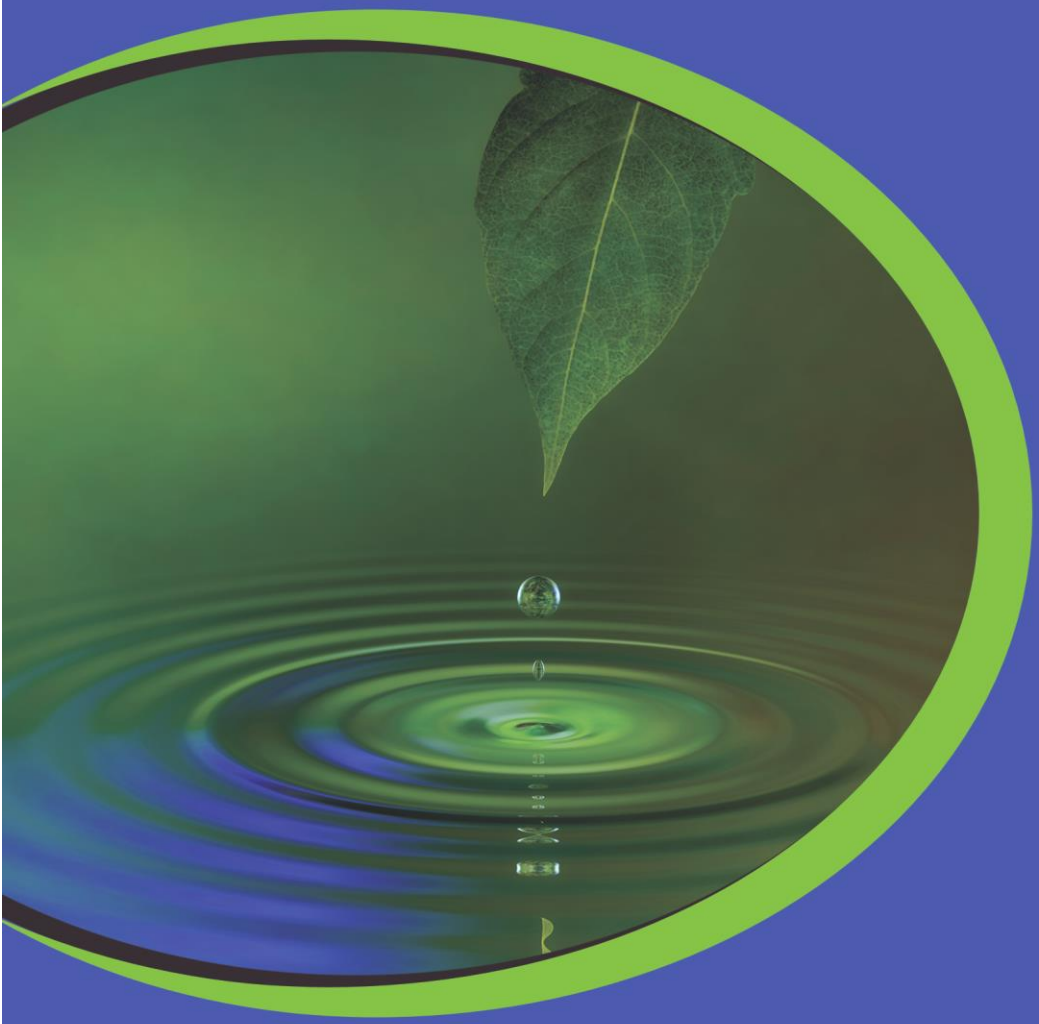
GUIDE

Residential Wood Ash Recycling and Forest Soil Amendment

An Operations Guide



Friends of the Muskoka Watershed

Residential Wood Ash Recycling and Forest Soil Amendment

Operations Guide

For communities and private landowners looking to restore calcium in forest soils and watersheds that have been damaged by acid rain.

Written and published in association with Friends of the Muskoka Watershed, and with the financial support of the Ontario Trillium Foundation

An agency of the Government of Ontario
Un organisme du gouvernement de l'Ontario

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Contents

About This Document

This document is intended for organizations interested in developing a residential wood ash recycling program for the purpose of remedying calcium decline in forest soils that have been damaged by acid rain. The document provides insights into the operating paradigm of this type of undertaking, as well as provides 'how-to' guidance pertaining to logistics and community engagement.

The information contained in this document is based on ASHMuskoka's experience in setting up a small-scale residential wood ash recycling program in Muskoka, Ontario. As such, the information provided is limited in scope to this context.

While this document aims to encourage other organizations to become involved in reducing landfill and improving the health of calcium-deficient forests through the recycling and application of residential wood ash, it does not attempt to explain in scientific detail the relationship between acid rain, calcium-depleted forests, and wood ash as a remedy. For detailed scientific explanations about this issue, please refer to the *Reference and Resource Material* section at the end of this document.

Disclaimer

ASHMuskoka is a division of the Friends of the Muskoka Watershed organization, a not-for-profit corporation incorporated under the laws of Canada. For simplicity, the term ASHMuskoka as used herein will refer to Friends of the Muskoka Watershed and all of its divisions, successors, and assigns.

Errors and Omissions, Liability

Every effort has been made to provide complete and accurate information in this document, however, ASHMuskoka is not responsible for any errors or omissions, or for the results obtained from the use of this information. As stated in the "About This Document" section, information in this document pertaining to ASHMuskoka's program activities are limited entirely to ASHMuskoka's experience and are not representative of all potential possibilities or outcomes. Therefore, use of the information in this document is at your own risk.

For more context regarding ASHMuskoka's experience, refer to the 'About ASHMuskoka' section of this document.

While ASHMuskoka has included some information in this document pertaining to environmental compliance, regulations, and the regulatory process, this information is

experiential and should not be considered authoritative. For all regulations and activities pertaining to the collection, transport, storage, and use of wood ash, the Ontario Ministry of the Environment, Conservation and Parks should be consulted as well as your local municipality.

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Contextual Background

Calcium depletion in Muskoka forest soils and watersheds

Environmental analyses have identified that a negative outcome of acid rain has been the depletion of the mineral calcium in forest soils. Reduced calcium in forest soils impedes healthy tree growth and reproduction (notably among sugar maple trees), and further reduces the leaching of calcium through to neighbouring watersheds. The reduction of calcium leaching into watersheds is of concern because organisms in watershed environments such as crustaceans, mollusks, and turtles have a high reliance on this mineral to survive.

While almost all living organisms require calcium to survive, crayfish, turtles, and mollusks have a proportionately high reliance on this mineral.

The geological and ecological nature of the Muskoka region has made it particularly susceptible to negative outcomes associated with acid rain. For detailed information about this ecological problem, see the *Reference and Resource Material* section at the end of this document for links to other related material.

Friends of the Muskoka Watershed and ASHMuskoka

Calcium depletion in Muskoka's forests and watersheds is an issue of particular concern adopted by the *Friends of the Muskoka Watershed* (FOTMW) organization. With financial support from the *Ontario Trillium Foundation* (OTF), *Friends of the Muskoka Watershed* have been studying the science and feasibility of collecting wood ash from local and regional sources (citizens), and using it to replenish forest soils and watersheds with the calcium they need to ensure and expedite environmental recovery.

The study and engagement of this issue by *Friends of the Muskoka Watershed* has been progressive and conducted in two phases. The first (and now complete) phase is collectively referred to as the *Hauling Ash to Solve Ecological Osteoporosis (HATSEO)* project. The second and current phase is referred to as *ASHMuskoka*. For more information about the activities of FOTMW, HATSEO, and ASHMuskoka, see the *Reference and Resource Material* section at the end of this document, or visit the ASHMuskoka website at https://ashmuskoka.ca/.

About ASHMuskoka

At the outset, ASHMuskoka was a three-year project (January 2018 – December 2021) intended to:

- Logistically develop and execute a local residential wood ash recycling program.
- Navigate associated regulatory compliance requirements in collecting, transporting, storing, and dispersing residential wood ash on forest soils.
- Pioneer the usage of recycled residential wood ash as a forest soil amendment in solving calcium decline caused by acid rain.
- Partner and collaborate with the environmental sciences community to help foster additional learning about wood ash as a solution to calcium deficiency in ecological systems.
- Engage the public in solving the calcium decline problem in Muskoka forests and watersheds, while at the same time reducing landfill.
- Share learning, as well as mentor and support the expansion and scaling up of residential wood ash recycling programs in other effected areas of Ontario.

Over the past 30 months, ASHMuskoka has:

- Collected over 17 tonnes of wood ash from Muskoka residents.
- Enabled and received wood ash donations from over 1100 Muskoka residents.
- Partnered and engaged with a broad range of government, community, business, academic, and not-for-profit entities in building and driving a community based solution to an environmental problem.
- Dispersed ash on several hectares of forest soil in Muskoka.

Outcomes of collecting residential wood ash and using it as a forest soil amendment include:

Environmental

- Increased tree reproductive abilities and the growth of stronger, healthier trees.
- Improved tree photosynthetic rates and therefore greater volumes of greenhouse gases captured and converted to wood. This helps combat climate change.
- Improved transpiration rates by trees, which provides more capacity for watersheds to store meltwater and potentially mitigate flooding.
- More calcium in watersheds and neighboring lakes, which promotes restoration or maintenance of ecological balance by ensuring organisms with high proportional dependencies on calcium such as crayfish, water mollusks, turtles, and daphnia (water flea) survive.

Economic

- Increased sap flows in sugar maple trees leads to larger harvests at maple sugarbushes. Early results of HATSEO and ASHMuskoka work have shown increased sap yields of between 25-70% within one year of wood ash being dispersed on calcium-depleted soils.
- To date, ASHMuskoka has diverted 17 tonnes of wood ash from landfill.

Social

- To date, ASHMuskoka has engaged and enabled over 1100 residents to help improve the health of their natural environment.

What is Residential Wood Ash?

Residential wood ash comes from non-industrial enterprises and is primarily derived from households that heat their homes with wood.

Residential wood ash is commonly referred to as 'non-industrial wood ash', or NIWA, in regulatory or technical documents.

For the purposes of using residential wood ash to remedy calcium-depleted forest soils, it is important to note that the ash should come from the combustion of raw, untreated wood only. It should not come from the combustion of pressure-treated wood, or wood that may contain chemicals from paint, stain, glue, insecticides, etc. It should also not come from wood that has been burned *along with* other materials such as construction or demolition materials, insulation, metals, plastics, composites, and garbage.

Residential wood ash collected by ASHMuskoka

While logging and forest product enterprises may produce ash from the combustion of unused biomass, this is considered 'industrial' wood ash, and is beyond the purview of this document.

Does Your Forest or Watershed Have a Calcium Problem?

Not all forests and watersheds in Ontario are calcium-deficient.

