



2011 UNACCOUNTED USED OIL STUDY FINAL REPORT

Prepared For:

**British Columbia Used Oil Management Association (BCUOMA)
Chilliwack, British Columbia**

**APRIL 2013
REF. NO. 049352 (8)**

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List of Conversions, Symbols and Acronyms

BC	British Columbia
BCUOMA	British Columbia Used Oil Management Association
BTU	British thermal unit
CIU	Consumed-in-Use
Collector	Registered Collector
CRA	Conestoga-Rovers & Associates
DIY	Do-It-Yourself
Generator	used oil materials generator
HDPE	High-density polyethylene
HW	Hazardous Waste
L	litres
Processor	Registered Processing Facility
RD	Regional District
Return Facility	Registered Return Collection Facility
Study	2011 Unaccounted Used Oil Study

1.0 INTRODUCTION

This 2011 Unaccounted Used Oil Study (Study) has been prepared by Conestoga-Rovers & Associates (CRA) on behalf of the British Columbia Used Oil Management Association (BCUOMA), to determine the different uses or disposal methods of used oil that was not collected and processed through BCUOMA's oil collection and recycling program in 2011 (thereby considered unaccounted).

An assumption that 30.1 percent of oil sold is consumed-in-use (CIU) and cannot be collected has been used based on a previous CIU study for British Columbia (BC) prepared for BCUOMA by Rob Spence (Consultant) (Spence, 2005). A ± 20 percent source of error (24.1 to 36.1 percent) has been applied to the CIU factor in order to account for the variation of the CIU factors for each use and type of oil which can range from 4 to 80 percent, resulting in a range for the unaccounted used oil portion.

The 2011 BCUOMA *Report to the Director* (BCUOMA, 2012) indicates that 93.50 million L of virgin oil had been sold in British Columbia (BC), and 47.88 million L of used oil had been recovered through the BCUOMA collection and recycling program in the 2011 calendar year. After subtracting the CIU portion of the sales and the recovered used oil, there remains an unaccounted portion of used oil. BCUOMA is aware of the major uses/disposal methods of unaccounted used oil; however the quantities associated with each are unknown and vary over time. The objective of this Study is to estimate the quantities associated with the major uses/disposal methods and provide a breakdown to account for the 17.47 million L of unaccounted used oil. The CIU source of error results in a range of unaccounted used oil from 11.87 to 23.09 million L which encompasses the variability in oil sales each year and the uncertainty associated with the CIU value and unaccounted quantities.

1.1 BACKGROUND AND SCOPE OF STUDY

The BCUOMA is a not-for-profit Society composed of 209 producer members in the province of BC, and is responsible for the operation of a province-wide collection and recycling program for used lubricating oil, oil filters and used oil containers sold through the producer members' retail and wholesale facilities, as mandated by the province.

The BCUOMA recycling program consists of a network of over 4,000 used oil material generators (Generators), of which almost 500 of them are Return Collection Facilities (Return Facilities) for the do-it-yourselfers (DIYs). The Generators consist mainly of

auto service and repair centers and industrial operations throughout BC. BCUOMA Registered Collectors (Collectors) regularly pick up the used oil materials from the Generators and deliver them to BCUOMA Registered Processing Facilities (Processors) in BC, Alberta (AB), and Washington State (WA).

This Study involved the analysis and quantification of unaccounted used oil in 2011 based on oil sales in the province and from the operation of BCUOMA's collection and recycling program. This unaccounted portion totals 17.47 million L and has been broken down into major categories for further analysis and quantification. A similar study was completed for BCUOMA's 2005 calendar year (Spence, 2006) which has been used as a resource for the 2011 Study.

For the purpose of this Study, it was assumed that the carryover of unaccounted used oil from year to year is equal or very close to equal, therefore the potential long term storage of unaccounted used oil was not considered. Quantifying the breakdown of unaccounted used oil is a challenging practice because of the variety of sources, categories and uses associated with it. As a result, a list of contacts was developed (and reviewed by BCUOMA) including companies and individuals associated with all aspects of oil production, use, collection, and recycling in order to determine and quantify the potential uses/disposal methods of the unaccounted oil.

