Open Burning Emissions Reduction Study
Report on Mapping, Yard Waste BMP, and Technical Appendix
Cowichan Valley Regional District, BC

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June 30, 2017

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Executive Summary

This Final Report on Open Burning Emissions Reduction integrated revisions from Phase I & II, included additional material requests made by CVRD, expands upon the results achieved so far, and delivers additional analysis and interpretation content which informs the study Conclusions that:

- Electoral Areas B, F, E and A (in descending order of volume) will likely generate the most land clearing debris on an annual basis under the current OCP implementation over the next 30 years.
- An approach which uses standard waste composition tables for estimating future yard waste production was determined to be not applicable to the CVRD Electoral areas and was not used in this study.
- Factors contributing to participation in recycling programs concluded that participation was weakly correlated with cost or convenience;
- Open burning complaint calls primarily originated from established rural areas such as Sahtlam, Glenora, and South Cowichan;
- Curbside yard waste pick-up, chipping programs, drop-off yards and facilitating backyard composting were the most common, and reportedly successful, BMP to reduce open burning of yard waste.

From which, and based on other evidence provided in this study, the following recommendations are made:

- I recommend that CVRD consider a chipping, splitting or other land clearing debris disposal requirement for development permits issued in Electoral Areas B, F, E and A.
- I recommend that CVRD consider facilitating an on-site land clearing debris recycling program whereby rural properties and farm operators can access a supported mobile chipping/shredding program.
- An engagement and facilitation campaign to increase the diverted proportion of yard waste to organic recycling facilities would be prudent.
- I recommend communication, engagement and facilitation of backyard composting, as supported by BMP reviewed within this study.

- I recommend CVRD conduct a detailed financial analysis of a very limited curbside collection of yard waste for Electoral Areas which currently receive waste-disposal services.

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Cowichan Valley Regional District, BC

1 Introduction

This document presents the results of the Open Burning Emissions Reduction Study (OBERS) commissioned by the Cowichan Valley Regional District (CVRD). This initiative is a response to Action 25 (Tighten burning regulations) and Action 27 (Make smoke management a strategy) in the BC Air Action Plan (2008).

The OBERS purpose is to develop metrics that will identify opportunities to reduce open burning emissions from land clearing debris and backyard burning with CVRD Electoral Areas. To develop the metrics, this study will:

- Assess production factors of land clearing debris & yard waste;
- Assess motivating and impact factors of backyard burning;
- Estimate volumes generated by land clearing debris & yard waste;
- Integrate quantitative & socioeconomic factors contributing to land clearing debris and yard waste 'hotspots';
- Identify current backyard burning, land clearing debris and yard waste management practices amongst similar composition areas elsewhere in BC;
- Resolve potential solutions, based on the above information, for managing land clearing debris as well as yard and garden waste;

The goals of OBERS is to inform decision makers within CVRD about current and projected open burning activities, the related generation of land clearing debris and yard waste, assess the implications for air quality, and to evaluate the regulatory and provision-

of-service options to mitigate or reduce open burning emissions within the 9 electoral areas. This final report presents the following components:

- GIS maps and data
- Review of comparable Yard Waste Management Practices
- Ranking of BMPs suitable for CVRD Yard Waste management
- A mapping of 'ideal' BMPs for electoral areas of the study area
- Evaluation of Curbside Collection of yard waste as a management practice for the electoral areas
- First-Order financial assessment of curbside collection
- Technical appendix

1.1 Mapping Yard Waste

A critical component of the OBERS is evaluating location and composition of open burning activities. Currently, bylaws exist that allow open burning during climatic windows for yard waste and when using air curtain burners to dispose of land clearing debris. Open burning is further increased by a propensity for citizens to not transport their yard waste, and/or the limited availability to transport land clearing debris[1], to organic matter recycling facilities. As such, it is important for the study area to be delineated and assessed for potential to: generate land clearing debris or yard waste, and to otherwise encourage excessive or offensive open burning. These concepts are defined as follows.

1.1.1 The Study Area

The CVRD comprises 9 electoral areas, and encompass a total area of approximately 327,000 hectares. For this project, we narrowed down the study area to specific parcels based on land use, zoning, official community plan (OCP) designations and CVRD backyard burning restrictions. Municipalities and towns were excluded from the study (North Cowichan, Town of Ladysmith, City of Duncan, and the Village of Lake Cowichan).

[1] It should be noted that only some regional organic matter recycling facilities accept Land Clearing Debris, such as Central Landscape Supply in Cobble Hill and Coast Environmental in Chemainus, in part due to the specialty equipment required to break-down larger components (e.g. stump splitters) prior to processing and compost.

1.1.2 Land Clearing Debris

This section discusses the estimated volumes of debris that would result from land clearing. The potential for land clearing debris generation within the study area was determined through land cover classification, estimates of residue and waste volumes for young and mature forest clearing, estimated percentage of a parcel that would likely be cleared based on zoning.

1.1.3 Development Pressure Index

An assessment of factors influencing development of land-parcels within the study area identified and ranked areas that are likely to undergo land clearing activities. The resulting Development Pressure Index (DPI) was developed through the analysis of BC Assessment data, using indicators including property value increase, subdivision and changes land use changes.

1.1.4 Yard Waste

Yard waste volume potential calculations were approached in two ways: (1) extrapolating from waste composition studies on a per-capita/per-household basis; and (2) developing an area-based production model. Total organic waste collected in 2016 by the organic matter recycling facilities in the CVRD was utilized as a benchmark for comparison (8,026 tonnes), keeping in mind that this represents a mixture of yard waste and land clearing debris.

1.1.5 Air Quality and Critical Burning Hotspots

Areas identified within an air quality and smoke accumulation index considered particulate matter accumulation areas, proximity to organic recycling depots, air quality and venting indices, as well as burning bylaw offences. From which, a relative index designed to identify critical burning hotspots was created by rolling up the main data analysis results:

- Predicted Land Clearing Volumes;
- Yard Waste Potential;
- Development Pressure Index (DPI); and
- Air Quality and Smoke Accumulation Index;

1.1.5.1 Background Information on Air Quality

In 2015, the CVRD commissioned a study on air quality (CVRD 2015). One of the objectives of the study was to find ways to reduce particulate matter ($PM_{2.5}$) emissions from local open burning resulting from land clearing and backyard burning. The justification for reducing particulate matter is due to the impact of PM on human health, and the health of the environment.

A threshold of 25 (ug/m^3)[1] over a 24 hour period, or an annual average threshold of 8 (ug/m^3) (micrograms per cubic metre) has been established by the provincial government (AAQO) to determine safe and unsafe levels of PM. However, health impacts have been found even at low concentrations, indicating that there may be no safe level of air contaminants such as $PM_{2.5}$ (CVRD 2015). Particulate matter can be categorized by diameter into inhalable (PM_{10}) and respirable ($PM_{2.5}$). The CVRD report states that 77% of the $PM_{2.5}$ in the region is coming from local sources, and that open burning accounts for 53% of the total $PM_{2.5}$ and wood burning appliances account for 23% of the total $PM_{2.5}$.

1.2 Best Management Practices (BMP) Evaluation

This section inventories and reviews yard waste and open burning management practices of various comparable districts within B.C. The assessment of management practices is focused on evaluating suitability and feasibility based on demographics, waste volumes and population distribution within CVRD Electoral Areas. A financial assessment of a curbside collection program is evaluated.

1.2.1 Review and Ranking of Yard Waste Management Practices

Similar jurisdictions, mainly in BC were examined by property demographics and their yard waste management practices. Following the examination, they were ranked for suitability with the CVRD based on rural to urban land area ratios.

1.2.2 Review of Open Burning BMPs

Open burning reduction strategies generally consist of yard waste management programs and burning regulations. It has already been established that open burning from land clearing contributes particulate matter to the airshed from previous air quality studies[2], in addition to which, there is the inherent increased risk for forest fires to open burning. In

[2] Measuring BC's Air Quality: http://www2.gov.bc.ca/assets/gov/environment/research-monitoring-and-reporting/reporting/envreportbc/content/air_infographic.pdf (Accessed June 2017)

this section, we review programs for open burning reduction, open burning bylaws, and assess the potential to rank open burning forest fire risk based on geospatial data developed in this OBERS program.

1.2.3 First Order Financial Assessment of Curbside Yard Waste Collection

The first order financial assessment of yard waste curbside collection provides two approaches to a first-order financial assessment of implementing curbside collection. Firstly, the operational cost of trucking and surface transport in Canada[3] on a per-kilometer basis is used to estimate cost of operating nine months of the year. Secondly, a per-household estimate of cost is adapted from a neighbouring district to estimate cost of yard waste collection for nine months of the year.

2 Methodology

Hereafter we detail the specific approach, data sources, analysis and assumptions which comprise our Land Clearing Debris mapping, Development Pressure Index, Yard Waste Mapping, and Critical Burning Hotspot identification.

Later in this section we detail the comparative evaluation of Best Management Practices and approach to first-order financial assessment.

2.1 Property Yard Waste Mapping

2.1.1 Definition of Study Area

Areas were included in the study according to the following zoning or OCP designations:

Zoning	OCP
• Commercial • Industrial • Mixed Use • Residential	• Commercial • Comprehensive Development • Future Development Area • Industrial • Mixed Use • Residential

As requested by the CVRD, current or future-intended land uses were excluded as follows:

[3] Barton Associated Ltd., Logistics Solution Builders Inc., The Research and Traffic Group. 2008. Operating Costs of Trucking and Surface Intermodal Transportation In Canada.

Land Use	CVRD reasoning for non-inclusion
Agricultural	No ability to regulate
Crown	No ability to regulate
Forestry	No ability to regulate
Institutional	Beyond scope
Parks	Beyond scope
Transportation	Beyond scope
Utilities	Beyond scope

2.1.1.1 Exception and Refinement Handling

Exceptions to this definition scheme were parcels currently zoned for one of the excluded land uses that were located within an approved OCP designated area. For example, land zoned for forestry within a residential OCP area was included in the study area as it is expected to be re-zoned and developed for residential use in the future. Parcels zoned for transportation/utilities/water were removed from the study area regardless of OCP designation.

The *Smoke Control Regulation Bylaw* (CVRD Bylaw No. 3716) further restricted the study area by requiring backyard burning to be kept a minimum of 10m from all property boundaries within electoral areas A, B, C, D and E. Assuming an average burn pile diameter of 1m, a parcel must therefore be at least 21m by 21m for burning to be permitted. To identify which parcels met this criterion, an interior buffer of 10.5m was produced from parcel boundaries within electoral areas A to E (using ArcMap 10.4). Polygons were then created representing any remaining interior area at the centre of each parcel. Only parcels that contained an interior polygon were included in the final study area. Parcels with no interior area (after applying buffers) were eliminating from the study area for open burning, but not when evaluating potential yard waste generated or curbside collection.

Some additional refinements were made by excluding riparian areas within parcels throughout the CVRD. Streamside and lakeshore areas within the CVRD are protected from vegetation clearing under the Provincial *Riparian Areas Regulation*. The study area was further refined by extracting a riparian buffer around streams and lakes. An average buffer of 15m was applied to all of the streams and lakes, and an additional 30m buffer was applied to larger streams such as the Cowichan and Koksilah Rivers.

2.1.2 Land Clearing Debris Potential

2.1.2.1 Land Cover Classification

Land cover within the study area was classified using Landsat 8 imagery. Three broad vegetation classes were used: Mature Forest, Young Forest and Shrub, and Herbaceous (lawns fields and meadows). Other land cover classes were created to capture non-vegetated and sparsely-vegetated areas: Bare Ground, Impervious Surfaces, and Water.

Imagery

QGIS software[4] was used to download the imagery and perform the supervised image classification (described below). Landsat 8 imagery was selected using the following criteria:

- Full coverage of the study area
- Little to no cloud cover
- Taken during the growing season
- As recent as possible

Acquired image information:

- Image ID - LC80480262016127LGN00;
- date and time: May 6th, 2016 at 19:06;
- path 48;
- row 26;
- Combined Operational Land Imager (OLI) and Thermal Infrared Sensor (TIRS);
- cloud cover: 0%;
- OLI Multispectral Spatial Resolution: 30m;
- TIRS Spatial Resolution: 100m, resampled to 30m;
- Cubic Convolution resampling;
- 16-bit pixel values

Base Imagery Limitations

Ideally, the selected imagery would have been captured with a high sun angle to limit shadow length; however the imagery that met the previous requirements was taken during

[4] Downloaded from: http://www.qgis.org/en/site/, using Version 2.18.9 Las Palmas.

the evening. Furthermore, the spatial resolution was resolved at 30m, which would limit some aspects of geospatial data analysis.

Preprocessing and Data Grooming

Preprocessing the imagery involved pan-sharpening and atmospheric correction. Landsat 8 bands 1 through 7 were used in the classification, which have a spatial resolution of 30m. However, using the USGS cited Landsat pan-sharpening method[5] the spatial resolution was improved to 15m (measured as cell width).

Classification

Supervised classification involved the creation of "training" polygons using the region growing algorithm tool, which ensured each training polygon contained spectrally similar cells. The "Minimum Distance" classification algorithm appeared to produce the most accurate and finest resolution result (as compared to the "Maximum Likelihood" and "Spectral Angle" algorithms).

As expected, there was some spectral overlap between similar cover classes (e.g. Young Forest – Mature Forest, and Herbaceous – Young Forest), resulting is some incorrectly classified cells. Training input was iteratively improved to limit these errors, and to err on the side of greater debris production. That is, it was preferred to incorrectly classify herbaceous land cover as young forest, and young forest as old forest, rather than the other way around.

Emphasis was placed on ensuring that classification results provided a reasonably accurate representation of vegetation cover in the study area. The accuracy of the classification was assessed visually by comparing the classification result to high resolution orthophotos.

2.1.2.2 Predicting Land Clearing Debris Volumes

Land clearing debris is the organic material or woody debris left over after a forest is cleared and the merchantable timber has been removed.

In the event of a proposed development, it is assumed that any merchantable lumber will first be removed. For mature forests, it is estimated that the residual amount of land clearing debris post logging will be about 143 m^3/ha (Carissa Logue, Timber Cruising and Waste Specialist, Forests, Lands and Natural Resource Operations – *pers. comm.*).

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[5] Discussion: https://landsat.usgs.gov/panchromatic-image-sharpening-landsat-7-etm

Method: http://www.arcgis.com/home/item.html?id=c34fd380d16f40a7bb7995ac4d7ab8de

For young forests (<40 years), it is assumed that no merchantable timber would be present, so the volume of land clearing debris includes the entire forest. We acknowledge that some forests less than 40 years old do contain merchantable timber; however, the amount is generally low and varies greatly depending on the site and species. For the purpose of this study, it was preferred to potentially overestimate rather than underestimate debris volumes. The average volume of land clearing debris for young forest was based on reported volume estimates for four types of young forest, including Douglas-fir with a secondary component of western hemlock, and Douglas-fir with a deciduous component (BC Ministry of Forests, 1995). These reported volumes resulted in an average of 28.25 m^3 per hectare, which was used as the young forest clearing debris volume in this study.

Land Clearing Debris and Forest Classification

The estimated volumes of woody debris from mature and young forest (143m^3/ha and 28.25 m^3/ha respectively) were multiplied by the number of hectares of mature and young forest in each parcel, resulting in the predicted land clearing debris volumes for parcels classified as forest.

Land Clearing Debris and Build-Out Status

Land clearing debris volume estimates were categorized by build-out status, as parcels that have likely been subdivided to their fullest extent are less likely to produce any further land clearing debris. Build-out status was assessed based on minimum parcels sizes for each zoning designation, with guidance from Mike Tippet, CVRD Manager of Community and Regional Planning. If a parcel's area was less than three times the minimum allowable size, it was considered to be built-out (i.e. unlikely to be subdivided further).

This criterion provided a generalized indication of whether or not an area has been fully developed. However, it does not account for all situations. For example, a parcel may be at or near the minimum size while being completely forested and subject to further land clearing. Another limitation with this method of determining built-out status is that it assumes the current zoning is the intended future zoning. However, there are some lands with forestry or agricultural zoning designations that are located in OCP areas intended for future residential/commercial/industrial use. As such, land clearing debris volume estimates are presented with built-out areas included and excluded, to provide a comparison. The land clearing debris volumes calculated for the entire study area are likely to be an over-estimate of actual volumes produced, whereas the volumes calculated with the built-out areas excluded are likely an underestimate.