The probability of a forest or watershed being calcium-deficient is based on the combination of three factors:

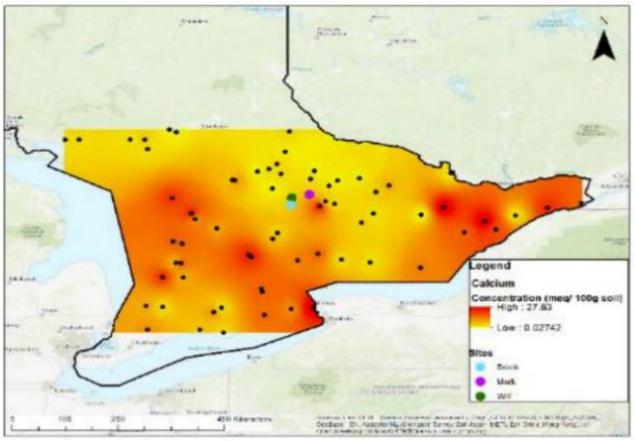
- Location in a region with historically high acid deposition rates.
- Shallow forest soils over granitic bedrock rather than calcium-rich limestone.
- Forest composition dominated by hardwoods, such as sugar maple, which have a relatively high need for calcium.

All of the above predisposes the portion of the Great Lakes-St Lawrence Forest in Canada[1] (which laterally stretches across the middle of Ontario and through to parts of southern Quebec and eastern Canada) that sits on top of the Canadian Shield[2] to be calcium-deficient.

Soil analysis conducted by a commercial lab or academic institution can confirm site-specific deficiencies in calcium.

The figure below was taken from work conducted by Trent University[3] to determine baseline soil chemistry across most of southern Ontario. Black dots represent sampling points, and colored dots represent planned ASHMuskoka ash dispersal sites (at three sugarbushes). Of importance is the gradation in color between yellow and red. Yellow areas denote a low concentration of calcium in soil samples.

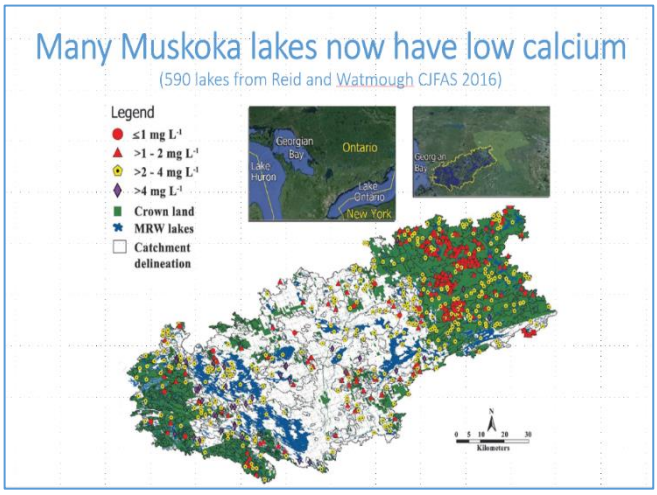
[1] https://www.nrcan.gc.ca/sites/nrcan/files/forest/SFM/classification/Canada_forest_regions.pdf
[2] https://www.thecanadianencyclopedia.ca/en/article/shield
[3] "*Utilization of Wood Ash as a Potential Remediation for Hardwood Forests: Baseline Soil Chemistry*," Aneica Lloyd, Shaun Watmough, Trent School of the Environment, 2019-20. Background data sourced from "*Air pollution, climate, soil acidity, and indicators of forest health in Ontario's sugar maple forests*" Diane E. Miller and Shaun A. Watmough Canadian Journal of Forest Research, 6 November 2009. https://cdnsciencepub.com/doi/10.1139/X09-124



Yellow areas in the map above denote a low concentration of calcium in soil samples. Red areas show where calcium concentrations are high.

Almost half the lakes in Muskoka now have calcium levels below minimum thresholds that would allow native organisms with high levels of calcium dependency to thrive. Because lakes get calcium from their watersheds, it follows then that neighboring watersheds and forests are also calcium-deficient.

The illustration below depicts the level of calcium concentrations in Muskoka's Lakes. Red circles or triangles denote lakes with calcium concentrations below thresholds that allow native organisms with high levels of calcium dependency to survive.



Calcium levels in Muskoka lakes. Red circles or red triangles denote lakes with insufficient calcium concentrations necessary for the survival of some species such as crayfish, mollusks, turtles and Daphnia (water flea).

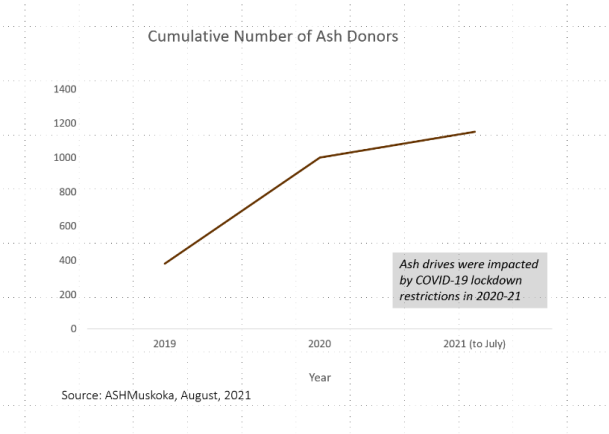
In addition to Muskoka, other areas of Ontario that likely have calcium deficient forests and watersheds include Haliburton, Nipissing, Hastings, and Parry Sound.

Assessing the Supply of Residential Wood Ash in Your Area

Residential Wood Ash Supply

According to Statistics Canada, 3% of households in Ontario heat with wood[4]. Considering that rural areas are more likely to have households located beyond the range of hydro or gas lines, it is natural to assume that these areas would have a greater proportion of homes that heat with wood. Therefore, a baseline of 3% of households would be a conservative starting point in terms of estimating the number of households that could potentially contribute wood ash to a recycling program in a given area, should that area be predominantly rural.

An early feasibility survey conducted by ASHMuskoka among households who heat with wood determined that 2/3rds of these homes would be willing to participate in a wood-ash recycling program should it be convenient for them to do so.



Over a period of 30 months[5], ASHMuskoka has acquired wood ash donations from over 1100 households, with over 600 of those donors contributing ash more than once.

Over a 24-month period (June 2019 to June 2021) ASHMuskoka has collected over 17,000 kg of wood ash.

How Much Wood Ash is Needed?

[4] https://www150.statcan.gc.ca/n1/pub/11-526-s/2013002/t002-eng.htm

[5] During this 30 month period, ASHMuskoka activities were necessarily impacted by COVID-19 lockdowns and related restrictions. Furthermore, it is important to note that the ASHMuskoka initiative is currently only able to accept wood ash donations at one location in Bracebridge, thus deterring potential donors who would be required to drive inconvenient distances from participating.

Academic assessment of how much wood ash is needed to remedy calcium deficiency in forest soils effected by acid rain is still underway; however, it is currently believed that 2 metric tonnes of residential wood ash per hectare is a sufficient dosage to bring calcium levels in forest soils back to pre-acid rain levels. It is also believed that only one application of wood ash at this dosage rate is necessary to restore forest and neighboring watershed health (if we exclude forested areas used for logging and related resource harvesting).

Operations Guide

Introduction

There are many component pieces to successfully operating a residential wood ash recycling program. They include:

- Cognizance towards regulatory requirements.
- Understanding where wood ash can and cannot be dispersed as a forest soil amendment.
- Establishing partnerships to acquire necessary approvals, outreach support, and learning.
- Marketing and communications strategies
- Logistical setup
- Feedback mechanisms

Details pertaining to these operating components make up the core sections of this operating guide.

Regulatory Considerations and Environmental Compliance Approvals (ECA)

Crown Land vs Private Land

Crown forests in Ontario are managed regionally by organizations granted a 'sustainable forest licence' by the Ministry of Natural Resources and Forestry.[6] Muskoka is part of the French-

[6] A list of sustainable forest licences in Ontario, and the companies who hold them can be found on the Ontario.ca website. https://www.ontario.ca/page/sustainable-forest-licences

Severn Forest MU (management unit)[7] and is managed by Westwind Forest Stewardship Inc.[8], a not-for-profit, community-based company.

The regulatory framework for the management and protection of forest resources on crown land is different than it is for private land. Residential wood ash is prohibited from use as a forest soil amendment on crown land. While there is some interest in modifying policies as they pertain to crown forest management (see also *A Look to the Future/What's Next for Friends of the Muskoka Watershed and ASHMuskoka/Mentoring and Collaborating/Bioenergy),* **currently all of ASHMuskoka's work is necessarily restricted to the remediation of calcium decline in forest soils and watersheds on private land only**.

Private landowners have fewer restrictions and greater control over applications of ash on their own property. It is ASHMuskoka's longer-term aim to educate private landowners on appropriate uses of residential wood ash on their own properties and thereby expand the acreage of calcium-depleted forests remediated with calcium-rich wood ash through direct citizen participation. (See *A Look to the Future/What's Next for Friends of the Muskoka Watershed and ASHMuskoka/Enabling and Mobilizing Citizen Participation*).

Regulatory Paradigm for Residential Wood Ash

Environmental regulations associated with wood ash are largely under provincial jurisdiction.[9]

While the aim of using residential wood ash (specifically referred to as non-industrial wood ash (NIWA) in regulatory documents) as a forest soil amendment is intended to solve an environmental problem, the reality is, government legislation (and ensuing regulations) exist to ensure that activities and enterprises do not harm our physical environment. When these existing regulatory frameworks were created, the use of residential wood ash as a forest soil amendment had not been studied or considered. Since the toxicological nature of ash is entirely dependent upon the substances that are burned, from a regulatory perspective it has been convenient to classify ash as a potentially hazardous waste.[10]

Therefore, for ASHMuskoka – or any other enterprise – to collect, transport, store, or use residential wood ash as a forest soil amendment (fertilizer) on private land, an 'Environmental

[7] For a map of the French-Severn MU, see *A Look to the Future/What's Next for Friends of the Muskoka Watershed and ASHMuskoka/Enabling and Mobilizing Citizen Participation*

[8] http://www.westwindforest.ca/our-company/

[9] "*Regulations and guidelines for the use of wood ash as a soil amendment in Canadian forests"*, K.D. Hannam et al., Natural Resources Canada, 2016, https://publications.gc.ca/collections/collection_2017/rncan-nrcan/Fo123-2-17-2016-eng.pdf. See also "*Wood ash as a soil amendment in Canadian forests: what are the barriers to utilization?"* K.D. Hannam et al., Canadian Science Publishing, 2018, https://cdnsciencepub.com/doi/10.1139/cjfr-2017-0351

[10] The MECP recognizes the need to review and potentially amend policies and regulations pertaining to the use of wood ash as a forest soil amendment. In general, they are supportive of ASHMuskoka's endeavours.

Compliance Approval' (ECA) is currently required from the Ontario Ministry of the Environment, Conservation and Parks (MECP) issued under Part V of the Environmental Protection Act.

Environmental Compliance Approvals (ECAs)

ECAs involving residential wood ash as a forest soil amendment are handled by the MECP on a case-by-case basis. They are conditional, and they expire.

Applications and guidelines on how to apply for an ECA are available on the MECP website. However, given that the use of residential wood ash as a forest soil amendment is nascent, and the procedure to evaluate and approve this kind of an application for the MECP is relatively new, it is recommended that interested parties approach their MECP district office for coaching and guidance regarding the ECA application process. Alternatively, the MECP has a 'Client Services and Permissions Branch' in Toronto where questions can be directed. (See also *Navigating the Regulatory Environment*, below.)

Detailed information pertaining to Environmental Compliance Approvals can be referenced from the Ontario Environmental Protection Act, regulations 255/11 and 347, and from the Ontario Nutrient Management Act, regulation 267/03.