The majority of used oil (greater than 36 million L) collected through the BCUOMA program is re-refined into new oil. Used oil recycled for re-refining purposes yields new consumer lubricating oil products that are shipped to retailers across the province. The remaining quantity of used oil that is collected ends up in pulp mills (1.00 million L), asphalt plants (greater than 7.50 million L), and other approved end uses (2.29 million L). (BCUOMA, 2012)

For oil filters, the processing process yields crushed paper and metal, and reclaimed oil. For oil containers, processing yields HDPE pellets and reclaimed oil. It is noted that the recovered oil from the collected oil filters and containers has been included in the total oil collected.

1.2 ORGANIZATION OF THE REPORT

This Report has been organized into the following sections:

- **Section 1.0 Introduction:** presents an introduction and background to the Study

- **Section 2.0 Methodology:** conveys how the study was performed and provides list of contacts
- **Section 3.0 Data Collection, Results, and Discussion:** presents the data collected for the Study provided by BCUOMA, Generators, Collectors, Return Facilities, Processors, and additional resources along with the results and discussion for each category
- **Section 4.0 Conclusions:** provides a summary of the performed Study and concluding statements

2.0 METHODOLOGY

After the initial meeting with BCUOMA, a contact list was developed and included a wide variety of companies and individuals. These contacts ranged from the oil producers themselves through to the consumers and finally the collectors and recyclers. Initially the contacts were broken down into major categories to ensure all end uses/disposal methods were considered and identified. A large number of contacts were generated for each category so that the received information could be quantified, compared, and reported with the greatest possible accuracy. The primary correspondence method with each of the contacts was a combination of telephone and e-mail. Each telephone conversation and e-mail correspondence was documented and can be provided if necessary. This Study has been divided into the following major categories:

- Used Oil Burners
 - Paving companies
 - Used oil furnaces, boilers, and air conditioners
- Pulp and Mill
- Mining
- Cement
- Landfill
 - Oil Filters and Containers
 - DIY Other
- Explosives Manufacturing
- Engine Oil Burn Systems
- Naval Vessels
- Catch-all Category

Supporting documentation and data was also obtained in the form of journal articles and historical data to aid in further justification and accuracy of the results.

Contacts that provided information for this Study were:

- **Oil Companies**
 - Imperial Oil
 - Petro-Canada Lubricants
 - Federated Cooperatives
 - McTar Petroleum Company Ltd. (contractor)

- **Collectors & Processors**
 - M&R Environmental
 - Newalta
 - Safety-Kleen (Clean Harbours)
 - Tri-Arrow Industrial Recovery Inc.
 - GFL Environmental
 - Merlin Plastics Supply
 - BC Hydro
 - Hetherington
 - Load Em Up Petroleums Ltd.
 - Tervita (including former Peninsula Wastewater Services)
 - North Arm Transportation

- **Pulp & Saw Mills**
 - Canfor Pulp & Paper Co.
 - West Fraser Mills Ltd.

- **Mining Industry**
 - None

- **Cement & Paving Companies**
 - Lafarge Canada Inc.
 - Lehigh Cement
 - Korpac Cement Products

- **Government**
 - **Regional Landfills**
 - Bulkley-Nechako
 - Cariboo
 - Central Kootenay
 - Columbia Shuswap
 - Fraser-Fort George
 - Kitimat-Stikine
 - North Okanagan
 - Northern Rockies
 - Squamish-Lillooet
 - Skeena-Queen

 - **Regional Ministry of Environment Offices**
 - Thompson

- Kootenay
- Omineca
- Okanagan

- **Used Oil Burner Manufacturers & Distributors**
 - Clean Burn
 - Babco Equipment

- **Explosives Manufacturers**
 - Orica Canada Inc.
 - Pashco Blasting Ltd.
 - Continental Explosives Ltd.
 - Maxam Bulk Services Inc.

- **Large Power Engines**
 - CAT
 - Synergy Engineering Ltd.

- **Vessels & Naval Uses**
 - B.C. Ferries
 - Silver King Marine Charters

- **Others**
 - Queen Charlotte Islands
 - BC Greenhouse Grower's Association
 - Ecowaste Industries Ltd.

3.0 DATA COLLECTION, RESULTS, AND DISCUSSION

A summary of the quantified unaccounted used oil in BC for each investigated category is presented in Table 1.

