The Benefits of Using Recycled Crushed Aggregates in Infrastructure Projects
Study Report

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Foreword

Extensive road-related construction is a constant in the dynamic Greater Toronto Area and beyond. As the region continues to experience population growth, there is also an ongoing need to replace older roads, curbs, sidewalks and bridge structures as municipalities renew these important infrastructure assets. When these assets are kept in a state of good repair, the concrete 'waste' generated by these activities ends up in recycling yards, with the goal being to process this material for reuse in other construction projects.

Unfortunately, many of the same municipalities creating this reusable supply of recycled crushed aggregates (RCAs) do not specify this valuable resource when rebuilding those same roads, curbs, sidewalks and bridges. Instead, tender documents tend to favour virgin or primary materials that are sourced at a great distance from market. At a time when policies and programs promoting the sustainable use of resources tops the public and government agenda, members of the Toronto and Area Road Builders Association (TARBA) believe that prioritizing the reuse of RCAs will be welcome by the public and decision makers.

The use of recycled crushed aggregates preserves a non-renewable resource, reduces the demand for new pits and quarries and lowers energy use and greenhouse gases associated with longer truck hauling. Aggregate recycling facilities located in the GTA provide municipalities and contractors with locations to recover reclaimed concrete nearby and the opportunity to divert it from landfill or from being underutilized as clean fill. TARBA members play an important role in accepting and processing these materials in what should be an excellent example of the merits associated with the circular economy of resource stewardship.

Fortunately, we have a good example of resource stewardship within Ontario. The Ministry of Transportation (MTO) has a long-standing commitment to using recycled aggregates in 400-series highways, where approximately 20 per cent of all aggregates used in MTO projects contain recycled content. Properly processed or re-engineered recycled concrete aggregate that meets Ontario Provincial Standard Specifications (OPSS) has proven to be a reliable material for use in road construction, as engineered backfill and as a base material in many other applications. In fact, used appropriately, recycled crushed aggregates perform as well or better than primary aggregates in most applications.

The advantages of using suitable RCA materials in favour of virgin or primary aggregates mined and hauled from increasingly distant locations needs to be better understood by the public and decision makers. Although previous research has documented the positive results about the high-performance qualities of this product, TARBA commissioned this study to focus attention once again on why better stewardship of this valuable resource is required now.

Board of Directors' Recycling Committee
Toronto and Area Road Builders' Association

Executive Summary

In the Greater Toronto Area (GTA), recycled crushed aggregate (RCA1010) is readily available at reduced cost when compared to virgin aggregates; this sustainable product has a proven track record as a high-performance material for granular base, sub-base and other road and airfield construction projects.

In addition to testing the performance qualities of RCA samples, this report reviews in detail how a sustainable approach to the use of this resource creates significant economic and environmental advantages for road building authorities. The opportunities to lower energy consumption, reduce GHG emissions, protecting primary sources and lower material and transportation costs when building and renewing infrastructure are presented in detail.

This study report discusses the results of sieve analyses for physical properties, sulphate contents, Freeze Thaw and Magnesium Sulphate Soundness, and SPLP Leachate Analytical Testing of Granular A Recycled Crushed Aggregates (RCA1010) that have been collected from six (6) selected crusher yard locations within GTA. This study also includes a GHG analysis and case studies from previous projects.

Laboratory test results indicate that a high percentage of the tested samples of the RCA1010 material achieve the requirements for Granular A as per the OPSS1010 Standard Specifications adopted in Ontario for road construction projects. To achieve this standard, the report emphasizes the need for good quality control of the stockpiled materials in recycling yards.

In addition, this study presents case studies/projects where the use of recycled crushed aggregates (RCA) had successfully achieved the required pavement performance in highways, municipal roads, airfield facilities and development engineering projects while providing savings in terms of construction costs and avoided emissions.

This study suggests there is a room for growth and improvement by encouraging Ontario municipalities to rely more on RCA1010 in their projects. It will be important for local governments to undertake a review of their policies and tender documents for infrastructure projects to ensure that the economic and environmental benefits associated with the use of recycled concrete aggregates are recognized and realized in the future.

To facilitate the adoption and use of recycled crushed aggregates in greater quantities for infrastructure projects, this study suggests five categories for future actions and next steps:
1) Support and enhance the circular economy objectives of Ontario municipalities.
2) Foster quality assurance and production certification for RCA at Crusher Yards.
3) Perform in-situ testing of existing roads for selected projects to confirm the pavement performance and properties of RCA.
4) Build up municipal engineers’ training and knowledge sharing.
5) Update municipal standard specifications.

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Appendices

1. Introduction

EXP Services Inc. (EXP) is pleased to present TARBA the findings of our study on the use of recycled crushed aggregate (RCA1010) in infrastructure projects. There are tens of millions of tonnes of valuable concrete available from construction sites across the province as roads, bridges and other concrete structures are demolished and replaced. The objective of the study is to encourage municipalities and road authorities to increase the application of the Gran A (RCA1010) that is produced by recycling this old concrete for reuse in the construction of road granular base layer.

Concrete is one of the most versatile building materials and has facilitated urban growth in the last century. It can be difficult to get rid of concrete waste, however, when concrete buildings are demolished (higher likelihood of being contaminated with other materials, such as rebar, wood, or gypsum). Crushed old concrete is recycled as aggregates in highway pavements but it is not used in buildings and bridges because of uncertainties related to its performance in new concrete. As ongoing investment in the nation's infrastructure must continue, the volume of available secondary concrete will increase. Reusing the crushed aggregates processed from this material in new roads and other infrastructure projects will reduce the environmental impact of disposing of this "waste" and help to reduce demand for new supplies.

Concrete is a 100 per cent recyclable material, and this product can be crushed, cleaned, screened and reused in new construction. Typically, the RCM can be processed into different sizes and repurposed as aggregate in road bases, shoulders and backfill among other applications. The recycled concrete material (RCM) comes primarily from two sources: (1) returned concrete (relatively clean from contamination) and (2) construction and demolition streams - recovery of concrete material from buildings, bridges, sidewalks, and other concrete structures at end of life (higher likelihood of being contaminated with other materials, such as asphalt, or even rebar, wood or gypsum).

A pavement is a multi-layered structure comprising various layers such as the surface, base, subbase, and subgrade. The main role of the base layers is to provide uniform support for pavement surface layers and adequate drainage during the lifetime of the pavement. Materials used in unbound granular layers must meet specific engineering requirements such as gradation and physical properties. In order to provide a viable option for the use of construction waste, there is an urgent need to ramp up the proportion of RCA as an unbound granular material in road base, subbase and other construction projects.

Although the application of RCA as granular road base material is a common practice in many jurisdictions, there are still some concerns amongst municipalities about the potential for adverse environmental impacts to the subsurface conditions from heavy metals leaching from the granular materials. Based on analytical testing conducted as part of this study, the marginally detected concentrations of the selected metal, Volatile Organic Compound (VOC) or Semi-Volatile Organic Compound (SVOC) parameters analyzed in the Gran A (RCA1010) granular base effluent did not suggest the potential for sub-surface environmental impacts to result from the use of Gran A (RCA1010) granular base materials.

The essential need to preserve natural resources and extend the life of landfill spaces has motivated governments and organizations from different countries to make a concentrated effort to replace virgin aggregates with recycled aggregate.

1.1 General Background

Between July and November 2022, this study examined the gradation and physical properties of Gran A (RCA1010) collected from different yards/crushers around the GTA and the environmental and sustainability considerations, including a desktop review of previous research, studies and projects where recycled crushed aggregate had been incorporated into construction projects. This research was commissioned by the Toronto and Area Road Builders Association. Financial support has been received from Good Roads (formerly known as the Ontario Good Roads Association), the Ontario Stone, Sand, and Gravel Association, Concrete Ontario, the Greater Toronto Sewer and Watermain Contractors Association and the Ontario Road Builders' Association. In-kind support has been offered by the Association of Consulting Engineering Companies – Ontario, as well as the Ontario Society of Professional Engineers.

These industry associations advocate for the increased use of recycled aggregate materials in infrastructure projects in Ontario, with their primary interests being:

- To promote sustainable and more environmentally friendly practices.
- To support municipalities in achieving the targeted goals with efficiencies, by furthering the use of RCA more widely throughout the province of Ontario.

According to the Environmental Commissioner of Ontario, in her "Good Choices, Bad Choices, 2017 Environmental Protection Report," a total of about 184 million tonnes of aggregate are used annually in the province of Ontario. New aggregate (from quarries and pits) meets most of this demand and only about 13 million tonnes or 7 per cent come from recycled sources. In contrast, some European countries use up to 20 per cent recycled aggregate. The Commissioner concluded that Ontario could avoid extracting up to 33 million tonnes of new aggregate per year if a similar recycling rate was achieved in Ontario.

It is understood that the concrete is not being recycled in greater quantities because many municipalities in Ontario prohibit or severely limit the use of recycled aggregate in road construction and other public works. And yet, collectively, municipalities are the largest consumers of aggregate in the province, using between 60 and 70 million tonnes a year (based on Ontario Ministry of Natural Resources, State of the Aggregate Resource in Ontario Study, Consolidated Report, 2010). Although the same report did note that the annual use of recycled aggregate rose from 6 million tonnes in 1991 to 13 million tonnes in 2006.

A new study produced in July 2022 that was commissioned by the Ontario Stone, Sand & Gravel Association (OSSGA) and prepared by the Ontario Chamber of Commerce, titled “The Long Haul: Examining the Implications of Far-From-Market Aggregates”, provides useful background information on the consequences of relying on new aggregate supply that is produced further from market. Aggregate production is considered a major contributor to Ontario’s $51 billion construction industry (2019) as very little can be built without aggregates. The report makes the case for keeping aggregate production near where construction and industry need it. Longer hauling distances increase costs, results in a larger carbon footprint with trucks having a negative impact on road wear and traffic safety. **Table 1** below summarizes some of the figures mentioned in the OSSGA report for the expected consumption of aggregates in the Greater Toronto and Hamilton Area (GTHA) by 2041.

Table 1. Expected Consumption of Aggregates in GTHA by 2041

Item Description	Amount ($)
Worth of New Aggregate Production in Ontario (2019)	$1.7 Billion
Aggregate Production in East Central Ontario (Peterborough and the Kawarthas and the surrounding areas to the east and north) -2019	$22 Million Tonnes
Aggregate Production in GTHA	$25 Million Tonnes
Aggregate consumption in Greater Toronto and Hamilton Area (GTHA), approx.	$73 Million Tonnes
Expected consumption of Aggregates in GTHA by 2041 (With continuing the development in Ontario)	$1.5 billion tonnes

Based on the OSSGA report, the GTHA is dotted with quarries but cannot keep up with its own supply needs. The consumption of aggregate in the GTHA is greater than what is produced there. This means that aggregate mining in areas like Peterborough and the Kawarthas plays a key role in not only their own development, but that of larger neighbours such as the GTHA.

If quarries reach end of life or are not allowed to expand, aggregate consumers will simply buy it at a greater distance from market. The GTHA is increasingly relying on pits and quarries further away and can expect to exhaust all close-to-market aggregate production supply within the next 10 to 15 years. This means that aggregate mining in areas such as Peterborough and the Kawarthas will play an even greater role in supplying distant markets in the GTHA.

Figure 1 shows the 2019 virgin aggregate production in Tonnes by Ontario Region (from July 2022 OSSGA Study Report, based on aggregate production by permit and license only as they make up the majority of overall production).

The objective of this Phase I ESA was to identify potential sources of environmental concern to the Site. A Phase I ESA is a systematic qualitative process to assess the environmental condition of a Site based on its historical and current uses. The Phase I ESA was completed in general accordance to CSA Standard Z768-01, (R2016). Subject to this standard of care, EXP makes no express or implied warranties regarding its services and no third-party beneficiaries are intended.

Limitation of liability, scope of report and third-party reliance are outlined in Section 9 of this report.

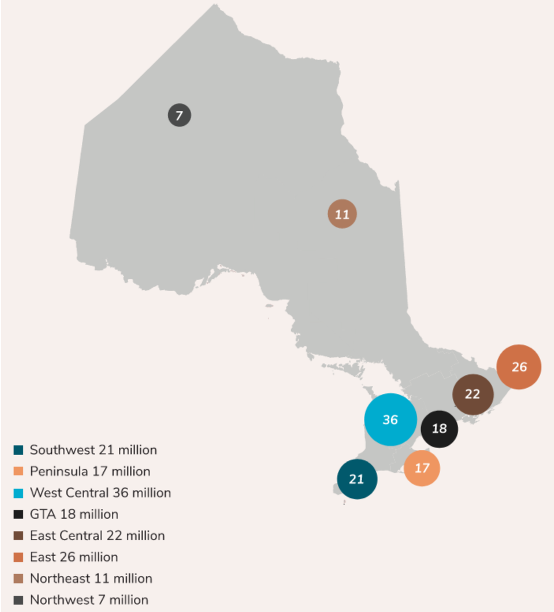


Figure 1: 2019 Virgin Aggregate Production in Tonnes by Ontario Region

The following **Table 2** summarizes some of the figures mentioned in the OSSGA report for aggregate hauling distances and associated costs.

Table 2. Ontario Aggregate Hauling Distances and Associated Costs

Item Description	Figure
Current Average Hauling Distance for Close-To-Market Production	35 km
Current Haulage Cost (one-way)	$5.92/tonne
Expected Average Hauling Distance (if the current sources of aggregate are exhausted)	110 km
Expected Hauling Cost (one-way)	$12.67/tonne
Expected increasing in Hauling Cost of 32-tonne truck load (one-way)	$216 per load
In this case, the cost of sourcing aggregate would increase the transportation costs alone by	$169 million (double what we are currently seeing)

The additional costs mentioned in Table 2 will be passed on to builders, increasing the cost of things like homes, roads, and bridges. Longer distances also mean trucks will not be able to make as many trips per day, requiring more trucks and more time driving. As per the same report, sourcing aggregates further from market is expected to burn an additional 32.8 million litres of fuel, generating an extra 88,594 metric tonnes of CO_2 [Green House Gas (GHG)] emissions annually.

Ester Gerassime, OCC's economic analyst and author of the OSSGA study report (based on the article "Dwindling aggregate supply will lead to significant infrastructure costs: Study" of Angela Gismondi, Daily Commercial News, August 23,2022) said the following:

- "We found, for example, that the additional haul distance or having to bring these aggregates farther away would result in an additional $6.2 million to the cost of an average subway extension project … as well as $510,000 to the cost of an average hospital build,". "It doesn't seem like much individually but if you take this on a bigger scale, if you're looking at all the municipalities throughout the GTHA, all of this starts to add up."
- "What that currently amounts to is about $2.7 million in economic costs under the current carbon price of $30 per tonne". "But by 2030, when the carbon price reaches $170 per tonne, the added emissions will cost more than $15 million."
- "Without the continued replacement of licensed reserves in the GTHA, you're looking at exhausting all close-to-market aggregates within the next 10 to 15 years from now". "It seems far away but in the aggregates world with regulations, with planning, with having to establish where the new sites and quarries are going to be and getting the appropriate approvals, all of that takes a lot of time."
- "We know from an objective standpoint that there are both economic and environmental costs involved and you need to be thinking about who is going to bear those additional costs and remain competitive."

What is clear is the value of the industry, its integral role in all communities, and the implications for hauling aggregates from further distances – increased costs and pollution. As region's become more populated, conflict between residents and pit and quarry operations will increase. There are legitimate concerns regarding dust, noise, air quality, water quality, and truck traffic. Based on the above, a proactive approach should be adopted in this sector by addressing concerns, minimizing environmental impacts, and finding ways to integrate pit and quarry operations within each community as well as using RCA instead of using native/virgin aggregate.

Every year in Ontario, millions of tonnes of reusable asphalt and concrete aggregate is generated from road building and other construction projects. These valuable resources are recyclable and can be used by municipalities in their roads and infrastructure projects. Unfortunately, municipal policies and specifications often prohibit or severely limit the reuse of recycled aggregates in their construction projects, and large volumes of recyclable aggregate end up in our landfills.

Where there is a high level of aggregate production will complete their operational lifespans. Combined with an increasingly restrictive zoning and application process for new aggregate extraction sites in Ontario, there will be a need to continue to characterize and develop sources of reclaimed materials as a sustainable alternative to natural aggregates. Materials such as RCA and RAP are readily available in urbanized regions of Ontario in large quantities as a potential alternative material in road structure layers. Consequently, there is a need to study the benefits and the concerns (if any) of using RCA or RCM in a variety of potential alternative applications, including in Granular A RCM and Granular A RAP in unbound granular base materials, and/or 50 mm crushed aggregate unbound subbase materials, to encourage use of increased quantities of recycled aggregate that meet OPSS specifications in roads/highways projects.

As per OSSGA – Recycling webpage (http://aggregaterecyclingontario.ca), **Table 3** below summarizes the quantities of RCA in some of Ontario/GTA projects for the period from 2001 to 2013.

Table 3. Quantities of the Used Recycled Concrete Aggregate - Ontario/GTA projects 2001-2013

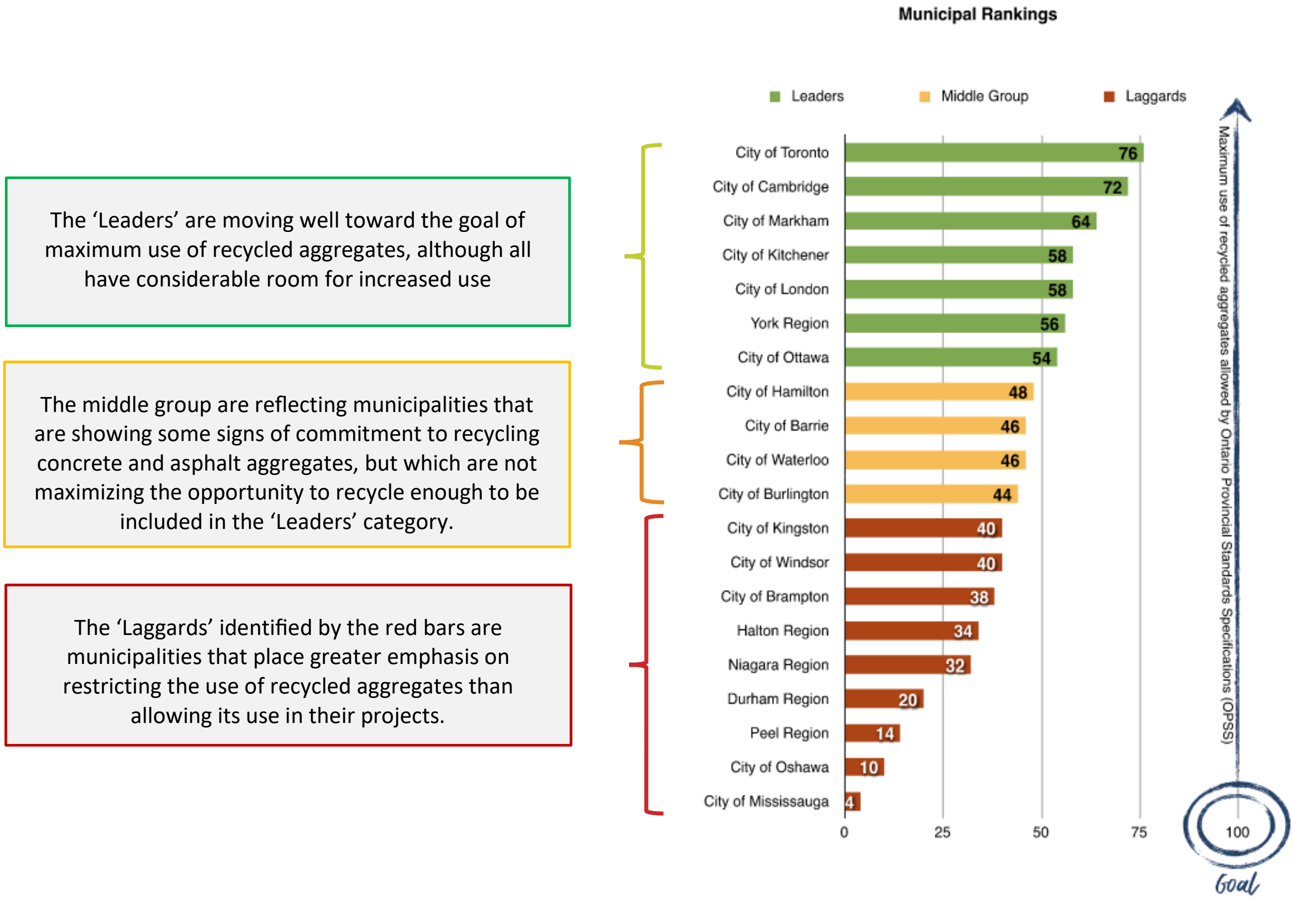
Year	Project Name	Contractor	Used Quantity of RCA (Tonnes)
2001	TTC Subway – Sheppard Line	Walters SCI Construction	250,000
2002	Gardiner Bridge Demolition & Rebuilding Lakeshore Blvd	Grascan Construction	50,000
	Air Canada Centre Arena	PCL Constructors	20,000
2004	TTC Subway Bessarion Station	Bondfield Construction	20,000
2007	Bass Pro - Vaughan Mills Mall	Ellis Don Construction	50,000
2009	Toronto Film Studios	Bird Construction	30,000
2010	City Place – Concord Adex Development (Road & Sewers)	-	25,000
2012	MTO Highway 401 (Jane Street to Kipling Avenue)	Dufferin Construction	40,000
2013	Pan Am Village Roadworks	Coco Paving	20,000
	Whitby GO Station Bus Terminal	Loc-Pave Construction	80,000

Considering the foregoing, road authorities/municipalities should be encouraged to use increased quantities of recycled aggregate that meet OPSS specifications in their infrastructure projects. Accordingly, EXP has collaborated with the Ontario Ministry of Transportation (MTO) to undertake an extensive literature review in this study to highlight the benefits of using crushed reclaimed concrete {commonly referred to as recycled concrete aggregate (RCA) or recycled concrete material (RCM).

1.2 TARBA Aggregates Recycling Goals

In April 2018, the Toronto and Area Road Builders Association (TARBA) commissioned an independent researcher, Kate Graham to examine the current policies and practices regarding the use of recycled aggregate in Ontario municipalities. The purpose of the study was to understand current policies and practices regarding the use of recycled aggregates in a sample of urban municipalities in Ontario and develop a ranked comparison of these municipalities based on the data collected. The surveyed sample included a total of 25 municipalities within Ontario (six regional municipalities and 19 single or lower tier municipalities). The municipal staff member responsible for roads (Director or equivalent) in each municipality was contacted by email to fill in an online survey (Questionnaire).

The study ranked the “leaders” and “laggards” and outlined the maximum use of recycled aggregates allowed by Ontario Provincial Standards Specifications (OPSS) [1]. **Figure 2** is the graphic from the final report. Leaders include the Cities of Toronto and Markham, where practices align with Climate Action Goals from reducing the carbon footprint across the cities’ buildings, sites, fleet vehicles and infrastructure. To that point, best practices and standards from these leaders can be used to challenge the Middle Group and Laggards to follow suit and increase the use of RCA within their municipalities.



The ‘Leaders’ are moving well toward the goal of maximum use of recycled aggregates, although all have considerable room for increased use

The middle group are reflecting municipalities that are showing some signs of commitment to recycling concrete and asphalt aggregates, but which are not maximizing the opportunity to recycle enough to be included in the ‘Leaders’ category.

The ‘Laggards’ identified by the red bars are municipalities that place greater emphasis on restricting the use of recycled aggregates than allowing its use in their projects.

Figure 2. TARBA Leaders and Laggards, Results from April 2018 Independent Study [1]

The main findings of this research were as follows:

1) **Municipal Rankings:** Although Ontario has provincial standards with respect to the use of recycled aggregate materials in infrastructure projects, municipalities have discretion in the implementation of these standards - and in their local policies. As a result, practices can vary widely by municipality.

2) **Current Policy Environment:**_Most municipalities surveyed have an established policy, standards or otherwise regarding the use of recycled aggregate materials. Only one municipality indicated that they do not have a municipal policy in place as they are following the Ontario Provincial Standard Specifications. The following **Figure 3** summarizes the results of the responses to the question *"Has your municipality's policy on the use of recycled aggregates changed within the past two years?"*

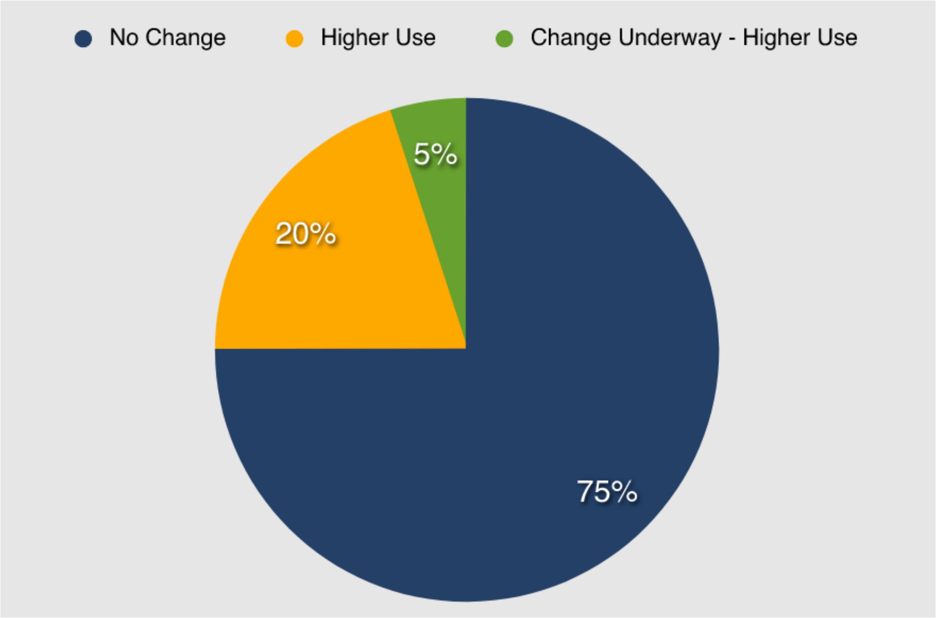


Figure 3. Current Policy Environment, Results from TARBA 2018 Independent Study [1]

3) **Policy Priorities:** Based on the responses received almost all municipalities selected performance as the most important consideration. The second most important consideration is reliability. Factors such as cost efficiency, reducing waste and protecting the environment emerged as less important considerations. **Figure 4** summarizes the priorities and important considerations based on the responses to the question *"What considerations do you think are most important when setting policy about the use of recycled aggregate?"*

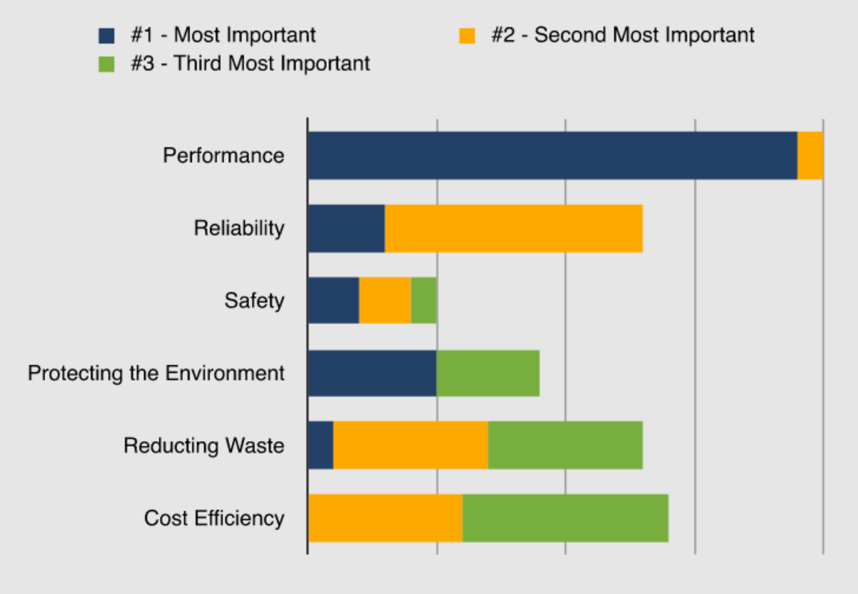


Figure 4. Policy Priorities, Results from TARBA 2018 Independent Study [2]

4) **Future Policy Environment:** Based on the responses of the municipalities surveyed, the most common response was to indicate that no changes are expected. Half of the municipalities do not envision any changes in the near future. In municipalities where a policy change is anticipated, six indicated that the shift will be towards higher use of recycled aggregates, and one indicated that the shift will be towards lower use. **Figure 5** summarizes the responses to the question *"Do you envision your municipality's policy on the use of recycled aggregates to change in the next two years?"*

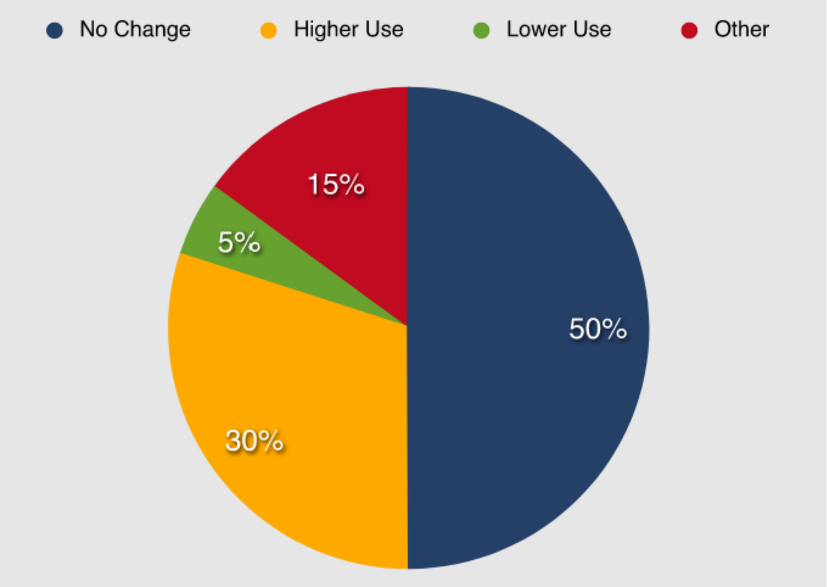
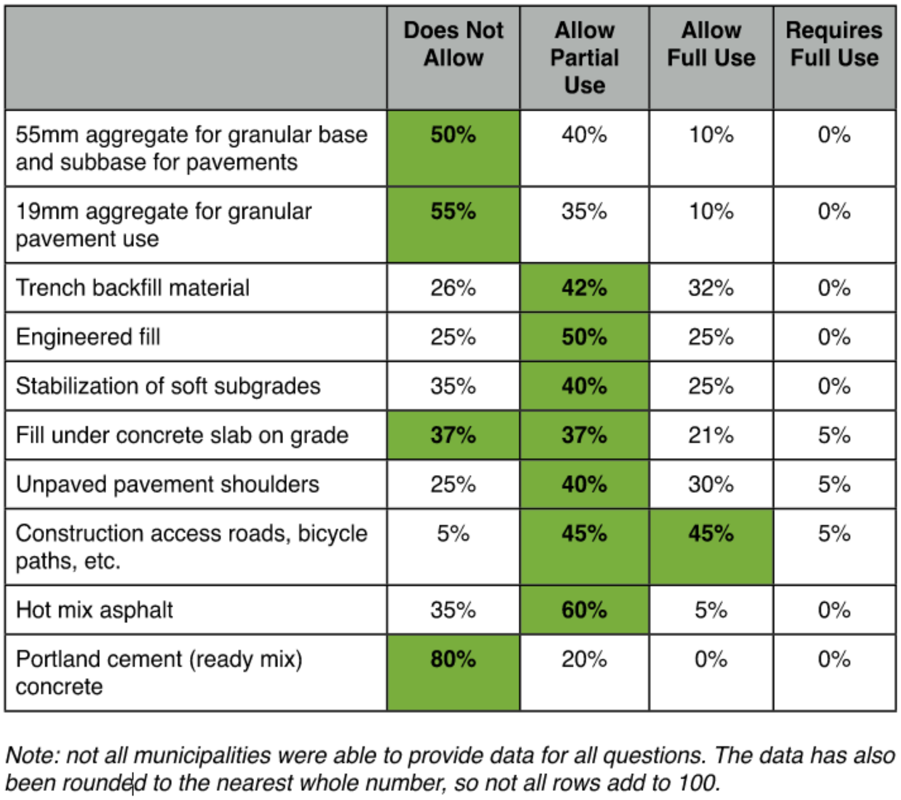


Figure 5. Future Policy Environment, Results from TARBA 2018 Independent Study [1]

5) **Use of Recycled Aggregates for New Roads and Infrastructure:** Based on the responses of the municipalities surveyed, most mentioned allowing no or some use of recycled aggregates in base, subbase and pavement. Most municipalities allow partial use for trench backfill, engineered fill, stabilization, fill under concrete slab, and unpaved shoulders. The highest percentage of municipalities allowing full use occurs for lower value applications such as construction access roads and bicycle paths. **Table 4** summarizes the responses to the question *"Please indicate your municipality's standards for the use of recycled concrete and asphalt aggregates for new roads and infrastructure"*

Table 4. Use of Recycled Aggregates for New Roads and Infrastructure, Results from TARBA 2018 Independent Study [1]

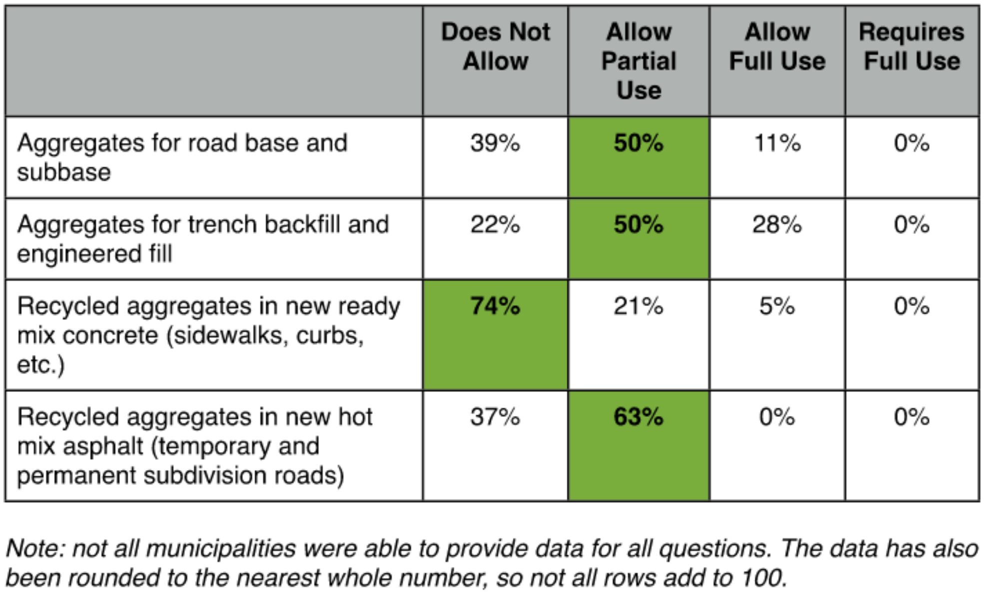


	Does Not Allow	Allow Partial Use	Allow Full Use	Requires Full Use
55mm aggregate for granular base and subbase for pavements	**50%**	40%	10%	0%
19mm aggregate for granular pavement use	**55%**	35%	10%	0%
Trench backfill material	26%	**42%**	32%	0%
Engineered fill	25%	**50%**	25%	0%
Stabilization of soft subgrades	35%	**40%**	25%	0%
Fill under concrete slab on grade	**37%**	**37%**	21%	5%
Unpaved pavement shoulders	25%	**40%**	30%	5%
Construction access roads, bicycle paths, etc.	5%	**45%**	**45%**	5%
Hot mix asphalt	35%	**60%**	5%	0%
Portland cement (ready mix) concrete	**80%**	20%	0%	0%

Note: not all municipalities were able to provide data for all questions. The data has also been rounded to the nearest whole number, so not all rows add to 100.

6) **Use of Recycled Aggregates for Municipal Subdivisions:** Based on the responses of the municipalities surveyed, most municipalities indicated allowing no use of recycled aggregates in new ready mix concrete projects such as subdivision sidewalks and curbs. Most municipalities allow partial use for projects such as road base and subbase, trench backfill and engineered fill, and in new hot mix asphalt. There were no cases where municipalities require full use in any of the types of projects identified. Generally municipal restrictions on the use of recycled aggregates are even greater for private subdivision redevelopment than for their own infrastructure projects. **Table 5** summarizes the responses to the question "Please indicate your municipality's standards for the use of recycled concrete and asphalt aggregates for new roads and infrastructure" in municipal subdivisions.

Table 5. Use of Recycled Aggregates for Municipal Subdivision, Results from TARBA 2018 Independent Study [1]



	Does Not Allow	Allow Partial Use	Allow Full Use	Requires Full Use
Aggregates for road base and subbase	39%	**50%**	11%	0%
Aggregates for trench backfill and engineered fill	22%	**50%**	28%	0%
Recycled aggregates in new ready mix concrete (sidewalks, curbs, etc.)	**74%**	21%	5%	0%
Recycled aggregates in new hot mix asphalt (temporary and permanent subdivision roads)	37%	**63%**	0%	0%

Note: not all municipalities were able to provide data for all questions. The data has also been rounded to the nearest whole number, so not all rows add to 100.

Considering the foregoing results and findings, the conclusions of Kate Graham/TARBA research **[1]** are listed below:

1. Ontario's largest municipalities have a long way to go before they can fully realize the benefits of increased use of recycled aggregate materials. Currently, policies and practices across Ontario municipalities vary.
2. Based on the survey data provided by the municipalities, some municipalities emerge as "Leaders" and others as "Laggards" in this area. Even in the municipalities identified as "Leaders" there is room for continued growth.
3. There is much that municipalities can learn from one another in this respect, sharing best practices and working together to increase the use of recycled aggregate materials in order to realize more of the associated benefits for their communities.
4. Ontario municipalities may also benefit from looking to the Government of Ontario as an example of a public tendering agency that accepts and encourages aggregates recycling. About 20 per cent of the aggregates used in Ministry of Transportation (MTO) projects - whether for granular base and fills or new hot mix asphalt - are recycled asphalt and concrete materials.
5. Millions of Ontarians rely on their municipalities to build and maintain critical infrastructure, such as roads. Citizens also expect that municipal governments will pursue opportunities to reduce their impact on the environment, decrease costs, and find efficiencies. Increasing the use of recycled aggregate materials in road infrastructure projects represents an opportunity to help municipalities achieve these objectives.

1.3 Project Objectives and Scope

The main objectives of this study are highlighted under the following topics:

1) The negative impact of failure to recycle concrete and the benefits to municipalities should they allow increased recycled aggregate use in their road construction and other infrastructure projects. These issues are summarized as follows:

Negative Impact of Failure to Recycle Concrete:

If not reused, the concrete that is generated from the demolition of buildings and infrastructure would end up being stockpiled in growing mountains of urban rubble or dumped in a landfill. That is a terrible waste of a precious resource.

Significant Benefits to Use of Recycled Concrete:

- Using recycled concrete as a gravel reduces the need for fresh gravel from mining sources, easing pressure to develop and expand quarry operations.
- Reduced tippage and related freight charges. By using increased quantities of recycled aggregate, which are located close to major construction projects, the need to haul fresh aggregate from distant quarries is dramatically reduced. This lowers energy consumption and greenhouse gas emissions and accordingly has a significantly lower negative impact on the environment.
- Reduction of landfill space required for concrete debris and keeping aggregate out of the waste stream.
- A more economical source of aggregate compared with newly mined aggregate. It is noted that producing recycled aggregate for reuse is more cost-effective than sending un-wanted materials to landfill and incurring a landfill tipping fee.
- By removing both the waste disposal and new material production costs, transportation costs for each specific project are significantly reduced.
- Reduced GHGs emissions due to lower transportation requirements and manufacturing processes when compared to with producing and supplying virgin/native aggregates.

2) Successful projects using RCA1010 on road construction projects.
3) Unsuccessful project due to previous failure to use RCA1010 in road construction.
4) Recommended improvements on the quality control and production certification at concrete recycling yards/crushers.
5) The characteristics of Gran A (RCA1010) and comparison with applicable OPSS PROV.1010 specifications.
6) The impact of using Gran A (RCA1010) in excess soil management and associated benefits.

1.4 Applicable Standard Specifications

Granular A aggregate shall be processed according to OPSS 1010 and shall conform to the requirements of gradation and physical properties as specified in the standard specifications of the concerned project. Ontario Provincial Standard Specification (OPSS.PROV or OPSS.MUNI) 1010, Material Specification for Aggregates – Base, Subbase, Select Subgrade, and Backfill Material, contain requirements for a wide variety of aggregate products utilized in the construction of road base and subbase layers. Among these requirements, OPSS 1010 permits the use of several types of recycled or reclaimed materials, including recycled concrete aggregate (RCA) and recycled asphalt pavement (RAP), in a number of designated classes of aggregate base and subbase products including Granular B Type I and Granular B Type III. At present, however, RCA and RAP materials are prohibited from use in Granular B Type II mixes, as this specification only permits the inclusion of 100 per cent crushed bedrock, talus, iron blast furnace slag or nickel slag.

The following **Table 6** summarizes the gradation requirements of Granular A materials based on the OPSS.PROV 1010 Standard Specifications.

Table 6. Gradation Requirements of Granular A (Granular Base) in Ontario and Associated Specifications

Item	**% Passing by Mass – Granular A (OPSS.PROV 1010)**							
Sieve No	26.5 mm	19 mm	13.2 mm	9.5 mm	4.75 mm	1.18 mm	300 um	75 um
Acceptable Limits	100 - 100	85 - 100 (87-100) *	65 - 90 (75-95) *	50 - 73 (60-83) *	35 - 55 (40- 60) *	15 - 40	5 - 22	2 - 8 (2-10) **

* Where the aggregate is obtained from an iron blast furnace slag source.

** Where the aggregate obtained from a quarry or slag source.

The following **Table 7** summarizes the allowable percentage of recycled materials in granular materials based on the OPSS.PROV 1010 Standard Specifications.

Table 7. Allowable Limits of Recycled Materials

Standard Specifications	**Material**	**Allowable Percentage of Recycled Material (%) – by mass**	
		RCA	**RAP**
OPSS.PROV 1010 (April 2013)	Granular A	Not specified	Up to 30 %
	Granular B Type I and Type III	Not specified	Up to 30 %
	Granular B Type II	0 % (Recycled materials shall not be permitted)	

The following **Table 8** shows the required physical properties of granular base materials (Granular A) based on the OPSS.PROV 1010 Standard Specifications.

Table 8. Physical Properties of Granular A (Granular Base) Based on OPSS.PROV1010

Physical Property	OPSS.PROV 1010 (April 2013)
Coarse Aggregate Petrographic Requirement (LS-609)	Test is Not Specified
Fine Aggregate Petrographic Requirement (LS-616)	Test is Not Specified
Micro-Deval abrasion coarse aggregate loss, % maximum (LS-618)	25 %
Micro-Deval abrasion fine aggregate loss, % maximum (LS-619)	30 %
Plasticity Index, maximum (LS-703/704)	NP (Non-Plastic– LS-631)
Percent crushed, minimum (LS-607)	60 %
Asphalt Coated Particles, % maximum (LS-621)	30 %
Recycled Concrete Materials, % maximum	Not specified
Amount of Contamination, % maximum (LS-630)	<= 1 % (total, combined) <= 0.1 % (wood only)
Sulphate Concentration (Environmental)	Not Specified
Determination of Permeability, k (LS-709)	k > 1.0 x 10^-4 cm/s

1.5 Work Approach and Methodology

For this study, four (4) specialized teams from EXP have been involved to achieve the objectives (i.e., Pavement, Concrete, Excess Soil Management/ Environmental, and Sustainability). The adopted approach has included the following:

A. Collaborate with Roads Authorities

- Convene meetings with appropriate MTO staff to get feedback on their requirements to achieve the objectives of this study and outline MTO requirements for publishing a paper based on this study.
- Communicate with selected road authorities/municipalities to collect related information and previous cases of using recycled concrete material/aggregate. This included conducting three (3) site visits for previous construction projects where recycled concrete aggregates (base and/or subbase layers) were used.

B. Desktop Review of Historical Records

1. Communicating with TARBA to collect related documentation/records as well as to arrange for sample collections from different yards/stockpiles.
2. Review the historical records of EXP from previous projects where recycled crushed aggregate (RCA) has been used.
3. Conduct literature review for previous related studies, research papers and best practices including literature from the MTO archives.
4. Present previous successful projects of highways, municipal roads, airfield facilities, and development engineering projects.

C. Laboratory Testing

1. Conduct six (6) site visits for different yards to collect one Gran A (RCA1010) sample from each location for the testing program, familiarization with the applied quality control measures and taking site photographs. In addition, two (2) crushed limestone samples and one (1) native sand and gravel sample of Gran A were obtained from three (3) different yards.
2. Perform laboratory testing as described in other sections of this study report and comparing with acceptable limits of current OPSS.PROV 1010.

D. Study Report Preparation

Preparation of a comprehensive study report in collaboration with the MTO, including a summary of the related literature review, previous related projects, laboratory test results, statistics/charts, photographs, conclusions and next steps.

E. Conference Preparation

EXP (as cowriter) has worked with the appropriate MTO staff to prepare/produce a technical presentation at the 2022 Municipal Engineers Association (MEA) Annual Conference on November 18, 2022. This presentation will be prepared in accordance with the requirements of the organizer of the conference hosted by the City of Toronto and be held at the Chelsea Hotel in downtown Toronto).

F. Attend 2022 Municipal Engineers Association (MEA) Conference

Jointly with MTO staff, staff from EXP will attend in-person the 2022 Municipal Engineers Association (MEA) Conference which will be held on November 15 - 18 2022.

2. Literature Review

2.1 General

The widespread acceptance of RCA in pavement base layer applications is probably because these uses offer some of the greatest environmental benefits at a low cost, while providing the potential for performance that meets or exceeds what can be achieved with natural aggregate. The constructability, qualification testing and applicable standard specifications, and pavement design considerations should be considered while using RCA in both unbound and bound (stabilized) RCA base applications.

Many previous studies/research/technical publications conducted in Ontario and elsewhere in North America and around the world have studied the impact and viability of Recycled Concrete Aggregate (RCA) as constituent materials of unbound granular layers in the pavement structure.

As per Circular Economy Solutions Series - Workshop Summary Report, dated February 2022” **[2]**, the main challenges and perceived risks with using Recycled Concrete Material (RCM) can be categorized as follows:

1) Quality and Consistency Concerns (contamination and deleterious materials may create environmental and/or performance-related challenges).
2) Performance Issues (strength, log-term durability, freeze-thaw resistance and drying and wet cycles).
3) Availability and Cost (availability and distance travelled can affect cost, and recycled materials may not be available in less urban centres).
4) Prescriptive Standards (prescriptive specifications can create issues with maximizing the use of recycled aggregate).
5) Lack of Consistent Approaches (lack of harmonized approaches across local governments and regions makes it challenging for industry to invest in the infrastructure and provide consistent supply when demand is unreliable).
6) Perceived Risks and/or Business As Usual (sometimes, it can be a lack of familiarity with using or specifying recycled aggregate in projects, or a previously negative experience that might keep people from wanting to use it in the future).

As per Kim, Ceylan et al. 2011 [3], in 2002 a memorandum was released by the Federal Highway Administration (FHWA) agency within the U.S. Department of Transportation, which has accentuated the interest of FHWA in using recycled material products in the national highway system. Thereafter, in the United States, over 130×106 tons of construction and demolition (C&D) waste is produced each year of which around 70 % of RCA is produced and used in pavement construction and particularly as a granular material in base and subbase layers (Gabr, Cameron et al. 2012 [4]). In the 1990s, Australian authorities started the technology of using RCA in lightly trafficked road construction. In 2004 and 2005, South Australia was generating around 1.5 million tons of C&D waste of which 70% was recovered. In recent years, over 500 million kg of RCA have been produced annually in South Australia, mostly from building demolition waste, and a significant proportion of this is used in pavement construction (Gabr, Cameron 2012 **[5]**). In Europe, from 1945 to 2000, around 600×106 m3 of waste masonry was used in the rebuilding of Germany after World War II. Whereas, in 1998 about 350,000 tons of crushed concrete was used in base and subbase layers of Finland's road construction (Gabr, Cameron et al. 2012 [4]).

As per the Construction & Demolition Recycling Association (CDRA) **[6]**, Unstabilized (granular) base applications are the most common use of RCA produced from concrete pavements. **Figure 6** shows that at least 34 states currently allow the use of RCA in pavement base applications based on a 2012 survey of state materials engineers. Of the six responding states that did not then allow the use of RCA as an aggregate base, two were considering allowing its use and a third indicated that RCA would be used if requested.

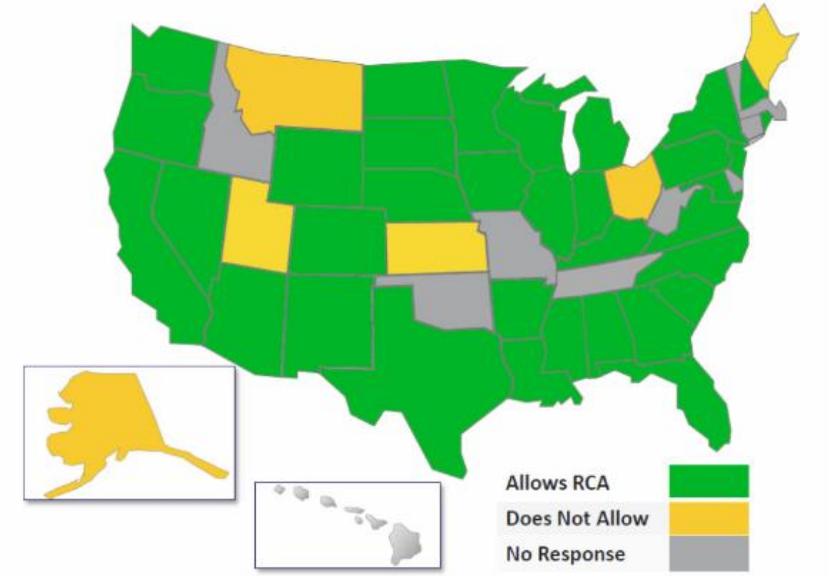


Figure 6. Responses to 2012 Survey of RCA Use for Unbound Bases (CDRA 2012) [6]

As per U.S Department of Transportation, FHWA State of the Practice National Review, "Transportation Applications of Recycled Concrete Aggregate" September 2004, the State Transportation Agencies were surveyed to determine the current uses of RCA. From the results of this survey, five states were identified as being among the highest consumers as well as large suppliers of RCA in the United State. The following three figures (**Figure 7 through Figure 9**) depict the extent of use for recycled concrete aggregate as determined by the survey results throughout the United States. In Michigan, recycled concrete has been a favoured material in more than two dozen MDOT projects since 1983.

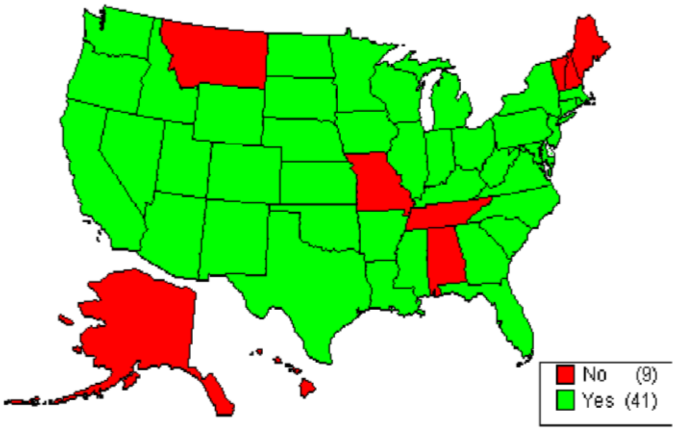


Figure 7. US States Recycling Concrete as Aggregate (FHWA-TAORCA-2004)

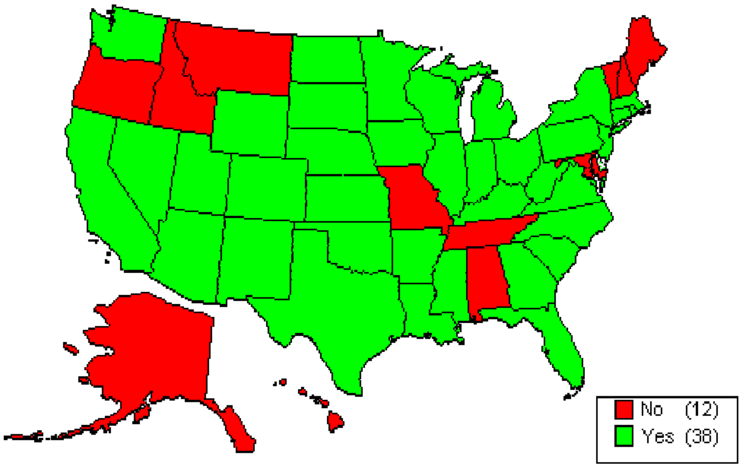


Figure 8. US States Recycling Concrete as Aggregate Base (FHWA-TAORCA-2004)

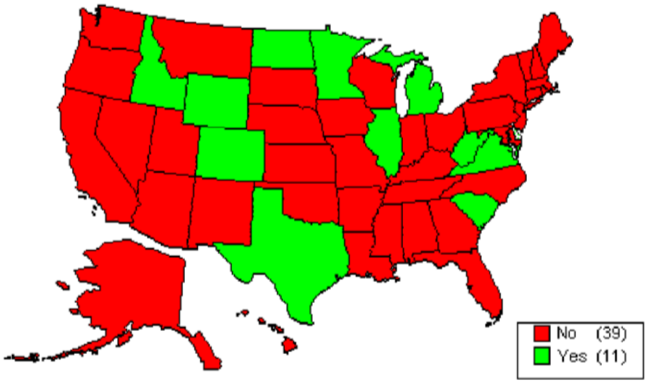


Figure 9. US States Recycling Concrete as Aggregate for PCC (FHWA-TAORCA-2004)

As per American Concrete Pavement Association (ACPA) **[7]**, concrete recycling can also produce economical dense-graded base materials that include higher proportions of crushed concrete particles of all sizes. Dense-graded RCA bases are highly effective because the angular, rough-textured particles provide excellent stability, while the secondary hydration of RCA fines often results in further strengthening of the base layer.

2.2 Previous Studies and Research

Snyder **[8]** in his research, discussed the following performance considerations, qualification testing, and environmental considerations of using recycled concrete aggregate (RCA) in the unbound aggregate base applications:

- **Performance Considerations**

1) Structural Performance

RCA has been widely and successfully used in unbound base layer applications. The available literature yielded no reports of pavement performance problems related to structural deficiencies in any properly designed and constructed RCA foundation layer. In fact, some agency engineers believe RCA outperforms natural aggregate in unbound base applications (FHWA 2004).

While there are anecdotal reports of possible frost and/or moisture heave in some more densely graded RCA base materials in Michigan and Minnesota, these problems seem to disappear with more open gradations (e.g., permeability greater than ~300 ft/day, or 1.05x10^-3 m/sec), which can be achieved by removing 15% to 25% of the fines (whether recycled or not) or by limiting the percent passing through the No. 200 sieve to 6% or less. An alternate approach is to stabilize the RCA with cement or asphalt to bind the fines that would otherwise be susceptible to frost or moisture heave.

2) Drainage Performance

RCA has been used with great success in most pavement base applications, especially in dense-graded, undrained foundation layers and fill applications. The use of RCA in unbound applications that are exposed to drainable water (e.g., free-draining base layers, drainpipe backfill material, and dense-graded base layers that provide significant flow or runoff to pavement drainage systems) has been associated with the deposit of crushed concrete dust and leachate (calcium carbonate precipitate or “calcareous tufa”) in drainage pipes and on filter fabric.

Although these products can clog the fabrics and form deposits in drainage pipes, thereby inhibiting the function of the drainage system, they typically do not affect the performance of the foundation system. However, in extreme cases, they can cause water to be retained in the pavement structure for longer periods.

Accumulations of precipitate and residue in drainage pipes can be significant and can reduce discharge capacity, but rarely (if ever) completely prevent drainage flow. The accumulation of these materials typically takes place early in the pavement life and dissipates as the dust and soluble calcium hydroxide are removed from the RCA surface.

The mechanism of precipitate formation was explained by Bruinsma et al. (1997). The authors described the dissolution of calcium hydroxide (a by-product of cement hydration) into water from freshly exposed crushed concrete surfaces and the subsequent precipitation of calcium carbonate as the dissolved calcium hydroxide reacts with atmospheric carbon dioxide. Therefore, all recycled concrete aggregates that are exposed to water have the potential to produce precipitate, regardless of the product gradation.

The amount of precipitate that will be produced is directly related to the amount of freshly exposed cement paste surface (i.e., increased quantities of cement paste fines), the amount of water flowing over the aggregate surfaces, and the amount of time that the water is exposed to atmospheric conditions. The potential for precipitation decreases with time as the available calcium hydroxide is depleted. Additional possible mechanisms include evaporation and temperature changes that result in supersaturation of the calcium hydroxide-infused solution, resulting in precipitate formation.

Bruinsma (1995) and Tamirisa (1993) also determined that as much as 50% of the material deposited in drainage structures and on associated filter fabrics may be dust and insoluble residue produced by crushing operations. Washing RCA prior to use reduces the presence of this material (Bruinsma 1995).

Snyder (1995) and Snyder and Bruinsma (1996) summarized several laboratory and field studies to characterize and identify solutions to the potential problems of accumulated precipitate and dust/insoluble residue from crushing. The following techniques have been suggested and can often be used in various combinations to prevent problems with pavement drainage systems when using unbound RCA base materials in drainable layers:

- ***Production and Stockpiling:*** Carefully select the crusher type for the aggregate gradation being produced to reduce the generation of fines and the need for mitigation measures. Good stockpile and material management practices can also reduce RCA degradation, which produces fines.

- ***Washing:*** Wash the RCA or use other dust removal techniques (such as air blowing) prior to placement in the base to minimize the contribution of "crusher dust" to drainage system problems. While washing is effective for controlling crusher dust, it is not believed to significantly reduce the potential for precipitate formation.

- ***Avoid using Fine RCA:*** Selectively grade the RCA to eliminate the inclusion of fine RCA particles (i.e., material passing the No. 4 sieve, which has the greatest surface area per unit weight of material), which will significantly reduce inclusion of crusher dust and potential for precipitate formation. Use unbound fine RCA in layers that do not transport water to the pavement drainage system.

- ***Blend with Virgin Aggregate:*** Use virgin aggregate to partially replace the RCA (particularly for small particle sizes) to reduce inclusion of crusher dust and the potential for precipitate formation.

- ***Use High-Permittivity Filter Fabrics:*** Use filter fabrics with initial permittivity values that are at least double the minimum required so that adequate flow will be maintained even if some clogging takes place (Snyder 1995).

- ***Use Effective Drainage Design Features:*** Design the drainage system to allow residual crusher dust to settle in a granular filter layer at the bottom of the trench rather than allowing direct entry to the pipe. This can be accomplished by placing the pipe (with slots oriented to the bottom) on the filter layer rather than directly at the bottom of the trench. Also wrap the drainpipe trench (rather than wrapping the pipe) to prevent fines from the subgrade and fore-slope from clogging the trench backfill material (see **Figure 10**).

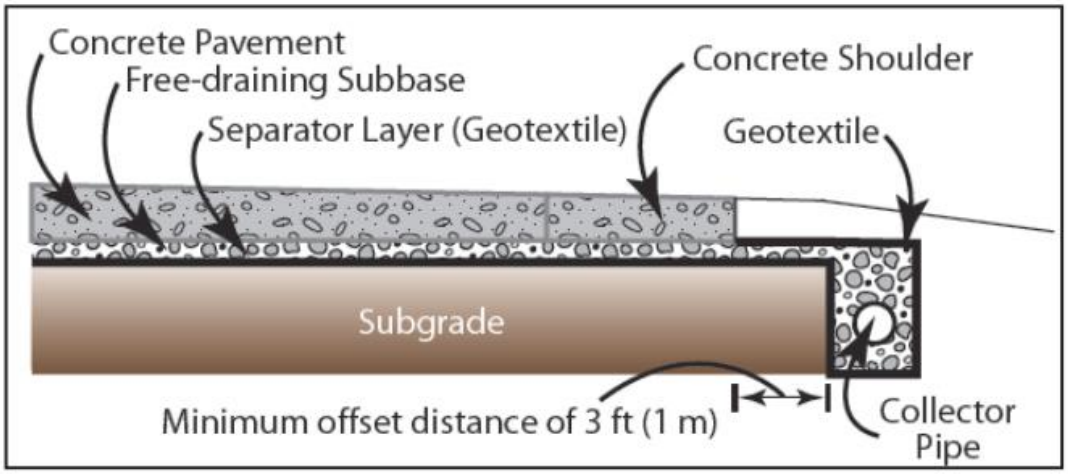


Figure 10. Typical Drainage System for Use of Free-Draining RCA Base (© ACPA) [8]

- ***Use Daylighted Base Designs***: Consider using daylighted base designs, where a drainable base layer is extended across the shoulder to the face of the fore-slope and drains directly to the ditch rather than to a pipe underdrain system. Day-lighted base designs are described in the American Concrete Pavement Association's (ACPA's) Engineering Bulletin EB204P (ACPA 2007).

- ***Stabilize the Base:*** Stabilize the base layer with cement or asphalt. This is an effective strategy for reducing dust and leachate concerns.

➢ Qualification Testing

1) ***Gradation:*** Unbound RCA base materials are typically required to meet the same grading requirements (e.g., AASHTO M 147 [2017], ASTM D2940/D2940M, or local requirements) that are applied to conventional unbound base materials to ensure stability (for both the pavement structure and the paving equipment) and the desired degree of drain-ability. The aggregate top size should not exceed 1/3 of the layer thickness, and base layers thicker than 6 in. are not economical or recommended in most cases.

Regardless of the size(s) produced, the Gradation Bands/Specifications should be adjusted to provide suitable gradations for the intended application (e.g., free-draining vs. dense-graded) and to minimize production of materials that cannot be used.

Guidance on specific gradations to achieve un-stabilized base materials that provide good stability with varying degrees of permeability (free drainage capacity) can be found in the ACPA's Engineering Bulletin EB204P (ACPA 2007).

2) ***Other Physical Requirements:***

○ ***Los Angeles (LA) Abrasion Test:*** LA abrasion test (AASHTO T 96) requirements for RCA are typically the same as for natural aggregate materials (i.e., loss of not more than 50%). RCA usually meets this requirement without difficulty but generally exhibits higher losses than most conventional aggregate types. This can be a concern in construction, where compaction efforts result in an effective change in gradation.

○ ***Soundness Testing:*** Soundness testing of RCA is sometimes required but cannot be performed with conventional sodium or magnesium sulfate soundness tests (AASHTO T 104) because RCA is susceptible to sulfate attack, which produces unusual mass loss values that are not representative of the actual durability of the RCA. Therefore, soundness testing of RCA is often waived (particularly for unbound base applications). For similar reasons, unbound RCA bases should not be used in areas with high-sulfate soils.

AASHTO M 319 describes alternative soundness testing approaches, including AASHTO T 103 (a freeze-thaw procedure conducted in water with 25 cycles of freezing and thawing and a maximum allowable loss of 20 %). Other listed alternates are the New York State Department of Transportation Test Method NY 703-08 and Ontario Ministry of Transportation Test Method LS-614, both of which involve freeze-thaw cycles in a sodium chloride brine solution with a maximum allowable mass loss of 20 %.

○ ***Deleterious Materials (Foreign Materials):*** Limits on deleterious materials are often applied because, while RCA primarily comprises crushed concrete material and natural aggregate particles, it is not uncommon to find that some natural soils, asphalt concrete (from shoulder, base, or repair materials), and other potentially deleterious materials have been included. These materials should be limited as follows:

- ***Bituminous Concrete Materials:*** Bituminous concrete materials are limited to 5% or less, by mass, of the RCA in AASHTO M 319, with a note that validation testing should be performed to justify the use of higher percentages. Appendix X4 of that specification describes the use of the California Bearing Ratio test (AASHTO T 193) and the resilient modulus test (AASHTO T 307) for validation. The specification also describes validation by field application (construction of a test strip or historical data to show that higher percentages of asphalt concrete will not adversely affect the performance of the granular base). As a result, many agencies allow significantly more than 5% asphalt material in their unbound RCA base materials.

