



Water and Waste Department • Service des eaux et des déchets

Summit Landfill Soil Fabrication Pilot Project

Year Two Annual Report

February 2020

Prepared For:

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Introduction

The City produces approximately 50,000 tonnes of biosolids at the North End Sewage Treatment Plant (NEWPCC) per year. In 2014, the City released a Biosolids Master Plan that outlined strategies to maximize nutrient recovery and recycling, and the beneficial use of biosolids.

On May 7, 2018 the City of Winnipeg received approval from Manitoba Conservation and Climate (MCC) under the Exemption Clause (6) of the *Classes of Development Regulation* to commence the three year Summit Soil Fabrication pilot project, 2018-2020, examining the viability of fabricating soil with biosolids to complete the cap system at Summit Landfill. This annual report covers the activities and results from the second operational year. The main goals for Year Two were to improve site logistics, and operational efficiency through testing equipment and processes.

The main findings from Year Two are:

- The soil fabrication operation at Summit Road Landfill has the capacity to accept 18,015 tonnes of biosolids in all weather conditions.
- Soil and surface water monitoring results from the Year One, Phase One plot show no negative environmental impacts.
- The fabricated soil has the ability to support the vegetative growth of oats as a cover crop, even in dry summer conditions.
- Fabricated soil mixed and spread by a manure spreader met the industrial criteria for soil quality based on the CCME Guidelines for the protection of Environment and Human Health.
- Fabricated soil windrows can be effectively mixed and spread using a dozer.

Soil fabrication allows the City to divert biosolids from being buried at the Brady Road Resource Management Facility (BRRMF). Utilizing biosolids and other organic residuals in soil fabrication and vegetation establishment can reduce the cost of landfill closure, the need to import non-renewable sources of topsoil from other sites, and provide a beneficial use opportunity for multiple regionally generated residuals.

Vision and Goals

The vision for this project is an operational-scale demonstration of an all-season, ongoing operation that utilizes residuals as feedstocks to fabricate soil blends tailored to complete the cap system at Summit Landfill while protecting human health and the environment. Using biosolids, street sweepings, wood chips, and other potential residuals the soil blends are designed to be environmentally protective and support vegetative growth, while restoring the landfill to a native prairie landscape.



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In order to achieve this vision, the City of Winnipeg has designed this pilot project with three primary goals:

- Demonstrate that biosolids fabricated soil is a viable, environmentally sound option for completion of the cap system of Summit landfill, specifically producing a growing media that can be placed as a topsoil layer to permanently support a vegetated prairie ecosystem of native grasses and forbs.
- Demonstrate soil fabrication is an operationally viable multi-season beneficial use option for biosolids, and a diversion option for several other residuals, including wood waste from City arboriculture, and mineral material from street sweepings and other sources.
- Produce sufficient information to complete a business case for an ongoing soil fabrication operation, provide and support capacity development opportunities for City staff, and identify interdepartmental operational efficiencies and shared benefits.

Timeline

This pilot project spans three years, from 2018 to 2020. Each study year will be informed by previous results and timelines and designs may change. Mixing operations, timing and volumes in Year Three will be informed by results obtained during Year One and Year Two. Year Two of the study consisted of a rough timeline of:

- a) February 4 to March 29: Biosolids receiving operational Phase
- b) Spring: Seeding, monitoring, analysis and preparation for second operational phase
- c) Summer: monitoring, analysis and preparation for second operational phase
- d) September 26 to November 29: Second biosolids receiving operational phase

Year Two had one winter and one autumn operational phase. The winter phase focused primarily on operating in cold temperature conditions, and the autumn phase focused on wet weather conditions.

Feedstocks Volumes

Biosolids fabricated soil consists of three main feedstocks: biosolids, a mineral source, and a carbon source. Year Two operations utilized biosolids from NEWPCC, wood chips, and street sweepings.

Biosolids: wastewater residuals that have been treated and stabilized through digestion and dewatering. A total of 18,015 tonnes, which is approximately 18,015 m³ were used in Year Two.

Mineral Source: The mineral source for Year Two is screened street sweepings.



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Carbon Source: Year Two utilized wood waste from the Public Works Department tree management program. This includes, but is not limited to, elm and ash wood waste. Wood chips were also accepted from other contracted operations. Approximately 36,000m³ were used in Year Two.