The total quantified amount of unaccounted used oil calculated in the Study is **19.94 million L**. This estimated amount corresponds with the BCUOMA reported oil sales and the recovered oil quantities as well as the CIU quantity. The 20 percent source of error on the CIU factor has an impact on all categories and estimate and therefore the specific CIU factor for the oil type and end use has been applied where possible to improve estimates in each category.

Where the consumption of used oil is associated with a specific practice or process as in explosives manufacturing and large diesel power engines the quantifiable amount of used oil consumed can be estimated. Many of the other categories of investigation require estimates based on conversations, historical data, and journal articles as mentioned in Section 2.0.

The results for each category of investigation are presented below with a further explanation of estimation methods and practices relating to each specific category.

3.1 USED OIL BURNERS

When used oil is burned in furnaces, boilers or air conditioners, it is typically generated on-site. Companies and individuals who burn used oil in this manner are also typically located in the northern area of the province and the Kootenays where the recycling of used oil is not as feasible or convenient. Paving industries are consumers of the majority of the used oil that is self-generated and even purchase contaminated oil from used oil processors like Newalta and M&R Environmental for heating asphalt. The total quantity of used oil estimated to be consumed by used oil burners and the paving industry is **6.56 million L**.

3.1.1 PAVING INDUSTRY

Formula Powell (FP) is a used oil collection company that is not registered through the BCUOMA program and services the northern parts of BC. FP is likely to supply a number of the northern paving companies with unaccounted used oil for the paving industry. These paving industries also likely consume all internally generated used oil

as well, as previously mentioned. Other processors and collectors are likely not to send their contaminated used oil to paving companies, but rather re-processors for other purposes. This practice has been confirmed by Newalta. Road oiling is no longer legal in BC and therefore this practice is likely not to take place as commonly as in the past; however, it has been confirmed that this still occurs to some extent in the northern part of the province.

A previous estimate of 1.8 million L (Spence, 2006) for this category was used as a starting point since information was not easily obtainable for this category. An estimated **1.44 million L** of unaccounted used oil for 2011 is represented by the paving industries and Formula Powell collection. A decrease of 20 percent from the previous 2005 estimate can potentially be attributed to regulations on road oiling for dust prevention and sale of contaminated oil to re-processors along with increased collection locations and focus on proper disposal and recycling practices.

3.1.2 USED OIL FURNACES, BOILERS, AND AIR CONDITIONERS

Through contact with the used oil furnace, boiler, and air conditioner retailers it was determined that the industrial, commercial, and residential markets for the purchase of these types of units have remained generally stable over the years. Higher sales were identified by some retailers in the northern parts of the province. One of the retailers, Clean Burn, identified their most common unit size is 250,000 BTU which consumes 2 gallons of oil per hour, and would operate for approximately 1,000 hours per year. An explosives manufacturing company burns all their used oil in a used oil furnace unless it is too contaminated; their furnace consumes about 300 L per week from October through March.

A collector in central BC sold just over 190,000 L (11%) of their collected used oil to individuals using used oil burning furnaces which is not accounted for through the BCUOMA program. The collector previously stopped selling to these individuals which eliminated the ability to purchase used oil legally for burning in central BC. These individuals then sought out the generators directly and began purchasing used oil directly from them. This eliminated any possibility of these unaccounted quantities from being recorded or quantified. The collector then began selling to these individuals again to prevent purchase from the generators and has kept record of all sales to used oil burners along with the amount claimed through the BCUOMA program. It should also be noted that the collector has identified that this market is growing each year with sales increasing to the individuals burning used oil. The sale of used oil to this type of market

without claim through the program is likely a more common practice than expected to prevent the purchase directly from generators elsewhere in the province.

Ratios of the number of units to the population were utilized to estimate the number of units currently in use in the province. The northern regions of the province were assigned a unit to population ratio of one unit per 1,000 people (1:1000), whereas the more southern regions were assigned a ratio of 1:3000; ratios were based on the 2005 study since markets have remained generally stable since then (Spence, 2006). The densely populated areas (Metro Vancouver, Fraser Valley, and Capital) were assigned a more conservative ratio of 1:25500 in the 2005 study and in this 2011 Study, as this type of heating is not likely to be as common in these areas as there is greater opportunity for used oil collection and more environmentally friendly heating methods available. All the unit sizes (BTUs) and consumption rates from the retailers were analyzed to create a breakdown of the total number of units and the amount of used oil consumed per year by size. With the information provided from retailers and current census population data ratios, the number of units estimated to be in use in BC is 922.

