City of Richmond

Memorandum

Community Safety Division
Business Licences

To:	Mayor and Councillors	**Date:**	April 23, 2021
From:	Carli Williams, P.Eng. Manager, Business Licence and Bylaws	**File:**	12-8080-12-01/Vol 01
Re:	**Response to Council Referral for Soil Use for the Placement of Fill Application for 8511 No. 6 Road (Jiang)**		

This memorandum responds to a referral made by Council at the October 13, 2020 regular Council meeting. At the meeting, Council considered the report "Soil Use for the Placement of Fill Application for the Property Located at 8511 No. 6 Road (Jiang)", which proposes to deposit soil on the subject property for the purpose of remediating the property and developing a blueberry farm. During consideration of the report, Council referred the matter back to staff to provide feedback regarding the following:

(1) That the 'Soil Use for the Placement of Fill' application, submitted by Bohan Jiang (the "Applicant"), proposing to deposit soil on the property located at 8511 No. 6 Road, be referred back to staff to review additional sources of soil as proposed by the Applicant;

(2) That staff comment as to whether it is prudent to impose geographic restrictions in terms of the source of soils for all of the soil or just the topsoil; and

(3) That staff examine the wisdom of the soil tracker application and report back.

Additional Source Review

The Applicant's qualified Agrologist (Daniel Lamhonwah, PhD, MES, P.Ag) has provided a report (Attachment 1) identifying locations where soil that is acceptable for completing the proposed project may be sourced. Mr. Lamhonwah identifies source sites beyond Richmond that will be suitable to import in order to remediate the property. Staff requested that Bruce McTavish, MSc, MBA, P.Ag, RPBio, review the Madrone report on behalf of the City. Mr. McTavish's review (Attachment 2) confirmed "that the geographic source of the soil is not important [and that] it is the texture and the absence of contamination of the soil that is critical for the successful restoration of the site".

Geographic Restrictions

City staff consider that geographic restrictions may potentially eliminate appropriate source sites located outside of Richmond that have been identified and confirmed by a qualified Agrologist (the "Agrologist") responsible for a project proposal. Such a restriction could limit or eliminate the ability of a property owner to successfully improve and/or remediate a property that, subject to the opinion of an Agrologist, requires soil importation to achieve such an improvement.

In addition, such a restriction may potentially place the City at odds with the Agricultural Land Commission (ALC). ALC staff have stated that the ALC does not restrict soil relocation to the region in which the soil originates from. It is the responsibility of the Agrologist who is responsible for the project to ensure such criteria match that of the source sites identified by the Agrologist. In general, soils should be medium textured, stone-free with a suitable amount of organic matter content. As long as a source site's soil meets the criteria established by the ALC, the ALC would not typically restrict importation due to a source site being situated beyond the community in which the project is located. Attachment 3 identifies the criteria utilized by the ALC.

In consideration of the above, it is not recommended to impose geographic restrictions on the source site for this application.

Soil Tracker Application

Through the City's permitting process, staff have incorporated a significant number of requirements that must be adhered to which assist in ensuring permit holders are held accountable to permit conditions. The most significant requirements are as follows:

- The Agrologist providing project oversight must sign-off on a source site prior to soil being imported from the identified site to the approved soil deposit site;
- On-site monitor inspecting each load prior to importation; and
- An Agrologist report is provided every 3,000 cubic metres.

Staff do consider that a soil tracker application is potentially a more efficient way to meet these requirements should a project receive approval. However, the only application available at this time is a proprietary application run by a third party business. Requiring the use of an application would be directing work to a specific business. The Community Charter generally prohibits the provision of any form of financial assistance to businesses, subject to specific limited exceptions. This prohibition specifically encompasses the provision of a grant, benefit, advantage, or other form of assistance. Adding the provision of utilizing a specific application would be considered a form of assistance.

Any further questions on this matter can be directed to the writer who will also be available during the regular General Purposes meeting on April 19, 2021.

Carli Williams, P.Eng.
Manager, Business Licence and Bylaws
(4136)

pc: SMT

Att. 1: Madrone Report re. Locations for Suitable Soil (rev. 06 Apr 2021)
Att. 2: McTavish Review re. Madrone Report (05 Mar 2021)
Att. 3: ALC Soil Suitability Table for Agricultural Reclamation

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April 6, 2021

Mr. Barry Mah
Westwood Topsoil Ltd.
6604 62B Street
Delta, BC V4K 5A8
westwoodbarry@mac.com

Dear Mr. Mah,

RE: Locations of suitable soils for importation to 8511 No. 6 Road, Richmond, BC (CD 28808)

1 Introduction

Madrone Environmental Services Ltd. ('Madrone'), acting as the qualified professionals (QP's) retained by you, Mr. Barry Mah ('the Client'), was asked by Mr. Mike Morin[1], Soil Bylaw Officer, City of Richmond ('the City'), to respond to commentary[2] from the City regarding suitable locations to source soil for completion of the importation project proposed for 8511 No. 6 Road, Richmond, BC ('the Site'). This report, prepared by Daniel Lamhonwah, PhD, MES, P.Ag, of Madrone provides the following information requested by the City:

- Identify how much of the proposed volume of soil to be deposited is subsoil vs. topsoil;
- Provide the soil make up (i.e., soil texture) and soil mapping for the proposed locations Madrone has identified as suitable topsoil sources to complete the project, which are situated in:
    - Richmond;
    - Delta;
    - South Vancouver;
    - South Burnaby; and
    - The UBC Endowment Lands;

[1] Email communication addressed to Barry Mah from Mike Morin, Soil Bylaw Officer, Community Bylaws, City of Richmond. Subject: CD 28808 - Request for additional information re. Council referral (Jiang). Sent on Monday, 19 October 2020 12:44.

[2] City of Richmond Council Meeting minutes. October 13, 2020 (7:00 PM). Richmond City Hall.

- Provide a more thorough explanation for each map that was provided with Madrone's October 13, 2020 memo prepared by Madrone to the City; and
- Provide additional maps and explanation of the areas identified above and any other locations in the Lower Mainland that have the appropriate soil to complete the project.

2 Proposed Soil Volumes – Topsoil and Subsoil

The approximate volume of **topsoil** required for completion of the project is 18,750 m^3, calculated based on the proposed import area (2.5 ha; 25,000 m^2) and the depth of topsoil needed (75 cm).

The approximate volume of **subsoil** required for completion of the project is 6,250 m^3, calculated based on the proposed import area (2.5 ha; 25,000 m^2) and the depth of subsoil needed (25 cm). Note that the subsoil in this case is the silty clay loam or silty clay textured soil cap proposed to be placed over the existing wood residue on the Site.

The total volume of soil (subsoil and topsoil) requested for the project is therefore 25,000 m^3.

3 Suitable Topsoil Importation Locations

It is our professional opinion that the textural and origin criteria for suitable **topsoil** required for project completion include:

1. A loam textured soil (ideally a silt loam to loam)
2. Contains minimal coarse fragment content (i.e., minimal gravel, cobble and stone content); and
3. Is sourced from an area currently and historically zoned residential due to a lower risk of contamination compared to a commercial area or industrial area. Lands zoned and used for agriculture were considered to not be unsuitable sources locations because of the regulatory restrictions of removing soils form agricultural lands.

Information about local/regional soil associations been provided by the provincial Soil Information Finder (SIFT) Tool[3] with mapping completed, in most cases, at a scale of 1:20,000. Mapping showing the locations of suitable soils are presented in the appendices of this report.

[3] Province of British Columbia (2018). Soil Information Finder Tool. https://www2.gov.bc.ca/gov/content/environment/air-land-water/land/soil/soil-information-finder. Accessed November 9, 2020.

3.1 Municipality of Richmond

The majority of Richmond contains soils classified as 'unclassified urban'; these soils are found west of No.4 Road and stretch towards coastal areas. Central Richmond (between No.4 and No. 6 Roads) is characterized by the presence of poorly-drained organic (peat) soils belonging to the Lumbum, Triggs, Lulu and Richmond soil associations. Organic soils are still the dominant soil type toward east Richmond (east of No. 6 Road) however, there are occasional, discontiguous areas of mineral soils (e.g., silt loam soils).

Within Richmond, suitable topsoils for importation to the Site belong to the Annis, Blundell, Crescent and Westham soil associations (Appendix A). Of these soils, Blundell appears to be most spatially distributed in residential neighbourhoods, particularly in the areas surrounding the Greenacres Golf Course (between Sidaway Road and No.7, north of the Westminster Highway), and thus theoretically available as a source for the Site. There also appears to be discontiguous areas of Blundell soils mapped in the Southarm neighbourhood, in between No.4 Road and No. 5 Road, north and south of Steveston Highway.

3.2 Municipality of Delta

Within Delta, suitable topsoils for the purpose of importation to the Site belong to the Ladner and Benson soil associations (Appendix B). Although Ladner soils cover a substantial area in Delta, most of the areas where these soils are found are located on existing agricultural lands and thus cannot be removed without extensive permitting (and even then, this may be unjustified given the importance of topsoil for agricultural land). There may be some residential areas in Delta where Ladner soils are available such as west of the Delta Hospital in the neighbourhood of Ladner. The remaining areas in Delta are predominantly mapped as containing silt clay loam (mineral soils) or are classified as 'unclassified urban'.

3.3 South Vancouver

Within South Vancouver, suitable topsoils for importation to the Site belong to the Ladner and Benson soil associations (Appendix C). In South Vancouver, these soils are mapped around the Point Grey Golf and Country Club, with Ladner soils being more spatially distributed and theoretically available as a source for importation. The majority of South Vancouver is mapped as containing 'unclassified urban' soil which is not suitable topsoil for importation to the Site.

3.4 South Burnaby

Madrone had previously suggested that South Burnaby may contain topsoils suitable for importation to the Site. Our follow-up desktop study indicated that soils belonging to the Ladner and Delta soil associations in South Burnaby, which would otherwise have been suitable for importation, do not appear to be in residential areas and thus not ideal for importation to the Site (Appendix D). The majority of the remaining soils mapped for South Burnaby belong to the Richmond, Triggs, Annacis or Lumbum soil associations – all of which are organic soils which would not be suitable for topsoil either due to the non-ideal texture, high to extreme acidity and high organic carbon content. There are also large areas near the Fraser River where the soil is

indicated as 'anthropogenic' (human-made or influenced, such as deposited sands and gravels for dykes) which is also unsuitable for topsoil. It is our professional opinion that South Burnaby is not a suitable source location for topsoils required to complete the proposed project on the Site.

3.5 UBC Endowment Lands

Madrone had also previously suggested that the University of British Columbia (UBC) Endowment Lands may contain topsoils suitable for importation to the Site. Our follow-up desktop study indicated that the UBC Endowment Lands is mapped as containing 'unclassified urban' soil and thus not suitable topsoil for importation to the Site based on available information. Because there is an absence of provincial soils data for this area, a detailed investigative study (including field test pits) would be required to determine suitability for importation to the Site.

4 Conclusions

Based on Madrone's desktop assessment, there are limited single locations (particularly in the Richmond and Delta areas) where enough loam textured topsoil can be sourced (18,750 m^3 required for the Site) that would be suitable topsoil for importation to the Site for the purpose of project completion. Thus, the sourcing of suitable topsoil would likely need to come from multiple locations, including areas outside of the Richmond and Delta area, for completion of the proposed importation project within a 2 year timeframe. As such, we recommend that the following locations (**Figure 1**) be considered for sourcing of imported soils proposed for the Site:

- Blundell soils (silt loam texture; stone-free) in Richmond mapped around the Greenacres Golf Course between Sidaway Road and No. 7, north of the Westminster Highway (**Point 1, Figure 1**);
- Blundell soils (silt loam texture; stone-free) in the Southarm neighbourhood of Richmond mapped between No.4 Road and No. 5 Road, north and south of Steveston Highway (**Point 2, Figure 1**);
- Ladner soils (silt loam texture; stone-free) in the Municipality of Delta mapped west of the Delta Hospital in the neighbourhood of Ladner (**Point 3, Figure 1**); and
- Ladner soils (silt loam texture; stone-free) in South Vancouver mapped around the Point Grey Golf and Country Club (**Point 4, Figure 1**)

Note that these recommendations are based on provincial mapping which was developed at a small scale covering large areas (1:20,000) and were likely not field verified (via assessment of soil pits) for specific residential neighbourhoods. We advise that a field assessment be conducted by a qualified professional to confirm the location-specific textural characteristics of any soils prior to importation. Moreover, prior to importation to the Site, source soils should be sampled and submitted for laboratory analyses to ensure they are not chemically contaminated (heavy metals, polyaromatic hydrocarbons etc.).

Please contact the undersigned authors should there be any questions regarding the contents of this report.

Sincerely,

MADRONE ENVIRONMENTAL SERVICES LTD.

Prepared by:

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

Daniel Lamhonwah, PhD, MES, P.Ag
Environmental Scientist, Professional Agrologist

Senior Reviewed by:

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

Jessica Stewart, P.Ag, P.Geo
Professional Agrologist, Professional Geoscientist

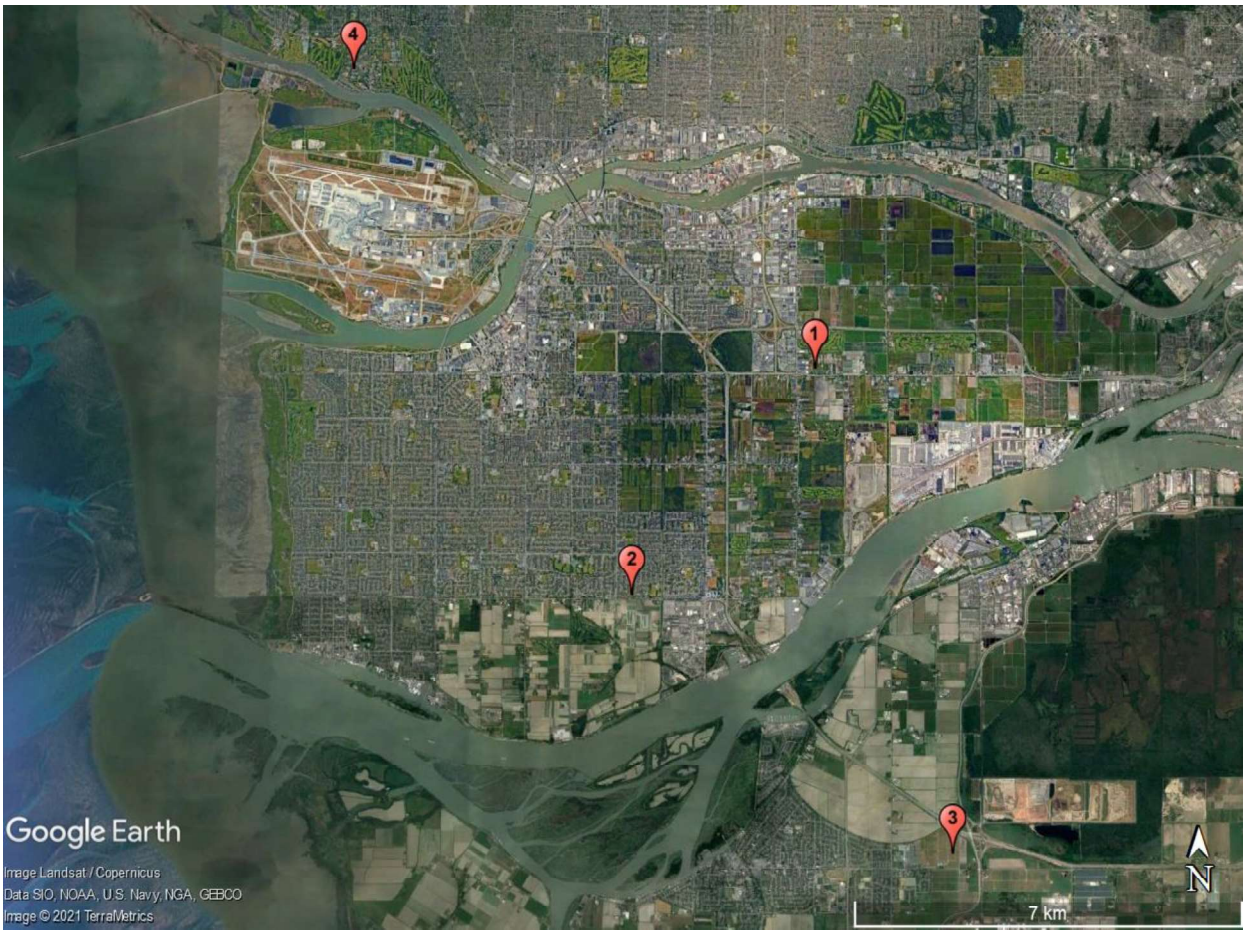

FIGURE 1. RECOMMENDED LOCATIONS TO SOURCE SOIL FOR IMPORTATION TO 8511 NO. 6 ROAD, RICHMOND, BC

APPENDIX A – Soil Mapping for Municipality of Richmond

Note: The mapped distribution of each soil association described in each appendix is visualized with the thick yellow line on the provided mapping. The area(s) shaded in red are interpreted as being residential (i.e., locations most ideal for sourcing of that particular soil association). This visualization is the same for each map presented in the appendices.

Soils association: Annis
Characteristics: Silt loam texture, 0% coarse fragment content (stone-free), poorly drained
Mapped distribution: Limited presence in Richmond and Delta. Distribution in residential areas not identified.

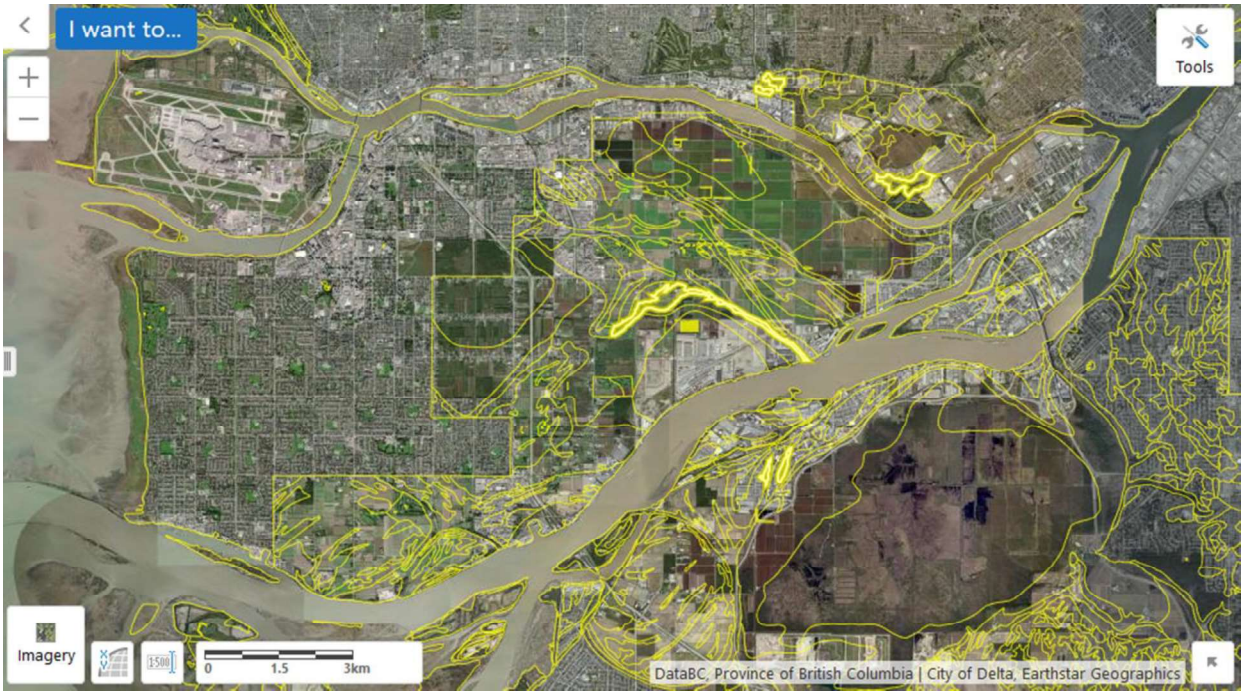

FIGURE A1. ANNIS SOIL SERIES MAPPED LOCATIONS – OUTLINED IN SOLID YELLOW.

Soils association: Blundell

Characteristics: Silt loam texture, 0% coarse fragment content (stone-free), poorly drained

Mapped distribution: Found mostly in agricultural areas in central and east Richmond, and industrial and commercial areas in north Delta proximal to the Fraser River. Limited distribution in residential areas.

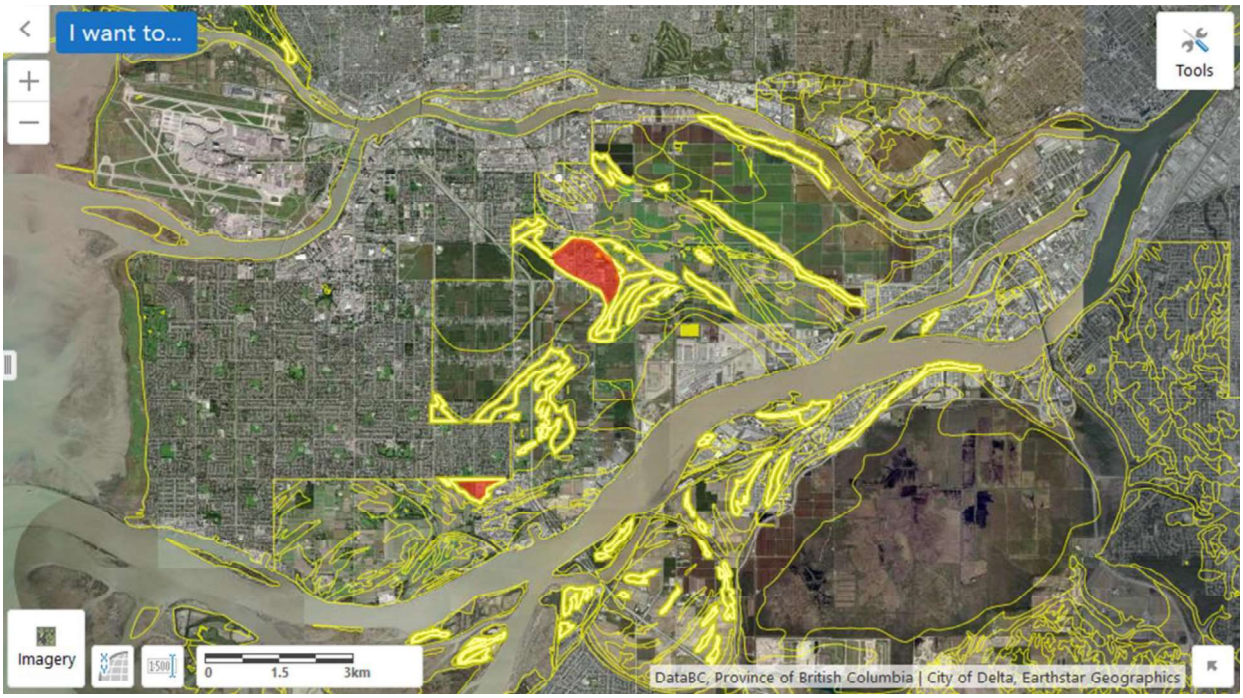

FIGURE A2. BLUNDELL SOIL SERIES MAPPED LOCATIONS – OUTLINED IN SOLID YELLOW. LOCATIONS HIGHLIGHTED IN RED REPRESENT THE MOST IDEAL AREA(S) FOR SOURCING OF THIS PARTICULAR SOIL ASSOCIATION.

Soils association: Crescent

Characteristics: Silt loam texture, 0% coarse fragment content (stone-free), poorly drained

Mapped distribution: Found mostly in agricultural areas in south Richmond, and industrial and commercial areas in north Delta proximal to the Fraser River. Limited distribution in residential areas.

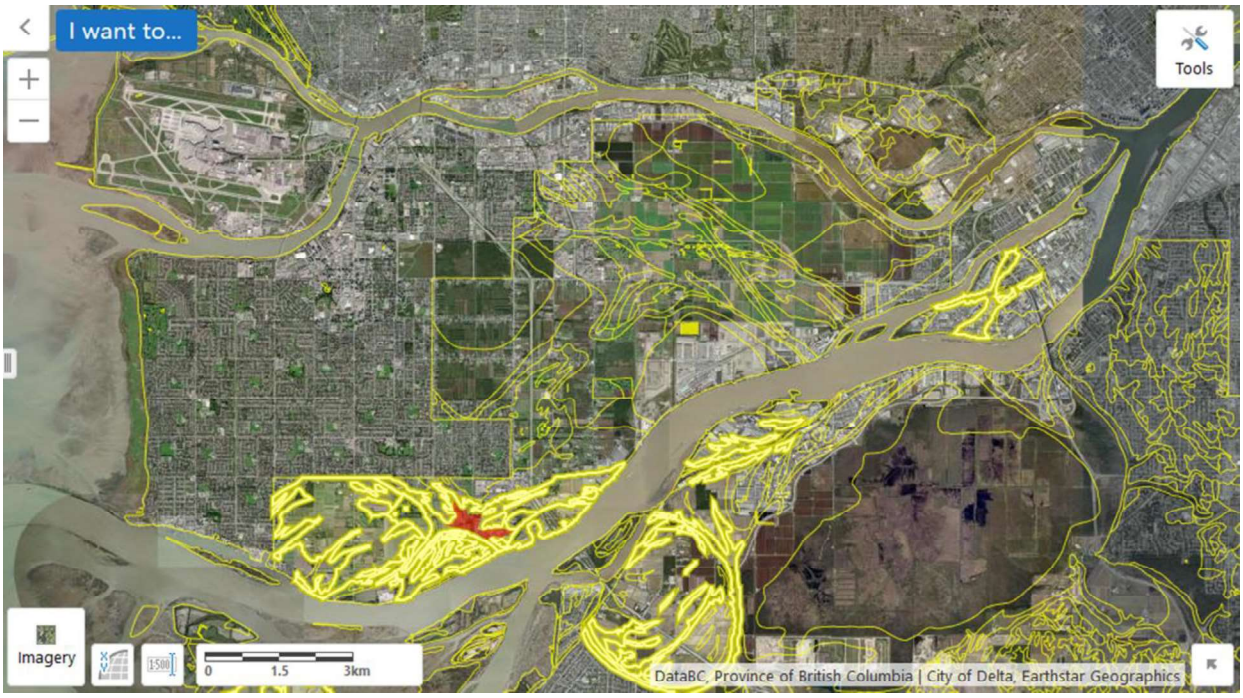

FIGURE A3. CRESCENT SOIL SERIES MAPPED LOCATIONS – OUTLINED IN SOLID YELLOW. LOCATIONS HIGHLIGHTED IN RED REPRESENT THE MOST IDEAL AREA(S) FOR SOURCING OF THIS PARTICULAR SOIL ASSOCIATION.

Soils association: Westham

Characteristics: Silt loam texture, 0% coarse fragment content (stone-free), poorly drained

Mapped distribution: Found mostly in agricultural areas in south Richmond, and industrial and commercial areas in north Delta proximal to the Fraser River. Limited distribution in residential areas.

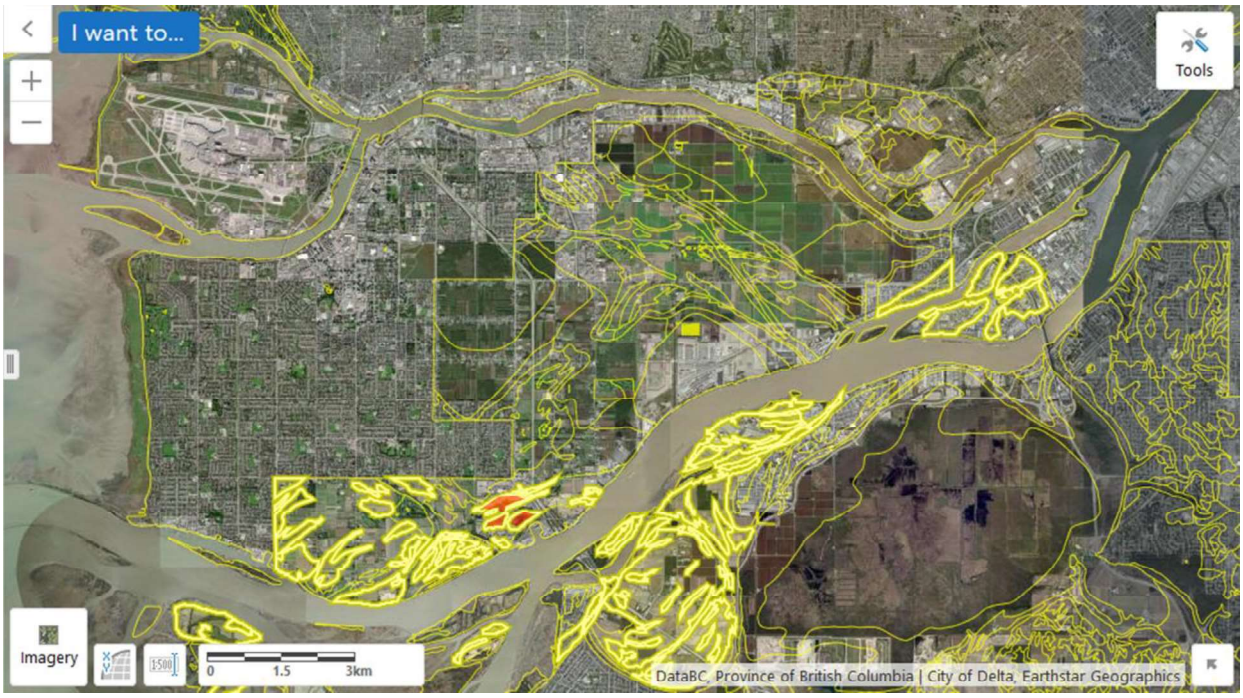

FIGURE A4. WESTHAM SOIL SERIES MAPPED LOCATIONS – OUTLINED IN SOLID YELLOW. LOCATIONS HIGHLIGHTED IN RED REPRESENT THE MOST IDEAL AREA(S) FOR SOURCING OF THIS PARTICULAR SOIL ASSOCIATION.

APPENDIX B – Soil Mapping for Municipality of Delta

Soils association: Ladner

Characteristics: Silt loam texture, 0% coarse fragment content (stone-free), poorly drained

Mapped distribution: Found mostly in agricultural areas in Delta. Limited distribution in residential areas.

FIGURE A5. DELTA SOIL SERIES MAPPED LOCATIONS – OUTLINED IN SOLID YELLOW. LOCATIONS HIGHLIGHTED IN RED REPRESENT THE MOST IDEAL AREA(S) FOR SOURCING OF THIS PARTICULAR SOIL ASSOCIATION.

APPENDIX C – Soil Mapping for South Vancouver

Soils association: Ladner

Characteristics: Silt loam texture, 0% coarse fragment content (stone-free), poorly drained

Mapped distribution: Found mostly on and proximal to the Point Grey Golf and Country Club in the residential areas immediately east.

FIGURE A6. LADNER SOIL SERIES MAPPED LOCATIONS – OUTLINED IN SOLID YELLOW. LOCATIONS HIGHLIGHTED IN RED REPRESENT THE MOST IDEAL AREA(S) FOR SOURCING OF THIS PARTICULAR SOIL ASSOCIATION.

Soils association: Benson

Characteristics: Loam texture, <5% coarse fragment content, poorly drained

Mapped distribution: Found proximal to the Point Grey Golf and Country Club in the residential areas immediately west.

FIGURE A7. BENSON SOIL SERIES MAPPED LOCATIONS – OUTLINED IN SOLID YELLOW. LOCATIONS HIGHLIGHTED IN RED REPRESENT THE MOST IDEAL AREA(S) FOR SOURCING OF THIS PARTICULAR SOIL ASSOCIATION.

APPENDIX D – Soil Mapping for South Burnaby

Soils association: Ladner

Characteristics: Silt loam texture, 0% coarse fragment content (stone-free), poorly drained

Mapped distribution: Located on small commercial (potential contamination sites) and parkland areas adjacent to the Fraser River. Distribution in residential areas not identified.

FIGURE A8. LADNER SOIL SERIES MAPPED LOCATIONS – OUTLINED IN SOLID YELLOW.

Soils association: Delta

Characteristics: Silt loam texture, 0% coarse fragment content (stone-free), poorly drained

Mapped distribution: Located on a small commercial area (potential for contamination) adjacent to the Fraser River. Distribution in residential areas not identified.

FIGURE A9. WESTHAM SOIL SERIES MAPPED LOCATIONS – OUTLINED IN SOLID YELLOW. LOCATIONS HIGHLIGHTED IN RED REPRESENT THE MOST IDEAL AREA(S) FOR SOURCING OF THIS PARTICULAR SOIL ASSOCIATION.

March 5, 2021

Re: Madrone February 15, 2021 report titled:
Locations of suitable soils for importation to 8511 No. 6 Road, Richmond, BC (CD 28808)
(Madrone report(

This memo provides a review of the Madrone report by Mr. Bruce McTavish, MSc MBA PAg RPBio of McTavish Resource & Management Consultants Ltd. (McTavish).