- ***Liquid Limit, Plasticity Index, and Sand Equivalent Test:*** AASHTO M 319 limits the inclusion of plastic soils such that the liquid limit (AASHTO T 89) of materials passing the No. 40 sieve is 30 or less and the plasticity index (AAS-HTOT 90) of the same material is less than 4. Alternatively, the sand equivalent test (AASHTO T 176) value of the same material must be a minimum of 25%.

- ***Solid Waste or Hazardous Materials:*** RCA should be free of all materials that can be considered solid waste or hazardous materials, as defined locally.

- ***Deleterious Materials:*** RCA should also be "substantially free" (i.e., each less than 0.1% by mass) of other potentially deleterious materials such as wood, gypsum, metals, or plaster. These limits can be adjusted if it is determined that the adjustments will not have a negative impact on the performance of the base course.

Environmental Considerations

Due to the nature of RCA base materials, there is the potential for heavy metals to be released and be present in the RCA base drainage effluent (Chen, et. al, 2013). Based on their findings, it was concluded that the major elements that would be released from the RCA granular base materials consists of calcium, iron, aluminum, magnesium, sodium and potassium. Additionally, trace concentrations of arsenic, barium, cadmium, cobalt, chromium, copper, molybdenum, nickel, lead, antimony, selenium, and zinc were also noted. The reported concentrations of the trace metals in the RCA leachate testing conducted as part of the 2013 study were found to occasionally exceed the EPA drinking water standards for arsenic, chromium, lead and antimony. The levels of selenium were reported to exceed the standards throughout the study period. However, the results were reported to be at similar levels to the baseline testing results of locally sourced virgin aggregate.

Water percolating through RCA foundation layers can result in effluent that is initially highly alkaline, often with pH values of 11 or 12. This is an effect that generally diminishes

> with time in service as the calcium hydroxide near the exposed RCA surfaces is dissolved and removed from the system. Furthermore, this high pH effluent is generally not considered an environmental hazard, because it is effectively diluted with much greater quantities of surface runoff at a very short distance from the drain outlet (Sadecki et al. 1996, Reiner 2008).
>
> It is not uncommon, however, to see very small regions of vegetation kill in the immediate area of the drain outlet. Awareness of the sensitivity of local soils, surface waters, and groundwater to the presence of alkaline effluent may necessitate setting limits on the proximity of RCA placement to sensitive areas. This same effluent may also cause or accelerate corrosion of exposed metals in culverts and other appurtenant structures, so those types of exposure should be avoided.
>
> The gradation and washing recommendations previously provided to prevent precipitate formation are generally effective in reducing initial pH levels in RCA base drainage effluent (Snyder and Bruinsma 1996). Chapter 7 of Snyder et al. (2018) offers additional information and guidance on mitigating the presence of elevated pH effluent and other environmental concerns associated with concrete recycling.

It should be noted that Snyder **[8]** in his research, also discussed the performance considerations, qualification testing, and environmental considerations of using recycled concrete aggregate (RCA) in the bound (stabilized) base applications.

Tuncer B. Edil et al **[9]** in their study, mentioned that the extensive investigation undertaken on RCA and RAP indicate that these materials are generally suitable for unbound base course applications, and they show equal or superior performance characteristics compared to natural aggregates in terms of stiffness, freeze-thaw and wet-dry durability, and toughness. No apparent trends were observed between resilient modulus (SRM) and brick content of RCA, but a decrease in plastic strain was observed with increased brick content. RCA has high absorption capacity due to the porous nature of the cement paste portion. Therefore, the amount of water required to achieve the maximum dry unit weight (MDU) for RCA is higher than for natural aggregate and RAP.

The effect of compaction was evaluated by varying the effort of compaction and running resilient modulus tests on the specimens to compare compaction effort on stiffness. A decrease in compaction effort resulted in lower SRM for all materials, but the decrease was greater in the recycled materials than in natural aggregate. The resilient modulus decreased with an increase in moisture content for RAP and RCA. The effect of compaction moisture content on resilient modulus was greater for RCA than RAP. The rate of decrease in SRM for RAP is lower than RCA.

The RCA specimens saw a decrease in stiffness after the first five freeze-thaw cycles, but then an increase in stiffness after 10 and 20 freeze-thaw cycles, which may be attributed to progressive generation of fines and hydration of cement paste. Overall, both RAP and RCA had higher stiffness than Class 5 (natural aggregate) regardless of the number of freeze-thaw cycles.

Micro-Deval and particle size distribution tests were conducted on RAP, RCA, and natural aggregate after 5, 10, and 30 wet/dry cycles and no apparent trend was found between particle degradation and wet/dry cycling of the material.

Adam Schneider et al **[10]** in their study, evaluated the performance of reclaimed materials meeting the particle size and physical quality requirements of OPSS 1010 for Granular B Type II unbound dense-graded subbase materials as an alternative to the use of crushed rock (either in whole or in part). From two different source locations, five subbase test mixtures of differing volumetric proportions of crushed rock, crushed RCA and processed RAP (100 % crushed rock, 25 % crushed RCA blended with 75 % crushed rock, 50 % crushed RCA blended with 50 % crushed rock, 100 % crushed RCA, and 70 % crushed RCA blended with 30% crushed RAP) were utilized in this study. Field testing programs indicate that the subbase test mixtures meeting OPSS Granular B Type II gradation requirements and incorporating different proportions of crushed rock, RCA and/or RAP exhibit similar field rolling compatibility relative to 100 % crushed rock. The mixes incorporating 100% crushed rock showed aggregate breakdown on all measured sieves and an increase in material passing the 75µm sieve based on gradation tests conducted before and after compaction, whereas some of the mixes having blends of RCA and/or RAP showed some aggregate breakdown with only minimal increases in material passing the 75µm sieve. Tests using a lightweight deflectometer (LWD) were subject to substantial variability but indicated that mixes using elevated levels of RCA (50% and 100%) can potentially have lower in-situ moduli compared to the other blends tested. Laboratory tests indicate that high replacement levels of RCA can be used in subbase materials as a substitute for 100% crushed rock while maintaining good water permeability characteristics and similar or higher resilient moduli in blends incorporating RCA and/or RAP. CBR testing results were similar across all test blends incorporating crushed rock and RCA, but also indicated that the inclusion of 30% RAP can potentially reduce the bearing capacity of the granular material by approximately 30-40 % in comparison to all other blends which do not contain RAP. Based on the results of this study, RCA and RAP appear to be capable of successfully substituting for natural aggregates in Granular B Type II in a range of compositional proportions.

As per MTO Report MI137 “The use of Recovered Bituminous and Concrete Materials in Granular and Earth” dated December 1989 **[11]**, it is mentioned that in Ontario, only certain municipalities have used recovered concrete products in granular base to any great extent, confirming that the Ministry has used them as a substitute for granular base from as early as 1971. MTO encourages the use of recovered construction materials in highway contracts, in keeping with the Provincial Government Policy on Sustainable Development. This policy will (i) reduce the use of virgin aggregates which are a non-renewable resource; (ii) reduce the accumulation of waste products; and (iii) use a product that is probably superior to standard granular materials.

Jeffrey S. Melton **[12]**, described the attributes of the Recycled Concrete Aggregate (RCA) and Building Derived Concrete (BDC) as shown in the following **Table 9**.

Table 9. Comparison Between Recycled Concrete Aggregate (RCA) and Building Derived Concrete (BDC) [12]

Item Description	Recycled Concrete Aggregate (RCA)	Building Derived Concrete (BDC)
Source	mostly obtained from concrete pavements	Crushed concrete primarily derived from the demolition of industrial buildings and related infrastructure
Contamination	Generally free of other materials	Can contain stone, brick, asphalt pieces, porcelain and decorative concrete. May also have a higher soil fraction
Gradation	Fines from the mortar fraction can cause “self-cementation” or “re-cementation” when water is added. Individual particles adhere, forming a stiffer layer	Gradation depends on processing, but typically has a higher fine content.
Absorption	Higher for RCA than natural aggregates, and ranges between 4 and 8 %	Higher for BDC than natural aggregates. Depends on proportions of concrete, rock, RAP, etc.
Specific Gravity	2.0 % for fines and 2.5 % for coarse particles. It is slightly lower than that of natural aggregates due to the mortar fraction.	2.0 % for fines and 2.5 % for coarse particles. It is slightly lower than that of natural aggregates due to the mortar fraction and RAP.
Stability	High friction angle, typically in excess of 40°. Good stability and little post-compaction settlement.	Generally has a medium to high friction angle due to the crushed aggregate.
Strength Characteristics	Crushed RCA is highly angular in shape. The California Bearing Ratio (CBR) values range from 90 to more than 140, which is comparable to crushed limestone aggregates.	The CBR values are similar to RCA (>90) but decrease with the addition of RAP. Also, brick tends to lower CBR, especially wet CBR
Durability	Generally, exhibit good durability with resistance to weathering and erosion. RCA is non-plastic and is not susceptible to frost.	Generally exhibit good durability with resistance to weathering and erosion. Presence of clay-based aggregates may increase moisture sensitivity and weathering
Drainage Characteristics	RCA (mainly coarse fraction) is free draining and is more permeable than conventional granular material because of lower fines content.	BDC is generally free draining because the fines are usually screened off.
pH and Tufa	The initial pH of pore water in the can be 11 or greater but decreases with time. The release of calcium compounds has sometimes caused creation of “tufa”, a form of calcium carbonate. However, removing the fine fraction (#4 mesh) greatly reduces pH problems.	Like RCA, the initial pH of pore water in the can elevated but decreases with time. Since BDC contains a much higher fraction of non-concrete material, pH issues are not as significant.
SRM MR Values From RMRC**	RCA → 178 MPa*	BDC → 223 MPa*

* SRM MR Values From RMRC: Class 5 Aggregate → 152 MPa; Crushed Gravel → 174 MPa; Sand → 181 MPa.

** Summary Resilient Modulus evaluated at a bulk stress of 208 kPa. In both studies the recycled materials performed better than natural aggregates.

Figures 11 and 12 show photographs of the Recycled Concrete Aggregate (RCA) obtained from concrete pavements and Building Derived Concrete (BDC), respectively, based on reference **[17]**.

Figure 11. Photo of Recycled Concrete Aggregate (RCA) Obtained from Concrete Pavements [12]

Figure 12. Photo of Building Derived Concrete (BDC) [12]

Adam Redling **[13]**, posted his article mentioning that the researchers at the University of British Columbia (UBC) Okanagan’s School of Engineering conducted side-by-side comparisons of recycled and conventional concrete within two common applications—a building foundation and a municipal sidewalk. In conducting the study, UBC researchers tested the compressive strength and durability of recycled concrete compared with conventional concrete. They found that the recycled concrete had comparable strength and durability after five years of being in service. The results of a new five-year study of recycled concrete show that it performs as well, and in several cases, even better than conventional concrete, researchers say.

Within the findings, the researchers discovered that the long-term performance of recycled concrete adequately compared to its conventional form and experienced no issues over the five years of the study. In fact, the recycled concrete had a higher rate of compressive strength after 28 days of curing while maintaining a greater or equal strength during the period of the research, according to the university. The researchers suggest the recycled concrete can be a 100 percent substitute for non-structural applications.

“As innovations continue in the composition of recycled concrete, we can envision a time in the future where recycled concrete can be a substitute within more structural applications, as well,” the researchers stated in a release.

According to Shahria Alam, co-director of UBC’s Green Construction Research and Training Center and the lead investigator of the study, “we live in a world where we are constantly in search of sustainable solutions that remove waste from our landfills”, “A number of countries around the world have already standardized the use of recycled concrete in structural applications, and we hope our findings will help Canada follow suit.”, “Waste materials from construction and demolition contribute up to 40 percent of the world’s waste”, and in Canada, that waste amounts to 9 million metric tons per year.

Nazanin Ardalan et al **[14]** in their study, evaluated the application of Recycled Concrete Aggregate (RCAg) as an unbound granular base course material for road construction in New Zealand by investigating the physical properties of recycled concrete aggregate and their engineering performance (durability) through experimental laboratory-based tests and compares the characteristics of tested RCAg with the specification of Basecourse materials (NZTA M4). The results proved that RCAg meets the requirements of New Zealand basecourse specification and the 28 days cured specimens reached higher strength and stiffness. On the other hand, the self-cementing property of RCAg affects the rutting of pavement. According to tests results (in terms of gradation, some physical properties, compaction, strength and stiffness, and the range of existing contamination in recycled concrete aggregate), tested RCAg had proven to meet a ‘premium’ grade product and it is expected that crushed recycled concrete if production is appropriately managed, could have high potential use as a base course material in road construction and in some cases perform better than common natural aggregates.

Colin Leek et al **[15]** in their study, documented Western Australia experience in the use of recycled road base sourced from demolition materials and investigates the properties and performance characteristics of both recycled products and new quarried road base to enable a comparison of performance. The study discussed the performance of three roads (Gilmore Avenue, Welshpool Road, and Warton Road) where different road base materials (crushed granite road base CGRB, crushed recycled road base containing concrete only CCRB, and crushed recycled road base containing mixed demolition materials CDRB) were used after considering the results of the visual pavement condition survey (pavement distresses), deflection testing (Benkelman Beam and/or FWD testing), Particle size distribution and Atterberg limits, Unconfined compressive strength (UCS), and Repeat load triaxial testing (RLTT). Based on the research undertaken in WA, the following generalized observations were provided:

- Recycled road base materials sourced from recycled demolition materials can provide a good quality high strength base for roads.
- Recycled base material are likely to give an increased asphalt fatigue life, but some minor block cracking may be the compromise.
- The source of concrete in recycled materials may have a significant effect on rehydration and subsequent excessive stiffness and block cracking.
- It is probable that the addition of brick, tile and or sand as a fine material into the recycled product may control excess stiffness and limit the effects of rehydration.
- Rehydration may not be adequately described by a 28-day UCS.
- Further research into the rehydration effects of recycled road base is required.
- Further research into the source of the concrete and its effect on stiffness is required.
- Further research into the effect of the source of fines on the long-term stiffness of recycled materials is required.

Colin Leek et al **[16]** in their study, evaluated seven different types of recycled aggregates from construction and demolition waste (CDW) as granular materials for unbound road sub-bases construction. The results showed that recycled concrete aggregates complied with all specifications for use in the construction of unbound structural layers (sub-base) for T3 and T4 traffic categories according to the Spanish General Technical Specification for Road Construction (PG-3). Some mixed recycled aggregates fell short of some specifications due to a high content of sulphur compounds and poor fragmentation resistance. Sieving off the fine fraction prior to crushing the mixed CDW reduces the total sulphur content and improves the quality of the mixed recycled aggregates. By contrast, pre-sieving concrete CDW had no effect on the quality of the resulting aggregates. The results were compared with a crushed limestone as natural aggregate.

2.3 Previous Selected Successful Projects

2.3.1 Airfield Projects

Project (1): Lester B. Pearson International Airport - Old Terminal 1: Decommissioning and Demolition - 2004

Project Description: On November 3, 2004, the last piece of the structure was demolished and old Terminal One was passed into the aviation history books. The rubble from the former old Terminal 1 rises and lives as part of the foundation for the new airport facility, considering that the old Terminal 1 was located in the new apron development area, as shown in **Figure 13**. Material recycling involves the salvaging process by the owner and the trade contractor. Reuse and recycle of a minimum of 80 % of the construction and demolition waste was one of the main objectives and targets of this project. The second important target/objective was to remediate a minimum of 90% of petroleum hydrocarbon and glycol impacted soil and/or gravel encountered during the work period. The concrete rubble from the demolition of the former Terminal 1 structure amounted to a total quantity of 253,000 tonnes (refer to **Table 10**, based on TP-C01-001 Waste Reduction Work Plan Summary). The rubble concrete was transferred to an on-site holding area for crushing and processing, as shown in **Figure 14**. The concrete debris was 100 % recycled to an engineering backfill with a gradation similar to Granular B. The processed concrete was used as the apron's subbase holding up the final concrete and HMA apron structure. The subbase use was per Greater Toronto Airport Authority's (GTAA's) requirements (Refer to the following **Table 11**, based on Specification Documents. TP-G02-001 Apron Stage 2 2004). This project would be an ideal model for 3Rs (Reduce, Recycle, and Reuse) with the largest emphasis on Recycling.

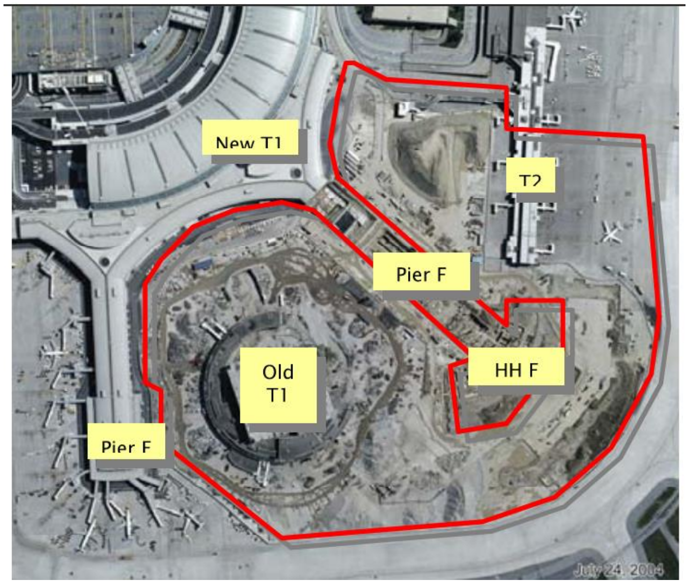


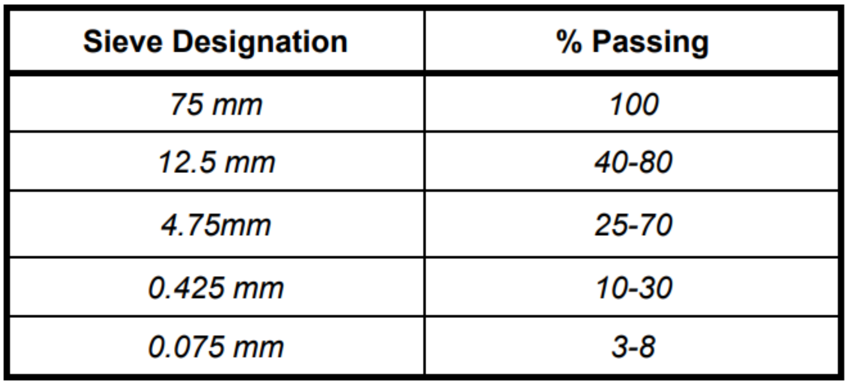
Figure 13. Pearson International Airport - Old Terminal One Located in the New Apron Development Between the New Pier E and the Constructed Pier F (2004)

Table 10. Pearson Int. Airport – Total Quantities of Recycled Material from Old Terminal 1Project (2004)

Old T1 Demolition		
Material Category ([19]) **(Quantities rounded)**	**tonnes**	**Percentage Recycled**
Scrap Metal	*24000*	*100%*
Concrete	*253000*	*100%*
Asphalt	*10000*	*99%*
Waste	*2900*	*95%*
Brick Rubble	*1500*	*100%*
Drywall	*110*	*99%*
Hazardous Materials (Asbestos, Vermiculite Panels, etc)	*2900*	*100% Reduction*

Figure 14. Pearson International Airport –
One Site Concrete Crushing Plant and Processed Concrete Backfill (2004)

Table 11. Crushed Debris Specifications (Subbase) from Concrete Crushing Plan (2004)



Sieve Designation	% Passing
75 mm	*100*
12.5 mm	*40-80*
4.75mm	*25-70*
0.425 mm	*10-30*
0.075 mm	*3-8*

Year of Demolishing and Recycling of Old Terminal One: 2004

Year of Construction of New T1 Apron: 2006

Source of Information: Lester B. Pearson Airport Greater Toronto Airports Authority, "Old Terminal 1 Decommissioning and Demolition", Paper prepared for presentation at the "Innovations in Bridge Engineering (A)" Section of the 2005 Annual Conference of the Transportation Association of Canada, Calgary, Alberta.

EXP - CYYZ Geotechnical Investigation and Pavement Rehabilitation Design for Various Locations (2021-2022)

- **Age of Existing Pavement:** The age of the existing flexible pavement is about 16 years, considering that original construction was between 2004 and 2006. A few localized resurfacing activities were carried out in 2016 and 2019 for not tracked areas. No rehabilitation works were carried out since original construction of the T1 Apron.
- **Pavement Condition and Observed Defects at T1 Apron:**
  The existing flexible pavement is in fair condition (including previous localized patches) with occasional construction joint cracking ~~is~~ being of slight to moderate severity and slight asphalt raveling, as shown in **Figure 15** and **Figure 16** for 2021 site photographs.

Figure 15. Pearson International Airport – T1 Apron Asphalt Observed Patches in Fair Condition (EXP - November 2021)

Figure 16. Pearson International Airport – T1 Apron Asphalt, Occasional Construction Joint Cracking in Slight to Moderate Severity. Occasional Asphalt Raveling in Slight Severity (EXP - November 2021)

- **Geotechnical Investigation and Subsurface Conditions (November and December 2021):**
  - Granular and soil are generally in very dense state, occasional hard.

- No free water was encountered at any of the three drilled boreholes in T1 Apron. Filed moisture content of granular materials ranged from 3.1 % to 8.2 % (5.9 % average).
- The existing pavement structure consists of HMA (Between 150 mm and 190 mm, 167 mm average), over granular materials (Between 1060 mm to 2,290 mm, with 1,738 mm average). It should be noted that occasional trace brick fragments were encountered in one borehole at a depth between 635 mm and 2500 mm.
- The current ICAO- PCN Code for T1 Apron as per the Airport *PLR Chart is 83/F/C/1.75 MPa Max /T (PLR = 12)*. However, based on the results of the geotechnical investigation carried out in 2021 by EXP, the ICAO- PCN Code for existing pavement structure of T1 Apron is *103/F/C/1.75 MPa Max/T (PLR = 13)*.
- The equivalent granular thickness 't' of the existing flexible pavement structure (2,070 mm) is greater than the minimum required pavement equivalent granular thickness 't' for new flexible pavement design (1,500 mm) for a B777-300 ER type aircraft in accordance with the TC method. It should be noted that the overload ratio of existing pavement structure is less than 1.0, with *no restrictions to full operation of B777-300 ER type aircraft.*
- Recommended Pavement Rehabilitation: Mill 50 mm, perform full depth asphalt patches/repair for any remaining identified full depth cracks and/or settled areas, as required, pave new 50 mm HMA surface course.

Project (2): Toronto Pearson Airport's Runway Rehabilitation Project - Ongoing

Project Description: Rehabilitation of Runway 06L/24R, Pearson's second-busiest runway. This project will extend the life of the runway by 30 years and enhance the safety of the runway. The project will include the use of recycled materials to help in reducing its carbon footprint. Other environmentally friendly construction practices include using crushed concrete from the runway pavement removal for the sub-base and base materials and recycled milling asphalt materials on approach roads in the vicinity of the runway.

Year of Construction: April - Fall 2022

Source of Information: ReNew Canada – Infrastructure Magazine, July/August 2022.

Project (3): Hartsfield-Jackson Atlanta International Airport (ATL) - Using RCA as Unbound Aggregate Base

Project Description: RCA was successfully produced on-site at ATL using pavement slabs from construction in the 1980s, some of which had alkali-silica reactivity. RCA was allowed for use (at the contractor's option) as both fill and cement-treated base materials at the airport. The primary reason for RCA use was the saving of landfill costs in disposing of existing concrete. When used as fill, the RCA complied with the Georgia Department of Transportation (GDOT) specifications for graded aggregate bases. However, RCA at ATL was required to exceed GDOT virgin aggregate standard specifications for Sections 800 (Coarse Aggregate) and 815 (Graded Aggregate). This resulted in a 1.5-in. top size material with 4% to 11% passing the No. 200 sieve, LA abrasion maximum mass loss of 51% to 65%, and a sand equivalent test result of at least 28%. Construction of RCA CSB at ATL was accomplished using conventional equipment. There was concern that the RCA would degrade during compaction, but no evidence of degradation was observed. It was reported that the RCA fill and cement-stabilized bases have performed adequately (Saeed et al. 2006). **Figure 17** shows locations at ATL where RCA has been used as a cement-stabilized base. In addition, it has also been used successfully under flexible (asphalt) pavement at the Southeast Navigation, Lighting, and Visual Aid Road (not shown).

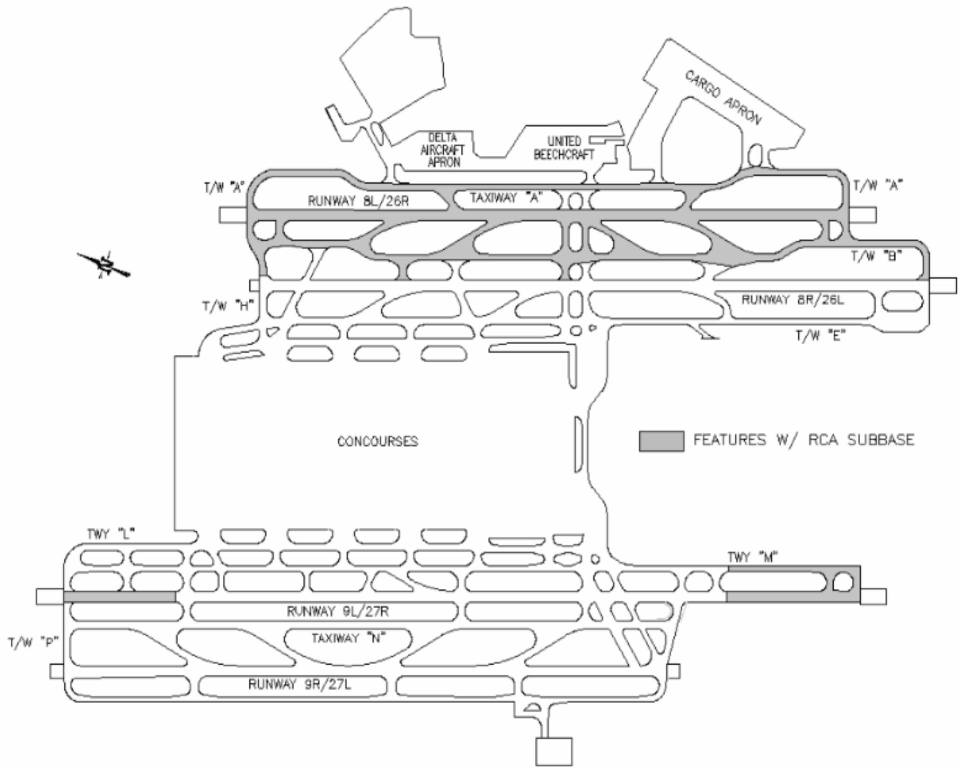


Figure 17. Airfield Pavement Layout at Hartsfield- Jackson Atlanta Airport Showing Features with RCA Base [8]

Year of Construction: 1980

Source of Information: "Using Recycled Concrete Aggregate in Pavement Base Products", Concrete Pavement (CP) Road Map- Map Brief July 2018.

Website: https://intrans.iastate.edu/app/uploads/2018/12/MAPbriefJul2018.pdf

2.3.2 Highways Projects

Based on the historical records provided by MTO, several projects were constructed in 2020 using Granular A - Recycled Concrete Aggregates (RCA) for five contracts for 400-highway series within the Central Region as shown in the following **Table 12**.

Table 12. Granular A - Placement Information 2020 - MTO Central Region

Highway Number:		401	400	401	404	410
Location:		Between Credit River and 410/403 Interchange	HWY 400 From 1.0km North of King Road northerly to 1.9km North of Lloydtown-Aurora Road.	Jane St to Allen Rd	Richmond Hill, ON	Highway 410 Brampton, ON
Construction Year:		2020	2020	2020	2020	2020
Granular A Unit Rate (Avg. 3 Low Bids):		$ 15.25	$ 18.89		$ 22.44	$ 24.20
Granular A Tender Quantity in tonnes:		275,955	142,841	10,240	64,175	46,087
Total Qty of Natural & Recycled Aggregates Placed in 2020:		25,459	47,366	1,121	21,185	22,680
Recycled Materials	**RCA- Quantity (t)**	24,949	47,366	974	16,842	15,780
Source Info:	**Name of the Source**	D Crupi & Sons	Strada Aggregates	Furfari	D. Crupi	Gazzola
	Location of the Source	176 Bethridge	Vaughan Yard	1159 Tapscott Rd Scarborough	14th Ave, Markham	529 Carlingview Dr. Etobicoke

Project (1): Highway 400 – 2021 (MTO, Ontario) - Using RCA as Unbound Base and Subbase

Project Description: Highway Widening including Center Barrier Wall Replacement from Major Mackenzie Drive to King Road.

Project No.: MTO#2017-2001

Contractor: Dufferin Construction Ltd

Year of Construction: Commencing 2017 and completed 2021

Brief Description Recycled Concrete Aggregate: Recycled aggregate was used to replace both Gran B and Gran A requirements providing it met OPSS1010 specifications. Material was used for base aggregate and fine grading aggregate through the whole project.

Supplier of Recycled Concrete Aggregate: Strada Aggregate

The Total Quantity of the Used Recycled Concrete Aggregate (Over the Years): 300,000 tonnes

Cost Savings of Using Recycled Concrete Aggregate: 1.2 million ($4.0 per tonne vs. Natural/Virgin Aggregate)

Source of the Used Recycled Concrete Aggregate (Distance to Site): The recycled aggregate source was less the 10 km to the project which demonstrates a significant reduction in carbon footprint.

Current Pavement Condition: Based on EXP's site visit on September 20th, 2022, the pavement condition is excellent with no distresses as shown in the following **Figures 18, 19, 20, and 21**.

Figure 18. Highway 400- NB – Before Teston Road Bridge- No Distresses (September 2022)

Figure 19. Highway 400- NB – Before King Road Bridge - No Distresses (September 2022)

Figure 20. Highway 400- Southbound Direction
Before King Vaughan Road Bridge - No Distresses (September 2022)

Figure 21. Highway 400- Southbound Direction
Before Exit to Major Mackenzie Drive - No Distresses (September 2022)

Project (2): Edens Expressway, Chicago, Illinois—1978 (ACPA 2009) - Using RCA as Unbound Aggregate Base

Project Description: The 1978 Edens Expressway project (I-94 through the north-ernsuburbs of Chicago) was the first major US urban freeway completely reconstructed and also the largest highway project on which concrete recycling had been used up to that time (Dierkes 1981, Krueger 1981). The Illinois Department of Transportation (IDOT) permitted the use of RCA in base layers and fill applications on this project. While there were adequate supplies of acceptable virgin base aggregate approximately 18 miles from the project site, the haul from the source to the job site would have required a 3-hour round trip during daytime traffic conditions. As such, on-site recycling was selected (Darter et al. 1998). The crushing plant was set up in an interchange cloverleaf area (Refer to **Figure 22**). The area was heavily populated, so noise was a serious concern. Crushing operations were suspended from midnight until 6 a.m. every day, and some modifications to typical operational procedures were instituted (such as truck drivers not being allowed to bang their tailgates to help discharge materials from their truck beds). Nearly 350,000 tons of the old pavement were crushed at this site, with about 85% of the RCA produced being used in fill areas, while the remaining 15% was used as a 3-in. unbound aggregate base. An asphalt-treated base and 10-in. continuously reinforced concrete pavement (CRCP) were placed over the RCA base.

Figure 22. Concrete Recycling Operation Set up Inside of Edens Expressway Cloverleaf Interchange (Photo from NHI 1998) [13]

The estimated quantity of saved fuel (from recycling the old concrete pavement) is 200,000 gallons that would otherwise have been consumed in disposing of demolished concrete and hauling virgin aggregate to the job site (Darter et al. 1998).

This pavement provided excellent service for nearly 40 years under extremely heavy traffic (up to 170,000 vehicles per day in 2007) and demonstrated the feasibility (and economy) of completely recycling and reconstructing a high-volume urban concrete expressway.

RCA has been successfully used as unbound aggregate base in hundreds of projects since the 1978 IDOT Eden's Expressway project. Recent well-documented example projects are described in Chapter 2 of Snyder et al. (2018). These include:

- The Illinois State Toll Highway Authority use of RCA in base materials between 2006 and 2016, resulting in a savings of more than $61 million (2016 dollars);
- A 1981 18-mile two-lane recycling project in Minnesota that saved 150,000 gallons of fuel and 27 percent of project costs; and
- A 2015 1.5-mile Wisconsin Inter-state project that was projected to save more than $250,000 over the project life.

Source of Information: "Using Recycled Concrete Aggregate in Pavement Base Products", Concrete Pavement (CP) Road Map- Map Brief July 2018.

Website: https://intrans.iastate.edu/app/uploads/2018/12/MAPbriefJul2018.pdf

2.3.3 Light Rail Transit (LRT) Projects

Project: Finch LRT – Ongoing Project (P3 design build, Toronto, Ontario) - Using RCA for Various Applications

Project Description: Constructing Light Rail Transit on Finch Avenue (Humber College Road to Keel Street)

Contractors: Joint Venture Aecon, Dragados, Dufferin Construction

Year of Construction: Started 2019 and Schedule to Finish 2023

Brief Description Recycled Concrete Aggregate: Recycled aggregate is being used for various applications. The clean recycled concrete materials (RCM) with no asphalt particles can be used to replace Gran A for pipe bedding providing it meets the TS1010 Standard Specifications. The RCM where asphalt particles do not exceed 20 % can be used for road construction allowance.

Supplier of Recycled Concrete Aggregate: Strada Aggregate

The Total Estimated Quantity of the Used Recycled Concrete Aggregate (Over the Years): 85,000 tonnes

Cost Savings of Using Recycled Concrete Aggregate: $510,000 ($6.0 per tonne vs. Natural/Virgin Aggregate)

Source of the Used Recycled Concrete Aggregate (Distance to Site): The recycled aggregate source was less than 10 km to the project which demonstrates a significant reduction in carbon footprint. It should be noted that the contractors were permitted to dispose clean concrete and asphalt locally.

2.3.4 Development Engineering Projects

- **Project (1):** Greenwood Racetrack Development (for Metrus Development Inc.)
- **Project Location/Limits:** The development is for the east half of the former Greenwood Racetrack, and the Site is bounded by Queen Street to the north, Lakeshore Boulevard to the south, Woodbine Avenue to the east and Coxwell Avenue to the west in the City of Toronto, Ontario. A total of 900 units of single detached and semi-detached dwellings, townhouses and retail/apartments and apartments are proposed for the development. The development had also involved the construction of five streets together (Boardwalk Drive, Joseph Duggan Road, Sarah Ashbridge Avenue, Winners Circle, and Northern Dancer Boulevard) with the necessary infrastructure such as sewers, watermain and other underground services.
- **Site Location:** As shown in location plan in the following **Figure 23**.

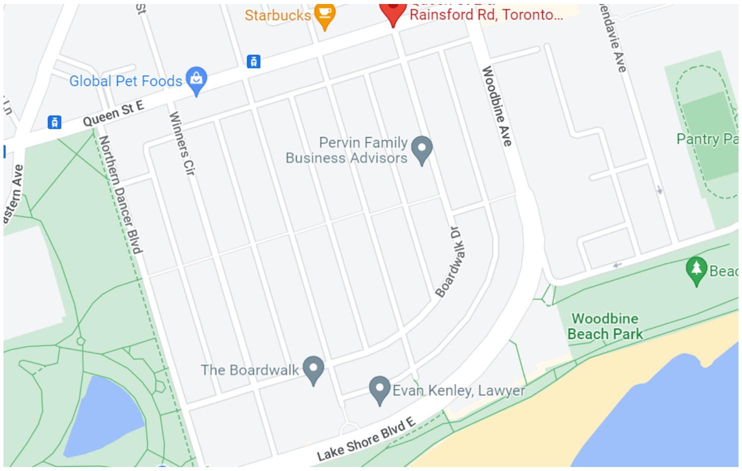


Figure 23. Greenwood Racetrack Development – Location Map

- **Pavement Surface Course Year of Construction:** 2002 (Age: 20 years)
- **Brief Description of the project and the usage of Recycled Crushed Concrete:** The constructed flexible pavement structures at the five streets mentioned consisted of 150 mm HMA, over 150 mm Gran A (Recycled concrete aggregates – 19 mm max size), over 300 mm Gran B (Recycled concrete aggregates – 50 mm max size). This is the very first usage of recycled crushed as road base material in Toronto's history. Before that, the City of Toronto used concrete base for rigid or composite pavement with native granular base and subbase.
- **Previous FWD Testing Results (prior to place the surface course), for Boardwalk Drive and Joseph Duggan Road:**
  - Year: 2002

  - The levels of HMA and subgrade resilient moduli back-calculated (for flexible pavement structure) from the collected FWD data indicate average strength of approximately 2500 MPa for HMA and 50 MPa for the subgrade.
  - The pavement at each road (Boardwalk Drive and Joseph Duggan Road) prior to place the surface course was in good condition and no structural problems were evident.
  - The distress level survey of the tested pavements and the FWD back-calculated results indicate that the flexible pavements showed less deformations and have fairly consistent and high resilient modulus values for the materials used in its construction.
- **Current Pavement Condition (September 2022 – by EXP):**
  - The pavement of all streets within Greenwood Development in Toronto are in good condition, without any structural failures. Refer to **Figure 24** through **Figure 27** for site photographs.
  - Frequent slight ravelling, occasional moderate and very severe due to asphalt hardening/ aging.
  - Few to intermittent slight single, transverse, and/or random cracks, occasional moderate.
  - Few slight asphalt patches for utility cuts, occasional moderate.
  - <u>Maintenance Needs-</u> <u>Plan:</u> The area will need few rout and seal asphalt cracks (approx. 250 l.m – total length) and few full depths asphalt patches/repair (approx. 30 sq.m, total repair area) within 2-3 years.
  - Rehabilitation Needs - Plan: It will need mill 40 mm and pave 40 mm new surface course within 4-6 years to renew the asphalt wearing course.

Figure 24. Greenwood Development – Boardwalk Dr at Sarah Ashbridge Ave (Sept 2022)

Figure 25. Greenwood Development – Boardwalk Dr (Sept 2022)

Figure 26. Greenwood Development – Joseph Duggan Road (Sept 2022)

Figure 27. Greenwood Development – Winners Circle (Sept 2022)

- **Project (2):** Huntington Glen – Industrial Subdivision – Phase 2 (Boca East Investment Ltd.)
- **Project Location/Limits:** The development is east of Highway 50. The two roads within the development area are Hunter's Valley Road (north of Trade Valley Drive to north of Can-Ar Gate) and Can-Ar Gate, City of Vaughan, Ontario.
- **Project Location Map:** As shown in the following **Figure 28** location map.

Figure 28. Huntington Glen – Industrial Subdivision Development – Phase 2 – Location Map

- **Year of Construction:** Road works up to the base asphalt was conducted in 2012, and top asphalt was installed in 2016 (Age: 6 years).
- **Brief Description of the project and the usage of Recycled Crushed Concrete:** The constructed flexible pavement structures at the two streets mentioned consisted of 125 mm HMA, over 125 mm Granular Base (19 mm diameter Recycled Concrete Aggregates), over 405 mm Granular Subbase (50 mm diameter Recycled Concrete Aggregates). It should be noted that "50 mm Recycled Concrete" and "19 mm Recycled Concrete" materials were used in the subbase and base layers of pavement in lieu of "50 mm Crusher Run Limestone" and "20 mm Crusher Run Limestone", respectively. As such, the thickness of subbase layer was increased by 15% to 405 mm comparing to 350 mm in thickness required by the City of Vaughan pavement design, due to substitution of Granular B Type II (which is required as per the project specifications) to Granular B Type I Material.

- **Test Results of Used Recycled Concrete:** In 2012 EXP retrieved samples of 19 mm and 50 mm recycled concrete material (RCM) from Strada Aggregates Inc. located at 120 Wentworth Court in Brampton, to conduct various physical property and sieve analysis test at EXP's laboratory. The purpose of this testing was to determine if the physical properties and gradation of both 19 mm and 50 mm RCM are in conformance with the OPSS 1010 Granular A and Granular B Type I, gradation and physical property requirements. The grain Size Analysis and physical property test analysis indicated that all test results completed on the 19 mm and 50 mm RCM samples are in conformance with Granular A and Granular B Type I requirements outlined by OPSS 1010.

- The pavement of all streets within Huntington Glen Development in City of Vaughan are in good condition, without any structural failures. Refer to **Figure 29** through **Figure 32** for site photographs.

Figure 29. Huntington Glen – Hunter's Valley Road (October 2022)

Figure 30. Huntington Glen – Hunter's Valley Road (October 2022)

Figure 31. Huntington Glen – Can-Ar Gate (October 2022)

Figure 32. Huntington Glen – Can-Ar Gate (October 2022)

- **Project (3):** Queensville Subdivision Phase 6 (Queensville Development Inc.)
- **Location:** Town of East Gwillimbury (John Candy Drive and Ben Sinclair Avenue, Queensville,ON)
- **Site Locations:** As shown in the following **Figure 33**.

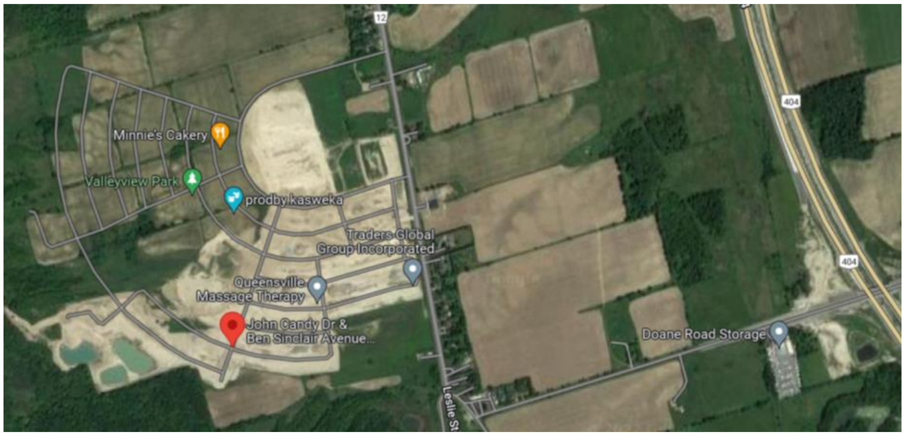


Figure 33. Queensville Subdivision Phase 6 – Site Location Map

- **Year of Construction:** July 2021
- **Quantity of the Used RCA (Gran A and Gran B):** 13,230 tonnes (4,410 tonnes for Gran A and 8,820 tonnes for Gran B).
- **Supplier:** Strada Aggregates (Mount Albert Yard) – Saving is $11.5 per tonne for either Gran or Gran B.

- **Brief Description of the project and the usage of Recycled Crushed Concrete:**

  ✓ **Original and Alternative Pavement Designs:**

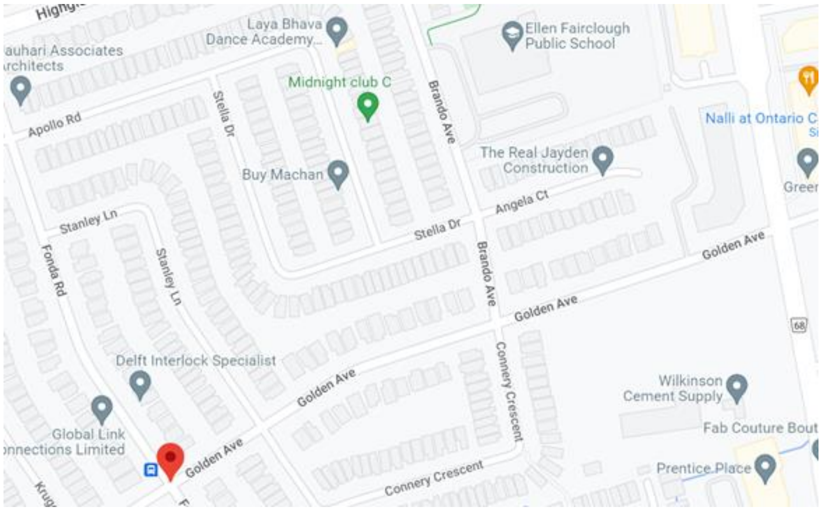
Town's Minimum Pavement Design		EXP Alternative Pavement Design	
Material	**Layer Thickness**	**Material**	**Layer Thickness**
HL3	40 mm	HL3 (15 % RAP)	40 mm
HL8	50 mm	HL8 (20 % RAP)	60 mm
Gran A (19 mm CRL)	150 mm	Gran A (19 mm RCA)	200 mm
Gran B-1 (50 mm CRL)	300 mm	Gran B (50 mm RCA)	400 mm
Total Thickness	**540 mm**	**Total Thickness**	**700 mm**

- **Results:**

  ✓ In this project approx. 88 % of recycled material had been used, which exceeds the requirement of the "Thinking Green Development Standards" that 30 % of recycled materials to be used (saving in the GHG emission).

  ✓ Economic Savings: $152,145.

Other Development Engineering Projects:



Other development engineering projects using recycled concrete aggregate were executed for Markham Road Cluster. The constructed roads in Markham were Golden Avenue, Connery Crescent, Stanley Lane, Angela Court, Brando Avenue, Apollo Road, and Stella Drive. These Roads in Markham were constructed in the late 1990s and RCA was used on all those roads/streets. There were minor repairs done to some sidewalk slabs and some minor curb work and some patching around catch basins and some rout and sealing. These roads are performing extremely well over 20 years.

2.4 Previous Unsuccessful Project

Case Study for Unsuccessful Project: Highway 427 – 2010 (MTO, York Region, Ontario)

Project Description: Highway 427 from South of Highway 7 to Zenway Boulevard.

Problems Encountered:

1) The new lane as part of pavement widening was raised/heaved approx. 70 mm, as shown in site photographs in the following **Figure 34**.

Figure 34. Highway 427 – Pavement Heaving in 2010

2) Crack reappears between lanes, as shown in site photographs dated 2011 in the following **Figure 35**.

Figure 35. Highway 427 – Reappearance of Cracks Between Lanes in 2011

3) Unevenness between lanes (Safety Concerns) as shown in site photographs in the following **Figure 36**.

Figure 36. Highway 427 – Pavement Distresses Between Lanes in 2010 - 2011

4) Guiderail Height Outside of Desirable Range and Swale Created Adjacent to Lane, as shown in site photographs in the following **Figure 37**.

Figure 37. Highway 427 – Guiderail Height Outside of Desirable Range and Swale Created Adjacent to Lane (2010)

5) Other Problems, as shown in site photographs in the following **Figure 38**.

Figure 38. Highway 427 – Different Pavement Distresses (2010 -2011)

Possible Causes:

1) Typical frost heave problem due to winter freeze/thaw?

2) Drainage? Relatively shallow drainage between the Highway 7 off-ramp to just north of Highway 7. Does not explain why there is a problem in the high fill areas. Pavement remains expand after two winter periods and repair. Poor drainage may be a contributing factor to the problem; however, it is not the main cause (Conclusion: Drainage not typical for frost heave situations)

3) Material Problem? If so, which Material?

- Subgrade (Native/ Earth Material)? Standard Penetration Test (SPT) confirmed subgrade had good strength. Grain Size/Hydrometer Test confirmed subgrade material had low to moderate susceptibility to frost heave (Conclusion: Subgrade not the cause of the problem)
- Asphalt? FWD Testing confirmed asphalt is generally structurally adequate. No issue with material identified (Conclusion: Asphalt not the cause of the problem).
- Recycled Concrete Material (RCM)?

  ❖ **Moisture Content:**

    ✓ New highway constructed adjacent to existing highway that has been in operation for approximately 20 years, as shown in **Figure 39** for site photograph.

Figure 39. Highway 427 – New Highway Constructed Adjacent to Existing Highway

    ✓ Expect similar moisture contents between the old and new pavement structure as shown in the following **Figure 40**.

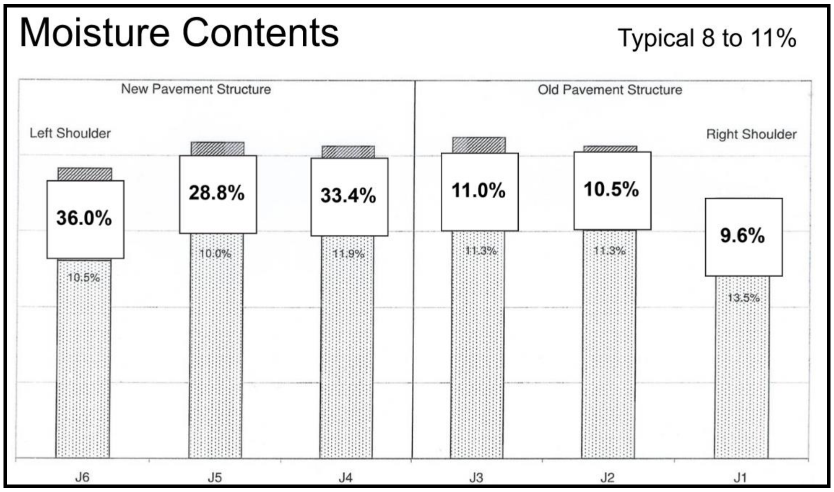
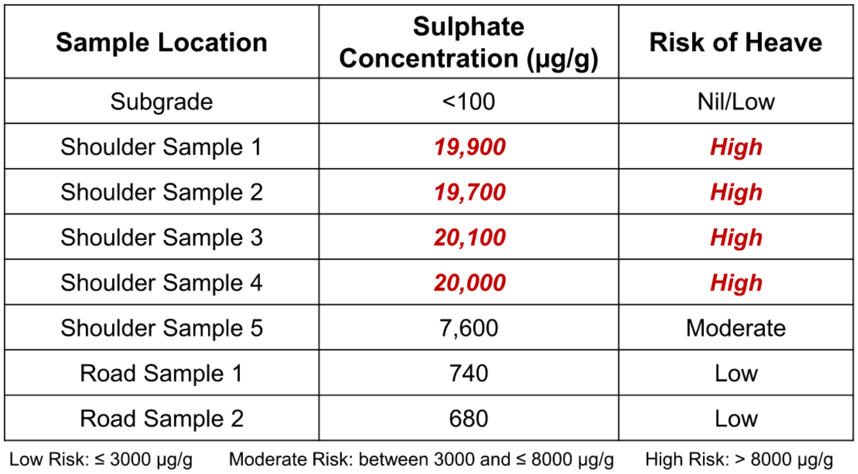


Figure 40. Highway 427 – Moisture Contents for Old and New Pavement Structures

- **In-Situ Wet/Dry Density (After Issue Identified)**
  - ✓ Wet Density: 1,680 – 1,990 kg/m^3 (typically ~ 2,150 kg/m^3)
  - ✓ Dry Density: 1,450 – 1,750 kg/m3 (typically ~ 1,950 kg/m^3)
  - ✓ Represents 15 % to 20 % expansion.
- **Petrographic Analysis:**
  - ✓ **Coarse Aggregate:** Up to 10 % deleterious material found (by mass) - Gypsum, wallboard, drywall, and plaster.
  - ✓ **Fine Aggregate:** Up to 2.9 % of contamination and up to 12.1 % of soft RCM.
- **Chemical Tests:**
  - ✓ Highly Expansive Sulphate Minerals (thaumasite and ettringite)
  - ✓ Gypsum found up to 5 % (by mass)
  - ✓ Sulphate Concentration (Risk of Expansion) {Low Risk<=3000 µg/g; Moderate Risk between 3000 µg/g and <=8000 µg/g; High Risk: > 8000 µg/g}. Tables 13 and 14 summarize the results of sulphate Concentration of the tested samples.

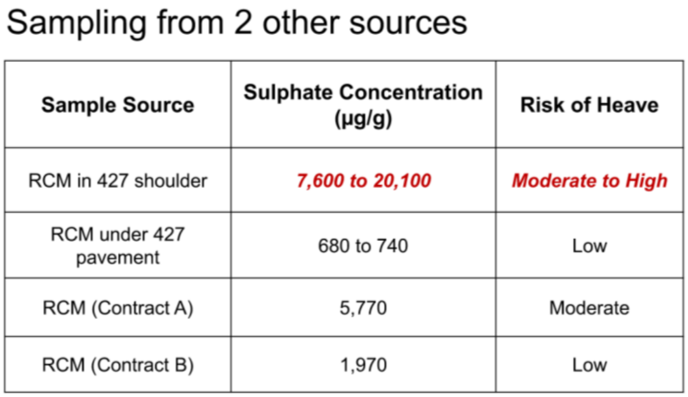
Table 13. Highway 427 – Sulphate Concentration Test Results and Associated Heave Risks (2011)



Sample Location	Sulphate Concentration (µg/g)	Risk of Heave
Subgrade	<100	Nil/Low
Shoulder Sample 1	***19,900***	***High***
Shoulder Sample 2	***19,700***	***High***
Shoulder Sample 3	***20,100***	***High***
Shoulder Sample 4	***20,000***	***High***
Shoulder Sample 5	7,600	Moderate
Road Sample 1	740	Low
Road Sample 2	680	Low

Low Risk: ≤ 3000 µg/g Moderate Risk: between 3000 and ≤ 8000 µg/g High Risk: > 8000 µg/g

Table 14. Sulphate Concentration Test Results and Associated Heave Risks for Highway 427 Vs. Other Contracts (2011)



Sampling from 2 other sources

Sample Source	Sulphate Concentration (µg/g)	Risk of Heave
RCM in 427 shoulder	***7,600 to 20,100***	***Moderate to High***
RCM under 427 pavement	680 to 740	Low
RCM (Contract A)	5,770	Moderate
RCM (Contract B)	1,970	Low

- Simulation of % Swell Using RCM is shown in the following **Figure 41** for % Swell for different periods.

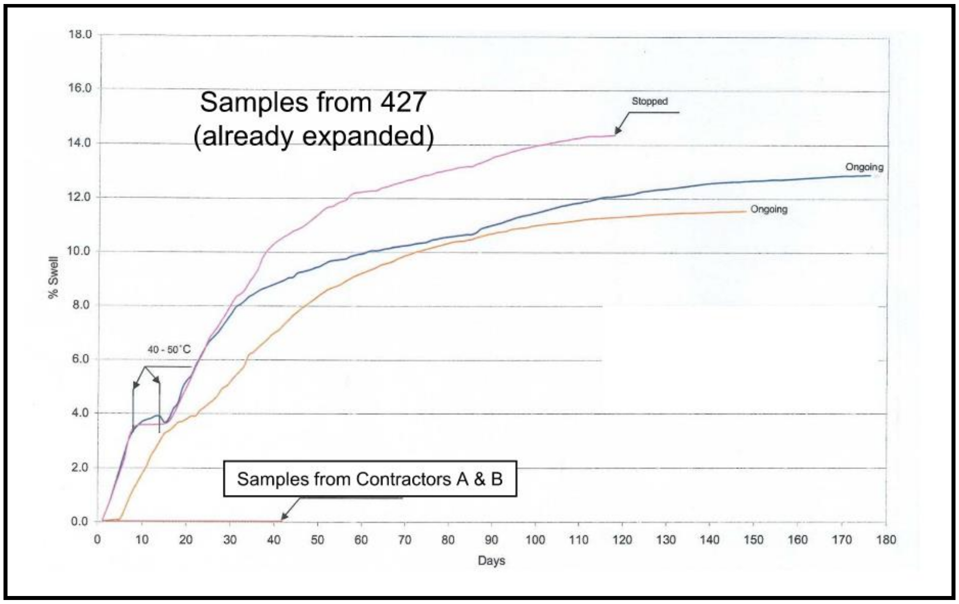


Figure 41. Simulation of % Swell (Expansion) for Different Periods – Samples from Highway 427 Vs. Samples from Other Contracts

Conclusion:

York Region theorized that the key factor causing pavement and shoulder problems is the deleterious material in the recycled concrete materials (RCM).

Source of Information: “A Forensic Investigation: Potential Issues with Recycled Concrete Materials (RCM)”, Edward Chiu, York Region, November 18, 2015.

Website:
https://municipalengineers.on.ca/files/workshop_presentations/2015/IssuesWithRecycledConcrete%20Aggregate.pdf

3. Sustainability and Environmental Impacts

3.1 General Background

The production of concrete for use in infrastructure is a large consumer of natural virgin aggregate. As infrastructure ages, the demands on our quarries will surpass the availability of this natural resource from local or regional suppliers. As the use of virgin aggregate continues to be required, and local quarries cannot meet supply, it will be necessary for projects to source materials from quarries located farther from the site. This results in significant financial and environmental impacts, including increased hauling costs and higher greenhouse gas (GHG) emissions from transporting the material over a greater distance.

It is inevitable that roads will require repairs for reasons beyond overuse or age of infrastructure. The impacts of climate change are more noticeable in the last decade, with an increase in severe weather events. Flooding, stronger and more frequent hurricanes, colder and more precipitous winters and increased seismic activity are a few reasons that roadways are burdened by more than the flow of commercial and industrial traffic. Roads are not designed to handle the additional impacts from subzero temperatures, standing water, and hotter than normal summers **[17]**. A report from the Canadian Climate Institute indicates that more than half of the country's winter roads in its northern regions, built on frozen lakes and rivers each fall, may in 30 years become unusable or impossible to build **[18,19]**.

The solution is not easy; it includes a multi-disciplinary approach to provide engineering resolve in newly designed infrastructure, that accounts for limits within our supply chain and mitigates the risks of climate change across the full lifecycle of the systems **[19]**.

3.2 Climate Change: Environmental Benefits and Avoided Consequences by using RCA

Research shows that recycled concrete aggregates (RCA) have been widely used over the last 80 years in both Europe and the United States (US). Many early applications were non-structural. However, in the US, RCA has been used for roadway construction as early as the reconstruction of US Route 66 in Illinois in the 1940s **[20]**.

The recommendation to use RCA in transportation system applications is a solution that provides cost and environmental benefits.

- Reduces the negative impacts associated with active pits , quarries and extends the life of these quarries.
- Lowers the cost of hauling virgin aggregate to project sites
- Diverts aggregates from landfill
- Reduces GHG emissions from the extraction and hauling processes

There is risk that the natural virgin aggregate may be unavailable, not only from the complete use of the resource from existing quarries, but from the closing of the quarry itself. Two real-life examples were presented in a 2021 study commissioned by the Ontario Stone, Sand and Gravel Association (OSSGA). The first focused on sourcing the natural virgin aggregate from non-regional or local quarries. The second analyzed the regional and local implications of closing a single site in Burlington, Ontario **[21]**.

The study determined that the average distance from source to site was 35 km. A conservative estimate of approximately three times the hauling distance, or 110 km, was used in comparison. Transportation costs exceeded $169 million, or double the current costs, while GHG emissions increased by 89,000 metric tonnes ($MTCO_2e$). This impact would be felt by everyone in the construction industry, not just infrastructure projects.

Closing a quarry completely produces similar results for transportation costs and GHG emissions. On an annual basis, the economic impact is $20.6 million. Environmental impacts equate to 1,600 MTCO2e within that same timeframe.

GHG and Energy Reductions from using RCA

The impacts and benefits of using RCA can be broken down to the project level, or even further, to the unit of energy consumption (in Megajoules, or MJ) and GHG emissions (in kilograms, or kg) per ton (t) of material. Our approach uses a “cradle-to-grave” analysis for roadway construction. It begins with the extraction process. For virgin materials, this means extraction from a quarry. For recycled aggregate, the extraction point would be a site where construction and demolition waste (CDW) is available for processing. Materials (in both forms) are transported to a processing plant. At this point, the CDW must be sorted and only the usable materials are then crushed into RCA. Transportation from the plant to the construction site completes the process.

Figure 42 depicts the lifecycle described in the foregoing paragraph. Though included in the figure, energy, cost and GHG emission impacts from the additional process for the diversion of the non-usable CDW to the landfill is excluded from our analysis **[22]**.

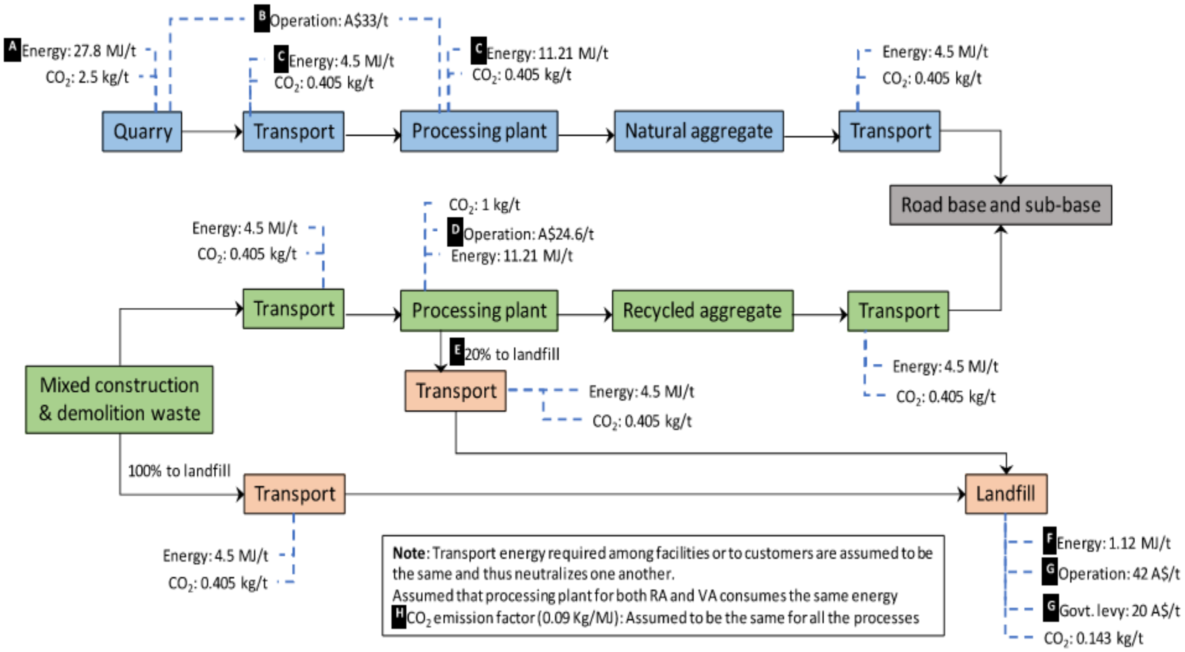


Figure 42. Life Cycles of virgin and recycled aggregates and associated costs in different phases [22]

In this figure, metrics associated with energy and GHG emissions (from CO_2) have been included. Assumptions have been made around the transportation and processing metrics for both virgin and recycled aggregate, as follows:

- Transportation energy and GHG emissions, from either the quarry or the site where demolished material is being collected, has been assumed equal. Energy consumption is 4.5 MJ/t and GHG emissions are 0.405 kg/t per trip.
- Transportation energy and GHG emissions of natural and recycled aggregate, from the processing plant to the construction site for the roadway, has been assumed equal. The values of 4.5 MJ/t and 0.405 kg/t per trip also apply here.
- Energy consumption associated with processing natural material or the construction and demolition waste is assumed to be equal. Energy consumption is 11.21 MJ/t.
- A single emissions factor of 0.09 kg/MJ is used for all phases of the analysis.

Tables 15 and 16 break down the associated energy consumption (MJ/t) and GHG emissions (kg/t) for aggregates. Values for 30 per cent reclaimed material have been extrapolated from the concrete and untreated granular values.

Table 15. Condensed Table of Energy Consumption for Processes [23]

Product	Aggregates (MJ/t)
Continuous reinforced concrete	29
30% reclaimed material	37
Untreated Granular Material	40

Table 16. Condensed Table of GHG Emissions for Processes [23]

Product	Aggregates (kg/t)
Continuous reinforced concrete	5.1
30% reclaimed material	8.25
Untreated Granular Material	9.6

For a more comprehensive analysis of the resulting savings from energy and GHG emissions through use of RCA, additional research and calculations, using baseline assumptions from Figure 42 and Tables 15 and 16, were performed in our study. The following apply to our results:

- There is no energy consumption or GHG emissions saving at the processing plant (i.e., crushing, screening), through transportation of the material, or in laying the material, as it requires the same amount of energy and emits same amount of GHG when using RCA or natural aggregate.
- There is no energy consumption or GHG emissions saving with the demolition of existing concrete or asphalt. This process will be required whether the demolished materials will be reused as paving material or sent to the landfill.
- Energy consumption and GHG emissions will be saved by eliminating the extraction of natural aggregate from the quarry, when using RCA.
- The aggregate values for GJ/t and kg/t presented in **Tables 15 and 16** represent the energy consumption and GHG emissions from the extraction process and crushing / screening at the processing plant.
- The transportation ("transport") values have been assumed at 75 km from the source to the processing plant and then 20 km from the processing plant to the construction site.
- Laying is the process of laying the material at the construction site.
- Each tonne of unbound granular material, from extraction to laying, will consume 114 MJ of energy and emit 15 kg of GHG emissions.
- The required energy consumption and GHG ratio between the quarry (i.e., extraction) and the processing plant is 70 per cent to 30 per cent, respectively, as presented in **Table 17**.
- Assuming a 70/30 ratio, and referencing the 'Unbounded Granular Material', we were able to separate the extraction and processing plant amounts (GJ and kg) from **Tables 15 and 16**.