Provided in Table 2 is a breakdown of the distribution of the number of units for each size and the estimated annual consumption. The distribution of units has been adapted from the previous study (Spence, 2006) and information provided by retailers. An estimated total of **5.12 million L** of used oil was burned in used oil burners, furnaces, and air conditioners in 2011.

3.2 LANDFILL

Some Regional Districts (RDs) in BC do not have the services implemented to accept and recycle used oil directly at their landfills. All the RD landfills contacted redirect customers to local drop-off stations or back to the retailer for proper oil disposal. Annual household hazardous waste (HHW) round-ups are performed by some districts including ones that are more remote such as Columbia Shuswap and North Okanagan, during that time waste is stored on site until picked up by a collector or processor such as Newalta or CCS Hazco (Tervita).

Other RDs such as Fraser-Fort George and Thompson-Nicola accept and recycle containers and filters through the BCUOMA program. When the used oil is collected at landfills there is a high probability of contamination as it is all mixed together in collection containers/vessels. These RDs also accept 22.7 L bag-in-a-box oil bladder bags that are not routinely brought to landfills. The used oil typically contains small amounts of water and residual contaminants; all used oil is stored on-site in a waste oil

storage tank provided by BCUOMA. Northern Rockies RD also stores used oil on-site in 2,000 L tanks located in their shop.

It is to be noted that rags, motor oils, and absorbents can easily end up in landfills throughout the province inside bagged household garbage without the knowledge of waste management staff. Rural landfill locations in various RDs receive a number of 20 L containers which are not typically contaminated with water and are redirected to BCUOMA. Estimates of landfilled or received waste oils could not be provided by the RDs. Instead, waste audits and characterization studies have been used to estimate the amount of used oil.

Contact-provided and publicly available waste audits and characterization studies for the RD landfills have been utilized to estimate the total annual waste landfilled in the province. Used oil is classified as a hazardous waste (HW) in the province of BC and therefore the percentage of HW received at each landfill through these waste audits has been averaged for the province. It is assumed the landfilled HW totals about 1 percent of all waste landfilled, and within that 1 percent, an estimated 5 percent is used oil, based on waste audits and characterization studies specifying used oil quantities. These percentages were applied to the total tonnes of waste landfilled in BC for 2011 resulting in an estimated total of **1.95 million L** of unaccounted used oil.

This estimated value has decreased since the 2005 report (Spence, 2006), which may be attributed to the increased number of collection locations, diversion practices, and increased public education relating to used oil recycling and reuse. It is important to note here that the calculations for this category were completed using a slightly different estimation method than for the 2005 study as well.

3.2.1 USED OIL FILTERS AND CONTAINERS

Used oil filters and containers not collected by BCUOMA are assumed to be landfilled. Most landfills in the RDs do not accept and recycle used oil filters however, it is likely that filters can be found in mixed waste and are landfilled without RD knowledge. There are some landfills in the RDs that do accept used oil filters and containers and recycle them through the BCUOMA program. According to M&R Environmental, a 205 L drum retains 40-50 L of oil that can be extracted. However, CRA's previous Used Oil Filter Study (CRA, 2007) identified that average volume of free product recovered per drum was in the range of 10-20 L.

Based on the above quantities and CRA's previous Used Oil Container Study, it has been assumed that plastic containers retain 10 to 20 percent residual volume of oil after use. An average of 15 percent residual was applied to the mass of unaccounted containers. This has been adjusted from the assumption made in the 2010 Greenhouse Gas Savings and Environmental Impact Reductions Study (CRA, 2011) of 10 percent residual by weight to account for the information provided by processors and unaccounted containers that have not been properly drained and contain considerably more residual oil.

Ecowaste Industries estimated that less than 5 percent of the volume of oil in a filter remains in the filter after use. Published values for the unaccounted oil that is landfilled with filters are between 60 mL to 240 mL per filter. The assumption that 300 mL used oil remains within each filter was made to account for some of the filters that are not drained prior to disposal.

Based on the number of unaccounted filters and containers from BCUOMA, this category comprises approximately **0.30 million L** of unaccounted used oil, which is estimated to have been landfilled within the province in 2011.

