



Regulations and guidelines for the use of wood ash as a soil amendment in Canadian forests

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Abstract

In Canada, the ash generated during bioenergy production from woody residues is generally treated as a waste material and landfilled. However, wood ash is rich in calcium, magnesium, potassium and phosphorus. As a consequence, forest managers in some European countries are actively encouraged to use wood ash as a soil amendment to replace the nutrients removed during timber and biomass harvesting; to counteract the effects of atmospheric deposition on soil acidity; and to increase soil fertility and forest productivity. As bioenergy production expands in Canada, the need to find alternative uses for wood ash will also grow. Regulations and guidelines for the use of wood ash as a soil amendment are largely under provincial/territorial jurisdiction. There has been little formal guidance developed specifically for soil applications of wood ash in Canada, and the use of wood ash as a soil amendment on forest soils is uncommon. Instead, regulations that were developed for other materials (e.g., biosolids, compost, hazardous waste) are typically also applied to wood ash, and these can be confusing and difficult to interpret. To help resource managers and policy makers address this issue, we have compiled information on the current guidance relevant to soil applications of wood ash for each province and territory in Canada. We have also reviewed the available guidance from European countries where the use of wood ash as a soil amendment is more common, in order to identify ways in which practices could be developed or refined to ensure that the use of wood ash as a soil amendment in Canadian forests is conducted safely, efficiently and effectively.

1.0 Introduction

In response to growing efforts to reduce global consumption of fossil fuels, bioenergy production is expanding around the world. In Canada, a large fraction of bioenergy production is derived from the combustion of residues generated during timber harvesting (e.g., tree tops and branches) and wood processing (e.g., bark, wood chips and sawdust). As bioenergy production expands, so does the volume of wood ash generated as a by-product of the biomass combustion process. At present, wood ash is often treated as a waste product, and is landfilled at a cost to energy producers and to society at large. However, studies have shown that ash derived from contaminant-free woody residues can be used as a soil liming agent and can also be a valuable source of many nutrients required by plants (e.g., calcium, magnesium, potassium and phosphorus). When applied to forest soils, wood ash has been used to replace the nutrients removed during timber and biomass harvesting; to counteract the acidifying effects of atmospheric deposition on soil and water; and to improve tree growth on sites where nitrogen does not limit productivity. The effects of wood ash applications on some soil chemical properties (e.g., increased soil pH and improved nutrient availability) are similar to the changes observed after wildfire. Thus, soil applications of wood ash could potentially be used as a management tool for emulating some of the effects of wildfire. Increased use of wood ash as a forest soil amendment would also decrease the social, financial and environmental costs of landfilling.

The goal of this report is to provide information for ash producers and potential ash consumers, including nutrient management specialists and foresters, on the process of obtaining approval to use wood ash as a soil amendment in Canadian forests. The information is presented separately for each province and territory, and was up-to-date as of October 2016. To compile information for this report, we searched the Internet for government department documents related to wood ash applications, and directly surveyed individuals responsible for the approval process in each province and territory. Where possible, we provide web references to applicable legislation, guidelines and best management practices for the use of wood ash as a soil amendment, and list the government contacts needed to initiate the approval process. In order to further inform users of this guide and to assist policy makers in refining Canadian regulations and guidelines, we also briefly review the guidance developed for the use of wood ash as a soil amendment on forested sites in other countries.

2.0 Overview of the guidance surrounding the use of wood ash as a soil amendment in Canadian forests

The use of wood ash as a soil amendment is largely under provincial and territorial jurisdiction and, as such, it varies significantly across Canada (Table 2.1). Similarly, government support for the practice also differs from one province or territory to another. Policies aimed at encouraging land applications of wood ash clearly have a strong influence over the quantity of material that is diverted from the landfill each year. In Alberta, guidelines aimed specifically at the use of wood ash as a liming agent on agricultural soils were published over a decade ago, and soil applications of wood ash have become relatively standard practice. In Quebec, most of the wood ash generated at co-generation plants (i.e., not associated with pulp and paper mills) is used as a soil amendment because high landfilling fees have been imposed to encourage waste reduction. In Nova Scotia, the provincial government encourages the use of wood ash as a fertilizer and liming agent on farmland by subsidizing the transportation costs for agricultural producers; the practice has become so popular that supplies of available wood ash often run out.

In some provinces (e.g., British Columbia, Ontario, Quebec, New Brunswick), guidelines developed to facilitate the appropriate use of other residual materials as soil amendments (e.g., fruit culls, municipal biosolids, pulp and paper sludge) also apply to the use of wood ash. In other jurisdictions, wood ash is treated as a hazardous waste that should be landfilled; often, some form of environmental impact assessment would be required to obtain approval to use wood ash as a soil amendment.

Table 2.1 Use of wood ash as a soil amendment in Canadian provinces and territories

Province	Ash used as a soil amendment?	Common uses of applied ash	
		Purpose	Site type
Alberta	Yes	Liming	Agriculture
British Columbia	Yes	Liming	Agriculture/Forestry
Manitoba	No	-	-
New Brunswick	Yes	Fertilizing/Liming	Agriculture
Newfoundland & Labrador	No	-	-
Nova Scotia	Yes	Fertilizing/Liming	Agriculture
Northwest Territory	No	-	-
Nunavut	No	-	-
Ontario	No	-	-
Prince Edward Island	No	-	-
Quebec	Yes	Liming	Agriculture/Forestry
Saskatchewan	No	-	-
Yukon Territory	No	-	-

Regardless of the jurisdiction or the approval process involved, wood ash must usually be analysed to determine the concentrations of 11 trace metals (arsenic, cadmium, chromium, cobalt, copper, mercury, molybdenum, nickel, lead, selenium and zinc) before any approval for land application can proceed (Table 2.2). Some jurisdictions require additional analyses to determine, e.g., pH, acid neutralizing value, moisture content, or concentrations of potassium, dioxins and furans, and/or polyaromatic hydrocarbons. This information is used to calculate application rates and to ensure that ash applications will not cause soil and water contamination. Many provinces and territories (e.g., New Brunswick, Newfoundland and Labrador, Northwest Territories, Prince Edward Island, Saskatchewan) use the trace metal limits set for compost by the Canadian Council of Ministers of the Environment (CCME), although this is not always the case (e.g., British Columbia, Ontario, Quebec). Wood ash that exceeds trace metal limits must be treated and disposed of as hazardous waste. The provincial/territorial approval process can sometimes be streamlined if the ash has received certification as a fertilizer or liming material from the Canadian Food Inspection Agency (CFIA) or the Bureau de Normalisation du Quebec (BNQ), because fertilizers and liming agents are commonly used as soil amendments and the guidance surrounding their use is well developed.

Prior to gaining approval to spread wood ash on a specific site, chemical analysis of the receiving soil must also usually be conducted to ensure that the soil trace metal contents do not already exceed provincial standards. Furthermore, most jurisdictions require that best management practices regarding distance from water bodies, slope, application timing and site type, etc., be followed during ash spreading. These guidelines would often be adapted from those developed for manure, biosolids or other approved soil amendments.

At present, the use of wood ash as a soil amendment is more common on agricultural soils than on forest soils in Canada (Table 2.1). Over the last few decades, however, several research trials have been established in British Columbia, Saskatchewan, Manitoba, Ontario and Quebec to examine the effects of wood ash applications on forest soil physical and chemical properties, soil biodiversity, vegetation communities, tree growth and water quality. Although many of these trials are relatively new, the results of this work will assist policy makers and forest managers in refining regulations, guidelines and recommended practices to improve the safety, efficiency and efficacy of wood ash applications on forest soils (<http://cfs.nrcan.gc.ca/projects/140>).

In the following section, we outline the processes required to obtain approval to use wood ash as a forest soil amendment for each province and territory in Canada. Italicized text highlights documents that are provided as web links under the Relevant Legislation or Guidance Documents sections. Although we have done our best to convey the information succinctly and accurately, users of this guide must directly consult the relevant legislation and guidelines, and discuss their applications with the provincial/territorial authorities involved, to ensure that they have complete, accurate and up-to-date information.

Table 2.2 Variability in the trace metal limits (mg kg⁻¹ dry weight) applied to wood ash used as a soil amendment across Canada

	CCME		CFIA	AB	BC	NS		ON		QC	
	Compost ^b		Fertilizer or Supplement	Wood Ash	Soil Amendment	Biosolids ^c		Non-Agricultural Source Material ^d		Fertilizing Residual ^e	
	A	B				Class A	Class B	CM1	CM2	C1	C2
Arsenic	13	75	75	-	75	13	75	13	170	13	41
Cadmium	3	20	20	46	20	3	20	3	34	3	10/15 ^f
Chromium	210	- ^a	-	-	1060	210	1060	210	2800	210	1000
Cobalt	34	150	150	-	150	34	150	34	340	34	150
Copper	400	- ^a	-	-	2200	400	760	100	1700	400	1000
Lead	150	500	500	-	500	150	500	150	1100	120	300
Mercury	0.8	5	5	-	5	0.8	5	0.8	11	0.8	4
Molybdenum	5	20	20	-	20	5	20	5	94	10	20
Nickel	62	180	180	-	180	62	180	62	420	62	180
Selenium	2	14	14	-	14	2	14	2	34	2	14
Zinc	700	1850	1850	5500	1850	700	1850	500	4200	700	1850

^a Trace metal limits for chromium and copper have not been established but would be 1060 mg kg⁻¹ and 757 mg kg⁻¹, respectively, if calculated with the same method used to establish limits for the other nine trace elements (Canadian Council of Ministers of the Environment 2005).

^b **Category A Compost:** wood ash with 'trace element' concentrations that fall below the limits set for category A compost by the Canadian Council of Ministers of the Environment (2005) is considered 'unrestricted' and can be used as a soil amendment in any application; **Category B Compost:** wood ash with 'trace element' concentrations that fall above the limits for category A compost but below the limits for category B compost has 'restricted' use and 'may require additional control when deemed necessary by a province or territory'; wood ash with 'trace element' concentrations above the limits for Category B Compost 'must be used or disposed of appropriately'.

^c **Class A Biosolids:** wood ash with trace metal concentrations that fall below the 'maximum acceptable metal concentrations' for Class A Biosolids can get approval from Nova Scotia Environment for agricultural land application; **Class B Biosolids:** the policy applied to wood ash with trace metal concentrations that fall above the 'maximum acceptable metal concentrations for Class A Biosolids but below those for Class B Biosolids is not clear but, at a minimum, a Land Application Plan would be required. Wood ash with trace metal concentrations that exceed the maximum concentrations for Class B biosolids are 'not acceptable for land application'.

^d **CM1:** wood ash with a 'content of regulated metals' (CM) that falls below the limits for CM1 non-aqueous non-agricultural source materials (NASM) set by Ontario Regulation 267/03 of the Nutrient Management Act (Government of Ontario 2002); **CM2:** wood ash with a 'content of regulated metals' (CM) that falls above the limits for CM1 NASM but below the limits for CM2 NASM. The rules for applying NASM that fall within the limits for CM1 and CM2 NASM are different (e.g., minimum depth to ground water, proximity to surface water). If the concentrations of one or more trace metals exceed the limits for CM2 materials, then 'the material cannot be land applied as a NASM'.

^e **C1:** wood ash with a 'chemical contaminant content' that falls below the limits for category 1 (C1) fertilizing residuals (FR) according to the guidelines described in Hébert (2008) and Hébert (2015); **C2:** wood ash with a 'chemical contaminant content' that falls above the limits for C1 FR but below the limits for category 2 (C2) FR. The rules for applying FR that fall within the limits for C1 and C2 materials are different (e.g., maximum application rate). **Note:** If trace metal concentrations do not meet the limits for C1 or C2 FR, alternative criteria (based on neutralizing value) may be applied to C2 FR used as amendments on forest soils. This option is based on standards set by the Bureau de Normalisation du Québec (BNQ 0419-090).