The 6,250 m^3 required to increase the depth of the existing subsoil cap, can be any source of stone free soil with texture ranging from silty clay loam to silty clay. Madrone has identified areas and soil series in Richmond, Delta and elsewhere that meet these criteria. McTavish agrees with Madrone that the geographic source of the soil is not important, it is the texture and the absence of contamination of the soil that is critical for the successful restoration of the site. There are may areas of the lower mainland that have soils that have developed from Deltaic deposits and any of these sources are appropriate if they meet the soil texture and stone free criteria.

In general McTavish agrees with the Madrone recommendation on appropriate topsoil. McTavish believes that the soil series that can be used as sources of topsoil can be broadened. The historical topsoil on the site is primarily Lulu and some Triggs. Lulu soils vary from undecomposed to well-decomposed organic material, with partially decomposed (mesic) subsurface deposits. The underlying soil is fine textured deltaic deposits, either silty clay loam (SiCL) or silty clay (SiC). The incorporation and mixing of some organic soil into a topsoil that is silty clay loam to silty clay would therefore be appropriate for this site. Since the subsoil will be silty clay loam to silty clay in texture the topsoil should not be loam as it is at least 1 textural class away from SiCL or 2 from SiC, so a discontinuity will form between the topsoil and subsoil layers.

Regards,

Bruce McTavish, MSc MBA PAg RPBio
Senior Agrologist
McTavish Resource & Management Consultants Ltd.

ALC Soil Suitability for Agricultural Reclamation

Rating/Property	Good	Fair	Poor	Unsuitable
Reaction (pH)	>5.0 to 7.5	4.0 to 5.0 & 7.6 to 8.4	3.5 to 4.0 & 8.5 to 9.0	<3.5 and >9.0
Salinity (EC) (dSM)	<2	2 to 4	4 to 8	>8
Stoniness	Class 1, 2	Class 3,4	Class 5,6	Class 7
Total coarse fragments (% volume 2 mm to 75 mm diameter)	<10%	11 to 40%	41 to 90%	
Cobbles and Stones (% volume > 75 mm diameter)	<1%	2 to 15%	16 to 80%	
Texture	Fine Sandy Loam, Loam, Sandy Loam, Silt Loam	Clay Loam, Sandy Clay Loam, Silt Clay Loam	Sand, Loamy Sand, Sandy Clay, Silt Clay, Clay, Heavy Clay	
Moist Consistency	very friable, friable	loose	firm, very firm	extremely firm
Organic Carbon %	2 to 17	1 to 2	<1	>17 (soil amendment only)
Equivalent Organic Matter %	3.4 to 30	1.7 to 3.4	<1.7	

City of Richmond

Report to Committee

To:	General Purposes Committee	**Date:**	August 27, 2020
From:	Cecilia Achiam General Manager, Community Safety	**File:**	12-8080-12-01/Vol 01
Re:	**Soil Use for the Placement of Fill Application for the Property Located at 8511 No. 6 Road (Jiang)**		

Staff Recommendation

That the 'Soil Use for the Placement of Fill' application, submitted by Bohan Jiang (the "Applicant"), proposing to deposit soil on the property located at 8511 No. 6 Road for the purpose of remediating the property to develop a blueberry farm, be authorized for referral to the Agricultural Land Commission (ALC) for the ALC to review and determine the merits of the proposal from an agricultural perspective as the Applicant has satisfied all of the City's current reporting requirements.

Cecilia Achiam
General Manager, Community Safety
(604-276-4122)

Att. 14

REPORT CONCURRENCE	
ROUTED TO:	**CONCURRENCE**
Engineering	☑
Policy Planning	☑
Sustainability	☑
Transportation	☑
SENIOR STAFF REPORT REVIEW	**INITIALS:** CJ
APPROVED BY CAO	

Staff Report

Origin

The City of Richmond received a 'Soil Use for the Placement of Fill' application for the property located at 8511 No. 6 Road (the "Property"). The intent of the application is to address damage to a large portion of the Property due to past activities of a previous landowner(s) approximately 38 years ago, which included excavating and removing the native soil and replacing the soil with untreated woodwaste. The Applicant is proposing to improve the agricultural capability of the Property from its current Class 6 or 7 rating to a Class 1 rating to allow for the development of a blueberry farm.

The Property is situated within the Agricultural Land Reserve (ALR) and is subject to provisions of the *Agricultural Land Commission Act (ALC Act)* and its regulations (the "Regulations"), and the City's Soil Removal and Fill Deposit Regulation Bylaw No. 8094 (the "Soil Bylaw").

Pursuant to applicable Provincial regulations, a 'Soil Use for the Placement of Fill' application requires authorization from local government in order to be referred to the Agricultural Land Commission (ALC) for their review and approval. As such, this application must be submitted to the City for review and a decision from Council. Should the application be referred to the ALC and should it subsequently be approved by the ALC, the Applicant is required to satisfy the City's requirements outlined in the Soil Bylaw before a soil deposit permit would be issued by the City.

The Applicant has satisfied all of the City's referral requirements for submission to the ALC.

This report supports Council's Strategic Plan 2018-2022 Strategy #2 A Sustainable and Environmentally Conscious City:

> *Environmentally conscious decision-making that demonstrates leadership in implementing innovative, sustainable practices and supports the City's unique biodiversity and island ecology.*
>
> *2.1 Continued leadership in addressing climate change and promoting circular economic principles.*
>
> *2.3 Increase emphasis on local food systems, urban agriculture and organic farming.*

Analysis

The Property is zoned AG1 (Agriculture). The current zoning permits a wide range of farming and compatible uses consistent with the provisions of the *ALC Act* and Regulations and the City's Official Community Plan and Zoning Bylaw. The Applicant is proposing to deposit 30,000 cubic metres of soil over approximately 2.5 ha of the 4.05 ha Property at an average depth of 1.0m, which would bring the Property to the same elevation as neighbouring properties as it currently resides at a lower elevation due to the previous excavation and removal of native soil.

The soil deposition will serve to cap untreated woodwaste placed on the Property by a previous owner(s) in addition to improving the Property's soil conditions to develop a blueberry farm.

Uses on Adjacent Lots

- To the North: ALR – Land is not in agricultural production
- To the East: ALR – Golf course
- To the South: ALR – Land is in agricultural production
- To the West: ALR – Land is not in agricultural production

Table 1: Existing Information and Proposed Changes for the Property

Item	Existing
Owner/Applicant	Bohan Jiang (the "Applicant")
Authorized Agent/Lead Contractor	Barry Mah (the "Agent")
Authorized Consultants	Daniel Lamhonwah, PhD candidate, MES, P. Ag. and Thomas Elliot, PhD, P. Geo, P. Ag. (Madrone Environmental Services Ltd.) (the "Agrologists)
Authorized Farm Manager	Quan Ming Wu (the "Farm Manager")
Lot Size	4.05 hectares (10 acres)
Current Land Uses	A portion of the Property is currently under agricultural production (blueberries and orchard)
Proposed Land Uses	Remediate 2.5ha of the Property to create a blueberry farm
Official Community Plan Designation	Agriculture
ALR Designation	Property is within the ALR
Zoning	AG1
Riparian Management Area (RMA)	Yes; no disturbance proposed
Environmental Sensitive Area (ESA)	No

Project Overview

The Applicant – who has owned the Property since 2005 – is applying to deposit 30,000 cubic metres of soil over approximately 2.5 ha of the 4.05 ha Property at an average depth of 1.0m. The objective is to improve the agricultural capability of the Property from its current Class 6/7 rating to a Class 1 rating to allow for the development of a blueberry farm. Class 1 soil would provide the maximum flexibility for future agricultural activities because it would allow a farmer to grow the widest range of crops.

In addition, the soil deposition will serve to ensure the woodwaste deposited on the Property by a previous owner approximately 38 years ago remains in an anaerobic state to ensure leachate does

not enter neighbouring watercourses. As per the Agrologists, the remediation work will ensure the long term stability of the woodwaste.

The Applicant has advised that the project will take two years to complete. The timeline for completion is heavily dependent on ensuring the appropriate soil – as recommended by the Agrologists – is sourced to complete the project. Soil sourcing has not commenced at this time due to the considerable period of time involved with respect to the soil deposit application process and seeking approval from the City and ALC.

Staff Comments

The proposal aligns with a number of Council endorsed strategies and directions including concerns about the use of Richmond soil. Other objectives satisfied by the project are described as follows:

- The Applicant's desire to utilize Richmond soil where possible provides for a reduction in carbon emissions as there will be a considerable decrease in mileage as trucks will not be traveling back and forth from City approved development projects to the Fraser Valley as is the common practice;
- Following completion of the project, the Applicant's Farm Plan will include expansion of current farming operation by over six acres thus supporting initiatives as described within the City's Food Charter; and
- The proposal to raise the Property to improve the agricultural viability is consistent with the City's current Flood Protection Management Strategy (FPMS) which identifies raising land levels within all areas of the City as a key overall long-term objective. At the January 27, 2020 Regular Council Meeting, Council made a referral for staff to review the FPMS and provide comments with regard to the raising of land, specifically as it relates to agricultural land and agricultural viability. Staff are preparing a response to this referral.

Richmond Food Security and Agricultural Advisory Committee (FSAAC) Consultation

The Applicant presented the proposal to the FSAAC on July 23, 2020. The FSAAC unanimously supported the proposal with conditions, passing the following motion:

That the Food Security and Agricultural Advisory Committee support the ALR Soil Use for Placement of Fill Application at 8511 No. 6 Road, subject to the following considerations:

- *Monitoring and regular reporting of fill deposits (suitable fertile soil);*
- *Completion of a long-term lease (minimum 10 years) between the property owner and the farm operator; and*
- *Submission of a performance bond equal to the revenue from tipping fees minus the cost to implement the farm plan, to be returned upon completion of the farm plan.*

Agricultural Considerations

The Applicant has provided a Proposed Remediation Report (the "Remediation Report") prepared by Bruce McTavish, MSc MBA, PAg, RPBio and Dr. Hubert Timmenga, PhD, PAg, CMC. The Remediation Report (Attachment 1) outlines the history of the Property, the current soil conditions at the time of reporting, soil analysis conclusions, and proposed options to improve the Property. Following analysis and site investigation (ie. test digs), McTavish and Timmenga concluded that the agricultural capability of the Property had been negatively impacted due to the extraction of native peat and the subsequent backfilling of cedar woodwaste and wooden construction debris by a previous owner(s).

The Remediation Report indicates that at the time of their assessment of the Property, "the blueberry plants on the Property are stunted or dead due to the lack of adequate soil depth for them to grow in." It was the opinion of McTavish and Timmenga that "a large portion of the [Property] seems only capable of producing annual weeds". As per McTavish and Timmenga, the Property was deemed to have a Land Capability Assessment of a Class 6 or 7D.

The Remediation Report provided for two options to improve the agricultural capability of the Property. Option 1 outlines movement of the shallow soil cap to facilitate the removal of the woodwaste from the Property and import and deposit soil to complete remediation. This option is prohibitive due to the financial cost of the removal. In addition, as noted in the Remediation Report, "the disruption of the wood waste may lead to the generation of leachate which is not happening at the present time." In addition, the Remediation Report estimates that the Property contains 13,000 m^3 of woodwaste. As result, should Option 1 be undertaken – excavating and removing the woodwaste – it would result in the requirement for more soil to be imported/deposited to complete remediation than is currently being requested by the Applicant.

Option 2 (preferred by the Applicant) proposes to leave the woodwaste in its current state. The Remediation Report proposes that the Applicant deposit 25mm of silty clay to silty clay loam on top of the current soil. In addition, that 75mm of topsoil be deposited to improve the land capability for future crops. With the additional soil capping, anaerobic conditions will be maintained and will "inhibit the production of leachate."

The Remediation Report concluded that upon project completion, the land would be improved "to class 2 or 3 which [would] support a wide range of agricultural crops."

In addition, the Applicant has provided a Woodwaste Leachate and Site Drainage Report (the "Leachate/Drainage Report"). The Leachate/Drainage Report (Attachment 2) indicates "the wood waste has been buried on [the Property] for at least [38] years and it is in virtually the same condition as when it was buried." The Leachate/Drainage Report outlines the projected work plan to ensure the proposed capping with imported soil "preserve[s] the wood waste and prevent[s] the formation of leachate."

Subsequent to the initial reporting from McTavish and Timmenga, the Applicant was required to retain a new qualified professional as Mr. McTavish currently reviews and assesses soil deposit proposals on behalf of the City. As a result, Daniel Lamhonwah and Thomas Elliot, PhD, P. Geo,

P. Ag. of Madrone Environmental Services Ltd. were retained to review the proposal and provided additional information on behalf of the Applicant.

As per City requirements, the Agrologists provided an updated Farm Plan (Attachment 3). As noted in the Farm Plan, the Class 6 or 7D classification(s) is an "undesirable soil structure/aeration, with the limiting factor being the root restricting layer of anaerobic wood waste." Subsequent reporting by the Agrologists confirms that the majority of the Property remains a Class 6 or 7D classification.

Following additional study by the Agrologists, the initial conclusion by McTavish and Timmenga that the Property would be improved to a Class 2 or 3 was amended by the Agrologists, who state:

> *Following implementation of the Remediation Plan and the recommendations [within the Farm Plan], the proposed soil importation and deposit is targeting a* ***Class 1*** *agricultural capability by selectively receiving soils suitable to that end goal.*

The improvement to Class 1 will allow for the implementation of a blueberry farm as desired by the Applicant and the Farm Manager; however, the proposed improvements would allow for the growing of a multitude of different crops - as verified by the Agrologists - should the Applicant wish to vary crop types in the future. Such crops would require deep rooting (0.6m to 0.9m) and would include rhubarb, sweet potatoes, tomatoes, pumpkins and asparagus.

As per the Farm Manager (Attachment 4), who manages the Property on behalf of the Applicant, 8,000 blueberry bushes were planted in 2006 in addition to implementing irrigation improvements and the application of fertilizer and sawdust. Due to the conditions within the proposed soil deposit area, only 500 plants have survived as of 2016. Following consultation with other local blueberry farmers and continuing crop failure, the Applicant retained the Agent in 2012 to determine a means to improve the Property. The Agent in turn retained McTavish and Timmenga to assess the Property and provide recommendations.

Subsequent to the Remediation Report being provided by McTavish and Timmenga, the Applicant provided a Technical Addendum to [the] Remediation Plan (the "Remediation Addendum"). The Remediation Addendum (Attachment 5) outlines recommendations based on current regulatory practices. In particular, it focuses on source site approval and maintaining the quality of soil that is to be imported and deposited on the Property.

The Applicant has also provided a Technical Memorandum re. Appropriate Imported Soil and Soil Source Sites (the "Soil Memo"). The Soil Memo (Attachment 6) addresses the types of soil required to properly complete the project should the Applicant receive approval. In particular, the Soil Memo addresses why the Applicant should not be solely restricted to importing alluvial soils. Furthermore, the Agrologists advise that limiting the type of soil to alluvial and specifically to sources found within Richmond "may introduce an undesirable salinity limitation (Class N limitation) that may not have existed on a receiving site."

The Agrologists "recommend that the City favours imposing a condition that considers the physical and chemical properties of the soil proposed to be imported instead of restricting the imported soil to a deposition method and/or soil parent material type."

It must be noted that a portion of the Property to the west of the house was improved as a result of excavated soil – sourced from the Property due to construction of a house – being relocated to raise the level of the Property. The raised area (Attachment 7) was planted with blueberry plants and an orchard. The Agent has confirmed that there was no woodwaste under the raised area. This work was conducted following submission of the McTavish and Timmenga reports.

Should the proposal be approved, the City will require that a qualified agrologist be retained to monitor the project and provide regular reporting. Should an agrologist not be retained or cease providing regular oversight and reporting, the City would reserve the right, as per the Soil deposit permit (the "Permit") conditions, to suspend and/or void the Permit until such time as a new qualified agrologist, agreeable to the City and ALC, is retained to monitor the project and provide regular reporting.

The Applicant has confirmed with staff (Attachment 8), in response to the FSAAC conditions of support, that a long term lease will be signed once the proposed soil deposit area is improved to standard capable of growing crops. In addition, while there is no requirement within the current Soil Bylaw, the Farm Manager and Applicant have confirmed a willingness to "submit a $30,000 performance bond as a guarantee to implement and complete the Farm Plan, to be returned upon completion of the farm plan" (Attachment 9).

Drainage & Geotechnical Considerations

The Leachate/Drainage Report indicates that flow direction for the existing ditches on the Property is to be maintained with minor regrading and widening. In addition, it is proposed that a new ditch be constructed along the west property line. The Leachate/Drainage Report contends that there will be no increase to peak flows into City ditches.

The Leachate/Drainage has been reviewed by Colin S. Johnson, P.Eng (OOTB Engineering Ltd.) at the request of the City. The Drainage Assessment Memo (Attachment 10) confirms "that the site drainage recommendations in [the Leachate/Drainage Report] appear to be reasonable and should allow for adequate storm water drainage from the site, without altering peak flow conditions."

A Geotechnical Assessment (the "Geotech Assessment") has been provided by Tony Yam Engineering Ltd. The Geotech Assessment (Attachment 11) concludes that the "additional fills over the impacted area will not impact the drainage pattern of the adjacent areas (filling elevation of the impacted area is lower than the adjacent areas)." The Geotech Assessment has determined that the "placing of fills will not impact stability of adjacent areas as the impacted area is not less than 6 m away from adjacent properties." In addition, the Agrologists confirm that the soil deposition shall bring the Property to the same elevation as the neighbouring properties.

Permit conditions will provide staff the latitude to request a geotechnical report at any time in addition to requiring a closure report from the geotechnical engineer following completion of the project.

In response to discussions at previous Council and FSAAC meetings, the Agrologists have also provided a Soil Drainage & High Water Table Memorandum (the "Water Table Memo")

addressing the concept of berming and pumping the Property to address excess water issues on the Property rather than importing soil. As per the Water Table Memo (Attachment 12) and the conclusion of McTavish and Timmenga, the "[p]roperty is affected by groundwater and not flood water (i.e., from watercourses)."

A separate technical memorandum that focuses on the Agricultural Environmental Management Code (the "AEM Code Memo") (Attachment 13) further addresses the question of pumping excess water from the Property. The Agrologists state the following:

> *[P]ump works are generally suitable for bermed (or dyked) areas, such as floodplains, whereby the inundation/excess water is not congruent with the regional high water table. In many circumstances within the [City of Richmond], the issue is more related to high water table and regional conveyance rather than point-specific short duration inundation-water sources (i.e. flooding during the late spring freshet of the Fraser River) that pumping is ideally suited to resolve.*

It is the professional opinion of the Agrologists, that berming and pumping cannot eliminate the current excess water issues and that the Property will be improved via importing soil and raising the land.

Despite the aforesaid water table issue and the suitability of berming and pumping, the main driver of the proposal is to ensure that the woodwaste is capped with an appropriate level of soil to ensure that there is no potential for leachate and to ensure that there is an appropriate depth of soil to permit for the planting of a blueberry crop and orchard.

Environmental Considerations

While the overall objective is to improve the agricultural capability of the Property, an additional purpose of the proposal is to cap the woodwaste currently located beneath the surface soil to ensure water does not penetrate and permeate the woodwaste.

As per City staff, at the time of the deposition of the woodwaste and upon receipt of the application in 2012, there were no measures available for the City to undertake enforcement action. Prior to receipt of the application, staff were not aware of the issue and the City does not have any records or complaints related to the issue. Currently, there is no enforcement measure available within the Soil Bylaw or other City bylaws for the City to take action with respect to the woodwaste. In addition, the property owner is not required to advise the province of what has occurred on-site (ie. dumping of untreated woodwaste) as the site is not considered to be contaminated.

Staff note that landfilling with wood waste and the environmental liability associated with such a practice is covered under provincial jurisdiction. The "responsible party" is generally the previous owner, or the site operator who buried the woodwaste. The Agent has confirmed that due to the challenge in proving who undertook the work 38 years ago and the potential expense in litigating the matter, the Owner does not intend to address this matter through the courts; however, would prefer to utilize his financial resources to re-establish the Property to an agricultural standard capable of growing blueberries.

As noted in a Ditch Water Analysis Report submitted by McTavish and Timmenga (Attachment 14), which analysed the water within the ditches on the Property and in the City allowances, testing found that the ditch water was "not affected by wood waste leachate." The Leachate/Drainage Report provides recommendations to ensure there is no generation of leachates from the woodwaste following completion of the project. As per the Leachate/Drainage Report, placement of additional soil will ensure that "the wood waste [remains] in an anaerobic state". Staff are satisfied with the aforesaid reports and conclusions within.

The proposed soil deposition area is outside of the Riparian Management Area located on the east property line running along No. 6 Road.

Staff have determined that areas identified within the City's GIS mapping system as an Environmentally Sensitive Area along the north, south and western property lines are referencing vegetation on adjacent properties. The proposal will not impact any neighbouring Environmentally Sensitive Area.

There will be no impacts to trees due to the soil deposit operations.

As per Permit conditions, all work undertaken in or around a watercourse, must be completed in compliance with the *Water Sustainability Act*, under the guidance of a Qualified Environmental Professional (QEP). The City will require that erosion and sediment control measures be installed and inspected by a QEP should it be deemed necessary by City staff. Staff will require on-going monitoring by a QEP of the project to ensure no leachate enters City ditches or other watercourses.

Financial Costs and Considerations for the Applicant

Due to ongoing and approved development within the City of Richmond and the Lower Mainland, developers and contractors must find a location (the "End Site") that will accept soil excavated and removed off-site to facilitate development. Due to such demand, a market has been created in which End Site owners can generate income via tipping fees. Such fees are variable depending on the location, type and volume of soil, and season. Contractors are willing to pay a premium based on location of the soil (the "Source Site") to the End Site in order to reduce significant costs. Although End Site owners derive income due to tipping fees, soil deposit projects are not without significant costs to the Permit holder.

Please refer to the Farm Plan (pgs. 14-17) to review the potential tipping fee income and soil deposit project and farm development costs as provided by the Applicant.

Road and Traffic Considerations

A Traffic Management Plan has been submitted and reviewed by City staff. Truck access to the Property will be limited to Steveston Highway and will not be permitted to access the Property from Blundell Road or Westminster Highway.

Soil Deposit Permit Requirements and City Inspection and Project Oversight Protocols

Should the proposal receive ALC and City approval, City staff will prepare a comprehensive Permit that sets out a number of conditions, including but not limited to:

- Oversight by a professional agrologist;
- Source site inspection requirements;
- On-site monitoring and reporting requirements;
- Requirements for protection of the Riparian Management Area near the truck entrance point on No. 6 Road;
- Measures needed to eliminate impacts, including drainage, to neighbouring properties and City infrastructure;
- Permitted hours/days of operation;
- An approved Traffic Management Plan; and
- Security deposits (further explained below).

Despite the Remediation Report recommending that source site inspections occur for sites generating more than fifty truck loads, Qualified Professional reporting requirements are intended to be similar to the requirements for the Sixwest Holdings soil deposit project located on Westminster Highway. This will include the agrologist-of-record being required to inspect and approve all source sites. An on-site monitor will be required to inspect each load of soil prior to deposition on the Property and maintain an accurate daily log of trucks depositing soil on the site. At the sole discretion of the City, alternate measures may be required (i.e. survey) to determine the volume of soil deposited on the Property.

In addition to the expected reporting requirements of an agrologist or other qualified professionals to the City and ALC, City staff will maintain proactive inspection and enforcement on the Property that will include the following:

- multiple site inspections per week of the Property at the onset of the project to ensure conditions of the Permit are being maintained;
- weekly site assessments to continue to be undertaken when soil importation is underway to ensure the Permit conditions are respected;
- meet on-site with the site supervisor a minimum of two times per month;
- maintain communication with the agrologist-of-record and Agent on a regular basis;
- review reports to ensure conditions of the Permit are being satisfied; and
- advise the ALC of concerns relative to the project and request that ALC staff undertake inspections to ensure compliance with the approval conditions when deemed necessary by City staff.

No soil will be permitted to be imported/deposited until such time as all City and ALC requirements have been satisfied and the Permit has been issued by the City.

Security Bonds

Should the soil deposit project receive approval, the City will require that the Applicant provide the following security bonds:

- $5,000 pursuant to s. 8(d) of the current *Boulevard and Roadway Protection Regulation Bylaw No. 6366* to ensure that roadways and drainage systems are kept free and clear of materials, debris, dirt, or mud resulting from the soil deposit activity;
- $10,000 pursuant to s. 4.2.1 of the current *Soil Removal and Fill Deposit Regulation Bylaw No. 8094* to ensure full and proper compliance with the provisions of this Bylaw and all other terms and conditions of the Permit; and
- The Applicant has also proposed to provide a $30,000 bond to the City for implementation of the Farm Plan. Beyond completion of the soil project, this bond will provide security that the Farm Plan will be implemented.

In addition to the security bonds provided to the City, the ALC has the authority to require a performance bond to ensure that all required mitigation and monitoring measures are completed. The bond required by the ALC is also intended to ensure the rehabilitation of the Property in the event the project is not completed. ALC performance bonds and the approved volumes from four previous approvals for projects within the City are as follows:

- $70,000 – 17,500m^3 (Athwal - approved May 2020)
- $160,000 – 48,000m^3 (City of Richmond - approved June 2017)
- $290,000 – 140,000m^3 (Sixwest Holdings - approved Jan. 2017)
- $500,000 – 102,080m^3 (Sunshine Cranberry Farms – approved Jan. 2014)

As per the Permit conditions, security deposits will not be returned until all conditions as stated in the Permit and the ALC approval are satisfied in their entirety, to the satisfaction of the City. This will include confirmation that the Farm Plan has been completed as per a final report from the owner's agrologist-of-record. City staff is to conduct a final inspection and receive confirmation from the ALC that the project has been completed as per ALC approval prior to closing the file.

Alternatives to Council Approval

Should Council not authorize staff to refer the proposal to the ALC for their review and decision; the application will be considered to be rejected. Council may add additional recommendations for ALC consideration and/or conditions within a referral to the ALC, similar to conditions already provided within this report.

Financial Impact

None.

Conclusion

Staff recommends that the soil deposit application for the Property located at 8511 No. 6 Road be authorized for referral to the ALC for the ALC to review and determine the merits of the

proposal from an agricultural perspective as the Applicant has satisfied all of the City's current reporting requirements.

Mike Morin
Soil Bylaw Officer, Community Bylaws
(8625)

Carli Williams, P.Eng.
Manager, Business Licence and Bylaws
(4136)

Att. 1: Proposed Remediation Report (30 Sept 2012)
2: Woodwaste Leachate and Site Drainage Report (14 Dec 2013)
3: Farm Plan (11 Aug 2020)
4: Letter from Farm Manager re. Farming Background (10 Aug 2020)
5: Technical Addendum to Remediation Plan re. Regulatory Updates (30 Jun 2020)
6: Technical Memorandum re. Appropriate Imported Soil & Soil Source Sites (30 Jun 2020)
7: Farm Plan re. Figure 1 (16 Jun 2020)
8: Letter from Owner re. Lease Commitment (12 Aug 2020)
9: Letter of Commitment re. Farm Plan Security Bond (10 Aug 2020)
10: Drainage Assessment Memo (29 Jun 2020)
11: Geotechnical Assessment (10 Oct 2018)
12: Soil Drainage & High Water Table Memorandum (30 Jun 2020)
13: Technical Memorandum: Agricultural Environmental Management Code (09 Mar 2020)
14: Ditch Water Analysis Report (04 Mar 2015)

Proposed Remediation of Land Located at 8511 #6 Road Richmond, B.C.

BCAA Legal: SEC 20 BLK4N RG5W PL 3109 Parcel A, Subsidy Lot 3, (J71246E).

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Bohan Jiang

September 30, 2012

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1.0 Introduction

McTavish Resource & Management Consultants Ltd. was retained by Bohan Jiang to determine the cause for the Blueberry Crop failure and develop a remediation plan to allow agricultural production on the land. The farm is located at 8511 #6 Road in Richmond, B.C. The total farm size is 40475 m^2 or 10 acres and is zoned AG1. Approximately 2.5 hectares of the land is planted in Blueberries and ½ of the crop has been a complete failure and the other ½ has marginal growth.

2.0 Site Location

The subject properties are located at 8511 # 6 Road Richmond B.C. The legal description is: SEC 20 BLK4N RG5W PL 3109 Parcel A, Subsidy Lot 3, (J71246E).

2.1 Zoning and Present Land Use

The subject property is 4 hectares and is in the ALR and is zoned AG1. At the present time the owner is attempting to grow Blueberries on the land with limited success.

2.2 Previous Land Use

The use of the land for any agricultural use is severely impeded by the fact that approximately 25 to 30 years ago a previous owner has stripped all the organic soil (peat) from the site and filled it with cedar wood waste and wooden construction debris. This will be discussed in detail in section 3 of this report.

3.0 Soils

Based on existing soil mapping, the soils on the site are in a large polygon of Lulu and Triggs soils. The Lulu soils are composed of partially decomposed organic deposits (peat) varying in depth from 40 cm to 160 cm deep. The underlying soil is fine textured deltaic deposits, either silty clay loam, or silty clay. The Triggs soils are deep (at least 2m) un-decomposed organic deposits composed mainly of sphagnum and other mosses. The underlying soil is medium to moderately fine textured Fraser River deltaic or floodplain sediments.

The on-site soil survey information found that all of the organic soils (peat) on the site had been removed, and that the site was backfilled with cedar wood waste, and wooden construction debris. It is the understanding of the author that approximately 30 years ago the land owner at the time removed all the organic soil (peat) and back filled with wood

waste.[1] They then capped the wood waste with 35 to 40 cm of loam to silty loam soil. The soil map aerial photo shown in figure 2 which is from 1980 seems to show a large pile of wood waste at the eastern end of the property which would confirm the time frame that the wood waste was buried.

To determine the extent of the fill and the texture of the soil used to cap the site 12 soil pits were excavated and samples collected for laboratory analysis. The objective of the soil analysis was to determine if pH, Electrical Conductivity, or Sulphur were limiting factors to plant growth in the capping loam/silty loam soil and to determine the macro nutrients that were available for plant growth in the capping soil. In the capping soil (WP 211) the pH, and electrical conductivity were rated as good; pH was slightly acidic (5.9) and the organic matter was 6.0%. A soil sample beneath the fill was taken at site WP205 and on this soil the pH was 4.8 (acidic) and the sulphur content was high at 128 ppm. It is typical for various soils in Delta and Richmond to be acidic and have high sulphur content in subsoil. Plant roots would not reach those subsoil layers. The detailed results for all soil samples are provided in Appendix 1

Based on the soil analysis of the capping soil, there are no obvious limiting factors to growth. It is the opinion of the authors that the plant limiting factor is the shallow depth of the capping soil above the anaerobic wood waste. The present depth of soil above this layer is not deep enough for adequate root development for perennial plants. Roots of the perennial plants would penetrate the wood waste and be affected by its anaerobic conditions. At the present time only (shallow-rooting) annual weeds seem to thrive on the site.

It is important to note that the soils that underlay the wood waste are fine textured and as such have a low saturated hydraulic conductivity (low permeability) and water will move through them very slowly. This has effectively produced a sealed environment that has contained the wood waste in an anaerobic environment, and based on visual inspection inhibited the generation or movement of any wood waste leachate.

[1] Personal communication Mr. Barry Mah

Figure 1: Site and Sampling Locations

GP – 65

Figure 2: Soil Map of Site
Site Location Soil = LU-TR

GP – 66

4.0 Land Capability based on Mapping

The land capability mapping shown in figure 3 indicates that the site before the organic soil was removed was 7:O4W 3:O5WF (O3LW). This means that based on the published mapping without improvement 70% is class O4W with excess wetness as a restriction (O indicates and organic soil). Observation of the adjoining land would indicate that classification Class 4W and 5WF (W being the same for organic and mineral soils) is correct for this site and is described below:[2] The improved class to 3 LW which is also described below.

CLASS 4W: Frequent or continuous occurrence of excess water during the growing period causing moderate crop damage and occasional crop loss. Water level is near the soil surface during most of the winter and/or until late spring preventing seeding in some years, or the soil is very poorly drained.

CLASS 5W: Frequent or continuous occurrence of excess water during the growing period making the land suitable for only perennial forage crops, and/or improved pasture. Water level is near the soil surface until early summer, or the maximum period the water level is less than 20 cm below the soil surface is 6 weeks during the growing period, or the soil is very poorly drained, commonly with shallow organic surface layers. Effective grazing period is longer than 10 weeks.

CLASS 5F: Includes soils with very severe nutrient imbalances, extreme acidity or alkalinity and/or extremely high levels of carbonates. Fertility status restricts the range of crops to perennial forages or other specially adapted crops such as cranberries. With very intensive, closely controlled and carefully monitored applications of fertilizers and/or other soil amendments, these soils are improvable in crop range, climate permitting. If expected crop range upon improvement is wide the Improved Rating is 2F, otherwise 3F.

[2] Henk E., & I Cotic. 1983. Land Capability Classification for Agriculture. BC Ministry of Agriculture and BC Ministry of Environment.

CLASS 03L: Dominantly humic or fibric soil in the 30 to 150 cm depth and/or aquatic muck greater than 5 cm thick in the 100 to 150 cm depth of the profile and/or a cumulo or continuous layer of loamy soil greater than 5 cm thick occurring in the upper 150 cm.

