Recycled Concrete Aggregate Assessment
Fraser Grain Terminal

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1.0 INTRODUCTION

The Fraser Grain Terminal (FGT) Project (the "Project") is planned to be built within the former Bekaert Canada lease boundary. The above ground structures for the Bekaert operations building were recently removed. The remaining concrete slab, grade beam and trenches must also be removed, to allow for ground improvements required to meet seismic criteria and accommodate site facilities and utilities. A high-level review of options was conducted to evaluate 1) disposal of concrete offsite or 2) re-use of concrete as Recycled Concrete Aggregate (RCA) material.

2.0 METHODOLOGY

Methods for concrete crushing and placement of material on-site are outlined in Section 6.10 and 6.11 of the CEMP. In evaluating the plan to deal with the RCA, it has been assumed that all concrete will be temporarily stored in a bermed area in stockpiles, tested for contamination and once deemed clean, crushed to a nominal 75mm minus size for re-use as shallow (less than 1m deep) subgrade fill under impervious surfaces only. Should a stockpile of the concrete material be deemed contaminated, it will be segregated and hauled off-site to a disposal facility permitted to receive such material.

3.0 ASSUMPTIONS

The principles of reduce, reuse and recycle for construction materials were considered in this assessment. To evaluate beneficial re-use of RCA versus disposal off-site, the following factors were included:

- The estimated timeline for crushing the concrete to size is assumed to be ~2 weeks.
- Re-use of existing high quality uncontaminated material (i.e. concrete) as aggregate would off-set import of backfill granular materials.
- Number of trucks required to haul material (both concrete, wastes such as rebar and backfill)
- The off-site disposal of clean concrete would be the Tervita RBF facility in Richmond
- Estimates of duration of noise generated by concrete crushing
- Costs of producing RCA
- Costs of purchasing and importing granular fill
- Reducing the amount of noise, air emissions and traffic from hauling crushed concrete off-site.
- Reducing the amount of noise, air emissions and traffic from hauling new aggregate on-site to replace removed concrete
- RCA production method and recycling efficiency (volume losses due to concrete dusts/fines being produced)
- Crushing and storing material on-site would limit any dust and noise emissions to the construction site itself

The number of trucks was used as a proxy for environmental effects of each option.

The following parameters were determined through background research and information provided by FWS:

- Estimated tonnes of concrete slab (to calculate disposal costs) - 16,500 tonnes
- Trucking and facility tipping fee for clean concrete material - $46/m^3
- Estimated number of dump trucks to haul
  - Concrete waste off-site – 78
  - Non-concrete waste off-site (e.g., rebar) – 8 (10% rebar, off-spec or contaminated material)
  - Clean granular fill - 65
- Estimated volume of RCA available for reuse – ~6,200 m^3
- Typical noise levels of concrete crushing equipment - 90 dBA (Leq)
- Estimated volume of waste material generated from concrete crushing (e.g., rebar, off-spec or contaminated material) - 680 m^3
- Unit cost for granular fill (if RCA not used). $65/m^3 for 75mm minus
- Estimated volume of clean granular fill – ~6,200 m^3

4.0 OPTIONS FOR CONCRETE DISPOSAL / RE-USE

Seven options were reviewed for disposal or re-use of concrete slab as outlined in **Table 1** below.

Table 1: Options for Concrete Disposal or Re-use:

Option #	Description	Considered for Further Evaluation?	Rationale
1	Stockpiling and leaving on site	Not considered	Not acceptable to VFPA
2	Stockpiling off-site .	Not considered	Significant truck traffic would be required to haul the concrete off site and after calling some locations, understood there is no nearby location able to store this volume of concrete
3	Beneficially re-use material off-site	Not considered	Considerable uncertainties of locations that a Contractor could select for beneficial re-use.
4	Re-use on-site of material large (300mm) particles without crushing	Not considered	Large RCA material is not geotechnically suitable for re-use as subgrade material.
5	Re-use on-site of RCA crushed to 150 mm minus particles with crushing	Not considered	This size of RCA material is not suitable for re-use as subgrade material
6	Re-use on-site of RCA crushed to 75 mm minus particles with crushing	Considered	This size of RCA material is suitable for re-use as subgrade material
7	Disposal off-site	Considered	Assumed that a suitable disposal site is available within 20 km radius of the Project

Based on the option review, two options were carried forward for further evaluation.