To further improve the land clearing debris volume estimates, Mike Tippet also provided for each zoning designation the percentage of a parcel area that is likely to be cleared upon development. These percentages were applied to the total parcel area to determine the

total area that would not likely be cleared for development (assumed to be minimum retention area). If there was more forested area on a parcel than its minimum retention area, the difference between the two figures was considered to be the "clearable" forest area.

Integrated Land Clearing Debris Index

The clearable area was subtracted from the forested areas, half from the mature forest area and half from the young forest area. If either mature or young forest component was smaller than the amount subtracted, the difference was then subtracted from the other component. For example, if the clearable forest area was 6ha, mature forest area was 10ha and the young forest area was 2ha, then the clearable forest volume was calculated based on 4ha of mature forest and 2ha of young forest.

2.1.3 Development Pressure index (DPI)

The DPI is an extension of demonstrated socioeconomic drivers of population infill & growth within established analytic hierarchy process methods used for land-use planning[6]. By using BC Assessment data (2007-2017) provided by the CVRD, we were able to use three indicators (listed below) that could reflect development pressure. These indicators were also considered as surrogates for other indicators such as geographical location (e.g. commuting distance to Victoria, or distance to shopping or health services).

2.1.3.1 Development Pressure Indicators

The three indicators and the rationale for each are as follows:

- Reduction in parcel size: A change in parcel size is assumed to indicate subdivision.
- Increase in property value: A significant increase in property value was considered to indicate one of two possibilities: Construction of new buildings or additions had occurred, or simple market value had increased, which was assumed to increase the likelihood that a property could be developed or subdivided.
- Land use change: A change from any form of "vacant" status to any in-use residential, commercial or industrial use was assumed to indicate that development had occurred.

We rationalized that a change in parcel size and land use are more direct indications that land clearing will be likely, whereas change in property value is a more speculative

[6] Such as the one used by Gomez-Navarro, T. Garcia-Melon, M., Acuna-Dutra, S. and Diaz-Martin, D. 2008. An environmental pressure index proposal for urban development planning based on the analytic network process. Env Impact Asses Rev. V.29, is. 5, pp 319 – 329.

indicator. Together, they provide a general gauge of actual development activity on a parcel, or at least an indication of market pressure for development. As such, we believe that as the DPI increases, so does the likelihood that land clearing debris will be produced.

Thresholds for changes in parcel size and property values, that would result in a parcel's inclusion towards the DPI were set as follows:

- Parcel Size: A reduction of over 10% in parcel area from one year to the next was considered to indicate a subdivision for lots 25 acres or smaller. For parcels larger than 25 acres, a reduction in size by 2.54 acres was used as the subdivision threshold. We acknowledge that this analysis could be made more detailed and accurate by applying the minimum lot size restrictions by electoral area and zoning type; however, this was determined to be outside the scope of the study at this time. Further to which, we acknowledge that – due to data availability – this approach only captures back-casting development which would generate land clearing debris. However, an important aspect of this approach perspective is that all wood is not merchantable, which would result in parcels retaining forest-cover throughout subdivision and sale. Through assessment and experience we know that a survey and subdivision plan may precede land clearing activities, such as the lots of Westwood Rd off of Cowichan Valley Highway.
- Property Value: An increase of over 10% in property value from one year to the next was considered significant enough to indicate development had occurred, or is more likely to occur.

2.1.3.2 Development Pressure Index Accounting and Normalization

For each Property Identification Number (PID), any time one of the above indicator thresholds were exceeded from one year to the next, the DPI for that parcel increased by 1. Changes in size and value therefore had a maximum potential DPI contribution of 10 each for a single parcel. For land use change, we assumed a parcel can only change from vacant to in-use status once, thus contributing only 1 to a parcel's DPI. Since the other indicators had a maximum of 10, we updated the DPI formula so that a land use status change would increase a parcel's DPI by 10. As such, the maximum possible DPI for a parcel was 30 (although the maximum actual value was 16).

For example, a DPI of 0 was assigned to a parcel where none of the 3 indicators occurred between 2007 and 2017. A DPI of 7 represents a parcel where 7 of the indicators occurred between 2007 and 2017.

In order to equitably roll-up the DPI with the land clearing index, yard waste index and smoke accumulation index (each of which with a maximum value of 7), the DPI was normalized to also have a maximum value of 7. The pre-normalized maximum DPI value of 16 equates to the normalized DPI of 7. As the normalization resulted in decimal values these were split into integer classes from 0 to 7. Only a pre-normalized DPI of 0 resulted in a final DPI of 0. A normalized DPI > 0 and ≤ 1 was assigned a final DPI of 1, >1 and ≤ 2 was assigned a final DPI of 2, and so on.

2.1.3.3 Review of Index Limitations

After reviewing the results of this first iteration of the DPI, we became aware of opportunities for improvement – which is provisional on data availability. We outline the apparent limitations below.

The DPI does not properly account for "offspring" parcels in a subdivision. Consider the example of a "parent" parcel PID that existed from 2007 to 2017 that is subdivided two separate times during that period. All offspring parcels are given new PIDs which then begin an inaccurate start with a DPI of 0. To properly represent these offspring parcels, the offspring of the first subdivision should start with a DPI of 1, and the offspring of the second time the parent parcel was subdivided should begin with a DPI of 2. That is of course ignoring any other changes in value or land use. This issue was most conspicuous in uniform subdivisions where one of the parcels had a significantly higher DPI than the surrounding parcels (these higher DPI parcels likely carry the PID of the parent parcel).

With the BC Assessment data we currently have available, we helped alleviate this bias by adding 1 to the DPI of any PID that exists in 2017 but did not in 2007 (i.e. any new PID was assumed to be an offspring parcel). To properly account for successive subdivisions, we would need to know which offspring parcels (new PIDs) came from specified parent parcels from year to year. While the CVRD has this information, it cannot be incorporated into our analysis due to time constraints.

An increase in property value may also coincide with a change in livable area, vertical addition to the dwelling, or other non-land-clearing activity. Unfortunately, these types of metrics are typically held by regional real-estate boards and not subject to public query. Therefore, our intent – as outlined in the Approach letter – to engage the Vancouver Island Real Estate Board for data-mining should be re-evaluated. It should be noted that our project team did approach the VIREB, and were categorically denied access citing 'workload', 'difficulty', and 'not public data' as reasons for refusal.

An alternative approach to establishing level of build-out within a parcel would be to compare existing building density versus allowable building density, whereby if a parcel is sub-allowable and there is a positive change in price – there may be sufficient development pressure to redevelop the lot. This could be conducted through two approaches:

1. Access to the VIREB database to evaluate number and size of buildings on each parcel; or
2. Aerial image analysis, which would require object based recognition to geospatially correlate building density to allowable density.

2.1.4 Yard Waste Potential

To account for total potential yard waste generated within the electoral areas of CVRD, we utilized two different approaches. Both approaches predict yard waste total weight, however the first approach was conducted through waste composition tables published in CVRD and Federation of Canadian Municipalities reports; whereas the second approach utilized an area-based yard waste production model to estimate total.

2.1.4.1 Extrapolation from Waste Composition Tables

Yard waste volume extrapolations were first made on a per-parcel basis using the CVRD Waste Composition Study as a basis (Tetra Tech EBA, 2015). Note that this study only looked at yard waste that was disposed of as garbage. It is included only as an indication of the potential amount of yard waste originating in our study area that may be ending up in the landfill. As the single-family yard waste composition varied greatly by electoral area from 0% to 4.73% of the 286kg per capita, we decided to use the average of the five values – 1.51%.

Using BC Assessment data, we determined the number of parcels with single-family, multi-family and commercial/industrial use codes. Recognizing that yard waste would not be currently produced on "vacant" parcels, current potential yard waste predictions excluded these parcels. However, future potential yard waste predictions included both in-use and vacant parcels.

To translate the 286kg per capita per year average total waste value to represent the waste from each parcel, a multiplier of 2.5 people per household was applied (BC average from 2011 Census). This assumes one household per parcel, which will not always be the case, but this is the closest approximation we can make with the available data.

It should be stressed that the above analysis only relates to yard waste that was disposed of as garbage. To assess the volume of yard waste that might be captured by a curbside collection program, we looked at the closest-matching example provided in the Federation of Canadian Municipalities (FCM) waste composition table. As such, curbside collection quantities were predicted using values from Sudbury, Ontario which offered curbside collection of yard waste since 2001.

2.1.4.2 Area-Based Yard Waste Production Model

We approached the yard waste volume predictions by utilizing land classification mapping results. Areas classified as herbaceous were assumed to be yard waste producing areas. An apparent limitation here is that shrub-dominated gardens are capable of producing yard waste, but the land cover mapping could not differentiate between shrub cover and young forest. Note that only the herbaceous areas on non-"vacant" land, as identified by the 2017 BC Assessment data, were included in the yard waste calculations.

To develop an area-based volume estimate for yard waste, we looked at average volumes produced by lawns and forage crops. Lawns in California produce an average of 6.5 tons of grass clippings per acre per year (CalRecycle, 2011). In New England, a reported average was 6 tons per acre per year (FCSWMD, n.d.). Given the different climatic conditions that these areas experience, we have only included these values as benchmarks. Closer to the CVRD, an experimental farm in Saanichton, BC yielded 4.5 tons of alfalfa hay per acre, averaged over a four-year period (Canada Department of Agriculture, 1963). We consider this to be a reasonable estimate for grass clippings production under local climatic conditions. However, grass clippings from lawns represent just a single component of typical yard waste. Leaves are another major component of yard waste, along with general vegetation, sticks and branches, and untreated wood.

2.1.4.3 Evaluation of Estimates

To account for all types of yard waste in our volume estimate, we utilized the results of an organic waste composition study completed for the City of Surrey (Torrella et al, 2013). This study was selected as its location is within a similar climatic region, sampling was completed monthly over the course of a year, and it provided a detailed breakdown of yard waste composition. This study sampled organic waste from single family homes that participated in the pilot program for curbside collection. The pilot program ran for two years prior to City-wide roll out in October of 2012 (sampling began in November of 2012). Given that these samples were collected from voluntarily participating households, we believe it is reasonable to assume that the composition results in this study represent the total volume of yard waste produced. In other words, we assume that all yard waste

produced on these properties was disposed of via the curbside pickup program, rather than being composted or burned on site.

Given that the spatial resolution of the land classification was coarse in comparison to smaller residential lots, and small residential footprints on larger, mostly forested lots, the area-based yard waste model was unable to accurately calculate yard area in these circumstances. Our solution was to apply a percentage for yard area on smaller non-vacant lots, and to apply a minimum yard area to all other non-vacant lots (non-vacant as identified by the BC Assessment data). This way, all in-use lots were assumed to have some yard area that produces yard waste. For of lots less than 1,250m^2 in size, the yard area was estimated to be 16% of the lot area. For lots 1,250m^2 and larger, the minimum yard area was set at 200m^2.

2.1.5 Critical Burning Hotspots

The Cowichan Valley has a maritime climate with frequent consistent winds, which results in areas such as the east end of the Cowichan Valley (Cherry Point, Crofton and Cowichan Bay) often experiencing light winds coming off of Saanich Inlet and Stuart Channel. The effects of sea breeze on topographically confined valleys versus coastal areas, which slope from relatively higher to lower elevations, is known to impact air quality[7]. In areas influenced by sea breeze, air quality indicators (e.g. Ozone, CO, particulate) were found to re-circulate during the diurnal cycle out to sea and back toward the confined valley, whereas the sloping coastal areas had indicator concentrations decrease during diurnal airflow of sea/land breeze.

Furthermore, the continuous and topographically confined extent of Cowichan Valley can channelize wind from the predominant westerly direction. For example, in the summer, west winds come down the valley from Nitinat and Cowichan Lakes. However, there are areas in the Cowichan Valley that are sheltered from winds and only experience considerable wind movement during storms or other meso-scale meteorologic events.

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[7] Grossi, P. Thunis, P, Mertilli, A., Clappier, A. 2000. Effect of Sea Breeze on Air Pollution in the Greater Athens Area. Journal of Applied Meterology, v.39, pp. 563 – 575.

Section 3.2.4 & 3.4 Local Airflow regime of Sea/Land breeze and topography as per: https://www.ec.gc.ca/air/default.asp?lang=En&n=1F36EFBB-1&offset=4&toc=show

Chien, F., Mass, C., Kuo, Y., 1997. Interaction of a warm-season frontal system with the coastal mountains of the western United States. Part I: Prefrontal onshore push, costal riding and alongshore southerlies. Monthly Weather Review 125(8): 1730-1752.

The term airshed is sometime used to describe areas with distinct air flows; however this term is not very precise. Where one can determine the edges of a watershed, one cannot do so with an airshed. For this study we have mapped a large central airshed area in the Cowichan Valley that is low elevation, somewhat sheltered from strong winds, and would likely accumulate particulate matter in the event of an atmospheric inversion (Figure 6)[8]. An inversion is when warm air lies over cooler air at lower elevations, which can create a "smoke ceiling" that causes smoke to spread outward rather than venting upward.

Since the defined airshed only accounts for local-scale influences, there are going to be exceptions due to meso-scale and greater meteorological forces, as detailed in Section 2.1.5.2 below. Further investigation of airshed delineation, air quality indicators, or air mass movements within the CVRD are outside of the scope for this body of work.

2.1.5.1 Particulate Matter (PM) Accumulation Area

There is a large contiguous airshed which ranges from Honeymoon Bay in the west, to Ladysmith in the north, and south to Shawnigan Lake. Acknowledging that there are likely minor differences in air movement within this area due to local topography and composition of landscape, we delineated the CVRD airshed used in this report based on the principals outlined in Section 2.1.5 above.

Areas excluded from the particulate matter accumulation airshed include Mill Bay, Cherry Point, outer Cowichan Bay, Crofton, Yellowpoint, and all higher elevation areas. During an inversion with long duration, these areas could also accumulate particulate matter. Crofton and areas to the west and southwest may have higher particulate matter than other areas, but this is the result of industrial activities.

2.1.5.2 Smoke Accumulation Index (SAI)

A smoke accumulation index (SAI) was created through a topographic analysis. The rationale for the index is based on "worst-case-scenario" burning conditions and practices. That is, under atmospheric inversion with a low dispersion elevation, little to no wind, and the material being burned having a high moisture content. Under such conditions,

[8] As described in The BC Centre for Disease Control report on 'Wildfire smoke and public health risk' 2014. Environmental Health Services. http://www.bccdc.ca/resource-gallery/Documents/Guidelines%20and%20Forms/Guidelines%20and%20Manuals/Health-Environment/WFSG_EvidenceReview_WildfireSmoke_FINAL_v3_edstrs.pdf

smoke will generally accumulate in topographic depressions or low points in the landscape. The SAI was created to account for potential topographic effects on air quality.

A digital elevation model (DEM) was created based on 20m TRIM contours. Using the DEM, several parameters were calculated:

1) mean elevation within each parcel;
2) elevation range within a 2.5km radius of each parcel; and
3) minimum elevation within a 2.5km radius of each parcel.

The elevation range was divided into 8 elevation intervals. If the mean parcel elevation was less than the minimum elevation plus 1 * the elevation interval, the SAI was 7. If the mean parcel elevation was less than the minimum elevation plus 2 * the elevation interval, the SAI was 6. This pattern was continued to: If the mean parcel elevation was less than the minimum elevation plus 8 * the elevation interval, the SAI was 0.

What this achieved is to rank parcels based on their elevation, relative to the elevation of the surrounding area. Parcels in relative low-lying areas were assigned a high SAI, while parcels on relative high ground received a low SAI value. As with the other indices developed in this study, there are 8 classes with a range from 0 to 7.

2.1.5.3 Proximity to Organic Matter Recycling Facilities

Though initially proposed for evaluation through the Approach Framework, it was found through literature review that there is little correlation between distance from an Organic Matter Recycling Facility and the rate of open burning or illegal dumping of yard waste/land clearing debris. Consequently, we have not included this metric in our report.