While ECA application requirements are necessarily determined by the specific nature of the ECA request, the following will most likely be required:

- Confirmation that the NIWA will have value as a soil amendment at the intended dispersal site
- Details on where the wood ash will be collected, stored, and dispersed
- Details on how the wood ash will be transported
- GIS maps of the intended dispersal site location
- Specific chemical analyses of dispersal site soil
- Details pertaining to wood ash dosage, and dispersal site conditions including soil depth
- Chemical analysis of the wood ash being used including:
    - Chemical analysis of trace metals (see *Residential Wood Ash (NIWA): Classification as 'Non-Agricultural Source Material' (NASM),* below. See also, *Logistics/Ash Processing, Quality Control, and Testing*)
    - Analysis of various nutrient species (nitrogen, phosphorus)

    - Acidity and organic content
- Biosolids Utilization Committee (BUC) recommendation (see *Residential Wood Ash (NIWA): Classification as 'Non-Agricultural Source Material' (NASM),* below).

Application process and approval times are determined by case-by-case circumstances but can take anywhere from several months to a year.

Navigating the Regulatory Environment

To navigate the regulatory environment, an optimal starting point is to identify and connect with municipal staff who manage solid waste and composting. Municipal staff will have key contacts at their district MECP office who can provide guidance and support through the applications and approvals process.

Residential Wood Ash (NIWA): Classification as 'Non-Agricultural Source Material' (NASM)

The closest regulatory classification that fits the profile of residential wood ash, and the intended purpose of using it as a forest soil amendment, is 'non-agricultural source material' (NASM). According to the Ontario Ministry of Agriculture, Food, and Rural Affairs:

> *'Non-Agricultural Source Material, or NASM, is treated and recycled material from non-agricultural sources, like leaf and yard waste, fruit and vegetable peels, food processing waste, pulp and paper biosolids and sewage biosolids, that is applied to agricultural land to provide a beneficial use.'*[11]

The classification and safe usage of NASM is evaluated by the Biosolids Utilization Committee (BUC). The BUC is a multi-stakeholder, inter-ministerial committee that advises and makes recommendations to the MECP and OMAFRA on matters related to the use of biosolids and other materials (NASM) on agricultural land.[12]

The determination of NASM as a suitable forest (or agricultural) soil amendment is based on several outcomes of its chemical analysis. Of most relevance to wood ash is the concentration of 11 potentially toxic trace elements in the material being studied or used. Those elements are arsenic, cadmium, cobalt, chromium, copper, lead, mercury, molybdenum, nickel, selenium, zinc.

[11] http://www.omafra.gov.on.ca/english/nm/nasm.html

[12] http://www.omafra.gov.on.ca/english/nm/regs/nmpro/nmpro02-04.htm

Trace Element Thresholds

Per regulations, the concentration of the 11 identified trace elements (above) are evaluated against 2 threshold levels identified as CM1 and CM2 (CM is short for 'content of regulated metals'). If all concentration levels fall **below** CM1 levels, then the wood ash (or NASM) may be considered for unrestricted use.

If concentration levels of any of the metals fall **between** CM1 and CM2, then the use of the wood ash (or NASM) is dependent upon the concentration of metal levels in the soil at the intended addition site. It is also dependent upon other considerations such as minimum depth of soil to groundwater, and proximity to surface water.

If any metal concentration levels **exceed** CM2 thresholds, then the wood ash or substance is considered to be a hazardous waste and therefore cannot be applied to the land.

Residential wood ash collected and tested by ASHMuskoka showed 9 of the 11 trace metals had concentrations below CM1 thresholds. No trace elements exceeded Ontario's CM2 thresholds; however, 2 trace elements (copper and zinc) fell between CM1 and CM2 thresholds (just slightly above CM1).

Therefore, the ECA's that have been granted to ASHMuskoka to date, have been dependent upon the measured chemistry of the soil at the intended ash dispersal site.

Dispersal Site Planning

For the MECP to evaluate an ECA application to use residential wood as a forest soil amendment, it necessarily needs to consider details pertaining to the dispersal site location. The dispersal site location is the area of land that is intended to receive the ash.

When considering an ECA submission, an MECP inspector will likely want to visit the ash dispersal site to confirm the details of the ECA submission.

From a regulatory perspective, the following attributes of the dispersal site location are noteworthy and may be included (among other things) in the 'terms and conditions' of an ECA.

- Is the location of the site a minimum of:

  - 250 meters away from 'sensitive use'[13] areas, and/or residential areas
  - 100 meters away from a municipal well
  - 90 meters away from a private well
  - 90 meters away from a single residence
  - 60 meters away from surface water (e.g., lakes, rivers, ponds, streams, wetlands, swamps, etc.)
  - 30 meters away from a public roadway
- Do any areas of the site have a maximum sustained slope greater than 50%.
- Is there exposed bedrock.
- Is the depth of soil sufficient to impede immediate runoff of ash into watersheds.

Aerial view of ASHMuskoka's dispersal site location at Camp Big Canoe, Bracebridge. The red border marks the boundary of the dispersal site. Within the dispersal site, 12 study plots are identified.

Operational considerations when choosing a dispersal site location include distance from ash storage, and accessibility. (see also *Logistics/Infrastructure/Ash Storage Considerations*)

Partnerships

Developing and operating a residential wood ash recycling program requires support, consultation, and engagement from a wide range of formal and informal partners, spanning

[13] Commercial, recreational, or institutional uses, and locations where people regularly congregate (i.e., parks, sports fields, recreational areas).

multiple functional areas including government and community service organizations; commercial businesses and not-for-profit enterprises; and in the case of ASHMuskoka, science and academic institutions.

ASHMuskoka's operations benefit from the following partnerships:

Government and Community Services

Member of Provincial Parliament (MPP)

Norm Miller, Muskoka's local MPP, supports ASHMuskoka by advocating for ASHMuskoka's interests among policymakers and government agencies.

Ministry of Environment, Conservation and Parks (MECP)

Staff at the MECP help ASHMuskoka navigate regulatory requirements by providing guidance and informational support.

District Municipality of Muskoka (DMM)

Logistical support and permissions from the District Municipality of Muskoka – in particular the engineering and waste management group – is essential in order for ASHMuskoka to operate.

The DMM provides ASHMuskoka:

- Permission to collect and temporarily store ash at the Rosewarne transfer station
- Permission to discard coarse char from collected ash at the local municipal composting facility

Local Fire Departments

Local fire departments in Muskoka are partners in supporting the recycling of wood ash as a forest soil amendment. Given the potential fire hazard posed by uncooled ash, local fire departments help ASHMuskoka educate ash donors on the proper handling of ash.

> *A fire prevention officer for the town of Gravenhurst provides instructions in this social media post on how to safely handle and store wood ash:* https://www.instagram.com/p/By25JT9lko-/

Ontario Trillium Foundation (OTF)

A significant majority of the funding for the ASHMuskoka project has come from the Ontario Trillium Foundation. In addition to providing critical funding, the OTF has provided coaching and

educational resources to ASHMuskoka in the areas of marketing and community outreach.

Westwind Forest Stewardship

(See also *Regulatory Considerations and Environmental Compliance Approvals* (ECA)/*Crown Land vs Private Land*)

Information sharing between Westwind Forest Stewardship and ASHMuskoka provides synergistic benefits in terms of mapping out a vision for expanding the use of wood ash as a forest soil amendment in Ontario.

Commercial Businesses and Not-For-Profits

Abbey Gardens

Abbey Gardens is a private, not-for-profit enterprise in Haliburton that has been mentored by ASHMuskoka in restoring 300 acres of land from a gravel pit, to a healthy green space and forest.

https://abbeygardens.ca/

Aces Waste Management (Muskoka) Ltd.

Transporting wood ash (other than ash that one has generated personally) from one location to another requires government approval, or a submission on the Environmental Activity and Sector Registry (EASR). (See also *Logistics/Infrastructure/Transportation/Certified Waste Hauler*).

Aces Waste Management is a licensed waste management service and donates waste haulage services to ASHMuskoka on an as needed basis.

https://www.aceswaste.ca/

Camp Big Canoe

Camp Big Canoe is a not-for-profit recreational children's camp situated among 240 acres of Muskoka forest. Camp Big Canoe houses ASHMuskoka's ash storage facility, and is the location of a 10-hectare ash dispersal and study site.

http://www.campbigcanoe.ca/

Chamberlain Timber Mart (Gravenhurst)

As a supporter of ASHMuskoka, Chamberlain Timber Mart has helped ASHMuskoka acquire large quantities of 75-litre galvanized garbage cans at wholesale costs.

https://timbermart.ca/en/stores/chamberlain-timber-mart/

Garbage cans purchased from Chamberlain Timber Mart at wholesale costs

Dorset Heritage Museum & Information Centre

Dorset is a small town located at the boundary between Muskoka and Haliburton on the eastern edge of Lake of Bays. The Dorset Heritage Museum & Information Centre celebrates the history and early pioneer settlement of the area.

The Dorset Heritage Museum & Information Centre donates space within their facility for an educational ASHMuskoka display.

https://www.dorsetheritagemuseum.ca/

Momma Bear's Ice Cream & Sweets

Momma Bear's Ice Cream & Sweets is a local business in the heart of Bracebridge. The company has donated hundreds of used 11-litre ice cream buckets with lids for ASHMuskoka to give to ash donors to collect and store their ash.

Ice cream buckets donated to ASHMuskoka for ash collection

Muskoka Conservancy

The mission of Muskoka Conservancy is to conserve natural spaces in Muskoka for current and future generations. They do this by acquiring ownership of properties and legally registered agreements with private property owners to protect land for nature conservation purposes, forever.

The Muskoka Conservancy cares deeply about the health of our environment and its ecological systems. With similar interests to the Friends of the Muskoka Watershed, ASHMuskoka engages with the Muskoka Conservancy for information sharing purposes.

https://www.muskokaconservancy.org/

Muskoka Steamships and Discovery Centre

Muskoka Steamships and Discovery Centre is actively engaged in preserving, promoting, and celebrating the culture and heritage of the Muskoka district. The centre attracts over 10,000 visitors a year.

Muskoka Steamships and Discovery Centre donates space within their facility for an interactive, educational, ASHMuskoka display.

Additionally, Muskoka Steamships and Discovery Centre has developed a curriculum for school groups and summer camps that teaches kids about calcium depletion in forest soils caused by acid rain. The curriculum also explains how recycling wood ash and putting it on forest soils can help our forests and watersheds recover.

https://realmuskoka.com/discovery-centre/

Ontario Maple Syrup Producers Association, Algonquin Local

Maple syrup producers understand forest nutrition. They have been aware of the decline in the health of sugar maple trees as far back as 1985. Calcium decline in forest soils reduces sap flow, and therefore sugarbush productivity. Information sharing between maple syrup producers and ASHMuskoka provides synergistic learning.

https://www.omspa.ca/algonquin-district

Rotary Club, Bracebridge

The Rotary Club of Bracebridge handed out ash buckets to all its members and encouraged them to donate their ash.

Ryde Community Co-operative Inc.

Ryde Community Co-op is a volunteer-driven, community-based, not-for-profit charitable organization providing social, wellness, and educational programming for all ages. This organization sponsored ASHMuskoka ash drives and encouraged its members to donate their ash.

https://rydecommunityco-op.com/

Sugarbush Operators: Brooklands Farm, Mark's Muskoka Maple, Creasor Family Sugarbush

Three sugarbush operators in Muskoka have participated in ASHMuskoka ash dispersal studies on their properties.

https://brooklandsfarm.ca/
https://www.facebook.com/MarksMaple/

Suzanne Martineau, RE/MAX Hallmark Realty Ltd.

