REPORT, AGRICULTURE ASSESSMENT OF EAST WELLINGTON PARK

Document completed for the City of Nanaimo, Date: May 10, 2021.

A Report on the Agriculture Potential of E. Wellington Park. The report includes an assessment of soils and current forage productivity, a look at crops which are suited to the park, the need for infrastructure to support agriculture development, and an impact assessment of park activities and developments on future agriculture at this site.

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Figure 1, photo of E. Wellington park agricultural field looking south-south-east from the parking lot. August 13, 2020

Contents

Introduction

Purpose:

To assist and guide the city of Nanaimo, community groups, university students and the public in the development and use of the E. Wellington park property for farming. The Park is located at 2191 East Wellington Road Legal Description: Lot 1, Section 14 and 15, Range 7, Mountain District, Plan 14201, Except Part in Plan 45345.

East Wellington Park is within the Agriculture Land Reserve (ALR) and therefore farming is identified as a high priority use of this land. The land also has high biodiversity values, with the Millstone River and associated riparian areas adjacent to the western boundary of the current hay field. As identified by the City of Nanaimo's Habitat Atlas, the property is classified as an Environmentally Sensitive Area (ESA)—seasonally flooded Agricultural Field. The property lies within the floodplain of the Millstone River.

Sensitive species that have been documented on the site or have some probability of occurring there based on observed habitat conditions include: Northern Red Legged Frog, American Water Shrew, Great Blue Heron, Short-eared Owl, Geyer's onion, and Slim leafed onion (S. Bonner, 2018). There is nesting habitat along the low bluffs east of the hayfield, and the current hay crop provides habitat for small mammals, snakes, amphibians in wet areas, and grassland nesting birds in meadow areas, such as the Savannah sparrow.
The Millstone River provides an important regional habitat corridor for both fish and wildlife.

The agricultural assessment report will help identify crops and farm practices suited to the topography, soils, and landscape of the park. Recommendations for cropping practices will maintain and complement the park's natural environment. Impacts on current and future agriculture of non-farm use will be evaluated and mitigation strategies will be recommended.

Scope of Work

- Planning meetings with City of Nanaimo staff
- Review of Aquaparian's biophysical assessment and Chatwin's Biophysical Assessment.
- Collection and review of relevant reference information. Lidar, soil sifter tool, crop, data.
- Review of Side Channel Investigative Report and any recommendations for site modification.
- Investigation of Synergies with Cline Centre
- Collection of field data: Minimum of 5 soil pits to investigate soil texture and structure as well as aeration of soil/ degree of flooding impacts. Collection of 15 to 20 soil samples

and based on the soil pits either aggregated or separated into subsamples (max 3) for analysis of soil nutrient status.
    - Prepare imap soils type.
    - Field data collection
    - Development of form to record field soil information.
    - Summarization of results
- Lab analysis for nutrients and texture.
    - Soil hand texture at the site
    - Soil test request records pre shipping
    - Preparing samples, and shipping
    - Summarization of results
- Field crop survey of agricultural area (health and condition of current crop, weed content, productivity, and renovation potential).
    - Development of form
    - Summarization of results
- On site assessment of non-farm use on current and future agriculture opportunity (parking expansion area, trail, riparian buffer, wetland expansion).
    - Development of table
    - Summarization of results
- Review references on regenerative agriculture and permaculture design.
- Identify the most appropriate locations for specific farm uses. Identify which agricultural practices and crops would be feasible on this site given the soil, biophysical, and climatic conditions of the site. Develop a table with benefits, limitations, and risks. Develop a site map if feasible.
- Review of side channel or wetland soils information and incorporation of information and recommendations into report, prepare site map.
- Identification of best management practices to be used to ensure that agricultural uses support and contribute to environmental restoration and integration of environmental and agricultural objectives.
- Preparation of report.

East Wellington Park Site Description

East Wellington Park is located at: 2191 East Wellington Road Nanaimo, BC., legal description: Lot 1, Section 14 and 15, Range 7, Mountain District, Plan 14201, Except Part in Plan 45345. The parcel is 12.7 hectare (29.7 acres) including the Millstone river and associated riparian zone. During the rainy season, the park floods, which limits park access but provides important ecological function benefits. As identified by the City of Nanaimo's Habitat Atlas, the property is classified as an Environmentally Sensitive Area (ESA)—seasonally flooded agricultural field. The historically farmed area of the property (farm field) is 9.1 hectare (22.5 acres) which includes a gravelly compacted area of 0.28 hectare (.7 acres) at the field entrance in the northeast corner. The current agriculture crop is primarily domestic seeded forage species

which are hayed in late July or early August when the entire field becomes dry enough for a tractor, hay cutting and baling equipment to access the field without causing soil compaction.

The field is essentially flat with some slightly higher areas and some depressions which stay wetted in spring. The soil type is Chemainus, which is a silt loam to loam and is naturally moderately well drained. (R. Bertrand, 1985).

There is a city sewer line on the Eastern edge of the hayfield running north to south and low bluffs rise above this.

The park is used by the public for walking and a dirt path circumvents the field.

The Millstone river forms the western boundary of the hayfield and the property. The river, riparian habitat, rocky bluff, and hay meadow provide habitat for grass nesting birds, small mammals, raptors that feed on these, amphibians in the wetted areas and forage and habitat for larger mammals passing through.

The Agriculture Land Reserve

The entire E. Wellington park property falls within the boundaries of the Agriculture Land Reserve, see figure 2 below.

The purposes of the ALC as set out in Section 6 of the ***Agricultural Land Commission Act*** are:

> a) to preserve agricultural land;
> b) to encourage farming in collaboration with other communities of interest; and
> c) to encourage local governments, First Nations, the government, and its agents to enable and accommodate farm use of agricultural land and uses compatible with agriculture in their plans, bylaws, and policies (Agriculture Land Commission Act, Chapter 36, March 24, 2021. https://www.bclaws.gov.bc.ca/civix/document/id/complete/statreg/02036_01 and https://www.alc.gov.bc.ca/alc/content/about-the-alc).

Figure 2, Agriculture Land Reserve highlighted in green.

Topography and Soils (the foundation of production)

The farmed area of East wellington park is low lying land, consisting of alluvial soils deposited by the Millstone river. The topography slopes gradually (less than 1% on average from the northeast to the south west). The highest and driest land lies along the northern, eastern, and south west portions of the agricultural field. During a January site visit, a strip along the eastern edge of the field was found to be quite wet. The low-lying depressed areas including the centre of the field were also flooded (figure 3).

Figure 3, Wet areas of agriculture field

Soils are the foundation of crop production and their management is critical to both successful production and environmental stewardship.

The dominant soils in the East Wellington fields are of the Chemainus[1] soil series, which are loam to silt loam and are moderately well to imperfectly drained. This internal soil drainage and excellent nutrient and moisture storage capabilities of the Chemainus soils make them some of the most productive agricultural soils on Vancouver Island. They can support a wide diversity of crops and with water for irrigation are very productive. Chemainus soils are subject to periodic flooding in the lower lying areas.

Historically Vancouver Island has had relatively dry summers, with annual precipitation concentrated in the autumn, winter, and spring. Climate change is increasing average annual precipitation in the region with this increase concentrated in the winter and shoulder seasons, while the summers are becoming drier. Warming temperatures are also reducing annual snowfall, and the frequency and severity of extreme rainfall events is expected to increase. These combined factors are resulting in greater challenges in managing runoff and drainage on farmland (BC Agriculture & Food Climate Action Initiative, 2020).

Given possible climate change related increases in flood levels and duration, it is critical to select and grow flood tolerant perennial species suited to these conditions. Most annual species suited to the region could be readily grown on mid to higher elevation portions of the fields.

Generally flooding would be limited to the high rainfall period of November to February with lower lying areas subject to flooding into May and some years June. The highest elevation areas are likely subject to major storm event flooding only.

The high oxygen content of the water flooding the mid elevation field areas and the generally cooler weather conditions during this period may cause minimal damage to most shallow rooted perennials. To ensure minimal impacts to perennials from flooding, subsurface drainage and mounding is recommended.

Soil Survey

Location of soil survey sites

Five soil survey sites were chosen in different sections of the agriculture field, to sample soil for texture, structure, and consistency, and collect samples to be sent to a soil testing lab for nutrient and texture analysis (Figure 4). Four of the sites were selected to be located on slightly elevated field areas while the fifth (soil pit #3) was taken on a depressional area.

Figure 4, soil sample locations

Soil Survey Pits, Soil Texture and Structure Assessment Method

At each site, a soil pit was dug to a depth of 50 cm (20 inches) on hand dug holes and to more than 100 cm (40 inches) for the one machine dug hole. Texture, structure, evidence of mottling or fluctuating water table contributing to anoxic conditions (water saturation) was recorded using observation and a hand texturing method from the field manual used to describe terrestrial ecosystems (B.C. Ministry of Environment, Lands and Parks and B.C. Ministry of

Forests, 1998). Refer to Appendix 2 for methods. Samples were taken with a shovel and knife to obtain a vertical column of 40 cm deep by 5 cm square (16 inches by 2 inches^2).

Soil Pit Data

Soil pits # 1, 2, 4 and 5 are representative of the elevated portions of the field. Soil pit #3 is a more poorly drained area.

Figure 5, Soil pit 1

Soil data, Pit #1:

Date: July 14, 2020

Site Description: Map pit #1 (#1 for the day). Slightly elevated area, excellent forage stand

Soil Pit location: 25 m west of west edge of parking lot & 30 m south-south-east

Soil depth	Characteristics (texture, colour, mottling, structure, consistency)
0 to 10”	Loam, dark brown, organic enriched, no mottling, crumbly structure root excellent proliferation
10 to 16”	Silt loam to Silty clay loam brown, proliferation of roots, some mottling

10 to 24 ‘ Silt loam, yellow brown colour

Notes: 0-10”: A few small (< 3” diameter) rocks < 5% of soil volume, some concretions, many fine & course roots, chunks of charcoal and brick fragments. 10 to 16”: wood pieces 5-10% of soil layer, rock free, active rooting. 13 to 14 “: slight mottling. Mottling is indicative of a fluctuating water table contributing to oxygen limiting conditions in the soil. 16-24” yellowish brown, some fine roots, no mottles.

The surface 14 inches is well aggregated soil with spaces between soil particles being obvious. These spaces are important for root penetration, soil aeration and drainage. The loam texture (blend of sand, silt, and clay) is similarly beneficial to crop production. The soil is relatively well drained in the upper 14 inches with some indication of low oxygen conditions during some portion of the year at the 14-to-16-inch depth. Soil consistency (for all the soil pits) was slightly firm as evidenced by some resistance to shovel penetration. There was no evidence of significant compaction. The loam surface texture indicates more rapidly moving water during soil deposition than the silt loam to silty clay loam soil at 10-to-16-inch depth.

Figure 6, soil pit #2

Soil Data, Pit #2

Date: July 14, 2020

Site Description: Map pit #2 (#2 for the day). Slightly lower than pit #1

Soil Pit location: 75 m south-south east of field edge, 50 m south-south-east of pit #1

Soil depth	Characteristics (texture, colour, mottling, structure, consistency)
0-10"	Dark brown, crumbly, loam, course to fine root proliferation, small course fragments at 8-9"
	No mottles to 9", some mottling 9-10 "
10-16	Loam to silt loam, fine root proliferation, many orange mottles at 11.5" - 15.5 inches depth, 70% of soil mix
16-20"	Light brown, crumbly loam to silt loam, slightly tacky, over all a few mottles.

Notes:

Slightly lower elevation than pit #1, higher than pit #3, more fine grasses, little orchard grass, less forage, still quite productive.

The surface 9 inches of soil is of excellent crumbly consistency. The lower productivity is consistent with a slightly higher water table than pit# 1 (9 inches to mottling compared to 14 inches) affecting the crops ability to grow from late February to the time of soil pit digging (July 14th).

Soil data, Pit #3:

Date: July 14th ,2020

Site Description: Map Site #3, (#3 for the day) depressional reed canary grass area

Soil Pit location: middle of field

Soil depth	Characteristics (texture, colour, mottling, structure, consistency)
0-1"	Duff layer

0-10”	Highly organic matter enriched, black, course and fine root proliferation, mottling at 8 inches of depth
10-20	Clay loam to loam. Many concretions at 15-20“, slight mottling continues

Notes: 0-6” loam

The depressional area of pit #3 is highly organic matter enriched with dark brown to black soils. The mottling at 8 inches of soil depth along with dark soil colour and depressional nature of the site indicate the soil has a high-water table into the mid summer period most years.

Soil data, Pit #4:

Date: August 13th, 2020

Site Description: Map pit #4 (#2 for the day) machine dug pit

Soil Pit location: Middle of east end of main field, +/- 50 meters from east hedge row

Soil depth	Characteristics (texture, colour, mottling, structure, consistency)
0-10”	Organic enriched dark brown loam, root proliferation
10-36”	Yellow Sandy loam, many fine roots, crumbly
36-40”	Orange mottles yellow soil, loam
40”+	Loam to silty clay loam

Notes: No course fragments, no mottling, forages were harvested, however crop stubble and root growth indicated a productive stand of forage was harvested.

Well drained soil, most rapidly drained soil of all 5 soil pits. This soil likely suffers from a moisture deficit earlier in the growing season than other sites on the property. Irrigation would make this site the most productive of all sites on the property.

Figure 7, Machine dug soil pit #4

Note organic enrichment - dark brown colour of surface soils (right).

Soil Data, Pit #5

Date: August 13th, 2020

Site Description: Map pit #5

Soil Pit location: Middle of South East field

Soil depth	Characteristics (texture, colour, mottling, structure, consistency)
0-6”	Loam, well aggregated, massive course and fine roots
6-9”	Silty clay loam, well aggregated, many roots, 5% course fragments
9-16”	Dark brown to black soil, well aggregated, excellent rooting and aeration
16-20 inches	Slight yellow mottling, silty clay loam
20”+	Significant yellow mottling, still significant rooting, loam to silty clay loam

Notes: 20 meters away - deep core sample: 0-15” generally dark brown, low to no course fragments below 10”, massive rooting. Forages were harvested but remaining stubble and root growth indicated productive stand of forage was harvested.

Figure 8, pit #5

Note: root proliferation – very productive

Soil Nutrients

Soil Nutrient data collection

Date: August 13th, 2020

Over 22 core samples were taken across the field at 40 metre intervals with a random sampling pattern.

Notes: While collecting the core samples it was noted that soils along the east side of the main field showed signs of compaction (poor forage growth with course fragments on the surface, possibly indicating an old roadbed, or staging area for sewer line construction. The north east corner is covered with gravel (road base crush) to at least a depth of 8”, from access point, with poor forage vigour likely due to compaction and low moisture and nutrient holding capacity.

Lab Analysis

The core samples were dried, and then combined and sent to Exova lab for nutrient analysis.

Farm Soil Analysis

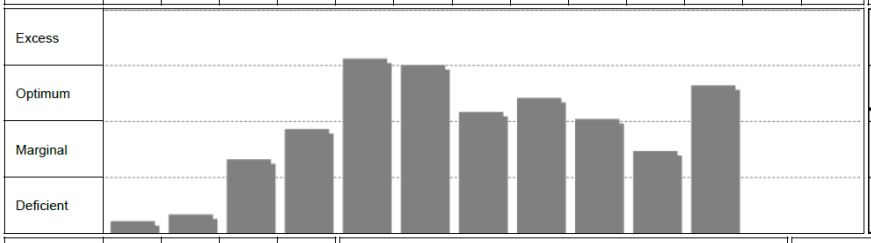
Bill To:	Hard to Come By Farm	Grower Name:	East Wellington	Lot Number:	1463556
Report To:	Hardisty Caverns LP	Client's Sample Id:		Report Number:	2579014
	PO Box 398	Field Id:	E.W Hay	Date Received:	Dec 08, 2020
		Acres:	25	Disposal Date:	Jan 07, 2021
	Edmonton, AB., Canada	Legal Location:		Report Date:	Dec 11, 2020
	T5J 2J9	Last Crop:	Orchardgrass - Hay	Arrival Condition:	
Agreement:	113442				

Nutrient analysis (ppm)

Depth	N*	P	K	S**	Ca	Mg	Fe	Cu	Zn	B	Mn	Cl	BiCarbP
0" - 6"	4	<5	99	7	2140	287	179	2.6	2	0.6	33.0		

Soil Quality

pH	EC(dS/m)	OM(%)	Sample#
6.3	0.2	13.2	7321313



Alkaline	*Extreme*	*High*
Neutral	*Very High*	*Normal*
Acidic	*High*	*Low*
Very Acidic	*Good*	*Very Low*

Total lbs/acre	8	10	198	13
Estimated lbs/acre	17	10	198	27

Texture *Loam* Hand Texture *n/a*
Sand 32.6 % Silt 42.0 % Clay 24.7 %
Ammonium 13.3 mg/kg

BS 58.5 % CEC n/a
Ca 45.8 % Mg 10.1 % Na 1.6 % K 1.1 %
TEC 23.4 meq/100 g Na 84 ppm