2.1.5.4 Air Quality and Venting Index

An analysis was performed comparing local air quality data with the venting index. The venting index is used to determine when the local weather is adequate for the safe dispersal of smoke (particulate matter and other substances) and therefore indicates the preferred days for burning. The venting index is published by Environment Canada and is based on predicted wind speeds coupled with air mixing heights above sea level. For example a day with a "Good" venting index will have some wind (>5 km/hr), and have a mixing height likely greater than 2000 m above sea level. Archived venting index information is available at the following Environment Canada website: http://www.env.gov.bc.ca/epd/epdpa/venting/polled_data/

This data was available in table format for 2002 to 2013. Due to the data format used from 2013 to present, only the 2002 to 2013 data was used in our analysis. A future review of the full data set would be a useful update of the analysis; however retrieval and processing of the additional 1500 files would need to be automated.

Air quality data is available from four local permanent air quality monitoring stations: Crofton Georgia Heights, Crofton Substation, Dykin Avenue, and Duncan Cairnsmore. For our analysis we chose the data from Duncan Cairnsmore because of its central location and proximity to the study area.

2.1.5.5 Burning Bylaw Offences

Smoke and open burning complaints have been monitored by the CVRD. The location of the complaints was examined and assessed by location. Upon investigation, there is value in accurate record keeping of incident reports when tracking open burning, particularly due to differences in attitudes across the region. The density of offenses was not included in overall analysis.

2.1.5.6 Open Burning Hotspot Index Rollup

Both land clearing and yard waste volumes were separated into eight classes, and normalized to a value of 0 to 7 (low to high). The DPI was also normalized within the range of 0 to 7. For these three indices, a value of 0 means there was no detected debris or yard waste volume or development pressure associated with a parcel or portion of a parcel. Eight classes (0 to 7) were also used to represent topographic influences in the smoke accumulation index. These four indices were compiled as equal-weighted components to create the open burning hotspot index.

Note that this index is strictly relative and has no defined proportional relationship to the likelihood or severity of open burning. It is provided as a general indication of where pressures are greatest and least; pressures that may contribute to the occurrence of open burning and associated negative impacts.

2.2 Best Management Practices (BMP) Evaluation

2.2.1 Review and Ranking of Yard Waste Management Practices

2.2.1.1 Review of Yard Waste Management Practices

Information regarding yard waste management practices was retrieved for twelve Pacific North-West communities. The most common approach was taken and put into a table

seen in section 3.2.2.1 which included: population density, population size, most common housing type, when and how often curbside collection occurred, maximum quantity collected, maximum branch diameter allowed.

Other yard waste management approaches promoted by the community were also examined and put into a list.

2.2.1.2 Ranking of Yard Waste Management Practices

The seven most comparable communities were chosen and compared to the nine electoral districts of the Cowichan Valley. Population statistics- population density, total area of jurisdiction, and population of jurisdiction- were taken from Stats Canada using the most recent data available no older than 2011. The total area of collection routes for the six comparable city or regions were approximated using iMapBC with the waste collection route map layers of each respective city or region. Urban neighbourhoods were defined by areas where houses were close together and lots were small (approximately 0.5 acres), as observed in zoning maps. Urban, commercial, and agricultural differences could not be accounted for in waste collection maps but were taken into account for the nine electoral districts of Cowichan Valley. For the nine electoral districts the colour coded zoning maps available and on the CVRD website were used to differentiate residential (urban and rural) from other types. Further, urban and agricultural lands were differentiated as they were with the other six comparable communities by approximation based on density of lots, and lot size (approximately 0.5 acres considered urban) and larger lots outside of clusters considered rural. These methods were used due to what map information was available and its pertinence to comparing the urban to rural land distribution. Islands other than Vancouver Island were ignored since populations on islands are not substantial enough for waste collection.

Although Cowichan Valley most closely resembled Prince George by statistics, Prince George does not have yard waste management in place so for the purpose of ranking it was ignored

2.2.2 Review of Open Burning BMPs

2.2.2.1 Open Burning and Forest Fire Risk

Review of available literature related to open burning, wildfire risk and provincial mitigation efforts were used to synthesize a summary assessment of potential hazards within identified hotspots and what BMP exist to mitigate or curtail said hazards.

2.2.2.2 Review of Open Burning Bylaws

Open burning related bylaws of several North-Western communities were analyzed from their respective bylaw indices.

2.2.2.3 Programs for Open Burning Reduction

The yard-waste management practices from other municipalities in the North-West that didn't include open burning were gathered through information available on their websites.

2.2.3 First Order Financial Assessment of Curbside Collection

This section provides two approaches to a first-order financial assessment of implementing curbside collection as a means of scoping financial cost of the 'standard' method of yard waste management for large municipalities within BC – established in Section 2.2 of this document.

Firstly, the operational cost of trucking and surface transport in Canada[9] on a per-kilometer basis is used to estimate cost of operating nine months of the year, as follows:

1. Using road network mapping, a form of network analysis, we determined an average density of 30 houses/km of urban road in Electoral Areas A - D; while rural sections in Electoral Areas B, E, and H had a density of 10 houses per km.
2. Equating the roughly 13,012 individual households in a 57/43% split between urban and rural results in a collection route distance of 247km in urban and 560km in rural areas, for a total driving distance of 807km.
3. Assumptions:
    a. Due to the low population density and relatively large lot sizes of Electoral Areas F, I, and to a lesser extent G; these areas were not considered in this assessment method;
    b. There was full participation of both Rural and Urban areas;
    c. There were no tipping fees incorporated as the organic feedstock was viewed as a resource input to commercial organic matter recycling operations looking to generate Class A compost as defined by the Organic Matter Recycling Regulation of BC (OMRR);

[9] Barton Associated Ltd., Logistics Solution Builders Inc., The Research and Traffic Group. 2008. Operating Costs of Trucking and Surface Intermodal Transportation In Canada.

d. No capital outlay by the contracting district government;

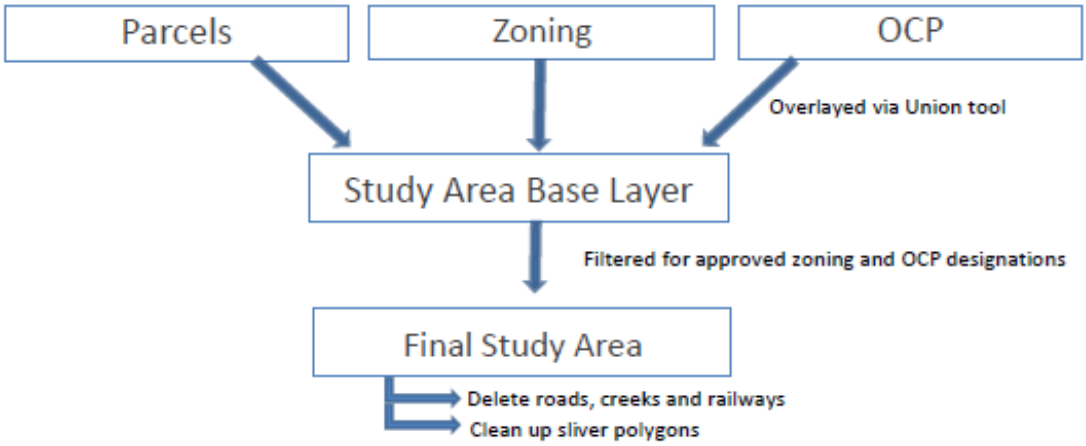
Secondly, a per-household estimate of cost is adapted from a neighbouring district to estimate cost of yard waste collection for nine months of the year. Assumptions 3.a – c from the first method (above) are held over for this assessment calculation.

2.2.4 Flowchart of Geospatial Analysis

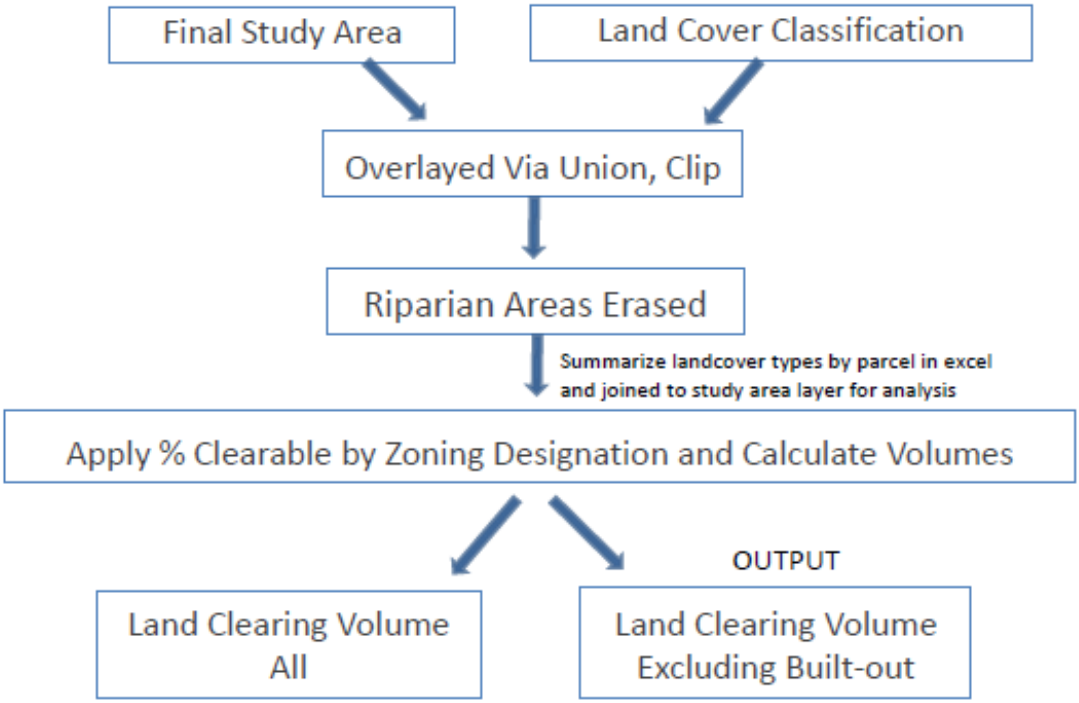
A series of flowcharts detailing the geospatial analysis are presented below to assist the reader.

GIS Workflow

Study Area Development

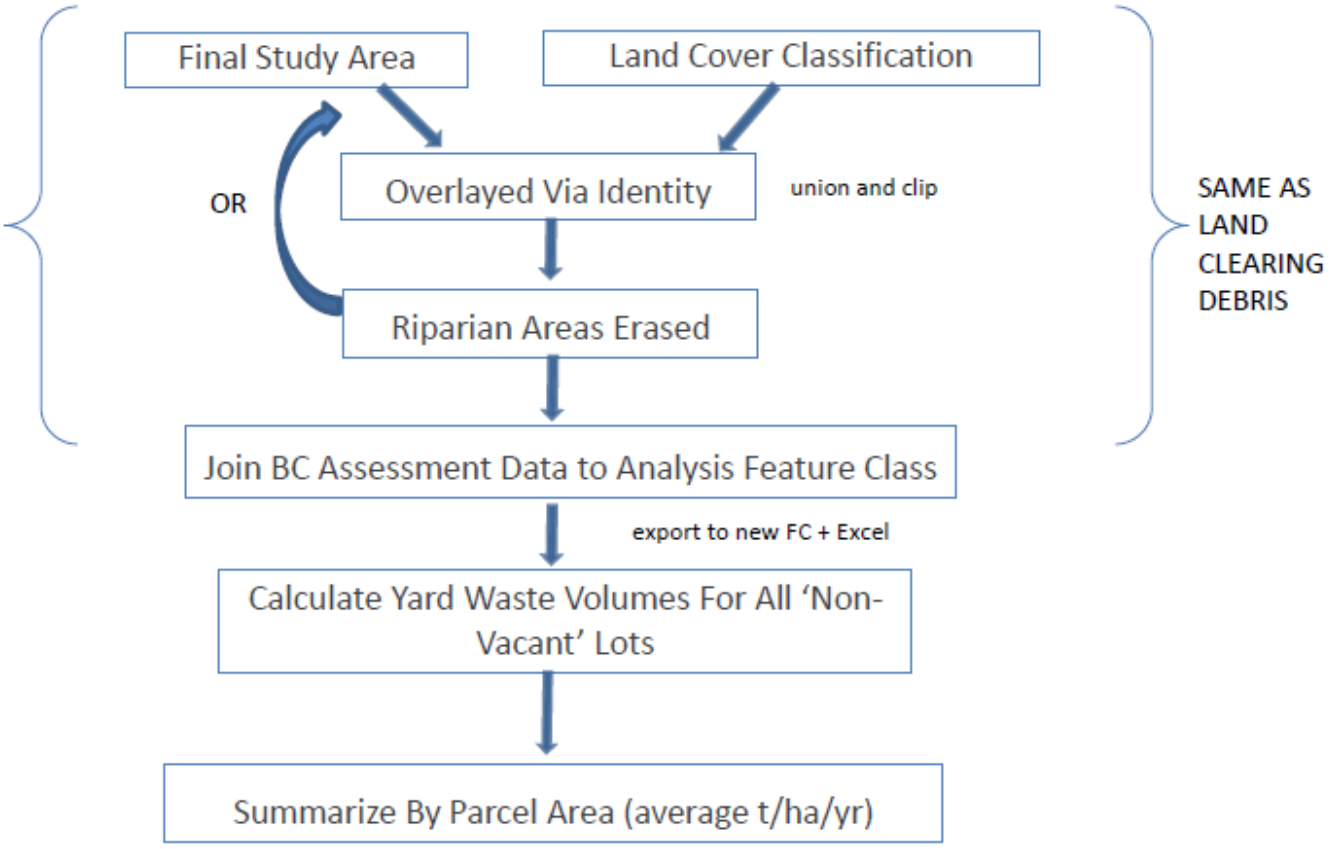


Land Clearing Debris



GIS Workflow

Yard waste – Area based volume estimates



3 Results and Discussion

3.1 Property Yard Waste Mapping

3.1.1 Definition of Study Area

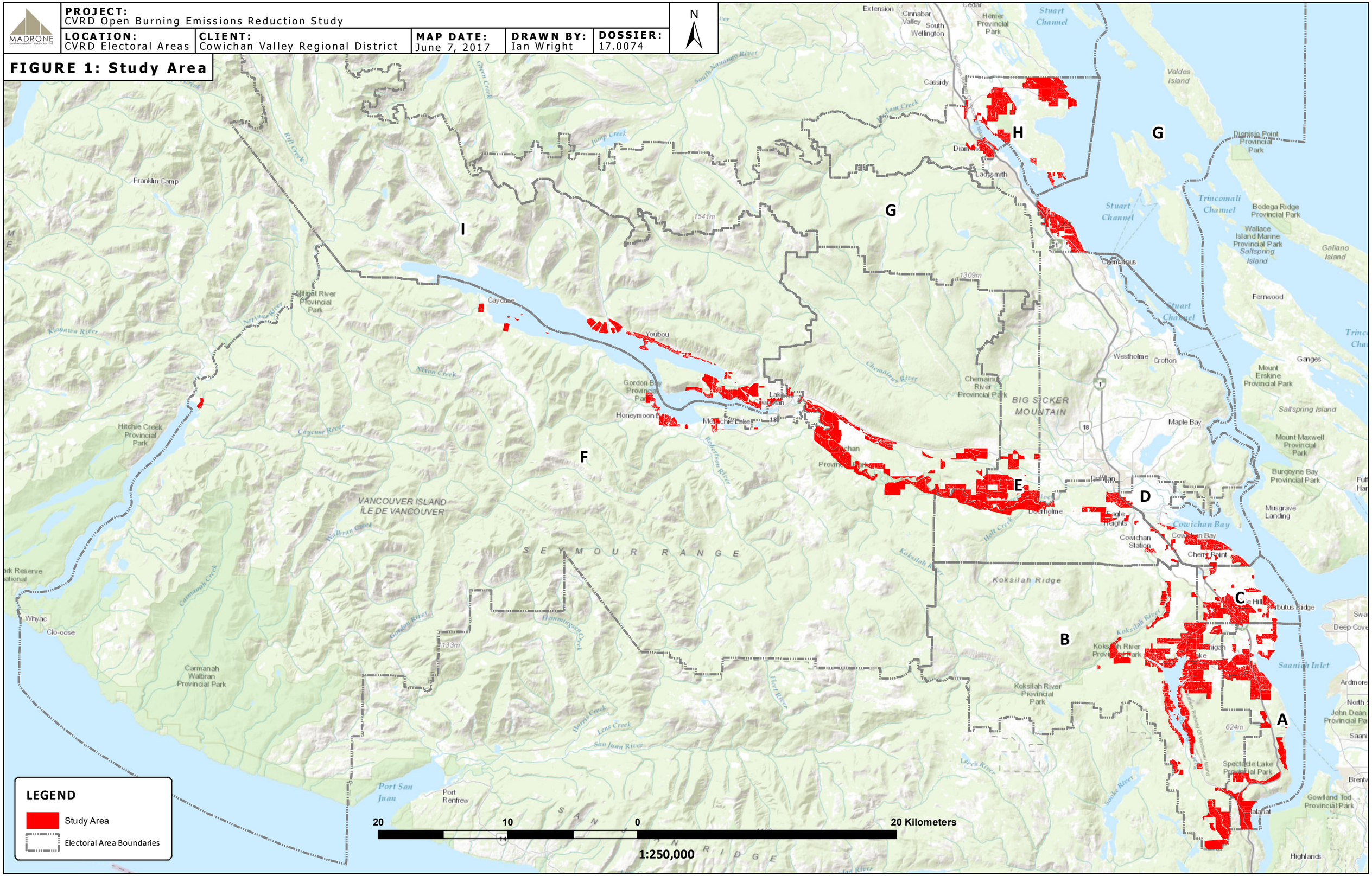
The final study area covered 10,442 hectares, or 3.1% of the electoral areas (Table 1). Figure 1 presents the geographical distribution of the study area.