^f For agricultural use, the cadmium limit for C2 FR is 10 mg kg⁻¹; for non-agricultural use, the cadmium limit for C2 FR is 15 mg kg⁻¹.

CCME: Canadian Council of Ministers of the Environment. 2005. Guidelines for Compost Quality. Available at:

http://www.ccme.ca/files/Resources/waste/compost_quality/compostgdlns_1340_e.pdf

CFIA: Canadian Food Inspection Agency. 1997. T-4-93 – Standards for Metals in Fertilizers and Supplements. Available at:

<http://www.inspection.gc.ca/plants/fertilizers/trade-memoranda/t-4-93/eng/1305611387327/1305611547479>

AB: Alberta Environment. 2002. Standards and guidelines for the use of wood ash as a liming material for agricultural soils. Available at:

<https://extranet.gov.ab.ca/env/infocentre/info/library/6680.pdf>

BC: Sylvis Environmental. 2008. Land Application Guidelines for the Organic Matter Recycling Regulation and the Soil Amendment Code of Practice: Best Management Practices. Available at: www2.gov.bc.ca/assets/gov/environment/waste-management/recycling/landappguidelines.pdf

NS: Nova Scotia Environment. 2010. Guidelines for land application and storage of municipal biosolids in Nova Scotia. Available at:

<https://www.novascotia.ca/nse/water/docs/BiosolidGuidelines.pdf>

ON: Ontario Ministry of Agriculture, Food and Rural Affairs. Information on analysis requirements for non-agricultural source materials. Available at:

<http://www.omafra.gov.on.ca/english/nm/nasm/labs.htm>

QC: Hébert, M. 2008. Guidelines for the Beneficial Use of Fertilizing Residuals – Edition 2008. Available at:

http://www.mddelcc.gouv.qc.ca/matieres/mat_res-en/fertilisantes/critere/guide-mrf.pdf

Hébert, M. 2015. Guide sur le recyclage des matières résiduelles fertilisantes: Critères de référence et normes réglementaires – Édition 2015.

Available at: http://www.mddelcc.gouv.qc.ca/matieres/mat_res/fertilisantes/critere/guide-mrf.pdf (French only)

3.0 Provincial and territorial approval processes

3.1 Alberta

In Alberta, the use of wood ash as a soil amendment is governed by the *Environmental Protection and Enhancement Act*. Soil applications of wood ash have largely been restricted to agricultural soils. Although work is underway to make it easier for wood ash to be used for improving marginal lands and for land reclamation, there has been little interest, to date, in using wood ash as a forest soil amendment. An ash producer wanting to provide wood ash for use as a soil amendment on forested land must submit an application to a Regional Director with the Ministry of Environment and Parks. The *Standards and Guidelines for the Use of Wood Ash as a Liming Material for Agricultural Soils* is the best resource to guide the preparation of such an application. The *Approvals and Registrations Procedure Regulation* (113/93 and onward) lists the information that must be included in the application.

Contact:

Alberta Ministry of Environment and Parks

Phone (toll free): 1-310-3773

Email: ESRD.Info-Centre@gov.ab.ca

The *Standards and Guidelines for the Use of Wood Ash as a Liming Material for Agricultural Soils* describes the control limits for trace metals (cadmium and zinc) (Table 2.2), water-soluble boron, hydrocarbons, acid neutralizing value and moisture that wood ash must meet in order to be used as a soil amendment. In order to calculate the appropriate quantity of ash that should be applied to the soil surface, the pH and lime requirement of the receiving soil must also be determined according to the protocol described in the *Standards and Guidelines for the Use of Wood Ash as a Liming Material for Agricultural Soils*. No more than 15 Mg ha⁻¹ of ash may be applied to the soil at any one time, and the sum of repeated ash applications must not exceed 45 Mg ha⁻¹. These loading rates were put in place to ensure that levels of soil contamination do not exceed the limits outlined in the *Alberta Tier 1 Soil and Groundwater Remediation Guidelines*.

There are also restrictions on the types of feedstock that can be used to produce wood ash utilized as a soil amendment (Table 3.1.1). The ash must be re-tested on a regular basis, and records of all analyses must be kept by the ash producer for a minimum of 10 years; test results must be provided to the person or company who will be using the wood ash as a soil amendment. As well, documentation must be retained that describes the quantity of ash provided, and the person or company to whom it was provided.

Table 3.1.1. Existing restrictions on the sources of wood ash that can be used as a soil amendment in Alberta*

Ash source	- only ash from energy recovery systems can be used
Feedstock	- ash must be produced only from non-hazardous substances (woody materials that have not been treated with preservatives) - at least 95% of the ash must be derived from woody residues, e.g., bark, sawdust, sander-dust trim ends, log yard wastes, primary or secondary pulp mill wastewater treatment sludge, pin and off-grade chips

Operational restrictions on the season of ash application and the maximum distance to water within which ash can be applied must be respected (Table 3.1.2.). Guidelines developed for manure, municipal wastewater sludge and mechanical pulp sludge also provide guidance on best practices that could be adapted for sloping sites, sites on coarse-textured or organic soils, and sites where groundwater contamination may be a concern (Table 3.1.2). These restrictions are not specifically mentioned in the *Standards and Guidelines for the Use of Wood Ash as a Liming Material for Agricultural Soils*.

Table 3.1.2. Existing guidance on the sites to which wood ash*, manure, municipal wastewater sludge*** or mechanical pulp sludge**** should be applied as a soil amendment in Alberta**

Season	- ash must not be applied to frozen or snow-covered soil* - manure should not be applied to wet soils** - mechanical pulp sludge should not be applied to frozen ground unless it can be incorporated within 72 hours****
Soil Type	- municipal wastewater sludge should not be applied on sandy or gravelly soils or on organic soils*** - mechanical pulp sludge should not be applied to organic soil, soil with a high C:N ratio, saline or sodic soil, or to low lying areas****
Distance from Surface or Groundwater	- ash must not be applied within 50 m of permanent water bodies* - municipal wastewater sludge should not be applied on sites where groundwater is within 2 m of the soil surface*** - mechanical pulp sludge should not be applied within 15 to 50 m, depending on slope, of permanent water bodies or on sites where groundwater is within 1.5 m of the soil surface****
Slope	- municipal wastewater sludge should not be applied to slopes > 9%*** - mechanical pulp sludge should not be applied to slopes > 15%****
Timing	- ash must be incorporated to a depth of 15 cm within one day of application* - mechanical pulp sludge must be incorporated within 72 hours of application****

Relevant Legislation for Alberta

Environmental Protection and Enhancement Act.

Available at: <http://www.qp.alberta.ca/documents/Acts/E12.pdf>

Approvals and Registrations Procedure Regulation – Environmental Protection and Enhancement Act (Alberta Regulations 113/1993, 216/96 & 89/2013).

Available at: http://www.qp.alberta.ca/documents/Regs/1993_113.pdf

Guidance Documents for Alberta

*Alberta Environment. 2002. Standards and Guidelines for the Use of Wood Ash as a Liming Material for Agricultural Soils. Available at: <https://extranet.gov.ab.ca/env/infocentre/info/library/6680.pdf>

Alberta Environment and Parks. 2016. Alberta Tier I Soil and Groundwater Remediation Guidelines. Available at: <http://aep.alberta.ca/lands-forests/land-industrial/inspections-and-compliance/documents/AlbertaTierIGuidelines-Feb02-2016A.pdf>

****Alberta Environmental Protection. 1999. Standards and Guidelines for the Land Application of Mechanical Pulp Mill Sludge to Agricultural Land.

Available at: <https://extranet.gov.ab.ca/env/infocentre/info/library/7267.pdf>

***Government of Alberta. 2001. Guidelines for the Application of Municipal Wastewater Sludges to Agricultural Lands. Available at: <https://extranet.gov.ab.ca/env/infocentre/info/library/6680.pdf>

Lickacz, J. 2002. Wood ash – an alternative liming material for agricultural soils.

Available at: [http://www1.agric.gov.ab.ca/\\$Department/deptdocs.nsf/all/agdex3435](http://www1.agric.gov.ab.ca/$Department/deptdocs.nsf/all/agdex3435)

**Prairie Province's Committee on Livestock Development and Manure Management. 2004. Tri-Provincial Manure Application and Use Guidelines: Alberta version.

Available at: [http://www1.agric.gov.ab.ca/\\$department/deptdocs.nsf/all/epw8709](http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/epw8709)

3.2 British Columbia

In British Columbia (BC), the use of wood ash as a soil amendment is governed by the *Code of Practice for Soil Amendments (CoPSA)*, under the *Public Health Act*, and the *Environmental Management Act*. The definition of soil amendments in the CoPSA includes: ‘fly ash derived from the burning of wood, other than wood that has been immersed in marine waters’, and ‘industrial residue of wood that has not been treated with glue, paint, a preservative, or another substance harmful to humans, animals or plants’. This definition has been widely, but not universally, interpreted to preclude the use of bottom ash as a soil amendment under the CoPSA. However, there is growing interest in changing or clarifying the definition of soil amendments in the CoPSA to allow for the use of bottom ash as well. If an ash producer wants to provide fly ash for use as a soil amendment, it must submit an application to the British Columbia Ministry of Environment.

Contact:

British Columbia Ministry of Environment Regional Offices
(<http://www.env.gov.bc.ca/main/regions.html>)

Cariboo Region

Williams Lake

Phone: 1-250-398-4214

Skeena Region

Smithers

Phone: 1-250-847-7260

Okanagan Region

Penticton

Phone: 1-250-490-8200

Peace Region

Fort St. John

Phone: 1-250-787-3411

Lower Mainland Region

Surrey

Phone: 1-604-582-5200

Vancouver Island Region

Nanaimo

Phone: 1-250-751-3100

Kootenay Region

Cranbrook

Phone: 1-250-354-6333

Thompson Region

Kamloops

Phone: 1-250-371-6200

Omineca Region

Prince George

Phone: 1-250-565-6135

The *Land Application Guideline for the Organic Matter Recycling Regulation and the Soil Amendment Code of Practice* provides guidance on the procedure to follow to meet the provincial regulations for applying ash to forest and agricultural soils under the CoPSA. Ash must be analysed to ensure it meets criteria for trace elements (2.2) and foreign matter. If the ash is deemed to meet these criteria and only 5 m³ of ash in total is to be applied, no Land Application Plan (LAP) is required prior to ash application. If, however, more than 5 m³ of fly ash is to be applied, a LAP must be prepared by a Qualified Professional. LAPs do not require approval by the BC Ministry of Environment; the applicator must simply provide a copy of the LAP to the appropriate Ministry of Environment Regional Director at least 30 days prior to the proposed application date. A completed LAP includes detailed information on the location of the proposed application; the chemical analysis of the fly ash; the calculations used to determine the application rate; the proposed method of application; information about the climate, vegetation, soil chemical and physical properties of the receiving site; and the practices that will be used to protect environmental quality.

To date, soil applications of bottom ash have typically required a *Waste Discharge Authorization* under the *Environmental Management Act*. Applications for *Waste Discharge Authorizations* require approval by the BC Ministry of Environment.

The *Land application guidelines for the Organic Matter Recycling Regulation and the Soil Amendment Code of Practice* provides guidance on the practices to follow when applying wood ash to the soil, and includes some information specific to forests (Table 3.2.1).

