TECHNICAL MEMORANDUM

DATE August 28, 2015 **PROJECT No.** 1529718/6000/6001

TO Mr. Nando Tinti
Colacem Canada Inc.

CC Marc Bataille; Maxime Leduc; Francois Gervais

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GROUNDWATER SUPPLY REVIEW
PERMITTING AND SUPPORT FOR THE 3,000 TONNE PER DAY CEMENT PLANT
L'ORIGNAL, ONTARIO

Golder Associates Ltd. (Golder) has been retained to provide support to Colacem Canada Inc. (Colacem) in the permitting of a 3,000 tonne per day cement plant located in L'Orignal, Ontario. The location of the proposed cement plant is adjacent to an established quarry owned and operated by Colacem. The subject lands are currently farmed and have an area of approximately 56 hectares (138 acres), with available access to County Road 17.

This Technical Memorandum presents the results of the groundwater supply review which focused on the potential for quarry sump water to meet the water supply requirements of the proposed cement plant.

The water supply requirements for the proposed cement plant are understood to be about 22 cubic metres per hour (m^3/hr) (or about 81 Imperial gallons per minute (IGPM) based on an assumed 24 hours of taking per day), or approximately 550 m^3/day, and 180,000 m^3/year. Allowing for stoppages in cement production for maintenance and kiln fault, the average number of production days per year is approximately 320 days. It is understood that the potential sources of water to be considered at this time for the proposed cement plant are the quarry sump discharge water or quarry sump discharge water augmented with groundwater from a water supply well(s); a surface water supply is not being considered at this time.

Scope of Work

In order to evaluate the potential for using quarry sump water as a component of the water supply for the proposed cement plant, Golder reviewed the available quarry dewatering records provided by Colacem that included the volume of water pumped, the seasonality of this pumping, and water quality characteristics. In this regard, it is assumed that the water discharged off-site from the upper quarry sump represents the total potential available water supply for use in cement production. It is also assumed that the water discharged from the upper quarry sump is not being discharged off-site for the purpose of mitigating impacts (associated with quarry dewatering) to the receiving off-site water courses and that limiting discharge to these water courses, through the diversion of some water to the cement plant, would not inadvertently cause an adverse effect.

To evaluate the potential for groundwater to augment the water demand for the cement plant, a data review was undertaken of available water well information to further explore the target aquifers and their depths, likely yields and water quality characteristics. These available data include the information provided to Golder by Colacem,

Ministry of Environment and Climate Change (MOECC) water well records, and published geological reports and maps.

A complete list of the documents consulted in the preparation of this Technical Memorandum is provided below under the section entitled "*Data Sources Consulted*".

Data Review

Geological and Hydrogeological Setting

The quarry property is located within an area characterized by discontinuous deposits of glacial till over limestone bedrock (Bobcaygeon Formation). The narrow exposure of shallow bedrock near surface, where the proposed cement plant site is located, is flanked to the east and west by thick deposits of marine silt and clay which attain thicknesses up to about 60 metres. Based on available bedrock maps, the Bobcaygeon Formation is composed of interbedded calcarenite and sublithographic to fine crystalline limestone. The vertical thickness of the Bobcaygeon Formation in the area of the existing quarry property is not fully known and it is underlain at an unknown depth by the Gull River Formation (limestone and dolostone). Based on a hydrogeological investigation conducted by Morey Houle Chevrier Engineering Ltd. (1998), it was concluded that the bedrock underlying the quarry property has a relatively low horizontal hydraulic conductivity and the available groundwater within the Bobcaygeon Formation is mineralized and commonly has elevated concentrations of iron, fluoride, sodium, sulphate and chloride.

Existing Quarry Dewatering System

Quarry sump dewatering and off-site discharge is permitted at the site under the following instruments: Amended Permit to Take Water Number 3388-7K9PA7 (PTTW) issued on February 27, 2009 and Certificate of Approval (Industrial Sewage Work) NUMBER 2558-7DBNQA (C of A) issued on May 2, 2008.