Table 1: Study areas by CVRD electoral area

Electoral Area	Commercial (ha)	Industrial (ha)	Residential (ha)	Mixed Use (ha)	Other* (ha)	Total (ha)
A	44	159	1,016	101	23	1,344
B	19	53	2,068	0	235	2,374
C	14	46	492	47	6	607
D	0	14	290	20	9	333
E	14	88	1,197	0	44	1,343
F	47	67	1,154	0	861	2,130
G	9	0	372	0	0	381
H	30	18	935	0	190	1,172
I	109	69	559	0	21	758
Total	**286**	**514**	**8,083**	**169**	**1,389**	**10,442**

MADRONE environmental services ltd	**PROJECT:** CVRD Open Burning Emissions Reduction Study				N
	LOCATION: CVRD Electoral Areas	**CLIENT:** Cowichan Valley Regional District	**MAP DATE:** June 7, 2017	**DRAWN BY:** Ian Wright	**DOSSIER:** 17.0074

FIGURE 1: Study Area



3.1.2 Land Clearing Debris Potential

Due to the large regional distribution, relative small parcel size, and difficulty distinguishing between index levels at scales greater than 1:25:000, we will present results of this study within the written report as subset areas. In particular, we will highlight a portion of Electoral Areas A, B & C due to varied topography and multiple community 'centers' within those areas.

3.1.2.1 Land Cover Classification

A sample of the results of the land cover classification is presented in Figure 2. This figure covers portions of Electoral Areas A, B, and C. The study area land cover classification results are summarized in Table 2.

Mature forest covered the majority of the study area with 4,806 ha, followed by Young forest (3,221 ha), Herbaceous (1,016 ha) and non- or sparsely-vegetated (Table 2). Electoral areas B, F, H and E contained the largest areas of mature forest. Area B also has the most areas of Young Forest and Herbaceous cover.

Table 2: Land Cover Classification Results

Electoral Area	Mature Forest (ha)	Young Forest (ha)	Herbaceous (ha)	Non-vegetated or sparsely vegetated (ha)
A	600	412	138	140
B	1,085	790	245	174
C	244	173	62	114
D	119	108	38	59
E	626	390	107	148
F	1,071	671	157	74
G	131	140	58	45
H	682	303	94	69
I	249	234	117	102
Total	4,806	3,221	1,016	925

MADRONE environmental services ltd	**PROJECT:** CVRD Open Burning Emissions Reduction Study				N
	LOCATION: CVRD Electoral Areas	**CLIENT:** Cowichan Valley Regional District	**MAP DATE:** June 7, 2017	**DRAWN BY:** Ian Wright	**DOSSIER:** 17.0074

FIGURE 2: Land Cover Classification - Portions of Areas A, B and C

Area C

Area B

Area A

LEGEND

- Electoral Area Boundaries

Land Cover Classification

- Mature Forest
- Young Forest / Shrub
- Herbaceous
- Bare Ground
- Impervious Surfaces
- Water

0 600 1,200 2,400 Meters

1:25,000

3.1.2.2 Predicting Land Clearing Debris Volumes

Volumes of woody debris were resolved and are presented in terms of total volume for the entire study area (m^3) (Table 3). Total volume of potential land clearing debris that can possibly be generated per hectare was resolved and mapped for this study, which can be seen in the associated data catalogue, and a subset of which is shown in Figure 3a. The values shown in Figure 3a are equivalent to the debris volume generated by denuding each parcel. The estimates of annual debris volume were derived from the total clearable forest debris volume linearly averaged over a 30 year build-out period.

The total land clearing debris for each electoral area is the sum of estimated woody debris for each parcel within that area. Tables 3 & 4 present the total forest area and volume, as well as the "clearable" area and volume. Table 3 includes the entire study area, while Table 4 excludes the areas that were defined as built-out.

Over the entire study area, Area B had the largest volume of potential land clearable debris (177,432m^3), followed by Areas F (172,173m^3) and H (106,027m^3). After excluding built-out areas, Area F had the largest clearable forest volume (124,951 m^3), followed by Area B (68,471 m^3), then Areas A (46,818 m^3) and H (44,618 m^3).

Based on this analysis, it is estimated that 7,699 m^3 of land clearing debris will be generated annually from all 9 electoral areas from parcels not currently built-out, whereby Area B is the largest contributor at 24.6% of total volume due to vegetation type, size of parcels, and built-out status thereof. A subset area showing the predicted land clearing debris is shown in Figure 3b below. The values shown in Figure 3b are the likely volume of debris generated if each parcel is brought to 'built-out' status, based on CVRD definition thereof[10].

While the estimate of total land clearing debris volume generated is accurate to the method, there is a low likelihood that all of said debris will be subject to burning-disposal. Alternative disposal methods include being left on the land, or otherwise mulched and used on site, or transferred to an organic composting facility.

It is important to note that the breakdown of land clearing debris disposal options would require specific query and interviews with key stakeholders, such as: developers, land clearing operations, and compost facility operators. Unfortunately, these metrics are outside of the scope of this study – but would be a prudent extension.

[10] As per *Per Comm.* with Mike Tippet, regional planner for CVRD.

Table 3: Predicted land clearing volumes by electoral area – entire study area.

Electoral Area	Total Forest Area (ha)	Maximum Potential Land Clearing Debris Volume (m3)	Maximum Potential Land Clearing Debris Volume - Average by Area (m3/ha)	Clearable Forest Area (ha)	Clearable Forest Debris Volume (m3)	Clearable Forest Debris Volume - Average by Area (m3/ha)	Annual Land Clearing Debris Estimate (m3/yr)
A	1,012	97,425	53	681	61,704	43	2,057
B	1,875	177,432	72	1,390	130,758	64	4,359
C	416	39,713	43	260	23,165	30	772
D	227	20,131	40	176	14,511	36	484
E	1,016	100,485	50	593	53,125	41	1,771
F	1,742	172,173	62	774	65,641	44	2,188
G	270	22,607	46	270	22,607	46	754
H	985	106,027	69	505	46,208	47	1,540
I	483	42,227	51	445	39,727	49	1,324
Total	**8,027**	**778,219**	**56**	**5,096**	**457,447**	**47**	**15,248**

Predicted volumes of land clearing debris are presented spatially in Figures 3a (maximum potential debris volume in m3/ha) and 3b (clearable forest debris volume in m3/ha).

Table 4: Predicted land clearing volumes by electoral area – excluding "built-out" areas.

Electoral Area	Total Forest Area (ha)	Maximum Potential Land Clearing Debris Volume (m3)	Maximum Potential Land Clearing Debris Volume - Average by Area (m3/ha)	Clearable Forest Area (ha)	Clearable Forest Debris Volume (m3)	Clearable Forest Debris Volume - Average by Area (m3/ha)	Annual Land Clearing Debris Estimate (m3/yr)
A	470	46,818	74	355	33,935	61	1,131
B	734	68,471	76	604	56,900	70	1,897
C	121	12,417	70	89	8,744	51	291
D	86	7,945	61	61	5,118	48	171
E	471	43,268	58	403	36,859	55	1,229
F	1,203	124,951	81	520	44,614	52	1,487
G	28	2,617	67	28	2,617	67	87
H	376	44,618	68	175	17,045	47	568
I	301	27,407	70	265	25,144	60	838
Total	**3,790**	**378,511**	**70**	**2,501**	**230,977**	**58**	**7,699**

MADRONE environmental services ltd

PROJECT: CVRD Open Burning Emissions Reduction Study

LOCATION: CVRD Electoral Areas

CLIENT: Cowichan Valley Regional District

MAP DATE: June 7, 2017

DRAWN BY: Ian Wright

DOSSIER: 17.0074

N

FIGURE 3a: Total Potential Land Clearing Debris Volume for Portions of Areas A, B and C

Area C

Area B

Area A

LEGEND

- Electoral Area Boundaries
- Parcels
- Built-Out

Land Clearing Debris (m3/ha)

- 0 to 5
- > 5 to 15
- > 15 to 30
- > 30 to 45
- > 45 to 60
- > 60 to 75
- > 75 to 90
- > 90 to 143

0 750 1,500 3,000 Meters

1:25,000

MADRONE environmental services ltd

PROJECT: CVRD Open Burning Emissions Reduction Study

LOCATION: CVRD Electoral Areas

CLIENT: Cowichan Valley Regional District

MAP DATE: June 7, 2017

DRAWN BY: Ian Wright

DOSSIER: 17.0074

N

FIGURE 3b: Predicted Clearable Land Clearing Debris for Portions of Areas A, B and C

C

Area A

Area B

LEGEND

- Electoral Area Boundaries
- Parcels
- Built-Out

Land Clearing Debris (m3/ha)

- 0 to 5
- > 5 to 15
- > 15 to 30
- > 30 to 45
- > 45 to 60
- > 60 to 75
- > 75 to 90
- > 90 to 143

0 750 1,500 3,000 Meters

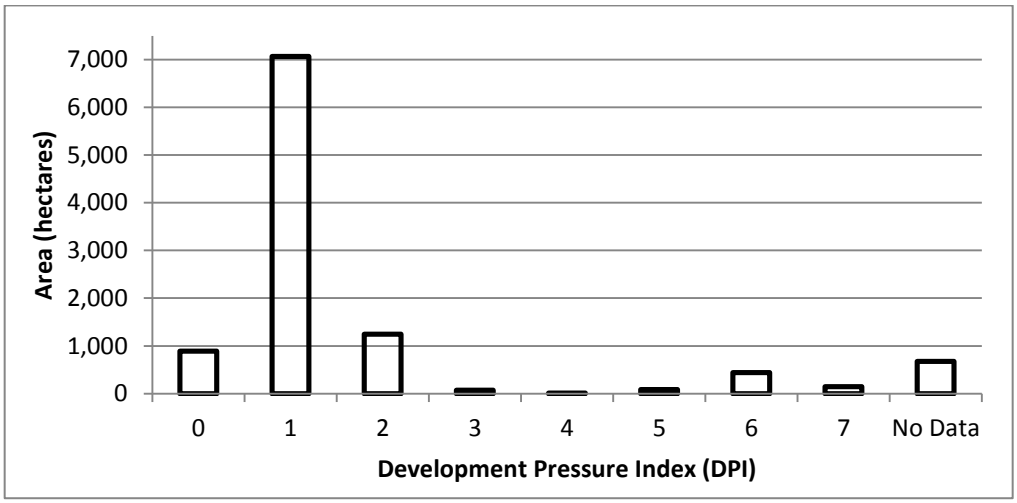
1:25,000

3.1.3 Development Pressure index (DPI)

The DPI results are summarized by area in hectares for each electoral area and the total study area in Table 5. In this table the DPI serves as an indicator of year-to-year changes in parcel size, value and land use. A DPI of 7 represents the greatest development pressure and a DPI of 0 means no development pressure was detected in the BC Assessment Data between 2007 and 2017.

Table 5: Development Pressure Index (DPI) results by Electoral Area (ha).

Electoral Area	Development Pressure Index (DPI)									
	0	1	2	3	4	5	6	7	No Data	Total
A	176	884	104	11	9	3	50	12	95	1,344
B	159	1,683	262	5	0	23	151	71	111	2,465
C	97	396	65	0	0	5	17	3	23	607
D	23	237	44	1	0	5	14	3	7	333
E	9	833	351	42	0	16	66	21	70	1,408
F	170	1,663	104	2	0	12	65	6	114	2,136
G	7	241	90	1	0	4	18	11	8	381
H	132	676	118	2	0	11	40	11	201	1,190
I	120	453	109	6	0	6	18	5	42	758
All	892	7,066	1,246	69	9	84	439	143	672	10,621



Graph 1. Hectares classified by DPI Index

The development pressure index is also presented spatially in Figure 4. This figure provides the DPI for portions of electoral areas A, B, and C.

MADRONE environmental services ltd

PROJECT: CVRD Open Burning Emissions Reduction Study

LOCATION: CVRD Electoral Areas

CLIENT: Cowichan Valley Regional District

MAP DATE: June 9, 2017

DRAWN BY: Ian Wright

DOSSIER: 17.0074

N

FIGURE 4: Development Pressure Index (DPI) for Portions of Areas A, B and C

Area C

Area B

Area A

LEGEND

- Electoral Area Boundaries
- Parcels
- Built-Out

Development Pressure Index (DPI)

- 0 - Least Pressure
- 1
- 2
- 3
- 4
- 5
- 6
- 7 - Most Pressure
- No Data

0 750 1,500 3,000 Meters

1:25,000

There are a minimal number of hectares under maximum development pressure, whereby nearly half of the parcels within the study area are under the lowest level of development pressure. Areas that could have been targeted for redevelopment, and therefore generation of land clearing debris, would fall under DPI categories 5 or greater – wherein there is 221 ha total.

Acknowledging that the DPI is history matching, the presentation of data in map format starts to quickly identify clustered centers of increased DPI and areas that are, or have, undergone land clearing activities. From which, it can be reasonably argued that: areas adjacent and surrounding will also experience similar development pressures and will therefore also undergo land clearing; areas with low (4 or less) DPI are building toward a greater development pressure, which will see land clearing activities in the future; and an extension of this study would be to characterize the parcels with high DPI values and resolve similar parcels within the larger study area.

3.1.4 Yard Waste Potential

3.1.4.1 Waste Composition Table Extrapolation

The CVRD commissioned Tetra Tech study found that the average total waste produced per household in the CVRD was 286 kilograms per capita per year. Of this total amount of waste, the composition of yard waste was reported for single-family residences in the participating Electoral Areas D, E, F, G and I. Yard waste composition was reported as an average across these areas for multi-family (7.17%) and industrial/commercial properties (0.32%).

Yard waste accounted for 10.1% of total waste composition, as reported by FCM in their Solid Waste as a Resource Workbook (2004). The yard waste prediction results are summarized by electoral area and the total study area in Table 6.

Table 6: Yard waste predictions

Electoral Area	Based on CVRD Waste Composition Study*		Based on FCM Waste Composition Table**	
	Current Potential Yard Waste (t/year)	Future Potential Yard Waste (t/year)	Current Potential Yard Waste (t/year)	Future Potential Yard Waste (t/year)
A	17.8	19.1	98.6	109.6
B	28.0	29.9	163.0	181.1
C	15.4	15.8	85.9	95.5
D	9.1	9.7	52.3	58.1
E	7.6	8.3	51.4	57.1
F	8.6	9.6	56.6	62.8
G	9.6	10.3	55.0	61.1
H	8.1	8.8	53.4	59.4
I	10.8	13.0	72.9	81.0
Total	114.7	124.4	689.2	765.7

*These yard waste volume predictions are only provided as an indication of the potential amount of yard waste originating in our study area that may be ending up in the landfill.
**Sudbury, ON is located in a significantly different climatic region and we have not assessed the comparability in terms of demographics, population density, average parcel size etc. However, Sudbury was the closest in terms of total population to the CVRD from the data provided in the FCM document.