Season	<ul style="list-style-type: none"> - forest fertilization activities should not occur over snow, on frozen ground or during intense rainfall events - avoid applications to juvenile stands during spring candling
Soil Type	<ul style="list-style-type: none"> - avoid shallow soils, coarse-textured soils, and very xeric sites - take care on subhygric to hygric sites, on organic soils and on lacustrine soils high in clay
Distance from Surface or Groundwater	<ul style="list-style-type: none"> - leave 30 m buffers around wells, lakes, rivers and streams as best practice, but buffers are not required as long as the soil amendment meets CoPSA criteria - increase buffers on sites with slopes, on bare soil, and on sites with subsurface flow or cemented horizons - consider increasing buffers to protect groundwater - avoid active floodplains or riparian areas
Slope	<ul style="list-style-type: none"> - avoid sites sloping directly toward surface bodies of water - take care on steep slopes, on slopes with a south- or west-facing aspect, on gullied slopes with several water courses, on long, uniform slopes with shallow soils and on slopes with soils containing a high coarse fragment content

Relevant Legislation for British Columbia

Environmental Management Act (SBC 2003).

Available at: http://www.bclaws.ca/civix/document/id/complete/statreg/03053_04

Public Health Act (SBC 2008).

Available at: http://www.bclaws.ca/Recon/document/ID/freeside/00_08028_01

Code of Practice for Soil Amendments (CoPSA).

Available at: http://www.bclaws.ca/Recon/document/ID/freeside/210_2007

Guidance Documents for British Columbia

*Sylvia Environmental. 2008. *Land Application Guidelines for the Organic Matter Recycling Regulation and the Soil Amendment Code of Practice: Best Management Practices*.

Available at: www2.gov.bc.ca/assets/gov/environment/waste-management/recycling/landappguidelines.pdf

Waste Discharge Authorizations.

Available at: <http://www2.gov.bc.ca/gov/content/environment/waste-management/waste-discharge-authorization>

3.3 Manitoba

Wood ash has not been used widely as a soil amendment in agriculture or forestry in Manitoba, and there has been no guidance developed for its use. Legislation governing soil applications of wood ash in Manitoba include the Nutrient Management Regulation under the Water Protection Act, the Environment Act, the Farm Practices Protection Act, the Pesticides and Fertilizers Control Act, the Crown Lands Act, the Forest Act, the Forest Health Protection Act, and/or the Wildfires Act.

Regulatory approval to apply wood ash on Crown Forest land would be granted by the Integrated Resources and Environmental Management Team (IRMT) along with Forest and Peatlands Management Branch of the Manitoba Department of Sustainable Development. Proponents would be required to fill in an 'Application for General Permit or an 'Application for a Forest General Permit' and submit a proposal that describes the project in detail; proposals would be reviewed by the IRMT and associated branch offices. These forms are not available on-line, but can be obtained from the Department of Sustainable Development. The IRMT may determine that an Environment Act License (EAL) is required. An EAL would be issued through the Environmental Approvals Branch of the Manitoba Department of Sustainable Development.

Contact:

Department of Sustainable Development – Lands Branch

(https://www.gov.mb.ca/conservation/lands_branch/contact.html)

Eastern Region

Lac du Bonnet

Phone: 1-204-345-1452

Northeast Region

Thompson

Phone: 1-204-679-0987

Central Region

Gimli

Phone: 1-204-642-6074

Northwest Region

The Pas

Phone: 1-204-627-8252

Western Region

Dauphin

Phone: 1-204-622-2103

Department of Sustainable Development - Forestry Branch

(<http://www.gov.mb.ca/conservation/forestry/contact.html>)

Winnipeg

Phone: 1-204-945-7989

Manitoba's Soil Management Guide and Nutrient Management Regulation under the Water Protection Act provide some operational guidance for applying soil amendments on agricultural soils (Table 3.3.1). The multi-stakeholder, multi-disciplinary Forest Practices Committee, which is responsible for developing forest management policy in Manitoba, is currently reviewing this topic as it pertains to Crown Land.

Season	- do not apply manure on frozen soil or snow-covered ground* - do not apply a substance containing N or P between November 10 & April 10**
Distance from Surface or Groundwater	- consult application standards in the Nutrient Management Regulation under the Water Protection Act for details regarding the maintenance of buffer zones around groundwater features; lakes, rivers and creeks; and wetlands, bogs, marshes and swamps**
Slope	- practice contour tillage*
Timing	- incorporate manure as soon as possible after application (within 48 hours on tilled soils in the Red River Valley and on flood plains)*

Relevant Legislation for Manitoba

Statutes of Manitoba. Available at: http://web2.gov.mb.ca/laws/statutes/index_ccsm.php

**The Water Protection Act: Nutrient Management Regulation.

Available at: http://web2.gov.mb.ca/laws/regs/current/_pdf-regs.php?reg=62/2008

Guidance Documents for Manitoba

*Province of Manitoba. 2008. Soil Management Guide.

Available at: <http://www.gov.mb.ca/agriculture/environment/soil-management/soil-management-guide/pubs/soil-management-guide.pdf>

3.4 New Brunswick

In New Brunswick (NB), the use of wood ash as a soil amendment is governed by the *Water Quality Regulation* under the *Clean Environment Act*. There has been no guidance developed specifically for the use of wood ash as a soil amendment in NB.

As described in *A Guide to Environmental Impact Assessment in New Brunswick*, an Environmental Impact Assessment (EIA) is required for '(i) all waste disposal facilities or systems, and (ii) all disposal, destruction, recycling, reprocessing or storage of waste that originates outside New Brunswick and all facilities or systems for the disposal, destruction, recycling, reprocessing or storage of such waste'. EIAs are administered by the Sustainable Development, Planning & Impact Evaluation Branch of the Department of Environment and Local Government.

Contact:

Sustainable Development, Planning & Impact Evaluation Branch

Phone: 1-506-444-5382

Email: eia-eie@gnb.ca

An application for an EIA must outline the potential negative effects of wood ash applications and the methods used to mitigate these impacts. The EIA process in New Brunswick involves a formal registration step, in which proponents describe the project location, proposed activity, potential impacts and possible mitigation methods. Registered projects undergo a Determination Review (DR) to identify and evaluate environmental risks; this review is completed by a Technical Review committee composed of federal, provincial and municipal specialists. During the DR, the proponent may be asked to provide additional information. The DR process is usually completed within 120 days of project registration. In cases where the project is considered particularly risky, a Comprehensive Review (CR) may be deemed necessary. Following completion of the CR, the project may receive a Certification of Determination, in which case the project can proceed after meeting specified terms and conditions, or the project may be rejected.

If it can be demonstrated that the ash is of beneficial use to the soil or forest, the ash may not be considered a waste and the EIA review requirement could be waived. This would be assessed on a case-by-case basis. In this situation, the ash producer would need to obtain approval to apply wood ash to a forest soil by completing an *Application for a Certificate of Approval to Operate for the Beneficial Use of Industrial By-Products as Soil Amendments*. The *Guidelines for the Beneficial Use of Industrial By-Products as Soil Amendments* describes the procedure involved in completing such an application, which varies depending on the trace metal concentrations and agronomic value of the ash. This form is not yet available on-line but can be obtained by request (see below).

Contact:

Approvals Engineer - Impact Management Branch

Email: Sylvie.Morton@gnb.ca

In outlining the terms and conditions for approving the use of wood ash as a soil amendment on forest soils, the *Guidelines for the Beneficial Use of Industrial By-Products as Soil Amendments* would be used for general guidance (Table 3.4.1).

Table 3.4.1. Existing guidance relevant to application of ‘materials of agronomic value’ (MAV) to agricultural and non-agricultural soil in New Brunswick*	
Season	- land application may not occur when the ground is frozen, snow-covered or saturated, during or immediately following heavy precipitation or when heavy precipitation is forecast
Distance from Surface or Groundwater	- land application may not occur when and where there is a risk of flooding - watercourses or wetlands on level terrain require a 30 m setback - watercourses or wetlands on 3-6% slopes require a 90 m setback - watercourses or wetlands on 6-9% slopes require a 200 m setback - setbacks are required where the depth to groundwater is < 0.75 m
Slope	- no applications are allowed on slopes >9%

Relevant Legislation for New Brunswick

New Brunswick Acts, by Title. Available at: <http://laws.gnb.ca/en/BrowseTitle?letter=all>

Guidance Documents for New Brunswick

Department of Environment and Local Government. 2012. A Guide to Environmental Impact Assessment in New Brunswick. Available at:

<http://www2.gnb.ca/content/dam/gnb/Departments/env/pdf/EIA-EIE/GuideEnvironmentalImpactAssessment.pdf>

*Department of Environment and Local Government. 2014. Guidelines for the Beneficial Use of Industrial By-Products as Soil Amendments. Available at:

<http://www2.gnb.ca/content/dam/gnb/Departments/env/pdf/LandWaste-TerreDechets/GuidelinesForSoilAmendments.pdf>

3.5 Newfoundland and Labrador

The use of wood ash as a soil amendment in Newfoundland and Labrador (NL) is governed by the *Environmental Protection Act* (EPA), including the *Environmental Assessment Regulations* under the *Environmental Protection Act*. To date, no specific guidance has been developed for wood ash applications on forest or agricultural soils in the province. Although soil applications of wood ash are not specifically mentioned in the EPA, it is likely that any large-scale use of wood ash as a soil amendment in NL would require an Environmental Assessment (EA). To confirm that the project requires an EA, a brief project description (including information on the quantity of ash being applied, the area to which the ash would be applied, the mode, timing and frequency of application, etc.) should be sent to the Director of the EA Division of the Department of Environment and Conservation.

Contact:

Newfoundland and Labrador Department of Environment and Conservation
Environmental Assessment Division
Phone: 1-709-729-4211 / 1-800-563-6181 (toll free)
EA Director (Bas Cleary):
1-709-729-0672

According to *Environmental Assessment: A Guide to the Process*, project registration is the first step in the EA process. During registration, the proponent will be required to more fully describe the project, its possible environmental and socio-economic implications, and the best management practices that will be followed to minimize any potential harmful effects. Chemical analysis of the ash and receiving soil will be required. Within 45 days of submitting the registration, the proponent will be informed that the project may proceed as described, that further information is needed, or that the project has been rejected; as long as the project does not violate law or policy, however, it cannot be rejected at the screening stage. If further information is required, an Environmental Preview Report or an Environmental Impact Statement will be requested; the proponent will be provided with guidelines describing the information needed and any steps that the proponent must take (e.g., public meetings) to complete the request. A committee will be struck to guide the proponent through the process, review the new materials presented, and provide advice to decision makers on the final outcome of the project.

Relevant Legislation for Newfoundland and Labrador

Legislation administered by the Department of Environment and Conservation.
Available at: <http://www.env.gov.nl.ca/env/department/legislation.html>

Guidance Documents for Newfoundland and Labrador

Government of Newfoundland and Labrador. 2002. Guide to the Environmental Protection Act.
Available at: http://www.env.gov.nl.ca/env/env_assessment/guide_to_epa.pdf
Government of Newfoundland and Labrador. 2012. Environmental Assessment: A Guide to the Process. Available at: http://www.env.gov.nl.ca/env/env_assessment/#guide

3.6 Northwest Territories

In the Northwest Territories (NWT), the use of wood ash as a soil amendment is governed by the *Environmental Protection Act*; the *Mackenzie Valley Resource Management Act (MVRMA)* and the *Waters Act* (in the Mackenzie Valley); and the *Inuvialuit Final Agreement* (in the Inuvialuit Settlement Region).

Productive forests are located in the southern part of the Mackenzie Valley Region (MVR), along floodplains and on the southern and western shores of Great Slave Lake. In the MVR, any activity or undertaking involving the use of wood ash as a soil amendment could require a land use permit and/or water licence. Land use permits and water licences can be obtained from local Land and Water Boards (LWB). An application for a land use permit and/or water licence requires a detailed site description, and information on the purpose of the project and the best management practices that will be followed to mitigate negative impacts on air and water quality, vegetation, wildlife, heritage resources and human health. For more information about land use permitting and water licensing processes, project proponents must contact the appropriate LWB. Even if the activity is deemed not to require authorization from the local LWB, guidance must be obtained from the regional office of the Department of Environment and Natural Resources before any wood ash is applied to the soil.