The existing sewage works at the quarry consists of a lower quarry sump and an upper quarry sump each outfitted with a pump on a raft. The lower sump discharges into the upper sump which in turn discharges into a drainage ditch at ground surface on the quarry property. The discharge water then flows eastward in a ditch eventually flowing into the Charlesbois municipal drain.

The PTTW allows water taking from the quarry sumps (lower lift of quarry and upper quarry sump) for the purpose of quarry dewatering. Water pumped from the upper quarry sump can be taken at a rate of 4,400 Litres per minute for 24 hours a day for a daily total taking of 6,336,000 Litres. The PTTW also recognizes water taking from the "Ready Mix Sump" which is a separate sump used for the production of Ready-Mix concrete. The PTTW does not include a taking for the purpose of cement production and thus, if quarry sump water is to be used in the production of cement, an amendment to the existing PTTW would be required for any water volume diverted to the cement plant.

The C of A allows an off-site discharge from the upper sump at a rate of 4,400 litres per minute. It is possible that the C of A would require an amendment to allow for a split discharge of water off the quarry site however this would be evaluated at that time.

As with most quarry dewatering systems, peaks in off-site discharge of quarry sump water are typically associated with the spring melt, increased precipitation during the fall of the year and other rainfall events during which time the quarry dewatering system is used on an as-needed basis to adequately dewater the excavation to permit safe operation of the quarry. Conversely, the cement plant operation would need a consistent water supply throughout the year to satisfy operational needs.

Quarry Dewatering Records

The volume of water discharged off-site in 2012, 2013 and 2014, along with the monthly water quality analyses on the sump discharge water, are presented in the Colacem letters dated March 27, 2013, March 26, 2014 and March 13, 2015, respectively. Monthly samples of the sump discharge water (excluding December 2013 as the quarry dewatering system was not operated during the month of December 2013) were analyzed for nitrite, nitrate, total suspended solids, ammonia, phenols, total kjeldahl nitrogen, total phosphorus, oil and grease (mineral), oil and grease (non-mineral), pH, temperature and unionized ammonia as per the requirements of the C of A.

During 2012, 2013 and 2014, the pH in the discharge water ranged from 6.4 to 8.9 and no analytical parameter consistently exceeded their respective Provincial Water Quality Objective based on the available water quality data.

The total water discharged from the quarry site in the period from 2011 to 2014 based on both the MOECC Water Taking Reporting System (WTRS) database and a review of the available daily pumping records from the period from 2012 to 2014 (Note: daily pumping records are not available for 2011) are summarized in the following table:

Year	Total Water Discharged (m^3) (WTRS)	Total Water Discharged (m^3) (calculated from available daily records)
2011	266,594	-
2012	375,593	375,197
2013	272,062	272,366
2014	606,908	607,888

The table below summarizes the number of days per month discharging, total number of days per year discharging, maximum and average daily quarry discharge volumes for the period from 2012 through 2014.

Month	Pumping Days/month		
	2012	2013	2014
January	10	10	29
February	21	14	23
March	31	30	29
April	29	29	30
May	30	23	31
June	24	29	30
July	23	30	31
August	17	26	30
September	17	24	27
October	20	25	28
November	14	19	23

Month	Pumping Days/month		
	2012	2013	2014
December	13	0	25
Total Days	**249**	**259**	**336**
Maximum (m^3/day)	**4,320**	**5,772**	**5,735**
Average* (m^3/day)	**1,507**	**1,052**	**1,809**

Note: * Average volume discharged on a daily basis for days during which discharge occurred.

It is evident from the above tables that the total volume of quarry sump water discharged from the quarry site was similar in the years 2011 (266,594 cubic metres) and 2013 (272,062 cubic metres). During 2012, the total volume of quarry sump water discharged from the quarry site was slightly higher at 375,593 cubic metres and in 2014, the total volume of quarry sump water discharged from the quarry site was significantly higher at 606,908 cubic metres. The larger volume discharged in 2014 is reflected in the total number of days pumping in 2014 of 336 days as compared to 249 days in 2012 and 259 days in 2013. Figure 1 shows the number of quarry dewatering days per month for the period from 2012 to 2014.