Our calculations concluded that, if natural granular base is replaced with RCA or a percentage of that aggregate mix contains reclaimed materials, the estimated energy consumption and GHG emissions savings from extraction to laying would be:

Table 17. Energy and GHG Emissions Savings

Product	Energy Savings (%)	GHG Emissions Savings (%)
Virgin/Natural Aggregate	-	-
30% RAP with 70% Natural	7 %	14 %
100% RCA	25 %	46 %

3.3 Integration of RCAs to Support Climate Action Strategies

Future Cost Impacts – Carbon Penalties

The financial burden of the first cost impacts from closing a quarry or transporting natural aggregate from other regions is significant. Use of reclaimed material, in any quantity, can provide an energy savings of 7 – 25 per cent and a 14 – 46 per cent GHG emissions savings.

Further, we must also consider future impacts related to carbon pricing or taxation from municipalities. Depending on the region, additional costs may be incurred for carbon penalties. With a push toward carbon neutrality, the cost for not reducing or offsetting your carbon can also put economic burden on a project owner, developers, tenants, and municipalities. These costs will inherently be passed down. When applied to a building, owners and developers may charge higher rates of rent to tenants to make up for the economic gap. In the transportation industry, it is reasonable to assume that increases may be seen in local and regional taxes or in toll charges for vehicles using certain highways.

Today, carbon prices are estimated at $30 per tonne. Ester Gerassime, the Ontario Chamber of Commerce's (OCC) economic analyst and author of the OSSGA commissioned report, estimates that by 2030, prices will be more than five times the current value. In less than a decade, the financial impact would go from $2.7 million to over $15 million **[24]**.

Call to Action

The business case for use of RAM goes beyond energy and GHG emissions savings. Our municipalities must be proactive in investing in full scale adoption of RCAs and other means to adapt to the impacts that climate change will have on our infrastructure. When repaving roads, selecting materials and specifying mixes that can withstand the predicted climate 20 to 30 years in the future can reduce costs by over 90per cent **[25]**. If done correctly, the outcome will result in more sustainable and resilient infrastructure, while contributing to Canada's transition to a low carbon future.

3.4 Case Study on Reduced Environmental Impacts from Using RCA

Section 4.2 outlines detailed information on the four (4) selected projects for our case study for the costs and estimated savings from using Recycled Crushed Aggregate (RCA1010), including the resultant economic value associated with the use of RCAs. In this section, we will build on the environmental value for those same case studies.

In addition to the inputs shown in **Table 18** for the four (4) projects case study that were used for the calculations, as presented in Section 4.2 of this report. The following additional assumptions have been outlined as follows:

- The transportation emissions of the unfinished product (both virgin and reclaimed) have been assumed equal. Emissions are calculated assuming 0.405 kg/t, or 0.000405 $MTCO_2e/t$.
- The extraction emissions for virgin material from the quarry is 2.5 kg/t, or 0.0025 $MTCO_2e/t$.
- Extraction emissions for the reclaimed material are 0 kg/t, or 0 $MTCO_2e/t$. The demolition of buildings or roadways would occur whether the materials were being reused/repurposed for new construction.
- The emissions associated with processing the virgin material at the plant are 0.000405 $MTCO_2e/t$.
- Emissions associated with processing the reclaimed material are 0.001 $MTCO_2e/t$. Additional emissions are assumed for sorting and separating the reclaimed material before the usable product is crushed.

Table 18. Details of Inputs for the Four Projects Case Study

Pit / Quarry Location	Avg. Distance from Pit / Quarry to Project Location (km)	Crusher Location	Avg. Distance from Closest Crusher of RCA to Project Location (km)	Total Tonnes per Project (approx.)
Brechin	80.5	Mt. Albert	18	11,000
Orillia	115	Vaughan	6	100,000
Milton	52	Brampton	10	7,000
Flamboro	70	Mississauga	14	50,000

In our four (4) projects case study, information on the origin of the finished product has been provided. With the distance (km) from the plant to the project site, details on the GHG emissions of transporting the finished product from either the quarry/processing plant or the crusher/processing plant has been determined, in lieu of considering the values equal.

- As outlined in the OSSGA study **[21]**, the GHG emissions associated with all truckloads transporting aggregate to construction sites is 5 $MTCO_2e/day$.
- On average, 710 trucks transport 5 loads of material each day, with an average load of 32 tonnes.
- This equates to an emissions factor of 0.0014 $MTCO_2e/load$.

The greatest impacts in savings can been seen when there are large quantities of material and when the transportation distance between source and site are minimized. The following **Table 19** presents additional information on GHG emissions saved by using RCAs in these four (4) projects.

Table 19. Details of Emissions Saving for the Four Projects Case Study

GHG Emissions ($MTCO_2e$)												
Pit / Quarry Location	**Extraction**		**Transportation of Unfinished Product to Processing Plant**		**Processing**		**Transportation of finished product to Site [1]**		**TOTAL**		**Savings by using RCA**	**Equivalent Passenger Vehicles of Avoided Emissions**
	Gran A - Native	**Gran A - RCA**	**Gran A - Native**	**Gran A - RCA**	**Gran A - Native**	**Gran A - RCA**	**Gran A - Native**	**Gran A - RCA**	**Gran A - Native**	**Gran A - RCA**		
	**** impacts from quarry only***		**** assumed equal***		**** additional emissions in RCA for sorting***		**** using distances from each location***		****cumulative results for each product type***			
Brechin	27.50	0.00	4.46	4.46	4.46	16.50	38.74	8.66	75.15	29.62	45.53	9.8
Orillia	250.00	0.00	40.50	40.5	40.50	150.00	503.13	26.25	834.13	216.75	617.38	133.0
Milton	17.50	0.00	2.84	2.84	2.84	10.50	15.93	3.06	39.10	16.40	22.70	4.9
Flamboro	125.00	0.00	20.25	20.25	20.25	75.00	153.13	30.63	318.63	125.88	192.75	41.5
Total Equivalent Passenger Vehicles of the Avoided Emissions - for Four Projects												**189.3**

Note 1: Each trip assumes one truck carrying 32 tonnes

The emissions savings have also been translated into avoided emissions, in a recognizable metric, of equivalent passenger vehicles.

- The U.S. Environmental Protection Agency (US EPA) estimates that a car or truck averages 18,640 km (11,520 miles) per year **[26]**.
- The average fuel efficiency of a vehicle is 9.44 km/L (22.2 miles per gallon, or mpg).
- The factor used to report only on CO_2 emissions, instead of GHG emissions as CO_2, CH4 and N20, is 1.006.
- There are 0.00235 $MTCO_2e$/L (0.00889 $MTCO_2e$/gal) of gasoline.
- This equates to 4.640 $MTCO_2e$/vehicle/year.

From these four projects, savings reported is the equivalent of 189 passenger vehicles. This is not a small number. When looking at these values, and factoring nationwide savings across all annual construction projects, we could avoid the emissions equivalent of 30,000 vehicles **[27]**.

4. Availability Cost, and Quality of the Recycled Crushed Aggregate

4.1 Availability of Recycled Crushed Aggregate in GTA and Surrounding Areas

Arguably the single biggest advantage of using RCA compared to virgin aggregate is its availability and proximity to virtually any market. Construction demolition is prevalent in all major urban centres, ensuring a supply of readily accessible material. If a structure is deconstructed and the resulting construction and demolition waste (CDW) is used for suitable applications onsite, the owner reduces the need to purchase and transport virgin aggregate while also saving the hauling, dumping, and landfill costs for these materials.

Within the GTA and surrounding areas, numerous crusher yards are available for recycling the concrete to produce recycled concrete aggregate (RCA) of Gran A and Gran B. In addition to the crusher yards, many other depots are also available to supply RCA. **Figure 43** shows the location map for all the yards where recycled concrete aggregate is available within GTA and surrounding areas (Source of Information: [Phil | The virtual soil broker (getphil.app)]

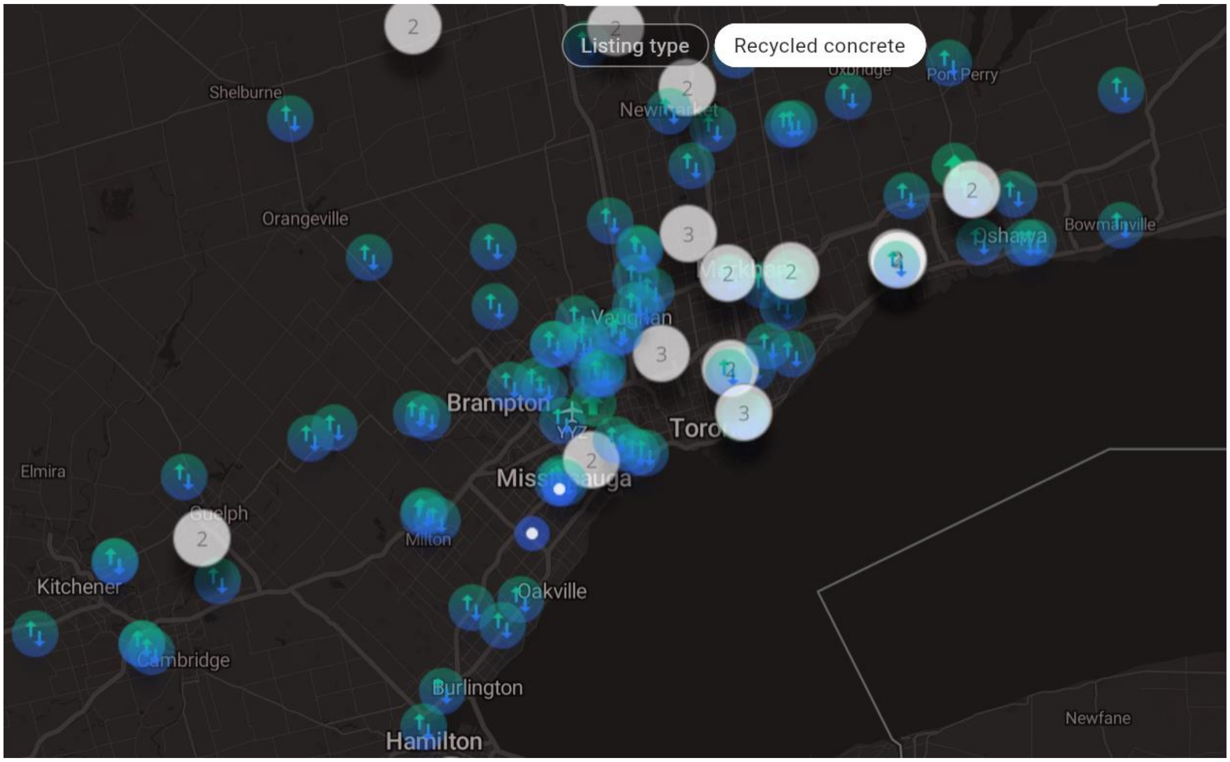


Figure 43: Location Map for the Recycled Concrete Aggregate Yards within GTA and Surrounding Areas

4.2 Cost of Recycled Crushed Aggregate and Estimated Savings

Based on the market prices, the cost of the virgin/native is higher than the cost of the recycled crushed aggregate. To compare the actual unit rates of using Granular A Native with Granular A (RCA1010) and the associated savings, four different projects from different locations within the GTHA were considered in this study after considering the distance from the construction site to the pit/quarry of the native aggregate and the distance to the RCA1010 Crusher Yard. The four projects considered in the study are as follows:

Project 1: Gregor Site Works parking lot located at Wellington Street and Leslie Street (Aurora). The approximate quantity of aggregate was 11,000 tonnes.

Project 2: Con Drain Site Walmart Distribution Centre (Vaughan) Jane Street and Teston Road. The approximate quantity of aggregate was 100,000 tonnes.

Project 3: Hady Contracting Industrial Bldg. at Huntington Road and Langstaff Avenue (Vaughan). The approximate quantity of aggregate was 7,000 tonnes.

Project 4: Metric Contracting at Bombardier Project on Alstep Street (Mississauga). The approximate quantity of aggregate was 50,000 tonnes.

The following **Table 20** shows the estimated savings in each of the four different projects within the four zones of GTHA. The average saving from using Recycled Crushed Aggregate comparing with native aggregate is about $8 per tonne and varied from $7 to $9 per tonne. Based on the total quantity of the used recycled crushed aggregate for each of the projects and the saving amount per tonne, the total amount of the saving for all four projects is $1,436,500 as shown in **Table 20.**

Table 20. Unit Rates of Gran A RCA1010 Vs. Gran A Native and Estimated Savings

Project No.	Pit / Quarry Locations	Average Distance from Pit/Quarry to Project Location (km)	Average Distance from Closest Crusher of RCA1010 to Project Location (km)	Total Tonnes per Project (approx.)	Unit Rate ($/ton)		Savings (Gran A – RCA Vs. Gran A – Native)	
					Gran A - Native	Gran A - RCA	$/ton	$/Project
1	Brechin	80.5	18 (Mt. Albert)	11,000	$22	$15	$7	77,000
2	Orillia	115	6 (Vaughan)	100,000	$23	$14	$9	900,000
3	Milton	52	10 (Brampton)	7,000	$22.5	$14	$8.5	59,500
4	Flamboro	70	14 (Mississauga)	50,000	$24	$16	$8	400,000
							Total Savings for four Projects ($)	**1,436,500**

4.3 Implemented Quality Control

Based on EXP site visits to 6 locations of crusher yards within the GTA (3 locations for Strada Aggregates and 3 locations for D. Crupi and Sons), Quality Control Plan and The Best Practices Guide for Recycling Aggregates provided by TARBA (Cover Pages of TARBA QC Plan and TARBA The Best Practices Guide for Recycling Aggregate are shown in **Figures 44 and 45,** for more details refer to **Appendix A**), the process of recycled crushed aggregate can be summarized as follows:

1. Delivery of concrete rubble to the crusher plant via dump trucks where the truck loads are visually inspected at the main entrance/gate. The concrete rubble material is inspected to be checked for the presence of organics, plastics, woods, rebar, amount of asphalt and other deleterious materials as mentioned in OPSS 1010.
2. Once the load of rubble material is approved, the trucks should proceed to off-loading (dumping) at the right location (Concrete Only, Concrete with asphalt, asphalt only) as directed by the crusher plant personnel.
3. After that, the stockpiled rubble material is placed into a two-stage crusher by wheel loader. The first stage is using the crusher to reduce the size of the rubble pieces to smaller sizes, followed by transporting the material via a conveyor belt to second stage crushing.
4. During the crushing process, the rebar and other metallic objects are removed by magnets. In addition, any other foreign (deleterious) materials are detected visually by crusher plant personnel and manually removed from the belt prior to final screening of the crushed concrete.
5. The crushed concrete is then screened to comply with gradation requirements (Gran A, Granular B, RAP materials) for roads construction projects.
6. The final product of crushed and screened concrete is then stockpiled by transporting and depositing to the top of the stockpile via a conveyor belt, based on product type (e.g., Gran A, Gran B, RAP).

Based on the site observations, the implemented on-site quality control means are efficient in terms of the following:

1) Removing the deleterious materials (Such as metal, paper, plastic) prior to process/crushing the raw concrete, screening, and stockpiling for use.
2) The separation of stockpiles containing visually significant amounts of asphalt and asphaltic concrete rubble is kept at the site and then the material is added to the crushing of concrete process in limited amount in order to comply with OPSS1010 requirements.
3) Checking the material type/components of each loaded truck and accordingly specifying the right place for dumping the raw material.

Project Name: Quality Control Plan
Date: October 27, 2022

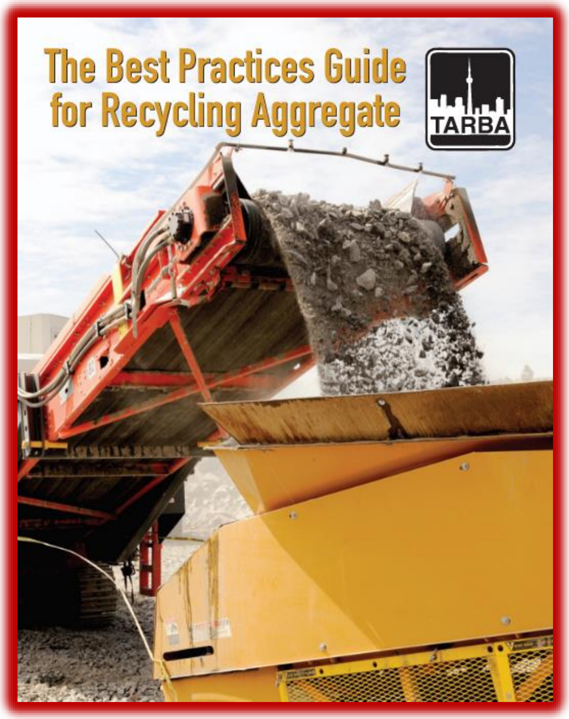
TARBA

QUALITY CONTROL PLAN
Production of Recycled Crushed Aggregates
TARBA – Product Producers

Date: October 27, 2022
Revision: 1

QC Plan for Production of Recycled Crushed Aggregates

Figure 44: TARBA QC Plan – Cover Page



The Best Practices Guide for Recycling Aggregate

TARBA

Figure 45: TARBA- The Best Practices Guide for Recycling Aggregates – Cover Page

5. Laboratory Testing

5.1 Sample Collections

The samples of Granular A RCA were collected from 6 Locations within GTA by experienced staff from EXP according to MTO Guidelines for Sampling of Aggregates (LS-625) and Standard Practice for Sampling Aggregates (ASTM D75/D75M-19). Site photographs for some GTA-Crusher locations and the stockpiles from where the samples were collected are shown in **Appendix B**.

EXP coordinated with representative at each Crusher/Yard location and contacted the on-site person to ensure provision of a front-end-loader to excavate into the stockpiles for obtaining buckets of material across the open face as required. The following **Table 21** illustrates the details of the collected samples in this study.

Table 21. Details of Collected Samples of Granular A RCA1010 and Granular A-Native

Sample No.	RCA Supplier	Yard	Yard Address	Sample Collection Date
Gran A RAP (Recycled Concrete Aggregate)				
1P/1C/1E- Gran A RCA1010 - STRADA – Concord	Strada Aggregates	Strada Aggregate/Crusher	1667 Creditstone Rd, Concord, ON	August 8th, 2022
2P/2C/2E- Gran A RCA1010 – D. Crupi – Etobicoke	D. Crupi & Sons Limited	D. Crupi & Sons Limited	176 Bethridge Rd, Etobicoke, ON	August 30th, 2022
3P/3C/3E- Gran A RCA1010 – D. Crupi – Markham	D. Crupi & Sons Limited	D. Crupi & Sons Limited	2777 14th Ave, Markham, ON	August 8th, 2022
4P/4C/4E- Gran A RCA1010 – D. Crupi – Scarborough	D. Crupi & Sons Limited	D. Crupi & Sons Limited	85 Passmore Ave, Scarborough, ON	August 30th, 2022
5P/5C/5E- Gran A RCA1010 – Strada – Brampton	Strada Aggregates	Strada Brampton Depot	120 Wentworth Crt, Brampton, ON	September 7th, 2022
6P/6C/6E- Gran A RCA1010 – Strada – Toronto	Strada Aggregates	Strada Aggregate/Crusher	10 Leslie St, Toronto, ON	September 8th, 2022
Gran A Native				
1E- Gran A Native – STRADA - Shelburne	Strada Aggregates / Strada Crusher	Strada Aggregates / Strada Crusher	437159 4 Line, Shelbourne	August 9th, 2022
2E- Gran A Native (CRL) - BRECKON EAST	-	BRECKON EAST	-	September 16th, 2022
3E- Gran A Native (CRL) - DUNDAS WEST	-	DUNDAS WEST	-	September 16th, 2022

5.2 Laboratory Tests

5.2.1 Gradation and Physical Property Tests

EXP's laboratory in Brampton has carried out the laboratory testing as per the following list of tests to determine gradation and physical properties of the collected samples of Gran A (RCA1010). The following tests were performed:

- Coarse Aggregate Petrographic Requirement (LS- 609 - Coarse -Petro)
- Fine Aggregate Petrographic Requirement (LS-616 Fine -Petro)
- Micro-Deval abrasion coarse aggregate loss, % maximum (LS-618)
- Micro-Deval abrasion fine aggregate loss, % maximum (LS-619)
- Plasticity Index, maximum (LS-703/704)
- Percent crushed, minimum (LS-607) for Gran A RCM only
- Asphalt Coated Particles, % maximum (LS-621)
- Amount of Contamination (LS-630)
- Determination of Permeability, k (LS-709)
- Sieve Analysis (LS-602)

The numbers of the six (6) samples of Gran A (RCA1010) that were collected from different stockpiles from different yards within the GTA to perform Sieve Analysis (gradation) and Physical Property Requirements are shown in **Table 22**.

Table 22: Sample Numbers for Sieve Analysis and Physical Property Tests

Material	Test Name	Standards	Total Samples
Gran A RCA1010	Gradation and Physical Properties	OPSS 1010	6 (Sample # 1P,2P,3P,4P,5P, 6P)

5.2.2 Freeze-Thaw and Magnesium Sulphate Soundness Tests

EXP has carried out the laboratory testing as per the list of tests shown in **Table 23** to determine the durability of waste concrete as road base aggregate, i.e., the ability of the Gran A (RCA1010) to handle freeze thaw cycles without breaking down.

Table 23: Sample Numbers for Freeze/Thaw Cycle and Soundness Tests

Material	Test Name	Standards	Total Samples
Granular RCA1010	Freeze/Thaw Cycle	CSA	6 (Sample # 1C,2C,3C,4C,5C, 6C)
	Magnesium Sulphate Soundness	CSA	

5.2.3 Synthetic Precipitation Leaching Procedure (SPLP) Testing

To understand the concentrations of heavy metals that would be present in the effluent from the use of Gran A RCA1010 granular base materials, one representative RCA1010 sample was collected from six (6) different yards (Samples: '1E-Gran A RCA1010', '2E-Gran A RCA1010', '3E-Gran A RCA1010', '4E-Gran A RCA1010', '5E-Gran A RCA1010' and '6E-Gran A RCA1010'). In addition, two (2) laboratory crushed limestone samples (2E- Gran A Native (CRL) -BRECKON EAST and 3E- Gran A Native (CRL)- DUNDAS WEST) and one (1) native sand and gravel sample (1E- Gran A Native - STRADA – Shelburne) were obtained from three (3) different yards. The samples were submitted to a laboratory accredited by the Canadian Association for Laboratory Accreditation (CALA) for the Ministry of the Environment, Conservation and Parks (MECP) Synthetic Precipitation Leaching Procedure (mSPLP) analysis. The SPLP procedure is intended to determine the concentrations of contaminants that would leach when exposed to a simulated rainwater solution. The contaminants of concern analyzed using the mSPLP procedure consisted of arsenic, chromium, lead, antimony and selenium (Chen, et. al, 2013). For due diligence purposes, the leachate samples were also subjected to other metal parameters, semi-volatile organic compounds (SVOCs) and volatile organic parameters (VOCs) listed in the MECP Excess Soil Quality Leachate Screening Levels from Part II of the "Rules for Soil Management and Excess Soil Quality Standards," adopted by reference in Ontario Regulation 406/19 (On-Site and Excess Soil Management).

5.3 Laboratory Test Results and Discussions

Based on the results of six (6) tested samples of Gran A (RCA1010), collected from six (6) different locations/stockpiles, the following sub-sections will summarize and discuss the results of gradation and physical properties of the tested samples.

5.3.1 Gradation and Physical Property

Gradation Requirements:

Laboratory test results indicate that 100 % of the tested granular base materials (Gran A RCA1010) do meet gradation requirements of Granular A. Accordingly, all the tested samples sourced from six (6) different crushers/stockpiles within GTA are acceptable as granular base, comparing with gradation specifications/requirements for Granular A base materials. **Table 24** summarizes the results of each individual tested samples, minimum, maximum, and average % passing from each required sieve.

Table 24. Sieve Analysis (Gradation) Results of Tested Materials

Item	% Passing by Mass – Granular A (OPSS.PROV 1010)							
Sieve No	26.5 mm	19 mm	13.2 mm	9.5 mm	4.75 mm	1.18 mm	300um	75 um
Acceptable Limits	100 - 100	85 - 100 (87-100) *	65 - 90 (75-95) *	50 - 73 (60-83) *	35 - 55 (40- 60) *	15 - 40	5 - 22	2 - 8 (2-10) **
Sample No.	**Results – Total % Passing (Gran A RCA1010)**							
1P	100	96.1	81.8	65.8	40.9	25.2	12.7	5.2
2P	100	95.0	82.3	68.6	51.6	31.3	16.1	7.9
3P	100	91.7	76.6	64.5	46.8	31.3	15.9	5.0
4P	100	96.3	84.3	66.7	43.1	21.0	9.9	4.6
5P	100	93.0	74.2	61.4	45.2	32.3	18.1	6.5
6P	100	94.0	81.4	70.1	53.5	33.4	19.0	8.0
Minimum	100	91.7	74.2	61.4	40.9	21.0	9.9	4.6
Maximum	100	96.3	84.3	70.1	53.5	33.4	19.0	8.0
Average	**100**	**94.3**	**80.1**	**66.1**	**46.8**	**29.0**	**15.2**	**6.2**

* Where the aggregate is obtained from an iron Blast furnace slag source.

** Where the aggregate obtained from a quarry or slag source.

Figure 46 shows the gradation curves of six (6) tested samples of granular materials (Gran A RCA1010) according to standard specifications envelope of Granular A.

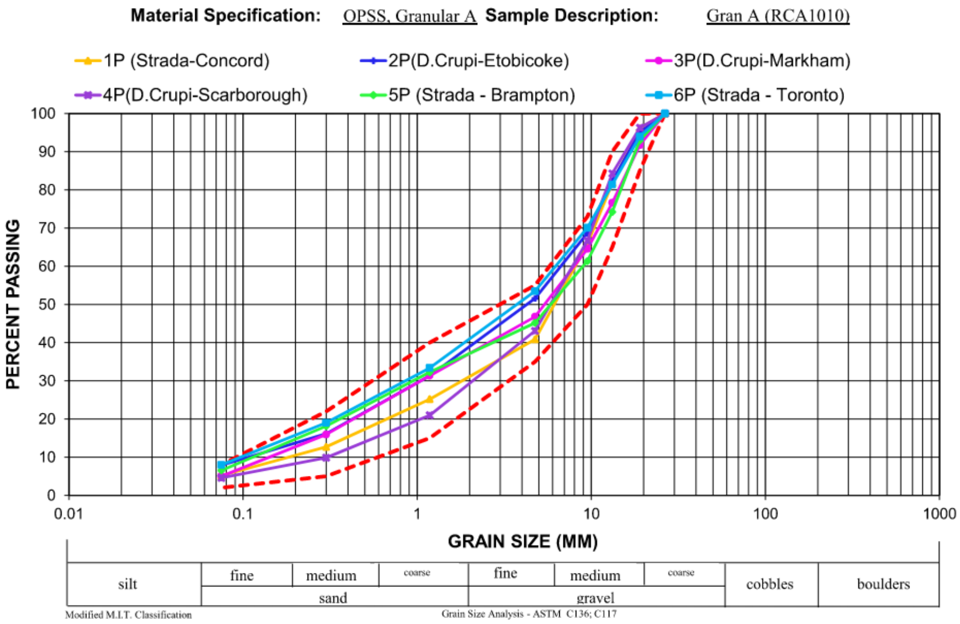


Figure 46: Gradation Curves of Tested Samples According to Standard Specifications Envelope

Physical Properties:

Laboratory test results of the physical properties of all tested samples (#1P to 6P) indicate the following:

- The average percentage of *Asphalt Coated Particles* is 13.8 % (ranged from 1.4 % to 33 %). Noted that 84 % of the tested samples (5 out of 6 sample) are acceptable (below maximum allowable limit of 30 % according to OPSS1010). The percentage in one sample (sample # 4P) is 33 % (marginally above the acceptable limit). **Figure 47** summarizes the related test results of the Asphalt Coated Particles for the tested samples.

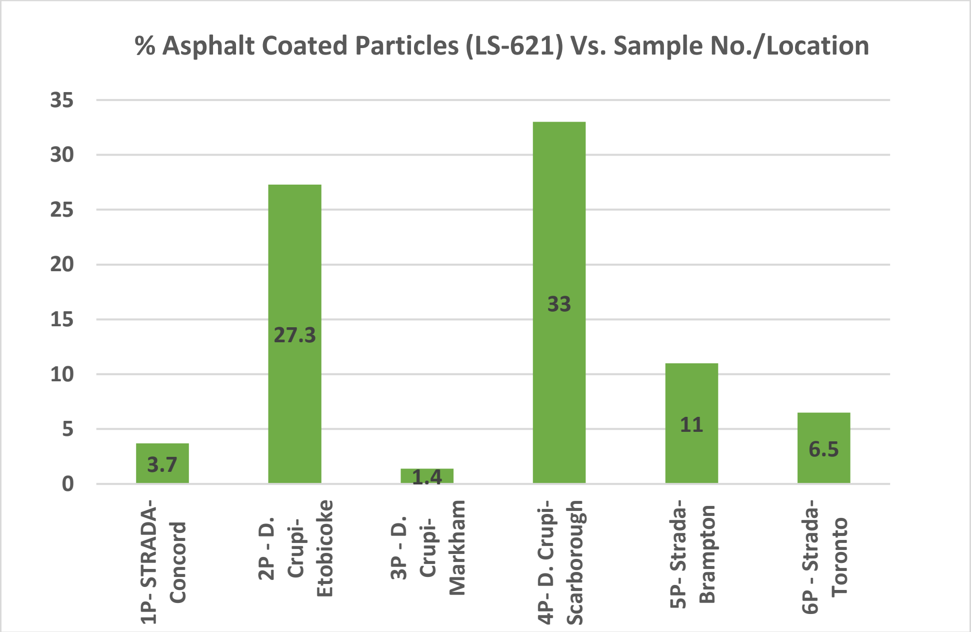


Figure 47: Histogram for % Asphalt Coated Particles of Tested Samples

- The average percentage of *Crushed Particles* is 98 % (ranged from 96 % to 99.7 %). Noted that 100 % of the tested samples are acceptable (above the minimum acceptable limit of 60 % according to OPSS1010). **Figure 48** summarizes the related test results of % Crushed Particles for the tested samples.

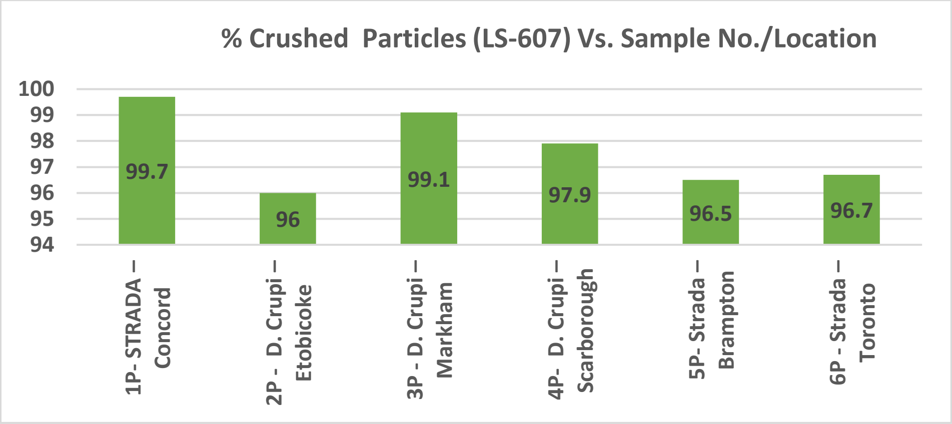


Figure 48: Histogram for % Crushed Particles of Tested Samples

- The average percentage of *Micro-Deval Abrasion Loss (for coarse aggregate)* is 18.2 % (ranged from 16.5 % to 22.2 %). Noted that 100 % of the tested samples are acceptable (below the maximum acceptable limit of 25 % according to both OPSS1010 and TS1010). **Figure 49** summarizes the related test results of % Micro-Deval Abrasion Loss (for coarse aggregate) for the tested samples.

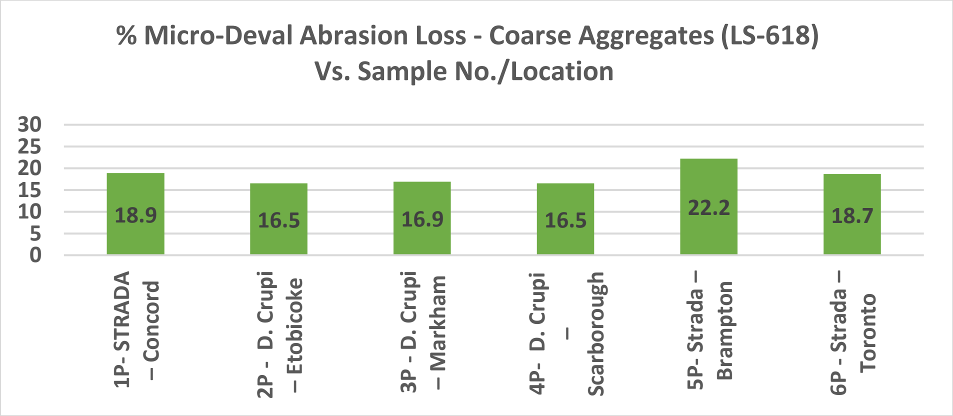


Figure 49: Histogram for % Micro-Deval Abrasion Loss (for coarse aggregate) of Tested Samples

- The average percentage of *Micro-Deval Abrasion Loss (for fine aggregate)* is 13.1 % (ranged from 7.9 % to 19.4 %). Noted that 100 % of the tested samples are acceptable (below the maximum acceptable limit of 30 % according to OPSS1010). **Figure 450** summarizes the related test results of % Micro-Deval Abrasion Loss (for coarse aggregate) for the tested samples.

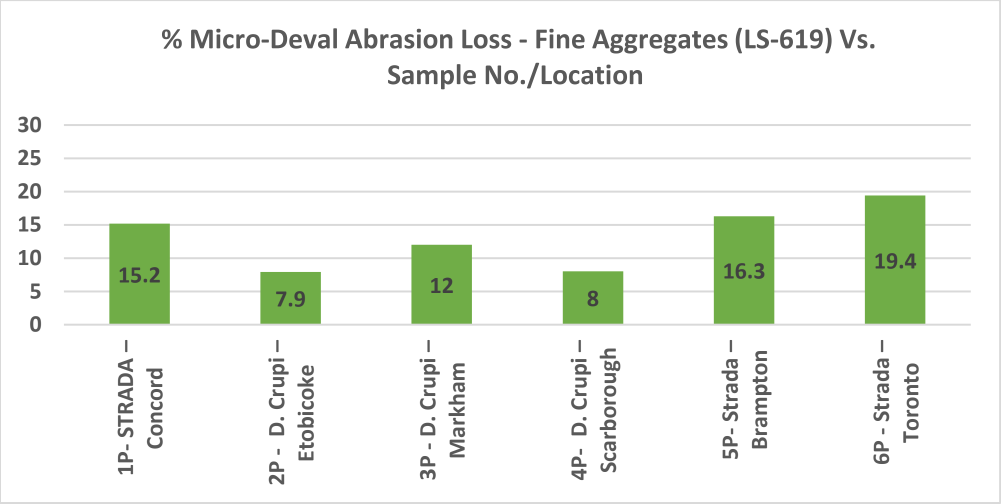


Figure 50: Histogram for % Micro-Deval Abrasion Loss (for fine aggregate) of Tested Samples

- Based on the results of % contamination for coarse aggregate (LS-630), the contamination is encountered in two samples (0.02 % wood in sample # 1P and 0.1 % ceramic in sample #3P). Accordingly, 100 % of the tested samples are acceptable according to OPSS 1010. It should be noted that the maximum combined limit of the amount of contamination as per OPSS1010 is 1.0 %, (<= 0.1 % - wood only).

Figure 51 shows the related test results of the percentage of Amount of Contamination for the tested samples of coarse aggregate of Gran A (RCA1010).

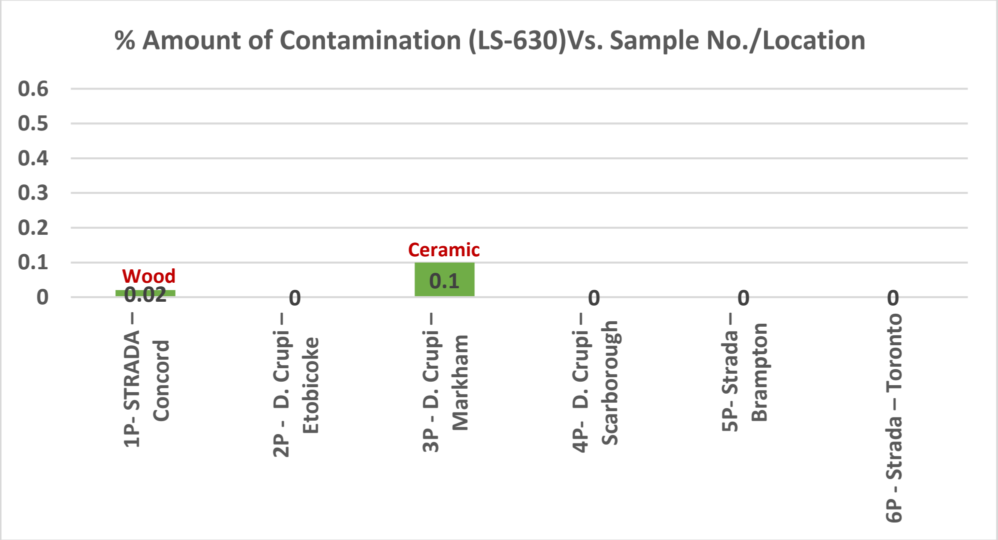


Figure 51: Histogram for % Amount of Contamination (for Coarse Aggregate -LS630) of Tested Samples

- As shown in **Table 25** the results of *Permeability (k)* testing indicate 100 % of the tested samples are acceptable (pass) with k-value greater than minimum limit of 1.0 x 10^-4 cm/s according to OPSS1010.

Table 25. Permeability Results (k-Values) of Tested Materials

Permeability, k (LS-709) (cm/sec)						
Sample No.	**1P**	**2P**	**3P**	**4P**	**5P**	**6P**
k- Value (cm/sec)	1.7X 10^-4	3.6 X 10^-3	6.9X 10^-4	1.3 X 10^-2	1.3 X 10^-4	5.9 X 10^-4
Result	Pass	Pass	Pass	Pass	Pass	Pass

- As shown in **Table 26** the results of *Plasticity Index* testing indicate 100 % of the tested samples of Gran A (RCA1010) are non-plastic (pass) and do meet plasticity index requirements for Granular A, in according to OPSS1010.

Table 26. Plasticity Index Results of Tested Materials

Plasticity Index, maximum (LS-703/704)						
Sample No.	**1P**	**2P**	**3P**	**4P**	**5P**	**6P**
Plasticity Index, maximum (LS-703/704)	Non- Plastic	Non- Plastic	Non-Plastic	Non- Plastic	Non-Plastic	Non-Plastic
Result	Pass	Pass	Pass	Pass	Pass	Pass

- Based on the results of *Petrographic Analysis* for coarse aggregate (LS-609) and fine aggregate (LS-616), the deleterious materials are encountered in six (6) samples of coarse aggregates. The types of deleterious materials in those samples are summarized in **Table 27**.

Table 27. Encountered Deleterious Materials in Coarse Aggregate – Petrographic Analysis

% Deleterious Materials – Coarse Aggregate (LS-609) **						
Sample No.	**1P**	**2P**	**3P**	**4P**	**5P**	**6P**
Deleterious Type						
Shale	-	0.2	-	0.1	-	0.4
Asphalt	-	0.5	-	0.9	0.5	-
Clay	-	-	-	-	0.1	-
Ochre	-	-	-	-	-	0.2
Gypsum	-	-	-	-	-	0.4
% Total (Weighted)	0	0.7	-	1.0	0.6	1.0
Result (OPSS1010) *	Pass	Pass	Pass	Pass	Pass	Pass

* Maximum Acceptable Limit for Gran A: Up to 1.0 % - total, combined.
** Deleterious means at least 75 percent of the particle has very low strength material. It can be crumbled or broken with fingers, or it can be scraped or peeled with ease. The particles which were placed in deleterious are in that category because they are very low quality.

Accordingly, the acceptance of the tested samples is as follows:

- ✓ The gypsum is encountered in sample # 6 with an acceptable percentage of 0.4 % as shown in **Table 27** in accordance with both OPSS1010.
- ✓ No wood, glass, or ceramic are encountered in any of the tested samples of Gran A RAP, based on the petrographic analysis {coarse aggregate (LS-609) and fine aggregate (LS-616)}. However, 0.1 % ceramic is encountered in sample # 3P as mentioned previously. Based on the test of % Amount of Contamination (LS-630 – for Coarse Aggregate), sample # 3P is acceptable according to OPSS1010.
- ✓ Based on the encountered percentage of deleterious material in the tested coarse aggregate as mentioned in **Table 27** (varied from 0.6 to 1.0 %), the total percentage of the acceptable samples in terms of deleterious material is 100 % according to OPSS 1010 (maximum acceptable limit is up to 1.0 % - total, combined).

Table 28 summarizes the related test results of Petrographic Analysis (LS-609 Coarse Aggregates and LS-616 Fine Aggregates) for the tested samples of Gran A RCA1010.

Table 28. Summary of Petrographic Analysis for Coarse and Fine Aggregates

Sample No.	Gran A RAP (RCA)-Aggregate Classification	% Total Good Agg.	% Total Weighted				% Total Weighted Contamination**	% Total Weighted		
			Fair Agg.	Poor Agg.	Deleterious Aggregate*	Concrete		Gypsum	Glass & Ceramic	Wood
1P	Coarse (PN132)	89.2	8.0	2.8	0.0	84.9	0.0	0.0	0.0	0.0
	Fine	N/A	N/A	N/A	N/A	60.1	0.0	0.0	0.0	0.0
% Total Weighted for Sample 1P							0.0	0.0	0.0	0.0
(For Coarse and Fine Aggregates)										
2P	Coarse (PN230)	72.5	3.0	23.8	0.7	51.0	0.0	0.0	0.0	0.0
	Fine	N/A	N/A	N/A	N/A	37.5	0.0	0.0	0.0	0.0
% Total Weighted for Sample 2P							0.0	0.0	0.0	0.0
(For Coarse and Fine Aggregates)										
3P	Coarse (PN131)	89.8	7.6	2.6	0.0	84.7	0.0	0.0	0.0	0.0
	Fine	N/A	N/A	N/A	N/A	62.5	0.0	0.0	0.0	0.0
% Total Weighted for Sample 5P							0.0	0.0	0.0	0.0
(For Coarse and Fine Aggregates)										
4P	Coarse (PN273)	64.7	2.5	31.9	1.0	45.9	0.0	0.0	0.0	0.0
	Fine	N/A	N/A	N/A	N/A	52.2	0.0	0.0	0.0	0.0
% Total Weighted for Sample 4P							0.0	0.0	0.0	0.0
(For Coarse and Fine Aggregates)										
5P	Coarse (PN127)	92.1	5.0	2.3	0.6	81.2	0.0	0.0	0.0	0.0
	Fine	N/A	N/A	N/A	N/A	63.8	0.0	0.0	0.0	0.0
% Total Weighted for Sample 5P							0.0	0.0	0.0	0.0
(For Coarse and Fine Aggregates)										
6P	Coarse (PN136)	89.1	7.1	2.8	1.0	83.8	0.0	0.4	0.0	0.0
	Fine	N/A	N/A	N/A	N/A	77.9	0.0	0.0	0.0	0.0
% Total Weighted for Sample 6P							0.0	0.4	0.0	0.0
(For Coarse and Fine Aggregates)										

* Deleterious Material means materials from the recycling stream other than glass, ceramic, reclaimed asphalt pavement, and reclaimed concrete materials that includes but is not limited to the following: wood, clay brick, clay tile, plastic, gypsum, gypsum plaster, and wallboard.

** Contamination Materials are included glass, ceramic, reclaimed asphalt pavement, and reclaimed concrete materials.

- Based on the results of *Sulphate Contents* (Environmental Test) as shown in **Table 29**, the average sulphate content of six tested samples is 770 µg/g, ranged from 650 to 870 µg/g. All the results are acceptable according to TS1010, where the maximum allowable value of sulphate content should be less than 5000 ug/g. It should be noted that the maximum allowable limit is not mentioned in OPSS1010.

In addition, the potential risk for heaving for all the tested samples is low based on the level specified in the risk assessment methodology developed by Texas Depart of Transportation (TxDOT), summarized as follows:

- Sulphate concentration <= 3000 µg/g; little risk of sulphate-induced heave.
- Sulphate concentration > 3000 µg/g to <= 8000 µg/g; moderate risk of sulphate-induced heave.
- Sulphate concentration > 8000 µg/g; high risk of sulphate-induced heave.

Table 29. Summary Results of Sulphate Concentration and Potential Risk of Heave

Sample No.	Sulphate (µg/g)	Results (Pass/Fail)	Risk of Heave
1E- Gran A RCM- STRADA – Concord	700	Pass	Low
2E- Gran A RCM- D. Crupi – Etobicoke	830	Pass	Low
3E- Gran A RCM-D. Crupi – Markham	650	Pass	Low
4E- Gran A RCM- D. Crupi – Scarborough	840	Pass	Low
5E- Gran A RCM- Strada – Brampton	780	Pass	Low
6E- Gran A RCM- Strada – Toronto	870	Pass	Low

The sulphate testing EXP carried out is important to limit the possibility for contamination of the crushed concrete with waste drywall. Drywall is made up of gypsum which is calcium sulphate. The inclusion of sulphates in the waste concrete could cause expansion of the road base material which could lead to heaving of the road surface. The testing that we carried out shows insignificant quantities of sulphate if any, was detected.

- Based on the results of *pH values* (Environmental Test) as shown in **Table 30**, the average pH value of six tested samples of Gran A RAP (RCA) is 12.1, ranged from 11.9 to 12.2. As expected, crushed concrete has a high pH. Even after leachate testing the pH is still quite high. The high pH of this material is only an issue in very specific circumstances which are typically not an issue in roads construction.

Table 30. Summary Results of pH Values Before Leachate

Sample No.	pH -Before Leachate
1E- Gran A RCM- STRADA – Concord	12.2
2E- Gran A RCM- D. Crupi – Etobicoke	11.9
3E- Gran A RCM-D. Crupi – Markham	12.1
4E- Gran A RCM- D. Crupi – Scarborough	11.9
5E- Gran A RCM- Strada – Brampton	12.1
6E- Gran A RCM- Strada – Toronto	12.1

5.3.2 Freeze-Thaw and Magnesium Sulphate Soundness (Concrete)

Based on the results obtained for all six (6) samples (#1C to 6C) as shown in **Table 31**, all samples tested were able to meet OPSS 1002 LS-606 (Soundness). However, they were not able to meet OPSS LS-614 (freeze-thaw). The standards specified in OPSS 1010 – material specification for aggregates - governs, and as such all aggregates tested have met these requirements. It should be noted that the OPSS 1002 also states that the requirement for Freeze Thaw will be waived if samples pass Magnesium Sulphate Soundness test.

Table 31. Summary Results of Soundness and Freeze-Thaw

Sample Number	Magnesium Sulphate Soundness (LS 606)		Unconfined Freeze/Thaw (LS-614)		Meets OPSS 1002	
	Results (% Loss)	OPSS 1002 (Max % Loss)	Results (% Loss)	OPSS 1002 (Max % Loss)	Soundness (LS 606)	Unconfined Freeze/Thaw (LS-614)
1C	3.1	12	34.4	6	Yes	No
2C	2.6	12	36.1	6	Yes	No
3C	4.0	12	19	6	Yes	No
4C	6.9	12	24.2	6	Yes	No
5C	4.4	12	21.7	6	Yes	No
6C	5.0	12	27.8	6	Yes	No

Based on the laboratory test results all samples have met OPSS requirements. The produced crushed concrete, whether it includes any Supplementary Cementing Materials (SCMs) or admixtures will not affect the performance of the recycled crushed aggregate.

For additional details related to the laboratory test results, please refer to **Appendix C**.

5.3.3 SPLP Leachate Analytical Testing Results

For a general understanding of the reported leachate concentrations of the contaminants analyzed, the leachate test results were compared to the following MECP standards from Excess Soil Leachate Screening Levels (‘ESQS LSL’):

- Table 1 Background ESQS LSL for residential/parkland/institutional/industrial/ commercial/community (RPIICC) property uses (applicable for lands within 30 m of environmentally sensitive features);
- Table 2.1 Full Depth ESQS LSL in a Potable Ground Water Condition under industrial/commercial/community (ICC) property uses;
- Table 3.1: Full Depth ESQS LSL in a Non-Potable Ground Water Condition for ICC property uses; and
- Table 5.1: Stratified Site Conditions in a Non-Potable Groundwater Condition for ICC property uses and sub-surface soils.

It should be noted that the MECP ESQS LSL are associated with their corresponding bulk excess soil quality standards. Given that RCA and Quarry Sourced Granular Materials do not meet the definition of soil, bulk analysis of granular base materials evaluated were not subjected to the bulk analysis. In the absence of comparison to the bulk excess soil quality standards, the rationale for the ESQS LSLs may not be applicable to the leachate analytical results. As such, the laboratory testing result comparison to the MECP EQSQ LSL is limited to providing general understanding of the anticipated contaminants that are present and not a confirmation of compliance with the regulatory standards.

The MECP ESQS LSL criteria selected for comparison are the typical Site Condition Standards that would be encountered within a road alignment in Southern Ontario. The analytical results were compared to the most stringent leachate quality standard for each parameter. The recorded concentrations of all tested parameters for all RCA and Native Granular samples were either below laboratory method detection limits or recorded below the Leachate Screening Level Standards. The following table summarizes the concentrations of the metal parameters of concern along with the most stringent leachate quality standard for each parameter. A summary of the all the analytical test results is included in **Table 32** and the laboratory certificates of the analyses are included in **Appendix C**.

Table 32: Analytical Test Results

Parameters	**Parameter Concentration (ug/L)**										**Selected ESQS Standard LSL/Rationale**
	Criteria	1E- Gran A RCA1010	2E- Gran A RCA1010	3E- Gran A RCA1010	4E- Gran A RCA1010	5E- Gran A RCA1010	6E- Gran A RCA1010	1E- Gran A Native	2E-Gran A Native Limestone Sample 1	3E-Gran A Native Limestone Sample 2	
Antimony	6	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	Table 2.1 ICC/No LSL Standard in Table 1 for RPIICC property use
Arsenic	300	<1	<1	<1	<1	<1	<1	<1	<1	<1	Table 5.1 ICC Sub-Surface/No LSL Standard in Tables 1, 2.1 or 5.1 Surface Standards for ICC property use.
Chromium	50	6	<5	<5	<5	17	7	<5	<5	<5	Table 2.1 ICC/No LSL Standard in Table 1 for RPIICC property use
Lead	4	<0.5	<0.5	<0.5	<0.5	3.4	0.6	<0.5	<0.5	<0.5	Table 5.1 ICC Sub-Surface/No LSL Standard in Tables 1, 2.1 or 5.1 Surface Standards for ICC property use.
Selenium	10	<2	<2	<2	<2	<2	<2	<2	<2	<2	Table 2.1 ICC/No LSL Standard in Table 1 for RPIICC property use
pH (leachate)	N/A	11.89	11.62	11.68	11.66	11.01	11.62	9.67	9.49	9.89	No ESQS LSL pH standard

Based on the analytical testing conducted, the marginally detected concentrations of the selected metal, VOC or SVOC parameters analyzed in the RCA granular base effluent did not suggest the potential for sub-surface environmental impacts to result from the use of RCA Granular base materials.

6. Conclusions

1. Greater use of recycled aggregate materials in municipal roads and infrastructure construction and maintenance represents the opportunity for Ontario municipalities to demonstrate their commitment to sustainable resource practices and will help to achieve better outcomes.

2. Based on numerous successful projects that used RCA, municipalities should be encouraged to adopt the use OPSS1010 including RCA as a standard specification for infrastructure construction projects.

3. Most of the previously undertaken research and studies (within Canada, United States, and other countries) confirmed the value of using RCA due to the proven high pavement performance, cost savings and environmental benefits.

4. The values of the sulphate concentrations based on the chemical test results varied from 650 µg/g to 870 µg/g with an average value of 770 µg/g. The maximum recorded sulphate concentration value of 870 µg/g is much lower than the maximum allowable value of 5000 µg/g as specified in TS 1010. In other words, the probability of risks associated with heaving/expansion of the recycled concrete aggregates (due to sulphate and deleterious material) to occur is low (840 µg/g is lower than the maximum limit of sulphate concentration of 3000 µg/g, based on Risk Assessment Methodology developed by Texas Department of Transportation).

5. Recycled crushed aggregates materials (Gran A base and Granular B subbase) are available in large quantities at different yards/depots across the Greater Toronto Region with economic unit rates comparable and often cheaper to native granular materials. This conclusion is drawn in part after considering the distribution of the RCA crushers/yards across the GTA and surrounding region and the short travel distance from those yards to project sites compared with long travel distances from native aggregate pits and quarries.

6. The existing Gran A RCA1010 produced within the Greater Toronto Region can achieve/pass all the required standard specifications for Gran A – Native of gradation, physical properties, sulphate concentration, and Soundness of Aggregate using Magnesium Sulphate mentioned in related OPSS1010, OPSS 1002, and TS1010 without any issues or concerns.

7. As expected, crushed concrete has a high pH. Even after leachate testing the pH is still quite high. The high pH of this material is only an issue in very specific circumstances which are typically not applicable in roads construction or other right-of-way projects

8. The sulphate testing EXP carried out is important to limit the possibility for contamination of the crushed concrete with waste drywall. Drywall is made up of gypsum which is calcium sulphate. The inclusion of sulphates in the waste concrete could cause expansion of the

road base material which could lead to heaving of the road surface. The testing that we carried out shows insignificant quantities of sulphate if any, was detected.

9. Based on the laboratory test results all samples have met OPSS requirements. The produced crushed concrete, whether it includes any Supplementary Cementing Materials (SCMs) or admixtures will not affect the performance of the recycled crushed aggregate.

10. Additional analytical testing found that the marginally detected concentrations of the selected metal, VOC or SVOC parameters analyzed in the RCA granular base effluent did not suggest the potential for sub-surface environmental impacts to result from the use of RCA Granular base materials.

11. It is important that suppliers (industry producers) adhere to a QC Plan to ensure consistency of the RCA produced and that it meets OPSS1010 requirements. A full testing program should be conducted for all recycled crushed aggregates as per OPSS1010, including the Petrographic Analysis for fine and coarse aggregates and sulphate concentration.

7. Next Steps

The key actions and next steps to accelerate the adoption and use of recycled concrete aggregates for road construction and other infrastructure projects as described in the following Section 7.1 through Section 7.5.

7.1 Enhancing the Sustainability Objectives of Ontario Municipalities

Advocacy for the use of reclaimed material will be important to wide-scale adoption. Details from case studies, like those presented in this report, prove that the reclaimed product gives quality results and withstands traffic, climate and other conditions expected on streets, roads and highways. Energy, greenhouse gas emissions and cost savings are positive metrics that can be attributed to the use of RCA.

Carbon reduction goals must be set by municipalities for all aspects of their community, including infrastructure. Using reclaimed material for road and other projects can have a positive impact and allow for greater achievements lowering carbon targets.

Sustainability objectives should be linked with all next steps presented in this section. Specifically, reporting on the energy and greenhouse gas emissions data from each of the processes will be important to continue to prove and validate the reductions from use of the reclaimed material:

- Quality assurance and production certification for the RCA1010 from crusher yards must also be coupled with details on the emissions factors and energy consumption from the process.
- In-situ testing of roads that have used natural virgin aggregate and those that have RCA should be complete and results compared, including lifecycle.
- Training should include information on the environmental benefits and other attributes of using RCA1010.
- Committees responsible for updating standards and outlining specifications for products used in roadway construction should be informed of the environmental benefits. Coupled with the quality assurance and other positive impacts from using RCA1010, standards and specifications must be updated to include reclaimed materials.
- Incorporating financial and environmental objectives into municipal documents; adopting KPIs relating to the use of recycled crushed aggregates.

7.2 Ensuring Quality Assurance for RCA at Crusher Yards

To remove the risks associated with producing recycled crushed aggregates (RCA) and addressing any concerns around quality, the Toronto and Area Road Builders Association (TARBA) will work with the main industry suppliers across the Greater Toronto Region to ensure the involvement of qualified third-party consultants to perform the following tasks:

- Ensure adequate third-party verification exists to build confidence amongst government procurement and public works practitioners. This will help support for local governments with respect to sampling and testing of RCA materials to address any production capacity issues.
- Foster greater quality assurance by having checks and balances upon supervision and sampling of the processed material by the client's geotechnical consultant.
- Develop a third-party certification process for RCA materials (i.e., for suppliers or at the facility level) focused on addressing quality and variability concerns which could be referenced by local governments and others in tender document.
- Work with MTO and Ontario's municipalities to establish quality standards for construction materials coming from secondary sources and provide a certification process to give certainty to buyers regarding the performance of the material.
- Conduct the required on-site (at crusher years) review/audit by third party qualified consultants for the implemented QC Plans of the relevant industry producers and provide the required recommendations for any non-conformance and/or required improvement.
- Establish a comprehensive RCA database for all infrastructure projects where RCA materials were used, including archiving all associated lab test results (before supplying the material to the project and during construction). This will include yearly site visits to the project to perform visual pavement condition surveys and take site photographs, with a yearly pavement performance update.
- Study the possibility of increasing the RAP percentage in Recycled Crushed Aggregates up to 35 or 40 per cent (instead of current requirements of up to 30 per cent by conducting the required studies.

7.3 Involving Third Party Consultants for In-Situ Testing of Selected Projects

1. The Toronto and Area Road Builders Association (TARBA) will work with the main industry suppliers in the Greater Toronto region to ensure involving a qualified third-party consultant to offer non-destructive testing (e.g., FWD testing) and drilling for some selected roads/streets to verify the pavement performance and properties/quality of the material used in constructed roads where recycled crushed aggregate (RCA) materials were used as granular base and/or subbase layers.

2. Continue to undertake lab and field work on various granular materials in different road layers, as well as resilience modulus for road performance as it relates to greater integration of RCA and RAP. This could start with a literature review and gap analysis, followed by targeted layer-by-layer analysis to understand performance and risks in various geographic regions/municipalities.

7.4 Promoting Training and Knowledge Sharing with Municipal Engineers

The Toronto and Area Road Builders Association (TARBA) will:

1. Encourage municipalities to publish and share on their websites the brief details of the projects where RCA materials had been used (e.g. project name and number, names of contractor and consultant, project limits, quantities, unit rates, and suppliers of the used recycled material).
2. Invite the Municipal Engineers/Project Managers to attend workshops, visit crusher yards and certified laboratories where different types of recycled concrete materials are produced and tested, with the intent to bridge any gap and/or be familiar with using or specifying RCA in projects, or to address a previously negative experience that might keep people from wanting to use the product in the future.
3. Work closely with Municipal Engineers/ Project Managers to establish new pavement management systems (PMS) and/or enhance existing pavement management systems at each road authority to ensure the availability of any required information related to the recycled concrete materials.
4. Share the TARBA's QC template plan with contractors and project developers which can be referenced in tenders for road construction projects.
5. Continue to engage key stakeholders on the opportunities for maximizing the use of recycled aggregates for road construction in Ontario, including local and provincial governments (engineering and procurement), federal departments, contractors and road builders, recycled aggregate suppliers, relevant industry associations, the research community, and standards bodies.

7.5 Updating Current Municipal Standard Specifications

The Toronto and Area Road Builders Association (TARBA) will:

1. Encourage Ontario municipalities to examine their policies and find ways to realize the benefits of greater use of recycled materials.
2. Foster collaboration between the Ontario Ministry of Transportation (MTO) and Ontario municipalities to establish and approve a list of certified sources of recycled crushed aggregate (RCA) materials within Ontario and have them inspected on a regular basis, taking the burden off of local governments. This will also include studying how quality control and assurance procedures should be integrated within existing standards for road construction in order to enable greater use of recycled aggregates.
3. Encourage Ontario's Road authorities and municipalities to provide bonuses and/or awards to contractors that use recycled aggregate in place of primary aggregate and apply GreenRoads / GreenPave practices while assessing the new tenders.
4. Work with roads authorities to develop/update standards that allow for the greater use of recycled aggregates in various layers of road construction and other applications, based on performance and outcomes (including addressing environmental risks, adjusting for local

conditions, etc.), rather than prescriptive specifications which can create issues with maximizing the use of recycled aggregate.

5. Continue to research any measurable environmental risks from using recycled aggregates (particularly the impact of RAP in sub-base layers) in line with leachate concerns. This could include undertaking research to support geo-textile selection to better understand permeability of compacted asphalt and/or using RAP for an unbound layer as potential solutions to preventing contamination from getting into sub-grade and drainage.
6. Undertake research efforts to collect better data on the demand for and supply / availability of recycled aggregate materials across Ontario at municipal and regional levels to better inform policy, infrastructure investments, and the business case for greater use of recycled crushed aggregates in road construction projects, including development engineering projects.
7. Work closely with MTO and road authorities/municipalities to establish a consistent, harmonized approach across local governments and regions to avoid any challenges to the industry to invest in the infrastructure and provide consistent supply based on reliable demand for the recycled crushed aggregates.

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9. About EXP Team

Aswan Assadi is a registered professional engineer and Senior Pavement Engineer with more than 22 years of experience in the civil engineering industry, specializing in the construction and rehabilitation of Provincial and Municipal Roads, Airports, and Parking Lots. Aswan has spent his career focusing on pavement design of flexible, rigid, and composite pavements at various stages, including new construction, maintenance and rehabilitation. As an experienced professional engineer, Aswan has successfully completed more than 35 projects in pavement evaluation/assessment, investigation, and design for new construction and rehabilitation projects using different pavement design/analysis techniques/tools, including the Life Cycle Costing Analysis, FWD Testing and GPR Survey for different projects across Ontario.

During his career, Aswan was also involved for several projects related to comprehensive assessment of roads and roads structures after considering the results of durability and structural analysis, risk assessment and value engineering, development and/or enhancement of different modules for asset management systems based on the clients requirements and practical adopted procedures, rehabilitation and maintenance projects for pavements, bridges, and tunnels. Aswan has a passion for helping organizations to achieve their business strategic goals and objectives by maximizing the value from their assets and projects, with minimizing/eliminating the associated risks.

Amy Pastor is the vice president of sustainability at EXP. As a licensed mechanical engineer, Amy specializes in sustainable designs, commissioning, energy studies, energy modeling, measurement and verification, and project management. Amy takes a holistic approach to sustainable design in buildings; assessing a building for its full spectrum of capabilities to meet the environmental requirements for today and the future. She has extensive experience in LEED-related commissioning, an element requiring extensive knowledge in quality-based processing to determine the efficiency of a facility and all major systems and processes (planning, design, installation, operations and maintenance) to ensure the building is functioning efficiently. By specializing in commissioning, she identifies the most practical and effective opportunities for energy and cost savings, ensuring clients receive the highest return on their investment and occupants benefit from the inherent environmental benefit. Amy takes immense pride in building better, including lasting relationships with clients and quality, sustainable buildings, without surrendering the integrity of the design. She has personally worked on over 200 LEED Certified projects.

Peter Waisanen has over 45 years of experience in all aspects of construction including road building and design, sewer installation, concrete pavements and all other concrete construction. His expertise has been developed through extensive experience in both the public and private sector, including his role as the former Ontario Regional Manager of the Cement Association of Canada. As a voting member of the National Concrete Standard for over 20 years, Peter has dedicated his career to advancing concrete technologies with a keen interest in guiding industry practices towards environmental sustainability while maintaining product performance

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Appendix A TARBA QC Plan and The Best Practices Guide for Recycling Aggregates

TARBA

QUALITY CONTROL PLAN
Production of Recycled Crushed Aggregates
TARBA – Product Producers

Date: October 27, 2022
Revision: 1

Table of Contents

1. Introduction

The main objective is to ensure that all aggregate material recovered from construction projects will be re-engineered and re-used in new construction projects as a replacement for primary aggregates. Re-using concrete and asphalt materials is advantageous from both environmental and economic perspectives. The use of recycled aggregate preserves non-renewable resources, reduces our need for new pits and quarries and lowers energy use and greenhouse gases associated with longer truck hauling. Recycled aggregates can often be supplied locally and less expensively than primary aggregate.

