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Derwent Way Soil Transfer and Barge Facility Environmental Air Assessment

PRESENTED TO

Summit Earthworks

#109-32885 Mission Way
Mission BC V2V 6E4

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EXECUTIVE SUMMARY

This air assessment report is part of Summit Earthworks' application to Port Metro Vancouver for a proposed soil transfer and barge facility located adjacent to the Derwent Way swing bridge at the eastern portion of Lulu Island, New Westminster. The assessment follows guidance provided by Port Metro Vancouver in 'Project & Environmental Review: Guidelines – Environmental Air Assessment.'

Proposed facility-related activities will produce low levels of fugitive dust – due mainly to dumping and shovelling of soils, diesel-powered vehicle and equipment exhaust and potentially VOCs from contaminated soils which are temporarily stockpiled on the property. With the installation of a tree line barrier along the western property boundary and following protocols to accept only soils which contain VOC concentrations not exceed Industrial Levels as defined in BC Ministry of Environment's Contaminated Sites Regulations, air quality impacts on nearby residents are not anticipated to occur. However, it is recommended to conduct periodic air sampling for both particulate matter and VOCs west of the property once the facility is operational to ensure air quality objectives are not exceeded and that VOC concentrations in the air remain typical of background levels for Metro Vancouver.

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ACRONYMS & ABBREVIATIONS

Acronyms/Abbreviations	Definition
BC	Black Carbon
CO	Carbon Monoxide
CSR	Contaminated Sites Regulations (BC Ministry of Environment)
DPM	Diesel Particulate Matter
HC	Hydrocarbons
hp	Horsepower
MV	Metro Vancouver
NO_2	Nitrogen Dioxide
NO_x	Oxides of Nitrogen
O_3	(Ground-level) Ozone
PAH	Polycyclic Aromatic Hydrocarbons
$PM_{2.5}$	Particulate Matter smaller than 2.5 microns
PM_{10}	Particulate Matter smaller than 10 microns
PMV	Port Metro Vancouver
SO_2	Sulphur Dioxide
TEX	Toluene, Ethylbenzene, Xylene
TPM	Total Particulate Matter (used to describe fine and coarse size-fractions, also TSP)
USEPA	United States Environmental Protection Agency (also EPA)
VOC	Volatile Organic Compounds

LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of Summit Earthworks and their agents. Tetra Tech Canada Inc. (Tetra Tech) does not accept any responsibility for the accuracy of any of the data, the analysis, or the recommendations contained or referenced in the report when the report is used or relied upon by any Party other than Summit Earthworks, or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. Use of this report is subject to the terms and conditions stated in Tetra Tech Canada Inc.'s Services Agreement. Tetra Tech's General Conditions are provided in Appendix A of this report.

1.0 INTRODUCTION

Tetra Tech EBA Inc. (Tetra Tech EBA) was retained by Summit Earthworks to conduct an air assessment for a proposed soil transfer and barge facility (herein referred to as '*the property*', '*the facility*' or '*the site*') located on Salter St., adjacent to Derwent Way in New Westminster, BC. The methodology for the assessment follows guidance provided by Port Metro Vancouver (PMV) in '*Project & Environmental Review Guidelines – Environmental Air Assessment*'.

This report is the second revision of the initial Environmental Air Assessment originally submitted August 2016.

1.1 Facility Overview

The facility will be located adjacent to the Derwent Way swing bridge at the eastern end of Lulu Island (New Westminster) on the northern bank of Annacis Channel (a side channel of the South Arm of the Fraser River), near other industrial/commercial properties. The open air facility will serve as a transfer station for soils removed during excavation at construction sites throughout Metro Vancouver. Such sites may be designated under the BC Ministry of Environment's Contaminated Sites Regulations (CSR) as industrial land use. As a result, the soils may contain volatile organic compounds (VOC) at concentrations not exceeding Industrial Levels defined by the CSR.

Soils will be received at the facility and temporarily placed into stockpiles, not exceeding 5 m in height, in a designated storage area on the property. Depending on throughput, soils will be loaded once or twice weekly onto a barge via conveyor and towed by tug 48 km up the Fraser River to Summit Earthworks Inc.'s landfill facility, located at 7252 River Place, Mission, BC for further handling and treatment.

The facility will receive and handle between 15 and 60 dump truck loads of soil per day. Trucks will access the facility from Salter St. via Derwent Way. Trucks will first enter the scale area to be weighed and then and unload their contents into the receiving area. Facility equipment will consist of a single backhoe/loader for handling soils on the property and will employ the use of a dump truck once or twice weekly to facilitate loading of the barge.

The facility will be operational weekdays, during normal business hours.

2.0 PROJECT DESCRIPTION

2.1 Project Overview

As described in Section 1.1, the proposed facility will accept excavated soils from industrial land use sites throughout Metro Vancouver which potentially contain VOCs. The facility will only receive soils which meet Industrial Level standards as defined by the CSR.

2.2 Baseline Case

The facility is proposed and the site is currently unoccupied. Baseline air quality is described in Section 5.1.

2.3 Project Case

The facility is expected to receive a throughput of between 15 and 60 loads of soil per day, transferred by typical construction-type dump trucks. Load capacity will vary, however assuming an average payload of 22,600 kg (CAT Specifications: Model CT660), the facility would expect to receive between 340 and 1360 tonnes of soil a day, or 4250 tonnes per week on average.

Material throughput will be unloaded in the receiving area, and transferred into stockpiles. Once or twice weekly, stored soils will be transferred via standard dump truck to a barge moored in Annacis Channel and towed via river or harbour tug to Summit Earthworks Inc.'s landfill facility in Mission, BC.

2.4 No Project Case

The facility is proposed and does not currently exist, therefore the No Project case, with respect to the local air quality, is described by the existing baseline conditions.

3.0 GEOGRAPHIC SCOPE

3.1 Facility

For the purpose of the air assessment, the geographic extent of the facility is considered to be areas within the property boundaries, the barge, the maneuvering zone of the tug immediately adjacent to the property, and the portion of Salter St. used as access by incoming trucks. The geographic extent of the facility boundaries is shown as a blue shaded area in Figure 3.1.

3.2 Supply Chain

The geographic extent of the supply chain extends along the Fraser River between the site and Summit Earthworks Inc.'s landfill facility in Mission, representing the tugboat and barge route. On land, it is assumed for the purpose of the air assessment that the geographic extent of the supply chain is limited to local roads which access the property from Highways 91 and 91A. It is assumed that two general routes will be used to access the property:

- Boyd St. and Derwent Way for vehicles accessing from the north (via Queensborough Bridge) and from the west (via Highway 91); and
- Cliveden Ave. (including the off ramp from Hwy 91), Belgrave Way and Derwent Way for vehicles accessing from the south (via Alex Fraser Bridge).

The geographic extent of the supply chain boundaries is shown in Figure 3.1 as yellow lines.

3.3 Receiver Identification and Proximity

The facility will be located at the eastern end of Lulu Island adjacent to other industrial and commercial properties. The community of Queensborough, located west/northwest of Derwent Way is residential. The property line of the closest resident (on Salter St. at Pembina St.) is 55 m from the facility boundary. A townhouse development west of Pembina St. between Salter St. and S. Dyke Rd., is situated west of the property with the closest residence approximately 100 m from the facility boundary. The entire townhouse complex as well as 18 individual residences are located within 200 metres of the facility boundary.

Table 3.1 summarizes the distance and direction from the proposed facility to public (non-residential) areas and locations of interest in the community of Queensborough. Figure 3.2 shows the community of Queesnborough and the location of the identified sites of interest relative to the proposed facility. Radial distances from the western property line are also shown on the figure for reference.

Table 3.1 – Summary of Non-Residential Sensitive Locations of Interest near Proposed Facility

Public Area/Location of Interest	Type	Distance from Proposed Facility	Direction
New West Montessori Daycare	School	420 m	W
Queensborough Middle School	School	520 m	WSW
Queen Elizabeth Elementary School	School	820 m	WSW
Holy Spirit Catholic Church	Public Gathering	650 m	W
Queensborough Community Center	Public Gathering	770 m	WSW
Old Schoolhouse Park	Park	250 m	NNW
Queensborough Skatepark & Playground	Park	680 m	WSW

4.0 EMISSION SOURCES

4.1 Primary Sources

Emission sources from facility-related activities are summarized as follows:

- on-site loader (used for transferring received soil into storage piles, truck loading)
- transiting dump trucks (containing soil received at the facility for temporary storage)
- on-site dump truck (used for transferring soils from the stockpile to the barge once or twice weekly)
- tug (used for towing the barge once or twice weekly between the facility and the Mission landfill site)
- soil storage piles
- dust from facility access road (paved with medium silt content)
- dust from existing Metro Vancouver road network to access the facility (paved with low silt content)

4.2 Emission Variability

The facility will be operational five days a week, with normal operational hours – opening between 7 and 8 AM and closing between 4 and 6 PM. Daily operations will vary based on the throughput of received soils, typically between 15 and 60 loads daily. The barge will be loaded once or twice weekly, depending on weekly throughput, and towed by tug to the landfill site in Mission. Barge loading may occur any day(s) of the week and is expected to occur throughout the day. Barge loading may also occur over multiple days.

Peak activity hours are assumed to begin shortly after the opening of the facility as regional construction activities commence and soils arrive at the facility and would be expected to follow the activity schedule of typical construction sites (subsiding during lunch hour and towards the end of the operational day).

Fugitive dust emissions would be expected to show some seasonal variability corresponding with regional climate, with slightly higher levels of dust emission generally expected during the drier spring and summer months and slightly lower levels generally expected in the fall and winter due to natural mitigation from increased precipitation.

4.3 Pollutants of Concern

The major pollutant of concern is fugitive particulate matter originating from the handling and storage of soils and re-suspended road dust. Particulate matter is further defined in terms of size-fractions: TPM – total particulate matter, PM_{10} – defined as particles smaller than 10 microns and $PM_{2.5}$ – defined as particles smaller than 2.5 microns. PM_{10} and $PM_{2.5}$ are respirable and long-term exposure can potentially lead to respiratory and other health issues. Larger fraction particulate matter, or dust, falls out of suspension close to the source. Consistent facility-related dust deposition in quantifiable amounts could be considered a nuisance for nearby residences.

Of secondary concern is the potential release of VOCs contained in the pore space of received soils. Excavated soils from sites classified as ‘Industrial Land Use’ may contain various hydrocarbons and organic chemicals which may be toxic with repeated and long-term exposure to elevated levels. Prevalent VOC species potentially contained in industrial land use soils consist of benzene, TEX (toluene, ethylbenzene, xylene) and polycyclic aromatic hydrocarbons (PAH) such as naphthalene and benzo(a)pyrene. VOC emissions from excavated soils typically peak immediately following a disturbance event (such as shovelling) and subside rapidly to negligible levels as the soil cap re-settles and pore space gas re-establishes equilibrium (USEPA 1989). Studies have shown that the majority of organic compound vapours are volatized during the excavation process (USEPA 1989).

Of tertiary concern are diesel-powered equipment and vehicle exhaust emissions consisting of SO_2, NO_x, CO and smaller fraction $PM_{2.5}$, consisting largely of diesel particulate matter (DPM). DPM consists of a variety of organic chemicals which can cause health issues with repeated exposure to significant concentrations.

5.0 CURRENT CONDITION

5.1 Local Ambient Air Quality

The proposed facility is located at the eastern end of Lulu Island on the north side of Annacis Channel, near the residential community of Queensborough, New Westminster. The area of Lulu Island in the vicinity of the proposed facility is light industrial/commercial consisting of shipping facilities, lumber yards and container yards. The easternmost end of Lulu Island, is primarily residential. Port Metro Vancouver - WWL is located at the northern end of Annacis Island, 250 m across Annacis Chanel. Port Metro Vancouver - Fraser Surrey Docks are located 1.3 km southeast of the facility across the South Arm of the Fraser River. The area north of Fraser Surrey Docks, along South Fraser Perimeter Road is entirely commercial/industrial. The City of New Westminster, containing higher density residential and commercial areas is 2 km to the northeast.

Local ambient air quality is inferred from annual Metro Vancouver (MV) air quality monitoring summaries from nearby stations - locations shown in Figure 5.1. The annual summary reports list the maximum recorded concentrations for various contaminants over the averaging periods defined by Metro Vancouver Air Quality Objectives. The stations used for the analysis report the following:

- MV station North Delta (T13): NO_2, $PM_{2.5}$, ground-level O_3

- MV station Richmond South (T17): SO_2, NO_2, CO, $PM_{2.5}$, ground-level O_3
- MV station Burnaby South (T18): SO_2, NO_2, CO, PM_{10}, $PM_{2.5}$, ground-level O_3 and black carbon (BC)

Local air quality is presented in Table 5.1 as the maximum recorded concentration at each station in 2013 and 2014, along with the relevant Metro Vancouver Ambient Air Quality Objective for each contaminant/averaging period where applicable.