With reference to Figure 1, the following comments are provided:

- With the exception of March, the total number of days discharging per month for the period from 2012 to 2014 was highest in 2014;
- For the period 2012 to 2014, the total number of days discharging per month for the months from March to July ranged from 23 days to 31 days;
- For the period 2012 to 2014, the total number of days discharging per month for the months from August to October ranged from 17 days to 30 days;
- For the period 2012 to 2014, the total number of days discharging per month for the months of February and November ranged from 14 days to 23 days; and
- For the period 2012 to 2013, the total number of days discharging per month for the months of January and December ranged from 0 days to 13 days, with a significant increase in the number of days discharging during these months in 2014 (29 days in January and 25 days in December).

Figure 2 illustrates the daily quarry dewatering volumes as compared to daily precipitation data from the Montebello (Sedbergh), Quebec weather station. In general, as would be expected, higher daily quarry discharge volumes are coincident with the spring melt and precipitation events. The increased daily quarry dewatering volumes and increased daily frequency of quarry dewatering in 2014 is evident on Figure 2.

Ministry Water Well Records

The MOECC Well Water Information System (WWIS) identifies six water well records located within 500 metres of the quarry site (with a UTM reliability code less than six). All of the wells are completed in bedrock and are used for domestic (5) or commercial (1) uses with the water quality being described as fresh (5) or containing sulphur (1). Information provided in the MOECC WWIS indicates the well yields at these locations vary between 9.1 L/min [2 Imperial gallons per minute (IGPM)] and 31.8 L/min (7 IGPM), with the average being 15.9 L/min

(3.5 IGPM). The total depth of the water supply wells were reported to be between 27.4 and 61.0 metres, with an average depth of 42.9 metres.

Local groundwater quality data/information is available from a number of documents that include the sampling of water supply wells in the vicinity of the subject property.

In the Morey Houle Chevrier Engineering Ltd. (1998) report, water quality analyses were presented for a local water supply well (Laplante well) and three separate monitoring well screens completed at various depths below ground surface in Test Well #1 for the operating quarry. The water quality in the Laplante well is characterized by elevated concentrations of fluoride [1.9 to 2.2 milligrams per Litre (mg/L)], sodium (269 - 278 mg/L) and chloride (261 – 263 mg/L). In the monitoring wells, the groundwater quality is characterized by elevated concentrations of iron (0.14 to 0.78 mg/L), sodium (201 to 375 mg/L), sulphate (58 to 597 mg/L), chloride (168 to 221 mg/L) and potassium (8 to 52 mg/L).

In the Morey Houle Chevrier Engineering Ltd. letter dated September 28, 2000 (Note: Golder has an incomplete copy of this document), the results of the sampling of ten (10) residential, farm and commercial wells in the vicinity of the operating quarry were presented. The water samples collected from the ten wells were analyzed for chloride, colour, conductivity, hardness, hydrogen sulphide, turbidity, iron, sodium, total coliform and *E. Coli*. The actual results of the water quality analyses were missing from the copy of this document provided to Golder. However, based on the review of the letter, local wells appear to have elevated levels of iron, colour, turbidity, hydrogen sulphide, sodium and chloride.

In the Houle Chevrier Engineering letter dated February 17, 2009, the results of an existing well survey are presented. The existing well survey included water supply wells within 250 metres of the quarry. The existing well survey included owners of twelve (12) drilled well but did not include water quality analyses for these wells. From a water quality perspective, the well owners were asked to comment verbally on the quality of their water supplies. Typical comments on the quality of the water supply were “contains sulphur and iron”.

Discussion

As stated above, the water supply requirements for the proposed cement plant is understood to be about 22 cubic metres per hour (m^3/hr) or approximately 550 m^3/day (based on an assumed 24 hours of taking per day and up to 320 days per year of cement production), and 180,000 m^3/year.