Lime 4 T/ac Buffer pH 6.0 Est. N Release n/a K/Mg Ratio n/a

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

RECOMMENDATIONS FOR BALANCED CROP NUTRITION

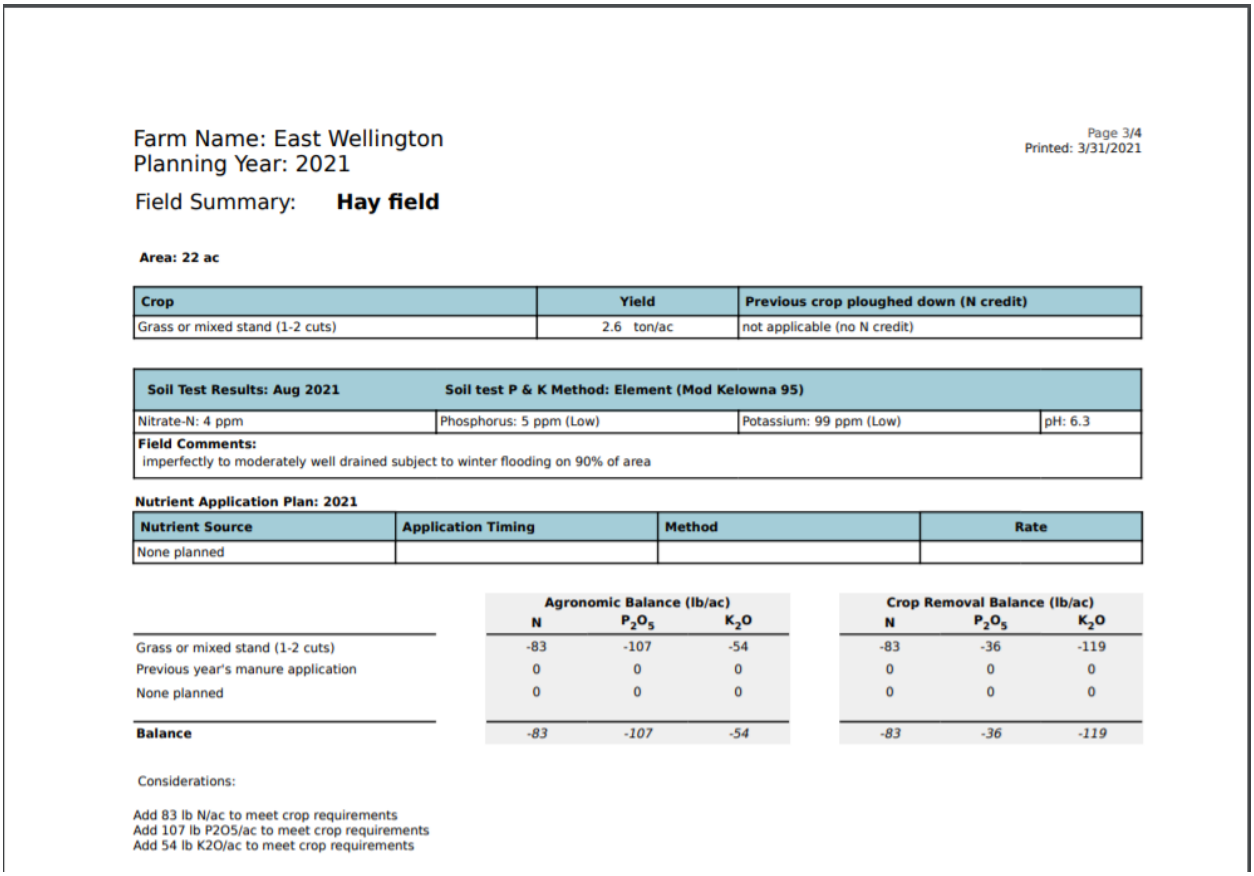
	Potatoes					Carrots				
Macro-nutrients	**Yield**	**N**	**P_2O_5**	**K_2O**	**S**	**Yield**	**N**	**P_2O_5**	**K_2O**	**S**
Growing Condition	T/ac	To be added (lbs/acre)				bu/ac	To be added (lbs/acre)			
Excellent	20	181	72	179	0	4	114	166	168	5
Average	16	114	55	138	0	3	96	150	139	5
Your Goal	0.0					0				
Removal Rate (Seed/Total)	20	141 / 251	40 / 73	238 / 327	13 / 20	4	0 / 0	0 / 0	0 / 0	0 / 0
Micro-nutrients	Iron	Copper	Zinc	Boron	Manganese	Iron	Copper	Zinc	Boron	Manganese
To be added (lbs/ac)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Parts of the field may be Boron deficient.

The ideal pH range is 6.0 to 7.5

Comments:

Figure 9, Nutrient Analysis results from Exova lab



Farm Name: East Wellington
Planning Year: 2021

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Field Summary: **Hay field**

Area: 22 ac

Crop	Yield	Previous crop ploughed down (N credit)
Grass or mixed stand (1-2 cuts)	2.6 ton/ac	not applicable (no N credit)

Soil Test Results: Aug 2021	Soil test P & K Method: Element (Mod Kelowna 95)		
Nitrate-N: 4 ppm	Phosphorus: 5 ppm (Low)	Potassium: 99 ppm (Low)	pH: 6.3
Field Comments: imperfectly to moderately well drained subject to winter flooding on 90% of area			

Nutrient Application Plan: 2021

Nutrient Source	Application Timing	Method	Rate
None planned			

	Agronomic Balance (lb/ac)			Crop Removal Balance (lb/ac)		
	N	P_2O_5	K_2O	N	P_2O_5	K_2O
Grass or mixed stand (1-2 cuts)	-83	-107	-54	-83	-36	-119
Previous year's manure application	0	0	0	0	0	0
None planned	0	0	0	0	0	0
Balance	*-83*	*-107*	*-54*	*-83*	*-36*	*-119*

Considerations:

Add 83 lb N/ac to meet crop requirements
Add 107 lb P2O5/ac to meet crop requirements
Add 54 lb K2O/ac to meet crop requirements

Figure 10, hay crop nutrient recommendations

Calculations for hay crop nutrient recommendations were made on the BC Nutrient Management Calculator using a predicted average yield of 2.6 ton/acre: https://nmp.apps.nrs.gov.bc.ca/

N.P.K requirements for the current hay crop are: 83lbs N, 107lbs P205, and 54lbs K20 to maintain current production levels.

Results of Soil Survey and Nutrient Analysis

Four of the 5 soil pits indicated soils consistent with the Chemainus soil series. Pit #4, an anomaly, contained sandy loam textures in the 10-to-36-inch layer of soil, providing superior drainage and aeration. The alluvial (deposited by streams) nature of the Chemainus soils does contribute to some variation in soil texture. All surface soils (0-to-6-inch depth) were loam to silt loam in texture based on hand texturing (see appendix #1). The soil texture lab analysis (combined from over 20 core samples) indicated soils of a loam texture containing 33% sand, 42% silt and 25% clay for the top 15 cm (6 inches) of soil. This depth of soil is the layer generally tilled and where the greatest root proliferation occurs. While subsurface soils are important for soil drainage, aeration and moisture holding capacity the surface soils have the greatest

influence on soil tilth (soils response to cultivation and ability to support root proliferation and seed germination) moisture, and nutrient holding capacity.

Chemainus soils are some of the easiest soils to farm. Once high winter water levels have subsided, the surface soils support cultivation relatively soon after rain events, and tend not to create soil crusting, which can limit seed germination.

Refer to the Soil Management Handbook for Vancouver Island for more detailed information on the Chemainus soils series and some detailed information in appendix #2. The handbook indicates with improvements there are no limits to crop production on the Chemainus soil series, however since diking the property is not being considered by the city of Nanaimo, flood risks must be managed for using other strategies. Also refer to Technical Report number 15 for soils of the Duncan and Nanaimo area (Jungen et al., 1985).

There are at least 16 elements known to be essential for plant growth. Macronutrients are generally used in larger amounts than micronutrients (Mackenzie, R, 1992). Soil test results at E. Wellington park showed Nitrogen, Phosphorus and Potassium to be marginal. As sampling took place in August it is expected that the crop would have taken up nitrogen available in the soil from spring applications of fertilizer. However, there should have been higher residual N at this time of year to boost fall regrowth, indicating that fertilizer applied for the forage crop was low. Nitrogen is a component of chlorophyll, and proteins and enzymes in plants. It is essential for plant growth. Phosphorus is also required for plant growth, utilization of sugars and starches, photosynthesis, the transfer and storage of energy and root growth. Adequate phosphorous results in rapid growth and early maturity (Agri-facts, Alberta Agriculture rural development, 1998). Phosphorus is generally applied to crops at the time of planting and can be added annually in a fertilizer blend such as 18-18-18. Low soil phosphorous levels indicate a lack of phosphorous in annual fertilizer applications. It is important to apply phosphorus at levels that the crop requires and to maintain soil phosphorus levels in the recommended safe levels (below 100 ppm of P) as leaching (or soil erosion) of phosphorous can be detrimental to fish. Potassium levels are also marginal at E. Wellington park. Potassium is required by all plant and animal life. Adequate levels of potassium assist in improved efficiency of photosynthesis, improved plant quality, and increased disease resistance. Forage yields can be increased by the adequate application of fertilizers. Soil testing on a regular basis (once every 3 years) is recommended to ensure accurate nutrient applications. This can be in the form of manures and or chemical fertilizers. When different crops are grown such as carrots and potatoes shown in figure 9, fertilizer amounts should be adjusted to suit the crop type and estimated production. Refer to: Agriculture soil and nutrients, website information, available from the BC government for information on soil testing, nutrient management, and the nutrient management calculator.

https://www2.gov.bc.ca/gov/content/industry/agriculture-seafood/agricultural-land-and-environment/soil-nutrients

Field Crop Survey of Agricultural Area

A vegetation survey was conducted at 4 of the 5 same sites also sampled for soil type. Species found at each site were grouped under grasses, forbs and weeds found. In addition, a ¼ m²plot was clipped to estimate production. The field is an agriculture area currently used for hay production, so species are a mix of seeded agronomics with some native species and some introduced increaser species and or invaders. Weed species were recorded as well as the severity of distribution. Clipped weights were extrapolated to estimate production in kg/ha, tons/acre, and lbs/acre (Table 1-4 below).

Table 1, Site 1

Site Number:	1		Site Description:	Near parking lot						
Date:	July 14th		Photos:	1-3 on ipad, 1-7 on cell phone						
Productivity Rating:	Good									
Species identified:			Grasses		Forbes		Weeds	Weed Density and distribution		
			Tall fescue		Alsike Clover		creeping buttercup	scattered plants		
			Orchardgrass		Vetch		oxeye daisy	at field perimeter		
			quack grass		Alfalfa		Tansy ragwort	at field perimeter		
			sweet vernal grass				cats ear			
			Colonial bentgrass				night flowering catchfly	at field perimeter		
			velvet grass				blackberry	at field perimeter		
			bluegrass				quackgrass			
		Grams/1/4 m²	Grams/m²	kg/ha		tons/acre	lbs/acre			
Clipped Weight: 1/4 m² plot:		173	692	6920		3.09	6174			

Figure 11, Site 1, Forage Crop

Site 1 is near the parking lot. This is a productive area, vegetated with a forage crop of tall fescue and orchard grass. Sweet vernal grass, bentgrass, velvet grass and bluegrass are also present. Forbs include Alsike clover, purple vetch, and alfalfa. Scattered plants of buttercup and quackgrass were found in the field. Oxeye daisy, Tansy ragwort, cats ear, night-flowering catchfly and blackberry were at the edge of the field. The estimated forage production at this site is 6920 kg/ ha or 3.09 tons/acre.

Table 2, Site 2

Site Number:	2		Site Description:							
Date:	July 14th		Photos:	ipad photo 13						
Productivity Rating:	Good									
Species identified:			Grasses		Forbes		Weeds	Weed Density and distribution		
			Tall fescue		Vetch			none recorded		
			sweet vernal grass							
			Colonial bentgrass							
			Bluegrass							
		Grams	Grams/m²	kg/ha		tons/acre	lbs/acre			
Clipped Weight: 1/4 m² plot:		157	628	6280		2.8	5603			

Figure 12, Site 2, Forage Crop

Site 2 is located SE of site 1. See figure 2. This area is dominated by tall fescue, vetch, with sweet vernal grass, Colonial bentgrass, and bluegrass throughout. No invasive weeds were

recorded at this site and the productivity was rated as good. The production is estimated at 6280 kg/ ha or 2.8 tons/ acre.

Table 3, Site 3

Site Number:	3		Site Description:							
Date:	July 14th		Photos:	ipad photo 14,15,16,17						
Productivity Rating:	Fair									
Species identified:			Grasses		Forbes		Weeds	Weed Density and distribution		
			Tall fescue	not headed out	Vetch		Buttercup	scattered plants		
			Sweet vernal grass		Birds foot trefoil					
			Colonial bentgrass							
			Velvet grass							
			Bluegrass							
			Reed Canary Grass	Patches nearby, beside soil pit						
		Grams	Grams/m²	kg/ha		tons/acre	lbs/acre			
Clipped Weight: 1/4 m² plot:		125	500	5000		2.23	4461			

Figure 13, Site 3, Forage Crop

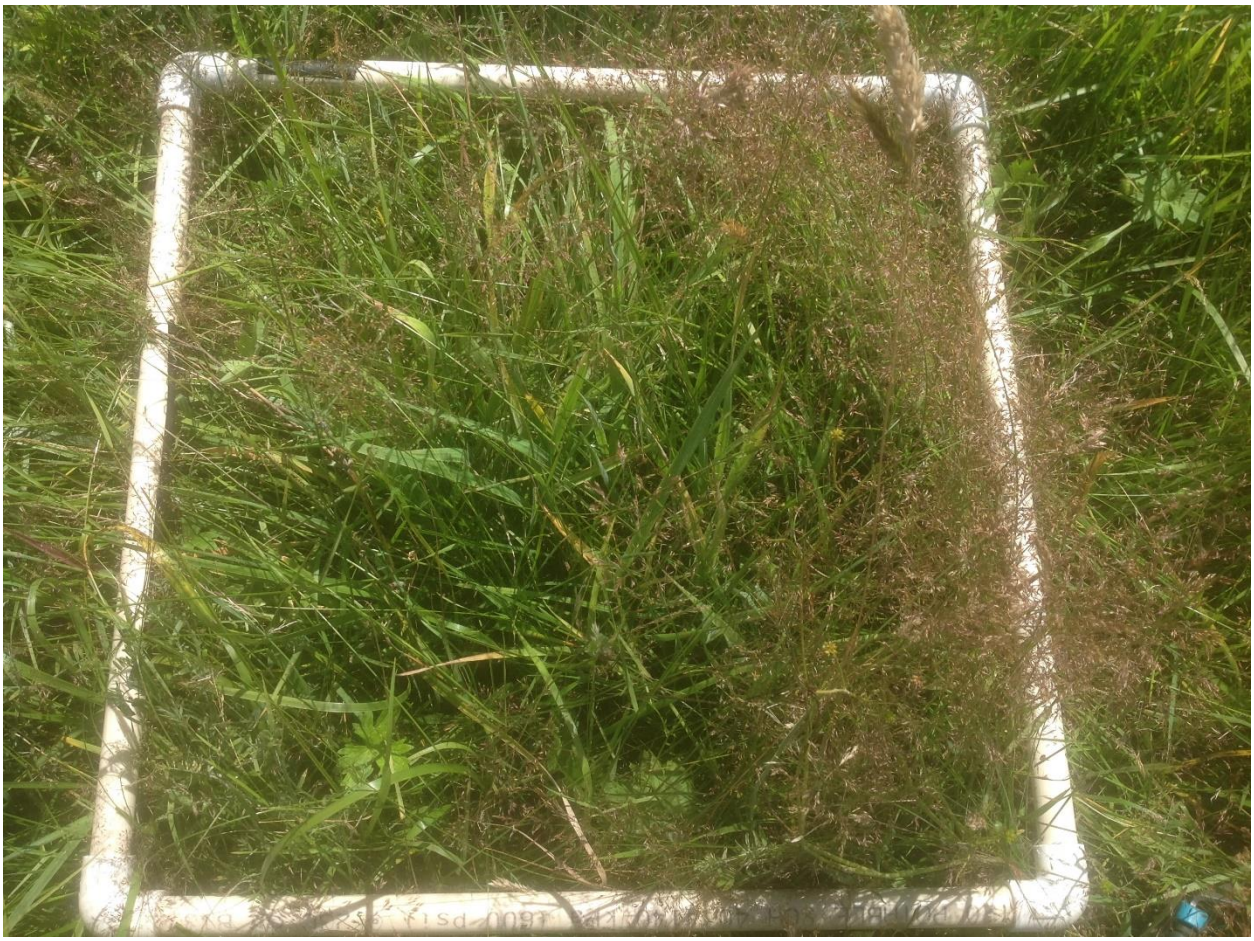


Figure 14, Site 3, Clipped Plot

Site 3 is SE of site 1 and 2 and about mid point in the forage field and park area. The forage in this area is a mix of tall fescue, and less productive sweet vernal grass, Colonial bentgrass, velvet grass, and bluegrass. Reed canary grass was found near by. Forage producing forbs included vetch and birdsfoot trefoil. Scattered plants of buttercup were present. Productivity of this site was considered fair at 5000kg/ha or 2.23 tons/acre.

Table 4, Site 4

Site Number:	4		Site Description:							
Date:	July 14th		Photos:	ipad photo last 4						
Productivity Rating:	Fair									
Species identified:			Grasses		Forbes		Weeds	Weed density and distribution		
			Tall fescue	just heading out	Clover		none oberved in plot			
			Sweet vernal grass		Vetch					
			Colonial bentgrass							
			Creeping Red Fescue							
			Velvet grass							
Notes	Sparrows chirping at this site, possible nest or fledglings nearby.									
		Grams	Grams/m²	kg/ha		tons/acre	lbs/acre			
Clipped Weight: 1/4 m² plot:		129	516	5160		2.3	4604			

Figure 15, Site 4, Forage Crop

Site 4 is again SE of the other sites and at the far end of the first forage field, northwest of the hedge row. Forage here was a mix of tall fescue, Creeping red fescue, clover, and vetch with less productive sweet vernal grass, Colonial bentgrass, and velvet grass present. No invasive weeds were recorded here. Productivity was fair, at 5160 kg/ ha or 2.3 tons/ acre. Sparrows either nesting nearby or with fledglings were disturbed when we walked by.

Figure 16, Site 4, Clipped Plot

Site 5 was not clipped. However, this site has a heavy and productive crop of tall fescue, and orchard grass and red clover with some plantain, rattlebox, sweet vernal grass and bentgrass. There were a few scattered plants of oxeye daisy and one patch of buttercup. The wetter portion of this field is dominated by Reed Canary grass.