CLASS 3W: Occasional occurrence of excess water during the growing period causing minor crop damage, but no crop loss, or the occurrence of excess water during the winter months adversely affecting perennial crops. Water level is near the soil surface until mid-spring forcing late seeding, or the soil is poorly and in some cases imperfectly drained, or the water level is less than 20 cm below the soil surface for a continuous maximum period of 7 days during the growing period.

Given the removal of all of the organic soils from the site the land capability improved ratings will not be applicable to this site. It is the author's opinion that a strategy must be developed that will improve the existing site which presently would be classed as 6[3] or 7[4] with the limiting factor being the root restricting layer of anaerobic wood waste. It is not clear if perennial grasses would survive on this site due to the shallow (34cm) soil cap. At the present time a large portion of the site seems only capable of producing annual weeds.

[3] Class 6 land is nonarable but is capable of producing native and or uncultivated perennial forage crops.
[4] Class 7 land has no capability for arable culture or sustained natural grazing.

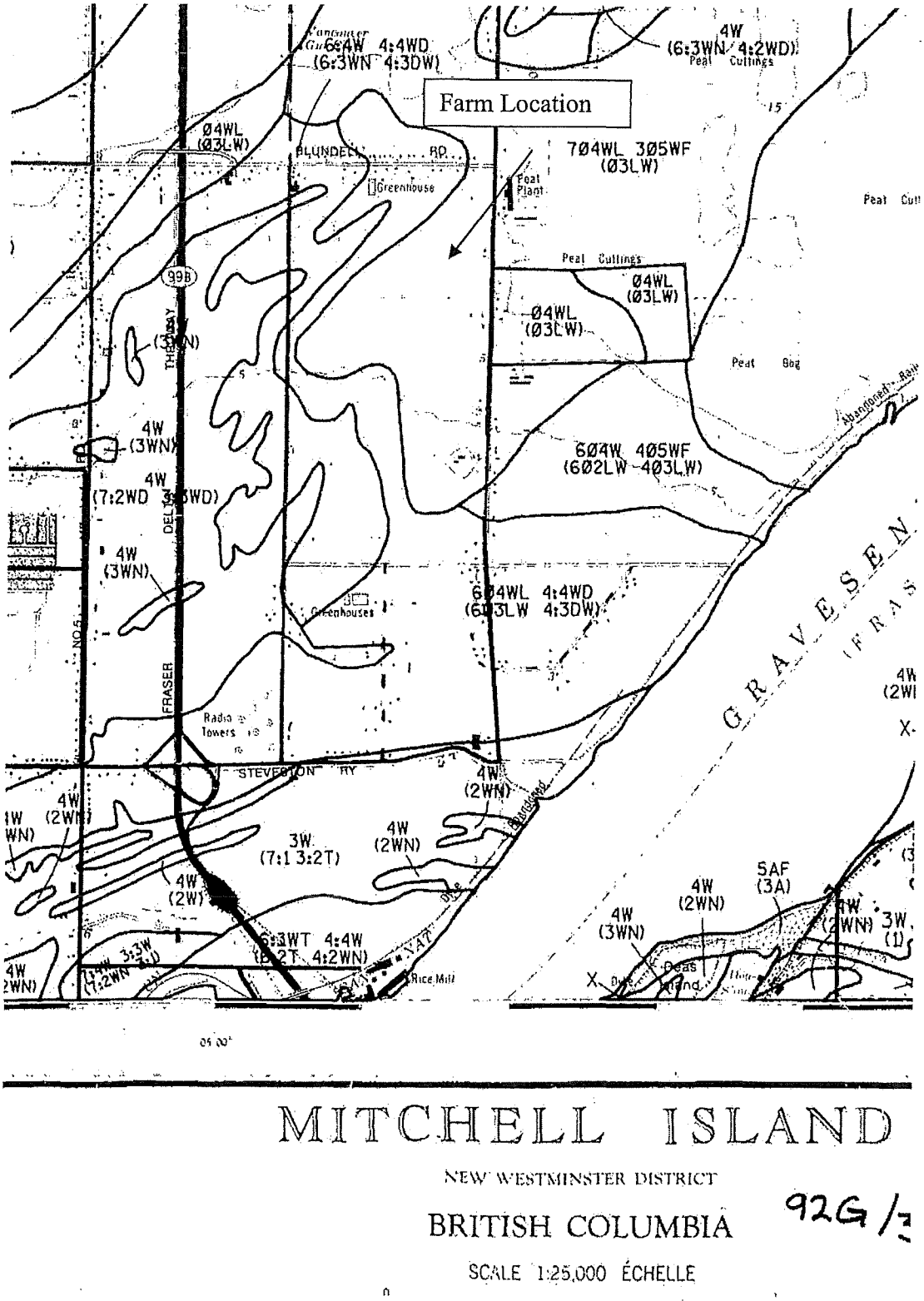

Figure 3: Land Capability for Agriculture

5.0 On Site Observations from Soil Pits

Nineteen soil pits were dug on the site. The pits were located in positions to observe typical soils and depth of wood waste burial on the site. The sampling locations are shown on Figure 1 while Figure 4 shows a typical sample of the wood waste debris found on the site, Figure 5 shows typical depth of soil capping wood waste and Figure 6 shows an example of the cedar shavings (hog fuel) found on the site. Figure 7 shows the undisturbed organic soil from Pit WP 272, in the northwest corner of the property.

All soil pits showed a profile including a cap of fill of various depths overlaying semi decomposed wood waste over non-decomposed wood waste. The border between decomposed and non-decomposed wood waste appeared to be the summer water table for the property, which was at about 1m depth. The winter water table appeared to be at the surface of the soil, with some lower areas being flooded during the winter – according to Ming Wu, the site manager.

Location	Depth of Capping (cm)	Depth of Wood (cm)
WP 202	32	118 (limit of backhoe)
WP 203	30	120 (limit of backhoe)
WP 204	60	140 (limit of backhoe)
WP 205	46	34
WP 206	0	40
WP 207	40	20
WP 208	30	30
WP 209	38	0
WP 210	35	15
WP 211	35	15
WP 212	35	67
WP 213	23	30
WP 268	55	110
WP 269	28	47
WP 270	45	27
WP 271	48	46
WP 272	15	60 organic soil no wood
WP 273	30	95 ++ limit of hoe
WP 274	85	40++ limit of hoe
Average	37.4	

Table 1 Depth of Soil Cap and Wood Waste

Figure 4: Typical Wood Debris found buried on the Farm

Figure 5: Cedar Shaving Buried on Site

The capping soil on all pit sites was hand textured and one sample was sent to the laboratory for particle size analysis. Hand texturing indicted the capping soil was loam to silty loam and this was confirmed by the lab analysis as seen in appendix I (detailed soil analysis). The average depth of the capping soil is 33.7 cm and the depth of the wood waste and hog fuel (cedar shavings) varies considerably as shown in Table 1. In locations WP 202 to 204, and 273 and 274 it may have been considerably deeper as the depth in the shown in Table 1 was the maximum depth the excavator could dig. These areas are where the Triggs were located and depths are likely to be much greater than 2m.

Figure 6: Buried Wood waste

Figure 7: Undisturbed Soil Profile

Most of the buried wood waste was in almost fresh condition with no signs of decomposition as can be seen in figure 4 and 6. It appears that the high water table and the soil capping are keeping the wood waste in anaerobic conditions and no microbial

decomposition is taking place. There is no visual indication of toxic leachates being generated from this material. The ditch to the south was visually observed and there were no signs of typical wood waste leachate, and the blueberry plants on property to the south are in healthy condition. For wood waste to generate toxic substances there needs to be oxygen present as seen by the high chemical and biological oxygen demand in studies on generation of leachate from cedar and other wood waste.[5] [6]

The blueberry plants on the subject property are stunted or dead due to the lack of adequate soil depth for them to grow in, and possibly through flooding of the property, as alluded to by the Manager. Review of the laboratory analysis of the site soils provided in Appendix I indicate that pH, electrical conductivity and sulphur are within normal parameters. The flooding hypothesis appears plausible for stunted growth. Figure 8 provides contours for the depth of wood waste: red is the 100cm depth contour, orange the 50cm contour and green the 25cm contour. Wood waste filling does not appear to be beyond the property boundaries.

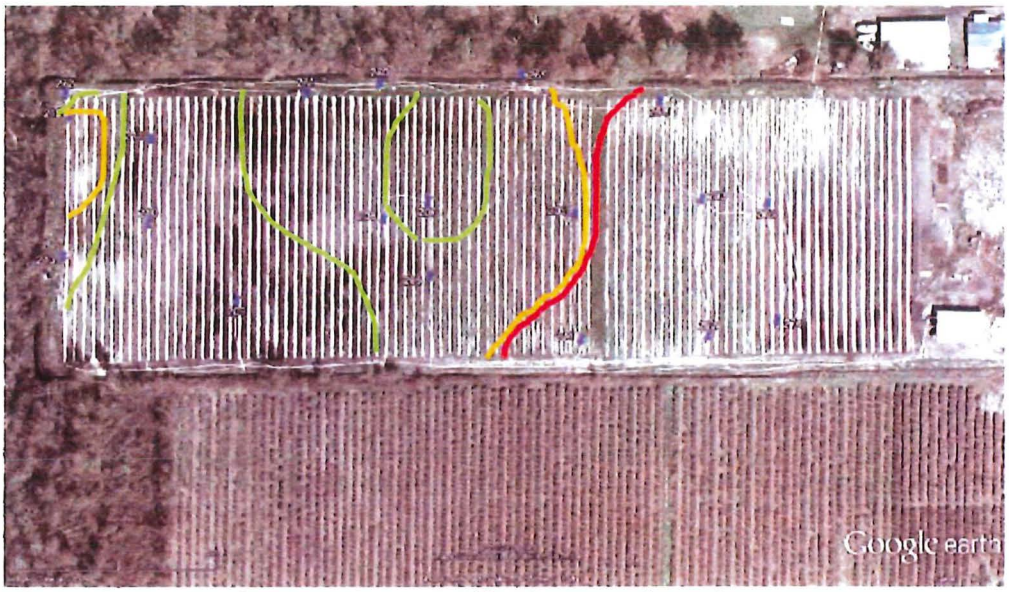

Figure 8: Depth of Wood Waste on Site (contour in cm)

6.0 Site Remediation

There are two options to remediate this site and bring it back into agricultural productivity. One option is to remove the capping soil, remove all the wood waste, fill the site with clean fill and top this with a minimum of 50 cm of high quality topsoil. A second option is to leave the wood waste in place, improve the soil cap by importing and depositing a 50 cm layer of silty clay or silty clay loam to increase the depth of the cap

[5] Hall, Kne J, et. al. 2005. Water Quality Research Journal of Canada vol. # 4 40 pp 476-483
[6] Samis, S.C. et.al. 1999. Mitigation of Fisheries Impacts from the Use and Disposal of Wood Residue in British Columbia and the Yukon. Canadian Technical Report of Fisheries and Aquatic Sciences 2296.

and provide additional rooting depth and topping this with a and topping this with a minimum of 50 cm of high quality topsoil, preferably silty loam or loam.

6.1 Option 1 Removal of Wood waste

Removal of the wood waste would require the:

- removal of all irrigation works and irrigation lines
- removal of all vegetation
- stripping of the existing soil cap,
- excavation of the wood waste (this will be in excess of 13,000 m^3 as it is not possible to determine the depth of the eastern portion of the property.)
- hauling and disposal of the wood waste
- importing of fill to backfill from wood waste removal (difference between removal is an estimated increase of 20% in compaction of fill vs. the wood waste.
- Importing and spreading a minimum of 50 cm of topsoil or about 12,500 m^3 after compaction

Removal would eliminate any long term threat of pollution and provide a suitable site for agricultural production in the future. The negative side of removal is that the disruption of the wood waste may lead to the generation of leachate which is not happening at the present time; the disposal of this material is difficult and it would end up in landfills in the area and there is a significant financial cost to excavate and remove the material.

6.2 Option 2 Leave Wood waste improve Cap and Topsoil

The Richmond, Triggs and Lulu soil complexes found at and around the site consist of peat of various depth and state of decomposition (Richmond: 40 – 160 cm of well decomposed organic matter; Triggs more than 160cm mainly sphagnum moss; and Lulu 40 – 160 cm of partially decomposed organic matter). All are located over moderately to fine textured deltaic deposits.

Formation of a peat soil typically takes place when vegetation grows in stagnant bodies of water such as lakes or cut-off river arms. First, dying water plants accumulate on the bottom followed by remains of reeds, sedges, and later trees. Because of the stagnant water with low oxygen content and a low pH, organic matter is not decomposed and accumulates to fill the complete body of water. This may be followed by a build-up of growth of primarily sphagnum moss that will form a dome with a locally elevated water table, thus forming a sphagnum-peat bog.

Peat bogs typically have an impermeable bottom and water turn-over is rather low. This will deprive the water of oxygen which is used in the decomposition process, and the pH is typically low, around pH 4 or 4.5. When peat is dug from peat bogs and the remaining area is not dewatered, the peat forming process repeats itself. When peat soils are dewatered and cultivated, organic matter is quickly oxidized and the depth of the peat soil rapidly diminishes.

At the subject site, peat has been replaced by wood waste. During the site investigation it was found that is the wood waste had not decomposed to a great extent, likely due to the site conditions that allowed the anaerobic conditions and low water movement to continue. A remediation plan that includes capping, should include measures to keep the peat formation factors in place to preserve the wood waste and prevent the formation of leachate.

6.3 Preferred Option

The preferred option based on our site observations is to leave the wood waste in place and return the land to agricultural production by increasing the depth of the cap by 25 cm and adding a minimum of 75 cm of topsoil.

The wood waste has been buried on this site for at least 30 years and as can be seen in figure 5 and 6, it is in virtually the same condition as when it was buried. The fine textured deltaic deposits that underlay the wood waste and the fine textured soil barrier between the wood waste and the ditches to the south and north has effectively sealed this site[7]. One of the key considerations in keeping the wood waste in an anaerobic condition is to ensure that the ground water is recharged at historical rates, as these have kept the wood waste submerged for most of the year. For this reason it is recommended that the cap depth be increased by 25 cm using silty clay loam or silty clay and not compacting to a state of impermeability. This cap will allow water to move slowly through and assist in the recharge of the water table on the site. There will of course be some recharge from the lateral and vertical movement of water into the site from the natural water table.

On top of this cap a layer of 75 cm of quality topsoil should be applied. The combination of 25 cm of the capping layer and the topsoil will provide between 75 and 100 cm of rooting depth while keeping the wood waste contained in its present anaerobic condition. The added topsoil will act as a small "pre-load" for the site and may compact the wood waste layer. While in the case of wood waste (the pieces of 2x4 seen in one of the pictures) the compaction will be minimal, some of the fine wood waste may be compacted. This will keep the wood waste under water and in the stable, anaerobic state.

The increase of height of the soil will also prevent flooding of the property during the winter wet season, allowing permanent vegetation such as blueberries to survive and other crops such as nursery trees to flourish. A small part of the property has been raised with quality topsoil and now supports vegetable production and some large fruit trees.

[7] The saturated hydraulic conductivity of these soils will be between 0.42 and 1.41 um/sec

The preferred option would require:

- Removal of all irrigation works including pressure lines and drip hoses
- Removal of all vegetation, either by mowing or uprooting and hauling for disposal, or through digging and saving blueberry plants that are several years old.
- Placing 25 cm of cap
- Placing of 75cm of quality topsoil
- Crowning and ditching where required
- Seed with cover crop and establish soil forming processes
- Installing subsurface drainage where required
- Installing irrigation works where required
- Improve ditch on north side of property and clean the ditch on the south side.

7.0 Summary and Recommendation

Based on the analysis provided in this report it is recommended that the wood waste and debris be left in place and that 25 cm of silty clay loam to silty clay cap be placed on top of the existing soil cap and that 75cm of quality topsoil be placed on top of the soil cap. This strategy will maintain the wood waste in anaerobic conditions and inhibit the production of leachate and improve the land capability to class 2 or 3 which will support a wide range of agricultural crops.

The estimated volume of fill is provided below:

Area of proposed fill m^2	Fill depth m	m^3 compacted	loose	m^3 loose material
Fill – silty clay loam or silty clay				
2.5 hectares	0.25	6,250	1.25	7,800
Topsoil*				
2.5 hectares	0.75	18,750	1.2 compaction factor	22,500
Total Loose Volume Fill capping + Top Soil				**30,300 m^3**

Table 2 Fill Volume Estimates

8.0 Site Management

Good site management will be critical for the success of the fill operation and the final use of the site for an agricultural production.
The following activities must take place:

- Monitor the removal of irrigation works and vegetation
- Monitor the incoming fill to ensure that there are is not concrete, asphalt, plastic or other non-soil materials mixed with the fill
- Monitor to ensure that there are no contaminants in any of the fill brought to the site.
- Monitor to ensure that there is no large woody debris or other non-mineral components in the fill.
- Ensure that the truck wash facility is operating properly and that sediment is removed from wash water before entering waterways.
- Install silt fencing to protect all ditches.

The fill operator has agreed and it is assumed it will be a condition of the permit that a Professional Agrologist will carry out regular monitoring and oversight, and that they will have the authority to stop filling if there are issues with the fill quality or environmental concerns on the site.

8.1 Soil Stockpiling

Since topsoil will be delivered at the same time as mineral fill, it is important that topsoil be stockpiled and managed separately. As well, any excavated organic soil that is being retained on site should also be separately stockpiled. For all topsoil piles the following procedures should be implemented.

- Compaction will be minimized by minimizing vehicle traffic when stockpiling and handling soils when not wet
- Stockpiles will be constructed to heights of 4m or less with 2 H: 1 V slopes.
- The shape of the stockpile should provide for positive drainage (i.e. sufficiently sloped to prevent puddling or ponding), to minimize water infiltration into the pile.
- Peat and topsoil will be stockpiled separate from mineral fill to ensure they are not mixed.

8.2 Sediment Control

- Sediment will be controlled by the installation of silt fences along all watercourses.
- The on-site Agrologist will also make decisions to halt the fill operation of weather conditions are so wet that excess sediment is being produced from the site that the sediment control fences cannot handle.
- All sediment will be removed from truck wash water prior to discharge.

8.3 Dust Control

- All tires will be washed which will reduce dust during dry periods
- Access roads will be watered on a regular basis during dry periods to minimize dust.

8.4 Drainage Management

- The ditch on the north side of the property will need to be widened and deepened to ensure positive drainage of surface water,
- The ditch on the south side of the property should be cleaned.

8.5 Management of Fill Quality

Management of fill quality is critical for the success of this site and for meeting the legal requirements of the ALC and the City of Richmond. This section expands on the comments made in section 8.0.

- There cannot be any fill that has any probability of hydrocarbon or metal contamination. Soil must adhere to Schedule 7 Column III of the Contaminated Sites Regulation. If soil originates from a contaminated site an Approved Soil

Relocation Agreement and authorization from the ALC must be in place. This requires the fill operator to be certain of the origin of all fill.

- There cannot be any concrete, asphalt, plastic or other non granular soil/gravel contaminants in the fill. It is understood that occasionally a piece of asphalt or concrete or other material may be in a load, but is the responsibility of the fill operator to spot this on dumping and remove it prior to spreading of the fill. The on-site staff must be fully briefed and trained on the importance of ensuring no contaminants enter the site.
- If there are more than 50 truck loads originating from a source site the fill should be inspected at the point of origin by a Professional Agrologist prior to entering the fill site.
- On a regular basis (at least once per month) a professional agrologist will with the cooperation of the fill operator dig random test holes to make observations on the quality of the fill.

8.5 Transition to Agriculture

Once the project is completed it is recommended that forage grasses and legumes be planted and harvested for the first two years. This will help establish good soil structure, create macrospores to improve drainage, and improve fertility. After two years the pasture can be cultivated, and a wide range of agricultural crops will be capable of growing on the site.

9.0 References

Bertrand, R.A., G.A. Hughes-Games, D.C. Nikkel. 1991. *Soil Management Handbook for the Lower Fraser Valley.* BC Ministry of Agriculture, Fisheries and Food. Abbotsford, B.C.

Henk E., & I Cotic. 1983. *Land Capability Classification for Agriculture in British Columbia.* BC Ministry of Environment & Ministry of Agriculture and Food. Kelowna, B.C.

Luttmerding, H.A. 1981. *Sols of the Langley-Vancouver Map Area.* RAB Bulletin 18, Vol. 1 & 3. BC Ministry of Environment, Victoria, B.C.

Appendix I Soil Chemical Analysis

GP – 81

Site WP 202 Existing soil cap

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Exova

Farm Soil Analysis

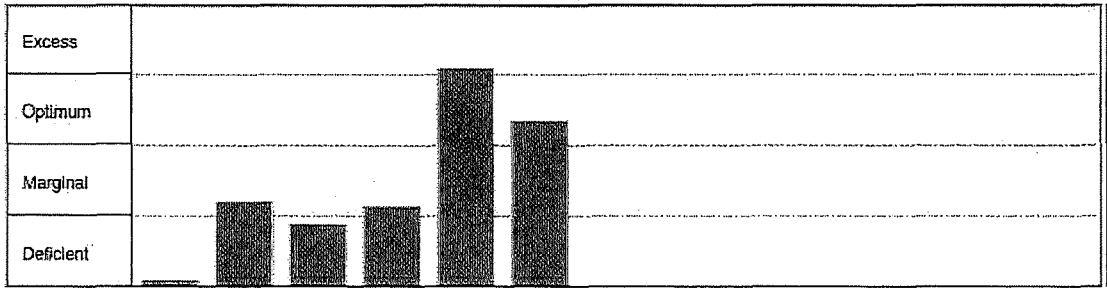
Bill To:	McTavish Resource & Management Consultants	Grower Name:	Ming Wu	Lot Number:	878074
Report To:	McTavish Resource & Management Consultants	Client's Sample Id:	#6 Road	Report Number:	1747015
		Field Id:	WP 202 Topsoil	Date Received:	Jun 26, 2012
	2858 Bayview Street	Acres:		Disposal Date:	Jul 26, 2012
	Surrey, BC., Canada	Legal Location:		Report Date:	Jun 29, 2012
	V4A 2Z4	Last Crop:	Crop not provided	Arrival Condition:	
Agreement:	36394				

Nutrient analysis (ppm)

Depth	N*	P	K	S**	Ca	Mg	Fe	Cu	Zn	B	Mn	Cl	BiCarbP
0" - 6"	<2	17	66	3	1900	109							

Soil Quality

pH	EC(dS/m)	OM(%)	Sample#
6.7	0.13	3.6	4102833



Alkaline	*Very Toxic*	*High*
→ *Neutral*	*Toxic*	*Normal* ←
Acidic	*Caution*	*Low*
Very Acidic	*Good* ←	*Very Low*

Total lbs/acre	4	34	133	6
Estimated lbs/acre	8	34	133	11

Texture *n/a* Hand Texture *n/a*
Sand n/a Silt n/a Clay n/a
Ammonium <0.4 ug/g

BS 90.6 %
Ca 81.4 % Mg 7.7 % Na <1 % K 1.5 %
TEC 11.6 meq/100g Na <30 ppm

Lime 0 T/ac Buffer pH 6.9 Est. N Release n/a C:N Ratio n/a

*Nitrate-N **Sulfate-S n/a = not analysed

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Farm Soil Analysis

Bill To:	McTavish Resource & Management Consultants	Grower Name:	Ming Wu	Lot Number:	878074
Report To:	McTavish Resource & Management Consultants	Client's Sample Id:	#6 Road	Report Number:	1747013
		Field Id:	WP 205 Native Soil	Date Received:	Jun 26, 2012
	2858 Bayview Street	Acres:		Disposal Date:	Jul 26, 2012
	Surrey, BC., Canada	Legal Location:		Report Date:	Jun 28, 2012
	V4A 2Z4	Last Crop:	Crop not provided	Arrival Condition:	
Agreement:	36394				

Nutrient analysis (ppm)														Soil Quality			
Depth	N*	P	K	S**	Ca	Mg	Fe	Cu	Zn	B	Mn	Cl	BiCarbP	pH	EC(dS/m)	OM(%)	Sample#
0" - 6"	3			128										4.8	0.63		4102831

Excess	*Alkaline*	*Very Toxic*	*High*
Optimum	*Neutral*	*Toxic*	*Normal*
Marginal	*Acidic*	*Caution*	*Low*
Deficient	*Very Acidic*	*Good*	*Very Low*

Total lbs/acre	7			256
Estimated lbs/acre	14			521

Texture *n/a* Hand Texture *n/a*
Sand n/a Silt n/a Clay n/a
Ammonium n/a

BS n/a
Ca n/a Mg n/a Na n/a K n/a
TEC n/a Na n/a

Lime n/a Buffer pH n/a Est. N Release n/a C:N Ratio n/a

*Nitrate-N **Sulfate-S n/a = not analysed

GP – 83

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Farm Soil Analysis

Bill To:	McTavish Resource & Management Consultants	Grower Name:	Ming Wu	Lot Number:	878074
Report To:	McTavish Resource & Management Consultants	Client's Sample Id:	#6 Road	Report Number:	1747014
		Field Id:	WP 204 Hog Fuel	Date Received:	Jun 26, 2012
	2858 Bayview Street	Acres:		Disposal Date:	Jul 26, 2012
	Surrey, BC., Canada	Legal Location:		Report Date:	Jun 28, 2012
	V4A 2Z4	Last Crop:	Crop not provided	Arrival Condition:	
Agreement:	36394				

Nutrient analysis (ppm)

Depth	N*	P	K	S**	Ca	Mg	Fe	Cu	Zn	B	Mn	Cl	BlCarbP
0" - 6"	<2			10									

Soil Quality

pH	EC(dS/m)	OM(%)	Sample#
5.8	0.12		4102832

Excess	*Alkaline*	*Very Toxic*	*High*
Optimum	*Neutral*	*Toxic*	*Normal*
Marginal	*Acidic*	*Caution*	*Low*
Deficient	*Very Acidic*	*Good*	*Very Low*

Total lbs/acre	4			20
Estimated lbs/acre	8			40

Texture *n/a* Hand Texture *n/a*
Sand n/a Silt n/a Clay n/a
Ammonium n/a

BS n/a
Ca n/a Mg n/a Na n/a K n/a
TEC n/a Na n/a

Lime n/a Buffer pH n/a Est. N Release n/a C:N Ratio n/a

*Nitrate-N **Sulfate-S n/a = not analysed

RECOMMENDATIONS FOR BALANCED CROP NUTRITION

GP – 84

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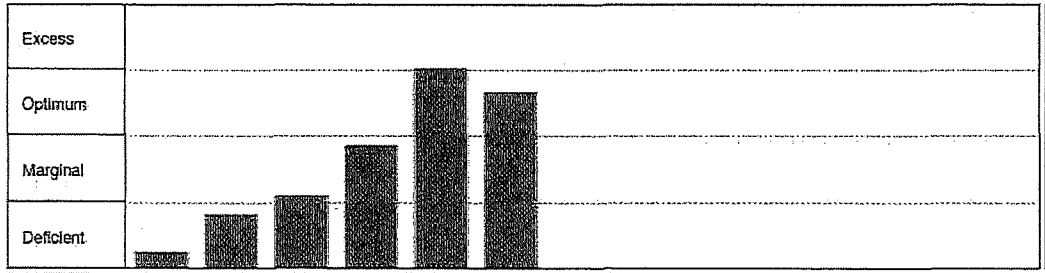
Farm Soil Analysis

Bill To:	McTavish Resource & Management Consultants	Grower Name:	Ming Wu	Lot Number:	878074
Report To:	McTavish Resource & Management Consultants	Client's Sample Id:	#6 Road	Report Number:	1746976
		Field Id:	WP 211 Topsoil	Date Received:	Jun 26, 2012
	2858 Bayview Street	Acres:		Disposal Date:	Jul 26, 2012
	Surrey, BC., Canada	Legal Location:		Report Date:	Jun 29, 2012
	V4A 2Z4	Last Crop:	Crop not provided	Arrival Condition:	
Agreement:	36394				

Nutrient analysis (ppm)														Soil Quality			
Depth	N*	P	K	S**	Ca	Mg	Fe	Cu	Zn	B	Mn	Cl	BiCarbP	pH	EC(dS/m)	OM(%)	Sample#
0" - 6"	5	13	83	7	1400	180								5.9	0.15	6.0	4102829



					Alkaline	*Very Toxic*	*High*
					Neutral	*Toxic*	*Normal*
					Acidic	*Caution*	*Low*
					Very Acidic	*Good*	*Very Low*

Total lbs/acre	10	25	166	13
Estimated lbs/acre	21	25	166	27

Texture *Loam* Hand Texture *n/a*
Sand 49.0 % Silt 34.0 % Clay 17.0 %
Ammonium 0.9 ug/g
Lime 3.0 T/ac Buffer pH 6.2

BS 50.6 %
Ca 40.7 % Mg 8.6 % Na <0.8 % K 1.2 %
TEC 17.2 meq/100g Na <30 ppm
Est. N Release n/a C:N Ratio n/a

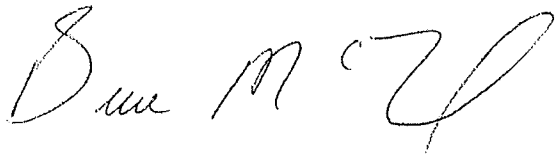
*Nitrate-N **Sulfate-S n/a = not analysed

GP – 85

Woodwaste Leachate and Site Drainage Addendum I To Proposed Remediation of Land Located at 8511 #6 Road Richmond, B.C.

BCAA Legal: SEC 20 BLK4N RG5W PL 3109 Parcel A, Subsidy Lot 3, (J71246E).

Prepared by:



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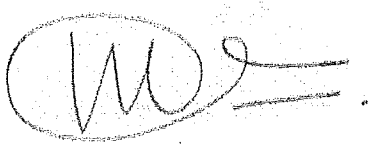

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Prepared for:

Bohan Jiang

December 14, 2013

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1.0 Introduction

McTavish Resource & Management Consultants Ltd. was retained by Bohan Jiang to determine the cause for the Blueberry Crop failure and develop a remediation plan to allow agricultural production on the land. That report was submitted to the City of Richmond in September of 2012. The City of Richmond requested further information on the generation of leachate from the wood waste and a drainage plan. This current report provides further information on wood waste leachate and recommended mitigation measures.

2.0 Site Location

The subject properties are located at 8511 No 6 Road Richmond B.C. The legal description is: SEC 20 BLK4N RG5W PL 3109 Parcel A, Subsidy Lot 3, (J71246E).

The street address is 8511 No 6 Road in Richmond, B.C. The total farm size is 40475 m^2 or 10 acres and is zoned AG1. Approximately 2.5 hectares of the land is planted in Blueberries and ½ of the crop has been a complete failure and the other ½ has marginal growth.

2.1 Previous Land Use

The use of the land for any agricultural use is severely impeded by the fact that approximately 25 to 30 years ago a previous owner has stripped all the organic soil (peat) from the site and filled it with cedar wood waste and wooden construction debris. This has been discussed in detail in section 3 of the September 2012 report.

3.0 Recommendations from 2012 Report

The Richmond, Triggs and Lulu soil complexes found at and around the site consist of peat of various depth and state of decomposition (Richmond: 40 – 160 cm of well decomposed organic matter; Triggs more than 160cm mainly sphagnum moss; and Lulu 40 – 160 cm of partially decomposed organic matter). All are located over moderately to fine textured deltaic deposits. Formation of a peat soil typically takes place when vegetation grows in stagnant bodies of water such as lakes or cut-off river arms. First, dying water plants accumulate on the bottom followed by remains of reeds, sedges, and later trees. Because of the stagnant water with low oxygen content and a low pH, organic matter is not decomposed and accumulates to fill the complete body of water. This may be followed by a build-up of growth of primarily sphagnum moss that will form a dome with a locally elevated water table, thus forming a sphagnum-peat bog.

Peat bogs typically have an impermeable bottom and water turn-over is rather low. This will deprive the water of oxygen which is used in the decomposition process, and the pH is typically low, around pH 4 or 4.5. When peat is dug from peat bogs and the remaining area is not dewatered, the peat forming process repeats itself. When peat soils are dewatered and cultivated, organic matter is quickly oxidized and the depth of the peat soil rapidly diminishes.

At the subject site, peat has been replaced by wood waste. During the site investigation it was found that is the wood waste had not decomposed to a great extent, likely due to the site conditions that allowed the anaerobic conditions and low water movement to continue. A remediation plan that includes capping, should include measures to keep the peat formation factors in place to preserve the wood waste and prevent the formation of leachate.

The preferred option based on site observations is to leave the wood waste in place and return the land to agricultural production by increasing the depth of the fine textured soil cap by 25 cm and adding a minimum of 75 cm of topsoil.

The wood waste has been buried on this site for at least 30 years and it is in virtually the same condition as when it was buried. The fine textured deltaic deposits that underlay the wood waste and the fine textured soil barrier that exists in most locations between the wood waste and the ditches to the south and north has effectively sealed this site[1]. One of the key considerations in keeping the wood waste in an anaerobic condition is to ensure that the ground water is recharged at historical rates, as these have kept the wood waste submerged for most of the year. For this reason it is recommended that the cap depth be increased by 25 cm using silty clay loam or silty clay and not compacting to a state of impermeability. This cap will allow water to move slowly through and assist in the recharge of the water table on the site. There will of course be some recharge from the lateral and vertical movement of water into the site from the natural water table.