Aggregate recycling facilities provide municipalities and contractors with a location to recover reclaimed concrete and asphalt material and the opportunity to re-use a valuable resource instead of diverting it as waste to a landfill or underutilizing it as clean fill. Properly processed or re-engineered recycled aggregate that meets **Ontario Provincial Standard Specifications** (OPSS) has proven to be a good material for use in road construction, as engineered backfill and as a base material in many other applications. Used appropriately, recycled aggregate performs as well or better than primary aggregate in many applications.

The purpose of this document is to provide a technically sound quality control plan for producing, utilizing and ensuring the quality of recycled aggregates. The producers of recycled aggregates within TARBA utilize the standard procedures and protocols identified in this document.

Adherence to this plan assures Quality Controls that ensure product standards specified in OPSS 1010. Individual Producers may enhance these requirements to achieve company objectives and/or to meet more particular standards.

2. Recycled Aggregate Products

2.1 Definitions

- **Aggregate** – Granular material used in construction as defined in OPSS.PROV 1010 and OPSS.MUNI 1010. The product may be natural, manufactured or recycled.

- **Deleterious Material** – Materials containing wood, clay brick, clay tile, plastic, gypsum, gypsum plaster, wallboard and others that could preclude achievement of OPSS 1010.

- **Fines** – Material passing the 75 µm sieve when tested according to LS-601 or LS-602.

- **Free of Clay** – The amount of material with a particle diameter less than 2 µm shall not be greater than 1% of the total sample when tested according to LS-702.

- **Granular A** – A set of requirements for dense graded aggregates intended for use as granular base within the pavement structure, granular shouldering, and backfill.

- **Granular B** – A set of requirements for well-graded aggregates intended for use as granular subbase within the pavement structure and granular backfill. Granular B may be Type I, Type II or Type III.

- **Granular M** – Means a set of requirements for dense graded aggregates intended for use on unpaved road surfaces and for the maintenance of unpaved shoulders.

- **Granular O** – Means a set of requirements for open graded aggregates intended only for use as a free draining granular base within the pavement structure.

- **Granular S** – Means a set of requirements for dense graded aggregates intended only for use as surface dressing of low volume unpaved roads with an AADT less than 200.

- **Reclaimed Concrete Material (RCM)** – A material that is removed or processed from old hydraulic cement concrete and which may also contain up to 30% recycled asphalt pavement as permitted by OPSS 1010.

- **Reclaimed Asphalt Pavement (RAP)** – Means processed hot mix asphalt material that is recovered by partial or full depth removal.

- **Recycled Crushed Aggregate** (RCA) – Aggregate resulting from the processing of inorganic material previously used in construction.

- **Select Subgrade Material (SSM)** – A set of requirements for well-graded non-plastic aggregates used to replace poor subgrade materials and as swamp backfill.

2.2 Sources of Raw Materials

Recycled aggregate materials can be obtained from a number of primary sources including:

- **Asphalt Sources** – Existing asphalt from highways, roadways and parking lot surfaces.
- **Road Infrastructure Concrete Sources** – Existing concrete from sidewalks, curbs, pavements or concrete structures.
- **Reclaimed hydraulic cement concrete** – Such as existing bridges that contain concrete footings, foundation walls and deck slabs.
- **Unused, returned concrete washout and asphalt.**

2.3 Recycled Crushed Aggregate Final Products

Recyclable materials can then be used to produce product in the following categories:

- Aggregate base materials (Granular A, Granular B, etc.).
- Aggregate materials for concrete (U-fill, controlled low strength material, etc.).
- Aggregate materials for asphalt (RAP).

19mm Crushed Concrete

50mm Crushed Concrete

RAP Pile

3. Safety

Safety remains the most important aspect of any construction process and recycled aggregate production. The raw material comes from existing asphalt from highways, roadways and parking lot surfaces and the concrete comes from existing concrete from sidewalks, curbs, pavements or concrete structures and buildings that contain concrete footings, foundation walls and floor slabs.
This material is transported to secondary sites where it is then processed before being sent out as a re-engineered product to be used again in construction projects.

For this reason, it is important to note that many different safety exposure conditions exist in the product production process, from the demolition or material recovery process at the original construction site, to the product unloading and processing stage, to the final product delivery at the new jobsite.

Since aggregate recycling equipment can be either located at permanent or temporary locations, additional safety challenges exist around the aggregate processing equipment. The Health and Safety Plan shall be followed by all persons at a recycled aggregate production facility. Minimum safety requirements include:

- Where required, visitors must report to the scale house for safety induction.
- All on-site personnel must wear appropriate personal protective equipment in accordance with the Ministry of Labour's requirements and any site-specific requirements.
- All drivers must report to the loader operator or scale house before dumping and must follow instructions at all times.
- Loaders should be equipped with a backup alarm and have the right-of-way in the yard.
- Extreme care should be taken around the vertical face of all stockpiles.
- Visitors, drivers or company employees that do not comply with any of these requirements will be barred from the facility up to losing future dumping privileges.

4. Receiving Recycled Raw Materials

Any owner, contractor or municipality with construction materials available that are suitable candidates for the production of recycled aggregates may contact any TARBA member to determine if their raw material is acceptable for recycling purposes. Acceptance of these materials is based on the following criteria:

- Reliability of the demand.
- Current storage and processing space available at the site.
- Ability to produce a final product based upon the raw material proposed.
- The quality of the raw material.
- History with the owner, contractor or material hauler.

TARBA Producers may request access to the site that will be supplying the raw materials for recycling purposes prior to receiving delivery of any material in order to inspect the material ahead of time.

Based upon the results of the site inspection and/or the verbal discussion with the proposed supplier of the raw material, the producer may request that additional testing be performed on the raw material prior to acceptance or the producer may reject the material.

4.1 Acceptance Conditions for Raw Recycled Material

The first step in the aggregate recycling process is to perform an initial evaluation of the product to see if the product is suitable.
Producers will accept concrete and asphalt that meet the following conditions:

- Material which is clean and meets the tolerances for small amounts of deleterious material such as wood, plastic, wallboard, gypsum drywall, plaster, bricks, tiles, clay-based materials and organics as established by TARBA-Producer policies and can be screened to meet OPSS Specifications.

- Concrete containing reinforcing bars or wire mesh must be **pre-approved** and are subject to rejection.

- Reclaimed hydraulic cement concrete – Such as existing bridges that contain concrete footings, foundation walls and deck slabs.

Companies that do not conform to the rules may lose all dumping privileges, at the discretion of TARBA-Producer.

4.2 Visual Inspection Upon Unload at Sites

Unloading shall only take place in the location indicated by TARBA-Producer for the type of recycled material being received (asphalt and/or concrete).

TARBA Producers visually inspect all loads prior to dumping them in their yards.

If, upon visual inspection of the material received, the representative determines that the supplied material does not conform to their raw material screening requirements, the material will be removed from the stockpile and reloaded back onto the truck.

4.3 Stockpile Contamination

Unacceptable material shall be removed from stockpiles as soon as it is identified.

4.4 Separation of Raw Materials

TARBA-Producers may separate the raw materials into three (3) piles:

- Asphalt only
- Concrete only
- Concrete and asphalt

5. Production and Quality Control

The final product conforms to the material requirements of OPSS 1010.

5.1 Facility Requirements

- Crushing units must meet Ministry of Labour standards for safety and have a valid Ministry of Environment operating permit (Environmental Compliance Approval or ECA) where required.

- Crushing operations shall comply with Ministry of Environment regulations and permit requirements for dust and noise suppression and other environmental mitigation measures as required.

- Producers utilize appropriate equipment to minimize segregation, such as radial or telescoping stackers using anti-segregation hoppers and paddles at the head pulleys. As well, keeping the drop height between the head pulley of the stacker and stockpile top to a minimum to control segregation and dust emissions.

- Equipment operators shall ensure consistent stockpiling of crushed finished products to eliminate potential sources of segregation.

5.2 Product Sampling Requirements

All production samples shall be obtained by trained personnel. The facility shall have a sampling plan based on industry best practices, designed to ensure products conform to the requisite OPSS specifications.

Sampling plans shall establish sample frequency, methodology, safety, equipment and training.

References for creating sampling plans may include but are not limited to:
- MTO LS-625
- ASTM D75-03 Standard Practice for Sampling Aggregates
- ASTM D3665 Standard Practice for Random Sampling of Construction Materials
- CSA A23.2-1A Attachment 1A, Sampling Aggregate from Stockpiles or Transportation Units
- Guidelines for Working Safely Around Stockpiles, March 2004, MASHA
- National Stone Association, Aggregate Handbook, Chapter 16, “Sampling and Testing Principles”

5.3 Aggregate Quality Control Requirements

The minimum test requirements for the various aggregate products shall meet OPSS 1010, Table 1, Physical Property Requirements and Table 2, Gradation Requirements.

When TARBA-Producer supplies aggregate products to a local agency where the limits are different, then OPSS 1010 shall meet the local requirements. At the customer request, Producers shall provide test results for the recycled materials they have purchased; such test results will comply with LS testing requirements for frequency.

5.4 Laboratory Certification Requirements

All aggregate laboratory testing conducted as part of the Quality Control production requirements shall be conducted by a laboratory that at the minimum has the appropriate laboratory certification as issued by the Canadian Council of Independent Laboratories or equivalent. Any additional testing, as required by the owner, shall be completed by accredited laboratories.

5.5 Additional Quality Control Testing Requirements

TARBA-Producer shall utilize control charts to document the material performance of the products generated.

TARBA-Producer sites planning on supplying product to a local agency which has other test requirements, in addition to OPSS 1010, must identify the minimum test frequency and acceptance limits for each additional test.

5.6 Retention of Quality Control Records

TARBA-Producers maintain Quality Control test records for all products generated for a minimum of 3 years. Purchasers requesting confirmation of the ability of the product to conform to OPSS 1010 requirements shall be provided with the most recent copy of the Quality Control test results.

5.8 Loading and Weigh Out of Final Products

The shipping face of a stockpile must be re-blended continuously during the loading operation. The load-out operation should take place across the base of the stockpile to ensure that finished product is not segregated.

The loader operator will ensure the loader bucket is kept clean to avoid contamination of materials when loading trucks. The loader operator should not dig down into the floor of the stockpile or scrape the aggregate site floor before digging into the stockpile in such a manner that may cause material contamination.

5.9 Environmental Compliance

TARBA-Producer will provide SDS sheets for all recycled aggregates and comply with all relevant provincial and federal environmental regulations.

Note: R.R.O., 1990, Reg. 347 under the Environmental Protection Act, exempts concrete (RCA) and asphalt (RAP) from EPA waste management approval requirements where the materials are to be re-used as a construction material (e.g. recycled aggregates).

6.0 Owner Quality Assurance

Prior to the start-up of any project, the Owner is responsible for conducting their own testing at the point of production for assurance that the product is acceptable and meets their specifications. Owner quality assurance testing is recommended periodically throughout the production process. The Owner shall notify the TARBA-Producer of any tests that indicate non-conformity as soon as they are identified. Owner testing shall be done in conjunction with TARBA-Producer's Quality Control personnel.

The Best Practices Guide for Recycling Aggregate

TARBA

Recycled Aggregate Best Practices Guide

The Recycled Aggregate Best Practices Guide provides guidelines and standards for producing quality recycled aggregates for road and sidewalk bases, trench backfill, engineered fill, access roads, trails, and other construction applications.

The guide includes measures needed to meet Ontario Provincial Standard Specifications and Ministry of Labour and Ministry of Environment standards.

Safety

Safety during loading and production is paramount. The receiving yard is responsible for the safety of both on-site personnel (loader operators, yardmen and scale house personnel) and the delivery truck drivers entering the facility.

- All drivers must wear a hard hat, safety vest and boots in accordance with the Ministry of Labour's requirements when exiting their vehicles.
- All trucks must have a properly operating backup alarm, brakes and horn.
- All drivers must report to the loader operator or scale house before dumping and must follow instructions at all times.
- Loaders have the right of way in the yard.
- Drivers must follow all individual yard rules.

Drivers who do not comply with any of these requirements will be barred from the facility and will lose future dumping privileges.

Raw Material Quality

Advanced Notice

A company disposing of broken concrete and/or asphalt must:

- Notify the scale house in advance of its intention to send material to be recycled.
- Specify the location of the site from which the material is being shipped.
- Advise the scale house of the quantity and type of materials being delivered.

Types of Materials

The recycling yard will accept concrete and asphalt that meet the following conditions:

- Concrete and asphalt must be separated at the job site. Well bonded asphalt to concrete composite pavement is the only exception.
- Concrete and asphalt must be free of deleterious material such as wood, plastic, and organics. No exceptions are permitted and any violations are subject to zero tolerance.
- Cinder blocks, bricks, tiles or any clay-based materials are not allowed.
- Concrete containing reinforcing bars or wire mesh must be pre-approved for delivery to the receiving yard. All incoming loads will be inspected and subject to rejection.

- Solid concrete demolition materials such as footings, floor slabs and poured concrete walls must be pre-approved. The receiving facility's personnel will inspect the originating site before delivery to the recycling yard is scheduled.

A reloading and rehandling charge will apply to any load that contravenes the above conditions. Companies that do not conform to the rules will lose all dumping privileges.

Quality Control

General

- The recycling yard must have strict controls and monitoring protocols in place during production and shipping to produce a consistent quality aggregate.
- Materials delivered to the crushing facility should be sorted into properly identified stockpiles – typically asphalt only, concrete only, and concrete and well bonded asphalt.
- Production control gradations, including the percentage of asphalt cement coated particles, are to be conducted every 1,000 tonnes of production. The producer will record the results in a control chart logbook and provide the results to pavement owners and their agents upon request.
- Physical aggregate testing including petrographic analysis, micro deval abrasion and % crushed count, will be performed every 25,000 tonnes of production and compared to Ontario Provincial Standard Specification #1010.
- Canadian Council of Independent Laboratories' sampling procedures will be used to take representative samples.
- Samples must be tested in CCIL certified labs.

Job Site Quality Control

- The producer will provide documentation at the production facility outlining gradation and the physical properties of the product as outlined above.
- Prior to the start-up of any new project, owners are encouraged to test materials at the point of production in conjunction with the producer's quality control personnel.

If issues arise when material is placed in the field, the producer's quality control personnel will investigate and monitor as soon as possible. The producer's quality control personnel will issue a field investigation report highlighting any inconsistencies found between the field and production testing and the reasons why those inconsistencies have occurred.

Production

- Crushing units must meet Ministry of Labour standards for safety and have a valid Ministry of Environment Certificate of Approval.
- Primary and secondary crushers must be equipped with magnets to remove any rebar and extraneous metals.
- The producer must use mist sprayers and/or other dust suppressers during the crushing operation to prevent dust particles from migrating and becoming airborne.
- Up to date stackers and efficient rehandling equipment (such as loaders and bulldozers) must be used to ensure consistent stockpiling of crushed finished products and to eliminate potential sources of segregation.

Loading and Weight Out

- The shipping face of a stockpile must be re-blended continuously during the loading operation. The load-out operation should take place across the base of the stockpile to ensure that finished product is not segregated.
- The producer will monitor loading to ensure the weight of the load is within the legal limits allowed by the individual Commercial Vehicle Operator's Registration certificate and that the weight of the load is uniformly distributed in the truck box as per Ministry of Transportation of Ontario requirements.
- A government certified scale must be used during the weigh out operation. Scale tickets can be bar coded for the convenience of the receiving agency's tally sheets if required.

Environmental Compliance

The recycling facility will provide MSDS sheets for all recycled aggregates.

Leachate testing under O. Reg. 558 is not required for recycled aggregates used in construction since the Ministry of Environment defines these materials as a "product" and not a waste. The Toronto Area Road Builders Association can provide representative leachate test results of recycled aggregates upon request.

Specifications

Ontario Provincial Standard Specification 1010 covers the use of aggregates for base, subbase and backfill.

It is the responsibility of the contractor supplying and using recycled aggregates to meet OPSS 1010 requirements when it is included as a job specification.

OPSS 1010 includes details on submission and design requirements, materials, production, quality control and quality assurance. It also addresses the use of reclaimed and recycled materials.

"All aggregate source materials shall be clean hard durable particles free of earth, humus, and clay, e.g., coatings, lumps, and fragments. Where reclaimed materials are permitted, they shall be homogeneously blended. Where RCM (recycled concrete material) is permitted, RCM shall not contain loose reinforcing materials." [1010.05.01]

"Granular A and Granular M may contain up to 100% RCM but shall not contain more than 30% by mass of asphalt coated particles and not more than a combined total of 15% by mass of glass and ceramic material. The combined amount of deleterious material shall not exceed a total of 1% by mass.." [1010.05.02]

"Granular B Type I may contain up to 100% RCM but shall not contain more than 30% by mass of asphalt coated particles." [1010.05.03.02]

TARBA

The Toronto Area Road Builders Association
365 Brunel Road, Unit 4
Mississauga, Ontario

905-507-4899

OSSGA

The Ontario Stone, Sand & Gravel Association
5720 Timberlea Blvd., Unit 103
Mississauga, Ontario

905-507-0711
www.ossga.com

The Recycled Aggregates Best Practices Guide outlines best practices associated with the production of recycled aggregates. It is not a design manual and producers should verify with independent certified laboratories and consulting engineers to ensure that their practices meet all legislative rules and regulations. Neither TARBA nor OSSGA provides any warrantees or guarantees associated with the production of recycled aggregates, the quality of recycled materials or their suitability for use in construction applications.

Appendix B GTA Crusher Site Photographs

Typical Site Photographs

Strada Aggregate Crusher: 1667 Creditstone Rd, Concord, ON

(Site Visit Date: August 8th, 2022)

Photo (1): Strada Crusher at 1667 Creditstone Rd, Concord, ON

Photo (2): Strada Crusher at 1667 Creditstone Rd, Concord, ON – Raw Material

Photo (3): Strada Crusher at 1667 Creditstone Rd, Concord, ON – Dumping of Raw Material

Photo (4): Strada Crusher at 1667 Creditstone Rd, Concord, ON – Producing RCA

Photo (5): Strada Crusher at 1667 Creditstone Rd, Concord, ON – Breaking Big Pieces

Photo (6): Strada Crusher at 1667 Creditstone Rd, Concord, ON – Old Asphalt Raw Material

Photo (7): Strada Crusher at 1667 Creditstone Rd, Concord, ON – Stockpiles of RCA

Photo (8): Strada Crusher at 1667 Creditstone Rd, Concord, ON – Stockpile of RCA (Gran A RAP)

Photo (9): Strada Crusher at 1667 Creditstone Rd, Concord, ON – Stockpile of RCA (Gran A RAP)

Photo (10): Strada Crusher at 1667 Creditstone Rd, Concord, ON – Sample Collection

Typical Site Photographs

D. Crupi & Sons Limited Crusher: 2777 14th Ave, Markham, ON

(Site Visit Date: August 8th, 2022)

Photo (11): Crupi Crusher at 2777 14th Ave, Markham, ON

Photo (12): Crupi Crusher at 2777 14th Ave, Markham- Raw Concrete Material

Photo (13): Crupi Crusher at 2777 14th Ave, Markham- Raw Concrete Material

Photo (14): Crupi Crusher at 2777 14th Ave, Markham- Stockpiling of Produced RCA

Photo (15): Crupi Crusher at 2777 14th Ave, Markham- Stockpiles of Produced RCA and RAP

Photo (16): Crupi Crusher at 2777 14th Ave, Markham- Produced RCA (Gran A RAP)

Typical Site Photographs

D. Crupi & Sons Limited Yard: 176 Bethridge Rd, Etobicoke, ON

(Site Visit Date: August 30th, 2022)

Photo (17): Crupi Crusher at 176 Bethridge Rd, Etobicoke, ON – Producing RCA

Photo (18): Crupi Crusher at 176 Bethridge Rd, Etobicoke, ON – Stockpiles of RCA

Photo (19): Crupi Crusher at 176 Bethridge Rd, Etobicoke, ON – Stockpile of RCA

Photo (20): Crupi Crusher at 176 Bethridge Rd, Etobicoke, ON – Stockpile of RCA (Gran A RAP)

Typical Site Photographs

D. Crupi & Sons Limited Yard: 85 Passmore Ave, Scarborough, ON

(Site Visit Date: August 30th, 2022)

Photo (21): Crupi Yard at 85 Passmore Ave, Scarborough, ON – Stockpile of RCA

Photo (22): Crupi Yard at 85 Passmore Ave, Scarborough – Sample Preparation- RCA (Gran A RAP)

Photo (23): Crupi Yard at 85 Passmore Ave, Scarborough – Sample Preparation- RCA (Gran A RAP)

Photo (24): Crupi Yard at 85 Passmore Ave, Scarborough – Sample Collection - RCA (Gran A RAP)

Typical Site Photographs

Strada Aggregate Crusher: 120 Wentworth Crt, Brampton, ON

(Site Visit Date: Sept 7th, 2022)

Photo (25): Strada Aggregate Crusher: 120 Wentworth Crt, Brampton, ON – Producing RCA

Photo (26): Strada Aggregate Crusher: 120 Wentworth Crt, Brampton, ON – Producing RCA

Photo (27): Strada Aggregate Crusher: 120 Wentworth Crt, Brampton, ON – Stockpiling of RCA

Photo (28): Strada Aggregate Crusher: 120 Wentworth Crt, Brampton, ON – Preparation for Sample Collection (Gran A RAP)

Typical Site Photographs

Strada Aggregate Crusher: 10 Leslie St, Toronto, ON

(Site Visit Date: Sept 8th, 2022)

Photo (29): Strada Aggregate Crusher: 10 Leslie St, Toronto, ON– Producing RCA

Photo (30): Strada Aggregate Crusher: 10 Leslie St, Toronto, ON– Stockpiles of RCA

Photo (31): Strada Aggregate Crusher: 10 Leslie St, Toronto, ON
Breaking Big Pieces of Concrete Prior Crushing

Photo (32): Strada Aggregate Crusher: 10 Leslie St, Toronto, ON – Stockpiles of RCA (Gran A RAP)

Photo (33): Strada Aggregate Crusher: 10 Leslie St, Toronto, ON – Stockpiles of RCA

Photo (34): Strada Aggregate Crusher: 10 Leslie St, Toronto, ON
Stockpiles of RCA (Gran A Rap) – Sample Collection

Typical Site Photographs

Pave AL Crusher: 1250 Shawson Dr., Mississauga, ON

Photo (35): Pave AL Crusher: 1250 Shawson Dr., Mississauga, ON

Photo (36): Pave AL Crusher: 1250 Shawson Dr., Mississauga, ON

Photo (37): Pave AL Crusher: 1250 Shawson Dr., Mississauga, ON

Photo (38): Pave AL Crusher: 1250 Shawson Dr., Mississauga, ON

Photo (39): Pave AL Crusher: 1250 Shawson Dr., Mississauga, ON

Photo (40): Pave AL Crusher: 1250 Shawson Dr., Mississauga, ON

Appendix C Laboratory Test Result

exp Services Inc.
1595 Clark Boulevard, Brampton
Ontario, Canada, L6T 4V1
Telephone: (905) 793-9800
Fax: (905) 793-0641

Grain Size Analysis Test Report

ST06-Granular

Sample Test No.: 403135-4 **Report No.:** 1 **Date Reported:** 30-Aug-2022

Project No.: BRM-22019043-B0 13
Project Name: Laboratory Testing

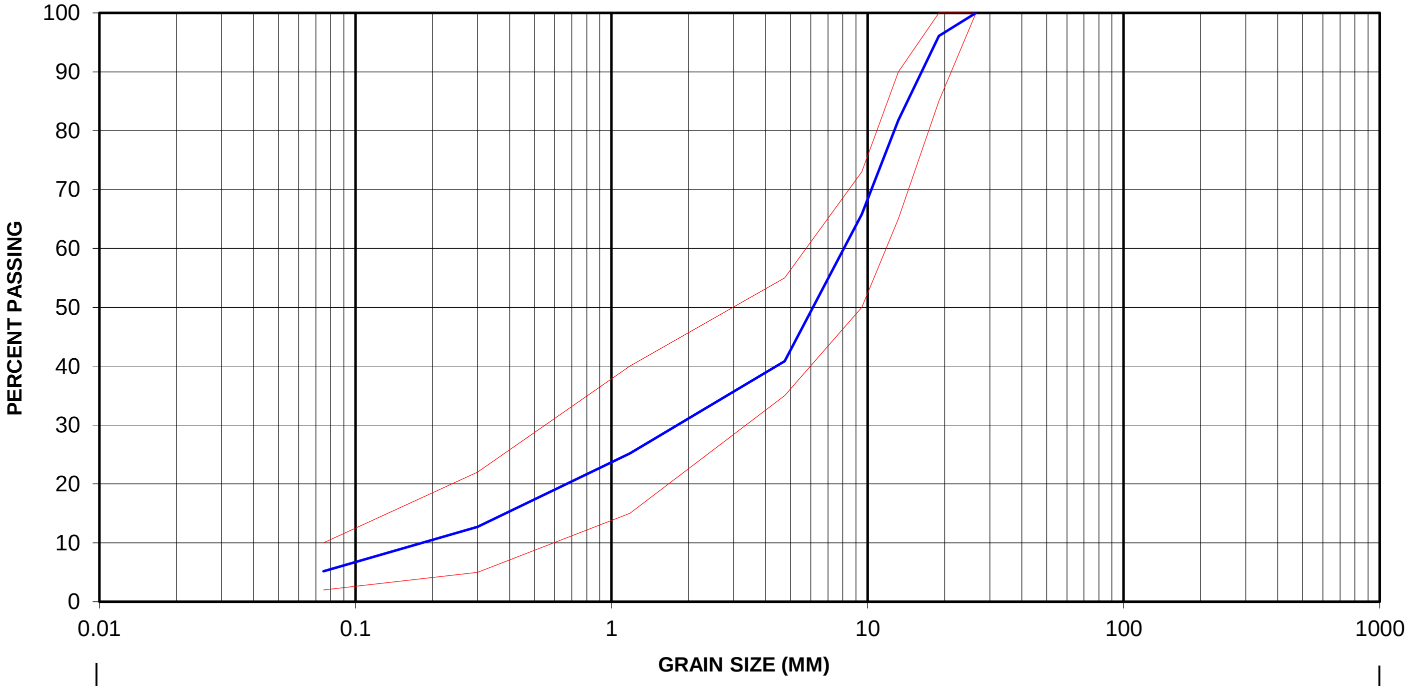
Material Specification: OPSS, Granular A

Sieve Size (mm)	% Passing		
	Sample	Spec. (Min.)	Spec. (Max.)
26.5	100.0	100	100
19.0	96.1	85	100
13.2	81.8	65	90
9.5	65.8	50	73
4.75	40.9	35	55
1.18	25.2	15	40
0.300	12.7	5	22
0.075	5.2	2	10

Notes: *Out of Specification

Sample Information

Material Supplier: Strada Aggregates
Sample Description: Gran A (RCA1010)
Sampled By: exp Brampton
Date Sampled: 8-Aug-2022
Date Received: 8-Aug-2022
Contractor Name:
Proposed Use:
Client Sample ID: 1P (Strada-Concord)
Sample Location: 1667 Creditstone Rd., Concord
Remarks: Acceptable as Gran A



silt	fine	medium	coarse	fine	medium	coarse	cobbles	boulders
	sand			gravel				

Modified M.I.T. Classification Grain Size Analysis - ASTM C136; C117

Project Manager: Aswan Assadi **Approved By:** *Original Signed By* Mukul (Mickey) Misra **Date Approved:** 30-Aug-2022

exp Services Inc.
1595 Clark Boulevard, Brampton
Ontario, Canada, L6T 4V1
Telephone: (905) 793-9800
Fax: (905) 793-0641

Grain Size Analysis Test Report

ST06-Granular

Sample Test No.: 404035-1 **Report No.:** 2 **Date Reported:** 8-Sep-2022

Project No.: BRM-22019043-B0 13
Project Name: Laboratory Testing

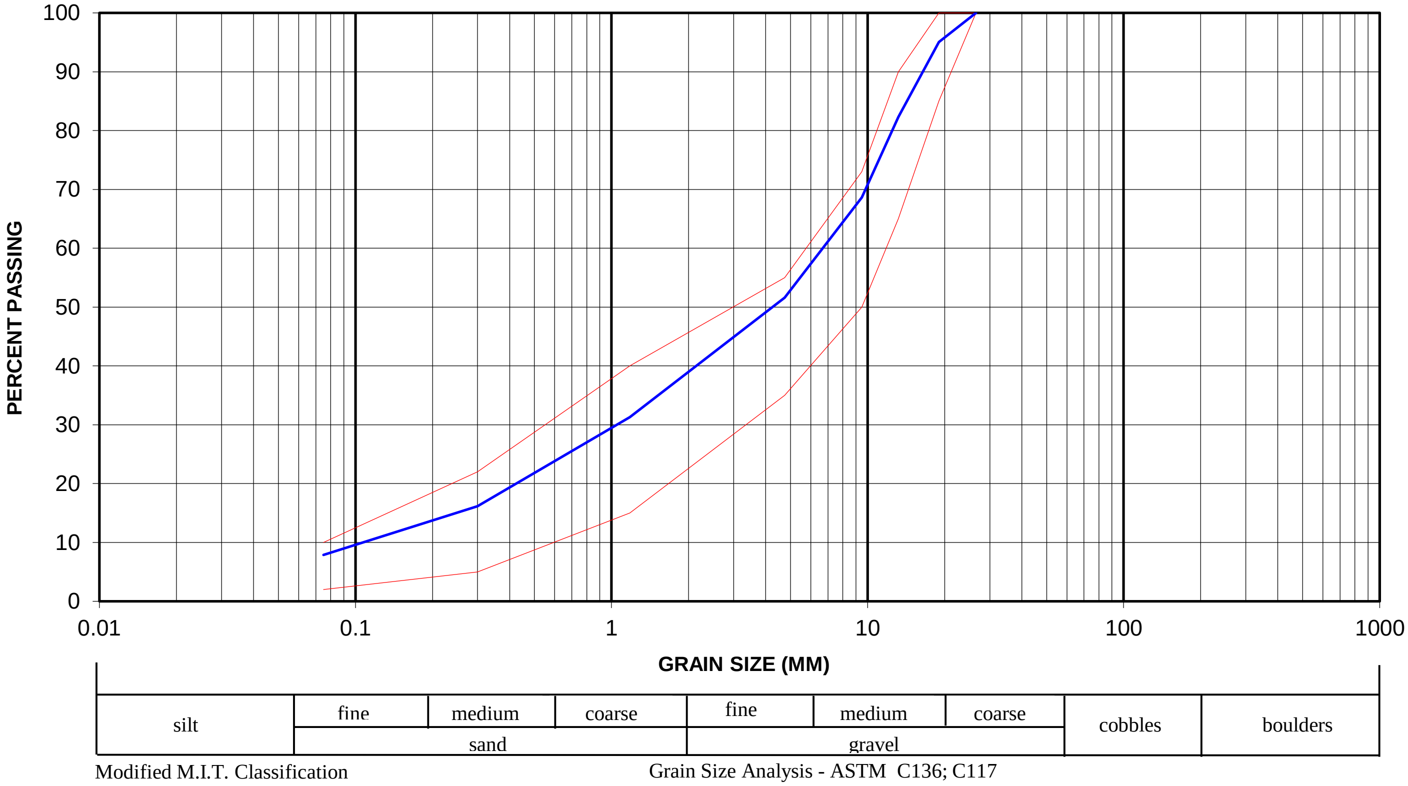
Material Specification: OPSS, Granular A

Sieve Size (mm)	% Passing		
	Sample	Spec. (Min.)	Spec. (Max.)
26.5	100.0	100	100
19.0	95.0	85	100
13.2	82.3	65	90
9.5	68.6	50	73
4.75	51.6	35	55
1.18	31.3	15	40
0.300	16.1	5	22
0.075	7.9	2	10

Notes: *Out of Specification

Sample Information

Material Supplier: D.Crupi
Sample Description: Gran A (RCA1010)
Sampled By: exp Brampton
Date Sampled: 30-Aug-2022
Date Received: 30-Aug-2022
Contractor Name:
Proposed Use:
Client Sample ID: 2P(D.Crupi-Etobicoke)
Sample Location: 176 Bethridge Rd., Etobicoke
Remarks: Acceptable as Gran A



Modified M.I.T. Classification

Grain Size Analysis - ASTM C136; C117

Project Manager: Aswan Assadi **Approved By:** *Original Signed By* Mukul (Mickey) Misra **Date Approved:** 8-Sep-2022

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Grain Size Analysis Test Report

ST06-Granular

Sample Test No.: 403136-4 **Report No.:** 3 **Date Reported:** 31-Aug-2022

Project No.: BRM-22019043-B0 13
Project Name: Laboratory Testing

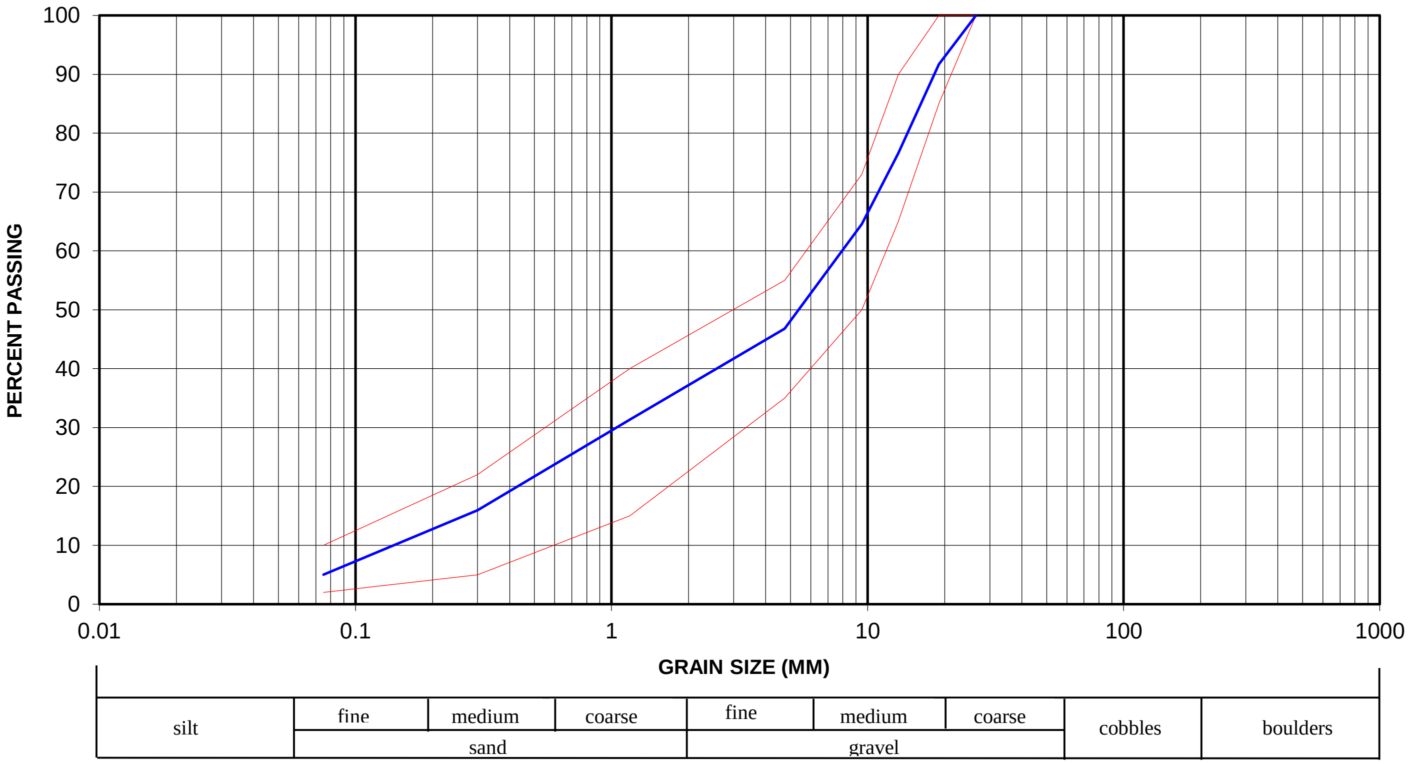
Material Specification: OPSS, Granular A

Sieve Size (mm)	% Passing		
	Sample	Spec. (Min.)	Spec. (Max.)
26.5	100.0	100	100
19.0	91.7	85	100
13.2	76.6	65	90
9.5	64.5	50	73
4.75	46.8	35	55
1.18	31.3	15	40
0.300	15.9	5	22
0.075	5.0	2	10

Notes: *Out of Specification

Sample Information

Material Supplier: D.Crupi
Sample Description: Gran A (RCA1010)
Sampled By: exp Brampton
Date Sampled: 8-Aug-2022
Date Received: 8-Aug-2022
Contractor Name:
Proposed Use:
Client Sample ID: 3P(D.Crupi-Markham)
Sample Location: 2777 14th Ave, Markham -D.Crupi
Remarks: Acceptable as Gran A



Modified M.I.T. Classification

Grain Size Analysis - ASTM C136; C117

Project Manager: Aswan Assadi **Approved By:** *Original Signed By* Mukul (Mickey) Misra **Date Approved:** 31-Aug-2022

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Grain Size Analysis Test Report

ST06-Granular

Sample Test No.: 403995-1 **Report No.:** 4 **Date Reported:** 7-Sep-2022

Project No.: BRM-22019043-B0 13
Project Name: Laboratory Testing

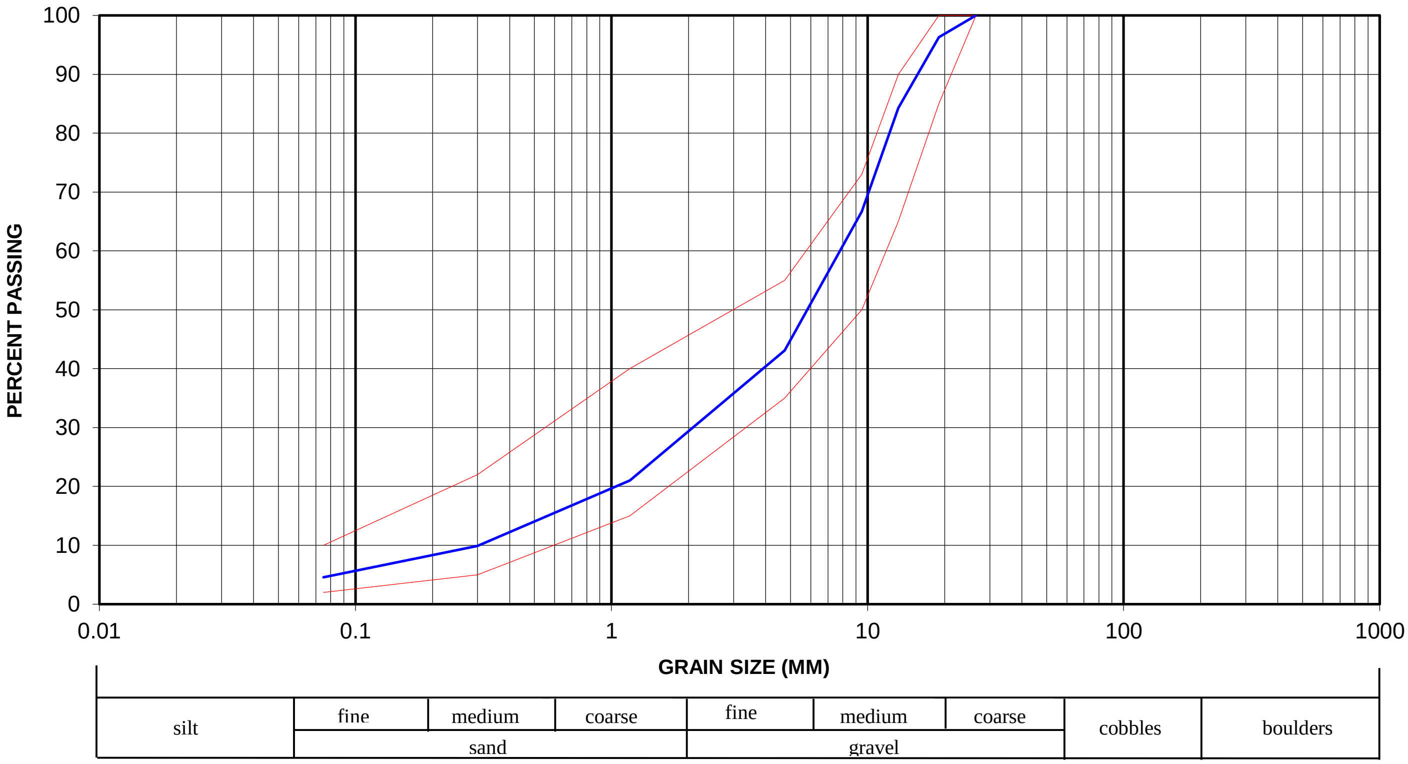
Material Specification: OPSS, Granular A

Sieve Size (mm)	% Passing		
	Sample	Spec. (Min.)	Spec. (Max.)
26.5	100.0	100	100
19.0	96.3	85	100
13.2	84.3	65	90
9.5	66.7	50	73
4.75	43.1	35	55
1.18	21.0	15	40
0.300	9.9	5	22
0.075	4.6	2	10

Notes: *Out of Specification

Sample Information

Material Supplier: D.Crupi
Sample Description: Gran A (RCA1010)
Sampled By: exp Brampton
Date Sampled: 30-Aug-2022
Date Received: 30-Aug-2022
Contractor Name:
Proposed Use:
Client Sample ID: 4P(D.Crupi-Scarborough)
Sample Location: 85 Passmore Ave; (D.Crupi)
Remarks: Acceptable as Gran A



Modified M.I.T. Classification

Grain Size Analysis - ASTM C136; C117

Project Manager: Aswan Assadi **Approved By:** *Original Signed By* **Date Approved:** 7-Sep-2022
Mukul (Mickey) Misra

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Ontario, Canada, L6T 4V1
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Fax: (905) 793-0641

Grain Size Analysis Test Report

ST06-Granular

Sample Test No.: 404194-1 **Report No.:** 5 **Date Reported:** 12-Sep-2022

Project No.: BRM-22019043-B0 13
Project Name: Laboratory Testing

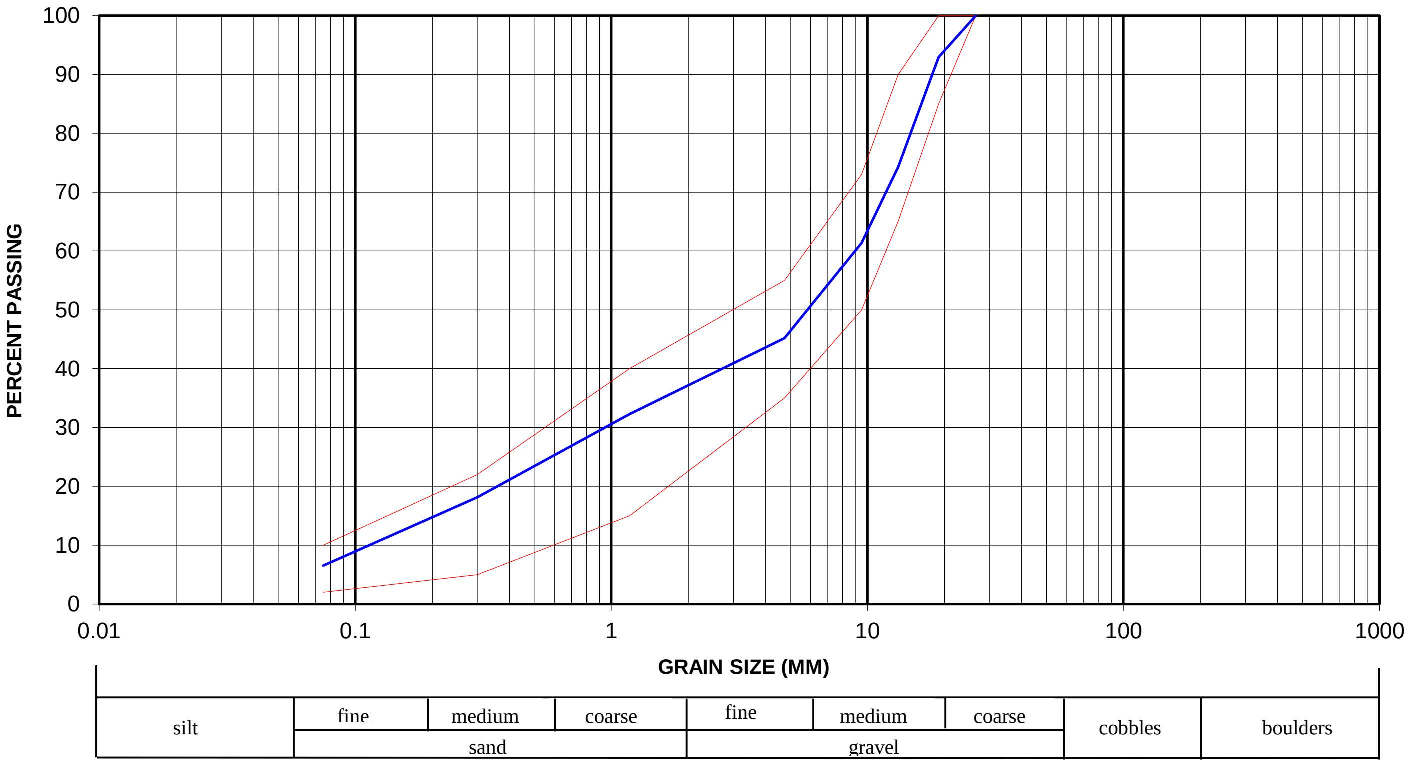
Material Specification: OPSS, Granular A

Sieve Size (mm)	% Passing		
	Sample	Spec. (Min.)	Spec. (Max.)
26.5	100.0	100	100
19.0	93.0	85	100
13.2	74.2	65	90
9.5	61.4	50	73
4.75	45.2	35	55
1.18	32.3	15	40
0.300	18.1	5	22
0.075	6.5	2	10

Notes: *Out of Specification

Sample Information

Material Supplier: Strada
Sample Description: Gran A (RCA1010)
Sampled By: exp Brampton
Date Sampled: 7-Sep-2022
Date Received: 7-Sep-2022
Contractor Name:
Proposed Use:
Client Sample ID: 5P (Strada - Brampton)
Sample Location: 120 Wentworth Ct., Brampton
Remarks: Acceptable as Gran A



Modified M.I.T. Classification

Grain Size Analysis - ASTM C136; C117

Project Manager: Aswan Assadi **Approved By:** *Original Signed By* **Date Approved:** 12-Sep-2022

Mukul (Mickey) Misra

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Grain Size Analysis Test Report

ST06-Granular

Sample Test No.: 404616-1 **Report No.:** 6 **Date Reported:** 16-Sep-2022

Project No.: brm-22019043-b0 13

Project Name: Lab Testing

Material Specification: OPSS, Granular A

Sieve Size (mm)	% Passing		
	Sample	Spec. (Min.)	Spec. (Max.)
26.5	100.0	100	100
19.0	94.0	85	100
13.2	81.4	65	90
9.5	70.1	50	73
4.75	53.5	35	55
1.18	33.4	15	40
0.300	19.0	5	22
0.075	8.0	2	10

Notes: *Out of Specification

Sample Information

Material Supplier: Strada

Sample Description: Gran A (RCA1010)

Sampled By: EXP

Date Sampled: 14-Sep-2022

Date Received: 14-Sep-2022

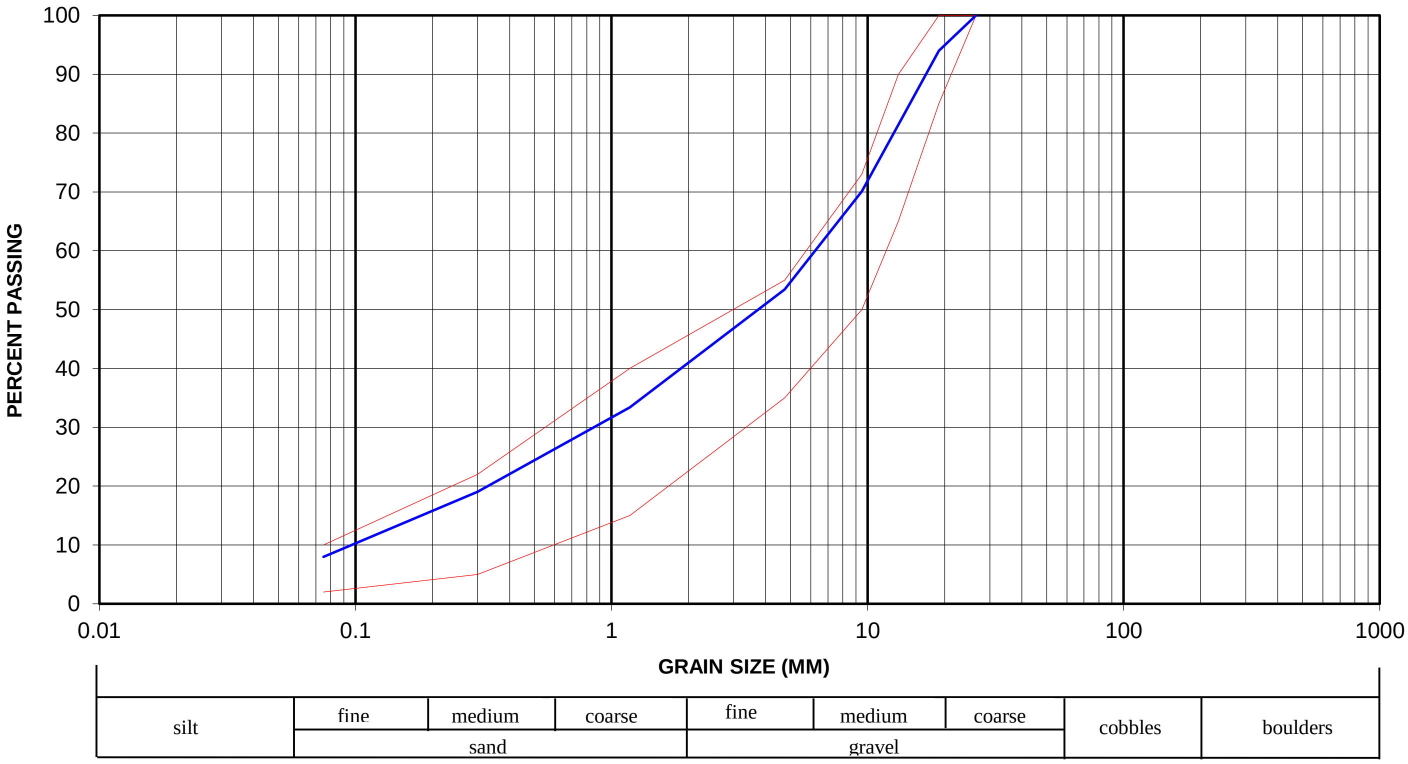
Contractor Name:

Proposed Use:

Client Sample ID: 6P (Strada - Toronto)

Sample Location: 10 Leslie St, Toronto

Remarks: Acceptable as Gran A



Modified M.I.T. Classification

Grain Size Analysis - ASTM C136; C117

Project Manager: Aswan Assadi **Approved By:** *Original Signed By* **Date Approved:** 16-Sep-2022

Mukul (Mickey) Misra

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www.exp.com

Laboratory Test Report (Physical Properties)

Description of Sample: Granular A (RCA1010)

Project No:BRM-22019043-B0 13 (Client: TARBA)

Sample Location: Strada (1667 Creditstone Rd)

Sample No.: 1P

Date Sampled: Aug 8,2022

Sampled By: EXP Brampton

Date Received: Aug 8,2022; (EXP #403135)

Date Reported: Sep 22,2022

Physical Property (Test Method)	Result	OPSS MUNI 1010 Specification	OPSS PROV 1010 Specification	Pass/Fail
Asphalt Coated Particles (LS-621) %	**3.7**	<=30	<=30	Pass
Percent Crushed (LS-607)	**99.7**	>=60	Not Specified	Pass
Plasticity Index (LS-703/704)	**Non Plastic**	0 %	NP (Non-Plastic) (Plastic Fines – LS-631)	Pass
Micro-Deval Abrasion Loss-Coarse (LS-618)	**18.9**	<=25	<=25	Pass
Micro-Deval Abrasion Loss-Fine (LS-619)	**15.2**	<=30	<=30	Pass
Petrographic Analysis - Coarse (LS-609)	Refer to the Attached Report			
Petrographic Analysis – Fine (LS-616)	Refer to the Attached Report			
Amount of Contamination (LS-630)	**0.02% (Wood)**	<= 1 % <= 0.1 % (wood only)	<= 1 % <= 0.1 % (wood only)	Pass
Permeability, k (LS-709) (cm/sec)	**1.7 X 10^-4**	k > 1.0 x 10^-4	k > 1.0 x 10^-4	Pass

Project Manager: Aswan Assadi

Approved By: *Original Signed By*
Mukul (Mickey) Misra

Date Approved: 22-Sep-2022

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www.exp.com

Laboratory Test Report (Physical Properties)

Description of Sample: Granular A (RCA1010)
Project No:BRM-22019043-B0 13 (Client: TARBA)
Sample Location: D.Crupi (176 Bethridge Rd)
Sample No.: 2P
Date Sampled: Aug 30,2022
Sampled By: EXP Brampton
Date Received: Aug 30,2022; (EXP #404035)
Date Reported: Sep 12,2022

Physical Property (Test Method)	Result	OPSS MUNI 1010 Specification	OPSS PROV 1010 Specification	Pass/Fail
Asphalt Coated Particles (LS-621) %	**27.3**	<=30	<=30	Pass
Percent Crushed (LS-607)	**96.0**	>=60	Not Specified	Pass
Plasticity Index (LS-703/704)	**Non Plastic**	0 %	NP (Non-Plastic)	Pass
Micro-Deval Abrasion Loss-Coarse (LS-618)	**16.5**	<=25	<=25	Pass
Micro-Deval Abrasion Loss-Fine (LS-619)	**7.9**	<=30	<=30	Pass
Petrographic Analysis - Coarse (LS-609)	Refer to the Attached Report			
Petrographic Analysis – Fine (LS-616)	Refer to the Attached Report			
Amount of Contamination (LS-630)	**0**	<= 1 % <= 0.1 % (wood only)	<= 1 % <= 0.1 % (wood only)	Pass
Permeability, k (LS-709) (cm/sec)	**3.6 X 10^-3**	k > 1.0 x 10^-4	k > 1.0 x 10^-4	Pass

Project Manager: Aswan Assadi

Approved By: *Original Signed By*
Mukul (Mickey) Misra

Date Approved: 12-Sep-2022

exp Services Inc.
1595 Clark Boulevard
Brampton, Ontario, L6T 4V1
Tel: (905) 793-9800
Fax: (905) 793-0641
www.exp.com

Laboratory Test Report (Physical Properties)

Description of Sample: Granular A (RCA1010) Project No:BRM-22019043-B0 13 (Client: TARBA)

Sample Location: D.Crupi (14th Ave.,Markham) Sample No.: 3P

Date Sampled: Aug 8,2022 Sampled By: EXP Brampton

Date Received: Aug 8,2022; (EXP #403136) Date Reported: Aug 31,2022

Physical Property (Test Method)	Result	OPSS MUNI 1010 Specification	OPSS PROV 1010 Specification	Pass/Fail
Asphalt Coated Particles (LS-621) %	**1.4**	<=30	<=30	Pass
Percent Crushed (LS-607)	**99.1**	>60	Not Specified	Pass
Plasticity Index (LS-703/704)	**Non Plastic**	0 %	NP (Non-Plastic)	Pass
Micro-Deval Abrasion Loss-Coarse (LS-618)	**16.9**	<=25	<=25	Pass
Micro-Deval Abrasion Loss-Fine (LS-619)	**12.0**	<=30	<=30	Pass
Petrographic Analysis - Coarse (LS-609)	**Refer to the Attached Report**			
Petrographic Analysis – Fine (LS-616)	**Refer to the Attached Report**			
Amount of Contamination (LS-630)	**0.2% (ceramic)**	<= 1 % <= 0.1 % (wood only)	<= 1 % <= 0.1 % (wood only)	Pass
Permeability, k (LS-709) (cm/sec)	**6.9 X 10^-4**	k > 1.0 x 10^-4	k > 1.0 x 10^-4	Pass

Project Manager: Aswan Assadi

Approved By: *Original Signed By*
Mukul (Mickey) Misra

Date Approved: 30-Aug-2022

exp Services Inc.
1595 Clark Boulevard
Brampton, Ontario, L6T 4V1
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Fax: (905) 793-0641
www.exp.com

Laboratory Test Report
(Physical Properties)

Description of Sample: Granular A (RCA1010) Project No:BRM-22019043-B0 13 (Client: TARBA)

Sample Location: D.Crupi (85 Passmore Ave) Sample No.: 4P

Date Sampled: Aug 30,2022 Sampled By: EXP Brampton

Date Received: Aug 30,2022; (EXP #403995) Date Reported: Sep 7,2022

Physical Property (Test Method)	Result	OPSS MUNI 1010 Specification	OPSS PROV 1010 Specification	Pass/Fail
Asphalt Coated Particles (LS-621) %	**33.0**	<=30	<=30	Fail
Percent Crushed (LS-607)	**97.9**	>=60	Not Specified	Pass
Plasticity Index (LS-703/704)	**Non Plastic**	0 %	NP (Non-Plastic)	Pass
Micro-Deval Abrasion Loss-Coarse (LS-618)	**16.5**	<=25	<=25	Pass
Micro-Deval Abrasion Loss-Fine (LS-619)	**8.0**	<=30	<=30	Pass
Petrographic Analysis-Coarse (LS-609)	**Refer to the Attached Report**			
Petrographic Analysis-Fine (LS-616)	**Refer to the Attached Report**			
Amount of Contamination (LS-630)	**0**	<= 1 % <= 0.1 % (wood only)	<= 1 % <= 0.1 % (wood only)	Pass
Permeability, k (LS-709) (cm/sec)	**1.3 X 10^-2**	k > 1.0 x 10^-4	k > 1.0 x 10^-4	Pass

Project Manager: Aswan Assadi

Approved By: *Original Signed By*
Mukul (Mickey) Misra

Date Approved: 12-Sep-2022

exp Services Inc.
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Brampton, Ontario, L6T 4V1
Tel: (905) 793-9800
Fax: (905) 793-0641
www.exp.com

Laboratory Test Report (Physical Properties)

Description of Sample: Granular A (RCA1010)
Project No:BRM-22019043-B0 13 (Client: TARBA)
Sample Location: Strada (120 Wentworth Ct))
Sample No.: 5P
Date Sampled: Sep 7.2022
Sampled By: EXP Brampton
Date Received: Sep 7,2022; (EXP #404194)
Date Reported: Sep 12,2022

Physical Property (Test Method)	Result	OPSS MUNI 1010 Specification	OPSS PROV 1010 Specification	Pass/Fail
Asphalt Coated Particles (LS-621) %	**11.0**	<=30	<=30	Pass
Percent Crushed (LS-607)	**96.5**	>=60	Not Specified	Pass
Plasticity Index (LS-703/704)	**Non Plastic**	0 %	NP (Non-Plastic)	Pass
Micro-Deval Abrasion Loss-Coarse (LS-618)	**22.2**	<=25	<=25	Pass
Micro-Deval Abrasion Loss-Fine (LS-619)	**16.3**	<=30	<=30	Pass
Petrographic Analysis - Coarse (LS-609)	**Refer to the Attached Report**			
Petrographic Analysis - Fine (LS-616)	**Refer to the Attached Report**			
Amount of Contamination (LS-630)	**0**	<= 1 % <= 0.1 % (wood only)	<= 1 % <= 0.1 % (wood only)	Pass
Permeability, k (LS-709) (cm/sec)	**1.3 X 10^-4**	k > 1.0 x 10^-4	k > 1.0 x 10^-4	Pass

Project Manager: Aswan Assadi

Approved By: *Original Signed By*
Mukul (Mickey) Misra

Date Approved: 12-Sep-2022

exp Services Inc.
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Brampton, Ontario, L6T 4V1
Tel: (905) 793-9800
Fax: (905) 793-0641
www.exp.com

Laboratory Test Report (Physical Properties)

Description of Sample: Granular A (RCA1010)

Project No:BRM-22019043-B0 13 (Client: TARBA)

Sample Location: Strada (10 Leslie St)

Sample No.: 6P

Date Sampled: Sep 8.2022

Sampled By: EXP Brampton

Date Received: Sep 8,2022; (EXP #404250)

Date Reported:

Physical Property (Test Method)	Result	OPSS MUNI 1010 Specification	OPSS PROV 1010 Specification	Pass/Fail
Asphalt Coated Particles (LS-621) %	**6.5**	<=30	<=30	Pass
Percent Crushed (LS-607)	**96.7**	>=60	Not Specified	Pass
Plasticity Index (LS-703/704)	**Non Plastic**	0 %	NP (Non-Plastic)	Pass
Micro-Deval Abrasion Loss-Coarse (LS-618)	**18.7**	<=25	<=25	Pass
Micro-Deval Abrasion Loss-Fine (LS-619)	**19.4**	<=30	<=30	Pass
Petrographic Analysis - Coarse (LS-609)	**Refer to the Attached Report**			
Petrographic Analysis– Fine (LS-616)	**Refer to the Attached Report**			
Amount of Contamination (LS-630)	**0**	<= 1 % <= 0.1 % (wood only)	<= 1 % <= 0.1 % (wood only)	Pass
Permeability, k (LS-709) (cm/sec)	**5.9 X 10^-4**	k > 1.0 x 10^-4	k > 1.0 x 10^-4	Pass

Project Manager: Aswan Assadi

Approved By: *Original Signed By*
Mukul (Mickey) Misra

Date Approved: 12-Sep-2022

LS-609 (Part A) - Coarse Aggregate Petrographic Analysis (Petrographic Number, PN)

SAMPLE #: 1P - Gran A RCA1010	ANALYST: Ashley Meagher		DATE TESTED: September 8, 2022	
TESTING LAB: EXP Services Inc.	TEL: 905 793 9800	FAX: 905 793 0641	EXP Project #: BRM-22019043-B0 - 100	
SAMPLED BY:EXP Services Inc.(August 8, 2022)	DATE RECEIVED: August 18, 2022		SAMPLE TYPE:	
SOURCE NAME: Strada Aggregates, Concord	SOURCE LOCATION: 1667 Creditstone Road, Concord, ON		MAIDB #:	
AGGREGATE TYPE: Granular A - RCA1010	AGGREGATE PRODUCT: Aggregate/Crusher		LOT #:	SUBLOT #:
CONTRACT:	CONTRACT LOCATIONIHWY.:		CONTRACTOR:	

TYPE	TYPE No.	53.0 / R19		P19.0 / R13.2		P13.2 / R9.5		P 9.5 / R4.75		Weighted Composition (%)
		Mass (g)	% of Fraction	Mass (g)	% of Fraction	Mass (g)	% of Fraction	Mass (g)	% of Fraction	
CONCRETE (HARD)				1035.6	66.8	337.8	66.4	130.2	63.6	65.3
CONCRETE COVERED AGGREGATES (hard)				165.8	10.7	45.9	9.0	22.7	11.1	10.4
CARBONATE (slightly sandy, hard or medium hard)	02			100.5	6.5	28.1	5.5	10.6	5.2	5.7
GRANITE-DIORITE-GABBRO (hard)	08			25.8	1.7	20.2	4.0	6.7	3.3	3.0
CARBONATE (hard, silty, hard)	01			22.6	1.5	6.5	1.3	3.5	1.7	1.5
CARBONATE (slightly cherty <5%)	21			6.2	0.4	2.5	0.5	2.3	1.1	0.7
CONGLOMERATE-SANDSTONE-ARKOSE (medium hard)	22			6.1	0.4	5.8	1.1	0.0	0.0	0.4
CARBONATE (surface weathering, silty, medium hard)	20			30.9	2.0	10.2	2.0	4.6	2.2	2.1
TOTAL GOOD AGGREGATE	–			1393.5	89.9	457.0	89.8	180.6	88.2	89.2
CARBONATE (soft;silty; slightly shaley)	35			7.8	0.5	4.0	0.8	1.2	0.6	0.6
CHERT-CHERTY CARBONATE (< 20% leached chert)	26			6.0	0.4	0.0	0.0	2.1	1.0	0.6
CONCRETE (soft)				120.8	7.8	35.6	7.0	12.5	6.1	6.9
TOTAL FAIR AGGREGATE	–			134.6	8.7	39.6	7.8	15.8	7.7	8.0
CONCRETE (friable)	-			15.0	1.0	9.3	1.8	7.5	3.7	2.3
ASPHALT COATED PARTICALS				6.4	0.4	3.0	0.6	0.9	0.4	0.5
TOTAL POOR AGGREGATE	–			21.4	1.4	12.3	2.4	8.4	4.1	2.8
TOTAL DELETERIOUS AGGREGATE	**–**			0.0	0.0	0.0	0.0	0.0	0.0	0.0
Estimate % Crushed = 100%	**TOTALS**			1549.5	100.0	508.9	100.0	204.8	100.0	100.0
	CONTAMINANTS (Not included in PN calculations)									
	Totals (with contaminants)									