Table 5.1 – Metro Vancouver Ambient Air Quality Objectives and Local Air Quality (2013 & 2014)

Contaminant	Averaging Period	MV Air Quality Objective ug/m^3 (or ppb)	Maximum Recorded Concentration ug/m^3 (or ppb)					
			Burnaby South		Richmond South		North Delta	
			2014	2013	2014	2013	2014	2013
CO	1-hour	30,000	1,307	1,346	2,569	2,371	-	-
	8-hour	10,000	1,080	1,196	1,389	1,495	-	-
	Hourly Average	-	*250*	*250*	*220*	*230*	-	-
NO_2	1-hour	200	53	86	56	95	80	89
	Annual	40	26	27	24	24	14	26
SO_2	1-hour	196	8	23	6	17	-	-
	24-hour	125	3	7	2	5	-	-
	Annual	30	0.6	1.5	0.4	1.4	-	-
Ground Level O_3	1-hour	(82 ppb)	49 ppb	50 ppb	56 ppb	52 ppb	55 ppb	52 ppb
	8-hour	(65 ppb)	43 ppb	44 ppb	47 ppb	47 ppb	49 ppb	46 ppb
	Hourly Average	-	*17 ppb*	*16 ppb*	*16 ppb*	*17 ppb*	*16 ppb*	*18 ppb*
PM_{10}	24-hour	50	34	30	-	-	-	-
	Annual	20	10	10	-	-	-	-
$PM_{2.5}$	24-hour (Rolling Avg.)	25	30	24	28	30	27	18
	Annual	8	6.2	6.1	5.9	6.9	6.6	5.8
Black Carbon (BC)	1-hour	n/a	9.9	-	-	-	-	-
	24-hour (Rolling Avg.)	n/a	4.3	-	-	-	-	-
	Annual	n/a	0.6	-	-	-	-	-

The main emission sources in Metro Vancouver are described for the contaminants listed in Table 5.1 as follows along with relevance of the local readings to the air quality in the vicinity of the site:

- Over 94% of CO emissions in Metro Vancouver come from mobile sources and non-road engines. Likewise, the highest concentrations of NO_2 are measured in more densely trafficked areas, such as the arterial roads of New Westminster, Burnaby, North Delta and Surrey. The community of Queensborough and Annacis Island are lower-trafficked areas.

- Emissions of NO_2 (the reported form of NO_x) is dominated by mobile sources, namely cars and on-road trucks, non-road equipment and marine vessels. Natural gas use in homes, offices and industry also plays a role in NO_2 emissions. Regionally, NO_2 concentrations are highest in the most populated areas with the highest amount of vehicle and marine traffic (Vancouver and Richmond) and decrease to the east.

- Ocean-going vessels are the largest source of SO_2 emissions in Metro Vancouver, hence the highest concentrations regionally are observed around Burrard Inlet. SO_2 levels in the vicinity of the proposed facility are much lower in comparison and would be expected to be similar to nearby stations.

- Ozone (O_3) is a major pollutant formed when NO_X and reactive VOCs react chemically in the presence of heat and sunlight. The highest levels generally occur in the eastern parts of Metro Vancouver and the Fraser Valley, downwind of major precursor emissions. Local readings would be expected to be similar to nearby stations.

- PM_{10} is emitted from a variety of localized sources with the largest contribution from road dust. Other major contributors to PM_{10} are transportation, construction and demolition, agriculture and industry. Natural sources of PM_{10} include wind-blown soil and forest fires. The local area is not heavily-trafficked and is a suburban/industrial area generally free of major sources of loose dust. Readings would be expected to be similar or lower than at nearby stations

- Emissions of $PM_{2.5}$ are dominated by heating, transportation and industrial sources and non-road diesel engines. $PM_{2.5}$ can be transported long distances in the air from natural sources such as large forest fires. Secondary $PM_{2.5}$ is formed by reactions of NO_X and SO_2 with ammonia in the air - mainly from agricultural sources - and accounts for a significant percentage of $PM_{2.5}$ in summer. Local $PM_{2.5}$ levels would be expected to be similar to nearby station readings.

- Black carbon (BC) is formed by the incomplete combustion of fossil fuels, biofuels, and biomass, and is emitted directly in the form of fine particulate matter ($PM_{2.5}$). Mobile sources contribute 80% of BC emissions in Metro Vancouver. Diesel fuelled non-road engines, heavy duty vehicles and marine vessels are other significant sources. Black carbon concentrations are generally greater on weekdays. There are no provincial, federal or Metro Vancouver objectives for black carbon. Local readings would be expected to be slightly higher than nearby stations due to the general industrial nature of the area and the greater number of diesel-powered vehicles and equipment.

5.2 Meteorological Influences

Predominant winds in the vicinity of the site were determined from hourly wind data recorded at Metro Vancouver's air quality network instrument testing station at Annacis Island (T38) located at 49.1657º N 122.9607º W (Figure 5.1). Data was analyzed for the period January 2009 to October 2012.

Figure 5.2 shows the period of record wind rose. Annually, predominant winds are from the northeast with south-southeasterly and westerly winds occurring with secondary predominance. Figure 5.3, illustrates the seasonal wind pattern as wind roses for winter (December, January and February) and summer (June, July and August). The winter figure, left, shows that northeasterly winds, most commonly associated with Fraser Valley outflows, are the typical winter pattern. The summer figure, right, shows southerly winds, most commonly associated with high pressure, and westerly winds, associated with the sea breeze, are the typical summer patterns.

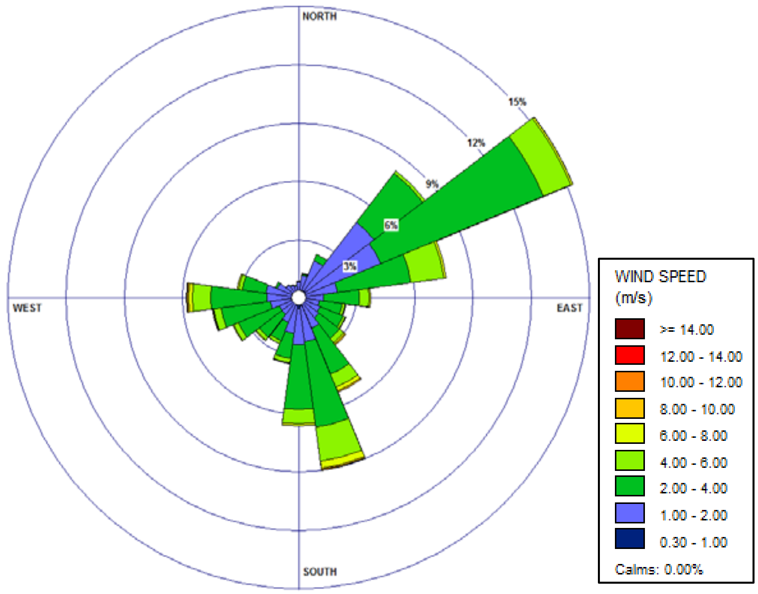

Figure 5.2 – Annacis Island Wind Roses Metro Vancouver Annacis Island Station T38

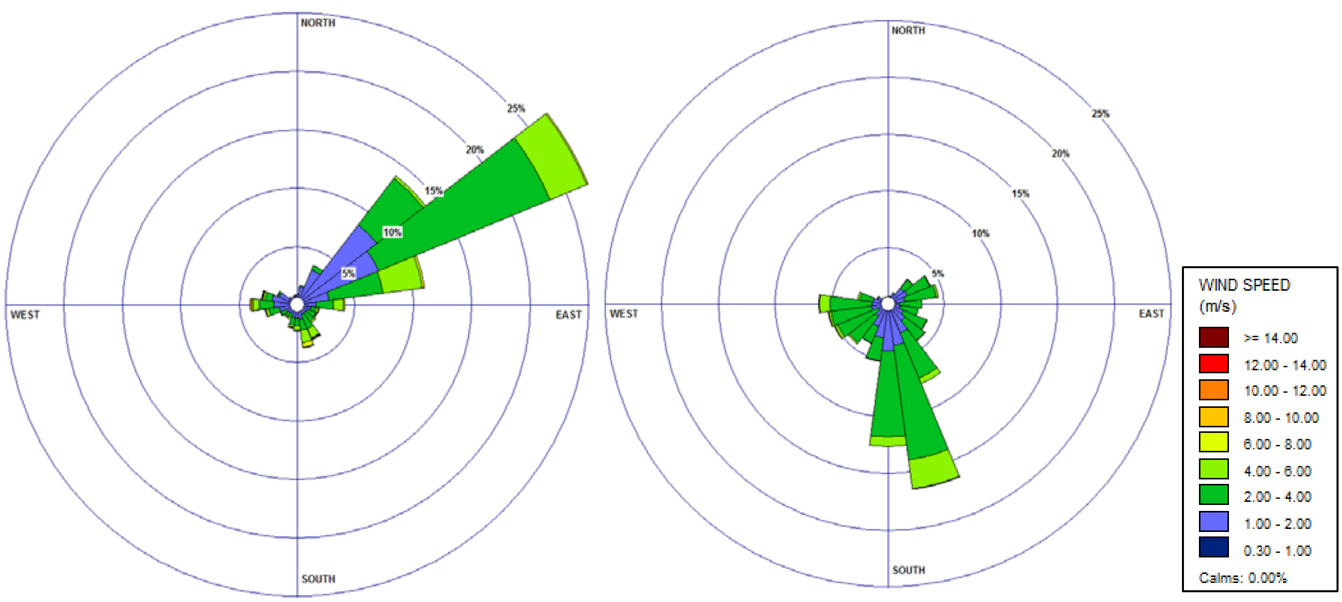

Figure 5.3 – Winter (DJF) Wind Rose (left) Summer (JJA) Wind Rose (right)

The predominant winds indicate that the project area is subjected to the downwind transport of air contaminants from New Westminster and the industrial/commercial areas along the Fraser River in the vicinity of Fraser Surrey Docks as well as from Annacis Island. Winds also indicate that air contaminant emissions generated from site would most commonly transport to areas west/southwest and north-northwest of the proposed facility.

5.3 Historical Trends

The facility currently does not exist and the proposed location is vacant.

6.0 FUTURE CONDITION

It is expected that the throughput estimates provided by Summit Earthworks would remain constant through the life of the project due to capacity restrictions. The facility design has a finite soil storage area and soil stockpile volumes cannot exceed the design specifications.

7.0 EMISSION ESTIMATES

7.1 Baseline Case

The facility does not currently exist, therefore facility-related emissions are zero. Baseline air quality is described in Section 5.1.

7.2 Project Case

Emission estimates are generally calculated for all facility-related activities as follows:

Emission Rate = Emission Factor x Activity Rate

Emission factors are empirically-derived values or equations which describe anticipated emissions of relevant air contaminants for a variety of industrial activities. Emission factors for diesel-powered heavy equipment were taken from the United States Environmental Protection Agency's (USEPA) NONROAD (MOVES2014a) emissions model. Emission factors for fugitive dust from material handling, wind erosion and roads were taken from USEPA's AP-42 '*Compilation of Air Pollutant Emission Factors*'. Marine emission factors were taken from Environment Canada's 2010 '*National Marine Emission Inventory*'. Emissions related to the release of hydrocarbons trapped in pore space during the excavation process of contaminated sites were estimated using information contained in USEPA's '*Estimation of Air Impacts for the Excavation of Contaminated Soil*' (1992), '*Air Emissions from the Treatment of Soils Contaminated with Petroleum Fuels and Other Substances*' (1992) and '*Estimating Air Emissions from Petroleum UST Cleanups*' (1989).

Activity rates are metrics which describe, for example, the amount of time an emission-producing activity will occur, the material throughput, the dimensions of a storage pile or the vehicle distance travelled. Table 7.1 lists the identified emission sources, the expected contaminants emitted and relevant activity metrics associated with the source. Each source type is further described along with a quantitative estimate of annual emissions (in tonnes per year) in the following sub-sections.