As a supporter of ASHMuskoka, Suzanne Martineau includes educational material about ASHMuskoka in welcome baskets given to clients who are new to the area.

https://www.mymuskoka.com/

Debbie Vernon, Royal LePage

As a supporter of ASHMuskoka and a former board member of FOTMW, Debbie Vernon supported the FOTMW for a number of year by donating a portion of her realtor commissions each time she sold a home in the Muskoka area.

https://www.debbievernon.com/

Science and Academic Community

Dorset Environmental Science Centre (DESC)

An adjunct of the MECP, the DESC is an internationally renowned freshwater research laboratory located on the border of the Muskoka and Haliburton regions in Ontario. The DESC has been a very supportive partner of ASHMuskoka and has provided critical scientific analyses and laboratory space for toxicological work required by the project.

Trent University: School of the Environment

Critical work and analysis done by graduate students under the direction of Dr. Shaun Watmough at Trent University's School of the Environment serves to advance the scientific understanding of wood ash as a forest soil amendment.

University of Victoria: Environmental, Social, and Personality Lab

Under the direction of Dr. Robert Gifford, research work at the University of Victoria has been done in collaboration with ASHMuskoka to identify psychological barriers to participation in a residential wood ash recycling program. This work has helped ASHMuskoka shape its marketing and community outreach strategies, and optimize community engagement.

Laurentian University: Science Communication

Under the direction of Dr. Chantal Barriault, an educational video for public consumption has been produced for ASHMuskoka. The video explains the problem of calcium decline, and how dispersing wood ash on forest soil is a solution to the problem. The video can be viewed here: https://youtu.be/R2Mtq-N18FA

Marketing and Communications

Marketing and communications work is essential in helping to ensure that the objectives of a residential wood ash recycling program are successfully attained. The time and energy required to develop, manage, maintain, and effectively utilize marketing and communications resources for maximum benefit is substantial, and should not be underestimated.

Foundational Components

Foundational components of marketing and communications activities include:

- Establishing a brand.
- Constructing and maintaining a website.
- Setting up and maintaining a presence on social media.
- Developing a marketing and communications plan with accompanying strategies to achieve objectives.
- Developing and maintaining a catalogue of ready-to-use content and materials such as photos, copy, video, signage, brochures, testimonials, statistics, and good stories.
- Developing an e-newsletter template. Collecting and databasing email addresses of people interested in receiving emails containing news and updates of your organization's activities.[14]

[14] Per Canada's anti-spam legislation (CASL), organizations may only send marketing or promotional emails to people who have 'opted in' to receiving them. Furthermore, all marketing and promotional email must include a link that allows recipients to 'unsubscribe' from an email distribution list at any time. For more information visit https://fightspam.gc.ca/eic/site/030.nsf/eng/home

The Importance of a Brand

In very simplistic terms, a brand helps unify the collective experience and messaging of an enterprise, product, or service in the minds of the people who are exposed to it.

Where feasible and relevant, ASHMuskoka leverages all opportunities to brand its activities and reinforce the messaging and purpose of its operations through the exposure of its logo. This includes:

- Putting its logo on all printed material, advertising vehicles, display set-ups, and presentations.
- Including its logo on all signage at ash drives.
- Placing large stickers of the ASHMuskoka logo on all containers given to ash donors for ash collection and storage.

Objectives: Building an 'Army of Advocates'

ASHMuskoka's overriding marketing and communication objective is to 'build an army of advocates.' These are people who love the environment, love the trees, love the environment they live in, and want to contribute to improving the health and vitality of the ecological system around them. ASHMuskoka's success hinges on its ability to build and activate the passion of its 'army of advocates,' and to nurture the enthusiasm and engagement of these participants so that the momentum of the enterprise and its purpose can grow and reach more and more citizens.

For strategic execution purposes, ASHMuskoka breaks its overriding marketing and communication objective of building an 'army of advocates' into four component objectives:

- Acquiring new wood ash donors
- Educating and sustaining new and existing wood ash donors
- Encouraging citizens to volunteer
- Generating and nurturing community partnerships and goodwill

Acquiring New Wood Ash Donors

ASHMuskoka at the Gravenhurst Farmer's Market

Without ash donors, the program cannot succeed. The greater the number of ash donors who participate in donating their ash, the more ash is available for ASHMuskoka to remedy calcium-deprived forests.

In order to acquire new ash donors, ASHMuskoka's strategy is to 'tell our story as often as we can.'

The tone of ASHMuskoka's marketing and communication activities is typically educational in tone, with next to no persuasive tactics. The concept and purpose behind ASHMuskoka's activities – once people know about it – sells itself.

Educating and Sustaining New and Existing Wood Ash Donors

Once people have decided to participate in donating their ash, they need to know the following:

- Where to acquire an ASHMuskoka ash collection container.
- Wood ash do's and don'ts (see *Wood Ash Do's and Don'ts*, below).
- How to safely handle and store their ash (see *Safe Handling of Wood Ash*, below)
- Location and timing of ash drives for ash drop-off (see *Logistics/Wood Ash Collection Process/About Ash Drives*).

To keep donors interested and engaged in the program, and to encourage repeat ash donations, ASHMuskoka does the following:

- Offers prizes and giveaways at ash drives (see *Logistics/Wood Ash Collection Process/About Ash Drives/Donor Engagement).*
- Acknowledges ash donor contributions through e-newsletters and social media posts.
- Shares feedback on the success of the program through e-newsletters, social media posts, and other relevant communication vehicles.

Wood Ash Do's and Don'ts

Ash donors need to be informed of the following Do's and Don'ts:

- Do not allow ash to become wet. Its chemistry changes when it becomes wet. It may also interact with the metal if stored in a metal garbage can and become unusable as a forest soil amendment.
- Do not collect ash from:
    - Construction waste (pallets, demolition wood, etc.)
    - Pressure treated wood
    - Wood that may contain chemical preservatives, insecticides, glue, paint, stain
    - Wood containing nails, staples, or other metals
    - Plastic products of any kind
    - Metallic foil of any kind, including insulation
- Do not dump wood ash in any waterbody
- Do remove all nails, staples, and metal from wood before burning

Safe Handling of Wood Ash

- **FIRE HAZARD -** Wood ashes retain enough heat to re-ignite or ignite other combustible materials for several days. Uncooled ashes are a common cause of forest fire, and if not handled properly, can be a fire hazard for homes and property. It is important that wood ash is allowed to cool and that it contains no hot embers before it is stored and transported. Do not simply rely on visual inspection.
- **SKIN BURNS** - The alkalinity of wood ash is incredibly high when it becomes wet. Avoid direct contact with skin if ash is wet.
- **FLY ASH** - The fly ash component of wood ash is a fine particulate. If it is not handled carefully, or if suitable eye and breathing protection are not used, it could become airborne and pose a health risk.

In this social media post, ASHMuskoka donors are reminded to store their ash outside away from the house, and not on wooden patios.

Encouraging Citizens to Volunteer

In order to operate the ASHMuskoka program efficiently, volunteers are required to help with high demand activities. (see *Logistics/Infrastructure/Personnel*)

Although the best way to generate volunteer help is through word of mouth, ASHMuskoka includes volunteer sign-up information on many of its marketing and communications materials.

To encourage continued support from volunteers, ASHMuskoka sends a follow-up thank you email to volunteers who participated in an event or activity. Volunteers are also updated on program progress and success stories.

Generating and Nurturing Community Partnerships and Goodwill

Without the participation and support from its vast array of partners, the vision of ASHMuskoka's residential wood ash recycling program - and consequently the remedying of forests affected by acid rain - simply could not be realized.

ASHMuskoka works to grow its exposure and positive brand recognition. The more people know about ASHMuskoka's purpose and activities, the greater the equity and value it can offer – by association - to its partners (see *Partnerships*).

Motivators

In its short life, ASHMuskoka has touched and involved many people including local business owners, ash donors, university students, retirees, representatives from community organizations, scientists, local residents, and cottage owners.

Without exception, these individuals have all demonstrated genuine excitement in being given the opportunity – whether it be big or small - to do something positive for the environment. While supporters donate ash, time, services, and in some cases money towards ASHMuskoka activities, ASHMuskoka, in turn, provides them with a means to make a difference in restoring our (and their) environment to a healthier state.

ASHMuskoka staff engage with all of these committed individuals, and the collective energy and enthusiasm that is fostered through these interactions is uplifting, and highly motivating.

Strategies

Strategies for meeting one or more marketing and communications objectives include:

- Generating media coverage through press releases and outreach to media outlets.
- Setting up speaker engagements (cottage associations, conservancy groups, field naturalist groups, private woodlot associations, general interest groups, Ducks Unlimited, high schools, horticulture and garden clubs, Rotary, Lions Club, etc.).
- Having a presence at farmer's markets, and community events (i.e., Muskoka Earth Festival, Muskoka Maple Festival, Santa Claus Parade, etc.)
- Appealing to local businesses for promotional support (firewood suppliers, fireplace/wood stove stores, real estate agents (see also *Partnerships/Commercial Businesses and Not-For-Profits*).
- Collaborating and partnering with other community based not-for-profit organizations (Muskoka Discovery Centre, Dorset Heritage Museum, Abbey Gardens (see also *Partnerships/Commercial Businesses and Not-For-Profits*)

The activities of Friends of the Muskoka Watershed and ASHMuskoka have been featured by many local media platforms including newspaper, magazine, radio, and television.

What is 'Gardeners of The Forest'

'Gardeners of the Forest' is a metaphorical concept that ASHMuskoka uses in many of its educational and communications materials. It is a phrase that was coined by Dr. Norman Yan (see *About Dr. Norman Yan*) to help explain the relationship that citizens need to have with our present-day forests.

In ecological balance, nature takes care of itself. But the ecology of forests has been effected by human activity in the last century and some forests are out of balance.

Gardeners understand that the health of what is grown in a garden is dependent upon the conditions and nutrient availability in the garden soil. Soil nutrition is not infinite. If the stems, leaves, flowers, and fruit are not harvested (or removed), they are returned to the soil after the growing season when plants die. When farmers harvest their crops and crop nutrients are transported elsewhere for human or animal consumption, farmers know they must add fertilizer

or compost to their crop fields so that nutrients added back to the soil can enable the land to produce another cycle of healthy crops.

And so it now is with forests. If human activity removes calcium from forest soils through acid rain, humans must find a way to 'garden the forest' so that the nutrients the forest needs to produce oxygen, habitat, lumber, maple sap and ecological balance can be returned. Similarly, if humans remove forest nutrients through lumber harvesting (see *A Look to the Future/What's Next For Friends of the Muskoka Watershed and ASHMuskoka/Mentoring and Collaborating/Bioenergy*), we must actively 'garden the forest' to ensure the forest can reproduce itself.

The greater function of ASHMuskoka is to lead and empower fellow citizens to be 'Gardeners of the Forest.'