On top of this cap a layer of 75 cm of quality topsoil should be applied. The combination of 25 cm of the capping layer and the topsoil will provide between 75 and 100 cm of rooting depth while keeping the wood waste contained in its present anaerobic condition. The added topsoil will act as a small "pre-load" for the site and may compact the wood waste layer. While in the case of wood waste (the pieces of 2x4 shown in the 2012 report) the compaction will be minimal, some of the fine wood waste may be compacted. This will keep the wood waste under water and in the stable, anaerobic state.

The increase of height of the soil will also prevent flooding of the property during the winter wet season, allowing permanent vegetation such as blueberries to survive and other crops such as nursery trees to flourish. A small part of the property has been raised with quality topsoil and now supports vegetable production and some large fruit trees.

The preferred option will require:

- removal of all irrigation works including pressure lines and drip hoses;
- removal of all vegetation, either by mowing or uprooting and hauling for disposal, or through digging and saving blueberry plants that are several years old;
- placing 25 cm of cap of fine textured soil;
- placing of 75cm of quality topsoil;

[1] The saturated hydraulic conductivity of these soils will be between 0.42 and 1.41 um/sec

- crowning and ditching improvements where required;
- seed with cover crop and establish soil forming processes;
- installing irrigation works where required;
- improve ditch on north side of property and clean the ditch on the south side; and
- implement measures to ensure a minimum of a 2 m sealed buffer between the wood waste and the ditches on the north and south of the property. This is a new recommendation.

4.0 Potential for Leachate Generation and Mitigation

Based on visual observations made during 2012 and 2013 there does not appear to be any leachate entering the ditches on the north or south side of the property. To determine the potential impact on the surrounding ditches, on-site observations were made in December of 2013 to determine the distance of buried wood waste to the ditches on the north and south of the property. Figure 1 shows where auguring took place to identify underlying conditions.

4.1 Site Observations December 2013

From the onsite investigation it appears that the former owner of the property only excavated peat and replaced it with wood waste on the property itself and not on the adjoining properties. The west side of the property did not contain wood waste (or only to a very small extent), and in most places the wood waste was at least 2m from the north or the south ditches. However in one location (GPS location 826) wood waste was found close to the north ditch. Along the south ditch there is an area (between GPS location 831 and 832) where the wood waste is near and/or underneath the ditch. The wood waste close to and underneath the ditch was covered with a layer of 20 to 30 cm of clay and the wood waste was virtually in a non-decomposed form. At the south ditch the water level was well above the top of the wood waste in the soil and the ditch water was clear and did not appear to have been affected by the wood waste.

These observations indicate that no or very little lateral movement of water takes place through the wood waste and into the ditches. It appears that in the current configuration, there is enough of a clay buffer between the wood waste and the ditches to keep the wood waste anaerobic and the ditches unaffected.

4.2 Leachate Risk Management

The rehabilitation plan is geared towards capping the surface of the wood waste to prevent precipitation water from entering this mass. This protection will be enhanced with the crowning of the subsoil and topsoil. Precipitation will move by overland flow and lateral movement through the topsoil towards the ditches. Some downwards percolation is preferred to keep the wood waste in an anaerobic state.

Based on the recent findings; (December 12, 2013 field visit – see Appendix I) there are locations where the wood waste is close to or even underneath the perimeter ditches. In these areas it is recommended that when the project is underway, that wood waste is stripped from near the ditches to a width of 2 m from the ditches and replaced with clay or silty clay to provide

a barrier between the remaining wood waste and the ditch. This will prevent any wood waste leachate from reaching the ditch and thus ensure that the municipal drainage system unaffected. Stripping wood waste and replacing it with clay to form a barrier is only required in a few areas as most of the site it is separated from the ditches by at least 2 m of natural soil.

It is recommended that at the time of project execution the consultants work with the contractor and clearly mark all areas where the 2m buffer is not in place and supervise the removal of wood waste in these areas and the back filling with clay or silty clay.

5.0 Summary and Conclusions Leachate

Extensive sampling of the site (see figure 2) has identified of the extent and the anaerobic condition of the wood waste as described in the September 2012 report and this report. To ensure that leachate is not generated from this site, the following recommendations need to be implemented as part of the process of making the subject property a productive and environmentally safe farm:

- cap with 25 cm of fine texture soil
- add 75 cm of topsoil
- crown the land to facilitate drainage
- ensure a 2m buffer between the woodwaste and the ditches

6.0 Site Drainage

The subject farm presently has a ditch on the north and south side of the property. The north ditch has its flow split with part of the ditch flowing east to the # 6 road ditch part flowing west, connecting to a north south ditch flowing south and connecting with the ditch on the southern border of property.

The south ditch flows to the west from approximately the mid-point of the property and continues into the adjoining property to the west. At the present time these ditches are not functioning properly as grades fluctuate and the ditches are overgrown with vegetation.

It is recommended that the following drainage plan be implemented

a) Keep the flow direction as is and do minor regarding and clean ditches of water flow constricting vegetation;
b) Construct a new ditch along the western side of the property if the existing ditch is on the neighbouring property;
c) During the filling operation ensure that subsoil and topsoil is crowned to enable water to flow from the centre of the property to the ditches on the north and south sides of the property.

These activities will not increase peak flows to the City of Richmond ditches above historical levels as all ditches previously existed (with one replacing the neigbouring ditch), and only needed maintenance and re-grading is taking place

6.1 New Ditch Elevations

The following section provides details on ditch elevations and flow directions. The purpose is to improve the site drainage by minor regarding and clearing of vegetation and debris that is impeding water flow.

6.1.1 Southern Ditch

The property (like most of Richmond) has very little natural grade and therefore the slope of the ditches have very little gradient. The highest point along the southern ditch is at the culvert invert across from the access road shown on the elevation map in Appendix II. The ditch elevation at this point is 0.81m the ditch slopes from this point to the west to an elevation of 0.21m at the western end of the ditch. From this point it continues to flow to the west into the neigbouring property which has an ESA designation and is considered a Freshwater Wetland.

The southern ditch requires minor regarding to eliminate the topographic fluctuations and make the bottom an even gradient to the west, keeping western bottom of ditch elevation at approximately its present level (See Appendix II). Some ditch widening is recommended to have an average cross section as shown in Appendix II. At the eastern end it will not be possible to maintain 0.50 m ditch depth, however there is little flow at this end of the system and a shallower ditch will be functional.

6.1.2 Northern Ditch

The northern ditch should be graded from approximately the cross section 5 line on the topographic map to have all flow from this point split go east to the #6 road ditch and all flow to the west of this point to drain as it presently does to the west. The water flowing west presently connects with a north south ditch that connects with the south property ditch. The north south ditch seems to be on the neigbouring property and a new ditch that is entirely on the subject property should be installed to connect the north and south ditches. See Appendix III for detailed elevations.

6.1.3 Western Ditch

As described in section 6.1.2 there is a ditch running from north to south along the western property boundary. Based on survey pins observed during the December site visit this ditch seems to be on the neighbouring property. For this reason a new ditch should be installed on the subject property to connect the north and south ditches. Elevations are shown in Appendix IV.

6.1.4 Impact on Western Environmentally Sensitive Area

The southern ditch flows to the west into an Environmentally Sensitive Area (ESA) that is categorized as Fresh Water Wetland (FRWT). By keeping the drainage flow direction as it presently exists on this property the freshwater recharge from the subject property to the ESA will be maintained.

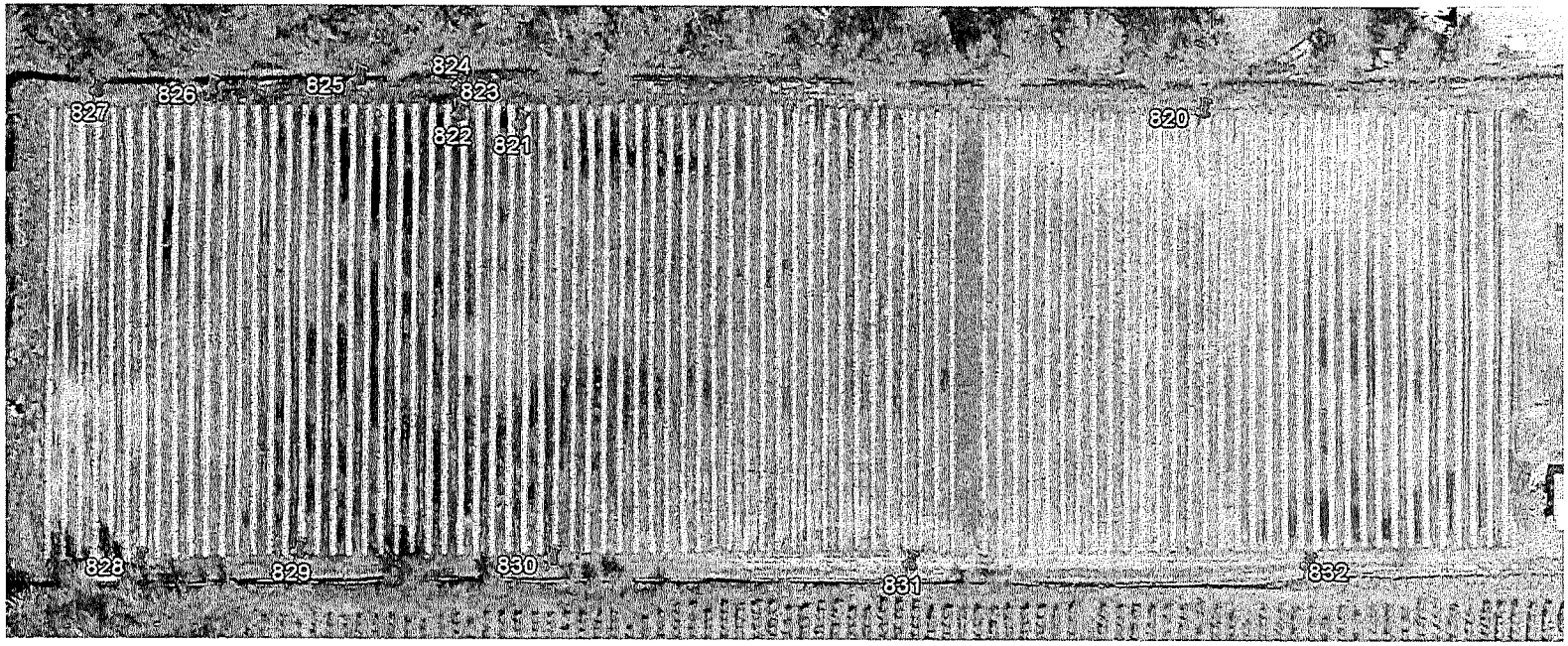

Figure 1: Auger Sampling Points December 2013

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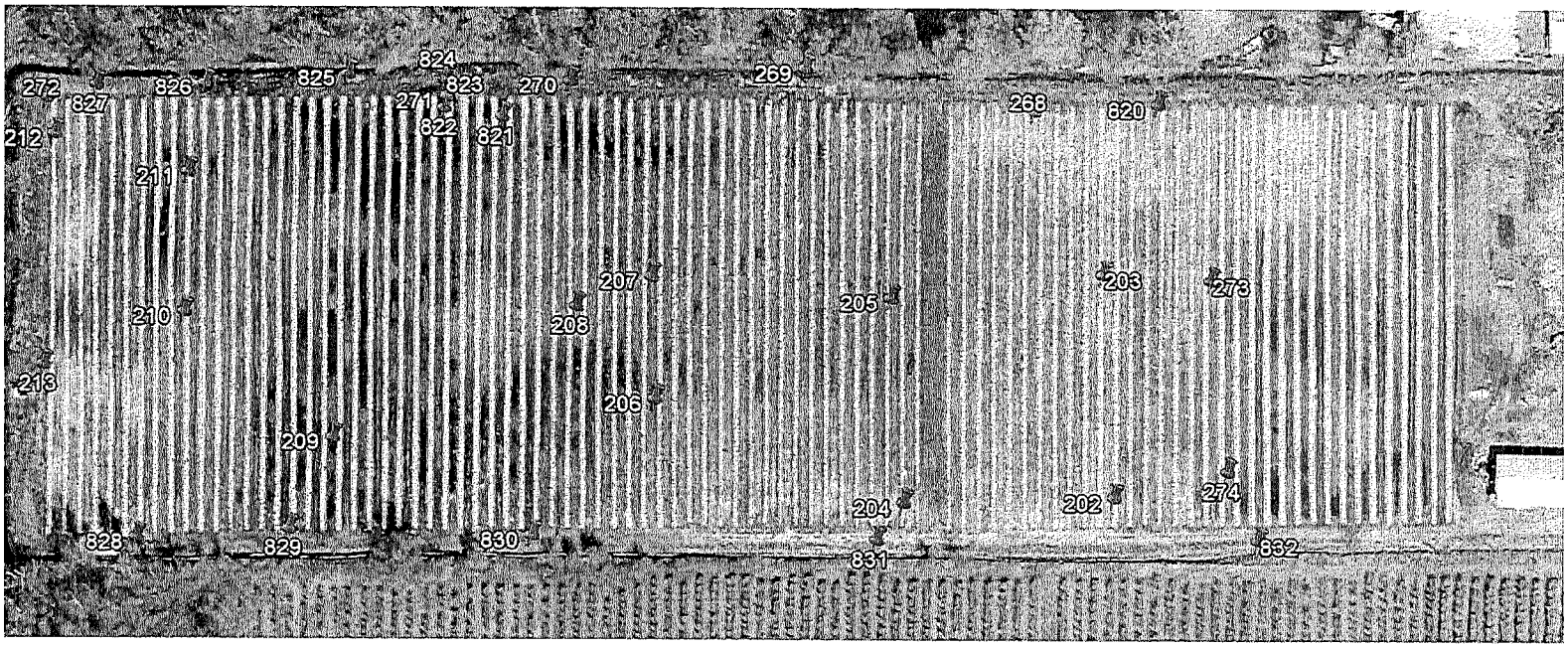


Figure 2: Sampling Sites 8511 #6 Road

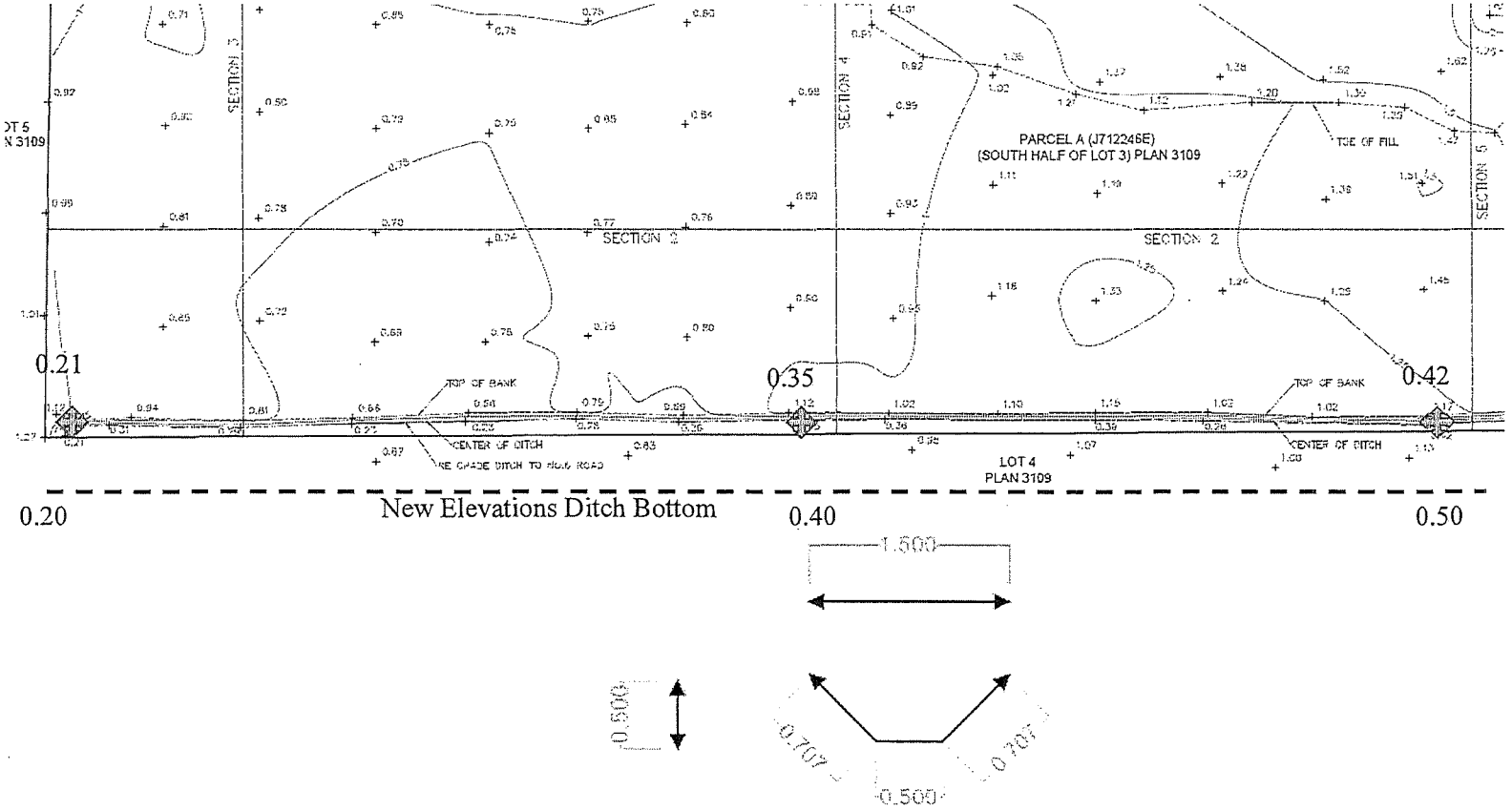
GP – 94

Appendix I Field Notes

GPS Location	Comments
820	Ditch lower than adjacent land to north Property to north is peat/organic soil as seen by ditch edge
821	Woodwaste 60 cm below surface Greater than 3m away from north ditch
822	Woodwaste 35 cm below surface Woodwaste 7.5m from ditch
823	Woodwaste 40 cm below surface Woodwaste 4 m from ditch
824	Shallow layer of woodwaste 3m from ditch
825	Auger 2m from ditch no woodwaste, peat only
826	Woodwaste at 15 cm below surface 1m from ditch 0.5 m from ditch only a thin layer of woodwaste
827	2m from ditch no woodwaste
828	3m from ditch no woodwaste
829	3m from ditch no woodwaste
830	2m from ditch no woodwaste
831	Woodwaste at 75cm from ditch edge Sample in ditch, woodwaste found buried below 20 cm clay layer, still anaerobic, no sign of leaching or pollution
832	Sample in ditch, woodwaste found buried below 20 cm clay layer, still anaerobic, no sign of leaching or pollution

Appendix II Ditch Elevations and Cross Sections South Ditch

Leave water flow in historical directions



Average Ditch Cross-Section South Ditch

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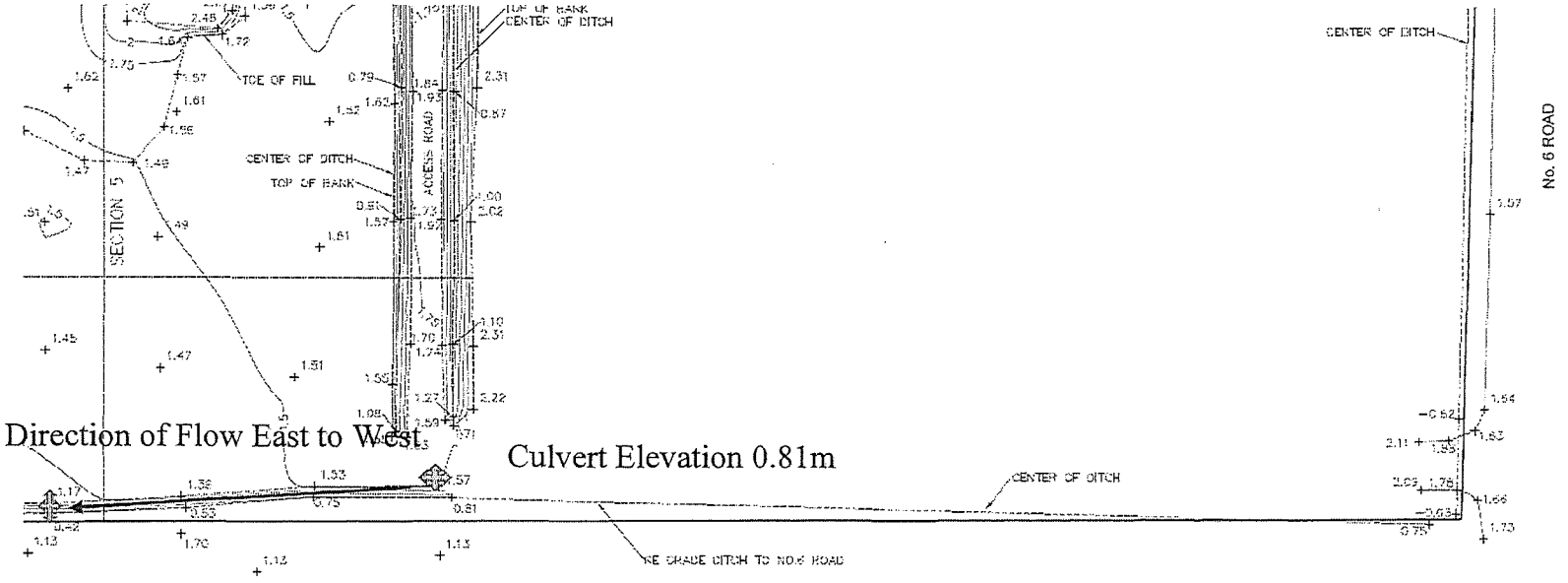

0.50

New Elevations Ditch Bottom

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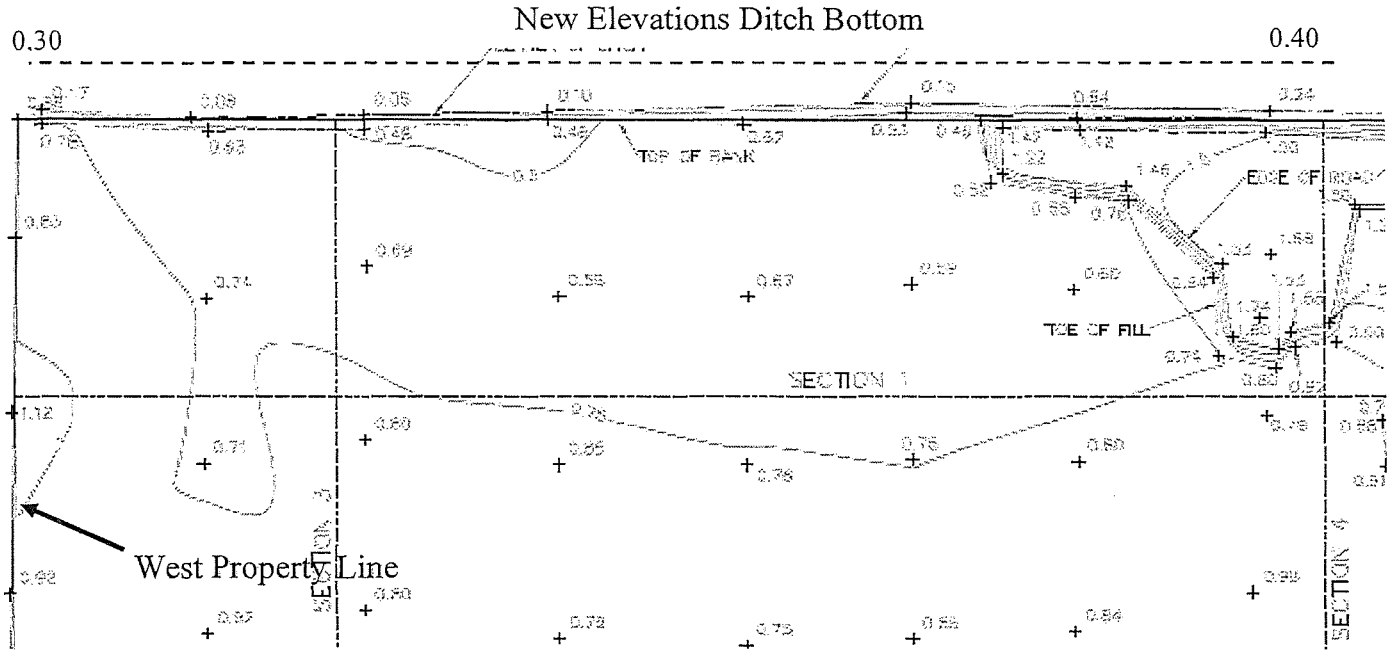
Appendix III Ditch Elevations North Ditch



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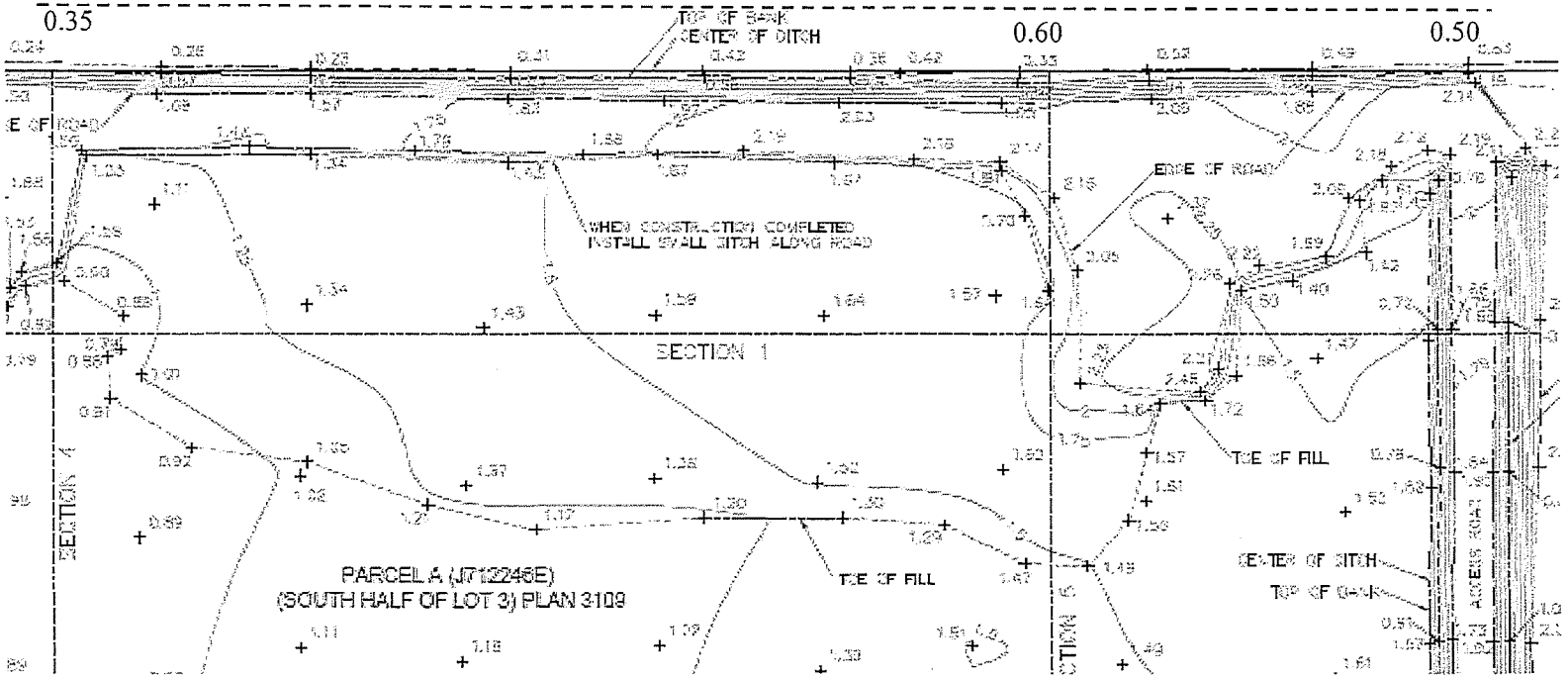
Flow east to west this section

Regrade to ensure flow west to east



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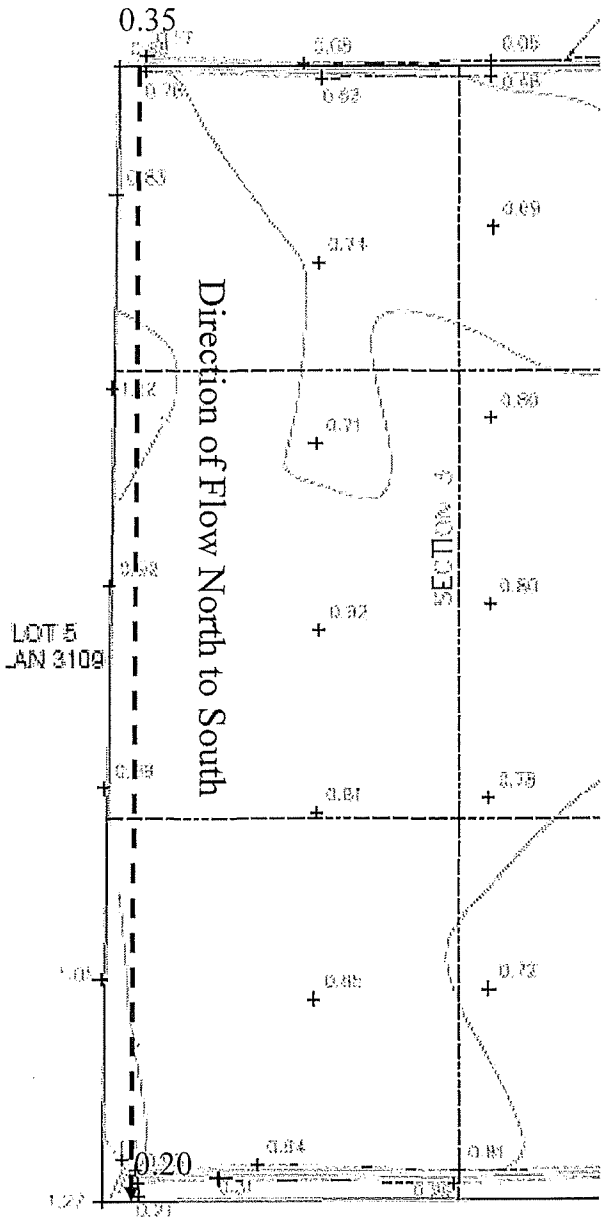
Appendix IV Ditch Elevations West Ditch



This is a new ditch to be installed of existing ditch is on the neighbouring property. This will be a relative shallow ditch due to the existing bottom of ditch elevations.

Appendix VEnvironmentally Sensitive Areas

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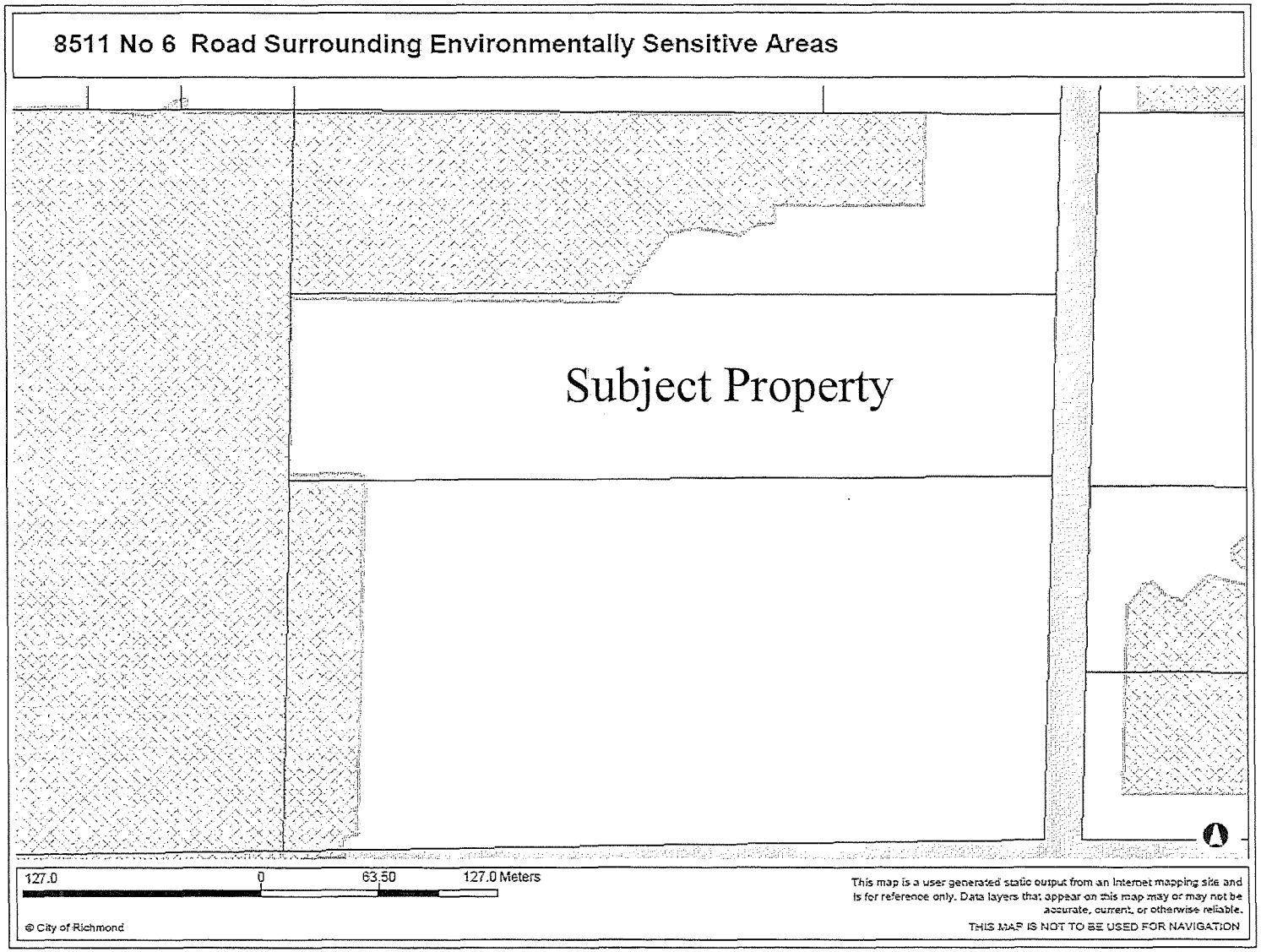
8511 No 6 Road Surrounding Environmentally Sensitive Areas
Subject Property
127.0
0
63.50
127.0 Meters
This map is a user generated static output from an Internet mapping site and is for reference only. Data layers that appear on this map may or may not be accurate, current, or otherwise reliable.
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THIS MAP IS NOT TO BE USED FOR NAVIGATION

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August 11, 2020

Barry Mah
Westwood Topsoil Ltd.
6604 62B Street
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westwoodbarry@mac.com

Dear Mr. Mah,

RE: Requirement of a Farm Plan for 8511 No. 6 Road, Richmond, BC (CD 28808)

Madrone Environmental Services Ltd. ('Madrone') understands that you, Mr. Barry Mah ('the Client'), requires the development of a Farm Plan to facilitate a proposal to import soil onto a parcel located at 8511 No. 6 Road, Richmond, BC ('the Property') for the purpose of remediating the land for crop cultivation. This soil importation proposal will be reviewed by the City of Richmond ('the City'), the City's Food Security and Agricultural Advisory Committee (FSAAC) and the Agricultural Land Commission (ALC).