Please see Appendix A	% GOOD	0.0 X 1 =		89.9 X 1 =	89.9	89.8 X 1 =	89.8	88.2X 1 =	88.2	**Weighted Average PN**
	% FAIR	0.0 X 3 =		8.7 X 3 =	26.1	7.8 X 3 =	23.4	7.7 X 3 =	23.1	
	% POOR	0.0 X 6 =		1.4 X 6 =	14.0	2.4 X 6 =	14.4	4.1 X 6 =	24.6	
	% DELETERIOUS	0.0 X 10 =		0.0 X 10 =	0.0	0.0 X 10 =	0.0	0,0 X 10 =	0.0	
	PN =	0.0		130.0		127.6		135.9		132

COARSE AGGREGATE GRADATION OF AS-RECEIVED SAMPLE, % RETAINED

P75.0/R53.0	**P53.0 IR37.5**	**P37.5 I R26.5**	**P26.5 I R19.0**	**P19.0 I R13.2**	**P13.2 I R9.5**	**P 9.5 I R4.75**
-	-	-	6.6	24.2	27.0	42.2

PH-CC-343a 15-01

Approved By:

Ashley R. Meagher

Ashley Meagher, CCIL Petrographic Analyst
exp Services Inc.,
1595 Clark Blvd., Brampton ON L6T 4V1

September 8, 2022
Date

Ontario

LS-616 (Part A) FINE AGGREGATE PETROGRAPHIC ANALYSIS

Sample #:	**1P - Gran A RCA1010**	**Analyst:**	**Ashley Meagher**	**Date Tested:**	**9/7/2022**
Testing Lab:	**EXP Services Inc.**	**Telephone #:**	**905 793 9800 ext 2493**	**Fax #:**	
Sampled By:	**EXP Services Inc.**	**Date Sampled:**	**8/8/2022**	**Sample Type:**	
Source Name:	**Strada Aggregates**	**Source Location:**	**STRADA - CONCORD**	**MAIDB #:**	
Aggregate Type:	**Gran A (RCA1010)**	**Aggregate Product:**	**Exp Project Number: BRM-22019043-B0-100**		
CONTRACT #:		**CONTRACT LOCATION/HWY.:**		**CONTRACTOR:**	
LOT NUMBER:			**SUBLOT NUMBER:**		

ROCK, MINERAL OR MATERIAL TYPE	**SIEVE SIZE**												
	4.75 - 2.36		**2.36 - 1.18**		**1.18 - 600 µm**		**600 - 300 µm**		**300 - 150 µm**		**150 - 75 µm**		WEIGHTED AVERAGE
	#	%	#	%	#	%	#	%	#	%	#	%	
SILICATE ROCKS AND MINERALS (e.g. granite, gabbro, gneiss, quartz, feldspar, amphibole, quartzite)*	10	5.0	41	20.1	57	28.4	69	34.5	92	44.9	115	51.8	27.3
CARBONATE (e.g. limestone, dolostone, calcite, dolomite)	55	27.5	27	13.2	20	10.0	12	6.0	7	3.4	6	2.7	12.2
SHALE, ARGILLITE, CLAY, OCHRE													
MICACEOUS MINERALS (e.g. biotite, muscovite, chlorite)													
CHERT (leached and unleached), FLINT, JASPER													
CEMENTED PARTICLES													
SULPHATE ROCKS AND MINERALS (e.g. gypsite, gypsum, anhydrite)													
SULPHIDE ROCKS AND MINERALS (e.g. pyrite, pyrrhotite, chalcopyrite)													
HORNBLEND									1	0.5	6	2.7	0.4
CONCRETE	135	67.5	136	66.7	124	61.7	119	59.5	105	51.2	95	42.8	60.1
OTHER (please list, describe)													
TOTAL	200.0	100.0	204.0	100.0	201.0	100.0	200.0	100.0	205.0	100.0	222.0	100.0	100.0
GRADATION: percent retained on individual sieve	22.7		19.5		16.8		16.9		12.1		Ret.	8.2	
											Pass.	3.8	
Estimate percent totally crushed particles	100		100		100		100		100		100		

*Includes all silicate rock and mineral types except those listed as separate individual categories within the table (e.g. chert, micaceous minerals)

COMMENTS AND NOTES:

LS-609 (Part A) - Coarse Aggregate Petrographic Analysis (Petrographic Number, PN)

SAMPLE #: 2P - Gran A RCA1010	ANALYST: Ashley Meagher		DATE TESTED: September 23, 2022
TESTING LAB: EXP Services Inc.	TEL: 905 793 9800	FAX: 905 793 0641	EXP Project #: BRM-22019043-B0 - 100
SAMPLED BY: EXP Services Inc. (August 30th, 2022)	DATE RECEIVED: September 6, 2022		SAMPLE TYPE:
SOURCE NAME: D. Crupi & Sons Limited, Etobicoke	SOURCE LOCATION: 176 Bethridge Road, Etobicoke		MAIDB #:
AGGREGATE TYPE: Granular A (RCA1010)	AGGREGATE PRODUCT:		LOT #: SUBLOT #:
CONTRACT:	CONTRACT LOCATIONIHWY.:		CONTRACTOR:

TYPE	TYPE No.	53.0 / R19		P19.0 / R13.2		P13.2 / R9.5		P 9.5 / R4.75		Weighted Composition (%)
		Mass (g)	% of Fraction	Mass (g)	% of Fraction	Mass (g)	% of Fraction	Mass (g)	% of Fraction	
CONCRETE (HARD)				745.3	49.7	240.1	47.6	97.6	48.1	48.4
CONCRETE COVERED AGGREGATES (hard)				128.0	8.5	55.2	10.9	23.5	11.6	10.5
CARBONATE (slightly sandy, hard or medium hard)	02			52.5	3.5	18.0	3.6	3.6	1.8	2.7
GREYWACKE - ARGILLITE (medium hard)	06			57.9	3.9	16.3	3.2	2.1	1.0	2.4
CARBONATE (hard, silty, hard)	01			10.6	0.7	4.0	0.8	1.9	0.9	0.8
CARBONATE (slightly cherty <5%)	21			1.2	0.1	3.0	0.6	1.7	0.8	0.6
GRANITE-DIORITE-GABBRO (hard)	08			12.9	0.9	3.9	0.8	1.6	0.8	0.8
TRAP (hard)	09			7.8	0.5	2.6	0.5	0.3	0.1	0.4
CONGLOMERATE-SANDSTONE-ARKOSE (medium hard)	22			68.0	4.5	2.7	0.5	1.2	0.6	1.7
CARBONATE (surface weathering, silty, medium hard)	20			84.2	5.6	17.2	3.4	7.6	3.7	4.2
TOTAL GOOD AGGREGATE	–			1168.4	77.9	363.0	71.9	141.1	69.5	72.5
CARBONATE (soft;silty; slightly shaley)	35			0.0	0.0	4.1	0.8	1.6	0.8	0.6
CONCRETE (soft)				43.1	2.9	14.3	2.8	4.1	2.0	2.5
TOTAL FAIR AGGREGATE	–			43.1	2.9	18.4	3.6	5.7	2.8	3.0
CONCRETE (friable)	-			30.0	2.0	8.2	1.6	0.6	0.3	1.1
ASPHALT COATED PARTICALS				259.1	17.3	113.8	22.6	53.3	26.3	22.6
TOTAL POOR AGGREGATE	–			289.1	19.3	122.0	24.2	53.9	26.6	23.8
SHALE	61			3.6	0.2	1.2	0.2	0.2	0.1	0.2
ASPHALT				0.0	0.0	0.0	0.0	2.1	1.0	0.5
TOTAL DELETERIOUS AGGREGATE	**–**			0.0	0.2	1.2	0.2	2.3	1.1	0.7
Estimate % Crushed = 100%	**TOTALS**			1500.6	100.0	504.6	100.0	203.0	100.0	100.0
	CONTAMINANTS (Not included in PN calculations)									
	Totals (with contaminants)									

Please see appendix A	% GOOD	0.0 X 1 =		77.9 X 1 =	77.9	71.9 X 1 =	71.9	69.5 X 1 =	69.5	**Weighted Average PN**
	% FAIR	0.0 X 3 =		2.9 X 3 =	8.7	3.6 X 3 =	10.8	2.8 X 3 =	8.4	
	% POOR	0.0 X 6 =		19.3 X 6 =	115.8	24.2 X 6 =	145.2	26.6 X 6 =	159.6	
	% DELETERIOUS	0.0 X 10 =		0.2 X 10 =	2.0	0.2 X 10 =	2.0	1.1 X 10 =	11.0	
	PN =	0.0		204.4		229.9		248.5		230

COARSE AGGREGATE GRADATION OF AS-RECEIVED SAMPLE, % RETAINED

P75.0/R53.0	P53.0 IR37.5	P37.5 I R26.5	P26.5 I R19.0	P19.0 I R13.2	P13.2 I R9.5	P 9.5 I R4.75
-	-	-	7.1	22.2	26.0	44.6

PH-CC-343a 15-01

Approved By: Ashley R. Meagher

Ashley Meagher, CCIL Petrographic Analyst
exp Services Inc.,
1595 Clark Blvd., Brampton ON L6T 4V1

September 23, 2022
Date

Ontario

LS-616 (Part A) FINE AGGREGATE PETROGRAPHIC ANALYSIS

Sample #:	**2P-Gran A RCA1010**	**Analyst:**	**Ashley Meagher**	**Date Tested:**	**9/24/2022**
Testing Lab:	**EXP Services Inc.**	**Telephone #:**	**905 793 9800 ext 2493**	**Fax #:**	
Sampled By:	**EXP Services Inc.**	**Date Sampled:**	**8/30/2022**	**Sample Type:**	
Source Name:	**D. Crupi & Sons Ltd**	**Source Location:**	**176 Bethridge Road, Etobicoke**	**MAIDB #:**	
Aggregate Type:	**Gran A (RCA1010)**	**Aggregate Product:**	**Exp Project Number: BRM-22019043-B0-100**		
CONTRACT #:		**CONTRACT LOCATION/HWY.:**		**CONTRACTOR:**	
LOT NUMBER:			**SUBLOT NUMBER:**		

ROCK, MINERAL OR MATERIAL TYPE	**SIEVE SIZE**												WEIGHTED AVERAGE
	4.75 - 2.36		**2.36 - 1.18**		**1.18 - 600 µm**		**600 - 300 µm**		**300 - 150 µm**		**150 - 75 µm**		
	#	%	#	%	#	%	#	%	#	%	#	%	
SILICATE ROCKS AND MINERALS (e.g. granite, gabbro, gneiss, quartz, feldspar, amphibole, quartzite)*	8	3.7	25	11.2	41	19.1	48	22.3	84	37.5	120	58.5	21.9
CARBONATE (e.g. limestone, dolostone, calcite, dolomite)	70	32.4	60	26.8	55	25.6	44	20.5	36	16.1	39	19.0	24.2
SHALE, ARGILLITE, CLAY, OCHRE													
MICACEOUS MINERALS (e.g. biotite, muscovite, chlorite)											3	1.5	0.2
CHERT (leached and unleached), FLINT, JASPER													
CEMENTED PARTICLES													
SULPHATE ROCKS AND MINERALS (e.g. gypsite, gypsum, anhydrite)													
SULPHIDE ROCKS AND MINERALS (e.g. pyrite, pyrrhotite, chalcopyrite)													
HORNBLEND											8	3.9	0.4
CONCRETE	78	36.1	89	39.7	90	41.9	98	45.6	76	33.9	35	17.1	37.5
ASPHALT	60	27.8	50	22.3	29	13.5	25	11.6	28	12.5			15.8
TOTAL	216.0	100.0	224.0	100.0	215.0	100.0	215.0	100.0	224.0	100.0	205.0	100.0	100.0
GRADATION: percent retained on individual sieve	18.7		18.2		20.1		19.9		12.5		Ret.	7.6	
											Pass.	3.0	
Estimate percent totally crushed particles	100		100		100		100		100		100		

*Includes all silicate rock and mineral types except those listed as separate individual categories within the table (e.g. chert, micaceous minerals)

COMMENTS AND NOTES:

LS-609 (Part A) - Coarse Aggregate Petrographic Analysis (Petrographic Number, PN)

SAMPLE #: 3P- Gran A RCA1010	ANALYST: Ashley Meagher		DATE TESTED: September 5, 2022
TESTING LAB: EXP Services Inc.	TEL: 905 793 9800	FAX: 905 793 0641	EXP Project #: BRM-22019043-B0 - 100
SAMPLED BY: EXP Services Inc. (August 8, 2022)	DATE RECEIVED: August 18, 2022		SAMPLE TYPE:
SOURCE NAME: D. Crupi & Sons Limited (Markham)	SOURCE LOCATION: 2777 14th Ave. Markham, ON		MAIDB #:
AGGREGATE TYPE: Granular A (RCA1010)	AGGREGATE PRODUCT:		LOT #: SUBLOT #:
CONTRACT:	CONTRACT LOCATIONIHWY.:		CONTRACTOR:

TYPE	TYPE No.	53.0 / R19		P19.0 / R13.2		P13.2 / R9.5		P 9.5 / R4.75		Weighted Composition (%)
		Mass (g)	% of Fraction	Mass (g)	% of Fraction	Mass (g)	% of Fraction	Mass (g)	% of Fraction	
CONCRETE (HARD)				995.1	65.3	299.5	58.8	119.9	61.2	62.5
CONCRETE COVERED AGGREGATES (hard)				182.0	11.9	89.3	17.5	24.7	12.6	13.4
CARBONATE (slightly sandy, hard or medium hard)	02			93.9	6.2	28.9	5.7	12.1	6.2	6.1
GRANITE-DIORITE-GABBRO (hard)	08			22.4	1.5	10.2	2.0	3.2	1.6	1.6
CARBONATE (hard, silty, hard)	01			30.1	2.0	4.0	0.8	4.9	2.5	1.9
CARBONATE (slightly cherty <5%)	21			30.4	2.0	2.1	0.4	0.0	0.0	1.0
CONGLOMERATE-SANDSTONE-ARKOSE (medium hard)	22			4.2	0.3	2.7	0.5	1.2	0.6	0.4
CARBONATE (surface weathering, silty, medium hard)	20			37.3	2.4	20.6	4.0	5.6	2.9	2.9
TOTAL GOOD AGGREGATE	–			1395.4	91.5	457.3	89.8	171.6	87.6	89.8
CARBONATE (soft;silty; slightly shaley)	35			0.0	0.0	3.1	0.6	2.5	1.3	0.6
CHERT-CHERTY CARBONATE (< 20% leached chert)	26			6.0	0.4	2.0	0.4	1.1	0.6	0.4
CONCRETE (soft)				102.1	6.7	35.6	7.0	12.0	6.1	6.6
TOTAL FAIR AGGREGATE	–			108.1	7.1	40.7	8.0	15.6	8.0	7.6
CONCRETE (friable)	-			14.7	1.0	8.9	1.7	8.4	4.3	2.2
ASPHALT COATED PARTICALS				6.4	0.4	2.2	0.4	0.3	0.2	0.3
TOTAL POOR AGGREGATE	–			21.1	1.4	11.1	2.2	8.7	4.4	2.6
TOTAL DELETERIOUS AGGREGATE	**–**			0.0	0.0	0.0	0.0	0.0	0.0	0.0
Estimate % Crushed = 100%	**TOTALS**			1524.6	100.0	509.1	100.0	195.9	100.0	100.0
	CONTAMINANTS (Not included in PN calculations)									
	Totals (with contaminants)									

Please see appendix A	% GOOD	0.0 X 1 =		91.5 X 1 =	91.5	89.8X 1 =	89.8	87.6 X 1 =	87.6	**Weighted Average PN**
	% FAIR	0.0 X 3 =		7.1X 3 =	21.3	8.0 X 3 =	24.0	8.0 X 3 =	24.0	
	% POOR	0.0 X 6 =		1.4 X 6 =	14.0	2.2 X 6 =	13.2	4.4 X 6 =	26.4	
	% DELETERIOUS	0.0 X 10 =		0.0 X 10 =	0.0	0.0 X 10 =	0.0	0,0 X 10 =	0.0	
	PN =	0.0		126.8		127.0		138.0		131

COARSE AGGREGATE GRADATION OF AS-RECEIVED SAMPLE, % RETAINED

P75.0/R53.0	**P53.0 IR37.5**	**P37.5 I R26.5**	**P26.5 I R19.0**	**P19.0 I R13.2**	**P13.2 I R9.5**	**P 9.5 I R4.75**
-	-	-	15.6	28.4	22.7	33.3

PH-CC-343a 15-01

Approved By: Ashley R. Meagher

Ashley Meagher, CCIL Petrographic Analyst
exp Services Inc.,
1595 Clark Blvd., Brampton ON L6T 4V1

September 5, 2022
Date

LS-616 (Part A) FINE AGGREGATE PETROGRAPHIC ANALYSIS

Sample #:	**3P-Gran A RCA1010**	**Analyst:**	**Ashley Meagher**	**Date Tested:**	**9/6/2022**
Testing Lab:	**EXP Services Inc.**	**Telephone #:**	**905 793 9800 ext 2493**	**Fax #:**	
Sampled By:	**EXP Services Inc.**	**Date Sampled:**	**8/8/2022**	**Sample Type:**	
Source Name:	**D. Crupi & Sons Ltd**	**Source Location:**	**2777 14th Ave. Markham**	**MAIDB #:**	
Aggregate Type:	**Gran A (RCA1010)**	**Aggregate Product:**	**Exp Project Number: BRM-22019043-B0-100**		
CONTRACT #:		**CONTRACT LOCATION/HWY.:**		**CONTRACTOR:**	
LOT NUMBER:			**SUBLOT NUMBER:**		

ROCK, MINERAL OR MATERIAL TYPE	**SIEVE SIZE**												WEIGHTED AVERAGE
	4.75 - 2.36		**2.36 - 1.18**		**1.18 - 600 µm**		**600 - 300 µm**		**300 - 150 µm**		**150 - 75 µm**		
	#	%	#	%	#	%	#	%	#	%	#	%	
SILICATE ROCKS AND MINERALS (e.g. granite, gabbro, gneiss, quartz, feldspar, amphibole, quartzite)*	15	7.4	30	14.9	48	24.7	72	35.8	84	41.8	99	51.8	28.3
CARBONATE (e.g. limestone, dolostone, calcite, dolomite)	42	20.8	27	13.4	15	7.7	7	3.5	7	3.5	3	1.6	8.9
SHALE, ARGILLITE, CLAY, OCHRE													
MICACEOUS MINERALS (e.g. biotite, muscovite, chlorite)													
CHERT (leached and unleached), FLINT, JASPER													
CEMENTED PARTICLES													
SULPHATE ROCKS AND MINERALS (e.g. gypsite, gypsum, anhydrite)													
SULPHIDE ROCKS AND MINERALS (e.g. pyrite, pyrrhotite, chalcopyrite)													
HORNBLEND									1	0.5	3	1.6	0.3
CONCRETE	145	71.8	145	71.8	131	67.5	122	60.7	109	54.2	86	45.0	62.5
OTHER (please list, describe)													
TOTAL	202.0	100.0	202.0	100.0	194.0	100.0	201.0	100.0	201.0	100.0	191.0	100.0	100.0
GRADATION: percent retained on individual sieve	20.5		14.9		16.2		19.1		14.6		Ret. Pass.	9.7 5.0	
Estimate percent totally crushed particles	100		100		100		100		100		100		

*Includes all silicate rock and mineral types except those listed as separate individual categories within the table (e.g. chert, micaceous minerals)

COMMENTS AND NOTES:

LS-609 (Part A) - Coarse Aggregate Petrographic Analysis (Petrographic Number, PN)

SAMPLE #: 4P - Gran A RCA1010	ANALYST: Ashley Meagher		DATE TESTED: September 23, 2022	
TESTING LAB: EXP Services Inc.	TEL: 905 793 9800	FAX: 905 793 0641	EXP Project #: BRM-22019043-B0 - 100	
SAMPLED BY: EXP Services Inc. (August 30th, 2022)	DATE RECEIVED: September 6, 2022		SAMPLE TYPE:	
SOURCE NAME: D. Crupi & Sons Limited, Scarborough	SOURCE LOCATION: 85 Passmore Ave., Scarborough, ON		MAIDB #:	
AGGREGATE TYPE: Granular A (RCA1010)	AGGREGATE PRODUCT:		LOT #:	SUBLOT #:
CONTRACT:	CONTRACT LOCATIONIHWY.:		CONTRACTOR:	

TYPE	TYPE No.	53.0 / R19		P19.0 / R13.2		P13.2 / R9.5		P 9.5 / R4.75		Weighted Composition (%)
		Mass (g)	% of Fraction	Mass (g)	% of Fraction	Mass (g)	% of Fraction	Mass (g)	% of Fraction	
CONCRETE (HARD)				615.8	40.3	222.7	43.5	100.6	46.1	43.9
CONCRETE COVERED AGGREGATES (hard)				124.1	8.1	47.6	9.3	25.5	11.7	10.1
CARBONATE (slightly sandy, hard or medium hard)	02			33.8	2.2	18.0	3.5	3.6	1.7	2.3
GREYWACKE - ARGILLITE (medium hard)	06			47.1	3.1	14.9	2.9	2.1	1.0	2.1
CARBONATE (hard, silty, hard)	01			25.5	1.7	4.0	0.8	1.9	0.9	1.0
CARBONATE (slightly cherty <5%)	21			25.9	1.7	3.0	0.6	1.7	0.8	1.0
CONGLOMERATE-SANDSTONE-ARKOSE (medium hard)	22			5.8	0.4	2.7	0.5	1.2	0.6	0.5
CARBONATE (surface weathering, silty, medium hard)	20			71.2	4.7	17.2	3.4	7.6	3.5	3.7
TOTAL GOOD AGGREGATE	–			949.2	62.2	330.1	64.5	144.2	66.1	64.7
CARBONATE (soft;silty; slightly shaley)	35			20.8	1.4	3.2	0.6	1.8	0.8	0.9
CONCRETE (soft)				29.7	1.9	10.6	2.1	2.3	1.1	1.6
TOTAL FAIR AGGREGATE	–			50.5	3.3	13.8	2.7	4.1	1.9	2.5
CONCRETE (friable)	-			6.0	0.4	4.4	0.9	0.2	0.1	0.4
CEMENATAION (partial)	53			9.4	0.6	0.0	0.0	0.3	0.1	0.2
ASPHALT COATED PARTICALS				511.7	33.5	163.2	31.9	64.9	29.8	31.3
TOTAL POOR AGGREGATE	–			527.1	34.5	167.6	32.8	65.4	30.0	31.9
SHALE	61			0.0	0.0	0.0	0.0	0.3	0.1	0.1
ASPHALT				0.0	0.0	0.0	0.0	4.1	1.9	0.9
TOTAL DELETERIOUS AGGREGATE	**–**			0.0	0.0	0.0	0.0	4.4	2.0	1.0
Estimate % Crushed = 100%	**TOTALS**			1526.8	100.0	511.5	100.0	218.1	100.0	100.0
	WOOD			0.0	0.0	0.0	0.0	0.1	0.0	0.0
	CONTAMINANTS (Not included in PN calculations)									
	Totals (with contaminants)							218.2	100.0	0.0

Please see appendix A	% GOOD	0.0 X 1 =		62.2 X 1 =	62.2	64.5X 1 =	64.5	66.1 X 1 =	66.1	**Weighted Average PN**
	% FAIR	0.0 X 3 =		3.3 X 3 =	9.9	2.7 X 3 =	8.1	1.9 X 3 =	5.7	
	% POOR	0.0 X 6 =		34.6 X 6 =	207.0	32.8 X 6 =	196.8	30.0 X 6 =	180.0	
	% DELETERIOUS	0.0 X 10 =		0.0 X 10 =	0.0	0.0 X 10 =	0.0	2.0 X 10 =	20.0	
	PN =	0.0		279.1		269.4		271.8		273

COARSE AGGREGATE GRADATION OF AS-RECEIVED SAMPLE, % RETAINED

P75.0/R53.0	P53.0 IR37.5	P37.5 I R26.5	P26.5 I R19.0	P19.0 I R13.2	P13.2 I R9.5	P 9.5 I R4.75
-	-	-	5.8	19.5	29.1	45.6

PH-CC-343a 15-01

Approved By:

Ashley R. Meagher

Ashley Meagher, CCIL Petrographic Analyst
exp Services Inc.,
1595 Clark Blvd., Brampton ON L6T 4V1

September 23, 2022
Date

LS-616 (Part A) FINE AGGREGATE PETROGRAPHIC ANALYSIS

Sample #:	**4P-Gran A RCA1010**	**Analyst:**	**Ashley Meagher**	**Date Tested:**	**9/22/2022**
Testing Lab:	**EXP Services Inc.**	**Telephone #:**	**905 793 9800 ext 2493**	**Fax #:**	
Sampled By:	**EXP Services Inc.**	**Date Sampled:**	**8/30/2022**	**Sample Type:**	
Source Name:	**D. Crupi, Scarborough**	**Source Location:**	**2777 14th Ave. Markham**	**MAIDB #:**	
Aggregate Type:	**Gran A (RCA1010)**	**Aggregate Product:**	**Exp Project Number: BRM-22019043-B0-100**		
CONTRACT #:		**CONTRACT LOCATION/HWY.:**		**CONTRACTOR:**	
LOT NUMBER:			**SUBLOT NUMBER:**		

ROCK, MINERAL OR MATERIAL TYPE	**SIEVE SIZE**												
	4.75 - 2.36		**2.36 - 1.18**		**1.18 - 600 µm**		**600 - 300 µm**		**300 - 150 µm**		**150 - 75 µm**		WEIGHTED AVERAGE
	#	%	#	%	#	%	#	%	#	%	#	%	
SILICATE ROCKS AND MINERALS (e.g. granite, gabbro, gneiss, quartz, feldspar, amphibole, quartzite)*	4	1.8	6	2.8	20	10.0	38	19.0	90	44.6	155	66.2	19.2
CARBONATE (e.g. limestone, dolostone, calcite, dolomite)	20	8.9	15	7.1	10	5.0	7	3.5	6	3.0	4	1.7	5.2
SHALE, ARGILLITE, CLAY, OCHRE	2	0.9	1	0.5									0.3
MICACEOUS MINERALS (e.g. biotite, muscovite, chlorite)											2	0.9	0.1
CHERT (leached and unleached), FLINT, JASPER													
CEMENTED PARTICLES													
SULPHATE ROCKS AND MINERALS (e.g. gypsite, gypsum, anhydrite)													
SULPHIDE ROCKS AND MINERALS (e.g. pyrite, pyrrhotite, chalcopyrite)													
HORNBLEND											5	2.1	0.2
CONCRETE	140	62.5	130	61.6	122	61.0	112	56.0	68	33.7	35	15.0	52.2
ASPHALT	58	25.9	59	28.0	48	24.0	43	21.5	38	18.8	33	14.1	22.9
TOTAL	224.0	100.0	211.0	100.0	200.0	100.0	200.0	100.0	202.0	100.0	234.0	100.0	100.0
GRADATION: percent retained on individual sieve	20.1		16.9		18.8		20.9		13.7		Ret.	7.4	
											Pass.	2.2	
Estimate percent totally crushed particles	100		100		100		100		100		100		

*Includes all silicate rock and mineral types except those listed as separate individual categories within the table (e.g. chert, micaceous minerals)

COMMENTS AND NOTES:

LS-609 (Part A) - Coarse Aggregate Petrographic Analysis (Petrographic Number, PN)

SAMPLE #: 5P - Gran RCA1010	ANALYST: Ashley Meagher		DATE TESTED: September 27, 2022
TESTING LAB: EXP Services Inc.	TEL: 905 793 9800	FAX: 905 793 0641	EXP Project #: BRM-22019043-B0 - 100
SAMPLED BY: EXP Services Inc. (September 7, 2022)	DATE RECEIVED: September 9th, 2022		SAMPLE TYPE:
SOURCE NAME: Strada Aggregates	SOURCE LOCATION: Strada Brampton Depot - 20 Wentworth Crt., Brampton, ON		MAIDB #:
AGGREGATE TYPE: Gran A (RCA1010)	AGGREGATE PRODUCT:		LOT #: SUBLOT #:
CONTRACT:	CONTRACT LOCATIONIHWY.:		CONTRACTOR:

TYPE	TYPE No.	53.0 / R19		P19.0 / R13.2		P13.2 / R9.5		P 9.5 / R4.75		Weighted Composition (%)
		Mass (g)	% of Fraction	Mass (g)	% of Fraction	Mass (g)	% of Fraction	Mass (g)	% of Fraction	
CONCRETE (HARD)				1198.5	79.7	369.9	71.4	146.2	73.0	75.8
CONCRETE COVERED AGGREGATES (hard)				121.5	8.1	49.3	9.5	13.6	6.8	8.0
CARBONATE (slightly sandy, hard or medium hard)	02			17.2	1.1	8.1	1.6	2.6	1.3	1.3
GRANITE-DIORITE-GABBRO (hard)	08			12.2	0.8	5.6	1.1	1.5	0.7	0.9
CARBONATE (hard, silty, hard)	01			25.3	1.7	2.1	0.4	3.9	1.9	1.5
GREYWACKE (medium hard)	06			18.3	1.2	6.6	1.3	2.1	1.0	1.2
TRAP (hard)	09			10.5	0.7	2.1	0.4	0.9	0.4	0.6
CONGLOMERATE-SANDSTONE-ARKOSE (medium hard)	22			6.0	0.4	2.7	0.5	1.5	0.7	0.5
CARBONATE (surface weathering, silty, medium hard)	20			26.7	1.8	20.6	4.0	4.5	2.2	2.4
TOTAL GOOD AGGREGATE	–			1436.2	95.5	467.0	90.1	176.8	88.3	92.1
CARBONATE (soft;silty; slightly shaley)	35			0.0	0.0	4.5	0.9	3.2	1.6	0.7
CONCRETE (soft)				38.0	2.5	30.9	6.0	12.0	6.0	4.4
TOTAL FAIR AGGREGATE	–			38.0	2.5	35.4	6.8	15.2	7.6	5.0
CONCRETE (friable)	-			19.0	1.3	5.6	1.1	1.3	0.6	1.0
SILTSTONE	56					3.5	0.7	1.5	0.7	0.4
ASPHALT COATED PARTICALS				10.5	0.7	6.9	1.3	1.6	0.8	0.9
TOTAL POOR AGGREGATE	–			29.5	2.0	16.0	3.1	4.4	2.2	2.3
CLAY	62			0.0	0.0	0.0	0.0	0.4	0.2	0.1
ASPHALT				0.0	0.0	0.0	0.0	3.4	1.7	0.5
TOTAL DELETERIOUS AGGREGATE	**–**			0.0	0.0	0.0	0.0	3.8	1.9	0.6
Estimate % Crushed = 100%	**TOTALS**			1503.7	100.0	518.4	100.0	200.2	100.0	100.0
	CONTAMINANTS (Not included in PN calculations)									
	Totals (with contaminants)									
Please see appendix A	% GOOD	0.0 X 1 =		95.5 X 1 =	95.5	90.1 X 1 =	90.1	88.3 X 1 =	88.3	**Weighted Average PN**
	% FAIR	0.0 X 3 =		2.5 X 3 =	7.5	6.8 X 3 =	20.4	7.6 X 3 =	22.8	
	% POOR	0.0 X 6 =		1.4 X 6 =	12.0	3.1 X 6 =	18.6	2.2 X 6 =	13.2	
	% DELETERIOUS	0.0 X 10 =		0.0 X 10 =	0.0	0.0 X 10 =	0.0	1.9 X 10 =	19.0	
	PN =	0.0		115.0		129.1		143.3		127

COARSE AGGREGATE GRADATION OF AS-RECEIVED SAMPLE, % RETAINED

P75.0/R53.0	**P53.0 IR37.5**	**P37.5 I R26.5**	**P26.5 I R19.0**	**P19.0 I R13.2**	**P13.2 I R9.5**	**P 9.5 I R4.75**
-	-	-	12.8	34.2	23.5	29.5

PH-CC-343a 15-01

Approved By:

Ashley R. Meagher

Ashley Meagher, CCIL Petrographic Analyst
exp Services Inc.,
1595 Clark Blvd., Brampton ON L6T 4V1

September 27, 2022
Date

LS-616 (Part A) FINE AGGREGATE PETROGRAPHIC ANALYSIS

Sample #:	5P-Gran A RCA1010	**Analyst:**	Ashley Meagher	**Date Tested:**	9/25/2022
Testing Lab:	EXP Services Inc.	**Telephone #:**	905 793 9800 ext 2493	**Fax #:**	
Sampled By:	EXP Services Inc.	**Date Sampled:**	9/7/2022	**Sample Type:**	
Source Name:	Strada Aggregates	**Source Location:**	120 Wentworth Crt. Brampton	**MAIDB #:**	
Aggregate Type:	Gran A (RCA1010)	**Aggregate Product:**	Exp Project Number: BRM-22019043-B0-100		
CONTRACT #:		**CONTRACT LOCATION/HWY.:**		**CONTRACTOR:**	
LOT NUMBER:			**SUBLOT NUMBER:**		

ROCK, MINERAL OR MATERIAL TYPE	SIEVE SIZE												WEIGHTED AVERAGE
	4.75 - 2.36		2.36 - 1.18		1.18 - 600 µm		600 - 300 µm		300 - 150 µm		150 - 75 µm		
	#	%	#	%	#	%	#	%	#	%	#	%	
SILICATE ROCKS AND MINERALS (e.g. granite, gabbro, gneiss, quartz, feldspar, amphibole, quartzite)*	5	2.5	15	7.5	43	21.5	67	33.3	92	45.5	107	51.4	27.5
CARBONATE (e.g. limestone, dolostone, calcite, dolomite)	25	12.4	20	10.1	14	7.0	8	4.0	7	3.5	5	2.4	6.5
SHALE, ARGILLITE, CLAY, OCHRE	1	0.5	1	0.5									0.2
MICACEOUS MINERALS (e.g. biotite, muscovite, chlorite)													
CHERT (leached and unleached), FLINT, JASPER													
CEMENTED PARTICLES													
SULPHATE ROCKS AND MINERALS (e.g. gypsite, gypsum, anhydrite)													
SULPHIDE ROCKS AND MINERALS (e.g. pyrite, pyrrhotite, chalcopyrite)													
HORNBLEND							1	0.5	5	2.5	10	4.8	1.3
CONCRETE	165	82.1	160	80.4	141	70.5	125	62.2	98	48.5	86	41.3	63.8
ASHPHALT	5	2.5	3	1.5	2	1.0							0.8
TOTAL	201.0	100.0	199.0	100.0	200.0	100.0	201.0	100.0	202.0	100.0	208.0	100.0	100.0
GRADATION: percent retained on individual sieve	17.6		14.1		15.9		18.9		16.7		Ret. Pass.	11.8 5.0	
Estimate percent totally crushed particles	100		100		100		100		100		100		

*Includes all silicate rock and mineral types except those listed as separate individual categories within the table (e.g. chert, micaceous minerals)

COMMENTS AND NOTES:

LS-609 (Part A) - Coarse Aggregate Petrographic Analysis (Petrographic Number, PN)

SAMPLE #: 6P - Gran A RCA1010	ANALYST: Ashley Meagher		DATE TESTED: September 26, 2022
TESTING LAB: EXP Services Inc.	TEL: 905 793 9800	FAX: 905 793 0641	EXP Project #: BRM-22019043-B0 - 100
SAMPLED BY: EXP Services Inc. (September 8, 2022)	DATE RECEIVED: September 13th, 2022		SAMPLE TYPE:
SOURCE NAME: Strada Aggregates	SOURCE LOCATION: Strada Aggregate / Crusher - 10 Leslie Street, Toronto, ON		MAIDB #:
AGGREGATE TYPE: Granular A (RCA1010)	AGGREGATE PRODUCT:		LOT #: SUBLOT #:
CONTRACT:	CONTRACT LOCATIONIHWY.:		CONTRACTOR:

TYPE	TYPE No.	53.0 / R19		P19.0 / R13.2		P13.2 / R9.5		P 9.5 / R4.75		Weighted Composition (%)
		Mass (g)	% of Fraction	Mass (g)	% of Fraction	Mass (g)	% of Fraction	Mass (g)	% of Fraction	
CONCRETE (HARD)				1232.4	82.1	369.1	71.2	138.2	68.6	72.6
CONCRETE COVERED AGGREGATES (hard)				81.8	5.4	49.3	9.5	17.8	8.8	8.2
CARBONATE (slightly sandy, hard or medium hard)	02			21.1	1.4	8.1	1.6	3.0	1.5	1.5
GRANITE-DIORITE-GABBRO (hard)	08			0.0	0.0	3.8	0.7	1.1	0.5	0.5
CARBONATE (hard, silty, hard)	01			10.6	0.7	5.4	1.0	2.1	1.0	1.0
CONGLOMERATE-SANDSTONE-ARKOSE (medium hard)	22			0.0	0.0	4.5	0.9	0.0	0.0	0.3
CARBONATE (surface weathering, silty, medium hard)	20			55.0	3.7	25.7	5.0	11.8	5.9	5.1
TOTAL GOOD AGGREGATE	–			1400.9	93.3	465.9	89.9	174.0	86.4	89.1
CARBONATE (soft;silty; slightly shaley)	35			4.9	0.3	9.0	1.7	4.0	2.0	1.5
CONCRETE (soft)				38.9	2.6	23.9	4.6	15.6	7.7	5.6
TOTAL FAIR AGGREGATE	–			43.8	2.9	32.9	6.4	19.6	9.7	7.1
CONCRETE (friable)	-			13.5	0.9	6.7	1.3	2.3	1.1	1.1
ASPHALT COATED PARTICALS				19.6	1.3	6.9	1.3	4.2	2.1	1.7
TOTAL POOR AGGREGATE	–			33.1	2.2	13.6	2.6	6.5	3.2	2.8
SHALE	61			15.2	1.0	2.5	0.5	0.0	0.0	0.4
OCHRE	60			0.0	0.0	0.0	0.0	0.9	0.4	0.2
GYPSUM	79			8.7	0.6	3.2	0.6	0.4	0.2	0.4
TOTAL DELETERIOUS AGGREGATE	**–**			23.9	1.6	5.7	1.1	1.3	0.6	1.0
Estimate % Crushed = 100%	**TOTALS**			1501.7	100.0	518.1	100.0	201.4	100.0	100.0
	CONTAMINANTS (Not included in PN calculations)									
	Totals (with contaminants)									

Please see appendix A	% GOOD	0.0 X 1 =		93.3 X 1 =	93.3	89.9 X 1 =	89.9	86.4 X 1 =	86.4	**Weighted Average PN**
	% FAIR	0.0 X 3 =		2.9 X 3 =	8.7	6.4 X 3 =	19.2	9.7 X 3 =	29.1	
	% POOR	0.0 X 6 =		2.2 X 6 =	13.2	2..6 X 6 =	15.0	3.2 X 6 =	19.2	
	% DELETERIOUS	0.0 X 10 =		1.6 X 10 =	16.0	1.1 X 10 =	6.6	0.6 X 10 =	6.0	
	PN =	0.0		131.2		130.7		140.7		136

COARSE AGGREGATE GRADATION OF AS-RECEIVED SAMPLE, % RETAINED

P75.0/R53.0	**P53.0 IR37.5**	**P37.5 I R26.5**	**P26.5 I R19.0**	**P19.0 I R13.2**	**P13.2 I R9.5**	**P 9.5 I R4.75**
-	-	-	4.5	19.3	28.9	47.3

PH-CC-343a 15-01

Approved By: Ashley R Meagher

Ashley Meagher, CCIL Petrographic Analyst
exp Services Inc.,
1595 Clark Blvd., Brampton ON L6T 4V1

September 26, 2022
Date

Ontario

LS-616 (Part A) FINE AGGREGATE PETROGRAPHIC ANALYSIS

Sample #:	**6P-Gran A RCA1010**	**Analyst:**	**Ashley Meagher**	**Date Tested:**	**9/26/2022**
Testing Lab:	**EXP Services Inc.**	**Telephone #:**	**905 793 9800 ext 2493**	**Fax #:**	
Sampled By:	**EXP Services Inc.**	**Date Sampled:**	**9/8/2022**	**Sample Type:**	
Source Name:	**Strada Aggregates**	**Source Location:**	**10 Leslie Street, Toronto, ON**	**MAIDB #:**	
Aggregate Type:	**Gran A (RCA1010)**	**Aggregate Product:**	**Exp Project Number: BRM-22019043-B0-100**		
CONTRACT #:		**CONTRACT LOCATION/HWY.:**		**CONTRACTOR:**	
LOT NUMBER:			**SUBLOT NUMBER:**		

ROCK, MINERAL OR MATERIAL TYPE	**SIEVE SIZE**												WEIGHTED AVERAGE
	4.75 - 2.36		**2.36 - 1.18**		**1.18 - 600 µm**		**600 - 300 µm**		**300 - 150 µm**		**150 - 75 µm**		
	#	%	#	%	#	%	#	%	#	%	#	%	
SILICATE ROCKS AND MINERALS (e.g. granite, gabbro, gneiss, quartz, feldspar, amphibole, quartzite)*							12	6.0	29	14.5	40	19.5	7.3
CARBONATE (e.g. limestone, dolostone, calcite, dolomite)	10	5.0	9	4.5	5	2.5							1.7
SHALE, ARGILLITE, CLAY, OCHRE	3	1.5	2	1.0	1	0.5							0.4
MICACEOUS MINERALS (e.g. biotite, muscovite, chlorite)													
CHERT (leached and unleached), FLINT, JASPER													
CEMENTED PARTICLES													
SULPHATE ROCKS AND MINERALS (e.g. gypsite, gypsum, anhydrite)													
SANDSTONE	9	4.5	5	2.5	2	1.0							1.1
HORNBLEND									2	1.0	3	1.5	0.4
CONCRETE	140	70.0	153	76.5	165	82.5	160	80.0	157	78.5	160	78.0	77.9
ASPHALT	38	19.0	31	15.5	27	13.5	28	14.0	12	6.0	2	1.0	11.2
TOTAL	200.0	100.0	200.0	100.0	200.0	100.0	200.0	100.0	200.0	100.0	205.0	100.0	100.0
GRADATION: percent retained on individual sieve	13.9		13.0		15.8		22.0		19.1		Ret.	11.6	
											Pass.	4.6	
Estimate percent totally crushed particles	100		100		100		100		100		100		

*Includes all silicate rock and mineral types except those listed as separate individual categories within the table (e.g. chert, micaceous minerals)

COMMENTS AND NOTES:

APPENDIX A:

This appendix is applicable to all recycled concrete analyzed for this project 1P, 2P, 3P, 4P, 5P and 6P. The purpose of this investigation is to determine the suitability of recycled concrete material as a granular base for concrete and asphalt. The quality of the recycled concrete was an important component of this research. As such the concrete was subdivided into categories of Good, Fair, Poor and Deleterious. This was done by comparing the hardness of the concrete against a stainless-steel knife. The thickness of the scratch marks left on the recycled concrete determined its strength. It should be noted determining concrete hardness is not part of the LS-609 test method. Due to the objective of this project classifying the concrete into separate categories was necessary for engineers to have a complete understanding for the quality of the concrete.

It should be noted that when determining deleterious material, the principals of LS-609 were followed. Generally, to be considered Deleterious at least 75 percent of the particle has very low strength material. It can be crumbled or broken with fingers, or it can be scraped or peeled with ease.

Approved By:

Ashley R. Meagher

Ashley Meagher, CCIL Petrographic Analyst

exp Services Inc.,
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Summary of Petrographic Analysis (LS-609 Coarse Aggregates & LS-616 Fine Aggregates)

Sample No.	RCM-Aggregate Classification	% Total Good Agg.	% Total Fair Agg.	% Total Poor Agg.	% Total Deleterious Aggregate*	% Total Concrete	% Total Contamination**	% Total Gypsum	% Total Glass & Ceramic	%Total Wood
1P	Coarse **(PN132)**	89.2	8.0	2.8	0.0	84.9	0.0	0.0	0.0	0.0
	Fine	N/A	N/A	N/A	N/A	60.1	0.0	0.0	0.0	0.0
% Total Weighted for Sample 1P (For Coarse and Fine Aggregates)							**0.0**	**0.0**	**0.0**	**0.0**
2P	Coarse **(PN230)**	72.5	3.0	23.8	0.7	51.0	0.0	0.0	0.0	0.0
	Fine	N/A	N/A	N/A	N/A	37.5	0.0	0.0	0.0	0.0
% Total Weighted for Sample 2P (For Coarse and Fine Aggregates)							**0.0**	**0.0**	**0.0**	**0.0**
3P	Coarse**(PN131)**	89.8	7.6	2.6	0.0	84.7	0.0	0.0	0.0	0.0
	Fine	N/A	N/A	N/A	N/A	62.5	0.0	0.0	0.0	0.0
% Total Weighted for Sample 5P (For Coarse and Fine Aggregates)							**0.0**	**0.0**	**0.0**	**0.0**
4P	Coarse **(PN273)**	64.7	2.5	31.9	1	45.9	0.0	0.0	0.0	0.0
	Fine	N/A	N/A	N/A	N/A	52.2	0.0	0.0	0.0	0.0
% Total Weighted for Sample 4P (For Coarse and Fine Aggregates)							**0.0**	**0.0**	**0.0**	**0.0**
5P	Coarse**(PN 127)**	92.1	5.0	2.3	0.6	81.2	0.0	0.0	0.0	0.0
	Fine	N/A	N/A	N/A	N/A	63.8	0.0	0.0	0.0	0.0
% Total Weighted for Sample 5P (For Coarse and Fine Aggregates)							**0.0**	**0.0**	**0.0**	**0.0**
6P	Coarse**(PN136)**	89.1	7.1	2.8	1	83.8	0.0	0.4	0.0	0.0
	Fine	N/A	N/A	N/A	N/A	77.9	0.0	0.0	0.0	0.0
% Total Weighted for Sample 6P (For Coarse and Fine Aggregates)							**0.0**	**0.4**	**0.0**	**0.0**

* Deleterious Material means materials from the recycling stream other than glass, ceramic, reclaimed asphalt pavement, and reclaimed concrete materials that includes but is not limited to the following: wood, clay brick, clay tile, plastic, gypsum, gypsum plaster, and wallboard.

** Contamination Materials are included glass, ceramic, reclaimed asphalt pavement, and reclaimed concrete materials.

RESULTS OF ANALYSES OF SOLID

Bureau Veritas ID		TTK561		TTK561		
Sampling Date		2022/09/14		2022/09/14		
COC Number		n/a		n/a		
	UNITS	**RCM-10 LESLIE**	**QC Batch**	**RCM-10 LESLIE Lab-Dup**	**RDL**	**QC Batch**
Inorganics						
Available (CaCl2) pH	pH	12.1	8234730			
Soluble (20:1) Sulphate (SO4)	ug/g	870	8234726	870	40	8234726

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate

RESULTS OF ANALYSES OF SOLID

Bureau Veritas ID		TTK572	TTK573	TTQ112	TTQ113	
Sampling Date		2022/09/16	2022/09/16	2022/09/16	2022/09/16	
COC Number		n/a	n/a	n/a	n/a	
	UNITS	**LS- BRECKON EAST**	**LS- DUNDAS WEST**	**LS- BRECKON EAST-AFTER CRUSHING**	**LS- DUNDAS WEST-AFTER CRUSHING**	**QC Batch**
Inorganics						
Available (CaCl2) pH	pH	8.16	8.51	8.19	8.64	8234842
QC Batch = Quality Control Batch						

Your P.O. #: BRM-GEO
Your Project #: BRM-22019043-A0
Site Location: STRADA, D. CRUPI, SHELBORNE PIT, ON
Your C.O.C. #: n/a

Attention: Aamna Arora

exp Services Inc
Brampton Branch
1595 Clark Blvd
Brampton, ON
CANADA L6T 4V1

Report Date: 2022/09/08
Report #: R7288013
Version: 4 - Revision

CERTIFICATE OF ANALYSIS – REVISED REPORT

BUREAU VERITAS JOB #: C2M6136
Received: 2022/08/10, 16:40

Sample Matrix: Solid
Samples Received: 2

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
pH CaCl2 EXTRACT	2	2022/08/15	2022/08/15	CAM SOP-00413	EPA 9045 D m
Sulphate (20:1 Extract)	2	2022/08/15	2022/08/15	CAM SOP-00464	EPA 375.4 m

Remarks:

Bureau Veritas is accredited to ISO/IEC 17025 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by Bureau Veritas are based upon recognized Provincial, Federal or US method compendia such as CCME, MELCC, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in Bureau Veritas' profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and Bureau Veritas in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported; unless indicated otherwise, associated sample data are not blank corrected. Where applicable, unless otherwise noted, Measurement Uncertainty has not been accounted for when stating conformity to the referenced standard.

Bureau Veritas liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. Bureau Veritas has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by Bureau Veritas, unless otherwise agreed in writing. Bureau Veritas is not responsible for the accuracy or any data impacts, that result from the information provided by the customer or their agent.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.
Results relate to samples tested. When sampling is not conducted by Bureau Veritas, results relate to the supplied samples tested.
This Certificate shall not be reproduced except in full, without the written approval of the laboratory.
Reference Method suffix “m” indicates test methods incorporate validated modifications from specific reference methods to improve performance.
* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

Your P.O. #: BRM-GEO
Your Project #: BRM-22019043-A0
Site Location: STRADA, D. CRUPI, SHELBORNE PIT, ON
Your C.O.C. #: n/a

Attention: Aamna Arora

exp Services Inc
Brampton Branch
1595 Clark Blvd
Brampton, ON
CANADA L6T 4V1

Report Date: 2022/09/08
Report #: R7288013
Version: 4 - Revision

CERTIFICATE OF ANALYSIS – REVISED REPORT

BUREAU VERITAS JOB #: C2M6136
Received: 2022/08/10, 16:40

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Patricia Legette, Project Manager
Email: Patricia.Legette@bureauveritas.com
Phone# (905)817-5799
==
Bureau Veritas has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per ISO/IEC 17025, signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

RESULTS OF ANALYSES OF SOLID

Bureau Veritas ID		TKJ211		TKJ212		
Sampling Date		2022/08/08		2022/08/08		
COC Number		n/a		n/a		
	UNITS	**SS-STRADA**	**QC Batch**	**SS-CRUPI**	**RDL**	**QC Batch**
Inorganics						
Available (CaCl2) pH	pH	12.2	8166158	12.1		8166136
Soluble (20:1) Sulphate (SO4)	ug/g	700	8165777	650	20	8165777

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

TEST SUMMARY

Bureau Veritas ID: TKJ211
Sample ID: SS-STRADA
Matrix: Solid

Collected: 2022/08/08
Shipped:
Received: 2022/08/10

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
pH CaCl2 EXTRACT	AT	8166158	2022/08/15	2022/08/15	Taslima Aktar
Sulphate (20:1 Extract)	KONE/EC	8165777	2022/08/15	2022/08/15	Samuel Law

Bureau Veritas ID: TKJ212
Sample ID: SS-CRUPI
Matrix: Solid

Collected: 2022/08/08
Shipped:
Received: 2022/08/10

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
pH CaCl2 EXTRACT	AT	8166136	2022/08/15	2022/08/15	Taslima Aktar
Sulphate (20:1 Extract)	KONE/EC	8165777	2022/08/15	2022/08/15	Samuel Law

GENERAL COMMENTS

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

Package 1	3.3°C

Sample TKJ211 [SS-STRADA] : Sample bags, all containing headspace, were composited prior extraction. Analysis was performed with client consent.

Sample TKJ212 [SS-CRUPI] : Sample bags, all containing headspace, were composited prior extraction. Analysis was performed with client consent.

Results relate only to the items tested.

QUALITY ASSURANCE REPORT

			Matrix Spike		SPIKED BLANK		Method Blank		RPD	
QC Batch	**Parameter**	**Date**	**% Recovery**	**QC Limits**	**% Recovery**	**QC Limits**	**Value**	**UNITS**	**Value (%)**	**QC Limits**
8165777	Soluble (20:1) Sulphate (SO4)	2022/08/15	NC	70 - 130	106	70 - 130	<20	ug/g	0.095	35
8166136	Available (CaCl2) pH	2022/08/15			100	97 - 103			0.28	N/A
8166158	Available (CaCl2) pH	2022/08/16			100	97 - 103			0.17	N/A

N/A = Not Applicable

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

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

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

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

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

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by:

Eva P

Eva Pranjic

Ewa Pranjic, M.Sc., C.Chem, Scientific Specialist

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www.BVNA.com

6740 Campobello Road, Mississauga, Ontario L5N 2L8
Phone: 905-817-5700 Fax: 905-817-5779 Toll Free: 800-563-6266

CHAIN OF CUSTODY RECORD

ENV COC - 00014v3

Page 1 of 1

Invoice Information	Invoice to (requires report) ☐	Report Information (if differs from invoice)		Project Information	
Company:	Exp Services Inc	Company:		Quotation #:	Stream 3
Contact Name:	Aswan Assadi	Contact Name:	Aamna Arora	P.O. #/ AFE#:	BRM_GFO
Street Address:	1595 Clark Blvd	Street Address:		Project #:	BRM-22019043-A0
City:	Brampton Prov: ON Postal Code:	City:	Prov: Postal Code:	Site #:	
Phone:		Phone:		Site Location:	Strada, D. Crupi, Shelburne pit
Email:	aswan.assadi@exp.com	Email:	aamna.arora@exp.com	Site Location Province:	
Copies:		Copies:		Sampled By:	

LAB USE ONLY - PLACE STICKER HERE

Rush Confirmation #:

Regulatory Criteria

REG 153: ☐ Table 1 ☐ Table 2 ☐ Table 3 ☐ Table ____ ☐ Res/Park ☐ Ind/Comm ☐ Agri/other ☐ Med/Fine ☐ Course ☐ For RSC

OTHER: ☐ CCME ☐ Reg 558* *min 3 day TAT ☐ MISA ☐ PWQO ☑ Reg 406, Table: 2.1 ☐ Sanitary Sewer Bylaw ☐ Storm Sewer Bylaw Municipality ____ ☐ Other:

Include Criteria on Certificate of Analysis (check if yes): ☐

SAMPLES MUST BE KEPT COOL (<10°C) FROM TIME OF SAMPLING UNTIL DELIVERY TO BUREAU VERITAS

Regular Turnaround Time (TAT): ☑ 5 to 7 Day ☐ 10 Day

Rush Turnaround Time (TAT) Surcharges apply: ☐ Same Day ☐ 1 Day ☐ 2 Day ☐ 3 Day ☐ 4 Day

Date Required: YY __ MM __ DD __

	Sample Identification	Date Sampled YY	MM	DD	Time (24hr) HH	MM	Matrix	1 FIELD FILTERED	2 FIELD PRESERVED	3 LAB FILTRATION REQUIRED	4 BTEX/ F1	5 F2 - F4	6 VOCs	7 Reg 153 metals and inorganics	8 Reg 153 ICPMS metals	9 Reg 153 metals (Hg, Cr VI, ICPMS metals, HWS - B)	10	11 SPLP-metals and inorganics	12	13	14 SPLP-VOC	15 SPLP-SVOCs	16 pH and sulfate	17	18	19	20	21 # OF CONTAINERS SUBMITTED	22 HOLD - DO NOT ANALYZE	Comments
1	SS-Strada	22	08	08	AM		RC											✓			✓	✓	✓					1		recycled concrete (RC)
2	SS-Crupi	22	08	08	PM		RC											✓			✓	✓	✓					1		please process
3	SS1-GRA	22	08	09	AM		granular											✓			✓	✓						4		as necessary
4	SS2-GRA	22	08	09	AM		granular											✓										4		
5																														
6																														
7																														
8																														
9																														
10																														
11																														
12																														

10-Aug-22 16:40

Patricia Legette

C2M6136

RJM ENV-1479

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LAB USE ONLY	Yes	No	°C	1	2	3	LAB USE ONLY	Yes	No	°C	1	2	3	LAB USE ONLY	Yes	No	°C	1	2	3	Temperature reading by:
Seal present	✓			5	4	1	Seal present							Seal present							
Seal intact	✓						Seal intact							Seal intact							
Cooling media present							Cooling media present							Cooling media present							

	Relinquished by: (Signature/ Print)	Date YY	MM	DD	Time HH	MM	Received by: (Signature/ Print)	Date YY	MM	DD	Time HH	MM	Special instructions
1	Mary Stapleton	22	08	10	4	30		[illegible]	08	10	4	40	
2	MStapleton												

RESULTS OF ANALYSES OF SOLID

Bureau Veritas ID		TRQ867	TRQ868		
Sampling Date		2022/09/07	2022/09/07		
	UNITS	**RCM-WENTWORTH CT. BRAMPTON**	**RCMD-WENTWORTH CT. BRAMPTON**	**RDL**	**QC Batch**
Inorganics					
Available (CaCl2) pH	pH	12.1	12.2		8221136
Soluble (20:1) Sulphate (SO4)	ug/g	780	720	20	8223368

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Your P.O. #: BRM-GEO
Your Project #: BRM-22019043-A0
Site Location: VARIOUS YARDS-WATERDOWN, BETHRIDGE, SCARBOROUGH, ON
Your C.O.C. #: n/a

Attention: Aamna Arora

exp Services Inc
Brampton Branch
1595 Clark Blvd
Brampton, ON
CANADA L6T 4V1

Report Date: 2022/10/03
Report #: R7325692
Version: 6 - Revision

CERTIFICATE OF ANALYSIS – REVISED REPORT

BUREAU VERITAS JOB #: C2P0225
Received: 2022/08/31, 15:13

Sample Matrix: Solid
Samples Received: 2

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
pH CaCl2 EXTRACT	2	2022/09/06	2022/09/06	CAM SOP-00413	EPA 9045 D m
Sulphate (20:1 Extract)	2	2022/09/06	2022/09/06	CAM SOP-00464	EPA 375.4 m

Remarks:

Bureau Veritas is accredited to ISO/IEC 17025 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by Bureau Veritas are based upon recognized Provincial, Federal or US method compendia such as CCME, MELCC, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in Bureau Veritas' profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and Bureau Veritas in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported; unless indicated otherwise, associated sample data are not blank corrected. Where applicable, unless otherwise noted, Measurement Uncertainty has not been accounted for when stating conformity to the referenced standard.

Bureau Veritas liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. Bureau Veritas has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by Bureau Veritas, unless otherwise agreed in writing. Bureau Veritas is not responsible for the accuracy or any data impacts, that result from the information provided by the customer or their agent.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.
Results relate to samples tested. When sampling is not conducted by Bureau Veritas, results relate to the supplied samples tested.
This Certificate shall not be reproduced except in full, without the written approval of the laboratory.
Reference Method suffix “m” indicates test methods incorporate validated modifications from specific reference methods to improve performance.
* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

Your P.O. #: BRM-GEO
Your Project #: BRM-22019043-A0
Site Location: VARIOUS YARDS-WATERDOWN, BETHRIDGE, SCARBOROUGH, ON
Your C.O.C. #: n/a

Attention: Aamna Arora

exp Services Inc
Brampton Branch
1595 Clark Blvd
Brampton, ON
CANADA L6T 4V1

Report Date: 2022/10/03
Report #: R7325692
Version: 6 - Revision

CERTIFICATE OF ANALYSIS – REVISED REPORT

BUREAU VERITAS JOB #: C2P0225
Received: 2022/08/31, 15:13

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Patricia Legette, Project Manager
Email: Patricia.Legette@bureauveritas.com
Phone# (905)817-5799
==
Bureau Veritas has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per ISO/IEC 17025, signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Total Cover Pages : 2

RESULTS OF ANALYSES OF SOLID

Bureau Veritas ID		TPM834	TPM835		
Sampling Date		2022/08/30	2022/08/30		
COC Number		n/a	n/a		
	UNITS	**RCM-BETHRIDGE**	**RCM-SCARBOROUGH**	**RDL**	**QC Batch**
Inorganics					
Available (CaCl2) pH	pH	11.9	11.9		8207286
Soluble (20:1) Sulphate (SO4)	ug/g	830	840	40	8207212

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

TEST SUMMARY

Bureau Veritas ID: TPM834
Sample ID: RCM-BETHRIDGE
Matrix: Solid

Collected: 2022/08/30
Shipped:
Received: 2022/08/31

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
pH CaCl2 EXTRACT	AT	8207286	2022/09/06	2022/09/06	Taslima Aktar
Sulphate (20:1 Extract)	KONE/EC	8207212	2022/09/06	2022/09/06	Chandra Nandlal

Bureau Veritas ID: TPM835
Sample ID: RCM-SCARBOROUGH
Matrix: Solid

Collected: 2022/08/30
Shipped:
Received: 2022/08/31

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
pH CaCl2 EXTRACT	AT	8207286	2022/09/06	2022/09/06	Taslima Aktar
Sulphate (20:1 Extract)	KONE/EC	8207212	2022/09/06	2022/09/06	Chandra Nandlal

GENERAL COMMENTS

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

Package 1	9.0°C

Revised Report (2022/10/03): Showing only pH and Sulphate results for samples RCM-BETHRIDGE and RCM-SCARBOROUGH in this CofA as per Aamna Arora's request.

RCM-WATERDOWN: Final leach pH is 11.92.
RCM-BETHRIDGE: Final leach pH is 11.62.
RCM-SCARBOROUGH: Final leach pH is 11.66.

Results relate only to the items tested.

QUALITY ASSURANCE REPORT

			Matrix Spike		SPIKED BLANK		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
8207212	Soluble (20:1) Sulphate (SO4)	2022/09/06	103	70 - 130	103	70 - 130	<20	ug/g	NC	35
8207286	Available (CaCl2) pH	2022/09/06			100	97 - 103			2.0	N/A

N/A = Not Applicable

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

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

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

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

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (absolute difference <= 2x RDL).