Logistics

The logistical operations of a wood ash recycling program similar in scale to ASHMuskoka involves:

- Ensuring an infrastructure of people, materials, physical space, and transportation are in place.
- Having a collection process set up to receive wood ash donations from participating residents.
- Engaging in quality control measures to ensure wood ash is safe to use and meets environmental compliance requirements.
- Preparing dispersal sites and ash quantities for ash dispersal activity.
- Having recordkeeping systems in place to meet environmental compliance requirements as well as monitor outcomes of ash dispersal on forest (tree) health.

From donor to dispersal site, wood ash must travel through several logistical 'waypoints' to reach calcium-deficient forest soil. Virtually all logistical aspects of ASHMuskoka's wood ash operations are manual in nature, and require human engagement (See also, *A Look to the Future/What's Next For Friends of the Muskoka Watershed and ASHMuskoka/Scaling Up Operations*).

Infrastructure

Personnel

The number of hired staff and volunteers required to operate a wood ash recycling program will naturally be dependent upon the scale of the operation that is being undertaken. Below are minimum requirements for a small-scale operation similar in scope to ASHMuskoka's operations.[15]

Full-time Staff

- Technical Operations Manager, or Program Director
    - Project management, materials, logistics, regulatory compliance, record keeping, accounting, building partnerships
- Community Engagement Liaison or Manager
    - Marketing and communications functions
    - Ash donor communications
    - Community outreach (business and public)

Volunteers and/or Summer Students

Labour requirements ebb and flow depending on the timing of certain activities. Not only are volunteers an excellent resource to use for high demand activities, they are often passionate advocates who will increase the amplitude and volume of energy behind the enterprise. As many as 10 or more volunteers are needed during high-demand activities.

High-demand activities include:

- Ash drives: ash intake, sifting, storage, ash donor engagement
- Ash dispersal: ash dosage preparation, ash dispersal

[15] Important Note: Several elements of the ASHMuskoka operation are handled by a four person subcommittee of the Friends of the Muskoka Watershed volunteer board. They include: grant acquisition and compliance, high-level project management, stakeholder and community partner relations, and public speaking. Additionally, Dr. Norman Yan (see *About Dr. Norman Yan*) serves on this subcommittee. Dr. Yan was the primary creator and driver behind the ASHMuskoka concept. He necessarily leverages his deep scientific knowledge, experience, and connections to the academic community so that scientific learning from ASHMuskoka activities can be optimized.

- Community outreach: presence at booths, farmer's markets, etc.

ASHMuskoka volunteers and staff at an ash drive

Materials

Containers for Wood Ash

Containers for wood ash are required for four distinct purposes:

- For ash donors to collect and store their ash prior to donating it.[16]
- For ash intake, processing, and sifting.
- For storage.
- For ash dosage and dispersal.

Containers for each purpose have different requirements.

Containers for Ash Donors

Several variables should be considered when acquiring or providing ash containers for ash donor use:

- Cost
- Safety (fire)
- Protection from moisture (lids)
- Weight and transportability

[16] To encourage participation, ASHMuskoka provides containers - at no charge - for potential donors to collect and store their ash.

ASHMuskoka offers two types of containers for ash donors to use: 75-litre galvanized garbage cans (with lids), and 11-litre plastic containers with lids (donated by a local ice cream establishment).

75- litre galvanized garbage can

11-litre plastic container

The galvanized garbage can with lid protects against potential fire, but when full with ash is heavy and requires two people to lift and load it into a truck-bed or car trunk. The 11-litre plastic containers are convenient and easier for a single person to manage. This is a particularly important feature given that many ash donors tend to be senior citizens. However, plastic is flammable and donors must pay particular care to ensure ash is cold before placing ash in this type of container.

Note – while galvanized steel protects from fire, it does not protect from heat if ash placed inside contains hot embers or coals.

It is important to note that galvanized steel is corrosion-resistant and not corrosion-proof. Under the right conditions, galvanized steel will develop white rust which will eventually become red rust. This will not only impact the integrity of the container, but will contaminate the ash and render it unusable (see *Logistics/ Ash Processing, Quality Control, and Testing/Unusable Ash*).

Volume and Shrinkage

At the outset, ASHMuskoka received hundreds of 11-litre plastic buckets from Momma Bear's Ice Cream & Sweets that would have otherwise gone into plastic recycling bins. Supply of this type of container has been abundant, and therefore shrinkage (unreturned containers) has not been a concern.

At the beginning of its operations, ASHMuskoka purchased 500 galvanized garbage cans. Naturally, a quantity of garbage cans being 'lost' from the 'system' was a probability. To mitigate this, barcoding and tracking of all garbage cans was considered; however, this course of action was ultimately abandoned due to

administrative load. To date, participation in the wood ash recycling program has been sufficient for ASHMuskoka to reach its wood ash targets. Supply and re-stocking of garbage cans has not been required.

Containers for Ash Sifting and Processing

Wood ash needs to be sifted for quality control and compliance purposes prior to being dispersed on forest soil (See *Logistics/Ash Processing, Quality Control, and Testing/Sifting*). ASHMuskoka uses poly box trucks to catch and hold ash as it goes through the sifter.

Poly box trucks are used to contain ash during ash processing

It is also convenient to dump pre-sifted ash into a poly box truck prior to it being sifted. This makes it easier to handle and shovel the ash over the sifter.

As a matter of convenience and efficiency, ASHMuskoka sifts and processes donated ash *as it comes in* on ash drive days. As such, it is helpful to have 1-2 additional poly box trucks on hand to manage the overflow of ash when the volume coming in exceeds processing speeds.

Containers for Ash Storage

When donors bring in their ash, the unprocessed ash is immediately dumped into a poly box truck for processing and the container that the donor used is returned to them.

Once the wood ash is sifted and processed, it is necessary to have containers to store the ash until it is ready to be dispersed on forest soil. The chemistry of wood ash changes and becomes unusable as a forest soil amendment when it gets wet and is stored in metal containers. Therefore, it is critical for storage containers to be sealable and waterproof.

55-gallon polyethylene drum with lid

ASHMuskoka stores and transports its processed ash in 55-gallon, sealable, polyethylene drums.

Containers for Ash Dispersal

5-gallon plastic container with lid

When wood ash is prepared for hand dispersal on forest soil, it needs to be contained in vessels that are easily transportable by a single person over forest terrain. Also, to assist in evenly distributing a dosage of ash across a given area, it is helpful if the containers used to prepare and disperse the ash dosage are uniform (see *Logistics/Wood Ash Dispersal/Dosage Preparation*).

For ash dispersal purposes, ASHMuskoka uses 5-gallon plastic buckets with lids and handles.

Industrial Weighing Scale

Wood ash must be weighed when it is dropped off at the transfer station on ash drive days. While this information is a requirement of the transfer station, it is also an important piece of data for operational planning and evaluation.

Industrial weighing scale

Wood ash must also be weighed when dosages are prepared for forest soil dispersion.

For weighing wood ash, ASHMuskoka uses an all-weather, low profile, industrial weighing scale.

Ash Sifter

For quality control purposes, wood ash needs to be sifted through .635 cm (quarter-inch) square metal mesh screening (See *Logistics/Ash Processing, Quality Control, and Testing/Sifting*). To expedite this process ASHMuskoka constructed a homemade device whereby mesh was nailed to the bottom of a wood frame. The wood frame construction includes a runner on the bottom front and back edge of the device, with grooves that comfortably fit over the edge of a poly box truck. These runners facilitate the back and forth sifting motion.

Handmade ash sifter being lifted to remove coarse char particles.

Handmade ash sifter being agitated over a poly box truck.

Power Magnet

A powerful magnet, also known as a 'Power Pick,' is required to retrieve any metal objects during ash processing.

Power magnet

Other Tools and Equipment

Other tools and equipment that are required for operational purposes include:

- Traffic cones for ash drives.
- Personal protective equipment (PPE) for ash processing and dispersal including N95 masks, goggles, paper hazmat suits, rubber gloves, safety vests.
- Shovels for ash processing.
- Scoops for ash dispersal.
- Dolly for moving ash storage barrels.
- Container or vessel for char (product of incomplete combustion) removed during ash processing.
- Container for metal objects removed during ash processing.
- Trail markers and stakes for ash dispersal site.

Scoop used for ash dispersal

Physical Space

Apart from dispersal sites, designated physical space is required for administrative and practical functions that include:

Administrative Office

ASHMuskoka uses office space donated by Friends of the Muskoka Watershed.

Container Pickup Location(s) for Potential Donors

One or more central and easily accessible locations are required for interested ash donors to pick up ash collecting containers.

Ash Collection and Processing Site

(see also *Logistics/Wood Ash Collection Process/ About Ash Drives*)

Operating an ash collection and processing site requires an ECA. Space at one or more transfer stations with appropriate permits can serve this function but requires input and permission from the municipality.

While ASHMuskoka has only been able to leverage the use of one ash drop off location (Rosewarne Transfer Station, Bracebridge), research undertaken by the University of Victoria on behalf of ASHMuskoka has shown that a significant determinant for community residents to participate in a wood ash recycling program is 'convenience.'[17] *The anecdotal experience of ASHMuskoka supports this research.*

It follows then, that multiple ash collection locations would help maximize the participation of residents in donating ash, thereby increasing the volume of ash that is collected.

Regulatory options can be pursued to expand the scope of an organization's ash collection ability and range. However, this is not an area that ASHMuskoka has engaged in to date.

Ash Storage Site

(see also *Logistics/Infrastructure/Ash Storage Considerations/)*

Storing wood ash collected from residents requires an ECA.

ASHMuskoka stores ash in two progressive locations.

Following ash intake and processing at the Rosewarne Transfer Station, ash is sealed in 55-gallon drums and temporarily stored on-site in a 20' x 8' shipping container donated by the municipality. This shipping container is also used for the storage of ash processing tools. The shipping container itself is surrounded by a secure fenced-in area where additional sealed waterproof drums of ash can be stored until transportation to a second, longer-term storage site can be arranged.

40-foot long shipping container

ASHMuskoka's longer-term storage site (with ECA) is located at Camp Big Canoe, Bracebridge. Processed drums of ash are stored in a 40' x 8' shipping container rented from the camp.

[17] '*Psychological Determinants of Participation in a Residential Wood Ash Recycling Program',* Leila Scannell, Robert Gifford, Norman Yan. Department of Psychology, University of Victoria, BC, Canada.

Ash Storage Considerations

Physical Requirements

At an average dry weight of 550 kg per m3, bulk storage of wood ash can be a challenge in terms of space and support.

- 1 tonne of filtered ash will occupy approximately 1.82 m3 (2.38 cubic yards).
- A 55-gallon drum is 0.2082 cubic metres (208.2 litres); therefore, 1 tonne of ash will fill approximately nine 55-gallon barrels.
- On average, a 55-gallon drum filled with ash weighs 115 kg (about 250 lbs).

If ash is not stored in sealed containers, keeping it dry and protected from excessive air currents is of paramount concern.

A shipping container filled with 55-gallon drums of ash

Regulatory Requirements

(See also Dispersal Site Planning)

Terms and conditions of an ECA may require that ash storage sites be:

- A minimum of 60 meters away from surface water (e.g., streams, rivers, watercourses, wetlands, lakes, etc.).

- A minimum of 250 meters away from 'sensitive use' areas, and/or residential areas.
- A minimum of 90 meters away from a single residence.
- A minimum of 30 meters away from a public roadway.