As can be seen on Figure 2, the daily quarry dewatering rates typically exceed the 550 m^3/day required for cement production, except for days when no dewatering is taking place. The periods of time when quarry dewatering does not take place for several consecutive days typically occurs in February and November. The reasons for the reduction in the frequency of quarry dewatering in February and November could be related to seasonal changes in the frequency of quarry operation, maintenance of the quarry dewatering system, low water levels in the sumps that do not require frequent dewatering, sub-freezing conditions, etc. It should be noted that there are also blocks of days in the summer months where pumping rates appear to be sustained at levels lower than 550 m^3/day required for the cement plant.

Figure 3 illustrates the total volume of quarry sump water discharged on a monthly basis from 2012 to 2014 along with the calculated amount of water required for cement production (i.e., 550 m^3/day x number of days in the month). From Figure 3, it is evident that the monthly amount of water required for cement production can typically be met by the volume of water available for off-site discharge from the quarry sump (based on the available 2012 to 2014 dewatering records). As shown on Figure 3, the monthly amount of water required for cement production was not met periodically during the months of January (2012 and 2013), February (2013),

March (2013), August (2012) and December (2013). For the period from December to March, the inability of the quarry dewatering system to meet the monthly amount of water required for cement production could be related to reduced operation of the quarry during the winter months which will vary year to year depending on the market demand, etc. From the available data, it is not possible to assess whether sufficient quarry sump water was available during this period of time for the purpose of cement production.

Given that this groundwater supply review is based on limited available data and the potential exists for extended periods of time without precipitation (which may not be reflected in the existing dewatering records), contingency measures could be considered with respect to ensuring an adequate and uninterrupted water supply for the cement plant is available. Though the quarry sump would be considered the primary source of water for the cement plant, one contingency measure that could be considered as a supplemental source of water to be used on an as needed basis, is a future groundwater supply provided from one or more drilled water supply wells. In general, the water supply from a well(s) would not be as sensitive (as compared to the quarry sump water supply) to seasonal variations in precipitation and associated problems related to water production under sub-freezing conditions. Based on the review of available water well records, it is expected that the yields from drilled wells on the property would likely be less than 10 Imperial gallons per minute (45.5 Litres per minute). However, given the nature of fractured rock, it is possible to drill a well that has a higher yield than is typically noted from the review of the MOECC water well records and other available documents. If such a contingency measure was considered, either at the present time or in the future, the MOECC will require these water takings from a drilled well(s) to be included on the PTTW for the site.

With respect to potential future quarry dewatering rates from the sump, it would be expected that the available volume of water in the quarry sump may increase over time as a result of an increase in the surface area of the quarry excavation as it expands since more precipitation would be captured in the quarry excavation. It would also be expected that the volume of water in the quarry sump would increase slightly as the quarry is deepened and expands to its lateral permitted limits, as a result of capturing more groundwater within the quarry excavation. As this occurs, it is possible that the volume of pumped water from the quarry sump would remain consistently above the 550 m^3/day of water required for the cement plant operation.

Data Sources Consulted

The following documents were provided to Golder for review:

- Permit to Take Water 0063-8EDMH6 issued on February 27, 2009;
- Certificate of Approval (Industrial Sewage Work) NUMBER 2558-7DBNQA issued on May 2, 2008;
- Ministry of the Environment letter (2007 Permit to Take Water Compliance Inspection) to Bertrand Construction L'Orignal Inc., dated July 26, 2007;
- Ministry of the Environment letter (2007 Industrial Sewage Works Compliance Inspection) to Bertrand Construction L'Orignal Inc., dated July 27, 2007;
- Ministry of the Environment letter (2007 Permit to Take Water Compliance Inspection) to Bertrand Construction L'Orignal Inc., dated August 9, 2007;
- Permits Control Sheet, revised June 2012;
- Houle Chevrier Engineering report 07-701, Existing Well Survey, Permit to Take Water, L'Orignal Quarry, February 2009;