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by:

Anastassia Hamanov, Scientific Specialist

---

www.BVNA.com

6740 Campobello Road, Mississauga, Ontario L5N 2L8
Phone: 905-817-5700 Fax: 905-817-5779 Toll Free: 800-563-6266

CHAIN OF CUSTODY RECORD

ENV COC - 00014v3

Page 1 of 1

Invoice Information Invoice to (requires report) ☐

Company: Exp Services Inc
Contact Name: Aswan Assadi
Street Address: 1595 Clark Blvd
City: Brampton Prov: ON Postal Code:
Phone:
Email: aswan.assadi@exp.com
Copies:

Report Information (if differs from invoice)

Company:
Contact Name: Aamna Arora
Street Address:
City: Prov: Postal Code:
Phone:
Email: aamna.arora@exp.com
Copies:

Project Information

Quotation #: Stream 3
P.O. #/ AFE#: BRM-GEO
Project #: BRM-22019843-A0
Site #: Various yards => Waterdown, Bethridge, Scarborough
Site Location:
Site Location Province:
Sampled By:

LAB USE ONLY - PLACE STICKER HERE

Rush Confirmation #:

Regulatory Criteria

REG 153: ☐ Table 1 ☐ Table 2 ☐ Table 3 ☐ Table ______ ☐ Res/Park ☐ Ind/Comm ☐ Agri/other ☐ Med/Fine ☐ Course ☐ For RSC

OTHER: ☐ CCME ☐ Reg 558* *min 3 day TAT ☐ MISA ☐ PWQO ☑ Reg 406, Table: 2.1 ☐ Sanitary Sewer Bylaw ☐ Storm Sewer Bylaw Municipality ______ ☐ Other:

Include Criteria on Certificate of Analysis (check if yes): ☐

SAMPLES MUST BE KEPT COOL (<10°C) FROM TIME OF SAMPLING UNTIL DELIVERY TO BUREAU VERITAS

	Sample Identification	Date Sampled YY	MM	DD	Time (24hr) HH	MM	Matrix	1 FIELD FILTERED	2 FIELD PRESERVED	3 LAB FILTRATION REQUIRED	4 BTEX/ F1	5 F2 - F4	6 VOCs	7 Reg 153 metals and inorganics	8 Reg 153 ICPMS metals	9 Reg 153 metals (Hg, Cr VI, ICPMS metals, HWS - B)	10	11 SPLP-metals and inorganics	12	13	14 SPLP-VOC	15 SPLP-SVOC	16 pH and sulfate	17	18	19	20	21 # OF CONTAINERS SUBMITTED	22 HOLD - DO NOT ANALYZE	Comments
1	RCM-Waterdown	Aug 24, 2022					RC											✓			✓	✓	✓					4		recycled concrete(RC)
2	RCM-Bethridge	Aug 30, 2022					RC											✓			✓	✓	✓					4		please process
3	RCM-Scarborough	Aug 30, 2022					RC											✓			✓	✓	✓					4		as necessary
4																														
5																														
6																														
7																														
8																														
9																														
10																														
11																														
12																														

Regular Turnaround Time (TAT)
☑ 5 to 7 Day ☐ 10 Day

Rush Turnaround Time (TAT) Surcharges apply
☐ Same Day ☐ 1 Day
☐ 2 Day ☐ 3 Day
☐ 4 Day
Date Required: YY MM DD

31-Aug-22 15:13
Patricia Legette
C2P0225
JDK ENV-1545

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LAB USE ONLY	Yes	No	°C	1	2	3
Seal present		✓		9	9	9
Seal intact		✓				
Cooling media present	✓					

LAB USE ONLY	Yes	No	°C	1	2	3
Seal present						
Seal intact						
Cooling media present						

LAB USE ONLY	Yes	No	°C	1	2	3	Temperature reading by:
Seal present							
Seal intact							
Cooling media present							

	Relinquished by: (Signature/ Print)	Date YY	MM	DD	Time HH	MM	Received by: (Signature/ Print)	Date YY	MM	DD	Time HH	MM	Special instructions
1	Karam Ismail-Vag	2022	Aug	31	2:59	PM		[illegible]	08	31	15	13	
2													

Your P.O. #: BRM-GEO
Your Project #: BRM-22019043-A0
Site Location: STRADA, D. CRUPI, SHELBORNE PIT, ON
Your C.O.C. #: n/a

Attention: Aamna Arora

exp Services Inc
Brampton Branch
1595 Clark Blvd
Brampton, ON
CANADA L6T 4V1

Report Date: 2022/09/15
Report #: R7296984
Version: 5 - Revision

CERTIFICATE OF ANALYSIS – REVISED REPORT

BUREAU VERITAS JOB #: C2M6136
Received: 2022/08/10, 16:40

Sample Matrix: Solid
Samples Received: 4

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
ABN Compounds in SPLP Leachates	3	2022/08/15	2022/08/16	CAM SOP-00301	EPA 8270 m
1,3-Dichloropropene Sum	3	N/A	2022/08/19		EPA 8260D m
Cyanide (WAD) in Leachates	4	N/A	2022/08/15	CAM SOP-00457	OMOE 3015 m
Dinitrotoluene Sum	3	N/A	2022/08/16	CAM SOP - 00301	EPA 8270
Fluoride by ISE in Leachates	4	2022/08/13	2022/08/15	CAM SOP-00449	SM 23 4500-F- C m
Mercury (low level SPLP Leachable)	4	2022/08/15	2022/08/15	CAM SOP-00453	EPA 7470 m
Total Metals in SPLP Leachate by ICPMS	4	2022/08/16	2022/08/16	CAM SOP-00447	EPA 6020B m
Modified SPLP extraction - Weight	4	N/A	2022/08/13	CAM SOP-00941	OMOECP LaSB E9003 R3
Nitrate& Nitrite as Nitrogen in Leachate	4	N/A	2022/08/16	CAM SOP-00440	SM 23 4500-NO3I/NO2B
pH CaCl2 EXTRACT	2	2022/08/15	2022/08/15	CAM SOP-00413	EPA 9045 D m
pH CaCl2 EXTRACT	1	2022/09/14	2022/09/14	CAM SOP-00413	EPA 9045 D m
Sulphate (20:1 Extract)	2	2022/08/15	2022/08/15	CAM SOP-00464	EPA 375.4 m
SPLP Zero Headspace Extraction	3	2022/08/15	2022/08/16	CAM SOP-00430	EPA 1312 m
Volatile organics in SPLP leachates	3	N/A	2022/08/18	CAM SOP-00228	EPA 8260D m

Remarks:

Bureau Veritas is accredited to ISO/IEC 17025 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by Bureau Veritas are based upon recognized Provincial, Federal or US method compendia such as CCME, MELCC, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in Bureau Veritas' profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and Bureau Veritas in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported; unless indicated otherwise, associated sample data are not blank corrected. Where applicable, unless otherwise noted, Measurement Uncertainty has not been accounted for when stating conformity to the referenced standard.

Bureau Veritas liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. Bureau Veritas has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by Bureau Veritas, unless otherwise agreed in writing. Bureau Veritas is not responsible for the accuracy or any data impacts, that result from the information provided by the customer or their agent.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope

Your P.O. #: BRM-GEO
Your Project #: BRM-22019043-A0
Site Location: STRADA, D. CRUPI, SHELBORNE PIT, ON
Your C.O.C. #: n/a

Attention: Aamna Arora

exp Services Inc
Brampton Branch
1595 Clark Blvd
Brampton, ON
CANADA L6T 4V1

Report Date: 2022/09/15
Report #: R7296984
Version: 5 - Revision

CERTIFICATE OF ANALYSIS – REVISED REPORT

BUREAU VERITAS JOB #: C2M6136
Received: 2022/08/10, 16:40

dilution methods.
Results relate to samples tested. When sampling is not conducted by Bureau Veritas, results relate to the supplied samples tested.
This Certificate shall not be reproduced except in full, without the written approval of the laboratory.
Reference Method suffix “m” indicates test methods incorporate validated modifications from specific reference methods to improve performance.
* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Patricia Legette, Project Manager
Email: Patricia.Legette@bureauveritas.com
Phone# (905)817-5799
==
Bureau Veritas has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per ISO/IEC 17025, signing the reports.
For Service Group specific validation please refer to the Validation Signature Page.

Total Cover Pages : 2

O.REG 406 EXCESS SOIL SPLP ABNS (SOLID)

Bureau Veritas ID		TKJ211	TKJ212			TKJ212		
Sampling Date		2022/08/08	2022/08/08			2022/08/08		
COC Number		n/a	n/a			n/a		
	UNITS	**SS-STRADA**	**SS-CRUPI**	**RDL**	**QC Batch**	**SS-CRUPI Lab-Dup**	**RDL**	**QC Batch**
Semivolatile Organics								
Leachable (SPLP) Bis(2-chloroethyl)ether	ug/L	<2.0	<2.0	2.0	8166687	<2.0	2.0	8166687
Leachable (SPLP) Bis(2-chloroisopropyl)ether	ug/L	<2.0	<2.0	2.0	8166687	<2.0	2.0	8166687
Leachable (SPLP) p-Chloroaniline	ug/L	<5.0	<5.0	5.0	8166687	<5.0	5.0	8166687
Leachable (SPLP) 3,3'-Dichlorobenzidine	ug/L	<0.40	<0.40	0.40	8166687	<0.40	0.40	8166687
Leachable (SPLP) Diethyl phthalate	ug/L	<1.0	<1.0	1.0	8166687	<1.0	1.0	8166687
Leachable (SPLP) Dimethyl phthalate	ug/L	<1.0	<1.0	1.0	8166687	<1.0	1.0	8166687
Leachable (SPLP) 2,4-Dinitrophenol	ug/L	<5.0	<5.0	5.0	8166687	<5.0	5.0	8166687
Leachable (SPLP) 2,4-Dinitrotoluene	ug/L	<3.0	<3.0	3.0	8166687	<3.0	3.0	8166687
Leachable (SPLP) 2,6-Dinitrotoluene	ug/L	<3.0	<3.0	3.0	8166687	<3.0	3.0	8166687
Leachable (SPLP) 2,4,6-Trichlorophenol	ug/L	<0.70	<0.70	0.70	8166687	<0.70	0.70	8166687
Calculated Parameters								
Leachable 2,4- & 2,6-Dinitrotoluene	ug/L	<4.2	<4.2	4.2	8162282			
Surrogate Recovery (%)								
Leachable (SPLP) 2,4,6-Tribromophenol	%	70	73		8166687	68		8166687
Leachable (SPLP) 2-Fluorobiphenyl	%	64	63		8166687	67		8166687
Leachable (SPLP) D14-Terphenyl (FS)	%	91	89		8166687	91		8166687
Leachable (SPLP) D5-Nitrobenzene	%	71	75		8166687	73		8166687

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate

O.REG 406 EXCESS SOIL SPLP ABNS (SOLID)

Bureau Veritas ID		TKJ213		
Sampling Date		2022/08/09		
COC Number		n/a		
	UNITS	**SS1-GRA**	**RDL**	**QC Batch**
Semivolatile Organics				
Leachable (SPLP) Bis(2-chloroethyl)ether	ug/L	<2.0	2.0	8166687
Leachable (SPLP) Bis(2-chloroisopropyl)ether	ug/L	<2.0	2.0	8166687
Leachable (SPLP) p-Chloroaniline	ug/L	<5.0	5.0	8166687
Leachable (SPLP) 3,3'-Dichlorobenzidine	ug/L	<0.40	0.40	8166687
Leachable (SPLP) Diethyl phthalate	ug/L	<1.0	1.0	8166687
Leachable (SPLP) Dimethyl phthalate	ug/L	<1.0	1.0	8166687
Leachable (SPLP) 2,4-Dinitrophenol	ug/L	<5.0	5.0	8166687
Leachable (SPLP) 2,4-Dinitrotoluene	ug/L	<3.0	3.0	8166687
Leachable (SPLP) 2,6-Dinitrotoluene	ug/L	<3.0	3.0	8166687
Leachable (SPLP) 2,4,6-Trichlorophenol	ug/L	<0.70	0.70	8166687
Calculated Parameters				
Leachable 2,4- & 2,6-Dinitrotoluene	ug/L	<4.2	4.2	8162282
Surrogate Recovery (%)				
Leachable (SPLP) 2,4,6-Tribromophenol	%	53		8166687
Leachable (SPLP) 2-Fluorobiphenyl	%	64		8166687
Leachable (SPLP) D14-Terphenyl (FS)	%	88		8166687
Leachable (SPLP) D5-Nitrobenzene	%	74		8166687

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

O.REG 406 EXCESS SOIL SPLP PREP (SOLID)

Bureau Veritas ID		TKJ211	TKJ211	TKJ212	TKJ213	TKJ214	
Sampling Date		2022/08/08	2022/08/08	2022/08/08	2022/08/09	2022/08/09	
COC Number		n/a	n/a	n/a	n/a	n/a	
	UNITS	**SS-STRADA**	**SS-STRADA Lab-Dup**	**SS-CRUPI**	**SS1-GRA**	**SS2-GRA**	**QC Batch**
Inorganics							
Dry Weight	g	100	100	100	100	100	8163223

QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate

O.REG 406 EXCESS SOIL SPLP VOCS (SOLID)

Bureau Veritas ID		TKJ211	TKJ212	TKJ213			TKJ213	
Sampling Date		2022/08/08	2022/08/08	2022/08/09			2022/08/09	
COC Number		n/a	n/a	n/a			n/a	
	UNITS	**SS-STRADA**	**SS-CRUPI**	**SS1-GRA**	**RDL**	**QC Batch**	**SS1-GRA Lab-Dup**	**QC Batch**
Charge/Prep Analysis								
Amount Extracted (Wet Weight) (g)	N/A	25	25	25	N/A	8166289	25	8166289
Calculated Parameters								
Leachable (ZHE) 1,3-Dichloropropene (cis+trans)	ug/L	<0.42	<0.42	<0.42	0.42	8161008		
Volatile Organics								
Leachable (SPLP) Bromomethane	ug/L	<0.40	<0.40	<0.40	0.40	8173937		
Leachable (SPLP) Carbon Tetrachloride	ug/L	<0.19	<0.19	<0.19	0.19	8173937		
Leachable (SPLP) Chloroform	ug/L	<0.90	<0.90	<0.90	0.90	8173937		
Leachable (SPLP) 1,2-Dichlorobenzene	ug/L	<0.40	<0.40	<0.40	0.40	8173937		
Leachable (SPLP) 1,4-Dichlorobenzene	ug/L	<0.40	<0.40	<0.40	0.40	8173937		
Leachable (SPLP) 1,1-Dichloroethane	ug/L	<0.40	<0.40	<0.40	0.40	8173937		
Leachable (SPLP) 1,2-Dichloroethane	ug/L	<0.40	<0.40	<0.40	0.40	8173937		
Leachable (SPLP) 1,1-Dichloroethylene	ug/L	<0.40	<0.40	<0.40	0.40	8173937		
Leachable (SPLP) cis-1,2-Dichloroethylene	ug/L	<0.40	<0.40	<0.40	0.40	8173937		
Leachable (SPLP) trans-1,2-Dichloroethylene	ug/L	<0.40	<0.40	<0.40	0.40	8173937		
Leachable (SPLP) 1,2-Dichloropropane	ug/L	<0.40	<0.40	<0.40	0.40	8173937		
Leachable (SPLP) cis-1,3-Dichloropropene	ug/L	<0.30	<0.30	<0.30	0.30	8173937		
Leachable (SPLP) trans-1,3-Dichloropropene	ug/L	<0.30	<0.30	<0.30	0.30	8173937		
Leachable (SPLP) Ethylene Dibromide	ug/L	<0.19	<0.19	<0.19	0.19	8173937		
Leachable (SPLP) 1,1,1,2-Tetrachloroethane	ug/L	<0.40	<0.40	<0.40	0.40	8173937		
Leachable (SPLP) 1,1,2,2-Tetrachloroethane	ug/L	<0.40	<0.40	<0.40	0.40	8173937		
Leachable (SPLP) Tetrachloroethylene	ug/L	<0.40	<0.40	<0.40	0.40	8173937		
Leachable (SPLP) 1,1,2-Trichloroethane	ug/L	<0.40	<0.40	<0.40	0.40	8173937		
Leachable (SPLP) Trichloroethylene	ug/L	<0.40	<0.40	<0.40	0.40	8173937		
Surrogate Recovery (%)								
Leachable (SPLP) 4-Bromofluorobenzene	%	89	89	86		8173937		
Leachable (SPLP) D4-1,2-Dichloroethane	%	113	113	112		8173937		
Leachable (SPLP) D8-Toluene	%	95	95	94		8173937		

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate
N/A = Not Applicable

SPLP INORGANICS PACKAGE (SOLID)

Bureau Veritas ID		TKJ211			TKJ211			TKJ212	TKJ213		
Sampling Date		2022/08/08			2022/08/08			2022/08/08	2022/08/09		
COC Number		n/a			n/a			n/a	n/a		
	UNITS	**SS-STRADA**	**RDL**	**QC Batch**	**SS-STRADA Lab-Dup**	**RDL**	**QC Batch**	**SS-CRUPI**	**SS1-GRA**	**RDL**	**QC Batch**
Inorganics											
Leachable Fluoride (F-)	mg/L	0.17	0.10	8164846	0.14	0.10	8164846	<0.10	<0.10	0.10	8164846
Leachable WAD Cyanide (Free)	mg/L	<0.010	0.010	8164851	<0.010	0.010	8164851	<0.010	<0.010	0.010	8164851
Leachable Nitrite (N)	mg/L	<0.10	0.10	8164845	<0.10	0.10	8164845	<0.10	<0.10	0.10	8164845
Leachable Nitrate (N)	mg/L	<1.0	1.0	8164845	<1.0	1.0	8164845	<1.0	<1.0	1.0	8164845
Leachable Nitrate + Nitrite (N)	mg/L	<1.0	1.0	8164845	<1.0	1.0	8164845	<1.0	<1.0	1.0	8164845
Metals											
Leachable (SPLP) Antimony (Sb)	ug/L	<0.5	0.5	8167865				<0.5	<0.5	0.5	8167865
Leachable (SPLP) Arsenic (As)	ug/L	<1	1	8167865				<1	<1	1	8167865
Leachable (SPLP) Barium (Ba)	ug/L	34	5	8167865				66	6	5	8167865
Leachable (SPLP) Beryllium (Be)	ug/L	<0.5	0.5	8167865				<0.5	<0.5	0.5	8167865
Leachable (SPLP) Boron (B)	ug/L	<10	10	8167865				<10	<10	10	8167865
Leachable (SPLP) Cadmium (Cd)	ug/L	<0.1	0.1	8167865				<0.1	<0.1	0.1	8167865
Leachable (SPLP) Chromium (Cr)	ug/L	6	5	8167865				<5	<5	5	8167865
Leachable (SPLP) Cobalt (Co)	ug/L	<0.5	0.5	8167865				<0.5	<0.5	0.5	8167865
Leachable (SPLP) Copper (Cu)	ug/L	<1	1	8167865				2	<1	1	8167865
Leachable (SPLP) Lead (Pb)	ug/L	<0.5	0.5	8167865				<0.5	<0.5	0.5	8167865
Leachable (SPLP) Mercury (Hg)	ug/L	0.04	0.02	8166486	0.05	0.02	8166486	<0.02	<0.02	0.02	8166486
Leachable (SPLP) Molybdenum (Mo)	ug/L	2	1	8167865				1	<1	1	8167865
Leachable (SPLP) Nickel (Ni)	ug/L	<1	1	8167865				<1	<1	1	8167865
Leachable (SPLP) Selenium (Se)	ug/L	<2	2	8167865				<2	<2	2	8167865
Leachable (SPLP) Silver (Ag)	ug/L	<0.1	0.1	8167865				<0.1	<0.1	0.1	8167865
Leachable (SPLP) Thallium (Tl)	ug/L	<0.05	0.05	8167865				<0.05	<0.05	0.05	8167865
Leachable (SPLP) Vanadium (V)	ug/L	2	1	8167865				<1	<1	1	8167865
Leachable (SPLP) Zinc (Zn)	ug/L	<5	5	8167865				<5	<5	5	8167865

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate

SPLP INORGANICS PACKAGE (SOLID)

Bureau Veritas ID		TKJ214			TKJ214		
Sampling Date		2022/08/09			2022/08/09		
COC Number		n/a			n/a		
	UNITS	**SS2-GRA**	**RDL**	**QC Batch**	**SS2-GRA Lab-Dup**	**RDL**	**QC Batch**
Inorganics							
Leachable Fluoride (F-)	mg/L	<0.10	0.10	8164846			
Leachable WAD Cyanide (Free)	mg/L	<0.010	0.010	8164851			
Leachable Nitrite (N)	mg/L	<0.10	0.10	8164845			
Leachable Nitrate (N)	mg/L	<1.0	1.0	8164845			
Leachable Nitrate + Nitrite (N)	mg/L	<1.0	1.0	8164845			
Metals							
Leachable (SPLP) Antimony (Sb)	ug/L	<0.5	0.5	8167865	<0.5	0.5	8167865
Leachable (SPLP) Arsenic (As)	ug/L	<1	1	8167865	<1	1	8167865
Leachable (SPLP) Barium (Ba)	ug/L	9	5	8167865	9	5	8167865
Leachable (SPLP) Beryllium (Be)	ug/L	<0.5	0.5	8167865	<0.5	0.5	8167865
Leachable (SPLP) Boron (B)	ug/L	<10	10	8167865	<10	10	8167865
Leachable (SPLP) Cadmium (Cd)	ug/L	<0.1	0.1	8167865	<0.1	0.1	8167865
Leachable (SPLP) Chromium (Cr)	ug/L	<5	5	8167865	<5	5	8167865
Leachable (SPLP) Cobalt (Co)	ug/L	<0.5	0.5	8167865	<0.5	0.5	8167865
Leachable (SPLP) Copper (Cu)	ug/L	<1	1	8167865	<1	1	8167865
Leachable (SPLP) Lead (Pb)	ug/L	<0.5	0.5	8167865	<0.5	0.5	8167865
Leachable (SPLP) Mercury (Hg)	ug/L	<0.02	0.02	8166486			
Leachable (SPLP) Molybdenum (Mo)	ug/L	<1	1	8167865	<1	1	8167865
Leachable (SPLP) Nickel (Ni)	ug/L	<1	1	8167865	<1	1	8167865
Leachable (SPLP) Selenium (Se)	ug/L	<2	2	8167865	<2	2	8167865
Leachable (SPLP) Silver (Ag)	ug/L	<0.1	0.1	8167865	<0.1	0.1	8167865
Leachable (SPLP) Thallium (Tl)	ug/L	<0.05	0.05	8167865	<0.05	0.05	8167865
Leachable (SPLP) Vanadium (V)	ug/L	<1	1	8167865	<1	1	8167865
Leachable (SPLP) Zinc (Zn)	ug/L	<5	5	8167865	<5	5	8167865

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate

RESULTS OF ANALYSES OF SOLID

Bureau Veritas ID		TKJ211		TKJ212			TKJ213	TKJ213	
Sampling Date		2022/08/08		2022/08/08			2022/08/09	2022/08/09	
COC Number		n/a		n/a			n/a	n/a	
	UNITS	**SS-STRADA**	**QC Batch**	**SS-CRUPI**	**RDL**	**QC Batch**	**SS1-GRA**	**SS1-GRA Lab-Dup**	**QC Batch**
Inorganics									
Available (CaCl2) pH	pH	12.2	8166158	12.1		8166136	8.17	8.22	8224503
Soluble (20:1) Sulphate (SO4)	ug/g	700	8165777	650	20	8165777			

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate

TEST SUMMARY

Bureau Veritas ID: TKJ211
Sample ID: SS-STRADA
Matrix: Solid

Collected: 2022/08/08
Shipped:
Received: 2022/08/10

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
ABN Compounds in SPLP Leachates	GC/MS	8166687	2022/08/15	2022/08/16	Milijana Avramovic
1,3-Dichloropropene Sum	CALC	8161008	N/A	2022/08/19	Automated Statchk
Cyanide (WAD) in Leachates	SKAL/CN	8164851	N/A	2022/08/15	Prgya Panchal
Dinitrotoluene Sum	CALC	8162282	N/A	2022/08/16	Automated Statchk
Fluoride by ISE in Leachates	ISE	8164846	2022/08/13	2022/08/15	Kien Tran
Mercury (low level SPLP Leachable)	CV/AA	8166486	2022/08/15	2022/08/15	Japneet Gill
Total Metals in SPLP Leachate by ICPMS	ICP/MS	8167865	2022/08/16	2022/08/16	Prempal Bhatti
Modified SPLP extraction - Weight		8163223	N/A	2022/08/13	Jian (Ken) Wang
Nitrate& Nitrite as Nitrogen in Leachate	LACH	8164845	N/A	2022/08/16	Raiq Kashif
pH CaCl2 EXTRACT	AT	8166158	2022/08/15	2022/08/15	Taslima Aktar
Sulphate (20:1 Extract)	KONE/EC	8165777	2022/08/15	2022/08/15	Samuel Law
SPLP Zero Headspace Extraction		8166289	2022/08/15	2022/08/16	Archit Prajapati
Volatile organics in SPLP leachates	HS/MS	8173937	N/A	2022/08/18	Gladys Guerrero

Bureau Veritas ID: TKJ211 Dup
Sample ID: SS-STRADA
Matrix: Solid

Collected: 2022/08/08
Shipped:
Received: 2022/08/10

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Cyanide (WAD) in Leachates	SKAL/CN	8164851	N/A	2022/08/15	Prgya Panchal
Fluoride by ISE in Leachates	ISE	8164846	2022/08/13	2022/08/15	Kien Tran
Mercury (low level SPLP Leachable)	CV/AA	8166486	2022/08/15	2022/08/15	Japneet Gill
Modified SPLP extraction - Weight		8163223	N/A	2022/08/13	Jian (Ken) Wang
Nitrate& Nitrite as Nitrogen in Leachate	LACH	8164845	N/A	2022/08/16	Raiq Kashif

Bureau Veritas ID: TKJ212
Sample ID: SS-CRUPI
Matrix: Solid

Collected: 2022/08/08
Shipped:
Received: 2022/08/10

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
ABN Compounds in SPLP Leachates	GC/MS	8166687	2022/08/15	2022/08/16	Milijana Avramovic
1,3-Dichloropropene Sum	CALC	8161008	N/A	2022/08/19	Automated Statchk
Cyanide (WAD) in Leachates	SKAL/CN	8164851	N/A	2022/08/15	Prgya Panchal
Dinitrotoluene Sum	CALC	8162282	N/A	2022/08/16	Automated Statchk
Fluoride by ISE in Leachates	ISE	8164846	2022/08/13	2022/08/15	Kien Tran
Mercury (low level SPLP Leachable)	CV/AA	8166486	2022/08/15	2022/08/15	Japneet Gill
Total Metals in SPLP Leachate by ICPMS	ICP/MS	8167865	2022/08/16	2022/08/16	Prempal Bhatti
Modified SPLP extraction - Weight		8163223	N/A	2022/08/13	Jian (Ken) Wang
Nitrate& Nitrite as Nitrogen in Leachate	LACH	8164845	N/A	2022/08/16	Raiq Kashif
pH CaCl2 EXTRACT	AT	8166136	2022/08/15	2022/08/15	Taslima Aktar
Sulphate (20:1 Extract)	KONE/EC	8165777	2022/08/15	2022/08/15	Samuel Law
SPLP Zero Headspace Extraction		8166289	2022/08/15	2022/08/16	Archit Prajapati
Volatile organics in SPLP leachates	HS/MS	8173937	N/A	2022/08/18	Gladys Guerrero

TEST SUMMARY

Bureau Veritas ID: TKJ212 Dup
Sample ID: SS-CRUPI
Matrix: Solid

Collected: 2022/08/08
Shipped:
Received: 2022/08/10

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
ABN Compounds in SPLP Leachates	GC/MS	8166687	2022/08/15	2022/08/16	Milijana Avramovic

Bureau Veritas ID: TKJ213
Sample ID: SS1-GRA
Matrix: Solid

Collected: 2022/08/09
Shipped:
Received: 2022/08/10

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
ABN Compounds in SPLP Leachates	GC/MS	8166687	2022/08/15	2022/08/16	Milijana Avramovic
1,3-Dichloropropene Sum	CALC	8161008	N/A	2022/08/19	Automated Statchk
Cyanide (WAD) in Leachates	SKAL/CN	8164851	N/A	2022/08/15	Prgya Panchal
Dinitrotoluene Sum	CALC	8162282	N/A	2022/08/16	Automated Statchk
Fluoride by ISE in Leachates	ISE	8164846	2022/08/13	2022/08/15	Kien Tran
Mercury (low level SPLP Leachable)	CV/AA	8166486	2022/08/15	2022/08/15	Japneet Gill
Total Metals in SPLP Leachate by ICPMS	ICP/MS	8167865	2022/08/16	2022/08/16	Prempal Bhatti
Modified SPLP extraction - Weight		8163223	N/A	2022/08/13	Jian (Ken) Wang
Nitrate& Nitrite as Nitrogen in Leachate	LACH	8164845	N/A	2022/08/16	Raiq Kashif
pH CaCl2 EXTRACT	AT	8224503	2022/09/14	2022/09/14	Taslima Aktar
SPLP Zero Headspace Extraction		8166289	2022/08/15	2022/08/16	Archit Prajapati
Volatile organics in SPLP leachates	HS/MS	8173937	N/A	2022/08/18	Gladys Guerrero

Bureau Veritas ID: TKJ213 Dup
Sample ID: SS1-GRA
Matrix: Solid

Collected: 2022/08/09
Shipped:
Received: 2022/08/10

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
pH CaCl2 EXTRACT	AT	8224503	2022/09/14	2022/09/14	Taslima Aktar
SPLP Zero Headspace Extraction		8166289	2022/08/15	2022/08/16	Archit Prajapati

Bureau Veritas ID: TKJ214
Sample ID: SS2-GRA
Matrix: Solid

Collected: 2022/08/09
Shipped:
Received: 2022/08/10

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Cyanide (WAD) in Leachates	SKAL/CN	8164851	N/A	2022/08/15	Prgya Panchal
Fluoride by ISE in Leachates	ISE	8164846	2022/08/13	2022/08/15	Kien Tran
Mercury (low level SPLP Leachable)	CV/AA	8166486	2022/08/15	2022/08/15	Japneet Gill
Total Metals in SPLP Leachate by ICPMS	ICP/MS	8167865	2022/08/16	2022/08/16	Prempal Bhatti
Modified SPLP extraction - Weight		8163223	N/A	2022/08/13	Jian (Ken) Wang
Nitrate& Nitrite as Nitrogen in Leachate	LACH	8164845	N/A	2022/08/16	Raiq Kashif

TEST SUMMARY

Bureau Veritas ID: TKJ214 Dup
Sample ID: SS2-GRA
Matrix: Solid

Collected: 2022/08/09
Shipped:
Received: 2022/08/10

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Total Metals in SPLP Leachate by ICPMS	ICP/MS	8167865	2022/08/16	2022/08/16	Prempal Bhatti

GENERAL COMMENTS

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

Package 1	3.3°C

Revised Report (2022/09/15): Additional analysis for pH completed on sample SS1-GRA. Final leach pH results included in this CofA as per Aamna Arora's request.

SS-STRADA: Final leach pH is 11.89.
SS-CRUPI: Final leach pH is 11.68.
SS1-GRA: Final leach pH is 9.67.
SS2-GRA: Final leach pH is 9.62.

Sample TKJ211 [SS-STRADA] : Sample bags, all containing headspace, were composited prior extraction. Analysis was performed with client consent.

Sample TKJ212 [SS-CRUPI] : Sample bags, all containing headspace, were composited prior extraction. Analysis was performed with client consent.

Sample TKJ213 [SS1-GRA] : Sample container submitted with headspace. Analysis performed with client consent.

Results relate only to the items tested.

QUALITY ASSURANCE REPORT

			Matrix Spike		SPIKED BLANK		Method Blank		RPD		Leachate Blank	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits	Value	UNITS
8166687	Leachable (SPLP) 2,4,6-Tribromophenol	2022/08/16	78	30 - 130	86	30 - 130	65	%				
8166687	Leachable (SPLP) 2-Fluorobiphenyl	2022/08/16	68	30 - 130	73	30 - 130	66	%				
8166687	Leachable (SPLP) D14-Terphenyl (FS)	2022/08/16	95	30 - 130	92	30 - 130	91	%				
8166687	Leachable (SPLP) D5-Nitrobenzene	2022/08/16	72	30 - 130	78	30 - 130	70	%				
8173937	Leachable (SPLP) 4-Bromofluorobenzene	2022/08/18	96	70 - 130	96	70 - 130	88	%				
8173937	Leachable (SPLP) D4-1,2-Dichloroethane	2022/08/18	110	70 - 130	103	70 - 130	114	%				
8173937	Leachable (SPLP) D8-Toluene	2022/08/18	106	70 - 130	108	70 - 130	95	%				
8164845	Leachable Nitrate (N)	2022/08/16	95	80 - 120	103	80 - 120	<1.0	mg/L	NC	25	<1.0	mg/L
8164845	Leachable Nitrate + Nitrite (N)	2022/08/16	98	80 - 120	104	80 - 120	<1.0	mg/L	NC	25	<1.0	mg/L
8164845	Leachable Nitrite (N)	2022/08/16	109	80 - 120	106	80 - 120	<0.10	mg/L	NC	25	<0.10	mg/L
8164846	Leachable Fluoride (F-)	2022/08/15	73 (1)	80 - 120	93	80 - 120	<0.10	mg/L	16	25	<0.10	mg/L
8164851	Leachable WAD Cyanide (Free)	2022/08/15	91	80 - 120	91	80 - 120	<0.0020	mg/L	NC	20	<0.010	mg/L
8165777	Soluble (20:1) Sulphate (SO4)	2022/08/15	NC	70 - 130	106	70 - 130	<20	ug/g	0.095	35		
8166136	Available (CaCl2) pH	2022/08/15			100	97 - 103			0.28	N/A		
8166158	Available (CaCl2) pH	2022/08/16			100	97 - 103			0.17	N/A		
8166486	Leachable (SPLP) Mercury (Hg)	2022/08/15	100	75 - 125	101	80 - 120	<0.02	ug/L	3.7	30	<0.02	ug/L
8166687	Leachable (SPLP) 2,4,6-Trichlorophenol	2022/08/16	82	10 - 130	92	10 - 130	<0.70	ug/L	NC	40		
8166687	Leachable (SPLP) 2,4-Dinitrophenol	2022/08/16	12	10 - 130	11	10 - 130	<5.0	ug/L	NC	40		
8166687	Leachable (SPLP) 2,4-Dinitrotoluene	2022/08/16	85	30 - 130	89	30 - 130	<3.0	ug/L	NC	40		
8166687	Leachable (SPLP) 2,6-Dinitrotoluene	2022/08/16	84	30 - 130	90	30 - 130	<3.0	ug/L	NC	40		
8166687	Leachable (SPLP) 3,3'-Dichlorobenzidine	2022/08/16	106	30 - 130	105	30 - 130	<0.40	ug/L	NC	40		
8166687	Leachable (SPLP) Bis(2-chloroethyl)ether	2022/08/16	69	30 - 130	75	30 - 130	<2.0	ug/L	NC	40		
8166687	Leachable (SPLP) Bis(2-chloroisopropyl)ether	2022/08/16	62	30 - 130	68	30 - 130	<2.0	ug/L	NC	40		
8166687	Leachable (SPLP) Diethyl phthalate	2022/08/16	73	30 - 130	93	30 - 130	<1.0	ug/L	NC	40		
8166687	Leachable (SPLP) Dimethyl phthalate	2022/08/16	48	30 - 130	91	30 - 130	<1.0	ug/L	NC	40		
8166687	Leachable (SPLP) p-Chloroaniline	2022/08/16	83	30 - 130	89	30 - 130	<5.0	ug/L	NC	40		
8167865	Leachable (SPLP) Antimony (Sb)	2022/08/16	108	80 - 120	106	80 - 120	<0.5	ug/L	NC	35	<0.5	ug/L
8167865	Leachable (SPLP) Arsenic (As)	2022/08/16	102	80 - 120	100	80 - 120	<1	ug/L	NC	35	<1	ug/L
8167865	Leachable (SPLP) Barium (Ba)	2022/08/16	97	80 - 120	96	80 - 120	<5	ug/L	0.47	35	<5	ug/L
8167865	Leachable (SPLP) Beryllium (Be)	2022/08/16	102	80 - 120	102	80 - 120	<0.5	ug/L	NC	35	<0.5	ug/L

QUALITY ASSURANCE REPORT(CONT'D)

			Matrix Spike		SPIKED BLANK		Method Blank		RPD		Leachate Blank	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits	Value	UNITS
8167865	Leachable (SPLP) Boron (B)	2022/08/16	94	80 - 120	95	80 - 120	<10	ug/L	NC	35	<10	ug/L
8167865	Leachable (SPLP) Cadmium (Cd)	2022/08/16	102	80 - 120	100	80 - 120	<0.1	ug/L	NC	35	<0.1	ug/L
8167865	Leachable (SPLP) Chromium (Cr)	2022/08/16	94	80 - 120	93	80 - 120	<5	ug/L	NC	35	<5	ug/L
8167865	Leachable (SPLP) Cobalt (Co)	2022/08/16	99	80 - 120	98	80 - 120	<0.5	ug/L	NC	35	<0.5	ug/L
8167865	Leachable (SPLP) Copper (Cu)	2022/08/16	99	80 - 120	95	80 - 120	<1	ug/L	NC	35	<1	ug/L
8167865	Leachable (SPLP) Lead (Pb)	2022/08/16	99	80 - 120	96	80 - 120	<0.5	ug/L	NC	35	<0.5	ug/L
8167865	Leachable (SPLP) Molybdenum (Mo)	2022/08/16	100	80 - 120	98	80 - 120	<1	ug/L	NC	35	<1	ug/L
8167865	Leachable (SPLP) Nickel (Ni)	2022/08/16	98	80 - 120	96	80 - 120	<1	ug/L	NC	35	<1	ug/L
8167865	Leachable (SPLP) Selenium (Se)	2022/08/16	105	80 - 120	104	80 - 120	<2	ug/L	NC	35	<2	ug/L
8167865	Leachable (SPLP) Silver (Ag)	2022/08/16	100	80 - 120	98	80 - 120	<0.1	ug/L	NC	35	<0.1	ug/L
8167865	Leachable (SPLP) Thallium (Tl)	2022/08/16	104	80 - 120	103	80 - 120	<0.05	ug/L	NC	35	<0.05	ug/L
8167865	Leachable (SPLP) Vanadium (V)	2022/08/16	96	80 - 120	94	80 - 120	<1	ug/L	NC	35	<1	ug/L
8167865	Leachable (SPLP) Zinc (Zn)	2022/08/16	104	80 - 120	101	80 - 120	<5	ug/L	NC	35	<5	ug/L
8173937	Leachable (SPLP) 1,1,1,2-Tetrachloroethane	2022/08/18	100	70 - 130	101	70 - 130	<0.40	ug/L	NC	30		
8173937	Leachable (SPLP) 1,1,2,2-Tetrachloroethane	2022/08/18	101	70 - 130	98	70 - 130	<0.40	ug/L	NC	30		
8173937	Leachable (SPLP) 1,1,2-Trichloroethane	2022/08/18	114	70 - 130	111	70 - 130	<0.40	ug/L	NC	30		
8173937	Leachable (SPLP) 1,1-Dichloroethane	2022/08/18	103	70 - 130	103	70 - 130	<0.40	ug/L	NC	30		
8173937	Leachable (SPLP) 1,1-Dichloroethylene	2022/08/18	102	70 - 130	105	70 - 130	<0.40	ug/L	NC	30		
8173937	Leachable (SPLP) 1,2-Dichlorobenzene	2022/08/18	94	70 - 130	97	70 - 130	<0.40	ug/L	NC	30		
8173937	Leachable (SPLP) 1,2-Dichloroethane	2022/08/18	103	70 - 130	100	70 - 130	<0.40	ug/L	NC	30		
8173937	Leachable (SPLP) 1,2-Dichloropropane	2022/08/18	106	70 - 130	106	70 - 130	<0.40	ug/L	NC	30		
8173937	Leachable (SPLP) 1,4-Dichlorobenzene	2022/08/18	109	70 - 130	115	70 - 130	<0.40	ug/L	NC	30		
8173937	Leachable (SPLP) Bromomethane	2022/08/18	99	60 - 140	97	60 - 140	<0.40	ug/L	NC	30		
8173937	Leachable (SPLP) Carbon Tetrachloride	2022/08/18	97	70 - 130	98	70 - 130	<0.19	ug/L	NC	30		
8173937	Leachable (SPLP) Chloroform	2022/08/18	102	70 - 130	101	70 - 130	<0.90	ug/L	NC	30		
8173937	Leachable (SPLP) cis-1,2-Dichloroethylene	2022/08/18	108	70 - 130	108	70 - 130	<0.40	ug/L	NC	30		
8173937	Leachable (SPLP) cis-1,3-Dichloropropene	2022/08/18	100	70 - 130	99	70 - 130	<0.30	ug/L	NC	30		
8173937	Leachable (SPLP) Ethylene Dibromide	2022/08/18	102	70 - 130	99	70 - 130	<0.19	ug/L	NC	30		
8173937	Leachable (SPLP) Tetrachloroethylene	2022/08/18	88	70 - 130	91	70 - 130	<0.40	ug/L	NC	30		
8173937	Leachable (SPLP) trans-1,2-Dichloroethylene	2022/08/18	106	70 - 130	107	70 - 130	<0.40	ug/L	NC	30		

QUALITY ASSURANCE REPORT(CONT'D)

			Matrix Spike		SPIKED BLANK		Method Blank		RPD		Leachate Blank	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits	Value	UNITS
8173937	Leachable (SPLP) trans-1,3-Dichloropropene	2022/08/18	110	70 - 130	107	70 - 130	<0.30	ug/L	NC	30		
8173937	Leachable (SPLP) Trichloroethylene	2022/08/18	98	70 - 130	101	70 - 130	<0.40	ug/L	NC	30		
8224503	Available (CaCl2) pH	2022/09/14			100	97 - 103			0.55	N/A		

N/A = Not Applicable

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

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

Leachate Blank: A blank matrix containing all reagents used in the leaching procedure. Used to determine any process contamination.

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

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

Surrogate: A pure or isotopically labeled compound whose behavior mirrors the analytes of interest. Used to evaluate extraction efficiency.

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

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (absolute difference <= 2x RDL).

(1) Recovery or RPD for this parameter is outside control limits. The overall quality control for this analysis meets acceptability criteria.

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by:

Anastassia Hamanov, Scientific Specialist

Eva

CHARTERED
Eva Pranjic
CHEMIST

Ewa Pranjic, M.Sc., C.Chem, Scientific Specialist

Bureau Veritas has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per ISO/IEC 17025, signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

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Phone: 905-817-5700 Fax: 905-817-5779 Toll Free: 800-563-6266

CHAIN OF CUSTODY RECORD

ENV COC - 00014v3

Page 1 of 1

Invoice Information	Invoice to (requires report) ☐	Report Information (if differs from invoice)		Project Information	
Company:	Exp Services Inc	Company:		Quotation #:	Stream 3
Contact Name:	Aswan Assadi	Contact Name:	Aamna Arora	P.O. #/ AFE#:	BRM_GFO
Street Address:	1595 Clark Blvd	Street Address:		Project #:	BRM-22019043-A0
City:	Brampton Prov: ON Postal Code:	City: Prov: Postal Code:		Site #:	
Phone:		Phone:		Site Location:	Streda, D. Crupi, Shelborne pit
Email:	aswan.assadi@exp.com	Email:	aamna.arora@exp.com	Site Location Province:	
Copies:		Copies:		Sampled By:	

LAB USE ONLY - PLACE STICKER HERE

Rush Confirmation #:

Regulatory Criteria

REG 153: ☐ Table 1 ☐ Table 2 ☐ Table 3 ☐ Table ____ ☐ Res/Park ☐ Ind/Comm ☐ Agri/other ☐ Med/Fine ☐ Course ☐ For RSC

OTHER: ☐ CCME ☐ Reg 558* *min 3 day TAT ☐ MISA ☐ PWQO ☑ Reg 406, Table: 2.1 ☐ Sanitary Sewer Bylaw ☐ Storm Sewer Bylaw Municipality ____ ☐ Other:

Include Criteria on Certificate of Analysis (check if yes): ☐

SAMPLES MUST BE KEPT COOL (<10°C) FROM TIME OF SAMPLING UNTIL DELIVERY TO BUREAU VERITAS

Regular Turnaround Time (TAT)

☑ 5 to 7 Day ☐ 10 Day

Rush Turnaround Time (TAT) Surcharges apply

☐ Same Day ☐ 1 Day
☐ 2 Day ☐ 3 Day
☐ 4 Day

Date Required: YY MM DD

	Sample Identification	Date Sampled YY	MM	DD	Time (24hr) HH	MM	Matrix	1 FIELD FILTERED	2 FIELD PRESERVED	3 LAB FILTRATION REQUIRED	4 BTEX/ F1	5 F2 - F4	6 VOCs	7 Reg 153 metals and inorganics	8 Reg 153 ICPMS metals	9 Reg 153 metals (Hg, Cr VI, ICPMS metals, HWS - B)	10	11 SPLP-metals and inorganics	12	13	14 SPLP-VOC	15 SPLP-SVOCs	16 pH and sulfate	17	18	19	20	21 # OF CONTAINERS SUBMITTED	22 HOLD - DO NOT ANALYZE	Comments
1	SS-streda	22	08	08	AM		RC											✓			✓	✓	✓					1		recycled concrete (RC)
2	SS-Crupi	22	08	08	PM		RC											✓			✓	✓	✓					1		please process
3	SS1-GRA	22	08	09	AM		granular											✓			✓	✓						4		as necessary
4	SS2-GRA	22	08	09	AM		granular											✓										4		
5																														
6																														
7																														
8																														
9																														
10																														
11																														
12																														

10-Aug-22 16:40
Patricia Legette
C2M6136
RJM ENV-1479

*UNLESS OTHERWISE AGREED TO IN WRITING, WORK SUBMITTED ON THIS CHAIN OF CUSTODY IS SUBJECT TO BUREAU VERITAS STANDARD TERMS AND CONDITIONS. SIGNING OF THIS CHAIN OF CUSTODY DOCUMENT IS ACKNOWLEDGMENT AND ACCEPTANCE OF OUR TERMS AND CONDITIONS WHICH ARE AVAILABLE FOR VIEWING AT WWW.BVNA.COM/TERMS-AND-CONDITIONS OR BY CALLING THE LABORATORY LISTED ABOVE TO OBTAIN A COPY

LAB USE ONLY	Yes	No	°C			
Seal present	✓			5	4	1
Seal intact	✓					
Cooling media present				1	2	3

LAB USE ONLY	Yes	No	°C			
Seal present						
Seal intact						
Cooling media present				1	2	3

LAB USE ONLY	Yes	No	°C				Temperature reading by:
Seal present							
Seal intact							
Cooling media present				1	2	3	

	Relinquished by: (Signature/ Print)	Date YY	MM	DD	Time HH	MM	Received by: (Signature/ Print)	Date YY	MM	DD	Time HH	MM	Special instructions
1	Mary Stapleton	22	08	10	4	30		[illegible]	08	10	14	40	
2	MStapleton												

Your P.O. #: BRM-GEO
Your Project #: BRM-22019043-A0
Site Location: VARIOUS YARDS-WATERDOWN, BETHRIDGE, SCARBOROUGH, ON
Your C.O.C. #: n/a

Attention: Aamna Arora

exp Services Inc
Brampton Branch
1595 Clark Blvd
Brampton, ON
CANADA L6T 4V1

Report Date: 2022/10/03
Report #: R7325692
Version: 6 - Revision

CERTIFICATE OF ANALYSIS – REVISED REPORT

BUREAU VERITAS JOB #: C2P0225
Received: 2022/08/31, 15:13

Sample Matrix: Solid
Samples Received: 2

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
pH CaCl2 EXTRACT	2	2022/09/06	2022/09/06	CAM SOP-00413	EPA 9045 D m
Sulphate (20:1 Extract)	2	2022/09/06	2022/09/06	CAM SOP-00464	EPA 375.4 m

Remarks:

Bureau Veritas is accredited to ISO/IEC 17025 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by Bureau Veritas are based upon recognized Provincial, Federal or US method compendia such as CCME, MELCC, EPA, APHA.

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Bureau Veritas liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. Bureau Veritas has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by Bureau Veritas, unless otherwise agreed in writing. Bureau Veritas is not responsible for the accuracy or any data impacts, that result from the information provided by the customer or their agent.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.
Results relate to samples tested. When sampling is not conducted by Bureau Veritas, results relate to the supplied samples tested.
This Certificate shall not be reproduced except in full, without the written approval of the laboratory.
Reference Method suffix “m” indicates test methods incorporate validated modifications from specific reference methods to improve performance.
* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

Your P.O. #: BRM-GEO
Your Project #: BRM-22019043-A0
Site Location: VARIOUS YARDS-WATERDOWN, BETHRIDGE, SCARBOROUGH, ON
Your C.O.C. #: n/a

Attention: Aamna Arora

exp Services Inc
Brampton Branch
1595 Clark Blvd
Brampton, ON
CANADA L6T 4V1

Report Date: 2022/10/03
Report #: R7325692
Version: 6 - Revision

CERTIFICATE OF ANALYSIS – REVISED REPORT

BUREAU VERITAS JOB #: C2P0225
Received: 2022/08/31, 15:13

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Patricia Legette, Project Manager
Email: Patricia.Legette@bureauveritas.com
Phone# (905)817-5799
==
Bureau Veritas has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per ISO/IEC 17025, signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

RESULTS OF ANALYSES OF SOLID

Bureau Veritas ID		TPM834	TPM835		
Sampling Date		2022/08/30	2022/08/30		
COC Number		n/a	n/a		
	UNITS	**RCM-BETHRIDGE**	**RCM-SCARBOROUGH**	**RDL**	**QC Batch**
Inorganics					
Available (CaCl2) pH	pH	11.9	11.9		8207286
Soluble (20:1) Sulphate (SO4)	ug/g	830	840	40	8207212

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

TEST SUMMARY

Bureau Veritas ID: TPM834
Sample ID: RCM-BETHRIDGE
Matrix: Solid

Collected: 2022/08/30
Shipped:
Received: 2022/08/31

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
pH CaCl2 EXTRACT	AT	8207286	2022/09/06	2022/09/06	Taslima Aktar
Sulphate (20:1 Extract)	KONE/EC	8207212	2022/09/06	2022/09/06	Chandra Nandlal

Bureau Veritas ID: TPM835
Sample ID: RCM-SCARBOROUGH
Matrix: Solid

Collected: 2022/08/30
Shipped:
Received: 2022/08/31

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
pH CaCl2 EXTRACT	AT	8207286	2022/09/06	2022/09/06	Taslima Aktar
Sulphate (20:1 Extract)	KONE/EC	8207212	2022/09/06	2022/09/06	Chandra Nandlal

GENERAL COMMENTS

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

Package 1	9.0°C

Revised Report (2022/10/03): Showing only pH and Sulphate results for samples RCM-BETHRIDGE and RCM-SCARBOROUGH in this CofA as per Aamna Arora's request.

RCM-WATERDOWN: Final leach pH is 11.92.
RCM-BETHRIDGE: Final leach pH is 11.62.
RCM-SCARBOROUGH: Final leach pH is 11.66.

Results relate only to the items tested.

QUALITY ASSURANCE REPORT

			Matrix Spike		SPIKED BLANK		Method Blank		RPD	
QC Batch	**Parameter**	**Date**	**% Recovery**	**QC Limits**	**% Recovery**	**QC Limits**	**Value**	**UNITS**	**Value (%)**	**QC Limits**
8207212	Soluble (20:1) Sulphate (SO4)	2022/09/06	103	70 - 130	103	70 - 130	<20	ug/g	NC	35
8207286	Available (CaCl2) pH	2022/09/06			100	97 - 103			2.0	N/A

N/A = Not Applicable

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

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

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

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

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (absolute difference <= 2x RDL).

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by:

Anastassia Hamanov, Scientific Specialist

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www.BVNA.com

6740 Campobello Road, Mississauga, Ontario L5N 2L8
Phone: 905-817-5700 Fax: 905-817-5779 Toll Free: 800-563-6266

CHAIN OF CUSTODY RECORD
ENV COC - 00014v3

Page 1 of 1

Invoice Information Invoice to (requires report) ☐

Company: Exp Services Inc
Contact Name: Aswan Assadi
Street Address: 1595 Clark Blvd
City: Brampton Prov: ON Postal Code:
Phone:
Email: aswan.assadi@exp.com
Copies:

Report Information (if differs from invoice)

Company:
Contact Name: Aamna Afora
Street Address:
City: Prov: Postal Code:
Phone:
Email: aamna.afora@exp.com
Copies:

Project Information

Quotation #: Stream 3
P.O. #/ AFE#: BRM-GEO
Project #: BRM-22019043-A0
Site #: Various yards => Waterdown, Bethridge, Scarborough
Site Location:
Site Location Province:
Sampled By:

LAB USE ONLY - PLACE STICKER HERE

Rush Confirmation #:

Regulatory Criteria

REG 153: ☐ Table 1 ☐ Table 2 ☐ Table 3 ☐ Table ______ ☐ Res/Park ☐ Ind/Comm ☐ Agri/other ☐ Med/Fine ☐ Course ☐ For RSC

OTHER: ☐ CCME ☐ Reg 558* *min 3 day TAT ☐ MISA ☐ PWQO ☑ Reg 406, Table: 2.1 ☐ Sanitary Sewer Bylaw ☐ Storm Sewer Bylaw Municipality ______ ☐ Other:

Include Criteria on Certificate of Analysis (check if yes): ☐

SAMPLES MUST BE KEPT COOL (<10°C) FROM TIME OF SAMPLING UNTIL DELIVERY TO BUREAU VERITAS

	Sample Identification	Date Sampled YY	MM	DD	Time (24hr) HH	MM	Matrix	1 FIELD FILTERED	2 FIELD PRESERVED	3 LAB FILTRATION REQUIRED	4 BTEX/ F1	5 F2 - F4	6 VOCs	7 Reg 153 metals and inorganics	8 Reg 153 ICPMS metals	9 Reg 153 metals (Hg, Cr VI, ICPMS metals, HWS - B)	10	11 SPLP-metals	12 and inorganics	13	14 SPLP-VOC	15 SPLP-SVOC	16 pH and sulfate	17	18	19	20	21 # OF CONTAINERS SUBMITTED	22 HOLD - DO NOT ANALYZE	Comments
1	RCM-Waterdown	Aug 24, 2022					RC											✓			✓	✓	✓					4		recycled concrete (RC)
2	RCM-Bethridge	Aug 30, 2022					RC											✓			✓	✓	✓					4		please process
3	RCM-Scarborough	Aug 30, 2022					RC											✓			✓	✓	✓					4		as necessary
4																														
5																														
6																														
7																														
8																														
9																														
10																														
11																														
12																														

Regular Turnaround Time (TAT)
☑ 5 to 7 Day ☐ 10 Day

Rush Turnaround Time (TAT) Surcharges apply
☐ Same Day ☐ 1 Day
☐ 2 Day ☐ 3 Day
☐ 4 Day

Date Required: YY MM DD

31-Aug-22 15:13
Patricia Legette
C2P0225
JDK ENV-1545

*UNLESS OTHERWISE AGREED TO IN WRITING, WORK SUBMITTED ON THIS CHAIN OF CUSTODY IS SUBJECT TO BUREAU VERITAS STANDARD TERMS AND CONDITIONS. SIGNING OF THIS CHAIN OF CUSTODY DOCUMENT IS ACKNOWLEDGMENT AND ACCEPTANCE OF OUR TERMS AND CONDITIONS WHICH ARE AVAILABLE FOR VIEWING AT WWW.BVNA.COM/TERMS-AND-CONDITIONS OR BY CALLING THE LABORATORY LISTED ABOVE TO OBTAIN A COPY

LAB USE ONLY	Yes	No	°C	1	2	3
Seal present		/		9	9	9
Seal intact		/				
Cooling media present	/					

LAB USE ONLY	Yes	No	°C	1	2	3
Seal present						
Seal intact						
Cooling media present						

LAB USE ONLY	Yes	No	°C	1	2	3	Temperature reading by:
Seal present							
Seal intact							
Cooling media present							

	Relinquished by: (Signature/ Print)	Date YY	MM	DD	Time HH	MM		Received by: (Signature/ Print)	Date YY	MM	DD	Time HH	MM	Special instructions
1	Karam Iswail-Vaqa	2022	Aug	31	2:59	PM	1		22	08	31	15	13	
2							2							

Your P.O. #: BRM-GEO
Your Project #: BRM-22019043-A0
Site Location: VARIOUS YARDS-WATERDOWN, BETHRIDGE, SCARBOROUGH, ON
Your C.O.C. #: n/a

Attention: Aamna Arora

exp Services Inc
Brampton Branch
1595 Clark Blvd
Brampton, ON
CANADA L6T 4V1

Report Date: 2022/09/15
Report #: R7297022
Version: 5 - Revision

CERTIFICATE OF ANALYSIS – REVISED REPORT

BUREAU VERITAS JOB #: C2P0225
Received: 2022/08/31, 15:13

Sample Matrix: Solid
Samples Received: 3

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
ABN Compounds in SPLP Leachates	3	2022/09/06	2022/09/07	CAM SOP-00301	EPA 8270 m
1,3-Dichloropropene Sum	3	N/A	2022/09/06		EPA 8260D m
Cyanide (WAD) in Leachates	3	N/A	2022/09/02	CAM SOP-00457	OMOE 3015 m
Dinitrotoluene Sum	3	N/A	2022/09/08	CAM SOP - 00301	EPA 8270
Fluoride by ISE in Leachates	3	2022/09/02	2022/09/02	CAM SOP-00449	SM 23 4500-F- C m
Mercury (low level SPLP Leachable)	3	2022/09/02	2022/09/06	CAM SOP-00453	EPA 7470 m
Total Metals in SPLP Leachate by ICPMS	3	2022/09/02	2022/09/06	CAM SOP-00447	EPA 6020B m
Modified SPLP extraction - Weight	3	N/A	2022/09/02	CAM SOP-00941	OMOECP LaSB E9003 R3
Nitrate& Nitrite as Nitrogen in Leachate	3	N/A	2022/09/06	CAM SOP-00440	SM 23 4500-NO3I/NO2B
pH CaCl2 EXTRACT	3	2022/09/06	2022/09/06	CAM SOP-00413	EPA 9045 D m
Sulphate (20:1 Extract)	3	2022/09/06	2022/09/06	CAM SOP-00464	EPA 375.4 m
SPLP Zero Headspace Extraction	3	2022/09/01	2022/09/02	CAM SOP-00430	EPA 1312 m
Volatile organics in SPLP leachates	2	N/A	2022/09/02	CAM SOP-00228	EPA 8260D m
Volatile organics in SPLP leachates	1	N/A	2022/09/03	CAM SOP-00228	EPA 8260D m

Remarks:

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Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope

Your P.O. #: BRM-GEO
Your Project #: BRM-22019043-A0
Site Location: VARIOUS YARDS-WATERDOWN, BETHRIDGE, SCARBOROUGH, ON
Your C.O.C. #: n/a

Attention: Aamna Arora

exp Services Inc
Brampton Branch
1595 Clark Blvd
Brampton, ON
CANADA L6T 4V1

Report Date: 2022/09/15
Report #: R7297022
Version: 5 - Revision

CERTIFICATE OF ANALYSIS – REVISED REPORT

BUREAU VERITAS JOB #: C2P0225
Received: 2022/08/31, 15:13

dilution methods.

Results relate to samples tested. When sampling is not conducted by Bureau Veritas, results relate to the supplied samples tested.