Storage On Private Property, Potential Issues

When considering a storage site location on private property, the following potential issues should be considered:

- Is road access to the property available year-round? i.e., is the road plowed in winter?
- Do activities on the property limit access in terms of timing (i.e., campers, rentals, other property uses)?
- Is the location of the storage site flexible and convenient relative to the dispersal site?
- Can ash be stored safely and securely, away from potentially combustible materials?

Transportation

Certified Waste Hauler

Transporting wood ash collected from residents requires either an ECA or Environmental Activity and Sector Registry (EASR) submission (see *EASR*, below). Therefore, unless an individual is transporting wood ash that they produced, transportation of collected wood ash must be handled by a certified waste management operator, or be conducted under an EASR registration.

Transportation of wood ash collected by ASHMuskoka is currently handled by Aces Waste Management (Muskoka) Ltd. as a donated service.

Sealed 55-gallon barrels of ash are manually loaded onto a roll-off box. Close to 20 barrels fit in one box. This does not conveniently, or completely fill the space within the box. Due to the angle of the roll-off box when it is loaded on and off the truck, the

Waste management truck with roll-off box.

barrels can shift within the container. This, combined with their weight, can potentially pop the lids off the barrels. To minimize the impact of barrels shifting, plastic construction drums are used to fill in gaps within the roll-off box.

EASR

EASR is an acronym for Environmental Activity and Sector Registry. It is a "public, web-based system that allows businesses conducting certain activities to register them with the ministry [MECP], rather than applying for an environmental approval."

With regard to the transportation of wood ash, ASHMuskoka investigated the regulatory option of registering on the EASR. This would have allowed ASHMuskoka to potentially expand ash donor collection to multiple locations, and transport ash to an ECA compliant storage facility using a truck and trailer. ASHMuskoka has not pursued this option because the scale of the operation (to date) has not required it.

For more information about the EASR, contact the MECP, or reference:

https://www.ontario.ca/page/environmental-registration
https://www.ontario.ca/page/environmental-activity-and-sector-registry

All-terrain Vehicle (ATV) With Trailer

Depending on the distance between the long-term ash storage location and the ash dispersal location, it makes sense to secure one or more ATVs with trailers to move small quantities of ash dosages to the designated dispersal site.

ATV's with trailers moving ash dosage containers to dispersal site.

Other

Other infrastructural things to consider include:

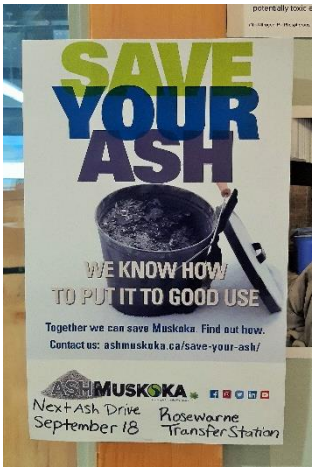
- Liability insurance
- Health and workplace safety training. More information on health and workplace safety can be found at *Workplace Safety and Insurance Board*, https://www.wsib.ca/en

Wood Ash Collection Process

About Ash Drives

(See also *Logistics/Infrastructure/Physical Space/ Ash Collection and Processing Site*)

The main vehicle for ash collection behind the ASHMuskoka wood ash recycling program is the set-up and execution of periodic 'ash drives.' Ash drives occur on specific days that are advertised to the community. Ash donors are invited to bring their residential wood ash to one or more specific locations for collection and processing.



ASHMuskoka promotional poster with ash drive notification.

An ash donor brings wood ash to the Rosewarne Transfer Station for drop-off.

Timing and Frequency

Ash drives can be held at any time of the year dependent upon transfer station availability and weather. For staff, volunteer, and ash donor safety, ash drives should not be conducted if the threat of lightning is present. It is also inadvisable to collect ash on rainy days as the potential for the ash to become compromised by moisture as it is being collected and processed is very high.

The ideal time to be collecting ash is during the fall and winter seasons when ash donors are heating their homes and producing more ash. For the sake of continuity and convenience, ASHMuskoka aims to run ash drives every month[18].

Ash Drive Set-Up

On ash drive days, ASHMuskoka personnel and volunteers arrive as soon as they are able to access the facility to set up a designated ash drop-off area with signage, traffic directing cones, and necessary processing equipment.

[18] Ash drives are cancelled during COVID-19 lockdowns.

In addition to signage, a portable canopy is set up at the drop-off area for ash donors to recognize the ash drop-off area from a distance.

Ash drive set-up at Rosewarne transfer station

Ash Intake Process

(See also *Logistics/Ash Processing, Quality Control, and Testing*)

When ash donors arrive, ASHMuskoka personnel and volunteers physically handle the containers that have been brought in containing wood ash. The containers are first brought over to an industrial weighing scale.

Wood ash must be weighed (see also *Logistics/Infrastructure/Materials/Industrial Weighing Scale*) when it is dropped off at the transfer station. This information is a requirement of the transfer station, but it is also an important piece of data for operational planning and evaluation.

The wood ash is weighed, and the weight is recorded along with:

- Vehicle licence plate
- Donor name
- Donor contact information (preferably email address)

Once the ash is weighed and visually checked for usability (see Logistics/*Ash Processing, Quality Control, and Testing/Unusable Ash*), it is dumped into a 'receiving' poly box truck and processed. A replacement container is given to the ash donor.

Ash Donor Engagement

Ash drives provide an invaluable opportunity to engage one-to-one with ash donors.

ASHMuskoka's philosophy is to make the ash drive experience fun and memorable. Ash donors are provided an opportunity to win gift certificates and donated prizes, and on special occasions,

all donors may receive a small giveaway such as candy canes at Christmastime, or cinnamon hearts on Valentine's Day. Personnel and volunteers may also wear costumes when ash drives are scheduled close to holidays.

An ASHMuskoka volunteer is dressed safely at the Canada Day-themed drive.

Personnel and Volunteer Safety

Personnel and volunteers working at ash drives need to be advised of basic safety requirements including the need to wear personal protective equipment (particularly when handling the ash), steel toe shoes, and fluorescent safety vests.

Personnel and volunteers need to be advised to exercise caution when receiving ash from donors. Despite efforts to educate ash donors on the safe handling of ash, on rare occasions ash may be delivered containing hot embers. This can render the collection container too hot to handle. Similarly, ash may contain sharp objects.

Ash Processing, Quality Control, and Testing

Following intake, all non-ash material must be removed from the ash.

ASHMuskoka typically collects 2-3 tonnes of unfiltered ash on ash drive days. It is ASHMuskoka's practice to do all 'quality control' and sifting of ash as it comes in on ash drive days. The goal is to get the ash processed and sealed as soon as possible (See *Lessons Learned: Ash Processing and Storage*, below).

All non-ash material is removed from the ash for two reasons: it is an ECA requirement, and foreign objects such as nails and screws pose a safety hazard.

Approximately 15% of ash weight coming in is unburnt wood (char), 85% of it is finely screened, useable ash.

Lessons Learned: Ash Processing and Storage

In the early days of ASHMuskoka's operations, containers of ash were received from donors, weighed, and then immediately stored on pallets under tarps and strapped down. If the container brought in was a plastic ice cream bucket, the ash was moved to an available garbage can. Ash sifting and processing occurred weeks (and sometimes months) later.

ASHMuskoka found this process was inefficient for several reasons. First, it required a larger volume of ash donor containers (garbage cans) to be in circulation. When ash donors dropped off a garbage can full of ash, the garbage can they brought in would be held by ASHMuskoka, and the ash donor would receive an empty replacement can. Second, the use of volunteer time was not optimized. Often ash drive volunteers were standing around with little to do during lulls in donor drop-off traffic. Although it is a messy job, sifting and processing the ash as it comes in keeps volunteers busy.

Storing garbage cans of unprocessed ash under tarps was problematic for other reasons. Although the garbage cans had lids on them, the ash was not 'sealed' and therefore the risk of a spill was greater. Furthermore, tarps degraded over time, and the risk of ash becoming compromised due to wetness and moisture increased.

Currently, ASHMuskoka processes all ash as it comes in on ash drive days, and then immediately stores it in sealable drums.

Unusable Ash

When ash is received, a visual quality control check is done before adding it to a large intake container (poly box truck) for processing. **Ash that has gotten wet, or that has been stored in a corroded metal container cannot be used and should be discarded.**

Ash stored in a corroded garbage can is unusable.

Ash stored in a galvanized garbage can that has gotten wet and become corroded.

When the galvanized coating on the inside of a garbage can gets wet for a period of time and airflow is restricted, the zinc chemistry changes, and a white ring of mobile zinc will move up the can where it was wet (referred to as 'wet storage stain'). This exposes the iron in the metal underneath and

the can rapidly rusts right through. If ash is stored in a wet or corroded garbage can, it may become contaminated with the metals from the garbage can. There is cadmium in the zinc, and it is very toxic.

Sifting

Non-ash materials are removed by sifting the ash through a .635 cm (quarter-inch) square metal mesh screen (see also *Logistics/Infrastructure/Materials/Ash Sifter*).

Ash is shoveled from an intake container (poly box truck) onto a sifter that is fitted on top of a large receiving container (poly box truck). The sifter is agitated to allow the fine particulate ash to fall through the screen.

Once the ash is screened, a power magnet is run through the char that remains on top of the sifter screen. [19]

Ash is shoveled over a handmade sifter resting on top of a poly box truck

Metal objects are removed during the ash sifting process

All metal objects and garbage are removed and appropriately discarded.

The remaining char is bagged and sent by permission to a local compost facility.20

Sifted ash is shovelled into sealable 55-gallon drums and stored until ready to use.

[19]Video content at these links demonstrate the ash sifting process:

https://www.instagram.com/p/CONDRHclhQD/

https://www.instagram.com/p/CPFtWanlzfk/

https://www.instagram.com/p/COPoJSMhyoR/

[20]Compost is typically acidic. The addition of char to compost should bring down its acidity.

Testing

ECAs require wood ash to be tested prior to its use as a forest soil amendment to ensure trace metal concentrations in the ash are within compliant ranges (see *Regulatory Considerations and Environmental Compliance Approvals (ECA)/ Residential Wood Ash (NIWA): Classification As 'Non-Agricultural Source Material' (NASM)/Trace Metal Thresholds*)

Additionally, ECA's require that the soil at the intended dispersal site be tested for trace elements to ensure that the additive values of the trace element in both the wood ash and the soil do not exceed the highest threshold (CM2).

Composite samples of substances such as wood ash and soil can be chemically tested[21] by commercial companies that perform these types of services.[22]

Wood Ash Dispersal

Trail Preparation, Markers, and Dispersal Site Signage

'Bush-whacking' over fallen logs, tree roots, and stones can be a challenge for any able-bodied individual, let alone a person or ATV transporting buckets of wood ash. Trail preparation using chain-saws on fallen, dead logs may be required depending on the terrain you are working on and the distance from storage site to dispersal site.

It is easy to become disoriented in a forest and lose your sense of direction. Trail markers ensure you and your volunteers do not get lost.

Per ECA requirements, the dispersal site should be clearly marked and easily identifiable.

An ASHMuskoka staff member measures and stakes out the perimeter of an ash dispersal site.

Dosage Preparation

[21] For more detailed information, refer to *Ontario Environmental Protections Act, regulation 347*
[22] For example, https://www.sgs.ca/en/our-company/about-sgs/sgs-in-brief

(See also *Logistics/Infrastructure/Materials/Containers for Wood Ash Dispersal*)

The prescribed dosage to remedy calcium-deprived forest soil is 2 metric tonnes per hectare.