In an email[1], Mr. Mike Morin, Community Bylaws, City of Richmond, outlined requirements for the Farm Plan which includes a site plan, site description, legal description, zoning and current land use, soils description and unimproved agricultural capability, soil management rationale/improved agricultural capability, recommended agricultural uses and suitable crops, drainage requirements, irrigation requirements, proposed agricultural operation, proposed planting plan and a cost estimate for agricultural improvement. Mr. Morin also commented that although the aforesaid information may be found in other reports specifically prepared for the Property by Qualified Professionals (QPs), the City wants said information consolidated into a single document to better clarify what is planned post-project completion.

This report has been prepared by Daniel Lamhonwah, MES, P.Ag, and reviewed by Thomas R Elliot, PhD P.Ag, P.Geo, of Madrone for the specific purpose of providing the City and the FSAAC with the information required in a summarized manner for review. Please note that this Farm Plan has been informed by reports previously prepared by non-Madrone QPs for the Property. Information available from municipal and provincial sources were used by Madrone for the purpose of corroborating information presented in previous

[1] Email communication addressed to Barry Mah from Mike Morin, Community Bylaws, City of Richmond. Subject: CD 28808 - Outstanding application requirements - Jaing/Barry Mah (21 Apr 2020). Sent on April 21, 2020 12:47 PM.

reports for making applicable updates to the Farm Plan. Madrone did not conduct any field investigations on the Property to specifically inform this report.

1 Introduction

The Client had previously retained McTavish Resource and Management Consultants Ltd. ('McTavish') and Timmenga and Associates Inc. ('Timmenga') to design a remediation plan[2] ('the Remediation Plan') for the Property, further to which a drainage and leachate management plan[3] ('the Drainage and Leachate Plan') and analysis of perimeter ditch water report[4] ('the Ditch Analysis Report') was developed jointly by these two firms. Since the development of aforementioned plans, Bruce McTavish, former Principal of McTavish, has been employed by the City as a municipal agrologist, thus creating a conflict of interest within the context of City review of the Client's intention for soil importation on the Property. Thus, the Client has retained Madrone to act as QPs for the purpose of finalizing documentation for intended remediation works on the Property for review by the City, FSAAC, and the Agricultural Land Commission (ALC), acting at the QPs during any future council meetings, and monitoring the proposed soil importation works on the Property should they be approved.

2 Site Description

The Property is a 4.05 ha (10 acre) parcel of private land located at the street address 8551 No.6 Road, in Richmond, BC. Information about the Property, as provided by the City[5], is summarized in Table 1. Recent satellite imagery of the Property (2018) is shown in Figure 1.

3 Current and Previous Land Use

At time of writing, it is Madrone's understanding that the owner of the Property, Mr. Bohan Jiang, is attempting to grow blueberries on the land with limited success. Our understanding is supported by recent satellite imagery provided by the City showing limited agricultural activity for the majority of the Property (~3.0 ha; 7.4 acre), particularly in the centre and western sides of the parcel (Figure 1). As reported in the Remediation Plan, the Property has been severely impeded by removal of native surficial organic soil (peat)

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[2] Proposed Remediation of Land Located at 8511 #6 Road Richmond, B.C. Prepared by McTavish Resource and Management Consultants Ltd. and Timmenga and Associates Inc. Prepared for Bohan Jiang. Dated September 30, 2012.

[3] Woodwaste Leachate and Site Drainage Addendum I To Proposed Remediation of Land Located at 8511 #6 Road Richmond, B.C. Prepared by McTavish Resource and Management Consultants Ltd. and Timmenga and Associates Inc. Prepared for Bohan Jiang. Dated December 14, 2013.

[4] Analysis of Perimeter Ditch Water from Property Located at 8511 #6 Road Richmond, B.C. Prepared by McTavish Resource and Management Consultants Ltd. and Timmenga and Associates Inc. Prepared for Bohan Jiang. Dated March 4, 2015.

[5] City of Richmond (2019). Richmond Interactive Map. https://maps.richmond.ca/rim/. Accessed April 30, 2020.

from the site, which was replaced with cedar wood waste and, as reported, 'wooden construction debris' with a mineral-soil cap-layer, approximately 25 to 30 years ago by a previous land owner.

TABLE 1. PROPERTY INFORMATION FOR 8511 NO. 6 ROAD, RICHMOND, BC

PID	005-147-077
Property Roll	025686728
Legal	SEC 20 BLK 4N RG 5W PL NWP3109 Parcel A, Block 4N, Plan NWP3109, Sublot 3, Section 20, Range 5W, New Westminster Land District, (J712 46E)
Richmond Key	162678
Official Community Plan (OCP) Land Use	Agriculture
Official Community Plan (OCP) Environmentally Sensitive Areas (ESAs)	Freshwater Wetland (FRWT)
Environmentally Sensitive Areas (ESAs) Development Permit (DP)	Yes
Agricultural Land Reserve (ALR)	Yes
Agricultural Land Reserve (ALR) Development Permit (DP)	No
Zoning Development Permit (DP)	No
Flood construction Level (FCL)	3.0 m GSC

FIGURE 1. SATELLITE IMAGERY OF 8511 NO.6 ROAD OUTLINED IN YELLOW. THE RED SHADED AREA REPRESENTS TO PROPOSED AREA FOR SOIL IMPORTATION. IMAGE PROVIDED BY THE CITY OF RICHMOND AND DATED AS TAKEN IN 2018.

4 Soils Description

Provincial soil mapping[6] indicates that the area of the Property contains soils of the Lulu soil association. Lulu soils are composed of partially decomposed organic deposits that are between 40 to 160 cm deep with underlying silty clay loam or silty clay deltaic deposits. The provincially mapped Land Capability for Agriculture (LCA) for the Property is Class O4 and contains an excess water (W) limitation and degree of decomposition – permeability (L) limitation.

An on-site soil survey conducted by McTavish and Timmenga in 2012 as reported in the Remediation Plan[7] found that the organic peat on the Property was removed by a previous landowner (estimated to be between 20 to 30 years ago) and backfilled with cedar wood waste and 'wooden construction debris'. From review of site photographs in the Remediation Plan (specifically Figure 4), Madrone disputes the presence of 'wooden construction debris' and instead identifies the materials present as 'end cuts' which are a standard byproduct of sawmills when cutting feedstock to dimensional lumber. This distinction is of moderate importance as

[6] Province of British Columbia (2019). BC Soil Information Finder Tool. https://www2.gov.bc.ca/gov/content/environment/air-land-water/land/soil/soil-information-finder. Accessed April 30, 2020.

[7] Proposed Remediation of Land Located at 8511 #6 Road Richmond, B.C. Prepared by McTavish Resource and Management Consultants Ltd. and Timmenga and Associates Inc. Prepared for Bohan Jiang. Dated September 30, 2012.

construction debris is not suitable fill material as per the *Agricultural Environmental Management Code of Practice*[8] (AEMCoP), while end cuts are a category of wood residue acceptable for use on agricultural land as per the AEMCoP. Hereafter, these materials will be referred to as 'wood residue' to be in line with current regulations. The wood residue layer was backfilled with 35 to 40 cm of loam to silty loam sand by the previous landowner. These activities resulted in subsurface conditions which limit root growth highly acidic, poorly draining and anaerobic subsurface environment due to the natural perched watertable creating the local 'W' agricultural capability limitation, as identified in provincial mapping of Lulu soils.

5 Unimproved Agricultural Capability

Based on the soil and landscape conditions of the Property at time of assessment, the professional opinions of McTavish and Timmenga[9], the land has an LCA of Class 6 or 7D (D subclass is undesirable soil structure/aeration)[10], with the limiting factor being the root restricting layer of anaerobic wood waste. **Note that Class 6 and 7 lands, as defined by the ALC, are unsuitable for cultivation or use of farm machinery, or the soils do not respond to intensive improvement practices.** We at Madrone understand that the Property has retained a Class 6 or 7D limitations to LCA because, to our knowledge, no management practices or earthworks have been implemented to improve the site LCA.

6 Soil Importation Rationale and Site Plan

The Remediation Plan developed by McTavish and Timmenga recommends that the wood residue be left in place (and kept at an anaerobic state) and that the land be returned to agricultural production by:

- Removing all irrigation works including pressure lines and drop hoses;
- Removing all vegetation, either by mowing or uprooting and hauling for disposal, or through digging and saving blueberry plants that are several years old;
- Increasing the cap depth by 25 cm with noncompacted permeable silty clay loam or silty clay; and

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[8] Province of British Columbia (2019). Environmental Management Act Agricultural Environmental Management Code of Practice. http://www.bclaws.ca/civix/document/id/complete/statreg/8_2019. Accessed April 30, 2020.

[9] As reported in the Remediation Plan.

[10] Land in Class 6 provides sustained natural grazing for domestic livestock and is not arable in its present condition. Land is placed in this class because of severe climate, or the terrain is unsuitable for cultivation or use of farm machinery, or the soils do not respond to intensive improvement practises. Some unimproved Class 6 lands can be improved by draining and/or diking. Class 7 land may have limitations equivalent to Class 6 land but they do not provide natural sustained grazing by domestic livestock due to climate and resulting unsuitable natural vegetation. Also included are rockland, other nonsoil areas, and small water-bodies not shown on maps. Some unimproved Class 7 land can be improved by draining or diking. (source: https://www.alc.gov.bc.ca/assets/alc/assets/library/agricultural-capability/agriculture_capability_classification_in_bc_2013.pdf)

- Adding a minimum of 75 cm of topsoil.

Based on the proposed area of soil important (2.5 ha), the Remediation Plan involves importing ~30,000 m^3 of soil (silty clay loam or silty clay + topsoil).

McTavish and Timmenga comment that the plan will also prevent flooding of the Property during the wet season and allow permanent vegetation (i.e. blueberries) to survive and nursery plants to flourish. Additional recommendations in this remediation plan includes:

- Crowning and ditching the remediated land where required;
- Seeding the topsoil with cover crop and establishing soil forming processes;
- Installing subsurface drainage where required;
- Installing irrigation works where required; and
- Improving the ditch on the north side of Property and cleaning the ditch on the south side.

A site plan ('the Site Plan') showing the proposed fill for the Property based on McTavish and Timmenga's reporting was developed by Peak Surveying in 2013 and is attached at the end of this Farm Plan developed by Madrone.

In 2018, the Client retained Tony Yam Engineering Ltd. ('Tony Yam') as the geotechnical engineer to evaluate the remediation works proposed by McTavish and Timmenga for the Property. Following a site visit and test pit excavation, Tony Yam provided the following comments in a letter-style report[11] prepared for the Client:

- Placing 1.0 m of additional fill over the impacted area (whereby the impacted area refers to the area where organic soils were removed, and wood waste was placed by a previous owner) will not impact the drainage pattern of adjacent areas;
- The weight of additional fill will not impact the stability of adjacent areas; and
- The remediated area is only suitable for agricultural use and is not suitable to support any building structure without further site improvement.

Madrone acknowledges that the importation of soil onto the Property (25 cm of noncompacted permeable silty clay loam or silty clay, and 75 cm) will raise lands on the Property to a similar elevation of adjacent land parcels in the area. This statement is based on a survey prepared by Peak Surveying and provided to Madrone by the Client. The survey, which contains cross sections, point elevations and site plan for the Property, shows point elevations of the adjacent parcel to the left ranging from 1.55 to 1.77 m above sea level (masl).

[11] Project No: G18154-00 – Remediation of Farm Land, 8511 No.6 Road, Richmond BC. Prepared by Tony Yam Engineering Ltd. Prepared for Barry Mah. Dated October 10, 2018.

Point elevations of proposed fill area on the Property generally range from ~0.60 to 0.85 masl. Thus, the addition of soil at an average depth of 100 cm (1.0 m) across the proposed fill area would result in the Property being level with surrounding lands.

7 Improved Agricultural Capability

It is the professional opinion of Madrone that following implementation of the Remediation Plan and the recommendations outlined in the next section (*8 Proposed Agricultural Plan*), the proposed soil importation and deposit is **targeting a Class 1 agricultural capability**[12] by selectively receiving soils suitable to that end goal[13]. If the deposited soil is assessed as anything other than a Class 1 agricultural capability upon completion of the project, the farm operator (Mr. Jiang) should endeavour to improve the agricultural limitations through soil amendment, irrigation, or some combination thereof.

8 Proposed Agricultural Plan

8.1 Soil Preparation and Amendments

Following Madrone's review of the Remediation Plan, we have determined that all proposed works and recommendations are appropriate based on the available background information and field survey results detailed in these reports. We would however like to make the following soil preparation and amendment recommendations to supplement the professional opinions expressed by McTavish and Timmenga:

- It is our understanding that peat moss has been removed and recovered from the Property. Peat moss can be used as a soil conditioner and/or amendment on farms, thus we encourage the use of such on the Property to facilitate crop growth. Similarly, any clean wood waste recovered from the Property can be chipped into mulch, composted as per AEMCoP and/or the *Organic Matter Recycling Regulation*[14] (OMRR), and used as a soil conditioner and/or amendment.

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[12] Class 1 is defined as land that has no or only very slight limitations that restrict its use for the production of common agricultural crops. Land in Class 1 is level or nearly level. The soils are deep, well to imperfectly drained under natural conditions, or have good artificial water table control, and hold moisture well. They can be managed and cropped without difficulty. Productivity is easily maintained for a wide range of field crops. (source: https://www.alc.gov.bc.ca/assets/alc/assets/library/agricultural-capability/agriculture_capability_classification_in_bc_2013.pdf)

[13] The Remediation Plan prepared by McTavish and Timmenga states that following importation of soil under their recommendations, the agricultural capability of the Property will be improved "to class 2 or 3 which will support a wide range of agricultural crops". It is Madrone's professional opinion that there is potential for the Property to be improved to Class 1 if the receiving soil is suitable.

[14] Province of British Columbia (2019). Environmental Management Act and Public health Act Organic Matter Recycling Regulation. http://www.bclaws.ca/civix/document/id/complete/statreg/18_2002. Accessed April 30, 2020.

- We encourage that any vegetation removed by mowing or uprooting be composted on-site as opposed to being hauled off-site for disposal. Compost generated on the Property can be used as an additional soil conditioner and/or amendment. Composting is a permitted use on land in the ALR, however are subject to conditions outlined in the *Part 6 Division 2 – Agricultural Composting in the Environmental Management Act Agricultural Environmental Management Code of Practice*[15].
- When increasing the cap depth over the wood residue by 25 cm with silty clay loam or silty clay, Madrone recommends grading the surface to facilitate drainage to perimeter ditching.
- Due to the local perched water table, seasonal inundation from flooding and requirement to maintain anaerobic conditions within the historically deposited wood residue through increased thickness of low-permeability silty clay loam/silty clay cap, Madrone recommends installation of widely spaced (~10m) subsurface drainage tile.
- Once the 75 cm of topsoil has been applied to the 25 cm cap, we recommend grading the soils to a 1V:2H slope (1 m vertical, 2 m horizontal) on the north, west and south sides of the soil import area to mitigate slumping along the perimeters.
- Madrone recommends progressive use of fall rye (cereal rye) as a cover crop option for areas completed in the fall or early winter. Fall rye is effective at loosening compact soil, suppressing weeds and adding nitrogen to soil. If cover crop is to be established in the spring, we recommend using buckwheat, clover, annual ryegrass or oats as options.
- Following one to two years of cover cropping, we recommend that the topsoil be tested for nutrient concentrations in the spring, specifically to quantify nitrogen (N), phosphorus (P), potassium (K), boron (B) and magnesium (Mg) as recommended by the *BC Berry Production Guide*[16]. It is recommended that 10 to 20 individual samples to a depth of 15 cm be taken from a uniform sample width through the entire 0 to 15 cm soil profile. The *BC Berry Production Guide* contains general recommendations on how to determine how much fertilizer to apply based on nutrient range ratings.
- We further we recommend testing the topsoil pH post placement and adjusting (increasing[17] or reducing[18]) the pH range using soil amendments if necessary. Blueberries do best in acid soil with a pH range of 4.5 to 5.2. A pH outside this range can result in poor growth and low yields.

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[15] Province of British Columbia (2019). Environmental Management Act Agricultural Environmental Management Code of Practice. http://www.bclaws.ca/civix/document/id/complete/statreg/8_2019. Accessed April 30, 2020.

[16] Province of British Columbia (2012). Berry Production Guide – Beneficial Management Practices for Commercial Growers in British Columbia. https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/agriculture-and-seafood/agriservicebc/production-guides/berries/nutrient_management.pdf. Accessed April 30, 2020.

[17] Anderson, N.P. et al. (2013). Applying Lime to Raise Soil pH for Crop Production (Western Oregon). http://ir.library.oregonstate.edu/xmlui/bitstream/handle/1957/38531/em9057.pdf. Accessed April 30, 2020.

[18] Horneck, D. et al. (2004). Acidifying Soil for Crop Production West of the Cascade Mountains (Western Oregon and Washington).

8.2 Suitable Crop and Proposed Planting Plan

Madrone acknowledges that blueberries are a suitable choice following remediation of the Property based on favourable soil conditions (assuming all recommendations are implemented), regional climate and distance to market. Please note that the proposed texture and depth of imported soil would facilitate the growth of crops that typically require deep rooting such as rhubarb, sweet potatoes, tomatoes, pumpkins and asparagus, all of which would require 0.6 to 0.9 m (24 to 36 inches) of soil for optimal growth. Blueberry production is detailed in this Farm Plan because this crop is the preferred choice of the proposed farm operator (8.7 Proposed Agricultural Operator).

Table 2, informed by the Blueberry Production Guide[19] (an online resource) developed by the Province of British Columbia, outlines a planting plan for the proposed blueberry farm. It is anticipated that new plantings will occur in the spring (March) following cover cropping in the previous year. Additional information such as disease control, insect control, weed control and food safety can be found in the aforementioned guide. The guide also contains information pertaining to blueberry varieties and pollination strategies.

TABLE 2. BLUEBERRY PLANT CARE SCHEDULE

Timing	Activity	Plant Care Recommendations
March	Budding	• New plantings • Begin land preparation for fall or next spring plantings
Late March to Late April	Leaf and flower bud break	• Make first fertilizer application (mid-April) • New plantings. Set out new plants as conditions permit (up to mid-May)
Late April/May	Blossoming	• Place bee hives in field when 10% of blossoms are open. Protect hives from bears where necessary • Remove hives from fields when blossoming is over
June	Fruit development	• Make second fertilizer applications up to mid-June • Irrigate as necessary
July	Fruit development and ripening	• Monitor soil moisture and irrigate as necessary
July to September	Harvesting	• Harvest and market fruit. Collect plant tissue samples (mid-July to mid-August) for nutrient analysis • Irrigate as needed
September	Post-harvest growth	• Irrigate as necessary
October	Post-harvest growth	• Continue to prune out and remove diseased wood.

https://catalog.extension.oregonstate.edu/sites/catalog/files/project/pdf/em8857.pdf. Accessed April 30, 2020.

[19] Province of British Columbia (n.d.). Blueberries. https://www2.gov.bc.ca/gov/content/industry/agriservice-bc/production-guides/berries/blueberries. Accessed April 30, 2020.

Timing	Activity	Plant Care Recommendations
		• New plantings. Set out new plants. Best time to plant container stock in coastal areas.
November/December	Plants dormant	• Apply sawdust mulch, if necessary • Order bees for the coming season
January/February	Plants dormant	• Prune beginning after leaf drop. Be sure to remove diseased and dead wood.

8.3 Field Layout and Plant Spacing

The following recommendations are outlined in the BC Blueberry Production Guide[20]:

- Fields should be designed for mechanical harvesting to allow flexibility in future harvesting decisions. Mechanical harvesting requires a minimum of 3 m between the rows. Provide a 4.5 to 5.0 m wide row break every 125 m for unloading harvesters and other machinery. Most harvesters require 7.6 to 9.0 m at the ends of rows (headlands) to turn around.
- The risers or posts for overhead irrigation should be no higher than 2.1 m and placed in the center of the row.
- Plant on raised beds to reduce fruit drop when harvesting mechanically. Beds place the catcher plates nearer to the narrow base of the plant, keeping them in close contact resulting in less fruit drop. Build the beds 20 cm high and 120 cm wide at the base.
- The most commonly used in-row spacing between plants is 90 cm. The number is plants required for this spacing scheme is ~4115 plants per ha or ~1646 plants per acre (depending on variety).

Based on these guidelines, we estimate that the Property can accommodate ~50 vertical rows of blueberry plants based on the approximate 250 m length of the proposed soil important area. This includes a row break every 125 m, and an 8 m distance along the perimeter of the growing area to allow room for mechanical harvesters to turnaround. Over the ~2.5 ha of proposed soil importation, ~10,000 to 12,000 blueberry plants are required.

8.4 Drainage Requirements

The Drainage and Leachate Plan developed by McTavish and Timmenga as an addendum to the initial Remediation Plan makes a number of recommendations, which we incorporate to this Farm plan with commentary as follows:

[20] Province of British Columbia (n.d.). Blueberries. https://www2.gov.bc.ca/gov/content/industry/agriservice-bc/production-guides/berries/blueberries. Accessed April 30, 2020.

i. That a 'sealed buffer' (2 m minimum) be placed between the wood residue and ditches on the north and south of the Property to "ensure that leachate is not generated from this site", whereby this site refers to the Property.
   a. Madrone interprets this recommendation to require the excavation to low permeability native material adjacent to the ditch line, removal of wood residue, and replacement with the fine-texture capping material;
   b. This approach is not conducive with best practices for setback from sensitive habitats, as outlined in the Federal Fisheries Act S.35 which '*prohibits harmful alteration, disruption or destruction of fish habitat unless authorized (e.g. removing stream side vegetation)*';
   c. These modifications would require a Section 11 – working in or about water – of the BC Water Sustainability Act;
   d. Madrone strongly recommends that this recommendation from the Drainage and Leachate Plan be substituted for the modified version contained in section 8.5 of this report (Below).

ii. Southern ditch: Regrade to eliminate topographic fluctuations and make the bottom (of the ditch) an even gradient to the west; some ditch widening is also recommended;
   a. Madrone recommends a gradient of 1 – 2%, with a minimum ditch width of 3m.
   b. These modifications would require a Section 11 – applications for changes in and about a stream – of the BC Water Sustainability Act;
   c. All works should be conducted during low flow season with full isolation of working area from natural streams;

iii. Northern ditch: Regrade to have all flow split east and west;
   a. Madrone recommends an even split of flow between east and west, established through re-grading of the ditch bottom to a central crest with a 1 – 2% gradient descending therefrom;
   b. These modifications would require a Section 11 – applications for changes in and about a stream – of the BC Water Sustainability Act;
   c. All works should be conducted during low flow season with full isolation of working area from natural streams;

iv. Western ditch: Install a new ditch to connect the north and south ditches.
   a. Madrone recommends a 1 – 2% gradient;
   b. These modifications would require a Section 11 – applications for changes in and about a stream – of the BC Water Sustainability Act;
   c. All works should be conducted during low flow season with full isolation of working area from natural streams;

Madrone otherwise agrees with the recommendations contained in the Drainage and Leachate Plan developed by McTavish and Timmenga.

8.5 Update of Drainage and Leachate Plan Recommendation

A follow-up Ditch Analysis Report by McTavish and Timmenga, saw ditch water sampled and analyzed. Laboratory results indicated that "the quality of the ditch water of the lateral drainage ditches on the subject

property and in the main City of Richmond ditch is not affected by wood waste leachate and is not toxic to fish" whereby subject property refers to the Property.

Therefore, we, Madrone, do not see a requirement to further laterally encapsulate the existing wood residue provided that:

i. The existing cap layer is enhanced with additional thickness, as recommended, and extended out to a 5 m buffer of the streamside area; and
ii. The subsurface drain tile is installed atop the cap layer so as to rapidly convey subsurface water toward the perimeter ditches without infiltration to the wood residue.

By pursuing the above course of action, there will be limited water flux through the wood residue from precipitation. Further, influx of water from the perimeter ditches will not change from the preceding 20 – 30 years wherefrom it has been demonstrated there is little/no influence from such, as evidenced through analytic testing.

We do not have any additional contributions to the drainage plan.

8.6 Irrigation Requirements

The Remediation Plan developed by McTavish and Timmenga did not include detailed information regarding irrigation requirements and planning for the Property, thus we at Madrone have provided the required details and resources for irrigation in this section of the Farm Plan. The monthly and annual irrigation demand for the intended blueberry farm on the Property was estimated using the *BC Agriculture Water Calculator*[21] (Table 3). The soil type selected was silty clay loam which conforms to the recommended imported soil texture in the Reclamation Plan. The irrigation season was selected to be from the start of May to the end of September (153 days). Climactic data and growing season were automatically generated by the calculator based on the location of the Property. Note that the *BC Agriculture Water Calculator* does not take into account climate change (rising air surface temperatures resulting in changes to evapotranspiration), thus irrigation estimates reflect current climactic conditions.

Guidelines for irrigation best management practices can be found in the *BC Irrigation Management Guide*[22]. Typically, blueberry plants on commercial farms are irrigated using a sprinkler or drip system. We recommend using a drip system because water is applied directly to the root zone, better water control and distribution uniformity compared to a sprinkler system, and the ability for fertigation and other chemical

[21] BC Agriculture Water Calculator (n.d.). BC Agriculture Water Calculator. http://bcwatercalculator.ca/agriculture. Accessed May 1, 2020.

[22] Province of British Columbia (2005). BC Irrigation Management Guide. https://www2.gov.bc.ca/gov/content/industry/agriculture-seafood/agricultural-land-and-environment/water/irrigation/irrigation-management-guide. Accessed May 1, 2020.

application. For drip irrigation systems, it is recommended that one irrigation line is installed per row with 1.9 L per hour (0.5 gallons per hour) emitters every 30.5 cm (12 inches)[23].

TABLE 3. IRRIGATION REQUIREMENT ESTIMATES

Month	Irrigation demand (sprinkler system)	Irrigation demand (drip system)
May	620 m^3	490 m^3
June	1990 m^3	1560 m^3
July	2730 m^3	2130 m^3
August	2080 m^3	1630 m^3
September	740 m^3	580 m^3
Total	**8160 m^3**	**6390 m^3**

8.7 Proposed Agricultural Operator

It is Madrone's understanding that the proposed agricultural operator for the blueberry farm is the owner of the Property, Mr. Bohan Jiang. It is assumed that Mr. Jiang will be responsible for the management decisions in operating the proposed agricultural operation (blueberry farm) on the Property. Management decisions pertinent to blueberry farming (and farming in general) involve planting, harvesting, marketing and sales, and making capital purchases and other financial decisions[24].

9 Agricultural Improvement Cost and Revenue Estimate

A cost estimated developed by Madrone for the proposed blueberry farm's establishment (Year 1) is presented in Table 4. We estimate the total cost for establishment to be $2,050 to $171,350 (median total cost is $86,700). Please note that estimating costs of farming is largely speculative and depends on the size of farm, the intended use of the farm products (i.e., for personal consumption, for sale via farmer's markets, road stands or u-pick, or a mix several of these factors), experience with farming, and whether the agricultural operator owns basic farm equipment and/or machinery such as a mechanical berry harvester which can cost between $80,000 to $120,000 used. Access to farm labour is also critical and may dictate which crops to grow if labour cannot be sourced at specific harvest windows. There are many other costs to consider, including material such as packing crates, a container for temporary cool storage, harvest tools and fencing supplies. We have not included these in the establishment cost table as such detail may result in excessively complicated and extensive cost tables.

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[23] United States Department of Agriculture (2011). Irrigation Guidelines for Better Blueberry Production. http://extension.missouri.edu/blueberry/documents/Shared_Documents/MOBBSchool/MOBBSchoolConf11/Blueberry%20Irrigation%20MO%2010_7_11%20Bryla.pdf. Accessed May 1, 2020.

[24] Government of Canada (2019). Farm operation – definition. https://www23.statcan.gc.ca/imdb/p3Var.pl?Function=Unit&Id=103167. Accessed May 1, 2020.

As estimated in *8.3 Field Layout and Plant Spacing*, over the ~2.5 ha of proposed soil importation, ~10,000 to 12,000 blueberry plants are required. If each plant following maturation can produce 5 to 20 lbs of blueberries[25], there is a potential yield of 60,000 to 240,000 lbs per annum barring any major disease, weather or pest-related growing restrictions. Blueberry plants take a minimum of 2 to 3 years to mature for fruit production, and at least 7 years before full maturation (optimal growing). Assuming that the price of blueberries is $2.50 CAD/lb[26], there is the potential for gross venue[27] of ~$150,000 CAD 2 to 3 years after farm establishment (Years 3 and 4). According Statistics Canada[28], the average operating profit margin for fruit and tree nut farming in 2017 was 15.8 cents, resulting in a net profit for the proposed blueberry farm of ~$24,000 CAD 2 to 3 years after initial establishment. By Year 8, there is the potential for up to ~$95,000 CAD net profit with optimal fruit yield (20 lbs/plant) and/or market conditions.

TABLE 4. ESTIMATED COSTS FOR BLUEBERRY FARM ESTABLISHMENT AT NO.6 ROAD, RICHMOND, BC

Activity	Description of Work	Units	Unit Costs	Total ($CAD, 2020 estimated)
Soil importation	Importation of clean, silty clay loam[29] and topsoil for remediation	Remediation would require ~30,000 m^3 (39,238.5 yd^3) of imported soil	$60 to $80 tipping fee per truckload; typical dump truck has a capacity of 10 yd^3	$240,000 to $320,000
	Ongoing monitoring and reporting by Professional Agrologist as required by the ALC and the City of Richmond (generally per 3,000 m^3)	At minimum 10 visits required for 30,000 m^3 of imported soil, to meet ALC monitoring requirements	$500 per monitoring visit and report	$5000

[25] Blue Grass Blueberries (2020). Small Farm Business Opportunity – How to Profit From Blueberry Sales? https://bluegrassblueberries.com/small-farm-business-opportunity-how-to-profit-from-blueberry-sales/. Accessed May 4, 2020.

[26] Note that price of berries can vary based on variety and quality. Indicate price assumes general market cost for premium berries for high-demand varieties.

[27] Gross venue is intermediate earnings figure before all expenses are included for farm operations including labour, soil amendments, machinery, irrigation, fuel, taxes etc.

[28] Statistics Canada (2019). Chart 2 Average operating profit margin, by farm type, Canada, 2017. https://www150.statcan.gc.ca/n1/daily-quotidien/190329/cg-c002-eng.htm. Accessed May 4, 2020.

[29] Soil texture is readily found in the Richmond area therefore, trucking distances are anticipated to be small.