The totals presented in Table 6 each represent a weight of yard waste which less than 10% of the total yard waste dropped off at organic matter recycling facilities in the CVRD for 2016 (8,026 tonnes). This result invalidates the approach which uses standard waste composition tables for estimating future yard waste production due to factors which include:

- The rate of land-fill disposal of yard waste is relatively low as reported in the CVRD waste composition study;
- The FCM table used significantly underestimated Pacific Northwest bio-productivity;
- Alternatives for yard waste disposal exist within the CVRD, which include open burning.

and therefore we shift focus to our second approach, which is the area-based model – presented in Section 4.1.4.2 below.

3.1.4.2 Area Based Yard Waste Production Model

Grass clippings (green and brown) accounted for an average of 38% of total yard waste composition (by weight) in the City of Surrey study. The yield of 4.5 tons of alfalfa hay per acre per year was used to represent the production of grass clippings from lawns in the

CVRD, and was assumed to comprise 38% of total yard waste. Converted to metric, this value is 10.1 tonnes per hectare per year. Based on that, the average total yard waste production was calculated to be 26.5 tonnes per hectare per year. To derive an area-based annual yard waste production estimate for the study area, the area of herbaceous land cover was multiplied by this value and used to populate Table 7.

As shown in Table 7, Area B had the greatest yard waste production potential, when including vacant parcels, at 7,200 tonnes per year, followed by Areas F (3,954 tonnes/yr), A (3,954 t/yr) and I (3,177 t/yr). Area D had the lowest yard waste potential at 1,171 tonnes per year.

For the entire study area, the area-based model predicted that 28,833 tonnes of yard waste would be produced each year when including vacant lots; and 22,988 tonnes per year when excluding.

Table 7: Area-based yard waste potential

Electoral Area	Total Yard Waste Tonnage (t/yr)	Average Yard Waste Tonnage (t/ha/yr)	Total Yard Waste Tonnage - Non-Vacant Only (t/yr)	Average Yard Waste Tonnage - Non-Vacant Only (t/ha/yr)
A	3,954	4.1	3,230	4.2
B	7,200	3.6	5,602	3.6
C	1,935	4.0	1,832	4.1
D	1,171	4.1	1,017	4.1
E	2,946	3.9	2,516	4.0
F	4,241	3.9	3,072	4.2
G	1,609	5.0	1,524	5.1
H	2,600	3.9	2,270	3.9
I	3,177	4.8	1,923	4.8
Total	**28,833**	**4.1 (Average)**	**22,988**	**4.1 (Average)**

See Figure 5 for a map of predicted yard waste volumes for portions of Areas A, B and C.

Please note that the above estimates are provided as rough approximations based on three main assumptions:

4. Herbaceous land cover as mapped in Section 2.2.1 provides a reasonable approximation of actual yard area in the study area;
5. Reported yields of alfalfa hay in Saanichton BC provide a reasonable approximation of grass clipping yields from lawns in the CVRD; and

6 Yard waste composition as referenced in the City of Surry study provides a reasonable approximation of yard waste composition in the CVRD.

These predicted values presented in Table 7 are approximately three to four times higher than reported tonnage at recycling facilities in 2016 (8,026 tonnes). The difference of ~15,000 to ~20,000 tonnes may represent a total volume of yard waste which, in part or totality:

- may not be generated (i.e. left *in situ*) or not collected due to parcel vacancy,
- is potentially left on site to compost intentionally,
- could be burned,
- or may be illegally dumped off site.

MADRONE environmental services ltd	**PROJECT:** CVRD Open Burning Emissions Reduction Study				N
LOCATION: CVRD Electoral Areas	**CLIENT:** Cowichan Valley Regional District	**MAP DATE:** June 7, 2017	**DRAWN BY:** Ian Wright	**DOSSIER:** 17.0074	

FIGURE 5: Predicted Yard Waste Tonnes per Hectare per Year for Portions of Areas A, B and C

C

Area A

Area B

LEGEND

- Electoral Area Boundaries
- Parcels
- Vacant Parcels

Predicted Yard Waste (t/ha/yr)

- 0 to 1
- > 1 to 1.5
- > 1.5 to 2.5
- > 2.5 to 3
- > 3 to 4
- > 4 to 7
- > 7 to 12
- > 12 to 26.6

0 750 1,500 3,000 Meters

1:25,000

3.1.5 Critical Burning Hotspots

3.1.5.1 Particulate Matter (PM) Accumulation Area

As shown in Figure 6, the PM accumulation area was delineated based on topographic relief analyzed using CVRD contour data, prevalent wind conditions as indicated by local weather stations and wind-rose diagrams[11], and over eight-decades of combined local knowledge[12].

An important component of the PM accumulation area, as defined here, is that cool air introduced from offshore sources becomes trapped beneath an inversion layer during daily diurnal temperature fluctuation, and is also relatively isolated from wind-driven atmospheric mixing within the topographic surround. Therefore, it should be noted that critical impact burning hotspots are more likely to occur in the PM accumulation area due to the heightened potential impact on human health, which is a correlative aspect to settlement in regionally low-lying areas.

3.1.5.2 Proximity to Organic Matter Recycling Facilities

An analysis of parcel proximity to the nearest organic matter recycling facility was completed as part of the first draft of this study. We expected that the further the distance of a parcel from an organic matter recycling facility, the more likely it is that land clearing debris or yard waste produced on that property would be burned on site. Illegal dumping was also expected to be more likely when distances to facilities are significant. However, the bulk of our research to validate this portion of our analysis was inconclusive.

Studies on factors contributing to participation in recycling programs concluded that participation was weakly correlated with cost or convenience (Blaine et al 2001; Ramayah et al 2012; Rhodes et al 2014). Peoples' willingness to recycle or willingness to travel to recycle is more closely tied to their attitudes, values, and perceived convenience, in contrast to actual distance or convenience (Sidique et al 2010; Rhodes et al 2014). This suggests that resources allocated towards outreach and education may be more important than increasing the geographic distribution of recycling facilities. One study found that while there was a consistent relationship between distance and recycling buy-in in its literature review, particular attitudes also consistently correlate with recycling behaviour

[11] Provided by the report entitled 'Cowichan Valley Regional District Air Quality Study' produced by Stantec, 2015.

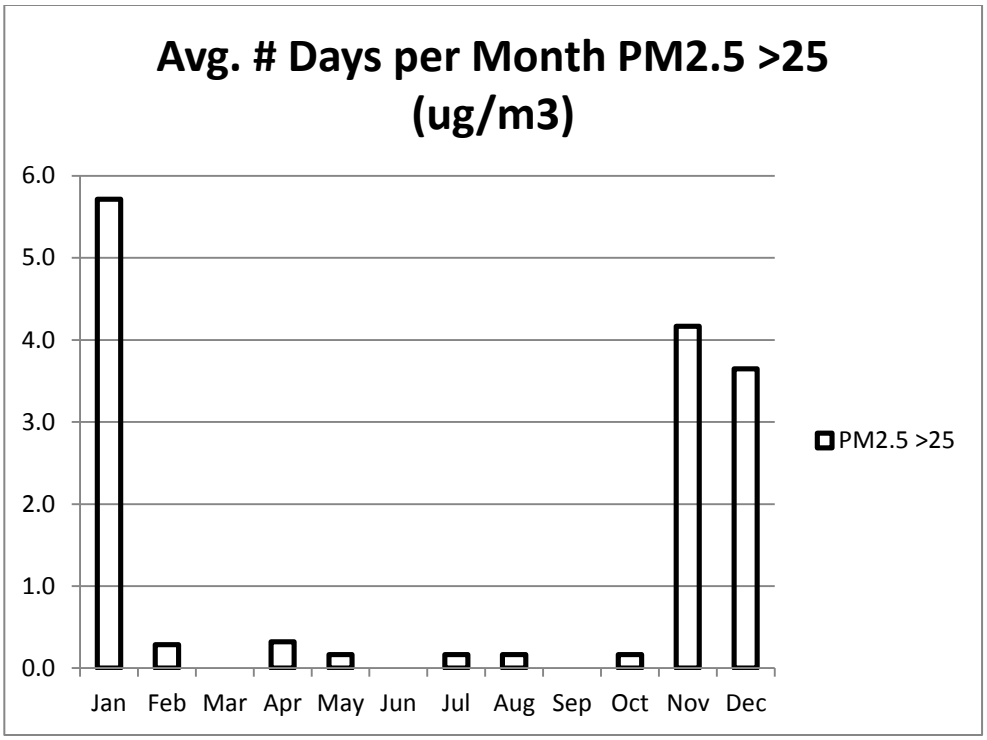
[12] Long-term residents of Cowichan and current employees of Madrone: Williams, H. P.Ag *Per comm*., Hughes-Adams, K. P.Eng *Per comm*., Butt, G. MSc P.Geo P.Ag *Per comm*.

(Schultz et al 1995). Because of the lack of relatable data to quantify the relationship between distance and peoples' willingness to utilize drop-off organic matter recycling facilities, we have not included this factor in our analysis.
Convenience is, however, a significant determinant of recycling participation when comparing curbside pickup with central drop-off locations. A study by Statistics Canada in 2007 pointed out that, "households without access to curbside recycling pickup programs were much less likely to have recycled. Even when households without access to curbside pickup did recycle, they were much less likely to have recycled all of their recyclable waste."

3.1.5.3 Air Quality Monitoring and Venting Index

The data from Duncan Cairnsmore showed a typical increase in $PM_{2.5}$ concentrations in late afternoon and evening. $PM_{2.5}$ and meteorological data analysis revealed that the sporadic exceedances may have been due to local burning and space heating (wood burning stoves) in winter (CVRD 2015).

Using the Cairnsmore data we looked at the average number of days per month where $PM_{2.5}$ exceeded 25 (ug/m3), and noted that exceedances were most common in the winter months (November, December, and January). Wood heating and the low venting index at this time of year is the likely reason for the exceedance (Graph 1).



Graph 2. Data from Duncan Cairnsmore air monitoring station (2010-2017) shows PM2.5 exceedances greatest in November, December, and January.

The daily venting index data for the South Island was only available up to Sept. 9, 2013 whereas the air quality information from Duncan Cairnsmore was available up to the present. Thus the only dates where we could compare the venting index with the air quality data were December 14, 2010 to Sept. 9, 2013 - an overlap period of 1002 days (Table 9). No clear trend was seen in these results: there were exceedances on both good and poor venting days. The highest percentage of exceedances occurred on fair venting days. Exceedances on poor venting days can be explained by poor smoke dispersal - any smoke generated is more likely to persist. On good venting days, people are outside, and are perhaps more likely to burn because of the favourable weather.

Table 8: Venting index days and Duncan Cairnsmore air quality data

Number of Days at Duncan Cairnsmore (Dec 14, 2010 to Sep 9, 2013)				
Venting Index	**Total Days**	**PM2.5 >25**	**PM2.5 <25**	**% Exceedances**
Poor	435	15	420	3.6
Fair	295	17	278	6.1
Good	271	9	262	3.4
Total	1001	41	960	4.3

Average Number of Days per Year at Duncan Cairnsmore (Dec 14, 2010 to Sep 9, 2013)				
Venting Index	**Avg # of days/yr**	**PM2.5 >25**	**PM2.5 <25**	**% Exceedances**
Poor	159	5	153	3.6
Fair	108	6	101	6.1
Good	99	3	96	3.4
Total	365	15	350	4.3

Other types of emissions and contaminants besides PM can occur in the airshed including:

- sulphur dioxide (SO_2)
- nitrogen dioxide (NO_2),
- total reduced sulphur (TRS),
- carbon monoxide (CO),
- Volatile Organic Compounds (VOCs)
- ozone (O_2)

Sources of air emissions in addition to open burning include: (CVRD 2015):

- Mobile vehicle and aircraft emissions
- Stationary industrial point sources
- Residential or commercial area sources
- Agricultural
- Road dust
- Motorized recreational vehicles
- Natural sources (eg forest fires started by lightning)
- Long range transport (fires in other areas)

Action items arising from the 2015 CVRD report are:

- Develop consistent airshed wide regulatory approaches for open burning

- Contribute to provincial efforts to control wood smoke through participation in wood smoke strategy discussions

3.1.5.4 Burning Bylaw Offences

The CVRD has monitored complaints regarding smoke and open burning. The bylaws in question are Bylaw 2020 (Land clearing) and Bylaw 3716 (Open burning). In all cases the offenses were outdoor open burning (as opposed heating with wood).

In the study area, the highest number of complaints are from the Cobble Hill, Cowichan Bay and Shawnigan Lake areas of the CVRD. These are fairly high population areas, and with growing public awareness around the air quality issue, it is not surprising that more calls originate from these locations.

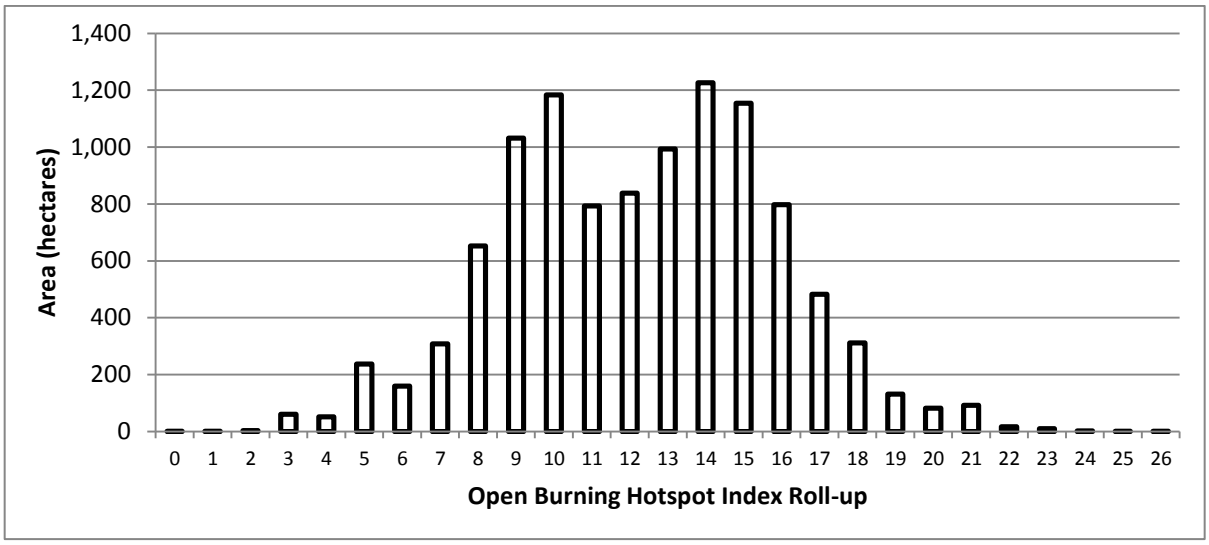
There are fewer complaints from the Cowichan Lake area, however this does not mean that there is necessarily less open burning in this area. There may be more public acceptance of outdoor burning in this area due to the proportionally higher number of people who work in forestry, heat-wood supply, or other related vocational, industries.

With more particulate matter accumulation occurring in the central Cowichan airshed due to atmospheric, vegetation and topographic controlled microclimate effects, it is not surprising that a number of the calls did come from established rural areas such as Sahtlam, Glenora, and South Cowichan. These are areas where outdoor burning does occur on a regular basis and sometimes outside of atmospheric windows due to allowance under farm-activity and the 'Right to Farm' act. However, these same rural areas are where people are also concerned with air quality and do note when aspects of their surround are 'not right'.

Because burning bylaw enforcement is dependent on complaints, which is partially dependent on public awareness and sensitivity to air quality issues, we decided not to include the density of offenses in our overall analysis.