Table 7.1 – Emission Sources and Activity Metrics

Source Type	Specific Emission Source	Contaminants Emitted	Activity Metric
Equipment/Vehicle Exhaust	transiting dump trucks on-site dumper-type truck on-site loader/backhoe	SO_2, NO_X, CO, VOC (incl. air toxics), PM_{10}, $PM_{2.5}$ (DPM)	▪ between 15 and 60 trucks daily ▪ on-site dump truck active once or twice weekly for barge loading ▪ loader operating every weekday ▪ assume 62.5% utilization of excavator and on-site dump truck ▪ assume 100 hp (74.5 kW) for loader, 175 hp (130.5 kW) for site dumper, 300 hp (223 kW) for dump trucks ▪ assume 40 km/hr average speed of trucks through supply chain roads, 20 km/hr on facility roads ▪ assume 10 minutes unloading time per truck ▪ assume barge loading 1.5 times per week
Road Dust	Facility segments Facility boundary segment (includes estimate of trackout) Supply chain segment	TPM, PM_{10}, $PM_{2.5}$	▪ 15 to 60 dump trucks per day ▪ 9750 round trips for barge loading annually based on throughout and assumed payload ▪ 130 m of site road ▪ 65 m of site road between stockpiles and barge ▪ 230 m of local roads within facility boundary ▪ 2.7 km of supply chain road (average of 3.2 km access through Annacis Island and 2.1 km access from Boyd St.)
Marine Emissions	harbour tug (barge)	SO_2, NO_X, CO, VOC, PM_{10}, $PM_{2.5}$ (DPM)	▪ barge towing once or twice weekly ▪ assumed 20 minutes maneuvering time at facility ▪ 4.3 hours towing to Mission Landfill (one way)
Material Handling	dumping of accepted soils shovelling of accepted soils into stockpiles shovelling of soils from stockpile loading of soils onto barge loading conveyor dumping of soils onto barge	TPM, PM_{10}, $PM_{2.5}$	▪ average throughput based on assumed dump truck payload of 22.7 t and 15 to 60 trucks per day
Wind Erosion	loose soil from stockpiles	TPM, PM_{10}, $PM_{2.5}$	▪ maximum stockpile height of 5 m ▪ between zero to 16 conical piles weekly on average based on expected average throughput
Contaminated Soils	loose newly excavated soils	VOC	▪ bulk of pore gas escapes at excavation site and emission rates decrease rapidly, spiking with disturbance ▪ maximum accepted levels are Industrial Land Use (CSR) ▪ average exposed area (1520 m2) based on weekly average of eight stockpiles

7.2.1 Equipment/Vehicle Exhaust

Diesel powered equipment operating at the transfer facility includes dump trucks (both those transporting materials to the facility and the one used on-site for loading of the barge) and the loader/backhoe. A variety of contaminants are released in the exhaust of diesel combustion engines, including toxic VOCs. Emission factors for these contaminants are provided in USEPA's NONROAD emissions model (included in USEPA's Motor Vehicle Emission Simulator, MOVES2014a). Emission factors are power- and time-based (in g/hp-hr) with the exception of SO_2, which is dependent on the sulfur content in the diesel fuel (the model's default values were assumed). NONROAD provides average emission factors across all model years, defined based on United States emission standards (Tier 1, Tier 2, Tier 3, etc.) for various engine capacity ranges.

The emission factors contained in NONROAD were converted to annual emissions (in tonnes) with the engine capacity of the specific equipment and an estimate of the operational hours in a given year.

It was conservatively assumed that the loader will be operating at full capacity 62.5% of the time (utilization), or an average of 5 out of 8 hours a day. With 250 operating days in a given year (five days a week, inclusive of statutory holidays and exclusive of closures) at a 62.5% utilization, the excavator is estimated to log 1250 hours in a given year. The engine capacity of a small excavator representative of the type to be used at site is assumed to be 100 hp (74.5 kW) based on specifications of typical models provided by CAT and CASE.

It is assumed for the on-site dump truck that barge loading will occur an average of 1.5 times per week and the dump truck will only be operating during this time at a 62.5% utilization rate, for a total of 390 operational hours annually. The engine capacity is assumed as 175 hp (149.1 kW), typical of smaller dump trucks (CAT, CASE, BELL) used in the construction industry (heaped capacity between 10 m^3 and 15 m^3).

For dump trucks transporting soils to the facility, exclusive of unanticipated queuing during peak periods, it was assumed each truck would be on site for a total of ten minutes. It was assumed that an average of 37.5 trucks would frequent the facility per operational day and the mean engine capacity was 300 hp (223.7 kW).

The total hours spent on municipal roads within the facility boundary and the supply chain boundary respectively were estimated based on the road segment lengths and an assumed average vehicle speed of 20 km/hr between the facility and the Derwent Way/Salter St. intersection and 40 km/hr on municipal roads within the supply chain boundary.

Road segment lengths are shown in Figure 7.1 and were defined for the purpose of the air assessment as follows:

Within the facility boundary:

- 130 m of site road for receiving trucks
- 230 m of municipal roads between the facility and the Derwent Way/Salter St. intersection

Within the supply chain boundary:

- 3.2 km of municipal roads for trucks accessing from the south - between Alex Fraser Bridge and Derwent Way/Salter St. intersection via Annacis Island (total of 6.4 km round trip)
- 2.1 km of municipal roads for trucks accessing from the north - between Highway 91A off ramp and Derwent Way/Salter St. intersection via Howes St., Boyd St. and Derwent Way (total of 4.2 km round trip)

Table 7.2 summarizes the annual emission estimates for criteria air contaminants due to diesel combustion engines from facility vehicles and equipment. Table 7.3 summarizes annual emission estimates for prevalent air toxics contained in diesel exhaust from the facility.

Table 7.2 – Diesel Combustion Engine Exhaust Emission Estimates – Major Contaminants

Vehicle Type	Op. Hrs (Annual, Estimated)	Emissions (tonnes/year)						
		CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC	*HC
FACILITY BOUNDARY EMISSIONS								
Loader/Backhoe	1250	0.621	0.506	0.091	0.088	<0.001	0.111	0.103
Barge Loading Dump Truck (Site)	390	0.128	0.220	0.025	0.024	<0.001	0.036	0.034
Material Transferring Dump Trucks (Site)	1563	0.105	0.433	0.017	0.016	<0.001	0.063	0.054
Material Transferring Dump Trucks (Roads)	216	0.014	0.060	0.002	0.002	<0.001	0.009	0.007
SUPPLY CHAIN BOUNDARY EMISSIONS								
Material Transferring Dump Trucks (Roads)	1242	0.083	0.344	0.014	0.013	<0.001	0.050	0.043
TOTAL EXHAUST EMISSIONS ESTIMATE		**0.95**	**1.56**	**0.14**	**0.14**	**0.003**	**0.27**	**0.24**

*HC = Hydrocarbons
Source: USEPA – NONROAD Model (MOVES 2014a)

Table 7.3 – Diesel Combustion Engine Exhaust Emission Estimates – Air Toxics

Area	Emissions (tonnes/year)							
	Benzene	Toluene	Ethylbenzene	Xylene	Formaldehyde	1,3 Butadiene	Acrolein	Acetaldehyde
Facility	0.006	0.006	0.001	0.005	0.051	<0.001	0.004	0.018
Supply Chain	0.001	0.001	0.001	0.002	0.011	<0.001	0.001	0.003
TOTAL	**0.007**	**0.007**	**0.002**	**0.007**	**0.062**	**<0.001**	**0.005**	**0.021**

Source: USEPA – NONROAD Model (MOVES 2014a)

7.2.2 Road Dust

The emission factor for re-suspension of loose material on the road surface due to truck traffic is provided in EPA AP-42 Section 13.2.1 '*Paved Roads*'. The annual emission factor is defined as

$$EF\ (g/VKT) = [k(sL)^{0.91} \cdot W^{1.02}]\left(1 - \frac{P}{(4 \cdot 365)}\right)$$

Where:

- K is the particle size multiplier (3.23 for TPM, 0.62 for PM_{10} and 0.15 for $PM_{2.5}$)
- sL is the road surface silt loading (in g/m^2)
- W is the average weight of vehicles travelling on the road (in U.S. tons – conversion factor of 1.102 from tonnes)
- P is the number of days with at least 0.254 mm of precipitation (169, taken from Environment Canada's 1981 – 2010 Climate Normals for Vancouver International Airport)

An estimate of the silt loading on the property access road segment was taken from values presented in EPA AP-42 Table 13.2.1-3 – *Typical Silt Content and Loading Values for Paved Roads at Industrial Facilities*. A conservative mean silt loading value of 32 g/m^2 was assumed based on the maximum range of test values obtained from municipal solid waste landfill sites in the United States. EPA AP-42 Section 13.2.1 provides a baseline silt loading value of 0.2 g/m^2 for medium-to-low volume roads (500 – 5,000 vehicles per day), which was assumed for the local road network within the supply chain boundary, and a value of 0.6 g/m^2 for low volume roads. To account for soil track-out onto the municipal road from the facility, silt loading for the road segment between the facility boundary and Derwent Way was conservatively assumed to be 16.3 g/m^2 – the average of the site value and the low volume road baseline level. Road segment lengths are shown in Figure 7.1.

Table 7.4 summarizes emission estimates for entrainment of road dust due to facility-related vehicle traffic.

Table 7.4 – Road Dust Emission Estimates

Activity	Emissions (tonnes/year)		
	TPM	PM_{10}	$PM_{2.5}$
Site Roads	5.65	1.08	0.26
Facility Boundary Roads	2.70	0.52	0.13
Supply Chain Roads	1.14	0.22	0.053
TOTAL PAVED ROAD DUST EMISSIONS ESTIMATE	**9.48**	**1.82**	**0.44**

7.2.3 Marine Emissions

Emissions from the tug used to tow the materials barge to and from the Mission landfill facility can be divided into facility emissions and supply chain emissions. Facility marine emissions are related to the maneuvering activity of the tug on the Fraser River in the vicinity of the dock. Supply chain emissions are related to time spent in underway mode while the tug is towing the barge on the Fraser River between the Derwent Way transfer facility and the Mission landfill.

Emission factors for tugs is provided by Environment Canada's National Marine Emission Inventory, shown in Table 7.5.

Table 7.5 – Emission Factors for Tugboats

Vessel	Fuel-Based Emission Factors (g/kWh)					
	PM_{10}	$PM_{2.5}$	CO	NO_X	SO_2	VOC
Tugboat	0.26*	0.24*	1.1	13.2	0.21*	0.5

*assumed diesel sulphur content in marine diesel oil (MDO) of 0.05%
Source: Environment Canada National Marine Inventory

Emissions are calculated using the following formula:

$$E = ME \cdot LF \cdot T \cdot EF_{fuel}$$

Where:

- ME is the main engine power (river tug, assumed as 1044 kW (1,400 hp), adopted from '*Fraser Surrey Docks Direct Coal Transfer Facility: Air Quality Assessment*' (Levelton 2014)
- LF is the load factor (defined as the ratio of actual speed to maximum speed, assumed as 0.8 for tugs in all modes (The Chamber of Shipping 2007)
- T is the time in mode
- EF_{fuel} is the fuel based emission factor from Table 7.5

Twenty minutes was the assumed maneuvering time of the tug at the Derwent Way facility upon departure and arrival of the barge. The average underway speed of the tug was assumed as 6 knots. The river distance between the Derwent Way Facility and the Mission Landfill site is approximately 48 km, resulting in a two-way transit time of 8.6 hours. An average of 1.5 barge tows per week (78 annually) were assumed based on the proposed throughput volumes and proposed operations. Total marine emissions are summarized in Table 7-6.

Table 7.6 – Marine Emission Estimates

Vessel	Emissions (tonnes/year)					
	PM_{10}	$PM_{2.5}$	CO	NO_X	SO_2	VOC
Facility Emissions	0.011	0.010	0.047	0.568	0.009	0.021
Supply Chain Emissions	0.148	0.136	0.619	7.429	0.118	0.281
TOTAL MARINE EMISSIONS ESTIMATE	**0.159**	**0.146**	**0.666**	**7.997**	**0.127**	**0.303**

7.2.4 Material Handling

Adding aggregate material to a storage pile or removing it involves dropping the material onto a receiving surface, generating emissions of fugitive particulate matter, or dust (TPM, PM_{10} and $PM_{2.5}$). This will occur with the following activities:

- newly received soils being dumped from trucks into the receiving area;
- shovelling of received materials by a front-end loader and loading into storage piles;
- shovelling from storage piles and loading into dump truck for barge loading;
- dumping of materials onto the barge.

Based on the proposed 15 to 60 loads of soil received daily (average of 37.5), assuming a maximum per vehicle payload of 22,680 kg (CAT 660) and an operational schedule of five days a week excluding closures, the average annual facility throughput is estimated to be 212,625 tonnes.

The EPA AP-42 emission factor for particulate matter emissions from material handling is taken from Section 13.2.4 '*Aggregate Handling And Storage Piles*' and is described as follows:

$$EF\ (kg/tonne) = k * 0.0016 * \frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}$$

Where:

- EF is the emission factor (in kg per tonne of material throughput)
- k is the particle-size multiplier (0.74 for TPM, 0.35 for PM_{10} and 0.053 for $PM_{2.5}$)
- U is the mean annual wind speed (2.5 m/s, taken from Metro Vancouver Annacis Island Air Quality Station (T38), 2009 to 2012)
- M is the material moisture content (assumed as 4.8%, the maximum of soil moisture ranges used in developing the AP-42 emission factors and recommended by the EPA as a conservative value if actual soil moistures exceed 4.8%)

Since all soil accepted by the facility will be loaded onto the barge and shipped to the landfill facility in Mission, the throughput for all handling activities is identical. Table 7.7 shows the various material handling operations and the total estimated fugitive dust emissions at the facility in tonnes per year.