Activity	Description of Work	Units	Unit Costs	Total ($CAD, 2020 estimated)
	Earthworks costs including project management, load inspector (on Site), machine / labour costs, fuel and traffic management	Costs take into consideration complete development of the soil deposit area (~2.5 ha)	Estimated at $23,000 to $27,000/acre ($50,000 to $60,000/ha) based on other projects of similar nature and location	$100,000 to $120,000
Post-importation land preparation and pre-planting preparation	Tractor purchase (one-time)	1 tractor for field preparation and ongoing farm maintenance	$35,000 to $50,000 per machine [A]; used tractor, diesel-powered; includes costs of periodic maintenance	$40,000 to $55,000
	Plowing or tilling field, applying manure and/or fertilizer, mulch application, fence construction, bed construction	Estimated 2 months of labour from 1 farm worker	$14.60/hr [B] x 40 hr/week x 2 months	$4600
	Soil testing - nutrients and pH	Laboratory fees at AGAT Laboratories: Nutrients 5 package - $160/soil sample (includes pH and environmental handling and compliance fee)[c]	$160/soil sample x 4 soil samples $500 minimum consultant time to collect samples, report results	$1200
	Tractor use during pre-planting preparation	Estimated 50 hours of machine time Fuel consumption - 4L/hr Diesel cost - Richmond price, $1.10/L [c]	4 L/hr x 50 hr = 200 L 200 L x $1.10/L	$220
	Erosion and sediment control implementation such as silt fencing installation, gravel road rehabilitation and possible wheel wash installation	Material and installation costs	$5000 to $10,000	$5000 to $10,000

Activity	Description of Work	Units	Unit Costs	Total ($CAD, 2020 estimated)
Irrigation system (drip)	Purchase and installation by hired farm labourers, accounted for above; one-time cost (until replacement needed due to age, wear and tear)	$1/m planted Length of vertical row (80) x # of rows (50 to 55) = 4000 to 4400 m of drip irrigation	$1/m x 4000 to 4400 m	$4000 to $4400
Plant purchase	Purchase juvenile blueberry plants	10,000 to 12,000 plants required	$4/1.5-year-old blueberry starter plant	$40,000 to $48,000
Soil amendment**	75 lbs per acre of 18-9-9 of granular fertilizer is applied twice Year 1 [D]	Soil import area is ~7.0 acres ~1100 lbs (550 lbs x 2 applications) of fertilizer is required	40 lb bag is ~$100 CAD [E]	$2750
Pest management consultant	Retention of a pest management consultant prior to seeding of either crop to test soil and prescribe biological controls (if organic farming, assuming no applications of chemical controls, or pesticides)	10 to 20 hours consultant time, plus travel for initial consultation, soil testing and reporting recommendations. Cost of biological controls unknown.	$150 per hour consultant time (Professional Agrologist)	$3000
Maintenance of crop during growing and harvesting	Mechanical harvester (one-time)	1 mechanical harvester for blueberry harvesting	$80,000 to $125,000 per machine [F]; used harvester, diesel-powered; includes costs of periodic maintenance	$85,000 to $125,000
	Mechanical harvester operator and general farm maintenance (e.g., fertilizer application, irrigation, weeding, pruning, fruit quality control, fruit preparation for sales, new plantings)	Estimated 4 months of labour from 2 farm workers	$14.60/hr [B] x 40 hr/week x 4 months x 2 workers	$18,700

Activity	Description of Work	Units	Unit Costs	Total ($CAD, 2020 estimated)
Application fee	If the proposal is forwarded to the ALC by the City of Richmond	One-time application fee to the ALC	$1500	$1500
Other service and reporting costs from Qualified Professional (QP)	Final topographic survey	Includes travel, field time, equipment fees, report writing, map and/or survey development (if applicable), senior review and report formatting	$2000 to $4000	$2000 to $4000
	Final geotechnical report (if required)		$2000 to $4000	$2000 to $4000
	Final closure report from Professional Agrologist		$3000 to $4000	$3000 to $4000
Estimated total cost for farm establishment without revenue from tipping fees				$317,950 to $411,350
Estimated total cost for farm establishment with revenue from tipping fees				$2050 to $171,350 (median total cost is $86,700)

Green text represents revenue from tipping fees
Red text represents capital costs for farm establishment (Year 1)

* based on information from other soil importation projects in the area

** does not include the cost to increase or decrease soil pH with lime, sphagnum peat, elemental sulfur, aluminum sulfate, iron sulfate, acidifying nitrogen, and organic mulches; these includes additional costs following soil testing

Cost estimation sources

[A] Used tractor sales: https://www.countrytractor.ca/default.asp?page=xPreOwnedInventory and https://www.islandtractors.com/default.asp?page=xPreOwnedInventory

[B] BC minimum wage by June 1, 2020: https://www2.gov.bc.ca/gov/content/employment-business/employment-standards-advice/employment-standards/wages/minimum-wage

[C] Average diesel cost: https://www.gasbuddy.com/GasPrices/British%20Columbia/Richmond

[D] Standard blueberry fertilizer blend: http://files.tlhort.com/product_info/3855-standard_blueberry_blend_18-9-9.pdf

[E] 40 lb bag 18-9-18: https://www.domyown.com/contec-dg-18918-fertilizer-40-lb-p-21463.html

[F] Used blueberry harvester sale: https://www.marketbook.ca/listings/farm-equipment/for-sale/list/category/300103/specialty-crop-equipment-harvesters-grape-berry

10 Closure

By following the recommendations contained in previous reports for the Property, and incorporating any modifications thereto as contained within this Farm Plan, we are confident in establishing a robust agriculturally capable land base (targeted as Class 1 by selectively receiving suitable soil) on which the Farm Operator can pursue blueberry production. We also anticipate that, should recommendations be followed, the existing wood residue on the Property will maintain a low level of decomposition, therefore generating limited amounts of leachate with no considerable impact to surrounding aquatic resources or environmental receptors.

Sincerely,

MADRONE ENVIRONMENTAL SERVICES LTD.

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

Daniel Lamhonwah, PhD candidate, MES, P.Ag
Environmental Scientist, Professional Agrologist

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

Thomas R Elliot, PhD, P.Geo, P.Ag
Hydrogeologist, Professional Agrologist

August 10th, 2020

To: Mike Morin
Soil Bylaw Officer
City of Richmond
6911 No.3 Road
Richmond, B.C
V6Y 2C1

Dear Mike,

As per my agricultural, farming, and nursery experience.

Before founding Garden in Gardens, I worked at Garden City Greenhouses on 9460 Cambie Road from 1995 to 2004 as a manager where I was in charge of all farming and landscaping operations. During this time, I have managed numerous blueberries and vegetable farms from inception to completion

In 2004, I founded my business Garden in Gardens, where our retail operations have supplied trees and plants to the lower mainland for over fifteen years. On our agricultural side, we have successfully completed and managed over 6 farms, with a majority of them being blueberry farms. We have managed these farms from beginning to end, from site/land prep, ploughing, crop sourcing, planting, to fertiliser application. Our services also include the continual maintenance and operations of these farms in which we are presently managing several blueberry farms.

When Mr Bo Han Jiang purchased the land in 2005, we were contacted to oversee Mr Jiang's blueberry operations. In 2006, we prepared the site, set up irrigation, placed sawdust, planted around 8000 blueberry bushes and fertilized all plants. It was noticed that the following winter, roughly 1000 blueberries plant died due to the high water table. For the following 3 years, we replanted roughly 1000 blueberries plants annually. After that, we continued to maintain the land but did not replant the blueberries as it was not economically feasible to do so.

In 2010, we consulted with numerous other blueberry farmers and we were all told that the land was too low and that the water table was too high. This is later reaffirmed by the Madrone Environmental Services LTD report dated June 30th, 2020.

Soil conditioners were not used; however, it is important to note that the application of soil amendment on cedar wood waste (imported by the previous owner after the removal of native surficial organic soil), in addition to the high water table, would unlikely yield a successful outcome. It's evident that importing soil is the only practical solution to address both these problems.

In 2012, Mr Barry Mah was contacted to import soils onto the parcel.

In 2016, when only roughly 500 plants were remaining from the initial 8000 bushes, the remaining bushes were moved to the west of the house where the elevation is the same as the house due to peat removal from the home construction. These plants have been monitored and no further blueberry bushes have died.

Quan Ming Wu
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June 30, 2020

Barry Mah
Westwood Topsoil Ltd.
6604 62B Street
Delta, BC V4K 5A8
westwoodbarry@mac.com

Dear Mr. Mah,

RE: Technical Addendum to Remediation Plan for 8511 No. 6 Road, Richmond, BC (CD 28808)

Madrone Environmental Services Ltd. ('Madrone'), acting as the qualified professionals (QPs) retained by you, Mr. Barry Mah ('the Client'), was asked by Mr. Mike Morin[1], Community Bylaws, City of Richmond ('the City'), to respond to commentary[2] from City staff regarding updates to technical requirements in a Remediation Plan[3] ('the Plan' or 'Plan') developed for 8511 No. 6 Road, Richmond, BC ('the Property') to be in line with recent regulatory changes that have been enacted (by the BC Ministry of Environment and the Agricultural Land Commission) since the original Plan was completed in 2012.

This addendum has been prepared by Daniel Lamhonwah, MES, P.Ag, and reviewed by Jessica Stewart, P.Ag., P.Geo, of Madrone for the specific purpose of updating the Plan's technical requirements. The section numbers referred to below are in the original Plan.

Under section ***8.4 Drainage Management***, we recommend the following updates:

- In-stream works should be completed in compliance with the BC Water Sustainability Act[4] (WSA), under guidance from a Qualified Environmental Professional (QEP), with adherence to applicable

[1] Email communication addressed to Barry Mah from Mike Morin, Soil Bylaw Officer, Community Bylaws, City of Richmond. Subject: CD 28808 - Outstanding application requirements (06 Dec 2019). Sent on Friday, December 6, 2019, 15:04.

[2] Food Security and Agricultural Advisory Committee meeting minutes. Held Thursday, September 12, 2019 (7:00 PM). M.2.004. Richmond City Hall.

[3] McTavish and Timmenga (2012). Proposed Remediation of Land Located at 8511 #6 Road Richmond, B.C. Prepared by McTavish Resource and Management Consultants Ltd. and Timmenga and Associates Inc. Prepared for Bohan Jiang. Dated September 30, 2012.

[4] Province of British Columbia (2020). Water Sustainability Act Water Sustainability Regulation B.C. Reg. 36/2016. Last amended December 17, 2019 by B.C. Reg. 278/2019. http://www.bclaws.ca/civix/document/id/crbc/crbc/36_2016. Accessed April 20, 2020.

"wildlife timing windows". Timing guidelines for works in and about watercourses to limit risk of negative impacts to aquatic organisms specific to the Lower Mainland Region is provided by the BC Ministry of Environment[5].

- Any disturbed banks of the ditches should be stabilized/re-vegetated to limit ongoing erosion following works on the Property.

Under section *8.5 **Management of Fill Quality***, we recommend the following updates:

- Imported soil to the Property should meet applicable agricultural land standards under the BC Contaminated Site Regulations (BC CSR) *Schedule 3.1, Part 1 Numerical Soil Standards, Column 4 Agricultural (AL)*[6].
- Imported soil to the Property should not contain Prohibitive Fills as defined in Section 36 of the Agricultural Land Commission Act Agricultural Land Reserve Use Regulation[7].
- All soil import source sites should be approved by a QEP prior to soil removal from the source site and deposition on the Property. The QEP should be knowledgeable in the fields of contaminated sites and invasive species management. Each shipment origin, truckload, and end location must be tracked and available upon request from the City. This is an updated City of Richmond requirement.

Madrone has the capacity and experience to fulfil the role(s) of QEP described in the above recommendations, particularly with contaminated sites and invasive species management, to ensure that the quality of imported soil (i.e. also referred to as fill) meets provincial standards. Please contact the undersigned authors should there be any questions regarding the contents of this addendum and/or for discussions regarding Madrone's QEP services to facilitate the Plan.

---

[5] BC Ministry of Environment (2006). Guidelines for Reduced Risk Instream Work Windows Ministry of Environment, Lower Mainland Region (March, 2006). https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/working-around-water/work_windows_low_main.pdf. Accessed April 20, 2020.

[6] Province of British Columbia (2020). Environmental Management Act Contaminated Sites Regulation Schedule 3.1 [includes amendments up to B.C. Reg. 13/2019, January 24, 2019]. http://www.bclaws.ca/civix/document/id/complete/statreg/375_96_07. Accessed April 20, 2020.

[7] Agricultural Land Commission Act (2020). Agricultural Land Commission Act Agricultural Land Reserve Use Regulation. http://www.bclaws.ca/civix/document/id/complete/statreg/30_2019#section36. Accessed April 30, 2020.

Sincerely,

MADRONE ENVIRONMENTAL SERVICES LTD.

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

Daniel Lamhonwah, PhD candidate, MES, P.Ag
Environmental Scientist, Professional Agrologist

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

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Professional Geoscientist, Professional Agrologist

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June 30, 2020

Barry Mah
Westwood Topsoil Ltd.
6604 62B Street
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westwoodbarry@mac.com

Dear Mr. Mah,

RE: Appropriate Imported Soil and Soil Source Sites for 8511 No. 6 Road, Richmond, BC (CD 28808)

Madrone Environmental Services Ltd. ('Madrone'), acting as the qualified professionals (QPs) retained by you, Mr. Barry Mah ('the Client'), was asked by Mr. Mike Morin[1], Community Bylaws, City of Richmond ('the City'), to respond to commentary[2] from City staff regarding the use of "alluvial soil" for proposed soil importation projects. This memo, prepared by Daniel Lamhonwah, MES, P.Ag, and reviewed by Jessica Stewart, P.Ag., P.Geo, of Madrone discusses why restricting soil importation to solely alluvial soils puts strong limitations on sourcing soil for the project and furthermore, may result in the importation of suboptimal textures. The proposal is intended to remediate the property and improve the existing agricultural capability.

Alluvium is defined[3] as loose, unconsolidated soil or sediment that has been eroded, reshaped by water in some form, and redeposited in a non-marine setting. Soils originating from alluvial parent material (alluvial soils) do not necessarily have physical properties that would make them favourable for agriculture because of the variable texture (from sandy gravel to silty clay) which is dependent on source and exact forming process. Fine textured alluvial soils, such as those that are predominantly composed of silts and clays, can limit the movement of water through the soil profile and possibly created elevated watertables, therefore limiting the growth of certain crops. Thus, if the soil importer acts upon the directive to only import alluvial to a receiving site under the assumption that alluvial soils the best method to preserve and/or improve agricultural capability

[1] Email communication addressed to Barry Mah from Mike Morin, Soil Bylaw Officer, Community Bylaws, City of Richmond. Subject: CD 28808 - Outstanding application requirements (06 Dec 2019). Sent on Friday, December 6, 2019, 15:04.

[2] Food Security and Agricultural Advisory Committee meeting minutes. Held Thursday, September 12, 2019 (7:00 PM). M.2.004. Richmond City Hall.

[3] GeoTech.org (n.d.). Dictionary of Geologic Terms https://web.archive.org/web/20110501155938/http://www.geotech.org/survey/geotech/dictiona.html. Accessed April 30, 2020.

without taking into account the texture of the alluvial soil, this action may result in undesired subsurface drainage conditions.

The physical properties of native soils on the Property must also be taken into consideration when determining the type and source of soils for importation to reclaim the land as to not impact the conveyance of surface water. Based on existing mapping[4], the Property is in an area containing Triggs soils, characterized by deep (at least 2 m) un-decomposed organic deposits composed mainly of sphagnum and other mosses. The on-site soil survey information for the Property found that all the organic soils (peat) on the site had been removed[5]. Using fine textured alluvial soils, such as silts and clays, to reclaim the removed Triggs soils is likely to cause undesirable surface drainage conditions on the Property, particularly infiltration-excess overland flow during precipitation events, which may impact neighboring parcels downslope.

Furthermore, the importation of alluvial soils commonly found in the Richmond area, including Blundell[6] and Delta[7] soils which are characterized by subsoil salinity (conductivity > 4 dS m^{-1}), may introduce an undesirable salinity limitation (Class N limitation) that may not have existed on a receiving site. Salinity limitations are difficult to improve.

To conclude, it is our qualified professional opinion that soil importation projects, with the intent of preserving agricultural capability at receiving sites, should not be limited to the use of alluvial soils. We recommend that the City imposes a condition that considers the physical and chemical properties of the soil proposed to be imported instead of restricting the imported soil to a deposition method and/or soil parent material type. This would likely reduce completion time of the proposed soil importation projects because it would increase the potential number of soil source sites available to the applicant. The ALC has recently advised through information bulletin 7 (in March of 2019) that "the Commission will not consider fill placement activities that would extend beyond two years."[8]

Please contact the undersigned authors should there be any questions regarding the contents of this memo.

---

[4] Province of British Columbia (2020). BC Soil Information Finder Tool. https://www2.gov.bc.ca/gov/content/environment/air-land-water/land/soil/soil-information-finder. Accessed April 17, 2020.

[5] McTavish and Timmenga (2012). Proposed Remediation of Land Located at 8511 #6 Road Richmond, B.C. Prepared by McTavish Resource and Management Consultants Ltd. and Timmenga and Associates Inc. Prepared for Bohan Jiang. Dated September 30, 2012.

[6] Canadian Soil Information Service (2013). Description of soil BCBNLpsad~A (BLUNDELL). http://sis.agr.gc.ca/cansis/soils/bc/BNL/psad~/A/description.html. Accessed April 17, 2020.

[7] Canadian Soil Information Service (2013). Description of soil BCDLTansadN (DELTA). http://sis.agr.gc.ca/cansis/soils/bc/DLT/ansad/N/description.html. Accessed April 17, 2020.

[8] Agricultural Land Commission (2019). Information Bulletin 07 Soil or Fill Uses in the ALR. https://www.alc.gov.bc.ca/assets/alc/assets/legislation-and-regulation/information-bulletins/information_bulletin_07_-_soil_or_fill_uses_in_the_alr.pdf. Accessed April 30, 2020.

Sincerely,

MADRONE ENVIRONMENTAL SERVICES LTD.

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

Daniel Lamhonwah, PhD candidate, MES, P.Ag
Environmental Scientist, Professional Agrologist

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

Jessica Stewart, P.Ag, P.Geo
Professional Geoscientist, Professional Agrologist

*Raised area identified in blue

FIGURE 1. SATELLITE IMAGERY OF 8511 NO.6 ROAD OUTLINED IN YELLOW. THE RED SHADED AREA REPRESENTS TO PROPOSED AREA FOR SOIL IMPORTATION. IMAGE PROVIDED BY THE CITY OF RICHMOND AND DATED AS TAKEN IN 2018.

Attachment 8

August 12th, 2020

To Whom It May Concern,

Mr Quan Ming Wu has been working on my property since I purchased my property in 2005. Upon the post-completion of the project should it be approved; I intend to sign a minimum 10-year lease with Mr Wu to allow him to farm and grow blueberries and vegetables on the parcel.

Bo Han Jiang
8511 No.6 Road
Richmond, B.C
V6W 1E3

August 10th, 2020

To:
Mike Morin
Soil Bylaw Officer
City of Richmond
6911 No.3 Road
Richmond, B.C
V6Y 2C1

Should the soil deposit proposal be formally approved at the upcoming FSAAC meeting, I (Quan Ming Wu) will voluntarily submit a $30,000 performance bond as a guarantee to implement and complete the Farm Plan, to be returned upon completion of the farm plan.

Quan Ming Wu
7600 No.5 Road
Richmond, B.C
V6Y 2V2

Attachment 10

out of the box
ENGINEERING

June 29, 2020

2020-1091

Madrone Environmental
#202 - 2790 Gladwin Rd
Abbotsford, BC V2T 4S7

Attention: **Daniel Lamhonwah**

Reference: **Review of Site Drainage Report**
8511 #6 Road, Richmond, BC

Out of the Box Engineering (OOTBE) has been asked to review the site drainage recommendations stated in the *Woodwaste Leachate and Site Drainage Addendum I To Proposed Remediation of Land Located at 8511 #6 Road Richmond B.C.* report prepared by McTavish Resource & Management Consultants Ltd. (McTavish) and dated December 14, 2013. It is our understanding that the property is planned to be used for vegetable farming and prior to this being successful, remediations are necessary to the site conditions in order to establish a proper growing medium and allow for proper storm water drainage from the site.

A site visit and meeting with the property manager (Barry Mah) was done on June 17, 2020. The condition of the site appeared to be similar to that stated in the 2013 report. The site is overgrown, has visible wood pieces scattered throughout, and has areas with visible wetland plants.

In reference to the site drainage, McTavish's report recommends the site be cleared of excess vegetation and the slopes/ditches be repaired. It is to be ensured that all ditches are located on the subject site. The report states that the recommended changes will not increase peak flows. Also, the direction of flows and discharge locations will not be altered.

OOTBE finds that the site drainage recommendations in McTavish's report appear to be reasonable and should allow for adequate storm water drainage from the site, without altering peak flow conditions. If required, OOTBE can perform an additional site visit when contacted following the works to review the conformance of the site drainage.

Please note that only drainage recommendations in the report were reviewed by OOTBE. Other topics were not reviewed as they are out of our scope of expertise.

If there are any questions, please do not hesitate to contact the undersigned.

Regards,

Collin S. Johnson, P.Eng.

ENGINEERS & GEOSCIENTISTS | OQM CERTIFIED

Out of the Box Engineering (DBA 0772308 BC LTD)
Box 274 Agassiz PO, Agassiz, BC V0M 1A0
604-819-9809 / ootbe2013@gmail.com

TONY YAM ENGINEERING LTD.

GEOTECHNICAL AND MATERIAL INSPECTION

Project No.: G18154-00 October 10, 2018

c/o Barry Mah

Dear Sir:

Re: Owner – Bohaw Jiang
Remediation of Farm land
8511 No.6 Road
Richmond, B.C.

We have retained by Mr. Mah, agent of the subject property (8511 No.6 Road, Richmond) as the geotechnical engineer to evaluate the remediation works proposed by McTavish Resource and Management Consultants Ltd. (MRMCL) for the above-mentioned address. Our scope of work is limited to the geotechnical aspect of the project. For this, we obtain and reviewed reports prepared by MRMCL including the site drainage plans.

The site is located on the west side of No.6 Road and is approximately 360 m south of Blundell Road. Site frontage along No.6 Road is 94 m and site depth is 410 m. There is an existing house along the front section of the site next to No.6 Road. The remaining of the site is vacant. We understand organic soils (peat) were removed in the mid-section of the site and the excavated area was filled with wood wastes. For remediate this section of the site so it can be used for agriculture usage, MRMCL has proposed to deposit up to 0.75m of topsoil, over 0.25m of un-compacted silty fill over the existing ground surface of the impacted area.

We visit the site on September 28, 2018. We noted the impacted area (area requires remediation is 4 to 5 feet lower than the adjacent properties to the east and the west. At the time of our site visit, two pits were put down in the impacted area. Both of the test pits encountered an existing fill, several inches thick, over wood wastes, 4 to 5 feet (1.2 to 1.5 m) thick, over a silty clay deposit to the depth of excavation. Groundwater was encountered in all test pits at approximately 1 foot (0.3m) from the existing ground surface.

Based on the test pit excavation and our observation, followings are our comment.

1. As the impacted area is 4 to 5 feet (1.2 to 1.5m) lower than the adjacent areas, placing of 3.3 feet (1.0 m) of additional fills over the impacted area will not impact the drainage pattern of adjacent areas (finishing elevation of the impacted area is lower than the adjacent areas).

2. Weight of the additional fills will be approximately 250 psf (2 feet of topsoil and one foot of silty clay). Placing of fills will not impact stability of adjacent areas as the impacted area is not less than 6 m away from adjacent properties.

3. The remediated area is only suitable for agricultural use and is not suitable to support any building structure without further site improvement.

2876 EAST 6TH AVENUE, VANCOUVER, B.C. V5M 1R8
PHONE (778)552-7112 PHONE (778)868-5635
eMAIL: asyam@telus.net

Should you have any questions regarding the above or if we can be of further assistance, please call.

Yours truly,

TONY YAM ENGINEERING LTD.,

Per.

Zhao Guan, M.A.Sc., P.Eng.

MADRONE
environmental services ltd.

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www.madrone.ca

June 30, 2020

Barry Mah
Westwood Topsoil Ltd.
6604 62B Street
Delta, BC V4K 5A8
westwoodbarry@mac.com

Dear Mr. Mah,

RE: Soil Drainage and High Water Table at 8511 No. 6 Road, Richmond, BC (CD 28808)

Madrone Environmental Services Ltd. ('Madrone'), acting as the qualified professionals (QPs) retained by you, Mr. Barry Mah ('the Client'), was asked by Mr. Mike Morin[1], Community Bylaws, City of Richmond ('the City'), to respond to commentary[2] from City staff regarding whether at 8511 No. 6 Road, Richmond, BC ('the Property') can be 'bermed and pumped' rather than being filled with imported soil to address the drainage limitations to agricultural productivity.

Existing information indicates that Property is affected by groundwater and not flood water (i.e., from watercourses). Based on provincial mapping, the native soils in the Property area is the Lulu soil series (classified as a *Terric Mesisol*) which is an organic soil characterized by very poor drainage[3]. According to The Canadian Soil Information Service[4], excess water is present in Lulu soils for the greater part of the year with groundwater flow and subsurface flow being the major water sources. These soil conditions were reported by McTavish and Timmenga[5] whereby a locally elevated water table was observed during field assessment.

---

[1] Email communication addressed to Barry Mah from Mike Morin, Soil Bylaw Officer, Community Bylaws, City of Richmond. Subject: CD 28808 - Outstanding application requirements (06 Dec 2019). Sent on Friday, December 6, 2019, 15:04.

[2] Food Security and Agricultural Advisory Committee meeting minutes. Held Thursday, September 12, 2019 (7:00 PM). M.2.004. Richmond City Hall.

[3] Province of British Columbia (2020). BC Soil Information Finder Tool. https://www2.gov.bc.ca/gov/content/environment/air-land-water/land/soil/soil-information-finder. Accessed April 16, 2020.

[4] CanSIS (2013). Description of soil BCLULd~~~~A (LULU). http://sis.agr.gc.ca/cansis/soils/bc/LUL/d~~~~/A/description.html. Accessed April 16, 2020.

[5] McTavish and Timmenga (2012). Proposed Remediation of Land Located at 8511 #6 Road Richmond, B.C. Prepared by McTavish Resource and Management Consultants Ltd. and Timmenga and Associates Inc. Prepared for Bohan Jiang. Dated September 30, 2012.

This report described the border between the decomposed and non-decomposed wood waste[6] to be the summer water table which was at about 1 m depth. The winter water table appeared to be at the surface of the soil, with some lower areas being inundated during the winter.

In previous communication with Mr. Morin, Jessica Stewart, P.Ag, P.Geo and Thomas R Elliot, PhD, P.Ag, P.Geo of Madrone prepared a technical memorandum titled *Significance of the Code of Practice for Agricultural Environmental Management (AEM Code) for low-lying agricultural land in the City of Richmond*. Because drainage issues on the Property is affected by groundwater and not flood water, we believe that the aforementioned technical memorandum addresses the questions posed by the City re: berming and pumping. For your convenience, the memorandum is attached to this memo.

Please contact the undersigned authors should there be any questions regarding the contents of this memo.

Sincerely,

MADRONE ENVIRONMENTAL SERVICES LTD.

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

BRITISH COLUMBIA 3253 Daniel Lamhonwah PAg INSTITUTE OF AGROLOGISTS

Daniel Lamhonwah, PhD candidate, MES, P.Ag
Environmental Scientist, Professional Agrologist

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

Jessica Stewart, P.Ag, P.Geo
Professional Geoscientist, Professional Agrologist

[6] According to McTavish and Timmenga (2012), approximately 20-30 years ago the previous landowners stripped the native organic soils and replaced them with cedar wood waste and wooden construction debris. This is referred to as 'wood waste' in reports for the property.

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www.madrone.ca

March 9, 2020

Mr. Michael Morin, Soil Bylaw Officer
& Planning and Development
City of Richmond

Dear Mr. Morin

Re: Technical Memorandum: Significance of the Code of Practice for Agricultural Environmental Management (AEM Code) for low-lying agricultural land in the City of Richmond

INTRODUCTION

Madrone Environmental Services Ltd. (Madrone) is a multi-disciplinary scientific consulting firm with offices in both the Fraser Valley (Abbotsford) and Duncan, B.C. Since 2009, agrologists at our firm have prepared land capability assessments, soil deposit assessments (for both non-farm use and farm-use soil deposition on ALR Land), farm plans[1], and reclamation plans (including soil testing for contaminants, invasive species screening, fill removal plans) for landowners of properties in the City of Richmond (CoR, or 'the city'). Most, if not all, of these properties have been in the Agricultural Land Reserve (ALR).

Madrone continues to work with CoR planners and bylaw officers on such projects as a consultant and agent for applications by the respective landowners. Recently, Thomas Elliot, P.Ag. of Madrone has been engaged with the city in interpreting the significance of a new provincial regulation called the Code of Practice for Agricultural Environmental Management (AEM Code).

The AEM Code came into effect on February 28, 2019 and applies to all agricultural operations in the province[2]. We emphasize that this applies to agricultural operations – not all agricultural land in the ALR has agricultural operations conducted on site (i.e. the land is completely fallow with no nutrient inputs, or the operation on site is not defined as an applicable agricultural operation in the AEM Code – the exact definition

[1] Madrone's first agricultural-related project in the City of Richmond was a farm plan prepared for the Shia Muslim Community of B.C. (8580 No. 5 Road, Richmond).

[2] https://www2.gov.bc.ca/gov/content/environment/waste-management/industrial-waste/agriculture Agricultural Environmental Management. Province of B.C. Accessed January 28, 2020

is in this memo, below). This code replaces the former Agricultural Waste Control Regulation (AWCR) for the province.

We (Jessica Stewart, P.Ag. and Thomas Elliot PhD, P.Ag.) at Madrone believe that the AEM Code should be considered when reviewing soil deposit applications for properties in the ALR, specifically, properties that are low-lying with little topographic relief and are subject to **high water tables**. We emphasize that there are instances in which properties subject to excess wetness (which is a defined agricultural limitation in the Land Capability Classification for Agriculture in B.C. MOE Manual 1)[3] but are not on designated floodplains. In an effort to disambiguated, the City of Richmond Flood Plain Designation and Protection Bylaw No. 8204 defines a floodplain[4] as:

> *"Floodplain means a lowland area, whether or diked or floodproofed, which, by reasons of land elevation, is susceptible to flooding from an adjoining watercourse, river, ocean, lake or other body of water, and that is designated as flood plain in Part 1 of this bylaw"*

Whereas lands with excess wetness are resulting from a regionally high water table, either as a result of low elevation or due to a low-permeability soil-layer below ground, resulting in water that percolates through the soil and causes limitations to planting-season (i.e. early) machine access to the lands; ability to realize two crop-rotations within the prevalent climatic conditions in City of Richmond that allow for such; and also survivability of perennial crops.

The excess wetness experienced on these properties (due to high water tables) results in agricultural limitations that we believe can be improved by placement of a mineral soil layer to elevate the growing medium (which is typically, salvaged topsoil native to the property). The significance of the AEM Code to this stance is described as follows.

AEM CODE – PURPOSE AND SECTIONS OF NOTE

The AEM Code is a new regulation that falls under the Environmental Management Act (the 'Act')[5]. According to an expert with the British Columbia Organic Grower (Journal for The Certified Organic Associations of B.C.)[6], it was developed as the old code (the Agricultural Waste Control Regulation, AWCR)

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[3] https://www.alc.gov.bc.ca/assets/alc/assets/library/agricultural-capability/land_capability_classification_for_agriculture_in_bc_1983.pdf Land Capability Classification for Agriculture in British Columbia. MOE Manual 1. Accessed January 28, 2020

[4] https://www.richmond.ca/__shared/assets/Bylaw_8204_0410201225280.pdf Bylaw 8204 Flood plain designation and protection bylaw. City of Richmond. Accessed January 28, 2020

[5] http://www.bclaws.ca/civix/document/id/complete/statreg/03053_00 Environmental Management Act. BC Laws. Accessed January 28, 2020

[6] http://bcorganicgrower.ca/2019/09/ask-an-expert-a-new-agricultural-environmental-management-regulation/ Ask An Expert: A New Agricultural Environmental Management Regulation. Published: September 1, 2019. Accessed January 28, 2020

was believed to be too vague for farm operators to follow and was not adequately protecting the environment. This expert with the Ministry of Environment & Climate Change Strategy (MoECSS) further stated:

> *"The new regulation includes provisions that aim to: ensure watercourses and groundwater are protected through proper storage and use of manure, other nutrient sources, and other materials, such as wood residue; prevent water quality impacts from contaminated run-off; prohibit direct discharges into watercourses; require nutrient management planning; allow for increased monitoring in high-risk areas; provide clear compliance expectations for agricultural operators for setbacks, storage, and nutrient applications; and, require record-keeping."*

The AEM Code therefore ensures that agricultural practices do not impact drinking water, watercourses, air, or public health. According to the AEM Code[7]:

"...for the purpose of minimizing the introduction of waste into the environment and preventing adverse impacts to the environment and human health, this code requires persons to use environmentally responsible and sustainable agricultural practices when carrying out agricultural operations described in subsection (3)"

Section 2 (2) This code applies to an agricultural operation described in subsection (3) that is carried out in British Columbia

(a) on

(i) an agricultural land base that is owned, rented or leased, and managed, by the person who carries out the agricultural operation, and

(ii) land that is not zoned for residential purposes, and

(b) primarily for the purpose of distributing agricultural products to other persons, whether

(i) directly or indirectly,

(ii) with or without a fee, or

(iii) on a commercial or non-commercial basis.