A wood chipping operation was established at Summit Landfill in July of 2018. This commercial operation accepts diseased Dutch Elm wood which is chipped on site. Wood chips from this operation are used in soil fabrication.

Fabricated Soil: Based on the total biosolids volume, along with the required ratio of woodchips and street sweepings, approximately 108,000 m³ of material was fabricated into soil in Year Two. Fabricated soil volume is a result of biosolids and street sweepings filling the voids in wood chip volumes. Additionally, windrowed fabricated soil has shown to have approximately 30% volume settlement. Once mixed together with the loaders and mixed and spread with a dozer, the material loses volume as its density increases. The material is anticipated to further lose volume after spreading to a minimum depth of 60 cm in 2020.

Operations

The soil blend of 1(biosolids):2(wood chips):3(sweepings) was determined by bench scale testing (Technical Memorandum Bench-Scale Soil Fabrication for Use at Summit Landfill May 11, 2018). Feedstock ratios were tracked through loader bucket counts.

Year Two operations utilized 18,015 m³ of biosolids, approximately 36,000 m³ of wood chips and 54,000 m³ of street sweepings. The material for both phases was layered and left in windrows before spreading. Approximately half of the fabricated soil (Y2P1 & Y1P2) was spread using a dozer in the fall of 2019. The soil plot covered 5 ha. Year Two Phase Two (Y2P2) fabricated soil was windrowed and will finish being spread in the spring of 2020. The total area to be covered and seeded in the spring of 2020 is anticipated to be around 10 ha. Site layout and photographs from the operation can be found in Appendix A.

Due to the presence of rocks in the windrows, the original plan to mix with a windrow turner was reassessed. A dozer and discer pair was tested to assess the mixing capability. This method worked effectively and will continue in Year 3.

Environmental Results

Weather

Operational conditions in Year Two ranged from 14°C to -27°C. Operations were manageable across the temperature range. Cold weather conditions were conducive to operations due to solid travel surfaces. Wet weather conditions required more on-site flexibility and maintenance of travel surfaces.



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Odour

Biosolids odour was detected in the operating area during biosolids receiving operations. Odours were observed to be reduced after mixing biosolids with woodchips and street sweepings. No odour complaints were received through 311 or other public sources.

Soil

The Year One Phase One plot was sampled on April 4th, 2019 prior to being seeded with a cover crop of oats. Soil for this plot was mixed and spread using a manure spreader in the fall of 2018. The plot was split up into four even quadrants. Five samples from each quadrant were then taken at a depth of 0-60 cm and amalgamated to make one composite sample per quadrant (Appendix B). These samples were taken at the same location as the background samples of the clay cap taken in May 2018, and are labelled as such (ie. 1.1, 1.2, 1.3, 1.4). Results show that the material meets Canadian Council of Ministers of the Environment (CCME) Recommended Canadian Soil Quality Guidelines for Industrial uses.

Further soil samples were taken of various spread plots to assess the mix was created using a dozer, and subsequently a pull-behind discer. These samples were visually analyzed for homogeneity of material, showing a good level of amalgamation with very few isolated pockets of singular material.

Vegetation

The Year One Phase One plot was seeded with a cover crop of oats in spring, 2019. The plot had good weed suppression, strong even growth of oats, with a dark green colour. The oats were mowed three times over the growing season to reduce self-seeding in anticipation of over seeding with native grasses in 2020. A vegetation survey was completed using an aerial photograph of the seeded area taken on October 24th, 2019. A 15m by 15m grid was placed over the plot, and squares were chosen at random to be analyzed for density growth. Of the 88 - 15m² squares a representative sample 11 of these squares were selected at random to be analyzed. Three Environmental Technologists analyzed each square independently, quantifying the amount of immature (Green) vegetation, mature (Brown) vegetation and bare earth (Black). An average was taken from these observations, showing almost 92% vegetation coverage of the plot (Appendix C).

This method does not distinguish between oats and weed growth. However, visual observation taken in the field over the summer months noted that weed growth was at a minimum in the designated area.

No additional seeding was done in 2019 before the end of the optimal spring seeding window, and the extremely wet September and October, followed by cold temperatures at the end of October and beginning of November.