Results of Vegetation Survey

Pasture productivity of up to 3.5 tons of dry matter per acre (7-8 tonne/ha) is possible (Gunner A, 1994). With fertilization, drainage, and irrigation this number can be increased to 10-14 tonnes/ha (S Bittman et al, 1999). Estimated production at E. Wellington ranged from 2.2-3 09 tons/acre (4.9 to 6.9 tonne/ha). These quantities represent fair to good productivity for single cut, dryland hay farming on Vancouver Island.

Improved fertility through balanced application of fertilizer could likely improve production, the number of cuts that can be achieved, and hay quality. Irrigation is possible with development of access to water through wells, a licence on streams, municipal water and water storage or a

combination of these. Hay and or cereal crops as well as all other proposed crops would benefit from access to water.

Field Perimeter Assessment

The perimeter of the field was found to be weedy, likely due to disturbance resulting from the trail along the edge of the field.
Invasive weeds were more abundant here and included Canada Thistle, Tansy ragwort, blackberry, and oxeye daisy.
Control of invasive weeds is recommended, either through mechanical means or use of herbicides if used in accordance with the pesticide label.

Biophysical assessments and agriculture:

Table 5, Biophysical assessment

• The property supports ground nesting birds, migratory waterfowl, and other wildlife that must be protected from / supported by park development	Identify Agricultural activities and timing to minimize impacts to wildlife.
• Two environmental reports have been carried out in support of the plan and should inform the agricultural assessment	Consider information from environmental reports in Ag. plan
• There may be opportunities to construct new side channels off the Millstone River to support fish and other wildlife habitat (a feasibility study for this was carried out in 2020)	Will avoid sampling and soil analysis in proposed side channel area.

Management of Soils

The Chemainus soils have no limitations to the crops, suited to the region, that can be grown on them. However, at East Wellington park, the lowest laying soils are subject to flooding periodically throughout the late fall and winter, while the mid elevation soils (in relation to the Millstone river elevation) are subject to flooding during and following major storm events. The highest elevation field areas are subject to flooding during periods of 1 in 20 storm events or larger. The relatively good internal soil drainage on these soils, indicate that once water levels have subsided 12 inches below the soil surface, tillage may be undertaken with light equipment such as a walk behind rototiller. For heavy tillage equipment pulled by a tractor, soils should be drained a minimum of 18 inches below the depth of tillage.

The soil should be given some time to drain following rain events before tilling to minimize the break down of soil aggregates. Soil aggregates help maintain soil tilth, drainage, and aeration. To determine when the soil is dry enough for tillage, pick up a handful and squeeze it. If the ball of soil in your hand falls apart when poked, the soil is dry enough. If it stays together in a ball, the soil is too wet for tilling. The same approach should be followed for entry into the garden areas. Soil compaction from foot impacts can occur when the soil is too wet. Compaction is currently evident on the pathways around the park.

Flooding Management and Drainage System

On a site visit January 28th, 2021, it was observed (see photo below) that the river was flowing a few feet below the general field elevation, even though there were significant areas of standing water in the fields. To optimize crop production from perennial crops or during the shoulder seasons of late fall and early spring, the property would benefit significantly from the installation of a sub surface drainage system. There may be subsurface drainage installed by previous farm property owners, however, this system if it exists, may have failed over time.

The presence of excess soil moisture is the main cause of soil compaction. The cultural practice with the greatest potential to reduce soil compaction in much of the humid areas of British Columbia is the use of subsurface drainage. The whole soil is more easily deformed, and soil particles can be forced together when subjected to external pressure when they are wet. In saturated soils, the soil particles are dislodged and subsequently redeposited in a dense, layered form. Wheel ruts and tillage pans formed in soft wet soils can be seen to influence crop growth long after any excess soil moisture is gone. Drainage systems can be designed to prevent saturated soil conditions thereby greatly reducing soil compaction problems. (R.A. Bertrand et al., 1991)

A new subsurface drainage system should be installed if changes are planned in crop types to be grown at E. Wellington Park. This will provide the best solution to improving imperfectly drained areas if installed properly. On these imperfectly to moderately well drained soils, drain placements at a depth of 100 to 120 centimeters (39 to 47 inches) at 20 to 25 metre (65 to 82 feet) intervals, would dramatically improve drainage.

Alternatively, or in combination with subsurface drainage, an interception ditch can be located at the toe of the slope, adjacent to the trail.

Figure 17, January 28th, 2021, photo of field water levels

Recommend that the ditch be a minimum of 1-metre-deep, constructed along the base of the trail to improve drainage along the east side of the field. The ditch could be connected back into the millstone at the south east edge of the property or could be connected back to the millstone with a subsurface drain. For purposes of safety a gentle slope should be created out of the field side of the ditch. On these loam to silt loam soils ditch side slopes should be 1.75:1 or less. Likely any ditching could be used to raise portions of the property to improve field elevation or fill low lying areas to expand garden beds. To minimize soil compaction this work should be done at the driest time of the year (July to September). See Appendix 6 for design details.

Figure 18, 1999 orthophoto showing wet areas.

The 1999 orthophoto clearly indicates the areas of superior drainage along the northern and southern portions of the property. Refer to the B.C. Agricultural Drainage Manual , to plan out subsurface drain requirements and installation at E. Wellington Park (Lalonde and Hughes-Games, 1997) https://www2.gov.bc.ca/gov/content/industry/agriculture-seafood/agricultural-land-and-environment/water/drainage/agricultural-drainage-manual

Agricultural practices

Current forage crop

The current forage production system of a single early summer harvest optimizes soil organic matter, minimizes soil compaction and is ecologically friendly. The perennial crop cover provides nesting and foraging habitat for ground nesting bird species such as the Savanah sparrow. It also provides habitat for reptiles, voles, and mice. Small mammals are a food source for birds of prey. Fall regrowth of the forage crop helps protect the soil from erosion during winter and early spring flood events.

The hay field is generally hayed in mid to late July. On July 14th, during the soil and vegetation survey, grassland nesting birds were in evidence in the area. Haying in late July or when the young have fledged would increase the nest success of these species. Use of flushing bars on mower equipment is strongly recommended to reduce wildlife mortality while haying. Flushing bars have been found to reduce death of grassland nesting birds and hiding fawns (Champe Green, 2017)

The low-lying areas of the property, mapped as area 3, which are dominated by a current forage cover of Reed Canary grass, Tall fescue, Bentgrass, Sweet vernal grass, Velvet grass and Vetch likely should continue to be managed for forage production. Few tree or shrub species, with an annually harvestable crop, would prosper on these imperfectly drained soil areas without land improvements such as elevational increase provided by fill, mounding and drainage.

Crops and high-water levels

Perennial shrub and tree species

Only those perennials less sensitive to flooding should be considered. By creating raised bed planting areas, mounding the soil 6 inches to 1 foot above the surrounding soil, can result in improved drainage for shallow rooted species like blue berries or fully dwarf apple trees. Examples of tree and shrub perennials that may withstand some flooding during the coolest season of the year follows. See appendix 3 for more information on perennials. Perennial crop species may also be well suited to planting in the riparian buffer area. See section on riparian buffer.

Annual crops such as field vegetables

All annual crops suited to the region can be grown and can be planted once frost risk has passed and there is at least 6 inches of drained soil above the water-table. Note the soil lab analysis indicates a soil pH of 6.3, close to neutral, suited to a wide range of crop production.

Crop production showcase – Perennials

Table 6, Crop production showcase

Crop to be grown	Crop notes	Production challenges
Apples on dwarf rootstock	Grow on a raised bed, at least 1 foot high by 4-foot diameter for drainage	Crown and root rots (Phytophthora), Support system may be required. Deer fencing and rabbit guards required.
Blueberries	Grow on a raised bed, at least 1 foot high by 4-foot diameter for drainage. There are more flood resistant varieties available	Fencing for rabbits and deer recommended, lower the soil pH with elemental sulfur to 5.5
Hazelnuts / Filberts	Likely can be grown on the whole property by may not be	Grow Easter Filbert Blight resistant varieties

	productive on the lowest, wettest areas	
Quince & Pears	Can withstand some flooding and wet soils, could be used as a rootstock for pear production	Quince is suited only to processing.
Western crabapple	Can withstand some flooding and on wet soils, may be used as a rootstock for apple production	Crab apples are used mostly for canning and other processing such as in cider blends. Deer fencing and rabbit guards required.
Western Service Berry / Saskatoon	Most consumers prefer blueberries over saskatoons. There is a productive saskatoon orchard in Cobble Hill	Requires some irrigation or the berries will be dry and of low flavor. Deer fencing required.

Other perennials:

The following species should only be grown on the highest elevational areas with relatively good drainage and with raised beds. During years with extreme high levels of flooding, crop die off may occur.
Artichokes – early weed control is necessary as they are slow to germinate.
Asparagus (put slug bait out early).
Strawberries - There are 3 classes of Strawberries:
• June bearing (summer bearing) strawberries produce one large crop in June.
• Day neutral strawberries fruit continuously throughout the summer and into fall.
• Everbearing (two-cropping) strawberries produce a crop in June and another in early fall.
Flowers and nursery tree production. A wide diversity of species is suited to the region. Both perennial and annual flowers are a major attractant to pollinators and can also provide a marketable crop.
Kale (really a biannual) is productive in the late fall and early spring.
Rhubarb – should have a foot of drained soil in the early spring.

Crop production showcase – annuals

Any of the annual crops suited to the region can be grown successfully on the site. Early season planting or late season harvesting would only be suited to the higher elevation, better drained areas. The growing of annual crops will not be compatible with supporting the Savannah sparrow and other ground nesting birds but can support an increased diversity of pollinators with the growing of flowering species in the vegetable areas.

Table 7, crop production showcase, annuals

Crop to be grown	Crop notes	Production challenges
Beans (Pole, Snap)	Require warm soil temperatures (16˚C) for germination	To get an early start on pole varieties grow plant starts and plant out at the two true leaf stage.
Beets	Sow seed 1.5 to 2.0 cm deep in rows 30 to 38 cm apart. Precision seed or thin to leave 5 to 7.5 cm between plants. Planting soil temp -10 ˚C	Require good weed management until plants are 2 inches high. All root crops may require vole management if living mulches are grown.
Broccoli and other cole crops (Brussels Sprouts, cabbage, Cauliflower)	Best grown from transplants	Susceptible to severe losses from many pests. Crop monitoring encouraged.
Carrots	A chisel plow is recommended to work soils to a depth of 30 to 40 cm for good root penetration.	Carrot rust fly-requires floating row covers or a spray program most years. Monitoring with traps is encouraged.
Cereal grains	Only spring seeded due to winter flooding	Lowest, wettest areas would require later seeding
Corn	High nitrogen feeder	Will shade other crops
Cucurbits	Cucumber, Muskmelon, Pumpkin, squash…	A black plastic or wavelength selective mulch provides excellent weed control and other benefits. Broadleaf weed control with herbicides is very difficult in vine crops.
Dill and other herbs	Many different herbs are suited to the region	Early weed control is essential, monitor for pests.
Onions	Dry bulb or green onions	Monitor for insects and disease
Eggplant	Use transplants for best results	Mulching with plastic is recommended
Garlic	Planting must be done as early as soil and weather conditions allow in the spring or plant on the highest ground in raised beds before November	Mulching with straw, tree leaves, or compost is great for weed control. Buy cloves for planting free of white mold and be sure not to bring it into the garden.
Leeks	Leeks cannot withstand flooding – select higher dryer areas	Transplanting is recommended, select the right variety for the expected planting date.

Lettuce and other greens	Direct seeding or transplants are effective depending on target harvest dates.	Suited to well drained soils with good moisture holding capacity, similar to the higher Chemainus soils.
Parsnips	Plant early	Preemergent and early weed control is critical. Monitor for carrot rust fly.
Peas Including Sugar Snap types	Peas will germinate at soil temperatures above 4 ˚C	As Peas are nitrogen fixers no nitrogen fertilizer should be needed if the seed is inoculated.
Peppers	Transplants are strongly recommended.	Hardening of transplants is necessary. Plasticulture provides many advantages
Potatoes	50 g seed pieces are planted 30 cm apart in 90 cm rows. Spacing will vary according to variety and local conditions	Barnyard manures at rates of 22 to 45 tonnes/ha (10 to 20 tonnes/acre) or poultry manures at 11 to 18 tonnes/ha (5 to 7 tonnes/acre) provided they do not contain excessive amounts of shavings or sawdust are desirable in that they provide extra nutrients and maintain organic matter.
Radishes	Use hot-water-treated seed to avoid introducing soil born diseases. Drop 21 seeds 15 mm deep every 25 cm of row. Space rows 20 cm apart	Avoid planting radishes after radishes in the same year. Burry crop remains or remove them from field after harvest to prevent carry-over of diseased refuse, control volunteers and wild radish.
Specialty vegetables	A variety of vegetables that are traditionally associated with regions outside of North America.	Cultural practices to reduce disease problems include: Crop rotation of at least 3 years. Use resistant varieties (if available). Use certified disease-free seed or hot water seed treatments. Use healthy transplants grown in clean plug trays and sanitized greenhouses. Control disease vectors such as aphids and weed hosts. Rogue out infected plants. Avoid moving in the field when foliage and soil are wet (to reduce the spread of bacterial diseases). Reduce overhead irrigation. Deep-plow crop residues into the soil. Eliminate cull piles.
Spinach	Spinach bolts quickly (produces flower stalks) under long-day and warm-	Maintaining high soil organic matter is important for good production.

	weather conditions. This explains why the crop is produced mostly in the spring or fall when temperatures are cooler, and the hours of daylight are shorter. Varieties differ in their susceptibility to bolting.	
Tomatoes	The tomato is a warm-temperature vegetable and requires a long growing season. Transplants are necessary.	Harden transplants for about a week before transplanting to the field by slightly reducing the moisture and maintaining approximate outdoor temperatures.
Turnips	For summer harvest, sow as early in the spring as possible. For later harvests sow up to the 7th of June.	The use of hot-water-treated seed is a precaution against blackleg and black rot.

Crops produced in relatively large volumes in British Columbia include potatoes, sweet corn,

Cole crops (such as broccoli, Brussel sprouts and cabbage), beans, cucurbits (such as pumpkins, squash, and zucchini), lettuce, carrots, and peas. Refer to the B.C. government production guide for vegetables: https://www2.gov.bc.ca/gov/content/industry/agriservice-bc/production-guides/vegetables. Also see the Oregon State Extension website for growing tips and crop suggestions in the Pacific Northwest. :https://extension.oregonstate.edu/gardening/vegetables/growing-vegetables-pacific-northwest-coastal-region. Note: not all species suited to Oregon will do well on Vancouver Island, without greenhouses, tunnels, or plastic mulches.

Winter gardening or greenhouse production can contribute to significant season extension or year around production. Low light and temperature are the limiting factors to late fall and winter production. Greenhouses could be considered in the gravelly area near the road. Wastewater from greenhouses may need to be managed either with a small pond using aquatic plants to cleanse the water or a water recycling system (J. West, A. Huber, C. Carlow, 2018). https://www.flowerscanadagrowers.com/uploads/2018/04/guidance%20document.pdf and W. Prystay & K. V. Lo (2001), Treatment of greenhouse wastewater using constructed wetlands, Journal of Environmental Science and Health, Part B,36:3,341-353, DOI:10.1081/PFC-100103574.

Producing fruits and vegetables in the late fall to early spring should only be considered on the highest and driest areas of the fields. BC Farm and Food lists vegetables that can be grown in the winter at https://bcfarmsandfood.com/12-vegetables-you-can-grow-in-winter/. Westcoast

seeds vegetable planting chart for Coastal British Columbia is another great reference for year around (almost) production. https://cdn.shopify.com/s/files/1/0011/2341/8172/files/SM400-Vegetable-Planting-Chart.pdf?1519708249303731838

A crop rotation program is recommended to reduce weed, insect, and disease issues. This is especially important for field grown vegetables. West coast seeds covers this topic in a blog (MacDonald, 2021): https://www.westcoastseeds.com/blogs/garden-wisdom/crop-rotation corn, strawberries and flowers can be added to the list of 4 crop "families" to rotate.

Nutrient management of vegetable crops:

Based on the nutrient management calculator (appendix - https://nmp.apps.nrs.gov.bc.ca/) nutrients required to meet production of a 10-ton, mid season potato yield, are: 143 lbs. of nitrogen, 152 lbs. of phosphorous and 178 lbs of potassium. If organic sourced fertilizers are preferred, then poultry manure is likely the best source of nutrients. Recommended application rate is 12 tons of fresh broiler manure per acre to meet most crop nutrient requirements except for potassium which would be low by 58 pounds and should be supplemented by muriate of potash at (0-0-62) at 100 lbs per acre. Composted manures would lose nitrogen during the composting period and therefor would require heavier applications. Testing of the nutrient content of compost is recommended.

Crop Development Areas

Figure 19, Air photo identifying agriculture development areas.

Community Garden, Greenhouses and Buildings

The compact gravelly area in the North East corner of the field would be the best location for a community garden with raised garden beds, greenhouses and potentially a washroom and equipment storage building. This site provides close access off E. Wellington Rd, and opportunity for field access beyond if this area is fenced separately and gated. The compact gravelly area is approximately .38 ha or .94 acres in size. The greenhouses are best suited to the

south west end of this site for better access to sunlight. The washroom and equipment storage building are best located on the North East corner to reduce shading of proposed raised beds.