Table 7.7 – Material Handling Emission Estimates

Activity	Emissions (tonnes/year)		
	TPM	PM_{10}	$PM_{2.5}$
Dumping of accepted soils at site	0.087	0.041	0.006
Pile loading of accepted soils into storage	0.087	0.041	0.006
Load out of soils from storage pile onto conveyor	0.087	0.041	0.006
Dumping of soil onto barge	0.087	0.041	0.006
TOTAL MATERIAL HANDLING EMISSION ESTIMATE	**0.349**	**0.165**	**0.025**

7.2.5 Wind Erosion

The emission factor for particulate matter emissions due to wind erosion of stockpiled material is taken from Environment Canada's National Pollutant Release Inventory (NPRI) guidance and is described as follows:

$$EF = 1.12x10^{-4} \cdot J \cdot 1.7 \cdot \left(\frac{s}{1.5}\right) \cdot 365 \cdot \left(\frac{365 - P}{235}\right) \cdot \left(\frac{I}{15}\right)$$

Where:

- EF is the emission factor in (kg/m^2)
- J is the particulate aerodynamic factor (TPM = 1.0, PM_{10} = 0.5, $PM_{2.5}$ = 0.2)
- S is the average silt loading of the storage pile in weight percent (9%, taken as the average of typical values for sand and gravel (8%) and overburden (10%), as described in NPRI guidance)
- P is the average number of days during the year with at least 0.254 mm of precipitation (169, taken from Environment Canada's 1981 – 2010 Climate Normals for Vancouver International Airport)
- I is the percentage of time in the year with unobstructed wind speed >19.3 km/h in percent (%) at the mean pile height (5 m) (1.9%, extrapolated to 10 m using logarithmic wind profile, taken from Metro Vancouver Annacis Island Air Quality Station (T38), 2009 to 2012)

Total annual emissions are then estimated by multiplying the emission factor by the average exposed area of the stockpile(s). The method assumes a conical stockpile with lateral area equal to:

$$A = \pi r \sqrt{(r^2 + h^2)}$$

Where:

- r is the radius of the base of the storage pile (in m)
- h is the height of the storage pile (in m)

The maximum height of stockpiles at the facility will be 5 metres. If we assume a radius-to-height ratio of 1:1, the maximum volume of a conical stockpile (see equation x) is 131 m^3.

$$V_{cone} = \frac{1}{3}\pi r^2 h$$

Transporting of soils to the Mission facility by barge will occur once a week (or twice, if necessary, depending on throughput). Under the more conservative assumption of once a week barge loading (larger stockpile volume) and assuming handling and loading of the stockpiles occurs only on the day the material is to be towed, the maximum volume of stockpiled soil on site will be 2100 m^3 (4 days) contained in 16 conical stockpiles. The average number of stockpiles during a given week under this scenario therefore is eight (zero stockpiles immediately following barge loading). Total annual particulate matter emissions due to wind erosion of stockpiled material are summarized in Table 7.8 assuming an average of eight piles and a total exposed lateral area of 891 m^2.

Table 7.8 – Wind Erosion of Stockpiled Material Emission Estimates

Activity	Emissions (tonnes/year)		
	TPM	PM_{10}	$PM_{2.5}$
TOTAL WIND EROSION EMISSION ESTIMATE	**0.010**	**0.005**	**0.002**

*assumes no wind screening on windward side of stockpiles

The emission factors used in the estimates assume an un-obstructed lateral area on the windward side of the pile. As the number of stockpiles increase, wind shielding of piles on the leeward side of the prevalent wind will inevitably occur and the erosion potential of shielded piles will diminish. In that regard, the estimates are conservative. Additionally, the erosion potential of the surface material tends to decay as natural crusting binds the erodible material, resulting in reduction of the erosion potential, although this is much less of a factor in loose soils or other aggregate materials consisting of sand-sized materials (USEPA).

7.2.6 Volatile Organic Compounds (VOC) from Contaminated Soils

Excavated soils accepted by the transfer facility will originate from industrial land use sites and possibly contain VOCs. The term “industrial” covers a wide range of land uses and therefore the type and amount of VOCs contained in the soils will be highly variable. The facility will only accept excavated materials that adhere to the CSR designation of “*Industrial Levels*” which defines the maximum allowable concentration of specific VOCs contained in the soil. CSR maximum allowable concentrations are listed for some prevalent VOCs in Table 7.9.

Table 7.9 – Maximum Allowable Levels of VOC in Industrial Land Use Soils (CSR)

Species	Maximum Allowable Concentration in Soil (µg/g)
Benzene	6,500
Toluene	550,000
Ethylbenzene	700,000
Xylene	>1,000,000
Styrene	50
Benzo(a)pyrene	50
Naphtalene	50
VPHs (Petroleum hydrocarbons from C6-C10)	200
LEPHs (Petroleum hydrocarbons from C10-C19)	2,000
HEPHs (Petroleum hydrocarbons from C19-C32)	5,000

The USEPA attempted to quantify emission factors for VOCs released during the excavation of petroleum-contaminated soils in several papers: '*Estimating Air Emissions from Petroleum UST Cleanups*' (USEPA 1989), '*Estimation of Air Impacts for the Excavation of Contaminated Soil*' (Eklund 1992) and '*Air Emissions from the Treatment of Soils Contaminated with Petroleum Fuels and Other Substances*' (Eklund et al. 1992). The papers focus on the release of VOCs during the excavation process when soils are initially disturbed, resulting in peak VOC emissions, however releases from stockpiled materials is also discussed.

The application of a quantified emissions estimate representative of the facility is a difficult exercise since the concentrations listed in Table 7.8 are maximums and actual soil concentrations will be some fraction of those values. Soils received at the facility will vary in moisture content and grain size, and thus the propensity of pore gas to escape will be variable. A soil may also contain more than one type of VOC, complicating the pore space vapour equilibrium which effects the emission rate.

Furthermore, the exact contaminant is not known, nor is the amount of time since excavation occurred for a particular soil, or the amount of handling which occurred prior to being received at the transfer station. The USEPA papers describe an initial burst of emissions which occur at excavation followed by a sharp decline in emission rate, with short-period bursts each time materials are disturbed.

The rate of VOC emission from stockpiled contaminated soils is relative to the total exposed surface area of the material. The total surface area of a cone is given by:

$$\boldsymbol{A} = \boldsymbol{\pi r}\left(\mathrm{r} + \sqrt{(\boldsymbol{r}^2 + \boldsymbol{h}^2)}\right)$$

The total surface area of a 1:1 (height-to-radius) storage pile of 5 m height is 190 m^2. As described in Section 7.2.5, the average number of stockpiles in a given week is eight.

Figure 7.2 is taken from USEPA 1989 and provides an estimate of the **maximum** emission rate of gasoline VOCs from excavation sites. Figure 7.3 provides the emission rate for benzene. Note that the emission rate varies with temperature. USEPA 1989 specifically describes sites with underground storage tanks that have released gasoline into the soil. The origin of the soils received at the transfer facility can be variable, however excavated soils from sites previously operating as gas stations would be expected to be a common occurrence, therefore the analysis provide a relevant reference. The conversion factor for m^2 to ft^2 is 10.76 (i.e. 2045 ft^2 per stockpile). The conversion factor from lbs/hr to kg/hr is 0.454. Assuming an annual mean temperature of 10ºC for Vancouver, the maximum gasoline VOC emission rate is 330 kg/hr (8 piles x 90 lbs/hr x 0.454 kg/lbs). Likewise, the maximum benzene emission rate is 29 kg/hr.

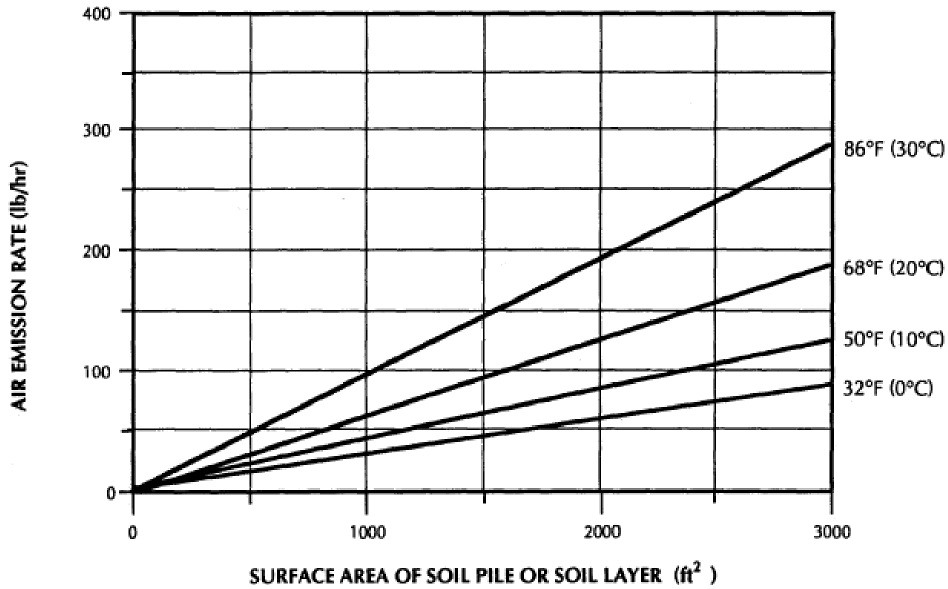

Figure 7.2 – Estimated Maximum Gasoline VOC Emission Rate for Excavated Soils with Leaching from Underground Storage Tanks

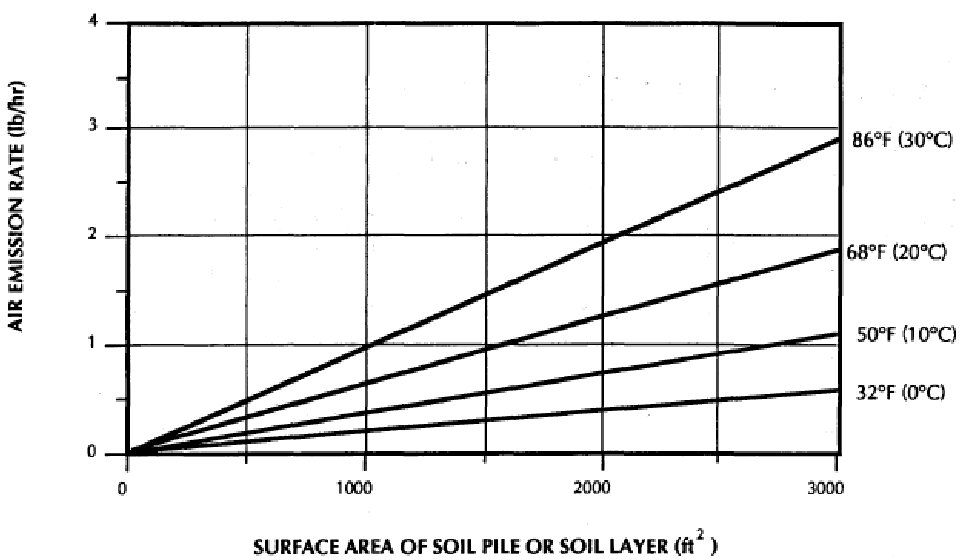

Figure 7.3 – Estimated Maximum Benzene Emission Rate for Excavated Soils with Leaching from Underground Storage Tanks

The values presented in the figures represent estimates of the maximum emission rate, indicative of the initial burst occurring after the initial disturbance (excavation). Following excavation, emission rates decrease rapidly with time, with short-period increases upon material handling. Eklund et al. 1992 states that theoretical models indicate that 70% of volatile compounds (such as xylene) contained in the soil are emitted during excavation.

7.2.7 Summary of Anticipated Facility-Based Emissions

Annual estimated facility emissions from all combined sources are summarized for criteria air contaminants in Table 7.10.

Table 7.10 – Summary of Combined Estimated Facility and Supply Chain Emissions (Annual)

*Emissions (tonnes/year)								
Fugitive Dust			Diesel Exhaust Emissions					
TPM	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	CO	NOx	SO_2	VOC
9.84	1.99	0.47	0.31	0.29	1.62	9.56	0.13	0.57

*Summary does not include possible VOC emission from contaminated soils which will be highly variable

7.3 No-Project Case

The facility does not currently exist, therefore the no-Project case is the same as the baseline case (Section 7.1).

8.0 LEVEL 2 – DISPERSION MODELLING

Not currently applicable pending direction from Port Metro Vancouver.

9.0 MITIGATION POTENTIAL

9.1 Application of Best Available Procedures

Particulate matter emissions from the facility can be reduced through the application of dust mitigation techniques as follows:

- installation of a vegetated barrier (lock block wall, berm, fence and trees) along the western property boundary) (Figure 9.1);
- Maintain the proposed maximum stockpile height of 5 m;
- occasional watering of stockpiles or application of dust suppression material if necessary;
- minimizing the drop distance of soil loads;
- maintaining a reasonably low vehicle speed while driving or maneuvering on facility roads.