- Summary table of groundwater levels, Carrières Ontario, 2009-2015;
- Houle Chevrier Engineering letter report, Quarry Water Discharge Investigation, L'Orignal Quarry, September 27, 2007;
- Colacem Canada letter report, Annual Reporting for L'Orignal Quarry #2558-7DBNQA, March 13, 2015;
- Colacem Canada letter (total suspended solids exceedence from March sampling) to the Ministry of the Environment, Cornwall Area Office, July 29, 2014;
- Colacem Canada letter report, Annual Reporting for L'Orignal Quarry #2558-7DBNQA, March 26, 2014;
- Colacem Canada letter report, Annual Reporting for L'Orignal Quarry #2558-7DBNQA, March 27, 2013;
- Morey Houle Chevrier Engineering Ltd., Hydrogeological Investigation, Proposed Deepening of L'Orignal Quarry, August 1998;
- Morey Houle Chevrier Engineering Ltd. letter report, Survey of Existing Wells, Proposed Deepening of L'Orignal Quarry, September 28, 2000;
- Houle Chevrier Engineering letter report, Description of Proposed Water Taking Operations, Permit to Take Water Application, August 26, 2008;
- Figure – Existing Features, Page 1 of 3, L'Orignal Quarry;
- Figure – Operational Plan, Page 2 of 3, L'Orignal Quarry;
- Figure – Progressive Rehabilitation & Final Rehabilitation Plans, Page 3 of 3, L'Orignal Quarry;
- Ministry of Environment and Climate Change, Water Taking reporting System, 2011 – 2014; and
- Figure M-100 – Township of Longueuil, Sheet Number 14 of 18.

Limitations

This technical memorandum was prepared for the exclusive use of Colacem Canada Inc. The technical memorandum, which specifically includes all tables and figures, is based on data and information provided to Golder Associates Ltd. by Colacem Canada Inc.

Golder Associates Ltd. has relied in good faith on all information provided and does not accept responsibility for any deficiency, misstatements, or inaccuracies contained in the reports as a result of omissions, misinterpretation, errors or omissions in the reviewed documentation.

The services performed, as described in this technical memorandum, were conducted in a manner consistent with that level of care and skill normally exercised by other members of the engineering and science professions currently practicing under similar conditions, subject to the time limits and financial and physical constraints applicable to the services.

Any use which a third party makes of this technical memorandum, or any reliance on, or decisions to be made based on it, are the responsibilities of such third parties. Golder Associates Ltd. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this technical memorandum.

The findings and conclusions of this report are valid only as of the date of this report. If new information is discovered in future work, Golder Associates Ltd. should be requested to re-evaluate the conclusions of this report, and to provide amendments as required.

Closure

If you have any questions, please contact the undersigned.