Contacts for the Mackenzie Valley Region:

Mackenzie Valley Land and Water Board (MVLWB)

Phone: 1-867-669-0506

<https://mvlwb.com>

Gwich'in Land and Water Board

Phone: 1-867-777-4954

<https://glwb.com>

Northwest Territories' Department of Environment and Natural Resources Regional Offices

Deh Cho Region

Phone: 1-867-695-7462

Sahtu Region

Phone: 1-867-587-3500

Sahtu Land and Water Board

Phone: 1-867-598-2413

<https://slwb.com>

Wek'èezhìi Land and Water Board

Phone: 1-867-765-4592

<https://wlwb.ca>

North Slave Region

Phone: 1-867-767-9238 (ext. 53236)

South Slave Region

Phone: 1-867-872-6414

Information about the land use permitting and water licensing processes in the MVR is available at: <https://mvlwb.com/resources/policy-and-guidelines>. Documents include:

- Guide to the Land Use Permitting Process; MVLWB Standard Land Use Permit Conditions; MVLWB Standard Process for New Conditions
- Guide to Completing a Water License Application; Guide to the Water Licensing Process (in development); Water and Effluent Quality Management Policy; Water Use Fee Policy
- Guidelines for Developing a Waste Management Plan
- Document Submission Standards; Standards for Geographic Information (GIS) Submissions; Standard Outline for Management Plans

- Engagement and Consultation Policy; Information for Proponents on the MVLWB’s Engagement Requirements; Engagement Guidelines for Applicants and Holders of Water Licences and Land Use Permits; Rules of Procedure, Including Public Hearings

The Inuvialuit Settlement Region (ISR) does not contain productive forests. However, depending on the location and purpose of wood ash applications on soils in the ISR, approval could be required from the Aurora Research Institute, Commissioner and Territorial Lands, the Inuvialuit Water Board, the Environmental Impact Screening Committee and/or the Inuvialuit Land Administration. The Inuvik regional office of the Department of Environment and Natural Resources should also be contacted for guidance.

Contacts for the Inuvialuit Settlement Region:

Aurora Research Institute (for research permits)

<http://nwtresearch.com>

Commissioner & Territorial Lands, Govt. of the Northwest Territories, Dept. of Lands

<http://www.lands.gov.nt.ca/en/land-administration>

Inuvialuit Environmental Impact Screening Committee

<http://www.screeningcommittee.ca/contact.html>

Inuvialuit Land Administration (to traverse Inuvialuit Private Lands)

<http://www.inuvialuitland.com>

Inuvialuit Water Board

<http://www.inuvwb.ca>

Inuvik Regional Office of Department of Environment and Natural Resources

Phone: 1-867-678-6693

No guidance specifically aimed at the use of wood ash as a soil amendment has been developed for NWT, but the *Guidelines for Agricultural Waste Management* include details of some best management practices that could be adapted for this purpose (Table 3.6.1).

Table 3.6.1. Existing guidance relevant to applications of manure to agricultural soil in the Northwest Territories*	
Season	- manure should not be spread on frozen and/or snow-covered soil unless it can be demonstrated that it will not contaminate water - for winter applications: spread manure on relatively flat land that is not subject to water erosion
Slope	- avoid spreading manure on sloping land adjacent to watercourses

Relevant Legislation for the Northwest Territories

Environmental Protection Act. Available at: <http://www.canlii.org/en/nu/laws/stat/rsnwt-nu-1988-c-e-7/latest/part-1/rsnwt-nu-1988-c-e-7-part-1.pdf>

Inuvialuit Final Agreement. Available at: <http://www.irc.inuvialuit.com/about/finalagreement.html>

Mackenzie Valley Waters Regulations under the MVRMA (applies to federal areas).

Available at: <http://laws-lois.justice.gc.ca/eng/regulations/SOR-93-303/>

Mackenzie Valley Land Use Regulations under the MVRMA.

Available at: <http://laws-lois.justice.gc.ca/PDF/SOR-98-429.pdf>

Northwest Territories Waters Regulations under the MVRMA (applies to federal areas).

Available at: <http://laws-lois.justice.gc.ca/eng/regulations/SOR-93-303/>

Waters Act (applies to non-federal areas).

Available at: <https://www.justice.gov.nt.ca/en/files/legislation/waters/waters.a.pdf>

Waters Regulations under the Waters Act (applies to non-federal areas).

Available at: <https://www.justice.gov.nt.ca/en/files/legislation/waters/waters.r.l.pdf>

Guidance Documents for the Northwest Territories

*Department of Resources, Wildlife and Economic Development and Territorial Farmer's Association. 1999. Guideline for Agricultural Waste Management. Available at:

http://www.enr.gov.nt.ca/sites/default/files/guidelines/agricultural_waste.pdf

3.7 Nova Scotia

In Nova Scotia, the use of wood ash as a forest soil amendment is governed by the *Environment Act*. Wood ash is widely applied on agricultural soils to improve soil nutrient content and raise soil pH but the use of wood ash as a soil amendment on forest soils is not standard practice.

Ash producers can obtain approval from Nova Scotia Environment to distribute wood ash as a soil amendment on agricultural soils if they can demonstrate that it has trace metal concentrations lower than limits for Class A municipal biosolids. Farms that complete a Nutrient Management Plan through the Nova Scotia Environmental Farm Plan Program can get approval to apply ash as a soil amendment and obtain financial assistance for transportation costs from the province.

Contact:

Nova Scotia Environment
 Phone (toll free): 1-902-424-2547
 Email: emc@gov.ns.ca

Although wood ash is not currently applied to forest soils in Nova Scotia, *The guidelines for land application and storage of municipal biosolids in Nova Scotia* stipulate that Class A municipal biosolids can be applied to forests, provided that a Land Application Plan, outlining vegetation/soil/site requirements, nutrient and trace metal concentrations in the biosolids, and calculated application rates is submitted to Nova Scotia Environment. Given that Class A biosolids have low metal contents (Table 2.2), they are not considered a ‘waste’ product and do not have to go through the same approval process as that required for Class B biosolids. Nevertheless, Nova Scotia Environment recommends that guidelines for the use of Class B biosolids be applied to Class A biosolids as best practice, and this would likely also be the case for the use of wood ash as a soil amendment on forested sites (Table 3.7.1.).

Timing	- <i>must not be applied when ground is frozen, snow-covered or saturated; must not be applied immediately following heavy rains or when heavy rain is forecasted</i>
Soil Type	- <i>must not be applied within 10 m of bedrock outcrops</i>
Distance from Surface or Groundwater	- <i>must not be applied where the depth to groundwater or to the water table is <1 m (clayey and silty soils) or <1.5 m (sandy or gravelly soils)</i>
Slope	- <i>on slopes <3%, must not be applied within 90 m; 60 m; or 15 m of perennial water bodies and watercourses; intermittent water bodies and watercourses; or swales and man-made ditches, respectively</i> - <i>on 3% to 6% slopes, must not be applied within 125 m of perennial or intermittent water bodies and watercourses</i> - <i>on >8% slopes, must not be applied within 180 m of perennial or intermittent water bodies and watercourses</i>
Application	- <i>Class A municipal biosolids can be land applied by surface spreading as a top dressing or through incorporation; Class B municipal biosolids must be incorporated within 24 hours of spreading</i>

Relevant Legislation for Nova Scotia

Environment Act. Available at: <http://nslegislature.ca/legc/statutes/environment.pdf>

Approval and Notification Procedures Regulations made under Section 66 of the Environment Act
<http://www.novascotia.ca/just/regulations/regs/envapproval.htm>

Guidance Documents and Other Resources for Nova Scotia

*Nova Scotia Environment. 2010. Guidelines for land application and storage of municipal biosolids in Nova Scotia. Available at: <https://www.novascotia.ca/nse/water/docs/BiosolidGuidelines.pdf>

Nova Scotia Environmental Farm Plan. Nutrient Management Planning.

Available at: <http://www.nsfa-fane.ca/efp/resources/nutrient-management-planning/>

Nova Scotia Environmental Farm Plan. Soil Amendments.

Available at: <http://www.nsfa-fane.ca/efp/soil-amendments/>

3.8 Nunavut

In Nunavut (NU), the use of wood ash as a soil amendment may be governed by the *Nunavut Land Claims Agreement Act*, the *Nunavut Waters and Nunavut Surface Rights Tribunal Act*, the *Nunavut Planning and Project Assessment Act* and/or the *Environmental Protection Act*. At present, the *Environmental Guidelines for the Burning and Incineration of Solid Waste* recommend that bottom ash produced from burning paper, paperboard and untreated wood waste be buried in a designated pit or municipal landfill, as long as it meets the criteria outlined in the *Environmental Guideline for Industrial Waste Discharges into Municipal Solid Waste and Sewage Treatment Facilities*. Given that there is no large-scale agriculture or forestry conducted in NU, it is unlikely that there will be significant interest in using wood ash as a soil amendment. That being said, approval to use wood ash as a soil amendment in NU could be requested by submitting a proposal to the Nunavut Planning Commission (NPC), which is responsible for ensuring that activities conform to the land use plans for a given region.

Contact:

Nunavut Planning Commission

Iqaluit

Phone: 1-867-979-3444

Cambridge Bay

Phone: 1-867-4625

Arviat

Phone: 1-867-857-2242

Proposals that meet the requirements of a region's land use plan are forwarded to the Nunavut Impact Review Board (NIRB) for a Screening Assessment (SA) to determine whether there is potential for significant negative impacts to the environment or to people, and whether there is sufficient information to predict and mitigate these impacts. SA are completed within 45 days, after which the NIRB may: i. approve the project, with terms and conditions (which could include a requirement for ongoing monitoring); ii. request a full Environmental Review; iii. request further information; or iv. reject the proposal. Full Environmental Reviews are generally reserved for major development projects or projects that cause significant public concern.

Relevant Legislation for Nunavut

Environmental Protection Act. Available at: <http://www.canlii.org/en/nu/laws/stat/rsnwt-nu-1988-c-e-7/latest/part-1/rsnwt-nu-1988-c-e-7-part-1.pdf>

Nunavut Land Claims Agreement Act. Available at: <http://laws-lois.justice.gc.ca/eng/acts/n-28.7/>

Nunavut Waters and Nunavut Surface Rights Tribunal Act. Available at: <http://laws-lois.justice.gc.ca/PDF/N-28.8.pdf>

Project Planning and Assessment Act. Available at: <http://laws.justice.gc.ca/eng/acts/N-28.75/>

Guidance Documents and Other Resources for Nunavut

Department of Environment, Government of Nunavut. 2012. Environmental Guideline for the Burning and Incineration of Solid Waste. Available at: http://www.gov.nu.ca/sites/default/files/guideline_-_burning_and_incineration_of_solid_waste_2012.pdf

Nunavut Impact Review board. Available at: <http://www.nirb.ca/>

Nunavut Planning Commission. Available at: <http://www.nunavut.ca>

3.9 Ontario

The use of wood ash as a soil amendment in Ontario is governed by the *Environmental Protection Act* and the *Nutrient Management Act*. Wood ash is not used regularly as a soil amendment on agricultural or forest soils in Ontario, and no specific guidelines have been developed for its use.

Two main steps would be involved in obtaining regulatory approval to use wood ash as a soil amendment in Ontario. In the first step, approval must be obtained from the Ministry of the Environment and Climate Change (MOECC) to transport the wood ash. Wood ash must be transported using a 'Waste Management System', as defined under the *Environmental Protection Act*. To legally operate a 'Waste Management System' in Ontario, a proponent must do one of the following:

- Register on the MOECC's Environmental Activity Sector Registry as a 'Solid Non-Hazardous Waste Management System'. The *Environmental Activity & Sector Registry (EASR) User Guide – Non-Hazardous Waste Transportation Systems* describes the registration process and the criteria under *Ontario Regulation 351/12* that must be met in order to be eligible for registration.