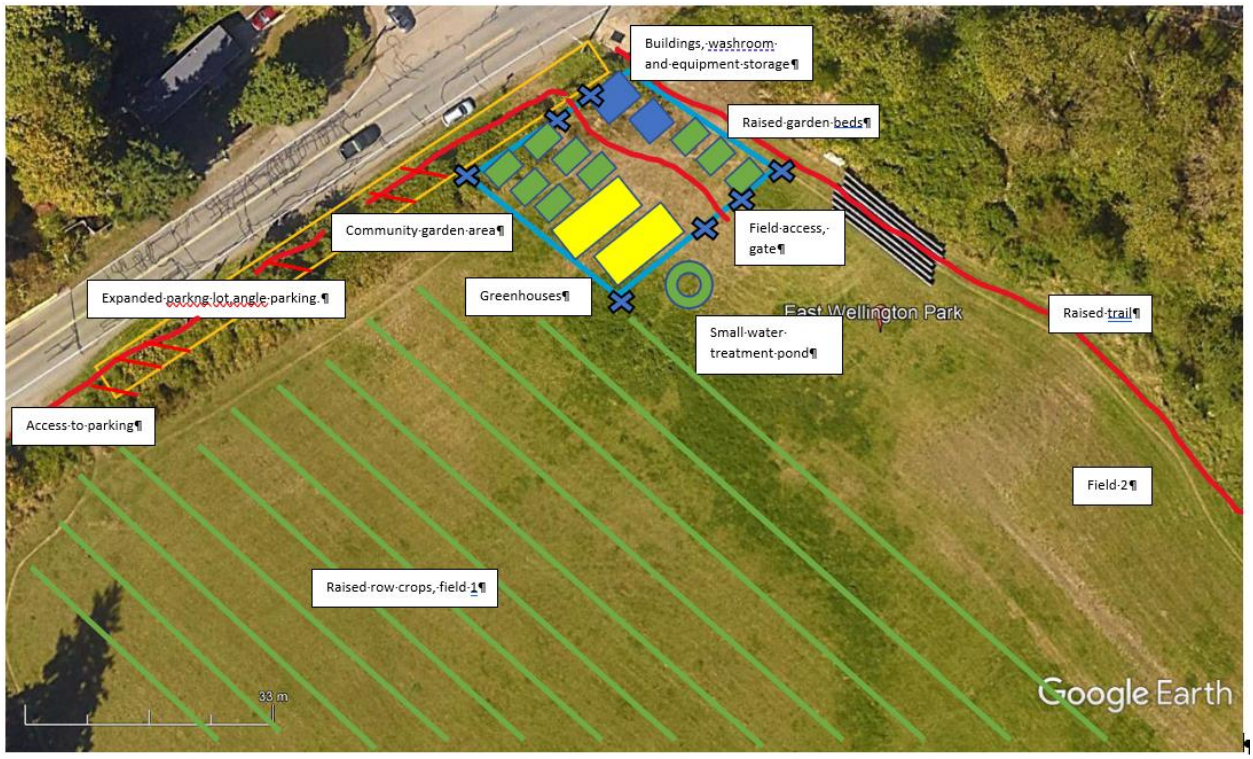


Figure 20, Community Garden, Infrastructure, expanded parking, and proximity to Field 1 and 2.

Area 1

Area 1 is recommended for initial development as it is the highest, driest portion of the property. It also has some of the best internal soil drainage on the property. This area is well suited to growing a wide range of perennials as well as annuals early in the spring and late into the fall. This area is currently 1.17 ha in size. It is strongly recommended that the riparian buffer in this section not exceed 10m to maximize the area available for crop production on the best site. However, if the 30-metre buffer is absolutely required along the river then it is recommended that 20 metres of this buffer include perennials like Filberts, apple trees or floriculture shrubs (see perennial crop recommendations). To minimize shading of the garden areas, only lower growing vegetation should be grown in the 20m crop buffer. Shade reduces crop productivity and increases plant disease risks. The shade impacts would be quite substantial on the E. Wellington field due to the river lying south west of the field. See above ortho photo and shading into the field from tall trees in the current riparian zone.

Area 2

Area 2 is suited to late spring and summer annual vegetable production. Installation of sub surface drainage would dramatically improve the range of crops that could be planted in Area 2. With drainage, there is opportunity to plant flood tolerant perennials on raised mounds or earlier spring to later fall crops of annuals. As there may be some high water, and overland flow

in this area, a cover crop must be grown in the late summer and irrigated to insure germination and growth into the fall. Frost tolerant species like fall rye, winter wheat, vetch or Austrian winter peas should be grown. Fall grown cover crops are strongly encouraged to maintain cover during winter months to protect the soil from erosion and to provide organic matter in the spring when tilled.

Area 3

Areas 3 is subject to significant overland flow during high water levels. There is a depressional area here that stays wet longer. The current perennial forage crop planted here is well suited to this site and helps reduce erosion risks. Alternatively, if annual crops are grown, manage this site with improved drainage, crop mounding, and plant suitable cover crops in the late summer, but before September.

Area 4

Area 4 is slightly less at risk of overland flow and prolonged flooding. It can be treated similarly to Area 2 for soil management requirements.

Area 5

Area 5 has a depressional area in the middle that stays wet longer into the growing season. This area is suited to forage production.

Elevation increases of low areas using fill.

If any excavations are made for a new side channel, smaller fish habitat channels or ditching for drainage purposes, then the priority for excavated material is within the more intensive farmed areas and low-lying areas. Ideally garden area 2,3 and 4 would be raised 30 to 60 cm above the surrounding area, and garden area 1 should be raised by 30 cm.

Area and height of filled area from pond excavations Note the surface soil layer can be placed directly on top of the area to be filled while the topsoil must be peeled back from areas to be filled with subsoil and then replaced above the subsoil.

Volume of material from off channel pond excavation	Area that can be raised 6 inches (15 cm)	Area that can be raised 12 inches (30 cm)
Pond 1: 1200m^3	2 acres, (8000m^2)	1 acre, (4000m^2)
Pond 2: 1200m^3	2 acres, (8000m^2)	1acre, (4000m^2)
Pond 3: 1200m^3	2 acres, (8000m^2)	1acre, (4000m^2)

Best Management Practices (Regenerative and permaculture practices)

Table 8, Best Management Practices

Best Management Practice	Management Considerations	Benefits of Practice

Cover crops	Good site preparation and seeding prior to rains. Irrigation will be needed for seed germination and some time in the year.	Reduced soil erosion, increased soil organic matter, smother weeds, increased forage for pollinators and increased soil organism biodiversity
The addition of organic matter (compost, straw, living mulch)	Adding organic matter takes time and expense, living mulches are the least expensive option but may compete with crops	will maintain or increase soil organic matter levels, aiding in carbon sequestration and improving soil tilth
Minimize tillage, especially with a rotovator	Select tillage methods that minimize pounding of soil aggregates, i.e., cultivator	Minimizes soil aggregate breakdown, maintaining soil aeration and drainage, maintains high organic matter levels in the soil
Timing of tillage – always wait after rain or flooding until surface soils are sufficiently dry. Water table at least 12 inches below the surface before light tillage.	Sufficiently dry soils minimize soil compaction and maintain soil aggregates, see appendix XXX for when soil is sufficiently dry for tillage	Soil aggregates and soils without compaction optimize root penetration, soil aeration and drainage
Plant a diversity of flowering plants	Seed can be expensive, requires planning and time	Increases pollinator biodiversity
Balanced fertility, nutrients added at the right amount for optimizing crop yields	Requires planning to estimate crop yields and expected nutrient demand as well as nutrient release from tilled in cover crops	Minimizes nutrient loss, particularly nitrogen. See Appendix XXX for measuring nitrogen added from a tilled in cover crop. For detailed information on cover cropping also see: https://www.sare.org/wp-content/uploads/Managing-Cover-Crops-Profitably.pdf

A raised bed system	Time consuming to create, creative tillage practices needed to maintain raised beds.	Improved soil drainage resulting in warmer soil and earlier crop germination/growth. Can impede overland water flows. Reduced nitrous oxide release from saturated soil and excess nitrogen.
Sub surface drainage system	Expensive investment for the long term	Improved soil drainage resulting in dramatically warmer soil and earlier crop germination. Can dramatically increase the diversity and area of perennial crops. Reduced nitrous oxide release from saturated soil and excess nitrogen
Legumes and nitrogen fixing cover crops	Require tilling or rolling, well before nitrogen becomes available	

Regenerative agriculture

Regenerative agriculture is a term used by advocates who are dedicated to promoting soil regeneration to mitigate climate change, restore biodiversity, improve water cycles, and support a healthy food system (Regeneration Canada, https://regenerationcanada.org/en/)

The term regenerative agriculture does not have a widely accepted definition. However, the principles of regenerative agriculture have been described as: use of cover crops, the integration of livestock, reducing or eliminating tillage to improve soil health, to sequester carbon, and to increase biodiversity (P. Newton et al., 2020).

The current grass/forage system supports the concepts of regenerative agriculture except for supporting a more diverse and productive healthy food system. Note that the current high-water table and flooding contributes to a low population of earthworms in the soil which likely contributes significantly to the current high organic matter levels in the soil (earthworms are a major contributor to soil organic matter decomposition when present in large numbers). While feeding on soil organic matter they improve soil aeration and drainage, but this process releases carbon dioxide trapped in the soil. Overall, the researchers have determined that earthworms' burrowing causes a 33 percent increase in carbon dioxide emissions, and a 42 percent increase in the emissions of another greenhouse gas, nitrous oxide (I. Lubbers, v Groenigen, K. Fonte, 2013, *Nature Climate Change*).

Mitigate climate change.

The addition of organic matter (compost, straw, living mulch) will maintain or increase soil organic matter levels, aiding in carbon sequestration. If crop nutrients are added at or slightly below levels required to optimize crop yields the release of nitrous oxide should be minimized. Also raised bed systems and the resultant improved drainage for the growing crop will contribute to reduced nitrous oxide release. Nitrous oxide tends to be released when there is a source of nitrogen available that is subjected to high soil water content contributing to denitrification. Fertility for crop production should be balanced to minimize the build-up of any nutrient, of concern is phosphorous and nitrogen which can contribute to anoxic conditions in slow moving water bodies.

Cover Crops.

Fall cover crops are consistent with regenerative agriculture and permaculture practices and provide significant benefits to soil tilth and long-term crop productivity. They add significant organic matter to the soil which aids in maintaining soil aggregates. Soil aggregates are part of good soil structure and support soil aeration and drainage.

Fall cover crops should be considered the ultimate best management practice as they also dramatically reduce the risk of erosion if there is an overland flow of water. The soil must be well prepared with moisture conserving techniques such as harrowing or raking, following tillage, and seeding the cover crop well before mid September regardless of whether the crop has been harvested. At the very least, strips of cover crops should be established well before fall rains occur.

The current forage crop at E Wellington Park and gardening is environmentally friendly. The soil profile shows soil organic matter levels that range from good to excellent. There are other strong indicators of soil health. However, if it is desirable to utilize the property more intensively for food production that is directly edible by humans, then regenerative and permaculture approaches to gardening should be considered.

When possible, winter cover crops consisting of winter wheat, Austrian winter peas, fava beans, vetch and fall rye should be planted in all fields except for strawberry fields and plowed down in the spring. Fall seeded crops are generally planted in September. This presents a challenge since many of the farm's crops may not be harvested until late into October. Fall rye and Fava beans will germinate down to temperatures of 2 degrees Celsius for later season planting. Austrian winter peas require 5 degrees C to germinate, compared to 15 degrees C for Hairy vetch.

The smaller the seed, the more important a packed seedbed becomes to optimize seed to soil contact. Packing the seed into the seedbed is effective for optimizing germination. Seeding depth should reflect seed size, smaller seeds, shallower depth. Fall seeded crops, such as fall rye, when it has sufficient growth, will capture residual soil nitrates preventing leaching to groundwater and loss to the environment. For example, the 10 ppm of nitrate-N residual in a

strawberry crop in October would likely be lost with fall and winter rains without a cover crop.

Excellent cover crops can replenish soil organic matter for the benefit of subsequent crops. 40 to 90 % of the nitrogen in the cover crops is available to the following crop. The percent of N available depends on the percentage of N in the cover crop, with lower N content cover crops releasing a lower percentage of their N than higher N content cover crops (D.M. Sullivan and N.D. Andrews, 2012).

In order to calculate the availability of nutrients following a cover crop, Oregon State University (OSU) recommends harvesting samples i.e., 2ft x 2ft, weighing them and shipping a subsample to a lab for analysis. See table below for details. The Ministry of Environment Lab in Victoria: https://www2.gov.bc.ca/gov/content/environment/research-monitoring-reporting/research/analytical-lab will analyze samples for $20 per sample.

Row planting of vegetables with a cover crop of legumes planted between the rows can be done in the spring at the time of seeding. These strips can be mowed through the growing season to keep weeds down or they can be left to flower to provide valuable bee pollination habitat. They can be left over the winter to reduce soil erosion. Then in the spring a narrow tine rototiller can be used to cultivate the planting row between the strips for spring seeding or if organic matter is in demand, then cultivated and replanted.

Figure 21, clover crop planted between rows of corn.

Figure 22, photo showing clover and brassica crop

A similar model uses mulch between the rows.

Figure 23, photo showing mulch and row vegetables, raised bed.

Over irrigation during the growing season should be avoided.

To maintain high organic matter levels in the soil, not only can organic matter be added, but tillage, especially tillage with a roto tiller should be minimized. Tillage with a roto tiller

pulverizes soil particles and aerates the soil increasing organic matter breakdown, decreasing drainage especially below the “plow pan” (a compacted layer that forms at the depth of repeated tillage).

Restore biodiversity:

While the current forage production system supports a healthy population of ground nesting birds it is less supportive than a garden could be of native pollinators, especially if a diversity of flowering plants is grown. The addition of organic matter and raised beds should increase soil biodiversity of organisms. Generally, the garden areas will support populations of the Pacific Chorus Frogs and other species like garter snakes, swallows, and dozens of native bee species. Locate nest boxes, and blue orchard bee houses in strategic areas to encourage bees and birds.

Pollinator Plants to Support BC Bees

By planting native flowers, plants and herbs, habitat can be created in the garden to help rebuild threatened bee populations. Canada has 800 species of native bees, ranging from tiny black foragers to blue orchard bees and yellow-striped bumblebees. The survival of these important pollinators is essential to the reproduction of approximately three-quarters of the fruit, nuts, vegetables, and herbs we eat (BC Farm and Foods, July 16, 2013. https://bcfarmsandfood.com/plant-a-bee-attracting-garden/) The article on bees and planting for bees by BC Farm and Foods has a list of pollinator species that can be planted to attract bees. These can be grown in rows beside the vegetables or intermixed.

Improve water cycles:

A raised bed system, along with growing flood tolerant perennials will contribute to earlier planting in the spring and later crop growth in the fall, when natural precipitation can sustain crop growth. However, to optimize yields and in fact make gardening viable, irrigation would be required. Organic mulches also reduce evaporative losses, reducing the need for irrigation, except for living mulches. Irrigation will be necessary for establishing cover crops, to minimize soil erosion, and optimize soil organic matter.

Support a healthy food system:

Gardening provides food for local consumption, reducing the need for long distance trucking and its associated greenhouse gases (nitrous oxide and carbon dioxide). It also helps develop a greater sense of community.

Permaculture systems:

Permaculture can be understood as the growth of agricultural ecosystems in a self-sufficient and sustainable way.
This form of agriculture draws inspiration from nature to develop synergetic farming systems based on crop diversity, resilience natural productivity, and sustainability. Still, since the early 1980s, the pre-conceived idea of permaculture extended to a systemic approach that goes far

beyond the agricultural domain. Nowadays synonymous with *permanent culture* in its broadest sense, permaculture is a global ethic method for designing integrated systems based on the idea of sustainable development. Therefore, human activities must consider natural ecosystems and operate in harmony with them.

Permaculture Design: The Principles and Techniques of Permaculture

Based on the precise observation of how ecosystems work (particularly in terms of productivity and efficiency), permaculture draws on non-fixed modes of design that are adaptable to the fields of application. The result is a method of universal principles known as permaculture design. The permaculture design (the word "*design"* here includes the notions of project and process of realization) is set up from three founding ethical requirements**:** Preservation of the environment and biodiversity; willingness to build a community for individual and collective well-being; and sharing of resources and equitable redistribution of excesses (for the benefit of humans and the environment).
Permaculture design implements many solutions inspired by scientific ecology, biomimicry, and empirical practices developed over the ages by traditional societies. For example, permaculture in Agriculture might involve no-till practices that ensure the preservation of soil balance and long-term fertility.
See appendix 4 for more on Permaculture and Regenerative agriculture.

Example Farm Model:

One excellent example of a model farm in Victoria is the: Haliburton Farm on 7.22 acres that leases properties to member farmers. Plots are generally 1 acre in size and are leased for a 4-year period with possibilities for renewal. The farm property has a 7-foot-high deer fence and metered water available to each plot. The lease also features a shared farm marketing stand and vegetable washing area. Some plots have greenhouse facilities and or perennial crops. See appendix 5 for details.

Community Farm and Research Opportunities at E. Wellington Park.