3.2.2 DIY OTHER - RAGS AND ABSORBENT MATERIALS

This section encompasses the remainder of the used oil that is landfilled but is not within a container or oil filter. Rags and absorbent materials used to clean up oil spills would fall into this category along with DIYs who dispose of their oil improperly, ending up in a landfill. As described in the previous study (Spence, 2006) farmers and truck owners/operators would contribute to this section as well, especially in more rural areas where collection and recycling of used oil is not feasible or practical, resulting in landfill disposal. Convenience of disposal is another factor that would contribute a significant amount of unaccounted used oil to this category as through contact with the MOE, DIY oil changes are becoming more common. As a result more rural locations where this practice is assumed to take place would likely not have convenient drop-off or collection locations for DIYs to dispose of their used oil which would then end up in a landfill. DIYs are also not expected to be as diligent in preventing spills and recycling as commercial oil change locations. Approximately **1.65 million L** has been assumed for this category.

3.3 ENGINE OIL BURN SYSTEMS

Large power engines (greater than 2500 HP) typically within large ore haul trucks in mining sites around the province have engine oil burn systems. These engine oil burn systems allow for extended oil draining intervals which reduces downtime for the trucks. CAT mentioned that virgin oil is mixed with used oil in the equipment during top-ups. They recycle all used oil through Newalta (the Collector). These engine oil burn systems have been banned in the U.S. in diesel vehicles unless they have been certified against the emissions standards. The estimate from the previous study (Spence, 2006) of 600,000 L has been assumed to remain unchanged for 2011. As a result, it is estimated that **0.60 million L** of used oil is consumed by engine oil burn systems. This practice still takes place in the mines in BC and likely in other parts of the province where extended service intervals and used oil generation reduction is desired, as these types of systems can be retrofitted to diesel engines; including diesel trucks and stationary power generators.

3.4 PULP, MILL, LOGGING, AND CONSTRUCTION - USED OIL LUBRICANTS

Unfortunately, little information was obtainable for this sector. Lubricants like metal working oil and chain oil are not included in this study; however used oil can still be used as a lubricant. Two of the larger pulp and mill companies Canfor Pulp Ltd. And West Fraser were contacted during the Study, West Fraser has all of their used oil collected by Newalta or Load 'Em Up Petroleums Ltd. (Petro-Canada) depending on the location. Canfor uses natural gas in their kilns which would not typically be mixed with used oil during production and they also collect and recycle used motor, hydraulic, sawglide, and other oils through licensed firms. In the previous study it was identified that Canfor had a pilot project where internally generated oil was consumed at one of their pulp mills (Spence, 2006) however, this could not be confirmed and no current or further information is publicly available.

From the Consumed in Use Study completed by Rob Spence in 2005, it was estimated that 50 percent of the hydraulic oil and 25 percent of the heavy duty engine oil sales were to plywood mills, pulp and paper mills, logging, and construction companies. This breakdown was assumed to be representative of the 2011 year as well. After the CIU factor was applied to the 2011 sales for these two types of oil, 9.35 million L of used oil should be available for recycling. Using the same assumptions as in the 2005 study, 50 percent of used heavy duty engine oil and 75 percent of used hydraulic oil is used for

a variety of lubrication purposes in each of the industries (Spence, 2006), which is estimated at **6.10 million L** for 2011, compared to 3.1 million L for 2005.

The previous estimation of 200,000 L (Spence, 2006) contributed by the logging, construction, and other industries has been maintained.

The total estimated unaccountable used oil for this category is **6.30 million L**.

It is noted that this may be an over-estimate based on the increased collection practices and recycling focuses of companies like West Fraser as indicated above, however there is currently no accurate way to estimate this difference in practice. Also, it is noted that there is a significant difference in the value for this category compared to 2005.

3.5 CEMENT AND LIME KILNS

All of the companies contacted in this section recycle their used oil through Newalta, Safety-Kleen, Tri-Arrow, and other registered BCUOMA collectors. Each of the contacts used their purchased oil for similar purposes; in vehicles, equipment, gearboxes, forms, and production. There are many potential sources of unaccounted used oil; re-use for lubrication, contamination, and use for heating. It is estimated that not all recoverable oil is recycled by every company in the industry due to historical practices, collection convenience, and economic feasibility (use of used oil versus purchasing new oil). Based on the recycling practices of the companies contacted in this industry as compared to the results of the 2005 study where the majority of pulp mills with lime kilns burn their used oil, there has likely been a significant reduction in the amount of used oil that is consumed compared to the previous estimate of 600,000 L (Spence, 2006). Based on contact with Graymont, no used oil is combusted in their lime kiln. We have assumed a 20 percent reduction in the use of used oil in this category from the 2005 study for an estimated total of **0.48 million L**.