3.1.5.5 Critical Burning Hotspot Index Rollup

Results of index rollup are presented in Graph 3 and Figure 7. Note that a value of 0 means there was no detected land clearing debris, yard waste volume, or development pressure associated with a parcel, as well as having the lowest likelihood of topographic smoke accumulation. Although the potential maximum index value was 28 (the sum of four indices, each with a maximum of 7), the actual maximum value within the study area was 26.



Graph 3. Open Burning Hotspot Index Rollup

MADRONE environmental services ltd

PROJECT: CVRD Open Burning Emissions Reduction Study

LOCATION: CVRD Electoral Areas | **CLIENT:** Cowichan Valley Regional District | **MAP DATE:** June 9, 2017 | **DRAWN BY:** Ian Wright | **DOSSIER:** 17.0074

N

FIGURE 6: Smoke Accumulation Airshed and Index

See Inset Map for Areas G & H

Area I

Lake Cowichan Fire Hall

Duncan Cairnsmore

Area D

Area E

Area F

Area B

Shawnigan Lake Discovery Elementary

Area A

Inset Map

Area H

Area G

Area G

Area F

1:150,000

0 2.5 5 10 km

1:150,000

LEGEND

- CVRD Air Quality Monitoring Stations
- Electoral Area Boundaries
- Smoke Accumulation Airshed

Smoke Accumulation Index (SAI)

[Mean parcel elevation relative to surrounding 2.5km radius]

- 0 - Least Accumulation Potential (relative high ground)
- 1
- 2
- 3
- 4
- 5
- 6
- 7 - Most Accumulation Potential (relative low-lying ground)

Digital Elevation Model (from 20m TRIM)

- High : 1593.33
- Low : 0

PROJECT: CVRD Open Burning Emissions Reduction Study				
LOCATION: CVRD Electoral Areas	**CLIENT:** Cowichan Valley Regional District	**MAP DATE:** June 9, 2017	**DRAWN BY:** Ian Wright	**DOSSIER:** 17.0074

FIGURE 7: Open Burning Hotspot Index Rollup

N

See Inset Map for Areas G & H

Area I

Area F

Area E

Area D

Area B

Area A

Area H

Area G

Area G

Area F

Inset Map

1:150,000

0 2.5 5 10 km

1:150,000

LEGEND

- Electoral Area Boundaries

Open Burning Hotspot Index Rollup

LCI + YWI + DPI + SAI

- 0
- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10
- 11
- 12
- 13
- 14
- 15
- 16
- 17
- 18
- 19
- 20
- 21
- 22
- 23
- 24
- 25
- 26

3.2 Best Management Practices (BMP) Evaluation

3.2.1 Review and Ranking of Yard Waste Management Practices

3.2.1.1 Review of Yard Waste Management Practices

Instead of burning, which is generally done by permit (depending on property use, material being burned, air quality, fire risk – See Section 3.2), regions and municipalities have the following programs in place and/or encourage people to do the following with their organics and yard waste:

- Curbside yard waste pick-up in bins between 246 L – 1080 L given by the municipality or in Kraft bags, or stick bundles, or piles according to guidelines on a weekly-monthly frequency commonly year round or from spring-fall, Table 10 shows a summary of these practices.
- Chipping programs ran by region or city (sometimes free).
- Yard-waste drop off (free or small fees).
- Encourages backyard composting, sources for backyard composting education, and yard waste reduction tips. Places to pick-up composting bins and learn how to compost. Tips on reducing pests in compost piles.
- Warns illegal dumping dangers.
- Gives advice on how to deal with wood waste:
    - Promoting chipping, chips can be used for: mulch, compost, landscaping, soil conditioning, animal bedding, pellets.
    - Prepare wood to be used as firewood.
    - Rebates on chipping.

Within Appendix A –Information about Yard Waste Management Approaches by Community the reader will find documentation of management practices used to fulfill Table 9 below.

Table 9: Yard waste pick-up information by comparable jurisdiction.

Jurisdiction	Population	Pop. Density /km²	Dominant Housing Type	Pickup Frequency	Collection Months	Max Volume	Max Branch Diameter	Cost per Household
Courtenay	55,213	88.3	Single-detached house (66.5%), Apartment (12.3%)	Weekly	Year-round	Unlimited	3" or 8 cm	$152.50/ household (incl. recycling, garbage and yard-waste)
Squamish	17,479	165.5	Single-detached house (49.5%), Apartment (17.2%), Row house (13.8%)	Bi-weekly Weekly from June-October (pending)	Year-round	246 L (or 120 L for townhouse residents)	2" or 5 cm	For 132L $190/year For 246L $263/year For 356L $405/year Costs include garbage, recycling, and organics collection
Grand Forks	4,049	338.1	Single-detached house (77%)	Monthly	Monthly Mar – Nov (9 times/yr)	3 garbage cans of volume (bundles + cans can't pass "3 cans of volume")	3" or 8 cm	Not found
Chilliwack	92,308	75.7	Single-detached house (61.6%), Apartment (17.1%)	Weekly	Year-round	1 "Green Cart" up to 360 L, during Apr-Jun & Sep-Nov can also put out 10 extra paper bags or branch bundles/week at no extra cost. Outside of these times, can buy a bag tag for extras.	6" or 15 cm	Yard waste collection included in utility charge and covers entire cost of program. Depends on green cart size: 80L = $18.00 120L = $18.60 240L = $19.20 360L = $19.80
Abbotsford	143,000 83% rural (by area) 17% urban (by area)	355.5	Single-detached (43.6%), Apartment (25.8%)	Weekly	Year-round	10 x 80 L cans per week weighing less than 23 kg each (or tied bundles or Kraft paper bags)	6" or 15 cm	$220/year
Campbell River	32,000	20.8	Single detached house (66.4%), Apartment (13.2%)	Weekly	Mar 6-Nov 24	Unlimited	3" or 7.5 cm	$189/year

Jurisdiction	Population	Pop. Density /km²	Dominant Housing Type	Pickup Frequency	Collection Months	Max Volume	Max Branch Diameter	Cost per Household
Terrace	15,569	210.6	Single-detached house (37%) Apartment (9.9%)	Weekly	Spring-Fall	Unlimited	0.4" or 1 cm	Not found.
Port Angeles, WA	19,256	687	Not found	Bi-weekly (Mar-Nov) Monthly (Dec-Feb)		Doesn't specify	4" or 11 cm	Extra $8.85 USD/month
Olympia, WA	50,302	1007	Not found	Bi-weekly	Year round	360 L	No limit specified	$20.5 USD/ Bi-monthly
Regional District of Central Okanagan	179,839 81% Urban 19% Rural	61.9	"Private occupied dwellings" : 83,836	Bi-Weekly	Mar-Nov	Can upgrade up to 1080 L	2" or 5 cm	Between $0- $86/year
Prince George	84,232	4.8	Single-detached house (65.5%), Apartment (13.3%)	No curbside yard-waste pick-up.				
Sunshine Coast Regional District	29,970	7.9	Single-detached house (80%)	No curbside yard-waste pick-up.				

3.2.1.2 Ranking of Yard Waste Management Practices

Existing and operational yard waste management practices explored in section 3.1 are deemed to be 'successful' in the sense that they are currently serving communities within BC. As such, the BMP – being the one that works for a specified area – is a matter of feasibility when deploying a similar program customized to meet CVRD electoral area requirements. This section 'ranks' the yard waste BMP for each electoral area by identifying which management practice is successful in comparable districts through a series of metrics, in the following tables.

Within said tables, we present the Cowichan Valley with the most similar community match based on urban to rural land area percentages. The tables compare population densities, land area, current solid waste management area covered, urban and rural coverage and populations which are covered by the service in question.

An overview of the Cowichan Valley Regional District (excluding Duncan, North Cowichan, Ladysmith, and Lake Cowichan) with the top seven best matches from the community review is presented along with information of their statistics related to curbside pick-up in Table 10.

Table 11 further breaks down the Cowichan Valley Regional District into its nine electoral districts (A-I), providing an approximation of the urban and rural area percentages (this time excluding agricultural, forestry, and commercial land) within the respective electoral area.

In Table 12, each district is matched with the community with the most similar values of urban to rural area composition that is covered by curbside yard waste pick-up.

Table 13 compares the population data with the two regions found to provide chipping programs. Appendix B – Qualicum Beach Chipping Information contains transcript of interviews with Qualicum Beach waste management coordinator used to inform the feasibility of a Chipping Program.

TABLE 10: COMPARABLE COMMUNITY CURBSIDE WASTE PICK-UP INFORMATION.

The six communities with most comparable populations proportions and good yard waste management practices are listed along with statistics on the population served by curbside yard waste collection.

Jurisdiction	Population density in area of collection	Total approximate area of collection routes (km^2)	Total approximate area of jurisdiction (km^2)	Population of jurisdiction	Approximate waste collection area urban (incl. commercial) vs. rural(incl. agricultural)	Number of private dwellings	Curbside yard waste collection? How often?
Cowichan Valley Regional District excluding Duncan, North Cowichan, Ladysmith, Lake Cowichan	24.1[1]	235	3471	46,383	142 km^2 urban -60% 93km^2 rural - 40% Total collection area 235km^2	13,012	No
Central Okanagan Regional District, Including all municipalities	67.1[1]	753	2905	194,882 81% Urban 19% Rural	97km^2 urban – 13% 657km^2 rural - 87% Total collection area 753km^2	81,383	Yes, bi-weekly for 9 months/year
City of Chilliwack	320.2	281	261	83,788	36 km^2 urban – 13% 245 km^2 rural – 87% Total collection area 281 km^2	32,440	Yes, weekly year-round
City of Abbotsford-Mission	281	97	602	181,000	30km^2 urban – 31% 67km^2 rural – 69% Total area collected: 97km^2	62,631	Yes, weekly year-round

Jurisdiction	Population density in area of collection	Total approximate area of collection routes (km^2)	Total approximate area of jurisdiction (km^2)	Population of jurisdiction	Approximate waste collection area urban (incl. commercial) vs. rural(incl. agricultural)	Number of private dwellings	Curbside yard waste collection? How often?
City of Campbell River	225	31	143	31,000	22km^2 urban – 70% 10km^2 rural – 32% Total area collected: 31km^2	14,201	Yes, weekly for 9 months/year
City of Courtenay	789	27	32	25,600	20km^2 urban – 63% 12km^2 rural - 37% Total area collected: 32km^2	24,512	Yes, weekly year-round
City of Grand Forks	388.1	10	10	4,049	10km^2 urban – 100% Total area collected: 10km^2	1,944	Yes, monthly for 9 months/year
City of Prince George[2]	232.5[1,2]	178	318	74,003 Not all included in curbside pick-up	63km^2 urban – 35% 115km^2 rural – 65% Total are collected: 178km^2	32,098	No

[1]For entire region, not just area of collection, for just area of collection would presumably be higher

[2] Prince George disqualified from further comparison due to little yard-waste management in practices.

Table 11: The nine electoral areas of the CVRD

(excluding Lake Cowichan, Duncan, North Cowichan, and Ladysmith) with statistics on current solid waste collection routes and population breakdowns of the area.

CVRD electoral area	Population density[13]	Total approximate area of collection routes (km²)	Total approximate area of jurisdiction (km²)	Population of jurisdiction [14]	Approximate urban and rural population by area	Number of private dwellings	Curbside yard waste collection? How often?
A – Mill Bay/Malahat	not available	38	49	4393	4 km² urban – 30% 9 km² rural – 70% Total populated area: 13 km²	1768	No
B – Shawnigan Lake	not available	57	307	8127	18 km² urban - 75% 6 km² rural - 25% Total populated area: 24 km²	3066	No
C – Cobble Hill (South Cowichan)	not available	20	23	4796	3 km² urban -60% 2 km² rural- 40% Total populated area: 5 km²	2113	No
D – Cowichan Bay	not available	12	15.7	2971	2km² urban – 67% 1km² rural – 33% Total populated area: 3 km²	1269	No
E – Cowichan Station / Sahtlam / Glenora	not available	48	135	3854	8 km² rural -100% Total populated area: 8 km²	1528	No

[13] http://www12.statcan.gc.ca/census-recensement/2011/as-sa/fogs-spg/select-Geo-Choix.cfm?Lang=Eng&GK=CMA&PR=10#PR59
[14] http://www.bcstats.gov.bc.ca/StatisticsBySubject/Census/2011Census/PopulationHousing/MunicipalitiesByRegionalDistrict.aspx

CVRD electoral area	Population density[13]	Total approximate area of collection routes (km^2)	Total approximate area of jurisdiction (km^2)	Population of jurisdiction [14]	Approximate urban and rural population by area	Number of private dwellings	Curbside yard waste collection? How often?
F – Cowichan Lake South / Skutz Falls	not available	19	1793	1649	2 km^2 urban -25% 6 km^2 rural -75% Total populated area: 8 km^2	712	No
G – Saltair / Gulf Islands	not available	6	295	2221	1 km^2 urban - 20% 4 km^2 rural - 80% Total populated area: 5 km^2	993	No
H – North Oyster / Diamond	not available	6	295	2221	1 km^2 urban - 20% 4 km^2 rural - 80% Total populated area: 5 km^2	993	No

TABLE 12: CURBSIDE PICK-UP COMPARABILITY TABLE BY ELECTORAL DISTRICTS WITH THEIR BEST COMMUNITY MATCH BASED ON RURAL TO URBAN POPULATION AREA RATIO.

Jurisdictions with Curbside Collection of Yard Waste						
CVRD Electoral Areas	**Central Okanagan Regional District**	**City of Chilliwack**	**City of Abbotsford-Mission**	**City of Campbell River**	**City of Courtenay**	**City of Grand Forks**
A – Mill Bay/Malahat			X			
B – Shawnigan Lake				X		
C – Cobble Hill (South Cowichan)					X	
D – Cowichan Bay				X		
E – Cowichan Station / Sahtlam / Glenora	X	X				
F – Cowichan Lake South / Skutz Falls			X			
G – Saltair / Gulf Islands	X	X				
H – North Oyster / Diamond			X			
I – Youbou / Meade Creek					X	

TABLE 13: CHIPPING SERVICE COMPARABILITY SUMMARY. COMMUNITIES COMPARED BY POPULATION, HOUSING NUMBERS AND LAND AREA USAGE.

Jurisdiction	Population Density in area of collection (people/km²)	Total approximate area of collection routes (km²)	Total approximate area of jurisdiction (km²)	Population	Number of private dwellings	Total approximate area of urban and rural centers	Chipping program?
Cowichan Valley Excluding Duncan and North Cowichan, Ladysmith, and Lake Cowichan	24.1[15]	230	3471	46,383	13,012	47 km² urban- 57% 35 km² rural- 43% Total populated area: 82 km²	No
Town of Qualicum Beach	497.4	18	18	8,943	4,644	6 km² urban - 66% 3 km² rural – 33% Total populated area: 9 km² *urban includes commercial and rural includes agricultural	Yes, for residents in city boundaries
Regional District of Central Okanagan Including municipalities	67.1	2905	2905	194,882 81% Urban 19% Rural	81,383	-	Yes, for agricultural use

3.2.2 Review of Open Burning BMPs

3.2.2.1 Open Burning and Forest Fire Risk

Within BC, over the past 10 years an average of 39% of wildfires was human caused (as opposed to lightning caused). The human causes are generally, as stated by the Province of British Columbia: "open burning, the use of engines or vehicles, dropping burning substances such as cigarettes, or any number of other human-related activities that can

[15] For entire region including Duncan and North Cowichan, Ladysmith, and Lake Cowichan, not just area of collection.

create a spark or a heat source sufficient to ignite a wildfire."[16] While human-caused, there is often a compounding excess of combustible fuel which results in an increased forest fire risk.

The common use of open burning to dispose of land clearing debris prompted us to investigate mitigation measures. The fuel types present on development properties (i.e. land clearing debris) can be variable, but they are often forested with young or mature trees. These fuel types will be similar to the coniferous, deciduous and mixed fuel types (Classes C-1 to C-7) described in Strathcona (2012).

Lands where open burning is likely to occur should be ranked Moderate, High or Extreme according to the Interface Wildfire Threat rating classes (Strathcona 2012).