Several Agricultural Production Objectives are listed in the Biophysical Assessment &User Group Land Review report. These are:

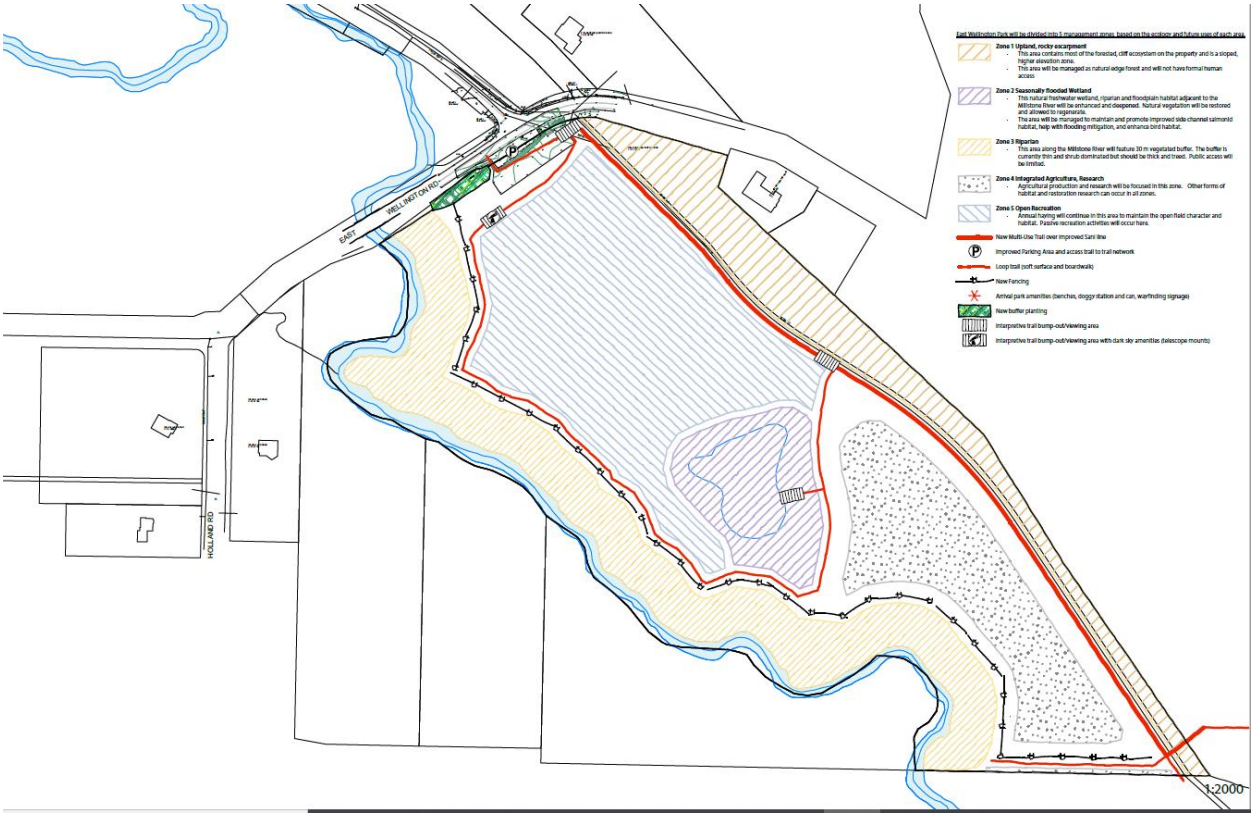
1) Facilitate ecologically sensitive agriculture and horticulture opportunities within the park.
2) Focus on agriculture and horticulture practices that respect the ecological values of the park.
3) Research into feasible agriculture and horticulture uses for the site is supported.
4) Collaborate with other agencies and community groups.

a. Use and research agreements with Vancouver Island University, Nanaimo Food Share, and/or other community groups focused on agriculture and horticulture, is encouraged.
b. Maintain ongoing communication with the Agricultural Land Commission regarding park uses in relation to their mandate to preserve agricultural land and encourage farming. (S. Bonner, 2018).

Farm Share, the Vancouver Island University (VIU) and other community organizations may be potential partners with the City of Nanaimo for the development of the East Wellington Park Farm property. Currently Farm Share is leasing a portion of the Cline farm property which lies adjacent to the City's property to the south. Benefits of partnerships with other organizations could include sharing knowledge, information, equipment, water, field access, farm workers, funding and more. VIU has a nine-month horticulture technician program. The City of Nanaimo has identified opportunities to partner with the University to create and advance research at the park. This could combine agriculture and environmental studies.

Potential impacts of proposed park activities on farmland:

Proposed Uses of E. Wellington Park



Planned uses of E. Wellington Park, map supplied by City of Nanaimo.

Proposed expansion of parking area

There is an area of approximately 0.38 hectare (.94 acres) at the field entrance in the northeast corner. A portion of this area could be dedicated to expanding the parking lot, providing a public toilet, perhaps a covered shelter area for a picnic site and developing a secure building for storage of equipment associated with farming. This area is currently compacted and gravelled likely due to past uses of the site including construction of the sewer line and access. Access to this area could be from the current parking lot and angle parking would keep the footprint small and along E. Wellington Rd. The parking lot could also be used to access the proposed community garden site, buildings, greenhouses, and fields beyond.

Proposed raised walking trail:

The raised walking trail will be located along the sewer line. As such it will have minimal impact on the farmable areas of the property. Consider minimizing the width of the trail so that it does not overlap the current crop area.

Proposed riverside walking trail: 3-5m wide adjacent to riparian buffer.

The proposed park riverside trail would remove another 3-5m of farmland for the length of the property on the west side. This would amount to x ha. If the side channel ponds are also constructed, then the buffer and walking trail if located on the outside of these, will reduce the farmable area much further. Consider the following: minimize the width of the walking trail to avoid excess overlap with the crop areas and consider locating the trail within the riparian buffer area.

Proposed Fence

If more intensive crops are to be grown at E. Wellington Park, fencing will be necessary to protect crops from deer, and possibly rabbits. A seven-foot-high deer fence is recommended. This fence can be located between the 10m native riparian buffer and the 20m crop species buffer. The walking trail is then best located outside of and adjacent to the fenced area. Poultry wire may be necessary along the bottom of this fence where annuals are grown to protect vegetables from rabbits.

Proposed river buffer

Fisheries Act

There are three main sections of the Fisheries Act which could apply to farmland. These are: Section 35(1) which prohibits the harmful alteration, disruption or destruction of fish habitat unless authorized. Section 36(3) prohibits the deposit of deleterious substances into watercourses (deleterious substances could enter through unhealthy riparian areas). Section 38(4): requires reporting infractions of Sections 35 or 36. One way of reducing risk to fish habitat associated with farm practices that may fall under section 35 and 36 is to have effective buffers (BC Environmental Farm Plan Reference Guide, chapter 11, Stewardship Areas).

There is no current legislation requiring farmland to maintain a riparian buffer except in circumstances when farming practices and seasonal weather conditions would result in runoff of manure, fertilizer, or pesticides. In these circumstances, maintaining a minimum buffer is recommended, and this would generally be between 5 and 8m in width or greater depending on the farm activities. Buffers can be a combination of riparian vegetation and cropped land.

The current hayfield is approximately 9.39ha or 23.2 ha in size. A 30m riparian buffer is recommended for the Millstone River based on the classification of the River. However, if a 30-metre river buffer is removed from the crop land area there would be approximately 8.3 ha hectare (20.54 acres) left and available for farming. If the walking trail and fence with a width of 5m is located adjacent to this buffer and surrounding the field this would remove another 1500m and .75 ha unless the trail can be located within the riparian buffer zone. Expansion of the riparian buffer in places to a width of 30-metre may be excessive as a wide buffer on the north east side of the river provides the least benefit in terms of shade from the sun for fish species.

The north western area of the field (Area 1) has superior drainage, and the site is more suited to intensive agriculture such as vegetable crops. Here, especially, consider reducing the buffer to no more than 10 metres wide, for 135 metres, south east of the bridge, to retain a larger area of the best site for intensive farming. The buffer could be expanded to 30 metres south of Area 1 and in places is already 30m wide. Note: A 30m buffer will significantly reduce the area available for farming (figure 24 and 25 below shows E. Wellington Field with a 10-metre buffer and a 10m versus 30m buffer).

Figure 23, E. Wellington Park farm field and 10m buffer.

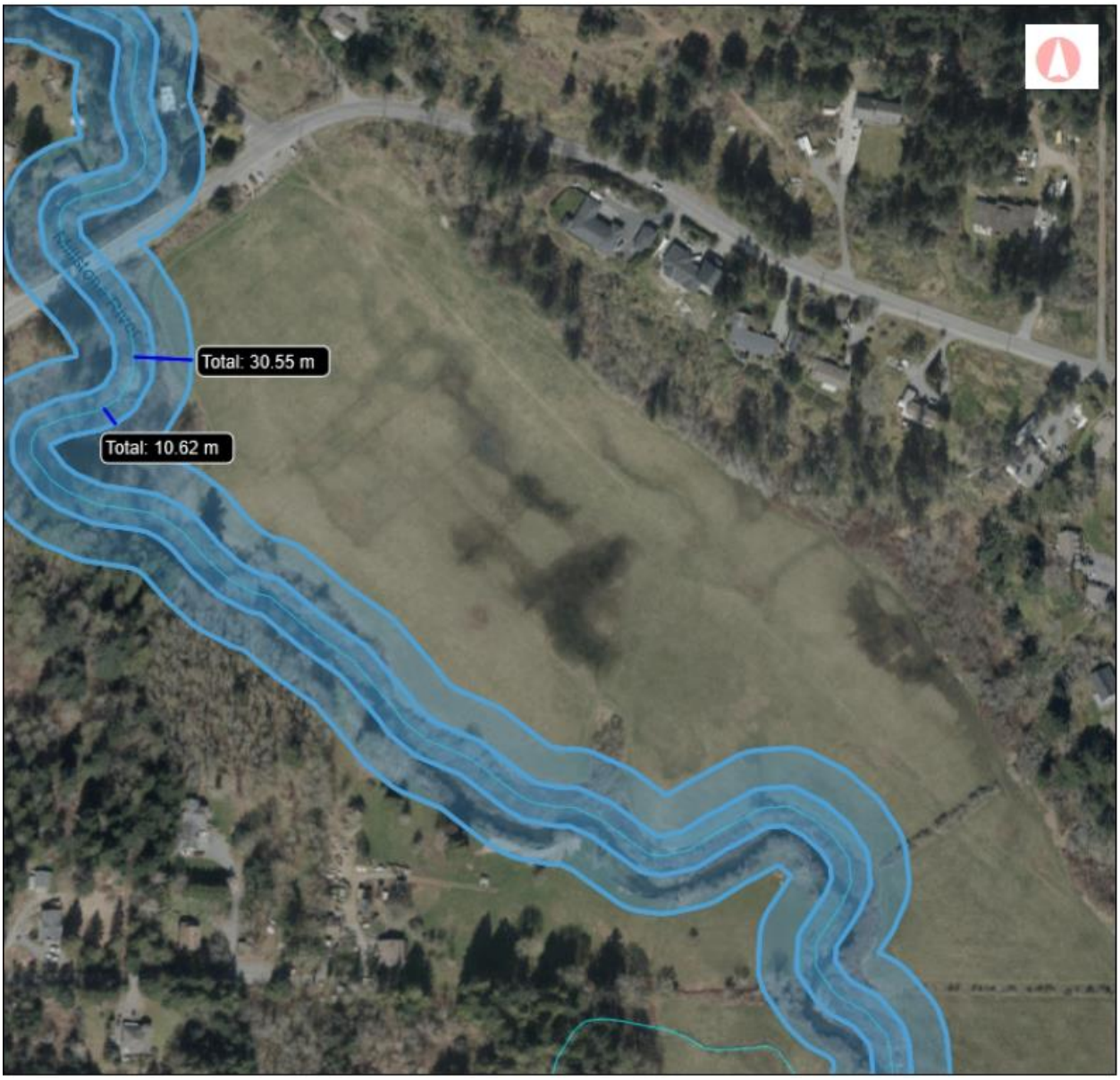


Figure 24, E. Wellington Park Farm field with 10m versus 30m buffer

Buffers can be designed to provide a mix of native riparian species closer to the river and perennial crop species further away. In this way farmable areas can be maintained while still achieving some of the functions of a buffer.

Agricultural use of riparian areas can occur when the function of the riparian area is maintained. Implement farm practices consistent with achieving properly functioning condition of riparian areas. For example, if livestock are well-managed, forages grown in riparian areas can be harvested by grazing such as in riparian pastures. Traditional crops that are planted, managed, and harvested appropriately can be grown in riparian areas, such as hay. Specialty crops that can be harvested by hand can be grown in riparian areas and can include floral crops

(pussy willow, contorted willow, ferns), medicinal crops (cascara bark, hawthorn leaves and fruit), food crops (fiddleheads, berries, nuts) and conifer boughs for the Christmas market. (BC Environmental Farm Plan Reference Guide, chapter 11, Stewardship Areas).

A 10m native buffer combined with a 20m cropped buffer is recommended for E. Wellington Park. This will maintain the function of a riparian buffer while limiting impact on the cropped area. It will also help control shading of crops to the east. Consider limiting height of riparian buffer species when selecting native and crop species to be grown within the buffer area. In addition, this model will allow better separation of cropped and uncropped areas

Proposed Side Channel and off Channel Ponds

An alternative concept that can be constructed independently or in conjunction with a side-channel is a single or series of off-channel ponds. The pond intercepts groundwater and backwater from the Millstone River. Higher flows during the winter months will increase the depth and area of the pond.

The ponds are connected to the mainstem roughly perpendicular to the bank on the outside bends. The ponds are 8 m wide, and 40 m long with bank sloped at 2H:1V. The banks and 15 m of the overbank will be planted with a mix of native plant species consisting of grasses, shrubs, and trees (deciduous and coniferous).

The pond's bottom is set to the top of the silty clay horizon, resulting in a cut of about 2.2 m. An approximate 1,200 m^3 of material is removed for each pond. To prevent turbidity issues, well-graded sand to cobble cap will cover the exposed silty clay material.

(Northwest Hydraulics Consultants Ltd., Feb 8, 2021).

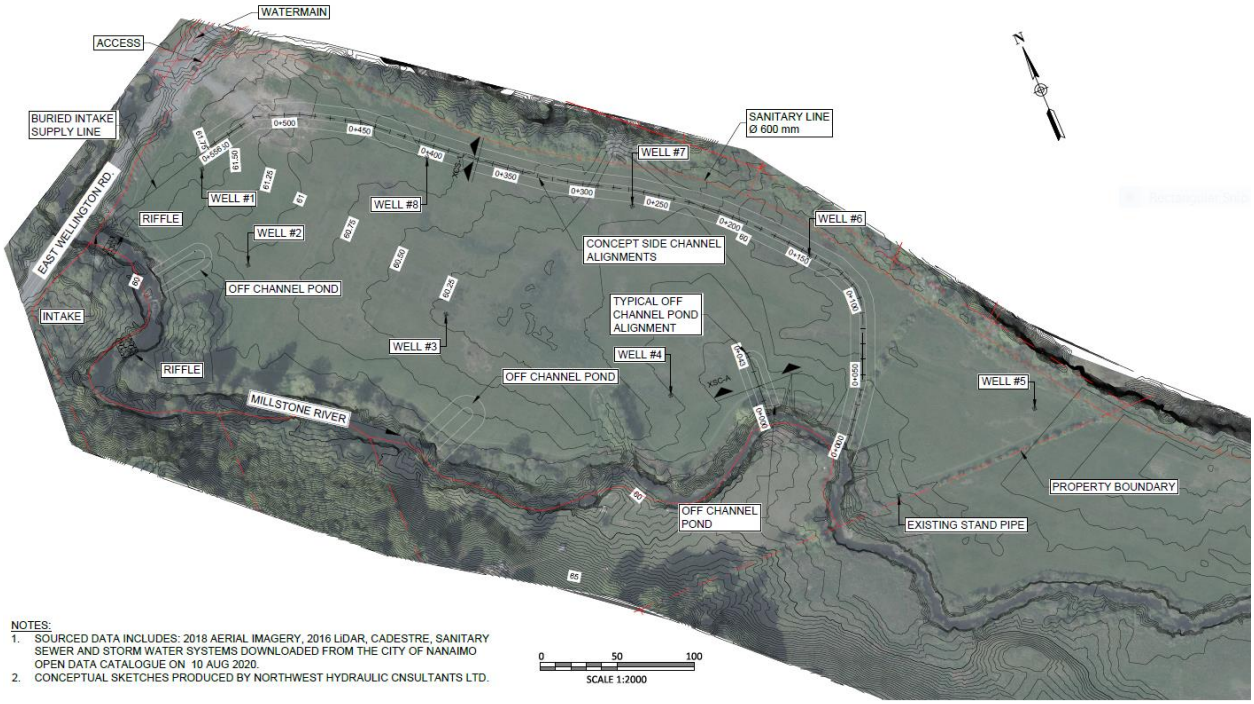


Figure 25, Diagram from Northwest Hydraulics Draft Engineering Report, Feb, 2021

The proposed off channel ponds, 3 in total would have the following impacts on Agriculture activities at E. Wellington Park.

Off Channel Ponds

Three off channel pond locations are shown in the engineering plan for E. Wellington Park. The channels are 40m long and 8m wide with a 15m riparian buffer around the perimeter. The E. Wellington field would be reduced to 7.5ha or 18.6 ha if all three channels are developed in combination with the 30m riparian buffer. The current wet areas of the field and the compact gravelly area near the entrance would reduce the farmable areas even further, down to 5 ha (12.39 acres).