OR

- For projects that do not meet the criteria for EASR registration, submit an Environmental Compliance Approval (ECA) application for a 'Soil Conditioner Waste Management System', as described in the *Guide to Applying for an Environmental Compliance Approval*. One can also hire a company that has already obtained an ECA from the MOECC to transport wood ash.

Next, approval must be obtained to store and/or land apply the wood ash:

- To apply wood ash on a non-agricultural site, a second ECA must be obtained from the MOECC, as per the *Environmental Protection Act*. The *Guide to Applying for an Environmental Compliance Approval* describes the types of information required when requesting an ECA for this purpose; because the MOECC does not have guidelines specific to the use of fertilizing materials on Crown Forest Land, any proposed application would be evaluated on a case-by-case basis. At a minimum, information on the quality and beneficial use of the wood ash would be required. Proponents should contact the local MOECC District Office for guidance.
- To apply wood ash on an agricultural site, a Non-Agricultural Source Material (NASM) plan must be submitted for approval to the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA), in accordance with *Ontario Regulation 267/03* under the *Nutrient Management Act*. NASM plans must be prepared by certified NASM plan developers and include the results of chemical analyses of the ash (e.g., trace metals; Table 2.2) and receiving soil, a description of the property to which the ash will be applied, the proposed beneficial use of the ash, and a description of the methods that will be used to protect sensitive features on the receiving site. The ash (a Category 3 NASM) must meet at least one of the requirements for beneficial use found in Section 98.0.6 of *Ontario Regulation 267/03*. Land application standards for the use of NASM on agricultural soils are described in *Ontario Regulation 267/03* (Table 3.9.1). Proponents should contact OMAFRA's Agriculture Information Contact Centre for guidance.

Table 3.9.1. Existing guidance relevant to CMI/CPI or CM2/CPI¹ non-agricultural source materials (NASM) on agricultural soils in Ontario**	
Season	- consult standards in Ontario Regulation 267/03 for applications during restricted period (between December 1 and March 31) and when soils are snow-covered or frozen
Soil Type	- only apply on organic soils if applications were described in an approved NASM plan
Distance from Surface or Groundwater	- do not apply to land with < 30 cm of unsaturated soil (but consult application standards in Ontario Regulation 267/03 for further details) - consult application standards in Ontario Regulation 267/03 for details regarding depth to bedrock - consult application standards in Ontario Regulation 267/03 for details regarding vegetated buffer zones, crop residue retention and buffer widths adjacent to surface water
Slope	- consult application standards in Ontario Regulation 267/03 for details regarding modified buffer width requirements on sloping sites adjacent to surface water
Timing	- consult application standards in Ontario Regulation 267/03 for details regarding the timing of incorporation into the soil

¹ **CMI:** wood ash with a 'content of regulated metals' (CM) that falls below the limits for CMI non-aqueous non-agricultural source materials (NASM) set by Ontario Regulation 267/03 of the Nutrient Management Act; **CM2:** wood ash with a 'content of regulated metals' that falls above the limits for CMI NASM but below the limits for CM2 NASM; **CPI:** wood ash with a 'content of a pathogen' (CP) that falls below the limits for CPI NASM set by Ontario Regulation 267/03. Soil applications of CMI/CPI and CM2/CPI NASM must follow different rules (e.g., regarding minimum depth to ground water, proximity to surface water).

Contact:

Ontario Ministry of the Environment and Climate Change District/Area Offices:

Northern Region -

Thunder Bay

Phone: 1-807-475-1205

Sault Ste. Marie

Phone: 1-705-942-6354

Kenora

Phone: 1-807-468-2718

Sudbury

Phone: 1-705-564-3237

North Bay

Phone: 1-705-497-6865

Timmins

Phone: 1-705-235-1500

Eastern Region -

Belleville

Phone: 1-613-962-9208

Ottawa

Phone: 1-613-521-3450

Cornwall

Phone: 1-613-933-7402

Peterborough

1-705-755-4300

Kingston

Phone: 1-613-549-4000

Central Region -

Barrie

Phone: 1-705-739-6441

York-Durham

Phone: 1-905-427-5600

Metro Toronto

Phone: 1-416-326-6700

Halton-Peel

Phone: 1-905-319-3847

West Central Region -

Guelph

Phone: 1-519-826-4255

Hamilton

Phone: 1-905-521-7650

Niagara

Phone: 1-905-704-3900

Southwestern Region -

London

Phone: 1-519-873-5000

Windsor

Phone: 1-519-948-1464

Owen Sound

Phone: 1-519-371-2901

Sarnia

Phone: 1-519-336-4030

Agriculture Information Contact Centre

Phone: 1-877-424-1300

Email: ag.info.omafra@ontario.ca

Relevant Legislation for Ontario

**Nutrient Management Act. O. Reg. 267/03: GENERAL. Available at:

<https://www.ontario.ca/laws/regulation/030267>.

Environmental Protection Act. O. Reg 351/12: Registrations under Part II.2 of the Act – Waste Management Systems. Available at: <https://www.ontario.ca/laws/regulation/120351>

Environmental Protection Act. O. Reg 347: GENERAL – Waste Management. Available at: <https://www.ontario.ca/laws/regulation/900347>

Guidance Documents and Other Resources for Ontario

Ontario Ministry of Agriculture, Food and Rural Affairs. Preparing a Nutrient Management or Non-Agricultural Source Materials Strategy/Plan. Available at:

<http://www.omafra.gov.on.ca/english/agops/index.html>

Ontario Ministry of the Environment. 2012. Environmental Activity & Sector Registry (EASR) User Guide – Non-Hazardous Waste Transportation Systems. Available at:

<https://dr6j45jk9xcmk.cloudfront.net/documents/986/3-1-5-non-hazardous-waste-transport-guide-en.pdf>

Ontario Ministry of the Environment. 2012. Environmental Compliance Approval Application. Available at: <https://www.ontario.ca/document/environmental-compliance-approval-application>

Ontario Ministry of the Environment. 2012. Guide to Applying for an Environmental Compliance Approval. Available at: <https://dr6j45jk9xcmk.cloudfront.net/documents/962/5-8-2-eca-guide-en.pdf>

3.10 Prince Edward Island

The use of wood ash as a soil amendment on Prince Edward Island (PEI) is governed by the *Environmental Protection Act*. There have been no major initiatives to use wood ash as a soil amendment in agriculture or forestry in PEI. Proponents can pursue approval to apply wood ash as a soil amendment on forest soils through the Environmental Impact Assessment (EIA) process, administered by the Environmental Land Management Section of the Department of Communities, Land and Environment.

Contact:

Prince Edward Island Department of Communities, Land and Environment
 Environmental Land Management Section:
 Phone: 1-902-368-5049 or 1-866-368-5044 (toll free)

An EIA request would require analysis of the ash and a detailed description of the receiving site. The management practices described in PEI’s *Best Management Practices: Agricultural Waste Management* could be adapted for soil applications of wood ash (Table 3.10.1). That being said, PEI’s guidelines for forest biomass harvesting and ecosystem-based forest management assume that sufficient forest biomass is left on-site to maintain soil quality, and no mention is made of the use of soil amendments.

Table 3.10.1. Existing guidance relevant to application of agricultural waste on agricultural soils on Prince Edward Island*

Season	<ul style="list-style-type: none"> - do not spread manure on frozen, bare or snow-covered land between November and mid-April - do not apply manure to wet soils - apply manure before planting annuals, between mid-April and mid-June - apply manure to cereals immediately after harvest and before conservation tillage, between mid-June and August - apply manure to grasslands between September and October; avoid areas subject to runoff and tillage until after October 15; - apply manure between September and October to lands that will be planted with winter cover crops
Distance from Surface or Groundwater	<ul style="list-style-type: none"> - all of PEI is susceptible to groundwater contamination because the upper layer of soil is thin and the underlying bedrock fractured - manure must not be discharged or allowed to enter any water course - manure should not be spread within 30 m of a watercourse on slopes < 5% and within 60 m of a watercourse on slopes > 5%
Slope	<ul style="list-style-type: none"> - see above
Timing	<ul style="list-style-type: none"> - avoid yearly applications of manure unless both soil and manure tests show there is no risk of causing excessive nutrient levels - incorporate manure as soon as possible after spreading, ideally within 24 hours of application

Relevant Legislation for Prince Edward Island

Environmental Protection Act. Available at: <http://www.gov.pe.ca/law/statutes/pdf/e-09.pdf>

Guidance Documents for Prince Edward Island

*Province of Prince Edward Island/Environment Canada. (n.d.) Best Management Practices: Agricultural Waste Management. Available at: www.gov.pe.ca/photos/original/af_bmp_wastemgt.pdf.

Province of Prince Edward Island. 2009. Biomass Guidelines. Available at: <http://www.gov.pe.ca/photos/original/09biomasguide.pdf>

Province of Prince Edward Island. 2014. Ecosystem-based forest management standards manual. Available at: <http://www.gov.pe.ca/forestry/PEIforestmanagement>

Province of Prince Edward Island. 2010. Environmental Impact Assessment Guidelines. Available at: http://www.gov.pe.ca/photos/original/eia_guidelines.pdf

3.11 Quebec

In Quebec, the use of wood ash as a soil amendment on forest soils is governed by the *Environmental Quality Act* and the *Sustainable Forest Development Act*. In 2006, approximately 50% of the 300 000 Mg of wood ash produced in the province that year was landfilled (Hébert and Breton 2009). By 2015, the most common method of wood ash disposal depended on where it was generated: most of the wood ash produced at pulp and paper mills was dumped at low cost in on-site landfills but most of the wood ash generated at cogeneration plants (and not associated with pulp and paper mills) was land applied because of the high fees charged to landfill the ash off-site. Wood ash is predominantly applied as a liming agent and fertilizer on agricultural soils in Quebec (Table 3.11.1). That being said, Domtar often uses the wood ash generated at its Windsor pulp and paper mill as a soil amendment on young plantations.

Table 3.11.1. Total quantity of wood ash (Mg) used as a soil amendment for agriculture, forestry, and site reclamation in Quebec in 2015 (Hébert, M., Direction des matières résiduelles - Ministère du Développement durable, de l'Environnement et de la Lutte contre les changements climatiques, personal communication, June 2016)

Agriculture	Forestry	Site reclamation	Total
51 387	12 817	14 272	78 476

There are two main routes for getting approval to use wood ash as a soil amendment on forest soils in Quebec:

- One can obtain a certificate of authorization (C of A) from the Ministry of Sustainable Development, the Environment and the Fight Against Climate Change/ Ministère du Développement durable, Environnement et Lutte contre les changements climatiques (MDDELCC) to apply wood ash as a fertilizing residual (FR)/ Matière résiduelle fertilisante (MRF), as described in the *Guidelines for the Beneficial Use of Fertilising Residuals/ Guide sur le recyclage des matières résiduelles fertilisantes: Critères de référence et normes réglementaire*. The 2015 edition of this guide includes several modifications for the use of FRs in silviculture but it is only available in French; the 2008 English edition of the guide has not been updated and does not include these modifications.
- One can obtain certification from the BNQ to label the ash as a liming material according to *BNQ Standard 0419-090 – Liming Materials from Industrial Processes/ BNQ Norme 0419-090 Amendement calciques ou magnésiens provenant de procédés industriels*.