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Surface Water

The project is located within the boundaries of the Summit Road Landfill surface water system. This system captures runoff from the spread plots on the west side of the site. A sample was taken upstream of the Y1P1 plot (SWQ-18-SF-P1-Upstream), downstream of the Y1P1 plot (SWQ-18-SF-P1-Downstream). These were compared against the control plot with a sample taken downstream of the control plot (SWQ-18-SF-C-Downstream). No water was present upstream of the control. This runoff was sampled in early April after the spring thaw, and results were compared to CCME surface water guidelines (Appendix D). Nitrate and Nitrite-N did not exceed surface water guidelines. Ammonia was high downstream of both the control and fabricated soil plots. Nitrogen parameters were highest downstream of the control plot, while phosphorus was highest upstream of the fabricated soil plot. These results indicate that there is no clear correlation that soil fabrication directly impacts surface water quality.

Vectors

No vectors were observed during the operational phase.

Dust, noise, nuisance

There were no dust, noise or nuisance concerns during operations.

Year Three

Year Three will increase the volume of biosolids received over two, three-month long biosolids receiving operational phases. Year Three will include spreading and seeding operations, and environmental monitoring including surface water, soil, and vegetation monitoring and analysis. Additionally, testing of additional mineral feedstocks, including lime mud, is expected in 2020. The timeline is roughly as follows:

- Y3P1 Biosolids receiving operation, mixing and spreading: January 20th to April 24th 2020
- Seeding: Spring
- Surface water and soil sampling: Spring
- Y3P2 Biosolids receiving operation: September 28th to December 31st, 2020

Pilot Project Completion

As per the MCC approval for the pilot project, this three year pilot will end on December 31st, 2020. The final report will be submitted by June 30, 2021.

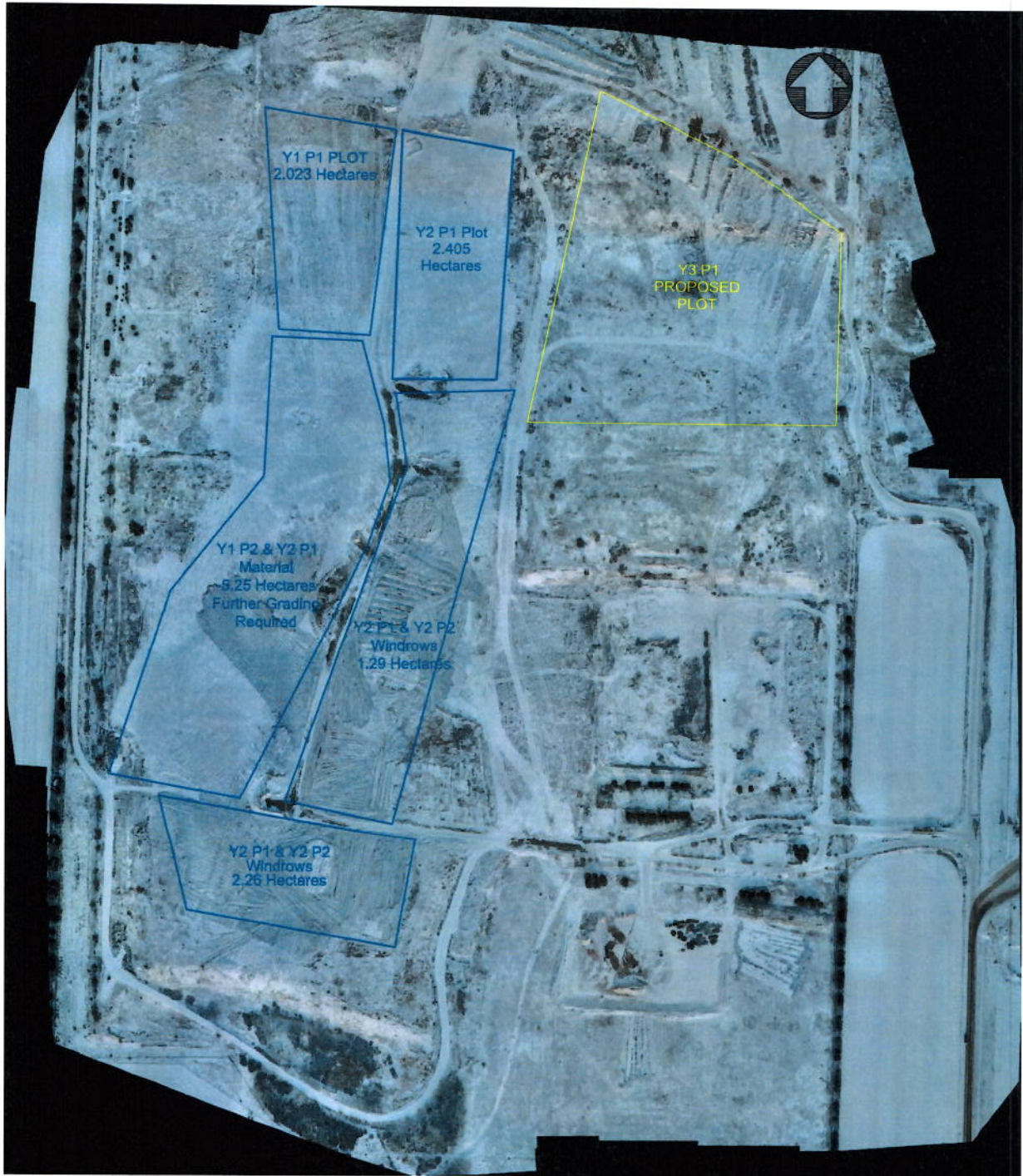
Appendix A
Soil Fabrication Plots - Summit Landfill
Aerial Taken May 8th, 2019



