Protocol.

TABLE 1.2: Assessment of Possible Baseline Scenarios

1. Baseline Options	2. Description	3. Static / Dynamic Baseline	4. Accept or Reject and Justify
Historic Benchmark:	*(Typically site-specific and can be constructed to reflect reductions in a base period (such as the average emissions of the previous three years).)*	Dynamic	Reject: The amount of sludge being land applied is variable each year and this method would not give an accurate estimate of the amount of carbon being sequestered above or below ground due to variability.
Performance Standard:	*(Assumes the typical emissions profile for the industry or sector is a reasonable representation of the baseline.)*	Dynamic	Reject: Each mechanical mill operator has different processes and operating procedures thus an industry baseline is not reasonable.
Comparison-based:	*(Actual measurements of parameters from a control group to compare with the project.)*	Dynamic	Accept: Actual measurements produce the most accurate and reliable results and can not be discounted by variability.
Projection-	*(Projections of reductions in the*	Dynamic	Reject: There are too many

Based:	*future can use a variety of techniques, from simple straight-line growth assumptions to complex models.)*		variables that would need to be input into a model such as soil type, landscape variability, climate factors, crop species, farming and management practices, etc.
Adjusted Baseline:	*(Takes into account current practice levels of a particular project and specified that the same baseline is used for all projects of a certain type, regardless of historical practices.)*	Dynamic	Reject: There are no well documented current practice levels and too much variability associated with the baseline for an adjusted baseline.
Other (Explain):			

B.10. Selection of Baseline Scenario: (For the selected baselines scenario(s) from the above analysis, the Protocol Developer must explain why the Baseline approach is static or dynamic, justify the selection of the most appropriate baseline scenario(s) including references and any assumptions.)

The emissions profile for the baseline activity does change during the credit duration period. Although the input parameters and the quantification methodology remain constant throughout the credit allocation period, factors such as sludge disposal practices, annual sludge production, climate conditions, precipitation, soil type and farm management practices, etc., can affect the input parameters and thus the baseline approach is dynamic.

B.11. Definition of the Project Condition: (Define the project condition and justification for the scope of the activity considered.)

The project condition consists of land application of mechanical pulp sludge. Pulp sludge is a traditionally discarded by-product created by the operations of mechanical pulp mills. Land application of mechanical pulp sludge is an improved, environmentally responsible alternative to incineration and landfilling sludge.

Mechanical pulp sludge provides benefits to the soil such as added nutrients and organic matter and improved physical properties such as soil structure and water holding capacity, resulting in enhanced above and below ground carbon reservoirs. The sludge contains approximately 45% carbon, which when added to soil results in an increase in the initial soil carbon (below ground carbon) reservoir, which in turn enhances the above ground carbon reservoirs (crop growth) which subsequently produces increased root biomass which is contributed to the soil resulting in additional carbon being stored in the below ground reservoir.

B. 12. Functional Equivalence: (Explain how the project and the baseline are comparable in terms of products and/or activity level. Justify any lack of equivalency.)

The project and baseline condition are both serving as a disposal mechanism for the waste product (sludge) produced during the pulping process of mechanical pulp mills. Sludge is disposed of by landfilling or incineration in the baseline condition and in the project condition it is disposed of by land application thus the two are functionally equivalent. The amount of energy required for disposal in the baseline and project condition is not equivalent. The baseline condition requires energy inputs to dry the sludge and emits CO_2 in the case of incineration. Landfilling results in CH_4 emissions. The project condition requires more energy for transportation and application of the sludge than the baseline condition.

B.13. Flexibility Mechanisms: (Explain optional approaches for quantifying the reductions to be achieved from the project type.)

Flexibility in applying the quantification protocol is provided to project developers.

1. This protocol applies to the reduction of atmospheric GHGs by land application of sludge and avoided emissions from no longer incinerating or landfilling sludge. This protocol

can be combined with other protocols where multiple projects are undertaken by the pulp mill to reduce overall GHG emissions.

2. Site specific emission factors may be substituted for the generic emission factors used in this protocol document. Emission factors must be verifiable and/or obtained from a credible reference.

3. A contingent way for calculating or estimating the below ground carbon offsets from land application of mechanical pulp mill sludge will be provided. The quantification methods outlined can be applied to areas where no control strip has been established for comparison measurements and can be used for projects dating back to 2002. Appropriate time and date stamped operational records are required to verify the amount of sludge hauled and applied to each designated section of land.

Appendix A. Executive Summary from Alberta Research Council Report "Substituting sludge for commercial fertilizer in crop production". Prepared by T.M. Macyk and R.L. Faught, February 2000.

EXECUTIVE SUMMARY

The land application of sludge research conducted to date has shown that the sludge amended treatments have resulted in increased yields that have persisted for up to six or seven years. The objective of this project is to determine whether a specific rate of applied sludge can economically replace a portion, or all of a commercial fertilizer application to achieve a target yield.

Nine plots (5 m x 10 m) at the existing agricultural field site were used for implementing this experiment in May 1997. Six of the plots received a 5 cm application of sludge. The plots were tilled to a depth of 15 to 17 cm after sludge application and the fertilizer was applied. The treatments included D5F0 (5 cm sludge only), D0F (850 g 11-51-0+375g 34-0-0 only), and D5F (5 cm sludge + 1000 g 35-15-0). In 1998 and 1999 the plots were seeded to Duel barley and fertilizer was added at the rate of 1000 g of 35-15-0 for the D0F plots and 500 g of 35-15-0 for the D5F plots.

In 1999 soil samples were collected from the 0 to 15 cm depth interval in each of the plots prior to fertilization, immediately following completion of seeding on May 26, and again following the crop harvest on August 26. Grain yields and straw weights (dry basis) were determined for each of the plots.

The largest total plant, straw, and grain yields in 1999 occurred in the D5F or sludge and fertilizer combined treatment. The D0F (fertilizer and no sludge) and D5F0 (sludge and no fertilizer) treatment yields were similar. The mean yields obtained in 1999 were similar to the yields in 1997. After three growing seasons the D0F and D5F0 treatments produced the same mean yield over the three crop years.

Plant available nitrogen data for samples obtained immediately following the harvest indicated that all of the fertilizer nitrogen added to the D0F treatment in the spring was used during the growing season indicating that refertilization would be required in the spring of 2000 to maintain yields comparable to previous years. After the barley harvest in 1999, plant available nitrogen levels in the sludge only treatment were lower than they were in previous years suggesting that the effectiveness of the sludge in enhancing crop yield may begin to decline in 2000.

On the basis of a set of assumptions and consideration of input costs and crop value a farmer could cost-effectively invest $98 per acre in sludge acquisition and application to break even compared to the no sludge or fertilizer only treatment when growing barley as a crop.

It is recommended that cropping be continued in 2000 to assist in making a better estimate of the cost-effectiveness of using the sludge and to get a better estimate of the longevity of the yield enhancement associated with sludge use.