One 5-gallon bucket holds approximately 10 kg of sifted, homogenized ash, therefore it takes 200 buckets of ash, at 10 kg each, to dose one hectare of forest.

Dispensing the required dosage of ash from the 55-gallon drums into smaller, uniform containers allows for easier mobility of the ash to the dispersal site, and helps manage uniform dispersal of the ash over the dispersal area.

A dosage of ash is prepared at Camp Big Canoe, Bracebridge.

Timing

The best time of year to apply wood ash to forest soil is late August to early November. Winter is a good time for the ash to get worked into the soil, and increases the availability of calcium for the following spring growing season.

Dispersing ash during the spring should be avoided due to ground thaw and a greater incidence of heavy rain. Late spring and early summer are inconvenient times to disperse ash because of black flies and mosquitoes.

Weather conditions and ECA restrictions significantly affect the timing of ash dispersal:

- Ash should not be dispersed over top of snow because snow migrates and can take the ash with it. For similar reasons, ash should not be dispersed on frozen ground, or ice.
- Ash should not be dispersed during periods of heavy rainfall, or on windy days.
- Ash should not be dispersed on ponded water, or on flooded or saturated areas, or on exposed bedrock.

Dispersal Process

To ensure even distribution of the ash dosage, it is helpful to stake out the perimeter of the dispersal area, and then divide the area into a grid pattern made up of equal, manageable parts. For example:

If a full hectare is being dosed at 2 tonnes per hectare, and ash dosage containers contain 10 kgs of ash, then the dispersal site should be sectioned off into 200 equal areas… one section per bucket of ash (see *Logistics/Wood Ash Dispersal/Dosage Preparation*).

It is ASHMuskoka's practice to place 1 bucket of ash in the top right corner of each section of the grid at the outset. This provides a visual sense of how much area each bucket of ash must cover. When spreading ash on a given area, the lid of the ash container is used to reference the starting point (top right corner of the grid section). While referencing the starting point of the working grid section, as well as neighboring sections, one spreads the ash from the ash container across the grid section as evenly as possible in one continuous layer.

Ash is spread using a scoop and is sprinkled on top of the forest floor (over top of fallen leaves, and branches).

Ash should be spread thinly and as evenly as possible.

Ash dosage containers are placed in a grid pattern over the dispersal site. A volunteer spreads ash over a section of the grid

A staff member spreads ash at a dispersal site located at a sugarbush

Recordkeeping, Monitoring, Measuring Results

The terms and conditions of an ECA will likely require detailed recordkeeping of the following:

- Wood ash metal and nutrient testing results.
- Metal and nutrient analyses of soil at dispersal site before ash application, and monitored at regular intervals for a few years after ash application.
- GPS coordinates of dispersal location.
- Application dosage and timing of dispersal.

While monitoring and measuring tree growth at the dispersal site may be required by an ECA, it is also a sound way to determine the success of the program.

Assessing Tree Growth

There are multiple ways in which to assess how trees in a forest are responding to a dosage of wood ash. They include measuring circumference of the tree trunk, taking photographs, collecting leaves at standing height and having them tested for calcium concentrations, and measuring the amount of sap that sugar maples yield in the spring (see details below).

How one chooses to assess tree growth is a subjective choice and depends on one's needs and objectives. However, in all cases, to optimally assess tree growth one should follow the BACI experimental design if possible.

BACI

BACI stands for before-after-control-impact. 'Before' and 'after' refer to the timing in which observations or measurements should be collected, and 'control' and 'impact' refer to the locations where observations or measurements should be collected. All four are required.

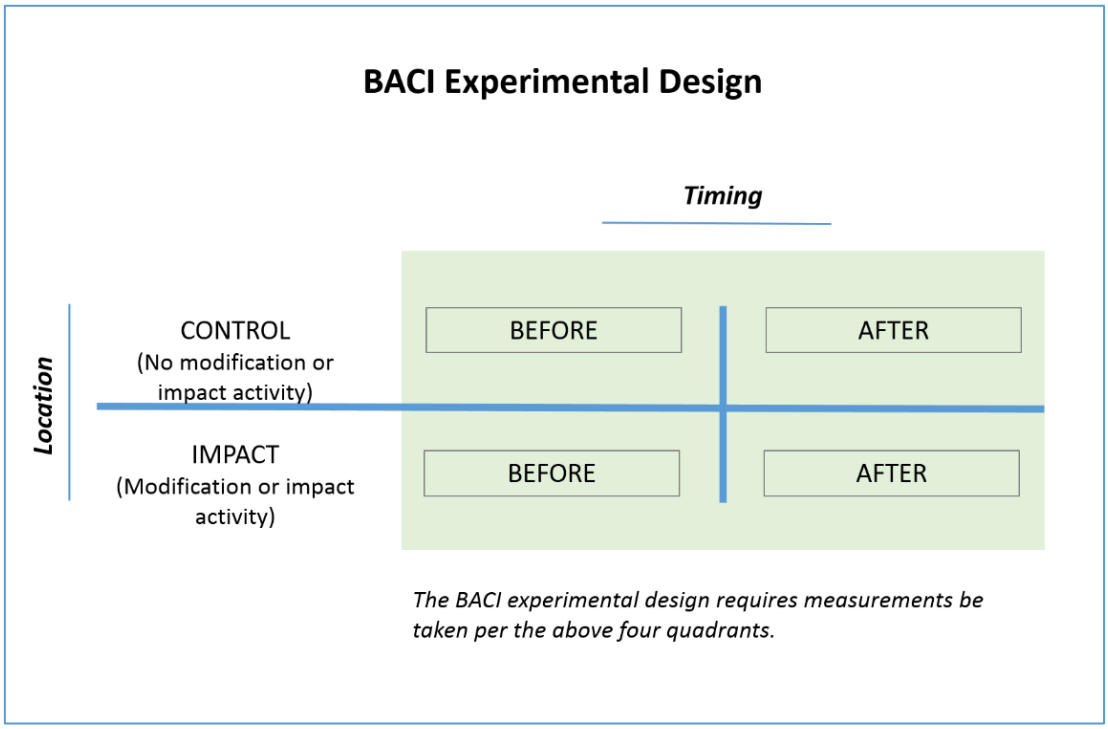
Before: measurements should be taken before an environmental modification (or cause of impact) has occurred. In this case, the measurement of study trees should occur before wood ash has been applied to the surrounding soil.

After: measurements should be taken after the environmental modification (or cause of impact) has occurred. In this case, measurements of study trees should be taken on an annual basis for several years. Measurements should be taken

consistently on roughly the same *day* of the year, and in some cases at the same *time* of day.

Control: measurements should be taken from study points that have not been exposed to the environmental modification or 'impact'. In this case, study trees should be chosen from outside the ash dispersal area, at a minimum distance of 10 metres and if possible upstream of groundwater flow.

Impact: measurements should be taken from study points that have been exposed to the environmental modification or 'impact.' In this case, the study trees should be located within the ash dispersal area.



In general, a handful of study trees should be chosen for each BACI requirement. At the outset, choose trees that are young but mature (e.g. about 1 to 2 feet in diameter) and reside on thin soil (less than 3 feet). Choose hardwood trees, and if possible include sugar maple trees. Ensure study trees are flagged or marked so that they will be recognized as time passes, and so that measurements for each tree can be tracked over time.

Circumference

The simplest way to assess tree growth is to measure the circumference of the tree trunk at 1.3 meters (about 4.5 feet) from the ground. This measure is referred to as DBH (diameter at breast height), and the only tool required to do this is a good quality metric measuring tape.

A tree fitted with a dendrometer

For this method of assessment, it is best to take measurements at a point in the summer following the spring growing period and to mark the height on the tree for the measurement. It is critical that the tape be wrapped fully horizontally around the tree, and taking the measurement a few times to ensure accuracy is a good idea.

More refined measures of diameter can be achieved by fixing a dendrometer to the study tree. Dendrometers are instruments typically used by forestry professionals and scientists.

Photographs

Taking a photograph looking up into the tree canopy from a point on the ground provides excellent 'data' for comparing the growth and density of the canopy over time. A healthier canopy will have more foliage and less visible sky.

Photos should be taken on the same day of the year, and at the same time during the day. Summer, or spring when leaves are fully out is the optimal time to assess the growth of tree canopy using photographs.

Leaf Chemistry

Taking leaves from saplings or mature trees in the summer and having them tested for calcium concentration levels (by a commercial lab), is another way to determine whether trees are benefitting from the addition of wood ash on soil.

Studies supported by ASHMuskoka have shown a 100% increase in the calcium levels of leaves from sugar maple saplings after ash addition.

Sap Flow

Measuring the amount of sap that a sugar maple tree yields during springtime is an excellent indicator of tree health and potential growth. Preliminary findings from

Apparatus taking sap from a sugar maple for sap flow assessment.

ASHMuskoka and our Trent University partners indicate dramatic increases in sap flow in sugar maple the year after ash additions.

Community and Partner Feedback

To refine operations, respond to concerns, and share information on the progress of the program, ASHMuskoka has a formalized advisory board that meets annually. The advisory board includes members of the community, local government, interest groups such as cottage associations, the media, and the science community.

ASHMuskoka's advisory board has provided an invaluable connection to the community. It has resulted in increased levels of engagement, and helped ensure the program is successful.

A Look to the Future

The work to help our forests and watersheds in Ontario recover from acid rain has only just begun. Thousands of hectares of forest are calcium-deprived and need help to become strong and healthy. And, now more than ever, we need our forests to be healthy so that they can help our planet mitigate climate change.

Friends of the Muskoka Watershed initially launched the ASHMuskoka project as a small-scale science and social experiment. With the help of a wide range of committed and engaged partners, we now have a nucleus of citizens regularly donating their wood ash to help solve an environmental problem.

So, where do we go from here?

What's Next for Friends of the Muskoka Watershed and ASHMuskoka

Charitable Status

OTF Funding for ASHMuskoka will expire in 2022. Friends of the Muskoka Watershed is actively pursuing grants and government funding to continue the exploratory work that has been done by the ASHMuskoka team, as well as enable the organization to scale up its operations. We are awaiting disclosure regarding our application for charitable status. Should charitable status be granted, we will mobilize a team to approach private investors for support.

Scaling Up Operations

Scaling up the operations of our residential wood ash recycling program would allow ASHMuskoka to reap a larger proportion of available residential wood ash, and in turn remedy larger swaths of calcium-depleted forests.

Notwithstanding existing administrative rigor with regard to acquiring regulatory approvals, immediate areas for operational development include:

- Developing the means and infrastructure to offer multiple ash drop-off locations for ash donors.
- Expanding ash processing to include ash pelletization (see *What Is Ash Pelletization* below).

- Reducing the manual labour involved in dispersing wood ash at forest sites by investigating dispersal via helicopter and/or modified manure spreaders. Note: both dispersal methods require ash to be in pellet form.

What is Pelletization?

Pelletization is a process whereby fine particles are rolled and shaped into uniform pellets with the help of a binding agent.