3.6 EXPLOSIVES MANUFACTURING

Few contacts were successful within this industry and the contacts able to provide information do not manufacture explosives themselves, but rather purchase them for use. One of the industries contacted maintained a used oil furnace during the colder months for heating, which has been previously included in the Used Oil Burners section above.

Previously the coal mines located in the Elk Valley region were producers of explosives. Assuming the Elk Valley mines are still purchasing 5.0 million L of oil each year, previously estimated values for the use of used oil in the production of explosives are likely to be similar as well. Therefore, **1.5 million L** of used oil is assumed to have been consumed by these mines for the production of explosives in 2011, which remains unchanged from the 2005 study.

One of the largest manufacturers of explosives in the province, Maxam Bulk Services, is diligent about the use and recycling of their oil. There are only four other relatively small explosive manufacturers in BC (Natural Resources Canada, 2012). The remainder of the province is therefore estimated to contribute **0.10 million L** to this industry which is a 50 percent reduction from the previous estimate of 200,000 L to account for expanded recycling practice and the limited number of explosives manufacturers throughout the province.

3.7 HAIDA GWAII (FORMERLY QUEEN CHARLOTTE ISLANDS)

Haida Gwaii returns minimal oil through the BCUOMA program. In 2011, 200,000 L of virgin oil was sold by Fast Fuel located in Queen Charlotte City on behalf of Imperial Oil. Based on this figure and the CIU factor, it is estimated that 140,000 L of oil was not returned. The regional landfill has an area set aside for waste oil to be stored inside an Intermodal Container in 171 L barrels including filters, oil rags, and absorbents. A separate contractor in Queen Charlotte has waste oil totes and an area for waste oil containers and filters. Stored oil is picked up from the landfill by local greenhouse operators and warehouse owners for use in oil burning furnaces. It was also reported that used oil is used in airport hangers for heating purposes as well.

The Islands recycle used oil only when the used oil is not clean enough to burn (i.e. greater than 35 percent water content or too contaminated). The Islands tried to utilize a BCUOMA-approved contractor for waste oil (above 35 percent) removal in 2009 but found this was a costly expenditure and have instead decided to handle the disposal of waste oil internally.

From the total collection in each zone of the province it is known that a very small portion of the oil that is sold to the Islands is sent back through the BCUOMA program, as only 410 L of used oil was recycled from Zone 11 in 2011. Another 3,600 L was accounted for and transported from the islands via North Arm Transportation. With the assumption that a total of 750,000 L is sold to the Islands (Spence, 2006), a very limited amount is recycled through BCUOMA, and the information obtained from the island

landfill (Skeena-Queens), the amount of unaccounted used oil consumed on Haida Gwaii was estimated at approximately **0.52 million L**.

3.8 NAVAL VESSELS

Most naval companies and vessels have become more diligent with proper disposal of used oil. There are a number of collection locations and companies involved in the collection of used oil which allows for a large portion of used oil from naval vessel to be accounted for. However, when the oil becomes contaminated with water (greater than 35 percent), the used oil processors can no longer claim this oil through the BCUOMA program. The majority of this water contaminated oil comes from the naval vessels and collection points along the coast. It was also reported by one of the contacts that used oil has been used to light fires. Silver King Marine Charters identified that naval operators have also become more conscious of the killer whale activity off the shores of BC and as a result there has been a more conscious effort to reduce the number of oil spills at sea.

Previously a total of 400,000 L (Spence, 2006) of unaccounted used oil was estimated through practices such as dumping at sea, burning on-board, and lubrication (fish and pleasure boats, Victoria harbor, BC ferries, cruise ships, coast guard, and navy). It has been assumed that the water-contaminated oil, oil burnt on-board, lubrication, and oil spills at sea account for an estimated **0.40 million L** of unaccounted used oil for 2011, with no change from 2005 values. It is noted the more accurate data is needed from Newalta and M&R Environmental to more accurately calculate the contaminated used oil collected with more than 35 percent water content.