Contact :

Ministère du Développement durable, Environnement et Lutte contre les changements climatiques (MDDELCC)

Direction des matières résiduelles: Phone: 1-418-521-3950

Bas-Saint-Laurent et Gaspésie-Îles-de-la-Madeleine Saguenay-Lac-Saint-Jean

Phone: 1-418-986-6116

Phone: 1-418-695-7883

Capitale-Nationale et Chaudière-Appalaches

Phone: 1-418-248-0984

Mauricie et Centre-du-Québec

Phone: 1-819-752-4530

Estrie et Montérégie

Phone: 1-450-534-5424/1-450-370-3085

Outaouais

Phone: 1-819-772-3434

Montréal, Laval, Lanaudière et Laurentides

Phone: 1-450-752-6860

Côte-Nord

Phone: 1-418-964-8888/1-418-294-8888

Abitibi-Témiscamingue et Nord-du-Québec

Phone : 1-819-763-3333

Bureau de normalisation du Québec (BNQ)

Phone: 1-418-652-2238/1-800-386-5114 ext. 2419

Email: martine.ebacher@bnq.qc.ca

Certificate of Authorization (C of A)

In order to obtain a C of A, an ash producer (or a representative of the producer) must hire a forest engineer to produce a complete Agri-Environmental Reclamation Plan (AERP). This plan must be included in a request for a C of A, which is then submitted to a regional office of the MDDELCC. Completed AERPs must include information on the method of ash production, sampling, and analysis, and must demonstrate that the ash meets the standards outlined in the *Guidelines for the Beneficial Use of Fertilizing Residuals/ Guide sur le recyclage des matières résiduelles fertilisantes: Critères de référence et normes réglementaires*. Wood ash samples must be collected over a 12-month period prior to the C of A application; the number of required samples increases with the quantity of ash produced by the facility. Ash must be analyzed for such properties as dry matter, total P, K, organic matter, pH and trace metals, as well as dioxins and furans if the ash is derived from contaminated wood or from materials exposed to seawater. Trace metal limits are derived from the BNQ standard described below. If trace metal concentrations in the wood ash are above the limits for C1 or C2 FR (Table 2.2), alternative criteria (based on neutralizing value) may be applied to C2 FR used as amendments on forest soils; this option is based on standards set by the Bureau de Normalisation du Québec (BNQ 0419-090 - *Liming Materials from Industrial Processes/ Amendements calciques ou magnésiens provenant de procédés industriels*).

The chemistry of the receiving soil must also be analyzed (e.g., for available P, extractable aluminum and pH). In forests that have never been ploughed, soil samples should be taken from the B horizon, rather than from the mineral soil surface. Completed AERPs are generally processed within 70 days of receipt, at which point a C of A will either be issued to the ash producer by the MDDELCC or the project will be rejected. When applying wood ash to the soil surface, the best management practices described in

the 'Guidelines for the Beneficial use of Fertilizing Residuals/ Guide sur le recyclage des matières résiduelles fertilisantes: Critères de référence et normes réglementaires' must be followed (Table 3.11.2).

Season	- land application is prohibited on frozen or snow-covered soil
Distance from Surface or Groundwater	- consult the guidance for buffer requirements around groundwater catchment areas, ditches, water courses, lakes, swamps > 1000 m ² , ponds and flood-prone areas
Slope	- do not apply on slopes >9% that are hydrologically connected to ditches or other types of surface water

Certification by the Bureau de normalisation du Québec (BNQ)

The costs of BNQ certification are borne by the ash producer. Liming materials certified by the BNQ can include ash that has been mixed with lime or lime mud generated in kraft mills. Producers must demonstrate that the ash or ash-containing material meets the standards outlined in BNQ 0419-090 – *Liming Materials from Industrial Processes (3rd ed.)/ Amendement calciques ou magnésiens provenant de procédés industriels (3^e ed.)*. The certification process itself is described in BNQ 0419-910 - *Amendement calciques ou magnésiens provenant de procédés industriels – Protocole de certification*, which is currently under review. Completed applications for BNQ certification must include information on aggregate size, dry matter, total N, P, K, B, Mg, pH, trace metals, dioxins, furans and polyaromatic hydrocarbons (depending on feedstock), as well as a detailed plan for ensuring that product quality is maintained. Prior to certification, BNQ inspectors will visit the site where the ash is produced to confirm feedstock quality, to examine quality control systems and to collect additional samples. After certification, the site will be inspected on a regular basis to monitor quality control records and collect additional samples for confirmation that standards are being maintained. The certification process usually takes three to six months, and is valid for two years.

BNQ-certified ash can be land-applied without requiring a C of A from the MDDELCC, provided that the directions of use dictated by the BNQ are followed. As indicated in the *Water Withdrawal and Protection Regulation* under the *Environmental Quality Act*, the groundwater catchment regulations for BNQ-certified ash are the same as those required for ash without BNQ certification.

Relevant Legislation for Quebec

Laws and regulations administered by the Ministry of Sustainable Development, Environment and the Fight against Climate Change: <http://www.mddelcc.gouv.qc.ca/publications/lois-reglem-en.htm>
Sustainable Forest Development Act. Available at:

http://www2.publicationsduquebec.gouv.qc.ca/dynamicSearch/telecharge.php?type=2&file=/A_18_1/A18_1_A.html

Guidance Documents and Other Resources for Quebec

Bureau de normalisation du Québec (BNQ). 2015. *Norme BNQ 0419-090 – Liming Materials from Industrial Processes/ Amendements calciques ou magnésiens provenant de procédés industriels*. Available at: <http://www.bnq.qc.ca/fr/normalisation/environnement/amendements-calciques-ou-magnesiens.html>

**Hébert, M. 2008. Guidelines for the Beneficial Use of Fertilizing Residuals – Edition 2008. Available at: http://www.mddelcc.gouv.qc.ca/matieres/mat_res-en/fertilisantes/critere/guide-mrf.pdf

Hébert, M and Breton, B. 2009. Recyclage agricole des cendres de bois au Québec – État de la situation, impacts et bonnes pratiques agro-environnementales. Agrosolutions 19: 18-33. Available from: http://www.irda.qc.ca/assets/documents/Publications/documents/hebert-breton-2008_article_recyclage_agricole_cendres.pdf

*Hébert, M. 2015. Guide sur le recyclage des matières résiduelles fertilisantes: Critères de référence et normes réglementaires – Edition 2015. Available at:

http://www.mddelcc.gouv.qc.ca/matieres/mat_res/fertilisantes/critere/guide-mrf.pdf (French version)

3.12 Saskatchewan

The use of wood ash as a soil amendment on forest soils is governed by *The Environmental Management and Protection Act (2010)* and *The Forest Resources Management Act*. The application of ash to forest soils is not standard practice and there has been no guidance developed specifically to address the use of wood ash as a soil amendment in Saskatchewan. A proponent wishing to apply wood ash to soils in Saskatchewan should contact an Environmental Protection Branch Office of the Saskatchewan Ministry of Environment to discuss the project and determine the information required to submit a proposal.

Contact:

Saskatchewan Ministry of Environment (General Inquiries)

Phone: 1-800-567-4224

Email: centre.inquiry@gov.sk.ca

The proponent will then be asked to prepare a written proposal. The 'Information Submissions for Approval Process' section of the *Industrial Works Construction Application Standard (IWCAS)* should be used as a guide for preparing such a written proposal. According to the *IWCAS*, detailed information about the site to which the wood ash will be applied and the characteristics of the ash are required. There is also a website for *Environmental Quality Guidelines* that 'is a searchable database of provincial, science-based substances and goals for the quality of atmospheric, aquatic and terrestrial ecosystems'. Depending on the scope of the project, the Environmental Assessment Branch of the Ministry of Environment may be consulted by the Environmental Protection Branch to review the application.

Relevant Legislation for Saskatchewan

The Environmental Management and Protection Act, 2010. Available at:

<http://www.qp.gov.sk.ca/documents/english/Chapters/2010/E10-22.pdf>

The Forest Resources Management Act. Available at:

<http://www.qp.gov.sk.ca/documents/english/statutes/statutes/fl19-1.pdf>

Guidance Documents and Other Resources for Saskatchewan

Environmental Quality Guidelines. Available at: <https://envonline.gov.sk.ca/seqg/>

Industrial Works Construction Application Requirements and Submission Process. Available at:

<http://environment.gov.sk.ca/adx/asp/adxGetMedia.aspx?DocID=a71c423d-da37-491e-980e-faea39271b6f>

3.13 Yukon

In the Yukon, there are no specific guidelines regarding the use of wood ash as a soil amendment and there has been no precedent for this type of activity on forest or agricultural soils. The use of wood ash as a soil amendment would have to comply with the *Environment Act* and its regulations. Both the wood ash and the soil at the receiving site would need to meet the standards listed in Schedules 1 and 2 of the *Contaminated Sites Regulation*.

Proponents may be required to obtain one or more permits and/or licences to use wood ash as a forest soil amendment. Wood ash derived from untreated brush and wood products would not be considered a solid waste and, as such, a permit under the *Solid Waste Regulations* would not be required. Depending on the quality of the wood ash and the location of the proposed receiving site, however, other regulators could be involved. For example, approval may be required from the Environmental Programs Branch of the Department of Environment, as well as the Forest Management and/or Land Management Branches of the Department of Energy, Mines and Resources (EMR). Proponents can refer to the *Permit and Authorization Guide for Yukon Activities* for guidance on which government regulators should be consulted. Before preparing any application for a permit or license, it is recommended that the proponent contact the Government of Yukon regulators involved. Proponents must also confirm whether authorization is required from other governments (e.g., First Nations, municipal).

Contact:

Department of Environment

Environmental Programs Branch

1-867-667-5683

envprot@gov.yk.ca

Department of Energy, Mines and Resources

Agriculture Branch

1-867-667-5838

agriculture@gov.yk.ca

Forest Management Branch

1-867-456-3999

forestry@gov.yk.ca

Land Management Branch

1-867-667-5215

land.use@gov.yk.ca

Government of Yukon regulators will review each application that is submitted and either reject the project or approve it by issuing the requested permit or licence. Regulators will also identify if an assessment is required under the *Yukon Environmental and Socio-economic Assessment Act* (YESAA) before a permit or license can be issued. If an assessment is required, the proponent will be instructed to submit a proposal to the Yukon Environmental and Socio-Economic Assessment Board (YESAB). Proponents are encouraged to contact YESAB before preparing an application, to ensure that the procedure is followed correctly.

Contact:

Yukon Environmental and Socio-Economic Assessment Board

Phone (toll free): 1-866-322-4040

Email: yesab@yesab.ca

Proposals submitted to YESAB will need to include: a detailed project description; information on the purpose of the project and alternative methods for disposing of the ash; the outcome of all consultations with affected First Nation(s); the environmental and socio-economic values that may be impacted; the best management practices that will be followed; and mitigation measures that will be implemented to reduce, eliminate or control adverse impacts. Completed project proposals are typically processed within about 42 days of submission. Assessors with YESAB will submit their recommendations to the appropriate decision body(ies), which will then accept, reject or vary project recommendations. A decision body is the government with responsibility for the project as a regulator; depending on the project location and required authorizations, the decision body could be the Government of Yukon, a First Nation government or a federal government agency. The *Energy, Mines and Resources (EMR) Assessment – Regulatory Guide* provides more details about the process for requesting project approval from government regulators and for submitting a project proposal to the YESAB.

Relevant Legislation for the Yukon

Environment Act. Available at: http://www.env.gov.yk.ca/environment-you/Environment_Act.php

Solid Waste Regulations. Available at: http://www.gov.yk.ca/legislation/regs/oic2000_011.pdf

Contaminated Sites Regulations. Available at: http://www.gov.yk.ca/legislation/regs/oic2002_171.pdf

Guidance Documents and Other Resources for Yukon

Yukon Department of Energy, Mines and Resources. 2015. Permit and Authorization Guide for Yukon Activities. Available at: <http://www.emr.gov.yk.ca/pdf/permit-authorization-guide-yukon-activities-july2015.pdf>

Yukon Department of Energy, Mines and Resources. 2006. Energy, Mines and Resources (EMR) Assessment – Regulatory Guide. Available at: http://www.eco.gov.yk.ca/pdf/yesaa_guide_final_web.pdf

Yukon Environmental and Socio-Economic Assessment Board: Project Proponents. Available at: <http://www.yesab.ca/submit-a-project/>

3.14 Canadian Food Inspection Agency

The Canadian Food Inspection Agency (CFIA) regulates the sale of fertilizers and soil supplements sold in and imported to Canada. In provinces and territories where the regulations and guidelines surrounding the use of wood ash as a soil amendment have not yet been clearly defined, chemical characterization of wood ash as a fertilizer or liming agent via the CFIA may simplify the approval process.