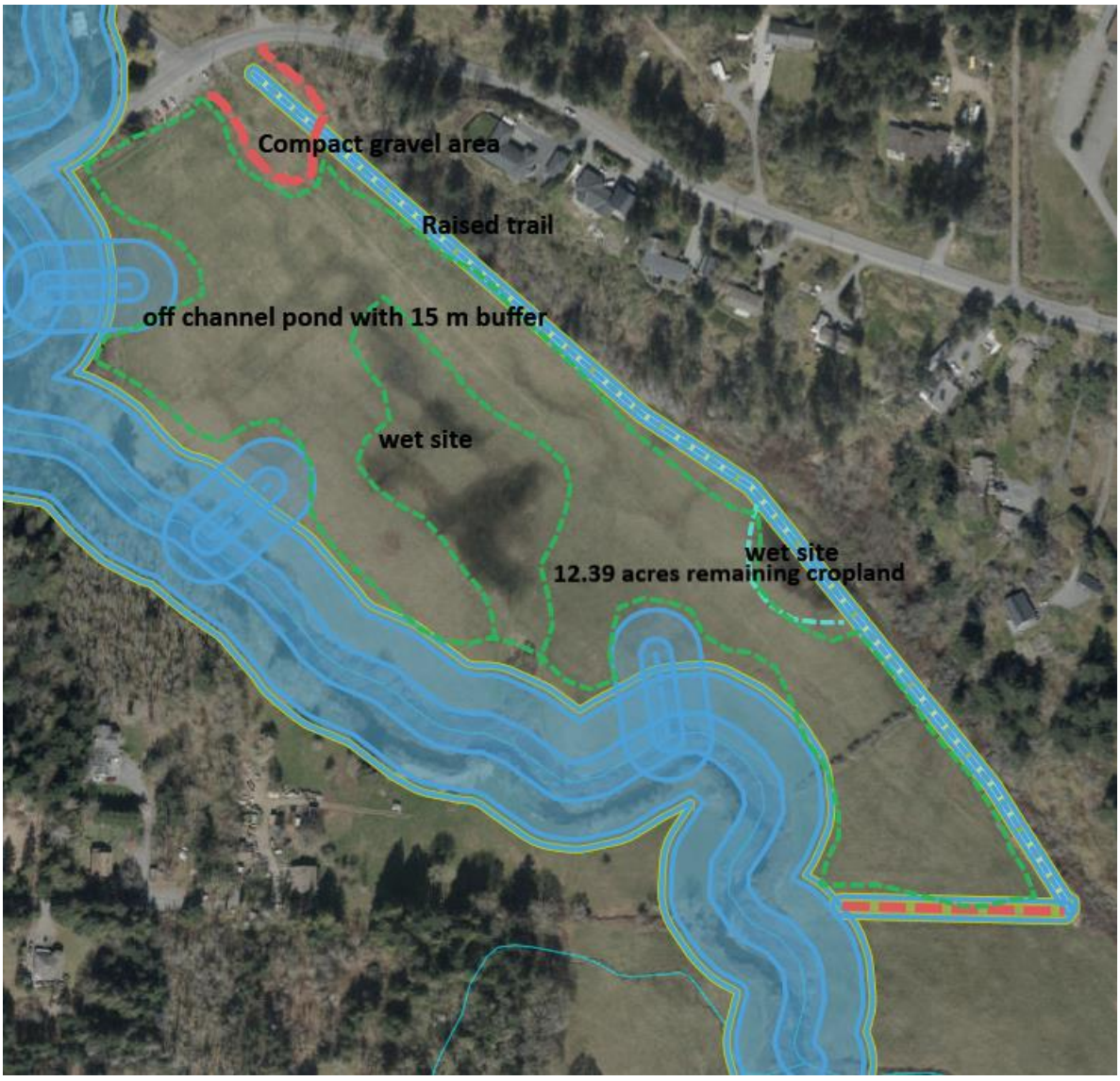


Figure 26, Field remaining after 30m buffer, 3 ponds, walking trail, compact area. and wet areas.

Off Channel pond in Area 1

This pond would have the highest impact on future agriculture activities. Area 1 is the highest elevation land and is less prone to lengthy seasonal flooding. It is here that more intensive crop practices are recommended. This area has the lowest risk of soil loss with annual cropping. Flooding would still occur but for shorter periods of time. Field area 1 is 1.2 ha. With the buffer and a side channel pond located here, this field would be reduced to about .9 ha and less with the walking trail and fence. It is not recommended to locate an off-channel pond in area 1.

The excavation of off-channel ponds can provide a benefit to agriculture. Approximately 1200 m^3 of soil will be excavated out of each pond. If this material is properly separated into topsoil and subsoil, then it can be used to raise the elevation of other areas. This is done by peeling back and stockpiling the topsoil on both the pond area and on the receiving site. Subsoil can

then be moved from the pond excavation to raise the elevation of the receiving site. After this is completed, the topsoil is carefully spread back on top. Failure to do this procedure properly can destroy the agriculture capability of the site. Area 1 should be prioritized for the relocation of some soil and topsoil, as this area is already slightly higher in elevation and less prone to flooding.

Off channel pond in Area 3

Area 3 is subject to overland water flow during the wet season.

If area 3 is kept in forage production a channel in this area might create an obstacle for farming and equipment. In addition, the proposed location may cut off access to the field and walking trail during the wet season as there is also a lower depression wet area just to the east of this location. Fill from the pond could be used to fill in depressional areas, raise the field elevation and or be used to construct planting mounds.

Off channel pond in area 5

Area 5 is subject to flooding and has a large depressional area in the middle that stays wet longer into the growing season. If forage crops are to be retained here, an off-channel pond may be an additional obstacle for equipment. Rather than creating a new pond in this area and relocating the fill, consider moving the proposed pond to the low depressional area just to the south.

Current off channel receiving site between area 3 and 5.

There is a lower elevation water receiving site located in the area between 3 and 5. This site, although it can be hayed later in the dry season, would not be suitable for more intensive cropping. It was discussed during the field visit, to locate one of the off-channel ponds at this site. Relocating one of the ponds here is recommended from an agriculture perspective as this site has lower agriculture potential than some of the other areas proposed for ponds (Figure below).

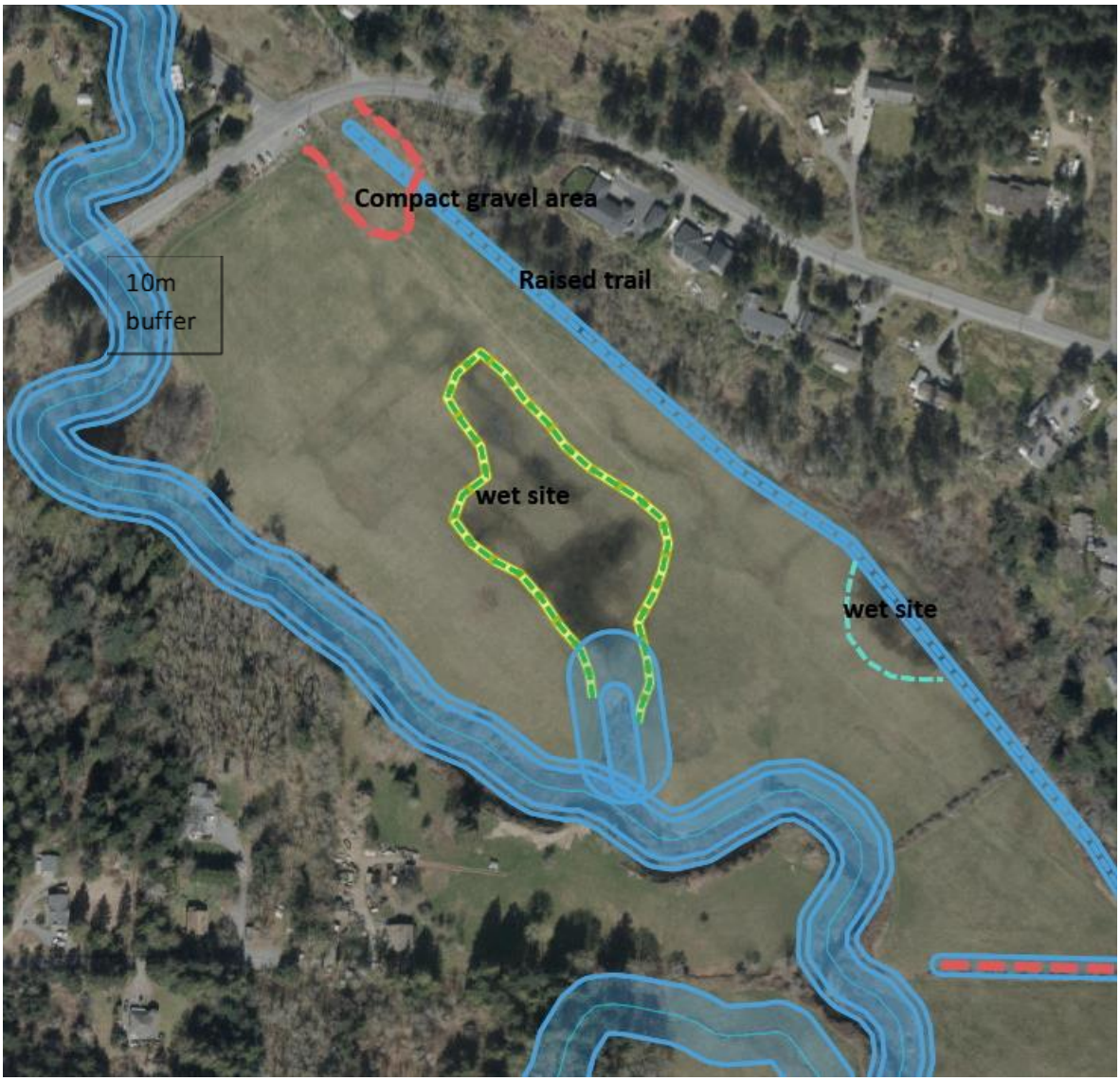


Figure 27, showing 10m riparian buffer and one fish side channel pond in wet site.

Side Channel

The side channel would have a high impact on the agriculture potential of the property due to its size and location. Although the channel might help drain part of the property and the soil excavated from the site could be used to raise the elevation of other areas, it would also cut off access to the south end of the property.

Table 9, Impacts of park activities on agriculture.

Park activity	Impacts on agriculture	Possible solutions	Impacts on agriculture	Possible solutions
Hikers and dogs present on trails	Dogs defecating in garden areas	Deer fencing to keep deer and	Park visitors stealing or	Deer fencing with a lockable

or near garden areas		dogs out of gardens	damaging garden production etc.	gate. As a minimum 7-foot-high knotted high tensile deer wire installation is recommended.
Raised trail on Sewer line	May utilize some agricultural land	Mitigate with the installation of a 2" waterline that can supply the agricultural lands with water	Access area for construction of sewer line and raised trail from field can cause compaction	Ditch at base of raised trail, providing drainage and "low-spot" fill materials. Construct line and trails during driest season
Ponds and possible side channel	May strand some areas regarding field access. Major side channel removes significant farmland from production while the smaller off channel ponds with associated riparian buffer do the same.	Reduce number of ponds to 1. Locate the pond within the wettest portion of the field. Or select one of the southern 2 ponds which have less impact on agriculture. Raise the remaining farm areas with the excavated material placing topsoil on top.	Shade from riparian area will affect crops and result in loss of significant field area from farming.	Consider ditch and pond option above as providing some benefits. Consider Agroforestry in buffer. Install subsurface drainage system and waterlines to optimize production on remaining land.
Expanded parking area.	Expansion of the parking area would permanently remove this area from cropping areas.	Location of the parking along the road with angle parking or on the site that is compacted and gravelly would have the least overall impact.		

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Appendix #2 Information on Soils

Hand texturing soils:

https://www.for.gov.bc.ca/isb/forms/lib/fs238.pdf see below.

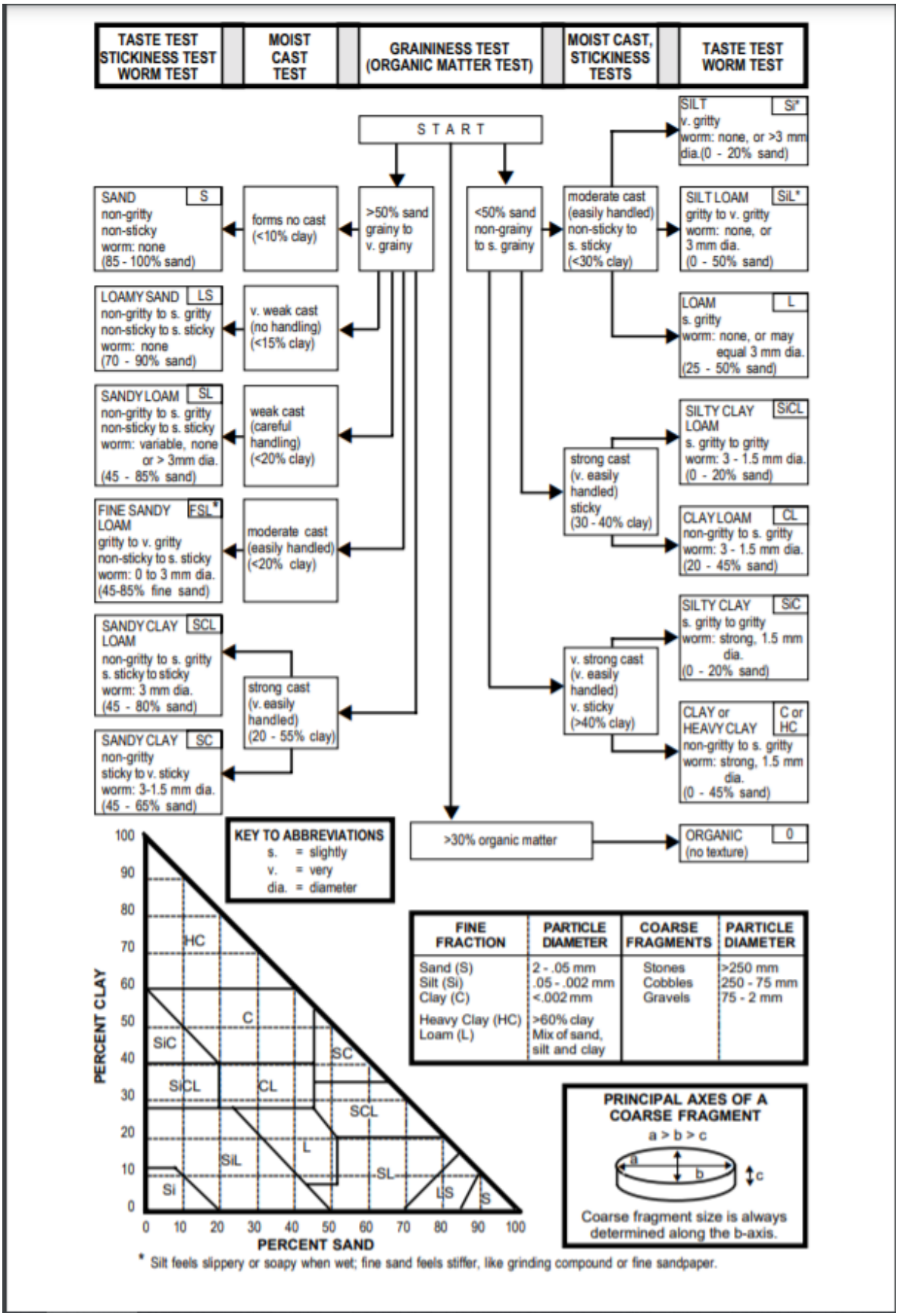
BRITISH COLUMBIA

ESTIMATING SOIL TEXTURE IN THE FIELD

Soil texture is the relative proportion of various "size fractions" of a soil:

- **Coarse fragments** consist of particles greater than 2 mm in diameter. They are estimated visually as a percentage of the whole soil:
  % stones + % cobbles + % gravels + % fine fraction = 100% (total soil)
- The **fine fraction** consists of particles less than or equal to 2 mm in diameter (for non-spherical particles, see accompanying figure):
  % sand + % silt + % clay = 100% (fine fraction)
- Particles of the two size fractions are defined on the accompanying figure.
- The **relative proportion of fine fraction** particles (**sand**, **silt** and **clay**) are estimated through the use of their unique properties of "feel". **Sand** can always be felt as individual **grains**, but silt and clay generally cannot. Dry **silt** feels floury, and wet silt is **slippery** or soapy but not sticky. Dry **clay** forms hard lumps, is very sticky when wet, and plastic (like plasticene) when moist.
- Most soils are a mixture of sand, silt and clay, so the graininess, slipperiness or stickiness will vary depending upon how much of each particle size is present. As the amount of clay increases, soil particles bind together better, form stronger casts and longer, stronger worms. As sand and silt increase, the soil binding strength decreases, and only weak to moderately strong casts and worms can be formed. The various classes of soil texture (defined on the **textural triangle** in the accompanying figure) are named by a combination of the dominant particle size, the term **loam** meaning a relatively even mix of the three.
- The field determination of soil texture is subjective and can only be done consistently with training and experience. The field tests, outlined below, are used in sequence with the accompanying flow chart to assist in the field determination of soil texture:
  1) **Graininess Test**: Rub the soil between your fingers. If sand is present, it will feel "grainy". Determine whether sand comprises more or less than 50% of the sample.
  2) **Moist Cast Test**: Compress some moist soil by clenching it in your hand. If the soil holds together (i.e., forms a "cast"), then test the durability of the cast by tossing it from hand to hand. The more durable it is, the more clay is present.
  3) **Stickiness Test**: Wet the soil thoroughly and compress between thumb and forefinger. Degree of stickiness is determined by noting how strongly the soil adheres to the thumb and forefinger upon the release of pressure, and how much it stretches. Stickiness increases with clay content.
  4) **Worm Test**: Roll some moist soil between the palms of your hands to form the longest, thinnest worm possible. The more clay there is in the soil, the longer, thinner and more durable the worm will be.
  5) **Taste Test**: Work a small amount of soil between your front teeth. Silt particles are distinguished as fine "grittiness", unlike sand which is distinguished as individual grains (i.e., graininess). Clay has no grittiness at all.
- Well-decomposed **organic matter** (humus) imparts silt-like properties to the soil. It feels floury when dry and slippery when moist, but *not* sticky and *not* plastic. However, when subjected to the taste test, it feels non-gritty. It is generally very dark when moist or wet, and stains the hands brown or black. Humus-enriched soils often occur on wet sites in association with a heavy moss cover, and on grasslands. Humus is *not* used as a determinant of soil texture; an estimate of the silt content of any humus-enriched mineral soil should be reduced accordingly.
- "Organic" soil samples are those that contain more than 30% organic matter. Soil texture is *not* determined on organic samples. Most organic soils and deep organic horizons are found on wet sites, often in depressions or on flood plains; also in association with a dense moss cover (frequently *Sphagnum* spp.).