Based on discussions with Peter Lehman the Senior Service Manager Marine with Tervita the majority of used oil collected at Tervita's Victoria marine facility is from Coast Guard, Navy and International vessels which do not participate in the BCUOMA program. In addition, Mr. Lehman indicated that used oil collected from international ships typically have high concentrations of vanadium (from bunker fuel) presenting a barrier to oil recycling.

3.9 TRANSFORMER AND INSULATING OIL

Used oil can also be used for purposes other than heating such as insulating and in high voltage transformers where the oil serves as lubricator and insulator for internal parts. BC Hydro uses all of their used oil for this purpose throughout the province. They purchased 1.5 million L of virgin oil in 2011 and with deduction of the CIU factor just

over 1 million L of used oil remains. Even oil which is contaminated with water is re-used, only a small percentage (less than 1 percent) that is contaminated with PCBs is sent to Newalta for processing. There is also the generation of a small portion of solid waste (less than 1 percent) which is collected by a separate contractor. After deduction of solid waste and PCB-contaminated oil, it is estimated the total amount of used oil used in transformers and other insulating purposes is **1.03 million L**.

3.10 CATCH ALL

This category encompasses used oil sources like the sewer, toilet, road oiling, weed control etc., which cannot be accounted for because those at fault are not willing to admit to disposing used oil inappropriately. This results in unsubstantiated estimates for this category. Separating used oil from water from municipal wastewater is typically performed using an additive. Therefore, the amount of used oil removed from the water is very difficult to estimate and justify. In order to acknowledge that this does occur, an estimate must be assigned to this category. An amount of **0.50 million L** is assigned to this category as it was for the 2005 study (Spence, 2006).

4.0 CONCLUSIONS

CRA completed an update to the unaccounted used oil study completed in 2006. The information for the study was collected through telephone and email with industrial used oil generators and used oil collectors. Generally the fraction of unaccounted oil is decreasing as industrial users recycle a greater amount of used oil.

Based on the information collected as part of this study, CRA concludes the following trends (Table 2):

- **Used Oil Burners** - The amount of used oil combusted in oil burners decreased, primarily due to an estimated decrease in the combustion of used oil in the paving industry.
- **Landfills** - Based on waste composition studies the amount of used oil landfilled has decreased as participation in used oil recycling programs has increased.
- **Engine Oil Burn Systems** - The amount of fuel estimated to have been used in engine oil burn systems has not changed.
- **Pulp, Mill, Logging, and Construction** - The amount of used oil consumed in the pulp, mill, logging and construction industry increased due to increases in activity in these sectors since the last study.
- **Cement and Lime Kilns** - Based on changes in industry practices, CRA estimated a 20 percent reduction of used oil in this category.
- **Explosives Manufacturing** - A small decrease was estimated in this category as one of the small explosives manufacturers noted a decrease in used oil as a feedstock. Information could not be collected on Elk Valley explosives manufacturing (majority of the category) and therefore the amount of used oil allocated to this category did not change.
- **Haida Gwaii** - The amount of used oil sold versus amount collected is low in Haida Gwaii. The unaccounted for used oil was estimated based on the difference between the sold and returned, corrected for consumed in use.
- **Naval Vessels** - The amount of unaccounted used oil remained unchanged as a large portion of waste oil collected is assumed to be water-contaminated.
- **Transformers and Insulating Oil** - The information on the amount of used oil was not included in the 2005 study. The estimated 1.03 million of used oil used for insulating purposes was based on discussions with BC Hydro.
- **N.E. Oil and Gas Patch** - Based on discussions with upstream oil and gas companies, used oil is no longer used as a fuel at upstream facilities. Therefore no unaccounted used oil was allocated to this category.
- **Catch All** - The amount of used oil allocated to this category remained unchanged as no additional information was gathered as part of this Study.

5.0 REFERENCES

BCUOMA, 2012. *Report to the Director. 2011 Calendar Year.* June 29, 2012.

<http://www.usedoilrecycling.com/resources/file/BC/2011ReportToDirectorJun30-12.pdf>

Conestoga-Rovers & Associates. (2011). *2010 Greenhouse Gas (GHG) Savings And Environmental Reductions Study.* Waterloo, ON : CRA.