If an ash producer is interested in obtaining a CFIA label for the sale of their ash, it is recommended that they undertake a pre-submission consultation with the CFIA. During this consultation, the CFIA will assist the producer in determining the approval process most appropriate for their product, and the types of information that must be gathered. Prior to the meeting, the producer will need to supply data on the chemical composition of the ash, its method of production, and the possible mode of action for the active ingredients. The CFIA will then help the proponent determine the policies and standards that apply, and the information required to complete the approval process.

Contact:

Canadian Food Inspection Agency (CFIA), Fertilizer Safety Section

Pre-market Application Submission Office (PASO)

Phone: 1-855-212-7695

Email: passo-bpdpm@inspection.gc.ca

Products sold as a liming material (which falls under the category of ‘Supplements’, according to the CFIA rules) do not require a pre-market assessment and product registration. Nevertheless, producers are ‘encouraged (although it is not mandatory)’ to seek a letter of no-objection (LONO) for the sale of their product from the Fertilizer Section and Fertilizer Safety Office of the CFIA. To do so, they must complete *Form T-4-112 Information Required for the Assessment of By-products and Other “Waste-derived” Materials sold as Fertilizers and Supplements*. This form requires details on the proposed use of the ash; the process by which it was generated; the methods and results of chemical analyses; the potential safety issues associated with the use of the product; and the results of relevant scientific research on its use.

Products sold as a fertilizer must be registered by the CFIA. This involves completing the *Fertilizer or Supplement Registration Application* form. This form also requires details on the proposed use of the ash; the process by which it was generated; the methods and results of chemical analyses; the available nutrient content of the material; the potential safety issues associated with the use of the product; and the results of relevant scientific research on its use. The process of registering wood ash as a fertilizer is more involved than that required to obtain a LONO but is appropriate for materials that will be used as a nutrient source and not just to correct soil pH.

Once the material has been appropriately characterized by the CFIA, the provincial or territorial process for obtaining approval to use wood ash as a soil amendment is usually simpler because the rules surrounding the use of fertilizers and liming agents are well established. That being said,

provincial and territorial regulations and guidance regarding buffers around water bodies, maximum cumulative metal additions, slope and other restrictions must still be followed.

In New Brunswick, both J.D. Irving Ltd. and Twin Rivers Paper Company have successfully obtained a label from the CFIA to use the ash produced in some of their wood waste boilers as a fertilizer. This ash is used on a regular basis as a soil amendment on agricultural land in New Brunswick and Nova Scotia.

Guidance documents and other resources for the Canadian Food Inspection Agency

The pre-submission process: <http://www.inspection.gc.ca/plants/fertilizers/registration-requirements/pre-submission-consultations/eng/1330910327069/1330910496655>.

The T-4-112 'Information Required for the Assessment of by-products and Other "Waste-derived" Materials sold as Fertilizers and Supplements', used to obtain a LONO for liming materials:

<http://www.inspection.gc.ca/plants/fertilizers/trade-memoranda/t-4-112/eng/1307864536371/1320192988468>

The 'Fertilizer or Supplement Registration Application' form, used to obtain a CFIA label for Farm Fertilizers: http://www.inspection.gc.ca/DAM/DAM-plants-vegetaux/STAGING/text-texte/c3778_1320289978773_eng.pdf

Regulation of Liming Materials offered for sale in, and/or imported into, Canada:

<http://www.inspection.gc.ca/plants/fertilizers/registration-requirements/liming-materials/eng/1330931268185/1330931734066>

Submissions checklists for new registrations of Farm Fertilizers:

<http://www.inspection.gc.ca/plants/fertilizers/registration-requirements/checklists/eng/1311313337062/1311313432185>

4.0 Possible gaps in existing Canadian regulations and guidelines

Although interest in the use of wood ash as a soil amendment is growing across Canada, the practice remains relatively rare, particularly on forested sites. In some European countries, however, wood ash applications on forest soils are strongly encouraged and, as a result, there have been significant refinements in the guidance surrounding this practice over the last 20 years. Below, we briefly summarize some of these, in the hopes that they can be used to further inform those interested in developing policies and practices that ensure the efficient, effective and safe use of wood ash for amending forest soils in Canada.

4.1 Sites where ash should or should not be applied

The motivation for applying wood ash to forest soils varies among European countries for historical and geographical reasons. In Finland, for example, an abundance of drained peatlands and a critical shortage of wood production after WWII motivated early research into the effects of wood ash amendments on tree growth on organic soils (Emilsson et al. 2006). In Sweden, soil and water acidification caused by atmospheric deposition is more widespread, and alkaline wood ash has been used to increase soil pH (Emilsson et al. 2006). The ultimate stated motivation for applying wood ash on forested sites has implications for Forest Stewardship Council (FSC) certification (Stupak et al. 2007). For example, wood ash applications for restoring site quality, facilitating reforestation or addressing nutrient imbalances are allowable under Finnish FSC rules but wood ash applications to increase tree growth are not. Similarly, Swedish FSC rules allow ash applications to sustain 'natural processes' and maintain forest productivity, while Danish FSC rules allow wood ash applications to prevent possible negative impacts on forest growth of biomass harvesting (Stupak et al. 2007). Such restrictions may need to be considered when planning wood ash applications on FSC-certified forests in Canada.

In many Scandinavian countries, whole trees are removed during harvesting. The stems are used for wood and pulp production and the residual materials (e.g., tree tops, branches and stumps) are used for bioenergy production. Given that tree tops and branches tend to be particularly nutrient-rich, the ash produced during combustion also tends to be nutrient-rich (although most of the nitrogen and some of the sulphur is lost). There is significant concern that removing nutrient-rich tree tops and branches from the stand, rather than leaving them behind to decay, will cause nutrient deficiencies over repeated rotations. Thus, amending forest soils with the ash produced during the combustion of these materials is considered a means of returning or recycling nutrients back to the forest. Wood ash amendments are strongly recommended on forested stands from which residues have been removed for biomass production in Denmark, Finland, Lithuania, Sweden, and the United Kingdom (Emilsson 2006; Karlton et al. 2008; Skogsstyrelsen 2008; Stupak et al. 2008; Forestry Commission 2009a, 2009b).

That being said, there are numerous restrictions on the types of sites to which ash can and should be applied, and these vary from country to country. In order to prevent N leaching and contamination of surface water in the UK, for example, applications of wood ash are not recommended on upland forest soils that have received high rates of atmospheric deposition (Pitman 2006; Forestry Commission 2009a, 2009b). In Sweden, ash applications are not recommended on sites with sensitive flora, such as sphagnum moss (Skogsstyrelsen 2008). In Finland, however, ash applications are encouraged on drained peatlands because tree growth is often increased. The positive response of forest productivity to ash applications on peatland sites is believed to be due, in part, to the enhanced decay of organic material and release of mineral nitrogen for uptake by tree roots. If wood ash accelerates the decomposition of peat material, the surface organic layer may be entirely lost over time (Pitman 2006). Therefore, ash applications would be counterproductive where restoration of wetlands and soil carbon sequestration take precedence over timber production (Pitman 2006).

4.2 Ash pre-treatment

At present, there is little specific guidance available in Canada to ensure that ash is spread safely and efficiently. Freshly combusted ash is highly reactive and can damage the equipment used for applying the ash. Measures must also be taken to avoid skin contact with or inhalation of ash because it can be extremely caustic (Griffin 2006; Risse and Gaskin 2013; Saunders 2014). Although fertilizer or lime spreaders can be used to apply wood ash to the surface of agricultural soils, this equipment can produce significant amounts of dust (Lickacz 2002; Hébert and Breton 2009; Risse and Gaskin 2013). Wetting is often recommended to reduce dust and ease ash handling and storage (Sylvia Environmental, 2008; Hébert and Breton 2009; Risse and Gaskin 2013), but wetted ash tends to harden into large chunks that can damage equipment. Hébert and Breton (2009) recommend that more robust manure spreaders be used to apply ash to the soil surface and that prolonged storage of wetted ash be avoided to prevent hardening. This approach contrasts with that of many European countries. In Finland and Sweden, for example, some type of ash hardening, or 'stabilization', is recommended to prevent burning of vegetation while also prolonging the fertilization effect, reducing the mobility of heavy metals, suppressing dust production during ash application, and minimizing damage to equipment (Emilsson 2006; Pitman 2006; Wildbacher 2007; Skogsstyrelsen 2008).

There are three common methods of ash stabilization described in the current guidance for Denmark, Finland and Sweden: self-hardening, pelletization and granulation (Emilsson 2006; Stupak et al. 2008). Self-hardening is the least expensive and most widely practiced method of ash stabilization (Emilsson 2006), although it yields a less homogeneous product than the other two methods. Self-hardening involves wetting the ash and then spreading it in a loaf-shaped pile on a paved surface; after several months, the hardened ash is broken up with a crusher or sieving bucket and, depending on the amount of fine material released after crushing, it may be screened prior to application to the soil. Pelletization

involves wetting the ash and then applying pressure to form particles of more uniform size (e.g., by pressing the wetted ash between grooved cylinders to form long strands that are then cut to the desired length). Sometimes, binding agents (e.g., cement) are added. Ash pellets usually take about one month to harden, after which they can be easily transported with little physical breakdown (Emilsson 2006). Granulation involves wetting the ash and then rotating it under hot air inside a drum or on a moving plate until granules are formed. Granulation is the most expensive method of ash stabilization, because of the energy expended to heat the granules as they form, but it produces a very homogeneous and stable product (Emilsson 2006).

In order for ash to be effectively stabilized, it must contain less than 10% carbon; if the carbon content is higher than 10%, it can be re-burned (Emilsson 2006; Wildbacher 2007; James et al. 2012). Re-burning can also be used to reduce the polyaromatic hydrocarbon content of ash (Emilsson 2006; Pitman 2006). Some work has also been done to develop a method for assessing the chemical reactivity of stabilized ash (Vesterinen 2003; Skogsstyrelsen, 2008; Levin and Eriksson 2010).

4.3 Nutrient content of ash

In Finland, Lithuania and Sweden, wood ash applications are often considered a means of increasing forest productivity and/or replacing nutrients removed during harvesting. As such, guidelines have been established to ensure that the concentrations of Ca, Mg, K, and P are sufficient to meet these goals. In contrast, Denmark allows no more than 90 kg P ha⁻¹ to be applied as wood ash every three years (Stupak et al. 2008). Existing guidelines in Canada often recommend that the content of plant-available N, K and P in soil amendments be measured to help determine application rates (e.g., Government of Ontario 2002; Hébert 2008; Sylvis 2008; New Brunswick Department of Environment and Local Government, 2014; Hébert 2015). If improved soil nutrient availability is the main purpose for applying ash to forest soils, then minimum ash nutrient contents may also need to be considered in Canada.