Vehicular emissions of diesel combustion by-products can be reduced by:

- conducting regular maintenance of the fleet (the on-site dumper and backhoe);
- using newer-model vehicles on site with more stringent emission controls;

- eliminating unnecessary idling by shutting off engines during downtime or queuing;
- minimizing the time transiting trucks are on site with engines running or queuing by maintaining a schedule, efficient scale procedures and regular clearing of the dump area;
- using low-sulfur diesel fuel for on-site equipment.

Potential VOC emissions can be greatly reduced (as described in Section 7.2.6) by minimizing the frequency of disturbances to the soil piles and minimizing surface area. Watering of soils or the use of water-based foams decreases the air-filled porosity of soil and cools soil temperature, reducing VOC vapour transport. Wind barriers are also effective at reducing VOC emissions as they lower the wind speed at the soil surface (Eklund et. al. 1992).

10.0 IMPACT POTENTIAL

10.1 Baseline Case to Project Case

The primary air contaminant emitted from the facility will be particulate matter. The majority of particulate matter entrained into the air from soil handling is coarser-grained material (greater than 10 microns) which falls out very close to the source (loading and shovelling) and is not anticipated to impact nearby residents. With respect to fine-particulate matter (PM_{10} and $PM_{2.5}$), the prevailing winds are from the northeast, particularly in winter (Section 5.2), which would tend to impact areas southwest of the facility with the greatest frequency. The magnitude of impact will be greatly reduced with the installation of the proposed lock-block wall, berm, fence and treeline along the western property boundary (see Figure 9.1). The trees will act as a filter as wind-entrained particulate matter will deposit on leaves and branches.

As the properties north and east of the proposed facility conduct industrial and commercial operations, vehicular emissions originating from the property will represent a very small increase over the current level in the area. The increase in truck traffic along Derwent Way due to facility operations (between 15 and 60 per day, or approximately 2 to 7 per hour), represents a very small increase on current volumes. The majority of the time, a single backhoe would be operating on site, with a dumper for barge loading utilized only once or twice weekly. This level of activity would not be expected to have an appreciable impact on nearby residents.

It is estimated that a tug will spend a maximum of 20 minutes maneuvering the barge into place once or twice a week with an additional maximum of 20 minutes maneuvering the barge away from the dock as it is towed to Mission. The maneuvering area is approximately 200 m east of the nearest residence. Tug emissions are not anticipated to impact nearby residents. Along the supply chain, the increase in tug activity on the Fraser River due to facility operations (once or twice weekly barge towing) is small compared to the current level of river traffic and activity.

The potential impact of VOCs is difficult to ascertain as received soils will originate from various land use sites and may contain a variety of species with highly variable concentrations. Section 7.2.6 describes studies that show the majority of VOCs contained in contaminated soils is released upon excavation. However, it would be expected that soils being stored and handled at the transfer facility likely contain trace amounts of volatiles, some of which may include toxic constituents such as benzene, naphthalene, styrene etc. Long-term and repeated exposure to high concentrations of such compounds is typically associated with health risks. The maximum concentration of VOCs contained in the pore space of soils accepted by the facility is restricted by the Contaminated Sites Regulations (Industrial Levels). The highest VOC emission rates would occur with highly porous soils with a higher proportion of pore space vapor and when wind speeds are highest, impacting areas downwind of the prevailing wind direction with the greatest frequency.

10.2 Project Case to No-Project Case

The facility does not currently exist and the site is vacant, covered in shrubs and trees. The project to no-project case impact potential is therefore the reverse of the baseline case to project case described in Section 9.1.

10.3 Project Case to Best Available Technique

The majority of the mitigation measures described in Section 9.1 will generally be followed as standard best practice procedures. The fence/berm/tree barrier will be installed as a requirement of the application and will greatly reduce particulate matter transport southwest of the facility. The applied mitigation practices will have an overall reduction of emissions at the source, or will restrict the transport of contaminants away from the facility.

10.4 Conclusion

Without mitigation, facility-related emissions of particulate matter have the potential to impact the overall air quality in the immediate area southwest of the facility, due to the close proximity of the residences and the direction of the prevailing winds (particularly in winter). Handling of soils (dumping and shoveling), may result in a slight increase in airborne PM_{10} and $PM_{2.5}$ concentrations and dust deposition southwest of the proposed facility, however the increase would not be expected to result in exceedances of Metro Vancouver ambient air quality objectives as the estimated rates of emission are quite low. The largest impacts to nearby residents would be anticipated to occur during the facility's operational hours when soil is being actively handled and much more commonly during dry winter days when prevailing winds are from the northeast. Estimated dust emissions due to wind erosion of stockpiles, are approximately 3% of those estimated due to soil handling activities (see Tables 7.7 and 7.8) and would not be expected to have a measurable impact on local air quality outside of operational hours. During the summer, winds are much more commonly from the south and the southwest, transporting particulate matter away from residential areas.

The installation of a tree barrier along the western boundary of the property would filter particulate matter from the air as it transports southwest, providing air quality impact mitigation. Once the facility is operational, it is recommended to conduct periodic particulate matter sampling southwest of the facility during periods of north-easterly winds to quantitatively assess local air quality in terms of particulate matter. While not anticipated, if airborne concentrations show to be elevated, further mitigation can be considered.

The potential impacts due to VOC contained in pore space is difficult to ascertain. Soils received at the facility will contain pore space VOCs at or below concentrations defined by Industrial Land Use Standards in the CSR. Furthermore, soils will have been previously disturbed while being excavated at sites throughout Metro Vancouver, reducing pore space VOC concentrations by up to 70% (Eklund et. al. 1992). It is not anticipated that VOC emissions from stockpiled and handled soils will have any acute impacts on the local air quality (i.e. will not produce airborne concentrations of toxic VOCs exceeding human health exposure limits). However due to the close proximity of residents, it is recommended that periodic air sampling occur to quantitatively assess the downwind concentration of more common VOC species (e.g. benzene, toluene, xylene, etc.). It is not anticipated that levels will exceed the normal range of ambient conditions observed throughout Metro Vancouver (ambient VOC emission sources through Metro Vancouver include vehicle and equipment exhaust, industry, etc.), however, if airborne concentrations do show to be elevated, further mitigation will need to be considered for the protection of people living in the area.

11.0 CLOSURE

This report and its contents are intended for the sole use of Summit Earthworks and their agents. Tetra Tech Canada Inc. (Tetra Tech) does not accept any responsibility for the accuracy of any of the data, the analysis, or the recommendations contained or referenced in the report when the report is used or relied upon by any Party other than Summit Earthworks, or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. Tetra Tech's General Conditions are provided in Appendix II of this report.

We trust this report meets your present requirements. If you have any questions or comments, please contact the undersigned.

Respectfully submitted,
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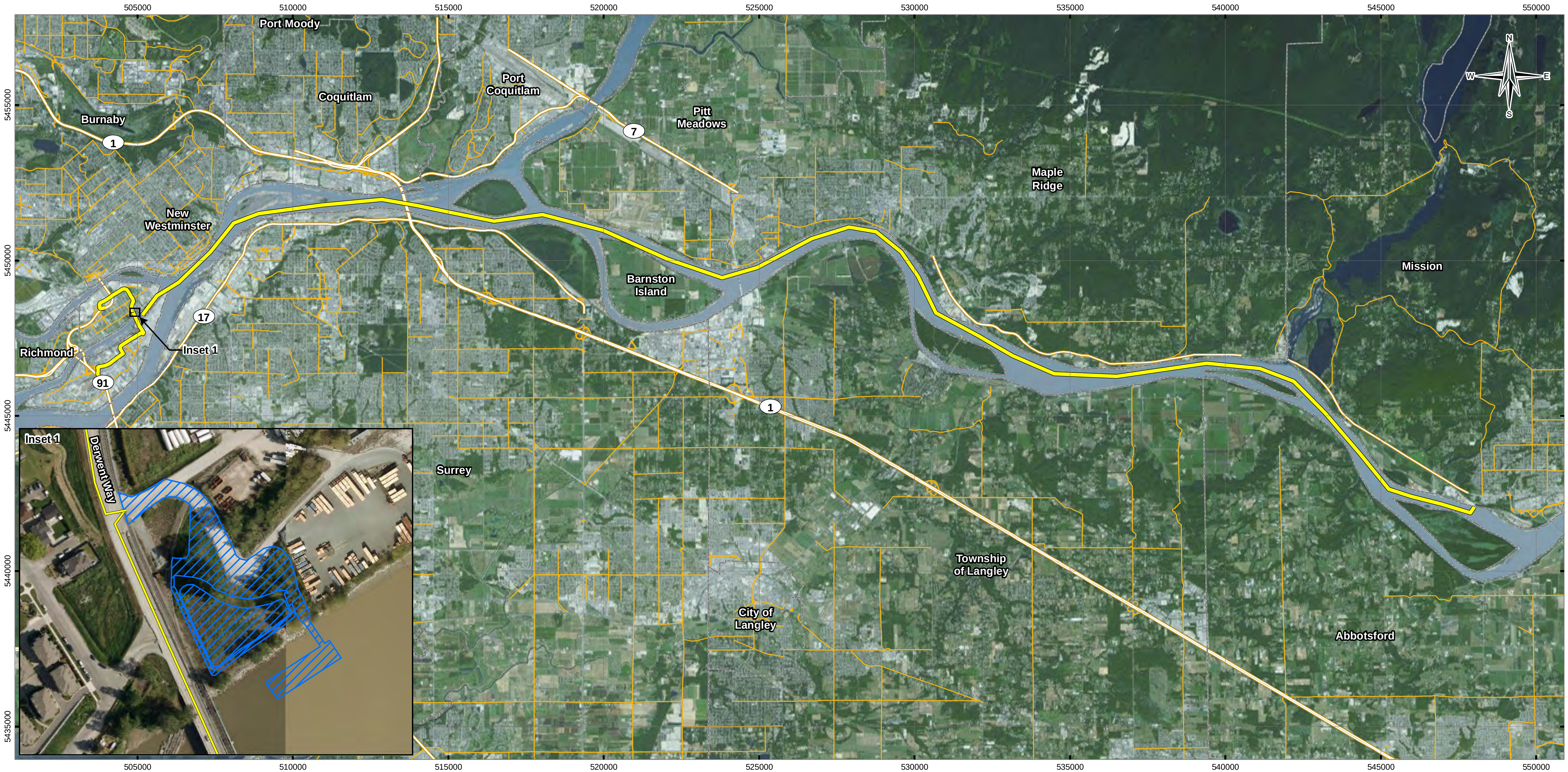
FIGURES



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LEGEND

- Supply Chain
- Facility Boundary
- Major Road
- Minor Road
- Municipal Boundary