The Benefits of Pelletizing Ash

- Pelletization reduces the risk of breathing in fine particulates of wood ash.
- It allows for more mechanized distribution (can fall from the air via helicopter, or can be mechanically sprayed).
- Pelletized ash can be bagged more easily.
- It can correct for any nutrient deficiencies in the ash being pelletized, or in the soil it is being added to, through the pellet binding agent. For example, it can lower the pH of the ash a little bit, or add nitrogen in dispersal areas not effected by acid rain.

Mentoring and Collaborating

It is the aim of the FOTMW to support the momentum and development of using wood ash as a forest soil amendment through shared learning.

The FOTMW and its ASHMuskoka team will continue to collaborate with government, policymakers, the science community, private businesses, and citizen interest groups to foster education and encourage other organizations to activate their own means to collect and recycle residential wood ash for the purposes of remedying or sustaining the health of our natural environment.

Bioenergy

Industry around the globe has been mobilizing toward creating and generating more environmentally sustainable forms of energy. Returning nutrients from

unused biomass ((branches, leaves, etc.) in the form of wood ash is becoming a commonplace part of the logging process in some parts of the world (*see Reference and Resource Material/International Resources*). ASHMuskoka is collaborating with forest industry stewards to help foster and support the momentum of this practice in Ontario with the hope that it will drive further development of bioenergy technology.

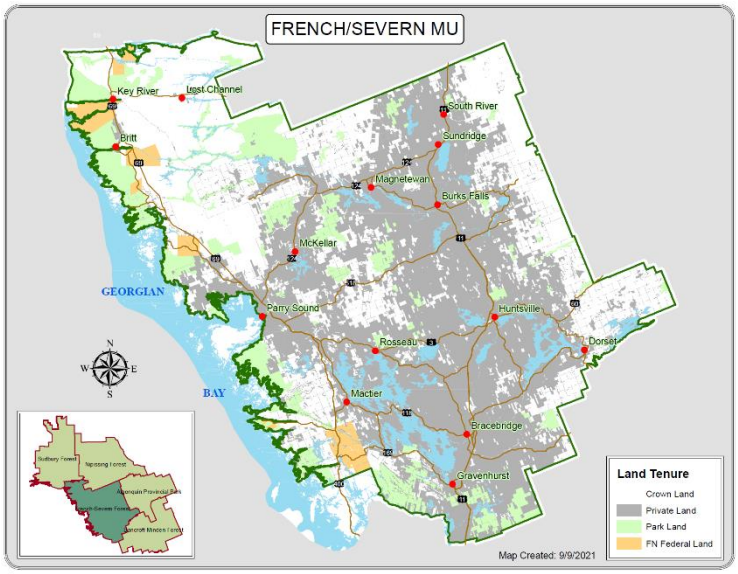
Enabling and Mobilizing Citizen Participation

Should a private landowner wish to use wood ash as a forest soil amendment on their own property, it is likely beyond their means and motivation to:

- collect wood ash from others
- ensure the wood ash is safe from contaminants
- identify areas of their property that suffer from calcium deficiency
- know how much ash is needed to remedy calcium decline on their property
- know how to safely and correctly disperse wood ash on their property

A significant proportion of land in Muskoka is privately owned. In order to expand forest soil recovery from calcium decline as broadly as possible, it is the vision of ASHMuskoka to enable private landowners to disperse wood ash on their own properties, safely and effectively.

ASHMuskoka would continue to collect wood ash from residents and process it for quality control purposes. The wood ash would be tested and pelletized, and then made available to private landowners - along with counsel and guidance – for dispersal on their own properties.



Map of crown vs private land in the French/Severn Forest management area (MU). Map provided by Westwind Forest Stewardship

Citizen Science

Enabling and mobilizing citizens to participate in remediating calcium-depleted soil on their own properties with wood ash would go a long way in solving a greater environmental problem. An extension of that vision is to encourage those same citizens to engage in simple scientific activities and share the data they collect with ASHMuskoka, and by extension, the scientific community. For example, if participating citizens performed tree growth assessments (see *Logistics/Recordkeeping, Monitoring, Measuring Results/Assessing Tree Growth*) or soil pH analysis on their property, the amount of information about the performance of wood ash on forest soils would expand dramatically. This information could be used by ASHMuskoka (and by extension the scientific community) to refine the direction and effectiveness of the ASHMuskoka program.

Teaching the Kids

With substantive assistance from the Muskoka Steamships and Discovery Centre, a curriculum pertaining to the nature, cause, and impacts of calcium decline on forest soils and watersheds has been developed for school groups.

With continued support from the Muskoka Steamships and Discovery Centre, and with the support of Camp Big Canoe, it is the vision of ASHMuskoka to develop the wood ash study site at Camp Big Canoe into an outdoor educational opportunity for schools, camps, and educators.

Friends of the Muskoka Watershed Support

Staff and board members at *Friends of the Muskoka Watershed* and *ASHMuskoka* are available to answer questions about the content of this report.

Mentoring, educational support, and speaker opportunities with Dr. Norman Yan, Dr. Neil Hutchinson, and Gord Miller, are also available upon request.

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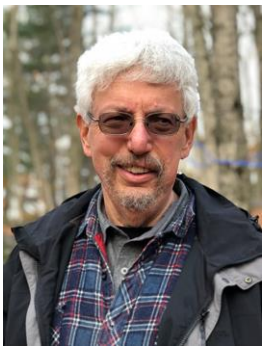
About Dr. Norman Yan, Ph.D, FRSC



Dr. Norman Yan is the driving visionary behind the ASHMuskoka Project.

Dr. Norman Yan completed his MSc and PhD dissertations on the effects of acid rain and metal pollution on Ontario lakes, then worked as a research scientist with the Ontario Ministry of the Environment for 25 years. In 2000, he negotiated a 5-year partnership between the MOE and York University, accepting a position as Professor in York's Biology Department, and conducting a body of research on the effects of multiple stressors on Ontario Lakes co-developed by Yan and collaborating government scientists. Given its success, this partnership was renewed twice, until Norman's retirement in 2014. During this period, Norman taught in Toronto, but conducted most of his research in Muskoka.

Norman has co-authored over 200 publications on Canadian lakes, a body of work that is widely recognized. He is one of only a few Canadians to receive both the K. Patalas award for research excellence in applied limnology (the study of lakes), and the F.H. Rigler Memorial Award from the Society of Canadian Limnology for his contributions to fundamental understanding in limnology. Dr. Yan received a Premier's Research Excellence Award from the Ontario government, and has received visiting fellowships from the Australian and Italian governments. For his contributions to the understanding and wise management of Canadian lakes, he was inducted as a Fellow by the Royal Society of Canada in 2014.

Glossary and Acronyms

BUC	Biosolids Utilization Committee The BUC is a multi-stakeholder, inter-ministerial committee. It advises and makes recommendations to the MECP and OMAFRA on matters related to the utilization of biosolids (pulp and paper biosolids, sewage biosolids, etc) and other materials that are not from an agricultural source, and are intended to be added to land as a nutrient additive.
CASL	Canada's anti-spam legislation https://fightspam.gc.ca/eic/site/030.nsf/eng/home
EASR	Environmental Activity and Sector Registry "a public, web-based system that allows businesses conducting certain activities to register them with the ministry [MECP], rather than applying for an environmental approval." https://www.ontario.ca/page/environmental-registration *See also:* https://www.ontario.ca/page/environmental-activity-and-sector-registry
ECA	Environmental Compliance Approval
Dendrometer	An instrument used to precisely measure the growth of tree trunks.
DBH	Diameter at breast height A standard measure used over a period of time to determine the growth rate of a tree.
DESC	Dorset Environmental Science Centre
DMM	District Municipality of Muskoka
Ecological Osteoporosis	A term devised by Dr. Norman Yan to describe the impact on biota in our watershed from calcium erosion in soils and watersheds due to acid rain. Similar to the osteoporosis or 'brittle bones' in humans often due to calcium deficiency.
FOTMW, FMW	Friends of the Muskoka Watershed
GIS	Geographic Information System A geographic information system connects location data with descriptive information, and displays it in visual map form. Examples of descriptive information include watersheds, topography, roads, dwellings, among other things. See *Reference and Resource Material* for a link to GIS mapping data for the District Municipality of Muskoka.
HATSEO	Hauling Ash To Solve Ecological Osteoporosis Precursor to the ASHMuskoka project
MECP	Ministry of the Environment, Conservation and Parks (Ontario) Formerly known as:

	• Ministry of the Environment & Climate Change (MECC), 2014 – 2018 • Ministry of the Environment & Energy (MOEE) 1993 – 1997 • Ministry of the Environment (MOE) 1972 – 1993
NASM	Non-agricultural source material
NIWA	Non-industrial wood ash
OMAFRA	(Ontario) Ministry of Agriculture, Food and Rural Affairs
OTF	Ontario Trillium Foundation
PPE	Personal protective equipment
Sensitive Use	Commercial, recreational, or institutional uses, and locations where people regularly congregate (i.e., parks, sports fields, recreational areas).

Reference and Resource Material

Acid Rain

- Description of acid rain and its impact in Canada:
  https://www.ec.gc.ca/air/default.asp?lang=En&n=7E5E9F00-1#ws0EF0FB73

ASHMuskoka

- https://ashmuskoka.ca/

Bioenergy

- Bioenergy in Canada:

  https://www.nrcan.gc.ca/our-natural-resources/energy-sources-distribution/renewable-energy/bioenergy-systems/7311

Calcium Decline in Forest Soils and Watersheds Due to Acid Rain

- *Could a residential wood ash recycling programme be part of the solution to calcium decline in lakes and forests in Muskoka (Ontario, Canada)?* Azan, Yan, Celis-Salgado, Arnott, Rusak, Sutey. FACETS, 2019

  https://www.facetsjournal.com/doi/full/10.1139/facets-2018-0026

- *Report: Is Residential Wood Ash Safe for Use to Help Solve the Calcium Decline Problem in Muskoka?* Azan, Shakira. FOTMW, 2018

  https://fotmw.org/2021/05/report-is-residential-wood-ash-safe-for-use-to-help-solve-the-calcium-decline-problem-in-muskoka/

- *Healthy Forests, Healthy Ecosystem,* Challis, John. Unique Muskoka, August 2021

  https://simplebooklet.com/uniquemuskokaissue30august2021#page=51

- AshNet Resources (Canada)

  https://www.nrcan.gc.ca/science-data/research-centres-labs/forestry-research-centres/great-lakes-forestry-centre/ashnet/20279

Dorset Environmental Science Centre

- https://desc.ca/

Environmental Activity and Sector Registry (EASR)

- Ministry of The Environment, Conservation and Parks

  https://www.ontario.ca/page/environmental-registration

  https://www.ontario.ca/page/environmental-activity-and-sector-registry

Environmental Compliance Approvals (ECAs) and How to Apply (Ontario)

- Ministry of The Environment, Conservation and Parks

  https://www.ontario.ca/page/environmental-permissions

Friends of the Muskoka Watershed

- https://fotmw.org/

GIS Map Data, District Municipality of Muskoka

- GIS data, maps, and applications

  https://map.muskoka.on.ca/

International Resources

- The Swedish Forest Agency

  https://www.skogsstyrelsen.se/en/

Muskoka Steamships and Discovery Centre

- https://realmuskoka.com/discovery-centre/

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Hart Lake at Camp Big Canoe, Bracebridge. Camp Big Canoe is the site of ASHMuskoka's most recent ash dispersal study area.

This document was written on behalf of Friends of the Muskoka Watershed by Kathy Corcoran