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Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Patricia Legette, Project Manager
Email: Patricia.Legette@bureauveritas.com
Phone# (905)817-5799
==

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O.REG 406 EXCESS SOIL SPLP ABNS (SOLID)

Bureau Veritas ID		TPM833	TPM834			TPM834		
Sampling Date		2022/08/24	2022/08/30			2022/08/30		
COC Number		n/a	n/a			n/a		
	UNITS	**RCM-WATERDOWN**	**RCM-BETHRIDGE**	**RDL**	**QC Batch**	**RCM-BETHRIDGE Lab-Dup**	**RDL**	**QC Batch**
Semivolatile Organics								
Leachable (SPLP) Bis(2-chloroethyl)ether	ug/L	<2.0	<2.0	2.0	8208380	<2.0	2.0	8208380
Leachable (SPLP) Bis(2-chloroisopropyl)ether	ug/L	<2.0	<2.0	2.0	8208380	<2.0	2.0	8208380
Leachable (SPLP) p-Chloroaniline	ug/L	<5.0	<5.0	5.0	8208380	<5.0	5.0	8208380
Leachable (SPLP) 3,3'-Dichlorobenzidine	ug/L	<0.40	<0.40	0.40	8208380	<0.40	0.40	8208380
Leachable (SPLP) Diethyl phthalate	ug/L	<1.0	<1.0	1.0	8208380	<1.0	1.0	8208380
Leachable (SPLP) Dimethyl phthalate	ug/L	<1.0	<1.0	1.0	8208380	<1.0	1.0	8208380
Leachable (SPLP) 2,4-Dinitrophenol	ug/L	<5.0	<5.0	5.0	8208380	<5.0	5.0	8208380
Leachable (SPLP) 2,4-Dinitrotoluene	ug/L	<3.0	<3.0	3.0	8208380	<3.0	3.0	8208380
Leachable (SPLP) 2,6-Dinitrotoluene	ug/L	<3.0	<3.0	3.0	8208380	<3.0	3.0	8208380
Leachable (SPLP) 2,4,6-Trichlorophenol	ug/L	<0.70	<0.70	0.70	8208380	<0.70	0.70	8208380
Calculated Parameters								
Leachable 2,4- & 2,6-Dinitrotoluene	ug/L	<4.2	<4.2	4.2	8201221			
Surrogate Recovery (%)								
Leachable (SPLP) 2,4,6-Tribromophenol	%	82	56		8208380	59		8208380
Leachable (SPLP) 2-Fluorobiphenyl	%	44	49		8208380	54		8208380
Leachable (SPLP) D14-Terphenyl (FS)	%	94	93		8208380	92		8208380
Leachable (SPLP) D5-Nitrobenzene	%	50	53		8208380	51		8208380

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate

O.REG 406 EXCESS SOIL SPLP ABNS (SOLID)

Bureau Veritas ID		TPM835		
Sampling Date		2022/08/30		
COC Number		n/a		
	UNITS	**RCM-SCARBOROUGH**	**RDL**	**QC Batch**
Semivolatile Organics				
Leachable (SPLP) Bis(2-chloroethyl)ether	ug/L	<2.0	2.0	8208380
Leachable (SPLP) Bis(2-chloroisopropyl)ether	ug/L	<2.0	2.0	8208380
Leachable (SPLP) p-Chloroaniline	ug/L	<5.0	5.0	8208380
Leachable (SPLP) 3,3'-Dichlorobenzidine	ug/L	<0.40	0.40	8208380
Leachable (SPLP) Diethyl phthalate	ug/L	<1.0	1.0	8208380
Leachable (SPLP) Dimethyl phthalate	ug/L	<1.0	1.0	8208380
Leachable (SPLP) 2,4-Dinitrophenol	ug/L	<5.0	5.0	8208380
Leachable (SPLP) 2,4-Dinitrotoluene	ug/L	<3.0	3.0	8208380
Leachable (SPLP) 2,6-Dinitrotoluene	ug/L	<3.0	3.0	8208380
Leachable (SPLP) 2,4,6-Trichlorophenol	ug/L	<0.70	0.70	8208380
Calculated Parameters				
Leachable 2,4- & 2,6-Dinitrotoluene	ug/L	<4.2	4.2	8201221
Surrogate Recovery (%)				
Leachable (SPLP) 2,4,6-Tribromophenol	%	81		8208380
Leachable (SPLP) 2-Fluorobiphenyl	%	53		8208380
Leachable (SPLP) D14-Terphenyl (FS)	%	92		8208380
Leachable (SPLP) D5-Nitrobenzene	%	54		8208380

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

O.REG 406 EXCESS SOIL SPLP PREP (SOLID)

Bureau Veritas ID		TPM833	TPM834	TPM835	
Sampling Date		2022/08/24	2022/08/30	2022/08/30	
COC Number		n/a	n/a	n/a	
	UNITS	**RCM-WATERDOWN**	**RCM-BETHRIDGE**	**RCM-SCARBOROUGH**	**QC Batch**
Inorganics					
Dry Weight	g	100	100	100	8201548
QC Batch = Quality Control Batch					

O.REG 406 EXCESS SOIL SPLP VOCS (SOLID)

Bureau Veritas ID		TPM833	TPM834	TPM835		
Sampling Date		2022/08/24	2022/08/30	2022/08/30		
COC Number		n/a	n/a	n/a		
	UNITS	**RCM-WATERDOWN**	**RCM-BETHRIDGE**	**RCM-SCARBOROUGH**	**RDL**	**QC Batch**
Charge/Prep Analysis						
Amount Extracted (Wet Weight) (g)	N/A	25	25	25	N/A	8201469
Calculated Parameters						
Leachable (ZHE) 1,3-Dichloropropene (cis+trans)	ug/L	<0.42	<0.42	<0.42	0.42	8201220
Volatile Organics						
Leachable (SPLP) Bromomethane	ug/L	<0.40	<0.40	<0.40	0.40	8203814
Leachable (SPLP) Carbon Tetrachloride	ug/L	<0.19	<0.19	<0.19	0.19	8203814
Leachable (SPLP) Chloroform	ug/L	<0.90	<0.90	<0.90	0.90	8203814
Leachable (SPLP) 1,2-Dichlorobenzene	ug/L	<0.40	<0.40	<0.40	0.40	8203814
Leachable (SPLP) 1,4-Dichlorobenzene	ug/L	<0.40	<0.40	<0.40	0.40	8203814
Leachable (SPLP) 1,1-Dichloroethane	ug/L	<0.40	<0.40	<0.40	0.40	8203814
Leachable (SPLP) 1,2-Dichloroethane	ug/L	<0.40	<0.40	<0.40	0.40	8203814
Leachable (SPLP) 1,1-Dichloroethylene	ug/L	<0.40	<0.40	<0.40	0.40	8203814
Leachable (SPLP) cis-1,2-Dichloroethylene	ug/L	<0.40	<0.40	<0.40	0.40	8203814
Leachable (SPLP) trans-1,2-Dichloroethylene	ug/L	<0.40	<0.40	<0.40	0.40	8203814
Leachable (SPLP) 1,2-Dichloropropane	ug/L	<0.40	<0.40	<0.40	0.40	8203814
Leachable (SPLP) cis-1,3-Dichloropropene	ug/L	<0.30	<0.30	<0.30	0.30	8203814
Leachable (SPLP) trans-1,3-Dichloropropene	ug/L	<0.30	<0.30	<0.30	0.30	8203814
Leachable (SPLP) Ethylene Dibromide	ug/L	<0.19	<0.19	<0.19	0.19	8203814
Leachable (SPLP) 1,1,1,2-Tetrachloroethane	ug/L	<0.40	<0.40	<0.40	0.40	8203814
Leachable (SPLP) 1,1,2,2-Tetrachloroethane	ug/L	<0.40	<0.40	<0.40	0.40	8203814
Leachable (SPLP) Tetrachloroethylene	ug/L	<0.40	<0.40	<0.40	0.40	8203814
Leachable (SPLP) 1,1,2-Trichloroethane	ug/L	<0.40	<0.40	<0.40	0.40	8203814
Leachable (SPLP) Trichloroethylene	ug/L	<0.40	<0.40	<0.40	0.40	8203814
Surrogate Recovery (%)						
Leachable (SPLP) 4-Bromofluorobenzene	%	90	90	91		8203814
Leachable (SPLP) D4-1,2-Dichloroethane	%	112	117	114		8203814
Leachable (SPLP) D8-Toluene	%	97	96	95		8203814

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
N/A = Not Applicable

SPLP INORGANICS PACKAGE (SOLID)

Bureau Veritas ID		TPM833			TPM833		
Sampling Date		2022/08/24			2022/08/24		
COC Number		n/a			n/a		
	UNITS	**RCM-WATERDOWN**	**RDL**	**QC Batch**	**RCM-WATERDOWN Lab-Dup**	**RDL**	**QC Batch**
Inorganics							
Leachable Fluoride (F-)	mg/L	0.21	0.10	8204121			
Leachable WAD Cyanide (Free)	mg/L	<0.010	0.010	8204117			
Leachable Nitrite (N)	mg/L	<0.10	0.10	8204120			
Leachable Nitrate (N)	mg/L	<1.0	1.0	8204120			
Leachable Nitrate + Nitrite (N)	mg/L	<1.0	1.0	8204120			
Metals							
Leachable (SPLP) Antimony (Sb)	ug/L	<0.5	0.5	8204416	<0.5	0.5	8204416
Leachable (SPLP) Arsenic (As)	ug/L	<1	1	8204416	<1	1	8204416
Leachable (SPLP) Barium (Ba)	ug/L	43	5	8204416	45	5	8204416
Leachable (SPLP) Beryllium (Be)	ug/L	<0.5	0.5	8204416	<0.5	0.5	8204416
Leachable (SPLP) Boron (B)	ug/L	<10	10	8204416	<10	10	8204416
Leachable (SPLP) Cadmium (Cd)	ug/L	<0.1	0.1	8204416	<0.1	0.1	8204416
Leachable (SPLP) Chromium (Cr)	ug/L	6	5	8204416	6	5	8204416
Leachable (SPLP) Cobalt (Co)	ug/L	<0.5	0.5	8204416	<0.5	0.5	8204416
Leachable (SPLP) Copper (Cu)	ug/L	10	1	8204416	10	1	8204416
Leachable (SPLP) Lead (Pb)	ug/L	<0.5	0.5	8204416	<0.5	0.5	8204416
Leachable (SPLP) Mercury (Hg)	ug/L	<0.02	0.02	8204798			
Leachable (SPLP) Molybdenum (Mo)	ug/L	3	1	8204416	3	1	8204416
Leachable (SPLP) Nickel (Ni)	ug/L	2	1	8204416	2	1	8204416
Leachable (SPLP) Selenium (Se)	ug/L	<2	2	8204416	<2	2	8204416
Leachable (SPLP) Silver (Ag)	ug/L	<0.1	0.1	8204416	<0.1	0.1	8204416
Leachable (SPLP) Thallium (Tl)	ug/L	<0.05	0.05	8204416	<0.05	0.05	8204416
Leachable (SPLP) Vanadium (V)	ug/L	2	1	8204416	2	1	8204416
Leachable (SPLP) Zinc (Zn)	ug/L	<5	5	8204416	<5	5	8204416

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate

SPLP INORGANICS PACKAGE (SOLID)

Bureau Veritas ID		TPM834	TPM835			TPM835		
Sampling Date		2022/08/30	2022/08/30			2022/08/30		
COC Number		n/a	n/a			n/a		
	UNITS	**RCM-BETHRIDGE**	**RCM-SCARBOROUGH**	**RDL**	**QC Batch**	**RCM-SCARBOROUGH Lab-Dup**	**RDL**	**QC Batch**
Inorganics								
Leachable Fluoride (F-)	mg/L	0.29	0.18	0.10	8204121	0.16	0.10	8204121
Leachable WAD Cyanide (Free)	mg/L	<0.010	<0.010	0.010	8204117	<0.010	0.010	8204117
Leachable Nitrite (N)	mg/L	0.33	<0.10	0.10	8204120	<0.10	0.10	8204120
Leachable Nitrate (N)	mg/L	<1.0	<1.0	1.0	8204120	<1.0	1.0	8204120
Leachable Nitrate + Nitrite (N)	mg/L	<1.0	<1.0	1.0	8204120	<1.0	1.0	8204120
Metals								
Leachable (SPLP) Antimony (Sb)	ug/L	<0.5	0.5	0.5	8204416			
Leachable (SPLP) Arsenic (As)	ug/L	<1	<1	1	8204416			
Leachable (SPLP) Barium (Ba)	ug/L	83	44	5	8204416			
Leachable (SPLP) Beryllium (Be)	ug/L	<0.5	<0.5	0.5	8204416			
Leachable (SPLP) Boron (B)	ug/L	<10	<10	10	8204416			
Leachable (SPLP) Cadmium (Cd)	ug/L	<0.1	<0.1	0.1	8204416			
Leachable (SPLP) Chromium (Cr)	ug/L	<5	<5	5	8204416			
Leachable (SPLP) Cobalt (Co)	ug/L	2.4	<0.5	0.5	8204416			
Leachable (SPLP) Copper (Cu)	ug/L	3	7	1	8204416			
Leachable (SPLP) Lead (Pb)	ug/L	<0.5	<0.5	0.5	8204416			
Leachable (SPLP) Mercury (Hg)	ug/L	<0.02	<0.02	0.02	8204798	<0.02	0.02	8204798
Leachable (SPLP) Molybdenum (Mo)	ug/L	5	2	1	8204416			
Leachable (SPLP) Nickel (Ni)	ug/L	<1	2	1	8204416			
Leachable (SPLP) Selenium (Se)	ug/L	<2	<2	2	8204416			
Leachable (SPLP) Silver (Ag)	ug/L	<0.1	<0.1	0.1	8204416			
Leachable (SPLP) Thallium (Tl)	ug/L	<0.05	<0.05	0.05	8204416			
Leachable (SPLP) Vanadium (V)	ug/L	1	2	1	8204416			
Leachable (SPLP) Zinc (Zn)	ug/L	<5	<5	5	8204416			

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate

RESULTS OF ANALYSES OF SOLID

Bureau Veritas ID		TPM833		TPM834	TPM835		
Sampling Date		2022/08/24		2022/08/30	2022/08/30		
COC Number		n/a		n/a	n/a		
	UNITS	**RCM-WATERDOWN**	**RDL**	**RCM-BETHRIDGE**	**RCM-SCARBOROUGH**	**RDL**	**QC Batch**
Inorganics							
Available (CaCl2) pH	pH	12.2		11.9	11.9		8207286
Soluble (20:1) Sulphate (SO4)	ug/g	1600	60	830	840	40	8207212

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

TEST SUMMARY

Bureau Veritas ID: TPM833
Sample ID: RCM-WATERDOWN
Matrix: Solid

Collected: 2022/08/24
Shipped:
Received: 2022/08/31

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
ABN Compounds in SPLP Leachates	GC/MS	8208380	2022/09/06	2022/09/07	Kathy Horvat
1,3-Dichloropropene Sum	CALC	8201220	N/A	2022/09/06	Automated Statchk
Cyanide (WAD) in Leachates	SKAL/CN	8204117	N/A	2022/09/02	Kruti Jitesh Patel
Dinitrotoluene Sum	CALC	8201221	N/A	2022/09/08	Automated Statchk
Fluoride by ISE in Leachates	ISE	8204121	2022/09/02	2022/09/02	Kien Tran
Mercury (low level SPLP Leachable)	CV/AA	8204798	2022/09/02	2022/09/06	Japneet Gill
Total Metals in SPLP Leachate by ICPMS	ICP/MS	8204416	2022/09/02	2022/09/06	Arefa Dabhad
Modified SPLP extraction - Weight		8201548	N/A	2022/09/02	Jian (Ken) Wang
Nitrate& Nitrite as Nitrogen in Leachate	LACH	8204120	N/A	2022/09/06	Samuel Law
pH CaCl2 EXTRACT	AT	8207286	2022/09/06	2022/09/06	Taslima Aktar
Sulphate (20:1 Extract)	KONE/EC	8207212	2022/09/06	2022/09/06	Chandra Nandlal
SPLP Zero Headspace Extraction		8201469	2022/09/01	2022/09/02	Abdul Rahman Mohammed
Volatile organics in SPLP leachates	HS/MS	8203814	N/A	2022/09/02	Manpreet Sarao

Bureau Veritas ID: TPM833 Dup
Sample ID: RCM-WATERDOWN
Matrix: Solid

Collected: 2022/08/24
Shipped:
Received: 2022/08/31

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Total Metals in SPLP Leachate by ICPMS	ICP/MS	8204416	2022/09/02	2022/09/06	Arefa Dabhad

Bureau Veritas ID: TPM834
Sample ID: RCM-BETHRIDGE
Matrix: Solid

Collected: 2022/08/30
Shipped:
Received: 2022/08/31

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
ABN Compounds in SPLP Leachates	GC/MS	8208380	2022/09/06	2022/09/07	Kathy Horvat
1,3-Dichloropropene Sum	CALC	8201220	N/A	2022/09/06	Automated Statchk
Cyanide (WAD) in Leachates	SKAL/CN	8204117	N/A	2022/09/02	Kruti Jitesh Patel
Dinitrotoluene Sum	CALC	8201221	N/A	2022/09/08	Automated Statchk
Fluoride by ISE in Leachates	ISE	8204121	2022/09/02	2022/09/02	Kien Tran
Mercury (low level SPLP Leachable)	CV/AA	8204798	2022/09/02	2022/09/06	Japneet Gill
Total Metals in SPLP Leachate by ICPMS	ICP/MS	8204416	2022/09/02	2022/09/06	Arefa Dabhad
Modified SPLP extraction - Weight		8201548	N/A	2022/09/02	Jian (Ken) Wang
Nitrate& Nitrite as Nitrogen in Leachate	LACH	8204120	N/A	2022/09/06	Samuel Law
pH CaCl2 EXTRACT	AT	8207286	2022/09/06	2022/09/06	Taslima Aktar
Sulphate (20:1 Extract)	KONE/EC	8207212	2022/09/06	2022/09/06	Chandra Nandlal
SPLP Zero Headspace Extraction		8201469	2022/09/01	2022/09/02	Abdul Rahman Mohammed
Volatile organics in SPLP leachates	HS/MS	8203814	N/A	2022/09/02	Manpreet Sarao

TEST SUMMARY

Bureau Veritas ID: TPM834 Dup
Sample ID: RCM-BETHRIDGE
Matrix: Solid

Collected: 2022/08/30
Shipped:
Received: 2022/08/31

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
ABN Compounds in SPLP Leachates	GC/MS	8208380	2022/09/06	2022/09/07	Kathy Horvat

Bureau Veritas ID: TPM835
Sample ID: RCM-SCARBOROUGH
Matrix: Solid

Collected: 2022/08/30
Shipped:
Received: 2022/08/31

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
ABN Compounds in SPLP Leachates	GC/MS	8208380	2022/09/06	2022/09/07	Kathy Horvat
1,3-Dichloropropene Sum	CALC	8201220	N/A	2022/09/06	Automated Statchk
Cyanide (WAD) in Leachates	SKAL/CN	8204117	N/A	2022/09/02	Kruti Jitesh Patel
Dinitrotoluene Sum	CALC	8201221	N/A	2022/09/08	Automated Statchk
Fluoride by ISE in Leachates	ISE	8204121	2022/09/02	2022/09/02	Kien Tran
Mercury (low level SPLP Leachable)	CV/AA	8204798	2022/09/02	2022/09/06	Japneet Gill
Total Metals in SPLP Leachate by ICPMS	ICP/MS	8204416	2022/09/02	2022/09/06	Arefa Dabhad
Modified SPLP extraction - Weight		8201548	N/A	2022/09/02	Jian (Ken) Wang
Nitrate& Nitrite as Nitrogen in Leachate	LACH	8204120	N/A	2022/09/06	Samuel Law
pH CaCl2 EXTRACT	AT	8207286	2022/09/06	2022/09/06	Taslima Aktar
Sulphate (20:1 Extract)	KONE/EC	8207212	2022/09/06	2022/09/06	Chandra Nandlal
SPLP Zero Headspace Extraction		8201469	2022/09/01	2022/09/02	Abdul Rahman Mohammed
Volatile organics in SPLP leachates	HS/MS	8203814	N/A	2022/09/03	Manpreet Sarao

Bureau Veritas ID: TPM835 Dup
Sample ID: RCM-SCARBOROUGH
Matrix: Solid

Collected: 2022/08/30
Shipped:
Received: 2022/08/31

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Cyanide (WAD) in Leachates	SKAL/CN	8204117	N/A	2022/09/02	Kruti Jitesh Patel
Fluoride by ISE in Leachates	ISE	8204121	2022/09/02	2022/09/02	Kien Tran
Mercury (low level SPLP Leachable)	CV/AA	8204798	2022/09/02	2022/09/06	Japneet Gill
Nitrate& Nitrite as Nitrogen in Leachate	LACH	8204120	N/A	2022/09/06	Samuel Law

GENERAL COMMENTS

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

Package 1	9.0°C

Revised Report (2022/09/15): Final leach pH results included in this CofA as per Aamna Arora's request.

RCM-WATERDOWN: Final leach pH is 11.92.
RCM-BETHRIDGE: Final leach pH is 11.62.
RCM-SCARBOROUGH: Final leach pH is 11.66.

Results relate only to the items tested.

QUALITY ASSURANCE REPORT

			Matrix Spike		SPIKED BLANK		Method Blank		RPD		Leachate Blank	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits	Value	UNITS
8203814	Leachable (SPLP) 4-Bromofluorobenzene	2022/09/02	98	70 - 130	98	70 - 130	92	%				
8203814	Leachable (SPLP) D4-1,2-Dichloroethane	2022/09/02	111	70 - 130	104	70 - 130	109	%				
8203814	Leachable (SPLP) D8-Toluene	2022/09/02	103	70 - 130	105	70 - 130	98	%				
8208380	Leachable (SPLP) 2,4,6-Tribromophenol	2022/09/07	93	30 - 130	108	30 - 130	101	%				
8208380	Leachable (SPLP) 2-Fluorobiphenyl	2022/09/07	64	30 - 130	53	30 - 130	55	%				
8208380	Leachable (SPLP) D14-Terphenyl (FS)	2022/09/07	100	30 - 130	93	30 - 130	91	%				
8208380	Leachable (SPLP) D5-Nitrobenzene	2022/09/07	60	30 - 130	52	30 - 130	52	%				
8203814	Leachable (SPLP) 1,1,1,2-Tetrachloroethane	2022/09/02	97	70 - 130	100	70 - 130	<0.40	ug/L	NC	30		
8203814	Leachable (SPLP) 1,1,2,2-Tetrachloroethane	2022/09/02	98	70 - 130	94	70 - 130	<0.40	ug/L	NC	30		
8203814	Leachable (SPLP) 1,1,2-Trichloroethane	2022/09/02	109	70 - 130	109	70 - 130	<0.40	ug/L	NC	30		
8203814	Leachable (SPLP) 1,1-Dichloroethane	2022/09/02	105	70 - 130	109	70 - 130	<0.40	ug/L	NC	30		
8203814	Leachable (SPLP) 1,1-Dichloroethylene	2022/09/02	99	70 - 130	107	70 - 130	<0.40	ug/L	NC	30		
8203814	Leachable (SPLP) 1,2-Dichlorobenzene	2022/09/02	95	70 - 130	96	70 - 130	<0.40	ug/L	NC	30		
8203814	Leachable (SPLP) 1,2-Dichloroethane	2022/09/02	103	70 - 130	102	70 - 130	<0.40	ug/L	NC	30		
8203814	Leachable (SPLP) 1,2-Dichloropropane	2022/09/02	98	70 - 130	100	70 - 130	<0.40	ug/L	NC	30		
8203814	Leachable (SPLP) 1,4-Dichlorobenzene	2022/09/02	105	70 - 130	109	70 - 130	<0.40	ug/L	NC	30		
8203814	Leachable (SPLP) Bromomethane	2022/09/02	88	60 - 140	92	60 - 140	<0.40	ug/L	NC	30		
8203814	Leachable (SPLP) Carbon Tetrachloride	2022/09/02	96	70 - 130	102	70 - 130	<0.19	ug/L	NC	30		
8203814	Leachable (SPLP) Chloroform	2022/09/02	100	70 - 130	102	70 - 130	<0.93 (1)	ug/L	NC	30		
8203814	Leachable (SPLP) cis-1,2-Dichloroethylene	2022/09/02	108	70 - 130	111	70 - 130	<0.40	ug/L	NC	30		
8203814	Leachable (SPLP) cis-1,3-Dichloropropene	2022/09/02	91	70 - 130	90	70 - 130	<0.30	ug/L	NC	30		
8203814	Leachable (SPLP) Ethylene Dibromide	2022/09/02	96	70 - 130	96	70 - 130	<0.19	ug/L	NC	30		
8203814	Leachable (SPLP) Tetrachloroethylene	2022/09/02	87	70 - 130	93	70 - 130	<0.40	ug/L	NC	30		
8203814	Leachable (SPLP) trans-1,2-Dichloroethylene	2022/09/02	102	70 - 130	107	70 - 130	<0.40	ug/L	NC	30		
8203814	Leachable (SPLP) trans-1,3-Dichloropropene	2022/09/02	100	70 - 130	96	70 - 130	<0.30	ug/L	NC	30		
8203814	Leachable (SPLP) Trichloroethylene	2022/09/02	97	70 - 130	102	70 - 130	<0.40	ug/L	NC	30		
8204117	Leachable WAD Cyanide (Free)	2022/09/02	91	80 - 120	96	80 - 120	<0.0020	mg/L	NC	20	<0.010	mg/L
8204120	Leachable Nitrate (N)	2022/09/06	102	80 - 120	105	80 - 120	<1.0	mg/L	NC	25	<1.0	mg/L
8204120	Leachable Nitrate + Nitrite (N)	2022/09/06	101	80 - 120	104	80 - 120	<1.0	mg/L	NC	25	<1.0	mg/L

QUALITY ASSURANCE REPORT(CONT'D)

			Matrix Spike		SPIKED BLANK		Method Blank		RPD		Leachate Blank	
QC Batch	**Parameter**	**Date**	**% Recovery**	**QC Limits**	**% Recovery**	**QC Limits**	**Value**	**UNITS**	**Value (%)**	**QC Limits**	**Value**	**UNITS**
8204120	Leachable Nitrite (N)	2022/09/06	99	80 - 120	101	80 - 120	<0.10	mg/L	NC	25	<0.10	mg/L
8204121	Leachable Fluoride (F-)	2022/09/02	88	80 - 120	102	80 - 120	<0.10	mg/L	7.6	25	<0.10	mg/L
8204416	Leachable (SPLP) Antimony (Sb)	2022/09/06	111	80 - 120	108	80 - 120	<0.5	ug/L	NC	35	<0.5	ug/L
8204416	Leachable (SPLP) Arsenic (As)	2022/09/06	103	80 - 120	103	80 - 120	<1	ug/L	NC	35	<1	ug/L
8204416	Leachable (SPLP) Barium (Ba)	2022/09/06	100	80 - 120	101	80 - 120	<5	ug/L	3.6	35	<5	ug/L
8204416	Leachable (SPLP) Beryllium (Be)	2022/09/06	103	80 - 120	97	80 - 120	<0.5	ug/L	NC	35	<0.5	ug/L
8204416	Leachable (SPLP) Boron (B)	2022/09/06	98	80 - 120	94	80 - 120	<10	ug/L	NC	35	<10	ug/L
8204416	Leachable (SPLP) Cadmium (Cd)	2022/09/06	104	80 - 120	103	80 - 120	<0.1	ug/L	NC	35	<0.1	ug/L
8204416	Leachable (SPLP) Chromium (Cr)	2022/09/06	96	80 - 120	98	80 - 120	<5	ug/L	3.0	35	<5	ug/L
8204416	Leachable (SPLP) Cobalt (Co)	2022/09/06	100	80 - 120	102	80 - 120	<0.5	ug/L	NC	35	<0.5	ug/L
8204416	Leachable (SPLP) Copper (Cu)	2022/09/06	104	80 - 120	103	80 - 120	<1	ug/L	5.4	35	<1	ug/L
8204416	Leachable (SPLP) Lead (Pb)	2022/09/06	96	80 - 120	98	80 - 120	<0.5	ug/L	NC	35	<0.5	ug/L
8204416	Leachable (SPLP) Molybdenum (Mo)	2022/09/06	102	80 - 120	98	80 - 120	<1	ug/L	1.7	35	<1	ug/L
8204416	Leachable (SPLP) Nickel (Ni)	2022/09/06	99	80 - 120	102	80 - 120	<1	ug/L	6.7	35	<1	ug/L
8204416	Leachable (SPLP) Selenium (Se)	2022/09/06	102	80 - 120	102	80 - 120	<2	ug/L	NC	35	<2	ug/L
8204416	Leachable (SPLP) Silver (Ag)	2022/09/06	99	80 - 120	98	80 - 120	<0.1	ug/L	NC	35	<0.1	ug/L
8204416	Leachable (SPLP) Thallium (Tl)	2022/09/06	97	80 - 120	99	80 - 120	<0.05	ug/L	NC	35	<0.05	ug/L
8204416	Leachable (SPLP) Vanadium (V)	2022/09/06	97	80 - 120	98	80 - 120	<1	ug/L	4.3	35	<1	ug/L
8204416	Leachable (SPLP) Zinc (Zn)	2022/09/06	102	80 - 120	104	80 - 120	<5	ug/L	NC	35	<5	ug/L
8204798	Leachable (SPLP) Mercury (Hg)	2022/09/06	98	75 - 125	101	80 - 120	<0.02	ug/L	NC	30	<0.02	ug/L
8207212	Soluble (20:1) Sulphate (SO4)	2022/09/06	103	70 - 130	103	70 - 130	<20	ug/g	NC	35		
8207286	Available (CaCl2) pH	2022/09/06			100	97 - 103			2.0	N/A		
8208380	Leachable (SPLP) 2,4,6-Trichlorophenol	2022/09/07	84	10 - 130	72	10 - 130	<0.70	ug/L	NC	40		
8208380	Leachable (SPLP) 2,4-Dinitrophenol	2022/09/07	89	10 - 130	89	10 - 130	<5.0	ug/L	NC	40		
8208380	Leachable (SPLP) 2,4-Dinitrotoluene	2022/09/07	87	30 - 130	78	30 - 130	<3.0	ug/L	NC	40		
8208380	Leachable (SPLP) 2,6-Dinitrotoluene	2022/09/07	74	30 - 130	59	30 - 130	<3.0	ug/L	NC	40		
8208380	Leachable (SPLP) 3,3'-Dichlorobenzidine	2022/09/07	93	30 - 130	108	30 - 130	<0.40	ug/L	NC	40		
8208380	Leachable (SPLP) Bis(2-chloroethyl)ether	2022/09/07	59	30 - 130	52	30 - 130	<2.0	ug/L	NC	40		
8208380	Leachable (SPLP) Bis(2-chloroisopropyl)ether	2022/09/07	54	30 - 130	47	30 - 130	<2.0	ug/L	NC	40		

QUALITY ASSURANCE REPORT(CONT'D)

			Matrix Spike		SPIKED BLANK		Method Blank		RPD		Leachate Blank	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits	Value	UNITS
8208380	Leachable (SPLP) Diethyl phthalate	2022/09/07	84	30 - 130	88	30 - 130	<1.0	ug/L	NC	40		
8208380	Leachable (SPLP) Dimethyl phthalate	2022/09/07	54	30 - 130	70	30 - 130	<1.0	ug/L	NC	40		
8208380	Leachable (SPLP) p-Chloroaniline	2022/09/07	56	30 - 130	63	30 - 130	<5.0	ug/L	NC	40		

N/A = Not Applicable

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

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

Leachate Blank: A blank matrix containing all reagents used in the leaching procedure. Used to determine any process contamination.

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

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

Surrogate: A pure or isotopically labeled compound whose behavior mirrors the analytes of interest. Used to evaluate extraction efficiency.

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (absolute difference <= 2x RDL).

(1) The detection limit was raised due to matrix interferences.

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by:

Anastassia Hamanov, Scientific Specialist

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CHAIN OF CUSTODY RECORD

ENV COC - 00014v3

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Invoice Information Invoice to (requires report) ☐

Company: Exp Services Inc
Contact Name: Aswan Assadi
Street Address: 1595 Clark Blvd
City: Brampton Prov: ON Postal Code:
Phone:
Email: aswan.assadi@exp.com
Copies:

Report Information (if differs from invoice)

Company:
Contact Name: Aamna Arora
Street Address:
City: Prov: Postal Code:
Phone:
Email: aamna.arora@exp.com
Copies:

Project Information

Quotation #: Stream 3
P.O. #/ AFE#: BRM-GEO
Project #: BRM-22019043-A0
Site #: Various yards => Waterdown, Bethridge, Scarborough
Site Location:
Site Location Province:
Sampled By:

LAB USE ONLY - PLACE STICKER HERE

Rush Confirmation #:

Regulatory Criteria

REG 153
☐ Table 1 ☐ Table 2 ☐ Table 3 ☐ Table ____
☐ Res/Park ☐ Ind/Comm ☐ Agri/other
☐ Med/Fine ☐ Course ☐ For RSC

OTHER
☐ CCME ☐ Reg 558* *min 3 day TAT ☐ MISA ☐ PWQO
☑ Reg 406, Table: 2.1
☐ Sanitary Sewer Bylaw ☐ Storm Sewer Bylaw Municipality ____ ☐ Other:

Include Criteria on Certificate of Analysis (check if yes): ☐

SAMPLES MUST BE KEPT COOL (<10°C) FROM TIME OF SAMPLING UNTIL DELIVERY TO BUREAU VERITAS

Regular Turnaround Time (TAT)
☑ 5 to 7 Day ☐ 10 Day

Rush Turnaround Time (TAT) Surcharges apply
☐ Same Day ☐ 1 Day ☐ 2 Day ☐ 3 Day ☐ 4 Day

Date Required: YY MM DD

	Sample Identification	Date Sampled YY	Date Sampled MM	Date Sampled DD	Time (24hr) HH	Time (24hr) MM	Matrix	1 FIELD FILTERED	2 FIELD PRESERVED	3 LAB FILTRATION REQUIRED	4 BTEX/ F1	5 F2 - F4	6 VOCs	7 Reg 153 metals and inorganics	8 Reg 153 ICPMS metals	9 Reg 153 metals (Hg, Cr VI, ICPMS metals, HWS - B)	10	11 SPLP-metals and inorganics	12	13	14 SPLP-VOC	15 SPLP-SVOC	16 pH and sulfate	17	18	19	20	21 # OF CONTAINERS SUBMITTED	22 HOLD - DO NOT ANALYZE	Comments
1	RCM-Waterdown	Aug 24, 2022					RC											✓			✓	✓	✓					4		recycled concrete (RC)
2	RCM-Bethridge	Aug 30, 2022					RC											✓			✓	✓	✓					4		please process
3	RCM-Scarborough	Aug 30, 2022					RC											✓			✓	✓	✓					4		as necessary
4																														
5																														
6																														
7																														
8																														
9																														
10																														
11																														
12																														

31-Aug-22 15:13
Patricia Legette
C2P0225
JDK ENV-1545

*UNLESS OTHERWISE AGREED TO IN WRITING, WORK SUBMITTED ON THIS CHAIN OF CUSTODY IS SUBJECT TO BUREAU VERITAS STANDARD TERMS AND CONDITIONS. SIGNING OF THIS CHAIN OF CUSTODY DOCUMENT IS ACKNOWLEDGMENT AND ACCEPTANCE OF OUR TERMS AND CONDITIONS WHICH ARE AVAILABLE FOR VIEWING AT WWW.BVNA.COM/TERMS-AND-CONDITIONS OR BY CALLING THE LABORATORY LISTED ABOVE TO OBTAIN A COPY

LAB USE ONLY	Yes	No	°C	1	2	3
Seal present				9	9	9
Seal intact						
Cooling media present						

LAB USE ONLY	Yes	No	°C	1	2	3
Seal present						
Seal intact						
Cooling media present						

LAB USE ONLY	Yes	No	°C	1	2	3	Temperature reading by:
Seal present							
Seal intact							
Cooling media present							

	Relinquished by: (Signature/ Print)	Date YY	Date MM	Date DD	Time HH	Time MM	Received by: (Signature/ Print)	Date YY	Date MM	Date DD	Time HH	Time MM	Special instructions
1	Varun Ismail-Va	2022	Aug	31	2:59PM			Ow	08	31	15	13	
2													

Your P.O. #: BRM-GEO
Your Project #: BRM-22019043-A0
Site Location: WENTWORTH CT., BRAMPTON, ON

Attention: Aamna Arora

exp Services Inc
Brampton Branch
1595 Clark Blvd
Brampton, ON
CANADA L6T 4V1

Report Date: 2022/09/15
Report #: R7298141
Version: 1 - Final

CERTIFICATE OF ANALYSIS

BUREAU VERITAS JOB #: C2Q0199
Received: 2022/09/09, 16:09

Sample Matrix: Solid
Samples Received: 2

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
ABN Compounds in SPLP Leachates	2	2022/09/14	2022/09/15	CAM SOP-00301	EPA 8270 m
1,3-Dichloropropene Sum	2	N/A	2022/09/15		EPA 8260D m
Dinitrotoluene Sum	2	N/A	2022/09/15	CAM SOP - 00301	EPA 8270
Total Metals in SPLP Leachate by ICPMS	2	2022/09/14	2022/09/15	CAM SOP-00447	EPA 6020B m
Modified SPLP extraction - Weight	2	N/A	2022/09/14	CAM SOP-00941	OMOECP LaSB E9003 R3
pH CaCl2 EXTRACT	2	2022/09/13	2022/09/13	CAM SOP-00413	EPA 9045 D m
Sulphate (20:1 Extract)	2	2022/09/14	2022/09/15	CAM SOP-00464	EPA 375.4 m
SPLP Zero Headspace Extraction	2	2022/09/12	2022/09/13	CAM SOP-00430	EPA 1312 m
Volatile organics in SPLP leachates	1	N/A	2022/09/13	CAM SOP-00228	EPA 8260D m
Volatile organics in SPLP leachates	1	N/A	2022/09/15	CAM SOP-00228	EPA 8260D m

Remarks:

Bureau Veritas is accredited to ISO/IEC 17025 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by Bureau Veritas are based upon recognized Provincial, Federal or US method compendia such as CCME, MELCC, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in Bureau Veritas' profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and Bureau Veritas in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported; unless indicated otherwise, associated sample data are not blank corrected. Where applicable, unless otherwise noted, Measurement Uncertainty has not been accounted for when stating conformity to the referenced standard.

Bureau Veritas liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. Bureau Veritas has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by Bureau Veritas, unless otherwise agreed in writing. Bureau Veritas is not responsible for the accuracy or any data impacts, that result from the information provided by the customer or their agent.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.
Results relate to samples tested. When sampling is not conducted by Bureau Veritas, results relate to the supplied samples tested.
This Certificate shall not be reproduced except in full, without the written approval of the laboratory.
Reference Method suffix “m” indicates test methods incorporate validated modifications from specific reference methods to improve performance.

Your P.O. #: BRM-GEO
Your Project #: BRM-22019043-A0
Site Location: WENTWORTH CT., BRAMPTON, ON

Attention: Aamna Arora

exp Services Inc
Brampton Branch
1595 Clark Blvd
Brampton, ON
CANADA L6T 4V1

Report Date: 2022/09/15
Report #: R7298141
Version: 1 - Final

CERTIFICATE OF ANALYSIS

BUREAU VERITAS JOB #: C2Q0199
Received: 2022/09/09, 16:09

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

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Patricia Legette, Project Manager
Email: Patricia.Legette@bureauveritas.com
Phone# (905)817-5799
==

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For Service Group specific validation please refer to the Validation Signature Page.

Total Cover Pages : 2

O.REG 406 EXCESS SOIL SPLP ABNS (SOLID)

Bureau Veritas ID		TRQ867	TRQ868		
Sampling Date		2022/09/07	2022/09/07		
	UNITS	**RCM-WENTWORTH CT. BRAMPTON**	**RCMD-WENTWORTH CT. BRAMPTON**	**RDL**	**QC Batch**
Semivolatile Organics					
Leachable (SPLP) Bis(2-chloroethyl)ether	ug/L	<2.0	<2.0	2.0	8224652
Leachable (SPLP) Bis(2-chloroisopropyl)ether	ug/L	<2.0	<2.0	2.0	8224652
Leachable (SPLP) p-Chloroaniline	ug/L	<5.0	<5.0	5.0	8224652
Leachable (SPLP) 3,3'-Dichlorobenzidine	ug/L	<0.40	<0.40	0.40	8224652
Leachable (SPLP) Diethyl phthalate	ug/L	<1.0	<1.0	1.0	8224652
Leachable (SPLP) Dimethyl phthalate	ug/L	<1.0	<1.0	1.0	8224652
Leachable (SPLP) 2,4-Dinitrophenol	ug/L	<5.0	<5.0	5.0	8224652
Leachable (SPLP) 2,4-Dinitrotoluene	ug/L	<3.0	<3.0	3.0	8224652
Leachable (SPLP) 2,6-Dinitrotoluene	ug/L	<3.0	<3.0	3.0	8224652
Leachable (SPLP) 2,4,6-Trichlorophenol	ug/L	<0.70	<0.70	0.70	8224652
Calculated Parameters					
Leachable 2,4- & 2,6-Dinitrotoluene	ug/L	<4.2	<4.2	4.2	8218717
Surrogate Recovery (%)					
Leachable (SPLP) 2,4,6-Tribromophenol	%	27 (1)	33		8224652
Leachable (SPLP) 2-Fluorobiphenyl	%	72	65		8224652
Leachable (SPLP) D14-Terphenyl (FS)	%	94	90		8224652
Leachable (SPLP) D5-Nitrobenzene	%	79	72		8224652

RDL = Reportable Detection Limit

QC Batch = Quality Control Batch

(1) Surrogate recovery was below the lower control limit due to matrix interference. This may represent a lower bias in some results.

O.REG 406 EXCESS SOIL SPLP METALS (SOLID)

Bureau Veritas ID		TRQ867	TRQ867	TRQ868		
Sampling Date		2022/09/07	2022/09/07	2022/09/07		
	UNITS	**RCM-WENTWORTH CT. BRAMPTON**	**RCM-WENTWORTH CT. BRAMPTON Lab-Dup**	**RCMD-WENTWORTH CT. BRAMPTON**	**RDL**	**QC Batch**
Metals						
Leachable (SPLP) Antimony (Sb)	ug/L	<0.5	<0.5	<0.5	0.5	8224193
Leachable (SPLP) Arsenic (As)	ug/L	<1	<1	<1	1	8224193
Leachable (SPLP) Barium (Ba)	ug/L	68	66	55	5	8224193
Leachable (SPLP) Beryllium (Be)	ug/L	<0.5	<0.5	<0.5	0.5	8224193
Leachable (SPLP) Boron (B)	ug/L	<10	<10	13	10	8224193
Leachable (SPLP) Cadmium (Cd)	ug/L	<0.1	<0.1	<0.1	0.1	8224193
Leachable (SPLP) Chromium (Cr)	ug/L	17	16	17	5	8224193
Leachable (SPLP) Cobalt (Co)	ug/L	<0.5	<0.5	<0.5	0.5	8224193
Leachable (SPLP) Copper (Cu)	ug/L	6	6	6	1	8224193
Leachable (SPLP) Lead (Pb)	ug/L	3.4	3.2	<0.5	0.5	8224193
Leachable (SPLP) Molybdenum (Mo)	ug/L	6	6	3	1	8224193
Leachable (SPLP) Nickel (Ni)	ug/L	2	2	1	1	8224193
Leachable (SPLP) Selenium (Se)	ug/L	<2	<2	<2	2	8224193
Leachable (SPLP) Silver (Ag)	ug/L	<0.1	<0.1	<0.1	0.1	8224193
Leachable (SPLP) Thallium (Tl)	ug/L	<0.05	<0.05	<0.05	0.05	8224193
Leachable (SPLP) Uranium (U)	ug/L	<0.1	<0.1	<0.1	0.1	8224193
Leachable (SPLP) Vanadium (V)	ug/L	2	2	3	1	8224193
Leachable (SPLP) Zinc (Zn)	ug/L	<5	<5	9	5	8224193

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate

O.REG 406 EXCESS SOIL SPLP PREP (SOLID)

Bureau Veritas ID		TRQ867	TRQ868	
Sampling Date		2022/09/07	2022/09/07	
	UNITS	**RCM-WENTWORTH CT. BRAMPTON**	**RCMD-WENTWORTH CT. BRAMPTON**	**QC Batch**
Inorganics				
Dry Weight	g	100	100	8222231
QC Batch = Quality Control Batch				

O.REG 406 EXCESS SOIL SPLP VOCS (SOLID)

Bureau Veritas ID		TRQ867			TRQ867		
Sampling Date		2022/09/07			2022/09/07		
	UNITS	**RCM-WENTWORTH CT. BRAMPTON**	**RDL**	**QC Batch**	**RCM-WENTWORTH CT. BRAMPTON Lab-Dup**	**RDL**	**QC Batch**
Charge/Prep Analysis							
Amount Extracted (Wet Weight) (g)	N/A	25	N/A	8219295	25	N/A	8219295
Calculated Parameters							
Leachable (ZHE) 1,3-Dichloropropene (cis+trans)	ug/L	<0.42	0.42	8218716			
Volatile Organics							
Leachable (SPLP) Bromomethane	ug/L	<0.40	0.40	8221250	<0.40	0.40	8221250
Leachable (SPLP) Carbon Tetrachloride	ug/L	<0.19	0.19	8221250	<0.19	0.19	8221250
Leachable (SPLP) Chloroform	ug/L	<0.90	0.90	8221250	<0.90	0.90	8221250
Leachable (SPLP) 1,2-Dichlorobenzene	ug/L	<0.40	0.40	8221250	<0.40	0.40	8221250
Leachable (SPLP) 1,4-Dichlorobenzene	ug/L	<0.40	0.40	8221250	<0.40	0.40	8221250
Leachable (SPLP) 1,1-Dichloroethane	ug/L	<0.40	0.40	8221250	<0.40	0.40	8221250
Leachable (SPLP) 1,2-Dichloroethane	ug/L	<0.40	0.40	8221250	<0.40	0.40	8221250
Leachable (SPLP) 1,1-Dichloroethylene	ug/L	<0.40	0.40	8221250	<0.40	0.40	8221250
Leachable (SPLP) cis-1,2-Dichloroethylene	ug/L	<0.40	0.40	8221250	<0.40	0.40	8221250
Leachable (SPLP) trans-1,2-Dichloroethylene	ug/L	<0.40	0.40	8221250	<0.40	0.40	8221250
Leachable (SPLP) 1,2-Dichloropropane	ug/L	<0.40	0.40	8221250	<0.40	0.40	8221250
Leachable (SPLP) cis-1,3-Dichloropropene	ug/L	<0.30	0.30	8221250	<0.30	0.30	8221250
Leachable (SPLP) trans-1,3-Dichloropropene	ug/L	<0.30	0.30	8221250	<0.30	0.30	8221250
Leachable (SPLP) Ethylene Dibromide	ug/L	<0.19	0.19	8221250	<0.19	0.19	8221250
Leachable (SPLP) 1,1,1,2-Tetrachloroethane	ug/L	<0.40	0.40	8221250	<0.40	0.40	8221250
Leachable (SPLP) 1,1,2,2-Tetrachloroethane	ug/L	<0.40	0.40	8221250	<0.40	0.40	8221250
Leachable (SPLP) Tetrachloroethylene	ug/L	<0.40	0.40	8221250	<0.40	0.40	8221250
Leachable (SPLP) 1,1,2-Trichloroethane	ug/L	<0.40	0.40	8221250	<0.40	0.40	8221250
Leachable (SPLP) Trichloroethylene	ug/L	<0.40	0.40	8221250	<0.40	0.40	8221250
Surrogate Recovery (%)							
Leachable (SPLP) 4-Bromofluorobenzene	%	99		8221250	97		8221250
Leachable (SPLP) D4-1,2-Dichloroethane	%	104		8221250	105		8221250
Leachable (SPLP) D8-Toluene	%	97		8221250	99		8221250

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate
N/A = Not Applicable

O.REG 406 EXCESS SOIL SPLP VOCS (SOLID)

Bureau Veritas ID		TRQ868		
Sampling Date		2022/09/07		
	UNITS	**RCMD-WENTWORTH CT. BRAMPTON**	**RDL**	**QC Batch**
Charge/Prep Analysis				
Amount Extracted (Wet Weight) (g)	N/A	25	N/A	8219295
Calculated Parameters				
Leachable (ZHE) 1,3-Dichloropropene (cis+trans)	ug/L	<0.42	0.42	8218716
Volatile Organics				
Leachable (SPLP) Bromomethane	ug/L	<0.40	0.40	8221250
Leachable (SPLP) Carbon Tetrachloride	ug/L	<0.19	0.19	8221250
Leachable (SPLP) Chloroform	ug/L	<0.90	0.90	8221250
Leachable (SPLP) 1,2-Dichlorobenzene	ug/L	<0.40	0.40	8221250
Leachable (SPLP) 1,4-Dichlorobenzene	ug/L	<0.40	0.40	8221250
Leachable (SPLP) 1,1-Dichloroethane	ug/L	<0.40	0.40	8221250
Leachable (SPLP) 1,2-Dichloroethane	ug/L	<0.40	0.40	8221250
Leachable (SPLP) 1,1-Dichloroethylene	ug/L	<0.40	0.40	8221250
Leachable (SPLP) cis-1,2-Dichloroethylene	ug/L	<0.40	0.40	8221250
Leachable (SPLP) trans-1,2-Dichloroethylene	ug/L	<0.40	0.40	8221250
Leachable (SPLP) 1,2-Dichloropropane	ug/L	<0.40	0.40	8221250
Leachable (SPLP) cis-1,3-Dichloropropene	ug/L	<0.30	0.30	8221250
Leachable (SPLP) trans-1,3-Dichloropropene	ug/L	<0.30	0.30	8221250
Leachable (SPLP) Ethylene Dibromide	ug/L	<0.19	0.19	8221250
Leachable (SPLP) 1,1,1,2-Tetrachloroethane	ug/L	<0.40	0.40	8221250
Leachable (SPLP) 1,1,2,2-Tetrachloroethane	ug/L	<0.40	0.40	8221250
Leachable (SPLP) Tetrachloroethylene	ug/L	<0.40	0.40	8221250
Leachable (SPLP) 1,1,2-Trichloroethane	ug/L	<0.40	0.40	8221250
Leachable (SPLP) Trichloroethylene	ug/L	<0.40	0.40	8221250
Surrogate Recovery (%)				
Leachable (SPLP) 4-Bromofluorobenzene	%	88		8221250
Leachable (SPLP) D4-1,2-Dichloroethane	%	117		8221250
Leachable (SPLP) D8-Toluene	%	93		8221250

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
N/A = Not Applicable

RESULTS OF ANALYSES OF SOLID

Bureau Veritas ID		TRQ867	TRQ868		
Sampling Date		2022/09/07	2022/09/07		
	UNITS	**RCM-WENTWORTH CT. BRAMPTON**	**RCMD-WENTWORTH CT. BRAMPTON**	**RDL**	**QC Batch**
Inorganics					
Available (CaCl2) pH	pH	12.1	12.2		8221136
Soluble (20:1) Sulphate (SO4)	ug/g	780	720	20	8223368

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

TEST SUMMARY

Bureau Veritas ID: TRQ867
Sample ID: RCM-WENTWORTH CT. BRAMPTON
Matrix: Solid

Collected: 2022/09/07
Shipped:
Received: 2022/09/09

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
ABN Compounds in SPLP Leachates	GC/MS	8224652	2022/09/14	2022/09/15	Kathy Horvat
1,3-Dichloropropene Sum	CALC	8218716	N/A	2022/09/15	Automated Statchk
Dinitrotoluene Sum	CALC	8218717	N/A	2022/09/15	Automated Statchk
Total Metals in SPLP Leachate by ICPMS	ICP/MS	8224193	2022/09/14	2022/09/15	Azita Fazaeli
Modified SPLP extraction - Weight		8222231	N/A	2022/09/14	Omer Imtiaz Uddin
pH CaCl2 EXTRACT	AT	8221136	2022/09/13	2022/09/13	Surinder Rai
Sulphate (20:1 Extract)	KONE/EC	8223368	2022/09/14	2022/09/15	Samuel Law
SPLP Zero Headspace Extraction		8219295	2022/09/12	2022/09/13	Archit Prajapati
Volatile organics in SPLP leachates	HS/MS	8221250	N/A	2022/09/15	Gladys Guerrero

Bureau Veritas ID: TRQ867 Dup
Sample ID: RCM-WENTWORTH CT. BRAMPTON
Matrix: Solid

Collected: 2022/09/07
Shipped:
Received: 2022/09/09

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Total Metals in SPLP Leachate by ICPMS	ICP/MS	8224193	2022/09/14	2022/09/15	Azita Fazaeli
SPLP Zero Headspace Extraction		8219295	2022/09/12	2022/09/13	Archit Prajapati
Volatile organics in SPLP leachates	HS/MS	8221250	N/A	2022/09/15	Gladys Guerrero

Bureau Veritas ID: TRQ868
Sample ID: RCMD-WENTWORTH CT. BRAMPTON
Matrix: Solid

Collected: 2022/09/07
Shipped:
Received: 2022/09/09

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
ABN Compounds in SPLP Leachates	GC/MS	8224652	2022/09/14	2022/09/15	Kathy Horvat
1,3-Dichloropropene Sum	CALC	8218716	N/A	2022/09/15	Automated Statchk
Dinitrotoluene Sum	CALC	8218717	N/A	2022/09/15	Automated Statchk
Total Metals in SPLP Leachate by ICPMS	ICP/MS	8224193	2022/09/14	2022/09/15	Azita Fazaeli
Modified SPLP extraction - Weight		8222231	N/A	2022/09/14	Omer Imtiaz Uddin
pH CaCl2 EXTRACT	AT	8221136	2022/09/13	2022/09/13	Surinder Rai
Sulphate (20:1 Extract)	KONE/EC	8223368	2022/09/14	2022/09/15	Samuel Law
SPLP Zero Headspace Extraction		8219295	2022/09/12	2022/09/13	Archit Prajapati
Volatile organics in SPLP leachates	HS/MS	8221250	N/A	2022/09/13	Gladys Guerrero

GENERAL COMMENTS

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

Package 1	0.7°C

Final leach pH results included in this CofA as per Aamna Arora's request.

RCM-WENTWORTH CT. BRAMPTO: Final leach pH is 11.01.
RCMD-WENTWORTH CT. BRAMPT: Final leach pH is 10.98.

Results relate only to the items tested.

QUALITY ASSURANCE REPORT

			Matrix Spike		SPIKED BLANK		Method Blank		RPD		Leachate Blank	
QC Batch	**Parameter**	**Date**	**% Recovery**	**QC Limits**	**% Recovery**	**QC Limits**	**Value**	**UNITS**	**Value (%)**	**QC Limits**	**Value**	**UNITS**
8221250	Leachable (SPLP) 4-Bromofluorobenzene	2022/09/13	102	70 - 130	101	70 - 130	89	%				
8221250	Leachable (SPLP) D4-1,2-Dichloroethane	2022/09/13	110	70 - 130	104	70 - 130	115	%				
8221250	Leachable (SPLP) D8-Toluene	2022/09/13	100	70 - 130	102	70 - 130	92	%				
8224652	Leachable (SPLP) 2,4,6-Tribromophenol	2022/09/15	86	30 - 130	86	30 - 130	61	%				
8224652	Leachable (SPLP) 2-Fluorobiphenyl	2022/09/15	70	30 - 130	72	30 - 130	79	%				
8224652	Leachable (SPLP) D14-Terphenyl (FS)	2022/09/15	93	30 - 130	89	30 - 130	91	%				
8224652	Leachable (SPLP) D5-Nitrobenzene	2022/09/15	80	30 - 130	80	30 - 130	77	%				
8221136	Available (CaCl2) pH	2022/09/13			100	97 - 103			0.58	N/A		
8221250	Leachable (SPLP) 1,1,1,2-Tetrachloroethane	2022/09/15	99	70 - 130	93	70 - 130	<0.40	ug/L	NC	30		
8221250	Leachable (SPLP) 1,1,2,2-Tetrachloroethane	2022/09/15	110	70 - 130	92	70 - 130	<0.40	ug/L	NC	30		
8221250	Leachable (SPLP) 1,1,2-Trichloroethane	2022/09/15	107	70 - 130	96	70 - 130	<0.40	ug/L	NC	30		
8221250	Leachable (SPLP) 1,1-Dichloroethane	2022/09/15	91	70 - 130	95	70 - 130	<0.40	ug/L	NC	30		
8221250	Leachable (SPLP) 1,1-Dichloroethylene	2022/09/15	88	70 - 130	99	70 - 130	<0.40	ug/L	NC	30		
8221250	Leachable (SPLP) 1,2-Dichlorobenzene	2022/09/15	96	70 - 130	89	70 - 130	<0.40	ug/L	NC	30		
8221250	Leachable (SPLP) 1,2-Dichloroethane	2022/09/15	100	70 - 130	95	70 - 130	<0.40	ug/L	NC	30		
8221250	Leachable (SPLP) 1,2-Dichloropropane	2022/09/15	100	70 - 130	96	70 - 130	<0.40	ug/L	NC	30		
8221250	Leachable (SPLP) 1,4-Dichlorobenzene	2022/09/15	105	70 - 130	103	70 - 130	<0.40	ug/L	NC	30		
8221250	Leachable (SPLP) Bromomethane	2022/09/15	87	60 - 140	98	60 - 140	<0.40	ug/L	NC	30		
8221250	Leachable (SPLP) Carbon Tetrachloride	2022/09/15	91	70 - 130	97	70 - 130	<0.19	ug/L	NC	30		
8221250	Leachable (SPLP) Chloroform	2022/09/15	98	70 - 130	95	70 - 130	<0.90	ug/L	NC	30		
8221250	Leachable (SPLP) cis-1,2-Dichloroethylene	2022/09/15	97	70 - 130	99	70 - 130	<0.40	ug/L	NC	30		
8221250	Leachable (SPLP) cis-1,3-Dichloropropene	2022/09/15	99	70 - 130	93	70 - 130	<0.30	ug/L	NC	30		
8221250	Leachable (SPLP) Ethylene Dibromide	2022/09/15	100	70 - 130	90	70 - 130	<0.19	ug/L	NC	30		
8221250	Leachable (SPLP) Tetrachloroethylene	2022/09/15	82	70 - 130	86	70 - 130	<0.40	ug/L	NC	30		
8221250	Leachable (SPLP) trans-1,2-Dichloroethylene	2022/09/15	91	70 - 130	98	70 - 130	<0.40	ug/L	NC	30		
8221250	Leachable (SPLP) trans-1,3-Dichloropropene	2022/09/15	105	70 - 130	96	70 - 130	<0.30	ug/L	NC	30		
8221250	Leachable (SPLP) Trichloroethylene	2022/09/15	97	70 - 130	100	70 - 130	<0.40	ug/L	NC	30		
8223368	Soluble (20:1) Sulphate (SO4)	2022/09/15	NC	70 - 130	105	70 - 130	<20	ug/g	17	35		
8224193	Leachable (SPLP) Antimony (Sb)	2022/09/15	107	80 - 120	104	80 - 120	<0.5	ug/L	NC	35	<0.5	ug/L
8224193	Leachable (SPLP) Arsenic (As)	2022/09/15	106	80 - 120	104	80 - 120	<1	ug/L	NC	35	<1	ug/L

QUALITY ASSURANCE REPORT(CONT'D)

			Matrix Spike		SPIKED BLANK		Method Blank		RPD		Leachate Blank	
QC Batch	**Parameter**	**Date**	**% Recovery**	**QC Limits**	**% Recovery**	**QC Limits**	**Value**	**UNITS**	**Value (%)**	**QC Limits**	**Value**	**UNITS**
8224193	Leachable (SPLP) Barium (Ba)	2022/09/15	100	80 - 120	99	80 - 120	<5	ug/L	3.3	35	<5	ug/L
8224193	Leachable (SPLP) Beryllium (Be)	2022/09/15	110	80 - 120	107	80 - 120	<0.5	ug/L	NC	35	<0.5	ug/L
8224193	Leachable (SPLP) Boron (B)	2022/09/15	98	80 - 120	97	80 - 120	<10	ug/L	NC	35	<10	ug/L
8224193	Leachable (SPLP) Cadmium (Cd)	2022/09/15	105	80 - 120	101	80 - 120	<0.1	ug/L	NC	35	<0.1	ug/L
8224193	Leachable (SPLP) Chromium (Cr)	2022/09/15	102	80 - 120	101	80 - 120	<5	ug/L	4.5	35	<5	ug/L
8224193	Leachable (SPLP) Cobalt (Co)	2022/09/15	105	80 - 120	103	80 - 120	<0.5	ug/L	NC	35	<0.5	ug/L
8224193	Leachable (SPLP) Copper (Cu)	2022/09/15	103	80 - 120	101	80 - 120	<1	ug/L	2.5	35	<1	ug/L
8224193	Leachable (SPLP) Lead (Pb)	2022/09/15	100	80 - 120	99	80 - 120	<0.5	ug/L	5.4	35	<0.5	ug/L
8224193	Leachable (SPLP) Molybdenum (Mo)	2022/09/15	107	80 - 120	104	80 - 120	<1	ug/L	0.14	35	<1	ug/L
8224193	Leachable (SPLP) Nickel (Ni)	2022/09/15	104	80 - 120	104	80 - 120	<1	ug/L	0.24	35	<1	ug/L
8224193	Leachable (SPLP) Selenium (Se)	2022/09/15	109	80 - 120	109	80 - 120	<2	ug/L	NC	35	<2	ug/L
8224193	Leachable (SPLP) Silver (Ag)	2022/09/15	106	80 - 120	102	80 - 120	<0.1	ug/L	NC	35	<0.1	ug/L
8224193	Leachable (SPLP) Thallium (Tl)	2022/09/15	101	80 - 120	100	80 - 120	<0.05	ug/L	NC	35	<0.05	ug/L
8224193	Leachable (SPLP) Uranium (U)	2022/09/15	109	80 - 120	108	80 - 120	<0.1	ug/L	NC	35	<0.1	ug/L
8224193	Leachable (SPLP) Vanadium (V)	2022/09/15	106	80 - 120	103	80 - 120	<1	ug/L	0.29	35	<1	ug/L
8224193	Leachable (SPLP) Zinc (Zn)	2022/09/15	105	80 - 120	105	80 - 120	<5	ug/L	NC	35	<5	ug/L
8224652	Leachable (SPLP) 2,4,6-Trichlorophenol	2022/09/15	94	10 - 130	93	10 - 130	<0.70	ug/L	NC	40		
8224652	Leachable (SPLP) 2,4-Dinitrophenol	2022/09/15	46	10 - 130	60	10 - 130	<5.0	ug/L	NC	40		
8224652	Leachable (SPLP) 2,4-Dinitrotoluene	2022/09/15	90	30 - 130	90	30 - 130	<3.0	ug/L	NC	40		
8224652	Leachable (SPLP) 2,6-Dinitrotoluene	2022/09/15	90	30 - 130	86	30 - 130	<3.0	ug/L	NC	40		
8224652	Leachable (SPLP) 3,3'-Dichlorobenzidine	2022/09/15	89	30 - 130	106	30 - 130	<0.40	ug/L	NC	40		
8224652	Leachable (SPLP) Bis(2-chloroethyl)ether	2022/09/15	85	30 - 130	82	30 - 130	<2.0	ug/L	NC	40		
8224652	Leachable (SPLP) Bis(2-chloroisopropyl)ether	2022/09/15	76	30 - 130	74	30 - 130	<2.0	ug/L	NC	40		
8224652	Leachable (SPLP) Diethyl phthalate	2022/09/15	89	30 - 130	99	30 - 130	<1.0	ug/L	NC	40		
8224652	Leachable (SPLP) Dimethyl phthalate	2022/09/15	63	30 - 130	95	30 - 130	<1.0	ug/L	NC	40		

QUALITY ASSURANCE REPORT(CONT'D)

			Matrix Spike		SPIKED BLANK		Method Blank		RPD		Leachate Blank	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits	Value	UNITS
8224652	Leachable (SPLP) p-Chloroaniline	2022/09/15	76	30 - 130	98	30 - 130	<5.0	ug/L	NC	40		

N/A = Not Applicable

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

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

Leachate Blank: A blank matrix containing all reagents used in the leaching procedure. Used to determine any process contamination.

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

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

Surrogate: A pure or isotopically labeled compound whose behavior mirrors the analytes of interest. Used to evaluate extraction efficiency.

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

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (absolute difference <= 2x RDL).

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by:

Cristina Carriere

Cristina Carriere, Senior Scientific Specialist

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CHAIN OF CUSTODY RECORD

ENVCOC - 00014v3

Page 1 of 1

09-Sep-22 16:09
Patricia Legette
C2Q0199
AJH ENV-1101

Invoice Information	Invoice to (requires report) ☐	Report Information (if differs from invoice)		Project Information	
Company:	EXP Services Inc	Company:		Quotation #:	Stream 3
Contact Name:	Aswan Assadi	Contact Name:	Aamna Arora	P.O. #/ AFE#:	BRM-GEO
Street Address:	1595 Clark Blvd	Street Address:		Project #:	BRM-22019043-A0
City:	Brampton Prov: ON Postal Code:	City:	Prov: Postal Code:	Site #:	Wentworth Ct. Brampton
Phone:		Phone:		Site Location:	
Email:	aswan.assadi@exp.com	Email:	aamna.arora@exp.com	Site Location Province:	
Copies:		Copies:		Sampled By:	

Regulatory Criteria

REG 153: ☐ Table 1 ☐ Table 2 ☐ Table 3 ☐ Table ______ ☐ Res/Park ☐ Ind/Comm ☐ Agri/other ☐ Med/Fine ☐ Course ☐ For RSC

OTHER: ☐ CCME ☐ Reg 558* *min 3 day TAT ☐ MISA ☐ PWQO ☑ Reg 406, Table: 2.1 ☐ Sanitary Sewer Bylaw ☐ Storm Sewer Bylaw Municipality ______ ☐ Other:

Include Criteria on Certificate of Analysis (check if yes): ☐

SAMPLES MUST BE KEPT COOL (<10°C) FROM TIME OF SAMPLING UNTIL DELIVERY TO BUREAU VERITAS

Regular Turnaround Time (TAT)

☑ 5 to 7 Day ☐ 10 Day

Rush Turnaround Time (TAT) Surcharges apply

☐ Same Day ☐ 1 Day
☐ 2 Day ☐ 3 Day
☐ 4 Day

Date Required: YY MM DD

	Sample Identification	Date Sampled YY	MM	DD	Time (24hr) HH	MM	Matrix	1 FIELD FILTERED	2 FIELD PRESERVED	3 LAB FILTRATION REQUIRED	4 BTEX/ F1	5 F2 - F4	6 VOCs	7 Reg 153 metals and inorganics	8 Reg 153 ICPMS metals	9 Reg 153 metals (Hg, Cr VI, ICPMS metals, HWS - B)	10	11 SPLP metals and inorganics	12	13	14 SPLP-VOC	15 SPLP-SVOCs	16 pH and sulfate	17	18	19	20	21 # OF CONTAINERS SUBMITTED	22 HOLD - DO NOT ANALYZE	Comments
1	RCM-Wentworth Ct. Brampton	September 7, 2022					RC											✓			✓	✓	✓					2		Recycled concrete (RC)
2	RCMD-Wentworth Ct. Brampton	September 7, 2022					RC											✓			✓	✓	✓					2		Please process
3																														as necessary
4																														
5																														
6																														
7																														
8																														
9																														
10																														
11																														
12																														

*UNLESS OTHERWISE AGREED TO IN WRITING, WORK SUBMITTED ON THIS CHAIN OF CUSTODY IS SUBJECT TO BUREAU VERITAS STANDARD TERMS AND CONDITIONS. SIGNING OF THIS CHAIN OF CUSTODY DOCUMENT IS ACKNOWLEDGMENT AND ACCEPTANCE OF OUR TERMS AND CONDITIONS WHICH ARE AVAILABLE FOR VIEWING AT WWW.BVNA.COM/TERMS-AND-CONDITIONS OR BY CALLING THE LABORATORY LISTED ABOVE TO OBTAIN A COPY

LAB USE ONLY	Yes	No	°C	1	2	3
Seal present	/	/		2	0	0
Seal intact	/	/				
Cooling media present						

LAB USE ONLY	Yes	No	°C	1	2	3
Seal present						
Seal intact						
Cooling media present						

LAB USE ONLY	Yes	No	°C	1	2	3	Temperature reading by:
Seal present							
Seal intact							
Cooling media present							

	Relinquished by: (Signature/ Print)	Date YY	MM	DD	Time HH	MM	Received by: (Signature/ Print)	Date YY	MM	DD	Time HH	MM	Special instructions
1	Karan Ismail	2022	Sep.	9	3:59PM		1	[illegible]	09	09	16	05	
2							2						

Your P.O. #: BRM-GEO
Your Project #: BRM-22019043-B0
Site Location: 10 LESLIE STREET YARD,TORONTO, ON
Your C.O.C. #: n/a

Attention: Aamna Arora

exp Services Inc
Brampton Branch
1595 Clark Blvd
Brampton, ON
CANADA L6T 4V1

Report Date: 2022/09/22
Report #: R7308348
Version: 2 - Final

CERTIFICATE OF ANALYSIS

BUREAU VERITAS JOB #: C2Q8287
Received: 2022/09/16, 14:58

Sample Matrix: Solid
Samples Received: 1

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
ABN Compounds in SPLP Leachates	1	2022/09/21	2022/09/22	CAM SOP-00301	EPA 8270 m
1,3-Dichloropropene Sum	1	N/A	2022/09/22		EPA 8260D m
Dinitrotoluene Sum	1	N/A	2022/09/22	CAM SOP - 00301	EPA 8270
Total Metals in SPLP Leachate by ICPMS	1	2022/09/21	2022/09/21	CAM SOP-00447	EPA 6020B m
Modified SPLP extraction - Weight	1	N/A	2022/09/20	CAM SOP-00941	OMOECP LaSB E9003 R3
pH CaCl2 EXTRACT	1	2022/09/20	2022/09/20	CAM SOP-00413	EPA 9045 D m
Sulphate (20:1 Extract)	1	2022/09/20	2022/09/20	CAM SOP-00464	EPA 375.4 m
SPLP Zero Headspace Extraction	1	2022/09/20	2022/09/21	CAM SOP-00430	EPA 1312 m
Volatile organics in SPLP leachates	1	N/A	2022/09/21	CAM SOP-00228	EPA 8260D m

Remarks:

Bureau Veritas is accredited to ISO/IEC 17025 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by Bureau Veritas are based upon recognized Provincial, Federal or US method compendia such as CCME, MELCC, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in Bureau Veritas' profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and Bureau Veritas in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported; unless indicated otherwise, associated sample data are not blank corrected. Where applicable, unless otherwise noted, Measurement Uncertainty has not been accounted for when stating conformity to the referenced standard.