NOTES
Base data source: Imagery from ESRI (various dates), CanVec 1:50K

STATUS
ISSUED FOR USE

DERWENT WAY SOIL TRANSFER AND BARGE FACILITY ENVIRONMENTAL AIR ASSESSMENT FOR PORT METRO VANCOUVER

Facility and Supply Chain Boundaries

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	SUMMIT EARTHWORKS

Scale: 1:125,000
2 1 0 2
Kilometres

TETRA TECH EBA

FILE NO.
VGEO03082-01_Figure3-1_SupplyChain.mxd

PROJECT NO.	DWN	CKD	APVD	REV
ENG.VGEO03082-01	MEZ	SL	TM	1

OFFICE	DATE
Tt EBA-VANC	January 18, 2017

Figure 3.1

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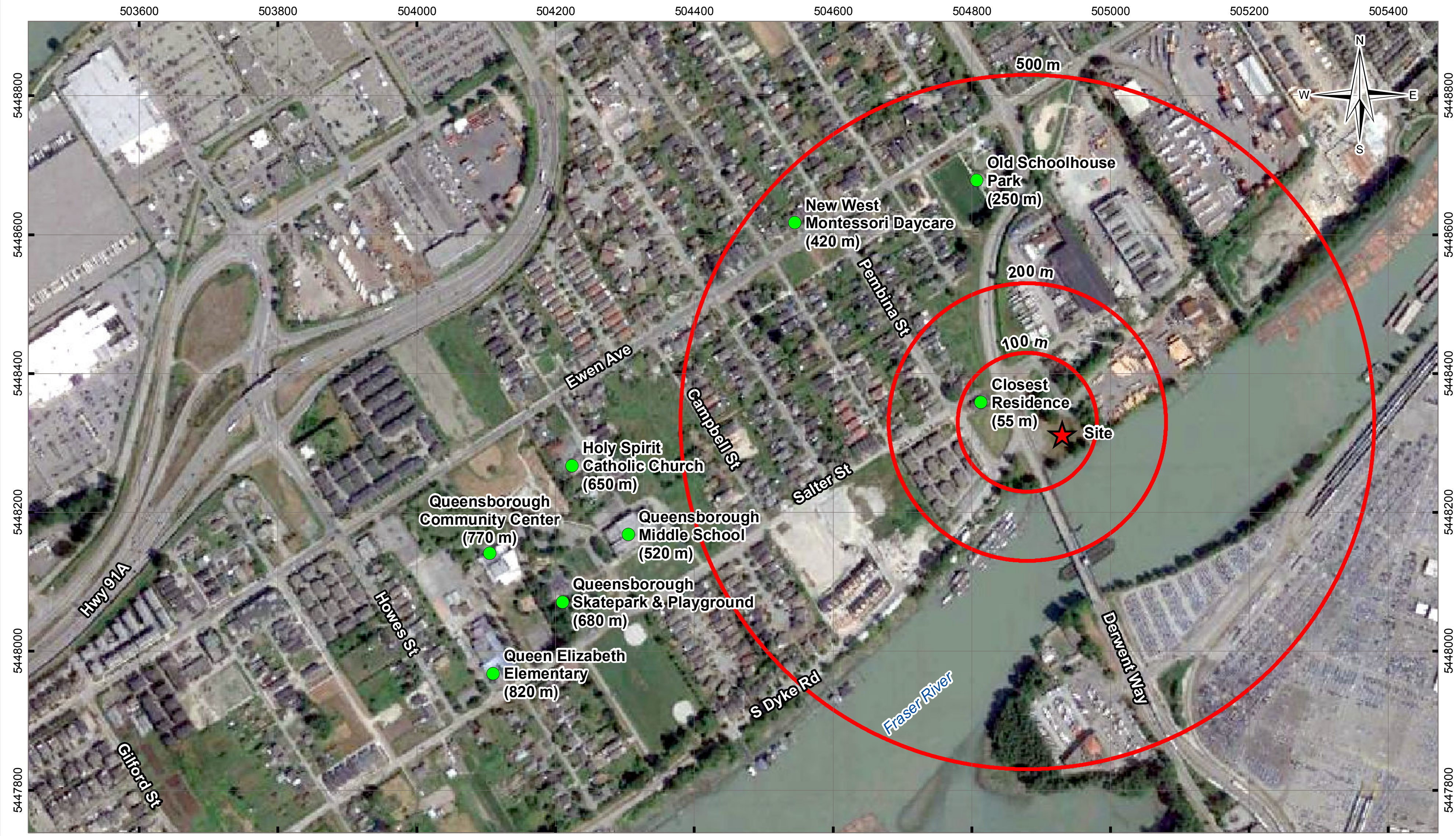


LEGEND

- Site Location
- Receiver (distance from Site)
- Buffer

NOTES
Base data source:
Imagery from Google (2014)

Scale: 1:8,000
100 50 0 100
Metres

PROJECTION	DATUM
UTM Zone 10	NAD83

FILE NO.
VGEO03082-01_Figure3-2_Receivers.mxd

CLIENT
SUMMIT EARTHWORKS
TETRA TECH EBA

DERWENT WAY SOIL TRANSFER AND BARGE FACILITY ENVIRONMENTAL AIR ASSESSMENT FOR PORT METRO VANCOUVER

Locations of Interest and Distance from Site

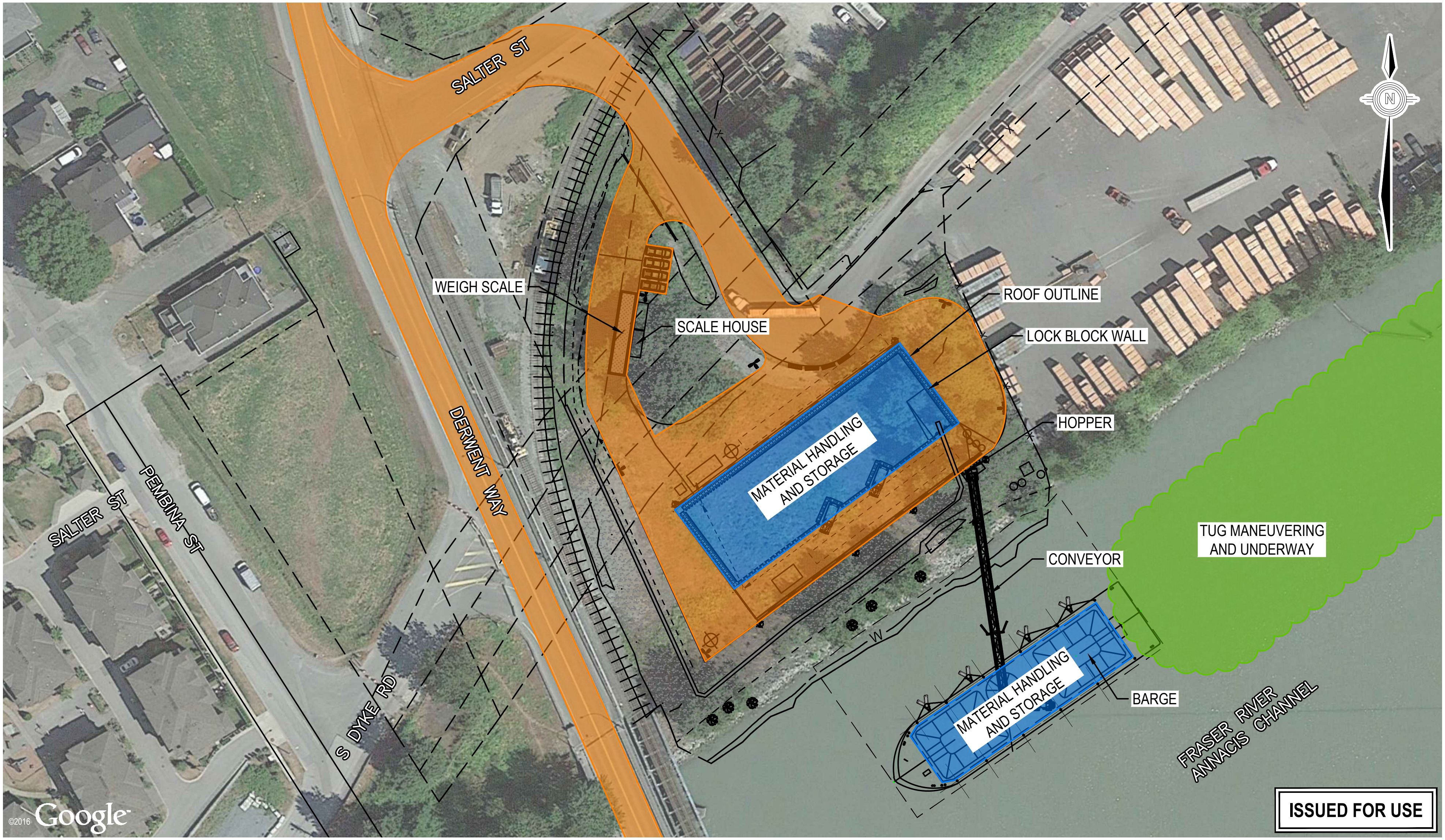
PROJECT NO.	DWN	CKD	APVD	REV
ENG.VGEO03082-01	MEZ	SL	TM	1

OFFICE	DATE
Tt EBA-VANC	January 18, 2017

Figure 3.2

STATUS
ISSUED FOR USE

Q:\Vancouver\Drafting\Engineering\VGEO\ENG.VGEO03082-01\ENG.VGEO03082-01 Location of Emission Sources R2A.dwg [FIGURE 4.1] July 19, 2019 - 4:10:37 pm (BY: HALL, ROBERT J)



LEGEND
- Road emission areas
- Material and storage area emissions
- Tug maneuvering emission areas

NOTES
1. Imagery from Google Earth Pro.
2. Based on Dwgs. 03082-04 and 03082-100.

SCALE 1:1250

10 0 10 30 50m

CLIENT

SUMMIT EARTHWORKS

TETRA TECH

DERWENT WAY SOIL TRANSFER AND BARGE FACILITY ENVIRONMENTAL AIR ASSESSMENT FOR PORT METRO VANCOUVER

LOCATION OF EMISSION SOURCES

PROJECT NO.	DWN	CKD	REV
VGEO03082-01.005	RH	TM	2

OFFICE	DATE
VANC	July 19, 2019

Figure 4.1

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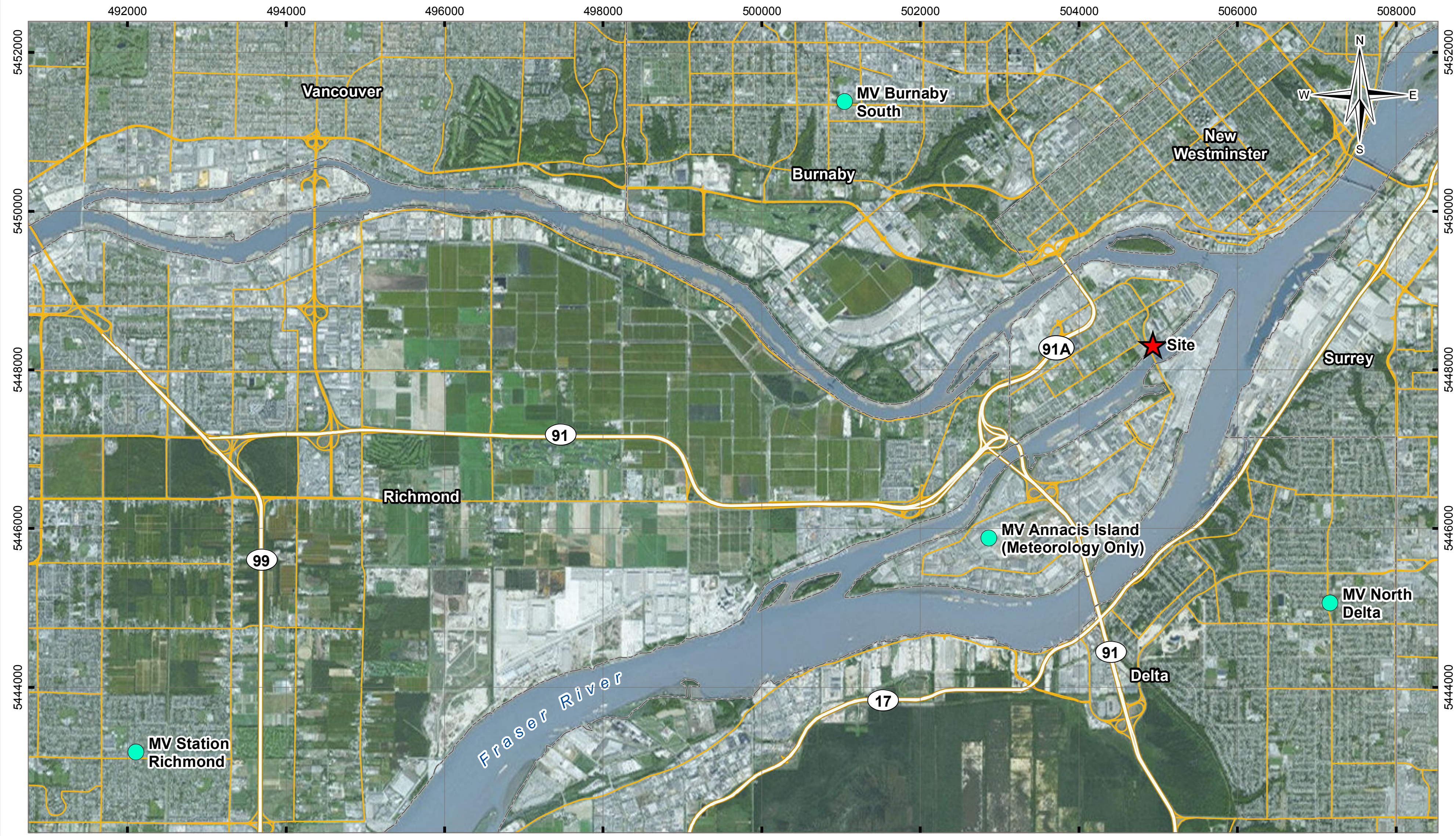


LEGEND

- Site Location
- Metro Vancouver Air Quality Monitoring Station
- Major Road
- Minor Road
- Municipal Boundary