Conestoga-Rovers & Associates. (2007). *Used Oil Filter Study.* Richmond, BC : CRA
Government of Australia. (2010, September). *Management of Diesel Oil Burn Systems.*
Retrieved November 2012, from Department of Sustainability, Environment, Water,
Population and Communities :

<http://www.environment.gov.au/atmosphere/fuelquality/publications/pubs/diesel-oil-burn-position-paper.pdf>

Natural Resources Canada. (2012, June 4). *Authorization for Explosives .* Retrieved
November 2012, from Natural Resources Canada:

<http://www2.nrcan-rncan.gc.ca/mms/lae-lea/index.cfm?fuseaction=p.sr&lang=eng>

Spence, Rob. *Consumed In Use Study: Draft Report.* August 2005. Prepared for the British Columbia Used Oil Management Association.

Spence, Rob. *Unaccounted Used Oil Study: Draft Report.* April 2006. Prepared for the British Columbia Used Oil Management Association.

TABLE 1
BREAKDOWN OF TOTAL UNACCOUNTED USED OIL BY CATEGORY
2011 UNACCOUNTED USED OIL STUDY
BCUOMA

Category	2011 Unaccounted Used Oil (million L)	Percentage of Total	2005 Unaccounted Used Oil (million L)	Percentage of Total	Percentage Change (from 2005 to 2011)	Change in Estimated Unaccounted Oil (from 2005 to 2011)
Used Oil Burners	6.56	32.9%	8.10	43.2%	-19%	Decrease ⁽¹⁾
Landfill	1.95	9.8%	2.55	13.6%	-24%	Decrease ⁽²⁾
Engine Oil Burn Systems	0.60	3.0%	0.60	3.2%	0%	No Change
Pulp, Mill, Logging and Construction	6.30	31.6%	2.40	12.8%	163%	Increase ⁽³⁾
Cement and Lime Kilns	0.48	2.4%	0.60	3.2%	-20%	Decrease ⁽⁴⁾
Explosives Manufacturing	1.60	8.0%	1.70	9.1%	-6%	Decrease ⁽⁵⁾
Haida Gwaii	0.52	2.6%	0.40	2.1%	30%	Increase
Naval Vessels	0.40	2.0%	0.40	2.1%	0%	No Change
Transformers and Insulating Oil	1.03	5.2%	-	-	-	<i>Not included in 2005</i>
N.E. Oil and Gas Patch	-	-	1.50	8.0%	-	<i>Not included in 2011</i>
Catch All	0.50	2.5%	0.50	2.7%	0%	No Change
TOTAL	19.94	100.0%	18.75	100.0%	6%	Overall Increase ⁽⁶⁾

Notes:

1. Assumed 20 percent reduction in the use of used oil in paving industry. Used oil burner consumption calculated based on population changes. Ratio of burners per capita similar to 2005 study.
2. Percent of oil in landfills calculated using different methodology than in 2005 study.
3. Increase in the sales of hydraulic oil and heavy engine oil affected the total unaccounted used oil in 2011 when compared to 2005 for this category. Method for estimating unaccounted used oil similar to 2005 Study by Spence.
4. Assumed reduction of 20 percent in the use of used oil for this category based on changes in industry.
5. No change in coal mine operations; 50 percent reduction assumed in the use of used oil in explosives manufacturing due to changes in practice.
6. Note that an overall increase in the amount of unaccounted used oil from 2005 to 2011 is not considered exact, as many of the values used in the 2011 study are estimates only.

TABLE 2
BREAKDOWN OF USED OIL BURNER UNITS AND CONSUMPTION
2011 UNACCOUNTED USED OIL STUDY
BCUOMA

Unit Size	Unit Breakdown*	Unit Percentage Breakdown of Total	Consumption per year per unit (L/unit)	Totals (million L)
500,000 BTU Unit	50	5.4%	13,300	0.67
300,000 BTU Unit	100	10.8%	8,600	0.86
250,000 BTU Unit	250	27.1%	6,100	1.53
150,000 BTU Unit	500	54.2%	4,100	2.05
Smaller Unit	22	2.4%	1,000	0.02
Total No. of Units	922		Total Used Oil Burned	5.12

*Assumed distribution of the total number of units, based on the 2006 Report and popularity of the 250,000 BTU unit