Appendix A
Soil Fabrication Plots - Summit Landfill
Aerial Taken October 25th, 2019



Appendix A
Soil Fabrication Plots - Summit Landfill
Aerial Taken December 6th, 2019



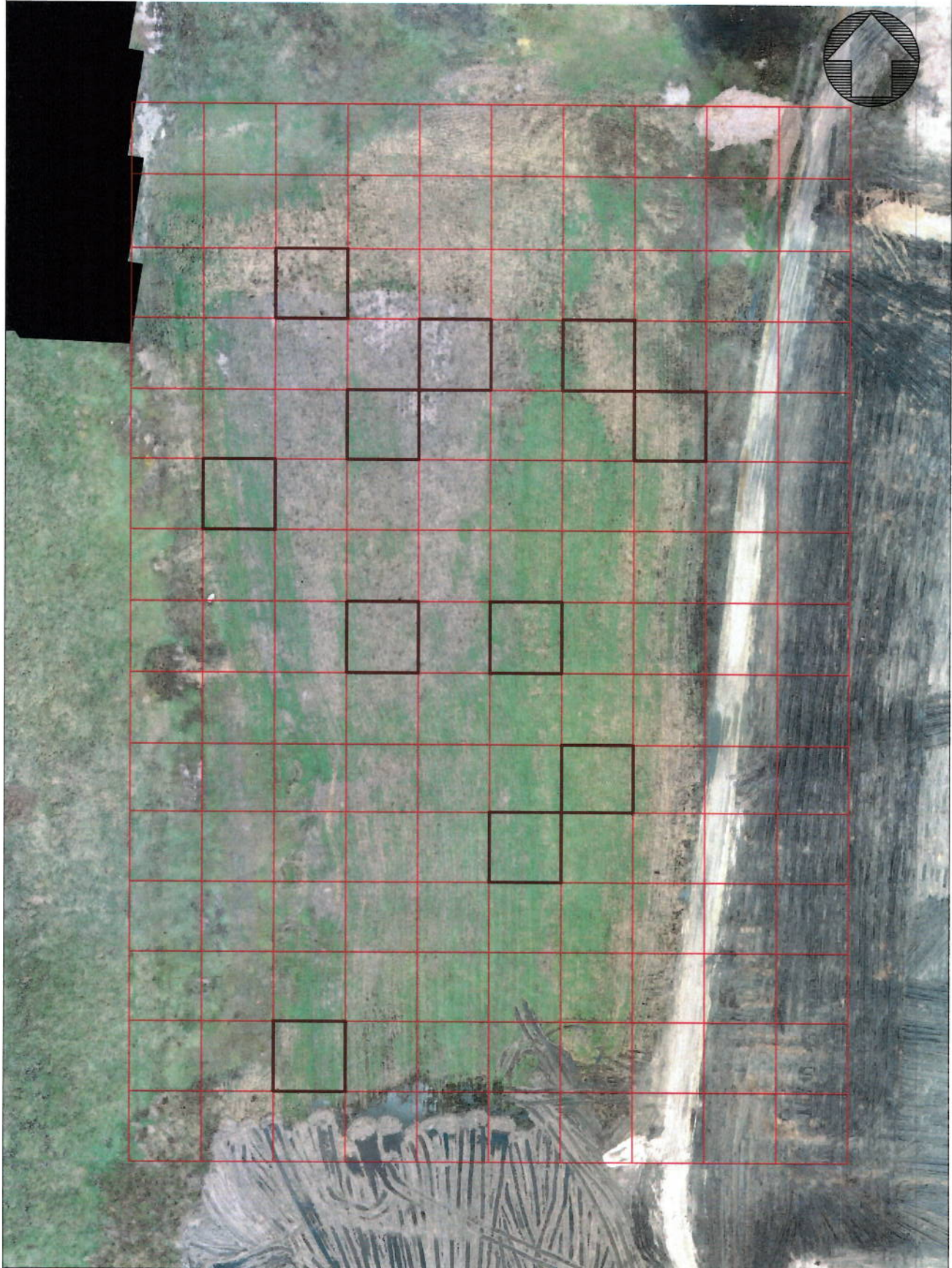
Appendix B - Soil Sampling Results
Summit Soil Fabrication Pilot Project