NOTES
Base data source:
Imagery from Google (2014),
CanVec 1:50,000

STATUS
ISSUED FOR USE

Scale: 1:70,000

1 0.5 0 1

Kilometres

PROJECTION	DATUM
UTM Zone 10	NAD83

FILE NO.
VGEO03082-01_Figure5-1_AQStns.mxd

CLIENT
SUMMIT EARTHWORKS

TETRA TECH EBA

DERWENT WAY SOIL TRANSFER AND BARGE FACILITY ENVIRONMENTAL AIR ASSESSMENT FOR PORT METRO VANCOUVER

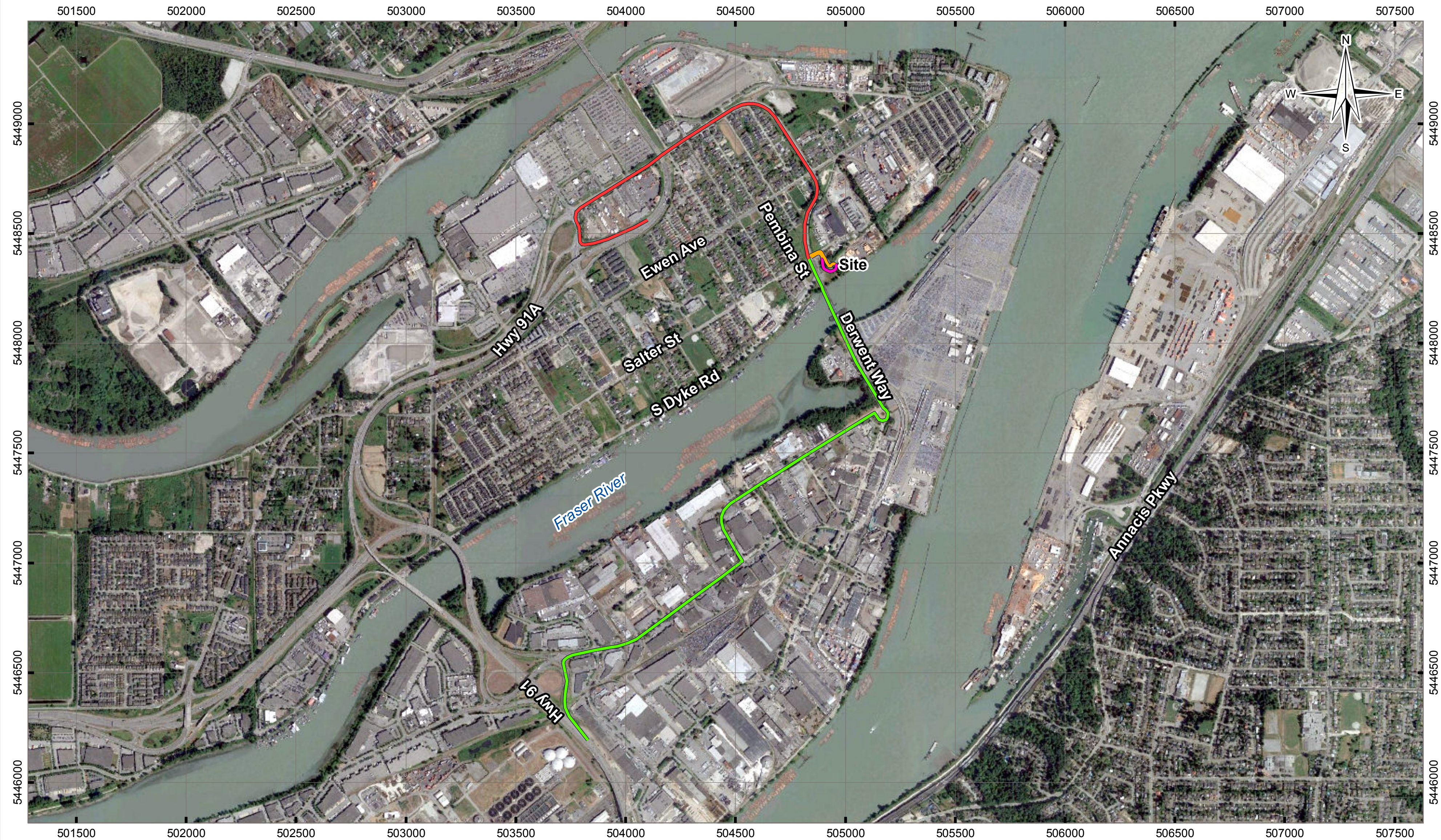
Location of Metro Vancouver Air Quality Stations

PROJECT NO.	DWN	CKD	APVD	REV
ENG.VGEO03082-01	MEZ	SL	TM	1

OFFICE	DATE
Tt EBA-VANC	January 18, 2017

Figure 5.1

Q:\Vancouver\GIS\ENGINEERING\VGEO\VGEO03082-01\Maps\AirAssessment\VGEO03082-01_Figure7-1_Roads.mxd modified 1/18/2017 by morgan.zondervan



LEGEND

Road Segment

- North Access via Boyd Street (2262 m)
- South Access via Annacis Island (3320 m)
- Facility Access Road (229 m)
- Site Road (135 m)

NOTES
Base data source:
Imagery from Google (2014)

Scale: 1:25,000
500 250 0 500
Metres

PROJECTION	DATUM
UTM Zone 10	NAD83

FILE NO.
VGEO03082-01_Figure7-1_Roads.mxd

CLIENT
SUMMIT EARTHWORKS

TETRA TECH EBA

STATUS
ISSUED FOR USE

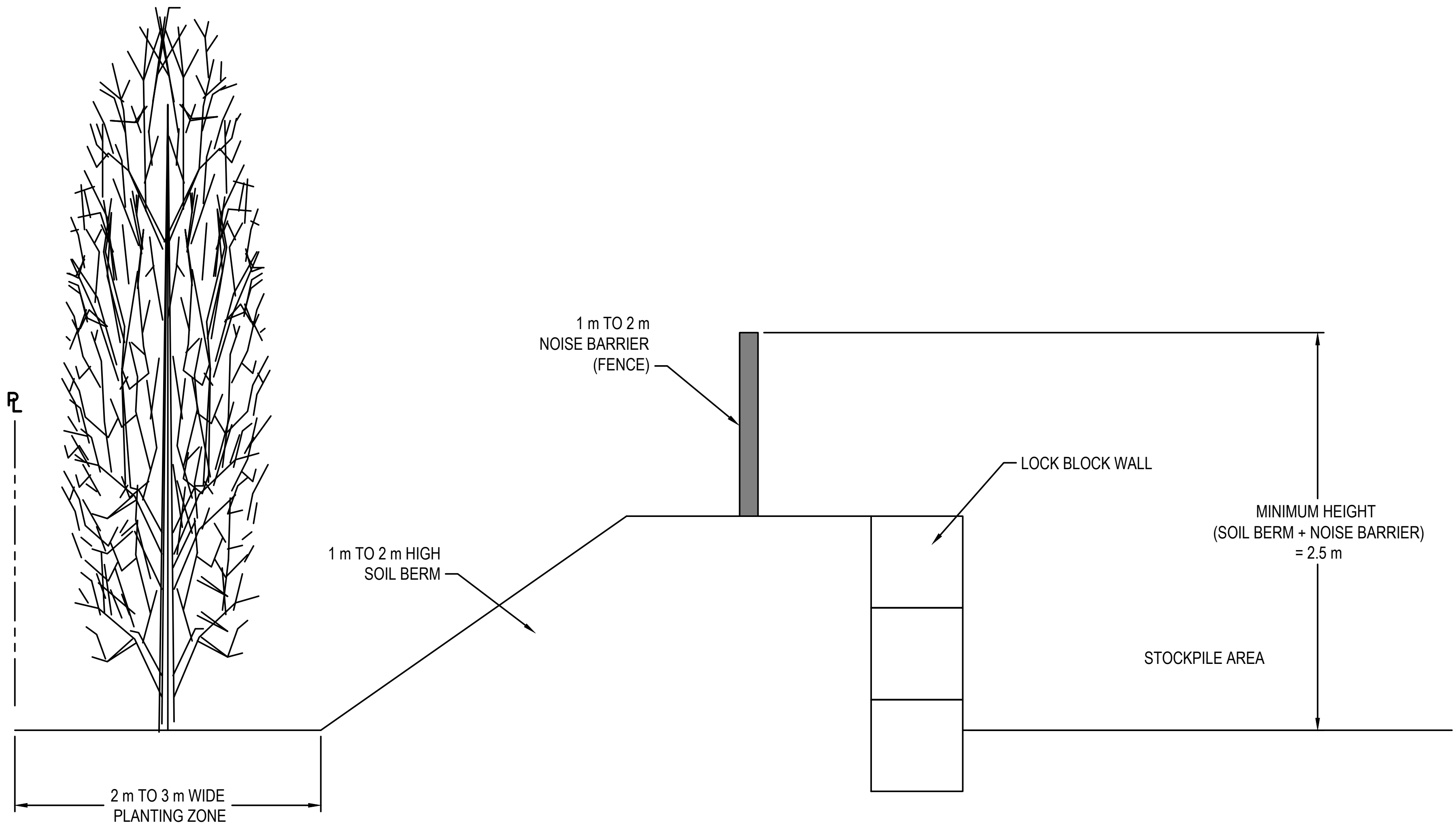
DERWENT WAY SOIL TRANSFER AND BARGE FACILITY ENVIRONMENTAL AIR ASSESSMENT FOR PORT METRO VANCOUVER

Road Segment Lengths

PROJECT NO.	DWN	CKD	APVD	REV
ENG.VGEO03082-01	MEZ	SL	TM	1

OFFICE	DATE
Tt EBA-VANC	January 18, 2017

Figure 7.1



ISSUED FOR USE

LEGEND

NOTES

SCALE: NTS

CLIENT

SUMMIT EARTHWORKS

TETRA TECH

DERWENT WAY SOIL TRANSFER AND BARGE FACILITY
ENVIRONMENTAL AIR ASSESSMENT
FOR PORT METRO VANCOUVER

CONCEPTUAL NOISE SHIELDING
ALONG WESTERN BOUNDARY

PROJECT NO.	DWN	CKD	REV
ENG.VGEO03082-01	RH	TM	1

OFFICE	DATE
EBA-VANC	March 22, 2017

Figure 9.1

APPENDIX A

ESTIMATION METHODOLOGIES

TABLE 1: TYPICAL VEHICLE SPECIFICATIONS

Vehicle Type	Model	Payload (kg)	Capacity - Struck (m3)	Capacity - Heaped (m3)	Empty Weight (kg)	Loaded Weight (kg)	Mean Weight (t)	Width (m)	Height (m)	Dump Height (m)	Engine Power (kW)
Dump Truck	CT660	22680	11	14	17963	40643	29.303	2.5	3.18	0.7	163
	Mack Granite		9					2.55	3.58	0.5	223
			Bucket Capacity (m3)	**Engine Capacity**							
				(kW)	**(hp)**						
Excavator	CASE CX130D		0.5	76.4	102						
	CAT 313F L			74.4	100						

TABLE 2: EPA MOTOR VEHICLE EMISSIONS SIMULATOR (MOVES 2014a) - EXHAUST EMISSIONS FROM DIESEL ENGINES

Vehicle Type	Power (hp)	Utilization	Number of trucks (day)	Round Trip kms Travelled	Assumed Speed (kph)	Op Hrs (per yr)
Loader/Backhoe	100	0.625				1250
On-Site Dumper (Diesel)	175	0.625				390
Transiting Dump Trucks (on site)	300		37.5			1563
Transiting Dump Trucks (Facility Boundary Roads)	300		37.5	0.46	20	216
Transiting Dump Trucks (Supply Chain Roads)	300		37.5	5.3	40	1242

Emission Factors (from MOVES2004a) (in g/hr)

	HC	CO	NO_x	Benzene	1,3 Butadiene	Formaldehyde	Acetaldehyde	Acrolein	SO_2	Ethylbenzene
Tractors/Loaders/Backhoes										
Running Exhaust	80.54	496.89	404.93	2.51	0.15	20.40	7.23	1.89	0.38	0.53
Crankcase Running Exhaust	1.56			0.05		0.39	0.14	0.04		0.01
TOTAL	**82.10**	**496.89**	**404.93**	**2.56**	**0.15**	**20.79**	**7.37**	**1.93**	**0.38**	**0.54**
Dumpers										
Running Exhaust	84.52	328.59	563.83	2.64	0.17	21.28	7.56	2.12	0.44	0.61
Crankcase Running Exhaust	1.63			0.05		0.41	0.15	0.04		0.01
TOTAL	86.15	328.59	563.83	2.69	0.17	21.69	7.71	2.16	0.44	0.62
Off-Highway Trucks										
Running Exhaust	34.38	66.97	277.26	0.80	0.039	9.21	3.01	0.46	0.66	0.23
Crankcase Running Exhaust	0.12			0.007	0.0003	0.04	0.01	0.002		0.0006
TOTAL	34.5	66.97	277.26	0.807	0.0393	9.25	3.02	0.462	0.66	0.2306