- Moderate: built-up suburban areas with dispersed fuel types; tree overstory less than 20% canopy coverage, patches of conifer trees, good fire protection and adequate response times.
- High: forested land with conifer cover exceeding 40% canopy closure, dispersed rural development, delayed fire protection or no fire protection, difficult access, threats to homes and structures.
- Extreme: Forested land with continuous conifer closed canopy, low water availability, often outside fire protection boundaries, some inaccessible terrain, history of frequent fires, threats to home and structures.

Mapping of potential land clearing debris was conducted in Section 2.1.2 – Predicted Land Clearing Volumes of this report. It is also possible to apply the methodology used for Section 2.2.1 – Land Cover Classification to surrounding forested areas, which would provide the necessary information to rank surrounding lands under the Strathcona (2012) scheme.

Therefore, identification of development areas that increase forest fire risk within high or extreme Wildfire Threat zones is feasible as an extension of geospatial data developed for this research program. Identifying select areas as contributors to forest fire risk due to open burning facilitates the use of targeted management programs for reducing open burning.

[16] Wildfire Averages: http://www2.gov.bc.ca/gov/content/safety/wildfire-status/wildfire-statistics/wildfire-averages (Accessed May 2017)

3.2.2.2 Review of Open Burning Bylaws

The following is a listing of existing open burning bylaws enacted by comparable jurisdictions.

Abbotsford

Relevant bylaws: Consolidated Fire Service Bylaw #1513-2006
Burning regulations:

- Open air burning on urban areas banned, open air burning in rural areas with permit.
- Land clearing burning with permit from Oct 1 - May 31.
- No rural burning from June 1 - Sept 30.

Campbell River

Relevant bylaws: Clear Air Bylaw #3293
Burning regulations:

- Banned open burning of garbage and noxious materials (including yard waste and compost) within Campbell River Area A: Clean Air Bylaw No. 3293, 2007.
- Open fire with permit outside of central city (Area B).

Chilliwack

Relevant bylaw: Open Air Burning Regulation Bylaw #3511
Burning regulations:

- Burning allowed by permit during: March 1 - April 30 and October 1 -November 30.
- Burning prohibited in residential zones.
- No land clearing burning allowed.
- $25/permit.
- Permit lasts for the 2 month burning seasons.

Courtenay

Relevant bylaws: Fire Protective Services Bylaw #2556
Burning regulations:

- Allowed within the Fire Protection district (but outside of city boundaries) when no Air Quality Advisory in effect with permit between April 1 - October 31.

- No fires in city limits.
- No burning garbage or any material producing black smoke.
- No land clearing slash burning in city limits.

Grand Forks

Relevant bylaws: Bylaws #1965 and #1605.
Burning regulations:

- Burning in city not allowed (Bylaw 1965).
- No one shall light a fire in open air without permit from the Fire Chief.
- Burning of garden waste prohibited in the city boundaries.
- Outdoor incinerators banned in city limits.

Nelson

Relevant bylaws: Fire Regulation and Prevention #3268
Burning regulations:

- Allows backyard burning in city for 2 weeks (not guaranteed, depends on risk) in April or May, untreated wood only, still need permit. $10/permit.

Redding, CA.

Burning regulations:

- Specified burn days with size and placement restraints.
- Only for residents of single and two-family dwellings burning dry vegetation (or agricultural). $9/permit.
- Residential burn season from Nov 1st-April 30th. Permit required. Allowed in city limits and in Fire Department Districts.

Prince George

Relevant bylaws: Clean Air Bylaw #8266
Burning regulations:

- No open burning in city limits (yard materials other than fire wood).

Regional District of the Central Okanagan:

Relevant bylaws: Smoke Control Regulatory Bylaw #773, #1066
Burning regulations:

- Open burning (with permit and air quality permitting) allowed from October 1st to April 30th.
- Burning materials allowed: wood, prunings, tree trunks, vegetation which has been drying for at least two years.
- Burning only allowed on days with low particulate matter and a high venting index.
- Illegal to burn compostable materials (leaves, grass clippings) and garbage.
- It is suggested to not start until after 10 am due to poor venting, and to dry material for burning to under 50% dryness. Also suggested smaller piles for more efficient burning.
- Illegal to burn compostable materials.

District of Sechelt

Relevant bylaws: The Open Air Burning Bylaw #486
Burning regulations:

- Land clearing burning prohibited since Jan 2014.
- Burning not allowed apart from campfires.

Squamish

Relevant bylaws: Fire Service Bylaw #2314
Burning regulations:

- Land clearing debris permit: $500.
- Burning generally not allowed- campfires only.

3.2.2.3 Programs for Open Burning Reduction

Through survey of comparable jurisdictions, we found that open burning reduction programs generally involved:

- Composting programs (information, encouragement support programs and one-time or repeating opportunities for people to acquire tools in order to start backyard composting);
- Curbside yard waste pick-up;
- Putting in place “voluntary no-burn days” and “mandatory no-burn days”, and fire bans when air quality is poor;
- Re-use of lumber when possible;

- Leaving grass clippings on lawn to compost so as to reduce yard waste;
- Landfill/green depot drop-off of yard waste;
- Wood chipping and removal or compost;
- Energy and biomass recovery facilities (turning wood waste into pulp, methanol/ethanol production, wood pellets, garden bedding, compost, mulch, fibre, particle board);
- Permits required to burn;
- Designated burn days, burning permits required, and banning land clearing burning;

See Appendix A for detailed yard waste management practices by evaluated jurisdiction.

3.2.3 First Order Financial Assessment of Curbside Collection

Using road network mapping, a form of network analysis, we determined an average density of 30 houses/km of urban road; while rural areas had a density of 10 houses/km. Equating the roughly 13,012 individual households in a 57/43% split between urban and rural (see Table 14 above) results in a collection route distance of 247km in urban and 560km in rural areas, for a total driving distance of 807km.

The operational cost of trucking, using a six-axled flatbed expenses as equivalent to a standard three-axle solid-waste management compactor truck, within BC at a marginal 5% profit margin is between 240 to 206.9 cents/km, based on annual KM driven. Assuming nine months of weekly yard waste curbside pickup, with a total driving distance of 807km + 50% as waste-transport to drop-off when full – there is a total yearly transport distance requirement of 43,578km. As such, the operational cost of trucking would fall under the 240 cents/km category. A nine-month per kilometer operational cost with 5% profit margin – including operator – based on a single dedicated curbside yard-waste collection vehicle servicing all 9 electoral districts of CVRD is estimated as **$104,587.**

By comparing the CVRD electoral areas to reasonably similar districts we determined that a feasibility assessment for yard waste pickup to serve over 23,500 households of the Regional District of Nanaimo provides a useful benchmark. This was estimated to cost an average of $50/household to provide bi-weekly collection and processing for 9 months of the year, despite contractor estimates of $18 to $36 per household[17]. As such, the simple equitable arithmetic indicates an annual cost of curbside collection for CVRD to fall

[17] http://www.rdn.bc.ca/dms/documents/solid-waste-management-plan-review/yard_waste_collection.pdf

between **$468,432**, as the reasonable upper-end of contractor estimates, and **$650,600** as the actual cost incurred by the CVRD. Additionally, it is of significance to future CVRD consideration of curbside yard waste collection that the Regional District of Nanaimo did not pursue the 9 months bi-weekly collection option after financial review. A reduced collection window to coincide with primary yard waste generation seasons with a modified pickup schedule may be appropriate for the CVRD.

It should be noted that the latter figure includes processing, and other poorly-publicized accounting, while the former is a straight accounting of operational cost (including profit) of a waste collection truck.

4 Summary and Conclusions

Through this study, we have:

- Assessed production factors of land clearing debris in Sections 2.1, 3.1 & 4.1, and Tables 3 & 4. Potential land clearing debris volumes had the geospatial distribution resolved within map products – subset examples of which are provided as hard copies in Figures 3a, 3b, 4, and 5;
    - It was found that electoral areas B, F, E and A (in descending order of volume) will likely generate the most land clearing debris on an annual basis under the current OCP implementation over the next 30 years.

- Integrated multidisciplinary factors contributing to land clearing debris and yard waste hotspots in Sections 2.1.3, 3.1.3, and 4.1.3, which was further broken down in Table 6 & 7;
    - An approach which uses standard waste composition tables for estimating future yard waste production was determined to be not applicable to the CVRD Electoral areas and was not used in this study.
    - Non-vacant parcels in the CVRD Electoral areas are predicted to generate an average of 4.1 tonne/ha/year of yard waste.
    - Predicted annual yard waste production is 3 – 4x larger than reported tonnage at recycling facilities in 2016.

- Resolved motivating and impact factors of backyard burning in Sections 2.1, 3.1.5, and 4.1.5, and extended the impact of open burning into an integrated 'Open Burning Hotspot' map product, as shown in Figure 7;

- factors contributing to participation in recycling programs concluded that participation was weakly correlated with cost or convenience;
    - We have not included a proximity to organic recycling facilities factor in our analysis.

- The highest percentage of particulate matter index exceedance events occurred on fair venting days. On fair to good venting days, people are outside in favourable weather, and are perhaps more likely to burn because of said weather.
- Open burning complaint calls primarily originated from established rural areas such as Sahtlam, Glenora, and South Cowichan;
    - Outdoor burning does occur on a regular basis in rural areas, and sometimes outside of atmospheric windows due to allowance under farm-activity and the 'Right to Farm' act.

- Identified, evaluated and conveyed current BMP of comparable regional districts and municipalities within BC through Sections 2.2, 3.2, 4.2 and further explored in Tables 10 through 14;
    - Curbside yard waste pick-up, chipping programs, drop-off yards and facilitating backyard composting were the most common, and reportedly successful, BMP to reduce open burning of yard waste.

- Resolved the most applicable, functioning, yard and garden waste management programs in comparable regional districts and municipalities of BC through Section 3.2.1 – 3 and 4.2.1 – 3.
    - Education, engagement and value-added opportunities were cited in *per. Comm.* as important components of BMP.
    - Each district is matched with the community with the most similar values of urban to rural area composition that is covered by curbside yard waste pick-up in Table 12.
    - A summary of Chipping Service compatibility is presented in Table 13.
    - Cost of operating a curbside collection truck for all 9 electoral districts is estimated to be ~$105,000 for nine months of each year;

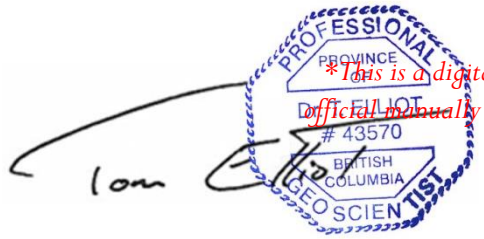
- Including tipping fees, facilitation, sorting, etc. and other additional costs of running a curbside yard waste collection program, the total would range between ~$468,000 - $651,000 for nine months of each year.

5 Recommendations

- Accounting for potential land clearing debris, I recommend that CVRD consider a chipping, splitting or other debris disposal requirement for development permits issued in Electoral Areas B, F, E and A.
  - A program such as this can be operated under environmental Qualified Professional guidance, similar to existing soil deposit, riparian or stormwater bylaws.

- An engagement and facilitation campaign to increase the diverted proportion of yard waste to organic recycling facilities would be prudent.
- To address the proportion of open burning reports in rural areas, I recommend that CVRD consider facilitating an on-site organic matter recycling program whereby rural properties and farm operators can access a supported mobile chipping/shredding program.
- I recommend communication, engagement and facilitation of backyard composting, as supported by BMP reviewed within this study.
- I recommend CVRD conduct a detailed financial analysis of a very limited curbside collection of yard waste for Electoral Areas which currently receive waste-disposal services.
  - The scoping of this should be limited to high-volume times of year, which are typically Spring and Autumn; otherwise backyard composting engagement programs would be made less effective through decreased use.

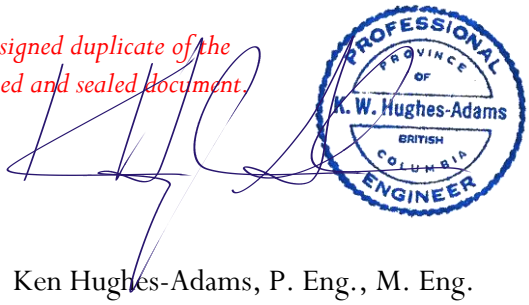
Prepared by:



Thomas R. Elliot PhD P.Geo P.Ag

*This is a digitally signed duplicate of the official manually signed and sealed document.

Reviewed by:



Ken Hughes-Adams, P. Eng., M. Eng.

6 Limitations

One limitation in property yard waste mapping was the absence of building footprint size for each parcel. If available, we would have been able to further eliminate smaller parcels where the building footprint size exceeded that of the parcel's interior buffer polygon. It is likely that some of the smaller lots that were included in this study would be excluded, as the interior area (greater than 10m from the property boundary) is covered by a building and outdoor burning would not be allowed.

As we acknowledge there are significant limitations to the Waste Composition Table methods in section 2.1.4. In fact, we do not recommend using values generated from this method as they have proven to be unreliable and under-report the potential total of yard waste generated per annum.

7 References

Where not provided throughout as footnotes with commentary, works referenced to generate this report are as follows.

BC Ministry of Agriculture. 2014. Farm Practice – Burning. Strengthening Farming Order No. 870.218-28. Accessed from http://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/agriculture-and-seafood/agricultural-land-and-environment/strengthening-farming/farm-practices/870218-28_burning.pdf

BC Ministry of Forests. 1995. Summary of BC forest inventory statistics by land administration class. Vol. 6. Vancouver Forest Region. Research Branch BC Min of Forests, Victoria, BC.

Blaine, T.W., Mascarella, K.D. and D.N. Davis. 2001. An Examination of Rural Recycling Drop-Off Participation. *Journal of Extension*. 39:5.

CalRecycle. 2011. Landscape Waste Prevention – Grasscycling. Accessed from http://www.calrecycle.ca.gov/organics/grasscycling/

Canada Department of Agriculture. 1963. Growing Forage Crops on Vancouver Island. Publication 1181.

CVRD. 2015. Cowichan's Regional Airshed Protection Strategy.

Federation of Canadian Municipalities. 2004. Solid Waste as a Resource Workbook.

FCSWMD (Franklin County Solid Waste Management District). N.d. Don't Trash Grass. Accessed from http://www.franklincountywastedistrict.org/grass.html
Ramayah, T., Lee, J. W. C., & Lim, S. .2012. Sustaining the environment through recycling: An empirical study. Journal of Environmental Management.,102: 141-147.

Rhodes, R.E., Beauchamp, M.R., Conner, M., de Bruijn, G-J, Kaushal, N. and A.L. Cheung. 2014. Prediction of Depot-Based Specialty Recycling Behaviour Using an Extended Theory of Planned Behaviour. Journal of Environment and Behaviour. 1-23.

Schultz, P.W., Oskamp, S. and T. Mainieri. 1995. Who recycles and when? A review of personal and situational factors. Journal of Environmental Psychology. 15:105-121.

Sidique, S.F., Lupi, F. and S.V. Joshi. 2010. The effects of behavior and attitudes on drop-off recycling activities. Journal of Resources, Conservation and Recycling. 54:163-170.

Statistics Canada. 2007. Recycling by Canadian Households. Accessed at http://www.statcan.gc.ca/pub/16-001-m/2010013/part-partie1-eng.htm

Strathcona Forestry Consulting. 2012. Cowichan Valley Regional District Community Wildfire Protection Plan 2012 Update. Report to CVRD, Duncan BC

Tetra Tech EBA. 2015. CVRD Waste Composition Study.

Torrella, L., Lim, Y. and Waraich, T. 2013. Organic Waste Composition Study. Technical memo provided by TRI Environmental Consulting to the City of Surrey.

APPENDIX A

INFORMATION ABOUT YARD WASTE MANAGEMENT APPROACHES BY COMMUNITY

Abbotsford

http://www.abbotsford.ca/city_services/garbage_recycling_and_composting.htm Slides 176 onward:
http://www.abbotsford.ca/Assets/2014+Abbotsford/Corporate+Services/Finance/Budget+Presentations/2017-2021+Financial+Plan+Budget+Presentation.pdf

- Yard and garden waste collection:
    - In compost bin with household compost collected weekly.
    - Accepts: Yard waste includes grass clippings, tree pruning, hedge pruning, leaves, plants, flowers, weeds, bark mulch and trunks/branches up to 1.0 m in length and 60 cm in diameter.
    - Max amount: 10 x [80 L cans (weighing less than 23 kg each) per week or tied bundles (12 kg max each) or Kraft paper bags (max 12 kg each)].
- Burning regulations:
    - Open air burning on urban areas banned, open air burning in rural areas with permit.
    - Land clearing burning with permit from Oct 1 - May 31.
    - No rural burning from June 1 - Sept 30.
- Other options given for yard waste:
    - Coupons for free yard waste drop-off.
    - Land clearing waste to go to yard waste drop-off facility for a fee, and chipping services also for a fee.