FS238 HRE 01/01


TASTE TEST STICKINESS TEST WORM TEST
MOIST CAST TEST
GRAININESS TEST (ORGANIC MATTER TEST)
MOIST CAST, STICKINESS TESTS
TASTE TEST WORM TEST
START
>50% sand grainy to v. grainy
<50% sand non-grainy to s. grainy
>30% organic matter
forms no cast (<10% clay)
v. weak cast (no handling) (<15% clay)
weak cast (careful handling) (<20% clay)
moderate cast (easily handled) (<20% clay)
strong cast (v. easily handled) (20 - 55% clay)
moderate cast (easily handled) non-sticky to s. sticky (<30% clay)
strong cast (v. easily handled) sticky (30 - 40% clay)
v. strong cast (v. easily handled) v. sticky (>40% clay)
SAND S
non-gritty
non-sticky
worm: none
(85 - 100% sand)
LOAMY SAND LS
non-gritty to s. gritty
non-sticky to s. sticky
worm: none
(70 - 90% sand)
SANDY LOAM SL
non-gritty to s. gritty
non-sticky to s. sticky
worm: variable, none or > 3mm dia.
(45 - 85% sand)
FINE SANDY LOAM FSL*
gritty to v. gritty
non-sticky to s. sticky
worm: 0 to 3 mm dia.
(45-85% fine sand)
SANDY CLAY LOAM SCL
non-gritty to s. gritty
s. sticky to sticky
worm: 3 mm dia.
(45 - 80% sand)
SANDY CLAY SC
non-gritty
sticky to v. sticky
worm: 3-1.5 mm dia.
(45 - 65% sand)
SILT Si*
v. gritty
worm: none, or >3 mm dia.(0 - 20% sand)
SILT LOAM SiL*
gritty to v. gritty
worm: none, or 3 mm dia.
(0 - 50% sand)
LOAM L
s. gritty
worm: none, or may equal 3 mm dia.
(25 - 50% sand)
SILTY CLAY LOAM SiCL
s. gritty to gritty
worm: 3 - 1.5 mm dia.
(0 - 20% sand)
CLAY LOAM CL
non-gritty to s. gritty
worm: 3 - 1.5 mm dia.
(20 - 45% sand)
SILTY CLAY SiC
s. gritty to gritty
worm: strong, 1.5 mm dia.
(0 - 20% sand)
CLAY or HEAVY CLAY C or HC
non-gritty to s. gritty
worm: strong, 1.5 mm dia.
(0 - 45% sand)
ORGANIC O
(no texture)
KEY TO ABBREVIATIONS
s. = slightly
v. = very
dia. = diameter
PERCENT CLAY
PERCENT SAND
HC
C
SiC
SC
SiCL
CL
SCL
L
SiL
SL
Si
LS
S
FINE FRACTION
PARTICLE DIAMETER
COARSE FRAGMENTS
PARTICLE DIAMETER
Sand (S) 2 - .05 mm
Silt (Si) .05 - .002 mm
Clay (C) <.002 mm
Heavy Clay (HC) >60% clay
Loam (L) Mix of sand, silt and clay
Stones >250 mm
Cobbles 250 - 75 mm
Gravels 75 - 2 mm
PRINCIPAL AXES OF A COARSE FRAGMENT
a > b > c
a
b
c
Coarse fragment size is always determined along the b-axis.
* Silt feels slippery or soapy when wet; fine sand feels stiffer, like grinding compound or fine sandpaper.

CHEMAINUS SOIL MANAGEMENT GROUP

Soil Series:
Chemainus and Flewett Variants:
'g' - Contain 20 to 50% coarse fragments in the surface 25 cm. Refer to the Dougan Soil Management Group.
'id' - Imperfectly drained.
's' - Underlain by another parent material or strongly contrasting texture at a depth of 50 to 100 cm.
General Characteristics:
- Stone free.
- Fine sandy loam to silt loam floodplain deposits.
- Moderately well to well drained. N (Note some references indicate imperfectly to moderately well drained and this describes the full range of variability found at East Wellington)
- High nutrient and water-holding capacity.
Dominant Soil Limitations:
On modal Chemainus and Flewett soils, there are no significant limitations to agriculture,
On 'id' variants, some excess wetness may limit growth of some water sensitive crops.
On 's' variants, there are slight limitations to root and water penetration due to restricting subsoils occurring between 50 to 100 cm from the surface.
Well Suited Crops:
All climatically suited crops on non-variant soils.
Management Inputs:
Irrigation System: To overcome climatic moisture deficit, irrigation is required to maximize production of some crops in some years.
Erosion Control Practices: On shallow soils ('s' variants) soil conservation management practices should be used to prevent any soil loss due to erosion.
Water Management System: Some Chemainus soils require diking for flood protection.
Suited Crops:
On 'id' variants only: alfalfa, raspberries and tree Fruits which require management inputs.
Management Inputs:
Water Management System: Water control to prevent excess wetness and winter injury.
Unsuited Crops:
None
Soil Management Handbook for Vancouver Island R Maxwell et al 2010 (base work included the series of Soil Management Technical Reports for Vancouver Island 1985 +/-)

Appendix# When soil is dry enough to be tilled, a ribbon of soil pushed out between the thumb and index finger will break before it reaches 5 inches in length. Likewise, soil made into a ball will break apart when thrown into the air. If the soil is too wet, it is more "plastic" and fails these tests. https://crops.extension.iastate.edu/cropnews/2019/03/spring-planting-and-wet-soil-management Spring Planting and Wet Soil Management, Iowa State University, 2019

Element labs soil test results:

Farm Soil Analysis

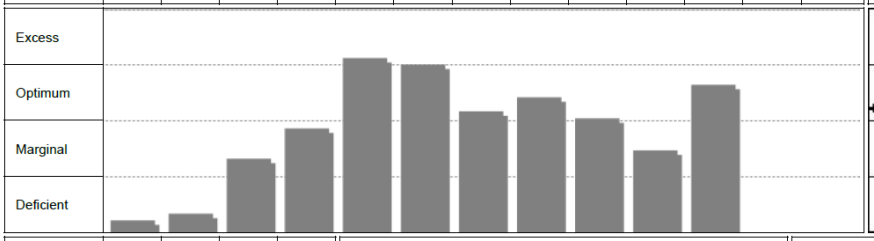
Bill To:	Hard to Come By Farm	Grower Name:	East Wellington	Lot Number:	1463556
Report To:	Hardisty Caverns LP	Client's Sample Id:		Report Number:	2579014
	PO Box 398	Field Id:	E.W Hay	Date Received:	Dec 08, 2020
		Acres:	25	Disposal Date:	Jan 07, 2021
	Edmonton, AB., Canada	Legal Location:		Report Date:	Dec 11, 2020
	T5J 2J9	Last Crop:	Orchardgrass - Hay	Arrival Condition:	
Agreement:	113442				

Nutrient analysis (ppm)

Depth	N*	P	K	S**	Ca	Mg	Fe	Cu	Zn	B	Mn	Cl	BiCarbP
0" - 6"	4	<5	99	7	2140	287	179	2.6	2	0.6	33.0		

Soil Quality

pH	EC(dS/m)	OM(%)	Sample#
6.3	0.2	13.2	7321313



Alkaline	*Extreme*	*High*
Neutral	*Very High*	*Normal*
Acidic	*High*	*Low*
Very Acidic	*Good*	*Very Low*

Total lbs/acre	8	10	198	13
Estimated lbs/acre	17	10	198	27

Texture *Loam* Hand Texture *n/a*

Sand 32.6 % Silt 42.0 % Clay 24.7 %

Ammonium 13.3 mg/kg

Lime 4 T/ac Buffer pH 6.0 Est. N Release n/a K/Mg Ratio n/a

BS 58.5 % CEC n/a

Ca 45.8 % Mg 10.1 % Na 1.6 % K 1.1 %

TEC 23.4 meq/100 g Na 84 ppm

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

RECOMMENDATIONS FOR BALANCED CROP NUTRITION

	Potatoes					Carrots				
Macro-nutrients	**Yield**	**N**	**P_2O_5**	**K_2O**	**S**	**Yield**	**N**	**P_2O_5**	**K_2O**	**S**
Growing Condition	T/ac	To be added (lbs/acre)				bu/ac	To be added (lbs/acre)			
Excellent	20	181	72	179	0	4	114	166	168	5
Average	16	114	55	138	0	3	96	150	139	5
Your Goal	0.0					0				
Removal Rate (Seed/Total)	20	141 / 251	40 / 73	238 / 327	13 / 20	4	0 / 0	0 / 0	0 / 0	0 / 0
Micro-nutrients	Iron	Copper	Zinc	Boron	Manganese	Iron	Copper	Zinc	Boron	Manganese
To be added (lbs/ac)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Parts of the field may be Boron deficient.

The ideal pH range is 6.0 to 7.5

Comments:

Soil pit #2

Soil data:

Date: _____August 13th, 2020_____

Site Description: see pits #4 and #5 below, over 22 core samples taken across the fields at 40 metre intervals with a random sampling pattern_____

Notes: Soils along the east side of the main field showed signs of compaction (poor forage growth with course fragments on the surface, possibly indicating an old roadbed or staging area for sewer line construction. North east corner covered with gravel (road base crush) to at least a depth of 8”, from

access point, also poor forage vigour likely due to compaction and low moisture and nutrient holding capacity.

Soils in the north east corner indicating poor forage vigour, compacted, gravelly soil.

Soil data:

Date: _____August 13th, 2020_____

Site Description: Map pit #5_____

Soil Pit location: Middle of South east field_____

Soil depth	Characteristics (texture, colour, mottling)
0-6”	Loam, well aggregated, massive course, and fine roots
6-9”	Silty clay loam, well aggregated, many roots, 5% course fragments
9-16”	Dark brown to black soil, well aggregated, excellent rooting, and aeration
16-20 inches	Slight yellow mottling, silty clay loam
20”+	Significant yellow mottling, still significant rooting, loam to silty clay loam

Notes: 20 meters away - deep core sample:0-15” generally dark brown, low to no course fragments below 10”, massive rooting. Forages were harvested but remaining stubble and root growth indicated productive stand of forage was harvested.

Pit #5

Note: root proliferation – very productive soil.

Soil data:

Date: _____ August 13th, 2020_____

Site Description: Map pit #4 (#2 for the day) machine dug pit_____

Soil Pit location: Middle of east end of main field, +/- 50 meters from east hedge row_____

Soil depth	Characteristics (texture, colour, mottling)
0-10”	Organic enriched dark brown loam, root proliferation
10-36”	Yellow Sandy loam, many fine roots, crumbly
36-40”	Orange mottles- yellow soil, loam
40”+	Loam to silty clay loam

Notes: No course fragments, no mottling, forages were harvested however root growth indicated productive stand of forage was harvested. Well drained soil- most rapidly drained soil of all 5 soil pits.

Machine dug soil pit.

Note organic enrichment - dark brown colour of surface soils (right).

Appendix # 3

Perennials suited to periodic flooding.

Quince (Cydonia oblonga) a species able to withstand wet soils and suited to processing OR grow quince rootstock and graft preferred pear varieties onto them. Quince rootstock results in a more precocious tree (fruiting earlier).

Hazelnut (Corylus avellana): Note: in the Cowichan Valley a Filbert orchard growing mostly on poorly drained Cowichan silt loams has experienced considerable tree loss in areas of stagnant water / winter flooding. The rest of the orchard is quite productive. We expect that on those areas of East Wellington that have slightly higher elevations Filberts will grow very well. On the depressional areas the relatively high-water table and winter to spring flooding may cause the trees to succumb to Phytophthora root rot. Most trees would likely survive but may be of low productivity. If Hazelnuts are planted only Eastern Filbert Blight resistant trees should be planted due to the presence of the disease on the Island.

Blueberries (Vaccinium Cyanococcus),. Some varieties of Blueberries are much more able to withstand flooding than others, for example Bluecrop. One reference indicated the flooding tolerance ability of the blueberry species studied was as follows: highbush (Vaccinium corymbosum L.) > half-high (V. corymbosum L. x V. angustifolium Ait.)> lowbush (V . angustifolium Ait.). The flooding tolerance ability of different cultivars can be summarized in the following order: 'Aron'> 'Bluecrop'> 'Northcountry'> 'St. Cloud'> '7917'>

'Blomidon'='Brunswick'> 'Chignecto'> 'Northsky'. (COMPARISON OF FLOODING TOLERANCE ABILITY AMONG DIFFERENT BLUEBERRY CULTIVARS IN CHINA, W. Lin et al, International Society for Horticultural Science, 2002

The highbush blueberry cultivar 'Aron' showed a high flooding tolerance ability. The plants grew normally although some plants were damaged after 32 days of continuous flooding during the summer. If the flooding period did not exceed 25 days, the plants could recover. BREEDING OF HIGHBUSH BLUEBERRY IN FINLAND, ISHS Acta Horticulturae 165: III International Symposium on Vaccinium Culture H. Hiirsalmi, 10.17660/ActaHortic.1985.165.8

Western Serviceberry (Amelanchier alnifolia) can tolerate winter flooding. It can grow in full sun to partial shade. It does well in a moist, well-drained soil but tolerates a wide range of conditions. The 12 foot or shorter bushes produce ½" bluish-purple, juicy edible berries which ripen in early summer. The versatile fruit may be used fresh or dried, cooked or raw. It was a common food source among Native Americans, who used the berries as a component of mincemeat. The berries are popular with wildlife.

(http://www.pnwplants.wsu.edu/PlantDisplay.aspx?PlantID=345)

E-Flora
https://linnet.geog.ubc.ca/Atlas/Atlas.aspx?sciname=Amelanchier%20alnifolia&redblue=Both&lifeform=4

Western crabapple (Malus fusca), while this species is resistant to saturated soils the fruit is sour and smaller than standard apple trees and tends to be used for as a minority component in processed fruit products such as cider, and thus has a lower market value. See appendix #P

Thimbleberry (Rubus parviflorus) Sun/partial shade 4-10 feet May - June Moist to dry soils; white flowers; red berries; makes thickets and spreads easily.

Salmonberry (Rubus spectabilis) Partial sun/shade 5-10 feet February - April Prefers moist, wet soils; good soil binder; magenta flowers; yellow/orange fruit; early nectar source for hummingbirds; makes thickets.

(https://www.psp.wa.gov/downloads/LID/draft_2012/AppendixFiles_Jan2012.pdf)

All these perennial species would require fencing to exclude deer and rabbits. Dwarf apple trees would need to be supported by a trellis system or individual tree posts. (Due to the small post diameter of individual tree posts, they rot off in about half the time of larger diameter posts used in trellis systems). For the perennials to be fruitful they would require an irrigation system to overcome the moisture deficit that occurs from June to September. To determine the appropriate apple rootstock see: https://ctl.cornell.edu/wp-content/uploads/plants/GENEVA-Apple-Rootstocks-Comparison-Chart.pdf Geneva apple rootstocks Cornell university.

A Quince Essential Fruit - How to Grow Quince Trees

23 January 2014, written by Helen Gazeley

Fashions come and go, no less in fruit-growing than in the width of trouser-leg (though rather more slowly), but if you want to be á la mode in your garden right now I recommend you plant a quince tree. It's even The California Rare Fruit Growers Association's 2014 fruit tree of the year.

Its renaissance is long overdue. The tree itself is full of character, tending to grow into an irregular shape with twisted branches. Its flowers, which appear in June, are single, large and pinky to white. The large fruits ripen to golden-yellow and shine out from among the strikingly large leaves, which are grey and furry underneath, making you want to stroke them. The fruit itself is delicious.

What I love, though, is its part in history and myth. It's often mooted that the apples awarded to Aphrodite by Paris were actually quinces, as might have been the fruit with which the serpent tempted Eve. It seems the seeds were once used as a gelling agent (before commercially produced gelatine made things easier) and it has always been a useful source of pectin for jams. Quince trees live to a ripe old age, and venerable examples include the four wizened veterans in the Cloisters Museum in New York.

Tasty, Scented Fruits

Moreover, though, is a beautiful taste and scent. The fruit has to be cooked as it's too hard to eat fresh (an exception, in a good summer, may be the early-ripening variety Ivan), but although many recipes call for long hours of baking, if you stew it in a pan, it will actually cook

in about fifteen minutes. Its slightly spicy, intensely rich flavour combines excellently with apples or dried fruit.

The fruits smell rather like pineapple—not the fresh fruit (the introduction of which probably helped in the quince's decline), but pineapple sweets. A bowl of quinces will scent a room, and some people even recommend putting one in the car as an air-freshener.

Growing Quince Trees

Another good point is that a quince will tolerate most soils, acid or alkaline. Quince prefers a deep, rich loam that stays moist, so long as it didn't become waterlogged.