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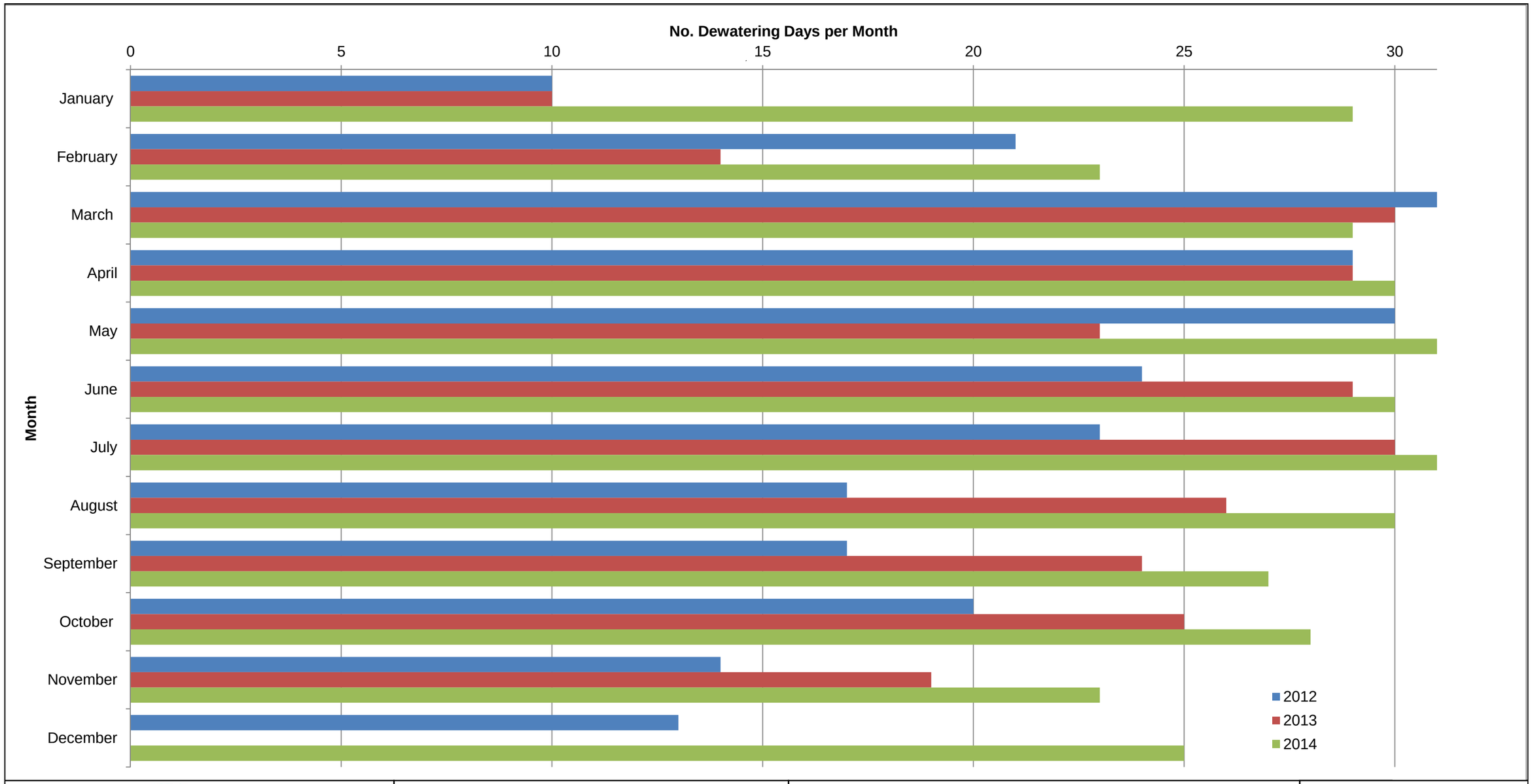
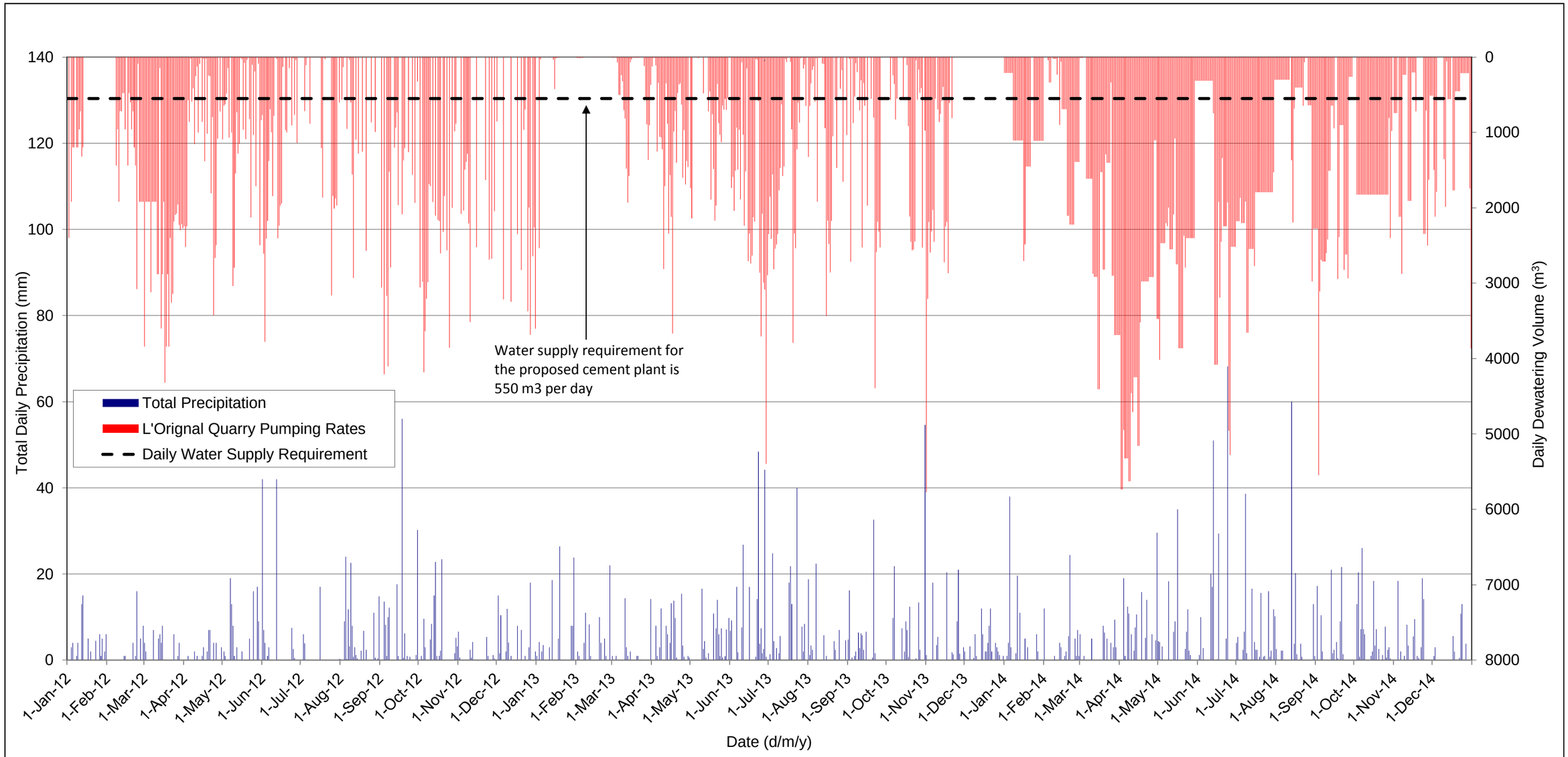
Attachments: Figure 1 – Number of Quarry Dewatering Days per Month (2012, 2013 and 2014)
Figure 2 – Daily Quarry Dewatering Volumes Compared to Daily Precipitation Data (2012, 2013 and 2014)
Figure 3 – Total Monthly Quarry Discharge Volumes (2012, 2013 and 2014)