Sample No.	Description	Date	Aluminum (Al)	Antimony (Sb)	Arsenic (As)	Barium (Ba)	Beryllium (Be)	Bismuth (Bi)	Boron (B)	Cadmium (Cd)	Calcium (Ca)	Chromium (Cr)	Cobalt (Co)	Copper (Cu)	Iron (Fe)	Lead (Pb)	Magnesium (Mg)	Manganese (Mn)	Mercury
SS.18.0	Control Pit	5/8/2018	13900	0.33	4.99	138	0.59	0.155	13	0.165	78900	30.7	8.04	19.3	16900	18.4	35400	353	
SS.18.1.1	Y1P1 Pit - Clay Cap	5/7/2018	15400	0.44	5.97	141	0.65	0.162	13	0.208	68600	37.1	8.57	23.5	18900	24.8	29500	362	
SS.18.1.2	Y1P1 Pit - Fabricated Soil	4/23/2019	6270	0.63	3.02	60.8	0.31	0.058	11	0.296	96900	31.7	4.73	54.5	12800	18.4	41400	296	0.0688
SS.18.1.3	Y1P1 Pit - Clay Cap	5/7/2018	16500	0.53	5.79	161	0.7	0.181	15	0.222	62800	33.6	8.93	29.7	20000	105	28100	410	
SS.18.1.4	Y1P1 Pit - Fabricated Soil	4/23/2019	5560	0.5	2.54	64.7	0.27	0.029	11	0.278	100000	28	4.15	39.8	10200	14.3	41900	215	0.0487
SS.18.1.5	Y1P1 Pit - Clay Cap	5/8/2018	14400	0.44	5.29	152	0.6	0.163	15	0.248	77000	31.7	8	22.4	17400	36.9	33900	362	
SS.18.1.6	Y1P1 Pit - Fabricated Soil	4/23/2019	3940	0.54	1.88	53.1	0.18	1.03	<10	0.275	91400	28.9	3.08	42.1	9450	12.1	36700	181	0.0774
SS.18.1.7	Y1P1 Pit - Clay Cap	5/8/2018	13000	0.41	4.74	132	0.57	0.148	14	0.21	78900	33.4	7.35	20.8	16500	23.7	34000	340	
SS.18.1.8	Y1P1 Pit - Fabricated Soil	4/23/2019	4780	0.58	2.28	65.1	0.22	1.21	10	0.339	96900	43.3	3.58	54.7	10200	23.3	37900	183	0.0731
SPREAD #1 (Broomhuts)	Test Spread - Membrane Spreader	6/18/2018	3990	0.72	1.88	55	0.14	1.66	<10	0.329	92400	47	2.88	61.6	11200	14.3	39400	184	0.0853
SPREAD #2 (Excavator Mats)	Test Spread - Membrane Spreader	6/18/2018	6940	0.64	3.39	86.1	0.31	0.9	11	0.272	91000	45.9	4.64	43.5	12200	69.4	37300	244	0.101