Bureau Veritas liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. Bureau Veritas has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by Bureau Veritas, unless otherwise agreed in writing. Bureau Veritas is not responsible for the accuracy or any data impacts, that result from the information provided by the customer or their agent.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.
Results relate to samples tested. When sampling is not conducted by Bureau Veritas, results relate to the supplied samples tested.
This Certificate shall not be reproduced except in full, without the written approval of the laboratory.
Reference Method suffix “m” indicates test methods incorporate validated modifications from specific reference methods to improve performance.
* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

Your P.O. #: BRM-GEO
Your Project #: BRM-22019043-B0
Site Location: 10 LESLIE STREET YARD,TORONTO, ON
Your C.O.C. #: n/a

Attention: Aamna Arora

exp Services Inc
Brampton Branch
1595 Clark Blvd
Brampton, ON
CANADA L6T 4V1

Report Date: 2022/09/22
Report #: R7308348
Version: 2 - Final

CERTIFICATE OF ANALYSIS

BUREAU VERITAS JOB #: C2Q8287
Received: 2022/09/16, 14:58

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Patricia Legette, Project Manager
Email: Patricia.Legette@bureauveritas.com
Phone# (905)817-5799
==
Bureau Veritas has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per ISO/IEC 17025, signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Total Cover Pages : 2

O.REG 406 EXCESS SOIL SPLP ABNS (SOLID)

Bureau Veritas ID		TTK561		
Sampling Date		2022/09/14		
COC Number		n/a		
	UNITS	**RCM-10 LESLIE**	**RDL**	**QC Batch**
Semivolatile Organics				
Leachable (SPLP) Bis(2-chloroethyl)ether	ug/L	<2.0	2.0	8238861
Leachable (SPLP) Bis(2-chloroisopropyl)ether	ug/L	<2.0	2.0	8238861
Leachable (SPLP) p-Chloroaniline	ug/L	<5.0	5.0	8238861
Leachable (SPLP) 3,3'-Dichlorobenzidine	ug/L	<0.40	0.40	8238861
Leachable (SPLP) Diethyl phthalate	ug/L	<1.0	1.0	8238861
Leachable (SPLP) Dimethyl phthalate	ug/L	<1.0	1.0	8238861
Leachable (SPLP) 2,4-Dinitrophenol	ug/L	<5.0	5.0	8238861
Leachable (SPLP) 2,4-Dinitrotoluene	ug/L	<3.0	3.0	8238861
Leachable (SPLP) 2,6-Dinitrotoluene	ug/L	<3.0	3.0	8238861
Leachable (SPLP) 2,4,6-Trichlorophenol	ug/L	<0.70	0.70	8238861
Calculated Parameters				
Leachable 2,4- & 2,6-Dinitrotoluene	ug/L	<4.2	4.2	8232480
Surrogate Recovery (%)				
Leachable (SPLP) 2,4,6-Tribromophenol	%	87		8238861
Leachable (SPLP) 2-Fluorobiphenyl	%	68		8238861
Leachable (SPLP) D14-Terphenyl (FS)	%	83		8238861
Leachable (SPLP) D5-Nitrobenzene	%	77		8238861

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

O.REG 406 EXCESS SOIL SPLP METALS (SOLID)

Bureau Veritas ID		TTK561	TTK561		
Sampling Date		2022/09/14	2022/09/14		
COC Number		n/a	n/a		
	UNITS	**RCM-10 LESLIE**	**RCM-10 LESLIE Lab-Dup**	**RDL**	**QC Batch**
Metals					
Leachable (SPLP) Antimony (Sb)	ug/L	<0.5	<0.5	0.5	8237695
Leachable (SPLP) Arsenic (As)	ug/L	<1	<1	1	8237695
Leachable (SPLP) Barium (Ba)	ug/L	70	73	5	8237695
Leachable (SPLP) Beryllium (Be)	ug/L	<0.5	<0.5	0.5	8237695
Leachable (SPLP) Boron (B)	ug/L	<10	<10	10	8237695
Leachable (SPLP) Cadmium (Cd)	ug/L	<0.1	<0.1	0.1	8237695
Leachable (SPLP) Chromium (Cr)	ug/L	7	7	5	8237695
Leachable (SPLP) Cobalt (Co)	ug/L	0.9	0.9	0.5	8237695
Leachable (SPLP) Copper (Cu)	ug/L	8	8	1	8237695
Leachable (SPLP) Lead (Pb)	ug/L	0.6	0.6	0.5	8237695
Leachable (SPLP) Molybdenum (Mo)	ug/L	3	3	1	8237695
Leachable (SPLP) Nickel (Ni)	ug/L	2	2	1	8237695
Leachable (SPLP) Selenium (Se)	ug/L	<2	<2	2	8237695
Leachable (SPLP) Silver (Ag)	ug/L	<0.1	<0.1	0.1	8237695
Leachable (SPLP) Thallium (Tl)	ug/L	<0.05	<0.05	0.05	8237695
Leachable (SPLP) Uranium (U)	ug/L	<0.1	<0.1	0.1	8237695
Leachable (SPLP) Vanadium (V)	ug/L	1	1	1	8237695
Leachable (SPLP) Zinc (Zn)	ug/L	<5	<5	5	8237695

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate

O.REG 406 EXCESS SOIL SPLP PREP (SOLID)

Bureau Veritas ID		TTK561	
Sampling Date		2022/09/14	
COC Number		n/a	
	UNITS	**RCM-10 LESLIE**	**QC Batch**
Inorganics			
Dry Weight	g	100	8233768

QC Batch = Quality Control Batch

O.REG 406 EXCESS SOIL SPLP VOCS (SOLID)

Bureau Veritas ID		TTK561		
Sampling Date		2022/09/14		
COC Number		n/a		
	UNITS	**RCM-10 LESLIE**	**RDL**	**QC Batch**
Charge/Prep Analysis				
Amount Extracted (Wet Weight) (g)	N/A	25	N/A	8235852
Calculated Parameters				
Leachable (ZHE) 1,3-Dichloropropene (cis+trans)	ug/L	<0.42	0.42	8232479
Volatile Organics				
Leachable (SPLP) Bromomethane	ug/L	<0.40	0.40	8237923
Leachable (SPLP) Carbon Tetrachloride	ug/L	<0.19	0.19	8237923
Leachable (SPLP) Chloroform	ug/L	<0.90	0.90	8237923
Leachable (SPLP) 1,2-Dichlorobenzene	ug/L	<0.40	0.40	8237923
Leachable (SPLP) 1,4-Dichlorobenzene	ug/L	<0.40	0.40	8237923
Leachable (SPLP) 1,1-Dichloroethane	ug/L	<0.40	0.40	8237923
Leachable (SPLP) 1,2-Dichloroethane	ug/L	<0.40	0.40	8237923
Leachable (SPLP) 1,1-Dichloroethylene	ug/L	<0.40	0.40	8237923
Leachable (SPLP) cis-1,2-Dichloroethylene	ug/L	<0.40	0.40	8237923
Leachable (SPLP) trans-1,2-Dichloroethylene	ug/L	<0.40	0.40	8237923
Leachable (SPLP) 1,2-Dichloropropane	ug/L	<0.40	0.40	8237923
Leachable (SPLP) cis-1,3-Dichloropropene	ug/L	<0.30	0.30	8237923
Leachable (SPLP) trans-1,3-Dichloropropene	ug/L	<0.30	0.30	8237923
Leachable (SPLP) Ethylene Dibromide	ug/L	<0.19	0.19	8237923
Leachable (SPLP) 1,1,1,2-Tetrachloroethane	ug/L	<0.40	0.40	8237923
Leachable (SPLP) 1,1,2,2-Tetrachloroethane	ug/L	<0.40	0.40	8237923
Leachable (SPLP) Tetrachloroethylene	ug/L	<0.40	0.40	8237923
Leachable (SPLP) 1,1,2-Trichloroethane	ug/L	<0.40	0.40	8237923
Leachable (SPLP) Trichloroethylene	ug/L	<0.40	0.40	8237923
Surrogate Recovery (%)				
Leachable (SPLP) 4-Bromofluorobenzene	%	98		8237923
Leachable (SPLP) D4-1,2-Dichloroethane	%	105		8237923
Leachable (SPLP) D8-Toluene	%	97		8237923

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
N/A = Not Applicable

RESULTS OF ANALYSES OF SOLID

Bureau Veritas ID		TTK561		TTK561		
Sampling Date		2022/09/14		2022/09/14		
COC Number		n/a		n/a		
	UNITS	**RCM-10 LESLIE**	**QC Batch**	**RCM-10 LESLIE Lab-Dup**	**RDL**	**QC Batch**
Inorganics						
Available (CaCl2) pH	pH	12.1	8234730			
Soluble (20:1) Sulphate (SO4)	ug/g	870	8234726	870	40	8234726

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate

TEST SUMMARY

Bureau Veritas ID: TTK561
Sample ID: RCM-10 LESLIE
Matrix: Solid

Collected: 2022/09/14
Shipped:
Received: 2022/09/16

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
ABN Compounds in SPLP Leachates	GC/MS	8238861	2022/09/21	2022/09/22	Anh Lieu
1,3-Dichloropropene Sum	CALC	8232479	N/A	2022/09/22	Automated Statchk
Dinitrotoluene Sum	CALC	8232480	N/A	2022/09/22	Automated Statchk
Total Metals in SPLP Leachate by ICPMS	ICP/MS	8237695	2022/09/21	2022/09/21	Azita Fazaeli
Modified SPLP extraction - Weight		8233768	N/A	2022/09/20	Jian (Ken) Wang
pH CaCl2 EXTRACT	AT	8234730	2022/09/20	2022/09/20	Taslima Aktar
Sulphate (20:1 Extract)	KONE/EC	8234726	2022/09/20	2022/09/20	Samuel Law
SPLP Zero Headspace Extraction		8235852	2022/09/20	2022/09/21	Mohammed Abdul Nafay Shoeb
Volatile organics in SPLP leachates	HS/MS	8237923	N/A	2022/09/21	Karen Hughes

Bureau Veritas ID: TTK561 Dup
Sample ID: RCM-10 LESLIE
Matrix: Solid

Collected: 2022/09/14
Shipped:
Received: 2022/09/16

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Total Metals in SPLP Leachate by ICPMS	ICP/MS	8237695	2022/09/21	2022/09/21	Azita Fazaeli
Sulphate (20:1 Extract)	KONE/EC	8234726	2022/09/20	2022/09/20	Samuel Law

GENERAL COMMENTS

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

Package 1	5.7°C

Final leach pH results included in this CofA as per Aamna Arora's request.

RCM-10 LESLIE: Final leach pH is 11.62.

Results relate only to the items tested.

QUALITY ASSURANCE REPORT

			Matrix Spike		SPIKED BLANK		Method Blank		RPD		Leachate Blank	
QC Batch	**Parameter**	**Date**	**% Recovery**	**QC Limits**	**% Recovery**	**QC Limits**	**Value**	**UNITS**	**Value (%)**	**QC Limits**	**Value**	**UNITS**
8237923	Leachable (SPLP) 4-Bromofluorobenzene	2022/09/21	100	70 - 130	99	70 - 130	99	%				
8237923	Leachable (SPLP) D4-1,2-Dichloroethane	2022/09/21	105	70 - 130	101	70 - 130	102	%				
8237923	Leachable (SPLP) D8-Toluene	2022/09/21	99	70 - 130	99	70 - 130	97	%				
8238861	Leachable (SPLP) 2,4,6-Tribromophenol	2022/09/22	85	30 - 130	91	30 - 130	67	%				
8238861	Leachable (SPLP) 2-Fluorobiphenyl	2022/09/22	66	30 - 130	71	30 - 130	66	%				
8238861	Leachable (SPLP) D14-Terphenyl (FS)	2022/09/22	79	30 - 130	84	30 - 130	79	%				
8238861	Leachable (SPLP) D5-Nitrobenzene	2022/09/22	73	30 - 130	78	30 - 130	71	%				
8234726	Soluble (20:1) Sulphate (SO4)	2022/09/20	NC	70 - 130	100	70 - 130	<20	ug/g	0.48	35		
8234730	Available (CaCl2) pH	2022/09/20			100	97 - 103			1.1	N/A		
8237695	Leachable (SPLP) Antimony (Sb)	2022/09/21	102	80 - 120	100	80 - 120	<0.5	ug/L	NC	35	<0.5	ug/L
8237695	Leachable (SPLP) Arsenic (As)	2022/09/21	104	80 - 120	102	80 - 120	<1	ug/L	NC	35	<1	ug/L
8237695	Leachable (SPLP) Barium (Ba)	2022/09/21	97	80 - 120	98	80 - 120	<5	ug/L	3.8	35	<5	ug/L
8237695	Leachable (SPLP) Beryllium (Be)	2022/09/21	101	80 - 120	101	80 - 120	<0.5	ug/L	NC	35	<0.5	ug/L
8237695	Leachable (SPLP) Boron (B)	2022/09/21	99	80 - 120	99	80 - 120	<10	ug/L	NC	35	<10	ug/L
8237695	Leachable (SPLP) Cadmium (Cd)	2022/09/21	100	80 - 120	98	80 - 120	<0.1	ug/L	NC	35	<0.1	ug/L
8237695	Leachable (SPLP) Chromium (Cr)	2022/09/21	99	80 - 120	98	80 - 120	<5	ug/L	2.0	35	<5	ug/L
8237695	Leachable (SPLP) Cobalt (Co)	2022/09/21	99	80 - 120	97	80 - 120	<0.5	ug/L	6.5	35	<0.5	ug/L
8237695	Leachable (SPLP) Copper (Cu)	2022/09/21	97	80 - 120	99	80 - 120	<1	ug/L	9.4	35	<1	ug/L
8237695	Leachable (SPLP) Lead (Pb)	2022/09/21	97	80 - 120	97	80 - 120	<0.5	ug/L	2.1	35	<0.5	ug/L
8237695	Leachable (SPLP) Molybdenum (Mo)	2022/09/21	102	80 - 120	100	80 - 120	<1	ug/L	4.4	35	<1	ug/L
8237695	Leachable (SPLP) Nickel (Ni)	2022/09/21	98	80 - 120	98	80 - 120	<1	ug/L	0.52	35	<1	ug/L
8237695	Leachable (SPLP) Selenium (Se)	2022/09/21	106	80 - 120	105	80 - 120	<2	ug/L	NC	35	<2	ug/L
8237695	Leachable (SPLP) Silver (Ag)	2022/09/21	100	80 - 120	98	80 - 120	<0.1	ug/L	NC	35	<0.1	ug/L
8237695	Leachable (SPLP) Thallium (Tl)	2022/09/21	97	80 - 120	96	80 - 120	<0.05	ug/L	NC	35	<0.05	ug/L
8237695	Leachable (SPLP) Uranium (U)	2022/09/21	108	80 - 120	105	80 - 120	<0.1	ug/L	NC	35	<0.1	ug/L
8237695	Leachable (SPLP) Vanadium (V)	2022/09/21	100	80 - 120	98	80 - 120	<1	ug/L	5.7	35	<1	ug/L
8237695	Leachable (SPLP) Zinc (Zn)	2022/09/21	102	80 - 120	104	80 - 120	<5	ug/L	NC	35	<5	ug/L
8237923	Leachable (SPLP) 1,1,1,2-Tetrachloroethane	2022/09/21	91	70 - 130	91	70 - 130	<0.40	ug/L	NC	30		
8237923	Leachable (SPLP) 1,1,2,2-Tetrachloroethane	2022/09/21	91	70 - 130	87	70 - 130	<0.40	ug/L	NC	30		
8237923	Leachable (SPLP) 1,1,2-Trichloroethane	2022/09/21	96	70 - 130	93	70 - 130	<0.40	ug/L	NC	30		

QUALITY ASSURANCE REPORT(CONT'D)

			Matrix Spike		SPIKED BLANK		Method Blank		RPD		Leachate Blank	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits	Value	UNITS
8237923	Leachable (SPLP) 1,1-Dichloroethane	2022/09/21	91	70 - 130	92	70 - 130	<0.40	ug/L	NC	30		
8237923	Leachable (SPLP) 1,1-Dichloroethylene	2022/09/21	95	70 - 130	97	70 - 130	<0.40	ug/L	NC	30		
8237923	Leachable (SPLP) 1,2-Dichlorobenzene	2022/09/21	91	70 - 130	90	70 - 130	<0.40	ug/L	NC	30		
8237923	Leachable (SPLP) 1,2-Dichloroethane	2022/09/21	95	70 - 130	94	70 - 130	<0.40	ug/L	NC	30		
8237923	Leachable (SPLP) 1,2-Dichloropropane	2022/09/21	92	70 - 130	91	70 - 130	<0.40	ug/L	NC	30		
8237923	Leachable (SPLP) 1,4-Dichlorobenzene	2022/09/21	104	70 - 130	102	70 - 130	<0.40	ug/L	NC	30		
8237923	Leachable (SPLP) Bromomethane	2022/09/21	89	60 - 140	89	60 - 140	<0.40	ug/L	NC	30		
8237923	Leachable (SPLP) Carbon Tetrachloride	2022/09/21	88	70 - 130	89	70 - 130	<0.19	ug/L	NC	30		
8237923	Leachable (SPLP) Chloroform	2022/09/21	90	70 - 130	89	70 - 130	<0.90	ug/L	NC	30		
8237923	Leachable (SPLP) cis-1,2-Dichloroethylene	2022/09/21	95	70 - 130	95	70 - 130	<0.40	ug/L	NC	30		
8237923	Leachable (SPLP) cis-1,3-Dichloropropene	2022/09/21	93	70 - 130	92	70 - 130	<0.30	ug/L	NC	30		
8237923	Leachable (SPLP) Ethylene Dibromide	2022/09/21	91	70 - 130	88	70 - 130	<0.19	ug/L	NC	30		
8237923	Leachable (SPLP) Tetrachloroethylene	2022/09/21	85	70 - 130	87	70 - 130	<0.40	ug/L	NC	30		
8237923	Leachable (SPLP) trans-1,2-Dichloroethylene	2022/09/21	94	70 - 130	95	70 - 130	<0.40	ug/L	NC	30		
8237923	Leachable (SPLP) trans-1,3-Dichloropropene	2022/09/21	90	70 - 130	100	70 - 130	<0.30	ug/L	NC	30		
8237923	Leachable (SPLP) Trichloroethylene	2022/09/21	96	70 - 130	97	70 - 130	<0.40	ug/L	NC	30		
8238861	Leachable (SPLP) 2,4,6-Trichlorophenol	2022/09/22	85	10 - 130	89	10 - 130	<0.70	ug/L	NC	40		
8238861	Leachable (SPLP) 2,4-Dinitrophenol	2022/09/22	100	10 - 130	30	10 - 130	<5.0	ug/L	NC	40		
8238861	Leachable (SPLP) 2,4-Dinitrotoluene	2022/09/22	85	30 - 130	94	30 - 130	<3.0	ug/L	NC	40		
8238861	Leachable (SPLP) 2,6-Dinitrotoluene	2022/09/22	81	30 - 130	91	30 - 130	<3.0	ug/L	NC	40		
8238861	Leachable (SPLP) 3,3'-Dichlorobenzidine	2022/09/22	72	30 - 130	96	30 - 130	<0.40	ug/L	NC	40		
8238861	Leachable (SPLP) Bis(2-chloroethyl)ether	2022/09/22	68	30 - 130	73	30 - 130	<2.0	ug/L	NC	40		
8238861	Leachable (SPLP) Bis(2-chloroisopropyl)ether	2022/09/22	61	30 - 130	66	30 - 130	<2.0	ug/L	NC	40		
8238861	Leachable (SPLP) Diethyl phthalate	2022/09/22	79	30 - 130	101	30 - 130	<1.0	ug/L	NC	40		
8238861	Leachable (SPLP) Dimethyl phthalate	2022/09/22	54	30 - 130	97	30 - 130	<1.0	ug/L	NC	40		

QUALITY ASSURANCE REPORT(CONT'D)

			Matrix Spike		SPIKED BLANK		Method Blank		RPD		Leachate Blank	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits	Value	UNITS
8238861	Leachable (SPLP) p-Chloroaniline	2022/09/22	61	30 - 130	87	30 - 130	<5.0	ug/L	NC	40		

N/A = Not Applicable

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

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

Leachate Blank: A blank matrix containing all reagents used in the leaching procedure. Used to determine any process contamination.

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

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

Surrogate: A pure or isotopically labeled compound whose behavior mirrors the analytes of interest. Used to evaluate extraction efficiency.

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

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (absolute difference <= 2x RDL).

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by:

Anastassia Hamanov, Scientific Specialist

Cristina Carriere

Cristina Carriere, Senior Scientific Specialist

Bureau Veritas has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per ISO/IEC 17025, signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam
A Bureau Veritas Group Company

6740 Campobello Road, Mississauga, Ontario L5N 2L8
Phone: 905-817-5700 Fax: 905-817-5779 Toll Free: 800-563-6266
CAM FCD-01191/2

CHAIN OF CUSTODY RECORD

Page 1 of 1

Invoice Information

Company Name: EXP Services Inc.
Contact Name: AAMNA ARORA
Address: 1595 CLARK BLVD.,
BRAMPTON
Phone: 416-710-0016 Fax:
Email: aamna.arora@exp.com

Report Information (if differs from invoice)

Company Name:
Contact Name:
Address:
Phone: Fax:
Email:

Project Information (where applicable)

Quotation #: STREAM 3
P.O. #/ AFE#: BRM- GEO
Project #: BRM-22019043-B0
Site Location: 10 Leslie Street Yard
Site #: TORONTO
Sampled By:

Turnaround Time (TAT) Required

☒ **Regular TAT (5-7 days)** Most analyses

PLEASE PROVIDE ADVANCE NOTICE FOR RUSH PROJECTS

Rush TAT (Surcharges will be applied)

☐ **1 Day** ☐ **2 Days** ☐ **3-4 Days**

Date Required:

Rush Confirmation #:

MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE MAXXAM DRINKING WATER CHAIN OF CUSTODY

Regulation 153

☐ Table 1 ☐ Res/Park ☐ Med/ Fine
☐ Table 2 ☐ Ind/Comm ☐ Coarse
☐ Table 3 ☐ Agri/ Other
☐ Table ____

FOR RSC (PLEASE CIRCLE) no

Other Regulations

☐ CCME ☐ Sanitary Sewer Bylaw
☐ MISA ☐ Storm Sewer Bylaw
☐ PWQO Region
☐ Other (Specify) 406
☐ REG 558 (MIN. 3 DAY TAT REQUIRED)

Include Criteria on Certificate of Analysis: Y / N

SAMPLES MUST BE KEPT COOL (< 10 °C) FROM TIME OF SAMPLING UNTIL DELIVERY TO MAXXAM

Analysis Requested (REFER TO BACK OF COC)

	SAMPLE IDENTIFICATION	DATE SAMPLED (YYYY/MM/DD)	TIME SAMPLED (HH:MM)	MATRIX	# OF CONTAINERS SUBMITTED	FIELD FILTERED (CIRCLE) Metals / Hg / CrVI	BTEX/ PHC F1	PHCs F2 - F4	VOCs	REG 153 METALS & INORGANICS	REG 153 ICPMS METALS	REG 153 METALS (Hg, Cr VI, ICPMS Metals, HWS - B)	pH and grain size	SPLP- Metals, VOC, SVOC	pH and Sulphate	Final pH after leach (SPLP)					HOLD- DO NOT ANALYZE	COMMENTS
1	RCM-10 Leslie	14-Sep-22	p.m.	RC	2									X	X	X						Recycled Concrete, plesae process as necessary
2																						
3																						
4																						
5																						
6																						
7																						
8																						
9																						
10																						

LABORATORY USE ONLY

CUSTODY SEAL Y / N		COOLER TEMPERATURES
Present	Intact	
y	y	6/7/5

COOLING MEDIA PRESENT: [✓ Y] / N

RELINQUISHED BY: (Signature/Print)	DATE: (YYYY/MM/DD)	TIME: (HH:MM)	RECEIVED BY: (Signature/Print)	DATE: (YYYY/MM/DD)	TIME: (HH:MM)
Nathan Brandt	2022-09-16			2022/09/16	1458

16-Sep-22 14:58
Patricia Legette
C2Q8287

RJM ENV-600

Your P.O. #: BRM-GEO
Your Project #: BRM-22019043-B0
Site Location: BRECKON EAST AND DUNDAS WEST YARDS, ON
Your C.O.C. #: n/a

Attention: Aamna Arora

exp Services Inc
Brampton Branch
1595 Clark Blvd
Brampton, ON
CANADA L6T 4V1

Report Date: 2022/09/22
Report #: R7308338
Version: 2 - Final

CERTIFICATE OF ANALYSIS

BUREAU VERITAS JOB #: C2Q8296
Received: 2022/09/16, 14:58

Sample Matrix: Solid
Samples Received: 4

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
ABN Compounds in SPLP Leachates	4	2022/09/21	2022/09/22	CAM SOP-00301	EPA 8270 m
1,3-Dichloropropene Sum	4	N/A	2022/09/22		EPA 8260D m
Dinitrotoluene Sum	4	N/A	2022/09/22	CAM SOP - 00301	EPA 8270
Total Metals in SPLP Leachate by ICPMS	4	2022/09/21	2022/09/21	CAM SOP-00447	EPA 6020B m
Modified SPLP extraction - Weight	4	N/A	2022/09/20	CAM SOP-00941	OMOECP LaSB E9003 R3
pH CaCl2 EXTRACT	4	2022/09/20	2022/09/20	CAM SOP-00413	EPA 9045 D m
SPLP Zero Headspace Extraction	4	2022/09/20	2022/09/21	CAM SOP-00430	EPA 1312 m
Volatile organics in SPLP leachates	4	N/A	2022/09/21	CAM SOP-00228	EPA 8260D m

Remarks:

Bureau Veritas is accredited to ISO/IEC 17025 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by Bureau Veritas are based upon recognized Provincial, Federal or US method compendia such as CCME, MELCC, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in Bureau Veritas' profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and Bureau Veritas in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported; unless indicated otherwise, associated sample data are not blank corrected. Where applicable, unless otherwise noted, Measurement Uncertainty has not been accounted for when stating conformity to the referenced standard.

Bureau Veritas liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. Bureau Veritas has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by Bureau Veritas, unless otherwise agreed in writing. Bureau Veritas is not responsible for the accuracy or any data impacts, that result from the information provided by the customer or their agent.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.
Results relate to samples tested. When sampling is not conducted by Bureau Veritas, results relate to the supplied samples tested.
This Certificate shall not be reproduced except in full, without the written approval of the laboratory.
Reference Method suffix “m” indicates test methods incorporate validated modifications from specific reference methods to improve performance.
* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

Your P.O. #: BRM-GEO
Your Project #: BRM-22019043-B0
Site Location: BRECKON EAST AND DUNDAS WEST YARDS, ON
Your C.O.C. #: n/a

Attention: Aamna Arora

exp Services Inc
Brampton Branch
1595 Clark Blvd
Brampton, ON
CANADA L6T 4V1

Report Date: 2022/09/22
Report #: R7308338
Version: 2 - Final

CERTIFICATE OF ANALYSIS

BUREAU VERITAS JOB #: C2Q8296
Received: 2022/09/16, 14:58

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Patricia Legette, Project Manager
Email: Patricia.Legette@bureauveritas.com
Phone# (905)817-5799
==
Bureau Veritas has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per ISO/IEC 17025, signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

O.REG 406 EXCESS SOIL SPLP ABNS (SOLID)

Bureau Veritas ID		TTK572	TTK573	TTQ112		
Sampling Date		2022/09/16	2022/09/16	2022/09/16		
COC Number		n/a	n/a	n/a		
	UNITS	**LS- BRECKON EAST**	**LS- DUNDAS WEST**	**LS- BRECKON EAST-AFTER CRUSHING**	**RDL**	**QC Batch**
Semivolatile Organics						
Leachable (SPLP) Bis(2-chloroethyl)ether	ug/L	<2.0	<2.0	<2.0	2.0	8238861
Leachable (SPLP) Bis(2-chloroisopropyl)ether	ug/L	<2.0	<2.0	<2.0	2.0	8238861
Leachable (SPLP) p-Chloroaniline	ug/L	<5.0	<5.0	<5.0	5.0	8238861
Leachable (SPLP) 3,3'-Dichlorobenzidine	ug/L	<0.40	<0.40	<0.40	0.40	8238861
Leachable (SPLP) Diethyl phthalate	ug/L	<1.0	<1.0	<1.0	1.0	8238861
Leachable (SPLP) Dimethyl phthalate	ug/L	<1.0	<1.0	<1.0	1.0	8238861
Leachable (SPLP) 2,4-Dinitrophenol	ug/L	<5.0	<5.0	<5.0	5.0	8238861
Leachable (SPLP) 2,4-Dinitrotoluene	ug/L	<3.0	<3.0	<3.0	3.0	8238861
Leachable (SPLP) 2,6-Dinitrotoluene	ug/L	<3.0	<3.0	<3.0	3.0	8238861
Leachable (SPLP) 2,4,6-Trichlorophenol	ug/L	<0.70	<0.70	<0.70	0.70	8238861
Calculated Parameters						
Leachable 2,4- & 2,6-Dinitrotoluene	ug/L	<4.2	<4.2	<4.2	4.2	8232480
Surrogate Recovery (%)						
Leachable (SPLP) 2,4,6-Tribromophenol	%	80	76	77		8238861
Leachable (SPLP) 2-Fluorobiphenyl	%	65	68	64		8238861
Leachable (SPLP) D14-Terphenyl (FS)	%	82	80	81		8238861
Leachable (SPLP) D5-Nitrobenzene	%	74	77	70		8238861

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

O.REG 406 EXCESS SOIL SPLP ABNS (SOLID)

Bureau Veritas ID		TTQ112			TTQ113		
Sampling Date		2022/09/16			2022/09/16		
COC Number		n/a			n/a		
	UNITS	**LS- BRECKON EAST-AFTER CRUSHING Lab-Dup**	**RDL**	**QC Batch**	**LS- DUNDAS WEST-AFTER CRUSHING**	**RDL**	**QC Batch**
Semivolatile Organics							
Leachable (SPLP) Bis(2-chloroethyl)ether	ug/L	<2.0	2.0	8238861	<2.0	2.0	8238861
Leachable (SPLP) Bis(2-chloroisopropyl)ether	ug/L	<2.0	2.0	8238861	<2.0	2.0	8238861
Leachable (SPLP) p-Chloroaniline	ug/L	<5.0	5.0	8238861	<5.0	5.0	8238861
Leachable (SPLP) 3,3'-Dichlorobenzidine	ug/L	<0.40	0.40	8238861	<0.40	0.40	8238861
Leachable (SPLP) Diethyl phthalate	ug/L	<1.0	1.0	8238861	<1.0	1.0	8238861
Leachable (SPLP) Dimethyl phthalate	ug/L	<1.0	1.0	8238861	<1.0	1.0	8238861
Leachable (SPLP) 2,4-Dinitrophenol	ug/L	<5.0	5.0	8238861	<5.0	5.0	8238861
Leachable (SPLP) 2,4-Dinitrotoluene	ug/L	<3.0	3.0	8238861	<3.0	3.0	8238861
Leachable (SPLP) 2,6-Dinitrotoluene	ug/L	<3.0	3.0	8238861	<3.0	3.0	8238861
Leachable (SPLP) 2,4,6-Trichlorophenol	ug/L	<0.70	0.70	8238861	<0.70	0.70	8238861
Calculated Parameters							
Leachable 2,4- & 2,6-Dinitrotoluene	ug/L				<4.2	4.2	8232480
Surrogate Recovery (%)							
Leachable (SPLP) 2,4,6-Tribromophenol	%	77		8238861	78		8238861
Leachable (SPLP) 2-Fluorobiphenyl	%	69		8238861	73		8238861
Leachable (SPLP) D14-Terphenyl (FS)	%	79		8238861	83		8238861
Leachable (SPLP) D5-Nitrobenzene	%	77		8238861	81		8238861

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate

O.REG 406 EXCESS SOIL SPLP METALS (SOLID)

Bureau Veritas ID		TTK572	TTK573	TTQ112	TTQ113		
Sampling Date		2022/09/16	2022/09/16	2022/09/16	2022/09/16		
COC Number		n/a	n/a	n/a	n/a		
	UNITS	**LS- BRECKON EAST**	**LS- DUNDAS WEST**	**LS- BRECKON EAST-AFTER CRUSHING**	**LS- DUNDAS WEST-AFTER CRUSHING**	**RDL**	**QC Batch**
Metals							
Leachable (SPLP) Antimony (Sb)	ug/L	<0.5	<0.5	<0.5	<0.5	0.5	8237695
Leachable (SPLP) Arsenic (As)	ug/L	<1	<1	<1	<1	1	8237695
Leachable (SPLP) Barium (Ba)	ug/L	19	<5	25	<5	5	8237695
Leachable (SPLP) Beryllium (Be)	ug/L	<0.5	<0.5	<0.5	<0.5	0.5	8237695
Leachable (SPLP) Boron (B)	ug/L	62	<10	73	<10	10	8237695
Leachable (SPLP) Cadmium (Cd)	ug/L	<0.1	<0.1	<0.1	<0.1	0.1	8237695
Leachable (SPLP) Chromium (Cr)	ug/L	<5	<5	<5	<5	5	8237695
Leachable (SPLP) Cobalt (Co)	ug/L	<0.5	<0.5	<0.5	<0.5	0.5	8237695
Leachable (SPLP) Copper (Cu)	ug/L	<1	<1	<1	<1	1	8237695
Leachable (SPLP) Lead (Pb)	ug/L	<0.5	<0.5	<0.5	2.5	0.5	8237695
Leachable (SPLP) Molybdenum (Mo)	ug/L	<1	2	<1	4	1	8237695
Leachable (SPLP) Nickel (Ni)	ug/L	<1	<1	<1	<1	1	8237695
Leachable (SPLP) Selenium (Se)	ug/L	<2	<2	<2	<2	2	8237695
Leachable (SPLP) Silver (Ag)	ug/L	<0.1	<0.1	<0.1	<0.1	0.1	8237695
Leachable (SPLP) Thallium (Tl)	ug/L	<0.05	<0.05	<0.05	<0.05	0.05	8237695
Leachable (SPLP) Uranium (U)	ug/L	<0.1	<0.1	<0.1	<0.1	0.1	8237695
Leachable (SPLP) Vanadium (V)	ug/L	<1	<1	<1	<1	1	8237695
Leachable (SPLP) Zinc (Zn)	ug/L	<5	<5	<5	<5	5	8237695

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

O.REG 406 EXCESS SOIL SPLP PREP (SOLID)

Bureau Veritas ID		TTK572	TTK573	TTK573	TTQ112	
Sampling Date		2022/09/16	2022/09/16	2022/09/16	2022/09/16	
COC Number		n/a	n/a	n/a	n/a	
	UNITS	**LS- BRECKON EAST**	**LS- DUNDAS WEST**	**LS- DUNDAS WEST Lab-Dup**	**LS- BRECKON EAST-AFTER CRUSHING**	**QC Batch**
Inorganics						
Dry Weight	g	100	100	100	100	8233768

QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate

Bureau Veritas ID		TTQ113	
Sampling Date		2022/09/16	
COC Number		n/a	
	UNITS	**LS- DUNDAS WEST-AFTER CRUSHING**	**QC Batch**
Inorganics			
Dry Weight	g	100	8233768

QC Batch = Quality Control Batch

O.REG 406 EXCESS SOIL SPLP VOCS (SOLID)

Bureau Veritas ID		TTK572			TTK572		
Sampling Date		2022/09/16			2022/09/16		
COC Number		n/a			n/a		
	UNITS	**LS- BRECKON EAST**	**RDL**	**QC Batch**	**LS- BRECKON EAST Lab-Dup**	**RDL**	**QC Batch**
Charge/Prep Analysis							
Amount Extracted (Wet Weight) (g)	N/A	25	N/A	8235852	25	N/A	8235852
Calculated Parameters							
Leachable (ZHE) 1,3-Dichloropropene (cis+trans)	ug/L	<0.42	0.42	8232479			
Volatile Organics							
Leachable (SPLP) Bromomethane	ug/L	<0.40	0.40	8237923	<0.40	0.40	8237923
Leachable (SPLP) Carbon Tetrachloride	ug/L	<0.19	0.19	8237923	<0.19	0.19	8237923
Leachable (SPLP) Chloroform	ug/L	<0.90	0.90	8237923	<0.90	0.90	8237923
Leachable (SPLP) 1,2-Dichlorobenzene	ug/L	<0.40	0.40	8237923	<0.40	0.40	8237923
Leachable (SPLP) 1,4-Dichlorobenzene	ug/L	<0.40	0.40	8237923	<0.40	0.40	8237923
Leachable (SPLP) 1,1-Dichloroethane	ug/L	<0.40	0.40	8237923	<0.40	0.40	8237923
Leachable (SPLP) 1,2-Dichloroethane	ug/L	<0.40	0.40	8237923	<0.40	0.40	8237923
Leachable (SPLP) 1,1-Dichloroethylene	ug/L	<0.40	0.40	8237923	<0.40	0.40	8237923
Leachable (SPLP) cis-1,2-Dichloroethylene	ug/L	<0.40	0.40	8237923	<0.40	0.40	8237923
Leachable (SPLP) trans-1,2-Dichloroethylene	ug/L	<0.40	0.40	8237923	<0.40	0.40	8237923
Leachable (SPLP) 1,2-Dichloropropane	ug/L	<0.40	0.40	8237923	<0.40	0.40	8237923
Leachable (SPLP) cis-1,3-Dichloropropene	ug/L	<0.30	0.30	8237923	<0.30	0.30	8237923
Leachable (SPLP) trans-1,3-Dichloropropene	ug/L	<0.30	0.30	8237923	<0.30	0.30	8237923
Leachable (SPLP) Ethylene Dibromide	ug/L	<0.19	0.19	8237923	<0.19	0.19	8237923
Leachable (SPLP) 1,1,1,2-Tetrachloroethane	ug/L	<0.40	0.40	8237923	<0.40	0.40	8237923
Leachable (SPLP) 1,1,2,2-Tetrachloroethane	ug/L	<0.40	0.40	8237923	<0.40	0.40	8237923
Leachable (SPLP) Tetrachloroethylene	ug/L	<0.40	0.40	8237923	<0.40	0.40	8237923
Leachable (SPLP) 1,1,2-Trichloroethane	ug/L	<0.40	0.40	8237923	<0.40	0.40	8237923
Leachable (SPLP) Trichloroethylene	ug/L	<0.40	0.40	8237923	<0.40	0.40	8237923
Surrogate Recovery (%)							
Leachable (SPLP) 4-Bromofluorobenzene	%	99		8237923	99		8237923
Leachable (SPLP) D4-1,2-Dichloroethane	%	103		8237923	104		8237923
Leachable (SPLP) D8-Toluene	%	98		8237923	99		8237923

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate
N/A = Not Applicable

O.REG 406 EXCESS SOIL SPLP VOCS (SOLID)

Bureau Veritas ID		TTK573	TTQ112	TTQ113		
Sampling Date		2022/09/16	2022/09/16	2022/09/16		
COC Number		n/a	n/a	n/a		
	UNITS	**LS- DUNDAS WEST**	**LS- BRECKON EAST-AFTER CRUSHING**	**LS- DUNDAS WEST-AFTER CRUSHING**	**RDL**	**QC Batch**
Charge/Prep Analysis						
Amount Extracted (Wet Weight) (g)	N/A	25	25	25	N/A	8235852
Calculated Parameters						
Leachable (ZHE) 1,3-Dichloropropene (cis+trans)	ug/L	<0.42	<0.42	<0.42	0.42	8232479
Volatile Organics						
Leachable (SPLP) Bromomethane	ug/L	<0.40	<0.40	<0.40	0.40	8237923
Leachable (SPLP) Carbon Tetrachloride	ug/L	<0.19	<0.19	<0.19	0.19	8237923
Leachable (SPLP) Chloroform	ug/L	<0.90	<0.90	<0.90	0.90	8237923
Leachable (SPLP) 1,2-Dichlorobenzene	ug/L	<0.40	<0.40	<0.40	0.40	8237923
Leachable (SPLP) 1,4-Dichlorobenzene	ug/L	<0.40	<0.40	<0.40	0.40	8237923
Leachable (SPLP) 1,1-Dichloroethane	ug/L	<0.40	<0.40	<0.40	0.40	8237923
Leachable (SPLP) 1,2-Dichloroethane	ug/L	<0.40	<0.40	<0.40	0.40	8237923
Leachable (SPLP) 1,1-Dichloroethylene	ug/L	<0.40	<0.40	<0.40	0.40	8237923
Leachable (SPLP) cis-1,2-Dichloroethylene	ug/L	<0.40	<0.40	<0.40	0.40	8237923
Leachable (SPLP) trans-1,2-Dichloroethylene	ug/L	<0.40	<0.40	<0.40	0.40	8237923
Leachable (SPLP) 1,2-Dichloropropane	ug/L	<0.40	<0.40	<0.40	0.40	8237923
Leachable (SPLP) cis-1,3-Dichloropropene	ug/L	<0.30	<0.30	<0.30	0.30	8237923
Leachable (SPLP) trans-1,3-Dichloropropene	ug/L	<0.30	<0.30	<0.30	0.30	8237923
Leachable (SPLP) Ethylene Dibromide	ug/L	<0.19	<0.19	<0.19	0.19	8237923
Leachable (SPLP) 1,1,1,2-Tetrachloroethane	ug/L	<0.40	<0.40	<0.40	0.40	8237923
Leachable (SPLP) 1,1,2,2-Tetrachloroethane	ug/L	<0.40	<0.40	<0.40	0.40	8237923
Leachable (SPLP) Tetrachloroethylene	ug/L	<0.40	<0.40	<0.40	0.40	8237923
Leachable (SPLP) 1,1,2-Trichloroethane	ug/L	<0.40	<0.40	<0.40	0.40	8237923
Leachable (SPLP) Trichloroethylene	ug/L	<0.40	<0.40	<0.40	0.40	8237923
Surrogate Recovery (%)						
Leachable (SPLP) 4-Bromofluorobenzene	%	99	99	99		8237923
Leachable (SPLP) D4-1,2-Dichloroethane	%	102	103	106		8237923
Leachable (SPLP) D8-Toluene	%	99	99	98		8237923

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
N/A = Not Applicable

RESULTS OF ANALYSES OF SOLID

Bureau Veritas ID		TTK572	TTK573	TTQ112	TTQ113	
Sampling Date		2022/09/16	2022/09/16	2022/09/16	2022/09/16	
COC Number		n/a	n/a	n/a	n/a	
	UNITS	**LS- BRECKON EAST**	**LS- DUNDAS WEST**	**LS- BRECKON EAST-AFTER CRUSHING**	**LS- DUNDAS WEST-AFTER CRUSHING**	**QC Batch**
Inorganics						
Available (CaCl2) pH	pH	8.16	8.51	8.19	8.64	8234842
QC Batch = Quality Control Batch						

TEST SUMMARY

Bureau Veritas ID: TTK572
Sample ID: LS- BRECKON EAST
Matrix: Solid
Collected: 2022/09/16
Shipped:
Received: 2022/09/16

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
ABN Compounds in SPLP Leachates	GC/MS	8238861	2022/09/21	2022/09/22	Anh Lieu
1,3-Dichloropropene Sum	CALC	8232479	N/A	2022/09/22	Automated Statchk
Dinitrotoluene Sum	CALC	8232480	N/A	2022/09/22	Automated Statchk
Total Metals in SPLP Leachate by ICPMS	ICP/MS	8237695	2022/09/21	2022/09/21	Azita Fazaeli
Modified SPLP extraction - Weight		8233768	N/A	2022/09/20	Jian (Ken) Wang
pH CaCl2 EXTRACT	AT	8234842	2022/09/20	2022/09/20	Taslima Aktar
SPLP Zero Headspace Extraction		8235852	2022/09/20	2022/09/21	Mohammed Abdul Nafay Shoeb
Volatile organics in SPLP leachates	HS/MS	8237923	N/A	2022/09/21	Karen Hughes

Bureau Veritas ID: TTK572 Dup
Sample ID: LS- BRECKON EAST
Matrix: Solid
Collected: 2022/09/16
Shipped:
Received: 2022/09/16

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
SPLP Zero Headspace Extraction		8235852	2022/09/20	2022/09/21	Mohammed Abdul Nafay Shoeb
Volatile organics in SPLP leachates	HS/MS	8237923	N/A	2022/09/21	Karen Hughes

Bureau Veritas ID: TTK573
Sample ID: LS- DUNDAS WEST
Matrix: Solid
Collected: 2022/09/16
Shipped:
Received: 2022/09/16

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
ABN Compounds in SPLP Leachates	GC/MS	8238861	2022/09/21	2022/09/22	Anh Lieu
1,3-Dichloropropene Sum	CALC	8232479	N/A	2022/09/22	Automated Statchk
Dinitrotoluene Sum	CALC	8232480	N/A	2022/09/22	Automated Statchk
Total Metals in SPLP Leachate by ICPMS	ICP/MS	8237695	2022/09/21	2022/09/21	Azita Fazaeli
Modified SPLP extraction - Weight		8233768	N/A	2022/09/20	Jian (Ken) Wang
pH CaCl2 EXTRACT	AT	8234842	2022/09/20	2022/09/20	Taslima Aktar
SPLP Zero Headspace Extraction		8235852	2022/09/20	2022/09/21	Mohammed Abdul Nafay Shoeb
Volatile organics in SPLP leachates	HS/MS	8237923	N/A	2022/09/21	Karen Hughes

Bureau Veritas ID: TTK573 Dup
Sample ID: LS- DUNDAS WEST
Matrix: Solid
Collected: 2022/09/16
Shipped:
Received: 2022/09/16

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Modified SPLP extraction - Weight		8233768	N/A	2022/09/20	Jian (Ken) Wang

Bureau Veritas ID: TTQ112
Sample ID: LS- BRECKON EAST-AFTER CRUSHING
Matrix: Solid
Collected: 2022/09/16
Shipped:
Received: 2022/09/16

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
ABN Compounds in SPLP Leachates	GC/MS	8238861	2022/09/21	2022/09/22	Anh Lieu

TEST SUMMARY

Bureau Veritas ID: TTQ112
Sample ID: LS- BRECKON EAST-AFTER CRUSHING
Matrix: Solid

Collected: 2022/09/16
Shipped:
Received: 2022/09/16

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
1,3-Dichloropropene Sum	CALC	8232479	N/A	2022/09/22	Automated Statchk
Dinitrotoluene Sum	CALC	8232480	N/A	2022/09/22	Automated Statchk
Total Metals in SPLP Leachate by ICPMS	ICP/MS	8237695	2022/09/21	2022/09/21	Azita Fazaeli
Modified SPLP extraction - Weight		8233768	N/A	2022/09/20	Jian (Ken) Wang
pH CaCl2 EXTRACT	AT	8234842	2022/09/20	2022/09/20	Taslima Aktar
SPLP Zero Headspace Extraction		8235852	2022/09/20	2022/09/21	Mohammed Abdul Nafay Shoeb
Volatile organics in SPLP leachates	HS/MS	8237923	N/A	2022/09/21	Karen Hughes

Bureau Veritas ID: TTQ112 Dup
Sample ID: LS- BRECKON EAST-AFTER CRUSHING
Matrix: Solid

Collected: 2022/09/16
Shipped:
Received: 2022/09/16

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
ABN Compounds in SPLP Leachates	GC/MS	8238861	2022/09/21	2022/09/22	Anh Lieu

Bureau Veritas ID: TTQ113
Sample ID: LS- DUNDAS WEST-AFTER CRUSHING
Matrix: Solid

Collected: 2022/09/16
Shipped:
Received: 2022/09/16

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
ABN Compounds in SPLP Leachates	GC/MS	8238861	2022/09/21	2022/09/22	Anh Lieu
1,3-Dichloropropene Sum	CALC	8232479	N/A	2022/09/22	Automated Statchk
Dinitrotoluene Sum	CALC	8232480	N/A	2022/09/22	Automated Statchk
Total Metals in SPLP Leachate by ICPMS	ICP/MS	8237695	2022/09/21	2022/09/21	Azita Fazaeli
Modified SPLP extraction - Weight		8233768	N/A	2022/09/20	Jian (Ken) Wang
pH CaCl2 EXTRACT	AT	8234842	2022/09/20	2022/09/20	Taslima Aktar
SPLP Zero Headspace Extraction		8235852	2022/09/20	2022/09/21	Mohammed Abdul Nafay Shoeb
Volatile organics in SPLP leachates	HS/MS	8237923	N/A	2022/09/21	Karen Hughes

GENERAL COMMENTS

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

Package 1	5.7°C

Final leach pH results included in this CofA as per Aamna Arora’s request.

LS- BRECKON EAST: Final leach pH is 9.48.
LS- DUNDAS WEST: Final leach pH is 9.89.
LS- BRECKON EAST-AFTER CRUSHING: Final leach pH is 9.49.
LS- DUNDAS WEST-AFTER CRUSHING: Final leach pH is 9.89.

Sample TTQ112 [LS- BRECKON EAST-AFTER CRUSHING] : Sample bags, all containing headspace, were composited prior to extraction. Analysis was performed with client's consent.

Sample TTQ113 [LS- DUNDAS WEST-AFTER CRUSHING] : Sample bags, all containing headspace, were composited prior to extraction. Analysis was performed with client's consent.

Results relate only to the items tested.

QUALITY ASSURANCE REPORT

			Matrix Spike		SPIKED BLANK		Method Blank		RPD		Leachate Blank	
QC Batch	**Parameter**	**Date**	**% Recovery**	**QC Limits**	**% Recovery**	**QC Limits**	**Value**	**UNITS**	**Value (%)**	**QC Limits**	**Value**	**UNITS**
8237923	Leachable (SPLP) 4-Bromofluorobenzene	2022/09/21	100	70 - 130	99	70 - 130	99	%				
8237923	Leachable (SPLP) D4-1,2-Dichloroethane	2022/09/21	105	70 - 130	101	70 - 130	102	%				
8237923	Leachable (SPLP) D8-Toluene	2022/09/21	99	70 - 130	99	70 - 130	97	%				
8238861	Leachable (SPLP) 2,4,6-Tribromophenol	2022/09/22	85	30 - 130	91	30 - 130	67	%				
8238861	Leachable (SPLP) 2-Fluorobiphenyl	2022/09/22	66	30 - 130	71	30 - 130	66	%				
8238861	Leachable (SPLP) D14-Terphenyl (FS)	2022/09/22	79	30 - 130	84	30 - 130	79	%				
8238861	Leachable (SPLP) D5-Nitrobenzene	2022/09/22	73	30 - 130	78	30 - 130	71	%				
8234842	Available (CaCl2) pH	2022/09/20			100	97 - 103			0.085	N/A		
8237695	Leachable (SPLP) Antimony (Sb)	2022/09/21	102	80 - 120	100	80 - 120	<0.5	ug/L	NC	35	<0.5	ug/L
8237695	Leachable (SPLP) Arsenic (As)	2022/09/21	104	80 - 120	102	80 - 120	<1	ug/L	NC	35	<1	ug/L
8237695	Leachable (SPLP) Barium (Ba)	2022/09/21	97	80 - 120	98	80 - 120	<5	ug/L	3.8	35	<5	ug/L
8237695	Leachable (SPLP) Beryllium (Be)	2022/09/21	101	80 - 120	101	80 - 120	<0.5	ug/L	NC	35	<0.5	ug/L
8237695	Leachable (SPLP) Boron (B)	2022/09/21	99	80 - 120	99	80 - 120	<10	ug/L	NC	35	<10	ug/L
8237695	Leachable (SPLP) Cadmium (Cd)	2022/09/21	100	80 - 120	98	80 - 120	<0.1	ug/L	NC	35	<0.1	ug/L
8237695	Leachable (SPLP) Chromium (Cr)	2022/09/21	99	80 - 120	98	80 - 120	<5	ug/L	2.0	35	<5	ug/L
8237695	Leachable (SPLP) Cobalt (Co)	2022/09/21	99	80 - 120	97	80 - 120	<0.5	ug/L	6.5	35	<0.5	ug/L
8237695	Leachable (SPLP) Copper (Cu)	2022/09/21	97	80 - 120	99	80 - 120	<1	ug/L	9.4	35	<1	ug/L
8237695	Leachable (SPLP) Lead (Pb)	2022/09/21	97	80 - 120	97	80 - 120	<0.5	ug/L	2.1	35	<0.5	ug/L
8237695	Leachable (SPLP) Molybdenum (Mo)	2022/09/21	102	80 - 120	100	80 - 120	<1	ug/L	4.4	35	<1	ug/L
8237695	Leachable (SPLP) Nickel (Ni)	2022/09/21	98	80 - 120	98	80 - 120	<1	ug/L	0.52	35	<1	ug/L
8237695	Leachable (SPLP) Selenium (Se)	2022/09/21	106	80 - 120	105	80 - 120	<2	ug/L	NC	35	<2	ug/L
8237695	Leachable (SPLP) Silver (Ag)	2022/09/21	100	80 - 120	98	80 - 120	<0.1	ug/L	NC	35	<0.1	ug/L
8237695	Leachable (SPLP) Thallium (Tl)	2022/09/21	97	80 - 120	96	80 - 120	<0.05	ug/L	NC	35	<0.05	ug/L
8237695	Leachable (SPLP) Uranium (U)	2022/09/21	108	80 - 120	105	80 - 120	<0.1	ug/L	NC	35	<0.1	ug/L
8237695	Leachable (SPLP) Vanadium (V)	2022/09/21	100	80 - 120	98	80 - 120	<1	ug/L	5.7	35	<1	ug/L
8237695	Leachable (SPLP) Zinc (Zn)	2022/09/21	102	80 - 120	104	80 - 120	<5	ug/L	NC	35	<5	ug/L
8237923	Leachable (SPLP) 1,1,1,2-Tetrachloroethane	2022/09/21	91	70 - 130	91	70 - 130	<0.40	ug/L	NC	30		
8237923	Leachable (SPLP) 1,1,2,2-Tetrachloroethane	2022/09/21	91	70 - 130	87	70 - 130	<0.40	ug/L	NC	30		
8237923	Leachable (SPLP) 1,1,2-Trichloroethane	2022/09/21	96	70 - 130	93	70 - 130	<0.40	ug/L	NC	30		
8237923	Leachable (SPLP) 1,1-Dichloroethane	2022/09/21	91	70 - 130	92	70 - 130	<0.40	ug/L	NC	30		

QUALITY ASSURANCE REPORT(CONT'D)

			Matrix Spike		SPIKED BLANK		Method Blank		RPD		Leachate Blank	
QC Batch	**Parameter**	**Date**	**% Recovery**	**QC Limits**	**% Recovery**	**QC Limits**	**Value**	**UNITS**	**Value (%)**	**QC Limits**	**Value**	**UNITS**
8237923	Leachable (SPLP) 1,1-Dichloroethylene	2022/09/21	95	70 - 130	97	70 - 130	<0.40	ug/L	NC	30		
8237923	Leachable (SPLP) 1,2-Dichlorobenzene	2022/09/21	91	70 - 130	90	70 - 130	<0.40	ug/L	NC	30		
8237923	Leachable (SPLP) 1,2-Dichloroethane	2022/09/21	95	70 - 130	94	70 - 130	<0.40	ug/L	NC	30		
8237923	Leachable (SPLP) 1,2-Dichloropropane	2022/09/21	92	70 - 130	91	70 - 130	<0.40	ug/L	NC	30		
8237923	Leachable (SPLP) 1,4-Dichlorobenzene	2022/09/21	104	70 - 130	102	70 - 130	<0.40	ug/L	NC	30		
8237923	Leachable (SPLP) Bromomethane	2022/09/21	89	60 - 140	89	60 - 140	<0.40	ug/L	NC	30		
8237923	Leachable (SPLP) Carbon Tetrachloride	2022/09/21	88	70 - 130	89	70 - 130	<0.19	ug/L	NC	30		
8237923	Leachable (SPLP) Chloroform	2022/09/21	90	70 - 130	89	70 - 130	<0.90	ug/L	NC	30		
8237923	Leachable (SPLP) cis-1,2-Dichloroethylene	2022/09/21	95	70 - 130	95	70 - 130	<0.40	ug/L	NC	30		
8237923	Leachable (SPLP) cis-1,3-Dichloropropene	2022/09/21	93	70 - 130	92	70 - 130	<0.30	ug/L	NC	30		
8237923	Leachable (SPLP) Ethylene Dibromide	2022/09/21	91	70 - 130	88	70 - 130	<0.19	ug/L	NC	30		
8237923	Leachable (SPLP) Tetrachloroethylene	2022/09/21	85	70 - 130	87	70 - 130	<0.40	ug/L	NC	30		
8237923	Leachable (SPLP) trans-1,2-Dichloroethylene	2022/09/21	94	70 - 130	95	70 - 130	<0.40	ug/L	NC	30		
8237923	Leachable (SPLP) trans-1,3-Dichloropropene	2022/09/21	90	70 - 130	100	70 - 130	<0.30	ug/L	NC	30		
8237923	Leachable (SPLP) Trichloroethylene	2022/09/21	96	70 - 130	97	70 - 130	<0.40	ug/L	NC	30		
8238861	Leachable (SPLP) 2,4,6-Trichlorophenol	2022/09/22	85	10 - 130	89	10 - 130	<0.70	ug/L	NC	40		
8238861	Leachable (SPLP) 2,4-Dinitrophenol	2022/09/22	100	10 - 130	30	10 - 130	<5.0	ug/L	NC	40		
8238861	Leachable (SPLP) 2,4-Dinitrotoluene	2022/09/22	85	30 - 130	94	30 - 130	<3.0	ug/L	NC	40		
8238861	Leachable (SPLP) 2,6-Dinitrotoluene	2022/09/22	81	30 - 130	91	30 - 130	<3.0	ug/L	NC	40		
8238861	Leachable (SPLP) 3,3'-Dichlorobenzidine	2022/09/22	72	30 - 130	96	30 - 130	<0.40	ug/L	NC	40		
8238861	Leachable (SPLP) Bis(2-chloroethyl)ether	2022/09/22	68	30 - 130	73	30 - 130	<2.0	ug/L	NC	40		
8238861	Leachable (SPLP) Bis(2-chloroisopropyl)ether	2022/09/22	61	30 - 130	66	30 - 130	<2.0	ug/L	NC	40		
8238861	Leachable (SPLP) Diethyl phthalate	2022/09/22	79	30 - 130	101	30 - 130	<1.0	ug/L	NC	40		
8238861	Leachable (SPLP) Dimethyl phthalate	2022/09/22	54	30 - 130	97	30 - 130	<1.0	ug/L	NC	40		

QUALITY ASSURANCE REPORT(CONT'D)

			Matrix Spike		SPIKED BLANK		Method Blank		RPD		Leachate Blank	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits	Value	UNITS
8238861	Leachable (SPLP) p-Chloroaniline	2022/09/22	61	30 - 130	87	30 - 130	<5.0	ug/L	NC	40		

N/A = Not Applicable

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

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

Leachate Blank: A blank matrix containing all reagents used in the leaching procedure. Used to determine any process contamination.

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

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

Surrogate: A pure or isotopically labeled compound whose behavior mirrors the analytes of interest. Used to evaluate extraction efficiency.

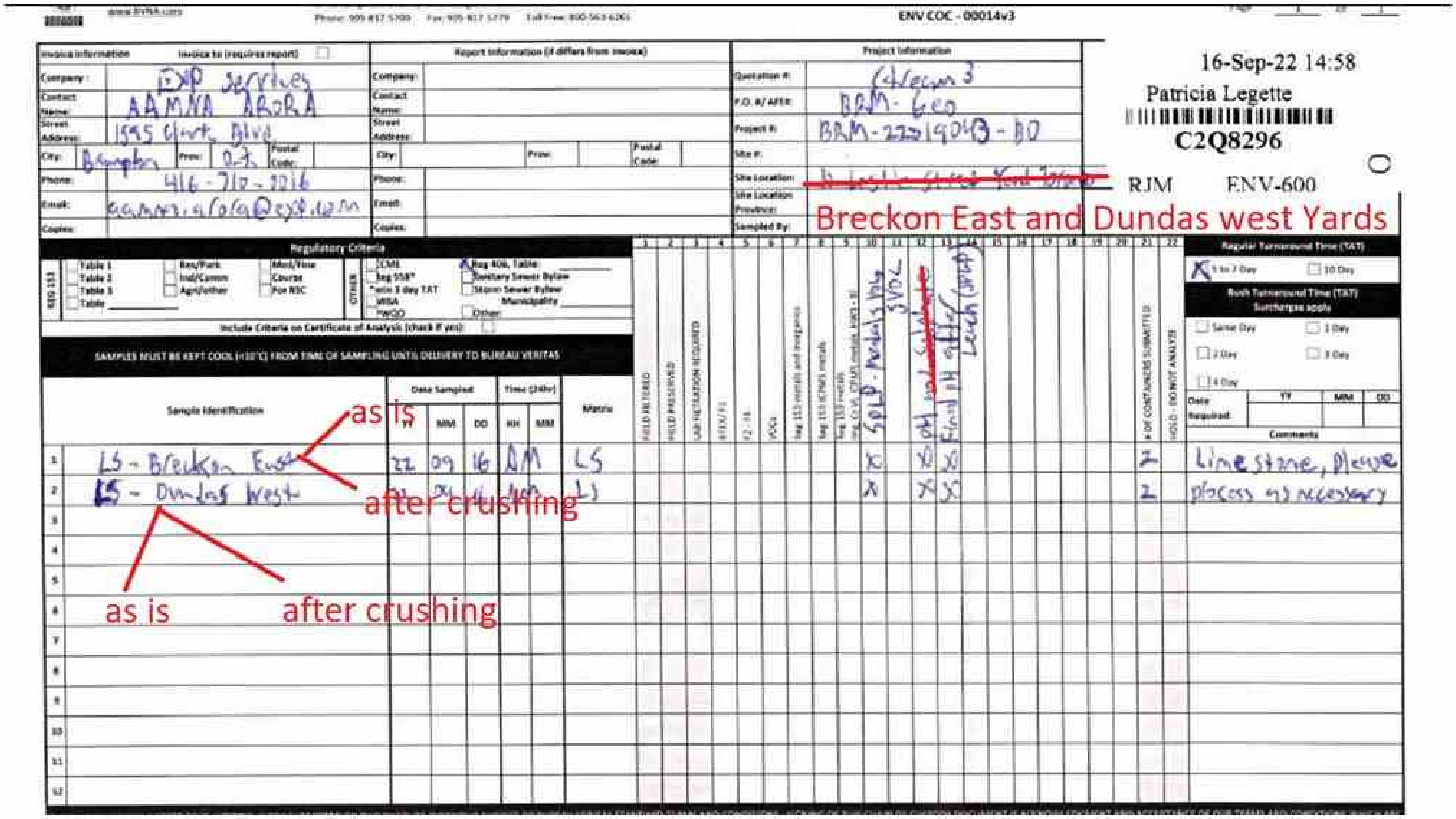
NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (absolute difference <= 2x RDL).

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by:

Cristina Carriere

Cristina Carriere, Senior Scientific Specialist



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ENV COC - 00014v3

Page 1 of 1

16-Sep-22 14:58

Patricia Legette

C2Q8296

RJM ENV-600

Invoice Information	Invoice to (requires report) ☐
Company:	EXP services
Contact Name:	AAMNA ARORA
Street Address:	1595 Clark Blvd
City:	Brampton
Prov:	ON
Postal Code:	
Phone:	416-710-2016
Email:	aamna.arora@exp.com
Copies:	

Report Information (if differs from invoice)	
Company:	
Contact Name:	
Street Address:	
City:	
Prov:	
Postal Code:	
Phone:	
Email:	
Copies:	

Project Information	
Quotation #:	C4 Brecon 3
P.O. #/ AFE#:	BRM - Geo
Project #:	BRM-22219043-B0
Site #:	
Site Location:	~~Breckon Street Yard Brampton~~
Site Location Province:	
Sampled By:	

Breckon East and Dundas west Yards

Regulatory Criteria

REG 153: ☐ Table 1 ☐ Table 2 ☐ Table 3 ☐ Table ____ ☐ Res/Park ☐ Ind/Comm ☐ Agri/other ☐ Med/Fine ☐ Course ☐ For RSC

OTHER: ☐ CCME ☐ Reg 558* *min 3 day TAT ☐ MISA ☐ PWQO ☒ Reg 406, Table ____ ☐ Sanitary Sewer Bylaw ☐ Storm Sewer Bylaw Municipality ____ ☐ Other ____

Include Criteria on Certificate of Analysis (check if yes): ☐

SAMPLES MUST BE KEPT COOL (<10°C) FROM TIME OF SAMPLING UNTIL DELIVERY TO BUREAU VERITAS

	Sample Identification	Date Sampled YY	MM	DD	Time (24hr) HH	MM	Matrix	1 FIELD FILTERED	2 FIELD PRESERVED	3 LAB FILTRATION REQUIRED	4 BTEX/F1	5 F2-F4	6 VOCs	7 Reg 153 metals and inorganics	8 Reg 153 ICPMS metals	9 Reg 153 metals (Hg, Cr VI, ICPMS metals, HWS - B)	10 SPLP - Metals/Vols	11 SVOC	12 ~~pH and Sulphate~~ pH	13 Final pH after Leach (SPLP)	14	15	16	17	18	19	20	21 # OF CONTAINERS SUBMITTED	22 HOLD - DO NOT ANALYZE	Comments
1	LS - Breckon East	22	09	16	AM		LS										X		X	X								2		Limestone, please
2	LS - Dundas West	″	″	″	AM		LS										X		X	X								2		process as necessary
3																														
4																														
5																														
6																														
7																														
8																														
9																														
10																														
11																														
12																														

as is

after crushing

as is

after crushing

Regular Turnaround Time (TAT)

☒ 5 to 7 Day ☐ 10 Day

Rush Turnaround Time (TAT) Surcharges apply

☐ Same Day ☐ 1 Day

☐ 2 Day ☐ 3 Day

☐ 4 Day

Date Required:	YY	MM	DD