Section 2 (3) Subject to subsection (4), the following are agricultural operations for the purposes of this code:

(a) rearing and keeping livestock or poultry, and growing and harvesting agricultural products, for

(i) consumption or use by humans, including as food, fibre or fuel,

(ii) use as animal feed,

---

[7] http://www.bclaws.ca/civix/document/id/complete/statreg/8_2019#division_d1e5540 Code of Practice For Agricultural Environmental Management. BC Laws. Accessed January 28, 2020

(iii) use as breeding stock or to produce seedlings or flowers,

(iv) use in landscaping or for ornamental purposes, in the case of plants, or

(v) work or recreational purposes, in the case of horses;

(b) storing

(i) nutrient sources and agricultural by-products, and

(ii) the primary products of livestock, poultry, insects, plants and fungi;

(c) carrying out agricultural composting processes;

(d) applying nutrient sources to land;

(e) washing, grading or packaging agricultural products, if carried out on the same agricultural land base as the livestock or poultry were reared or kept or the agricultural products were grown or harvested;

(f) disposing of or incinerating mortalities and processing wastes, if carried out on the same agricultural land base as the livestock or poultry were reared or kept;

(g) operating equipment in relation to

(i) an activity referred to in this subsection, or

(ii) other activities in relation to agriculture, other than processing primary products beyond the activities described in paragraph (e).

Section 2 (4) The following are ***not*** *agricultural operations for the purposes of this code:*

(a) aquaculture and activities described in subsection (3) that are carried out in respect of aquaculture;

(b) soil blending operations that bring manure, sand or other materials onto a parcel of land for the purpose of producing soil for use other than on that parcel.

Therefore, there are properties in the ALR that are not agricultural operations under the AEM Code. The majority of the Lower Mainland (including the entirety of Richmond) is identified as a High-Risk Area[8] under

[8] https://governmentofbc.maps.arcgis.com/apps/MapSeries/index.html?appid=c16cde73574c43da877674f423304ae9 High Precipitation Areas Map Tool. Government of B.C. Accessed January 28, 2020

the AEM Code due to high precipitation, which is defined as 600 mm or more of precipitation between October 1st and April 30th.

The AEM Code stipulates that:

> *"a person must not apply nutrient sources to land:*
>
> *(a) **in a high-precipitation area** during the period that begins on November 1 and that ends on February 1 of the next year,*
>
> *(b) during strong, divergent windy conditions, unless the nutrient sources are applied*
>
> *(i) below the soil surface, or*
>
> *(ii) under a crop canopy having a height of at least 8 cm,*
>
> *(c) **during storm events, or periods of short-term intense or high rainfall,** or*
>
> *(d) during any high-risk conditions that are identified by a director under this Part and are relevant to the application of nutrient sources to land.*
>
> *(2) **A person must not apply nutrient sources, other than wood residue, to land in a high-precipitation area during February, March or October unless both of the following conditions are met:***
>
> *(a) the nutrients are needed by, and will be available to, the intended crop;*
>
> *(b) a risk assessment is made in accordance with subsection (4) before application begins.*
>
> *(3) Without limiting subsection (2), a person may apply nutrient sources to bare soil in a high-precipitation area in the fall only if the following conditions are met:*
>
> *(a) a crop is planted before the winter non-growing season begins;*
>
> *(b) the application is to medium or fine-textured soils with a low risk of leaching;*
>
> *(b) **the nutrients will not enter a watercourse or go below the seasonal high water table.***
>
> *(4) A person must prepare a risk assessment, in writing and in the form and manner required by a director,*
>
> *(a) for each field to which nutrient sources are to be applied, and*
>
> *(c) considering the special circumstances of the high-precipitation area and any high-risk conditions.*

[am. B.C. Reg. 8/2019, App. 3.]

Therefore, there are limitations to applying nutrients to land in high precipitation areas, including in the City of Richmond. The application window is smaller than elsewhere in the province where annual precipitation is not as high.

Furthermore, in Division 4, Nutrient Application and Management of the AEM Code, Section 49:

(1) A person must not apply nutrient sources to land

(a) on which there is standing water or water-saturated soil,

(b) on ground in which the top 5 cm of soil is frozen so as to be impenetrable to manually-operated equipment,

(c) on a field having at least 5 cm of ice or snow over at least 50% of its area, or

(d) **at a rate of application, under meteorological, topographical or soil conditions**, or in a manner, that may cause nutrient sources or contaminated runoff, leachate or solids to **enter a watercourse**[9], cross a property boundary or **go below the seasonal high water table.**

(2) A person must not apply to land a material described in any of paragraphs (e) to (g) of the definition of "nutrient source" unless the material is treated, provided, used or produced, as applicable, in accordance with this code and the applicable regulation referred to in those paragraphs.

This requirement under the AEM code, combined with high precipitation in Richmond, further limits windows for nutrient applications that may be necessary for an agricultural operation.

SIGNIFICANCE OF THE AEM CODE TO CoR AGRICULTURAL LAND

Based on our experience assessing the agricultural capability of agricultural land in the CoR, and subsequently preparing soil deposit plans to elevate properties subject to excess wetness[10], we have determined the following:

[9] Such as a ditch – the CoR defines all ditches in the city as watercourses.

[10] Dr. Elliot and Ms. Stewart have prepared such applications and reports since 2014.

1 There are several areas within CoR that are not subject to seasonal floodwaters (i.e. the classic definition of floodplain), but are generally low-lying (1 to 5 m above sea level), with fine-texture subsoil (such as silty clay loams) or bedrock which prevents vertical drainage into the subsurface;

2 The lack of vertical drainage coupled to the regionally high water table in the low-lying areas results in poor conveyance (i.e. local drainage) of water **out** of these areas – which is not otherwise improvable through installation of subsurface drain-tiles due to said drain-tile outfalls being **below** the water table; and

3 Pump-works may supress the local elevation of water table, however the water will be required to be pumped to an area that will:

   a. Receive the waters and not impact other agricultural lands; and
   b. Receive the waters and not allow them to be communicated back to the field via subsurface or displacement within the regional drainage works.

Unfortunately, pump works are generally suitable for bermed (or dyked) areas, such as floodplains, whereby the inundation/excess water is not congruent with the regional high water table. In many circumstances within the CoR, the issue is more so related to high water table and regional conveyance rather than point-specific short-duration inundation-water sources (i.e. flooding during the late spring freshet of the Fraser River) that pumping is ideally suited to resolve.

With a known issue of regionally high water tables and the AEM Code disambiguation below, Dr. Elliot's interpretation is that land application of nutrient sources within certain land-parcels of CoR will be disallowed (under the AEM Code) until such time as the high water table does not allow direct transmission of nutrient sources/nutrient to adjacent watercourses, which – in some circumstances – would result in the land parcel and agricultural operation falling under one or more of the following categories:

A. A complete mismatch of nutrient application timing window with crop needs (common case);
B. A disallowance of nutrient application during the early planting season (moderate case);
C. An outright disallowance of nutrient application during the growing season (worst case);

If only Category A is applicable, then the land is not suited to grow the operational crop or the crop will be limited to one rotation when two or more is possible based on all other factors, and the question then reverts to the standard soil importation decision making process. If Category B and C are applicable, then the portion of land determined to be limited by the excess water condition is essentially sterilized for agriculture –forcing importation of soil as the only reasonable pathway toward improving agricultural capability (due to either ineffectiveness of other options, as described in our Determinations 1 – 3 above).

The next question is how to distinguish what restrictions are resulting from AEM Code based on field-based evidence. For example, Madrone prepared a Land Capability for Agriculture assessment for an ALR property in the CoR to determine the type of agricultural limitation(s) that exist on Site. From that assessment, we found the native Lulu Soil Series (an organic Terric Mesisol – formed in areas of high groundwater and low

conveyance) overlies dense, fine-grained deltaic sediments (silt, clay). This essentially forms 'a bathtub' under the whole area.

Therefore, since the area described in the above example is not subject to seasonal floodwater (i.e. Fraser River freshet) and is instead subject to **seasonal high water table** (Land Capability Classification for Agriculture, LCA Class 'W' limitation), the AEM Code applies and limits application of nutrient sources to Category A (timing mismatch) and potentially C (complete disallowance) circumstances as indicated above, whereas Category B does not apply due to the intended perennial crops (that by definition, live for more than two years and after harvest, do not need to be replanted every year).

We believe that there are lands in the ALR which would benefit greatly from importation of soil so long as adequate (if not excessive, to account for Changing Climate) compensation of regional drainage capacity (through enlarged ditching requirements, such as installation of canals instead of ditches) is included in the process as a requirement.

Such a tactic would still result in increased (productive) agricultural lands, and increased capability for agriculture of said lands, while addressing the most common objection to soil importation, which is that regional drainage/flooding will be negatively impacted.

MINISTRY OF ENVIRONMENT & CLIMATE CHANGE STRATEGY RESPONSE

Dr. Thomas Elliot, P.Ag. has requested input from Margaret Crowley, M.Sc., P.Ag. with the Ministry of Environment & Climate Change Strategy (MoECCS). Ms. Crowley is one of the authors of the AEM Code.

Her perspective, as interpreted from written correspondence to Dr. Elliot, is that:

- Inundation due to flooding does not discount application of nutrient sources (fertilizers, compost, wood residue, etc.), which allows for continued use of floodplains as agricultural lands;
- Seasonal high water table at, near or above ground surface **would however,** restrict land application of nutrient sources both during times of water table above ground surface (which is not surprising, as fertilizing standing water isn't effective), but also during period of generally high water table whereby precipitation/infiltration/dispersion would result in direct transmission of nutrients to groundwater/nearby watercourse.

CONCLUSIONS

The Code of Practice for Agricultural Environmental Management in a regulation under the Environmental Management Act. The regulation was made law in the province in February of 2019. As such, it is less than one year old and may not be a familiar regulation to consultants nor to municipal staff tasked with a preparing and reviewing relevant development applications in the ALR, respectively.

Dr. Thomas Elliot of Madrone has reviewed the AEM Code and has found that the combination of high precipitation in the municipality of Richmond (which results in it being defined as a High Risk Area according to AEM Code criteria) and high seasonal water tables in many low-lying agricultural areas (that are not necessarily located on floodplains) results in very narrow windows for nutrient applications for agricultural operators of said lands.

In instances where agricultural operators and landowners wish to improve excess wetness due to high seasonal water tables by raising their land via soil importation, we believe special consideration should be made by the CoR of how the AEM Code may impact that particular property (and the proposed agricultural operation, if not pre-existing).

Prepared by:

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March 9, 2020

Mr. Michael Morin, Soil Bylaw Officer
& Planning and Development
City of Richmond

Dear Mr. Morin

Re: Technical Memorandum: Significance of the Code of Practice for Agricultural Environmental Management (AEM Code) for low-lying agricultural land in the City of Richmond

INTRODUCTION

Madrone Environmental Services Ltd. (Madrone) is a multi-disciplinary scientific consulting firm with offices in both the Fraser Valley (Abbotsford) and Duncan, B.C. Since 2009, agrologists at our firm have prepared land capability assessments, soil deposit assessments (for both non-farm use and farm-use soil deposition on ALR Land), farm plans[1], and reclamation plans (including soil testing for contaminants, invasive species screening, fill removal plans) for landowners of properties in the City of Richmond (CoR, or 'the city'). Most, if not all, of these properties have been in the Agricultural Land Reserve (ALR).

Madrone continues to work with CoR planners and bylaw officers on such projects as a consultant and agent for applications by the respective landowners. Recently, Thomas Elliot, P.Ag. of Madrone has been engaged with the city in interpreting the significance of a new provincial regulation called the Code of Practice for Agricultural Environmental Management (AEM Code).

The AEM Code came into effect on February 28, 2019 and applies to all agricultural operations in the province[2]. We emphasize that this applies to agricultural operations – not all agricultural land in the ALR has agricultural operations conducted on site (i.e. the land is completely fallow with no nutrient inputs, or the operation on site is not defined as an applicable agricultural operation in the AEM Code – the exact definition

[1] Madrone's first agricultural-related project in the City of Richmond was a farm plan prepared for the Shia Muslim Community of B.C. (8580 No. 5 Road, Richmond).

[2] https://www2.gov.bc.ca/gov/content/environment/waste-management/industrial-waste/agriculture Agricultural Environmental Management. Province of B.C. Accessed January 28, 2020

is in this memo, below). This code replaces the former Agricultural Waste Control Regulation (AWCR) for the province.

We (Jessica Stewart, P.Ag. and Thomas Elliot PhD, P.Ag.) at Madrone believe that the AEM Code should be considered when reviewing soil deposit applications for properties in the ALR, specifically, properties that are low-lying with little topographic relief and are subject to **high water tables**. We emphasize that there are instances in which properties subject to excess wetness (which is a defined agricultural limitation in the Land Capability Classification for Agriculture in B.C. MOE Manual 1)[3] but are not on designated floodplains. In an effort to disambiguated, the City of Richmond Flood Plain Designation and Protection Bylaw No. 8204 defines a floodplain[4] as:

> *"Floodplain means a lowland area, whether or diked or floodproofed, which, by reasons of land elevation, is susceptible to flooding from an adjoining watercourse, river, ocean, lake or other body of water, and that is designated as flood plain in Part 1 of this bylaw"*

Whereas lands with excess wetness are resulting from a regionally high water table, either as a result of low elevation or due to a low-permeability soil-layer below ground, resulting in water that percolates through the soil and causes limitations to planting-season (i.e. early) machine access to the lands; ability to realize two crop-rotations within the prevalent climatic conditions in City of Richmond that allow for such; and also survivability of perennial crops.

The excess wetness experienced on these properties (due to high water tables) results in agricultural limitations that we believe can be improved by placement of a mineral soil layer to elevate the growing medium (which is typically, salvaged topsoil native to the property). The significance of the AEM Code to this stance is described as follows.

AEM CODE – PURPOSE AND SECTIONS OF NOTE

The AEM Code is a new regulation that falls under the Environmental Management Act (the 'Act')[5]. According to an expert with the British Columbia Organic Grower (Journal for The Certified Organic Associations of B.C.)[6], it was developed as the old code (the Agricultural Waste Control Regulation, AWCR)

---

[3] https://www.alc.gov.bc.ca/assets/alc/assets/library/agricultural-capability/land_capability_classification_for_agriculture_in_bc_1983.pdf Land Capability Classification for Agriculture in British Columbia. MOE Manual 1. Accessed January 28, 2020

[4] https://www.richmond.ca/__shared/assets/Bylaw_8204_0410201225280.pdf Bylaw 8204 Flood plain designation and protection bylaw. City of Richmond. Accessed January 28, 2020

[5] http://www.bclaws.ca/civix/document/id/complete/statreg/03053_00 Environmental Management Act. BC Laws. Accessed January 28, 2020

[6] http://bcorganicgrower.ca/2019/09/ask-an-expert-a-new-agricultural-environmental-management-regulation/ Ask An Expert: A New Agricultural Environmental Management Regulation. Published: September 1, 2019. Accessed January 28, 2020

was believed to be too vague for farm operators to follow and was not adequately protecting the environment. This expert with the Ministry of Environment & Climate Change Strategy (MoECSS) further stated:

> *"The new regulation includes provisions that aim to: ensure watercourses and groundwater are protected through proper storage and use of manure, other nutrient sources, and other materials, such as wood residue; prevent water quality impacts from contaminated run-off; prohibit direct discharges into watercourses; require nutrient management planning; allow for increased monitoring in high-risk areas; provide clear compliance expectations for agricultural operators for setbacks, storage, and nutrient applications; and, require record-keeping."*

The AEM Code therefore ensures that agricultural practices do not impact drinking water, watercourses, air, or public health. According to the AEM Code[7]:

"...for the purpose of minimizing the introduction of waste into the environment and preventing adverse impacts to the environment and human health, this code requires persons to use environmentally responsible and sustainable agricultural practices when carrying out agricultural operations described in subsection (3)"

Section 2 (2) This code applies to an agricultural operation described in subsection (3) that is carried out in British Columbia

(a) on

(i) an agricultural land base that is owned, rented or leased, and managed, by the person who carries out the agricultural operation, and

(ii) land that is not zoned for residential purposes, and

(b) primarily for the purpose of distributing agricultural products to other persons, whether

(i) directly or indirectly,

(ii) with or without a fee, or

(iii) on a commercial or non-commercial basis.

Section 2 (3) Subject to subsection (4), the following are agricultural operations for the purposes of this code:

(a) rearing and keeping livestock or poultry, and growing and harvesting agricultural products, for

(i) consumption or use by humans, including as food, fibre or fuel,

(ii) use as animal feed,

---

[7] http://www.bclaws.ca/civix/document/id/complete/statreg/8_2019#division_d1e5540 Code of Practice For Agricultural Environmental Management. BC Laws. Accessed January 28, 2020

(iii) use as breeding stock or to produce seedlings or flowers,

(iv) use in landscaping or for ornamental purposes, in the case of plants, or

(v) work or recreational purposes, in the case of horses;

(b) storing

(i) nutrient sources and agricultural by-products, and

(ii) the primary products of livestock, poultry, insects, plants and fungi;

(c) carrying out agricultural composting processes;

(d) applying nutrient sources to land;

(e) washing, grading or packaging agricultural products, if carried out on the same agricultural land base as the livestock or poultry were reared or kept or the agricultural products were grown or harvested;

(f) disposing of or incinerating mortalities and processing wastes, if carried out on the same agricultural land base as the livestock or poultry were reared or kept;

(g) operating equipment in relation to

(i) an activity referred to in this subsection, or

(ii) other activities in relation to agriculture, other than processing primary products beyond the activities described in paragraph (e).

Section 2 (4) The following are ***not*** *agricultural operations for the purposes of this code:*

(a) aquaculture and activities described in subsection (3) that are carried out in respect of aquaculture;

(b) soil blending operations that bring manure, sand or other materials onto a parcel of land for the purpose of producing soil for use other than on that parcel.

Therefore, there are properties in the ALR that are not agricultural operations under the AEM Code. The majority of the Lower Mainland (including the entirety of Richmond) is identified as a High-Risk Area[8] under

[8] https://governmentofbc.maps.arcgis.com/apps/MapSeries/index.html?appid=c16cde73574c43da877674f423304ae9 High Precipitation Areas Map Tool. Government of B.C. Accessed January 28, 2020

the AEM Code due to high precipitation, which is defined as 600 mm or more of precipitation between October 1st and April 30th.

The AEM Code stipulates that:

> *"a person must not apply nutrient sources to land:*
>
> *(a) **in a high-precipitation area** during the period that begins on November 1 and that ends on February 1 of the next year,*
>
> *(b) during strong, divergent windy conditions, unless the nutrient sources are applied*
>
> *(i) below the soil surface, or*
>
> *(ii) under a crop canopy having a height of at least 8 cm,*
>
> *(c) **during storm events, or periods of short-term intense or high rainfall,** or*
>
> *(d) during any high-risk conditions that are identified by a director under this Part and are relevant to the application of nutrient sources to land.*
>
> *(2) **A person must not apply nutrient sources, other than wood residue, to land in a high-precipitation area during February, March or October unless both of the following conditions are met:***
>
> *(a) the nutrients are needed by, and will be available to, the intended crop;*
>
> *(b) a risk assessment is made in accordance with subsection (4) before application begins.*
>
> *(3) Without limiting subsection (2), a person may apply nutrient sources to bare soil in a high-precipitation area in the fall only if the following conditions are met:*
>
> *(a) a crop is planted before the winter non-growing season begins;*
>
> *(b) the application is to medium or fine-textured soils with a low risk of leaching;*
>
> *(b) **the nutrients will not enter a watercourse or go below the seasonal high water table**.*
>
> *(4) A person must prepare a risk assessment, in writing and in the form and manner required by a director,*
>
> *(a) for each field to which nutrient sources are to be applied, and*
>
> *(c) considering the special circumstances of the high-precipitation area and any high-risk conditions.*

[am. B.C. Reg. 8/2019, App. 3.]

Therefore, there are limitations to applying nutrients to land in high precipitation areas, including in the City of Richmond. The application window is smaller than elsewhere in the province where annual precipitation is not as high.

Furthermore, in Division 4, Nutrient Application and Management of the AEM Code, Section 49:

(1) A person must not apply nutrient sources to land

(a) on which there is standing water or water-saturated soil,

(b) on ground in which the top 5 cm of soil is frozen so as to be impenetrable to manually-operated equipment,

(c) on a field having at least 5 cm of ice or snow over at least 50% of its area, or

(d) **at a rate of application, under meteorological, topographical or soil conditions**, or in a manner, that may cause nutrient sources or contaminated runoff, leachate or solids to **enter a watercourse**[9], cross a property boundary or **go below the seasonal high water table.**

(2) A person must not apply to land a material described in any of paragraphs (e) to (g) of the definition of "nutrient source" unless the material is treated, provided, used or produced, as applicable, in accordance with this code and the applicable regulation referred to in those paragraphs.

This requirement under the AEM code, combined with high precipitation in Richmond, further limits windows for nutrient applications that may be necessary for an agricultural operation.

SIGNIFICANCE OF THE AEM CODE TO CoR AGRICULTURAL LAND

Based on our experience assessing the agricultural capability of agricultural land in the CoR, and subsequently preparing soil deposit plans to elevate properties subject to excess wetness[10], we have determined the following:

[9] Such as a ditch – the CoR defines all ditches in the city as watercourses.

[10] Dr. Elliot and Ms. Stewart have prepared such applications and reports since 2014.

1 There are several areas within CoR that are not subject to seasonal floodwaters (i.e. the classic definition of floodplain), but are generally low-lying (1 to 5 m above sea level), with fine-texture subsoil (such as silty clay loams) or bedrock which prevents vertical drainage into the subsurface;

2 The lack of vertical drainage coupled to the regionally high water table in the low-lying areas results in poor conveyance (i.e. local drainage) of water **out** of these areas – which is not otherwise improvable through installation of subsurface drain-tiles due to said drain-tile outfalls being **below** the water table; and

3 Pump-works may supress the local elevation of water table, however the water will be required to be pumped to an area that will:

   a. Receive the waters and not impact other agricultural lands; and
   b. Receive the waters and not allow them to be communicated back to the field via subsurface or displacement within the regional drainage works.

Unfortunately, pump works are generally suitable for bermed (or dyked) areas, such as floodplains, whereby the inundation/excess water is not congruent with the regional high water table. In many circumstances within the CoR, the issue is more so related to high water table and regional conveyance rather than point-specific short-duration inundation-water sources (i.e. flooding during the late spring freshet of the Fraser River) that pumping is ideally suited to resolve.

With a known issue of regionally high water tables and the AEM Code disambiguation below, Dr. Elliot's interpretation is that land application of nutrient sources within certain land-parcels of CoR will be disallowed (under the AEM Code) until such time as the high water table does not allow direct transmission of nutrient sources/nutrient to adjacent watercourses, which – in some circumstances – would result in the land parcel and agricultural operation falling under one or more of the following categories:

A. A complete mismatch of nutrient application timing window with crop needs (common case);
B. A disallowance of nutrient application during the early planting season (moderate case);
C. An outright disallowance of nutrient application during the growing season (worst case);

If only Category A is applicable, then the land is not suited to grow the operational crop or the crop will be limited to one rotation when two or more is possible based on all other factors, and the question then reverts to the standard soil importation decision making process. If Category B and C are applicable, then the portion of land determined to be limited by the excess water condition is essentially sterilized for agriculture –forcing importation of soil as the only reasonable pathway toward improving agricultural capability (due to either ineffectiveness of other options, as described in our Determinations 1 – 3 above).

The next question is how to distinguish what restrictions are resulting from AEM Code based on field-based evidence. For example, Madrone prepared a Land Capability for Agriculture assessment for an ALR property in the CoR to determine the type of agricultural limitation(s) that exist on Site. From that assessment, we found the native Lulu Soil Series (an organic Terric Mesisol – formed in areas of high groundwater and low

conveyance) overlies dense, fine-grained deltaic sediments (silt, clay). This essentially forms 'a bathtub' under the whole area.

Therefore, since the area described in the above example is not subject to seasonal floodwater (i.e. Fraser River freshet) and is instead subject to **seasonal high water table** (Land Capability Classification for Agriculture, LCA Class 'W' limitation), the AEM Code applies and limits application of nutrient sources to Category A (timing mismatch) and potentially C (complete disallowance) circumstances as indicated above, whereas Category B does not apply due to the intended perennial crops (that by definition, live for more than two years and after harvest, do not need to be replanted every year).

We believe that there are lands in the ALR which would benefit greatly from importation of soil so long as adequate (if not excessive, to account for Changing Climate) compensation of regional drainage capacity (through enlarged ditching requirements, such as installation of canals instead of ditches) is included in the process as a requirement.

Such a tactic would still result in increased (productive) agricultural lands, and increased capability for agriculture of said lands, while addressing the most common objection to soil importation, which is that regional drainage/flooding will be negatively impacted.

MINISTRY OF ENVIRONMENT & CLIMATE CHANGE STRATEGY RESPONSE

Dr. Thomas Elliot, P.Ag. has requested input from Margaret Crowley, M.Sc., P.Ag. with the Ministry of Environment & Climate Change Strategy (MoECCS). Ms. Crowley is one of the authors of the AEM Code.

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CONCLUSIONS

The Code of Practice for Agricultural Environmental Management in a regulation under the Environmental Management Act. The regulation was made law in the province in February of 2019. As such, it is less than one year old and may not be a familiar regulation to consultants nor to municipal staff tasked with a preparing and reviewing relevant development applications in the ALR, respectively.

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Prepared by:

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Jessica Stewart, P.Ag., P.Geo. on behalf of:

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

Thomas Elliot, PhD, P.Ag., P.Geo.

Analysis of Perimeter Ditch Water from Property Located at 8511 #6 Road, Richmond, BC

BCAA Legal: SEC 20 BLK4N RG5W PL 3109 Parcel A, Subsidy Lot 3, (J71246E)

Richmond File # 12-624176

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March 4 2015

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1.0 Introduction

The following report is the final report in a series of reports prepared by McTavish Resource & Management Consultants Ltd. on the property located at 8511 No 6 Road in Richmond BC. The series of reports are to provide information to the City of Richmond and the Agricultural Land Commission with respect to an application to import fill and topsoil onto the subject property. The following documents have been submitted to the City of Richmond:

- Original fill application was submitted in October 25, 2012 including supporting Agrologist's report;
- Reply letter from the City of Richmond December 13, 2012:
- Report on site drainage and leachate submitted December 14, 2013;
- Letter on wheel wash procedures submitted on December 15, 2013; and
- Letter on road access submitted February 5, 2014.

This report contains the water sampling results from the surrounding ditches as requested by the City of Richmond as part of due diligence review for the proposal import fill and topsoil to the subject property This property contains historic buried wood waste that is estimated to be at least 30 years old. The remediation plan proposes to further cap the buried wood waste with topsoil and to direct surface run-off water to the municipal ditch system along No 6 Road.[1] The City of Richmond was concerned that any seepage from the historic buried wood waste would enter the municipal drainage system.

The site contains wood waste varying in depth of over 3 m at the east side of the property to 0.5m at the west side as shown during previous excavation and soil testing that was performed by McTavish Management and Consulting Ltd. The historic wood waste is covered with a layer of 0.2 - 0.5m of topsoil. The previous excavation results showed that the wood waste was virtually non-decomposed indicating that it is kept waterlogged in stagnant low oxygen water and was well preserved. An access road is present alongside the north lateral ditch and may restrict water flow to that ditch due to soil compaction.

Wood waste can exude leachate when water is percolating through it. Wood waste leachate is toxic to fish (Samis et. al, 1999)[2], has a high chemical oxygen demand and contains tannins and lignin (Tao et.al.

[1] McTavish B., H. Timmenga, 2012. Proposed Remediation of Land Located at 8511 #6 Road Richmond, BC.
[2] Samis, S.C, S.D Liu, B.G. Wernick and M.D. Nassichuk, 1999. Mitigation of fisheries impacts from the use and disposal of wood residue in British Columbia and the Yukon. Can. Tech. Rep. Fish. Aquat. Sci. 2296: viii and 91p. Part 1: http://www.for.gov.bc.ca/hfd/library/ffip/Samis_SC1999_pt1.pdf; Part 2: http://www.for.gov.bc.ca/hfd/library/ffip/Samis_SC1999_pt2.pdf.

2005).[3] Both COD and tannins and lignin have been implicated in fish toxicity (Samis et.al., 1999). Metals have not been reported as an issue in wood waste leachate (Frankowski, 2000).[4]

2.0 Methodology

In order to check whether wood waste leachate was affecting the water in the lateral drainage ditches and to compare water quality in these ditches with the quality of water in the main City of Richmond ditch draining the area, water samples were taken in December 2014, during the Lower Mainland's wet period. Samples were analysed for the parameters that are characteristic for wood waste leachate. Emphasis was given to the potential toxicity of such leachate.

Samples were taken for the following tests:

- Fish toxicity (pass-fail test);
- Chemical oxygen demand;
- Tannins and lignins; and
- Total metals.

All sample analyses were performed by Maxxam Laboratories in Burnaby BC.

3.0 Results

Sampling took place December 8, 2014. The site was dry, and the lateral ditches to the north and south of the property contained water that was clear but yellow-brown in colour. The ditches contained organic matter in the form of grass and leaves. Both ditches appear stagnant at the time of sampling, and water smelled anaerobic. Dissolved Oxygen in these ditches appeared low at 1.6 and 2.4mg/L (see Maxxam Reports in Appendix I). The main drainage ditch to the west of No 6 Road was also sampled, both up-stream and down-stream of the subject property, beyond the existing drains of the lateral drainage ditches from the subject property. The main City of Richmond ditch flows north to south along the west side of No. 6 Road. Water in the City of Richmond ditch was clear and light yellow-brown in colour. The ditch contained organic matter and green plant growth. The dissolved oxygen was moderate at 4.9 and 5.8 mg/L.

The following results were obtained from the ditch water sampling. Results were compared with the wood waste leachate characteristics outlined in Tao et al, 2005. While Tao lists a range of concentrations for differently aged wood waste, we have selected the values of aged wood waste leachate (5 year old) as a comparison.