TOTAL EMISSIONS									(in tonnes/yr)	
Tractors/Loaders/Backhoes	0.103	0.621	0.506	0.003	1.88E-04	0.026	0.009	0.002	4.75E-04	6.75E-04
Dump Truck (Site)	0.034	0.128	0.220	1.05E-03	6.63E-05	0.008	0.003	8.42E-04	1.72E-04	2.42E-04
Dump Trucks (Site Roads)	0.054	0.105	0.433	0.001	0.000	0.014	0.005	0.001	0.001	0.000
Dump Trucks (Facility Roads)	0.007	0.014	0.060	0.000	0.000	0.002	0.001	0.000	0.000	0.000
Dump Trucks (Supply Chain Roads)	0.043	0.083	0.344	0.001	0.000	0.011	0.004	0.001	0.001	0.000
TOTAL EMISSIONS	**0.240**	**0.952**	**1.563**	**0.007**	**0.0004**	**0.062**	**0.021**	**0.005**	**0.003**	**0.002**
FACILITY				0.006	0.0003	0.051	0.018	0.004		0.001

Toluene	Xylene	PM_{10}	$PM_{2.5}$	Benzo(a)pyrene	VOC	Napthalene
1.95	1.60	72.54	70.37	0.00	87.30	0.34
0.04	0.03				1.68	0.01
1.99	**1.63**	**72.54**	**70.37**	**0.00**	**88.99**	**0.34**
1.97	1.72	63.19	61.30	0.00	91.38	0.36
0.04	0.03				1.76	0.01
2.01	1.75	63.19	61.30	0.00	93.14	0.36
1.25	1.34	10.88	10.55		40.069	0.5708
0.01					0.14	0.0006
1.26	1.34	10.88	10.55	0	40.209	0.5714

0.002	0.002	0.091	0.088	3.49E-06	0.111	4.27E-04
7.84E-04	6.83E-04	0.025	0.024	7.80E-08	0.036	1.42E-04
0.002	0.002	0.017	0.016	0.000	0.063	0.001
0.000	0.000	0.002	0.002	0.000	0.009	0.000
0.002	0.002	0.014	0.013	0.000	0.050	0.001
0.007	**0.007**	**0.148**	**0.144**	**0.000**	**0.269**	**0.002**
0.006	0.005			0.000		0.002

TABLE 3: EMISSION FACTOR EQUATIONS FOR DUST EMISSIONS FROM PAVED ROADS: (EPA AP-42 Section 13.2.1 'Paved Roads')

$E = k(sL)^{0.91}x(W)^{1.02}$

k=	3.23	TSP
	0.62	PM_{10}
	0.15	$PM_{2.5}$

32	Road silt loading (g/m^2 - high range for municipal solid waste landfill tests from Table 13.2.1-3)
0.6	Road silt loading (ubiquitous baseline low volume - Table 13.2.1-2)
0.2	Road silt loading (ubiquitous baseline med. volume - Table 13.2.1-2)

	Emission rate (g/VKT)					Emissions (tonnes/year)		
	TSP	PM_{10}	$PM_{2.5}$	Dist (km)		TSP	PM_{10}	$PM_{2.5}$
Paved Roads (Site)	2316.0	444.6	107.6	0.130		2.82	0.54	0.13
Paved Roads (Site - Barge Loading)	2316.0	444.6	107.6	0.065		2.82	0.54	0.13
Paved Roads (Facility Boundary)	1253.6	240.6	58.2	0.230		2.70	0.52	0.126
Paved Roads (Supply Chain)	22.9	4.4	1.1	2.65		1.14	0.22	0.053
					TOTAL	**9.48**	**1.82**	**0.44**

	Road Distance	
Access from Alex Fraser	3.2	km
Access from Queensborough, Hwy 91	2.1	km
Facility Roads	320	m

9375 Annual storage to yard to barge loads (based on payload of small dump truck/dumper) - see material handling

TABLE 4: TUG EMISSIONS

		Emission Factor (g/kWh)										
Vessel	**Engine Type**	**TSP**	**PM_{10}**	**$PM_{2.5}$**	**CO**	**NOx**	**SO_2**	**VOC**	**CO_2**	**CH_4**	**N_2O**	**CO_2e**
Tugboat	Main-4-stroke	0.27	0.26	0.24	1.1	13.2	0.21	0.5	670	0.004	0.017	676.5

Canadian 2010 National Marine Emissions Inventory

MDO Sulfur Content 0.05 %

	Main Engine Capacity	
River Tugboats	1044	*Engine information for tugboats, supplied by the tug operator - Levelton Fraser Surrey Docks*

Load factor	0.8	
Time in mode (maneuvering, arrival)	0.33	hrs
Time in mode (maneuvering, departure)	0.33	hrs
Time in mode (travel to landfill)	**4.3**	hrs
Number of trips (annual, estimate)	78	

River Dist. to Site (km) 48 Speed 6 knots (RWDI - Pacific Pilotage Authority Speed limits)

	Emissions (tonnes/year) *assumes 1.5 weekly barge towing						
	TSP	**PM_{10}**	**$PM_{2.5}$**	**CO**	**NOx**	**SO_2**	**VOC**
Facility Boundary	0.012	0.011	0.010	0.047	0.568	0.009	0.021
Supply Chain Boundary	0.154	0.148	0.136	0.619	7.429	0.118	0.281
TOTAL	0.166	0.159	0.146	0.666	7.997	0.127	0.303

TABLE 5: EMISSION FACTOR EQUATIONS FOR MATERIAL HANDLING (EPA AP-42 Section 13.2.4 'Aggregate Handling And Storage Piles')

		Throughput (tonnes)		
Activity	**Frequency**	**Low**	**High**	**Annual**
Dumping of New Material at Site	15 to 60 trucks/day	340.2	1360.8	**212625**
Shovelling of Material into Storage Pile	8 hours /day			
Shovelling of Material from Storage Pile	8 hours/1 or 2 days/week			
Loading into Site Dump truck	8 hours/1 or 2 days/week			
Dumping of Material onto Barge	1 or 2 days/week			

2.5	Mean Wind Speed (m/s) - Metro Vancouver Annacis Island T38 2009-2012
4.8	Material Moisture Content (%)

9375 Annual Loads -> Storage to barge (based on payload of dump truck)

	Emissions (tonnes/year)		
	TPM	**PM_{10}**	**$PM_{2.5}$**
Dumping of New Material at Site	0.087	0.041	0.0063
Shovelling of Material into Storage Pile	0.087	0.041	0.0063
Loading into Site Dump truck	0.087	0.041	0.0063
Dumping of Material onto Barge	0.087	0.041	0.0063
TOTAL	**0.349**	**0.165**	**0.025**

TABLE 6: EMISSION FACTOR EQUATIONS FOR WIND EROSION OF AGGREGATE STOCKPILES (EC National Polutant Release Inventory Guidance)

Maximum Stockpiled Weekly (m^3)	2100	(based on average number of vehicles and heaped capacity of dump truck - 14m^3 - vehicle specifications)
Theoretical Max Volume per Stockpile	131	(Max height 5 m - specs, 1:1 h:r ratio)

Maximum number of stockpiles	16.04
Average number of stockpiles per week	8.02
Total Exposed Lateral Area (average)	**891.0**

Average silt loading of the pile	9	(average from sand and gravel, from NPRI)
Average number of days >0.254 mm precip	169	(YVR 1981 - 2010 Climate Normals for >=0.2 mm)
% time with unobstructed wind speed >19.3 km/h	1.9	(Metro Vancouver Annacis Island T38 2009-2012)

Emissions (tonnes/year)		
TPM	**PM_{10}**	**$PM_{2.5}$**
0.010	**0.005**	**0.002**

*assumes no wind screening (70% reduction) on winward side of stockpiles (east)

APPENDIX B

TETRA TECH'S GENERAL CONDITIONS

GENERAL CONDITIONS

HYDROTECHNICAL

This report incorporates and is subject to these "General Conditions".

1.1 USE OF REPORT AND OWNERSHIP

This report pertains to a specific site, a specific development, and a specific scope of work. The report may include plans, drawings, profiles and other supporting documents that collectively constitute the report (the "Report").

The Report is intended for the sole use of TETRA TECH's Client (the "Client") as specifically identified in the TETRA TECH Services Agreement or other Contract entered into with the Client (either of which is termed the "Services Agreement" herein). TETRA TECH does not accept any responsibility for the accuracy of any of the data, analyses, recommendations or other contents of the Report when it is used or relied upon by any party other than the Client, unless authorized in writing by TETRA TECH.

Any unauthorized use of the Report is at the sole risk of the user. TETRA TECH accepts no responsibility whatsoever for any loss or damage where such loss or damage is alleged to be or, is in fact, caused by the unauthorized use of the Report.

Where TETRA TECH has expressly authorized the use of the Report by a third party (an "Authorized Party"), consideration for such authorization is the Authorized Party's acceptance of these General Conditions as well as any limitations on liability contained in the Services Agreement with the Client (all of which is collectively termed the "Limitations on Liability"). The Authorized Party should carefully review both these General Conditions and the Services Agreement prior to making any use of the Report. Any use made of the Report by an Authorized Party constitutes the Authorized Party's express acceptance of, and agreement to, the Limitations on Liability.

The Report and any other form or type of data or documents generated by TETRA TECH during the performance of the work are TETRA TECH's professional work product and shall remain the copyright property of TETRA TECH.

The Report is subject to copyright and shall not be reproduced either wholly or in part without the prior, written permission of TETRA TECH. Additional copies of the Report, if required, may be obtained upon request.

1.2 ALTERNATIVE REPORT FORMAT

Where TETRA TECH submits both electronic file and hard copy versions of the Report or any drawings or other project-related documents and deliverables (collectively termed TETRA TECH's "Instruments of Professional Service"), only the signed and/or sealed versions shall be considered final. The original signed and/or sealed version archived by TETRA TECH shall be deemed to be the original. TETRA TECH will archive the original signed and/or sealed version for a maximum period of 10 years.

Both electronic file and hard copy versions of TETRA TECH's Instruments of Professional Service shall not, under any circumstances, be altered by any party except TETRA TECH. TETRA TECH's Instruments of Professional Service will be used only and exactly as submitted by TETRA TECH.

Electronic files submitted by TETRA TECH have been prepared and submitted using specific software and hardware systems. TETRA TECH makes no representation about the compatibility of these files with the Client's current or future software and hardware systems.

1.3 STANDARD OF CARE

Services performed by TETRA TECH for the Report have been conducted in accordance with the Services Agreement, in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions in the jurisdiction in which the services are provided. Professional judgment has been applied in developing the conclusions and/or recommendations provided in this Report. No warranty or guarantee, express or implied, is made concerning the test results, comments, recommendations, or any other portion of the Report.

If any error or omission is detected by the Client or an Authorized Party, the error or omission must be immediately brought to the attention of TETRA TECH.

1.4 ENVIRONMENTAL AND REGULATORY ISSUES

Unless expressly agreed to in the Services Agreement, TETRA TECH was not retained to investigate, address or consider, and has not investigated, addressed or considered any environmental or regulatory issues associated with the project.

1.5 DISCLOSURE OF INFORMATION BY CLIENT

The Client acknowledges that it has fully cooperated with TETRA TECH with respect to the provision of all available information on the past, present, and proposed conditions on the site, including historical information respecting the use of the site. The Client further acknowledges that in order for TETRA TECH to properly provide the services contracted for in the Services Agreement, TETRA TECH has relied upon the Client with respect to both the full disclosure and accuracy of any such information.

1.6 INFORMATION PROVIDED TO TETRA TECH BY OTHERS

During the performance of the work and the preparation of this Report, TETRA TECH may have relied on information provided by persons other than the Client.

While TETRA TECH endeavours to verify the accuracy of such information, TETRA TECH accepts no responsibility for the accuracy or the reliability of such information even where inaccurate or unreliable information impacts any recommendations, design or other deliverables and causes the Client or an Authorized Party loss or damage.

1.7 GENERAL LIMITATIONS OF REPORT

This Report is based solely on the conditions present and the data available to TETRA TECH at the time the Report was prepared.

The Client, and any Authorized Party, acknowledges that the Report is based on limited data and that the conclusions, opinions, and recommendations contained in the Report are the result of the application of professional judgment to such limited data.

The Report is not applicable to any other sites, nor should it be relied upon for types of development other than those to which it refers. Any variation from the site conditions present at or the development proposed as of the date of the Report requires a supplementary investigation and assessment.

It is incumbent upon the Client and any Authorized Party, to be knowledgeable of the level of risk that has been incorporated into the project design, in consideration of the level of the hydrotechnical information that was reasonably acquired to facilitate completion of the design.

The Client acknowledges that TETRA TECH is neither qualified to, nor is it making, any recommendations with respect to the purchase, sale, investment or development of the property, the decisions on which are the sole responsibility of the Client.

1.8 JOB SITE SAFETY

TETRA TECH is only responsible for the activities of its employees on the job site and was not and will not be responsible for the supervision of any other persons whatsoever. The presence of TETRA TECH personnel on site shall not be construed in any way to relieve the Client or any other persons on site from their responsibility for job site safety.