Campbell River

http://www.campbellriver.ca/docs/default-source/Document-Library/bylaws/3293-clean-air-bylaw-2007-consolidated-to-3388-2009.pdf?sfvrsn=4

http://www.campbellriver.ca/docs/default-source/Document-Library/bylaws/3509-recycling-and-garbage-regulations-2013-consolidated-to-bylaw-3621-2016.pdf?sfvrsn=6

http://www.campbellriver.ca/docs/default-source/Document-Library/bylaws/3271-user-fees-and-charges-bylaw-consolidated-to-3664-2016.pdf?sfvrsn=6

Relevant bylaws: Clear Air Bylaw #3293 Recycling, Garbage Regulations Bylaw #3509 and User Fees and Charges Bylaw #3271

- Curbside collection program for yard waste:
    - Cost: $ 189 annually as a Solid Waste user Fee for organic, recycle, and garbage pick-up.
    - March 7 to November 25 for weekly yard waste pick-up.
    - Accepted and unaccepted materials: "Leaves, grass clippings, branches, plants, flowers, tree or hedge trimmings, and small amounts of sod or soil are acceptable. Items not accepted include: rocks, stumps, painted or treated wood, garbage, kitchen waste, home renovation or construction materials"
    - Must be in compostable bags or rigid open-top containers (max 80L) unlimited amount.
    - "Yard Waste shall be placed in biodegradable bags, kraft paper yard waste bags, or lidded refuse containers no larger than 80 litres and clearly marked as containing Yard Waste. No bag or container containing contents shall exceed 20 kilograms in weight. Tree and hedge prunings and branches shall be tied in secure bundles not longer than 90 centimetres, not wider than 60 centimetres, not weighing more than 20 kilograms, and with an individual branch not exceeding 7.5 centimetres in diameter. Yard Waste shall be set out for collection in a similar manner as required in Section 14 (d) for the collection of Garbage and Recyclable Materials."

- Burning regulations:
    - Banned open burning of garbage and noxious materials (including yard waste and compost) within Campbell River Area A: Clean Air Bylaw No. 3293, 2007.

- Open fire with permit outside of central city (Area B).

- Other options given for yard waste:
  - Yard Waste Drop-off Centre (open year round), and 2 other yard waste drop off centers.
  - Encouragement and information for backyard composting.
  - Illegal Dumping Dangers – educational info.

Chilliwack

http://www.chilliwack.ca/main/page.cfm?id=2547
http://www.chilliwack.ca/main/page.cfm?id=245
http://www.chilliwack.ca/main/attachments/Files/363/BL%203511%20Open%20Air%20Burning%20Regulation%20Bylaw%20%28Consolidated%29.pdf

Private communication

Relevant bylaw: Open Air Burning Regulation Bylaw #3511

- Curbside collection program for yard waste:
  - Implemented May 1st 2017 green cart system includes household compost and: glass clippings, flowers and weeds, leaves and moss, small trimming and branches (up to 6" in diameter), plants (no rocks or soil), sawdust and shavings.
  - Entire cost of program is covered by the user fees (between 80L for $18/month – 360L for $19.80/month)

- Burning regulations:
  - Burning allowed by permit during: March 1 - April 30 and October 1 -November 30.
  - Burning prohibited in residential zones.
  - No land clearing burning allowed.
  - $25/permit.
  - Permit lasts for the 2 month burning seasons.

- Other options given for yard waste:
  - Green depot drop-off ($55/tonne for yard waste or $75/tonne for invasive species.)

- Sanitary landfill yard waste and clean wood collection ($5 flat rate up to 55kg, $89/tonne up to 5 tonnes.)
- Backyard composting.
- Leave grass clippings on lawn.
- Discourages illegal dumping and states dumping within 30 meters of watercourse is illegal.

Courtenay

http://www.courtenay.ca/

http://www.courtenay.ca/EN/main/departments/courtenay-fire-department/open-burning.html

- Curbside collection program for yard waste:
  - Branches must be less than 3" diameter.
  - Does not accept: rocks or stumps, painted or treated wood.
- Burning regulations:
  - Allowed within the Fire Protection district (but outside of city boundaries) when no Air Quality Advisory in effect (with permit between April 1 - October 31).

Grand Forks

http://www.grandforks.ca/recycling-garbage/

http://www.grandforks.ca/wp-content/uploads/bylaws/bylaw1965.pdf
https://www.rdkb.com/LinkClick.aspx?fileticket=YNEZXJvydA4%3d&tabid=552

Relevant bylaws: Bylaws 1965 and 1605.

- Curbside collection program for yard waste:
  - 3 "cans" of volume allowed each pick-up.
  - Pickup happens 9 times a year at month intervals.
  - Included cost in utility bill.
  - Illegal since 2001 to put yard waste in garbage.
- Burning regulations:
  - Burning in city not allowed (bylaw 1965).

- No one shall light a fire in open air without permit from the Fire Chief.
- Burning of garden waste prohibited in the city boundaries.
- Outdoor incinerators banned in city limits.

- Other options given for yard waste:
  - Yard waste drop off:

    Yard and garden waste (grass and leaves, including branches less than 1 cm): $5/load.

    Branches and wood waste: $50/tonne ($2.50 minimum).

    Land clearing waste: $175/tonne.

Nelson

http://www.nelson.ca/assets/City~Services/Pubs~and~Reports/Composting%20Review_Final_Reduced_Web.pdf#search="yard waste"

http://www.nelson.ca/EN/main/services/fire-rescue-services/faqs.html
https://nelson.civicweb.net/filepro/documents/488?preview=18081

Relevant Bylaws: Fire Regulation and Prevention #3268

- No curbside pick-up of yard waste.
- Burning regulations:
  - Burning with permits ($10/permit).
  - Allows burning for 2 weeks (not guaranteed, depends on risk) in April or May, untreated wood only.
- Other options given for yard waste:
  - Free yard waste drop-off for 2 specified days in May otherwise $5-50/load for drop-off.
  - City received $140,000 from Recycle BC to fund waste management.

Olympia, WA

http://olympiawa.gov/city-utilities/garbage-and-recycling/organics-and-yard-waste/commercial-organics.aspx

- Curbside collection program for yard waste:
  - Bi-weekly collection, 360 L bins provided.

- Bin combines yard waste with household organics.
- Allowed: Grass, shrubs & limbs, flowers & leaves, potted plants, lumber scraps (not painted, stained or treated).

- Other options given for yard waste:
  - Promotes leaving grass clippings on lawn.
  - Promotes backyard composting.
  - Insect and rodent prevention information of organics bins.

Port Angeles, WA
http://wa-portangeles.civicplus.com/Faq.aspx?QID=118

- Curbside collection program for yard waste:
  - Yard waste bin with monthly fee, 4" branch max, as much allowed as will fit in bin.
  - Extra bin at extra cost.

Redding, CA
http://www.cityofredding.org/departments/solid-waste/residential-customers/green-waste

- Curbside collection program for yard waste:
  - Weekly collection of green bin (yard waste, max 4" diameter for branches).
  - 242L -363L bins available.

- Burning:
  - Specified burn days with size and placement restraints.
  - Only for residents of single and two-family dwellings burning dry vegetation (or agricultural). Residential burn season from Nov 1st-April 30th. Permit required. Allowed in city limits and in Fire Department Districts.

- Other options given for yard waste:
  - Offers free leaf disposal at drop-off station from Nov 1st – Jan 31st for non-commercial.

Prince George

http://www.rdffg.bc.ca/services/environment/waste-reduction/overview-15
http://www.rdffg.bc.ca/uploads/reports/Solid-Waste/RSWMP2015.pdf

https://bylaws.princegeorge.ca/Modules/bylaws//Bylaw/Details/2ba611d7-0d3e-40fd-9533-9284a1097a86

Relevant bylaws: Clean Air Bylaw (#8266), Garbage Collection Regulation Bylaw #7661 (couldn't open).

- No curb-side pick-up of yard waste.
- Burning regulations:
    - No open burning in city limits (yard materials other than fire wood).
- Other:
    - Encourages backyard composting (how-to guides online and hardcopy).
    - Landfill accepts:

        Land clearing waste disposed of at landfill for $82/tonne (or $6 minimum).

        Yard and garden waste disposed for free. Branches up to 3" diameter, leaves, clippings, and plants, and chips less than 5 cm.

Regional District of the Central Okanagan:

https://www.regionaldistrict.com/your-services/waste-reduction-office/yard-waste.aspx
http://www.investkelowna.com/application/files/6114/7795/4798/rdco_ag_overview_2009-03.pdf

https://www.kelowna.ca/sites/files/1/docs/related/2016_landfill_annual_report_.pdf

Source: private communication

- Curbside collection program for yard waste:
    - Program began in 2009.
    - $117/yr for 240 L bin, money collected through mix of utilities and taxes (depending on municipality in Central Okanagan).
    - Bi-weekly yard waste collection.
    - Extra yard waste (up to 250 kg) can be dropped at landfill for free or another nearby waste facility with fee.

- Accepted contents in the container: Grass clippings, leaves, weeds, plant trimmings, pruning up to 2" in diameter, pine needles and cones, pumpkins, fruit droppings. Cannot add household compost.
- Waste quantity limits and costs by city or district:

  City of West Kelowna: Can have three 360 L containers adding $70/year compared to one 240 L.

  City of Kelowna: Offers containers between 240-360 L. A household can have up to three 360 L carts. (up to $66 / year added to property taxes to upgrade from one 240 L cart to for the max of three 360 L carts).

  District of Lake Country: Can have max three 360L containers adding $86/year compared to one 240 L.

  District of Peachland: Can have three 360 L containers adding $70/year compared to one 240 L.

- Burning :
  - Open burning (with permit and air quality permitting) allowed from October 1st to April 30th.
  - Burning materials allowed: wood, prunings, tree trunks, vegetation which has been drying for at least two years.
  - Illegal to burn compostable materials (leaves, grass clippings) and garbage.
  - Permits required for greater than 1 hectare.
- Other options given for yard waste:
  - Free year-round yard waste drop-off.
  - Yard waste pick-up, private.
  - Air curtain burning (air incineration for faster burning with less smoke).
  - Chipping. Free orchard chipping program for agricultural land in RDCO limits.
  - Great guide for how to deal with agricultural waste includes 5 uses for wood chips: https://www.regionaldistrict.com/media/28185/Ag_BestMgmtPractisesGuide.pdf

- Glenmore landfill information:

  197,018 people use landfill.

  0.78 tonnes of refus/person per year.

  51,056 tonnes/yr of yard waste, prunings, and clean construction wood waste recycled.

  Diversion rate: 30.9%.

Sunshine Coast / Sechelt

http://www.sechelt.ca/Live/Backyard-Burning
http://www.sechelt.ca/LinkClick.aspx?fileticket=oPZ6t4SpeTo%3d&portalid=0

http://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/details/page.cfm?B1=All&Code1=5929&Code2=59&Data=Count&Geo1=CD&Geo2=PR&Lang=E&SearchPR=01&SearchText=Sunshine+Coast&SearchType=Begins&TABID=1
Electoral maps of SCRD: http://www.scrd.ca/pdf-maps

http://www.scrd.ca/Yard--Food-Waste

https://en.wikipedia.org/wiki/Sunshine_Coast_Regional_District

Relevant Bylaws: The Open Air Burning Bylaw #486

- No curbside collection program for yard waste.
- Burning not allowed due to air quality by the Open Burning bylaw #486
  - Land clearing burning prohibited since Jan 2014.
- Other option given for yard waste:
  - Chipping.
  - Composting of debris.
  - Landfill drop-off:

    If you don't have a lot of waste, consider joining a neighbour to make a visit to the landfill.

Squamish

https://squamish.ca/our-services/garbage-and-waste-diversion/curbside-collection/

https://squamish.ca/our-services/protective-services/fire-rescue/permits-and-fire-safety-plans/fire-permit/

https://squamish.civicweb.net/filepro/documents/19302?preview=137349
https://squamish.civicweb.net/filepro/documents/19302?preview=137534
https://squamish.civicweb.net/filepro/documents/19302?preview=118984

Relevant Bylaws: #2012 (Fees and Charges), #2375 (Solid Waste), #2314 (Fire Service Bylaw)

- Curbside collection program for yard waste:
    - 246 L organic totes for collection by city year-round bi-weekly, some 120 L for townhouse residents.
    - Cost of collection unclear but is between $190-$405 per year. Unclear if cost is just for landfill waste or if also for recycle and yard waste.
- Burning regulations:
    - Land clearing debris permit: $500.
    - Burning generally not allowed- campfires only.
- Other options given for yard waste:
    - If too much waste for one week, stockpile until you can fit into your tote.
    - Use a backyard composter.
    - Leave grass clipping on grass.
    - Take to landfill or Carneys depot (small cost for yard waste).
    - Ask neighbours if they have extra space if your waste is too much for your bin.

North Cowichan

http://www.northcowichan.ca/EN/main/departments/engineering/environment/air-quality/Alternatives_to_Open_Burning.html

http://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/details/page.cfm?B1=All&Code1=5919&Code2=59&Data=Count&Geo1=CD&Geo2=PR&Lang=E&SearchPR=01&SearchText=Cowichan+Valley&SearchType=Begins&TABID=1

- Does not collect yard waste.
- Burning allowed.
- Other:

- In Engineering>Environment>Air Quality>Alternatives to Open Burning: Gives alternatives to burning on chipping, yard waste center, compost at home.
- Residents are referred to Bings Creek or Peerless Road Recycling Centres (year-round, free of charge).

APPENDIX B

Qualicum Beach's Free Chipping Program for Residents

Qualicum has a unique program in place where the city owns a chipper and twice a year they operate through the city chipping piles of wood waste that households have left on the street. Further information provided in the interview below.

There is no curbside pick-up of yard waste apart from the chipping program.

Qualicum's burning bylaws:

1. Burning by permit of agricultural land clearing and garden refuse (grass and leaves) for $45/permit.
2. Wood must be not suitable for utilization.
3. Encourages reduction of amount being burned.

Qualicum's chipping program:

4. One spring and one fall pick-up, dates vary by year.
5. City divided into two zones.
6. Pile guidelines:
    7. Maximum pile size of 8 ft x 8 ft x 5 ft pile, another pile allowed for every 0.5 acre of property.
    8. Accepts tree branches and woody shrubs.
    9. 4 inches for maximum diameter of wood within pile.

A phone interview with Tony who has been a part of the program for many years from the Town Hall of Qualicum Beach was conducted May 16th, 2017. The following questions were asked, answers are paraphrased:

Q: What's the participation rate of the program?
A: There are no statistics, but the participation is generally very good. More waste coming from smaller urban lots than from larger lots. Older neighborhoods have more waste presumably since older vegetation needs to be trimmed more.

Q: Where does funding for this program come from?
A: Taxes, from the Parks budget.

Q: What are running costs?
A: Varies heavily. Participation is weather-dependent which directly affects the cost.

Q: Where do the chippers come from?
A: The city rented-to-own a chipper, said company was very willing to do a rent-to-own program.

Q: How many houses are included in the area? Urban or rural?
A: About 4,000 homes. Mostly urban, the few rural do not leave as much yard waste to chip.

Q: How many days does it take to do one of the zones (about half of the city, so about 2000 houses)?
A: Varies by year, weather, growing season etc. 2 staff members, 5 days/week, 8 hours/week, take a few weeks to do 4000 households.

Other information provided during interview: Program started out using contractors but they didn't do a good job. They left the streets messy and weren't using quality standards about what to chip.

References:

http://www.qualicumbeach.com/chipping-program

https://qualicumbeach.civicweb.net/filepro/documents/10?preview=5007

Tony from Town Hall, personal communication

250.752.6921