[3] Tao W., Ken J.Hall, A Masbough, K Frankowiski, and Sheldon J.B. Duff, 2005. Characterization of Leachate from a Woodwaste Pile. Water Quality Research Journal of Canada, Vol 40. No4:476-483. https://www.cawa.,q.ca/journal/temp/article/279.pdf

[4] Frankowsski, K.A., 2000. The Treatment of Wood Leachate Using Constructed Wetlands. MSc Thesis University of British Columbia. https://circle.ubc.ca/handle/2429/10463

Table 1 Primary Ditch Water Quality Parameters

Parameter	North Ditch on Subject Property	South Ditch On Subject Property	No. 6 Road Ditch Up-stream of Subject Property	No. 6 Road Ditch Down-stream of Subject Property	Typical wood waste leachate (5 year old pile; Tao et al, 2005)
Fish toxicity	pass	pass	pass	pass	Fail
COD	199	171	67	70	3908
Tannin/Lignin	9.09	8.18	4.04	3.65	1100

Table 2 Total Metals in Water Samples

Maxxam ID		LI1685	LI1686	LI1687	LI1688	
Sampling Date		2014/12/08 10:30	2014/12/08 10:30	2014/12/08 10:30	2014/12/08 10:30	
COC Number		G100417	G100417	G100417	G100417	
	Units	NORTH	SOUTH	UPSTREAM	DOWNSTREAM	RDL
Calculated Parameters						
Total Hardness (CaCO3)	mg/L	129	75.7	60.0	64.4	0.50
Total Metals by ICPMS						
Total Aluminum (Al)	ug/L	868	791	752	647	3.0
Total Antimony (Sb)	ug/L	<0.50	<0.50	<0.50	<0.50	0.50
Total Arsenic (As)	ug/L	3.08	1.24	1.21	1.29	0.10
Total Barium (Ba)	ug/L	36.8	27.6	25.4	24.8	1.0
Total Beryllium (Be)	ug/L	<0.10	<0.10	0.11	<0.10	0.10
Total Bismuth (Bi)	ug/L	<1.0	<1.0	<1.0	<1.0	1.0
Total Boron (B)	ug/L	<50	<50	<50	<50	50
Total Cadmium (Cd)	ug/L	0.063	0.037	0.138	0.111	0.010
Total Chromium (Cr)	ug/L	2.7	1.8	1.7	1.6	1.0
Total Cobalt (Co)	ug/L	5.79	2.22	5.15	5.03	0.50
Total Copper (Cu)	ug/L	5.19	12.6	6.03	5.76	0.50
Total Iron (Fe)	ug/L	9330	4990	1310	1280	10
Total Lead (Pb)	ug/L	1.20	1.44	0.66	0.56	0.20
Total Lithium (Li)	ug/L	<5.0	<5.0	<5.0	<5.0	5.0
Total Manganese (Mn)	ug/L	746	275	109	145	1.0
Total Mercury (Hg)	ug/L	<0.050	<0.050	<0.050	<0.050	0.050
Total Molybdenum (Mo)	ug/L	<1.0	<1.0	<1.0	<1.0	1.0
Total Nickel (Ni)	ug/L	12.3	4.9	11.1	11.6	1.0
Total Selenium (Se)	ug/L	0.25	0.12	0.10	<0.10	0.10
Total Silicon (Si)	ug/L	11700	7990	5580	5140	100
Total Silver (Ag)	ug/L	<0.020	<0.020	<0.020	<0.020	0.020
Total Strontium (Sr)	ug/L	167	105	78.3	91.4	1.0
Total Thallium (Tl)	ug/L	<0.050	<0.050	<0.050	<0.050	0.050
Total Tin (Sn)	ug/L	<5.0	<5.0	<5.0	<5.0	5.0
Total Titanium (Ti)	ug/L	20.7	11.7	7.0	5.6	5.0
Total Uranium (U)	ug/L	0.12	<0.10	0.14	0.14	0.10
Total Vanadium (V)	ug/L	7.4	<5.0	<5.0	<5.0	5.0
Total Zinc (Zn)	ug/L	24.8	14.8	26.6	67.9	5.0
Total Zirconium (Zr)	ug/L	0.83	<0.50	<0.50	0.52	0.50
Total Calcium (Ca)	mg/L	31.9	20.6	15.3	16.1	0.050
Total Magnesium (Mg)	mg/L	11.9	5.89	5.28	5.88	0.050
Total Potassium (K)	mg/L	7.20	4.74	5.97	7.15	0.050
Total Sodium (Na)	mg/L	17.7	3.57	5.33	6.72	0.050
Total Sulphur (S)	mg/L	18.3	4.8	9.6	13.4	3.0

Table 3 Guidelines for Total Metals in Water

	Units	CCME Irrigation [5]	CCME Livestock	Canada Drinking Water ug/L[6]	Exceed?
Calculated Parameters					
Total Hardness (CaCO3)	mg/L				
Total Metals by ICPMS					
Total Aluminum (Al)	ug/L	5000	5000		
Total Antimony (Sb)	ug/L			6	
Total Arsenic (As)	ug/L	100	25	10	
Total Barium (Ba)	ug/L			1000	
Total Beryllium (Be)	ug/L				
Total Bismuth (Bi)	ug/L				
Total Boron (B)	ug/L		5000		
Total Cadmium (Cd)	ug/L	5.1	80	5	
Total Chromium (Cr)	ug/L	8 / 4.9	50 /50	50	
Total Cobalt (Co)	ug/L	50	1000		
Total Copper (Cu)	ug/L	200-1000	500-5000		
Total Iron (Fe)	ug/L	5000			North ditch likely due to natural conditions
Total Lead (Pb)	ug/L	200	100	10	
Total Lithium (Li)	ug/L	2500			
Total Manganese (Mn)	ug/L	200			North/south likely due to natural conditions
Total Mercury (Hg)	ug/L		3	1	
Total Molybdenum (Mo)	ug/L		500		
Total Nickel (Ni)	ug/L	200	1000		
Total Selenium (Se)	ug/L		50	50	
Total Silicon (Si)	ug/L				
Total Silver (Ag)	ug/L				
Total Strontium (Sr)	ug/L				
Total Thallium (Tl)	ug/L				
Total Tin (Sn)	ug/L				
Total Titanium (Ti)	ug/L				
Total Uranium (U)	ug/L	10	200	20	
Total Vanadium (V)	ug/L	100	100		
Total Zinc (Zn)	ug/L		50,000		
Total Zirconium (Zr)	ug/L				

[5] Water Quality Guidelines for the Protection of Agriculture - CCME current document. http://st-ts.ccme.ca/en/index.html accessed December 19, 2014

[6] Guidelines for Canadian Drinking Water Guidelines – current table. http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/sum_guide-res_recom/index-eng.php#t2 accessed December 19, 2014

Total Calcium (Ca)	mg/L				
Total Magnesium (Mg)	mg/L				
Total Potassium (K)	mg/L				
Total Sodium (Na)	mg/L				
Total Sulphur (S)	mg/L				

4.0 Discussion

1) Ditch water in the lateral ditches and in the No 6 Road drainage ditch is not toxic to fish.
2) The COD in all ditch water is well below that in aged wood waste leachate; No guidelines for COD have been set.
3) The colour of the water in both lateral ditches and in the main City of Richmond drainage ditch is yellow brown, which is to be expected in an area with natural peat deposits and in stagnant ditches.
4) The tannins and lignin concentration in all ditch water is well below the typical values for aged wood waste leachate. Tannins and lignins are well below the BC Drinking water working criteria of 400ug/L, [7] but none is listed in the BC Approved Water Quality Guidelines.[8]
5) All metals in ditch water are below the Canada Drinking Water standard. Only iron and manganese may be over the irrigation or livestock guidelines, however samples reflect total metals, not dissolved metals, which typically are lower. The iron and manganese may be related to clay particles in the water sample or to the soil on the property that may be naturally high in iron or manganese. Metals are not typically related to wood waste leachate.

5.0 Conclusion

Sampling results have shown that the quality of the ditch water of the lateral drainage ditches on the subject property and in the main City of Richmond ditch is not affected by wood waste leachate and is not toxic to fish.

[7] Nagpal, N.K., L.W. Pommen, L.G. Swain, 2006. A Compendium of Working Water Quality Guidelines for British Columbia. BC Ministry of Environment, Science and Information Branch – Water Quality. http://www.env.gov.bc.ca/wat/wq/BCguidelines/working.html Accessed December 22, 2014.

[8] http://www2.gov.bc.ca/gov/topic.page?id=044DD64C7E24415D83D07430964113C9

Appendix I Laboratory Results

Maxxam
A Bureau Veritas Group Company

RESULTS OF RAINBOW TROUT 96 HR LC50 @ 100%

Success Through Science®

Client : 9844 Corporate Client - Maxxam Burnaby Job Number: B4B1245

Client Project Name & Number:

Test Result:

96 hrs LC50 % vol/vol (95% CL): >100 (N/A) Statistical Method: Visual

Sample Name : NORTH

Description:	dark amber			Sample Number:	LI1685-04
Sample Collected:	Dec 08, 2014 10:30 AM	Sampling Method :	N/A	Site Collection:	N/A
Sample Collected By:	N/A	Volume Received:	1 x 20CB	Temp.Upon Arrival:	11 °C Storage: 1-7 °C
Sample Received:	Dec 08, 2014 02:00 PM	pH:	5.7	Dissolved Oxygen:	1.6 mg/L
Analysis Start :	Dec 09, 2014 12:30 PM	Temperature :	14.9 °C	Sample Conductance:	283 µS/cm [2]

Concentration	Temperature (°C)	Temperature (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (mg/L)	pH	pH	Conductivity uS/cm²	Mortality (#)	Mortality (%)	Atypical Behaviour (#)
% vol/vol	Initial	96 hrs	Initial	96 hrs	Initial	96 hrs	Initial	96 hrs	96 hrs	96 hrs
0	15.2	15.0	10.0	9.6	7.1	7.2	36	0	0	0
100	14.9	15.0	7.2	9.6	6.0	7.8	280	0	0	0

Comments : At test initiation the fish in 100% concentration were surfacing and had slow respiration. For the remainder of the test all fish appeared and behaved normallly.

Culture/Control/Dilution Water Burnaby Municipal Dechlorinated Water

Hardness (EDTA Method): 20 mg/L $CaCO_3$ Other parameters available on request.

Test Conditions		Test concentration :	0,100 (% vol/vol)		
Organisms per Vessel :	10	Test Temperature :	15 ± 1 °C	Solution Depth :	>15 cm
Total # of Organisms Used :	20	Pre-aeration Time :	60 min.	Rate of Pre-aeration :	6.5±1 mL/min/L
Test Volume :	15 L	Vessel Volume :	20L	Test pH Adjusted:	No
Loading Density :	0.33 g/L	Photoperiod :	16:8 (light: dark)		

Test Organism :	Rainbow Trout *(Oncorhynchus mykiss)*	Source :	Lyndon Fish Hatcheries Inc.		
Culture Temperature :	15 ± 2 °C	Weight (Mean) +- SD :	0.50 ± 0.13 g	Length (Mean) +- SD :	4.01 ± 0.35 cm
Culture Water Renewal :	≥ 1L/min/kg fish	Weight (Range) :	0.35 – 0.82 g	Length (Range) :	3.50 – 4.70 cm
Culture Photoperiod :	16:8 (light: dark)			% Mortality within 7 days :	0.25%
Feeding rate and frequency :	daily: 1-5% biomass of trout.				

Reference chemical:	Zinc	Test Date:	Nov 17, 2014
Test Endpoint 96 hrs LC50 (95% confidence interval) :	0.16 (0.13, 0.20) mg/L	Statistical Method :	Untrimmed Spearman-Kärber
Historical Mean LC50 (warning limits) :	0.11 (0.06, 0.24) mg/L	Concentration :	0,0.04,0.08,0.16,0.32,0.64 mg/L

Test Method Maxxam's BBY2SOP-00004 is based on the latest versions of EPS 1/RM/9, EPS 1/RM/13, and EPS 1/RM/50.

Method Deviations : None.

Note: The results contained in this report refer only to the testing of the sample submitted. This report may not be reproduced, except in its entirety, without the written aprroval of the laboratory.

Analyst : Michael Brassil

Verified By : Kimberly Tamaki, BBY QA Coordinator Date: Dec 17, 2014 01:21 PM

Maxxam
A Bureau Veritas Group Company

RESULTS OF RAINBOW TROUT 96 HR LC50 @ 100%

Success Through Science®

Client: 9844 Corporate Client - Maxxam Burnaby **Job Number:** B4B1245

Client Project Name & Number:

Test Result:

96 hrs LC50 % vol/vol (95% CL): >100 (N/A) **Statistical Method:** Visual

Sample Name: SOUTH

Description:	dark amber			**Sample Number:**	LI1686-04
Sample Collected:	Dec 08, 2014 10:30 AM	**Sampling Method:**	N/A	**Site Collection:**	N/A
Sample Collected By:	N/A	**Volume Received:**	1 x 20CB	**Temp.Upon Arrival:**	11 °C **Storage:** 1-7 °C
Sample Received:	Dec 08, 2014 02:00 PM	**pH:**	5.5	**Dissolved Oxygen:**	2.4 mg/L
Analysis Start:	Dec 09, 2014 12:30 PM	**Temperature:**	14.8 °C	**Sample Conductance:**	166 µS/cm ²

Concentration	Temperature (°C)	Temperature (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (mg/L)	pH	pH	Conductivity uS/cm²	Mortality (#)	Mortality (%)	Atypical Behaviour (#)
% vol/vol	Initial	96 hrs	Initial	96 hrs	Initial	96 hrs	Initial	96 hrs	96 hrs	96 hrs
0	15.2	15.0	10.0	9.6	7.1	7.2	36	0	0	0
100	14.9	15.1	7.1	9.6	5.8	7.7	164	0	0	0

Comments: At test initiation the fish in 100% concentration were surfacing, and had slow respiration. For the remainder of the tests all fish appeared and behaved normally.

Culture/Control/Dilution Water Burnaby Municipal Dechlorinated Water

Hardness (EDTA Method): 20 mg/L $CaCO_3$ Other parameters available on request.

Test Conditions Test concentration: 0,100 (% vol/vol)

Organisms per Vessel:	10	**Test Temperature:**	15 ± 1 °C	**Solution Depth:**	>15 cm
Total # of Organisms Used:	20	**Pre-aeration Time:**	60 min.	**Rate of Pre-aeration:**	6.5±1 mL/min/L
Test Volume:	15 L	**Vessel Volume:**	20L	**Test pH Adjusted:**	No
Loading Density:	0.33 g/L	**Photoperiod:**	16:8 (light: dark)		

Test Organism: Rainbow Trout *(Oncorhynchus mykiss)* **Source:** Lyndon Fish Hatcheries Inc.

Culture Temperature:	15 ± 2 °C	**Weight (Mean) +- SD:**	0.50 ± 0.13 g	**Length (Mean) +- SD:**	4.01 ± 0.35 cm
Culture Water Renewal:	≥ 1L/min/kg fish	**Weight (Range):**	0.35 – 0.82 g	**Length (Range):**	3.50 – 4.70 cm
Culture Photoperiod:	16:8 (light: dark)			**% Mortality within 7 days:**	0.25%
Feeding rate and frequency:	daily; 1-5% biomass of trout.				

Reference chemical:	Zinc	**Test Date:**	Nov 17, 2014
Test Endpoint 96 hrs LC50 (95% confidence interval):	0.16 (0.13, 0.20) mg/L	**Statistical Method:**	Untrimmed Spearman-Kärber
Historical Mean LC50 (warning limits):	0.11 (0.06, 0.24) mg/L	**Concentration:**	0,0.04,0.08,0.16,0.32,0.64 mg/L

Test Method Maxxam's BBY2SOP-00004 is based on the latest versions of EPS 1/RM/9, EPS 1/RM/13, and EPS 1/RM/50.

Method Deviations: None.

Note: The results contained in this report refer only to the testing of the sample submitted. This report may not be reproduced, except in its entirety, without the written approval of the laboratory.

Analyst: Michael Brassil

K.Tamaki

Verified By: Kimberly Tamaki, BBY QA Coordinator **Date:** Dec 17, 2014 01:22 PM

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Maxxam
A Bureau Veritas Group Company

RESULTS OF RAINBOW TROUT 96 HR LC50 @ 100%

Success Through Science®

Client : 9844 Corporate Client - Maxxam Burnaby **Job Number:** B4B1245

Client Project Name & Number:

Test Result:

96 hrs LC50 % vol/vol (95% CL): >100 (N/A) **Statistical Method:** Visual

Sample Name : UPSTREAM

Description:	light amber			**Sample Number:**	L11687-04
Sample Collected:	Dec 08, 2014 10:30 AM	**Sampling Method :**	N/A	**Site Collection:**	N/A
Sample Collected By:	N/A	**Volume Received:**	1 x 20CB	**Temp.Upon Arrival:**	11 °C **Storage:** 1-7 °C
Sample Received:	Dec 08, 2014 02:00 PM	**pH:**	5.6	**Dissolved Oxygen:**	4.9 mg/L
Analysis Start :	Dec 09, 2014 12:10 PM	**Temperature :**	14.9 °C	**Sample Conductance:**	135 µS/cm [2]

Concentration	Temperature (°C)	Temperature (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (mg/L)	pH	pH	Conductivity uS/cm [2]	Mortality (#)	Mortality (%)	Atypical Behaviour (#)
% vol/vol	Initial	96 hrs	Initial	96 hrs	Initial	96 hrs	Initial	96 hrs	96 hrs	96 hrs
0	15.2	15.0	10.0	9.6	7.1	7.2	36	0	0	0
100	15.1	15.2	7.1	9.4	5.9	7.5	134	0	0	0

Comments : All fish appeared and behaved normally during the test.

Culture/Control/Dilution Water Burnaby Municipal Dechlorinated Water

Hardness (EDTA Method): 20 mg/L $CaCO_3$ Other parameters available on request.

Test Conditions		Test concentration :	0,100 (% vol/vol)		
Organisms per Vessel :	10	**Test Temperature :**	15 ± 1 °C	**Solution Depth :**	>15 cm
Total # of Organisms Used :	20	**Pre-aeration Time :**	40 min.	**Rate of Pre-aeration :**	6.5±1 mL/min/L
Test Volume :	15 L	**Vessel Volume :**	20L	**Test pH Adjusted:**	No
Loading Density :	0.33 g/L	**Photoperiod :**	16:8 (light: dark)		

Test Organism :	Rainbow Trout *(Oncorhynchus mykiss)*	Source :	Lyndon Fish Hatcheries Inc.		
Culture Temperature :	15 ± 2 °C	**Weight (Mean) +- SD :**	0.50 ± 0.13 g	**Length (Mean) +- SD :**	4.01 ± 0.35 cm
Culture Water Renewal :	≥ 1L/min/kg fish	**Weight (Range) :**	0.35 – 0.82 g	**Length (Range) :**	3.50 – 4.70 cm
Culture Photoperiod :	16:8 (light: dark)			**% Mortality within 7 days :**	0.25%
Feeding rate and frequency :	daily: 1-3% biomass of trout.				

Reference chemical:	Zinc	**Test Date:**	Nov 17, 2014
Test Endpoint 96 hrs LC50 (95% confidence interval) :	0.16 (0.13, 0.20) mg/L	**Statistical Method :**	Untrimmed Spearman-Kärber
Historical Mean LC50 (warning limits) :	0.11 (0.06, 0.24) mg/L	**Concentration :**	0,0.04,0.08,0.16,0.32,0.64 mg/L

Test Method Maxxam's BBY2SOP-00004 is based on the latest versions of EPS 1/RM/9, EPS 1/RM/13, and EPS 1/RM/50.

Method Deviations : None.

Note: The results contained in this report refer only to the testing of the sample submitted. This report may not be reproduced, except in its entirety, without the written aprroval of the laboratory.

Analyst : Michael Brassil

KKTmaki

Verified By : Kimberly Tamaki, BBY QA Coordinator **Date:** Dec 17, 2014 01:24 PM

Maxxam
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RESULTS OF RAINBOW TROUT 96 HR LC50 @ 100%

Success Through Science®

Client: 9844 Corporate Client - Maxxam Burnaby Job Number: B4B1245

Client Project Name & Number:

Test Result:

96 hrs LC50 % vol/vol (95% CL): >100 (N/A) Statistical Method: Visual

Sample Name: DOWNSTREAM

Description:	light amber			Sample Number:	L11688-04
Sample Collected:	Dec 08, 2014 10:30 AM	Sampling Method:	N/A	Site Collection:	N/A
Sample Collected By:	N/A	Volume Received:	1 x 20CB	Temp.Upon Arrival:	11 °C Storage: 1-7 °C
Sample Received:	Dec 08, 2014 02:00 PM	pH:	5.7	Dissolved Oxygen:	5.8 mg/L
Analysis Start:	Dec 09, 2014 12:00 PM	Temperature:	14.9 °C	Sample Conductance:	152 µS/cm²

Concentration	Temperature (°C)	Temperature (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (mg/L)	pH	pH	Conductivity uS/cm²	Mortality (#)	Mortality (%)	Atypical Behaviour (#)
% vol/vol	Initial	96 hrs	Initial	96 hrs	Initial	96 hrs	Initial	96 hrs	96 hrs	96 hrs
0	15.2	15.0	10.0	9.6	7.1	7.2	36	0	0	0
100	15.1	15.2	7.3	9.4	6.1	7.5	151	0	0	0

Comments: All fish appeared and behaved normally during the test.

Culture/Control/Dilution Water Burnaby Municipal Dechlorinated Water

Hardness (EDTA Method): 20 mg/L $CaCO_3$ Other parameters available on request.

Test Conditions Test concentration: 0,100 (% vol/vol)

Organisms per Vessel:	10	Test Temperature:	15 ± 1 °C	Solution Depth:	>15 cm
Total # of Organisms Used:	20	Pre-aeration Time:	30 min.	Rate of Pre-aeration:	6.5±1 mL/min/L
Test Volume:	15 L	Vessel Volume:	20L	Test pH Adjusted:	No
Loading Density:	0.33 g/L	Photoperiod:	16:8 (light: dark)		

Test Organism: Rainbow Trout *(Oncorhynchus mykiss)* Source: Lyndon Fish Hatcheries Inc.

Culture Temperature:	15 ± 2 °C	Weight (Mean) +- SD:	0.50 ± 0.13 g	Length (Mean) +- SD:	4.01 ± 0.35 cm
Culture Water Renewal:	≥ 1L/min/kg fish	Weight (Range):	0.35 – 0.82 g	Length (Range):	3.50 – 4.70 cm
Culture Photoperiod:	16:8 (light: dark)			% Mortality within 7 days:	0.25%

Feeding rate and frequency: daily: 1-5% biomass of trout.

Reference chemical: Zinc Test Date: Nov 17, 2014

Test Endpoint 96 hrs LC50 (95% confidence interval): 0.16 (0.13, 0.20) mg/L Statistical Method: Untrimmed Spearman-Kärber

Historical Mean LC50 (warning limits): 0.11 (0.06, 0.24) mg/L Concentration: 0,0.04,0.08,0.16,0.32,0.64 mg/L

Test Method Maxxam's BBY2SOP-00004 is based on the latest versions of EPS 1/RM/9, EPS 1/RM/13, and EPS 1/RM/50.

Method Deviations: None.

Note: The results contained in this report refer only to the testing of the sample submitted. This report may not be reproduced, except in its entirety, without the written approval of the laboratory.

Analyst: Michael Brassil

Verified By: Kimberly Tamaki, BBY QA Coordinator Date: Dec 17, 2014 01:28 PM

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Your C.O.C. #: G100417

Attention:Hubert Timmenga
Timmenga & Associates
292 E 56 Ave
Vancouver, BC
CANADA V5X 1R3

Report Date: 2014/12/17
Report #: R1718510
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B4B1245
Received: 2014/12/08, 14:00

Sample Matrix: Water
Samples Received: 4

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
COD by Colorimeter	4	2014/12/09	2014/12/10	BBY6SOP-00024	SM 22 5220 D m
Hardness Total (calculated as CaCO3)	4	N/A	2014/12/17	BBY7SOP-00002	EPA 6020a R1 m
Na, K, Ca, Mg, S by CRC ICPMS (total)	4	2014/12/08	2014/12/17	BBY7SOP-00002	EPA 6020A R1 m
Elements by CRC ICPMS (total)	4	2014/12/11	2014/12/16	BBY7SOP-00002	EPA 6020A R1 m
Rainbow Trout 96 hr LC50 @ 100%	4	N/A	2014/12/09	BBY2SOP-00004	EPS 1/RM/13 m
Tannin & Lignin (Total)	4	N/A	2014/12/11	BRN SOP-00221 R1.0	SM-5550 B

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

Encryption Key Shanaz Akbar
19 Dec 2014 11:18:03 -08:00

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Shanaz Akbar, Project Manager
Email: SAkbar@maxxam.ca
Phone# (604) 734 7276

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Maxxam Analytics International Corporation o/a Maxxam Analytics Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

Maxxam Job #: B4B1245
Report Date: 2014/12/17

Timmenga & Associates

RESULTS OF CHEMICAL ANALYSES OF WATER

Maxxam ID		LI1685	LI1686	LI1687	LI1688		
Sampling Date		2014/12/08 10:30	2014/12/08 10:30	2014/12/08 10:30	2014/12/08 10:30		
COC Number		G100417	G100417	G100417	G100417		
	Units	NORTH	SOUTH	UPSTREAM	DOWNSTREAM	RDL	QC Batch
Demand Parameters							
Chemical Oxygen Demand	mg/L	199	171	67	70	10	7747711
MISCELLANEOUS							
Tannins and Lignins	mg/L	9.09	8.18	4.08 (1)	3.65	0.10	7750831
Rainbow Trout Bioassay							
LC50	% vol/vol	ATTACHED	ATTACHED	ATTACHED	ATTACHED	N/A	7756260

RDL = Reportable Detection Limit
N/A = Not Applicable
(1) Matrix Spike invalid due to high sample concentration.

Maxxam Job #: B4B1245
Report Date: 2014/12/17

Timmenga & Associates

CSR TOTAL METALS IN WATER (WATER)

Maxxam ID		LI1685	LI1686	LI1687	LI1688		
Sampling Date		2014/12/08 10:30	2014/12/08 10:30	2014/12/08 10:30	2014/12/08 10:30		
COC Number		G100417	G100417	G100417	G100417		
	Units	NORTH	SOUTH	UPSTREAM	DOWNSTREAM	RDL	QC Batch
Calculated Parameters							
Total Hardness (CaCO3)	mg/L	129	75.7	60.0	64.4	0.50	7746841
Total Metals by ICPMS							
Total Aluminum (Al)	ug/L	868	791	752	647	3.0	7750767
Total Antimony (Sb)	ug/L	<0.50	<0.50	<0.50	<0.50	0.50	7750767
Total Arsenic (As)	ug/L	3.08	1.24	1.21	1.29	0.10	7750767
Total Barium (Ba)	ug/L	36.8	27.6	25.4	24.8	1.0	7750767
Total Beryllium (Be)	ug/L	<0.10	<0.10	0.11	<0.10	0.10	7750767
Total Bismuth (Bi)	ug/L	<1.0	<1.0	<1.0	<1.0	1.0	7750767
Total Boron (B)	ug/L	<50	<50	<50	<50	50	7750767
Total Cadmium (Cd)	ug/L	0.063	0.037	0.138	0.111	0.010	7750767
Total Chromium (Cr)	ug/L	2.7	1.8	1.7	1.6	1.0	7750767
Total Cobalt (Co)	ug/L	5.79	2.22	5.15	5.03	0.50	7750767
Total Copper (Cu)	ug/L	5.19	12.6	6.03	5.76	0.50	7750767
Total Iron (Fe)	ug/L	9330	4990	1310	1280	10	7750767
Total Lead (Pb)	ug/L	1.20	1.44	0.66	0.56	0.20	7750767
Total Lithium (Li)	ug/L	<5.0	<5.0	<5.0	<5.0	5.0	7750767
Total Manganese (Mn)	ug/L	746	275	109	145	1.0	7750767
Total Mercury (Hg)	ug/L	<0.050	<0.050	<0.050	<0.050	0.050	7750767
Total Molybdenum (Mo)	ug/L	<1.0	<1.0	<1.0	<1.0	1.0	7750767
Total Nickel (Ni)	ug/L	12.3	4.9	11.1	11.6	1.0	7750767
Total Selenium (Se)	ug/L	0.25	0.12	0.10	<0.10	0.10	7750767
Total Silicon (Si)	ug/L	11700	7990	5580	5140	100	7750767
Total Silver (Ag)	ug/L	<0.020	<0.020	<0.020	<0.020	0.020	7750767
Total Strontium (Sr)	ug/L	167	105	78.3	91.4	1.0	7750767
Total Thallium (Tl)	ug/L	<0.050	<0.050	<0.050	<0.050	0.050	7750767
Total Tin (Sn)	ug/L	<5.0	<5.0	<5.0	<5.0	5.0	7750767
Total Titanium (Ti)	ug/L	20.7	11.7	7.0	5.6	5.0	7750767
Total Uranium (U)	ug/L	0.12	<0.10	0.14	0.14	0.10	7750767
Total Vanadium (V)	ug/L	7.4	<5.0	<5.0	<5.0	5.0	7750767
Total Zinc (Zn)	ug/L	24.8	14.8	26.6	67.9	5.0	7750767
Total Zirconium (Zr)	ug/L	0.83	<0.50	<0.50	0.52	0.50	7750767
Total Calcium (Ca)	mg/L	31.9	20.6	15.3	16.1	0.050	7746842
Total Magnesium (Mg)	mg/L	11.9	5.89	5.28	5.88	0.050	7746842
Total Potassium (K)	mg/L	7.20	4.74	5.97	7.15	0.050	7746842
Total Sodium (Na)	mg/L	17.7	3.57	5.33	6.72	0.050	7746842
Total Sulphur (S)	mg/L	18.3	4.8	9.6	13.4	3.0	7746842
RDL = Reportable Detection Limit							

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GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	11.3°C

Results relate only to the items tested.

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Maxxam Job #: B4B1245
Report Date: 2014/12/17

Timmenga & Associates

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits
7747711	Chemical Oxygen Demand	2014/12/10	95	80 - 120	107	80 - 120	<10	mg/L	NC	20
7750767	Total Aluminum (Al)	2014/12/16	107	80 - 120	116	80 - 120	<3.0	ug/L	NC	20
7750767	Total Antimony (Sb)	2014/12/16	109	80 - 120	112	80 - 120	<0.50	ug/L	NC	20
7750767	Total Arsenic (As)	2014/12/16	100	80 - 120	105	80 - 120	<0.10	ug/L	NC	20
7750767	Total Barium (Ba)	2014/12/16	102	80 - 120	104	80 - 120	<1.0	ug/L	NC	20
7750767	Total Beryllium (Be)	2014/12/16	104	80 - 120	105	80 - 120	<0.10	ug/L	NC	20
7750767	Total Bismuth (Bi)	2014/12/16	108	80 - 120	103	80 - 120	<1.0	ug/L	NC	20
7750767	Total Boron (B)	2014/12/16					<50	ug/L	NC	20
7750767	Total Cadmium (Cd)	2014/12/16	103	80 - 120	102	80 - 120	<0.010	ug/L	NC	20
7750767	Total Chromium (Cr)	2014/12/16	112	80 - 120	101	80 - 120	<1.0	ug/L	NC	20
7750767	Total Cobalt (Co)	2014/12/16	106	80 - 120	100	80 - 120	<0.50	ug/L	NC	20
7750767	Total Copper (Cu)	2014/12/16	108	80 - 120	110	80 - 120	<0.50	ug/L	NC	20
7750767	Total Iron (Fe)	2014/12/16	NC	80 - 120	113	80 - 120	<10	ug/L	11	20
7750767	Total Lead (Pb)	2014/12/16	107	80 - 120	103	80 - 120	<0.20	ug/L	NC	20
7750767	Total Lithium (Li)	2014/12/16	102	80 - 120	102	80 - 120	<5.0	ug/L	NC	20
7750767	Total Manganese (Mn)	2014/12/16	NC	80 - 120	108	80 - 120	<1.0	ug/L	5.9	20
7750767	Total Mercury (Hg)	2014/12/16	113	80 - 120	114	80 - 120	<0.050	ug/L		
7750767	Total Molybdenum (Mo)	2014/12/16	104	80 - 120	115	80 - 120	<1.0	ug/L	NC	20
7750767	Total Nickel (Ni)	2014/12/16	104	80 - 120	105	80 - 120	<1.0	ug/L	NC	20
7750767	Total Selenium (Se)	2014/12/16	98	80 - 120	103	80 - 120	<0.10	ug/L	NC	20
7750767	Total Silicon (Si)	2014/12/16					<100	ug/L	13	20
7750767	Total Silver (Ag)	2014/12/16	90	80 - 120	92	80 - 120	<0.020	ug/L	NC	20
7750767	Total Strontium (Sr)	2014/12/16	NC	80 - 120	104	80 - 120	<1.0	ug/L	10	20
7750767	Total Thallium (Tl)	2014/12/16	100	80 - 120	92	80 - 120	<0.050	ug/L	NC	20
7750767	Total Tin (Sn)	2014/12/16	107	80 - 120	114	80 - 120	<5.0	ug/L	NC	20
7750767	Total Titanium (Ti)	2014/12/16	99	80 - 120	84	80 - 120	<5.0	ug/L	NC	20
7750767	Total Uranium (U)	2014/12/16	106	80 - 120	100	80 - 120	<0.10	ug/L	NC	20
7750767	Total Vanadium (V)	2014/12/16	103	80 - 120	98	80 - 120	<5.0	ug/L	NC	20
7750767	Total Zinc (Zn)	2014/12/16	NC	80 - 120	101	80 - 120	<5.0	ug/L	NC	20
7750767	Total Zirconium (Zr)	2014/12/16					<0.50	ug/L	NC	20

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QUALITY ASSURANCE REPORT(CONT'D)

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits
7750831	Tannins and Lignins	2014/12/11	NC	80 - 120	96	80 - 120	<0.10	mg/L	0.78	20

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than 2x that of the native sample concentration).

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (one or both samples < 5x RDL).

Maxxam
A Bureau Veritas Group Company

4606 Canada Way, Burnaby, BC Canada V5G 1K5

CHAIN OF CUSTODY RECORD

Page: ___ of ___

G100417

Maxxam Job#: B4B1245

Invoice To: Require Report? Yes ☐ No ☐

Company Name: TIMMENGA & ASSOCIATES

Contact Name: Hubert Timmenga

Address: 292 E 56 Ave, Vancouver PC: V5X1R3

Phone / Fax: Ph: 604-321-1242

E-mail: htimmenga@telus.net

Report To:

Company Name:

Contact Name: Hubert Timmenga

Address:

PC:

Phone / Fax: Ph: 604-321-1242

E-mail: htimmenga@telus.net

PO #:

Quotation #:

Project #:

Proj. Name:

Location:

Sampled By:

REGULATORY REQUIREMENTS

☐ CSR

☐ CCME

☐ BC Water Quality

☐ Other

☐ DRINKING WATER

SERVICE REQUESTED:

☑ Regular Turn Around Time (TAT) (5 days for most tests)

☐ RUSH (Please contact the lab)

☐ 1 Day ☐ 2 Day ☐ 3 Day

Date Required:

Special Instructions:

Return Cooler ☐ Ship Sample Bottles (please specify) ☐

ANALYSIS REQUESTED

	Sample Identification	Lab Identification	Sample Type	Date/Time Sampled	Total Metals Field Acidified?	COD	TANNIN/LIGNIN	TOX DOES/Rad
1	NORTH	I1685	water	Dec 8	✓	✓	✓	✓
2	South	I1686	water	10:30	✓	✓	✓	✓
3	UPStream	I1687	water	am	✓	✓	✓	✓
4	Downstream	I1688	water		✓	✓	✓	✓
5								
6								
7								
8								
9								
10								
11								
12								

B4B1245

Samples are from a Drinking Water Source? YES / NO

Does source supply multiple households? YES / NO

Relinquished by:	Date (YY/MM/DD):	Time:	Received by:	Date (YY/MM/DD):	Time:	Time Sensitive	Temperature on Receipt (°C)	Custody Seal Intact on Cooler?
[signature]	14/12/08	2 PM	Laurel Berthue	2014/12/08	14:00	☐	13,10,11 JS	NA Yes ☐ No ☐