Sample No.	Description	Date	Molybdenum (Mo)	Nickel (Ni)	Phosphorus (P)	Potassium (K)	Selenium (Se)	Silver (Ag)	Sodium (Na)	Strontium (Sr)	Tantalum (Ta)	Tin (Sn)	Titanium (Ti)	Uranium (U)	Vanadium (V)	Zinc (Zn)
SS.18.0	Control Pit	5/8/2018	0.62	24.4	420	2710	-0.50	<0.10	267	64	0.18	<5.0	119	0.818	41.6	56
SS.18.1.1	Y1P1 Pit - Fabricated Soil	5/7/2018	0.74	28.6	470	3040	-0.50	<0.10	336	63.9	0.22	<5.0	139	0.984	45.7	80
SS.18.1.2	Y1P1 Pit - Clay Cap	4/23/2019	1.24	20	1300	1500	-0.50	0.53	423	66.8	<0.10	<5.0	95.1	1.09	21.3	156
SS.18.1.3	Y1P1 Pit - Fabricated Soil	5/7/2018	0.66	27.8	470	3230	-0.50	<0.10	384	70.1	0.22	<5.0	185	0.995	49.6	77
SS.18.1.4	Y1P1 Pit - Clay Cap	4/23/2019	1.07	18.3	1170	1380	-0.50	0.37	326	58.1	<0.10	<5.0	89.8	0.915	18.4	136
SS.18.1.5	Y1P1 Pit - Fabricated Soil	5/8/2018	0.67	25.6	480	2850	-0.50	<0.10	360	73.9	0.2	<5.0	157	1.13	44	82
SS.18.1.6	Y1P1 Pit - Clay Cap	4/23/2019	1.23	11.9	1350	1160	-0.50	0.42	408	56.1	<0.10	<5.0	68.7	0.911	13.4	154
SS.18.1.7	Y1P1 Pit - Fabricated Soil	5/8/2018	0.75	24.3	410	2600	-0.50	<0.10	322	68.9	0.18	<5.0	148	0.96	38.9	65
SS.18.1.8	Y1P1 Pit - Clay Cap	4/23/2019	1.31	17	1620	1360	-0.50	0.43	365	61.5	<0.10	<5.0	60.7	1.08	16	166
SPREAD #1 (Broomhuts)	Test Spread - Membrane Spreader	6/18/2018	2.01	15.4	2090	1190	-0.50	0.63	460	56.4	<0.10	<5.0	53.6	1.29	13	213
SPREAD #2 (Excavator Mats)	Test Spread - Membrane Spreader	6/18/2018	1.48	17	1190	1750	-0.50	0.42	576	62.9	<0.10	<5.0	80.7	1.23	23.2	149

COMS Soil Quality Guidelines for the Protection of Environment and Human Health - Industrial Database
 Concentrations of COME - highlighted in yellow
 * Detection Limit (Mass Custom required due to high concentration of base analyte)

**Appendix C - Vegetation Survey Grid
Soil Fabrication - Summit Landfill
Aerial Taken October 25th, 2019**



Appendix C - Vegetation Sampling Results
Summit Soil Fabrication Pilot Project - Y1P1 PLOT

Summit Fabricated Soil Vegetation Survey - Y1P1 Plot										
Date	Plot	Sample ID	Analyzer	% Immature Oats & Husk (Green)	% Mature Oats (Brown)	% Bare Earth (Black)	% Total Foliage	Totals	Comments	
10/24/2019	Y1P1	1	Averages	7.33%	74.33%	18.33%	81.67%			
		2	Averages	0.00%	70.00%	30.00%	70.00%			
		3	Averages	32.67%	66.67%	0.33%	99.67%			
		4	Averages	37.67%	53.33%	9.00%	91.00%			
		5	Averages	35.00%	56.67%	6.67%	91.67%			
		6	Averages	63.33%	31.67%	5.00%	95.00%			
		7	Averages	14.33%	81.67%	4.00%	96.00%			
		8	Averages	81.33%	14.67%	4.00%	96.00%	Average Immature Oats & Husk:	46.85%	
		9	Averages	88.67%	11.00%	0.33%	99.67%	Average Mature Oats:	44.94%	
		10	Averages	82.67%	11.67%	5.33%	94.33%	Average Bare Earth:	9.82%	
		11	Averages	72.33%	22.67%	25.00%	95.00%	Total Foliage:	91.82%	