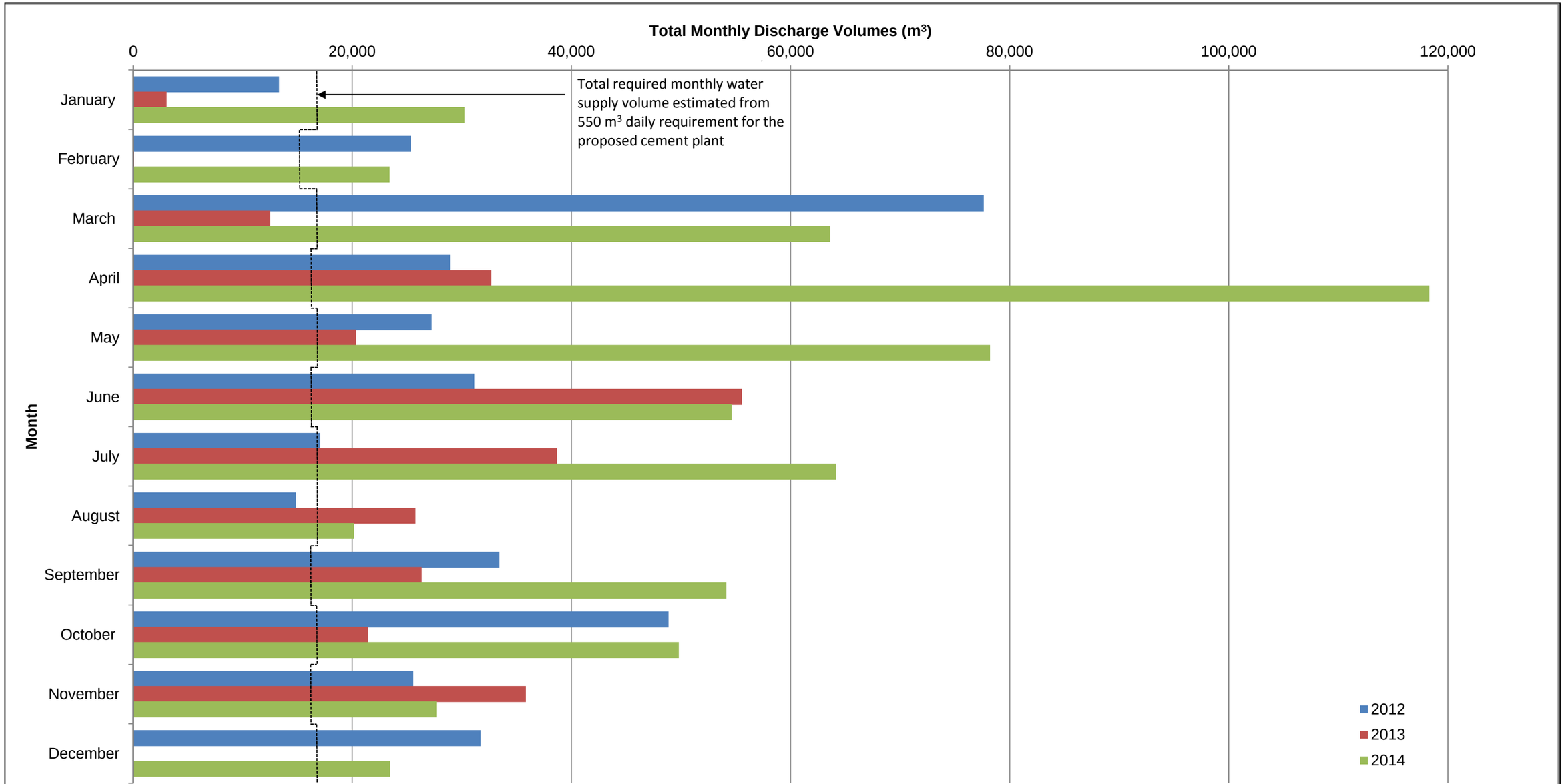


Golder Associates	Date: August 2015 Drawn: DH Project: 1529718/6000/6001 Chkd: KAM	Colacem Canada Inc. Number of Quarry Dewatering Days per Month (2012, 2013 and 2014)	FIGURE 1



Note: Daily precipitation data obtained from Environment Canada Montebello (Sedbergh), Quebec weather station

Golder Associates	Date: August 2015 Drawn: DH Project: 1529718/6000/6001 Chkd: KAM	Colacem Canada Inc. Daily Quarry Dewatering Volumes Compared to Daily Precipitation Data (2012, 2013 and 2014)	FIGURE 2



Golder Associates	Date: August 2015 Drawn: DH Project: 1529718/6000/6001 Chkd: KAM	Colacem Canada Inc. Total Monthly Quarry Discharge Volumes (2012, 2013 and 2014)	FIGURE 3