Western crabapple (Malus fusca), small deciduous tree to 40 ft, 35 ft spread, fragrant white/pink flowers in spring, yellow to reddish-purple fruit that may hang on over winter. Full sun/part-shade, slow growing, may form thickets, butterfly host. (https://extension.oregonstate.edu/gardening/flowers-shrubs-trees/pnw-native-plants-streamside-garden)

Tolerant of prolonged soil saturation; produces fruit (https://www.psp.wa.gov/downloads/LID/draft_2012/AppendixFiles_Jan2012.pdf)

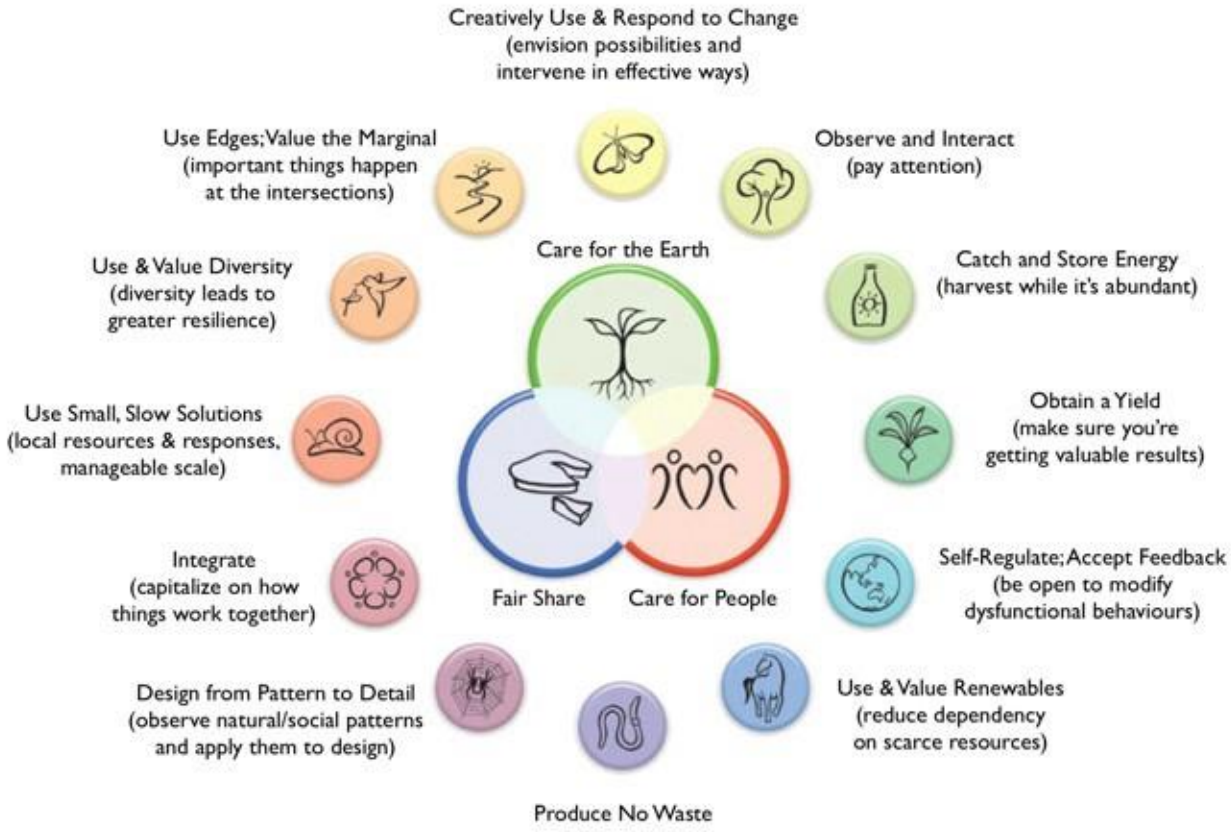
Appendix#4

Permaculture and Agroecology: Differences and Similarities

Agroecology and permaculture are often confused, yet these two practices are different. Agro-ecology goes further than biological agricultural as it uses sustainable agricultural systems with techniques such as complementarity, composting or cultivation on mounds. It integrates these systems in an ecological way by saving water and reducing potential for erosion. The practices above can be found in permaculture too, but the latter is broader since it focuses not only on creating sustainable and resilient farming systems but also on integrating them into a broader life system where other variables are also accounted for.

From: https://youmatter.world/en/definition/definitions-permaculture-definition/#:~:text=Definition%20Of%20Permaculture,%2C%20natural%20productivity%2C%20and%20sustainability.

The Twelve Principles of Permaculture:



https://www.permaculture.co.uk/sites/default/files/images/permaculturepriciples.jpg

The Twelve Principles of Permaculture:

Observe and Interact.

Being observant and responding to what we see is important in moving towards a more ethical and sustainable way of life. We can learn from nature and from other people, observing how others have moved to a greener and more ethical approach, and working with the world around us to succeed in our goals.

Catch and store energy.

Energy is abundant on our planet. Learning how to catch and store energy in plants, with renewable energy infrastructure, or in other ways, is key to living a sustainable way of life.

Obtain a yield.

Taking the three-core ethics of permaculture into account, we can work with nature to get all the things we need. Obtaining a yield can be as simple as using organic gardening techniques.

Apply Self-Regulation and Feedback

Understanding where we have succeeded and where we've gone wrong is vitally important to creating real and lasting change.

Use and Value Renewables By using the power of the sun, the wind, or the water, we can power our homes, grow our food, and regenerate our environments.

Rather than relying on finite and polluting fossil fuels, we should make full use of renewable sources of energy: for example, switching to a green energy supplier – or even generating our own power with solar panels or other renewable infrastructure at home – is something many of us can do to move to a more sustainable way of life.

Produce No Waste

Moving towards zero waste lifestyle means looking at all the trash we chuck out and trying to eliminate it. We can do this by reducing the amount we buy, by buying wisely, by reusing or recycling where possible, by composting, and by working with ethical companies who look at waste throughout the entire life cycle of their products.

Design from Patterns to Details

Whether designing a new vegetable garden, or an entire new sustainable way of life, look at the big picture before getting bogged down in the little things.

Thinking wholistically, about all areas of our lives, can help us move forwards in a positive direction.

Integrate, don't segregate.

Plants work well in diverse systems – the same is true of people too. Planting polycultures (guilds of plants which work together) is just one example of how this principle works in the real world. And as well as applying this in the garden, we can also apply it to communities, groups, or organisations. Sustainability is something we achieve together – through collaboration and co-operation – it's not something we do alone.

Use Small, Slow Solutions

Every journey begins with a single step. Whenever we try to do too much too soon, it's easy to become overwhelmed – and though big changes can bring big benefits, they bring bigger risks too. Making small, incremental changes is the best way to move towards sustainable change.

For example, don't start a farm, try a small windowsill garden. Don't overhaul your entire shopping philosophy, change things one ethical purchase at a time.

Use and Value Diversity

Just as ecosystems work best when filled with a greater variety of different plants and animals, so human society functions best when a variety of different people are represented.

In your garden, home, and your life in general, it is a good idea to promote and value diversity in all its forms.

Use Edges and Value the Marginal

Sustainability is about making use of all the resources that we have at our disposal. Whether we are talking about land use, workplaces, homes or society in general, making use of all we have involves valuing fringes and fringe elements.

This might be as simple as using a neglected corner of your outside space to grow more food, or something more abstract, like thinking outside the box.

Creatively Use and Respond to Change

Finally, change is an inevitable part of life. It is important to remember that permaculture isn't just about now, but about the future. We design for change, understanding that things will alter over time. The changing seasons, changing attitudes, our changing climate… how we respond to these changes will shape sustainable progress in the years to come.

These principles are a starting point for an understanding of permaculture and can begin to give us an idea of how we can translate thought to action, and transition to a more ethical – and truly sustainable – way of life.

Organic matter conservation and management is the key to most regenerative and permaculture production systems.

Research supports the application of fertilizer to promote more biomass production for the benefit of soil organic matter. Fertilizers can be replaced by nutrient rich sources of livestock and fish waste such as: layer manure, broiler manure, hog manure, fish processing waste…

Shrubs and trees have a role to play in reducing tillage and adding organic matter from leaf litter, root system dieback and to a lesser extent root exudate. They also moderate the growing areas temperature and wind for shade tolerant plants that may be grown under or near the tree or shrub canopy.

Most cropland in North America is characterized by large monocultures, whose productivity is maintained through a strong reliance on costly tillage, external fertilizers, and pesticides (Schipanski et al., 2016). Despite this, farmers have developed a regenerative model of farm production that promotes soil health and biodiversity, while producing nutrient-dense farm products profitably. Little work has focused on the relative costs and benefits of novel regenerative farming operations, which necessitates studying in situ, farmer-defined best management practices. Here, we evaluate the relative effects of regenerative and conventional

corn production systems on pest management services, soil conservation, and farmer profitability and productivity throughout the Northern Plains of the United States. Regenerative farming systems provided greater ecosystem services and profitability for farmers than an input-intensive model of corn production. Pests were 10-fold more abundant in insecticide-treated corn fields than on insecticide-free regenerative farms, indicating that farmers who proactively design pest-resilient food systems outperform farmers that react to pests chemically. Regenerative fields had 29% lower grain production but 78% higher profits over traditional corn production systems. Profit was positively correlated with the particulate organic matter of the soil, not yield. These results provide the basis for dialogue on ecologically based farming systems that could be used to simultaneously produce food while conserving our natural resource base: two factors that are pitted against one another in simplified food production systems. To attain this requires a systems-level shift on the farm; simply applying individual regenerative practices within the current production model will not likely produce the documented results. LaCanne CE, Lundgren JG. 2018. Regenerative agriculture: merging farming and natural resource conservation
profitably. PeerJ 6:e4428 https://doi.org/10.7717/peerj.4428

Elizabeth Waddington, ethical.net operated by Centre for applied Ethics Ltd.

Appendix #5

Haliburton Farm Model

EDUCATION, WORKSHOPS & THE HALIBURTON ECOFARM SCHOOL

Haliburton Community Organic Farm is zoned as a Rural Demonstration Farm. This brings with it obligations to provide opportunities for education in many forms.

We offer practical experience in learning how to grow certified organic vegetables, fruit, herbs and flowers on a farm with a strong ecological, place-based and holistic philosophy.

Past students and interns have learned skills including organic farming, greenhouse growing, restoring and integrating a healthy farm ecosystem, processes required for organic certification, plus public communication, nutrition and food handling, storage and preservation.

HCOFS Rental Unit 3 Request for Proposals Addendum to: Land Use Plan (2011 – 2014) And Request for Proposals For complete information on Haliburton Community Organic Farm,

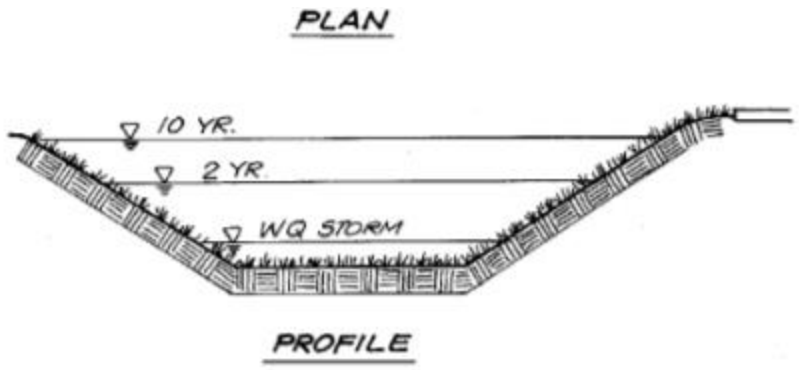
Application Process and Application Form, please see “Land Use Plan (2011 – 2014) And Request for Proposals”. This document is available by request from info@haliburtonfarm.org Description of Opportunities There are two business opportunities available in relation to Rental Unit #3 of Haliburton Community Organic Farm. Opportunity 1: Purchase of hard assets at Rental Unit #3 Hard assets (perennials and berry orchard) for sale by Sunbird Farm. If purchasers wish to establish a farm business on Rental Unit #3, they must also apply to, and be approved by, Haliburton Community Organic Farm Society (HCOFS). Opportunity 2: Rent land for own farm business We are looking for a farm business to make full use of Rental Unit #3 of Haliburton Community Organic Farm, under a 4 year (with possibility of extension) agreement. The farm business is to focus on produce production for sales at Farm stand and other local markets. What we offer Land Base • 1 acre certified organic land. Infrastructure • 7' deer fence enclosing farm area • Separate water meter with direct irrigation line access, (irrigation line is available for purchase from the current farmers) • 4 compost bins, 2 complete from 2010 growing season. • Shared produce washing facility • Shared permanent farm stand Equipment • No equipment provided Perennials • Herbs and perennials available for purchase • Permanent berry orchard available for purchase. Note: Sunbird Farm and HCOFS prefer to leave the berry orchard in place as it is site of a rich, established ecosystem. There are two options in the event the orchard is not purchased by the next tenant of Rental Unit #3: • Proceeds from the berry orchard are to be split between the new farm business rental and the HCOFS. OR • The orchard is donated to the HCOFS and 0.05 of an acre and irrigation compensation would be written into the Memorandum of Agreement with HCOFS. Additional • IOPA certified farm site with mandatory renewal • Memorandum of Agreement for use of land for up to 4 years, with possibility of renewal • Access to established markets – Food Basket program, on-site farm stand, various community Markets (i.e., Moss Street) • Own “Farm Page” on Haliburton web site (http://haliburtonfarm.org/). Current farm page remains for succession and archives on history of the land. Your responsibilities Expenses • $500/yr membership fee • Land Utilities (irrigation water) • Education Centre Utilities (18% of Education Centre water, electricity, telephone and oil - may be readjusted depending on actual use) • Share, as required, expenses such as sewage pumping, furnace repair, grass cutting, house repairs with other farm businesses and the Society. • Proportional share of IOPA certification fees.1 Insurance • Responsibility of farm business, to be discussed with HCOFS Board Maintenance • Contribute to shared equipment maintenance • Upkeep of Farm area (keeping grass mowed, debris cleaned up, farm area tidy) • Maintenance of various biodiversity infrastructure in partnership with the Biodiversity Team such as: Permanently maintained Hummingbird feeder, Bee boxes, permanent snake cairns (rock piles), contribution of weeding and watering permanent hedgerows, keeping permanent habitat area next to berry orchard, maintenance of border fences and perimeter grass cutting • Winterizing (covering with wood chips) water lines and shut-off valves to prevent pipes bursting • Shutting off water upon leaving premises, if it is not on a timer Farm Management • Use land for the purpose of growing produce for sales at farm stand , other local markets and 1 IOPA certification fees are based on income level. Haliburton is charged one fee by IOPA and we share the costs internally. To calculate fee share, all farm

revenues are added, proportion of income calculate. That proportion is used to calculate IOPA fee portion. i.e., Farm 1: $20,000 plus Farm 2: $3,000 plus Farm 3: 15,000. Total income from Haliburton = $38,000. Farm 1 portion of total income is: $20,000 / $38,000 = 53%. So, Farm 1 pays 53% of the IOPA certification fee. In 2010, Haliburton IOPA fees were $763 total. Food Basket program. • Follow IOPA certified organic standards • Complete IOPA paperwork required for continued certification (assistance provided) Community participation • Use of the designated area to its full capacity • Offer communal support of other Farm businesses • Participation in Society and other education programs, open to taking apprentices, volunteers • Participation in Food Basket program. • Share responsibility for operating farm stand, Food Basket program and attending markets • Attend Farmer meetings and support fellow farmers • Engage in succession discussions with all previous farmers of Rental Unit 3 plus at least one member of the Biodiversity group managing the wetland, to become informed of history of land and its role in the surrounding eco-system. • Work cooperatively to manage and adhere to whole farm planting plan and annual Farmers' planning meeting outcome at year end. (i.e., one farm business may grow strawberries, another may do artichokes etc.) • Share public area ground maintenance with other Haliburton Farm businesses and Society. • Volunteer work for the Society, including assisting with workshops, farm tours and demonstrations (avg 4 hours/week during growing season) • Commitment to building relationships with the local community and fellow farmers Other • Adherence to conditions in the head lease with the Municipality of Saanich. Clauses of specific importance include (but are not limited to): Section 12 "The Lessee further covenants to comply with all bylaws and regulations of the Municipality." "The Lessee covenants not to keep or graze farm animals or poultry on the land except those listed below: a) Chickens and Muscovy Ducks, limited to a combined total of 60 b) Roosters. Limited to a total of 5. Section 13 "The hours of operation for farming activities, utilizing mechanized equipment, are limited to between 7am and 9pm daily." Section 16 "The Lessee covenants not to install or utilize any additional outdoor lighting for farming or special events without the consent of the Land Commissioner or his designate first had and obtained."

Appendix #6

Ditch Side Slopes:

The side slopes should be somewhat flat. A maximum slope of 2.5:1 (H:V) is recommended and a 4:1 slope is preferred where space permits.



Low Impact Development Stormwater Management Planning and Design Guide, City of Seattle (https://cvc.ca/wp-content/uploads/2012/02/lid-swm-guide-chapter4-4.8-enhanced-grass-swales.pdf)

Appendix #7

Worksheet for Estimating Site Specific Plant Available N from Cover Crop

Table 2 Estimating N from cover crop

Line no.		Your value	Example: Vetch	Units
1	Area sampled to determine cover crop biomass: *Quadrat area (ft²) x number of quadrats*		16	ft²
2	Number of sample areas per acre: *43,560 ft²/acre ÷ Line 1*		2,723	sample areas/ acre
3	Wet weight of cover crop field sample (lb)		12	lb wet cover crop
4	Percent DM in cover crop: *lab data or your "shortcut" estimate*[2]		15	DM, % in wet cover crop biomass
5	Calculate cover crop DM (ton/a): *(Line 2 x Line 3 x Line 4 ÷ 100) ÷ 2,000*		2.45	ton DM/acre
6	Cover crop total N percentage: *lab data or your "shortcut" estimate (N, % dry wt)*[3]		3. 0	N, % in cover crop DM
7	Plant-available N from cover crop decomposition: *Find your %N in DM in column 1 of Table 2 (page 5), and then find estimated PAN release under the "Calculator" column.*		24	PAN, lb/ton DM
8	Calculate plant-available N for summer crop[4] (lb PAN/acre): *Line 5 x Line 7*		59	PAN, lb/acre

[1]The OSU Organic Fertilizer and Cover Crop Calculator calculates PAN (Line 8) from the input data in lines 1–6.

https://extension.oregonstate.edu/organic-fertilizer-cover-crop-calculators

Suggestions:

The waterline, to supply all potential garden areas for irrigation, could be placed at the time of raised trail construction frost protected inground outlets could be extended beyond the ditch.

Appendix 8

Forage Crop Yields

Species	Cultivar	Annual Yield (t dry matter /ha)[1]		
		Age of Stand: Young	Old	Difference
PERSISTENT GRASSES				
Orchardgrass	Hallmark	14.5	13.4	-1.1
Orchardgrass	Prairial	14.6	13.7	-0.9
Orchardgrass	Mobite	13.0	12.2	-0.8
Tall fescue	Johnstone	13.7	14.0	0.3
Meadow fescue	Bundi	10.9	10.2	-0.7
Timothy	Toro	14.9	14.0	-0.9
Meadow bromegrass	Regar	14.5	13.1	-1.4
NON-PERSISTENT GRASSES				
Prairiegrass	Grassland Matua	13.7	—	—
Reed canarygrass	Palaton	12.5	—	—
Perennial ryegrass (2N)[2]	Frances	11.4	—	—
Perennial ryegrass (4N)[2]	Bastion	10.9	—	—
Perennial ryegrass (4N)[2]	Condesa	10.9	—	—
Perennial ryegrass (2N)[2]	Melle	10.7	—	—
Sweet bromegrass	Deborah	—	—	—
Bromus sitchensis	Grassland Hakari	—	—	—
Smooth bromegrass	Manchar	—	—	—

[1] for T/ ac multiply by 0.45

[2] 2N= diploid, 4N= tetraploid