**Appendix D - Surface Water Sampling Results
Summit Soil Fabrication Pilot Project**

Sample No.	Date	Parameters						
		Ammonia, Total (as N) mg/L	Nitrate and Nitrite as N mg/L	Nitrate (as N) mg/L	Nitrite (as N) mg/L	Total Kjeldahl Nitrogen mg/L	Orthophosphate-Dissolved (as P) mg/L	
Units								
CCME Guidelines								
SWQ-1B-SF-C-Downstream(DS)	4/23/2019	1070	31	31	60 NO 2 N <5.0 *	7410	19.1	
SWQ-1B-SF-P1-Upstream(US)	4/23/2019	15	<5.1	<5.0	<1.0	1710	136	
SWQ-1B-SF-P1-Downstream(DS)	4/23/2019	15	<5.1	<5.0	<1.0	2830	13.4	

CCME Water Quality Guidelines for the Protection of Aquatic Life - Freshwater

Exceedances of CCME - Highlighted in Yellow

* Detection Limit Raised: Dilution required due to high concentration of test analyte(s)

**Appendix D - Surface Water Sampling Results
Summit Soil Fabrication Pilot Project**

Location ⁽⁴⁾	Date	Field pH (units)	Field Temp. (°C)	Temp. (°K)	pKa ⁽¹⁾	f ⁽²⁾	Unionized Ammonia (mg/L)	Ammonia as N
CCME							0.019	0.01600
<u>SWQ-18-SF-C-Downstream(DS)</u>	4/23/2019	7.1	9.7	283.85	9.707654	0.002462	2.634263652	1070
<u>SWQ-18-SF-P1-Upstream(US)</u>	4/23/2019	7.5	10.6	284.75	9.677256	0.006605	0.09907336	15
<u>SWQ-18-SF-P1-Downstream(DS)</u>	4/23/2019	7.7	10.2	284.35	9.690743	0.010112	0.151682182	15

Notes:

1. $pKa = 0.09018 + 2729.92/T$, where T = Temperature in Kelvins

2. $f = 1 / (10^{(pKa - pH)} + 1)$

3. Unionized Ammonia = (f) x (Ammonia)

Ammonia as N can be converted from Total Ammonia by multiplying the Total Ammonia by 0.8224; the guideline for Ammonia as N is 0.016

CCME Water Quality Guidelines for the Protection of Aquatic Life - Freshwater

Exceedances of CCME - Highlighted in Yellow

* Detection Limit Raised: Dilution required due to high concentration of test analyte(s)

Appendix D - Surface Water Sampling Results
Summit Soil Fabrication Pilot Project

Soil Fabrication Surface Water Sampling Field Parameters

Year Two - Phase One

DATE: 4/23/2019

WEATHER	TEMP ©	HUMIDIT Y %	BAR	WIND S KM/h	WIND D	CONDITIONS
	15°C	54.00%	101.74	5	SSW	Sunny

FIELD REPS: BM/NH

SWQ-18-SF-C-Downstream(DS)

ARRIVAL TIME: N/A SAMPLE TIME: 13:10

COMMENTS

Down Stream of Control

Temp (©)	pH	Cond (mS/cm)	Turb (NTU)	Dissolved Oxygen	Flow
9.7	7.1	1.28	5.18	7.7	0

SWQ-18-SF-P1-Upstream(US)

ARRIVAL TIME: N/A SAMPLE TIME: 12:45

COMMENTS

Up Stream of Phase One

Temp (©)	pH	Cond (mS/cm)	Turb (NTU)	Dissolved Oxygen	Flow
10.6	7.5	0.34	9.18	4.95	0

SWQ-18-SF-P1-Downstream(DS)

ARRIVAL TIME: N/A SAMPLE TIME: 13:00

COMMENTS

Down Stream of Phase One

Temp (©)	pH	Cond (mS/cm)	Turb (NTU)	Dissolved Oxygen	Flow
10.2	7.7	0.28	5.18	3.51	0