Table 2: Options Considered for Additional Evaluation

Option	Economic Considerations	Environmental Considerations
A. Beneficial Re-use of RCA Onsite	Rental of concrete crusher Testing, sorting and handling material Disposal of waste (e.g., rebar) Construction and post-construction monitoring	2 weeks of concrete crushing resulting in: • 90 dBA emissions (during work hours as defined by VFPA) • Localized concrete dust emissions[1] • Traffic disruption and emissions from 8 trucks moving material off-site • Equipment emissions from onsite material handling # trucks required to haul material off-site[2] = 86
B. Disposal of Waste Concrete	Testing of material to determine disposal Cost of trucking (Cost for landfill disposal of concrete =	2 weeks of concrete slab hauling offsite resulting in • 84 dBA (Lmax)3 dumptruck emissions (during work hours as defined by VFPA) • Localized diesel and noise emissions and added traffic volumes • Equipment emissions from onsite material handling Additional inputs to local landfills not environmentally sustainable # trucks required to haul material off-site[4] = 860 # trucks required to haul clean granular to site = 687

1 Emissions resulting from concrete crushing considered as
2 Assume that 10% of material will be unsuitable for use as RCA
3 As measured at 15 m
4

5.0 SUMMARY AND CONCLUSIONS

Seven options were identified to address the appropriate disposal or re-use of the concrete waste generated due to the removal of the slab on the lease area formerly occupied by the Bekaert building. Five options were determined to be either not feasible or to have too many uncertainties to be considered further. Two options were considered for further analysis and evaluated in **Table 2**:

A. Re-use on-site of RCA crushed to 75 mm minus particles with crushing – Considered – this size of RCA material is suitable for re-use as subgrade material.

B. Disposal off-site – Considered – Assumed that suitable disposal sites available within 20 km of the Project.

5.1 ECONOMIC SUMMARY

Option A: Concrete Re-used On-site

Breakup and stockpile onsite	6,880 m^3 x \$100 = \$688,000
Monitoring, sampling and analysis during construction	= \$37,000
2mm minus fines removal	6,880 m^3 x \$12.00 = \$82,500
Haul 10% 2mm minus fines offsite	690 m^3 x \$20.00 = \$13,800
Tipping Fee for Clean Fill	690 m^3 x \$26.00 = \$17,900
Install Concrete Granular	6,200 m^3 x \$12.00 = \$74,400
Supply & Install New Granular Fill (75mm minus)	690 m^3 x \$65.00 = \$44,850
Monitoring and sampling post-construction	\$80,000
Total	**\$1,036,450**

Option B: Concrete Disposal Off-site:

Breakup and stockpile onsite	6,880 m^3 x \$100 = \$688,000
Sampling and analysis	= \$37,000
Haul concrete offsite	6,880 m^3 x \$20.00 = \$137,600
Tipping Fee for Clean Fill	6,880 m^3 x \$26.00 = \$178,800
Supply & Install New Granular Fill (75mm minus)	6,880 m^3 x \$65.00 = \$447,200
Total	**\$1,488,680**

Total Savings = \$452,230

5.2 ENVIRONMENTAL CONSIDERATIONS SUMMARY

As noted above, the number of trucks was used as a proxy for the environmental effects of each option. Environmental effects would include noise and diesel emissions, and effects to traffic volumes and congestion on haul routes.

Option	Description	# Trucks
A. Beneficial Re-use of RCA Onsite	Trucks required to haul material off site (based on 10% not being suitable for RCA)	86
	• Disposal of concrete waste	78
	• Disposal costs off-site – (assume 10% of not suitable RCA)	8
	Trucks required to provide granular to replace RCA	70
	Total truck one-way trips (either on or off-site)	**156 trucks**
B. Disposal of Waste Concrete	Trucks to dispose crushed concrete and rebar	860 trucks
	Trucks to haul new granular to site	687 trucks
	Total truck one-way trips (either on or off-site)	**1547 trucks**

5.3 CONCLUSION

Based on both economic and environmental factors considered in this analysis, beneficial re-use of concrete on-site is considered the preferred option for the concrete slab waste generated by the Project.

6.0 CLOSURE

This Work was performed in accordance with 08-17-115C Professional Services Agreement between Hemmera Envirochem Inc. (“Hemmera”) and Parrish and Heimbecker Ltd. c/o FWS Group of Companies (“Client”), dated December 8, 2017 (“Contract”). This Report has been prepared by Hemmera, based on information provided by FWS Group , for sole benefit and use by Fraser Grain Terminal Ltd. In performing this Work, Hemmera has relied in good faith on information provided by others and has assumed that the information provided by those individuals is both complete and accurate. This Work was performed to current industry standard practice for similar environmental work, within the relevant jurisdiction and same locale. The findings presented herein should be considered within the context of the scope of work and project terms of reference; further, the findings are time sensitive and are considered valid only at the time the Report was produced. The conclusions and recommendations contained in this Report are based upon the applicable guidelines, regulations, and legislation existing at the time the Report was produced; any changes in the regulatory regime may alter the conclusions and/or recommendations.

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