Table 4.3.1. Minimum nutrient contents (g kg⁻¹ dry weight) for wood ash applied to forest soils

Country	Ca	Mg	K	P	Zn	Cl
Finland	60 [*] , ^{**}		K + P = 10 [*] ; K + P = 20 ^{**}			20 ^{***}
Lithuania ^{***}	125	20	30	10		
Sweden [*]	125	15	30	7	0.5	

^{*}Skogsstyrelsen 2008; Obernberger and Supancic 2009; van Eijk et al. 2012; ^{**}van Eijk et al. 2012;

^{***}Stupak et al. (2008)

4.4 Timing and frequency of ash applications in forests

There are a wide variety of recommendations surrounding the frequency and stage of stand development at which wood ash should be applied. In most cases, one or two applications are recommended per rotation (Pitman 2006; Stupak et al. 2008; Skogsstyrelsen 2008; Varnagirytė-Kabašinskienė 2012). By applying ash to clearcuts (during site preparation or tree planting, for example), the number of stand entries is reduced, the risk of stem damage to regenerating trees is minimized, and the ability to accurately estimate the quantity of ash required to replace nutrients removed during harvesting is improved (Lomander et al. 2005; Emilsson 2006). However, some European guidelines recommend that ash not be applied within five years before or after harvest (Emilsson 2006; Karlton et al. 2008; Stupak et al. 2008) because of concerns about the potential for increased leaching of potassium and nitrate in the absence of uptake by plant roots (Emilsson 2006; Wildbacher 2007; Stupak et al. 2008). To address this concern, several guidelines suggest that ash only be applied to clearcuts with established vegetation (Lomander et al. 2005; Skogsstyrelsen 2008); that ash only be applied to clearcuts with low soil N content (Skogsstyrelsen 2008); that ash never be applied to clearcuts on N-rich sites that are located adjacent to watercourses (Skogsstyrelsen 2008); that N not be applied together with ash on clearcuts (Varnagirytė-Kabašinskienė 2012); and that only very stable ash products (e.g., thoroughly hardened, large-grained, cylinder-pelletized ash) be applied (Lomander et al. 2005; Emilsson 2006; Wildbacher 2007; Skogsstyrelsen 2008). Alternatively, some guides suggest delaying ash applications for five to eight years after harvest, when vegetation has established enough to inhibit leaching but is not yet large enough to impede application (Emilsson 2006; Wildbacher 2007). That being said, ash applications during the period of most rapid tree growth (Pitman 2006); during thinning (Stupak et al. 2008; Varnagirytė-Kabašinskienė 2012); in thinned stands (Lomander et al. 2005, Skogsstyrelsen 2008); and in mid- to late-rotation stands (Pitman 2006; Varnagirytė-Kabašinskienė 2012) are also widely recommended. Ash applications later in stand development appear to be motivated by the desire to improve forest productivity and/or replace nutrients that will be removed during biomass removals.

4.5 Dosage rate of ash applications in forests

There are a wide variety of recommended wood ash dosage rates among countries. As in many jurisdictions in Canada, the recommended dosage rates often vary with the heavy metal concentrations of the ash and the soil to which it is applied (Vesterinen 2003; Stupak et al. 2008). However, the species composition and fertility of the soil (Vesterninen 2003; Skogsstyrelsen 2008; Stupak et al. 2008); the stand development stage (Emilsson 2006; Pitman 2006; Stupak et al. 2008); the acidity of atmospheric deposition (Stupak et al. 2008); or the nutrient reserves removed during harvesting (Lomander et al. 2005; Skogsstyrelsen 2008; Stupak et al. 2008) are also used to determine optimal dosage rates in some countries.

In Sweden, two methods for calculating ash dosage rate are recommended: the fixed dose method and the nutrient balance method (Lomander et al. 2005). The fixed dose method is recommended when few details are available about previous biomass removals or if wood ash is being applied to compensate for nutrient losses caused by stem-only harvesting (Lomander et al. 2005; Emilsson 2006). Using this method, ash dosage is determined by the dominant tree species and the location of the site (north, central or south Sweden) (Emilsson 2006). The nutrient balance method is recommended when data are available on the quantity of nutrients and acid buffering capacity removed from the stand during biomass harvesting (Lomander et al. 2005; Emilsson 2006). Useful examples demonstrating the range of dosage rates calculated using the fixed dose and nutrient balance methods on different site types can be found in Lomander et al. (2005) and Emilsson (2006).

In Canada, maximum ash dosage rates have not been developed specifically for forest soils. In most provinces, dosage rates are determined by the liming requirement of the soil and/or by the trace metal concentrations in the ash and receiving soil (e.g., Hébert 2008; Sylvis Environmental 2008; Alberta Environment 2002; Government of Ontario 2002; Hébert 2015). Ash dosages rates are typically calculated to ensure that additions of trace metals to the soil do not exceed maximum acceptable limits. The maximum acceptable trace metal concentrations applied to wood ash under the Canadian Council of Ministers of the Environment/Canadian Food Inspection Agency guidelines (Table 2.2; Canadian Council of Ministers of the Environment 2005; Canadian Food Inspection Agency 1997) were calculated assuming a cumulative total application rate of 200 Mg ha⁻¹ over a 45-year period. In Alberta, ash applications on agricultural soils must not exceed 15 Mg ha⁻¹ at any one time; the sum of repeated ash applications must not exceed 45 Mg ha⁻¹ over a lifetime (Alberta Environment 2002). In Quebec, ash that meets the trace metal limits for C2 fertilizing residuals must not exceed 22 Mg ha⁻¹ on agricultural soils over a five-year period to a maximum of 88 Mg ha⁻¹ every 20 years (Hébert 2015). On forest soils, one-time dosage rates of up to 66 Mg ha⁻¹ may be considered acceptable because re-applications are unlikely (Hébert, M., Direction des matières résiduelles - Ministère du Développement durable, de l'Environnement et de la Lutte contre les changements climatiques, personal

communication, June 2016). These dosage rates are higher than the recommended dosage rates for wood ash on forest soils in Europe (Table 4.5.1).

Table 4.5.1. Recommended wood ash dosage rates for several European countries

Country	Dosage recommendations	Source
Austria	- a maximum of 3 Mg ha ⁻¹ of wood ash can be applied every 50 years	Wildbacher 2007; Obernberger & Supancic 2009
Denmark	- 0.5 - 7.5 Mg ha ⁻¹ can be applied every 10 years, to a maximum of 7.5 Mg ha ⁻¹ rotation ⁻¹ ; dosage is based on the quantity of Cd in the ash	Stupak et al. 2008
Finland	- dosage is based on the quantity of P in the ash, which should be equivalent to at least 45 kg ha ⁻¹ ; the quantity of K in the ash should be 70 kg ha ⁻¹ , but this is considered less critical - 3-5 Mg ha ⁻¹ of wood ash or 4-8 Mg ha ⁻¹ of mixed peat and wood ash are recommended for drained peatlands - 2.3 - 3 Mg ha ⁻¹ of wood ash is recommended for upland forests	Emilsson 2006; Karlton et al. 2008; Stupak et al. 2008
Lithuania	- 5 - 6 Mg ha ⁻¹ is recommended on nutrient-poor sandy soils that are being afforested - Two doses of 1.5 - 3.5 Mg ha ⁻¹ (depending on site type) are recommended during stand thinning and in middle-aged stands; lower doses (e.g., 2 Mg ha ⁻¹) are recommended on less productive sites because fewer nutrients are removed during biomass harvesting	Karlton et al. 2008; Stupak et al. 2008; Varnagirytė-Kabašinskienė 2012
Sweden	- doses of no more than 3 Mg ha ⁻¹ of wood ash should be applied every 10 years, to a maximum of 6 Mg ha ⁻¹ rotation ⁻¹ ; the total amount of heavy metals spread over a 100-year rotation must not exceed that which was removed during harvesting	Lomander et al. 2005; Stupak et al. 2008; Skogsstyrelsen 2008

4.6 Distribution pattern of ash applications in forests

There are few recommendations in any of the extant guidelines regarding the distribution pattern of wood ash applied to forest soils. In general, the implication appears to be that wood ash should be spread relatively evenly across the soil surface. The most recently published guidance for Sweden recommends that <25% of the area to which wood ash is applied should receive more than double the dose (Skogsstyrelsen 2008). Interestingly, however, Lundborg (1998) suggested that patches of untreated ground be left in stands to which wood ash has been applied. The reason for this

recommendation is unclear, but such a practice might be appropriate when spreading ash to emulate the effects of wildfire, which can also have a patchy distribution across the soil surface (Bodí et al. 2014).

4.7 Co-applications

Wood ash tends to have high concentrations of calcium, magnesium, potassium and phosphorus but low concentrations of nitrogen. Thus, wood ash amendments are not recommended on N-poor sites in the UK, because of the risk of causing N deficiency (Forestry Commission 2009a, 2009b). To avoid inducing nutrient deficiencies after wood ash applications, simultaneous amendment with other fertilizers are often advised. In Sweden, for example, co-applications of ash and N are recommended for vigorously growing stands (Emilsson 2006), and for sites with low levels of N deposition and high levels of biomass extraction (Skogsstyrelsen 2008). In Lithuania, co-applications of ash and N (70 to 120 kg N ha⁻¹, depending on site fertility and moisture regime) are recommended once per rotation (Karlton et al. 2008; Varnagirytė-Kabašinskienė 2012). Applications of granules produced from wood ash and N-rich pulp and paper mill sludge have also been proposed (Emilsson 2006). Simultaneous applications of lime (as limestone or dolomite) and ash are recommended in severely acidified watersheds in Sweden (Emilsson 2006), while simultaneous applications of K (as biotite) are recommended when applying K-poor peat ash to peatlands in Finland (Emilsson 2006; Stupak et al. 2008). Although the effects of co-applications of wood ash with urea (Brais et al. 2015) or fish silage (McDonald et al. 1994; Prescott and Brown 1998) on tree growth and foliar nutrients have been reported for two forested sites in Canada, ongoing Canadian studies are investigating various combinations of wood ash and urea, biochar, N-P-S fertilizer, lime mud, and pulp and paper biosolids (<http://cfs.nrcan.gc.ca/projects/140>).

4.8 Record-keeping

Guidelines from Alberta and from Sweden recommend that wood ash applications be carefully documented in order to prevent over-application. Details that should be recorded include: location, application date, application rate and the chemical composition of the ash (Alberta Environment 2002; Emilsson 2006; Stupak et al. 2008). If wood ash is being applied to compensate for nutrients removed during biomass harvesting in Sweden, the tree species harvested, quantity of biomass removed, date of extraction and removal or retention of foliage must also be recorded (Emilsson 2006; Skogsstyrelsen 2008).

4.9 International Guidance Documents and Other Relevant Resources

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5.0 Summary

In Canada, the residues generated as by-products of timber harvesting and wood processing are increasingly being utilized to generate bioenergy. The ash produced during combustion of these materials has a high pH and is rich in calcium, magnesium, potassium and phosphorus. Research in Europe and North America has demonstrated that this ash can be used as a soil amendment to replace the nutrients removed during logging, to counteract the acidifying effects of atmospheric deposition, and to improve forest productivity. Despite this, most of the wood ash generated in Canada is landfilled. Efforts to divert this material out of the waste stream and use it as a soil amendment on forest soils in Canada are often hampered by the lack of clear guidance developed specifically for soil applications of wood ash. In many provinces/territories, legislation and guidelines developed for other materials, such as biosolids, compost, and hazardous waste, also apply to the use of wood ash. In some jurisdictions, environmental impact assessments may be required in order to obtain approval to apply wood ash to forest soils. In other jurisdictions, existing guidelines are inconsistent with those in countries where ash is routinely applied to forest soils. For example, the maximum applications rates in Canada were largely developed for agricultural soils and tend to be much higher than those recommended for forest soils in Europe. Furthermore, methods of ash stabilization (used to prevent burning of vegetation, prolong the fertilizing effect, reduce the mobility of heavy metals, suppress dust production during ash spreading, and minimize damage to equipment and human health) may need to be considered for the Canadian context. A number of research trials have been established across Canada to examine the effects of wood ash applications on forest soil properties, water quality, tree growth and ecosystem health; the results of these trials will be used to inform policy development in the future. Nevertheless, more work is required to refine dosage rate calculations, improve the methodology for applying wood ash and identify the forest sites to which ash applications would be most appropriate.